DEPARTMENT OF COMMERCE
WASHINGTON

RECOMMENDED MINIMUM REQUIREMENTS FOR SMALL DWELLING CONSTRUCTION

REPORT
OF
BUILDING CODE COMMITTEE

BUREAU OF STANDARDS

WASHINGTON
GOVERNMENT PRINTING OFFICE
1923

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July 20, 1922

Ira H. Woolson, Chairman

Edwin H. Brown
William K. Hatt
Rudolph P. Miller
John A. Newlin
Ernest J. Russell
Joseph R. Worcester

Frank P. Cartwright, Technical Secretary

BUREAU OF STANDARDS

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MEMBERSHIP OF THE BUILDING CODE COMMITTEE OF THE DEPARTMENT OF COMMERCE.

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FRANK P. CARTWRIGHT, Technical Secretary.

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WASHINGTON, D. C.,
July 20, 1922.

Hon. HERBERT HOOVER,
Secretary of Commerce,
Washington, D. C.

SIR: By direction of the Building Code Committee appointed by you, I transmit herewith its report upon Recommended Minimum Requirements for Small Dwelling Construction. The committee recommends that the report be printed for public distribution.

The committee began to function in June, 1921, and in accordance with your suggestion has limited its work thus far to consideration of the requirements for small dwellings. A tentative report was distributed for suggestions and criticism to all technical and industrial organizations in the country interested in the subject and to several hundred individual architects, engineers, constructors, and public officials. The voluminous response was gratifying and helpful. All this material was given careful consideration and the tentative report modified wherever a change seemed justified.

In the opinion of the committee the appendix, which presents information underlying the requirements, will be helpful to the owners and builders of dwellings generally, and will result in better and more economical forms of construction. The committee has endeavored best to utilize materials of construction in the interests of conservation of these materials and of the finished structure.

Yours very truly,

IRA H. WOOLSON,
Chairman Building Code Committee,
Department of Commerce.

LETTER OF ACCEPTANCE.

DEPARTMENT OF COMMERCE,
OFFICE OF THE SECRETARY,
Washington, September 18, 1922.

Mr. IRA H. WOOLSON,
Chairman Building Code Committee,
Department of Commerce.

DEAR MR. WOOLSON: I have the Recommended Requirements for Small Dwelling Construction transmitted by you in behalf of the Building Code Committee.

This report fully justifies the hopes I had entertained when the committee was appointed in May, 1921, as to what might be accomplished, and it is most gratifying to have it appear as a publication of the Department of Commerce. I am confident that the generous and voluntary contribution of time and energy which you and your colleagues have given to this work will result not only in a very appreciable money saving to millions of American families, but that it will have a positive influence toward better housing that can not be counted in dollars.

This report has been built up by cooperation of the Government and the public, which I feel will appeal to everyone. The committee itself represents the great voluntary organizations most interested in public service in this direction, but beyond this you have consulted with many other associations and you have submitted the report in its preliminary form to over 900 municipal officials, architects, engineers, officials of trade associations, and incorporated their criticisms into its final form. I believe this method of intellectual legislation is unique and gives the report a value far beyond any similar work undertaken to date.

I join with you in the belief that it will be helpful not only through practical use by municipalities in building codes and in promoting greater uniformity in codes throughout the country, but that with its appendix it will prove directly useful to owners and builders of dwellings generally.

Yours faithfully,

HERBERT HOOVER.

RECOMMENDED MINIMUM REQUIREMENTS FOR SMALL DWELLING CONSTRUCTION.

This report is subdivided into three general headings, as follows:

Part I.—Introduction: Covering a general description of the circumstances leading to formation of the committee and outlining its method of procedure and scope of operation.

Part II.—Minimum Requirements for Safe and Economical Construction of Small Dwellings: These are briefly stated in the form of an ordinance suitable for municipal adoption.

Part III.—Appendix: Containing material not suited to be incorporated in a building law, but which is explanatory of various requirements made in Part II.

PART I.—INTRODUCTION.

Defects of Existing Building Laws.

The United States Senate Committee on Reconstruction and Production, appointed in 1920, investigated the underlying reasons for high cost and inactivity in building industries in all parts of the country. In almost every city where hearings were held statements were made to the effect that local building laws required more material or refinements of workmanship than were justified, considering the purpose of the buildings affected. It was further disclosed that building codes and builders, either through ignorance or selfish motives, frequently failed to recognize modern methods of construction, thus denying the property owner such benefits as might accrue therefrom.

The following excerpt taken from the preliminary report of the Senate Committee on Reconstruction and Production is significant:

> The building codes of the country have not been developed upon scientific data, but rather on compromises; they are not uniform in principle and in many instances involve an additional cost of construction without assuring more useful or more durable buildings.

This subject was further expanded in the final report of that committee (S. Rept. No. 829, p. 57), from which the following extracts are taken:

> A study of these codes and experience under them would be of great service in preparing the material for the drafting of a building code which would be

as nearly uniform as the varying conditions in the different cities would permit; * * * new drafts of codes could be prepared in the light of the collected experience of the whole country, and not as a result of purely local consideration. * * * A great saving in building throughout the country could be secured by careful study of building construction and standardization of building materials similar to the work done by the Bureau of Standards in other lines.

Additional reasons exist for drafting standardized building laws which could be easily adopted as municipal ordinances. The United States census statistics for 1920 show a total of 1,467 cities and towns in the United States having population of 5,000 or over. Of these, it is elsewhere reported that 371, or 25 per cent, have no building code and no inspector. Of the latter, 145 have population of 10,000 to 25,000 and 35 of them exceed 25,000 population.

Origin and Purpose of the Building Code Committee.

The report of the Senate committee gave wide publicity to the building-code discrepancies long known by architects and building engineers, but not fully comprehended by the general public. Secretary Hoover, of the Department of Commerce, recognizing the necessity for some central coordinating body to standardize so far as possible the building laws of the country, organized the Building Code Committee for that purpose. The committee is a part of the newly created division of building and housing, which has under way a broad program of investigation into the causes of building-industry sluggishness and possible remedies therefor.

Following is the Secretary's letter to members of the committee, and which is suggestive of the general purposes for which it was organized.

My Dear Mr.———: The increasing demand for buildings of every kind, especially for housing, makes it imperative that practical steps be taken to relieve the present stagnated condition of the building industry.

From numerous sources it has come to my attention that there is a wide diversity in many of the fundamental requirements of building laws throughout the United States, which results in wastefulness in the use of building materials. I have been informed that a saving of from 5 to 10 per cent upon the cost of building construction might reasonably be expected by a standardization of building-code requirements and perhaps more in some cases. Although such a saving on a single building might be small, the aggregate saving upon the several billion dollars' worth of building construction which is now demanded would be large, and would be in line with sound economic principles of conservation.

It has been suggested to me by men connected with the various building industries who have been studying the economic problems of the whole industry, as well as those problems connected with their own materials, that I should secure the advice of a voluntary committee otherwise having no connection with the Government, and probably not exceeding six in number, of well-known experts in various branches of building construction, men whose professional standing will give weight to their public utterances; this committee should seek constructive criticism from manufacturers, industrial associations, architectural and engineering societies, and from other sources as to improper and inconsistent building laws; and that perhaps subcommittees of these organizations might study and report to the committees of experts upon special subjects of which such subcommittees may have practical experience.

It also has been suggested that the facilities of the Department of Commerce should be utilized, and that there might be placed at the disposal of the committee of experts such of the Bureau of Standards' physical research equipment as would be useful for work of investigation, together with the services of several experienced investigators on building materials and construction, and that the department might cooperate in securing the attendance before the committee of specialists whose advice might be required.

The evidence and information thus collected from all sources might be considered by the committee of experts, and opinions rendered upon each question studied, and these opinions or decisions might from time to time be promulgated as standards of practice rendered by the committee and indorsed by this department. This promulgation might occur through distribution of the printed recommendations of the committee as well as through activities of local chambers of commerce, real estate boards, contractors' and builders' organizations, chapters of architects, engineering societies, also through special local committees in the larger communities and cities. However, detailed plans of procedure would later be developed by the committee itself.

I am favorably impressed with the suggestions, because the opinions rendered by the committee of experts would be, in fact, the opinions of the whole construction industry itself, backed by the technical knowledge of the Bureau of Standards, and should emphasize through proper publicity the advantage of revising the existing building codes in harmony with improved standards based upon the latest knowledge of materials.

It is not unlikely that by the time the principal object of the committee of experts has been accomplished it might develop that a permanent committee, subject to call from time to time, may be useful to furnish advice upon various building-code questions, which are continually arising, to the end that the municipalities throughout the country may have at their disposal the best scientific and practical advice in the evolution of their building codes and that buildings may be constructed with increasing regard to economy, durability, and habitability.

Being assured of the cooperation not only of the manufacturers, architects, and engineers but also of the chambers of commerce and real estate boards of the country as well, the question now resolves itself into completing the committee of experts whose standing is nation-wide and who can promptly give the necessary attention to the matter.

Because of your extended experience with building codes through your work, and because of your lifelong contact with structural engineering problems, I shall be pleased to learn that you have consented to serve on this committee. In view of conditions surrounding the industry I hope that the committee will be completed and the details of its operations agreed upon at a very early date.

Yours faithfully,

HERBERT HOOVER.

The committee organized the last of May, 1921, and secured the appointment of a technical secretary and other clerical assistants who should be in constant attendance at the committee's office, which was established in the Department of Commerce Building in Washington. The task of gathering data was at once begun.

The general purposes of the committee are as follows:

1. To study existing building codes and determine the nature of their disagreement and the extent to which their requirements are oppressive to building industry.

2. To gather information concerning minimum requirements considered essential by architects and engineers for safe and proper construction of buildings of different types and varying occupancy, in an effort to secure safe, economical construction, and eliminate waste in building.

3. To prepare and publish recommended building regulations, based upon the consensus of reliable information obtained through various channels of inquiry throughout the country, such recommendations to represent minimum safe practice in all matters pertaining to engineering design and general building methods.

These recommendations to be drafted in such form as to be easily adapted as amendments to existing building codes or adopted as ordinances by municipalities which at present have no building laws.

4. To investigate the merits of new building materials and methods of construction which promise economy, and, so far as it can do so legitimately, to recommend such as appear to have special merit.

5. Supplemental to the foregoing, the committee may use its influence to further any measures promising improvement in present methods of building regulation or which encourage building industry.

6. It is not the purpose of this committee, at least for the present, to draft a complete building code. It believes the main objects desired can be most quickly and easily secured by recommending standards of practice in those portions of the building codes subject to the greatest general criticism.

Regulations for Dwelling Construction a Pressing Necessity.

The great scarcity of dwellings throughout the country, especially the small one and two family types, reported by various organizations investigating that subject during the preceding two years, made it apparent that any assistance the committee could render in reducing the cost of such construction would be immediately helpful. Secretary Hoover was particularly interested in this phase of the work and at his request the committee gave it precedence.

The financial importance of such construction is indicated by statistics compiled by the Chamber of Commerce of the United States, which show that the cost of such structures built during the year 1920 was about 75 per cent of the total cost of dwelling accommodation provided in cities, and about 28 per cent of the total cost of all classes of building construction. One and two family dwellings made up 42 per cent of all building operations reported, and both this percentage and the proportion of total cost given undoubtedly would have been greater if figures could have been obtained from more small cities and towns. According to dependable statistics, the shortage of homes in the United States was 1,200,000. It was apparent, therefore, that if building regulations could be so modified and standardized as to effect even a small saving on each building without endangering its efficiency or permanency a large total economy would result.

Further investigations showed also that many of the buildings erected where there were no building regulations or no means to enforce existing regulations were of such low-grade construction that much of the money invested in new homes was wasted. The committee felt it could render valuable service by spreading reliable information concerning sound building practice throughout the country, so that poor building, which is actually the most wasteful, might be reduced. Elimination of this more insidious form of loss is believed to be fully as important as the modification of code requirements.

Cooperation of the Building Public Sought.

In order to get an expression of public opinion as to what were the most important factors in the problem presented, and to enlist assistance in its solution, the committee sent out a broad appeal for information and suggestions. The response was generous and helpful.

Letters were sent to about 100 mayors in a selected list of cities outlining the purpose of the committee and requesting that the matter be brought to the attention of the building inspectors in these cities; also that copies of city building codes be sent to the committee. At the same time these officials were asked to support the committee's program and to give their personal opinion as to the general defects of building laws and to suggest remedies. The replies in nearly every case were carefully prepared and valuable. Correspondence upon specific questions later developed with a very much larger number of building officials.

Similar letters explaining the purpose of the committee were sent to all active technical societies, both national and local, whose activities were associated with building industry; also to a large number of builders' exchanges in the most important cities, and to a selected list of national industrial associations closely concerned with the manufacture and use of structural materials. Each organization was invited to appoint a member to act as its representative in forwarding suggestions or data on building regulations or improvements in building practice to the Building Code Committee, and through whom recommendations based on examinations of such material might be submitted for criticism or approval of the organization.

In response to this appeal, 90 point-of-contact men were appointed by the various organizations with instructions to further the work in every way possible. These men have responded freely whenever called upon and in future will be able to render further service to the committee.

Industrial organizations responding to this suggestion were also asked to prepare briefs setting forth what they considered the best and most economical methods of utilizing their respective products. A number of these briefs were furnished in elaborate detail, notably those from the Common Brick Manufacturers' Association of America, the National Lumber Manufacturers' Association, the National Lime Association, the Portland Cement Association, the Gypsum Industries Association, and the Fiber Wall Board Manufacturers' Association. All the briefs received were very helpful to the committee both in preparation of the recommendations and in compiling data for the appendix.

The more promising suggestions obtained through contact with all organizations and through the cooperation of various independent engineers and architects were assembled and submitted informally to public officials and others whose experience qualified them to discuss such matters.

Reduction in Wall Thicknesses Suggested.

As a means for reducing construction costs in masonry walled buildings, strong appeals were made to the committee for more generous recognition of 8-inch walls than they are now receiving in building codes of the country. The committee realized that marked differences of opinion existed upon this subject, and above all that safety and efficiency must not be sacrificed for economy. It decided, therefore, to ascertain current practice in different parts of the country and to make a thorough investigation of the matter from every angle before offering recommendations.

In order that a wide expression of opinion might be obtained as to the relative fire resistance and structural stability of 8 versus 12 inch masonry walls, questionnaires of considerable length and intended to develop full information upon the subject of inquiry were addressed to about 225 building inspectors in the largest cities, to about 400 fire chiefs and fire marshals, and 350 insurance companies and fire insurance adjustment bureaus.

Replies to these inquiries were not as numerous as desired, still the number was large enough to reflect the prevailing opinion in each class fairly well. The returns were extremely interesting and quite complex, for the subject was viewed from many angles and widely different conclusions expressed. In no case were statistics or classified data available upon which to predicate judgments. The opinions offered were founded upon personal observation and a more or less intimate acquaintance with the behavior of walls in service. All the information thus obtained was analyzed and classified for ready reference by the committee members. A brief summary of this will be found in the appendix.

In connection with this collection of data on walls, the United States Bureau of Standards generously assisted the committee by undertaking a broad investigation of the relative merits of various types and thicknesses of brick walls. Its program includes the following:

1. A careful analysis of wall requirements in 134 selected building codes.

2. The conduct of a notable series of fire tests upon solid and hollow brick walls of large size, built with different varieties of brick and mortar.

Aside from the information to be derived as to the effect of heat upon the materials employed, these tests were designed to determine the effect of heat upon stability of the walls as a whole, also the relative heat conductivity of different walls, and to show the influence of restraint upon the walls.

3. An elaborate investigation of the strength of brick walls in the largest units adapted to the 10,000,000-pound testing machine at the bureau's Pittsburgh laboratory.

4. Various minor studies to be made concurrently with the execution of the main project.

The fire tests are under the able direction of S. H. Ingberg. Several of the bureau's engineers cooperated to make this investigation as complete and authoritative as possible. When finished it will be the subject of a special report by the bureau and will be of great value. A part of the work has been done and made available for the use of the committee. Further reference to it will be found in the appendix.

Recommendations Submitted for Discussion.

The Building Code Committee held several meetings for consideration of the material submitted by contact men and that otherwise obtained. As a result of those meetings a report of tentative recommendations for the regulation of all structural features of small dwellings was prepared, and about 1,000 copies were distributed to individuals whose experience qualified them to speak with authority on the subject; also to the industrial and technical organizations associated with the committee in its work, and particularly to chapters of the American Institute of Architects, with a general request for constructive criticism and for suggestions as to changes or additions which would make the report more useful to those engaged in drafting or revising regulations for dwelling construction.

The response to this request was gratifyingly complete and representative both as to attitude and experience of the respondents and their geographical location. About 150 letters were received, most of which were official expressions of opinion from interested groups or organizations, and which therefore represented a wide field of professional experience.

Regarding the feasibility of standardizing building regulations, opinion apparently is almost unanimously favorable. Only two or three respondents expressed doubt as to the probable success of the plan. In no case was a majority of respondents found to be opposed to the substance of any division or section of the tentative report nor to the general policies which the committee had adopted governing the liberality of the requirements, the omission of detailed specifications, the insistence on minimum standards justifiable by police-power considerations, emphasis on fire protection, and the inclusion of informative material to explain the committee's decisions. The committee devoted a full week to consideration of these numerous suggestions, and the report in its present revised form is based both on information accumulated previous to the drafting of the preliminary report and also on criticisms and suggestions received in regard to that report. The committee wishes to emphasize the fact that the final draft herewith presented differs considerably from the tentative form, and is also, in its belief, a distinct improvement.

Simplification of Plumbing Equipment.

Among the many suggestions received by the committee meriting special attention as a probable source of considerable saving, one frequently repeated and strongly emphasized was that plumbing requirements should be revised and standardized. Accepting this suggestion the committee made analyses of 80 selected plumbing ordinances to ascertain average and extreme types of practice. Numerous letters were sent to building inspectors and plumbing experts in different parts of the country seeking information upon the desirability of changes in present methods of plumbing installation. It promptly developed that there was unanimity of thought that economies could be effected, but no agreement as to plans for accomplishing same.

Strong differences of opinion have long existed as to the merits of various plumbing devices and special methods of installation. Several investigations of the problems involved have been conducted in recent years under different auspices, and while each furnished some valuable information it appears that none of them has been carried to a conclusion satisfactory to all interests. The expense and time involved in such researches have made them impractical under private or municipal direction. The great value of a thorough impartial investigation by the Bureau of Standards to settle disputed points was recognized.

It was apparent that the technical nature of the problems presented demanded attention from those widely experienced in such matters, and a subcommittee of sanitary engineers and authorities on plumbing was appointed by Secretary Hoover to supervise the bureau's investigation and to draft recommendations for plumbing requirements based on study of the completed tests.

Membership of the subcommittee is as follows: George C. Whipple, chairman, professor of sanitary engineering, Harvard University; Albert L. Webster, consulting sanitary engineer, New York, N. Y.; William C. Groeniger, consulting sanitary engineer, Columbus, Ohio; Thomas F. Hanley, chairman standardization committee, National Association of Master Plumbers, Chicago, Ill.; August E. Hansen, consulting sanitary engineer, New York, N. Y.; Harry Y. Carson, consulting sanitary engineer, Birmingham, Ala.; and William J. Spencer, secretary-treasurer building trades department, American Federation of Labor, Washington, D. C.

The subcommittee on plumbing was organized during November, 1921, and a tentative report covering recommendations for regulation of plumbing installations in small dwellings has been prepared and widely distributed for critical discussion. It is planned to revise this tentative report in view of such suggestions as may be received and to publish it at a later date in the form of a Supplement to the Recommended Minimum Requirements for Small Dwelling Construction.

Scope and Purpose of This Report.

This report deals only with construction of dwellings intended for the occupancy of not more than two families between exterior or party walls. No recommendations are made as to proportion of lots that buildings may cover, the distance between buildings or between buildings and lot lines, or the effect upon construction imposed by such considerations. Lack of reference to these features is not due to their unimportance, but merely because the committee has considered them beyond the scope of the present report. An advisory committee on zoning has been organized in the division of building and housing to assist the department on zoning and city planning questions. All matters such as those mentioned above and those concerning necessities for light and air, also the general suitability of buildings as living quarters, will be considered jointly with that committee and recommendations made later.

It is recognized that the requirements recommended in Part II constitute, in some particulars, relaxations from those considered advisable for construction of large buildings. The committee believes, however, that for the simple types of buildings specified, and because of the need of eliminating all possible waste, the minimum standards advised are compatible with a due measure of utility and durability in the structures affected. The objects which the committee had in view in recommending these regulations were (1) to help eliminate waste in home building, (2) to secure safe and yet economical construction, and (3) to reconcile inharmonious and frequently too restrictive provisions in existing codes.

The recommendations are predicated on the assumption that good materials and workmanship will be used and all necessary care taken in assembling the various parts of the structures. The committee feels that thorough building inspection is often lacking and that many unnecessarily rigid code requirements have been adopted to offset possible laxity in enforcement. In modifying such provisions to reduce cost, therefore, local authorities should insist upon supervision of construction by an adequate, competent personnel.

It has been called to the committee's attention that some misunderstanding exists with regard to the legal status of its recommendations. It should be recognized that the committee's functions are purely advisory. The recommendations can not be considered in any sense as obligatory, but are issued to make available to those locally responsible for exercise of the police power the latest and most reliable information on building regulation for the class of buildings considered.

It is not intended that these recommendations be regarded as fixed. Building laws can continue to be of the highest usefulness only when they reflect progress in the art of building construction. Many of the injustices and discrepancies of existing building codes result from delay in their revision to meet changing conditions. It is planned that whenever changes in the building art or in the conditions to which buildings are exposed are reliably established these national recommendations will be altered at intervals to take account of them. In this way it is hoped that best assistance may be rendered those responsible for revision and enforcement of local ordinances.

Acknowledgment of Assistance.

The committee desires to express its especial appreciation of the cordial cooperation received from Dr. S. W. Stratton, Director of the Bureau of Standards. The splendid facilities and skilled professional staff of the bureau have been placed at the committee's service. The results of the various research investigations undertaken by the bureau at the suggestion of the committee will constitute very valuable features of its reports, and these would not have been possible without this kindly assistance.

In addition to the individuals and organizations already mentioned as assisting in the work, the committee desires to acknowledge the willing and valuable cooperation extended by the great number of engineers, architects, building inspectors, fire chiefs, and others with whom it has been in contact. Their prompt and well-considered response to requests for information has greatly facilitated the work and has been much appreciated.

The committee also desires to acknowledge the courtesy of the following organizations in furnishing the cuts with which the Appendix of the report is illustrated: Plate 4 and Figures 1 and 2 of Plate 1 were furnished by the American Face Brick Association; Plates 3 and 23 and Figure 3 of Plate 1 by the Hollow Building Tile Association; Plate 2 by the Common Brick Manufacturers' Association of America; Plate 19 by the Gypsum Industries Association; Plates 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, and 18 by the Weyerhaeuser Forest Products; and Plates 20, 21, 22, 24, 25, 26, 27, 28, 29, and 30 by the National Board of Fire Underwriters.

PART II.—MINIMUM REQUIREMENTS FOR SAFE AND ECONOMICAL CONSTRUCTION OF SMALL DWELLINGS RECOMMENDED BY THE BUILDING CODE COMMITTEE OF THE DEPARTMENT OF COMMERCE.

ARTICLE I. GENERAL.

Section 1. Limitations.

These requirements apply only to buildings used as dwellings, either detached, semidetached, or in rows, and intended for the occupancy of not more than two families in each unit.

