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DURABILITY OF STUCCO AND PLASTER CONSTRUCTION

(PROGRESS REPORT CONTAINING RESULTS OF INVESTIGATIONS UP TO APRIL, 1916)

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In cooperation with an advisory committee composed of practical plasterers, representatives from Government offices, engineering societies, and industrial associations

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ADVISORY COMMITTEE

The advisory committee of the stucco and plaster investigation was organized in the spring of 1914, consisting of representatives of the various interests concerned (metal lath, cement, lime, gypsum, and hollow tile); also of representatives from the Bureau of Standards, the Supervising Architect's Office, and the American Concrete Institute. Three contracting plasterers of wide practical experience, recommended by and acceptable to the various interests on the committee, were also invited to serve.

The personnel of the committee as now organized is as follows:

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J. C. Pearson, Bureau of Standards, Washington, D. C.

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H. J. Brown, Keystone Plaster Co., Chester, Pa., representing the Gypsum Industries Association. Alternate: D. L. Haigh.

H. S. Spackman, 2024 Arch Street, Philadelphia, Pa., representing the Alca-Lime Manufacturers. Alternate: E. L. Conwell.

L. R. Ferguson, 101 Park Avenue, New York, N. Y., representing the Portland Cement Association.

C. M. Chapman, 37 Wall Street, New York, N. Y., representing the American Concrete Institute.

A. G. Bagnall, 505 Hippodrome Prospect Building, Cleveland, Ohio, representing the Bagnall-Taylor Co., contracting plasterers. Alternate: J. C. Taylor.

William O. Humphreys, 1233 St. James Street, Philadelphia, Pa., representing John C. Humphreys & Son, contracting plasterers.

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S. G. Webb, 18 East Forty-first Street, New York, N. Y., representing the Gypsum Industries Association.

W. E. Carson, Riverton, Va., representing the National Lime Manufacturers Association.

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Julian Armstrong, commissioner, representing Associated Metal Lath Manufacturers, 332 South Michigan Avenue, Chicago, Ill.

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I. INTRODUCTION

The unquestioned popularity of the so-called "stucco"[1] house in recent years has given rise to a comparatively rapid development of a type of building construction, not entirely new by any means, but characterized by the use of new methods and new materials. The rapid adoption of this new construction has been due to many conditions, among which may be mentioned the desire for a cheap but fire-resistive type of structure, the increase in price and decrease in quality of lumber, the development in the use of Portland cement, and the production of metal lath, hollow building tile, and other materials; but perhaps most of all to the fact that the stucco house appeals to the prospective home builder, because of its generally attractive appearance and anticipated low maintenance.

There have been, however, many total or partial failures of stucco and many letters have been received by the Bureau for information regarding the best methods of application, and the probable

[1] The word "stucco" as used in this report may be defined as a material used in a plastic state to form a hard coating for the exterior walls or other exterior surfaces of any building or structure. "Stucco" as here used is a mixture of one or more cementitious materials, with sand or other fillers and with or without other materials, such as hair, coloring matter, etc. The word "stucco" is used without regard to the composition of the material, defining only its use and location of its use, as contrasted with the words "plaster" and "mortar."

permanency and durability of good stucco construction. In 1910 the Associated Metal Lath Manufacturers, because of cases of corrosion in metal-lath construction, particularly in cases where the metal was not protected by painting or galvanizing and the stucco was of doubtful quality, and believing that the majority of failures were due to careless construction, requested the cooperation of the Bureau in determining experimentally what protective measures would insure reasonable durability of the metal lath under stucco and plaster.

In compliance with this request the Bureau planned a preliminary series of exposure tests which eventually took form in the erection of some 300 panels of metal lath, 18 by 24 inches, plastered with various combinations of the commonly used plastering materials, viz, cement, lime, and gypsum. Approximately one-half of the total number of panels formed a part of the exterior walls of a storage building on the Bureau grounds, and the remainder were erected on interior partitions. A fair idea of the exposure of these panels may be obtained from Figs. 1 and 2. These panels were erected in the fall of 1911. Two years later a careful inspection was made and a summary of the results, together with a full description of the tests was presented at the meeting of the American Concrete Institute, February, 1914.[2]

It is to be borne in mind that these tests were primarily comparative corrosion tests of metal lath, and the results obtained indicated that, irrespective of the type of plastering material, the lath which was galvanized, whether cut from galvanized sheets or galvanized after expansion, was in the best condition, whereas the uncoated plain steel lath was in many cases badly corroded. The apparent order of excellence of the various classes of lath determined at that time and confirmed by subsequent observation was as follows: Galvanized after expansion, cut from galvanized sheets, painted ingot iron, painted steel, sherardized steel, plain ingot iron, and plain steel.

It was also the purpose of the tests to determine in so far as possible the protective qualities of different stuccos and plasters; but as indicated in the progress report of the tests, a number of the mixtures were criticized as being oversanded, and the comparative results in this respect were therefore open to question. These tests were severely criticized by some manufacturers and therefore it was decided to immediately outline a more comprehensive series of tests on a much larger scale. In order that the

[2] Jour. Am. Conc. Inst., Vol. 2, p. 445, November, 1914; also Concrete-Cement Age, Vol. 5, p. 38, July, 1914.

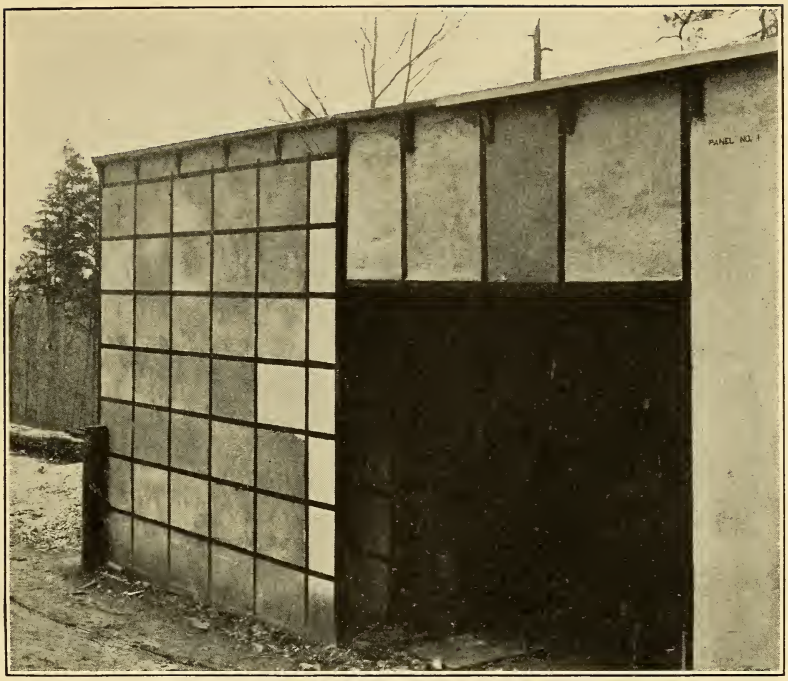

FIG. 1.—*North wall of test panels erected in 1911*

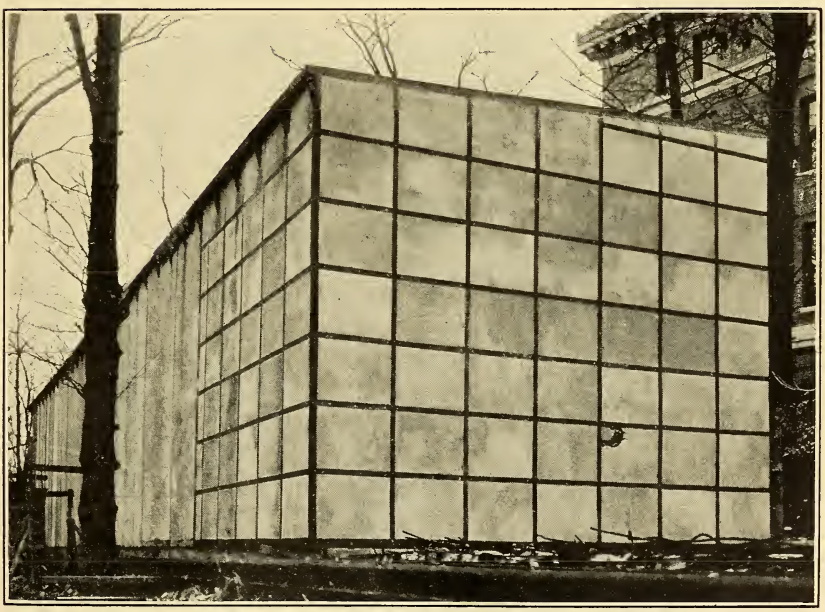

FIG. 2.—*South and east walls of the test panels erected in 1911*

further work should be carried out efficiently and should preclude as far as possible all subsequent criticism of materials, proportions of plaster ingredients, construction, and workmanship, it was decided to place the entire program in the hands of a committee invited by the Bureau to act in an advisory capacity and to inspect and be responsible for the satisfactory construction of the test panels.

Thus originated the plan of the present cooperative stucco and plaster investigation, of which the tests briefly described in the foregoing paragraphs constitute only a preliminary investigation. These preliminary tests are still in progress and will be concluded in the course of the next year or two when it becomes necessary to remove the building of which the panels form a part. The new series of tests embraces at the present time only that part of the investigation relating to exterior stuccos, a complete description of which is presented in this report.

II. SCOPE OF INVESTIGATION

The members of the advisory committee were unanimously of the opinion that the proposed investigation should not be limited to tests of stucco and plaster on metal lath but should include, in so far as possible, all the common types of both exterior and interior plastering. It was believed that plastering faults directly due to corrosion of embedded metal are a comparatively small portion of all the objectionable features, which are generally indicated by the development of cracks with consequent disfiguration and gradual disintegration of the plaster coating. A study of the origin and methods of prevention of cracks in various types of plaster is therefore one of the chief purposes of the investigation.

The committee decided unanimously that the test panels should be of large size, not only to enable the plastering to be done on a scale comparable with that of ordinary residence construction but also large enough to contain window and door openings, at which structural cracks, or cracks due to expansion and contraction of the stucco or plaster, are most likely to develop. The size of exterior panel eventually decided upon was approximately 15 feet long by 10 feet high. Since the very large number of possible combinations, or even desirable combinations, of different stuccos on different bases would, on this plan, require an enormous test structure, it was decided to select approximately 50 of the most typical combinations and embody these in construction on the walls of a building erected in such manner as to compare favorably in rigidity and solidity with good residence construction, and allow a variety

of base materials, such as wood and metal lath, hollow terra-cotta tile, gypsum block, gypsum plaster board, brick, concrete block, "Bishopric Board," etc. If cracks eventually developed which were evidently due to structural faults, such as insecure foundations or imperfect framing or bracing, an endeavor would be made to distinguish such cracks from others resulting solely from the failure of stucco materials. The test structure would also be available for the erection of interior plasters, although this branch of the investigation was not to be undertaken until after the exterior stucco investigation was well advanced.

In view of the limited number of large-size panels the plan of the investigation also calls for supplementary field work, this to be carried on as opportunity offers and to follow such lines as may be suggested by developments in the test panels.

The general scope of the investigation as thus outlined can be conveniently elaborated by reference to the following list of exterior panels which was gradually developed by correspondence and conference with the advisory committee during the year following its organization. In this program the proportions given for the various stucco mixtures are those recommended by the representatives of the various manufacturing organizations, who were also invited to furnish such materials for the tests as they desired, provided this was acceptable to the committee as a whole. While in some respects this arrangement is more open to criticism than that of purchasing the materials in the open market, the manufacturers thus had the privilege of submitting materials which they knew to be satisfactory and which would presumably represent the best that could be obtained. Under the supplementary tests of materials described later, detailed information is given as to the source of all materials used.

III. LIST OF EXTERIOR PANELS INCLUDED IN INVESTIGATION

In the following list of panels all proportions are by weight unless otherwise specified, three coats to be applied over wood and metal lath, two coats over all other bases; hair to be used only in Groups I, III, and IV unless otherwise specified. The several types of stucco are referred to by letters as follows:

Cement Lime

A–1. First coat. 1 part cement, 0.10 part high magnesian hydrated lime, 3 parts sand, 0.05 part hair, by weight. Second coat. Same as first coat, without hair. Third coat. Same as second coat, sand float finish.

A–2. First coat. 0.75 part cement, 0.25 part high magnesian hydrated lime, 3 parts sand, 0.05 part hair. Second coat. Same as first coat, without hair. Third coat. Same as second coat, sand float finish.

A–3: Same as 1 except high calcium hydrated lime to be used instead of magnesian hydrated lime.

A–4: First coat. 1 part cement, 0.10 part high magnesian hydrated lime, 4 parts sand, 0.05 part hair, by weight. Second coat. Same as first coat, without hair. Third coat. Same as second coat, sand float finish.

Lime Cement

B–1: First coat. 0.25 part cement, 0.75 part high calcium hydrated lime, 3 parts sand, 0.075 part hair, by weight. Second coat. 0.25 part cement, 0.75 part high calcium hydrated lime, 4 parts sand, by weight. Third coat. Same as second coat, sand float finish.

B–2: Same as 1 except high magnesian hydrated lime to be used in place of high calcium hydrated lime.

"Alca" Lime

C–1: First coat. 1 part Alca lime, 3.5 parts sand, 0.075 part hair, by weight. Second coat. 1 part Alca lime, 4 parts sand, by weight. Third coat. Same as second coat, sand float finish.

C–2: First coat. 0.75 part Alca lime, 0.25 part cement, 3.5 parts sand, 0.075 part hair, by weight. Second coat. 0.75 part Alca lime, 0.25 part cement, 4 parts sand, by weight. Third coat. Same as second coat, sand float finish.

Straight Cement

D–1: First coat. 1 part cement, 2.5 parts sand, by weight. Second coat. Same as first coat.

D–2: First coat. 1 part cement, 2 parts sand, 0.05 part hair, by weight. Second coat. 1 part cement, 3 parts sand, by weight. Third coat. Same as second coat, sand float finish.

D–3. First coat. 1 part cement, 3 parts sand, 0.05 part hair, by weight. Second coat. Same as first coat, without hair. Third coat. Same as second coat, sand float finish.

Half-and-Half Cement Lime

E: First coat. 0.5 part cement, 0.5 part high magnesian hydrated lime, 3 parts sand, 0.05 part hair, by weight. Second coat. 0.5 part cement, 0.5 part high magnesian hydrated lime, 4 parts sand, by weight. Third coat. Same as second coat, sand float finish.

STUCCO WITH INTEGRAL WATERPROOFING

F–1: Calcium soap type ("Medusa"). First coat. 1 part cement, 3 parts sand, 0.05 part hair, 0.02 part Medusa, by weight. Second coat. Same as first coat, without hair. Third coat. Same as second coat, sand float finish.

F–2: Asphaltic emulsion type ("Impervite"). Same mixture as (1) except Impervite to be used in place of Medusa, using 1 gallon (9 pounds) per bag of cement.

WHITE PORTLAND CEMENT

G–1: First coat. 1 part gray cement, 3 parts sand, 0.3 part high magnesian hydrated lime, by weight. Second coat. 1 part white cement, 2 parts white silica sand, 0.1 part high magnesian hydrated lime, by weight, sand float finish.

G–2: First coat. 1 part gray cement, 3 parts sand, 0.1 part high magnesian hydrated lime, 0.05 part hair, by weight. Second coat. Same as first coat, without hair. Third coat. 1 part white cement, 3 parts limestone screenings, 0.1 part high magnesian hydrated lime, by weight, float finish.

PANELS

Group I

Plastered one side over sheathing and sheathing paper, ½-inch crimped galvanized furring, 12 inches o. c. More or less air space between plaster and sheathing.

Panel 1, expanded metal lath, diamond type, 26 g galvanized, one-half before and one-half after expansion, stucco A–1; panel 2, expanded metal lath, diamond type, 24 g painted, stucco A–1; panel 3, expanded metal lath, diamond type, 24 g painted, stucco B–2; panel 4, expanded metal lath, diamond type, 24 g painted, stucco C–1; panel 5, expanded metal lath, diamond type, 24 g painted, stucco D–2; panel 6, expanded metal lath, diamond type, 24 g painted, stucco D–3; panel 7, expanded metal lath, diamond type, 24 g painted, stucco F–1; panel 8, expanded metal lath, diamond type, 24 g painted, stucco F–2; panel 55, expanded metal lath, diamond type, 24 g painted, stucco C–2; panel 9, wire lath, 20 g galvanized after woven, stucco A–2.

Group II

Plastered one side over sheathing and sheathing paper, ½-inch crimped galvanized furring, 12 inches o. c. No hair used in any coat, plaster pushed through to thoroughly embed lath.

Panel 10, expanded metal lath, 24 g diamond type painted, stucco A–1; panel 11, expanded metal lath, 24 g diamond type painted, stucco B–2; panel 54, expanded metal lath, 24 g diamond type painted, stucco A–1, to be coated with cement gun; panel 12, wire lath, 20 g galvanized after woven, stucco A–1; panel 13, expanded metal lath, 26 g galvanized, one-half before and one-half after expansion, stucco C–1 (use limestone screenings in finish coat).

Group III

One-half inch crimped galvanized furring attached to studs 12 inches o. c. No sheathing, lath back plastered. Outer faces of studs coated with "hydronon."

Panel 14, expanded metal lath, ribbed type, 27 g painted, stucco G–2; panel 15, expanded metal lath, ribbed type, 27 g painted, stucco A–1; panel 16, expanded metal lath, ribbed type, 27 g painted, stucco B–1; panel 17, wire lath, 20 g galvanized after woven, stucco E.

Group IV

Wood lath over sheathing and sheathing paper, ⅜ by 1¼ inch wood furring, 12 inches o. c. Plain lathing.

Panel 18, spruce lath, uncoated, stucco A–3; panel 19, spruce lath, uncoated, stucco B–2; panel 20, spruce lath, coated with "hydronon," stucco B–2.

Group V

Wood lath over sheathing and sheathing paper, no furring, counter lathing.

Panel 21, spruce lath, uncoated, stucco A–3; panel 22, spruce lath, uncoated, stucco B–1; panel 23, spruce lath, uncoated, stucco C–1; panel 24, spruce lath, coated with "hydronon," stucco A–3; panel 25, spruce lath, coated with "hydronon," stucco B–1.

Group VI

Plaster board, ⅜ inch thick, nailed to studs 12 inches o. c. Four-inch spacing of nails, ¼ inch between boards.

Panel 26, perforated, one-half felt, one-half chip surface, stucco A–1; panel 27, perforated, "parlocked," stucco A–1; panel 28, unperforated, one-half felt, one-half chip surface, stucco A–1; panel 29, unperforated, "parlocked," stucco A–1.

Group VII

Tile (terra-cotta tile to be hard burned, with dovetail ragged scoring).

Panel 30, concrete block, lower half rough block, upper half smooth block; left half to be wetted and right half to be wetted and grouted before plastering with stucco A–1; panel 31, terra-cotta tile, stucco A–1; one-half to be plastered with haired mortar, one-half without hair; panel 32, terra-cotta tile, stucco B–1; panel 33, terra-cotta tile, stucco C–1; panel 34, terra-cotta tile, stucco D–1; panel 35, terra-cotta tile, one-half glazed tile, all covered with ¾-inch wire mesh, stucco A–1; panel 36, terra-cotta tile, one-half painted with bituminous material, stucco A–2; panel 37, terra-cotta tile, one-half painted with bituminous material, stucco G–1; panel 38, glazed tile, one-half painted with bituminous material, stucco A–1 (panels 36, 37, and 38 to be one-fourth "parlocked" and one-fourth coated with "antihydrine"); panel 53, terra-cotta tile, stucco A–1; to be coated with cement gun.

Group VIII

Brick, common rough, hard-burned brick to be used.

Panel 39, brick, stucco A–1, one-half plastered with haired mortar, one-half without hair; panel 40, brick, stucco B–2; panel 41, brick, painted, plaster keyed with two bituminous materials, stucco A–1.

Group IX

Gypsum block.

Panel 42, smooth block "parlocked," stucco A–1; panel 43, corrugated block, "parlocked," stucco A–1; panel 44 corrugated block, uncoated, stucco A–1.

Group X

Monolithic concrete.

Panel 45, smooth, "parlocked," stucco A–1; panel 46, panel to be divided into four vertical sections, *a*, *b*, *c*, *d*—(*a*) to have surface untreated in any way, (*b*) to have surface grouted but not mechanically roughened, (*c*) to have surface wire brushed only, (*d*) to have surface wire brushed and grouted (all to be plastered when concrete is green with stucco A–1); panel 47, panel to be divided into three vertical sections, *a*, *b*, *c*—(*a*) to be roughened with pick or other suitable tool, (*b*) to be scrubbed with 1:4 muriatic acid solution, (*c*) to be scrubbed with equivalent acetic acid solution (all allowed to dry before any treatment, stucco A–1); panel 48, cement gun on concrete, stucco A–1; panel 49, half as forms are removed without treatment, half with wire brush, stucco C–1; panel 50, concrete, upper half as forms are removed, lower half wire brushed, left half thin coated with 1:1 grout, right half thin coated with 1:2 grout, stucco A–1.

Group XI

Miscellaneous.

Panel 51, "Bishopric board," one-half creosoted lath, one-half uncreosoted lath, stucco A–1; panel 52, same as 51, but plastered with stucco B–1; panel 53, see Group VII; panel 54, see Group II; panel 55, see group I; panel 56, "Clinton Welded Sheathing" applied directly to studs, stucco A–4.

The preceding outline will indicate that the committee has endeavored to arrange the panels in groups according to the bases on which the stuccos are applied. The number of panels in the different groups is proportioned, roughly, by the probable extent to which similar construction is used throughout the country, although this number is augmented or decreased according to the importance of certain groups or for the purpose of introducing special tests where found desirable. Thus, since metal lath is used most extensively, the first three groups comprise three different types of construction on metal lath as a base and each having certain advantages. It should be stated, in order to avoid a misconception of the purpose of the tests, that while comparisons between various groups and individual panels are always possible, it has been the sense of the committee that each panel should stand primarily on its own merits as representative of a certain type and method of construction, and its eventual condition and rating should be established without reference to any other panel. Thus the metal-lath panels are for the most part made up of painted steel because this class of material is recommended by the lath manufacturers (the uncoated steel is not recommended). The painted steel is very widely used, and is much less expensive than galvanized lath. On the other hand, a few panels of galvanized lath have been introduced as typical of the best in metal-lath construction.

Group I typifies a form of construction of exterior stucco in which more or less air space is designedly introduced between the plaster and sheathing, and affords a direct comparison of several different stuccos. In Group II the air space is eliminated for the purpose of better embedding the metal in mortar, the insulating value of the air space being sacrified for the added protection to the lath. Group III affords a still heavier coating of mortar over the lath, this method eliminating the cost of sheathing and insuring good protection for the metal fabric, but sacrificing to some extent the rigidity and insulation contributed by the sheathing. In good construction of this type, special measures are necessary for taking care of these two features.

Wood lath is probably used to a much greater extent for exterior stucco than the number of panels in Group IV would indicate. The committee was divided in its opinion as to the suitability of wood lath for this purpose, however, and as the counter lathing seemed to be more favored than the plain lathing, a larger number

of panels were assigned to Group V. To determine if possible whether a bituminous coating on the wood lath would affect the durability of the stucco, one panel of Group IV and two of Group V were coated with "hydronon" (a bituminous paint). The distribution of the two types of stucco containing a large proportion of Portland cement in one and of hydrated lime in the other (A–3 and B–1, respectively) on the wood-lath panels is such as to afford a direct comparison between the coated and the uncoated wood lath.

Groups VI and IX may be regarded as experimental groups introduced at the special request of the Gypsum Industries Association, rather than as examples of common construction. These materials are used to some extent, but not widely, for exteriors, and the seven panels of these two groups embody the experimental variations recommended by the association.

Group VII contains a larger number of panels than was originally assigned to hollow tile. This group was enlarged for experimental purposes in view of the fact that the use of this material for stucco houses is rapidly increasing and because a number of cases have been reported in which this type of construction has not been satisfactory. Of the 10 panels in this group 1 is of concrete block, 5 offer a direct comparison of different stuccos, and 4 show variations in material or treatment with a view to improving adhesion or eliminating cracks.

Only three brick panels were included in Group VIII, in accordance with the opinion of the committee that brick is one of the most satisfactory bases for stucco and that information regarding this type of construction can readily be obtained in the field. Two of the brick panels represent the ordinary specified construction for stucco, one having a high cement and the other a high lime content; the third was designed to represent an old painted wall on which the plaster bond was to be supplied by two types of bituminous material. The brick base of this panel did not dry out sufficiently to warrant painting before cold weather and is consequently unfinished at the present time.

Group X includes a number of experimental variations in the treatment of monolithic concrete for the purpose of observing what methods are likely to give satisfactory adhesion of a plaster coat to the concrete. It may be remarked that this group is important rather in its relation to the decorative treatment of retaining walls, bridges, large residences, storehouses, warehouses, and other

monolithic structures than in connection with ordinary residence construction. Three of the panels of Group X are representative of walls that have hardened and dried out before plastering, and three of freshly molded walls.

Group XI includes three panels of special proprietary materials, substitutes for wood or metal lath, included upon recommendation of the advisory committee.

As indicated by the list of panels, the experimental part of the investigation is confined mainly for the present to a study of typical stuccos on the bases commonly used, namely, wood and metal lath, brick, tile, and concrete. There has been no intention of going into the possible or desirable variations in surface treatment of stuccos nor into the use of waterproofing to any extent. The sand-float finish has been uniformly used throughout because it is commonly used in practice and because it is well adapted to the detection of small defects. Comparatively few proprietary materials have been used, and only two stuccos include any special waterproofing treatment. It has been the opinion of the committee that the investigation of waterproofing and decorative surface treatments can not be satisfactorily undertaken as a part of the one already outlined, and that if these features are to be considered later they should be taken up as separate investigations and should be based on as complete a knowledge as possible of the causes and prevention of failures in the untreated stuccos. Accordingly the experimental work already undertaken largely avoids integral and special surface treatments, although such information as is available will be obtained as opportunity offers in the field work of the present investigation.

IV. CONSTRUCTION OF THE TEST STRUCTURE

A fairly good idea of the test structure may be obtained from the photographs, Figs. 3 and 4. The structure is approximately 200 feet long, 26 feet wide, and 25 feet high (above grade), of two stories, covered with a low hip roof, and ornamented with cornice and pilasters. Level ground not being available, the structure is located on a hillside, which in the process of other construction work had been covered with 10 to 15 feet of soft clay fill. Some excavation was necessary at the north end of the structure, but the south end overhangs the slope of the hill and is supported on a steel-frame foundation resting on concrete footings. A portion of the steelwork is shown in Fig. 3. As the peculiar ground conditions and the nature of the foundation may naturally suggest the

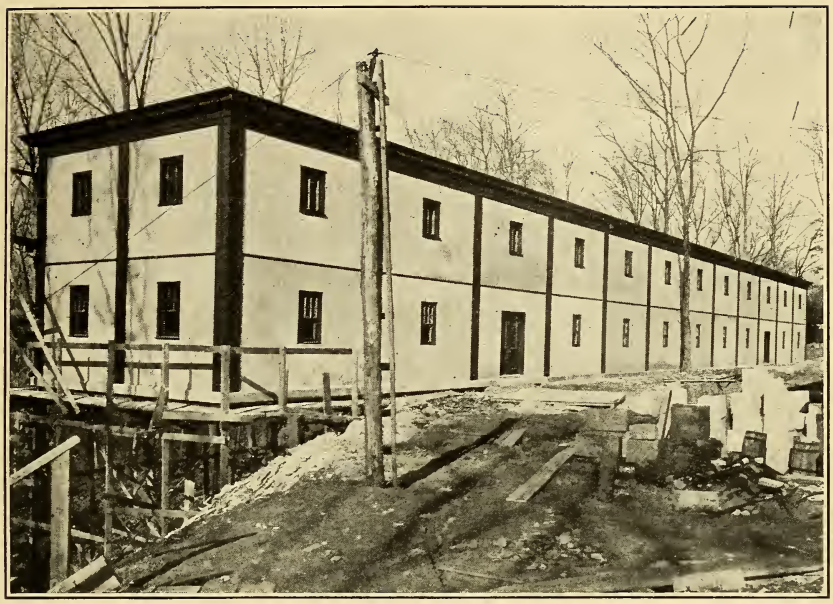

FIG. 3.—*The new test structure from the southeast*

FIG. 4.—*General view of the new test structure from the northwest*

possibility of settlement or lateral movement in the structure, the foundation layout may be described somewhat more in detail.

