

Ceiling-Supported Electrical Distribution System 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.

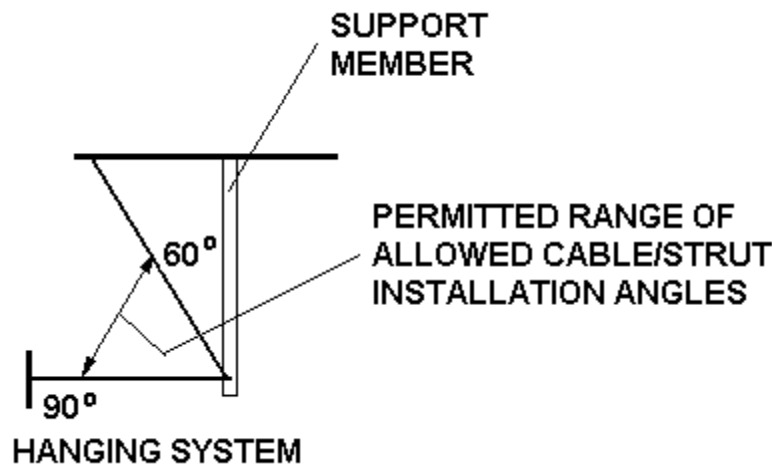
It is assumed in this section that all conduit is rigid. For non-rigid conduit and if the conduit is large enough to require restraint, adequate hardware to accomplish this task is required at each support location.

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.



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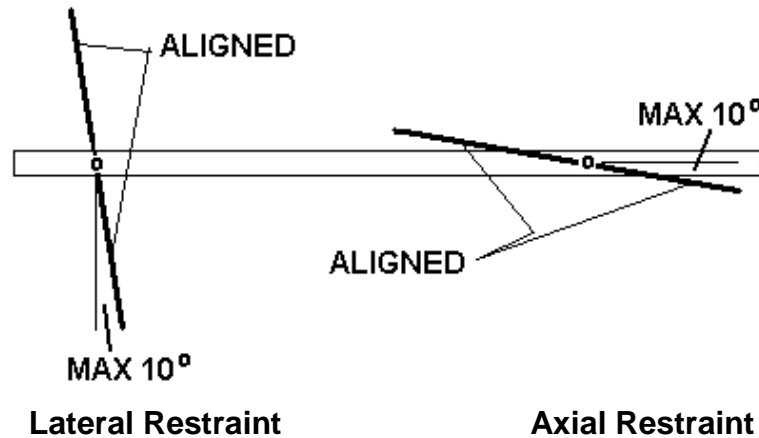
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When installing restraints, lateral restraints should be installed perpendicular (± 10 degrees) to the run in plan. Axial restraints should be in line with the run, ± 10 degrees, again in the plan view. All restraint cables should be aligned with each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



In general, when restraining electrical distribution systems and conduit the component actually being restrained is the system support device. This may be a clevis, a clamp, or a trapeze bar. Because the goal is to restrain the actual cable tray, duct or piece of conduit, it is necessary that the restrained element be connected 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 piece of conduit that is not clamped in place, it is obvious that the axial forces generated by the conduit cannot be restrained by the connection to the trapeze bar. Some other arrangement is needed.

When firmly connecting restraints to cable trays, ducts or conduit there are a few general rules that should be followed:

- 1) A conventional pipe or conduit clevis cannot restrain a piece of conduit in the axial direction.
- 2) Trapeze-mounted ducts, trays and conduit should be tightly connected to the trapeze bar.
- 3) If a tray or duct is used and it is mounted with the long dimension in the horizontal plane, the maximum spacing for restraints should be based on the allowable spacing for a pipe of a diameter equal to the tray's long axis dimension.
- 4) If a tray or duct is used and it is mounted with the short dimension in the horizontal plane, the maximum spacing for restraints should be based on the allowable spacing for a pipe of a diameter equal to the tray's short axis dimension.

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

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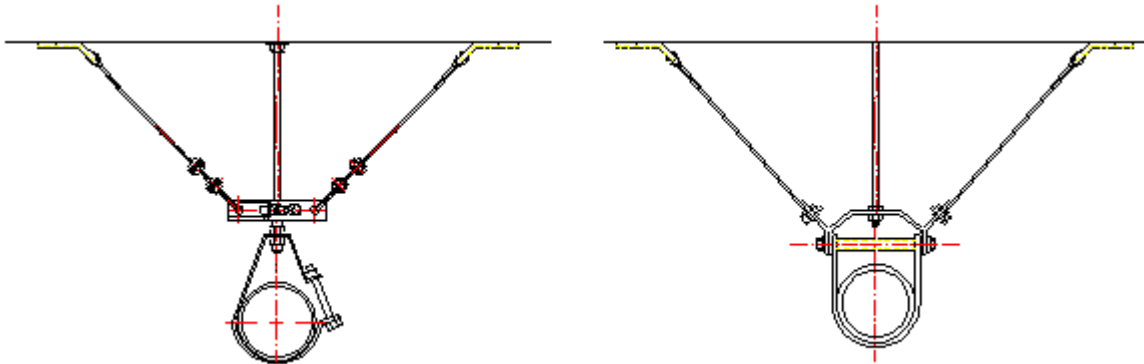


Hanging Systems Restrained with Cables

Hanging systems may include supports for single or multiple conduit runs, buss ducts or cable trays. Single conduit runs can be supported using clevis hangers but wherever multiple items are used, they are normally supported on trapeze bars.