(The restrictions, limitations, and tabulations apply to small dwellings only, and are not to be considered as general for or applicable to other and larger types of construction. The recommendations are in no sense a housing code or tenement house law in the ordinary acceptation of these terms, neither do they take into consideration regulations in regard to fire limits or congested mercantile districts or types of construction that should or should not be used because of exterior fire risks. See Introduction, p. 9.)

Sec. 2. Heights and Areas.

1. The number of stories in dwellings having masonry or concrete walls of the minimum thickness permitted is limited only by the permissible height of the walls. Dwellings classified as frame construction, where built for accommodation of two families, are limited for the purposes of this ordinance to two and one-half stories.

A half story is a story situated wholly within the roof framing or having a floor level not more than 3 feet below the top of the roof plate. No family shall be domiciled within such half story.

NOTE.—Dwellings exceeding the height limitations fixed for the minimum wall thicknesses hereafter given require code regulation additional to that provided in the following sections.

2. No limitations are placed on the allowable floor area of dwellings for which minimum requirements are herein prescribed, except that not more than two families shall be housed within the same division or exterior walls.

ARTICLE II. DWELLINGS WITH SOLID BRICK WALLS.

(The restrictions, limitations, and tabulations apply to small dwellings only and are not to be considered as general for, or applicable to, other and larger types of construction.)

Sec. 3. Thickness, Height, and Bonding of Exterior Walls.

The minimum thickness of exterior solid brick walls shall be 8 inches for a height not exceeding 30 feet. When gable construction is used an additional 5 feet is permitted to the peak of the gable. In all 8-inch brick walls at least every sixth course shall be a header course or there shall be at least one full header in every 72 square inches of wall surface. All walls shall be securely bonded or anchored at points where they intersect. (See Appendix, pars. 1 to 6. Requirements for brick and mortar, Pt. II, sec. 7. Requirements governing construction of interior walls and partitions, Pt. II, secs. 28, 29, and 30. Requirements for foundation walls, Pt. II, sec. 31.)

NOTE.—Where sawed stone is available its use shall be permitted for walls under the same circumstances and subject to the same restrictions as solid brick.

Sec. 4. Piers.

The unsupported height of isolated brick or plain concrete piers shall not exceed 10 times their least dimension. Stone posts shall not be used as supports for girders or walls in cellars or basements. (See Appendix, par. 7.)

Sec. 5. Chases.

Chases shall not be permitted in 8-inch walls. In thicker walls the backs of chases shall be not less than 8 inches thick.

Sec. 6. Arches and Lintels.

1. Openings for doors and windows shall have well-buttressed arches, or lintels of masonry, plain or reinforced, or of metal which shall have bearing at each end of not less than 4 inches on the wall.

2. On the inside of openings less than 4 feet wide, in which the thickness of lintels or arches is less than the thickness of the wall supported, timber which will rest at each end not more than 2 inches on the wall and be chamfered or cut to serve as centers for arches may be permitted.

Sec. 7. Quality of Brick and Mortar.

Brick.—Brick, whether of clay or other materials, used for 8-inch exterior, party or chimney walls or piers, shall at least meet the following requirements:

Kind.	Absorption limits, per cent.		Compressive strength (flat), pounds per square inch.		Modulus of rupture, pounds per square inch.	
	Mean of five tests, maximum.	Individual, maximum.	Mean of five tests, minimum.	Individual, minimum.	Mean of five tests, minimum.	Individual, minimum.
Face brick	10	12	1,500	1,000	300	250
Common brick	12	15	1,500	1,000	300	250

When sampled at the plant the age of concrete brick when tested shall be not less than 28 days nor more than 60 days. Tests may be made on the brick delivered on the job.

Mortar for foundation or exterior walls, chimneys, or piers shall have a strength not less than that of a cement-lime mortar of the following proportions by volume: One part Portland cement, one part lime, six parts sand.

All cements and limes shall conform to the requirements of the standard specifications for such materials issued by the American Society for Testing Materials. (See Appendix, par. 10. For precautions necessary in laying brickwork in freezing weather or in warm, dry weather, see Appendix, par. 11. Requirements governing framing in masonry walled buildings, Pt. II, Art. VI.)

ARTICLE III. DWELLINGS HAVING WALLS OF HOLLOW BUILDING TILE, HOLLOW CONCRETE BLOCK, OR HOLLOW WALLS OF BRICK.

(The restrictions, limitations, and tabulations apply to small dwellings only and are not to be considered as general for or applicable to other and larger types of construction.)

Sec. 8. Thickness, Height, and Bonding of Exterior Walls.

The minimum thickness of exterior walls built of hollow building tile, hollow concrete block, or hollow walls of brick shall be 8 inches for the uppermost 20 feet. The total height shall be limited to 30 feet, provided that when gable construction is used an additional 5 feet is permitted to the peak of the gable. (See Appendix, pars. 12 and 13.)

All tile and block walls shall be bonded in every course by breaking joints at least 3 inches. Where a 3-inch facing of stone ashlar or terra cotta or a facing of brick is used, the thickness of the hollow-wall backing may be 2 inches less than that required for exterior walls, provided the facing is well bonded to the wall. (See Appendix, par. 15. Requirements for foundation walls, Pt. II, sec. 31. Requirements governing construction of interior walls and partitions, Pt. II, secs. 28, 29, and 30.)

NOTE.—The expression "hollow walls of brick" used in the above section and hereafter includes only those of the all rolock types built with a solid row of headers immediately below and above the ends of joints. The term "hollow concrete block" shall be understood throughout the report as including all types of hollow concrete units, including those designed by use in combination to bring about interior spaces in walls.

Sec. 9. Piers of Hollow Building Tile or Hollow Concrete Block.

Hollow building tile or hollow concrete block shall not be used for isolated piers unless solidly filled with concrete. The unsupported height of such piers shall not exceed ten times their least horizontal dimension.

Sec. 10. Bearing for Concentrated Loads.

Walls of hollow building tile or hollow concrete and hollow brick walls on which beams, joists, or concentrated loads rest shall be provided with bearing plates or courses of solid tile, brick, or concrete. Such bearing plates when of tile or concrete shall be of form adapted to the service required.

Sec. 11. Chases.

Chases shall not be permitted in 8-inch walls. In thicker walls chases shall not be cut but may be built in, and the back of the chase shall be not less than 6 inches thick.

Sec. 12. Quality of Materials.

Hollow building tile: The average compressive strength of hollow building tile used for exterior or party walls or piers, laid with the cells vertical, shall be not less than 1,200 pounds per square inch of gross sectional area tested with the webs vertical.

The average compressive strength of hollow building tile laid with the cells horizontal, and which are tested with the cells in that position, shall be not less than 700 pounds per square inch of gross sectional area.

Hollow concrete block: The average compressive strength of hollow concrete block used for exterior or party walls or piers shall be not less than 700 pounds per square inch of gross sectional area tested as used in the wall. Hollow concrete block or tile shall show not to exceed 10 per cent absorption, under a 48-hour test. (See Appendix, par. 14.)

Brick: Brick for hollow walls shall conform to requirements of Part II, section 7. (See Appendix, par. 8.)

Mortar: Either cement mortar, or cement-lime mortar, as defined in section 7, shall be used for walls of hollow unit construction or hollow walls of brick.

(See Requirements governing framing in masonry walled buildings, Pt. II, Art. VI.)

ARTICLE IV. CONCRETE DWELLINGS OF MONOLITHIC, UNIT, OR STRUCTURAL FRAME TYPE.

(The restrictions, limitations, and tabulations apply to small dwellings only and are not to be considered as general for or applicable to other and larger types of construction.)

Sec. 13. Monolithic Concrete Dwellings.

For height limits see Part II, section 16.

1. Monolithic concrete construction containing not more than two-tenths of 1 per cent of reinforcement shall be classed as plain concrete. Solid bearing walls shall be at least 6 inches thick.

2. Reinforcement not less than two-tenths of 1 per cent, computed on a vertical height of 12 inches, shall be placed over all wall openings and at corners of the structure to prevent cracks. Floor and roof connection details shall be designed to transmit safely the vertical and horizontal loads imposed.

3. Hollow monolithic walls shall have not less than 6 inches aggregate thickness of material. Wall openings and corners shall be reinforced in

the same manner as solid monolithic walls. The inner and outer parts of such walls shall be securely braced and tied together with noncorrodible ties or other means to bring them into common action. Where floor and roof systems are carried by such walls, provision shall be made for the distribution of these loads to all parts of the wall. (See Appendix, pars. 16 and 17. Foundation wall requirements, Pt. II, sec. 31.)

Sec. 14. Unit Construction.

Precast concrete units for construction of dwellings shall be of sufficient strength, and where necessary shall be reinforced to carry safely the loads imposed. Connections between the several parts of such structures shall be sufficiently strong and rigid to resist the vertical and horizontal forces which may be imposed. (See Appendix, par. 18.)

Sec. 15. Concrete Structural Frame with Inclosing Walls.

Dwellings constructed with monolithic reinforced-concrete frames cast in metal lath or other forms, and with inclosing walls of concrete plastered or shot on metal lath, or of precast units carried by such frames, or having reinforced-concrete bearing walls, shall be designed in accordance with standard methods of reinforced-concrete design to carry safely the dead weight of the structure and the live loads which may be imposed. Inclosure or panel walls shall be of sufficient strength and rigidity to resist lateral forces and transmit them to the framework. (See Appendix, par. 19.)

Sec. 16. Height of Concrete Exterior Walls.

The height of exterior concrete walls of the minimum thickness specified in Part II, section 13, shall be not greater than 30 feet. Where gable construction is used, an additional 5 feet is permitted to the peak of the gable. (See Requirements governing construction of interior walls and partitions, Pt. II, secs. 28, 29, and 30.)

Sec. 17. Floors, Floor Beams, and Columns.

Floors, floor beams, and columns shall be designed in accordance with standard methods to carry safely the loads imposed. (See Requirements governing framing in masonry walled buildings, Pt. II, Art. VI.)

ARTICLE V. FRAME CONSTRUCTION.

(The restrictions, limitations, and tabulations apply to small dwellings only, and are not to be considered as general for or applicable to other and larger types of construction.)

Sec. 18. Definition.

In frame construction all structural parts are of wood or are dependent upon a wood frame for support. This includes buildings with facings other than wood. The minimum sizes specified in these requirements, when not specifically mentioned as otherwise, shall be understood as referring to the nominal sizes of such timbers. (See Appendix, par. 20. Height limit for two-family frame dwelling, Pt. II, sec. 2.)

Sec. 19. Exterior Walls.

1. Wood studding shall be not less than 2 by 4 inches and spaced not to exceed 16 inches on centers.

2. Where exterior walls or parts thereof more than one story high are sheathed the boards shall be not less than three-fourths inch actual thickness. Sheathing boards shall be laid tight and properly nailed to each stud with not less than two eightpenny nails. Where the sheathing is omitted or is not laid diagonally, all corners shall be diagonally braced and such other measures taken to secure rigidity as may be necessary.

3. Wood sheathing may be omitted when other types of construction are used that are proven of adequate strength and stability by tests conducted by recognized authorities.

4. Ledger or ribbon boards used to support joists shall be not less than 1 by 4 inches, shall be cut into the studs, and securely nailed with not less than two tenpenny nails to each stud.

Sec. 20. Masonry Veneer on Frame Construction.

1. Masonry veneer applied to the walls of frame structures shall rest directly upon the masonry foundation of the structure and shall be not less than 3¾ inches in thickness.

2. Flashing shall be installed where necessary to prevent moisture from penetrating behind the wall.

3. The masonry veneer shall be securely attached to the frame structure at intervals of not more than 16 inches vertically and 24 inches horizontally.

4. A sheathing shall be securely attached to the framework of the structure back of the masonry veneer. (See Appendix, par. 21.)

Sec. 21. Stucco on Frame Construction.

1. Flashing or other expedients adequate to prevent penetration of moisture behind the stucco surface shall be used where necessary.

2. Back plastering shall be required where sheathing is omitted. (See Appendix, par. 22–4.)

3. Where wooden sheathing is used it shall be of boards not less than 1 by 6 inches and securely nailed to the studding. (See Appendix, par. 22–2.)

4. Metal lath used for stucco base shall be expanded metal lath weighing not less than 3.4 pounds per square yard, or wire lath woven or welded and not lighter than No. 19 gauge.

5. Where back-plastered construction is used the plaster shall be of sufficient thickness to extend back at least one-fourth inch between the studs. (See Appendix, par. 22–4.)

6. Cement and lime used for stucco shall conform to the standard specifications of the American Society for Testing Materials. (See Appendix, par. 10.)

7. Stucco shall be kept at least 8 inches above the adjacent ground surface. (See Pt. II, sec. 31–3, Appendix, par. 22, and footnote for additional information on stucco.)

ARTICLE VI. WOOD FRAMING.

(The restrictions, limitations, and tabulations apply to small dwellings only and are not to be considered as general for or applicable to other and larger types of construction.)

Sec. 22. General Requirements.

All members shall be so framed, anchored, tied, and braced together as to develop the maximum strength and rigidity consistent with the purposes for which they are used.

Sec. 23. Strength of Members.

1. All wooden structural members shall be of sufficient size and strength to carry the load safely without exceeding the allowable working stress of the material as specified in Table I. The strength of such members shall be determined from actual dimensions of the pieces and not from nominal dimensions. (See Appendix, par. 20.)

2. The allowable stress due to combined wind, and live and dead load shall not exceed one and one-half times that given in Table I. Stress due to dead and live loads acting singly or in combination, without wind load, shall not exceed the allowable stress given in Table I. (See Appendix, par. 23.)

3. The stress in compression across the grain may be increased 50 per cent in the case of joists supported on a ribbon board and spiked to the studding. (See Appendix, par. 24, bearing values for joists; par. 25, sizes for girders and maximum permissible length of floor joists; and par. 27, for general information on use of lumber.)

TABLE I.—*Allowable stresses permissible for structural timbers in small dwellings.*[1]

Species.	Grade.[2]	Allowable stresses in— Bending. In extreme fiber.	Bending. Horizontal shear.	Compression. Parallel to grain "short columns."	Compression. Perpendicular to grain.	Modulus of elasticity.
		Lbs./in.²	*Lbs./in.²*	*Lbs./in.²*	*Lbs./in.²*	*1,000 Lbs./in.²*
Cedar, western red	1	900	80	700	200	1,000
	2	600	53	467	200	
Cedar, northern white	1	750	70	550	175	800
	2	500	47	384	175	
Chestnut	1	950	90	800	300	1,000
	2	633	60	533	300	
Cypress	1	1,300	100	1,100	350	1,400
	2	867	67	733	350	
Douglas fir [3]	1	1,500	90	1,100	325	1,600
	2	1,000	60	750	300	
Douglas fir (Rocky Mountain region).	1	1,100	85	800	275	1,200
	2	767	57	533	275	
Fir, balsam	1	900	70	700	150	1,000
	2	600	47	467	150	
Gum, red	1	1,100	100	800	300	1,200
	2	767	67	533	300	
Hemlock, western	1	1,300	75	900	300	1,400
	2	867	50	600	300	
Hemlock, eastern	1	1,000	70	700	300	1,100
	2	667	47	467	300	
Larch, western	1	1,200	100	1,100	325	1,300
	2	800	67	733	325	
Maple, sugar or hard	1	1,500	150	1,200	500	1,600
	2	1,000	100	800	500	
Maple, silver or soft	1	1,000	100	800	350	1,100
	2	667	67	533	350	
Oak, white or red	1	1,400	125	1,000	500	1,500
	2	933	83	667	500	
Pine, southern yellow [3]	1	1,500	110	1,100	325	1,600
	2	1,000	70	750	300	
Pine, eastern white, western white, and western yellow	1	900	85	750	250	1,000
	2	600	57	500	250	
Pine, Norway	1	1,100	85	800	300	1,200
	2	733	57	533	300	
Spruce, red, white, and Sitka	1	1,100	85	800	250	1,200
	2	733	57	533	250	
Spruce, Engelmann	1	750	70	600	175	800
	2	500	47	400	175	
Tamarack, eastern	1	1,200	95	1,000	300	1,300
	2	800	63	667	300	

[1] Data furnished by the Forest Products Laboratory, Forest Service, U. S. Department of Agriculture, Aug. 1, 1922.

[2] Grade 1 shall have the defects limited as in the rules for select structural grade, adopted by the Southern Pine Association. Grade 2 may have defects of double the size, or defects which have double the effect, of those allowed in grade 1.

[3] Douglas fir and southern yellow pine which conform to the A. S. T. M. standards for "dense" will be allowed an additional extreme fiber stress of 250 pounds per square inch.

Sec. 24. Beams, Joists, Girders, and Rafters.

1. Anchors: Each tier of floor joists shall be securely anchored to masonry walls with T-shaped steel anchors at intervals of not more than 6 feet. Anchors shall be attached in a way to afford easy release in case of fire burning through the joists.

The ends of lapped joists resting upon girders or bearing partitions shall be securely spiked. When abutted they shall be connected with steel straps or dogs.

Joists running parallel to masonry inclosing walls shall be anchored to the walls at least once between bearings with steel anchors. Such anchors shall extend back and engage at least three joists.

Girders shall be anchored to the walls and fastened to each other in a suitable manner with steel straps.

When inclosing walls are of wood each joist, beam, and girder entering same shall be securely spiked or anchored to the wall construction. Where joists rest upon ledger or ribbon boards they shall be securely spiked to the studs.

The roof structure where resting on masonry walls shall have steel anchors not less than four-tenths square inch in cross section, extending down into the wall not less than 2 feet, and spaced not over 6 feet apart.

2. Support of beams and rafters: Every beam supported by masonry shall have bearing at least 3 inches in length.

The ends of beams resting in masonry walls shall be beveled to release the joist from the wall in case of fire.

Joists carrying nonbearing partitions running in the same direction shall be double. If nonbearing partitions cross joists near their center, these joists shall be of size required for normal loading, with a span 2 feet greater than the actual span. (See Appendix, par. 25.)

Rafters shall be vertically supported near the ridge when the slope is less than 6 inches per foot and all rafters shall be thus supported unless their feet are thoroughly tied at the plate.

3. Bridging: All floor and flat-roof beams shall be rigidly bridged at intervals not exceeding 8 feet.

4. Separation of beam ends: Wooden beams shall not enter 8-inch brick party or division walls unless recesses for timbers on both sides are provided at the time the wall is built, otherwise a 12-inch wall is required. In all masonry walls the beams on opposite sides shall be so placed as to provide at least 4 inches of solid masonry between them.

NOTE.—For general information on the selection, care, and economical use of timber for building purposes, see Appendix, par. 27.

Sec. 25. Basement Columns.

Basement columns supporting the first floor or parts thereof shall meet the following requirements:

Wooden columns shall rest on metal or masonry footings extending at least 3 inches above the basement or cellar floor.

Wrought iron or steel pipe columns shall be filled with concrete and shall have metal top and bottom bearing plates.

Cast-iron columns shall have metal top and bottom bearing plates. Such columns need not be filled with concrete.

Sec. 26. Bearing Partitions.

1. Bearing partitions shall be provided at the top with double plates, each at least 2 inches thick and of same width as stud. When the studs are placed directly below each joist, a single top plate may be used. If properly fire-stopped, studs may run through the floor and rest on girders or on partition plates.

2. All partitions not resting upon girders, or of which the studs do not rest on partition plates below, shall have sole plates of dimensions not less than the studs.

3. Partitions unsupported by walls shall be supported on girders or double joists, or on sole plates if placed at an angle to the joists.

Sec. 27. Nonbearing Partitions.

Nonbearing partitions shall be provided with at least one 2-inch plate on top and bottom of same width as stud or be otherwise properly fire-stopped at floor lines.

NOTE.—For information on the advisability of double flooring see Appendix, par. 26.

ARTICLE VII. PARTY AND DIVISION WALLS AND PARTITIONS.

(The restrictions, limitations, and tabulations apply to small dwellings only, and are not to be considered as general for or applicable to other and larger types of construction.)

Sec. 28. Party and Division Walls.

1. Party or division walls between dwellings occupied by not more than two families each may be constructed of wooden studs covered on both sides with metal lath and plaster. When thus constructed fire-stops shall extend the full depth of the joists and at least 4 inches above the level of each floor. Such walls shall be supported below the first floor by a masonry wall not less than 8 inches in thickness. (See Appendix, par. 31.)

Not more than four families shall be permitted in attached dwellings without a party wall of masonry.

2. Where party or division walls of masonry are required, they shall have the following thicknesses and shall conform in other respects to the requirements for exterior walls of the same materials:

The minimum thickness of solid-brick party or division walls shall be 8 inches for the uppermost 20 feet of height and shall be at least 12 inches for the remaining lower portion.

The minimum thickness of party or division walls of hollow building tile or hollow concrete block or of hollow-wall construction shall be 12 inches. No such wall shall be broken into for the insertion of building members. (See Appendix, par. 30.)

Concrete party and division walls shall be solid and not less than 8 inches thick. (See Requirements governing insertion of timbers into masonry party walls, Pt. II, sec. 24–4.)

Sec. 29. Parapet Walls.

All masonry party and division walls in houses built in rows shall project through combustible roofs to a height of at least 12 inches, shall have the full thickness of the top-story wall, and shall be coped. No parapet wall shall exceed in height four times its thickness. (See Appendix, par. 32.)

Sec. 30. Interior Partitions.

Nothing in this article shall preclude the use in cellars or basements of 4-inch brick, tile, or concrete-block partitions laid in cement or cement-lime mortar. Such partitions shall be reinforced where concentrated loads occur. (See Appendix, par. 33.) Gypsum block may be used for non-bearing partitions where not exposed continuously to dampness.

ARTICLE VIII. FOUNDATIONS.

(The restrictions, limitations, and tabulations apply to small dwellings only and are not to be considered as general for, or applicable to, other and larger types of construction.)

Sec. 31. Foundation Walls.

1. Foundation walls for solid-wall construction shall be of brick, concrete, concrete block, or stone. When built of brick, concrete block, or coursed stone they shall be at least 12 inches thick where they serve as cellar or basement walls, but may be 8 inches thick when the inclosure is not excavated. In the latter case the foundation walls shall be included in the allowable height of 8-inch walls. When built of concrete cast in place they shall be at least as thick as the walls they support, but in no case less than 8 inches. When built of rubble stone they shall be not less than 16 inches thick. (See Appendix, pars. 34 to 38, inclusive.)

2. Foundation walls for hollow building tile, hollow concrete block, hollow walls of brick and for frame construction may be built of brick, concrete, concrete block, or of salt-glazed tile or vitrified fire-clay tile, with special thick walls and low degree of absorption. Tile foundation walls shall be not less than 12 inches thick.

3. Foundation walls for frame construction shall extend at least 8 inches above the adjacent ground surface.

4. The quality of materials for foundation walls shall be the same as required for exterior walls except that ordinary hollow building tile shall not be used.

(NOTE.—For anchorage of structure to foundation walls see Appendix, par. 43.)

Sec. 32. Footings.

All foundation walls shall extend below the frost line and have suitable provision at the bottom to keep load distribution within carrying capacity of the soil. (See Appendix, par. 35.)

Sec. 33. Ventilation.

Cross ventilation shall be provided for the space inclosed by foundation walls, whether it be excavated or not. (See Appendix, par. 36.)

ARTICLE IX. MISCELLANEOUS REQUIREMENTS.

(The restrictions, limitations, and tabulations apply to small dwellings only, and are not to be considered as general for or applicable to other and larger types of construction.)

Sec. 34. Loads.

1. Dead loads: Dead loads shall consist of the weight of the walls, floors, roofs, and partitions.

2. Live loads: Live loads shall include all loads except dead loads.

3. All parts of dwellings shall be designed to support their own weight and the portion of the live load on floor or roof which they carry. In computing the dead load the weights of various materials shall be assumed as given in Part II, section 35.

