HAVE YOU EVER BEEN ASKED whether your oor or roof is restrained or unrestrained for re protection design?

If so, it was probably because of requirements in Section 703.2.3 in the 2015 *International Building Code* (*IBC*). The code states that the quali cation of construction for the restrained classi cation, in accordance with ASTM E119 or ANSI/UL 263, is the purview of the registered design professional for the acceptance of the building of cial. Restrained construction is required to be identi ed on the construction documents.

When used with oor construction that is appropriately quali ed as restrained, the restrained classi cation properly provides for life safety and property protection. The owner bene ts from a lower cost for re protection, the architect is happier because smaller clearances are required in the building nishes and reducing the quantity of any product (when possible) is a hallmark of sustainability. For all these reasons and more, it's the right thing to do.

So how can you correctly identify and properly use restrained classi cations? It's actually quite easy. Following is a succession of simple tools you can use, starting with the easiest.

1. Ma a . Underwriters Laboratories (UL) Design D982 provides identical re-protection thickness requirements for both restrained and unrestrained two-hour assembly ratings for oor construction and associated secondary members. It is based on UL tests that were carried out on structurally loaded, and physically restrained or physically unrestrained, oor assembly specimens incorporating steel beams. Therefore, the unrestrained assembly ratings in this UL design are based on the structural performance of unrestrained oor assemblies. This is in contrast to other UL designs where the unrestrained assembly ratings are derived indirectly from tests on physically restrained oor specimens. These indirect unrestrained ratings are based not on the structural performance but rather on thermal (only) performance using overly conservative temperature limits. (See the sidebar on page 56 for further information.)

The two-hour assembly ratings in UL Design D982 can be used with any UL-certi ed spray-applied re-resistive material (SFRM) with thickness "suf cient to provide a one-hour Unrestrained Beam Rating." This one-hour unrestrained beam rating is a generic means of specifying the re protection (.36re p)d ste1(

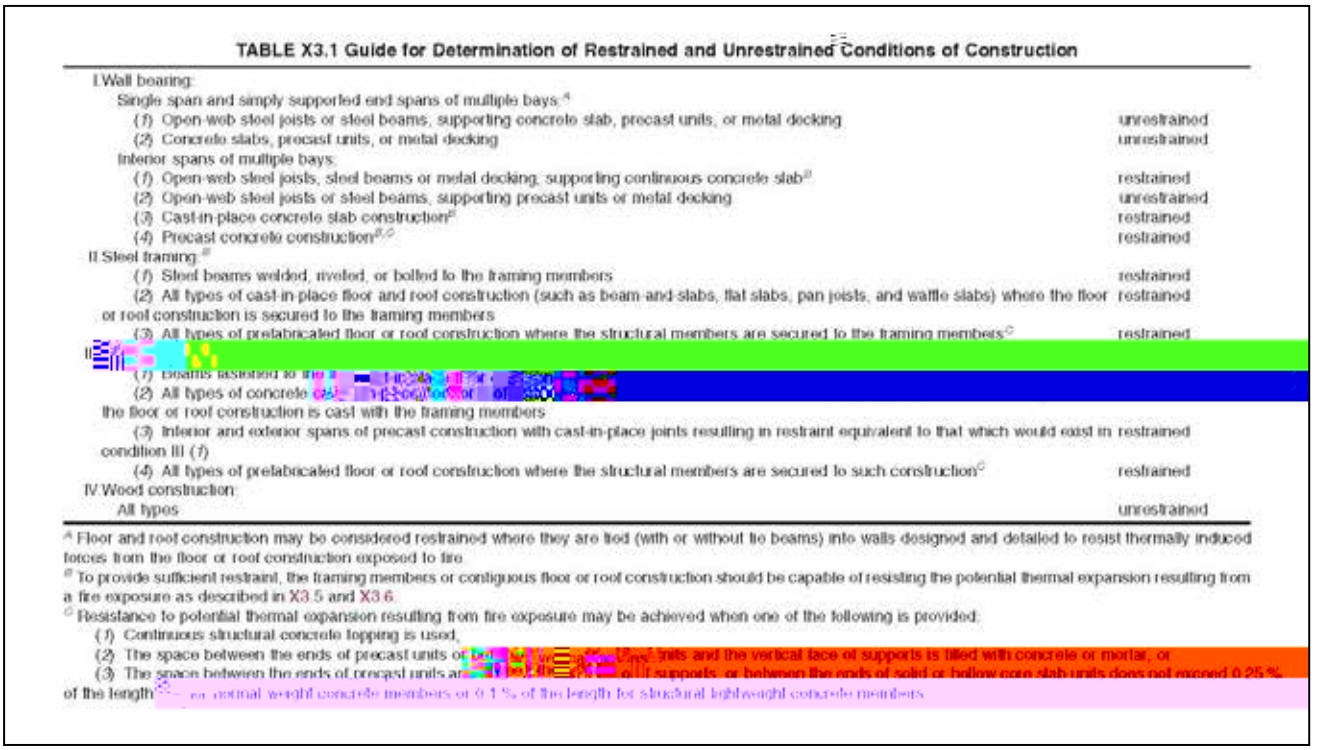


TABLE X3.1 Guide for Determination of Restrained and Unrestrained Conditions of Construction

