SRM VALLIAMMAI ENGINEERING COLLEGE

SRM Nagar, Kattankulathur – 603 203

DEPARTMENT OF CIVILENGINEERING

M.E-STRUCTURAL ENGINEERING

QUESTION BANK

III SEMESTER

1917304 –DESIGN OF SUB STRUCTURES

Regulation – 2019

Academic Year 2022 – 23

Prepared by

Mr. SATTAINATHAN SHARMA.A, Assistant Professor/ CIVIL

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SUBJECT : 1917304 –DESIGN OF SUB STRUCTURES

SEM / YEAR: III/II

UNIT-1 SHALLOW FOUNDATIONS

Soil investigation – Basic requirements of foundation – Types and selection of foundations. Bearing capacity of soil - plate load test – Design of reinforced concrete isolated, strip, combined and strap footings – mat foundation.

PART - A

Q.No	Questions	BT Level	Competence
1.	Distinguish the terms Foundation and Substructure	BT-2	**Understanding**
2.	Define site reconnaissance.	BT-1	**Remembering**
3.	Compare the various methods of site exploration	BT-2	**Understanding**
4.	Define Significant depth of exploration.	BT-1	**Remembering**
5.	What do you mean bybore log report and list the information given in a bore log report?	BT-1	**Remembering**
6.	What are the various stages of sub surface exploration?	BT-1	**Remembering**
7.	Name different types of mat foundation.	BT-1	**Remembering**
8.	Distinguish between disturbed & un-disturbed samples.	BT-2	**Understanding**
9.	Recall "Tilt" of a foundation.	BT-1	**Remembering**
10.	List the various parameters affecting the sampling disturbance.	BT-1	**Remembering**
11.	Identify In what way the local shear failure differs from General shear failure.	BT-1	**Remembering**
12.	Sketch the contact pressure distribution diagram below rigid footing and flexible footing on sand and clay.	BT-2	**Understanding**
13.	Where the Raft or Mat Foundation would be used?	BT-1	**Remembering**
14.	Associate the reasons for providing inside and outside clearance in sampling tubes.	BT-2	**Understanding**
15.	Explain about strap beam and when it is preferred?	BT-2	**Understanding**
16.	Recommend the circumstances where strap footing is adopted.	BT-1	**Remembering**
17.	Apply the concept of combined footing and its necessity.	BT-3	**Applying**

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Mr. SATTAINATHAN SHARMA.A, Assistant Professor/ CIVIL

18.	What are the objective of site investigation?	BT-1	**Remembering**
19.	Differentiate inside clearance and outside clearance.	BT-2	**Understanding**
20.	Differentiate Area ratio and recovery ratio.	BT-2	**Understanding**
21.	List different types of boring.	BT-1	**Remembering**
22.	Brief about various bearing capacity failures.	BT-2	**Understanding**
23.	Enlist the methods of analyzing raft foundation.	BT-1	**Remembering**
24.	What do you mean by buoyancy raft foundation?	BT-1	**Remembering**
25.	Enlist the various types of shallow foundation.	BT-1	**Remembering**

PART - B

1. Plate load test were conducted in a C – Ø soil, on plate of two different sizes and the following results water obtained — BT-4 **Analyzing**

Load (kN)	Size of plate	Settlement
50	0.3 m x 0.3 m	25 mm
110	0.6 m x 0.6 m	25 mm

Find the size of square footing required to carry a load of 1000 kN at the same specified settlement of 25 mm.

2. Explain the plate load test in detail and enumerate its importance in the design of foundation. — BT-3 **Applying**

3. Analyze and design a strap footing for two columns C_1 and C_2 carrying a load of 700 kN and 800 kN respectively. Size of the column is 500 X 500 mm and is spaced at a distance of 4.10 m centre to centre. The face of the column C_1 is on the property line. The bearing capacity of the soil is 175 kN/m^2. — BT-4 **Analyzing**

4. The results of two plate load tests for a settlement of 25.4 mm are given — BT-4 **Analyzing**

Plate Diameter	Load(kN)
0.3 m	31
0.6 m	65

A square column foundation is to be designed to carry a load of 800 kN with an allowable settlement of 25.4 mm. Determine the size of the foundation.

5. — BT-3 **Applying**
   a) Explain different types of Raft foundation in detail.
   b) Discuss about the situations where rafts are used.

6. Two columns carrying 500 kN and 650 kN spaced 3.75 m apart and they have to provided with a foundation on soil having a net safe bearing capacity of 160 kg/cm^2. The footing must be restricted to 2.25 m. Use M 25 grade concrete and Fe 415 grade steel. design a combined footing. — BT-4 **Analyzing**

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Mr. SATTAINATHAN SHARMA.A, Assistant Professor/ CIVIL

