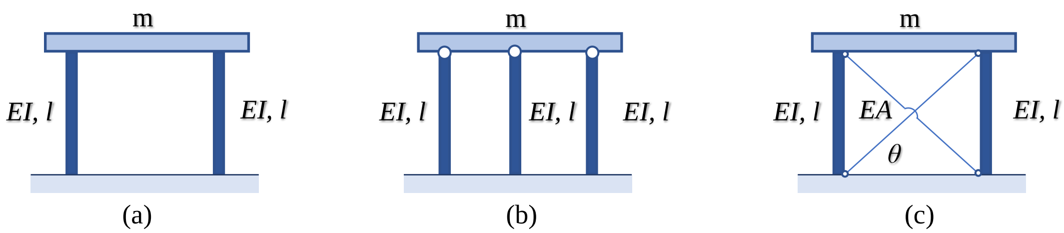
DYNAMICS AND EARTHQUAKE ANANLYSIS OF STRUCTURES

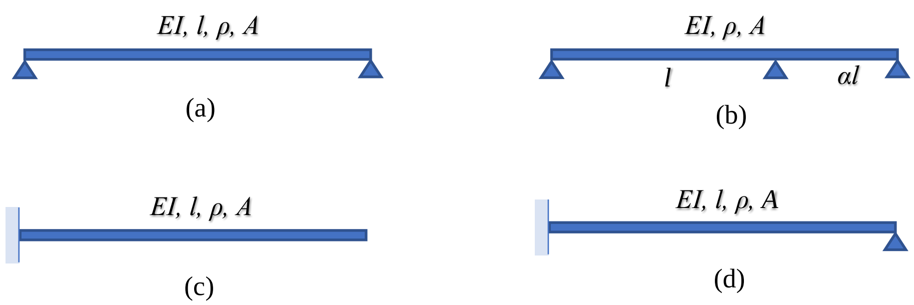
Question Sheet No. 1

(For steel take E=200 GN/m^2 and for concrete E=14 GN/m^2)

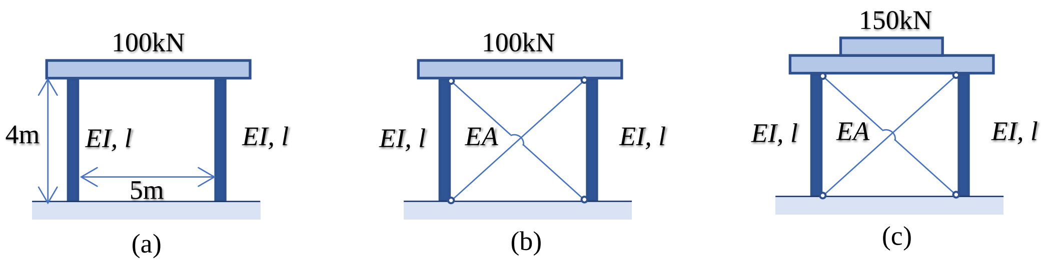
1. For the structures shown below, determine the natural frequency of vibration using simple structural concepts.



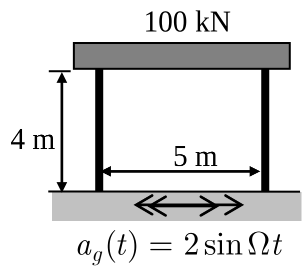
2. For the beam structures shown below, determine the natural frequency of vibration using Rayleigh's method.



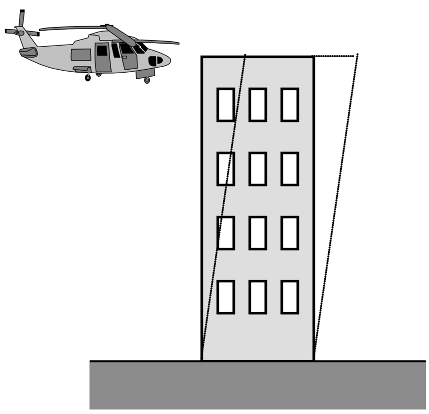
3. The portal frame structure shown in (a) below has a weight of 100 kN. If the natural period of vibration is 0.9 seconds,
   (a) determine the lateral stiffness of the structure;
   (b) determine the diameter of the steel cross-braces required to strengthen the structure shown in (b) by reducing the period to 0.3 seconds; and
   (c) determine the period if a further load of 50 kN is added to the strengthened structure shown in (c).



4. The portal frame of exercise 3(a) is subject to a sinusoidal ground vibration with a horizontal acceleration amplitude of 2 m/s^2. Assuming a damping ratio of 5%, determine the maximum displacement and maximum total acceleration of the frame when the period of the floor vibration is: (a) 0.1 seconds; (b) 0.9 seconds; and (c) 5 seconds.



5. A building has a height of 100 m, a square base measuring 20x20 m^2, an average specific weight of 1500 N/m^3 and a natural period of vibration of 5 s. The top floor of the building is hit by a helicopter with a mass of 10,000 kg and travelling at 30 m/s. Determine the maximum deflection at the top, assuming conservation of linear momentum and a vibration shape function that increases linearly with the height.



6. The building of exercise 5 is hit by a sudden wind gust which results in the sudden application of horizontal forces distributed along the height of the building as shown in the figure. Assuming a vibration shape function that increases linearly with height and neglecting damping, determine the maximum displacement at the top of the building.