Pros and Cons of Struts Versus Cables

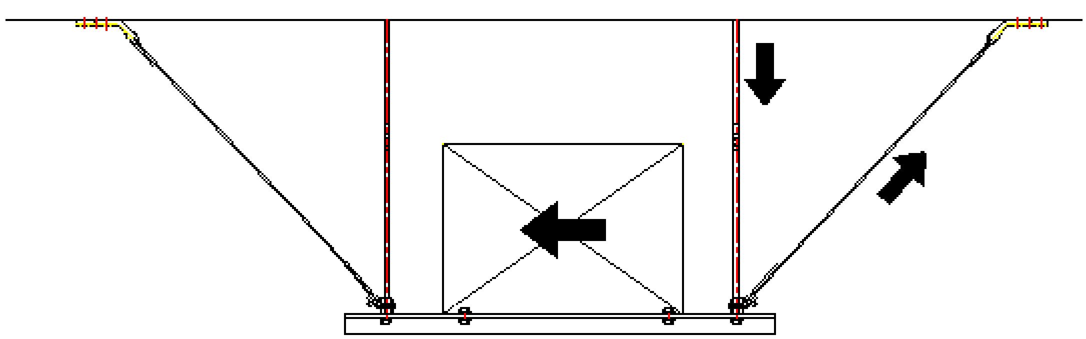
Both cables and struts have their place in the restraint of equipment. In order to minimize costs and speed up installation, the differences between the two should be understood.

When restraining equipment there is typically no difference in the number of restraints needed. This is unlike piping or ductwork where normally a single strut can replace 2 cable assemblies. The difference between equipment and piping/ductwork is that the equipment is small enough that in addition to swinging laterally from a seismic input, it can easily rotate. 2 struts acting at 90 degrees to one another cannot resist this rotation. Under some cases it can be resisted using 3 struts properly aligned, but unless carefully reviewed a minimum of 4 struts are recommended.

The obvious advantage to struts is that, when space is at a premium, cables angling up to the ceiling on each side of a piece of equipment may take more space than is available. Struts can be fitted to one side only, allowing a more narrow packaging arrangement.

There are three significant advantages of cables, where they can be used. First, they cannot increase the tensile forces in the hanger rod that results from the weight load, so rod and rod anchorage capacities are not impacted. Second, they are easily set to the proper length. And third, they are well suited to isolated equipment applications.

To better explain the differences between the systems, it is necessary to look at how seismic forces are resisted with cables and struts. Shown below are sketches of both cable-restrained and strut-restrained equipment.



Cable Restrained

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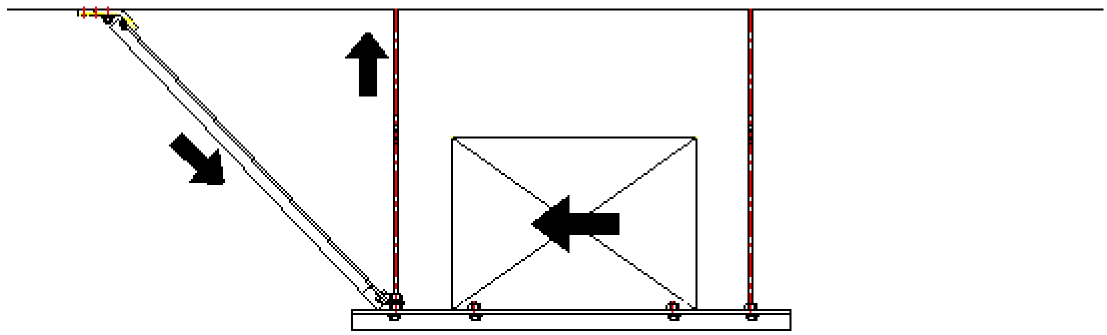

Strut Restrained

The key factor to note is that cables can only be loaded in tension. This means that seismic forces can only generate compressive loads in the hanger rod. Seismic forces can, however, load the strut in compression resulting in a tensile load on the hanger rod.

This tensile load is in addition to any deadweight load that may already be supported by the hanger and is often significantly higher than the original load. This has the potential to rip the hanger rod out of the support structure and must be considered when sizing components.

Because of this added tensile component and the resulting impact on the necessary hanger rod size, most strut manufacturers limit the maximum allowable strut angle (to the horizontal) to 45 degrees. This is lower than typical allowable angles for cables that often reach 60 degrees from the horizontal. Although the tables listed in Chapter D4 of this manual allow the use of higher angles for strut systems, users will find that the penalties in hanger rod size and anchorage will likely make these higher angles unusable in practice.

It should also be noted that the hanger rods in tension become seismic elements. This occurs with struts, but does not with cables. As a result, the system must comply with all of the anchor requirements specified by ICBO. This includes the use of wedge-type anchors and embedment depths that are a minimum of 8 anchor diameters. With larger anchor sizes, floor slab thickness may cause this to become a significant problem.

With both cables and struts, the hanger rods can be loaded in compression. As the seismic force increases, it eventually overcomes the force of gravity and produces a buckling load in the hanger rod. It is mandatory in all cases that the rod be able to resist this force.

There is a wide range of variables involved in determining the need for rod stiffeners to resist this buckling load. Factors that impact this need are 1) the magnitude of the compressive force, 2) the weight load carried by the hanger rod, 3) the length of the hanger rod, 4) the diameter of the hanger rod, and 5) the angle between the restraint strut

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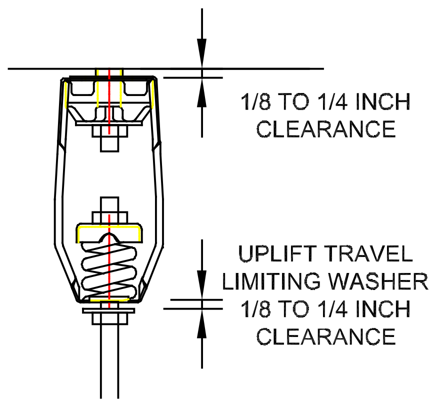
or cable and the horizontal axis.

Tables are included in Chapter D4 of this manual that allow the user to determine if there is a need for a stiffener and to allow the proper selection if required.

Because uplift occurs, some attention must be given to isolated systems. First, when using isolators, the location of the isolation element needs to be at the top end of the hanger rod (close to, but not tight against the ceiling). If placed at the middle of the hanger rod, the rod/isolator combination will have virtually no resistance to bending and will quickly buckle under an uplift load.

Second, a limit stop must be fit to the hanger rod, just beneath the hanger such that when the rod is pushed upward a rigid connection is made between the hanger housing and the hanger rod that prevents upward motion. This is accomplished by adding a washer and nut to the hanger rod just below the isolator (see the sketch below).



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