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THE OPEN UNIVERSITY OF SRI LANKA
Bachelor of Technology (Civil) - Level 6
CEU 4302 – Geotechnical Engineering

FINAL EXAMINATION - *2005 / 06*

Time Allowed: **Three (03) Hours**

Date: 2006 - 04 - 26 (Wednesday) Time: 1330 -1630 hrs.

The paper consists of Eight (8) questions. Answer Five (5) questions.

Q1.

i. A multi storey-building complex is proposed to be built on a top layer of lateritic formation and a lower layer of clayey soil, which lie above the hard bedrock.

a. Give a suitable technique for obtaining undisturbed samples for the given site. Provide reasons for your selection. (4 points)

b. State the factors that you may consider in deciding the depth of subsurface investigation of a project. (4 points)

ii.

a. Explain the effect of the presence of a dense silty sand deposit below the water table on the interpretation of Standard Penetration test (SPT) results. (4 points)

b. Determine a suitable width for a strip foundation for a load-bearing wall carrying a uniformly distributed service load of 400 kN/m. The site investigation revealed the presence of a loose to dense silty sand deposit to a great depth. The water table was encountered at a depth of 1 m below the ground surface at the time of investigation. SPT results obtained in a nearby borehole gave the following values.

Depth m	1.0	2.0	3.0	4.0	5.0
N	6	8	8	14	17

Use $C_N = 9.78(1/\sigma_v')^{1/2}$ for overburden correction where σ_v' is in kPa.

Assume a saturated unit weight of 17 kN/m^3 for the sand in computations. You may use the charts attached. (8 points)

Q2.

i. The results of sieve analysis test conducted on samples of four soils A, B, C and D are given in Table No. Q2.

BS sieve	Particle size	Percentage smaller			
		Soil A	Soil B	Soil C	Soil D
63 mm		100		100	
20mm		64		76	
6.3mm		39	100	65	
2mm		24	98	59	
600μm		12	90	54	
212μm		5	9	47	100
63μm		0	3	34	95
	0.020mm			23	69
	0.006mm			14	46
	0.002mm			7	31

Table No. Q2.

The results of limit tests conducted on sample of soil D are:

Liquid Limit Test

Cone Penetration (mm)	15.5	18.0	19.4	22.2	24.9
Water Content %	39.3	40.8	42.1	44.6	45.5

Plastic Limit Test

Water Content %	23.9	24.3

The fine fraction of soil C has a liquid limit of 26 and plasticity index of 9.

a. Classify each soil according to the Unified System. (Annexed) (12 Points)

b. Indicate the response of soil D to visual classification tests the Dry Strength test, Dilatancy reaction, Toughness at Plastic limit, and Plasticity. (4 points)

c. Describe the observed gradations. (4 points)

Q3.

a. Explain how engineers classify the weathering profiles in major civil engineering constructions. (4 points)

b. Describe how you would determine the RQD value and core recovery of a rock sample in a core box. Explain how RQD expressed in percentage could be used to assess the quality of the rock mass. (6 points)

c. Describe how Brazilian Test on rock is conducted to determine the tensile strength. Also state why this is preferred to other methods of tensile testing. (6points)

d. Explain how Point Load Test could be used to assess the compressive strength of the intact rock. (4 Points)

Q4.

i. State the assumptions used in the Taylor's method of analysis of slope stability. (5 points)

ii. How would you analyze the stability of a slope after a complete sudden drawdown, using the Taylor's method of analysis? (5 points)

iii. A canal with a depth of 5m has banks with uniform 1: 1 slope. The properties of soil on the slope are, $c = 20\ kN/m^3$ and $\phi = 15°$, $e = 0.7$, $G = 2.6$. Calculate the factor of safety of the slope with respect to cohesion using Taylor's stability charts for the following cases:

  a. When canal runs full (5 points)

  b. When it is suddenly and completely emptied (5 points)
  (Stability Chart annexed)

Q5. Geotechnical and geological assessment is required in the preliminary stages to determine suitable sites for dam projects. A zoned embankment dam is proposed to be built in the dry zone of Sri Lanka. Assuming that you are the appointed geotechnical engineer of this embankment dam project:

i. Discuss geological consideration relating to the construction of the embankment dam. (4 points)

ii. Describe how you would conduct the site reconnaissance survey. (4 points)

iii. Explain with help of a neat sketch, the components of a zoned embankment dam, with their functions. (4 points)

iv. Propose suitable methods that could be adopted for seepage control / drainage of this dam. (4 points)

v. How you could use seismic refraction method in geological and geotechnical investigation of this dam project. (4 points)

Q6.

Fig. Q6. (Annexed) shows a weir with a cut off wall at downstream side. The weir is constructed in a uniform deposit of soil overlying impermeable bedrock. The permeability of the soil below the weir is 5×10^{-4}cm/sec. Note that the figure is drawn to scale.

i. Draw a flow net for seepage for this case paying attention to specific rules that you have learnt in sketching a flow net. (4 points)

ii. Using the flow net given in figure calculate the quantity of seepage under the weir. (4 points)

iii. Compute the pore water pressure at point A. (4 points)

iv. Derive an expression for the hydraulic gradient of a granular soil in terms of the grain specific gravity and void ratio. (4 points)

v. Explain what happens if the exit gradient of seepage flow exceeds the critical hydraulic gradient in the above case. (4 points)

Q7.

i. A road is to be constructed from a hill country to the commercial capital in lowland. The first part of 120km is through a mountainous rocky terrain and the latter part is through a low-lying coastal plain.

a. Explain using sketches how the bedding planes, joint planes etc. contribute to the different types of failures e.g. plane, wedge, toppling etc. in rocks. (4 points)

b. How would you stabilize cut slopes in rock along the proposed road? (4 points)

ii. A utility tunnel is to be driven through a folded layer of sedimentary rocks.

a. Explain how you will use Bienawaski Rock Mass Classification to assess the stand up time of the tunnel. (4 points)

b. Discuss a supporting system that can be used in the said tunnel. (4 points)

c. Give the main problems that need to be looked into from a hydro geological point of view during construction and planning of the tunnel. (4 points)

Q8.

i. Discuss how different types discontinuities of rocks are formed due to genetic origin. (6 points)

ii. The selection of a scale for different types of maps is an important issue.

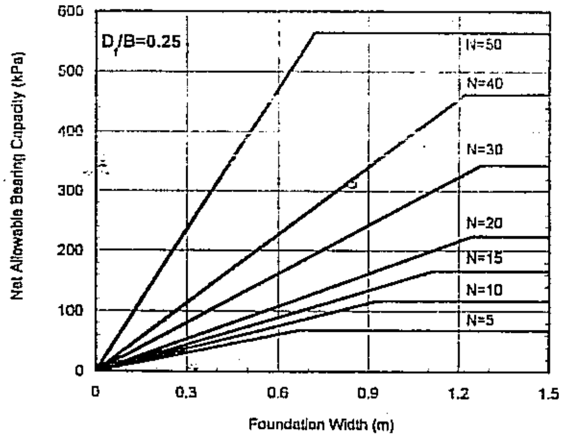
a. The choice of the scale of the base maps is decided considering the purpose. Describe this statement. (4 points)

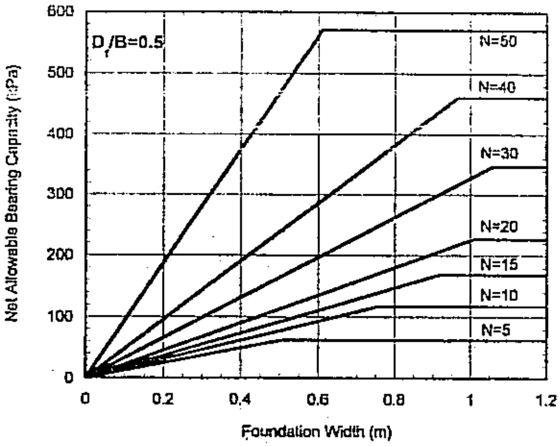
b. Select suitable types and scales for engineering geological maps for the following purposes: (6 points)

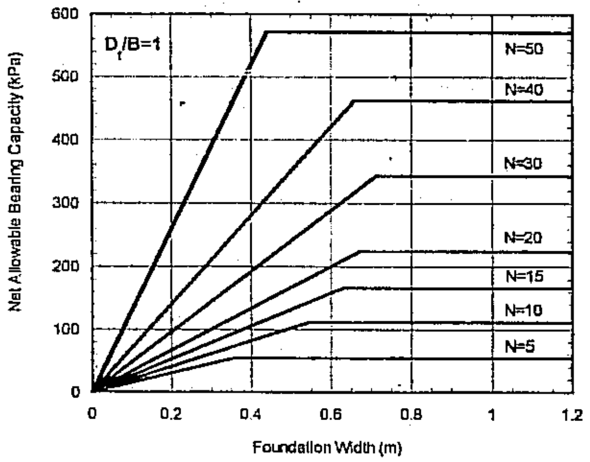
For regional land use planning
To determine the landslide patch of an area
To determine the suitability of a trace of a tunnel

c. Explain the significance of engineering geological maps in site investigation. (4 points)

Q1.


