PFS TEST REPORT #86-10
ASTM E 119 FIRE ENDURANCE TEST
OF WOOD-WEBBED TRUSS FLOOR-CEILING ASSEMBLY
DESIGN FC 392 — 1 HOUR
FOR
TRUSS PLATE INSTITUTE
MADISON, WISCONSIN
AND
WOOD TRUSS COUNCIL OF AMERICA
CHICAGO, ILLINOIS

BY
PFS CORPORATION
2402 DANIELS STREET
MADISON, WISCONSIN 53704
ACKNOWLEDGMENTS

The Metal Plate Connected Wood Truss Industry wishes to express its grateful appreciation to the following companies for their exemplary contributions to this industry endeavor.

- Florida Truss, Inc.
- Gang-Nail Systems, Inc.
- Inter-Lock Steel Company, Inc.
- Linkwood Truss Systems
- Littfin Lumber Company, Inc.
- Lock, Incorporated
- Panel Clip Company
- Robbins Manufacturing Company
- Truswal Systems Corporation
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SUMMARY

Wood-webbed trusses spaced 24 in. on center, having 4x2 members with one layer of 5/8-in.-thick gypsum wallboard US Gypsum Firecode C, (Type C) directly applied as ceiling membrane, and 23/32-in.-thick nailed and glued T & G plywood floor sheathing achieved a 1-hour fire endurance rating under full design load. The assembly did not fail within a 64.0-minute period of fire exposure. The assembly is representative of construction of similar assemblies in the field with exception of the joint-fixity detail for the 2x8 brace as connected to end trusses 1 & 11. (See Figure 6.)
CONSTRUCTION SUMMARY

1. Wood-webbed Trusses:
   * Span of 13-ft. 3-in. center-to-center of bearing.
   * Spacing 24 in. on center
   * 2x6 bearing plates

2. Plywood Sheathing:
   * Tongue and groove 23/32-in.-thick floor sheathing (APA-rated Sturdi Floor) in 4-by-8-ft. sheets
   * Underlayment Group I interior with exterior glue
   * Installed perpendicular to the trusses using AFG-01 construction adhesive and 6d deformed shank nails, 12 in. on center

3. Gypsum Wallboard:
   * One layer of 5/8-in.-thick, 4-by-8-ft. US Gypsum Firecode C, Type C, sheets with 8 ft. lengths normal to the trusses
   * Layer fastened with 1-7/8 in. Type S gypsum drywall screws 8 in. on center

4. Edge blocking:
   * 8 ft. lengths of 1/2-in.-thick plywood
   * Fastened to truss elements using 8d nails
5. **Brace:**

* Nominal 2x8 continuous length of lumber installed parallel to inside vertical edge of truss chase opening at center span and bearing against top chords of trusses
* Fastened with three 16d nails at each truss
* Bearing block, 2x4, beneath ends to have brace bearing on bottom chord of end trusses.
* End trusses free to deflect along the span.

6. **Cross Brace:**

* A single 2x4 cross brace between adjacent top and bottom truss chords installed near the truss chases at center of the assembly
* Fastened to chords using two 10d nails at each chord juncture and three 10d nails at intersection of brace elements

7. **Wallboard Joint Blocks:**

* Nominal 4x2 wood blocks 20-1/2-in.-long with Panel Clip Z-clips at ends
* Z-clips fastened to blocks and top surface of lower chord with two 10d truss nails at each location
GENERAL

This report describes the construction, test procedure, and the results of a fire endurance test conducted in accordance with ASTM Standard Designation E 119-83 on a protected wood-webbed (4x2 members) truss floor-ceiling assembly.

The ASTM E 119-83 Standard Method of Fire Tests of Building Construction and Materials is intended to evaluate the duration for which an assembly will contain a fire, or retain its structural integrity or both, dependent upon the type of assembly involved, during fire exposure.

