INDIAN INSTITUTE OF ENGINEERING SCIENCE AND TECHNOLOGY, SHIBPUR

ME (Civil) 2ND Semester Examination, April 2014

Sub: Dynamics of Soils and Foundations (CE – 1012)

Full Marks: 100 **Time: 3 hours**

Answer any FIVE questions

1. (i) State the design criterion of a block type machine foundation as adopted in IS 2974.

   (ii) Design a block type foundation for a machine weighing 0.5 ton with minimum area of base plate 350 mm x 600 mm. Operating frequency of the machine is 1500 rpm. Use Tschebotarioff's 'Reduced Natural frequency' method to obtain the size of the block foundation resting on soil having G = 200 kg/cm^2 and $\nu = 0.25$.

   (8+12)

2. i) Find the natural frequencies of vibration of the two degree of freedom system shown in Fig.1. Evaluate and sketch the normal modes of vibration corresponding to each natural frequency. Consider $m_1 = m_2 = m$.

   ii) A seismic refraction survey was carried out on a stratified soil deposit. The measured P-wave velocities are 400 m/s, 1600 m/s, and 2400 m/s for the Layer – I, II, and III respectively. The thickness of Layer – I and II measured 5 m and 10 m respectively. Determine the time of first arrival wave at geophone. The distance between the shot point and geophone is 30 m.

   (12+8)

3. A single degree of freedom undamped system is subjected to a forced vibration with a constant amplitude harmonic loading of $P \cos \omega t$. If the system had started vibrating from absolute stationary state, derive the expression (from first principle) for the final displacement response of the the system. Also draw the displacement response profile for a limiting case when the exciting frequency approaches the natural frequency of the system.

   (20)

4. (i) Vertical vibration test was conducted on a *1.5 m x 0.75 m x 0.7 m* high concrete block in an open pit of depth 2.5 m which is equal to the anticipated depth of actual foundation. The soil properties are $c=0$, $\phi = 30^0$, $\gamma_{sat} = 18\ kN/m^3$ *and* $\nu = 0.25$. Weight of the oscillator and motor is *150 kg*. Natural frequency of the block was observed *30 Hz*. Estimate the dynamic soil properties C_u and G. Determine the coefficient of elastic uniform compression (C_u) of a foundation *3.5m x 3.0m x 1.75 m* high. Assume unit weight of the foundation block as *24 kN/m^3* and the ground water table at *5.0 m* below the surface.

   (ii) Two linear spring constants K_1 and K_2 are connected in series to a rigid block of mass M and subjected to free vibration with natural period of 5 sec. The same springs, when connected in parallel, with the same rigid block, gives a natural period of 2 sec. under free vibration. Compute the ratio of the spring constants.

   (10+10)

5. (i) Define transmissibility. Explain how the frequency ratio and the static deflection affect the transmissibility value.

   (ii) A machine and its foundation weigh 140 kN. The spring constant and damping ratio of the supporting soil may be taken as 12 x 10^4 kN/m and 0.2 respectively. Forced vibration of the foundation is caused by a force $Q(t) = 46 \sin \omega t$. For an operating frequency *25 Hz* determine the *(a)* undamped natural frequency of the foundation, *(b)* amplitude of motion and *(c)* maximum dynamic force transmitted to the subgrade.

   (10+10)

6. Make a dynamic analysis of a concrete block foundation 4.0m×3.0m×3.5m high for a symmetrically mounted reciprocating machine operating at a speed of 250 rpm. The vibration at operating speed generates (i) 2.5 kN vertical unbalanced force and (ii) 2.0 kN horizontal unbalanced force at a height of 0.2m above the top of the block. The machine weight is negligible in comparison to the weight of the foundation. Determine the natural frequencies and amplitudes under vertical and rocking (about the least dimension) modes of vibration. Assume a coefficient of elastic uniform compression of 3.62×10^4 kN/m^2 and a damping coefficient of 0.3.

(20)

7. Write short notes on any TWO of the following.
   i) Vibration isolation
   ii) Stress-strain behavior of cyclically loaded soil.
   iii) Cyclic plate load test.
   iv) Characteristics of Spectral Analysis of Surface Wave Test.

(10+10)

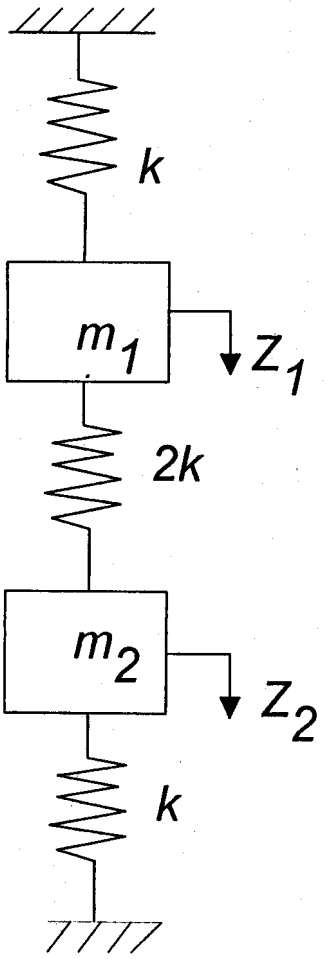

Fig.1