NBSIR 80-2111-5

Review and Refinement of ATC 3-06 Tentative Seismic Provisions

Joint Committee on Review and Refinement

Coordinating Committee

Technical Committee

- Committee 1: Seismic Risk Maps
- Committee 2: Structural Design
- Committee 3: Foundations
- Committee 4: Concrete
- Committee 5: Masonry
- Committee 6: Steel
- Committee 7: Wood
- Committee 8: Architectural, Mechanical and Electrical
- Committee 9: Regulatory Use

Report of Technical Committee 5: Masonry

This report documents the deliberations of a group of professionals jointly selected by the Building Seismic Safety Council and the National Bureau of Standards and is for use in modifying the Tentative Provisions for trial designs

...partment of Commerce
...Bureau of Standards
...Engineering Laboratory
...for Building Technology
...gton, D.C. 20234

October 1980

NBSIR 80-2111-5

REVIEW AND REFINEMENT OF ATC 3-06 TENTATIVE SEISMIC PROVISIONS

REPORT OF TECHNICAL COMMITTEE 5: MASONRY

Jerry G. Stockbridge, Co-Chairman, American Society of Civil Engineers
George Hanson, Co-Chairman, The Masonry Society
Edgar V. Leyendecker, Secretary, National Bureau of Standards
Louis E. Cattaneo, Secretary, National Bureau of Standards
Richard M. Gensert, American Concrete Institute
Alan H. Yorkdale, Brick Institute of America
Andrei Gerich, Interagency Committee on Seismic Safety in Construction
James E. Amrhein, Masonry Institute of America
Mark Hogan, National Concrete Masonry Association
Mario Catani, Portland Cement Association
Ed Johnson, Structural Engineers Association of California
Donald A. Wakefield, Western States Clay Products Assoc.
Melvyn Mark, Applied Technology Council
Ron Mayes, Applied Technology Council
Vincent Bush, Building Seismic Safety Council

Prepared for use by the:

BUILDING SEISMIC SAFETY COUNCIL

Sponsored by:

FEDERAL EMERGENCY MANAGEMENT AGENCY

Center for Building Technology
National Bureau of Standards
Washington, D.C. 20234

November 1980

U.S. DEPARTMENT OF COMMERCE, Phillip M. Klutznick, Secretary
Luther H. Hodges, Jr., Deputy Secretary
Jordan J. Baruch, Assistant Secretary for Productivity, Technology, and Innovation
NATIONAL BUREAU OF STANDARDS, Ernest Ambler, Director

Abstract

The TENTATIVE PROVISIONS FOR THE DEVELOPMENT OF SEISMIC REGULATIONS FOR BUILDINGS were developed by the Applied Technology Council to present, in one comprehensive document, the current state of knowledge pertaining to seismic engineering of buildings. The TENTATIVE PROVISIONS are in the process of being assessed by the building community. This report is one of a series of reports that documents the deliberations of a group of professionals jointly selected by the Building Seismic Safety Council and the National Bureau of Standards and charged with reviewing the TENTATIVE PROVISIONS prior to the conduct of trial designs. The report contains the recommendations and records of the committee charged with review of the masonry design provisions. The committee made 109 ballot recommendations for revisions to the TENTATIVE PROVISIONS. These recommendations were made to the parent group, the Joint Committee on Review and Refinement, and their action on these recommendations is documented in a companion report.

Key Words: Building; building codes; building design; earthquakes; engineering; masonry; standards; structural engineering

TABLE OF CONTENTS

1.0 INTRODUCTION

1.1 General

The Tentative Provisions for the Development of Seismic Regulations were developed by the Applied Technology Council (ATC) in an effort that included a wide range of experts in the actual drafting of the provisions. Two external review drafts were circulated to a large portion of the interested and informed community of eventual users. However, because the Tentative Provisions, were innovative, doubts about them existed. Consequently, an attempt was made to investigate these doubts and to improve the Tentative Provisions where possible before an expensive assessment of the Tentative Provisions was undertaken by conducting trial designs.

This review and refinement project was planned and conducted by the National Bureau of Standards with the advice and approval of the Building Seismic Safety Council, a private sector organization formed in 1979 for the purpose of enhancing public safety by providing a national forum to foster improved seismic safety provisions for use by the building community.

The assessment of the Tentative Provisions was performed using the committee structure shown in Figure 1. Nine Technical Committees were formed with interests that collectively cover the Tentative Provisions. The Joint Committee on Review and Refinement consists of all voting members of the Technical Committees. The chairmen of the Technical Committees form a Coordinating Committee.

Membership of each Technical Committee is made up of representatives of organizations that have particular interest in the Tentative Provisions; the participants are listed in the committee membership section of this report.

In addition to the voting members, each Technical Committee includes a non-voting member from each of the following organizations: The Applied Technology Council (ATC), the Building Seismic Safety Council (BSSC) and the National Bureau of Standards (NBS). The ATC representative served as a technical resource to the committee since he was closely involved with the development of the provisions of interest to the committee. The NBS representative was the technical secretary throughout the effort. The BSSC representative provided a link with the Building Seismic Safety Council, which will be involved in trial designs and evaluations.

1.2 Committee Summary

Technical Committee 5 had as its responsibility, the review and refinement of Chapters 12 and 12A of the Tentative Provisions for the Development of Seismic Regulations for Buildings. Committee membership (shown in Section 3.2) was drawn from professional organizations, standards development organizations, and industry. The committee held five formal meetings. The first meeting was held in Gaithersburg, Maryland, the second meeting was held in Arlington, Texas, the third meeting was held in Denver, Colorado, the fourth meeting was held in Chicago, Illinois, and the fifth meeting was held in Washington, D.C. Each of these meetings, as well as a Task Group meeting, is summarized below. Sections 1.3, 2.0 and 3.0 of this report contain committee minutes and documentation of committee actions.

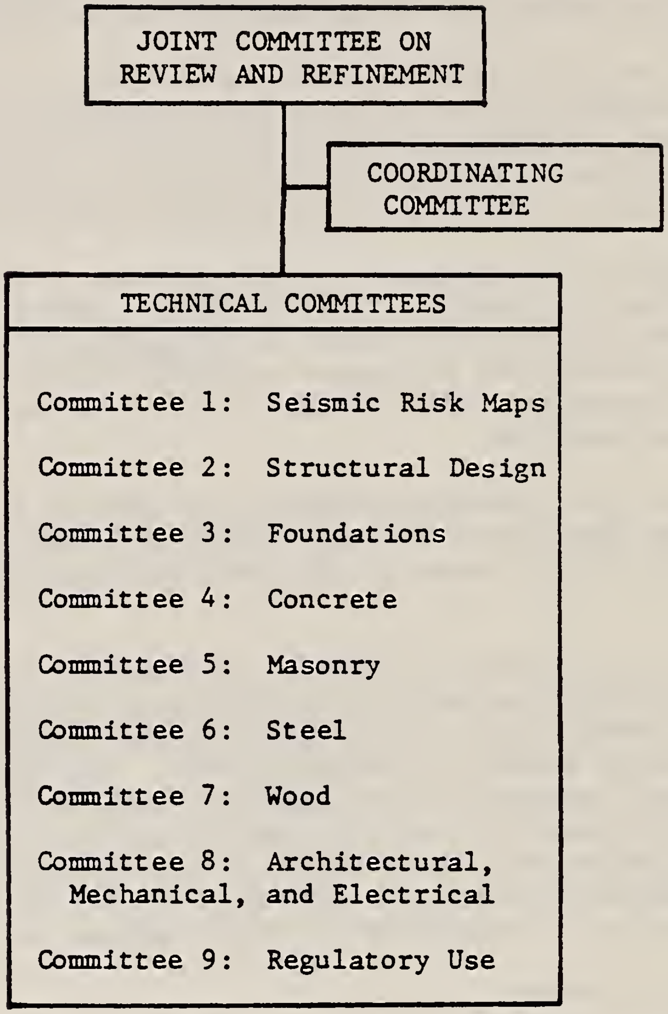


Figure 1: Committee Structure

The first meeting was a half-day meeting held on December 11, 1979, in Gaithersburg, Maryland. The committee selected Mr. George Hanson and Mr. Jerry Stockbridge to serve as Co-Chairmen. Mr. Alan Yorkdale was selected to serve as the representative to Technical Committee 2 - Structural Design. The committee discussed many general points at the December 11 meeting. Two points generally agreed upon by the committee were:

1. It is improper to use ultimate strength design for masonry at this time.
2. Chapter 12A is not an acceptable document for masonry design in nonseismic areas.

These were two major issues that needed to be resolved prior to reviewing the masonry chapters in the ATC 3-06 document. Because of this, a Task Group was established to meet and make recommendations at the next formal meeting of the full committee scheduled to be held in Arlington, Texas.

On January 4 the Task Group met in Northbrook, Illinois, to further study the points described in the December 11 meeting of Committee 5. The Task Group made the major decision that they would recommend reworking Chapters 12 and 12A even though that meant using the ultimate strength concept. Although the Task Group had reservations, they did agree to move in that direction. At the Task Group meeting, it was still agreed that Chapter 12A, as it existed, was not a workable document. The Task Group, however, was divided into two equal groups that each wanted to go their own direction. These two groups agreed to prepare proposals for the next full committee meeting.

On February 21 and 22, the committee met in Arlington, Texas. Two presentations were made to the committee with regard to Chapter 12A. One proposal involved modifying ACI 531 on masonry design so that it would include both clay and concrete products and substituting that for Chapter 12A. The second proposal was presented by a group that had carefully examined Chapter 12A and concluded that it was possible to modify it for use in trial designs. That group proved its point by presenting a detailed examination of Chapter 12A and the needed revisions. After much discussion, Committee 5 agreed unanimously to proceed with the proposal to modify Chapter 12A.

The committee next met in Denver, Colorado, on March 21 and 22. At this meeting Chapter 12A was finished and Chapter 12 was examined in some detail and prepared for ballot. At the conclusion of this meeting, both Chapters 12 and 12A were in the committee's hands for ballot. It should be noted at this point that the committee discussed all items in Chapters 12 and 12A at the Arlington, Texas, and Denver Colorado, meetings to determine changes that should be ballotted in written form. Thus, prior to written ballot, each item was voted on in a committee meeting. The next stage was to collect written ballots with written comments.

The next meeting of the committee was held in Chicago, Illinois, on May 16. The committee held an 18-hour session in Chicago and completed discussion and reballoting of all items of Chapter 12A. At that point, the ATC representative asked that the committee set aside its prior ballots on

Chapter 12 and give ATC the opportunity to prepare a new Chapter 12 which considered changes the committee had made in Chapter 12A. The committee agreed to do this and set the next meeting for Washington, D.C. to discuss the ATC proposals.

The committee next met in Washington, D.C. on June 5 and 6. Prior to taking up Chapter 12, the committee concluded its discussions of Chapter 12A by incorporating design guidelines for hollow clay masonry. The committee then took up the ATC proposal for Chapter 12. The committee went through, item by item, all proposals for Chapter 12 that were presented by the ATC representatives to the committee.

The ballot document enclosed in section 2 contains every item that was balloted by the committee and the resulting vote count. At the July 16 and 17 meeting of the full Joint Committee, a ballot was presented and discussed in limited detail by the committee and by the ATC representative. At that meeting, it was made clear by the attendees that the ballot document that had been put together grouped too many individual changes into each ballot item. The full Joint Committee indicated that it would prefer to ballot on a larger set of items, each with a small number of changes, so that the work of the committee could be considered in more detail. Committee 5 then held an ad hoc evening session on July 16 and an ad hoc session on July 17 and reported back to the Joint Committee that they could indeed provide the material requested. The enclosed ballot document is the result of the efforts of Committee 5 and the ATC representatives to prepare the requested material. Furthermore, summary sheets are enclosed which contain a committee statement and an ATC recommendation and statement on each ballot item as finally submitted to the full Joint Committee as a result of the July 16 and 17 meeting.

1.3 Chairman's Statement

Committee 5 was charged with reviewing Chapters 12 and 12A. Chapter 12A was included in the ATC report because no recognized standard for all masonry design exists. However, as written, Chapter 12A contained many seismic design provisions and was not up to date with the current state-of-the-art for the eastern and western parts of the United States. For this reason, Chapter 12A was extensively revised to act as a basic design document without seismic provisions. Furthermore, the chapter was modified both to be up to date and to be applicable for the entire U.S. Chapter 12 was then revised and restricted to contain modifications of Chapter 12A that were necessary to provide seismic control for design and construction of masonry. The ballot item numbers referred to below reference the items contained in section 2 on Committee Actions. A total of 81 ballot items were recommended on Chapter 12A and 28 ballot items were recommended on Chapter 12. In some instances these contain group changes; that is, more than one change to the document. Thus, the total number of changes exceeds the ballot items. Individual comments on the ballot items are contained in section 2. General comments are contained in this section. In general, ballot items 5A/1 - 5A/42 are changes made to provide compatibility within the document and to update references. The current ATC document covers only solid clay masonry. The Committee 5 recommendations for items 5A/43 - 5A/53 are intended to cover solid clay, concrete masonry, and hollow clay. This provides material that is not currently in the ATC document. Items 5A/54 - 5A/59 are changes made to provide compatibility within the document and to update material to the current state-of-the-art. Item 5A/60 is a major change in terminology but not in substance. It provides a definition for reinforced masonry and eliminates the reference to partially reinforced masonry with the allowance for the design of masonry using required reinforcement in place of minimum required reinforcement. Reference to partially reinforced masonry leaves the impression that this type of construction is not adequate. Restrictions on allowable stresses in accordance with those allowed unreinforced masonry applying in masonry not having a minimum amount of reinforcing as provided for fully reinforced masonry. Items 5A/61 - 5A/73 are for internal consistencies in the document and update of references. Item 5A/74 is a deletion on arbitrary minimum thicknesses. Items 5A/75 - 5A/81 are for internal consistency of the document.

Chapter 12 was modified to provide seismic design requirements for masonry. These requirements were intended to apply in addition to those of Chapter 12A. The chapter was worked closely with ATC and from a draft submitted to the committee by ATC which transferred applicable items from Chapter 12A to Chapter 12. Special design and construction procedures that are applicable to seismic provisions are contained in this chapter. Seismic performance categories in A, C and D remain basically the same as in the original document with some modifications to seismic performance category B.

Committee 5 made a large number of changes to the ATC Chapters 12 and 12A. These recommendations were made after careful consideration to provide a document that was useful in design of all types of masonry construction in all parts of the U.S. The committee recognizes that there may yet be some inconsistencies in the document due to the large amount of work in a short period of time. The committee further recognizes that all of the recommendations may not pass the balloting process. Because of this, it is recommended that the committee review the ballot items after completion of the process to be sure that the document is consistent. Further evaluation of consistency and workability of the document will be determined during the trial design phase.

2.0 Committee Actions

The following pages contain the recommended changes to the Tentative Provisions made by Committee 5. Recommendations for change in Chapter 12A are contained in Section 2.1, changes for Chapter 12 are contained in Section 2.2. Both sections contain a list of ballot items for the particular chapter, all of the changes made to the document annotated on a copy of the text of the chapter, and comments by the committee and each ballot item. All recommendations for change in the text, along with a committee ballot on each change are shown on the text pages. Each item of change is identified by a committee reference number that is used in the minutes in Section 3.1. Ballot results are in parenthesis with a sequence of yes - no - abstain being used. In some instances, individual changes are grouped to form a ballot item for use by the Joint Committee. These are identified as 5A/XX for Chapter 12A and 5/XX for Chapter 12.

2.1 Recommendations for Change in Chapter 12A

Recommended Ballot Items

Number	Short Title
5A/1	Clarify definitions
5A/2	Delete load-bearing definition
5A/3	New definitions
5A/4	Delete definitions
5A/5	Delete definitions
5A/6	Delete definition
5A/7	Delete definition
5A/8	Modify definition
5A/9	Reference documents
5A/10	Symbols
5A/11	Unit criteria and absorption
5A/12	Glass units
5A/13	Shrinkage
5A/14	Cement
5A/15	Lime, Mortar
5A/16	Grout consistancy
5A/17	Mixing
5A/18	Construction
5A/19	Joints
5A/20	Starter courses

Number	Short Title
5A/21	Contact surfaces
5A/22	Adjacent wythes
5A/23	Templates
5A/24	Tie placenent
5A/25	Unburned clay masonry
5A/26	Grouted masonry
5A/27	Toothing
5A/28	Misc. grouted masonry requirements
5A/29	Cleanouts
5A/30	Vertical barriers
5A/31	Reinforced construction
5A/32	Grout thickness
5A/33	Hollow unit
5A/34	Grout procedures
5A/35	Grouting
5A/36	Lifts
5A/37	Cleanout
5A/38	Partially reinforced masonry
5A/39	Glass Masonry
5A/40	Detailed requirements
5A/41	Dissimilar units
5A/42	Unreinforced masonry design

Items 5A/43 - 5A/53 contain material not in ATC 3-06. That document contained only procedures for solid clay masonry in section 12A.6.2. A "yes" ballot means take the text as shown since there is nothing comparable in ATC 3-06. A "no" ballot means accept the ATC recommended modification of the committee's material.

Number	Short Title
5A/43	Unreinforced solid clay brick masonry design procedures
5A/44	Unreinforced solid clay allowable stresses
5A/45	Unreinforced solid clay masonry design
5A/46	Unreinforced concrete masonry design procedures
5A/47	Unreinforced concrete masonry allowable stresses
5A/48	Unreinforced concrete masonry design
5A/49	Unreinforced hollow clay masonry design procedures
5A/50	Axial compressive stresses for walls
5A/51	Unreinforced hollow clay masonry design
5A/52	Shear wall stresses
5A/53	Unreinforced hollow clay masonry design
5A/54	Reinforced masonry
5A/55	Anchorage of reinforcement
5A/56	Other design requirements
5A/57	Reinforced masonry walls
5A/58	Axial wall stresses
5A/59	Nomenclature
5A/60	Shear stress allowables
5A/61	Placement
5A/62	Axial column stresses
5A/63	Other design requirements
5A/64	Hook requirements
5A/65	Anchorage requirements
5A/66	Wall shear
5A/67	Other construction

Number	Short Title
5A/68	Quality Control
5A/69	Clarification of quality control
5A/70	Seismic quality control
5A/71	Miscellaneous requirements
5A/72	Required strengths
5A/73	Core tests and tables
5A/74	Minimum thicknesses
5A/75	Title
5A/76	h/t ratios
5A/77	Tables
5A/78	Stresses
5A/79	Stresses
5A/80	Footnote
5A/81	Footnote

CHAPTER 12A

MASONRY CONSTRUCTION

Sec. 12A.1 GENERAL

This Chapter applies to new masonry construction of a structural and nonstructural nature. It is included because a nationally applicable seismic design standard is not available. Except as portions of it may be incorporated by reference, it does not apply to the repair or rehabilitation of existing masonry nor to the construction of masonry veneers. See Chapters 13 and 14 for repair and Chapter 8 for veneers.

12A.1.1 DEFINITIONS

The following definitions and those of Chapter 2 provide the meaning of terms used in this Chapter.

AREA, GROSS CROSS-SECTIONAL. The total area face-to-face of masonry including cells or cavities of a section perpendicular to the direction of loading. Re-entrant spaces are excluded in the gross area unless these spaces are to be occupied by masonry by portions of adjacent units.

1 (10-0-0) AREA, NET. The gross cross-sectional area at any plane minus the area of ungrouted cores, notches, cells, etc. Net area is the actual surface area of a cross-section.

AREA, NET BEDDED. The actual area of masonry units that bear on the mortar bed with deductions for rakes and similar joint treatments. In grouted construction the continuous vertical filled grout cores or grout spaces are included.

AREA, NET CROSS-SECTIONAL OF HOLLOW UNIT. The gross cross-sectional area of a section minus the average area of ungrouted cores or celluar and other spaces.

AREA, NET VERTICAL SHEAR. The minimum gross cross-sectional area at any vertical plane of hollow units less their ungrouted cores or the mortar contact areas at head joints, whichever is less.

5A/1 BOND, RUNNING. When in a wythe, at least 75 percent of the units in any transverse vertical plane lap the ends of the units above and below a distance not less than 1.5 inch or one-half the height of the units, whichever is greater; the wythe, for the purpose of this document, shall be considered to be laid in running bond. (Note that for the purpose of this definition center bond or half bond is not necessarily required to obtain running bond.) Where corners and wall intersections are constructed in a similar fashion, they shall be considered to be laid in running bond.

BOND, STACKED. All conditions of head joints not qualifying as running bond and all continuous vertical joints (excepting true joints such as expansion and contraction joints) shall be considered to be stacked bond construction.

DIMENSIONS. Overall dimensions given for masonry units and walls are nominal; actual dimensions of unit masonry may not be decreased by more than 1/2 inch from the nominal dimension. Dimensions of grout spaces, clearances and cover given are actual.

EFFECTIVE ECCENTRICITY. The actual eccentricity of the applied vertical load including that caused by member deflections and thermal or other movements of connected members plus the additional eccentricity which would produce a moment equal in magnitude to that produced by the lateral loads.

2 (10-0-0) GROUTED MASONRY. Masonry composed of hollow units in which designated cells are solidly filled with grout or masonry of two or more wythes in which the cavities between wythes are solidly filled with grout.

JOINT, BED. The horizontal layer of mortar on or in which a masonry unit is laid.

12A.1.1 Cont.

3 (10-0 0) ~~JOINT, COLLAR. The interior longitudinal vertical joint in a wall between wythes. In grouted masonry construction, it is the grout space.~~

5A/1 cont. JOINT, COLLAR. The vertical space separating a wythe of masonry from another wythe or from another continuous material and filled with mortar or grout.

JOINT, HEAD. The vertical mortar joint between ends of masonry units.

JOINT, SHOVED. Produced by placing a masonry unit on a mortar bed and then immediately shoving it a fraction of an inch horizontally against the mortar in the head joints to effect solid, tight joints.

5A/2 4 (10-0-0) ~~LOAD BEARING. Synonymous with Structural.~~

MASONRY. An assemblage of masonry units bonded together with mortar or grout.

5A/3 5 (8-2-0)

(A) MASONRY, REINFORCED. Masonry in which reinforcement is used to resist forces as well as the purpose of crack control.

(B) MASONRY, UNREINFORCED. Masonry in which reinforcement is used only for the purpose of crack control.

5A/4 ~~MASONRY, GROUTED. Construction conforming to Sec. 12A.3.5 is most often referred to as grouted brick construction.~~

MASONRY UNIT. Any brick, tile, stone, or block conforming to the requirements specified in this Chapter.

5A/5 6 (10-0-0) ~~NONBEARING. This term refers to a nonload-bearing component, usually a wall.~~

7 (10-0-0) ~~NONLOAD BEARING. Synonymous with Nonstructural.~~

NONSTRUCTURAL. This term refers to components or systems which do not serve in providing resistance to loads or forces other than induced by their own weight. Walls that enclose a building or structure's interior are structrual components.

5A/6 8 (9-0-1) ~~PARTIALLY REINFORCED MASONRY. Masonry construction conforming to Sec. 12A.3.7 and other applicable provisions of this Chapter.~~

5A/7 9 (8-2-0) ~~REINFORCED MASONRY. Grouted masonry construction conforming to Sec. 12A.3.5(C) or Hollow Unit Masonry conforming to Sec. 12A.3.6(A). Reinforced masonry shall also conform to other applicable provisions of this Chapter, including Sec. 12A.2.2, 12A.2.4, 12A.6.3 and 12A.6.4.~~

REINFORCEMENT RATIO. This is the ratio of the areas of reinforcement to the gross cross-sectional area of the masonry perpendicular to the reinforcement.

5A/8 10 (10-0-0) SHEAR WALL is a vertical component resisting lateral forces by in-plane shear and flexure. ~~(unless defined elsewhere).~~

STRUCTURAL. This term refers to a system or component which serves in providing resistance to loads or forces other than induced by the weight of the element itself. All portions of the seismic resisting system are structural, but not all structural components need be part of the seismic resisting system. Bracing components, bracing systems, and walls that enclose a building or structure's exterior are structural elements.

12A.1.2 REFERENCE DOCUMENTS

5A/9 The following standards apply to masonry materials and to the testing thereof:

12A.1.1 Cont.

11 (10-0-0)

Testing

MATERIALS AND ~~DESIGN~~	STANDARD DESIGNATION
Building and Facing Brick	
Clay and Shale	ASTM C62, C216, C652*
Sand-Lime	ASTM C73
Method of Test	ASTM C67
Concrete Masonry Units	
Hollow Load-Bearing	ASTM C90
Solid Load-Bearing	ASTM C145
Hollow Nonload-Bearing	ASTM C129
Brick	ASTM C55
Method of Test	ASTM C140
Structual Clay Tile	
For Walls - Load-Bearing	ASTM C34, C212 ,C126
For Walls - Nonbearing	ASTM C56
For Floors	ASTM C57
Cast Stone	ACI 704
Unburned Clay	Uniform Building Code Standard 24-~~15~~ 14
Reinforcement	
Reinforcing Steel	ASTM A615, A616, A617 and A706
Masonry Joint Reinforcement	ASTM A82
Welding	AWS D12.1
Cement	
Blended Hydraulic Cement	ASTM C595
Portland Cement and Air-Entraining Portland Cement	ASTM C150
Masonry Cement	ASTM C91
Lime	
Quicklime	ASTM C5
Hydrated Lime for Masonry Purposes	ASTM C207
Processed Pulverized Quicklime	ASTM C51
Mortar	
Other than Gypsum	ASTM C270
Aggregates for Mortar	ASTM C144
Field Tests for Mortar	Sec. 12A.8.2
Grout	
Aggregates for Grout	ASTM C404
Field Tests for Grout	Sec. 12A.8.2

12 (9-0-1)

13 (9-0-1)

5A/9 cont.

*And Western States Clay Products Standard Specifications for Hollow Brick.

12A.1.2 Cont.

5A/9 cont. 14 (8-0-2)

~~Testing~~

- Masonry Assemblies, ~~Cores, Mortar and Grout~~ — Sec. 12A.7 & 12A.8
- ~~Slump Test for Grout~~ — ~~Sec. 12A.8.2~~
- ~~Rate of Absorption~~ — ~~ASTM C67-73~~

12A.1.3 SYMBOLS

The symbols used in this Chapter are defined as follows:

a = Angle between inclined web bars and axis of the beam.

A_g = Gross cross-sectional area, square inches.

5A/10 15 (9-0-1)

A_s = Effective cross-sectional area of reinforcement in a column or flexural member.

A_v = Total area of web reinforcement in tension within a distance of s, or the total area of all bars bent up in any one plane, square inches.

b = Effective width of rectangular section or stem of I- or T-sections, inches.

C_e = Eccentricity coefficient.

C_s = Slenderness coefficient.

d = Effective depth from compression face of beam or slab to centroid of longitudinal tensile reinforcement, inches.

d_b = Reinforcement diameter, inches.

e = Effective eccentricity, inches.

e_i = Effective eccentricity about the principal axis which is normal to the length of the element.

e_1 = Smaller effective eccentricity at lateral support at ends of member (at either top or bottom), inches.

e_2 = Larger effective eccentricity at lateral support at ends of member (at either top or bottom), inches.

e_t = Effective eccentricity about the principal axis which is normal to the thickness of the element.

E_m = Modulus of elasticity of masonry in compression, psi.

E_s = Modulus of elasticity of steel in tension or compression, psi.

f_g = Masonry strength for development length or splice determination, psi. (See Sec. 12A.6.3(D))

f_m = Allowable compressive unit stress, psi.

f'_m = Compressive strength of masonry, psi.

f'_{mb} = Brick masonry design strength, psi.

12A.1.3 Cont.

f_t = Allowable flexural tensile stress in masonry, psi.

f_v = Allowable unit stress in web reinforcement, psi.

16 (9-0-1)

h = Effective height, the height or length of a column or wall used for purposes of determining slenderness effects.

i = Effective length of rectangular wall element or column.

j = Ratio of distance between centriod of compression and centroid of tension to the depth d.

l_a = A dimension determined in accordance with Sec. 12A.6.3(D), inches.

l_d = Development length, inches.

M_c = Minimum allowable moment capacity, inch-pounds.

5A/10 cont.

n = Ratio of modulus of elasticity of steel to that of masonry.

$$n = \frac{E_s}{E_m}$$

17 (9-0-1)

p = A_s/bd, Ratio of the area of reinforcement to the area (bd).

P = Allowable vertical load, pounds.

r = Radius of gyration, inches.

R_e = Eccentricity ratio for elements subject to bending about both principal axes.

s = Spacing of stirrups or of bent bars in a direction parallel to that of the main reinforcement, inches.

t = Effective thickness, inches.

v = Shearing unit stress, psi.

v_m = Allowable unit shearing stress in the masonry, psi.

V = Total shear, pounds.

β_b = A ratio as determined by Sec. 12A.6.3(D)1.

12A.1.4 CRITERIA FOR MASONRY UNITS

Masonry units shall be of a type, quality, and grade consistent with the applicable provisions and intent of the referenced documents considering:

The intended usage such as structural or nonstructural.

5A/11

The surrounding environment such as severe frost action in presence of water, contact with the ground, exposure to the weather and/or enclosure within a building.

Type, quality, grade, and any similar additional special requirements of this Chapter or Chapter 12 for masonry units, all as applicable, shall be indicated on the design documents.

12A.1 Cont.

12A.1.5 INITIAL RATE OF ABSORPTION

At the time of laying, burned clay units and sand-lime units shall have a rate of absorption not exceeding 0.025 ounce per square inch during a period of one minute. Test procedures shall be in accordance with ASTM C67-73. In the absorption test the surface of the unit shall be held 1/8 inch below the surface of the water. Water content shall be that of the units to be laid, i.e., the units shall not be dried.

5A/11 cont. 18 (9-0-1)

12A.1.6 ~~BRICK~~ MASONRY UNIT SURFACES FOR GROUTED MASONRY

~~Masonry~~ units for ~~reinforced and unreinforced~~ grouted masonry shall have all surfaces to which grout is to be applied capable of adhering to grout with sufficient tenacity to resist ~~a~~ the required shearing stress~~. of 100 psi after curing 28 days~~. Tests, when required, shall conform to Sec. 12A.7 and 12A.8.3.

12A.1.7 RE-USE OF MASONRY UNITS

Masonry units may be re-used when clean, whole, and in conformance with the requirements of this Chapter and those of the applicable reference documents. Conformance must be established by tests of representative samples.

12A.1.8 CAST STONE

Every cast stone unit more than 18 inches in any dimension shall conform to the requirements for concrete in Chapter 11.

12A.1.9 NATURAL STONE

Natural stone shall be sound, clean, and in conformity with other provisions of this Chapter

5A/12 19 (9-0-1)

12A.1.10 GLASS BUILDING UNITS

Glass block shall have unglazed or satisfactorily treated surfaces to allow adhesion on all mortared faces. Units shall be constructed so that a minimum panel thickness of ~~3.5~~ 3.0 inches can be obtained at the mortar joints.

12A.1.11 GLAZED AND PREFACED UNITS

Glazed and prefaced units shall conform to the physical criteria for unglazed and unfaced units required by this Chapter and Chapter 12 in addition to any special requirements desired for the exposed finish. Surfaces receiving mortar and surfaces to be grouted shall be unglazed.

12A.1.12 WATER

Water used in mortar, grout, or masonry work shall be clean and free from injurious amounts of oil, acid, alkali, organic matter, or other harmful substances.

5A/13 20 (9-0-1)

~~12A.1.13 SHRINKAGE OF CONCRETE UNITS~~

~~Concrete masonry units used for structural purposes shall have a maximum linear shrinkage of 0.065 percent from the saturated to the oven-dry condition.~~

12A.1 Cont.

21 (5-3-2)

12A.1.14 CEMENT

Cements for mortar are limited to those allowed by ASTM ~~C270~~ C476, this Chapter and Chapter 12 except masonry cement shall not be used for grout.

22 (9-0-1)

5A/14

~~EXCEPTION:~~
~~Approved types of plasticizing agents may be added to portland cement Type I or Type II in the manufacturing process, but not in excess of 12 percent of the total volume. Plastic or waterproofed cements so manufactured shall meet the requirements for portland cement except in respect to the limitations on insoluble residue, air-entrainment, and additions subsequent to calcination.~~

~~Cements for grout shall be Type I, IA, II, IIA, III, IIIA, or V portland cement, or Type 1S, 1S-A, 1S (MS), 1S-A (MS), 1P, or 1P-A blended hydraulic cement.~~

23 (9-0-1)

12A.1.15 LIME

~~Lime putty shall be made from quicklime or hydrated lime. If made from other than processed pulverized quicklime, the lime shall be slaked and then screened through a No. 16 mesh sieve. After slaking and screening, and before using, it shall be stored and protected for not less than 10 days.~~
Lime for mortar and grout is limited to those allowed by ASTM C207
~~Processed pulverized quicklime shall be slaked for not less than 48 hours and shall be cool when used.~~

12A.1.16 MORTAR

Mortar shall be prepared in accordance with either ~~of~~ the property or proportions procedures given ~~below:~~ in ASTM C270.

5A/15

- ~~The Property Specifications of ASTM C270 may be used with acceptability based upon the properties of both the ingredients and samples of mortar mixed and tested in the laboratory using the proportions and materials proposed for use. Compressive strengths shall not be less than required by Table 12A-1A.~~

24 (10-0-0)

- ~~The Proportion Specifications of ASTM C270 may be used with acceptability based upon the properties of the ingredients, the water retention of laboratory mixed and tested samples, and the proportions of the ingredients summarized in Table 12A-1B.~~

Where mortar colors are used or where minimum compressive strengths are required for mortar used in the work, only the Property Specifications shall be used. Field tests shall conform to Sec. 12A.7 and 12A.8.2.

Where the source or the proportions of ingredients for mortar, classified in accordance with the Property Specifications, are intended to be changed during the course of the work, acceptability of the new mortar shall be reestablished in accordance with ASTM C270.

ASTM C270 Types O and K mortar shall not be used.

~~Masonry units used in foundation walls and footings shall be laid up in Type S or Type M mortar. See Sec. 12A.2 and Chapter 12 for further limitations.~~

12A.1.16 Cont.

Admixtures shall be added only after approval by the Regulatory Agency. Coloring ingredients shall be limited to inert mineral or inorganic synthetic compounds not exceeding 15 percent of the weight of cement or carbon black not exceeding 3 percent of the weight of cement.

25 (10-0-0) To maintain plasticity, mortar may be retempered with water by the method of forming a basin in the mortar and reworking it. However, any mortar which has ~~become harsh shall not be used in the work.~~ hardened or stiffened due to hydration of the cement shall not be used.

12A.1.17 GROUT

(A) PROPORTIONING. Grout shall be proportioned by volume and shall have sufficient water added to produce consistency for pouring without segregation. Aggregates shall conform to ASTM C404 except that larger size coarse aggregate may be used in large grout spaces where approved by the Regulatory Agency.

5A/15 cont.

EXCEPTION:
Grout may be proportioned by weight when weight-volume relationships are established and periodically verified.

(B) TYPE. The requirements for coarse and fine grout shall be as follows:

26 (9-0-1) 1. Fine Grout. Fine grout shall be composed, by volume, of one part cement, to which may be added not more than 1/10 part hydrated lime ~~or lime putty,~~ and 2-1/4 to 3 parts of sand.

2. Coarse Grout. Coarse grout shall be composed, by volume, of one part of cement, to which may be added not more than 1/10 part hydrated lime ~~or lime putty,~~ two to three parts sand, and one to two parts gravel. Larger proportions of gravel may be used in large grout spaces where approved by the Regulator Agency.

27 (10-0-0) ~~Coarse grout may be used in grout spaces in grouted masonry 2 inches or more in width and in grout spaces in filled cell construction having an area of 15 square inches with a least dimension of 2 inches.~~

~~Coarse grout shall be used where the least dimension of the grout space exceeds 6 inches and where otherwise required.~~

5A/16 28 (9-1-0) (C) CONSISTENCY. Grout shall have a consistency, considering the methods of consolidation to be utilized, to completely fill all spaces to be grouted without segregation.~~except that slumps shall not be less than 4.5 inches for all grout nor more than 10 inches for fine grout or 8 inches for coarse grout.~~

(D) ADMIXTURES. Admixtures shall be approved by the Regulatory Agency.

5A/17 29 (9-1-0) (E) MEASURING AND MIXING. Materials for grout shall be measured in suitable calibrated devices. After the addition of water, all materials shall be mixed for at least three minutes in a ~~drum type batch~~ mechanical batch mixer. ~~Mixing equipment and procedures shall produce grout with the uniformity required for concrete by ASTM C94.~~

5A/18 (F) STRENGTH. Grout shall attain the minimum compressive strength required by design or required to obtain the prism strength required by design, but shall not be less than 2000 pounds per square inch at 28 days. The Regulatory Agency may require field tests to verify the grout strength. Such tests shall be made in accordance with Sec. 12A.7 and 12A.8.2.

12A.1.17 Cont.

(G) ALUMINUM EQUIPMENT. Grout shall not be handled nor pumped utilizing aluminum equipment.

30 (10-0-0) ~~EXCEPTION: Aluminum equipment may be used if it can be demonstrated that there will be no deleterious effect on the strength of the grout and it is specifically approved by the Regulatory Agency.~~

12A.1.18 REINFORCEMENT

Reinforcement over one-fourth inch (No. 2) in diameter shall be deformed bars.

Sec. 12A.2 <u>CONSTRUCTION</u>

~~At the time of laying all masonry units shall be clean and free of dust. Burned clay and sand-lime units shall be dampened prior to laying with an absorption rate conforming to Sec. 12A.1.5. Surfaces of concrete masonry units to receive mortar shall be dampened by means of a fog spray or equivalent during hot and dry weather, as described in Sec. 12A.2.5. At the time of laying all unburned clay units shall be damp at the surface. All masonry units shall not be so wet that free water is present on the surfaces.~~

Storage, handling and preparation at the site shall conform to the following requirements.

5A/18 cont. 31 (9-0-1) Masonry materials shall be stored so that at the time of laying the materials are clean and not damaged.

Concrete masonry units shall not be wetted unless otherwise approved.

~~Surfaces of all masonry units for grouted construction at the time of laying shall be capable of developing the required bond with grout as specified in Sec. 12A.1.6.~~

12A.2.1 JOINTS

32 (9-0-1) All units shall be laid with shoved mortar joints. Solid units shall have all head and bed joints solidly filled. ~~Except for cavity walls, spaces to be grouted, and as provided in Sec. 12A.3.3, all wall joints, collar joints, and joints between wythes shall be solidly filled.~~ unless otherwise approved.

5A/19 33 (9-1-0) All hollow units shall be laid with ~~full~~ face shell bed joints and head joints filled solidly with mortar for a distance in from the face of the unit not less than the thickness of the face shells unless more stringent construction is required by this Chapter, Chapter 12, or by design. Cross webs and end shells of all starter courses shall be bedded on mortar. ~~This applies to units laid on foundations or floor slabs or similar, and all courses of piers, columns, and pilasters.~~ unless otherwise specified.

5A/20 34 (8-2-0) ~~Concrete abutting structural masonry such as at starter courses or at wall intersections not designed as true separation joints, shall be roughened to a full amplitude of 1/8 inch, shall be moistened per the requirements of Sec. 12A.2, and shall be bonded to the masonry per the requirements of this Chapter as if it were masonry. Unless keys are provided, vertical joints shall be considered to be stacked bond.~~

5A/21 35 (9-1-0) Surfaces in contact with mortar or grout shall be clean and free of laitance, debris, or other deleterious materials.

Except as provided for firebrick or otherwise restricted, initial bed joint thickness shall not be less than 1/4 inch nor more than 1 inch; subsequent bed joints shall not be less than 1/4 inch and not more than than 5/8 inch in thickness.

12A.2.2 BOND PATTERN

All bed joints shall be horizontal and all head joints between adjacent units shall be vertical.

EXCEPTIONS:
1. Rubble stone masonry joints may vary from the horizontal or vertical.
2. The joints in arches and similar construction may vary from the horizontal or vertical.

12A.2.2 Cont.

3. The joints in other masonry construction may vary from the horizontal or vertical provided the construction is approved in accordance with Sec. 1.5.

36 (10-0-0) (A) REQUIREMENTS. Adjacent wythes shall be bonded to each other in accordance with the applicable provisions of ~~Sec. 12A.2.1 and~~ Sec. 12A.3.

All wythes of all masonry walls and all corners and wall intersections shall be laid in running bond except where true joints such as expansion and contraction joints are provided and except as follows.

37 (10-0-0) Where not prohibited in Chapter 12 or this Chapter, unreinforced stacked bond masonry may be used with one of the mechanical bonding devices indicated in Sec. 12A.2..2 (A) 1, 2, and 3 below:

~~For unreinforced masonry the mechanical bond shall be provided by one of the following:~~

1. Not less than two continuous corrosion-protected wires conforming to ASTM A82 in bed joints spaced not over 16 inches vertically. The wires shall provide a minimum reinforcement ratio of 0.00027 or each shall have a minimum cross-sectional area of 0.017 square inch, whichever is greater. At corners and intersections the wires shall be bent and shall be continued beyond the bend. No splices of continuous wires shall occur within 12 inches of the bend. Splices of the continuous wires shall be at least 12 inches in length and splices of alternate wires shall be staggered.

2. Where only the corner or intersecting joints are of stacked bond construction these joints may be bonded by 1/4-inch diameter steel rods, bent into a rectangular shape so that two legs cross the joint, laid in bed joints spaced not over 16 inches vertically. The rods shall extend a distance equal to the length of the masonry units, but not less than 6 inches, beyond each side of the joint. For masonry construction with other than hollow units, corrosion-protected steel straps having the same total area may be used in lieu of the rods. The ends of the straps shall be bent up 2 inches or cross pins for anchorage shall be provided.

5A/22

For brick masonry designed in accordance with Sec. 12A.6.2 where the intersecting walls are regularly toothed or blocked with 8-inch maximum offsets, the bonding may be provided with metal anchors. The anchors shall be 1/4 inch by 1-1/2 inch with ends bent up at least 2 inches, or with cross pins to form anchorage. Such anchors shall be at least 24 inches long, and shall be placed in bed joints spaced not over 48 inches vertically.

For nonstructural masonry the mechanical bond at intersecting joints, when required, shall be provided by corrosion-protected steel ties or clips at least 7/8-inch wide and not less than 16 gage or their wire equivalent, embedded in the bed joints, extending 3-inches minimum each side of the continuous vertical joint, placed not over 32 inches vertically.

3. For cavity walls the provisions of 1 and 2 above apply to each wythe.

38 (6-0-4) ~~For stacked bond reinforced grouted or reinforced hollow unit masonry, see Chapter 12. For stacked bond partially reinforced masonry, see Sec. 12A.3.7(A) and Chapter 12. For shear walls see Sec. 12A.6.4 and Chapter 12.~~

12A.2.3 CORBELING

39 (9-0-1) ~~Corbels in unreinforced masonry may be built only into solid masonry walls 12 inches or more in thickness. Corbels in partially reinforced masonry may be built only into masonry walls 12 inches or more in thickness unless the construction provided for the~~

12A.2.3 Cont.

39 cont.

~~corbel is designed and constructed as reinforced masonry. The projection for each course in such corbels and in unreinforced corbels in reinforced masonry construction shall not exceed 1 inch, and the maximum projection shall not exceed 1/3 of the total thickness of the wall when used to support a chimney built into the wall. The top course of all unreinforced corbels shall be a header course.~~

The slope of corbelling (angle measured from the horizontal to the face of the corbeled surface) shall not be less than 60°. The maximum horizontal projection of the corbel from the plane of the wall shall not exceed one-half the wythe thickness for cavity walls one one-half the wall thickness for all other walls.

12A.2.4 REINFORCEMENT

40 (10-0-0)

~~Reinforcement shall conform to the requirements of this Section.~~

Reinforcement shall conform to the requirements of this Section. All metal reinforcement shall be free from loose rust and other coatings that would reduce bond to the reinforcement.

(A) BAR SPACING. The minimum clear distance between parallel reinforcement, except in columns, shall be not less than the reinforcement diameter nor 1 inch except that lapped splices may be wired together. The center-to-center spacing of bars within a column shall not be less than 2-1/2 times the bar diameter. In addition to the preceding, the minimum clear distance between parallel reinforcement embedded in coarse grout shall not be less than 1-1/3 times the maximum aggregate size.

41 (10-0-0)

(B) SPLICES. Splices in reinforcement may be made only at approved locations or ~~and~~ as indicated on the approved design documents. Splices shall conform to the provisions of Sec. 12A.6.3(D)7.

5A/22 cont.

(C) EMBEDMENT AND COVERAGE. All reinforcement shall be completely embedded in mortar or grout. Joint reinforcement embedded in mortar joints shall have not less than 5/8-inch mortar coverage from an exposed face and 1/2 inch from other faces. All other reinforcement shall have a minimum masonry coverage of one bar diameter, but not less than 3/4 inch except where exposed to water, weather, or soil in which case the minimum coverage shall be 2 inches. See Sec. 12A.3.5(C) and 12A.3.6(A) for minimum grout coverage.

(D) SIZE LIMITATIONS. Longitudinal wall bars and other longitudinal bars shall be limited to deformed bars, #3 minimum and #10 maximum, when used in reinforced or partially reinforced masonry construction.

EXCEPTIONS:

1. Number 11 bars may be used provided the grout cover, measured from masonry units to reinforcing bar, including areas at splices is at least 1-1/2 inches.
2. The size limits do not apply to masonry joint reinforcement or column ties. See Sec. 12A.6.3(E)2 and 12A.6.3(F)2.

(E) WELDING. Welding of reinforcement shall conform to AWS D12.1. Reinforcement to be welded shall conform to the chemical requirements of ASTM A706 or the chemical constituents shall be verified.

12A.2.5 TEMPERATURE LIMITATIONS

42 (9-0-1)

~~No masonry shall be laid when the temperature of the outside air is below 40°F unless approved methods are used during construction to prevent damage to the masonry. Such methods include protection of the masonry for a period of at least 24 hours where Type III portland cement is used in mortar and grout and for a period of at least 48 hours where other cements are used. Materials to be used and materials to be built upon shall be free from ice and snow.~~

Cold weather construction shall conform to the requirements of "Recommended Practices and Guide Specifications for Cold Weather Construction" by the International Masonry Industry All-Weather Council.

When the ambient air has a temperature of more than 90° F in the shade, and has a relative humidity of less than 50 percent, protect newly erected masonry from direct exposure to wind and sun for 48 hours after installation.

12A.2 Cont.

12A.2.6 ANCHORAGE

5A/22 cont. Masonry walls shall be anchored to components providing lateral support as required by Sec. 3.7.6. Nonstructural walls required to be separated from the structural system shall be provided with anchorages which will permit relative movement between the wall and the structure as required by Sec. 3.8.

12A.2.7 BOLT PLACEMENT

Edge distances and center-to-center spacings shall not be less than required by Table 12A-6.

5A/23 43 (9-1-0) In grouted construction, all bolts shall be grouted in place. The bolts shall be accurately set ~~with templates or by approved equivalent means~~ and held in place to prevent movement. Grout coverage shall be as required for reinforcing bars of equivalent size.

In ungrouted construction, bolts shall be securely embedded in mortar except that for hollow unit masonry the cells containing bolts shall be grouted or mortared solid. There shall be at least 1/4 inch of mortar between bolts and masonry units for bolts set in mortar.

In cavity wall construction the wall shall be made solid at bolts for at least six diameters each side of the bolt.

5A/24 44 (7-1-2) Vertical bolts at the top of and near the ends of reinforced masonry walls shall be set within hairpins or ties located within ~~2.5~~ 4 inches from the top of the wall. See Sec. 12A.6.3(F) and 12.4.1(B) for bolts at the top of piers, pilasters, and columns.

12A.2.8 PENETRATIONS AND EMBEDMENTS

No conduits, plumbing, and similar embedments, holes, sleeves, chases, recesses, or other weakening construction are permitted unless indicated on the approved plans. See Sec. 12A.4.4 and 12A.4.5.

12A.2.9 SUPPORT BY WOOD

Wood members shall not be used to support any permanent loads imposed by masonry construction except as provided in Sec. 9.5.2.

Sec. 12A.3 <u>TYPES OF CONSTRUCTION</u>

5A/25 The types of masonry construction in Sec. 12A.3.1 through 12A.3.7 may be used for structural or nonstructural purposes and the type of masonry construction in Sec. 12A.3.B may be used for nonstructural purposes subject to requirements of Chapter 12 and this Chapter.

12A.3.1 UNBURNED CLAY MASONRY

~~Unburned clay masonry is that form of construction made with unburned clay units. Masonry of unburned clay units shall not be used in any building more than one story in height. All footing walls which support masonry of unburned clay units shall extend to an elevation not less than 6 inches above the adjacent ground at all points.~~

45 (10-0-0) Unburned clay masonry is that form of construction made with unburned clay stabilized with emulsified asphalt. Such units shall not be used in any building more than one story in height. All footing walls which support masonry of unburned clay units shall extend to an elevation not less than 6 inches above the adjacent ground at all points.

12A.3 Cont.

12A.3.2 STONE MASONRY

Stone masonry is that form of construction made with natural or cast stone with all joints thoroughly filled.

In ashlar masonry, bond stones uniformily distributed shall be provided to the extent of not less than 10 percent of the area of exposed faces.

Rubble stone masonry 24 inches or less in thickness shall have bond stones with a maximum spacing of 3 feet vertically and 3 feet horizontally, and if the masonry is of greater thickness than 24 inches, shall have one bond stone for each 6 square feet of wall surface on both sides.

12A.3.3 SOLID MASONRY

soild concrete or clay masonry units

46 (9-0-1) Solid masonry shall be ~~brick, concrete brick, or solid load bearing concrete masonry units,~~ laid contiguously in mortar.

The bonding of adjacent wythes in bearing and nonbearing walls shall conform to one of the following methods:

5A/25 cont.

- HEADERS. The facing and backing shall be bonded so that not less than 4 percent of the exposed face area is composed of solid headers extending not less than 3 inches into the backing. The distance between adjacent full length headers shall not exceed 24 inches vertically or horizontally. Where backing consists of two or more wythes, the headers shall extend not less than 3 inches into the most-distant wythe or the backing wythes shall be bonded together with separate headers whose area and spacing conform to this Subsection.

- METAL TIES. The facing and backing shall be bonded with corrosion-resistant unit metal ties or cross wires or approved joint reinforcement conforming to the requirements of Sec. 12A.3.4 for cavity walls. Unit ties shall be of sufficient length to engage all wythes, with ends embedded not less than one inch in mortar, or shall consist of two lengths, the inner embedded ends of which are hooked and lapped not less than 2 inches.

Where the space between metal tied wythes is solidly filled with mortar the allowable stresses and other provisions for masonry bonded walls shall apply. Where the space is not filled, metal tied walls shall conform to the allowable stress, lateral support, thickness (excluding cavity), height, and mortar requirements for cavity walls.

12A.3.4 CAVITY WALL MASONRY

Cavity wall masonry is that type of construction made with brick, structural clay tile or concrete masonry units, or any combination of such units in which facing and backing are completely separated except for the metal ties which serve as bonding.

In cavity walls neither the facing nor the backing shall be less than 4 inches in thickness and the cavity shall be not less than 1-inch net in width nor more than 4 inches in width. The backing shall be at least as thick as the facing.

EXCEPTION:
Where both the facing and backing are constructed with solid units, the facing and backing may each be 3 inches in thickness.

12A.3.4 Cont.

5A/25 cont. The facing and backing of cavity walls shall be bonded with 3/16-inch-diameter steel rods or metal ties of equivalent strength and stiffness embedded in the horizontal joints. There shall be one metal tie for not more than 4.5 square feet of wall area for cavity widths up to 3.5 inches. Where the cavity exceeds 3.5 inches net in width, there shall be one metal tie for not more than each 3 square feet of wall area. Ties in alternate courses shall be staggered and the maximum vertical distance shall not exceed 36 inches. Rods bent to rectangular shape shall be used with hollow masonry units laid with the cells vertical; in other walls the ends of ties shall be bent to 90-degree angles to provide hooks not less than 2 inches long. Additional bonding ties shall be provided at all openings, spaced not more than 3 feet apart around the perimeter and within 12 inches of the opening. Ties shall be of corrosion-resistant metal, or shall be coated with a corrosion-resisting metal or other approved protective coating.

47 (10-0-0) 12A.3.5 GROUTED MASONRY - MULTI/WYTHE WALLS

5A/26 48 (4-0-5) ~~Grouted masonry is that form of construction made with brick or solid concrete units in which interior joints of masonry are filled by pouring grout therein as the work progresses. Only Type M or Type S mortar shall be used. When reinforced in accordance with subsection (C) below masonry shall be classified as reinforced grouted masonry.~~

Grouted multi-wythe is a form of construction in which interior joints between wythes are filled with grout. Only Type M or Type S mortar shall be used.

5A/27 49 (8-1-1) ~~Toothing of masonry walls is permitted only when designed and detailed by the design engineer or architect and only at approved locations. Racking is to be held to a minimum.~~

50 (10-0-0) ~~Grouting and construction procedures shall conform to the requirements given below.~~

Grouting procedures for the space between wythes shall conform to the requirements given below. Coarse grout may be used in grout spaces 2 inches or more in width. Coarse grout shall be used where the least dimension of the grout space exceeds 5 inches.

(A) LOW LIFT. Low lift grouted construction procedures are as follows:

51 (10-0-0) ~~1. All units in the two outer tiers shall be laid with full shoved head and bed mortar joints.~~ Masonry headers shall not project into the grout space.

52 (8-0-2) 1. ~~2.~~ All longitudinal vertical joints shall be grouted and shall not be less than 3/4 inch in thickness for unreinforced construction and 1-1/2 inches in width for reinforced construction, but not less than that requred to maintain grout thicknesses between masonry units and reinforcement. In members of three or more ~~tiers~~ wythes in thickness, interior bricks shall be embedded into the grout so that at least 3/4 inch of grout surrounds the side and ends of each unit. Floaters ~~shall~~ may be used where the grout space exceeds 5 inches in width. ~~The thickness of grout between masonry units and floaters shall be not less than 1 inch.~~ All grout shall be puddled ~~with a grout stick~~ immediately after pouring.

5A/28 53 (10-0-0) 2. ~~3.~~ One exterior ~~tier~~ wythe may be carried up 18 inches before grouting, but the other exterior ~~tier~~ wythe shall be laid up and grouted in lifts not to exceed six times the width of the grout space with a maximum of 8 inches.

3. ~~4.~~ If the work is stopped for one hour or longer, the horizontal construction joints shall be formed by stopping all ~~tiers~~ wythes at the same elevation and with the grout 1 inch below the top.

(B) HIGH LIFT. High lift grouted construction procedures are as follows:

54 (9-0-1) ~~1. All units in the two tiers shall be laid with full head and bed joints.~~

12A.3.5 Cont.

5A/28 cont. 55 (10-0-0) 1. The two wythes ~~tiers~~ shall be bonded together with wall ties. Ties shall be not less than No. 9 wire in the form of rectangles 4 inches wide and 2 inches in length less than the overall wall thickness. Kinks, water, drips, or deformations shall not be permitted in the ties. Approved equivalent ties may also be used. One wythe ~~tier~~ of the wall shall be built up not more than 18 inches ahead of the other tier. Ties shall be laid not to exceed 24 inches on center horizontally and 16 inches on center vertically for running bond and not more than 24 inches on center horizontally and 12 inches on center vertically for stacked bond.

5A/29 56 (8-1-1) 2. Cleanouts shall be provided for each pour by leaving out ~~every other~~ units in the bottom tier of the section being poured, or by cleanout openings in the foundation. During the work, mortar fins and any other foreign matter shall be removed from the grout space. ~~by means of a high pressure jet stream of water, air jets, or other approved procedures. Material falling to the bottom of the grout space shall be thoroughly removed.~~ The cleanouts shall be sealed after inspection and before grouting.

57 (10-0-0) 3. The grout space (longitudinal vertical joint) shall not be less than 2 ~~3~~ inches in width ~~and not~~ nor less than the thickness required by the placement of steel with the required clearances and shall be poured solidly with grout. ~~Masonry walls shall cure at least three days to gain strength before grout is poured.~~

58 (10-0-0)

EXCEPTION:
If the grout space contains no horizontal steel, it ~~may be reduced to 2 inches.~~ shall be at least 3 inches.

59 (9-0-1) 4. Vertical grout barriers or dams shall be built of solid masonry across the grout space the entire height of the wall to control the flow of the grout horizontally. Grout barriers shall be not more than 30 feet apart. ~~Unless a true joint occurs at the barrier,~~ Reinforcement, if it is present, shall be continuous through the barrier. In work that is part of the seismic resisting system, the grout barriers shall be constructed so as to form keys, at least 3/4-inch deep, with the grout except that construction providing equivalent irregular surfaces may be used where appropriate.

5A/30

5. Grout shall be a plastic mix suitable for pumping without segregation of the constituents, and shall be mixed thoroughly. Grout shall be placed by pumping or by an approved alternate method and shall be placed before any initial set occurs.

6. Grouting shall be done in a continuous pour, in lifts not exceeding 6 feet. The full height of each lift shall be consolidated by mechanical vibrating during placing and reconsolidated after excess moisture has been absorbed, but before plasticity is lost. The grouting of any section of a wall between control barriers shall be completed in one day with no interruptions greater than one hour.

60 (10-0-0) 7. Inspection during grouting shall be provided in accordance with Sec. 12A.7. ~~however, the work shall not qualify for the stresses entitled, "Special Inspection", unless fully inspected per Sec. 1.6.2, 1.6.4, and 12A.7.~~

5A/31 61 (9-1-0) (C) REINFORCED CONSTRUCTION. ~~All required reinforcement except masonry joint reinforcement and column ties conforming to the paragraph below shall be embedded in grout.~~ All ~~other~~ reinforcement shall be embedded in mortar or grout. All ~~vertical~~ reinforcement shall be held firmly in place during grouting by ~~a frame or~~ suitable ~~equivalent~~ devices. ~~All horizontal reinforcement in the grout space shall be tied to the vertical reinforcement or held in place during grouting by equivalent means.~~

12A.3.5 Cont.

The thickness of mortar between masonry units and reinforcement shall not be less than 1/4 inch, except that where allowed 1/4 inch bars or less may be laid in horizontal mortar joints at least twice the thickness of the wire diameter. See Sec. 12A.6.3(F) and Chapter 12.

62 (10-0-0) The thickness of grout between masonry units and reinforcement shall not be less than 1/4 inch where fine grout is used nor 1/2 inch where coarse grout is used. See Sec. 12A.1.17 and 12A.2.4.

See Chapter 12 for stacked bond limitations.

12A.3.6 HOLLOW UNIT MASONRY

Hollow unit masonry is that form of construction made with hollow masonry units made from concrete, burned clay, or shale.

5A/32 Where two or more hollow units are used to make up the thickness of an unreinforced wall, the stretcher course shall be bonded at vertical intervals not exceeding 34 inches by lapping at least 4 inches over the unit below or by lapping at vertical intervals not exceeding 17 inches with units which are at least 50 percent greater in thickness than the units below; or by bonding with corrosion-resistant metal ties conforming to the requirements for cavity walls. There shall be one metal tie for not more than each 4.5 square feet of wall area. Ties in alternate courses shall be staggered, and the maximum vertical distance between ties shall not exceed 18 inches, and the maximum horizontal distance shall not exceed 36 inches. Walls bonded with metal ties shall conform to the requirements for allowable stress, lateral support, thickness (excluding cavity), height, and mortar for cavity walls.

5A/33 63 (7-3-0) ~~Hollow unit masonry construction, where certain cells are continuously filled with concrete or grout, and reinforcement, in accordance with Subsection (A) below, is embedded therein shall be classified as reinforced hollow unit masonry. Reinforced hollow unit masonry shall generally be one wythe in thickness. If constructed of more than one wythe, each wythe shall be designed as a separate element or wall or the wythes shall be bonded together by means approved by the Regulatory Agency. This bonding shall be designed so the wythes shall act as a unit.~~

GROUTING PROCEDURES

5A/34 64 (8-1-1) (A) ~~REINFORCED CONSTRUCTION.~~ Units shall be laid with mortar in accordance with Sec. 12A.2.1. ~~Only Types M or S mortar shall be used.~~ Where only certain vertical cells are to be filled, the walls and cross webs of these cells shall be full bedded in mortar to prevent grout leakage. Vertical cells to be filled shall have vertical alignment sufficient to maintain a clear, unobstructed continuous vertical cell measuring not less than ~~2~~ 1 1/2 inches by 3 inches. If walls are battered or if alignment is offset, the ~~2~~ 1 1/2 inch by 3 inch clear opening shall be maintained as measured from course to course.

65 (10-0-0) Overhanging mortar fins projecting ~~more than the thickness of the mortar joint~~ into the grout space shall be ~~carefully~~ removed. ~~as the work progresses in a manner that prevents the mortar from falling to the bottom of the cells.~~

5A/35 66 (10-0-0) Coarse grout may be used in hollow masonry units having an area of 10 square inches with a least dimension of 3 inches. Coarse grout shall be used when the least dimension of the grout space exceeds 5 inches and where otherwise required.

67 (10-0-0) Except as provided in Chapter 12, all reinforcing except ties and masonry joint reinforcement, where permitted, shall be embedded in grout. Longitudinal horizontal reinforcing shall be placed in bond beams ~~units,~~ except as permitted for masonry joint reinforcement. ~~See Sec. 12A.6.3(F) and Chapter 12.~~

Vertical reinforcement shall be positively held in position at top and bottom and at intervals not exceeding 192 diameters of the reinforcement.

12A.3.6 Cont.

68 (10-0-0) The thickness of the grout between the masonry units and reinforcing shall be a minimum 1/4 inch for fine grout and 1/2 inch for coarse grout. See Sec. 12A.1.17 and 12A.2.4. See Chapter 12 for stacked bond limitations.

Grouting procedures shall conform to the requirements given below. When grouting is stopped for one hour or longer, horizontal construction joints shall be formed by stopping the pour of grout at least 1/2 inch above or below a bed joint.

1. Low Lift. Low lift grouted construction procedures are as follows:

a. Hollow units shall be laid to a height not to exceed 4 feet 8 inches prior to filling cells with grout; grouting shall not be in lifts greater than 4 feet.

5A/35 cont.

b. All cells containing reinforcement shall be filled solidly with grout. All grout shall be consolidated at the time of pouring by puddling or vibrating. When the grout lift exceeds two feet, the grout shall be reconsolidated after excess moisture has been absorbed, but before workability is lost.

c. Reinforcing shall be in place prior to grouting.

2. High Lift. High lift grouted construction procedures are as follows:

5A/36 69 (7-2-1) ~~a. Units may be laid up 8 inches higher than the total height of the grout lift which shall not exceed 16 feet for walls 8 inches or more in nominal thickness nor 8 feet for thinner walls.~~

5A/37 70 (8-0-2) b. Cleanouts shall be provided in the foundation or ~~by omitting~~ in the face shells in the bottom course of each cell to be grouted. ~~to facilitate cleanout which shall be accomplished by means of a high pressure jet stream of water, air jets, or other approved procedures. Material falling to the bottom of the grout space and other debris shall be thoroughly removed.~~ Debris in the grout space shall be removed.

c. The cleanouts shall be sealed after inspection and before grouting. Grout shall be a workable mix suitable for pumping without segregation of the constituents and shall be mixed thoroughly. Grout shall be placed by pumping or by an approved alternate method and shall be placed before initial set or hardening occurs.

71 (10-0-0) d. Grouting shall be done in a continuous pour and may be done in partial lifts. ~~so as to avoid blowout of units.~~

The full height of each lift shall be consolidated by mechanical vibrating during placing, and reconsolidated after excess moisture has been absorbed but before workability is lost. The grouting of any section of a wall shall be completed in one day with no interruptions greater than 1.5 hours.

5A/38

72 (10-0-0) e. Inspection during grouting shall be provided in accordance with Sec. 12A.7~~; however, the work shall not qualify for the stresses entitled, "Special Inspection", unless fully inspected per Sec. 1.6.2, 1.6.3, and 12A.7.~~

73 (9-0-1) ~~12A.3.7 PARTIALLY REINFORCED MASONRY~~

~~Partially reinforced masonry is grouted masonry or hollow unit masonry containing reinforcement as specified below. Masonry joint reinforcement shall be and ties may be embedded in the mortar in the bed joints. All other reinforcement shall be embedded in grout. Minimum masonry, mortar, and grout coverages applicable to reinforced masonry shall be provided.~~

5A/38 cont. 73 cont. Partially reinforced masonry shall be designed as unreinforced masonry, except that reinforced masonry areas or elements may be considered as resisting stresses in accordance with the design criteria specified for reinforced masonry provided such elements fully comply with the design and construction requirements for reinforced masonry except as herein noted; however R factors of Table 3-B shall be as required for unreinforced masonry. Only Types M or S mortar shall be used.

(A) REINFORCEMENT. Reinforcing for columns shall conform to the requirement of Sec. 12A.6.3(F). For walls the maximum spacing of vertical reinforcement shall be 8 feet where the nominal thickness is 8 inches or greater and 6 feet where the nominal thickness is less than 8 inches. Vertical reinforcement shall also be provided each side of each opening and at each corner of all walls. Horizontal reinforcement not less than 0.2 square inch in area shall be provided at the top of footings, at the bottom and top of wall openings, near roof and floor levels, and at the top of parapet walls and, where distributed joint reinforcement is not provided, at a maximum spacing of 12 feet where the nominal masonry thickness is 8 inches or greater and 9 feet where the nominal thickness is less than 8 inches. The vertical reinforcement ratio and the horizontal reinforcement ratio shall each be not less than 0.00027.

Where not prohibited by Chapter 12 or this Chapter, stacked bond construction may be used. When stacked bond is used the minimum horizontal reinforcement ratio shall be increased to 0.0007. This ratio shall be satisfied by masonry joint reinforcement spaced not over 16 inches or by reinforcement embedded in grout spaced not over 4 feet. Reinforcement shall be continuous at wall corners and intersections.

Splices for reinforcement shall conform to all requirements for splices in reinforced masonry.

Partially reinforced masonry walls shall be considered as reinforced masonry for the purpose of applying Table 12A-2.

12A.3.8 GLASS MASONRY

5A/39

74 (6-0-4) Masonry of glass blocks may be used in nonloadbearing exterior or interior walls and in openings, either isolated or in continuous bands, provided the glass block panels have a minimum thickness of ~~3.5~~ 3.0 inches at the mortar joint.

The panels shall be supported laterally to resist the horizontal forces specified in Chapter 8. Glass block panels for exterior walls shall not exceed 144 square feet of unsupported wall surface nor 15 feet in any dimension. For interior walls, glass block panels shall not exceed 250 square feet of unsupported area nor 25 feet in any dimension.

75 (6-0-4) Glass block shall be laid in Type~~s~~ N ~~M or S~~ mortar by proporation. Both vertical and horizontal mortar joints shall be at least 1/4 inch and not more than 3/8-inch thick and shall be completely filled.

Every exterior glass block panel shall be provided with 1/2-inch expansion joints at the sides and top. Expansion joints shall be entirely free of mortar, and shall be filled with resilient material.

Sec. 12A.4 DETAILED REQUIREMENTS

5A/40 76 (10-0-0) Masonry shall be designed to resist all vertical and horizontal load effects including effects of eccentricity of application of vertical loads. Unreinforced masonry shall not be loaded in direct tension. Structural and nonstructural elements including

12A.4 Cont.

partitions shall be designed for seismic forces induced by their own weight. Design of structural masonry that is not part of the seismic system shall consider the effects of seismic drift in accordance with Sec. 3.8.

5A/40 cont. 77 (7-0-1)

Except where specifically allowed otherwise, stresses shall be calculated on actual net dimension of masonry considering reductions for raking, tooling, and other joint treatments and partial bed or head joints where applicable. Where required by the Regulatory Agency, Chapter 12, this Chapter, or by other governing provisions, ~~specific~~ inspections and tests shall be provided. In addition where called for or where required by the use of design stresses so specifying, Special Inspection shall be provided.

12A.4.1 COMBINATION OF DISSIMILAR UNITS OR CONSTRUCTION

In walls or other structural members composed of different kinds or grades of units, materials, mortars, or construction types, the maximum stress shall not exceed the allowable stress for the weakest of the combination of units, materials, mortars, or construction types of which the member is composed. Alternatively, provided the effects of different moduli of elasticity are accounted for in design, the maximum stress shall not exceed the allowable stress for the material occurring at the point of stress consideration. The net thickness of any facing unit which is used to resist stress shall not be less than 1.5 inches.

In cavity walls composed of different kinds or grades of units or mortars the maximum stress shall not exceed the allowable stresss for the weaker of the combination of units and mortars where both wythes are loadbearing; where only one wythe is loadbearing maximum stresses shall not exceed the allowable stresses for the units and mortars of that wythe.

12A.4.2 THICKNESS OF WALLS

5A/41 78 (10-0-0)

All masonry walls shall be designed so that allowable stresses are not exceeded ~~and so that their thicknesses are not less than required by the maximum thickness ratios and the minimum thicknesses of Table 12A-2. When a change in minimum thickness requirements occurs between floor levels, the greater thickness shall be carried to the higher floor level. In computing the thickness ratio for cavity walls, the value for thickness shall be determined by Footnote 5 of Table 12A-2. In walls composed of different kinds or classes of units or mortars, the ratio of height to length to thickness shall not exceed that allowed for the weakest of the combination of units and mortars of which the member is composed.~~ and that the provisions of table 12A-2 are satisfied.

79 (10-0-0)

EXCEPTION:
The maximum thickness ratio of Table 12A-2 may be increased ~~and the minimum nominal thicknessess of Table 12A-2 may be decreased when data is submitted which justifies such liberalization and approval is obtained from the Regulatory Agency. For all walls and elements serving to support vertical loads other than induced by the walls or elements themselves such data shall include consideration of the additional eccentricity of vertical load due to deflections perpendicular to the plane of the wall or element and, for unreinforced and partially reinforced masonry, a consideration of stress and stability under reduced vertical loads in accordance with the provisions of Chapters 3 and 4 including Formula 3-2a for unreinforced masonry.~~ when justified by substantiating data.

5A/42 80 (10-0-0)

12A.4.3 PIERS

~~Every structural pier whose width is less than three times its thickness shall be designed and constructed as required for columns.~~

12A.4.3 Cont.

80 cont. ~~Every structural pier in reinforced masonry construction whose width is between 3 and 5 times its thickness or less than 1/2 the height of adjacent openings shall have all horizontal steel in the form of ties except that in walls less than 12 inches in nominal thickness and in reinforced grouted construction such steel may be in one layer in the form of hairpins.~~

12A.4.4 CHASES AND RECESSES

Chases and recesses in masonry walls shall be designed and constructed so as to satisfy the required strength or fire resistance of the wall. See Sec. 12A.2.8.

12A.4.5 HOLES, PIPES, AND CONDUITS

Pipes, conduits, and similar items may be sleeved through masonry with sleeves large enough to pass hubs and couplings. Pipes, conduits, and similar items may be embedded in masonry, provided all applicable provisions for Sec. 6.3 of ACI Standard 318 are satisfied. The design shall consider the net section at the location of the weakening element. Details shall be shown on the approved plans. In applying ACI Standard 318, the terms "concrete" and "structural concrete" shall mean masonry. (See Sec. 12A.2.8.) Unless all of the above requirements are satisfied, holes and embedments are not allowed.

12A.4.6 ARCHES AND LINTELS

Members supporting the vertical load of masonry shall be of noncombustible materials.

5A/42 cont.

12A.4.7 ANCHORAGE

Masonry walls that meet or intersect shall be bonded or anchored as required by Sec. 12A.2.1 and 12A.2.2 except where separation is provided for in the design. Masonry walls shall be anchored to the roof and floors as required by Sec. 3.7.6. Structural members framing into or supported on walls or columns shall be bonded or anchored thereto.

12A.4.8 END SUPPORT

81 (10-0-0) Beams, girders, or other similar concentrated loads supported by a wall or column ~~pier~~ shall have a bearing at least 3 inches in length upon solid or grouted elements of masonry not less than 4 inches thick or upon a metal bearing plate of adequate design and dimensions. The loads shall be ~~safely~~ distributed to the wall or column ~~pier~~, or to a continuous reinforced masonry member ~~projecting not less than 3 inches from the face of the wall,~~ or by other approved means.

82 (9-0-1) Joists, precast planks, and similar elements shall have a bearing at least 2.5 inches in length upon solid or grouted masonry elements ~~at least 2.25 inches thick,~~ or other provisions shall be made to distribute the loads ~~safely~~ to the masonry.

Anchorage to the masonry shall conform to Chapter 3.

12A.4.9 DISTRIBUTION OF CONCENTRATED LOADS

In calculating wall stresses concentrated loads may be distributed over a maximum length of wall not exceeding the center-to-center distance between loads.

Where the concentrated loads are not distributed through a structural element the length of wall considered shall not exceed the width of the bearing plus four times the wall thickness.

12A.4.9 Cont.

~~Concentrated loads shall not be considered to be distributed by metal ties in stacked bond construction, nor to be distributed across continuous vertical joints. This provision shall apply when considering overturning effects in shear walls if stacked bond is not prohibited.~~

83 (10-0-0) Concentrated loads shall not be considered to be distributed across continuous vertical joints unless reinforced horizontal elements designed to distribute the concentrated loads are employed.

Sec. 12A.5 STRENGTHS AND ALLOWABLE STRESSES

Material strength determinations and allowable stresses shall conform to the requirements of this Section.

12A.5.1 MASONRY

Except for the stresses listed in Table 12A-3 which are applicable to unreinforced masonry, the design of masonry is based on the compressive strength f'_m. The strength f'_m is reduced when the design is based on the alternate design procedure for unreinforced brick masonry of Sec. 12A.6.2. The higher stresses allowed in the Tables in this Chapter under the heading "Special Inspection Required" may only be used when all the applicable requirements for Special Inspection have been met; see Sec. 1.6 and 12A.7.

(A) DETERMINATION OF MASONRY COMPRESSIVE STRENGTH f'_m. When required for design, the value of f'_m shall be determined by tests of masonry assemblies in accordance with 12A.5.1(A).1 or shall be assumed in accordance with 12A.5.1(A).2.

1. Determination of f'_m by Prism Tests. When the masonry strength is to be established by tests, the procedures shall conform to the provisions of Sec. 12A.8 with tests made both prior to and during construction.

5A/42 cont. 2. Assumed Compressive Strength f'_m. When prism tests are not made as in 12A.5.1(A).1, f'_m may be assumed as listed in Table 12-4 provided other tests are made and certifications are furnished when required by the footnotes to Table 12-4 or by the provisions upon which the design is based.

The tests in 12A.5.1(A).1 and 2 shall not qualify the masonry for the stresses entitled "Special Inspection" unless Special Inspection fully conforming to Sec. 1.6 and 12A.7 is provided.

83A - New (10-0-0) (B) ALLOWABLE STRESSES FOR MASONRY. Except for unreinforced ~~brick~~ masonry designed under the provisions of Sec. 12A.6.2, the allowable stresses for unreinforced masonry are given in Table 12A-3 and for reinforced masonry the allowable stresses are given in Table 12A-5.

If used for design, the value of f'_m shall be clearly shown on the plans.

12A.5.2 STEEL

Stresses in reinforcement shall not exceed the following:

	POUNDS PER SQUARE INCH
TENSILE STRESS:	
For deformed bars with a yield of 60,000 pounds per square inch or more and in sizes No. 11 and smaller	24,000
Joint reinforcement, 50 percent of the minimum specified yield point for the particular kind and grade of steel used, but in no case to exceed	30,000
For all other reinforcement	20,000

12A.5.2 Cont.

	POUNDS PER SQUARE INCH
COMPRESSIVE STRESS IN COLUMN VERTICALS:	
40 percent of the minimum yield strength, but not to exceed	24,000
COMPRESSIVE STRESS IN FLEXURAL MEMEBERS:	
For compressive reinforcement in flexural members, the allowable stress shall not be taken as greater than the allowable tensile stress shown above.	
The modulus of elasticity of steel reinforcement may be taken as	29,000,000 to 30,000,000

12A.5.3 BOLTS

The allowable shear loads on bolts shall not exceed the values given in Table 12A-6. See Sec. 12A.2.7 for construction requirements.

Sec. 12A.6 DESIGN REQUIREMENTS

84 (9-0-1)

The design of masonry elements shall conform to the appropriate provisions of this Section. The higher stresses allowed in the Tables in this Chapter under the heading "Special Inspection Required" may only be used when all of the requirements for Special Inspection have been met; see Sec. 1.6 and 12A.7. The load combinations of Sec. 3.7 shall be investigated. All plans shall clearly show the specified value of f'_m used in design. ~~and the age when the masonry elements may be loaded.~~ All stresses and capacities shall be based on actual net dimensions, thickness and sections.

5A/42 cont.

12A.6.1 DESIGN PROCEDURE FOR UNREINFORCED MASONRY

85 - Mod (10-0-0)

The design of unreinforced masonry shall be based upon a rational analysis using accepted engineering practice and linear stress and strain relationships. ~~An~~ Alternate procedures for design ~~is~~ are given in Sec. 12A.6.2.

(A) LIMITATIONS. The stresses on masonry elements including the stresses at the extreme fibers of the masonry element resulting from the combined effects of flexural and axial loads shall not exceed those given in Table 12A-3. The allowable compressive stresses of Table 12A-3 are applicable only if the thickness ratios of Table 12A-2 are not exceeded.

The allowable stresses for compression of Table 12A-3 shall be reduced by 20 percent when applied to columns.

Each wythe of cavity walls shall be designed separately for the loadings and effects imposed on it. The wythes shall not be assumed to act compositely.

(B) EFFECTIVE THICKNESS. For solid walls and metal tied walls, the effective thickness shall be determined as for cavity walls unless the collar joints in such walls are filled with mortar or grout.

For cavity walls loaded on both wythes, each wythe shall be considered to act independently and the effective thickness of each wythe shall be taken as its actual thickness. For cavity walls loaded on one wythe only, the effective thickness shall be taken as the actual thickness of the loaded wythe.

12A.6.1(B) Cont.

For rectangular columns, the effective thickness shall be taken as its actual thickness in the direction considered. For nonrectangular columns, the effective thickness shall be taken as equal to 3.5 times its radius of gyration r about the axis considered.

Where raked or similar mortar joints are used, the thickness and length of the member shall be reduced for stress considerations in accordance with the depth of the raking.

(C) ECCENTRICITY NORMAL TO AXES OF MEMBER. In solid walls and columns, the eccentricity of the load shall be considered with respect to the centroidal axis of the member.

In cavity walls loaded on one wythe, the eccentricity shall be considered with respect to the centroidal axis of the loaded wythe. In cavity walls loaded on both wythes, the load shall be distributed to each wythe according to the eccentricity of the load about the centroidal axis of the wall.

For members composed of different kinds or grades of units or mortar, the variation in the moduli of elasticity shall be taken into account and the eccentricity shall be considered with respect to the center of resistance or the centroidal axis of the transformed area of the member.

(D) EFFECTIVE HEIGHT. Where a wall is laterally supported top and bottom, its effective height shall be taken as the actual height of the wall. Where there is no lateral support at the top of the wall, its effective height shall be taken as twice the height of the wall above the bottom lateral support.

5?/42 cont. Where a column is provided with lateral supports in the directions of both principal axes at both top and bottom, the effective height in any direction shall be taken as the actual height. The actual height shall be taken as not less than the clear distance between the floor surface and the underside of the deeper beam framing into the column in each direction at the next higher floor level.

Where a column is provided with lateral support in the directions of both principal axes at the bottom and in the direction of one principal axis at the top, its effective height relative to the direction of the top support shall be taken as the height between supports and its effective height at right angles to this shall be taken as twice its height above the lower support.