With reference to Fig. 5 it will be observed that the foundation plan is in the form of a grid of 12 sections, each 16 feet 6 inches by 24 feet 8 inches, these measurements being taken to the center of

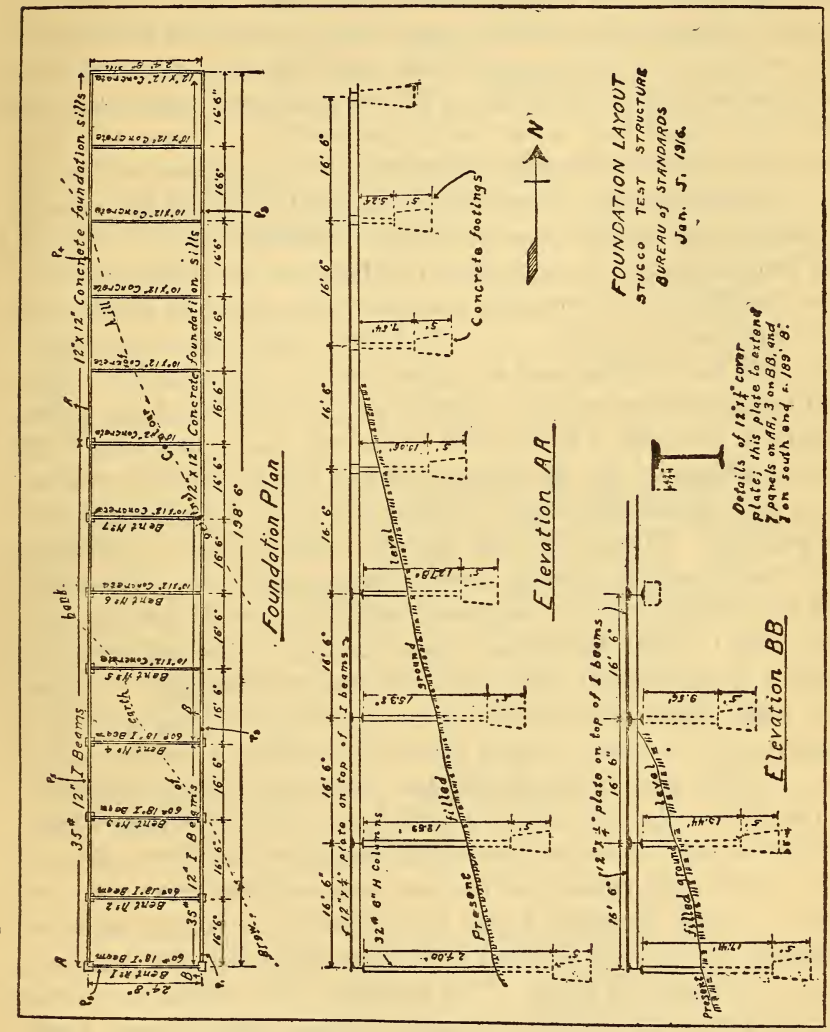

FIG. 5.—*Foundation plan of test structure*

the frame of the superstructure. These sections correspond to the 12 rooms into which the first story of the structure is divided, as explained below. Of the 12 sections of sill on the west side, 7 are 35-pound, 12-inch I beams and 5 are 12 by 12 inch concrete sills. On the east side, the south 3 sections are of steel and the remaining 9 of concrete. Of the 13 cross sills, the south 4 are

60-pound 18-inch I beams and the remainder are of 10 by 12 inch concrete. As shown by the space between the dotted lines, a large portion of the center of the structure rests on earth fill, which is very dense and well packed under the east sill, but is softer under the west sill. On the west side, therefore, all footings at the intersections are set approximately 3 feet below the original ground surface and the same is true of the three south footings on the east side. (See elevations AA and BB, Fig. 5.) Furthermore, all concrete sills lying on fill are reinforced with four one-half inch round rods as an added precaution. Where the concrete cross sills join the steel sills on the west side, these reinforcing rods extend through corresponding holes in the web of the 12-inch I beams, and having been previously threaded serve as ties at the intersections. Longitudinal ties between the steel and concrete portions of the foundation are provided partly by reinforcing rods, but mainly by the 2 by 10 inch floor joists which run lengthwise with the building and are spiked to the transverse sills. The footings under the 10 steel columns are pyramidal in form, 3 feet square at the base, 2 feet square at the top, and 5 feet high. All other footings at the sill intersections in the earth-filled sections are 3 feet square and vary in height from 2 to 6 feet, depending on position. Where sills are laid on solid ground, no footings were placed at intersections nor reinforcing rods used. The south end of the foundation is stiffened with four sets of bracing consisting of 1⅛-inch turnbuckle rods attached to the columns just below the girders and just above the concrete footings. Twelve-inch steel plates are riveted to the top flanges of the 12-inch I beams and the south 18-inch girder to conform in width to the concrete sills and to provide for the water table described below.

The plan of the test structure calls for 22 masonry panels which, with the exception of the two panels containing the doors, are the total number of panels in the east and west walls on the first story. It was therefore found most feasible to erect a skeleton frame of 6 by 6 inch Georgia pine posts and fill in the masonry panels between the posts. The masonry thus serves as a base for the second story, which is entirely of frame construction. Three by 6 inch wood sills were first bolted to the 13 transverse foundation sills, on which rise 2 by 6 inch partition studs to the height of the first story. The 6 by 6 inch posts were set at the ends of each transverse sill and rise to the full height of the building. Fig. 6 is a section of the structure showing the construction at an interior partition and the method of transverse bracing. It may

also be noted with reference to Fig. 6 that the floors, interior partitions, and floor loads are carried mainly by the transverse sills, the exterior walls and roof by the longitudinal and two end sills.

The frames of the interior partitions were first erected and braced longitudinally with temporary braces while the masonry panels were being constructed. These panel walls are nominally 8 inches thick (the brick and gypsum block being slightly more than this) and rest directly on the longitudinal sills without special anchorage, but spikes are set in all joints where the masonry

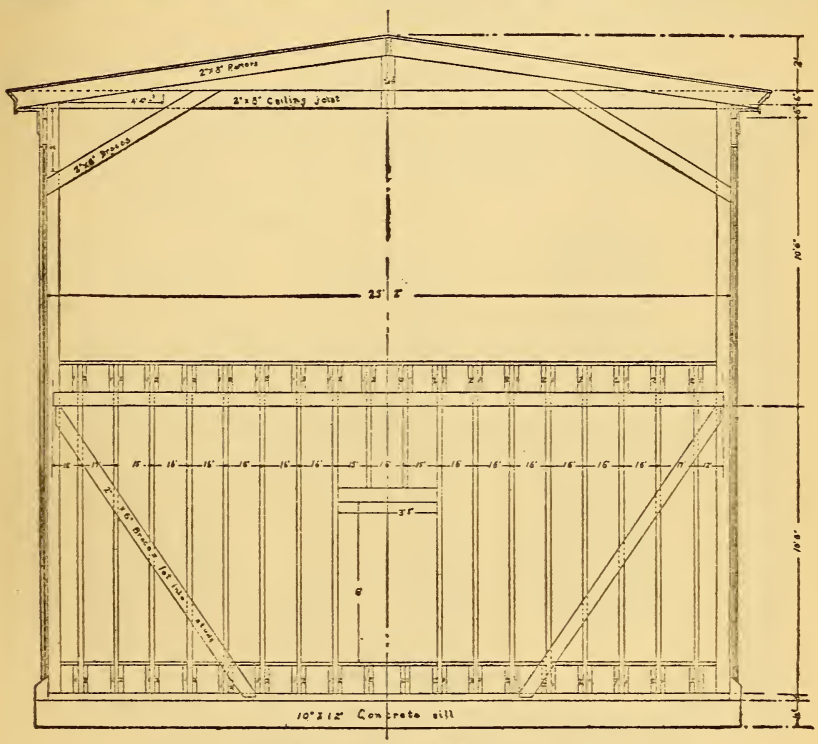

FIG. 6.—*Section of test structure at an interior partition*

joins the skeleton frame. When the masonry panels were brought to their full height, 3 by 6 inch wood sills were then fastened along the top by means of anchor bolts, and also spiked to the 6 by 6 inch posts. On these sills rise the 2 by 6 inch wall studs of the second story.

The framing of the north and south ends and of the door panels is similar to that of the second story, except in this case the studs run the full height of the building. The north end elevation is shown in Fig. 7, the western half of which shows the method of framing and bracing. Both north and south ends are unsheathed.

The former carries the four panels of back-plastered metal lath of Group III, the latter the four panels of plaster board (Group IV) which is nailed directly to the studs. It should be noted here that the bridging shown between the studs on the end sections was omitted, the oversight not being discovered until the plastering was nearly completed. As it seemed unwise to attempt to cut in this bridging after the plastering was completed, 8-inch sheathing was spiked across the interior faces of the studs where the bridging should have been, to prevent as far as possible any twisting of the studs between floors.

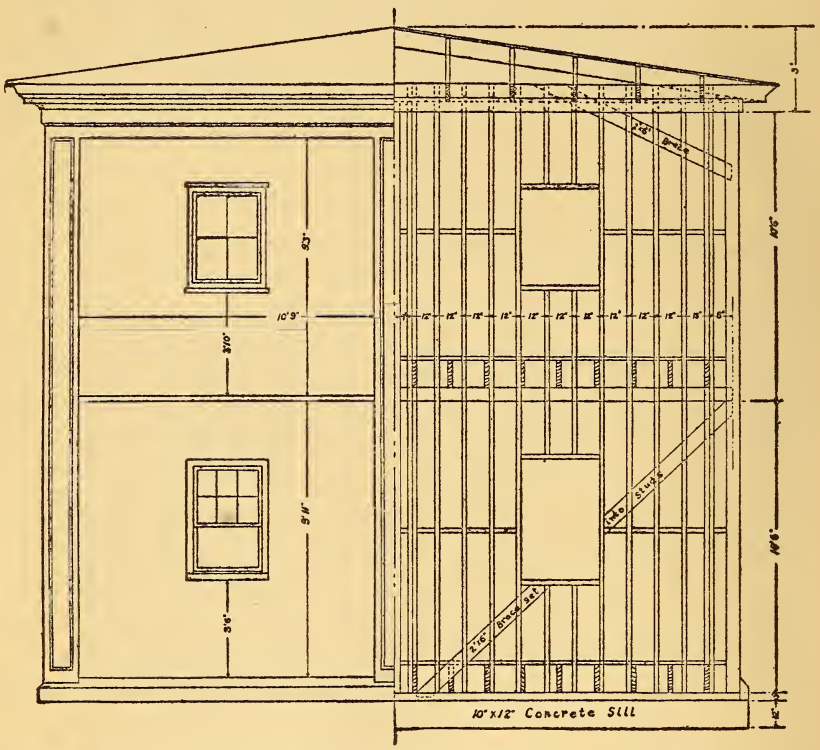

FIG. 7.—*North elevation of test structure showing framing of ends*

Fig. 8 shows the construction of two typical wall sections. In further explanation it should be stated that longitudinal bracing is supplied by the diagonal sheathing securely nailed at each stud and 6 by 6 inch post, and covering the entire east and west walls of the second story, with the exception of the south-end panel on the west side.

The roof construction is evident from Figs. 6, 7, and 8. It is supported on a 2 by 6 inch collar beam spiked to the outside of each

wall stud and 6 by 6 inch post. The roof trusses are made up of the rafters and ceiling joists as shown in Fig. 6, solidly spiked together where these overlap, and braced at the center. The ceiling joists are notched over the supporting collar beams and are cut to serve as a partial support for the cornice. The roof is of ⅞-inch plain

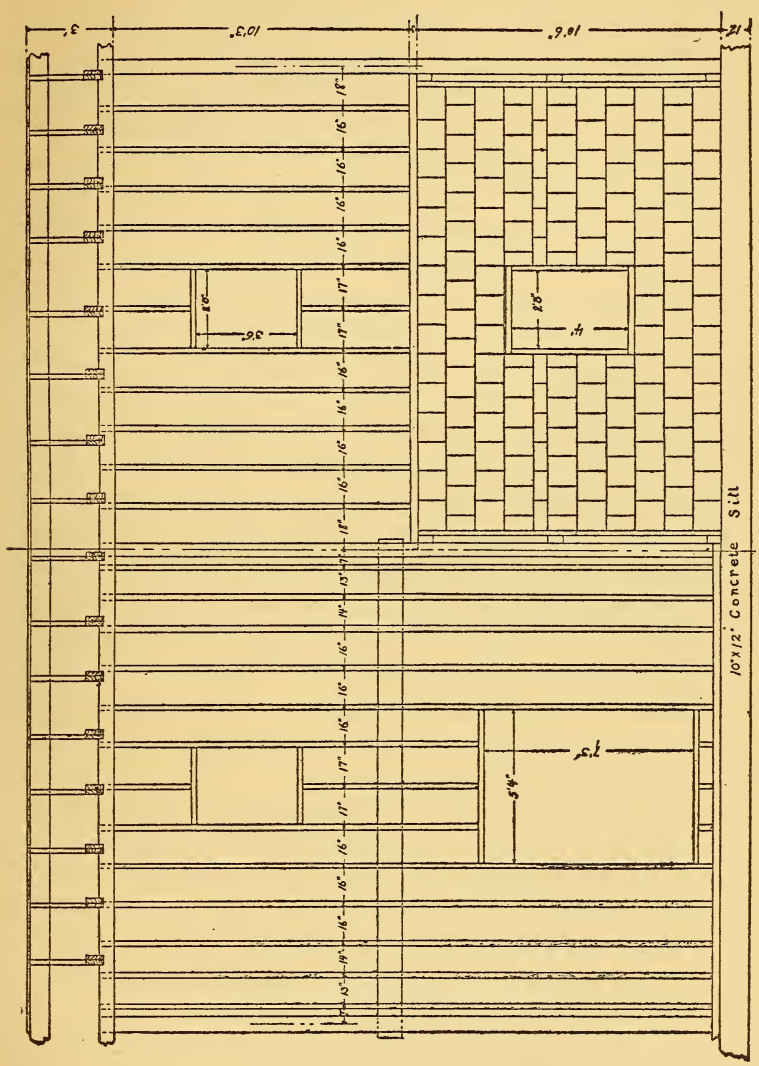

FIG. 8.—*Two typical wall sections of test structure, showing the north door panel (No. 52), the adjacent tile panel (No. 33), and the two second-story frame panels (Nos. 9 and 10)*

dressed sheathing, covered with heavy-weight "ruberoid" sheet roofing fastened with "holtite" fasteners, according to the recommendation of the manufacturers. The roof projects slightly over the cornice, an efficient drip being provided by galvanized-iron flashing extending ⅜ inch below the undersurface of the sheathing. In

this manner the cornice and upper edges of the second-story panels are well protected. No gutters are provided, in order that the drip from the roof may be allowed to strike the face of the panels whenever weather conditions permit.

To protect the bases of the first-story panels from ground moisture a continuous water table of brick and cement mortar was first laid on the foundation sills and rises to a height of 9 inches on the faces of the masonry panels. The vertical surface of the table, which is flush with the outer surface of the foundation sill, rises to a height of 6 inches above grade and is then beveled inward.

The bases of the pilasters were cut to the slope of the water table and erected after the completion of the water table and cornice, but prior to lathing and plastering. The pilaster posts are rabbeted to project over the edge of the stucco. A 2-inch wood strip divides the first and second story panels as shown in Fig. 7. The outer face of the strip is flush with the face of the stucco and the lower edge of the strip is provided with a galvanized lip to prevent water getting behind the stucco of the lower panels.

As shown in Fig. 8, the windows are small and of ordinary types. The second-story windows are outswing casements hinged at the top, provided with projecting caps and sills. The cap flashing is similar to that used at the eaves, and the sills are provided with drip grooves and also flashing similar to that used on the belt course. The side trim of these windows is flush with the face of the stucco. The first-story windows are of the double-sash type, recessed on the masonry panels, but provided with flashed caps and sills on the north and south ends of the building where the wall construction is similar to that of the second story.

The foregoing description of the construction of the test structure is intended only to cover those details which may have some bearing on the durability of the panels. While it is believed that the foundations are firm and the bracing sufficient to prevent swaying, six reference marks have been established for the purpose of detecting settlement and lateral movement of the base. The marks consist of steel pins set at different points in the water table where movement would be most likely to occur and are indicated on the foundation plan at the points P_1, P_2, etc., Fig. 5. Levels will be taken on these pins from time to time and compared with the original measurements taken soon after the building was completed. At the present time no structural cracks have been observed in the masonry panels, which indicates that the foundation has not moved to an appreciable extent.

V. DETAILED DESCRIPTION OF PANELS

The following descriptive list of the test panels is intended to include in condensed form all the essential information regarding the location and construction of the individual panels, together with notes on the erection, condition of the plaster coats, and other pertinent items up to April, 1916. To avoid unnecessary repetition, however, certain general conditions may first be outlined, which apply to all the panels or to the separate groups of panels.

As previously stated, the number of masonry panels is 22, divided as follows: Nine hollow terra-cotta tile, 6 monolithic concrete, 3 brick, 3 gypsum block, and 1 hollow concrete block. In order to distribute the weight of these panels to best advantage over the different sections of the foundation, the gypsum block panels are placed in the section of the building supported on structural steel—that is, at the south end of the west wall; the brick panels at the north end of the west wall; the monolithic concrete panels in the middle sections of the east wall; and the tile panels in the six middle sections of the west wall, the two south sections of the east wall, and the two north sections of the east wall. The plaster board panels occupy the entire south end of the structure and the back plastered metal lath panels the north end. The metal lath panels of Group I occupy the entire second story on the east wall, except the two north panels, which are of metal lath and belong to Group II. On the second-story west wall the three north panels complete Group II, the next three are of plain wood lath, the next five are of wood lath, counterlathed, and the remaining panel at the south end of the second-story wall is of "Clinton welded sheathing." Finally, the two door panels, which are the third from the south end and the third from the north end on the east side, are of "Bishopric board." This arrangement not only provides solid foundations for the heavier wall sections, but also affords a fairly symmetrical distribution of the various groups.

From the surface of the sheathing to the surface of the finished coat of plaster on the lath panels is nominally 1⅜ inches. On the masonry panels the plaster is ¾ inch thick. In the case of the metal lath panels, the ½-inch furring provides for a coating over the face of the lath approximately ¾ inch thick. In the plain wood lath panels, the furring consists of lath laid vertically over the sheathing paper 12 inches on centers upon which the lath carrying the plaster are nailed horizontally with spacing from ⅜ to ½ inch and with joints broken every twelfth lath. In the

counterlathed panels, the first layer of lath is laid diagonally across the sheathing and directly against the sheathing paper with approximately 1-inch spacing in such manner that a 4-foot lath spans 3 feet horizontally. The outer layer is laid in the same manner but sloped in the opposite direction. As the wood lath is 3/8 inch thick, the nominal thickness of the plaster coating over the outer face of the lath is 5/8 inch. On the plaster board and "Bishopric board" panels the thickness of the plaster coat is from 3/4 to 7/8 inch. The back plastering of the metal lath panels on the north end of the building varies from 1/2 to 3/4 inch thick, although in one case (panel No. 17) this coating was found to be 1 inch thick in places.

In order to observe the manner in which the plaster keys behind the wood and metal lath laid over sheathing, certain cut-outs in the latter between studs were provided which could be removed after the plastering was completed. In order that the lathers should nail into these sections no more than necessary, the positions of the cut-outs were indicated by chalk lines on the sheathing paper, as shown in Fig. 11.

As already outlined, the specifications provide for two-coat work on the plaster board and masonry panels. When the plastering was started it was found that the plasterers were accustomed first to apply a thin scratch coat on such bases, immediately following this with a "laid-on" or "double-up" coat, the latter being later rodded and darbied to a fairly true surface, and finally heavily scratched to receive the finish coat. Thus the chief distinction between two-coat work and three-coat work is that, in the former case, the completion of the plastering requires two days and in the latter three days. Also in the so-called two-coat work performed in this manner, the first coat, consisting of the thin scratch coat and the "double-up" coat, is probably somewhat heavier than the first coat in strictly two-coat work, and similarly, the finish coat is somewhat lighter. However, the method was satisfactory to the inspectors representing the cement and lime interests, and to the local members of the advisory committee, and was adhered to in so far as possible. In a number of cases, especially toward the completion of the plastering with cooler and wet weather, the thin scratch coat did not stiffen rapidly enough, which made it advisable to change from the two-coat work specified to three-coat work. Three coats were also applied over the plaster board and masonry panels coated with bituminous materials, on account

of the lack of absorption of the base and the tendency of the heavy double coat to slide.

The method of finishing the cement panels at the beginning of the work was, first, to lay on the finish coat, and bring to a fairly true surface with darby and float, usually in the forenoon; the coat was then left to stiffen, sometimes for several hours, depending upon circumstances, and finally given a wet float as the final treatment. While this is undoubtedly the practice in most cement finishing and apparently necessary in cornice construction and certain other classes of work, it is nevertheless contrary to the well-recommended practice of avoiding a break of the initial set in the cement, which is probably one of the contributing causes of the unsightly crazing of cement surfaces, especially those exposed to the weather. Accordingly, after conference with representatives of the cement manufacturers' association, it was decided that all panels containing high cement stuccos should be floated to a final finish as soon as possible after laying on the finish coat, even at the sacrifice of evenness and neatness in the finished panel. This change was made on November 5 with some objection from the plasterers, and in some cases at an unnecessary sacrifice in the excellence of the finish. In order to finish in this manner, it was necessary to control the consistency of the plaster more closely. This change, however, affords an opportunity for subsequent comparison of the condition of those cement panels finished in the usual manner and those finished in such manner as to avoid working the cement after the initial set had taken place.

In the erection and plastering of the panels, it was the constant aim of those in charge to carry out every detail of the work to the complete satisfaction of all directly interested in the investigation. To this end, the members of the advisory committee and a number of individual manufacturers were urged to be present and inspect the application of those materials in which they were particularly interested. In general, such inspection was usually provided, the Portland Cement Association and the National Lime Manufacturers' Association having inspectors present during the entire period when the stucco was being applied.

The plastering was done by experienced local plasterers who were recommended by Mr. Earley, of the advisory committee, and furnished by him without compensation other than reimbursement for the plasterers' wages. The mixing was done by hand in small batches usually weighing between 500 and 1000 pounds.

The proportions of the various mixes were under constant inspection and in no case is it probable that there was any considerable departure from the original specifications except in one or two instances noted in the description of the individual panels. The proportions were in all cases determined by weight with the understanding that a bag of cement should be considered 100 pounds n proportioning and that the sand should be weighed as used without regard to its moisture content. The moisture content of the sand was determined from time to time under varying conditions and was found to vary between 5 and 10 per cent with an average value of about 7 per cent.

The hair used in the scratch coats on the lath panels, when not furnished ready mixed with the plastering materials, was the ordinary type of cattle hair obtained in the local market and commonly furnished for this purpose. The hair was first weighed out in small lots as specified in the original program; then the amount required for any particular batch was placed in a sack and the lime was removed by beating with sticks. The hair was thus cleaned and separated, and finally added by hand to the other ingredients in the mixing box. At best, this method is decidedly inferior to machine mixing, but better than the commonly used method of first soaking the hair and then adding it to the mix in small clots.

Some difficulty was experienced in coating the wood lath for panels 20, 24, and 25 with "hydronon." This material is a coal-tar product of the consistency of heavy paint. An attempt was first made to coat the lath with an ordinary paint brush, but the rough surface of the lath made it practically impossible to get a continuous coating. Dipping the lath in the heated compound worked better, but this method required so much material that it was prohibitive. The method finally adopted was to apply the material with a scrub brush; in this manner a fairly satisfactory coating was obtained, but the method can hardly be considered a practicable one.

The "parlock" coating was applied by machinery. The bond material is an asphaltic compound sprayed upon the surface to be coated by means of air at 30 to 40 pounds pressure. This coat is immediately followed by a spray of coarse sand, also applied by an air blast, which adheres to the bituminous material and forms a mechanical bond for the plaster.

The plastering was started October 19 and completed November 24, 1915, with the exception of panels 41 and 56. During the first two weeks of this period, warm and very favorable weather pre-

vailed and the completed plaster coats of the cement stuccos were sprinkled twice daily. After November 3 the weather was noticeably cooler, the drying of the panels was slow, and in view of the possibility of freezing, the sprinkling was discontinued. All plaster coats were wet down with a brush immediately before the next coat was applied, except in a few cases as reported where the plaster was wet. Heavy tarpaulins were frequently used, especially when the work was nearing completion, to protect the freshly plastered coats from rain and frost.

The notes on each panel are so arranged as to give the complete history of the panel with a minimum of reference to other parts of the report. In connection with these notes one may refer to the folded insert at the end, which shows the panel plan of the test structure and gives briefly the construction, base treatment, and stucco formula for each panel. This insert is so arranged that the description of any panel and the panel plan can be examined side by side without turning the pages. Under "weather" are summarized only special weather conditions which might be unfavorable; that is, rain, freezing temperatures, and high winds. Such conditions are noted from the date of application of the first coat until six days after the completion of the panel. Under "superficial inspection" and "detailed inspection" are given the results of the inspection made during the first week of April, 1916.[8] Explanation of the method of examination and system of rating is given in the summarized report on the condition of the test panels, page 58.

GROUP I.

Metal lath on ½-inch crimped galvanized furring, 12 inches apart, over sheathing and sheathing paper. Hair used in first coat. More or less air space between stucco and sheathing.

Panel No. 1

Location: East side, second story, south-end panel.

Construction: 26-gauge galvanized diamond-mesh metal lath, upper half cut from galvanized sheets (sec. a), lower half galvanized after expansion (sec. b), same as panel No. 13. (See Fig. 11.)

Stucco: A–1 (parts by weight, 1 cement, 0.1 high magnesian hydrated lime, 3 sand), first coat applied afternoon of October 27, second coat afternoon of October 28, finish coat morning of October 29, finished afternoon.

Weather: Moderately gusty wind afternoon of October 30, warm high wind November 2, cold wind November 3, moderate rain and wind November 4, no freezing.

Superficial inspection: Color, light gray, not wholly uniform; structural cracks plainly visible, no other cracking noticeable; surface rough, showing float marks; general appearance fair to good (good to very good except for cracks).

[8] See also remarks on the condition of the panels December 8, 1916, p. 72.

Detailed inspection: Structural and body cracks, no surface cracks; bond good; condition fair.

Remarks: Finished panel photographed November 18 with panel No. 31 (see Fig. 22), showing cracks radiating from window.

Panel No. 2

Location: East side, second story, second panel from south end.

Construction: 24-gauge painted diamond-mesh metal lath, similar to panel No. 13. (See Fig. 11.)

Stucco: A–1 (parts by weight, 1 cement, 0.1 high magnesian hydrated lime, 3 sand), first coat applied afternoon of October 27, second coat afternoon of October 28, finish coat morning of October 29, finished afternoon.

