Calculation of a 2-Hour Fire Endurance Assembly for Metal-Plate-Connected Wood Truss Structural Floor and Roof Framing Systems

SRR No. 1509-02

October 2, 2017

Structural Building Components Association (SBCA)

SBCA is an APPROVED SOURCE

This research report is based on practical scientific research (literature review, testing, analysis, etc.). This research report complies with the following sections of the building code:

- **IBC Section 104.11.1** and **Section 1703.4.2** – "Research reports. Supporting data, where necessary to assist in the approval of materials or assemblies not specifically provided for in this code, shall consist of valid research reports from approved sources."

- **IBC Section 202** – "APPROVED SOURCE. An independent person, firm or corporation, approved by the building official, who is competent and experienced in the application of engineering principles to materials, methods or systems analyses."
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Introduction:

There will be instances when materials and assemblies used in a building may not be readily available from prescriptive tables and tests. Theoretical methods have been developed that offer an alternative to full scale fire tests. For example, historically, Section 704.1.1 of the 1996 BOCA National Building Code, Section 703.3 of the 1994 Uniform Building Code and 701.2.1 of the 1994 Standard Building Code permit fire resistance ratings of building assemblies and structural elements to be determined in accordance with an approved analytical method. Current versions of the International Building Code also offer guidance regarding fire-resistance ratings in 2015 IBC Sections 703.2 and Section 703.3 as follows:

**703.2 Fire-resistance ratings.** The fire-resistance rating of building elements, components or assemblies shall be determined in accordance with the test procedures set forth in ASTM E119 or UL 263 or in accordance with Section 703.3.

**703.3 Methods for determining fire resistance.** The application of any of the methods listed in this section shall be based on the fire exposure and acceptance criteria specified in ASTM E119 or UL 263. The required fire resistance of a building element, component or assembly shall be permitted to be established by any of the following methods or procedures:

1. Fire-resistance designs documented in approved sources.
2. Prescriptive designs of fire-resistance-rated building elements, components or assemblies as prescribed in Section 721.
3. Calculations in accordance with Section 722.
4. Engineering analysis based on a comparison of building element, component or assemblies designs having fire-resistance ratings as determined by the test procedures set forth in ASTM E119 or UL 263.
5. Alternative protection methods as allowed by Section 104.11.
6. Fire-resistance designs certified by an approved agency.

The analysis in this research report used the method listed in IBC Section 703.3, method number 4, Engineering analysis. Note, the calculation in accordance with Section 722 (#3) for wood are limited to a maximum of 1 hour (Section 722.6.1.1), however, that limitation does not apply to method 4. Also note that Section 721 (#2) Table 721.1(3), item 28-1.1, includes a prescriptive ceiling design using I-joists\(^2\), 3 layers of 5/8" Type C gypsum and 7/8" furring channel with a 2 hour rating.

One theoretical method known as the “Ten Rules of Fire Endurance Ratings” was published by T.Z. Harmathy in the May, 1965 edition of Fire Technology\(^2\). Harmathy’s Rules provided a foundation for extending fire endurance assembly data and are used extensively in this report. Fire endurance assembly calculations are also delineated in Fire Safety Design in Buildings, by the Canadian Wood Council; Component Additive Method for Calculating and Demonstrating Assembly Fire Endurance, by the American Wood Council (AWC), and Chapter 7 of BOCA’s Guidelines for Determining Fire Resistance Ratings of Building Elements, and ICC’s Resource A Guidelines on Fire Ratings of Archaic Materials and Assemblies. Additionally, the UL Fire Resistance Directory, Design Number L538 assembly is a calculated assembly and was developed in conjunction with the component additive method (CAM) principles. UL Design L538 was authored by the primary author of this report, Mr. Kirk Grundahl, and Mr. Dan Svytnyk of UL.

The calculations in this report are based on CAM principles for metal plate connected wood truss construction using engineering analysis based on comparisons to tested assemblies in accordance with method #4 on behalf of the Structural Building Components Association.
Assembly:

![Diagram of assembly](image)

Specifications:

Fire Rating: Two hours  
Finish Rating: More than 90 minutes

1. **Finish flooring**: 5/8”-thick or thicker sheets of interior plywood or oriented strand board (OSB), manufactured with exterior glue having tongue-and-groove edges along the 8’ side of 4’x8’ sheets, shall be installed perpendicular to the trusses with end joints centered over the top chord of the truss, and placed so the end joints are staggered. The application of the plywood or OSB shall comply with the specifications and recommendations provided by the American Plywood Association.

   A lightweight concrete topping may be (but does not have to be) applied over the plywood or OSB. Generally, this topping should be 3/4”-thick or thicker, following the architectural specifications and topping manufacturer’s guidelines.

2. **Structural members**: A minimum 12”-deep metal plate connected wood truss spaced at a maximum of 24” o.c. can be used in this assembly. The truss application should follow the installation recommendations developed by the Structural Building Components Association (SBCA).

3. **Ceiling Membrane**: Three layers of Type C gypsum wallboard are used in this assembly. Each sheet used is assumed to be a minimum of 4’ wide. The gypsum wallboard attached directly to the trusses should be placed perpendicular to the trusses. The gypsum wallboard attached to the furring channels is assumed to be installed perpendicular to the furring channels. The ceiling is created as follows:

   a. **Wallboard Layer 1**: The first 5/8” layer of gypsum wallboard is attached directly to the bottom chord of the truss using 1-1/4” Type S bugle-head screws spaced 6” o.c. along wallboard ends and edges, and 12” o.c. in the field. The application of the Type C gypsum wallboard shall follow the manufacturer’s installation instructions. The wallboard end joints should be centered on the bottom chord of the trusses, and should be staggered. The minimum end distance (minimum distance the screws are to be held back from 4’ end of wallboard, i.e., butt end) allowed for the base layer is 5/8”. The minimum edge distance (minimum distance the screws are to be held back from 8’, 10’, etc., side of wallboard) is 1-1/2”.

   b. **Furring Channel**: Resilient or inverted hat-type furring channels are placed over the top of the first layer of 5/8” Type C gypsum wallboard. The channels are made of 25-gauge galvanized steel, and installed perpendicular to the structural members. The channels are spaced at a maximum of 24” o.c., and attached to each truss (through the gypsum) with one 1-7/8” Type S screw.

   c. **Wallboard Layer 2**: This layer of 5/8” Type C gypsum wallboard is attached to the furring or resilient channels. Layer 2 is attached with 1 or 1-1/4” Type S bugle-head screws spaced at a maximum of 6” o.c. The end joints of each gypsum wallboard sheet shall be centered on the resilient or furring channel. End distance shall be a minimum of 5/8”. Edge distance shall be a minimum of 1-1/2”.

   d. **Wallboard Layer 3**: The finish layer of 5/8” Type C gypsum wallboard shall be attached to each resilient or furring
channel with a 1-5/8 or 1-7/8” Type S bugle-head screw that passes through wallboard layer 2. The screws shall be spaced at a maximum of 6” o.c. End distance shall be a minimum of 5/8”. Edge distance shall be a minimum of 1-1/2”. The end and edge joints of the finish layer of gypsum should be staggered at a minimum of 24” from the joints that exist in layer 2. The end joints of the face layer must be centered on the furring channels. If this is not the case, end joints shall be attached to Wallboard Layer 2 with 1-1/2” Type G screws spaced 6” o.c. with an end and edge distance of 1-1/2”.

All screws shall be set so that they are flush with the face of the wallboard and do not damage the core of the wallboard.

The following gypsum wallboard may be used in this assembly:

- American Gypsum Co., LLC: Type AG-C
- CertainTeed Gypsum, Inc.: Type C
- CGC Inc.: Types C, IP-X2, IBP-AR
- Continental Building Products Operating Co.: Type LGFC-C/A
- Georgia-Pacific Corp., Gypsum Division: Types 5, DAPC, TG-C
- National Gypsum Co.: Types FSK-C, FSMR-C, FSW-C
- Pabco Gypsum Co.: Type C
- Temple-Inland Forest Products Corp.: Type TG-C
- United States Gypsum: Types C, IP-X2, IPC-AR

4. **Wallboard Screws**: Type S bugle head screws that are self-drilling and self-tapping shall be used. Where needed, Type G wallboard screws can also be used. Screws shall meet ASTM C1002 or ASTM C954 standards.

5. **Finishing Systems** (Not Shown): The face layer joints shall be covered with tape and coated with joint compound. Screws shall also be covered with joint compound.

**Analysis:**

*Membrane Protection*

The critical feature of any fire endurance assembly, particularly a horizontal assembly, is the performance of the gypsum membrane. In order for an assembly to obtain a given fire endurance resistance performance, the membrane must stay intact for the full duration of fire resistance performance prior to falling off. Information pertaining to fire endurance membranes and their performance, with respect to use with a metal plate connected truss system, follows:

Harmathy states that “the thermal fire endurance of a construction consisting of a number of parallel layers is greater than the sum of the thermal fire endurance characteristics of the individual layers when exposed separately to the fire.”

For example, in Table 1, a single layer of 1/2” gypsum wallboard yields a membrane rating of 15 min. If one uses two such layers, the rating is 40 minutes, instead of the expected 30. This confirms the foregoing statement on the addition of multiple layers.

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2 For the most current listing of acceptable Type C gypsum board see UL Design Number L538.
<table>
<thead>
<tr>
<th>Wallboard Membrane Description</th>
<th>Time (min.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/8&quot; Douglas fir plywood phenolic bonded</td>
<td>5</td>
</tr>
<tr>
<td>1/2&quot; Douglas fir plywood phenolic bonded</td>
<td>10</td>
</tr>
<tr>
<td>5/8&quot; Douglas fir plywood phenolic bonded</td>
<td>15</td>
</tr>
<tr>
<td>3/8&quot; gypsum wallboard</td>
<td>10</td>
</tr>
<tr>
<td>1/2&quot; gypsum wallboard</td>
<td>15</td>
</tr>
<tr>
<td>1/2&quot; Type X gypsum wallboard</td>
<td>25</td>
</tr>
<tr>
<td>5/8&quot; gypsum wallboard</td>
<td>20</td>
</tr>
<tr>
<td>5/8&quot; Type X gypsum wallboard</td>
<td>40</td>
</tr>
<tr>
<td>Double 3/8&quot; gypsum wallboard</td>
<td>25</td>
</tr>
<tr>
<td>1/2 and 3/8&quot; gypsum wallboard</td>
<td>35</td>
</tr>
<tr>
<td>Double 1/2&quot; gypsum wallboard</td>
<td>40</td>
</tr>
</tbody>
</table>

Table 1: Time Assigned to Wallboard Membranes, showing the Effect of Adding Together Layers of Wallboard.\(^5,6,7,8,9,10\)
Associated with the above additive rule for fire endurance assemblies, another rule states that the fire endurance of a construction does not decrease with the addition of additional layers. The validity of this rule follows from the fact that by adding layers of material, both the resistance to heat flow and heat capacity of the construction increase. This, in turn, reduces the rate of temperature rise in the plenum and, therefore, at the unexposed surface. For this to work, however, certain restrictions must apply. The added layer must have similar thermal expansion characteristics to that of the adjacent layer. The added layer must also have similar thermal transmission properties, and be a material that is inherently thermal resistant like gypsum board. In other words, adding a layer of steel to the unexposed surface would not enhance the fire performance of the assembly, whereas adding a plaster layer would.

The following analysis shows a protective membrane of 120 min. using the CAM:

<table>
<thead>
<tr>
<th>Wallboard Membrane Description</th>
<th>Time (min.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5/8&quot; Type X gypsum wallboard</td>
<td>40</td>
</tr>
<tr>
<td>5/8&quot; Type X gypsum wallboard</td>
<td>40</td>
</tr>
<tr>
<td>5/8&quot; Type X gypsum wallboard</td>
<td>40</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>120</strong></td>
</tr>
</tbody>
</table>

Table 2: Combined Wallboard Membrane Time Calculation

This amount of membrane protection yields the 2-hour rating desired. It is known that the direct addition of membrane times is conservative, based on the rules given above and shown by the 1/2" gypsum wallboard example in Table 1. Additionally, Type C gypsum is specified in the assembly since it has better fire endurance performance than Type X.

**Assembly Fire Endurance Performance Enhancements**

In order to be more conservative in this calculated assembly, enhancements have been added to provide greater assurance that this assembly will meet the 2-hour rating. The description of these enhancements follow:

- Harmathy states that the fire endurance of constructions containing continuous air gaps or cavities is greater than the fire endurance of similar constructions of the same weight, but containing no air gaps or cavities. The validity of this rule rests on the fact that the insertion of voids produces an additional resistance to the path of heat flow, much like a storm window.

As seen in the assembly described above, resilient channels have been inserted between Wallboard Layer 1 of the assembly and the two layers below it. This serves the following functions:

- It creates a continuous air space that will enhance the fire performance of the membrane system and creates dead air space that is insulating.

- Attaching the resilient channel over the first layer of gypsum provides additional support for, and therefore enhances the stability of, the first layer of gypsum wallboard. This will aid in keeping this layer of gypsum in place, resulting in better assembly fire performance.

- There will be two connection points of the first layer into the truss system. The first will be attaching the gypsum layer to the truss, and the second will be attaching the resilient channel through the first gypsum layer into the truss. As noted above, these additional connections will enhance the stability of the membrane attachment, and thus keep layer 1 on longer and improve the overall fire performance of the assembly.

- In the analysis performed for the National Fire Protection Research Foundation (NFPRF), entitled, National Engineered Lightweight Construction Fire Research Project, two assemblies were analyzed that showed the effects of the addition of resilient channels. The Factory Mutual reports, Design FC-240 and Design FC-235 indicate an 12

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11 Harmathy, loc. cit.
12 Type X board has glass fibers in the core for enhanced fire performance and is tested in specific fire-rated assemblies. Type C meets all the requirements of the Type X board and is further enhanced with additional glass fibers and other core ingredients for an even greater level of fire performance. Type C core ingredients are proprietary. If the design calls for a Type C board, a Type X board cannot be used as a substitute. See the gypsum products listed in the assembly.
13 Harmathy, loc. cit.
SBCA Research Report (SRR)

additional 6 minutes of performance due to the addition of resilient channels. See a summary of these reports in Appendix A.

