

SRM VALLIAMMAI ENGINEERING COLLEGE

SRM Nagar, Kattankulathur – 603 203

DEPARTMENT OF CIVIL ENGINEERING

M.E-STRUCTURAL ENGINEERING

QUESTION BANK



III SEMESTER

PST603 DESIGN OF SUB STRUCTURES

Regulation – 2023

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Prepared by

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DEPARTMENT OF CIVIL ENGINEERING



QUESTION BANK

SUBJECT : PST603 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.	Enlist the Sub-surface investigations stages.	BT-1	Remembering
2.	List the basic requirements of a foundation.	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 by bore log report and list the information given in a bore log report?	BT-1	Remembering
6.	Sketch the critical sections for Uniform and rectangular Footing.	BT-2	Understanding
7.	Name different types of mat foundation.	BT-1	Remembering
8.	Distinguish between disturbed & un-disturbed samples.	BT-2	Understanding
9.	What factors influence the selection of a strip footing?	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.	Sketch the critical sections for Stepped and rectangular Footing.	BT-2	Understanding
15.	Sketch the critical sections for wall Footing.	BT-2	Understanding
16.	What is a strap beam and when it is preferred?	BT-1	Remembering
17.	Apply the concept of combined footing and its necessity.	BT-3	Applying
18.	What are the objective of site investigation?	BT-1	Remembering

19.	Differentiate inside clearance and outside clearance.	BT-2	Understanding
20.	Sketch the pressure distribution of isolated footing subjected to eccentric loading.	BT-2	Understanding
21.	What is the significance of soil shear strength in foundation design?	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 <table><tr><th>Load (kN)</th><th>Size of plate</th><th>Settlement</th></tr><tr><td>50</td><td>0.3 m x 0.3 m</td><td>25 mm</td></tr><tr><td>110</td><td>0.6 m x 0.6 m</td><td>25 mm</td></tr></table> Find the size of square footing required to carry a load of 1000 kN at the same specified settlement of 25 mm.	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	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										
2.	With neat sketch, explain the procedure of plate load test in detail.	BT-3	Applying									
3.	a) Explain different types of Raft foundation in detail. b) Discuss about the situations where rafts are used.	BT-3	Applying									
4.	The results of two plate load tests for a settlement of 25.4 mm are given <table><tr><th>Plate Diameter</th><th>Load(kN)</th></tr><tr><td>0.3 m</td><td>31</td></tr><tr><td>0.6 m</td><td>65</td></tr></table> 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.	Plate Diameter	Load(kN)	0.3 m	31	0.6 m	65	BT-4	Analyzing			
Plate Diameter	Load(kN)											
0.3 m	31											
0.6 m	65											
5.	Design a plain concrete footing for a column of 400 mm x 400 mm carrying an axial load of 400 kN under service loads. Assume safe bearing capacity of soil as 300 kN/m ² at a depth of 1 m below the ground level. Use M 20 and Fe 415 for the design.	BT-5	Evaluating									
6.	Design an isolated footing for a square column, 400 mm x 400 mm with 12-20 mm diameter longitudinal bars carrying service loads of 1500 kN with M 20 and Fe 415. The safe bearing capacity of soil is 250 kN/m ² at a depth of 1 m below the ground level. Use M 20 and Fe 415.	BT-5	Evaluating									

