Ref. No. : Ex/PG/CE/T/113E/2024

**M.E. CIVIL ENGINEERING FIRST YEAR FIRST SEMESTER - 2024**
**SUBJECT: SEISMIC DESIGN OF FOUNDATION (SMFE)**
**Time: 3 HOURS Full Marks : 100**
**Assume reasonable values of data not supplied**
**Use IS codes for design of Foundations**

## PART I (40 MARKS)

1. (a) Draw the free-body diagram of soil wedge for Richard's model corresponding to general shear failure of soil below a strip footing under seismic load. Also derive the expression for corresponding bearing capacity factors. Further give the modified expressions incorporating coefficient of horizontal and vertical seismic acceleration. 10

(b) A strip foundation of size 2m wide is to be built at a site that is expected to experience an earthquake of M=6.8 in Richter scale. Compute the static and seismic bearing capacity for the foundation considering the soil properties: c = 30 kN/m$^2$ and phi = 10$^0$. Density of soil = 18 kN/m$^3$. The foundation will be placed at a depth of 1.5m below ground level. 10

2(a) Draw the Mononobe's force diagram behind a gravity type retaining wall and also give the expression for coefficient for active and passive earth pressure under seismic condition. 8

(b) What are the major lacunae of M-O method? 4

(c) A 6m high vertical retaining wall is proposed to be constructed in earthquake zone 4 as per IS:1893 with Z = 0.24, I = 1.2 and R = 1.5. The inclination of backfill is 10$^0$. Density of backfill = 18 kN/m$^3$ with $\phi = 32^0$ and $\delta = 18^0$.
Determine the active and passive earth pressure and find out the corresponding base moment using M-O method. 8

[Turn Over

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

## Part-II

### SEISMIC DESIGN OF FOUNDATION (SMFE)

[***Answer all questions***]

[*Assume any data reasonably if not provided*]

***FM:*** 60

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

1.(a) Discuss on (i) Richter local magnitude ($M_L$) and (ii) Surface wave magnitude ($M_S$) scale.

(b) A Seismograph which is located 1100 km away from an earthquake epicenter, records a maximum ground displacement of 13mm for surface wave. Calculate the surface wave magnitude of the earthquake.

(c) Write a short note on 'Magnitude Saturation'

[7+6+6]

2. (a) Define 'Yield Acceleration'. Discuss the factors that affect 'Yield Acceleration'.

(b) Derive an expression for the maximum relative displacement when a block on an inclined plane is subjected to a rectangular acceleration pulse of amplitude $A$ and duration $\Delta t$ as shown in Fig. 1. Also plot the variations of velocity and displacement due to the pulse. [$a_y$ is the yield acceleration]

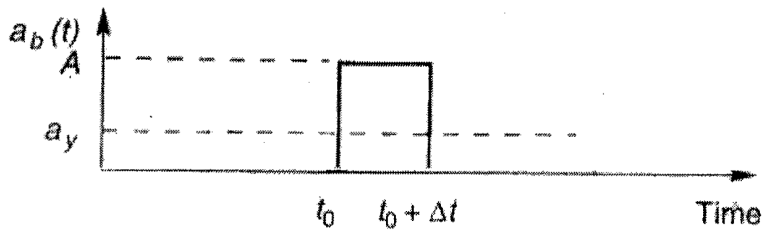
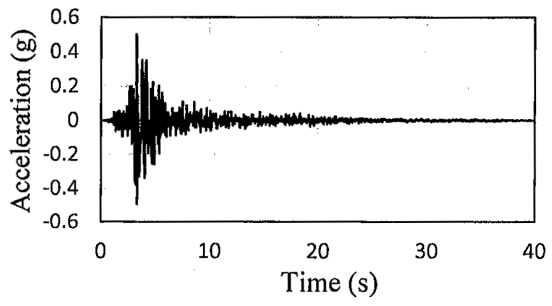



**Fig. 1**

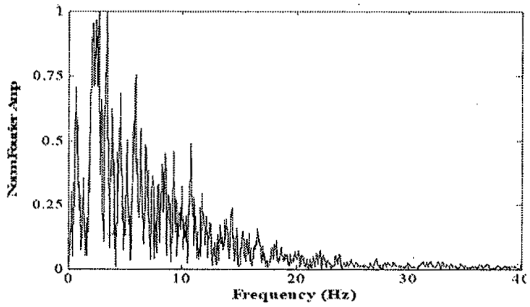
(c) The yield acceleration of a slope is estimated to be 0.15g. Compute the expected value of permanent slope displacement if the slope is subjected to a motion shown in Fig. 2 using: (i) Newmark's Sliding Block Analysis and (ii) Yegian et al. (1991) recommendations (given). [assume, $v_{max} = 34\ cm/s$ and $Neq = 12$]

***Given:***

$$\log u^* = \log\left(\frac{u}{a_{max} N_{eq} T^2}\right) = 0.22 - 10.12\frac{a_y}{a_{max}} + 16.38\left(\frac{a_y}{a_{max}}\right)^2 - 11.48\left(\frac{a_y}{a_{max}}\right)^3$$




Earthquake Moion




Normalized Fourier Spectra

**Fig. 2**

[5+8+8]

3. 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. 3) below. The region is expected to experience an earthquake of magnitude 6.5 with $a_{max}$ of '0.21g' under the expected earthquake. Estimate the free-field settlement that the site would experience using:

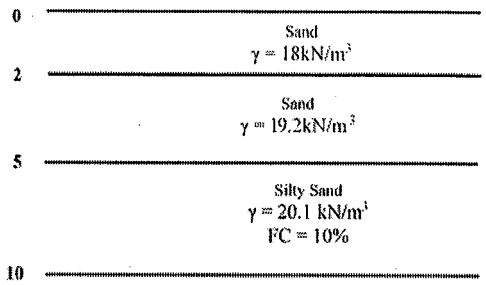
   (a) Tokimatsu and Seed (1987) Approach

   (b) Ishihara and Yoshimine (1992) Approach

Also compute the corrected settlement using Cetin et al. (2009) recommendations. [20]

**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 |

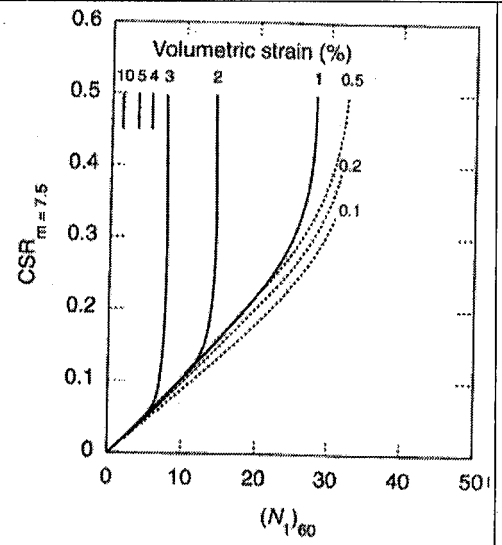



***Given:***

- [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]

**Fig. 3**

Figures Given




| 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 |