

Ceiling-Supported Pipe Restraint Arrangements

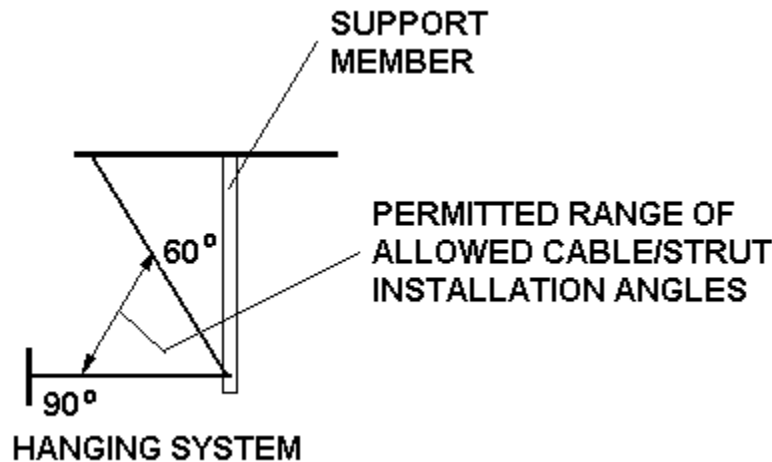
Although the basic principle of diagonal bracing is almost always used to design restraint systems, the actual arrangement of these systems can vary significantly. Despite what looks like substantially different designs, the design forces in the members remain the same, and the same rules apply when sizing components. Illustrated here are many different restraint arrangements, all of which can be used in conjunction with the design “rules” provided in this manual.

Details of the end connections and anchorage hardware are shown in subsequent sections of the manual. It is assumed in this manual that the restraint component is attached to a structural element capable of resisting the design seismic load.

Due to variations in the installation conditions such as structural clearance, locations of structural attachment points, and interference with other pieces of equipment or systems, there will likely be significant benefits to using different arrangements in different locations on the same job.

The only significant caution here is that it is not permissible to mix struts and cables on the same run.

This manual addresses diagonal bracing slopes of between horizontal and 60 degrees from the horizontal. Angles in excess of 60 degrees to the horizontal are not permitted.



When installing restraints, lateral restraints should be installed perpendicular (± 10 degrees) to the pipe in plan. Axial restraints should be in line with the pipe, ± 10 degrees, again in the plan view. All restraint cables should be aligned with each other. See the sketch below.

CEILING-SUPPORTED PIPE RESTRAINT ARRANGEMENTS

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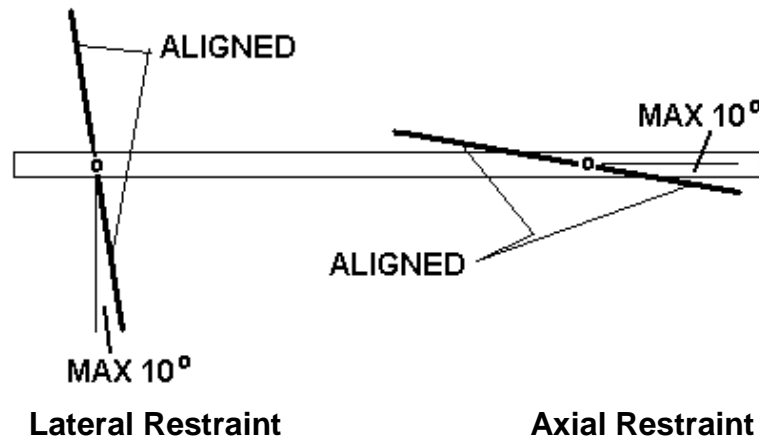
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Lateral Restraint

Axial Restraint

In general, when restraining piping the component actually being restrained is the support device for the pipe. This may be a pipe clevis, a heavy-duty pipe clamp, or a trapeze bar. Because the goal is to restrain the actual pipe, it is necessary that the restrained element be connected to the pipe in such a way as to transfer the appropriate forces between the two. For example, if an axial restraint is installed on a trapeze bar which in turn supports a pipe that is carried by a roller, it is obvious that the axial forces generated by the pipe cannot be restrained by the connection to the trapeze bar, and some other arrangement is needed.

When firmly connecting restraints to piping there are a few general rules that should be followed:

- 1) A pipe clevis cannot restrain a pipe in the axial direction.
- 2) If the pipe is wrapped with insulation and an axial restraint is needed, a riser clamp should be tightly clamped to the pipe prior to wrapping it with insulation and the restraint device should penetrate the insulation material.
- 3) If the pipe is wrapped with insulation and lateral restraint is needed, a hardened insulation material should be fitted at the restraint location.
- 4) Piping which expands and contracts significantly should include expansion joints or loops between each axially restrained component.
- 5) Trapeze-mounted piping should be tightly clamped to the trapeze bar.

