GYPSUM PARTITION TILE

THE GYPSUM INDUSTRIES

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by

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The American Institute of Architects
Standard Construction Classification
10a3

THE GYPSUM INDUSTRIES
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INDEX

General Data

PREFACE

GYPSUM TILE or block for interior non-bearing partitions and the fireproofing of structural steel columns, girders and beams has been in use in this country for the past twenty-five years. Numerous fire and water tests have been conducted during this time on gypsum tile partitions, at the Underwriters' Laboratories, Inc., Columbia University, and by the British Fire Prevention Bureau. The fire test data in Part I of this publication are taken from these tests.

The Technical Problems Committee of The Gypsum Industries prepared the specifications in Part II governing the erection of gypsum partition tile. The methods recommended therein have been adopted as standard by this Industry.

Part III contains the American Society for Testing Materials Standard Specifications for Gypsum Partition Tile or Block (C52-27). It is recommended that specifications governing the quality of gypsum tile shall conform to these standards.

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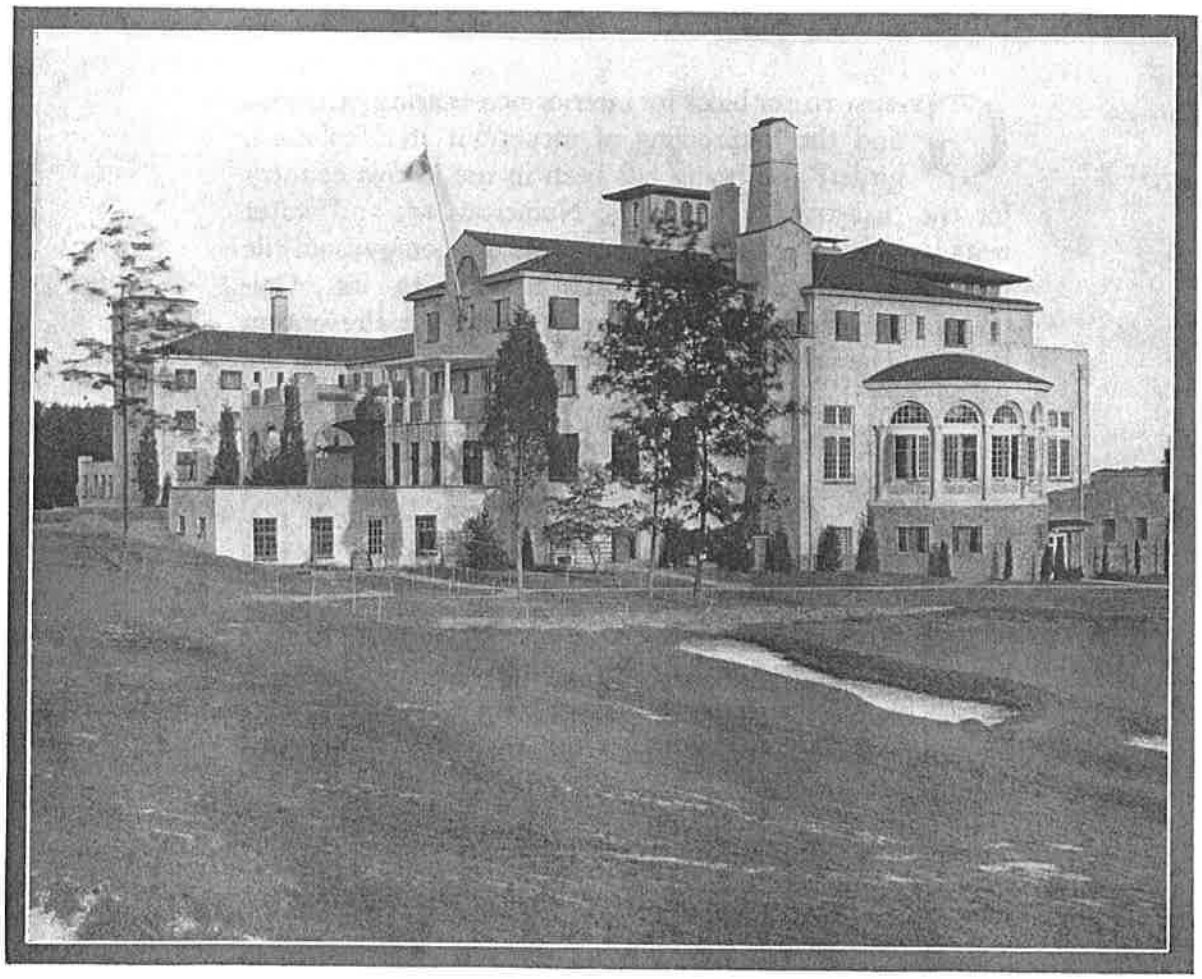
Chief Engineer
THE GYPSUM INDUSTRIES

February 1, 1928



Congressional Country Club, Bethesda, Maryland. P. M. Jullien, Architect.

GYPSUM PARTITION TILE

ALL materials used for fireproof partitions or enclosures, for the fireproofing of steel or other metal supporting members, or for fireproof construction of any character, in order to fully and effectively render the required fire protection must possess the following physical characteristics:

(1) They must be incombustible, so that by their presence in the construction the inflammability and fire hazard of the structure will not be increased. They must also be of such nature, and so erected, as to be capable of stopping or retarding the progress of fire by confining it to its place of origin.

(2) Such materials must be poor conductors of heat, so that constructions in which they are used, or of which they are a part, cannot, by fire, be raised in temperature to a degree which would cause the spread of fire by heat conduction through the material and construction.

(3) When subjected to the action of fire they must be of such character as not to heat quickly or readily. In the presence of fire temperatures they must be of such nature as to permit of the lowest possible total amount of expansion, since undue expansion under such conditions contributes to the creation of internal stresses which in turn will cause the warping, bulging, buckling and consequent disruption and disintegration of the structure in which they are placed and of which they are a part.

The questions of heat conductivity and low total amount of expansion are as important as the properties of fire resistance and incombustibility. Fires have spread from one side of a construction to the other by conduction only, also, columns and other supporting constructions have been pushed out of plumb, and have been wrecked, due to the high heat conductivity of the protective material, or the expansion of partitions and similar walls which were laid between such columns or constructions.

Gypsum tile or block possess all of the enumerated physical requirements for a perfect fireproofing material to a greater extent than any other known building material used for a like purpose in fireproof and other buildings.

FIRE BEHAVIOR OF GYPSUM

Gypsum is calcium sulphate with approximately twenty per cent of water combined with it in crystalline form. When gypsum is exposed to the action of fire this water of crystallization is liberated. This action is known as calcination and is that characteristic which gives gypsum its unique fire resistance. Calcination begins at the surface exposed to the fire and slowly continues into the wall. It proceeds more and more slowly as time goes on, due to the continually increasing thickness of calcined gypsum on the surface which acts as a barrier or insulator protecting the uncalcined portion from the fire.

At that point in the construction where calcination is in progress, the water of crystallization is being liberated and as it is a law of physics that water cannot be heated above 212° F., so it is likewise impossible to heat gypsum above this temperature until all of the water of crystallization has been evaporated.

The practical significance of this phenomenon of calcination is that the temperature of materials protected with gypsum cannot exceed 212° F. as long as there is any gypsum present. The behavior of gypsum in withstanding the effect of fire is

unique in that no other material used for like purpose retards the transfer of heat as it does. The following authentic and authoritative tests are presented in substantiation of these statements:

CALCINATION TESTS

In 1911 a series of fire tests on gypsum were conducted at the Underwriters' Laboratories, Inc. to determine the effect of heat at different temperatures applied for different periods of time.

The temperatures employed were 1000, 1300, 1600, 1900 and 2200 degrees Fahrenheit and the duration periods for each of these temperatures were for ½, 1, 1½, 2, 3, and 4 hours. Thermocouples were embedded in the gypsum at points 1, 2, 3, 4, and 5 inches from the exposed surface as well as thermometers on the unexposed surface. These tests were conducted on solid blocks of gypsum six inches thick and two feet square and conclusively proved that:

(1) The transmission of heat through gypsum is not proportional to the time or temperature.