Sec. 35. Weight of Materials.

The weights of construction materials used in calculating dead loads shall be assumed as follows:

	Pounds per cubic foot.
Solid brickwork, ordinary	120
Concrete—stone and gravel	150
Plaster and mortar	96
Oak	48
Yellow pine	48
Douglas fir and cypress	36
Spruce and hemlock	30
Maple and birch	48
Hollow gypsum partition block	48
Hollow tile partition block	60

Wooden-stud partitions, three coats of plaster each side, 99 pounds per square yard.

Wooden-stud partitions with gypsum wall-board surfaces, 45 pounds per square yard.

Wooden-stud partitions with fiber wall-board surfaces, 30 pounds per square yard.

Hollow walls of brick, 8 inches, 72 to 90 pounds per square foot.

Sec. 36. Floor Loads.

1. Floors shall be designed to support their own weight, the dead loads they are to carry, and a live load of 40 pounds per square foot, except that for floors of monolithic type or of solid or ribbed slabs the live load may be taken as 30 pounds per square foot.

2. Girders or other members supporting a floor area not exceeding 100 square feet shall be designed to carry a minimum of 40 pounds live load per square foot uniformly distributed over the surface.

When the floor area supported exceeds 100 square feet and is not over 200 square feet, the assumed live load may be reduced to 35 pounds per square foot, and when the floor area exceeds 200 square feet the live load may be assumed at 30 pounds per square foot. (See Appendix, pars. 39 and 40.)

Sec. 37. Roof Loads.

Roofs having a rise of 4 inches or less per foot shall be proportioned for a vertical live load of 30 pounds per square foot of horizontal projection, applied to any or all slopes. With a rise of more than 4 inches and less than 12 inches per foot a vertical live load of 20 pounds on the horizontal projection shall be assumed. If the rise exceeds 12 inches per foot, provision shall be made for a wind force acting in a normal direction (on one slope at a time) of 15 pounds per sloping square foot. (See Appendix, par. 41.)

NOTE.—For recommendations regarding roof coverings, see Appendix, par. 42.

Sec. 38. Plastering.

If a dwelling is plastered, the following requirements shall apply:

Plaster on wood or metal lath or on other materials which support the plaster by keying shall be not less than two-coat work and at least five-eighths inch thick.

Plaster on masonry surfaces, plaster board, or on other materials which do not support the plaster by keying, may be one-coat work, but shall be of sufficient thickness to cover the surface amply and to correct all unevenness. (See Appendix, par. 44–1.)

NOTE.—For material on plastering practice and plaster substitutes see Appendix, pars. 43 to 47, inclusive.

Sec. 39. Timber in Walls.

No timber, except inside lintels as prescribed is Part II, section 6, and no nailing blocks longer than 8 inches horizontally or nearer together than 2 feet, shall be built into any masonry wall.

Furring: See Appendix, paragraph 48, for material on advisability of furring masonry structures.

Sec. 40. Chimneys.

1. Chimneys shall not rest upon or be carried by wooden floors, beams, or brackets, nor be hung from wooden rafters.

2. Chimneys shall be built upon concrete or masonry foundations properly proportioned to carry the weight imposed without danger of settlement or cracking.

3. The walls of brick buildings may form part of a chimney, but the walls of the chimney shall be securely bonded into the walls of the building and the flue shall be lined the same as an independent chimney. Flues in party walls shall not extend beyond the center of the wall, and their location shall be permanently indicated on the exposed surface of the wall.

4. No wall less than 12 inches thick shall be used to support a corbeled chimney. Such corbeling shall not project more than 6 inches from the face of the wall, and in all such cases the corbeling shall consist of at least five courses of brick.

5. Chimneys shall be built at least 3 feet above flat roofs and 2 feet above the ridges of peak roofs and shall be properly capped with stone, terra cotta, concrete, cast iron, or other approved material, but no such capping shall decrease the required flue area.

6. All chimneys built of brick, stone, concrete block, or hollow building tile, except chimneys having solid brick walls 8 inches or more thick, shall be lined throughout with fire-clay flue lining. Flue linings shall be not less than three-fourths of an inch thick, and shall be made for the purpose and adapted to withstand high temperatures and the resultant gases from burning fuel. Adjoining flue linings in a chimney shall have the joints broken at least 7 inches. The flue sections shall be set in mortar of quality at least as rich in cement as that required for walls and shall have joints struck smooth on the inside. The masonry shall be built around each section of lining as it is placed, and all spaces between masonry and linings shall be completely filled with mortar. No defective flue linings shall be used. Linings shall start below the bottom of smoke intakes or from the throats of fireplaces and shall be continuous the entire height of the flue. (See Appendix, par. 49–3. See also Plate 20 for details of the construction required above.)

7. Concrete for chimneys cast in place shall flow readily, be well rodded, and shall be reinforced vertically and horizontally. The walls shall be not less than 3¾ inches thick and shall be lined with fire-clay flue lining, or the linings may be omitted, provided the walls of the chimney be not less than 6 inches thick. (See Appendix, par. 49–1.)

8. Concrete blocks used in chimney construction shall be not less than 3¾ inches thick, and blocks inclosing more than one flue shall have suitable reinforcement completely encircling the blocks and well embedded in them. (See Appendix, par. 49–2.)

9. Stone chimneys, unless built of sawed or dressed stone in courses, properly bonded at corners and tied with metal anchors, shall have walls at least 8 inches thick.

10. Hollow building tile shall not be used for the walls of isolated or independent chimneys, but may be used for chimneys built in connection with exterior hollow-tile walls of buildings, in which case the chimney walls shall be not less than 8 inches thick. The outer 8 inches of a building wall may serve as the outside wall of the chimney, but the remaining chimney walls shall be constructed of two layers of 4-inch tile set with broken joints, or they may be built of 4 inches of solid brickwork. In either case the outside walls of the chimney shall be securely bonded into the wall of the building. No chimney shall be corbeled from a hollow-tile wall. (See Pl. 23.)

11. The inside area of flue linings shall be not less than 75 square inches for a furnace or fireplace, and 49 square inches for stoves and ranges when coal, coke, wood, or oil is the fuel used. When gas is the fuel used in a heating-furnace boiler or automatic hot-water heater, the flue shall be of the same size and construction as required for stoves and ranges using other fuel. Vent flues, where required for other domestic gas-burning appliances, may be of smaller size but not less than 10 square inches. Such flues shall be made of fire clay or its equivalent, not less than 1 inch thick, with joints properly designed to effect a permanent seal, and in such cases the surrounding masonry walls may be omitted. Metal vent flues are not permitted. (See Appendix, par. 49–3.)

12. Connections between chimneys and roofs shall be made with sheet metal counter or cap flashing arranged to overlap roof flashing and allow for movement that may occur between chimney and roofs.

13. No change in the exterior dimensions of chimneys shall be made within a distance of 12 inches above or below the rafters or roof joists.

14. Smokepipe intakes to flues shall always enter the chimney through the side, and shall consist of fire clay or metal thimbles securely set in the chimney wall with mortar, or the intake may be cast in concrete. Such openings shall be at least 18 inches below wooden lath and plaster or other combustible ceilings or open joists, unless the surface above the pipe is protected with incombustible material. Neither the intake pipe nor the thimble shall project into the flue.

No woodwork shall be placed within 6 inches of the thimble. Wherever possible the brickwork for a space of 6 inches surrounding the thimble shall project to the plane of the lath of any furred wall covering the chimney and the plaster be made continuous over the lath and brickwork. Where this method of construction is not practicable, the thimble shall be surrounded by metal lath and plaster for a space of at least 6 inches or an open space of that width provided on all sides. In either of the last two cases the open space between chimney and furred wall shall be closed on all sides by metal lath and plaster. If a heavy metal thimble be used, the latter requirement may be omitted. (See detailed sketch, Pl. 20.)

15. All flues shall be thoroughly cleaned and left smooth on the inside.

Sec. 41. Woodwork Around Chimneys.

1. No wooden beams, joists, or rafters shall be placed within 2 inches of the outside face of chimneys. No woodwork shall be placed within 4 inches of the back wall of any fireplace.

2. All spaces between chimneys and wooden joists or beams shall be filled with loose cinders, loose mortar refuse, gypsum block, or other porous incombustible material to form a fire stop.

The incombustible material shall be supported by strips of sheet metal or metal lath set into the brickwork and nailed to the wooden beams, forming a buckled flexible joint between, or by similar strips of metal nailed to the woodwork with the inner edge close to the chimney.

3. No wooden studding, furring, lathing, or plugging shall be placed against any chimney or in the joints thereof. Wooden construction shall either be set away from the chimney or the plastering shall be directly on the masonry or on metal lathing or on incombustible furring material. Wood furring strips placed around chimneys to support base or other trim shall be insulated from the masonry by asbestos paper, at least one-eighth inch thick, and metal wall plugs or approved incombustible nail-holding devices attached to the wall surface shall be used for nailing.

4. The walls of fireplaces shall never be less than 8 inches thick, and if built of stone the minimum thickness shall be 12 inches.

5. All fireplaces and chimney breasts shall have trimmer arches or other approved fire-resistive construction supporting hearths. The arches and hearths shall be at least 20 inches wide, measured from the face of the chimney breast. The arches shall be of brick, stone, or hollow tile, not less than 4 inches thick. A flat stone or a reinforced concrete slab may be used to carry the hearth instead of an arch if it be properly supported and a suitable fill be provided between it and the hearth. The length of trimmer arches and hearths shall be not less than 24 inches longer than the fireplace opening. Hearths shall be of brick, stone, tile, or concrete, as may be specified.

6. No coal-burning heater shall be placed in a fireplace which does not conform to the foregoing requirements.

7. No wooden mantel or other woodwork shall be placed within 8 inches of the side or top of any open fireplace.

Sec. 42. Fire-Stopping.

1. Fire-stopping shall be arranged to cut off all concealed draft openings and form an effectual horizontal fire barrier between stories and roof spaces.

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2. Furred walls: For all walls furred with wood the masonry between the ends of wooden beams shall project the thickness of the furring beyond the inner face of the wall for the full depth of the beams, or a double course of bricks or other masonry above and below the beams shall project beyond the face of the wall the full thickness of the furring. (See Appendix, par. 55–1 and Pl. 25, Figs. 3 and 4.)

Where floor beams are parallel to a wall furred with wood there shall be a space of not less than $2\frac{1}{2}$ inches between such wall and the nearest beam. This space shall be filled solidly with brickwork or concrete for the full depth of the floor beams or be equivalently fire-stopped.

3. Walls studded off: Where walls are studded off the space between the inside face of the wall and the studding at the floor level shall be fire-stopped with incombustible material.

The spaces between beams directly over the studded-off space shall be fire-stopped by covering the bottom of the beams with metal lath and plaster and then placing a 3-inch loose fill of incombustible material on the plaster between the beams, or 3-inch gypsum plaster partition blocks may be cut to fill the spaces between joists and be supported on cleats. (See Appendix, par. 55–2.)

4. Partitions: Where stud partitions rest directly over each other and cross wooden floor beams at any angle, and the studs run down between the floor beams and rest on the top plate of the partition below, the spaces between the studding shall be filled in solid to at least 4 inches above each floor level with incombustible materials.

5. Roofs: Dwellings within 10 feet of other nonfireproofed buildings shall have the walls behind the eaves or cornices fully equipped to prevent fire from a near-by building breaking through into the attic space.

NOTE.—See Plates 28 and 30 for details of construction required above.

6. Cornices: Cornices built of wood or having wooden frames on rows of buildings shall be either fully fire-stopped between each building or shall be completely separated. (See Appendix, par. 55–6.)

7. Stairs: The space between stair carriages shall be fire-stopped by a header beam at top and bottom. Where a stair run is not all in one room or where a closet is located beneath the stairs, the stair carriages shall have an intermediate fire-stop, so located as to cut off communication between portions of the stairs in different rooms, or between the closet and the room in which it is placed. Such stops can best be made of plank.

If a flight of stairs is so arranged as to be the only construction separating two stories at the place where they are located—as, for example, between the cellar and the story above—the underside of the stairs shall be covered with metal lath or one-half inch plaster board and plastered to a total thickness of three-fourths inch.

8. Warm-air pipes and registers: Where a furnace warm-air pipe passes through a floor, the space between the pipe and floor construction shall

be filled with incombustible material supported by sheet metal or metal lath.

The space between a register box set in a floor and the casing protecting the floor construction shall be filled with incombustible material. This shall include the space around that portion of the warm-air pipe attached to the register box down to the bottom of the joists in wooden floor construction, and a layer of sheet metal or metal lath shall surround the pipe and be securely nailed to the underside of the joists to support the fire-stopping. When a register box is fire-stopped in this manner, the space between the box and the casing may be reduced to 2 inches; otherwise it shall be 4 inches. (See Appendix, par. 55–7. See also Pl. 29, Figs. 1 and 2, for details.)

9. No fire-stopping shall be concealed from view until opportunity has been given the owner or his representative to inspect same.

Sec. 43. Private Garages Combined with Dwellings.

When a garage is located beneath or attached to a dwelling, the following regulations as to its construction shall be rigidly observed:

1. The floor and ceiling construction above the garage when it is located beneath the building, or the roof when the garage is attached to the building, shall be unpierced and shall have a fire resistance of one hour, based upon the standard specifications for fire tests of materials and construction. (See Appendix, par. 56–1.)

2. Walls and partitions shall be of such construction as will meet the requirements of the one-hour fire test as above specified. (See Appendix, par. 56–6.)

3. When a garage is located beneath a dwelling all doors and windows with their frames and sash shall be of standard fireproof construction and glazed with wired glass. (See Appendix, par. 56–8.)

4. Openings from dwelling into garage shall be restricted to a single doorway; such opening shall be protected by a standard, swinging, self-closing fire door with approved fire-resistive frame and hardware. No glass shall be permitted in such door.

5. When a doorway connects directly with a cellar or basement on the same or lower level in which there is any heating device or gas fixture, the doorsill shall be raised at least 1 foot above the garage floor level; or the doorway shall lead into a vestibule from which a second door connects with the cellar or basement.

6. Garage floors shall be of concrete or equally fire-resistive and impervious material.

PART III.—APPENDIX.

Purpose.

The appendix consists of explanatory matter referring to Part II and includes summaries of various briefs on special subjects prepared for the committee's assistance. It is a vital part of this report. The committee has been singularly fortunate in its facilities for obtaining data and test records from all parts of the country. It has had for consideration a large accumulation of reliable material on which many of its recommendations have been based, thus adding greatly to their significance. The appendix is the merest digest of this wealth of material and is submitted for its educational value.

The Building Code Committee is convinced that the requirements of a building code should be as brief and simple as possible. It should contain merely the minimum requirements necessary and not be a set of specifications covering methods of building. The committee further believes that every such document should be accompanied by an appendix, which should not be a law or ordinance, but which should contain such general explanatory statements of the requirements in the code as would make them easily understandable and such other information of value as could not be obtained elsewhere in concise form, if at all, for the education of the home builder. The committee strongly recommends that in the event of any State or municipality using Part II as the basis of a building ordinance for dwellings such an appendix be published accompanying the ordinance for the direct benefit of builders.

It should be further stated that the committee, after prolonged study of the voluminous data at its disposal, has placed the requirements in Part II as low as it considers safe for durable and proper building, as indicated in Part I of this report. The appendix contains many suggestions for better methods of building, so that they will be available for those who are financially able to take advantage of such opportunities.

Paragraph 1. Thickness, Height, and Bonding of Solid Brick Exterior Walls.

In deciding upon the allowable height of 8-inch solid brick walls for dwellings the committee had reference to several compilations of information and opinion on the subject, as follows:

1. *Present code requirements.*—An investigation by the Bureau of Standards of the requirements of 134 building codes, representing all parts of the country, disclosed the following facts:

Fifty-five codes, or about 41 per cent of the number, permit construction of two-story dwellings with 8-inch exterior walls, the average permissible height of such walls being 27 feet; six codes allow three-story dwellings with 8-inch walls of an average height of 35 feet, and 13 codes permit the upper two stories of three-story dwellings to be 8 inches thick.

An independent search, under the auspices of the Common Brick Manufacturers' Association of America, shows that of 113 codes examined 44, or about 39 per cent, permit two-story dwellings with 8-inch brick walls and 8 permit three-story dwellings of this type.

In each case the requirements noted refer to construction both within and outside the congested districts, and represent the minimum in allowable thickness for solid exterior brick walls. Codes investigated by the two agencies were chosen independently, and but 57 cities are on both lists. Considering the almost identical results obtained from the two studies, the following tables may be accepted as indicating general building practice.

TABLE II.—*Summary of investigation by the United States Bureau of Standards.*

[Average requirements of 134 codes for brick foundations and solid exterior walls for dwellings.]

THICKNESS WITHIN FIRE LIMITS ONLY.

Foundation, in inches.	Stories.				Height.	Length.	Width.	Area.
	First.	Second.	Third.	Fourth.				
	Inches.	*Inches.*	*Inches.*	*Inches.*	*Feet.*	*Feet.*	*Feet.*	*Sq. ft.*
12.5	9.7	....	....	....	15.5	65.9	23.7	1,311
13.7	11.0	9.7	....	....	28.7	69.8	24.3	1,311
16.2	13.1	11.8	10.5	....	41.5	80.2	24.4	....
18.5	16.0	13.5	12.3	11.2	53.7	80.6	24.9	....

THICKNESS WITHIN OR OUTSIDE OF FIRE LIMITS.

Foundation, in inches.	First.	Second.	Third.	Fourth.	Height.	Length.	Width.	Area.
12.5	9.2	....	....	....	15.3	65.7	23.5	1,244
13.6	10.4	9.2	....	....	28.5	69.7	23.9	1,404
16.2	12.8	11.5	10.2	....	41.5	81.8	22.9	....
18.5	14.4	13.2	12.0	11.0	54.0	83.6	25.0	....

TABLE III. *Summary of investigation by the United States Bureau of Standards.*

[Requirements for solid exterior walls of dwellings within or outside of fire limits.]

Thickness of walls, in inches.	Number of cities.	Average limitations.			
		Height.	Length.	Width.	Area.
One story:		*Feet.*	*Feet.*	*Feet.*	*Sq. ft.*
8	97	15	54	23	1,244
12	35	16	98	25	....
17	2	18	....	....	....
Two story:					
8- 8	55	27	52	23	1,404
12- 8	39	28	68	24	....
12-12	37	31	98	25	....
16-12	3	33	....	....	....
Three story:					
8- 8- 8	6	35	....	23	....
12- 8- 8	15	40	69	....	
12-12- 8	30	41	72	24	....
12-12-12	48	42	83	25	....
16-12- 8	7	40	80	25	....
16-12-12	20	44	104	26	....
16-16-12	4	45	....	....	....
20-16-12	1	....	....	....	....
Four story:					
8- 8- 8- 8	1	40	50	26	....
12-12- 8 -8	5	49	43	27	....
12-12-12- 8	5	46	70	25	....
12-12-12-12	12	53	93	24	....
16-12-12- 8	17	55	76	24	....
16-12-12-12	51	54	83	25	....
16-16-12- 8	4	48	....	....	....
16-16-12-12	23	57	99	26	....
20-16-12- 8	1	....	....	....	....
20-16-12-12	4	55	....	....	....
20-16-16-12	6	59	....	....	....
24-20-16-12	1	....	....	....	....

NOTE.—Eighty-two of the above codes require the beams to be anchored.

TABLE IV.—*Summary of investigation by Common Brick Manufacturers' Association of America.*

[Minimum allowable thickness of solid brick exterior walls for dwellings according to building codes of 113 cities.]

Dwellings.	Walls.	Cities.
One-story	8-inch	88
Do	Over 8-inch	25
Two-story	8-inch, both stories	44
Do	Over 8-inch, first story	38
Do	Over 8-inch, both stories	31
Three-story	8-inch, all stories	8
Do	Over 8-inch, first story	17
Do	Over 8-inch, first and second stories	30
Do	Over 8-inch, all stories	53

2. *Load-carrying capacity of walls.*—Available test data upon bearing capacity of walls show that the compressive strength of brick masonry is from 15 per cent to 40 per cent of the strength of individual brick when tested according to the requirements of the American Society for Testing Materials, with a fair minimum of 20 per cent where constructed of such materials and in such manner as specified in Part II. As a result of the strength limitations of these materials, the floor spans and loads in dwellings, the reduc-

tion of bearing area due to openings and insertion of joists, and the eccentric loading usually present, a factor of safety in compression of about 3.5 is obtained at the foot of a three-story, 8-inch dwelling wall when built on natural ground. When built upon filled ground unequal settlement will usually cause greater stresses, and extra precautions, as described in the appendix, paragraph 35, are necessary. This compares favorably with factors of safety ordinarily obtaining for other materials having similarly varying properties. It is believed, therefore, that so far as compressive strength is concerned, 8-inch walls not over 30 feet high are safe for one and two family dwellings.

3. *Lateral stability.*—While it is true that 12-inch walls by reason of their weight and thickness offer greater resistance than do 8-inch walls to lateral forces, such as eccentric floor loads, thrust from rafters, wind loads, and expansion due to temperature difference, it must also be recognized that even the heavier walls in use are an absurdity from the standpoint of inherent stability. The average four-story wall (see foregoing tables), unless receiving lateral support from floor construction, intersecting walls, pilasters, or similar reinforcement, would be blown over by a 25-mile wind. Hence it is believed that the stability of walls, except as insured by support from associated construction, is not an important consideration in determining the minimum thickness, and that the 8-inch wall is sufficiently satisfactory in this regard.

Regarding the nature and necessary frequency of lateral support, matters commonly specified in building codes, the expression of opinion obtained by the committee was not conclusive. In general, it appears that walls of small dwellings are short enough and sufficient reinforcement is afforded by the closely spaced partitions and floors to make additional buttresses or pilasters unnecessary. Furthermore, it is considered doubtful whether such masonry reinforcements, unless of disproportionate size and spaced not more than 10 feet apart, would materially improve lateral stability of the wall.

Evidence has been received showing that 8-inch walls have suffered severely in localities subject to high winds, and in such regions and those liable to severe earthquake shocks walls thicker than 8 inches are deemed advisable.

The live load impacts and vibrations incidental to residence occupancy are negligible.

4. Heat transmission.—Several fire tests made at the Bureau of Standards indicate that 8-inch solid brick walls afford more than sufficient insulation against spread of fires in residence structures. In no case did temperatures on the outside of a wall during the first two hours of the test reach a point endangering ignition of combustible material, even at cracks and imperfections. A number of correspondents, furthermore, have remarked that it is inconsistent to require heavier exterior walls to resist fire exposure so long as the openings in such walls are unprotected.

Par. 2. Stability and Salvage Values.

Testimony as to the relative stability of 8 and 12 inch walls during fires, and the salvage values from buildings so constructed, was received from several sources.

From fire chiefs.—Among 53 experienced fire chiefs expressing opinions on these points, 48 believe that a 12-inch wall will stand up longer; resist the overturning action of falling joists, heat expansion, and fire streams better; involve less danger to firemen; and furnish greater salvage value after a severe fire than an 8-inch wall under the same conditions. Some would not sanction the 8-inch wall under any circumstances. Several considered the difference slight, and others appeared somewhat biased by their knowledge of the behavior of such walls in commercial buildings, particularly in upper stories, where their tendency to sudden collapse is a serious life hazard to the fire fighters.

Practically all these men would prefer two-story brick dwellings, with 8-inch walls, to frame dwellings. About 50 per cent would approve erection of the former in all areas of cities except in congested mercantile districts. The other 50 per cent would require greater restrictions. It appears, therefore, that even those closely acquainted with the behavior of burning buildings do not seriously object to 8-inch walls for dwellings.

