337 16/11/23

21 NOV 23

SCHEME OF VALUATION
SCORING INDICATORS

REVISION: 15 COURSE CODE: 5013
COURSE TITLE: GEOTECHNICAL ENGINEERING

| Ques No: | Scoring Indicator | Split up score | Sub Total | Total |
|---|---|---|---|---|
| I | Part-A. | | | |
| 1. | Void ratio :- ratio of volume of voids to volume of solids | 1 | | |
| | Porosity :- ratio of volume of voids to total volume of given sample. | 1 | 2 | |
| 2. | Meniscus correction<br>-dispersion agent correction<br>Temperature correction.<br>-Combined correction. | ½×4 | 2 | |
| 3. | The property of soil which permits flow of water or any other liquid through it is called permeability. | 2 | 2 | |
| 4. | Auger boring, Wash boring, Percussion boring, Rotary boring. | ½×4 | 2 | |
| 5. | Concrete, steel, Timber, Composite piles | ½×4 | 2 | 5×2 =10 |
| II | Part-B | | | |
| | The water content at which the soil changes from one state to next are called consistency limit. The liquid limit plastic limit and shrinkage limit | 1½ | | |
| | - Liquid limit - Water content at which soil changes from liquid state to plastic | 1½ | | |

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|---|---|---|---|---|
| | plastic limit<br>The water content at which the soil changes from plastic state to semisolid state. | 1½ | | |
| | Shrinkage limit.<br>The water content at which soil changes from semisolid to solid state. | 1½ | 6 | |
| II 2. | - Improves the natural property of soil.<br>- Increase dry density of soil.<br>- Increase the shear strength of soil.<br>- to reduce the tendency of settlement of soil under loading.<br>- To decrease the permeability of soil.<br>- To reduce the water absorption of soil. | 1x6 | 6 | |
| 3. | 1. Free water - Water moves by gravitational force - | 1 | | |
| | 2. Held water :- Water held in the soil against the gravity. | 1 | | |
| | a. structural water<br>water chemically combined in the crystal structure of the soil mineral. (Part of soil particle)<br>- Cannot be seperated or removed by oven drying at $105^{0} - 110^{0}C$.<br>- driven off at high temperature as would cause the destruction of crystal structure. | 2 | | |

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| | Adsorbed water<br>water stick on the surface of soil by electro chemical forces - Surrounds the surface of individual soil grains as very thin film.<br>removed by oven drying. | 1 | | |
| | Capillary water.<br>- Held in soil mass due to capillary action | 1 | 6 | |
| 4 | Disturbed Samples.<br>The natural structure of soil gets disturbed.<br>- represent the composition and mineral content of soil.<br>- used to determine grain size, plasticity and sp: gravity.<br>- These samples can be taken by excavation by Auger boring or by any drilling methods | 3 | | |
| | Undisturbed Samples.<br>Samples in which the natural structure of the soil and natural water content are retained.<br>- used to determining the engineering properties of soil such as compressibility shear strength, permeability and shrinkage limit.<br>Undisturbed samples of cohesion less soils from below water table are difficult to be obtained. | 3 | 3+3 =6 | |

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| 5. | 1. For small and less important buildings, even one bore hole or trial pit in the centre.<br>2. For compact buildings covering an area of about 0.4 hectares — at least 5 bore holes, one at centre and four near corners.<br>3. For large and multi-storeyed buildings, the bore holes should be drilled at all the corners<br>4. Multistoreyed building spacing between bore hole is kept between 10 to 30m depending upon the variation in the surface condition and loading.<br>5. For highways. along the proposed centre line the spacing varies between 150m – 300m. if substrata is irratic spacing reduces to even 30m.<br>6. Concrete dams. — spacing varies between 40 to 80m. | 6x1 | 6 | |
| 6. | – To distribute and transmit the total load coming on the structure to a larger area.<br>– To prevent excessive settlement and differential settlement of the structure.<br>– To provide stability to the structure against many disturbing forces.<br>– To transmit the load to a safer level with out any settlement. | | | |