(2) Transmission of heat proceeds more and more slowly as the duration of time increases.

(3) The calcined portion will not fall away but adheres to the uncalcined portion and retards further calcination.

(4) It is impossible to increase the temperature on the unexposed side above 212° F. while there is any water of crystallization in the gypsum.

The following table gives the furnace temperatures and the temperatures on the unexposed face of the tile for different periods:

Furnace Temperature in Degrees F.	*Temperature on Unexposed Face of Tile*					
	Duration of Fire in Hours					
	½	1	1½	2	3	4
1000	81	82	92	104	129	161
1300	80	83	94	113	146	178
1600	80	85	100	121	168	185
1900	73	80	100	129	179	189
2200	77	86	108	144	186	208

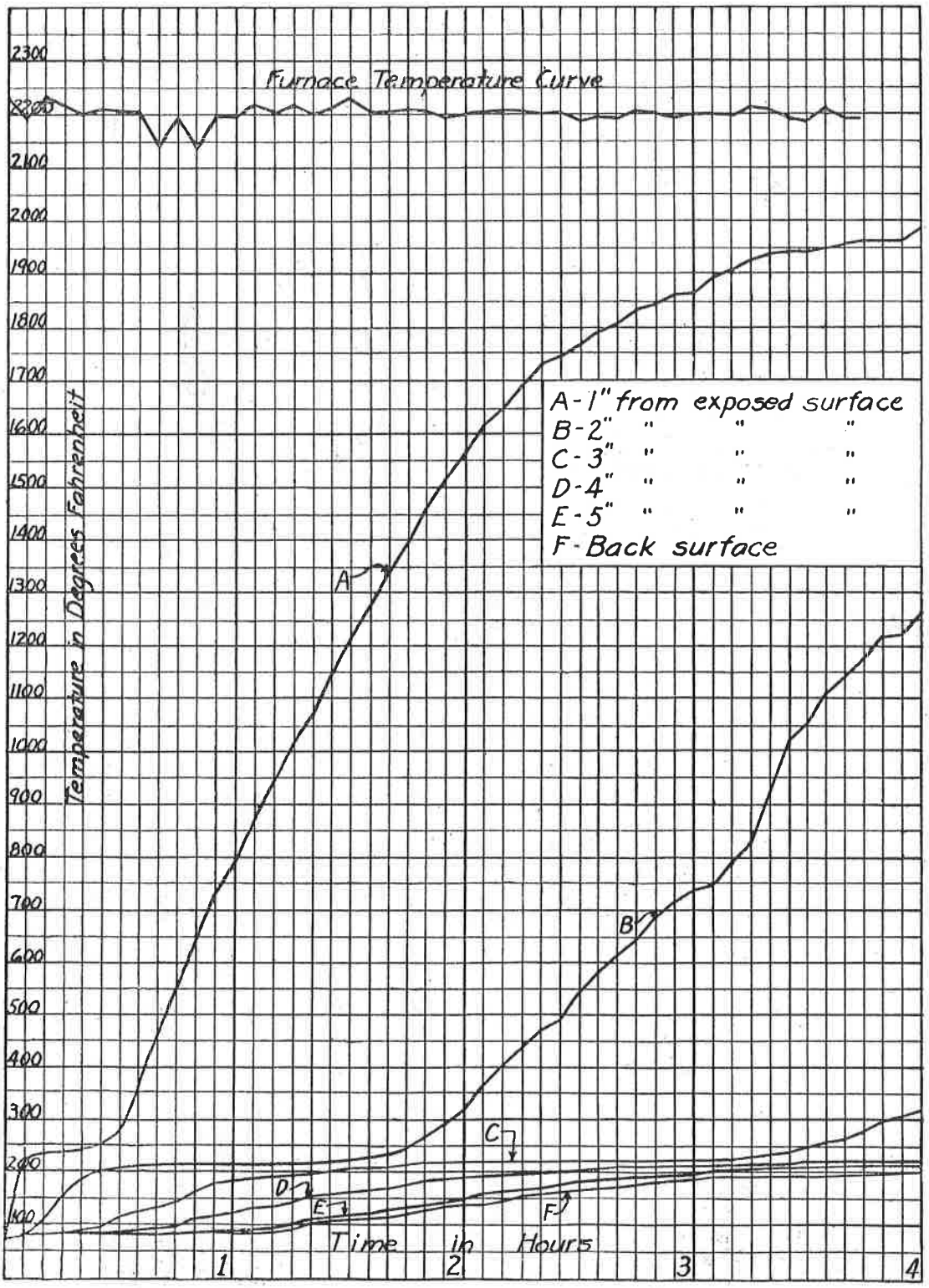
In the test the material calcined to a depth of 1¼ inches in one-half hour with a temperature of 2200° F. and with this same temperature applied for four hours, the depth of calcination was but $3\frac{5}{16}$ inches.

The temperature curves shown on the opposite page illustrate the resistance of gypsum to the passage of heat. This resistance is typical of all temperature applications, the variations being in the time taken to liberate the water of crystallization. With lower temperature applications the resistance is correspondingly greater. The chart illustrates the most extreme condition, namely, with 2200° F. applied.

STAIRWAY AND ELEVATOR ENCLOSURES OF SPECIAL CONSTRUCTION

A special type of gypsum partition construction was designed for protection around vertical communications. This construction consisted of five-inch solid blocks, twenty-four inches long and twelve inches high with the ends of the blocks grooved to receive one-half inch vertical reinforcing rods.

The horizontal joints were reinforced with strips of No. 24 gage diamond mesh expanded metal four inches wide. The partition was ten feet wide, eleven feet high, and plastered on both sides with five-eighths inch of sanded gypsum plaster. The furnace tem-

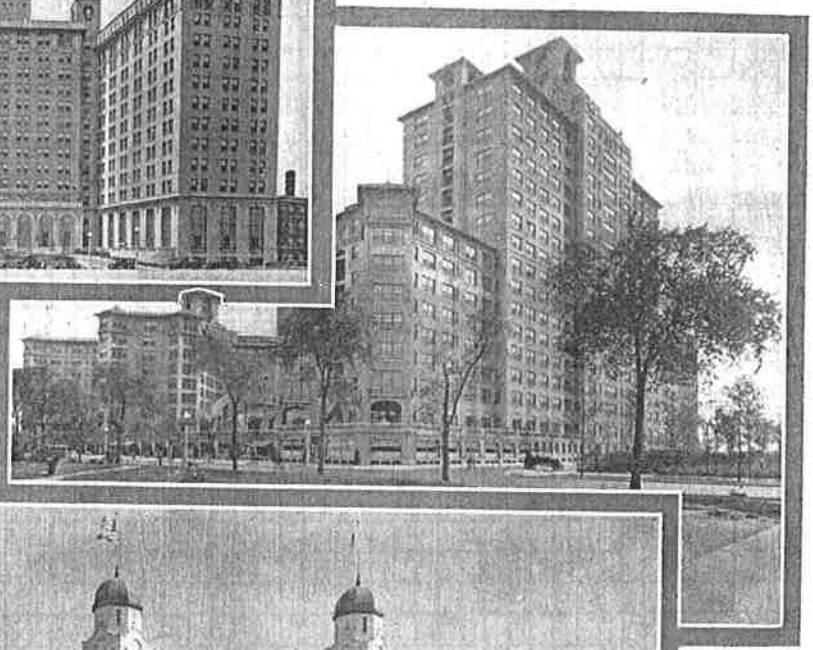


GRAPH SHOWING TEMPERATURES AT VARIOUS DISTANCES FROM EXPOSED SURFACE OF GYPSUM TILE SUBJECTED TO 2200° FAHR.

Arlington Hotel, Hot Springs, Arkansas, Mann & Stern, Architects, Little Rock, Arkansas.

Edgewater Beach Hotel, Chicago, Illinois, Marshall & Fox, Architects, Chicago, Illinois.

Shoreland Hotel, Chicago, Illinois, Fridstein & Company, Architects, Chicago, Illinois.



