Vibration Isolation and Seismic Control
Manufacturer's Association
994 Old Eagle School Road -- Suite 1019
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SEISMIC RESTRAINT OF HOT PIPING

Introduction

Hot piping, whether it is steam or domestic hot water, presents certain problems for the people laying out and installing seismic restraints. In particular, the piping grows in length as it heats up; the higher the temperature, the greater the growth in length. This paper will discuss the basics of dealing with seismic restraints for hot piping.

ASME Pressure Piping Systems

Most steam and high pressure hot water lines will fall under the category of ASME pressure piping systems. ASCE 7-05, 7-10 and 7-16[1] Section 13.6.8.1 has the following to say about ASME pressure piping.

> *Pressure piping systems, including their supports, designed and constructed in accordance with ASME B31 shall be deemed to meet the force, displacement, and other requirements of this section as long as the non-mandatory factors listed in ASME B31-9-2008 Appendix B are followed. In lieu of specific force and displacement requirements provided in ASME B31, the force and displacement requirements of Section 13.3 shall be used.*

What this means is that steam and high pressure hot water lines that are designed and constructed per ASME B31 will not require further seismic restraint for 2006, 2009, 2012 and 2015 IBC[2]. Proper design, documentation, and construction of steam and high pressure hot water lines will save a lot of expense and effort when considering seismic restraint.

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1 ASCE/SEI 7-05, 7-10, 7-16 Minimum Design Loads for Buildings and Other Structures; American Society of Civil Engineers, 1801 Alexander Bell Drive, Reston, Virginia,20191-4400

2 2006, 2009, 2012, 2015 International Building Code; International Code Council, Inc., 4051 West Flossmoor Road, Country Club Hills, Illinois 60478-5795

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Longitudinal Seismic Restraints

Since longitudinal seismic restraints are hard connected to the pipe, they will create anchor points for the hot piping run. For instance, shown in Figure 1 is a run of hot pipe with a single longitudinal restraint placed in the center of the run.

Notice that the pipe will expand equally on both sides of the longitudinal restraint such that one half of the growth, ***G***, will occur at each end of the run.

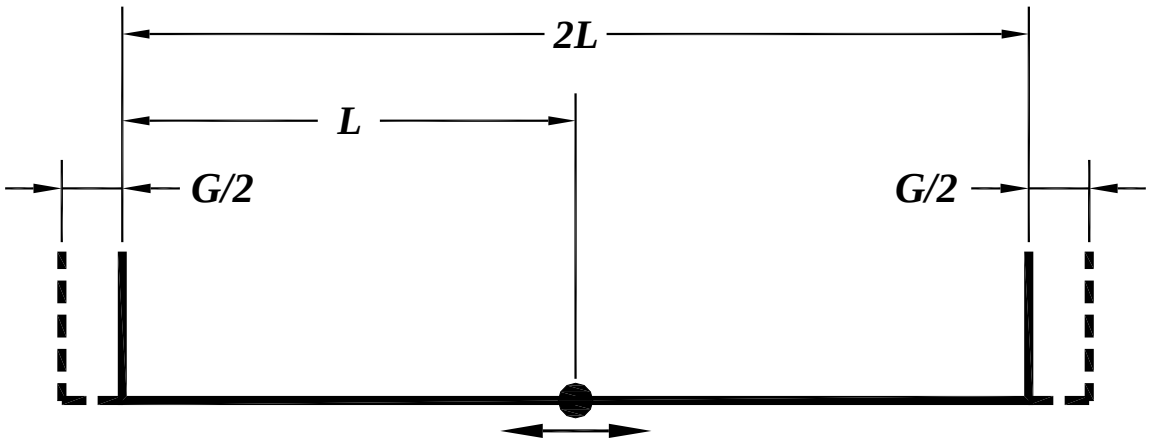

Figure 1. Hot Piping Run with One Longitudinal Restraint at the Middle of the Run

If however, the longitudinal seismic restraint is placed on one end of the run as shown in Figure 2, the expansion will effectively be on one side of the restraint, and all of the growth, ***G***, will occur on one end.

