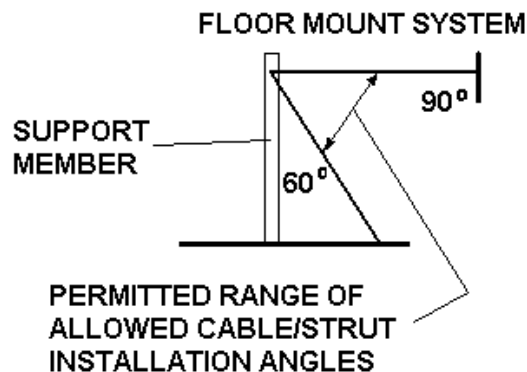


Floor- or Roof-Supported Duct Restraint Arrangements

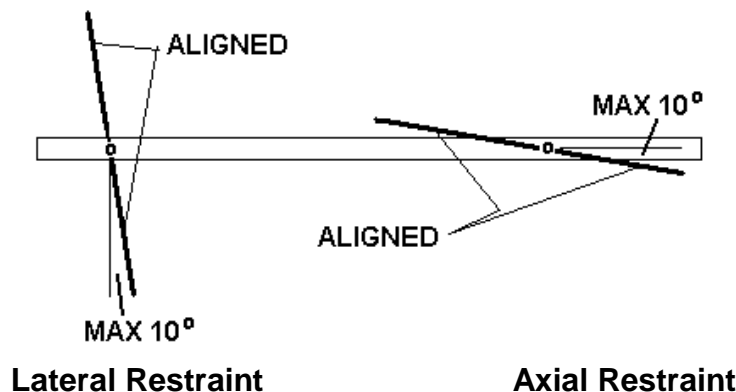
Although the basic principle of diagonal bracing is almost always used to design restraint systems, the actual arrangements of these systems can vary significantly. Despite what look like substantially different designs, the design forces in the members remain the same, and the same rules apply when 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 (± 10 degrees) to the duct in the plan view. Axial restraints should be in line with the duct (± 10 degrees) again in the plan view. All restraint cables should be aligned with each other. See the sketch below.



FLOOR- OR ROOF-SUPPORTED DUCT RESTRAINT ARRANGEMENTS

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In general, when restraining ductwork the component actually being restrained is the support device for the duct. For floor-mounted equipment this would normally be either a fabricated frame or a trapeze bar. Because the goal is to restrain the actual duct, it is necessary that the restrained element be connected to the duct in such a way as to transfer the appropriate forces between the two.

Based on the Maximum Horizontal Force requirement and Force Class from Section D4, the appropriate size and quantity of fasteners to connect ducts to support/restraint members is as follows:

Force Class	I	II	III	IV	V	VI
Force (Lbs)	250	500	1000	2000	5000	10000
#10 Screw	3	5	10	20		
¼ Screw			3	6	20	40

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

- 1) Attachment screws should be spread evenly either around or along the top and bottom of the duct.
- 2) To minimize wind noise, short screws with minimal projection into the air stream should be selected.
- 3) Trapeze-mounted ductwork must be fully encompassed by a frame or screwed to the trapeze at each lateral restraint point.
- 4) Axially restrained duct connections must be positive and require screws as indicated above.

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

Floor- or Roof-mounted Systems Restrained with Cables

Floor- or roof-mounted systems may include supports for single or multiple ducts. Typically, simple box frames are fabricated to support the ductwork, whether independent or in groups.

Lateral Restraint Examples

For a cable-restrained duct support bracket there are four options normally encountered for non-isolated systems and four similar arrangements for isolated systems. These options are shown below. The vertical legs of the support bracket must be sized to carry both the weight load of the supported ductwork 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.