Nautilus Hotel, Miami Beach, Florida. Schultze & Weaver, Architects, New York City.

perature at the end of one hour was 1940° F. and near the end of the test it had reached 2300° F. without the full fire resistive value of the partition having been developed. The test was discontinued at the end of four and one-half hours and the panel allowed to cool. The blocks were found to be calcined about halfway through. The plaster on the exposed face was completely calcined and showed evidence of vitrification and fusion in places, particularly in the upper part of the panel, but on the unexposed side the plaster remained in place during the test without any reduction in bond. An idea of the severity of this test can be gained from the fact that the fire brick on the side and the concrete lintel above, fused and ran down on the panel. The insulation provided by gypsum against the transmission of heat at high temperatures is indicated by the temperature on the unexposed side of the panel which reached a maximum of 153° F. The calcined gypsum remained in place during the entire test, and taking into consideration the insulation it afforded to the gypsum back of the line of calcination, it is safe to assume that less than half the fire resistive period had been passed when the test was discontinued. A similar panel was submitted to the standard fire exposure for three-quarters of an hour, after which a hose stream from a 1⅛ inch nozzle under fifty pounds pressure for two and one-half minutes was applied to the panel from a distance of 18.4 feet. The fire stream washed off the calcined portion, which was about 1¼ inches deep including the thickness of the plaster.

FIRE AND WATER TEST ON THREE INCH GYPSUM TILE PARTITION

In June, 1909, the Underwriters' Laboratories, Inc. conducted a fire and water test on a three-inch gypsum tile partition plastered with wood fibered gypsum plaster. At that time the present specifications governing fire tests had not been adopted. These specifications recognize the injustice of submitting a partition to a fire stream test after it has undergone a fire endurance test, and take into account the fact that in an actual fire the firemen will have the water playing on the fire within a reasonable time after its start.

The fire test specifications under which materials and assemblies are now tested, provide for a fire endurance test which is continued until failure occurs or until certain specified test conditions have been met. If these conditions require a fire stream test, a duplicate sample is subjected to a fire exposure test for a period equal to one-half of that indicated as the resistance period in the fire endurance test, but not for more than one hour, immediately after which the fire hose stream is applied.

In the 1909 test, however, the fire stream was applied at a pressure of fifty pounds per square inch through a 1⅛ inch nozzle for five minutes to the sample which had just undergone the two-hour fire endurance test. The panel resisted the fire stream well. Only the calcined material was washed off, the plaster on the unexposed side remaining in place during the fire endurance and fire stream test. The temperature of the furnace during the last one and one-half hours of the test was 1700° F. and the temperature on the unexposed side of the panel at the end of the test was 166° F.

HEAT INSULATING VALUE

Mr. Walter A. Hull, formerly Associate Physicist at the Bureau of Standards, conducted a series of tests, the results of which are published in Technologic Paper of the Bureau of Standards No. 130 entitled, "A Comparison of the Heat Insulating Properties of Some of the Materials Used in Fire

Resistive Construction." In this paper Mr. Hull states:

> "These tables show that the length of time required for a temperature of 600° C. (1112° F.) to be attained at a depth of one and one-half inches does not vary greatly in the . . . and . . . specimens. The gypsums are seen to be distinctly better than the . . . and . . . in this respect, only one of them reaching the temperature of 600° C. (1112° F.) at a depth of one and one-half inches in the three and one-half hour test."

It is of considerable interest to note that of twenty-eight gypsum specimens tested, twenty-five had not reached the temperature of 600° C. at a depth of one and one-half inches at the end of four hours and ten minutes when the test was discontinued. Mr. Hull comments on this as follows:

> "Obviously, the gypsum specimens and the one of . . . having failed to reach 600° C. (1112° F.) at a depth of one and one-half inches, were far from reaching it at a depth of two and one-half inches and indicate distinctly superior thermal protection for embedded steel."

COLUMN PROTECTION TESTS

Definite information regarding the value of different types of material usually employed for fireproofing structural steel columns was not obtainable until the Bureau of Standards, the National Board of Fire Underwriters and the Associated Factory Mutual Fire Insurance Companies jointly conducted fire tests on building columns at the Underwriters' Laboratories, Inc., Chicago, from 1917 to 1919. In this series 106 columns were tested, there being 91 fire tests and 15 fire and water tests. The load was maintained constantly on the column during the test. Five columns protected with gypsum block were submitted to the fire test, and two columns to the fire and water test. The following table which gives the results of the tests on the gypsum protected columns clearly indicates the value of gypsum as a fireproofing material:

Table 42f.—Results of Fire Tests
Columns Protected by Gypsum Block

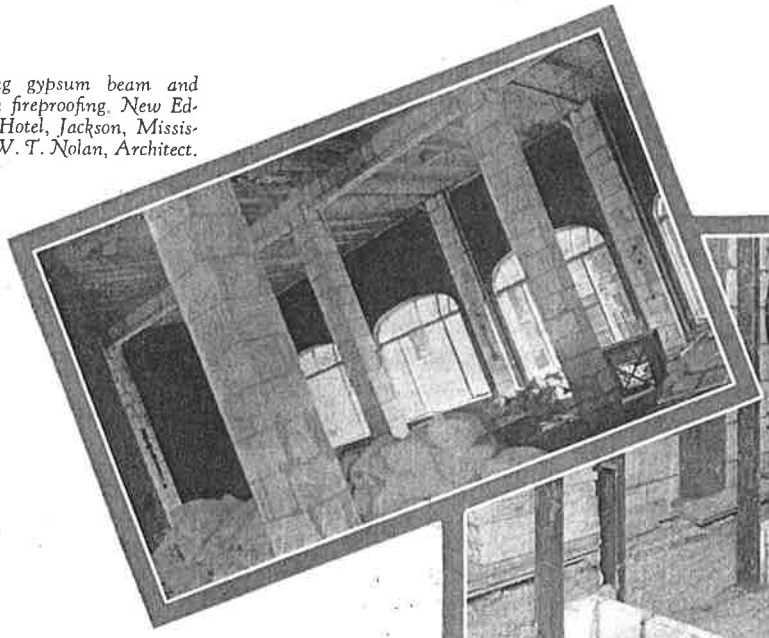
Test No.	Section	Protection: Thickness of Block In.	Protection: Kind of Block, Filling and Method of Tying	Age of Covering, Days	Load Sustained during Test, lb.	Time to Failure, hr.min.	Furnace Exposure Per cent
64	Rolled H	4	Western gypsum (solid). Hollow gypsum block fill. Wall ties in joints.	502	119500	4-43¼	104.5
65	Plate and Channel	2	Western gypsum (solid). Solid gypsum block fill. Wall ties in joints.	505	111000	2-21½	104.5
66	Latticed Channel	2	Eastern gypsum (solid). Poured gypsum fill. Wire mesh in joints.	495	111000	2-36	101.0
67	Rolled H	4	Same as No. 66.	492	119500	5-31½	101.2
67 A	Rolled H	4	Same as No. 66	491	119500	6-24½	99.7

The following passage is quoted from Technologic Paper of the Bureau of Standards No. 184 regarding the heat insulating properties of the gypsum covering:

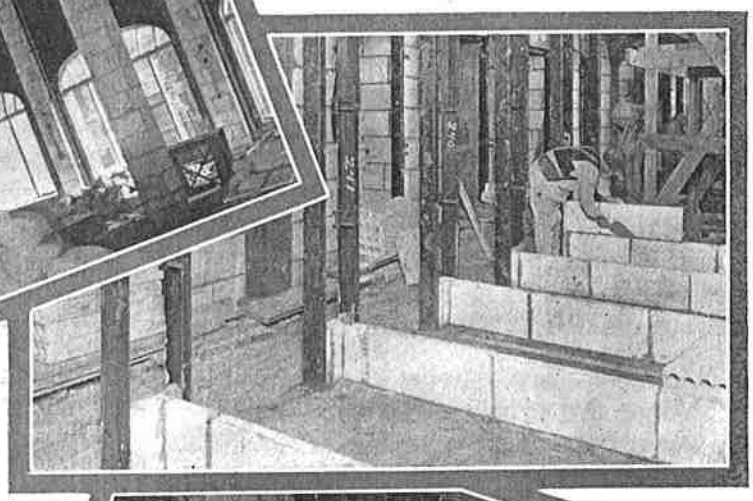
> "(4). *Heat Insulating Properties.* The maximum temperature in the steel up to the point where the blocks (gypsum) begin to fall off was generally below 150 degrees C. (302 degrees F.), which was much lower than those obtained in comparable tests with the other covering materials after the same duration of fire exposure. The high heat insulating value of gypsum is due in part to the heat consumed by the change in crystalline structure which consists mainly in the transformation of hydrated gypsum of the formula $CaSO_4 \cdot 2H_2O$ to anhydrous calcium sulphate, by evaporation of the chemically combined water."

