Vibration Isolation and Seismic Control
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General Guidance on the Use of Rod Stiffeners when Seismically Restraining Pipe/Duct/Electrical Distribution Systems

Hanger rods are normally loaded with a tensile (downward) force that is generated by the weight of the component they are supporting. When cables or struts are used as horizontal restraint devices, the lateral load generated by a seismic event is resisted by tensile forces in the cable. As these tensile forces act at an upward angle, they in turn generate a compressive (upward) force in the hanger rod. When the upward force generated by the seismic event exceeds the weight generated downward force, the component will begin to "lift" and the hanger rod has the potential to buckle. If the hanger rod buckles significantly, it can fail and the supported component will drop to the floor.

There are five (5) significant factors that can impact whether or not the hanger rod will buckle. Some of these can be further broken down. I have tabulated the 5 main factors below and have broken down the Amplitude and Weight factors in the following paragraph:

Amplitude of the horizontal force	Ability of the Hanger Rod to resist bending
Weight supported on Hanger Rod	Overall Length of the Hanger Rod
Steepness of the Cable or Strut	

The amplitude of the horizontal force is generated by the horizontal acceleration (which varies with the elevation of the component in the structure), the spacing between the restraints (for distributed systems) and the weight of the component being restrained. The weight supported on the hanger rod is a function of the number of supports (or spacing of the supports for distributed systems), the weight of the component being supported and whether or not (in distributed systems) the system is supported with single rod hangers or on a trapeze with 2 supports.

This wide range of factors makes selecting an appropriate stiffener more difficult and the options exist to go with a simplified selection system that is "overkill" in many instances or a more detailed process that requires a better knowledge of the application but offers a savings in the hardware specified. Many of the manufacturers of restraint components offer tables or other forms of guidance to simplify the selection process.

For the purpose of this document, we will ignore the sizing process of rod Stiffeners (if required) and will focus on eliminating those cases where it is clear that are no uplift forces and hence no need for stiffeners. We will also focus on distribution systems (pipe, duct and electrical) only. To that end, below is a guide which indicates the point at which the uplifting forces exceed the weight generated forces in the hanger rods applied to distributed systems. If operating below these levels, it can safely be assumed that there will not be any requirement for Hanger Rod stiffeners.

This simple table is based on several typical assumptions. First, the worst case installation angle (steepness) of the cable does not exceed 60 deg. Second, the support spacing is assumed to be approx. 10 ft on center. Lastly, the system supported is assumed to be of constant weight throughout its length. As long as it is constant, the actual weight per ft does not make any difference.

Restraint Spacing (ft)	Supported by Single Hanger Rods	Trapezed (2 Hanger Rods)
10	.57 g	.29 g
20	.29 g	.15 g
30	.19 g	.10 g
40	.14 g	.07 g
60	.10 g	.05 g
80	.07 g	.04 g

In using the table, design seismic forces at the appropriate elevation in the structure, as long as they do not exceed the above listed maximums, will not generate uplift forces and as such will eliminate from consideration the need to fit rod stiffeners. If on the other hand, the computed seismic forces for an application exceed the above value (in g's), uplifting forces can be shown to be present and depending on the amount that the tabulated values are exceeded, the stiffness of the hanger rod used and its length, some type of rod stiffener is likely to be required.

It is also of value to note that the more closely spaced the restraints, the more tolerant the system is in resisting uplift loads. In some cases it may be preferable to decrease the spacing between restraints versus adding rod stiffeners.

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VISCMA is a non-profit association representing the manufacturers of seismic restraint, vibration isolation and noise control equipment. The primary objectives of the organization are to educate the construction industry on the proper use and application of vibration isolation and seismic restraint and to develop standards to continually improve the industry.

In partnership with FEMA and ASCE, VISCMA also publishes three Seismic Installation and Inspection Manuals designed to assist field personnel.

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