D_f/B=0.25
Net Allowable Bearing Capacity (kPa)
Foundation Width (m)
0
100
200
300
400
500
600
0
0.3
0.6
0.9
1.2
1.5
N=50
N=40
N=30
N=20
N=15
N=10
N=5


D_f/B=0.5
Net Allowable Bearing Capacity (kPa)
Foundation Width (m)
0
100
200
300
400
500
600
0
0.2
0.4
0.6
0.8
1
1.2
N=50
N=40
N=30
N=20
N=15
N=10
N=5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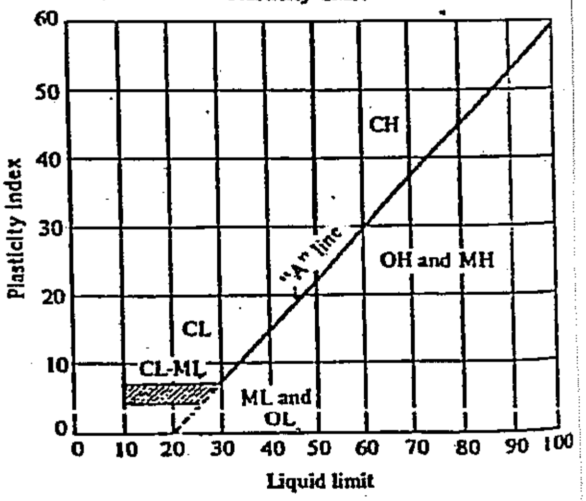
Net Allowable Bearing Capacity (kPa)
Foundation Width (m)
0
100
200
300
400
500
600
0
0.2
0.4
0.6
0.8
1
1.2
N=50
N=40
N=30
N=20
N=15
N=10
N=5

Unified Soil Classification System (ASTM-D2487)

Major Divisions			*Group Symbols*		*Typical Names*	*Laboratory Classification Criteria*		
Coarse-grained soils (More than half of material is larger than No. 200 sieve size)	Gravels (More than half of coarse fraction is larger than No. 4 sieve size)	Clean gravels (Little or no fines)	GW		Well-graded gravels, gravel-sand mixtures, little or no fines	Determine percentages of sand and gravel from grain-size curve. Depending on percentage of fines (fraction smaller than No. 200 sieve size), coarse-grained soils are classified as follows: Less than 5 per cent GW, GP, SW, SP More than 12 per cent GM, GC, SM, SC 5 to 12 per cent *Borderline* cases requiring dual symbols[b]	$C_u = \frac{D_{60}}{D_{10}}$ greater than 4; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between	
			GP		Poorly graded gravels, gravel-sand mixtures, little or no fines		Not meeting all gradation requirements for GW	
		Gravels with fines (Appreciable amount of fines)	GM[a]	d	Silty gravels, gravel-sand-silt mixtures		Atterberg limits below "A" line or P.I. less than 4	Above "A" line wi between 4 and 7 are *b* *line* cases requiring dual symbols
				u				
			GC		Clayey gravels, gravel-sand-clay mixtures		Atterberg limits below "A" line with P.I. greater than 7	
	Sands (More than half of coarse fraction is smaller than No. 4 sieve size)	Clean sands (Little or no fines)	SW		Well-graded sands, gravelly sands, little or no fines		$C_u = \frac{D_{60}}{D_{10}}$ greater than 6; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1	
			SP		Poorly graded sands, gravelly sands, little or no fines		Not meeting all gradation requirements for SW	
		Sands with fines (Appreciable amount of fines)	SM[a]	d	Silty sands, sand-silt mixtures		Atterberg limits above "A" line or P.I. less than 4	Limits plotting in ha zone with P.I. betw and 7 are *borderline* requiring use of dual bols.
				u				
			SC		Clayey sands, sand-clay mixtures		Atterberg limits above "A" line with P.I. greater than 7	
Fine-grained soils (More than half material is smaller than No. 200 sieve)	Silts and clays (Liquid limit less than 50)		ML		Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts with slight plasticity			
			CL		Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays			
			OL		Organic silts and organic silty clays of low plasticity			
	Silts and clays (Liquid limit greater than 50)		MH		Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts			
			CH		Inorganic clays of high plasticity, fat clays			
			OH		Organic clays of medium to high plasticity, organic silts			
	Highly organic soils		Pt		Peat and other highly organic soils			