7.	Design a sloped footing for a square column of 400 mm x 400 mm with 16 longitudinal bars of 16 mm diameter carrying a service load of 1400 kN. Use M 20 and Fe 415 both for column and footing slab. The safe bearing capacity of soil is 150 kN/m ² .	BT-5	Evaluating									
8.	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	LOAD	Column A	Column B	DL	540kN	690kN	LL	400kN	810kN	BT-4	Analyzing
LOAD	Column A	Column B										
DL	540kN	690kN										
LL	400kN	810kN										
9.	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.	BT-5	Evaluating									
10.	A circular column of 480 mm diameter transfers an axial dead 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.	BT-5	Evaluating									
11.	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.	BT-5	Evaluating									
12.	Quote the design consideration for footing as per IS 456:2000.	BT-4	Analyzing									
13.	Design a RC footing for a 345 mm thick masonry load bearing wall which supports a characteristic 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.	BT-5	Evaluating									
14.	Design one isolated footing for a column 300 mm x 450 mm, having 20 bars of 20 mm diameter (A _{st} = 4021 mm ²) carrying P _u = 1620 kN and M _u = 170 kNm using M 25 and Fe 415. Assume that the moment is reversible. The safe bearing capacity of the soil is 200 kN/m ² at a depth of 1 metre from ground level. Use M 25 and Fe 415 for the footing.	BT-5	Evaluating									
15.	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.	BT-5	Evaluating									

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-5	Evaluating
17.	Tabulate the general design criteria to be considered regarding the selection of foundation based on soil condition?	BT-2	Understanding
18.	Design a combined footing for two columns C1, 400 mm x 400 mm with 8 bars of 16 mm diameter carrying a service load of 800 kN and C2, 300 mm x 500 mm with 8 bars of 20 mm diameter carrying a service load of 1200 kN. The column C1 is flushed with the property line. The columns are at 3.0 m c/c distance. The safe bearing capacity of soil is 200 kN/m ² at a depth of 1.5 m below the ground level. Use M 20 and Fe 415 for columns and footing.	BT-5	Evaluating

UNIT-2 PILE FOUNDATIONS

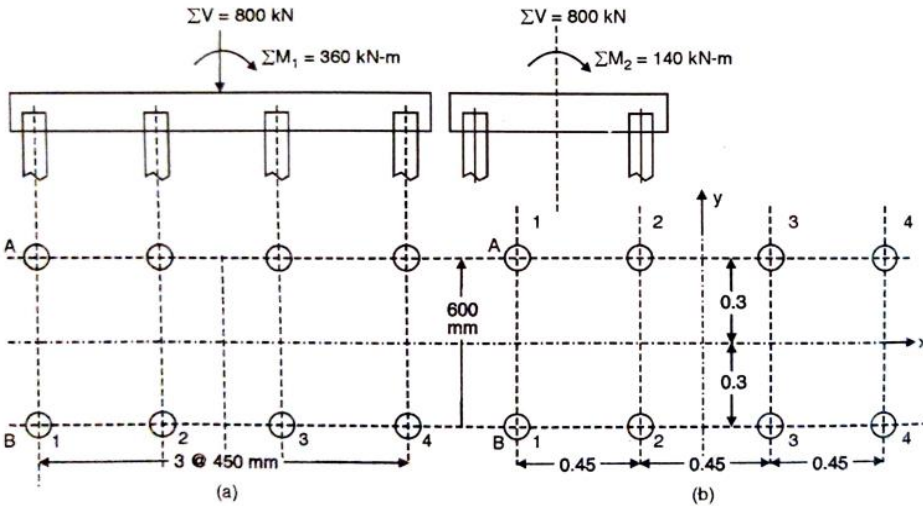
Introduction – Types of pile foundations – load carrying capacity - pile load test – structural design of straight piles –configuration of piles- different shapes of piles cap – structural design of pile cap – Under reamed Pile foundation

PART - A

Q.No	Questions	BT Level	Competence
1.	What are the advantages of using piles compared to shallow foundations?	BT-1	Remembering
2.	Discuss about Lateral Load Capacity of pile.	BT-1	Remembering
3.	Enlist the methods of pile driving.	BT-1	Remembering
4.	Quote the Ultimate end-bearing resistance (q_u) formula for piles in cohesive soil.	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.	What are the key factors influencing the design of straight piles?	BT-1	Remembering
12.	What is a pile cap? Specify the function of a pile cap.	BT-1	Remembering
13.	Why pile load test are carried out? List the reasons.	BT-1	Remembering
14.	Define Negative skin friction (or) down drag.	BT-1	Remembering

