

Suspended Equipment Attachment Details

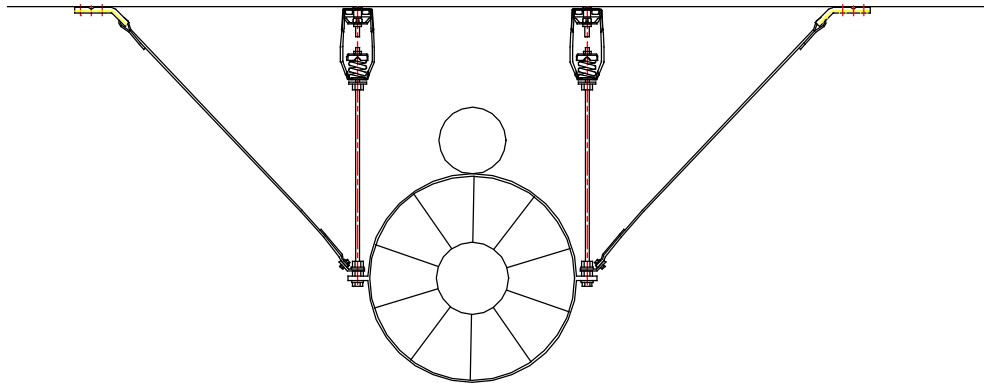
Equipment is normally supported individually but on rare occasions can be grouped together and supported on a trapeze structure. Restraints can be installed in the same manner. When installing restraints, however, it is critical that (except for horizontally oriented restraint members) they be located in the immediate proximity of a vertical hanger rod, as the support is required to absorb vertical forces that are developed during the restraint process.

If the equipment is isolated, cable restraints need to be used in lieu of struts to prevent the transfer of vibration through the strut into the structure. For non-isolated arrangements, where cables are illustrated, they can be replaced with a single strut mounted in a similar fashion.

Equipment with integral support points suspended on Hangers

All pieces of equipment should be suspended on a minimum of two hanger rods and should be fitted with a minimum of four cable or four strut restraint members.

Common mounting arrangements involve four or more supports and four restraints oriented as described in Section D10.4.2. A typical detail for an Axial Fan is shown below.



Note that on this isolated case, the spring isolators are mounted close to, but not in direct contact with the supporting structure. In addition, the hanger rods are fitted with a nut and washer directly below the hanger box that will limit the maximum upward travel of the rod (and thus the equipment) to 1/4"

When using the double rod arrangement, restraints must connect at an elevation that will preclude swaying of the equipment. See also section D10.4.2 for more information on this.

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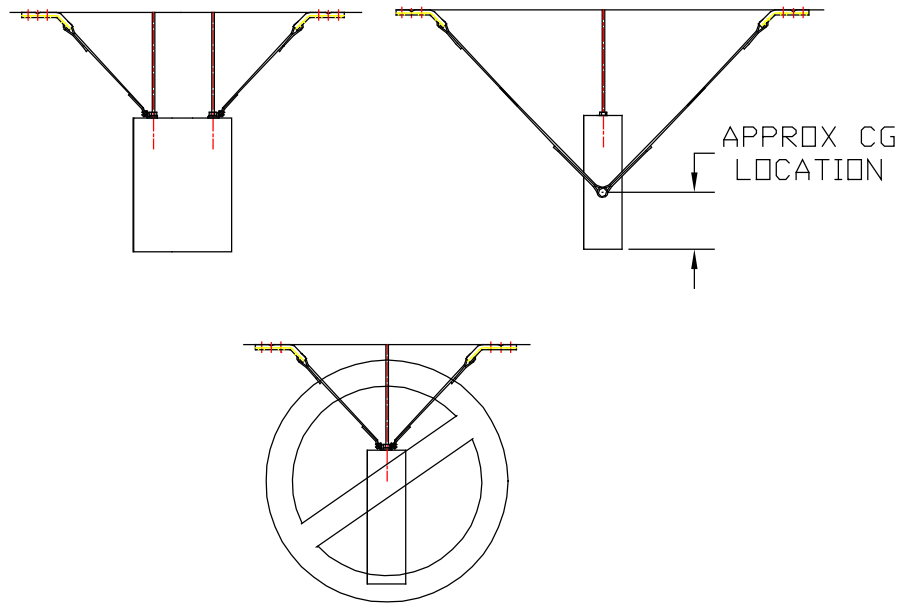
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Right and Wrong was to restrain equipment supported on 2 hanger Rods

