steelwise

PROPER APPLICATION OF STEEL BEAM LOAD RESTRICTION FACTORS TO UL DESIGNS

UL, AISC and AISI update the applicability of load restrictions for UL Designs for steel beams.

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AS AN UPDATE to the "UL Design Considerations" article (October 2015, available at www.modernsteel.com), following is the latest from Underwriters Laboratories. This and subsequent information will continue to be available at www.aisc.org/ULclarity.

Underwriters Laboratories (UL), the American Iron and Steel Institute (AISI) and the American Institute of Steel Construction (AISC) have been collaborating to provide answers and solutions to questions that have been raised about the need for load restriction factors with UL Designs. We have identified a number of clarifications and updates that will be made in UL Guide BXUV, as well as in UL Designs themselves. We jointly offer the following summary so that the information is known and can be used now, while UL updates their documents.

Recent testing conducted by UL for AISI and AISC provides for the following conclusions related to application of load restriction factors to UL Designs for steel beams in US practice:

1. Load restriction factors for steel beams need not be applied to any UL Design that is based upon strength calculated using the 2005 or 2010 AISC *Specification*. Table 1 below shows the UL (and ULC) Designs that meet this condition.

Table 1. Unrestricted UL and ULC Designs

	For W-Shape Beams	For Specialty Beam Products
UL Designs	G592, D798, D799, D982, D985, D988, E701, E702, N743, N852, N860, S750, S751, and S812	N858, N904, N905, and N906
ULC Designs	D501, F906, F912, and N815	O710, N900, N901, and N902

View these and other UL Designs at www.ul.com/firewizard.

Fire-Rated Design Bulletin

The information in this article was extracted from a UL bulletin to its members, jointly drafted by UL, the American Iron and Steel Institute (AISI) and AISC, and is meant to inform the industry of updates to UL fire-rated designs that specify a "Restricted Load Condition." It is being presented as the result of a series of tests sponsored by AISI to investigate this subject matter. Over the coming months, the UL directory will be updated to reflect these new findings both in the general information of BXUV as well as in the specific fire rated designs. Proposed updates are also included.




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2. Load restriction factors for steel beams need not be applied to any other UL Design if an unrestrained beam rating is used. Unrestrained beam ratings are determined using a limiting temperature criterion of 1,100 °F and a load maintenance criterion. The testing of steel beams at varying load levels has shown that the time it takes to reach this limiting temperature is not a function of the magnitude of the applied load.

3. Load restriction factors for steel beams need not be applied to any other UL Design if a 1-hour restrained beam rating is used. A 1-hour restrained beam rating is based upon the same criteria used for a 1-hour unrestrained beam rating. Therefore, as stated in item 2 above, the rating is not a function of the magnitude of the applied load.

4. When using a UL Design for which none of the foregoing conditions applies, a load restriction factor of 0.9 is applicable for both composite design and non-composite design in U.S. practice. UL, AISI and AISC have determined that the load restriction factors specified for use with Canadian design codes are not appropriate for use in the US. In the US marketplace, a smaller load reduction of 10% is appropriate for UL Designs based upon 1989 or earlier AISC ASD *Specification* requirements.

Stated more directly, load restriction is only applicable to 1.5-, 2-, 3- and 4-hour restrained beam ratings in UL Designs that were loaded based upon 1989 or earlier AISC ASD *Specification* requirements. In these cases, a 10% load reduction (0.9 load restriction factor) shall be used.

Moving forward, UL, AISI and AISC understand the need for practical and useful solutions to make fire protection selection and design easier for all. Accordingly, we are now collaborating to develop an approach wherein the fire protection thickness can be adjusted to account for conditions that differ from those used in the testing for a given design. We expect that this approach will be preferable in the marketplace and intend that it will replace the load restriction approach when available.

Loading of Test Specimens

Following are proposed updates to ANSI/UL 263–*Standard for Fire Tests of Building Construction and Materials*:

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 Allowable Stress Design (ASD) Method or the Load and Resistance Factor Design (LRFD) Method. For applications where these two design methods are available, the load applied to the test sample was determined in accordance with the Allowable Stress Design Method unless the rated assembly specifically references the Load and Resistance Factor Design. 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 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.

Assemblies tested with less than the maximum allowable load that would result from loading calculated using the Limit States Design Method in Canada or post-2005 AISC *Specification* criteria in the United States are identified as "Restricted Load Condition." The Percent Load Reduction and corresponding Load Restricted Factor for typical assemblies noted in Table 2 are based upon loading calculated in accordance with pre-2005 AISC ASD *Specification* criteria as compared to loading calculated in accordance with 2005 and later AISC *Specification* criteria in the United States.

The calculations were performed for assemblies representing spans and member sizes of typical fire-test assemblies. The loads were calculated assuming a span of 13 ft for floors and roofs and 10 ft for walls. Calculations for wide flanged steel beams assume a live to dead load ratio of 3:1.

A load restriction need not be applied for an unrestrained condition of any hourly rating nor applied for a restrained condition with a hourly rating of one hour or less.

Some fire-resistive designs are specified with a Restricted Load Condition. When using fire-resistive designs with a Restricted Load Condition, the factored resistance of the structural members or components should be reduced by multiplying the factored resistance by the Load Restricted Factor specified in the individual fire-resistive designs.

The Load Restricted Factor should be applied to the factored resistance of all structural members or components, including, but not limited to, factored moment resistance (M_r), factored shear resistance (V_r), factored tensile resistance (T_r) and factored compressive resistance (C_r).

The engineer of record should be consulted whenever fire-resistive assemblies with Load Restricted Factors are selected. The indicated load reductions are based upon factored load effects that are governed by the reduced factored resistance of the structural elements. The selection of structural elements is, at times, based upon service limits, such as deflection and vibration. These factors and others, such as the change in material strength properties as a function of temperature, should be considered when selecting fire-resistive assemblies with Load Restricted ratings.

Unless stated in a design, it is recommended the Load Restricted Factors in Table 2 be used.

Assemblies developed from tests where the load applied on the sample was based upon calculations in accordance with the Load and Resistance Factor Design are identified in the individual certifications. These assemblies shall not be considered "Load Restricted." ■

Table 2

Type of Assembly	Percent Load Reduction (LRFD-ASD) / LRFD	Load Restricted Factor
W8×28 – AISC (W200×42 – CISC) noncomposite steel beam	10%	0.9
W8×28 – AISC (W200×42 – CISC) composite steel beam	10%	0.9
Floor/Roof supported by open-web steel joists	4%	0.96
Floor supported by cold-formed steel channels	0%	none
Floor supported by 2 × 10 in. (38 × 235 mm) wood joists	35%	0.65
Wall supported by 2 × 4 in. (38 × 89 mm) wood studs	18%	0.82
Wall supported by cold-formed steel studs	0%	none
Steel columns	*	*
The ratings for floors supported by cold-formed steel channels and walls supported by coldformed steel studs do not have a Load Restriction Factor as the associated loads in Canada and the U.S. are based on the same standard: CSA S136, "North American Specification for the Design of Cold-Formed Steel Structural Members," and "North American Specification and Commentary for the Design of Cold-Formed Steel Structural Members."		
*Unless otherwise specified in the individual designs, columns do not have a Load Restriction Factor, as those ratings are based on temperature limitations in accordance with ANSI/UL 263.		