Water Supply & Sanitary Engineering (DI05006021)

Unit 5: Maintenance of Water Supply Mains

Lecture 20: Maintenance of Water Supply Mains & Leak Detection

GTU Diploma Engineering

Agenda

- Importance of Maintenance
- Types of Maintenance (Preventive, Corrective)
- Causes and Consequences of Leaks
- Traditional and Acoustic Leak Detection
- Advanced Detection: Correlators and Loggers
- Methods for Leak Repair

Why Maintain Water Supply Mains?

- Ensure continuous and reliable water supply to consumers at adequate pressure.
- Prevent the contamination of treated water in the distribution network.
- Minimize physical water losses and reduce non-revenue water.
- Extend the useful life of the pipeline infrastructure, delaying costly replacements.

Types of Maintenance

Concept 1	Concept 2

Preventive Maintenance: Scheduled tasks to prevent failures. Includes systematic flushing, valve exercising, and routine inspections.

Corrective Maintenance: Reactive work performed after a failure occurs, such as repairing a burst main or replacing a broken valve.

Predictive Maintenance: Using condition monitoring and data analytics (e.g., continuous acoustic logging) to predict and prevent imminent failures.

Routine Preventive Tasks

- **Unidirectional Flushing (UDF)**: Closing specific valves to create high-velocity flow, scouring biofilms, sediments, and tuberculation from pipes.
- **Valve Exercising**: Fully opening and closing valves annually to prevent them from seizing due to corrosion or mineral buildup.
- **Hydrant Maintenance**: Inspecting fire hydrants for leaks, proper drainage, and adequate flow capacity.

Causes of Pipe Leaks

- **Internal and External Corrosion**: Weakens pipe walls, especially in older cast iron and steel mains, creating pinholes.
- **Ground Movement**: Soil subsidence, frost heave, or earthquakes can cause shear stress and break rigid pipes.
- **Water Hammer**: Sudden changes in flow (e.g., rapid valve closure) cause pressure surges that rupture pipes.
- **Traffic Loads**: Heavy vehicles create continuous vibrations and dynamic loads on shallowly buried pipes.
- **Poor Workmanship**: Improper bedding, poor jointing, or damaged O-rings during installation.

Consequences of Leaks

- **Financial Loss**: Significant loss of treated, pumped water which costs money to produce (electricity and chemicals).
- **Contamination Risk**: During low pressure events, negative pressure can pull contaminated groundwater into the pipe through the leak.
- **Property Damage**: Washouts can undermine roads, causing sinkholes, and flood basements.
- **Reduced Pressure**: Large leaks lower the hydraulic gradient, leaving downstream consumers with inadequate water pressure.

Introduction to Leak Detection

- **Passive Leak Control**: Waiting for leaks to show up on the surface (e.g., wet spots, sinkholes) or relying on customer complaints.
- **Active Leak Control (ALC)**: Systematically searching for hidden, underground leaks using specialized equipment.
- **Step-Testing**: Closing valves sequentially at night to isolate sections; observing sudden drops in flow meters indicates a leak in the isolated section.

Acoustic Leak Detection: Principles

- Water escaping under pressure creates a distinct 'hissing' sound or vibration.
- This sound travels along the pipe wall and through the surrounding soil.
- Metallic pipes (iron, steel) transmit sound very well over long distances.
- Plastic pipes (PVC, PE) absorb sound, making acoustic detection much more difficult and limiting the listening range.

Acoustic Equipment: Geophones and Microphones

- **Listening Sticks**: Simple mechanical devices placed on valves or hydrants to listen for vibrations.
- **Geophones (Ground Microphones)**: Electronic listening devices with highly sensitive microphones placed on the ground surface above the pipe.
- **Operation**: The operator walks the pipe route, placing the geophone at intervals. The loudest sound indicates the point directly above the leak.

Advanced Detection: Leak Correlators

- Uses two sensors placed on contact points (e.g., valves) on either side of a suspected leak.
- The leak sound travels to both sensors. Because the leak is usually not exactly in the middle, the sound arrives at one sensor slightly before the other.
- The correlator measures the time delay (t).
- Using the distance between sensors (D) and the velocity of sound in that specific pipe material (V), it calculates the exact leak location.

Advanced Detection: Noise Loggers

- Small, magnetic sensors deployed temporarily or permanently on valves across the network.
- They record acoustic noise overnight (e.g., 2 AM to 4 AM) when ambient traffic noise and normal water usage are minimal.
- If a continuous noise is recorded every night, it strongly indicates a leak.
- Data is transmitted via cellular networks to the utility's control center for analysis.

Preventing Leaks and Repair Methods

- **Prevention**: Installing pressure relief valves to stop water hammer, using cathodic protection to halt corrosion, and ensuring proper pipe bedding.
- **Repair Clamps (Stainless Steel)**: Wrapped around a cracked pipe or pinhole leak and bolted tight. A fast, permanent fix for localized damage.
- **Repair Sleeves/Collars**: Used to connect a replacement segment when a large section of the pipe is shattered.
- Repairs must be done under sanitary conditions, often requiring localized disinfection of the repaired segment.

Summary

- Maintenance is crucial for network longevity, water quality, and minimizing losses.
- Leaks are caused by corrosion, pressure surges, and physical stress.
- Active Leak Control uses acoustic methods (geophones, correlators) to find hidden leaks.
- Modern technology like noise loggers enables continuous monitoring of the distribution system.

Next Lecture Preview

- Water Conservation Strategies
- Understanding Non-Revenue Water (NRW)
- Pressure Management Techniques
- Trenchless Pipe Rehabilitation (Slip lining, CIPP)