The subject of this Report is a floor and ceiling assembly consisting of prestressed, precast concrete double tee units with the underside of the assembly protected by a wallboard ceiling. For the assembly, two nominal 8-ft wide concrete units were used. One unit was cast with normal weight concrete and the other with lightweight concrete. Powder-actuated and hand driven fasteners were used to secure hanger wires to the concrete units.
The object of this investigation was to establish a fire resistance Classification for the floor and ceiling assembly described herein, by means of a fire endurance test conducted in accordance with the Standard, Fire Tests of Building Construction and Materials, UL263 (ASTM E119, NFPA No. 251).

The fire endurance test was supplemented by other tests and examinations which provided additional information relative to the composition and physical properties of the materials used in the test assembly.

**DESCRIPTION**

**Materials**

The following is a description of the materials used in the test assembly.

*Steel supports*—The angles used to support the ends of the concrete units were 6 x 6 x 3/4-in. steel members on top of which rested 3 in. wide x 3/4 in. thick steel plates. The plates provided the recommended minimum bearing width of 3 in.

*Prestressed precast concrete units*—The units were manufactured in a plant selected by the submittor and were of the configuration shown on Figs. 1a and 1b. Other properties of the units and method of manufacture are considered proprietary and are on file at Underwriters' Laboratories, Inc. for future use in the follow-up service inspection program.

The precast concrete units will be Classified by Underwriters' Laboratories, Inc. in the Fire Resistance Index.

*Fasteners*—The steel fasteners used to secure hanger wires to the concrete units were of two types. One type was hand-driven into the concrete units and the other was powder-actuated.

The hand-driven fasteners were threaded 1 7/16 in. long, 1/4 in. diameter, with a 7/16 in. diameter pan-shaped head.

The powder-actuated fasteners consisted of a 0.163 in. diameter pointed shank, with a 0.054 in. thick washer. The washer diameter was 0.466 in. The upper portion of the fastener was 3/8 in. long x 3/4 in. wide, and contained an oval opening approximately 5/16 in. diameter.

*Hanger wire*—The hanger wire used to support the wallboard furring channels was No. 18 steel wire gage (0.048 in. diameter) galvanized steel wire.

*Wallboard furring channels*—The channels were 3/4 in. high and 2 3/4 in. wide at the base. The face width was 1 1/4 in. The channels were formed from No. 25 ga (0.021 in. thick) galvanized steel.

*Wallboard—4 x 12 ft x 5/8 in. thick* Classified by Underwriters' Laboratories, Inc. in the Fire Resistance Index. The wallboard was manufactured by United States Gypsum Company and designated Type C.

*Wallboard fasteners*—1 in. long, Type S, with bugle head.

*Joint tape*—0.009 in. thick, 2 1/8 in. wide with numerous perforations throughout.

*Joint compound*—Prepared dry mixture adhesive cement for gypsum
Fig. 1 a. Floor plan of assembly (for sections see Fig. 1 b).
wallboard joint treatment.

**Erection of test assembly**

The prestressed, precast concrete units were provided in nominal 8-ft widths. Two full width units were placed in the furnace frame and supported at their ends on the 3-in. wide bearing plates. The unit over the north half of the test frame was made with normal weight concrete and the unit over the south half was made with light weight concrete. To fill the furnace opening a filler slab, 9 in. wide, was placed along the north and south edges of the assembly. The clear span of the units was 13 ft 2 in. The units were positioned in the test frame so that a clearance of approximately 3 1/4 in. was provided between them and the frame along each side.

During casting weld plates were placed in the concrete units at their quarter points. Fillet welds, 3 in. long, secured the units together at the weld plates. Between adjacent units, a clearance of approximately 1/4 in. was maintained. The joints between the units were sealed with a high early strength, low water content grout.

To permit expansion during fire exposure, three 3/8 in. thick sheets of asbestos paper (total thickness 3/8 in.), 8 3/4 in. deep, 17 ft 4 in. long, were
Fig. 2. Exposed surface before tests.

Fig. 3. Unexposed surface before tests.
Fig. 4. Furnace temperatures.
placed along the east and west edges of the assembly between the concrete units and the test frame. Along the north and south edges, four sheets of asbestos paper were positioned in the same manner. It has been shown that asbestos paper will compress to one-half its thickness so the units were installed to permit a \( \frac{3}{16} \) in. expansion per 14 ft of length and \( \frac{1}{4} \) in. per 8 ft of width. The remaining space between the asbestos paper and the furnace frame was filled with grout.