Weather: Moderately gusty wind afternoon of October 30, warm high wind November 2, cold wind November 3, moderate rain and wind November 4, no freezing.

Superficial inspection: Color, light gray, not wholly uniform; structural cracks plainly visible, no other cracking noticeable; surface rough, showing float marks; general appearance fair to good (good to very good except for cracks).

Detailed inspection: Structural and body cracks, no surface cracks; bond good; condition fair. (Very similar in appearance and condition to panel No. 1.)

Panel No. 3

Location: East side, second story, third panel from south end.

Construction: 24-gauge painted diamond-mesh metal lath, similar to panel No. 13. (See Fig. 11.)

Stucco: B–2 (parts by weight, 0.25 cement, 0.75 high magnesian hydrated lime, 3 sand; second and third coats, 4 parts sand), first coat applied morning of November 6, second coat afternoon of November 8, finish coat 10 a. m. November 15, floated at 1.30 p. m.

Weather: Freezing temperatures recorded November 16, 17, and 18; moderate rain afternoon of November 12, moderate rain throughout day November 14, rain in early morning, gusty northwest wind afternoon of November 15, cold northwest wind November 16, heavy southeast storm night of November 18, showers afternoon of November 19, gusty wind November 21.

Superficial inspection: Color, buff, decidedly nonuniform, blotchy; structural and other prominent cracks visible; float marks somewhat visible; general appearance poor.

Detailed inspection: Structural and body cracks, the latter more vertical than horizontal, some may follow furring; bond good; condition fair.

Panel No. 4

Location: East side, second story, fourth panel from south end.

Construction: 24-gauge painted diamond-mesh metal lath, similar to panel No. 13. (See Fig. 11.)

Stucco: C–1 (parts by weight, 1 "Alca" lime, 3.5 sand; second and third coats 4 part sand), first coat applied morning of October 30, second coat afternoon of November 1, finish coat afternoon of November 3; first coat slightly cracked when second coat was applied.

Weather: Moderately gusty wind afternoon of October 30, warm high wind November 2, cold wind November 3, moderate rain and wind November 4, no freezing.

Superficial inspection: Color, buff to light buff, not wholly uniform; cracks numerous and somewhat visible; float marks somewhat visible; general appearance fair to poor.

Detailed inspection: Structural and body cracks, the latter more vertical than horizontal, some may follow furring; bond good; condition fair. (Condition is very similar to panel No. 3.)

Remarks: Finished panel photographed November 18, after wetting and allowing partially to dry, shows extensive cracking. (See Fig. 9.)

Panel No. 5

Location: East side, second story, fifth panel from south end.

Construction: 24-gauge painted diamond-mesh metal lath, similar to panel No. 13. (See Fig. 11.)

Stucco: D–2 (parts by weight, 1 cement, 2 sand; second and third coats, 3 parts sand), first coat applied morning of November 2, second coat afternoon of November 3, finish coat laid on morning of November 5, dry floated, and finally brushed with a wet whitewash brush, rotary motion, at 3.30 p. m.

Weather: Warm high wind November 2, cold wind November 3, moderate rain and wind November 4, no freezing.

Superficial inspection: Color, medium gray, uniformly mottled; structural cracks and brush marks visible; general appearance good (very good except for cracks).

Detailed inspection: Structural and body cracks, no surface cracks; bond good; condition fair to good. (Condition is similar to panel No. 2, but body cracks are not so wide.)

Panel No. 55

Location: East side, second story, sixth panel from south end.

Construction: 24-gauge painted diamond-mesh metal lath, similar to panel No. 13. (See Fig. 11.)

Stucco: C–2 (parts by weight, 0.75 "Alca" lime, 0.25 cement, 3.5 sand; second and third coats, 4 parts sand), first coat applied afternoon of November 1, second coat morning of November 3, finish coat afternoon of November 4.

Weather: Warm high wind November 2, cold wind November 3, moderate rain and wind November 4, no freezing.

Superficial inspection: Color, light buff, not wholly uniform; structural cracks and float marks somewhat visible; general appearance fair (good except for cracks).

Detailed inspection: Structural and body cracks, the latter vertical at regular intervals over portion of lower part of panel, may follow furring; bond good; condition fair to good.

Panel No. 6

Location: East side, second story, sixth panel from north end.

Construction: 24-gauge painted diamond-mesh metal lath, similar to panel No. 13. (See Fig. 11.)

Stucco: D–3 (parts by weight, 1 cement, 3 sand), first coat applied afternoon of October 29, second coat morning of October 30, finish coat morning of November 1; first coat still wet when second was applied; no water used.

Weather: Moderately gusty wind afternoon of October 30, warm high winds November 2, cold wind November 3, moderate rain and wind November 4; no freezing.

Superficial inspection: Color, medium gray, not wholly uniform on account of spray from cement gun used on panel No. 48 below; structural cracks; float marks somewhat visible; general appearance fair.

Detailed inspection: Structural cracks and one small body crack; bond good; condition good.

Panel No. 7

Location: East side, second story, fifth panel from north end.

Construction: 24-gauge painted diamond-mesh metal lath, similar to panel No. 13. (See Fig. 11.)

Stucco: F–1 (parts by weight, 1 cement, 0.02 "Medusa" waterproofing compound, 3 sand), first coat applied afternoon of November 15, second coat morning of November 18, finish coat morning of November 22; first coat possibly very slightly frozen on surface on morning of November 16.

Weather: Freezing temperatures recorded November 16, 17, 18, 22, 23, 25, and 28, rain in early morning, gusty northwest wind afternoon of November 15, cold northwest wind November 16, heavy southeast storm night of November 18, showers afternoon of November 19, gusty wind November 21, cold northwest wind November 22, panel protected with tarpaulin; rain night of November 23.

Superficial inspection: Color, medium gray, decidedly nonuniform, showing efflorescence on large section of panel; no cracks; surface rough, showing float marks; general appearance fair.

Detailed inspection: Structural cracks and some surface cracks; bond good; condition very good.

Remarks: At the request of the representative of the manufacturer of Medusa waterproofing compound, the finished panel was wet down November 23, 24, 26, 27, 29, and 30. On November 23 water was sprinkled on with a brush and quickly turned to ice on surface of panel. This gradually melted and was absorbed. Soon after the ice formed and before it melted, temperature of the air was observed to be 38° F. Prior to plastering, this panel was open sheathed on interior wall in opposite direction to outside sheathing. This inside bracing was added on panels Nos. 7 and 8, because cracks had been observed on other panels of this group already completed, these cracks developing at upper and lower diagonal corners of windows and running perpendicular to the direction of the sheathing. These cracks were attributed to shrinkage in the sheathing and the bracing was designed to counteract this effect. The fact that the cracks on panels Nos. 7 and 8 are very much smaller in size and number than on similar panels indicates that the cause of the structural cracks is correctly assigned. The waterproofing compound was mixed as follows: A bag of cement was spread upon a tarpaulin and 2 pounds of the compound sprinkled over it. The whole was then mixed to uniform color, sifted twice, and resacked for use as required.

Panel No. 8

Location: East side, second story, fourth panel from north end.

Construction: 24-gauge painted diamond-mesh metal lath, similar to panel No. 13. (See Fig. 11.)

Stucco: F–2 (parts by weight, 1 cement, 0.09 "White Impervite" waterproofing compound, 3 sand), first coat applied morning of November 18, second coat morning of November 19, finish coat morning of November 23, first coat very wet from heavy rain night of November 18 when second coat was applied. The latter was soft when straightened up and scratched afternoon of November 19 and was protected with tarpaulin.

Weather: Freezing temperatures recorded November 18, 22, 23, 25, and 28. Heavy southeast storm night of November 18, showers afternoon of November 19, gusty wind November 21, cold northwest wind November 22, rain at night November 23, cold northwest wind November 29.

Superficial inspection: Color, dark gray, uniform; structural cracks faintly visible; surface rough; general appearance very good.

Detailed inspection: Structural cracks only; bond good; condition excellent.

Remarks: At the request of the manufacturers of Impervite waterproofing compound the finished panel was wet down November 24, 26, 27, 29, and 30. On November 24 the surface was noticeably water repellant, although quite damp when water was applied. Prior to plastering, this panel was open sheathed on the interior wall in opposite direction to outside sheathing. (See remarks under panel No. 7.) This panel after application of first coat is shown at top of Figure 30. The waterproofing was added as follows: Nine pounds of the compound for each bag of cement was thoroughly mixed with water in a bucket. This was added to the other ingredients of the mortar in the mixing box as a part of the mixing water.

Panel No. 9

Location: East side, second story, third panel from north end.

Construction: 20-gauge wire lath, 2½ mesh, galvanized after woven, same as panel No. 12. (See Fig. 10.)

Stucco: A–2 (parts by weight, 0.75 cement, 0.25 high magnesian hydrated lime, 3 sand); first coat applied afternoon of November 2; second coat afternoon of November 4; finish coat laid on 11.15 a. m.; November 5, dry floated, and finally brushed vertically with soft brush 3.30 p. m.; not floated in usual manner. Some air blisters in finish coat were not eliminated.

Weather: Warm high winds November 2; cold wind November 3; moderate rain and wind November 4; no freezing.

Superficial inspection: Color, light buff, badly streaked; furring strips appear to show through; few structural cracks; brush marks slightly visible; general appearance fair (good if not streaked).

Detailed inspection: Structural and surface cracks, vertical and horizontal body cracks; vertical cracks at regular intervals appear to follow furring; at least one horizontal crack follows lap of lath and is apparently fundamental; bond good; condition fair to poor.

Remarks: The lath was so flexible that the original 12-inch spacing of furring was deemed too great, and additional furring was put in, making spacing 6 inches.

GROUP II

Metal lath on ½-inch crimped galvanized furring, 12 inches apart, over sheathing and sheathing paper. No hair used in any coat. Plaster pushed through to thoroughly embed lath.

Panel No. 10

Location: East side, second story, second panel from north end.

Construction: 24-gauge painted diamond-mesh metal lath, similar to panel No. 13. (See Fig. 11.)

Stucco: A–1 (parts by weight, 1 cement, 0.1 high magnesian hydrated lime, 3 sand). First coat applied afternoon of October 27; second coat afternoon of October 28; finish coat laid on morning of October 29; finished afternoon. First coat was very soft when left on October 27 and was broomed instead of scratched in usual manner.

Weather: Moderately gusty wind afternoon of October 30; warm high wind November 2; cold wind November 3; moderate rain and wind November 4; no freezing.

Superficial inspection: Color, light gray, not wholly uniform; structural and other prominent cracks; surface rough, showing float marks; general appearance fair.

Detailed inspection: Several structural and numerous body cracks; some fundamental cracks apparently following furring; bond good; condition poor.

Panel No. 11

Location: East side, second story, north-end panel.

Construction: 24-gauge painted diamond-mesh metal lath, similar o panel No. 13. (See Fig. 11.)

Stucco: B–2 (parts by weight, 0.25 cement, 0.75 high magnesian hydrated lime, 3 sand; second and third coats 4 parts sand). First coat applied morning of November 6; second coat morning of November 9; finish coat laid on 9 a. m., finished 11 a. m., November 15. Second coat was observed to be badly cracked (mostly horizontal cracks) November 10.

Weather: Freezing temperatures recorded November 16, 17, and 18; moderate rain in afternoon of November 12; moderate rain throughout day November 14; rain in early morning, gusty northwest wind afternoon of November 15; cold northwest wind November 16; heavy southeast storm night of November 18; showers afternoon of November 19; gusty wind November 21.

Superficial inspection: Color, buff, uniform, shows little efflorescence; structural cracks and float marks somewhat visible; general appearance very good.

Detailed inspection: Structural and body cracks, and probably some fundamental cracks along furring and laps; bond good, condition fair to poor.

Panel No. 12

Location: West side, second story, north-end panel.

Construction: 20-gauge wire lath, 2½ mesh, galvanized after woven. (Shown in Fig. 10.)

Stucco: A–1 (parts by weight, 1 cement, 0.1 high magnesian hydrated lime, 3 sand). First coat applied afternoon of October 26; second coat morning of October 27; finish coat laid on before noon October 28, finished 4.30 p. m. First coat somewhat too wet for best results, mortar tending to ooze out at bottom of panel when left October 26. This coat required some straightening before application of second. Finish coat was also applied rather wet and was still soft when finished five or six hours after laying on.

Weather: Gusty southeast wind afternoon of October 26, developed into thunder shower 8 p. m.; moderately gusty wind afternoon of October 30; warm high wind November 2; cold wind November 3; no freezing.

Superficial inspection: Color, light gray, uniform; structural cracks; surface rough; general appearance good (very good except for cracks).

Detailed inspection: Some structural cracks; several body cracks at bottom which may align with furring; a few surface cracks; bond good; condition fair to good.

Remarks: Lath was too flexible for the application specified for Group II and additional furring was inserted between the original furring, the final spacing being 6 inches.

Panel No. 13

Location: West side, second story, second panel from north end.

Construction: 26-gauge galvanized diamond-mesh metal lath, upper half cut from galvanized sheets (sec. a), lower half galvanized after expansion (sec. b). (Shown in Fig. 11.)

Stucco: C–1 (parts by weight, 1 "Alca" lime, 3.5 sand; second coat 4 parts sand; finish coat 4 parts limestone screenings). First coat applied afternoon of November 1; second coat morning of November 3; finish coat afternoon of November 4. Panel protected with tarpaulin November 4.

Weather: Warm high winds November 2; cold wind November 3; moderate rain and wind November 4; no freezing.

Superficial inspection: Color, light, nearly white, not wholly uniform; surface covered with prominent cracks, free from float marks; general appearance very poor.

Detailed inspection: Very numerous body cracks a few inches apart, mostly horizontal and vertical, some may follow furring and laps in the lath, bond good; condition very poor.

Panel No. 54

Location: West side, second story, third panel from north end.

Construction: 24-gauge painted diamond-mesh metal lath coated with cement gun. Similar to panel No. 13. (See Fig. 11.) Application of coat shown in Fig. 12.

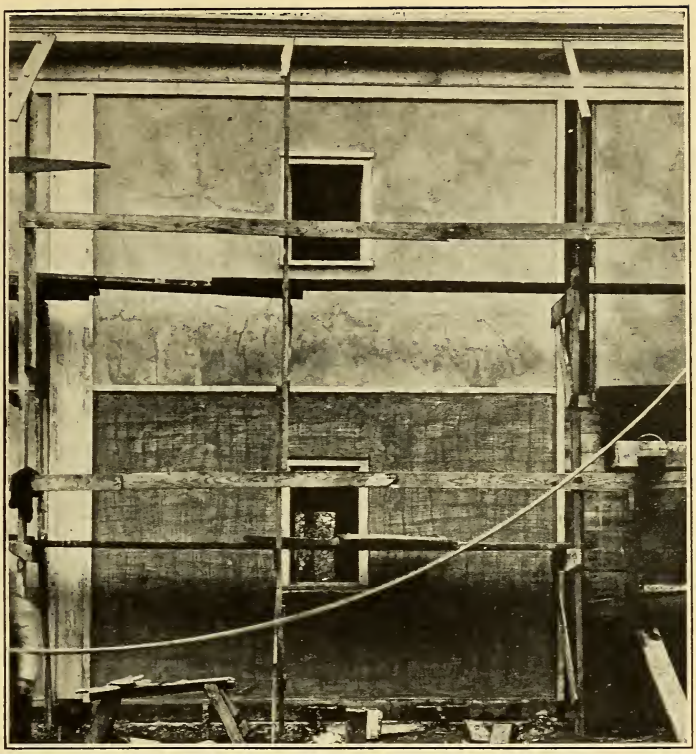

FIG. 9.—*Panel No. 4 (upper) showing extensive body and structural cracks after spraying with water and allowing partially to dry. The photograph was taken November 18, 1915, about two weeks after the plastering of this panel was completed. The lower panel is No. 49, scratch coated only*

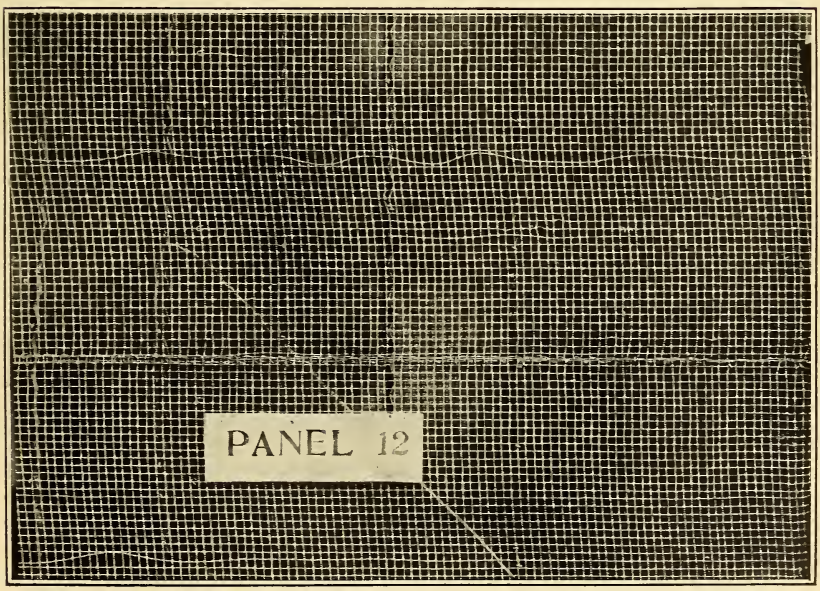

FIG. 10.—*Galvanized woven wire lath on panel No. 12, showing furring 6 inches apart. Same construction on panel No. 9*

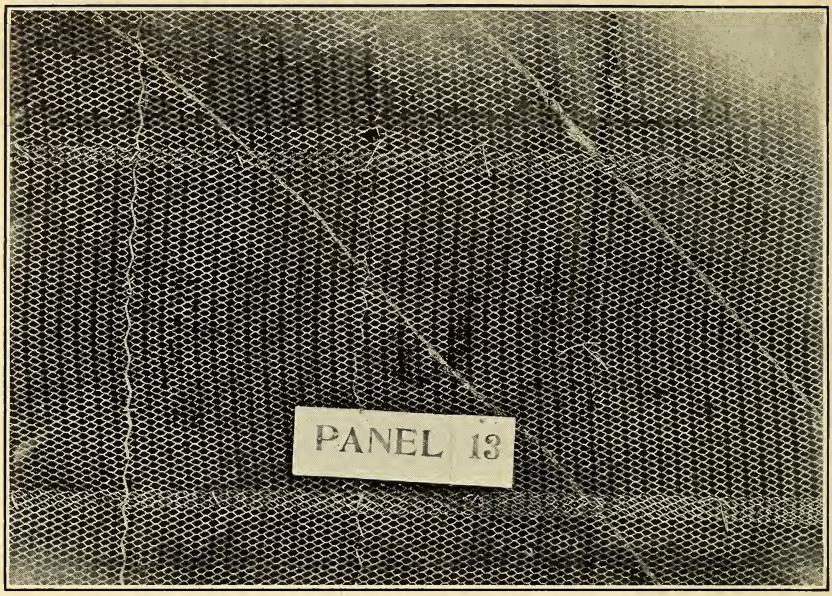

FIG. 11.—*Diamond-mesh expanded metal lath on panel No. 13. Similar construction on panels Nos. 1, 2, 3, 4, 5, 6, 7, 8, 10, 11, 54, and 55*

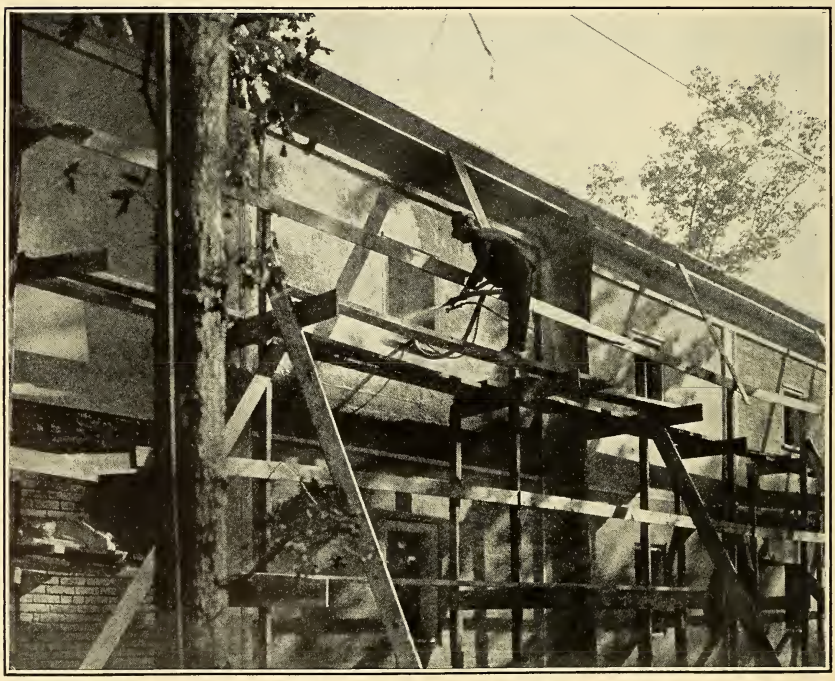

FIG. 12.—*Applying cement gun coating on panel No. 54*

Stucco: A–1 (parts by weight, 1 cement, 0.1 high magnesian hydrated lime, 3 sand; see remarks under panel 48, Group X). Stucco applied November 10, rodded and floated by hand. November 11 this panel showed a few horizontal shrinkage cracks in neighborhood of window, which were retouched.

Weather: Freezing temperature recorded November 16; moderate rain in afternoon of November 12; moderate rain throughout day November 14; rain in early morning, gusty northwest wind afternoon of November 15, cold northwest wind November 16.

Superficial inspection: Color, medium gray, not wholly uniform; structural cracks faintly visible, surface rough, general appearance fair to good.

Detailed inspection: Structural cracks only, bond good, condition excellent.

GROUP III

Metal lath on ½-inch crimped galvanized furring attached directly to studs 12 inches apart. No sheathing, lath back plastered on inside between studs. Outer faces of studs coated with "hydronon."

Panel No. 14

Location: North end, second story, east panel.

Construction: 27-gauge painted ribbed metal lath, same as panel No. 16. (See Fig. 13.)

Stucco: G–2 (parts by weight, 1 cement, 0.1 high magnesian hydrated lime, 3 sand; finish coat; 1 white cement, 0.1 high magnesian hydrated lime, 3 limestone screenings). First coat applied morning of November 9, back plastered morning of November 11, second coat afternoon of November 11, finish coat afternoon of November 12. Second coat was fairly hard but quite wet when finish coat was laid on about 2.45 p. m. The latter settled slightly as it was being floated and was still soft when finished at 4.30 p. m.

Weather: Freezing temperatures recorded November 16, 17, and 18. Moderate rain in afternoon of November 12, panel protected with tarpaulin. Moderate rain throughout day November 14; rain in early morning, gusty northwest wind afternoon of November 15; cold northwest wind November 16.

Superficial inspection: Color, uniform white; no cracks, float marks slightly visible, general appearance excellent.

Detailed inspection: Surface and body cracks only slightly visible, owing to the white-finish cracks practically invisible 10 feet away from panel, bond good; condition very good.

Panel No. 15

Location: North end, second story, west panel.

Construction: 27-gauge painted ribbed metal lath, same as panel No. 16. (See Fig. 13.)

Stucco: A–1 (parts by weight, 1 cement, 0.1 high magnesian hydrated lime, 3 sand). First coat applied afternoon of October 29, back plastered morning of November 1, second coat morning of November 1, finish coat laid on morning of November 2, finished afternoon. Second coat slid a little at first and was retouched afternoon of November 1. Finish coat of this panel dried rather rapidly in high wind of November 2 and was fairly hard when floated. In consequence, the finished panel has a more sandy appearance than the majority of the A–1 stuccos.

Weather: Moderately gusty wind October 30, warm high winds November 2, cold wind November 3, moderate rain and wind November 4, no freezing.

Superficial inspection: Color, uniform dark gray; no cracks; surface rough, general appearance excellent.

Detailed inspection: No cracks; bond good; condition excellent.

Panel No. 16

Location: North end, first story, east panel.

Construction: 27-gauge painted ribbed metal lath. (Shown in Fig. 13.)

Stucco: B–1 (parts by weight, 0.25 cement, 0.75 high calcium hydrated lime, 3 sand. Second and third coats, 4 parts sand). First coat applied morning of November 9, back plastered afternoon of November 12, second coat afternoon of November 15, finish coat laid on morning of November 18, finished afternoon. Second coat was possibly slightly surface frozen morning of November 16; surface was well broomed before applying finish coat.

Weather: Freezing temperatures recorded November 16, 17, 18, 22, and 23; moderate rain afternoon of November 12; moderate rain throughout day November 14; rain in early morning, gusty northwest wind afternoon of November 15; cold northwest wind November 16; heavy southeast storm night of November 18; showers afternoon of November 19; gusty winds November 21; cold northwest winds November 22; rain at night November 23.

Superficial inspection: Color, light buff, not wholly uniform; apparent efflorescence to right of window; structural cracks and float marks slightly visible, general appearance good.

Detailed inspection: Several body and structural cracks, at least two fundamental cracks follow studs half the height of panel, some surface cracks; finish coat imperfectly bonded at right of window; condition fair.

Panel No. 17

Location: North end, first story, west panel.

Construction: 20-gauge wire lath, 2½ mesh, galvanized after woven. (Shown in Fig. 14.)

Stucco: E (0.5 cement, 0.5 high magnesian hydrated lime, 3 sand; second and third coats, 4 parts sand). First coat applied morning of November 4; back plastered afternoon of November 5, second coat morning of November 6, finish coat laid on morning of November 8, finished 1 p. m. Lath so flexible that first coat had to be applied with very little pressure. Back plastering found to be badly cracked November 6, apparently wide shrinkage cracks extending through coat. This coat was probably too heavy and too rich, being of the same proportions as the first coat.

Weather: Moderate rain and wind November 4, moderate rain in afternoon of November 12, moderate rain throughout day November 14, no freezing.

Superficial inspection: Color, uniform light buff, one prominent vertical crack, float marks somewhat visible, general appearance good (very good except for crack).

Detailed inspection: Several surface and structural cracks, some body cracks, at least one fundamental crack over stud; bond good, condition fair.

GROUP IV

Wood lath on ⅜ by 1¼ inch wood furring, 12 inches apart, over sheathing and sheathing paper. Plain lathing, joints broken every twelfth lath. Spacing of lath ⅜ inch.

Panel No. 18

Location: West side, second story, fourth panel from north end.

Construction: Spruce lath, uncoated, similar to panel 20. (See Fig. 15.)

Stucco: A–3 (parts by weight, 1 cement, 0.1 high calcium hydrated lime, 3 sand). First coat applied morning of October 23, second coat morning of October 25, finish coat laid on morning of October 27, finished afternoon. Lath thoroughly wetted about two hours before plastering.

