UNIVERSITY OF RUHUNA

Faculty of Engineering

End-Semester 6 Examination in Engineering: December 2015

Module Number: CE 6252 **Module Name: Dynamics and Control of Structures**

[Three Hours]

[Answer **all questions**]

Q1 a) List out four different sources of vibration in building structures.

[2 Marks]

b) Identify damages in building structures due to dynamic loads induced by the sources of vibration listed in Part (a).

[4 Marks]

c) Discuss possible methods that can be used to strengthen building structures to resist dynamic loads induced by the sources of vibration listed in Part (a).

[6 Marks]

Q2 a) List out and compare characteristics of different seismic waves.

[4 Marks]

b) Determine the size of the earthquake, which produced a ground shaking seismic wave as shown in Figure Q2 (a). You may use the Richter scale given in Figure Q2 (b).
Note: Extrapolation of the scale is possible, if necessary.

[4 Marks]

c) Compare the seismic shaking produced by a magnitude of 8.1 Richter scale earthquake with the shaking from a magnitude of 7.1 Richter scale earthquake.

[4 Marks]

Q3 a) A two storey shopping complex has rigid floors. For the dynamic analysis, the building can be considered as "shear frame structure" and the masses of the building are lumped on to the floor slabs as shown in Figure Q3. Assume that $EI/mh^3=15$

i) Idealize the frame and derive the equation of motion for the structure.
ii) Determine natural frequencies and associated mode shapes in the structure.
iii) Sketch the mode shapes with respect to a vertical axis of the structure.

[6 Marks]

b) What will be the natural frequencies and mode shapes of the frame, if the top most level of the frame is supposed to resist a water tank of mass of $2m$?

[6 Marks]

Clearly state any assumption you may made

Q4 a) Explain briefly "forced vibration" and "steady state response"

[1 Mark]

b) What are the different types of external forces? Explain clearly by proving neat sketches and examples.

[3 Marks]

c) Time and frequency responses of ground vibration induced by roller compaction are shown in Figures Q4 (a) and (b), respectively. Identify the characteristics of ground vibration induced in vertical, transverse and longitudinal directions.

[4 Marks]

d) An elevated water tank is located nearby the soil compaction site. The water tank has mass of 42, 000 kg. The tower of the tank is 20 m high and a tubular section with outer diameter of 4.0 m and inner diameter of 3.2 m. The concrete used for the tower and the tank has Young's modulus of 40 GPa.

i) Determine the natural frequency of the tank.

ii) Can the water tank be excited by the external force induced by soil compaction? Justify your answer by determining magnification factor.

[4 Marks]

Q5 a) What is damping?

[1 Mark]

b) Discuss briefly following damping conditions.

i) Under damping

ii) Over damping

iii) Critical damping

[3 Marks]

c) Briefly explain damping devices that can be used as passive control techniques to control vibration.

[4 Marks]

d) What are advantages and disadvantages of active control techniques applied to wind induced structural vibration?

[4 Marks]