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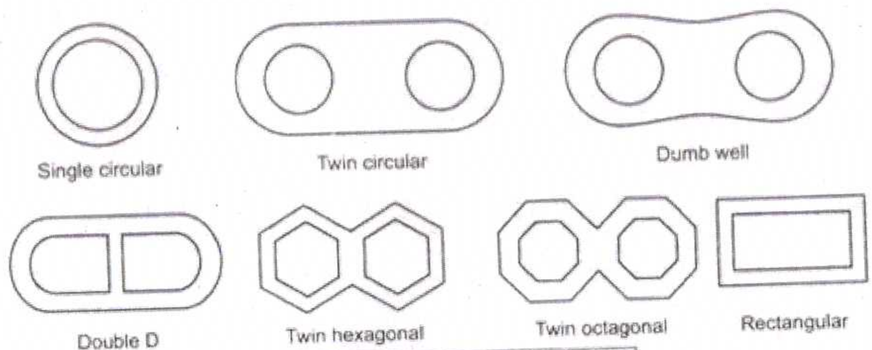
| Ques No: | Scoring Indicator | Split up score | Sub Total | Total |
|---|---|---|---|---|
| | - To provide a level platform for the construction of the supper structure.<br>- distribute non-uniform load of the superstructure evenly to sub soil. | 6x1 | 6 | |
| 7. | <br><br>**FIG. 11.30** Different shapes of wells | any 6<br>1x6 | 6 | 5x6<br>=30 |
| | Part. C | | | |
| III a | Consider three phase diagram in terms of voids ratio. Volume of solids $V_s = 1$<br>- Area of c/s of soil mass is taken as unity. | | 1 | |

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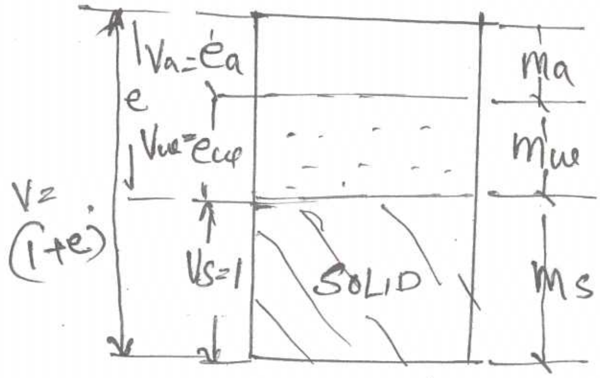
|---|---|---|---|---|
| |   | 1 ~~2~~ | | |
| | $\frac{V_v}{V_s} = e$ | | | |
| | $V_v = e$ | 1 | | |
| | $S = \frac{V_w}{V_v} = \frac{e_w}{e}$ | | | |
| | $\therefore e_w = Se$ | 1 | | |
| | Bulk density | | | |
| | $\rho = \frac{M}{V} = \frac{M_s + M_w}{(1+e)}$ | | | |
| | $\rho_s = \frac{M_s}{V_s} = \frac{M_s}{1}$ | | | |
| | Specific gravity $G = \frac{\rho_s}{\rho_w}$ | 1 | | |
| | $\therefore \rho_s = G\rho_w = M_s$ —— (1) | | | |
| | Density of water $\rho_w = \frac{M_w}{Se}$ | 1 | | |
| | $M_w = \rho_w \times Se$ —— (2) | | | |
| | water content $w = \frac{M_w}{M_s}$ | | | |
| | $w = \frac{\rho_w Se}{G \times \rho_w}$ | 2 | | |
| | $w = \frac{Se}{G}$ | | | |
| | or | | | |
| | $e = \frac{wG}{S}$ | | 8 | |