For the assembly described above, the following calculation could then be made:

<table>
<thead>
<tr>
<th>Description</th>
<th>Time (min.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 layers of 5/8&quot; Type X gypsum wallboard</td>
<td>120</td>
</tr>
<tr>
<td>Resilient channels spaced to a maximum of 16&quot; o.c.</td>
<td>6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>126</strong></td>
</tr>
</tbody>
</table>

Table 3: Revised Calculation Adding Resilient Channels

Note that there has still been no credit given for the multiple layer effect. This membrane could be calculated as at least a 136-minute assembly by adding the 10-minute performance increase, using the 2 layers of 1/2" gypsum example shown earlier.

<table>
<thead>
<tr>
<th>Description</th>
<th>Time (min.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 layers of 5/8&quot; Type X gypsum wallboard</td>
<td>120</td>
</tr>
<tr>
<td>Resilient channels spaced to a maximum of 16&quot; o.c.</td>
<td>6</td>
</tr>
<tr>
<td>Credit for Multiple Layers of Gypsum</td>
<td>10</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>136</strong></td>
</tr>
</tbody>
</table>

Table 4: Revised Calculation Adding Resilient Channels and Multiple Gypsum Layer Effect

Engineering Evaluation from ASTM E119 Tests

To evaluate the reliability and reasonability of this assembly, currently performed and publicly reported ASTM E119 testing can be reviewed as a generally accepted industry standard and methodology. This method presents the confidence needed to recommend that this proposed fire endurance assembly will provide 2-hour fire endurance protection. Justification based on ASTM E119 testing follows:

There are three examples of assemblies that utilize 2 layers of 5/8" Type C gypsum wallboard: UL L505, L511 and L538 (see 2015 summaries of each test in Appendix B, Appendix C & Appendix D respectively). The finish rating is 75, 71 and more than 90 minutes, respectively. In these assemblies, the resilient channel was spaced 24" o.c., and the wallboard was attached with 8d nails spaced 7" o.c. These tests illustrate the endurance performance of the wallboard, and provide the time it took for this membrane and connection system to provide thermal protection of the assembly to 250° F plus ambient on average, or 325°F, plus ambient at a single point.

- There are two metal plate connected truss tests available that provides an indication of single gypsum layer performance with trusses spaced at 24" o.c. Factory Mutual FC-235 (Appendix A) shows 5/8" USG Type C board provides a 24-minute finish rating and PFS 88-03\(^\text{15}\) shows 5/8" USG Type C board provides a 23-minute finish rating\(^\text{16}\). Performing a combined finish rating calculation yields:

<table>
<thead>
<tr>
<th>Description</th>
<th>Time (min.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single layer of 5/8&quot; Type C wallboard attached to Trusses</td>
<td>71-75</td>
</tr>
<tr>
<td>Resilient channels</td>
<td></td>
</tr>
<tr>
<td>Single layer of 5/8&quot; Type C wallboard attached to resilient channels</td>
<td>23-24</td>
</tr>
<tr>
<td><strong>Finish rating range of performance</strong></td>
<td><strong>94-99</strong></td>
</tr>
</tbody>
</table>

Table 5: Combined Finish Rating Performance

This range is conservative given the additive rule described above, where the addition of material adds more fire resistance than the pure sum of fire resistance.

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\(^{15}\) PFS 88-03 is referenced in NER-392 as one of the documents submitted for evidence.

\(^{16}\) Grundahl, Kirk, P.E., National Engineered Lightweight Construction Fire Research Project, Phase I: Literature Search and Technical Analysis, National Fire Protection Research Foundation, October, 1992. Table 4-2.11 pg. 123
SBCA Research Report (SRR)

This analysis shows the time it takes the back side of the wallboard to reach an average of 250°F above the ambient temperature (approximately 250 + 70 = 320°), which is well below the temperature that wood begins to char (482°F).

The performance of the trusses in the fire test assemblies FC-235 and PFS 88-03 after the finish rating was reached was 26 and 29 minutes, respectively.

By adding these values to the finish rating range of performance above:

<table>
<thead>
<tr>
<th>Description</th>
<th>Time (min.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Finish Rating Range of Performance</td>
<td>94-99</td>
</tr>
<tr>
<td>Truss Performance after Finish rating is achieved</td>
<td>26-29</td>
</tr>
</tbody>
</table>

**Table 6:** Finish Rating Performance with Truss Performance

Therefore, the ASTM E119 testing justifies the previous fire endurance performance calculations, shown in Table 2, Table 3 and Table 4. The beneficial effect of adding layers of wallboard together has still not been included in the analysis. This effect should add a minimum of 10 minutes to the performance for a range of 130 - 138 minutes, which is in excess of the 2-Hour rating desired.

<table>
<thead>
<tr>
<th>Description</th>
<th>Time (min.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Finish Rating Range of Performance</td>
<td>94-99</td>
</tr>
<tr>
<td>Truss Performance after Finish rating is achieved</td>
<td>26-29</td>
</tr>
<tr>
<td>Beneficial Effect of Adding Gypsum Layers Together</td>
<td>10</td>
</tr>
</tbody>
</table>

**Table 7:** Assembly Performance Rating with Gypsum Added

**Connection System**

In order for the membrane system to adequately or suitably protect the trusses from the impact of fire, the connection detailing becomes extremely important. The connections must hold the gypsum membrane in place during the exposure time and have enough withdrawal resistance to hold the dead load of the gypsum wallboard. The calculations for the screwing patterns as described above follow:

- Since the trusses are spaced 24" o.c. and the base layer screw spacing is 6" o.c., each screw must hold 1 ft.² of gypsum weight. Type C gypsum weighs approximately 2.5 lbs. per ft.², so each screw must hold 2.5 lbs. of dead weight. Assuming the typical 1-1/4" Type S, 6 gauge screws are being used with wood that has a specific gravity assumed to be 0.42 or greater, which covers Spruce-Pine-Fir chord stock, a screw withdrawal resistance of 69 lbs./in. of length. This is based on the 2015 National Design Specification for Wood Construction. Since attaching 5/8" thick gypsum with a 1-1/4" screw, the shank length of the screw going into the wood is 5/8". Therefore, the screw holding power for each base layer screw is 43.125 lbs. This is much greater than the 2.5 lbs. required. (Using Southern Pine or Douglas Fir Larch for chords, 0.50 specific gravity, results in a value of 61.25 lbs. per screw.)

- Since the resilient channels are spaced 24" o.c., and the joists are spaced 24" o.c., the screws attaching the resilient channel to the wood joist must hold four square feet of gypsum times two layers of gypsum times 2.5 lbs./ft.² for each 5/8" Type C gypsum layer. This is a total of 20 lbs. of load per screw. Using a 1-7/8" Type S screw that penetrates a 5/8" thick layer of gypsum and the resilient furring channel leaves approximately 1-1/4" of penetration. Using a withdrawal design value of 69 lbs./in. of penetration yields a capacity for each screw holding the resilient channel to the joist of 86.25lbs. This is far in excess of the 20 lbs. required.

- The middle layer of the wallboard should be attached to each furring or resilient channel with 1 or 1-1/4" Type S screws spaced 6" o.c. These screws must each carry 1.0 ft.² of load, with Type C gypsum weighing 2.5 lbs./ft.², requiring a screw load capacity of 2.5 lbs. The calculated pull-out (withdrawal) resistance of a #6 Type S screw penetrating 25-gauge, 33 ksi, steel resilient channels exceeds 60 lbs., which far exceeds the 2.5 lbs. required.

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18 AISI S100-2012, Eq. E4.4.1-1

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**Assembly Modifications**

**Depth/Spacing:**
The trusses in this design have a minimum depth of 12". Trusses with depths greater than 12” may be used. Dimensions included for depth of assemblies are minimums, spacings are maximums. **GA-600** includes the following statement under General Explanatory Notes, item 17 & 20:

17. Specified floor-ceiling and roof-ceiling framing sizes or truss dimensions are minimums. Greater joist or truss sizes (depths) shall be permitted to be used in metal- or wood-framed systems. Indicated joist and truss spacings are maximums.

20. Floor-ceiling and roof-ceiling systems were fire tested at less than 36 inches total depth. However, the total depth of the systems, with either directly attached or suspended ceiling membranes, shall be permitted to extend greater than 36 inches.

**Insulation:**
Both UL and GA include specific guidance regarding the use of insulation in assemblies. G500, L500, M500, and P500 series designs listed by **UL BXUV** allow addition of any depth of insulation at any location in an assembly that does not include insulation, but only as long as another layer of gypsum (of the same type as specified in the tested assembly) is installed at the ceiling. Any other method of adding insulation is prohibited in assemblies tested without insulation. A similar general provision is included in **GA-600**. However, **IBC 703.3**, items 4 or 5 do allow modifications to assemblies, including inclusion or placement of insulation, based on rational design provided to the building official.

In deeper trusses, the space above the 12” plenum depth may contain insulation, provided the insulation is supported adequately so that the plenum depth is maintained at 12” from the backside of the gypsum due to the conservative design methodology.

**Conclusion:**
This assembly has been developed using engineering analysis based on a comparison to assemblies having fire-resistance ratings as determined by the test procedures set forth in **ASTM E119** or **UL 263** and is shown to achieve a 2-hour fire endurance performance rating, based both on the CAM and as verified by comparison to existing **ASTM E119** tests. The development of this assembly was deliberately conservative to ensure 2-hour performance in the following ways:

- **Type C gypsum wallboard is specified instead of Type X as given in Table 1.** This wallboard has proven to be a more stable wallboard, and thus will more adequately protect the truss assembly.

- By placing the resilient channels over the top of wallboard layer 1, the channels will hold the wallboard in place and enhance the performance of the fire endurance assembly. This is due to the increased likelihood the wallboard will not fall away from the trusses prematurely.

- **The Type S gypsum wallboard screws are spaced at 6” o.c. to provide good connection support of the wallboard membrane.** The loads carried by each fastener has also been considered to ensure that there is a large margin of reserve capacity for each screw. The key to an assembly's performance is an intact membrane. This fastener schedule seeks to ensure the membrane will stay intact and perform as expected.

Given the above, the described assembly will confidently afford a 2-hour fire endurance performance as required by the building code.
Appendix A: Reports

Report: Floor/Ceiling Wood Truss Assembly Design FC-235

Author: W.R. Price and W.F. Shield, Factory Mutual Research
Sponsor: Truss Plate Institute
Date: August 6, 1976

Basic Test Description: The floor assembly consisted of floor trusses, 12 in. deep with nominal 2 x 4 wood chords and webs. The floor trusses were 17 ft., 5 in. long, and were spaced 24 in. on center. The floor was a single layer of 3/4 in. thick plywood with vinyl asbestos tile attached to it. The ceiling was a single layer of 5/8 in. Type FSW (or Type C) gypsum wallboard, produced by National Gypsum Company, and was secured directly to the bottom chords of the trusses.

Test Method Used: ASTM E119.

Report Observations: Observations were made of the exposed and unexposed surface, deflection measurements of the floor were made, and the temperature of the unexposed surface, plenum and furnace were measured.

Report Summary: The assembly was subjected to a uniformly distributed live load of 50.1 psf, which resulted in a combined live and dead load of 57.4 psf. The deflection at the center of the assembly at 50 min. was 3.5 in. There were no unusual occurrences based on the observations made for both the unexposed and exposed surfaces during the test. The test was terminated at 50 min. when the assembly failed to support the superimposed load. The finish rating was calculated to be 24 min.

Comments: This test gives an indication of the performance of metal plate connected wood trusses with single layer gypsum protection. The gypsum board used was identical to that used in the I-joist test above.

Report: Floor/Ceiling Truss Assembly Design FC-240

Authors: W.R. Price and W.F. Shield, Factory Mutual Research
Sponsor: Truss Plate Institute
Date: April 13, 1977

Basic Test Description: The floor assembly consisted of floor trusses 12 in. deep with nominal 2 x 4 wood chords and webs, and were 17 ft., 5 in. long. Trusses were spaced 24 in. on center. The floor was a single layer of 3/4 in. thick tongue-and-groove plywood. The ceiling was a single layer of 5/8 in. thick Firecode C gypsum wallboard manufactured by USG secured to furring channels attached to the bottom chords of the trusses. The furring channels, manufactured by USG and designated as RC-1 resilient channels, were installed perpendicular to the trusses, and located 16 in. on center.

Test Method Used: ASTM E119.

Report Observations: Observations of the exposed and unexposed surfaces were made, and the deflection of the floor, the temperature of the furnace, plenum, and unexposed surface, and time of failure of the assembly were recorded.

Report Summary: The assembly was subjected to a uniformly distributed live load of 50.7 psf, which resulted in a combined live and dead load of 57.8 psf. There were no unusual observations of either the exposed or unexposed surfaces during the test. The maximum deflection of the floor occurred at 58 min., where the center-most deflection was 2.13 in. The test was terminated at 58 min., when the assembly failed to support the superimposed load. The finish rating was calculated to be 26 min.

Comments: This test highlights the effects of resilient channels on trusses with all other factors being equal. In this case, the resilient channel added approximately 6 min. to the performance of the assembly, calculated as follows:

\[(58-26)-50-24) = 6 \text{ min.}\]

This calculation accounts only for performance after the finish rating was met for the membrane, and is certainly not absolute for all cases. It only provides an indication.
Appendix B: UL Design No. L505
Design No. L505

June 22, 2015

Unrestrained Assembly Rating — 2 Hr.
Finish Rating — 75 Min.

This design was evaluated using a load design method other than the Limit States Design Method (e.g., Working Stress Design Method). For jurisdictions employing the Limit States Design Method, such as Canada, a load restriction factor shall be used — See Guide BXUV or BXUV7

* Indicates such products shall bear the UL or cUL Certification Mark for jurisdictions employing the UL or cUL Certification (such as Canada), respectively.

1. Flooring System — The flooring system shall consist of one of the following:

**System No. 1**

**Subflooring** — Min 1 by 6 in. T & G lumber fastened diagonally to joists, or min 15/32 in. thick wood structural panels or 7/18 in. thick oriented strand board (OSB) wood structural panels, min grade "C-D" or "Sheathing". Face grain of plywood or strength axis of panels to be perpendicular to the joists with joints staggered.