From insurance organizations.—Of about 50 insurance companies expressing their opinions on the question of relative salvage to be expected from 8-inch and 12-inch walled buildings, 60 per cent signified the belief that less salvage value would be obtained from burned buildings having 8-inch walls than from like buildings and occupancies having 12-inch walls. This opinion is based on their observation that 8-inch walls bulge more readily than 12-inch walls when expanded by heat, thus allowing the joists to fall out, and that 8-inch walls do not resist the shock of falling joists as well as 12-inch walls.

It appears to be general practice to impose a penalty for 8-inch walls in rating insurance risks. While this is probably fair for buildings having commercial occupancy, particularly when more than one story high, the evidence secured by the committee upon the relative fire resistance of 8 and 12 inch walls would not appear to justify the custom for small dwelling houses.

PLATE 1.

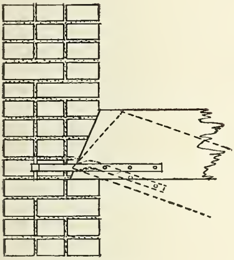


FIG. 1.

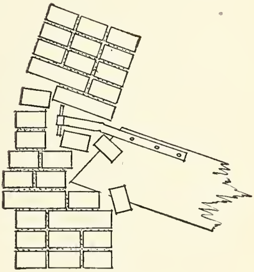


FIG. 2.

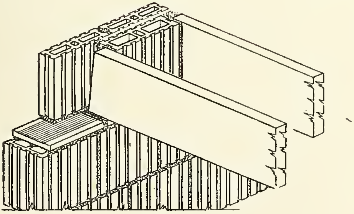


FIG. 3.

Figs. 1 and 2 illustrate the release of joists correctly and incorrectly anchored, when burned through at the center. A good method of seating joists in thin tile walls is shown in Fig. 3.

The fact that more than half of the companies responding favor more extended use of 8-inch walls indicates that they have no very serious disadvantages from an insurance standpoint.

From building inspectors.—Opinions on the wall question were received from about 100 building inspectors in the larger cities. Seventy-five per cent of these approve the use of 8-inch walls for two-story dwellings, and about 15 per cent consider them adequate for three-story dwellings. Many of these men discussed the factors involved rather thoroughly and several gave reasoned opinions at variance with the building codes they enforce.

Par. 3. General Conclusions on Solid Brick Walls.

Summing up the foregoing: It appears that two or two and one-half story dwellings with 8-inch brick walls are in use in at least 40 per cent of American cities; that such walls are safe from a structural viewpoint and practically as resistant to lateral forces as 12-inch walls; that they provide sufficient insulation to prevent transmission of fire through the walls in buildings of such occupancy; and though less fire resistant generally than 12-inch walls their shortcomings in this respect are not sufficiently important to justify restrictions against their use for two-family dwellings.

Suggestions were received by the committee from a number of sources that the permissible heights of walls, of the various types dealt with, be stated in terms of number of stories allowable. In view of the wide variation in story heights as employed in different parts of the country, the committee felt that such a method of stating minimum requirements was not sufficiently definite. The permissible heights chosen, however, are thought to be such as would allow of economical utilization both in the North and South.

Par. 4. Advantages of 12-Inch Walls Recognized.

While 8-inch solid brick walls for dwellings are recommended as more economical and are proving generally satisfactory in use, nevertheless it is a recognized fact that 12-inch walls, due to increased mass and better bonding, have superior stability, hence greater ability to resist high wind pressures. They also are less subject to moisture penetration and more resistant to intense cold. Some evidence has been presented indicating that such walls withstand earthquake vibrations better than thinner walls. With these thoughts in mind, the committee would advise 12-inch brick walls for dwellings in regions subject to extremely high winds or to intense cold, and in general where cost considerations are not important.

Par. 5. Saving Involved in Requirements Recommended for Exterior Walls.

Adoption of the minimum requirements recommended in Part II for solid brick walls would result in considerable economy of materials and labor, as shown by the following:

The average thickness required by 134 building codes for exterior solid brick walls of dwellings one story in height is 9.2 inches. That recommended is 8 inches.

For two-story dwellings the average thickness requirements of the 134 codes are 10.4 inches for the first story and 9.2 inches for the second. Part II permits 8 inches throughout.

For three-story dwellings the average code requirements are 12.8 inches, 11.5 inches, and 10.2 inches for the first, second, and third stories, respectively, the average maximum story height to which these figures apply being about 14 feet. The committee's suggested requirements permit 8-inch exterior walls for three stories of not more than 9 feet each.

In volume of brickwork the average code requirements exceed those of the committee by 15, 23, and 26 per cent, respectively, for one, two, and three story dwellings of the average maximum story height permissible.

Corresponding reductions in volume of hollow clay tile and hollow concrete block exterior walls, which adoption of the committee's recommendations would produce, are 14, 13, and 24 per cent, respectively, for one, two, and three story dwellings of the maximum story heights indicated.

Par. 6. Minor Restrictions Eliminated by Recommended Requirements.

Of the 134 building codes analyzed by the United States Bureau of Standards, a number, as indicated in the following paragraphs, require dwelling walls to be thicker than recommended by the committee, but allow walls of lesser thickness conditional on specified restrictions of the floor area, story height, length of wall, or span of joists. Sometimes two or three of these items are restricted when thinner wall sections are permitted.

Sixteen codes permit thinner walls when the floor areas are restricted. With the possible exception of two at 800 square feet and six at 1,000 square feet, these restrictions do not seriously limit the construction of one and two family dwellings.

Forty of the 134 codes reduce the allowable story height when thinner walls are used. The story height restrictions vary with the locality, but the average allowable height of such walls is 3.5 feet less for two-story dwellings and 6.5 feet less for three-story dwellings than that for walls not thus reduced in thickness.

Thirty-two of the 134 codes allow reduced thickness, but require such walls to be shorter laterally than is permissible for thicker walls. The average limit thus set is 43 feet, so it does not appear that length restrictions seriously hamper construction of small dwellings.

The committee's recommendations do not include regulation of floor areas, story heights, or wall lengths; therefore, if adopted, they would have the effect of relaxing many present requirements governing these features.

Par. 7. Piers.

Stone posts are prohibited as supporting members in interior spaces, because stone splits and spalls freely when attacked by heat, and a fire in the cellar is thus liable to cause collapse of the building.

Par. 8. Quality of Brick.

The standard requirements of the American Society for Testing Materials for clay building brick are as follows:

Grade.	Absorption limits, per cent.		Compressive strength (on edge), pounds per square inch.		Modulus of rupture, pounds per square inch.	
	Mean of five tests.	Individual, maximum.	Mean of five tests.	Individual, minimum.	Mean of five tests.	Individual, minimum.
Vitrified brick	5 or less	6	5,000 or over	4,000	1,200 or over	600
Hard brick	5–12	15	3,500 or over	2,500	600 or over	400
Medium brick	12–20	24	2,000 or over	1,500	450 or over	300
Soft brick	20 or over	No limit.	1,000 or over	800	300 or over	200

By reason of the fact that varieties of brick, other than clay brick, would not all meet the requirements for a "medium" clay brick as given in the above table, and as some of these other brick manifestly would be suitable for the types of buildings considered, the committee, as shown in Part II, section 7, has decided to depart from the A. S. T. M. requirements for clay brick.

The standard size of building brick is established as $2\frac{1}{4}$ by $3\frac{3}{4}$ by 8 inches, and this standard size forms the basis for the recommendations in Part II

Par. 9. Quality of Mortar.

In proportioning cement and lime for mortar it is convenient to remember that a bag of Portland cement equals about 1 cubic foot, and a bag of hydrated lime equals about $1\frac{1}{4}$ cubic feet; also that 1 cubic foot of stiff lime putty is approximately equal to a bag of dry hydrated lime. The proportions of sand and cement specified in section 7 are based on the assumption that damp sand will ordinarily be used. If sand is thoroughly dry, a slightly smaller relative volume is advisable.

It is also quite important when a mortar as lean in cement as 1–1–6, as specified in section 7, is used, that the mixing be very thoroughly done in order to get uniform strength and quality.

The committee does not feel justified in approving use of straight lime mortar for construction of walls of the minimum thickness herein permitted, for the reason that its weakness in compression and slowness of set as compared with cement-lime mortar, coupled with its tendency to disintegrate under high temperatures, combine to unsuit it for this purpose. Where walls of greater thickness are used or where 8-inch walls are used for a one-story building and where reasonable care is taken to prevent undue loads, the use of straight lime mortar should be made optional.

Natural cement.—The committee would not prohibit the use of natural cement conforming to the test specifications of the American Society for Testing Materials, wherever such cement is available, and experience has proven that it gives satisfactory results.

(For standard mortar strength see Pt. II, sec. 7.)

Par. 10. Quality of Other Materials.

Standard specifications for the quality of a number of structural materials have been adopted by the American Society for Testing Materials. These specifications are the result of long and thorough investigation and represent the agreement of manufacturers and producers as to the standards of quality necessary for practical, successful results. They are intended for incorporation in working agreements of all sorts and under any conditions, and are therefore especially to be recommended for the general purposes of building codes. Copies of the specifications may be obtained from the offices of the American Society for Testing Materials, 1315 Spruce Street, Philadelphia, Pa. Following is a list of commonly used building materials for which standard specifications have been adopted:

Material.	Serial No. of specification.
Standard definitions of terms relating to structural timber	D–9–15.
Portland cement	C–9–21.
Natural cement	C–10–09.
Drain tile	C–4–21.
Building brick	C–21–20.
Clay sewer pipe	C–13–20.
Cement-concrete sewer pipe	C–14–20.
Gypsum plasters	C–28–21.
Structural steel for buildings	A–9–21.
Cast-iron soil pipe and fittings	A–74–18.
Billet steel concrete reinforcement bars	A–15–14.
Rail steel concrete reinforcement bars	A–16–14.

Tentative specifications, representing the best information and experience obtainable to date, have been prepared for the following additional materials:

Material.	Serial No. of specification.
Quicklime for structural purposes	C–5–21 T.
Hydrated lime for structural purposes	C–6–21 T.
Concrete aggregates	C–33–21. T.
Clay hollow building tile	C–34–21 T.
Gypsum	C–22–21 T.
Calcined gypsum	C–23–21 T.
Gypsum plastering sand	C–35–21 T.
Gypsum wall board	C–36–21 T.
Gypsum plaster board	C–37–21 T.

Par. 11. Laying of Brick.

During warm and dry weather all brick should be thoroughly wet just previous to being laid, in order that a good bond may be obtained between brick and mortar, and so that sufficient water will be left in the mortar to permit its acquiring full set.

It is common practice in our northern cities to build upon frozen brickwork for dwellings and other small structures, but if long-continued low temperatures ensue precautions against injury and overloading must be observed and special care should be taken if brickwork is subjected to alternate freezing and thawing. Brick should be thoroughly dry when laid in cold weather, and for best results both bricks and mortar should be warm, so that the latter may obtain at least a partial set before it is frozen.

Par. 12. Exterior Masonry Walls of Hollow Units.

Hollow building tile and hollow concrete blocks are allowed slightly less latitude than brick in the construction of 8-inch walls, for the following reasons:

1. These materials are more variable in quality than brick and are not as fully classified according to accepted standards. Concrete blocks especially need constant local inspection to insure a fair quality of material.

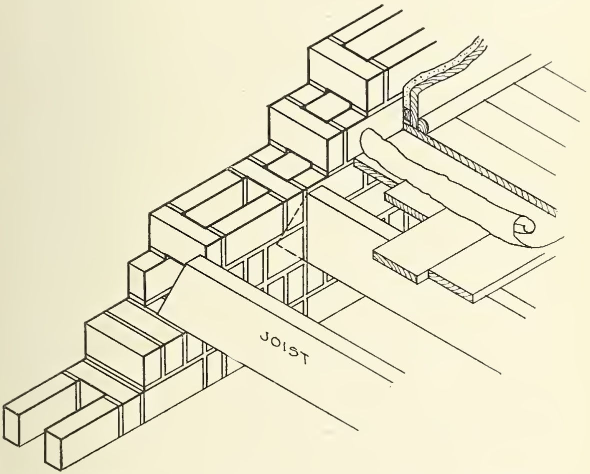
2. Walls constructed of these materials have less weight than those of solid brick, and are therefore slightly less stable.

3. Walls of hollow units are more liable to destruction in case of fire than are brick walls, tile and blocks made of certain materials being especially liable to damage.

4. The greater difficulty of anchoring joists and of bonding cross walls is considered to detract somewhat from the stability of such walls as compared with that of solid brick walls.

Experience reported with walls of hollow units indicates, however, that the above considerations are not sufficiently important to justify

Plate 2.



Details of 8-inch hollow wall of brick (all rolock), illustrating best methods of joist support.

a general increase in their thickness for small houses over that required for solid brick.

Of 58 building inspectors in the larger cities who have expressed an opinion as to the comparative merits of 8-inch solid brick walls and 8-inch hollow building tile and hollow concrete block walls, 42 would consider hollow clay tile the equivalent of brick for residence purposes. Opinion on concrete blocks is not so unanimous. About 60 per cent of the respondents would allow them the same latitude as solid brick for two or three story dwellings, and a number of others would permit their use where good quality is insured through inspection.

Par. 13. Hollow Walls of Brick.

The disadvantages of hollow units, except for the second and fifth, do not apply to the hollow wall built of brick. On the other hand, while these walls are being built in many places, and are allowed by building officials in several large cities, they are still in an experimental stage as compared with the types of masonry walls already discussed. Preliminary reports from an uncompleted series of tests at the Bureau of Standards indicate that the load-bearing properties of the 8-inch hollow walls of brick are adequate for two-story dwellings. In the absence of fuller information and lacking reports of experience as to its other qualities the committee feels that the hollow wall of brick can not be recommended at this time for the same general purposes as the solid brick wall of the same thickness.

The committee also limits its recommendations for use of 8-inch hollow walls of brick to the type built with alternate headers and stretchers in each course, until it obtains sufficient information on the merits of other types to justify their recognition.

Par. 14. Quality of Hollow Building Tile and Concrete Block.

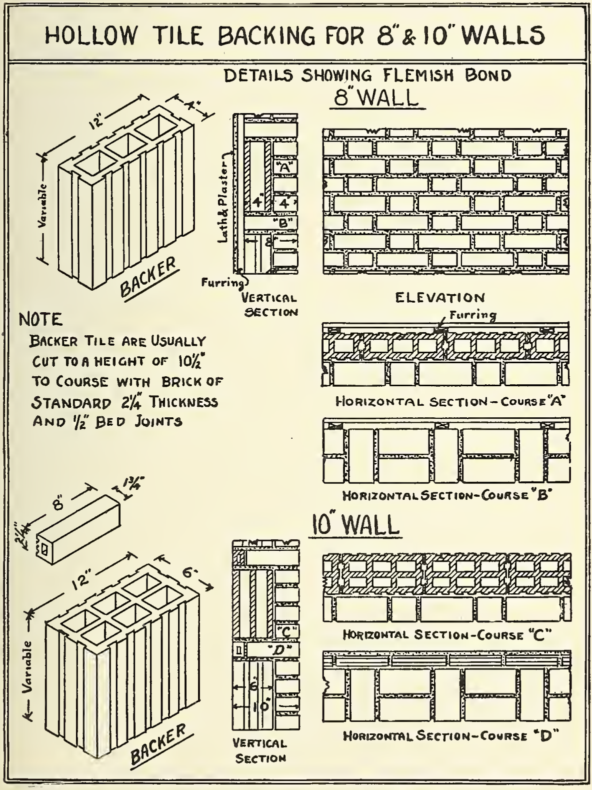
Limits of absorption for hollow building tile were considered by the committee, but their adoption was deferred on account of insufficient information bearing on the relations between this characteristic and the frost-resisting qualities of the material.

The crushing strength allowable for acceptable concrete block and tile is justified as being within the average demonstrated strength of the material, also by the fact that the comparatively thick shells and webs of such blocks afford a better distribution of stress in the mortar joints.

Par. 15. Laying Hollow Building Tile.

1. A running bond of 6 inches will usually be found most satisfactory in providing for openings, when using the standard sizes of tile. When hollow building tile is combined with a facing of brick

PLATE 3.



Details of building brick veneer on tile backing, 8 and 10 inch walls.

17649°—23——4

or cut stone, a masonry bond between the two materials should be used, so that the entire thickness may act as a bearing wall.

2. So far as possible the cross webs of one course should rest upon those of the course below, and care should be taken to insure full mortar joints on all web-bearing surfaces.

3. Arch lintels may be constructed successfully of hollow tile, but the most practical form of tile lintel is made by butting a sufficient number of tile end to end, filling the cells with concrete, and inserting reinforcement rods in the lower tier of cells, thereby obtaining the effect of a reinforced concrete beam. The coarse aggregate for such filling should not exceed one-half inch diameter.

4. Sills should project at least 1 inch beyond the finished surface of stucco, and to prevent passage of moisture a window sill of solid material should in no case extend entirely through the wall.

Par. 16. Construction Methods for Concrete Houses.

Construction practice has developed the following general types:

1. Monolithic construction, in which the concrete is placed in forms and remains in place in the structure. Monolithic construction is accomplished with various systems of forms ranging from those for casting a complete house in one operation to those for casting small portions of walls in courses.

2. Unit construction, in which precast units different from ordinary concrete block or concrete tile are employed. These structural parts range from the special forms of small units, which serve merely as inclosure walls between members of a load-carrying framework, to large slabs forming an entire side wall of the building, or even to the members for an entire house which are precast and transported.

3. Reinforced-concrete structural frame with light inclosure and partition walls of reinforced concrete. This type has a structural frame of reinforced-concrete columns, beams, and girders and floor slabs cast in place, and thin inclosure walls plastered and back plastered or shot with a cement gun on wire mesh or metal lath attached to columns and beams.

4. Blocks, brick, or tile of concrete laid into walls with mortar joints.

City building codes do not, in general, provide for the construction of concrete houses of all four types described. These codes usually contain a table of wall thicknesses, but these refer only to masonry walls composed of units laid with mortar joints. Often the units allowed for such walls are enumerated and include brick, tile, and concrete block. Some codes refer to brick only.

The various systems of unit construction and the systems which utilize structural concrete frame with light inclosure walls are generally not permitted because not mentioned in city building codes.

City building departments are prone to allow only just what is provided for in the code regardless of the merit of any proposed new type of construction. Satisfactory, meritorious types of construction obviously should be covered with general requirements for structural adequacy and the building department should be clothed with the power of selection and should be furnished with the necessary means of investigation.

Par. 17. Concrete Houses with Monolithic Walls.

The vertical loads on bearing walls of buildings not more than three stories high are comparatively small, and the stability of the completed structure as a whole should be considered in any analysis of wall thickness requirements for dwellings.

Experience in the construction of houses having plain concrete bearing walls has shown that a thickness of 6 inches is sufficient. It is customary to include a small amount of reinforcement over openings and at corners of concrete walls. The amount of reinforcement thus used rarely exceeds two-tenths of 1 per cent, and it appears that monolithic walls containing not more than this amount of reinforcement may properly be classed as plain concrete. Where concrete walls contain more than two-tenths of 1 per cent of reinforcement they may be classed as reinforced concrete, and the thickness should be determined by the dead. live. and wind loads and the amount of reinforcement used.

Several systems of construction have been successfully used which produce double concrete walls. Usually these systems produce two walls, each 4 inches thick, with an air space between. These walls are connected together with metal ties, which contribute something to stability; but if the area of both walls is required to carry the loads, positive means should be provided to transmit floor reactions to both walls.

Par. 18. Concrete Houses of Unit Construction.

The strength of large precast concrete units can be computed and verified by tests. The structural adequacy of a system employing units of sufficient strength will depend largely on the details of the connections, the support afforded by adjacent units, and the stability of the structure as a whole. Systems that employ relatively small units should be judged on the basis of the structural adequacy of the framework carrying the units. If the units themselves are reinforced-concrete structural members, they are susceptible of theoretical analysis, and a decision as to structural adequacy will therefore be based on engineering design.

Par. 19. Structural Concrete Frame with Light Inclosure or Panel Walls.

The adequacy of a structural concrete frame proposed for dwelling houses is susceptible of analysis according to principles of reinforced-concrete design, and building codes should specifically provide for the use of such a system. Inasmuch as the structural frame carries all the loads, the inclosure walls need have only such strength as is necessary to transmit wind loads to the structural frame. This has been successfully accomplished by a thickness of $1\frac{1}{2}$ inches of cement mortar plastered and back plastered on metal lath which is attached to the structural frame of the building. The interior portion of exterior walls is formed by plastering on metal lath to a thickness of seven-eighths to 1 inch. An air space is thus provided for insulation. The total thickness of such exterior walls is governed by the width required for window and door frames, and is usually not less than 6 inches.

Instead of constructing the inclosure or curtain walls by plastering on metal lath, the cement gun or other mechanical means of applying concrete or mortar may be used.

In view of the relatively light types of reinforcement customary for concrete dwelling construction, it is strongly recommended that the concrete covering over such reinforcement be of sufficient thickness for full protection against corrosion. Metal lath or other lightweight metal reinforcing fabric should be thoroughly galvanized or painted.

Par. 20. Term "Nominal Size."

The term "nominal size" as applied to timber or lumber means the ordinary commercial size by which timber is known and sold in the market. The actual dimensions of seasoned and surfaced lumber are from one-eighth to one-half inch less than the nominal. The deficiency varies somewhat with the size of the piece, the number of planed surfaces, and the rules of the association under which it is produced.

Par. 21. Masonry Veneer on Frame Construction.

Frame structures veneered with a single layer of brick or structural stone attached at frequent intervals to the wooden framework or sheathing are popular in many parts of the country and the committee has investigated these structures from various points of view to determine what regulations justly apply in their construction. The consensus of opinion thus obtained regarding them is summarized as follows:

1. So far as structural stability is concerned, opinion favored well-built veneered dwellings of the same height and under the same cir-

PLATE 4.

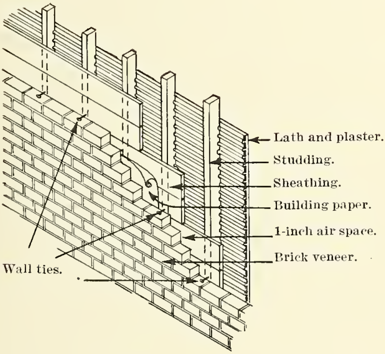
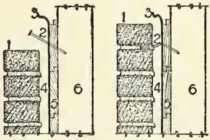


FIG. 1.



(1, Face Brick; 2, Wall Ties; 3, Tar Paper; 4, Air Space; 5, Sheathing; 6, Studding.)

FIG. 2.

Details of construction approved for brick veneer on frame backing.

cumstances as those with solid 8-inch brick walls. This construction should not extend below the first floor joists.

2. Veneered construction resists exposure fires far better than frame and is held by some to offer practically as good exterior fire resistance as an 8-inch wall. The resistance of a veneered wall to internal fires is about that of frame, except that when the space between veneer and sheathing is poorly fire-stopped or the sheathing is not of incombustible material difficulty is experienced in extinguishing such fires.

3. Anchorage between veneer and sheathing should be frequent, noncorrodible, and substantial. Openings should be carefully flashed to prevent entrance of water behind the facing, and the use of building paper between veneer and sheathing is strongly recommended. Adequate fire-stops should be installed at floor lines and at intersection of partitions with walls. With these precautions veneered structures are said to be safe, durable, exceptionally dry, and easy to heat.

Par. 22. Stucco on Frame Construction.

