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Internal Assessment Test - II

Sub:	Basic Geotechnical Engineering							Code:	15CV45
Date:	10 / 05 / 2017	Duration:	90 mins	Max Marks:	50	Sem:	IV	Branch:	CIVIL

Note: Answer all questions. Assume any missing data suitably. Answer to the point. Provide neat sketches whereever necessary

Marks

1(a) Explain Mohr-Coulomb theory of shear strength. Sketch typical strength envelope for a soft clay, clean sand and a silty clay [4]

$\tau = f(\sigma)$ - equation and Figure (1.25)
$\tau = c + \sigma\, tan\varphi$ - equation and Figure (1.25)
Strength envelope –for 3 different soils (0.5×3)

Shear strength of a soil represents the resistance to shear stresses. According to Mohr, failure is caused by a critical combination of normal and shear stresses as represented by equation (1).

$$\text{Or} \quad \tau = f(\sigma) \quad (1)$$

Graphically equation (1) will be curved in shape. At failure, the Mohr failure envelope will be tangential to the Mohr's circle as shown in Figure 1.a.1.

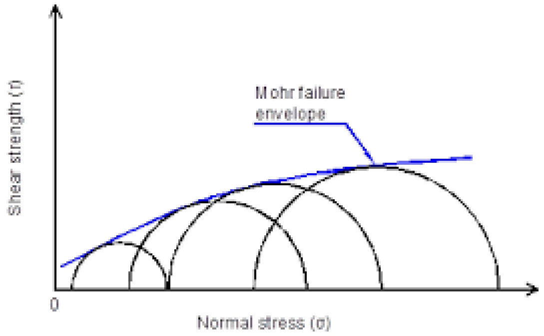


Figure 1.a.1. Mohr's failure envelope

Coulomb modified Mohr's theory by stating that shear strength of soil is dependent on two parameters: cohesion between the soil particles and the friction between the particles. Accordingly Equation (1) was modified and the equation for modified failure envelope is given by Equation (2). Mohr's envelope along with modified failure envelope is given in Figure 1.a.2. Figure 1.a.3 shows the Mohr-Coulomb failure envelope for different types of soils.