The test exposes a test specimen to a standard fire exposure controlled to achieve specified temperatures by specified times as follows:

<table>
<thead>
<tr>
<th>TIME (min.)</th>
<th>TEMPERATURE °F</th>
<th>°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Ambient</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>1000°</td>
<td>538°</td>
</tr>
<tr>
<td>10</td>
<td>1300°</td>
<td>704°</td>
</tr>
<tr>
<td>30</td>
<td>1550°</td>
<td>843°</td>
</tr>
<tr>
<td>45</td>
<td>1638°</td>
<td>892°</td>
</tr>
<tr>
<td>60</td>
<td>1700°</td>
<td>927°</td>
</tr>
<tr>
<td>120</td>
<td>1850°</td>
<td>1010°</td>
</tr>
<tr>
<td>240</td>
<td>2000°</td>
<td>1093°</td>
</tr>
</tbody>
</table>

Measured is the assembly’s response to the exposure in terms of the transmission of temperature and hot gases through the assembly, and in terms of its ability to carry load during the exposure. The following caveat in the use of the results of the test are given in the standard:

"This standard should be used to measure and describe the properties of materials, products or assemblies in response to heat and flame under controlled laboratory conditions and should not be used to describe or appraise the fire hazard or fire risk of materials, products or assemblies under actual fire conditions. However, results of this test may be used as elements of a fire risk assessment which takes into account all of the factors which are pertinent to an assessment of the fire hazard of a particular end use."

This report describes the evaluation of a distinct assembly, and includes descriptions of the test procedure followed, the assembly tested, and all results obtained. All test data are on file and are available for review by persons so authorized by the Truss Plate Institute.
ASSEMBLY AND FIRE-ENDURANCE TEST

Materials

Wood-webbed Trusses:

The trusses were designed under the auspices of Truss Plate Institute of Madison, Wisconsin, and fabricated according to the design drawing (Figure 1). The associated design calculations are shown in Figure 2. The typical end detail showing the connection over the bearing is in Figure 3. The lumber used in all members of the trusses was the specified grade of nominal 2x4 structural Southern Pine. These trusses were 14-1/4-in.-deep and 13-ft.-9-in.-long. The weight of each truss averaged 85 lb. Gang-Nail toothed metal plates (Types GNA 20 described in ICBO Report 1329) were embedded to connect adjacent truss chord and web members. The splice plates in the top chord were a Type GNA 20 of 3-by-6.2-in. dimensions, and in the bottom chord a Type GNA 20 of 3-by-7-in. dimensions. The actual dimensions of the metal plates in the tested assembly are as given in the table in Appendix II. Average plate thickness was 0.0356 in.

The grades of structural Southern Pine lumber used in various locations were:

Top Chord: No. 1D KD-15
Bottom Chord: No. 1D KD-15
Diagonal Webs and Verticals: No. 3 KD-15

Wallboard Ceiling:
5/8-in.-thick, US Gypsum Firecode C, Type C gypsum wallboard manufactured in 4-by-10-ft. sheets. The average weight per sheet was 101 lb. Sheets were trimmed and applied in 4-by-8-ft. sheets.

Flooring:
23/32-in.-thick APA-rated Sturdi Floor plywood in 4-by-8-ft. sheets having long edges tongue and grooved

Vertical Perimeter Blocking:
Plywood, 1/2-in.-thick, 8-ft.-long, nailed to truss elements around perimeter of assembly to enclose plenum of assembly.

Plates:
Nominal 2x6 lumber

Brace:
Nominal 2x8 continuous length of lumber

Cross Brace:
A 2x4 cross-brace between top and bottom chords of adjacent trusses
Construction

The floor-ceiling assembly was installed in the test frame.

Nominal 2x6 structural-grade wood sill members were placed along the top of 6-by-4-by-3/4-in. structural steel angles embedded in the fireproofing concrete at the east and west sides of the test frame.

The trusses were placed symmetrically about the east-west center line of the test frame after positioning the first truss in the center and spacing the remaining trusses 24 in. on center (Figure 4). Each truss was secured to the wood sill member by means of one 8d common nail driven through the bottom chord at each end. Perimeter blocking consisting of 8 ft. lengths of 1/2 in. plywood was placed over each end of the trusses and non-over lapping the wood sill plate (Figure 5).

A continuous nominal 2x8 was installed with nominal 8 in. dimension vertical to laterally brace the trusses at the mid-span chase. The top of the lateral brace beared against the top chord and was attached to the vertical web member of each truss using three 16d common nails. The bottom of the brace was blocked with a 2x4 at the end trusses of the assembly (Figure 6).

A cross brace was fabricated of two 2x4's which would provide lateral restraint between top and bottom chords of adjacent trusses at the center of the assembly (Figure 7). Three 10d nails fastened the intersection of the 2x4's. The ends were fastened to the chords using two 10d nails at each location.

