Loading Structural Steel Joists In Roof Assemblies

As the world's leading provider of passive fireproofing products, Isolatek International addresses the proper application of roof assembly UL Designs, specifically loading requirements and limitations for roof joists listed therein.

Selecting the appropriate UL fire resistance design for a roof assembly can be difficult. There are many factors that need to be considered such as insulation type and thickness, type of decking, and the hourly fire resistance rating requirements. Often, the loading limits of the structural member in a given UL roof assembly are overlooked. Loading limits are a critical factor when determining the appropriate design and material to use.

UL conducts full-scale fire tests on roof-ceiling assemblies in accordance with ANSI/UL 263 test method, loading the assemblies up to 30,000 psi (30 ksi). This loading is a standard outlined by the Steel Joist Institute (SJI) and is a nationally recognized structural design criterion for roof systems and structural supports. Loading limits are identified in UL designs under steel supports, beams or joists and are identified by maximum tensile strength. ANSI/UL 263 Fire Tests of Building Construction and Materials allows manufacturers to reduce the maximum load and list it in a particular design if they so choose. The standards for the loading of roof supports is 30 ksi. UL provides loading procedures under Loading of Test Specimens, in the introductory portion of the UL Fire Resistance Directory Volume 1.

When a UL roof-ceiling design (P-series and/or S-series) is utilized and lists structural members loaded to less than 30 ksi, a structural engineer needs to be consulted to determine how that compares to loading conditions on the project. If the project roof-ceiling assembly is subjected to a load greater than that which is referenced in the design, then an alternate UL design must be utilized to obtain a UL fire resistance rating. A UL design that does not list a maximum tensile strength has been loaded to 30 ksi.

Manufacturers may choose to test under-loaded designs to ensure adhesion and to allow for reduced UL design thicknesses. Utilizing under-loaded designs (i.e. P741) will result in lower thickness requirements for SFRMs. These lower thicknesses are not sufficient and will not provide the required UL fire resistance ratings for a roof joist loaded to 30 ksi.

It is Isolatek International's mission to test to industry standards and provide accurate information to industry professionals. This is a critical life safety issue that must be addressed in the design phase of every project.

800.631.9600 or + 1 973.347.1200
technical@isolatek.com | sales@isolatek.com
technical-international@isolatek.com | sales-international@isolatek.com
www.isolatek.com

Cafco® Brand

WE SAVE LIVES®

ISOLATEK® Brand

C-IS-LSSJIRA-10/19

Building Units — A category for a group of UL-certified products. The complete description of the products in the category and supplementary requirements for certification are covered under Building Units (BZXX).

Concealed Grid System — Suspension system for acoustical material that is not visible from the occupied space.

Exposed Grid System — Suspension system for acoustical material that is visible from the occupied space.

Fire-resistant Joint System — An assemblage of specific materials or products rated in accordance with ANSI/UL 2079 to resist for a prescribed period of time, the passage of fire through joints between fire-resistance-rated assemblies. See Joint Systems (XHBN).

Insulating Concrete — Nonstructural concrete with a unit weight less than 60 pcf.

Membrane Penetration — An opening made through one side (wall, floor or ceiling membrane) of a fire-resistance-rated assembly.

Mineral and Fiber Boards — A category for a group of UL-certified products. The complete description of the products in the category and supplementary requirements for certification are covered under Mineral and Fiber Boards (CERZ).

Miscellaneous (Direct-applied Protection) — Various types of fire-resistive coating materials, including intumescent mastic and subliming coatings.

Miscellaneous (Wall and Partitions) — Various types of wall assemblies, including gypsum wallboard shaft walls, log walls, folding assemblies and assemblies with glazing materials.

Partition Panel Units — A category for a group of UL-certified products. The complete description of the products in the category and supplementary requirements for certification are covered under Units, Partition Panel (CJMR).

Prefabricated Building Columns — Structural building columns that include a fire-resistive protection system when delivered to the construction site. These products are certified and identified as Prefabricated Building Columns (CGHT). The complete description of the products and supplementary requirements for certification are covered under CGHT.