I Wall bearing:	
Single span and simply supported end spans of multiple bays [A]	
(1) Open-web steel joists or steel beams, supporting concrete slab, precast units, or metal decking	unrestrained
(2) Concrete slabs, precast units, or metal decking	unrestrained
Interior spans of multiple bays:	
(1) Open-web steel joists, steel beams or metal decking, supporting continuous concrete slab [B]	restrained
(2) Open-web steel joists or steel beams, supporting precast units or metal decking	unrestrained
(3) Cast-in-place concrete slab construction [B]	restrained
(4) Precast concrete construction [B,C]	restrained
II Steel framing: [B]	
(1) Steel beams welded, riveted, or bolted to the framing members	restrained
(2) All types of cast-in-place floor and roof construction (such as beam-and-slabs, flat slabs, pan joists, and waffle slabs) where the floor or roof construction is secured to the framing members	restrained
(3) All types of prefabricated floor or roof construction where the structural members are secured to the framing members [C]	restrained
II [illegible]	
(1) Beams fastened to [illegible]	
(2) All types of concrete [illegible]	
the floor or roof construction is cast with the framing members	
(3) Interior and exterior spans of precast construction with cast-in-place joints resulting in restraint equivalent to that which would exist in condition III (1)	restrained
(4) All types of prefabricated floor or roof construction where the structural members are secured to such construction [C]	restrained
IV Wood construction:	
All types	unrestrained

[A] Floor and roof construction may be considered restrained where they are tied (with or without tie beams) into walls designed and detailed to resist thermally induced forces from the floor or roof construction exposed to fire.

[B] To provide sufficient restraint, the framing members or contiguous floor or roof construction should be capable of resisting the potential thermal expansion resulting from a fire exposure as described in X3.5 and X3.6.

[C] Resistance to potential thermal expansion resulting from fire exposure may be achieved when one of the following is provided:

(1) Continuous structural concrete topping is used,

(2) The space between the ends of precast units of [illegible] units and the vertical face of supports is filled with concrete or mortar, or

(3) The space between the ends of precast units ar[illegible] of supports or between the ends of solid or hollow core slab units does not exceed 0.25 % of the length [illegible] for normal weight concrete members or 0.1 % of the length for structural lightweight concrete members.

▲ Table X3.1 of ASTM E119.

4.3.3. U . .a C .. c.

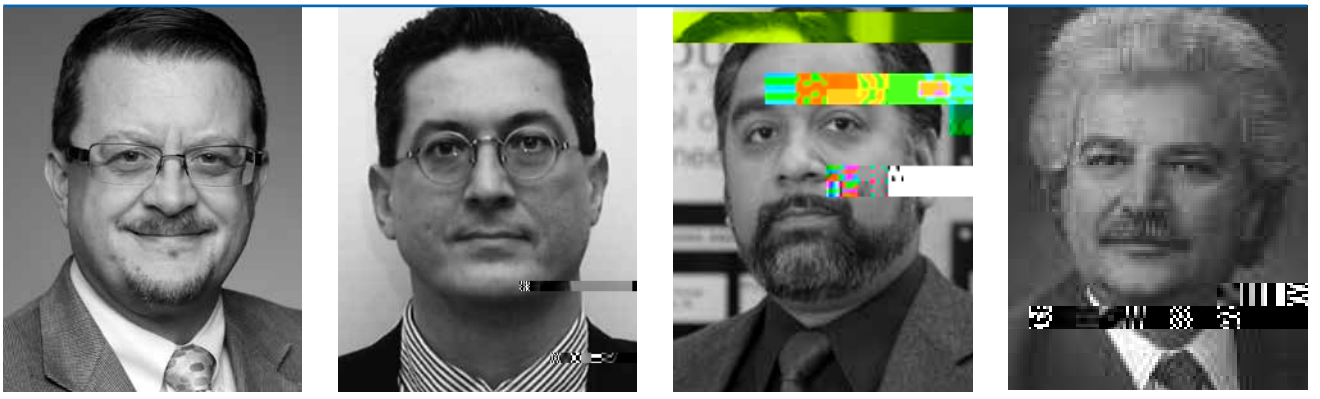
Steel beams, girders and frames that do not support a concrete slab shall be considered unrestrained unless the members are bolted or welded to surrounding construction that has been speci cally designed and detailed to resist effects of elevated temperatures.