In the absence of lateral support at the top, the effective height of a column relative to both principal axes shall be taken as twice its height above the lower support.

(E) CROSS-SECTIONAL AREA. For solid walls and columns, A_g shall be taken as the actual gross cross-sectional area of the member. For metal-tied walls, A_g shall be determined as for cavity walls unless the collar joints in such walls are filled with mortar or grout.

For cavity walls loaded on one wythe, A_g shall be taken as the actual gross cross-sectional area of the loaded wythe.

In hollow unit construction, stresses shall be based on net areas.

12A.6.1(E) Cont.

Where raked or similar mortar joints are used, the thickness used in determining A_g or net areas shall be reduced accordingly.

(F) STIFFNESS. When used for design, the moduli of elasticity or rigidity may be assumed from values that would be applicable to similar masonry construction designed under other provisions of this Chapter. When the stiffness cannot or is not determined in this manner, supporting data shall be submitted.

5A/42 cont. 86 (10-0-0) (G) SHEAR WALLS. Design of shear walls shall conform to the applicable provisions of Sec. 12A.6.4.~~and Chapter 12.~~

86A - New (10-0-0) (H) LOADS PERPENDICULAR TO CAVITY WALLS. The distribution to each cavity wall wythe of loads perpendicular to the plane of the wall shall consider relative wythe flexural rigidities, wythe end support conditions, and continuity or lack of continuity of each wythe.

5A/43 87 - Mod (8-1-1)

~~12A.6.2 ALTERNATE DESIGN PROCEDURE FOR UNREINFORCED BRICK MASONRY~~

~~For unreinforced brick masonry constructed with only new solid units made from clay or shale conforming to ASTM C62 or ASTM C216 and subject to the limitations of Footnote 4 to Table 12A-4, the alternate design procedure of this Section may be used. The requirements of Sec. 12A.6.1 apply except as specifically modified herein.~~

~~The value of the brick masonry design strength, f'_{mb}, for establishing the allowable stresses for use in this Section shall be 0.73 of the value of the masonry compressive strength determined in accordance with Sec. 12A.5.1, i.e.:~~

$$f'_{mb} = 0.73\ f'_m$$

~~All plans shall clearly show the values of f'_m, and f'_{mb}, at their required age.~~

~~(A) SLENDERNESS RATIOS. The slenderness ratio of a wall shall be taken as the ratio of its effective height, h, to the effective thickness, t, and shall not exceed the smaller of the values determined from Table 12A-2 or as determined by the following formula:~~

$$\frac{h}{t} \leq 10\ (3 - \frac{e_1}{e_2}) \qquad (12A\text{-}1)$$

~~where the value of e_1/e_2 is positive where the member is bent in single curvature, and negative where the member is bent in double or reverse curvature. Where e_1 and e_2 are both equal to zero, e_1/e_2 shall be assumed to be zero.~~

~~The slenderness ratio of a column shall be the greater value obtained by dividing the effective height h in any direction by the effective thickness t in the corresponding direction and shall not exceed the value determined by the following formula:~~

$$\frac{h}{t} \leq 5\ (4 - \frac{e_1}{e_2}) \qquad (12A\text{-}2)$$

~~The minimum thickness and maximum slenderness requirements of Sec. 12A.4.2 shall also be satisfied. However, those requirements and the slenderness limits of the above formulas may be waived in accordance with Sec. 1.5. Conformance to the formulas, by itself, shall not act as a waiver for the requirements of Sec. 12A.4.2. The requirements of the exceptions of that Section, as applicable, shall be satisfied. Where applicable, the design procedures following this Subsection may be used in satisfying the requirements of those exceptions. Particular attention shall be paid to the requirements for stress and stability under reduced vertical load including Formula 3-2a and to transverse loads.~~

~~(B) ALLOWABLE VERTICAL LOAD. The allowable vertical loads and bearing stresses shall be determined as follows:~~

12A.6.2(B) Cont.

5A/43 cont. | 87 Mod. cont.

1. Allowable Vertical Load. The allowable vertical load, P, on an unreinforced masonry wall or column shall be determined in accordance with the following.

a. When e/t or R_e, as applicable, do not exceed 1/3:

$$P = f_m A_g C_s C_e \qquad (12A\text{-}3)$$

where f_m is the allowable axial compressive stress from Table 12A-7.

A_g is the cross-sectional area of the element determined from the effective thickness and length.

C_s is the slenderness coefficient as determined by the following formula:

$$C_s = 1.20 - \frac{h/t}{300}\left[5.7 + \left(1.5 + \frac{e_1}{e_2}\right)^2\right] \leq 1.0 \qquad (12A\text{-}4)$$

C_e is the eccentricity coefficient, related to the ratio of maximum effective eccentricity to effective thickness, e/t as determined below.

When e/t is equal to or less than 1/20, the value of C_e is 1.0.

When e/t exceeds 1/20 but is equal to or less than 1/6 the value of C_e shall be determined by use of the following formula:

$$C_e = \frac{1/3}{1 + 6\frac{e}{t}} + \frac{1}{2}\left(\frac{e}{t} - \frac{1}{20}\right)\left(1 - \frac{e_1}{e_2}\right) \qquad (12A\text{-}5)$$

When e/t exceeds 1/6 but is equal to or less than 1/3, the value of C_e shall be determined by use of the following formula:

$$C_e = 1.95\left(\frac{1}{2} - \frac{e}{t}\right) + \frac{1}{2}\left(\frac{e}{t} - \frac{1}{20}\right)\left(1 - \frac{e_1}{e_2}\right) \qquad (12A\text{-}5a)$$

For members subject to tranverse loads greater than 10 pounds per square foot between lateral supports, C_e shall be based on Formula 12A-5 or 12A-5a, whichever is applicable, except e_1/e_2 shall be taken as 1.0.

When the elements are subject to bending about both principal axes, the eccentricity coefficient is related to the ratio:

$$R_e = \frac{e_i t + e_t i}{it} \qquad (12A\text{-}6)$$

where e_i is the effective eccentricity about the principal axis which is normal to the length of the element.

e_t is the effective eccentricity about the principal axis which is normal to the thickness of the element.

5A/43 cont. | 87 Mod. cont.

12A.6.2(B) Cont.

i is the effective length of the element.

t is the effective thickness of the element.

When R_e is equal or less than 1/20 the value of C_e is 1.0.

When R_e exceeds 1/20 but is equal to or less than 1/6, the value of C_e shall be determined by use of Formula 12A-5 except that R_e shall be substituted for e/t.

b. When e/t or R_e, as applicable, exceed 1/3:

For walls and elements subject to bending in one direction only and the ratio e/t exceeds 1/3, the maximum tensile and flexural compression stress in the masonry, assuming linear stress distribution, shall not exceed the values given in Table 12A-7. Where these values are exceeded, the member shall be redesigned and/or reinforced.

For walls and elements subject to bending in both directions, and the ratio R_e exceeds 1/3, the members shall be redesigned and/or reinforced.

See Chapter 12 for modifications under seismic loads.

2. Bearing Stress. The bearing stress under beams, lintels and girders and from similar concentrated loads supported on unreinforced masonry shall not exceed the values set forth in Table 12A-7.

(C) SHEAR WALLS. Design of shear walls shall comply with all applicable provisions of Sec. 12A.6.4 and Chapter 12. In unreinforced shear walls, the effective eccentricity e_i about the principal axis which is normal to the length i of the shear wall shall not exceed an amount which will produce tension. In unreinforced shear walls subject to bending about both principal axes, R_e shall not exceed 1/3. Where the effective eccentricity exceeds the values given in this Section, shear walls shall be redesigned or reinforced.

Allowable vertical loads on unreinforced shear walls shall be determined in accordance with Sec. 12A.6.2(B) except that the value of h used in determining C_s may be taken as the minimum vertical or horizontal distance between lateral supports.

The allowable shear stresses in unreinforced shear walls shall be taken as the allowable stresses given in Table 12A-7. The allowable shear stress may be increased by 1/5 of the average compressive stress due to dead load at the level being analyzed for all loading combinations except those including seismic loadings. In no case, however, shall the allowable shear stresses exceed the limiting values given in Table 12A-7.

(D) CONSTRUCTION. Masonry designed in accordance with this Section shall have head and bed joints with an average thickness not over 1/2 inch. All interior joints shall be solidly filled.

(Replace Sec. 12A.6.2 with the following:)

12A.6.2 ALTERNATE DESIGN PROCEDURES FOR UNREINFORCED MASONRY

Unreinforced brick masonry using solid clay units and unreinforced concrete masonry may be designed by the alternate provisions following. The requirements of Sec. 12A.6.1 shall apply except as specifically modified.

(A) UNREINFORCED BRICK MASONRY USING SOLID CLAY UNITS.

Unreinforced brick masonry using solid clay units may be designed under the applicable cited provisions of the "Building Code Requirements for Engineered Brick Masonry", Brick Institute of America, 1969 (BIA-1969) subject to the design and construction limitations listed.

1. Design shall conform to BIA-1969 Sec. 4.7.1 through 4.7.12 excluding Sec. 4.7.9, 4.7.10 and 4.7.12.5.

2. Materials shall conform to BIA-1969 Sec. 2.2.1 and 2.2.2.1.

3. Mortar joints shall conform to BIA-1969 Sec. 5.2.1

5A/43 cont. 4. Construction shall be solid masonry, cavity wall or grouted masonry - multiple wythe.

87 Mod. cont. 5. Allowable stresses shall conform to BIA-1969 Table 3 with the following modifications:

a. The words "without inspection" of BIA-1969 Table 3 shall mean "without special inspection". The words "with inspection" shall mean "with special inspection".

b. Allowable compressive and bearing stresses without special inspection shall be 2/3 of those with special inspection.

c. Allowable flexural tension stresses without special inspection shall be 1/2 of those with special inspection.

5A/44 d. Allowable shear stresses without special inspection shall be 60% of those with special inspection.

6. Modulii of Elasticity shall conform to Table 12A-5, this chapter.

87-5 (9-0-1) 7. Brick Masonry ultimate compressive strength f'_m for use in this ~~the~~ alternate procedure shall be ~~73% of the values obtained by the provisions of Sec. 12A.5.a(A) of this chapter which otherwise are applicable.~~ taken from Table 12A-4, or shall be 82% of the values obtained by prism testing according to section 12A.8 (h/t =2)

5A/45 8. References to BIA-1969 Sec. 4.7.9 and 4.7.10 shall mean reinforced masonry conforming to the provisions for same of this chapter.

9. Footnote 4 to Table 12A-4 is applicable.

10. The Slenderness requirements of Sec. 12A.4.2 this chapter shall be satisfied; however these requirements and the slenderness limits of the alternate procedure may be waived in accordance with Sec. 1.5 of Chap. 1. Particular care shall be paid to requirements for stress and stability under reduced vertical loads.

11. For walls and elements subject to bending in one direction only, where the ratio e/t exceeds 1/3, the maximum tension and flexural compression stresses, assuming linear stress distribution, shall not be exceeded.

12. Design of shear walls shall comply with all applicable provisions of this chapter. Loading combinations shall include reduced vertical loads in combination with seismic loads, where applicable. The allowable shear stress increase shall consider this vertical load reduction.

141 3 of 7

5A/46 87 Mod. cont.

(B) UNREINFORCED CONCRETE MASONRY.

Unreinforced concrete masonry using solid or hollow units and grouted or ungrouted construction, may be designed using the applicable cited supplemental provisions of the "Specification for the Design and Construction of Load-Bearing Concrete Masonry", National Concrete Masonry Assoc., 1979 (NCMA - 1979) subject to the design and construction limitations listed.

5A/47 87-11 (8-1-1)

1. Design shall conform to NCMA - 1979 Sec. 3.3.1, 3.3.2 and Sec. 3.8.6 through 3.8.8 except that allowable stresses and resistances therein are for work only with special inspection; for work without special inspection ~~they shall be reduced 50%~~ compressive stresses shall br reduced by 1/3, other stresses shall be reduced bv 1/2.

5A/48 87/7 (9-0-1)

2. Allowable shear and tension stresses shall conform to **Table 12A-3**, this chapter.

3. Mortar shall conform to NCMA-1979 Sec. 2.2.2.2.

4. Joints shall conform to NCMA-1979 Sec. 4.2.3.2.

5. **BEARING STRESS (f_{br})**

On full area, $F_{br} = .25\ f'_m$

On one-third area or less, $F_{br} = .30\ f'_m$

This increase shall be permitted only when the least distance between the edges of the loaded and unloaded area is a minimum of 1/4 of the parallel side dimension of the loaded area. The allowable bearing stress on a reasonably concentric area greater than one-third, but less than the full area shall be interpolated between the values given.

(C) DESIGN, UNREINFORCED HOLLOW CLAY MASONRY

GENERAL

Unreinforced masonry using hollow clay units may be used when designed in accordance with the provisions of this section.
5A/49 87/1 (9-0-1) The allowable stresses shown herein are for work only with special inspection, for work without special inspection these allowable stresses shall be reduced by 1/3 for compressive stress, other stresses shall be reduced by 1/2.

(C)1 COMPRESSION IN WALLS AND COLUMNS

A. AXIAL LOADS

Stresses due to compressive forces applied at the centroid of the member may be computed assuming uniform distribution over
5A/50 the effective area. The allowable axial compressive stress is given by:

$$F_a = .225\, f'_m\, [1-(h'/40t)^3] \quad \text{walls} \qquad \text{Eq. 12A-1}$$

$$F_a = 0.18\, f'_m [1-(h/30t^3)] \text{ columns}$$

in which:

f'_m = ultimate compressive strength of masonry. For assumed values of f'_m use Table 12A-1.

87/4 (9-0-1)

h = (same as p. 149)

5A/51 t = effective thickness (the minimum effective thickness in the case of columns

ASSUMED VALUES OF f'_m for use in Eq. 12A-1.

The design ultimate compressive stress of masonry, f'_m, ay be assumed based upon the compressive strength of the units and mortar to be used. Values of f'_m which may be assumed are presented in Tables 12A-1.

141 5 of 7

B. BEARING STRESS (f_{br})

On full area, $F_{br} = .25\ f'_m$ Eq. 12A-2

On one-third area or less, $F_{br} = .30\ f'_m$ Eq. 12A-3

87/6 (9-0-1) This increase shall be permitted only when the least distance between the edges of the loaded and unloaded area is a minimum of 1/4 of the parallel side dimension of the loaded area. The allowable bearing stress on a reasonably concentric area greater than one-third, but less than the full area shall be interpolated between the values given.

(c)2. BENDING OR COMBINED BENDING AND AXIAL LOADS

87/8 (9-0-1) Stresses due to combined bending and centroidally applied axial load shall satisfy the requirements of Section 12A.6.3(b) where F_a is given by Equation 12A-1. (A) and (B).

5A/51 cont.

(c)3. FLEXURAL DESIGN

A. Tensile stresses due to flexural shall not exceed the values given in Section 12A.6.2.(c)3B where:

$$f_b = Mc/I \qquad \text{Eq. 12A.4}$$

87/9 (9-0-1) and:

f_b = computed flexural stress due to bending loads only.

M = design moment on a section.

c = distance from neutral axis to extreme fiber.

I = moment of inertia of the section considered.

B. TENSILE STRESS - FLEXURAL (F_t)

87/10 (6-3-1) With no tensile reinforcement in masonry

Values for tension normal to bead joints are for running bond; no tension is allowed across bead joints in stack bond masonry.

Tension Normal to Bed Joints (net bedded area)

	Clay Units
Hollow Units, F_t =	24

Tension Normal to Head Joints

Hollow Units, F_t = 48 psi

Stresses are calculated on net bedded areas

87-10 cont.

Compression stresses due to flexural (F_b) shall not exceed 0.33 f'_m.

(C)4. SHEAR IN FLEXURAL MEMBERS AND SHEAR WALLS

A. SHEAR IN FLEXURAL MEMBERS

$$v_m = V/A_e \qquad \text{Eq. 12A-5}$$

where:

5A/51 cont.

v_m = design shear stress with no shear reinforcement. The allowable shear stresses, V_m, may be equal to $1.0\sqrt{f'_m}$ but not to exceed 50 psi.

87/12 (9-0-1)

V = total design force

A_e = effective area

Where v_m as computed by the foregoing equation exceeds the allowable shear stress, V_m, web reinforcement shall be provided and designed to carry the total shear force in accordance with the requirements of reinforced masonry in Section 12.6.3.(c).

B. SHEAR WALLS WITH NO SHEAR REINFORCEMENT SHALL BE DESIGNED USING THE FOLLOWING EQUATIONS:

5A/52 87/15 (no vote)

No shear reinforcement

$$a/L < 1, \quad V_m = \frac{1}{3}\left[4 - \frac{a}{L}\right] f'_m, \quad 50 \text{ max.} \qquad \text{Eq. 12A-6}$$

$$A/L \geq 1, \quad V_m = 1.0 \sqrt{f'_m}, \quad 35 \text{ max.} \qquad \text{Eq. 12A-7}$$

141 7 of 7

5A/52 cont. 87/15 cont.

a = height of wall or segment for cantilevered condition, 1/2 height of wall or segment for fixed conditions top and bottom.

L = length of wall or segment.

The allowable shear stress in masonry may be increased by $0.2\ f_{md}$, where f_{md} is the compressive stress in masonry due to dead load only.

5A/53 87/13 (9-0-1)

C. SHEAR WALL OVERTURNING

Not more than 2/3 of the dead load shall be used to resist overturning due to horizontal forces. Any resultant tensile stresses shall be resisted by reinforcing in accordance with the requirements of Section 12A.6.3.

87/14 (9-0-1)

(c) 5. CORBELS

The slope of corbelling (angle measured from the horizontal to the face of the corbelled surface) shall not be less than 60°.

The maximum horizontal projection of corbelling from the plane of the wall shall not exceed one-half the wythe thickness for cavity walls or one-half the wall thickness for other walls.

5A/54

12A.6.3 DESIGN PROCEDURE FOR REINFORCED MASONRY

The design of reinforced masonry shall comply with this Section and be based on accepted engineering practice for the "working stress" theory which incorporates the following principal assumptions:

- A section that is plane before bending remains plane after bending.
- Moduli of elasticity of the masonry and of the reinforcement remain constant.

-142-

- Tensile forces are resisted only by the tensile reinforcement.

- Reinforcement is completely surrounded by and bonded to masonry material so that they will work together as a homogenous material within the range of working stresses.

Stresses shall not exceed those given in Sec. 12A.5 and this Section.

(A) FLEXURAL COMPUTATIONS. All members shall be designed to resist at all sections the maximum bending moment and shears produced by dead load, live load, and other forces as determined by the principles of continuity and relative rigidity. The clear distance between lateral supports of a beam shall not exceed 32 times the least width of the compressive flange or face.

In computing flexural stresses for masonry wall elements the effective length tributary to a reinforcing bar shall be limited to:

88 (10-0-0) 1. Running Bond. Six times ~~that~~ the wall thickness. ~~for construction using running bond.~~

89 (10-0-0) 2. Stacked Bond. Three times the wall thickness or the length of the masonry units for construction using stacked bond, whichever is less.

(B) COMBINED AXIAL AND FLEXURAL STRESSES. Members subject to combined axial and flexural stresses shall be proportioned, except as modified by Chapter 12, so that the following formula is satisfied:

$$\frac{f_a}{F_a} + \frac{f_b}{F_b} \leq 1.0 \qquad \text{(12A-7)}$$

where:

5A/54 cont. f_a = Computed axial unit stresses, determined from total axial load and effective area.

F_a = Axial unit stress permitted by this Chapter if member were carrying axial load only.

f_b = Computed flexural unit stress.

F_b = Flexural unit stress permitted by this Chapter if member were carrying bending load only.

90 (7-1-2) Other interaction equations based on elastic methods and design assumptions may be used.

(C) SHEAR AND DIAGONAL TENSION. The shearing unit stress, v, in reinforced masonry flexural members shall be computed by:

$$v = \frac{V}{bjd} \qquad \text{(12A-8)}$$

where:

b = The net effective width of a rectangular section or stem of I- or T-sections. The value of bd shall not exceed the net vertical shear area, net bedded area, nor the net cross-sectional area in hollow unit construction.

d = The effective depth.

12A.6.3(C) Cont.

91 (10-0-0) j = Ratio of distance between centroid of compression and centriod of tension to depth, d. j = ~~0.8~~ may be assumed as 0.85 or j may be determined by a strain compatibility analysis.

92 (10-0-0) In vertical joints of stacked bond construction, ~~the masonry~~ the vertical joints shall not be assumed to resist shearing stresses. Where the shear reinforcement is parallel to the vertical joints, reinforcement equal to the required shear reinforcement shall be provided perpendicular to the vertical joints at a spacing not to exceed 16 inches. ~~Bond beam units shall be used for hollow unit construction.~~

93 (10-0-0) Where the values of the shearing unit stress computed by Formula 12A-8 exceeds the shearing unit stress, v_m, ~~masonry web~~ shear reinforcement shall be provided to carry the entire stress. ~~Web reinforcement shall cross stacked bond joints.~~

94 (10-0-0) 1. ~~Web~~ shear Reinforcement. ~~Web~~ shear reinforcement shall consist of:

a. ~~Stirrups or web~~ Shear reinforcement bars perpendicular to longitudinal steel, or

b. ~~Stirrups or web~~ Shear reinforcement bars anchored around or beyond the longitudinal steel and making an angle of 30 degrees or more thereto, or

c. Longitudinal bars bent so that the axis of the inclined portion of the bar makes an angle of 15 degrees or more with the axis of the longitudinal portion of the bar, or

5A/54 cont. d. Special arrangements of bars with adequate provisions to prevent slip of bars or splitting of masonry by the reinforcement.

95 (9-0-1) ~~Stirrups or other~~ Bars to be considered effective as ~~web~~ shear reinforcement shall be anchored at both ends.

96 (10-0-0) 2. ~~Stirrups.~~ Required Area. The area of steel, A_v, required ~~in stirrups placed~~ perpendicular to the longitudinal reinforcement shall be computed by the following formula:

$$A_v = \frac{Vs}{f_v jd} \qquad (12A\text{-}9)$$

where V is the total shear, in pounds.

97 (10-0-0) s is the spacing of ~~stirrups or bent~~ bars in a direction parallel to that of the main reinforcement, inches.

98 (10-0-0) f_v is the allowable unit stress in the ~~web~~ shear reinforcement, psi.

99 (10-0-0) Inclined ~~stirrups~~ bars shall be proportioned in accordance with the provisions of paragraph 3 of this Subsection.

100 (10-0-0) 3. Bent Bars. Only the center 3/4 of the inclined portion of any longitudinal bar that is bent up for ~~web~~ shear reinforcement shall be considered effective for that purpose, and such bars shall be bent around a pin having a diameter not less than six times the bar size.

12A.6.3(C) Cont.

101 (10-0-0) When the ~~web~~ shear reinforcement consists of a single bent bar or of a single group of parallel bars all bent at the same distance form the support, the required area, A_v, of such bars shall be computed by the following formula:

$$A_v = \frac{V}{f_v \sin a} \qquad (12A\text{-}9a)$$

where a is the angle between inclined web bars and the axis of the beam.

Where there is a series of parallel bars or groups bent up at different distances from the support, the required area shall be determined by the following formula:

$$A_v = \frac{Vs}{f_v jd\ (\sin a + \cos a)} \qquad (12A\text{-}9b)$$

102 (10-0-0) 4. Spacing of ~~Web~~ shear Reinforcement. Where ~~web~~ shear reinforcement is required it shall be so spaced that every 45 degree line extending from the mid-depth of the beam to the longitudinal tension bars shall be crossed by at least one line of ~~web~~ shear reinforcement.

(D) REINFORCEMENT DEVELOPMENT, ANCHORAGE, AND SPLICES. Reinforcement shall be arranged, placed, spliced, and anchored to develop design stresses therein and as specified in this Subsection and Chapter 12.

5A/54 cont.

103 (9-0-1) 1. General Development Requirements. The calculated tension or compression in the reinforcement at each section shall be developed on each side of that section by embedment length or end anchorage or a combination thereof. For bars in tension, hooks may be used in developing the bars. Plain bars in tension shall terminate in standard hooks. Tension reinforcement may be anchored by bending ~~it across the web~~ and making it continuous with the reinforcement on the opposite face of the member, or anchoring it there.

104 (10-0-0) The critical sections for development of reinforcement in flexural members are at points of maximum stress and at points within the span where adjacent reinforcement terminates, or is bent. Reinforcement shall extend beyond the point at which it is no longer required to ~~resist~~ flexure for a minimum distance equal to the effective depth of the member or 12 bar diameters, whichever is greater, except at supports of simple spans and at the free end of cantilevers. Continuing reinforcement shall have an embedment length not less than the development length l_d beyond the point where bent or terminated tension reinforcement is no longer required to resist flexure.

Flexural reinforcement shall not be terminated in a tension zone unless one of the following conditions is satisfied:

a. Allowable shear stresses at the cutoff point do not exceed 2/3 of that permitted, or

105 (10-0-0) b. ~~Stirrup area~~ Area of shear reinforcement in excess of that required is provided along each terminated bar over a distance from the termination point equal to 3/4 the effective depth of the member. The ~~stirrups~~ shear reinforcement shall be proportioned to provide 50 percent of the allowable shear capacity of the member based on the allowable shear stresses of Table 12A-5 for reinforcement taking no shear. The resulting spacing s shall not exceed $d/8\beta_b$ where β_d is the ratio of the area of bars cut off to the total area of bars at the section, or

c. The continuing bars provide double the area required for flexure at the cutoff point and shear stresses do not exceed 3/4 of that permitted.

2. Positive Moment Reinforcement. At least 1/3 of the positive moment reinforcement in simple members and 1/4 the positive moment reinforcement in continuous members shall extend along the same face of the member into the support, and in beams at least 6 inches.

5A/55 106 (6-4-0) When a flexural member is part of the primary lateral load resisting system, the positive reinforcement required above to be extended into the support shall be anchored for its tension development length, l_d, or if the support is not of masonry construction, the reinforcement shall be anchored to develop its ~~yield strength~~ at the face of the support.
calculated stress

At simple supports and at points of inflection, positive moment tension reinforcement shall be limited to a diameter such that the required development length, l_d, determined in this Section does not exceed:

$$\frac{M_c}{V} + l_a \qquad (12A\text{-}10)$$

Where M_c is the lesser moment capacity of the member, based on allowable stresses, determined from both the masonry and the reinforcement, and V is the maximum applied shear at the section. At the point of support, l_a shall be the sum of the embedment length supplied beyond the center of the support and the equivalent embedment length of any furnished hook or mechanical anchorage. At the point of inflection l_a shall be limited to the effective depth of the member or $12d_b$, whichever is greater, where d_b is the diameter of the reinforcement.

3. Negative Moment Reinforcement. Tension reinforcement in a continuous, restrained, or cantilever member, or in any member of the primary lateral force resisting system, shall be anchored in or through the supporting member by embedment length, hooks, or mechanical anchorage.

Negative moment reinforcement shall be developed into the span as required by Sec. 12A.6.3(D)1.

5A/56 At least 1/3 of the total reinforcement provided for negative moment at the support shall have an embedment length beyond the point of inflection not less than the effective depth of the member, $12d_b$, or 1/16 of the clear span, whichever is greater.

4. Special Members. Adequate end anchorage shall be provided for tension reinforcement in flexural members where reinforcement stress is not directly proportional to moment; such as: sloped, stepped, or tapered members; brackets; deep beams; or members in which the tension reinforcement is not parallel to the compression face.

107 (8-0-2) 5. Development Lengths. The basic development length, l_d, for deformed reinforcement shall be at least $\cancel{.05\, d_b^2 f_y/\sqrt{f_g}}$ (but not less than 24 d_b for reinforcement of 40,000 psi yield strength nor $36d_b$ for reinforcement over 40,000 psi yield strength, nor less than 12 inches for reinforcing bars and 6 inches for masonry joint reinforcement where:

$0.0015 d_b f_s$

d_b = the diameter of the smaller bar spliced, inches.

$\cancel{f_y}$ = the specified bar ~~yield strength~~, psi.
calculated stress
f_s

12A.6.3(D) Cont.

107 cont.

~~f_g = the strength of the mortar or grout, as applicable, immediately surrounding the reinforcement but not more than the prism strength, psi.~~

Development lengths for plain reinforcing shall be twice that required for deformed reinforcement but not less than 12 inches.

EXCEPTIONS:
1. For deformed main compression reinforcement in columns that are not part of the seismic system, these values may be reduced to $18d_b$ for bars of 40,000 psi yield strength and and $27d_b$ for bars over 40,000 psi yield strength.
2. In flexural members that are not part of the primary lateral load resisting system the development lengths may be reduced where excess reinforcement is provided. For these cases, the previously determined development lengths may be multiplied by the ratio of the area of reinforcement required by design to that provided.

6. Hooks. The term "hook" or "standard hook" as used herein shall mean:

a. A complete semicircular turn plus an extension of at least 4 bar diameters at the free end of the bar but not less than 2-1/2 inches, or

5A/56 cont.

b. A 90-degree bend having a radius of not less than 4 bar diameters plus an extension of 12 bar diameters, or

c. For stirrup anchorage only, a 135-degree turn with a radius on the axis of the bar of 3 diameters, plus an extension of at least 6 bar diameters at the free end of the bar.

EXCEPTIONS:
1. The hook for ties placed in the horizontal bed joints, where permitted, shall consist of a 90-degree bend plus an extension of 32 bar diameters.
2. The hook for ties in the form of crossties as described in this Subsection may have a 90-degree hook at one end provided the 90-degree hooks are alternated with the 135-degree hooks along the bar.

Inside diameter bends shall be as required for concrete reinforcement. Hooks having a radius of bend of more than 6 bar diameters shall be considered merely as extensions to the bars. In general, hooks shall not be permitted in the tension portion of any beam except at the ends of simple or cantilever beams or at the freely supported ends of continuous or restrained beams.

For tension bars, the hook at its start (point of tangency) may be considered as developing not more than 3/8 of the allowable tensile stress or the development length, l_d, for reinforcement of 40,000 psi yield strength and not more than 5/16 of the allowable tensile stress of the development length for reinforcement over 40,000 psi yield strength.

Hooks shall not be considered effective in adding to the compressive resistance of bars.

Any mechanical device capable of developing the strength of the bar without damage to the masonry may be used in lieu of a hook. Tests must be presented to show the adequacy of such devices.

7. Splices. Splices shall be made only at such point and in such manner that the strength of the member will not be reduced. Splices shall be made by lapping the bars, by welding, or by mechanical connections. Lapped splices shall not be used for tension tie members.

107A (10-0-0) Lengths of laps, in inches, for deformed reinforcement shall be at least ~~$0.08\, d_b^2\, f_y/\sqrt{f_g}$~~ $0.002 d_b F_s$ but not less than $40d_b$ for reinforcement of 40,000 psi yield strength nor less than 60 d_b for reinforcement over 40,000 psi yield strength, nor less than 12 inches for reinforcing bars and 9 inches for masonry joint reinforcement. Lap lengths for plain reinforcing shall be twice that required for deformed bars but not less than 12 inches. The terms d_b, ~~f_y~~, and ~~f_g~~ F_s shall be as defined in Sec. 12A.6.3(D)5.

> EXCEPTION:
> For deformed main compression reinforcement in columns that are not part of the seismic system, the lap length may be reduced to $30d_b$ for bars of 40,000 psi yield strength and $45d_b$ for bars over 40,000 psi yield strength.

5A/56 cont. Welded or mechanical connections shall develop the yield strength of the bar in tension.

> EXCEPTION:
> For compression bars in columns that are not part of the seismic system and are not subject to flexure the compressive strength need only be developed.

108 (10-0-0) 8. Anchorage of ~~Web~~ Shear Reinforcement. Shear ~~web~~ reinforcement shall be placed as close to the compression and tension surfaces of the member as cover requirements, practicability, and the proximity of other steel will permit, and in any case the ends of single-leg, simple- or multiple-U stirrups shall be anchored by one of the following means:

a. A standard hook plus an effective embedment of 5/8 l_d for reinforcement of 40,000 psi yield strength or 11/16 l_d for reinforcement over 40,000 psi yield strength. The effective embedment of a stirrup leg shall be taken as the distance between the mid-depth of the member, d/2, and the start of the hook (point of tangency), or

b. Embedment above or below the mid-depth, d/2, of the compression side of members that are not part of the seismic system for a full development length l_d, or

c. Bending around the longitudinal reinforcement through at least 180 degrees. Hooking or bending stirrups around the longitudinal reinforcement shall be considered effective anchorage only when the stirrups make an angle of at least 45 degrees with deformed longitudinal bars not less in diameter than the stirrup bars.

Between the anchored ends, each bend in the continuous portion of a transverse simple- or multiple U-stirrup shall enclose a longitudinal bar, not less in diameter than the stirrup bars.

109 (10-0-0) Longitudinal bars bent to act as ~~web~~ shear reinforcement shall, in a region of tension, be continuous with the longitudinal reinforcement and in a compression zone shall be anchored, above or below the mid-depth, d/2, as specified for development length in this Subsection.

12A.6.3(D) Cont.

Pairs of U-stirrups or ties so placed as to form a closed unit shall be considered properly spliced when the laps satisfy the requirements of this Subsection.

5A/56 cont.

9. Flexural Compression Reinforcement. Required flexural compression steel in members that are not part of the seismic system shall be anchored (enclosed) by ties or stirrups not less than 1/4 inch in diameter, spaced not further apart than 16 bar diameters or 48 tie diameters. Such ties or stirrups shall be used throughout the distance where compression steel is required.

Required flexural compression reinforcement in members that are part of the seismic system shall be anchored as required for column longitudinal reinforcement.

5A/57 110 (8-0-2)

(E) REINFORCED MASONRY WALLS. ~~Reinforced masonry bearing wall thicknesses shall conform to Sec. 12A.4.2 and to the requirements of this Subsection and Chapter 12.~~

5A/58 111 (8-2-0)

1. Stresses. The axial stress in reinforced masonry bearing walls shall not exceed the value determined by the following formula:

$$f_m = \overset{0.225}{\cancel{0.20}}\, f'_m \left[1 - \left(\frac{h}{40t}\right)^3\right] \qquad (12A\text{-}11)$$

where:

5A/59

f_m = Compressive unit axial stress in masonry wall.

f'_m = Masonry compressive strength as determined by Sec. 12A.5.1. The value of f'_m shall not exceed 6000 psi.

t = Thickness of wall in inches.

112 (9-0-1)

h = Effective height or width. ~~Clear distance in inches, between supporting or stiffening elements (vertical or horizontal).~~ Effective height or length different from clear distance may be used if justified.

5A/60 113 (9-1-0)

~~2. Reinforcement. Reinforcement of walls and wall elements shall be provided for all loadings and other requirements of these Regulations. Except for the more stringent requirements of Chapter 12 and this Chapter, as applicable, the minimum reinforcement ratio in each direction shall be .0007 and the sum of the ratios for each direction shall not be less than .002. Maximum reinforcement spacing shall not exceed 4 feet on center. Only horizontal reinforcement which is continuous in the wall shall be considered in computing the minimum area of reinforcement.~~

2. Reinforcement. Reinforcement of walls and wall elements shall be provided for all loadings as required by design. Where reinforcement ratios are less than: A. 0.0007 in any direction, B. 0.002 or the sum of the ratios in each direction then; permissible stresses for unreinforced masonry must be used. If reinforcement ratios are equal to or greater than these ratios, the stresses of table 12A-5 may be used.

5A/61 114 (8-1-1)

~~If the wall is constructed of more than two units in thickness, the minimum area of required reinforcement shall be equally divided into two layers, except where designed as retaining walls. Where reinforcement is added above the minimum requirements such additional reinforcement need not be so divided.~~

When using the stresses in Table 12.5A, horizontal reinforcement shall be provided at the top of footings, at the top of wall openings, at roof and floor levels and at the top of parapet walls. If continuous, these special bars may be considered in satisfying the minimum horizonal reinforcement ratios of Sec. 12.7.

There shall not be less than one No. 4 or two No. 3 bars on all sides of, and adjacent to, every opening which exceeds 24 inches in either direction, and such bars shall extend not less than the development length, but in no case less than 24 inches, beyond the corners of the opening. ~~The bars required by this paragraph shall be in addition to the minimum reinforcement required elsewhere.~~

12A.6.3(E) Cont.

3. Columns Constructed Within Walls. When the reinforcement in bearing walls is designed, placed, and anchored in position as for columns, the allowable stresses shall be as for columns. The length of the wall to be considered effective shall not exceed the center-to-center distance between concentrated loads nor shall it exceed the width of the bearing plus 4 times the wall thickness.

4. Shear Walls. Shear walls shall, additionally, comply with the provisions of Sec. 12A.6.4.

(F) REINFORCED MASONRY COLUMNS. The least dimension of every reinforced masonry column shall be not less than 12 inches.

EXCEPTION:
The minimum column dimension may be reduced to not less than 8 inches provided the design is based upon 1/2 the allowable stresses for axial load. Bending stresses need not be so reduced.

5A/62 115 (6-3-1)

The axial load on columns shall not exceed:

$$P = A_g\,(\overset{0.20}{\cancel{0.18}}\, f'_m + 0.65\, p_g \overset{F_s}{\cancel{f_s}})\,[(1 - (\frac{h}{40t})^3] \qquad \text{(12A-12)}$$

where:

P = Maximum concentric column axial load.

A_g = The gross area of the columns with deductions for rakes and similar joint treatments.

f'_m = Compresssive masonry strength as determined by Sec. 12A.5.1. The value of f'_m shall not exceed 6000 psi.

116 (10-0-0)

p_g $\cancel{p_g}$ = Ratio of the effective cross-sectional area of vertical reinforcement to A_g.

f_s = Allowable stress in reinforcement; see Sec. 12A.5.2.

t = Least thickness of column in inches.

5A/63

h = ~~Clear height in inches.~~ Effective height-Clear distance in inches between supporting or stiffening elements. Effective height different from clear distance may be used if justified

117 (9-0-1)

118 (10-0-0)

1. Vertical Reinforcement. The ratio p_g shall not be less than 0.5 percent nor more than 4 percent. The number of bars shall not be less than four, nor the size less than No. ~~4~~ 3. Except as provided in Sec. 12A.2.4(D), the maximum bar size shall be No. 10. Splices shall conform to Sec. 12A.6.3(D)7.

2. Ties. All longitudinal bars for columns shall be enclosed by lateral ties. Lateral support shall be provided to the longitudinal bars, as specified below, by the corner of a complete tie having an included angle of not more than 135 degrees or by a hook at the end of a tie. The corner longitudinal bars shall have lateral support provided by a complete tie enclosing the longitudinal bars.

Lateral ties shall be placed not less than 1.5 inches and not more than 5 inches from the surface of the column, and may be against the vertical bars or placed in the rizontal bed joints where permitted by Sec. 12A.3.5(C).

12A.6.3(F) Cont.

The spacing shall not be greater than 16 bar diameters, 48 tie diameters, or the least column dimension, but not more than 18 inches.

Ties shall be at least No. 2 in size for No. 7 or smaller longitudinal bars and No. 3 in size for No. 8 or larger longitudinal bars except that when No. 11 bars are allowed under the exceptions to Sec. 12A.2.4(D) the minimum tie size shall be No. 4.

EXCEPTION:
Ties placed in horizontal bed joints, where permitted by Sec. 12A.3.5(C) may be smaller in size than required above but not less than No. 2 in size, provided that the total cross-sectional area of such smaller ties crossing a vertical plane is equal to the area of the larger ties at their required spacing.

5A/63 119 (10-0-0) ~~See Chapter 12 for additional requirements, where applicable.~~

120 (10-0-0) 3. ~~Grouting. All columns shall be grouted solid.~~ All column or longitudinal reinforcing shall be solidly embedded in grout.

12A.6.4 MASONRY SHEAR WALLS

121 (10-0-0) The design of masonry shear walls and wall elements for in-plane shears shall conform to this Section. ~~Chapter 12~~, and all applicable provisions of these Regulations. See Chapter 12 for stacked bond construction limitations based on construction categories.

122 (9-0-1) (E) ~~(A)~~ BOUNDARY ELEMENTS. Boundary elements are members at the ends of shear walls which help resist overturning effects.

Unit compressive stresses in the masonry at wall openings shall conform to the requirements of this Chapter unless boundary elements conforming to the provisions of Sec. 12.7.2 are provided.

5A/64 123 (9-1-0) Reinforcement required to resist wall shear shall be terminated with a standard hook ~~which encloses the boundary reinforcing~~ at the end of the wall sections. The hook may be turned up, down, or horizontal and shall be embedded in mortar or grout. Wall reinforcement terminating in boundry columns or beams shall be fully anchored into the boundary elements.

(A) ~~1. Intersecting Walls and Masonry Columns.~~ INTERSECTING WALLS AND MASONRY COLUMNS. Where shear walls intersect a wall or walls to form symmetrical T- or I-sections, the effective flange width shall not exceed 1/6 of the total wall height above the level being analyzed, and its overhanging width on either side of the shear wall shall not exceed six times the nominal thickness of the intersected wall for unreinforced masonry nor eight times the nominal thickness of the intersected wall for reinforced masonry.

5A/65 Where shear walls intersect a wall or walls to form L or C sections, the effective overhanging flange width shall not exceed 1/16 of the total wall height above the level being analyzed nor six times the nominal thickness of the intersected wall for unreinforced masonry nor eight times the nominal thickness of the intersected wall for reinforced masonry.

Limits on effective flange width may be waived when approved after a review of a written justification.

The vertical shear at the intersection of shear wall web and flange shall be considered in design.

124 (10-0-0) (B) VERTICAL TENSION AND COMPRESSION STRESSES. Except as provided for masonry designed under the alternate design procedure of Sec. 12A.6.2(A) ~~12A.6.2 as modified by Chapter 12,~~ vertical stresses in shear walls shall be determined from the combined effects of vertical loads ~~and from the overturning effects of lateral loads. Minimum vertical loads shall be considered. Formula 3-2a shall be used for unreinforced masonry design.~~

12A.6.4(B) Cont.

125 (8-2-0) 5A/65 cont. Allowable tension stresses for unreinforced masonry shall not be exceeded. Anchorage ~~Reinforcement anchored~~ to the foundation shall be provided to resist calculated tension in unreinforced walls.

126 (9-0-1) (C) HORIZONTAL ELEMENTS. Provisions shall be made for shear and flexural effects in horizontal elements of shear wall systems, such as beams that couple walls ~~piers. For unreinforced masonry, allowable shear and tensile stresses shall not be exceeded. Tensile reinforcing and shear reinforcing, if required, shall be provided for reinforced masonry. In reinforced masonry, when the horizontal span of the element is less than twice the total height of the element, shear reinforcing shall be in the form of diagonal bars extending from corner to corner with complete anchorage to the pier elements or shall be web reinforcing conforming to Sec. 12A.6.3(C).~~

5A/66 127 (9-1-0) (D) WALL SHEAR. In computing the shear resistance of the wall, only the web shall be considered. ~~For unreinforced masonry~~ The depth of the web may be considered out to out of flanges.

128 (10-0-0) Shear resistance of masonry shall be based on minimum net areas parallel to the shear. Both vertical and horizontal shear shall be considered. ~~including the net bedded area, the net cross-sectional area of hollow units, and the net vertical shear area. Where only partial mortar coverage is provided, such as in hollow unit construction where only the face shells in the bed joints and partial head joint coverage is usually specified, only the actual specified mortar coverage shall be considered effective. However~~, Continuous vertical and horizontal grout elements may be considered as part of the net areas.

For reinforced masonry, the shear stress shall be computed by Formula 12A-8. Horizontal shear reinforcing, when required, shall be provided with that portion required to resist shear uniformly distributed and spaced out not more than 1/3 the wall depth or as required by Sec. 12.7, whichever is less.

~~Reinforcement required to resist wall shear shall be terminated with a standard hook which encloses the boundary reinforcing of wall sections. The hook may be turned up, down, or horizontal and shall be embodded in mortar or grout. Wall reinforcement terminating in boundary columns or beams shall be fully anchored into the boundary elements.~~

5A/67 12A.6.5 SCREEN WALLS

Masonry units may be used in nonbearing decorative screen walls. Units may be laid up in panels with units on edge with the open pattern of the unit exposed in the completed wall.

129 (10-0-0) The panels shall be capable of spanning between supports to resist horizontal forces. Wind loads shall be based on gross projected area of the ~~block.~~ panel.

130 (10-0-0) ~~The maximum size of panels shall be 144 square feet with the maximum dimension in either direction of 15 feet. Each panel shall be supported on all edges by a structural member of concrete, masonry, or steel. Supports at the top and ends of the panel shall be by means of confinement of the masonry by at least 1/2 inch into and between the flanges of a steel channel. The space between the end of the panel and the web of the channel shall be at least 1/2 inch and shall be void of mortar. The use of equivalent configuration in other steel sections or in masonry or concrete is acceptable.~~

131 (10-0-0) ~~Horizontal and vertical joints shall be not less than 1/4 inch thick. All joints shall be completely filled with mortar and shall be shoved joints.~~

(A) UNREINFORCED PANELS. Unreinforced panels are allowed only in Category A construction provided allowable stresses are not exceeded. Otherwise the panels shall be reinforced as provided in Sec. 12A.6.5(B).

12A.6.5 Cont.

(B) REINFORCED PANELS. All panels in Categories B, C, or D construction shall be reinforced per Sec. 12.4.1(D).

132 (9-0-1) Sec. 12A.7 ~~SPECIFIC INSPECTIONS, SPECIAL~~ INSPECTIONS, AND TESTS

133 (9-0-1) ~~Specific and Special~~ Inspections shall be provided and Tests shall be made in accordance with the requirements of this Section. The Regulatory Agency may for masonry work which it determines to be minor in nature waive requirements for certifications, ~~Specific~~ Inspections, Tests, ~~Special Inspection~~, or some items of Special Inspection. ~~The Special Inspections and Tests of Sec. 12A.7.2, where applicable, shall be provided for all parts of masonry construction. The Special Inspection requirements of Sec. 1.6.2 are in addition to Sec. 12A.7.2 and apply only to the designated seismic system.~~

134 (9-0-1) ~~Specific and Special~~ Inspection shall be done to an extent that the Inspector(s) or testing agency can certify to the requirements of Sec. 1.6.4. ~~In general, for large jobs or for moderate size jobs, this will require continuous observation during the masonry work. However, some inspections may be done on a periodic basic provided they satisfy the requirements of this Chapter and provided this periodic scheduled inspection is performed as outlined in the project design documents or the approved Quality Assurance Plan.~~

135 (9-0-1) 12A.7.1 ~~SPECIFIC~~ FREQUENCY OF INSPECTIONS AND TESTS

5A/67 For all masonry construction, ~~Specific~~ Inspection, Certifications, or Tests shall be provided when required by one or more of the following:

- When required by provisions of Chapter 12 and this Chapter.
- When in the opinion of the Regulatory Agency work involves unusual hazards.
- Where required by the approved Quality Assurance Plan or design documents.

~~The Specific~~ Inspections, Certifications, or Tests may consist of one or more of those listed in Sec. 12A.7.2(A) and 12A.7.2(B), however in order to qualify as Special Inspection all the applicable Certifications, Inspections, and Tests of Sec. 12A.7.2 shall be provided.

12A.7.2 SPECIAL INSPECTION AND TESTS

All applicable Special Inspections and Tests designated in Sec. 12A.7.2(A) and 12A.7.2(B) shall be provided when stresses entitled "Special Inspection" are used for design, when required by the items listed in Sec. 12A.7.1, and when Special Inspection is otherwise required.

(A) SPECIAL INSPECTION. Special Inspection shall be provided as follows:

- For the examination of materials and/or certifications of materials for compliance.
- For the observation of measurement and mixing of field-mixed mortar and grout including checks on consistency.
- For the determination of the moisture conditions of the masonry units at the time of laying.
- For periodic observation of the laying of masonry units with special attention to joints including preparations prior to buttering, portions to be filled, shoving, etc.

5A/67 cont.

12A.7.2 Cont.

- For observation of the bonding of units in the walls between wythes and at corners and intersections.
- For the proper placement of reinforcement including splices, clearances, and support.
- For observation of the construction of chases, recesses, and the placement of pipes, conduits, and other weakening elements.
- For inspection of grout spaces immediately prior to grouting including the removal of mortar fins as required, removal of dirt and debris, and the conditions at the bottom of the grout space. For high lift work this shall be done prior to the closing of cleanouts and shall also include the proper sealing of cleanouts.
- For the preparation, or supervision of preparation, of required samples such as mortar, grout and prisms.
- For the observation of grout placement with special attention to procedures to obtain filling of required spaces, the avoidance of segregation, and proper consolidation and reconsolidation.

(B) TESTS AND~~/OR~~ CERTIFICATIONS. Tests and~~/or~~ certifications shall be performeo and~~/or~~ supplied as follows.

5A/68 136 (10-0-0)

- ~~For mortar, grout, and prisms.~~ One prism test series shall be made for each 5000 square feet of wall. ~~Alternatively a series of both mortar and grout tests shall be made on the first three consecutive days of the work and on each third day thereafter.~~

  ~~In addition, when f'_m is equal to or greater than 2600 psi or when f'_m is to be established by tests, a minimum of three prism test series shall be made during the progress of the work~~. When f'_m is to be established by tests there shall be an initial prism test series prior to the start of construction.

  The requirements for numbers of test series apply separately for each variation or type of masonry construction. ~~except for the total number for a building.~~

5A/69 137 (9-0-1)

- For masonry units. When shipments of masonry units are not identified and accompanied by certification ~~acceptable to the Regulatory Agency,~~ one series of tests for strength, absorption, saturation, moisture content, shrinkage, and modulus of rupture shall be made for each 5000 square feet of wall or equivalent. When the reference document or standard for the units has no acceptance or rejection limits for a test, the test need not be made.

5A/70 138 (8-2-0)

- ~~For unreinforced or reinforced~~ grouted masonry Seismic Performance Category D, one series of core tests for shear bond shall be made for each 5000 square feet of wall or equivalent. Move to Ch. 12

12A.7.2 Cont.

- For cement used for mortar and grout, certification acceptable to the Regulatory Agency shall accompany the cement when the required volume of cement exceeds 500 sacks.

- For reinforcement. One tensile and bend test shall be made for each 2-1/2 tons or fraction thereof of each size of reinforcing. Testing is not required if the reinforcement is identified by heat number and is accompanied with a certified report of the mill analysis.

- For plant mix ("transit mix") grout a certificate conforming to both Sections 14.1 and 14.2 of ASTM C-94 shall accompany the plant mix. Substitute "grout" for "concrete" in ASTM C-94. The requirements for the testing of grout shall also apply.

- For other tests performance shall be as indicated in the Approved Quality Assurance Plan.

Where the number of tests or test series is not defined, one test or test series, as applicable, shall be made for each 5000 square feet of wall or equivalent.

12A.7.3 LOAD TESTS

5A/71 When a load test is required the member or portion of the structure under consideration shall be subject to a superimposed load equal to twice the specified live load plus 1/2 of the dead load. This load shall be left in position for a period of 24 hours before removal. If, during the test or upon removal of the load, the member or portion of the structure shows evidence of failure, such changes or modifications as are necessary to make the structure adequate for the rated capacity shall be made; or, where lawful, a lower rating shall be established. A flexural member shall be considered to have passed the test if the maximum deflection "D" at the end of the 24-hour period neither exceeds:

$$D = \frac{L}{200}$$

$$\text{nor } D = \frac{L^2}{4000\ t}$$

and the beams and slabs show a recovery of at least 75 percent of the observed deflection within 24 hours after removal of the load where:

L = span of the member in feet

t = thickness or depth of the member in feet.

12A.7.4 REPORTING

Reporting and compliance procedures shall conform to Sec. 1.6.4.

Sec. 12A.8 <u>TEST CRITERIA</u>

Masonry prisms, mortar and grout samples, and masonry cores shall be prepared and tested in accordance with the procedures in this Section.

12A.8.1 MASONRY PRISMS

Requirements for prisms shall be those of ASTM E447, except as modified by this Section.

12A.8.1 Cont.

Prisms shall be built of the same materials, under the same conditions, and, insofar as possible, with the same bonding arrangements as for the structure including the lapping of units except that for prisms which are one masonry unit in length, the units may be laid in stacked bond. The moisture content of the units at time of laying, consistency of mortar, and workmanship shall be the same as will be used in the structure for each type of construction.

Prisms shall be not less than 12 inches high and shall have a height to minimum thickness dimension ratio of not less than 2.0 nor more than 5.0. Ungrouted hollow masonry unit prisms shall be not less than one masonry unit in length. Solid grouted prisms of hollow units shall have a minimum length of one complete cell with cross webs. Solid masonry unit prisms or solid filled prisms shall be not less than 4 inches in length. The thickness and type of construction of the specimen shall be representative of the masonry element under consideration.

Cores for hollow unit masonry shall not be filled. All cores for solidly grouted reinforced hollow unit masonry shall be filled with grout. For prisms representing partially grouted hollow unit masonry both unfilled and completely filled samples shall be taken and the value of f'_m used for design shall be a weighted average of both as established by the design authority and approved by the Regulatory Agency. The strength of f'_m of each sample shall be taken as the compressive strength of the specimens multiplied by the following correction factor:

Ratio of H/d	2.0	3.0	4.0	5.0
Correction Factor	1.00	1.20	1.30	1.37

where:

H = height of specimen in inches
d = minimum dimension of specimen in inches
Intermediate values may be interpolated.

5A/71 cont.

447 (A) STORAGE OF TEST PRISMS. For storage of test prisms follow Method B of ASTM ~~E477~~ except as modified herein. Test prisms made in the laboratory shall be stored for seven days in air, at a temperature of 70 degrees plus or minus 5 degrees, in a relative humidity exceeding 90 percent; and then in air at a temperature of 70 degrees plus or minus 5 degrees, at a relative humidity of 30 percent to 50 percent until tested.

139 (8-0-2) Test prisms made in the field shall be stored undisturbed and protected from freezing and excessive drying for 48 ~~to 96~~ hours in the field under the same conditions, insofar as possible, and adjacent to the work they are to represent. ~~They may be covered with wood or damp burlap, but such covering shall not shade the sides from the sun.~~ After field storage, they shall be transported to the laboratory for continued curing as specified for laboratory constructed prisms. ~~Field curing may continue as specified for the initial seven days.~~

Test prisms and cores cut from the work shall not be taken before the work is seven days old. Prisms cut from the work shall be stored as required for prisms made in the field.

(B) SAMPLING, TEST SERIES, AND COMPRESSION TESTS. Not less than five specimens shall be made for each initial preliminary test series required to establish f'_m. Not less than three specimens shall be made for each field test series required to confirm that the materials are as specified in the design.

140 (10-0-0) ~~Prisms shall be capped and tested in compression. The standard age of test specimens shall be 28 days, but 7-day tests may be used provided the relation between the 7-day and 28-day strengths of the masonry is established by adequate test data for the materials used.~~

12A.8.1 Cont.

(C) DETERMINATION OF f'_m. The value of f'_m shall be the average value of all specimens tested but shall not be more than 125 percent of the minimum value determined by tests, whichever is less.

When approved by the Regulatory Agency, tests may be analyzed statistically considering the variability of test results.

140A-New (8-2-0)

12A.8.2 ~~TESTS FOR GROUT AND MORTAR~~ GROUT TEST AND FIELD MORTAR TESTS

Tests for grout and field mortar shall conform to this Section.

(A) GROUT SAMPLES FOR COMPRESSION TESTS. On a flat, nonabsorbent base form a space approximately 3 inches by 3 inches by 6 inches high, i.e., twice as high as it is wide, using masonry units having the same moisture conditions as those being laid. Line the space with a permeable paper or porous separator so that water may pass through the liner into the masonry units. Thoroughly mix or agitate grout to obtain a fully representative mix and place into molds in two layers, and puddle each layer with a 1-inch by 2-inch puddling stick to eliminate air bubbles. Level off and immediately cover molds and keep them damp until taken to the laboratory. After 48 hours set, have the laboratory carefully remove the masonry unit mold and place the grout samples in the fog room until tested in the damp condition.

5A/71 cont.

~~(B) MORTAR SAMPLES FOR COMPRESSION TESTS. Spread mortar on the masonry units 1/2-inch to 5/8-inch thick. Place a masonry unit on top of the mortar and allow to stand for two minutes. Immediately remove mortar and place in a 2-inch by 4-inch cylinder in two layers, compressing the mortar into a cylinder using a flat-end stick or fingers. Lightly tap mold on opposite sides, level off, and immediately cover molds and keep them damp until taken to the laboratory. After 48-hours set, have the laboratory remove molds and place them in the fog room until tested in the damp condition.~~

141-Mod (7-3-0)

(B) FIELD MORTAR SAMPLES FOR COMPRESSION TESTS. Spread a ½ inch layer of mortar on masonry units having the same moisture conditions as those being laid. Place a masonry unit on top of the mortar and press to achieve a 3/8 inch mortar joint. After pressing let stand for 2 minutes if the mortar contains 5/8 parts of lime to cement by volume or less; let stand 3 minutes if the mix containes more lime. Immediately remove mortar and place in a 2 inch round by 4 inch high cylinder mold (or a 2 inch cube mold), compressing the mortar using a flat stick or fingers. Lightly tap mold and level off. Immediately cover mold on opposite sides and keep it damp until taken to the laboratory. After 48 hours, the laboratory shall remove the mortar specimen from the mold and place it in a fog room until tested in the damp condition.

(C) SLUMP TESTS FOR GROUT. Slump tests for grout shall conform to ASTM C143. Substitute the word "grout" for "concrete" in ASTM C143.

141A-New (8-2-0)

(D) COMPRESSION TESTS. Excluding curing, storage, and test age requirements, compression testing procedures for field mortar cubes shall conform to Sec. 8.6.2, 8.6.3, and 9 of ASTM C109. Procedures for field mortar cylinders and for grout shall conform to Sec. A6.3.3 through A.6.3.6, A.6.4, and A.6.5 of ASTM C780.

5A/72 141B-New (6-4-0)

~~(E) REQUIRED STRENGTHS. Unless higher strengths are required by the construction documents, minimum required strengths shall be 2000 psi for grout, 1500 psi for field mortar cylinders (and 2000 psi for field mortar cubes).~~

12A.8.3 CORE TESTS FOR SHEAR BOND

Core tests for shear bond between grout and masonry units used in unreinforced and reinforced grouted masonry construction shall conform to the provisions of this Subsection.

5A/73

(A) SAMPLES. Samples shall be cores drilled from the wall with axes perpendicular to the face of the wall and diameters approximately 2/3 the wall thickness. These shall contain no reinforcing and shall be taken from locations selected by the design engineer who shall also specify the procedure for repair of the holes in the wall.

(B) NUMBER OF TESTS. A test series shall comprise one test between grout and masonry unit for each combination of different grout type and/or masonry unit type. One test series shall be made for each 5,000 square feet of wall or equivalent but not less than one series for any building.

12A.8.3 Cont.

142 (7-1-2) (C) PROCEDURES. The wall shall be at least 14-days old before cores are taken. Cores shall be tested at ~~approximately~~ a minimum of 28 days of age. Storage shall be as required for prisms.

5A/73 cont.

The apparatus shall be of an approved design, similar to a guillotine, designed to shear only one wythe of masonry units from the grout. The shear force and its reaction shall be capable of being applied as close to the bond lines between units and grout as is practicable, one on one side of the plane and the other on the opposite side. Uniform bedding for the shearing force and the reaction shall be provided, both symmetric about a plane which contains the axis of the core. No forces external to the core and perpendicular to the shear plane shall be applied.

Core samples shall not be soaked before testing. The apparatus shall be placed and loaded in a testing machine as required for prisms.

The unit shear strength shall be calculated and reported as the maximum load divided by the shear area. Visual examination of all cores shall be made to ascertain if the joints are filled. The report shall include the results of these examinations and the condition of all cores cut on each project regardless of whether or not the core specimens failed during the cutting operation.

143 (7-1-2) ~~The unit shear strength shall not be less than 100 psi.~~ Where an unusual number of cores fail during the cutting operation, the design authority shall determine if the test program is extensive enough to satisfy the requirements of Sec. 12A.1.5. Move to Ch. 12

144
(10-0-0)

TABLE 12A-1A

COMPRESSIVE STRENGTH OF MORTAR CLASSIFIED
IN ACCORDANCE WITH PROPERTY SPECIFICATIONS
(Pounds per Square Inch)

Mortar Type	Average Compressive Strength at 28 Days
M	2,500
S	1,800
N	1,500

Both tables are covered by ASTM C270

5A/73
cont.

145
(10-0-0)

TABLE 12A-1B

MORTAR PROPORTIONS FOR MORTAR CLASSIFIED
IN ACCORDANCE WITH PROPORTIONS CLASSIFICATIONS
(Parts by Volume)

Mortar Type	Portland Cement	Masonry Cement	Hydrated Lime or Lime Putty[1]	Aggregate Measured in a Damp, Loose Condition
M	1	1	--	Not less than 2½ and not more than 3 times the sum of the volumes of the cements and lime used.
	1	--	¼	
S	½	1	--	
	1	--	over ¼ to ½	
N	--	1	--	
	1	--	over ½ to 1¼	

[1]When plastic or waterproof cement is used as specified in Sec. 12A.1.14, hydrated lime or putty may be added but not in excess of one-tenth the volume of cement.

146
(void)

5A/74 147 (7-1-2)

5A/75 148 (9-1-0)

5A/76 149 (10-0-0) (8-2-0)

TABLE 12A-2

~~MINIMUM THICKNESS OF MASONRY WALLS~~

MAXIMUM HEIGHT TO THICKNESS RATIOS

TYPE OF MASONRY	Maximum ~~thickness~~ ratio on unsupported height or length to Thickness[1]	~~NOMINAL MINIMUM THICKNESS (INCHES)[3]~~ Walls whose only structural function is exterior enclosure, nonstructural walls, and partitions	~~Other Structural Uses~~ Thickness for the uppermost 35[6] foot high portion of wall	~~Other Structural Uses~~ Thickness increase for each 35 feet or fraction thereof below the uppermost 35[6] foot high portion of wall
STRUCTURAL WALLS:				
Unburned Clay Masonry	10	~~16~~	~~16~~	~~--~~
Stone Masonry	14	~~16~~	~~16~~	~~4~~
Cavity Wall Masonry	20[5]	~~8~~	~~12[7]~~	~~4~~
Hollow Unit Masonry	20	~~8~~	~~12[7]~~	~~4~~
Solid Masonry	20	~~8~~	~~12[7,8]~~	~~4~~
Grouted Masonry	20[2]	~~6~~	~~10[7,8]~~	~~4~~
Reinforced Grouted Masonry	~~25[2,9]~~ 36[2]	~~6~~	~~6~~	~~--~~
Reinforced Hollow Unit Masonry	~~25[2,9]~~ 36[2]	~~6~~	~~6~~	~~--~~
NONSTRUCTURAL AND PARTITIONS:[4]				
Unreinforced	36[5]	~~2~~	~~--~~	~~--~~
Reinforced	48	~~4~~	~~--~~	~~--~~

[1]For cantilever walls, the actual height or length, as applicable, used to compute the actual thickness ratio shall be doubled.

[2]If the only structural function of the wall is the enclosure of a building's exterior, the maximum thickness ratio may be increased to 22 for grouted masonry and 36 for reinforced walls.

150 (8-0-2)

~~[3]The minimum thickness requirements of Sec. 12A.3 shall also be satisfied.~~

[4]The thickness of plaster coatings may be considered in satisfying thickness ratios and minimum thickness requirements but shall not be used to take stresses.

[5]In determining the thickness ratio for cavity walls, an effective thickness shall be used.

For cavity walls loaded on both wythes the effective thickness for thickness ratio determination only shall be determined from the following formula:

5A/77 150A -New (7-2-1)

$$\cancel{T = 2/3\,(T_o - w_c)}\quad T = \sqrt{t_1^2 + t_2^2}$$

where ~~T_o = overall thickness of wall, including width of cavity,~~

~~w_c = width of cavity~~

T =

t_1 =

t_2 =

h =

For cavity walls loaded on one wythe only, the effective thickness shall be taken for that loaded wythe only.

151 (8-0-2)

See Sec. 12A.6.1(B) for the definition of effective thickness to be used for masonry design.
See Sec. 12A.6.1(E) for applicable cross-sectional areas for masonry design.

152 (8-0-2)

~~[6]Seventy feet for stone masonry.~~

~~[7]These thicknesses may be reduced to 8 inches for walls that are not over 35 feet in total height in buildings that are not over three stories high.~~

153 (8-0-2)

~~[8]These thicknesses may be reduced to 6 inches for grouted walls and 8 inches for solid masonry walls in one-story buildings when the wall is not over 9 feet in total height, provided that when gable construction is used an additional 6 feet in height is permitted to the peak of the gable.~~

154 (7-1-2)

~~[9]Except for partially reinforced masonry, the maximum thickness ratios for one-story walls designed as deep beams may be increased to 36.~~

TABLE 12A-3

ALLOWABLE WORKING STRESSES IN UNREINFORCED MASONRY

5A/77 cont.

	MORTAR TYPE								
	M	S	M OR S				N		
MATERIAL[6]	Compression[1]	Compression[1]	Shear or Tension in Flexure[2,3,8]		Tension in Flexure[3,4,8]		Compression[1]	Shear or Tension in Flexure[2,3,8]	
Special Inspection required	No	No	Yes	No	Yes	No	No	Yes	No
Solid Brick Masonry									
>4501 psi[7]	250	225	20	10	40	20	200	15	7.5
2501-4500 psi[7]	175	160	20	10	40	20	140	15	7.5
1500-2500 psi	125	115	20	10	40	20	100	15	7.5
Solid Concrete Masonry									
Grade N	175	160	12	6	24	12	140	12	6
Grade S	125	115	12	6	24	12	100	12	6
Grouted Masonry, Multiwythe with Solid Units									
>4501 psi[7]	350	275	25	12.5	50	25			
2501-4500 psi[7]	275	215	25	12.5	50	25			
1500-2500 psi	225	175	25	12.5	50	25			
Hollow Unit Masonry[5]	170	150	12	6	24	12	140	10	5
Cavity Wall Masonry									
Solid Units[5]									
>2501 psi	140	130	12	6	30	15	110	10	5
1500-2500 psi	100	90	12	6	30	15	80	10	5
Hollow Units[5]	70	60	12	6	30	15	50	10	5
Stone Masonry									
Cast Stone	400	360	8	4	--	--	320	8	4
Natural Stone	140	120	8	4	--	--	100	8	4
Unburned Clay Masonry	30	30	8	4	--	-			

[1]Allowable axial or flexural compressive stresses in psi gross on cross-sectional area (except as noted). The allowable working stresses in bearing directly under concentrated loads may be 50 percent greater than these values. Allowable axial stresses are only applicable if the maximum thickness ratios of Table 12A-2 are not exceeded. Reduce these values by 20 percent when designing columns.

[2]This value of tension is based on tension across a bed joint, i.e., vertically in the normal masonry work.

[3]No tension allowed in stacked bond across head joints.

[4]The values shown here are for tension in masonry in the direction of the bond, i.e., horizontally between supports.

[5]Net bedded area or net cross-sectional area, whichever is more critical.

[6]Strengths listed in this column are those of masonry units.

[7]When the required strengths of the units exceed 2500 psi, compression tests of the units conforming to the applicable reference documents and Sec. 12A.7 shall be made. This shall not be required if certifications acceptable to the Regulatory Agency accompany the units.

[8]Allowable shear and tension stresses where lightweight concrete units are used are limited to 85 percent of the tabulated values.

5A/77 cont.

87/2 (9-0-1)

TABLE 12A-4

ASSUMED COMPRESSIVE STRENGTH OF MASONRY

f'_m - psi

TYPE OF UNIT	COMPRESSIVE STRENGTH OF UNITS, psi OR GRADE	f'_m [3] TYPE N MORTAR	f'_m [3] TYPE S MORTAR	f'_m [3] TYPE M MORTAR
Solid Clay[4] and Net Area of Hollow Clay	14,000 psi gross[1]	4300[2,5]	5300[2,5]	6300[2,5]
	12,000 psi gross[1]	3800[2,5]	4600[2,5]	5500[2,5]
	10,000 psi gross[1]	3300[2,5]	4000[2,5]	4600[2,5]
	8,000 psi gross[1]	2700[2,5]	3300[2,5]	3800[2,5]
	6,000 psi gross[1]	2200[5]	2600[5]	3000[2,5]
	4,000 psi gross[1]	1600	1900	2200[5]
	2,000 psi gross[1]	1100	1200	1300
Solid Concrete ~~Units other than Clay~~ and Net Area of Hollow Concrete	6,000 psi gross[4]	1350	~~1900~~ 2400	2400
	4,000 psi gross[4]	1250	~~1650~~ 2000	2000
	2,500 psi gross[4]	1100	~~1350~~ 1550	1550
	1,500 psi gross	875	~~1025~~ 1150	1150
	1000	700	900	900
~~Hollow Concrete~~	~~Gd. N~~	~~--~~	~~1350~~	~~1350~~
~~Hollow Concrete - Grouted Solid~~	~~Gd. N~~	~~--~~	~~1500~~	~~1500~~
~~Hollow Clay~~	~~Gd. LB with 1-½" Min face Shell~~	~~--~~	~~1350~~	~~1350~~
~~Hollow Clay - Grouted Solid~~	~~Gd. LB with 1-½" Min face Shell~~	~~--~~	~~1500~~	~~1500~~
~~Hollow Clay Brick~~	~~5,000 psi net[1]~~	~~--~~	~~2500[5]~~	~~2500[5]~~
~~Hollow Clay Brick - Grouted or Reinforced~~	~~Type I~~	~~--~~	~~2000~~	~~2000~~

[1]When the required strength of the units exceeds 3000 psi, compression tests of the units conforming to the applicable reference documents and Sec. 12A.7 shall be made. These tests shall not be required if certifications conforming to Sec. 12A.7 and Sec. 12A.8 and acceptable to the Regulatory Agency are provided during construction.

[2]When the assumed f'_m exceeds 2600 psi, prism tests conforming to Sec. 12A.7 and Sec. 12A.8 shall be provided during construction. Certification of the units is not acceptable in lieu of tests.

[3]Intermediate values may be interpolated.

[4]When the alternate design procedure for unreinforced brick masonry of Sec. 12A.6.2 is used for design the units shall comply with the dimension and distortion tolerances specified for type FBS. Where such brick do not comply with these requirements, the compressive strength of brick masonry shall be determined by prism tests as required by Sec. 12A.5.1(A)1.

[5]Where grouted construction is used, the value of f'_m shall not exceed the compressive strength of the grout unless prism tests conforming to Sec. 12A.7 and 12A.8 are provided during construction. As an alternative, the grout strength may be specified at not less than the value of f'_m with grout tests conforming to Sec. 12A.7 and 12A.8 provided during construction for verification.

TABLE 12A-5

ALLOWABLE WORKING STRESSES (PSI) FOR REINFORCED MASONRY

		TYPE OF STRESS	REINFORCED GROUTED AND HOLLOW UNIT MASONRY SPECIAL INSPECTION REQUIRED YES	NO
5A/78	155A-New (6-4-0)	Compression-Axial, Walls	See Section 12A.6.3(E)	2/3 ~~one-third~~ of the values permitted under Section 12A.6.3(E)
	155B-New (6-4-0)	Compression-Axial, Columns	See Section 12A.6.3(F)	2/3 ~~One-third~~ of the values permitted under Section 12A.6.3(E)
	156-Mod (8-1-1)	Compression-Flexural	0.33 f'_m but not to exceed ~~900~~ 2000	0.166 f'_m but not to exceed ~~450~~ 1000
		Shear:		
	157 (void)	Reinforcement taking no shear[3]		
		Flexural[2]	1.1 $\sqrt{f'_m}$ 50 Max.	25
		Shear walls[3,4] M/VD ≥ 1[6]	.9 $\sqrt{f'_m}$ 40 Max.	20
		M/Vd = 0[6]	2.0 $\sqrt{f'_m}$ 50 Max.	25
		Reinforcing taking all shear		
		Flexural	3.0 $\sqrt{f'_m}$ 150 Max.	75
		Shear walls[4] M/Vd ≥ 1[6]	1.5 $\sqrt{f'_m}$ 75 Max.	35
		M/Vd = 0[6]	2.0 $\sqrt{f'_m}$ 120 Max.	60
		Modulus of Elasticity	600 f'_m but not to exceed 3,000,000	500 f'_m but not to exceed 1,500,000
5A/79		Modulus of Rigidity	240 f'_m but not to exceed 1,200,000	200 f'_m but not to exceed 600,000
	158-Mod (9-0-1)	Bearing on full Area[5]	0.25 f'_m but not to exceed ~~900~~ 1500	0.125 f'_m but not to exceed ~~450~~ 750
		Bearing on 1/3 or less of area[5]	0.30 f'_m but not to exceed ~~1200~~ 1800	0.15 f'_m but not to exceed ~~600~~ 900

[1]Stresses for hollow unit masonry are based on net section.

159 (10-0-0) [2]~~Web~~ reinforcement shall be provided to carry the entire shear in excess of 20 pounds psi whenever there is required negative reinforcement for a distance of 1/16 the clear span beyond the point of inflection.

[3]Allowable shear resisted by the masonry where lightweight concrete units are used is limited to 85 percent of the tabulated values.

[4]Interpolate by straight line for M/Vd values between 0 and 1.

[5]This increase shall be permitted only where the least distance between the edges of the loaded and unloaded areas is a minimum of ¼ of the parallel side dimension of the loaded area. The allowable bearing stress on a reasonable concentric area greater than 1/3, but less than the full area, shall be interpolated between the values given.

[6]M is the maximum bending moment occurring simultaneously with the shear load V at the section under consideration.

TABLE 12A-6

ALLOWABLE SHEAR ON BOLTS[1,4]

DIAMETER OF BOLTS (Inches)	UNBURNED CLAY UNITS MINIMUM EMBEDMENT (Inches)	UNBURNED CLAY UNITS SHEAR (Pounds)[2]	ALL OTHER MASONRY MINIMUM EMBEDMENT (Inches)	ALL OTHER MASONRY SHEAR SOLID MASONRY (Pounds)[2]	ALL OTHER MASONRY SHEAR GROUTED CONSTRUCTION (Pounds)[2]
1/4	--	--	4	--	180
3/8	--	--	4	--	270
1/2	--	--	4	230	370
5/8	12	130	4	330	500
3/4	15	200	5	500	730
7/8	18	270	6	670	1000
1	21	330	7	830	1230[3]
1-1/8	24	400	8	1000	1500[3]

[1]Edge distance shall be not less than 2 inches nor 5 bolt diameters for edges parallel to the direction of stress. Edge distances shall be not less than 3 inches nor 6 bolt diameters for edges perpendicular to the direction of stress. Center to center spacings shall be not less than 12 bolt diameters.
[2]The tabulated values are for construction where Special Inspection is not provided. Where Special Inspection is provided 150 percent of these values are permitted.
[3]These values are permitted only with units having a minimum net area compressive strength of 2500 pounds per square inch or more.

5A/80 160 (8-1-1)

[4]An anchor bolt is a bolt that has a right angle extension of at least 3 diameters. A standard machine bolt is acceptable.

5A/81 161 (8-0-2)

162 - New
(9-0-1)

TABLE 12A-7

ALLOWABLE STRESSES TO BE USED WITH THE
ALTERNATE DESIGN PROCEDURE FOR UNREINFORCED BRICK MASONRY[1]

DESCRIPTION		ALLOWABLE STRESSES, PSI WITHOUT SPECIAL INSPECTION	WITH SPECIAL INSPECTION
Compressive, Axial[2]			
Walls	f_m	$0.13\ f'_{mb}$	$0.20\ f'_{mb}$
Columns	f_m	$0.10\ f'_{mb}$	$0.16\ f'_{mb}$
Compressive, Flexural[2]			
Walls	f_m	$0.21\ f'_{mb}$	$0.32\ f'_{mb}$
Columns	f_m	$0.17\ f'_{mb}$	$0.26\ f'_{mb}$
Tensile, Flexural[5,6]			
Normal to bed joints[2]			
M or S mortar	f_t	18	36
N mortar	f_t	14	28
Parallel to bed joints[3]			
M or S mortor	f_t	36	72
N mortar	f_t	28	56
Shear[7]			
M or S mortar	V_m	$0.3\sqrt{f'_{mb}}$ but not exceed 35	$0.3\sqrt{f'_{mb}}$ but not to exceed 75
N mortar	V_m	$0.3\sqrt{f'_{mb}}$ but not to exceed 28	$0.3\sqrt{f'_{mb}}$ but not to exceed 56
Bearing			
On full area	f_m	$0.17\ f'_{mb}$	$0.25\ f'_{mb}$
On one-third area or less[4]	f_m	$0.21\ f'_{mb}$	$0.375\ f'_{mb}$
Modulus of Elasticity	E_m	$500\ f'_{mb}$ but not to exceed 1,500,000 psi	$600\ f'_{mb}$ but not to exceed 3,000,000 psi
Modulus of Rigidity	E_r	$200\ f'_{mb}$ but not to exceed 600,000 psi	$240\ f'_{mb}$ but not to exceed 1,200,000 psi

[1]See Section 12A.6.2.
[2]Direction of stress is normal to bed joints; vertically in normal construction.
[3]Direction of stress is parallel to bed joints; horizontally in normal masonry construction. If masonry is laid in stacked bond, tensile stresses in the horizontal direction shall not be permitted in the masonry.
[4]This increase shall be permitted only when the least distance between the edges of the loaded and unloaded areas is a minimum of one-fourth of the parallel side dimension of the loaded area. The allowable bearing stress on a reasonably concentric area greater than one-third but less than the full area shall be interpolated between the values given.
[5]For computing the flexural resistance of cavity walls, the lateral load shall be distributed to the wythes according to their respective flexural rigidities.
[6]In the use of these allowable stresses, consideration shall be given to the influence of unusual vibration and impact forces.
[7]See Section 12A.6.3(c).

