Early work on dynamics of Earthquake stops

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General approach

- to look at the equivalent static acceleration, assume the mass accelerates through the gap with that acceleration and hits the stop. Knowing the elasticity of the stop, to look at the motion that occurs in the stop, to compare it with allowable motion (to avoid OSEM-flag interference) and to look at the contact stresses;
- to extend this with a FEA model of a simple 1-D representation of the structure with a time-history input. This could allow for multiple bounces.

Initial motion of mass

- Apply the standard equations of motion

$$s = ut + \frac{1}{2}at^2 \qquad \Rightarrow \qquad t = \sqrt{\frac{2s}{a}}$$

$$v = u + at$$

  - a=4 m/s^2 (=0.4g); s=0.001m
- Yields
  - Time to impact = 0.02 sec
  - Speed on impact = 0.09 m/s

Deflection of stop

- Equate kinetic energy of mass to elastic energy of stop

$$\frac{1}{2}mv^2 = \frac{1}{2}k\delta^2$$

- Stiffness of structure (Hayler, T060058) is ~2E6 N/m
- Mass is 40kg
  - Yields a deflection of 0.4mm
  - Max force is then 800N (spread over three stops = 270N/stop)

Stress at contact

- Assume spherical surface (end of stop) contacting flat surface (mirror)
- Standard contact stress equations
  - 200mm diameter stop tip
- Yield max stress of ~200MPa for the 270N force

$$\sigma_{comp} = 1.5\frac{F}{\pi a^2}$$

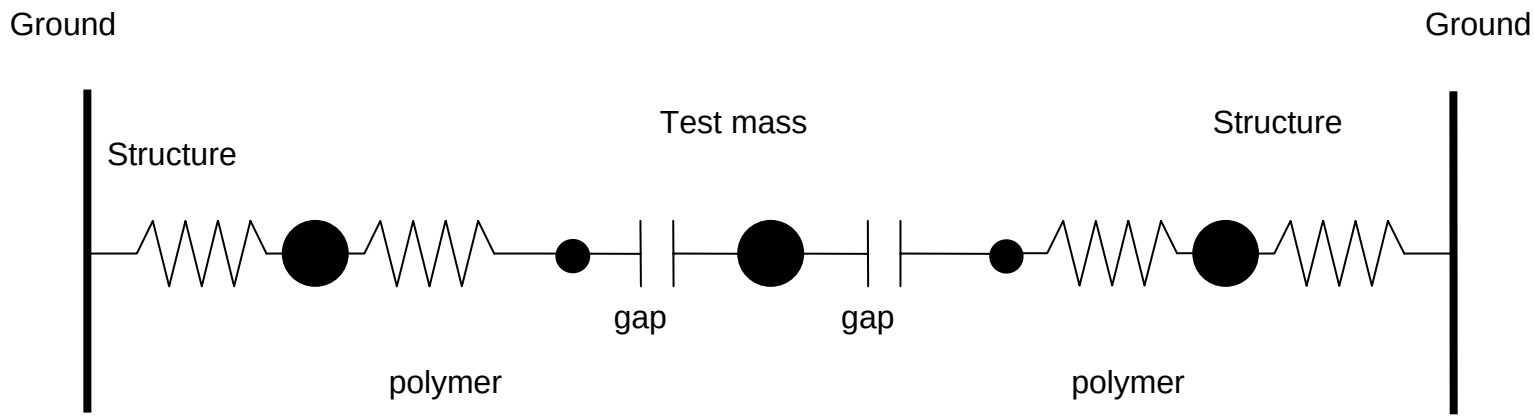
where

$$a = 0.721 \times \sqrt[3]{F D_2 C_E}$$

and

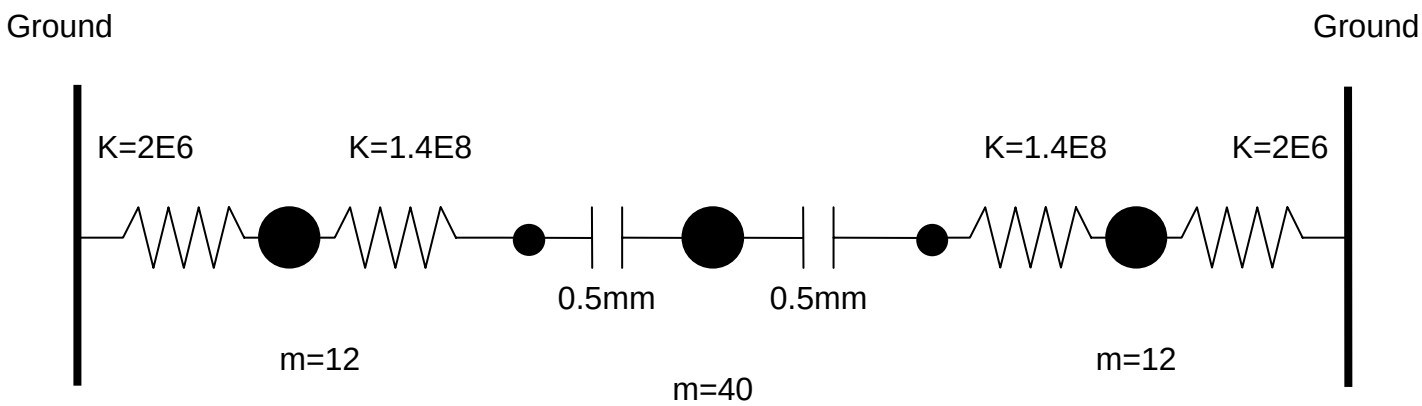
$$C_E = \frac{1-\nu_1^2}{E_1} + \frac{1-\nu_2^2}{E_2}$$

FEA model



- Dynamic mass of structure from $f = \frac{1}{2\pi}\sqrt{\frac{k}{m}}$
  - m=12kg
- Stiffness of polymer from $k = \frac{Ea}{l}$
  - k=1.4E8

FEA model



- What kind of ground motion to use?
- How to model damping in polymer?