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|---|---|---|---|---|
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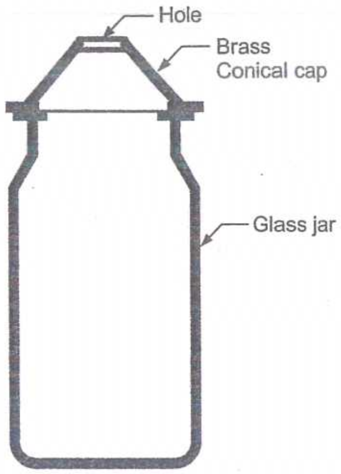
| III b. |  fig | 2 | | |
| | 1. The pycnometer is cleaned and dried. The mass of pycnometer is recorded as $M_1$.<br>2. about 200 to 400 gm of oven dried soil passing through 4.75mm sieve is placed in the pycnometer. The mass of pycnometer and soil is taken as $M_2$<br>3. Then the pycnometer is filled with distilled water and thoroughly mixed with glass rod. The mass of bottle with water and soil is found. Let it be $M_3$<br>4. Pycnometer is emptied washed clean and filled with distilled water up to top its mass is found Let it be $M_4$ | 3 | | |
| | Dry mass of soil $= M_2 - M_1$<br>Mass of equal volume of water $= (M_4 - M_1) - (M_3 - M_2)$<br>Specific gravity $= \frac{\text{Dry mass}}{\text{mass of equal volume of water}} = \frac{(M_2 - M_1)}{(M_2 - M_1) - (M_3 - M_4)}$ | 2 | 7 | 8+7<br>15 |

IV a.

OR

IVa

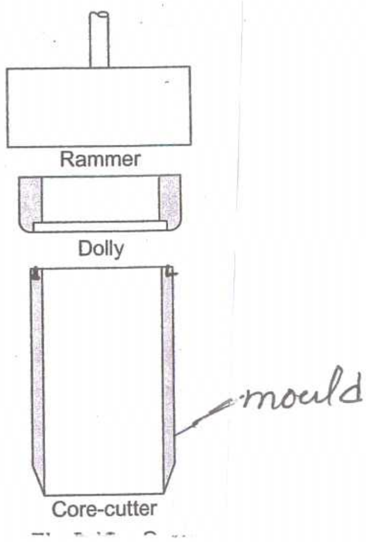



fig: 1

Materials and equipment.

1) Cylindrical core cutter of steel 127.4mm long and 10cm internal diameter with a wall thickness of 3mm levelled at one end.

2) Steel dolly 2.5cm high and 10cm internal diameter with wall thickness 7.5mm fitted on top of the core cutter.

3) Steel rammer.

4) steel rule

5) spade, Straight edge, Balance etc.

Procedure

- The core cutter and dolly are cleaned. The mass $m_1$ and volume V of the core cutter are determined.

2. The core cutter is greased on the inner side.

- The ground is cleaned and levelled
- The dolly is fitted on the top of the core cutter and driven in to the ground using a hammer.
- The core cutter is dug out with a crow bar with out disturbing the soil sample.
- The dolly is removed and both the top and bottom surfaces of the soil are trimmed with a straight edge.
- The mass of the core cutter with wet soil $M_2$ is determined. 4

