DYNAMICS AND EARTHQUAKE ANALYSIS OF STRUCTURES

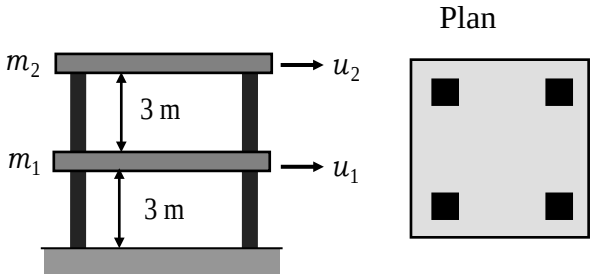
Example Sheet No. 3

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

1- The two-storey building shown is supported by four square concrete columns of dimensions 0.35 x 0.35 m^2. The total masses of the bottom and top floors are 150,000 kg and 100,000 kg respectively.

(a) Determine the natural modes and frequencies of vibration in the horizontal direction shown.

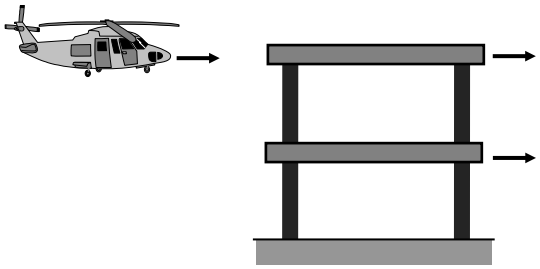
(b) Determine the frequency of vibration that would be obtained making the assumption that the fundamental mode of vibration increases linearly with height.



2- The two-story building of exercise 1 is hit by a helicopter with a mass of 10,000 kg travelling at 20 m/s.

(a) Determine the resulting vibration and maximum displacement at the top of the building using both modes of vibration.

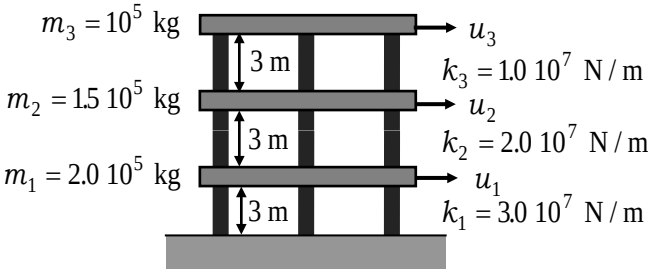
(b) Determine the resulting vibration and the maximum displacement at the top on the assumption that the linearly increasing mode absorbs the total momentum.



3- A three-storey building has the mass and stiffness distribution shown.

(a) Approximate the first period of vibration using a linearly increasing mode.

(b) Using a linearly increasing mode together with a second Ritz vector increasing quadratically with height, approximate the first two modes and frequencies of vibration.



4- The building of exercise 3 is subject to the Eurocode 8 elastic design earthquake with the response spectrum shown. Obtain the total base shear, overturning moment, maximum floor displacements and storey forces using (a) a single mode linear with height and (b) a complete combination of the three modes of vibration.