Through Penetration — An item such as a pipe, cable tray or duct that passes through a horizontal or vertical fire-resistive assembly.

Through-penetration Firestop Systems — An assemblage of specific materials rated in accordance with ANSI/UL 1479 (ASTM E814), "Fire Tests of Through-Penetration Firestops." Firestop systems maintain the fire-containment integrity of horizontal or vertical fire-resistive assemblies where through penetrations are located. See Through-penetration Firestop Systems (XHEZ).

Unprotected Fire-resistive Assemblies — Assemblies that do not require direct-applied coatings or suspended ceilings to protect the structural elements.

3. Numbering System

The summarized form of the test assembly is identified by an alphanumeric design number. The prefix letter designates the group of construction, the first number designates the type of protection, and the other numbers and letters identify the particular assembly.

The prefix letters representing the various groups of constructions are:

Prefix Letters	Group of Construction
A	Floor-Ceiling Designs – Concrete with Cellular Steel Floor Units and Beam Support
D	Floor-Ceiling Designs – Concrete with Steel Floor Units and Beam Support
G	Floor-Ceiling Designs – Concrete and Steel Joists
I	Non-load-bearing Horizontal Barrier
J or K	Floor-Ceiling Designs – Precast and Field Poured Concrete
L	Floor-Ceiling Designs – Wood or Combination Wood and Steel Joist Assemblies
N	Beam Designs for Floor-Ceiling Assemblies
P	Roof-Ceiling Designs
S	Beam Designs for Roof-Ceiling Assemblies
U or V	Wall and Partition Designs
X or Y	Column Designs

II. GENERAL

The following information is applicable to all fire-resistive designs described in this Directory. It is recommended that the users review this information in addition to the general guidelines provided for specific materials and construction types.

Authorities Having Jurisdiction should be consulted before construction.

Fire-resistance ratings apply only to assemblies in their entirety. Except for those separately rated structural members supporting tested assemblies, individual components are not assigned a fire-resistance rating and are not intended to be interchanged between assemblies but rather are designated for use in a specific design in order that the ratings of the design may be achieved. Unless otherwise specified in the individual design or certification, attachments to structural steel have not been investigated.

All ratings are based on the assumption that the stability of the structural members supporting the assembly are not impaired by the effects of fire. The extent of damage of the test assembly at the rating time is not a criteria for the rating.

The specifications for materials in an assembly are important details in the development of fire-resistance ratings. Those materials provided with an "*" in the design text are eligible to be produced under the Follow-Up Service Program of UL. Information identifying such materials and the certified companies authorized to provide the materials are located in the product category section of this Directory. The appearance of the UL Certification Mark on the product is the only method provided by UL to identify products that have been produced under its Follow-Up Service.

1. Metric Dimensions

It is recommended that the "Metric Guide for Federal Construction," published by the National Institute of Building Sciences (NIBS), be consulted for guidance regarding the use of metric-dimensioned building materials. The dimensional conversion of building materials from the inch-pound system to metric may either be hard or soft.

Hard conversions are typically applied to manufactured products used in modular construction. These products include suspended-ceiling systems, gypsum wallboard, insulation boards, etc. Certified products which are available in metric sizes are identified in the certification information for the individual product categories located near the end of this Directory.

For soft conversions, inch-pound dimensions are mathematically converted to exact equivalent metric values. Examples of dimensions which may be soft converted include concrete thickness, depth of concealed space above suspended ceilings, and coating thicknesses.

It is recommended that dimensions which are identified as minimum or maximum in fire-resistive designs be initially soft converted and, if required, further converted to a hard metric equivalent following the min/max guidance. The spacing of hanger wire and other supports for suspended ceilings would be examples requiring this type of consideration.