Calculation

Mass of core cutter = $M_1$ gm

Mass of core cutter + wet soil = $M_2$ gm

Mass of wet soil = $(M_2 - M_1)$ $1+4+\frac{1}{2}$

Field density = $\frac{M_2 - M_1}{V}$ g/cm³ 2 $= 7$

IV b) water content $w = \frac{320-285}{285} = 12.28\%$ 1

Bulk unit weight $\gamma = \frac{W}{V} = \frac{320}{0.0195} = 1.641$ kN/m³ 1

Dry unit weight $\gamma_d = \frac{\gamma}{(1+w)}$

$= \frac{16.41}{(1+0.1228)} = 14.615$ kN/m³ $1\frac{1}{2}$

$\gamma_d = \frac{G\gamma_w}{(1+e)}$

$(1+e) = \frac{2.651 \times 10}{14.615} = 1.813$

$(1+e) = 1.813$

$\underline{e = 0.813}$ | 1½

Porosity $n = \frac{e}{(1+e)}$

$= \frac{0.813}{1+0.813} = 0.4484$

$= \underline{44.84\%}$ | 1½

Degree of Saturation $S = \frac{wG}{e}$

$= \frac{0.1228 \times 2.65}{0.813}$

$S = \underline{40.03\%}$ | 1½ | 8 | 7+8 = 15

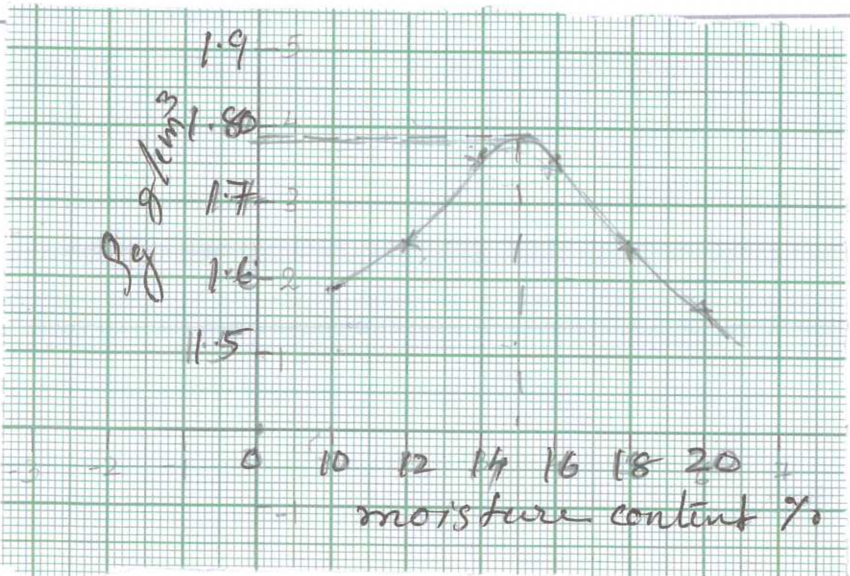
## Module – II

V(a) - Particle size
- Structure of soil mass.
- Shape of particle
- Voids ratio
- properties of water.
- Degree of Saturation
- Adsorbed water
- Impurities of water

any 7 1×7 | 7

Vb)

| water Cont | 0.10 | 0.12 | 0.14 | 0.16 | 0.18 | 0.20 |
|---|---|---|---|---|---|---|
| ρ g/cm³ | 1.747 | 1.842 | 2.021 | 2.052 | 1.936 | 1.88 |
| ρd g/cm³ | 1.588 | 1.645 | 1.77 | 1.77 | 1.64 | 1.57 |




OMC = 15%

Max drydensity = 1.79g/cm3

VI

OR

a. Water content

At low water content the soil is stiff and offers more resistance to compaction. As water content increases the soil mass becomes more workable and the particles have closer packing The dry density increases till the optimum moisture content is reached. with further increase in water content the air voids donot decrease but total air voids increases and the dry density decreases

2) Amount of Compaction

The amount of compactive effort is to increase the maximum dry density and to decrease the optimum water content.

Types of Soil

Coarse grained soils can be compacted to higher dry density than fine grained soils. with the addition of even a small quantity of fines to a coarse grained soil, the soil attains a much higher dry density for the same compactive effort.

- A well grained soil attains a much higher dry density than a poorly graded soil.

- Cohesive soils have high air voids, these soils attains a relatively lower maximum dry density as compared with the cohesionless soils.

- Heavy clays of very high plasticity have very low dry unit weight and a very high optimum water content.

4. method of compaction

Dry density depends on the method of compaction. For the same amount of compactive effort, The dry density will depends up on the methods of compaction -

5. Admixtures :- The compaction characterstics of the soil are improved

by adding other materials known as admixtures. The dry density achieved depends upon the type and amount of admixture any 4

eg: lime, cement, and bitumen. 4x2 8

VI b. $L = 10cm$, $h_1 = 50cm$, $h_2 = 30cm$. 1

$t = 20mt = 20 \times 60 = 1200$ sec. 1

diameter of sample $= d$ 1

dia of stand pipe $= 0.1d$ 1

$$A = \frac{\pi d^2}{4}$$

$$a = \frac{\pi \times (0.1d)^2}{4} = \frac{0.01 \pi \times d^2}{4}$$

$$K = \frac{2.303\, a L \log_{10} h_1/h_2}{A t}$$ 1

$$K = \frac{2.303 \times \pi \times d^2 \times 0.01 \times 4 \times \log_{10}\left(\frac{50}{30}\right)}{4 \times \pi d^2 \times 1200}$$

$$= \frac{2.303 \times 0.01 \log_{10}(50/30)}{1200} = 4.24 \times 10^{-6}\ cm/sec^2$$ 7 8+7 15

Module. III

VII a. It is a test to determine the ultimate bearing capacity of soil and the propable settlement under a given loading. 1

- The test plate may be circular or square in shape.
- size 30 to 75 cm.