A steel member bearing on a wall in a single span or at the end span of multiple spans shall be considered unrestrained unless the wall has been designed and detailed to resist effects of thermal expansion.

These are clear and concise statements in the consensus standard for steel design and construction, and you can use them to properly classify the common types of structural steel construction. The *Specification* explicitly labels the most common con guration of steel construction as restrained in Section 4.3.2. This covers the majority of steel construction.

3. ASTM E119 A , X3 a ANSI/UL 263 A - , C c . . ca . If you have a case that isn't directly addressed in the *Specification* or you want to use an alternative basis of classi cation, you can use ASTM E119 Appendix X3 and Table X3.1 (see the latter, above).

Here again, these are clear and concise statements. They are provided in the consensus standard for prescriptive re-protection testing, and you can use them to properly classify the common types of structural steel construction. This standard is broader in its coverage and also explicitly labels types of construction as restrained and unrestrained. It covers all steel construction.



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The two-hour assembly ratings in UL Design D982 can be used with any UL-certified spray-applied fire-resistive material (SFRM) with thickness "sufficient to provide a one-hour Unrestrained Beam Rating."

And as a paper published in a peer-reviewed and juried journal, it is authoritative. Furthermore, the bibliography assembles the additional body of supporting work. It is substantial and de nitive should you want further detail or support of a speci c point.

5. F … a c … a … c …. Other AISC publications relate and provide similarly clear and useful recommendations regarding classi cation, as well as supporting information. Additionally, other organizations have published similar documents of their own. Following is a summary of the available documents and their content relevant to this article.

AISC has published AISC Design Guide and Facts documents on re protection and design. Design Guide 19: *Fire Resistance of Structural Steel Framing* is available at .a c. . / , and Facts for Steel Buildings Number 1: *Fire Facts* is available at .a c. . / ac. .

- The Design Guide states:

  "Most common types of steel-framed construction are classi ed as thermally restrained. Appendix X3 of ASTM E119 lists the few instances where individual steel beams and girders, or steel-framed oor and roof assemblies, are classi ed as unrestrained."

- The Facts document states:

  "Appendix X3, Table X3.1 of ASTM E119 provides guidance on the classi cation of beams, oor and roof systems in construction as restrained or unrestrained ...in most practical cases, structural steel beams and steel-framed oor systems within steel-framed buildings are classi ed as restrained."

The Council of American Structural Engineers (CASE) has published its own guideline document: *Structural Engineer's Guide to Fire Protection*. This is a very useful summary document written primarily for the structural engineer of record. It states the following, speci cally related to restrained and unrestrained classi cations:

> In structural steel construction, the "thermal restraint" developed under re conditions is a combination of two primary effects:
>
> 1. Resistance to axial thermal expansion provided by the surrounding framing and oor slab or roof deck
> 2. Resistance to rotation of the ends of the beams and girders. This restraint is in uenced by connection stiffness, girder or column stiffness and interaction of the beams with composite or non-composite components of the oor or roof construction
>
> Both modes of restraint occur in steel-framed buildings and they both contribute to the re resistance of a structural steel-supported oor or roof system. Indeed, there is strong evidence that, of the two modes, rotational restraint is the more signi cant. Even minimal rotational restraint provided by simple connections is effective in achieving "thermally restrained" performance. This suggests that calculation (documentation) of the amount of thermal restraint that exists in a structural steel frame building is unnecessary.
>
> …information about the test frame stiffness has sometimes been misinterpreted. It has been suggested that a building structure must have stiffness greater than that of the test frame to qualify as thermally restrained. This is an erroneous interpretation.

These documents all add to the clarity, usefulness and appropriateness of restrained classi cations in steel construction. They also demonstrate a breadth and variety of organizations and entities that are consistent on this subject. In fact, we are not aware of a single credible technical document that contradicts the usefulness and appropriateness of restrained classi cation.

What if Someone Challenges You?

It's clear that there are those who are committed to their belief that unrestrained classi cations should be used in all cases. They continue to maintain this belief even in the face of the mountain of available proof to the contrary, including in the aforementioned information. They do so without a shred of research, testing or other proof to support their case. This is why their arguments are based only on confusing statements—even when there is no confusion.

As summarized in the sidebar, UL will perform tests in the restrained con guration or in the unrestrained con guration. However, only AISI (American Iron and Steel Institute) and AISC have ever used the unrestrained con guration to establish a UL Design. That's right. All those who advocate that steel must be classi ed as unrestrained do not conduct their own tests in the very condition they insist is more appropriate as a classi cation. If that's what they believe, they should be consistent and conduct their tests using specimens built in the unrestrained condition. We believe this speaks volumes about their position.

In the absence of any technical basis, there have been some attempts to use as "proof" International Code Council (ICC)