1. It is essential that penetration of moisture behind stucco surfaces be prevented. Poorly drained stucco surfaces should be avoided; copings, cornices, exterior trim, and the frames of all openings should be carefully flashed or otherwise designed to carry water away from the stucco. Roof drainage should be built to prevent leakage and carried well away from the stucco surface.

2. Wooden sheathing laid horizontally is less apt to result in stucco cracks than when laid diagonally. Ledger boards and diagonal corner braces let into the studs are advisable, and where sheathing is omitted bridging of the studs midway of each story is recommended. Such bridging should be kept back at least one-half inch from the outer face of the studs. Experience indicates that stucco cracks are less likely to occur when the wall studs are continuous from foundation to roof, as the insertion of horizontal timbers at the floor lines gives more opportunity for vertical shrinkage and consequent stresses in the enveloping stucco surface.

3. Substantial building paper between furring and sheathing improves the heat and moisture insulating properties of the wall. Insulating material such as building paper may also be used effectively between back-plastered construction and the inner plastered wall.

4. *Back plastering.*—Carefully conducted tests appear to have demonstrated that an exterior cement stucco wall upon metal lath attached to wooden studs and properly back plastered is more rigid than a similar stucco backed with wooden sheathing. The back

plastering also serves fully to incase the metal lath, thus protecting it from corrosion, and reduces the fire hazard.

5. Metal furring and metal or wire lath should be galvanized or painted and securely stapled to the sheathing or to the wooden frame. Metal lath should preferably be laid horizontally, the joints being butted and securely tied or laced with wire. Lapped vertical joints should occur over supports and should be well stapled to avoid lines of weakness. Only metal lath which has been galvanized should be used with magnesite stucco.

6. Wood lath is not recommended for cement stucco, but is satisfactory for use with lime or magnesite stuccos.

7. Surfaces to be stuccoed should be moist but not wet enough to yield moisture to the coat applied.

8. Stucco should be machine mixed where possible, and careful attention given to obtaining uniform proportions and thorough mixing.

9. Neither Portland cement nor lime stucco should be applied when the temperature is below 40° F.

10. Three-coat work is desirable. No coat should be richer in cement than 1 to 3; and lime should not be added in greater proportions than one-fifth volume of cement. Plastering should be carried on continuously in one general direction without allowing the plaster to dry at the edge. The second coat should follow the first within 24 hours, and in back-plastered construction the backing coat should be applied directly following completion of the brown coat. All necessary precautions should be taken to prevent the plaster from drying out before attaining its set.

NOTE.—For a complete treatment of cement stucco, reference is made to Recommended Practice for Portland Cement Stucco, prepared by the committee of the American Concrete Institute on Treatment of Concrete Surfaces, and adopted by that organization April 17, 1920. Copies of this report may be obtained from the secretary of the institute, 314 New Telegraph Building, Detroit, Mich., or an authorized reprint may be obtained from the Portland Cement Association, 111 West Washington Street, Chicago, Ill.

For a complete treatment of lime stucco, reference is made to Lime Stucco, a bulletin prepared and issued by the National Lime Association, 918 G Street NW., Washington, D. C.

Par. 23. Removal of Overloads on Timber Construction.

The load which a wooden member such as a floor joist or a rafter will sustain is dependent to a considerable extent upon the length of time the load remains on the timber. If the load remains on 10 times as long, then the amount of load required to break the timber will be reduced about 10 per cent. If a given load will break a timber in 40 days, a load about one-third greater will break the same timber in one hour. From the above it will be seen that it is important to remove the load from any overloaded wooden floor or roof as soon as possible, since it is not certain that the roof or floor will not fail merely because it has held the load for a few hours or days.

For the above reason temporary stresses caused by wind or snow loads may be greater without danger of failure than those due to dead loads or long continued live loads.

NOTE.—The table of allowable stresses permissible for structural timbers in small dwellings, the table of girder factors and maximum allowable lengths of joists, and paragraphs 23, 24, 25, and 27 of the Appendix were prepared for this report by the United States Forest Products Laboratory, Section of Timber Mechanics, under direction of J. A. Newlin.

TABLE V.—*Girder factor and maximum permissible lengths of floor joists.*[1]

[Girder factor based on 30 pounds per square foot live load and 15 pounds per square foot weight of floor. Permissible length of joists based on 40 pounds per square foot live load and 10 pounds per square foot weight of floor. Lowest line in each group is based upon the deflection of one three-hundred-and-sixtieth of span which is considered the maximum allowable with plastering and is based on 40 pounds per square foot live load only. Actual sizes used in all calculations.]

Species.	Girder factor.	Grade.[2]	Stress.	Modulus of elasticity.	Maximum permissible lengths for sizes. Nominal, 2 by 4 inches; actual, 1⅝ by 3⅝ inches, for joist spacings— 16 inches.	Nominal, 2 by 4 … 24 inches.	Nominal, 2 by 6 inches; actual, 1⅝ by 5⅝ inches, for joist spacings— 16 inches.	Nominal, 2 by 6 … 24 inches.	Nominal, 2 by 8 inches; actual, 1⅝ by 7½ inches, for joist spacings— 16 inches	Nominal, 2 by 8 … 24 inches.	Nominal, 2 by 10 inches; actual, 1⅝ by 9½ inches, for joist spacings— 16 inches.	Nominal, 2 by 10 … 24 inches.	Nominal, 2 by 12 inches; actual, 1⅝ by 11½ inches, for joist spacings— 16 inches.	Nominal, 2 by 12 … 24 inches.
			Lbs./in.[2]	*1,000 Lbs./in.*[2]	*Ft. in.*	*Ft. in.*	*Ft. in.*	*Ft. in.*	*Ft. in.*	*Ft. in.*	*Ft. in.*	*Ft. in.*	*Ft. in.*	*Ft. in.*
Cedar, northern white Spruce, Engelmann	0.270 .270	1	750		5 2	4 3	8 0	6 7	10 8	8 9	13 6	11 1	16 5	13 4
		2	500		4 3	3 6	6 7	5 4	8 9	7 1	11 1	9 0	13 4	10 11
				800	5 3	4 7	8 1	7 1	10 10	9 5	13 9	11 11	16 7	14 5
Chestnut Cedar, western red Fir, balsam Pine, eastern white Pine, western white Pine, western yellow	.225 .225 .241 .225 .225 .225	1	900		5 8	4 7	8 9	7 2	11 8	9 7	14 10	12 1	17 11	14 8
		2	600		4 7	3 8	7 2	5 10	9 7	7 9	12 1	9 10	14 8	11 11
				1,000	5 8	4 11	8 9	7 8	11 8	10 3	14 9	12 11	17 11	15 8
Maple, silver Hemlock, eastern	.202 .241	1	1,000		5 11	4 10	9 3	7 7	12 4	10 1	15 8	12 9	18 11	15 5
		2	667		4 10	3 11	7 7	6 2	10 1	8 3	12 9	10 5	15 5	12 7
				1,100	5 10	5 1	9 0	7 10	12 1	10 6	15 3	13 4	18 6	16 2
Spruce Gum, red Douglas fir (Rocky Mountain type) Pine, Norway	.199 .184 .199 .199	1	1,100		6 3	5 1	9 8	7 11	12 11	10 7	16 5	13 5	19 10	16 2
		2	733		5 1	4 2	7 11	6 5	10 7	8 7	13 5	10 11	16 2	13 3
				1,200	6 0	5 3	9 3	8 1	12 5	10 10	15 9	13 9	19 0	16 7
Tamarack Larch, western	.178 .169	1	1,200		6 6	5 4	10 1	8 3	13 6	11 0	17 1	13 11	20 9	16 11
		2	800		5 4	4 4	8 3	6 9	11 0	9 0	13 11	11 5	16 11	13 10
				1,300	6 2	5 5	9 6	8 4	12 9	11 1	16 2	14 1	19 10	17 1
Cypress Hemlock, western	.169 .225	1	1,300		6 10	5 7	10 7	8 8	14 1	11 6	17 10	14 7	21 7	17 7
		2	867		5 7	4 7	8 8	7 1	11 6	9 5	14 7	11 11	17 7	14 4
				1,400	6 4	5 6	9 9	8 7	13 1	11 5	16 7	14 6	20 0	17 6
Oak	.144	1	1,400		7 1	5 9	10 11	8 11	14 7	11 11	18 6	15 1	22 5	18 3
		2	933		5 9	4 8	8 11	7 4	11 11	9 9	15 1	12 4	18 3	14 11
				1,500	6 5	5 7	10 0	8 9	13 4	11 8	16 11	14 10	20 6	17 11
Maple, sugar	.135	1	1,500		7 4	5 11	11 4	9 3	15 1	12 4	19 2	15 8	23 2	18 11
		2	1,000		5 11	4 10	9 3	7 7	12 4	10 1	15 8	12 9	18 11	15 5
				1,600	6 7	5 8	10 3	8 11	13 8	11 11	17 3	15 0	20 11	18 4
Douglas fir, coast	.169	1 D[3]	1,750		7 11	6 5	12 3	10 0	16 4	13 4	20 8	16 11	25 0	20 5
		1 S[4]	1,500		7 4	5 11	11 4	9 3	15 1	12 4	19 2	15 8	23 2	18 11
Pine, southern yellow	.135	2 D[3]	1,250		6 8	5 5	10 4	8 6	13 10	11 3	17 6	14 4	21 2	17 4
		2 S[4]	1,000		5 11	4 10	9 3	7 7	12 4	10 1	15 8	12 9	18 11	15 5
				1,600	6 7	5 8	10 3	8 11	13 8	11 11	17 3	15 0	20 11	18 4

[1] Data furnished by the Forest Products Laboratory, Forest Service, U. S. Department of Agriculture, Jan. 11, 1922.

[2] Grade 1 shall have the defects limited as in the rules for select structural grade, adopted by the Southern Pine Association. Grade 2 may have defects of double the size, or defects which have double the effect of those allowed in grade 1.

[3] D. dense material under definition of A. S. T. M.

[4] S. sound not graded for density.

Par. 24. Bearing Values for Joists.

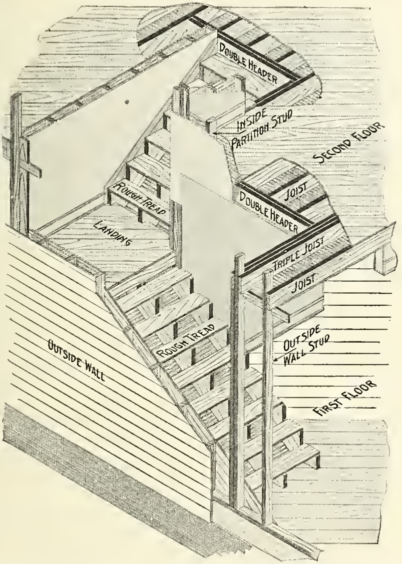
The reasons for allowing a greater stress in compression across the grain when the joists rest upon a ribbon or ledger board than when the ends rest upon or in masonry are that they are more certain of being dry and are consequently stronger; that the stress is not at the extreme end of the joist and in case of a slight overload they will not yield so much; and that the joists are to be spiked to the studding, thus gaining some support through the nails.

Par. 25. Explanation and Comments Relative to Table on Girder Factor and Maximum Permissible Lengths of Floor Joists.

Use of the table.—The size of girder necessary in any small dwelling may be found as follows:

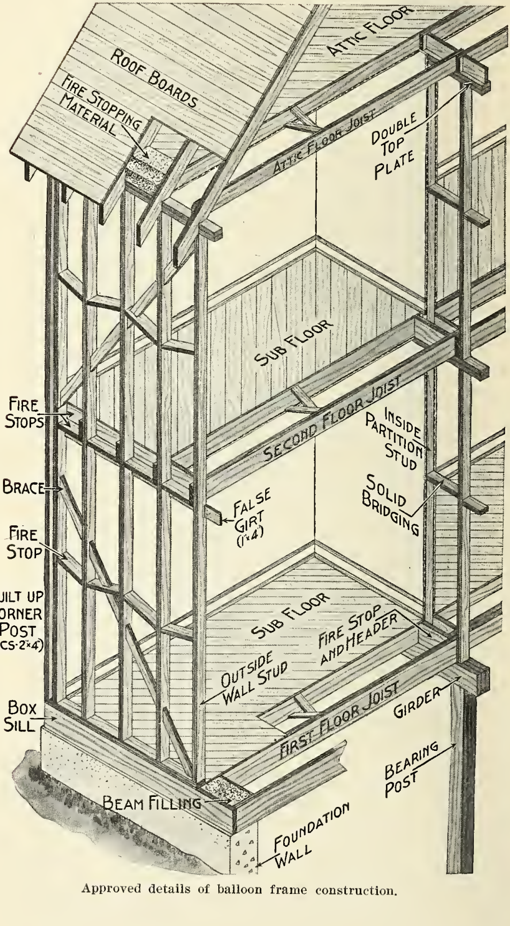
Add together the joist spans in feet meeting at the girder. Multiply this width by the figure given in the table under "girder factor" and opposite the species of which the girder is to be made. This will give for *grade 1 timbers* the minimum width of the girder in inches to support one floor *when the distance between supports of the girder is 12 times* its height. To get the thickness of the girder for more than one floor multiply the thickness for one floor by the number of floors. When the supports under the girder are placed closer together, the thickness of the girder can be proportionately decreased. When the distance between supports is not over 10 times the girder height, grade 2 timbers may be used except that the shakes and checks should conform to the requirements of grade 1. When it is desirable to place the posts farther apart than given by the above rule the girder should always be calculated by a competent engineer or architect. Joints in built-up girders should occur only over supports. In determining from the table the maximum permissible lengths of joists, all figures (except the girder factors) grouped opposite any one bracket apply to all the species in the bracketed lines. Find the species which it is proposed to use, and the grade of material; then run horizontally across to the first length as great or greater than the proposed joist span. The head of this column will be found marked 16 inches. This means a spacing of 16 inches center to center, and the figures above give the nominal and actual sizes of joists. Three columns farther to the right, ordinarily, the required length for 24-inch spacing will be found, although occasionally it will be found that the same size joist is required with either 16 or 24 inch spacing. Where the floor joists are to support plastering, the length of joist should never be greater than that given in the lowest horizontal line in each group of species, since this length is considered to be the maximum which can be used without serious cracking of the plastering, and lengths greater than this will give floors which shake considerably.

PLATE 5.



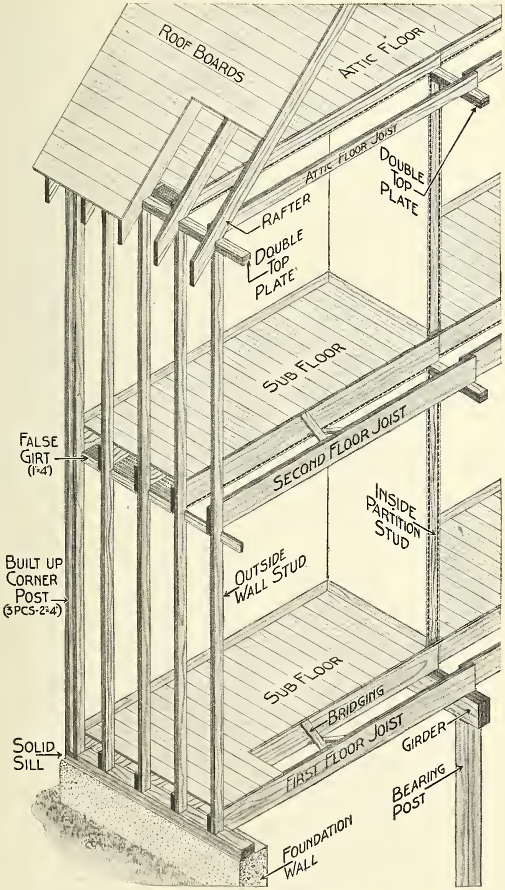
Desirable features of framing for stairways are illustrated above. Note that strength lost by cutting studs and joists is regained by reinforcing the remaining timbers.

PLATE 6.



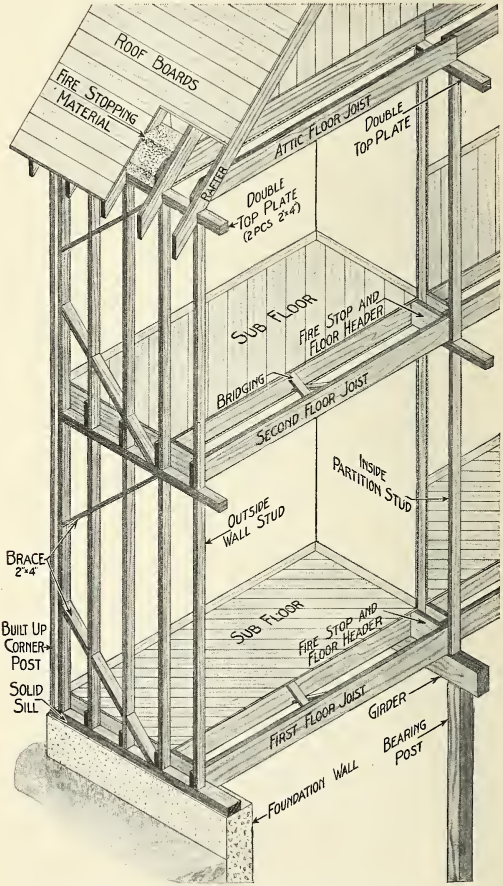
Approved details of balloon frame construction.

PLATE 7.



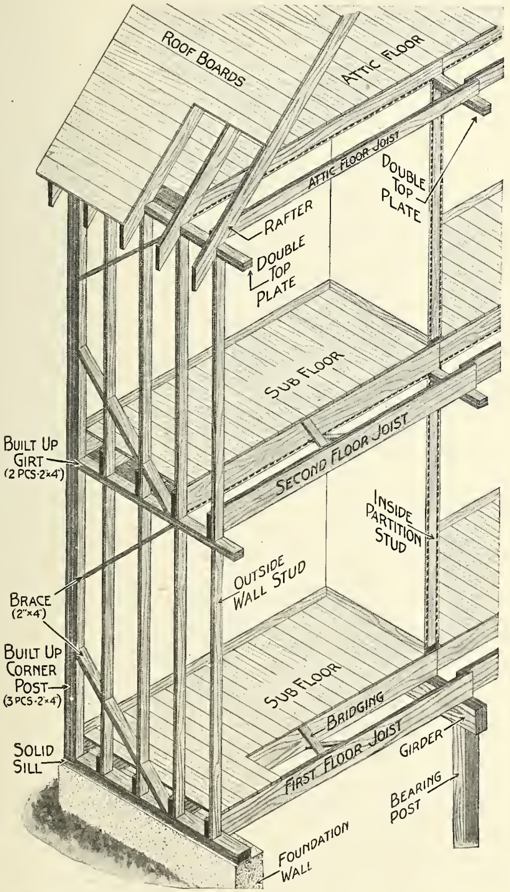
The above illustration shows some common defects in balloon frame construction, which are avoided on Plate 6. Omission of floor headers and of fire stops permits heat losses by free air circulation; lack of corner braces impairs rigidity; and unequal settlement results from resting partition studs on the subfloor.

PLATE 8.



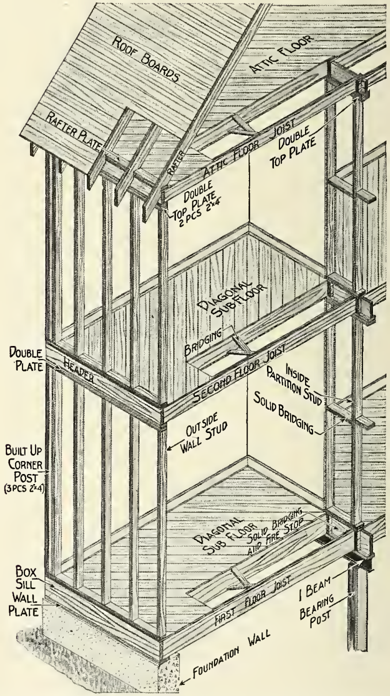
Approved details of modern braced-frame construction.

PLATE 9.



The above illustration shows some common faults in building modern braced-frame construction. Note that the floor headers and fire-stopping shown on Plate 8 are omitted, that the subfloor is laid perpendicular to joists, and that interior partition studs rest upon the subfloor instead of the partition plates below.

PLATE 10.



The above illustration shows details of the platform-frame type of construction, in which each story is built as a separate unit. Note settlement is equalized by making the height of horizontal timbers the same in exterior walls and interior partitions.

Par. 26. Flooring.

Wherever cost will permit, the committee recommends that all flooring be double with a layer of heavy asbestos paper or incombustible floor felt, gypsum board, or other incombustible material, between the finish and rough flooring. This will make the floor warmer, assist as a sound deadener, and will aid materially in resisting passage of fire through the floor. In any event, it is advisable to put some good type of building paper between the flooring.

Par 27. Notes Bearing on the Use of Lumber and Timber in Small-House Construction.

1. *Desirability of protecting lumber.*—The care of lumber prior to use for building purposes and its condition at the time of use often determine to a large extent the value of the building or the rate at which depreciation will take place. Green or partially dry lumber, when not properly piled, will twist and warp in drying and will retain this twisted and warped condition after being taken from the pile. Green lumber, when closely piled, or stored without ample provision for the circulation of air, is very likely to stain and become infected with decay. This is especially true in warm, damp weather. Decay once started in a timber will quite frequently continue after the timber has been placed in the building, even though it be used in a relatively dry location where a perfectly sound, dry timber would never be attacked by decay. Timbers used in a building in a fairly green condition and so inclosed as partially to cut off circulation of the air are very likely to be attacked by decay. In this respect sapwood is much worse than heartwood, although in the strength of the sound material there is no difference.

When the rough lumber is delivered at a building site, but little attention is generally paid to the piling or to the protection of the lumber from rain and sunshine. It is common practice to use some of the building material for concrete forms. This material when removed is not infrequently thrown around in a rather promiscuous pile. The effect on lumber of such treatment and the ensuing wetting and drying are often quite disastrous, resulting in development of checks, shakes, warping, twisting, and cupping. Joist material, for instance, may have been in the very best condition when received and practically fall to pieces between the rings under such treatment.

2. *Influence of shrinking and swelling.*—In designing the frame of a wooden dwelling it is important to consider the influence of shrinkage and swelling in keeping the floors level. It is very uncommon for the frame lumber to be so dry when placed in a building that it will not ultimately shrink considerably. This shrinkage may cause considerable trouble, which could be partly eliminated, however, by proper design. For instance, if one end of a joist rests upon a

concrete foundation, the other end should not be supported on top of a timber girder, since the girder will shrink and lower that end of the joist. In small houses it is a better plan to place the girder flush with the top of the joists, which can be accomplished by supporting the joists on members spiked to the side of the girder.

When either interior or exterior trim is at too high a moisture content when used the joints will open, due to subsequent drying and shrinkage across the grain. If the material is too wet, miter joints, for instance, will open at the inner corner as the wood shrinks, and if too dry at the outer corner when it swells. (If the material is at the proper moisture content when put in position, but if it is placed over wet plastering or allowed to become wet from other causes, the miter joints will first open at the outer corner, and later when the material becomes dry they will open throughout their entire length.) The bad influence of shrinking and swelling will be much greater when flat-grained material is used than when quarter-sawed stock is used, since flat-grain material shrinks and swells about 50 per cent more than quarter-sawed stock with the same moisture changes. Quarter-sawed material is much less inclined to twist and warp than flat-sawed material, and also has the advantage of offering a more uniform resistance to wear. From this it will be seen that quarter-sawed finish, flooring, and the like are much superior to flat-sawed material, even when what is usually the chief factor, its appearance, is disregarded.