The purpose of the fire protection of metal members is to prevent an increase of temperature to a critical point, of the members protected, and in this particular respect,

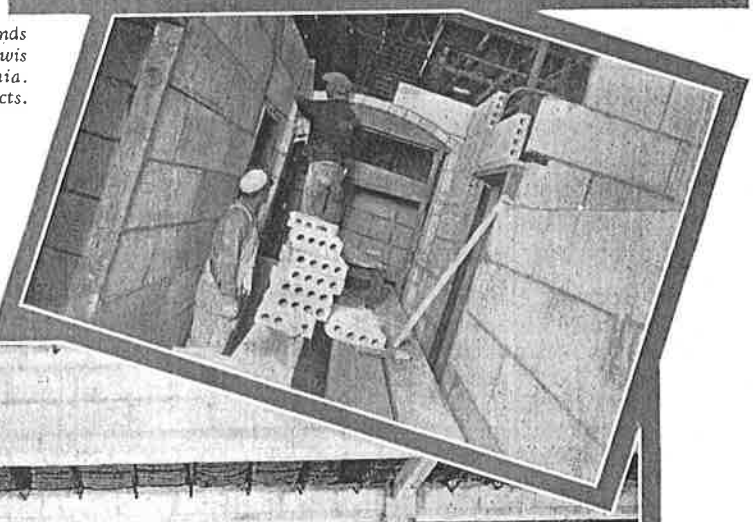
Showing gypsum beam and column fireproofing. New Edwards Hotel, Jackson, Mississippi, W. T. Nolan, Architect.



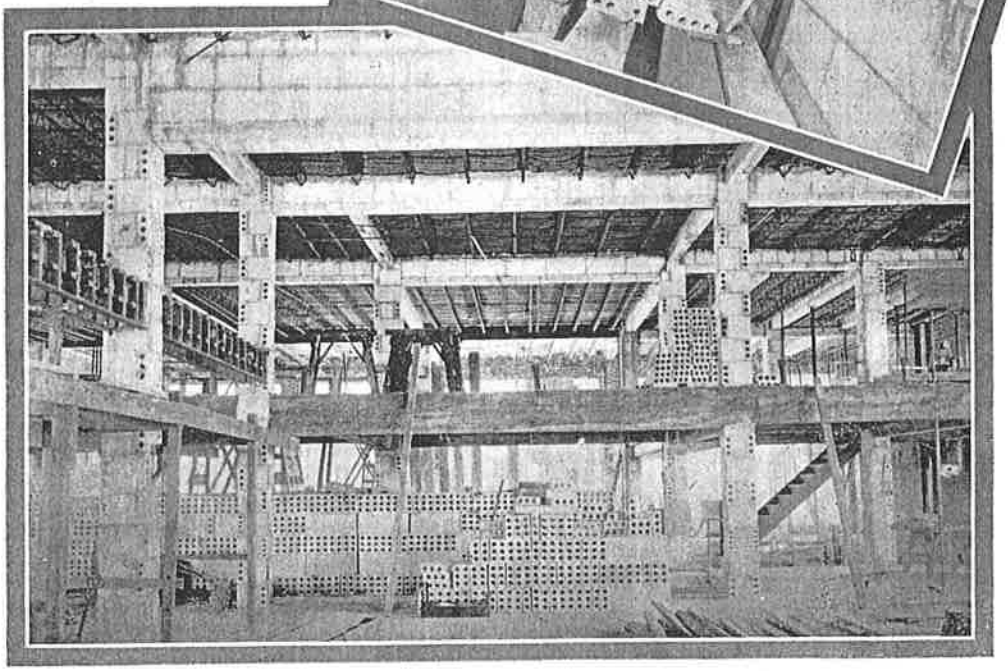
Showing erection of gypsum tile partition in connection with steel bucks. Peterson Storage Warehouse, Chicago. Moores & Dunford, Architects.



Illustrating how readily gypsum tile lends itself to circular work. Manuel Lewis Apartment, Sacramento, California. George C. Sellon Company, Architects.



Photograph showing the use of gypsum beam, girder and column fireproofing. Missouri Hotel, Jefferson City, Missouri. Kennerly & Stiegemeyer, Architects.



gypsum functions more efficiently than any of the materials commonly used for this purpose.

The Edison Company's fire at East Orange, New Jersey, in 1914, was an excellent example of the fire resistance afforded by gypsum tile. In this case the gypsum tile elevator enclosure, although calcined throughout, was still in place and afforded a barrier to the passage of fire. The temperature of the fire was estimated at 3300° Fahrenheit.

The twelve story Alwyn Court Apartment House fire in New York, March 4, 1910, was a wonderful illustration of the fire protection afforded by two inches of gypsum. The partitions, also of gypsum tile, absolutely checked the progress of the fire and saved the structure. The fused glass and hardware indicated that the temperature had reached about 2200° Fahrenheit. Experiences of a similar character, distinctly favorable to gypsum tile, are found in the history of many fires including the following:

Engineers' Building, University of Pennsylvania
Home Club, New York City
Perry Building, Philadelphia, Pennsylvania
Statler Hotels, Buffalo and Cleveland
Cleveland Athletic Club, Cleveland, Ohio
Knickerbocker Warehouse, Newark, New Jersey
Kresge Building, Detroit, Michigan.

Tests conducted by the Bureau of Buildings, New York City, to determine the efficiency of materials claimed to be suitable for fire protection purposes, and reported on December 23, 1903, when referring to gypsum state:

"It is evident that the plaster coverings (gypsum tile) offer the greatest resistance to heat transmission, and with them in this respect may be classed Lignolith.

"It seems that the solid (gypsum) block, which are generally more homogenous in structure, absorb the heat, holding and transmitting it to the iron plates gradually."

When reporting on Bureau of Standards' tests entitled "Fire Tests of Concrete Columns" (1918-1919), with reference to the additional fire protection afforded by the use of a covering of one inch of gypsum over the concrete, Mr. Walter A. Hull states:

"It will be seen that the ultimate strength of this column (No. 27), at the end of the four-hour fire test, was slightly more than three times the average strength of the two columns of the same kind which had no plaster * * * * the lower temperature attained in the center of the plastered column is to be credited largely to the thermal insulation of the (gypsum) plaster."

The Proceedings for 1925 of the American Society for Testing Materials contain a paper by Mr. S. H. Ingberg, Physicist at the Bureau of Standards, entitled "The Fire Resistance of Gypsum Partitions," which gives in concise form the results of numerous fire and water tests on gypsum tile partitions and concludes with the following paragraphs:

"Where gypsum partitions are built on combustible floors and have openings with wood framing, doors and sash, the fire resistance is limited by these details. Even so used, they serve the ordinary purposes of a partition and while no considerable degree of fire resistance is to be expected, the blocks add no fuel to the fire, and, as taken over the whole exposed area, they exert without doubt appreciable retarding effects.

"To develop the full fire resistance of the construction, gypsum partitions should be erected on incombustible foundations, preferably directly on incombustible and fire resistive floor constructions and against similar constructions at the top and sides. Door and window openings, where present, should be suitably framed with incombustible materials and doors and sash should be of metal and glazed with wire glass. Framing for heavy doors should preferably be anchored to the floor or roof construction above, to relieve the partition from undue impacts. With such details, gypsum block partitions can be practically applied in building construction so that they will develop a large part of the fire resistance indicated by performance in tests."

When the Underwriters' Laboratories, Inc. constructed the addition to their laboratories in Chicago they used gypsum tile partitions, and metal doors and sash glazed with wire glass.

