INTERNATIONAL MOLYBDENUM ASSOCIATION
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Stainless steel stops leaks

Repair sleeves are found in the tool box of virtually every water utility. They allow quick repair of leaking water pipes without replacing them. Often fabricated from molybdenum-grade Type 316 stainless steel, they reduce water wastage and are yet another way that molybdenum helps sustain Earth's resources.

In 97 CE, Emperor Nerva Augustus appointed Sextus Julius Frontinus *curator acquarum* (water commissioner) of the city of Rome. The city was founded over 800 years before, and by then had a highly-refined water system. Nine aqueducts carried water to the city from the Tiber River and other sources, and wells within the city supplied additional water. Archaeologists estimate these sources delivered between 500,000 and 1 million cubic meters of water each day. A system of clay tile, lead pipes, and free-flow channels interconnected with tanks, basins, and reservoirs, distributed water to the city which at its height reached over 1 million people. As a comparison, Tokyo's water authority today serves some 12.5 million people delivering just over 4 million cubic meters per day.

According to his treatise *De aquaeductu urbis Romae*, Frontinus was concerned with a potential shortage of water for a variety of reasons. They included periods of drought, city growth, the demands of Rome's many fountains and baths, leaky old pipes and, most importantly, the loss of taxes by theft. The problems of water loss and potential shortages remain the same today as Rome is facing a drought and reportedly is losing 44% of its water to leakage and theft. Of course these issues concern not only this ancient city but municipalities around the world.

Water loss in municipal distribution systems

The American Water Works Association (AWWA) sets a standard for leakage in new pipes, which applies at the time of installation and testing. The allowable leakage is based on the pipe diameter and length, the number of joints, and the water pressure. As time passes, the ground moves, pipes deflect and corrode, and gaskets deteriorate, all of which increase leakage. Many municipalities have programs to manage pipe leakage and replacement. Pipes are typically considered for replacement after 30 to 50 years of service. However, the best management plans can be turned upside-down by Mother Nature. While pipes with low corrosion rates in stable soil have been known to last more than 100 years with little or no leakage, pipes in less stable conditions might need replacement after only 25 years of service.

Older systems are typically plagued with higher water losses. For example, Washington, DC, which has a 100-year-old water system, loses some 35% of its water on the way to customers. Meanwhile, its neighbor to the south, the growing and affluent Fairfax County, loses less than 3% of its water because the pipes are quite new and the county has the resources to support a strong maintenance program.

United States municipal water systems are estimated to have about 1.6 million kilometers of distribution piping. There is a need to repair, replace or newly install some 21,000 kilometers of pipe each year. Most of this is in diameters of 100–500 millimeters, used for smaller mains and distribution piping.

The "Repair Sleeve" maintenance solution

When a leak occurs, it is not easy to replace a length of pipe because the pipe is buried and it is tied into a pressurized water distribution network. A cost-effective solution is to repair the portion of pipe where the leak is located.

Stainless steel has long played an important role in repairing leaking pipes without having to replace a section or dig up an entire length of pipe. The method employs a "collar" fastened around ›

Type 316 stainless steel repair clamps are used to stop pipe leaks without replacing lengths of pipe. © JCM Industries, Inc.

A leak in a water main can lose a large amount of water in a short time.
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the leaking pipe instead of welding or threading a replacement section. It is like a Band-Aid® wrapped around one's finger. Here, a 304 or 316 stainless steel band with an attached rubber gasket is fastened around the pipe, over the damage. Tightening the clamp, or sleeve, applies more sealing pressure on the exterior of the pipe than is on the interior, stopping the leak.

These sleeves are widely used and are readily available for almost any pipe size, although mostly for pipes greater than 300 millimeters in diameter. They can also be used to add branching tees and to make general repairs. They have even been used to add a tee to reinforced concrete pipe; here the device strengthens the pipe that has had its reinforcing bar cut to make the tap. One municipality has used them with concrete pipe having diameters as large as 1200 millimeters. The overriding advantages of repair sleeves are their ready availability, low cost, durability and cost-effective installation.

Molybdenum completes the seal

The sleeve's metal component is almost always stainless steel, most commonly Type 304 because it is compatible with many soils. However, when soil corrosion is a concern, molybdenum-containing Type 316 is specified because it is very resistant to both general corrosion and pitting. Recently, some manufacturers are even offering molybdenum-containing 2205 duplex stainless steel as a superior alternative to Type 316. Duplex 2205 has more than double the strength and is resistant to stress-corrosion cracking and general corrosion. High strength is important because the outer metal sleeve is subjected to considerable stress as it is tightened to seal the rubber sleeve.

Technicians are reviewing the steps required to install the sleeve correctly. © Charleston Commissioners of Public Works

"Mock" installation of a custom-fabricated Type 316 stainless steel repair sleeve. The technicians are practicing the underwater installation on a piece of pipe in the dry. © Charleston Commissioners of Public Works

Adaptability for special needs

Some manufacturers provide engineering and fabrication services for custom-made sleeves for critical applications. One supplier, for example, undertook a very difficult underwater repair of a failed 610 millimeter diameter HDPE plastic pipe for the city of Charleston, SC. This 4.8-bar water main failed at a fusion joint on the harbor bed under 7.5 meters of water.

Initially, the Charleston Commissioners of Public Works made a repair using a stock Type 304 sleeve and coated carbon steel restrainer. However, for a permanent solution, the authority desired a more robust sleeve that would support high stresses on the pipe and assure good long-term performance. They asked the fabricator to engineer and build a new sleeve to completely encapsulate the repair sleeve, and to build a restrainer to relieve stresses on the extending plastic pipe. In addition to designing and fabricating the new Type 316 sleeve, the project specification included a dry run to test the anticipated difficult installation under 7.5 meters of water. The new sleeve was installed in 2004 and has performed very well, with no problems reported to date.

Stainless steel repair sleeves have been used for decades to repair municipal water pipes at the point of leakage. As water scarcity becomes more pronounced, water authorities increase their efforts to reduce water loss. Simultaneously, the need for repairs increases with the aging water infrastructure and the lack of funding for wholesale replacement. Repair sleeves will therefore become even more important in the future. (Curtis Kovach)