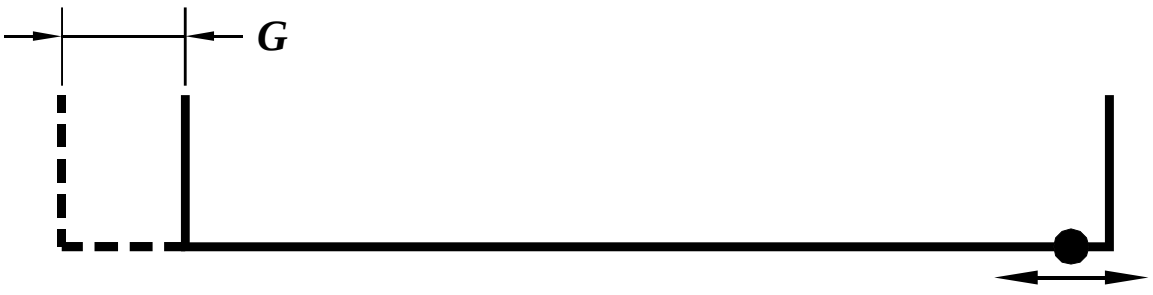

Figure 2. Hot Piping Run with One Longitudinal Restraint at the End of the Run

Either scheme is viable. Although, the piping designer must know which scheme is going to be used early on to take into account the growth in the pipe when computing the stresses in the pipe at bends and terminations.

Only one longitudinal restraint per run of hot piping may be used. This will prevent the expansion of the pipe from buckling the pipe or failing the seismic restraints and their attachments. If the run of pipe is too long for just one longitudinal restraint, an expansion compensation device must be placed between the longitudinal restraints.

In many cases domestic hot water piping will be designed and installed without regard to the expansion or contraction of the piping runs. The seismic restraint designer and/or installer should install one longitudinal restraint per run of domestic hot water in the middle of the run. This will cause the least amount of growth at each end, and the lowest stresses in the pipe at bends and terminations.

Transverse Seismic Restraints

Transverse seismic restraints, except if located with the longitudinal restraint, must be loosely attached to the pipe to allow the pipe to grow "through" them. This prevents undue stress from being placed on the restraint and its anchorage. This practice will also prevent the creation of additional anchor points along the run of pipe.

Care must be taken not to place a transverse restraint too close to a bend. The ASHRAE Handbook [3] has guidelines for computing the critical distance from the first restraint or guide to a bend. Figure 3 shows the transverse restraints at the critical distance, L_C, away from the bend.

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[3] 2016 ASHRAE Handbook – HVAC Systems and Equipment; American Society of Heating, Refrigeration, and Air-Conditioning Engineers, Inc.; 1791 Tullie Circle, N.E., Atlanta, Georgia 3029; Chapter 46 Pp 46.10-46.12

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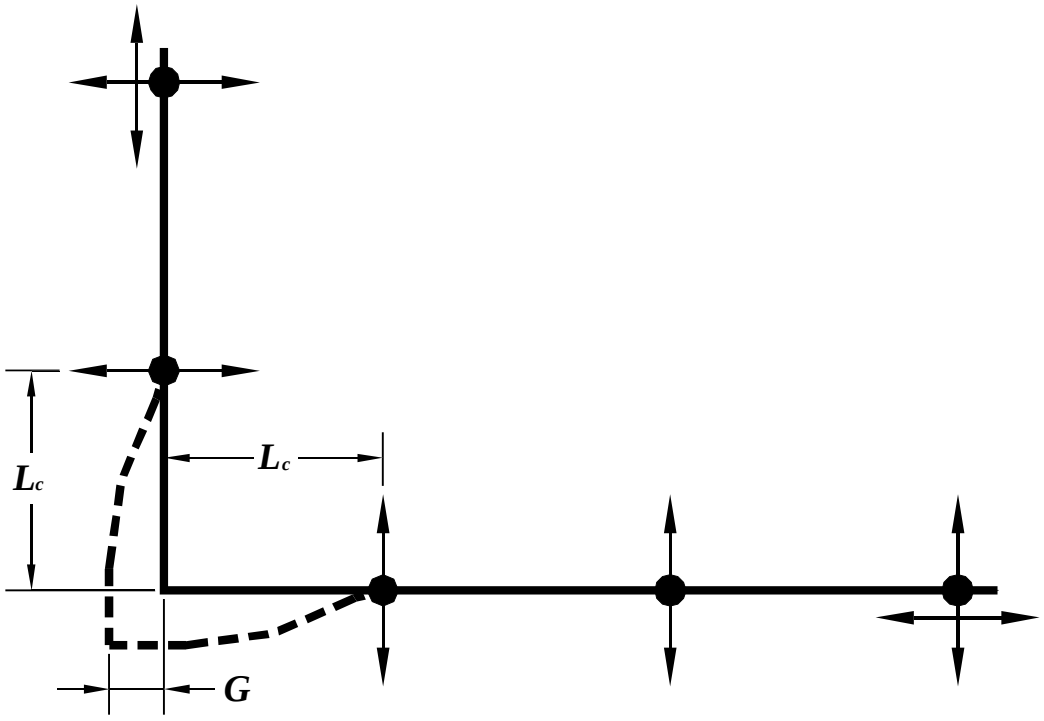