It is likely that equipment supplied for the installation is not equipped with mounting points that are aligned with the horizontal CG. If this is the case, additional restraint points will have to be added by the installation contractor to facilitate this connection.

Restraint Arrangements for Equipment Supported on a Trapeze

General Trapeze Design

Where there is no direct provision on equipment to allow its suspension directly, it can be supported on trapeze bars. Depending on the installation, it may be preferable to attach restraints to the top of the equipment rather than to the bottom. This can be done, but there are two key items that must be addressed when fitting the restraints.

- 1) The bar that is being laterally restrained must be the bar that is bolted or welded to the equipment. It is not appropriate to sandwich the equipment between two trapeze bars, bolt that equipment to the bottom one and restraint the top one. If the top bar is connected to the restraints, it must also be hard connected to the equipment.
- 2) A positive connection between the restraint cable or strut and the support hanger rod (that can withstand both tensile and compressive loads) is required. This means that the trapeze bar must be locked in place on the hanger rod with nuts both above and below the trapeze bar. In addition, it means that all components that are between the connection point of the restraint and the connection point of the hanger must be positively interconnected.

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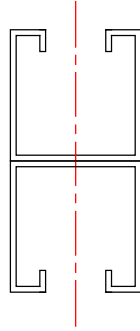
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When restraining large pieces of equipment, some caution should be exercised when selecting the trapeze bar to ensure that it has adequate capacity to transfer the horizontal load from the equipment to the restraint connections. This is particularly true when using some channel type strut arrangements which can be significantly stiffer in the vertical axis than they are in the horizontal (see illustration below.) These components are normally selected based on the deadweight load, but in some cases with current code requirements, horizontal loads may be 3 to 4 times higher. Because the range of applications for trapeze bars is limitless, details will not be addressed here, but should be reviewed by a competent design professional.



Section that is Stiff Vertically But Weak Horizontally

Equipment Connections to Trapeze Bars

When installing restraints on large units that use 3 or more trapeze bars for support, typically not all support points will require treatment. For those trapeze bars that are not laterally restrained, no special connection treatment is required. Where lateral restraint is provided at a location, motion between the equipment and the trapeze bar must be prevented.

This is normally accomplished with the use of hardware that is similar in size to that used to secure the restraint to the trapeze bar.

Connections should not be made to sheet metal or other non-structural materials in the equipment without the prior consent of the equipment manufacturer. It should not be assumed that these are designed to withstand seismic loads and as such, without confirmation that they are adequate, should be ignored when arranging restraints.

Cable and Strut Hardware Attachment Options for use on equipment with integral connection points

A typical equipment installation begins with suspending the equipment, and then returning later and adding restraints. While this eliminates the need to deal with restraints when

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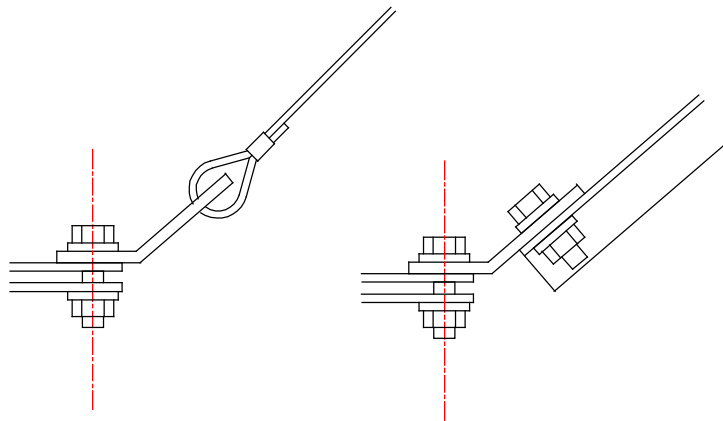
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actually hanging the equipment, it normally results in more time expended, and possible rework, during the restraint installation phase. Increasing the diameter of hanger rods for strut-restrained systems, relocation or duplication of supports for more accessible restraint installation, and dismantling and reassembling hanger components to make appropriate connections are the three primary examples of this.

