When is a riser nipple too long or too weak to transfer seismic loads?

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When sway bracing is required, the goal is to keep the pipe(s) from swinging or moving freely relative to the building structure during the seismic event. This goal is accomplished by using one or a combination of sway braces, line restraints, U-hooks, and/or short hanger rods to prohibit the pipe from moving freely, except when differential movement between two independent structures is anticipated – then a seismic separation joint is used.

By providing sway bracing the pipes, joints, fittings, and sprinklers should all remain connected, intact, and ready to put out a fire after a seismic event.

One of the fundamental concepts of this approach is the assumption that the pipe(s) and connection(s) are strong enough to transfer their seismic forces to the sway brace. This concept is further reinforced by the zone of influence methodology used to determine the seismic force acting on it. The sway brace must be strong enough to resist the seismic force of all the pipe within the zone of influence.

The seismic force on a sway brace (Fpw) shall be determined as the seismic coefficient (Cp) multiplied by the water filled weight of pipe (Wp) shown as the formula Fpw = Cp * Wp } (in the NFPA sections 2013 §9.3.5.9.3, 2016 §9.3.5.9.3, 2019 §18.5.9.3 and 2022 §18.5.9.3)

In the case of a lateral sway brace on a cross main, the sway brace is required to restrain all seismic forces which are perpendicular to the cross main. In addition, the sway brace must also resist the seismic forces of the branchlines in a longitudinal direction. Using this example, the seismic force from the branchline(s) and the crossmain must be collectively transferred to the sway brace. For this to occur, all portions of the pipes, joints, or fittings must be strong enough not to break during the load transfer to the sway brace.

The NFPA standard ensures that all pipes are strong enough to transfer the seismic forces within the zone of influence to the sway brace by requiring that stresses on crossmains and riser nipples be checked. When completing the riser nipple evaluation, one must confirm that a riser nipple will not shear or break off due to the longitudinal seismic forces of the line as the force is transferred to the crossmain. This requirement originally appeared in the 2013 edition in §9.3.5.9.6.1, which required the evaluation of riser nipples for the potential to be over stressed. In the 2016, edition this section was revised to only require evaluation of riser nipples which exceeded certain length and force factors. The specifics of the revisions meant that only riser nipples greater than 4' in length and with Cp greater than 0.5 or greater than 3' in length, and a Cp greater than 0.67 or greater than 2' in length, and with a Cp greater than 1.0 need to be evaluated. In the 2019 edition these requirements were moved to §18.5.9.6.1. In the 2022 edition these requirements have been changed slightly and appear in §18.5.9.6.1. In all four editions of the standard, the core principle has remained the same: that a riser nipple shall be strong enough to transfer the longitudinal seismic forces of the line to the crossmain and ultimately to the sway brace. Since the riser nipple is the vertical supply which connects and transfers seismic load between the crossmain and the branchline, it should be measured between the crossmain top of pipe and the branchline bottom of pipe. Any groove-o-let on a main or line should be considered a portion of the riser nipple as it is a part of the vertical pipe which may have a coupling or two.

The standard provides a formula to check if the riser nipple will be overstressed by the seismic forces of the line to be transferred to the crossmain. The formula compares the seismic forces applied to a riser nipple and the structural properties of a riser nipple to the yield strength of the riser nipple pipe material. The seismic forces applied to the riser nipple cannot exceed the yield strength of the material.

From the 2022 edition 18.5.9.6.2 provides the formula:

$$\frac{(Hr * Wp * Cp)}{S} \leq Fy$$

Where:

- Hr = length of riser nipple piping in inches
- Wp = tributary weight in pounds for the branchline or portion of the branchline within the zone of influence including the riser nipple
- Cp = seismic coefficient
- S = sectional modulus of the riser nipple pipe
- Fy = allowable yield strength of 30,000 psi for steel, 30,000 psi for copper (soldered), and 8,000 psi for CPVC.

By using this formula, one can answer the title question. If the riser nipple stress is less than the yield, this confirms that the seismic load of the branchline will not exceed the capacity of the riser nipple to transfer the load to the crossmain and ultimately to the sway brace. Complying with the NFPA standard is one way to be confident that the sprinkler system will remain intact after a seismic event

Learn more about ASC Engineered Solutions seismic fire protection design and support solutions at asc-es.com.

John Deutsch

A recent addition to the ASC Engineered Solutions team.

Prior to joining ASC, he has worked as a sprinkler designer and design manager with over 30 years of experience.

He has also been a NFPA 13 Hanging and Bracing Technical Committee member since the 2010 edition.

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