3. Considerations affecting joist sizes.—In determining the size of joists and the grade of material to be used, the following points should be borne in mind:

The stiffness of the floor is quite important if the dishes are not to rattle and the plastering to crack. The stiffness of a joist of a given span under a given load is proportional to the cube of its height. Thus, if the height is increased by a given per cent, the increase in thickness is more than three times this per cent. This is true so long as it is not so thin and high that it buckles sidewise under the load. The stiffness of a joist is but little influenced by the grade of the material. The load which a joist of a given length will hold without breaking varies as the square of the height. The load which a beam or joist will sustain is dependent upon the defects and the quality of the clear wood. It is not good economy to skimp on the height of joists, since the lower-grade material with a greater height will probably give a more satisfactory floor at the same price than could be obtained from the higher-grade material and correspondingly shallower joist. It is not usually good economy to use joists over 16 feet long, since it requires additional bridging, a greater depth of joist, and there is usually a considerable advance in the price per board foot of the lumber.

4. Cost influenced by length.—In the manufacture of lumber, especially in the large mills that cut fir and pine, there is great advantage in having the lumber of uniform length. The most economical length to handle appears to be 16 feet. In the stacking of lumber it is very necessary to have it of uniform lengths, so that it can be properly held in place while drying. Even after the lumber is dry, ends of boards projecting from the pile will usually become checked and warped, and of little value. On account of these and other reasons, which might be mentioned, it is common to manufacture lumber in lengths which are multiples of 2 feet; 12, 14, and 16 feet being the ordinary standards. Shorter lengths may come in on account of the limited lengths of logs which it is economical to take from the tree or as a result of cutting off defects in trimming. The shorter lengths are usually sold at the same price as the 14-foot material, and although in reality it costs the manufacturer more to produce them, many of the consumers seem to be of the impression that they should obtain the material at a greatly reduced figure.

Lumber and timbers are produced in lengths greater than 14 or 16 feet, but such material usually commands a greater price. In the designing of a house not infrequently the size of a room may be changed by 6 inches without any material inconvenience and joists 2 feet shorter may result. The height of the ceiling of a room may be changed an inch or two in order to avoid extra lengths of studding or the plate may be double in place of single, and many other expedients may be resorted to in order to utilize the full length of the lumber as it comes from the saw, the resulting building being just as satisfactory and just as well constructed, but at a lower cost.

5. Laminated girders.—Built-up or laminated girders should be supported under joints.

6. Importance of thorough bracing.—Proper bracing of a frame building is of great importance. In a building with sheathing there is no better bracing for the exterior walls than to put the sheathing on diagonally and thoroughly nail it to the studs. When the sheathing is thoroughly dry it can be put on horizontally and a rigid wall obtained. As a rule, however, walls with horizontal sheathing and without other braces will ultimately skew somewhat out of shape. Not infrequently a single sheathing board, run diagonally from corner to corner of a wall and thoroughly nailed to all the studdings, about two tenpenny nails in each, will make a more rigid wall than the entire side covered with partially dry horizontal sheathing, nailed in the same manner as the diagonal plank.

It is exceedingly important that the building be thoroughly tied to resist the thrust of the rafters. When it is not feasible to tie the building together at the foot of the rafters, the thrust may be transferred to the end walls by a system of diagonal bracing on the

PLATE 11.

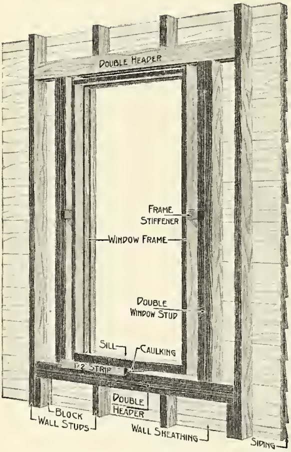


FIG. 1.

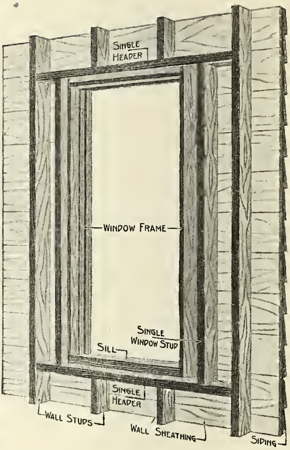


FIG. 2.

The illustrations show desirable and undesirable framing around window openings. The double headers and window studs in Fig. 1 are as strong and rigid as continuous studs, and with the stiffeners at the sides help to prevent windows from binding and rattling. The calking and rabbeted strip beneath the sill exclude air, which otherwise enters freely.

PLATE 12.

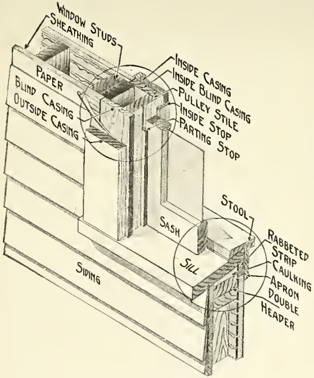


Fig. 1.

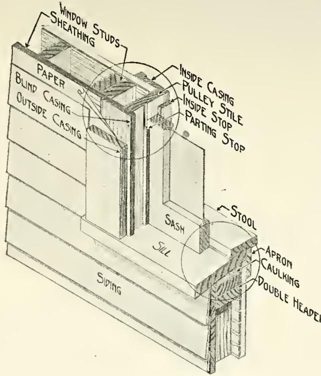


Fig. 2.

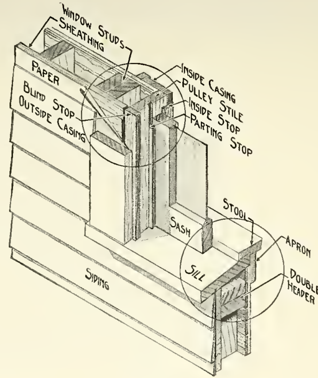
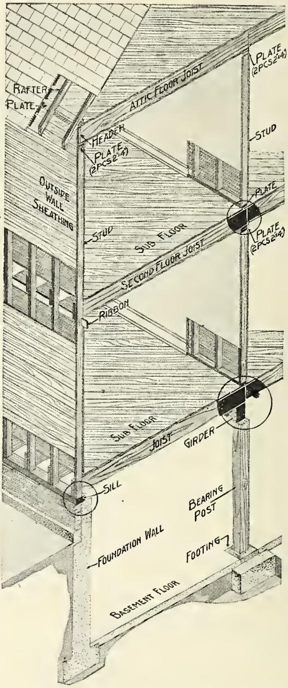


Fig. 3.

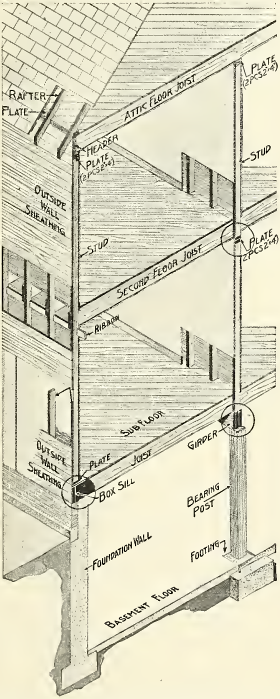
Poorly built or fitted window frames admit air and moisture, and the adjacent interior walls shortly become unsightly with dirt and water stains. The type of frame shown in Fig. 1 will prevent this, and that in Fig. 2, carefully installed, will be found satisfactory. Note the provision, in the first two cases, of calking between sill and header; the siding and rabbeted strip let into the underside of sill in Fig. 1; the additional protection afforded by blind casings extending back to the window studs and sealed with building paper; and the rabbeting of the sill in Figs. 1 and 2 to receive the sash.

PLATE 13.



Wood shrinks crosswise, not lengthwise of the fiber. A dwelling framed as shown above will in time settle from 1 to 2 inches more in the center than at the walls. This renders floors uneven, causes plaster to crack, and makes doors bind and rattle. Equal settlement, as obtained by the method shown across, will greatly diminish these effects.

PLATE 14.



If a building is framed to equalize the total height of horizontal timbers in exterior walls and interior partitions, their relative positions remain the same after settlement occurs. This helps to avoid plaster cracks and other inconveniences. (See Plate 13.)

PLATE 15.

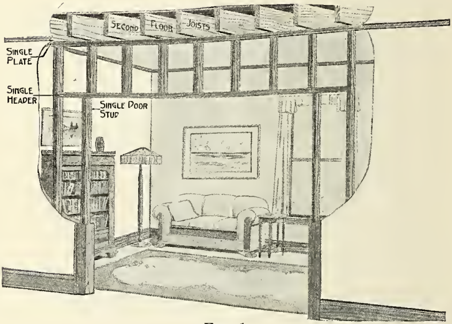


FIG. 1.

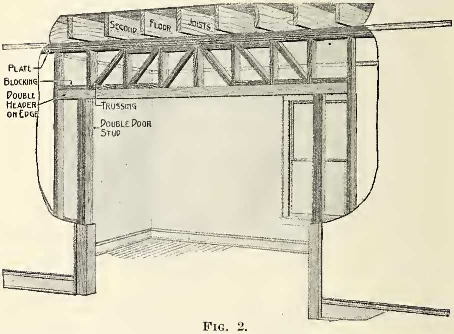
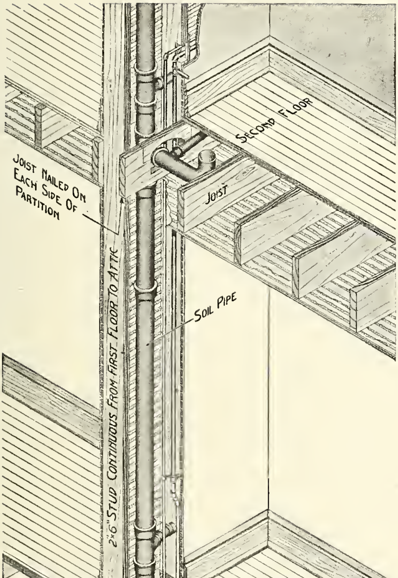


FIG. 2.

Inadequate framing over wall and partition openings, illustrated in Fig. 1, permits local settlement, causes unsightly plaster cracks, and spoils the fit of doors. The precautions shown in Fig. 2 help to prevent these undesirable results. Note that the plate, header, and door studs have been doubled, and the header turned on edge to afford greater strength. The short diagonal and horizontal members form a truss which provides rigid support for joists over the opening.

PLATE 16.



Careless cutting and notching of timbers often weakens floors unnecessarily; 2 by 6 inch partition studs accommodate vertical pipes readily and without undue loss of supporting capacity, when notched. Horizontal pipes should be run through the centers of joists to avoid weakening them and to leave a good nailing surface for the floor.

underside of the rafters. This in reality makes trusses of the two halves of the roof which are nailed together at the peak.

In small barns this system of bracing may be used to eliminate very objectionable ties across the center of the barn, or in a garage the end containing the doors will not get out of shape if a proper system of bracing is used on the roof or underneath the ties and if the other three walls are well braced.

Par. 28. Thickness and Height of Party or Division Walls.

The thickness advisable for party and division walls depends on several factors not affecting exterior walls. Such separating walls also serve the purpose of fire walls. The vertical loads, while higher than on exterior walls, produce no greater stresses, owing to the equalizing effect of floor loads from both sides. More bearing area is lost by insertion of joists on both sides and the close proximity of these reduces the efficiency of thin walls as fire-stops.

It is the committee's opinion that while the lateral stability of party walls, due to double support, is normally greater than that of exterior walls, their service as fire walls is an important consideration and justifies stricter requirements than for exterior walls.

Par. 29. Saving Involved in Requirements Recommended for Party or Division Walls.

Considerable economy in brickwork also would result from adoption of the committee's recommendations for thickness of party or division walls. The average code requirements exceed these by 40, 30, and 28 per cent, respectively, for one, two, and three story dwellings of the average maximum story heights permissible. (See pars. 38 and 40 of the appendix for savings involved in foundation wall and floor-load requirements.)

Par. 30. Party and Division Walls of Hollow Building Tile, Hollow Concrete Block, or Built as Hollow Walls of Brick.

Party and division walls of above-named materials and construction are required to be thicker than solid walls for the reasons given in paragraphs 12 and 13 of the appendix. Consideration was also given to the increased difficulty of inserting joists in such walls and obtaining support and protection for the ends.

When the building on one side only of a party or division wall is completed with the wall, and where subsequent construction may require breaking into the wall for insertion of floor beams or other members, it is believed that the above types of construction should not be used. Where the disadvantages of breaking into such hollow walls can be overcome, as for instance by solid wall construction extending at least one course above and below where the future line of joists will be inserted, the committee would approve party and division walls of the types named.

Par. 31. Party Walls, Alternative Construction.

Whenever tests by responsible authorities show that other wall constructions have fire resistance equal to that of the wall described in Part II, section 28, they should be permitted as an alternative.

Par. 32. Parapet Walls.

The object of a parapet wall is to prevent a fire in a house from entering an adjoining house through the attic space, also to restrict flames from lapping over and igniting the adjoining roof. Where party or division walls do not extend through the roof the joint between the wall and the roof boards may be effectively closed by metal lath bent into the angle between wall and roof and plastered with cement plaster.

Par. 33. Masonry Partitions.

Partitions of incombustible materials of all kinds are desirable wherever a fire barrier is advisable, and are recommended whenever costs justify their use. When such construction in the form of blocks or slabs is used it should have such thickness or interior bracing and anchorage to connecting construction as will insure stability when subjected to the expansive stresses due to a fire on one side.

Tests conducted in this country and in England show conclusively that 4-inch brick walls are amply strong for bearing partitions in cellars and basements and have the additional advantages of durability and fire resistance. It is felt that the 8-inch partition ordinarily called for by the building codes of the country is unnecessary in this type of dwelling. The committee recommends strongly that wherever possible, brick, tile, gypsum block, or concrete block partitions be substituted for ordinary stud partitions.

Par. 34. Concrete Basement Walls.

The economical thickness of basement walls will depend to a large extent on soil conditions. The actual loads coming on basement walls of dwelling houses not more than three stories high would not require walls nearly so thick as those in common use. The thickness of monolithic concrete walls for houses need not be greater than 8 inches, except that they should not be thinner than the exterior walls of superstructures. Concrete hollow block or concrete tile walls 8 inches thick have been used extensively to carry two-story dwellings where soil conditions are normal. The committee, however, feels that this is not good and safe practice in general and therefore they have made their recommendations for 12-inch walls. (See Pt. II, sec. 31.)

PLATE 17.

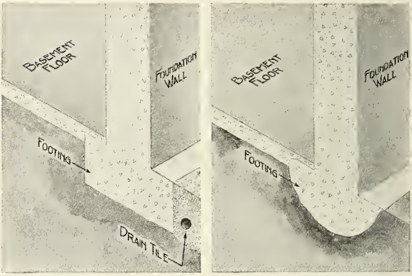


FIG. 1.

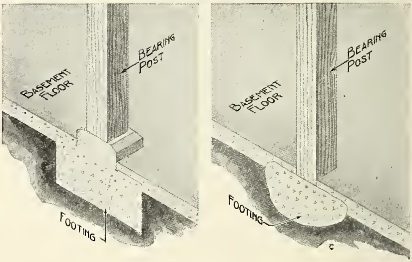


FIG. 2.

Broad and flat footings for foundation walls and basement columns are much more effective in preventing settlement than are undersized footings with rounded or wedge-shaped surfaces. Footings should rest on solid, well-packed material and should never be built on frozen soil. In damp soils a 4-inch tile pipe should drain the footing and discharge into a suitable outfall. Column footings should extend above the floor to protect the column from dampness.

Par. 35. Bearing for Foundation Walls.

It is of vital importance for the permanence and the stability of a dwelling that the walls and interior piers should be supported upon a permanent and unyielding material. If a hard, dry sand, gravel, or clay is encountered at the level at which the walls would naturally rest, a very moderate spread of the foundation wall, or even no spread at all, will be sufficient to support the load. If, on the other hand, the material at the bottom of the wall is an artificial fill or is underlaid with mud, peat, or similar organic matter, it is liable to settlement no matter how much the wall footing may be spread to distribute the load. It is inadvisable to attempt to support any building which is intended to be permanent on other than a stratum of natural ground, free from organic material. If such a stratum can not be reached by carrying the excavations for the entire wall down to its level, other means such as piles, either wood or concrete, may be employed.

Par. 36. Drainage for Foundations.

A line of small drainage tile with proper outfall extending around the outside of the foundation wall and level with its base will help materially to prevent settlements and dampness of basements.

Where provision is not made for circulation of air within inclosed spaces next to the ground surface, dampness accumulates and timber decays rapidly. Openings for the admission of air help to prevent such decay and increase the life of the structure. The total area of such openings should be not less than 7 per cent of the ground area inclosed.

Par. 37. Alternative Foundation Wall Requirements.

In case the grade or ground level varies on different sides of the building two interpretations of the regulations applying to minimum heights of 8-inch walls are available.

(*a*) The structure may be built with 8-inch walls to the height permitted above the highest grade level, all walls below that level being required to have a greater thickness.

(*b*) The 8-inch walls may extend to the height permitted above the lowest grade level, walls of greater thickness being required at all places below grade when the basement or cellar is excavated.

Par. 38. Saving Involved in Recommendations for Foundation Walls.

The following tabulation shows average minimum thickness requirements for foundation walls, based on examination of 134 building codes. (A number of the codes did not regulate all the items listed.)

Height of building.	Thickness of foundation wall.			
	Brick.	Concrete.	Stone.	Hollow block or tile.
	Inches.	*Inches.*	*Inches.*	*Inches.*
One-story	12.5	12.1	16.2	11.3
Two-story	13.6	12.7	17.4	12.6
Three-story	16.4	16.6	19.4	15.6

Variations in existing foundation wall requirements correspond practically to those shown for thickness of solid brick walls, the thickness of foundation walls being from 2 to 8 inches more, with an occasional case where basement and first-story walls are the same thickness.

Assuming for wall thicknesses recommended by the committee the average maximum story height permitted by the codes, and disregarding the recommendation that foundation walls inclosing unexcavated spaces may be 8-inch walls under certain circumstances, the thickness of foundation walls required by the committee under conditions similar to those above would be as follows:

Height of building.	Thickness of foundation wall.			
	Brick.	Solid concrete.	Rubble-stone.	Hollow concrete or clay tile.[1]
	Inches.	*Inches.*	*Inches.*	*Inches.*
One-story	12	8	16	12
Two-story	12	8	16	12
Three-story	12	12	16	12

[1] Of types permissible.

Par. 39. Variation in Floor-Load Requirements.

Investigation of the floor-load requirements prescribed by 109 codes discloses variations as follows:

Minimum floor load for dwellings.

Number of codes in which required:	Pounds per square foot.
1	25
2	30
24	40
29	50
42	60
4	70
1	75
2	80
1	100
Average	53.2

Three codes examined do not attempt to regulate floor loads, 15 permit a reduction of 10 to 20 pounds per square foot for upper floors, and 8 allow 20 or 30 pounds per square foot as a basis for design of attic-floor systems.

The committee believes that if the precautions and unit stresses elsewhere recommended are used for design of wooden floors the minimum live-load requirement of 40 pounds per square foot advocated will be ample so far as their load-bearing capacity is concerned and will insure the rigidity necessary to prevent plaster cracks and undue vibration. In the case of monolithic floors or those with solid or ribbed slabs wider load distribution, greater proportion of dead to live loads, and greater inherent rigidity justify reduction of the live floor load to 30 pounds per square foot.

Par. 40. Saving Involved in Recommended Floor-Load Requirements.

The average requirements for first floors in 109 representative building codes was 53.2 as against 40 pounds per square foot, the larger of the two requirements recommended by the committee. Assuming that the sizes and grades of material used are determined by code requirements, general adoption of the committee's recommendations would permit timbers of given size to be used for spans of approximately 10 per cent greater length, and in many cases would allow use of smaller timbers for given purposes. Economies possible in floor systems of various fire-resistive types also are considerable, but less capable of brief analysis. For the cities in which codes prescribe 60-pound floor loads and over, economies resulting from adoption of the committee's recommendations would be correspondingly greater.

Par. 41. Roof Loads.

The minimum roof loads specified apply only in localities where snow loads are not an important consideration. Roofs having a slope of less than 20° are always liable to accidental loading, such as groups of moving people, storage of material, etc. Hence the necessity of moderate unit loads even where snow is not to be expected. Where large snow loads are to be anticipated the loadings prescribed in Part II, section 37, should be increased in accordance with local experience.

Par. 42. Roof Coverings.

1. No direct requirements for roof coverings are included in Part II, owing to the committee's decision not to consider in this report the influence upon construction of fire hazards created by building congestion, as explained in the first paragraph under the heading "Scope and purpose of this report," page 9.

2. The committee, however, is unanimously of the opinion that incombustible roof coverings should be used upon all two-family dwellings, and it recommends such roofings upon all buildings in congested areas on account of the well-recognized conflagration hazard of wooden shingles or other combustible roofing materials.

3. Any roofing material of a grade not lower than class C as established by the Underwriters' Laboratories would be satisfactory for dwelling-house roofs. A large number of such roofings suitable for flat or sloping surfaces have been tested and approved. The cost will vary somewhat with the locality, but many of the approved roofings are but little more expensive than first-class wooden shingles.

4. A list of approved roofings can be obtained upon request addressed to the Underwriters' Laboratories, Chicago, Ill.

5. Probably no type of roof covering has caused more comment and discussion than the wooden shingle. The great danger of the wooden-shingle roof is from chimney sparks and flying brands from burning buildings or bonfires. The danger from chimney sparks is largely confined to wood or soft-coal fuel and the sparks resulting from the burning of chimney soot.

6. The wooden shingle has various well-recognized merits. It is light in weight, has excellent insulating value, thus promoting comfort by equalizing attic temperatures, can be easily applied, furnishes attractive architectural effects, and high-grade shingles properly laid produce a roof having excellent durability.

7. The main objection to the use of wooden-shingle roofs is the fire hazard. Sparks or flying embers are more likely to roll or blow off from the smooth surface of a newly shingled roof than from an old roof with weather-worn shingles having curled and broken edges. For this reason any treatment of shingles, such as staining or creosoting the shingles, which will tend to maintain a smooth surface incidentally improves their fire resistance. Few if any of the compounds used for treating shingles directly increase the fire resistance. If rain water for household purposes is to be collected from a roof, care must be taken to select treated shingles which will not contaminate the water.

8. When wooden shingles are used the very best grades of shingles available should be obtained, as they are more economical to the house owner in the long run than cheaper grades and prolong the life of a smooth-surface roof, thus promoting safety. For best results use edge-grain shingles free from knots and other imperfections and having a thickness at the butt not less than that represented by five shingles in 2 inches (four-tenths inch each). Shingles are made in 16, 18, and 24 inch lengths. Sixteen-inch shingles on a roof having a one-half pitch or greater should be laid $4\frac{1}{2}$ inches to the

weather; 18 to 24 inch shingles can be laid safely with larger exposure.

9. Ordinary wire nails are entirely unsuited to hold shingles. They rust out long before the shingles decay. Hot-dipped, zinc-coated, cut iron nails are the best. Plain cut iron or galvanized wire nails will serve fairly well. The heads of nails should not be driven into the shingles. Untreated shingles should be thoroughly wet before laying.

Par. 43. Desirability of Plaster.

The committee is of the opinion that a requirement for the universal use of plaster in dwelling construction is not within the scope of a building code. Its value as a heat and sound insulator, for purposes of fire protection, and for decorative and other uses is such that only the strongest cost considerations justify its omission. Where used, and where paid for by the builder or buyer of a residence, it should conform to certain standards which will insure successful performance of its nominal functions. In localities subject to high winds and where plaster is not used it is advisable to anchor the frame of a wooden dwelling to the masonry foundations sufficiently to obtain the element of stability otherwise resulting from the weight of the plaster.

