

## Connection Options for Awkward Situations

Almost every project will include some areas where installing restraints in a conventional fashion will be difficult. This segment of the manual offers options to consider when confronted with various situations.

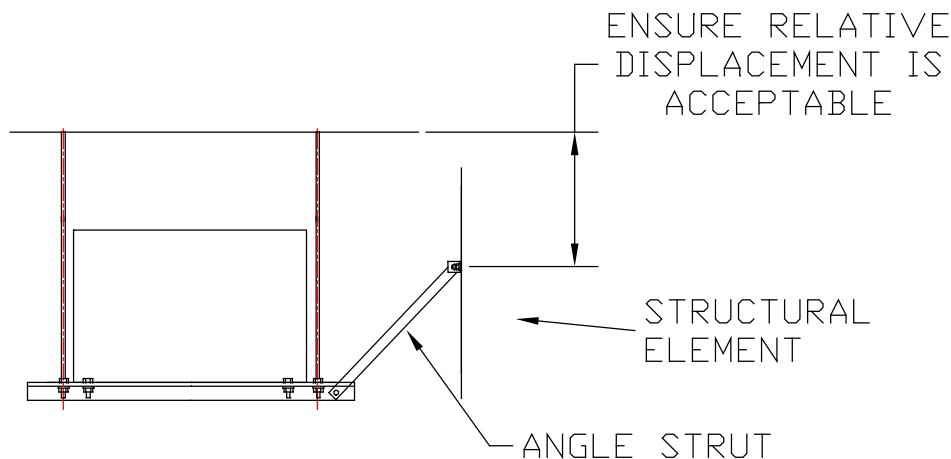
*Note: The options shown below illustrate equipment viewed on a single axis, Equivalent restraint is however needed on both principle axes.*

### Long, Narrow Spaces

Probably the most common issue in the field is how to deal with restraints in long, narrow spaces. Often in these kinds of spaces there is not enough room to angle restraints up to the ceiling structure. Frequently the walls are not structural and do not offer a surface to which to anchor.

When evaluating these kinds of spaces, the first issue is to determine if either of the walls bordering the space are structural. If they one or both are structural, they can offer a surface to which the restraints can often be attached. For structural walls, any relative displacement issues between the wall and the structure supporting the pipe must be identified. The maximum permitted relative displacement is  $\frac{1}{4}$  inch, which for most structures correspond to a difference in elevation of approximately 2 feet (see also the structural attachment section of this chapter).

Assuming the wall meets both of the above requirements, a lateral restraint can be run either directly over to the wall or up at a slight angle to the wall. Normally this would be done with a strut as shown below.



**Trapeze-Mounted Equipment Restrained to Structural Wall or Column with a Strut**

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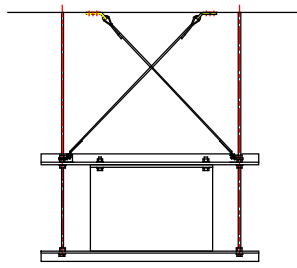
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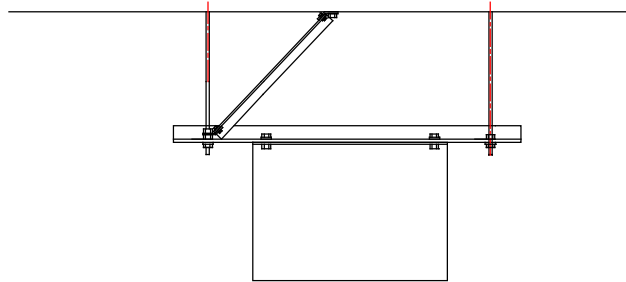


For the case where there are no nearby structural connection points or where the nearby structural elements are not suitable, there are several options that can be considered.

The first option is to restrain to the ceiling using “X” bracing or a diagonal strut.



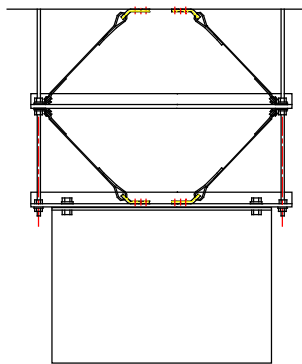
X-BRACED



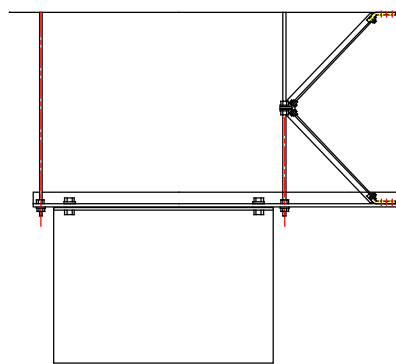
INTERNAL STRUT

**“X” or Diagonally Braced Restraint Arrangements**

A “K” or double “K” brace can also be used. The “K” can either be located inside the support rods or outside the support rods, but in the case of a double “K”, both sides must be identical (either inside or outside).



