Kansas Department of Agriculture

Conduits

Inspection, repair, and renovation

What should I know about pipes conveying water?

Today, across the United States, many conduits — pipes conveying water— through embankment dams are past their designed service life and deteriorating. Cracks, joint separation, rust, and other forms of damage can cause the conduit to leak (seepage). This, in turn, can cause internal erosion in the dam. As with other hydraulic and structural problems, erosion increases the risk of dam failure and compels dam owners to make decisions regarding potentially expensive repair. Conduits and their accompanying inlet and outlet devices vary in structural composition and size. Similarly, varying construction materials react differently to the embankment depending on their chemistry, component relationships, quality, reinforcement, and placement.

For example, corrugated metal pipe (CMP), although lightweight and relatively easy to install, has an average service life of 25 to 30 years — even less in certain soils and water conditions — yet also can last twice as long or more in other situations. As CMP ages, corrosion and CMP's propensity for joint separation have resulted in many embankment dam failures. Grazing cattle, too, easily can damage exposed ends of these pipes.

Plastic pipes have a 50-to-100-year service life, which is less than that of concrete but preferable in situations with aggressive water or highly alkaline or acidic soil. Plastic pipe sections also can be fused for more durable watertight joints. However, plastic conduits often have size limitations and can be easily damaged or displaced during construction. Exposed polyvinyl chloride (PVC), as other plastics, also can catch fire during vegetation burning. Older unprotected PVC pipe is particularly susceptible to damage from ultraviolet radiation. Durable with a typically long service life, reinforced concrete pipe or boxes are often used on moderate-to-large dams.

Reinforced concrete pipe, normally placed in sections, is prefabricated, while concrete boxes can be prefabricated or cast in place. Drawbacks of concrete include a tendency to leak — through cracks and joints — and high cost in comparison to CMP. Steel cylinder reinforced concrete pipe addresses most of the drawbacks of concrete conduits, but is still higher in cost.

Repair begins by determining the cause of damage. If the cause isn't addressed, the repair also may become subject to the same damage or deterioration. Begin by inspecting the area above and surrounding the conduit for information about its condition. Clues include cracking or deterioration of the conduit exterior; signs of soil in the conduit; depressions, sinkholes, or cavities on the embankment surface above or near the conduit; water flowing from the embankment when the conduit is operating at full discharge capacity; cloudy water carrying soil; sediment deposits at the exit or downstream; changes in vegetation; unusual noise; or unexplained reductions in discharge capacity. If possible, use remotely operated inspection equipment to inspect the conduit interior. Refrain from entering the conduit unless specially trained and with a companion. Typical problems include rusting or erosion of pipe material, obstructions, joint offsets, separations, cracking, and mechanical damage such as chips. Measure, document, and monitor damaged or questionable areas to aid subsequent decision making.

Replacing aged conduits can be difficult, time consuming, and expensive. Determining whether to renovate, replace, repair, or abandon a conduit also depends on the site, benefit/cost ratio, and other factors. The first step should be contacting a licensed professional engineer for advice regarding these options:

Removal and replacement. In the past, owners often removed and replaced the entire conduit. This required excavation of the existing conduit and any attached drains or valves, possible reconstruction of the inlet and outlet structures, placement of the new pipe or box, and embankment material replacement. This solution, too, has been commonly used for low hazard embankment dams built without adequate engineering, since it generally is less expensive, eliminates guesswork regarding original construction, allows a full conduit evaluation and repairs along the existing conduit, and installation of seepage control measures.

Abandonment and replacement. In some instances, it is technically and economically more feasible to inject grout or concrete into the conduit at its upstream or downstream ends or drill holes from the surface to close the conduit, leave it in place, and abandon. Abandonment can have some advantages over conduit removal in site-specific situations. For example, when a new conduit is installed above the abandoned conduit, it lessens the amount of excavation required. Many times after abandonment, the new pipe can be laid in a 'broken-back' configuration with less excavation.

Abandonment and spillway construction or modification. Another option associated with abandonment is to forego a primary spillway conduit and to build a service spillway or modify the auxiliary spillway to function as a service spillway. Either would require extensive engineering and probable reworking of dam elevation top.

Sliplining. Today, a common method of renovation in which complete excavation is avoided is sliplining. This involves pulling or pushing a plastic (e.g., PVC or high density polyethylene) or less commonly a steel pipe of smaller diameter into the existing conduit and grouting the open area (annulus) between the liner and original pipe. Less expensive than replacement, sliplining is not appropriate for existing conduits that have significant deterioration or conduits with bends. Since the mid-1990s, plastic cured-in-place pipe lining ("elastic sock") that is installed by placing and curing a membrane insertion in the existing conduit also has been used. This method doesn't require grouting because of the tight fit and isn't suited for conduits with bends or changes in diameter.

Spray lining. A related innovation to sliplining is spray lining — spraying a cement mortar mix or epoxy resin on existing conduit walls — used since the 1920s mainly for small diameter water mains but with life and watertight barrier limitations. This process is generally not suited to conduits in dams because it provides no strength to the deteriorating conduit, but under special circumstances might be worth considering.

Fold and Form PVC liner. One process showing promise of inexpensive, effective repair of leaking pipes is the insertion of a flexible PVC tube into a deteriorating pipe. The liner is pulled through the host pipe, steamed, expanded with air pressure, cooled, and trimmed at ends to create an inner protective, seamless lining. Economical with high impact strength, this lining innovation differs from other heated thermoplastics because the PVC resets to its new, expanded shape and size. As a result, once the liner has been installed, it will not shrink away from the host pipe.

Source: Division of Water Resources staff and *Conduits through Embankment Dams: Best Practices for Design, Construction, Problem Identification and Evaluation, Inspection, Maintenance, Renovation, and Repair.* Federal Emergency Management Agency