OFFICE BUILDING ALTERATIONS

A study of materials, costs and construction practices in making alterations in office buildings was made by the Building Managers' Associaton of Chicago with assistance from the national association office. The work was begun in April, 1926, and completed April 1, 1927. The National Association of Building Owners and Managers, Chicago, Illinois, published the results of this investigation as a report entitled, "Office Building Alterations."

The data contained in the report were obtained from an investigation of seventeen buildings, all but one of which was located in what is known as the Loop District. Of the seventeen one was tenanted entirely by a large corporation, one had a medical tenancy, two were occupied by legal tenants, three were devoted almost entirely to retail shops on all floors, and the remaining ten had a general commercial tenancy.

The sizes of the buildings varied from 66,000 square feet of rentable area to 570,000 square feet, the average being 245,000 square feet. The buildings were from twelve to thirty-two stories in height.

Of the seventeen buildings included in the study one reported that no gypsum block was used, four used gypsum block and another material, and the remaining twelve used gypsum block for all subdividing partitions.

The preference of the various building managers for gypsum block was expressed as being due to the following reasons:

(1) Gypsum block is lighter in weight. This permits easier and faster handling.

(2) Gypsum blocks do not cause as much damage when dropped on marble, terrazzo or wood floors.

(3) Gypsum blocks may be cut with an ordinary hand saw, the same as lumber. This facilitates erection and such work as cutting a door in a standing wall.

(4) Gypsum block partitions are easily chased for conduits, switch boxes or pipe lines.

(5) Grounds are readily nailed to gypsum block and bucks may be anchored by nailing with ten penny cut nails directly into the end of each block course.

(6) The large gypsum block units, two and one-half square feet each, are economical to handle and set.

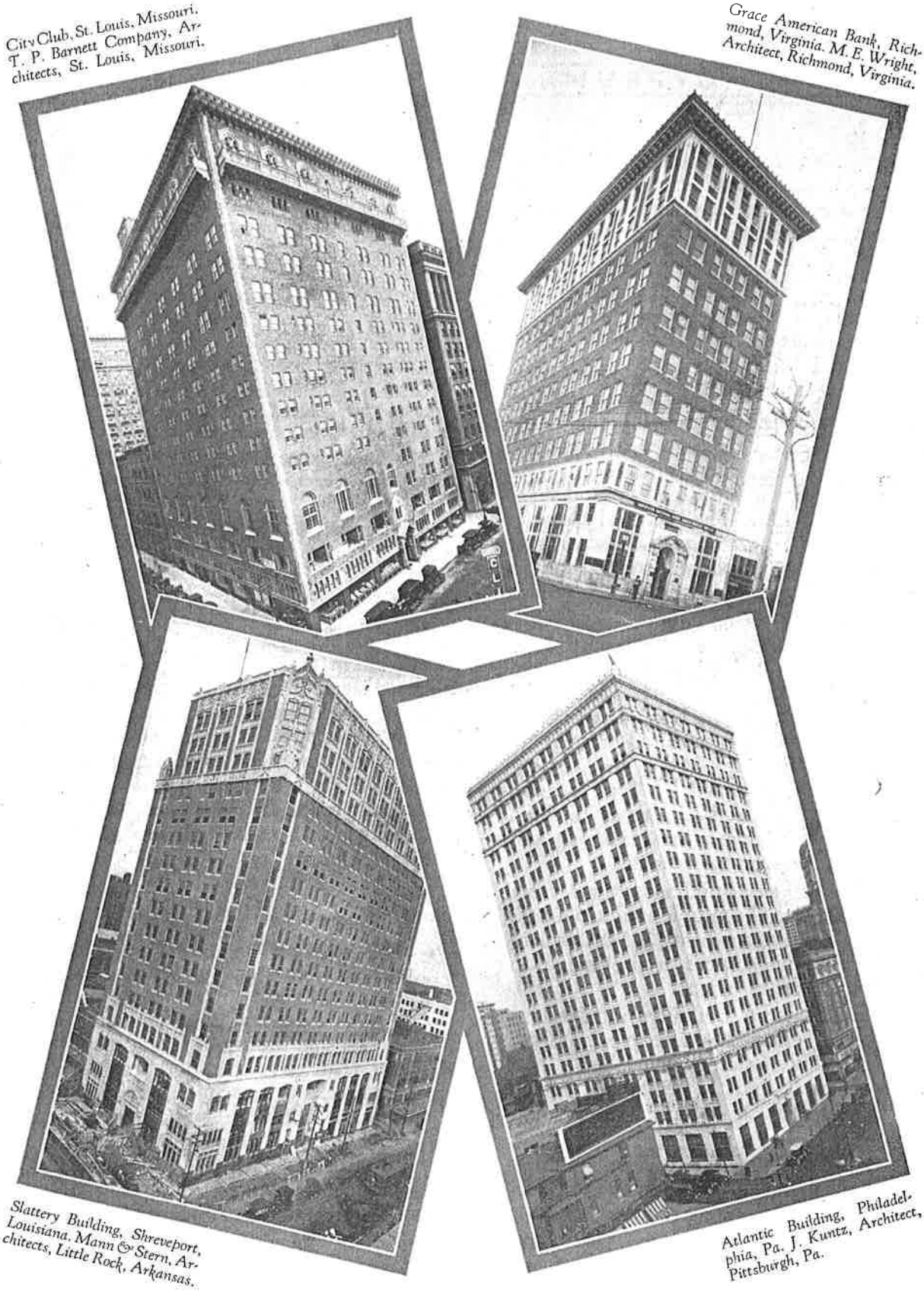
(7) The economy effected in wrecking these partitions.

EASE OF ERECTION

Because of the light weight of gypsum, these tile are made in units of two and one-half square feet per block. The combination of larger units and light weight permits more rapid erection of gypsum tile partitions than any other type of fireproof partition. The ease with which these tile can be sawed and fitted around pipes and openings and the true square edges also tend to lower the cost of setting per square foot.

SAVING IN DEAD LOAD

One point which architects and engineers should take into consideration when designing the structural part of a building is the saving in dead load when using gypsum tile partitions. Gypsum tile is not only considerably lighter than other tile but because of the larger units, less mortar is required for setting and due to the tile being molded in metal forms, thus insuring uniformity, a saving in plaster is effected. All these savings tend to lessen the dead load and naturally the cost. In the Statler Hotel, Cleveland,



City Club, St. Louis, Missouri. T. P. Barnett Company, Architects, St. Louis, Missouri.

Grace American Bank, Richmond, Virginia. M. E. Wright, Architect, Richmond, Virginia.

Slattery Building, Shreveport, Louisiana. Mann & Stern, Architects, Little Rock, Arkansas.

Atlantic Building, Philadelphia, Pa. J. Kuntz, Architect, Pittsburgh, Pa.

Ohio, the saving amounted to 2418 tons and in the Cleveland Athletic Club Building, the saving was 3762 tons.

ALTERATIONS EASILY MADE

Practically every office building has a number of mechanics who are kept busy each spring and fall making alterations in office layouts to accommodate new tenants. If the partitions are of gypsum, new doors can be easily cut in them or borrowed lights inserted with the minimum of expense and trouble. Some few years ago a prima donna stopped at one of the Statler Hotels and desired a suite of rooms. While they did not have the space required at that moment, Mr. Statler promised to have it that afternoon. A mechanic was immediately sent for and a new door opening cut between two rooms. A rug was placed over the threshold and drapes hid the edges and top of the opening and the suite desired was ready. Such accommodations would not have been possible had the partition been other than gypsum tile.

New doorways or openings can be sawed out of a gypsum tile partition without damaging the plaster or decoration other than would be covered by the casing and trim. This effects a considerable saving when making alterations.

NON-CONDUCTOR OF SOUND

Unless a partition is properly constructed with the purpose of excluding sound, the benefits derived by the use of a soundproof partition are lost. Authentic tests show that less than 1/100 of one per cent of incident sound is transmitted through a gypsum tile partition plastered with gypsum plaster.