<table>
<tr><td>7.</td><td>Analyze the strap footing for two columns C_1 and C_2 carrying a load of 600 kN and 800 kN respectively. Size of the column is 400 X 400 mm and us spaced at a distance of 4 m centre to centre. The face of the column C_1 is on the property line. The bearing capacity of the soil is 200 kN/m^2. Use M20 and Fe 415 grades.</td><td>BT-4</td><td>Analyzing</td></tr>
<tr><td>8.</td><td>Proportion a rectangular combined footing for the following data
Allowable soil pressure for DL + reduced LL = 150kN/m^2
DL + LL = 225kN/m^2
<table><tr><th>LOAD</th><th>Column A</th><th>Column B</th></tr><tr><td>DL</td><td>540kN</td><td>690kN</td></tr><tr><td>LL</td><td>400kN</td><td>810kN</td></tr></table>Distance between the columns = 5.4m c/c
Projection of footing beyond column A = 0.5m</td><td>BT-4</td><td>Analyzing</td></tr>
<tr><td>9.</td><td>A building consists of 12 columns 400mm X 400mm sizes arranged in 3 rows of four each. The distance between the columns is 5.0m each. The load carried by four corner columns is 500 kN each, that carried by exterior column is 550 kN each and that carried by interior column is 900 kN each. The allowable soil pressure is 50 kN/m^2. Design the raft foundation.</td><td>BT-6</td><td>Creating</td></tr>
<tr><td>10.</td><td>A circular column of 480mm diameter tranfers an axial deal load of 650kN and an axial live load of 500kN. The SBC of soil is 140kN/m^2. Design a circular footing to support the circular column.</td><td>BT-6</td><td>Creating</td></tr>
<tr><td>11.</td><td>Evaluate the capacity of a strap footing for two columns C1 and C2 carrying a load of 500 kN and 600 kN respectively. Size of both columns is 300mm X 300 mm and is spaced at a distance of 3m c/c the face of a column C1 is on the property line. The bearing capacity of the soil is 175 kN/m^2. Use the M20 concrete and Fe415 grade steel.</td><td>BT-5</td><td>Evaluating</td></tr>
<tr><td>12.</td><td>Proportion a rectangular combined footing for two columns 5 m apart. The exterior column of size 0.3 m x 0.3 m carries a load of 600 kN and interior column of size 0.4 m x 0.4 m carries a load of 900 kN. The allowable soil pressure is 100 kN/m^2</td><td>BT-4</td><td>Analyzing</td></tr>
<tr><td>13.</td><td>Design a RC footing for a 345 mm thick masonry load bearing wall which supports a charactersitc load of 250 kN/m including self weight. Assume SBC of soil as 150 kN/m^2 at a depth of 1.2m below ground level. Assume M20 concrete and Fe415 grade of steel.</td><td>BT-6</td><td>Creating</td></tr>
<tr><td>14.</td><td>With near sketch, relate the critical sections for bending moment, one way shear and punching shear for an isolated footing.</td><td>BT-2</td><td>Understanding</td></tr>
<tr><td>15.</td><td>Design a reinforced concrete footing for a rectangular column of section 300 mm × 500 mm supporting an axial factored load of 1500 kN. The safe bearing capacity of the soil at site is 185 kN/m^2. Adopt M20 grade concrete and Fe 415 HYSD Bars.</td><td>BT-6</td><td>Creating</td></tr>
</table>

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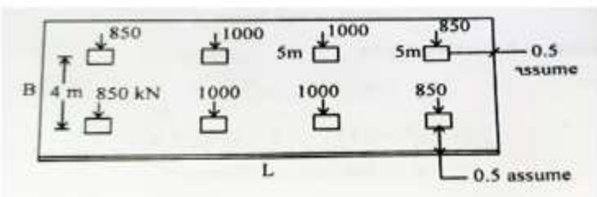
Mr. SATTAINATHAN SHARMA.A, Assistant Professor/ CIVIL

16.	Design a reinforced concrete circular footing for a circular column of 300 mm diameter supporting a factored axial load of 750 kN. Adopt safe bearing capacity of the soil as 200 kN/m^2 and use M20 grade concrete and Fe 415 HYSD Bars.	BT-6	**Creating**
17.	Design a combined column footing with a strap beam for two reinforced concrete columns 300 mm × 300mm size spaced 4 m apart and each supporting a factored axial load of 750 kN. Assume the ultimate safe bearing capacity of the soil at site as 225 kN/m^2. Adopt M20 grade concrete and Fe 415 HYSD Bars.	BT-6	**Creating**
	PART – C		
1.	Explain the effects of water table on foundation. Take a case study and illustrate with the example.	BT-3	**Applying**
2.	Write design procedure of a) Strap Footing b) Combined footing c) Raft Foundation	BT-3	**Applying**
3.	A multistoreyed building of overall size 12 m × 12 m has 16 reinforced concrete columns of size 300 mm × 300 mm spaced at intervals of 4 m on each side forming a square grid. Each column transmits a service load of 500 kN at the base. The safe bearing capacity of the soil at the site is 100 kN/m^2. Adopting M20 grade concrete and Fe415 HYSD reinforcements, design a raft foundation comprising the interconnecting beam between the columns and the inverted slab and sketch the details of reinforcements in the structural elements of the raft. The design should conform to the specifications of Indian Standard Codes IS 456-2000 and IS 2950-1981.	BT-6	**Creating**
4.	Tabulate the general design criteria to be considered regarding the selection of foundation based on soil condition?	BT-2	**Understanding**
5.	Design a mat foundation for system of columns shown in figure. All the columns are 500 mm x 500 mm. They carry loads as indicated in figure. 	BT-6	**Creating**

UNIT-2 PILE FOUNDATIONS
Introduction – Types of pile foundations – load carrying capacity - pile load test – structural design of straight piles –configuration of piles- different shapes of piles cap – structural design of pile cap.
PART - A

Q.No	**Questions**	**BT**	**Competence**
1.	Discuss the merits and demerits of pile foundation.	BT-1	**Remembering**