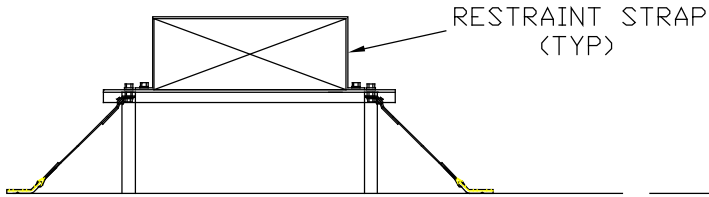
FLOOR- OR ROOF-SUPPORTED DUCT RESTRAINT ARRANGEMENTS



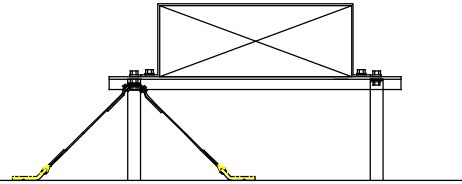
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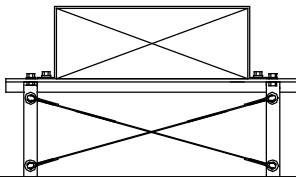
OUTSIDE RESTRAINT



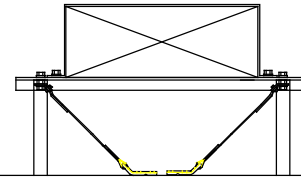
SINGLE LEG RESTRAINT



X-BRACED

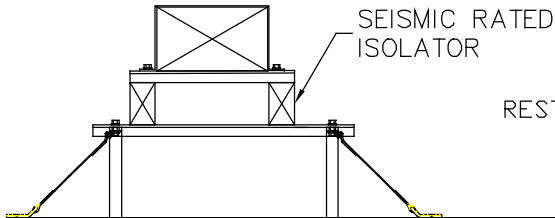


INSIDE RESTRAINTS

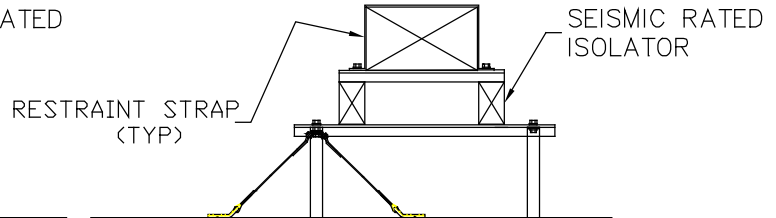


Lateral Cable Restraints used in conjunction with Floor-Mounted Duct Support Stands (Non-isolated)

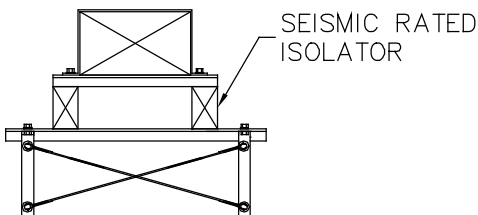
OUTSIDE RESTRAINT



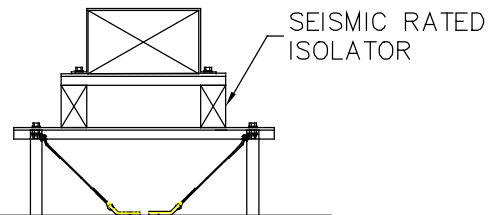
SINGLE LEG RESTRAINT



X-BRACED



INSIDE RESTRAINTS



Lateral Cable Restraints used in conjunction with Floor-Mounted Duct Support Stands (Isolated)

FLOOR- OR ROOF-SUPPORTED DUCT RESTRAINT ARRANGEMENTS

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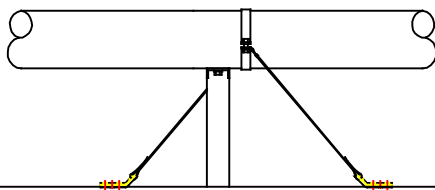
Axial Restraint Examples

When axially restraining ductwork, a perimeter metal strap or angle tightly screwed to the duct is the most common device used to retain the duct to the support bar. Occasionally welded tabs or connections to flanges are used. (Caution: Connections to flanges should only be used with the flange manufacturer's concurrence that the flange can withstand the seismic forces.) Details on these connections will be addressed in later sections.