When pipes occur in partitions or when doors and transoms are present, the sound resistive value of the construction is materially reduced. Continuous floor finish under a partition, particularly if of cement, marble or tile, or suspended ceilings running over partitions, all tend to carry sound from one room to another.

Gypsum tile partitions are excellent non-conductors of sound and as such are recommended and successfully used in hospitals, schools, office buildings, apartments, hotels and all buildings where a soundproof partition is of particular importance.

FIRE PROTECTION

Gypsum tile has passed the required fire, water and strength tests of the Underwriters' Laboratories, Inc. and has received their approval for non-bearing fireproof partitions, stairway and elevator enclosures and unplastered non-bearing warehouse partitions. Three-inch hollow gypsum tile partitions plastered with gypsum plaster have been given a two-hour fire retardant rating by the Underwriters' Laboratories, Inc. and three-inch hollow unplastered gypsum tile partitions a one hour fire retardant rating.

WEIGHT PER SQUARE FOOT

As an aid to the architect and engineer, when estimating the dead load of partitions, the following table of approximate weights is included:

Description of Gypsum Furring and Partition Tile	*Wgt., Tile, per sq. ft., Lbs.*	*Wgt., Mortar, per sq. ft., Lbs.*	*Wgt., Plaster, One Side, per sq. ft., Lbs.*	*Total Wgt., Plastered One Side, per sq. ft., Lbs.*	*Wgt., Plaster, Two Sides, per sq. ft., Lbs.*	*Total Wgt., Plastered Two Sides, per sq. ft., Lbs.*
1½x12x30 " Split	5.0	1.5	3	8.0	.	....
2x12x30 " Split	6.5	1.5	3	9.5	.	....
2x12x30 " Solid	9.5	1.5	3	12.5	6	15.5
3x12x30 " Hollow	10.0	2.0	3	13.0	6	16.0
3x12x30 " Solid	13.0	2.0	3	16.0	6	19.0
4x12x30 " Hollow	13.0	2.5	3	16 0	6	19.0
5x12x30 " Hollow	15.5	3.0	3	18.5	6	21.5
6x12x30 " Hollow	16.5	3.0	3	19.5	6	22.5

PART II

SPECIFICATIONS FOR THE ERECTION OF GYPSUM PARTITION TILE

1. GENERAL — All permanent partitions and furring shall be started on the rough floor. All partitions of a temporary nature or that may be moved from time to time shall be started on the finished floor. Tile courses must not be started upon frozen concrete nor upon cinder concrete when such is used for the purpose of fill only.

2. PARTITIONS—All partitions shall be laid in horizontal superimposed courses with vertical joints broken. Such partitions shall extend from floor to ceiling, and shall be set plumb, straight and true, and shall be wedged at the ceiling, and the joints slushed with gypsum mortar.

3. ANCHORS—(To be placed in Masons' Specifications.) Partitions intersecting brick, or other masonry walls, shall be securely anchored to such walls by means of corrugated or other approved anchors furnished and set by the masonry contractor approximately 12¼ inches on centers so that they will project in the joints of the partition not less than 5 inches.

4. CORNERS AND INTERSECTIONS — Partitions shall be bonded at the corners and intersections by overlapping alternate courses back and forth (log cabin fashion). Overlapping tile shall cover the courses below to the full thickness of the tile.

5. FURRING—Gypsum tile furring shall be laid as is herein required for partitions. All close standing furring and that in contact with the construction shall be securely anchored to the masonry by means of 10 penny steel cut nails driven into the masonry joints at intervals not greater than every two feet horizontally and vertically, or shall be securely anchored by metal ties or other approved methods for securing furring to masonry. Free standing furring shall be of not less thickness, nor of greater height, than shown in the table below.

6. HEIGHT—The clear height of non-bearing partitions of gypsum tile shall not exceed the following:

Nominal Thickness of Tile	*Maximum Height*
2 inch Solid Partition or Enclosure	10 feet
3 inch Solid Partition or Enclosure	15 feet
3 inch Hollow Partition or Enclosure	13 feet
4 inch Hollow Partition or Enclosure	17 feet
5 inch Hollow Partition or Enclosure	20 feet
6 inch Hollow Partition or Enclosure	30 feet
8 inch Hollow Partition or Enclosure	40 feet

7. BUCKS—(To be placed in Carpenters' Specifications.) (*a*) *General*—In partition construction, regardless of the material employed, the frequency of openings and the size and height of such, are factors that should receive consideration when designing, since all such openings weaken the construction. The best constructions involve the use of door bucks which extend from floor to ceiling. Bucks of this character should be employed for large openings or in cases where such openings are of frequent occurrence.

(*b*) *Wood*—Where wood bucks are used they shall be of not less than 2-inch lumber and of a width equal to the total thickness of the tile and plaster construction. They may be rabbeted to receive the ends of the tile, or they may be of a width equal to the thickness of the tile, only with ½-inch grounds nailed to the sides and projecting beyond the buck not less than ¾ inch forming a rabbet to receive the ends of the partition tile.

All wood bucks shall be secured to the ends of the tile partition with corrugated or other approved anchors nailed to the buck and extending at least 5 inches into every horizontal joint.

(c) *Metal*—Where metal bucks are used they should be of sufficient width to receive the ends of the tile. When the metal bucks are of a width equal to the thickness of the tile construction, furring strips of wood shall be secured to the buck as a stop for the plaster coats and for a nailing base for trim. Where the metal bucks are of a width to include the total thickness of the tile and plaster construction, the trim shall be secured direct to the metal bucks or to wood nailing blocks bolted to the face of the bucks for such purpose.

8. LINTELS—(a) *Built Up.* Openings in partitions of gypsum tile which are not more than 22 inches in width may be spanned by a gypsum tile which shall have a bearing at each end upon the jamb of not less than 4 inches. When such openings are more than 22 inches but not more than 4 feet in width the gypsum tile over the openings shall be laid in the form of a jack arch. Skew-backs shall be cut in the tile used over the jambs, intermediate tile shall be beveled to fit the skew-backs, and a key tile to fit shall be set in the center of the jack arch. Bevel cuts shall not be less than 4 inches to the foot. The skew-back tile shall have a bearing on the jambs of not less than 12 inches nor shall they be set so as to project beyond the face of the jambs to a distance greater than one-half of the bearing.

(b) *Reinforced and Cast*—Openings in partitions of gypsum tile which are more than 4 feet but not over 6 feet in width may be spanned by lintels of reinforced gypsum of monolithic design.

All reinforced gypsum lintels shall have a bearing upon each jamb of not less than 8 inches.

Mat Reinforcement. Mat reinforced lintels shall be 12 inches in height and shall be reinforced with a galvanized welded wire mat on each side (face) of the lintel. The mat shall not be lighter than No. 12 gage longitudinal wires 5 inches on centers, and No. 12 gage cross wires 9 inches on centers.

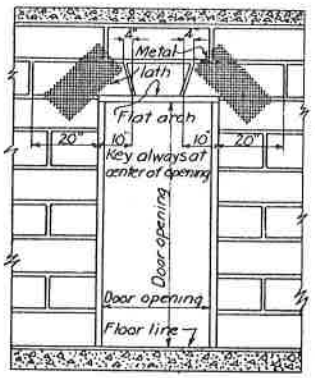
Rod Reinforcement. Rod reinforced lintels shall be 12 inches in height and shall be reinforced on each side (face) of the lintel with not less than two ¼ inch rods for the full length of the lintel. One of the required rods shall be straight and the other shall be bent up for shear. The horizontal part of the reinforcement, at the bottom, shall be one inch from the lower face of the lintel and both ends of both rods shall, at their extreme ends, be bent so as to form an anchor within the material.

(c) *Metal*—Openings in partitions of gypsum tile which are more than 6 feet in width shall be spanned by metal lintels of approved design. They shall be of such form as to provide a distributed and uniform bearing upon the supporting construction and shall provide a bearing upon each jamb of not less than 8 inches. Metal lintels shall be furnished by the steel contractor but set by the partition contractor. (This same sentence must be inserted in the steel specifications.)