DOUBLE K-BRACE  
(INTERNAL)



SINGLE K-BRACE  
(EXTERNAL)

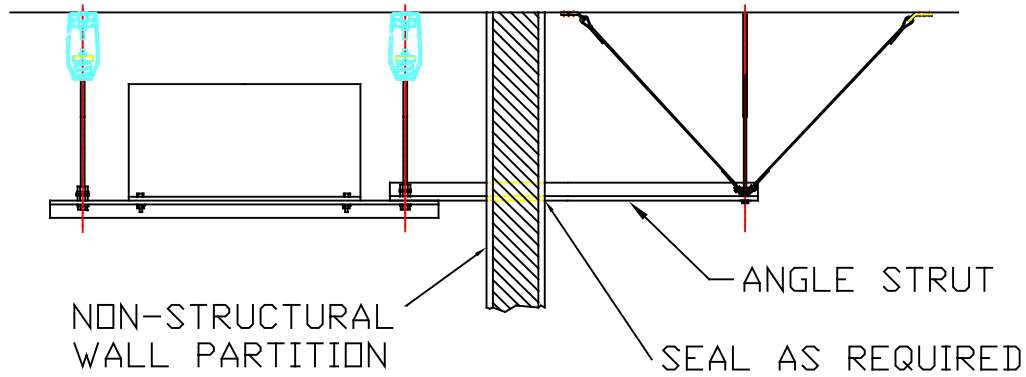
**Single and Double “K” Brace Restraint Arrangement**

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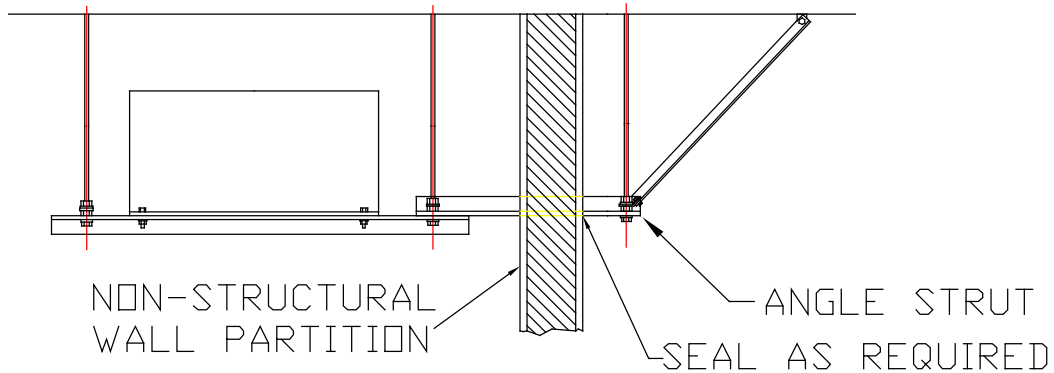


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**Wall Penetration Restraint (Cable)**



**Wall Penetration Restraint (Strut)**

Piggyback or Double-Tier Restraint

In congested areas, It may be possible to restrain a piece of equipment as well as an associated distribution system with one set of restraints. Care should be used in doing this to ensure that the the components restrained together have similar properties. For example:

- 1) Ductwork can be restrained with small AHU units or VAV boxes.
- 2) Pumps can be restrained with piping, valves or other piping components
- 3) Piping should not be restrained with AHU's
- 4) Ductwork should not be restrained with pumps.
- 5) Isolated systems must be restrained with other isolated systems
- 6) If piping or ductwork does not require restraint because of size or proximity to the ceiling, it cannot be connected to a piece of equipment that does.

