UL DESIGN Considerations

Using UL Designs for fire protection with today's steel design codes.

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RECENTLY, AISC AND AISI received several inquiries related to Monokote Fireproofing Bulletins that representatives of W.R. Grace are distributing. The bulletins in question concern load restrictions on structural steel beams in Underwriters Laboratories (UL) Designs. The prevailing sentiment in these inquiries seems to be that nobody understands what these bulletins mean, nor do they know what they need to do as a result of them.

UL usually tests their assemblies using beams that are loaded to the full design flexural strength of the beam used in the test. Before 2005—and even after that, depending upon the wishes of their client—UL often has used 1989 ASD (or earlier) design criteria to determine the beam test loading. Because modern structural steel design criteria recognize higher flexural strength, beams designed using LRFD or post-2005 ASD equations for beam design may experience higher loads than those assumed in some UL test assemblies, unless something other than flexural strength (deflection, for example) controls the design. This difference is the crux of the issue when discussing load restrictions related to UL Designs for beams.

UL Canada has implemented load restrictions for several years. In the U.S., however, the confusion occurs primarily because UL has not provided clear load restriction guidelines applicable to the U.S. marketplace. The recent W.R. Grace bulletins do not seem to provide clear guidelines either—they just state that the Canadian load restrictions now apply to UL Designs in the U.S.

Unfortunately, this is not a solution. Rather than settling the matter and bringing clarity, the W.R. Grace bulletins have been distributed in the absence of appropriate UL guidelines, thereby adding confusion. Neither the bulletins nor the UL guidelines provide any solution or clarification as to how to apply load restrictions in the U.S. This article attempts to clarify the matter and provide solutions.

Some Background

UL fire-resistance tests and the resulting UL Designs usually are sponsored by the manufacturers of proprietary fire protection materials, such as spray-applied fire-resistive materials (SFRM) and intumescent coatings. AISC and the steel industry usually have no involvement in the development of these UL Designs and the associated tests. Ultimately, UL and the sponsors of the UL Designs determine the structural loads used in the associated fire-resistance tests. While they follow the AISC *Specification* to determine the test loads, they do not always use the latest edition of the *Specification* and they do not always update their designs for the higher loads permitted by modern structural design codes and standards.

Recognizing this, AISC and the American Iron and Steel Institute (AISI) have been working with UL to facilitate the update of UL Designs. In addition to conducting tests at modern load levels to create new UL Designs using current design methods, AISC and AISI also funded a series of UL beam tests with varying levels of beam loading. We did the latter so that UL would have the data they need to update existing old UL Designs to current loading levels.

Our test program at UL is ongoing. Some results have already been made available in UL Design No. D982, which was publicized previously in *Modern Steel* (see "Restrained or Unrestrained?" in the September 2013 issue at **www.modernsteel.com**).

Although this reference is more focused on clarifying the restrained vs. unrestrained confusion, the article is an applicable reference for the load restriction question because we used modern loading calculations that work for both LRFD and ASD.

There are other UL Designs that are based upon modern loading levels. More on that later, but first…

Photos: Farid Alfawakhiri

How Can You Tell If Your UL Design Is Old or Modern?

UL provides subtle distinctions in the language that introduces each UL design. Generally, for older designs, the language used is:

> "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."

Generally, for modern designs the language used is:

> "Loading Determined by Allowable Stress Design Method or Load and Resistance Factor Design Method published by the American Institute of Steel Construction, or in accordance with the relevant Limit State Design provisions of Part 4 of the National Building Code of Canada."

Variations on the above statements do occur in some UL Designs. Nonetheless, as one example, a specifier would know that our UL Design No. D982 is "modern" because it is prefaced by the modern language indicating loads were calculated using modern methods.

The UL Guides BXUV or BXUV7 referenced in the language for older designs are related to ANSI/UL 263 and CAN/ULC-S101M, respectively. Both documents address load restriction, but do so using only terms consistent with Canadian codes and design methodologies; "Limit States Design" is Canadian terminology for LRFD. Thus, this language relates primarily to the Canadian marketplace, avoids the terms common in the U.S. marketplace and is not tied to any specific edition of the *Specification*.

It also remains unclear how the listed load restriction factors were derived. As a result, we are unsure whether the load restriction factors of 0.88 listed for the "non-composite steel beam" and 0.71 listed for the "composite steel beam" are appropriate in the context of U.S. standards.

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What Can You Do Now?

There are at least two solutions that you can use today. First, you can use a UL (or adapted ULC) Design that is not load restricted. If it is desired to maintain the usual relationship where the architect is responsible for fire protection and the structural engineer has little to no involvement, this solution clearly is preferable. Several unrestricted UL and ULC Designs for beams are shown in Table 1.

Table 1. Unrestricted UL and ULC Designs

	For W-Shape Beams	For Specialty Beam Products
UL Designs	G592, D798, D982, D985, N743, N852, N860 and S750	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**.

Alternatively, you can use an older UL Design and choose to apply the UL load restriction factors (LRF) to ensure the bending moment due to gravity loads does not exceed:

$$LRF \times \frac{M_n}{1.67} \text{ for ASD, or}$$

$$LRF \times 0.9M_n \text{ for LRFD}$$

If you choose this option, you are essentially accepting a U.S. adaptation of the reduced loading levels in restricted ULC Designs. This assumes that the same restrictions ULC provides for Canada can be used in the U.S. despite difference between Canadian and U.S. codes.

Note also that the second option is not as clean because it may require the structural engineer to do work beyond the normal scope of structural design services. Nonetheless, it is common for deflection and other serviceability criteria to already have limited the design moment, and this option can work without resulting in any design changes.

What Else Can We Do?

The answer to this question is not yet known. As of the time of writing of this article, AISC and AISI have a September meeting scheduled with UL. Updated information will be posted with this article at **www.aisc.org/ULclarity**. ■