2. Loading of Test Specimens

ANSI/UL 263 requires the load applied to test samples to be based upon the limiting conditions of design as determined by nationally recognized structural design criteria. For some applications, the nationally recognized design criteria may be based upon the Working Stress Design Method or the Limit States Design Method. For applications where these two design methods are available, the load applied to the test sample was determined in accordance with the Working Stress Design Method unless the rated assembly specifically references the Limit States Design Method. Also, unless otherwise stated, the load capacity of steel beams assumes the beams are fabricated from A36 steel.

ANSI/UL 263 permits samples to be tested with the applied load being less than the maximum allowable load as determined by the limiting conditions of a nationally recognized structural design criteria. The ratings for assemblies determined from tests where the applied load was less than allowed by the nationally recognized structural design criteria are identified as "Restricted Load Condition." The percent of the maximum load, the percent of the maximum stress, and the nationally recognized design criteria is identified in the text describing the structural element of rated assemblies with a restricted load condition. An example of the text used in an assembly with a restricted load condition and steel joist loaded to 80% of the maximum allowable is:

The design load for the structural member described in this design should not: (1) exceed 80% of the maximum allowable load specified in "Catalog of Standard Specifications and Load Tables for Steel Joists and Steel Girders," published by the Steel Joist Institute, or (2) develop a tensile stress greater than 24 ksi, which is 80% of the maximum allowable tensile stress of 30 ksi. (**Note:** The maximum allowable total load develops a tensile stress of approximately 30 ksi.)

Some restricted-load conditions have resulted from changes in product availability. An example is the substitution of K-Series joists for other series joists as described under **Section III, FLOOR-CEILINGS AND ROOF-CEILINGS, Item 7, Steel Joists**.

3. Penetrations

Penetrations through all or a portion of an assembly can significantly affect the rating. Firestop systems developed to protect openings created by penetration items are covered under Through-penetration Firestop Systems (XHEZ).

4. Finish Ratings

A finish rating is established for assemblies containing combustible (wood) supports. The finish rating is defined as the time at which the wood stud or wood joist reaches an average temperature rise of 250°F or an individual temperature rise of 325°F as measured on the plane of the wood nearest the fire. A finish rating is not intended to represent a rating for a membrane ceiling. The requirements for finish ratings are not included in ANSI/UL 263.

5. Nails and Screws

Nails are specified according to ASTM F547, "Standard Terminology of Nails for Use with Wood and Wood-Base Materials," or ASTM C514, "Standard Specification for Nails for the Application of Gypsum Board." Nails used to attach gypsum board to wood framing should be cement-coated box nails or cement-coated cooler nails unless specified otherwise in the individual designs. Screws meeting ASTM C1002, "Standard Specification for Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs," or ASTM C954, "Standard Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs from 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness," may be substituted for nails, one for one, when the head diameter, length, and spacing equal or exceed the requirements for the specified nails.

6. Interior and Exterior Applications

The fire-resistive designs and UL-certified materials are investigated with the understanding that their use is limited to interior applications unless otherwise specified in the individual designs or certification information (e.g., structural columns "Investigated for Exterior Use"). Where an exterior application of a UL-certified design is desired, the local building code and Authority Having Jurisdiction should be consulted to ensure compliance with other code requirements applicable to exterior use.

7. Exposed Interior Finishes

The surface flammability and smoke-development characteristics of certified materials that may be used as exposed interior finishes are measured by the test method in ANSI/UL 723 (ASTM E84), "Test for Surface Burning Characteristics of Building Materials." The flame-spread index of these materials is less than 200 and the smoke-development index of these materials is less than 450. Surface-burning certifications are contained in the Building Materials Directory.

8. Radiant Heating Cable and Panels

The effect of the use of electrical radiant heating cable or wire on the fire-resistance performance of assemblies has not been investigated. Unless otherwise specified in the specific design, the use of electrical radiant heating panels in a fire-resistance-rated assembly is not permitted.

9. Coating Materials

Coating materials include products identified as: 1) Spray-applied Fire-resistive Materials and 2) Mastic and Intumescent Coatings.

The type of material is specified in each design. Materials that have been investigated for exterior application are so indicated in the individual designs and in the product category.