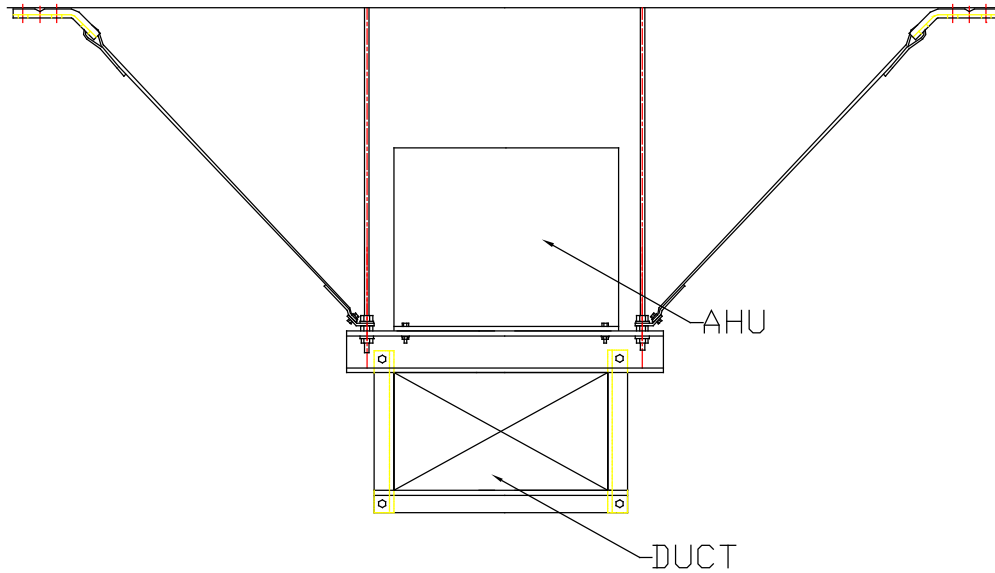
When selecting restraints, the restraints must be adequate in capacity to resist the total load generated by both the equipment and distribution system. These forces can be determined independently using the Force Class (D4) or other methods and then the results are simply added together to select components.

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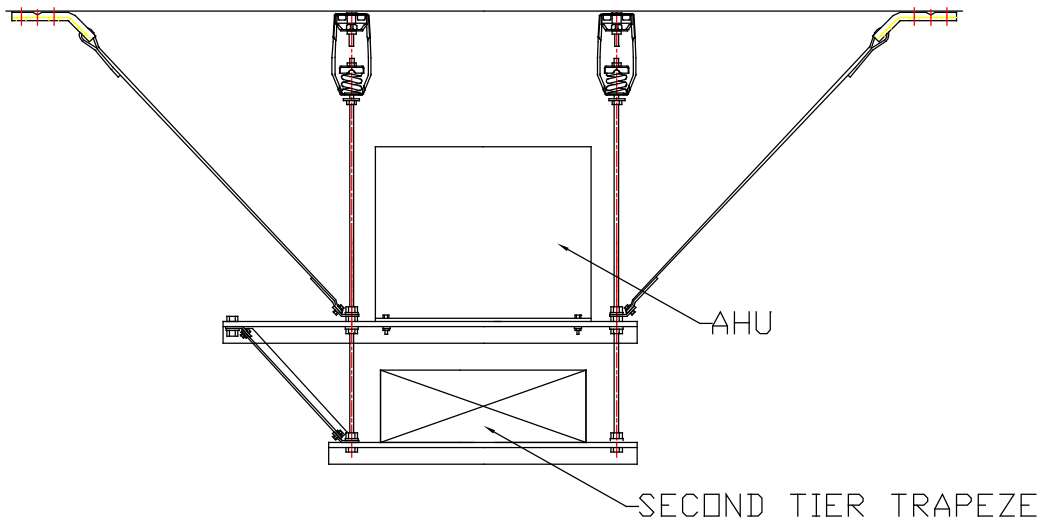
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### Piggyback Restraint Arrangement

It is possible under some conditions to brace one trapeze bar to the other, and then restrain the second trapeze bar to the structure. This is shown below:



### Double-Tier Restraint Arrangement

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## Restraints for Equipment Mounted Well Below the Support Structure

This situation is not easily handled. Past history has shown, and the code is quite clear, that it is not a good idea to support the equipment from one structural element and restrain it using another structural element that will undergo significantly different motions. Restraints fit in this fashion will likely fail or cause the equipment supports to fail. Neither of these outcomes is desirable.

About the only solution to this is to add a support structure for the equipment that is located either just above or just below the level of that equipment. The equipment can then be both attached and restrained to this structure.

The structure can be supported off the floor, off the ceiling, or from structural walls or columns. The support structure must be rigid enough to absorb all of the seismic loads, and particularly the moments, with minimal deformation, transferring pure shear or tensile forces into the supporting structure.

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