Assignment 1: Problem Statement

11 January 2022 09:57 AM

CE Dept., IIT Kanpur
Semester 2021-22-II

C. Kolay

CE 629A: Earthquake Analysis and Design of Structures
Assignment #1: Response Spectrum
Due Monday, January 14, 2018

Problem 1
Consider two single-degree-of-freedom (SDF) systems with $\zeta = 2\%$ and natural periods: (i) $T_n = 0.02$ sec and (ii) $T_n = 30$ sec. Study the responses of these two systems for the El Centro ground motion posted on the course site. Prepare the following figures for each system:

(i) Time histories of $u^t(t)$, $u(t)$, and $u_g(t)$ in one plot; and,

(ii) time histories of $\ddot{u}^t(t)$, $\ddot{u}_g(t)$, and $A(t)$ in another plot.

Make the time axis 10 sec long. Mark the absolute peak values of each of the above parameters. Comment on your results.

Problem 2
Plot the deformation, pseudo-velocity, and pseudo-acceleration response spectra of the El Centro ground motion posted in the course site for $\zeta = 0$, 2, 5, 10, and 20%. Make the natural vibration period axis 3 sec long.

Problem 3
A 3 m long vertical cantilever supports a 1000 kg weight at the top (Fig. 1). The cantilever is made of a 150 mm nominal diameter steel tube ($E = 200$ GPa). Tube properties are: Outside diameter 168.3 mm, thickness 4.85 mm, weight 19.6 kg/m, area of cross-section 2490 mm^2, the moment of inertia of the cross-section I = 83,24,000 mm^4. The cantilever is subjected to the El Centro ground motion for which you have generated the response spectra in Problem 2. Assume 2% damping. Using any of the response spectra developed in Problem 2, determine the maximum displacement at the top and the maximum bending stress in the cantilever.

Problem 4
Repeat Problem 3 above but for the design spectrum given by the tripartite plot of Fig. 2. Calculate the maximum seismic force in two ways and compare the results: (a) mass times the pseudo-spectral acceleration, and (b) lateral stiffness times the spectral displacement. Notice the spectrum carefully and state the value of peak ground acceleration.

Problem 5
Construct 50th and 84th percentile Newmark-Hall elastic design spectra on a tripartite logarithmic chart for a maximum design ground acceleration of 0.5g on a rock site. Assume 5% damping. You may either use the logarithmic chart appended to this assignment or use MATLAB to generate your own.

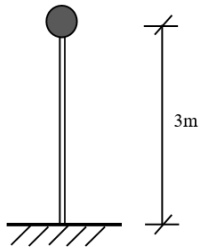
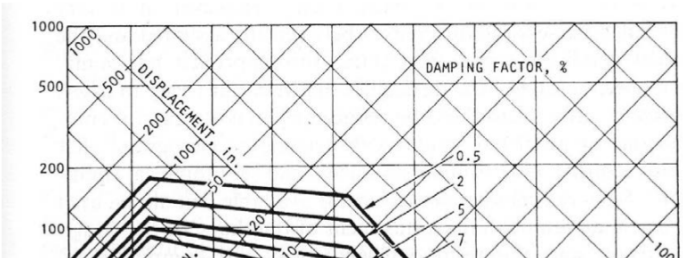


Fig. 1

CE Dept., IIT Kanpur
Semester 2021-22-II

C. Kolay



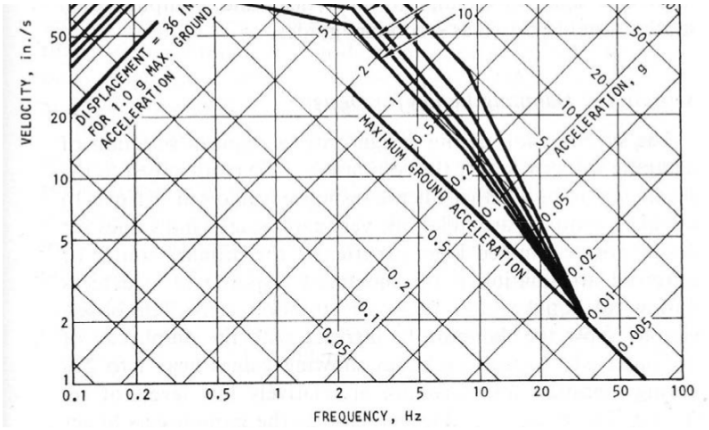
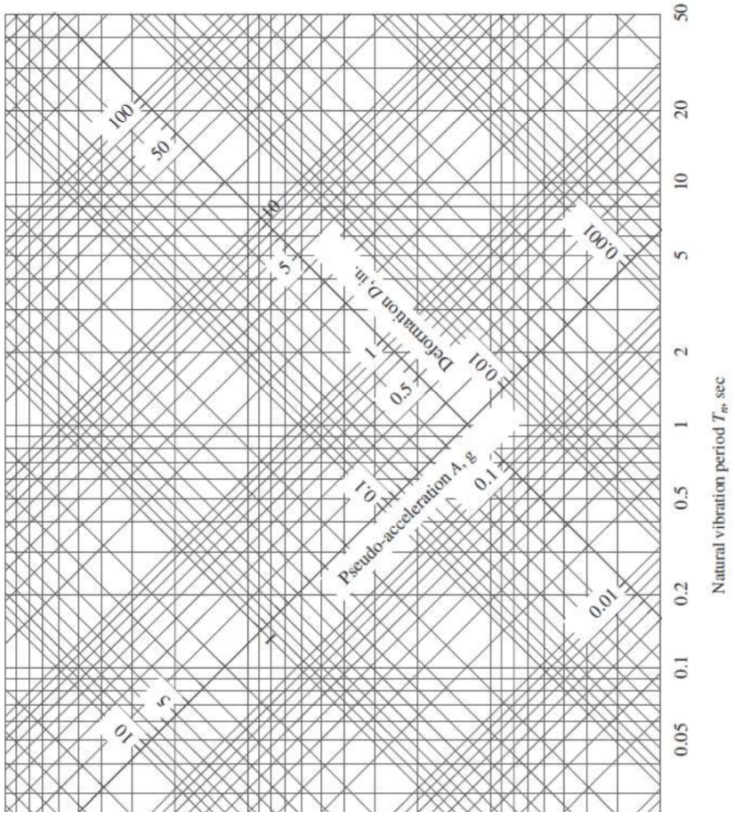


Fig. 2: Design spectrum curves used for the design of nuclear power plants. Plotting design spectrum curves with straight line segments was first done by N. M. Newmark in the late 1960's. The design spectrum reproduced here (horizontal component) is from NRC Regulatory Guide 1.60 and was developed by Newmark, Blume and Kapur in the early 1970's.




100
50
20
10
5
2
1
0.5
0.2
0.02
Pseudo-velocity V, in/sec