**Subflooring (Alternate) - Structural Cement-Fiber Units** — Nominal 19 mm (3/4 in.) thick tongue and groove structural cement-fiber units. Long dimension of panels to be perpendicular to joists with and joints staggered. Panels fastened to the joists with #10 self-drilling, self-tapping cement board screws 1-3/4 in. long. Screws shall be spaced 6 in. OC along the perimeter of each sheet and 12 in. OC in the field of each sheet. Screws shall be spaced 1/2 in. from end joints and 1 in. from side joints.

ECTEK INTERNATIONAL INC — Armoroc Panel

**Vapor Barrier** — Nom 0.010 in. thick commercial rosin-sized building paper.

**Finish Flooring** — Min 1 by 4 in. T & G lumber fastened perpendicular to joists, or min 19/32 in. wood structural panels, min grade "Underlayment" or "Single Floor". Face grain of plywood or strength axis of panels to be perpendicular to joists with joints staggered.
SBCA Research Report (SRR)

System No. 2

Subflooring — Min 15/32 in. thick wood structural panels, min grade "C-D" or "Sheathing". Face grain of plywood or strength axis of panels to be perpendicular to the joists with joints staggered.

Vapor Barrier - (Optional) — Nom 0.010 in. thick commercial asphalt saturated felt.

Finish Flooring - Floor Topping Mixture* — Min 3/4 in. thickness of floor topping mixture having a minimum compressive strength of 1800 psi. Refer to manufacturer’s instructions accompanying the material for specific mix design.

UNITED STATES GYPSUM CO — Types LRK, HSLRK, CSD

Floor Mat Materials* — (Optional) - Floor mat material loose laid over the subfloor. Refer to manufacturer’s instructions regarding the minimum thickness of floor topping over each floor mat material.

UNITED STATES GYPSUM CO — Types SAM, LEVELROCK® Brand Sound Reduction Board, LEVELROCK® Brand Floor Underlayment SRM-25

Alternate Floor Mat Materials* - (Optional) — Nom 3/8 in. thick floor mat material loose laid over the subfloor. Floor topping thickness shall be as specified under Floor Topping Mixture.

GRASSWORX L L C — Type SC50

Alternate Floor Mat Material* — (Optional) - Floor mat material nominal 3/8 in. thick loose laid over the subfloor. Floor topping shall be a min 3/4 or 1 in. thickness of floor topping mixture for min 19/32 or min 15/32 in. thick wood structural panels respectively.

System No. 3

Subflooring — Min 15/32 in. thick wood structural panels, min grade "C-D" or "Sheathing". Face grain of plywood or strength axis of panels to be perpendicular to the joists with joints staggered.

Vapor Barrier - (Optional) — Nom 0.030 in thick commercial asphalt saturated felt.

Finish Flooring - Floor Topping Mixture* — Min 1-1/2 in. thickness of floor topping mixture having a min compressive strength of 1000 psi and a cast density of 100 plus or minus 5pcf. Foam concentrate mixed 40:1 by volume with water and expanded at 100 psi through nozzle. Mixture shall consist of 1.4 cu feet of preformed foam concentrate to 94 lbs Type I Portland cement, 300 lbs of sand with 5-1/2 gal of water.

ELASTIZELL CORP OF AMERICA — Type FF

System No. 4

Subflooring — Min 15/32 in. thick wood structural panels, min grade "C-D" or "Sheathing". Face grain of plywood or strength axis of panels to be perpendicular to the joists with joints staggered.

Vapor Barrier - (Optional) — Nom 0.030 in thick commercial asphalt saturated felt.

Floor Mat Materials* — (Optional) — Floor mat material nom 5/64 in. (2 mm) thick adhered to subfloor with Hacker Floor Primer. Primer to be applied to the surface of the mat prior to the placement of a min 1-1/4 in. of floor-topping mixture.

ECORE INTERNATIONAL INC — Type QTecu 4002

HACKER INDUSTRIES INC — Type Hacker Sound-Mat.
Alternate Floor Mat Materials - (Optional) — Floor mat material nom 1/8 in. (3 mm) thick loose laid over the subfloor. Floor topping thickness shall be a min of 1 in. (25 mm)

HACKER INDUSTRIES INC — FIRM-FILL SCM 125

Alternate Floor Mat Materials - (Optional) — Floor mat material nom 1/4 in. (6 mm) thick loose laid over the subfloor. Floor topping thickness shall be a min of 1 in. (25 mm)

HACKER INDUSTRIES INC — Type FIRM-FILL SCM 250, Quiet Curl 55/025

Alternate Floor Mat Materials - (Optional) — Floor mat material nom 3/8 in. (10 mm) thick loose laid over the subfloor. Floor topping thickness shall be a min of 1-1/4 in. (32 mm)

HACKER INDUSTRIES INC — FIRM-FILL SCM 400, Quiet Curl 60/040

Alternate Floor Mat Materials - (Optional) — Floor mat material nom 3/4 in. (19 mm) thick loose laid over the subfloor. Floor topping thickness shall be a min of 1-1/2 in. (38 mm)

HACKER INDUSTRIES INC — Type FIRM-FILL SCM 750, Quiet Curl 55/075

Metal Lath (Optional) — For use with 3/8 in. (10 mm) floor mat materials, 3/6 in. expanded steel diamond mesh, 3,4 lbs/sq yd placed over the floor mat material. Hacker Floor Primer to be applied prior to the placement of the metal lath. When metal lath is used, floor topping thickness a nom 1-1/4 in. over the floor mat.

Finish Flooring - Floor Topping Mixture* — Min 3/4 or 1 in. thickness of floor topping mixture for min 19/32 or min 15/32 in. thick wood structural panels respectively, having a min compressive strength of 1100 psi. Mixture shall consist of 6.8 gal of water to 80 lbs of floor topping mixture to 1.9 cu ft of sand.

HACKER INDUSTRIES INC — Firm-Fill Gypsum Concrete, Firm-Fill 2010, Firm-Fill 3310, Firm-Fill 4010, Firm-Fill High Strength, Gyp-Span Radiant

System No. 5

Subflooring — Min 15/32 in. thick wood structural panels, min grade "C-D" or "Sheathing". Face grain of plywood or strength axis of panels to be perpendicular to the joists with joints staggered.

Vapor Barrier - (Optional) — Nom 0.030 in thick commercial asphalt saturated felt.

Finish Flooring - Floor Topping Mixture* — Min Lin. thickness of floor topping mixture having a min compressive strength of 1000 psi and a cast density of 100 lbs or minus 5 pcf. Foam concentrate mixed 40:1 by volume with water and expanded at 100 psi through nozzle. Mixture shall consist of 1.4 cu feet of preformed foam concentrate to 94 lbs Type I Portland cement, 52.5 lb of pea gravel, 312.5 lbs of sand with 5-1/2 gal of water.

LITE-CRETE INC — Type 1

System No. 6

Subflooring — Min 15/32 in. thick wood structural panels, min grade "C-D" or "Sheathing". Face grain of plywood or strength axis of panels to be perpendicular to the joists with joints staggered.

Vapor Barrier - (Optional) — Nom 0.030 in thick commercial asphalt saturated felt.

Finish Flooring - Floor Topping Mixture* — Min 3/4 or 1 in. thickness of floor topping mixture for 19/32 or 15/32 in. thick wood structural panels respectively, having a min compressive strength of 1000 psi. Mixture shall consist of 5 to 8 gal of water to 60 lbs of floor topping mixture to 2.1 cu ft of sand.

ULTRA QUIET FLOORS — UQF-A, UQF-Super Blend, UQF-Plus 200
**System No. 7**

**Subflooring** — Min 15/32 in. thick wood structural panels, min grade "C-D" or "Sheathing". Face grain of plywood or strength axis of panels to be perpendicular to the joists with joints staggered.

**Vapor Barrier - (Optional)** — Nom 0.030 in thick commercial asphalt saturated felt.

**Floor Mat Materials** - (Optional) — Nom 1/4 in. thick floor mat material loose laid over the subfloor. Maxxon Floor Primer to be applied to the surface of the mat prior to the floor topping placement. When floor mat material is used, min thickness of floor topping thickness is 1 in. Floor topping thickness a min 3/4 in. over Acousti-Mat I floor mat.

**MAXXON CORP** — Type Acousti-Mat I, Acousti-Mat II, Acousti-Mat II HP.

**Alternate Floor Mat Materials** - (Optional) — Nom 0.8 in. thick floor mat material loose laid over the subfloor with Crack Suppression Mat (CSM) loose laid over the floor mat material. Floor topping thickness shall be min 1-1/2 in.

**MAXXON CORP** — Type Acousti-Mat 3, Acousti-Mat 3 HP, Crack Suppression Mat (CSM)

**Metal Lath** — (Alternate to Crack Suppression Mat (CSM)) — 3/8 in. expanded galvanized steel diamond mesh, 3.4 lbs/sq yd loose laid over the floor mat material. Floor topping thickness shall be min 1-1/2 in.

**Fiber Glass Mesh Reinforcement** — (Optional) — Maxxon Corp’s "Maxxon Reinforcement (MR)" for use with or as an alternate to CSM or metal lath reinforcement, the materials consists of a plastic coated non-woven fiber glass mesh grid intended to suppress cracks in the Floor Topping Mixture

**Alternate Floor Mat Materials** - (Optional) — Nom 0.4 in. thick floor mat material loose laid over the subfloor. Maxxon Floor Primer to be applied to the surface of the mat prior to the floor topping placement. Floor topping thickness shall be min 1 in. Floor topping thickness shall be min 3/4 in. when used with Crack Suppression Mat (CSM), Metal Lath, or Maxxon Reinforcement (MR).

**MAXXON CORP** — Type Enkaconic 9110, Enkaconic 9110 HP.

**Alternate Floor Mat Materials** - (Optional) — Nom 0.2 in. thick floor mat material loose laid over the subfloor. Maxxon Floor Primer may be applied to the surface of the mat prior to the floor topping placement. Floor topping thickness shall be min 3/4 in. (1 in. for min 15/32 in. thick wood structural panels).

**MAXXON CORP** — Type Acousti-Mat LP-R

**Metal Lath** — (Optional) — For use with floor mat materials, 3/8 in. expanded galvanized steel diamond mesh, 3.4 lbs/sq yd or Maxxon Corp, UL Classified Crack Suppression Mat (CSM) loose laid over the floor mat material. Floor topping thickness shall be min 1 in.

**MAXXON CORP** — Type Crack Suppression Mat (CSM)

**Fiber Glass Mesh Reinforcement** — (Optional) — Maxxon Corp’s "Maxxon Reinforcement (MR)" for use with or as an alternate to CSM or metal lath reinforcement, the materials consists of a plastic coated non-woven fiber glass mesh grid intended to suppress cracks in the Floor Topping Mixture

**Finish Flooring - Floor Topping Mixture** — Min 3/4 or 1 in. thickness of floor topping mixture for min 19/32 or min 15/32 in. thick wood structural panels respectively, having a min compressive strength of 1000 psi. Mixture shall consist of 3 to 7 gal of water mixed with 80 lbs of floor topping mixture and 1.0 to 2.1 cu ft of sand.

**MAXXON CORP** — Type D-C, GC, GC 2000, L-R, T-F, CT
System No. 8

Subflooring — Min 15/32 in. wood structural panels, min grade "C-D" or "Sheathing". Face grain of plywood or strength axis of panels to be perpendicular to joists with joints staggered.

Vapor Barrier - (Optional) — Nom 0.030 in thick commercial asphalt saturated felt.

Floor Mat Materials* - (Optional) — Nom 1/4 in. thick floor mat material loose laid over the subfloor. Maxxon Floor Primer to be applied to the surface of the mat prior to the floor topping placement. When floor mat material is used, min thickness of floor topping mixture is 1 in. Floor topping thickness a min 3/4 in. over Acousti-Mat I floor mat.

MAXXON CORP — Type Acousti-Mat I, Acousti-Mat II, Acousti-Mat II HP.

Alternate Floor Mat Materials* - (Optional) — Nom 0.8 in. thick floor mat material loose laid over the subfloor with Crack Suppression Mat (CSM) loose laid over the floor mat material. Floor topping thickness shall be min 1-1/2 in.

MAXXON CORP — Type Acousti-Mat 3, Acousti-Mat 3 HP, Crack Suppression Mat (CSM)

Metal Lath — (Alternate to Crack Suppression Mat (CSM)) — 3/8 in. expanded galvanized steel diamond mesh, 3.4 lbs/sq yd loose laid over the floor mat material. Floor topping thickness shall be min 1-1/2 in.

Fiber Glass Mesh Reinforcement — (Optional) — Maxxon Corp’s "Maxxon Reinforcement (MR)" for use with or as an alternate to CSM or metal lath reinforcement, the materials consists of a plastic coated non-woven fiber glass mesh grid intended to suppress cracks in the Floor Topping Mixture

Alternate Floor Mat Materials* - (Optional) — Nom 0.4 in. thick floor mat material loose laid over the subfloor. Maxxon Floor Primer to be applied to the surface of the mat prior to the floor topping placement. Floor topping thickness shall be min 1 in. Floor topping thickness shall be min 3/4 in. when used with Crack Suppression Mat (CSM), Metal Lath, or Maxxon Reinforcement (MR).

MAXXON CORP — Type Enkasonic 9110. Enkasonic 9110 HP.

Alternate Floor Mat Materials* - (Optional) — Nom 0.2 in. thick floor mat material loose laid over the subfloor. Maxxon Floor Primer may be applied to the surface of the mat prior to the floor topping placement. Floor topping thickness shall be min 3/4 in. (1 in. for min 15/32 in. thick wood structural panels).

MAXXON CORP — Type Acousti-Mat LP-R

Metal Lath — (Optional) — For use with floor mat materials, 3/8 in. expanded galvanized steel diamond mesh, 3.4 lbs/sq yd or Maxxon Corp. UL Classified Crack Suppression Mat (CSM) loose laid over the floor mat material. Floor topping thickness shall be min 1 in.