While there is little that can be done from a hardware standpoint to deal with relocation issues, the proper selection of restraint hardware can reduce or eliminate the need to dismantle and reassemble previously installed supports.

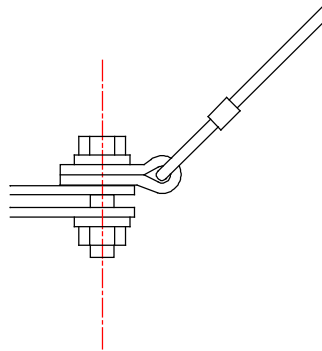
Cable/Strut Restraint Connection Hardware for Hanger Brackets

The CCA mounting clip can be used with either cables or struts, but for struts, the angle between the strut and the ground is limited to 45 degrees. See the sketches below.



Side-Mounted CCA Clip with Cable and Strut Connections

As an option to the CCA clip, a KSCU clip can be used for side-mounted cable restraint applications as shown below.



Side-Mounted KSUA Clips with Cable Connections

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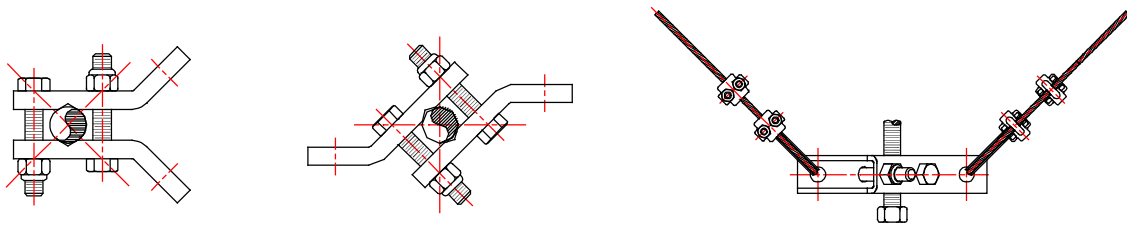


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The KSCA is the most versatile clip manufactured by Kinetics Noise Control. In applications involving connections to hanger rods, it offers the ability to directly connect to the hanger rod, offering a significant savings in installation time and cost. Shown here is both an "inline" arrangement for single axis restraint and a "V" arrangement where biaxial restraint is needed.

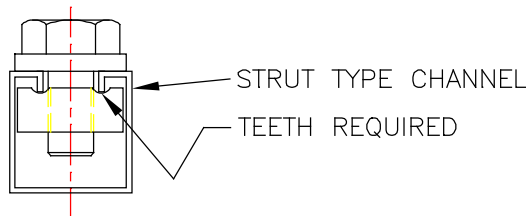


Hanger Rod-Mounted KSCA Cable Restraint Clip

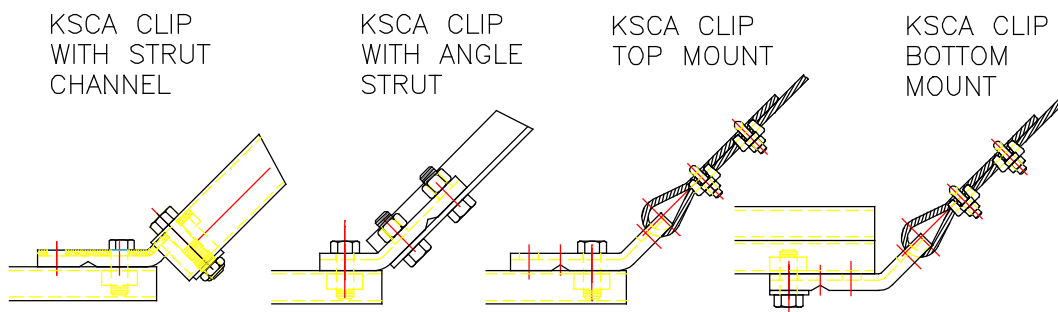
The KSCA is not suitable for extremely heavy-duty applications. This would encompass larger pieces of equipment in high seismic areas. However, it is appropriate for most applications. See the tables in Chapter D4 in this manual for sizing components.