$$\tau = c + \sigma\, tan\varphi \quad (2)$$

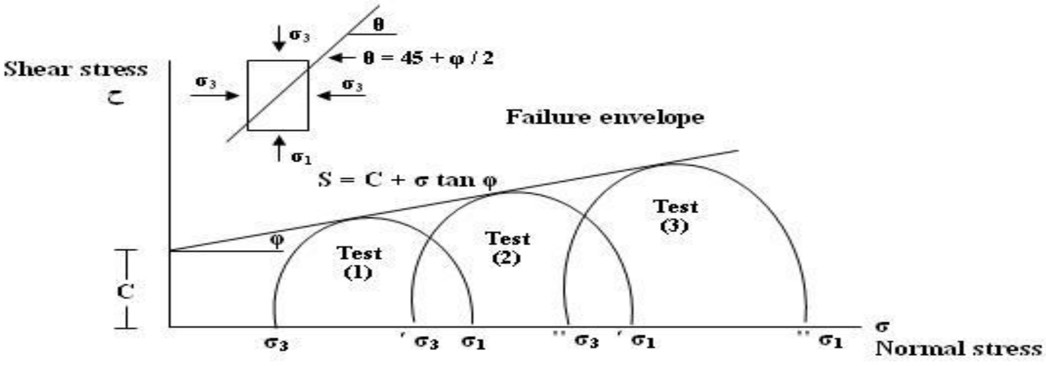


Figure 1.a.2. Mohr coulomb failure envelope

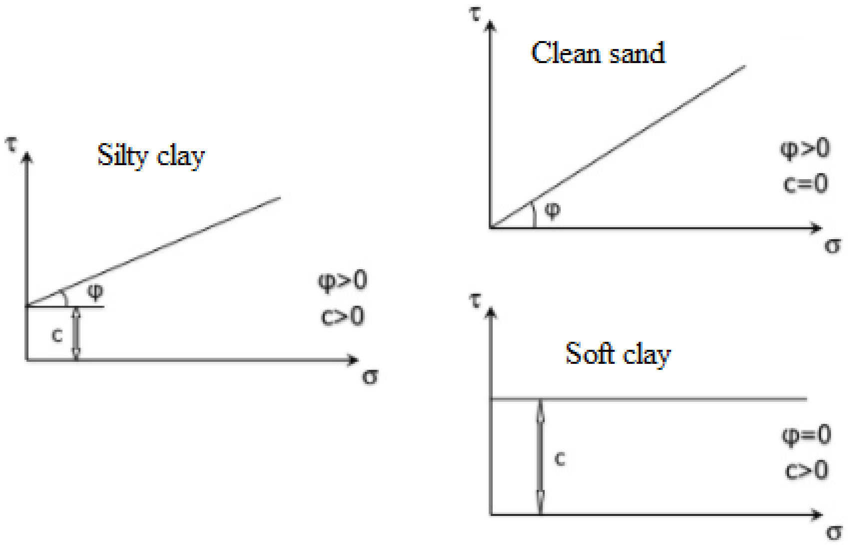


Figure 1.a.2. Mohr coulomb failure envelope for different soils

(b) **With neat sketch, explain determination of coefficient of consolidation by Taylor's method.** [5]

Figure- 3
Procedure-2

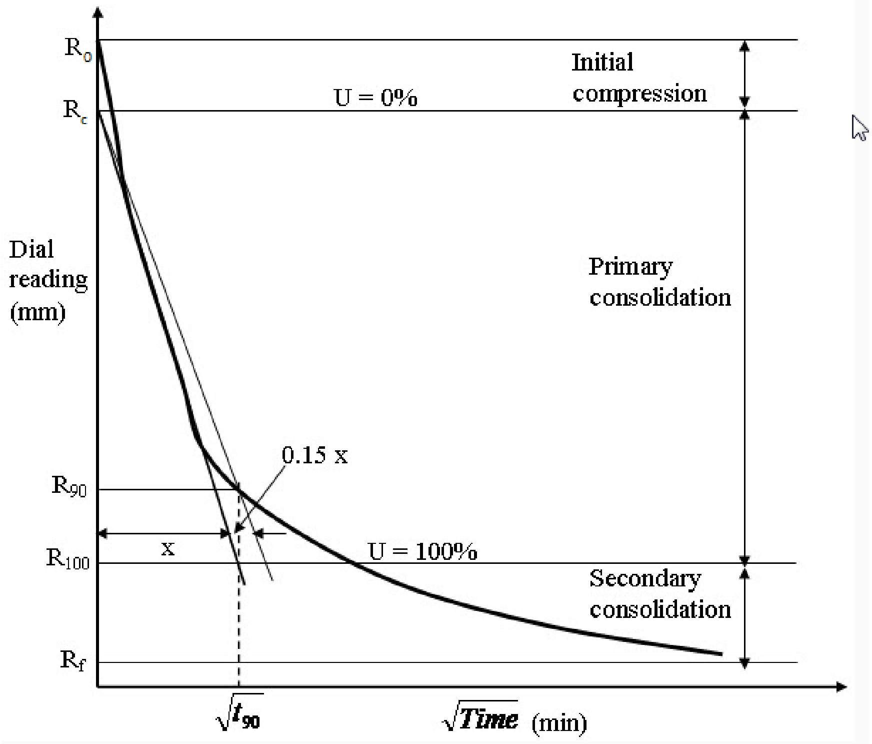


Figure 1.b.1

1. From the oedometer test the dial reading (settlement) corresponding to a particular time is measured. From the measured data, dial reading vs square root (time) graph is drawn.
2. A straight line can be drawn passing through the points on initial straight portion

of the curve (as shown in Figure). The intersection point between the straight line and the dial reading axis is denoted as Rc which is corrected zero reading i.e U = 0%. Starting from Rc, draw another straight line such that its abscissa is 1.15 times the abscissa of first straight line.

3. The intersection point between the second straight line and experimental curve represents the R90 and corresponding time is determined and noted as $\sqrt{t_{90}}$. Thus, the time required (t90) for 90% consolidation is calculated.
4. The Coefficient of consolidation (c_v) is determined as:

$$c_v = \frac{0.848d^2}{t_{90}}$$

$$where\ d\ is\ the\ drainage\ path = d\ for\ single\ face\ drainage\ and = \frac{d}{2} for\ two\ face\ drainage$$

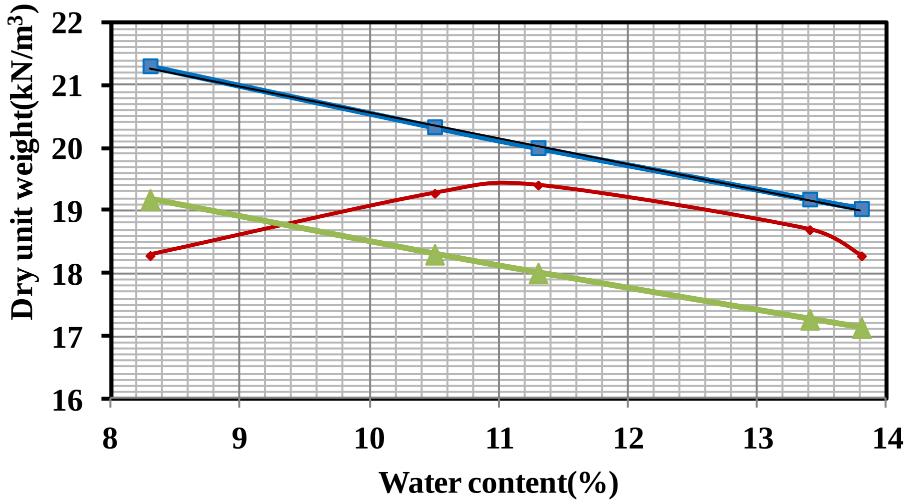
(c) Following are the results of a Standard Proctor Test.

Trial No	1	2	3	4	5
Moisture Content (%)	8.3	10.5	11.3	13.4	13.8
Bulk Unit weight (kN/m3)	19.8	21.3	21.6	21.2	20.8

The specific gravity of soil particles is 2.65. Plot the following and determine OMC and MDD (i) Moisture density curve (ii) Zero air voids curve (iii) Ten percent air content curve.

[6]

Graph- compaction curve – 2
OMC and MDD - 1
Zero air voids curve – 1.5
Ten percent air content curve -1.5



MDD = 19.5 kN/m^3
OMC = 11.4%

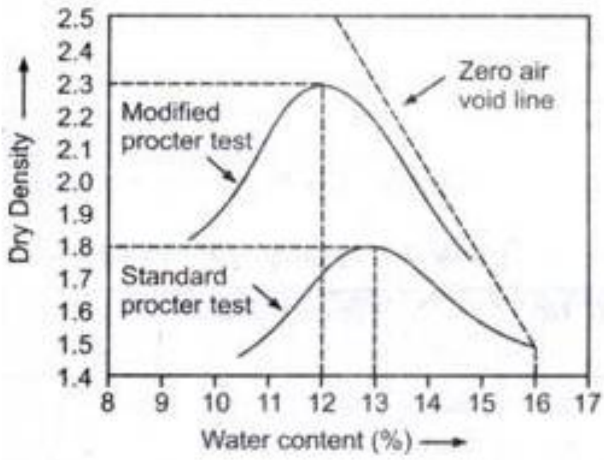
2(a) List the differences between standard and modified proctor compaction test. Calculate the compactive energy applied in both the tests?

[4]

Compaction energy – 1.5
Differences -1.5
Curve - 1

Sl No	Description	Standard compaction	Modified compaction
1	No of layers (N_L)	3	5
2	No of blows(N_B)	25	25

3	Mass of rammer, kg (M)	2.6	4.89
4	Height of rammer fall, mm (H)	310	450
5	Compaction energy $= \frac{MHN_LN_B}{Volume\ of\ mould}$ kNm/m^3)	593	2699
6	Practical application	Suitable for embankments	Suitable for airfield pavements