MAXXON CORP — Type Crack Suppression Mat (CSM)

Fiber Glass Mesh Reinforcement — (Optional) — Maxxon Corp’s "Maxxon Reinforcement (MR)" for use with or as an alternate to CSM or metal lath reinforcement, the materials consists of a plastic coated non-woven fiber glass mesh grid intended to suppress cracks in the Floor Topping Mixture

Finish Flooring - Floor Topping Mixture* — Min 3/4 or 1 in. thickness of floor topping mixture for min 19/32 or min 15/32 in. thick wood structural panels respectively, having a min compressive strength of 1200 psi. Mixture shall consist of 4 to 7 gal of water mixed with 80 lbs of floor topping mixture and 1.4 to 1.9 cu ft of sand.

RAPID FLOOR SYSTEMS — Type RF, RFP, RPU, RFR, Ortecrete
SBCA Research Report (SRR)

System No. 9

**Subflooring** — Min 1 by 6 in. T & G lumber fastened diagonally to joists, or min 15/32 in. thick wood structural panels or 7/16 in. thick oriented strand board (OSB) wood structural panels, min grade “C-D” or “Sheathing”. Face grain of plywood or strength axis of panels to be perpendicular to the joists with joints staggered.

**Finish Floor - Mineral and Fiber Board** — Min 1/2 in. thick, supplied in sizes ranging from 3 ft by 4 ft to 8 ft by 12 ft. All joints to be staggered a min of 12 in. with adjacent sub-floor joints.

**HOMASOTE CO** — Type 440-32 Mineral and Fiber Board

System No. 10

**Subflooring** — Min 15/32 in. thick wood structural panels, min grade “C-D” or “Sheathing”. Face grain of plywood or strength axis of panels to be perpendicular to the joists with joints staggered.

**Vapor Barrier - (Optional)** — Nom 0.030 in thick commercial asphalt saturated felt.

**Finish Flooring - Floor Topping Mixture** — Min 1-1/2 in. thickness of floor topping mixture having a min compressive strength of 1000 psi and a cost density of 105 plus or minus 5 pcf. Foam concentrate mixed 40:1 by volume with water and expanded at 100 psi through nozzle. Mixture shall consist of 1.2 cu feet of preformed foam concentrate to 94 lbs Type I Portland cement. 300 lbs of sand with 5.5 gal of water.

**AERIX INDUSTRIES** — Floor-Topping Mixture

System No. 11

**Subflooring** — Min 15/32 in. thick wood structural panels, min grade “C-D” or “Sheathing”. Face grain of plywood or strength axis of panels to be perpendicular to the joists with joints staggered.

**Vapor Barrier - (Optional)** — Nom 0.010 in. thick commercial rosin-sized building paper.

**Finish Flooring - Floor Topping Mixture** — Min 3/4 or 1 in. thickness of floor topping mixture for 19/32 or 15/32 in. thick wood structural panels respectively, having a min compressive strength of 1000 psi. Refer to manufacturer’s instructions accompanying the material for specific mix design.

**ALLIED CUSTOM GYPSUM** — Accu-Crete, AccuRadiant, AccuLevel G40 and AccuLevel SD30.

**Alternate Floor Mat Material** — (Optional) - Floor mat material nominal 2 - 9.5 mm thick loose laid over the subfloor. Floor topping shall be a min of 3/4 in. or 1 in. thick of floor topping mixture for 19/32 or 15/32 in. thick wood structural panels respectively.

**ALLIED CUSTOM GYPSUM** — Type AccuQuiet P80, Type AccuQuiet C40, AccuQuiet D13, and Type AccuQuiet D-18.

System No. 12

**Subflooring** — 15/32 or 19/32 in. thick wood structural panels, min. grade “C-D” or “Sheathing”. Face grain of plywood or strength axis of panels to be perpendicular to joists with joints staggered.

**Vapor Barrier — (Optional)** — Nom 0.030 in. thick commercial asphalt saturated felt.

**Finish Flooring — Floor Topping Mixture** — Min 3/4 or 1 in. thickness of floor topping mixture for 19/32 or 15/32 in. thick wood structural panels respectively, having a min compressive strength of 2100 psi. Refer to manufacturer’s instructions accompanying the material for specific mix design.
System No. 13

Subflooring — Min 15/32 in. thick wood structural panels, min grade "C-D" or "Sheathing". Face grain of plywood or strength axis of panels to be perpendicular to the joists with joints staggered.

Vapor Barrier — (Optional) - Commercial asphalt saturated felt, 0.030 in. thick.

Vapor Barrier — (Optional) - Nom 0.010 in. thick commercial rosin-sized building paper.

Finish Flooring* — Min 3/4 in. thickness of any Floor Topping Mixture bearing the UL Classification Marking as to Fire Resistance. See Floor- and Roof-Topping Mixtures (CCOX) category for names of Classified Companies.

Floor Mat Materials* — (Optional) - Nom. 1/4 in. thick loose laid over the subfloor. Floor topping thickness shall be a minimum of 3/4 in.

KEENE BUILDING PRODUCTS CO INC — Type Quiet Qurl 55/025 and Quiet Qurl 55/025 N

Alternate Floor Mat Materials* — (Optional) - Floor mat material Nom. 3/8 in. thick loose laid over the subfloor. Floor topping thickness shall be a minimum of 1 in.

KEENE BUILDING PRODUCTS CO INC — Type Quiet Qurl 60/040 and Quiet Qurl 60/040 N

Alternate Floor Mat Materials* — (Optional) - Floor mat material Nom. 3/4 in. thick loose laid over the subfloor. Floor topping thickness shall be a minimum of 1-1/2 in.

KEENE BUILDING PRODUCTS CO INC — Type Quiet Qurl 65/075, Quiet Qurl 65/075 N

Alternate Floor Mat Materials* — (Optional) - Floor mat material Nom. 1/8 in. thick loose laid over the subfloor. Floor topping thickness shall be a minimum of 3/4 in.

KEENE BUILDING PRODUCTS CO INC — Type Quiet Qurl 52/013 and Quiet Qurl 52/013 N

Alternate Floor Mat Materials* — (Optional) - Floor mat material Nom. ¼ in. entangled net core with a compressible fabric attached to the bottom loose laid over the subfloor. Floor topping thickness shall be a minimum of 1 in.

KEENE BUILDING PRODUCTS CO INC — Quiet Qurl 55/025 MT and Quiet Qurl 55/025 N MT

System No. 14

Subflooring — Min 15/32 in. thick wood structural panels, min grade "C-D" or "Sheathing". Face grain of plywood or strength axis of panels to be perpendicular to the joists with joints staggered.

Vapor Barrier — (Optional) — Nom 0.010 in. thick commercial rosin-sized building paper.

Finish Flooring - Floor Topping Mixture* — Min 3/4 or 1 in. thickness of floor topping mixture for 19/32 or 15/32 in. thick wood structural panels respectively, having a min compressive strength of 1000 psi. Refer to manufacturer’s instructions accompanying the material for specific mix design.

DEPENDABLE LLC — GSL M3.4, GSL K2.5 and GSL RH.

Floor Mat Materials* — (Optional) - Nom. 1/4 in. thick loose laid over the subfloor. Floor topping thickness shall be a minimum of 3/4 in.

KEENE BUILDING PRODUCTS CO INC — Type Quiet Qurl 55/025 and Quiet Qurl 55/025 N
Alternate Floor Mat Materials* — (Optional) - Floor mat material Nom. 3/8 in. thick loose laid over the subfloor. Floor topping thickness shall be a minimum of 1 in.

KEENE BUILDING PRODUCTS CO INC — Type Quiet Qurl 60/040 and Quiet Qurl 60/040 N

Alternate Floor Mat Materials* — (Optional) - Floor mat material Nom. 3/4 in. thick loose laid over the subfloor. Floor topping thickness shall be a minimum of 1-1/2 in.

KEENE BUILDING PRODUCTS CO INC — Type Quiet Qurl 65/075, Quiet Qurl 65/075 N

Alternate Floor Mat Materials* — (Optional) - Floor mat material Nom. 1/8 in. thick loose laid over the subfloor. Floor topping thickness shall be a minimum of 3/4 in.

KEENE BUILDING PRODUCTS CO INC — Type Quiet Qurl 52/013 and Quiet Qurl 52/013 N

Alternate Floor Mat Materials* — (Optional) - Floor mat material Nom. 1/4 in. entangled net core with a compressible fabric attached to the bottom loose laid over the subfloor. Floor topping thickness shall be a minimum of 1 in.

KEENE BUILDING PRODUCTS CO INC — Quiet Qurl 55/025 MT and Quiet Qurl 55/025 N MT

**System No. 15**

Subflooring — Min 15/32 in. thick wood structural panels, min grade "C-D" or "Sheathing". Face grain of plywood or strength axis of panels to be perpendicular to the joists with joints staggered.

Vapor Barrier — (Optional) - Commercial asphalt saturated felt, 0.030 in. thick.

Vapor Barrier — (Optional) - Nom 0.010 in. thick commercial rosin-sized building paper.

Finish Flooring* — Min 3/4 in. thickness of any Floor Topping Mixture bearing the UL Classification Marking as to Fire Resistance. See Floor- and Roof-Topping Mixtures (C20X) category for names of Classified Companies.

Floor Mat Materials* — (Optional) - Nom 3/32 in. thick loose laid over the subfloor. Floor topping thickness shall be a minimum of 3/4 in.

PLITEQ INC — Type GenieMat RST02

Floor Mat Materials* — (Optional) - Nom 3/16 in. thick loose laid over the subfloor. Floor topping thickness shall be a minimum of 3/4 in.

PLITEQ INC — Type GenieMat FF04

Floor Mat Materials* — (Optional) - Nom 1/4 in. thick loose laid over the subfloor. Floor topping thickness shall be a minimum of 3/4 in.

PLITEQ INC — Type GenieMat FF06

Floor Mat Materials* — (Optional) - Nom 3/8 in. thick loose laid over the subfloor. Floor topping thickness shall be a minimum of 1 in.

PLITEQ INC — Type GenieMat FF10
Floor Mat Materials* — (Optional) - Nom 3/4 in. thick loose laid over the subfloor. Floor topping thickness shall be a minimum of 1-1/2 in.

PLITEQ INC — Type GenieMat FF17

Floor Mat Materials* — (Optional) - Nom 1 in. thick loose laid over the subfloor. Floor topping thickness shall be a minimum of 1-1/2 in.

PLITEQ INC — Type GenieMat FF25

2. Wood Joists — Min 2 by 10, spaced 16 in. OC and effectively fireblocked in accordance with local codes.

3. Cross Bridging — Min 1 by 3 in. or min 2 by 10 solid blocking.

4. Resilient Channels — Resilient channels, formed from No. 25 MSG galv steel and shaped as shown, spaced 24 in. OC perpendicular to joist. Channels overlapped 1-1/2 in. at splices and secured to each joist with one 8d common nail. Min end clearance of channels to wall to be 3/4 in. Additional pieces, 60 in. long, placed immediatley adjacent to continuous channels at end joints of second layer of gypsum board (Item 5) and similarly secured. Additional channels shall extend 6 in. beyond each side edge of board.

4A. Steel Framing Members — As an alternate to Item 4, furring channels and Steel Framing Members* as described below:

a. Furring Channels — Furring channels, formed of No. 25 MSG galv steel, 2-9/16 in. or 2-23/32 in. wide by 7/8 in. deep, spaced 24 in. OC perpendicular to joists. Channels secured to joists as described in Item b. Ends of adjoining channels overlapped 6 in. and tied together with double strands of No. 18 SWG galv steel wire near each end of overlap.

b. Steel Framing Members* — Used to attach furring channels (Item a) to joists (Item 2). Clips spaced 48 in. OC, and secured to alternating joists with No. 8 x 2-1/2 in. coarse drywall screw through the center grommet. Furring channels are friction fitted into clips. RSIC-1 clip for use with 2-9/16 in. wide furring channels. RSIC-1 (2.75) clip for use with 2-23/32 in. wide furring channels. Adjoining channels are overlapped as described in Item a. As an alternate, ends of adjoining channels may be overlapped 6 in. and secured together with two self-tapping #8 framing screws, min. 7/16 in. long at the midpoint of the overlap, with one screw on each flange of the channel. Additional clips required to hold furring channel that supports the wallboard butt joints, as described in Item 5.

PAC INTERNATIONAL INC — Types RSIC-1, RSIC-1 (2.75).

4B. Steel Framing Members — (Not Shown)* - As an alternate to items 4, furring channels and Steel Framing Members as described below.

a. Furring Channels — Formed of No. 25 MSG galv steel, 2-3/8 in. wide by 7/8 in deep, spaced 24 in OC, perpendicular to joists. Channels secured to joists as described in Item b. Ends of adjoining channels overlapped 6 in. and tied together with double strand of No. 18 SWG galv steel wire near each end of overlap.

b. Steel Framing Members* — Used to attach furring channels (Item a) to the wood joists (Item 2). Clips spaced 48 in. OC, and secured to alternating joists with No. 8 x 2-1/2 in. coarse drywall screw through the center grommet. Furring channels are friction fitted into clips. Adjoining channels are overlapped as described in Item a. As an alternate, ends of adjoining channels may be overlapped 6 in. and secured together with two self-tapping No. 6 framing screws, min 7/16 in. long at the midpoint of the overlap, with one screw on each flange of the channel. Additional clips required to hold furring channel that supports the gyspsum board butt joints, as described in Item 5.

PLITEQ INC — Type Genie Clip
4C. **Alternate Steel Framing Members** — (Not Shown)* - As an alternate to item 4, furring channels and Steel Framing Members as described below.

a. **Furring Channels** — Formed of No. 25 MSG galv steel, 2-5/8 in. wide by 7/8 in. deep, spaced 24 in. O.C., perpendicular to joists. Channels secured to joists as described in Item b.

b. **Steel Framing Members** — Used to attach furring channels (Item a) to the wood joists (Item 2). Clips spaced at 24" O.C. and secured to the bottom of the joists with one No. 10 x 2-1/2 Coarse Drywall Screw through the center hole. Furring channels are then friction fitted into clips. Ends of channels are overlapped 6" and screwed with four #8 x 1/2 Self Drilling screws (2 per side 1 in. and 4 in. from overlap edge). Additional clips are required to hold the Gypsum Butt joints and side joints as described in Item 5.