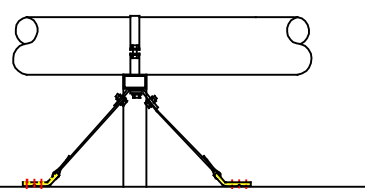
If the details of the connection are ignored at this point, general axial restraint arrangements recognized in this manual are illustrated below.

Axial restraints offset from the centerline of restrained ductwork will generate additional bending forces in the duct. Because of the nature of ducts, unless restraints are fitted on both sides, there will be an offset. As long as the restraint is immediately adjacent to the duct, it is permissible to use a single restraint point for axial restraint. For cases where multiple ducts are being supported on a common structure, the axial restraint should be between ducts in line with the approximate side-to-side center of gravity location.

**RESTRAINED
DUCT**

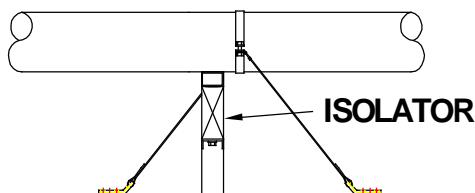


**RESTRAINED
SUPPORT**

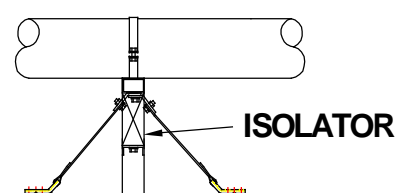


Axial Cable Restraints (Non-isolated)

**RESTRAINED
DUCT**



**RESTRAINED
SUPPORT**



Axial Cable Restraints (Isolated)

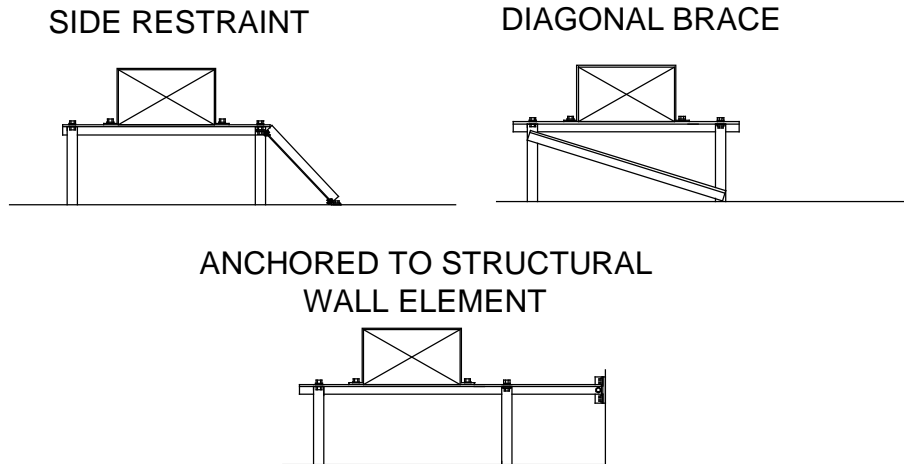
FLOOR- OR ROOF-SUPPORTED DUCT RESTRAINT ARRANGEMENTS