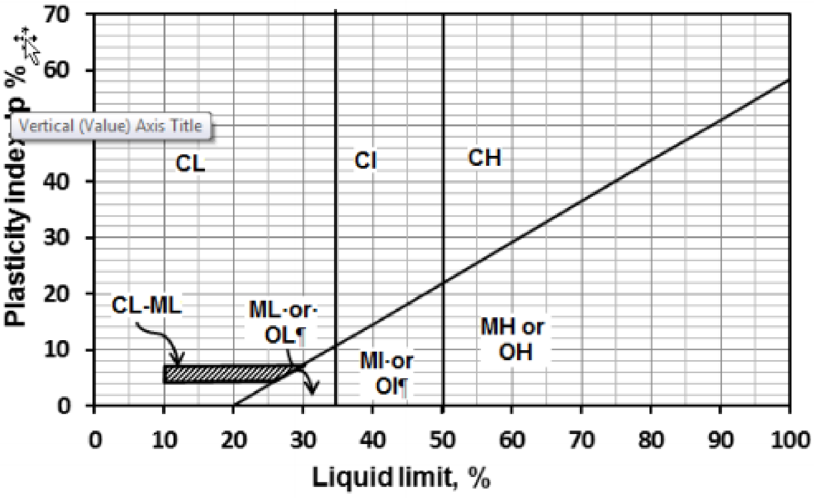
7	Effect on OMC and MDD	Increases MDD and decreases OMC when compared to standard compaction test 

(b) **Explain plasticity chart with a neat sketch and classify a fine grained soil with liquid limit= 20% and plastic limit is 14%.** [5]

Chart – 3
Classification – 1
Use - 1

Fine-grained soils are those for which more than 50% of the material has particle size less than 0.075 mm. A plasticity chart is a chart with liquid limit (WL) on X-axis and plasticity index (IP) on Y-axis. According to IS classification, fine grained soils are classified into 9 groups using A-line whose equation is given as IP= 0.73 (WL- 20).

Ip above A-line	Wl<35	CL
Ip above A-line	Wl between 35 and 50	CI
Ip above A-line	Wl>50	CH
Ip below A-line	Wl<35	ML or OL
Ip below A-line	Wl between 35 and 50	MI or OI
Ip below A-line	Wl>50	MH or OH
Ip above A-line	Ip between 4 and 7	CL-ML



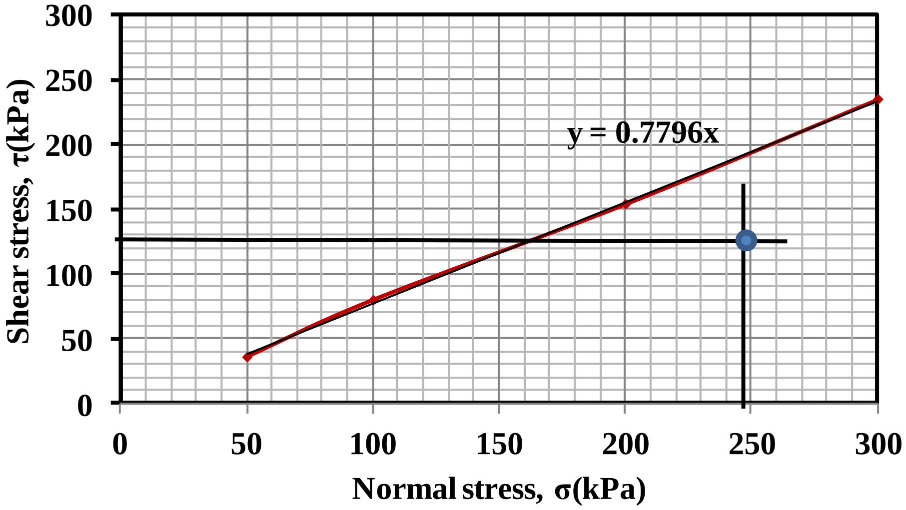
Soil is classified as CL-ML

(c) **The results of shear box test are as follows:**

Normal stress, kPa	50	100	200	300
Shear stress, kPa	36	80	154	235

Determine shear parameters. Would the failure occur on the plane within the soil mass when the shear stress is 122 kPa and normal stress is 246 kPa [6]

Graph + parameters– 4
Condition of soil and its comments- 2



When the shear stress is 122 kPa and normal stress is 246 kPa, soil is in stable condition since the soil lies below the failure envelope.