**STUDIO BUILDING SYSTEMS** — RESILMOUNT Sound Isolation Clips - Type A237R

5. **Gypsum Board** — Two layers 5/8 in. thick gypsum board. When resilient channels (Item 4) are used, first layer installed with long dimension perpendicular to joists, and end joints of boards located at the joists. Nailed to joists with uncoated 8d box nails spaced 7 in. O.C. All nails located 1/2 in. min distance from the edges and ends of the board. Second layer installed with long dimension perpendicular to the resilient channels and center line of boards located under a joist and so placed that the edge joint of this layer is not in alignment with the end joint of the first layer. Secured to resilient channels with 1 in. long gypsum board screws 12 in. O.C. with additional screws 3 in. from side joints. End joints secured to both resilient channels as shown in end joint detail. All screws located 1 in. min distance from edges of boards. If gypsum board is other than 48 in. wide, length of additional channel may be modified as required to allow full extension along joints, as well as attachment to joists at each end. Joint treatment not required for this rating, except for tapered, rounded-edge gypsum board where edge joints are covered with paper tape and joint compound. As an alternate, nom 3/32 in. thick gypsum veneer plaster may be applied to the entire surface of Classified veneer baseboard. Joints reinforced.

When **Steel Framing Members** (Items 4A or 4B) are used, sheets installed with long dimensions parallel with joists. Base layer attached to the furring channels using 1 in. long Type S bugle-head steel screws spaced 8 in. O.C. along butt end joints and 12 in. O.C. in the field of the board. Butted end joints shall be staggered min 2 ft. within the assembly, and occur midway between the continuous furring channels. Each end of each gypsum board shall be supported by a single length of furring channel equal to the width of the gypsum board plus 6 in. on each end. The two furring channels shall be spaced approximately 3-1/2 in. O.C., and be attached to underside of the joint with one RESIC-1 or Genie clip at each end of the channel. Butted base layer end joints to be offset a min of 24 in. in adjacent courses. Outer layer attached to the furring channels using 1-5/8 in. long Type S bugle-head steel screws spaced 8 in. O.C at butted joints and 12 in. O.C in the field. Butted end joints to be offset a min of 8 in. from base layer end joints. Butted side joints of outer layer to be offset min 18 in. from butted side joints of base layer.

When **Steel Framing Members** (Item 4C) are used, base layer of nom 5/8 in. thick, 4 ft wide gypsum board is installed with long dimensions perpendicular to furring channels. Gypsum board secured to furring channels with nom 1 in. long Type S bugle-head steel screws spaced 8 in. O.C. in the field of the board. Gypsum board butted end joints shall be staggered minimum 72 in. At the gypsum board butt joints, each end of each gypsum board shall be supported by a single length of furring channel equal to the width of the gypsum board plus 3 in. on each end, spaced approximately 2 in. in from joint. Screw spacing along the gypsum board butt joint shall be 8 in. O.C. Butt joint furring channels shall be attached with a RESILMOUNT Sound Isolation Clip secured to underside of every joist that is located over the butt joint. Over all Gypsum Board side joints, approximately 20 in. lengths of furring channel shall be installed parallel to joists (Item 2) between main furring channels. Side joint furring channels shall be attached to underside of the joint with RESILMOUNT Sound Isolation Clips - Type A237R located approximately 2 in. from each end of the approximate 20 in. length of channel. Both Gypsum Boards at side joints fastened into channel with screws spaced 8 in. O.C., approximately 1/2 in. from joint edge. Face layer attached per Item 5.
AMERICAN GYPSUM CO — Type AG-C.

CERTAINEED GYPSUM INC — Types FRPC, SF3, Type C

CONTINENTAL BUILDING PRODUCTS OPERATING CO, LLC — Type LGFC-C/A.

GEORGIA-PACIFIC GYPSUM LLC — Types S, C, DAPC, GPFS1, TG-C.

NATIONAL GYPSUM CO — Types FSK-C, FSK-G, FSW-C, FSW-G

PABCO BUILDING PRODUCTS LLC, DBA PABCO GYPSUM — Type C, PG-3 or PG-C

THAI GYPSUM PRODUCTS PCL — Type C

6. Screw, Gypsum Board — 1 in. long, with 0.129 in., self-drilling and self-tapping shank, and Phillips-type 0.355 in. diam head. Screws shall be driven no farther than slightly indented (not deeper than 1/64 in.) into the exposed surface of the gypsum board.

7. Finishing System - (Not Shown) — Vinyl, dry or premixed joint compound, applied in two coats to joints and screw-heads. Nom 2 in. wide paper tape embedded in first layer of compound over all joints. As an alternate, nom 3/32 in. thick veneer plaster may be applied to the entire surface of gypsum board.

* Indicates such products shall bear the UL or cUL Certification Mark for jurisdictions employing the UL or cUL Certification (such as Canada), respectively.
Appendix C: UL Design No. L511

Design No. L511
August 27, 2015

Unrestrained Assembly Rating — 2 Hr.
Finish Rating — 71 Min.

This design was evaluated using a load design method other than the Limit States Design Method (e.g., Working Stress Design Method). For jurisdictions employing the Limit States Design Method, such as Canada, a load restriction fact shall be used — See Guide RXLUV or RXLV7

* Indicates such products shall bear the UL or cUL Certification Mark for jurisdictions employing the UL or cUL Certification (such as Canada), respectively.

1. Flooring Systems — The flooring system shall consist of one of the following:

System No. 1

Subflooring — Min 1 by 6 in. T & G lumber fastened diagonally to joists.

Subflooring (Alternate) - Structural Cement-Fiber Units* — Nominal 19 mm (3/4 in.) thick tongue and groove structural cement-fiber units. Long dimension of panels to be perpendicular to joists with end joints staggered. Panels fastened to the joists with #10 self-drilling, self-tapping cement board screws 1-3/4 in. long. Screws shall be spaced 6 in. OC along the perimeter of each sheet and 12 in. OC in the field of each sheet. Screws shall be spaced 1/2 in. from end joints and 1 in. from side joints.

ECTEK INTERNATIONAL INC — Armoroc Panel

Vapor Barrier — Nom 0.010 in. thick commercial resin-sized building paper.

Finish Flooring — Min 1 by 3 in. T & G and end matched, laid perpendicular to joists.
Subflooring — Min 15/32 in. thick wood structural panels, min grade "C-D" or "Sheathing". Face grain of plywood or strength axis of panels to be perpendicular to the joints with joints staggered.

Vapor Barrier - (Optional) — Nom 0.010 in. thick commercial asphalt saturated felt

Finish Flooring - Floor Topping Mixture* — Min 3/4 in. thickness of floor topping mixture having a minimum compressive strength of 1800 psi. Refer to manufacturer’s instructions accompanying the material for specific mix design.

UNITED STATES GYPSUM CO — Types LRK, HSLRK, CSK

Floor Mat Materials* — (Optional) - Floor mat material loose laid over the subfloor. Refer to manufacturer’s instructions regarding the minimum thickness of floor topping over each floor mat material.

UNITED STATES GYPSUM CO — Types S, LEVELROCK® Brand Sound Reduction Board, LEVELROCK® Brand Floor Underlayment SRM-25

Alternate Floor Mat Materials* (Optional) — Nom 3/8 in. thick floor mat material loose laid over the subfloor. Floor topping thickness shall be as specified under Floor Topping Mixture*.

GRASSWORX LLC — Type SC50

System No. 3

Subflooring — Min 15/32 in. thick wood structural panels, min grade "C-D" or "Sheathing". Face grain of plywood or strength axis of panels to be perpendicular to the joints with joints staggered.

Vapor Barrier - (Optional) — Nom 0.010 in. thick commercial resin-sized building paper.

Finish Flooring — Min 19/32 in. wood structural panels, min grade "Underlayment" or "Single Floor". Face grain of plywood or strength axis of panels to be perpendicular to joints with joints staggered.

System No. 4

Subflooring — Min 15/32 in. thick wood structural panels, min grade "C-D" or "Sheathing". Face grain of plywood or strength axis of panels to be perpendicular to the joints with joints staggered.

Vapor Barrier - (Optional) — Nom 0.010 in. thick commercial resin-sized building paper.

Finish Flooring — Floor Topping Mixture* — Min 1-1/2 in. thickness of floor topping mixture having a min compressive strength of 1000 psi and a cast density of 100 plus or minus 5 pcf. Foam concentrate mixed 40:1 by volume with water and expanded at 100 psi through nozzle. Mixture shall consist of 1.4 cu feet of preformed foam concentrate to 94 lbs Type I Portland cement, 300 lbs of sand with 5-1/2 gal of water.

ELASTIZELL CORP OF AMERICA — Type FF

System No. 5

Subflooring — Min 15/32 in. thick wood structural panels, min grade "C-D" or "Sheathing". Face grain of plywood or strength axis of panels to be perpendicular to the joints with joints staggered.

Vapor Barrier - (Optional) — Nom 0.010 in. thick commercial resin-sized building paper.

Floor Mat Materials* — (Optional) — Floor mat material nom 3/64 in. (2mm) thick adhered to subfloor with Hacker Floor Primer. Primer to be applied to the surface of the mat prior to the placement of a min 1-1/4 in. of floor-topping mixture.

ECORE INTERNATIONAL INC — Type QTsub 4002

HACKER INDUSTRIES INC — Type Hacker Sound-Mat.

Alternate Floor Mat Materials - (Optional) — Floor mat material nom 1/4 in. (6mm) thick adhered to subfloor with Hacker Floor Primer. Primer to be applied to the surface of the mat prior to the placement of a min 1-1/4 in. (32mm) of floor-topping mixture.

ECORE INTERNATIONAL INC — Type QTrbm 3006-3
SBCA Research Report (SRR)

HAFFER INSTITUTES INC — Type Hacker Sound-Mat II.

Alternate Floor Mat Materials - (Optional) — Floor mat material nom 1/8 in. (3mm) thick loose laid over the subfloor. Floor topping thickness shall be a min of 1 in. (25mm)

HAFFER INSTITUTES INC — FIRM-FILL SCM 125

Alternate Floor Mat Materials - (Optional) — Floor mat material nom 1/4 in. (6mm) thick loose laid over the subfloor. Floor topping thickness shall be a min of 1 in. (25mm)

HAFFER INSTITUTES INC — Type FIRM-FILL SCM 250, Quiet Qurl 55/025

Alternate Floor Mat Materials - (Optional) — Floor mat material nom 3/8 in. (10mm) thick loose laid over the subfloor. Floor topping thickness shall be a min of 1-1/4 in. (32mm)

HAFFER INSTITUTES INC — FIRM-FILL SCM 400, Quiet Qurl 60/040

Alternate Floor Mat Materials - (Optional) — Floor mat material nom 3/4 in. (19mm) thick loose laid over the subfloor. Floor topping thickness shall be a min of 1-1/2 in. (38mm)

HAFFER INSTITUTES INC — Type FIRM-FILL SCM 750, Quiet Qurl 65/075

Metal Lath (Optional) — For use with 2-1/8 in. (10 mm) floor mat materials, 3/8 in. expanded steel diamond mesh, 3.4 lbs/sq yd placed over the floor mat material. Hacker Floor Primer to be applied prior to the placement of the metal lath. When metal lath is used, floor topping thickness a nom 1-1/4 in. over the floor mat.

Finish Flooring — Floor Topping Mixture* — Min 3/4 or 1 in. thickness of floor topping mixture for min 19/32 or min 15/32 in. thick wood structural panels respectively, having a min compressive strength of 1100 psi. Mixture shall consist of 6.8 gal of water to 50 lbs of floor topping mixture to 1.9 cu ft of sand.


System No. 6

Subflooring — Min 15/32 in. thick wood structural panels, min grade "C-D" or "Sheathing", Face grain of plywood or strength axis of panels to be perpendicular to the joists with joints staggered.

Vapor Barrier - (Optional) — Nom 0.010 in. thick commercial resin-sized building paper.

Finish Flooring - Floor Topping Mixture* — Min 1 in. thickness of floor topping mixture having a min compressive strength of 1000 psi and a cast density of 100 plus or minus 5 pcl. Foam concentrate mixed 40:1 by volume with water and expanded at 100 psi through nozzle. Mixture shall consist of 1.4 cu feet of preformed foam concentrate to 94 lbs Type I Portland cement, 62.5 lb of pea gravel, 312.5 lbs of sand with 5-1/2 gal of water.

LITE-CRETE INC — Type I

System No. 7

Subflooring — Min 15/32 in. thick wood structural panels, min grade "C-D" or "Sheathing", Face grain of plywood or strength axis of panels to be perpendicular to the joists with joints staggered.

Vapor Retarder - (Optional) — Nom 0.030 in. thick commercial asphalt saturated felt.

Finish Flooring — Floor Topping Mixture* — Min 3/4 or 1 in. thickness of floor topping mixture for min 19/32 or min 15/32 in. thick wood structural panels respectively, having a min compressive strength of 1000 psi. Mixture shall consist of 5 to 9 gal of water to 60 lbs of floor topping mixture to 2.1 cu ft of sand.

ULTRA QUIT FLOORS — Types UQF-A, UQF-Super Blend, UQF-Plus 200
Subflooring — Min 15'/32 in. thick wood structural panels, min grade "C-D" or "Sheathing". Face grain of plywood or strength axis of panels to be perpendicular to the joists with joints staggered.

Vapor Barrier — (Optional) — Nom 0.030 in. thick commercial asphalt saturated felt.

Floor Mat Materials* — (Optional) — Nom 1/4 in. thick floor mat material loose laid over the subfloor. Maxxon Floor Primer to be applied to the surface of the mat prior to the floor topping placement. When floor mat material is used, min thickness of floor topping mixture is 1 in. Floor topping thickness a min 3/4 in. over Accou-Mat I floor mat.

MAXXON CORP — Type Accou-Mat I, Accou-Mat II, Accou-Mat II HP.

Alternate Floor Mat Materials* — (Optional) — Nom 0.8 in. thick floor mat material loose laid over the subfloor with Crack Suppression Mat (CSM) loose laid over the floor mat material. Floor topping thickness shall be min 1-1/2 in.

