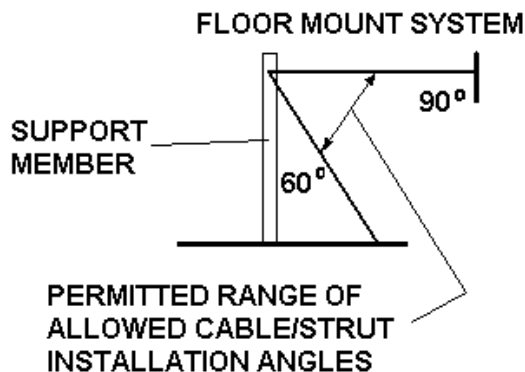


## Floor- or Roof-Supported Electrical System Restraints

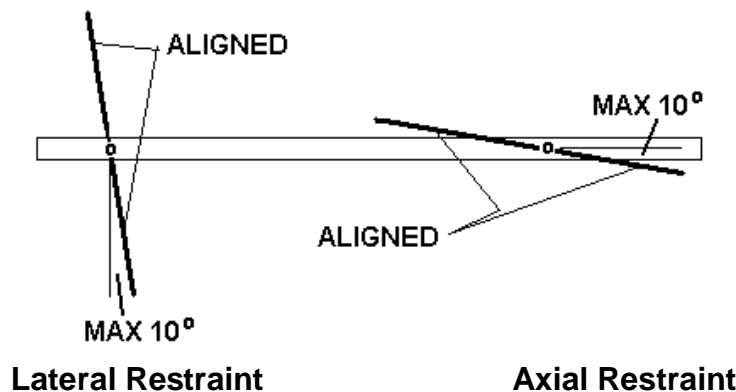
Although the basic principle of diagonal bracing is almost always used to design restraint systems, the actual arrangements of these systems can vary significantly. Despite what looks like substantially different designs, the design forces in the members remain the same, and the same rules apply when sizing components. Illustrated here are many different floor- and roof-mounted 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 this manual. It is assumed in this manual that the restraint component is attached to a structural element capable of resisting the design seismic load.

This manual addresses diagonal bracing oriented 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 ( $\pm 10$  degrees) to the conduit or tray in the plan view. Axial restraints should be in line with the conduit or tray ( $\pm 10$  degrees) again in the plan view. All restraint cables should be aligned with each other. See the sketch below.



### FLOOR- OR ROOF-SUPPORTED ELECTRICAL SYSTEM RESTRAINTS

PAGE 1 OF 5

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In general, when restraining conduit or trays, the component actually being restrained is the support device for the system. For floor-mounted equipment this would normally be either a fabricated frame or a trapeze bar. Because the goal is to restrain the actual conduit or tray, it is necessary that the restrained element be connected to the conduit or tray 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 conduit or tray that is not clamped tightly to it, it is obvious that the axial forces generated by the conduit or tray cannot be restrained by the connection to the trapeze bar and some other arrangement is needed.

With respect to firmly connecting restraints to conduit or tray, there are a few general rules that should be followed:

- 1) For Axial restraints, conduit clamps must be heavy duty and must be tightly clamped against the conduit itself.
- 2) If the pipe is wrapped or covered with a material that can reduce the clamps ability to grip it, the material must be removed or hardened to the point that positive clamping action can be assured.
- 3) Trapeze-mounted conduit or trays should be tightly clamped or bolted to the trapeze bar.

In addition, when sizing restraint components that affect multiple components, the total weight of all of the restrained componentry must be considered.

### **Floor- or Roof-mounted Systems Restrained with Cables**

Floor- or roof-mounted systems may include supports for single runs of conduit, multiple runs, cable trays or bus ducts. Typically, simple box frames are fabricated to support these, no matter what they are.

### **Lateral Restraint Examples**

For a cable-restrained support brackets there are four options normally encountered for non-isolated systems. As Electrical distribution systems are rarely isolated, for the purposes of this document, isolated systems will not be addressed. These options are shown below. The vertical legs of the support bracket must be sized to carry both the weight load of the supported pipes as well as the vertical component of the seismic forces. Refer to Chapter D4 for more detailed information as to how to size these members.

### **Axial Restraint Examples**

When axially restraining conduit, a trapeze or clamp tightly fitted to the conduit is the most common connecting device between the restraint strut and a single piece of conduit.

## **FLOOR- OR ROOF-SUPPORTED ELECTRICAL SYSTEM RESTRAINTS**

PAGE 2 OF 5

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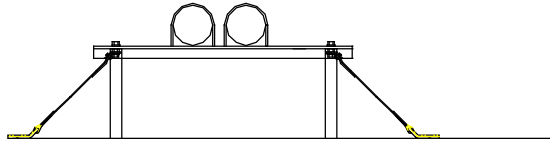
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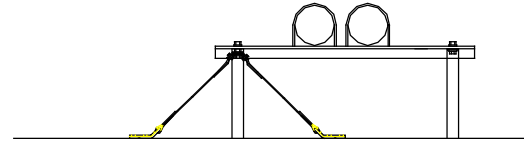


When connecting to a cable tray or bus duct, bolts or tray clamps are typically used. Details on these connections will be addressed in later sections.