Joint Committee Ballot No.	Type of Change and Committee Comment	ATC Recommendation and Comments
5A/1	• Definition - The new definition for net area is a clarification. • Definition - The definition for grouted masonry clarifies the one proposed for deletion in ballot item 5A/4. A yes vote here should have a yest vote on 5A/4.	Yes - This just clarifies some definitions.
5A/2	• Deletion - The definition is unnecessary. Load bearing is an accepted term; however, all structural walls may not be load bearing (e.g., shear walls).	No - Editorial revision must be assured. Preferable to leave as is. Term "load bearing" is used in other places.
5A/3	• Insert - These new definitions are consistent with the text as revised. Specific allowable stresses are defined in the text. The committee prepared the text, especially ballot item 5A/60 prior to preparing 5/3 which is similar for seismic. Item 5A/60 needs to be checked for consistency with 5/3 after ballots are counted. A yes vote here should have a yes vote on 5A/6.	Yes, with explanation A yes vote carries the implication that Ch. 12A be editorially revised so that the definition for reinforced masonry is consistent with the definitions given in 12.2.1(B). These definitions state when reinforced and unreforced allowable stresses can be used.
5A/4	• Deletion - The definition was clarified in item 5A/1 which replaces 5A/4. A yes vote here should also have a yes vote on 5A/1.	Yes - This definition has now been covered under ballot item 5A/1.
5A/5	• Deletion - The definition of non-bearing does not add to the currently accepted definition. The term non-load bearing is contradictory since they may be structural elements.	No - Same reason for disapproval as 5A/2.
5A/6	• Deletion - This definition should be deleted since it is not consistent with the recommendation of item 5 A/3. A yes vote on 5A/3 should have a yes vote here.	Yes - No objection as long as the document clearly delineates the difference between "reinforced" stresses and other conditions of less reinforcement. Important that it be understood that the term "partially reinforced" described masonry with less than prescribed minimum reinforcing ratios and hence did not qualify it for using "reinforced" stresses. See also 5A/3.
5A/7	• Deletion - same as 5A/6	Yes - see 5A/3 and 5A/7
5A/8	• Partial deletion - Minor editorial revision	Yes - Minor editorial revision

Joint Committee Ballot No.	Type of Change and Committee Comment	ATC Recommendation and Comments
5A/9	• Insert - Editorial modification and specification update and addition.	Yes - Minor editorial expansion.
5A/10	• New insert - The inserts make the revised text and symbols consistent.	Yes - Changes were minor and have no real objection. Item 16 - would be difficult to visualize a "length" of column that is governing rather than height. Item 17 - term p should actually be p_g.
5A/11	• Deletion and editorial modification - The deleted item was considered seismic and therefore was moved to Ch. 12	Yes - This requirement has been transferred to SPC-'C'.
5A/12	• Modification - The change from 3.5 to 3.0 was felt more appropriate for the material as used.	Abstain - Didn't feel the amount of construction involved had any real impact.
5A/13	• Deletion - Shrinkage control is considered a serviceability, not a safety or seismic item. Shrinkage properties of concrete masonry units are already adequately covered in the referenced ASTM specifications.	Abstain - Abstained with the idea that it would be included in 'SPC-'B', however, we made an ommission error in not picking this up until SPC-'C'.
5A/14	• Modification - The modification is to use a more appropriate ASTM reference with an additional statement so that only portland cement can be used. • Deletion - The "exception" is not needed with the above modification.	No - ASTM C270 limits cements for mortar, not grout. It does not allow type V cement, which can be used for grout. It does allow masonry cement, which is not suitable for grout. If this change is allowed, Sec. 12A.1.17(B) should be revised to permit only portland cement or blended hydraulic cement. Note that the UBC and BIA codes allow only portland cement for grout.
5A/15	• Partial deletions and inserts - All are minor editorial changes.	Yes - No objection to minor changes.
5A/16	• Partial deletion - Grout consistency should match job requirements. The designer may be misled by slump limits. Lower slump limits are not better than larger ones for grout.	No - Felt it is important construction consideration to have limits (upper and lower) on grout consistency.
5A/17	• Deletion - A "drum type batch mixer" is only one type of suitable mechanical mixer. ASTM C94 does not refer to mix uniformity.	No - Performance criteria will allow the inspector to order obviously defective equipment off the job.
5A/18	• Deletions and inserts - The insertions are briefer improvements over the deleted material. Other deleted material is not needed.	Yes - Felt dampening of units for certain weather conditions was desirable but back-off on this in "spirit of compromise"

Joint Committee Ballot No.	Type of Change and Committee Comment	ATC Recommendation and Comments
5A/19	• Partial deletion and insert - The deleted material is a laundry list, the insert is more appropriate and concise.	No - Floor slabs or spandrel beams within walls should not be treated different from foundations. Highly stressed masonry in columns and pilasters should be continuous for the vertical load.
5A/20	• Deletion - The material is adequately covered with the insert in 5A/21. The amplitudes given cannot be enforced. The item was added in SPC-B.	Yes - We now have no objection since this was picked up in SPC-'B'.
5A/21	• Insert - This item must be inserted with the deletion in the previous ballot.	Yes - Desirable construction requirement.
5A/22	• Deletions and inserts - These are editorial revisions	Yes - Minor editorial revision.
5A/23	• Partial deletion - A template is only one way to achieve the performance requirement to accurately set bolts. The template is specified in Ch.12.	No - "Templates" provides a standard for "approved equivalent means." "Dunking" and "stabbing" anchor bolts is prevalent practice (abuse); it should be controlled.
5A/24	• Modification - The 2.5-inch requirement may require special cutting since units do not come in multiples of 2.5 inches. The 4-inch dimension is compatible to standard units.	No - Five-eighths and smaller bolts require only 4-in. embedment. Ties 4 in. down will not be effective.
5A/25	• Partial deletions and inserts - These are all editorial.	Yes - Minor editorial revision.
5A/26	• Partial deletion and insert - This change allows the use of multi-wythe grouted walls in common and satisfactory usage in many parts of the U.S., including California. Solid units will use solid unit stresses and hollow units will use hollow unit stresses.	No - A no vote would revert this to the original definition. Proposed wording could permit defining almost any type of masonry construction as "grouted masonry" and to include any types of units such as hollow, tile, etc. ATC wording defines "grouted masonry" consistent with provision of UBC, SBCC, and common usage. "Allowable stresses" are for the ATC definition which should be retained. Allowables for other possibilities have not been developed.
5A/27	• Deletion - This was felt to be needed only for seismic so it was moved to Ch. 12.	Yes - No further objection since this has now been incorporated in SPC.'B'.
5A/28	• Deletions and insertions - All are editorial.	Yes - Unobjectionable editorial changes.

Joint Committee Ballot No.	Type of Change and Committee Comment	ATC Recommendation and Comments
5A/29	• Partial deletion - The deletion requires cleanouts only as necessary for a job to insure cleanliness. It is performance rather than specification oriented.	No - Leaving out every other unit follows approved 1976 UBC code change wording by the masonry industry. Fin and foreign matter removal procedures are suggestions, conforming to the ACI 531 Commentary, as to what is required. This could be removed; however, the word "other" allows alternatives. Successful high-lift work requires the special procedures of this paragraph and cleaning procedures should have a basic standard.
5A/30	• Editorial changes	Yes - Unobjectionable changes.
5A/31	• Partial deletion - The material remaining after the deletion is all that is necessary to cover embedded reinforcement, both horizontal and vertical. All reinforcement, not just vertical, must be suitably anchored.	No - Unless the principal bar reinforcing is embedded in grout, the form of construction will be other than that commonly known as "reinforced grouted masonry--multiple wythe" and that tested as such. This is the only form of construction shown in the BI of California handbook and the ACI 531 Commentary as "reinforced grouted masonry--multiple wythe."
5A/32	• Insert - Additional aggregate requirements are included.	Yes - No objection.
5A/33	• Deletion - The paragraph is unnecessary considering the redefinition of reinforced masonry.	No - This paragraph is needed so addition of steel in just any fashion to hollow unit construction will not qualify the construction as being reinforced. The construction described here and in Sec. 12A.3.6(A) following conforms to that commonly known as "hollow unit work" and that tested as such. The paragraph should be retained and will be included in the editorial redefinition of reinforced masonry.
5A/34	• Title change - The revised title is a more appropriate description of the content of the paragraph.	No - Title: There may be a real problem with the title. Sec. 12A.3.6, following the UBC, recognized only <u>ungrouted</u> unreinforced work. Allowable stresses of Table 12A-3 apparently are only set up for this format. If 12A.3.6 is to allow unreinforced <u>grouted</u> hollow unit construction, then more revisions may be required in the allowable stresses and other areas.
5A/35	• Editorial changes.	Yes - Minor editorial and reinserting previously removed items.
5A/36	• Deletion - the paragraph suggests construction in which it is difficult to clean out debris. It restricts grout lifts which have been successfully used on numerous occasions.	No - Need some limits. ACI Commentary Sec. 6.4 places the limit at 12 ft. The ATC provision is more liberal and should be retained.
5A/37	• Partial deletion - refer to comment on 5A/29	No - Same comment as 5A/29

Joint Committee Ballot No.		Type of Change and Committee Comment	ATC Recommendation and Comments
5A/38	•	Deletions - The deletions are necessary for consistency with other changes in definitions of reinforced masonry	Yes - Changes made for consistency with other approved changes.
5A/39	•	Modification - Refer to 5A/12	Abstain - Same comment as 5A/12
5A/40	•	Partial deletion and editorial.	Yes - Item 76 is just reinsertion of an item. Other change is minor editorial.
5A/41	•	Partial deletions, inserts - The deleted material is covered by the reference to table 12A-2.	Yes - (with explanation) A 'yes' vote on 78 was made with the understanding that Table 12A-2 would be referenced. A later change then substantially changed Table 12A-2. Therefore, in light of this development, reference should be made to the items of Table 12A-2.
5A/42	•	Partial deletions and inserts - Editorial changes	Yes - Essentially editorial changes

The current ATC 3-06 sec. 12A.6.2 covers only solid clay. The new 12A.6.2 (items 5A/43 through 5A/53) covers solid clay, concrete masonry and hollow clay. A 'yes' ballot means take the text as shown. 'No' means taken with the ATC recommendation.

5A/43	•	Alternate design procedures - New introduction to bring in new materials.	Yes - This is only down to Section 12A.6.2(A) 5a.
5A/44	•	Insert - Part of new material. The material shown will make uninspected masonry consistent with provisions in existing design standards.	No - This 'no' vote will change all permissible stresses for uninsp'd brick masonry to 50% of the permissible stresses for insp'd brick masonry. And this is to be consistent with our other recommendations for other materials. We believe it is very important because of the potential quality control with uninspected masonry.
5A/45	•	Introduces new material	Yes - Continuation of item 5A/43 that is from 12.A.6.2(A)6.
5A/46	•	Introduces lead-in to new material.	Yes - This pertains to 1st paragraph only in which there was no change.
5A/47	•	Modification of new insert - The stress reductions shown are consistent with ACI 531 for design of masonry.	No - This pertains to 12.A.6.2(B)1 only. Same comment as 5A/44.
5A/48	•	New insert - Provide guidance not in ATC 3-06.	Yes - This pertains to 12.A.6(B)2,3,4,5
5A/49	•	New insert - Provides guidance not in ATC 3-06. Wording provides for allowable stresses consistent with other materials.	No - This pertains to 1st paragraph "GENERAL". This is to be consistent with other permissible stresses for other material. See 5A/44.
5A/50	•	New insert - Provides guidance not in ATC 3-06. The coefficient is consistent with that recommended for other materials.	No - Our 'no' vote infers that the 0.225 constant of Eq. 12A-1 should be 0.20. We missed this on the original vote.
5A/51	•	New insert - Provides guidance not in ATC 3-06.	Yes - Pertains to everything from Eq. 12A-1 to 12A.6.2(C)4A. Had no objection to changes.

Joint Committee Ballot No.	Type of Change and Committee Comment	ATC Recommendation and Comments
5A/52	• New insert - Provide guidance not in ATC 3-06. Due to lack of time, this is the only item that was not formally ballotted by the entire committee. The proponent states that this is the best currently available data. The committee agrees with ATC on the need for an examination of fundamental data forming the basis for allowable shear stresses. Such an examination is unlikely to be completed before trial designs. Stresses used in this document are those which are currently accepted.	No - A 'no' vote infers a re-examination of the allowable shear stresses for all three (materials) of unreinforced construction by Committee 5. This item was never resolved during Com. 5 deliberations.
5A/53	• Minor editorial changes.	Yes - Minor editorial changes
5A/54	• Minor editorial changes	Yes - Primarily minor editorial changes
5A/55	• Editorial revision - the paragraph shown as item 106 was revised to base anchorage on a working stress basis for compatibility with the rest of Ch. 12A. The strength-based development length was moved to the strength-based Ch. 12. In making this change, a minimum anchorage length was inadvertently omitted. The committee agrees that the need for such a minimum should be examined prior to trial designs. Anchorage based on yield is a ductility requirement for seismic.	Yes - It was felt that a min. anchorage length should be stipulated. Therefore use anchorage to develop calculated stress or a minimum specified anchorage length, whichever is greater.
5A/56	• Minor change to convert to working stress based design.	Yes - Had no objections to proposed changes.
5A/57	• Deletion - The height/thickness ratios are more appropriately controlled by the interaction equation 12A-7.	No - Should be retained since it removes the height/thickness ratios which we believe are important.
5A/58	• Partial additions and inserts - The major item is the coefficient 0.225 in eq. 12A-11. The change to 0.225 is consistent with existing standards such as ACI 531 and NCMA. There has been considerable laboratory and field experience to justify these standards. It should be noted that the committee did agree to retain the 0.20 for the seismic Ch. 12 but not this nonseismic chapter.	No - If this change in coefficient is passed, it leads to greater allowables in reinforced masonry walls than in reinforced concrete walls. The concrete walls have a greater amount of reinforcement (0.004 as compared to 0.002) for masonry. At a slenderness ratio of 25, ACI Eqtn 14-1 for walls reduces to 0.134 f'_c using the alternate (working stress) method, and to 0.151 f'_c using a u factor, averaged for dead and live loads at 1.55. At the same slenderness ratio the proposed ballot item would allow a masonry stress of 0.170 f'_m. The factor of 0.20 is used in UBC but 0.225 is used in NCMA and ACI.

Joint Committee Ballot No.		Type of Change and Committee Comment	ATC Recommendation and Comments
5A/59	•	Editorial for consistency	Abstain - Actually redundant. This was covered under 5A/10.
5A/60	•	Insert - Based on new definition of reinforced masonry. It is intended to provide reinforcement limits as to which tables of stresses can be used. The committee noted that this item was prepared about a month before the more comprehensive item 5/3 in Ch. 12. Following balloting it should be examined for consistency.	No - The 'No' vote infers that the original wording of ATC-3-06 should be retained so that spacing and continuity of horizontal reinforcement is covered. This is another item that needs to be editorially revised in light of the new definitions for reinforced masonry.
5A/61	•	Partial deletion - The wording change was a clarification. The existing text is confusing on what to do with steel in multiple unit thickness walls.	No - The changes would remove commonly accepted practices.
5A/62	•	Modification - Refer to comment on 5A/58. The reason is the same. The lower coefficient was retained in Ch. 12 for seismic.	No - The 'No' votes infers that orig. ATC-03-06 coefficient should be retained. For columns in Item 115, if a comparison is made of short 12 in. x 12 in., columns with no eccentricity, $f'_m = f'_c = 6{,}000$ psi and 4 - #10 Grade 60 re-bars, the masonry column is allowed 87% of the load of a concrete column calculated with the alternate working stress method. This spread should be greater and, in addition, traditionally, masonry codes have allowed about 30% of wall loads for the design of columns.
5A/63	•	Editorial changes	Yes - Minor changes
5A/64	•	Partial Deletion - This was believed to be a seismic requirement if a requirement at all. Most did not readily see how the hook could be detailed in the prescribed manner.	No - This requirement for enclosing the boundary reinforcement is a desirable confinement of the vert. boundary bars and should be retained.
5A/65	•	Partial deletion and insert - clarifies text.	Yes - Agree with change.
5A/66	•	Deletion - The original wording is not clear. The new wording is an improvement but may also not be as clear as it should be. It is agreed that the wording should be examined again to avoid misinterpretation.	No - For reinforced walls shear should be based on an effective depth or jd. In Section 11.10.4 of ACI 318 the effective depth of the reinforced wall is specified as 0.8 ℓ_w or an effective depth determined by a strain compatibility analysis. If this item passes it effectively increases the allowable shear stresses by approximately 20% for reinforced masonry. The original wording needs to be revised to convey the intent.
5A/67	•	Partial deletion and inserts - Editorial and clarification.	Yes - No significant objections to the proposed changes

Joint Committee Ballot No.	Type of Change and Committee Comment	ATC Recommendation and Comments
5A/68	• Partial deletions - The deleted material is project specifications for quality control and not specifications to assure safety. It is not for design.	No - As the content of the first bullet has been amended, field prism tests are only required when f'm is to be established by prism test and special inspection stresses are used. The significant change from what was originally required is that no quality control is required when f'm is assumed from Table 12A-4 and special inspection stresses are used. The assumed values of f'm can be as high as 6,300 psi and the area of grout can be large in proportion to the total cross sectional area for some elements, especially columns, and there is no check on the prism or grout strength.
5A/69	• Editorial	Yes - Change was minor
5A/70	• Move to seismic Ch. 12	Yes - Had no objection when it was agreed to move this to Chap. 12
5A/71	• Editorial and reference to ASTM. Committee item 141 is on ATC proposal for revision.	Yes - Minor changes.
5A/72	• Deletion - Covered by ASTM specifications.	No - Deletion of this item removes any requirement for minimum strengths mortar and grout.
5A/73	• Editorial - ATC agrees that the deleted table 12-1 is covered by ASTM specs and need not be repeated.	Yes - No objections to changes.
5A/74	• Deletion - The thickness of a wall will be controlled by the limiting h/t restrictions and masonry units available for use. Therefore, arbitrary minimum thicknesses are not needed. The changes made in the text require the changes in the table.	No - (with explanation) A 'No' vote implies the retention of the Min. Thickness Requirements except that the last two columns will be removed.
5A/75	• Editorial	Yes - This should read "Unsupported Height". . . .
5A/76	• Change - the modifications made the h/t requirements consistent with existing standards.	No - The height to width ratio has been arbitrarily increased from 25 to 36 for reinforced walls with no backup test data. Both UBC and ANSI A41.2 use 25 and NCMA uses 30; ACI 531 uses 36.
5A/77	• Inserts and deletions - The change (150A) is one of several possibilities suggested by ATC. Others are for consistency.	Yes - No serious objections to proposed changes.
5A/78	• Coefficient change - Refer to 5A/44	No - Refer to 5A/44 for comments and as follows: The ATC document uses the most commonly used reductions on allowable stresses for uninspected masonry construction. If this ballot item passes and ballot items 111 and 115 pass, then allowable compressive stresses for work without special inspection will be 50% greater than stresses currently used.

Joint Committee Ballot No.		Type of Change and Committee Comment	ATC Recommendation and Comments
5A/79	•	Minor change	Yes - minor changes
5A/80	•	Insert - Net area strength is used in design and the insert makes the design procedure consistent.	No - Both ASTM C90-75 and C652-75 use gross area strengths for hollow units.
5A/81	•	Minor changes	Yes - Minor change.

2.2 Recommendations for Change in Chapter 12

Recommended Ballot Items

The Chapter 12 Ballot items are based on an ATC prepared document, based on changes in 12A, which the committee then reviewed and modified.

Number	Short Title
5/1	Background
5/2	Strength
5/3	Design procedures
5/4	S.P.C. A
5/5	S.P.C. B
5/6	Misc. requirements
5/7	Misc. requirements
5/8	Minimum wall thickness; Choose one option: A ____ B ____ C ____ D ____
5/9	S.P.C. B - Walls
5/10	S.P.C. B - columns, etc.
5/11	High-lift grout construction
5/12	Mortar and grout strength
5/13	Joints, glass masonry
5/14	Reinforcement development
5/15	Concentrated loads
5/16	S.P.C. C - construction limitations
5/17	Walls, hollow unit masonry
5/18	Bolt placement
5/19	Shrinkage control
5/20	Grout
5/21	Special inspection stresses, core tests
5/22	Material limitations

Number	Short Title
5/23	Material limitations
5/24	Masonry walls, grout and mortar strength
5/25	Material limitations
5/26	S.P.C. D - construction limitations
5/27	Shear wall and other requirements
5/28	Table 12.1

MASONRY

BACKGROUND

5/1 12-1/M-1 (10-0-0)

The masonry design and construction procedures given in this Chapter and Chapter 12A are essential to ~~providing the~~ provide seismic performance levels ~~implicit in the selection of the factors used in determining the seismic forces in these provisions. The requirements embodied in Chapters 12 and 12A have been demonstrated to be necessary by recent earthquakes and represent the latest developments in masonry construction to provide adequate seismic performance.~~ for the seismic forces exclusively for the purpose of this document.

12.1 REFERENCE DOCUMENTS

The quality and testing of masonry and steel materials and the design and construction of masonry and reinforced masonry components which resist seismic forces shall conform to the requirements of Chapter 12A and the references listed therein except as modified by the provisions of this Chapter. For definitions, see Sec. 12A.1.1.

12.2 STRENGTH OF MEMBERS AND CONNECTIONS

M-2 (10-0-0)

The strength of members and connections subjected to seismic forces acting alone or in combination with other prescribed loads shall be determined using a capacity reduction factor, ϕ, and 2.5 times the allowable working stresses of Chapter 12A or as these allowables are further modified by this chapter. The value of ϕ shall be as follows:

5/2

When considering axial or flexural compression and bearing stresses in the masonry.	$\phi = 1.0$
For reinforcement stresses except when considering shear.	$\phi = 0.8$
When considering shear carried by shear reinforcement and bolts.	$\phi = 0.6$
When considering masonry tension parallel to the bed joints, i.e., horizontally in normal construction.	$\phi = 0.8$
When considering shear carried by the masonry.	$\phi = 0.4$
When considering masonry tension perpendicular to the bed joints, i.e., vertically in normal construction.	$\phi =$ Zero

12-1AN (10-0-0)

Stresses entitled "special inspection" in Chapter 12A shall only be used when the work is fully inspected per Sec. 1.6.2, 1.6.4 and 12A.7. If f'_m is to be established by test, a minimum of three prism test series (as defined in 12A.8.1(B)) shall be made during the progress of the work.

12.2.1 SPECIAL DESIGN PROCEDURES FOR ~~UNREINFORCED~~ MASONRY SUBJECTED TO SEISMIC FORCES.

~~Unreinforced~~ Masonry shall be designed in accordance with this Section.

5/3 12-2N (10-0-0)

(A) ~~GENERAL~~ UNREINFORCED DESIGN PROCEDURE. Unreinforced masonry designed in accordance with Sec. 12A.6.1 shall be assumed to be cracked in the tension zone. The resultant linear distribution of compressive stresses must be in equilibrium with the applied forces and the maximum compressive stress must not exceed the values of Table 12A-3.

EXCEPTION:
Bed joints of unreinforced vertical components constructed using stacked bond, which are subjected to bending in the plane of the component, shall remain uncracked.

12-1

(B) REINFORCED MASONRY DESIGN. Reinforced masonry shall be designed and constructed in accordance with one of the following procedures and the provisions of other Sections of this Chapter.

1. Masonry designed and reinforced as required.

5/3 cont. 2. Masonry designed and reinforced as required and containing nominal prescribed reinforcing. Construction shall be grouted masonry -- multiwythe or hollow unit masonry containing

12-3N M-4 (9-1-0) reinforcement as specified below. Masonry joint reinforcement shall be, and ties may be, embedded in the mortar in the bed joints. All other reinforcement shall be embedded in grout. Minimum masonry, mortar, and grout coverages applicable to reinforced masonry shall be provided. Only type M or S mortar shall be used. Unreinforced masonry design procedures shall be used except that reinforced masonry areas or elements may be considered as resisting stresses in accordance with design criteria for reinforced masonry. The width of these elements, tributary to the reinforcement, must meet the requirement of effective width of masonry given in Section 12A.6. 3(A). Permissible shear stresses shall be determined in accordance with Section 12A.6.3(E). Permissible axial loads shall be determined in accordance with 12A.6.1. The R factor of Table 3-B shall be as required for unreinforced masonry unless all masonry structural elements are reinforced in accordance with Section 12.2.1(B)3.

Reinforcing for columns shall conform to the requirement of Sec. 12A.6.3(F). For walls the maximum spacing of vertical reinforcement shall be 8 feet where the nominal thickness

M-5 (9-0-1) is 8 inches or greater and 6 feet where the nominal thickness is less than 8 inches. Vertical reinforcement shall also be provided each side of each opening and at each corner of all walls. Horizontal reinforcement not less than 0.2 square inch in area shall be provided at the top of footings, at the bottom and top of wall openings, near roof and floor levels, and at the top of parapet walls and, where distributed joint reinforcement is not provided, at a maximum spacing of 12 feet where the nominal masonry thickness is 8 inches or greater and 9 feet where the nominal thickness is less than 8 inches. The vertical reinforcement ratio and the horizontal reinforcement ratio shall each be not less than 0.00025. Where not prohibited by Chapter 12A or this Chapter, stacked bond construction may be used. When stacked bond is used the minimum horizontal reinforcement ratio shall be increased to 0.0007. This ratio shall be satisfied by masonry joint reinforcement spaced not over 16 inches or by reinforcement embedded in grout spaced not over 4 feet. Reinforcement shall be continuous at wall corners and intersections.

5/3 cont. M-5 cont.

Splices for reinforcement shall conform to all requirements for splices in reinforced masonry.

These types of masonry walls shall be considered as reinforced masonry for the purpose of applying Table 12A-2. and section 12.4.1(G).

3. Masonry designed and reinforced with prescribed minimum areas in addition to the requirements of 12.2.1(B)(2). This additional reinforcement shall be in both horizontal and vertical directions. The sum of the areas of reinforcement in both directions shall be at least equal to 0.002 times the gross cross-section of the masonry with at least 0.0007 times the gross cross-sectional area of the masonry in each direction.

5/4 12-4N (10-0-0)

12.3 SEISMIC PERFORMANCE CATEGORY A

Buildings assigned to Category A may be of any construction permitted in Chapter 12A.

12.4 SEISMIC PERFORMANCE CATEGORY B

5/5

Buildings assigned to Category B shall conform to all the requirements for Category A and to the additional requirements and limitations of this Section.

12.4.1 CONSTRUCTION LIMITATIONS

Masonry components shall be constructed to conform to the limitations of this Section.

12-4-1 (10-0-0)

~~(1) HEIGHT LIMITATION. Components of the seismic resisting system in buildings under 35 feet in height shall be reinforced masonry when constructed using stacked bond and shall, as a minimum, be partially reinforced masonry when constructed using running bond. Components of the seismic resisting system in buildings over 35 feet in height shall be reinforced masonry and other structural components shall be partially reinforced masonry.~~

12-4-2/M-6 (10-0-0)

(A) DESIGN. Structural and nonstructural components of the building shall be designed and reinforced as specified in Table 12.1. The numbers designated 1, 2 and 3 in the Table refer to ~~Sections~~ subsections (1), (2) and (3) of ~~12.2.2.~~ 12.2.1(B).

5/6

(B) TIES. In addition to the requirements of Sec. 12A.6.3(F), additional ties shall be provided around anchor bolts which are set in the top of a column or pilaster. Such ties shall engage the bolts and at least four vertical column bars for reinforced masonry. Such ties shall be located within the top 4 inches of the member and shall consist of not less than two No. 4 or three No. 3 ties.

12-4-3/M-7
(10-0-0)

(C) SHEAR WALLS. Shear walls shall conform to the applicable requirements of Sec. 12.7.

~~EXCEPTION~~:
~~The reinforcement provisions of Sec. 12.7.[illegible] need not apply to specially reinforced masonry designed as unreinforced masonry~~.

5/6
cont.

(D) SCREEN WALLS. All screen walls shall be reinforced. Joint reinforcement shall be considered effective in resisting stresses. The units of a panel shall be so arranged that either the horizontal or the vertical joint containing reinforcing is continuous without offset. This continuous joint shall be reinforced with a minimum steel area of 0.03 square inch. Reinforcement shall be embedded in mortar or grout.

Joint reinforcing may be composed of two wires made with welded ladder or trussed wire cross ties. In calculating the resisting capacity of the system, compression and tension in the spaced wires may be utilized. Ladder wire reinforcing shall not be spliced and shall be the widest that the mortar joint will accommodate allowing 1/2-inch of mortar cover.

12-4-4
(10-0-0)

~~The maximum size of panels shall be 144 square feet with the maximum dimension in either direction of 15 feet.~~ Each panel shall be supported on all edges by a structural member of concrete, masonry, or steel. ~~Supports at the top and ends of the panel shall be by means of confinement of the masonry by at least 1/2 inch into and between the flanges of a steel channel. The space between the end of the panel and the web of the channel shall be at least 1/2 inch and shall be void of mortar. The use of equivalent configuration in other steel sections or in masonry or concrete is acceptable~~.

~~Horizontal and vertical joints shall be not less than 1/4 inch thick. All joints shall be completely filled with mortar and shall be shoved joints~~.

5/7

(E) NONSTRUCTURAL COMPONENTS. Nonstructural walls, partitions, and components shall be designed to support themselves and to resist seismic forces induced by their own weight. Holes and openings shall be suitably stiffened and strengthened. Nonstructural walls and partitions shall be anchored in accordance with the requirements of Sec. 12A.2.6.

(F) CONSTRUCTION TYPE. Cavity wall construction shall not be used for any structural masonry.

12-4-5 Committee voted to modify the table and move to seismic performance category C.

Table 12.2

(G) NOMINAL MINIMUM THICKNESS OF WALLS.

TYPE OF MASONRY	Walls whose only structural function is exterior enclosure, nonstructural walls, and partitions	Thickness for the uppermost 35[2] foot high portion of wall
STRUCTURAL WALLS:		
Unburned Clay Masonry	16	16
Stone Masonry	16	16
Cavity Wall Masonry	8	12[3]
Hollow Unit Masonry	8	12[3]
Solid Masonry	8	12[3,4]
Grouted Masonry	6	10[3,4]
Reinforced Grouted Masonry	6	6
Reinforced Hollow Unit Masonry	~~4~~ 6[5]	6
NONSTRUCTURAL AND PARTITIONS:[1]		
~~Unreinforced~~	~~2~~	~~--~~
Reinforced	~~2~~ 4	--

5/8 A B C D see below

[1]The thickness of plaster coatings may be considered in satisfying thickness ratios and minimum thickness requirements but shall not be used to take stresses.

[2]Seventy feet for stone masonry.

[3]These thicknesses may be reduced to 8 inches for walls that are not over 35 feet in total height in buildings that are not over three stories high.

[4]These thicknesses may be reduced to 6 inches for grouted walls and 8 inches for solid masonry walls in one-story buildings when the wall is not over 9 feet in total height, provided that when gable construction is used an additional 6 feet in height is permitted to the peak of the gable.

Except

[5]Nominal 4-inch-thick load-bearing reinforced hollow clay unit masonry walls with a maximum unsupported height or length to thickness of 27 may be permitted, provided net area unit strength exceeds 8000 psi, units are laid in running bond, bar sizes do not exceed 1/2 inch with no more than two bars or one splice in a cell, and joints are flush cut, concave or a protruding V-section. Minimum bar coverage where exposed to weather may be 1 1/2 inches.

$\boxed{\text{A - Modify as shown and move}}$ ← Committee preference

B - Modify as shown but keep in this location

C - Do not modify but move.

D - Do not modify and keep in this location

12-5

12-4-6/ M-13A (9-1-0)

(~~F~~ G) MASONRY WALLS. ~~Masonry bearing wall thickness shall conform to (G) with a maximum h/t ratio of 25.~~

Except for walls designed under the provisions of Sections 12A.6.1 and 12A.6.2(A) ~~1. Stresses.~~ The axial stress in ~~reinforced~~ masonry bearing walls shall not exceed the value determined by the following formula:

5/9 M-13B (9-1-0)

$$f_m = 0.20\, f'_m \left[1 - \left(\frac{h}{40t}\right)^3\right]$$

where:

f_m = Compressive unit axial stress in masonry wall.

f'_m = Masonry compressive strength as determined by Sec. 12A.5.1. The value of f'_m shall not exceed 6000 psi.

t = Thickness of wall in inches.

h = Clear distance in inches, between supporting or stiffening elements (vertical or horizontal).

Effective height different from clear distance may be used if justified.

~~Other requirements are specified in 12A.6.3(E).~~

12-4-7 (10-0-0)

(~~I~~ H) REINFORCED MASONRY COLUMNS. Every structural wall ~~or pier~~ whose horizontal length is less than two times its thickness shall be designed and constructed as required for columns. The least dimension of every reinforced masonry column shall not be less than 12 inches and the maximum h/t ratio shall be 20.

EXCEPTION:
The minimum column dimension may be reduced to not less than 8 inches provided the design is based upon 1/2 the allowable stresses for axial load. Bending stresses need not be so reduced.

The axial load on columns shall not exceed:

5/10

$$P = A_g\,(0.18\, f'_m + 0.65\, p_g\, f_s)\left[1 - \left(\frac{h}{40t}\right)^3\right]$$

where:

P = Maximum concentric column axial load.

A_g = The gross area of the columns with deductions for rakes and similar joint treatments.

f'_m = Compresssive masonry strength as determined by Sec. 12A.5.1. The value of f'_m shall not exceed 6000 psi.

p_g = Ratio of the effective cross-sectional area of vertical reinforcement to A_g.

f_s = Allowable stress in reinforcement; see Sec. 12A.5.2.

t = Least thickness of column in inches.

h = Clear height in inches.

Other requirements are specified in 12A.6.3(F).

12-4-8 (9-0-1)

(I) GROUTED MASONRY--MULTIWYTHE. Grouted masonry is that form of construction made with brick or solid concrete units in which interior joints of masonry are filled by pouring grout therein as the work progresses. Only Type M or Type S mortar shall be used.

Toothing of masonry walls is permitted only when designed and detailed by the design engineer or architect and only at approved locations. Racking is to be held to a minimum.

M15

5/10 cont.

When reinforced in accordance with the following requirements it shall be classified as reinforced grouted masonry --multiwythe. All required reinforcement except masonry joint reinforcement and column ties ~~conforming to the paragraph below~~ shall be embedded in grout. All other reinforcement shall be embedded in mortar or grout. All vertical reinforcement shall be held firmly in place during grouting by a frame or suitable equivalent devices. All horizontal reinforcement in the grout space shall be tied to the vertical reinforcement or held in place during grouting by equivalent means.

12-4-9/ M-16 (9-1-0)

5/11

(J) HIGH LIFT GROUTED CONSTRUCTION. For grouted masonry -multiwythe construction cleanouts shall be provided for each pour by leaving out every third ~~other~~ unit in the bottom tier of the section being poured. Other requirements are specified in 12A.3.4(B).

For hollow unit masonry construction cleanouts shall be provided for each pour by omitting face shells in the bottom course of each cell to be grouted. The grout pour ~~lift~~ shall not exceed 16 feet for walls 8 inches or more in nominal thickness nor 12 ~~8~~ feet for thinner walls. Cleaning shall be accomplished by means of a high-pressure jet stream of water, air jets, or other approved equivalent procedures. Other requirements are specified in 12A.3.6(B).

5/12

12-4-10 (8-2-0)

~~K (L) REQUIRED STRENGTHS FOR MORTAR AND GROUT. In addition to the requirements of Sec. 12A.8.2, minimum required strengths shall be 2000 psi for grout, 1500 psi for field mortar samples (2000 psi for field mortar cubes) unless higher strengths are required by the construction documents.~~

Note: Item (K) becomes Item (O) on p. 12-12 by a later ballot.

12-4-11 (10-0-0) (K) JOINTS. All hollow units shall be laid with face shell bed joints and head joints filled solidly with mortar for a distance in from the face of the unit not less than the thickness of the face shells unless more stringent construction is required by this Chapter, Chapter 12A, or by design. Cross webs and end shells of all starter courses shall be bedded on mortar. This applies to units laid on foundations or floor slabs, and all courses of piers, columns, and pilasters.

Concrete abutting structural masonry such as at starter courses or at wall intersections not designed as true separation joints, shall be roughened to a full amplitude of 1/8 inch, and shall be bonded to the masonry per the requirements of this Chapter as if it were masonry. Unless keys are provided, vertical joints shall be considered to be stacked bond.

5/13 12-4-12 (10-0-0) (L) GLASS MASONRY. Glass block shall be laid in Types M, S or N mortar. Both vertical and horizontal mortar joints shall be at least 1/4 inch and not more than 3/8 inch thick and shall be completely filled.

Glass block panels shall have reinforcement in the horizontal mortar joints, extending from end to end of mortar joints, but not across expansion joints, with any unavoidable joints spliced by lapping the reinforcement not less than six (6) inches. The reinforcement shall be spaced not more than two (2) feet apart vertically. In addition, reinforcements shall be placed in the joint immediately below and above any openings within a panel. The reinforcement shall consist of two (2) parallel, longitudinal, galvanized steel wires, No. 9 gage or larger, spaced two (2) inches apart, and having welded thereto No. 14 or heavier gage cross wires at intervals not exceeding eight (8) inches, or the equivalent approved by the Regulatory Authority.

5/14 12-4-13 (10-0-0) (M) REINFORCEMENT DEVELOPMENT, ANCHORAGE AND SPLICES. The requirements of 12A.6.3(D) are applicable except that calculated stress shall be replaced with yield strength. The following subsections 1 and 2 replace subsections 5 and 7, respectively, in 12A.6.3(D).

5/14 cont. 12-4-14 (10-0-0)

1. Development Lengths. The basic development length, l_d, for deformed reinforcement shall be at least .05 $d_b^2 f_y/\sqrt{f_g}$ but not less than 24 d_b for reinforcement of 40,000 psi yield strength nor 36d_b for reinforcement over 40,000 psi yield strength, nor less than 12 inches for reinforcing bars and 6 inches for masonry joint reinforcement where:

d_b = the diameter of the smaller bar spliced, inches.

f_y = the specified bar yield strength, psi.

f_g = the strength of the mortar or grout, as applicable, immediately surrounding the reinforcement but not more than the prism strength, psi.

Development lengths for plain reinforcing shall be twice that required for deformed reinforcement but not less than 12 inches.

EXCEPTIONS:
For deformed main compression reinforcement in columns that are not part of the seismic system, these values may be reduced to 18d_b for bars of 40,000 psi yield strength and and 27d_b for bars over 40,000 psi yield strength.
In flexural members that are not part of the primary lateral load resisting system the development lengths may be reduced where excess reinforcement is provided. For these cases, the previously determined development lengths may be multiplied by the ratio of the area of reinforcement required by design to that provided.

12-4-15 (10-0-0)

2. Splices. Splices shall be made only at such point and in such manner that the strength of the member will not be reduced. Splices shall be made by lapping the bars, by welding, or by mechanical connections. Lapped splices shall not be used for tension tie members.

Lengths of laps, in inches, for deformed reinforcement shall be at least 0.08 $d_b^2 f_y/\sqrt{f_g}$ but not less than 40d_b for reinforcement of 40,000 psi yield strength nor less than 60 d_b for reinforcement over 40,000 psi yield strength, nor less than 12 inches for reinforcing bars and 9 inches for masonry joint reinforcement. Lap lengths for plain reinforcing shall be twice that required for deformed bars but not less than 12 inches. The terms d_b, f_y, and f_g shall be as defined in Sec. 12A.6.3(D)6.

EXCEPTION:
For deformed main compression reinforcement in columns that are not part of the seismic system, the lap length may be reduced to 30d_b for bars of 40,000 psi yield strength and 45d_b for bars over 40,000 psi yield strength.

Welded or mechanical connections shall develop the yield strength of the bar in tension.

EXCEPTION:
For compression bars in columns that are not part of the seismic system and are not subject to flexure the compressive strength need only be developed.

12-4-16
(9-0-1)

(N) DISTRIBUTION OF CONCENTRATED LOADS. Concentrated loads shall not be considered to be distributed by metal ties in stacked bond construction, nor to be distributed across continuous vertical joints. This provision shall apply when considering overturning effects in shear walls if stacked bond is not prohibited.

5/15

12.4.2 MATERIAL LIMITATIONS.

The following materials shall not be used for any structural masonry:

Unburned Clay Masonry

Structural Clay Load Bearing Tile

12-4-17/
M-18
(9-1-0)

Mortar with Air Contents Greater than 15%
Masonry Cement ~~(Mortar and Grout)~~

~~Mortars other than types M or S.~~

12.5 SEISMIC PERFORMANCE CATEGORY C

Buildings assigned to Category C shall conform to all of the requirements for Category B and to the additional requirements and limitations of this Section.

12.5.1 CONSTRUCTION LIMITATIONS

Masonry components shall be constructed to conform to the limitations of this Section.

12-5N/
M-19
(10-0-0)

(A) REINFORCEMENT. All masonry shall be reinforced masonry conforming to section 12.2.1(B) except for one-story residences of running bond construction located in map area 5 shall conform to section 12.2.1(B)2.

(B) TIE ANCHORAGES. In addition to the requirements of Sec. 12.6.3.2 for tie anchorages, a minimum turn of 135 degrees plus an extension of at least 6 tie diameters but not less than 4 inches at the free end of the tie shall be provided.

5/16

(C) REINFORCED COLUMNS. In addition to the requirements of Sec. 12.6.3(F) for reinforced masonry columns, no longitudinal bar shall be farther than 6 inches from a laterally supported bar. Except at corner bars, ties providing lateral support may be in the form of cross-ties engaging bars at opposite sides of the column.

The tie spacing for the full height of masonry shear wall boundary columns and all other columns stressed by tensile or compressive axial overturning forces due to seismic effects and for the tops and bottoms of all other columns for a distance of 1/6 of clear column height but not less than 18 inches nor the maximum column dimension shall be not greater than 16 bar diameters nor 8 inches. Tie spacing for the remaining column height shall be not greater than 16 bar diameters, 48 tie diameters, or the least column dimension, but not more than 18 inches.

(D) SHEAR WALL BOUNDARY ELEMENTS. Boundary members shall conform to one of the following:

1. Sec. 11.8.4 when of reinforced concrete or structural steel.
2. Sec. 12.5.1(C) when of masonry.

12-6-N
(10-0-0)

(E) JOINT REINFORCEMENT. Longitudinal masonry joint reinforcement may be used in reinforced grouted masonry and reinforced hollow unit masonry only to fulfill minimum reinforcement ratios but shall not be considered in the determination of the shear strength of the member.

(F) STACKED BOND CONSTRUCTION. The minimum ratio of horizontal reinforcement shall be 0.0015 for all structural walls of stacked bond construction. The maximum spacing of horizontal reinforcing shall not exceed 24 inches. Where reinforced hollow unit construction forms part of the seismic resisting system, the construction shall be grouted solid and all head joints shall be made solid through the use of open end units.

12-6-1/ M-20 (10-0-0)

(G) ~~PIERS~~ WALLS. Every structural wall ~~or pier~~ in reinforced masonry construction whose horizontal length is between ~~3~~ 2 and 5 times its thickness or less than 1/2 the height of adjacent openings shall have all horizontal steel in the form of ties except that in walls less than 12 inches in nominal thickness and in reinforced grouted multi-wythe construction such steel may be in one layer in the form of hairpins.

5/17 12-6-2/ M-21 (10-0-0)

(H) HOLLOW UNIT MASONRY. Hollow unit masonry construction, where certain cells are continuously filled with concrete or grout, and reinforcement, in accordance with 12.2.~~2~~1(B)(3), is embedded therein shall be classified as reinforced hollow unit masonry. Reinforced hollow unit masonry shall generally be one wythe in thickness. If constructed of more than one wythe, each wythe shall be designed as a separate element or wall or the wythes shall be bonded together by means approved by the Regulatory Agency. This bonding shall be designed so the wythes shall act as a unit.

Vertical cells to be filled shall have vertical alignment sufficient to maintain a clear, unobstructed continuous vertical cell measuring not less than 2 inches by 3 inches. If walls are battered or if alignment is offset, the 2 inch by 3 inch clear opening shall be maintained as measured from course to course.

5/18 12-6-3 (8-1-1)

(I) BOLT PLACEMENT. Bolts shall be accurately set ~~with templates or by approved equivalent means~~ and held in place to prevent movement.

Vertical bolts at the top of and near the ends of reinforced masonry walls shall be set within hairpins or ties located within 2.5 inches from the top of the wall. See Sec. 12A.6.3(F) and 12.4.1(B) for bolts at the top of ~~piers~~, pilasters and columns.

5/19 12-6-4 (5-2-3)

~~(J) SHRINKAGE OF CONCRETE UNITS. Concrete masonry units used for structural purposes shall have a maximum linear shrinkage of 0.065 percent from the saturated to the oven-dry condition.~~

Notes: Item I, unchanged, also becomes Item D on p. 12-14. Item J becomes Item E on p. 12-14.

5/20 12-6-5 (8-1-1)

(K) GROUT. Grout shall have a consistency, considering the methods of consolidation to be utilized, to completely fill all spaces to be grouted without segregation except that slumps shall not be less than 4.5 inches for all grout. ~~nor more than 10 inches for fine grout or 9 inches for coarse grout~~.

Mixing equipment and procedures shall produce grout with the uniformity required for concrete by ASTM C94.

12-6-6/ M-22 (10-0-0)

(L) ALLOWABLE STRESSES WITHOUT SPECIAL INSPECTION. The allowable stresses for ~~uninspected reinforced construction~~ work without special inspection shall be those given in Table 12A.5 except that the factor of 2/3 for axial compression in walls and columns shall be reduced to 1/2.

5/21 12-6-7/ M-24 (10-0-0)

(M) CORE TESTS FOR SHEAR BOND IN GROUTED MASONRY-MULTIWYTHE. In addition to the requirements of Sec. 12A.3.3 the following provisions must be met for ~~all~~ core tests for grouted masonry-multiwythe construction when such tests are required.

The unit shear strength shall not be less than 100 psi. Where an unusual number of cores fail during the cutting operation, the design authority shall determine if the test program is extensive enough to satisfy the requirements of Sec. 12A.1.5.

One test series shall be made for each 5,000 square feet of wall or equivalent but not less than one series for any building.

5/24 M-32 (10-0-0)

(N) MASONRY WALLS. Masonry wall thickness shall conform to table 12-2. The ratio of height or length to thickness of reinforced structural walls shall not exceed 25.

M-33 (10-0-0)

(O) Insert Item (L) from p. 12-7.

12-7N

12.5.2 MATERIAL LIMITATIONS.

5/22

The following materials shall not be used for any structural purpose:

(3-2-0)

~~Building Brick and Hollow Brick made from Clay or Shale of Grade NW~~

5/23 (10-0-0)

~~Concrete Building Brick and Solid Load-bearing Concrete Masonry Units other than Grade N~~

(10-0-0)

Hollow Load-bearing Concrete Masonry Units other than Grade N

(7-3-0)

~~Sand-lime Building Brick other than grades SW and MW~~

(7-3-0)

Type N Mortar

(7-3-0)

Masonry Cement

12-7N continued

The following materials shall not be used for any nonstructural purpose:

(10-0-0) ~~Glass Units~~

5/25 Unburned Clay Masonry

Structural Clay Load-bearing and Nonload-bearing Wall Tile

(9-0-1) Masonry Cement (Mortar with Air Content Greater than 15%)

(10-0-0) ~~Mortar Types N, O and K~~

12.6 SEISMIC PERFORMANCE CATEGORY D

Buildings assigned to Category D shall conform to all of the requirements for Category C and to the additional requirements and limitations of this Section.

12.6.1 CONSTRUCTION LIMITATIONS

Materials for mortar and grout for structural masonry shall be measured in suitable calibrated devices. Shovel measurements are not acceptable. An approved admixture of a type that reduces early water loss and produces a net expansion action shall be used for grout for structural masonry unless it can be demonstrated that shrinkage cracks will not develop in the grout. The thickness of the grout between masonry units and reinforcing shall be a minimum of 1/2 inch for structural masonry.

(A) MINIMUM GROUT SPACE FOR GROUTED MASONRY. The minimum grout space for structural reinforced grouted masonry shall be 2-1/2 inches for low-lift construction and 3-1/2 inches for high-lift construction.

5/26 (B) REINFORCED HOLLOW UNIT MASONRY. Structural reinforced hollow unit masonry shall conform to requirements below:

1. Wythes and elements shall be at least 3 inches in nominal thickness with clear, unobstructed continuous vertical cells, without offsets, large enough to enclose a circle of at least 3-1/2 inches in diameter and with a minimum area of 15 square inches.

2. All grout shall be coarse grout. Grout consolidation shall be by mechanical vibration only. All grout shall be reconsolidated after excess moisture has been absorbed but before workability has been lost.

3. Vertical reinforcement shall be securely held in position at tops, bottoms, splices, and at intervals not exceeding 112 bar diameters. Approved intermediate centering clips or caging devices shall be used in high-lift construction, as required, to hold the vertical bars. Horizontal wall reinforcement shall be securely tied to the vertical reinforcement or held in place during grouting by equivalent means.

4. In wythes of less than 10-inch nominal thickness, in any vertical cell, there shall be a maximum of one No. 10 bar or two No. 3 bars with splices staggered for the two-bar situation.

5. The first exception of Sec. 12A.5.3(F) shall not apply; minimum nominal column dimension shall be 12 inches.

5/26

(C) STACKED BOND CONSTRUCTION. All stacked bond construction shall conform to the following requirements:

1. The minimum ratio of horizontal reinforcement shall be 0.0015 for nonstructural masonry and 0.0025 for structural masonry. The maximum spacing of horizontal reinforcing shall not exceed 24 inches for nonstructural masonry nor 16 inches for structural masonry.

2. Reinforced hollow unit construction which is part of the seismic resisting system shall (1) be grouted solid, (2) use double open end "H" block units so that all head joints are made solid, and (3) use bond beam units to facilitate the flow of grout.

3. Other reinforced hollow unit construction used structurally, but not part of the seismic resisting system, shall be grouted solid and all head joints shall be made solid by the use of open end units.

(10-0-0) (D) Insert Item (I) from p. 12-11 reinserting the phrase "with templates or by approved equivalent means."

(7-1-2) (E) Insert Item (J) from p. 12-11.

(10-0-0) (F) Insert Item (K) from p. 12-12 reinserting the phrase "not more than 10 inches for fine grout or 9 inches for coarse grout."

12-8-1
M-28
(10-0-0)

12.6.2 MATERIAL LIMITATIONS

~~other than Grade N,~~

Hollow nonload-bearing concrete masonry units shall not be used. Sand-lime building brick, ~~shall not be used for any structural masonry.~~ Building Brick and Hollow Brick made from Clay or Shale of Grade NW and Building Brick and Solid Load-bearing Concrete Masonry Units other than Grade N shall not be used for any structural masonry.

12.6.3 SPECIAL INSPECTION

Special inspection shall be provided for all structural masonry.

12.7 SHEAR WALL REQUIREMENTS

Shear walls shall comply with the requirements of this Section.

12.7.1 REINFORCEMENT

12-9
(10-0-0)

5/27 The following reinforcement requirements apply to shear walls required to comply with the provisions of 12.2.1(B)(3).

12-10
(10-0-0)

The minimum ratio of reinforcement for shear walls shall be 0.0015 in each direction. The maximum spacing of reinforcement in each direction shall be the smaller of the following dimensions: one-third the length and height of the element but not more than 48 inches. The area and spacing of reinforcement perpendicular to the shear reinforcement shall be at least equal to that of the required shear reinforcement. The portion of the reinforcement required to resist shear shall be uniformly distributed.

EXCEPTION:
For shear walls constructed using running bond, the ratio of reinforcement may be decreased to 0.0007 provided that all shear is resisted by the reinforcement. The sum of the ratios of horizontal and vertical reinforcement shall not be less than 0.002.

5/27
cont.

12-10-1 (10-0-0) Reinforcement required to resist wall shear shall be terminated with a standard hook which terminates beyond the boundary reinforcing at the end of the wall sections. The hook may be turned up, down or horizontally and shall be embedded in mortar or grout. Wall reinforcement terminating in boundary columns or beams shall be fully anchored into the boundary elements.

M-29 (10-0-0) Vertical stresses in shear walls shall be determined from the combined effects of vertical load and from the overturning effects of lateral loads. Minimum vertical loads shall be considered. Formula 3-2a shall be used for unreinforced masonry design.

In computing the shear resistance of the wall, only the web shall be considered. For unreinforced masonry the depth of the web may be considered out to out of flanges.

12.7.2 BOUNDARY MEMBERS

5/27 cont.

Where cross walls or boundary members form a part of the shear wall system, the intersections shall be constructed as required for the walls themselves. Connections to concrete shall conform to Sec. 12A.2.1. Where the boundary members are of structural steel, the shear transfer between the wall and the boundary member shall be developed by fully encasing the element in grout, by dowels, bolts, or shear lugs, or by similar approved methods.

When the structural system, as described in Chapter 3 and Table 3-8, consists of substantially complete vertical load-carrying frame, boundary members shall be provided at each end of the wall. The members shall be of the same construction as the frame columns. Where the frame is a special moment frame, those columns shall conform to the requirements for such members in Chapters 10 and 11. Also see Sec. 12.5.1(D) for Category C & D.

The required vertical boundary members and such other similar vertical elements as may be required shall be designed to carry all the vertical forces resulting from the wall loads, the tributary dead and live loads, and the seismic forces prescribed in these provisions.

Horizontal reinforcing in the walls shall be anchored to the vertical elements. Where the boundary element is structural steel this shall be accomplished by welding or by extension, with bends if required, into grout fully surrounding the column.

M-30 (10-0-0)

12.7.3 ~~COMPRESSIVE~~ STRESSES

For loading combinations including in-plane seismic forces, allowable compression stresses at any point shall not exceed those allowed for axial compression. For unreinforced masonry designed by Sec. 12A.6.1, the allowable working stress values are given in Table 12A-3. The allowable working stress values for reinforced masonry shall be the allowable working stresses given in Table 12A-5 and applicable reductions for slenderness effects shall apply. The minimum horizontal distance between lateral supports may be considered for walls as well as the minimum vertical distance. Formula 12A-7 shall not be used.

EXCEPTION:
For pier type wall elements that do not extend from floor to floor compression stresses under combined loading at any point may be limited to those allowed for flexural compression provided that Formula 12A-7 is also satisfied.

5/27

12.7.4 HORIZONTAL COMPONENTS

12-11
(10-0-0)

When shear reinforcing is required for loads that include seismic effects and diagonal bars conforming to Sec. 12A.6.4(D) are not provided, reinforcement approximately perpendicular to the required shear reinforcement shall be provided equal in amount and spaced not further apart than is required for the shear reinforcing. Horizontal reinforcing shall anchor into or be continuous through the pier elements. Horizontal components may be separated from the shear wall system by means of ~~[illegible]~~ joints. The joints shall provide for building movement determined in accordance with Sec. 3.8. The horizontal components shall be anchored to the building and designed as otherwise required by these provisions.

5/28

TABLE 12.1 DESIGN AND REINFORCEMENT REQUIREMENTS FOR SEISMIC PERFORMANCE CATEGORY B.

Type of Construction	Map Area 2		Map Area 3		Map Area 4	
	Buildings under 35 ft	Buildings over 35 ft	Buildings under 35 ft	Buildings over 35 ft	Buildings under 35 ft	Buildings over 35 ft
Structural Components						
Running Bond	1	~~2~~ 1	2	2	2	3
Stacked Bond	2	2	3	3	3	3
Nonstructural Components						
Running Bond	1	1	1	1	2	2
Stacked Bond	1	1	1	2	2	2

12-11-1

(9-0-1)

Note: 1. The numbers 1, 2 and 3 refer to subsections (1), (2) and (3) of 12.2.1(B)

2. Map areas refer to figure 1.2.

Chapter 12 ballots are based on an ATC proposed (working with committee members) draft that reflects the results of Chapter 12A ballots. The draft moves forward seismic items deleted from Chapter 12A and revises wording for compatibility.

Joint Committee Ballot No.	Type of Change and Committee Comment	ATC Recommendation and Comment
5/1	• Partial deletion and insertion - editorial change.	Yes - Editorial changes.
5/2	• New insert - editorial change for clarification. • New insert - seismic requirement from Ch. 12A	Yes - Editorial change and one of the items brought forward from Ch. 12A.
5/3	• Deletion and insertion - The section has been rewritten to be compatible with the approach in Ch. 12A in omitting the terminology "partial reinforcement." Care was taken in (B) Reinforced Masonry, to insure that sufficient reinforcement was present before permissible stresses for reinforced masonry could be used. Research is necessary to determine whether or not lower limits are possible. Reinforcement spacing and detailing have been moved from Chapter 12A.	Yes - These three definitions for reinforced masonry have been added because of Committee 5's desire to remove the terminology "partial reinforcement" from the document. They wanted to refer to reinforced masonry as masonry containing reinforcement regardless of its amount. This proposed ballot item certainly attains this objective but may lead to a more confusing situation with regard to what allowable stresses can be used when reinforcement is present. The allowable stresses for reinforced masonry have been developed on the assumption of prescribed minimum amounts. The wording in 12.2.1 (B) 2 attempts to clarify what allowable stresses can be used for the previously used "partial reinforcement" requirements. ATC recommends that this section be editorially revised.
5/4	• No change - The committee preferred reference to national standards but this was not completely possible.	Yes - No change from text.

Joint Committee Ballot No.	Type of Change and Committee Comment	ATC Recommendation and Comment
5/5	• Deletion and insertion - The proposed ATC wording was accepted with editorial change. The referenced Table 12-1 was modified in Ballot Item 5/28.	Yes - This comment pertains to Sec. 12.4.1 (A). This is a major change from the original requirements of Ch. 12.4.1 (A) and may produce an inconsistency with Category B requirements for Reinforced Concrete Ordinary Moment Frames. ATC recommends that the change from 2 to 1 for structural components in Table 12-1 with running bond in buildings over 35 feet high not be approved. Furthermore, the changes inherent in this table should be reviewed and commented upon by Committee 2 for consistency with other material requirements. However, ATC proposed this change of refinement in SPC-B.
5/6	• Deletion and insertion - This is the original text of 12.4.1 B and D. Part C is a minor change to delete reference to "partial reinforcement."	Yes - Pertains to 12.4.1 (B), (C), (D). Primarily original text.
5/7	• No change - original text.	Yes - Pertains to 12.4.1 (E), (F). Original text.
5/8	• Transfer, insertion, partial deletion - The table was felt to be unnecessary in SPC-B. Thickness would be controlled by the limiting h/t restrictions and available masonry units. The deleted types of structural walls are not allowed and therefore not needed. The 35-foot restriction is not needed and is deleted. Deletion of footnotes follow deletion of above items.	Option D - We believe this item should be in Ch. 12A but if removed from 12A, it is recommended to be retained under SPC-B.

Joint Committee Ballot No.	Type of Change and Committee Comment	ATC Recommendation and Comment
5/9	• Transfer and deletion - The section on masonry walls was transferred from Ch. 12A by the ATC rewrite. The lower coefficient of 0.20 for seismic rather than the 0.225 used in Ch. 12A was considered satisfactory. The h/t restriction was considered unjustified. Data are available for wall tests using h/t of up to 40. The h/t = 25 limit is in SPC-D as 5/24. The committee agrees with the ATC interpretation of a "no" vote.	No - This item has been transferred from Ch. 12A. ATC believes that the h/t limitation that is proposed for deletion should be retained, and, therefore, the ballot item not be passed with h/t deleted. A "no" vote means retention of the section including the h/t restriction. "Yes" means as shown.
5/10	• Transfer - The transfer from Ch. 12A with the lower coefficient of 0.18 for seismic rather than the 0.20 used in Ch. 12A was considered satisfactory. The transfer of (I) from Ch. 12A is supported.	Yes - Pertains to 12.4.1 (H), (I). Items brought forward from Ch. 12A.
5/11	• Transfer - The transfer of (J) from Ch. 12A for seismic is considered satisfactory.	No - Pertains to 12.4.1 (J). Recommend retention of leaving out every other unit for cleanouts.
5/12	• Transfer - This item was considered unnecessary in Ch. 12A since ASTM specifications provide the needed control. The same rationale holds for SPC-B. Its inclusion in SPC-C is supported (see Ballot Item 5/24).	No - This ballot item is identical to Ballot Item 5A/72 except that the committee proposes to move it from SPC-B to SPC-C. This item does not really relate to SPC because it is a quantitative quality control item for mortar and grout. Ifdeleted from Ch. 12, ATC strongly believes that it should remain in SPC-B and, therefore, recommends that this item not be passed.
5/13	• Transfer - The committee supports the transfer from Ch. 12A to Ch. 12.	Yes - Items (K) and (L) are just items brought forward from Ch. 12A.

Joint Committee Ballot No.	Type of Change and Committee Comment	ATC Recommendation and Comment
5/14	• Transfer - Ch. 12A is based on allowable stresses and includes material similar to this. Ch. 12 is based on strength. The committee supports transfer of this strength-related material to Ch. 12.	Yes - This item was brought forward from Ch. 12A and includes the development length for the yield stress of the reinforcement.
5/15	• Transfer, modification - Section (N) was transferred to Ch. 12 for seismic. The other changes are minor.	Yes - Pertains to 12.4.1 (N) and 12.4.2. Item (N) was brought forward from Ch. 12A. No objection to other change.
5/16	• Insert - These are the original SPC-C requirements except for changes in (A) and (E). (E) is editorial. Item (A) insert relaxes the reinforced masonry requirements for single-story residences.	Yes - Pertains to 12.5.1 (A), (B), (C), (D), (E), (F). This was the original SPC-C requirements including a liberalization for one-story masonry residences.
5/17	• Transfer - These are items brought forward, with minor change, from Ch. 12A.	Yes - Pertains to 12.5.1 (G), (H). Items were brought forward from Ch. 12A.
5/18	• Transfer - Item (I) was transferred from Ch. 12A for seismic reasons. The modified wording adopted for SPC-C is performance based with the requirement being to accurately set the bolts. Use of only templates is too restrictive. It should be noted that (I) with templates inserted back in is supported in SPC-D by 5/26 as Item D with its generally more restrictive requirements.	No - Recommend retention of templates or equivalent means and that this item be retained in SPC-C.

Joint Committee Ballot No.	Type of Change and Committee Comment	ATC Recommendation and Comment
5/19	• Transfer - This item was deleted in Ch. 12A but reconsidered for Ch. 12. Shrinkage was considered a serviceability and not a safety or seismic problem. It was adopted in SPC-D by 5/26 as item E.	No - Pertains to 12.5.1 (J). It was recommended that the shrinkage limits be retained in Ch. 12; however, if not, then it should occur in SPC-C.
5/20	• Transfer, deletion - The item was transferred from Ch. 12A. See remarks on 5A/16.	No - Pertains to 12.5.1 (K). Same reason as given in 5A/16.
5/21	• Transfer - Transfer from Ch. 12A is supported.	Yes - Pertains to 12.5.1 (L), (M), brought forward from Ch. 12A.
5/22	• Deletion - The NW grade is for durability purposes. It does not affect strength so there is no need for the restriction.	No - First listed item under 12.5.2 is recommended to be retained.
5/23	• Partial deletion and inserts - The changes are considered more appropriate for the specific materials shown.	Yes - No objections to remaining changes or additions made in Material Limitations list.
5/24	• Transfer - Item N was moved from SPC-B (5/9) to SPC-D. Item O was moved from SPC-B (5/12).	Yes - Also recommended that this be retained under SPC-B.
5/25	• Partial deletion, replacement - More appropriate use of materials.	Yes - No objection to changes and additions made under "nonstructural materials list."

Joint Committee Ballot No.	Type of Change and Committee Comment	ATC Recommendation and Comment
5/26	• No change - This is Sec. 12.6 of Ch. 12 in its entirety.	Yes - Pertains to 12.6 in its entirety.
5/27	• Transfer - Items (D), (E), (F) are similar to ballot items 5/18, 5/19, and 5/20, respectively. Other changes are minor.	Yes - No objection to remainder of changes and addition.
5/28	• Partial deletion and insertion - The table was proposed by ATC. The ballot refers only to changing the 2 to a 1 for Map Area 2 for buildings over 35 feet. The table and footnotes were accepted, otherwise.	No, with explanation - A "no" vote infers the retention of 2 rather than 1 for buildings over 35 feet in Map Area 2.

3.0 Committee Records

3.1 Minutes of Meetings

Five formal committee meetings were held:

1. December 1979, in Gaithersburg, Maryland
2. February 21-22, 1980 in Arlington, Texas
3. March 21-22, 1980 in Denver, Colorado
4. May 16, 1980 in Chicago, Illinois
5. June 5-6, 1980 in Washington, D.C.

The minutes for these meetings follow this page. The record of a Task Group meeting held January 4, 1980 in Northbrook, Illinois is presented as Exhibit B in Section 3.3.

The original minutes referred to various attachments. In this text the attachments are identified by an exhibit letter and are contained in Section 3.3. Ballot items referred to in the minutes may be found in Section 2.1 for Chapter 12A and 2.2 for Chapter 12.

Minutes of First Meeting

of

Technical Committee No. 5 on Masonry

for

Review and Refinement of Tentative Seismic

Provisions (ATC-3-06)

at

National Bureau of Standards

December 11, 1979

In accordance with the procedure approved by the BSSC, the Secretary, E. V. Leyendecker, representing the NBS Secretariat on this Committee, called the meeting to order at 12:10 P.M. for election of a Chairman. All current members of the committee, as follows, were present:

Name	Representative of
James Amrhein	Masonry Institute of America
Richard Gensert	American Concrete Institute
Andrei Gerich	Interagency Committee on Seismic Safety in Construction
George Hanson	The Masonry Society
Robert Helfrich	Western States Clay Products Institute
Mark Hogan	National Concrete Masonry Association
Jerry Stockbridge	American Society of Civil Engineers
Alan Yorkdale	Brick Institute of America
E. V. Leyendecker	National Bureau of Standards
Lou Cattaneo	National Bureau of Standards
Melvyn Mark	Applied Technology Council
Ron Mayes	Applied Technology Council
Vincent Bush	Building Seismic Safety Council

The Secretary followed the common agenda for the Technical Committees and called for nominations of a Chairman for this Committee. Richard Gensert and George Hanson were nominated for co-chairmanship by Robert Helfrich. Richard Gensert declined the nomination because of an already crowded professional committee work schedule and nominated Jerry Stockbridge to be co-chairman with George Hanson. Stockbridge and Hanson were elected co-chairmen by unanimous vote. By mutual agreement of the co-chairmen, Stockbridge presided over the remainder of this meeting.

For the next meeting of Committee No. 5 (to be held on February 21-22 by Committee consensus) 3 possible meeting places will be considered in the following order of preference:

(a) Univ. of Texas at Arlington (Dallas) - Availability to be investigated by Alan Yorkdale

(b) Six Flags Motel at Arlington (Dallas) - Availability to be investigated by Alan Yorkdale

(c) Federal Office Bldg. at Dallas, Texas - Availability to be investigated by Andrei Gerich

The chairman pointed out that the facilities for the February meeting must provide a room large enough to accommodate large attendance of a widely advertised public meeting. Vincent Bush indicated that ICBO (in addition to the ASCE and other newsletters mentioned at an earlier general meeting) would also publicize the February meeting.

Alan Yorkdale, BIA, was unanimously elected as the Masonry Committee representative to Committee 2 on Structural Design.

Ron Mayes initiated a discussion on establishing a work plan for the Committee and expressed the opinion that the work plan should include producing a replacement for Chapter 12-A of ATC-3-06.

Discussion was interrupted for lunch at 12:00 and resumed at 1:00 P.M. in Lecture Rm. B, Bldg. 101. In addition to the previously mentioned attendees, this session was attended by:

Alternate Member

Kevin Callahan	National Concrete Masonry Assoc.

Visitors

Roland Sharpe	Applied Technology Council
Edward Pfrang	National Bureau of Standards
Joseph Wintz	Brick Institute of America

for various lengths of time.

Melvyn Mark offered the opinion that Chapter 12-A could not be rewritten satisfactorily in the time allotted by the BSSC schedule (approx. 8 mos., in contrast with 4 years spent on the original writing) and called upon everyone to read Chapter 12-A completely and in detail with a view toward improving the language but without making mass changes.

Richard Gensert's recommendation of referencing both ACI-531 and the BIA Recommended Practice in Chapter 12-A drew the counter opinion from Hanson that such an approach would still be fragmented and that a unified set of masonry construction seismic requirements should be presented in Chapter 12-A for all types of masonry.

Andrei Gerich proposed that perhaps consideration should be given to making proposed revisions to ATC-3-06 on an individual basis. Robert Helfrich, on the other hand, felt that he spoke for the entire masonry industry in recommending that the necessary improvement of Chapter 12-A be accomplished by the concerted effort of a representative drafting task group.

George Hanson and Jerry Stockbridge both recommended that a vote be taken to determine whether a task group for drafting proposed revisions of Chapter 12-A should be appointed. The decision was affirmative. The co-chairmen appointed James Amrhein (Masonry Institute of America), Richard Gensert (American Concrete Institute), George Hanson (The Masonry Society), Mark Hogan (National Concrete Masonry Assoc), and Alan Yorkdale (Brick Institute of America) to the Task Group. Yorkdale was elected Task Group Chairman. Chairman Stockbridge charged all committee members with reviewing their familiarity with ATC-3-06 in order to pass-on proposed revisions to the Task Group. The Task Group will distribute to all Masonry Committee (No. 5) members, copies of documents recording correspondence and actions of the Task Group. The Chairman recommended that the Task Group be permitted to work alone in order to accomplish its task without undue delaying discussion but that it declare where and when it would work in order to receive input from contributors. (The Task Group will meet in Northbrook, Illinois January 4, 1980). The Task Group will engage in its task until January 30th (foregoing the ATC response to first proposals), and discuss and synthesize proposals received by that date until February 21 at which time a draft proposal will be presented to the full Committee (No. 5). The proposal adopted by Committee action at the February 21-22 meeting will be prepared by the Task Group for submittal by the Committee as an "additional" proposal on the March 10 milestone date of the BSSC schedule.

Melvyn Mark proposed that a second task group of 3 members be appointed to prepare a contingency proposal (concurrently with the first Task Group) to be submitted in the event that the first proposal not adopted; the second (contingency) proposal to be based on minor revisions of the present Chapter 12-A. Rather than appoint a second Task Group, co-chairmen Hanson and Stockbridge charged the existing Task Group with this proposed task by way of having them re-examine ATC-3-06, Chapter 12-A as it presently reads before going on to draft more extensive revisions.

Meeting adjourned at 3:45 p.m.

Respectfully submitted,

Edgar V. Leyendecker

Edgar V. Leyendecker, Secretary

Minutes of the Meeting

of

Technical Committee No. 5 - Masonry

for

Review and Refinement of Tentative Seismic

Provisions (ATC 3-06)

Inn of the Six Flags
601 Avenue H, East
Arlington, Texas 76011

February 21 and 22, 1980

1.0 The meeting was called to order at 10:15 a.m., February 21, by Co-Chairmen Hanson and Stockbridge.

1.1 All those present were asked to introduce themselves. A list of members and guests is attached.

1.2 Don Wakefield was introduced as the alternate to R. Helfrich, representative of Western States Clay Products Association.

1.3 Mario Catani was introduced as a voting member representing the Portland Cement Association.

2.0 The tentative agenda distributed February 14, 1980 was revised as in the attachment.

3.0 The minutes of the December 11, 1980 Committee 5 were reviewed. They were modified as follows and approved.

p. 3, para, 4, line 5 - change George Hanson (The Masonry Society) to Robert Helfrich (Western States Clay Products Assoc.)

p. 3, para. 1 - Continue the paragraph to read "It was noted during the discussion that some members had copies of only the masonry portions of the ATC 3-06 report."

4.0 The minutes of the January 4, 1980 Task Group Meeting (distributed with A. Yorkdale's January 15, 1980 memo) was reviewed (Exhibit B, section 3.3). They were modified as follows and approved.

p. 1 - change title from "Technical Committee No. 5 on Masonry" to "Task Group for Drafting Proposed Revisions to Chapters 12 and 12A of Technical Committee No. 5 on Masonry"

p. 1 - Section 1.0, line 2 - change from "the Committee present:" to "Technical Committee No. 5 were present:"

p. 1 - Section 1.1, change the affiliation of V. Bush from ATC to BSSC.

p. 1 - Section 1.1, Add Leyendecker, E. V. (non-voting), (NBS)

p. 1 - Section 1.3, Delete the entire section.

p. 2 - Section 2.2, Change "A" to "B" for the Seismicity Index of 2 and Seismic Hazard Exposure Group I.

p. 4 - Change "Committee" to "Task Group" on the lines numbered (2.4.3), (2.4.3.1), (2.5.1), (2.5.1.1), (2.6.1) and the third line of Section 2.7.

p. 5 - Section 3.1, line 2 - Change "the Committee" to "those."

5.0 Purpose of Project

5.1 Ed Pfrang reiterated that the purpose of the current project is to review and refine the ATC 3-06 report for use in carrying out trial designs. The end result of the process is a resource for use in codes and standards. This is strongly supported by BSSC, FEMA, and NBS. The timetable is critical to meet an October deadline for distributing reports to BSSC for consideration during its November annual convention. It is important to resolve issues within the Technical Committee in order to convince the full voting committee of the merit of changes. If agreement is not reached, then ATC 3-06 may be used unchanged. Fundamental concepts should not be changed.

5.2 In response to questions, Dr. Pfrang stressed the importance of applying for membership. This may be done through NBS or BSSC. Ultimately, the BSSC Board approves membership. It is not necessary to be a BSSC member to serve on a committee.

5.3 R. Gensert raised the question about some correspondence he felt questioned the committee's competence. He wanted to know if the committee had to respond? Pfrang responded that questions such as this should go to the BSSC.

6.0 Discussion of ACI 531, modified as an alternate to 12A and modifications to 12 was presented by Alan Yorkdale. His proposal, dated February 19, 1980, entitled Proposed Revision: Chapter 12 - Masonry was distributed to all present (Exhibit C, section 3.3).

6.1 Yorkdale prepared the proposal as a result of a charge at the January 4 Task Group meeting. Yorkdale considered his material as a starting point. It contains changes necessary in Ch. 12 in order to reference ACI 531, these are primarily in 12.1.2 and .3. He discussed three design approaches: (1) empirical, (2) engineered and reinforced as required, and (3) engineered with minimum reinforcing.

There is no change in seismic categories A and B and minor change in C and D.

6.2 There was considerable discussion that followed on ACI 531. There seemed to be general consensus that it was fine for block and composite construction. There was disagreement on its application to brick and if it was applicable to unreinforced construction. Discussion on these points was considerable but did not resolve disagreements.

The meeting adjourned for lunch at 11:55 and was scheduled to reconvene at 1:30.

The meeting was reconvened at 1:40 by the co-chairmen

7.0 Discussion of modifications to 12 and 12A was presented by James Amrhein. This was in the form of a memorandum to Committee 5 and BSSC from an eleven man-team (Amrhein, Bailey, Beavers, Borchelt, Dickey, Hanson, Helfrich, Noland, Salveson, Tawresey, Wakefield) that spent four days preparing recommendations. This document was distributed to all present (Exhibit D, section 3.3).

7.1 Amrhein summarized that after considerable study the group felt it was possible to modify 12 and 12 A. In some portions the proposed revisions are very detailed and, in view of the time available, very broad brush in others.

8.0 Having heard a brief description of two options before the committee, co-chairman Hanson and Stockbridge adjourned the meeting at 1:50 p.m. with the explicit charge to read both proposed options and be prepared to select one on reconvening at 4:00 p.m.

8.1 The meeting reconvened at 4:00 p.m. and discussion was requested.

8.2 Yorkdale said the group that revised Ch. 12 and 12a had done a big job in four days. Their material needed more work but with some change he could support it.

Gerich expressed the opinion that the committee should vote first on deleting 12A and adopting a recognized standard or rework 12A.

Noland thought there were still some format problems but that the document was a good start.

8.3 Yorkdale moved that Committee 5 adopt the approach of modifying Ch. 12A and use the task group report as the starting point. The motion was seconded and carried unanimously.

9.0 Working sessions then started to formulate a ballot.

9.1 Amrhein and Yorkdale made a presentation recommending that the Committee 5 propose changes in the Seismic Hazard Exposure (SHE) Category and Seismicity Index (SI) as follows:

(a) Table 1.A: Change the seismic performance category for SHE III buildings located in areas with an SI of 1 from A to B.

(b) Table 1-B: Change the SI for map area 1 from 1 to 0.

Change	the	SI	for	map	area	1	from	1 to 0.
"	"	"	"	"	"	2	"	2 to 1.
"	"	"	"	"	"	3	"	2 to 1.
"	"	"	"	"	"	4	"	3 to 2.
"	"	"	"	"	"	5	"	4 to 3.

9.1.1 Catani moved and Hogan seconded that Committee 5 recommend change (b) to Committee 2.

There was considerable discussion on the matter. Gerich expressed the strong opinion that Committee 5 is not qualified to make these judgements. We should be looking only at 12 and 12A. Both ATC representatives, Mark and Mayes, indicated that they have some problems with the suggestion and would want to make a response.

The motion passed with one negative.

9.1.2 Amrhein moved and Wakefield seconded that Committee 5 recommend change (a) to Committee 2.

The motion passed unanimously.

9.1.3 Most members wanted to base what is done in Ch. 12 and 12A on the assumption that the recommendations to Committee 2 are adopted. Stockbridge noted that this will have to be pointed out.

Mayes strongly urged that we assume that Table 1-A and 1-B will not change.

Although no formal action was taken, the committee seemed to proceed on the basis that the recommendations would be adopted.

9.2 Amrhein recommended that masonry use the same R factors as concrete. There was considerable favorable discussion.

Mark and Mayes strongly opposed this. They expressed the viewpoint that the factors were consistent with performance. As an example, Mayes pointed out that reinforcing is less for masonry than for concrete.

Amrhein moved and Yorkdale seconded that we consider R and C_d factors later. The motion passed unanimously.

9.3 At this point it was decided to tackle Ch. 12A first using the eleven-man task group report as the base and modify as necessary. The general approach was to cover suggested change for an entire page of ATC 3-06 at a time. Exhibit C, Section 3.3 contains the proposed changes is the basis for ballot. Discussion follows.

9.4 Page 117 changes - adopted unanimously

Page 118 - Yorkdale suggested definitions for empirical masonry, engineered masonry, and seismic reinforced masonry. It was decided to consider this for Ch. 12.

Page 119 - Considerable discussion on references.

In the following material, only discussion and recommendations different from the task group report are recorded.

Page 120 changes adopted unanimously

Page 122, Section 12A.1.6 - Mel Mark cautioned against deleting the reference to 100 psi. Maybe put it back in for Category D.

Section 12A.1.13 - Decided to delete entirely

Page 123, Section 12A.1.16 - Refer section task committee.

9.5 Catani moved and Hogan seconded that pages 124 to 134 (up to Sec. 12A.4) changes be put on the ballot without discussion. M. Mark was requested to prepare ATC comments in writing to the committee.

The motion passed with one abstention.

The meeting was adjourned for the evening.

9.6 The meeting was called to order at 8:59 a.m. on February 22. It was decided to adjourn at 4 p.m. in order to allow people to catch planes.

9.7 Page 136, Section 12.A.4.5 - Mel Mark stated that deletion of the reference to ACI 318 is not good. There ought to be some reference. It was decided to keep the section intact.

9.8 Al Yorkdale moved and Dick Gensert seconded to delete all construction items not related to seismic.

There was considerable back-and-forth discussion. The major points were to have a complete document versus one that did not duplicate material available elsewhere.

The motion passed 6 to 3.

9.9 Considerable discussion on Section 12A.6. This centered on Mark Hogan's contention that, as written, it does not inlcude an alternate procedure that covers unreinforced concrete masonry. A series of motions followed, all of which had considerable discussion.

9.9.1 Catani moved and Hogan seconded to delete 12A6.2 in its entirety.

M. Mark and Mayes discussed. Catani summarized his thought that the unification between brick and block brought about in 12A6 and 12A6.1 was fine. Keeping 12A6.2 destroys the unification.

Hanson asked if 12.2.1(A) on p. 111 was adequate; that is, was (B) necessary? M. Mark clarified that (B) controls the alternate procedure only. Hogan said he did not like separate procedures for solid and hollow masonry.

For - 2 Against - 4 Abstain - 3

9.9.2 Hogan moved and Catani seconded to add a design procedure for unreinforced concrete masonry which references ACI 531-79 as modified by Ch. 12.

Ron Mayes noted that this would cause conflict with the ATC table of stresses.

Other discussion occurred. Catani called for the question.

For - 4 Against - 4 Abstain - 1

9.9.3 Catani moved the chairman appoint someone to develop a section 12A6.2A to contain provisions covering unreinforced concrete masonry.

Wakefield seconded if "concrete" was deleted. Catani did not accept this amendment.

For - 6 Against - 2 Abstain 1

Mark Hogan was appointed.

9.9.4 Wakefield moved and Yorkdale seconded to allow hollow brick provisions to be developed.

Bush commented that it might be possible to have provisions for hollow and solid.

Noland noted that this has been done in Colorado.

Hogan offered support but thinks the time is not available.

9.10 At this point a recess was held from 10:45 to 11:08

9.11 After the recess Hanson reviewed Section 9.9 items. His major point was that the unity shown the day before had disappeared. The committee must get together again.