Nominal 2x4 blocks, 20-1/2-in.-long and having Panel Clip Universal Z-clips on the ends were installed perpendicular to the bottom chords at wallboard butt joint locations (Figure 8). Two 10d truss nails secured the Z-clip to the blocks and top surface of the bottom truss chord.

Vertical perimeter blocking of 1/2 in. plywood 8-ft.-long was nailed along the length of the end trusses and the bearing ends of trusses. Fasteners used were 10d nails. The vertical butt joint lay 8 ft. from the bearing end of the end trusses.

The 23/32 in. T & G plywood flooring was installed with the face grain perpendicular to the trusses and positioned to allow the end joints to occur over a truss. The end joint of adjacent rows was staggered 4 ft. The plywood was secured to the top chord of trusses with "Henry 217" (AFG-01 PFS certified) construction adhesive and 6d deformed shank nails spaced 12 in. on center at all perimeter and intermediate locations.
The as shipped 4-by-10-ft. gypsum wallboard sheets were cut to 4-by-8-ft. sheets by removing 1 ft. from each end and installed perpendicular to the trusses with end joints 24 in. apart in adjacent sheets. The wallboard was fastened to the bottom chord of trusses and blocking with 1-7/8-in.-long type S drywall screws spaced 8 in. on center.

All wallboard joints were reinforced with paper tape and covered with joint compound.

**Method**

The test was conducted in accordance with the Standard Fire Test of Building Construction and Materials ASTM Standard Designation E 119-83. The National Gypsum Company equipment at Buffalo, New York, for the testing of floor-ceiling assemblies was used for this test.

The temperature of the furnace chamber was measured with 16 thermocouples placed 12 in. below the ceiling exposed surface.

The temperatures of the non-fire-exposed surface were measured by 11 thermocouples located as shown on Figure 9, each covered with a 6-by-6-in. dry asbestos pad to provide thermal insulation.

The temperatures of the truss lower chord gypsum wallboard interface was measured by five thermocouples attached to the lower side of the chords located as shown in Figure 10.

The temperatures were taken at 10 locations in the plenum (see Figure 10). Five locations were at mid-height and five were on the plywood sheathing.

The assembly was surface loaded with 16 water tanks of total load 26,968 lb. This level is equivalent to a 116.3 psf live load over the assembly surface area of 13.25-by-17.5-ft.-dimension. The equivalent total load (live and dead) on this surface is 124.5 psf. (Figure 11.) This load stressed the trusses to the full allowable level based upon TPI design methodology (PCI-80). The load capability of the truss was based on an effective span of 13 ft. 3 in. center-to-center of bearing.

The deflections of the assembly were measured at the center and north-south quarter points throughout the test. Deflections were read directly from measuring tapes, which were moved by a line and pulley system anchored to the deck.

Throughout the test, observations were made to note the conditions of the exposed and non-fire-exposed surface and all other events relative to the fire-resistive performance of the assembly.
RESULTS

Character and Distribution of Fire
The fire was luminous and well distributed throughout the test. The furnace temperatures were well controlled in accordance with the Standard Time-Temperature Curve. The temperatures recorded are shown in Figure 12.

Observations

Observations of the Exposed Surfaces.