Cable/Strut Restraint Connection Hardware for Trapeze Bars

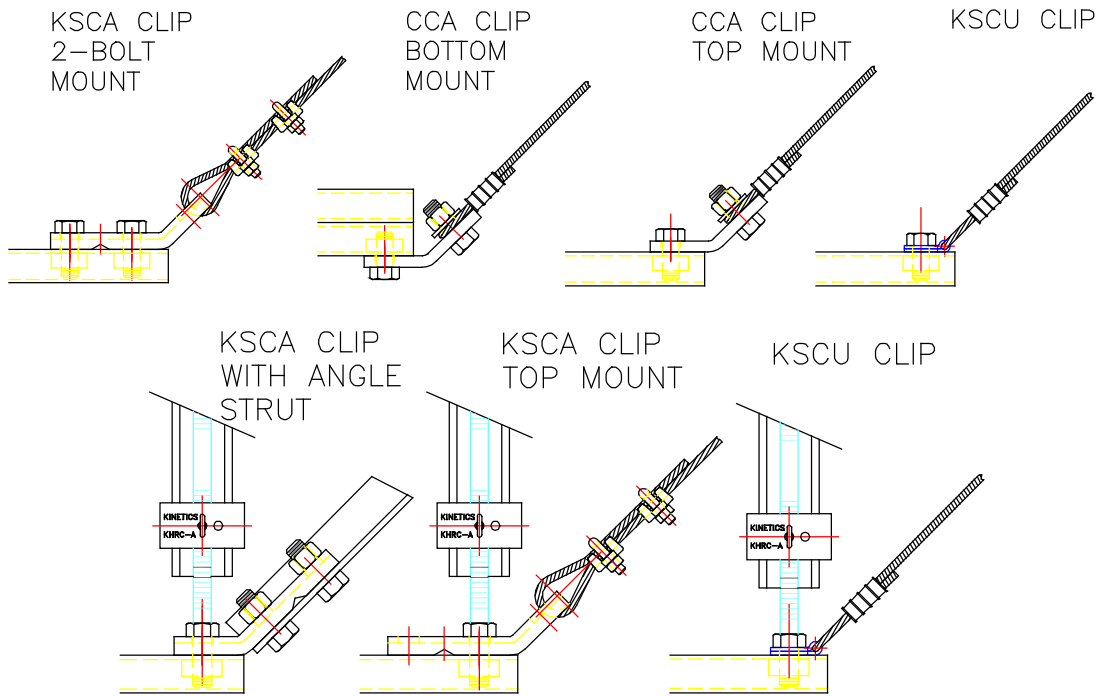
One of the most common materials for trapezoid support of equipment is formed strut-type channel (eg. Unitstrut). Connections to these materials, if using strut nuts, require the use of toothed nuts. Smooth nuts do not provide adequate resistance against friction and as such are not acceptable. All nuts must be tightened to their full-rated torque.



Shown below are various acceptable methods of mounting restraint hardware to struts.

