Restrained vs. Unrestrained

To most structural engineers, code officials and architects, the terms "Restrained" and "Unrestrained" are typically interpreted as referring to the connection of structural elements at ambient temperatures. However, in the fire protection industry, restrained and unrestrained are addressed at elevated temperatures, introducing the concept of "thermal restraint".

The issue of thermal restraint causes some controversy in determining whether an assembly should be considered restrained or unrestrained. The classification of an assembly in one of these categories has a bearing on the thickness of Spray-Applied Fire Resistive Material (SFRM) needed to satisfy code requirements. Higher SFRM thicknesses are typically required for unrestrained ratings.

In order to determine whether an assembly is restrained or unrestrained, one may refer to the actual "Fire Test Standards of Building Construction and Materials". According to Appendix X3 of ASTM E119 and Appendix C of UL 263, "Floor and roof assemblies and individual beams in buildings shall be considered restrained when the surrounding or supporting structure is capable of resisting substantial thermal expansion throughout the range of anticipated elevated temperatures. Construction not complying with this definition is assumed to be free to rotate and expand and shall therefore be considered as unrestrained".

To assist in determining this condition, ASTM E119 and UL 263 also list general construction classifications and whether they denote a restrained or unrestrained condition. This table of classifications, which at one time appeared in the UL Fire Resistance Directory, has been attached for reference purposes. According to UL, this information is intended as a guide for the determination of restrained conditions and is not meant as a specification. Engineering judgment must therefore be exercised to determine what constitutes restraint to "substantial thermal expansion".

Furthermore, the current UL Fire Resistance Directory states the following: "Restrained conditions for the fire test assemblies are provided by construction floor, beam, and roof test assemblies within nominal 14 ft x 17 ft frames of composite steel/concrete cross sections having an approximate stiffness (EI/L) of 850,000 kip-in and 700,000 kip-in along the 14 ft and 17 ft sides, respectively". This description provides structural engineers with the stiffness of UL's test frame so that they have a basis of comparison when determining conditions of restraint for beams on a project.

Due to the level of analysis and interpretation required, there is often confusion as to whether a building's construction shall be specified as restrained or unrestrained. Ultimately, the determination of the conditions of restraint remains in the hands of the structural engineer and the authority having jurisdiction. The level at which these conditions are addressed by the various code bodies differs between organizations. The International Building Code (IBC) addresses restrained vs. unrestrained criteria referring directly to Appendix X3 of ASTM E119. IBC clearly addresses restrained classification in its Section 703.2.3.

After determining restrained vs. unrestrained conditions, the appropriate restrained or unrestrained fire resistance rating must be utilized. Restrained and unrestrained fire ratings specified for both beams/joists and assemblies are used to determine the required fire protection material thicknesses which are listed in the UL Directory. Due to the difference in thickness requirements between restrained and unrestrained hourly ratings, its correct determination is critical to the life safety integrity of the building.

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