Ref. No.: Ex/PG/CE/T/127C/2024

M.E. CIVIL ENGINEERING FIRST YEAR SECOND SEMESTER EXAM 2024

SOIL DYNAMICS AND MACHINE FOUNDATION (SMFE)

Time : Three hours | Full Marks : 100

Use separate answer script for each Part

PART I (60 Marks)

[Questions 1 and 4 are compulsory, and answer any one from Questions 2 and 3]

[*Assume any data reasonably wherever necessary*]

1. (a) Derive the expressions for displacement and stress amplitudes of transmitted and reflected waves due to the propagation of a harmonic stress wave $\sigma_I(x,t) = \sigma_i e^{i(\omega t - k_1 x)}$ in the +x direction and approaching an interface of two different materials as shown in the figure (Fig. 1) below. [Symbols used carry the usual meaning].

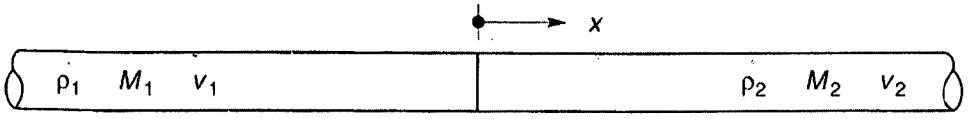

Fig. 1

(b) What is dispersion of surface waves? Explain the non-dspersive, normally-dispersive and inversely-dispersive media with neat sketches.

[14+6]

2. (a) Make a list of the field and laboratory tests associated with the determination of low strain and high strain dynamic soil properties.

(b) Discuss Steady State Vibration (Rayleigh wave) test in connection with the determination of shear wave velocity of soil.

(c) The results of a subsoil exploration by steady-state vibration technique are given in Table 1.

Table 1

Distance from the plate vibrated x (m)	Number of waves for the distance	Frequency of vibration of the plate (Hz)
10	41	900
10	18	400
10	9	200
10	4.55	100
10	2.65	90
10	2.3	75
10	1.77	60
10	1.47	50

Make necessary calculations and plot the variation of: (i) Rayleigh wave phase velocity vs Frequency and (ii) the variation of shear wave velocity with depth.

[4+8+8]

3. (a) Define G_{sec}, G_{tan}, G_{max} and backbone curve in connection with stress-strain behavior of cyclically loaded soil with a neat sketch.

[Turn over

(b) What is modulus reduction curve? Discuss the effect of plasticity index, confining pressure and number of cycles on modulus reduction curve with neat sketches.

(c) Following (Table 2) is the results of a cyclic plate load test. The size of plate used for test was 550 mm x 550 mm. Calculate the sub-grade modulus, spring constant and shear modulus of soil. What would be the value of dynamic shear modulus for a foundation of size 1.5m x 1.5m. Assume Poisson's ratio = 0.35. [Given: $E = \frac{C_z(1-\mu^2)\sqrt{A}}{1.13}$, C_z = subgrade modulus]

Table 2

Load per unit area, q (kPa)	Elastic settlement (mm).
75	0.53
150	1.1
225	1.5
300	2.1

[4+8+8]

4. (a) Write down the assumptions associated with 1D ground response analysis.
(b) Discuss the steps involve in linear elastic ground response analysis.
(c) Derive an expression of transfer function for '***Uniform Damped Soil on Rigid Rock***' case for the uniform soil layer with thickness H as shown in the figure (Fig. 2) below due to vertically propagating shear waves. Then, plot the variation of transfer function and also plot the mode shapes for first three natural frequencies.

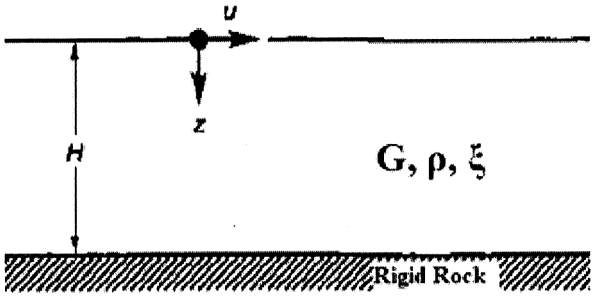

Fig. 2

[4+4+12]

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M.E. CIVIL ENGINEERING FIRST YEAR SECOND SEMESTER – 2024

SUBJECT: SOIL DYNAMICS AND MACHINE FOUNDATION (SMFE)

Time: 3 HOURS Full Marks: 100

PART II (40 Marks)

Use Separate Answer scripts for each PART

Assume reasonable values of data not supplied

1. The moving component of an electric motor weighs 2.5 kg with an eccentricity of 160mm. It is running at a constant speed of 1800 rpm. The motor is mounted on an isolator with damping factor of 0.25. Calculate the stiffness of the isolator spring such that 15% of the unbalanced force is transmitted to the foundation. Also determine the magnitude of the transmitted force. 10

2. Derive the equations of motion of a block foundation subjected to simultaneous sliding and rocking vibrations (Give neat sketches). Solve these two equations to obtain expressions for natural frequencies. Also derive the expressions for amplitudes of coupled rocking and sliding if only exciting moment (rocking) is acting on the block foundation. 15

OR

Draw a neat sketch of foundation for Impact type machine.
Write the equations of motion for hammer foundation considering Two-mass-spring analogy. Then derive the expressions for displacement for foundation and anvil. 15

3. A concrete block foundation of size 8.0m x 4.0m x 2.0m is to be used as a foundation for a reciprocating engine operating at 450rpm and mounted symmetrically with respect to foundation. The weight of the engine is 10kN. Maximum unbalanced vertical force acting on the machine is 1.7 kN. Maximum unbalanced horizontal force = 2.5 kN. The magnitude of elastic uniform compression is, $Cu = 5.0 \times 10^4$ kN/m^3. Take unit weight of concrete = 24kN/m^3. Determine the natural frequencies and amplitude of the block by weightless spring approach. 15