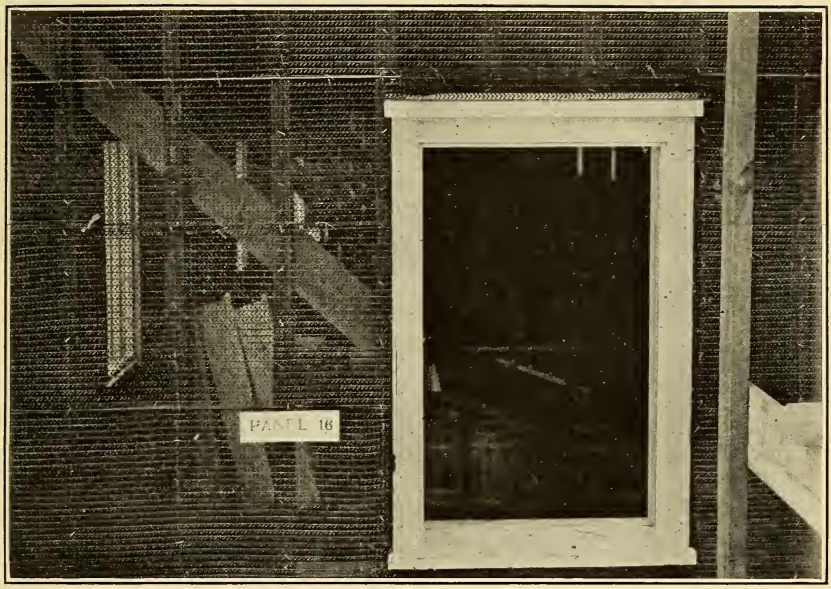

FIG. 13.—*Painted ribbed expanded metal lath on panel No. 16. Same construction on panels Nos. 14 and 15*

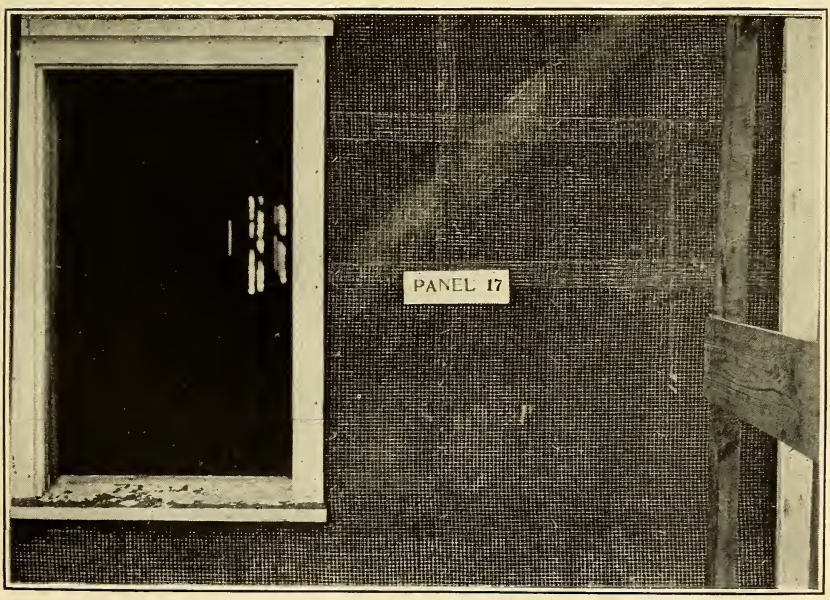

FIG. 14.—*Galvanized woven wire lath on panel No. 17*

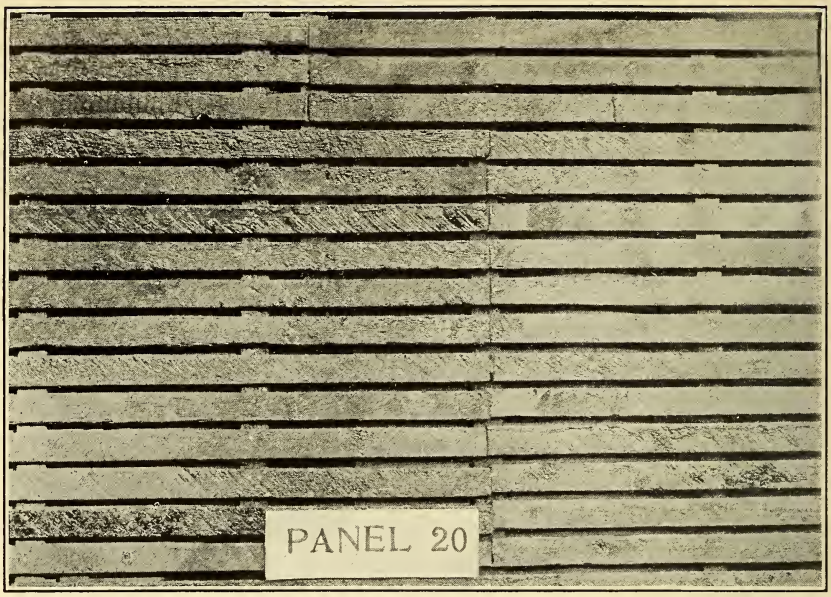

FIG. 15.—*Wood lath, plain lathing, on panel No. 20. Similar construction on panels Nos. 18 and 19*

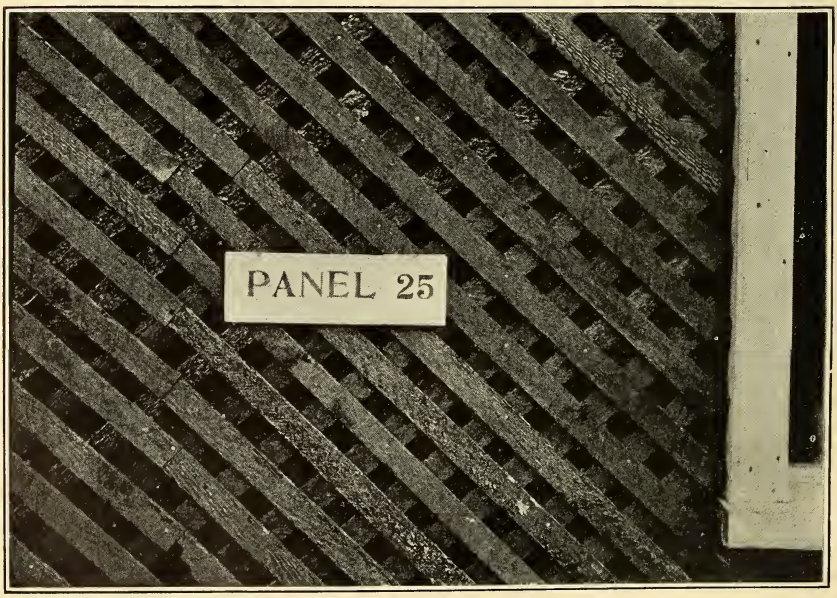

FIG. 16.—*Wood lath, counter lathing, on panel No. 25. Similar construction on panels Nos. 21, 22, 23, and 24*

Weather: Gusty southeast wind afternoon, developed into thunderstorm 8 p. m., October 26; moderately gusty wind afternoon of October 30; warm high wind November 2, no freezing.

Superficial inspection: Color, medium gray, not wholly uniform; structural cracks; surface rough; general appearance good.

Detailed inspection: Structural and a few body cracks; bond good; condition good.

Panel No. 19

Location: West side, second story, fifth panel from north end.

Construction: Spruce lath, uncoated, similar to panel 20. (See Fig. 15.)

Stucco: B–2 (parts by weight, 0.25 cement, 0.75 high magnesian hydrated lime, 3 sand; second and third coats, 4 parts sand). First coat applied morning of November 6, second coat afternoon of November 8, finish coat morning of November 12, finished 11 a. m. Lath thoroughly wetted prior to plastering.

Weather: Freezing temperatures recorded November 16, 17, and 18; moderate rain afternoon of November 12; moderate rain throughout day November 14; rain in early morning, gusty northwest wind afternoon of November 15; cold northwest wind November 16.

Superficial inspection: Color, buff, not wholly uniform; surface covered with prominent cracks; surface smooth, general appearance very poor.

Detailed inspection: Structural and numerous large body cracks, some of which may be fundamental; bond good; condition poor.

Panel No. 20

Location: West side, second story, sixth panel from north end.

Construction: Spruce lath, coated with "hydronon." (Shown in Fig. 15.)

Stucco: B–2 (parts by weight, 0.25 cement, 0.75 high magnesian hydrated lime, 3 sand; second and third coats, 4 parts sand). First coat applied morning of November 6, second coat afternoon of November 8, finish coat morning of November 12. Lath not wetted before plastering. Second coat had cracked November 9.

Weather: Freezing temperatures recorded November 16, 17, and 18; moderate rain afternoon of November 12; moderate rain throughout day November 14; rain in early morning, gusty northwest wind afternoon of November 15; cold northwest wind November 16.

Superficial inspection: Color, buff, not wholly uniform; a number of prominent cracks; surface smooth; general appearance fair (good except for cracks).

Detailed inspection: Some structural and numerous large body cracks, some of which may be fundamental; bond good; condition poor.

GROUP V

Wood lath over sheathing and sheathing paper, no furring, counterlathing. Spacing of lath 1 inch. Slope of lath such that the 4-foot lath spans 3 feet horizontally.

Panel No. 21

Location: West side, second story, sixth panel from south end.

Construction: Spruce lath, uncoated, similar to panel No. 25. (See Fig. 16.)

Stucco: A–3 (parts by weight, 1 cement, 0.1 high calcium hydrated lime, 3 sand). First coat applied afternoon of October 22, second coat morning of October 23, finish coat laid on October 27, finished afternoon. Lath thoroughly wetted before plastering. First coat on counterlathing required considerably more material than on plain lathing.

Weather: Gusty southeast wind afternoon, developed into thundershower 8 p. m., October 26; moderately gusty wind afternoon of October 30; warm high wind November 2, no freezing.

Superficial inspection: Color, light gray, not wholly uniform; structural cracks; surface rough; general appearance fair (good except for structural cracks).

Detailed inspection: Structural cracks, possibly one or two small body cracks; bond good; condition very good.

Panel No. 22

Location: West side, second story, fifth panel from south end.

Construction: Spruce lath, uncoated, similar to panel 25. (See Fig. 16.)

Stucco: B–1 (parts by weight, 0.25 cement, 0.75 high calcium hydrated lime, 3 sand; second and third coats, 4 parts sand). First coat applied afternoon of November 2, second coat morning of November 4, finish coat laid on morning of November 5, finished 3 p. m. Suction of first coat very strong; second coat went dry almost immediately, requiring use of darby after covering small area. Lath thoroughly wetted before plastering.

Weather: Warm high winds November 2, cold wind November 3, moderate rain and wind November 4, no freezing.

Superficial inspection: Color, light buff, not wholly uniform, shows pattern of lath over whole panel. Structural and other prominent cracks; float marks slightly visible; general appearance poor.

Detailed inspection: Numerous fundamental and many body cracks, some surface and structural cracks; bond good; condition very poor.

Panel No. 23

Location: West side, second story, fourth panel from south end.

Construction: Spruce lath, uncoated, similar to panel 25. (See Fig. 16.)

Stucco: C–1 (parts by weight, 1 "Alca" lime, 3.5 sand; second and third coats, 4 parts sand). First coat applied morning of October 30, second coat afternoon of November 1, finish coat morning of November 2. First coat extensively and second coat very slightly cracked. Lath thoroughly wetted before plastering.

Weather: Moderately gusty wind afternoon of October 30, warm high winds November 2, cold wind November 3, moderate rain and wind November 4, no freezing.

Superficial inspection: Color, light buff, shows pattern of lath over entire panel, stained by spray from cement gun used on panel 53, below; one structural crack, surface smooth, general appearance fair to poor.

Detailed inspection: Two body cracks and structural cracks around window; bond good; condition very good.

Panel No. 24

Location: West side, second story, third panel from south end.

Construction: Spruce lath, coated with "hydronon," same as panel 25. (See Fig. 16.)

Stucco: A–3 (parts by weight, 1 cement, 0.1 high calcium hydrated lime, 3 sand). First coat applied afternoon of October 22, second coat morning of October 23, finish coat laid on morning of October 26, finished 3.30 p. m. Lath not wetted before plastering.

Weather: Gusty southeast wind afternoon, developed into thundershower 8 p. m., October 26; moderately gusty wind afternoon of October 30, no freezing.

Superficial inspection: Color, dark gray, not wholly uniform; structural cracks and float marks somewhat visible; surface stained with "parlock" spray from panel No. 42 below; general appearance good.

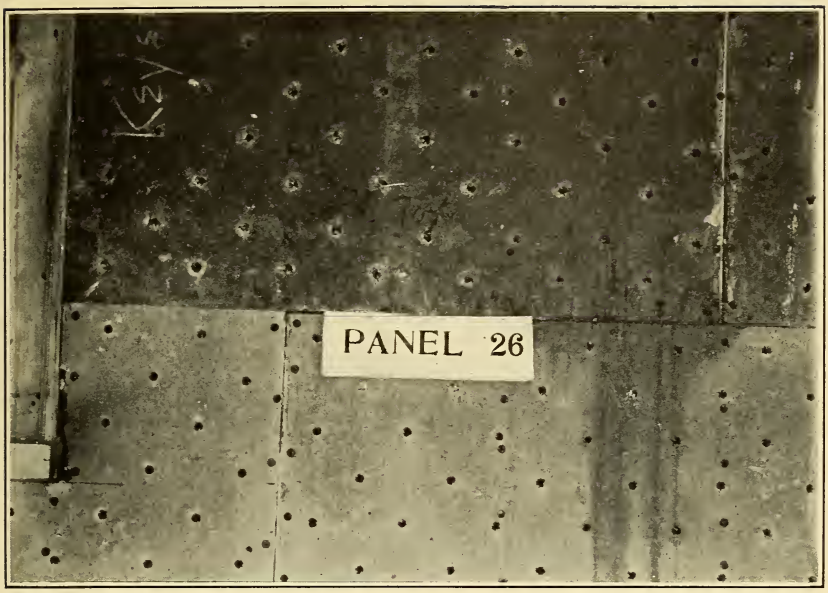

FIG. 17.—*Perforated uncoated plaster board on panel No. 26, felt surfaced board showing above the label, chip surface board below*

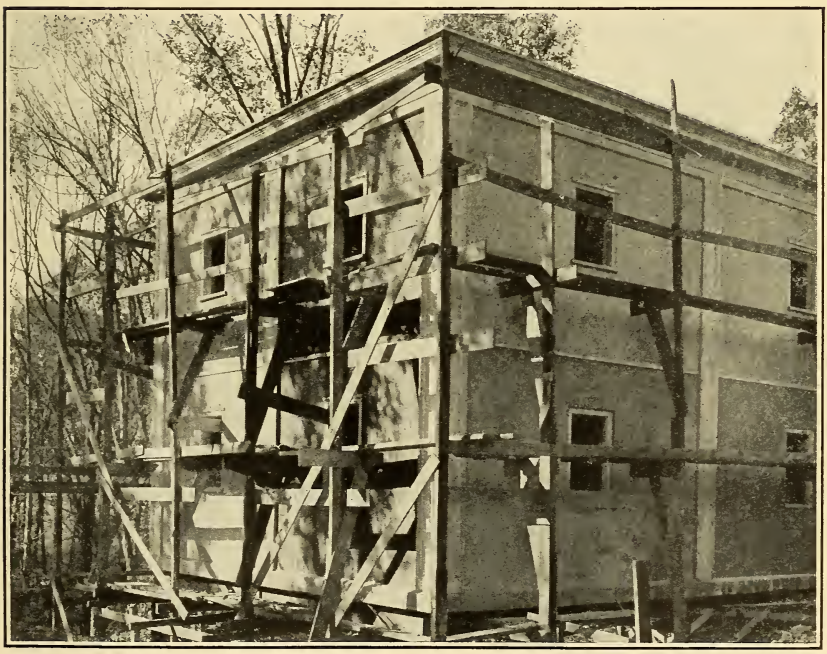

FIG. 18.—*The four plaster board panels on the south end of the test structure, panels Nos. 26 and 27 on the second story, 28 and 29 on first story. The plaster board of panels Nos. 27 and 29 are shown coated with "Parlock" and ready for plastering. Panels Nos. 26 and 28 are already finished*

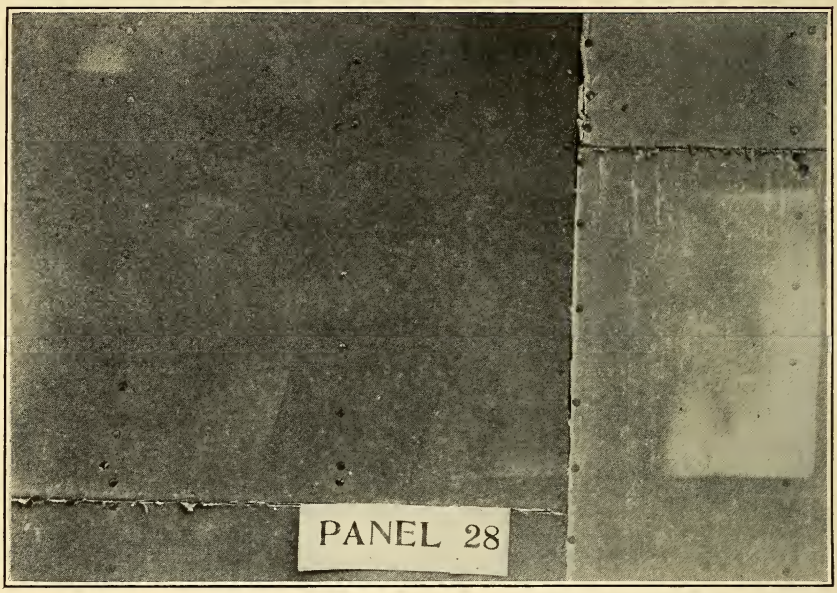

FIG. 19.—*Unperforated uncoated plaster board on panel No. 28. Felt surfaced board at the left, chip surfaced board at the right*

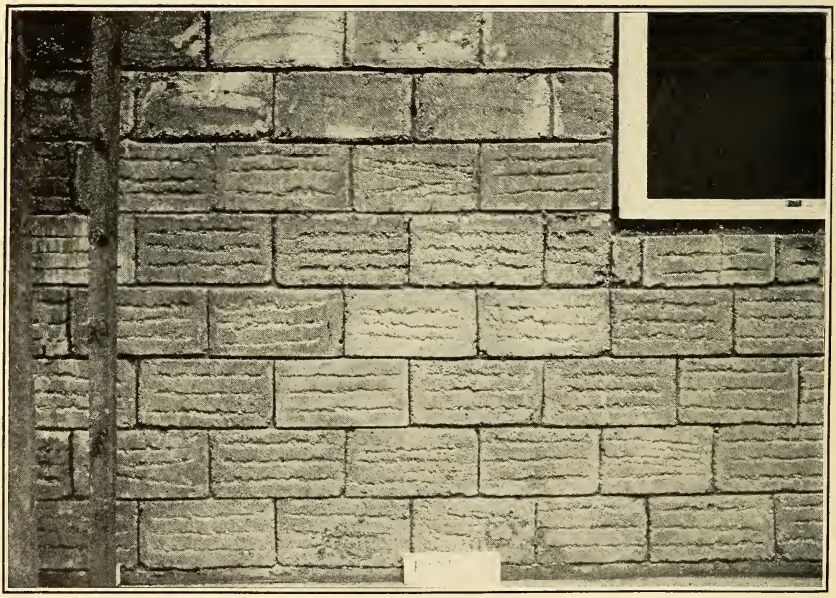

FIG. 20.—*Concrete block panel No. 30, rough block on lower half, smooth block on upper half, two courses of which are shown*

Detailed inspection: Structural cracks, several body cracks from bottom of panel to height of window; bond good; condition good.

Panel No. 25

Location: West side, second story, second panel from south end.

Construction: Spruce lath, coated with "hydronon." (Shown in Fig. 16.)

Stucco: B–1 (parts by weight, 0.25 cement, 0.75 high calcium hydrated lime, 3 sand; second and third coats, 4 parts sand). First coat applied afternoon of November 2, second coat morning of November 4, finish coat laid on 10 a. m., November 5, finished afternoon. Suction of first coat very strong; second coat went dry almost immediately, requiring use of darby after covering small area. Lath not wetted before plastering.

Weather: Warm high winds November 2, cold wind November 3, moderate rain and wind November 4, no freezing. Panel protected with tarpaulin November 4.

Superficial inspection: Color, buff, not wholly uniform; a number of cracks parallel to lath, float marks somewhat visible; general appearance fair.

Detailed inspection: Numerous fundamental and many body cracks; some surface and structural cracks; bond good; condition very poor. (Condition is very similar to panel No. 22.)

GROUP VI

Gypsum plaster board, 3/8 inch thick, nailed directly to studs 12 inches apart. Four-inch spacing of nails, 1/4 inch between boards. (NOTE.—In many places the plaster boards are laid close together or are separated by less than 1/4 inch.)

Panel No. 26

Location: South end, second story, west panel.

Construction: Perforated uncoated plaster board, upper half felt surface (sec. a) lower half chip surface (sec. b). (Shown in Fig. 17.)

Stucco: A–1 (parts by weight, 1 cement, 0.1 high magnesian hydrated lime, 3 sand). First coat applied afternoon of October 21, second coat morning of October 22, finish coat laid on October 26, finished afternoon. This coat dried more rapidly than usual and has a somewhat sandy finish. There was not time to "double up" the scratch coat on October 21, hence the departure from two-coat work specified in the original program: Plaster board not wetted before plastering.

Weather: Gusty southeast wind afternoon, developed into thunder shower 8 p. m., October 26; moderately gusty wind afternoon of October 30, no freezing.

Superficial inspection: Color, light gray, not wholly uniform; several prominent cracks; float marks somewhat visible; general appearance fair (good except for cracks).

Detailed inspection: A number of fundamental cracks following joints in plaster board, several body cracks diagonally over boards, no surface cracks; bond good; condition poor.

Panel No. 27

Location: South end, second story, east panel.

Construction: Perforated plaster board, upper half felt surface (sec. a) lower half chip surface (sec. b), all coated with "parlock." Panel 27 is shown ready for plastering in Fig. 18.

Stucco: A–1 (parts by weight, 1 cement, 0.1 high magnesian hydrated lime, 3 sand). First coat applied morning of November 11, second coat morning of November 13, finish coat morning of November 16.

Weather: Freezing temperatures recorded November 16, 17, 18, and 22; moderate rain afternoon of November 12; moderate rain throughout day November 14; rain in early morning, gusty northwest wind afternoon of November 15; cold northwest wind November 16; heavy southeast storm night of November 18; showers afternoon of November 19; gusty wind November 21; cold northwest wind November 22.

Superficial inspection: Color, light gray, not wholly uniform; several prominent cracks; float marks somewhat visible, general appearance fair (good except for cracks).

Detailed inspection: Felt board slightly wrinkled; a number of fundamental cracks following joints in plaster boards, a number of body cracks which appear to follow lines of studs, some running irregularly across boards; a number of surface cracks; bond good; condition poor.

Panel No. 28

Location: South end, first story, west panel.

Construction: Unperforated, uncoated plaster board, left half felt surface (sec. a), right half chip surface (sec. b). (Shown in Fig. 19.)

Stucco: A–1 (parts by weight, 1 cement, 0.1 high magnesian hydrated lime, 3 sand). First coat applied morning of October 22, immediately "doubled up," finish coat laid on morning of October 26, finished afternoon. The thin scratch coat adhered fairly well, the laid-on coat was apparently too heavy, for the whole cracked and sagged away from the plaster board in spots. Adhesion to the chip surface decidedly better than to the felt surface. The finish coat dried more rapidly than on clay tile or concrete bases and has a somewhat sandy appearance. Plaster board not wetted before plastering.

Weather: Gusty southeast wind afternoon, developed into thunder shower 8 p. m., October 26; moderately gusty wind afternoon of October 30, no freezing.

Superficial inspection: Color, light gray, not wholly uniform; several prominent cracks; float marks somewhat visible; general appearance fair (good except for cracks).

Detailed inspection: Felt-surfaced plaster board appeared to be considerably wrinkled in some cases, board cracked in one place. These wrinkles also found in the original board. Chip board in good condition. A number of fundamental cracks at joints, body and surface cracks; bond good; condition poor.

Panel No. 29

Location: South end, first story, east panel.

Construction: Unperforated plaster board, upper half felt surface (sec. a), lower half chip surface (sec. b), all coated with "parlock." Panel 29 ready for plastering is shown in Fig. 18.

Stucco: A–1 (parts by weight, 1 cement, 0.1 high magnesian hydrated lime, 3 sand). First coat applied morning of November 11, second coat morning of November 13, finish coat morning of November 16. "Parlock" coat is of irregular thickness, very heavy in spots, caused by rapid drying in sun when applied.

Weather: Freezing temperatures recorded November 16, 17, 18, and 22; moderate rain afternoon of November 12; moderate rain throughout day November 14; rain in early morning, gusty northwest wind afternoon of November 15; cold northwest wind November 16; heavy southeast storm night of November 18, showers afternoon of November 19; gusty wind November 21; cold northwest wind November 22.

Superficial inspection: Color, light gray, not wholly uniform; several prominent cracks; float marks somewhat visible; general appearance fair (good except for cracks).

Detailed inspection: Felt board very slightly wrinkled; a number of fundamental cracks at joints, body cracks, some running diagonally across boards, and surface cracks; bond good; condition poor.

Remarks: Panels Nos. 26, 27, 28, and 29 are very similar in appearance and condition.

