

Lecture Notes

Design of Surface Drainage Systems

1. Introduction

Surface drainage systems are engineered to remove excess water from the land surface, preventing waterlogging, soil erosion, and crop damage. Effective design ensures optimal agricultural productivity and infrastructure longevity.

2. Objectives of Surface Drainage

- Prevent Waterlogging: Remove excess surface water promptly.
- Enhance Soil Aeration: Improve root respiration and microbial activity.
- Reduce Soil Erosion: Control the velocity and volume of surface runoff.
- Protect Infrastructure: Safeguard roads, buildings, and other structures from water damage.

3. Components of a Surface Drainage System

- Field Drains
- Collector Drains
- Main Drains
- Outlets

4. Design Considerations

a. Hydrologic Design

Estimation of Runoff using the Rational Method:

$$Q = C \times I \times A$$

Where:

Q = Peak runoff rate (m^3/s)

C = Runoff coefficient (dimensionless)

I = Rainfall intensity (mm/hr)

A = Drainage area (hectares)

b. Hydraulic Design

Channel Design using Manning's Equation:

$$Q = (1/n) \times A \times R^{(2/3)} \times S^{(1/2)}$$

Where:

Q = Discharge (m^3/s)

n = Manning's roughness coefficient

A = Cross-sectional area (m^2)

R = Hydraulic radius (m)

S = Slope of the energy grade line (m/m)

c. Layout Planning

- Topography: Align drains along natural slopes.
- Soil Type: Consider infiltration rates and erosion potential.
- Land Use: Account for agricultural practices and infrastructure.

5. Types of Surface Drainage Systems

- Random Drainage System: Suitable for areas with scattered depressions.
- Parallel Field Drainage System: Effective in uniformly flat areas.

- Bedding System: Involves shaping land into beds and furrows.
- Grassed Waterways: Channels lined with vegetation to convey runoff.

6. Maintenance Considerations

- Regular Inspection: Check for blockages, erosion, and sedimentation.
- Vegetation Control: Manage plant growth within channels.
- Structural Repairs: Address damages to channels and outlets promptly.

7. Conclusion

Designing an efficient surface drainage system requires a comprehensive understanding of hydrologic and hydraulic principles, soil characteristics, and land use patterns. Proper design and maintenance ensure the longevity and effectiveness of the drainage infrastructure.

References

1. Lecture 51: Surface Drainage System Design-1, NPTEL, IIT Kharagpur.
2. Lecture 52: Surface Drainage System Design-2, NPTEL, IIT Kharagpur.
3. Chapter 1: Principles of Drainage, Irrigation Toolbox.
4. FAO: Chapter 4 Drainage Design.