MAXXON CORP — Type Accou-Mat 3, Accou-Mat 3 HP, Crack Suppression Mat (CSM)

Metal Lath — (Alternate to Crack Suppression Mat (CSM)) — 3/8 in. expanded galvanized steel diamond mesh, 3.4 lbs/sq yd loose laid over the floor mat material. Floor topping thickness shall be min 1-1/2 in.

Fiber Glass Mesh Reinforcement — (Optional) — Maxxon Corp’s "Maxxon Reinforcement (MR)" for use with or as an alternate to CSM or metal lath reinforcement, the materials consists of a plastic coated non-woven fiber glass mesh grid intended to suppress cracks in the Floor Topping Mixture.

Alternate Floor Mat Materials* — (Optional) — Nom 0.4 in. thick floor mat material loose laid over the subfloor. Maxxon Floor Primer to be applied to the surface of the mat prior to the floor topping placement. Floor topping thickness shall be min 1 in. Floor topping thickness shall be min 3/4 in. when used with Crack Suppression Mat (CSM), Metal Lath, or Maxxon Reinforcement (MR).

MAXXON CORP — Type Enkasonic 9110, Enkasonic 9110 HP.

Alternate Floor Mat Materials* — (Optional) — Nom 0.2 in. thick floor mat material loose laid over the subfloor. Maxxon Floor Primer may be applied to the surface of the mat prior to the floor topping placement. Floor topping thickness shall be as specified under Floor Topping Mixture.

MAXXON CORP — Type Accou-Mat LP-R.

Metal Lath — (Optional) — For use with floor mat materials, 3/8 in. expanded galvanized steel diamond mesh, 3.4 lbs/sq yd or Maxxon Corp. UL Classified Crack Suppression Mat (CSM) loose laid over the floor mat material. Floor topping thickness shall be min 1 in.

MAXXON CORP — Type Crack Suppression Mat (CSM)

Fiber Glass Mesh Reinforcement — (Optional) — Maxxon Corp’s "Maxxon Reinforcement (MR)" for use with or as an alternate to CSM or metal lath reinforcement, the materials consists of a plastic coated non-woven fiber glass mesh grid intended to suppress cracks in the Floor Topping Mixture.

Finish Flooring — Floor Topping Mixture* — Min 3/4 or 1 in. thickness of floor topping mixture for min 19/32 or min 15'/32 in. thick wood structural panels respectively, having a min compressive strength of 1000 psi. Mixture shall consist of 3 to 7 gal of water mixed with 80 lbs of floor topping mixture and 1.0 to 2.1 cu ft of sand.

MAXXON CORP — Type D-C, GC, GC2000, L-R, T-F, CT
System No. 9

Subflooring — Min 15/32 in. thick wood structural panels, min grade "C-D" or "Sheathing". Face grain of plywood or strength axis of panels to be perpendicular to the joists with joints staggered.

Vapor Barrier - (Optional) — Nom 0.030 in. thick commercial asphalt saturated felt.

Floor Mat Materials* - (Optional) — Nom 1/4 in. thick floor mat material loose laid over the subfloor. Maxxon Floor Primer to be applied to the surface of the mat prior to the floor topping placement. When floor mat material is used, min thickness of floor topping mixture is 1 in. Floor topping thickness a min 3/4 in. over Acousti-Mat I floor mat.

MAXXON CORP — Type Acousti-Mat I, Acousti-Mat II, Acousti-Mat II HP.

Alternate Floor Mat Materials* - (Optional) — Nom 0.8 in. thick floor mat material loose laid over the subfloor with Crack Suppression Mat (CSM) loose laid over the floor mat material. Floor topping thickness shall be min 1-1/2 in.

MAXXON CORP — Type Acousti-Mat 3, Acousti-Mat 3 HP, Crack Suppression Mat (CSM)

Metal Lath — (Alternate to Crack Suppression Mat (CSM)) — 3/8 in. expanded galvanized steel diamond mesh, 3.4 lbs/sq yd loose laid over the floor mat material. Floor topping thickness shall be min 1-1/2 in.

Fiber Glass Mesh Reinforcement — (Optional) — Maxxon Corp's "Maxxon Reinforcement (MR)" for use with or as an alternate to CSM or metal lath reinforcement; the material consists of a plastic coated non-woven fiber glass mesh grid intended to suppress cracks in the Floor Topping Mixture.

Alternate Floor Mat Materials* - (Optional) — Nom 0.4 in. thick floor mat material loose laid over the subfloor. Maxxon Floor Primer to be applied to the surface of the mat prior to the floor topping placement. Floor topping thickness shall be min 1 in. Floor topping thickness shall be min 3/4 in. when used with Crack Suppression Mat (CSM), Metal Lath, or Maxxon Reinforcement (MR).

MAXXON CORP — Type Enkasonic 9110, Enkasonic 9110 HP.

Alternate Floor Mat Materials* - (Optional) — Nom 0.2 in. thick floor mat material loose laid over the subfloor. Maxxon Floor Primer may be applied to the surface of the mat prior to the floor topping placement. Floor topping thickness shall be as specified under Floor Topping Mixture.

MAXXON CORP — Type Acousti-Mat LP-R

Metal Lath - (Optional) — For use with floor mat materials, 3/8 in. expanded galvanized steel diamond mesh, 3.4 lbs/sq yd or Maxxon Corp. UL Classified Crack Suppression Mat (CSM) loose laid over the floor mat material. Floor topping thickness shall be min 1 in.

MAXXON CORP — Type Crack Suppression Mat (CSM)

Fiber Glass Mesh Reinforcement — (Optional) — Maxxon Corp's "Maxxon Reinforcement (MR)" for use with or as an alternate to CSM or metal lath reinforcement; the material consists of a plastic coated non-woven fiber glass mesh grid intended to suppress cracks in the Floor Topping Mixture.

Finish Flooring - Floor Topping Mixture® — Min 3/4 or 1 in. thickness of floor topping mixture for min 19/32 or min 15/32 in. thick wood structural panels respectively, having a min compressive strength of 1200 psi. Mixture shall consist of 4 to 7 gal of water with mix of 80 lbs of floor topping mixture and 1.4 to 1.9 cu ft of sand.

RAPID FLOOR SYSTEMS — Type RF, RFP, RFU, RFR, Ortecrete
System No. 10

Subflooring — Min 15/32 in. thick wood structural panels, min grade "C-D" or "Sheathing". Face grain of plywood or strength axis of panels to be perpendicular to the joints with joints staggered.

Finish Floor - Mineral and Fiber Board* — Min 1/2 in. thick, supplied in sizes ranging from 3 ft by 4 ft to 8 ft by 12 ft. All joints to be staggered a min of 12 in. with adjacent sub-floor joints.

HOMASOTE CO — Type 440-32 Mineral and Fiber Board

System No. 11

Subflooring — Min 15/32 in. thick wood structural panels, min grade "C-D" or "Sheathing". Face grain of plywood or strength axis of panels to be perpendicular to the joints with joints staggered.

Vapor Barrier - (Optional) — Nom 0.030 in. thick commercial asphalt saturated felt.

Finish Flooring - Floor Topping Mixture* — Min 1-1/2 in. thickness of floor topping mixture having a min compressive strength of 1000 psi and a cast density of 105 plus or minus 5 pcf. Foam concentrate mixed 40:1 by volume with water and expanded at 100 psi through nozzles. Mixture shall consist of 1.2 cu ft of preformed foam concentrate to 94 lbs Type I Portland cement, and 300 lbs of sand with 5.5 gal of water.

AERIX INDUSTRIES — Floor Topping Mixture

System No. 12

Subflooring — Min 15/32 in. thick wood structural panels, min grade "C-D" or "Sheathing". Face grain of plywood or strength axis of panels to be perpendicular to the joints with joints staggered.

Vapor Barrier - (Optional) — Nom 0.010 in. thick commercial rosin-sized building paper.

Finish Flooring - Floor Topping Mixture* — Min 3/4 in. thickness of floor topping mixture, having a min compressive strength of 1000 psi. Refer to manufacturer’s instructions accompanying the material for specific mix design.

ALLIED CUSTOM GYPSUM — Accu-Crete, AccuRadiant, AccuLevel G40 and AccuLevel SD30.

Alternate Floor Mat Material* - (Optional) - Floor mat material nominal 2 - 9.5 mm thick loose laid over the subfloor. Floor topping shall be a min of 3/4 in. or 1 in. thickness of floor topping mixture for 19/32 or 15/32 in. thick wood structural panels respectively.

ALLIED CUSTOM GYPSUM — Type AccuQuiet P80, Type AccuQuiet C40, AccuQuiet D13, and Type AccuQuiet D-18.

System No. 13

Subflooring — 15/32 or 19/32 in. thick wood structural panels, min. grade "C-D" or "Sheathing". Face grain of plywood or strength axis of panels to be perpendicular to joints with joints staggered.

Vapor Barrier - (Optional) — Nom 0.030 in. thick commercial asphalt saturated felt.

Finish Flooring - Floor Topping Mixture* — Min 3/4 or 1 in. thickness of floor topping mixture for 19/32 or 15/32 in. thick wood structural panels respectively, having a min compressive strength of 2100 psi. Refer to manufacturer’s instructions accompanying the material for specific mix design.

System No. 14

Subflooring — Min 15/32 in. thick wood structural panels, min grade "C-D" or "Sheathing". Face grain of plywood or strength axis of panels to be perpendicular to the joints with joints staggered.

Vapor Barrier — (Optional) — Commercial asphalt saturated felt, 0.030 in. thick.

Vapor Barrier — (Optional) — Nom 0.010 in. thick commercial rosin-sized building paper.

Finish Flooring* — Min 3/4 in. thickness of any Floor Topping Mixture bearing the UL Classification Marking as to Fire Resistance. See Floor- and Roof-Topping Mixtures (COCX) category for names of Classified Companies.

Floor Mat Materials* — (Optional) — Nom. 1/4 in. thick loose laid over the subfloor. Floor topping thickness shall be a minimum of 3/4 in.

KEENE BUILDING PRODUCTS CO INC — Type Quiet Curl 55/025 and Quiet Curl 55/025 N
Alternate Floor Mat Materials* — (Optional) - Floor mat material Nom. 3/8 in. thick loose laid over the subfloor. Floor topping thickness shall be a minimum of 1 in.

KEENE BUILDING PRODUCTS CO INC — Type Quiet Qurl 60/040 and Quiet Qurl 60/040 N

Alternate Floor Mat Materials* — (Optional) - Floor mat material Nom. 3/4 in. thick loose laid over the subfloor. Floor topping thickness shall be a minimum of 1-1/2 in.

KEENE BUILDING PRODUCTS CO INC — Type Quiet Qurl 65/075, Quiet Qurl 65/075 N

Alternate Floor Mat Materials* — (Optional) - Floor mat material Nom. 1/8 in. thick loose laid over the subfloor. Floor topping thickness shall be a minimum of 3/4 in.

KEENE BUILDING PRODUCTS CO INC — Type Quiet Qurl 52/013 and Quiet Qurl 52/013 N

Alternate Floor Mat Materials* — (Optional) - Floor mat material Nom. 1/4 in. entangled net core with a compressible fabric attached to the bottom loose laid over the subfloor. Floor topping thickness shall be a minimum of 1 in.

KEENE BUILDING PRODUCTS CO INC — Quiet Qurl 55/025 MT and Quiet Qurl 55/025 N MT

System No. 15

Subflooring — Min 1 by 6 in. T & G lumber fastened diagonally to joists.

Vapor Barrier — Nom 0.010 in. thick commercial rosin-sized building paper.

Finish Flooring - Floor Topping Mixture* — Min 1 in. thickness of floor topping mixture having a min compressive strength of 1000 psi. Refer to manufacturer's instructions accompanying the material for specific mix design.

ALLIED CUSTOM GYPSUM — Accu-Crete, AccuRadiant

Floor Mat Material* — (Optional) - Floor mat material nominal 2 - 9.3 mm thick loose laid over the subfloor. Floor topping shall be a min of 3/4 in.

ALLIED CUSTOM GYPSUM — Type AccuQuiet P80, Type AccuQuiet C40, Type AccuQuiet RSM 20, Type AccuQuiet RSM 32, Type AccuQuiet RSM 48, Type AccuQuiet RSM 64, and Type AccuQuiet RSM 120

System No. 16

Subflooring — Min 15/32 in. thick wood structural panels, min grade “C-D” or “Sheathing”. Face grain of plywood or strength axis of panels to be perpendicular to the joists with joints staggered.

Vapor Barrier - (Optional) — Nom 0.010 in. thick commercial rosin-sized building paper.

Finish Flooring - Floor Topping Mixture* — Min 3/4 floor topping mixture, having a min compressive strength of 1000 psi. Refer to manufacturer’s instructions accompanying the material for specific mix design.

DEPENDABLE LLC — GSL M3,4, GSL K2,6 and GSL RH

Floor Mat Materials* — (Optional) - Nom. 1/4 in. thick loose laid over the subfloor. Floor topping thickness shall be a minimum of 3/4 in.

KEENE BUILDING PRODUCTS CO INC — Type Quiet Qurl 55/025 and Quiet Qurl 55/025 N

Alternate Floor Mat Materials* — (Optional) - Floor mat material Nom. 3/8 in. thick loose laid over the subfloor. Floor topping thickness shall be a minimum of 1 in.

KEENE BUILDING PRODUCTS CO INC — Type Quiet Qurl 60/040 and Quiet Qurl 60/040 N
**Alternate Floor Mat Materials** — (Optional) - Floor mat material Nom. 3/4 in. thick loose laid over the subfloor. Floor topping thickness shall be a minimum of 1-1/2 in.

**KEENE BUILDING PRODUCTS CO INC** — Type Quiet Qurl 65/075, Quiet Qurl 65/075 N

**Alternate Floor Mat Materials** — (Optional) - Floor mat material Nom. 1/8 in. thick loose laid over the subfloor. Floor topping thickness shall be a minimum of 3/4 in.

**KEENE BUILDING PRODUCTS CO INC** — Type Quiet Qurl 52/013 and Quiet Qurl 52/013 N

**Alternate Floor Mat Materials** — (Optional) - Floor mat material Nom. 1/4 in. entangled net core with a compressible fabric attached to the bottom loose laid over the subfloor. Floor topping thickness shall be a minimum of 1 in.

