# Water Supply & Sanitary Engineering (DI05006021)

## Unit 7: Drains and Sewers

## Lecture 25: Drains Classification and Sewer Sections

GTU Diploma Engineering

# Agenda

- Introduction to Drains and Sewers
- Classification of Drains
- Requirements of an Ideal Sewer Section
- Circular Sewer Sections
- Non-Circular Sewer Sections
- Comparison of Various Sewer Shapes

# Introduction to Drains and Sewers

- Drain: A conduit or channel primarily meant for carrying off surface water, stormwater, or excess groundwater. They often function under gravity flow.
- Sewer: An underground closed pipe or conduit specifically designed to carry foul sewage or wastewater away from a community to a treatment plant.
- While drains can be open to the atmosphere (open channels) or closed, sanitary sewers must always be closed conduits to prevent health hazards, foul odors, and public nuisance.

# Classification of Drains

- Drains are broadly classified based on their location and primary function into two categories:
- 1. Surface Drains: Located at or near the ground surface. Designed to intercept, collect, and convey stormwater, street washings, and surface runoff to natural water bodies.
- 2. Subsurface Drains: Laid below the ground level, usually consisting of perforated pipes. Their main function is to lower the groundwater table and prevent waterlogging of soils.

# Types of Surface Drains

- Open Surface Drains: Can be V-shaped, U-shaped, or semi-circular channels. Typically constructed using brickwork, stone masonry, or precast concrete.
- Cost-effective and easy to inspect, but highly prone to blockages from solid waste and can become breeding grounds for mosquitoes if water stagnates.
- Closed Surface Drains: Underground pipes equipped with street inlets and catch basins. Used in urban areas to carry heavy stormwater flow without causing surface flooding or obstructing traffic.

# Requirements of an Ideal Sewer Section

- Hydraulic Efficiency: Must yield maximum discharge and velocity for a given cross-sectional area and bed slope (maximum hydraulic mean depth).
- Self-Cleansing Velocity: Should maintain a sufficient flow velocity (usually ¿ 0.6 m/s) even at minimum dry weather flow to prevent the deposition of suspended organic solids.
- Structural Stability: Must be robust enough to resist internal hydraulic pressure, external earth pressure, and superimposed traffic loads without deformation.
- Economy and Maintenance: Should be economical to construct, manufacture in standard sizes, and easy to clean, inspect, and maintain.

# Circular Sewer Sections

- The circular shape is the universal standard for separate sanitary sewer systems.
- Advantages: Offers the maximum cross-sectional area for the least perimeter, resulting in high hydraulic efficiency when running full or half-full.
- Highly economical to manufacture in standard pipe lengths and provides excellent structural strength (arch action) under uniform external pressure.
- Limitation: Becomes hydraulically inefficient at very low flow depths (less than 1/3 full), causing velocity to drop and silting to occur.

# Need for Non-Circular Sewers

- Non-circular sections are primarily required in combined sewer systems.
- Combined systems face massive fluctuations: huge volumes during wet weather (stormwater + sewage) and very small volumes during dry weather (sanitary sewage only).
- During dry weather, flow depth in a large circular sewer becomes extremely shallow. Velocity drops below the self-cleansing limit, leading to sludge deposition.
- Non-circular sections are specifically designed to provide a narrower channel at the invert (bottom), increasing flow depth and velocity during dry periods.

# Egg-Shaped Sewers

- Designed with a larger radius arch at the top and a smaller radius invert at the bottom (Standard Egg-Shaped).
- Excellent Hydraulic Properties: The narrower bottom ensures a greater hydraulic depth and higher self-cleansing velocity even at minimum dry weather flows.
- Mostly constructed in-situ using brick masonry or concrete. They are more difficult and expensive to construct compared to circular pipes.
- Inverted Egg-Shaped: Sometimes used in extremely soft yielding soils where the wider base provides better load distribution.

# Horseshoe Shaped Sewers

- Shape: Resembles a horseshoe with a semi-circular arch top, diverging or vertical sides, and a flat or curved invert (bottom).
- Application: Primarily used for massive outfall sewers carrying huge combined discharges. Often used for heavy structural loads.
- Structural Considerations: Requires substantial side wall thickness or heavy reinforcement to bear the lateral earth pressure, making them expensive.
- Usually provided with a central V-notch or small channel at the invert to handle minimum dry weather flow effectively.

# Parabolic and Semi-Elliptical Sewers

- Parabolic Section: Top is a parabola with an elliptical invert. Very suitable for carrying relatively small discharges under high external loads.
- Semi-Elliptical Section: A highly stable arch shape that effectively resists external earth pressure due to strong arch action.
- Mostly adopted for large storm drains running full or partially full, where deep excavations in loose soils are required.
- Limitation: They are less stable under internal hydraulic pressure and are strictly meant for gravity flow.

# Rectangular and Box Sewers

- Rectangular or Box sections are primarily used for conveying large volumes of purely stormwater.
- Construction: Very easy to construct in the field using standard reinforced concrete forms and flat shuttering.
- Highly suitable for flat terrains where the available slope is minimal, yet a large cross-sectional area is needed without deep excavation.
- Corners at the bottom are typically filleted (chamfered) to prevent the deposition of grit and solids in dead zones.

# Comparison of Sewer Sections

| Concept 1 | Concept 2 |
|---|---|
| Circular: Best for separate sanitary systems; highly economical to manufacture; poor velocity at low flows. | |
| Egg-Shaped: Best for combined systems; maintains self-cleansing velocity at low flows; expensive and difficult to construct. | |
| Horseshoe: Best for large trunk/outfall sewers with heavy flows; requires heavy masonry/concrete base for lateral stability. | |
| Rectangular: Best for stormwater in flat areas; easy to cast in RCC; poor hydraulic mean depth for sewage flows. | |

# Summary

- Drains handle surface/subsurface water, while sewers carry hazardous wastewater.
- An ideal sewer must maintain self-cleansing velocity, be structurally sound, and be economical.
- Circular sewers are the standard for separate sanitary lines due to structural and hydraulic efficiency when flowing full.
- Non-circular sections, especially Egg-shaped and Horseshoe, are crucial for combined systems to handle highly variable flow rates.

# Next Lecture Preview

- Sewer Joints and Materials
- Importance of leak-proof joints in sewer lines.
- Types of joints: Bell and Spigot, Collar, Mechanical, Flexible.
- Materials used for manufacturing sewers: RCC, Stoneware, Cast Iron, and Plastics.