UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Slope Instability

2627-1-F7402Q008

Aims

The course aims at providing the student with an in-depth knowledge of the mechanisms of soil and rock slope instability, as well as practical skills in the recognition and characterization of different types of instability and in the operational use of methods and tools for stability analysis.

Knowledge and Understanding
To know and understand the geological, structural and geomechanical aspects that control slope instability processes in soils, rocks and fractured rock masses. To know and be able to evaluate the appropriate methods for the characterisation of different slope instability processes in the field and through remotely sensed data. To be able to process and interpret the results of investigations.

Applying Knowledge and Understanding
To be able to recognise, map, characterise and monitor the main types of landslides for the purposes of defining the degree of stability, predicting their evolution, characterising hazard and risk, and defining appropriate mitigation strategies. To be able to synthesise the results of investigations and analyses carried out through graphical outputs and reports.

Making Judgements
To be able to independently assess current, expected or potential slope instability issues within a given geological and morpho-climatic context, in order to identify the key parameters for analysis and to select the most appropriate and reliable investigation and stability analysis methods, including from a cost-benefit perspective.

Communication Skills
To be able to classify and describe natural slope instability processes in a concise yet rigorous manner and with appropriate use of terminology, providing clear operational links between the reference geological context, controlling and triggering factors, and the characteristics of ongoing or expected processes. To be able to clearly communicate the results of the investigations carried out, through written reports and their oral discussion.

Learning Skills

To be able to apply the concepts and methods acquired to understand and characterise real-world contexts.

Contents

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

Detailed program

Lectures (Delivered Didactics)

1. Slope system and its geological, topographic and hydrological setting. Landslide terminology, classification, controls and triggers. Landslide hazard and risk.

2. Landslide investigations. Photo-interpretation and field mapping, monitoring, site investigations (topographic, borehole, geophysical).

3. Slope instability processes. Physico-mechanical and constitutive features of soils and rocks relevant to slope instability. Stress distributions and paths in a slope. Role of water in slope instability. Concept of Safety Factor. Total stress and effective stress analyses. Short-term 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-indiced 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. Slope monitoring. Accuracy, precision and frequency of measurements. Architecture of a monitoring network. Surface displacement measurements: geotechnical and topographic methods, GNSS, laser scanning and photogrammetry. Landslide characterization and monitoring by radar interferometry (InSAR). Subsurface deformation measurements: inclinometric and extensometric techniques. Measurement of hydro-meteorological variables and fluid pressures.

6. Stability analysis methods. Limit Equilibrium (LEM) methods for circular failures: Taylor, Fellenius, GLE, Spencer, Bishop simplifiied, Janbu simplified). Methods for "structurally-controlled" failure mechanisms (planar and wedge failure, topplings): kinematic and LEM methods. Numerical methods (FEM-SSR). Probabilistic and reliability analyses.

7. Landslide risk mitigation. Active and passive approaches. Slope stabilization techniques. Landslide forecasting and Early Warning.

Lab work (Interactive Teaching)

1. Landslide recognition and mapping from aerial photos, ortho-photos and HRDEM, characterization of geological controls and interactions with elements at risk

2. Application of PC 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 e 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 (Interactive Teaching)

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. Analysis of the relationships between geological and morpho-dynamic settings and slope instability processes.

Prerequisites

Course of "Safety in the Field" (status: "Approved"). Basic knowledge of Geomorphology, Engineering Geology and Structural Geology.

Teaching form

The course is taught in English and divided into:

- 14 two-hour Lectures in person, Delivered Didactics (4 ECTS, 28 hours)
- 3 four-hour lab activities, in person, Interactive Teaching (1 ECTS, 12 hours)
- a twelve-hour field activity, in person, Interactive Teaching (1 ECTS, 12 hours)

The field activity consists of a 2-day end-of-course field trip with overnight stay.

Textbook and teaching resource

Lecture notes, supplementary materials, and datasets provided by the Teacher.

Semester

2nd semester

Assessment method

Verification of the knowledge and skills acquired by the student takes place by means of a final exam, aimed at assessing the student's theoretical preparation and his ability to: apply his basic geological knowledge to the

recognition of slope instability phenomena in different geological and morpho-climatic settings; identify current or potential instability processes, select the appropriate analysis approach and set up the correct solution path; correctly use modern slope stability analysis tools.

The final exam consists of an individual ORAL EXAMINATION, structured in:

- an interview on an individual slope stability project assignment, for the verification of disciplinary problem solving skills.
- an interview on the topics covered in class (3 questions), for the verification of knowledge and communication skills in the disciplinary field.

There are no *in itinere* tests.
The final grade is awarded in thirtieths.

Office hours

The Teacher receives on appointment, to be scheduled by e-mail.

Sustainable Development Goals

QUALITY EDUCATION | INDUSTRY, INNOVATION AND INFRASTRUCTURE | SUSTAINABLE CITIES AND COMMUNITIES | CLIMATE ACTION