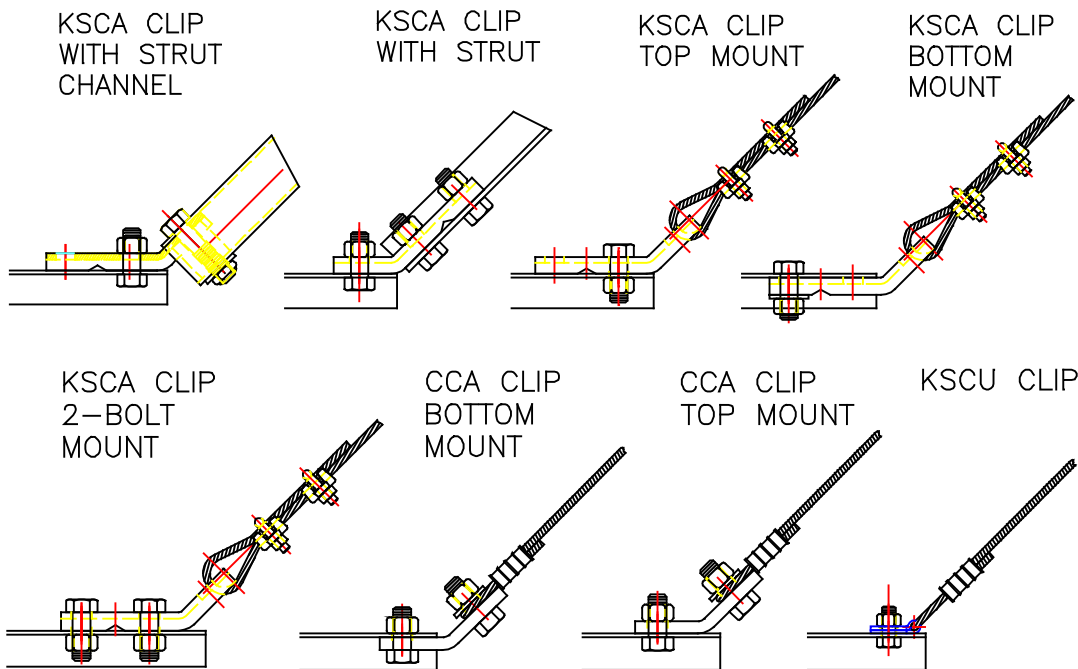


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Cable Restraint Bracket to Strut Trapeze Bar Connections (Typical)

Similar types of mounting arrangements can be used with trapeze bars made out of angle or other structural shapes as illustrated below.



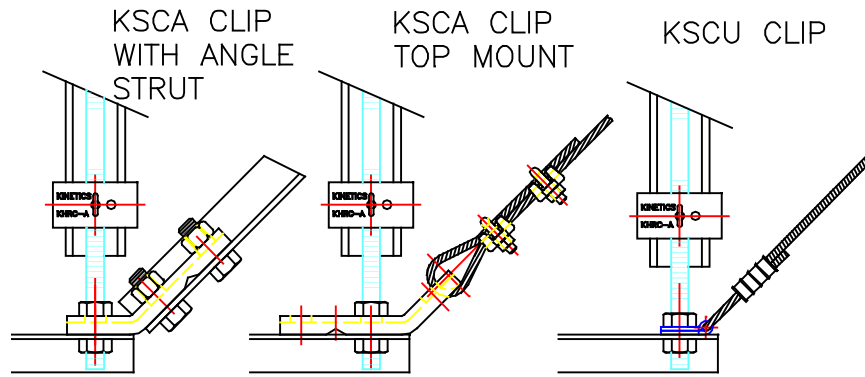
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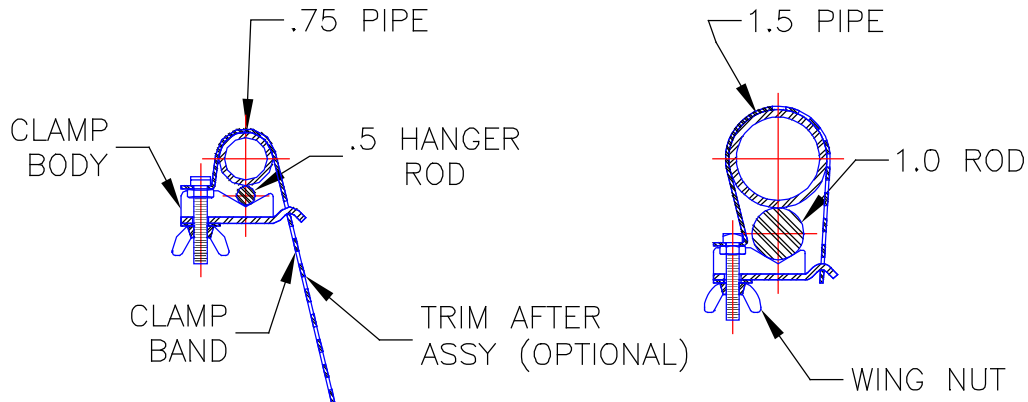