- mini size 30cm
- clayey, sandy and silty soil - 60cm
- gravelly and sandysoil - 30cm square.

Test pit should be dug upto the level of the foot before performing the load test.

- test pit should be 5 times width of plate.
- A small square hole is dug whose size equal to size of plate and the bottom level is corresponding to the bottom level of foundation.

$$\text{depth of hole} = \frac{D_P \times B}{B_P}$$

The loading to the test plate may be applied with the help of gravity loading method or reaction truss method.

In gravity loading method a heavy wooden platform built on top of vertical column which stands vertically over the test plate. The loading is done with the help of sand bags, stone or concrete blocks. shown in fig -

After fixing the equipment the load is applied with the help of hydraulic jack in convenient increment say about 1/5 of the expected safe B.C. settlement of the plate is observed by two dial gauges fixed diametrically opposite sides with sensitivity of 0.02mm.

- Settlement should be observed for each increment of load after an interval of 1, 4, 10, 20, 40 and 60 minutes and there after at hourly intervals until the rate of settlement becomes less than 0.02 mm/hr. From the observations load settlement curve is plotted. The Ultimate bearing capacity of soil may be arrived at from the graph be noting the reading corresponding to the straight line part of the graph.

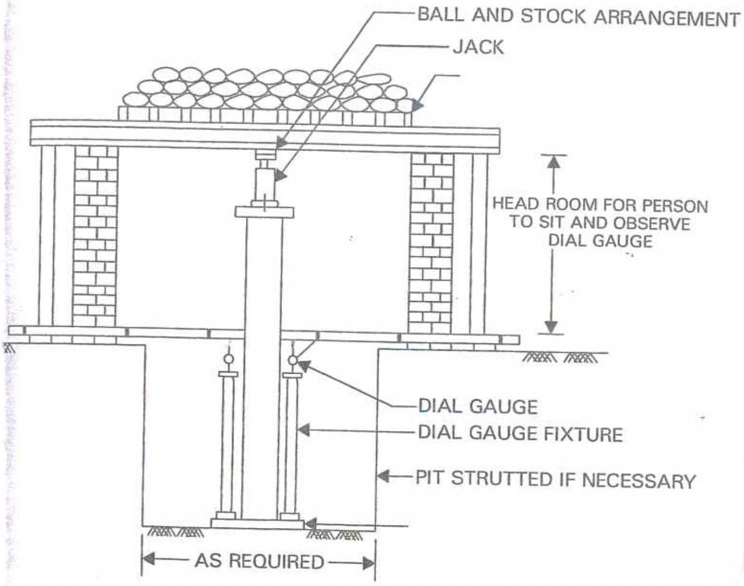


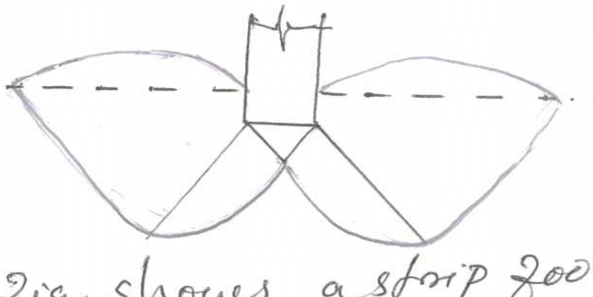

fig 2

explanation 5 1+2+5 = 8

VII b. - To select the type and depth of foundation
- To determine the bearing capacity of the soil.
- To estimate the probable maximum and differential settlements.
- To establish the ground water level.
- To determine the properties of water.
- To predict the latteral earth pressure against retaining walls and abutments.
- To select suitable construction techniques.
- To predict and to solve potendial foundation problems.
- To investigate the safety of the existing structures and to suggest the remedial measures.
- To ascertain the suitability of the soil as a construction material. any 7 1x7 | 7 | 8+7 = 15

