Fall Semester, 2025 **Instructor**: M.J. DeJong

CE 225 – Dynamics of Structures

Homework #6

Due: Monday, October 13

1) Certain types of near-fault ground motion can be represented by a few cycles of ground acceleration. For example, consider the following ground motion (similar equation as HW#5):

$\ddot{u}_g(t) = 8*\sin(\pi t / 0.4)$ ft/s^2 for $0 \leq t \leq 1.2$ sec

$\ddot{u}_g(t) = 0$ ft/s^2 for $t > 1.2$ sec

Assuming that the ground velocity and displacement are both zero at time zero, use the constant average acceleration method to numerically determine the pseudo-acceleration response spectrum for $\zeta = 0.05$. Use an appropriate time step and resolution of the natural period, T_n. Plot the spectrum against T_n.

2) a) A full water tank is supported on an 80-ft-high cantilever tower. It is idealized as an SDOF system with weight $w = 100$ kips, lateral stiffness $k = 4$ kips/in., and damping ratio $\zeta = 5\%$. The tower supporting the tank is to be designed for ground motion characterized by the design spectrum of Fig. 6.9.5 (see below), scaled to 0.8g peak ground acceleration. Determine the design values of lateral deformation and base shear.

(b) The deformation computed for the system in part (a) seemed excessive to the structural designer, who decided to stiffen the tower by increasing the size of its cross section. Determine the design values of deformation and base shear for the modified system if its lateral stiffness is 8 kips/in.; assume that the damping ratio is still 5%. Comment on the advantages and disadvantages of stiffening the system?

(c) If the stiffened tower were to support a tank weighing 200 kips, determine the design requirements; assume for purposes of this example that the damping ratio is still 5%. Comment on how the increased weight has affected the design requirements.

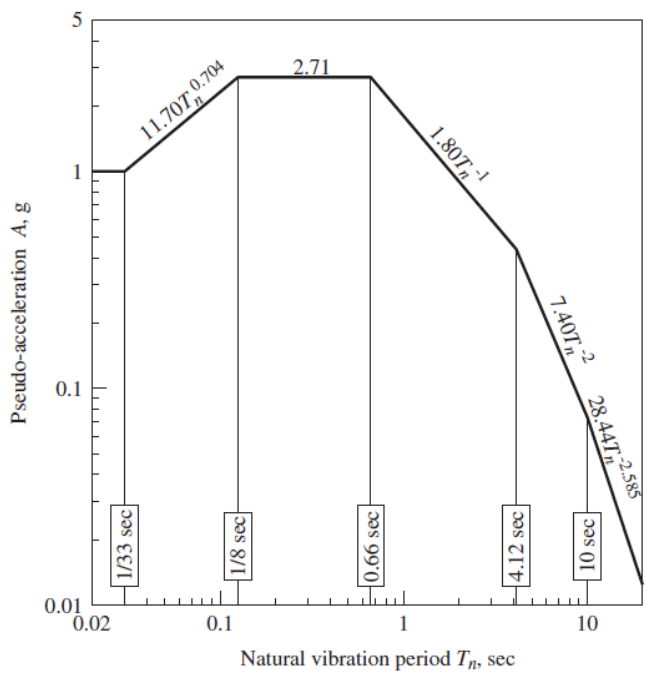

Figure 6.9.5 Elastic pseudo-acceleration design spectrum (84.1th percentile) for ground motions with $\ddot{u}_{go} = 1$g, $\dot{u}_{go} = 48$ in./sec, and $u_{go} = 36$ in.; $\zeta = 5\%$.

3) The ash hopper in Fig. 1 consists of a bin mounted on a rigid platform supported by four columns 24 ft long. The weight of the platform is 14 kips and the platform is 1 foot thick. The weight of the bin and its contents is 70 kips and may be taken as a point mass located 6 ft above the bottom of the platform. The columns are braced in the longitudinal direction, that is, normal to the plane of the paper, but are unbraced in the transverse direction. The column properties are: $A = 22$ in^2, $E = 29{,}500$ ksi, $I = 1800$ in^4, and section modulus $S = 140$ in^3.

Taking the damping ratio to be 5%, find the peak lateral displacement and the peak stress in the columns due to gravity and the earthquake characterized by the design spectrum of Fig. 6.9.5 scaled for a PGA of 0.4g acting in the transverse direction. Assume that the columns are clamped (i.e. fixed) at the base and at the rigid platform. Neglect axial deformation of the column and gravity effects on the lateral stiffness.

Figure 1: