Department of Civil engineering, N I T Srinagar

Major Examination
Subject: CIV-701, Structural Dynamics
Max^{m}. Marks : 90

Session: Autumn-2019
Semester : 7th B. Tech.
Time Allowed : 3 Hours

Note: Attempt any five questions. Use of IS: 1893 code is allowed.

Q.1 (a) Structures generally perform well under static loading but do undergo major failures when subjected to severe dynamic loading (such as strong earthquakes). Name the key factors, some within the structure and some outside the structure, which contribute to such failures under dynamic loading. (CO1)

b) Describe the concept of equivalent stiffness (K_{eq}) in dynamic analysis & explain how the expressions used to find K_{eq} for two cases (i.e. springs in parallel & series) are justified. (CO1)

c) Determine the natural frequency and natural period of horizontal vibration for the portal frame with rigid beam as shown in Fig-1. For the initial displacement of 25mm and initial velocity of 25mm/s, What will be the amplitude of motion and also displacement at the end of one second. Adopt EI=30 X 10^{12}N-mm^2 for each column. Consider total weight including self-weight of beam W= 30x10^6 N. (CO2) (4, 6, 8)

Q.2 (a) Name the three basic elements of a dynamic system and describe the three characteristics of structural system which correspond to each one of these elements. Also explain the dynamic equilibrium and the principle which governs it. (CO1)

(b) A machine of weight 5kN mounted centrally on a fixed beam produces a static deflection of 0.25mm at mid span. When in operation, the machine produces a harmonic vibration at a speed of 600rpm. Determine the dynamic amplification factor. Assume damping force is proportional to the velocity and is equal to 500N at a velocity of 25mm/sec. Also determine the max^m dynamic S F and B M in the beam if its span is 4m. Assume self-weight of beam is negligible. (CO2) (6, 12)

Q.3(a) Explain why damping does not play significant role in forced vibration under impulse loading. (CO1)

b) A simply supported beam of span 6 m is subjected to a pulse type dynamic force as shown in Fig.2. The beam carries a weight of 45000N at the centre. The other relevant data include: Section modulus, Z = 1500 X 10^3 mm^3, E = 2.1 X 10^5 N/mm^2 and I = 33400 X 10^4 mm^4. Also dynamic Amplification Factors for t_r/T = 0.5, 0.69 and 1.0 are 1.62, 1.32 and 1.0 respectively. Compute the max^m dynamic bending stress. Ignore the self-weight of the beam. (CO2) (3, 15)

Q.4 (a) Briefly discuss the Modal analysis method together with orthogonality property of eigenvectors. Also describe advantages & limitations of modal analysis method. (CO1)

b) Find the natural frequencies and corresponding mode shapes for the shear frame shown in Fig.3 and also prove the orthogonality of the modes. Adopt EI = 5 x 10^6N-m^2, m = 5 x 10^5kg. (CO3) (6, 12)

Q.5 Compute the dynamic response due to harmonic loading $F_1(t)$ = (50 sin20t) kN acting at 1st floor level for the shear frame of question 4(b). All the data remain same except both hinged supports to be replaced by fixed supports. Also determine the max^m horizontal forces at floor levels (corresponding to max^m dynamic responses) required for plot of dynamic S F & B M diagrams. (CO3) (18)

Q.6 (a) what are the limitations of equivalent lateral force method for finding lateral seismic loads and how is this method justified in practice for seismic design? (CO4)

(b) A three storey school building is to be constructed in Srinagar. The structure of the building is frame type with special moment resisting frame (and brick in-fill) having plan dimensions 20m x20m. The soil condition at the site is medium stiff and height of each storey is 3.6m. The intensity of total dead load at each level is 5kN/m^2 and live load to be adopted is 3kN/m^2. Using equivalent lateral force method, determine the total base shear and its distribution on the structure. Also plot shear diagram along building height. Adopt damping =3%. (CO4) (4, 14)

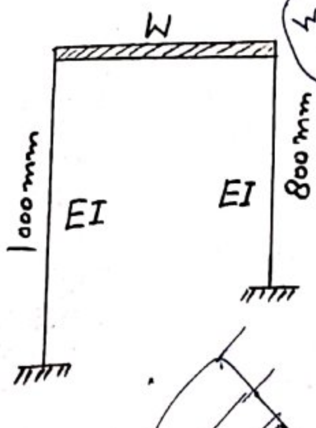

Fig-1

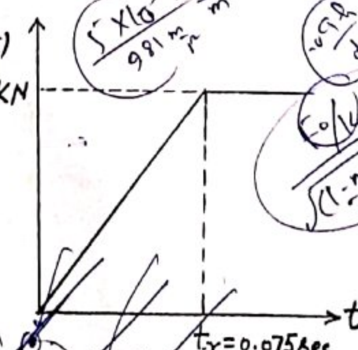

Fig-2

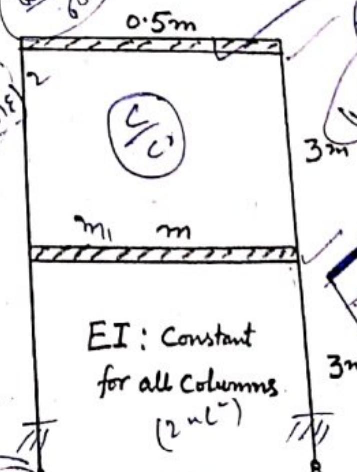

Fig-3