Plasticity Chart



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[a] Division of GM and SM groups into subdivisions of d and u are for roads and airfields only. Subdivision is based on Atterberg limits; suffix d used L.L. is 28 or less and the P.I. is 6 or less; the suffix u used when L.L. is greater than 28.

[b] Borderline classifications, used for soils possessing characteristics of two groups, are designated by combinations of group symbols. For ex GW-GC, well-graded gravel-sand mixture with clay binder.

Form No. K4

PARTICLE SIZE DISTRIBUTION

LOCATION No.......................

BORE HOLE No.......................

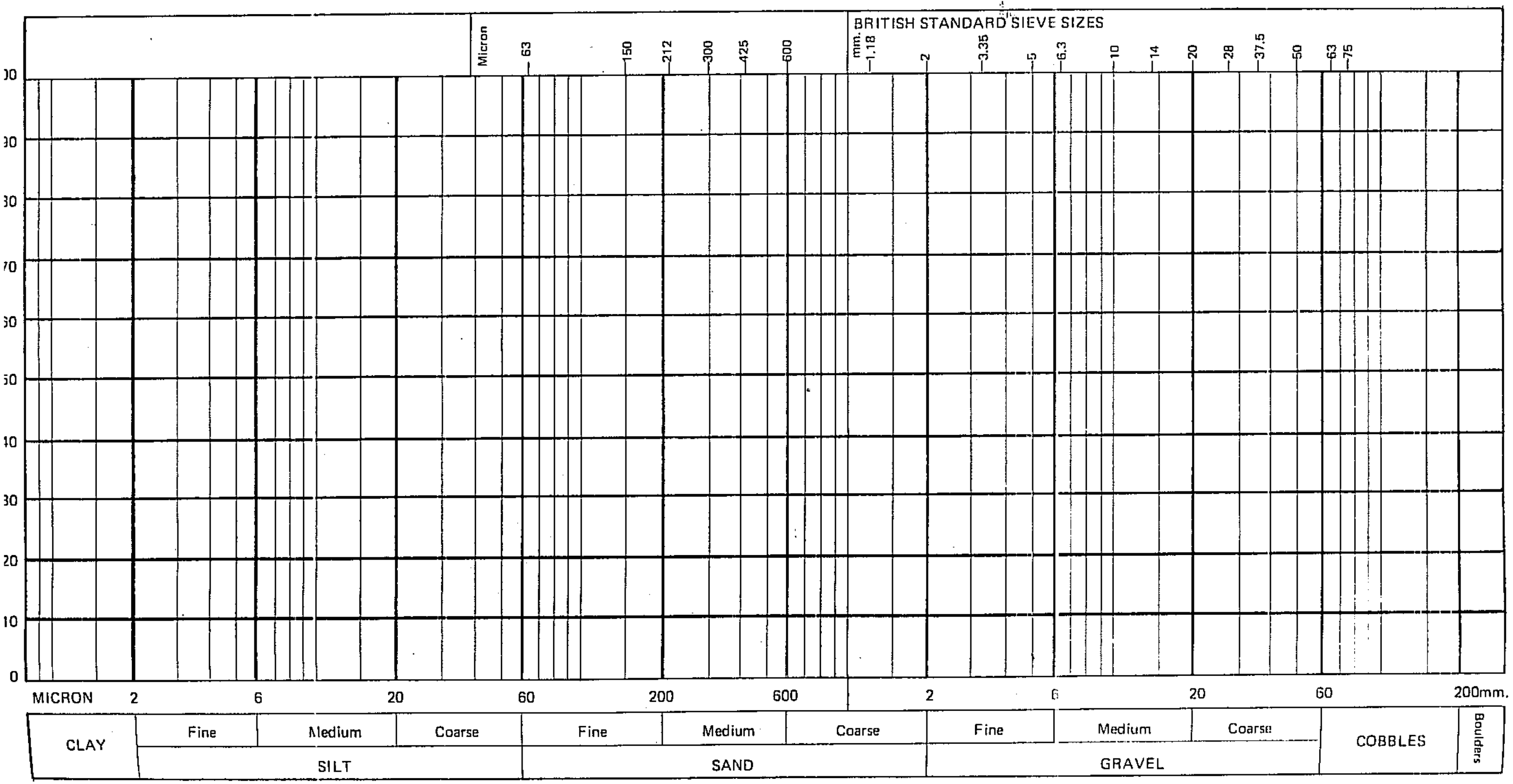
SAMPLE No.................