Floor- or Roof-Mounted Systems Restrained with Struts

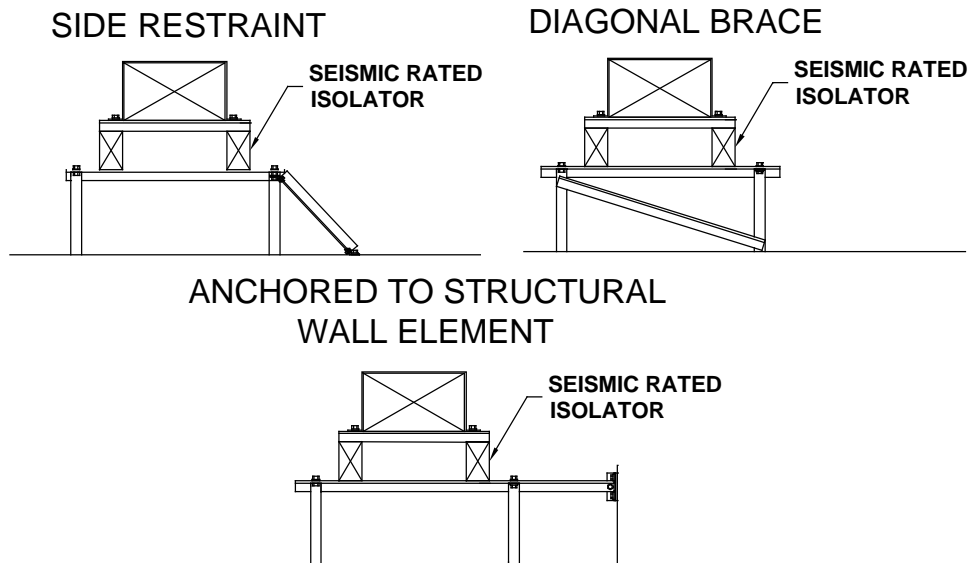
As with cable restraints, floor- or roof-mounted duct support systems will normally involve a box frame that supports the duct (single or multiple) with some kind of a trapeze bar. Restraint connections directly between an isolated duct and structure using a strut are not recommended.

Lateral Restraint Examples

With struts there are three typical configurations. As with the cable systems, these arrangements can be used with or without isolation as shown below.



Typical Lateral Restraint Strut Arrangements for Ductwork (Non-isolated)



Typical Lateral Restraint Strut Arrangements for Ductwork (Isolated)

FLOOR- OR ROOF-SUPPORTED DUCT RESTRAINT ARRANGEMENTS

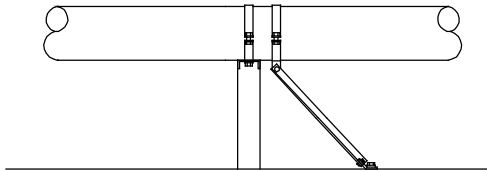
Axial Restraint Examples

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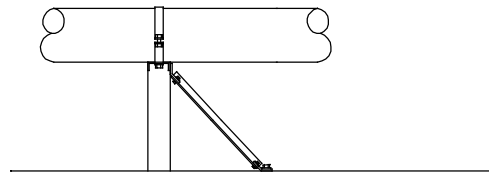
Ignoring the details of the connection at this point, common axial restraint arrangements recognized in this manual are illustrated below.

As with the cable restraints, axial restraints offset from the centerline of restrained ductwork will generate additional bending forces in the duct. Because of the nature of ducts, unless restraints are fitted on both sides, there will be an offset. As long as the restraint is immediately adjacent to the duct, it is permissible to use a single restraint point for axial restraint. For cases where multiple ducts are being supported on a common structure, the axial restraint should be between ducts in line with the approximate side-to-side center of gravity location.

RESTRAINED DUCT

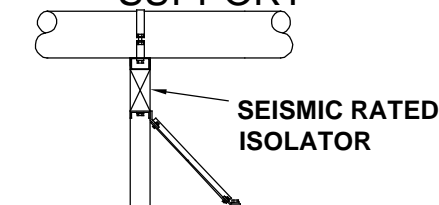


RESTRAINED SUPPORT



Ductwork Axially Restrained with Struts (Non-isolated)

RESTRAINED SUPPORT



Ductwork Axially Restrained with Struts (Isolated)

FLOOR- OR ROOF-SUPPORTED DUCT RESTRAINT ARRANGEMENTS

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