Lateral Restraint Examples

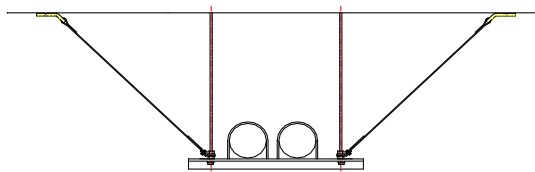
For a cable-restrained conduit supported by a hanger clevis, there are two options for non-isolated installations. Since the isolation of conduit is rare, it will not be addressed here, but would be similar to the isolated arrangements for piping and ductwork shown in the previous two chapters. These non-isolated options are shown below.



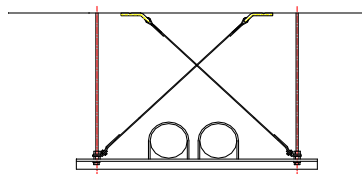
Lateral Cable Restraints clamped to Hanger Rod and attached to Clevis Tie Bolt

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 cable-restrained systems.

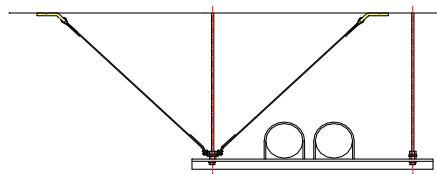
TRAPEZE \ / (TOP)



TRAPEZE X (TOP)



TRAPEZE V (TOP)



Lateral Cable Restraints Mounted to a Trapeze

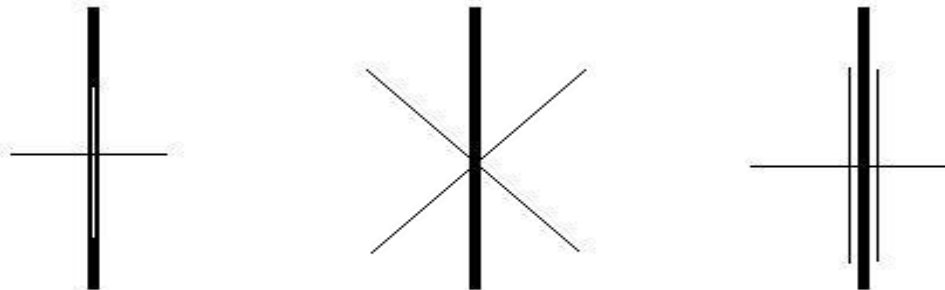
CEILING-SUPPORTED ELEC DIST SYSTEM RESTRAINT ARRANGEMENTS

Axial Restraint Examples

Axial restraints cannot be connected to a standard clevis and be expected to work. This is because there is inadequate friction between the bracket and the conduit to transfer the forces in the conduit to the restraint. When axially restraining conduit, a trapeze or conduit clamp tightly attached to the conduit is the most common connecting device used. 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 run of conduit, duct or cable tray will generate additional bending forces in the restrained system. This is true whether mounted to one end of a trapeze or along side a single duct or tray rather than directly over its center. Provisions should be made to avoid offsetting axial restraints when restraining a single conduit. This requires either that the restraint be attached to the centerline of the conduit, 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 conduit (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 components, 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.



CENTERED AXIAL
TRANSVERSE RESTRAINT

"X" AXIAL/TRANSVERSE
RESTRAINT

DOUBLED AXIAL
TRANSVERSE RESTRAINT

Various Acceptable Axial Restraint Arrangements

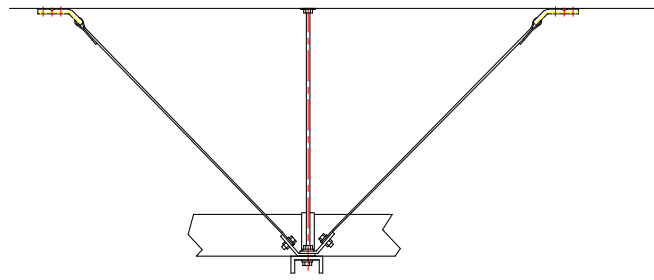
Hanging Systems Restrained with Struts

As with cable restraints, hanging systems may include supports for single pieces of conduit, multiple conduit runs or a mixture of cable trays, ducts and conduit. Single conduit arrangements can be supported using a clevis or conduit hanger, but multiple components are normally supported on trapeze bars.