In addition, when sizing restraint components for multiple pipes, the total weight of all of the restrained piping must be considered.

Hanging Systems Restrained with Cables

Hanging systems may include supports for single pipes or multiple pipes. Single pipes can be supported using clevis hangers but multiple pipes are normally supported on trapeze bars.

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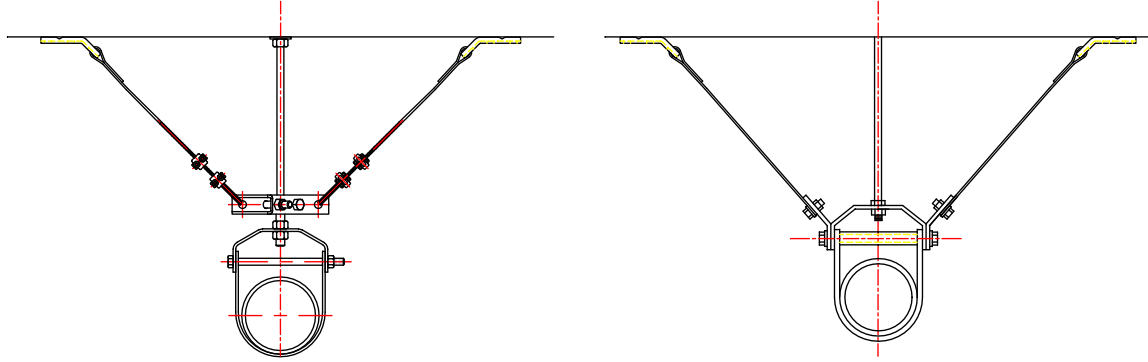
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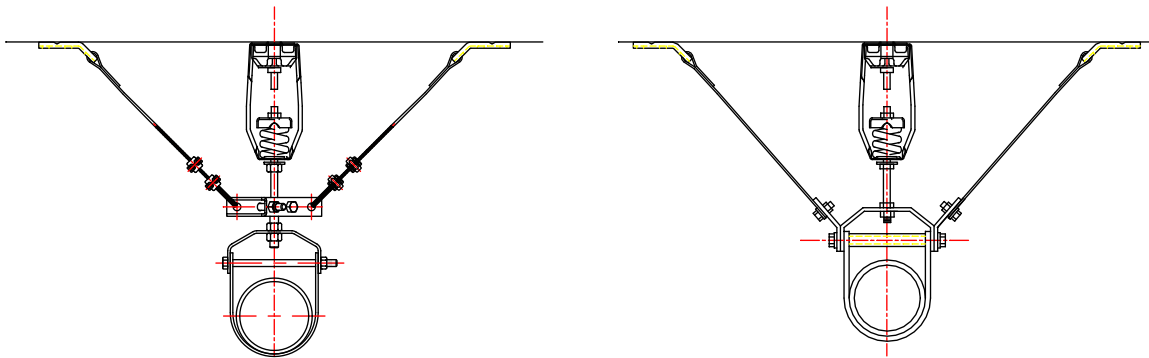


Lateral Restraint Examples

For a cable-restrained pipe supported by a hanger clevis, there are two options for non-isolated installations and two similar options for isolated installations. These options are shown below. Note that the isolator is mounted with minimal clearance to the structure and that a travel limiting washer is fitted to the hanger rod just below the isolator in the isolated arrangements.



Lateral Cable Restraints clamped to Hanger Rod and attached to Clevis Tie Bolt (Non-isolated)



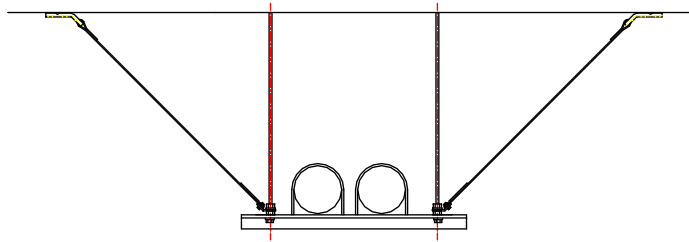
Lateral Cable Restraints clamped to Hanger Rod and attached to Clevis Tie Bolt (Isolated)

There are many options that exist for the arrangements of lateral restraints used in conjunction with trapeze-mounted systems. Shown below are several options for both non-isolated and isolated cable-restrained systems.

