

Water Supply & Sanitary Engineering (DI05006021)

Unit 5: Maintenance of Water Supply Mains
Lecture 21: Water Conservation and Pipe Rehabilitation

GTU Diploma Engineering

Agenda

- Utility-Level Water Conservation
- Understanding Non-Revenue Water (NRW)
- The IWA Water Balance
- Pressure Management for Leak Reduction
- The Need for Pipe Rehabilitation
- Trenchless Techniques: Slip Lining, CIPP, and Pipe Bursting

Water Conservation at the Utility Level

- Conservation is not just for consumers; utilities must conserve treated water to delay costly infrastructure expansion.
- ****Key Strategies****:
 - 1. Universal metering and replacing old, under-registering meters.
 - 2. Implementing active leak detection and rapid repair programs.
 - 3. Managing system pressure to reduce flow rates through existing leaks.
 - 4. Public education and implementing tiered pricing (higher rates for excessive use).

What is Non-Revenue Water (NRW)?

- ****Non-Revenue Water (NRW)**** is the difference between the volume of water put into the distribution system and the volume that is billed to customers.
- It represents water that generates no revenue for the utility.
- High NRW leads to financial instability for the utility and requires higher tariffs for paying customers.
- In many developing nations, NRW can exceed 40-50%.

The IWA Water Balance: NRW Components

- The International Water Association (IWA) defines NRW in three parts:
- ****1. Unbilled Authorized Consumption****: Firefighting, flushing mains, watering public parks (water used legitimately but not billed).
- ****2. Apparent Losses (Commercial Losses)****: Meter inaccuracies, data handling errors, and water theft/illegal connections.
- ****3. Real Losses (Physical Losses)****: Leakage from transmission mains, distribution pipes, service connections, and storage tank overflows.

Tackling Apparent Losses

- ****Meter Replacement Programs****: Mechanical meters wear out and under-register at low flows over time. Replacing them recovers lost revenue.
- ****Advanced Metering Infrastructure (AMI)****: Smart meters transmit data daily, detecting tampering and identifying customer-side leaks early.
- ****Audits and Inspections****: Physically inspecting connections to find illegal bypasses and prosecuting water theft.

Tackling Real Losses: Pressure Management

- Leakage rate is highly dependent on system pressure ($Q = C_d * A * (2gH)$). Higher pressure = Higher leakage.
- Networks must maintain high pressure during peak day demand. However, at night, demand drops, and pressure rises unnecessarily.
- ****Pressure Reducing Valves (PRVs)****: Installed to automatically lower the downstream pressure during off-peak hours.
- Reduces the flow from existing background leaks and prevents new pipe bursts caused by high night-time pressures.

The Need for Pipe Rehabilitation

- As pipes age (especially cast iron and steel), they suffer from internal tuberculation and external corrosion.
- ****Tuberculation****: Iron oxide mounds that grow inside the pipe, drastically reducing the effective diameter and increasing friction (lowering the 'C' value).
- Open-cut trenching to replace pipes is highly disruptive to traffic, expensive, and time-consuming.
- ****Solution****: Trenchless rehabilitation techniques restore structural integrity and flow capacity with minimal digging.

Cleaning and Cement Mortar Lining

- Used for structurally sound pipes suffering from tuberculation.
- ****Process****:
 - 1. Pipe is isolated and bypassed.
 - 2. Mechanical scrapers or high-pressure water jets remove tubercles and clean the pipe wall.
 - 3. A centrifugal spinning machine applies a thin, smooth layer of cement mortar to the inside.
- ****Benefits****: Stops corrosion, restores flow capacity, seals small pinholes.

Trenchless Tech: Slip Lining

- A structural rehabilitation method.
- A new, continuous flexible pipe (usually High-Density Polyethylene - HDPE) is pulled or pushed into the existing old pipe.
- The new pipe has a slightly smaller outer diameter than the old pipe's inner diameter.
- The annular space between the old and new pipe is filled with grout.
- ****Trade-off****: Reduces the cross-sectional area, but the smooth plastic often maintains or improves overall flow capacity.

Trenchless Tech: Cured-in-Place Pipe (CIPP)

- A flexible felt or fiberglass tube saturated with a thermosetting resin is inverted or pulled into the old pipe.
- Hot water or steam is circulated through the tube to cure (harden) the resin.
- Forms a tight-fitting, jointless, and structurally sound 'pipe-within-a-pipe'.
- Minimal reduction in pipe diameter compared to slip lining.
- Can negotiate bends and accommodate slight changes in pipe alignment.

Trenchless Tech: Pipe Bursting

- Used when a larger diameter pipe is required to increase capacity.
- A conical bursting head is pulled through the old rigid pipe (cast iron, clay).
- The head fractures the old pipe and pushes the fragments outwards into the surrounding soil.
- Simultaneously, it pulls a new, larger diameter HDPE pipe into the cavity created.
- Provides a brand new structural pipe and an upgrade in hydraulic capacity without trenching.

Comparing Rehabilitation Methods

Concept 1

Concept 2

****Cement Mortar Lining****: Non-structural. Restores water quality and flow. Cheapest.

****Slip Lining****: Structural. Reduces diameter. Very fast for straight, long runs.

****CIPP****: Structural. Minimal diameter loss. Can handle bends. Excellent for urban areas.

****Pipe Bursting****: Structural. Allows for capacity increase (upsizing). Requires old pipe to be fracturable.

Summary

- Non-Revenue Water (NRW) consists of apparent losses, real losses, and unbilled authorized use.
- Pressure management via PRVs is a critical tool for reducing real physical losses.
- Trenchless rehabilitation renews aging mains with minimal surface disruption.
- Techniques like CIPP, slip lining, and pipe bursting offer varying levels of structural renewal and hydraulic capacity.

Next Lecture Preview

- Introduction to Unit 6: Valves and Fittings
- Types of Valves in Water Supply
- Sluice Valves, Check Valves, Air Valves
- Fire Hydrants and Water Meters