

Rock Slope Stability

Course No.: 0-206-2-3871

Lecture: Bldg. C-58, Room 018, Wednesdays 12:00 – 14:00

Exercise: Bldg. C-58, Room 018, Wednesdays 14:00 – 15:00

Instructor: Prof. Yossi Hatzor

Office hours: Room 018, Bldg. C-58, Sundays 15:00 – 16:00

Teaching assistants and office hours:

Almog Baram, Bldg. 64, Room 201, Mondays 14:00 – 16:00

Yair Gordin, Bldg. 60, Room 08, Mondays 12:00 – 14:00

Doron Morad, Bldg. 60, Room 09, Tuesdays 14:00 – 16:00

Course outline

Lecture No. 1 – 2018/03/07: Introduction

- Scope of rock slope stability
- Important field case studies
- The case of the Vajont dam

Lecture No. 2 – 2018/03/14: Basic assumptions

- Basic considerations in rock slope engineering
- Maximum height of slope
- Sliding on a single plane
- Influence of water pressure
- Influence of reinforcement
- Definition of a factor of safety for a slope
- Failure modes for which factor of safety can be calculated
- Failure modes for which factor of safety cannot be calculated

Exercise #1: TA – Almog Baram

Lecture No. 3 – 2018/03/21: Frictional resistance of rock discontinuities

- Testing methods for shear strength of discontinuities
- Some examples from Israel
- Influence of pore water pressure on shear strength

- Influence of surface roughness
- Patton's Law
- Jaeger's criterion
- Ladanyi and Archambault' criterion
- Significance of boundary conditions in direct shear tests

Lecture No. 4 – 2018/03/28: Empirical shear strength criteria for rock joints

- Nick Renger's roughness and dilation envelopes
- Goodman's method to obtain dilation controlled shear stress
- Evidence for roughness degradation with shear
- The influence of normal stress
- Scales of roughness
- Significance of block size
- Barton's shear strength criterion
- Consideration of scale effects
- Consideration of infilling material
- Dynamics of frictional sliding

Exercise #2: TA - Almog Baram

Pesach Holiday 2018/04/04 – No Class 😊

Lecture No. 5 – 2018/04/11: Statistical characterization of rock joints

- Joints control rock slope behavior – some examples
- Joint sets
- Dip and dip direction
- Finding the resultant orientation of a joint set
- True and biased joint spacing
- Sampling bias correction
- Terzaghi's correction for multiple joint sets
- The Fisher distribution
- Bias-corrected Fisher distribution
- Contouring method using the stereographic projection

Memorial Day 2018/04/18 – No Class ☹

Lecture No. 6 – 2018/04/25: The complete stereographic projection

- Line Projection
- Plane Projection
- Equal angle equatorial net
- Upper and Lower Hemisphere Projections

- Quantitative Stereographic projection
 - Stereographic projection of a line
 - Stereographic projection of a plane
 - The line of intersection of two planes
 - The small circle
 - The complete equal angle stereonet

Exercise #3: TA – Yair Gordin

Lecture No. 7 – 2018/05/02: Vector operations using the stereographic projection

- The Cross Product of Two Vectors
- The Dot Product of Two Vectors
- Vector Addition and Subtraction
- Addition of three vectors
- Parametric Addition of Vectors

Exercise #4: TA – Yair Gordin

Lecture No. 8 – 2018/05/9: Single plane sliding

- Plotting Forces on the Stereographic Projection
 - Weight vector
 - Water force
 - Bolt force
 - Earthquake inertia force
- The Friction Circle and Definition of Factor of Safety
- Worked example in class of 3D LEA for single plane sliding
- Single plane sliding in 2D

Lecture No. 9 – 2018/05/16: Kinematical analysis on the stereonet

- Meaning of kinematic analysis
- The basic elements of a rock mass structure
- Kinematical test for plane sliding
- Kinematical test for double plane (wedge) sliding
- Kinematical test for Toppling
- Kinematical tests to select line elements for further analysis

Exercise #5: TA – Yair Gordin

Lecture No. 10 – 2018/05/23: Double plane sliding – slip of a tetrahedral wedge

Exercise #6: TA – Doron Morad

Students Day 2018/05/30 – No Class 😊

Lecture No. 11 – 2018/06/06: Using block theory to perform slope stability analysis

Field trip: 2018/06/7-8

Midterm Exam: 2018/06/13 12:00 – 15:00 (in class)

Lecture No. 12 – 2018/06/20: Hands on practice with computer programs (in computers class)

Exercise #7: TA – Doron Morad

Recommended Literature

E. Hoek: *Practical Rock Engineering* (see course site for free download)

Goodman, R. E. and Gen-hua Shi. *Block Theory and its Application to Rock Engineering*. Prentice-Hall, Inc. Englewood Cliffs, New Jersey p.338 (1985).

Goodman, R. E. *Methods of Geological Engineering in Discontinuous Rocks*. West Publishing Co., St. Paul p.472 (1976).

Goodman, R. E. *Introduction to Rock Mechanics*. John Wiley & Sons, New York 2nd Ed.,p.562 (1989).

Hoek, E. and J. W. Bray. *Rock Slope Engineering*, 3rd ed. Institution of Mining and Metallurgy, London 358pp (1981).

Rules of the games

Class attendance is not mandatory but is highly recommended. Attendance in the two-day field camp is mandatory. All homework assignments must be submitted one week after they are assigned. Two field reports must be submitted by the published deadlines by groups consisting of up to three members.

Grading

Homework assignments:	16%
Midterm exam	20%
Field report day 1 (Due July 06, 2018):	32%
Field report day 2: (Due July 20, 2018):	32%

Good luck,

Yossi.