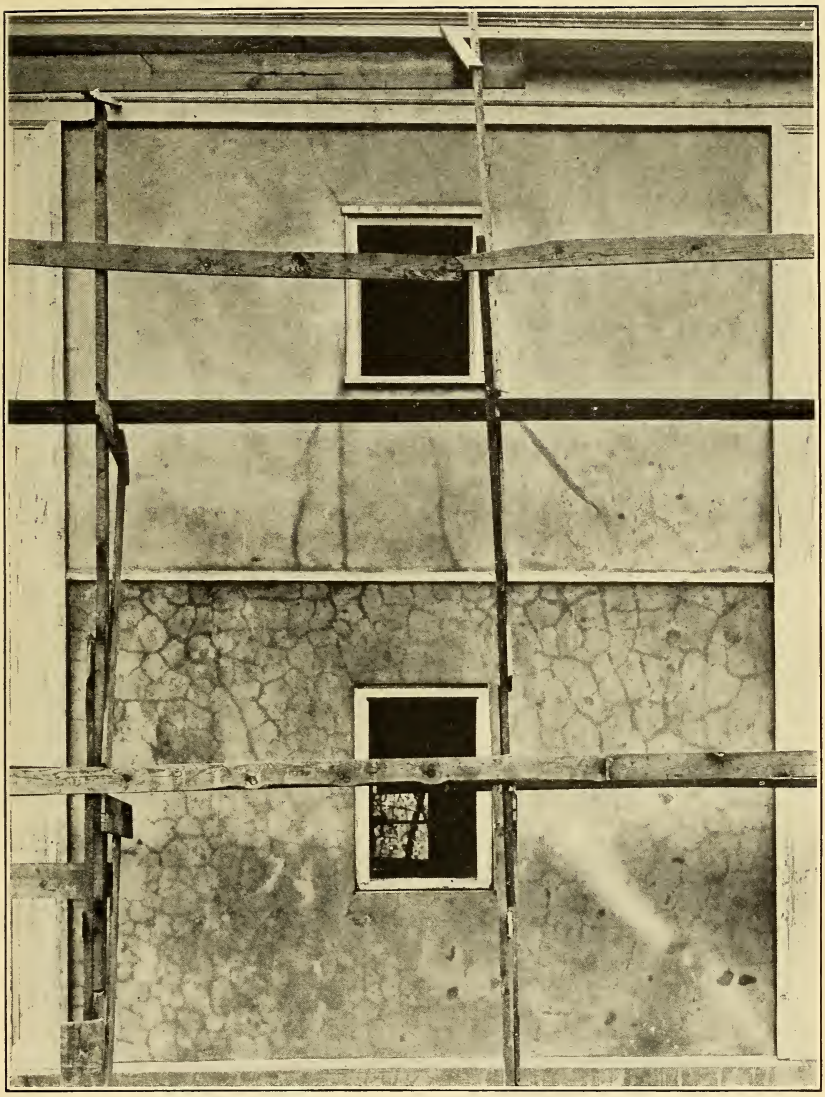

FIG. 22.—*Map cracking (body cracks) on panel No. 31 (lower) and structural cracks on panel No. 1 (upper), after spraying with water and allowing partially to dry. This photograph was taken November 18, about three weeks after the plastering of these panels was completed*

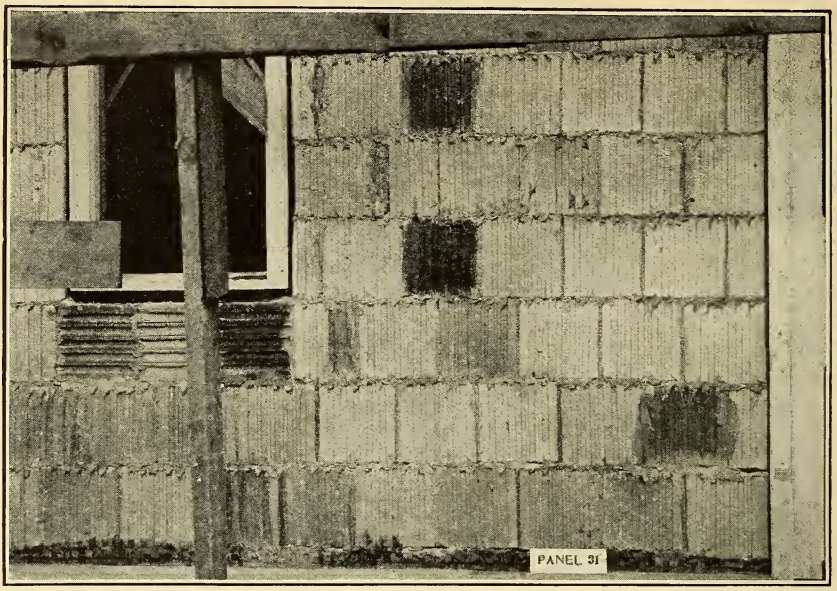

FIG. 21.—*Hollow terra cotta tile of panel No. 31. Same construction in panels Nos. 32, 33, 34, and 53*

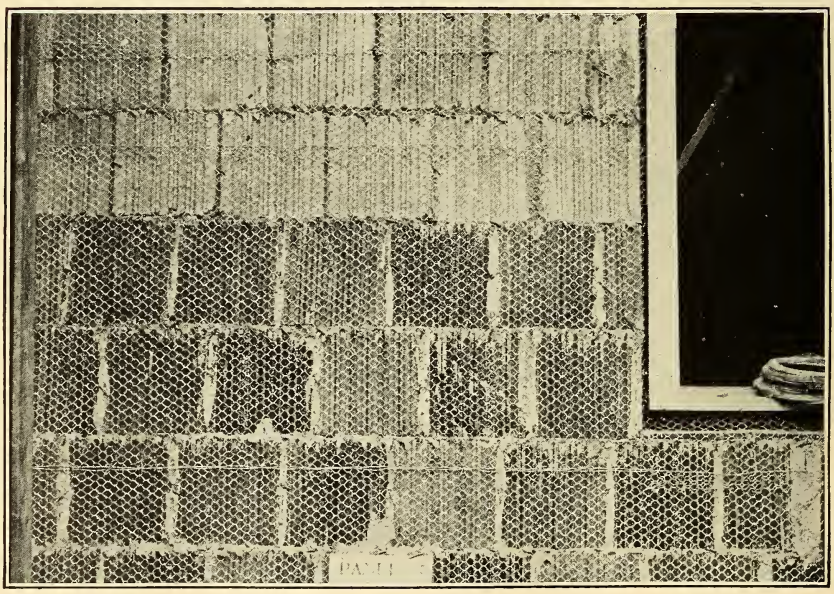

FIG. 23.—*Galvanized wire mesh over hollow terra cotta tile of panel No. 35. The dark colored tiles on the lower half are glazed*

GROUP VII

Glazed and unglazed hollow terra-cotta tile and concrete block. Terra-cotta tile hard burned, with dovetail ragged scoring.

Panel No. 30

Location: West side, first story, fourth panel from north end.

Construction: Hollow concrete block, upper half smooth block (sec. a), lower half rough block (sec. b). (Shown in Fig. 20.)

Stucco: A–1 (parts by weight, 1 cement, 0.1 high magnesian hydrated lime, 3 sand). First coat applied October 19, second coat October 20, finish coat laid on afternoon October 25, finished 5.30 p. m. First coat too wet to support laid-on coat October 19, hence panel was given three coats instead of two as originally specified. Left half of this panel wetted, right half wetted and brushed with neat cement grout immediately before plastering.

Weather: Heavy rain early morning October 20; gusty southeast wind afternoon developed into thundershower 8 p. m., October 26; moderately gusty wind afternoon of October 30, no freezing.

Superficial inspection: Color, light gray, several large discolored patches; one crack slightly, and float marks somewhat, visible; general appearance fair (good except for blotches).

Detailed inspection: Numerous surface cracks all over panel; numerous body cracks; one vertical crack may be structural; bond good; condition fair.

Panel No. 31

Location: East side, first story, south-end panel.

Construction: Hollow terra-cotta tile. (Shown in Fig. 21.)

Stucco: A–1 (parts by weight, 1 cement, 0.1 high magnesian hydrated lime, 3 sand, upper half of haired plaster (sec. a), lower half without hair (sec. b)). First coat applied afternoon of October 20, and immediately "doubled up." Some tendency of plaster to slide on section b apparently due more to use of wetter mix on lower half than to absence of hair. On October 21 this coat was retouched and straightened. Finish coat laid on morning of October 25, finished afternoon. Tile thoroughly wetted before plastering.

Weather: Heavy rain early morning October 20; gusty southeast wind afternoon developed into thundershower 8 p. m., October 26; moderately gusty wind afternoon of October 30, no freezing.

Superficial inspection: Color, light gray, not wholly uniform; no cracks visible; float marks slightly visible, general appearance good.

Detailed inspection: Surface and body cracks running in all directions cover entire panel a few inches apart; no fundamental nor structural cracks; bond good; condition fair to poor.

Remarks: Fig. 22 is a photograph of this panel showing typical "map cracking"; taken November 18 after wetting the panel and allowing partially to dry.

Panel No. 32

Location: East side, first story, second panel from south end.

Construction: Hollow terra-cotta tile, same as panel No. 31. (See Fig. 21.)

Stucco: B–1 (parts by weight, 0.25 cement, 0.75 high calcium hydrated lime, 3 sand; second coat 4 parts sand). First coat applied November 9 and immediately "doubled up." November 10 this coat was found to be badly cracked and was gone over with wet float and rescratched. Finish coat laid on morning of November 17, finished afternoon. Tile thoroughly wetted before plastering.

Weather: Freezing temperatures recorded November 16, 17, 18, 22, and 23; moderate rain in afternoon of November 12; moderate rain throughout day November 14; rain in early morning, gusty northwest wind afternoon of November 15; cold northwest wind November 16; heavy southeast storm night of November 18; showers afternoon of November 19; gusty wind November 21; cold northwest wind November 22; rain at night November 23.

Superficial inspection: Color, light buff, not wholly uniform, cracks somewhat visible; surface contains a number of blisters and scaly patches; general appearance poor.

Detailed inspection: Surface covered with body cracks running in all directions a few inches apart; some surface cracks; bond poor, outside coat appears to be loose and scaling in many places; condition very poor.

Panel No. 33

Location: East side, first story, second panel from north end.

Construction: Hollow terra-cotta tile, same as panel No. 31. (See Fig. 21.)

Stucco: C–1 (parts by weight, 1 "Alca" lime, 4 sand; this mixture used in both coats on manufacturers' recommendation). First coat applied November 3, about noon, immediately "doubled up," and finally straightened and scratched about 4 p. m. Finish coat applied morning of November 8. Tile thoroughly wetted before plastering.

Weather: Cold wind November 3, moderate rain and wind November 4, moderate rain afternoon of November 12, moderate rain throughout day November 14, no freezing.

Superficial inspection: Color, light buff, distinctly nonuniform; surface smooth but covered with prominent cracks; general appearance very poor.

Detailed inspection: Numerous body cracks running irregularly over surface of panel a few inches apart; bond good; condition poor.

Panel No. 34

Location: East side, first story, north-end panel.

Construction: Hollow terra-cotta tile, same as panel No. 31. (See Fig. 21.)

Stucco: D–1 (parts by weight, 1 cement, 2.5 sand). First coat applied afternoon of November 18, second coat morning of November 19, finish coat afternoon of November 22. First coat was very wet from heavy rain preceding night when second coat was applied. The latter was soft when straightened and scratched. Tile thoroughly wetted before plastering.

Weather: Freezing temperatures recorded November 18, 22, 23, 25, and 28; heavy southeast storm night of November 18, showers afternoon of November 19, panel protected with tarpaulin, gusty wind November 21; cold northwest wind November 22, panel protected with tarpaulin; rain at night November 23.

Superficial inspection: Color, dark gray, slightly blotchy; no cracks; surface rough; general appearance fair (good except for nonuniform color).

Detailed inspection: Body cracks slightly visible; stucco appears to have separated in spots but no blistering, cracking, or scaling noted; condition good.

Panel No. 35

Location: West side, first story, fifth panel from north end.

Construction: Hollow terra-cotta tile, upper half unglazed tile (sec. a), lower half glazed tile (sec. b), all covered with ¾-inch galvanized-wire mesh. (Shown in Fig. 23.)

Stucco: A–1 (parts by weight, 1 cement, 0.1 high magnesian hydrated lime, 3 sand). First coat applied morning of October 19, immediately "doubled up" and allowed to

stand until afternoon before straightening and scratching. This coat was rescratched October 20 to improve mechanical bond for finish coat. Finish coat laid on afternoon October 25, finished 4.30 p. m., somewhat too wet to finish nicely. Tile thoroughly wetted before plastering.

Weather: Heavy rain early morning October 20; gusty southeast wind afternoon developed into thundershower 8 p. m. October 26; moderately gusty wind afternoon of October 30, no freezing.

Superficial inspection: Color, light gray, nonuniform, one large discolored patch; several cracks somewhat visible, float marks slightly visible; general appearance poor (fair except for discolored patches).

Detailed inspection: Numerous body cracks several inches apart; no structural nor fundamental cracks, some surface cracks; no difference noted between sections a and b; bond good; condition fair to poor.

Panel No. 36

Location: West side, first story, sixth panel from north end.

Construction: Hollow terra-cotta tile, upper half uncoated (sec. a), lower left quarter coated with "parlock" (sec. b), lower right quarter coated with "hydronon" (sec. c). (Shown in Fig. 24.)

Stucco: A–2 (parts by weight, 0.75 cement, 0.25 high magnesian hydrated lime, 3 sand). First coat applied morning of November 10, second coat afternoon of November 15, finish coat afternoon of November 17. Vertical shrinkage cracks noted November 11 in first coat on sections b and c. Second coat possibly slightly surface frozen night of November 15. Bituminous coats extend 21 inches above window sill. Upper half of base well wetted prior to plastering.

Weather: Freezing temperatures recorded November 16, 17, 18, 22, and 23; moderate rain afternoon of November 12; moderate rain throughout day November 14; rain in early morning, gusty northwest wind afternoon of November 15; cold northwest wind November 16; heavy southeast storm night of November 18; showers afternoon of November 19; gusty wind November 21; cold northwest wind November 22, rain at night November 23.

Superficial inspection: Color, light gray, nonuniform. Several prominent cracks; float marks somewhat visible; left half shows large amount of efflorescence, especially on section b; general appearance fair.

Detailed inspection: Numerous surface and body cracks several inches apart on sections b and c, only surface cracks on section a; bond good; condition, section a, good; sections b and c, poor.

Panel No. 37

Location: West side, first story, sixth panel from south end.

Construction: Hollow terra-cotta tile, upper half uncoated (sec. a), lower left quarter coated with "parlock" (sec. b), lower right quarter coated with "antihydrine" (sec. c). (See Fig. 24.)

Stucco: G–1 (parts by weight, 1 cement, 0.3 high magnesian hydrated lime, 3 sand; finish coat, 1 white cement, 0.1 high magnesian hydrated lime, 2 white silica sand). First coat applied November 9, second coat afternoon of November 11, finish coat afternoon of November 17. Vertical shrinkage cracks in first coat noted November 11, rather more on this panel than on panels No. 36 and No. 38. November 12 second coat appeared to have separated in spots from first coat and cracked considerably. Bituminous coats extend 21 inches above window sill. Tile of section a thoroughly wetted prior to plastering.

Weather: Freezing temperatures recorded November 16, 17, 18, 22, and 23; moderate rain afternoon of November 12; moderate rain throughout day November 14; rain in early morning, gusty northwest wind afternoon of November 15; cold north-

west wind November 16; heavy southeast storm night of November 18; showers afternoon of November 19; gusty wind November 21; cold northwest wind November 22; rain at night November 23.

Superficial inspection: Color, uniform white; no cracks; surface even; general appearance excellent.

Detailed inspection: Sections b and c show a number of body cracks 8 to 10 inches apart, section a two or three cracks a few inches long; bond good; condition, section a, excellent; section b, fair to good; section c, fair.

Panel No. 38

Location: West side, first story, fifth panel from south end.

Construction: Glazed terra-cotta tile, upper half uncoated (sec. a), lower left quarter coated with "parlock" (sec. b), lower right quarter coated with "antihydrine" (sec. c). (Shown in Fig. 24.)

Stucco: A–1 (parts by weight, 1 cement, 0.1 high magnesian hydrated lime, 3 sand). First coat applied morning of November 10, second coat morning of November 13, finish coat morning of November 17. Vertical shrinkage cracks noted in first coat November 11. Bituminous coats extend 21 inches above window sill. Base not wetted before plastering.

Weather: Freezing temperatures recorded November 16, 17, 18, 22, and 23; moderate rain afternoon of November 12; moderate rain throughout day November 14; rain in early morning, gusty northwest wind afternoon of November 15; cold northwest wind November 16; heavy southeast storm night of November 18; showers afternoon of November 19; gusty wind November 21; cold northwest wind November 22; rain at night November 23.

Superficial inspection: Color, dark gray, uniform except for efflorescence (mostly on sec. c); no cracks; surface rough, especially on section a; general appearance fair (very good except for efflorescence).

Detailed inspection: Several body cracks on sections b and c, no cracks on section a; bond good; condition, section a, excellent; sections b and c, fair.

Panel No. 53

Location: West side, first story, fourth panel from south end.

Construction: Hollow terra-cotta tile, coated with cement gum, same as panel No. 31. (See Fig. 21.)

Stucco: A–1 (parts by weight, 1 cement, 0.1 high magnesian hydrated lime, 3 sand. See notes under Panel 48, Group X). Coating applied November 10, rodded and floated by hand. The panel is poorly finished, owing to darkness coming on before work was completed. Some shrinkage cracks were observed November 11, and retouched. Tile thoroughly wetted before coating was applied.

Weather: Freezing temperature recorded November 16; moderate rain in afternoon of November 12; moderate rain throughout day November 14; rain in early morning, gusty northwest wind afternoon of November 15; cold northwest wind November 16.

Superficial inspection: Color, dark gray, nonuniform, splotchy; two slightly visible cracks, float marks somewhat visible; general appearance poor.

Detailed inspection: Numerous surface cracks 8 to 10 inches apart covering entire panel, and a number of body cracks; bond good; condition fair.

GROUP VIII

Brick, common rough, hard burned. Where stucco is applied directly to brick, mortar joints are raked out to depth of $\frac{3}{8}$ or $\frac{1}{2}$ inch.

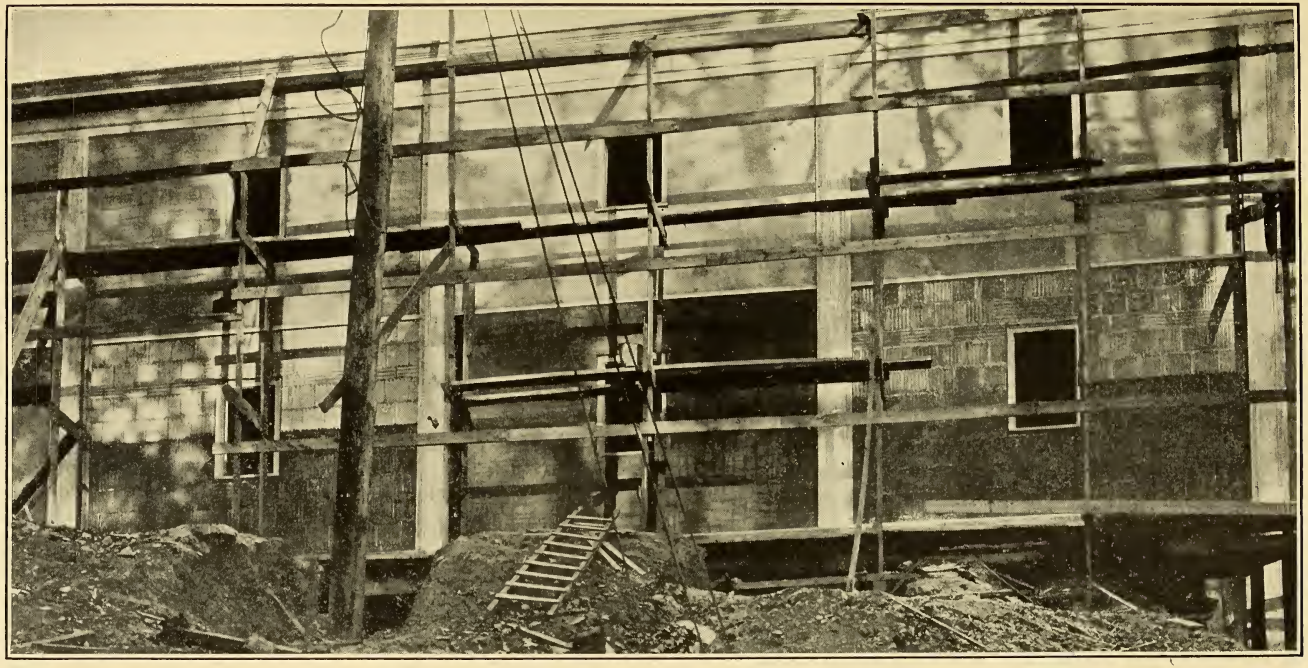

FIG. 24.—*Panels Nos. 36 and 38 ready for plastering are the lower left and lower right panels, respectively. The lower half of each is coated with bituminous material. Panel No. 37 (center) has already been scratch coated and is of the same construction and base treatment as panel No. 36*

FIG. 25.—*Brick of panel No. 39. Same construction in panel No. 40*

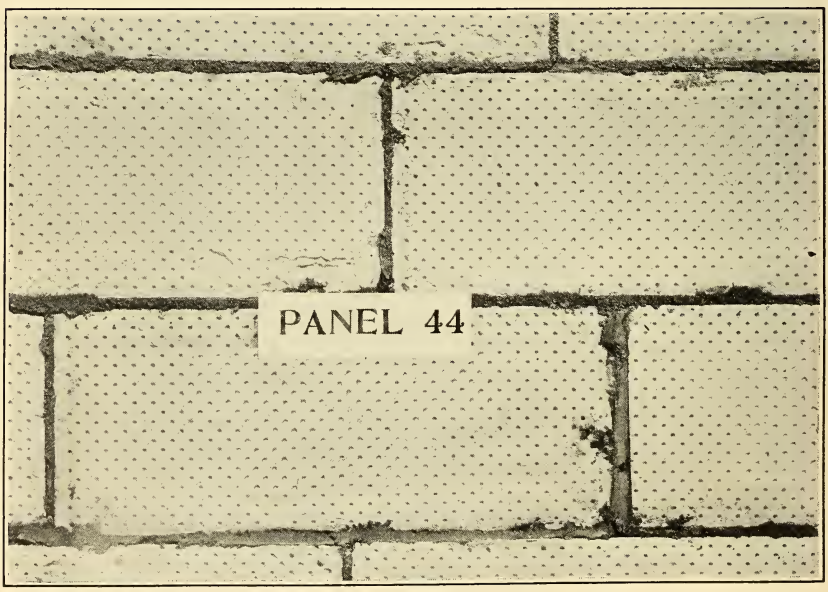

FIG. 27.—*Corrugated gypsum block of panel No. 44*

Panel No. 39

Location: West side, first story, north end panel.

Construction: Rough hard brick. (Shown in Fig. 25.)

Stucco: A–1 (parts by weight, 1 cement, 0.1 high magnesian hydrated lime, 3 sand). First coat applied October 21 and immediately "doubled up." Upper half of haired mortar (sec. a), lower half without hair (sec. b). Finish coat laid on morning of October 28, almost too wet to finish at 4.30 p. m. Brick thoroughly wetted before plastering.

Weather: Gusty southeast wind afternoon, developed into thunder shower 8 p. m., October 26; moderately gusty wind afternoon of October 30, warm high wind November 2; cold wind November 3; no freezing.

Superficial inspection: Color, light gray, showing a few prominent discolored spots; no cracks; float marks slightly visible; general appearance fair (good except for spots).

Detailed inspection: Surface cracks an inch or two apart all over panel; bond good; no difference noted in sections a and b; condition very good.

Panel No. 40

Location: West side, first story, second panel from north end.

Construction: Rough hard brick, same as panel 39. (See Fig. 25.)

Stucco: B–2 (parts by weight, 0.25 cement, 0.75 high magnesian hydrated lime, 4 sand. These proportions used throughout on this panel). First coat applied November 10, immediately "doubled up"; finish coat laid on morning of November 16, temperature about freezing. Plaster did not freeze but remained very soft and was not finally floated until 4 p. m. Panel was protected with tarpaulin night of November 16.

Weather: Freezing temperatures recorded November 16, 17, 18, and 22; moderate rain afternoon of November 12; moderate rain throughout day November 14; rain in early morning, gusty northwest wind afternoon of November 15; cold northwest wind November 16; heavy southeast storm night of November 18; showers afternoon of November 19; gusty wind November 21; cold northwest wind November 22.

Superficial inspection: Color, buff, nonuniform, no cracks nor float marks; general appearance, fair.

Detailed inspection: Numerous surface cracks several inches apart covering entire panel; several body cracks; bond just above water table seems to be affected by dampness, mortar softened and flaking; condition fair to good.

Panel No. 41

Location: West side, first story, third panel from north end.

Construction: Brick, with struck joints; that is, mortar finished flush with face of brick.

Remarks: This panel was to be painted to simulate an old wall, stucco to be keyed with two bituminous materials. Panel did not dry sufficiently before cold weather to warrant painting and is unfinished at the present time.

GROUP IX

Gypsum block, smooth and corrugated.

Panel No. 42

Location: West side, first story, third panel from south end.

Construction: Smooth gypsum block, coated with "parlock." (Shown in Fig. 26.)

Stucco: A–1 (parts by weight, 1 cement, 0.1 high magnesian hydrated lime, 3 sand). First coat applied morning of November 10, second coat afternoon of November 12, finish coat afternoon of November 16. Second coat very soft when finally straightened

at close of work November 12, and showed some tendency to bag. This coat showed patches of efflorescence November 16.

Weather: Freezing temperatures recorded November 16, 17, 18, and 22; moderate rain in afternoon of November 12; moderate rain throughout day November 14; rain in early morning, gusty northwest wind afternoon of November 15; cold northwest wind November 16, panel was protected with tarpaulin; heavy southeast storm night of November 18; showers afternoon of November 19; gusty wind November 21; cold northwest wind November 22.

Superficial inspection: Color, dark gray, uniform except for efflorescence; two prominent cracks; float marks slightly visible; general appearance fair to poor.

Detailed inspection: Some surface cracking—one crack appears to be a deep body crack, but may be fundamental; bond good; condition good.

Remarks: "Parlock" was applied October 27. Gypsum block were protected from rain October 26 by tarpaulins.

Panel No. 43

Location: West side, first story, second panel from south end.

Construction: Corrugated gypsum block, coated with "parlock." (Shown in Fig. 26.)

Stucco: A–1 (parts by weight, 1 cement, 0.1 high magnesian hydrated lime, 3 sand). First coat applied November 9, second coat morning of November 11, finish coat afternoon of November 16.

Weather: Freezing temperatures recorded November 16, 17, 18, and 22; moderate rain afternoon of November 12; moderate rain throughout day November 14; rain in early morning, gusty northwest wind afternoon of November 15; cold northwest wind November 16, panel protected with tarpaulin; heavy southeast storm night of November 18; showers afternoon of November 19; gusty wind November 21; cold northwest wind November 22.

Superficial inspection: Color, dark gray, uniform except for efflorescence; two prominent cracks; float marks slightly visible; general appearance fair.

Detailed inspection: Two large cracks, may be either body or fundamental; bond good, except possibly at lower right corner; condition good.

Remarks: "Parlock" was applied October 27. Gypsum block were protected from rain October 26 by tarpaulin.

Panel No. 44

Location: West side, first story, south-end panel.

Construction: Uncoated corrugated gypsum block. (Shown in Fig. 27.)

Stucco: A–1 (parts by weight, 1 cement, 0.1 high magnesian hydrated lime, 3 sand). First coat applied October 21. At the request of the gypsum manufacturers, the lower half of this panel was scratch coated with 1:2 gypsum plaster (sec. b), the upper half with stucco A–1 (sec. a). Prior to application of scratch coat, base was slightly wetted through a misunderstanding of instructions. Water was quickly absorbed from first coat, which was immediately "doubled up." Finish coat laid on morning of October 26; finished afternoon. This coat dried rapidly and has a sandy appearance.

Weather: Gusty southeast wind afternoon, developed into thunder shower 8 p. m., October 26: moderately gusty wind afternoon of October 30, no freezing.

Superficial inspection: Color, section a, medium gray, nonuniform: section b, uniform dark gray; three prominent cracks; surface smooth; general appearance: Section a, poor; section b, fair to good.

Detailed inspection: Possibly one or two structural cracks, numerous body cracks, especially on section b, bond poor in numerous places on both sections; condition: Section a, poor; section b, very poor.

Remarks: On October 22 and the following days the scratch coat on section a was sprinkled twice daily with whisk broom, the entire finish coat was sprayed regularly after October 27. Section a extends 4½ feet from top of panel.

FIG. 26.—*Panels Nos. 42 and 43 (first story) of smooth and corrugated gypsum block, respectively, coated with "Parlock" and ready for plastering*

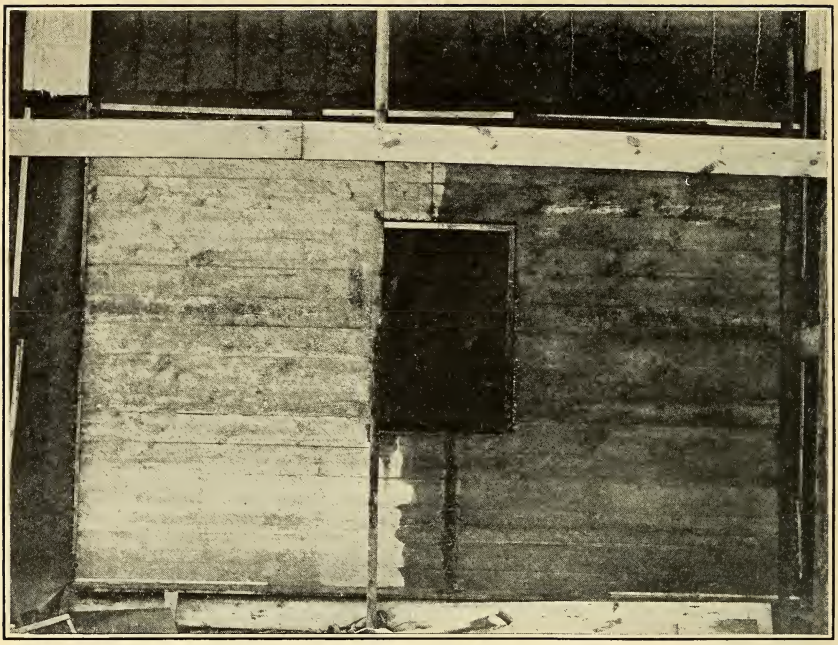

FIG. 28.—*Concrete base of panel No. 45, showing right half saturated with water just before "Parlock" coating was applied*

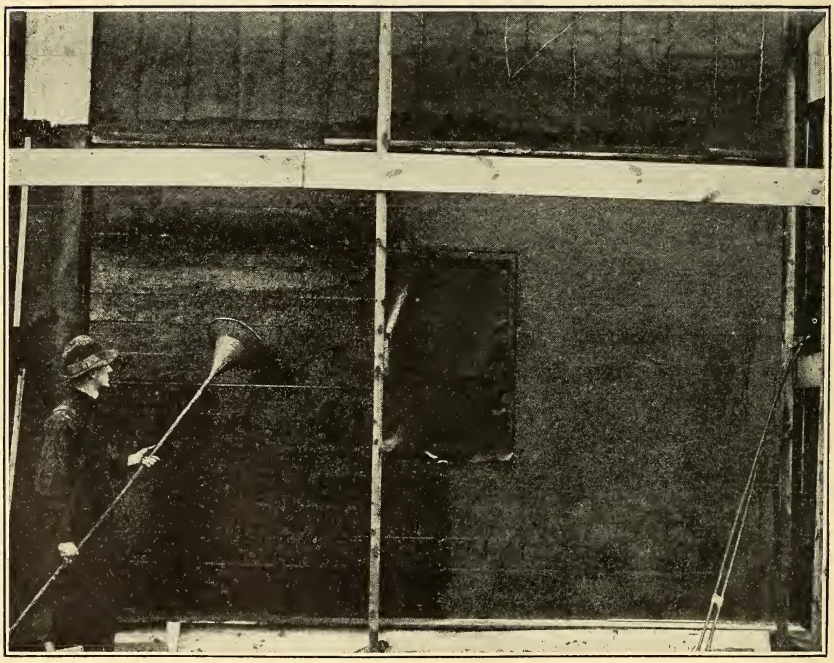

FIG. 29.—*Completing the application of "Parlock" on panel No. 45 with sand-spraying nozzle*

GROUP X

Monolithic Concrete. Of the six panels in this group, three were poured as the first-story walls were being erected, 9 or 10 weeks before plastering, and three were poured after the remainder of the structure was completed, 2 days before plastering. The concrete is 8 inches thick and composed of 1 part Portland cement, 2 parts sand and 4 parts gravel. The surfaces were generally smooth and free from pockets, except in the upper sections of the three last poured, where the construction did not permit of thorough spading.

Panel No. 45

Location: East side, first story, fifth panel from north end.

Construction: Monolithic concrete, poured September 14, coated with "parlock" October 26; right half of panel wetted at intervals for an hour or more previous to application of "parlock." (Shown in Fig. 28.) Figure 29 shows operator completing application of "parlock."

Stucco: A–1 (parts by weight, 1 cement, 0.1 high magnesian hydrated lime, 3 sand). First coat applied afternoon of November 18. This coat partially washed off by rain during night of November 18; remainder was removed with hose, and first coat reapplied morning of November 19; second coat afternoon of November 22; finish coat aid on 9 a. m. November 24; finished, when still soft, at 3 p. m. Mix for this coat appeared to be too wet for best results in finishing.

Weather: Freezing temperatures recorded November 22, 23, 25, 28, and 30; showers afternoon of November 19; gusty wind November 21; cold northwest wind November 22, panel protected with tarpaulin; rain at night November 23; cold northwest wind November 29.

Superficial inspection: Color, light gray, somewhat streaked; no cracks; surface rough and somewhat wavy; general appearance fair to good.

Detailed inspection: Numerous very fine body cracks, and numerous surface cracks running in all directions close together; bond good; condition fair.

Panel No. 46

Location: East side, first story, sixth panel from south end.

Construction: Monolithic concrete poured November 20, plastered soon after removal of forms. Base divided into four vertical sections: left section (a) untreated, second section (b) grouted only, third section (c) wire brushed only, right section (d) wire brushed and grouted.

Stucco: A–1 (parts by weight, 1 cement, 0.1 high magnesian hydrated lime, 3 sand). First coat applied afternoon of November 22, second coat morning of November 23, finish coat laid on 10 a. m., November 24, finished 1 p. m. Plaster for this coat appeared to be too wet for best results in finishing.

Weather: Freezing temperatures recorded November 22, 23, 25, 28, and 30; cold northwest wind November 22, panel protected with tarpaulin; rain at night November 23; cold northwest wind November 29.

Superficial inspection: Color, dark gray, nonuniform; no cracks, surface rough, general appearance fair.

Detailed inspection: Surface cracks slightly visible over entire surface, one small body crack; bond good; condition very good.

Remarks: Forms removed and base treatment given prior to plastering November 22. Sections a and d are each 3 feet 6 inches wide; sections b and c each 4 feet 1 inch wide.

Panel No. 47

Location: East side, first story, fourth panel from north end.

Construction: Monolithic concrete, poured September 13; base divided into three vertical sections: left section (a) scrubbed with 1:4 muriatic acid (7.3 per cent solution by weight); middle section (b) roughened with stone pick; right section (c) scrubbed with acetic acid (12 per cent solution by weight). (Shown in Fig. 30.)

Stucco: A–1 (parts by weight, 1 cement, 0.1 high magnesian hydrated lime, 3 sand). First coat applied afternoon of November 18; partially washed off by heavy rain night of November 18; remainder was scraped off, the base wire brushed, hosed, and replastered morning of November 19. Acid treatment not repeated before replastering. Second coat applied afternoon of November 22, finish coat afternoon of November 23.

Weather: Freezing temperatures recorded November 22, 23, 25, and 28; showers afternoon of November 19, panel protected with tarpaulin; rain at night November 23; cold northwest wind November 29.

Superficial inspection: Color, uniform medium gray, slightly streaked and spotted; no cracks nor float marks; surface slightly wavy; appearance good.

Detailed inspection: Surface cracks and one small blister noted; bond good; condition very good.

Remarks: The tooled portion of the base is 6 feet 2 inches wide, the acid-treated portions each 4 feet wide. Acid treatment did not expose aggregate in either case, but simply cleaned the surface. Action of acetic acid very slight as compared with that of muriatic acid.

Panel No. 48

Location: East side, first story, sixth panel from north end.

Construction: Monolithic concrete, poured September 15, smooth, untreated except wetting prior to coating with cement gun. Base of this panel similar to panel No. 45 before "parlock" treatment. (See Fig. 28.)

Stucco: A–1 (parts by weight, 1 cement, 0.1 high magnesian hydrated lime, 3 sand). Applied November 10, rodded and floated by hand. On November 11 the panel showed one shrinkage crack about 6 inches long near bottom.

Weather: Freezing temperatures recorded November 16; moderate rain in afternoon of November 12; moderate rain throughout day November 14; rain in early morning, gusty northwest wind afternoon of November 15; cold northwest wind November 16.

Superficial inspection: Color, dark gray, not wholly uniform, no cracks; float marks somewhat visible; general appearance very good.

Detailed inspection: Numerous surface cracks, particularly in lower section; bond good; condition very good.

Remarks: An attempt to "shoot" the returns at the windows of the gun-coated panels was not successful; these were finished by hand November 11. According to statement of the Cement Gun Co., the rebound of sand during application gives a coating in which the proportion of sand is about 2⅝ instead of 3, as used in the original mixture. The coating appears very dense but is not entirely uniform. This may be due to lack of an adequate air supply, which required the use of a smaller operating nozzle than is ordinarily employed.

Panel No. 49

Location: East side, first story, fourth panel from south end.

Construction: Monolithic concrete, poured November 16, forms removed and base treatment given prior to plastering November 18. Left half untreated (sec. a), right half wire brushed (sec. b). (Shown in Fig. 31. After this photograph was taken the smoother portions on right half were rebrushed.)

Stucco: C–1 (parts by weight, 1 "Alca" lime, 4 sand; these proportions used throughout on manufacturer's recommendation). First coat applied afternoon of November 18; partially washed off by heavy rain night of November 18, remainder scraped off, and base wire brushed, hosed, and replastered morning of November 19; second coat

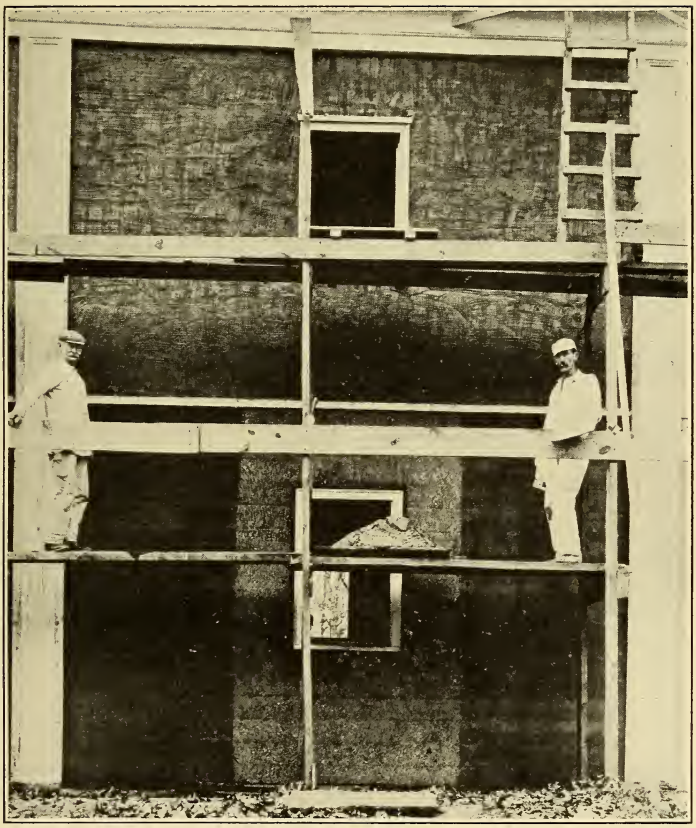

FIG. 30.—*Treated concrete base of panel No. 47 (lower) ready for plastering. Left section scrubbed with muriatic acid, middle section roughened with stone pick, right section scrubbed with acetic acid. Scratch coat on panel No. 8 shown above*

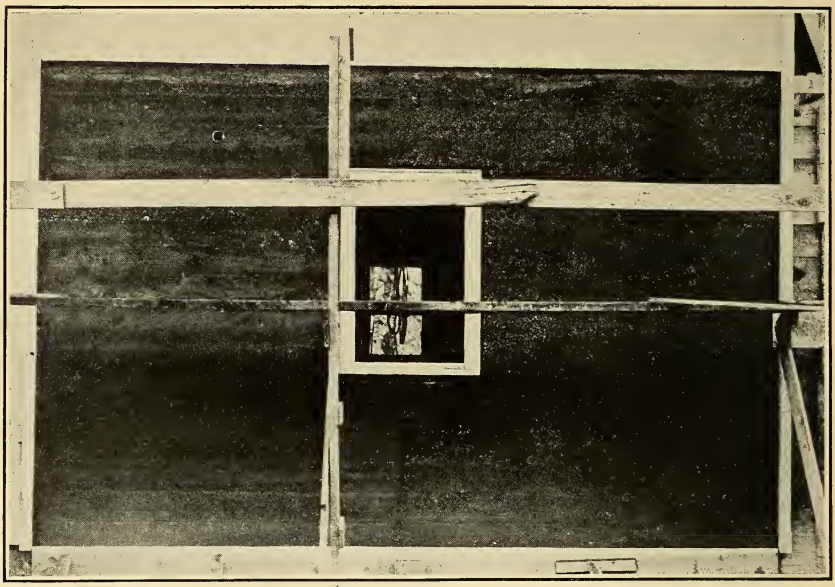

FIG. 31.—*Concrete base of panel No. 49, left half untreated, right half wire brushed. (The smoother portions of the right half were rebrushed after the photograph was taken and just before plastering was begun)*

FIG. 32.—*"Bishopric Board" on panal No. 51, left half creosoted lath, right half uncreosoted lath. Same construction on panel No. 52*

applied morning of November 22, finish coat laid on morning of November 24, finished 2 p. m. (Fig. 9 shows this panel after application of scratch coat.)

Weather: Freezing temperatures recorded November 22, 23, 25, 28, and 30; showers afternoon of November 19, panel protected with tarpaulin; gusty wind November 21; cold northwest wind November 22; rain at night November 23; cold northwest wind November 29.

Superficial inspection: Color, light, uniform; no cracks; float marks somewhat visible; appearance very good.

Detailed inspection: Fine body cracks only, mostly vertical and horizontal and short, a few extend across panel; bond good; condition good.

Panel No. 50

Location: East side, first story, fifth panel from south end.

Construction: Monolithic concrete, poured November 18; forms removed and base treatment given prior to plastering November 19; upper half not roughened; lower half wire brushed; left half coated with 1:1 grout, right half coated with 1:2 grout.

Stucco: A–1 (parts by weight, 1 cement, 0.1 high magnesian hydrated lime, 3 sand). First coat applied afternoon of November 19; second coat morning of November 22, finish coat laid on 11 a. m., November 24; finished 1.30 p. m.

Weather: Freezing temperatures recorded November 22, 23, 25, 28, and 30, showers afternoon of November 19, panel protected with tarpaulin; gusty wind November 21; cold northwest wind November 22; rain at night of November 23; cold northwest wind November 29.

Superficial inspection: Color, dark gray, not wholly uniform; no cracks; rough finish general appearance excellent.

Detailed inspection: A number of surface cracks faintly visible: bond good; condition excellent.

GROUP XI

Miscellaneous. This group includes three panels of which the bases are special proprietary materials

Panel No. 51

Location: East side, first story, third panel from south end (door panel).

Construction: Bishopric board, left half creosoted lath (sec. a), right half plain lath (sec. b). (Shown in Fig. 32.)

Stucco: A–1 (parts by weight, 1 cement, 0.1 high magnesian hydrated lime, 3 sand). First coat applied afternoon of October 19; second coat morning of October 20; finish coat laid on morning of October 25; finished afternoon. Lath thoroughly wetted before plastering.

Weather: Heavy rain early morning of October 20; gusty southeast wind afternoon developed into thunder shower 8 p. m., October 26; moderately gusty wind October 30; no freezing.

Superficial inspection: Color, uniform light gray; many prominent cracks; float marks not noticeable; general appearance fair (good except for cracks).

Detailed inspection: Structural, fundamental, and body cracks; most cracks do not follow joints in board, but many are parallel to lath; right half appears to have bulged outward slightly; bond good; condition poor.

Remarks: Bishopric board is a proprietary stucco or plaster board, consisting of wood lath backed with paper which is first given a heavy coat of asphaltic compound on the lath side. This compound serves as a waterproof coat and as an adhesive between the lath and paper. The lath are dovetailed in order to insure a firm key for the plaster. The board is shipped in rolls containing 100 square feet and is applied in such manner as to break joints every 3 or 4 feet. (See Fig. 32.) Bishopric board may be applied over sheathing or directly to studs.

Panel No. 52

Location: East side, first story, third panel from north end (door panel).

Construction: Bishopric board, left half creosoted lath (sec. a), right half plain lath (sec. b), same as panel 51. (See Fig. 32.)

Stucco: B–1 (parts by weight, 0.25 cement, 0.75 high calcium hydrated lime, 3 sand; second and third coats 4 parts sand). First coat applied November 9; second coat afternoon of November 11; finish coat laid on morning of November 17; finished afternoon. Lath thoroughly wetted before plastering.

Weather: Freezing temperatures recorded November 16, 17, 18, 22, and 23; moderate rain in afternoon of November 12; moderate rain throughout day November 14; rain early morning, gusty northwest wind afternoon of November 15; cold northwest wind November 16; heavy southeast storm night of November 18; showers afternoon of November 19; gusty wind November 21; cold northwest wind November 22; rain at night of November 23.

Superficial inspection: Color, light, uniform, but shows efflorescence; several prominent cracks; surface smooth; general appearance fair (good except for cracks).

Detailed inspection: Two structural cracks, some surface and fundamental cracks, many body cracks; cracking does not usually occur at joints in board; bottom flaking somewhat, especially under doorsill, apparently due to moisture and frost action; bond good; condition very poor.

Panels Nos. 53, 54, and 55

See Groups VII, II, and I, respectively.

Panel No. 56

Location: West side, second story, south-end panel.

Construction: "Clinton welded sheathing" applied directly to studs 16 inches apart, the latter being braced on the inside in the same manner as the back-plastered panels of Group III.

Stucco: A–4 (parts by weight, 1 cement, 0.1 high magnesian hydrated lime, 4 sand). First coat applied with difficulty, on account of cold, wet weather, lean mixture, and wide spacing of wires, morning of February 2, 1916. Surface freezing two hours after application. Second coat applied morning of February 7, first coat being first well broomed and rescratched with nail; first coat not very hard at this time. Rapid fall in temperature afternoon of February 7, with fresh northwest wind; surface freezing at 4.30 p. m. Third coat applied morning of February 18, finished 4 p. m.; weather fair and moderate temperature; in late afternoon conditions of February 7 repeated, and finish coat was slightly surface frozen during the night.

Weather: Freezing temperatures recorded on all days from February 2 to February 24, inclusive, except the 12th, 18th, and 23d. Severest weather of winter occurred in this interval. During the entire month the panel was protected by tarpaulin tacked to cornice and hung over scaffolding.

Superficial inspection: Color, dark gray, nonuniform; surface scaling slightly in spots; no cracks; rough finish; general appearance poor.

Detailed inspection: No cracks; bond good; condition excellent.

Remarks: "Clinton welded sheathing" is a proprietary stucco or plaster board consisting of a series of parallel No. 13 galvanized wires, spaced 3 inches apart and running horizontally, welded to a series of similar wires spaced 8 inches apart and running vertically, with tarred felt or sheathing paper laid between the two sets of wires before welding. The paper is punched at points where the wires intersect, which permits of welding and affords a small key for the plaster at each intersection. The material is applied directly to studs 16 inches apart, with the horizontal wires outside. The plaster is applied directly against the felt and imbeds the horizontal wires completely between the points of support.

In the foregoing notes it will be observed that the finish coats of the cement stuccos were frequently too wet to finish to best advantage, evidence of which is not lacking in the appearance of the panels at the present time. It is believed that while this was partly due to the cool weather which prevailed during the latter part of the work and the consequent slower setting of the mortar, the majority of such cases were due to excessive wetting of the under coats combined with a tendency of the plasterers to use too wet a mix to permit of finishing within the desired time. The change in the method of finishing the cement panels instituted on November 5, required better control of the consistency and, gennerally speaking, the use of a stiffer mix than the plasterers were accustomed to use. Probably no less important, however, is the control of the absorption or "suction" of the under coats by the proper amount of sprinkling or spraying just before the finish coat is applied.

In order to facilitate comparisons between panels of similar construction, the panel numbers are grouped in the following table, both according to bases and stuccos.

TABLE 1

Grouping the Test Panels According to Stuccos and Bases

Stuccos (parts by weight)	Bases											
	Metal lath			Wood lath		Gypsum plaster board (Group VI)	Terra-cotta tile (Group VII)	Brick (Group VIII)	Gypsum block (Group IX)	Monolithic concrete (Group X)	Proprietary bases (Group XI)	Total number of panels
	Group I	Group II	Group III	Group IV	Group V							
A-1 (1 cement, 0.1 magnesian hydrated lime, 3 sand)	1	10	15	.....	.....	26	[a] 30	39	42	45	[b] 51	....
	2	12	.....	.....	.....	27	31	[c] 41	43	46	.....	....
		[d] 54	.....	.....	.....	28	35	.....	44	47	.....	26
						29	33	.....	....	[d] 48	.....	....
							[d] 53	.....	....	50	.....	....
A-2 (0.75 cement, 0.25 magnesian hydrated lime, 3 sand)	9	.....	.....	.....	.....	.....	36	.....	....	.....	.....	2
A-3 (1 cement, 0.1 calcium hydrated lime, 3 sand)	.....	.....	.....	18	21	.....	.....	.....	....	.....	.....	....
					24	.....	.....	.....	....	.....	.....	3
A-4 (1 cement, 0.1 magnesian hydrated lime, 4 sand)	.....	.....	.....	.....	.....	.....	.....	.....	....	.....	[e] 56	1
B-1 (0.25 cement, 0.75 calcium hydrated lime, 3 sand; second and third coats, 4 sand)	.....	.....	16	.....	22	.....	32	.....	....	.....	[b] 52	5
					25	.....	.....	.....	....	.....	.....	....

[a] Hollow concrete block. [b] "Bishopric board." [c] Unfinished. [d] Coated with cement gun. [e] "Clinton welded sheathing."

TABLE 1—Continued

Stuccos (parts by weight)	Bases											
	Metal lath			Wood lath		Gypsum plaster board (Group VI)	Terra-cotta tile (Group VII)	Brick (Group VIII)	Gypsum block (Group IX)	Monolithic concrete (Group X)	Proprietary bases (Group XI)	Total number of panels
	Group I	Group II	Group III	Group IV	Group V							
B–2 (0.25 cement, 0.75 magnesian hydrated lime, 3 sand; second and third coats, 4 sand)	3	11	.....	19	.....	.....	.....	40	.....	.....	.....	5
			.....	20	.....	.....	.....	.....	.....	.....	.....	.....
C–1 (1 "Alca" lime, 3.5 sand; second and third coats, 4 sand)	4	13	.....	.....	23	.....	33	.....	.....	49	.....	5
C–2 (0.75 "Alca" lime, 0.25 cement, 3.5 sand; second and third coats, 4 sand)	55	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
D–1 (1 cement, 2.5 sand)	.....	.....	.....	.....	.....	.....	34	.....	.....	.....	.....	1
D–2 (1 cement, 2 sand; second and third coats, 3 sand)	5	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
D–3 (1 cement, 3 sand)	6	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
E (0.5 cement, 0.5 magnesian hydrated lime, 3 sand; second and third coats, 4 sand	.....	.....	17	.....	.....	.....	.....	.....	.....	.....	.....	1
F–1 (1 cement, 0.02 "Medusa" W. P. compound, 3 sand)	7	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
F–2 (1 cement, 0.09 "Impervite" W. P. compound, 3 sand)	8	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
G–1 (1 cement, 0.3 magnesian hydrated lime, 3 sand; second coat, 1 white cement, 0.1 magnesian hydrated lime, 2 white silica sand)	.....	.....	.....	.....	.....	.....	37	.....	.....	.....	.....	1
G–2 (1 cement, 0.1 magnesian hydrated lime, 3 sand; third coat, 1 white cement, 0.1 magnesian hydrated lime, 3 limestone screenings)	.....	.....	14	.....	.....	.....	.....	.....	.....	.....	.....	1
Total number of panels	10	5	4	3	5	4	10	3	3	6	3	56

VI. WEATHER CONDITIONS DURING PLASTERING OF PANELS

The following notes on the daily weather conditions during the plastering of the test structure are taken mainly from the Monthly Meteorological Summary published by the Weather Bureau, Department of Agriculture, Washington, D. C., and supplemented by general observations at the work from day to day. For convenience these notes are presented in tabular form, which is in effect a rearrangement of the Weather Bureau's tables.

The plastering was begun October 19 and completed November 25; the data are given for the period October 19 to November 30, inclusive.

TABLE 2

Summary of Weather Conditions During the Plastering of the Test Panels

Date	Temperature			Precipitation	Character of day	Per cent possible sunshine	Remarks
	Max.	Min.	Mean				
	Deg.	Deg.	Deg.	Inches			
Oct. 19	75	60	68	0.01	Cloudy	44	Warm and damp.
Oct. 20	72	63	68	.47	do	4	Heavy rain early morning, later warm and damp.
Oct. 21	79	60	70		Clear	75	Sprinkling of plaster coats begun to-day and continued thereafter twice daily until November 3.
Oct. 22	69	50	60		do	97	Very little breeze to date.
Oct. 23	60	37	48		do	100	Moderate breeze.
Oct. 24	55	35	45		do	100	Northerly breeze. Panels wet down once only.
Oct. 25	62	34	48		do	100	Heavy frost; no indication of plaster freezing.
Oct. 26	75	51	63	.07	do	92	Increasing cloudiness and gusty southeast wind in afternoon developed into thunder shower about 8 p. m.
Oct. 27	70	48	59		do	88	
Oct. 28	64	41	52		do	100	Near frost this morning.
Oct. 29	74	47	60	Trace	Part cloudy	83	Very little breeze.
Oct. 30	63	49	56		Clear	100	Cool and moderate breeze in morning, somewhat gusty in afternoon.
Oct. 31	68	40	54		do	100	Light breezes, panels wet down once only.
Nov. 1	77	49	63		Part cloudy	93	Light breezes.
Nov. 2	70	48	59		Clear	93	High winds.
Nov. 3	53	39	46		do	96	Cold wind, less violent than yesterday. Last day for regular sprinkling of finished coats.
Nov. 4	51	34	42	.02	Cloudy	19	Rain at intervals, moderate wind.
Nov. 5	59	41	50		Part cloudy	79	Breezy, warmer than past two days.
Nov. 6	49	34	42		Clear	100	Very little wind; heavy frost this morning, but no indication of freezing.
Nov. 7	57	35	46		do	100	
Nov. 8	60	33	46		Part cloudy	74	Gentle breeze.
Nov. 9	69	45	57		Clear	100	Moderate breezes.
Nov. 10	57	37	47		do	98	Do.
Nov. 11	64	37	50		Part cloudy	67	Very little breeze.
Nov. 12	71	50	60	.03	Cloudy	21	Rain in afternoon.
Nov. 13	58	41	50		Part cloudy	94	Little wind, ideal for exterior plastering.
Nov. 14	46	36	41	.21	Cloudy	0	Rain throughout day.
Nov. 15	52	37	44	.06	Part cloudy	61	Rain in early morning, ceased about 8.30 a. m. Gusty northwest wind last of afternoon, with decided drop in temperature.

TABLE 2—Continued.

Date	Temperature			Precipitation	Character of day	Per cent possible sunshine	Remarks
	Max.	Min.	Mean				
	Deg.	Deg.	Deg.	Inches			
Nov. 16	44	31	38	.....	Part cloudy...	93	Light freeze this morning, with cold northwest wind. (See notes under description of panels 7, 16, 36, and 40.)
Nov. 17	52	27	40	.....	Clear.....	100	Light freeze this morning. Very little breeze. No indications of plaster freezing.
Nov. 18	50	27	38	.02	Part cloudy....	79	Little or no ice observed this morning and no indications of plaster freezing. Fair and moderate temperature during morning, cloudy and chilly afternoon.
Nov. 19	64	46	55	.53	.....do.....	60	Heavy southeast storm and rain last night. (See notes under description of panels 8, 34, 45, 47, and 49.) Heavy clouds and showers in afternoon.
Nov. 20	57	41	49	.....	.....do.....	85	Breezy.
Nov. 21	62	41	52	.....	Cloudy.....	32	Mild, gusty winds.
Nov. 22	41	31	36	.....	Clear.....	94	Light freeze this morning, with cold northwest wind. No indication of plaster freezing.
Nov. 23	43	25	34	.05	Cloudy.....	0	Ice $\frac{1}{16}$ inch thick observed near test structure, but no indication of freezing of coats applied yesterday. (See notes under description of panel 7.) Chilly south breeze.
Nov. 24	49	34	42	.....	Part cloudy....	79	
Nov. 25	52	32	42	.....	.....do.....	67	
Nov. 26	59	34	46	.....	.....do.....	77	See notes under description of panels 7 and 8.
Nov. 27	63	41	52	.01	.....do.....	61	
Nov. 28	55	31	43	.....	.....do.....	78	
Nov. 29	50	34	42	Trace.	Cloudy.....	22	Cold northwest winds.
Nov. 30	39	27	33	.....	Clear.....	94	Light freeze early morning, cool and breezy during day.

