Fall Semester, 2025 **Instructor**: M.J. DeJong
CE 225 – Dynamics of Structures

Homework #7

Due: Monday, October 20

1) The lateral force–deformation relation of the system of a SDOF oscillator is idealized as elastic–perfectly plastic. In the linear elastic range of vibration this SDOF system has the following properties: lateral stiffness k = 2.5 kips/in. and ζ = 5%. The yield strength is f_y = 4.0 kips and the lumped weight w = 6000 lb.
(a) Determine the natural period of this system vibrating at amplitudes smaller than u_y .
(b) Using plots from the textbook, determine $\bar{f}_y$ and R_y for this system subjected to El Centro ground motion scaled up by a factor of 2.
(c) Again using plots from the textbook, estimate the ductility demand μ . You may interpolate.

2) From the response results presented below, compute the ductility demands for $\bar{f}_y$ = 0.5, 0.25, and 0.125.

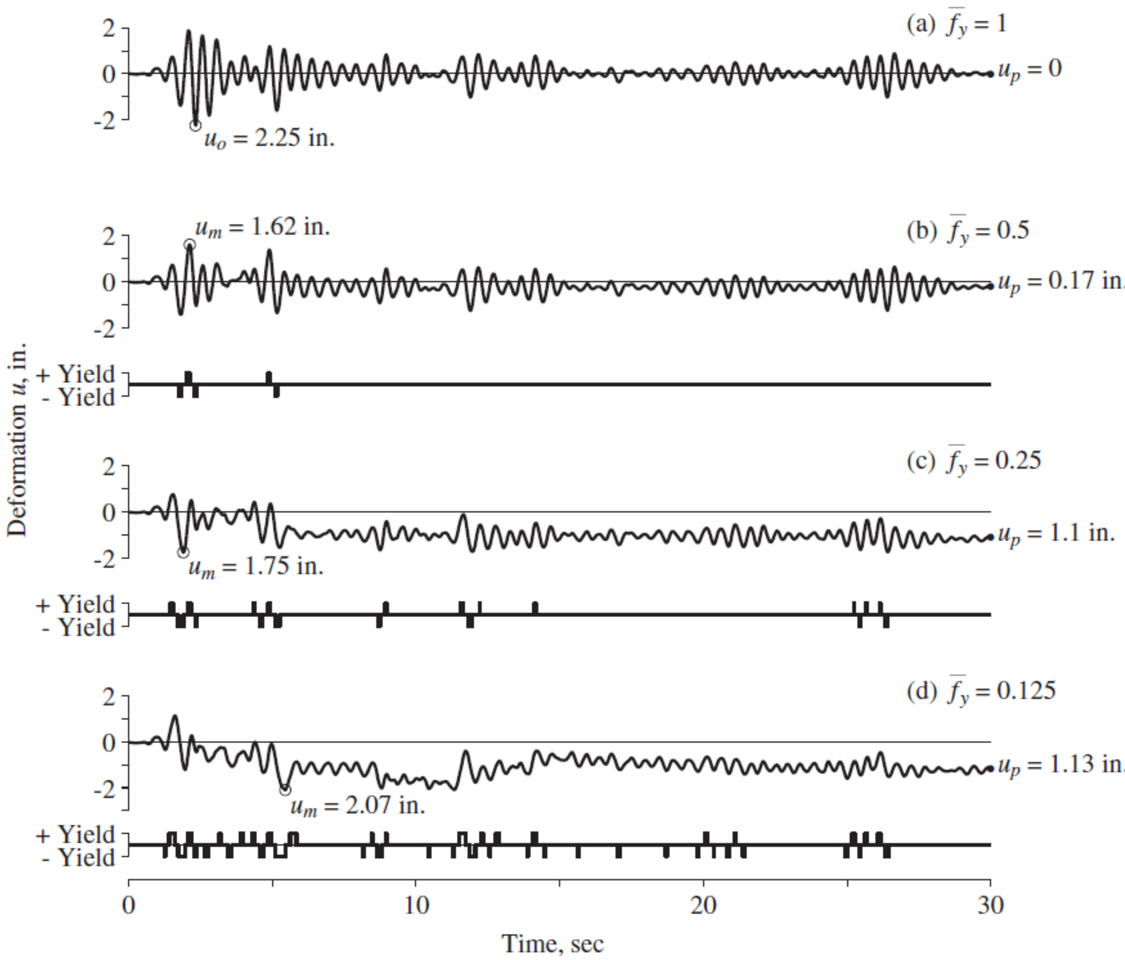

Figure 7.4.3 Deformation response and yielding of four systems due to El Centro ground motion; $T_n = 0.5$ sec, $\zeta = 5\%$; and $\bar{f}_y = 1, 0.5, 0.25$, and 0.125.