Cable Restraint Bracket to Structural Steel Trapeze Bar Connections (Typical)

Hanger Rod Stiffening Arrangements

In some cases, depending on hanger rod length and the applied seismic force, it may be necessary to protect the hanger rod from the buckling forces that can occur during a seismic event. Chapter D4 includes a section on determining the need for and sizing of the stiffener. When required, either a pipe or an angle can be used as a stiffener and must be clamped tightly to the hanger rod using rod clamps.

Kinetics Noise Control makes clamps for both pipe and angle stiffeners. These are designated the KSRC-P (for pipe) and KSRC-A (for angle). Both are adjustable and can be used over a wide range of hanger rod and stiffener sizes.



KSRC-P Hanger Rod Stiffener Clamp can be used to clamp Rods from .5" to 1.0" Diameter to Pipes from .75" to 1.5" Diameter

Both clamps feature two-part construction and "no tool required" installation. The KSRC-P is comprised of a flexible band punched with a number of slots that is fit to a clamp body with an integral seat for the hanger rod. Based on the size of the pipe stiffener and the hanger rod, the appropriate slot in the clamp band can be used for preliminary

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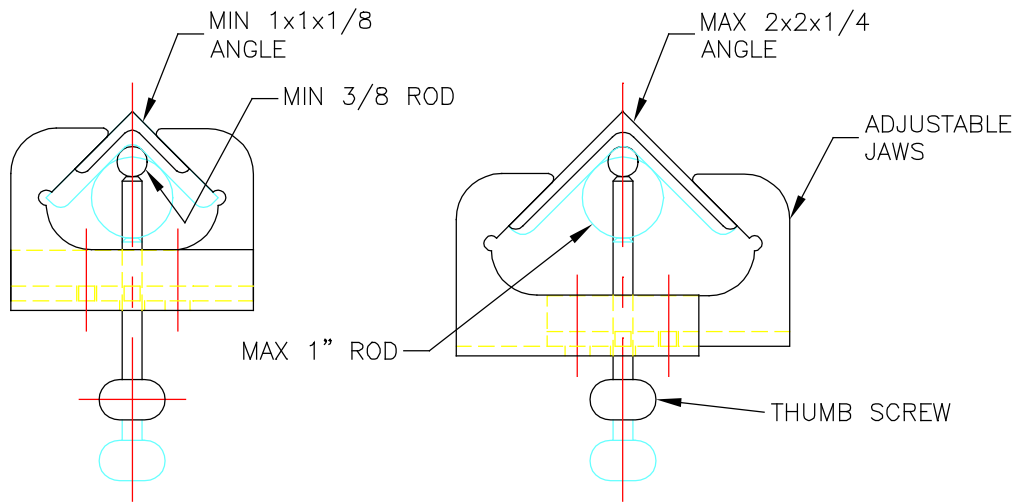


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adjustment, with final tightening by means of a wing nut.



KSRC-A Hanger Rod Stiffener Clamp can be used to clamp Rods from .5" to 1.0" Diameter to Angles with Leg lengths from 1 to 2 inches

Shown above is the KSRC-A Clamp. It is made up of two telescoping jaws and a thumbscrew. Preliminary adjustment is made by aligning the appropriate holes in the jaws for the thumb screw, and final tightening is made by tightening the screw.

For both of the above clamps the clamping screws are to be tightened so that they will not come loose in service through vibration. If significant vibration is expected, the use of Loctite or other thread binder is recommended.

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