Prepared by

Mr. SATTAINATHAN SHARMA.A, Assistant Professor/ CIVIL

2.	What is tension piles and where it is used?	BT-1	**Remembering**
3.	State the methods of pile driving	BT-2	**Understanding**
4.	Explain the Protection of pile during driving.	BT-2	**Understanding**
5.	Write down the necessity for lateral pile load test.	BT-2	**Understanding**
6.	Differentiate shallow foundation and deep foundation.	BT-2	**Understanding**
7.	Distinguish friction pile and batter pile.	BT-2	**Understanding**
8.	Demonstrate the precautions that should be carried to avoid heaving of soil while driving the pile?	BT-3	**Applying**
9.	Differentiate between driven and bored pile.	BT-2	**Understanding**
10.	Discuss the types of piles based on their function.	BT-3	**Applying**
11.	Are pile foundation checked for settlement? Justify your answer	BT-1	**Remembering**
12.	What is a pile cap? Specify the function of a pile cap.	BT-1	**Remembering**
13.	Write the principle of a pile group effect and how will you estimate the capacity of a pile group in clay?	BT-3	**Applying**
14.	Define Negative skin friction (or) down drag	BT-1	**Remembering**
15.	Define Pile group efficiency and list the factors affecting pile group efficiency	BT-1	**Remembering**
16.	Brief about under reamed pile.	BT-3	**Applying**
17.	What are the conditions where a pile foundation is more suitable than a shallow foundation?	BT-1	**Remembering**
18.	Sketch different shapes of pile caps.	BT-2	**Understanding**
19.	Compare the efficiency of Felds's rule and Converse-Labarre formula.	BT-2	**Understanding**
20.	Sketch a typical Pile cap and its reinforcement details.	BT-2	**Understanding**
21.	Explain the procedure used to get the group efficiency by feld's rule?	BT-2	**Understanding**
22.	Interpret the result of driving a displacement pile into a loose sand and plastic clay?	BT-1	**Remembering**
23.	Enlist the design parameters of Pile cap.	BT-1	**Remembering**
24.	Criticize the seismic considerations in pile foundation than that of in shallow foundation	BT-1	**Remembering**
25.	Recommend some important parameters in the design of pile caps.	BT-1	**Remembering**
PART - B			
1.	Distinguish Pile Foundation from Shallow Foundation.	BT-2	**Understanding**
2.	Explain in details about the various types of pile foundation with neat sketch and write their functions.	BT-3	**Applying**
3.	a) Give the necessity of pile foundation b) Factors influencing the selection of pile	BT-3	**Applying**

Prepared by

Mr. SATTAINATHAN SHARMA.A, Assistant Professor/ CIVIL

4.	Brief about a) Different types of pile drivers b) Methods of pile driving	BT-3	**Applying**
5.	How is the pile hammers classified? Explain them.	BT-3	**Applying**
6.	A square pile group of a piles passes through a recently filled up a material of 4.5m depth. The diameter of the pile is 30 cm and pile spacing is 90 cm centre to centre. If the unconfined compressive strength of the cohesive material is 60kN/m^2 and unit weight is 15kN/m^2, compute the negative skin friction of the pile group.	BT-1	**Remembering**
7.	A square group of 25 piles extends between depth of 2m and 12m in a deposit of 20m thick stiff clay overlying rock. The piles are 0.5m in a diameter and spaced at 1m centre to centre in the group. The undraned shear strength of the clay at the pile base level is 180kPa and the average value of the undrained shear strength over the depth of the pile is 110kPa. The adhesion coefficient (α) is 0.45. Estimate the capacity of the pile group considering an over all factor of safety equal to 3 against shear failure. NC corresponding to ϕ_u = 0 is 9.	BT-4	**Analyzing**
8.	Design a pile group to carry 2500kN at a place where the soil is uniform clay to a depth of 15m, underdrain by hard rock. The unconfined compressive strength (average) of the clay is 120 kN/m^2. Adopt a factor of safety of 2.5 against failure.	BT-6	**Creating**
9.	A group of 16 piles was driven into soft clay extending to a large depth. The dia& length of the piles were 50cm & 9m. if the unconfined compression strength of 30kN/m^2 and pile spacing 1m, c/c. bearing resistance may be neglected for the piles. Determine the ultimate load capacity of the group Adhesion factor is 0.6.	BT-2	**Understanding**
10.	Design a square pile group to carry 400kN in clay with an unconfined compressive strength of 60kN/m^2. The piles are 30cm diameter and 6m long. Adhesion factor may be taken as 0.6.	BT-6	**Creating**
11.	In a (4 X 4) pile group, the pile diameter is 0.45 m centre to centre spacing of the square group is 1.5 m. If cohesion is 50 kN/m^2, Defend whether the failure would occur with the pile acting individually, or as a group? Neglect bearing at the tip of the pile. All piles are 10 m long. Take m = 0.7 for shear mobilization around each pile.	BT-5	**Evaluating**
12.	Design a pile cap for a column of size 500 mm X 500 mm carrying a load of 2200 kN, supported by four piles. The size of the piles may be taken as 250 mm X 250 mm. The c/c distance between the piles is 1.10m. Use the M30 concrete and Fe415 grade steel.	BT-6	**Creating**

Prepared by

Mr. SATTAINATHAN SHARMA.A, Assistant Professor/ CIVIL

<table>
<tr><td>13.</td><td>The following data refers to a cyclic pile load test carried out on a 300mm diameter, 10 m long pile.