On the ceiling side of the assembly, pilot holes for the hand-driven fasteners, \( \frac{3}{8} \) in. diameter, 1 in. deep were drilled into the stems of the precast concrete units approximately 4 in. up from the base. The fasteners were driven into the pilot holes, leaving the head and approximately \( \frac{1}{8} \) in. of the shank exposed. To drive the powder-actuated fasteners, a 5/300 charge was used. The hand-driven fasteners were located in the west half of the assembly and the powder-actuated fasteners were used in the east half. The spacing of the fasteners was 24 in. on center, except where wallboard butt joints were to be located. At these locations, the fasteners were spaced 6 in. on center.

The wallboard furring channels were attached to the concrete units by looping two strands of hanger wire around each fastener and twist tying the wires together. To form a continuous channel, 17 ft 4 in. long, two lengths of channels were overlapped 6 in. and secured together at each end of the overlap by tie wire. The channel overlaps were located 21 in. north of the east-west centerline of the ceiling. The channels were spaced 24 in. on center, except where the wallboard butt joints were to occur. At these locations the channels were spaced 6 in. on center.

The wallboard was fastened to the furring channels with 1 in. long Type S wallboard fasteners with bugle heads. The screws were spaced 8 in. on center at the butt joints and 12 in. on center in the field of the board. Along the butt joints, the screws were spaced \( \frac{3}{4} \) in. from the board edge and along the side joints the screws were \( \frac{3}{4} \) in. from the board edge.

All the wallboard joints were covered with joint compound into which joint tape was imbedded. Afterwards, two coats of joint compound were applied over all joints and screw heads. The compound was applied in strips approximately 6 in. wide across each joint and feathered out at the edges, as shown in Fig. 2.

Two vertical layers of wallboard, 12 in. wide, were nailed to the test frame insulation along the east and west walls to seal the peripheral edges of the ceiling.

The overall distance between the top surface of the precast concrete units and the exposed wallboard surface was 9\( \frac{1}{2} \) in. The appearance of the exposed and unexposed surfaces before the test is shown on Figs. 2 and 3, respectively.

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**TEST RECORD NO. 1**

**Fire endurance test**

The test was conducted in accordance with the Standard Fire Tests of Building Construction and Materials, UL263 (ASTM E119, NFPA No. 251).

**Sample.** The test assembly was constructed as described in the previous section of this Report under “Erection of Test Assembly” as shown in Figs. 1-3.

The concrete units were 168 days old prior to subjecting them to the fire endurance test. Of this, the units were stored outdoors for 58 days, and 110 days in the Laboratories' facilities at
Fig. 5. Unexposed surface temperatures.
normal room temperature and humidity.

At the time of the fire test, the relative humidity of the normal weight unit was 73.5 percent, and the lightweight unit was 72.5 percent. The relative humidity of the units was determined at their deepest sections by moisture-sensitive electrical elements inserted into short lengths of pipe provided in the units.

Method. The standard equipment of Underwriters' Laboratories, Inc. for testing of floor and ceiling constructions was used.

The temperatures in the furnace chamber were measured with 16 thermocouples symmetrically located 12 in. below the exposed surface, as shown in Fig. 4.

The temperatures of the unexposed surface were measured with 16 thermocouples, each of which was covered with a 6 x 6-in. dry asbestos pad, located as shown in Fig. 5. Eight thermocouples were located over the normal weight unit and eight thermocouples were located over the lightweight unit.

The temperatures of the prestressing strands and wire mesh were measured by thermocouples attached to the steel during the casting of the units. The locations of these thermocouples are shown on Fig. 6.

The temperatures at various locations within the plenum area were also measured by thermocouples. The locations of these thermocouples are shown on Fig. 7.

The deflection of the assembly was recorded by three electronic transducers located along the north-south centerline of the assembly as shown in Fig. 8.

The load applied to the test assembly was arranged to provide a uniformly distributed live load of 46 lb per sq ft over the normal weight units and 51 lb
per sq ft over the lightweight units. This load was specified by the submit-
tor and calculated in accordance with the Building Code Requirements for Reinforced Concrete (ACI 318-71) to develop the assembly's maximum allowable load based on the ultimate capacity. The load was applied approximately 18 hr prior to the fire test.

Throughout the test, observations were made of the character of fire, the conditions of the exposed and unex-
posed surfaces and of all other events relative to the fire resistive performance of the assembly.

Results

Character and distribution of fire—The furnace fire was luminous and well distributed throughout the test. The temperatures developed conformed with the standard time-temperature curve as shown in the Standard For Fire Tests of Building Construction and Materials, UL263, and as shown on Fig. 4.

Observations of exposed surface—At 30 sec, the paper covering on the wall-
board ceiling began burning and turning black. By 4 min, the paper covering was completely charred. At 13 min, the surface of the wallboard was white in color and appeared rough in texture.

At 3 min, the ceiling joint com-
 pound began turning black and at 4 min began peeling. At 6 min, a small amount of joint compound had fallen from the joints and by 28 min most of it had fallen. The joint compound over the fasteners began falling off at 29 min and continued to fall at various loca-
tions throughout the remainder of the test.

At 30 min, the wallboard was bowing slightly between fasteners. At 97 min, this bowing had increased to a max-
imum of approximately 2 in. in the panel at the southeast corner of the assembly. By 112 min, this panel was bowing down, approximately 8 in., exposing the steel channel runners directly to the furnace fire. At 127 min the portion bowing down, approximately 15 sq ft, split in two and at 132 min fell into the furnace fire.

At 133 min, several soft popping noises were noted, followed at 136 min by a loud explosive sound.

At 136 min, the stem of the south filler slab spalled, partially exposing the prestressing strands.

At 151 min, the two wallboard panels adjacent to the south-east panel which fell into the furnace fire began to become unfastened.

At 165 min, the panel directly north of the south-east panel fell into the fur-
nace fire. The steel channel runners exposed by this fall off began to deform.

At 170 min, two of the channels at the west side of the furnace fell. Be-
tween 171 and 180 min, most portions of the three wallboard panels adjacent to the panel directly north of the south-east panel fell into the furnace fire.

At 103 min and observed throughout the remainder of the test were a num-
ber of minor cracks at various locations in the gypsum wallboard ceiling.

The furnace fire was extinguished at 182 min.

Observations of unexposed surface—At 10 min, a small amount of smoke began rising from the periphery of the assembly. By 30 min, the density of the smoke increased and continued until 50 min at which time the intensity of the smoke decreased. The light smoke continued until 125 min.

At 20 min, a small amount of mois-
ture was visible along the east and west edges of both slabs. By 50 min all visi-
ble indications of moisture had disap-
peared.

At 125 min, no cracks were visible. At 136 min, a noise indicating concrete spalling was heard. At 150 min, the east
Fig. 7. Plenum temperatures.
end of the south filler slab began rising. Also the center joint began to crack.

The furnace fire was extinguished at 182 min.

**Deflection of assembly**—The deflection of the assembly during the fire test is shown on Fig. 8.

**Temperature of unexposed surface**—The temperatures of the unexposed surface are shown on Fig. 5. The average initial temperature of the unexposed surface was 71 F. Therefore, based on a 250 degree average temperature rise and a 325 F maximum individual temperature rise, the limiting average temperature was 321 F and the limiting individual temperature was 396 F. At 151 min the limiting average temperature was reached over the north half of the assembly (normal weight unit) and at 158 min the limiting average temperature was reached over the south half of the assembly (lightweight unit). The limiting individual temperatures were reached at 175 and 167 min over the normal weight and lightweight units, respectively.

**Temperature of prestressing strands**—The temperatures of the prestressing strands are shown on Fig. 6. At 120 min the average temperature of the strands within the normal weight unit was 383 F and the average strand temperature of the lightweight unit was 407 F. At 180 min the average temperature of the strands within the normal weight unit was 568 F and the average strand temperature of the lightweight unit was 816 F.

**Observations after test**

The appearance of the exposed and unexposed surface after the fire test is shown on Figs. 9 and 10, respectively.

During the fire test, the wallboard
fell from below the lightweight unit. After the test, upon cooling, the wallboard fell from below the normal weight unit.

The surface of the lightweight unit was light in color with various hairline cracks in the stems and flanges. The center portion of the lightweight filler slab stem had spalled exposing the prestressing strands. The surface of the normal weight unit was light brown in color and contained few hairline cracks.