15.	Enlist the load test on pile.	BT-1	Remembering
16.	Brief about under reamed pile.	BT-3	Applying
17.	How do the dimensions and reinforcement of a pile cap impact its performance?	BT-1	Remembering
18.	Sketch different shapes of pile caps.	BT-2	Understanding
19.	Quote Converse-Labarre formula.	BT-1	Remembering
20.	Sketch a typical Pile cap and its reinforcement details.	BT-2	Understanding
21.	What factors affect the load-carrying capacity of a pile?	BT-2	Understanding
22.	What are the load carrying mechanisms of piles?	BT-1	Remembering
23.	Write about Settlement of piles.	BT-1	Remembering
24.	Quote about group efficiency of piles.	BT-1	Remembering
25.	How does the shape of a pile cap impact its structural behavior?	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
4.	Brief about a) Different types of pile drivers b) Methods of pile driving	BT-3	Applying
5.	Explain in detail about Pile load test.	BT-3	Applying
6.	i. A timber pile was driven by a drop hammer weighing 30 kN with a free fall of 1.2 m. The average penetration of the last few blows was 5 mm. What is the capacity of the pile according to Engineering News Formula? ii. A pile is driven with a single acting steam hammer of weight 15 kN with a free fall of 900 mm. The final set, the average of the last three blows, is 27.5 mm. Find the safe load using the Engineering News Formula. iii. A pile is driven in a uniform clay of large depth. The clay has an unconfined compression strength of 90 kN/m ² . The pile is 30 cm diameter and 6 m long. Determine the safe frictional resistance of the pile, assuming a factor of safety of 3. Assume the adhesion factor $\alpha = 0.7$.	BT-3	Applying

7.	i. A group of 16 piles of 50 cm diameter is arranged with a centre to centre spacing of 1.0 m. The piles are 9 m long and are embedded in soft clay with cohesion 30 kN/m^2. Bearing resistance may be neglected for the piles—Adhesion factor is 0.6. Determine the ultimate load capacity of the pile group. ii. A square group of 9 piles was driven into soft clay extending to a large depth. The diameter and length of the piles were 30 cm and 9 m respectively. If the unconfined compression strength of the clay is 90 kN/m^2, and the pile spacing is 90 cm centre to centre, what is the capacity of the group? Assume a factor of safety of 2.5 and adhesion factor of 0.75.	BT-3	Applying
8.	Explain in detail about under reamed pile foundation.	BT-3	Applying
9.	i. A 16-pile group has to be arranged in the form of a square in soft clay with uniform spacing. Neglecting end-bearing, determine the optimum value of the spacing of the piles in terms of the pile diameter, assuming a shear mobilisation factor of 0.6. ii. A square pile group of 9 piles passes through a recently filled up material of 4.5 m depth. The diameter of the pile is 30 cm and pile spacing is 90 cm centre to centre. If the unconfined compression strength of the cohesive material is 60 kN/m^2 and unit weight is 15 kN/m^3, compute the negative skin friction of the pile group.	BT-3	Applying
10.	Design a pile group (Proportion) consisting of RCC piles for a column of size 650 mm X 650 mm carrying a load of 5000 kN. the Soil exploration data reveal that the sub-soil consists of deposit of soil clay extending to a great depth. Take • $C_c = 0.10$ • $e_0 = 0.9$ • Saturated Unit weight = 19 kN/m^3 • $UCC = 40 \text{ kN/m}^2$ • Permissible settlement 50 mm	BT-5	Evaluating

11.	Estimate the axial force in each pile beneath the footing shown below.  (a) (b)	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-5	Evaluating
13.	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 M₂₀ & Fe 415 grade of materials.	BT-3	Applying
14.	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.	BT-4	Analyzing
15.	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 & sketch the details of reinforcements. Adopt M20 grade concrete & Fe 415 HYSD Bars.	BT-4	Analyzing