<table>
<thead>
<tr>
<th>Time (min.)</th>
<th>Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>Ignition of furnace</td>
</tr>
<tr>
<td>2.0</td>
<td>Browning of wallboard paper near center of assembly</td>
</tr>
<tr>
<td>3.0</td>
<td>Ignition of paper and charring begins.</td>
</tr>
<tr>
<td>5.0</td>
<td>Some local spalling of sprackel/tape joints</td>
</tr>
<tr>
<td>7.0</td>
<td>Peeling along edges of sprackel/tape joints</td>
</tr>
<tr>
<td>7.5</td>
<td>Charred remnants of paper falling from panels</td>
</tr>
<tr>
<td>12.0</td>
<td>Sprackel and tape peeling in 6 to 12 in. segments</td>
</tr>
<tr>
<td>13.0</td>
<td>No visible cracks in wallboard</td>
</tr>
<tr>
<td>17.0</td>
<td>More localized spalling of sprackel and tape joints</td>
</tr>
<tr>
<td>21.0</td>
<td>Sprackel/tape materials spalling frequently and extensively</td>
</tr>
<tr>
<td>23.0</td>
<td>Butt joints in two central locations have 1/16 to 1/8 in. gap.</td>
</tr>
<tr>
<td>28.5</td>
<td>Joints parallel to trusses are 1/8 to 1/4 in. open.</td>
</tr>
<tr>
<td>34.0</td>
<td>1/4 in. joint gap parallel to truss near center of assembly. Joint gaps along blocking are about 1/4-in.-wide.</td>
</tr>
<tr>
<td>36.0</td>
<td>A joint parallel to trusses is about 3/8-in.-wide.</td>
</tr>
<tr>
<td>37.0</td>
<td>Small hairline cracks normal to blocked joints are seen uniformly distributed.</td>
</tr>
<tr>
<td>Time (min.)</td>
<td>Observations</td>
</tr>
<tr>
<td>-------------</td>
<td>--------------</td>
</tr>
<tr>
<td>40.0</td>
<td>Joint parallel to truss span at center of about a 3/8 in. gap.</td>
</tr>
<tr>
<td>46.0</td>
<td>1/2 in. joint separation at previously stated location.</td>
</tr>
<tr>
<td>50.25</td>
<td>Some flaming from butt joints.</td>
</tr>
<tr>
<td>53.0</td>
<td>Cracks appearing normal to edge of joints that are parallel to machine length are getting slightly wider, but uniformly spaced.</td>
</tr>
<tr>
<td>55.0</td>
<td>Joint gaps normal to trusses are about 3/8-in.-(plus)-wide.</td>
</tr>
<tr>
<td>58.0</td>
<td>Pronounced flaming continues from a joint normal to trusses at edge of assembly (2 ft. away).</td>
</tr>
<tr>
<td>61.0</td>
<td>Gaps 1/2-in.-{(plus)}-wide at normal to truss joints 61.2.</td>
</tr>
<tr>
<td>61.2</td>
<td>Single loud noise from assembly.</td>
</tr>
<tr>
<td>63.5</td>
<td>Sheetrock loosened at WSW sector of assembly</td>
</tr>
<tr>
<td>63.97</td>
<td>Failure to carry load - gas cut (63 min. 58 sec.)</td>
</tr>
</tbody>
</table>
Observations Of Assembly After Test:

Some of the gypsum wallboard had fallen into the furnace. Assembly frame was lifted with assembly intact to area where flaming of assembly was put out using low pressure water hose. This knocked off residual gypsum wallboard.

Bottom splice plates on bottom faces were gone at west side locations of assembly on trusses 2, 4, and 6 (see Figure 4). Bottom plate still attached on truss 8. Two of the splice plates are visible on furnace floor for trusses 4 and 6. No other plates in furnace. Only two plates were found on furnace floor. Truss 3 has a ruptured lower chord at the center span (within chase) and block location. Bottom splice plate was gone on the east side for truss 7. Other splice plates were intact.

Truss 7 bottom chord ruptured at center span at a block location. Would appear that truss 7 may have suffered splice plate failure and segment of chord was broken off later.

The 2x8 lateral brace in the chase running normal to trusses was ruptured at center span between trusses 3 and 4.

All side plates are intact.
Floor Deflection

Deflection was recorded as follows:

<table>
<thead>
<tr>
<th>Time</th>
<th>North Quarter Point</th>
<th>Center</th>
<th>South Quarter Point</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>inches</td>
<td></td>
<td></td>
</tr>
<tr>
<td>min.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>5</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>10</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>15</td>
<td>0</td>
<td>0</td>
<td>1/16</td>
</tr>
<tr>
<td>20</td>
<td>0</td>
<td>0</td>
<td>1/8</td>
</tr>
<tr>
<td>30</td>
<td>0</td>
<td>0</td>
<td>3/16</td>
</tr>
<tr>
<td>40</td>
<td>0</td>
<td>0</td>
<td>1/4</td>
</tr>
<tr>
<td>43</td>
<td>0</td>
<td>0</td>
<td>1/4</td>
</tr>
<tr>
<td>50</td>
<td>0</td>
<td>0</td>
<td>1/4</td>
</tr>
<tr>
<td>56</td>
<td>1/16</td>
<td>1/16</td>
<td>3/8</td>
</tr>
<tr>
<td>61</td>
<td>1/4</td>
<td>1/16</td>
<td>3/8</td>
</tr>
<tr>
<td>63</td>
<td>1</td>
<td>7</td>
<td>1/2</td>
</tr>
</tbody>
</table>
Temperatures

Temperature at Bottom Chord (Finish Rating):

The protection afforded by the single layer of gypsum wallboard to the adjoining face of the bottom chord of the trusses is determined as the time at which the average temperature rise at these locations is 250°F above the initial temperature of the wood, or when the temperature of any individual location is raised 325°F.

