# High-Capacity Restraint Configurations

Beginning with the adoption of the 97 UBC code and later with the new IBC code, seismic design loads have increased dramatically. Applications where large pieces of equipment are located high in structures and, in particular, where they are anchored to concrete have become significantly more difficult to address.

Some of the factors driving this are 2:1 increase factors for isolated equipment attached to concrete, 3:1 or 4:1 increase factors for equipment located at rooftop levels, and higher basic design acceleration values.

These high design forces not only add to the shear load on equipment anchors but also greatly increase tensile (or uplift) loads. The tensile loads result from overturning factors on both the equipment and on the restraint itself. While there is often little that can be done with regard to equipment geometry, the location of the equipment in the structure, or the material to which it is attached, improvements can be made in the restraint to minimize tensile loads developed in its attachment anchors.

The need to do this is critical as the allowable tensile capacities of concrete anchors are very low compared to either their allowable shear loads or the tensile capacities of equivalent through bolts. This results in a significant penalty in capacity when using concrete anchors. In addition, the required embedment depth for larger anchors (often 6 to 10 inches) makes their use impractical (or even impossible) for a wide range of projects.

When the restraints are mounted by concrete anchors, the interaction between the tensile and shear forces applied to the anchor simultaneously dramatically reduces its ability to withstand a lateral load. This reduction is highly dependent on the height of the snubber element above the base of the restraint. For example, a restraint with the snubber element located 10 inches off the floor will resist only about ¼ of the lateral load than would an identical restraint with the snubber element located 2 inches off the floor.

As a result, especially if attaching to concrete, efforts should be made to keep the restraint element as close to the floor (or mounting surface) as possible.

Common older designs for seismically rated isolators have the restraint element located above the spring coil. The capacities on these units are greatly reduced in concrete anchorage applications and for critical areas they should be avoided.

A few combination isolator/restraints have the restraint relocated to the base, with the coil above. The FMS is Kinetics Noise Control's version of this type of seismically rated assembly.





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