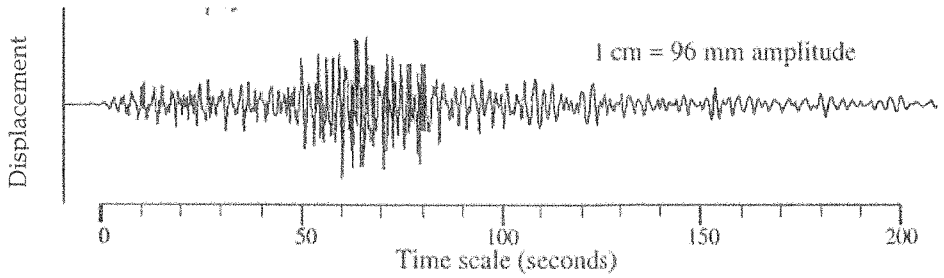


Figure Q2 (a): A seismograph record of a seismic wave

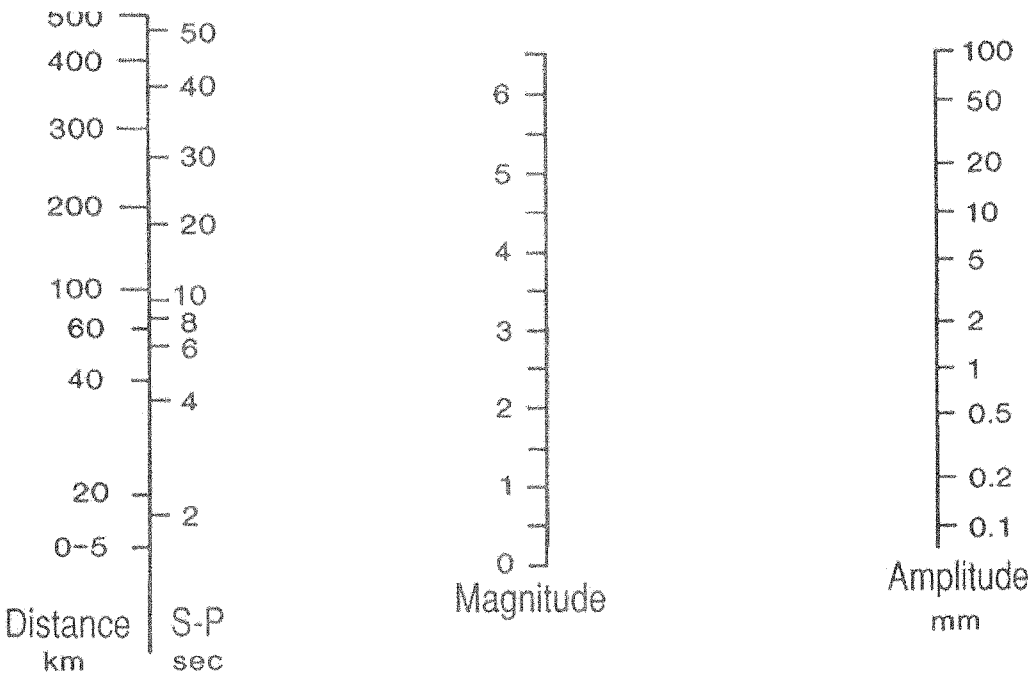


Figure Q2 (b) : Richter scale

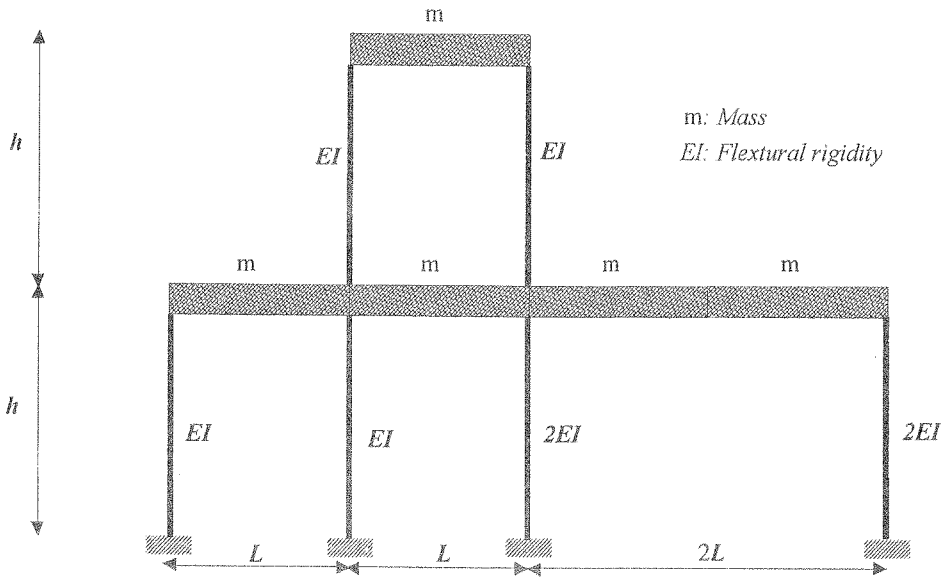