The furring channels below the lightweight unit were severely buckled and twisted. The remaining furring channels retained their structural integrity.

All fasteners remained secure to the concrete units.

On the unexposed surface, the lightweight unit had deflected approximately \( \frac{3}{4} \) in. at its center. No surface cracks were apparent.

**Study for classification purposes**

The purpose of this engineering study is to upgrade the assembly described herein in order to be eligible for a 3 hr restrained and unrestrained assembly rating. Because the limiting unexposed surface temperatures were reached prior to 3 hr, the flange thickness of the precast concrete units will be increased. Also, as discussed in the Report, the limiting temperature on the prestressing strands in the lightweight concrete unit was reached prior to 3 hr. To assure that these limiting temperatures are not reached prior to 3 hr, the strand cover will be increased.

The study will consist of two parts.
The normal weight precast concrete units will be discussed in the first part and the lightweight units in the second part. In each part the unexposed surface temperatures, prestressing strand temperatures and the assembly's structural integrity will be evaluated.

**Normal weight concrete unit.**

Unexposed surface temperatures—Based on data contained in Research Bulletin No. 223, published by the Portland Cement Association, a plot of concrete thickness versus time to reach the limiting unexposed surface temperatures is shown in Fig. 11. The test results contained in Fig. 11 have been compared to previous full scale fire tests conducted at Underwriters' Laboratories, Inc. and found to be conservative.

As shown in Fig. 11, to increase the time of reaching the temperature limits from 151 to 190 min, the concrete slab thickness should be increased from 2 to 2\(\frac{3}{4}\) or 0.70 in. This increase includes a 10 min factor of safety.

The additional concrete can be added in the top flange of the units or a minimum 1-in. thick concrete topping may be added in the field. The 1-in. thickness was selected as the minimum because of the impracticability of thicknesses less than 1 in.

Prestressing strand temperatures—Previous tests on stemmed units of var-

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![Fig. 11. Siliceous concrete slab thickness versus time (Source: PCA Research Department Bulletin No. 223).](image-url)
ious flange thicknesses have shown that an increase in thickness does not affect the prestressing strand temperature.

Structural integrity of proposed assembly—As shown on Fig. 8, the maximum deflection of the normal weight unit was 1.0 in. at 180 min. Previous fire tests have shown that stemmed units may deflect 8 in. without structural collapse during fire exposure. Also, the increased flange thickness will increase the units’ stiffness. Therefore, it is our opinion that based on test results the structural integrity of the proposed assembly will not be endangered.

Lightweight concrete unit.

Unexposed surface temperatures—Data from Research Bulletin No. 223 pertaining to lightweight concrete is shown in Fig. 12. To increase the time of reaching the temperature limits from 158 to 190 min, the concrete slab thickness should be increased from 2 to 2½ or 0.45 in.

The additional concrete can be added in the top flange of the unit or a minimum 1 in. thick concrete topping may be added in the field.

Prestressing strand temperatures—Data contained in a Report to the Prestressed Concrete Institute dated December 20, 1971, related prestressing strand temperature to concrete cover for stemmed units. A summary of this data is shown below:

| Unrestrained assembly rating, hr | Stem width at steel centroid in. | Strand cover, in. Bottom | Side |
|---------------------------------|---------------------------------|--------------------------|
| 1/2                             | 2-7/8                           | 1-1/2                    | 1-1/8 |
| 1                               | 4                               | 1-7/8                    | 1-1/2 |
| 1-1/2                           | 5-1/4                           | 2-1/4                    | 2-1/8 |
| 2                               | 6-3/4                           | 2-1/2                    | 2-5/8 |
A relation between the time to reach the limiting strand temperature, bottom strand cover and stem width of the precast concrete unit was determined to be:

\[
\text{Stem width} = (0.164) \ (\text{TEP})^{0.76} \\
\text{Bottom strand cover} = (0.841) \ (\text{stem width})^{0.588}
\]

where TEP is defined as the time in minutes when the average strand temperature is 800 F.

Applying the results of that report to ensure that the average strand temperature will not exceed 800 F by 190 min, the bottom strand cover should be increased \(\frac{7}{16}\) in. and the stem width at the steel centroid increased \(\frac{5}{8}\) in.

**Structural integrity of proposed assembly**—As shown in Fig. 8, the maximum deflection of the lightweight unit was 2.3 in. at 180 min. Previous fire tests have shown that stemmed units may deflect 8 in. without structural collapse during fire exposure. Also, the increased flange thickness will increase the unit’s stiffness. Therefore, it is judged that the structural integrity of the proposed assembly will not be endangered by these changes.

**CONCLUSIONS**

The following conclusions represent the judgment of Underwriters’ Laboratories, Inc., based on the results of the examination and tests presented in this Report, as they relate to established principles and previously recorded data.

**Fire resistive properties**

It is judged that floor and ceiling assemblies, constructed of the materials and in the manner herein described, will afford 2 or 3 hr protection against passage of flame and dangerous transmission of heat in a restrained or unrestrained condition.

Passage of flame through the unexposed surface of the test assembly did not occur during the fire exposure period. Transmission of heat through the assembly as tested or modified as discussed in this Report will not raise the temperature of the unexposed surface at any one point more than 325 F above the initial temperature and the average temperature will not exceed 250 F above the initial temperature during the rating periods. At the rating periods, the average temperature of the prestressing strands will be below 800 F. The assembly carried its rated live load during the fire endurance test.

The above Classifications are based on the “Conditions of Acceptance” for tests of floors and roofs in the Standard, Fire Tests of Building Construction and Materials, UL263 (ASTM E119, NFPA No. 251).

The test assemblies described herein will be illustrated in the Fire Resistance Index as “Design Nos. J502, J503, and J504.”

**Practicability**

The materials used in the test assembly were readily installed by qualified workers with tools and methods commonly used for the construction work of this nature.

Materials and installation procedures in accordance with those described in this Report are significant factors in the fire resistance of the construction.

**Conformity**

The assembly was tested in accordance with the Standard, Fire Tests of Building Construction and Materials, UL263 (ASTM E119, NFPA No. 251). The materials used in the test assembly are judged to be in conformance with the definition of “noncombustible” as specified in the Standard.

**Follow-up program**

Prestressed, precast concrete units which conform to the design and cross-sectional dimensions given herein
and as recorded in file, manufactured as specified, and found acceptable under the Follow-Up Service program of Underwriters' Laboratories, Inc. will bear a Classification Marking containing the following information:

**UNDERWRITERS' LABORATORIES, INC.**

**PRECAST CONCRETE UNITS**

**FIRE RESISTANCE CLASSIFICATION DESIGN NOS. J502, J503 or J504**

The gypsum wallboard is presently under the Follow-Up Service of Underwriters' Laboratories, Inc., and each board is eligible to bear a Classification Marking containing the following information:

**UNDERWRITERS' LABORATORIES, INC.**

**CLASSIFIED WALLBOARD GYPSUM**

**FIRE RESISTANCE CLASSIFICATION DESIGN NOS. J502, J503, and J504**

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**SPECIFICATIONS FOR FLOOR AND CEILING CONSTRUCTION**

**Design No. J502 (See Fig. A1)**

Restrained assembly ratings: 2 and 3 hr.
Unrestrained assembly ratings: 2 and 3 hr.

1. *Precast concrete units*—Normal weight concrete units with stems spaced a maximum 4 ft on center. For restrained assembly condition, a 3/8 in. clearance per 14 ft of length shall be provided for expansion. Also, a 1/4 in. lateral expansion joint shall be provided for each 8 ft of width.

<table>
<thead>
<tr>
<th>Rating, hr</th>
<th>Minimum total slab thickness, in.</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>2-3/4</td>
</tr>
</tbody>
</table>

If concrete topping is used, minimum thickness to be 1 in., 3000 psi compressive strength, 110 to 150 pcf unit weight.

*Bearing Underwriters' Laboratories, Inc. Classification Marking.*

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![Fig. A1. Design No. J502 (Restrained assembly rating: 2 and 3 hr. Unrestrained assembly rating: 2 and 3 hr.).](image-url)
Concrete Structures, Inc.

2. Minimum bearing: 3 in.

3. Grout (not shown)—Sand-cement grout, 3500 psi, along full length of joint. Weld tie plates to be used in conjunction with grout.

4. Fasteners—Attached to stems of precast concrete units. Used to provide a means of attaching hanger wire to units. Steel fasteners may be either of the following two types:

A threaded 1/4 in. diameter hand-driven fastener, 1 7/16 in. long with a 7/16 in. diameter pan head. Prior to driving the fasteners, a 3/16 in. diameter, 1 in. long pilot hole shall be drilled.