The following discussion of plastering practice outlines these desirable standards.

In no place is the importance of good, honest construction more evident than in the plastering of a house. If the general construction is neglected or skimped, the results are shown by the unsightly cracking and sometimes dangerous falling of the plaster. Therefore the committee, realizing that under the best of conditions it is impossible to avoid all cracks in plastering, wishes to emphasize the necessity of good building. Following are some of the common causes which result in cracked plastering: (1) Inadequate or faulty footings under bearing posts. (2) Too small girders or too few bearing posts. (3) Joists of insufficient size. (4) Joists under partitions not doubled. (5) Improper framing over wide openings. (6) Uneven settlement due to shrinkage of wood frame improperly designed and constructed. (7) Chimney not independent of the frame. (8) Settlement of wall footings and foundations. (9) Separation of partitions from walls. (10) Failure to conform to good plastering standards, such as are outlined in this paragraph and in paragraphs 44, 45, 46, and 47 of the appendix.

Measures by which some of the above causes of plaster cracks can be wholly or in part overcome are shown on Plates 11, 13, 14, 15, 17, 18, 22, and 23 of this report. Suitable design of footings is illustrated on Plate 17; proper framing over and around wide openings on Plates 11 and 15; framing to bring about uniform settlement on

Plates 13 and 14; methods of framing around chimneys and fireplaces on Plates 22 and 23; and approved methods of attaching inside partitions to walls of frame dwellings on Plate 18.

When gypsum wall board is used in place of lath and plaster, it should conform to the specifications of the American Society for Testing Materials. Gypsum plaster board may be used instead of wood or metal lath except where the latter is specifically required. When thus used it should conform to the specifications of the American Society for Testing Materials. (See Appendix, par. 10.)

Various substitutes for plaster and plaster board are on the market and classed under the general term "fiber boards." Such boards provide an economical wall surface, but they are subject to the same influences as wood sheathing, resulting in shrinkage and warping, and should be kept in a thoroughly dry condition from the time they are manufactured until applied. Their use should be restricted to construction where their inflammability will not constitute a serious hazard.

The following extracts are from specifications indorsed and adopted by the executive committee of the Fibre Wall Board Manufacturers' Association.

1. The moisture content of the board shall be restricted to a minimum of 10 per cent and a maximum of 15 per cent, giving consideration to climatic conditions where board is to be used.

2. Surfaces shall be covered with a priming coat or coats that will afford maximum protection from atmospheric moisture, at the same time providing a satisfactory and practical painting surface.

3, Wherever possible, the minimum size decorative strip to be used shall be 3 inches wide and one-half inch thick, and this decorative strip, as well as the panels of board, shall be well nailed and care be given to the selection and structure of studding and joists.

4. Fiber wall boards shall have a minimum thickness of three-sixteenths inch with permissible local variations of one sixty-fourth inch.

5. The weight of fiber wall board shall be not less than 475 nor more than 600 pounds per 1,000 square feet.

6. The strength of fiber wall board shall be sufficient to stand a weight of not less than 125 pounds, hung from a three-fourths-inch round iron rod placed across a strip 12 inches wide, nailed across pieces of regular studding, placed on 16-inch centers, the rod to be parallel to and halfway between the studding.

Par. 44. Preparation of Base for Plaster.

1. When plaster is to be applied directly to masonry surfaces these should be rough in texture but not uneven; free from dust, laitance, or other loose material which will prevent a good bond between plaster and wall; and particularly from grease, which will cause discolorations. The wall surface should be wet enough so that it does not withdraw water from the plaster, but not so wet as to fill the surface pores and prevent good bond or interfere with hardening. Care in this respect is not so important with lime plasters as with gypsum,

because lime holds water against suction better than gypsum and because water is not required for hardening lime while it is for gypsum.

2. To prevent undue lateral expansion and contraction of wood lath, which shears and loosens the plaster keys, such lath should not be over $1\frac{1}{2}$ by $\frac{3}{8}$ inch in section and key spaces should be not less than three-eighths inch for lime plaster or one-fourth inch for gypsum plaster. Wood lath should be thoroughly wet when plaster is applied. Lath should be attached to at least three supports, and good practice requires broken joints at least every eighth lath.

3. Expanded metal lath, weighing 2.2 pounds per square yard, or No. 20 wire cloth, two and one-half meshes to the inch, are sufficiently rigid for plaster supports in small dwellings where timbers are spaced not more than 16 inches for walls and 12 inches for ceilings. Longer spans demand heavier lath or special stiffeners. Ends of sheets should be joined over supports and horizontal edges lapped and laced securely with wire. Continuous sheets bent around corners tend to prevent corner cracks in the plaster. It is recommended that all metal lath be either galvanized or painted.

4. Gypsum plaster boards are essentially squares of gypsum plaster coated on both sides with paper, or, instead of paper, wood fiber or other vegetable fiber is mixed with the material of which the boards are made. They are usually about 32 by 36 inches and supplied in thicknesses from one-fourth inch up. For small dwellings, where the distance between supports is as given above, one-fourth inch board may be used. For greater spans a thicker board is required for rigidity, but in no case should the board be so thick that its face is not amply covered by the plaster in obtaining the required thickness. Each board should be fastened to at least three supports, and all joints perpendicular to supports should be broken. The surface of the board is finished so that plaster adheres readily and should not be wetted when plaster is applied.

Par. 45. Plaster Materials.

1. In a few localities plaster can be obtained mixed ready to spread on the wall. This practice permits more careful selection of the ingredients, better proportioning, and more thorough mixing than where the plaster is prepared on the job. The use of such plasters is therefore recommended wherever they can be obtained of good quality and at reasonable cost.

2. Lime will carry about twice as much sand as gypsum as ordinarily used, but the setting time of gypsum plasters can be more easily regulated. Gypsum plaster has greater inherent strength than lime plaster, and its better fire-resistive qualities are important when fire barriers are to be constructed. Lime plaster can be brought to

equal strength by tempering with Portland or Keene's cement and is more resistant to moisture than gypsum plaster. Selection of plasters should be made with reference to local practice, better work usually resulting from the use of familiar materials.

3. Gypsum wall board represents the nearest present approach to manufacture of completed plaster at the factory, ready to be erected in place. It is supplied in sheets 4 feet wide, usually three-eighths inch thick, in lengths to fit the height of a room, and coated on both sides with paper. It should be erected with no end joints between wall boards and the side joints always over a support. Any openings in joints between boards should be filled with plastic material. For decorative effect they may then be covered with wood or paper strips and the whole surface painted or papered, if desired. Wall board possesses the essential characteristics of rigidity, strength, and finished surface common to plaster.

Par. 46. Mixing and Application of Plaster.

1. Proportions of sand and lime or gypsum will vary with each grade or make of materials. Common practice requires the scratch coat to be one part of hydrated lime, or well-slacked lime putty, to three and one-half parts of sand, or one part by weight of gypsum to two parts sand. Corresponding figures for the brown coat are one to four for lime and one to three for gypsum. For best results these proportions must often be intelligently varied, and the old custom of adding sand by guess until it "feels right to the plasterer" can not be too strongly condemned.

2. The finish coat may be of straight gypsum or of lime. If lime is used, a very plastic lime prepared as putty is required, and in the case of slacked lime putty, aged for about two weeks, after which it is mixed with about half its volume of gypsum or tempered with plaster of Paris, applied to the wall and troweled to a smooth, hard finish. Much skill and care is needed for success. For best method of making lime putty see A. S. T. M. Standard C–5–21–T.

Par. 47. Number and Thickness of Plaster Coats Necessary.

1. The exposed aggregate method of making colored concrete is equally applicable to plaster, and requires merely a little care in the selection of the sand. Wood fibers used in the brown coat may be dyed and exposed by washing the plaster after it has set to give effects in color and texture. The ordinary brown coat may be rubbed down to a sand-float finish, which is satisfactory for some purposes, and may be improved by painting.

2. If the finish coat is omitted and a strong (rich) plaster used, the thickness for plaster can safely be reduced to five-eighths inch. This would result in economy with slight sacrifice of desirable qualities. Where rigidity is not important, two coats are sufficient,

PLATE 18.

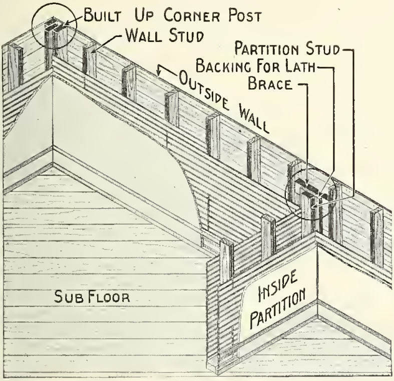
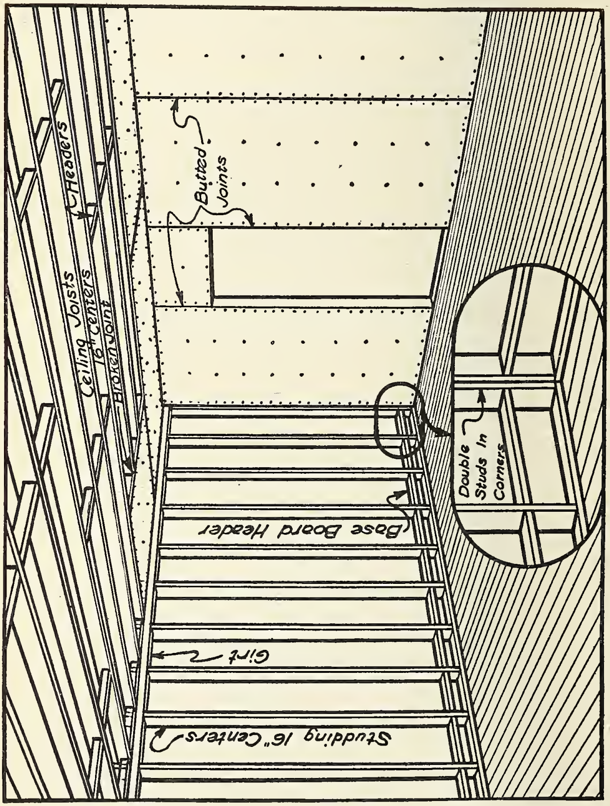


FIG. 1.

FIG. 2.

Figs. 1 and 2 show proper methods of securing backing for lath where partitions meet outside walls at or between wall studs. By such means firm backing is afforded for the ends of the lath and no lath extend through from room to room.

PLATE 19.



Methods of installing gypsum wall board.

whether scratch and brown or scratch and finish. Masonry walls and ceilings are plastered almost entirely for decorative reasons, and one coat, properly selected, is entirely sufficient if the surface is not too uneven. Under unfavorable conditions, two coats, totaling five-eighths inch thickness, are all that should be required.

Par. 48. Furring.

The committee is of the opinion that a requirement that all plaster surfaces be furred out from masonry walls is not within the scope of a building code. The advisability of this measure is plainly shown, however, by the following summary of experience reported from all parts of the country:

1. In regions subject to low temperature, high winds, heavy rains, or extreme humidity of considerable duration, furring of solid masonry exterior walls is practically a necessity to avoid unwholesome living conditions caused by damp walls, also the danger of ruining wall decorations.

2. In arid localities, where low temperatures are infrequent, furring may be omitted without serious results, but should be used wherever economy in construction cost is a secondary consideration.

3. Waterproofing paints or compounds applied to the interior of solid masonry walls help considerably to prevent moisture penetration, but have little effect in preventing condensation, and make it difficult to bond plaster directly to such treated walls.

4. Furring is somewhat less necessary on masonry exterior walls of hollow units, since the inclosed air cells help to check transmission of heat and moisture. However, mortar joints running through the wall are found to conduct moisture readily when poorly or incompletely made, and walls having such continuous joints require furring.

5. Furring a masonry wall lessens its heat conductivity, thus saving fuel, which saving, of course, continues throughout the life of the structure and may repay many times over the increased cost of furring.

6. Since hollow walls are good heat insulators, it has been found in many places that furring may be omitted and plaster applied directly to the interiors of walls which are built with a continuous hollow space, or in which the mortar joints extend but part way through the wall.

7. In concrete house construction provision for insulation of exterior walls is recommended. A dead-air space within the wall itself or formed by furring and plastering has been found effective and this requirement seems to be favored by those recommending the use of concrete external walls.

In applying plaster to furring lath, it is important that the keys shall not project through so as to touch the wall, nor be allowed to drop off and form a solid mass between plaster and wall. In either case moisture from the wall is liable to be transmitted through the plaster producing troublesome results, such as staining the wall, and ruining the lath—wood lath by dry rot and metal lath by corrosion. It is claimed that excellent results in furring 8-inch brick walls are obtained by attaching a layer of tarred paper to the back of the furring strips, or by using a lath in which such paper forms an integral part.

Incombustible furring is excellent since it entirely prevents a fire creeping along a wall from one story to another behind the plaster. Hollow tile or gypsum furring blocks are much used and are quite satisfactory. They have grooves in the back face which furnish air spaces between the wall and the plaster. There are also several forms of metal furring to which metal lath is attached and which serve the same purpose. Where walls are likely to be continuously damp, hollow tile furring will be more satisfactory than gypsum.

Par. 49. Chimneys.

1. Pure quartz gravel or other highly siliceous gravel concretes are not adapted to withstand rapid rises of temperature and it is therefore recommended that they should not be used for chimneys where subject to direct attack of heat.

2. The reinforcement required in concrete chimneys cast as a unit, or when built of large blocks inclosing more than one flue, is to resist stresses due to temperature variations or unequal settlement of foundations.

3. Experience has shown that more than one connection to a flue is bad practice. The draft is impaired and there is much danger, where only one of the connections is in active use, that fire will be communicated by way of the unused opening to connecting rooms.

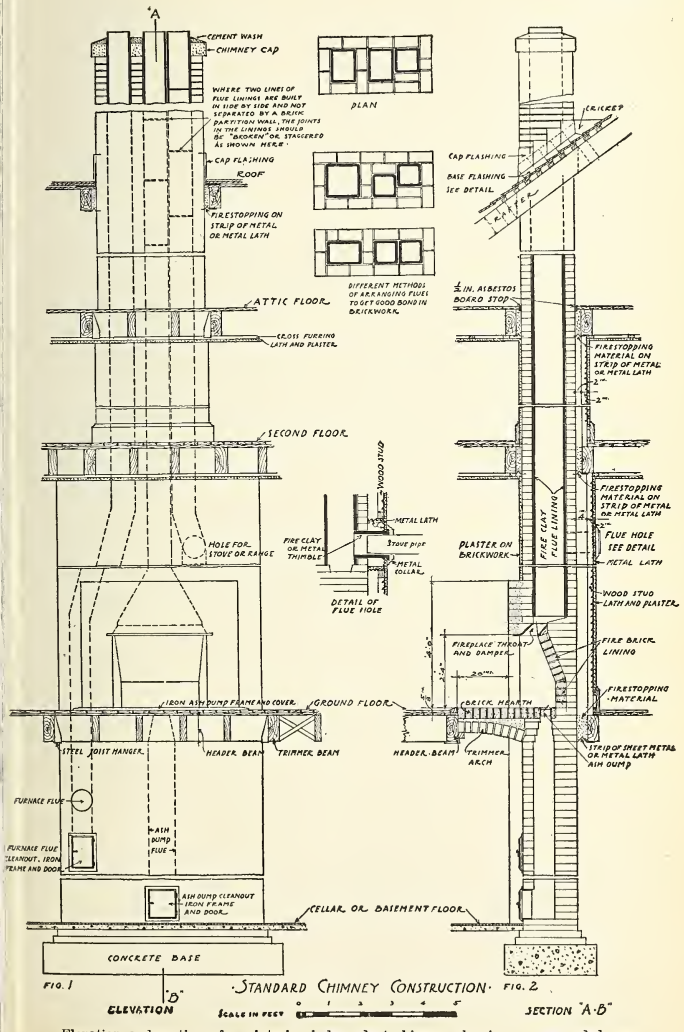
Where a connection is not in use there is danger that the flue stop may be displaced or destroyed by corrosion, thus permitting sparks to pass through. Such unused connections also accumulate soot which in time will burn and thus greatly increase the fire hazard.

In order to insure satisfactory draft, flues from heating furnaces and fireplaces should be separated from other flues in the same chimney by 4-inch withes or division walls. Linings should project 4 inches above the chimney top to allow for a 2-inch wash and a 2-inch projection of the lining.

4. A method of hearth foundation construction that has proven satisfactory consists of a reinforced concrete slab supported by steel members cantilevered from the masonry chimney.

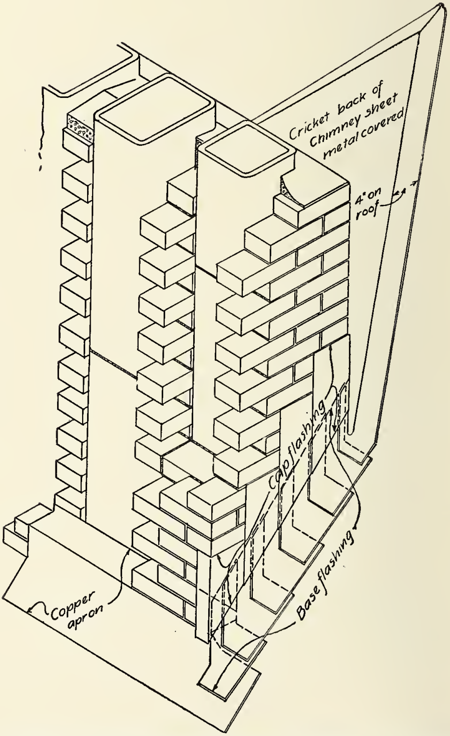
5. A smoke test of the chimney is recommended before its acceptance. The method of test is to build a smudge fire at the bottom of flue and while smoke is flowing freely from the flue to close it tightly

PLATE 20.



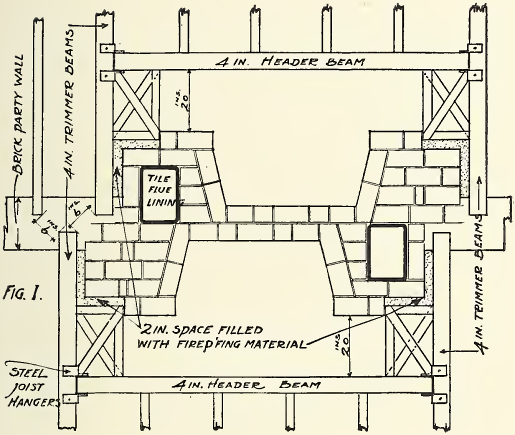
Elevation and section of an interior independent chimney showing recommended construction. Extra flues can be added as desired.

PLATE 21.



Details of chimney construction showing method of flashing at roof surface, also a wash course, but no cap surrounding flues at top. (See Plate 20.) Underflashing or cap flashing may be substituted for copper apron shown.

PLATE 22.



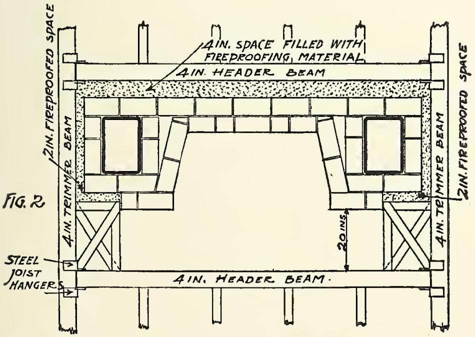
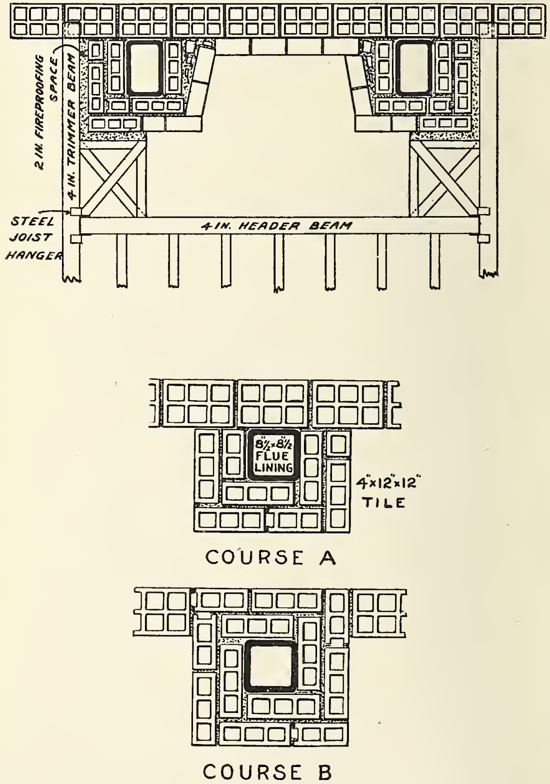


FIG. 1.—Method for building two fireplaces back to back in a brick party wall to secure proper spacing between ends of floor joists.

FIG. 2.—Floor framing around a single fireplace. Note filling between framing and brickwork, which serves both as insulator and fire-stop.

PLATE 23.



Approved hollow-tile construction for chimneys and fireplaces.

PLATE 24.

FIG. 1

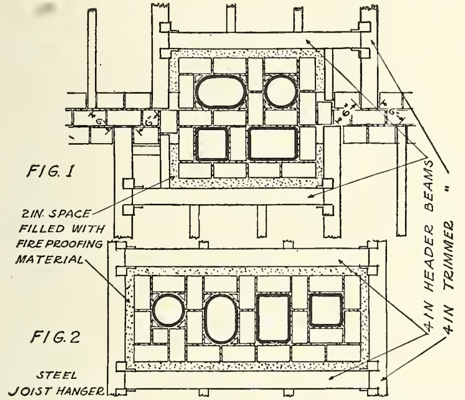


FIG. 2

FIG. 3

FIG. 4

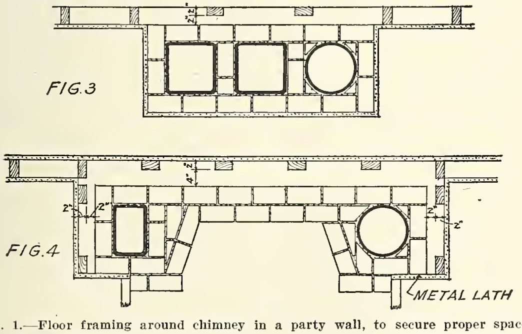


FIG. 1.—Floor framing around chimney in a party wall, to secure proper space between ends of floor joists.

FIG. 2.—Ordinary floor framing around a chimney. All timbers 2 inches clear of brickwork and space filled with fireproofing material.

FIG. 3.—Stud partition across back of a chimney showing proper method of arranging studs.

FIG. 4.—Stud partition across back of a fireplace and around the ends of the chimney breast, showing proper arrangement of studs. Method of fire-stopping this space is shown on chimney section, Plate 20.

at the top. Escape of smoke into other flues or through the chimney wall indicates openings that should be made tight before the chimney is accepted.

In the foregoing pages are shown elevations and section of typical chimney and fireplace construction according to the requirements of Part II, sections 40 and 41.

For complete specifications covering construction and care of low temperature chimneys, see An Ordinance for Construction of Chimneys, distributed gratis by the National Board of Fire Underwriters, 76 William Street, New York.

Par. 50. Installation of Heating Appliances.

All heating furnaces, boilers, laundry stoves, or other similar devices in which hot fires may be maintained should rest upon masonry foundations, and no woodwork should be permitted within 2 feet of same. All woodwork within 3 feet should be covered with loose fitting sheet metal or equivalent fire-protective material.