9.11.1 J. Amrhein moved and Stockbridge seconded, the following motion:

(a) Delete Section 12A6.2 from the main text on p. 140.
(b) Delete item 12.2.1 (B) and the exception from p. 112
(c) Put the material in 12A6.2 in the commentary

(d) Delete the second sentence in the first paragraph under 12A.6 on p. 138. Replace with "(see commentary)."

(e) Void all prior actions taken on unreinforced masonry (all of Section 9.9 of these minutes)

(f) Appoint a commentary task force.

Hanson led a discussion for clarification of the motion. Catani called for the question.

The motion passed unanimously.

9.11.2 A Task group of M. Mark (chairman), Amrhein, Noland, Hogan, and Yorkdale was appointed.

9.11.3 Hogan asked about the last sentence on p. 138 dealing with effective thickness. Since this is used for buckling, he thought both wythes should be used. Yorkdale supported the point. Hanson directed the Task Force to review it. It was suggested to look at Russel Brown's work. Mel noted that he had used UBC which he thought was a good procedure.

9.12 Comments on p. 142 and 143 adopted

9.13 All comments on p. 144 were adopted except retain the second paragraph and reword the first line to read "In beams of stacked bond construction, the vertical joints shall not be." Delete the last sentence.

For - 7 Abstain - 2

9.14 Adopted all comments on 145 except in "a" keep 2/3. Do not change to 1/2. It was felt there was no basis for a change.

9.15 Page 146, item C - Keep original text
item 2 - Keep original text
item 12A.6.3(D) 2 - Mel will have comments on this.
item 5 - Put the development length formula in working stress form. Change .05 to .0015 and change f_y to f_s. Define f_s

9.16 Page 148, first paragraph - change 0.08 to 0.06 and change f_y to f_s. adopt other changes.

9.17 Page 149 - Change the eq. 12A-11 coefficient from 0.2 to 0.225 for consistency. Some discussion, unanimous vote.

Page 149 - under def. of f'_m - keep the original text. Other changes adopted.

9.18 Meeting adjourned, reconvened at 1:45.

9.19 Page 150 - under def. of f'_m - keep the original text.

Page 150 - change the eq. 12A-12 coefficient from 0.18 to 0.225 (vote was 7 for)

Page 150 - change f_s to F_s

9.20 Page 151 and 152 comments adopted.

9.21 Page 153 12.A.7 - Mel explained that the difference between special and specific has been carefully worked on. Specific refers to a test. All comments on p. 153 were adopted.

9.22 Page 154 - All comments adopted except the last item referring to SPC D is to be moved to Chapter 12.

9.22 Comments on p. 156 - 159 adopted.

9.23 Page 160 Table 12A-2 - change adopted except as modified below.

Hogan moved and Yorkdale seconded to change the thickness ratio for reinforced grouted masonry and reinforced hollow unit masonry from 25 to 36. Passed unanimously

Yorkdale moved and Wakefield seconded to keep footnote 1 as written.

The following actions were taken on footnotes.

Delete number 3, keep 2 and 4, study 5, delete 6, 7, 8, 9.

Effective thickness of cavity walls was referred to task group.

9.24 Items not covered during the meeting in Chapter 12A will be included as is on the ballot

10.0 It was decided to have the next meeting in Denver on March 21.

The meeting was adjourned at 4:00.

Respectively submitted,

E. V. Leyendecker

E. V. Leyendecker, Secretary
Technical Committee 5: Masonry

Agenda Item 1.1 - Attendance

Members

James Amrhein
Vincent Bush
Mario J. Catani
Richard Gensert
Andrei Gerich
George Hanson
Mark B. Hogan
E. V. Leyendecker
Melvyn H. Mark
Ron Mayes
Jerry Stockbridge
Donald Wakefield
Alan H. Yorkdale

Guests

William Bailey
P. O. Box 425
Ft. Worth, Texas 76101
(Phone) 817-332-4101

J. Gregg Borchelt
Masonry Institute Houston-Galveston
5100 Westheimer 200
Houston, TX 77056
(Phone) 713-629-6024

W. R. Chalker
Brick Association of So. Carolina
1310 Lady St., Suite 402
Columbia, South Carolina 29201
(Phone) 803-799-9139

Walter L. Dickey
Consulting Engineer
1014 Fortune Way
Los Angeles, CA 90042
(Phone) 213-256-7117

John C. Grogan
Brick Institute of America
100 Northcreek, Suite 280
Atlanta, Georgia 30327
(Phone) 404-261-0225

James Noland
2619 Spruce St.
Boulder, CO 80302
(Phone) 303-444-3620

Edward O. Pfrang, Chief
Structures & Materials Div.
National Bureau of Standards
Rm. B368, Bldg. 226
Washington, D. C. 20234
(Phone) 301-921-2196

L. E. (Gene) Salveson
Executive Director
Masonry Institute of Washington
2366 Eastlake Ave. E.
Seattle, Washington 98102
(Phone) 206-329-0898

Joseph Wintz, III
Brick Institute of America
1750 Old Meadow Lane
McLean, VA 22101

Agenda Item 2.0 - Revised

Meeting of Technical Committee 5: Masonry

Inn of the Six Flags
601 Avenue H, East
Arlington, TX 76011

(817) 640-1666

February 21, 1980
10:00 a.m.

AGENDA

1. Introduction of members and guests

2. Changes in Agenda

3. Approval of minutes of December 11, 1979 Technical Committee meeting

4. Approval of minutes of January 4, 1980 Task Group Meeting

5. Purpose of project

6. Discussion of ACI 531 Building Code Requirements for Concrete Masonry Structures - What changes are necessary?

   - Alan Yorkdale

   - Other comments

7. Discussion of "Chapter 12: Masonry" and "Chapter 12a" Masonry Construction" in Tentative Provisions for the Development of Seismic Regulations for Buildings - Necessary modifications.

   - James Amrhein

   - Other comments

8. Select approach

9. Working session and formulation of ballot document

February 22, 1980
8:30 a.m.

9. Continuation of working session and formulation of ballot document

10. Selection of next meeting date and location

Minutes of the Meeting
of
Technical Committee No. 5 - Masonry
for
Review and Refinement of Tentative Seismic
Provisions (ATC 3-06)

Rodeway Inn-Airport
4590 Quebec Street
Denver, Colorado 80216

March 21, 1980

1.0 The meeting was called to order at 9:50 a.m., March 21, by co-chairmen Hanson and Stockbridge. The call to order was preceded by informal discussion beginning about 8:30 a.m. on various concerns facing the committee such as schedule and direction.

1.1 All those present were asked to introduce themselves. A list of members and guests is attached.

1.2 A. Isberner was introduced as the alternate and proxy for M. Catani by way of a letter from PCA.

1.3 Ed Johnson was introduced as a new member representing SEAOC.

1.4 K. Callahan indicated that he had been designated as a proxy for R. Gensert. Chairman Stockbridge asked E. Leyendecker if a verbal notice was in order with the rules. Leyendecker voiced the opinion that a written notice should be received from the organization that a person represents naming an alternate for the organization. The meeting proceeded without allowing Callahan to vote for Gensert. A request was made by Stockbridge for a formal ruling for future use.

1.5 Handout material was discussed. This included the material included with the March 20 memo from Leyendecker, a March 19 memo from M. Mark (copy attached), and handout titled Chapter 12 - Masonry from D. Wakefield (copy attached).

2.0 The committee schedule was discussed next.

2.1 The following working schedule was discussed and accepted by the committee.

3/21 - Proposal on Chapter 12A sent out
3/28 - Proposal on Chapter 12 sent out
3/28-4/21 - Additional ATC remarks on proposals
4/21 - Ballots on Chapters 12 and 12A due
5/5 - Results compiled and mailed to members
5/16 - Meeting and final vote in person
5/30 - ATC and NBS analysis
6/3 - Coordinating Committee

2.2 Mel Mark voiced the strong opinion that this was no way to proceed. He felt that Chapter 12A must be completed before proceeding with Chapter 12. This was considered necessary since the committee was deleting certain seismic items from 12A; we must be certain to pick them up in 12. He felt this could best be done by completing 12A first.

He also expressed the opinion that the committee was out of order since various deadlines had been missed and ATC had not had time to respond, particularly on ballot items for 12A.

The committee membership felt it could proceed according to the revised schedule and meet its deadline even if intermediate dates had been missed. The extension of the ballot deadline on 12A from April 14 to April 21 provides additional time for ATC response. It was also noted by Leyendecker that the first ballot is not final until consideration of negatives at the May 16 meeting, allowing time for additional input.

The committee also felt it could proceed with Chapter 12 since it would have ballot results from both 12 and 12A for consideration on May 16. With both chapters in hand, little would be overlooked.

3.0 A. Yorkdale reviewed the Committee 2 meeting held in Phoenix. It was described as a very good meeting. He concentrated on the map areas and seismic performance categories and expressed his feeling that Committee 2 would vote for some changes.

3.1 Mel Mark reviewed some of the background for this material.

3.2 Amrhein moved and the committee voted approval to assume for our purpose that the original recommendations of Committee 5 be assumed as adopted in developing Chapter 12. These are changes in Table 1B:

Change the SI for map area	1	from 1 to 0
	2	2 to 1
	3	2 to 1
	4	3 to 2
	5	4 to 3

J. Amrhein moved the following assumption for Table 1A: change the seismic performance category for SHE III buildings located in areas with an SI of 1 from A to B. The motion passed.

3.3 Hogan proposed insertion of the statement "Not Applicable" in Table 1A for those cases where 12A does not apply. This would be the case for SI values of zero.

Mel Mark felt this could be done better in Section 1.2 - Scope on p. 27 of ATC 3-06. He proposed not doing it in Table 1A.

It was moved and passed unanimously to insert the following statement as an exception on p. 27, Section 1.2 - Scope:

> "3. All buildings located in areas with a Seismicity Index of zero."

4.0 Considerable time was spent discussing the purpose of Chapter 12A. Is it meant to be a national standard or a document for use in trial designs. Various opinions were expressed on what it is and what it might become. It was considered by most as a document for use in trial designs.

5.0 The meeting was adjourned, and then reconvened at 1:00 p.m.

6.0 There was considerable discussion on the next step, whether to proceed with Chapter 12. Much of the discussion repeated that under Section 2.2.

Wakefield moved and Amrhein seconded that we proceed with Chapter 12 as we did with Chapter 12A in Arlington on Feb. 21 and 22. Additional discussion followed, Yorkdale called for the question.

The motion passed: 7 for, 1 against, 1 abstention.

7.0 The committee then decided to proceed using the handout provided by Wakefield as a base (this was the same as the Arlington agreement with the information marked on the text of Chapter 12 and is Exhibit G in section 3.3) and the comments provided by Mayes in his March 12 memo (Exhibit F, section 3.3). Discussion follows (page and section numbers refer to the original ATC manuscript).

7.1 p. 111 - Background - Modified to remove explanatory material.

7.2 Section 12.2 - The committee decided there was no basis for changes in the capacity reduction factors.

7.3 Section 12.2.1 was modified on the basis that the alternate design procedure previously eliminated in Chapter 12A would be added back in. The Secretary was instructed to editorially revise Section 12.2.1(B) to read (This incorporates material from 12A.3.7 on Partially Reinforced Masonry, deleting reference to partially reinforced masonry):

(B) MASONRY DESIGN:

1. Masonry designed and reinforced as required.

2. Masonry designed and reinforced with minimum prescribed reinforcing and other requirements. This includes grouted masonry or hollow unit masonry containing reinforcement as specified below. Masonry joint reinforcement shall be and ties may be embedded in the mortar in the bed joints. All other reinforcement shall be embedded in grout. Minimum masonry, mortar, and grout coverages applicable to reinforced masonry shall be provided.

This masonry shall be designed as unreinforced masonry, except that reinforced masonry areas or elements may be considered as resisting stresses in accordance with the design criteria specified for reinforced masonry provided such elements fully comply with the design and construction requirements for reinforced masonry except as herein noted; however R factors of Table 3-B shall be as required for unreinforced masonry. Only Types M or S mortar shall be used.

Reinforcing for columns shall conform to the requirement of Sec. 12A.6.3(F). For walls the maximum spacing of vertical reinforcement shall be 8 feet where the nominal thickness is 8 inches or greater and 6 feet where the nominal thickness is less than 8 inches. Vertical reinforcement shall also be provided each side of each opening and at each corner of all walls. Horizontal reinforcement not less than 0.2 square inch in area shall be provided at the top of footings, at the bottom and top of wall openings, near roof and floor levels, and at the top of parapet walls and, where distributed joint reinforcement is not provided, at a maximum spacing of 12 feet where the nominal masonry thickness is 8 inches or greater and 9 feet where the nominal thickness is less than 8 inches. The vertical reinforcement ratio and the horizontal reinforcement ratio shall each be not less than 0.00027.

Where not prohibited by Chapter 12 or this Chapter, stacked bond construction may be used. When stacked bond is used the minimum horizontal reinforcement ratio shall be increased to 0.0007. This ratio shall be satisfied by masonry joint reinforcement spaced not over 16 inches or by reinforcement embedded in grout spaced not over 4 feet. Reinforcement shall be continuous at wall corners and intersections.

Splices for reinforcement shall conform to all requirements for splices in reinforced masonry.

These types of masonry walls shall be considered as reinforced masonry for the purpose of applying Table 12A-2.

3. Masonry designed and reinforced with prescribed minimum areas. This additional reinforcement shall be in both horizontal and vertical directions. The sum of the areas of reinforcement in both directions shall be at least equal to 0.002 times the gross cross section of the masonry with at least 0.0007 times the gross cross sectional area of the masonry in each direction.

7.4 Mark Hogan moved and Yorkdale seconded to revise Section 12.3 to read:

"Buildings assigned to Category A may be of any construction permitted by existing national masonry standards when located in map area 2 and of any construction permitted by Chapter 12A when located in map area 3."

Several variations of the above were discussed, some considered using accelerations instead of map areas.

Discussion centered on whether or not the phrase "existing national masonry standards" was specific enough. Opinions varied from ok to meaningless. The general feeling was that the phrase was necessary and adequate in order to conduct trial designs.

The motion passed unanimously.

7.5 There was considerable discussion on seismic performance Category B. The committee concluded that it could not proceed with this category until Committee 2 had ballotted on the map area issue. Committee 5 will be notified as soon as results are available.

7.5.1 Before proceeding, Yorkdale asked the reasons for the material limitations in Section 12.4.2. M. Mark indicated that the limitations were there to eliminate the use of excessively weak or brittle materials or materials more subject to weathering.

7.6 Seismic performance category C was discussed at length. The concern was centered primarily about the map areas where it was required and not on the requirements for SPC C. Mel indicated that exceptions should be in Section 1.2 - Scope rather than 12.5

Wakefield moved that T.C.5 recommend rewording Section 1.2-Scope page 27, item 2 to read:

". . .Seismicity Index of 1, 2, or 3. . ."

The motion passed: 5 for, 3 against, 1 abstention
(This recommendation was passed on to Committee 2)

7.7 The reasons for including Section 12.5.1(E) were requested. M. Mark responded that the joint reinforcement does work for shrinkage but there is no test data showing it works for shear. There was not agreement on the matter. The committee unanimously moved the section to SPC D and delete from SPC C.

7.8 The committee discussed using a steel ratio of .0007 or .0015 in Section 12.5.1(F). The latter is used in concrete and the committee decided to stick with it.

7.9 Albert Isberner requested that 12.5.2 be included as a ballot item to allow comment. There was one abstention.

7.10 M. Mark began by stating that SPC D was for high-risk construction. Whatever this committee does won't change legal requirements in California. After some discussion Yorkdale moved and Stockbridge seconded that T.C.5 retain Section 12.6 intact.

Amrhein amended to delete "Shovel measurements are not acceptable." from the second line of the first paragraph in 12.6.1.

The amendment and the motion passed unanimously.

7.11 Section 12.7.1 was modified for clarity after M. Mark explained its intent. The intent was accepted but it was felt clarification was needed. Section 12.7.1 was modified as follows:

Add an introductory paragraph to read "The following reinforcement requirements apply to walls required to comply with the provisions of Section 12.2.1(B)(3)."

1st para, line 4 - change 32 to 48.

7.12 The meaning of Section 12.7.3 was explained. The committee unanimously agreed to leave as is.

7.13 In the sixth line of Section 12.7.4 change the phrase "true joints" to "joints."

7.14 The committee recessed at 6:15 and reconvened at 6:45 p.m.

8.0 M. Mark gave a Task Group report dated 3/19/80 (Exhibit I, section 3.3).

8.1 After discussion it was moved and seconded that p. 5, 6, and 7 of the report replace 1st paragraph of 12A.6.1 and 12A.6.2 on Alternate Design Procedure. The main discussion centered on the validity of the stresses used in concrete masonry.

The motion passed: 7 for, 1 against, 1 abstain

8.2 Tables 12A.1A and 1B (p. 3 of report) were discussed. It was decided to leave on the ballot. On p. 1 of the report it was decided to retain the sentence referring to O and K mortars, delete the sentence referring to foundation walls, retain the change to the last paragraph and leave the remaining text as written in the ATC 3-06 report.

8.3 Page 2 of the report concerning 12A.8.2 was discussed. It was agreed to put the title and B, D, and E up for ballot.

8.4 Page 4 of the report concerning 12A.6.1(H) - view was discussed along with options in Table 12A-2 for cavity walls. It was agreed to add (H) for the ballot and use option 3 for cavity wall thickness.

9.0 Wakefield discussed table 12A.5. The following changes were agreed to:

Ballot item 156 - Compression - flexural stress. Put the limits back in but under "yes" change 900 to 2000 and under "no" change 450 to 1000.

Ballot item 157 - Bearing stress. Put limits back in but under "yes" change 900 to 1500 and 1200 to 1800. Under "no" change 450 to 750 and 600 to 900.

10.0 Hogan discussed table 12A.5. It was agreed to delete ballot item 157. That is leave the shear limits unchanged. It was also agreed to put on the ballot whether uninspected masonry reducton coefficient should be 1/2 or 2/3 for compression-axial, walls and column. There was one negative on the latter point.

11.0 It is noted here that a number of the items placed on the ballot do not have full committee support but the committee wanted a formal ballot.

12.0 The meeting was adjourned at 8:15 p.m. with the next meeting location to be set by Leyendecker, probably in Chicago.

Respectfully submitted,

Edgar V. Leyendecker

Edgar V. Leyendecker, Secretary
Technical Committee 5: Masonry

Attendance of March 21, Meeting

Members or Alternates

Jerry Stockbridge
James Amrhein
Melvyn Mark
Ed Johnson
Mark Hogan
Alan Yorkdale
Andrei Gerich
E. V. Leyendecker
George Hanson
Don Wakefield (alternate for Helfrich)
Albert Isberner (alternate for Catani)

Guests

James Noland
Kevin Callahan (alternate for Hogan)
Walter Dickey
Gene Salveson
William Bailey

Ed Hedstrom
Ideal Basic Ind.
P. O. Box 8789
Denver, CO 80201
(303) 623-5661

Richard Wilsey
CMI
3003 E 3rd, Suite 301
Denver, CO 80206
(303) 697-6127

Minutes of the Meeting
of
Technical Committee No. 5 Masonry
for
Review and Refinement of Tentative Seismic
Provisions (ATC 3-06)

O'Hare American Inn
2175 Touhy Avenue
Chicago, Illinois 60018

May 16, 1980

1.0 The meeting was called to order at 9:00 a.m., May 16, by co-chairman Hanson and Stockbridge. The call to order was preceded by informal discussion beginning about 8:30 a.m.

1.1 The attendance list was passed and is attached.

1.2 The Secretary announced that Don Wakefield, who has been attending as the alternate for Robert Helfrich, has replaced Mr. Helfrich as the representative of Western States Clay Products Association.

1.3 Joseph Wintz was announced as the formal proxy for Alan Yorkdale for this meeting. A letter to this effect was introduced for the record of the committee.

2.0 The minutes of the February 21 and 22, 1980 committee meeting were reviewed. The secretary indicated that Mel Mark had submitted suggestions for change to the draft minutes. His suggestions were read and accepted. The minutes were then approved.

3.0 The minutes of the March 21, 1980 Committee meeting were reviewed. The secretary indicated that Mel Mark had submitted suggestions for change to the draft minutes. His suggestions were read and accepted. The minutes were then approved.

4.0 A general discussion followed on the subject of "substantive change."

4.1 Ron Mayes stated that ATC had a strong desire to back the output of this committee. However, he did feel that the committee was making substantive changes to the original document, referring back to the scope of the project as described in the original work plan.

4.2 Andrei Gerich voiced support for the idea that the committee is making substantive changes and that the original document should be used as much as possible.

4.3 Don Wakefield and Joseph Wintz expressed the position that the committee is trying to make the report workable and acceptable to industry.

4.4 Others expressed the opinion that substantive changes can be a matter of opinion. For example the committee has accepted basic concepts such as the strength approach (while realizing it is not a true strength approach), seismicity index, and seismic performance categories.

4.5 Don Wakefield expressed concern that BSSC might ballot only on changes. He felt that BSSC had not ballotted to accept the original ATC report yet.

4.6 Mel Mark indicated that he felt ATC was compromising by accepting deletion of certain items from Chapter 12A. The committee should be prepared to allow ATC to redo Chapter 12 incorporating items deleted from 12A. No action was taken on this point.

4.7 Ron Mayes introduced a handout from ATC dated May 7, Exhibit J, sec. 3.3. This contained an ATC ballot which was used as a means to introduce ATC position and comments on the ballot items.

5.0 The following committee members corrected their recorded ballots on the ballot tally sheets.

5.1 Dick Gensert indicated that he voted negative on items 78, 79, 106, 107, 115, 155, 156, 157, 158, 141B, and 150A of Ballot No. 1. He also recorded a question mark on item 91.

5.2 Ed Johnson indicated he had recorded his vote wrong on items 10, 11 and 13. His vote was yes instead of no. He also indicated that his comments were the same as those supplied in the ATC handout dated May 7. The following errors were noted therein: The second ballot item numbered 66 should be 67, the vote on 106 should be No rather than Abstain.

6.0 The committee then proceeded through Chapter 12 to discuss comments and negative ballots. Items without comment or negative ballot on the tally sheet were not discussed. A tally sheet is attached for Chapter 12A. Items reballotted are shown on this sheet.

6.1 Discussion then began (SEAOC or ATC comment refers to the May 7 handout). Reballot means a new vote was taken and recorded as shown.

Items 1-3: Not discussed

Item 4: The ATC comment was pursuasive. The text of Chapter 12A will be checked by the Secretary to editorially delete the reference to "load-bearing." Reballot.

Item 5: The ballot item was clarified as the definition of MASONRY and (A) MASONRY, REINFORCED and (B) MASONRY, UNREINFORCED. Wakefield moved and it was seconded to clarify this as Ballot Item 5. Amrhein called for the question. The vote was unanimous.

Discussion followed. Johnson stated that reinforced masonry requires definition so that the form of construction used in 12A.6.3 and Table 12A-4 are defined. The table doesn't apply unless minimum reinforcement is used. M. Mark reinforced this point. Mayes continued that research data aren't available to support using the table for steel percentages less than the minimum.

There was considerable back and forth discussion. The feeling expressed by Wakefield, Hogan, and others was that Chapter 12 refers to a category of construction requiring minimum steel, although the definition does not differ from masonry using less than the minimum.

Reballot.

Items 6, 7: Refer to discussion on Item 4. Reballot.

Item 8: No discussion or change.

Item 9: Refer to ATC comment and discussion on Item 5. Reballot

Items 10-20: No discussion or change

Item 21: Refer to ATC comment. Hedstrom offered that ASTM C476 was the appropriate reference, not ASTM C270. There was a motion to return to the original text; this carried by 9 yes, 1 no. Catani then moved to change ASTM C270 to C476. This carried by 9 yes, 1 no (Johnson). Johnson then moved to add "except masonry cement shall not be used for grout." Those opposed felt the phrase wasn't needed. Reballot.

The item now reads: Cements for mortar are limited to those allowed by ASTM C476, this Chapter and Chapter 12 except masonry cement shall not be used for grout.

Items 22 and 23: No discussion or change.

Item 24: Refer to ATC comment. It was agreed the ballot was in error. Amrhein moved and it was seconded to reinsert ASTM C270. The motion carried.

The item now reads the same as the original ballot with the insertion back in of the line reading: ASTM C270 Types O and K mortar shall not be used.

Items 25-27: No discussion or change.

Item 28: Refer to ATC comment. Johnson added he would vote yes if the item is included in Ch. 12. Those supporting the ballot item felt that specifying the grouting should be done without segregation takes care of any problem. Also that the lower limit is misleading. Reballot.

Item 29: Johnson indicated that the ATC comment was minor but that he wanted to see something said about mixing equipment. Those opposed said the reference is to ready mix concrete and is not applicable to grout. Reballot.

Item 30: No discussion or change.

Item 31: Refer to ATC comment. Gerich said he agreed with comment but did not feel strong about it. Reballot.

Item 32: No discussion or change.

Item 33: Refer to ATC comment. Discussion was over the need for deleting the last sentence. Response was that it wasn't needed. Reballot.

Item 34: Refer to ATC comment. Other arguments included a preference for the original wording although there seemed to be agreement that the 1/8 in. amplitude could not be enforced. Those preferring the new wording indicated that it was shorter and said all that needed to be said. Reballot.

Item 35: This item must be inserted since item 34 is deleted. Reballot.

Item 36, 37: No discussion or change.

Item 38: Refer to ATC comment. After discussion Gerich moved and it was seconded to modify item 38 by adding back the line: "3. For cavity walls the provisions of 1 and 2 above apply to each wythe." The paragraph following the line is still deleted. The motion carried.

Items 39, 40: No discussion or change.

Item 41: Refer to ATC comment. Ed Johnson moved and it was seconded to change the word "and" proposed for deletion in the ballot item to the word "are." The motion carried.

Item 41 reads (b) SPLICES. Splices and reinforcement may be made only at approved locations or as indicated on the approved design documents. Splices shall conform to the provisions of section sec. 12A.6.3(D)7.

Item 42: No discussion or change.

Item 43: Refer to ATC comment. Amrhein says that the proposed wording in ballot item 43 accomplishes the ATC comment. Reballot.

Item 44: Refer to ATC comment. The counter argument was that units do not come in multiples of 2.5 inches. Mel Mark argued that it does require detailing to accomplish what is stated in the original text of ballot item 44 but that it can be done. He also stated that 4 inches of anchorage won't hold. Reballot.

Items 45 through 47: No discussion or change.

Item 48: Refer to ATC comment. There was considerable discussion on the ATC comment here. Wakefield moved and it was seconded to change ballot item 48 to read "grouted multi/wythe masonry is a form of construction in which interior joints betwen wythes are filled with grout. Only type M or S mortar shall be used. The vote on this item was abstain ACI, BIA, ICSSC, NCMA, SEAOC.
Yes vote - ASCE, BCA, Masonry Society, WSCPA
Not voting - MIA

6.2 At this point is was decided to break for lunch and continue this discussion on item 48 after lunch. Prior to the break Mel Mark argued that the table 12A-3 was for solid units only.

6.3 Break for lunch at 1:40 p.m.

6.4 Reconvene at 2:45 p.m. It was announced that Gensert had gone and Mario Catani was his official proxy for the remainder of the meeting. Confirmation of this was obtained from ACI headquarters.

6.5 Discussion of the ballot items then continued.

Item 48: The discussion on this item continued. Tony Wintz made the point that ANSI A41 tables refer to solid stresses for multiwythe construction. The vote on the original motion made before lunch was taken up again with the following change in table 12A.3 on page 161 of the original report. On the line that reads "grouted masonry" the wording should be changed to read "grouted masonry multiwythe with solid units." A reballot was then taken. The motion changing the wording in the text and the wording in the table passed.

Item 49: Refer to ATC comment. Amrhein added that he felt this item should be moved to Chapter 12 and not just deleted. Gerich moved to keep item 49 but move it to Chapter 12. This was seconded. The item was then reballotted and the motion carried.

Item 50: No discussion or change.

Item 51: Refer to ATC comment. There was general agreement and Ed Johson moved to modify this ballot item to retain the last sentence. The motion was seconded and carried unanimously. Ballot item 51 now reads: 1. Masonry headers shall not project into the grout space.

Items 52-55: No discussion or change.

Item 56: Refer to ATC comment. There was considerable discussion on the subject of mortar fins projecting into the grout space. Wakefield stated that he felt any projection distance should be based on module sizes. There was general discussion on cleaning procedures. Reballot.

Item 57: Refer to ATC comment. Gerich stated that he agreed with the ATC comment. There was a response that UBC does not require the space stated in item 57. There was then agreement that item 57 could be changed to a unanimous vote provided changes occurred in item 58. With this agreement, item 57 was ballotted without change and passed unanimously.

Item 58: Following the agreement on item 57, Catani moved that ballot item 58 be modified to read EXCEPTION: If the grout space contains horizontal steel, it shall be at least 3 inches. The motion was seconded and the item ballotted. The motion passed unanimously.

Item 59: No discussion or change.

Item 60: Refer to ATC comment on item 60 and subsequent items. Ed Johnson stated that the requirement that was being deleted had always been in UBC. Amrhein says that he does not understand the reason for the requirement as originally included in UBC. He stated that high lift construction is self-tested. The argument was found convincing. Reballot.

Item 61: Refer to ATC comment. It was argued that the extensive original wording was unnecessary. Reballot.

Item 62: Refer to ATC comment. There was general agreement on the ATC comment and Ed Johnson moved to reinsert the deleted portion of ballot item 62, Catani seconded. The motion carried unanimously. Item 62 now reads: The thickness of grout between masonry units and reinforcement shall not be less than 1/4 inch where fine grout is used nor 1/2 inch where coarse grout is used. See section 12A.1.17 and 12A.2.4.

Item 63: Refer to ATC comment. Ed Johnson wanted to know the objection to including the paragraph in the text. Amrhein expressed the feeling that it added to the problem through confusion. Wakefield moved to add the item back. The motion was seconded and failed. The reinsertion of this paragraph was favored by Wakefield, Johnson and Gerich and opposed by others. Those favoring the addition of the paragraph are recorded as negative votes on ballot item 63.

Item 64: Refer to ATC comment. There was general discussion on whether or not the proposed new title was suitable. Ed Johnson stated that he really did not care, but he would not change his vote. Reballot.

Item 65: Refer to ATC comment. There was considerable discussion on the subject of cleanouts. This included projections into space whether or not it was practical to clean and so forth Wakefield said he would remove his objection to deleting item 65 since cleanouts were covered elsewhere. Gerich then moved to modify item 65 to read: Overhanging mortar fins projecting more than the thickness of the mortar joint into the grout space shall be removed. This was seconded. There were five votes for and five against. Catani then moved to have the item read: Overhanging mortar fins projecting into the grout space shall be removed. The motion was seconded and passed unanimously.

Item 66: Discussion centered around whether 15 square inches was necessary or not. Hogan moved to change the 15 to 10. The motion was seconded and passed unanimously.

Item 67: There was general discussion that bond beams did not have to be followed by the word unit. After some discussion of bond beams and construction, there was general agreement on deletion of the word unit. Also, there was agreement to delete the reference to other sections and chapter 12. Item 67 was modified to delete the last line. This passed unanimously. Item 67 now reads: Except as provided in chapter 12, all reinforcing except ties and masonry joint reinforcement, where permitted, shall be embedded in grout. Longitudinal horizontal reinforcing shall be placed in bond beams except as permitted for masonry joint reinforcement.

Item 68: Catani argued that the change in item 62 made a change in item 68 necessary for consistency. He thus moved to modify the ballot item to reinsert the portion proposed for deletion. The motion was seconded and passed unanimously. Item 68 now reads: The thickness of the grout between the masonry units and reinforcing shall be a minimum 1/4 inch for fine grout and 1/2 inch for coarse grout. See section 12A.1.17 and 12A.2.4. See chapter 12 for stacked bond limitations.

Item 69: Refer to ATC comment. Johnson wanted to know the objection to this paragraph. Wakefield responded that the extra 8 inches was the problem. Johnson and Hogan thought shrinkage could be a problem. Wakefield said no, just keep right on going all the way. Reballot.

Item 70: Ed Johnson stated he would change his ballot to be consistent with his vote on item 56. Reballot.

Item 71: Refer to ATC comment. There was general discussion on the ATC comment and the proposed ballot item 71. Following this discussion, it was moved by Ed Johnson and seconded to reword item 71 to read: Grouting shall be done in a continuous pour and may be done in partial lifts. The vote was unanimous.

Item 72: Ed Johnson removed his negative ballot for consistency with item 60.

Item 73: Gerich removed his negative ballot.

Items 74-75: No discussion or change.

Item 76: Stockbridge stated that he did not like the proposed deletion of reference to direct tension. He then moved to keep the original text of the ATC report. The motion was seconded and passed unanimously. The phrase "unrefinforced masonry shall not be loaded in direct tension" is thus retained in the text.

Item 77: No discussion or change.

Item 78: Refer to ATC comment. Wakefield added that he would like to add the maximum thickness ratios back in rather than delete them. There was some discussion and Wakefield moved to change ballot item 78 to read: All masonry walls shall be designed so that allowable stresses are not exceeded and that the provisions of table 12A-2 are satisfied. The motion was seconded and passed unanimously.

Item 79: Wakefield moved that rather than deletion the item should read: The maximum thickness ratio of table 12A-2 may be increased when justified by substaniating data. The motion was seconded and passed unanimously.

Item 80: Refer to ATC comment. There was considerable back and forth discussion on what constitutes a pier. It was decided to reserve this item for chapter 12. Reballot.

Item 81, 82: No discussion or change.

Item 83: Refer to ATC comment. Wakefield responded by saying that the original wording did not allow transfer across joints. Mel Mark says the problem is in striking the phrase "middle ties." Reballot.

Item 83A, 84, 85, 86, 86A: No discussion or change.

Item 87 - Modified: On the modified text 3rd page of the new page 142 under the heading "Unreinforced Concrete Masonry, Subparagraph 1." Mark Hogan argued for a 1/3 rather than a 1/2 reduction of stresses for work without special inspection. This argument was supported by PCA. Mark Hogan moved and it was seconded for the phrase to read: For work without special inspection compressive stresses shall be reduced by 1/3, other stresses shall be reduced by 1/2. The motion was seconded and the question called for. Wakefield voted no and Wintz abstain. The others voted affirmative.

Mark Hogan then began discussing the 2nd paragraph on the same page referring to shear stresses. He insisted that the shear and tension stresses in the NCMA document (which is dated 1969 not 1979) do not need to be modified. Mel Mark then discussed the various task committee correspondence and referred to factors of safety. There was a general discussion between Hogan and M. Mark referring to different modes of failure and the low stress values. Hogan then moved to delete item 2 on the 3rd page of the modified page 142. The motion was seconded. Under discussion Mayes then talked about 35-50 psi failures and diagonal tension in houses he has tested on the Berkley shake table. Gerich stated his strong feeling that we were looking at the ATC document and not the NCMA document. A vote was then taken yes - NCMA, PCA, ACI; no - SEAOC, ICSSC, Masonry Society; abstained - MIA, WSCPA, BIA, ASCE. It was then ruled that the motion did not pass due to the distribution of ballotting. Hogan objected to this. A vote was then taken on item 87 to afirm the prior votes. There was no vote change.

Item 88: No discussion or change.

Item 89: Refer to ATC comment. Ed Johnson wants to keep the original wording, Catani was in agreement with this. Johnson moved to modify ballot item 85 to return to the original ATC text. The motion was seconded and passed unanimously. Item 89 now reads: 2. Stacked Bond: three times the wall thickness or the length of the masonry units for construction using stacked bond, whichever is less.

Item 90: Reballot.

Item 91: Refer to ATC comment. There was general agreement with the ATC comment. Amrhein moved to modify ballot item 1 to read: "j may be assumed as 0.85 or." The motion was seconded and passed unanimously. Item 91 now reads: j = ratio of distance between centroid of compression and centroid of tension to depth, d. j may be assumed as 0.85 or j may be determined by a strain compatibility analyses.

Item 92: Refer to ATC comment. There was a general discussion on solid grouted units particularly open end units, and what portion may be assumed to transfer shear. Johnson moved to modify ballot item 92 to read: In vertical joints, stacked bond construction shall not be assumed to resist shearing stresses. Where the shear reinforcement is parallel to the vertical joints, reinforcement equal to the required shear reinforcement shall be provided perpendicular to the vertical joints at a spacing not to exceed 16 inches. The motion was seconded and passed unanimously.

Items 93-102: No discussion or change.

Item 103: Wakefield wanted to add in place of the deleted phrase, the phrase "it across the member." There was some discussion. Wakefield removed his negative ballot. The item remains as is with the editorial change of leaving the word "it" in place rather than deleting the word.

Items 104, 105: No discussion or change.

Item 106: Refer to ATC comment. Mel Mark would like to see a specific length mentioned. Hogan moved to change the phrase "calculated" to "allowable." The motion died for a lack of a second. Reballot.

Item 107: Refer to ATC comment. There is an error in the equation as listed. Both Catani and Hogan want to use the ACI equation. After some discussion it was moved that the equation read: $.0015\ d_b f_s$. The motion was seconded and carried.

Item 107a: This is on page 148, third paragraph, of the original document and was a missed ballot item referred to herein as 107A. The equation should be $.002\ d_b F_s$. It was moved and seconded and passed unanimously that this change be made. It was also pointed out that it will be necessary to define F_s and modify the paragraph of the text to delete f_y and f_g.

Item 111: Refer to ATC comment. ATC is strongly opposed to changing the coefficient .20 to the coefficient .225. A number of people indicated that the larger coefficient has been used in the rest of the nation for a long time. ATC indicated that it feels strongly on this and may carry it BSSC. They feel the increase is unjustified and adds to other increases the committee is making. Reballot.

Item 112: Don Wakefield would like to get in the phrase "effective height." It was agreed that this was an editiorial change and with this Wakefield withdrew his negative ballot. The new definition reads: Effective height - clear distance in inches between supporting or stiffening elements. Effective height different from clear distance may be used if justified. Note that this wording is the same as Item 117 which passed with one abstention.

Item 113: Refer to ATC comment. There was general discussion once again on reinforced masonry, going back to ballot item 5 of the morning session. Ron Mayes used the argument that the tables simply are not applicable unless minimum levels of reinforcement are present. Hanson indicated that he does not mind including the steel percentages or limits on use of the tables as long as we don't use terminology such as partially reinforced masonry. There was considerable discussion and several attempts to come up with a rewording. Ed Johnson moved the following wording be used for ballot item 113: 2. Reinforcement. Reinforcment of walls and wall elements shall be provided for all loadings as required by design. Where reinforcement ratios are less than: A. 0.0007 in any direction, B. 0.002 or the sum of the ratios in each direction then; permissible stresses for unreinforced masonry must be used. If reinforcement ratios are equal to or greater than these ratios, the stresses of table 12A-5 may be used. This motion was seconded. Wakefield strongly objected to this change. He stated that it puts back in what the committee had worked so hard to remove in prior meetings. He also stated that it harms his segment of the industry. Most people, however, found the argument that the table was not applicable unless minimum reinforcement is present a sound argument. A few were not convinced that the stated limitation on use of the tables is correct. Reballot. Wakefield will draft a section for insertion.

Item 114: Refer to ATC comment. Johnson moved to modify ballot item 114 to be as follows: Delete the first paragraph, keep the seond paragraph with the last sentence deleted. Mark Hogan suggested an amendment using a lead-in sentence to the second paragraph as follows: When using the stresses in table 12.A-5 horizontal etc. and that the paragraph be combined with the one following. The amendment was accepted and the motion was seconded. A ballot was taken and the motion passed.

Item 115: Refer ATC comments. Wintz said the factor should be 0.2 rather than the proposed .225. Hogan argued that plain concrete uses a factor of .25 and that .225 is consistent with ACI. Wintz moved to modify item 115 by changing the factor .225 to the factor .2. The motion was seconded and passed. Johnson moved to insert the suggested ATC h/t ratio limit of 20. The motion was seconded and failed. Catani moved to insert an h/t limit of 25. The motion was seconded and passed with one negative ballot.

6.6 Break for dinner at 7:00 p.m.

6.7 Reconvene at 8:30 p.m. It was announced that Amrhein would not be at the session and George Hanson had his proxy. Written confirmation was entered for the record.

Items 116-119: No discussion or change.

Item 120: Johnson moved to modify the ballot item to read: All column or longitudinal reinforcing shall be solidly embedded in grout. The motion was seconded and passed unanimously.

Item 121, 122: No discussion or ballot.

Item 123: Refer to ATC comment. The feeling seemed to be that the requirement was a seismic requirement. Johnson moved to add the phrase following standard hook "which terminates beyond the boundary reinforcing" and continue the paragraph. The motion was seconded and failed. The original ballot item is thus retained.

Item 124: Refer to ATC comment. Wintz moved that the deleted portion of item 124 be replaced with the phrase, "except as provided for masonry design under the alternate design procedure of section 12A.6.2 (A), vertical stresses in shear walls shall be determined from the combined effects of vertical loads. The rest of the paragraph should be deleted. The motion was seconded and passed unanimously.

Item 125: Stockbridge asked if the tension that was being resisted was intended to be calculated tension. The answer was yes; therefore he said he would remove his negative. Wintz moved to insert the word "calculated" before the word "tension." The motion was seconded and passed. Item 125 now reads: Allowable tension stresses for unreinforced masonry shall not be exceeded. Anchorage to the foundation shall be provided to resist calculated tension in unreinforced walls.

Item 126: No discussion or change.

Item 127: Refer to ATC comment. Most found the argument unconvincing. Reballot.

Item 128: Refer to ATC comment. It was argued that insertion of the word "minimum" covered the need expressed by the deletion in ballot item 128. The argument was convincing and Johnson changed his vote. Reballot.

Item 129: No discussion or change.

Items 130 and 131: Johnson indicated that he would remove his negative ballot if these items are picked up in chapter 12.

Item 132: No discussion or change.

Item 133: Wakefield indicated that he wanted the word "inspections" added back in. It was commented that this word had been erroneously marked out. With that statement, Wakefield withdrew his negative. Item 133 now reads the same as shown on the ballot item except the fourth line following the word "specific" the word "inspections" should be added back in so that the line reads: Inspections, tests, or some items of special inspection.

Item 134 and 135: No discussion or change.

Item 136: Refer to ATC comment. Mario Catani argued that some of the deleted words were project specifications, not design specifications to assure safety. With this, Ed Johnson indicated he would change his ballot to abstain. Catani then moved that item 136 be modified by changing the first bullet item under the section to read: When f'_m is to be established by tests, there shall be an initial prism test series prior to the start of construction and one prism test series shall be made for each 5000 square feet of wall. The motion was seconded and passed unanimously.

Item 137: Hogan asked about the phrase "identified and acommpanied." He wanted to known what it means. There was some discussion about certification and what sort of identification is attached to blocks, bricks and so on that are delivered on a job site. There was no suggested change and a reballot was taken.

Item 138: Refer to ATC comment. There was some discussion about moving this item to chapter 12 and then argue about seismic performance categories at that time. Johnson moved to transfer item 138 as originally written to Chapter 12. The motion was seconded and passed.

Item 139: Refer to ATC comments. Mel Mark indicated that the purpose of the original text was to try to simulate field conditions as closely as possible. Catani and others argued that the purpose of the tests is quality control not for field strength. He wanted to know what is being accomplished by testing things in the field. Reballot.

Item 140: There was some discussion that this item was already covered in the ASTM specs. already cited. It was moved to delete the entire paragraph used as ballot item 140. The motion was seconded and passed unanimously.

Item 140A: Catani moved that this item be reworded as :
12A.8.2 Grout Tests
Tests for grout shall conform to this section.
The motion was seconded and was favored by PCA, ACI, NCMA and MIA.
Those opposed were ICSSC, BIA, MS
There were two abstentions.
Therefore the motion did not carry and ballot item 140A stays as is.

Item 141 - Modified: Catani moved and it was seconded to delete this section entirely. For - PCA, ACI, NCMA, MIA; Against - ICSSC, BIA, MS, MIA, SEAOC, and two abstentions. The motion did not carry and ballot item 141 - Modified stays as is.

Item 141A: Briefly discussed and reballotted.

Item 141B: There was a brief discussion and no change in vote. Therefore this item was defeated.

Item 142: Refer to ATC comment. Hogan moved to editorially revise the first paragraph and delete the second. The motion was not seconded. Therefore item 142 stands. Reballot.

Item 143: Refer to ACT comment. Brief discussion. Reballot.

Item 144: Wintz moved to delete the entire table 12A-1A. The motion was seconded and was unanimous.

Item 145: Wintz moved to delete the entire table 12A-1B. The motion was seconded and passed unanimously. It was also recommended that for editorial convenience these tables be left in as blank so that all tables do not have to be renumbered. The reason for deletion of these two tables was that ASTM C270 covers them.

Item 146: The proposed change as item 146 automatically is defeated with the deletion of the two tables in items 144 and 145.

Item 147: Johnson changed his ballot to abstain. Mark Hogan indicated he would like to see some flag for inexperienced designers and would like to keep the deleted items. He moved to keep in the deletions. The motion was seconded and defeated.

Item 148: As an editorial change the footnote "1" should be left in. Johnson then moved that the title be modified to read: "Maximum Ratio on Supported Height or Length to Thickness." The motion was seconded and passed.

Item 149: There were attempts to modify this ballot in two parts. Part 1: Hogan moved and it was seconded that the h/t ratio of 18 should be changed to 20. The vote was unanimous. Part 2: Johnson moved that the ratios of 36 should be changed back to 25. The motion was seconded. There was discussion and the motion failed.

Item 150: No discussion or change.

Item 150A: Refer to ATC comment. Wintz moved and it was seconded to modify this ballot item to use an equation $T = T_o - T_c$ with a ratio of h/t = 18. The motion was seconded. For: ASCE, BIA, ACI, PCA; Against: MI, MS, ICSSC, NCMA, SEAOC; Abstain: WSCPA. Hogan then moved to use the equation as originally proposed with the ATC definitions and deleting the h/t ratio. The motion was seconded and passed.

Items 151-153: No discussion or change.

Item 154: Brief discussion with no change in ballot.

Item 155: General discussion centered around the proposed table being unworkable partly because ATSM C90 is based on gross area. The counter argument was that net area strength is needed for design. The committee ballotted with a five-five tie as shown on the ballot tabulation; therefore the motion failed and the original table in the ATC report is maintained.

Items 155A and 155B: Refer to ATC comments. The ATC comments were discussed with Gerich changing his ballot on these two ballots to negative but the motion passed by a simple majority.

Item 156: Modified, no discussion or change.

Item 157: This was deleted as a ballot item. Ron Mayes indicated that he would provide some input on this.

Item 158 - Modified: No discussion or change.

Item 159: No discussion or change

Item 160: Brief discussion, no change in ballot.

Item 161, 162: No discussion or change.

6.8 It was decided that the committee should have one final meeting to consider Chapter 12. The meeting was set for Washington, D.C. on June 6. This seemed to be about the only date available since both chairman would be unavailable for the month of June beginning the following week.

6.9 The meeting adjourned at approximately 3:00 a.m.

ATTENDANCE AT MAY 16

MEETING OF COMMITTEE 5

MEMBERS	MORNING SESSION	AFTERNOON SESSION	EVENING SESSION
George Hanson	√	√	√
Jerry Stockbridge	√	√	√
James Amrhein	√	√	--
Mario Catani	√	√	√
Richard Gensert	√	--	--
Andrei Gerich	√	√	√
Mark Hogan	√	√	√
Ed Johnson	√	√	√
Don Wakefield	√	√	√
Joseph Wintz (for Al Yorkdale)	√	√	√
E. V. Leyendecker	√	√	√
Mel Mark	√	√	√
Ron Mayes	√	√	√

GUESTS			
Ed Hedstrom	√	√	--
James Noland	√	√	--

Minutes of the June 5 and 6 Meeting

of

Technical Committee No. 5 - Masonry

Review and Refinement of Tentative
Seismic Provisions (ATC 3-06)

1.0 The June 5 meeting session was called to order at 8:30 p.m. by Co-Chairmen Hanson and Stockbridge at the Washington-Dulles International Airport, 100 Sally Road, Serling, Virginia 22170.

1.1 The following members were in attendance:

Jerry Stockbridge
George Hanson
Alan Yorkdale
Andrei Gerich
Mark Hogan
Mario Catani
Don Wakefield
Ron Mayes
Mel Mark (arrived about 10:30)
E.V. Leyendecker

1.2 The following guests were in attendance:

Joseph Wintz, III - Brick Institute of America
C. B. Monk, Jr. - Wiss, Janney and Elstner

1.3 The following proxies were announced:

George Hanson - for James Amrhein, night of June 5 only
Mario Catani - for Richard Gensert, all sessions

Co-Chairman Hanson inquired if there was a proxy for Ed Johnson. Both Leyendecker and Mayes indicated no. Both SEAOC and ATC had discussed the matter and decided it would be inappropriate for Ron Mayes to represent Ed Johnson. Therefore a proxy was not pursued. It was also noted by Leyendecker that significant ballotting on Chapter 12 was not anticipated until the June 6 session when Johnson would be present.

2.0 The minutes of the May 16 meeting were briefly discussed. These were held until June 6 when full attendance would be achieved.

3.0 Secretary Leyendecker handed out the following material:

a. ATC proposal for Chapter 12 based on committee action on Chapter 12A - Although members had already received this from ATC, Leyendecker announced that this copy had ballot numbers included. [refer to Section 2.2]

b. Ballot sheet for (a) above

c. Copy of letter ballot number 2 previously ballotted by the committee.

d. Proposed Section 12A.6.2 for design of unreinforced hollow clay masonry prepared by Wakefield. [Exhibit K in Section 3.3]

Leyendecker noted that Items (a) and (c) would enable members to observe differences between the ATC recommendations for Chapter 12 and the prior committee ballot on the same chapter. He also noted that these differences were indicated in Item (a) although some may have been missed. In addition, some items which should be ballotted may also have been missed. Both of these could be picked up during discussion and ballotting.

4.0 The committee then proceeded to discuss and ballot on Section 12A.6.2 based on Wakefield's handout (see Exhibit K for the handout and Section 2.1 for the ballot numbers). It should be noted that Ed Johnson's ballot is shown as abstain since he was not at this evening session. Numbers shown in parenthesis refer to the original text pages.

Item 87-1 (p. 141 sheet 5 of 7): A minor modification was accepted by a vote of 9 to 0.

Item 87-2 (p. 162): There was considerable spirited discussion on Wakefield's proposed Table 12A-1. Catani moved and Yorkdale seconded to modify Table 12A-4 rather than use Wakefield's proposal. The suggested values are based on ACI 531 values and are based on unit stresses using the appropriate areas. The vote was unanimous.

Item 87-3: Wakefield's suggested paragraph at the top of his p. 2 was discussed as a footnote to Table 12A-4. Catani moved to delete the paragraph as unnecessary. The motion carried unanimously.

Item 87-4 (p. 141 sheet 5 of 7): Wakefield moved and it was seconded to accept this item. The final item includes a new formula for columns plus some editorial corrections for consistency. The motion carried unanimously.

Item 87-5 (p. 141 sheet 3 of 7): Yorkdale moved and it was unanimously accepted to modify item 7 as shown on the indicated page. The modification was based on supporting test data and was backed by Mayes.

Item 87-6 (p. 141 sheet 6 of 7): Wakefield moved and it was unanimously accepted to use Section B on bearing stress with the following modifications: change 0.26 to 0.25, change 0.38 to 0.30

Item 87-7 (p. 141 sheet 4 of 7): Hogan moved and it was unanimously accepted to insert a paragraph the same as Item 87-6 with a paragraph number 5 in the section on Unreinforced Concrete Masonry.

Item 87-8 (p. 141 sheet 6 of 7): Wakefield moved and it was unanimously accepted to place this item on the ballot.

Item 87-9 (p. 141 sheet 6 of 7): Wakefield moved, it was seconded, and unanimously accepted to use the wording of paragraph A.

Item 87-10 (p. 141 sheet 6 of 7): Wakefield moved and it was seconded to accept paragraph B. Considerable discussion followed both pro and con. Hogan expressed the opinion that the committee seems to be willing to accept documentation for hollow brick but not concrete masonry. He felt the section should refer to Table 12A-3 for stresses. The motion passed with negative votes from ACI, NCMA and PCA.

Item 87-11 (p. 141 sheet 4 of 7): Hogan moved and it was unanimously accepted to modify paragraphs 1 and 2 as shown, similar to that for hollow clay.

Item 87-12 (p. 141 sheet 7 of 7): Paragraph A was unanimously accepted as shown.

Item 87-13 (p. 142): Yorkdale moved and it was unanimously accepted to take paragraph C as shown.

Item 87-14 (p. 142): Wakefield moved and it was unanimously accepted to take the paragraph on corbels as shown.

Item 87-15 (p. 147 sheet 7 of 7): Paragraph on shear wall stresses was discussed at length. Some agreed the stresses were too high, others about right. Mayes felt the whole question of shear stresses needed to be reviewed. At Mayes request discussion was postponed until June 6 when he would present some additional information. The item was set aside without resolution. Due to illness by Ron Mayes, he was unable to present material. This issue was never resolved by the committee and is, therefore, shown as no vote. Ron Mayes later distributed material, Exhibit M, Section 3.3, for consideration.

5.0 The meeting was adjourned at 12:35 a.m. to reconvene on June 6.

6.0 The June 6 meeting session was called to order at 9:00 a.m. by Co-Chairmen Hanson and Stockbridge at the headquarters of the National Concrete Masonry Association in Herndon, Virginia.

6.1 The following members were in attendance:

Jerry Stockbridge
George Hanson
Alan Yorkdale
Andrei Gerich
Mark Hogan
Mario Catani
Don Wakefield
Jim Amrhein
Ed Johnson
Ron Mayes (absent due to illness except for closing of meeting)
Mel Mark
Richard Marshall (for E. V. Leyendecker)

6.2 The following guests were in attendance:

Joseph Wintz, III
C. B. Monk, Jr.

6.3 The following proxy is still in effect:

Mario Catani for Richard Gensert.

6.4 Mel Mark announced that he had a series of changes to the material distributed Thursday evening (3.0a). (These are shown in Section 2.2 by the prefix M-.) These were entered into the record and the meeting continued.

7.0 The minutes of May 16 were discussed.

7.1 M. Mark indicated he had not had a chance to read the minutes. Hanson said he could do so and send comments to Leyendecker.

7.2 Wakefield disagreed with the vote tabulation in the minutes on item 140A. Hogan said the minutes were correct and Wakefield was satisfied.

7.3 Wakefield questioned item 115. He questioned the recorded tally. Catani said verbage should govern and Wakefield agreed.

7.4 Catani moved to adopt the minutes as corrected by Wakefield with the option that members can review and send in substantive comments within one week from June 6. Yorkdale seconded and it was unanimously accepted.

8.0 The issues in Chapter 12 were then addressed (refer to Section 2.2 for ballot items). In general, M. Mark's items will be voted on first. M. Mark announced that ATC wants the committee to know that the ATC reviewers are unhappy with the revisions. For example Table 12.1 has been made more liberal. Co-Chairman Hanson responded that he assumes M. Mark's earlier comments at this meeting represents ATC's rewrite of Chapter 12.

Item M-1: Hogan moved to accept as shown, Yorkdale seconded, the vote was unanimous (M-1 is shown also as 12-1).

Item M-2: It was moved and seconded to accept as shown, the vote was unanimous.

Item M-3: M. Mark wanted to change the last sentence to read: "A minimum of. . .work and for each 5,000 sq ft of wall." Catani moved to reject the proposal, Amrhein seconded. The motion carried unanimously. Item remains 12-1AN.

Item 12-1AN: Johnson moved to accept 12-1AN with M-3. Yorkdale seconded and it was unanimously approved.

Item 12-2N: This was approved in the earlier ballot on Chapter 12.

Item 12-3N (M-4): Yorkdale moved to adopt the proposed change which is to change the last two sentences of the paragraph to read "This masonry shall be designed as unreinforced masonry, except that reinforced masonry areas or elements may be considered as resisting stresses in accordance with the design criteria for reinforced masonry provided such elements fully comply with the design and construction requirements for reinforced masonry and Section 12.2.1(B)3; and only type M and S mortars are used; however, R factors of Table 3-B shall be as required for unreinforced masonry." The motion was seconded by Hogan and was approved with one negative vote from Wakefield. (It was later discovered, see Exhibit N, Section 3.3 that this change was not what was desired by the committee. Wakefield worked with Mayes and M. Mark to reach the compromise shown in Exhibit N. Leyendecker and Mayes reworded that compromise to arrive at the wording actually shown.)

Item M-5: Catani moved to accept the wording. The motion was approved with Wakefield abstaining.

Items 12-4N, 12-4-1 and 12-4-2(M-6): Unanimously accepted (Items were considered one at a time).

Item M-7: Modify the original ballot item 12-4-3 to leave in line (C) SHEAR WALLS etc. Delete only the EXCEPTION paragraph. Unanimously accepted.

Item 12-4-4: Discussion centered around deleting the entire paragraph. It was moved and passed unanimously to delete the entire paragraph except for the second sentence "Each panel. . .steel".

Item 12-4-5: Considerable discussion centered on the need for Table 12.2. Wakefield moved to delete the table. Amrhein seconded the motion. Negative votes were cast by Johnson, Hanson and Gerich. Yorkdale and Hogan abstained. Therefore the table will be deleted. (later moved to Category C, see discussion after Item 12-6-7)

Item M13A: M. Mark proposed adding a sentence to reinsert the h/t restriction of 25. There was a motion to delete the insert and leave Item 12-4-6 as shown. The motion passed with one negative from Johnson.

Item M13B: M. Mark proposed adding the insert "Except. . .12A.6.2(A)." It was moved and seconded. The motion carried with one negative from Wakefield.

(Note: Ron Mayes arrived at this time)

Item 12-4-7: Unanimously accepted.

Item 12-4-8(M15): The item was accepted with Wakefield abstaining.

Item 12-4-9(M16): Committee discussion led to the proposed changes. M. Mark's proposal added the statement on cleaning. This was accepted with one negative from Wakefield.

(Note: A. Yorkdale left the meeting, Wintz has his official proxy)

Item 12-4-10: It was moved and seconded to delete this section. The motion to delete carried with negative votes from Gerich and Johnson. (Note: this was added on p. 12-12 as Item O. See discussion on M-33)

Items 12-4-11, 12, 13, 14, and 15: Unanimously accepted (Items were considered one at a time)

Item 12-4-16: Accepted with Wakefield abstaining.

Item M-17: M. Mark proposed moving the following from paragraph (L) on p. 12-12 "(Q) STRESSES. Allowable masonry stresses for work without special inspection designed under 12A.6.2(B) shall be 50% of allowable stresses for work with special inspection." The motion was made and rejected with negative votes from all except Gerich and Johnson.

Item 12-4-17 (M-18): M. Mark proposed deleting "(Mortar and Grout)" and the last line. Catani proposed adding the air content limitation on masonry cement. Both items were accepted with a negative vote from Wakefield.

Item 12-11-1 (M-30): M. Mark proposed rewording note (1) and adding note 2. Catani moved to accept these changes and also to change the 2 to a 1 for buildings over 35 ft with running bond structural components in Map Area 2. Wintz seconded and the motion carried with one abstention from Gerich.

Item 12-5N (M-19): M. Mark proposed wording the first line to read "All masonry shall be reinforced masonry conforming to Section 12.2.1(B)." Wakefield moved to accept this with the addition of the phrase "except for. . .12.2.1(B)2." The motion carried unanimously.

Item 12-6N, 12-6-1(M-20), and 12-6-2(M-21): These items were discussed and approved unanimously one at a time.

Item 12-6-3: Amrhein moved to delete the phrase on templates shown in the ballot item and Hogan seconded. The motion carried with a negative from Johnson and abstention from Gerich. Johnson moved and Gerich seconded to reword, the motion was defeated. Paragraph I was later included unchanged as Item D on p. 12-14.

Item 12-6-4: Amrhein moved to delete this item, Wintz seconded. M. Mark argued this meant no quality control was desired. The motion was withdrawn. Hogan then moved the same motion and it was seconded. The motion to delete passed with yes-votes from Gensert, Amrhein, Catani, Hanson and Hogan. Johnson and Gerich voted no while Wintz, Wakefield and Stockbridge abstained. Paragraph J was later included unchanged as Item E on p. 12-14.

Item 12-6-5: The motion was made to accept with the change shown. The motion passed with a no vote from Johnson. Gerich abstained.

Item 12-6-6 (M-22): Mark revised as M-22. He then suggested (M-23) to move the item. It was moved and seconded to move this item as (Q) on p. 12-10. The motion was defeated. Yes votes were received from Johnson and Gerich. It was unanimously agreed to keep the revised section as Item (L).

Item 12-6-7 (M-24): Unanimously accepted.

Item - Special Issue: Ed Johnson wanted to move Table 12.2 to be referenced by Paragraph N. He first moved to modify the table as shown and relocate. The motion passed with a no vote from Wakefield. It was then moved to insert a new paragraph N. The motion passed unanimously. The changed table includes M. Mark and committee changes.

Item 12-7N: This item included ballotting on materials shown in Section 12.5.2. M. Mark asked during the ballotting if Catani had checked all issues with his proxy. Hanson said letter was on file from ACI designating Catani as his proxy. Ballotting was as follows:

(1) Catani moved to delete the line "Concrete Building. . ." The motion carried unanimously.

(2) Catani moved to delete the line "Hallow Load-Bearing. . ." The motion carried unanimously.

(3) Wintz moved to delete the line "Building Brick. . ." The motion carried with negatives from Johnson and Gerich.

(4) Johnson moved to add "Masonry Cement" to the list. The motion carried with negatives from Catani, Gensert and Hogan.

(5) Johnson moved to add "Type N mortar" to the list. The motion carried with negatives from Catani, Gensert and Hogan.

(6) The motion was made to add the air content restriction to masonry mortar on p. 12-13. The motion carried, BIA abstained.

(7) It was moved (M-33) to move paragraph (L) from p. 12-7 to become a new paragraph (N) on p. 12-12.
The vote was unanimous.

(8) Wakefield moved to delete glass chips from the list. The motion carried unanimously.

Item M-27: The motion was made to reinsert the phrase on shovel measurements. The vote was unanimous.

Item - Specil Issues: Ed Johnson moved the following material be inserted on p. 12-14 before Section 12.6.2:

(1) Add a new paragraph (D) using the original wording of paragraph I on p. 12-11. The motion carried unanimously.

(2) Add a new paragraph (E) using the wording of paragraph (J) on p. 12-11. The motion carried with a nagative from Hogan and abstention from Catani and Gensert.

(3) The motion was made and unanimously approved to add a new paragraph (F) as shown on p. 12-14.

Items 12-8-1 (M-28), 12-9, 12-10: Ballotted separately and each unanimously approved.

Item 12-10-1: The paragraph was unanimously approved.

Item M-29: The wording was unanimously approved along with relocating to follow the first paragraph in Section 12.7.3

Item M-30: The title change of 12.7.3 was unanimously approved.

Item 12-11: Unanimously approved.

9.0 The meeting was adjourned at 4:15 p.m.

Respectfully submitted,

Edgar V. Leyendecker, Secretary
Technical Committee 5: Masonry

3.2 Roster

COMMITTEE 5: Masonry

American Concrete Institute

Mr. Richard M. Gensert
Consulting Engineer
718 The Arcade
Cleveland, Ohio 44114

Phone: 216-241-7078

American Society of Civil Engineers

Mr. Jerry G. Stockbridge (Co-Chairman)
600 Fairway Drive
Glenview, Illinois 60025

Phone: 312-272-7400

Brick Institute of America

Mr. Alan H. Yorkdale (Representative to Committee 2: Structural Design)
Brick Institute of America
1750 Old Meadow Road
McLean, VA 22101

Phone: 703-893-4010

Interagency Committee on Seismic Safety in Construction

Mr. Andrei Gerich
Structural Engineering Division
Office of Architecture & Engineering Stds.
Department of Housing and Urban Development
Room 6172
Washington, D.C. 20410

Phone: 202-755-5924

Masonry Institute of America

Mr. James E. Amrhein
Director of Engineering
2550 Beverly Boulevard
Los Angeles, California 90057

Phone: 213-388-0472

National Concrete Masonry Association

Mr. Mark Hogan
National Concrete Masonry Association
P.O. Box 781
Herndon, Virginia 22070

Alternate: Mr. Kevin Callahan
(same address as Hogan)

Phone: 703-435-4900

Committee 5 (continued)

Portland Cement Association

Mario Catani
Portland Cement Association
Buildings Division
5420 Old Orchard Road
Skokie, Illinois 60077

Alternate: Albert W. Isberner
(address same as Catani)

Phone: 312-583-6200 Ext. 366

Structural Engineers Association of California

Ed Johnson
Atkinson, Johnson & Spurrier
4121 Napier Street
San Diego, California 92110

Phone: 714-275-1530

The Masonry Society

George Hanson, P.E. (Co-Chairman)
President, The Masonry Society
3003 South Williams
Denver, Colorado 80210

Phone: 303-427-6443 (office in home)

Western States Clay Products Association

Donald A. Wakefield, P.E.
Vice President
Interstate Brick & Ceramic Tile
9210 South 5200 West
P.O. Box 517
West Jordan, Utah 84084

Phone: 801-561-1471

Applied Technology Council

Mr. Melvyn Mark
Structural Engineer
Ferver Eng. Co.
3487 Kurtz Street
San Diego, California 92110

Phone: 714-224-3501

Committee 5 (continued)

Applied Technology Council

Dr. Ron Mayes
Applied Technology Council
2150 Shattuck Avenue, Suite 806
Berkeley, California 94704

Phone: 415-540-0223

Building Seismic Safety Council

Mr. Vincent Bush
International Conference of Building Officials
5360 South Workman Mill Road
Whittier, California 90601

Phone: 213-699-0541

National Bureau of Standards

Dr. E. V. Leyendecker
Secretariat
Committee 5, Masonry
National Bureau of Standards
Room B168, Building 226
Washington, D.C. 20234

Phone: 301-921-3471

(Mr. Lou Cattaneo)

Phone: 301-921-2184

3.3 Selected Committee Correspondence and Applied Technology Council Comments

The work of Technical Committee 5 (TC-5) resulted in considerable correspondence and handouts, all of which is on file with the committee secretary. Material referenced in the minutes in Section 3.1 and other selected material is contained in this section. A brief description of each exhibit follows.

Exhibit A - December 26, 1979 letter from A. Yorkdale to a TC-5 Task Group describing options for the committee.

Exhibit B - January 15, 1980 letter from A. Yorkdale to TC-5 enclosing a record of a January 4, 1980 Task Group meeting.

Exhibit C - February 19, 1980 letter from A. Yorkdale to TC-5 enclosing his draft proposal of revisions to Chapters 12 and 12A.

Exhibit D - February 20, 1980 report from J. Amrhein and others to TC-5 containing proposed revisions to Chapters 12 and 12A.

Exhibit E - February 29, 1980 letter from M. Hogan to M. Mark and R. Mayes containing proposed design procedures for unreinforced masonry.

Exhibit F - March 12, 1980 letter from R. Mayes to TC-5 transmitting his

1. assessment of options for Chapter 12
2. draft of revised Chapter 12 incorporating options
3. comparison of ATC 3-06 and UBC-79
4. evaluation of seismic safety of ATC 3-06 based on research at Berkeley
5. summary report of shaking table tests on four houses.

Items 1-3 are contained in Exhibit F. Items 4 and 5 are not but they are on file with the TC-5 secretary.

Exhibit G - March 14, 1980 letter from Mel Mark to TC-5 transmitting comments on proposed changes to Chapter 12A contained in Exhibit D.

Exhibit H - March 21 handout from D. Wakefield to TC-5 containing proposed Chapter 12 revisions.

Exhibit I - March 19, 1980 letter from M. Mark to TC-5 transmitting proposals on several subjects, including mortar, cavity walls, alternate design procedures.

Exhibit J - May 7, 1980 letter from R. Mayes and M. Mark to TC-5 transmitting comments on Chapter 12 and 12A committee ballot items.

Exhibit K - June 5, 1980 handout from D. Wakefield to TC-5 transmitting proposals for design of unreinforced hollow clay.

Exhibit L - June 2, 1980 letter from R. Mayes to TC-5 transmitting working draft of Chapter 12 based on changes in Chapter 12A.

Exhibit M - June 19, 1980 letter from R. Mayes to TC-5 transmitting assessment of allowable shear stresses for use in design of unreinforced masonry.

Exhibit N - June 24, 1980 letter from D. Wakefield to TC-5 transmitting proposed correction to error in Section 12.2.1(B)2 adopted at June meeting of TC-5.

Exhibit O - ATC comments on proposed ballot items.

Brick Institute of America 1750 Old Meadow Road, McLean, Virginia 22102 Phone: 703-893-4010

MEMO

TO: Task Group of Technical Committee 5:Masonry

James E. Amrhein (MIA)
Richard M. Gensert (ACI)
Robert Helfrich (WSCPA)
Mark Hogan (NCMA)

COPIES TO: Jerry G. Stockbridge
Andrei Gerich
Melvyn Mark
Ron Mayes
Vincent Bush
E.V. Leyendecker
Lou Cattaneo
Tony Wintz
Mark Fintel
Kevin Callahan

FROM: Alan H. Yorkdale (BIA),
Task Group Chairman

DATE: 26 December 1979

SUBJECT: TASK GROUP: MEETING, OPTIONS, SUGGESTIONS

Gentlemen:

I hope that each and all of you had a very Merry Christmas, but it's time to go back to work.

First, Jerry Stockbridge has arranged a conference room for our use at Wiss, Janney, Elstner and Associates. They are located at 330 Pfingsten Road,Northbrook, Illinois 60062. I suggest that we meet promptly at 9:00 a.m. C.S.T. to begin our work.

Second, I have received several telephone calls from members of our Task Group and from others, each of whom has "decided" what the T.G. should do and how we "must" go about it. To all of these I have listened and I suggest that few have considered all of our options. Also, I believe that the final decision must be made by the T.G. as a whole.

As I see it, we have a series of options concerning the Masonry Sections. We must also address other parts of the ATC 3-06 document, but that is covered later in this memo.

1. Our first choice, in my view, is to keep Chapter 12A or eliminate it.

As you all are aware, the masonry chapter is the only one with the added section.

A. If we choose to eliminate 12A, we must replace it by way of reference to a "nationally recognized consensus standard" that we can then modify via revisions to Chapter 12.

The standards that would be suitable for this type of reference are:

1) "Building Code Requirements for Reinforced Masonry", ANSI A41.2-1960 (1972).

This standard covers both clay and concrete units; both solid and hollow. It also covers both "reinforced" and "partially reinforced masonry".

2) "Building Code Requirements for Masonry", ANSI A41.1-1953 (1972).

This standard covers all types of masonry units, including stone and unreinforced concrete. It does not deal with reinforced masonry.

3) "Building Code Requirements for Concrete Masonry Structures", ACI 531-79.

This standard covers concrete masonry, both plain and reinforced, and composite masonry. The standard is accompanied by a "Commentary" (ACI 531R-79) to assist in its use.

4) The Canadian, "National Building Code", Chapter on Masonry.

This standard covers both clay and concrete units, both hollow and solid. It is directed toward "limit states" design.

5) British Standard of Practice CP-1.11, Masonry.

This standard covers both clay and concrete units, both hollow and solid. It is not very strong in reinforced masonry.

6) New British Standard of Practice, BS 5861.

This standard covers both clay and concrete units, both hollow and solid. It is a limit states approach that uses the principle of "Ultimate Strength Design".

B. If we choose not to eliminate 12A, we again have several choices. We can revise and modify what is currently there, or we can replace 12A with something else.

Suggestions that have been received for replacing 12A include:

1) The Masonry Society draft standard.

This draft standard covers brick, hollow brick, block, solid c.m.u., structural clay tile, stone and gypsum block. The standard is essentially the work of six or eight individuals. It has had no consensus review nor does it currently have a "commentary" or justification of the numbers and procedures.

2) Uniform Building Code, 79 edition, Masonry Chapter, or 74 edition.

This chapter, covers all types of masonry units. It has not been thru a real consensus process. It is not well organized and contains many repressive requirements.

3) "Building Code Requirements for Engineered Brick Masonry", BIA(SCPI) 1969.

This standard covers only solid clay brick units. It covers both reinforced and non-reinforced brick masonry. The standard is widely used and well documented. It has not cleared any consensus process.

4) "Specification for the Design and Construction of Load-Bearing Concrete Masonry", NCMA 1970.

This standard covers only concrete units. It covers reinforced and non-reinforced concrete masonry. The standard is widely used. It has not cleared any consensus process.

5) "Building Code Requirements for Engineered Brick and Hollow Brick Masonry", draft standard by BIA.

This draft standard is based on the 1969 BIA Standard, it covers only clay units both reinforced and non-reinforced brick and hollow brick masonry. It is the work of eight industry engineers. It is well documented in research and practice, but has not been subjected to any consensus review.

In summary, these are at least some of the options and choices that we have. I hope each of you will consider each of these carefully before our meeting on Friday, the 4th of January at WJE.

Third, I think we should consider other portions of the ATC 3-06 document than only Chapters 12 and 12A.

For example, I believe the situation can be materially improved with some attention to Chapter 3 and Chapter 1.

I suggest that we recognize the "white" and "pink" areas on the maps. These areas have seismicity of 0.05g or less. Any reasonably designed and constructed structure will perform within the elastic range at peak accellerations of 0.05g or less. We should propose revision of Table 1-B (page 35) as follows:

Coeff. Aa Figure 1	Map Area Number	Coeff. Av Figure 2	Seismicity Index
0.40	7	0.40	4
0.30	6	0.30	4
0.20	5	0.20	3
0.15	4	0.15	2
0.10	3	0.10	1
0.05	2	0.05	0
0.05	1	0.05	0

I am enclosing some proposed changes in draft form that were prepared by the concrete industry. We might consider supporting these or similar revisions. Also enclosed are the minutes from T.C.-2 which may also contain some ideas.

I look forward to seeing you all on the 4th in Northbrook.

Regards to all.

AHY:ts
Enclosures

Draft PCA
More Finished

BACKGROUND INFORMATION AND SUGGESTED INDUSTRY POSITION ON THE IMPACT OF PROPOSED ATC-3-06 SEISMIC DESIGN REQUIREMENTS

PREFACE

In recent years, the Applied Technology Council (ATC), consisting of a group of engineers and scientists considered expert in earthquake technology, was formed with the help of the Structural Engineers Association of California (SEAOC). Under a contract with the National Bureau of Standards (NBS), with funding by the National Science Foundation (NSF), ATC developed a document entitled "Tentative Provisions for the Development of Seismic Regulations for Buildings". The latest revised edition of this document (June 1978) is designated as ATC-3-06, and presumes to represent the most current state-of-the-knowledge in seismic engineering. It is intended that the design provisions contained in the document shall eventually be adopted in building codes throughout the country.

Many new concepts and procedures are incorporated in ATC-3-06. Before they are finally considered for code adoption, they must be assessed and tested for their workability, practicability, enforceability and cost impact on the nation. Therefore, NBS has undertaken a program to assess and imple- ment the tentative ATC code provisions and has invited all parties repre- senting widespread interests within the private sector as well as government agencies to participate in the assessment program. PCA, along with other segments of the concrete industry, will participate in the proceedings.

As an allied activity, the Building Seismic Safety Council (BSSC), an orga- nization newly formed under the auspices of the National Institute of Build- ing Sciences, will review the findings generated under the NBS program and will act as the final authority before the implementation process is initiated. PCA has representation on both the Board of Direction and the voting body of BSSC.

The entire process is intended to be a "checks and balances" system that will result in a viable document. As ATC-3-06 now stands, it will have a decided national impact on the entire building community.

The concrete industry perceives a significant opportunity to improve the seismic resistance, the buildability, and the economy of concrete structures by providing coordinated input to the Building Seismic Safety Council's activities and the NBS program in modifying ATC-3-06. There is also the need to reduce the potentially negative effect on concrete construction, should ATC-3-06 be implemented in its present form.

PRESENT SITUATION

Since 1966, Ductile-Moment-Resistant-Space-Frames (DMRSF) have been required by the Uniform Building Code (UBC) for tall concrete buildings. This is a replacement for the 1959 code provisions limiting height of concrete buildings to 13 stories, or 160 ft. The current code requirement has practically prevented construction of highrise concrete structures in California, since the DMRSF becomes unbuildable at about 15-18 stories.

Concrete is being utilized in the construction of medium-rise buildings in California, particularly where the design of structural systems requires only partial ductility (K = 0.8), or where no special ductility requirements are needed (K = 1.0). In low-rise construction, concrete is minimally affected by seismic codes.

While various degrees of seismic risk exist in most of the western United States and in some other regions of the country, earthquake resistance has been a predominant design consideration for buildings in California. In lesser seismic zones, where seismic resistance has only recently become a factor in engineering practice, the extent of seismic design is still mostly at the discretion of the design professionals. Only occasionally do engineers adhere fully to the seismic requirements as developed for the high seismicity of California.

The reason that highrise concrete buildings are not built in California under existing codes is not that reinforced concrete is a material unsuitable for seismic resistance. Rather, it is that the seismic codes require ductility details whether or not they are needed or usable. This creates expensive, even unbuildable, structures. It is a direct result of the use of elastic analysis under code-specified equivalent seismic forces. This type of analysis cannot give us a proper assessment of ductility requirements. Engineers and code writers have not yet adopted the more realistic inelastic analysis techniques for structural response developed in recent years. Absence of such analytical methods in the codes unnecessarily inhibits the use of concrete for highrise structures.

Outside of California, utilization of concrete for highrise buildings has been very successful, primarily due to concrete's economic advantages and its rigidity in resisting lateral forces. In these areas, the height of con- crete buildings is limited only by the strength of materials and by the efficiency of the chosen structural system.

EFFECTS OF ATC-3-06

All indications are that ATC-3-06, in its present form, will continue the present restrictive design requirements that prevent the design and construction of highrise concrete structures in California. The ATC provision will also have a detrimental effect on highrise concrete construction in all other parts of the country (including the east coast) which have seismicity indices of 2, 3 and 4. In addition, specific ATC-3-06 provisions related to prestressed and precast concrete construction (Ø factors) and to prestressed piles may be very detrimental to those respective industries.

The most significant impact on the entire concrete industry may come from the introduction of Response Modification Factors, "R". These elastic force reduction factors, ranging from 1¼ to 8 for the various materials and structural systems, were compiled arbitrarily by a small group of individuals, based solely on their experience and judgment. They were developed without the resource of any published background material or other substantiation, and without appraisal by the profession and the building industries.

The other negative influence of ATC-3-06 on the concrete industry is the perpetuation of the arbitrary height limitations for concrete buildings, carried over from the UBC, and the arbitrary assignment of levels of detailing requirements (seismic performance categories A, B, C and D) for the various seismic intensities and exposure groups.

GOALS OF THE CONCRETE INDUSTRY

To improve the earthquake resistance and the economy of highrise concrete structures in seismic regions, we advocate:

1. Encouraging the use of shear wall-frame interactive systems for earthquake resistance which are appropriate for concrete, rather than continuing to require the use of the DMRSF which is primarily suitable for steel construction.

2. Utilizing realistic inelastic methods of analysis to allow for control of inelastic behavior, thus requiring ductility details only where needed and usable. Current provisions that require ductility details over the entire structure, whether usable or not should be abandoned. For instance, in shear wall-frame structures, it is unlikely that ductility provided in most columns can ever be utilized. A recognition of this fact would make the construction of concrete structures much more prac- tical in seismic regions.

In the short term, the following changes are needed in the present building codes to improve the economy of concrete buildings:

1. Removal of some of the arbitrary restrictive provisions, such as: height limitations, restrictions on aspect ratios of beams and columns, limitations on prestress piles, etc.

2. Modification of some strength formulas where research results indicate that significantly higher strength is available.

