SCHOOL OF CIVIL ENGINEERING AND SURVEYING

UNIVERSITY OF PORTSMOUTH

ACADEMIC YEAR 2020/2021

SOILS AND MATERIALS 3 U23357

Coursework

N/A

Instructions: N/A

Provided: N/A

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School of Civil Engineering and Surveying		Student Registration Number:	
M23357 Soils and Materials 3		Course: BEng/MEng CE, BEng EG(SEGG)	Date Set: 12/10/2020
Item 1B – Cofferdam Report		Lecturer: Dr Mehdi Rouholamin	Date Due: 04/12/2020
		Ref:	Weight: 40%

Objectives:

To present calculations for the embedment depth of a sheet pile cofferdam and evaluate stability and construction issues.

Task:

The construction of pumping station very close to a river bank requires a long excavation, running parallel with the river, 25m in width and to a depth of 7m (Figure 1) To enable the foundations of the intake works to be constructed in the dry a steel sheet-pile cofferdam is to be constructed between the river and the excavation. The properties of the River bed soil are presented in Table 1.

(a) Using Geosolve Wallap and the strength factor design method, calculate the penetration depth (d) needed to achieve a factor of safety of 1.25 against overturning. Include a prop if you think it is necessary, and choose its position.

(b) Validate this design penetration depth (d) with hand calculations, again using the strength factor design approach, taking into account seepage forces and water pressures.

(c) The design penetration depth (d) will also impact the flow of water into the excavation under the sheet pile. Sketch a flow net for your chosen design penetration depth and use it to determine the quantity of flow into the excavation.

(d) Critically evaluate the design approach followed from part (a) to (c) considering any design requirements or construction aspects that have been overlooked, or assumptions that may not be reasonable.

Additional information for sheet pile construction and pumping is attached in Appendix 1.

Learning outcomes:

On successful completion of this Module, students should be able to:

1. Use hand calculations and software to analyse the stability flexible retaining walls.
2. Analyse ground water flow around flexible retaining walls
3. Evaluate all construction and economic considerations for the design of flexible retaining walls.

Reading / References:

- British Standards Institute. (2015). BS 8002. Code of practice for earth retaining structures. Retrieved from https:\\bsol.bsigroup.com.
- British Standards Institute. (2013). BS EN 1537. Execution of special geotechnical works – Ground anchors. Retrieved from https:\\bsol.bsigroup.com.
- British Standards Institute. (2004). 1997-1:2004+A1:2013. Eurocode 7: Geotechnical Design - Part 1: general rules. Retrieved from https:\\bsol.bsigroup.com.
- British Standards Institute. (2004). 1997-1:2004+A1:2013. Eurocode 7: Geotechnical Design - Part 2: Ground Investigation and testing. Retrieved from https:\\bsol.bsigroup.com.
- BS EN 1536:2010+A1:2015 Execution of special geotechnical work; Sheet-pile walls
- BS 6349-1-3:2012 Maritime works. General. Code of practice for geotechnical design
- Williams, B. P., & Waite, D. (1993). The Design and Construction of Sheet-Piles Cofferdams. London: CIRIA.
- Yandzio, E. (1998) Design Guide for Steel Sheet Pile Bridge Abutments. 1 Edition. The Steel Construction Institute.

Submission instructions

The two coursework reports for this Module, slope stability report and cofferdam report make up one coursework artefact and correspond to 60% and 40% of the total coursework mark respectively. The marks for each one will be added to give a mark out of 100%. They need to be submitted as one file on Moodle submission box. It is a soft copy Moodle submission, no hard copy is needed. These two coursework marks make up 40% of the overall mark for the Module (making them worth 30% and 20% of the Module respectively) with the exam accounting for the remaining 60%.

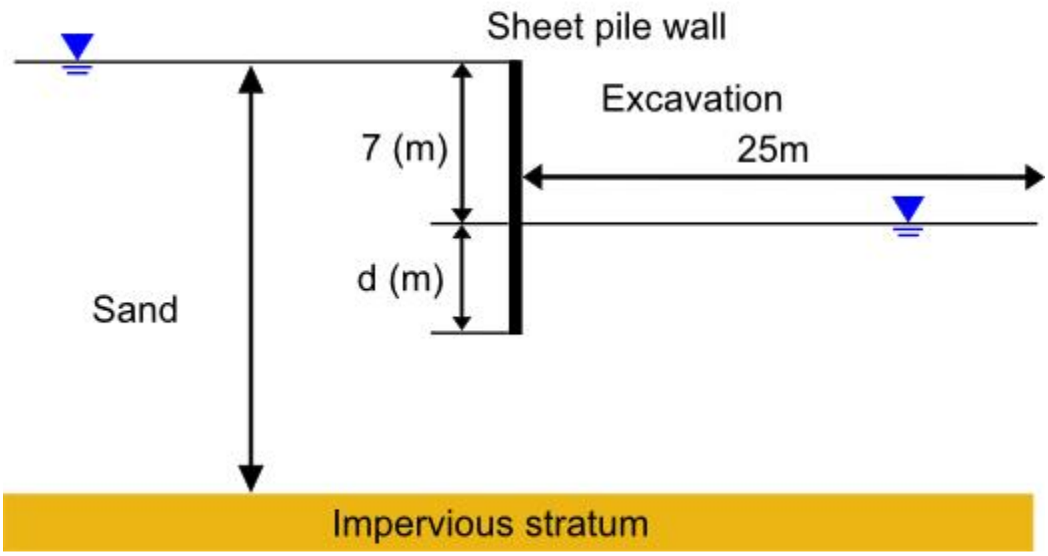

Figure 1

Table 1: Soil Properties:

Group ID	Layer	Description	Depth	ρ (Mg/m³)	c' (kN/m²)	Φ'	E (MN/m²)	k (m/s)
1&4	River bed	Sand	25	1.9	0	34	16	2.4×10^{-4}
2&5	River bed	Sand	25	2	0	35	17	4×10^{-4}
3&6	River bed	Sand	25	2.1	0	36	18	6×10^{-4}

Wall properties:

Take the Young's Modulus (E) of the wall to be 3.00×10^{7} KN.m^2/m.
Take the Moment of Inertia (I) of the wall to be 8.48×10^{-3} m^4/m run.

Strut properties:

Take the Young's Modulus (E) of the strut to be 2.00×10^{8} KN.m^2/m.
Take the Cross Sectional Area (A) of the strut to be 0.0625 m^2.
Take the Spacing of the struts to be 1m.
Take the Pre-stress/strut to be 100kN.

Grade Criteria

Please refer to the grade descriptors given in the Student Handbook. The following table shows specific features of work at each grade for this particular task.

Grade (%)	Specific Features
A* (80+)	Work is structured according to requirements with correct calculations and critical assessment of the design decisions taken for this slope, its long term stability and remedial options, showing originality and creativity and making use of references beyond the material given to provide extra insight. The report is clear and logical and procedures are well explained. The presentation is at a standard suitable for dissemination to a client of an engineering consultancy.
A (70-79)	Work is structured according to requirements with correct calculations and critical assessment of the design decisions taken for this slope, its long term stability and remedial options. The report is clear and logical and procedures are well explained. Professional presentation.
B (60-69)	Work approaches A grade but lacks critical thinking or shows some minor errors in structure, explanation of procedures followed or calculations.
C (50-59)	Work has some incorrect or missing aspects to structure or explanation of procedures and lacks critical thinking but appears to show correct calculation process.
D (40-49)	Work has significant incorrect or missing aspects to structure or explanation of procedures but appears to follow calculation process correctly.
E (30-39)	Incomplete and/or incorrect calculations. Inadequate explanation of procedures.
F (0-29)	No serious attempt to address the requirements of the assignment.

School of Civil Engineering and Surveying **Coursework self-assessment sheet for students**	**Student Registration Number:**	
	Date:	

Unit Name	**SOILS AND MATERIALS 3 U23357**		
Artefact Number	**Item 1**	**Artefact Title**	**Report**

The University of Portsmouth regulations require students to keep electronic copies of all assignments, and submit these at any time upon request.

Shaded areas to be completed by student and this sheet submitted with assignment.

Student comment: I have read and understood the University's regulations on plagiarism – please type an 'x'

Criteria Description	**Weighting %**	**Student Evaluation** *(to be completed before submission)* *(enter an 'x' in required boxes)*						
		Pass					**Fail**	
		A*	**A**	**B**	**C**	**D**	**E**	**F**
Wallap Analysis	25							X
Hand Calculations	25							X
Flow Net for chosen depth	25							X
Critical assessment of design approach	25							X

	Letter Grade (A* - F)	Percentage (100 – 0)
Overall Grade *(to be completed before submission)*		

Key: A*: 80% or above, A: 70% - 79%, B: 60% - 69%, C: 50% - 59%, D: 40% - 49%, E: 30% - 39%, F: 29% or less
IMPORTANT: See separate Grade Criteria for characteristics of work in the above grades

Student Comment *(to be completed before submission)*

APPENDIX 1 - ADDITIONAL INFORMATION

This project concerns the design of a cofferdam - essentially a temporary structure designed to support the ground and to exclude water from an excavation. The water may be either ground water or water lying above ground level, such as a lake or river. A cofferdam does not necessarily exclude all water as this may be uneconomical unless an impervious stratum lies at a relatively shallow depth.

Many different types of cofferdam are available - eg embankments of earth or rockfill, timber or concrete piling - but probably the most widely used is steel sheet piling. However, the choice of type depends on the site conditions, as well as on the availability and ease of transport to site of the construction materials and installation equipment.

Steel sheet piling is often used because of its structural strength, the watertightness given by its interlocking sections and its ability to be driven to deep penetration in most types of ground. There are many types of rolled-steel section available, a typical section being shown in Figure 2.

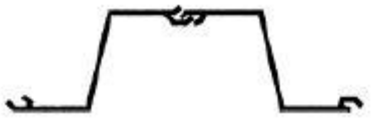

Figure 2: Typical steel sheet piling section

A cofferdam can consist of a single wall, which may be self-supporting by the cantilever action of the pile in the ground or may be supported by struts across the excavation. Where an excavation is too wide for cross-bracing, an earth or rockfill double-walled cofferdam may be adopted, while for large heads of water cofferdams are sometimes constructed in cellular form.