When it is necessary that coal ranges without legs, or any of the above-mentioned heating devices be supported by wooden floors, the floors should be protected by a hearth consisting of a sheet of metal or a one-eighth inch layer of asbestos board covered with not less than 4 inches of masonry set in cement mortar. The masonry should consist of one course of 4-inch hollow tile, or of two courses of brick, concrete, or tile, at least one of which should be hollow and be laid to preserve free circulation of air through the whole course; or such heating appliance may rest upon a 6-inch foundation built of incombustible materials supported within the thickness of the floor framing. Such hearths should extend at least 12 inches on the sides, back, and front of the furnace, range, or similar heating appliance; if solid fuel is used, the front extension should be at least 24 inches.

The overhead clearance of heating furnaces or boilers placed in the cellar or basement should never be less than 15 inches, and the wooden joists or ceiling over furnaces or boilers should be protected by metal lath and cement or gypsum plaster, or a one-half inch layer of either asbestos board or plaster board covered with sheet metal will serve, though not so good as the metal lath and plaster. Such protection should extend at least 3 feet beyond the heating device on all sides. Aside from the advantage of increased safety the saving in fuel by completely inclosing warm air furnaces in protective covering well warrants the moderate expense involved. Cellular asbestos covering one-half inch thick, especially adapted to this purpose, can be purchased at moderate prices.

Par. 51. Protection of Combustible Construction Near Stoves or Ranges.

If coal or wood burning stoves or ranges are set nearer than 12 inches to stud walls, the walls should be protected by incombustible shields extending at least 6 inches each side of the stove or range, and extending from the floor to at least 2 feet above the stove or range.

A practical method of accomplishing this is to cover the required area with some form of self-furring metal lath which will provide a space between the lath and the studs, and then plaster in the usual manner.

The danger when wood lath and plaster is exposed as indicated is that by a process of slow carbonization of the lath, which may result from even moderate heat long continued, the lath is put in a condition inducing spontaneous ignition. Fires are frequently started in this way, hence this warning.

Par. 52. Smoke Pipes.

The first essential in the installation of a smoke pipe is that it shall be securely anchored at frequent intervals by lightly drawn wires. No woodwork or wooden lath and plaster construction should be allowed within 9 inches of a smoke pipe. When wood or soft coal fuel is used, it is wise to provide a greater distance than 9 inches; but if it can not be obtained then a sheet-metal shield should be installed between the pipe and the woodwork with an air space between each. The fire danger of overheated smoke pipes is a very serious one. Thousands of fires are started every year from this cause. The remedy is very simple.

Par. 53. Importance of Fire Stops.

The committee desires to emphasize the fact that fire stops are an extremely important though inexpensive aid in preventing rapid distribution of fire.

Fire in buildings spreads by the movement of high temperature air and gases through every open channel. In addition to halls, stairways, and other large spaces, these heated gases also follow with equal facility the concealed spaces between floor joists, between the studs in partitions and walls of frame construction, and between the plaster and the wall where the former is carried on furring strips. In a dwelling or even in a large building where these hidden channels are not obstructed at suitable points, a fire will find its way in a few minutes to all parts of the structure, and either will destroy it entirely or will result in much greater loss than would have occurred if fire stops had been installed.

It is not practical to introduce cut-offs in hallways and stairways of the ordinary small size dwelling but fire-stopping of all hidden channels is easy.

1. In general, fire stops should be so located as to separate the open spaces within the walls and floor of each room from those of adjacent rooms. Especial care should be taken to shut off the cellar or basement from the first floor. A large proportion or residence fires start in such lower stories where the heating equipment is located and are readily communicated to all parts of the structures by way of hollow partitions and walls, and the spaces around warm-air pipes and floor registers. Hence the importance of having them all carefully fire-stopped.

2. Wherever possible fire stops should be of incombustible material, and should form a practically air-tight obstruction, for the hot air and gases generate pressure and will find their way through very small crevices.

3. Precautions such as described above, by delaying the spread of fire, will afford time for help to arrive, and result in saving many buildings and even lives which otherwise might be lost.

4. Experiments upon the thermal conductivity of walls indicate that heat losses are appreciably decreased by breaks in the furring spaces at each story, and that fire stops, in addition to their normal functions, help save fuel.

5. Fire stops, if properly installed, provide a valuable barrier to rats and other rodents.

Par. 54. Vigilance Necessary to Secure Fire Stops.

The greatest obstacle to securing efficient fire stops in a building is in getting architects and builders to realize the supreme importance of such precautions. The ordinary carpenter or builder is ignorant of the serious annual life and property loss due to fires in combustible dwellings, and considers the possibility of such a fire too remote to worry about. Some one must be responsible for rigid inspection to insure that such work is conscientiously performed. Wherever possible the building inspector should be required to inspect all fire-stopping before it is concealed from view. Usually the owner lacks experience and does not know what should be required.

Par. 55. Fire-Stopping Materials.

1. Two courses of bricks, tile slabs, or other masonry are required to cut off a furring space, for mortar joints may drop out of a single course and render it useless.

2. Incombustible material suitable as dry fill for fire-stopping may be crushed refuse mortar, plaster, concrete, hollow tile, gypsum block, or other similar material containing sufficient fine stuff to

fill voids when it settles. Loose boiler cinders are one of the best fire-stopping materials, and a mixture of sand and gravel with cinders or ashes or even dry earth will also serve the purpose. The weight of sand or gravel alone or of crushed concrete would be objectionable when supported on metal lath. Some of these materials are always found about a new building, and their use involves no expense except for labor.

3. Gypsum blocks are excellent for fire-stopping in dry locations. Ordinary partition blocks can easily be sawed to fit any space. Any open joints between such blocks should be mortar filled. Gypsum products absorb moisture freely, hence should not be used where likely to become wet. Under such conditions it would be liable to induce dry rot in adjoining woodwork. Metal lath and plaster is also excellent fire-stopping construction, especially where considerable surfaces are to be covered.

4. Metal lath is a convenient and inexpensive material for supporting fire-stopping material between studs or joints. It can be easily bent into shape to fit such spaces and then nailed to place. To avoid having the fine material sift through the lath, it is best to cover it with a layer of plaster or mortar before applying the fill material. Such fire-stopping will yield with the shrinkage of the woodwork and always maintain its full protective efficiency.

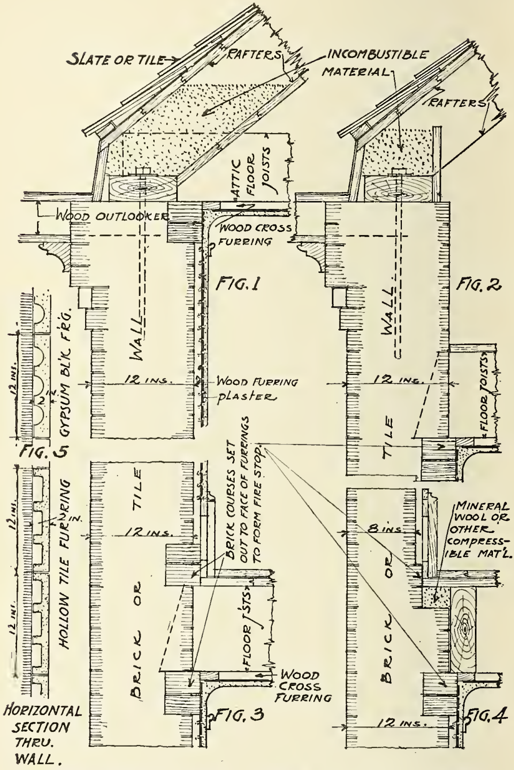
5. There are some places, such as between floor joists resting on a brick cellar partition, where concrete fire-stopping should not be used, because the shrinkage of the timber joists will bring the flooring to bear upon the rigid fire-stopping and the floor will bulge. Metal lath and plaster could also be used if proper precautions were taken to insure complete cut-offs.

6. Metal lath and cement plaster are excellent fire-stopping construction for the underside of a box cornice or a flat finish under the eaves.

7. Fire-stopping about warm-air pipes and registers is important but seldom done. Any such space should be fire-stopped irrespective of floor construction. In fireproof floor construction register boxes should fit the floor opening snugly, and so make fire-stopping unnecessary. The protection of woodwork, as elsewhere required around a register, will safeguard the wood from the heat of the pipe itself, but the open space provided around the pipe and register box forms an easy entrance for fire occurring in the lower story to gain access to the story which the register serves. The warm-air pipe and its connection will get red-hot and communicate fire to combustibles surrounding the register face, such as floors, carpets, rugs, and furniture. (See Pl. 29, figs. 1 and 2.)

8. The greatest hazard is in the cellar or basement where the furnace is located. There is an additional danger from the warm-air

PLATE 25.



DWELLINGS WITH WALLS OF BRICK OR OTHER MASONRY.

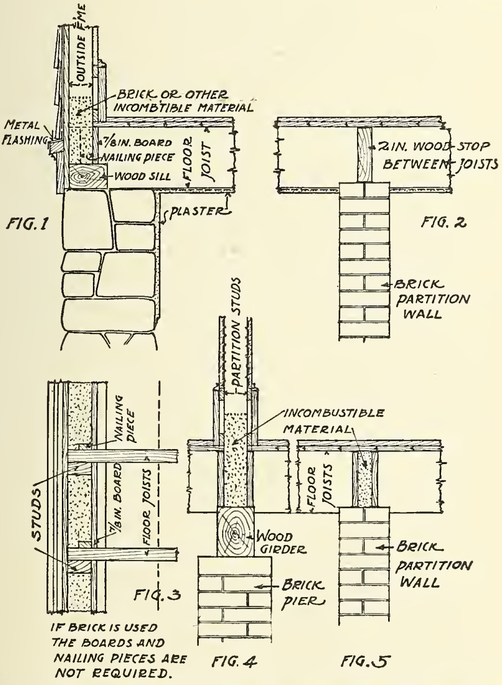
FIG. 1.—Method of fire-stopping at eaves when attic floor joists are level with plate.

FIG. 2.—Same as Fig. 1, except that attic floor joists are any distance below the plate and built into the wall. Support for fire-stopping might be same as in Fig. 1 if more convenient.

FIG. 3.—In this and the other figures of this plate note fire-stopping of wooden furring by two courses of brickwork being set out to face of furring above and below floor joists all around the building. Other types of masonry walls should be built out in the same manner.

FIG. 4.—Fire-stopping at a floor level when the wall is thinner above the floor than below.

PLATE 26.



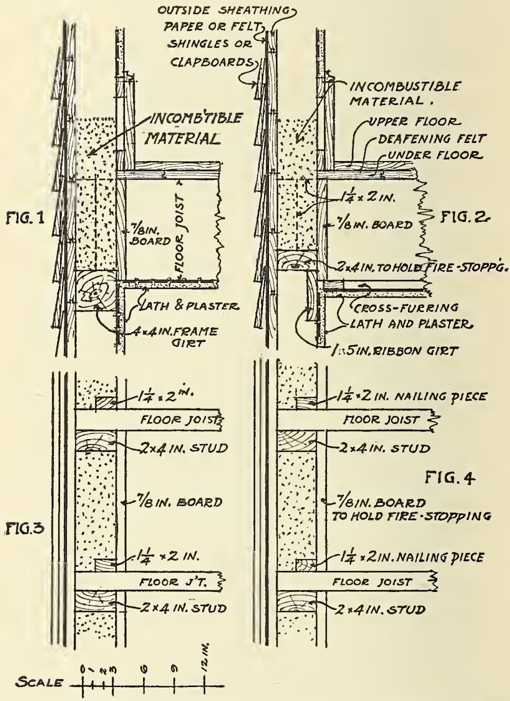
FIGS. 1 AND 3.—Elevation and plan showing fire-stopping of wall of frame building at line of sill and between studs and floor joists.

FIG. 2.—Fire-stopping with timber cut between floor joists on top of brick partition.

FIG. 4.—Fire-stopping of partition resting on wooden girder.

FIG. 5.—Same as Fig. 2, except that incombustible compressible material between two boards is used instead of a timber.

PLATE 27.



FIGS. 1 AND 3.—Elevation and plan showing fire-stopping in frame wall at connection of upper floor joists with girt.

FIGS. 2 AND 4.—Fire-stopping at same place for "balloon frame."

NOTE.—Wherever boards are indicated as supports to hold incombustible fire-stopping in place, metal lath is recommended as a superior substitute. It is easier installed and will not burn.

PLATE 28.

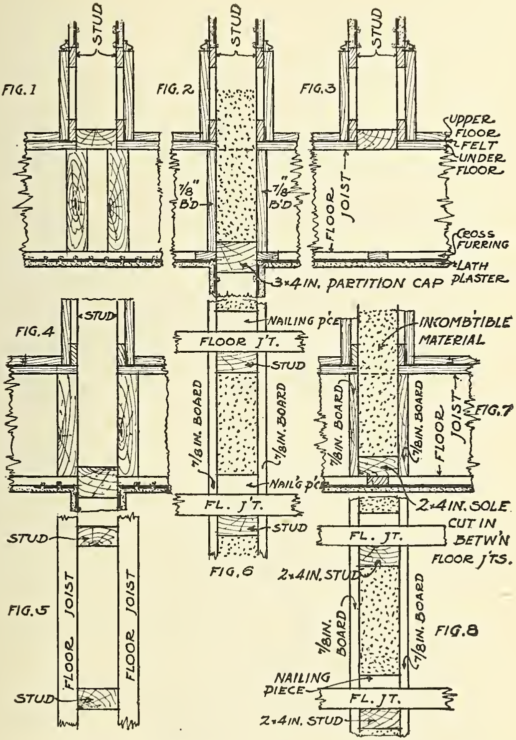


FIG. 1.—Interior partition running same direction as floor joists supported on double joists, fire-stopped at bottom by 2 by 4 inch sole.

FIGS. 2 AND 6.—Elevation and plan of partition footing on 3 by 4 inch cap of partition below running crosswise to joists, showing method of fire-stopping between joists.

FIG. 3.—Partition running crosswise to floor joists footing on sole used as a fire-stop. This would be improved by addition of some incombustible material on top of sole.

FIGS. 4 AND 5.—Elevation and plan of partition running same direction as floor joist footing on 3 by 4 inch cap of partition below used as fire-stop, and floor joists placed alongside studs.

FIGS. 7 AND 8.—Elevation and plan of partition running crosswise to joists footing on sole fitted between joists at bottom and fire-stopped with mineral wool between two boards. Brickwork or other solid incombustible material could be used.

PLATE 29.

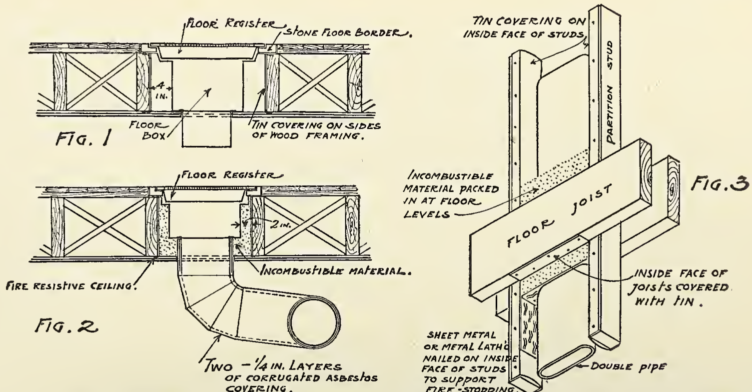


FIG. 1.—Method of fire-stopping around floor register. Note register box extended to line of ceiling protection which simplifies installation.

FIG. 2.—A more complete method of fire-stopping, and one well suited for existing buildings.

FIG. 3.—Isometric sketch showing method of fire-stopping between floor joists around a warm-air pipe carried up in a partition.

PLATE 30.

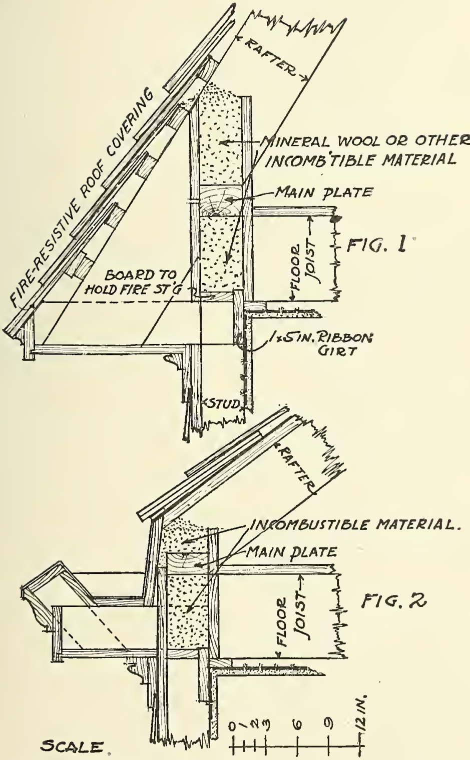


FIG. 1.—Connection of floor joists with outside "balloon" frame. Method of fire-stopping cornice and "gambrel" roof construction. Metal lath and cement plaster or stucco would make better fire protection than wood for the flat surface under the eaves.

FIG. 2.—Connection of floor joists with outside "balloon" frame at plate level, showing "box" cornice, gutter trough, and foot of roof rafters, and method of fire-stopping. This retards fire entering building if cornice burns. Same methods employed for girt framing.

pipes. Such pipes leading from the furnace, if not protected in case of a fire, would become intensely hot and burn the dust which invariably accumulates in them, thus making a flash fire, and there would be great danger of the fire being communicated to the floor above, even though the pipes and registers were fire-stopped at the floor openings. For this reason the pipes and the furnace itself should be fully covered with cellular asbestos or equivalent incombustible material at least one-half inch thick for the pipes and 1 inch for the furnace. Such covering is inexpensive and reduces coal bills by conserving the furnace heat. It is much used for this purpose alone. The covering is manufactured for the purpose and sold in rolls. Suitable metal bands to hold it in place are supplied.

9. It is common practice simply to cover warm-air pipes with a sheet of thin asbestos paper pasted to the pipe. Such protection is merely a pretense. Tests have shown that it has no value either as a heat insulator or as a fire resistant.

In the following plates are shown suggestions of various methods of fire-stopping as required in Part II, section 42:

NOTE.—At first glance it might appear that fire protection construction features have been unduly emphasized in the committee's recommendations, but in making a decision on this matter consideration should be given to the following facts:

1. Conservation of materials and manufactured products is one of the fundamentals to be considered in our problem of standardizing and economizing construction.

2. Reliable records show that 23 per cent of the total fire loss on buildings is due to fires in dwellings.

This indicates a very large number of dwellings destroyed each year, and thus would justify all reasonable construction requirements which would prevent the rapid spread of fire in such buildings.

Par. 56. Garage Construction.

1. The standard specifications for fire tests referred to in Part II, section 43–1, are those approved and issued by the American Society for Testing Materials and the National Fire Protection Association, and they are also approved by the American Engineering Standards Committee as tentative standards. They are the ones employed by the Bureau of Standards, the Underwriters' Laboratories, and other testing authorities in the conduct of fire tests on building construction.

2. For floors and ceilings over garages the best and most reliable construction is reinforced concrete or some other type of incombustible, fire-resistive floor complying with fire-test requirements.

3. An inexpensive type of floor and ceiling construction which has been found to meet the requirements of the specified test is constructed as follows:

Two-inch floor joists spaced on not more than 16-inch centers and properly bridged. Overhead flooring double, of seven-eighths inch rough and finished floor boards, with a layer of asbestos floor felt between. Ceiling of heavy metal lath and Portland cement or gypsum plaster, not less than three-fourths inch thick. The metal lath to be attached to the joists by sixpenny nails driven nearly home and heads turned over against the lath, also by strands of No. 8 annealed wire looped over each third joist engaging the lath at bottom of joist and twisted snugly to place. These loops to be spaced at intervals of 2 feet along the joists. The lath to be bent down 6 inches along the walls on all sides and securely attached to same.

4. Roof construction should be equivalent to that indicated for overhead floor and ceiling. (See Pt. II, sec. 43–2.)

5. For walls and partitions any construction meeting the test requirements should be approved. In absence of test records proving that less thickness of material may be employed, the following are recommended as acceptable materials: Brick, hollow tile, concrete block or gypsum block 4 inches thick, or reinforced concrete 3 inches thick.

6. An inexpensive construction which has been found by test to meet the requirements for walls consists of wooden studs spaced 16 inches on centers, with a back-plastered Portland-cement stucco on metal lath attached to the outside of the studs and with metal lath and three-fourths inch Portland cement or gypsum plaster attached to the inside of the studs.

7. For partitions, three-fourths inch Portland cement or gypsum plaster on metal lath on each side of stud construction as above specified may be accepted as fulfilling the requirement.

8. Only products approved by competent authorities should be used. A large variety of fire doors and windows have been tested and approved by the Underwriters' Laboratories, and are a standard commodity in the building-material market. Only fire doors and windows thus approved or which have withstood tests of equal severity conducted by other responsible parties should be used for the purposes mentioned in section 43. It is important, however, that such devices should be installed in metal frames and with hardware the same as that with which they were equipped when tested, otherwise they may fail to meet expectations when subjected to fire. Fire doors are made in both swinging and sliding types, and many of the former are as artistic in appearance as wooden doors.

Wired-glass glazing is required in all exterior windows or doors to prevent flames from a fire in the garage breaking through and endangering windows in the stories above.

9. A self-closing fire door as required in Part II, section 43–4, is one that is normally kept in a closed position by some mechanical

device. Wired glass is excluded from this door because such glass is liable to soften and sag from its fastenings at a temperature of about 1,600° F., which is a heat easily produced by burning gasoline or oil.

10. Although provision is made in Part II, section 43, 4, and 5, for entrance from the dwelling into the garage, it is recognized that even with the precautions specified some fire hazard still exists, and it is strongly recommended that when a garage is placed underneath or attached to a dwelling there should be no opening whatever between the two occupancies. It is much safer to enter the garage from the outside.

Par. 57. Value of Trade Publications on Construction Materials and Methods.

The Building Code Committee desires to call attention to the large number of publications distributed by national and local industrial organizations for the purpose of promoting correct practice in the use of their products. The committee does not necessarily agree with nor should it be quoted as endorsing the statements made in such publications. It believes, however, that the helpful information contained therein should be given careful consideration by those interested in building.

The following is an incomplete list of national and in some cases local organizations, the publications of which have come under observation of the committee:

Associated Metal Lath Manufacturers, 740 Edison Building, Chicago, Ill.
American Face Brick Manufacturers, 130 North Wells Street, Chicago, Ill.
Associated Tile Manufacturers, Beaver Falls, Pa.
California Redwood Association, 24 California Street, San Francisco, Calif.
Clay Products Association, 133 West Washington Street, Chicago, Ill.
Common Brick Manufacturers' Association of America, 1300 Schofield Building, Cleveland, Ohio.
Gypsum Industries Association, 111 West Washington Street, Chicago, Ill.
Hollow Building Tile Association, 1409 Conway Building, Chicago, Ill.
Indiana Limestone Quarrymen's Association, Bedford, Ind.
National Board of Fire Underwriters, 76 William Street, New York, N. Y.
National Conference on Concrete House Construction, care of Portland Cement Association, 111 West Washington Street, Chicago, Ill.
National Lime Association, 918 G Street NW., Washington, D. C.
National Lumber Manufacturers' Association, 1319 F Street NW., Washington, D. C.
Portland Cement Association, 111 West Washington Street, Chicago, Ill.
Southern Pine Association, Interstate Bank Building, New Orleans, La.
West Coast Lumbermen's Association, 425 Henry Building, Seattle, Wash.
Weyerhaeuser Forest Products, Merchants' National Bank Building, St. Paul, Minn.

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