Figure 3. Critical Distance of Last Transverse Restraint from a Bend

The analytical techniques in the ASHRAE Handbook are based on limiting the bending stress in the pipe to an allowable elastic stress for each different pipe material. This is to prevent damage to the pipe as it expands. The analysis does take into account any internal pressure that exists in the pipe as well. These techniques may be applied to several different pipe sizes and materials. For temperature differences associated with domestic hot water and HVAC hot water supply reasonable estimates for the value of the critical distance from the bend to the first transverse restraint may be obtained using the analytical techniques established in the ASHRAE Handbook. The results of this analysis are shown below in Table 1, and may be applied to all types of pipe materials. For steam applications, and temperature differences greater than those specified for the analysis, a detailed analysis using the techniques in the ASHRAE Handbook should be performed.

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Table 1. Critical Distance from Corner to the First Transverse Restraint for Domestic Hot Water and HVAC Hot Water Supply – Distance from the Corner to the Longitudinal Restraint of Up to and Including 40 ft & Temperature Differences Up to and Including 80° F

Pipe/Tubing Size Range (in)	Critical Distance From Corner to First Transverse Restraint ***Lc*** (ft)
3/4 to 2-1/2	5
3 to 10	10
11 to 22	15

Trapeze Supported Pipe

Occasionally hot pipes are not single hung, but are supported on a trapeze bar with other pipes which may not be hot pipes. There can be only one longitudinal restraint for each run of hot pipe, and the pipe must be clamped to the trapeze bar at the longitudinal restraint location for the hot pipe. The other pipes may have more longitudinal restraints in the run than the hot pipe. At the other longitudinal restraint locations for the other pipes, the hot pipe must be loosely clamped to the trapeze bars to prevent the creation of another anchor. The hot pipes must be loosely clamped to the trapeze bars at the transverse restraint locations. Care must be taken at bends to ensure that the expanding hot pipes do not interfere with the other pipes that are being supported on the trapeze bars.

Summary

This covers the basics of creating restraint layouts for and installing seismic restraints for hot piping. Following are the items that must be considered when applying seismic restraints to hot pipe.

1. Pressure piping designed and constructed in accordance with ASME B31 does not require additional seismic restraint.

2. Use one longitudinal restraint for each run of hot pipe.
    a. If the run of pipe is too long to restrain with one longitudinal restraint, break the pipe up into two or more runs by using expansion compensation devices and use a longitudinal restraint for each run.
3. For domestic hot water, place the longitudinal restrain in the middle of the run so that the pipe expands equally on both sides of the longitudinal restraint.
4. Do not clamp the transverse restraints tightly to the pipe. The pipe must be able to grow "through" the transverse restraints. If the transverse restraints away from the longitudinal restraint are clamped to the pipe another anchor is created at each transverse restraint location.
5. The first transverse restraint from a bend must be at least at the specified critical distance from the bend to prevent damage to the pipe when the pipe expands.
6. For trapeze supported hot pipe;
    a. The hot pipe should be clamped to the trapeze bar only at the longitudinal restraint location for the hot pipe. For all other restraint locations, the hot pipe should be loosely clamped to the trapeze bars.
    b. Make sure the growth of the hot pipe does not interfere with the other pipes at bends.

VISCMA is a non-profit association representing the manufacturers of seismic restraint, vibration isolation and noise control equipment. The primary objectives of the organization are to educate the construction industry on the proper use and application of vibration isolation and seismic restraint and to develop standards to continually improve the industry.

In partnership with FEMA and ASCE, VISCMA also publishes three Seismic Installation and Inspection Manuals designed to assist field personnel.

The association office is located at 994 Old Eagle School Road, Suite 1019, Wayne, PA 19087-1866 and can be reached at 610-971-4850 or info@viscma.com.