M.E. CIVIL ENGINEERING FIRST YEAR FIRST SEMESTER EXAM 2025

GEOTECHNICAL EARTHQUAKE ENGINEERING

PART- Full

FM: 100

[Answer any four from the following questions]

[***Use Code: IS 1893 (Part-I): 2016***]

[*Assume any data reasonably if not provided*]

1. (a) Discuss (i) Body wave magnitude scale (m_b) and (ii) Surface wave magnitude (M_S) scale.

   (b) During an earthquake the maximum amplitude recorded at a site by Wood- Anderson Seismograph is 23 cm. The maximum ground velocity recorded was 27 cm/sec. The site was found to be 78 km away from the epicenter. Determine the Magnitude and Intensity of the occurred earthquake.

   (c) Differentiate between intensity and magnitude scale of earthquake measurement.

   [10+8+7]

2. (a) Derive the 3D equations of motion for stress waves propagation in an infinite elastic medium. Also derive the longitudinal and shear wave equations by solving the equations of motion.

   (b) In connection with seismic wave propagation in a layered body, define specific impedance and impedance ratio. Discuss the impedance ratio cases of 'zero' and 'infinity'.

   [18+7]

3. (a) Lists the field and laboratory tests associated with the determination of low strain and high strain dynamic soil properties.

   (b) Discuss Spectral Analysis of Surface Waves (SASW) test in connection with the determination of shear wave velocity of soil.

   (b) The results of a refraction survey in terms of time of first arrival (in milliseconds) and distance in meters is given below in tabular form. Assuming that the soil layers are perfectly horizontal, determine the P-wave velocities of the underlying soil layers and their thicknesses.

Distance (m)	10	15	20	30	40	50	60	70	80	90	100	120
First arrival Time (ms)	41.7	62.5	83.4	91.8	101.2	110.2	119.2	128.1	136.2	141	143.8	152

[4+9+12]

4. (a) Write down the assumptions associated with 1D ground response analysis.

   (b) Derive an expression for transfer function for '***Uniform Undamped Soil on Rigid Rock***'. Also plot the variation of transfer function with frequency and then define the fundamental period of a soil column.

   (c) A soil stratum of 30 m thickness that lies over bedrock has an average shear wave velocity of 250 m/s. Compute the amplification at the ground level for maximum considered earthquake for the first two modes. Consider material damping of soil as 5%.

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[5+15+5]

5. At a project site SPT tests have been carried out at every 0.75m depth. The measured penetration resistance with depth is given in the table (Table 1) and the soil profile obtained is also shown in figure (Fig. 1) below. The region is expected to experience an earthquake of magnitude 6.5 with a_{max} of '0.25g' under the expected earthquake.

   (i) Calculate and Plot FS variation with depth.

   (ii) Estimate the free-field settlement that the site would experience using:
   (a) Tokimatsu and Seed (1987) Approach
   (b) Ishihara and Yoshimine (1992) Approach

[25]

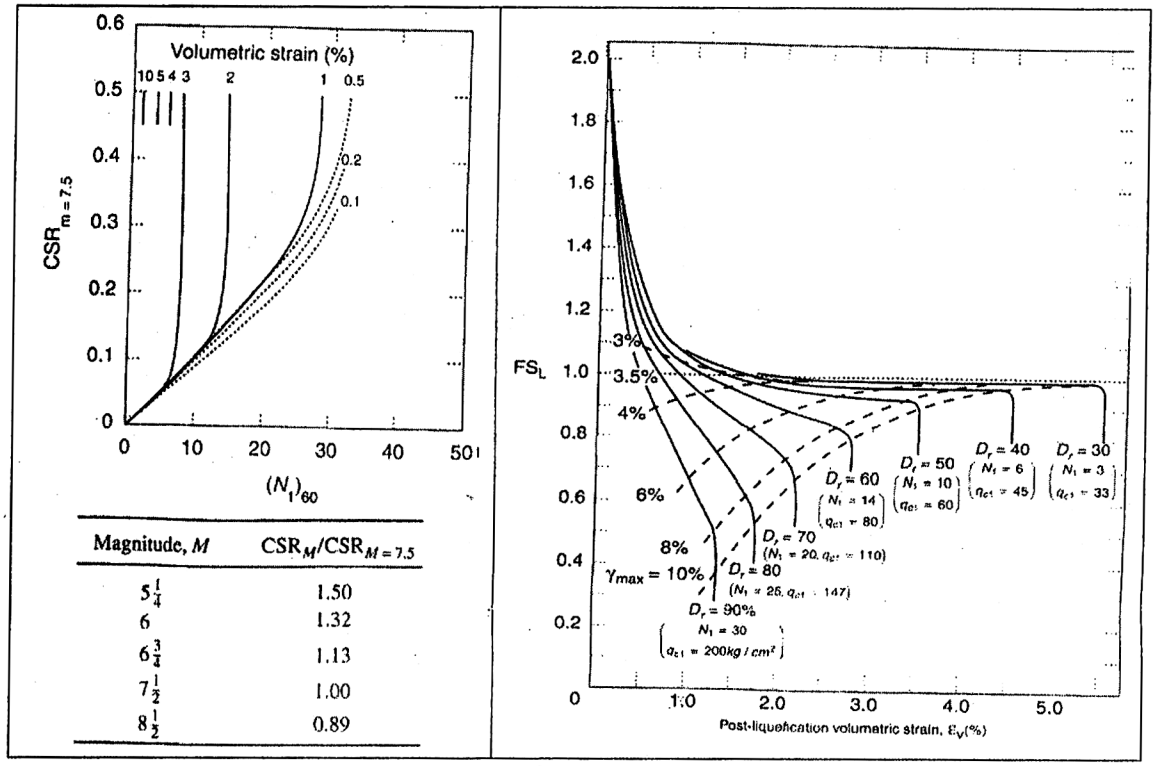
Table 1

Depth (m)	0.75	1.5	2.25	3.0	3.75	4.5	5.25	6.0	6.75	7.5	8.25	9	9.75
N-value	5	3	4	5	8	7	11	12	15	18	22	25	30

0m	$\gamma_{dry} = 15.9\ kN/m3$	Sand
2m	$\gamma_{dry} = 16.5\ kN/m3$	Sand
5m	$\gamma_{sat} = 20.1\ kN/m3$	Silty Sand
10m		

Given:

- [SPT was conducted following IS standard
- Use unit weight of water, $\gamma_w = 10\ kN/m^3$ in the calculations]
- Assume Water Table at ground surface]



Magnitude, M	$CSR_M/CSR_{M=7.5}$
$5\frac{1}{4}$	1.50
6	1.32
$6\frac{3}{4}$	1.13
$7\frac{1}{2}$	1.00
$8\frac{1}{2}$	0.89

Fig. 1