

King Fahd University of Petroleum & Minerals
CIVIL ENGINEERING DEPARTMENT

Course Name: CE 559 – Rock Mechanics (2-3-3)

Instructor: Dr. Naser A. Al-Shayea

Course Objective: To provide a selection of concepts, techniques, and applications of rock mechanics pertaining to engineering problems.

Course Description: Graduate Bulletin (2003-2005), p.175

Geological classification and index properties of rocks; strength and deformability behavior of intact and jointed rock masses; in-situ stresses; lab and field test methods; aspects of structural geology; stability of rock slopes; applications to surface excavations, underground openings and tunnels; foundations on rocks.

Prerequisite: Graduate standing and consent of instructor

Textbook: Introduction to Rock Mechanics, 2nd ed., 1989 by R.E. Goodman, John Wiley & Sons, Inc.

Selected References:

1. Farmer, I.W., Engineering Behavior of Rocks, 2nd ed., Chapman and Hall, 1983.
2. Goodman, R.E. and Shi, G.H., Block Theory and Its Application to Rock Engineering, Prentice-Hall, 1985.
3. Hoak, E. and Bray, J., Rock Slope Engineering, 3rd ed., Institute of Mining and Metallurgy, London, 1981.
4. Hoak, E. and Brown, E.T., Underground Excavations in Rock, Institute of Mining and Metallurgy, London, 1981.
5. Hudson, J.A., Brown, E.T., Fairhurst, C., and Hoek, E. (Editors), Comprehensive Rock Engineering – Principles, Practice and Projects, 1993.
6. Jaeger, J.C. and Cook, N.G.W., Fundamentals of Rock Mechanics, 3rd ed., Chapman and Hall, London, 1979.
7. Jumikis, A.R., Rock Mechanics, Trans-Tech Publication, 1983.
8. Lama, R.D., Vutukuri, V.S., and Saluja, S.S., Handbook on Mechanical Properties of Rocks, Trans-Tech Publication, Rockport, MA, 1974-1979.
9. Pande, G.N., Beer, G., and Williams, J.R., Numerical Methods in Rock Mechanics, John Wiley & Sons Ltd., 1990.

10. Turchaninov, I.A., Iofis, M.A., and Kasparyan, E.V., Principles of Rock Mechanics, Terraspace, Rockville, MD, 1979.
11. Wyllie, D.C., Foundations on Rock, Chapman & Hall, 1992.
12. Selected technical papers from Journals and Symposiums.

Course Syllabus

<u>Topics</u>	<u>No. of Lectures/Labs</u>
1.0 INTRODUCTION	1
1.1 Definitions of Rock	
1.2 Definition of Rock Mechanics	
2.0 GEOLOGICAL CLASSIFICATION	2
2.1 Genetic Classification of Rock	
2.2 Goodman's Classification of Rocks	
3.0 INDEX PROPERTIES OF ROCKS	2
3.1 Porosity	
3.2 Density	
3.3 Permeability	
3.4 Point Load Strength	
3.5 Schmidt Hammer Rebound Number	
3.6 Slaking Durability	
3.7 Sonic Velocity	
3.8 Rock Quality Designation (RQD)	
3.9 Bieniawski's Geomechanics Classification System	
4.0 FAILURE MECHANISMS IN ROCK	2
4.1 Tension	
4.2 Shear	
4.3 Crushing	
4.4 Mixed Mode	
5.0 LABORATORY STRENGTH TESTING	2
5.1 Unconfined Compression Test	
5.2 Triaxial Compression	
5.3 Stiff and Servo-Controlled Testing Machines	
5.4 Brazilian Split-Cylinder Test	
5.5 Flexural Tests	
5.6 Ring Shear Tests	
6.0 STRESS AND STRAIN BEHAVIOR OF INTACT ROCK	4
6.1 Stress Tensors	
6.2 Strain, Volumetric Strain	
6.3 Stress-Strain Relationship – Elasticity	
6.4 Definitions and Concepts	
EXAM # 1	1
7.0 FAILURE CRITERIA	5
7.1 Maximum Normal Stress Theory	
7.2 Maximum Normal Strain Theory	
7.3 Maximum Shear Stress Theory	
7.4 Maximum Total Strain Energy Theory	