3) Consider a vertical cantilever tower that supports a lumped weight w at the top; assume that the tower mass is negligible, $\zeta = 5\%$, and that the force–deformation relation is elastoplastic. The design earthquake has a peak ground acceleration of 0.6g, and its elastic design spectrum is given by Fig. 6.9.5 (see below). For three different values of the natural vibration period in the linearly elastic range, $T_n = 0.1$, 0.4, and 2 sec, determine the lateral deformation and lateral force (in terms of w) for which the tower should be designed if (i) the system is required to remain elastic, and (ii) the allowable ductility factor is 4. Comment on how the design deformation and design force are affected by structural yielding.

4) Consider a vertical cantilever tower with lumped weight w, $T_n = 1.5$ sec, and $f_y = 0.2w$. Assume that $\zeta = 5\%$ and assume elastoplastic force–deformation behavior. Determine the maximum lateral deformation using the design spectrum below (Fig. 6.9.5), scaled to a peak ground acceleration of 0.8g.

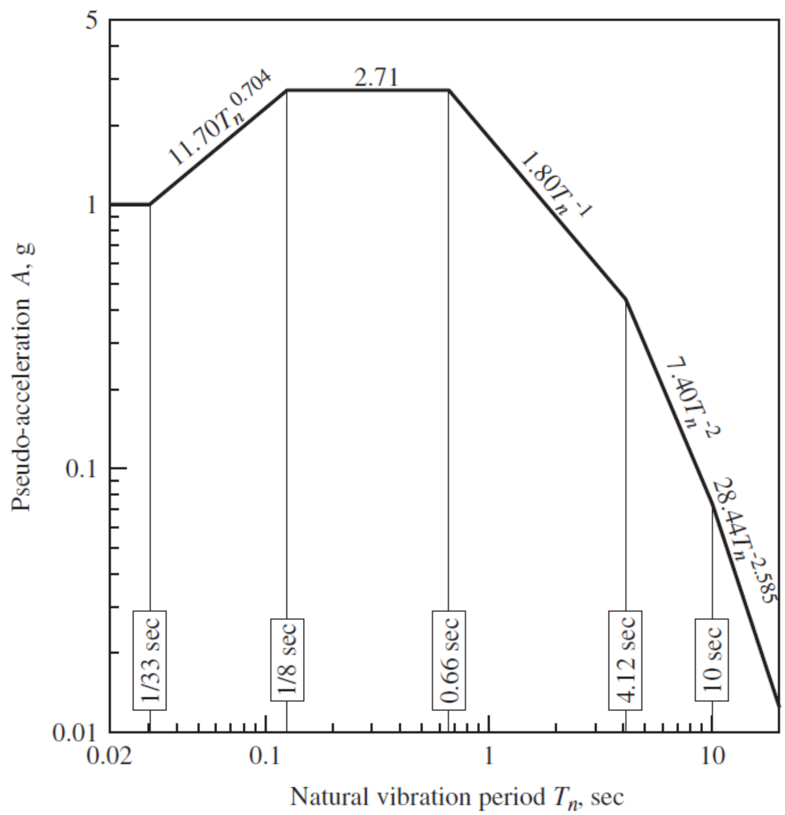

Figure 6.9.5 Elastic pseudo-acceleration design spectrum (84.1th percentile) for ground motions with $\ddot{u}_{go} = 1$g, $\dot{u}_{go} = 48$ in./sec, and $u_{go} = 36$ in.; $\zeta = 5\%$.