A powdered-actuated fastener, with a 0.163 in. diameter, 5/8 in. long pointed shank containing a 0.466 in. diameter, 0.054 in. thick washer. Head of fastener to be 5/8 in. long, 7/16 in. wide with an oval opening approximately 5/16 in. diameter. Powdered charge to be sufficient to fully imbed shank portion without damaging concrete surface.

5. Hanger wire—No. 18 SWG galvanized steel wire. Hanger wire used to attach wallboard furring channels to precast concrete units. Wire to be located at each intersection of furring channels and concrete stems.

6. Wallboard furring channels—No. 26 ga galvanized steel, 7/8 in. high, 2 3/4 in. base width, 1 1/4 in. face width and 12 ft long. Channels to be installed perpendicular to concrete stems and spaced 24 in. on center, except at wallboard butt joints where they are spaced 6 1/2 in. on center. Channels secured to concrete units with double strand of hanger wire looped through fasteners. At furring channel splices, channels to be overlapped 6 in. and tied together with hanger wire at each end of splice.

7. Wallboard—5/8 in. thick, 4 ft wide, installed with long dimension perpendicular to furring channels. Over butt joints, a 3 in. wide piece of wallboard to be inserted with ends extending a minimum 6 in. beyond board width.

United States Gypsum Company (Type C)

8. Wallboard fasteners—1 in. long, Type S, bugle head. Fasteners spaced 12 in. on center along each furring channel except at butt joints where fasteners spaced 8 in. on center. At butt joints, fasteners located 3 1/4 in. from board edge. Along side joints, fasteners located 3/4 in. from board edge.

9. Joint system (not shown)—Paper tape imbedded in cementitious compound over joints, and covered with two layers of cementitious compound with edges feathered out. Wallboard fastener heads covered with two layers of cementitious compound.

Design No. J503 (See Fig. A1)

Restrained assembly ratings: 2 and 3 hr. Unrestrained assembly ratings: 2 hr.

1. Precast concrete units—Lightweight concrete units with stems spaced a maximum 4 ft on center. For restrained assembly condition, a 3/8 in. clearance per 14 ft of length shall be provided for expansion. Also, a 3/4 in. lateral expansion joint shall be provided for each 8 ft of width.

<table>
<thead>
<tr>
<th>Rating hr</th>
<th>Minimum total slab thickness, in.</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>2 1/2</td>
</tr>
</tbody>
</table>

If concrete topping is used, minimum thickness to be 1 in., 3000 psi compressive strength, 110 to 153 pcf unit weight.

Concrete Structures, Inc.

2. Minimum bearing: 3 in.

3. Grout (not shown)—Sand-cement grout, 3500 psi, along full length of joint. Weld tie plates to be used in conjunction with grout.

4. Fasteners—Attached to stems of precast concrete units. Used to provide a means of attaching hanger wire to units. Steel fasteners may be either of the following two types:

A threaded 1/4 in. diameter hand-driven fastener, 1 7/16 in. long with a 7/16 in. diameter pan head. Prior to driving the fasteners, a 3/16 in. diameter, 1 in. long pilot hole shall be drilled.

A powdered-actuated fastener, with a

*Bearing Underwriters' Laboratories, Inc. Classification Marking.
0.163 in. diameter, 7/8 in. long pointed shank containing a 0.466 in. diameter, 0.054 in. thick washer. Head of fastener to be 7/8 in. long, 7/16 in. wide with an oval opening approximately 5/16 in. diameter. Powdered charge to be sufficient to fully imbed shank portion without damaging concrete surface.

5. **Hanger wire**—No. 18 SWG galvanized steel wire. Hanger wire used to attach wallboard furring channels to precast concrete units. Wire to be located at each intersection of furring channels and concrete stems.

6. **Wallboard furring channels**—No. 26 ga galvanized steel, 7/8 in. high, 2 3/4 in. base width, 1 5/8 in. face width and 12 ft long. Channels to be installed perpendicular to concrete stems and spaced 24 in. on center, except at wallboard butt joints where they are spaced 6 1/2 in. on center. Channels secured to concrete units with double strand of hanger wire looped through fasteners. At furring channel splices, channels to be overlapped 6 in. and tied together with hanger wire at each end of splice.