16.	A pile group consisting of RCC piles for a column of size 650 mm X 650 mm carrying a load of 5000 kN. the Soil exploration data reveal that the sub-soil consist of deposit of soil clay extending to a great depth. Take • $C_c = 0.10$ • $e_0 = 0.9$ • Saturated Unit weight = 19 kN/m^3 • $UCC = 40 \text{ kN/m}^2$ • Permissibler settlement 50 mm • Pile arrangement with 36 piles (6x6) Determine the Settlement of pile group.	BT-4	Analyzing																								
17.	The following data refers to a cyclic pile load test carried out on a 300mm diameter, 10 m long pile. <table border="1"><tr><td>Load on pile top (kN)</td><td>150</td><td>200</td><td>250</td><td>300</td><td>400</td><td>500</td><td>600</td></tr><tr><td>Top settlement of pile trip (mm)</td><td>1.45</td><td>2.25</td><td>2.75</td><td>3.60</td><td>5.75</td><td>10.75</td><td>30.00</td></tr><tr><td>Net settlement of pile trip (mm)</td><td>0.40</td><td>0.65</td><td>0.80</td><td>1.0</td><td>1.70</td><td>5.25</td><td>22.80</td></tr></table> Plot the load-settlement curve and estimate the allowable load of the pile as per IS code of practice.	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	BT-3	Applying
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																				
18.	A 30cm diameter pile of length 12m was subjected to a pile load test and the following were obtained. <table border="1"><tr><td>Load (kN)</td><td>0</td><td>500</td><td>1000</td><td>1500</td><td>2000</td><td>2500</td></tr><tr><td>Settlement during loading (cm)</td><td>0</td><td>0.85</td><td>1.65</td><td>2.55</td><td>3.8</td><td>6.0</td></tr><tr><td>Settlement during unloading (cm)</td><td>4.0</td><td>4.6</td><td>5.2</td><td>5.5</td><td>5.8</td><td>6.0</td></tr></table> Determine the allowable load.	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	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																					

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

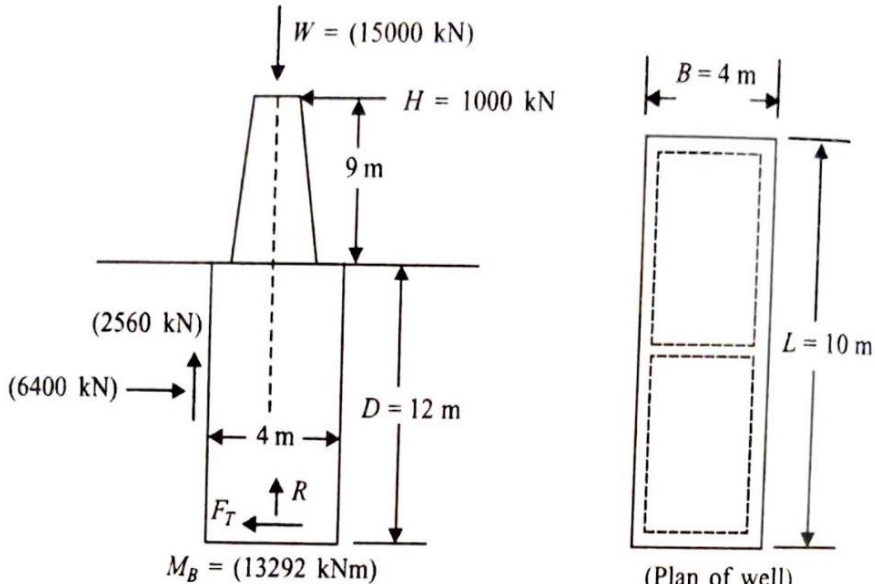
Q.No	Questions	BT Level	Competence
1.	What are Pneumatic caissons?	BT-1	Remembering
2.	What are open caissons?	BT-1	Remembering
3.	How the thickness of well steining is designed?	BT-1	Remembering
4.	List the forces acting on well foundation?	BT-1	Remembering
5.	Under what circumstances, a caisson is 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
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 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 foundation under 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.	Express in detail about the forces acting on well foundation.	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, ϕ is 30° . 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 $\sigma_c = 2400 \text{ kN/m}^2$ and $\gamma_c = 24 \text{ kN/m}^3$, 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
9.	Design the outside well diameter of a caisson to be sunk through 40m of sand and water bed rock if the allowable bearing capacity is 2000 kN/m^2 . The caisson receives a load of 50000 kN from the super structure. The mantle friction is 30 kN/m^2 . Test the feasibility of sinking. Also calculate the thickness of the seal.	BT-5	Evaluating
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 $\gamma' = 10 \text{ kN/m}^3$, $\phi = 30^\circ$, 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 $36,000 \text{ kN.m}$ 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 $\gamma' = 10 \text{ kN/m}^3$, and $\phi = 36^\circ$. 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.	A bridge pier in a sand deposit with external diameter $d = 8.5$ m and the depth of well below scour level $D = 15$ m is subjected to the following data • $H = 2000$ kN • Moment @ base level 42000 kN • $\phi = 30$ degree • Wall friction $= 20^\circ$ • Allowable bearing $= 60$ t/m² • $k_h/k_v = m = 1$ • Weight of the soil $= 20$ kN/m³ Check the lateral stability of the well under the above forces according to IRC 45 (1972) recommendations.	BT-4	Analyzing
16.	Write the elements of well foundation detail. Mention the function of each element with neat sketch.	BT-3	Applying
17.	With neat sketch, give the expression for base pressure calculation in well foundation.	BT-3	Applying
18.	A well foundation for a pier of a bridge in a sand deposit is shown in figure below. Determine the FS of the pier if the horizontal force of 1000 kN is acting at the top of the bearing. Take • $k_v = 180$ MN/m³ • $K_h = n_h y$ • $n_h = 1.60$ MN/m⁴ • $\mu = \mu' = 0.4$ • $\phi = 30$ degree • $\gamma = 20$ kN/m³  (Plan of well)	BT-4	Analyzing

