WHEN AND HOW TO USE PIPING RESTRAINTS

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Piping restraints play an essential role in ensuring safe water and wastewater system operations. However, it's important to evaluate criteria such as local soil conditions, materials, existing infrastructure, deflection, seismic activity, and cost to determine the most appropriate restraint to use.

Restraining techniques ensure piping stays connected and help prevent costly repairs that can shut down a water or wastewater system. Mechanical-joint piping connections such as 45s, 90s, end caps, and hydrant connections are common points of restraint as well as connections within wells, wastewater lift stations and treatment plants.

Restraining inline piping has become so common that the practice is often a matter of standard procedure among city or project engineers. Instead of using restraints for specific applications, some engineers use restraints throughout entire systems. Adding restraints in this manner can be expensive and increase project costs significantly. It's worth examining what criteria should be followed for restraining pipe connections and which techniques to use within particular conditions and environments.

CRITERIA FOR RESTRAINING PIPE

Although engineers typically decide when and how to restrain pipes, utility managers can and should be part of the process. Once a piping system is completed, it's in their hands to ensure the system works properly and to make repairs, so it's essential to include their input. The first things to examine are the factors that may affect the chances of pipe movement and separation. Important criteria to consider include the nature of the piping system, ground movement, and other ground stresses.

The Nature of the Piping System. The first consideration is the design of the piping system itself. In a pressurized buried pipeline, such as a water main or wastewater force main, axial thrust forces act on the pipe based on changes in fluid velocity, pipe size, or pipeline direction. This generally happens at fittings such as plugs, caps, valves, tees, bends, or reducers. Such hot spots definitely need to be restrained.

Ground Movement. Earthquakes and ground movement can cause connection failure, beam or shear breaks, and cracks along the length of a pipe. A region's geographic phenomena can greatly determine how much the ground moves. Some regions regularly experience ground movement, whereas others are relatively stable.

With its location on the San Andreas Fault, California experiences dramatic earthquakes, causing the ground to move suddenly and with great force. It's no surprise that a high level of restraint is used on water and sewer pipes in many areas along the West Coast. Although other parts of the country located on major fault lines can incur less dramatic ground movement, such movement can still stress water and wastewater pipelines.

The New Madrid Fault Line is particularly noteworthy, as it can affect more than 15 million people in Alabama, Arkansas, Illinois, Indiana, Kentucky, Mississippi, Missouri, and Tennessee. The Ramapo Fault runs about 70 miles through New Jersey, New York, and Pennsylvania. Ground movement caused by this fault has stressed piping systems even without full-blown earthquakes. In addition, scientists have warned of earthquake risk from hydraulic fracturing operations.

Ground movement can also be caused by seasonal weather changes, especially during winter and spring. The ground freezes in the winter, and ice melts in the ground during the spring; both cause major ground shifts. Ground movement is also correlated to extreme weather changes.

Other Ground Stresses. Pipe also can be affected by the ground in a variety of other ways. The amount of ledge or rock in the ground can negatively affect piping. If a high level of ledge is in the ground, even slight movements caused by traffic or weather can cause piping to break. Conversely, swampy areas with ground that is moist and spongy moves easily and can also stress pipes. There's also a long list of other environments that lead to pipes uncoupling, including tidal areas, bridge crossings, and pipes running under water. For these circumstances, it's best to consult with engineers on how to evaluate the risks associated with a distribution system's environment.

TECHNIQUES FOR RESTRAINING PIPE

Several techniques are available to restrain pipes. Each method has distinct advantages and disadvantages with regard to cost, time, and labor.

Rodding. Until relatively recently, rodding was the most commonly used technique for restraining pipes. It's effective and used in underground and aboveground installations. Thrust >>>

rods are usually all-thread rods with washers and bolts that dog-ear into connections for restraint. Some installers even use rodding for flanged connections. The main drawback of rodding is cost, as material costs are high. The time to install these rods is also a concern.

Thrust Blocks. Thrust blocks are engineered concrete blocks placed at either end of a line of pipes or beside a joint to prevent pipes from pulling out. Whereas rodding strings pipes together so they stay connected, thrust blocks provide a solid mooring at the end or a bend in a pipeline to prevent movement. Although thrust blocks are typically made of concrete, it's not uncommon to find makeshift versions made from steel posts, pressure-treated wood posts, or bags of ready-made concrete.

The materials used to make thrust blocks are inexpensive, but it takes time to construct the blocks, pour the concrete, and wait for it to cure. The water supply must be turned off to ensure the concrete cures properly before connecting the pipe. Although money is saved on materials, additional costs are incurred in terms of the time it takes for the job to be completed. In addition, there isn't always enough space for thrust blocks—for example, where utility lines are in close proximity.

Another way concrete is used to restrain pipes is by pouring concrete on the connection itself. This can be effective, but repairing the connection in the future can be tricky. At minimum, a pipe must be surrounded by plastic before the concrete is poured on it. If the plastic cover isn't applied, the entire pipe and connection will need to be cut out and replaced when repairs are required.

Mechanical Restraint Devices and Sleeves. Mechanical restraints and sleeves involve connecting a sleeve using multiple lugs. Several mechanical products like this are on the market, and it's a great way to join pipe. However, it's a time-consuming process. The larger the mechanical restraint device, the more bolts there are to tighten. The technique is particularly effective for large-diameter pipes that need significant reinforcement to stay connected.

The biggest drawback to mechanical restraint and sleeves is their high cost—mostly due to labor. The material cost of the lugs is also substantial. In addition, when using a product with lugs, the gripping mechanism creates stress points on the pipe. It can also take crews a long time to connect the lugs to the sleeves and ensure the lugs are tightened properly.

Coupling Restraints. Coupling-restraint products are relatively new to the market. These couplings use a mechanism to grip the pipes to restrain them. The products have been shown to be effective with relatively low cost compared to the above techniques, as the restraining technology is within the coupling itself.

Offered in a wide range of diameters, coupling restraints can be used on all metal and plastic pipes in situations where utility lines either cross or run parallel to water and wastewater pipes. Such close pipe-to-pipe proximity makes it difficult—if not impossible—to install thrust blocks and rodding. As with all new techniques, restraint-grip products have faced some skepticism from installers who are more familiar with techniques such as rodding or thrust blocks.

Some restraints also offer continuous dynamic deflection, meaning the pipe can flex within the coupling to maintain a strong connection while preventing pipe pullout. This feature can substantially help reduce future breaks, considering ground movement is a key cause for pipes pulling out. In one solution, a chain of gripping teeth applies counter-pressure that actually prevents the pipe's axial motion, thus restraining the pipe. In addition, a specially-designed hydraulic gasket self-inflates using existing water pressure – as water pressure rises in the pipe, water enters the gasket that self-inflates and allows for dynamic deflection of the pipes while maintaining a perfect seal.

TO RESTRAIN OR NOT TO RESTRAIN?

Some circumstances definitely require pipes to be restrained. These include wastewater lift stations, wells, piping in water and wastewater treatment plants, and industrial applications that involve hydrants and valves. In all of these situations, water flow can fluctuate and involve stresses associated with daily use.

The question of whether to restrain doesn't always have an obvious answer. Restraining pipes makes your system stronger, but if the risk is relatively small, it might not be worth restraining the pipe. Cost is always a consideration whenever making restraint decisions for your system. It's worth trying to evaluate the areas of your system that need to be restrained and which restraint technique will be most appropriate.

Thus, the question of whether to restrain piping should be considered carefully, according to the needs of each circumstance. By looking at all factors, including cost, engineers and system operators can determine the needs and benefits of each solution before deciding what kind of restraint is optimal for any given situation.

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