The initial temperature of the wood bottom chord was 60°F. The average limiting temperature therefore is 310°F and individual limiting maximum is 385°F. The graph of the interface temperature (Figure 13) shows the mean temperature of 310°F and the maximum individual of 385°F were reached simultaneously at 25.3 minutes.

Plenum Temperatures:

The mean plenum temperature is graphed as a function of fire-exposure time in Figure 14. The mean temperature is seen to have risen to 400°F at 35.5 minutes and 530°F at 63 minutes.

Temperature of Non-Fire-Exposed Surface:

The maximum temperature at a single location beneath asbestos pads on the floor sheathing top surface was 212°F at 60 minutes of fire exposure. This is well below the maximum of 385°F, and the mean of 310°F allowed. The actual temperatures for each thermocouple location on the surface are shown in Figure 15.
CONCLUSIONS

Fire-Resistance Properties:

Floor-ceiling assemblies of the construction described here will afford 60-minute protection against passage of flame and transmission of heat while supporting its design load.

The transmission of heat through the assembly did not raise the average temperature of the non-fire-exposed surface over the mean allowable 250°F limit or 325°F for any single temperature reading during the fire endurance test.

The finish rating occurs when the transmission through the ceiling is such as to allow an average temperature rise of 250°F, or an individual temperature rise of 325°F taken on the lower face of the bottom chord of the truss. The wallboard protection afforded a finish rating of 25.3 minutes to the truss.

Conformity:

This construction was tested in accordance with the Standard for Fire Tests of Building Construction and Materials ASTM E 119-83.

Practicality:

The assembly described here is practical for its intended use and can be installed without difficulty. The acceptability of the joint-fixity detail for the 2x8 brace and trusses 1 & 11 as shown in Figure 6 is unresolved. For additional insight, a load sharing frame analysis for fire test trusses 1 through 11 prepared by the University of Wisconsin, Department of Civil & Environmental Engineering is provided in Appendix IV.

To obtain the desired protection it is necessary to specify the composition and thickness of materials to be used and the methods of construction as described in this report.

EXTENSION OF RATING TO VARIANCES IN ASSEMBLY CONSTRUCTION

An extension of the fire-rating of this assembly to variations in assembly design and materials used is given in the following as based upon the results of this test, other tests conducted, established engineering principles, and accepted practices.
Finishing System

Nominal 3/32-in.-thick gypsum veneer plaster may be applied to the entire surface of the classified veneer baseboard, as an alternative to paper tape embedded in cementitious compound over joints and exposed screw heads covered with compound edges feathered out. Joints are reinforced.

Flooring Systems

In addition to the 4-by-8-ft. sheets of 23/32 in. T & G plywood, other acceptable alternative floor systems are (Reference UL Design L528):

System No. 1.

Finish-Flooring 4-by-8-ft.-by-23/32-in. interior plywood with exterior glue and T & G edge detail along 8 ft. sides. Plywood installed perpendicular to trusses with end joints staggered 4 ft. Plywood secured to trusses with construction adhesive and 6d ring shank nails. Adhesive applied as 3/8-in.-diameter bead to top chord of trusses and groove edges of plywood. Nails spaced 12 in. on center along each truss. As an option, lightweight insulating concrete with Perlite or Vermiculite aggregate or gypsum concrete may be placed on the flooring. The minimum thickness of insulating concrete shall be 3/4 in. The maximum thickness shall be determined by job site conditions. A thin plastic or paper vapor retarder may be emplaced on plywood prior to pouring the concrete.

System No. 2.

Finish-Flooring Floor Topping Mixture: 6.8 gal. of water to 80 lb. of floor-topping mixture to 1.9 cu. ft. of sand. Thickness to be 3/4 in. minimum.

Hecker industries, Inc. - FORTA-FILL Types I and II.

Sub-Flooring: 4-by-8-ft.-by-23/32-in. plywood with exterior glue minimum to be "standard" conforming to PS 1-66 specifications. Face grain of plywood to be perpendicular to joists with joints staggered.
System No. 3.