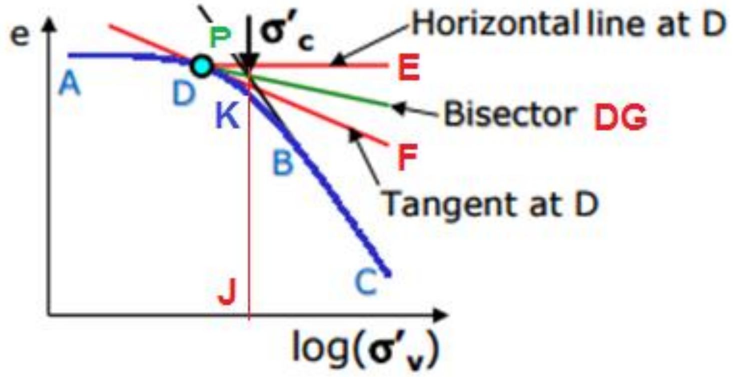
3 (a) **What is preconsolidation pressure? How is it determined by Casagrande's graphical method?** [5]

Definition-1
Procedure- 1.5
Figure -2.5

The maximum pressure to which the soil has been subjected to it, in the past is called as preconsolidation pressure. Casagrande's method for estimating preconsoldiation pressure is as explained below:

1. Choose by eye the point of maximum curvature on the consolidation curve Say D.
2. Draw a horizontal line from this point, line DE.

3. Draw a line tangent to the curve at the point D, line DF.
4. Bisect the angle made from the horizontal line DE and the tangent line DF. Name the bisector as DG.
5. Extend the "straight portion" of the virgin compression curve (high effective stress, low void ratio: almost vertical on the right of the graph) up to the bisector line DG so as to intersect at P.
6. Drop vertical PJ and the abscissa of PJ indicate pre consolidation pressure.
7. Vertical PJ intersect e-log $\bar{\sigma}$ curve at K, Curve ADK indicates recompression curve and curve KBC indicate virgin compression curve.



(b) The results of a liquid limit test are given below:

No.of blows	**5**	**16**	**23**	**42**
Water Content(%)	**31.93**	**27.62**	**25.51**	**23.3**

The plastic limit of the soil is 23%. Plot the flow curve and determine

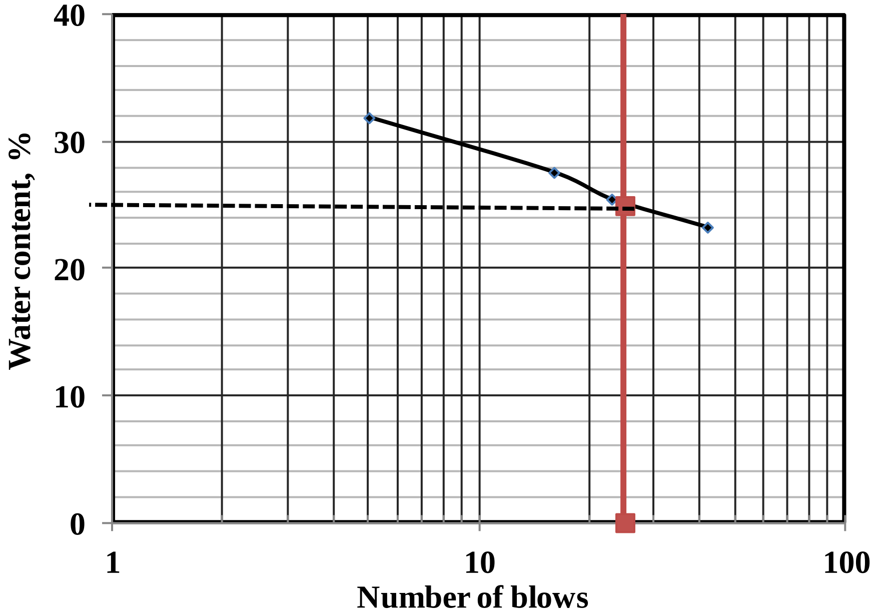
i) Liquid limit **ii) Plasticity index**

iii) Flow index and **iv) Toughness index**

[5]

