

Water Supply & Sanitary Engineering (DI05006021)

Unit 4: Conveyance of water

Lecture 17: Distribution Systems - Layouts and Design

GTU Diploma Engineering

Requirements of a Good Distribution System

- Water quality must not deteriorate in the distribution pipes.
- It should supply water at all intended locations with adequate pressure head (e.g., sufficient to reach a 2nd story building).
- It should be capable of supplying water during fire fighting emergencies.
- The layout should be such that no consumer is left without water during pipe repairs.

Layouts of Distribution Networks

- The arrangement of pipes depends on the road layout and topography of the city.
- Four primary types of layouts:
 - 1. Dead End or Tree System
 - 2. Grid Iron System
 - 3. Ring or Circular System
 - 4. Radial System

Dead End / Tree System

- Resembles a tree: A main pipe bifurcates into sub-mains, which bifurcate into branches, ending in dead ends.
- Suitable for irregularly developed or older, unplanned towns.
- Water flows in one direction only.

Dead End System: Pros and Cons

Concept 1

Concept 2

Advantages: Easy to design (simple calculations), cheap to install, fewer valves required.

Disadvantages: Stagnation of water at dead ends causes health hazards (loss of residual chlorine).

During repairs of a main line, all downstream areas are completely deprived of water.

Limited discharge available for fire fighting at the dead ends.

Grid Iron System (Interlaced System)

- Suitable for well-planned cities with rectangular road layouts (e.g., Chandigarh, Gandhinagar).
- Mains, sub-mains, and branches are all interconnected, forming a grid.
- Eliminates dead ends; water circulates continuously.

Grid Iron System: Pros and Cons

Concept 1

Concept 2

Advantages: Water reaches any point from multiple directions.
High flow available for fire fighting.

During repairs, only a small block is isolated by closing valves;
the rest of the city gets water.

Disadvantages: Complex hydraulic design (requires Hardy
Cross method or software).

High cost due to longer pipe lengths and a massive number of
sluice valves required at every junction.

- A closed ring of main pipes is laid around the periphery of the distribution area.
- Sub-mains branch off from this ring and cross the interior area, forming a grid.
- Often combined with the Grid Iron system to form a 'Ring and Grid' layout.

Ring System: Characteristics

- Advantages: Pressure is well equalized across the network. Very reliable supply.
- Heavy draw-off in one area is compensated by flow from the other side of the ring.
- Disadvantages: Requires large diameter pipes for the entire peripheral ring, making it costly.
- Applicability: Excellent for towns that have a circular or radiating road pattern.

Radial System

- The city is divided into several zones. A central Elevated Service Reservoir (ESR) is provided for each zone.
- Pipes radiate outwards from each central ESR towards the periphery of that zone.
- It's essentially a reverse Dead End system, but fed from the center rather than one edge.

Radial System: Pros and Cons

Concept 1

Advantages: Ensures high and uniform pressure throughout the zone.

Calculations for pipe sizes are simple and straightforward.

Disadvantages: Requires construction of multiple Elevated Service Reservoirs (high capital cost).

If a zonal ESR fails or requires maintenance, that entire zone loses water pressure.

Concept 2

Comparison of Layouts

Concept 1

Concept 2

Cost: Dead End (Lowest) ; Radial ; Ring ; Grid Iron (Highest)

Reliability: Grid Iron (Highest) ; Ring ; Radial ; Dead End (Lowest)

Design Complexity: Grid/Ring (Complex) vs. Dead End/Radial (Simple)

Summary of Distribution Layouts

- Dead-end networks are cheap but suffer from poor water quality and low reliability.
- Grid iron and Ring networks provide continuous flow and high redundancy, ideal for modern cities.
- Radial systems optimize pressure by distributing from central elevated reservoirs.
- Network choice is heavily dictated by existing town planning and topography.