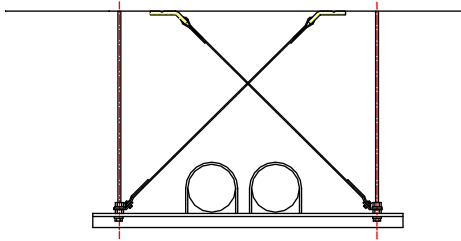
CEILING-SUPPORTED PIPE RESTRAINT ARRANGEMENTS



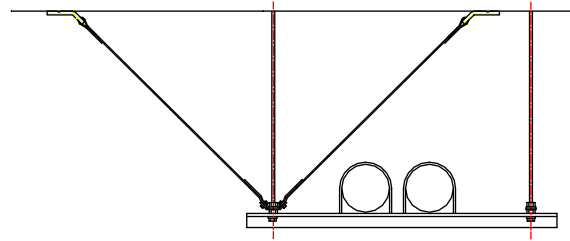
TRAPEZE _ / (TOP)



TRAPEZE X (TOP)

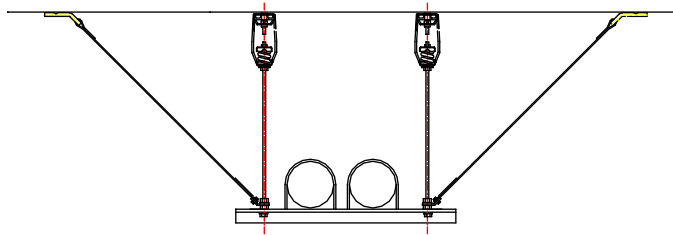


TRAPEZE V (TOP)

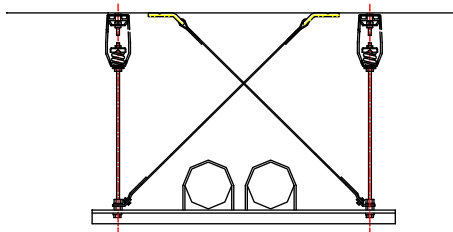


Lateral Cable Restraints Mounted to a Trapeze (Non-isolated)

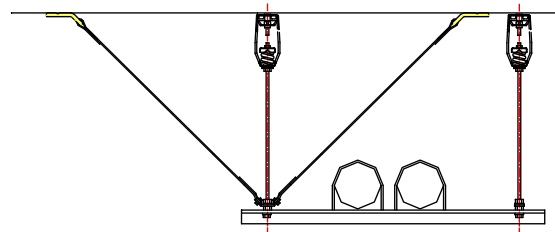
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TRAPEZE X (TOP)



TRAPEZE V (TOP)



Lateral Cable Restraints Mounted to a Trapeze (Isolated)

CEILING-SUPPORTED PIPE RESTRAINT ARRANGEMENTS

Axial Restraint Examples

Axial restraints cannot be connected to a standard pipe clevis and be expected to work. This is because there is inadequate friction between the clevis hanger and the pipe to transfer the forces in the pipe to the restraint. When axially restraining piping, a trapeze or riser clamp tightly attached to the pipe is the most common connecting device used, although a weld-on tab or connection to a flange is a possibility in some cases. Details on these connections will be addressed in later sections.

If the details of the connection are ignored at this point, general axial restraint arrangements recognized in this manual are illustrated below.

Note: Axial restraints offset from the restrained pipe will generate additional bending forces in the restrained pipe. This is true whether mounted to one end of a trapeze or along side a single pipe rather than directly over its center. Provisions should be made to avoid offsetting axial restraints when restraining a single pipe. This requires either that the restraint be attached to the centerline of the pipe, that the axial restraint be combined with a lateral restraint to form an "X" arrangement or that 2 axial restraints be fitted, one on either side of the pipe (See also the Figure below). (Note that when specifying and providing restraints, KNC assumes one of the 2 former arrangements are used, if the latter case is used, the installation contractor will have to procure and additional restraint set from KNC.) For trapezed systems supporting multiple pipes, a single axial restraint should be located at the approximate center of the trapeze bar or pairs of axial restraints should be installed on each end of the trapeze bar.