The foregoing summary indicates that the plastering of the test panels was done under generally favorable conditions; better, in fact, than might have been expected for the time of year. On two or three occasions only was there any question of the possibility of freezing. Aside from these and the rather cold days at the end when the concrete panels were being finished, better weather could not reasonably have been desired.

In order that one may obtain a general idea of the exposure of the panels up to the April inspection, and also compare the temperature extremes and variations with those in other parts of the

country, a complete daily temperature record from October 19, 1915, to April 7, 1916, is given in Fig. 33. The curves represent

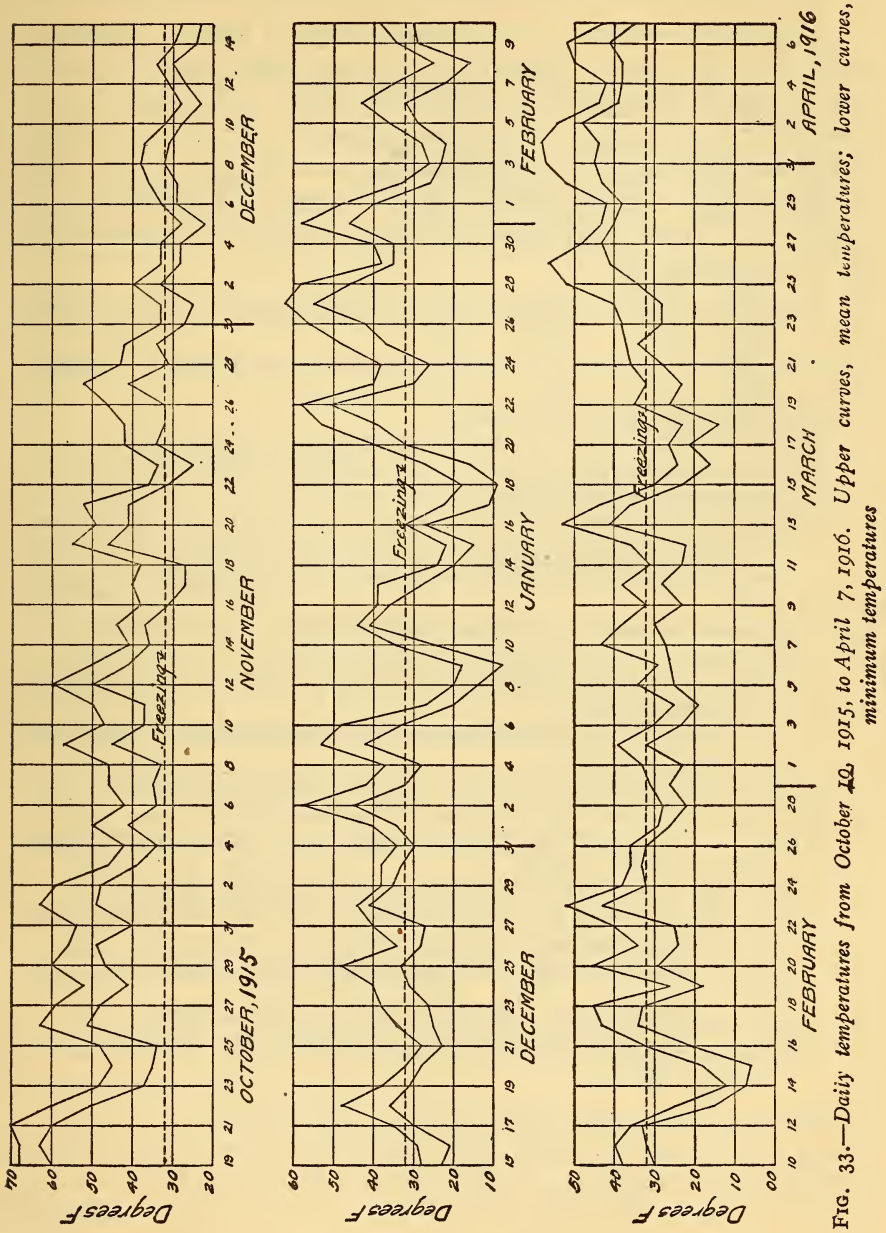

FIG. 33.—*Daily temperatures from October 19, 1915, to April 7, 1916. Upper curves, mean temperatures; lower curves, minimum temperatures*

the mean and minimum temperatures, and the maximum can be obtained, if desired, by adding the difference between mean and minimum to the former.

VII. SOURCES AND SUPPLEMENTARY TESTS OF MATERIALS USED IN CONSTRUCTION OF THE TEST PANELS

All materials entering into the construction of the test structure, aside from the panels themselves, were purchased from the funds appropriated or donated for the investigation. This applies to the steel and concrete work of the foundation, the lumber and hardware used in framing the structure, doors, windows, roofing, and outside trim. The materials used in erecting and plastering the panels were partly purchased and partly donated as enumerated in the following list:

Metal lath and furring, donated by the Associated Metal Lath Manufacturers, Chicago, Ill.

Wire lath and wire netting, donated by the Clinton Wire Cloth Co., Clinton, Mass.

Wood lath, purchased in local market.

Hollow tile, donated by the National Fireproofing Co., Pittsburgh, Pa.

Concrete block, purchased from local manufacturer.

Brick, purchased in local market.

Gypsum block and plaster board, donated by the Gypsum Industries Association, New York, N. Y.

"Bishopric board," donated by the Mastic Wall Board & Roofing Co., Cincinnati, Ohio.

"Hydronon," donated by the Barrett Manufacturing Co., New York, N. Y.

"Antihydrine," taken from a sample submitted for test.

"Medusa" waterproofing compound, donated by the Sandusky Portland Cement Co., Sandusky, Ohio.

White "Impervite" waterproofing compound, donated by the Standard Paint Co., New York, N. Y.

Cement, purchased in the local market under Government specification.

Sand, gravel, and limestone screenings, purchased in the local market.

White silica sand and White Portland cement, donated by the Atlas Portland Cement Co., New York, N. Y.

"Alca" lime, donated by the Aluminate Patents Co., Philadelphia, Pa.

Hydrated lime, donated by the Hydrated Lime Bureau of the National Lime Manufacturers Association, Pittsburgh, Pa.

"Parlock" materials, donated and applied by the Mastic Bond Co., New York, N. Y.

Cement gun panels, coated by the Cement Gun Co. (Inc.), New York, N. Y.

"Ruberoid" sheet roofing, purchased at cost price from the Standard Paint Co., New York, N. Y.

The majority of these materials have been submitted to the usual laboratory tests, the results of which are as follows:

TABLE 3

Chemical Analyses of Expanded Metal and Wire Lath

Chemical analysis	No. 8214 Galvanized-wire lath, 20-gauge	No. 8215 Painted diamond-mesh expanded lath, 24-gauge	No. 8216 Painted ribbed expanded lath, 26-gauge	No. 8217 Diamond-mesh expanded lath [a]	No. 8218 Diamond-mesh expanded lath [b]
Carbon	0.034	0.046	0.086	0.042	0.064
Sulphur	.072	.065	.048	.026	.034
Phosphorous	.099	.088	.056	.063	.091
Manganese	.33	.44	.26	.32	.35
Copper	.006	.007	.018	.006	.010
Zinc [c]	31.6	.....	.....	30.8	13.4

[a] Galvanized after expansion, 27-gauge.

[b] Cut from galvanized sheets, 27-gauge.

[c] Zinc is expressed as per cent of weight of original sample, each value being the average of three determinations.

CHEMICAL ANALYSES OF BONDING MATERIALS

Hydronon, Lab. No. 8251:	Per cent.
Volatile in 24 hours at 105° C	72.8
Nonvolatile [1]	27.2

Paint dries hard in 1 hour, and after heating to 105° C for 24 hours film is hard and somewhat brittle.

Tests indicate material is a coal tar thinned with a coal-tar naphtha.

Lifekote Dampproofing Bond, "Parlock" coating, Lab. No. 7645:	Per cent.
Volatile in 24 hours at 105° C	29.3
Nonvolatile [2]	70.7

Paint dries tacky in 1½ hours and after heating to 105° C for 24 hours is hard and slightly brittle.

Tests indicate material is a mixture of asphalts in which is some Trinidad asphalt fluxed with fatty material and thinned with a petroleum thinner.

NOTE.—The sample analyzed was taken from a small remaining quantity of material which had stood about 18 hours in an open bucket. This accounts for the high percentage of nonvolatile matter.

[1] Character of nonvolatile, hard and brittle. [2] Character of nonvolatile, hard and elastic.

Antihydrine, Lab. No. 1829:	Per cent.
Volatile in 24 hours at 105° C.	38.8
Nonvolatile [4]	61.2
Ash [5]	3.24
Fixed carbon	9.88
Distillation—	
100°–250° C.	39.4
Specific gravity	.743
Color	Clear.
250°–350° C.	11.8
Specific gravity	.841
Color	Light brown.
Residue [6]	48.8

Paint dries faintly tacky in 4 hours, and after heating to 105° C for 24 hours film is soft and elastic.

Tests indicate material is a series of fluxed asphalts thinned with a petroleum product. There are also present some fatty acids.

[4] Character of nonvolatile, moderately hard and plastic.
[5] Ash is chiefly silica and oxides of iron and aluminum.
[6] Character of residue, soft and plastic when cold, fluid when hot.

TABLE 4

Chemical and Physical Tests of Cements, Limes, and Integral Waterproofings

Chemical analyses and physical tests	"Tidewater" Portland cement		"Atlas" white Portland cement		"Limoid" high mag. hyd. lime		"Berkeley" high cal. hyd. lime		"Alca" lime (high mag. hyd. lime+Ca. aluminate)				"Medusa" waterproofing compound [a]	White "Impervite" waterproofing [b]
	No. 7300	No. 7993	No. 7989	No. 7994	No. 7301	No. 7995	No. 7880	No. 7998	No. 7489	No. 7490	No. 7882	No. 7997	No. 7996	No. 8235
Silica (SiO_2)	21.70	.....	.....	.....	3.30	2.46	1.60	1.80	4.64	4.80	4.92	5.14	Analysis indicates that this material is composed of approximately 1 part lime soap and 3 parts hydrated lime.	Analysis indicates that this material is composed of approximately 3 parts hydrated lime, 3 parts vaseline, and 4 parts water.
Iron oxide (Fe_2O_3)	3.15	.....	0.40	0.40	.10	trace	trace	trace	trace	.10	trace	trace		
Alumina (Al_2O_3)	6.55	.....	.....	.....	1.04	1.04	1.00	.96	5.90	3.56	4.16	4.02		
Calcium oxide (CaO)	59.80	.....	.....	.....	47.40	47.30	68.90	70.00	46.20	45.70	45.50	45.40		
Magnesium oxide (MgO)	2.72	2.64	1.64	1.68	31.80	30.84	2.40	1.84	27.12	29.20	29.20	28.00		
Sulphuric anhydride (SO_3)	1.62	1.44	1.75	1.69	.64	.46	.59	.56	1.14	.80	.88	.83		
Ignition loss	2.18	1.29	2.88	2.67	16.82	17.63	23.85	23.96	15.37	15.10	14.46	15.12		
Carbon dioxide (CO_2)	.....	.....	.....	.....	.93	1.47	2.40	2.57	.80	.76	.90	1.27		
Insoluble residue	.33	.36	.50	.26	.89	1.35	trace	trace	.25	.99	1.12	1.26		
Specific gravity	3.20	3.20	3.11	3.07	2.60	2.71	2.33	2.40	2.61	2.61	2.61	2.59		
Fineness: No. 100	96.0	95.6	99.8	99.6	98.2	94.8	99.8	99.9	94.0	93.6	96.0	97.6	.....	.....
Fineness: No. 200	79.1	77.0	89.4	90.5	89.9	92.4	96.6	98.3	88.3	80.1	72.4	88.9	.....	.....
Soundness	O. K.	O. K.	O. K.	O. K.	O. K.	O. K.	O. K.	O. K.	O. K.	O. K.	O. K.	O. K.	.....	.....
Initial set	5:12	2:07	2:57	3:09	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Final set	8:33	7:12	5:57	8:24	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Tensile strength:														
1:3—														
7-day average	233	197	237	230	.....	.....	.....	.....	51	70	34	52	.....	.....
28-day average	402	305	358	397	.....	.....	.....	.....	110	114	108	98	.....	.....
Lime plus magnesia, per cent of nonvolatile matter	.....	.....	.....	.....	94.69	95.71	96.48	96.30	.....	.....	.....	.....	.....	.....

PHYSICAL TESTS OF SANDS

Samples of sand were taken from nearly all deliveries for screen analysis and for moisture and silt determinations. The samples were taken at such time as to include the probable extremes of moisture conditions as well as the average conditions under which the sand was used.

The results of moisture and silt determinations, as obtained from the river sands, are as follows:

Laboratory No.	Per cent moisture	Per cent silt	Laboratory No.	Per cent moisture	Per cent silt
7302	7.9	2.68	7986	11.1	2.14
7488	3.6	2.12	7990	7.7	2.00
7639	6.2	2.70	7991	7.1	2.81
7640	9.1	2.46			
7642	5.2	2.76	Mean	7.36	2.49
7643	8.3	2.76			

The foregoing values were obtained by drying 200 g. samples to constant weight and computing the silt and moisture percentages on the basis of the dry weight.

The screen analyses were made on the Tyler screen scale series of 13 sieves from the 3-mesh to the 150-mesh, inclusive. The results are given in Table 5, showing the percentages of the various sands passing the sieves.

TABLE 5

Mechanical Analyses of Sands[a]

Sieve No.	Potomac River sand										"Parlock" sand	Limestone screenings	Silica sand
	No. 7302	No. 7486	No. 7639	No. 7640	No. 7642	No. 7643	No. 7986	No. 7990	No. 7991	Average	No. 7641	No. 7855	No. 7988
3	99.4	100.0	.....	100.0	100.0	99.4	100.0	100.0	99.6	99.8	.....	.....	.....
4	99.1	99.9	100.0	97.4	99.9	99.3	99.8	99.5	99.5	99.3	.....	100.0	.....
6	98.7	99.8	99.5	97.3	99.7	99.1	99.7	99.3	99.3	99.1	100.0	99.6	100.0
8	98.4	99.6	99.3	96.8	99.3	98.8	99.4	98.8	99.0	98.8	99.9	99.4	99.8
10	97.9	99.1	98.8	94.8	98.6	98.3	97.9	97.3	98.4	97.7	98.2	91.1	99.6
14	97.1	98.2	98.0	90.1	97.4	97.4	94.7	94.1	97.4	95.6	80.4	79.4	96.7
20	95.2	96.0	96.2	80.9	94.8	95.3	88.0	87.3	94.7	91.0	45.9	67.9	69.3
28	89.3	89.2	91.0	65.7	87.5	88.8	73.5	71.8	87.8	80.9	10.3	56.5	34.9
35	77.8	75.8	81.3	50.5	74.5	76.6	54.2	54.5	75.4	66.7	.9	48.5	27.7
48	49.2	44.2	54.9	27.9	45.5	47.4	29.9	28.6	46.1	40.0	.4	39.4	21.5
65	25.7	20.3	27.5	14.9	21.8	22.9	14.1	13.6	22.8	19.7	.2	32.5	16.9
100	9.2	6.6	8.8	6.5	6.7	8.6	4.0	3.8	8.1	6.6	.1	24.7	11.8
150	3.8	2.8	3.1	3.0	2.6	3.9	1.6	1.5	3.6	2.8	.1	18.2	7.5

[a] In column 11, headed "Average," are given the average percentage of the nine river sands passing each sieve. In Fig. 34 this average sand is plotted, together with the highest and lowest values of all the river sands. It will be noted that with the exception of two or three values on the finest screens, the highest values are given by sample No. 7639 and the lowest by sample No. 7640; that is, No. 7639 is the finest sand used (of the river sands) and No. 7640 is the coarsest, all the others lying between these two and not differing greatly from the "average" sample. The diagram also gives the curves of the special sands.

WEIGHT-VOLUME RELATIONS OF STUCCO MATERIALS

Because of the indefiniteness of volume measurements of cement, sand, lime, etc., the stucco materials used in the investigation have been proportioned in all cases by weight. It is customary in commercial practice, however, to specify the proportions of plaster mixtures by volume on account of the fact that it is more or less impracticable to weigh all materials as they are used "on the job." For purposes of comparison weight-volume determinations were made on the majority of materials used in the tests, the materials being shoveled, scooped, or poured into a 1 cubic-

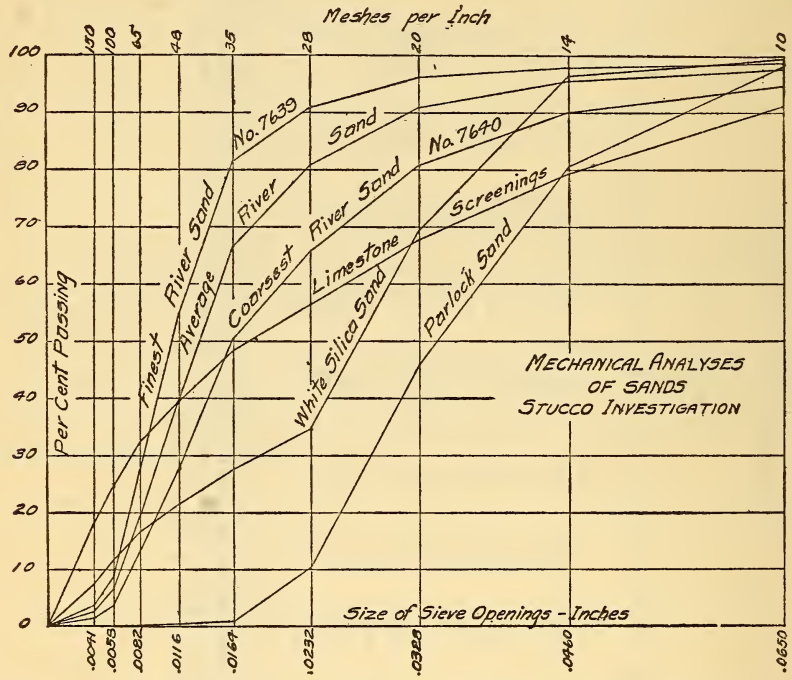

FIG. 34.—*Curves showing the granulometric composition of sands used in the stuccos*

foot measure, without special compacting, in a manner which imitates as nearly as possible that used in commercial practice.

The following results were obtained from a number of trials on each material:

	Weight of 1 cubic foot in pounds.
River sand (damp, shoveled in)	83
"Alca" lime (scooped from sack)	41
"Limoid" (high, magnesian hydrated lime, scooped from sack)	36
"Berkeley" (high calcium hydrated lime, poured from sack)	36
"Tidewater" (cement, poured from sack)	94
White silica sand (poured dry)	93
Limestone screenings (poured dry)	106

On the basis of the foregoing figures the stuccos are given in the following table, both by weight and volume proportions:

TABLE 6

Weight-Volume Relations of Stucco Materials

Stucco	Proportions by weight	Proportions by volume
A-1, A-3	1 cement, 0.1 hydrated lime, 3 sand	1 cement, 0.26 hydrated lime, 3.4 sand.
A-2	0.75 cement, 0.25 hydrated lime, 3 sand	0.75 cement, 0.65 hydrated lime, 3.4 sand.
A-4	1 cement, 0.1 hydrated lime, 4 sand	1 cement, 0.26 hydrated lime, 4.5 sand.
B-1, B-2	0.25 cement, 0.75 hydrated lime, 3 sand (second and third coats 4 sand).	0.25 cement, 1.96 hydrated lime, 3.4 sand (second and third coats 4.5 sand).
C-1	1 Alca lime, 3.5 sand (second and third coats 4 sand).	1 Alca lime, 1.7 sand (second and third coats 2.0 sand).
C-2	0.75 Alca lime, 0.25 cement, 3.5 sand (second and third coats 4 sand).	0.75 Alca lime, 0.12 cement, 1.7 sand (second and third coats 2.0 sand).
D-1	1 cement, 2.5 sand	1 cement, 2.8 sand.
D-2	1 cement, 2 sand (second and third coats 3 sand).	1 cement, 2.3 sand (second and third coats 3.4 sand).
D-3	1 cement, 3 sand	1 cement, 3.4 sand.
E	0.5 cement, 0.5 hydrated lime, 3 sand (second and third coats 4 sand).	0.5 cement, 1.3 hydrated lime, 3.4 sand (second and third coats 4.5 sand).
F-1	1 cement, 0.02 Medusa waterproofing compound, 3 sand.	1 cement, 3.4 sand (volume of Medusa waterproofing compound not determined).
F-2	1 cement, 0.09 Impervite waterproofing compound, 3 sand.	1 cement, 0.13 Impervite waterproofing compound, 3.4 sand.
G-1	1 cement, 0.3 hydrated lime, 3 sand (second coat, 1 white cement, 0.1 hydrated lime, 2 white silica sand).	1 cement, 0.78 hydrated lime, 3.4 sand (second coat, 1 white cement, 0.26 hydrated lime, 2.0 white silica sand).
G-2	1 cement, 0.1 hydrated lime, 3 sand (third coat, 1 white cement, 0.1 hydrated lime, 3 limestone screenings).	1 cement, 0.26 hydrated lime, 3.4 sand (third coat, 1 white cement, 0.26 hydrated lime, 2.7 limestone screenings).

In the foregoing table it should be noted that the river sand was measured and weighed damp, as used. If the sand had been measured dry, its weight per cubic foot would undoubtedly have been higher and the volume proportions of sand would have been somewhat less. For practical purposes, however, it is sufficient to remember that the volume proportions of cement and sand are approximately equal to their weight proportions, but since the weight of hydrated lime per cubic foot is less than half the weight of cement, a mixture of 1 part hydrated lime to 2 parts of sand by volume is nearly equivalent to a 1:4 proportion by weight.

VIII. SUMMARIZED REPORT ON CONDITION OF TEST PANELS

This report on the condition of the test panels embodies the results of two independent inspections, the first made on April 4 and 5 by Messrs. Bagnall, Earley, and Humphreys, expert plasterers and members of the advisory committee, and the second made on April 6 and 7 by Messrs. Wig, Pearson, and Emley of this Bureau. The same general plan was followed in the two inspections, viz, first a superficial examination was made in which the general condition and appearance of the panels was noted; then, a close and careful inspection was made immediately after spraying the panels with water. This treatment brings out very fine surface cracks and other defects which are not otherwise easily observed in the dry panels.

In the superficial examination the panels were observed from a distance of about 30 feet and notes made upon the color, uniformity of color, visible cracks, float marks, and general appearance. Under the general appearance, panels are rated as excellent, very good, good, fair, poor, and very poor, all conditions effecting appearance being taken into consideration except color. The notes tabulated below are self-explanatory, except under "float marks," which are designated as rough, medium, slightly visible, and smooth. These terms are intended to describe the relative combined effects of texture and evenness of floating and indicate in a general way the character of the surface finish.

In the detailed examination attention has been given mainly to defects due to construction, viz, cracks, separation of plaster coats, etc. An attempt has been made to divide cracks into four classes as follows: (1) Surface cracks, which are usually very fine and do not appear to penetrate into the body of the stucco. These cracks include, but are not limited to, the type commonly called "crazing," and are presumably caused by the effects of temperature changes and of alternate wetting and drying on the thin film of weak cementing material brought to the surface on finishing. (2) Body cracks, which appear to have some depth and may penetrate into the body of one or more coats of the stucco. These cracks, usually fine, are characterized by sharp, clean-cut edges, and are assumed to result from excessive strains in the body of the stucco set up by temperature changes, alternate wetting and drying, or by any causes which may induce differential movements between the plaster coats. It is frequently impossible to distinguish such

cracks from (3) Fundamental cracks, which appear to penetrate all coats of the stucco, but are not structural cracks. Thus fundamental cracks may appear over wood lath, over joints in wood lath, plaster board, or metal lath, over studs where sheathing is not used, or over joints in tile, concrete block, etc. The origin of such cracks is attributed to excessive strains set up by movements in the base which supports the stucco. (4) Structural cracks, which appear to be caused by settlement or movement of some part of the building and are not to be attributed to faults in the stucco itself or in its supporting base. Under "condition" in the following table the panels are rated on integrity alone, except that structural cracks are not taken into consideration. This exception is made on the ground that faults in construction of the building should not be charged against any particular stucco and its supporting base, although in residence construction such faults may not always be easily guarded against. It should be stated also that in assigning the rating surface cracks have been considered less serious than body cracks, and body cracks less serious than fundamental cracks.

The results of the inspection are given in tabular form on pages 60–66, and so arranged that they may be examined with easy reference to the panel plan, Fig. 35.

TABLE 7

Showing Condition of the Test Panels April 7, 1916

Panel No.	Base	Stucco	Superficial inspection				
			Color	Uniformity of color	Cracks	Float marks	Appearance
1	Metal lath	A-1	Light gray	Not wholly uniform	Prominent structural only	Rough	Fair to good.
2	do	A-1	do	do	do	do	Do.
3	do	B-2	Buff	Nonuniform dark patches	Structural and other prominent cracks.	Medium	Poor.
4	do	C-1	Buff to light buff	Not wholly uniform	Numerous, more or less visible.	do	Fair to poor.
5	do	D-2	Medium gray	Uniformly mottled	Structural cracks visible	Brush marks visible	Good.
6	do	D-3	do	Nonuniform	Structural only	Medium	Fair.
7	do	F-1	do	do	None	Rough	Do.
8	do	F-2	Dark gray	Uniform	Structural faintly visible	do	Very good.
9	do	A-2	Light buff	Badly streaked. Furring appears to show through.	Few structural only	Brush marks slightly visible.	Fair (good if not streaked).
10	do	A-1	Light gray	Not wholly uniform	Structural and other prominent cracks.	Rough	Fair.
11	do	B-2	Buff	Uniform, slight efflorescence.	Structural only	Medium	Very good.
12	do	A-1	Light gray	Uniform	do	Rough	Good.
13	do	C-1	Light (nearly white)	Not wholly uniform	Covered with prominent cracks.	Smooth	Very poor.
14	do	G-2	White	Uniform	None	Slightly visible	Excellent.
15	do	A-1	Dark gray	do	do	Rough	Do.
16	do	B-1	Light buff	Not wholly uniform	Structural only faintly visible.	Slightly visible	Good.
17	do	E	do	Uniform	One prominent fundamental.	Medium	Good (very good except for crack).
18	Wood lath	A-3	Medium gray	Not wholly uniform	Structural only	Rough	Good.