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
3.	What are the various types of machine foundation used for different kinds of machinery?	BT-1	Remembering
4.	Give the various load combination for machine foundation.	BT-1	Remembering
5.	Give the minimum requirement of reinforcement in foundation as per IS standard.	BT-1	Remembering
6.	Write down the technique adopted for isolation of a dynamic foundation.	BT-2	Understanding
7.	Recall coefficient of restitution.	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.	What will be the percentage variation in the value of the coefficient of elastic uniform compression if the diameter of the plate is halved?	BT-1	Remembering
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.	Determine the natural frequency of a machine foundation which has a base area of $2.20 \text{ m} \times 2.20 \text{ m}$ and a weight of 155 kN including the weight of the machine. Take the value of the coefficient of elastic uniform compression as $4.4 \times 10^4 \text{ kN/m}^3$.	BT-1	Remembering
19.	Define anvil & foundation support.	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 foundation for reciprocating type machines.	BT-3	Applying
2.	In a block test according to IS: 5249–1977 (Revised), a resonant frequency of 18 cps was observed in vertical vibrations. Determine the coefficient of elastic uniform compression. A machine weighing 90 kN is to be supported on a block of size 3 m × 4 m × 2 m high. Determine its natural frequency in vertical vibration.	BT-5	Evaluating
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-efficient of elastic uniform compression = 45000 kN/m ³	BT-5	Evaluating
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.	Design a foundation for a simple rotary machine which has following characteristics Weight $W_m = 230\text{kN}$ 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-4	Analyzing
6.	Briefly explain a) Block Vibration test b) Cyclic Plate load test	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.	a) 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. Determine the magnification factor and the transmitted force at an operating frequency of 6 Hz b) 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 20 kN, calculate the damping factor associated with it.	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 $C_u = 36,000 \text{ kN/m}^3$	BT-3	Applying
11.	Sketch a) Different types of foundation support. b) Typical foundation for instrument air compressor.	BT-3	Applying
12.	Discuss the principles of design in foundations for rotary type machines of low frequency.	BT-3	Applying
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 = $5 \times 10^4 \text{ kN/m}^3$ 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 = $5 \times 10^5 \text{ kN/m}^2$ 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 = $5 \times 10^4 \text{ kN/m}^3$	BT-5	Evaluating

14.	a) 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 . b) Determine 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 20% of the weight of foundation. Take $C_u = 36,000$ kN/m ³	BT-3	Applying
15.	Discuss about the various safety criterion for machine foundations.	BT-3	Applying
16.	Discuss about the construction criteria of foundations for rotary type machines of low frequency.	BT-3	Applying
17.	Obtain the velocity of the tup of a forge hammer before impact and that of the anvil after impact, given the following: weight of the tup and die = 15.50 kN stroke of tup = 900 mm weight of anvil and frame = 342 kN efficiency of drop = 0.9 coefficient of restitution = 0.5 steam pressure = 700 kN/m ² area of piston = 0.129 m ² Determine the amplitudes of vibration of the foundation and anvil if the limiting natural frequency of the anvil is 253 rad/s, and the two natural frequencies of the combined system are 272 rad/s and 54.3 rad/s.	BT-3	Applying
18.	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 - Reinforced earth retaining walls – Marine Foundations

PART - A

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.	Demonstrate the stability analysis for tower foundation.	BT-3	Applying

8.	Describe the impact of soil erosion on marine foundation stability and design.	BT-3	Applying
9.	What are expansive soils, and why do they pose challenges for foundation design?	BT-1	Remembering
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.	List the methods to mitigate the effects of expansive soils on foundations.	BT-1	Remembering
13.	What is a reinforced earth retaining wall, and what purpose does it serve?	BT-1	Remembering
14.	How do tidal and wave actions influence the design of marine foundations?	BT-1	Remembering
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.	Explain the role of geotextiles in reinforced earth retaining walls.	BT-3	Applying
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			
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 towers.	BT-2	Understanding
8.	Generalize the factors that decide the type of tower foundation? Discuss in detail.	BT-1	Remembering

9.	Rewrite the necessity of supports for foundation excavation.	BT-2	Understanding																	
10.	Design a wall breakwater for the following data - Depth of water = 16 m - Wind Velocity = 130 km/hr - Fetch of Wave = 220 km - Allowable rock pressure = 800 kN/m² Use Molitore's wave pressure diagram.	BT-5	Evaluating																	
11.	Assess in detail about Reinforced Earth retaining walls.	BT-3	Applying																	
12.	Tabulate in brief about the effects and causes of Foundation on expansive	BT-2	Understanding																	
13.	Discuss about the challenges in marine foundation.	BT-3	Applying																	
14.	Summarize the design aspects and procedure of marine foundation.	BT-3	Applying																	
15.	Write short notes on the difficulties in constructing reinforced earth retaining walls.	BT-2	Understanding																	
16.	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 $\phi = 30^\circ$ and 17kN/m ³ . 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 <table border="1"><thead><tr><th rowspan="2">Nature of load</th><th colspan="2">Load in kN under Conditions</th></tr><tr><th>N.C</th><th>B.W.C</th></tr></thead><tbody><tr><td>Downward</td><td>400</td><td>450</td></tr><tr><td>Uplift</td><td>300</td><td>380</td></tr><tr><td>Shear in transverse direction</td><td>3.3</td><td>25</td></tr><tr><td>Shear in longitudinal direction</td><td>-</td><td>16</td></tr></tbody></table>	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	BT-5	Evaluating
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17.	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 $\phi = 30^\circ$, $\gamma = 18.5$ 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 border="1"><thead><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></thead><tbody><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></tbody></table>	Nature of load	Actual Load		N.C	B.W.C	Downward load	500 kN	650 kN	Upward load	250 kN	325 kN	Shear in transverse direction	5 kN	20 kN	Shear in longitudinal direction	0	25 kN	BT-5	Evaluating
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18.	What design considerations are crucial for foundations in coastal or marine environments?	BT-1	Remembering
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