7.5	Maximum Distortional Strain Energy Theory	
7.6	Coulomb Theory	
7.7	Mohr Theory	
7.8	Griffith Theory	
7.9	Modified Griffith Theory	
7.10	3-D Griffith Theory	
7.11	Empirical Criteria of Failure	
7.12	Effective Stress Theory	
7.13	Size Effects	
7.14	Strength Anisotropy	
8.0	IN-SITU STRESSES	2
8.1	Vertical Stress	
8.2	Horizontal Stress	
8.3	Measurement of In-Situ Stresses	
9.0	ASPECTS OF STRUCTURAL GEOLOGY	6
9.1	Basic Definitions	
9.2	Dip, Strike and Outcrop Pattern from Drill Hole Data	
9.3	Structural Features	
9.4	Stereographic Projection Problems	
10.0	PLANES OF WEAKNESS IN ROCK	3
10.1	Definitions of Microfissures, Fissures, Joints, Shears & Faults	
10.2	Joint Surveys, Plotting Joints	
10.3	Joint Testing	
10.4	Strength Models	
10.5	Strength as a Function of Joint Orientation	
10.6	Conditions for Sliding Along a Discontinuity	
10.7	Effect of Water Pressure	
11.0	DEFORMABILITY OF ROCK MASSES	2
11.1	Definitions of Moduli	
11.2	Determining Rock Mass Modulus	
EXAM # 2		1
12.0	SLOPE STABILITY OF ROCK	7
12.1	Types of Slope Failures	
12.2	Plane Sliding	
12.3	Vector Analysis on Stereographic Projection	
12.4	Rock Reinforcement-Stereographic Analysis	
12.5	Analysis of Plane Slides by Traditional Block Sliding	
12.6	Wedge Failure	
12.7	Toppling Failure	
13.0	ROCK FOUNDATIONS	5
13.1	Types of Bedrock Surfaces	
13.2	Foundation Types	
13.3	Footings on Rock	

- 13.3.1 Stress Distribution Beneath Footings
- 13.3.2 Bearing Capacity and Settlement
- 13.4 Drilled Piers Socketed Into Rock
 - 13.4.1 Modes of Failure
 - 13.4.2 Settlement of Deep Foundations
 - 13.4.3 Distribution of Loads
 - 13.4.4 Ladanyi Procedure for Determining Optimum Depth of Embedment

Total

45

CE 559
Rock Engineering

SUGGESTED TERM PAPER TOPICS FOR CE 559 ROCK ENGINEERING

1. Case Histories: Foundations on Rock
2. Rock Bolting
3. Shotcreting
4. Blast Vibration monitors
5. Blasting Vibrations
6. Response Spectra for Blast Vibrations
7. Fracture Mechanics
8. Seepage through Discontinuities
9. Statistical Methods for Joint Orientations
10. Effect of Joint Orientation on Permeability
11. Effect of Joint Orientation on Wave Propagation
12. Hydraulic Fracturing
13. Slope Stability
14. Subsidence
15. Numerical Modelling
16. Rock Drilling and Sampling
17. Servo-Controlled Testing Machines
18. Acoustic Emissions in Rock
19. In-Situ Stress Measurement
20. Constitutive Models for Rock
21. Computer (Graphics) Program for Stereonets
22. Rock Creep
23. Rock Blast Design
24. Other

TERM PAPER GRADING FOR CE 559 – ROCK ENGINEERING

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| 1. EFFORT (30 POINTS) | ----- |
| 2. SYNTHESIS OF REFERENCED MATERIALS (20 POINTS) | ----- |
| 3. ORGANIZATION (10 POINTS) | ----- |
| 4. FIGURES & TABLES (10 POINTS) | ----- |
| 5. NOTATION (10 POINTS) | ----- |
| 6. SUBMISSION ON THE TIME (10-N POINTS
WHERE N=DAYS LATE) | ----- |
| 7. VISUAL PRESENTATION (5 POINTS) | ----- |
| 8. GRAMMAR AND SYNTAX (5 POINTS) | ----- |

Ref:

1. Natural Science Library
2. Eng. Sc. Library - ASCE Geotech Journal
- Civil Engg. (Non-Tech.)