Vibration Isolation and Seismic Control
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VISCMA

Seismic Restraint of Flexible Piping Systems

Flexible or flexibly connected piping systems are those systems that have the ability to flex significantly when exposed to lateral forces such as those generated by a seismic event. These systems can also be pulled apart if subjected to a significant axial load. They are systems composed of piping that has little inherent stiffness of its own or may be composed of rigid sections of pipe that are connected together with components that allow significant flexing and possible slip at the connection points. Below are listed typical examples of systems that can be considered to be flexible piping systems:

PCV Plastic Pipe
CPVC Plastic Pipe
Rigid Pipe with No-Hub Connection
Rigid Pipe with Hub and Oakum Seal
Angle Tolerant Groove Pipe Connection

Because these types of piping systems will flex, swing excessively or pull apart between restraint points, there is an increased likelihood for self-generated damage to occur. The added swinging motion not only results in higher shock loads and corresponding forces, but also increases the likelihood of contact between the piping system and other components or structural elements that may be nearby.

There are three primary industry recognized references that address the restraint of these types of systems. The first is the ASHRAE "Practical Guide to Seismic Restraint" and the second is the "Cast Iron Soil Pipe and Fittings Handbook" published by the Cast Iron Soil Pipe Institute (CISPI). Lastly, ASCE 7 itself has minimum exemption size callouts based on the Seismic Risk Category.

In the IBC 2012 and earlier documents, there is an exemption granted for piping that is suspended on hanger rods that have an effective length of 12" or less (this is commonly referred to as "The 12" Rule"). This has been changed in the 2016 IBC and while a general exemption is still present, the permitted length varies with rod size, the importance factor and the supported weight.

Looking at rigid piping with flexible connections, CISPI recommends that all piping 2" and larger be restrained against seismic forces. They list a maximum lateral (Transverse) restraint spacing of 40' and a maximum axial (longitudinal) restraint spacing of 80' for horizontally oriented piping. It also indicates a maximum lateral spacing of guides every 30' for vertically oriented piping. Lastly, there is a requirement that when several short pieces of piping are lined up in a row (be they fittings or short lengths of pipe) that a stiffener sleeve is to be provided to hold them in alignment.

ASHRAE in the reference listed above recommends that the spacing between restraints be limited to a significantly lesser distance based on the design seismic coefficient. Also required where seismic conditions exist, are double hose clamps between each pipe end and the hose connector (four total clamps per connection).

The recommended values for the spacing of restraints per ASHRAE for rigid piping with no-hub connections as well as for piping made out of flexible materials is as follows:

Max Seismic Accel Input (G)	Max Lateral Restraint Spacing	Max Axial Restraint Spacing
.25	25 ft	40 ft
.50	20 ft	40 ft
1.0	20 ft	40 ft
2.0	10 ft	20 ft

VISCMA recommends that the more conservative ASHRAE standard be followed with the following caveat: Unless the flexible connection is wrapped with a shield or stiffener to prevent it from bending, straight runs of rigid piping with flexible connections (no hub) should also be restrained laterally at least once per rigid pipe segment span with lateral restraints placed at the approximate location of the joints.

Besides the restraint spacing issue, it should also be noted that while the response factor (Rp) for rigid (non-flexible) piping systems can be as high as 12.0 for high deformability materials when used in B31 rated applications and fitted with welded or brazed connections (typically steel or copper). This factor drops to 6.0 for B31 applications and to 4.5 for non-B31 applications when medium deformability materials are used and systems are joined with flexible connections and/or connections that require threading or grooving the piping itself. An added penalty is incurred for flexible mechanical or plumbing systems where the durability factor can drop to 3.0 or even 2.5.

It should be noted that the larger the Rp factor is, the more durable the piping is assumed to be. From a design standpoint, this means that there is a reduction in the load penalty associated with restraint component selection for more durable piping. This is accomplished by reducing the seismic force assumed to be applied during the design process. Thus if selecting components to restrain a brittle and/or flexible system there can be as much as a 4-5 times spread between the restraints needed for a durable rigid pipe versus that for a flexible or brittle one.

While not a flexibility issue, the 3.0 factor also applies to materials that are brittle or prone to failure if distorted. Materials that fall into this category are any piping made up of cast iron, glass or brittle plastic.

ASCE 7-12 indicates that plumbing (drain, waste and vent piping) has been separated out from other types of piping and given an Rp factor of 2.5 across the board. This is important as for any type of piping with an Rp factor less than 4.5, all of the size exemptions have been eliminated by that version of the code. This supersedes the input or guidance offered by other documents and means that unless exempted by the use of a short hanger rod length (12" max and fitted with free swinging connections) all of this piping must be restrained.

Most recently ASCE 7-16 has backtracked on the above. While it still indicates that plumbing (drain, waste and vent piping) is to be given an Rp factor of 2.5. The possibility of exempting piping with an Rp factor of 2.5 has been reinstated if it still qualifies based on other criteria.

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