3. Modification of unjustifiably restrictive strength reduction factors.

SUGGESTED MODIFICATIONS IN ATC-3-06

With respect to ATC-3-06, the following activities should be undertaken:

1. Response Modification Factors, R - The R-factors should be derived on a rational basis using inelastic response studies. The concept of response modification factors introduced in ATC-3 to account for the inelasticity and damping of the various structural systems and materials is conceptually clear, simple, easy to apply, and presents a significant improvement over the present use of K-factors. However, the apparently arbitrary selection of R-factors in Table 3B makes the practical application of the concept very questionable at this time. Viable "R" values can be derived only with the help of inelastic response studies.

   To evaluate the suggested arbitrary Response Modification Factors, R, of various individual systems and materials by comparing them with the previous "K" values (also unsubstantiated) adopted arbitrarily 40 years ago is like the blind leading the blind.

   Studies to determine realistic R and C_d values must be carried out for the various structural systems and materials contained in Table 3B. The value of R to be derived from response history analyses is the ratio of base shear for the undamped elastic system to the base shear for the damped inelastic system, both systems representing the same structure and both being subjected to a properly selected ground motion. The inelastic response history analysis would yield required member ductilities corresponding to the R factor. If these required ductilities are attainable with the specified detailing, then the R factor is realistic; otherwise, it needs revision.

The total effort required to determine practical numbers is very extensive. However, it must be undertaken and systematically carried out if the proposed ATC-3 design provisions are to be based on a viable technological approach.

2. <u>Height limitations</u> - Height limitations for the various framing systems, as given in Section 3.3, are arbitrary, unjustified, and should be removed. The best performer in reinforced concrete, the shear wall-frame interactive system, has justifiably been assigned a high R-factor; it is, however, limited to a height of 240 ft. In comparison, the special moment frame, which in reality becomes unbuildable at about 15-18 stories, is the only concrete system allowed above 240 ft levels. We do not believe that the reasons and circumstances which prevailed in the early sixties and led to similar height limitations (primarily a lack of knowledge) are still valid today.

To assure safety of tall structures, we suggest that multistory buildings above a certain height be required to be analyzed and designed by the more realistic inelastic procedures, to make certain that ductility demands are within available limits. The only limiting factors to determine the height of buildings should be member capacity for strength and ductility.

3. <u>Seismic Performance Categories A, B, C and D</u> - These categories have been assigned arbitrarily to the various seismic exposure groups and to the seismicity index levels. They need to be studied to correlate ductility demands of structural systems at the various intensity levels

with required ductility details. While there is little question about requirements for the highest seismicity (4), and the lowest seismicity (1), detailing requirements for seismicity index levels 2 and 3 (i.e., Salt Lake City, Seattle, Boston, New York, Chicago, etc.) may prove to be either excessive or inadequate.

4. An Alternate Approach - A procedure based on inelastic dynamic analysis needs to be introduced for multistory buildings. Such a procedure became practicable with the development in recent years of highly efficient inelastic analysis computer programs. A good example of such a program is DRAIN-2D, developed at the University of California, Berkeley. Inelastic characteristics of structural elements of both concrete and steel have been incorporated into this program by the University of California at Berkeley (concrete), and by the University of Michigan (steel), respectively. The alternate inelastic approach gives engineering offices a valuable tool for designing multistory structures in which the amount and distribution of inelasticity can be controlled; consequently, ductility details may be included only where they can be utilized. The height of buildings so designed is controlled by the strength and ductility capabilities of the materials. The procedure is applicable to both concrete and steel high rise structures.

A number of design examples, carried out for shear wall-frame interactive systems and for coupled wall structures, show the feasibility and technical superiority, as well as the economic advantages of the inelastic approach.

5. Provisions of Chapter 11 - A number of provisions governing specific details are inconsistent with available research results and should be modified. The requirements for A706 steel, and the shear capacity, Equation 11-5, are two examples of restrictive provisions inconsistent with research results. Also, limitations on aspect ratios for beams and columns are arbitrary, without compelling justification, and should be eliminated or at least amended. Detailed comments on Chapter 11 have been previously submitted by PCA and PCI, and will be resubmitted.

6. Strength Reduction Factors Ø - The values 0.5 and 0.6, of strength reduction factors Ø for precast concrete and for shear in walls of 0.5 and 0.6, respectively, are extremely low arbitrary values.

SUMMARY

The Portland Cement Association, in conjunction with other concrete and allied industries, advocates strongly the pursuit of the above indicated goals, using the measures recommended in this position paper. It is the policy of this Association to advocate design requirements which will result in the construction of economical and structurally sound reinforced concrete buildings in seismic zones.

EXHIBIT A

PCA - Mark Fintel

Draft

TABLE 1-B - Page 35

REVISE THE "SEISMICITY INDEX" COLUMN OF TABLE 1-B TO READ AS SHOWN BELOW:

TABLE 1-B

Coefficients A_a and A_v and Seismicity Index

Coeff. A_a Figure 1	Map Area Number	Coeff. A_v Figure 2	Seismicity Index
0.40	7	0.40	4
0.30	6	0.30	4
0.20	5	0.20	~~4~~ 3
0.15	4	0.15	~~3~~ 2
0.10	3	0.10	~~2~~ 1
0.05	2	0.05	~~2~~ 1
0.05	1	0.05	1

REASON: The seismicity indices were introduces as a device to relate the seven map areas (acceleration intensities) with the various levels of detailing requirements, as classified in the four seismic performance categories (A, B, C, and D). The indices and the performance categories have been apparently arbitrarily interrelated with the seismic hazard exposure groups (Table 1-A).

While there is little question about detailing requirements for the highest seismicity (4), and for the lowest seismicity (1), detailing requirements for seismicity index levels of 2 and 3 remain a gray area without adequate background information.

It is not acceptable to require arbitrarily the same level of ductility detailing for acceleration levels of .40 (map area 7) as for acceleration level 0.15 (map area 4).

If we start from the lower end of the map areas, we can see that buildings in map areas 1 and 2, showing an acceleration of 0.05 will undoubtedly always remain in the elastic range, requiring no additional ductility details. The acceleration level of 0.10 (map area 3) will, in all probability, create an elastic response in buildings designed in conformity with modern reinforced concrete and steel codes. Regarding the acceleration levels of 0.15 and 0.20, (map areas 4 and 5), the major question is how much ductility will be required in the structural members. It should be considered that current codes (i.e., ACI 318) basically result in ductile members, as provisions over the last 20 years have been devised to eliminate brittleness. To suddenly require additional detailing (adding 30% of forces in perpendicular direction, and other reinforcement details) in cities like New York and Chicago, based largely on judgment, not necessarily supported by adequate background studies, seems questionable. Seismic code writers bear the responsibility to substantiate the need for any restrictive changes made to codes which have been developed in a consensus process over the last several decades. It is not for industries to prove that such changes are unnecessary and will increase the cost of buildings without adding to their safety. Added ductility requirements should be imposed only if seismicity vs ductility correlation studies for map areas 1, 2 and 3 indicate levels of ductility demands requiring such detailing.

Minutes of First Meeting

Technical Committee 2 - Structural Design

Review and Refinement of Tentative Seismic Provisions (ATC-3-06)

at

National Bureau of Standards

December 11, 1979

The meeting was convened at 12:00 noon in the Green Auditorium of the National Bureau of Standards by James Harris of NBS, the committee secretariat, with the following members present:

Richard McConnell, representing the Interagency Committee on Seismic Safety in Construction.

Nicholas Forell, representing the Structural Engineers Association of California.

Rene Luft, the alternate representative for the American National Standards Institute.

William Ayer, temporarily representing the American Society of Civil Engineers.

Roland Sharpe of the Applied Technology Council.

James Harris of the National Bureau of Standards.

Tim Reinhold, also of NBS

Members not present or organizations not represented were:

Ajit S. Virdee of the Building Seismic Safety Council

Mr. Ayer stated that the ASCE representative for the committee would be Mr. Hal Iyengar of Skidmore, Owings and Merrill of Chicago, Illinois.

Procedures for conduct of the project were discussed. The requirement for a 2/3 majority of the joint committee to pass a proposal as a recommended change was criticized by some, the feeling being that the provisions are too tentative to require such a backing for a change, that the issues are too technical for such wide agreement, and that the technical committees would be wasting time working on proposals that would not pass the final ballot. Others felt that the 2/3 majority rule is appropriate. General agreement was not reached on the 2/3 majority rule, but it was agreed that unsuccessful proposals should be retained in the eventual report to the Building Seismic Safety Council. It was also agreed that recommendations for the conduct of test and trial designs would be appropriate output from the committee, in addition to the primary output, namely, recommended changes to the ATC-03-06 seismic provisions.

The committee recessed at 1:00 p.m. and reconvened by Harris at 1:30 p.m. in the NBS cafeteria with the following additional members in attendance:

Joseph Tyrrell, representing Committee 3: Foundations

Mark Fintel, representing Committee 4: Concrete

Alan Yorkdale, representing Committee 5: Masonry

William Sontag, representing Committee 6: Steel

Edwin Zacher, representing Committee 7: Wood.

Robert Englekirk, representing Committee 1: Seismic Risk Maps[1/]

Edward Pfrang of NBS, observer.

The first item of business was the election of a chairman. As the nominations were opened, discussion ensued concerning the desirable qualifications for a chairman. Zacher, seconded by Sontag, then nominated Simpson for chairman and Iyengar for vice-chairman, both subject to their acceptance. McConnell, seconded by Yorkdale, nominated Forell for chairman. After the nominations were closed, Forell withdrew. No additional nominations were forthcoming, and the committee approved Simpson and Iyngar, subject to their acceptence. [2/]

After comparing the scheduled meeting dates for the other committees, it was decided to hold the next meeting on the days immediately preceding the BSSC Executive Board meeting, which is in Phoenix on February 29. Luft was then designated acting chairman for the duration of the meeting. The committee recessed at 2:00 and reconvened at 2:30 in the Green Auditorium with the same members as were present at the 12:00 noon session.

Harris introducted a list of areas in which the committee might receive proposals for change, based on his reading of the external review comments received by ATC in 1976 and 1977:

- The factor R for modification of the elastic response: Both changes and additions are possible.

- The formulas for approximate period of vibration.

[1/] Englekirk was a visitor at this meeting. The BSSC subsequently approved the representation of Committee 1 on Committee 2, and Englekirk is now a member of Committee.

[2/] Both gentlemen were contacted by phone later in the day. Simpson declined the offer, and Iyengar accepted the offer, thus succeeding to the chairmanship of the committee.

- The load combinations, especially the 0.5 factor for dead load for brittle components.
- The orthogonal load combination.
- The design spectrum for buildings with very short periods and high values of R.
- The design spectrum for modal analysis in the low frequency range.
- The lower limits on base shear and the upper limits on calculated periods.
- The height limits for various building types.
- The seismic performance categories
- The calculation of the value θ for use in determining the need for P-delta analysis.
- A simpler method of analysis
- The provisions requiring modal analysis for certain buildings.
- The reduction in the overturning moment at the base of a structure.

Sharpe then added the following:

- The factor C_d for amplification of elastic deflections.
- The drift limits.

McConnell added the need for an intermediate level of ductility for reinforced concrete.

Forell then contributed several points of concern (only the additional ones are listed)

- Load factor design
- Lack of provision for horizontal irregularity
- Restraints on certain combinations of seismic resisting systems (are lacking in ATC)
- The provision for disconinuity in a vertical sense
- The formula for the distribution of base shear to story forces
- The applicability of the torsion provision to wood diaphragms
- The provisions implying that plastic analysis be used for unbraced steel frames.

- The use of single degree of freedom per node modal analysis instead of a three degree of freedom method.

- R values for large flexible diaphragms

- Resolution of forces in the foundations, particularly for systems with low values for R.

The committee was joined during the session by William Sontag, the representative of Committee 6 and by William LeMessurier, the BSSC liaison for Committee 1. LeMessurier indicated an intent to participate in the meetings of this committee.

Sontag stated a concern with the requirements for the use of rolled steel sections qualified for plastic design in all "special moment frames," which effectively prohibit the single story rigid frame "metal building" in the highest seismic zones.

Luft questioned the use of lightgage cold rolled sections for earthquake resistance.

Considering the wide range of possible proposals, the committee decided to allow two days for the next meeting. The next meeting will be on February 27 and 28 in Phoenix, Arizona, exact time and place to be announced.

Respectfully submitted,

James Robert Harris
Secretary

EXHIBIT B

Brick Institute of America 1750 Old Meadow Road, McLean, Virginia 22102 Phone: 703-893-4010

MEMORANDUM

TO: All Members of TC 5: Masonry

FROM: Alan H. Yorkdale, P.E. AHY

DATE: 15 January 1980

SUBJECT: TC-5: Masonry - Meeting Date and Place

As indicated in the first Minutes of the Committee, the open meeting will be:

Date:	21 and 22 February 1980
Time:	10:00 a.m., C.S.T. on the 21st 8:30 a.m., C.S.T. on the 22nd
Place:	Inn of the Six Flags 601 Avenue H, East Arlington, Texas, 76011 (817) 640-1666

A block of rooms has been set aside in the name of the Brick Institute of America. Please mention that when making reservations.

The meeting room will be in the hotel.

Regards to all.

AHY/jcr

NOTES on the Meeting of:

TECHNICAL COMMITTEE No. 5 on MASONRY

for

Review and Refinement of Tentative Seismic Provisions (ATC 3-06)

Wiss, Janney, Elstner and Associates Conference Room	Northbrook, Illinois 4 January 1980

1.0 The meeting opened at 9:15 a.m., C.S.T., with the following members of the Committee present:

Amrhein, James E.	(MIA)
Gensert, Richard M.	(ACI)
Hogan, Mark	(NCMA)
Hanson, George	(TMS)
Helfrich, Robert	(WSCPA)
Stockbridge, J.G.	(ASCE)
Yorkdale, A.H.	(BIA)

1.1 Committee Members not Present:

Gerich, Andrei	(ISCCS-HUD)
Mark, Melvyn (non-voting)	(ATC)
Mayes, Ron (non-voting)	(ATC)
Bush, Vincent (non-voting)	(ATC)

1.2 One guest was present:

Wintz, J.A., III

1.3 It was noted that all but one voting member of the T.C. 5 was present. Therefore, any action taken could be considered that of the Committee after it is circulated.

2.0 It was suggested that the group consider some of the "design" questions, before attacking Chapters 12 and 12A.

The Committee reviewed some preliminary comments and positions prepared by Mark Fintel, of Portland Cement Association. Especially the Tables in Chapters 1 and 3 and height limitations.

It was the consensus that TC-5 should support these positions in general and several items in particular: i.e., Tables 1-A and 1-B, also some changes in Chapter 3.

The Schedule for the Committee was discussed and is as follows:

January 4	T.G. Meeting
January 11	T.G. Draft to full Committee
January 30	Committee Comments to T.G.
February 21 and 22	Full Public Meeting of Committee in Dallas
May 10	Submission of full proposals to ATC

2.1 The first subject to be considered was Table 1-B, which appears on page 35.

2.1.1 Following is the result of the discussion and consideration:

TABLE 1-B

COEFFICIENTS A_a and A_v and SEISMICITY INDEX

Coefficient A_a Figure 1	Map Area Number	Coefficient A_a Figure 2	Seismicity Index
0.40	7	0.40	4
0.30	6	0.30	4
0.20	5	0.20	3
0.15	4	0.15	2
0.10	3	0.10	1
0.05	2	0.05	1
0.00	1	0.00	0

The ATC says in their commentary that they assigned the arbitrary peak acceleration of 0.05 g to map area 1. The actual seismicity of map area 1 is actually zero. In addition, the peak acceleration of map area 2 is actually 0.00 to 0.05 as maximum.

It is the intention that any reasonably designed and built structure will survive a peak acceleration of 0.05 intact and all materials remain within the elastic range. Therefore, the Coefficients of Map Area 1 is reduced to 0.00 and the Seismicity Index for that area is reduced to 0. The other Seismicity Indices are adjusted accordingly.

2.2 The next subject to be considered was Table 1-A, on page 35.

TABLE 1-A

SEISMIC PERFORMANCE CATEGORY

Seismicity Index	Seismic Hazard Exposure Group III	II	I
4	D	C	C
3	C	C	B
2	B	B	A
1	B	A	A

The reasoning for these proposed changes is as follows:

.1 It is felt that Seismic Hazard Exposure Group III Buildings should be investigated and analyzed, even for Seismicity Index 1.

.2 It is also felt that based on performance history, S.H.E.G. I Buildings in S.I. 2 need not be required to be reinforced masonry.

2.3 The next item to be considered was the Building Categories, which appear in Sections 3.4 through 3.7 of the ATC Documents.

2.3.1 The proposed revisions will install the following general requirements:

.1 Building Category - A may be of any masonry system.

.2 Building Category - B requires analysis and foundation study, but will only be inforced as needed to resist the loads.

.3 Building Category - C requires analysis, foundation study, and be reinforced to minimum requirements.

.4 Building Category - D requires analysis, minimum reinforcement, foundation study and special details.

2.4 The next item considered was Table 3-B on page 52, concerning R factors and C_d factors.

2.4.1 It was determined that the R factors shown are only opinions. They have no basis technically.

2.4.2 In addition, the R factor is a material and system related confidence factor.

.1 Based on this, the Committee recommends that the R factors for reinforced masonry be at least equal to those for concrete.

.2 The Committee also recommends that the terms "partially reinforced" and "unreinforced masonry" be eliminated.

.3 The Committee recommends that the term to be used be "Engineered Masonry".

.4 Engineered Masonry requires analysis and design and is reinforced as needed.

.5 Reinforced Masonry also requires analysis and design, but is required also to have at least a minimum area of reinforcement.

.6 It is recommended that these terms be used in the Document and in Table 3-B.

.7 It is also recommended that all R factors and C_d factors be the same for Concrete and Reinforced Masonry.

2.4.3 It is the Committee's understanding that the Concrete Industry is performing computer inelastic studies to determine what the R factors and C_d factors should be.

.1 The Committee recommends the same factors for masonry.

2.5 The next item to be considered was Section 4.4 on page 57, dealing with accidental torsion.

2.5.1 The Committee recommends that the section be revised as follows:

Last paragraph: "The design shall provide for the torsional moment M resulting from location of the building masses or the torsional moments M_{ta} caused by assumed displacement of the mass each way from its actual location by a distance equal to 5 per cent of the dimension of the building perpendicular to the direction of the applied forces, whichever is the larger."

.1 The Committee believes that the minimum of 5 per cent for torsion is legitimate for "accidental" torsion. Also, we agree that actual torsion should be included, but to improve both requirements simultaneously is arbitrary and capricious.

2.6 The next item to be considered was Section 1.6.2, "Special Inspection", on page 31.

2.6.1 The Committee recommends that the section be revised as follows:

Section 1.6.2 Special Inspection, (E):

(E) STRUCTURAL MASONRY. Continuous Special Inspection required during placement of all masonry units for buildings assigned to Category D, and during all grouting operations for masonry which is part of the seismic resisting system in Categories C and D.

.1 The reason is that continuous special inspection should be required full time for Category D building, but only grouting operations inspection need be required for Category C.

2.7 The next item to be considered was Section 1.6.3, Special Testing (C) STRUCTURAL MASONRY.

The Committee recommends that the section be revised as follows:

(C) STRUCTURAL MASONRY. Special Testing of structural masonry shall be as follows:

.1 When f'_m is to be established by prism tests, at least five representative prisms shall be prepared and tested prior to start of work. During construction at least one sample prism shall be prepared per day, but not less than one sample prism per 5,000 sq ft of wall area nor less than five such sample prisms for any building during the progress of the work.

<u>OR</u>

.2 When f'_m is established based on the strength of units and mortar types

a. Sample at job site and test mortar and grout at the rate of at least once per day, but not less than once for each 2,000 sq ft of wall area, and

b. Sample at manufacturer's plant and test masonry units proposed for use. Sampling rate shall be at least five representative units per production lot, but not less than one unit per 5,000 sq ft of wall area. Tests shall be performed for compressive strength in accordance with ASTM Standards appropriate for the type of unit used.

3.0 Consideration of Chapters 12 and 12A

3.1 General - In a general discussion of the Chapters, 12 and 12A, the following appeared to be strong consensus of the Committee present:

3.1.1 General goal is to do what is in the best interest of the public and the industry.

3.1.2 Not to try to do away with the psuedo Ultimate Strength Design portion in Chapter 12.

3.1.3 We must check the ϕ factors to see what the resultant design will be.

3.1.4 It will also be necessary to check the R factors.

3.1.5 It was agreed that the present Chapter 12A is very bad. It is not worth attempting to revise.

3.2 It was at this point that the basic impasse was reached.

As perceived by the group, there are two choices:

3.2.1 Adopt a National Standard and eliminate Chapter 12A and make suitable revisions to Chapter 12.

.1 This position was supported by four of those present.

3.2.2 Keep a Chapter 12A, but insert a completely rewritten document, based on the ACI-531 Standard and the draft Standard of the Masonry Society.

.1 This position was supported by three of those present.

3.3 After considerable discussion, no agreement could be reached.

3.3.1 It was the general feeling that both would be developed, and at a point near completion, perhaps a decision could be reached.

4.0 The meeting adjourned at approximately 5:30 p.m., C.S.T.

Respectfully submitted,

Alan H. Yorkdale, P.E.

AHY/jcr

Distribution: To All on Committee List

Brick Institute of America 1750 Old Meadow Road, McLean, Virginia 22102 Phone: 703-893-4010

MEMORANDUM

TO: All Members of COMMITTEE 5: Masonry

Mr. Jerry Stockbridge, Co-Chairman
Mr. George Hanson, Co-Chairman

FROM: Alan H. Yorkdale
Task Group Chairman

AHY

DATE: 19 February 1980

SUBJECT: Proposed Revision: CHAPTER 12 - MASONRY

Reference is made to the Notes on the Meeting of the Task Group of T.C. 5 on Masonry of January 4, 1980.

As reported, there was general consensus on most matters considered at the meeting, which was attended by more than Task Group members. At the point of consideration of Chapters 12 and 12A, there was a difference of opinion on the approach to take. There was, however, some agreement, as follows:

3.0 Consideration of Chapters 12 and 12A

3.1 General - In a general discussion of the Chapters, 12 and 12A, the following appeared to be strong consensus of the Committee present:

3.1.1 General goal is to do what is in the best interest of the public and the industry.

3.1.2 Not to try to do away with the psuedo Ultimate Strength Design portion in Chapter 12.

"3.1.3 We must check the ϕ factors to see what the resultant design will be. (This was done by Jim Amrhein).

3.1.4 It will also be necessary to check the R Factors.

3.1.5 It was agreed that the present Chapter 12A is very bad. It is not worth attempting to revise.

3.2 It was at this point that the basic impasse was reached.

All Members of COMMITTEE 5: MASONRY
19 February 1980
Page Two

As perceived by the group, there are two choices:

3.2.1 Adopt a National Standard and eliminate Chapter 12A and make suitable revisions to Chapter 12.

.1 This position was supported by four of those present.

3.2.2 Keep a Chapter 12A, but insert a complete rewritten document, based on the ACI-531 Standard and the draft Standard of the Masonry Society.

.1 This position was supported by three of those present.

3.3 After considerable discussion, no agreement could be reached.

3.3.1 It was the general feeling that both would be developed, and at a point near completion, perhaps a decision could be reached."

The attached proposed revision to CHAPTER 12 is offered to the full Committee 5 for their consideration as stated in the above Minutes.

By way of explanation of this approach, we have suggested the ANSI/ACI 531-79, "Building Code Requirements for Concrete Masonry Structures: and the Commentary - 531R-79 be used as the referenced document. This document is "modified" in the proposal so that it can also be used for brick and hollow brick masonry. Further modifications are also made to address the specific seismic requirements presently found in Chapter 12A. Chapter 12A is eliminated by virtue of the use of a Reference Standard.

The original intent was to prepare this Proposal and have it in the hands of the full Committee 5 prior to this meeting to provide time for review. This was not possible, due to unforeseen circumstances. For this inconvenience I apologize as your Task Group Chairman.

On a personal note, I would like to state that, as a representative of the brick industry on this Committee, it is repugnant to me to offer a proposal that references a concrete masonry design standard. However, in the time provided, this is the only solution available. It should be noted, however, that this proposal is presented as an expedient measure only for the purpose of the trial designs.

The proposal is attached.

AHY/jcr
Attachment
25 copies for distribution at meeting

CHAPTER 12

MASONRY

12.1 REFERENCE DOCUMENTS

The quality and testing of masonry products and assemblages and reinforcing steel and the design and construction of Engineered Masonry and Reinforced Masonry components which resist seismic forces shall conform to the requirements of the references listed in this Section, except as modified by the provisions of this Chapter.

Ref. 12.1 "Building Code Requirements for Concrete Masonry Structures," ANSI* 531-79 and 531R-79 Commentary.

12.1.1 The referenced design standard covers the engineered design and construction of concrete masonry and composite elements of concrete and other masonry units.

12.1.2 For the purposes of this Chapter, the design procedures in the reference document as modified herein shall also pertain to engineered design and construction of masonry of fired clay brick, hollow brick and structural clay tile.

12.1.3 Table 4.3, "Values of f'm For Masonry" of the referenced Standard is hereby revised and expanded for the purpose of this document, and to provide for high strength brick, hollow brick and structural clay tile, as follows:

Compressive Strength of Units, psi, on Net Area	Compressive Strength of Masonry f'm, psi	
	Type M and S Mortar	Type N Mortar
14,000 and over	4600	3200
12,000	4000	2800
10,000	3400	2400
8,000	2800	2000
6,000	2400	1600

12.2 STRENGTH OF MEMBERS AND CONNECTIONS

The strength of members and connections subjected to seismic forces acting alone or in combination with other prescribed loads shall be determined using a capacity reduction factor, , and $2\frac{1}{2}$ times the allowable working stresses, given in Table 10-1, of the referenced standard. The value of ϕ shall be as follows:

*This design standard was developed by American Concrete Institute, Committee 531.

For axial or flexural compression and bearing stresses in the masonry - - - - - - - - - - - - - - - - - - - ϕ = ______

For reinforcement stresses except when considering shear - ϕ = ______

For shear carried by shear reinforcement and/or bolts - ϕ = ______

For tension in masonry parallel to the bed joints, i.e., horizontally in normal construction - - - - ϕ = ______

For shear carried by the masonry- - - - - - - - - - ϕ = ______

For tension in masonry perpendicular to the bed joints, i.e., vertically in normal construction - ϕ = ______

12.3 DESIGN PROCEDURES FOR MASONRY

12.3.1 The general design of masonry shall comply with the following definitions and criteria:

.1 Empirical Masonry, for the purpose of this chapter, is empirically designed masonry and is not covered.

.2 Engineered Masonry shall be analyzed and designed in accordance with the referenced document standard as modified. Engineered Masonry may or may not contain reinforcing to resist tensile forces as required by the design.

.3 Reinforced Masonry shall be analyzed and designed in accordance with the referenced document standard. In addition, Reinforced Masonry shall be reinforced with minimum ratio of area of steel of 0.002 to area of masonry, with no less than 0.0007 in either direction. Maximum reinforcement spacing shall not exceed four (4) ft on centers, as stated in Sec. 11.3.2.2 of Reference Document.

12.4 SEISMIC PERFORMANCE CATEGORY A

Buildings assigned to Category A may be of any construction permitted in the standard reference document, as modified.

12.5 SEISMIC PERFORMANCE CATEGORY B

Buildings assigned to Category B shall be of Engineered Masonry construction in accordance with Section 11 of the referenced standard, as modified.

12.6 SEISMIC PERFORMANCE CATEGORY C

Buildings assigned to Category C shall conform to all of the requirements for Category B and to the additional requirements and limitations of this Section.

12.6.1 CONSTRUCTION LIMITATIONS

Masonry components shall be constructed to conform to the limitations of this Section.

(A) REINFORCEMENT. All masonry shall be Engineered Reinforced Masonry.

(B) TIE ANCHORAGES. In addition to the requirements of Section 11.4.3 for tie anchorages, a minimum turn of 135 degrees plus an extension of at least six tie diameters but not less than 4 inches at the free end of the tie shall be provided.

(C) REINFORCED COLUMNS. In addition to the requirements of Section 11.4 for reinforced masonry columns, no longitudinal bar shall be farther than 6 inches from a laterally supported bar. Except at corner bars, ties providing lateral support may be in the form of cross-ties engaging bars at opposite sides of the column.

The tie spacing for the full height of masonry shear wall boundary columns and all other columns stressed by tensile or compressive axial overturning forces due to seismic effects and for the tops and bottoms of all other columns for a distance of 1/6 of clear column height but not less than 18 inches nor the maximum column dimension shall be not greater than 16 bar diameters nor 8 inches. Tie spacing for the remaining column height shall be not greater than 16 bar diameters, 48 tie dimaters, or the least column dimension, but not more than 18 inches.

(D) SHEAR WALL BOUNDARY ELEMENTS. Boundary members shall conform to one of the following:

1. Section 11.8.4 when of reinforced concrete or structural steel.

2. Section 12.5.1(C) when of masonry.

(E) JOINT REINFORCEMENT. Longitudinal masonry joint reinforcement may be used in reinforced grouted masonry and reinforced hollow unit masonry only to fulfill minimum reinforcement ratios but shall not be considered in the determination of the strength of the member.

(F) STACKED BOND CONSTRUCTION. The minimum ratio of horizontal reinforcement shall be 0.0015 for all structural walls of stacked bond construction. The maximum spacing of horizontal reinforcing shall not exceed 24 inches. Where reinforced hollow unit construction forms part of the seismic resisting system, the construction shall be grouted solid and all head joints shall be made solid through the use of open end units.

12.7 SEISMIC PERFORMANCE CATEGORY D

Buildings assigned to Category D shall conform to all of the requirements for Category C and to the additional requirements and limitations of this Section.

12.7.1 CONSTRUCTION LIMITATIONS

Materials for mortar and grout for structural masonry shall be measured in suitable calibrated devices. Shovel measurements are not acceptable. An approved admixture of a type that reduces early water loss and produces a net expansion action shall be used for grout for structural masonry unless it can be demonstrated that shrinkage cracks will not develop in the grout. The thickness of the grout between masonry units and reinforcing shall be a minimum of ½ inch for structural masonry.

(A) MINIMUM GROUT SPACE FOR GROUTED MASONRY. The minimum grout space for structural reinforced grouted masonry shall be 2½ inches for low-lift construction and 3½ inches for high-lift construction.

(B) REINFORCED HOLLOW UNIT MASONRY. Structural reinforced hollow unit masonry shall conform to requirements below:

1. Wythes and elements shall be at least 8 inches in nominal thickness with clear, unobstructed continuous vertical cells, without offsets, large enough to enclose a circle of at least 3½ inches in diameter and with a minimum area of 15 square inches.

2. All grout shall be coarse grout. Grout consolidation shall be by mechanical vibration only. All grout shall be reconsolidated after excess moisture has been absorbed but before workability has been lost.

3. Vertical reinforcement shall be securely held in position at tops, bottoms, splices, and at intervals not exceeding 112 bar diameters. Approved intermediate centering clips or caging devices shall be used in high-lift construction, as required, to hold the vertical bars. Horizontal wall reinforcement shall be securely tied to the vertical reinforcement or held in place during grouting by equivalent means.

4. In wythes of less than 10-inch nominal thickness, in any vertical cell, there shall be a maximum of one No. 10 bar or two No. 8 bars with splices staggered for the two-bar situation.

(C) STACKED BOND CONSTRUCTION. All stacked bond construction shall conform to the following requirements:

1. The minimum ratio of horizontal reinforcement shall be 0.0015 for non-structural masonry and 0.0025 for structural masonry. The maximum spacing of horizontal reinforcing shall not exceed 24 inches for non-structural masonry nor 16 inches for structural masonry.

2. Reinforced hollow unit construction which is part of the seismic resisting system shall (1) be grouted solid, (2) use double open end (H block) units so that all head joints are made solid, and (3) use bond beam units to facilitate the flow of grout.

3. Other reinforced hollow unit construction used structurally but not part of the seismic resisting system, shall be grouted solid and all head joints shall be made solid by the use of open end units.

12.7.2 SPECIAL INSPECTION

Special inspection shall be provided for all structural masonry.

12.8 SHEAR WALL REQUIREMENTS

Shear walls shall comply with the requirements of this Section.

12.8.1 REINFORCEMENT

The minimum ratio of reinforcement for shear walls shall be 0.0015 in each direction. The maximum spacing of reinforcement in each direction shall be the smaller of the following dimensions: one-third the length and height of the element, but not more than 32 inches. The area and spacing of reinforcement perpendicular to the shear reinforcement shall be at least equal to that of the required shear reinforcement. The portion of the reinforcement required to resist shear shall be uniformly distributed.

> EXCEPTION:
> For shear walls constructed using running bond, the ratio of reinforcement may be decreased to 0.0007 provided that all shear is resisted by the reinforcement. The sum of the ratios of horizontal and vertical reinforcement shall not be less than 0.002.

12.8.2 BOUNDARY MEMBERS

Where cross walls or boundary members form part of the shear wall system, the intersections shall be constructed as required for the walls themselves. Connections to concrete shall conform to Section 9.8. Where the boundary members are of structural steel, the shear transfer between the wall and the boundary member shall be developed by fully encasing the element in grout, by dowels, bolts, or shear lugs, or by similar approved methods.

When the structural system, as described in Chapter 3 and ...le 3-B, consists of substantially complete vertical load-carrying frame, b... ...y members shall be provided at each end of the wall. The members shall be o... ...same construction as the frame columns. Where the frame is a special momen... ...me, those columns shall conform to the requirements for such members in Chapt... ...0 and 11.

Horizontal reinforcing in the walls shall be anchored to t... vertical elements. Where the boundary element is structural steel this shall be accomplished by welding or by extension, with bends if required, into grout fully surrounding the column.

12.8.3 COMPRESSIVE STRESSES

For loading combinations including in-plane seismic forces, allowable compression stresses at any point shall not exceed those allowed for axial compression in Table 10-1.

EXHIBIT D

To: Jerry Stockbridge, Cochairman
George Hanson, Cochairman
Building Seismic Safety Council
Committee 5, Masonry

From: Jim Amrhein, Masonry Institute of America
Bill Bailey, Acme Brick Company
Stu Beavers, Concrete Masonry Association of California & Nevada
Gregg Borchelt, Masonry Institute of Houston - Galveston
Walter Dickey, Consulting Structural Engineer
George Hanson, Flickinger Associates
Bob Helfrich, Applied Science & Engineering
Jim Noland, Atkinson Noland & Associates
Gene Salveson, Masonry Institute of Washington
John Tawresey, KPFF
Don Wakefield, Interstate Brick Company

As you know, there is no recognized standard on the national level which covers all types of masonry design. As a result, the Applied Technology Council was asked to prepare design requirements for seismic provisions of masonry design and construction. This document, ATC 3-06, has been incorporated into Chapter 12 and 12A of the Tentative Seismic Provisions as published by the National Bureau of Standards and administered by the Building Seismic Safety Council.

There has been widespread dissatisfaction with Chapters 12 and 12A since publication of the document. Included among the problem areas are:

1. Excessive cross referencing to various parts of the chapters. This often leads to confusion since the effect of change in one section are not fully realized.

2. Repitition of material

3. Terminology unfamiliar to the entire masonry and design industry - "true" joint, "partially reinforced", "Specific" inspection.

4. Reference to standards for concrete.

5. Compliation of different design techniques for various materials without full explanation

6. Format inconsistencies

7. Lack of continuity in layout

In general it was felt that this particular draft added more confusion to the already muddled area of masonry design.

The persons listed at the head of this memo met to rectify as much of this as possible. Individuals in this group come from the following areas of the construction industry:

- consulting engineers
- research
- contractors
- labor
- manufacturers
- academia
- trade associations

The goal of the revisions is to maintain Chapters 12 and 12A in much of their orginal form, but include recent research results, existing practices when technically sound and make the result more acceptable to the design and construction industry.

The changes accompanying this memo are a result of that activity. The content changes are valid, any of the changes will be fully explained if requested. We do, however, recognize that the format needs improvement and additional changes should be made. This merely represents the next step.

It is hoped that a nationally recognized design standard for all masonry constrcution can someday replace Chapter 12A.

CORRECTIONS TO CHAPTER 12 AND 12A OF ATC 3-06

DELETIONS ARE LINE OUT ~~THUS~~, . OR DELETED BY NOTE

ADDITIONS ARE UNDERLINED

CHAPTER 12 MASONRY

The following correction appear on Page 111 of Chapter 12.

Under BACKGROUND the paragraph should read:

BACKGROUND

The masonry design and construction procedures given in this Chapter and Chapter 12A provide performance levels for seismic forces.

Under 12.2 STRENGTH OF MEMBERS AND CONNECTIONS, please note that

For reinforcement stresses except when considering shear.

for Grade 40, $\phi = 0.8$

for Grade 60, $\phi = 1.0$

CORRECTIONS APPEARING ON PAGE 112

New Section 12.2.2 MINIMUM REINFORCEMENT REQUIREMENTS FOR SPECIFIC SEISMIC CONDITIONS - appears right before Section 12.3

12.2.2 MINIMUM REINFORCEMENT REQUIREMENTS FOR SPECIFIC SEISMIC CONDITIONS

(A) Horizontal reinforcement not less than 0.2 square inches in area shall be provided at the top of wall openings, at structurally connected roof and floor levels and at the top of parapet walls. Vertical reinforcement not less than 0.2 square inches in area shall be provided on all sides of, and adjacent to, every opening which exceeds 24 inches in either direction, at all corners, and at the ends of walls. Bars around openings shall extend not less than their development length, but not less than 24 inches, beyond the corners of the opening.

(B) Reinforcement ratio in each direction of 0.0007 and the sum of the ratios for each direction shall not be less than 0.002. Maximum spacing of reinforcement shall not exceed 4 feet on center. Only continous reinforcement shall be considered in computing the minimum area of reinforcement. Reinforcement required by 12.2.(A) may be considered in satisfying the minimum horizontal ratio if continuous.

Under 12.4.1 CONSTRUCTION LIMITATIONS, paragraph (A) should read:

(A) ~~HEIGHT-LIMITATION~~. REINFORCEMENT. Components of the seismic resisting system in buildings shall be reinforced masonry and conform to 12.2.2 (A).

Delete paragraph (C)

~~(C)--SHEAR-WALLS.--Shear-walls-shall-conform-to-the-requirements of-Sec.-12.7~~.

Also EXCEPTION:

~~EXCEPTION:~~
~~The-reinforcement-provisions-of-Sec.-12.7.1-need-not-apply-to partially-reinforced-masonry-designed-as-unreinforced-masonry~~.

Under paragraph (D) SCREEN WALLS., the second paragraph should read:

Joint reinforcing may be composed of two wires made with welded ladder or trussed wire cross ties. In calculating the resisting capacity of the system, compression and tension in the spaced wires may be utilized.

CORRECTIONS APPEARING ON PAGE 113

Under 12.4.1 Delete paragraph (F)

~~(F)--CONSTRUCTION-TYPE.--Cavity-wall-construction-shall-not-be used-for-any-structural-masonry.~~

Under Section 12.4.2 MATERIAL LIMITATIONS, delete the following sentence:

~~Structural-Clay-Load-Bearing-Wall-Tile~~

The last sentence should read:

~~Mortars-other-than-Types-M-or-S-~~ Mortar Types O and K

Under Section 12.5 SEISMIC PERFORMANCE CATEGORY C, paragraph (A) should read:

(A) REINFORCEMENT. All masonry shall be reinforced masonry and conform to 12.2.2 (A).

Add new paragraph (D) SHEAR WALLS.

(D) SHEAR WALLS. Shear walls shall conform to the requirements of of Sec. 12.7.

EXCEPTION:
Shear walls in one and two family residences, one or two stories in height.

CORRECTIONS APPEARING ON PAGE 114

Under Section 12.5.1, Paragraph (D) SHEAR WALL BOUNDRY ELEMENTS. should read:

(E) SHEAR WALL BOUNDRY ELEMENTS. Boundry menbers shall conform to one of the following:

Delete Paragraph (E)

~~(E)--JOINT-REINFORGEMENT.--Longitudinal-masonry-joint-reinforcement may-be-used-in-reinforced-grouted-masonry-and-reinforced-hollow-unit-masonry only-to-fulfill-minimum-reinforcement-ratios-but-shall-not-be-considered-in-the determination-of-the-strength-of-the-member.--~~

Paragraph (F) STACKED BOND CONSTRUCTION. reads as follows:

(F) STACKED BOND CONSTRUCTION. The minimum ratio of horizontal reinforcement shall be ~~0.0015~~ 0.0007 for all structural walls of stacked bond construction. The maximum spacing of horizontal reinforcing shall not exceed ~~24~~ 48 inches. Where reinforced hollow unit construction forms part of the seismic resisting system, the construction shall be grouted solid and all head joints shall be made solid through the use of open end units.

Under Section 12.5.2 MATERIAL LIMITATIONS

The following materials shall not be used for any structural ~~or-nonstructural~~ purpose:

Under Section 12.6.1 CONSTRUCTION LIMITATIONS, the paragraph reads as follows:

CONSTRUCTION LIMITATIONS

Masonry components shall be reinforced masonry and conform to Sec. 12.2.2(B). Materials for mortar and grout for structural masonry shall be measured in suitable calibrated devices. ~~Shovel-measurements-are-not-acceptable. An-approved-admixture-of-a-type-that-reduces-early-water-loss-and-produces-a net-expansion-action-shall-be-used-for-grout-for-structural-masonry-unless-it-can-be-demonstrated-that-shrinkage-cracks-will-not-develop-in-the-grout.~~ The thickness of the grout between masonry units and reinforcing shall be a minimum of 1/2 inch for structural masonry.

Paragraph (A) reads as follows:

(A) MINIMUM GROUT SPACE FOR ~~GROUTED-MASONRY.~~ BETWEEN WYTHES. The minimum grout space between wythes for ~~structural~~ reinforced ~~grouted~~ masonry shall be ~~2-1/2-~~ 1-1/2 inches for low-lift construction and ~~3-1/2~~ 2 inches for high-lift construction.

CORRECTIONS APPEARING ON PAGE 114 CONT.

Under Paragraph (B) REINFORCED HOLLOW UNIT MASONRY. Section 1. should read:

1. Wythes and elements shall be at least ~~8~~ 6 inches in nominal thickness with clear, unobstructed continuous vertical cells, without offsets, large enough to enclose a circle of at least ~~3-1/2~~ 3 inches in diamter. ~~and with-a-minimum-area-of-15-square-inches~~.

2. ~~All-grout-shall-be-coarse-grout~~. Grout consolidation shall be by mechanical vibration only. All grout shall be reconsolidated after excess moisture has been absorbed but before workability has been lost.

CORRECTIONS APPEARING ON PAGE 115

Under Paragraph (C) STACKED BOND CONSTRUCTION. Section 1.

1. The minimum ratio of horizontal reinforcement shall be ~~0.0015~~ .0007 for non-structural masonry and ~~0.0025~~ 0.0015 for structural masonry. The maximum spacing of horizontal reinforcing shall not exceed ~~24~~ 48 inches for nonstructural masonry nor ~~16~~ 24 inches for structural masonry.

Under Section 12.7 SHEAR WALL REQUIREMENTS, the sectence reads as follows:

SHEAR WALL REQUIREMENTS

Shear walls shall comply with the requirements of this Section when referenced.

CORRECTIONS APPEARING ON PAGE 116

Under Section 12.7.3 COMPRESSIVE STRESSES the paragraph reads as follows:

COMPRESSIVE STRESSES

For loading combinations including in-plane seismic forces, allowable compression stresses at any point shall not exceed those allowed for ~~axial~~ flexural compression. For unreinforced masonry designed by Sec. 12A.6.1, the allowable working stress values are given in Table 12A-3. The allowable working stress values for reinforced masonry shall be the allowable working stresses given in Table 12A-5 and applicable reductions for slenderness effects shall apply. The minimum horizontal distance between lateral supports may be considered for walls as well as the minimum vertical distance. ~~Formula 12A-7-shall-not-be-used~~.

~~EXCEPTION:~~
~~For-pier-type-wall-elements-that-do-not-exceed-from-floor-to-floor compression-stresses-under-combined-loading-at-any-point-may-be limited-to-those-allowed-for-flexural-compression-provided-that-Formula--12-A-is-also-satisfied.~~

CORRECTIONS APPEARING ON PAGE 116

Under Section 12.7.4 HORIZONTAL COMPONENTS, the parapgraph reads as follows:

HORIZONTAL COMPONENTS

When shear reinforcing is required for loads that include seismic effects and diagonal bars conforming to Sec. 12A.6.4(D) are not provided, reinforcement approximately perpendicular to the required shear reinforcement shall be provided equal in amount and spaced not further apart than in required for the shear reinforcing. Horizontal reinforcing shall anchor into or be continuous through the ~~pier~~ elements. Horizontal components may be separated from the shear wall system by means of ~~true~~ joints. The joints shall provide for building movement determined in accordance with Sec. 3.8. The horizontal components shall be anchored to the building and designed as otherwise required by these provisions.

CORRECTIONS APPEARING ON PAGE 117

CHAPTER 12A

MASONRY CONSTRUCTION

Under Section 12A.1.1 DEFINITIONS

Under the first paragraph AREA, GROSS CROSS-SECTIONAL. and before the third paragraph AREA, NET BEDDED. add the following paragraph:

AREA, NET The gross cross-sectioned area at any place minus the area of ungrouted cores, notches, cells, etc. Net area is the actual surface area of a cross-section.

Between Paragraph EFFECTIVE ECCENTRICITY. and JOINT, BED. add the following paragraph:

GROUTED MASONRY. Masonry composed of hollow units in which designated cells are solidly filled with grout or masonry of two or more wythes in which the cavities between wythes are solidly filled with grout.

CORRECTIONS APPEARING ON PAGE 118

Continued under Section 12A.1.1

JOINT,COLLAR. ~~-The-interior-longitudinal-vertical-joint-in-a-wall-between wythes.--In-grouted-masonry-construction,-it-is-the-grout-space.~~

JOINT, COLLAR. The vertical separating a wythe of masonry from another wythe or from another continuous material and filled with mortar or grout.

CORRECTIONS APPEARING ON PAGE 118 Cont.

Section 12A.1.1 Cont.

~~LOAD-BEARING.--Synonymous-with-Structural~~.

MASONRY. An assemblage of masonry units bonded together with mortar or grout.

(A) MASONRY, REINFORCED. Masonry in which reinforcement is used to resist forces as well as the purpose of crack control.

(B) MASONRY, UNREINFORCED. Masonry in which reinforcement is used only for the purpose of crack control.

~~MASONRY,-GROUTED.--Construction-conforming-to-Sec.-12A.3.5-is-most-often referred-to-as-grouted-brick-construction.~~

Under MASONRY UNIT., add the following paragraph.

MASONRY UNIT. Any brick, tile, stone, or block conforming to the requirements specified in this Chapter.

(A) HOLLOW MASONRY UNIT. A masonry unit whose net cross-sectional area in every plane parallel to the bearing surface is less than 75% of the gross cross-sectional area in the same plane.

(B) SOLID MASONRY UNIT. A masonry unit whose net cross-sectional area in every plane parallel to the bearing surface is 75% or more of the gross cross-sectional area in the same plane.

NONBEARING. This term refers to a ~~nonload-bearing~~ nonstructural component. ~~usually-a-wall~~.

~~PARTIALLY-REINFORCED-MASONRY.--Masonry-construction-conforming-to-Sec. 12A.3.7-and-other-applicable-provisions-of-this-Chapter~~.

~~REINFORCED-MASONRY.--Grouted-masonry-construction-conforming-to-Sec.-12A.3.5(G or-Hollow-Unit-Masonry-conforming-to-Sec.-12A.3.6(A).--Reinforced-masonry shall-also-conform-to-other-applicable-provisions-of-this-Chapter,-including-Sec.-12A.2.2,-12A.2.4,-12A.6.3,-and-12A.6.4.~~

REINFORCEMENT RATIO. This is the ratio of the areas of reinforcement to the ~~gross-cross-sectional~~ net area of the masonry perpendicular to the reinforceme

SHEAR WALL is a vertical component resisting lateral forces by in-plane shear and flexure. (~~unless-defined-elsewhere~~).

CORRECTIONS APPEARING ON PAGE 119

Under Section 12A.1.1 Cont.

MATERIALS AND ~~DESIGN~~ TESTING

Under Structural Clay Tile, the line should read across:

For Walls - Load-Bearing	ASTM C34, C212, C126
Under Unburned Clay	Uniform Building Code Standard 24-~~15~~ 14

CORRECTIONS APPEARING ON PAGE 120

~~Testing~~

Masonry Assemblies, ~~Cores~~ ~~Mortar-and-Grout~~	Sec. 12A.7 & 12A.8
~~Slump-Test-for-Grout~~	~~Sec.-12A.8.2~~
~~Rate-of-Absorption~~	~~ASTM-C67-73-~~

Under Section 12A.1.3 SYMBOLS

Between A_g and A_v, insert the following:

A_s = Effective cross-sectional area of reinforcement in a column or flexural member.

CORRECTIONS APPEARING ON PAGE 121

Section 12A.1.3 Cont.

Under f_v insert the following:

h = Effective height, the height or length of a column or wall used for purposes of determining slenderness effects.

Under n, insert the following:

p = As/bd, Ratio of the area of reinforcement to the area (bd).

CORRECTIONS APPEARING ON PAGE 122

Under Section 12A.1.6

~~BRICK~~ MASONRY UNIT SURFACES FOR GROUTED MASONRY

~~Masonry~~ Units for ~~reinforced-and-unreinforced~~ grouted masonry shall have all surfaces to which grout is to be applied capable of adhering to grout with sufficient tenacity to resist the required shearing stress ~~of-100-psi-after curing-28-days.~~ Tests, when required, shall conform to Sec. 12A.7 and 12A.8.3

Under Section 12A.1.10 GLASS BUILDING UNITS

Glass block shall have unglazed or satisfactorily treated surfaces to allow adhesion on all mortared faces. Units shall be constructed so that a minimum panel thickness of ~~3.5~~ 3 inches can be obtained at the mortar joints.

Under Section 12A.1.13 SHRINKAGE OF CONCRETE UNITS

Concrete masonry units used for structural purposes shall have a maximum linear shrinkage ~~of-0.065-percent-from-the-satruated-to-the-oven-dry-condition.~~ in accordance with the appropriate ASTM specification.

CORRECTIONS APPEARING ON PAGE 123

Under Section 12A.1.14 CEMENT

Cements for mortar and grout are limited to those allowed by ASTM C270, this Chapter and Chapter 12.

~~EXCEPTION:~~
~~Approved-types-of-plasticizing-agents-may-be-added-to-portland-cement Type-I-or-Type-II-in-the-manufacturing-process,-but-not-in-excess-of 12-percent-of-the-total-volume.--Plastic-or-waterproofed-cements-so manufactured-shall-meet-the-requirements-for-portland-cement-except-in-respect-to-the-limitations-on-insoluble-residue,-air-entrainment, and-additions-subsequent-to-calcination.--~~

~~Cements-for-grout-shall-be-Type-I,-Ia,-IIA,-III,-IIIA,-or-V-portland cement,-or-Type-IS-IS-A,-IS-(MS),-IS-A-(MS),-IP,-or-IP-A-blended-hydraulic-cement.~~

12A.1.15 LIME

~~Lime-putty-shall-be-made-from-quickline-or-hydrated-lime.--If-made from-other-than-processed-pulverized-quicklime,-the-lime-shall-be-slaked-and-then-screened-through-a-No.-16-mesh-sleeve.--After-slaking-and-screening,-and-before-using,-it-shall-be-stored-and-protected-for-not-less-than-10-days.~~
Lime for mortar and grout is limited to those allowed by ASTM C207.

~~Processed-pulverized-quicklime-shall-be-slaked-for-not-less-than-48-hours-and-shall-be-cool-when-used.--~~

CORRECTIONS APPEARING ON PAGE 123

Under Section 12A.1.16 MORTAR

~~ASTM-C270-Types-O-and-K-mortar-shall-not-be-used.~~

Masonry units used in foundation walls and footings shall be laid up in ~~Type-S-or-Type-M-mortar~~. mortar having a minimum compressive strength of 1800 psi. See Sec. 12A.1 and Chapter 12 for further limitations.

CORRECTIONS APPEARING ON PAGE 124

Under Section 12A.1.16 Cont.

To maintain plasticity, mortar may be retempered with water by the method of forming a basin in the mortar and reworking it. However, any mortar which has ~~become-harsh-shall-not-be-used-in-the-work.~~ hardened or stiffened due to hydration of the cement shall not be used.

Under (B) Type. Number 1.

1. Fine Grout. Fine grout shall be composed, by volume, of one part cement, to which may be added not more than 1/10 part hydrated lime ~~or-lime~~ putty, and 2-1/4 to 3 parts of sand.

2. Coarse Grout. Coarse grout shall be composed, by volume, of one part of cement, to which may be added not more than 1/10 part hydrated lime ~~or-lime-putty~~, two to three parts sand, and one to two parts gravel. Larger proportions of gravel may be used in large grout spaces where approved by the Regulator Agency.

~~Coarse-grout-may-be-used-in-grout-spaces-in-grouted-masonry-2-inches or-more-in-width-and-in-grout-spaces-in-filled-cell-construction-having-an area-of-15-square-inches-with-a-least-dimension-of-3-inches.~~

~~Coarse-grout-shall-be-used-where-the-least-dimension-of-the-grout-space-exceeds-5-inches-and-where-otherwise-required.~~

(C) CONSISTENCY. Grout shall have a consistency, considering the methods of conslidation to be utilized, to completely fill all spaces to be grouted without segregation. ~~except-that-slumps-shall-not-be-less-than-4.6-inches-for all-grout-nor-more-than-10-inches-for-fine-grout-or-9-inches-for-coarse-grout.~~

(E) MEARSURING AND MIXING. Materials for grout shall be measured in suitable calibrated devices. After the addition of water, all materials shall be mixed for at least three minutes in a ~~drum-type-batch~~ mechanical batch mixer. ~~Mixing-equipment-and-procedures-shall-produce-grout-with-the-uniformity required-for-concrete-by-ASTM-C94.~~

CORRECTIONS APPEARING ON PAGE 125

Section 12A.1.17 Cont.

~~EXCEPTION:~~
~~Aluminum-equipment-may-be-used-if-it-can-be-demonstrated-that there-will-be-no-deleterious-effect-on-the-strength-of-the-grout-and-it-is-specifically-approved-by-the-Regulatory-Agency.~~

Sec. 12A.2 CONSTRUCTION

~~At-the-time-of-laying-all-masonry-units-shall-be-clean-and-free-of-dust. Burned-clay-and-sand-lime-units-shall-be-dampened-prior-to-laying-with-an-absorption-rate-conforming-to-Sec.-12A.1.5.--Surfaces-of-concrete-masonry-units to-receive-mortar-shall-be-dampened-by-means-of-fog-spray-or-equivalent-during hot-and-dry-weather,-as-described-in-Sec.-12A.2.5--At-the-time-of-laying-all unburned-clay-units-shall-be-damp-at-the-surface.--All-masonry-units-shall-not-be-so-wet-that-free-water-is-present-on-the-surfaces.~~

12A.2 CONSTRUCTION

Storage, handling and preparation at the site shall conform to the following requirements.

Masonry materials shall be sotred so that at the time of laying the materials are clean and not damaged.

Concrete masonry units shall not be wetted unless otherwise approved.

~~Surfaces-of-all-masonry-units-for-grouted-construction-at-the-time-of laying-shall-be-capable-of-developing-the-required-bond-with-grout-as-specified in-Sec.-12A.1.6.~~

12A.2.1 JOINTS

All units shall be laid with shoved mortar joints. Solid units shall have all head and bed joints solidly filled. ~~Except-for-cavity-walls,-spaces to-be-grouted,-and-as-provided-in-Sec.-12A.3.3,-all-wall-joints,-collar-joints, and-joints-between-wythes-shall-be-solidly-filled~~ unless otherwise approved.

All hollow units shall be laid with ~~full~~ face shell bed joints and head joints filled solidly with mortar for a distance in from the face of the unit not less than the thickness of the face shells unless more stringent construction is required by this Chapter, Chapter 12, or by design. Cross webs and end shells of all starter courses shall be bedded on mortar. ~~This-applies-to-units-laid-on-foundations-or-floor-slabs-or-similar,-and-all-courses-of piers,-columns-and-pilasters.~~ unless otherwise specified.

~~Concrete-abutting-structural,masonry-such-as-at-starter-courses-or-at-wall-intersections-not-designed-as-true-separation-joints,-shall-be-roughened-to a-full-amplitude-of-1/8-inch,-shall-be-moistened-per-the-requirements-of-Sec. 12A.2,-and-shall-be-bonded-to-the-masonry-per-the-requirements-of-this-Chapter as-if-it-were-masonry.--Unless-keys-are-provided,-vertical-joints-shall-be--considered-to-be-stacked-bond.~~

Third paragraph subsitition:

Surfaces in contact with mortar or grout shall be clean and free of laitance, debris, or other deleterious materials.

CORRECTIONS APPEARING ON PAGE 126

Section 12A.2.2 Cont.

(A) REQUIREMENTS. Adajcent wythes shall be bonded to each other in accordance with the applicable provisions ~~of Sec. 12A.2.1 and~~ Sec. 12A.2.

Where not prohibited in Chapter 12 or this Chapter unreinforced stacked bond masonry may be used with one of the mechanical bonding devices indicated in Sec. 12A.2.2(A) 1, 2, and 3 below:

~~For unreinforced masonry the mechanical bond shall be provided by~~ one of the following:

~~3. For cavity walls the provisions of 1 and 2 above apply to each wythe.~~

~~For stacked bond reinforced grouted or reinforced hollow units masonry, see Chapter 12. For stacked bond partially reinforced masonry, see Sec. 12A.3.7(A) and Chapter 12. For shear walls see Sec. 12A.6.4 and Chapter 12.~~

12A.2.3 CORBELING

~~Corbels in unreinforced masonry may be built only into solid masonry walls 12 inches or more in thickness. Corbels in partially reinforced masonry may be built only into masonry walls 12 inches or more in thickness unless the construction provided for the corbel is designed and constructed as reinforced masonry. The projection for each course in such corbels and in unreinforced corbels in reinforced masonry construction shall not exceed 1 inch, and the maximum projection shall not exceed 1/3 of the total thickness of the wall when used to support a chimney built into the wall. The top course of all unreinforced corbels shall be a header course.~~

12A.2.3 CORBELING

The slope of corbelling (angle measured from the horiztonal to the face of the corbeled surface) shall not be less than 60o. The maximum horizontal projection of the corbel from the plane of the wall shall not exceed one-half the wythe thickness for cavity walls one one-half the wall thickness for all other walls

CORRECTIONS APPEARING ON PAGE 127

Under Section 12A.2.4 REINFORCEMENT

REINFORCEMENT

Reinforcement shall conform to the requirements of this Section. All metal reinforcement shall be free from loose rust and other coatings that would reduce bond to the reinforcement.

Under Paragraph (B)

(B) SPLICES. Splices in reinforcement may be made only at approved locations ~~and~~ and indicated on the approved design documents. Splices shall conform to the provisions of Sec. 12A.6.3(D)7.

Under Paragraph (D)

(D) SIZE ~~LIMIATIONS~~.LIMITATIONS.

Under Section 12A.2.5 TEMPERATURE LIMITATIONS

Delete the entire paragraph beginning with "No masonry shall be laid when" - and ending with "free from ice and snow." The substition paragraph is as follows:

12A.2.5 TEMPERATURE LIMITATIONS

Cold weather construction shall conform to the requirements of "Recommended Practices and Guide Specifications for Cold Weather Construction" by the International Masonry Industry All-Weather Council.

CORRECTIONS ON PAGE 128

Under Section 12A.2.7 BOLT PLACEMENT

In grouted construction, all bolts shall be grouted in place. The bolts shall be accurately set ~~with templates or by approved equivalent means~~ and held in place to prevent movement. Grout coverage shall be as required for reinforcing bars of equivalent size.

Vertical bolts at the top of and near the ends of reinforced masonry walls shall be set within hairpins or ties located within ~~2.5~~ 4 inches from the top of the wall. See Sec. 12A.6.3(F) and 12.4.1(B) for bolts at the top of piers, pilasters, and columns.

Under Section 12A.3.1 UNBURNED CLAY MASONRY

Unburned clay masonry is that form of construction made with unburned clay stablized with emulsified asphalt. ~~Masonry of unburned clay~~ Such units shall not be used in any building more than one story in height. All footing walls which support masonry of unburned clay units shall extend to an elevation not less than 6 inches above the adjacent ground at all points.

CORRECTIONS APPEARING ON PAGE 129

Under Section 12A.3.3 SOLID MASONRY

SOLID MASONRY

Solid Masonry shall be ~~brick, concrete brick, or solid load bearing concrete masonry units,~~ solid concrete or clay masonry units laid contiguously in mortar.

CORRECTIONS ON PAGE 130

Under Section 12A.3.5 GROUTED MASONRY - MULTI/WYTHE WALLS

A form of Grouted masonry ~~is that form of~~ between wythes construction is made with ~~brick or solid concrete~~ masonry units in which interior ~~joints of masonry~~ are filled ~~by pouring~~ with grout. ~~therein as the work progresses. Only Type M or Type S mortar shall be used. When reinforced in accordance with subsection (C) below masonry shall be classified as reinforced grouted masonry.~~

~~Toothing of masonry walls is permitted only when designed and detailed by the design engineer or architect and only approved locations. Racking is to be held to a minimum.~~

Grouting ~~and construction~~ procedures for the space between wythes shall conform to the requirements given below. Coarse grout may be used in grout spaces 2 inches or more in width. Coarse grout shall be used where the least dimension of the grout space exceeds 5 inches.

Under (A) LOW LIFT.

~~1. All units in the two outer tiers shall be laid with full shoved head and bed mortar joints. Masonry headers shall not project into the grout space~~

~~2.~~ 1. All longitudinal vertical joints shall be grouted and shall not be less than 3/4 inch in thickness for unreinforced construction and 1-1/2 inches in width for reinforced construction, but not less than that required to maintain grou thicknesses between masonry units and reinforcement. In members of three or more ~~tiers~~ wythes in thickness, interior bricks shall be embedded into the grout so that at least 3/4 inch of grout surrounds the side and ends of each unit. Floaters ~~shall~~ may be used where the grout space exceeds 5 inches in width. ~~The thickness of grout between masonry units and floaters shall be not less than 1 inch.~~ All grout shall be puddled ~~with a grout stick~~ immediately after pouring.

~~3.~~ 2. One exterior ~~tier~~ wythe may be carried up 18 inches before grouting but the other exterior ~~tier~~ wythe shall be laid up and grouted in lifts not to exceed six times the width of the grout space with a maximum of 8 inches.

~~4.~~ 3. If the work is stopped for one hour or longer, the horizontal construction joints shall be formed by stopping all ~~tiers~~ wythes at the same elevation and with the grout 1 inch below the top.

Under Section (B) HIGH LIFT.

~~1.--All-units-in-the-two-tiers-shall-be-laid-with-full-head-and-bed joints.~~

CORRECTIONS ON PAGE 131

~~2.~~ 1. The two ~~tiers~~ wythes shall be bonded together with wall ties. Ties shall be not less than No.9 wire in the form of rectangles 4 inches wide and 2 inches in length less than the overall wall thickness. Kinks, water, drips, or deformation shall not be permitted in the ties. Approved equivalent ties may also be used. One ~~tier~~ wythe of the wall shall be built up not more than 18 inches ahead of the other tier. Ties shall be laid not to exceed 24 inches on center horizontally and 16 inches on center vertically for running bond and not more than 24 inches on center horizontally and 12 inches on center vertically for stacked bond.

~~3.~~ 2. Cleanouts shall be provided for each pour by leaving out ~~every-other~~ units in the bottom ~~tier~~ course of the section being poured, or by cleanout openings in the foundation. During the work, mortar fins and any other foreign matter shall be removed from the grout space. ~~by-means-of-a-high-pressure-jet stream-of-water,-air-jets,-or-other-approved-procedures.--Material-falling-to the-grout-space-shall-be-thoroughly-removed.~~ The cleanouts shall be sealed after inspection and before grouting.

~~4.~~ 3. The grout space (longitudinal vertical joint) shall not be less than ~~3~~ 2 inches in width ~~and-not-~~ nor less than the thickness required by the placement of steel with the required clearnaces and shall be poured solidly with grout. ~~Masonry-walls-shall-cure-at-least-three-days-to-gain-strength-before-grout-is-poure~~

Delete EXCEPTION:

~~If-the-grout-space-contains-no-horizontal-steel,-it-may-be-reduced 2-inches.~~

~~5.~~ 4. Vertical grout barriers or dams shall be built of solid masonry across the grout space the entire height of the wall to control the flow of the grout horizontally. Grout barriers shall be not more than 30 feet apart. ~~Unless-a-true-joint-occurs-at-the-barrier,~~ Reinforcement, if it is present, shall be continuous through the barrier. In work that is part of the seismic resisting system, the grout barriers shall be constructed so as to form keys, at least 3/4 inch deep, with the grout except that construction providing equivalent irregular surfaces may be used where appropriate.

~~6.~~ 5.

~~7.~~ 6.

~~8.~~ 7. Inspection during grouting shall be provided in accordance with Sec. 12A.7; ~~however,-the-work-shall-not-qualify-for-the-stresses-entitled,-"Special Inspection",-unless-fully-inspected-per-Sec.-1.6.2,-1.6.4,-and-12A.7.~~

(C) REINFORCED CONSTRUCTION. ~~All-required-reinforcement-except-masonry joint-reinforcement-and-column-ties-conforming-to-the-paragraph-below-shall-be-embedded-in-grout.~~ All ~~other~~ reinforcement shall be embedded in mortar or grout. All ~~vertical~~ reinforcement shall be held firmly in place during grouting~~-by-a-frame~~ or suitable equivalent devices. ~~All-horizontal-reinforcement-in-the-grout-space-shall-be-tied-to-the-vertical-reinforcement-or-held-in-place-during-grouting-by equivalent-means.~~

CORRECTIONS APPEARING ON PAGE 132

Second paragraph reads as follows:

The thickness of grout between masonry units and reinforcement shall not be less than 1/4 inch. See Sec. 12A.1.17 and 12A.2.4

Under Section 12A.3.6 HOLLOW UNIT MASONRY

Delete Paragraph beginning with "Hollow unit masonry" and ending with "so the wythes shall act as a unit.

(A) ~~REINFORCED-CONSTRUCTION~~.GROUTING PROCEDURES. Units shall be laid with mortar in accordance with Sec. 12A.2.1. ~~-Only-Types-M-or-S-mortar-shall-be~~ used. Where only certain vertical cells are to be filled, the walls and cross webs of these cells shall be full bedded in mortar to prevent grout leakage. Vertical cells to be filled shall have vertical alignment sufficient to maintain a clear, unobstructed continuous vertical cell measuring not less than ~~2~~ 1 1/2 inches by 3 inches. If walls are battered or if alignment if offset, the ~~2~~ 1 1/2 inch by 3 inch clear opening shall be maintained as measured from course to course.

Delete paragraph beginning "Overhanging mortar" and ending with "of the cells". In its place substitute:

Coarse grout may be used in hollow masonry units having an area of 15 square inches with a least dimension of 3 inches. Coarse grout shall be used when the least dimension of the grout space exceeds 5 inches and where otherwise required.

Except as provided in Chapter 12, all reinforcing except ties and masonry joint reinforcement, where permitted, shall be embedded in grout. Longitudinal horizontal reinforcing shall be placed in bond be~~am-units-~~ beams, except as permitted for masonry joint reinforcement. See Sec. 12A.6.3(F) and Chapter 12.

CORRECTIONS APPEARING ON PAGE 133

The thickness of the grout between the masonry units and reinforcing shall be a minimum 1/4 inch. ~~for-fine-grout-and-1/2-inch-for-coarse-grout~~.See Sec. 12A.1.17 and 12A.2.4. See Chapter 12 for stacked bond limitations.

Under Number 2. High Lift. Delete entire sentence a.

b. Cleanouts shall be provided in the foundation or ~~by-omitting~~ in the face shells in the bottom course of each cell to be grouted. ~~to-facilitate-cleanout which-shall-be-accomplished-by-means-of-a-high-pressure-jet-stream-of-water,-air jets,-or-other-approved-procedures.--Material-falling-to-the-bottom-of~~ Debris in the grout space ~~and-other-debris~~ shall be th~~oroughly~~ removed.

d. Grouting ~~shall~~ may be done in a continous pour, in partial lifts so as to avoid blowout of units.

Section 12A.3.6 Cont.

e. Inspection during grouting shall be provided in accordance with Sec. 12A.7. DELETE REMAINDER OF SENTENCE.

DELETE ENTIRE SECTION 12A.3.7 PARTIALLY REINFORCED MASONRY

Under Section 12A.3.8 GLASS MASONRY

Masonry of glass blocks may be used in nonloadbearing exterior or interior walls and in openings, either isolated or in continuous bands, provided the glass block panels have a minimum thickness of ~~3.5~~ 3.0 inches at the mortar joint.

Glass block shall be laid in Types ~~M-or-S-mortar.~~ N mortar, by proportion. Both vertical and horiztonal mortar joints shall be at least 1/4 inch and not more than 3/8 inch thick and shall be completely filled.

Under Section 12A.4 DETAILED REQUIREMENTS

Masonry shall be designed to resist all vertical and horizontal load effects including effects of eccentricity of application of vertical loads. ~~Unreinforced masonry-shall-not-be-loaded-in-direct-tension.~~ Structural and nonstructural elements including ---- CONTINUED ON PAGE 135.

Except where specifically allowed otherwise, stresses shall be calculated on actual net dimension of masonry considering reductions for raking, tooling, and other joint treatments and partial bed or head joints where applicable. Where required by the Regulatory Agency, Chapter 12, this Chapter, or by other governing provisions, ~~specific-~~ inspections and tests shall be provided. In addition where called for or where required by the use of design stresses so specifying, Special Inspection shall be provided.

Under Section 12A.4.2 THICKNESS OF WALLS

The paragraph reads as follows:

All masonry walls shall be designed so that allowable stresses are not exceeded. REMAINDER OF PARAGRAPH IS DELETED.

DELETE ENTIRE PARAGRAPH ENTITLED EXCEPTION:

DELETE SECTION 12A.4.3 PIERS

Under Section 12A.4.5 HOLES, PIPES, AND CONDUITS

Pipes, conduits, and similiar items may be sleeved through masonry with sleeve large enought to pass hubs and couplings. DELETE REMAINDER OF PARAGRAPH. ADD LAST LINE TO FIRST SENTENCE. Masonry around openings shall be designed considering any stress magnification effects on the opening.

CORRECTIONS APPEARING ON PAGE 136

Under Section 12A.4.8 END SUPPORT

Beams, firders, or other similar concentrated loads supported by a wall or ~~pier~~ column shall have a bearing at least 3 inches in length upon solid or grouted elements of masonry not less than 4 inches thick or upon a metal bearing plate of adequate deisgn and dimensions. The loads shall be ~~safely~~ distributed to the wall of ~~pier~~ column, or to a continuous reinforced masonry member ~~projecting-not-less-than-3-inches-from-the-face-of-the-wall,~~ or by other approved means.

Joists, precast planks, and similar elements shall have a bearing at least 2.5 inches in length upon solid or grouted masonry elements, ~~at-least-2.25-inches~~ thick, or other provisions shall be made to distribute the loads ~~safely~~ to the masonry.

Concentrated loads shall not be considered to be distributed ~~by-metal-ties in-stacked-bond-construction,-nor-to-be-distributed~~ across continuous vertical joints. unless reinforced horizontal elements designed to distribute the concentrate loads are employed. ~~This-provision-shall-apply-when-considering-overturning-effects in-shear-walls-if-stacked-bond-is-not-prohibited.--~~

CORRECTIONS APPEARING ON PAGE 138

Under Section 12A.6 DESIGN REQUIREMENTS

The design of masonry elements shall conform to the appropriate provisions of this Section. The higher stresses allowed in the Tables in this Chapter under the heading "Special Inspection Required" may only be used when all of the requirements for Special Inspection have been met; see Sec. 1.6 and 12A.7. The load combinations of Sec. 3.7 shall be investigated. All plans shall clearly show value of f_m used in design. ~~and-the-age-when-the-masonry-elements-may-be-loade~~ All stresses and capacities shall be based on actual net dimensions, thickness and sections.

CORRECTIONS APPEARING ON PAGE 140

Under Section 12A.6.1(E)

(G) SHEAR WALLS. Design of shear walls shall conform to the applicable provisions of Sec. 12A.6.2. ~~and-Chapter-12~~.

Under Section 12A.6.2 ALTERNATE DESIGN PROCEDURE FOR UNREINFORCED BRICK MASONRY

(A) SLENDERNESS RATIOS. The slenderness ratio of a wall shall be taken as the ratio of its effective height, h, to the effective thickness, t, and shall not exceed the ~~smaller-of-the~~ values ~~determined-from-Table-12A-2~~ or as determined by the following formula:

CORRECTION APPEARING ON PAGE 142

Under Section 12.6.2, small b.

Delete sentence: ~~See-Chapter-12-for-modifications-under-seismic-loads~~.

Section 12A.6.2 Cont.

(C) SHEAR WALLS. Design of shear walls shall comply with all applicable provisions of Sec. 12A.6.4~~-and-Chapter-12.~~ In unreinforced shear walls, the effective eccentricity ei about the principal axis which is normal to the length i of the shear wall shall not exceed an amount which will produce tension. In unreinforced shear walls subject to bending about both principal axes, R_e shall not exceed 1/3. Where the effective eccentricity exceeds the values given in this Section, shear wakks shall be redesigned or reinforced.

CORRECTIONS APPEARING ON PAGE 143

Under Section 12A.6.3

(A) FLEXURAL COMPUTATION.- sentence No.1

1. Running Bond. Six times that the wall thickness ~~for-construction using-running-bond~~.

2. Stacked Bond. Three times the wall thickness ~~or-the-length-of-the masonry-units-for-construction-using-stacked-bond,-whichever-is-less~~.

Under Section B.

Formula F_b add the following sentence.:

Other interaction equations based on elastic methods and design assumptions may be used.

j = Ratio of distance between centroid of compression and centriod of tension to depth, d. j = ~~0.8~~ 0.9 or j may be determined by a strain compatibility analysis.

DELETE ENTIRE FOLLOWING PARAGRAPH.

Where the values of the shearing unit stress computed by Formula 12A-8 exceeds the shearing unit stress, v_m, ~~masonry~~ web shear reinforcement shall be provided to carry the entire stress. ~~Web-reinforcement-shall-cross-stacked-bond joints.~~

1. Web Shear Reinforcement. Web Shear reinforcement shall consist of:

a. ~~Stirrups-or-web~~ Shear reinforcement bars perpendicular to longitudinal steel, or

b. ~~Stirrups-or-web~~ Shear reinforcement bars ~~arcHored~~ anchored around or beyond the longitudinal steel and making an angle or 30 degrees or more thereto, or

SECOND SENTENCE UNDER SMALL d.

~~Stirrups-or-other~~ Bars to be considered effective as web shear reinforcement shall be anchored at both ends.

2. ~~Stirrups.~~Required Area. The area of steel, A_v required ~~in-stirrups-placed~~ perpendicular to the longitudinal reinforcement shall be computed by the following formula:

CORRECTIONS APPEARING ON PAGE 144

UNDER FORMULA

s is the spacing of ~~stirrups-or-bent~~ bars in a direction parallel to that of the main reinforcement, inches.

f_v is the allowable unit stress in the ~~web~~ shear reinforcement, psi.

Inclined ~~stirrups~~ bars shall be proportioned in accordance with the provisions of paragraph 3 of this Subsection.

3. Bent Bars. Only the center 3/4 of the inclined portion of any longitudinal bar that is bent up for ~~web~~ shear reinforcement shall be considered effective for that purpose, and such bars shall be bent around a pin having a diameter not less than six times the bar size.

CORRECTIONS APPEARING ON PAGE 145

When the ~~web~~ shear reinforcement consists of a single bent bar or of a single group of parallel bars all bent at the same distance form the support, the required area, A_v, of such bars shall be computed by the following formula:

4. Spacing of ~~Web~~ Shear Reinforcement. Where ~~web~~ shear reinforcement is required it shall be so spaced that every 45 degree line extending from the mid-depth of the beam to the longitudinal tension bars shall be crossed by at least one line of ~~web~~ shear reinforcement.

1. General Development Requirements. The calcualted tension of compressio in the reinforcement at each section shall be developed on each side of that section by emdedment length or end anchorage or a combination thereof. For bars in tension, hooks may be used in developing the bars. Plain bars in tension shall terminate in standard hooks. Tension reinforcement may be anchored by bending ~~it across-the-web-~~ and making it continuous with the reinforcement on the opposite face of the member, or anchoring it there.

The critical sections for development of reinforcement in flexural members are at points of maximum stress and at points within the span where adjacent reinforcement terminates, or is bent. Reinforcement shall extend beyond the point at which it is no longer required to ~~assist-~~ resist flexure for a minimum distance equal to the effective depth of the member or 12 bar diameters, whichever is greater except at supports of a simple spans and at the free end of cantilevers. Continuing reinforcement shall have an embedment length not less than the development length l_d beyond the point where bent or terminated tension reinforcement is no longer required to resist flexure.

a. Allowable shear stresses at the cutoff point do not exceed ~~2/3~~ 1/2 of that permitted, or

b. ~~Stirrup-area~~ Area of shear reinforcement in excess of that required is provided along each terminated bar over a distance from the termination point equal to 3/4 the effective depth of the member. The ~~stirrups~~ shear reinforcement shall be proportioned to provide 50 percent of the allowable shear capacity of the member based on the allowable shear stresses of Table 12A-5 for reinforcement taking no shear. The resulting spacing shall not exceed $d/8B_b$, where B_d is the ratio of the area of bars cut off to the total area of bars at the section, or

CORRECTIONS APPEARING ON PAGE 146

c. The continuing bars provide double the area required for flexure at the cutoff point. ~~and shear stresses do not exceed 3/4 of that permitted~~.

2. Positive Moment Reinforcement. At least ~~1/3~~ 1/4 of the positive moment reinforcement in simple members and ~~1/4 the positive moment reinforcement~~ in continuous members shall extend along the same face of the member into the support, and in to beams at least 6 inches.

When a flexural member is part of the primary lateral load resisting system the positive reinforcement required above to be extended into the support shall be anchored for its tension development length, l_d, or if the support is not of masonry construction, the reinforcement shall be anchored to develop its ~~yield strength~~ calculated stress at the face of the support

12A.6.3(D) 2

Clarify intent of third paragraph containing formula

$$\frac{M_c}{v} + l_a$$

Mc is based on working stress while V is ultimate.

CORRECTIONS APPEARING ON PAGE 148

Lengths of laps, in inches, for deformed reinforcement shall be at least ~~0.08~~ 0.06 $d_b^2 f_y / \sqrt{f_g}$ but not less than $40d_b$ for reinforcement of 40,000 psi yield strength nor less than 60 d_b for reinforcement over 40,000 psi yield strength, nor less than 12 inches for reinforcing bars and 9 8 for masonry joint reinforcement. Lap lengths for plain reinforcing shall be twice that required for deformed bars but not less than 12 inches. The terms d_b, f_y, and f_g shall be as defined in Sec. 12A.6.3(D)5.

8. Anchorage of Web Shear Reinforcement. Web Shear reinforcement shall be placed as close to the compression and tension surfaces of the member as cover requirements, practicability, and the proximity of other steel will permit, and in any case the ends of single-leg, simple- or multiple-U stirrups shall be anchored by one of the following means:

PARAGRAPH 3 UNDER SMALL c.

