



UNIVERSITÀ  
DEGLI STUDI DI MILANO-BICOCCA

## COURSE SYLLABUS

### Slope Stability

2122-1-F7401Q076

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#### Aims

Advanced knowledge of processes and mechanisms of natural and engineered slope instability; ability to recognize and characterize different types of slope instabilities; ability to use stability analysis methods and tools to solve practical problems.

#### Contents

Theory and techniques for the recognition, characterisation and modelling of slope instability processes in soils and rocks.

#### Detailed program

##### Lectures:

- 1) Slope system and its geological, topographic and hydrological setting; landslide terminology, classification, controls and triggers; landslide risk.
- 2) Landslide investigations: photo-interpretation and field mapping, monitoring, site investigations (topographic, borehole, geophysical).
- 3) Slope instability processes: physic-mechanical and constitutive features of soils and rocks relevant to slope

stability; stress distributions and paths in a slope; role of water in slope instability; concept of Safety Factor; total stress and effective stress analyses; short- vs. long-term in slope stability; weakening, softening, and progressive failure; first-time rupture vs. reactivation.

4) Landslide types: large rock slope instabilities: morphostructural features, lithological and structural controls, triggering processes and long-term evolution; rockfalls: processes, characterization and modelling of onset and propagation, susceptibility and risk assessment; rainfall-induced shallow landslides: characterization, hydrological and mechanical aspects, stability analysis, regional-scale prediction; flow landslides and debris flows: rheology of water-sediment mixtures, onset and propagation processes, field evidence and dynamic modelling.

5) Methods of stability analysis: Limit Equilibrium (LEM) methods for circular failures: Taylor, Fellenius, GLE, Spencer, Bishop simplified, Janbu simplified); methods for "structurally-controlled" failure mechanisms (planar and wedge failure, topplings): kinematic analysis and LEM methods; probabilistic and reliability analyses; numerical methods.

6) Monitoring: aims and applications; ground-based and remote surface displacements monitoring techniques; underground deformation monitoring; monitoring of hydro-meteorological variables and pore pressures; monitoring network architecture.

7) Landslide risk mitigation: active vs. passive approaches; slope stabilization techniques; active and passive structural protection; non-structural protection and Early Warning.

#### **Lab work:**

1) landslide mapping from aerial photos, ortho-photos and HRDEM, characterization of geological controls and interactions with elements at risk

2) Reconstruction of a landslide geological model from field, site investigation and monitoring data.

3) Application of software tools to the practical solution of slope stability problems in soils and rock masses using: a) kinematic stability analysis methods for structurally controlled block failure modes; b) limit equilibrium analysis methods (LEM, deterministic and probabilistic) for soil and rock slopes, including the effects of water, dynamic loading, external actions and stabilization works; c) numerical finite-element methods (SSR-FEM).

#### **Field work:**

Field trip in the Central Alps: recognition and mapping of typical features related to different landslide types, visit to important historical or active landslide sites.

#### **Prerequisites**

Geology, hydrogeology, engineering geology

## **Teaching form**

- Lectures, 28 hours (4 CFU)
- Lab work, 12 hours (1 CFU)
- Field work, 10 hours (1 CFU)

During the Covid-19 emergency, teaching will be held in mixed mode, with delayed video-recorded lectures and partial physical presence (practical activities, i.e. some labs and fieldwork).

## **Textbook and teaching resource**

Lecture notes and supplementary material

## **Semester**

2nd semester

## **Assessment method**

Oral examination with a discussion on a project assignment and 4 questions on the theory

## **Office hours**

On appointment

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