Semi log sheet – 3

Determination of LL, PI, flow index and Toughness index - 2



Liquid limit = 25%

Plasticity index= 25- 23 = 2%

Flow index = $\frac{32-28}{log\left(\frac{20}{5}\right)}$ **= 6.64%**

Toughness index = $\frac{I_P}{I_F} = \frac{2}{6.64} = 0.301$

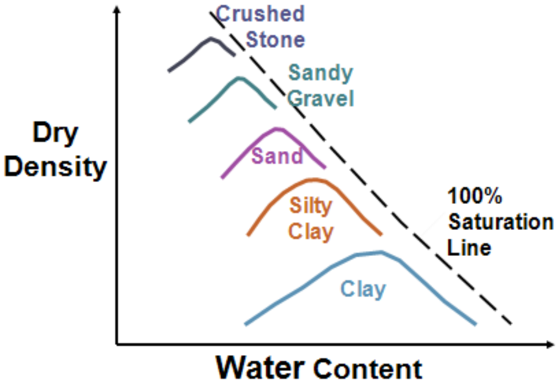
4(a) List and explain factors affecting compaction. [5]

5 Factors – 5

The factors which affect the degree of compaction are given below.

1. Type of soil

Normally, heavy clays, clays & silts offer higher resistance to compaction where as sandy soils and coarse grained or gravelly soils are amenable for easy compaction.



2. Compactive effort / compactive energy

Greater the compactive effort, greater will be the compaction energy, greater will be the extent of compaction. Type of compaction equipment to be used is mainly dependent upon the type of soil to be compacted. For example, Sheepfoot roller can be used for silty soil or clayey soil; Pneumatic tyred roller can be used for Sands, gravel, silty soil, clayey soils

3. Layer thickness / thickness of lift

Degree of compaction is inversely proportional to the layer thickness, i.e. for a given compactive energy, thicker layer will be less compacted as compared to thin layer. Generally 200 to 300 mm layer thickness is used in the field to achieve homogeneous compaction.

4. Number of roller passes

It is obvious that density increases as the no of roller passes increases. But after certain number of roller passes, there is no further increase in density. So it is very crucial to determine the number of roller passes for a given type of equipment, for a given type of soil at optimum moisture content.

5. Moisture content

Proper control of moisture content in soil is necessary for achieving desired density. Maximum density with minimum compacting effort can be achieved by compaction of soil near its OMC (optimum moisture content). Relative compaction is the ratio of field dry density to laboratory dry density.

6. Contact pressure

Contact pressure depends on the weight of the roller wheel and the contact area. In case of pneumatic roller, the tyre inflation pressure also determines the contact pressure in addition to wheel load. A higher contact pressure increases the dry density and lowers the optimum moisture content.

7. Speed of rolling

The greater the speed of rolling, the more length of embankment can be compacted in one day. But at greater speed there is likely to be insufficient time for the desired deformations to take place and more passes may be required to achieve the required compaction.

7. Admixtures

Addition of admixtures like flyash, granulated blast furnace slag, cement, lime, gypsum when added to problematic soils, improve its compaction characteristics.

(b) The time to reach 40% consolidation of a two way drained saturated clay sample of 12 mm thick in the laboratory is 40 sec. Determine the time required for 60% consolidation of the [5]

	same soil 11 m thick on an impervious layer subjected to same loading conditions as the laboratory sample.	
	Tv determination- 2 **D value- 2** **Time period estimation-1**	
	Given: H_{lab}=0.012 m ; d_{lab}=0.006 m H_{field}=11 m ; d_{field}=11 m $T_v = \frac{\pi}{4} \times U^2$ $T_v = \frac{\pi}{4} \times 0.4^2 = 0.1256$ $T_v = \frac{\pi}{4} \times 0.6^2 = 0.283$ $c_v = \frac{0.1256 \times 0.006^2}{40} = \frac{0.283 \times 11^2}{t_{60}}$ $t_{60} = 302928167\ sec$= 3506.11 days = 9.61 years	