Longitudinal bars bent to act as web shear reinforcement shall, in a region of tension, be continuous with the longitudinal reinforcement and in a compression zone shall be anchored, above or below the mid-depth, d/2, as specified for development length in this Subsection.

CORRECTION APPEARING ON PAGE 149

(E) REINFORCED MASONRY WALLS. Reinforced masonry bearing wall thicknesses shall conform to Sec. 12A.4.2 and to the requirements of this Subsection. ~~and Chapter 12~~.

UNDER FORMULA

f'_m = Masonry compressive strength as determined by Sec. 12A.5.1. ~~The value of f'_m shall not exceed 6000 psi.~~

t = Thickness of wall in inches.

h = Effective Height: Clear distance in inches, between supporting or stiffening elements (vertical or horizontal). Effective height different from clear distance may be used if justified.

PARAGRAPH 2 READS AS FOLLOWS:

2. Reinforcement. Reinforcement of walls and wall elements shall be provided for all loadings as required by design. More strigent requirements for areas of seismic activities are defined in Chapter 12.

DELETE THE FOLLOWING 3 PARAGRAPHS.

CORRECTIONS APPEARING ON PAGE 150

UNDER FORMULA

f'_m = Compressive masonry strength as determined by Sec. 12A.5.1 ~~The-value-of-f'_m-shall-not-exceed-6000-psi~~.

~~P~~ p_g = Ratio of the effective cross-sectional area of vertical reinforcement to A_g.

h = ~~Clear-height-in-inches~~. Effective Height - Clear distance in inches between supporting or stiffening elements. Effective height different from clear distance may be used if justified.

1. Vertical Reinforcement. The ratio p_g shall not be less than 0.5 percent nor more than 4 percent. The number of bars shall not be less than four, nor the size less than No. 4 3. Except as provided in Sec. 12A.2.4(D), the maximum bar size shall be No. 10. Splices shall conform to Sec. 12A.6.3(D)7.

CORRECTIONS APPEARING ON PAGE 151

~~See-Chapter-for-additional-requirements,-where-applicable.~~

~~3.--Grouting.--All-columns-shall-be-grouted-solid~~.

UNDER SECTION 12A.6.4 MASONRY SHEAR WALLS

The design of masonry shear walls and wall elements for in-plane shear shall conform to this Section ~~Chapter-12~~, and all applicable provisions of these Regulations. See Chapter 12 for stacked bond construction limitations based on construction categories.

~~(A)~~ (E) BOUNDARY ELEMENTS. Noundary elements are members at the ends of shear walls which help resist overturning effects.

Unit compressive stresses in the masonry at wall openings shall conform to the requirements of this Chapter unless boundary elements conforming to the provisions of Sec. 12.7.2 are provided.

Reinforcement required to resist wall shear shall be terminated with a standard hook ~~which-encloses-the-boundary-reinforcing~~ at the end of the wall sections. The hook may be turned up, down, or horizontal and shall be embedded in mortar or grout. Wall reinforcement terminating in boundry columns or beams shall be fully anchored into the boundary elements.

~~1.~~ (A) ~~Intersecting-Walls-and-Masonry-Columns~~. INTERSECTING WALLS AND MASONRY COLUMNS.

PARAGRAPHS CONTINUE AS USUAL.

(B) VERTICAL TENSION AND COMPRESSION STRESSES. ~~-Except-as-provided-for-masonry-designed-under-the-alternate-design-and-procedure-of-Sec.-12A.6.2-as-modified-by-Chapter-12~~, Vertical stresses in shear walls shall be determined from the combined effects of vertical load and from the overturning effects of lateral loads. Minimum vertical loads shall be considered. Formula 3-2a shall be used for unreinforced masonry design.

Allowable tension stresses for unreinforced masonry shall not be exceeded. ~~Reinforcement-anchored~~ Anchorage to the foundation shall be provided to resist tnesion in unreinforced walls.

(C) HORIZONTAL ELEMENTS. READS AS FOLLOWS:

(C) HORIZONTAL ELEMENTS. Provisions shall be made for shear and flexural effects in horizontal elements of shear wall systems, such as beams that couple ~~piers~~ walls.

(D) WALL SHEAR. In computing the shear resistance of the wall, only the web shall be considered. ~~-For-unreinforced-masonry-the~~ The depth of the web may be considered out to out of flanges.

SECOND PARAGRAPH READS AS FOLLOWS:

Shear resistance of masonry shall be based on minimum net areas parallel to the shear. Both vertical and horizontal shear shall be considered. Continous vertical and horizontal grout elements may be considered as part of the net areas.

PLEASE NOTE THAT "Reinforcement required --- is used as last paragraph of BOUNDARY ELEMENTS.

UNDER SECTION 12A.6.5 SCREEN WALLS

The panels shall be capable of spanning between supports to resist horizontal forces. Wind loads shall be based on gross projected area of the ~~block~~ panel.

DELETE SECOND AND THIRD PARAGRAPH UNDER SECTION 12A.6.5 SCREEN WALLS.

CORRECTIONS APPEARING ON PAGE 153

Under Section 12A.7 ~~-SPECIFIC-INSPECTION,-SPECIAL~~ INSPECTIONS AND TESTS

~~-Specific-and-Special~~ Inspections shall be provided and Tests shall be made in accordance with the requirements of this Section. The Regulatory Agency may for masonry work which it determines to be minor in nature waive requirements for certifications, ~~Specific~~ Inspections, Tests, ~~Special-Inspection~~, or some items of Special Inspection. The ~~-Special-Inspections-and-Tests-of-Sec.-12A.7.2-where applicable,-shall-be-provided-for-all-parts-of-masonry-construction.--The-Special Inspection-requirements-of-Sec.-1.6.2-are-in-addition-to-Sec.-12A.7.2-and-apply-only-to-the-designated-seismic-system.~~

FOLLOWING PARAGRAPH READS AS FOLLOWS:

Specific and Special Inspection shall be done to an extent that the Inspector(s) or testing agency can certify to the requirements of Sec. 1.6.4

CORRECTIONS APPEARING ON PAGE 153

Under Section 12A.7.1 -~~SPECIFIC~~ FREQUENCY INSPECTIONS AND TESTS

For all masonry construction, ~~Specific~~ Inspection, Certifications, or Tests shall be provided when required by one or more of the following:

~~The-Specific~~ Inspection, Certifications, or Tests may consist of one or more of those listed in Sec. 12A.7.2(A) and 12A.7.1(B)m however in order to qualify as Special Inspection all the applicable Certifications, Inspections, and Tests of Sec. 12A.7.2 shall be provided.

CORRECTIONS APPEARING ON PAGE 154

Under (B) Tests ~~AND/OR~~ CERTIFICATIONS. Tests ~~and/or~~ certifications shall be performed ~~and/or~~ supplied as follows:

THE FOUR FOLLOWING PARAGRAPHS READ AS FOLLOW:

- For mortar, grout and prisms. One prism test series shall be made for each 5000 square feet of wall.

  When f'_m is to be established by tests there shall be an initial prism test series prior to the start of construction.

  The requirements for numbers of test series apply separately for each variation or type of masonry construction.

- For grouted masonry in Seismic Performance Category D, one series of core tests for shear bond shall be made for each 5000 square feet of wall equivalent.

CORRECTIONS APPEARING ON PAGE 156

Under (A) STORAGE OF TEST PRISMS. SECOND PARAGRAPH READS AS FOLLOWS:

Test prisms made in the field shall be stored undisturbed and protected from freezing and excessive drying for 48 hours in the field under the same conditions, insofar as possible, and adjacent to the work they are to represent. After field storage, they shall be transported to the laboratory for continued curing as specified for laboratory constructed prisms.

Under (B) SAMPLING, TESTS SERIES, AND COMPRESSIONS TESTS. SECOND PARAGRAPH AS FOLLOWS:

Prisms shall be capped such that surfaces are parallel within 1^{o} and tested in compression. The standard age of test specimens shall be 28 days, but 7-day tests may be used provided the relation between the 7-day and 28-day strengths of the masonry is established by adequate test data for the materials used.

CORRECTIONS APPEARING ON PAGE 157

Under Section 12A.8.1

(B) MORTAR SAMPLES AND COMPRESSION TESTS. Spread mortar on the masonry units 1/2-inch to 5/8-inch thick. Place a masonry unit on top of the mortar and allow to stand for two minutes. Immediately remove mortar and place in a 2-inch by 4-inch cylinder or 2-inch cube mold layers, compressing the mortar into ~~a-cylinder~~ a mold using a flat-end stick ~~or-fingers~~ approximately 1/2 inch by 1 inch cross-section. Lightly tap mold on opposite sides, level off, and immediately cover molds and keep them damp until taken to the laboratory. After 48-hours set, have the laboratory remove molds and place them in the fog room until tested in the damp condition.

(C) PROCEUDRES. The wall shall be at least 14-days old before cores are taken. Cores shall be tested at ~~approximately~~ a minimum of 28 days of age. Storage shall be as required for prisms.

~~The-unit-shear-strength-shall-not-be-less-than-100-psi.--~~ Where an unusual numb of cores fail during the cutting operation, the design authority shall determine if the test program is extensive enough to satisfy the requirements of Sec. 12A.1.5

CORRECTIONS APPEARING ON PAGE 159

TABLE 12A-1A

Mortar Type	Minimum Average Compressive Strength at 28 Days
M	2,500
S	1,800
N	750
O	350
K	75

UNDER TABLE 12A-1B

Hydrated Lime 1
or Lime Putty

DELETE SENTENCE BEGINNING WITH "When plastic --- ending with "the volume of cement.

ADD IN THE CHART

Mortar Type	Portland Cement	Masonry Cement	Hydrated Lime or Lime Putty	Aggregate Measured in a Damp, Loose Condition
O	-- 1	1 --	-- over 11 to 2½	
K	1	--	over 2½ to 4	

CORRECTIONS APPEARING ON PAGE 160

TABLE 12A-2

~~MINIMUM THICKNESS OF MASONRY WALLS~~
MAXIMUM HEIGHT TO THICKNESS RATIO

DELETE ENTIRE TABLE ENTITLED NOMINAL MINIMUM THICKNESS (INCHES)[3]

COLUMN HEADED Maximum
~~thickness~~ ratio,
~~unsupported~~
height or
length to
Thickness

UNDER STRUCTURAL WALLS:

Cavity Wall Masonry ~~20~~[5] 18

UNDER NONSTRUCTURAL AND PARTITIONS:[4]
DELETE Sentences 1 and 3.

FORMULA IN MIDDLE OF PAGE SHOULD READ:

$$T = 2/3\ (T_o - W_c)$$

DELETE SENTENCES AT REMAINDER OF SECTION.

Sentence 9 should read as follows:

The maximum thickness ratios for one-story walls designed as deep beams may be increased to 36.

CORRECTIONS APPEARING ON PAGE 161

TABLE 12A-3

ALLOWABLE WORKING STRESSES IN UNREINFORCED MASONRY

ONLY UNDER SECTION TITLED MATERIAL[6]

Solid Brick
Masonry 4501 psi[7]
2501-4500 psi[7]

Grouted Masonry

2501-4500 psi[7]

DELETE SENTENCE NUMBER 7 ONLY.

CORRECTIONS APPEARING ON PAGE 162

Replace existing table with:

TABLE 12A-4

ASSUMED COMPRESSIVE STRENGTH OF MASONRY

f'_m - psi 1,2,3

Compressive Strength of Units - psi [4]	Mortar Type M or S (1800 psi min.)	Mortar Type N (750 psi min).
14000 or more	5300	3900
12000	4700	3300
10000	4000	2700
8000	3350	2100
6000	2700	1400
4000	2000	1200
2000	1350	900
1000	800	600

4 Compressive strength of solid units is based on gross area. Compressive stength of hollow units is based on minimum net area.

1. Intermediate values may be interpolated.
2. When the alternate design procedure for unreinforced brick masonry of Sec. 12A.6.2 is used for design the units shall comply with the dimension and distortion tolerances specified for type FBS. Where such brick do not comply with these requirements, the compressive strength of brick masonry shall be determined by prism tests as required by Sec. 12A.5.1(A)
3. Where grouted construction is used, the value of f'_m shall not exceed the compressive strength of the grout unless prism tests conforming to Sec. 12A.7 and 12A.8 are provided during construction. As an alternative, the grout strength may be specified at not less than the value of f'_m with grout tests conforming to Sec. 12A.7 and 12A.8 provided during construction for verification.

CORRECTIONS APPEARING ON PAGE 163

TABLE 12A-5

ALLOWABLE WORKING STRESSES (PSI) FOR REINFORCED MASONRY

UNDER THE SECOND COLUMN ENTITLED <u>YES</u>

THIRD LINE: 0.33 f'_m ~~but-not-to exceed-900~~

THE FOLLOWING FORMULAS HAVE THE FOLLOWING DELETED:

~~-50-Max.~~

~~-40-Max.~~

~~-50-Max.~~

~~-150-Max.~~

~~-75-Max.~~

~~-120-Max.~~

0.25 f'_m ~~but-not-to -exceed-900~~

0.30 f'_m ~~but-not-to exceed-1200~~

LINE TWO HAS ONLY CHANGE.

2~~Web~~ <u>Shear</u> reinforcement shall be provided to carry the entire shear in excess of 20 pounds psi whenever there is required negative reinforcement for a distance of 1/16 the clear span beyond the point of inflection.

CORRECTIONS APPEARING ON PAGE 164

TABLE 12A-6

ALLOWABLE SHEAR ON BOLTS 1,4

3These values are permitted only with units having a minimum net area compressive strength of 2500 pounds per square inch or more.

4An anchor bolt is a bolt that has a right angle extension of at least 3 diameters. A standard machine bolt is acceptable.

EXHIBIT E

BUILDING

THE

NEW

AMERICA

National Concrete Masonry Association

2302 Horse Pen Road
P.O. Box 781
Herndon, Virginia 22070
Phone (703) 435-4900

February 29, 1980

Melvin Mark, Structural Engineer,
Ferver Engineering Co.
3487 Kurtz St.
San Diego, Calif. 92110

Ron Mayes
Applied Technology Council
2150 Shattuck Avenue, Suite 806
Berkeley, Calif. 94704

I would like you to be aware of my proposed changes to the Masonry Chapter of ATC which may substantially resolve my objections as well as others who favor including Engineered Design of Concrete Masonry. The reason my objections are so strong is because this document, as currently modified by the Masonry Society, does not permit the use of Engineered Unreinforced Design of Concrete Masonry. Engineered Design has predominated over Empirical Design for the past 15 years. Reverting back to Empirical procedures has several undesirable effects which I feel are clearly not in the best interests of the public nor the industry. First, structural engineers are rarely involved with Empirical Design; the Design would most likely be handled within the architectural firm, thereby eliminating one of the most important members in the design team. Secondly, in Empirical Design there is no incentive to test prisms nor adhere strictly to construction specifications because the design is not based on prism strength, F'_m. There would be less involvement of the design firm during the construction phase and perhaps a false sense of security on the part of the designer feeling his building is "over designed" anyway, and workmanship need not be monitored that closely. In my estimation, better workmanship is one of the prime targets for improving masonry performance. There are undoubtedly many other undesirable ramifications if engineered masonry is excluded, not the least of which is reorientating the design profession which is now acustomed to Engineered Masonry Design.

I will propose for Committee consideration the following changes to Section 12A.6.1 on page 138:

12A.6.1 Design Procedure for Unreinforced Masonry

The design of unreinforced masonry shall be based upon a rational analysis using accepted engineering practice and linear stress and strain relationships. ~~An alternate procedure for design is given in Sec. 12A.6.2~~. (Add) Alternate procedures for design of Engineered masonry and Empirical Masonry shall be in accordance with TAE reference documents in Section 12A.6.1 of the commentary.

I will further propose modification to the commentary on page 473 as follows:

12A.6.1 Design Procedure for Unreinforced Masonry

Delete paragraph as worded and add: The alternate design of unreinforced masonry shall be in accordance with one of the following procedures:

(1) "Building Code Requirements for Engineered Brick Masonry"; Brick Institute of America, August 1969.

(2) "Specification for the Design and Construction of Load-Bearing Concrete Masonry"; National Concrete Masonry Association, April 1970.

(3) "Building Code Requirements for Concrete Masonry Structures (ACI 531-79) and Commentary - ACI (531R-79)"; American Concrete Institute, June 1979.

(4) "American National Standard Building Code Requirements for Masonry, A41.1"; American National Standards Institute, Inc., September 1953.

(5) "American National Standard Building Code requirements for Reinforced Masonry, A41.2"; American National Standards Institute, Inc., April 1960.

These documents have been referencedin the BOCA and Standard Building Codes for years, with the exception of ACI 531 which is currently being considered. Please review the enclosed package of masonry codes, I think you will agree that a trend toward more involvement of structural engineers and away from cook book type designs are evident. I believe it is important to maintain a continuity of this trend in design. It is in the best interests of the industry because it leads to better performance and thus wider use of masonry. Better for the design community because it results in fewer law suits and better owner/client relationships. Most importantly, it is in the best interest of the public because it r-esults in improve performance and life safety protection at a minimum cost.

Ron, I understand that you and Tony Wintz have discussed definitions for masonry in Chapter 12, which include Empirical Masonry, Engineered Masonry, Engineered Nominally Reinforced Masonry, and Seismically Reinforced Masonry. The referenced documents can serve as a detailed definition for each of these types of masonry.

Once the Committee approves a modified form of Chapter 12A, we can intelligently discuss the R and C_d coefficients for masonry. That is our level of confidence in the masonry standard (Chapter 12A) as it relates to seismic performance. The current factors apparently indicate a confidence level similar to 1979 U.B.C. practice for reinforced masonry. However, for unreinforced masonry ATC is requiring resistence levels significantly greater (2 to 5 times) than current resistence levels. As ATC staff members, will you provide the Committee with background data either performance or research data which necessitates this change.

I look forward to your comments.

Sincerely,

Mark B. Hogan, P.E.
Structural Design Engineer

MBH:ld

Applied Technology Council 2150 SHATTUCK AVE., SUITE 806 BERKELEY, CALIFORNIA 94704 (415) 540-0223
A Nonprofit Corporation

ATC

March 12, 1980 ATC-3-3

TO: COMMITTEE 5 - MASONRY

FROM: RON MAYES

At the February 21-22, 1980 meeting of Committee 5, I volunteered to work with Walt Dickey and Tony Wintz to produce a version of Chapter 12 that contained most of the options presented or discussed to date. Due to time constraints imposed by my impending vacation, I have not met with Walt, Tony, or Mel Mark. Therefore the enclosed material is my attempt at performing the Committee's function. I apologize for not being able to met with the Committee and also, in advance, for not having proof read the enclosed material. If there are any errors or typos, please accept my apology as this was typed after my departure.

The material enclosed consists of the following five items.

1. My assessment of options for Chapter 12 and its relation to other parts of the document.

2. A version of Chapter 12 containing most of the options presented to date.

3. A comparison of ATC-3-06 and 1979 UBC requirements that I prepared for the Committee's information.

4. An approximate evaluation of the seismic safety of ATC-3-06 Masonry Loads and Stresses based on the research performed at Berkeley. This information is part of a study that I am currently writing in report form on an evaluation of the seismic safety of current codes.

5. A copy of a summary report on the shaking table tests of four single-story masonry houses. This report will not be published for another year or so because a fifth test will now be performed. The objective of the fifth test is to determine

the performance of unreinforced walls subjected to both in-plane and out-of-plane forces. This report is included because, based on the test data obtained to date, minimum reinforcement requirements are required for single-story houses where the EPA is greater than 0.10g and this is orange areas and above on the map.

Throughout the documents referred to in Items 1 and 2 above, I have used the terms "East" and "West" for convenience. The East proposals refer to the documents prepared by the subcommittee headed by Alan Yorkdale, whereas the West proposals refer to the documents prepared by the group that included J. Amrhein, B. Bailey, S. Beavers, G. Borchelt, etc.

I hope you find this material useful for your meeting in late March and that you are able to resolve many of the difficult issues before the Committee.

AN ASSESSMENT OF THE OPTIONS FOR CHAPTER 12 OF ATC-3-06

by

Ronald L. Mayes

At this stage it is difficult to finalize what provisions and limitations should be included in the various Seismic Performance Categories (SPC) because these are related to the different map areas by Tables 1A and 1B. To the best of my knowledge, Committee 2 did not accept the changes to these tables proposed by Committee 5, although I believe this will become a ballot item. I would suggest that Committee 5 decide what requirements it believes are necessary for the various SPC's based on the A_a coefficient for Seismic Hazard Exposure Group 1. The SPC's can then be adjusted after Tables 1A and 1B are finalized by ballot.

It should be noted that the A_a values for the various map areas are generally lower bound values except for Map Area 1; e.g., Map Area 3 has A_a values from 0.10 to 0.15, Map area 5 has A_a values from 0.20 to 0.30.

SEISMIC PERFORMANCE CATEGORY A

For Seismic Performance Category A there appear to be no conflicts with ATC-3 and the East and West proposals. That is, whatever is acceptable in Chapter 12A is acceptable for SPC A. The differences occur in what A_a value or map area SPC A is permitted. ATC-3 limits it to Map area 1 (A_a less than 0.05) whereas the East and West proposals permit it up to Map Area 3 (A_a between 0.01 and 0.15).

It should be noted that the only extensive shaking table study of masonry structures to date concludes that a minimum specified amount of reinforcement is required in single-story houses for A_a values greater than 0.10. If Tables 1A and 1B stay as they are, Map Area 1 (A_a = 0.05) will be the limit for SPC A.

SEISMIC PERFORMANCE CATEGORY B

The greatest variation of options exists in SPC B. ATC-3-06 permits SPC B for SHE group 1 buildings in Map areas 2, 3 and 4, which covers A_a

values ranging from 0.05 to 0.20. The East and West proposals permit SPC B in Map Areas 4 and 5 with A_a values ranging from 0.15 to 0.30.

All walls in ATC-3 SPC B must as a minimum be partially reinforced and if they are over 35 feet in height the seismic resisting system must be reinforced.

The East proposal requires engineered masonry in SPC B. This is analyzed and designed in accordance wiht Chapter 12A. It may or may not contain reinforcement to resist tensile forces as required by the design.

The West proposal requires minimum reinforcement for SPC B. The minimum reinforcement requirements are similar to current partial reinforcement requirements.

Assuming Tables 1A and 1B remain as they are and SPC B in Map Areas 2, 3 and 4 with A_a varying from 0.05 to 0.20, the options are as follows:

1. Use East requirements. This would seem to be unreasonable in view of the single-story shaking table tests.
2. Use the West requirements.
3. Use the West requirements for Map Area 2 and as a minimum for Map areas 3 and 4 but require an engineering analysis to determine if more than the minimum specified is necessary. This would be similar to but more restrictive than the current ATC-3 requirements if the height restrictions of ATC-3-06 were removed.
4. Use the current ATC-3-06 requirements.

SEISMIC PERFORMANCE CATEGORY C

The East and ATC-3 requirements for SPC C and D are identical although they apply to different map areas. ATC-3 SPC C applies to Map Areas 5, 6 and 7 for SHE Group 1, with A_a values ranging from 0.20 to 0.40 and greater. The East and West proposals for SPC C are for Map Areas 6 and 7 with A_a values ranging from 0.30 to 0.40 and greater.

The major difference in the ATC-3 and West proposals for SPC C is the amount of reinforcement required for a wall to qualify as a rinforced wall.

SEISMIC PERFORMANCE CATEGORY D

ATC-3 SPC D requirements apply to SHE Group III buildings in Map Areas 6 and 7 with A_a values varying from 0.20 to 0.40 and greater. The East and West proposals for SPC D apply to Map Areas 6 and 7 with A_a values varying from 0.30 to 0.40 and greater.

There are some differences between the West and ATC-3 requirements although these are not major.

ADDITIONAL REQUIREMENTS FROM CHAPTER 12A

Although Mel Mark and I have not conferred in depth, there are a number of requirements that have been deleted from Chapter 12A that we believe must now be incorporated in Chapter 12. These include but are not limited to:

a. Minimum height to thickness ratios
b. Grouting requirements
c. Partial reinforcement
d. Inspection and test requirements
e. Development lengths for the yield strength of reinforcement

ATC-3-06 LOADS AND ALLOWABLE STRESSES

Based on the two enclosed documents which evaluate and then compare the ATC-3-06 requirements to the UBC requirements, it appears that the ϕ factors, allowable stresses, and R-factors are very much in the ball park based on available test data. It is very difficult at this stage to be very precise; however, the studies indicate that the values are within what should be considered as reasonable bounds. It should also be noted that when compared to the 79 UBC requirements the ATC-3 requirements are less stringent if the comparison is based on flexural stresses and shear stresses when the shear is taken by the reinforcement. The ATC-3 requirements are more stringent if the comparison is based on shear stresses when masonry takes all the shear.

OPTIONS FOR

CHAPTER 12

MASONRY

BACKGROUND

The masonry design and construction procedures given in this Chapter and Chapter 12A are essential to providing the performance levels implicit in the selection of the factors used in determining the seismic forces in these provisions. The requirements embodied in Chapters 12 and 12A have been demonstrated to be necessary by recent earthquakes and represent the latest developments in masonry construction to provide adequate seismic performance.

12.1 REFERENCE DOCUMENTS

The quality and testing of masonry and steel materials and the design and construction of masonry and reinforced masonry components which resist seismic forces shall conform to the requirements of Chapter 12A and the references listed therein except as modified by the provisions of this Chapter. For definitions, see Sec. 12A.1.1.

12.2 STRENGTH OF MEMBERS AND CONNECTIONS

The strength of members and connections subjected to seismic forces acting alone or in combination with other prescribed loads shall be determined using a capacity reduction factor, ϕ, and 2.5 times the allowable working stresses of Chapter 12A. The value of ϕ shall be as follows:

When considering axial or flexural compression and bearing stresses in the masonry.	$\phi = 1.0$
For reinforcement stresses except when considering shear.	$\phi = 0.8$
When considering shear carried by shear reinforcement and bolts.	$\phi = 0.6$
When considering masonry tension parallel to the bed joints, i.e., horizontally in normal construction.	$\phi = 0.6$
When considering shear carried by the masonry.	$\phi = 0.4$
When considering masonry tension perpendicular to the bed joints, i.e., vertically in normal construction.	ϕ = Zero

WEST PROPOSAL

For reinforcement stresses except when considering shear.

for Grade 40, $\phi = 0.8$

for Grade 60, $\phi = 1.0$

MAYES COMMENT

From the approximate evaluation performed using these ϕ factors the values appear to be reasonable although a differentiation could be made for the Category when shear is carried by the masonry.

This could be two categories as follows:

A. For code specified reinforcement qualifying as a reinforced wall $\phi = 0.5$

B. For partial reinforcement $\phi = 0.4$

These categories would recognize some of the more recent test data.

12.2.1 SPECIAL DESIGN PROCEDURES FOR UNREINFORCED MASONRY SUBJECTED TO SEISMIC FORCES.

Unreinforced masonry shall be designed in accordance with this Section.

(A) GENERAL DESIGN PROCEDURE. Unreinforced masonry designed in accordance with Sec. 12A.6.1 shall be assumed to be cracked in the tension zone. The resultant linear distribution of compressive stresses must be in equilibrium with the applied forces and the maximum compressive stress must not exceed the values of Table 12A-3.

EXCEPTION:
Bed joints of unreinforced vertical components constructed using stacked bond, which are subjected to bending in the plane of the component, shall remain uncracked.

(B) ALTERNATE DESIGN PROCEDURE. For unreinforced masonry designed in accordance with Sec. 12A.6.2 limit the ratio of e/t for bending in one direction and the ratio R_e for bending about both principal axes to 1/6. To satisfy these ratios, the stiffness and strength of all masonry that would otherwise be in a tension zone may be ignored and the calculations carried out as if it did not exist.

EXCEPTION:
Cracked bed joints are not permitted in unreinforced vertical components constructed using stacked bond which are subjected to bending in the plane of the component. Therefore the procedure of the last sentence of the above paragraph is not permitted for unreinforced stacked bond components subjected to in-plane bending.

MAYES COMMENT

These procedures are to be part of the subcommittee's deliberations that will be considering design procedures for unreinforced masonry.

EAST PROPOSAL

The general design of masonry shall comply with the following definitions and criteria:

1. *Empirical Masonry, for the purpose of this chapter, is empirically designed masonry and is not covered.*
2. *Engineered Masonry shall be analyzed and designed in accordance with the referenced document standard as modified. Engineered Masonry may or may not contain reinforcing to resist tensile forces as required by the design.*

3. *Reinforced Masonry* shall be analyzed and designed in accordance with the referenced document standard. In addition, Reinforced Masonry shall be reinforced with minimum ratio of area of steel of 0.002 to area of masonry, with no less than 0.0007 in either direction. Maximum reinforcement spacing shall not exceed four (4) ft on centers, as stated in Sec. 11.3.2.2 of Reference Document.

12.3 SEISMIC PERFORMANCE CATEGORY A

Buildings assigned to Category A may be of any construction permitted in Chapter 12A.

MAYES COMMENT

In the current ATC-3-06 Tables 1A and 1B, Category A applies to Map Area 1 with an A_a less than 0.05. In the East and West proposals this would apply to Map Areas 1, 2 and 3 with an A_a ranging up to 0.15. This would allow unreinforced construction in these map areas. This does not seem appropriate in view of the shaking table test results on single-story masonry houses in which minimum reinforcement is required for A_a values exceeding 0.10.

12.4 SEISMIC PERFORMANCE CATEGORY B

Buildings assigned to Category B shall conform to all the requirements for Category A and to the additional requirements and limitations of this Section.

12.4.1 CONSTRUCTION LIMITATIONS

Masonry components shall be constructed to conform to the limitations of this Section.

(A) HEIGHT LIMITATION. Components of the seismic resisting system in buildings under 35 feet in height shall be reinforced masonry when constructed using stacked bond and shall, as a minimum, be partially reinforced masonry when constructed using running bond. Components of the seismic resisting system in buildings over 35 feet in height shall be reinforced masonry and other structural components shall be partially reinforced masonry.

(B) TIES. In addition to the requirements of Sec. 12A.6.3(F), additional ties shall be provided around anchor bolts which are set in the top of a column or pilaster. Such ties shall engage the bolts and at least four vertical column bars for reinforced masonry. Such ties shall be located within the top 4 inches of the member and shall consist of not less than two No. 4 or three No. 3 ties.

(C) SHEAR WALLS. Shear walls shall conform to the requirements of Sec. 12.7.

EXCEPTION:
The reinforcement provisions of Sec. 12.7.1 need not apply to partially reinforced masonry designed as unreinforced masonry.

(D) SCREEN WALLS. All screen walls shall be reinforced. Joint reinforcement shall be considered effective in resisting stresses. The units of a panel shall be so arranged that either the horizontal or the vertical joint containing reinforcing is continuous without offset. This continuous joint shall be reinforced with a minimum steel area of 0.03 square inch. Reinforcement shall be embedded in mortar or grout.

Joint reinforcing may be composed of two wires made with welded ladder or trussed wire cross ties. In calculating the resisting capacity of the system, compression and tension in the spaced wires may be utilized. Ladder wire reinforcing shall not be spliced and shall be the widest that the mortar joint will accommodate allowing 1/2-inch of mortar cover.

(E) NONSTRUCTURAL COMPONENTS. Nonstructural walls, partitions, and components shall be designed to support themselves and to resist seismic forces induced by their own weight. Holes and openings shall be suitably stiffened and strengthened. Nonstructural walls and partitions shall be anchored in accordance with the requirements of Sec. 12A.2.6.

(F) CONSTRUCTION TYPE. Cavity wall construction shall not be used for any structural masonry.

12.4.2 MATERIAL LIMITATIONS

The following materials shall not be used for any structural masonry:

Unburned clay masonry

Building Brick and Hollow Brick made from clay or shale of Grade NW

Sand-Lime Building Brick other than grades SW and MW

Concrete Building Brick and Solid Load-Bearing Concrete Masonry Units, other than Grade N

Hollow Load-Bearing Concrete Masonry Units, other than Grade N

Structural Clay Load-Bearing Wall Tile

Masonry Cement (for mortar and grout)

Mortars other than Types M or S

<u>*EAST PROPOSAL*</u>

Buildings assigned to SPC B shall be of Engineered Masonry as defined in their proposal in Sec. 12.2. This proposal would delete all of the ATC-3 requirements.

<u>*WEST PROPOSAL*</u>

Delete Sec. 12.4.1(A) on Height Limitation.

Delete Sec. 12.4.1(C) on Shear Walls and add the requirement for reinforcement as follows:

Horizontal reinforcement not less than 0.2 sq in. in area shall be provided at the top of wall openings, at structurally connected roof and floor levels and at the top of parapet walls. Vertical reinforcement not less than 0.2 sq in. in area shall be provided on all sides of, and adjacent to, every opening which exceeds 24 in. in either direction, at all corners, and at the ends of walls. Bars around openings shall extend not less than their development length, but not less than 24 in., beyond the corners of the opening.

In Sec. 12.4.1(D) the second paragraph should be changed to:

Joint reinforcing may be composed of two wires made with welded ladder or trussed wire cross ties. In calculating the resisting capacity of the system, compression and tension in the spaced wires may be utilized.

Delete Sec. 12.4.1(F).

Under Sec. 12.4.2 MATERIAL LIMITATIONS delete the following sentence:

~~Structural Clay Load Bearing Wall Tile~~

The last sentence should read:

~~Mortars other than Types M or S~~ *Mortar Types O and K*

MAYES COMMENT

The ATC-3-06 SPC B requirements are for SEE Group 1 buildings in Map Areas 2, 3 and 4 which cover A_a values ranging from 0.05 to 0.20. The East and West proposals permit SPC B in Map Areas 4 and 5 with A_a values ranging from 0.15 to 0.30.

12.5 SEISMIC PERFORMANCE CATEGORY C

Buildings assigned to Category C shall conform to all of the requirements for Category B and to the additional requirements and limitations of this Section.

12.5.1 CONSTRUCTION LIMITATIONS

Masonry components shall be constructed to conform to the limitations of this Section.

(A) REINFORCEMENT. All masonry shall be reinforced masonry.

(B) TIE ANCHORAGES. In addition to the requirements of Sec. 12A.6.3(D) for tie anchorages, a minimum turn of 135 degrees plus an extension of at least 6 tie diameters but not less than 4 inches at the free end of the tie shall be provided.

(C) REINFORCED COLUMNS. In addition to the requirements of Sec. 12.6.3(F) for reinforced masonry columns, no longitudinal bar shall be farther than 6 inches from a laterally supported bar. Except at corner bars, ties providing lateral support may be in the form of cross-ties engaging bars at opposite sides of the column.

The tie spacing for the full height of masonry shear wall boundary columns and all other columns stressed by tensile or compressive axial overturning forces due to seismic effects and for the tops and bottoms of all other columns for a distance of 1/6 of clear column height but not less than 18 inches nor the maximum column dimension shall be not greater than 16 bar diameters nor 8 inches. Tie spacing for the remaining column height shall be not greater than 16 bar diameters, 48 tie diameters, or the least column dimension, but not more than 18 inches.

(D) SHEAR WALL BOUNDARY ELEMENTS. Boundary members shall conform to one of the following:

1. Sec. 11.8.4 when of reinforced concrete or structural steel.
2. Sec. 12.5.1(C) when of masonry.

(E) JOINT REINFORCEMENT. Longitudinal masonry joint reinforcement may be used in reinforced grouted masonry and reinforced hollow unit masonry only to fulfill minimum reinforcement ratios but shall not be considered in the determination of the strength of the member.

(F) STACKED BOND CONSTRUCTION. The minimum ratio of horizontal reinforcement shall be 0.0015 for all structural walls of stacked bond construction. The maximum spacing of horizontal reinforcing shall not exceed 24 inches. Where reinforced hollow unit construction forms part of the seismic resisting system, the construction shall be grouted solid and all head joints shall be made solid through the use of open end units.

12.5.2 MATERIAL LIMITATIONS

The following materials shall not be used for any structural or nonstructural purpose:

All the materials listed in Sec. 12.4.2

Structural Clay Nonload-bearing Wall Tile

Glass Units

EAST PROPOSAL

The only difference in the above and the East proposal is that all material limitations are removed in the East proposal.

WEST PROPOSAL

This is somewhat confusing as it states that all masonry shall be reinforced masonry and shall conform to the following:

Reinforcement ratio in each direction of 0.0007 and the sum of the ratios for each direction shall not be less than 0.002. Maximum spacing of reinforcement shall not exceed 4 ft on center. Only continuous reinforcement shall be considered in computing the minimum area of reinforcement. Reinforcement required by 12.2(A) may be considered in satisfying the minimum horizontal ratio if continuous.

However for shear walls except for one- and two-family dwellings the ATC-3-06 requirements of Sec. 12.7 are specified. These are more stringent than those proposed above and presumably would govern in all cases where the wall was a shear wall.

In addition to the above, delete Sec. 12.5.1(E).

Modify Sec. 12.5.1(F) as follows:

(F) STACKED BOND CONSTRUCTION. The minimum ratio of horizontal reinforcement shall be ~~0.0015~~ 0.0007 for all structural walls of stacked bond construction. The maximum spacing of horizontal reinforcing shall not exceed ~~24~~ 48 inches. Where reinforced hollow unit construction forms part of the seismic resisting system, the construction shall be grouted solid and all head joints shall be made solid through the use of open end units.

In Sec. 12.5.2 delete the word "nonstructural" in the first sentence.

MAIES COMMENT

ATC-3-06 SPC C requirements are for SEE Group 1 buildings in Map Areas 5, 6 and 7 with A_a values ranging from 0.20 to 0.40 and greater. The East and West proposals are for SEE Group 1 buildings in Map Areas 6 and 7 with an A_a ranging from 0.30 to 0.40 and greater.

12.6 SEISMIC PERFORMANCE CATEGORY D

Buildings assigned to Category D shall conform to all of the requirements for Category C and to the additional requirements and limitations of this Section.

12.6.1 CONSTRUCTION LIMITATIONS

Materials for mortar and grout for structural masonry shall be measured in suitable calibrated devices. Shovel measurements are not acceptable. An approved admixture of a type that reduces early water loss and produces a net expansion action shall be used for grout for structural masonry unless it can be demonstrated that shrinkage cracks will not develop in the grout. The thickness of the grout between masonry units and reinforcing shall be a minimum of 1/2 inch for structural masonry.

(A) MINIMUM GROUT SPACE FOR GROUTED MASONRY. The minimum grout space for structural reinforced grouted masonry shall be 2-1/2 inches for low-lift construction and 3-1/2 inches for high-lift construction.

(B) REINFORCED HOLLOW UNIT MASONRY. Structural reinforced hollow unit masonry shall conform to requirements below:

1. Wythes and elements shall be at least 8 inches in nominal thickness with clear, unobstructed continuous vertical cells, without offsets, large enough to enclose a circle of at least 3-1/2 inches in diameter and with a minimum area of 15 square inches.

2. All grout shall be coarse grout. Grout consolidation shall be by mechanical vibration only. All grout shall be reconsolidated after excess moisture has been absorbed but before workability has been lost.

3. Vertical reinforcement shall be securely held in position at tops, bottoms, splices, and at intervals not exceeding 112 bar diameters. Approved intermediate centering clips or caging devices shall be used in high-lift construction, as required, to hold the vertical bars. Horizontal wall reinforcement shall be securely tied to the vertical reinforcement or held in place during grouting by equivalent means.

4. In wythes of less than 10-inch nominal thickness, in any vertical cell, there shall be a maximum of one No. 10 bar or two No. 8 bars with splices staggered for the two-bar situation.

5. The first exception of Sec. 12A.6.3(F) shall not apply; minimum nominal column dimension shall be 12 inches.

(C) STACKED BOND CONSTRUCTION. All stacked bond construction shall conform to the following requirements:

1. The minimum ratio of horizontal reinforcement shall be 0.0015 for nonstructural masonry and 0.0025 for structural masonry. The maximum spacing of horizontal reinforcing shall not exceed 24 inches for nonstructural masonry nor 16 inches for structural masonry.

2. Reinforced hollow unit construction which is part of the seismic resisting system shall (1) be grouted solid, (2) use double open end (H block) units so that all head joints are made solid, and (3) use bond beam units to facilitate the flow of grout.

3. Other reinforced hollow unit construction used structurally, but not part of the seismic resisting system, shall be grouted solid and all head joints shall be made solid by the use of open end units.

12.6.2 MATERIAL LIMITATIONS

Hollow nonload-bearing concrete masonry units shall not be used. Sand-lime building brick shall not be used for any structural masonry.

12.6.3 SPECIAL INSPECTION

Special inspection shall be provided for all structural masonry.

EAST PROPOSAL

Delete the material limitation section.

WEST PROPOSAL

Under Sec. 12.6.1 CONSTRUCTION LIMITATIONS the paragraph reads as follows:

Masonry components shall be reinforced masonry and conform to Sec. Sec. 12.2.2(3). Materials for mortar and grout for structural masonry shall be measured in suitable calibrated devices. ~~Shovel measurements are not acceptable. An approved admixture of a type that reduces early water loss and produces a net expansion action shall be used for grout for structural masonry unless it can be demonstrated that shrinkage cracks will not develop in the grout.~~ The thickness of the grout between masonry units and reinforcing shall be a minimum of 1/2 in. for structual masonry.

Paragraph (A) reads as follows:

MINIMUM GROUT SPACE FOR ~~GROUTED MASONRY~~ BETWEEN WYTHES. The minimum grout space between wythes for ~~structural~~ reinforced ~~grouted~~ masonry shall be ~~2-1/2~~ in. for low-lift construction and ~~3-1/2~~ 2 in. for high-lift construction.

Under Paragraph (B) REINFORCED HOLLOW UNIT MASONRY Sec. 1 should read:

1. Wythes and elements shall be at least ~~8~~ 6 in. in nominal thickness with clear, unobstructed continuous vertical cells, without offsets, large enough to enclose a circle of at least ~~3-1/2~~ 3 in. in diameter. ~~and with a minimum area of 15 sq in.~~

2. ~~All grout shall be coarse grout.~~ *Grout consolidation shall be by mechanical vibration only. All grout shall be reconsolidated after excess moisture has been absorbed but before workability has been lost.*

Under Paragraph (C) STACKED BOND CONSTRUCTION, Sec. 1.

The minimum ratio of horizontal reinforcement shall be ~~0.0015~~ .0007 for nonstructural masonry and ~~0.0025~~ 0.0015 for structural masonry. The maximum spacing of horizontal reinforcing shall not exceed ~~24~~ 48 in. for nonstructural masonry nor ~~16~~ 24 in. for structural masonry.

MAYES COMMENT

The map areas for which SPC D requirements apply are the same as SPC C. The only difference is that SPC D requirements apply to SHE Group III buildings.

12.7 SHEAR WALL REQUIREMENTS

Shear walls shall comply with the requirements of this Section.

12.7.1 REINFORCEMENT

The minimum ratio of reinforcement for shear walls shall be 0.0015 in each direction. The maximum spacing of reinforcement in each direction shall be the smaller of the following dimensions: one-third the length and height of the element but not more than 32 inches. The area and spacing of reinforcement perpendicular to the shear reinforcement shall be at least equal to that of the required shear reinforcement. The portion of the reinforcement required to resist shear shall be uniformly distributed.

EXCEPTION:
For shear walls constructed using running bond, the ratio of reinforcement may be decreased to 0.0007 provided that all shear is resisted by the reinforcement. The sum of the ratios of horizontal and vertical reinforcement shall not be less than 0.002.

12.7.2 BOUNDARY MEMBERS

Where cross walls or boundary members form a part of the shear wall system, the intersections shall be constructed as required for the walls themselves. Connections to concrete shall conform to Sec. 12A.2.1. Where the boundary members are of structural steel, the shear transfer between the wall and the boundary member shall be developed by fully encasing the element in grout, by dowels, bolts, or shear lugs, or by similar approved methods.

When the structural system, as described in Chapter 3 and Table 3-B, consists of substantially complete vertical load-carrying frame, boundary members shall be provided at each end of the wall. The members shall be of the same construction as the frame columns. Where the frame is a special moment frame, those columns shall conform to the requirements for such members in Chapters 10 and 11. Also see Sec. 12.5.1(D) for Category C & D.

The required vertical boundary members and such other similar vertical elements as may be required shall be designed to carry all the vertical forces resulting from the wall loads, the tributary dead and live loads, and the seismic forces prescribed in these provisions.

Horizontal reinforcing in the walls shall be anchored to the vertical elements. Where the boundary element is structural steel this shall be accomplished by welding or by extension, with bends if required, into grout fully surrounding the column.

12.7.3 COMPRESSIVE STRESSES

For loading combinations including in-plane seismic forces, allowable compression stresses at any point shall not exceed those allowed for axial compression. For unreinforced masonry designed by Sec. 12A.6.1, the allowable working stress values are given in Table 12A-3. The allowable working stress values for reinforced masonry shall be the allowable working stresses given in Table 12A-5 and applicable reductions for slenderness effects shall apply. The minimum horizontal distance between lateral supports may be considered for walls as well as the minimum vertical distance. Formula 12A-7 shall not be used.

> EXCEPTION:
> For pier type wall elements that do not extend from floor to floor compression stresses under combined loading at any point may be limited to those allowed for flexural compression provided that Formula 12A-7 is also satisfied.

WEST PROPOSAL

Delete the last sentence of the provision and the exception.

12.7.4 HORIZONTAL COMPONENTS

When shear reinforcing is required for loads that include seismic effects and diagonal bars conforming to Sec. 12A.6.4(D) are not provided, reinforcement approximately perpendicular to the required shear reinforcement shall be provided equal in amount and spaced not further apart than is required for the shear reinforcing. Horizontal reinforcing shall anchor into or be continuous through the pier elements. Horizontal components may be separated from the shear wall system by means of true joints. The joints shall provide for building movement determined in accordance with Sec. 3.8. The horizontal components shall be anchored to the building and designed as otherwise required by these provisions.

WEST PROPOSAL

Under Sec. 12.7.4 HORIZONTAL COMPONENTS, the paragraph reads as follows:

When shear reinforcing is required for loads that include seismic effects and diagonal bars conforming to Sec. 12A.6.4(D) are not provided, reinforcement approximately perpendicular to the required shear reinforcement shall be provided equal in amount and spaced not further apart than is required for the shear reinforcing. Horizontal reinforcing shall anchor into or be continuous through the ~~pier~~ elements. Horizontal components may be separated from the shear wall system by means of ~~true~~ joints. The joints shall provide for building movement determined *in accordance with Sec. 3.8. The horizontal components shall be anchored to the building and designed as otherwise required by these provisions.*

COMPARISON OF ATC-3-06 AND 1979 UBC REQUIREMENTS

by

Ronald L. Mayes

The area of wall required to resist a load is determined by dividing the load by a measure of its resistance; thus:

$$\text{Area Required} = \frac{\text{Load}}{\text{Resistance}}$$

and a comparison of two codes by determining how much area each would require.

1. CODE LOADS

a. Uniform Building Code

The base shear for the 1979 UBC is V = ZIKCSW

where Z is a zone factor and has values of 3/16, 3/8, 3/4 and 1.0 for the four seismic zones. It will be assumed to equal 1 and K = 1.33 for load bearing wall systems.

and CS < 0.14.

Thus

$$V = Z(KCS)W$$

and for the flat part of the spectra where CS = 0.14

ZONE	1	2	3	4
Z(KCS)	0.035	0.07	0.14	0.186

b. ATC-3-06

The base shear

$$Y = C_s W$$

$$\text{where } C_s = \frac{1.2A_v S}{RT^{2/3}} \not> \frac{2.5_a}{R}$$

where R = 3.5 for a reinforced wall and 1.25 for an unreinforced or partially reinforced wall. For the flat part of the spectra where

$$C_s = \frac{2.5A_a}{R}$$

Map Area	A_a	C_s for Reinforced	C_s for Unreinforced
1	0.05	0.036	0.1
2	0.05	0.036	0.1
3	0.10	0.071	0.2
4	0.15	0.107	0.3
5	0.20	0.143	
6	0.30	0.214	
7	0.40	0.286	

2. CODE STRESSES

a. Flexural Compressive Stresses

These allowable values are the same for non-seismic forces and are 0.33 f'_m but they should not exceed 900psi. For seismic loads in the UBC this value may increase by 1.33. The corresponding increase for the ATC-3-06 requirements is 2.5. Thus the ratio of the UBC to ATC-3-06 allowable flexural stress is 0.53.

b. Shear Stresses

The allowable shear stresses of the UBC and ATC-3-06 requirements are the same for non-seismic forces. For seismic forces the UBC permits an 1.33 increase; however, the shear forces must be increased by 1.5 which in effect decreases the allowable stress by 1.5.

For ATC-3-06 when the reinforcement takes all the shear, the allowable stresses increase by 1.5 as the ϕ factor is 0.6. Thus when the masonry takes all the shear the allowable stresses do not increase as the ϕ factor is 0.4.

	Reinforcement Takes Shear	Masonry Takes Shear
$\frac{\text{UCB Allowable Shear}}{\text{ATC-3-06 Allowable Shear}}$	$\frac{1.33}{1.5 \times 1.5} = 0.59$	$\frac{1.33}{1.5} - 0.89$

3. COMPARISON OF UBC AND ATC-3-06 REQUIRED AREAS

This is somewhat difficult to do exactly because the UBC Seismic Zones include several of the ATC-3-06 map areas. Consequently, each map area will be included and the three allowable stresses given in Section 2 will be used. The ratio of required areas is given as follows.

$$\frac{\text{ATC Required Area}}{\text{UBC Required Area}} = \frac{\text{ATC Load}}{\text{UBC Load}} \times \frac{\text{UBC Stress}}{\text{ATC Stress}}$$

RATIO OF $\frac{\text{ATC-3}}{\text{UBC}}$ REQUIRED AREAS

	ATC-3 Map Area	Flexural Stress	Reinforcement Takes All Shear	Masonry Takes All Shear
For UBC Seismic Zone 2				
	5		1.20	1.81
	4	0.81	0.91	1.37
	3	0.54	0.60	0.91
	2	0.27	0.30	0.45
For UBC Seismic Zone 3				
	6	0.81	0.90	1.36
	5	0.53	0.60	0.90
	4	0.40	0.45	0.68
For UBC Seismic Zone 4				
	7	0.81	0.91	1.37
	6	0.61	0.68	1.02

IMPLICATIONS OF THE COMPARISON

The variations in the ATC-3 to UBC required areas is understandable in that the ATC-3 Map Areas provide a greater refinement of Seismic Risk than the UBC Seismic Zones. Thus the lowest ATC Map Area that occurs in a a UBC Seismic Zone has required areas significantly less than the UBC requirements; e.g., ATC-3 Map Area 4 in UBC Zone 3. On the other hand, the highest ATC Map Area that occurs in a UBC Seismic Zone provides less (but not significantly) stringent required areas than UBC based on a comparison of flexural stresses or when the reinforcement takes all the shear. When masonry takes all the shear the ATC-3 requirements are more stringent than the UBC.

EXHIBIT G

Applied Technology Council 2150 SHATTUCK AVE., SUITE 806 BERKELEY, CALIFORNIA 94704 (415) 540-0223
A Nonprofit Corporation

ATC

March 14, 1980

To: Committee 5 - Masonry

From: Mel Mark

Attached are my comments on the changes that were recommended for Chapter 12A but were not discussed at our last meeting. I have given each recommended change a number and by comments are then given by this number. My comments precede the numbered recommended changes.

Unfortunately Ron Mayes and I have not had a chance to discuss these so his input will have to await his return from New Zealand.

EXHIBIT G

File No. 79133

1. O.K. since moved to 12A.3.5 & 12A.3.6.
2. Object here is to obtain workable grout yet not have excessive water which compounds the shrinkage problem. Limits obtained from successful job specifications and from specialized standards. They are quite liberal. Prefer they remain. or put in SPC-C
3. Apparently no standards exist for mixers. Performace criteria will allow inspector to order obviously defective equipment off the job.
4. Substantive change for dampening concrete units during excessively hot and dry weather. Under these conditions conc. units tend to suck water from mortar too rapidly. Excessive dust will reduce mortar and grout bond. Prefer these two provisions be retained. Other changes delete cross references.
5. To be considered "solid masonry", all joints should be filled, "unless otherwise approved" would allow special construction. Could be moved to 12A.3.3.
6. Floor slabs or spandrel beams within walls should not be treated differently from foundations. Highly stressed masonry in columns and pilasters should be continuous for the vertical load.
7. Paragraph substitution does not address the problem and is redundant as it is covered in 12A.2. Problems are separation of the concrete and the masonry due to lack of bond and shear for shear walls. Procedure is the same as for concrete cold joints. This is necessary for seismic resistant construction. If removed from 12A it should go into Chap. 12.
8. Typo.
9. Assume 2nd Paragraph to remain.

10. Delete "one of the following" in view of changes to PP above.

11. For stacked bond cavity walls, both wythes should have mechanical bond. Prefer retention.

12. Cross reference PP. Changes should be deferred until substantive changes are completed.

13. Also list in 12.A.1.2, Reference Documents?

14. "Templates" provides a standard for "approved equivalent means". Prefer retention.

15. Five-eighths and smaller bolts require only 4" embedment. Ties 4" down will not be effective.

16. First sentence: ATC wording defines grouted masonry consistent with provisions of UBC, SBCC and common usage. Proposed wording could open up definition to whatever type of construction one might care to call grouted masonry and to any types of units such as hollow, tile, etc. Allowable stresses are for the ATC definition which should be retained.

    Second sentence: Allowable stresses of Tables 12A-3 and 12A-5 are for types M and S mortars only. Type N mortar could be used for unreinforced construction in Category A buildings using the allowable compressive stresses of the SBCC; however appropriate allowables for shear and tension are lacking. ATC wording should be retained.

    Third sentence: The sentence is needed so that just adding steel in any haphazard way will not qualify the construction as being "reinforced". Subsection (C) does not set reinforcing amounts; it just describes the construction. Sentence should remain.

17. Provision is from Calif. requirements for schools. If deleted, it

should be put in Chap. 12 under Category C. Note that Brick Institute of CA handbook recommends no toothing without permission of Architect or Engineer.

18. Provision against header projection is a requirement of UBC, SBCC and just makes sense.

19. Floaters should be used in thick grout of low lift construction in view of grout shrinkage. Puddling is used instead of vibration. This requirement can be moved to Chap. 12. Sentence re cover should be retained except it can be reduced to 3/4" per Brick Institute of CA recommendations.

20. Leaving out every other unit follows approved 1976 UBC code change wording by masonry industry. Fin and foreign matter removal procedures are suggestions, conforming to the ACI 531 Commentary, as to what is required; the word "other" allows alternatives. Sentence re "Material falling etc." is axiomatic. Successful high lift work requires the special procedures of this paragraph. It should be retained.

21. UBC and ATC require a 3" minimum grout space for reinforced high lift work. The CA school requirement is 3½". Believe the UBC provisions for high lift are based on Masonry industry studies which apparently included the 3" space and the 3 day cure. ATC wording should be retained.

22. Unless the principle bar reinforcing is embedded in grout, the form of construction will be something other than what is commonly known as Reinforced Grouted Masonry-Multiple Wythe and what has been tested as such. This is the only form of construction shown in the Brick Institute of CA Handbook and the ACI 531 Commentary as being

reinforced grouted masonry-multiple-wythe. The proponents of the change should explain what else they have in mind and that it really conforms to this type of construction as commonly used and tested; otherwise the ATC wording should be retained.

The Brick Institute of CA Handbook recommends that "all vertical reinforcing steel must be accurately placed and properly braced by mechanical devices to maintain correct positions shown on the plans". This is the reason for the wording "by a frame or suitable equivalent devices" which should be retained.

The last sentence can be deleted.

23. One-half inch clearance is needed to prevent segregation of coarse grout (with 3/8 pea gravel) in the narrow grout spaces. ATC wording should be retained.
24. This paragraph is needed so that just adding steel in any fashion to hollow unit construction will not qualify the construction as being reinforced. The construction described here and in (A) following conforms to what is commonly known as reinforced hollow unit work and what has been tested as such. The paragraph should be retained.
25. Title: There may be a real problem here. Sec. 12A.3.6, following the UBC, recognized only <u>ungrouted</u> unreinforced work. Allowable stresses of Table 12A-3 apparently are only set up for this form. If 12A.3.6 is to allow unreinforced grouted hollow unit construction then more revisions may be required.

Cell Width: UBC, CA schoolhouse requirements and ACI 531 Commentary specify 2" min. Colorado Masonry Institute specifies 1-3/4" minimum. ACE 531 Commentary recommends 3" for high lift. With reinforcement, 1-1/2" is just too tight for ordinary work.

26. Research, field problems and one significant lawsuit have clearly demonstrated the need for removing mortar fins. A similar provision appears in the UBC and the Colorado Mas. Inst. St'd. The ATC paragraph should be maintained.

    The additional paragraph, as suggested, is needed in view of the revisions to 12.A.1.17.(B)2.

27. The term "bond beams" commonly refers to a reinforced beam type element at floors and walls. The term "bond beam units" is correct. These are needed to obtain grout coverage over reinforcement in partially grouted work and aid in grout flow in fully grouted work.
28. See comment No. 23.
29. CA schoolhouse requirements, based on experience with the high lift method, limit the total pour to 12 feet for 8 inch walls and 16 feet for 12 inch walls. ACI Commentary Sec. 6.4 places the limit at 12 feet. The ATC provision is more liberal and should be retained.
30. See comment No. 20.
31. Demonstration walls made to qualify the high lift technique and the CA schoolhouse requirements, based on experience, include grouting in one pour without cold joints. The word "shall" should be retained.

32. If deleted, this section should be replaced in Chap. 12. See comments on chap. 12 to follow.

33. UBC requires S mortar. SBCC requires M, S or N mortar. Suggest M, S or N mortar to be permissive.

Note that SBCC requires joint reinforcement for exterior panels. ATC does not. Suggest joint reinforcement be added for Category B in Chap. 12.

34. The formula and the paragraphs immediately preceding and following it come from ACI 318, Sec. 12.2.3. The wording has been modified for consistency with reinforced masonry working stress design. Excluding seismic loads, both M_c and V are working stress capacities and loads respectively. With seismic loads M_c will be factored upward to an equivalent ultimate or yield level and V will be the load at which inelastic behavior starts as controlled by ATC Sections 3.7.1, 4.2.1 and 12.2.

35. The table is compiled from several sources including UBC, BIA & NCMA. The suggested substitute follows the TMS Draft. If the proposal were correct, it suggests that the other data is erroneous. For instance f'm for solid clay units is generally greater than for solid concrete or sand-lime units. The higher strengths would include concrete units whereas both ACI 531 and NCMA have upper bounds at unit strengths of 6000 psi. Both ASTM C90-75 and C652-75 use gross area strengths for hollow units; the table and footnote 4 is not applicable. It appears that if this new table were to be adopted, it should be justified with data for all the construction types it would include.

ATC footnotes 1 and 2 are deleted in the proposed revision. ATC

Footnote 1 requires that the strength of higher strength units be verified. Note that these strengths exceed the ASTM minimums and that manufacturer supplied certifications could be acceptable in lieu of tests. Footnote 2 requires that field prisms be made and tested to verify only the higher assumed values of f'm applicable to solid clay units. This is consistent with general practice for concrete.

The present ATC table should be retained.

36. Pending research data, an upper bound is needed. Suggest 2000 psi corresponding to the f'm limit of 6000 psi for design of walls and columns.
37. Research data is needed to support deleting the present upper bounds. Existing data generally supports these values which should be retained.
38. See item 36 above. Suggest new limits of 1500 and 1800 respectively.
39. See item 35 above for hollow units. Problem?
40. Why? Where would this new footnote be referenced? It is meant a standard head in lieu of the bend? Note that no pullout values are furnished.

CORRECTIONS APPEARING ON PAGE 123

Under Section 12A.1.16 MORTAR

~~ASTM-C270-Types-O-and-K-mortar-shall-not-be-used.~~

Masonry units used in foundation walls and footings shall be laid up in ~~Type-S-or-Type-M-mortar.~~ mortar having a minimum compressive strength of 1800 psi. See Sec. 12A.1 and Chapter 12 for further limitations.

CORRECTIONS APPEARING ON PAGE 124

Under Section 12A.1.16 Cont.

To maintain plasticity, mortar may be retempered with water by the method of forming a basin in the mortar and reworking it. However, any mortar which has ~~become-harsh-shall-not-be-used-in-the-work.~~ hardened or stiffened due to hydration of the cement shall not be used.

Under (B) Type. Number 1.

1. Fine Grout. Fine grout shall be composed, by volume, of one part cement, to which may be added not more than 1/10 part hydrated lime ~~or-lime~~ putty, and 2-1/4 to 3 parts of sand.

2. Coarse Grout. Coarse grout shall be composed, by volume, of one part of cement, to which may be added not more than 1/10 part hydrated lime ~~or-lime-putty~~, two to three parts sand, and one to two parts gravel. Larger proportions of gravel may be used in large grout spaces where approved by the Regulator Agency.

1

~~Coarse-grout-may-be-used-in-grout-spaces-in-grouted-masonry-2-inches-or-more-in-width-and-in-grout-spaces-in-filled-cell-construction-having-an-area-of-15-square-inches-with-a-least-dimension-of-3-inches.~~

~~Coarse-grout-shall-be-used-where-the-least-dimension-of-the-grout-space-exceeds-5-inches-and-where-otherwise-required.~~

4.5

2

(C) CONSISTENCY. Grout shall have a consistency, considering the methods of conslidation to be utilized, to completely fill all spaces to be grouted without segregation. ~~except-that-slumps-shall-not-be-less-than-4.6-inches-for-all-grout-nor-more-than-10-inches-for-fine-grout-or-9-inches-for-coarse-grout.~~

3

(E) MEARSURING AND MIXING. Materials for grout shall be measured in suitable calibrated devices. After the addition of water, all materials shall be mixed for at least three minutes in a ~~drum-type-batch~~ mechanical batch mixer. ~~Mixing-equipment-and-procedures-shall-produce-grout-with-the-uniformity-required-for-concrete-by-ASTM-C94.~~

CORRECTIONS APPEARING ON PAGE 125

Section 12A.1.17 Cont.

~~EXCEPTION:~~
~~Aluminum equipment may be used if it can be demonstrated that there will be no deleterious effect on the strength of the grout and it is specifically approved by the Regulatory Agency.~~

4

Sec. 12A.2 CONSTRUCTION

~~At the time of laying all masonry units shall be clean and free of dust. Burned clay and sand lime units shall be dampened prior to laying with an absorption rate conforming to Sec. 12A.1.5. Surfaces of concrete masonry units to receive mortar shall be dampened by means of fog spray or equivalent during hot and dry weather, as described in Sec. 12A.2.5 At the time of laying all unburned clay units shall be damp at the surface. All masonry units shall not be so wet that free water is present on the surfaces.~~

12A.2 CONSTRUCTION

Storage, handling and preparation at the site shall conform to the following requirements.

stored

Masonry materials shall be sotred so that at the time of laying the materials are clean and not damaged.

Concrete masonry units shall not be wetted unless otherwise approved.

~~Surfaces of all masonry units for grouted construction at the time of laying shall be capable of developing the required bond with grout as specified in Sec. 12A.1.6.~~

12A.2.1 JOINTS

5

All units shall be laid with shoved mortar joints. Solid units shall have all head and bed joints solidly filled. ~~Except for cavity walls, spaces to be grouted, and as provided in Sec. 12A.3.3, all wall joints, collar joints, and joints between wythes shall be solidly filled~~ unless otherwise approved.

6

All hollow units shall be laid with ~~full~~ face shell bed joints and head joints filled solidly with mortar for a distance in from the face of the unit not less than the thickness of the face shells unless more stringent construction is required by this Chapter, Chapter 12, or by design. Cross webs and end shells of all starter courses shall be bedded on mortar. ~~This applies to units laid on foundations or floor slabs or similar, and all courses of piers, columns and pilasters.~~ unless otherwise specified.

7

con'td on next page

~~Concrete abutting structural masonry such as at starter courses or at wall intersections not designed as true separation joints, shall be roughened to a full amplitude of 1/8 inch, shall be moistened per the requirements of Sec. 12A.2, and shall be bonded to the masonry per the requirements of this Chapter as if it were masonry. Unless keys are provided, vertical joints shall be considered to be stacked bond.~~

(7) Cont'd from previous page

Third paragraph subsitition:

Surfaces in contact with mortar or grout shall be clean and free of laitance, debris, or other deleterious materials.

CORRECTIONS APPEARING ON PAGE 126

Section 12A.2.2 Cont.

(8) (A) REQUIREMENTS. Adajcent wythes shall be bonded to each other in accordance with the applicable provisions ~~of Sec. 12A.2.1 and~~ Sec. 12A 2. 3

(9)

Where not prohibited in Chapter 12 or this Chapter unreinforced stacked bond masonry may be used with one of the mechanical bonding devices indicated in Sec. 12A.2.2(A) 1, 2, and 3 below:

(10) ~~For unreinforced masonry the mechanical bond shall be provided by~~ one of the following:

(11) ~~3. For cavity walls the provisions of 1 and 2 above apply to each wythe.~~

(12) ~~For stacked bond reinforced grouted or reinforced hollow units masonry, see Chapter 12. For stacked bond partially reinforced masonry, see Sec. 12A.3.7(A) and Chapter 12. For shear walls see Sec. 12A.6.4 and Chapter 12.~~

12A.2.3 CORBELING

~~Corbels in unreinforced masonry may be built only into solid masonry walls 12 inches or more in thickness. Corbels in partially reinforced masonry may be built only into masonry walls 12 inches or more in thickness unless the construction provided for the corbel is designed and constructed as reinforced masonry. The projection for each course in such corbels and in unreinforced corbels in reinforced masonry construction shall not exceed 1 inch, and the maximum projection shall not exceed 1/3 of the total thickness of the wall when used to support a chimney built into the wall. The top course of all unreinforced corbels shall be a header course.~~

12A.2.3 CORBELING

The slope of corbelling (angle measured from the horiztonal to the face of the corbeled surface) shall not be less than 60o. The maximum horizontal projection of the corbel from the plane of the wall shall not exceed one-half the wythe thickness for cavity walls one one-half the wall thickness for all other wal

CORRECTIONS APPEARING ON PAGE 127

Under Section 12A.2.4 REINFORCEMENT

REINFORCEMENT

Reinforcement shall conform to the requirements of this Section. All metal reinforcement shall be free from loose rust and other coatings that would reduce bond to the reinforcement.

Under Paragraph (B)

(B) SPLICES. Splices in reinforcement may be made only at approved locations ~~and~~ and indicated on the approved design documents. Splices shall conform to the provisions of Sec. 12A.6.3(D)7.

Under Paragraph (D)

(D) SIZE ~~LIMIATIONS~~.LIMITATIONS.

Under Section 12A.2.5 TEMPERATURE LIMITATIONS

Delete the entire paragraph beginning with "No masonry shall be laid when" - and ending with "free from ice and snow." The substition paragraph is as follows:

12A.2.5 TEMPERATURE LIMITATIONS

13 Cold weather construction shall conform to the requirements of "Recommended Practices and Guide Specifications for Cold Weather Construction" by the International Masonry Industry All-Weather Council.

CORRECTIONS ON PAGE 128

Under Section 12A.2.7 BOLT PLACEMENT

14 In grouted construction, all bolts shall be grouted in place. The bolts shall be accurately set ~~with-templates-or-by-approved-equivalent-means~~ and held in place to prevent movement. Grout coverage shall be as required for reinforcing bars of equivalent size.

15 Vertical bolts at the top of and near the ends of reinforced masonry walls shall be set within hairpins or ties located within ~~2.5~~ 4 inches from the top of the wall. See Sec. 12A.6.3(F) and 12.4.1(B) for bolts at the top of piers, pilasters, and columns.

Under Section 12A.3.1 UNBURNED CLAY MASONRY

Unburned clay masonry is that form of construction made with unburned clay stablized with emulsified asphalt. ~~Masonry-of-unburned-clay~~ Such units shall not be used in any building more than one story in height. All footing walls which support masonry of unburned clay units shall extend to an elevation not less than 6 inches above the adjacent ground at all points.

CORRECTIONS APPEARING ON PAGE 129

Under Section 12A.3.3 SOLID MASONRY

SOLID MASONRY

Solid Masonry shall be ~~brick, concrete brick, or solid load bearing concrete masonry units,~~ solid concrete or clay masonry units laid contiguously in mortar.

CORRECTIONS ON PAGE 130

Under Section 12A.3.5 GROUTED MASONRY - MULTI/WYTHE WALLS

16 A form of Grouted masonry ~~is that form of~~ between wythes construction is made with ~~brick or solid concrete~~ masonry units in which interior ~~joints of masonr~~ are filled ~~by pouring~~ with grout. ~~therein as the work progresses. Only Type M or Type S mortar shall be used. When reinforced in accordance with subsection (G) below masonry shall be classified as reinforced grouted masonry.~~

17 ~~Toothing of masonry walls is permitted only when designed and detailed by the design engineer or architect and only approved locations. Racking is to be held to a minimum.~~

Grouting ~~and construction~~ procedures for the space between wythes shall conform to the requirements given below. Coarse grout may be used in grout spaces 2 inches or more in width. Coarse grout shall be used where the least dimension of the grout space exceeds 5 inches.

Under (A) LOW LIFT.

18 ~~1. All units in the two outer tiers shall be laid with full shoved head and bed mortar joints. Masonry headers shall not project into the grout spac~~

~~2.~~ 1. All longitudinal vertical joints shall be grouted and shall not be less than 3/4 inch in thickness for unreinforced construction and 1-1/2 inches in width for reinforced construction, but not less than that required to maintain gro thicknesses between masonry units and reinforcement. In members of three or more ~~tiers~~ wythes in thickness, interior bricks shall be embedded into the grout so tha at least 3/4 inch of grout surrounds the side and ends of each unit. Floaters ~~shall~~ may be used where the grout space exceeds 5 inches in width. ~~The thickness of grout between masonry units and floaters shall be not less than 1 inch.~~ All grout shall be puddled ~~with a grout stick~~ immediately after pouring. 19

~~3.~~ 2. One exterior ~~tier~~ wythe may be carried up 18 inches before grouting but the other exterior ~~tier~~ wythe shall be laid up and grouted in lifts not to exceed six times the width of the grout space with a maximum of 8 inches.

~~4.~~ 3. If the work is stopped for one hour or longer, the horizontal construction joints shall be formed by stopping all ~~tiers~~ wythes at the same elevation and with the grout 1 inch below the top.

EXHIBIT G

Under Section (B) HIGH LIFT.

~~1. All units in the two tiers shall be laid with full head and bed joints.~~

CORRECTIONS ON PAGE 131

~~2.~~ 1. The two ~~tiers~~ wythes shall be bonded together with wall ties. Ties shall be not less than No.9 wire in the form of rectangles 4 inches wide and 2 inches in length less than the overall wall thickness. Kinks, water, drips, or deformation shall not be permitted in the ties. Approved equivalent ties may also be used. One ~~tier~~ wythe of the wall shall be built up not more than 18 inches ahead of the other tier. Ties shall be laid not to exceed 24 inches on center horizontally and 16 inches on center vertically for running bond and not more than 24 inches on center horizontally and 12 inches on center vertically for stacked bond.

~~3.~~ 2. Cleanouts shall be provided for each pour by leaving out ~~every other~~ units in the bottom ~~tier~~ course of the section being poured, or by cleanout openings in the foundation. During the work, mortar fins and any other foreign matter shall be removed from the grout space. ~~by means of a high pressure jet stream of water, air jets, or other approved procedures. Material falling to the grout space shall be thoroughly removed.~~ The cleanouts shall be sealed after inspection and before grouting.

20

~~4.~~ 3. The grout space (longitudinal vertical joint) shall not be less than ~~3~~ 2 inches in width ~~and not~~ nor less than the thickness required by the placement of steel with the required clearnaces and shall be poured solidly with grout. ~~Masonry walls shall cure at least three days to gain strength before grout is poured~~

21

Delete EXCEPTION:

~~If the grout space contains no horizontal steel, it may be reduced 2 inches.~~

~~5.~~ 4. Vertical grout barriers or dams shall be built of solid masonry across the grout space the entire height of the wall to control the flow of the grout horizontally. Grout barriers shall be not more than 30 feet apart. ~~Unless a true joint occurs at the barrier,~~ Reinforcement, if it is present, shall be continuous through the barrier. In work that is part of the seismic resisting system, the grout barriers shall be constructed so as to form keys, at least 3/4 inch deep, with the grout except that construction providing equivalent irregular surfaces may be used where appropriate.

~~6.~~ 5.

~~7.~~ 6.

~~8.~~ 7. Inspection during grouting shall be provided in accordance with Sec. 12A.7; ~~however, the work shall not qualify for the stresses entitled, "Special Inspection", unless fully inspected per Sec. 1.6.2, 1.6.4, and 12A.7.~~

(C) REINFORCED CONSTRUCTION. ~~All required reinforcement except masonry joint reinforcement and column ties conforming to the paragraph below shall be embedded in grout.~~ All ~~other~~ reinforcement shall be embedded in mortar or grout. All ~~vertical~~ reinforcement shall be held firmly in place during grouting ~~by a frame~~ or suitable equivalent devices. ~~All horizontal reinforcement in the grout space shall be tied to the vertical reinforcement or held in place during grouting by equivalent means~~

22

CORRECTIONS APPEARING ON PAGE 132

Second paragraph reads as follows:

23 The thickness of grout between masonry units and reinforcement shall not be less than 1/4 inch. See Sec. 12A.1.17 and 12A.2.4

Under Section 12A.3.6 HOLLOW UNIT MASONRY

24 Delete Paragraph beginning with "Hollow unit masonry" and ending with "so the wythes shall act as a unit.

25 (A) ~~REINFORCED-CONSTRUCTION.~~ GROUTING PROCEDURES. Units shall be laid with mortar in accordance with Sec. 12A.2.1. ~~Only-Types-M-or-S-mortar-shall-be used.~~ Where only certain vertical cells are to be filled, the walls and cross webs of these cells shall be full bedded in mortar to prevent grout leakage. Vertical cells to be filled shall have vertical alignment sufficient to maintain a clear, unobstructed continuous vertical cell measuring not less than ~~2~~ 1 1/2 inches by ~~3~~ inches. ~~If walls are battered or if~~ alignment ~~if offset, the 2~~ 1 1/2 inch by 3 inch clear opening shall be maintained as measured from course to course.

26 Delete paragraph beginning "Overhanging mortar" and ending with "of the cells". In its place substitute:

Coarse grout may be used in hollow masonry units having an area of 15 square inches with a least dimension of 3 inches. Coarse grout shall be used when the least dimension of the grout space exceeds 5 inches and where otherwise required.

27 Except as provided in Chapter 12, all reinforcing except ties and masonry joint reinforcement, where permitted, shall be embedded in grout. Longitudinal horizontal reinforcing shall be placed in bond ~~beam-units-~~ beams, except as permitted for masonry joint reinforcement. See Sec. 12A.6.3(F) and Chapter 12.

CORRECTIONS APPEARING ON PAGE 133

28 The thickness of the grout between the masonry units and reinforcing shall be a minimum 1/4 inch. ~~for-fine-grout-and-1/2-inch-for-coarse-grout.~~ See Sec. 12A.1.17 and 12A.2.4. See Chapter 12 for stacked bond limitations.

29 Under Number 2. High Lift. Delete entire sentence a.

30 b. Cleanouts shall be provided in the foundation or ~~by-omitting~~ in the face shells in the bottom course of each cell to be grouted. ~~to-facilitate-cleanout which-shall-be-accomplished-by-means-of-a-high-pressure-jet-stream-of-water,-air jets,-or-other-approved-procedures.--Material-falling-to-the-bottom-of~~ Debris in the grout space ~~and-other-debris~~ shall be ~~thoroughly~~ removed.

31 d. Grouting ~~shall~~ may be done in a continous pour, in partial lifts so as to avoid blowout of units.

EXHIBIT G

Section 12A.3.6 Cont.

e. Inspection during grouting shall be provided in accordance with Sec. 12A.7. DELETE REMAINDER OF SENTENCE.

32 DELETE ENTIRE SECTION 12A.3.7 PARTIALLY REINFORCED MASONRY

Under Section 12A.3.8 GLASS MASONRY

Masonry of glass blocks may be used in nonloadbearing exterior or interior walls and in openings, either isolated or in continuous bands, provided the glass block panels have a minimum thickness of ~~3.5~~ 3.0 inches at the mortar joint.

33 Glass block shall be laid in Types ~~M or S mortar.~~ N mortar, by proportion. Both vertical and horiztonal mortar joints shall be at least 1/4 inch and not more than 3/8 inch thick and shall be completely filled.

Under Section 12A.4 DETAILED REQUIREMENTS

Masonry shall be designed to resist all vertical and horizontal load effects including effects of eccentricity ~~of application~~ of vertical loads. ~~Unreinforced masonry shall not be loaded in direct tension.~~ Structural and nonstructural elements including ---- CONTINUED ON PAGE 135.

Except where specifically allowed otherwise, stresses shall be calculated on actual net dimension of masonry considering reductions for raking, tooling, and other joint treatments and partial bed or head joints where applicable. Where required by the Regulatory Agency, Chapter 12, this Chapter, or by other governing provisions, ~~specific~~ inspections and tests shall be provided. In addition where called for or where required by the use of design stresses so specifying, Special Inspection shall be provided.

Under Section 12A.4.2 THICKNESS OF WALLS

The paragraph reads as follows:

All masonry walls shall be designed so that allowable stresses are not exceeded. REMAINDER OF PARAGRAPH IS DELETED.

DELETE ENTIRE PARAGRAPH ENTITLED EXCEPTION:

DELETE SECTION 12A.4.3 PIERS

Under Section 12A.4.5 HOLES, PIPES, AND CONDUITS

Pipes, conduits, and similiar items may be sleeved through masonry with sleeves large enought to pass hubs and couplings. DELETE REMAINDER OF PARAGRAPH. ADD LAST LINE TO FIRST SENTENCE. Masonry around openings shall be designed considering any stress magnification effects on the opening.

CORRECTIONS APPEARING ON PAGE 146

c. The continuing bars provide double the area required for flexure at the cutoff point. ~~and shear stresses do not exceed 3/4 of that permitted~~.

2. Positive Moment Reinforcement: At least ~~1/3~~ 1/4 of the positive moment reinforcement in simple members and ~~1/4 the positive moment reinforcement~~ in continuous members shall extend along the same face of the member into the support, and in to beams at least 6 inches.

When a flexural member is part of the primary lateral load resisting system, the positive reinforcement required above to be extended into the support shall be anchored for its tension development length, l_d, or if the support is not of masonry construction, the reinforcement shall be anchored to develop its ~~yield strength~~ calculated stress at the face of the support.

12A.6.3(D) 2

34

Clarify intent of third paragraph containing formula

$$\frac{M_c}{V} + l_a$$

Mc is based on working stress while V is ultimate.

EXHIBIT G

CORRECTIONS APPEARING ON PAGE 162

Replace existing table with:

TABLE 12A-4

ASSUMED COMPRESSIVE STRENGTH OF MASONRY

f'_m - psi 1,2,3

35

Compressive Strength of Units - psi 4	Mortar Type M or S (1800 psi min.)	Mortar Type N (750 psi min).
14000 or more	5300	3900
12000	4700	3300
10000	4000	2700
8000	3350	2100
6000	2700	1400
4000	2000	1200
2000	1350	900
1000	800	600

4 Compressive strength of solid units is based on gross area. Compressive stength of hollow units is based on minimum net area.