OR

VIII a



1

fig. shows a strip footing resting on the surface of a dense sand or stiff clay. At a certain load intensity the settlement increases suddenly. A shear failure occurs and the failure surface extend to the ground surface. This type of failure is known as general shear failure. A heave on the sides is always observed. 2½

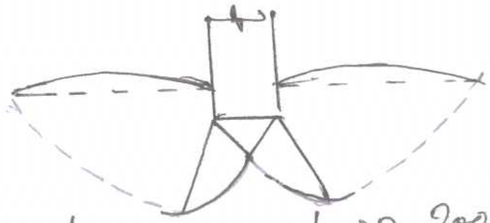
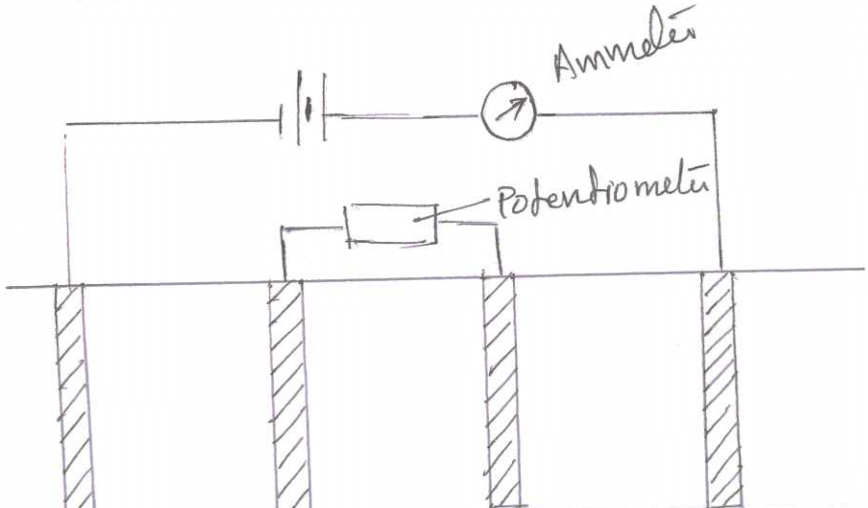


Fig shows a strip footing resting on a medium dense sand or on a clay of medium consistency. When the load is equal to a certain value the foundation movement is accompanied by sudden jerks. The failure surfaces gradually extend outwards from the foundation - a considerable movement of the foundation is required for the failure surface to extend to the ground surface (shown dotted). Beyond this point, an increase of load is accompanied by a large increase in settlement. - A heave is observed only when there is substantial vertical settlement. 1

2½ 3½+3½

7

VIII b. The principle - electrical resistance is different for different soils electrical resistance value is measured by this depth of water table and other changes in soil are estimated. 1




2

- 4 electrode are driven at equal distance along a straight line
- distance between electrode = depth at which the resistance is measured
- current is passed between end electrodes.
- Voltage drop between the inner electrod is measured by potentiometer. 3
- The spacing of inner electrods will indicate the depth of layer causing the specific changes in resistance.

mean resistivity, $\rho = \frac{2\pi a V}{I}$ 2

where V – voltage drop.
I – dc applied
a – spacing of electrod

| Type of soil | Resistivity Ωm |
|---|---|
| sound rock | 75000 |
| weathered rock | 5000 – 2500 |
| gravel | 1500 – 4000 |
| sand | 500 – 1500 |
| clayey sand | 200 – 500 |
| saturated clay | 2 – 100 |

8 7+8 = 15

Module - IV

IX a. Width of footing.
a. no footing provided – width 3 x thickness of wall
b. Width = $\frac{\text{Total load / m length}}{\text{Allowable bearing capacity}}$.
c. footings provided
$W = 2(t+a)$, t – wall thickness
a – offset of concrete

Take greater value. 4

Depth :

1 - minimum 1m, hard soil is available.
2. Total load/m² calculated the foundation should be taken to depth at which the soil has allowable bearing capacity greater than this value.
3 - depth obtained by drawing the lines of angles 45° and 60°
4. loose soil Rankines formula can be used.

