

**Course Name:**  
**Earth and Rockfill Dams**

**Course Number:**  
20430

**Credit:**  
3

**Course Content (outline):**

**1. GENERAL DESIGN CRITERIA**

- 1.1 Introduction
- 1.2 Requirement of a good Dam Site
- 1.3 Classification of Dams
- 1.4 Comparison of Rigid and Embankment Dams
- 1.5 Development of Storage in India
- 1.6 The Development of Earth Dams
- 1.7 Classification of Earth Dams
- 1.8 Types of Construction
- 1.9 Earth Dam Foundations
- 1.10 Materials of Construction
- 1.11 Causes of Construction
- 1.12 Preliminary Section

**2. THEORETICAL ASPECTS OF SEEPAGE**

- 2.1 Fundamentals of Seepage Flow
- 2.2 Kozeny's Solution
- 2.3 A. Cassagrande's Method
- 2.4 Top Flow Line for inclined Discharge Faces
- 2.5 Approximate Solution for a  $> 300^\circ$  due to L. Cassagrande
- 2.6 Transverse Isotropy
- 2.7 Non-net for Seepage through an Earth Dam
- 2.8 Electrical Analogy
- 2.9 Viscous flow Models Examples

**3. CONTROL OF SEEPAGE THROUGH EMBANKMENTS EMBANKMENTS**

- 3.1 Adverse effects of Seepage
- 3.2 Methods of Seepage Control
- 3.3 Provision of Impervious Zone or Core in the Embankment
- 3.4 Design of Transition Filters
- 3.5 Drainage of Embankments
- 3.6 Drainage of the Upstream Face
- 3.7 Control of Seepage Coming out on the Downstream Face

#### **4. CONTROL OF SEEPAGE THROUGH FOUNDATIONS**

- 4.1 Foundation Categories
- 4.2 Rock Foundation
- 4.3 Clayey Foundation
- 4.4 Pervious Foundation
- 4.5 Conventional Cutoffs
- 4.6 Slurry Trench and Concrete Diaphragm Cut-offs
- 4.7 Alluvial Grouting
- 4.8 The Upstream Impervious Blanket
- 4.9 The Downstream Loading Berm or the Counterberm
- 4.10 Relief Wells
- 4.11 Treatment of Liquefying Sands

#### **5. STABILITY ANALYSIS-SHEAR STRENGTH OF SOILS**

- 5.1 Introduction
- 5.2 General Concepts
- 5.3 Stress Relationships and Shear Parameters
- 5.4 Mohr Strength Theory
- 5.5 Mohr-Coulomb's Envelope
- 5.6 Experimental Determination of Shear Parameters
- 5.7 Shearing Strength of Cohesive Soils
- 5.8 Shearing Strength of Rockfill

#### **6. STABILITY ANALYSIS-PORE PRESSURES IN EARTH DAMS**

- 6.1 Introduction
- 6.2 Critical Stages for Design
- 6.3 Construction Pore Pressures
- 6.4 Pore Pressure Parameters
- 6.5 Hilf's Method
- 6.6 Other Factors Affecting Construction Pore Pressures
- 6.7 Steady Seepage Pore Pressures
- 6.8 Drawdown Pore Pressures
- 6.9 Effect of Air in Pores of Embankment
- 6.10 Control of Drawdown pore pressures
- 6.11 Control of Drawdown pore pressures
- 6.12 Field Measurements

#### **7. STABILITY ANALYSIS-METHOD OF COMPUTATION**

- 7.1 Basic Concepts
- 7.2 Location of Critical Slip Methods of Analysis
- 7.3 Total and effective Stress Methods of Analysis
- 7.4 Test Conditions
- 7.5 Factor of Safety
- 7.6 Methods of Analysis
- 7.7 Stability Analysis by Method of Slices

- 7.8 Accuracy of Simplified Methods
- 7.9 Choice between Fellini's and Bishop's Methods
- 7.10 Morgenstern-Price Method
- 7.11 Use of Digital Computer for Stability Analysis
- 7.12 Wedge Method
- 7.13 Three Dimensional Effects

## **8. STABILITY ANALYSIS-SEISMIC STABILITY**

- 8.1 Introduction
- 8.2 Nature of Earthquake damage
- 8.3 Earthquakes
- 8.4 Dynamic Response of an Earth Dam
- 8.5 Application of Dynamic Response Analysis
- 8.6 Deformation Analysis
- 8.7 Suggested Design Procedure
- 8.8 Concluding Remarks

## **9. STRESS-STRAIN ANALYSIS OF EARTH DAMS**

Application of FEM to Earth Dam Problems using Linear Elastic, Elastoplastic, Nonlinear Elastic and Elastoplastic Constitutive Laws in 2D and 3D Analysis

- 9.1 Analysis of Stresses and Deformations
- 9.2 FEM Analysis of Stability of Embankments
- 9.3 FEM Analysis of Rigid Cutoffs
- 9.4 Three Dimensional Analysis
- 9.5 General Scope and Utility

## **10. QUALITY CONTROL OF EARTH DAMS & INSTRUMENTATION**

- 10.1 General
- 10.2 Compaction
- 10.3 Compaction
- 10.4 Field Compaction Methods
  - 10.4.1 Compacting Cohesive Fine Grained Soils
  - 10.4.2 Compacting pervious sands and gravels
- 10.5 Placement Control of Embankment
- 10.6 Field Tests
- 10.7 Compaction Control of Gravelly Material
- 10.8 Frequency of Testing
- 10.9 Statistical Evaluation of Tests
- 10.11 Borrow Area Control
- 10.12 Foundation Preparation
- 10.13 Contact Treatment
- 10.14 Necessity
- 10.15 Pore Pressure Measurements
- 10.16 Vertical Movement Devices
- 10.17 Horizontal Movement devices
- 10.18 Extensometers

- 10.19 Inclinometers
- 10.20 Surface Measurements
- 10.21 Stress Measurements
- 10.22 Seismic Measurements
- 10.23 Choice of Instrumentation
- 10.24 Instrumentation Problems

## **11. SECTION DETAILS AND SPECIAL PROBLEMS**

- 11.1 Section Details
  - 11.1.2 Free board
  - 11.2.3 Slope Protection
- 11.4 Joint between Concrete and Earth Dams
- 11.5 Cranking and its Control
- 11.6 Dams on Fault Zones
- 11.7 Problems of Layout
- 11.8 River Diversion
- 11.9 Conduits through Earth Dams
- 11.10 Expansive Soils
- 11.11 Dispersive Clays

**PROJECT:** A real Earth Dam Project is assigned to the students to practice a complete design of an earth dam on a section of a river.

### **References:**

1. Haeri. S.M. (1984) "Fundamentals of Earth Dam Design" GMOS, Tehran, Iran
2. Singh, B. and Sharma, H.D. (1976) "Earth and Rockfill Dams", Sarita Prakashan, Meerut, India

Many other books and technical papers are assigned for further readings