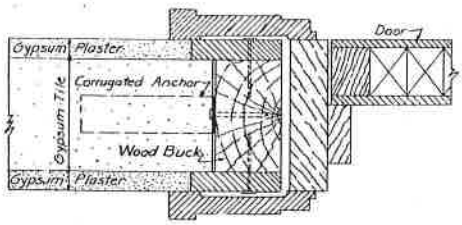
9. MORTAR—All gypsum tile construction shall be laid up with a gypsum mortar composed of one part of unfibered gypsum neat plaster to not more than three parts of clean, sharp sand. Gypsum mortar shall not be retempered.

10. PLASTERING—(To be placed in Plas-

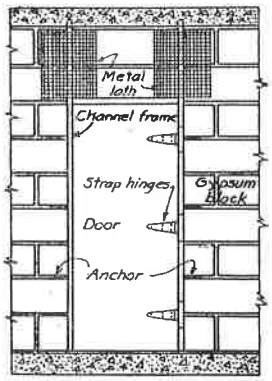
GYPSUM PARTITION TILE CONSTRUCTION DETAILS



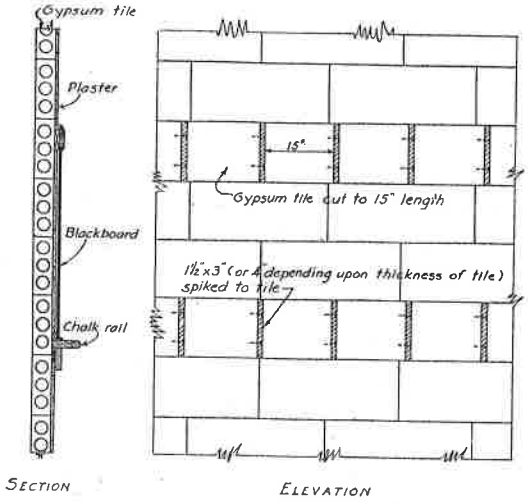
DETAIL SHOWING JACK ARCH CONSTRUCTION



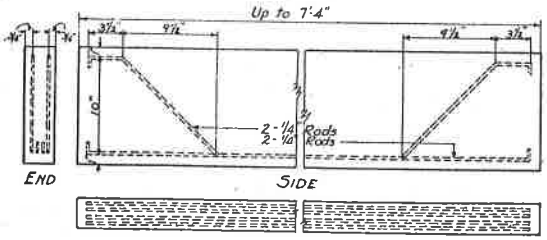
SECTION OF DOOR JAMB SHOWING WOOD BUCK



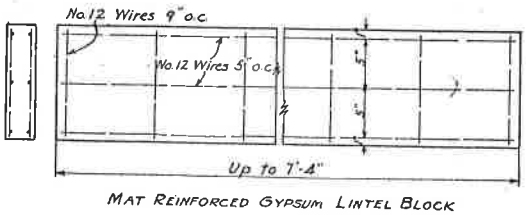
DETAIL OF DOOR WITH CHANNEL IRON FRAME



METHOD OF FASTENING SLATE BLACKBOARDS AND HEAVY FIXTURES TO GYPSUM PARTITIONS

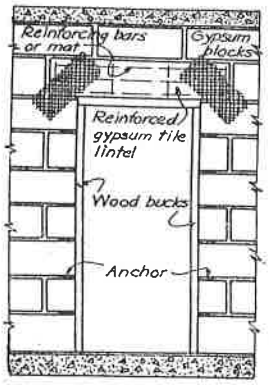


ROD REINFORCED GYPSUM LINTEL BLOCK

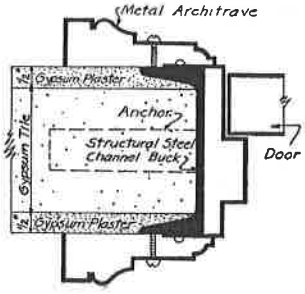


MAT REINFORCED GYPSUM LINTEL BLOCK

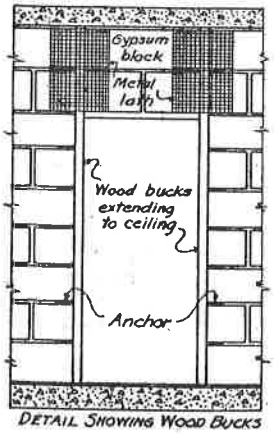
DETAILS OF REINFORCED GYPSUM LINTELS



DETAIL SHOWING REINFORCED GYPSUM LINTEL CONSTRUCTION



SECTION OF DOOR JAMB SHOWING METAL BUCK



DETAIL SHOWING WOOD BUCKS

terers' Specifications.) All plastering on gypsum tile shall be done with gypsum plasters applied in accordance with the specifications for such of The Gypsum Industries, or other specifications approved by the architect.

All joints between gypsum tile and other masonry construction shall, before the application of the plaster, be covered with a strip of metal lathing not less than 12 inches in width and weighing not less than 2.2 pounds per square yard.

When bucks extend from floor to ceiling that portion of the buck above the opening shall before the application of the plaster be covered with a strip of metal lathing weighing not less than 2.2 pounds per square yard and not less than 16 inches in width.

When bucks do not extend from floor to ceiling there shall be attached a strip of metal lathing 12 inches wide and not less than 2 feet long weighing not less than 2.2 pounds per square yard, to each side of the partition on both sides of the opening. This strip should run diagonally across the head of the opening over the buck.

11. CONDUITS—Where conduits occur in walls they shall be so placed as to allow the full thickness of the plaster being applied. A strip of metal lathing weighing not less than 2.2 pounds per square yard shall be applied over all pipe chases occurring in partitions.

Note—When conduits in partitions are placed within 12 inches of door bucks proper bearing of lintels or jack arches cannot be obtained. It is therefore recommended that a clause be inserted in the electrical specification requiring conduits to be kept at least 12 inches from the door bucks.

12. TRIM—(To be placed in Carpenters' Specifications.) All wood or metal trim shall be of such design as to completely cover any junction between metal bucks or furring and the plaster coats.

(*a*) Baseboards and similar trim shall be secured to grounds or to nailing blocks or shall be attached by other approved means. Nailing blocks shall be furnished and placed by the carpenter contractor. They shall be not less than 7/8 inch thick, shall be nailed directly to the end of the gypsum tile and shall be of such other dimensions as to completely cover the end of the tile. When nailing blocks are used they shall be spaced not to exceed 30 inches.

Note—Conditions on the job vary this practice as sometimes the nailing blocks are furnished by the carpenter and set by the mason.

(*b*) Chair rail, picture molding and plaster grounds shall be secured as is herein required for baseboards.

(*c*) Blackboards, toilet, and heavy fixtures, shall be secured by bolting through the tile construction with galvanized iron bolts, or shall be nailed to nailing blocks not less than 1½ inches thick of the character required for other trim, and spaced not to exceed 15 inches.

PART III

AMERICAN SOCIETY FOR TESTING MATERIALS

STANDARD SPECIFICATIONS FOR GYPSUM PARTITION TILE OR BLOCK

Serial designation: C52-27

These specifications are issued under the fixed designation C 52; the final number indicates the year of original adoption as standard or, in the case of revision, the year of the last revision.

ISSUED AS TENTATIVE, 1923; ADOPTED IN AMENDED FORM, 1925; REVISED, 1927.

1. DEFINITION—Gypsum partition tile or block is a building unit used for non-bearing construction in the interior of buildings.

Note—The words "tile" and "block" are synonymous and are used so as to be in accord with certain freight association nomenclature.

2. USES—(*a*) It is also used as a protection for columns, elevator shafts, etc., against fire.

(*b*) Gypsum cored tile, 3 or 4 in. in thickness, may be split and used for furring purposes.

MANUFACTURE

3. COMPOSITION—Gypsum tile consists of gypsum with or without an aggregate.

DIMENSIONS AND PERMISSIBLE VARIATIONS

4. FORM AND SIZE—Gypsum partition tile shall be rectangular in shape with straight and square edges and true surfaces. They may also be of special shape provided the requirements as otherwise mentioned herein, are met. They may be solid or cored and shall preferably be 12 by 30 in. in face dimensions.