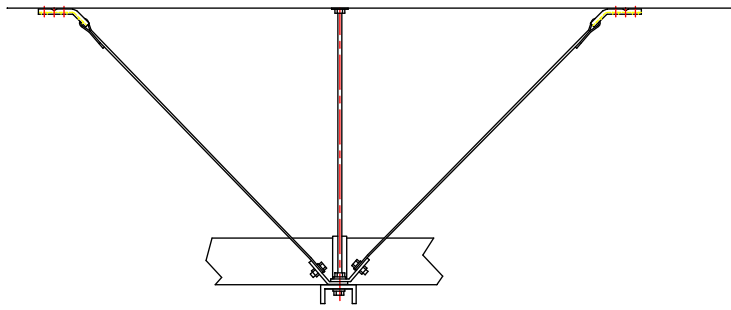
Various Acceptable Axial Restraint Arrangements

Hanging Systems Restrained with Struts

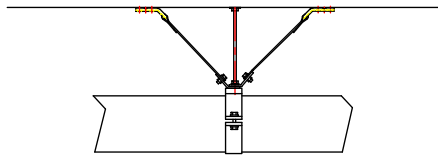
It is recommended that struts not be used to restrain isolated piping systems. Struts will generate hard connections between the piping and structure and will greatly reduce the efficiency of the isolation system. Having said that, in some special situations it may be possible to design restraint struts with integral isolation elements, but this is tedious and

CEILING-SUPPORTED PIPE RESTRAINT ARRANGEMENTS

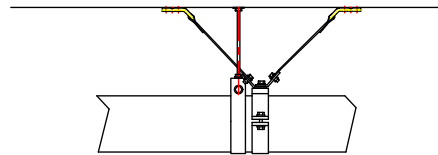
TRAPEZE



RISER CLAMP / SUPPORT

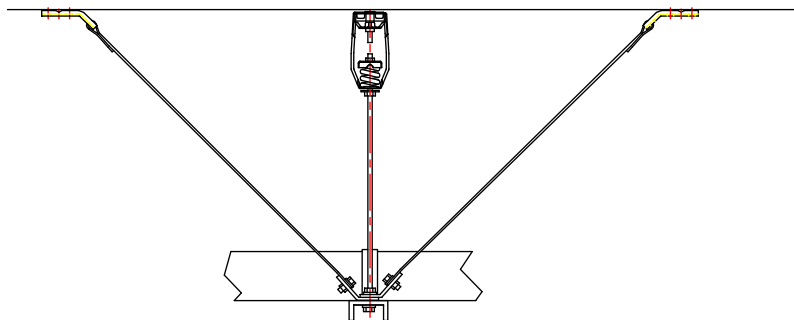


RISER CLAMP
ADJACENT TO SUPPORT

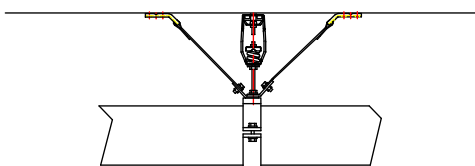


Axial Cable Restraints (Non-isolated)

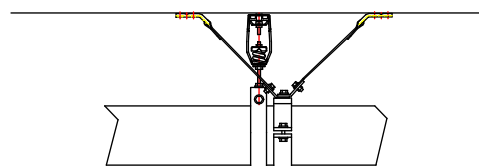
TRAPEZE



RISER CLAMP / SUPPORT



RISER CLAMP
ADJACENT TO SUPPORT



Axial Cable Restraints (Isolated)

CEILING-SUPPORTED PIPE RESTRAINT ARRANGEMENTS

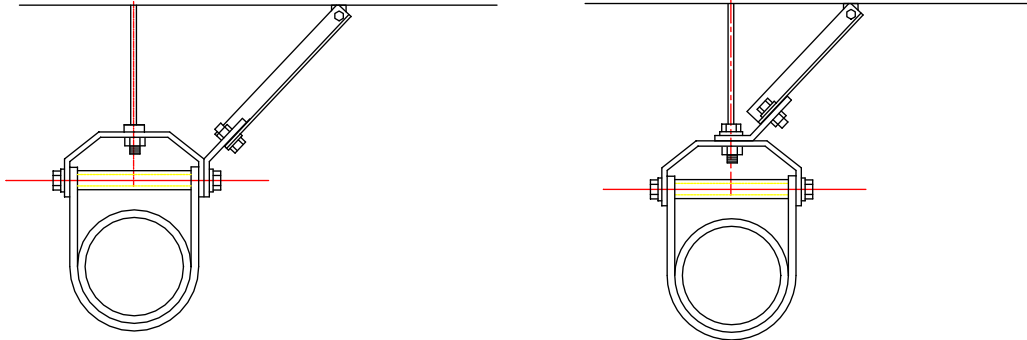


should be avoided unless drastic measures are required.

As with cable restraints, hanging systems may include supports for single pipes or multiple pipes. Single pipes can be supported using clevis hangers, but multiple pipes are normally supported on trapeze bars.