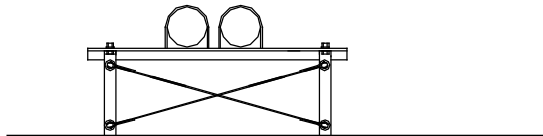
**OUTSIDE RESTRAINT**



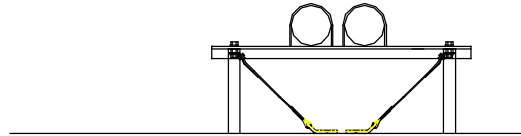
**SINGLE LEG RESTRAINT**



**X BRACED**



**INSIDE RESTRAINT**

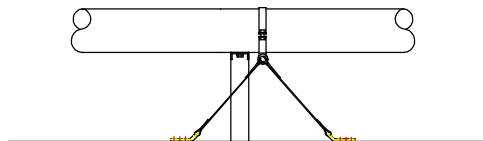


**Lateral Cable Restraints used in conjunction with floor-mounted distribution system support stands**

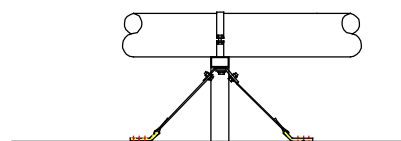
If the details of the connection are ignored at this point, general axial restraint arrangements recognized in this manual are illustrated below.

Note: Axial restraints offset from the restrained run 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 piece of conduit rather than directly under its center. When the restraint is offset, the maximum permissible offset from the center of the conduit, tray or duct is equal to its diameter or width. For trapezed systems supporting multiple runs, 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 or support frame.

**RESTRAINED PIPE**



**RESTRAINED SUPPORT**



**Axial Cable Restraints**

**FLOOR- OR ROOF-SUPPORTED ELECTRICAL SYSTEM RESTRAINTS**



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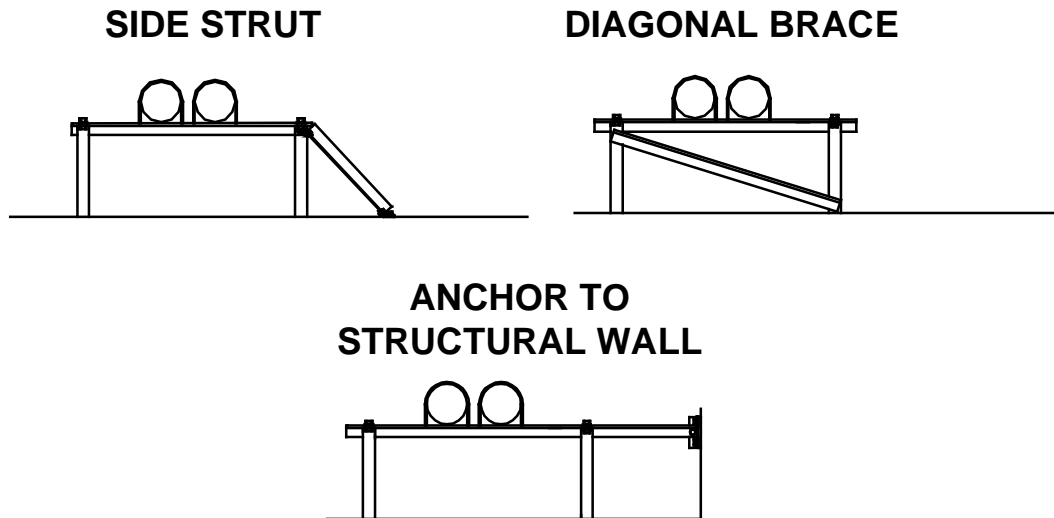


## Floor- or Roof-Mounted Systems Restrained with Struts

As with cable restraints, floor- or roof-mounted electrical distribution support systems will normally involve a box frame that supports the system (single or multiple runs) with some kind of a trapeze bar.

### Lateral Restraint Examples

With struts there are three typical configurations as shown below.



**Typical Lateral Restraint Strut Arrangements for Conduit**

### Axial Restraint Examples

When axially restraining conduit, a trapeze or clamp tightly fitted to the conduit is the most common connecting device between the restraint strut and a single piece of conduit. When connecting to a cable tray or bus duct, bolts or tray clamps are typically used. Details on these connections will be addressed in later sections.

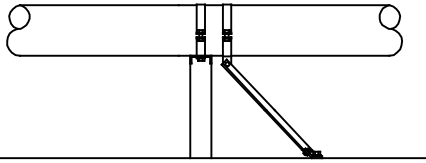
Ignoring the details of the connection at this point, common axial restraint arrangements recognized in this manual are illustrated below.

As with the cable restraints, it must be recognized that axial restraints offset from the restrained conduit, trays or ducts will generate additional bending forces in the component. This is true whether mounted to one end of a trapeze or along side a single piece of conduit rather than directly under its center. When the restraint is offset, the maximum permissible offset from the center of the conduit, tray or duct is equal to its diameter or width. For trapezed systems supporting multiple components, a single axial

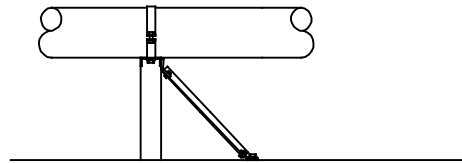
## FLOOR- OR ROOF-SUPPORTED ELECTRICAL SYSTEM RESTRAINTS

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 or support frame.

### RESTRAINED PIPE



### RESTRAINED SUPPORT



Piping Axially Restrained with Struts

## FLOOR- OR ROOF-SUPPORTED ELECTRICAL SYSTEM RESTRAINTS

PAGE 5 OF 5

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