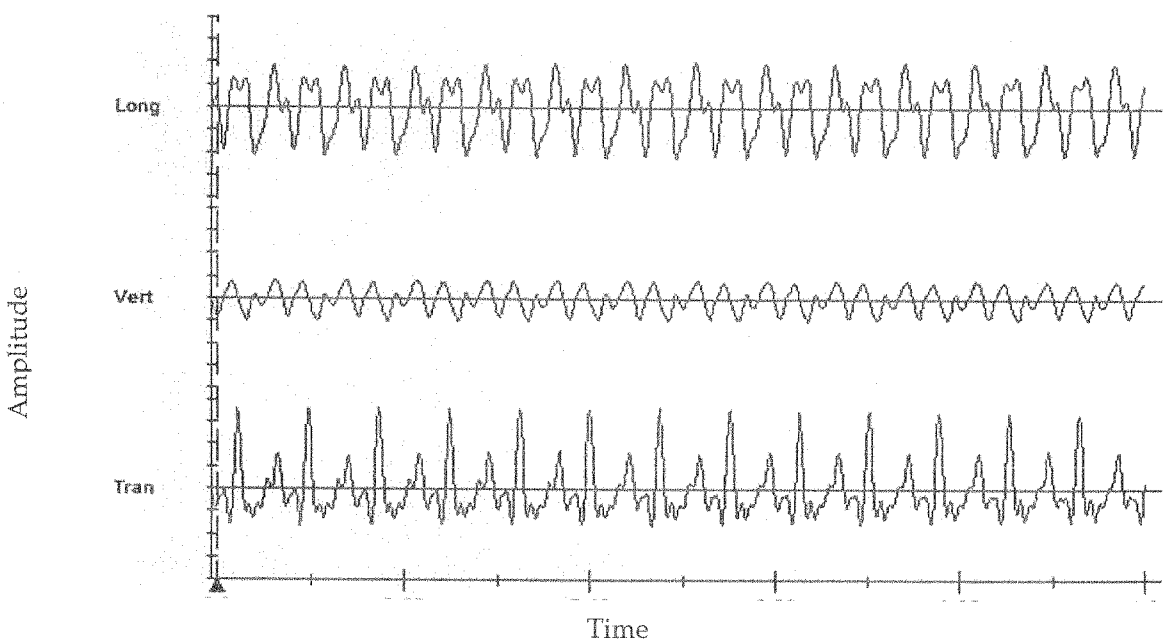
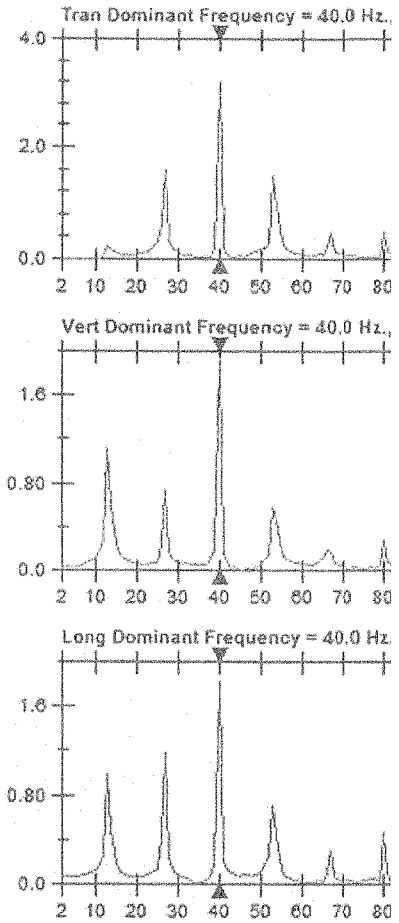


Figure Q3: Shear frame structure



Time Scale: 0.10 sec/div Amplitude Scale: Geo 0.500 mm/s/div

Figures Q4(a): Time response



Figures Q4(b): Frequency response