1. Intermediate values may be interpolated.
2. When the alternate design procedure for unreinforced brick masonry of Sec. 12A.6.2 is used for design the units shall comply with the dimension and distortion tolerances specified for type FBS. Where such brick do not comply with these requirements, the compressive strength of brick masonry shall be determined by prism tests as required by Sec. 12A.5.1(A)
3. Where grouted construction is used, the value of f'_m shall not exceed the compressive strength of the grout unless prism tests conforming to Sec. 12A.7 and 12A.8 are provided during construction. As an alternative, the grout strength may be specified at not less than the value of f'_m with grout tests conforming to Sec. 12A.7 and 12A.8 provided during construction for verification.

CORRECTIONS APPEARING ON PAGE 163

TABLE 12A-5

ALLOWABLE WORKING STRESSES (PSI) FOR REINFORCED MASONRY

UNDER THE SECOND COLUMN ENTITLED <u>YES</u>

36 THIRD LINE: 0.33 f'_m ~~but not to exceed 900~~

THE FOLLOWING FORMULAS HAVE THE FOLLOWING DELETED:

~~-50-Max.~~

~~-40-Max.~~

~~-50-Max.~~

37 ~~-150-Max.~~

~~-75-Max.~~

~~-120-Max.~~

38 0.25 f'_m ~~but not to exceed 900~~

0.30 f'_m ~~but not to exceed 1200~~

LINE TWO HAS ONLY CHANGE.

2Web <u>Shear</u> reinforcement shall be provided to carry the entire shear in excess of 20 pounds psi whenever there is required negative reinforcement for a distance of 1/16 the clear span beyond the point of inflection.

CORRECTIONS APPEARING ON PAGE 164

TABLE 12A-6

ALLOWABLE SHEAR ON BOLTS 1,4

⋮

39 [3]These values are permitted only with units having a minimum net area compressive strength of 2500 pounds per square inch or more.

40 [4]An anchor bolt is a bolt that has a right angle extension of at least 3 diameters. A standard machine bolt is acceptable.

CHAPTER 12

MASONRY

BACKGROUND

The masonry design and construction procedures given in this Chapter and Chapter 12A ~~are essential to~~ provid~~ing~~ the performance levels ~~implicit in the selection of the factors used in determining~~ FOR seismic forces ~~in these provisions.~~ ~~The requirements embodied in Chapters 12 and 12A have been demonstrated to be necessary by recent earthquakes and represent the latest developments in masonry construction to provide adequate seismic performance.~~

12.1 REFERENCE DOCUMENTS

The quality and testing of masonry and steel materials and the design and construction of masonry and reinforced masonry components which resist seismic forces shall conform to the requirements of Chapter 12A and the references listed therein except as modified by the provisions of this Chapter. For definitions, see Sec. 12A.1.1.

12.2 STRENGTH OF MEMBERS AND CONNECTIONS

The strength of members and connections subjected to seismic forces acting alone or in combination with other prescribed loads shall be determined using a capacity reduction factor, ϕ, and 2.5 times the allowable working stresses of Chapter 12A. The value of ϕ shall be as follows:

When considering axial or flexural compression and bearing stresses in the masonry.	$\phi = 1.0$
For reinforcement stresses except when considering shear. GR-40	$\phi = 0.8$
GR-60	$\phi = 1.0$
When considering shear carried by shear reinforcement and bolts.	$\phi = 0.6$
When considering masonry tension parallel to the bed joints, i.e., horizontally in normal construction.	$\phi = 0.6$
When considering shear carried by the masonry.	$\phi = 0.4$
When considering masonry tension perpendicular to the bed joints, i.e., vertically in normal construction.	$\phi =$ Zero

12.2.1 SPECIAL DESIGN PROCEDURES FOR ~~UNREINFORCED~~ MASONRY SUBJECTED TO SEISMIC FORCES.

12.2.2. Unreinforced masonry shall be designed in accordance with this Section.

(A) GENERAL DESIGN PROCEDURE. Unreinforced masonry designed in accordance with Sec. 12A.6.1 shall be assumed to be cracked in the tension zone. The resultant linear distribution of compressive stresses must be in equilibrium with the applied forces and the maximum compressive stress must not exceed the values of Table 12A-3.

EXCEPTION:
Bed joints of unreinforced vertical components constructed using stacked bond, which are subjected to bending in the plane of the component, shall remain uncracked.

12.2.1 Cont.

(B) ALTERNATE DESIGN PROCEDURE. For unreinforced masonry designed in accordance with Sec. 12A.6.2 limit the ratio of e/t for bending in one direction and the ratio R_e for bending about both principal axes to 1/6. To satisfy these ratios, the stiffness and strength of all masonry that would otherwise be in a tension zone may be ignored and the calculations carried out as if it did not exist.

EXCEPTION:
Cracked bed joints are not permitted in unreinforced vertical components constructed using stacked bond which are subjected to bending in the plane of the component. Therefore the procedure of the last sentence of the above paragraph is not permitted for unreinforced stacked bond components subjected to in-plane bending.

12.2.3 REINFORCED MASONRY, WHEN SPECIFICALLY REQUIRED, SHALL BE REINFORCED WITH A MINIMUM AMOUNT OF REINFORCEMENT IN ACCORDANCE WITH THIS SECTION.

(A) When specified, horizontal reinforcement not less than 0.2 square inches in area shall be provided at the top of wall opening, at structurally connected roof and floor levels and at the top of parapet walls. Vertical reinforcement not less than 0.2 square inches in area shall be provided on all sides of, and adjacent to, every opening which exceeds 24 inches in either direction, at all corners, and at the ends of walls. Bars around openings shall extend not less than their development length, but not less than 24 inches, beyond the corners of the opening.

(B) When specified, a minimum amount of reinforcement shall be required in addition to the requirements of Section 12.2.3.(A). This additional reinforcement shall be in both the vertical and horizontal directions. The sum of the areas of reinforcement in both directions shall be at least equal to 0.002 times the gross cross section area of the masonry with at least 0.0007 times the gross cross SECTIONAL area of the masonry in each direction.

The maximum spacing of reinforcement shall be 48 inches on center. Only reinforcement that is continuous in the wall shall be considered in computing the minimum area of reinforcement.

Reinforcement required by Section 12.2.2.(A), if continuous in the wall element, may be considered a part of the required minimum steel.

12.3 SEISMIC PERFORMANCE CATEGORY A

Buildings assigned to Category A may be of any construction permitted in Chapter 12A.

12.4 SEISMIC PERFORMANCE CATEGORY B

Buildings assigned to Category B shall conform to all the requirements for Category A and to the additional requirements and limitations of this Section.

12.4.1 CONSTRUCTION LIMITATIONS

Masonry components shall be constructed to conform to the limitations of this Section.

(A) ~~HEIGHT-LIMITATION~~. REINFORCEMENT. Components of the seismic resisting system in buildings shall be reinforced masonry and conform to 12.2.2 (A).

(B) TIES. In addition to the requirements of Sec. 12A.6.3(F), additional ties shall be provided around anchor bolts which are set in the top of a column or pilaster. Such ties shall engage the bolts and at least four vertical column bars for reinforced masonry. Such ties shall be located within the top 4 inches of the member and shall consist of not less than two No. 4 or three No. 3 ties.

~~(C) SHEAR WALLS. Shear walls shall conform to the requirements of Sec. 12.7~~.

~~EXCEPTION:~~
The ~~reinforcement provisions of Sec. 12.7.1 need not apply to partially reinforced masonry designed as unreinforced masonry~~.

(D) SCREEN WALLS. All screen walls shall be reinforced. Joint reinforcement shall be considered effective in resisting stresses. The units of a panel shall be so arranged that either the horizontal or the vertical joint containing reinforcing is continuous without offset. This continuous joint shall be reinforced with a minimum steel area of 0.03 square inch. Reinforcement shall be embedded in mortar or grout.

Joint reinforcing may be composed of two wires made with welded ladder or trussed wire cross ties. In calculating the resisting capacity of the system, compression and tension in the spaced wires may be utilized. ~~Ladder wire reinforcing shall not be spliced and shall be the widest that the mortar joint will accommodate allowing 1/2-inch of mortar cover~~.

12.4.1 Cont.

(E) NONSTRUCTURAL COMPONENTS. Nonstructural walls, partitions, and components shall be designed to support themselves and to resist seismic forces induced by their own weight. Holes and openings shall be suitably stiffened and strengthened. Nonstructural walls and partitions shall be anchored in accordance with the requirements of Sec. 12A.2.6.

~~(F) CONSTRUCTION TYPE. Cavity wall construction shall not be used for any structural masonry.~~

12.4.2 MATERIAL LIMITATIONS

The following materials shall not be used for any structural masonry:

Unburned clay masonry

Building Brick and Hollow Brick made from clay or shale of Grade NW

Sand-Lime Building Brick other than grades SW and MW

Concrete Building Brick and Solid Load-Bearing Concrete Masonry Units, other than Grade N

Hollow Load-Bearing Concrete Masonry Units, other than Grade N

~~Structural Clay Load-Bearing Wall Tile~~

Masonry Cement (for mortar and grout)

Mortars ~~other than~~ Types ~~M or S~~ O OR K

12.5 SEISMIC PERFORMANCE CATEGORY C

Buildings assigned to Category C shall conform to all of the requirements for Category B and to the additional requirements and limitations of this Section.

12.5.1 CONSTRUCTION LIMITATIONS

Masonry components shall be constructed to conform to the limitations of this Section.

(A) REINFORCEMENT. All masonry shall be reinforced masonry and conform to 12.2.2 (A).

(B) TIE ANCHORAGES. In addition to the requirements of Sec. 12A.6.3(D) for tie anchorages, a minimum turn of 135 degrees plus an extension of at least 6 tie diameters but not less than 4 inches at the free end of the tie shall be provided.

(C) REINFORCED COLUMNS. In addition to the requirements of Sec. 12.6.3(F) for reinforced masonry columns, no longitudinal bar shall be farther than 6 inches from a laterally supported bar. Except at corner bars, ties providing lateral support may be in the form of cross-ties engaging bars at opposite sides of the column.

The tie spacing for the full height of masonry shear wall boundary columns and all other columns stressed by tensile or compressive axial overturning forces due to seismic effects and for the tops and bottoms of all other columns for a distance of 1/6 of clear column height but not less than 18 inches nor the maximum column dimension shall be not greater than 16 bar diameters nor 8 inches. Tie spacing for the remaining column height shall be not greater than 16 bar diameters, 48 tie diameters, or the least column dimension, but not more than 18 inches.

(D) SHEAR WALLS. Shear walls shall conform to the requirements of of Sec. 12.7.

EXCEPTION:
Shear walls in one and two family residences, one or two stories in height.

12.5.1 Cont.

(E) SHEAR WALL BOUNDARY ELEMENTS. Boundary members shall conform to one of the following:

1. Sec. 11.8.4 when of reinforced concrete or structural steel.
2. Sec. 12.5.1(C) when of masonry.

~~(E) JOINT REINFORCEMENT. Longitudinal masonry joint reinforcement may be used in reinforced grouted masonry and reinforced hollow unit masonry only to fulfill minimum reinforcement ratios but shall not be considered in the determination of the strength of the member.~~

(F) STACKED BOND CONSTRUCTION. The minimum ratio of horizontal reinforcement shall be 0.0007 for all structural walls of stacked bond construction. The maximum spacing of horizontal reinforcing shall not exceed 24 inches. Where reinforced hollow unit construction forms part of the seismic resisting system, the construction shall be grouted solid and all head joints shall be made solid through the use of open end units.

12.5.2 MATERIAL LIMITATIONS

The following materials shall not be used for any structural ~~or nonstructural~~ purpose:

All the materials listed in Sec. 12.4.2

Structural Clay Nonload-bearing Wall Tile

Glass Units

12.6 SEISMIC PERFORMANCE CATEGORY D

Buildings assigned to Category D shall conform to all of the requirements for Category C and to the additional requirements and limitations of this Section.

12.6.1 CONSTRUCTION LIMITATIONS

Masonry components shall be reinforced masonry and conform to Sec. 12.2.2(B). Materials for mortar and grout for structural masonry shall be measured in suitable calibrated devices. ~~Shovel measurements are not acceptable. An approved admixture of a type that reduces early water loss and produces a net expansion action shall be used for grout for structural masonry unless it can be demonstrated that shrinkage cracks will not develop in the grout.~~ The thickness of the grout between masonry units and reinforcing shall be a minimum of 1/2 inch for structural masonry.

(A) MINIMUM GROUT SPACE FOR ~~GROUTED MASONRY~~. BETWEEN WYTHES. The minimum grout space between wythes for ~~structural~~ reinforced ~~grouted~~ masonry shall be ~~2-1/2~~ 1-1/2 inches for low-lift construction and ~~3-1/2~~ 2 inches for high-lift construction.

(B) REINFORCED HOLLOW UNIT MASONRY. Structural reinforced hollow unit masonry shall conform to requirements below:

1. Wythes and elements shall be at least 6 inches in nominal thickness with clear, unobstructed continuous vertical cells, without offsets, large enough to enclose a circle of at least 3-~~1/2~~ inches in diameter ~~and with a minimum area of 15 square inches~~.

2. ~~All grout shall be coarse grout~~. Grout consolidation shall be by mechanical vibration only. All grout shall be reconsolidated after excess moisture has been absorbed but before workability has been lost.

12.6.1 Cont.

3. Vertical reinforcement shall be securely held in position at tops, bottoms, splices, and at intervals not exceeding 112 bar diameters. Approved intermediate centering clips or caging devices shall be used in high-lift construction, as required, to hold the vertical bars. Horizontal wall reinforcement shall be securely tied to the vertical reinforcement or held in place during grouting by equivalent means.

4. In wythes of less than 10-inch nominal thickness, in any vertical cell, there shall be a maximum of one No. 10 bar or two No. 8 bars with splices staggered for the two-bar situation.

5. The first exception of Sec. 12A.6.3(F) shall not apply; minimum nominal column dimension shall be 12 inches.

(C) STACKED BOND CONSTRUCTION. All stacked bond construction shall conform to the following requirements:

1. The minimum ratio of horizontal reinforcement shall be 0.0007 for nonstructural masonry and 0.0015 for structural masonry. The maximum spacing of horizontal reinforcing shall not exceed 48 inches for nonstructural masonry nor 24 inches for structural masonry.

2. Reinforced hollow unit construction which is part of the seismic resisting system shall (1) be grouted solid, (2) use double open end (H block) units so that all head joints are made solid, and (3) use bond beam units to facilitate the flow of grout.

3. Other reinforced hollow unit construction used structurally, but not part of the seismic resisting system, shall be grouted solid and all head joints shall be made solid by the use of open end units.

12.6.2 MATERIAL LIMITATIONS

Hollow nonload-bearing concrete masonry units shall not be used. Sand-lime building brick shall not be used for any structural masonry.

12.6.3 SPECIAL INSPECTION

Special inspection shall be provided for all structural masonry.

12.7 SHEAR WALL REQUIREMENTS

Shear walls shall comply with the requirements of this Section, when referenced.

12.7.1 REINFORCEMENT

The minimum ratio of reinforcement for shear walls shall be 0.0015 in each direction. The maximum spacing of reinforcement in each direction shall be the smaller of the following dimensions: one-third the length and height of the element but not more than 32 inches. The area and spacing of reinforcement perpendicular to the shear reinforcement shall be at least equal to that of the required shear reinforcement. The portion of the reinforcement required to resist shear shall be uniformly distributed.

EXCEPTION:
For shear walls constructed using running bond, the ratio of reinforcement may be decreased to 0.0007 provided that all shear is resisted by the reinforcement. The sum of the ratios of horizontal and vertical reinforcement shall not be less than 0.002.

12.7.2 BOUNDARY MEMBERS

Where cross walls or boundary members form a part of the shear wall system, the intersections shall be constructed as required for the walls themselves. Connections to concrete shall conform to Sec. 12A.2.1. Where the boundary members are of structural steel, the shear transfer between the wall and the boundary member shall be developed by fully encasing the element in grout, by dowels, bolts, or shear lugs, or by similar approved methods.

When the structural system, as described in Chapter 3 and Table 3-B, consists of substantially complete vertical load-carrying frame, boundary members shall be provided at each end of the wall. The members shall be of the same construction as the frame columns. Where the frame is a special moment frame, those columns shall conform to the requirements for such members in Chapters 10 and 11. Also see Sec. 12.5.1(D) for Category C & D.

The required vertical boundary members and such other similar vertical elements as may be required shall be designed to carry all the vertical forces resulting from the wall loads, the tributary dead and live loads, and the seismic forces prescribed in these provisions.

Horizontal reinforcing in the walls shall be anchored to the vertical elements. Where the boundary element is structural steel this shall be accomplished by welding or by extension, with bends if required, into grout fully surrounding the column.

12.7.3 COMPRESSIVE STRESSES

For loading combinations including in-plane seismic forces, allowable compression stresses at any point shall not exceed those allowed for flexural compression. For unreinforced masonry designed by Sec. 12A.6.1, the allowable ~~working stress~~ values are given in Table 12A-3. The allowable working stress values for reinforced masonry shall be the allowable working stresses given in Table 12A-5 and applicable reductions for slenderness effects shall apply. The minimum horizontal distance between lateral supports may be considered for walls as well as the minimum vertical distance. ~~Formula 12A-7 shall not be used.~~

> ~~EXCEPTION~~:
> ~~For pier type wall elements that do not extend from floor to floor compression stresses under combined loading at any point may be limited to those allowed for flexural compression provided that Formula 12A-7 is also satisfied~~.

12.7.4 HORIZONTAL COMPONENTS

When shear reinforcing is required for loads that include seismic effects and diagonal bars conforming to Sec. 12A.6.4(D) are not provided, reinforcement approximately perpendicular to the required shear reinforcement shall be provided equal in amount and spaced not further apart than is required for the shear reinforcing. Horizontal reinforcing shall anchor into or be continuous through the ~~pier~~ elements. Horizontal components may be separated from the shear wall system by means of ~~true~~ joints. The joints shall provide for building movement determined in accordance with Sec. 3.8. The horizontal components shall be anchored to the building and designed as otherwise required by these provisions.

EXHIBIT I

March 19, 1980

TO: Co-Chairmen G.Hanson and J. G. Stockbridge
Committee 5, Masonry
Review and Refinement of ATC-3

FROM: Task Committee Chairman, M. H. Mark

SUBJECT: Mortar
Cavity Walls
Alternate Procedure(s)

The Task Committee consisted of A. H. Yurkdale, J. E. Amrhein, M. Hogan, J. L. Noland and myself. Our subject charges were viewed broadly; however, the alternate procedure(s) were considered limited to unreinforced construction and design only.

Recommendations and options are attached. These represent a majority view of Amrhein, Noland and myself, but since work was done by phone and mail, I may not have accurately represented all the views of Amrhein and Noland. I am sure they will call any differences of opinion to the full Committees' attention. I have been unable to get Yorkdale's views. Hogan's views differ especially on the alternate procedure(s); he will present them to you.

The recommendations and options will be explained at our meeting.

Respectfully Submitted,

Melvyn H. Mark

pp 123 & 124 (Mortar)

(Delete reference if 12A-1A & B deleted)

12A.1.16 MORTAR

Mortar shall be prepared in accordance with either of the procedures given below:

- The Property Specifications of ASTM C270 may be used with acceptability based upon the properties of both the ingredients and samples of mortar mixed and tested in the laboratory using the proportions and materials proposed for use. Compressive strengths shall not be less than required by Table 12A-1A.
- The Proportion Specifications of ASTM C270 may be used with acceptability based upon the properties of the ingredients, the water retention of laboratory mixed and tested samples, and the proportions of the ingredients summarized in Table 12A-1B.

Where mortar colors are used or where minimum compressive strengths are required for mortar used in the work, only the Property Specifications shall be used. Field tests shall conform to Sec. 12A.7 and 12A.8.2.

Where the source or the proportions of ingredients for mortar, classified in accordance with the Property Specifications, are intended to be changed during the course of the work, acceptability of the new mortar shall be reestablished in accordance with ASTM C270.

ASTM C270 Types O and K mortar shall not be used. (Decision?)

Masonry units used in foundation walls and footings shall be laid up in Type N, S or Type M mortar. See Sec. 12A.3 and Chapter 12 for further limitations.

(Suggest leaving as revised.) (See Committee change.)
(Not req'd if O & K eliminated)

Admixtures shall be added only after approval by the Regulatory Agency. Coloring ingredients shall be limited to inert mineral or inorganic synthetic compounds not exceeding 15 percent of the weight of cement or carbon black not exceeding 3 percent of the weight of cement.

To maintain plasticity, mortar may be retempered with water by the method of forming a basin in the mortar and reworking it. However, any mortar which has become ~~[illegible] shall not be used in the work.~~ hardened or stiffened due to hydration of the cement shall not be used.

(Note: Task Committee majority decision is to eliminate O & K mortar in Chap 12, certainly in Chap 12. Reasons will be explained.)

EXHIBIT I

P.157 (Mortar)

(Note that proposed changes herein differ from the other draft changes.)

12A.8.2 ~~TESTS-FOR-GROUT-AND-MORTAR~~ GROUT TESTS AND FIELD MORTAR TESTS

Tests for grout and field mortar shall conform to this Section.

(¶ A remains.)

(Delete ¶ B and replace with:)

(B) FIELD MORTAR SAMPLES FOR COMPRESSION TESTS. Spread a ½ inch layer of mortar on masonry units having the same moisture conditions as those being laid. Place a masonry unit on top of the mortar and press to achieve a 3/8 inch mortar joint. After pressing let stand for 2 minutes if the mortar contains 5/8 parts of lime to cement by volume or less; let stand 3 minutes if the mix containes more lime. Immediately remove mortar and place in a 2 inch round by 4 inch high cylinder mold (or a 2 inch cube mold), compressing the mortar using a flat stick or fingers. Lightly tap mold and level off. Immediately cover mold on opposite sides and keep it damp until taken to the laboratory. After 48 hours, the laboratory shall remove the mortar specimen from the mold and place it in a fog room until tested in the damp condition.

(¶ C remains.)

(D) COMPRESSION TESTS. Excluding curing, storage, and test age requirements, compression testing procedures for field mortar cubes shall conform to Sec. 8.6.2, 8.6.3, and 9 of ASTM C109. Procedures for field mortar cylinders and for grout shall conform to Sec. A6.3.3 through A.6.3.6, A.6.4, and A.6.5 of ASTM C780.

(Add a new ¶ as follows:)

(E) REQUIRED STRENGTHS. Unless higher strengths are required by the construction documents, minimum required strengths shall be 2000 psi for grout, 1500 psi for field mortar cylinders (and 2000 psi for field mortar cubes).

CORRECTIONS APPEARING ON PAGE 159 (Mortar)

TABLE 12A-1A

Mortar Type	Minimum Average Compressive Strength at 28 Days
M	2,500
S	1,800
N	750
O	350
K	75

?

UNDER TABLE 12A-1B

Hydrated Lime ½
or Lime Putty

DELETE SENTENCE BEGINNING WITH "When plastic --- ending with "the volume of cement."

ADD IN THE CHART

?

Mortar Type	Portland Cement	Masonry Cement	Hydrated Lime or Lime Putty	Aggregate Measured in a Damp, Loose Condition
O	1	1	--	over 1¼ to 2½
K	1	--		over 2½ to 4

(Shall the entire table, 12A-1A & 12A-1B, be retained?)

Cavity Walls

P.140

(Add a new Sec.12.A.6.1(H) as follows:)

(H) LOADS PERPENDICULAR CAVITY WALLS. The distribution to each cavity wall wythe of loads perpendicular to the plane of the wall shall consider relative wythe flexural rigidities, wythe end support conditions, and continuity or lack of continuity of each wythe.

P.160, Table 12A-2

(Three options are available for Chap. 12A. Only option #2 or #3 should be in Chap. 12.)

Option	T	Max h/T
1	$T=(T_o - W_c)$	18
2	$T=2/3(T_o-W_c)$	20
3	$T=\sqrt{t_1^2 + t_2^2}$	20

need to define t_1 and t_2

(If option 3 is chosen, the definitions require rewording.)

ALTERNATE PROCEDURES

(Note: Task Committee majority recommends not to put references in the "Commentary" but rather in the text. Reasons will be explained.)

P.137:

(B) ALLOWABLE STRESSES FOR MASONRY. Except for unreinforced ~~brick~~ masonry designed under the provisions of Sec. 12A.6.2, the allowable stresses for unreinforced masonry are given in Table 12A-3 and for reinforced masonry the allowable stresses are given in Table 12A-5.

P.138:

12A.6.1 DESIGN PROCEDURE FOR UNREINFORCED MASONRY

The design of unreinforced masonry shall be based upon a rational analysis using accepted engineering practice and linear stress and strain relationships. ~~An~~ Alternate procedures for design ~~is~~ are given in Sec. 12A.6.2.

PP.140 - 142:

(Replace Sec. 12A.6.2 with the following:)

12A.6.2 ALTERNATE DESIGN PROCEDURES FOR UNREINFORCED MASONRY

Unreinforced brick masonry using solid clay units and unreinforced concrete masonry may be designed by the alternate provisions following. The requirements of Sec. 12A.6.1 shall apply except as specifically modified.

(A) UNREINFORCED BRICK MASONRY USING SOLID CLAY UNITS.

Unreinforced brick masonry using solid clay units may be designed under the applicable cited provisions of the "Building Code Requirements for Engineered Brick Masonry", Brick Institute of America, 1969 (BIA-1969) subject to the design and construction limitations listed.

1. Design shall conform to BIA-1969 Sec. 4.7.1 through 4.7.12 excluding Sec. 4.7.9, 4.7.10 and 4.7.12.5.

2. Materials shall conform to BIA-1969 Sec. 2.2.1 and 2.2.2.1.

3. Mortar joints shall conform to BIA-1969 Sec. 5.2.1

4. Construction shall be solid masonry, cavity wall or grouted masonry - multiple wythe.

5. Allowable stresses shall conform to BIA-1969 Table 3 with the following modifications:

a. The words "without inspection" of BIA-1969 Table 3 shall mean "without special inspection". The words "with inspection" shall mean "with special inspection".

b. Allowable compressive and bearing stresses without special inspection shall be 2/3 of those with special inspection.

c. Allowable flexural tension stresses without special inspection shall be 1/2 of those with special inspection.

d. Allowable shear stresses without special inspection shall be 60% of those with special inspection.

6. Modulii of Elasticity shall conform to Table 12A-5, this chapter.

7. Masonry compressive strength f'_m for use in the alternate procedure shall be 73% of the values obtained by the provisions of Sec. 12A.5.a(A) of this chapter which otherwise are applicable.

8. References to BIA-1969 Sec. 4.7.9 and 4.7.10 shall mean reinforced masonry conforming to the provisions for same of this chapter.

9. Footnote 4 to Table 12A-4 is applicable.

10. The Slenderness requirements of Sec. 12A.4.2 this chapter shall be satisfied; however these requirements and the slenderness limits of the alternate procedure may be waived in accordance with Sec. 1.5 of Chap. 1. Particular care shall be paid to requirements for stress and stability under reduced vertical loads.

11. For walls and elements subject to bending in one direction only, where the ratio e/t exceeds 1/3, the maximum tension and flexural compression stresses, assuming linear stress distribution, shall not be exceeded.

12. Design of shear walls shall comply with all applicable provisions of this chapter. Loading combinations shall include reduced vertical loads in combination with seismic loads, where applicable. The allowable shear stress increase shall consider this vertical load reduction.

(B) UNREINFORCED CONCRETE MASONRY.

Unreinforced concrete masonry using solid or hollow units and grouted or ungrouted construction, may be designed using the applicable cited supplemental provisions of the "Specification for the Design and Construction of Load-Bearing Concrete Masonry", National Concrete Masonry Assoc., 1979 (NCMA - 1979) subject to the design and construction limitations listed.

1. Design shall conform to NCMA - 1979 Sec. 3.3.1 and Sec.3.8.6 through 3.8.8 except that allowable stresses and resistances therein are for work only with special inspection; for work without special inspection they shall be reduced 50%

2. Allowable shear and tension stresses shall conform to Table 12A-3, this chapter.

3. Mortar shall conform to NCMA-1979 Sec. 2.2.2.2.

4. Joints shall conform to NCMA-1979 Sec. 4.2.3.2.

P.165:

Delete Table 12A-7.

Applied Technology Council 2150 SHATTUCK AVE., SUITE 806 BERKELEY, CALIFORNIA 94704 (415) 540-0223
A Nonprofit Corporation

ATC

EXHIBIT J

RLM

May 7, 1980

ATC-3-3

TO: ATC REVIEW AND REFINEMENT
COMMITTEE 5: MASONRY

FROM: RON MAYES
MEL MARK

SUBJECT: ATC COMMENTS ON BALLOT ITEMS FOR CHAPTERS 12 AND 12A

Enclosed are Applied Technology Council comments on some of the ballot items for Chapters 12 and 12A. Also enclosed are the ballot sheets which are marked as we would have voted. You will note we have added an abstention column. The purpose of this is for ballot items on which we do not have a definite "yes" or "no" position. Many of these items are commented upon in the detailed comments. It should also be noted that some of the ballot items for which we have voted "yes" also have comments. We believe these comments will help clarify the provisions.

Please note our comments about what effect the lack of a definition for the term "reinforced masonry" would have if some of these ballot items pass. Also note that, if the term "partially reinforced masonry" is deleted, editorial changes to Table 3-B are needed.

We apologize for not having the enclosed material available to you prior to the balloting deadline; however, it should be of value to the deliberations at our next meeting.

ATC Review and Refinement
Committee No. 5: Masonry

etter Ballot No. 2

Issued: March 28, 1980
Due: April 21, 1980

Ballot Item Number	Yes	No*	Abstain	Comments
12-1	X			
12-2			X	
12-3	X			
12-4		X		
12-5	X			
12-6		X		
12-7		X		
12-8		X		
12-9	X			
12-10	~~X~~		X	
12-11	~~X~~		X	

*Please include comments for at least this category.

Name: ________________

Signature: ________________

Date: ________________

EXHIBIT J

ATC Review and Refinement
Committee No. 5: Masonry

Letter Ballot No. 1

Issued: March 20, 1980
Due: April 14, 1980

Ballot Item Number	Mel Mark Comment Number	Abstain	Yes	No *	Comments
1			X		
2			X		
3			X		
4				X	
5			X		
6				X	
7				X	
8		X			
9				X	
10			X		
11			X		
12		X			
13			X		
14		X			
15		X			

* Please include comments for at least this category.

Name: ____________________

Signature: ____________________

Date: ____________________

Ballot Item Number	Mel Mark Comment Number	Abstain	Yes	No *	Comments
16		X			
17		X			
18			X		
19		X			
20		X			
21				X	
22		X			
23		X			
24				X	
25			X		
26		X			
27	1		X		
28	2			X	
29	3			X	
30			X		
31	4			X	
32	5	X			
33	6			X	
34	7			X	
35	7		X		
36	8		X		
37	9, 10		X		
38	11, 12			X	
39		X			
40		X	X		
41				X	
42	15	X			
43	14			X	

Ballot Item Number	Comment Number	Abstain	Yes	No *	Comments
44	15			X	
45			X		
46		X			
47			X		
48	16			X	
49	17			X	
50			X		
51	18			X	
52	19	X			
53			X		
54		X			
55			X		
56	20			X	
57	21			X	
58		X			
59			X		
60				X	
61	22			X	
62	23			X	
63	24			X	
64	25			X	
65	26			X	
66	26		X		
67	27			X	
68	28			X	
69	29			X	
70	30			X	
					Initials:

Ballot Item Number	Comment Number	Abstain	Yes	No *	Comments
71	31			X	
72				X	
73	32	X			
74		X			
75	33	X			
76				X	
77		X			
78				X	
79			X		
80				X	
81			X		
82			X		
83				X	
84			X		
~~85~~					
86			X		
~~87~~					
88			X		
89				X	
90		X			
91				X	
92				X	
93			X		
94			X		
95			X		
96			X		
97			X		
					Initials: ____

Ballot Item Number	Comment Number	Abstain	Yes	No *	Comments
98			X		
99			X		
100			X		
101			X		
102			X		
103		X			
104			X		
105			X		
106		X			
107	34			X	
108			X		
109			X		
110		X			
111				X	
112		X			
113				X	
114				X	
115				X	
116			X		
117		X			
118			X		
119			X		
120				X	
121			X		
122		X			
123				X	
124				X	
					Initials: ___

Ballot Item Number	Comment Number	Abstain	Yes	No *	Comments
125				X	
126		X			
127				X	
128				X	
129			X		
130				X	
131				X	
132		X			
133		X			
134		X			
135		X			
136				X	
137				X	
138				X	
139				X	
140		X			
~~141~~					
142		~~X~~	X		
143				X	
144				X	
145				X	
146				X	
147				X	
148		~~X~~		X	
149				X	
150			X		
151			X		
					Initials:

Ballot Item Number	Comment Number	Abstain	Yes	No *	Comments
152			X		
153			X		
154				X	
155	35			X	
~~156~~	36				
~~157~~	37				
~~158~~	38				
159			X		
160	39			X	
161	40	X			

We vote yes on all the modified and n
ballot items except 155A & 155B, where
we vote no

Initials:

APPLIED TECHNOLOGY COUNCIL
COMMENTS ON COMMITTEE 5 BALLOT

CHAPTER 12

Ballot Number(s)	ATC Vote	ATC Comment
12-2	Abstain	(A) This also applies to concrete masonry under its alternate design procedure. (B) We believe that deletion of this alternate procedure for seismic design makes the design very conservative. The alternate procedure significantly liberalizes accepted procedures in a manner consistent with good seismic practice. We recommend this item not be included with Ballot No. 12-3 but be retained.
12-3	Yes(?)	We believe that this section is adequate but needs some polishing and additions. It requires a lead-in paragraph, such as the following: Reinforced masonry shall be designed and constructed in accordance with one of the following procedures and the provisions of other Sections of this Chapter. The first two sentences of (2) should be amended as follows: (2) Masonry designed and reinforced as required and containing nominal prescribed reinforcing: Construction shall be grouted masonry-multi-wythe or hollow-unit masonry containing reinforcement as specified below. p. 112 (2nd), second paragraph, first sentence, "12" should be "12A". Same page, add the following to the last sentence on the page. 12A-2 except that the maximum ratio of height or length to thickness for structural walls shall not exceed 25.
12-4	No	ATC vehemently believes that this ballot item should not pass. The inference, based on the changes to Tables 1-A and 1-B assumed by the Committee, is that unreinforced masonry is permitted in Map Area 3 with an Effective Peak Acceleration up to 0.15g. It should be remembered that, although the EPA for Map Area

APPLIED TECHNOLOGY COUNCIL
COMMENTS ON COMMITTEE 5 BALLOT
Page 2

Ballot Number(s)	ATC Vote	ATC Comment
12-4 (Cont.)		is 0.10g, this is a lower bound and it includes EPA values up to 0.15g. Refer to Mayes notes on the shaking table tests of masonry houses to see that minimum reinforcement is recommended for EPA's above 0.10g. Assuming the recent actions of Committee 2 with respect to Tables 1-A and 1-B are final, the proposed changes are meaningless. Committee 2 voted for no changes to these tables. The existing tables do not permit SPC A construction in Map Areas 2 and 3. A reasonable compromise might be to allow "existing national masonry standards" for SPC A if it applies only to Map Area 1 as now set up. This would be similar to the Zone 0 proposal which failed. It should be noted, though that the term is so vague it could be successfully argued that it should not appear in a document otherwise worded for enforcement purposes.
12-6	No	There is no test data to justify moving this from SPC C. It has not been shown that this reinforcement is effective in resisting in-plane forces and therefore this should remain conservative until proven otherwise.
12-7	No	ATC agrees with the removal of the word "nonstructural", provided a list for nonstructural is added. ATC also recommends that items not yet discussed in SPC B be added to the structural list. ATC therefore recommends the following: The following materials shall not be used for any any structural purpose: Unburned Clay Masonry Structural Clay Load-bearing Wall Tile Building Brick and Hollow Brick made from Clay or Shale of Grade NW Concrete Building Brick and Solid Load-bearing Concrete Masonry Units other than Grade N Hollow Load-bearing Concrete Masonry Units other than Grade N Masonry Cement (for mortar and grout) Mortar Types N, O and K (Note: List dependent on outcome of Chapter.12A ballot)

Ballot Number(s)	ATC Vote	ATC Comment
12-7 (Cont.)		The following materials shall not be used for any nonstructural purpose Glass Units Unburned Clay Masonry Structural Clay Load-bearing and Nonload-bearing Wall Tile Masonry Cement (for mortar and grout) Mortar Types N, O and K (Note: List dependent on outcome of Chapter 12A ballot.) For SPC D, the following should be added to the first sentence of Sec. 12.6.2: Building Brick and Hollow Brick made from Clay or Shale of Grade NW, Building Brick and Solid Load-bearing Concrete Masonry Units other than Grade N and Hollow Load-bearing Concrete Masonry Units other than Grade N.
12-8	No	This is currently accepted practice for the types of construction covered by this provision.
12-9	Yes(?)	ATC agrees with the provision but notes that it should read as follows(with the word "shear" inserted). The following reinforcement requirements apply to <u>shear</u> walls....

APPLIED TECHNOLOGY COUNCIL

COMMENTS ON COMMITTEE 5 BALLOT

CHAPTER 12A

Ballot Number(s)	ATC Vote	ATC Comment
4, 6, 7	No	Unless the term "load-bearing" is editorially revised in Chapter 12A, these definitions are needed. If it could be assured that the terms were completely editorially removed, the definitions could be removed.
none	No	No ballot item was included for the definition "Masonry" (A) and (B), which follows "load-bearing". The use of these terms is inconsistent with the policy of the Committee set for the revision of Chapter 12, Sec. 12.2.1(B). These terms were to be referred to by section-number reference. Also; these terms are inconsistant with the terms used in Table 3-B.
8	Abstain	This must be adequately covered in Chapter 12.
9	No	"Reinforced masonry" needs some definition so that the form of construction referred to in Sec. 12A.6.3 and the allowable stresses of Table 12A-4 are defined. The only definitions now appear in Chapter 12, yet Chapter 12A must stand alone.
13	Yes	The edition of the UBC and other standards should be defined.
14	Abstain	The references being deleted still appear in the text.
15	Abstain	This term does not appear to be used in Chapter 12A. If it does not, it should be deleted.
16	Abstain	This definition conflicts with other definitions of "h" used in the text.
17	Abstain	Same comment as for 15.
18	Yes	Because of other terminology changes, the words "grouted masonry" should be changed to "grouted masonry—multiple wythes" both in the definition and the text. If the 100psi requirement is deleted here, it must be included in Chapter 12.

APPLIED TECHNOLOGY COUNCIL
COMMENTS ON COMMITTEE 5 BALLOT
Page 2

Ballot Number(s)	ATC Vote	ATC Comment
20	Abstain	If deleted here, this item must be included in an appropriate SPC in Chapter 12.
21	No	ASTM C270 limits cements for mortar, not grout. It does not allow type V cement, which can be used for grout. It does allow masonry cement, which is not suitable for grout. If this change is allowed, Sec. 12A.1.17(B) should be revised to permit only portland cement or blended hydraulic cement. Note that the UBC and BIA codes allow only portland cement for grout.
22	Abstain	The exception may be deleted; however, it does appear in the UBC—apparently to address certain problems. It is permissive, not restrictive.
23	Abstain	If approved, ASTM C5 and C51 should be deleted from Sec. 12A.1.2.
24	No	This ballot item is incorrect as it does not reflect the Committee's decisions reached in Denver based the Task Committee's Report. The decision reached in Denver was as follows: a. The sentence deleting Types O and K mortar was to remain. b. The sentence regarding mortar in foundation walls was to be deleted. c. The remainder of the text was to remain as in the ATC-3 Report. ATC supports the above decisions reached in Denver, but not the ballot item.
28	No	The purpose of this provision is to obtain workable grout yet not to have excessive water which will compound the shrinkage problem. These provisions are quite liberal and if deleted here should be included in SPC C in Chapter 12.
29	No	Apparently no standards exist for mixers. Performance criteria will allow the inspector to order obviously defective equipment off the job. If removed here, consideration should be given to inserting this in Chapter 12.

APPLIED TECHNOLOGY COUNCIL
COMMENTS ON COMMITTEE 5 BALLOT
Page 3

Ballot Number(s)	ATC Vote	ATC Comment
31	No	Substantive change for dampening concrete units during excessively hot and dry weather. Under these conditions, concrete units tend to suck water from mortar too rapidly. Excessive dust will reduce mortar and grout bond. Prefer that these two provisions be retained. Other changes delete cross references.
32	Abstain	To be considered "solid masonry", all joints should be filled. "Unless otherwise approved" would allow special construction. This could be moved to Sec. 12A.3.3.
33	No	Floor slabs or spandrel beams within walls should not be treated different from foundations. Highly stressed masonry in columns and pilasters should be continuous for the vertical load. If deleted here, this should be inserted in Chapter 12.
34	No	Paragraph substitution does not address the problem and is redundant as this is covered in 12A.2. The problem is separation of the concrete and the masonry due to lack of bond and shear for shear walls. Procedure is the same as for concrete cold joints. This is necessary for seismic-resistant construction. If removed here, it should be inserted in Chapter 12.
38	No	We believe this ballot item should have been two separate ballot items. We believe Item 3 should be retained but agree with the deletion of the paragraph which follows it.
40	Abstain	Does "other coatings" mean galvanizing.
41	No	"Approved locations" and "as indicated on the drawings" are two independent considerations. The word "and" should remain.
42	Abstain	The reference document should be listed in Sec. 12A.1.2.
43	No	"Templates" provides a standard for "approved equivalent means". If deleted here, this should be inserted in Chapter 12.

APPLIED TECHNOLOGY COUNCIL
COMMENTS ON COMMITTEE 5 BALLOT
Page 4

Ballot Number(s)	ATC Vote	ATC Comment
44	No	Five-eights and smaller bolts require only 4 in. embedment. Ties 4 in. down will not be effective.
46	Abstain	Does this change exclude sand-lime units?
48	No	First sentence: Proposed wording could permit defining almost any type of masonry construction as "grouted masonry" and to include any types of units such as hollow, tile, etc. ATC wording defines "grouted masonry" consistent with provisions of UBC, SBCC, and common usage. "Allowable stresses" are for the ATC definition which should be retained. Second sentence: Allowable stresses of Tables 12A-3 and 12A-5 are for Types M and S mortars only. Type N mortar could be used for unreinforced construction in SPC A buildings using the allowable compressive stresses of the SBCC; however, appropriate allowables for shear and tension are lacking. ATC wording should be retained. Third sentence: The sentence is needed so addition of steel in any haphazard way will not qualify the the construction as being "reinforced". Sec. 12A.3.5(C) does not set reinforcing amounts; it just describes the construction. This sentence should remain. If this ballot item passes, appropriate definitions must be included in Chapter 12.
49	No	This provision is from State of California requirements for schools. If deleted here, it should be included in Chapter 12 under SPC C. Note that the BI of California handbook recommends that no toothing be used without the permission of the Architect or Engineer.
51	No	This ballot item should have been two ballot items. The first sentence could be deleted as it is redundant. The second sentence very definitely should be retained.
52	Abstain	Floaters should be used in the thick grout of low-lift construction in view of grout shrinkage. Puddling is used instead of vibration. This

APPLIED TECHNOLOGY COUNCIL
COMMENTS ON COMMITEE 5 BALLOT
Page 5

Ballot Number(s)	ATC Vote	ATC Comment
52 (cont.)		requirement can be moved to Chapter 12. The sentence regarding cover should be retained; however, it can be reduced to 3/4 in. per BI of California recommendations.
54	Abstain	This ballot item is a redundancy.
56	No	Leaving out every other unit follows approved 1976 UBC code change wording by the masonry industry. Fin and foreign matter removal procedures are suggestions, conforming to the ACI 531 Commentary, as to what is required. This could be removed; however, the word "other" allows alternatives. The sentence regarding "Material falling, etc." is axiomatic. Successful high-lift work requires the special procedures of this paragraph. It should be retained or inserted in Chapter 12.
57	No	UBC and ATC require a 3 in. minimum grout space for reinforced high-lift work. The California school requirement is 3-1/2 in. The UBC provisions for high lift are believed to be based on masonry industry studies which apparently included the 3 in. space and the 3-day cure. ATC wording should very definitely be retained. If it is not retained here, it should be added to Chapter 12.
60	No	The extra references refer to the main part of the document and should be removed; however, consideration should be given to adding relevant parts of Sec. 1.6.2 and 1.6.4 to Sec. 12A.7.
61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71		Also see individual comments on each ballot item. These will have to be incorporated in Chapter 12 if they are deleted from Chapter 12A.
61	No	Unless the principal bar reinforcing is embedded in grout, the form of construction will be other than that commonly known as "reinforced grouted masonry—multiple wythe" and that tested as such. This is the only form of construction shown in the BI of California handbook and the ACI 531 Commentary as "reinforced grouted masonry—multiple wythe". The

APPLIED TECHNOLOGY COUNCIL
COMMENTS ON COMMITTEE 5 BALLOT
Page 6

Ballot Number(s)	ATC Vote	ATC Comment
61 (Cont.)		proponents of this change should explain just what they have in mind and how it actually conforms to this type of construction as commonly used and tested; the ATC wording very definitely should be retained. The BI of California handbook recommends that "all vertical reinforcing steel must be accurately placed and properly braced by mechanical devices to maintain correct positions shown on the plans". Due to this recommendation, the wording "by a frame or suitable equivalent devices" is used and should be retained. The last sentence can be deleted.
62	No	One-half-inch clearance is needed to prevent segregation of coarse grout (with 3/8 pea gravel) in the narrow grout spaces. ATC wording should be retained.
63	No	This paragraph is needed so addition of steel in just any fashion to hollow unit construction will not qualify the construction as being reinforced. The construction described here and in Sec. 12A.3.6(A) following conforms to that commonly known as "hollow unit work" and that tested as such. The paragraph should be retained.
64	No	Title: There may be a real problem with the title. Sec. 12A.3.6, following the UBC, recognized only <u>ungrouted</u> unreinforced work. Allowable stresses of Table 12A-3 apparently are only set up for this form. If 12A.3.6 is to allow unreinforced <u>grouted</u> hollow unit construction, then more revisions may be required in the allowable stresses and other areas. Cell Width: UBC, State of California schoolhouse requirements, and ACI 531 Commentary specify 2 in. minimum. Colorado Masonry Institute specifies 1-3/4 in. minimum. ACI 531 Commentary recommends 3 in. for high lift. With reinforcement, 1-1/2 in. is actually too tight for ordinary work.

APPLIED TECHNOLOGY COUNCIL
COMMENTS ON COMMITTEE 5 BALLOT
Page 7

Ballot Number(s)	ATC Vote	ATC Comment
65	No	Research, field problems, and one significant law suit have clearly demonstrated the need for removing mortar fins. A similar provision appears in the UBC and the Colorado Masonry Institute Standard. The ATC paragraph should be retained.
66	Yes	The additional paragraph, as suggested, is needed in view of the revisions to Sec. 12.1.17(B)2.
67 ~~66~~	No	The term "bond beams" commonly refers to a reinforced beam-type element at floors and walls. The term "bond beam units" is correct. These are needed to obtain grout coverage over rinforcement in partially grouted work and to aid in grout flow in fully grouted work.
68	No	Same comment as for 62.
69	No	State of California schoolhouse requirements, based on experience with the high lift method, limit the total pour to 12 ft. for 8-in. walls and 16 ft. for 12-in. walls. ACI Commentary Sec. 6.4 places the limit at 12 ft. The ATC provision is more liberal and should be retained.
70	No	Same comment as for 56.
71	No	Demonstration walls made to qualify the high lift technique and the State of California schoolhouse requirements, based on experience, include grouting in one pour without cold joints. The word "shall" should be retained.
72	No	Same comment as for 60.
73	Abstain	Change must be coordinated with Ballot Item 12-3.
75	Abstain	UBC requires Type S mortar. SBCC requires Type M, S, or N mortar. Suggest "M, S, or N" mortar to be permissive. Note that SBCC requires joint reinforcement for exterior panels. ATC does not. Suggest joint reinforcement be added for Category B in Chapter 12.

APPLIED TECHNOLOGY COUNCIL
COMMENTS ON COMMITTEE 5 BALLOT
Page 8

Ballot Number(s)	ATC Vote	ATC Comment
76	No	This should be addressed in Chapter 12 if it is deleted here.
78	No	Even if the ballot items for Table 12A-2 pass, reference to the table requirements is needed. Suggest alternative wording as follows: All masonry walls shall be designed so that allowable stresses are not exceeded and so that the provisions of Table 12A-2 are satisfied. If deleted here, this should be addressed in Chapter 12.
80	No	If deleted here, this should be addressed in Chapter 12.
83	No	The additional wording is obvious whereas the additions are not to many engineers. The masonry wall does not know if vertical shear is induced by shear wall effects or by gravity effects—it will behave the same. If the deletions are passed, the additional wording should be included in Chapter 12.
89	No	Wording is consistent with not allowing vertical shear through continuous vertical stacked bond head joints.
91	No	Barring a strain-compatibility analysis, the presumptive value for j should be conservative. For balanced reinforcing, it will be about 0.85. The value of 0.9 is unconservative. The change is acceptable if 0.85 is used.
92	No	The basic principles apply to walls as well as to beams. Utilization of bond beam units is good practice. The ATC wording is more descriptive; i.e., the "masonry" shall not be assumed to resist shear.
103	Abstain	ATC recommends leaving in the word "it".

APPLIED TECHNOLOGY COUNCIL
COMMENTS ON COMMITTEE 5 BALLOT
Page 9

Ballot Number(s)	ATC Vote	ATC Comment
106	No ~~Abstain~~ typo error	For seismic design, provisions should be based on the assumption that all bars will yield. This assumption is not really necessary for nonseismic design. If the changes pass, revisions are necessary in Chapter 12. This also applies to the unnumbered change near the top of p. 148.
107	No	The same comment for 106 applies to changing f_y to f_s in 107. We believe the formula in Item 107 should not have the $\sqrt{f_g}$ term which would put it in agreement with ACI 531. Similarly, it is believed what is wanted for the formula near the top of p. 148 is $.002\ d_b\ f_s$. These two formulas give quite short lengths for large bars when compared to ACI 318 lengths. This doesn't make sense. It is probably the result of the assumed 160psi bond stress (as indicated in the ACI 531R Commentary). Is this bond value applicable to large bars considering that bond failure is really a splitting of the masonry. Even the earlier outdated concepts of UBC use 140psi and 100psi. The symbol "f_s" should be defined as the "specified or calculated bar stress". This should also be picked up in the third paragraph of page 148.
111	No	The proposed change is unjustified and leads to ridiculous results when compared to ACI 318 requirements for concrete. At a slenderness ratio of 25, ACI 318 Eq. (14-1) for walls reduces to an allowable stress of 0.134 f'_c using the Alternate (working stress) Design Method and to 0.151 f'_c using a U factor, averaged for dead and live loads, of 1.55. At the same slenderness ratio, the proposed coefficient would allow a masonry stress of 0.170 f'_m. Considering the amount of reinforcing in masonry vs. concrete, workmanship, the questionability of the prism test and general knowledge, the allowable for masonry should not be higher than that for concrete. Changes of this magnitude should not be considered unless adequately justified by test results. ATC strongly recommends that this change not be passed. If passed, rework ϕ factor.
113, 114	No	These proposed changes delete the most significant requirements which establish what is commonly accepted; what is in practically all codes and standards;

APPLIED TECHNOLOGY COUNCIL
COMMENTS ON COMMITTEE 5 BALLOT
Page 10

Ballot Number(s)	ATC Vote	ATC Comment
113, 114 (cont.)		what has been built as and what has been tested as "reinforced" masonry. Without these requirements "reinforced masonry" lacks definition. Additionally, the allowable stresses for "reinforced masonry" will now lack a standard for construction to which they should be applicable. Replacement of these requirements in Chapter 12 is not sufficient, as Chapter 12A must stand by itself. These proposed changes will in essence invalidate Chapter 12A with respect to reinforced masonry. ATC strongly recommends that this not pass.
115	No	As with ballot item 111, the proposed change is not validated with test results and should therefore not be considered. Comparing short 12 in. x 12 in. columns with no eccentricity, $f'_m = f'_c = 6000$psi and 4 - #10 Gd 60 rebars, the masonry column is allowed 97-1/2% of the load the concrete column can take under the Alternate (working stress) Design Method. The spread should be greater. Traditionally, masonry codes have allowed about 80% of wall loads for the design of columns. This is well-justified when consideration is given to prism tests. In addition to other drawbacks of prism tests, the ratio of grout to masonry unit cross-sectional area in prisms usually reflects the ratio for wall construction, not the larger ratio usually existing for columns. If this change passes, the ϕ factor of Chapter 12 should be reduced. There are two errors in Sec. 12A.6.3(F) which do need correction. First, the slenderness reduction term of Eq. 12A-12 should read: $\left[1 - \left(\frac{h}{40t}\right)^3\right]$ Second, a sentence should be added at the end of the beginning paragraph as follows: No masonry column shall have an unsupported length greater than 20 times its least dimension.

APPLIED TECHNOLOGY COUNCIL
COMMENTS ON COMMITTEE 5 BALLOT
Page 11

Ballot Number(s)	ATC Vote	ATC Comment
120	No	ATC recommends a change in wording to handle the problem for large columns which may have a hollow core. The recommended change is: Longitudinal reinforcing shall be solidly embedded in grout.
123	No	ATC recommends a change in wording in the paragraph that is moved. Instead of "standard hook at the end of wall sections" as currently on the ballot, change this to "standard hook which terminates beyond the boundary reinforcing".
124	No	The reference to the BIA procedure is needed. The new section to be referenced is Sec. 12A.6.2(A). The reference to Chapter 12 can be deleted.
125	No	If tension is not allowed, what would be the anchorage for unreinforced walls other than the addition of reinforcement?
127	No	For reinforced walls, shear is based on an effective depth or jd. If the change passes, this provision should be moved to Chapter 12; however, the principle holds for wind and other nonseismic lateral loads. See ACI 318, Sec. 11.10.4.
128	No	The words to be deleted are needed to define critical sections in hollow unit work.
130, 131	No	If deleted here, should be included in Chapter 12.
133	Abstain	The last sentence is needed. This could be moved to Chapter 12.
136	No	No objection to the changes to the title and the sentence following it. The following comments are made assuming ballot item 136 applies to the three paragraphs under the first bullet. The proposed changes delete tests for mortar and grout. If f'_m is not to be established by prism tests and is under 2600psi, inclusion of this deleted wording would give an alternate to making prism tests. This is a less-costly alternative. If this wording is retained

Ballot Number(s)	ATC Vote	ATC Comment
136 (cont.)		in the first paragraph, then the full wording of the second paragraph is needed. The ATC wording closely follows that of the UBC but removes the conflict between UBC Sec. 3.05(a)6 and UBC Sec. 2404(c)2.A, second paragraph. Thus it is more liberal than the UBC and the proposed changes.
137	No	This wording, as well as similar wording in the ATC-3 report is set up for regulatory-body use. For consistancy, it should be retained.
138	No	Tests are required only for grouted masonry—multiple wythe using special inspection stresses. If moved to Chapter 12, it should apply to SPC B.
139	No	The deleted sentence is needed so that prisms represent the actual walls insofar as is possible.
140	Yes	The second word of the title is "TESTS"
141 Modified	Yes	Sixth line, "contains" is misspelled.
142	Yes	In the first paragraph of Sec. 12A.8.3, words "grouted masonry" should be changed to "grouted masonry—multiple wythe".
143	No	The 100psi is needed since Chapter 12A must stand by itself without Chapter 12. Unless a pass-fail criteria exists, the tests are meaningless.
144, 145, 146	No	See comment on ballot item 24. The Committee decided to eliminate Types O and K mortar. Seven hundred fifty psi for Type N mortar is acceptable.
147	No	If this ballot item passes, the first column of minimum wall thicknesses should appear in Chapter 12. The two right-hand columns can be deleted.
148	No	This ballot item is in error as the footnote 1 reference at the end of the column heading should be retained as the footnote is to be retained. The word "unsupported" gives meaning to the requirements.

APPLIED TECHNOLOGY COUNCIL
COMMENTS ON COMMITTEE 5 BALLOT
Page 13

Ballot Number(s)	ATC Vote	ATC Comment
149	No	For cavity walls, a ratio of 20 was approved by the Committee to go along with the effective-thickness-formula change of ballot item 150A. The ratios of 36:1 for reinforced work are unjustified; U.S. building experience is with much stouter walls. Both UBC and ANSI A41.2 use 25. NCMA uses 30. If this change passes, Chapter 12 should restore the ratio of 25. Also see footnote 9.
150A	Yes	The h/t belongs in the first column of the table, not in the footnote. T = effective thickness t_1 = actual thickness of one wythe t_2 = actual thickness of the other wythe The symbol "h" is not needed here.
154	No	See comment for ballot item 149.
155A & B	No	The ATC drafts use the most commonly accepted factor for work without special inspection. If ballot items 111 for walls and 115 for columns pass along with these items, allowable stresses for work without special inspection will then be from 75% to 83% of stresses that were formally applicable to work done with special inspection. Stated another way, the allowables for work without special inspection would be increased by 50% to 66%. The higher values for both comparisons are applicable to columns. Clearly, such large increases require justification with test data. If passed, the ϕ factors of Chapter 12 should be revised downward.
160	No	Both ASTM C90-75 and C652-75 use gross strengths for hollow units.
161	Abstain	Why would this change be made? Where would this new footnote be referenced? Is it meant to be a standard head in lieu of the bend? Note that no pullout values are furnished.

APPLIED TECHNOLOGY COUNCIL
COMMENTS ON COMMITTEE 5 BALLOT
Page 14

Ballot Number(s)	ATC Vote	ATC Comment
155	No	The table is compiled from several sources including UBC, BIA and NCMA. The suggested substitute follows the TMS Draft. If the proposal were correct, it would suggest that the other data is erroneous. For instance, f'_m for solid clay units is generally greater than for solid concrete or sand-lime units. The higher strengths would include concrete units whereas both ACI 531 and NCMA have upper bounds at unit strengths of 6000psi. Both ASTM C90-75 and C652-75 use gross area strengths for hollow units; the table and footnote 4 are not applicable. It appears that if this new table were to be adopted, it should be justified with data for all the construction types it would include. ATC-3 footnotes 1 and 2 are deleted in the proposed revision. ATC footnote 1 requires that the strength of higher strength units be verified. Note that these strengths exceed the ASTM minimums and that manufacturer-supplied certifications could be acceptable in lieu of tests. Footnote 2 requires that field prisms be made and tested to verify only the higher assumed values of f'_m applicable to solid clay units. This is consistent with general practice for concrete.

1.

DESIGN, UNREINFORCED HOLLOW CLAY MASONRY

12A.6.2 (c) **GENERAL**

Unreinforced masonry using hollow clay units may be used when designed in accordance with the provisions of this section. The allowable stresses shown herein are for work only with special inspection, for work without special inspection these allowable stresses shall be reduced 50%.

12A.6.2 (c)1 **COMPRESSION IN WALLS AND COLUMNS**

A. AXIAL LOADS

Stresses due to compressive forces applied at the centroid of the member may be computed assuming uniform distribution over the effective area. The allowable axial compressive stress is given by:

$$F_a =).225\, f'_m \, [1-(h'/40t)^3] \qquad \text{Eq. 12A-1}$$

in which:

f'_m = ultimate compressive strength of masonry. For assumed values of f'_m use Table 12A-1.

h' = effective height

t = effective thickness (the minimum effective thickness in the case of columns

ASSUMED VALUES OF f'_m for use in Eq. 12A-1.

The design ultimate compressive stress of masonry, f'_m, ay be assumed based upon the compressive strength of the units and mortar to be used. Values of f'_m which may be assumed are presented in Tables 12A-1.

When the assumed value, (f'_m), used in the design exceeds 50% of the value for the appropriate unit strength and mortar type shown in Table 12A-1, the strength of the masonry shall be verified by prism tests in accordance with the provision of Section 12A.8 prior to construction.

TABLE 12A-1

ASSUMED DESIGN ULTIMATE STRENGTH OF MASONRY - f'_m (psi) - NET AREA STRENGTH

Compressive Strength of Units - psi[1]	Mortar Type[2]	
	M or S (1800 psi min.)	N (750 psi min.)
14000 or more	5300	3900
12000	4700	3300
10000	4000	2700
8000	3350	2100
6000	2700	1400
4000	2000	1200
2000	1350	900
1000	800	600

[1] Compressive strength of solid units is based on gross area. Compressive strength of hollow units is based on minimum net area.

[2] ASTM C270 - Mortar for Unit Masonry

B. BEARING STRESS (f_{br})

On full area, $F_{br} = .26\ f'_m$ Eq. 12A-2

On one-third area or less, $F_{br} = .38\ f'_m$ Eq. 12A-3

This increase shall be permitted only when the least distance between the edges of the loaded and unloaded area is a minimum of 1/4 of the parallel side dimension of the loaded area. The allowable bearing stress on a reasonably concentric area greater than one-third, but less than the full area shall be interpolated between the values given.

12A-6.2 (c)2. BENDING OR COMBINED BENDING AND AXIAL LOADS

Stresses due to combined bending and centroidally applied axial load shall satisfy the requirements of Section 12A.6.3(b) where F_a is given by Equation 12A-1.

12A.6.2 (c)3. FLEXURAL DESIGN

A. Tensile stresses due to flexural shall not exceed the values given in Section 12A.6.2.(c)3^B where:

$$f_b = Mc/I \qquad \text{Eq. 12A.4}$$

and:

f_b = computed flexural stress due to bending loads only.

M = design moment on a section.

c = distance from neutral axis to extreme fiber.

I = moment of inertia of the section considered.

B. TENSILE STRESS - FLEXURAL (F_t)

With no tensile reinforcement in masonry

Values for tension normal to head joints are for running bond; no tension is allowed across head joints in stack bond masonry.

Tension Normal to Bed Joints

	Clay Units
Hollow Units, F_t =	24

Tension Normal to Head Joints

4.

Hollow Units, F_t = 48 psi

Stresses are calculated in net areas

Compression stresses due to flexural (F_b) shall not exceed 0.33 f'_m.

12A.6.2(c) SHEAR IN FLEXURAL MEMBERS AND SHEAR WALLS

A. SHEAR IN FLEXURAL MEMBERS

$$v_m = V/A_e \qquad \text{Eq. 12A-5}$$

where:

v_m = design shear stress with no shear reinforcement. The allowable shear stresses, V_m, may be equl to $1.0\sqrt{f'_m}$ but not to exceed 50 psi.

V = total design force

A_e = effective area

Where v_m as computed by the foregoing equation exceeds the allowable shear stress, V_m, web reinforcement shall be provided and designed to carry the total shear force in accordance with the requirements of reinforced masonry in Section 12.6.3.(c).

B. SHEAR WALLS WITH NO SHEAR REINFORCEMENT SHALL BE DESIGNED USING THE FOLLOWING EQUATIONS:

No shear reinforcement

$$a/L < 1, \quad V_m = \frac{1}{3}\left[4 - \frac{a}{L}\right] f'_m, \ 50 \text{ max.} \qquad \text{Eq. 12A-6}$$

$$A/L \geq 1, \quad V_m = 1.0\sqrt{f'_m}, \ 35 \text{ max.} \qquad \text{Eq. 12A-7}$$

a = height of wall or segment for cantilevered condition, 1/2 height of wall or segment for fixed conditions top and bottom.

L = length of wall or segment.

The allowable shear stress in masonry may be increased by 0.2 f_{md}, where f_{md} is the compressive stress in masonry due to dead load only.

C. SHEAR WALL OVERTURNING

Not more than 2/3 of the dead load shall be used to resist overturning due to horizontal forces. Any resultant tensile stresses shall be resisted by reinforcing in accordance with the requirements of Section.

12A.6.2(c)5 CORBELS

The slope of corbelling (angle measured from the horizontal to the face of the corbelled surface) shall not be less than 60°.

The maximum horizontal projection of corbelling from the plane of the wall shall not exceed one-half the wythe thickness for cavity walls or one-half the wall thickness for other walls.

MEMO FROM

DONALD A. WAKEFIELD

I.B.DIV.

THIS COMPARISON SHEET COMPARES THE RECOMMENDED ASSUMED STRESSES FOR BSSC-ATC III-COMM 5 CODE WITH THE OTHER MASONRY CODES. ALL OF THE OTHER CODES EXCEPT TMS ALLOW HIGHER SHEAR & TENSILE STRESSES THAN BSSC.

CLEMSON UNIV. RESEARCH PROGRAM ON HOLLOW CLAY UNIT SHOW THAT THIS PROPOSAL IS CONSERVATIVE & VALID.

Don.

EXHIBIT K

ASSUMED DESIGN STRENGTH IN 12A-1 - TYPE M OR S MORTAR

Comp. strength of units	BSSC 12A f'_m	UBC RR 2730	BIA & UBC	ACI-531	TMS	Clemson
14000	5300		4600		5300	
12000	4700		4000		4700	
10000	4000	4000	3400		4000	5550 (S)
8000	3350	3300	2800		3350	6170 (M) for 9000 p of unit
6000	2700	2600	2200	2400	2700	
4000	2000	2000	1600	2000	2000	
2000	1350		1000	1350	1350	
1000	800			900	800	

TENSILE STRESSES - FLEXURAL - NO TENSILE REINFORCEMENT

HOLLOW UNITS USING Net areas

TENSION NORMAL TO BED JOINTS:

MORTAR TYPE	BSSC 12A	UBC	BIA	ACI-531	TMS	Clemson
M or S	24	36	36	$0.5\sqrt{m_o}$ MAX 25	12	$\frac{87}{3.63} = 24$
N	12	28			12	$\frac{70}{3.63} = 19.3$ S.F.

TENSION NORMAL TO HEAD JOINTS WITH RUNNING BOND

	BSSC 12A	UBC	BIA	ACI-531	TMS
M or S	48	72	72	$1.0\sqrt{m_o}$ MAX 50	24
N	24	56			24

SHEAR IN FLEXURAL MEMBERS

BSSC 12A	UBC	BIA	ACI-531	TMS
$1.0\sqrt{f'_m}$ MAX. 50	80	80	$1.1\sqrt{f'_m}$ MAX 50	$1.0\sqrt{f'_m}$ MAX 50

SHEAR WALLS

BSSC 12A	UBC	BIA	ACI-531	TMS	Clemson
M/VL < 1 - 50 MAX	$0.3\sqrt{f'_m}$	80	$2.0\sqrt{f'_m}$ MAX. 40	SAME AS BSSC	NO SUPERIMPOSED LOAD. $\frac{209}{35} = 6$ safety FACTORS
M/VL ≥ - 35 MAX	80 MAX	80	$0.9\sqrt{f'_m}$ MAX. 34		

International Conference of Building Officials

RESEARCH COMMITTEE RECOMMENDATION

Report No. 2730
April, 1974

HOLLOW BRICK OF CLAY OR SHALE
WESTERN STATES CLAY PRODUCTS ASSOCIATION
2550 BEVERLY BOULEVARD
LOS ANGELES, CALIFORNIA 90057

I. **Introduction:** At the request of the Western States Clay Products Association, Los Angeles, California, the Research Committee of the International Conference of Building Officials has made a re-examination of the data submitted in connection with Hollow Brick of Clay or Shale for use in reinforced grouted hollow unit masonry and reinforced grouted masonry.

II. **Description: General:** The Hollow Brick are fired clay or shale units made under two grades. Grade I brick, suitable for general use in facing masonry exposed to weather, and Grade II bricks intended for use as backup or interior facing and not suitable for exposure to weather. The Grade I and Grade II hollow brick shall conform to the following requirements:

1. **Coring:** (a) No part of any hole shall be less than ¾ inch from any edge of the brick, except for cored shell hollow brick and double shell hollow brick. Cores greater than 1 square inch in cored shells shall be not less than ½ inch from any edge. Cores not greater than 1 square inch in shells cored not more than 35 per cent shall be not less than ⅜ inch from any edge.

(b) Cells for reinforcement shall be not less than 2 inches in any dimension nor less than 5 square inches in area when containing one rebar nor 7 square inches for two bars or spliced bars.

(c) Face shells and webs shall be not less than as indicated in Table No. I.

Double shell hollow brick with inner and outer shells not less than ½ inch thick may have cells not greater than ⅝ inch in width nor 5 inches in length between the inner and outer shell.

(d) The thickness for webs between cells shall be not less than ½ inch, ⅜ inch between cells and cores nor ¼ inch between cores. The distance of voids from unexposed edges, which are recessed not less than ½ inch, shall be not less than ⅛ inch.

2. **Durability:** The durability of a brick in relation to its resistance to deterioration caused by freezing and thawing shall be determined by the physical property requirements in Table No. II or by the following requirements:

(a) If the average compressive strength is greater than 7000 psi on net area or the average absorption is less than 8 per cent after 24-hour submersion in cold water, the requirements for saturation coefficient in Table No. II shall be waived. The saturation coefficient shall be waived for use in areas where weathering index is 100 or less.

(b) The requirements set forth in Table No. II for water absorption (five-hour boiling) and saturation coefficient may be waived, provided a sample of five bricks meeting all other requirements, when subjected to the freeze and thawing test as specified in ASTM Standard C-67, results in no breakage and not more than 0.5 per cent loss in dry weight of any individual brick.

3. **Compressive Strength:** When greater compressive strengths than in Table No. II are prescribed, the purchaser shall specify the desired minimum compressive strength according to the designation given in Table No. III or as determined by Prism Test (Section 2404).

4. **Tolerance of Dimensions and Warpage:** The maximum permissible variation shall be as specified in U.B.C. Standard No. 24-1. Where a high degree of mechanical perfection is desired, the maximum permissible variation in dimension and warpage shall be one-half that permitted in U.B.C. Standard No. 24-1.

Design and Construction: The design and construction shall be in accordance with Chapter 24 for reinforced hollow unit masonry and reinforced masonry.

Fire Resistance: The fire-resistive time period for the units shall be as follows:

	NO PLASTER	⅝" PLASTER 1 Side	⅝" PLASTER 2 Sides
10" not continuously grouted	3 hours	4 hours	4 hours
8" solid grouted	4 hours	4 hours	4 hours
Grouted reinforcing & perlite grouted solid	4 hours	4 hours	4 hours
8" not continuously grouted	3 hours	4 hours	4 hours
6" solid grouted	3 hours	4 hours	4 hours
6" not continuously grouted	1 hour	2 hours	3 hours
4" solid grouted	1 hour	2 hours	3 hours

Identification: All bricks shall be packaged and identified with a stamp containing the following information:

(a) ICBO Research Report No. 2730.

(b) Date, compressive strength and identification of kiln firing.

III. **Evidence Submitted:** Descriptive data, drawings, compressive and absorption tests, shear tests and specifications are submitted.

Recommendation

IV. **Recommendation:** That the Hollow Brick of Clay or Shale are a satisfactory alternate method of construction to that specified in the Uniform Building Code provided the individual units comply with the material specifications and design requirements as set forth in Part II of this report.

This recommendation is subject to annual re-examination.

TABLE NO. III — COMPRESSIVE STRENGTH

DESIGNATION	COMPRESSIVE STRENGTH (p.s.i. Net Area)		f'_m
	Average of 5 Bricks	Individual Minimum	(See Footnote Number One)
Type I (Exposed)			
H 3000	3000 to 3999	2500	1800
H 4000	4000 to 4999	3200	2000
H 5000	5000 to 5999	4000	2300
H 6000	6000 to 6999	4800	2600
H 8000	8000 to 8999	6500	3300
H10,000	10,000 to 10,999	8500	4000
Type II only (Not Exposed)	2500 to 3000	2000	1500

[1]Where the assumed f'_m exceeds 2600 pounds per square inch, field tests in accordance with Section 2404 (c) 2 shall be required.

Applied Technology Council 2150 SHATTUCK AVE., SUITE 806 BERKELEY CALIFORNIA 94704 (415) 540-0223
A Nonprofit Corporation

ATC

EXHIBIT L

June 2, 1980

TO: ATC-3-06 REVIEW AND REFINEMENT COMMITTEE 5: MASONRY

FROM: RON MAYES

Enclosed is a working draft of Chapter 12 that contains provisions deleted from Chapter 12A that we believe should now be incorporated in Chapter 12. Because of the tight schedule Mel Mark has not had the opportunity to review the enclosed material.

Following this upcoming meeting, Mel and I request the opportunity to review the final drafts of both Chapters 12 and 12A to be sure that all relevant items are covered.

I have not marked the prior ballot items on this revision of Chapter 12. However, you will note that it includes ballot items 12-1, 12-2, 12-3, 12-5, 12-8, 12-9, 12-10 and 12-11.

The most controversial items of this draft will be the provisions for SPC B. If time permits, it may expedite matters if you are able to review the summary report on four masonry houses that I sent out with a memo on March 12, 1980. The conclusions of this study are that minimum reinforcement requirements (similar to our method 2 for reinforced design) are necessary for single-story houses in Map Area 3. The performance of an additional test may increase this to Map Area 4. Table 12-1, which specifies the type of reinforced design to be used in SPC B is based on the results of this study.

I look forward to seeing you all again at Gaithersburg.

Applied Technology Council 2150 SHATTUCK AVE., SUITE 806 BERKELEY, CALIFORNIA 94704 (415) 540-0223
A Nonprofit Corporation

EXHIBIT L

June 2, 1980

TO: ATC-3-06 REVIEW AND REFINEMENT COMMITTEE 5: MASONRY

FROM: RON MAYES

Enclosed is a working draft of Chapter 12 that contains provisions deleted from Chapter 12A that we believe should now be incorporated in Chapter 12. Because of the tight schedule Mel Mark has not had the opportunity to review the enclosed material.

Following this upcoming meeting, Mel and I request the opportunity to review the final drafts of both Chapters 12 and 12A to be sure that all relevant items are covered.

I have not marked the prior ballot items on this revision of Chapter 12. However, you will note that it includes ballot items 12-1, 12-2, 12-3, 12-5, 12-8, 12-9, 12-10 and 12-11.

The most controversial items of this draft will be the provisions for SPC B. If time permits, it may expedite matters if you are able to review the summary report on four masonry houses that I sent out with a memo on March 12, 1980. The conclusions of this study are that minimum reinforcement requirements (similar to our method 2 for reinforced design) are necessary for single-story houses in Map Area 3. The performance of an additional test may increase this to Map Area 4. Table 12-1, which specifies the type of reinforced design to be used in SPC B is based on the results of this study.

I look forward to seeing you all again at Gaithersburg.

EXHIBIT L

CHAPTER 12

MASONRY

BACKGROUND

The masonry design and construction procedures given in this Chapter and Chapter 12A are essential to providing the performance levels ~~implicit in the selection of the factors used in determining the seismic forces in these provisions. The requirements embodied in Chapters 12 and 12A have been demonstrated to be necessary by recent earthquakes and represent the latest developments in masonry construction to provide adequate seismic performance.~~ for the seismic forces exclusively for the purpose of this document.

12.1 REFERENCE DOCUMENTS

The quality and testing of masonry and steel materials and the design and construction of masonry and reinforced masonry components which resist seismic forces shall conform to the requirements of Chapter 12A and the references listed therein except as modified by the provisions of this Chapter. For definitions, see Sec. 12A.1.1.

12.2 STRENGTH OF MEMBERS AND CONNECTIONS

The strength of members and connections subjected to seismic forces acting alone or in combination with other prescribed loads shall be determined using a capacity reduction factor, ϕ, and 2.5 times the allowable working stresses of Chapter 12A. The value of ϕ shall be as follows:

When considering axial or flexural compression and bearing stresses in the masonry.	$\phi = 1.0$
For reinforcement stresses except when considering shear.	$\phi = 0.8$
When considering shear carried by shear reinforcement and bolts.	$\phi = 0.6$
When considering masonry tension parallel to the bed joints, i.e., horizontally in normal construction.	$\phi = 0.6$
When considering shear carried by the masonry.	$\phi = 0.4$
When considering masonry tension perpendicular to the bed joints, i.e., vertically in normal construction.	ϕ = Zero

Stresses entitled "special inspection" in Chapter 12A shall only be used when the work is fully inspected per Sec. 1.6.2, 1.6.4 and 12A.7. If f'_m is to be established by test, a minimum of three prism test series (as defined in 12A.8.1(B)) shall be made during the progress of the work.

12.2.1 SPECIAL DESIGN PROCEDURES FOR ~~UNREINFORCED~~ MASONRY SUBJECTED TO SEISMIC FORCES.

~~Unreinforced~~ Masonry shall be designed in accordance with this Section.

(A) ~~GENERAL~~ UNREINFORCED DESIGN PROCEDURE. Unreinforced masonry designed in accordance with Sec. 12A.6.1 shall be assumed to be cracked in the tension zone. The resultant linear distribution of compressive stresses must be in equilibrium with the applied forces and the maximum compressive stress must not exceed the values of Table 12A-3.

> EXCEPTION:
> Bed joints of unreinforced vertical components constructed using stacked bond, which are subjected to bending in the plane of the component, shall remain uncracked.

(B) REINFORCED MASONRY DESIGN. Reinforced masonry shall be designed and constructed in accordance with one of the following procedures and the provisions of other Sections of this Chapter.

1. Masonry designed and reinforced as required.

2. Masonry designed and reinforced as required and containing nominal prescribed reinforcing. Construction shall be grouted masonry -- multiwythe or hollow unit masonry containing reinforcement as specified below. Masonry joint reinforcement shall be, and ties may be, embedded in the mortar in the bed joints. All other reinforcement shall be embedded in grout. Minimum masonry, mortar, and grout coverages applicable to reinforced masonry shall be provided. This masonry shall be designed as unreinforced masonry, except that reinforced masonry areas or elements may be considered as resisting stresses in accordance with the design criteria specified for reinforced masonry provided such elements fully comply with the design and construction requirements for reinforced masonry except as herein noted; however, R factors of Table 3-B shall be as required for unreinforced masonry. Only Types M or S mortar shall be used.

Reinforcing for columns shall conform to the requirement of Sec. 12A.6.3(F). For walls the maximum spacing of vertical reinforcement shall be 8 feet where the nominal thickness is 8 inches or greater and 6 feet where the nominal thickness is less than 8 inches. Vertical reinforcement shall also be provided each side of each opening and at each corner of all walls. Horizontal reinforcement not less than 0.2 square inch in area shall be provided at the top of footings, at the bottom and top of wall openings, near roof and floor levels, and at the top of parapet walls and, where distributed joint reinforcement is not provided, at a maximum spacing of 12 feet where the nominal masonry thickness is 8 inches or greater and 9 feet where the nominal thickness is less than 8 inches. The vertical reinforcement ratio and the horizontal reinforcement ratio shall each be not less than 0.00027. Where not prohibited by Chapter 12A or this Chapter, stacked bond construction may be used. When stacked bond is used the minimum horizontal reinforcement ratio shall be increased to 0.0007. This ratio shall be satisfied by masonry joint reinforcement spaced not over 16 inches or by reinforcement embedded in grout spaced not over 4 feet. Reinforcement shall be continuous at wall corners and intersections.

Splices for reinforcement shall conform to all requirements for splices in reinforced masonry.

These types of masonry walls shall be considered as reinforced masonry for the purpose of applying Table 12A-2.

3. Masonry designed and reinforced with prescribed minimum areas. This additional reinforcement shall be in both horizontal and vertical directions. The sum of the areas of reinforcement in both directions shall be at least equal to 0.002 times the gross cross-section of the masonry with at least 0.0007 times the gross cross-sectional area of the masonry in each direction.

12.3 SEISMIC PERFORMANCE CATEGORY A

Buildings assigned to Category A may be of any construction permitted in Chapter 12A.

12.4 SEISMIC PERFORMANCE CATEGORY B

Buildings assigned to Category B shall conform to all the requirements for Category A and to the additional requirements and limitations of this Section.

12.4.1 CONSTRUCTION LIMITATIONS

Masonry components shall be constructed to conform to the limitations of this Section.

