Water Supply & Sanitary Engineering (DI05006021)

Unit 7: Drains and Sewers

Lecture 29: Laying, Testing, and Maintenance of Sewers

GTU Diploma Engineering

Agenda

- Setting Out the Alignment
- Trench Excavation and Timbering
- Bedding and Laying of Sewers
- Testing: Straightness and Obstruction
- Testing: Water, Air, and Smoke Tests
- Backfilling of Trenches
- Maintenance: Common Issues and Cleaning Equipment

Setting Out the Alignment

- Before digging, the exact center line of the sewer must be marked on the ground using surveying instruments (Theodolite/Total Station).
- Sight Rails: Horizontal wooden boards set up at fixed heights above the proposed invert level of the sewer. Placed at manhole locations and changes in gradient.
- Boning Rods: T-shaped wooden rods of a fixed length. Used by sighting across two sight rails to ensure the trench bottom and pipe invert are at the exact required gradient.

Excavation and Timbering of Trenches

- Excavation: Done manually or using backhoes. The trench width should be just wide enough to allow pipe laying and jointing (usually pipe diameter + 30 to 45 cm clearance on sides).
- Timbering (Shoring and Strutting): Essential in loose soils or deep trenches to prevent the collapse of vertical earth walls.
- Involves placing wooden boards (poling boards) against the trench walls, held apart by horizontal struts.
- Dewatering: If the groundwater table is high, trenches must be kept continuously dry using sump pumps or well-point systems.

Bedding of Sewers

- Pipes must not be laid directly on hard rocks or uneven soil, as concentrated point loads will crack them.
- Granular Bedding: A layer of compacted sand or gravel is placed at the trench bottom to distribute the earth load evenly around the pipe.
- Concrete Cradle Bedding: Required when the soil is very soft and yielding, or when the pipe is under extreme traffic loads. The pipe is partially embedded in a concrete cradle for maximum support.

Pipe Laying Process

- Direction: Laying always proceeds from the downstream end (outfall or lower manhole) towards the upstream end.
- Orientation: The Socket (Bell) end of the pipe must face upstream, while the Spigot end faces downstream.
- Reasoning:
- - Prevents flowing sewage from pushing into the joint packing material.
- - Makes it much easier to push the next spigot into the established socket on the trench floor.

Testing of Sewers: Why is it Necessary?

- Before the trench is backfilled with earth, the newly laid sewer must be rigorously tested.
- Objectives of Testing:
- 1. Ensure Watertightness: To guarantee no infiltration or exfiltration will occur at the joints.
- 2. Ensure Perfect Alignment: To verify the pipe is perfectly straight and the gradient is correct.
- 3. Ensure No Obstructions: To confirm no construction debris (tools, cement blocks) has been left inside the pipe.

Straightness and Obstruction Tests

- Mirror/Lamp Test (Straightness): A mirror is placed at a 45-degree angle at one manhole. A bright lamp is held at the other manhole. If the pipeline is perfectly straight, a full circle of light is seen in the mirror. Any misalignment shows as a crescent.
- Ball Test (Obstruction): A smooth, heavy ball (about 10% smaller than the pipe diameter) is rolled from the upstream end. If it emerges seamlessly at the downstream end, the pipe is clear of debris.

Water Test (Hydrostatic Test)

- The most common test for watertightness in gravity sewers.
- Procedure: The lower end of the sewer section is plugged watertight. The pipe is filled with water from the upper manhole to create a specific head of water (usually 1.0m to 1.5m above the pipe crown).
- The water is allowed to stand for 1 to 2 hours to allow the pipe material to absorb moisture.
- Result: Any drop in the water level in the upper manhole indicates a leak. The allowable leakage is strictly defined by codes (e.g., liters/cm diameter/km/day). Leaking joints are repaired and re-tested.

Air Test and Smoke Test

- Air Test: Used for large diameter pipes where huge volumes of water are impractical. Both ends are plugged, and air pressure (approx 100mm of water gauge) is applied. A specific pressure drop over 5 minutes indicates leaks.
- Smoke Test: Primarily used to detect leaks in soil pipes, vent pipes, and house drainage connections, or to find illegal stormwater connections to sanitary sewers.
- Smoke is pumped into the pipe using a blower. Visual inspection easily locates leaks where smoke escapes from the ground or joints.

Backfilling of Trenches

- Once tests are passed, the trench is backfilled.
- Process: Fine soil (free from large stones/boulders) is placed around and up to 30 cm above the pipe to prevent impact damage.
- The remaining trench is filled in horizontal layers of 150mm. Each layer is thoroughly watered and rammed (compacted).
- Importance: Proper compaction prevents future settlement of the trench, which would otherwise ruin the road surface above and potentially damage the pipe.

Maintenance of Sewers: Common Issues

- Despite perfect design, sewers require routine maintenance.
- Common Causes of Blockages:
- - Accumulation of grit, sand, and grease (fatbergs).
- - Intrusion of tree roots through minor joint cracks.
- - Structural collapse or pipe deformation.
- - Dumping of solid waste (plastics, rags) into open manholes or inlets.
- Sewer Gas Hazards: Accumulation of H2S and Methane poses deadly risks to maintenance workers. Ventilation and gas detection are mandatory before entry.

Sewer Cleaning Equipment

- Rodding Machines: Flexible steel rods with cutting tools pushed through the pipe to cut away tree roots and break hard grease crusts.
- High-Pressure Water Jetting: A specialized nozzle blasted backward with high-pressure water (up to 2000 psi) scours the pipe walls clean and flushes grit to the downstream manhole.
- Bucket Machines: Used for large sewers heavily choked with silt. A winch pulls a bucket through the pipe from one manhole to another, scooping out the sediment.

Summary of Unit 7

- We classified drains and analyzed hydraulic sewer sections (Circular vs Non-circular).
- We studied the importance of watertight joints and selected pipe materials (Stoneware, RCC, PVC).
- We explored appurtenances that make the system workable: Manholes, Catch Basins, and Siphons.
- Finally, we detailed the rigorous field execution: precise laying, mandatory hydrostatic testing, and ongoing mechanical maintenance.

End of Unit 7

- Next steps: Prepare for the unit assessment.
- Review all diagrams regarding sewer cross-sections and manhole components.
- Ensure understanding of the hydraulic logic behind non-circular sewers and flushing tanks.