Load on pile top (kN): 150, 200, 250, 300, 400, 500, 600
Top settlement of pile trip (mm): 1.45, 2.25, 2.75, 3.60, 5.75, 10.75, 30.00
Net settlement of pile trip (mm): 0.40, 0.65, 0.80, 1.0, 1.70, 5.25, 22.80

Plot the load-settlement curve and estimate the allowable load of the pile as per IS code of practice.</td><td>BT-3</td><td>Applying</td></tr>
<tr><td>14.</td><td>A column carrying a load of 2500 kN has to be supported by 4 piles, each of 30 cm X 30 cm size at a spacing of 100 cm c/c. The column size is 60 cm X 60 cm. Solve for the pile cap design. Use M_{20} concrete and Fe 415 steel.</td><td>BT-3</td><td>Applying</td></tr>
<tr><td>15.</td><td>A pile cap consisting of 4 piles of 300 mm × 300 mm is to be designed to support a reinforced concrete 500 mm × 500 mm carrying a load of 200 kN. The piles are located parallel to the column faces with their centers located 600 mm from the center to the column. Using M20 grade concrete and Fe415 HYSD Bars, design the pile cap and sketch the details of reinforcements.</td><td>BT-4</td><td>Analyzing</td></tr>
<tr><td>16.</td><td>The foundation for a structure consists of 10 piles to carry a load of 6000 kN. The piles are spaced 1.5 m centres. They are driven through a hard stratum available at a depth of 6 m. Design one of the piles and sketch the details of reinforcements. Adopt M20 grade concrete and Fe 415 HYSD Bars.</td><td>BT-4</td><td>Analyzing</td></tr>
<tr><td>17.</td><td>A pile group of three rows with 3 piles in a row is made in a uniform clay deposit with cohesion of 75kPa. The diameter and length of piles are 500mm and 12m respectively. The centre to centre spacing of piles is 1.5m in both directions. The adhesion factor is 0.4. Find the load carrying capacity of the pile group.</td><td>BT-4</td><td>Analyzing</td></tr>
<tr><td colspan="4">PART -C</td></tr>
<tr><td>1.</td><td>Briefly Describe about

a) Negative skin friction (4)
b) Pile cap (3)
c) Under reamed pile (3)
d) Laterally loaded piles(5)
e) Pile groups</td><td>BT-3</td><td>Applying</td></tr>
<tr><td>2.</td><td>With the help of a case study, briefly explain pile foundation and its failure.</td><td>BT-3</td><td>Applying</td></tr>
<tr><td>3.</td><td>Explain in detail about Pile load test.</td><td>BT-3</td><td>Applying</td></tr>
</table>

Prepared by

Mr. SATTAINATHAN SHARMA.A, Assistant Professor/ CIVIL

3.	A 30cm diameter pile of length 12m was subjected to a pile load test and the following were obtained.	BT-4	**Analyzing**

Load (kN)	0	500	1000	1500	2000	2500
Settlement during loading (cm)	0	0.85	1.65	2.55	3.8	6.0
Settlement during unloading (cm)	4.0	4.6	5.2	5.5	5.8	6.0

Determine the allowable load.

4.	A group of 16 friction piles is to support a column load of 4000kN. The piles will be driven in four rows with four members in each column. The piles are 35cm diameter and centre-to-centre spacing is 1m both ways. What set value must be attained by the piles when driven by a single acting 22.5kN steam hammer with 90cm stroke so that the pile group can carry the column load.	BT-4	**Analyzing**
5.	Design a friction square pile group to carry a load of 3000kN including the weight of the pile cap at a site where the soil is uniform clay to a depth of 20m, underdrain by rock. Average cohesion of the clay is 35kN/m^2. The clay may be assumed to be of normally loaded with liquid limit 60%. A factor of safety of 3 is required against shear failure.	BT-6	**Creating**

UNIT-3 WELL FOUNDATIONS

Types of well foundation – Grip length – load carrying capacity – construction of wells – Failures and Remedies – Design of well foundation – Lateral stability

PART - A

Q.No	Questions	BT Level	Competence
1.	What are Pneumatic caissons?	BT-1	**Remembering**
2.	What are open caissons?	BT-1	**Remembering**
3.	How the thickness of well steining is designed?	BT-1	**Remembering**
4.	List the forces acting on well foundation?	BT-1	**Remembering**
5.	Under what circumstances, a caisson is advantages compared to other types of deep foundations?	BT-1	**Remembering**
6.	What are the different shapes of well foundation?	BT-1	**Remembering**
7.	Discuss about drilled caissons.	BT-2	**Understanding**
8.	Predict the reasons for providing bottom concrete plug to a well.	BT-2	**Understanding**
9.	Describe well cap.	BT-2	**Understanding**
10.	Describe well curb.	BT-2	**Understanding**
11.	Differentiate between bottom plug and top plug.		
12.	Sketch a typical well foundation and its components.	BT-2	**Understanding**