Finish-Flooring Floor-Topping Mixture: 10-13 gal. of water to 170 lb. of floor-topping mixture to 595 lb. of sand. Compressive strength 900 psi minimum. Thickness to be 3/4 in. minimum.

Floor Crete Systems, Inc. - Type II.

Sub-Flooring: 4-by-8-ft.-by-23/32-in. interior plywood with exterior glue and T & G edge detail along 8 ft. sides. Plywood installed perpendicular to trusses with end joints staggered 4 ft. Plywood secured to trusses with construction adhesive and 6d ring shank nails. Adhesive applied as 3/8-in.-diameter bead to top chord of trusses and groove edges of plywood. Nails spaced 12 in. on center along each truss.

System No. 4.

Finish-Flooring Floor-Topping Mixture: 8 gal. of water to 80 lb. of floor-topping mixture to 180 lb. of sand. Compressive strength to be 1000 psi minimum. Thickness to be 3/4-in. minimum.

Gyp-Crete Corp. - Type GC
United Gypsum Co. - Type F.

Vapor Retarder (Optional): Commercial asphalt-saturated felt, 0.030-in. thick.

Sub-Flooring: 4-by-8-ft.-by-23/32-in. plywood with exterior glue, minimum grade to be "standard" conforming to PS 1-66 specifications. Face grain of plywood to be perpendicular to joists with joints staggered.

System No. 5.

Finish-Flooring Floor-Topping Mixture: A sufficient amount of water mixed with two bags of Portland Cement (Type III), one bag of component A, one bag of Component B, and 1050 lb. of saturated, surface dry sand. Thickness to be 1 in.

Master Builders - Type PC.

Sub-Flooring: 4-by-8-ft.-by-23/32-in. plywood with exterior glue conforming to PS 1-66. Face grain laid perpendicular to joists.
Blocking Clips

Alternative clips to the Z-clips employed to connect wallboard joint blocks to the trusses are illustrated in Figure 16.

Floor Sheathing

Single-layer structural wood-based-panel floor sheathing-underlayments of at least 23/32-in.-thickness recognized to carry 40 psf on trusses spaced 24 in. center-to-center are acceptable alternatives to the 23/32 in. T & G Group I Underlayment Plywood conforming to PS 1-83 used in this test.

Trusses

Other alternatives are wood-webbed trusses comprised of horizontally or vertically oriented 2x4 (or larger) lumber of depth equal to or greater than the 14-1/4-in.-deep trusses used in the assembly tested, and wood-webbed trusses of equivalent design (PCT-80 or TPI-85) incorporating the toothed metal-plates of the similar manufacture, but having embedded tooth depth and gauge thickness equal to or greater than the plates employed in the rated assembly.

Kirk Grundahl, P.E.
Director - Technical Services

Erwin L. Schaffer, Ph.D. / P.E.
Vice President - FFS Laboratories
### Design Criteria

<table>
<thead>
<tr>
<th>Chords</th>
<th>Size</th>
<th>Lumber Description</th>
<th>Design Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-2</td>
<td>4X2</td>
<td>NO. 3 SORY GD PINE</td>
<td>TOP CH LL=110 PSF</td>
</tr>
<tr>
<td>2-9</td>
<td>4X2</td>
<td>NO. 1 D KD15 GD PINE</td>
<td>DL=10 PSF</td>
</tr>
<tr>
<td>10-10</td>
<td>4X2</td>
<td>NO. 3 SORY GD PINE</td>
<td>DL=4 PSF</td>
</tr>
</tbody>
</table>

**Spacing:** 14 IN. C/C

**Input Data:**
- **Increase (Percent):**
- **Length:**
- **Nail:**
- **Net:**

**Nail Values:**
- **Net:**
- **Chords:**
- **Web:**

**Web Min:**

**Gross Area:**
- **At React:**
- **1:**
- **Camber:**

**Design Specifications:**
- **According to Uniform Building Code:**
- **Fabrication Inspection to be Provided:**
- **Table Section 21.794:**
- **Gross Area Calculation:**

**Ground Load:**
- **Wind:**
- **Snow:**

**Headers:**
- **No. 3 Tamarack:**
- **Screws:**
- **Nail:**

**Provisions:**
- **Studs:**
- **Nails:**
- **Camber:**

**Truss Design:**
- **Chords:**
- **Web:**

**Floor Truss Engineering Design Drawings**

**Figure 1**

- **Dimensions:**
  - **2:**
  - **3:**
  - **4:**
  - **5:**
  - **6:**
  - **7:**
  - **8:**
  - **9:**