**KEENE BUILDING PRODUCTS CO INC** — Quiet Qurl 55/025 MT and Quiet Qurl 55/025 N MT

**System No. 17**

**Subflooring** — Min 15/32 in. thick wood structural panels, min grade "C-D" or "Sheathing". Face grain of plywood or strength axis of panels to be perpendicular to the joists with joints staggered.

**Vapor Barrier** — (Optional) - Commercial asphalt saturated felt, 0.030 in. thick.

**Vapor Barrier** — (Optional) - Nom 0.010 in. thick commercial rosin-sized building paper.

**Finish Flooring** — Min 3/4 in. thickness of any Floor Topping Mixture bearing the UL Classification Marking as to Fire Resistance. See Floor- and Roof-Topping Mixtures (CCOX) category for names of Classified Companies.

**Floor Mat Materials** — (Optional) - Nom 3/32 in. thick loose laid over the subfloor. Floor topping thickness shall be a minimum of 3/4 in.

**PLITEQ INC** — Type GenieMat RST02

**Floor Mat Materials** — (Optional) - Nom 3/16 in. thick loose laid over the subfloor. Floor topping thickness shall be a minimum of 3/4 in.

**PLITEQ INC** — Type GenieMat FF04

**Floor Mat Materials** — (Optional) - Nom 1/4 in. thick loose laid over the subfloor. Floor topping thickness shall be a minimum of 3/4 in.

**PLITEQ INC** — Type GenieMat FF06

**Floor Mat Materials** — (Optional) - Nom 3/8 in. thick loose laid over the subfloor. Floor topping thickness shall be a minimum of 1 in.

**PLITEQ INC** — Type GenieMat FF10

**Floor Mat Materials** — (Optional) - Nom 3/4 in. thick loose laid over the subfloor. Floor topping thickness shall be a minimum of 1-1/2 in.

**PLITEQ INC** — Type GenieMat FF17
2. **Wood Joists** — Min 2 by 10, spaced 16 in. OC and effectively fireblocked in accordance with local codes.

3. **Cross Bridging** — Min 1 by 3 in. or min 2 by 10 solid blocking.

4. **Resilient Channels** — Formed of 25 MSG galv steel, spaced 24 in. OC perpendicular to joists and located 12 in. from each side edge of base layer gypsum board. Channels placed with 1/4 in. clearance at the ends and fastened to each joist with 1-7/8 in. long Type S bugle head screws. Min end clearance of channels to walls: 3/8 in. Additional channels 60 in. long, placed adjacent to continuous channels at end joints of second layers of gypsum board (Item 5) and similarly secured. Channel ends to extend 6 in. beyond each side of joint.

4A. **Steel Framing Members (Not Shown)** — As an alternate to Item 4, furring channels and Steel Framing Members as described below:

   a. **Furring Channels** — Formed of No. 25 MSG galv steel, 2-9/16 in. or 2-23/32 in. wide by 7/8 in. deep, spaced 24 in. OC perpendicular to joists. Channels secured to joists as described in Item b. Ends of adjoining channels overlapped 6 in. and tied together with double strand of No. 18 SWG galv steel wire near each end of overlap.

   b. **Steel Framing Members** — Used to attach furring channels (Item a) to joists. Clips spaced 48 in. OC, and secured to alternating joists with No. 8 x 2-1/2 in. coarse drywall screw through the center grommet. Furring channels are friction fitted into clips. RSIC-L (2.75) clip for use with 2-9/16 in. wide furring channels. RSIC-L (2.75) clip for use with 2-23/32 in. wide furring channels. Adjoining channels are overlapped as described in Item a. As an alternate, ends of adjoining channels may be overlapped 6 in. and secured together with two self-tapping No. 6 framing screws, min 7/16 in. long at the midpoint of the overlap, with one screw on each flange of the channel. Additional clips required to hold furring channel that supports the gypsum board butt joints, as described in Item 5.

   **PAC INTERNATIONAL INC** — Types RSIC-1, RSIC-1 (2.75).

4B. **Alternate Steel Framing Members** — (Not Shown) — As an alternate to items 4, furring channels and Steel Framing Members as described below.

   a. **Furring Channels** — Formed of No. 25 MSG galv steel, 2-3/8 in. wide by 7/8 in. deep, spaced 24 in. OC, perpendicular to joists. Channels secured to joists as described in Item b. Ends of adjoining channels overlapped 6 in. and tied together with double strand of No. 18 SWG galv steel wire near each end of overlap.

   b. **Steel Framing Members** — Used to attach furring channels (Item a) to the wood joists (Item 2). Clips spaced 48 in. OC, and secured to alternating joists with No. 8 x 2-1/2 in. coarse drywall screw through the center grommet. Furring channels are friction fitted into clips. Adjoining channels are overlapped as described in Item a. As an alternate, ends of adjoining channels may be overlapped 6 in. and secured together with two self-tapping No. 6 framing screws, min 7/16 in. long at the midpoint of the overlap, with one screw on each flange of the channel. Additional clips required to hold furring channel that supports the gypsum board butt joints, as described in Item 5.

   **PLITEQ INC** — Type Genie Clip

4C. **Alternate Steel Framing Members** — (Not Shown) — As an alternate to Item 4, furring channels and Steel Framing Members as described below.

   a. **Furring Channels** — Formed of No. 25 MSG galv steel, 2-5/8 in. wide by 7/6 in. deep, spaced 24 in. OC, perpendicular to joists. Channels secured to joists as described in Item b.

   b. **Steel Framing Members** — Used to attach furring channels (Item a) to the wood joists (Item 2). Clips spaced at 24" OC and secured to the bottom of the joists with one No. 10 x 2-1/2 Coarse Drywall Screw through the center hole. Furring channels are then friction fitted into clips. Ends of channels are overlapped 6" and screwed with four No. 8 x 1/2 Self Drilling screws (2 per side 1 in. and 4 in. from overlap edge). Additional clips are required to hold the Gypsum Butt joints and side joints as described in Item 5.

   **STUDCO BUILDING SYSTEMS** — RESILMOUNT Sound Isolation Clips - Type A237R
5. **Gypsum Board** - Two layers of nom. 5/8 in. thick, 4 ft wide gypsum board. When resilient channels (Item 4) are used, first layer installed perpendicular to joists with end joints located over bottom of joists. Gypsum board attached to joists with 6d cement coated cooler nails spaced 1 in., 6 in., and 21 in. from each side edge in the field of the board. Butt edges shall occur under joints, fastened with nails spaced 1 in., 6 in., 15 in. and 21 in. from side edges of board, and 1/2 in. back from butt edge. Second layer of gypsum board secured to resilient channels with 1 in. long Type S bugle head screws spaced 12 in. OC with additional screws placed 3 in. from each side edge. End joints of second layer offset from end joints in first layer, and secured to both resilient channels as shown in end joint detail. Screws located 3/4 in., and 1-1/4 in. from side and end joints of boards. When **Steel Framing Members** (Item 4A or 4B) are used, sheets installed with long dimensions parallel with joists. Base layer attached to the furring channels using 1 in. long Type S bugle head steel screws spaced 8 in. OC along butted end joints and 12 in. OC in the field of the board; Butt end joints shall be staggered min. 2 ft. within the assembly, and occur midway between the continuous furring channels. Each end of each gypsum board shall be supported by a single length of furring channel equal to the width of the gypsum board plus 6 in. on each end. The two furring channels shall be spaced approximately 3-1/2 in. OC, and be attached to underside of the joist with one RSIC-1 or Genie clip at each end of the channel. Butt base layer end joints to be offset a min. of 4 in. in adjacent courses. Outer layer attached to the furring channels using 1-5/8 in. long Type S bugle head steel screws spaced 8 in. OC at butt joints and 12 in. OC in the field. Butt end joints to be offset a min. of 8 in. from base layer end joints. Butt side joints of outer layer to be offset min. 19 in. from butt side joints of base layer. When **Steel Framing Members** (Item 4C) are used, base layer of gypsum board is installed with long dimensions perpendicular to furring channels. Gypsum board secured to furring channels with nom. 1 in. long Type S bugle head steel screws spaced 8 in. OC in the field of the board. Gypsum board butt end joints shall be staggered minimum 72 in. At the gypsum board butt joints, each end of each gypsum board shall be supported by a single length of furring channel equal to the width of the gypsum board plus 3 in. on each end, spaced approximately 2 in. from joint. Screw spacing along the gypsum board butt joint shall be 8 in. OC. Butt joint furring channels shall be attached with a RESILMOUNT Sound Isolation Clip secured to underside of every joist that is located over the butt joint. Over all Gypsum Board side joints, approximately 20 in. lengths of furring channel shall be installed parallel to joists (Item 2) between main furring channels. Side joint furring channels shall be attached to underside of the joist with RESILMOUNT Sound Isolation Clips - Type A237F located approximately 2 in. from each end of the approximate 20 in. length of channel. Both Gypsum Boards at side joints fastened into channel with screws spaced 8 in. OC, approximately 1/2 in. from joint edge. Face layer installed per Item 5.

**AMERICAN GYPSUM CO** — Type AG-C

**CERTAINTEED GYPSUM INC** — Type FRPC, Type C

**CGC INC** — Types C, IP-X2, IPC-AR

**CONTINENTAL BUILDING PRODUCTS OPERATING CO, LLC** — Type LGFC-C/A

**GEORGIA-PACIFIC GYPSUM LLC** — Types 5, DAPC, TG-C

**NATIONAL GYPSUM CO** — Types FSK-C, F5W-C, F5W-G

**PABCO BUILDING PRODUCTS LLC, DBA PABCO GYPSUM** — Type C

**PANEL REY S A** — Type PRC

**THAI GYPSUM PRODUCTS PCL** — Type C

**UNITED STATES GYPSUM CO** — Types C, IP-X2, IPC-AR

**USG BORAL ZAWAII DRYWALL LLC** — Type C

**USG MEXICO S A DE C V** — Types C, IP-X2, IPC-AR

6. **Finishing System** - (Not Shown) — Vinyl, dry or premixed joint compound, applied to two coats to joints and screw-heads. Nom. 2 in. wide paper tape embedded in first layer of compound over all joints. As an alternate, nom. 3/32 in. thick veneer plaster may be applied to the entire surface of the gypsum board.
Appendix D:

Design No. L538
BXUV.L538
Fire Resistance Ratings - ANSI/UL 263
February 27, 2017

Unrestrained Assembly Rating — 2 Hr.
Finish Rating — More Than 90 Min.

This design was evaluated using a load design method other than the Limit States Design Method (e.g., Working Stress Design Method). For jurisdictions employing the Limit States Design Method, such as Canada, a load restriction factor shall be used — See Guide BXUV or BXUV7.

* Indicates such products shall bear the UL or cUL Certification Mark for jurisdictions employing the UL or cUL Certification (such as Canada), respectively.
1. **Flooring Systems** — The flooring system shall consist of one of the following:

**System No. 1**

**Subflooring** — Min 5/8 in. thick wood structural panels, min grade "Underlayment" or "Single Floor". Face grain of plywood or strength axis of panels to be perpendicular to joists with end joints centered over the top chord of the joist and staggered.

**System No. 2**

**Subflooring** — Min 5/8 in. thick wood structural panels, min grade "Underlayment" or "Single Floor". Face grain of plywood or strength axis of panels to be perpendicular to joists with end joints centered over the top chord of the joist and staggered.

**Finish Flooring** — Min 3/4 in. thickness of lightweight insulating concrete with Perlite Aggregate* or Vermiculite Aggregate*, or gypsum concrete.

See Perlite Aggregate (CFFX) and Vermiculite Aggregate (CJZZ) categories for names of manufacturers.

**System No. 3**

**Subflooring** — Min 5/8 in. thick wood structural panels, min grade "Underlayment" or "Single Floor". Face grain of plywood or strength axis of panels to be perpendicular to joists with end joints centered over the top chord of the joist and staggered.

**Finish Floor — Mineral and Fiber Board** — Min 1/2 in. thick, supplied in sizes ranging from 3 ft by 4 ft to 8 ft by 12 ft. All joints to be staggered a min of 12 in. with adjacent sub-floor joints.
System No. 4

Subflooring — Min 1 by 6 in. T & G lumber fastened diagonally to joists, or min 15/32 in. thick plywood or 7/16 in. thick oriented strand board (OSB) wood structural panels, min grade "C-D" or "Sheathing". Face grain of plywood or strength axis of panels to be perpendicular to the joists with joints staggered.

Floor Mat Materials* — (Optional) — Floor mat material nom 5/64 in. (2 mm) thick adhered to subfloor with Hacker Floor Primer. Primer to be applied to the surface of the mat prior to the placement of a min 1 in. of floor-topping mixture.

HACKER INDUSTRIES INC — Type Hacker Sound-Mat.

Alternate Floor Mat Materials — (Optional) — Floor mat material nom 1/4 in. (6 mm) thick adhered to subfloor with Hacker Floor Primer. Primer to be applied to the surface of the mat prior to the placement of a min 1-1/4 in. (32 mm) of floor-topping mixture.

HACKER INDUSTRIES INC — Type Hacker Sound-Mat II

Alternate Floor Mat Materials — (Optional) — Floor mat material nom 1/8 in. (3 mm) thick loose laid over the subfloor. Floor topping thickness shall be a min of 3/4 in. (19 mm)

HACKER INDUSTRIES INC — FIRM-FILL SCM 125

Alternate Floor Mat Materials — (Optional) — Floor mat material nom 1/4 in. (6 mm) thick loose laid over the subfloor. Floor topping thickness shall be a min of 1 in. (25 mm)

HACKER INDUSTRIES INC — Type FIRM-FILL SCM 250, Quiet Qurl 55/025

Alternate Floor Mat Materials — (Optional) — Floor mat material nom 3/8 in. (10 mm) thick loose laid over the subfloor. Floor topping thickness shall be a min of 1-1/4 in. (32 mm)

HACKER INDUSTRIES INC — FIRM-FILL SCM 400, Quiet Qurl 60/040

Alternate Floor Mat Materials — (Optional) — Floor mat material nom 3/4 in. (19 mm) thick loose laid over the subfloor. Floor topping thickness shall be a min of 1-1/2 in. (38 mm)

HACKER INDUSTRIES INC — Type FIRM-FILL SCM 750, Quiet Qurl 65/075

Metal Lath — (Optional) — For use with 3/8 in. (10 mm) floor mat materials, 3/8 in. expanded steel diamond mesh, 3.4 lbs/sq yd placed over the floor mat material. Hacker Floor Primer to be applied prior to
the placement of the metal lath. When metal lath is used, floor topping thickness a nom 1-1/4 in. over the floor mat.