Prepared by

Mr. SATTAINATHAN SHARMA.A, Assistant Professor/ CIVIL

13.	Sketch and point out the types of drilled piers.	BT-2	**Understanding**
14.	State the Advantages and Disadvantages of Drilled Pier Foundations	BT-1	**Remembering**
15.	Relate box caisson with other types of well foundation.	BT-3	**Applying**
16.	Why lateral stability of the well foundation is is necessary?	BT-1	**Remembering**
17.	Summarize about grip length and how it is measure?	BT-3	**Applying**
18.	How lateral stability of well foundation is checked?	BT-1	**Remembering**
19.	Write about "caisson disease"	BT-2	**Understanding**
20.	Express "scour depth" in terms of the design of cassions.	BT-2	**Understanding**
21.	Sketch observed failure of the well foundationunder ultimate conditions.	BT-2	**Understanding**
22.	Define Base Resisting Moment.	BT-1	**Remembering**
23.	Enlist the conditions of surrounding soil of well foundation to be checked.	BT-1	**Remembering**
24.	Enlist the assumptions made in elastic theory.	BT-1	**Remembering**
25.	Express the condition for stability of well foundation.	BT-2	**Understanding**
	PART - B		
1.	What are the elements of bridge structures? Mention the function of each element.	BT-1	**Remembering**
2.	Explain in detail the design procedure of pier cap	BT-2	**Understanding**
3.	What are the causes of tilts and shifts? List the various methods of rectifying tilts and discuss them in detail.	BT-1	**Remembering**
4.	A circular well of 5m external diameter and steining 1 m is used as foundation for a bridge pier in a sandy stratum. the submerged unit weight of sand is 10kN/m^3 and angle of shearing resistance, ø is 30^o. The well is subjected to a horizontal force of 500 kN and a total moment of 5000 kNm at the scour level. the depth of well below scour level is 12m. Assuming the well to be light, check the lateral stability of the well.	BT-4	**Analyzing**
5.	A bridge pier is supported on two round caissons that is to rest on hard soil of a depth of 32m below the river bed. the caissons are to carry 28000 kN. The skin friction of the material above the soil may be assumed as 16 kN. Solve for the diameter of the caisson and the thickness of the plug.	BT-3	**Applying**
6.	An open caisson, 20 m deep, is of cylindrical shape, with external and internal diameters of 9 m and 6 m, respectively. If the water level is 2 m below the top of the caisson. solve for the minimum thickness of the seal required. Check for perimeter shear also. Assume σ_c = 2400 kN/m^2 and γc = 24 kN/m^3, for concrete. Allowable perimeter shear stress = 650 kN/m^2.	BT-3	**Applying**
7.	Explain in detail about the types of well foundation.	BT-2	**Understanding**
8.	With the help of IRC 45 code, give the step by step procedure of ultimate resistance method to calculate the soil resistance of well foundation.	BT-2	**Understanding**

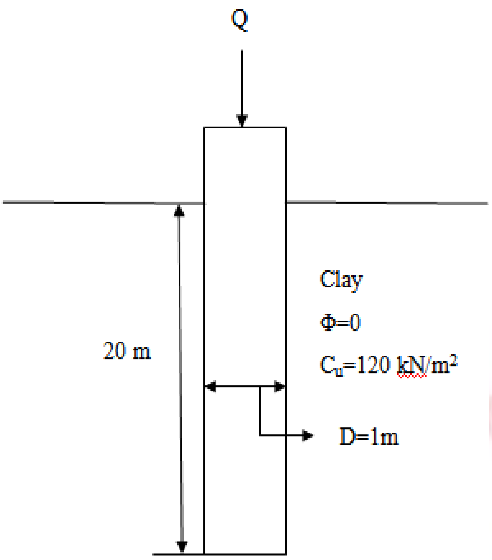
Prepared by

Mr. SATTAINATHAN SHARMA.A, Assistant Professor/ CIVIL

9.	Design the outside well diameter of a cassion to be sunk through 40m of sand and water bed rock if the allowable bearing capacity is 2000kN/m^2. The cassion receives a load of 50000kN from the super structure. The mantle friction is 30kN/m^2. Test the feasibility of sinking. Also calculate the thickness of the seal.	BT-6	**Creating**
10.	A cylindrical well of external diameter 6 m and internal diameter 4 m is sunk to a depth 16 m below the maximum scour level in a sand deposit. The well is subjected to a horizontal force of 1000 kN acting at a height of 8 m above the scour level. Determine the total allowable equivalent resisting force due to earth pressure, assuming that (a) the well rotates about a point above the base (b) the well rotates about the base. Assume γ' = 10 kN/m^3, φ = 30°, and factor of safety against passive resistance = 2. Use Terzaghi's Approach.	BT-5	**Evaluating**
11.	A circular well has an external diameter of 7.5 m and is sunk into a sandy soil to a depth of 20 m below the maximum scour level. The resultant horizontal force is 1800 kN. The well is subjected to a moment of 36,000 kN.m about the maximum scour level due to the lateral force. Check whether the well is safe against lateral forces, assuming the well to rotate (a) about a point above the base (b) about the base Assume γ' = 10 kN/m^3, and φ = 36°. a factor of safety of 2 against passive resistance. Use Terzaghi's analysis.	BT-5	**Evaluating**
12.	Examine the cross-sectional dimensions of a cylindrical open caisson to be sunk through 35 m of sand and water to bed rock if the allowable bearing pressure is 2000 N/m^2. The caisson has to support a load of 60 MN from the superstructure. Test the feasibility of sinking if the skin friction is 40 kN/m^2. Also calculate the necessary thickness of the seal.	BT-5	**Evaluating**
13.	Outline the Design Aspects of the Components of a Well Foundation.	BT-4	**Analyzing**
14.	Write the design procedure for calculating the soil resistance for well foundation by Elastic theory as per IRC 45 recommendations.	BT-3	**Applying**
15.	Express in detail about the forces acting on well foundation.	BT-3	**Applying**
16.	With neat sketch, give the expression for base pressure calculation in well foundation.	BT-3	**Applying**