- **Optimal Spacing:**
  - **1:**
  - **10:**
  - **11:**
  - **12:**
  - **13:**
  - **14:**
  - **15:**
  - **16:**

**Date:**
- **1986**

**U.S.C.**
# TPI 1-HOUR FIRE TEST SPECIMEN (FC-392)
## SYSTEM STRESS ANALYSIS

<table>
<thead>
<tr>
<th>TRUSS NO.</th>
<th>PLF</th>
<th>MAX. CSI</th>
<th>PLATE STRESS INDEX</th>
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<tbody>
<tr>
<td></td>
<td>Top</td>
<td>Bottom</td>
<td>Total¹</td>
</tr>
<tr>
<td>1 &amp; 11</td>
<td>33.2</td>
<td>8.6</td>
<td>41.8</td>
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<tr>
<td>2 &amp; 10</td>
<td>103.9</td>
<td>8.6</td>
<td>112.5</td>
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<td>3 &amp; 9</td>
<td>226.8</td>
<td>8.6</td>
<td>235.4</td>
</tr>
<tr>
<td>4 &amp; 8</td>
<td>272.2</td>
<td>8.6</td>
<td>280.8</td>
</tr>
<tr>
<td>5 &amp; 7</td>
<td>278.2</td>
<td>8.6</td>
<td>286.8</td>
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<tr>
<td>6</td>
<td>276.6</td>
<td>8.6</td>
<td>285.2</td>
</tr>
<tr>
<td>Component³</td>
<td>240.4</td>
<td>8.6</td>
<td>249.0</td>
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</tbody>
</table>

1. Example PLF Calculations for Trusses 2 & 10:

\[
\frac{[71.4 \text{ PSF (Uniform}^2\text{)Assembly}][\text{(5in. + 12in.)} \% 12\frac{\circ}{\circ}]}{R_L} = 112.5 \text{ PLF}
\]


# FIGURE 2
Truss design calculations
FIGURE 3

End-bearing detail for installing truss
FIGURE 4

Floor bracing layout
FIGURE 5

Detail of end of truss blocking with 1/2-in.-thick plywood extracted from 8 ft. sheets (Note 1/2 in. separation between 2x6 bearing plate and horizontal edge of plywood.)
FIGURE 6

Detail of lateral brace, 2x8, location at center span of trusses attached to vertical web element in chase opening
FLOOR ASSEMBLY "X" BRACING DETAIL

DECKING

2x4 "X" Brace

Truss
typical

(3) 10d nails

CEILING DRYWALL

(2) 20d nails

FIGURE 7

Floor assembly cross-brace between adjacent truss top and bottom chords
FIGURE 8

Wood block, 4x2, between lower chords of trusses for backing joints in gypsum wallboard ceiling
NON-FIRE-EXPOSED SURFACE

○ Thermocouples in Nine Point Grid

● A Critical Point Thermocouple
  9:  Long Joint
  11: Butt Joint

FIGURE 9
Non-fire-exposed surface thermocouple location
PLAN ORIENTATION

Thermocouples 3,6,9,12,15

Thermocouples Mid-Height 2,5,8,11,14

Finish Rating Thermocouples 1,4,7,10,13

FIGURE 10  VERTICAL SECTION

Thermocouple locations for recording finish rating and plenum temperatures
LOAD CALCULATIONS
FC-392

Floor Area (A): 13.25-by-17.5-ft. = 231.9 sq. ft.

Total Design Load
Allowable load (psf) x Area =
124.5 psf x 231.9 sq. ft. = 28,870 lb. 124.5 psf

Dead Load (D.L.)
Trusses (Mean) 85.1 lb./Truss 3.15 psf
Plywood (Mean) 4x8 67.7 lb./Sheet 2.12 psf
Wallboard (Mean) 4x10 101.0 lb./Sheet 2.52 psf
Blocking, Lateral Brace, X-Brace 0.40 psf
TOTAL DEAD LOAD 1,902 lb. 8.2 psf

