BIRLA INSTITUTE OF TECHNOLOGY & SCIENCE, PILANI

II Semester 2021-2022

Comprehensive Examination (9-5-2022) Duration: 180minutes

Course: CE F419 (Geotechnical Earthquake Engineering & Machine Foundation)

Open Book/Notes Max. Marks: 40

1. A machine foundation is subjected to a maximum vertical force of 2700kg. Weight of machine & foundation = 19000kg, spring constant = 75000kg/cm, operating frequency of machine = 45 radians per sec. If foundation can be idealized as a mass-spring system, determine:
(i) Natural frequency of system in Hz.
(ii) Maximum vertical displacement of the foundation in cm ($g = 981 cm/sec^2$).
If actual damping is 250 kg-sec/cm, determine damping coefficient. Assuming it to be small, determine ratio of successive amplitudes in free vibration. [1+1+2+1=5]

2. Refer Fig 1. Assume H = 5m, thickness of wall stem = 0.5m, and reinforced concrete wall footing is 3.5m wide by 0.75m thick. Ground surface in front of wall is level with top of wall and unit weight of concrete = $27KN/m^3$. Wall backfill consists of sand having $\phi = 30^0$ and $\gamma_t = 18KN/m^3$. Sand in front of wall has same properties. Friction angle between bottom of footing and bearing soil = 36^0. Neglecting wall friction on backside of wall and front side of footing, determine:
(i) Resltant normal force
(ii) Factor of safety for sliding
(iii) Factor of safety for overturning
For static condition and for earthquake condition using pseudostatic analysis if $a_{max} = 0.24g$.
[1+8+3=12]

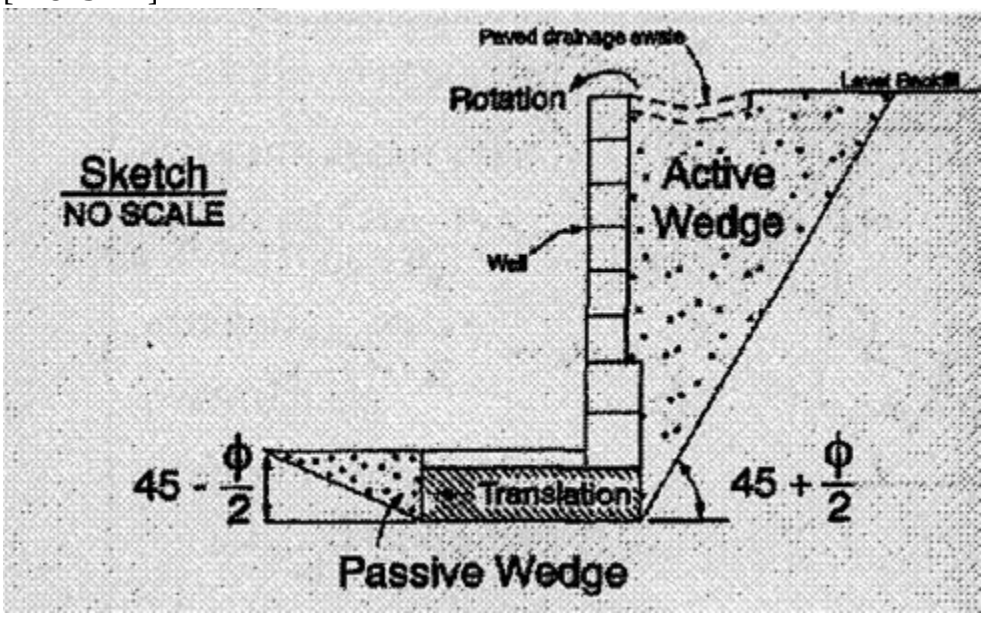

Fig. 1

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3. A slope has a height of 13m and the slope face is inclined at 3:1 (H:V). Wedge type analysis is to be performed where slip surface is planer through toe of slope and is inclined at 3.5:1 (H:V). Undrained shear strength parameters of sliding mass are c = 12.1kPa, $\phi = 0^0$. Factor of safety for earthquake condition of 0.96 is required. Determine total unit weight of sliding mass in KN/m^3. Site is to be designed for catastrophic earthquake. For this total unit weight, determine factor of safety for static case. Also determine slope deformation based on Newmark method in mm. Soil is not weakening type. [6+1+5=12]

4. At a particular site ground surface is horizontal and zone of liquefaction extends from depth of 1.5m to 7m. During construction additional 1.25m thick cohesive soil is placed at ground surface. Then school building is to be constructed at site. Bottom of footing for the building is to be at a depth of 0.5m below ground surface. For existing unliquefiable and additional placed layer, undrained shear strength is 65kPa. Calculate the factor of safety of the footing using punching shear analysis for (largest bearing pressure under footing approach):
(i) 1.5m wide strip footing under total vertical load of 65KN/m and earthquake induced moment of 10KN-m/m in the width direction.
(ii) 2.5m wide square footing under total vertical load of 650KN and earthquake induced moment of 150KN-m in the width direction. [5+3=8]

5. Moment magnitude of Loma Prieta earthquake of 1989 was found to be 6.92. Length of surface rupture was 40km and depth of aftershakes was 16km. Shear modulus of material along fault plane = $3x10^{10}N/m^2$. Determine average displacement of ruptured segment of fault in meters. [3]