Prepared by

Mr. SATTAINATHAN SHARMA.A, Assistant Professor/ CIVIL

17.	A multistory building is to be constructed in a stiff to very stiff clay. The soil is homogeneous to a great depth. The average value of undrained shear strength cu is 120 kN/m^2. It is proposed to use a drilled pier of length 20 m and diameter 1 m as shown in figure.  Calculate (a) Ultimate load capacity of the pier (b) Allowable load on the pier with Fs = 2.5.	BT-4	**Analyzing**

PART - C

1.	What are the Stability analyses of a well foundation? Explain them with neat sketches.	BT-3	**Applying**
2.	Discuss in detail the failures and remedies of well foundation.	BT-3	**Applying**
3.	Explain the construction procedure of caisson foundation.	BT-3	**Applying**
4.	Write the elements of well foundation detail. Mention the function of each element with neat sketch.	BT-3	**Applying**
5.	With the help of case study, explain about well foundation in detail.	BT-3	**Applying**

UNIT-4 MACHINE FOUNDATIONS

Introduction – Types of machine foundation – Basic principles of design of machine foundation – Dynamic properties of soil – vibration analysis of machine foundation – Design of foundation for Reciprocating machines and Impact machines – Reinforcement and construction details – vibration isolation.

PART - A

Q.No	Questions	BT Level	Competence
1.	Recall 'Frequency ratio'? What is its criterion in machine foundation?	BT-1	**Remembering**
2.	Define the term Frequency and resonance.	BT-1	**Remembering**

Prepared by

Mr. SATTAINATHAN SHARMA.A, Assistant Professor/ CIVIL

3.	What are the various types of machine foundation used for different kinds of machinery?	BT-1	**Remembering**
4.	What is the use of bonded rubber mountings in machine foundations?	BT-1	**Remembering**
5.	Write down the two basic principles of machine foundation design.	BT-2	**Understanding**
6.	Write down the technique adopted for isolation of a dynamic foundation.	BT-2	**Understanding**
7.	Explain about Machine foundation.	BT-2	**Understanding**
8.	What are the various techniques adopted for isolation of a dynamic foundation?	BT-1	**Remembering**
9.	Distinguish between horizontal amplitude and rotating amplitude in the design of machine foundation.	BT-2	**Understanding**
10.	Summarize the damping parameters.	BT-3	**Applying**
11.	Assess the importance of spring absorbers.	BT-3	**Applying**
12.	Define angular frequency, operation frequency, & Natural frequency.	BT-1	**Remembering**
13.	Define the terms period, cycle and period motion	BT-1	**Remembering**
14.	Differentiate free and forced vibration	BT-2	**Understanding**
15.	Distinguish between single mass system and multiple mass system.	BT-2	**Understanding**
16.	Sketch the different types of machine foundation.	BT-3	**Applying**
17.	Enlist the various vibration isolation technique.	BT-1	**Remembering**
18.	Brief Elastic Half Space Theory	BT-1	**Remembering**
19.	Tell about dynamic analysis of machine foundation.	BT-1	**Remembering**
20.	Dramatize the properties of isolating materials.	BT-3	**Applying**
21.	Enlist different types of machine foundation on various elements.	BT-1	**Remembering**
22.	Outline the loads to be considered for the design of machine foundation.	BT-1	**Remembering**
23.	Differentiate plate and spring foundation.	BT-2	**Understanding**
24.	Define damping.	BT-1	**Remembering**
25.	What do you mean by damper? Give examples.	BT-1	**Remembering**
	PART - B		
1.	Explain the design criteria for machine foundations	BT-3	**Applying**
2.	Design a foundation for a simple rotary machine which has following characteristics Weight Wm = 230kN Base Area = 2 x 4 m Height of CG = 1.2 m Speed = 1000 rpm Mass inertia = 8500 kg m^4 Vertical excitation force = 40 kN Co-efficient of elastic uniform compression = 60 MN/m^3 Assume M20 grade of concrete and Fe 415 Grade of steel	BT-6	**Creating**