5. CORE SPACES—(*a*) The core spaces shall be symmetrically spaced.

(*b*) *Shell Thickness*—The minimum cross-sectional shell dimensions of gypsum partition tile with circular, elliptical or rectangular core spaces shall conform to the following:

Thickness of Tile or Block, In.	*Side or Edge Shell Thickness, In.*	
	Circular Core	*Elliptical or Rectangular Core*
2½	½	9/16
3	½	11/16
4	¾	13/16
5	⅞	1⅛
6	½	11/16
8	¾	13/16

In tile or block having circular cores, the sum of the widths of the two side shells plus the width of the center vertical web shall not be less than 2 in. in the case of 6-in. tile, and not less than 2½ in. in the case of 8-in. tile. In tile or block having elliptical or rectangular cores, the sum of the widths of the two side shells plus the width of the center vertical web shall be not less than 2¾ in. in the case of 6-in. tile, and not less than 3¼ in. in the case of 8-in. tile.

6. DIMENSIONS—(*a*) Gypsum tile may be of any convenient length and height, but in general they shall not exceed 30 in. in length and 12 in. in height. The thickness shall be uniform throughout and within the limits specified in Paragraph (*b*).

(*b*) *Thickness*—Gypsum tile or block shall conform to the specified thicknesses with the following permissible variations:

Nominal Size of Tile or Block, In.	*Minimum Thickness, In.*	*Maximum Thickness, In.*
1½ (Furring)	1⅜	1⅝
2 (Furring)	1⅞	2⅛
2	2	2¼
2½	2⅜	2¾
3	2⅞	3¼
4	3⅞	4¼
5	4⅞	5¼
6	5¾	6¼
8	7¾	8¼

(*c*) *Dimension Determinations* — Overall dimensions shall be measured from opposite face to opposite face of the tile or block, the greatest measurement observed being taken as the dimension. Sectional dimensions of cored tile shall be taken 1 in. in from the ends of the tile or block, the least measurement observed being taken as the dimension. Shell dimensions shall be measured from the surface of the core space to the normal surface of the tile or block inside the scoring.

(*d*) *Dimension Tolerances*—A variation of ¼ in. in the nominal width and ⅜ in. in the nominal length of the tile or block is permissible.

(*e*) *Scoring*—The scoring upon gypsum tile or block shall be of such a nature as not to materially reduce the shell thickness.

PHYSICAL PROPERTIES AND TESTS

7. STRENGTH—(*a*) When tested in accordance with the methods described in Section 14, the compressive strength of gypsum tile or block shall not be less than 75 lb. per sq. in. for the average of five specimens tested.

(*b*) When completely saturated, the compressive strength shall not be less than 33⅓ per cent of the strength required for such tile or block when dried to constant weight.

(*c*) ABSORPTION—When tested in accordance with Section 16 the rate of absorption of gypsum tile or block shall not be less than 8 cc. nor more than 30 cc. for the first minute, nor less than 4 cc. for each of the next five subsequent minutes.

8. FIRE RESISTANCE—In locations where fire resistance is an essential property, gypsum tile or block shall meet the requirements of the Tentative Specifications of Fire Tests of Building Construction and Materials (Serial Designation: C 19—26 T) of the American Society for Testing Materials, as they apply for the construction in which the tile are used.

SAMPLING

9. SAMPLING—At least 1 per cent of the number of gypsum tile or block in a shipment, but in no case less than ten tile, shall be so selected as to be representative of the shipment. Twenty-five per cent of such selected tile, but in no case less than ten individual tile, shall constitute a sample for test purposes. In case a shipment consists of more than one car or carrier load, a sample shall be selected from each car or carrier. Sam-

ples for test shall be selected at the factory or at the point of delivery, as specified in the sales contract.

MARKING

10. MARKING—When gypsum tile or block are shipped for resale, the manufacturer's "Brand" name shall be shown upon each tile.

INSPECTION AND REJECTION

11. INSPECTION—Inspection may be made either at the point of shipment or at the point of delivery. The inspector representing the purchaser shall have free access to the carriers being loaded for shipment to the purchaser. He shall be afforded all reasonable facilities for inspection and sampling, which shall be so conducted as not to interfere unnecessarily with the loading of the carriers.

12. REJECTION—Any rejection shall be based upon failure to conform to the requirements of these specifications, and shall be reported within ten working days from the receipt of the shipment by the consignee. The notice of rejection shall contain a specific statement of the respects in which the tile or block have failed to meet the requirements of these specifications.

13. REHEARING—Claims for rehearing shall be valid only if made within twenty working days from receipt of notice of specific cause for rejection.

METHODS OF TESTING

COMPRESSIVE STRENGTH OF GYPSUM PARTITION TILE OR BLOCK

14. COMPRESSIVE STRENGTH OF TILE OR BLOCK—(*a*) Not less than ten full-size gypsum tile specimens shall be used.

(*b*) The test specimens shall be dried to constant weight at a temperature not exceeding 110° F. (43° C.), until two successive weighings of the same specimen do not show a variation in excess of 0.5 per cent. At the option of the manufacturer or purchaser, strength tests may be conducted on samples that are dried at room temperature. However, in cases of controversy all test samples shall be dried to constant weight as herein prescribed.

(*c*) The tile or block shall be tested in the position in which they are designed to be used and shall be bedded on and capped with a felt gasket not less than $\frac{1}{8}$ in. nor more than $\frac{1}{4}$ in. in thickness. At the option of the manufacturer or purchaser, or in cases of controversy, the test samples may be suitably bedded and capped with neat gypsum mortar, or the bearing surfaces of the tile may be planed or rubbed smooth and true. When neat gypsum mortar is used for bedding and capping, the test may be conducted after the mortar has set, but not sooner than twenty-four hours after the sample has been capped.

(*d*) The loading head shall completely cover the bearing area of the tile, and the applied load shall be transmitted through a spherical bearing block of proper design. The speed of the moving head of the testing machine shall not be more than 0.05 in. per minute.

TRANSVERSE STRENGTH OF GYPSUM PARTITION TILE OR BLOCK

15. TRANSVERSE STRENGTH OF TILE OR BLOCK—(*a*) Not less than ten full-size gypsum tile specimens shall be used.

(b) The test specimens shall be dried to constant weight as prescribed for the determination of the compressive strength in accordance with Section 14(b).

(c) The tile or block shall be supported on its face (flat) on fixed parallel bearings spaced 24 in. (600 mm.) on centers, and shall be loaded through a similar bearing midway between the supports. All bearing and load surfaces shall be true, shall engage the full width of the test specimen, and shall be rounded to a radius of ½ in. (12.7 mm.).

(d) The speed of the moving head of the testing machine shall not be more than 0.05 in. per minute. The modulus of rupture shall be calculated in pounds per square inch from the formula:

$$\text{Modulus of Rupture} = \frac{3\,wl}{2bd^2}$$

where l = distance between supports in inches;
b = breadth (width) of tile in inches;
d = thickness of tile in inches;
w = load in pounds at failure of test specimen.

ABSORPTION OF GYPSUM PARTITION TILE OR BLOCK

16. Absorption of Tile or Block—(a) The absorption shall be determined upon a test specimen of partition tile or block consisting of approximately one-half of a full-size tile.

(b) The test specimen shall be dried to constant weight as prescribed for the determination of the compressive strength in accordance with Section 14(b).

(c) The dried test specimen shall be submerged in water until a constant saturated weight is attained, but in no event for a period of less than two hours, the water temperature being maintained at between 70 and 80° F. (21 and 27° C.). The test specimen shall be removed, the surface wiped off with a damp cloth and the specimen weighed immediately. The percentage of absorption shall be calculated on the dry weight from the formula:

$$\text{Percentage of Absorption} = \frac{100\,(B-A)}{A}$$

where A = weight of dry test specimen;
B = weight of saturated test specimen.

(d) The rate of absorption shall be determined by sealing upon the face of the test specimen, which shall first be dried to constant weight as prescribed for determination of the compressive strength, a glass tube 1½ in. in internal diameter and 12 in. in length, graduated in centimeters and located centrally over a core. Into this tube shall be poured 250 cc. of water at a temperature of between 70 and 80° F. (21 and 27° C.). The rate of absorption shall be reported in cubic centimeters per minute.

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