Regulations governing the application and use of coating materials have been promulgated by many governmental agencies. Authorities Having Jurisdiction should be consulted for current local requirements.

Unless specifically detailed in the individual designs or in the product certification information, the interaction of dissimilar fireproofing materials on the same structural element or at the intersection of structural members, and the adherence of one product to the other, has not been investigated under fire-test conditions.

Unless specifically detailed in the individual designs or in the product certification information, the impact of galvanization applied to structural steel members has not been investigated under fire-test conditions. Galvanization may impact the adhesion of spray-applied fire-resistive materials or mastic and intumescent coatings.

Spray-applied Fire-resistive Materials

The surfaces on which the material is to be applied must be free of dirt, oil and loose scale. Surfaces may be primed with the primers/paints covered under Primers for Structural Steel (CGJM).

The following method of determining the bond strength of the spray-applied materials only applies to primers or paints that are not covered under Primers for Structural Steel (CGJM). Unless specifically prohibited in the individual designs, materials identified as Spray-applied Fire-resistive Materials (CHPX) may be applied to primed or similarly painted wide-flange steel shapes and pipe and tube-shaped columns provided: (A) the beam flange width does not exceed 12 in.; (B) the column flange width does not exceed 16 in.; (C) the beam or column web depth (defined as inside of top flange to inside of bottom flange) does not exceed 16 in.; (D) the pipe outer diameter or tube width does not exceed 12 in.; (E) bond tests conducted in accordance with ASTM E736, "Standard Test Method for Cohesion/Adhesion of Sprayed Fire Resistive Materials Applied to Structural Members," should indicate a minimum average bond strength of 80% and a minimum individual bond strength of 50% when compared to the bond strength of the fire-resistive coating as applied to clean uncoated 1/8 in. thick steel plate. The average and minimum bond strength values should be determined based upon a minimum of five bond tests conducted in accordance with ASTM E736.

The bond tests need only be conducted when the fire-resistive coating is applied to a primed or similarly painted surface for which acceptable bond strength performance between the primer or other similar material and the fire-resistive coating has not been measured. A bonding agent may be applied to the primed or similarly painted surface to obtain the minimum required bond strength where the bond strengths are found to be below the minimum acceptable values.

As an alternative to the bond test conducted on control samples applied to an uncoated steel plate, the following method may be used for unknown coatings in existing structures. Sections of painted steel are to be coated with a bonding agent compatible with the sprayed material being used on the project. The treated and untreated substrates should be coated with material, cured, and subjected to five bond tests each, in accordance with ASTM E736. If the failure mode of the sections treated with the bonding agent is 100% cohesive in nature, it will be acceptable to use this bond test value as the control bond strength. The value obtained on the untreated painted section should be compared to the control value using the minimum 80% average, 50% individual bond strength acceptance criteria established in ASTM E736.

If condition (E) is not met, a mechanical bond may be obtained by wrapping the structural member with expanded metal lath (minimum 1.7 lbs per sq yd).

If any of the conditions specified in (A), (B), (C) or (D) are not met, a mechanical break should be provided. A mechanical break may be provided by mechanically fastening one or more minimum 1.7 lbs per sq yd metal lath strips to the flange, web or tube and pipe surface either by weld, screw, or powder-actuated fasteners, on maximum 12 in. centers, on each longitudinal edge of the strip, so that the clear spans do not exceed the limits established in conditions (A), (B), (C) or (D) as appropriate. No less than 25% of the width of the oversize flange or web element should be covered by the metal lath. No strip of metal lath should be less than 3-1/2 in. wide.

As an alternative to metal lath, the mechanical break may be provided by the use of minimum 12 gauge steel studs with minimum 28 gauge galvanized steel disks if such a system is described in a specific design (usually a bottomless trench in an electrified floor design) for the fire-resistive coating being applied. The studs should be welded to the oversize element in rows such that the maximum clear span conforms to conditions (A), (B), (C) or (D) as appropriate. The spacing of studs along each row should not exceed 24 in. and a minimum one stud per 256 sq in. should be provided.