Applied Live Load (L.L.)
26,968 lb. 116.3 psf

26,968/16 Tanks = 1,686 lb./Tank
1,686 - 300 lb./Tank D.L. = 1,386 lb. H2O/Tank

FIGURE 11
Applied load calculation for wood-webbed truss assembly and water tank load application diagram
Furnace temperatures recorded as a function of time in conformance with the ASTM E-119
FIGURE 13

Temperature at bottom chord-gypsum wallboard interface (finish-rating temperature) versus fire-exposure time
FIGURE 14

Mean temperature in truss space plenum as function of fire-exposure time
Recorded surface thermocouple temperatures plotted against fire-endurance time
May 14, 1986

L-CLIP

<table>
<thead>
<tr>
<th>CLIP TYPE</th>
<th>MATERIAL</th>
<th>H</th>
<th>B</th>
<th>W₁W₂</th>
<th>NAILING</th>
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</thead>
<tbody>
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<td>L1</td>
<td>20 ga. gal.</td>
<td>1-1/2&quot;</td>
<td>1&quot;</td>
<td>5&quot;, 3-1/2&quot;</td>
<td>4-10d</td>
</tr>
<tr>
<td>L2</td>
<td>20 ga. gal.</td>
<td>1-1/2&quot;</td>
<td>1&quot;</td>
<td>5&quot;</td>
<td>4-10d</td>
</tr>
<tr>
<td>L3</td>
<td>20 ga. gal.</td>
<td>2-1/2&quot;</td>
<td>1&quot;</td>
<td>2-1/2&quot;</td>
<td>4-10d</td>
</tr>
</tbody>
</table>

Clip Type L1 and L2 could be used universally at any location along the bottom chord.

Clip Type L3 can only be affixed to panel point locations, and must be used in conjunction with the Z-Clip for intermediate panel point installation.

L-CLIP TYPE L1

![Diagram of L-Clip Type L1](image)

Alternative blocking clips for wallboard joint blocks
L-CLIP TYPE L2

31"

W1

H

H

L

B
APPENDIX I

Photos of Assembly During Construction and Prior to Test

PFS TEST REPORT #86-10
TRUSS PLATE INSTITUTE

1 - Truss components in-place with end blocking of 1/2 in. plywood and

PFS TEST REPORT #86-10
TRUSS PLATE INSTITUTE

2 - Typical toothed metal side plate for trusses.
PFS TEST REPORT #86-10
TRUSS PLATE INSTITUTE

3 - Typical grade mark on bottom chord of truss component.
PFS TEST REPORT #86-10
TRUSS PLATE INSTITUTE

4 & 5 - Typical 4x2 wood blocking as backer for butt joints in ceiling wallboard.
6 - General view of 4x2 wallboard block and 2x8 lateral brace.

7 - A 2x4 cross-brace installed between adjacent truss top and bottom chords near center of assembly.
8 - Detail of 2x4 vertical block for bearing under ends of 2x8 lateral brace.

9 - Typical Henry 217 AFG-01 Certified Sub-Floor and Construction Adhesive tube used in glue-nailing T & G plywood flooring to assembly.
10 - Completing installation of 3/4 in. T & G APA rated Sturdi-Floor plywood floor sheathing.

11 - The 5/8 in. wallboard (U.S. Gypsum Firecode C, Type C) ceiling in place prior to joint taping and cementing.
12 & 13 - Water tanks emplaced on assembly surface to generate uniform live load.
14 - Clock at termination of test reads 63 minutes, 58 seconds. Test was terminated upon failure of assembly to sustain applied load.
**APPENDIX II**

Table of actual dimension of toothed metal plates in wood-webbed trusses

**ACTUAL METAL PLATE DIMENSIONS**  
**USED IN WOOD-WEBBED FLOOR TRUSSES**

(See Figure 1 for Plate Locations)

<table>
<thead>
<tr>
<th>JOINT NUMBER</th>
<th>ACTUAL DIMENSION (inches)</th>
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<tbody>
<tr>
<td>B.C. Splice Plates</td>
<td>7.00 x 3.00</td>
</tr>
<tr>
<td>T.C. Splice Plates</td>
<td>6.25 x 2.94</td>
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<tr>
<td>1</td>
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<tr>
<td>2</td>
<td>7.81 x 5.16</td>
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<td>6.25 x 4.06</td>
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<td>7.88 x 5.12</td>
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<td>4.69 x 4.06</td>
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<td>15</td>
<td>4.75 x 4.09</td>
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<td>16</td>
<td>7.03 x 5.12</td>
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