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3.	Design for a suitable block foundation for a two cylinder vertical compressor for the following data: Crank angle : 0 & $\pi/2$ Weight of compressor = 200 kN Operating speed = 600 rpm Total weight of rotating mass = 0.06 kN Total weight of reciprocating mass = 0.27 kN Radius of Crank = 0.4 m Safe Bearing capacity of soil under static condition = 100 kN/m^2 Co-effiecient of elastic uniform compression = 45000 kN/m^3	BT-6	**Creating**
4.	A single cylinder engine with the following particulars is to be placed on a concrete foundation. Estimate the maximum unbalanced force generated by the engine: crank radius = 80 mm Length of connecting rod = 280 mm operating frequency = 1800 rpm Weight of reciprocating parts = 49 N	BT-4	**Analyzing**
5.	The exciting force in a constant force-amplitude excitation is 90 kN. The natural frequency of the machine foundation is 3 Hz. The damping factor is 0.30. Evaluate the magnification factor and the transmitted force at an operating frequency of 6 Hz.	BT-4	**Analyzing**
6.	Briefly explain the stiffness and damping parameters used in the design of machine foundation.	BT-2	**Understanding**
7.	Explain the "free vibration with damping" and bring out the meaning of over damped, under damped and critically damped conditions.	BT-2	**Understanding**
8.	Determine the coefficient of elastic uniform compression if a vibration test on a concrete block of 1 m cube gave a resonant frequency of 36 Hz in vertical vibration. The weight of the oscillator used was 500 N. Take the unit weight of concrete as 24.0 kN/m^3	BT-4	**Analyzing**
9.	How does the design of machine foundation differ from that of shallow foundation? Discuss in detail.	BT-3	**Applying**
10.	Examine the natural frequency of a machine foundation of base area 2m ×2m and weight 150 kN, assuming that the soil mass participating in the vibration is a) Negligible b) 20% of the weight of foundation. Take Cu = 36,000 kN/m^3	BT-3	**Applying**
11.	Describe the following in detail a) Significance of spring mass system in machine foundation. b) The role of resonance in the design of machine foundation.	BT-3	**Applying**
12.	Record the bulb of pressure concept proposed by "Balakrishna Rao" for the design of Machine foundations.	BT-3	**Applying**

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13.	Design a suitable foundation for a double-acting steam hammer for the following data: Weight of tup = 50 kN Height of fall = 1 m Area of piston = 0.2 m^2 Steam pressure on piston = 900 kN/m^2 Weight of anvil and frame = 1000 kN Safe bearing capacity under static loading conditions = 200 kN/m^2 Coefficient of elastic uniform compression of soil = $5 \times 10^4 kN/m^3$ Base area of anvil (base area of elastic pad also) = 5.5 m^2 Thickness of elastic pad = 0.60 m Modulus of elasticity of the material of the pad = $5 \times 10^5 kN/m^2$ Coefficient of restitution = 0.5 Unit weight of soil = 16 kN/m^3 Safe bearing capacity under static loading conditions = 200 kN/m^2 Coefficient of elastic uniform compression of soil = $5 \times 10^4 kN/m^3$	BT-6	**Creating**
14.	The resonant frequency of a block foundation, excited by an oscillator is observed as 20 Hz. The amplitude of vibration at resonance is 1 mm. The magnitude of the dynamic force at 20 Hz is 5 kN. If the total weight of the block and oscillator is 20kN, Record the damping factor associated with it.	BT-3	**Applying**
15.	Discuss about the various safety criterion for machine foundations.	BT-3	**Applying**
16.	Discuss about the various method of analysis of machine foundation.	BT-3	**Applying**
17.	Give the requirements of design of foundation for reciprocating machines as per IS code and also list the various aspects in the design criteria for machine foundation used for an impact engine.	BT-3	**Applying**
	PART - C		
1.	Take a heavy industrial building having larger number of vibrating machines. Discuss the type of foundation to be adopted for the machines. Illustrate with example.	BT-3	**Applying**
2.	Point out the requirements governing the design of foundations for impact type machines.	BT-1	**Remembering**
3.	Give the requirements of design of foundation for reciprocating machines as per IS code and also list the various aspects in the design criteria for machine foundation used for a Reciprocating engine.	BT-1	**Remembering**
4.	Explain the various techniques adopted for the isolating the dynamic effects in machine foundation.	BT-2	**Understanding**
5.	Summarize application to analysis of hammer foundation for impact type machines (hammer foundations) with neat model sketch.	BT-3	**Applying**

UNIT-5 SPECIAL FOUNDATIONS
Foundation on expansive soils – choice of foundation – Foundation for concrete Towers, chimneys – Design of anchors- Reinforced earth retailing walls.
PART - A

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Mr. SATTAINATHAN SHARMA.A, Assistant Professor/ CIVIL

Q.No	Questions	BT	Competence
1.	Indicate the general design criteria for the satisfactory performance of a tower foundation.	BT-2	**Understanding**
2.	What are anchored bulk heads?	BT-1	**Remembering**
3.	Give various types of foundation for transmission line towers.	BT-2	**Understanding**
4.	What are the forces acting on tower foundation?	BT-1	**Remembering**
5.	Explain the method of selecting a proper type of foundation for transmission.	BT-2	**Understanding**
6.	How the safety of tower foundation is checked against uplift?	BT-1	**Remembering**
7.	What do you mean by Ground anchor?	BT-1	**Remembering**
8.	Criticize between normal condition and broken wire condition in tower foundation design.	BT-2	**Understanding**
9.	Outline with sketch How do the ground anchors derive resistance loads?	BT-2	**Understanding**
10.	What are the forces to be considered in the design of foundation for chimneys?	BT-1	**Remembering**
11.	What are the IS codes to be followed for the satisfactory performance of a cooling tower foundation?	BT-1	**Remembering**
12.	Write down the points to be considered in the design of anchors.	BT-2	**Understanding**
13.	Compare the load transfer mechanism of single under reamed pile with that of double under reamed pile with neat sketches.	BT-2	**Understanding**
14.	Demonstrate the stability analysis for tower foundation.	BT-3	**Applying**
15.	Write the formula used for checking the uplift capacity of tower foundation.	BT-2	**Understanding**
16.	Categorize the types of loads to be considered for tower foundation	BT-2	**Understanding**
17.	Develop and sketch the Structural arrangement of foundation for towers	BT-3	**Applying**
18.	Recommend the importance of under reamed piles for loose soil.	BT-2	**Understanding**
19.	Show in what way reinforced earth walls differ from retaining wall.	BT-3	**Applying**
20.	Criticize the slip failure and its remedies.	BT-1	**Remembering**
21.	Brief marine foundation.	BT-2	**Understanding**
22.	Define chimneys.	BT-1	**Remembering**
23.	What are the factors to be considered for the design of marine foundation?	BT-1	**Remembering**
24.	Enlist the design aspects of tower foundation.	BT-1	**Remembering**
25.	Sketch a reinforced retaining earth wall with forces action on it.	BT-2	**Understanding**
	PART - B		

