Chapter 50: Lining of Canals – Types of Lining – Advantages and Disadvantages

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Introduction

Canals are man-made channels constructed to convey water from natural sources like rivers or reservoirs to agricultural fields, towns, or industries. However, a significant challenge associated with unlined canals is the *seepage losses*, which can lead to water wastage, rise in the water table, and damage to adjoining structures. To mitigate these issues, *lining of canals* is done.

Canal lining refers to the process of providing a protective impermeable layer on the bed and sides of a canal to reduce water loss through seepage and to improve hydraulic efficiency. This lining can be of various types, made using materials like concrete, brick, stone, or even plastic. The choice of lining depends on several factors such as soil conditions, cost, availability of materials, and purpose of the canal.

50.1 Objectives of Canal Lining

1. **To prevent seepage losses**: The primary aim is to reduce or eliminate water loss due to seepage through the canal bed and sides.
2. **To control waterlogging and salinity**: By reducing seepage, canal lining helps control the rise in water table and prevents salinity problems.
3. **To prevent erosion**: Lining protects the canal section from scouring and erosion caused by flowing water.
4. **To increase capacity and velocity**: A lined canal has a smoother surface, increasing flow velocity and discharge.
5. **To reduce maintenance cost**: Lined canals are less prone to weed growth, siltation, and structural failures, thus reducing maintenance.
6. **To improve conveyance efficiency**: Enhances the efficiency of water delivery for irrigation and other purposes.

50.2 Types of Canal Lining

Canal linings are broadly classified into the following categories:

50.2.1 Rigid Linings

These linings are made from hard, non-flexible materials and are structurally more stable.

a) Cement Concrete Lining

- Most widely used due to high impermeability and strength.
- May be reinforced or plain, depending on design.
- Can be cast in situ or pre-cast.

Advantages:

- Excellent impermeability.
- High durability and strength.
- Low maintenance.

Disadvantages:

- High initial cost.
- Cracking due to temperature variations.
- Skilled labor required.

b) Brick Lining

- Bricks are laid with cement mortar over the canal surface.

Advantages:

- Economical compared to concrete.
- Readily available materials.
- Simple construction.

Disadvantages:

- Less durable than concrete.
- Prone to seepage if mortar joints are not properly sealed.
- Maintenance-intensive.

c) Stone Masonry Lining

- Built using cut or random rubble stones.
- Usually adopted where stone is abundant.

Advantages:

- Good resistance to erosion.
- Economical in hilly and rocky terrain.

Disadvantages:

- Labor-intensive.
- Less impermeable than concrete.

50.2.2 Flexible Linings

These linings are capable of adjusting with minor soil movements and are often used in temporary or low-budget projects.

a) Compacted Clay Lining

- Formed by compacting layers of clay to create a dense, impermeable surface.

Advantages:

- Locally available and inexpensive.
- Effective in reducing seepage.

Disadvantages:

- Not suitable for all soil types.
- Requires proper compaction for efficiency.
- Can crack on drying.

b) Bituminous Lining

- Involves application of bitumen or asphalt over a prepared surface.

Advantages:

- Water-resistant.
- Relatively cheaper than concrete.

Disadvantages:

- Degrades under high temperature.
- Shorter lifespan.

c) Plastic Membrane Lining (LDPE, HDPE, PVC)

- Involves laying plastic sheets over the canal bed, often combined with other protective materials.

Advantages:

- Very low seepage.
- Quick installation.
- Lightweight.

Disadvantages:

- Vulnerable to puncture or UV damage.
- Needs protective layers (like soil or concrete tiles).
- Limited durability compared to concrete.

50.3 Composite Linings

These are hybrid linings combining two or more materials for optimized performance.

- **Examples**:
  - Plastic membrane with concrete tiles.
  - Bituminous lining with soil cover.
  - Clay layer topped with stone pitching.

Advantages:

- Economical and efficient.
- Combines impermeability with surface protection.
- Adaptable to various site conditions.

Disadvantages:

- Design complexity.
- Requires quality control during installation.

50.4 Advantages of Canal Lining

1. **Reduction in Seepage Losses**: Impermeable linings significantly reduce seepage, improving water use efficiency.
2. **Improved Flow Conditions**: Smooth lining reduces resistance, increasing velocity and discharge capacity.
3. **Minimized Waterlogging**: Reduced seepage prevents unwanted rise in the groundwater table.
4. **Protection from Erosion**: Lining prevents scouring of canal bed and banks.
5. **Reduced Maintenance Costs**: Weed growth, silt deposition, and canal breaches are minimized.
6. **Increased Command Area**: More water availability allows irrigation of a larger area.
7. **Durability**: Properly lined canals have a long service life.

50.5 Disadvantages of Canal Lining

1. **High Initial Cost**: Construction of lined canals requires significant upfront investment.
2. **Cracking and Leakage**: Rigid linings like concrete are prone to cracking if joints are not properly designed.
3. **Skilled Labor Requirement**: Proper installation needs experienced engineers and workers.

4. **Difficulty in Maintenance of Lining Itself**: Repairing damaged linings, especially plastic or bituminous, can be challenging.
5. **Environmental Considerations**: In some areas, lining may disturb natural groundwater recharge.
6. **Limited Flexibility**: In areas of expansive soils or seismic activity, rigid linings may fail.

50.6 Criteria for Selecting Canal Lining

The selection of a suitable lining type depends on the following factors:

- **Soil characteristics** of the canal bed.
- **Water table depth** and groundwater conditions.
- **Hydraulic requirements** such as discharge and velocity.
- **Availability of local materials**.
- **Climatic conditions** (freeze-thaw, temperature variations).
- **Cost and economic analysis**.
- **Type of canal** (main canal, branch canal, distributary, etc.).

50.7 Design Considerations for Lining

- **Hydraulic design**: Ensure flow capacity and permissible velocity.
- **Structural design**: Address stresses, joints, expansion, and contraction.
- **Thickness and type of lining**: Based on seepage, load, and durability.
- **Joint spacing and treatment**: Especially important for rigid linings.
- **Subgrade preparation**: Should be compacted and shaped accurately.
- **Protective measures**: Against animal burrowing, plant roots, or vandalism.