$$D = \frac{q_f}{\gamma}\left[\frac{1-\sin\phi}{1+\sin\phi}\right]^2$$

$q_f$ - bearing capacity.
$\gamma$ - density of soil, $\phi$ angle of repose.
Take greater value is taken. 4 4+4 =8

VI b. End bearing Piles.
- Transmit the loads through their bottom tips.
- act as column, transmit load through weak material to a firm stratum below.
- rock is at reasonable depth, piles extended to the rock.
- hard stratum - exist at a reasonable depth piles are extended a few meters in the hard strata. 2

2. Friction Pile
- do not reach hard strata
- transfer through skin friction.
- used when a hard strata does not exist at reasonable depth. 2

3. Combined end bearing and friction piles.
- Transfer loads by a combination of end bearing at the bottom of the pile and friction along the surface of the pile shaft.
- Ultimate load = load carried by the piles point + load carried by the skin friction. 2

names - 1 | 7 | 8+7 = 15

OR

Xa - Regulation of grabbing.
The higher side is grabbed more than the lower side
2. Eccentric loading.
- heavy loads are placed on the higher side.
- A suitable plat form may be constructed on the high side.
3. Dredging the outside of the high side
- Open excavation - on the higher side
- depositing more earth on other side.
4. Water jetting
- Water jet is forced on the outer side and inner side of the high side - skin friction is reduced.
- useful in sandy soil.
5. Blocking the cutting edge of lower side.
- Sinking on lower side is arrested by inserting wooden blocks underneath the cutting edge.
- Sinking operation is continued on the high side.
- After the tilt are rectified blocks are removed.
6: Pulling the Well
Pulling the well towards the higher by steel ropes round the well.

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COURSE TITLE:

| Ques No: | Scoring Indicator | Split up score | Sub Total | Total |
|---|---|---|---|---|
| | 7. Pushing the well<br>– Pushing by Jacks | any 4x1½ | 6 | |
| X b. | (figure below) | 4 | | |
| | | 5 | 9 | 6+9<br>15 |

7. Pushing the well

– Pushing by Jacks

any 4x1½ — 6

X b.

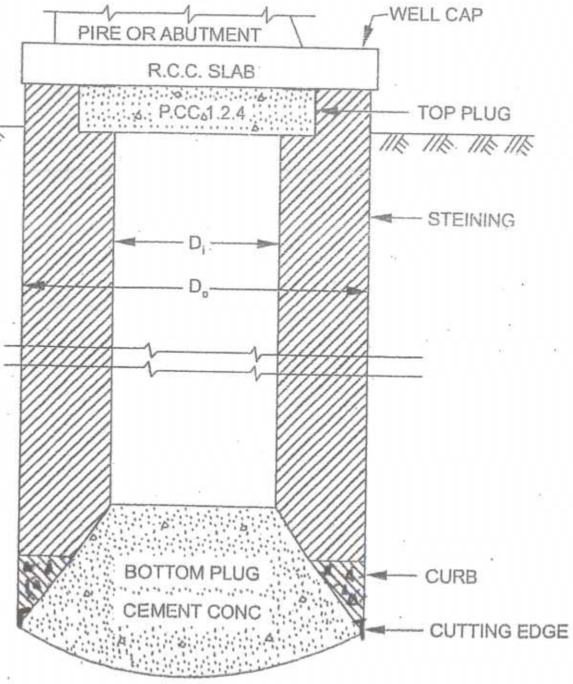


Fig. 1.9 Well Foundation

Well curb.

– Supports the weight of well

– Inside beveled reduce the wall thickness

Cutting edge.

– bevelled portion of ~~cutt~~ curb.

– Lower portion is wrapped with 12mm steel plate

– help to easy sinking.

Fig — 4

Bottom plug.

– prevent uplift pressure of soil

– bowl shape — invert arch action.

Steining.

= body of the well

– Thickness so designed that it is sunk by its own weight.

Top plug.

– concrete provided at the top of the well after filling it with sand.

Well Cap.

– over well steining.

– Transfer the load from pier to the well.

5 — 9 — 6+9 = 15