PRETREATMENT DETAILS...

DATE OF TEST.. ....

DESCRIPTION..

LOSS ON PRETREATMENT..................................%



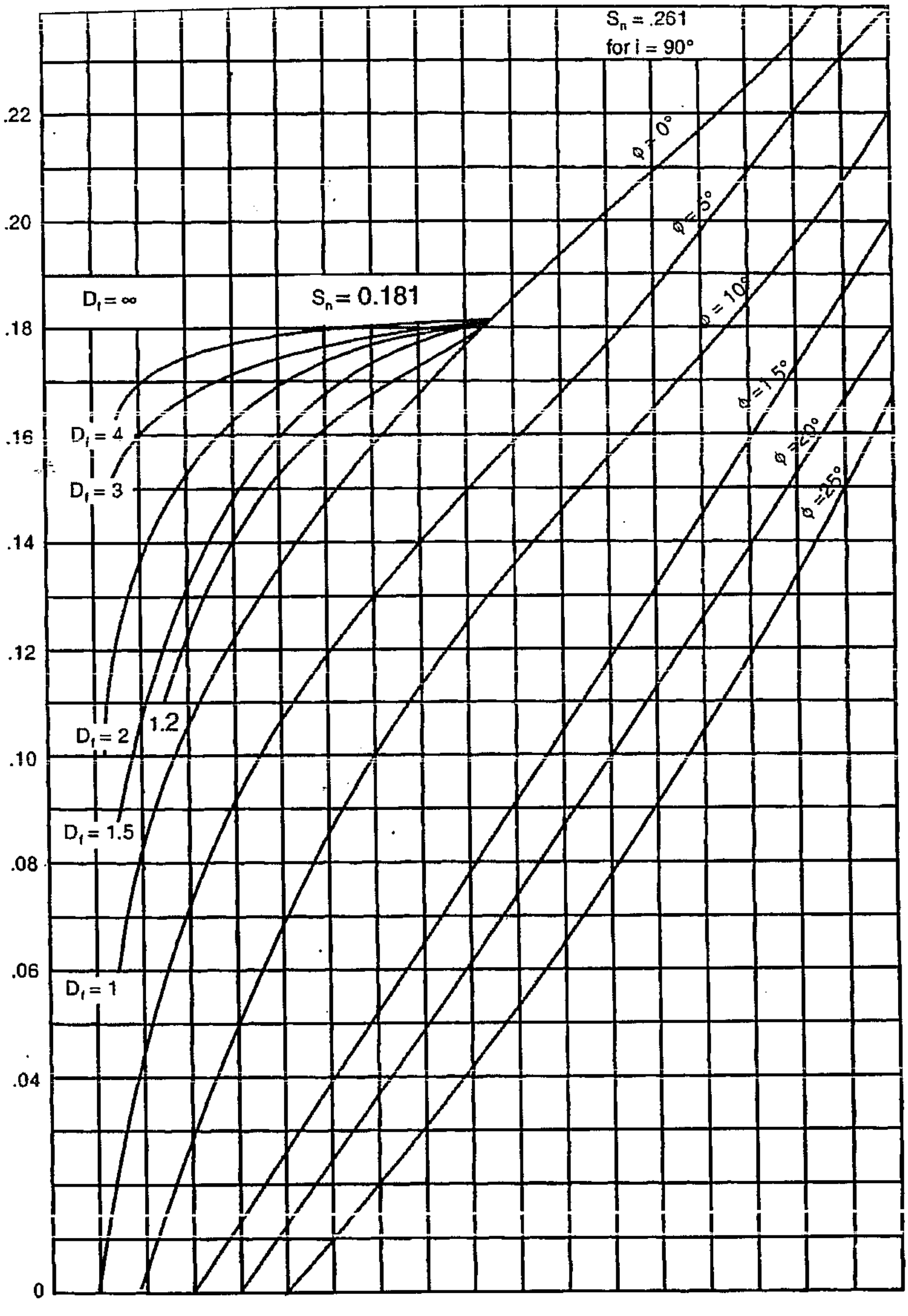
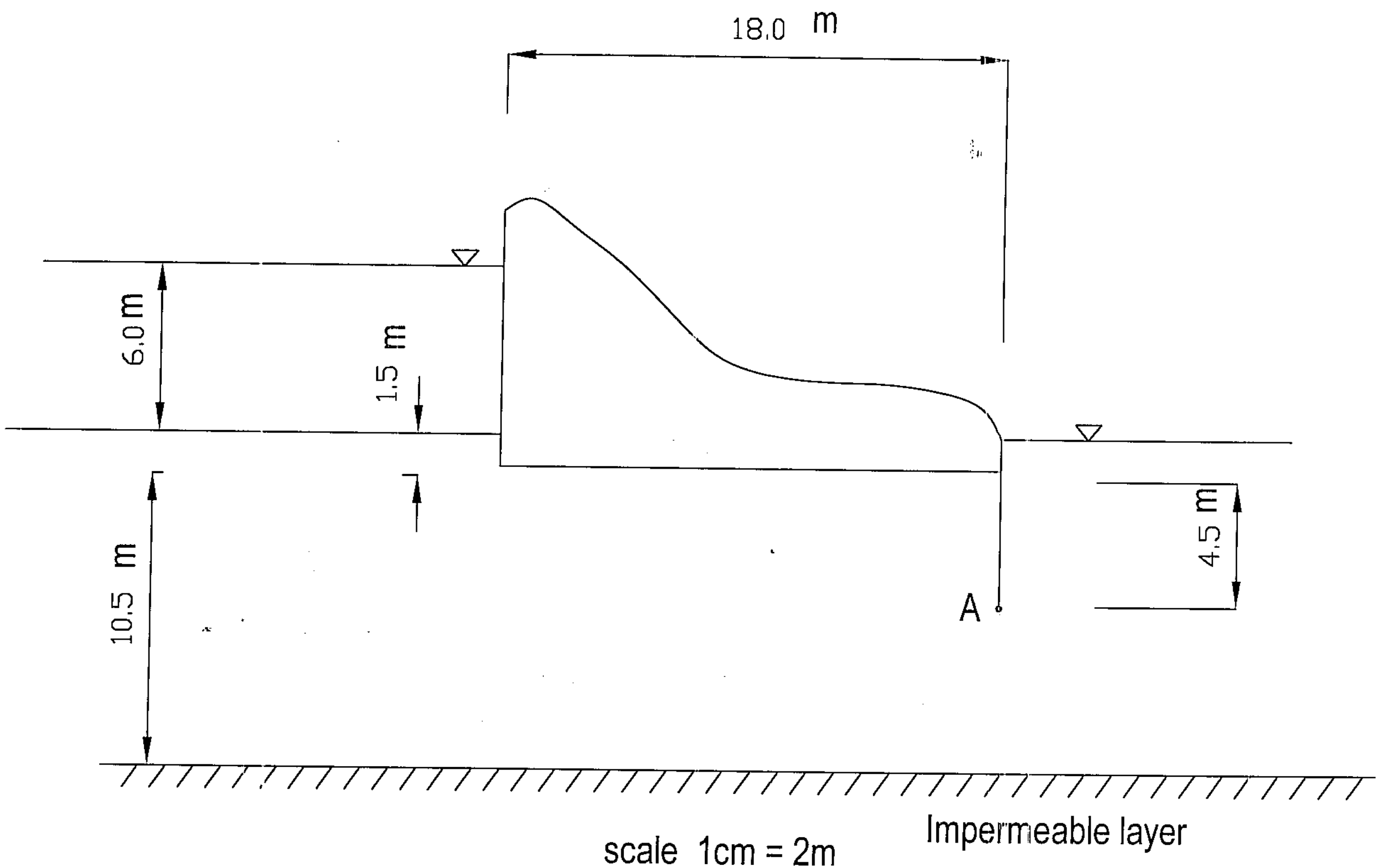


Chart for Taylor Stability Number



scale 1cm = 2m

Fig.Q 6