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1.	Give the necessary information and requirements for the design and construction of transmission line tower foundation	BT-1	**Remembering**
2.	What are the various types of foundations used for towers?	BT-1	**Remembering**
3.	Identify the forces acting on tower foundation and its effects.	BT-1	**Remembering**
4.	Employ how stability against overturning, uplift and lateral thrust is checked in tower foundation design?	BT-1	**Remembering**
5.	Outline the general design philosophy in the design of chimney & Pad foundation.	BT-2	**Understanding**
6.	Recall the methods of selecting a proper type of foundation.	BT-1	**Remembering**
7.	Sketch the various types of foundation in use for transmission line	BT-2	**Understanding**
8.	Generalize the factors that decide the type of tower foundation? Discuss in detail.	BT-1	**Remembering**
9.	Describe about ground anchors.	BT-3	**Applying**
10.	Illustrate the design principles of ground anchors.	BT-3	**Applying**
11.	Rewrite the necessity of supports for foundation excavation.	BT-2	**Understanding**
12.	Illustrate in detail about under reamed pile foundation.	BT-3	**Applying**
13.	Assess in detail about Reinforced Earth retaining walls.	BT-3	**Applying**
14.	Tabulate in brief about the effects and causes of Foundation on expansive soils.	BT-2	**Understanding**
15.	Discuss about the challenges in marine foundation.	BT-3	**Applying**
16.	Summarize the design aspects and procedure of marine foundation.	BT-3	**Applying**
17.	Write short notes on the difficulties in constructing reinforced earth retaining walls.	BT-2	**Understanding**

PART - C

1.	Design a suitable foundation for a 20° angle tower to be used in a double circuit 132 kV transmission line. The foundation is located in medium dense sand with ϕ = 30° and 17kN/m³. Depth of groundwater table is 5.0 m below the ground level. Use overload factors of 2 and 1.5 for normal and broken wire conditions respectively. The foundation is subjected to the following loadings	BT-6	**Creating**

Nature of load	**Load in kN under Conditions**	
	N.C	**B.W.C**
Downward	400	450
Uplift	300	380
Shear in transverse direction	3.3	25
Shear in longitudinal direction	-	16

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Mr. SATTAINATHAN SHARMA.A, Assistant Professor/ CIVIL

<table>
<tr><td>2.</td><td>Assess a suitable tower foundation for a double circuit 144KW transmission line without any deviation. The foundation is located in cohesive soil with allowable bearing pressure as 200kN/m^2. Consider C_u =20kN/m^2, γ = 18kN/m^3, ϕ = 35^o, for computation of uplift forces. The foundation is subjected to the loading given below.

<table>
<tr><th rowspan="2">Name of the Load</th><th colspan="2">Load in kN</th></tr>
<tr><th>N.C</th><th>B.W.C</th></tr>
<tr><td>Downward</td><td>250</td><td>300</td></tr>
<tr><td>Uplift</td><td>1750</td><td>250</td></tr>
<tr><td>Shear (transverse)</td><td>12</td><td>17</td></tr>
<tr><td>Shear (longitudinal)</td><td></td><td>8</td></tr>
</table>
</td><td>BT-5</td><td>Evaluating</td></tr>
<tr><td>3.</td><td>Formulate a suitable tower foundation for a double circuit 144 kV transmission line for the following specifications. The foundation is to be located in dense sand with ϕ = 30^o , γ = 18.5 kN/m^3, allowable bearing pressure as 250kN/m^2. The water table is located at a depth of 2 m below the existing GL.

<table>
<tr><th rowspan="2">Nature of load</th><th colspan="2">Actual Load</th></tr>
<tr><th>N.C</th><th>B.W.C</th></tr>
<tr><td>Downward load</td><td>500 kN</td><td>650 kN</td></tr>
<tr><td>Upward load</td><td>250 kN</td><td>325 kN</td></tr>
<tr><td>Shear in transverse direction</td><td>5 kN</td><td>20 kN</td></tr>
<tr><td>Shear in longitudinal direction</td><td>0</td><td>25 kN</td></tr>
</table>
</td><td>BT-5</td><td>Evaluating</td></tr>
<tr><td>4.</td><td>Two main brick wall of a room in a residential building 225mm thick, a loading of 40kN/m at foundation level. another cross wall of same thickness joins it and transmits a concentrated load 50kN. Design a under-reamed pile with spacing of piles 2m and also design grade beam for the foundation of a main wall.</td><td>BT-4</td><td>Analyzing</td></tr>
<tr><td>5.</td><td>With the help of a case study, discuss about the marine foundation.</td><td>BT-3</td><td>Applying</td></tr>
</table>

Prepared by

Mr. SATTAINATHAN SHARMA.A, Assistant Professor/ CIVIL