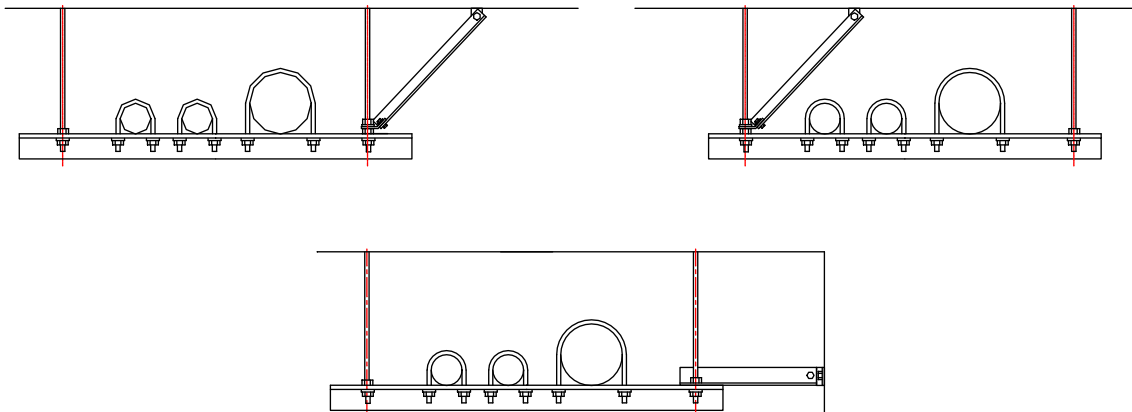
Lateral Restraint Examples

For a strut-restrained pipe supported by a hanger clevis there are two typical options. One is to connect the restraint to the clevis bolt and the other is to connect the restraint to the hanger rod. These are shown below.



Typical Lateral Restraint Strut Arrangements for Clevis-Supported Pipe

Shown below are 3 options for trapeze-supported piping. All are equivalent.



3 Arrangements for Laterally Restrained Trapezes with Struts

Axial Restraint Examples

As with cables, axial restraints using struts cannot be connected to a standard pipe clevis

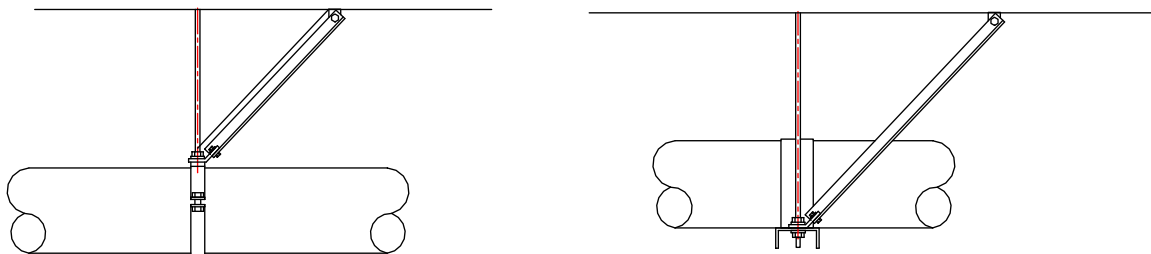
CEILING-SUPPORTED PIPE RESTRAINT ARRANGEMENTS

and be expected to work. When axially restraining piping, a trapeze or riser clamp tightly attached to the pipe is the most common connecting device between the restraint strut and the pipe, but occasionally a weld-on tab or connection to a flange can be used. Details on these connections will be addressed in later sections.

Ignoring the details of the connection at this point, common axial restraint arrangements recognized in this manual are illustrated below.

As with the cable restraints, it must be recognized that axial restraints offset from the restrained pipe will generate additional bending forces in the pipe. This is true whether mounted to one end of a trapeze or along side a single pipe rather than directly on its center. Provisions should be made to avoid offsetting axial restraints when restraining a single pipe. This requires either that the restraint be attached to the centerline of the pipe, that the axial restraint be combined with a lateral restraint to form an "X" arrangement or that 2 axial restraints be fitted, one on either side of the pipe. (Note that when specifying and providing restraints, KNC assumes one of the 2 former arrangements are used, if the latter case is used, the installation contractor will have to procure and additional restraint set from KNC.) For trapezed systems supporting multiple pipes, a single axial restraint should be located at the approximate center of the trapeze bar or pairs of axial restraints should be installed on each end of the trapeze bar.

Various Acceptable Axial Restraint Arrangements



Piping Axially Restrained with Struts

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