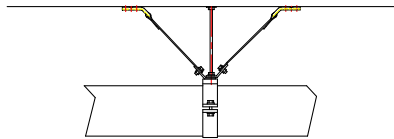
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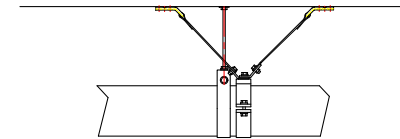
TRAPEZE



RISER CLAMP / SUPPORT



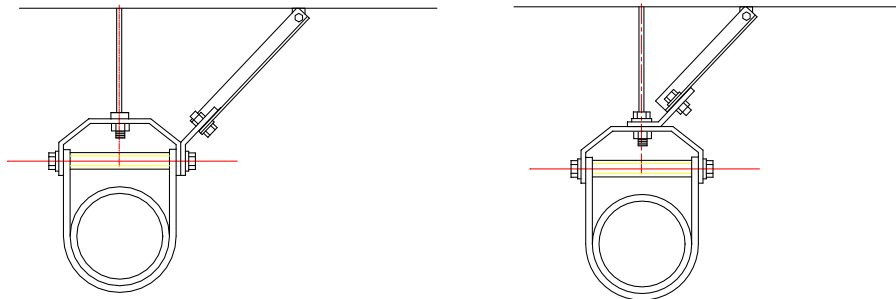
**RISER CLAMP
ADJACENT TO SUPPORT**



Axial Cable Restraints

Lateral Restraint Examples

For a strut-restrained conduit 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 Conduit

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

Axial Restraint Examples

As with cables, axial restraints using struts cannot be connected to a standard clevis and be expected to work. When axially restraining conduit, a trapeze or conduit clamp tightly attached to the conduit is the most common connecting device. It may however be

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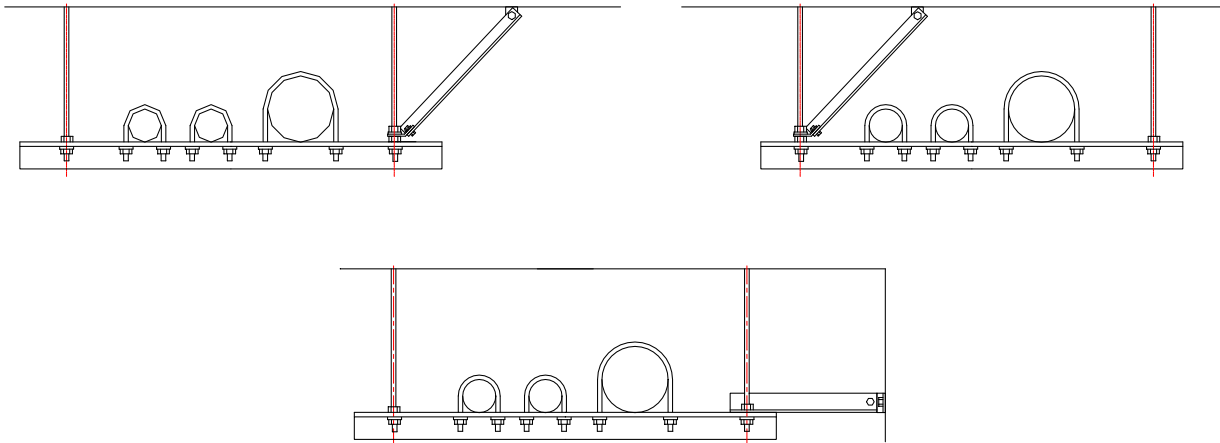


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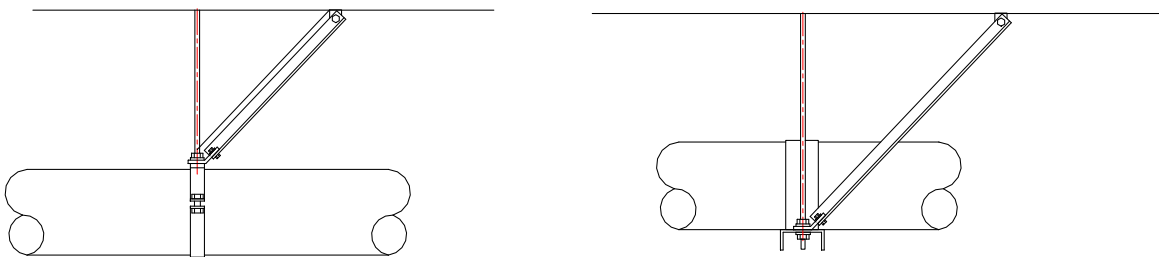
possible to attach the restraint to a connector fitting in some cases.



3 Arrangements for Laterally Restrained Trapezes with Struts

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 run will generate additional bending forces in the duct, tray or conduit itself. This is true whether mounted to one end of a trapeze or along side a single piece of conduit rather than directly on its center. Provisions should be made to avoid offsetting axial restraints when restraining a single conduit. This requires either that the restraint be attached to the centerline of the conduit, 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 conduit. (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 duct or tray installations, the maximum offset (from the centerline) cannot exceed the width dimension of the tray or duct. For trapezed systems supporting multiple components, 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.



Conduit Axially Restrained with Struts

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