19	.....do.....	B-2...	Buff.....	.....do.....	Covered with prominent cracks.	Smooth.....	Very poor.
20	.....do.....	B-2...	.....do.....	.....do.....	A number of prominent cracks.	.....do.....	Fair (good except for cracks).
21	.....do.....	A-3...	Light gray.....	.....do.....	Structural only.....	Rough.....	Do.
22	.....do.....	B-1...	Light buff.....	Nonuniform.....	Structural and other prominent cracks.	Slightly visible.....	Poor.
23	.....do.....	C-1...	.....do.....	.....do.....	One structural.....	Smooth.....	Fair to poor.
24	.....do.....	A-3...	Dark gray.....	Not wholly uniform.....	Structural somewhat visible.	Medium.....	Good.
25	.....do.....	B-1...	Buff.....	.....do.....	Number of cracks parallel to lath.	.....do.....	Fair.
26	Plaster board.....	A-1...	Light gray.....	.....do.....	Several prominent cracks..	.....do.....	Fair (good except for cracks).
27	.....do.....	A-1...	.....do.....	.....do.....	.....do.....	.....do.....	Do.
28	.....do.....	A-1...	.....do.....	.....do.....	.....do.....	.....do.....	Do.
29	.....do.....	A-1...	.....do.....	.....do.....	.....do.....	.....do.....	Do.
30	Concrete block.....	A-1...	.....do.....	Several large discolored patches.	One crack slightly visible	.....do.....	Fair (good except for patches).
31	Terra-cotta tile.....	A-1...	Light gray.....	Not wholly uniform.....	None.....	Slightly visible.....	Good.
32	.....do.....	B-1...	Light buff.....	.....do.....	Cracks somewhat visible. Blisters and scaly patches.	Smooth.....	Poor.
33	.....do.....	C-1...	.....do.....	Nonuniform.....	Covered with prominent cracks.	.....do.....	Very poor.
34	.....do.....	D-1..	Dark gray.....	Not wholly uniform.....	None.....	Rough.....	Fair (good except for blotches).
35	.....do.....	A-1...	Light gray.....	Discolored patch and nonuniform.	Several cracks somewhat visible.	Slightly visible.....	Poor (fair except for patch).
36	.....do.....	A-2...	.....do.....	Nonuniform.....	Several prominent cracks..	Medium.....	Fair.
37	.....do.....	G-1...	White.....	Uniform.....	None.....	Smooth.....	Excellent.
38	.....do.....	A-1...	Dark gray.....	Uniform except for efflorescence.	.....do.....	Rough, especially upper half.	Fair (very good except for efflorescence).
39	Brick.....	A-1...	Light gray.....	Few prominent spots.....	.....do.....	Slightly visible.....	Fair (good except for spots).
40	.....do.....	B-2...	Buff.....	Nonuniform.....	.....do.....	Smooth.....	Fair.

TABLE 7—Continued

Panel No.	Base	Stucco	Superficial inspection				
			Color	Uniformity of color	Cracks	Float marks	Appearance
41	Brick (unfinished)						
42	Gypsum block	A-1	Dark gray	Uniform except for efflorescence.	Two prominent cracks	Slightly visible	Fair to poor.
43	do	A-1	do	do	do	do	Fair.
44	do	A-1	Dark and medium gray	Lower half uniformly dark, upper half nonuniform.	Three prominent cracks	Smooth	Lower half fair to good, upper half poor.
45	Monolithic concrete.	A-1	Light gray	Not wholly uniform, somewhat streaked.	None	Rough, somewhat wavy	Fair to good.
46	do	A-1	Dark gray	Nonuniform	do	Rough	Fair.
47	do	A-1	Medium gray	Uniform, slightly streaked and spotted.	do	Smooth, slightly wavy	Good.
48	do	A-1	Dark gray	Not wholly uniform	do	Medium	Very good.
49	do	C-1	Light	Uniform	do	do	Do.
50	do	A-1	Dark gray	Not wholly uniform	do	Rough	Excellent.
51	Bishopric board	A-1	Light gray	Uniform	Numerous prominent cracks.	Smooth	Fair (good except for cracks).
52	do	B-1	Light	Uniform, but shows efflorescence.	Several prominent cracks	do	Do.
53	Terra-cotta tile	A-1	Dark gray	Nonuniform, splotchy	Two slightly visible cracks.	Medium	Poor.
54	Metal lath	A-1	Medium gray	Not wholly uniform	Structural faintly visible	Rough	Fair to good.
55	do	C-2	Light buff	do	Structural	Medium	Fair (good except for cracks).
56	Clinton welded sheathing.	A-4	Dark gray	Nonuniform	None	Rough	Poor.

Panel No.	Base	Stucco	Detailed inspection			
			Cracks	Bond	Structural condition	Remarks
1	Metal lath	A-1	Structural and body. No surface cracks.	Good	Fair	Structural cracks mainly responsible for appearance rating.
2	do	A-1	do	do	do	Do.
3	do	B-2	Structural and body	do	do	Body cracks more vertical than horizontal. Some may follow furring or studs.
4	do	C-1	do	do	do	Do.
5	do	D-2	Structural and body, no surface	do	Fair to good	Body cracks not so wide as in panels 1 and 2.
6	do	D-3	Structural cracks, one small body crack.	do	Good	Panel discolored by cement gun spray from panel 48.
7	do	F-1	Structural and some surface	do	Very good	Efflorescence shows plainly on large section of panel.
8	do	F-2	Structural only	do	Excellent	Panels 7 and 8 braced to counteract effects of shrinkage in sheathing.
9	do	A-2	Structural vertical and horizontal body surface.	do	Fair to poor	Vertical cracks at regular intervals appear to follow furring. At least one horizontal crack follows lap of lath. Such cracks appear to be fundamental.
10	do	A-1	A number of structural and body, some fundamental.	do	Poor	Some fundamental cracks apparently following furring.
11	do	B-2	Structural, body, and fundamental	do	Fair to poor	Do.
12	do	A-1	Some structural and body, few surface.	do	Fair to good	Several body cracks at bottom may be fundamental over furring.
13	do	C-1	Numerous body, a few inches apart	do	Very poor	Cracks mostly vertical and horizontal. Some may follow furring and laps.
14	do	G-2	Surface and body slightly visible	do	Very good	Practically no cracks visible 10 feet away on account of color.
15	do	A-1	No cracks	do	Excellent	
16	do	B-1	Some structural, body surface and two fundamental.	Imperfect on right half.	Fair	Apparent efflorescence on right side. Fundamental cracks half height of panel over studs.
17	do	E	Several surface, structural, body, and one fundamental.	Good	do	Fundamental crack over stud.

TABLE 7—Continued

Panel No.	Base	Stucco	Detailed inspection			
			Cracks	Bond	Structural condition	Remarks
18	Wood lath	A-3	Structural and few body	Good	Good	
19	do	B-2	Structural and numerous large body cracks.	do	Poor	Some of these cracks my be fundamental.
20	do	B-2	Some structural, numerous large body	do	do	Do.
21	do	A-3	Structural, possibly one or two small body.	do	Very good	
22	do	B-1	Some surface and structural. Numerous fundamental and many body.	do	Very poor	Entire panel shows pattern of lath.
23	do	C-1	Structural and two body	do	Very good	Entire panel shows pattern of lath. Discolored by cement gun spray from panel 53.
24	do	A-3	Structural, several body	do	Good	Panel stained by "Parlock" spray from panel 42. Body cracks extend from bottom of panel to height of window sill.
25	do	B-1	Some surface and structural, numerous fundamental and many body.	do	Very poor	Entire panel shows pattern of lath.
26	Plaster board	A-1	Fundamental and body	do	Poor	Fundamental cracks follow joints in plaster board. Body cracks diagonal over surface of boards.
27	do	A-1	Fundamental, body, and surface	do	do	Fundamental cracks follow joints in plaster board. Body cracks diagonal over surface of boards. Some body cracks appear to follow lines of studs. "Parlock" treatment shows no beneficial effect. Felt board slightly wrinkled.
28	do	A-1	do	do	do	Felt board considerably wrinkled, cracked in one place. Chip board in good condition.
29	do	A-1	do	do	do	Felt board very little wrinkled.
30	Concrete block	A-1	Surface cracks over entire panel. Numerous body.	do	Fair	One vertical crack, may be structural.

31	Terra-cotta tile	A-1	Surface and body	Good	Fair to poor	Fine cracks covering entire panel a few inches apart. Do not follow outline of tile.
32	do	B-1	Numerous body, some surface	Top coat loose in spots.	Very poor	Body cracks cover entire panel a few inches apart in all directions.
33	do	C-1	Numerous body	Good	Poor	Do.
34	do	D-1	Slightly visible body cracks	Imperfect	Good	Stucco appears to be separated in spots, but no blistering or cracking apparent.
35	do	A-1	Numerous body, some surface	Good	Fair to poor	Body cracks several inches apart. Upper and lower sections alike.
36	do	A-2	Numerous body and surface	do	Upper half good, lower half fair.	Only surface cracks on upper half. Left half shows efflorescence.
37	do	G-1	Body 8 to 10 inches apart on lower half, two or three on upper half.	do	(See remarks)	Upper half excellent, "parlocked" quarter fair to good, "antihydrine" quarter fair.
38	do	A-1	Numerous body on lower half, none on upper.	do	do	Efflorescence mostly on "antihydrine" quarter. Upper half excellent, lower half fair.
39	Brick	A-1	Surface, over entire panel an inch or two apart.	do	Very good	No difference in sections with and without hair.
40	do	B-2	Numerous surface, several body	Mortar soft and flaking just above water table.	Fair to good	Surface cracks several inches apart cover entire panel.
41	Brick (unfinished)					
42	Gypsum block	A-1	Two body, some surface	Good	Good	One crack appears deep and may be fundamental.
43	do	A-1	Two large body	Sounds hollow in lower right corner.	do	Cracks may be fundamental.
44	do	A-1	One or two structural, numerous body, especially in lower half.	Poor in several spots.	Upper half poor, lower half very poor.	
45	Monolithic concrete	A-1	Numerous body and surface	Good	Fair	Very fine cracks running in all directions and close together.
46	do	A-1	Surface, one small body	do	Very good	Surface cracks faintly visible over entire panel.
47	do	A-1	Surface only	do	do	One small blister noted.
48	do	A-1	Numerous surface only	do	do	Surface cracks particularly numerous in lower section.

TABLE 7—Continued.

Panel No.	Base	Stucco	Detailed inspection			
			Cracks	Bond	Structural condition	Remarks
49	Monolithe concrete.	C-1...	Fine body only.....	Good.....	Good.....	Cracks mostly vertical and horizontal and short. One or two run across panel.
50	.....do.....	A-1...	A number of surface only.....	.....do.....	Excellent.....	Cracks only faintly visible.
51	Bishopric board....	A-1...	Structural, fundamental, and body.....	.....do.....	Poor.....	Some body cracks appear to penetrate all coats. Most cracks do not occur at joints. Right half appears to have bulged outward. Majority of cracks parallel to lath.
52	.....do.....	B-1...	Two structural, some fundamental and surface, many body.	.....do.....	Very poor.....	Most cracks do not appear at joints. Bottom of panel flaking, apparently due to freezing.
53	Terra-cotta tile.....	A-1...	Numerous surface and some body.....	.....do.....	Fair.....	Surface cracks 8 to 10 inches apart over entire panel.
54	Metal lath.....	A-1...	Structural only.....	.....do.....	Excellent.....	
55	.....do.....	C-2...	Structural and body.....	.....do.....	Fair to good.....	Body cracks at regular intervals along bottom of panel indicate that they may follow furring.
56	Clinton welded sheathing.	A-4...	None.....	.....do.....	Excellent.....	Surface partly scaly and nonuniform due to freezing.

From this table it will be noted that the following panels have a rating of "good" or better both in appearance and structural condition: Nos. 8, 14, 15, 18, 24, upper half of 37, 47, 48, 49, and 50. It should be borne in mind, however, that the type of finish adopted for the test panels is designed to bring out the defects of the stuccos more prominently than the rougher finishes, and wherever defects of finish or structural defects have marred the general appearance, too great weight should not be given to the appearance ratings. Thus a number of additional panels will be found that are good, very good, or excellent structurally, but are not in the satisfactory class for some cause which it is believed can be easily remedied. Panels which come into this class are: Nos. 6, 7, 21, 34, upper half of 36, 38, 39, 46, 54, and 56. Of these panels, Nos. 6 and 21 show structural cracks, which are attributed to shrinkage of sheathing. Similar cracks have occurred on all panels of similar construction, but have not occurred on the panels over frame construction where sheathing was not used. In sheathing the second-story walls on the east and west side the boards were laid diagonally in one direction, which appears to have resulted in a rack upon the frame of all the panels so sheathed. It is believed that if adjacent panels had been sheathed in opposite directions, the structural cracks would have been largely eliminated. Panels 34, 39, 46, 54, and 56 have a reduced rating mainly on account of the method of finishing. The condition of these panels, and a number of others, indicates positively that a more even and pleasing finish can be obtained if the water content of the finish coat is kept under control, and the floating is done in such manner as to bring out the grain and, in so far as possible, to keep the fine cementing material from coming to the surface. Under these conditions surface cracks are much less likely to form, and, if they do occur to some extent, are much less visible. Panel 56 deserves special mention in that it is structurally perfect but on account of freezing of the finish coat a few hours after application has a thin scaling film over a considerable portion of the surface. Panels 7, 36, and 38 are discounted for efflorescence which is especially conspicuous on a smooth finish.

It does not seem desirable at the present time to go into further classification of the panels according to their rating, nor to draw general conclusions from many of the numerous comparisons which might be made. Mention should be made, however, of an attempt to determine the effect of the waterproofing compounds used in panels 7 and 8 in preventing absorption of water in comparison with stuccos of similar composition. The test was made by

wetting down panels 5, 6, 7, 8, 9, and 10 on the east side of the building three afternoons, the water being applied with a hose to each panel five alternate minutes and timing the rate of drying. An attempt was made to note the time when the first dry spot appeared, when approximately one-half the panel appeared dry, and when the panel was completely dry (except for water held in cracks and along the edges). From these and other observations it is now believed that the apparent rate of drying depends, perhaps largely, upon other factors than the composition of the stuccos and the assumption that the amount of absorption is indicated by the rate of drying under similar exposure conditions is not wholly justified. Nevertheless, a stucco which dries quickly or shows little contrast between damp and dry areas is desirable, and the following table of observations shows that the six panels differ considerably in this respect:

TABLE 8

Observations on the Rate of Drying of Waterproofed and Unwaterproofed Stuccos

Panel No.	Interval in minutes from end of wetting to—												Remarks
	First dry spot				One-half dry				Completely dry				
	May 22	May 27	May 29	Mean	May 22	May 27	May 29	Mean	May 22	May 27	May 29	Mean	
5....	15	14	17	15	71	66	90	76	(a)	(a)	(a)	180	Change from wet to dry gradual; damp areas merge into dry without distinct lines of separation. On account of slow rate of drying, time when completely dry not determined.
6....	13	10	15	13	28	30	35	31	103	80	(b)	92	Dries out gradually, showing blotchy appearance when partially dry. A number of round spots 2 or 3 inches in diameter appear damp long after remainder of panel appears dry.
7....	12	15	15	14	24	26	27	26	60	55	66	60	Contrast between wet and dry areas sharply defined. Appears very dark when wet. Two or three very small spots appear damp long after remainder of panel appears dry.
8....	10	9	10	10	24	22	23	23	59	38	42	46	Contrast between wet and dry areas even greater than in panel 7, otherwise the same remarks apply.
9....	9	12	13	11	23	23	35	27	84	71	(b)	78	Difficult to determine rate of drying on account of network of cracks, many of which show damp areas 2 or 3 inches wide long after remainder of panel appears dry.
10....	5	8	6	6	18	19	18	18	73	60	59	64	Same remarks apply as for panel 9, but wet areas at cracks are not so wide. This panel also shows a small slow drying area left of window.

(a) Estimated. (b) Thundershower May 29 prevented completion of observations on panels 6 and 9.

The weather conditions at the time the foregoing tests were made were as follows:

May 22, sky overcast, temperature 68, relative humidity 41, moderate gusty breeze.

May 27, sunny, some haze, temperature 85, relative humidity 46, moderate breeze.

May 29, sunny, some haze, temperature 85, relative humidity 50 to 60, sun obscured by approaching clouds 2.50 p. m., shower at 3 p. m.

The results of the tests are inconclusive. Panels 8, 7, and 10 show more rapid drying than panels 5 and 6, but there is a very great difference between the last two which is not easily explained. Similar unaccountable differences have been noted in other panels; for example, panel 50, directly under panel 5, is a very quick-drying panel, whereas panel 47, directly under panel 8, dries very slowly. These two panels have the same stuccos and similar bases.

IX. OBSERVATIONS

It is believed that general conclusions based on the present condition of the test panels are premature, and that further developments should be awaited and the results of an extensive field investigation should be available before recommendations for stucco construction are attempted. However, those especially interested in the subject may obtain much suggestive information by studying the tables containing the description of the forms of construction and present condition of the panels. Attention is called below to certain observations in connection with the test structure which are sufficiently interesting and important to warrant special mention in this first progress report. These are as follows:

1. No structural cracks have yet appeared in the test structure which can certainly be attributed to settlement. Those which are classed as structural cracks occur almost entirely in the sheathed panels of the second story, and the evidence indicates that these cracks are due to an improper method of sheathing.

2. Examination of the back of the panels in Groups I and II shows that where hair was used in the first coat the lath is generally well embedded, though where hair was omitted the lath is more completely embedded.

3. There is no apparent difference in the condition of the panels in which coated and uncoated wood lath was used which can be attributed to the treatment of the lath.

4. No fundamental cracks have been certainly identified over joints in tile, brick, concrete block, or gypsum block.

5. The lighter shades of stucco show cracks less prominently after wetting than the darker shades.

6. The stuccos applied directly on monolithic concrete bases have without exception been satisfactory to date.

7. The prominence which the smooth sand-float finish gives to fine cracks, unevenness of texture, blotches, and other small defects suggests the advisability of finishing stuccos with rougher surfaces, such as the "rough-cast" or "pebble-dash" finishes.

X. REPORT OF EXPERT PLASTERERS, MESSRS. EARLEY, BAGNALL, AND HUMPHREYS, ON CONDITION OF STUCCO PANELS APRIL 4 AND 5, 1916

We have classified cracking under three headings:

(1) Structural cracks, which probably extend through all coats, caused by movements in the building, appearing generally at or near window and door openings.

(2) Map cracks, which are secondary cracks, extend through one or more coats, and are probably due in some cases to over-rich mixtures, in others to movements in the stucco itself. All of these secondary cracks are termed map cracks without regard to their direction or pattern. There were many cracks of this type which we could not satisfactorily explain.

(3) Craze cracks. Under this head we have considered the very light irregular cracks which seem to be in the surface. We think these cracks are in a thin film of cementing material which is brought to the surface by finishing the stucco when it is too wet.

In this inspection color and texture of the panels were not taken into consideration, the statements being based on the general condition of the panels without regard to the type or quality of finish.

Panel 1.—Good panel except for large structural cracks around window. After wetting: Only structural cracks shown.

Panel 2.—Same remarks as for panel 1.

Panel 3.—Several cracks. Those at bottom of panel appear to be due to weakness over door. After wetting: Map cracked; cracks appear to run in straight lines rather than cross hatched.

Panel 4.—Poor condition, badly cracked, appearance not bad from distance. After wetting: Appears about the same as panel 3.

Panel 5.—Very good panel except for cracks around window. After wetting: A few additional cracks show under window.

Panel 6.—Same remarks as for panel 1.

Panel 7.—Very good condition. Cracks at window corners barely visible from ground. The better condition of panels 7 and 8 attributed to bracing behind. After wetting: Condition the same.

Panel 8.—Same remarks as for panel 7.

Panel 9.—Same remarks as for panel 1.

Panel 10.—Extensively cracked, more so than most of the panels on this side. The fault is believed to be in the base construction, but it is not clear why this panel differs in this respect from similar panels. After wetting: Condition the same.

Panel 11.—Panel looks well, a few very fine cracks. After wetting: Considerably map cracked.

Panel 12.—Same remarks as for panel 1.

Panel 13.—Very poor condition on lower half, upper half better. The mortar is probably too rich and floated too soon. After wetting: A few more cracks visible.

Panel 14.—Excellent condition. After wetting: Considerable crazing, probably due to wet finish.

Panel 15.—Excellent condition. After wetting: Condition the same.

Panel 16.—Panel good. Frost appears to have caught a section on right hand side. After wetting: Shows map cracks.

Panel 17.—Generally good panel except lower-left quarter which has crack over stud and several hair cracks probably due to floating too soon. After wetting: Considerable map cracking.

Panel 18.—Same remarks as for panel 1.

Panel 19.—Poor condition, badly cracked, possibly due to shrinkage (long cracks), also too rich. Condition confirmed with wetting.

Panel 20.—Same remarks as for panel 19.

Panel 21.—Same remarks as for panel 1.

Panel 22.—Panel good except that it shows pattern of lath. After wetting: Same condition, more cracks visible. Position of these cracks indicates that many were caused by the base.

Panel 23.—Panel good except that it shows pattern of lath. After wetting: Condition good, cracks at window.

Panel 24.—Same remarks as for panel 1. After wetting: Shows a few structural and map cracks.

Panel 25.—Appears well from a distance. After wetting: Badly cracked. Position of these cracks indicates that many were caused by the base.

Panel 26.—Panel good except for horizontal and vertical cracks. After wetting: Little or no map cracking or crazing. Position of structural cracks indicates that the cause is the base.

Panel 27.—Same remarks as for panel 26.

Panel 28.—Same remarks as for panel 26.

Panel 29.—Same remarks as for panel 26.

Panel 30.—Very good panel aside from blotchy appearance. Apparent shrinkage cracks below window. After wetting: Badly crazed and map cracked. Blotchy appearance probably caused by uneven drying; cement blocks probably held more water in one place than another.

Panel 31.—Badly map cracked. Panel hard, good bond. Left half o. k. in appearance, rather better than right half. After wetting: Badly map cracked all over, both sides equally bad. At present time do not think it advisable to assign cause.

Panel 32.—Badly map cracked; appearance bad; caught with frost; mortar too rich. After wetting: Same report as for panel 31, appearance similar to panel 31.

Panel 33.—Very unsatisfactory appearance and condition. Probably too rich mix. Mortar very hard but badly map cracked. Bond good. After wetting: Condition the same.

Panel 34.—Panel very good but peculiar blue-gray color. Bond appears to be broken in places. After wetting: Considerably map cracked.

Panel 35.—Badly cracked, blotchy appearance. Most of cracking appears to be over glazed tile. After wetting: Badly map cracked and crazed. Blotchy condition due to uneven drying construction, probably held more water in one place than another.

Panel 36.—Badly cracked in lower half. Bond good. After wetting: Condition same; map cracked and slightly crazed.

Panel 37.—Very good panel. After wetting: Considerably crazed and map cracked. Very difficult to make examination owing to extreme whiteness of finish. At present time can not notice any difference over the coated and uncoated portions of the base.

Panel 38.—Very good panel, bond perfect. After wetting: Badly map cracked. At present time can not notice any difference over the coated and uncoated portions of the base.

Panel 39.—Panel craze cracked. Two members of the committee think more sand in the stucco would have been better. After wetting: Badly crazed, probably due to finishing too wet.

Panel 40.—Very good panel. After wetting: Showed considerable map cracking.

Panel 41.—Unfinished.

Panel 42.—Good panel except for large crack above and below window, probably due to contraction. After wetting: Structural and craze cracks visible.

Panel 43.—Good panel except for two large cracks below window. After wetting: Condition same.

Panel 44.—Top coat on lower half cracked and bond poor in places. Upper half bond appears good. After wetting: Showed map cracks and crazing.

Panel 45.—Good panel. Probably finished too soon for good surface. Too much cement worked to top. Bond good. After wetting: Badly crazed.

Panel 46.—Good panel. Slightly craze cracked along water table, probably due to heavy coat. Good bond. After wetting: Badly crazed, appears to have been finished too wet.

Panel 47.—Good panel, good bond. Probably finished too soon for good surface. After wetting: Badly crazed.

Panel 48.—Fairly good panel except for considerable map cracking just above the water table. This cracking more extensive than on the two adjacent panels (46 and 45), perhaps due to richer mix resulting from gun application. Good bond. One member of committee expressed the opinion that the craze cracking is more probably due to too much cement on the finished surface than to too rich a mix. After wetting: Same condition.

Panel 49.—Good panel, slightly cracked at bottom. May be due to slightly heavy coat and floating too soon. After wetting: More map cracks show but are very short and in straight lines.

Panel 50.—Excellent condition, good bond. After wetting: Condition same (slightly crazed on bottom above water table).

Panel 51.—Appearance bad. Panel contains several large cracks but is not map cracked. After wetting: Same condition.

Panel 52.—Several large cracks, appearance bad. Stucco flaked off under door sill, apparently due to frost. Dampness appears to be working up from water table. After wetting: Badly map cracked, other conditions the same.

Panel 53.—Good panel aside from color. Fine cracks discernible. After wetting: Blotches from resurfacing; map cracked and crazed.

Panel 54.—Same remarks as for panel 1.

Panel 55.—Appearance good except for several cracks radiating from window. After wetting: Condition similar, a few cracks showed.

Panel 56.—Appears well except for flaked surface due to frost. After wetting: Condition same.

XI. SUPPLEMENTARY REMARKS ON THE CONDITION OF THE TEST PANELS DECEMBER 8, 1916

Owing to the delay in publication of this paper it has been deemed advisable to add a statement covering the more obvious developments in the test panels since the April, 1916, inspection. The following remarks are based on an examination of the panels

December 8, 1916, made by the Bureau, but not with sufficient thoroughness to warrant an entire revision of the April ratings.

Panel 1.—Cracks more prominent and noticeably more numerous.

Panel 2.—Cracks more prominent and decidedly more extensive than in panel 1. Condition of this panel now approximates that of panel 9.

Panel 3.—No decided change.

Panel 4.—No decided change.

Panel 5.—No decided change. This panel is now in better shape than panels 1 and 2.

Panel 6.—No decided change.

Panel 7.—Structural cracks larger and more prominent.

Panel 8.—Structural cracks larger and more prominent.

Panel 9.—More extensively cracked. Condition poor.

Panel 10.—More extensively cracked. Condition very poor.

Panel 11.—No decided change.

Panel 12.—A number of vertical body or fundamental cracks have developed, together with many surface cracks. Condition fair to poor.

Panel 13.—No decided change.

Panel 14.—Surface and apparently a number of fine body cracks cover nearly entire panel. These cracks are barely perceptible without wetting the panel.

Panel 15.—No change.

Panel 16.—More extensive body cracking.

Panel 17.—More extensive body and surface cracking.

Panel 18.—A number of cracks parallel to lath, visible without wetting. Considerable development of body and surface cracks, especially on lower half.

Panel 19.—No decided change. Shows pattern of lath after wetting.

Panel 20.—No decided change.

Panel 21.—Two or three prominent cracks parallel to lath visible without wetting. Five long cracks of this type showed after wetting.

Panel 22.—No decided change.

Panel 23.—No decided change.

Panel 24.—No decided change.

Panel 25.—Extensively cracked, both parallel and perpendicular to lath.

Panels 26, 27, 28, 29.—Structural and fundamental cracks more prominent.

Panel 30.—Shows three or four prominent cracks without wetting. Otherwise no decided change.

Panel 31.—Body cracks apparently more numerous. Some are visible without wetting.

Panel 32.—Body cracks apparently more numerous. Some are visible without wetting.

Panel 33.—No decided change.

Panel 34.—Body cracks now well distributed over entire panel. These cracks are not readily visible without wetting.

Panel 35.—No decided change.

Panel 36.—Possibly more extensive cracking. No decided change.

Panel 37.—No decided change.

Panel 38.—Cracking more extensive. Numerous body cracks have developed in upper half.

Panel 39.—No decided change.

Panel 40.—Possibly more extensive cracking. No decided change.

Panel 42.—Five prominent cracks. Otherwise no decided change.

Panel 43.—No decided change.

Panel 44. Cracks more numerous and prominent. On lower half stucco is separating and beginning to warp.

Panel 45.—Cracks prominent without wetting. Otherwise no decided change.

Panel 46.—Fine lace work of surface cracks covers entire panel. One large structural (?) crack extending through the concrete wall below window runs down into water table but apparently does not extend through concrete sill.

Panel 47.—Surface cracks form very fine and even lace work pattern over entire panel.

Panel 48.—No decided change.

Panel 49.—Fine cracks appear to be more numerous. No decided change.

Panel 50.—No decided change.

Panel 51.—Cracks wider and more conspicuous.

Panel 52.—Cracks appear to be more prominent and disintegration of coating at bottom of panel progressive.

Panel 53.—No decided change.

Panel 54.—No decided change.

Panel 55.—Possibly more extensive body cracking.

Panel 56.—One fine crack, possibly structural, has developed, extending from upper right corner of window to cornice. No other change apparent.

WASHINGTON, July 13, 1916.