**Finish Flooring — Floor Topping Mixture*** — Min 3/4 in. thickness of floor topping mixture having a min compressive strength of 1100 psi. Mixture shall consist of 6.8 gal of water to 80 lbs of floor topping mixture to 1.9 cu ft of sand.

**HACKER INDUSTRIES INC** — Firm-Fill Gypsum Concrete, Firm-Fill 2010, Firm-Fill 3310, Firm-Fill 4010, Firm-Fill High Strength, Gyp-Span Radiant

**System No. 5**

**Subflooring** — Min 1 by 6 in. T & G lumber fastened diagonally to joists, or min 15/32 in. thick plywood or 7/16 in. thick oriented strand board (OSB) wood structural panels, min grade "C-D" or "Sheathing". Face grain of plywood or strength axis of panels to be perpendicular to the joists with joints staggered.

**Finish Flooring — Floor Topping Mixture*** — Min 3/4 in. thickness of floor topping mixture having a minimum compressive strength of 1500 psi. Refer to manufacturer's instructions accompanying the material for specific mix design.

**MAXXON CORP** — Type D-C, GC, GC2000, L-R, T-F, CT, SS

**RAPID FLOOR SYSTEMS** — Type RF, RFP, RFU, RFR, Ortecrete

**Floor Mat Materials*** — (Optional) — Floor mat material loose laid over the subfloor. Refer to manufacturer's instructions regarding the minimum thickness of floor topping over each floor mat material.

**MAXXON CORP** — Type Acousti-Mat I, Acousti-Mat II, Acousti-Mat II HP, Enkasonic 9110, Enkasonic 9110 HP, Acousti-Mat 3, Acousti-Mat 3 HP, Acousti-Mat LP, Acousti-Mat LP-R, Acousti-Mat SD

**Floor Mat Reinforcement** — (Optional) - Refer to manufacturer's instructions regarding minimum thickness of floor topping over each floor mat material, primers, and use of crack suppression reinforcement.

**MAXXON CORP** — Crack Suppression Mat (CSM) or Maxxon Reinforcement (MR)

**Metal Lath** — (For use with or as an alternate to Crack Suppression Mat (CSM) or Maxxon Reinforcement (MR)) — 3/8 in. expanded galvanized steel diamond mesh, 3.4 lbs/sq yd loose laid over the floor mat material. Floor topping thickness shall be min 1-1/2 in.

**System No. 6**

Deleted

**System No. 7**
Subflooring — Nom 23/32 in. thick wood structural panels installed perpendicular to trusses with end joints staggered. Plywood or panels secured to trusses with construction adhesive and No. 6d ringed shank nails, spaced 12 in. OC along each truss. Staples having equal or greater withdrawal and lateral resistance strength may be substituted for the 6d nails.

Vapor Barrier — (Optional) — Nom 0.010 in. thick commercial asphalt saturated felt.

Finish Flooring — Floor Topping Mixture* — Min 3/4 in. thickness of floor topping mixture having a minimum compressive strength of 1800 psi. Refer to manufacturer’s instructions accompanying the material for specific mix design.

UNITED STATES GYPSUM CO — Types LRK, HSLRK, CSD

USG MEXICO S A DE C V — Types LRK, HSLRK, CSD

Floor Mat Materials* — Floor mat material loose laid over the subfloor. Refer to manufacturer’s instructions regarding the minimum thickness of floor topping over each floor mat material.

UNITED STATES GYPSUM CO — Types SAM, LEVELROCK® Brand Sound Reduction Board, LEVELROCK® Brand Floor Underlayment SRM-25

Alternate Floor Mat Materials* — (Optional) — Nom 3/8 in. thick floor mat material loose laid over the subfloor.

GRASSWORX L L C — Type SC50

System No. 8

Subflooring — Min 15/32 in. thick wood structural panels, min grade "C-D" or "Sheathing". Face grain of plywood or strength axis of panels to be perpendicular to the joists with joints staggered.

Vapor Barrier — (Optional) — Commercial asphalt saturated felt, 0.030 in. thick.

Vapor Barrier — (Optional) — Nom 0.010 in. thick commercial rosin-sized building paper.

Finish Flooring* — Min 3/4 in. thickness of any Floor Topping Mixture bearing the UL Classification Marking as to Fire Resistance. See Floor- and Roof-Topping Mixtures (CCOX) category for names of Classified Companies.

Floor Mat Materials* — (Optional) — Nom. 1/4 in. thick loose laid over the subfloor. Floor topping thickness shall be a minimum of 3/4 in.

KEENE BUILDING PRODUCTS CO INC — Type Quiet Qurl 55/025 and Quiet Qurl 55/025 N

Alternate Floor Mat Materials* — (Optional) — Floor mat material Nom. 3/8 in. thick loose laid over the subfloor. Floor topping thickness shall be a minimum of 1 in.
Alternate Floor Mat Materials* — (Optional) — Floor mat material Nom. 3/4 in. thick loose laid over the subfloor. Floor topping thickness shall be a minimum of 1-1/2 in.

KEENE BUILDING PRODUCTS CO INC — Type Quiet Qurl 65/075, Quiet Qurl 65/075 N

Alternate Floor Mat Materials* — (Optional) — Floor mat material Nom. 1/8 in. thick loose laid over the subfloor. Floor topping thickness shall be a minimum of 3/4 in.

KEENE BUILDING PRODUCTS CO INC — Type Quiet Qurl 52/013 and Quiet Qurl 52/013 N

Alternate Floor Mat Materials* — (Optional) — Floor mat material Nom. 1/4 in. entangled net core with a compressible fabric attached to the bottom loose laid over the subfloor. Floor topping thickness shall be a minimum of 1 in.

KEENE BUILDING PRODUCTS CO INC — Quiet Qurl 55/025 MT and Quiet Qurl 55/025 N MT

System No. 9

Subflooding — Min 5/8 in. thick wood structural panels, min grade "Underlayment" or "Single Floor". Face grain of plywood or strength axis of panels to be perpendicular to joists with end joints centered over the top chord of the joist and staggered.

Finish Flooring — Floor Topping Mixture* — Min 3/4 in. thickness of floor topping mixture having a min compressive strength of 1000 psi. Refer to manufacturer's instructions accompanying the material for specific mix design.

ALLIED CUSTOM GYPSUM — Accu-Crete, AccuRadiant, AccuLevel G40 and AccuLevel SD30

Floor Mat Material* — (Optional) — Floor mat material nominal 2 - 9.5 mm thick loose laid over the subfloor. Floor topping shall be a min of 1 in.

ALLIED CUSTOM GYPSUM — Type AccuQuiet P80, Type AccuQuiet C40, AccuQuiet D13, and Type AccuQuiet D-18

System No. 10

Subflooding — Min 5/8 in. thick wood structural panels, min grade "Underlayment" or "Single Floor". Face grain of plywood or strength axis of panels to be perpendicular to joists with end joints centered over the top chord of the joist and staggered.
Finish Flooring — Floor Topping Mixture* — Min 3/4 in. thickness of floor topping mixture having a min compressive strength of 1000 psi. Refer to manufacturer’s instructions accompanying the material for specific mix design.

DEPENDABLE LLC — GSL M3.4, GSL K2.6 or GSL RH

Floor Mat Materials* — (Optional) — Nom. 1/4 in. thick loose laid over the subfloor. Floor topping thickness shall be a minimum of 3/4 in.

KEENEBUILDINGPRODUCTS CO INC — Type Quiet Qurl 55/025 and Quiet Qurl 55/025 N

Alternate Floor Mat Materials* — (Optional) — Floor mat material Nom. 3/8 in. thick loose laid over the subfloor. Floor topping thickness shall be a minimum of 1 in.

KEENEBUILDINGPRODUCTS CO INC — Type Quiet Qurl 60/040 and Quiet Qurl 60/040 N

Alternate Floor Mat Materials* — (Optional) — Floor mat material Nom. 3/4 in. thick loose laid over the subfloor. Floor topping thickness shall be a minimum of 1-1/2 in.

KEENEBUILDINGPRODUCTS CO INC — Type Quiet Qurl 65/075, Quiet Qurl 65/075 N

Alternate Floor Mat Materials* — (Optional) — Floor mat material Nom. 1/8 in. thick loose laid over the subfloor. Floor topping thickness shall be a minimum of 3/4 in.

KEENEBUILDINGPRODUCTS CO INC — Type Quiet Qurl 52/013 and Quiet Qurl 52/013 N

Alternate Floor Mat Materials* — (Optional) — Floor mat material Nom. 1/4 in. entangled net core with a compressible fabric attached to the bottom loose laid over the subfloor. Floor topping thickness shall be a minimum of 1 in.

KEENEBUILDINGPRODUCTS CO INC — Quiet Qurl 55/025 MT and Quiet Qurl 55/025 N MT

System No. 11

Subflooring — Min 5/8 in. thick wood structural panels, min grade "Underlayment" or "Single Floor". Face grain of plywood or strength axis of panels to be perpendicular to joists with end joints centered over the top chord of the joist and staggered.

Finish Flooring* — Floor Topping Materials — Min 3/4 in. to 1-1/2 in. thickness of any Floor Topping Mixture bearing the UL Classification Marking as to Fire Resistance with a minimum compressive strength of 1500 psi.

See Floor- and Roof-Topping Mixtures (CCOX) category for names of Classified Companies.

Floor Mat Materials* — (Optional) — Floor mat material Nom 1/8 in. to 3/4 in. thick. Loose laid over the subfloor. When used, Acousti-flor CSM (crack suppression mat) is loose laid over the floor mat material. Floor topping material thickness is dependent on thickness of floor mat used.
WALFLOR INDUSTRIES INC — Type Acousti-flor, Acousti-flor CSM. Floor topping thickness depends on products used as follows:

Acousti-flor (1/8 in. thick) - Floor topping thickness shall be a minimum of 3/4 in.
Acousti-flor (1/4 in. thick) - Floor topping thickness shall be a minimum of 1 in.
Acousti-flor (3/8 in. thick) - Floor topping thickness shall be a minimum of 1 in.
Acousti-flor (3/4 in. thick) - Floor topping thickness shall be a minimum of 1-1/2 in.

Metal Lath — (Optional) — Expanded steel diamond mesh, 2.5 lb / sq yd loose laid over floor mat material.

Fiberglass Mesh Reinforcement — (Optional) — Coated non-woven glass fiber mesh grid loose laid over floor mat material.

2. Structural Wood Members* — Min 9-1/2 in. deep "I" shaped wood joists spaced at a max of 19.2 in. OC. Joists shall conform to ICC-ES ESR-1153 Report. Joist top and bottom chords minimum 1-3/8 in. deep by 2.3 in. wide and constructed of either Microllam laminated veneer lumber (LVL) or TimberStrand laminated strand lumber (LSL). Webs constructed of minimum 3/8 in. thick Performance Plus OSB, PS2, Exposure 1. Installation shall be in accordance with manufacturers published literature.

2A. Alternate Structural Wood Members* — Min 14 in. deep wood and steel trusses spaced max 19.2 in. OC. Min truss bearing on bearing plates to be in accordance with the truss manufacturer's published installation instructions. Trusses nailed or bolted to bearing plates, through steel bearing clips, in accordance with the manufacturer's published installation instructions.

3. Gypsum Board* — Three layers of 5/8 in. thick by 4 ft wide gypsum board. Top layer boards installed with the long dimension perpendicular to joists or trusses with end joints located under bottom of joists or trusses. End joints in adjacent rows shall be staggered on adjacent joists or trusses. Top layer boards secured to bottom chord of joists or trusses with 1-5/8 in. long Type S bugle head screws with hi-lo threads, spaced max 8 in. OC. Screws located 1-1/2 to 2 in., and 3/4 in. from side and end joints, respectively. Bottom two layers of gypsum board installed perpendicular to furring channels (Item 4) with end joints centered on the furring channels. Middle layer boards secured to each furring channel with 1 or 1-1/4 in. long Type S-12 bugle head steel screws with hi-lo threads spaced max 8 in. OC. Screws located 1-1/2 to 2 in. and 5/8 to 3/4 in. from side and end joints, respectively. Face layer boards secured to each furring channel through the middle layer with 1-5/8 or 1-7/8 in. long Type S-12 bugle head steel screws with hi-lo threads, spaced a max of 8 in. OC. Screws located 1-1/2 to 2 in. and 5/8 to 3/4 in. from side and end joints, respectively. End joints and side joints of the face layer boards shall be staggered a min of 16 in. from the joints in the middle layer. If end joints of the face layer boards are not centered on the furring channels, the end of boards at the end joint shall be attached to the middle layer boards with 1-1/2 in. long Type G steel screws spaced 8 in. OC and located 1-1/2 in. from the end joint. All screws shall be driven no further than flush with the face of the boards in order not to damage the core of the boards.

AMERICAN GYPSUM CO — Types AG-C

CERTAINEED GYPSUM INC — Type C

CGC INC — Types C, IP-X2, IPC-AR

CONTINENTAL BUILDING PRODUCTS OPERATING CO, L L C — Type LGFC-C/A
4. **Furring Channels** — Resilient channels, 1/2 in. deep, or inverted hat type furring channels, 7/8 in. deep, formed from 0.019 in. thick galv steel, spaced 16 in. OC perpendicular to joists or trusses. Channels secured to each joist or truss with 1-7/8 in. long Type S steel screws with hi-lo threads.

5. **Finishing System** — (Not Shown) — Vinyl, dry or premixed joint compound, applied in two coats to joints and screw-heads. Nom 2 in. wide paper tape embedded in first layer of compound over all joints. As an alternate, nom 3/32 in. thick veneer plaster may be applied to the entire surface of gypsum board.

* Indicates such products shall bear the UL or cUL Certification Mark for jurisdictions employing the UL or cUL Certification (such as Canada), respectively.