MODULE DESCRIPTOR 2019/20

CL917
Slopes and Walls
(with Mechanics of Unsaturated Soils)

Registrar: Prof Alessandro Tarantino	**Taught to:** MEng Civil Engineering / MEng Civil and Environmental Engineering / MSc Civil Engineering / MSc Civil Engineering with Industrial Placement	
Other Lecturers Involved:	**Credit Weighting:** 10	**Semester:** 2
Assumed Prerequisites: UG Students: CL217, CL314, and CL419 PG Students: Soil mechanics (water flow, compressibility, consolidation, and shear strength) and fundamentals of Mechanics of Collapse	**Compulsory/ optional/ elective class** Compulsory for Geotechnical Stream in the MSc Civil Engineering / MSc Civil Engineering with Industrial Placement	**Academic Level:** 5

Course Format and Delivery (hours):

Lecture	Tutorial	Laboratory	Coursework	Project	Private Study	**Total**
24	16		20		40	100

Class Aim(s)

This class aims to introduce advanced tools to analyse geotechnical structures at the ultimate limit state taking into account the effect of climate load

Learning Outcomes

On completion of the class the student is expected to be able to

LO1 Understand the fundamentals of hydro-mechanical behaviour of soils under saturated and unsaturated conditions.

LO2 Understand the unifying mechanisms underlying the collapse of geotechnical structures (shallow foundations, slopes, retaining walls and diaphragms, vertical cuts) under saturated and unsaturated conditions

LO3 Apply bounding theorems of plasticity to analyse collapse of simple slopes and retaining walls subjected to climate load.

LO4 Use numerical codes to analyse the stability of complex geotechnical structures subjected to climate load

Syllabus

The class will teach the following:

Topic 1: Water flow in unsaturated soils
Concept of suction, water retention behaviour, mass balance equation, Darcy's law for unsaturated porous media, analytical solutions for uncoupled flow, 'engineering' approach for conservative analysis of uncoupled water flow,

Topic 2: Shear strength of unsaturated soils
Extension of Mohr-Coulomb criterion to unsaturated soils, characterisation of shear strength of unsaturated soils using conventional equipment

Topic 3.Collapse of geotechnical structures
Plane-strain and stress in a plane. Rigid-perfectly plastic behaviour.
Plastic deformation and associated flow rule.
Lower bounding theorem of plastic collapse and application to drained and undrained analysis
Upper bounding theorem of plastic collapse and application to drained and undrained analysis

Topic 4. Analysis of collapse of geotechnical structures under saturated and unsaturated conditions
Prediction of excavation critical height.
Calculation of active thrust on gravity walls using bounding theorems of plasticity and basic design of gravity walls.
Calculation of active and passive thrust on diaphragm walls using bounding theorems of plasticity and basic design of diaphragm walls.
Calculation of slope factor of safety

Assessment Criteria

For each of the Course Learning Outcomes the following criteria will be used to make judgements on student learning:

LO1 Understand the fundamentals of hydro-mechanical behaviour of soils under saturated and unsaturated conditions.
C1 Estimate the shear strength of soils under unsaturated conditions.
C2 Estimate hydraulic behaviour of soils under unsaturated conditions.

LO2 Understand the unifying mechanisms underlying the collapse of geotechnical structures (shallow foundations, slopes, retaining walls and diaphragms, vertical cuts) under saturated and unsaturated conditions
C1 Write down and solve equations to analyse stability of geostructures using lower bound theorem of plasticity
C2 Write down and solve equations to analyse stability of geostructures using upper bound theorem of plasticity

LO3 Apply bounding theorems of plasticity to analyse collapse of simple slopes and retaining walls
C1 Calculate critical height of excavation
C2 Analyse collapse condition of retaining structures
C3 Analyse collapse condition of slopes

LO4 Use numerical codes to analyse the stability of complex geotechnical structures subjected to climate load
C1 Analyse rainwater flow in flat and sloping ground
C2 Determine factor of safety of geotechnical structures with complex collapse mechanisms

The standards set for each criterion per Learning Outcome to achieve a pass grade are indicated on the assessment sheet for all assessments.

Principles of Assessment and Feedback
see https://www.strath.ac.uk/staff/policies/academic/

Please state briefly how these are incorporated in this module.

Principle 1. Assessment and feedback practices promote effective student learning
Feedback is provided in real-time in an interactive fashion. Students are asked to solve problems of different level of complexity during the lecture and the lecture is tuned to the gaps shown by the students. In tutorials sessions, students are asked to become teachers by explaining tasks

Principle 2. Assessment and feedback practices are appropriate, fair, and transparent
These are discussed with the students at the beginning of the course and students' comments are taken into account

Principle 3. Assessment and feedback practices are clearly communicated to students and staff
These are discussed with the students at the beginning of the course and any point during the course should practices be revised

Principle 4. Assessment and feedback practices are continuously reviewed
We made use of mid-term questionnaires design to possibly adjust teaching approach

Recommended Reading

Tarantino, A & Di Donna, A. (2019). Mechanics of unsaturated soils: simple approaches for routine engineering practice. *Italian Geotechnical Journal*.

Craig, R.F. & Knappett, J.A., *Craig's Soil Mechanics*, 8th edn., (2012) Spon Press, ISBN 978-0-415-56126-6.

Powrie, W., *Soil Mechanics; Concepts and Applications*, 2nd edn., (2004), Spon Press, ISBN 0-415-31156-X.

Atkinson, J.H., *Mechanics of Soils and Foundations*, 2nd edition (2007). CRC Press, ISBN 978-0-415-36256-6.

PLEASE NOTE:
Students need to gain a summative mark of ~~40%~~ / 50% *(please delete as appropriate)* to pass the module. Students who fail the module at the first attempt will be re-examined during the August diet. This re-examination will consist entirely of exam / coursework / ~~viva~~ *(please delete as appropriate).*

Resit Arrangements

Re-examination consists of exam only if failure at the first attempt is due to failure of exam or exam + coursewor

Re-examination consists of coursework only if failure at the first attempt is due to failure of coursework

Approved

Programme Director Signature:

Date of Last Modifications: July 2019

(Updated August 2017)

Assessment and Feedback Schedule

Class Code	CL917	Class Title	Slopes and Walls

Brief Description of Assessment

80 % Exam in semester 2 exam period
20% Coursework

Indicate in the tables below the Hand-Out (H), Submission (S) and Feedback (F) dates for each lab report/coursework/project and the timing of each Exam/Class Test (E), (T). Include duration of exam in brackets (e.g. E (2)).

Semester 1

Assessment type (& title)	LOs	Weight (%)	Individual / Group	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9	WK10	WK11	Exam Period

Semester 2

Assessment type (& title)	LOs	Weight (%)	Individual / Group	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9	WK10	WK11	Exam Period
Exam	1-3	80%	Individual												E (3)
Coursework	4	20%	Individual					H					S	F	