BIRLA INSTITUTE OF TECHNOLOGY & SCIENCE, PILANI
II Semester 2021-2022
Course: CE F429 DESIGN OF FOUNDATION SYSTEM
Comprehensive Examination

Duration:180 min. Dated: 13-05-2022 Max. Marks: 40

Answer Part A and B in separate answer sheets.
You are allowed to do Part B (open book) after submitting Part A answer sheets.

Part A (Closed Book)

Q1. List various field tests for design of foundation. Mention various soil types for which these are most suitable and unsuitable in tabular form. **[2 marks]**

Q2. What is the importance of strain for dynamic properties of soil such as shear modulus and damping in context of machine foundations and seismic analysis of foundations? Draw neat figures and explain. Shear modulus obtained by SPT correlation correspond to high strain or low strain, explain. **[2 marks]**

Q3. What is the lowest cost testing procedure for finding safe bearing capacity and settlement of shallow foundation/combine footings with width ranging from 2 m to 5 m resting on dry deep deposit of loose to medium dense sand and why? List various tests (lab/field) to be performed and give design equations in which data/parameters from these tests will be used**. [2 marks]**

Q4. Which is most suitable anti-liquefaction measures for new industry away from existing habitation and why? Which technique is most suitable for a new multi-storey building in urban environment with environment protection and why? **[2 Marks]**

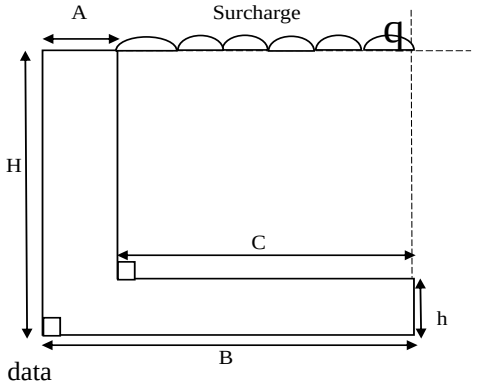
Q5. What are the different type of damping in soils? What are the ranges of these damping? How are these incorporated in the analysis of machine foundations? **[2 marks]**

PART B (OPEN BOOK)

Note: You are allowed to do Part B (open book) after submitting Part A answer sheets.

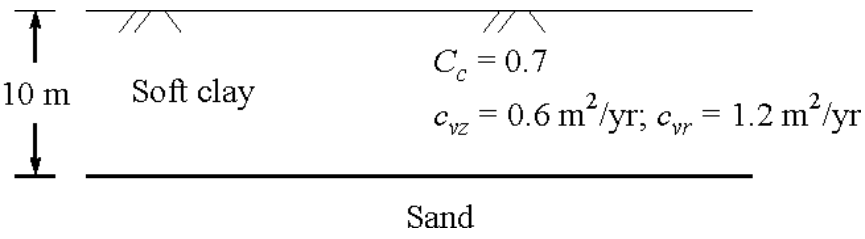
Q1. A L shape reinforced concrete retaining wall situated in Zone V is having dimensions H=3m, A=0.3 m, B=3 m, h=0.4m. Surcharge q=15 kPa imposed due to traffic load. Calculate the factor of safety with respect to sliding and overturning, taking into account the earthquake forces. Backfill soil unit weight $\gamma = 18$ kN/m^3, $\Phi' = 30$. Soil below retaining wall base is same as backfill. Allowable bearing pressure = 150 kPa. Use IRC 6-2017.

[7 marks]



Q2. It is proposed to install a 25 kN forging hammer in an industrial complex. The data pertaining to the hammer is given below:
Total weight of the hammer (anvil + frame) = 455 kN, Bearing area of the anvil = 4.0 m^2
Modulus of elasticity of the timber pad = 5 x 10^5 kPa, thickness of timber pad=600mm, Velocity of tup before impact = 6.5 m/sec. Weight of foundation block=2500 kN, Area of foundation in contact of soil= 48 m^2. The allowable soil pressure at the base of the foundation = 150 kN/m^2. Allowable compressive stress in the pad = 4000 kN/m^2. Coefficient of elastic restitution = 0.5
Assume soil unit weight = 20 kN/m^3. Take equivalent soil spring stiffness as 1.07 x 10^6 kN/m. As a part of design, check the following requirement as per IS code of practice are satisfied or not.
(a.)Vibration amplitude of the foundation block. b. Vibration amplitude of the anvil and frame. c. Maximum stress in the elastic pad. d. Stress in soil. [5 marks]

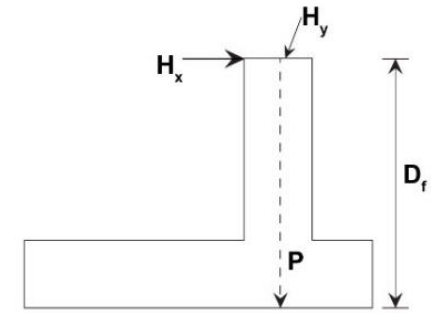
Q3. For soil profile below find
a) Find percentage of radial consolidation of soft clay layer with PVD after six months. Given that the spacing of PVD is 1m on a triangular grid and equivalent diameter of PVD is 100 mm.
(b) Find percentage of combined radial and vertical consolidation of soft clay layer with PVD after six months. Given that the spacing of PVD is 1m on a triangular grid. **(4M),** $C_c = 0.7$ $c_v = 0.6$ m^2/yr $c_h = 1.2$ m^2/yr

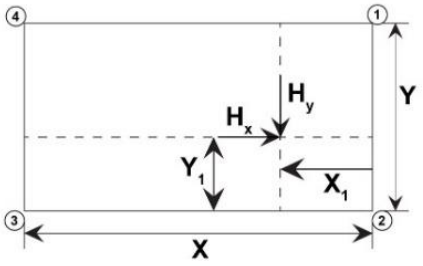


Q4. For a highway bridge free head reinforced concrete (M30) pile 0.71 m diameter in section is driven into a medium dense sand to a depth of 8.2 m. The sand is in a submerged state with design SPT value of 15. A lateral load of 80 kN and moment 160 kN-m is applied on the pile at ground level. (a)Compute the lateral deflection of the pile at ground level (b) Find maximum moment in pile. The submerged unit weight of the soil is 8.75 kN/m^3 **[4 marks]**

Q5. Find the safe thickness of the isolated rectangular footing by one-way shear (assume 0.5% steel), two-way shear and flexure for the column (size 500 mm x 600 mm) subjected to a factored axial force of Vu = 1800 kN and factored moment of Mu = 800 kNm due to earthquake. Assuming 4 m length and 3.0 m width of foundation is worked out safe and the center of column coincides with the center of footing. Take M 25 grade concrete and 20 mm bars of Fe 500 grade steel for both footing and column. Design and detail flexural reinforcement in both directions. Draw neat sketch showing all detailing. **[7 marks]**

Q6. An isolated footing X= 5 m and Y= 4 m is designed for the column whose center coincides with the center of footing (X=2 X_1 and Y= 2Y_1) is subjected to horizontal forces at height of D_f = 2m from base of footing as shown in figure (not to the scale) Hx = 900 kN and H_y = 300 kN, as well as vertical load P = 2100 kN. Uplifting of footing is allowed. Find pressure at corner 1, 2, 3 and 4 at base of footing. Draw the pressure distribution at the base. If uplifting occurs, draw zero pressure line. **[4 marks]**





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