7. **Wallboard**—5/8 in. thick, 4 ft wide, installed with long dimension perpendicular to furring channels. Over butt joints, a 3 in. wide piece of wallboard to be inserted with ends extending a minimum 6 in. beyond board width.

**United States Gypsum Company (Type C)**

8. **Wallboard fasteners**—1 in. long, Type S, bugle head. Fasteners spaced 12 in. on center along each furring channel except at butt joints where fasteners spaced 8 in. on center. At butt joints, fasteners located 3 1/4 in. from board edge. Along side joints, fasteners located 3/4 in. from board edge.

9. **Joint system** (not shown)—Paper tape imbedded in cementitious compound over joints, and covered with two layers of cementitious compound with edges feathered out. Wallboard fastener heads covered with two layers of cementitious compound.

*Bearing Underwriters' Laboratories, Inc. Classification Marking.*

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Fig. A2. Design No. J504 (Restrained assembly rating: 3 hr. Unrestrained assembly rating: 3 hr.).
Design No. J504 (See Fig. A2)

Restrained assembly ratings: 3 hr.
Unrestrained assembly ratings: 3 hr.

1. Precast concrete units*—Lightweight concrete units with stems spaced a maximum 4 ft on center. For restrained assembly condition, a \( \frac{3}{8} \) in. clearance per 14 ft of length shall be provided for expansion. Also, a \( \frac{3}{4} \) in. lateral expansion joint shall be provided for each 8 ft of width.

If concrete topping is used, minimum thickness to be 1 in., 3000 psi compressive strength, 110 to 153 pcf unit weight.

Concrete Structures, Inc.

2. Minimum bearing: 3 in.

3. Grout (not shown)—Sand-cement grout, 3500 psi, along full length of joint. Weld tie plates to be used in conjunction with grout.

4. Fasteners—Attached to stems of precast concrete units. Used to provide a means of attaching hanger wire to units. Steel fasteners may be either of the following two types:

A threaded \( \frac{1}{4} \) in. diameter hand-driven fastener, \( \frac{1}{16} \) in. long with a \( \frac{7}{16} \) in. diameter pan head. Prior to driving the fasteners, a \( \frac{5}{8} \) in. diameter, 1 in. long pilot hole shall be drilled.

A powdered-actuated fastener, with a 0.163 in. diameter, \( \frac{3}{8} \) in. long pointed shank containing a 0.466 in. diameter, 0.054 in. thick washer. Head of fastener to be \( \frac{3}{8} \) in. long, \( \frac{7}{16} \) in. wide with an oval opening approximately \( \frac{5}{8} \) in. diameter. Powdered charge to be sufficient to fully imbed shank portion without damaging concrete surface.

5. Hanger wire—No. 18 SWG galvanized steel wire. Hanger wire used to attach wallboard furring channels to precast concrete units. Wire to be located at each intersection of furring channels and concrete stems.

6. Wallboard furring channels—No. 26 ga galvanized steel, \( \frac{7}{8} \) in. high, 2\( \frac{3}{4} \) in. base width, 1\( \frac{1}{8} \) in. face width and 12 ft long. Channels to be installed perpendicular to concrete stems and spaced 24 in. on center, except at wallboard butt joints where they are spaced 6\( \frac{1}{2} \) in. on center. Channels secured to concrete units with double strand of hanger wire looped through fasteners. At furring channel splices, channels to be overlapped 6 in. and tied together with hanger wire at each end of splice.

7. Wallboard*—\( \frac{5}{8} \) in. thick, 4 ft wide, installed with long dimension perpendicular to furring channels. Over butt joints, a 3 in. wide piece of wallboard to be inserted with ends extending a minimum 6 in. beyond board width.

United States Gypsum Company (Type C)

8. Wallboard fasteners—1 in. long, Type S, bugle head. Fasteners spaced 12 in. on center along each furring channel except at butt joints where fasteners spaced 8 in. on center. At butt joints, fasteners located 3\( \frac{1}{4} \) in. from board edge. Along side joints, fasteners located \( \frac{3}{4} \) in. from board edge.

9. Joint system (not shown)—Paper tape imbedded in cementitious compound over joints, and covered with two layers of cementitious compound with edges feathered out. Wallboard fastener heads covered with two layers of cementitious compound.