~~(A) HEIGHT LIMITATION. Components of the seismic resisting system in buildings under 35 feet in height shall be reinforced masonry when constructed using stacked bond and shall, as a minimum, be partially reinforced masonry when constructed using running bond. Components of the seismic resisting system in buildings over 35 feet in height shall be reinforced masonry and other structural components shall be partially reinforced masonry~~.

(A) DESIGN. Structural and nonstructural components of the building shall be designed and reinforced as specified in Table 12.1. The numbers designated 1, 2 and 3 in the Table refer to Sections (1), (2) and (3) of 12.2.2.

(B) TIES. In addition to the requirements of Sec. 12A.6.3(F), additional ties shall be provided around anchor bolts which are set in the top of a column or pilaster. Such ties shall engage the bolts and at least four vertical column bars for reinforced masonry. Such ties shall be located within the top 4 inches of the member and shall consist of not less than two No. 4 or three No. 3 ties.

~~(C) SHEAR WALLS. Shear walls shall conform to the requirements of Sec. 12.7.~~

~~[illegible]~~
~~The reinforcement provisions of Sec. [illegible]~~
~~reinforced [illegible] masonry.~~

(D) SCREEN WALLS. All screen walls shall be reinforced. Joint reinforcement shall be considered effective in resisting stresses. The units of a panel shall be so arranged that either the horizontal or the vertical joint containing reinforcing is continuous without offset. This continuous joint shall be reinforced with a minimum steel area of 0.03 square inch. Reinforcement shall be embedded in mortar or grout.

Joint reinforcing may be composed of two wires made with welded ladder or trussed wire cross ties. In calculating the resisting capacity of the system, compression and tension in the spaced wires may be utilized. Ladder wire reinforcing shall not be spliced and shall be the widest that the mortar joint will accommodate allowing 1/2-inch of mortar cover.

The maximum size of panels shall be 144 square feet with the maximum dimension in either direction of 15 feet. Each panel shall be supported on all edges by a structural member of concrete, masonry, or steel. Supports at the top and ends of the panel shall be by means of confinement of the masonry by at least 1/2 inch into and between the flanges of a steel channel. The space between the end of the panel and the web of the channel shall be at least 1/2 inch and shall be void of mortar. The use of equivalent configuration in other steel sections or in masonry or concrete is acceptable.

Horizontal and vertical joints shall be not less than 1/4 inch thick. All joints shall be completely filled with mortar and shall be shoved joints.

(E) NONSTRUCTURAL COMPONENTS. Nonstructural walls, partitions, and components shall be designed to support themselves and to resist seismic forces induced by their own weight. Holes and openings shall be suitably stiffened and strengthened. Nonstructural walls and partitions shall be anchored in accordance with the requirements of Sec. 12A.2.6.

(F) CONSTRUCTION TYPE. Cavity wall construction shall not be used for any structural masonry.

EXHIBIT L

(G) NOMINAL MINIMUM THICKNESS OF WALLS.

TYPE OF MASONRY	Walls whose only structural function is exterior enclosure, nonstructural walls, and partitions	Thickness for the uppermost 35[2] foot high portion of wall
STRUCTURAL WALLS:		
Unburned Clay Masonry	16	16
Stone Masonry	16	16
Cavity Wall Masonry	8	12[3]
Hollow Unit Masonry	8	12[3]
Solid Masonry	8	12[3,4]
Grouted Masonry	6	10[3,4]
Reinforced Grouted Masonry	6	6
Reinforced Hollow Unit Masonry	4[5]	6
NONSTRUCTURAL AND PARTITIONS:[1]		
Unreinforced	2	--
Reinforced	2	--

[1]The thickness of plaster coatings may be considered in satisfying thickness ratios and minimum thickness requirements but shall not be used to take stresses.

[2]Seventy feet for stone masonry.

[3]These thicknesses may be reduced to 8 inches for walls that are not over 35 feet in total height in buildings that are not over three stories high.

[4]These thicknesses may be reduced to 6 inches for grouted walls and 8 inches for solid masonry walls in one-story buildings when the wall is not over 9 feet in total height, provided that when gable construction is used an additional 6 feet in height is permitted to the peak of the gable.

[5]Nominal 4-inch-thick load-bearing reinforced hollow clay unit masonry walls with a maximum unsupported height or length to thickness of 27 may be permitted, provided net area unit strength exceeds 8000 psi, units are laid in running bond, bar sizes do not exceed 1/2 inch with no more than two bars or one splice in a cell, and joints are flush cut, concave or a protruding V-section. Minimum bar coverage where exposed to weather may be 1 1/2 inches.

(H) MASONRY WALLS. Masonry bearing wall thickness shall conform to (G) with a maximum h/t ratio of 25.

~~1. Stresses.~~ The axial stress in ~~reinforced~~ masonry bearing walls shall not exceed the value determined by the following formula:

$$f_m = 0.20\ f'_m\ [1 - (\frac{h}{40t})^3] \qquad \cancel{(12\text{-}11)}$$

where:

f_m = Compressive unit axial stress in masonry wall.

f'_m = Masonry compressive strength as determined by Sec. 12A.5.1. The value of f'_m shall not exceed 6000 psi.

t = Thickness of wall in inches.

h = Clear distance in inches, between supporting or stiffening elements (vertical or horizontal).

Effective height different from clear distance may be used if justified.

Other requirements are specified in 12A.6.3(E).

(I) REINFORCED MASONRY COLUMNS. Every structural wall or pier whose horizontal length is less than two times its thickness shall be designed and constructed as required for columns. The least dimension of every reinforced masonry column shall not be less than 12 inches and the maximum h/t ratio shall be 20.

EXCEPTION:
The minimum column dimension may be reduced to not less than 8 inches provided the design is based upon 1/2 the allowable stresses for axial load. Bending stresses need not be so reduced.

The axial load on columns shall not exceed:

$$P = A_g\ (0.18\ f'_m + 0.65\ p_g\ f_s)\ [(1 - \frac{h}{40t})^3] \qquad \cancel{(12\text{-}12)}$$

where:

P = Maximum concentric column axial load.

A_g = The gross area of the columns with deductions for rakes and similar joint treatments.

f'_m = Compresssive masonry strength as determined by Sec. 12A.5.1. The value of f'_m shall not exceed 6000 psi.

p_g = Ratio of the effective cross-sectional area of vertical reinforcement to A_g.

f_s = Allowable stress in reinforcement; see Sec. 12A.5.2.

t = Least thickness of column in inches.

h = Clear height in inches.

Other requirements are specified in 12A.6.3(F).

(J) GROUTED MASONRY--MULTIWYTHE. Grouted masonry is that form of construction made with brick or solid concrete units in which interior joints of masonry are filled by pouring grout therein as the work progresses. Only Type M or Type S mortar shall be used.

Toothing of masonry walls is permitted only when designed and detailed by the design engineer or architect and only at approved locations. Racking is to be held to a minimum.

When reinforced in accordance with the following requirements it shall be classified as reinforced grouted masonry --multiwythe. All required reinforcement except masonry joint reinforcement and column ties conforming to the paragraph below shall be embedded in grout. All other reinforcement shall be embedded in mortar or grout. All vertical reinforcement shall be held firmly in place during grouting by a frame or suitable equivalent devices. All horizontal reinforcement in the grout space shall be tied to the vertical reinforcement or held in place during grouting by equivalent means.

(K) HIGH LIFT GROUTED CONSTRUCTION. For grouted masonry -multiwythe construction cleanouts shall be provided for each pour by leaving out every other unit in the bottom tier of the section being poured. Other requirements are specified in 12A.3.4(B).

For hollow unit masonry construction cleanouts shall be provided for each pour by omitting face shells in the bottom course of each cell to be grouted. The grout lift shall not exceed 16 feet for walls 8 inches or more in nominal thickness nor 8 feet for thinner walls. Other requirements are specified in 12A.3.6(B).

(L) REQUIRED STRENGTHS FOR MORTAR AND GROUT. In addition to the requirements of Sec. 12A.8.2, minimum required strengths shall be 2000 psi for grout, 1500 psi for field mortar samples (2000 psi for field mortar cubes) unless higher strengths are required by the construction documents.

(M) JOINTS. All hollow units shall be laid with face shell bed joints and head joints filled solidly with mortar for a distance in from the face of the unit not less than the thickness of the face shells unless more stringent construction is required by this Chapter, Chapter 12A, or by design. Cross webs and end shells of all starter courses shall be bedded on mortar. This applies to units laid on foundations or floor slabs, and all courses of piers, columns, and pilasters.

Concrete abutting structural masonry such as at starter courses or at wall intersections not designed as true separation joints, shall be roughened to a full amplitude of 1/8 inch, and shall be bonded to the masonry per the requirements of this Chapter as if it were masonry. Unless keys are provided, vertical joints shall be considered to be stacked bond.

(N) GLASS MASONRY. Glass block shall be laid in Types M, S or N mortar. Both vertical and horizontal mortar joints shall be at least 1/4 inch and not more than 3/8 inch thick and shall be completely filled.

Glass block panels shall have reinforcement in the horizontal mortar joints, extending from end to end of mortar joints, but not across expansion joints, with any unavoidable joints spliced by lapping the reinforcement not less than six (6) inches. The reinforcement shall be spaced not more than two (2) feet apart vertically. In addition, reinforcements shall be placed in the joint immediately below and above any openings within a panel. The reinforcement shall consist of two (2) parallel, longitudinal, galvanized steel wires, No. 9 gage or larger, spaced two (2) inches apart, and having welded thereto No. 14 or heavier gage cross wires at intervals not exceeding eight (8) inches, or the equivalent approved by the Regulatory Authority.

(O) REINFORCEMENT DEVELOPMENT, ANCHORAGE AND SPLICES. The requirements of 12A.6.3(D) are applicable except that calculated stress shall be replaced with yield strength. The following subsections 1 and 2 replace subsections 5 and 7, respectively, in 12A.6.3(D).

EXHIBIT L

1. Development Lengths. The basic development length, l_d, for deformed reinforcement shall be at least $.06\ d_b^2\ f_y/\sqrt{f_g}$ but not less than 24 d_b for reinforcement of 40,000 psi yield strength nor $36d_b$ for reinforcement over 40,000 psi yield strength, nor less than 12 inches for reinforcing bars and 6 inches for masonry joint reinforcement where:

d_b = the diameter of the smaller bar spliced, inches.

f_y = the specified bar yield strength, psi.

f_g = the strength of the mortar or grout, as applicable, immediately surrounding the reinforcement but not more than the prism strength, psi.

Development lengths for plain reinforcing shall be twice that required for deformed reinforcement but not less than 12 inches.

EXCEPTIONS:
For deformed main compression reinforcement in columns that are not part of the seismic system, these values may be reduced to $18d_b$ for bars of 40,000 psi yield strength and and $27d_b$ for bars over 40,000 psi yield strength.
In flexural members that are not part of the primary lateral load resisting system the development lengths may be reduced where excess reinforcement is provided. For these cases, the previously determined development lengths may be multiplied by the ratio of the area of reinforcement required by design to that provided.

2. Splices. Splices shall be made only at such point and in such manner that the strength of the member will not be reduced. Splices shall be made by lapping the bars, by welding, or by mechanical connections. Lapped splices shall not be used for tension tie members.

Lengths of laps, in inches, for deformed reinforcement shall be at least $0.09\ d_b^2\ f_y/\sqrt{f_g}$ but not less than $40d_b$ for reinforcement of 40,000 psi yield strength nor less than 60 d_b for reinforcement over 40,000 psi yield strength, nor less than 12 inches for reinforcing bars and 9 inches for masonry joint reinforcement. Lap lengths for plain reinforcing shall be twice that required for deformed bars but not less than 12 inches. The terms d_b, f_y, and f_g shall be as defined in Sec. 124.6.3(D)5.

EXCEPTION:
For deformed main compression reinforcement in columns that are not part of the seismic system, the lap length may be reduced to $30d_b$ for bars of 40,000 psi yield strength and $45d_b$ for bars over 40,000 psi yield strength.

Welded or mechanical connections shall develop the yield strength of the bar in tension.

EXCEPTION:
For compression bars in columns that are not part of the seismic system and are not subject to flexure the compressive strength need only be developed.

(P) DISTRIBUTION OF CONCENTRATED LOADS. Concentrated loads shall not be considered to be distributed by metal ties in stacked bond construction, nor to be distributed across continuous vertical joints. This provision shall apply when considering overturning effects in shear walls if stacked bond is not prohibited.

12.4.2 MATERIAL LIMITATIONS.

The following materials shall not be used for any structural masonry:

Unburned Clay Masonry
Structural Clay Load Bearing Tile
Masonry Cement (Mortar and Grout)
Mortars other than types M or S.

12.5 SEISMIC PERFORMANCE CATEGORY C

Buildings assigned to Category C shall conform to all of the requirements for Category B and to the additional requirements and limitations of this Section.

12.5.1 CONSTRUCTION LIMITATIONS

Masonry components shall be constructed to conform to the limitations of this Section.

(A) REINFORCEMENT. All masonry shall be reinforced masonry.

(B) TIE ANCHORAGES. In addition to the requirements of Sec. 12A.6.3(C) for tie anchorages, a minimum turn of 135 degrees plus an extension of at least 6 tie diameters but not less than 4 inches at the free end of the tie shall be provided.

(C) REINFORCED COLUMNS. In addition to the requirements of Sec. 12.6.3 F, for reinforced masonry columns, no longitudinal bar shall be farther than 6 inches from a laterally supported bar. Except at corner bars, ties providing lateral support may be in the form of cross-ties engaging bars at opposite sides of the column.

The tie spacing for the full height of masonry shear wall boundary columns and all other columns stressed by tensile or compressive axial overturning forces due to seismic effects and for the tops and bottoms of all other columns for a distance of 1/6 of clear column height but not less than 18 inches nor the maximum column dimension shall be not greater than 16 bar diameters nor 8 inches. Tie spacing for the remaining column height shall be not greater than 16 bar diameters, 48 tie diameters, or the least column dimension, but not more than 18 inches.

(D) SHEAR WALL BOUNDARY ELEMENTS. Boundary members shall conform to one of the following:

1. Sec. 11.8.4 when of reinforced concrete or structural steel.
2. Sec. 12.5.1(C) when of masonry.

(E) JOINT REINFORCEMENT. Longitudinal masonry joint reinforcement may be used in reinforced grouted masonry and reinforced hollow unit masonry only to fulfill minimum reinforcement ratios but shall not be considered in the determination of the strength of the member.

(F) STACKED BOND CONSTRUCTION. The minimum ratio of horizontal reinforcement shall be 0.0015 for all structural walls of stacked bond construction. The maximum spacing of horizontal reinforcing shall not exceed 24 inches. Where reinforced hollow unit construction forms part of the seismic resisting system, the construction shall be grouted solid and all head joints shall be made solid through the use of open end units.

(G) PIERS. Every structural wall or pier in reinforced masonry construction whose horizontal length is between 3 and 5 times its thickness or less than 1/2 the height of adjacent openings shall have all horizontal steel in the form of ties except that in walls less than 12 inches in nominal thickness and in reinforced grouted construction such steel may be in one layer in the form of hairpins.

(H) HOLLOW UNIT MASONRY. Hollow unit masonry construction, where certain cells are continuously filled with concrete or grout, and reinforcement, in accordance with 12.2.2.(B)(3), is embedded therein shall be classified as reinforced hollow unit masonry. Reinforced hollow unit masonry shall generally be one wythe in thickness. If constructed of more than one wythe, each wythe shall be designed as a separate element or wall or the wythes shall be bonded together by means approved by the Regulatory Agency. This bonding shall be designed so the wythes shall act as a unit.

Vertical cells to be filled shall have vertical alignment sufficient to maintain a clear, unobstructed continuous vertical cell measuring not less than 2 inches by 3 inches. If walls are battered or if alignment is offset, the 2 inch by 3 inch clear opening shall be maintained as measured from course to course.

(I) BOLT PLACEMENT. Bolts shall be accurately set with templates or by approved equivalent means and held in place to prevent movement.

Vertical bolts at the top of and near the ends of reinforced masonry walls shall be set within hairpins or ties located within 2.5 inches from the top of the wall. See Sec. 12A.6.3(F) and 12.4.1(B) for bolts at the top of piers, pilasters, and columns.

(J) SHRINKAGE OF CONCRETE UNITS. Concrete masonry units used for structural purposes shall have a maximum linear shrinkage of 0.065 percent from the saturated to the oven-dry condition.

(K) GROUT. Grout shall have a consistency, considering the methods of consolidation to be utilized, to completely fill all spaces to be grouted without segregation except that slumps shall not be less than 4.5 inches for all grout nor more than 10 inches for fine grout or 9 inches for coarse grout.

Mixing equipment and procedures shall produce grout with the uniformity required for concrete by ASTM C94.

(L) ALLOWABLE STRESSES WITHOUT INSPECTION. The allowable stresses for uninspected reinforced construction shall be those given in Table 12A.5 except that the factor of 2/3 for axial compression in walls and columns shall be reduced to 1/2.

(M) CORE TESTS FOR SHEAR BOND IN GROUTED MASONRY-MULTIWYTHE. In addition to the requirements of Sec. 12A.8.3 the following provisions must be met for all grouted masonry-multiwythe construction.

The unit shear strength shall not be less than 100 psi. Where an unusual number of cores fail during the cutting operation, the design authority shall determine if the test program is extensive enough to satisfy the requirements of Sec. 12A.1.5.

One test series shall be made for each 5,000 square feet of wall or equivalent but not less than one series for any building.

12.5.2 MATERIAL LIMITATIONS.

The following materials shall not be used for any structural purpose:

Building Brick and Hollow Brick made from Clay or Shale of Grade NW

Concrete Building Brick and Solid Load-bearing Concrete Masonry Units other than Grade N

Hollow Load-bearing Concrete Masonry Units other than Grade N

Sand-lime Building Brick other than grades SW and NW

EXHIBIT L

The following materials shall not be used for any nonstructural purpose:

Glass Units

Unburned Clay Masonry

Structural Clay Load-bearing and Nonload-bearing Wall Tile

Masonry Cement (for mortar and grout)

Mortar Types N, O and K

12.6 SEISMIC PERFORMANCE CATEGORY D

Buildings assigned to Category D shall conform to all of the requirements for Category C and to the additional requirements and limitations of this Section.

12.6.1 CONSTRUCTION LIMITATIONS

Materials for mortar and grout for structural masonry shall be measured in suitable calibrated devices. ~~Shovel measurements are not acceptable.~~ An approved admixture of a type that reduces early water loss and produces a net expansion action shall be used for grout for structural masonry unless it can be demonstrated that shrinkage cracks will not develop in the grout. The thickness of the grout between masonry units and reinforcing shall be a minimum of 1/2 inch for structural masonry.

(A) MINIMUM GROUT SPACE FOR GROUTED MASONRY. The minimum grout space for structural reinforced grouted masonry shall be 2-1/2 inches for low-lift construction and 3-1/2 inches for high-lift construction.

(B) REINFORCED HOLLOW UNIT MASONRY. Structural reinforced hollow unit masonry shall conform to requirements below:

1. Wythes and elements shall be at least 8 inches in nominal thickness with clear, unobstructed continuous vertical cells, without offsets, large enough to enclose a circle of at least 3-1/2 inches in diameter and with a minimum area of 15 square inches.

2. All grout shall be coarse grout. Grout consolidation shall be by mechanical vibration only. All grout shall be reconsolidated after excess moisture has been absorbed but before workability has been lost.

3. Vertical reinforcement shall be securely held in position at tops, bottoms, splices, and at intervals not exceeding 112 bar diameters. Approved intermediate centering clips or caging devices shall be used in high-lift construction, as required, to hold the vertical bars. Horizontal wall reinforcement shall be securely tied to the vertical reinforcement or held in place during grouting by equivalent means.

4. In wythes of less than 10-inch nominal thickness, in any vertical cell, there shall be a maximum of one No. 10 bar or two No. 8 bars with splices staggered for the two-bar situation.

5. The first exception of Sec. 12A.6.3(F) shall not apply; minimum nominal column dimension shall be 12 inches.

(C) STACKED BOND CONSTRUCTION. All stacked bond construction shall conform to the following requirements:

1. The minimum ratio of horizontal reinforcement shall be 0.0015 for nonstructural masonry and 0.0025 for structural masonry. The maximum spacing of horizontal reinforcing shall not exceed 24 inches for nonstructural masonry nor 16 inches for structural masonry.

2. Reinforced hollow unit construction which is part of the seismic resisting system shall (1) be grouted solid, (2) use double open end (H block) units so that all head joints are made solid, and (3) use bond beam units to facilitate the flow of grout.

3. Other reinforced hollow unit construction used structurally, but not part of the seismic resisting system, shall be grouted solid and all head joints shall be made solid by the use of open end units.

12.6.2 MATERIAL LIMITATIONS

Hollow nonload-bearing concrete masonry units shall not be used. Sand-lime building brick ,other than Grade N, ~~shall not be used for any structural masonry~~. Building Brick and Hollow Brick made from Clay or Shale of Grade NW and Building Brick and Solid Load-bearing Concrete Masonry Units other than Grade N shall not be used for any structural masonry.

12.6.3 SPECIAL INSPECTION

Special inspection shall be provided for all structural masonry.

12.7 SHEAR WALL REQUIREMENTS

Shear walls shall comply with the requirements of this Section.

12.7.1 REINFORCEMENT

The following reinforcement requirements apply to shear walls required to comply with the provisions of 12.2.1(B)(3).

The minimum ratio of reinforcement for shear walls shall be 0.0015 in each direction. The maximum spacing of reinforcement in each direction shall be the smaller of the following dimensions: one-third the length and height of the element but not more than 48 inches. The area and spacing of reinforcement perpendicular to the shear reinforcement shall be at least equal to that of the required shear reinforcement. The portion of the reinforcement required to resist shear shall be uniformly distributed.

EXCEPTION:
For shear walls constructed using running bond, the ratio of reinforcement may be decreased to 0.0007 provided that all shear is resisted by the reinforcement. The sum of the ratios of horizontal and vertical reinforcement shall not be less than 0.002.

Reinforcement required to resist wall shear shall be terminated with a standard hook which terminates beyond the boundary reinforcing at the end of the wall sections. The hook may be turned up, down or horizontally and shall be embedded in mortar or grout. Wall reinforcement terminating in boundary columns or beams shall be fully anchored into the boundary elements.

Vertical stresses in shear walls shall be determined from the combined effects of vertical load and from the overturning effects of lateral loads. Minimum vertical loads shall be considered. Formula 3-2a shall be used for unreinforced masonry design.

In computing the shear resistance of the wall, only the web shall be considered. For unreinforced masonry the depth of the web may be considered out to out of flanges.

12.7.2 BOUNDARY MEMBERS

Where cross walls or boundary members form a part of the shear wall system, the intersections shall be constructed as required for the walls themselves. Connections to concrete shall conform to Sec. 12A.2.1. Where the boundary members are of structural steel, the shear transfer between the wall and the boundary member shall be developed by fully encasing the element in grout, by dowels, bolts, or shear lugs, or by similar approved methods.

When the structural system, as described in Chapter 3 and Table 3-B, consists of substantially complete vertical load-carrying frame, boundary members shall be provided at each end of the wall. The members shall be of the same construction as the frame columns. Where the frame is a special moment frame, those columns shall conform to the requirements for such members in Chapters 10 and 11. Also see Sec. 12.5.1(D) for Category C & D.

The required vertical boundary members and such other similar vertical elements as may be required shall be designed to carry all the vertical forces resulting from the wall loads, the tributary dead and live loads, and the seismic forces prescribed in these provisions.

Horizontal reinforcing in the walls shall be anchored to the vertical elements. Where the boundary element is structural steel this shall be accomplished by welding or by extension, with bends if required, into grout fully surrounding the column.

12.7.3 COMPRESSIVE STRESSES

For loading combinations including in-plane seismic forces, allowable compression stresses at any point shall not exceed those allowed for axial compression. For unreinforced masonry designed by Sec. 12A.6.1, the allowable working stress values are given in Table 12A-3. The allowable working stress values for reinforced masonry shall be the allowable working stresses given in Table 12A-5 and applicable reductions for slenderness effects shall apply. The minimum horizontal distance between lateral supports may be considered for walls as well as the minimum vertical distance. Formula 12A-7 shall not be used.

EXCEPTION:
For pier type wall elements that do not extend from floor to floor compression stresses under combined loading at any point may be limited to those allowed for flexural compression provided that Formula 12A-7 is also satisfied.

12.7.4 HORIZONTAL COMPONENTS

When shear reinforcing is required for loads that include seismic effects and diagonal bars conforming to Sec. 12A.6.4(D) are not provided, reinforcement approximately perpendicular to the required shear reinforcement shall be provided equal in amount and spaced not further apart than is required for the shear reinforcing. Horizontal reinforcing shall anchor into or be continuous through the pier elements. Horizontal components may be separated from the shear wall system by means of ~~true~~ joints. The joints shall provide for building movement determined in accordance with Sec. 3.8. The horizontal components shall be anchored to the building and designed as otherwise required by these provisions.

TABLE 12.1 DESIGN AND REINFORCEMENT REQUIREMENTS FOR SEISMIC PERFORMANCE CATEGORY B.

Type of Construction	Map Area 2		Map Area 3		Map Area 4	
	Buildings under 35 ft	Buildings over 35 ft	Buildings under 35 ft	Buildings over 35 ft	Buildings under 35 ft	Buildings over 35 ft
Structural Components						
Running Bond	1	2	2	2	2	3
Stacked Bond	2	2	3	3	3	3
Nonstructural Components						
Running Bond	1	1	1	1	2	2
Stacked Bond	1	1	1	2	2	2

Note: The numbers 1, 2 and 3 refer to Sections (1), (2) and (3) of 12.2.2.

Applied Technology Council 2150 SHATTUCK AVE., SUITE 306 BERKELEY, CALIFORNIA 94704 (415) 540-0223
A Nonprofit Corporation

ATC

EXHIBIT M

June 19, 1980

TO: ATC-3-06 REVIEW AND REFINEMENT
Committee 5 - Masonry

FROM: Ron Mayes

Enclosed is the assessment I said I would provide for the Committee of the allowable stresses for unreinforced masonry. This is obviously a very important matter for the Committee to finalize and my assessment validates the statement I made at the 6/6/80 meeting that the racking test data is being incorrectly applied. The recommended values I have proposed are a departure from current practice and if the proposed concept is adopted the specific recommended values will require a thorough review and analysis of existing test data before they are incorporated into the document.

I will be in Yugoslavia from June 26th until July 9th and will be available before or after these dates to discuss the enclosed material.

RM:mh

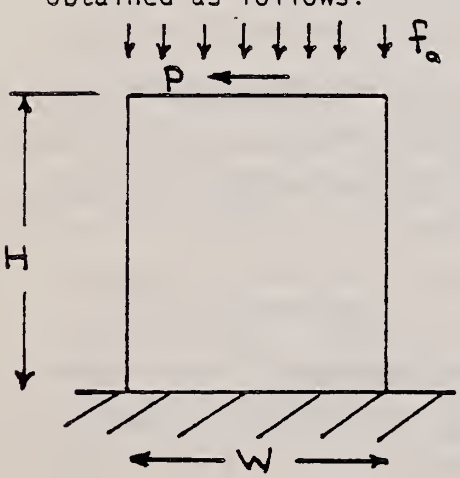
EXHIBIT M

ALLOWABLE SHEAR STRESSES IN UNREINFORCED WALLS

Ronald L. Mayes

At the 6/6/80 meeting of Committee 5, I expressed concern as to the applicability of the test methods used to determine the allowable shear stresses for unreinforced masonry. The NCMA code allowable stresses were derived from two different racking tests shown in Figures 1 and 3. I believe the BIA allowable stresses were obtained from the racking test shown in Figure 3. Many people have expressed concern with the test method shown in Figure 1 because of the unknown effect of the gradually increasing vertical force P_v. Consequently I believe we should not consider the results obtained using this test method and should concentrate our assessment on the validity of the diagonal compression test shown in Figure 3. Before this is done, an examination of the conditions under which shear stress governs the design of an element will be presented.

For unreinforced masonry Sec. 12.2.1 states that masonry shall be assummed to be cracked in the tension zone. That is no tension stresses are permitted. Under these conditions tension will govern the design of most elements until the vertical compressive stress reaches a critical value. To illustrate this a simple example of a cantilever element will be examined. The element has a height (H) and width (W) and thickness(T) and is subjected to a horizontal force (P) and axial compressive stress f_a. The ratio of the tension stress (f_t) to shear stress (f_v) can be obtained as follows:



$$f_t = \frac{M}{S}$$

where $M = PH \qquad S = \frac{w^2 t}{6}$

$$f_t = \frac{6PH}{w^2 t} \quad \text{and} \quad f_v = \frac{P}{wt}$$

$$\frac{f_t}{f_v} = 6 \left(\frac{H}{W}\right) \qquad \text{-------} \quad (1)$$

If we assume an allowable shear stress of 25 psi then $f_t = 150(\frac{H}{W})$ and shear would not govern until the axial compressive load was greater than $(150 \frac{H}{W})$ psi.

For squat walls say with a H/W ratio of 1 to 4, shear would govern only if the axial compressive stress (f_a) were greater than 37 psi. For a 1 to 1 ratio the axial compressive stress would have to be greater than 150 psi. Therefore for squat walls shear is more likely to govern. If it governs in more slender walls there will be a significant compressive load on the wall.

In lieu of this approximate assessment as to when shear stress governs in design, the mode of failure of squat and slender walls should be examined. Observations of past earthquake damage indicates that squat walls generally crack along a diagonal line in a stepwise manner along the bed joints and through the head joints. This would be characterized as a shear bond failure. On the other hand more slender walls tend to crack when the principal tension stress reaches a critical value. For fully grouted walls these cracks generally pass through the units.

The English code for brick masonry has recognized these modes of failure for unreinforced brick masonry and a comparison of their proposed revision and test data is shown in Figure 4. The first sloping region of their proposed revision is governed by bond and friciton between the mortar joints.

$$\tau = V_{bo} + \mu \sigma_c \qquad \text{-------------(2)}$$

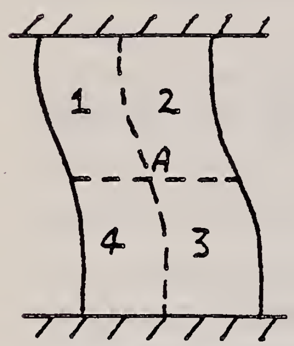
where V_{bo} is the bond strength, μ the coefficient of friction and σ_c the compressive stress. The second region is governed by diagonal tension and is the flat portion of the proposed revision. The third region is governed solely by friction where

$$\tau = \mu\sigma_c. \qquad \text{-------------(3)}$$

If Committee 5 agrees to adopt this approach towards allowable shear stresses in unreinforced masonry decisions on V_{bo}, μ and the value for the flat portion of the curve will have to be made.

The proposed revision to the English code for brick masonry used a V_{bo} of 12 psi and a coefficient of friction of 0.25. The flat part of the allowable curve was at 42 psi.

Before pursuing this further the validity of the results of the diagonal compression test shown in Figure 3 will be examined by comparing them with the results obtained from the Berkeley pier test program. At the last meeting Mr. Monk questioned the validity of performing this comparison because of the different stress states in the two test specimen. He correctly stated that regions 1 and 3 will have higher principal tensile stresses due to the combined affects of shear and bending tensile stresses than those existing at the center of pier-point A. In regions 2 and 4 the principal tensile stresses will be lower because the bending stresses are compressive and these (via Mohr's circle) lower the principal tension stresses. The pier test results show that the diagonal crack (when·it forms) passes from the top right to the bottom left corner, i.e. through the two regions subjected to compressive bending stresses.



For these regions the highest principal tensile stress is at A and is equal to

$$\sigma_{tcr} = \sqrt{(1.5\tau)^2 + (\sigma_c/2)^2} - \sigma_c/2 \qquad \text{(A)}$$

where τ is the average shear stress and σ_c is the compressive stress.

My postulated reason for explaining this direction of crack formation rather than the other direction from 1 to 3 where the principal tensile stresses are theoretically higher is because of the prescence and performance of the vertical steel at the jambs of the piers. Like a concrete beam in flexure this steel begins to act when flexural cracks develop. The formation of the flexural cracks due to high bending tensile stresses releases the tension stresses in the masonry and thus the theoretically higher principal tensile stresses in this region are reduced below those at point A. Thus comparing critical diagonal tensile stresses obtained at point A in the piers with those obtained from the diagonal compression test (Figure 3) is valid.

The comparison of the principal tensile stresses obtained from the pier (σ_{tcr}) by Eqtn. 4 and those obtained from the square panel σ^o_{tcr} from Blume's equation

$$\sigma^o_{tcr} = \sqrt{2.424^2 + (\sigma_c/2)^2} - (\sigma_c/2 + 0.832\tau)$$

are shown in Figures 5, 6 and 7 and Table 1 for the three different materials.

There is significant scatter in this data although most of the points lie between 0.5 and 1.5. Thus if the critical tensile strength methodology were to be used a reasonable lower bound could be obtained from these test results.

However this is not the way in which this data is applied. The average shear stress

$$\tau = \frac{P}{\sqrt{2}\,A}$$

obtained from the diagonal compression test (Figure 3) is used as the basis for determining code allowables by applying a factor of safety to the test results. This in my view is an incorrect application of the test results. If this is pursued we should compare the shear stresses obtained from the Berkeley diagonal compression test and those obtained from the pier tests assumming there is no vertical load. These two values are obtained from the following two equations. For piers

$$\tau_{pier} = \frac{\sigma_{tcr}}{1.5}$$

where σ_{tcr} is the critical tensile strength obtained from the pier test with the vertical load that existed at cracking and given in Table 1. For the square panels, of the Berkeley tests

$$\tau_{panel} = \frac{\sigma^o_{tcr}}{0.73}$$

because σ^o_{tcr} given in Table 1 was obtained from this equation. The values for τ_{pier} and τ_{panel} and the ratio τ_{pier}/τ_{panel} are also given in Table 1. The range of the ratio τ_{pier}/τ_{panel} is from .26 to 1.09 with the majority of the values between .26 and 0.70. The implication of this, is that if the current method of interpreting the diagonal compression test results is used to predict the shear strength of the piers the prediction would have been overestimated by 40% to 380%. This is clearly unacceptable and validates the earlier statement concerning the incorrect use of the diagonal compression test results.

The correct application, in my view is to work with the critical tensile stresses. Since this is not done in practical design its effect should be approximated in the application of the diagonal compression test results. The shear stresses obtained from the diagonal compression test should first be divided by 1.5 to account for the parabolic distribution of shear stress in a structural element. Some factor should then be applied to account for the variation obtained between the diagonal tension stresses of the piers σ_{tcr} and those of the panels σ^{o}_{tcr}. From Figures 5 to 7 this would be somewhere between 0.5 and 0.7 say 0.6. Thus the shear stresses obtained from the diagonal compression test should be multiplied by 0.6/1.5=0.4 before a factor of safety is applied. The factor of safety would then be applied to these reduced values to obtain an allowable shear stress that would be applicable to unreinforced masonry with no compressive load. If this methodology is applied to the results presented in the NCMA commentary where the average shear stress from the panel tests is given as 130 psi for type M and S mortar, the shear stress at failure with no compressive load would be 130 x 0.4 = 52 psi. Applying a factor of safety of 3 to this, the allowable shear stress would be 17 psi.

If a compressive stress of 100 psi is assumed to act on an element, the shear stress using the same methodology would obtained as follows

$$\sigma_{tcr} = \sqrt{(1.5\tau)^2 + (\sigma_c/2)^2} - \sigma_c/2$$

where σ_{tcr} = 1.5 x 52 psi = 78 psi from the panel tests ; or 0.6 x 130 = 78 psi

$$78 = \sqrt{(1.5\tau)^2 + (50)^2} - 50$$

$$\tau = 79 \text{ psi}$$

Using a factor of safety of three, this would correspond to an allowable shear stress of 26 psi when the compressive stress was equal to 100 psi.

Recommendation for Allowable Shear Stresses

Based on the foregoing presentation of determining allowable shear stresses in unreinforced masonry, I recommend that we follow the British approach. This recognizes the different modes of failure under different compressive loads and in the first region up to a compressive stress (σ_c) of 120 psi assumes the wall will fail in shear bond. The recommeded allowables for Type Mand S mortar would be:

Compression Stress Between 0 and 120 psi

Hollow Unit Concrete Masonry	$V = 12 + 0.2\ \sigma_c$.	$\ngtr 30$ psi
Fully Grouted Hollow Unit Concrete Masonry	$V = 18 + 0.2\ \sigma_c$	$\ngtr 36$ psi
Solid Concrete Masonry	$V = 12 + 0.2\ \sigma_c$	$\ngtr 36$ psi
Hollow Unit Clay Masonry	$V = 15 + 0.25\ \sigma_c$	$\ngtr 40$ psi
Fully Grouted Hollow Unit Clay Masonry	$V = 20 + 0.25\ \sigma_c$	$\ngtr 45$ psi
Solid Brick Masonry	$V = 15 + 0.25\ \sigma_c$	$\ngtr 45$ psi
Multi-wythe-Grouted Brick	$V = 20 + 0.25\ \sigma_c$	$\ngtr 45$ psi
Concrete	$V = 18 + 0.2\ \sigma_c$	$\ngtr 36$ psi

These recommeded values recognize the difference in the shear bond strength of a mortared joint and hollow unit masonry that is fully goruted. In addition the higher shear bond strength of clay masonry when compared to concrete masonry is also recognized. The upper limits recognize a difference in the critical tensile strengths of clay masonry and concrete masonry These values should be carefully evaluated using test data that both NCMA and BIA have available using the methodology discussed previously.

The upper limits for this first region could be used for all compressive stresses above 120 psi or the third region of the British curve could be used above say a compressive stress of 250 psi. In this region the allowable stress would be the upper limit of the first region, plus the factor $0.2\ (\sigma_c - 250)$ or $0.25\ (\sigma_c - 250)$ with another upper limit. We do not recommend the use of this third region for seismic loads, because of the brittle failure mechanism associated with high compressive loads.

If this third region is adopted the second region for compressive stresses between 120 and 250 psi would be the upper limits for the first region. The allowables for the third region would then be:

Compressive stress >250 psi

Hollow Unit Concrete Masonry	$V = 30 + 0.2(\sigma_c - 250)$	$\ngtr 40$ psi
Fully Grouted Hollow Unit Concrete Masonary	$V = 36 + 0.2(\sigma_c - 250)$	$\ngtr 45$ psi
Solid Concrete Masonry	$V = 36 + 0.2(\sigma_c - 250)$	$\ngtr 45$ psi
Concrete Multi-Wythe-Grouted	$V = 36 + 0.2(\sigma_c - 250)$	$\ngtr 45$ psi
Hollow Unit Clay Masonry	$V = 40 + 0.25(\sigma_c - 250)$	$\ngtr 50$ psi
Fully Grouted Hollow Unit Clay Masonry	$V = 45 + 0.25(\sigma_c - 250)$	$\ngtr 60$ psi
Solid Clay Masonry	$V = 45 + 0.25(\sigma_c - 250)$	$\ngtr 60$ psi
Brick Multi-Wythe-Grouted	$V = 45 + 0.25(\sigma_c - 250)$	$\ngtr 60$ psi

These recommended values for Type M and S mortar should be factored appropriately for Type N mortar say by 80%. The governing design equation for seismic loads in unreinforced masonry would be Eqtn. 3-2(a) on p. 49 of the ATC-3-06 report.

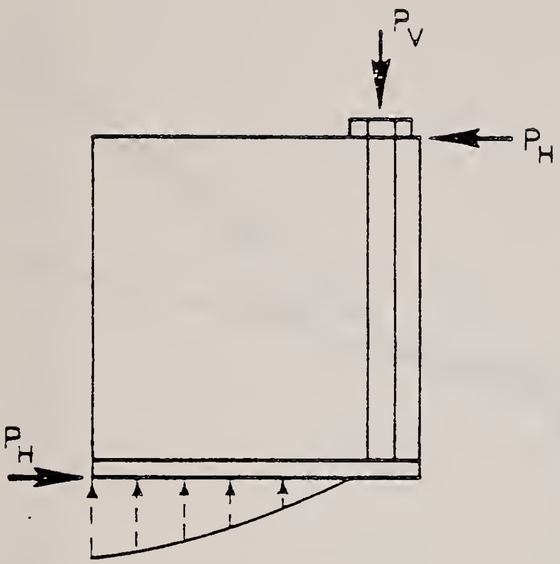
Although the recommended procedure for determining allowable stresses in unreinforced masonry is somewhat different to that currently in use, I believe it is a better reflection on the actual performance of the walls. I also believe that if Committee 5 proceeds with these recommendations we should evaluate any test data that NCMA and BIA have available on shear bond strength to determine what factor of safety is inherent in the suggested values at zero compression. We should also examine the available data on the diagonal compression tests (racking-Figure 3) using the methodology suggested herein to determine the factor of safety for the allowables in the 100 to 250 psi region.

If this procedure is not followed then the upper limits for shear stress should be determined using the methodology recommended herein assuming there is no vertical load on the element. This would involve multiplying the shear stresses obtained from Figure 3 by 0.4 and then dividing these results by a factor of safety of say 3.

EXHIBIT M

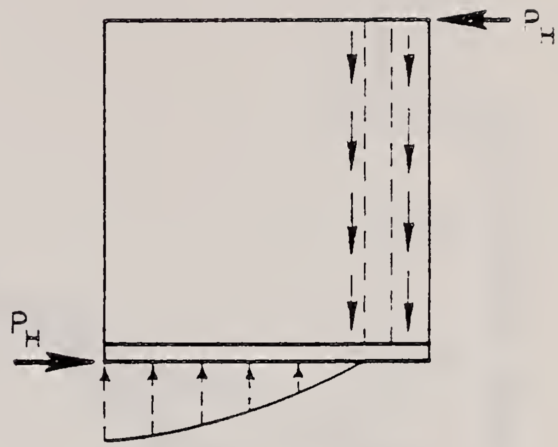
TABLE 1 PREDICTION OF SHEAR CRACK STRENGTH FOR FULLY GROUTED PIERS

Specimen	Vertical Steel Reinforcement (%)	Horizontal Steel Reinforcement (%)	Prism Compressive Strength f'_m (psi)	Square Panel Critical Tensile Strength σ_{tcr} (psi)	Pier Shear Crack Strength τ_s (psi)	Pier Axial Stress at Shear Crack σ_c (psi)	Pier Critical Tensile Strength σ_{tcr}	$\frac{\sigma_{tcr}}{\sigma_{tcr}}$	$\frac{\tau_s}{\sqrt{f'_m}}$	τ panel psi	τ pier psi	$\frac{\tau_{pier}}{\tau_{panel}}$
HCBL-21-1	0.09	--	2412	[illegible]	[illegible]	-67	186	0.58	2.[illegible]	438	124	.28
-1	0.14	--	2256	337	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	461	176	.38
-5	0.09	--	2502	280	114	-.15	158	0.[illegible]	2.[illegible]	383	172	.45
-7	0.08	0.[illegible]	2305	326	226	[illegible]	158	[illegible]	[illegible]	446	239	.54
-9	0.08	--	2510	[illegible]	164	-29[illegible]	[illegible]	0.57	[illegible]	334	93	.28
HCBL-11-1	--	--	[illegible]	[illegible]	115	-1[illegible]	[illegible]	[illegible]	[illegible]	170	100	.59
-3	0.17	--	1833	137	134	-69	170	[illegible]	[illegible]	188	113	.60
-4	0.17	0.09	1833	137	172	-107	209	1.53	3.99	188	139	.74
-6	0.17	0.34	1933	135	226	-144	275	2.04	5.28	185	183	.99
-7	0.43	--	1905	166	180	-91	[illegible]	1.27	4.[illegible]	227	152	.67
-9	0.43	0.17	1905	166	155	[illegible]	183	[illegible]	3.55	227	122	.54
-11	0.13	0.18	1330	[illegible]	240	[illegible]	[illegible]	[illegible]	6.58	182	198	1.09
HCPL-12-1	[illegible]	--	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	652	173	.38
-2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	652	179	.40
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	652	189	.42
-4	0.30	0.15	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	652	222	.49
-5	0.30	0.20	2988	330	226	-106	[illegible]	[illegible]	4.[illegible]	452	193	.43
-6	0.30	0.29	2988	330	244	[illegible]	[illegible]	0.97	4.46	452	213	.47
HCBP-21-1	--	--	4502	375	167	-580	[illegible]	0.54	[illegible]	513	136	.26
-2	0.51	--	4502	375	219	-568	[illegible]	0.58	3.55	513	145	.28
-4	0.51	0.20	4502	375	308	-415	209	[illegible]	4.59	513	200	.39
-6	0.51	0.30	4502	375	343	-492	325	0.87	5.[illegible]	513	217	.42
-8	0.51	0.40	4502	375	346	-485	331	0.88	5.16	513	221	.43
-9	0.51	0.50	4502	375	348	-476	316	0.90	5.19	513	224	.44
HCBR-11-1	--	--	2535	282	278	-128	334	[illegible]	5.52	386	189	.49
-3	0.19	--	2535	282	279	-.34	352	[illegible]	5.54	386	235	.61
-4	0.14	0.10	2722	363	303	-123	[illegible]	[illegible]	[illegible]	497	261	.53
[illegible]	0.14	0.44	2722	336	346	[illegible]	334	1.[illegible]	6.63	460	292	.63
-7	0.14	0.44	2535	282	[illegible]	[illegible]	[illegible]	[illegible]	5.36	386	211	.55
-8	0.15	--	2866	293	242	-123	307	1.05	4.52	401	205	.51
-10	0.15	0.18	2722	363	[illegible]	-153	[illegible]	[illegible]	5.67	497	250	.50
-12	0.15	[illegible]	2535	282	275	[illegible]	309	1.[illegible]	5.46	386	206	.53
-13	0.45	0.52	[illegible]	363	[illegible]	-112	361	0.99	5.31	497	241	.48
HCBR-12-2	0.31	0.28	2838	--	319	-125	420	--	5.99			
-3	0.31	0.15	2838	--	351	-150	457	--	[illegible]			
-4	0.31	0.23	2838	--	356	-143	467	--	6.68			
-5	0.31	0.41	2838	--	394	-154	519	--	7.40			
-6	0.31	0.52	2838	--	392	[illegible]	[illegible]	--	7.36			
CBPC-21-2	0.38	--	3315	284	295	-477	264	0.93	5.12	389	176	.45
-3	0.38	0.15	3315	284	264	-458	228	0.80	4.59	389	152	.39
-4	0.38	0.22	3315	284	267	-417	214	0.86	4.64	389	163	.42
-5	0.38	0.37	3315	284	262	[illegible]	247	0.87	4.55	389	165	.42
CBRC-11-1	--	--	2507	205	247	-236	251	1.22	4.93	281	167	.59
-2	0.13	--	2507	205	244	-.33	282	1.38	4.87	281	188	.67
-3	0.13	0.06	2507	205	239	-136	276	1.35	4.77	281	184	.65
-4	0.13	0.12	2507	220	268	-175	297	1.30	5.35	301	191	.63
-5	0.33	--	2507	205	217	-159	256	1.25	4.33	281	171	.61
-6	0.33	0.13	2507	220	272	-209	316	1.44	5.43	301	211	.70
-7	0.33	0.16	2507	220	257	[illegible]	310	1.41	5.[illegible]	301	207	.69
CBRC-12-1	0.23	--	2876	[illegible]	251	[illegible]	[illegible]	[illegible]	4.72	368	220	.60
-2	0.23	0.06	2876	[illegible]	250	-1[illegible]	316	[illegible]	4.66	368	211	.57
-3	0.23	0.11	2876	269	275	[illegible]	349	1.30	5.[illegible]	368	233	.63
-5	0.23	0.23	2876	269	231	-1[illegible]6	293	1.09	4.31	368	195	.53
-6	0.23	0.38	2876	269	240	-94	316	1.17	4.48	368	211	.57



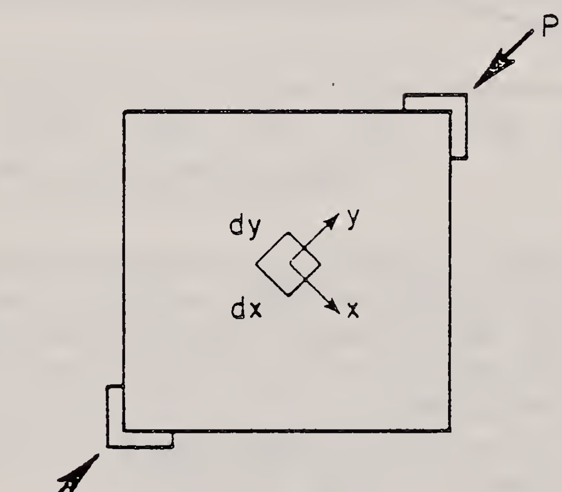
EXTERNAL HOLD DOWN

FIGURE 1



INTERNAL HOLD DOWN

FIGURE 2



RACKING PANEL

FIGURE 3

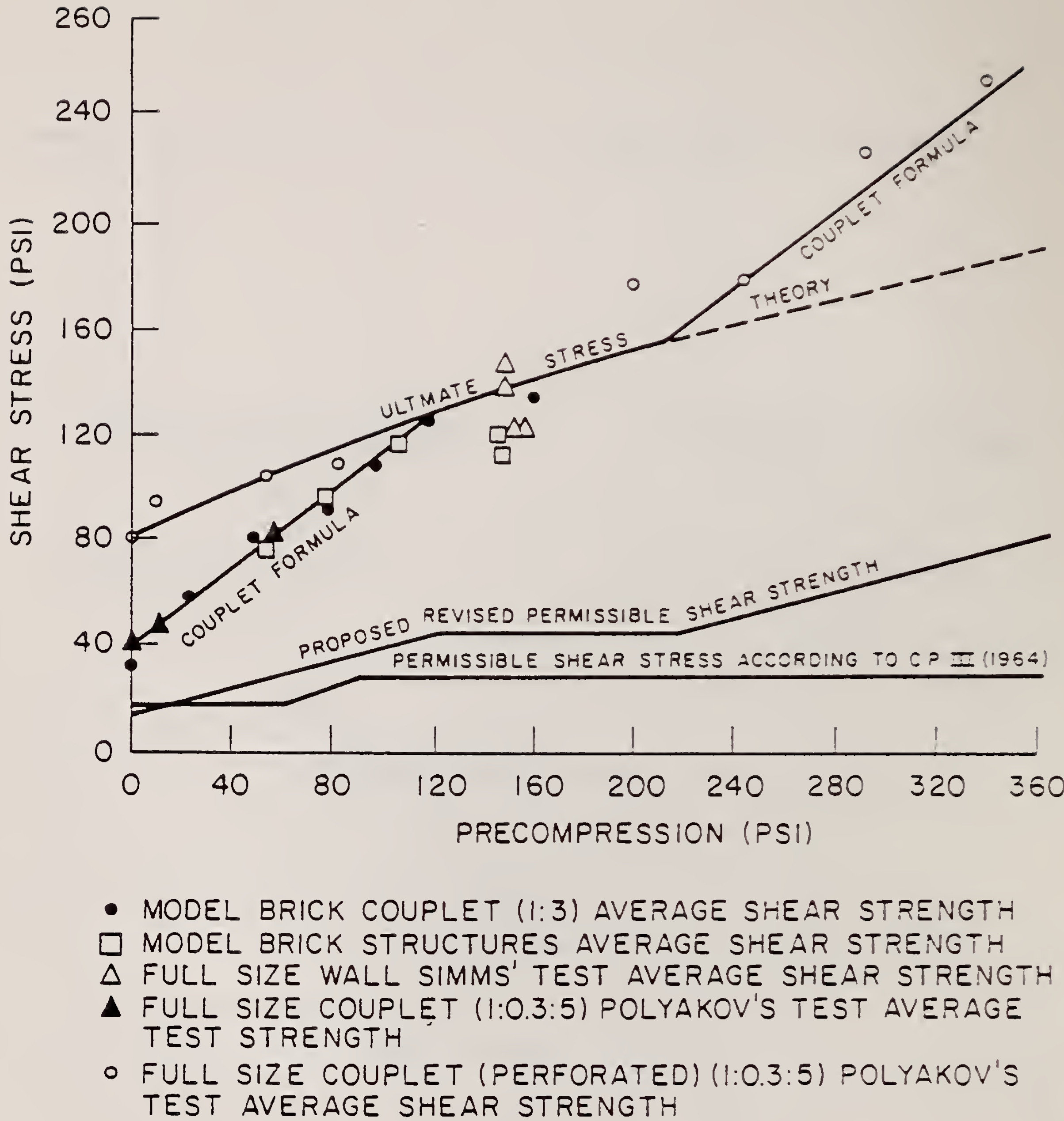


FIGURE 4 RELATIONSHIP BETWEEN ULTIMATE SHEAR STRESS AND PRE-COMPRESSION

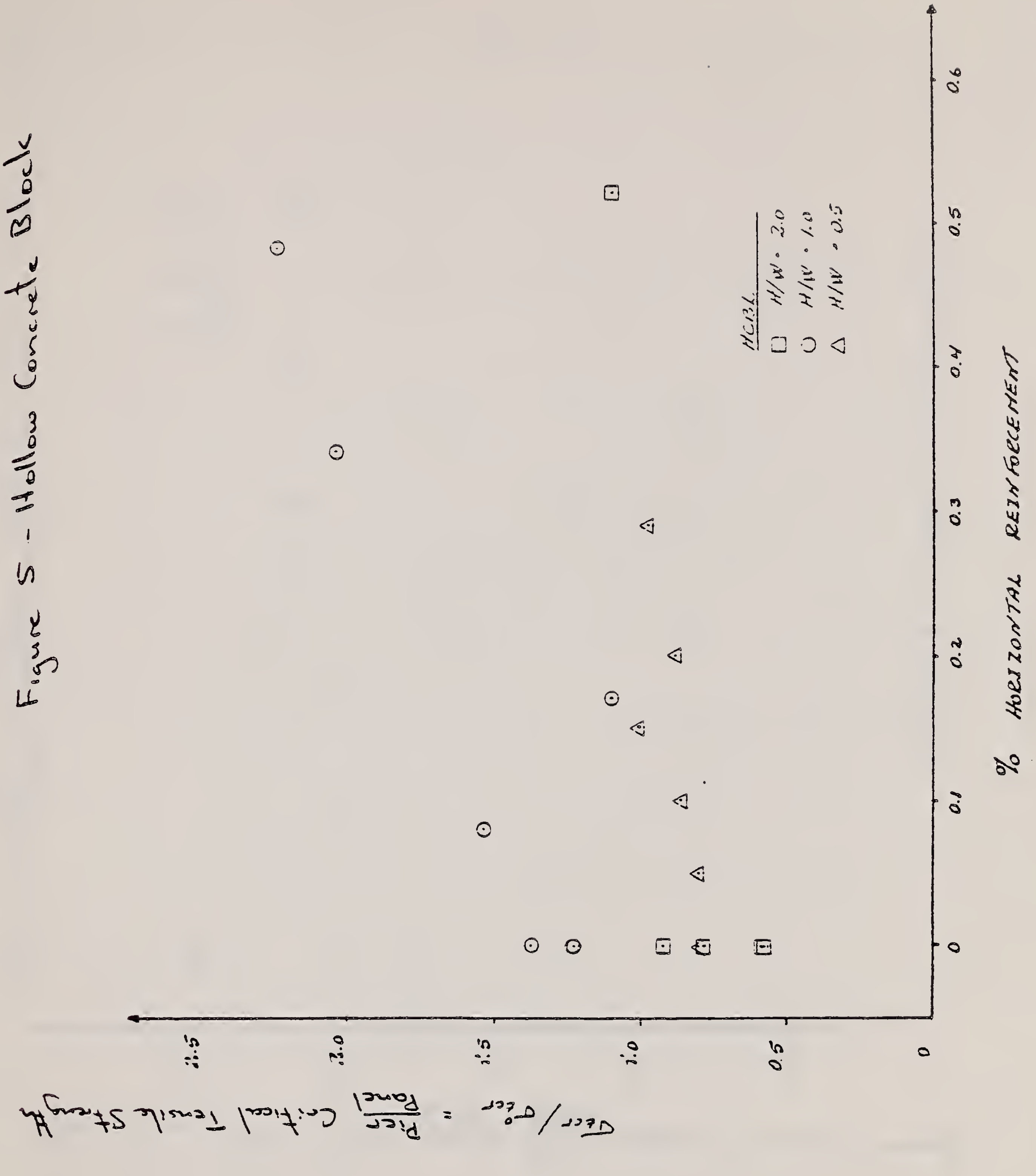


Figure 5 - Hollow Concrete Block
% HORIZONTAL REINFORCEMENT
0
0.1
0.2
0.3
0.4
0.5
0.6
0
0.5
1.0
MODEL
H/W = 2.0
H/W = 1.0
H/W = 0.5

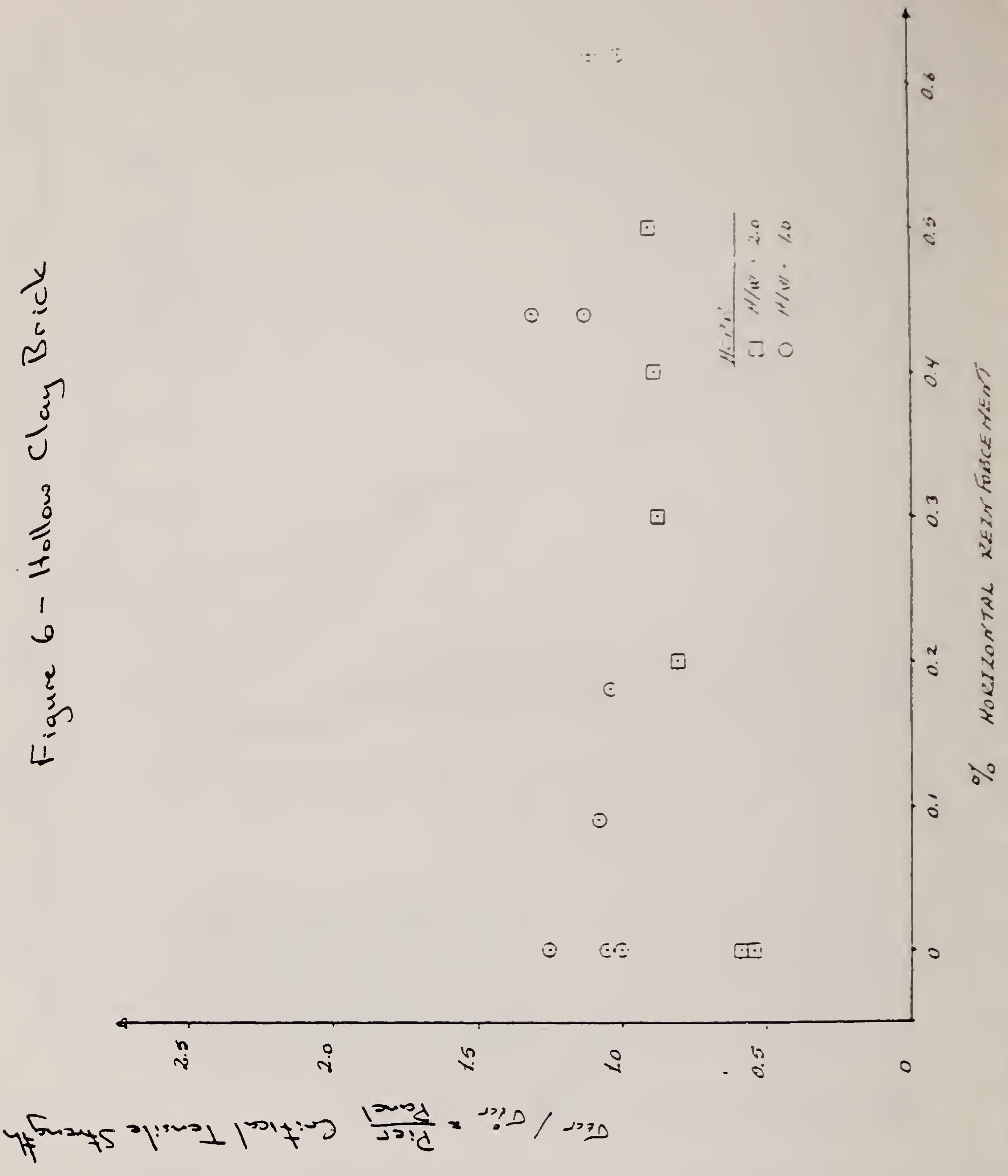
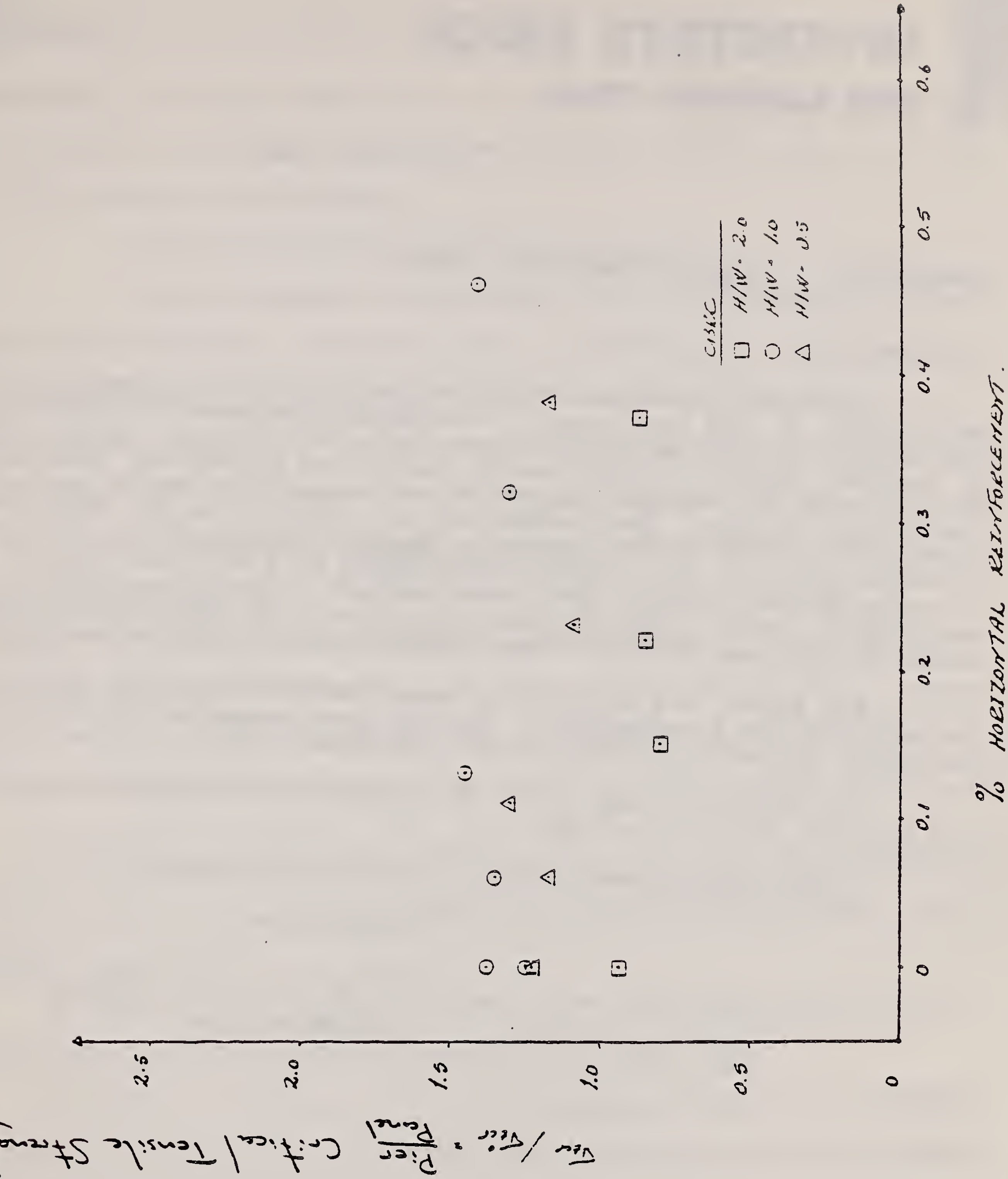


Figure 6 - Hollow Clay Brick

Figure 7 - Multi-wythe Brick - Grouted Core.



Entrada Industries

INTERSTATE BRICK
AND CERAMIC TILE

SHOWROOMS, SALES OFFICES & DISTRIBUTION CENTERS
WEST JORDAN FACILITIES
General Offices and Manufacturing Plant
9210 South 5200 West
P.O. Box 517
West Jordan, Utah 84084
Phone (801) 561-1471
SALT LAKE FACILITIES
3037 South 300 West
Salt Lake City, Utah 84115
Phone (801) 487-9901 and 561-1471
OGDEN FACILITIES
860 Wall Avenue
Ogden, Utah 84404
Phone (801) 394-7701 and 561-1471

EXHIBIT N

June 24, 1980

COMMITTEE 5 - MASONRY COMMITTEE - BSSC

Gentlmen:

On Monday, June 9th after our Friday, June 6th meeting in Washington, I read over some of the changes we made to Chapter 12 - one particular change hit me like a bolt of lighting. After reading it several times, I called George Hanson and Ron Mayes; both agreed with me that this change was wrong and changed the whole meaning and use of the section. The change was the addition by Mel Mark to Section 12.2.1 (B)2 that said "and Section 12.2.1.(B)3". This made it mandatory that all reinforced elements in a wall for Type 2 reinforced masonry had to have steel in both directions with .002 total and with at least .0007 in both directions. In other words Type 2 would be null and void and Type 3 would have to be used everywhere.

Ron Mayes, Mel Mark and I spent two weeks talking on the phone and working out a compromise. The enclosed suggested revision is the final suggested wording by Ron Mayes and myself.

I'm sending a copy to E. V. Leyondecker for substitution into the minutes of that meeting.

I hope you approve, if not, call me immediately.

Sincerely,

Don Wakefield

Don Wakefield

DW/cw

Encl.

EXHIBIT N

Suggested Revisions To Section 12.2.1. (B)

12.2.1. (B) REINFORCED MASONRY DESIGN. Reinforced masonry shall be designed and constructed in accordance with one of the following procedures and the provisions of other Sections of this Chapter.

1. Masonry designed and reinforced as required.

2. Masonry designed and reinforced as required and containing nominal prescribed reinforcing. Construction shall be grouted masonry--multiwythe or hollow unit masonry containing reinforcement as specified below. Masonry joint reinforcement shall be, and ties may be, embedded in the mortar in the bed joints. All other reinforcement shall be embedded in grout. Minimum masonry, mortar, and grout coverages applicable to reinforced masonry shall be provided. Only type M or S mortar shall be used. This masonry shall be designed as unreinforced masonry, except that reinforced masonry areas or elements may be considered as resisting stresses in accordance with the design criteria and allowable stresses specified for reinforced masonry provided such elements fully comply with the design and construction requirements for reinforced masonry; ~~and Sect. 12.2.1. (B) 3;~~ out

Exception: When these wall elements contain less reinforcement than required in Sect. 12.2.1. (B) 3, allowable shear stresses for unreinforced masonry shall be used.

The width of these elements, tributary to the reinforcement, must meet the requirement of effective width of masonry given in 12A.6. 3(A).

Only when all structural elements of the masonry building are reinforced in accordance with Sect. 12.2.1. (B) 3 shall the R factor for reinforced masonry be used. All other buildings designed in accordance with the provisions of this section shall have R-factors as required for unreinforced masonry.

Note: UNDERLINED WORDS REPLACE THE RULED OUT STATEMENT. ALL OTHERS ARE AS BEFORE

APPLIED TECHNOLOGY COUNCIL'S COMMENTS

ON COMMITTEE 5 BALLOT ITEMS

INTRODUCTION

Chapter 12A was included in the ATC-3-06 report because a nationally applicable design standard for masonry was and is still not available. Thus Chapters 12 and 12A were developed as complementary documents. Some seismic provisions were included in Chapter 12A and thus many of the bollot items involve a transfer of these items to appropriate Sections of Chapter 12.

Many of the other ballot items involve minor and editorial changes and ATC concurs with most of these. However, there are a number of other ballot items that ATC believes are substantive changes to the document. Comments on these items are in the accompanying tabulation of comments.

There are two important items that have not received adequate consideration by the committee at this time. These are the allowable stresses for unreinforced masonry and the design requirements for hollow unit masonry.

ATC therefore strongly recommends that Committee 5 continues its deliberations beyond the meeting of July 16th and 17th. This will ensure that consistency, cross-referencing and definitions have been adequately covered as a result of the large number of changes and that the two items referred to above can be adequately addressed.

NBS-114A (REV. 2-80)

U.S. DEPT. OF COMM. **BIBLIOGRAPHIC DATA SHEET** *(See instructions)*	1. PUBLICATION OR REPORT NO. NBSIR 80-2111-5	2. Performing Organ. Report No.	3. Publication Date October 1980

4. TITLE AND SUBTITLE

REVIEW AND REFINEMENT OF ATC 3-06 TENTATIVE SEISMIC PROVISIONS
Report of Technical Committee 5: Masonry

5. AUTHOR(S)

Edgar V. Leyendecker and Louis E. Cattaneo

6. PERFORMING ORGANIZATION *(If joint or other than NBS, see instructions)*

NATIONAL BUREAU OF STANDARDS
DEPARTMENT OF COMMERCE
WASHINGTON, D.C. 20234

7. Contract/Grant No.

8. Type of Report & Period Covered

Final

9. SPONSORING ORGANIZATION NAME AND COMPLETE ADDRESS *(Street, City, State, ZIP)*

Federal Emergency Management Agency
Washington, D.C. 20472

10. SUPPLEMENTARY NOTES

☐ Document describes a computer program; SF-185, FIPS Software Summary, is attached.

11. ABSTRACT *(A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here)*

The TENTATIVE PROVISIONS FOR THE DEVELOPMENT OF SEISMIC REGULATIONS FOR BUILDINGS were developed by the Applied Technology Council to present, in one comprehensive document, the current state of knowledge pertaining to seismic engineering of buildings. The TENTATIVE PROVISIONS are in the process of being assessed by the building community. This report is one of a series of reports that documents the deliberations of a group of professionals jointly selected by the Building Seismic Safety Council and the National Bureau of Standards and charged with reviewing the TENTATIVE PROVISIONS prior to the conduct of trial designs. The report contains the recommendations and records of the committee charged with review of the masonry design provisions. The committee made 109 ballot recommendations for revisions to the TENTATIVE PROVISIONS. These recommendations were made to the parent group, the Joint Committee on Review and Refinement, and their action on these recommendations is documented in a companion report.

12. KEY WORDS *(Six to twelve entries; alphabetical order; capitalize only proper names; and separate key words by semicolons)*

Building; building codes; building design; earthquakes; engineering; masonry; standards; structural engineering.

13. AVAILABILITY

- [XX] Unlimited
- [ ] For Official Distribution. Do Not Release to NTIS
- [ ] Order From Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.
- [XX] Order From National Technical Information Service (NTIS), Springfield, VA. 22161

14. NO. OF PRINTED PAGES

421

15. Price

$29.00

ADDENDA TO NBSIR 80-2111-5

Report of Technical Committee 5: Masonry

The following material was received after the report for Committee 5 was in press.

1. Additional explanatory material to be added to section 1.3 - Chairman's Statement on page 5.

2. Exhibit P to be added to Section 3.3.

CHAPTER 12

ITEM #:	COMMENTS:
5/9	See Committee comments Page 2, Chapter 12
5/11	The ability to clean the cavity would not be hampered by clean-outs spaced at every third unit rather than at every other unit and would provide cost saving in construction.
5/12	ATC states in comments that "this item does not relate to seismic performance category (SPC) because it is a quantitative quality control item for mortar and grout." Stipulation of minimum strengths for the separate items which constitute a masonry assemblage do not appear to be necessary when it is the prism strength of the assemblage which controls the final strength of the wall. In addition to this the requirement of 2000 psi minimum strength for mortar could cause the specifying of type M mortar as the A.S.T.M. listed minimum strength of type S mortar is 1800 psi. This could result in requiring type M mortar in the major portion of masonry construction.
5/18	Page 4, Chapter 12 Committee commentary.
5/19	See Committee comment on item 5/19. Committee moved this item to SPC-D by item 5/27 (misnoted as 5/26 on Committee comment 5/19).
5/20	Slump limits for grout must be controlled by job conditions and size of void to be grouted, not by arbitrary restrictions. A minimum slump may be acceptable if it is not used as a maximum. The upper limits of slump should be removed to allow for proper grout placement under conditions of high temperature, low humidity and high absorbent units. Generally, to obtain high enough slump of grout for proper placement is more difficult than the limitation of grout slump. See comments item 5A/16.
5/22	Item 5/22 page 5, Chapter 12 Committee comments.
5/28	This is a new addition proposed by ATC in their rewrite of Chapter 12. The Committee accepted the rewrite with the exception of replacing the 2 with 1 in the case running bond structures in seismic zone 2. (#1 is with reinforcing as required by design without arbitrary boundary steel).

CHAPTER 12A

ITEM #:	COMMENTS:
5A/2	Poor definition & not necessary. All structural walls need not be bearing walls but all bearing walls will be structural. This definition appears to be excess wording without any contribution to the text.
5A/14	ASTM C270 is replaced with ASTM C476 which is for mortar & grout & the elimination of mortar cement in grout makes the exception redundant.
5A/16	Slump should be controlled by job conditions & size of void to be grouted rather than by arbitrary restrictions. Smaller voids require greater slump to penetrate cavity & to supply proper amount of water to be absorbed by masonry where larger voids with less proportionate surface area will allow for lower slump & lower moisture requirements. See comments item #5/20
5A/17	All grout may not be mixed in a drum type mixer (paddle mixer). See Committees notes on 5A/17.
5A/19	The requirement for full bedding of cross webs & end shells of all starter courses would cover foundations, floor slabs and all supporting members. Full bedding on piers columns & pilasters could only be used for stack bond.
5A/23	See Committee comments Page 3, Chapter 12A.
5A/24	Acceptable no vote.
5A/26	See Committee comments Page 3, Chapter 12A. ATC definition indicates grout is placed as units are laid.
5A/29	The number of spacing of cleanouts and the method of cleaning will not guarantee a clean grout space. The main requirement is to obtain a clean grout space. In the present section there is no spacing or size requirement for cleanouts if placed in the foundation. Method of cleaning should be as selected by engineer or contractor and not specified in standard.
5A/31	See Committee comment Page 4, Chapter 12A. Revised definition to apply nationwide not to any one particular area.

ITEM #:	COMMENTS:
5A/33	This paragraph is no longer required as 5A/3 page 118 defines reinforced masonry (accepted by vote of 33-7-2).
5A/34	This paragraph describes grouting requirements for hollow unit masonry. There is no reference to reinforcing. Table 12A-3 does not include allowable stresses for grouted hollow unit masonry. The new approved table, item #5A/77 accepted by vote of 36-5-1, limits grouted masonry to multi wythe walls.
5A/36	By laying the units 8" higher than the grout lift the cleanout will be 8" above the bottom of the grout of the next grout lift. Cleaning of this area would be very difficult and if water was used to clean down the grout cavity this water would be difficult to remove before grouting. Arbitrary limits are hard to justify.
5A/37	The method of cleaning will not guarantee a clean grout space. The basic requirement is to provide a clean grout space by a method selected by the mason instead of requiring him to clean the space by a method which may not be feasable for the particular job. See comment item #5A/29.
5A/44	The f^1m value taken from the BIA 1969 Table 3 is 73% of the values designated in ATC 3-06 due to BIA prism ratios of 5:1 instead of 2:1. The 2/3 of the $.73f^1m$ then results in an f^1m of 49% of f^1m as related to 50% of f^1m as would be used in the other designs supported by ATC 3-06.
5A/47	See Committee comment Page 5, Chapter 12A.
5A/49	See Committee comment Page 5, Chapter 12A.
5A/50	See Committee comment Page 5, Cahpter 12A.
5A/52	See Committee comment & ATC comment Page 6, Chapter 12A.
5A/57	Committee comments - controlling the height to thickness ratio by the interaction equation will cause the designer to base the height of the wall on allowable stresses rather than by arbitrary numbers. This allowance is contained in the exception of Section 12A.4.2 of the present ATC 3-06 document and would be the effect of stresses due to axial loads combined with the stresses due to moments in the wall.

ITEM #: COMMENTS:

5A/58 See Committee comments Page 6, Chapter 12A.

5A/60 This change was made to allow for the change made in Section 12.2.1 (B) (item 1 masonry designed and reinforced as required). This replaces the old designation of partially reinforced masonry. Also see Committee comments on 5A/60.

5A/61 The paragraph omitted does not account for size of grout cavities between wythes & alignment of these wythes. This would be a special wall and would require special detailing. Commonly accepted practices could still be used.

5A/62 Committee comments on 5A/58 - The present equation of (.18f^1m + .65pgfs) for a 12 x 12 column with an f^1m of 6000 psi and 4-#10 grade 60 rebars would provide a factor of .272 f^1m as compared to 0.20 f^1m for walls or an increase of 36% of additional load for the column over the allowable load on an equivalent wall area. A 12 x 12 column with an f^1m of 3000 psi and 4-5/8" grade 40 rebars would provide a factor of 0.217 as compared to .20 f^1m for walls or an increase of 8½% of additional load for the column over the allowable load on an equivalent wall area.

5A/64 See Committee comment Page 7, Chapter 12A.

5A/66 The new wording clarifies the length of wall which may be used for the value of d. This has not changed the effective d to be used in the calculation of shear stress.

5A/68 The revised text requires a prism test for each 5000 square feet of wall with no stipulation as to how the design f^1m was obtained. In addition to this, if the f^1m is to be established by tests an initial prism test series is to be made prior to the start of construction. The original text did not require prism tests for required prism strength below 2600 psi and only 3 prism test series for the total project regardless of size of the project.

5A/72 ATC states in comments that "this item does not relate to seismic performance category (SPC) because it is a quantitative quality control item for mortar and grout." Stipulation of minimum strengths for the separate items which constitute a masonry assemblage do not appear to be necessary when it is the prism strength of the assemblage which controls the final strength of the wall. In addition to this the requirement of 2000 psi minimum strength for mortar could cause the specifying of type M mortar as the A.S.T.M. listed minimum strength of type S mortar is 1800 psi. This could result in requiring type M mortar in the major portion of masonry construction.

ITEM #:	COMMENTS:
5A/74	See Committee comments, Page 8, Chapter 12A.
5A/76	See Committee Comments Page 8, Chapter 12A. Note ATC indicates that the most recent standard ACI 531 uses 36.
5A/78	This is different than the 2/3 applied in 5A/44. Increase would be 33% instead of 50% as noted by ATC.
5A/80	With grouted construction the actual unit strength of the masonry unit and the grout would control. Although ASTM C90-75 and C652-75 use gross area to designate minimum unit strength of hollow units the realistic actual unit compressive strength of the hollow unit is based upon net area of the hollow unit.

Add to Section 3.3

<u>Exhibit F</u> - December 10, 1980, letter from Ron Mayes to TC-5 transmitting ATC Board resolution on allowable stresses.

EXHIBIT P

Applied Technology Council 2150 SHATTUCK AVE., SUITE 806 BERKELEY, CALIFORNIA 94704 (415) 540-0223
A Nonprofit Corporation

ATC

December 10, 1980 ATC-3-3

TO: NBS REVIEW AND REFINEMENT COMMITTEE 5 (MASONRY)

FROM: RON MAYES

SUBJECT: ALLOWABLE STRESSES FOR REDESIGNS

At the November 19, 1980 ATC Board of Directors meeting, the following resolution was unanimously passed:

> The Applied Technology Council Board of Directors recommend that trial designs for masonry buildings be performed with allowable stresses for unreinforced masonry from both Chapter 12A of ATC-3-06 and the standards of NCMA and BIA.