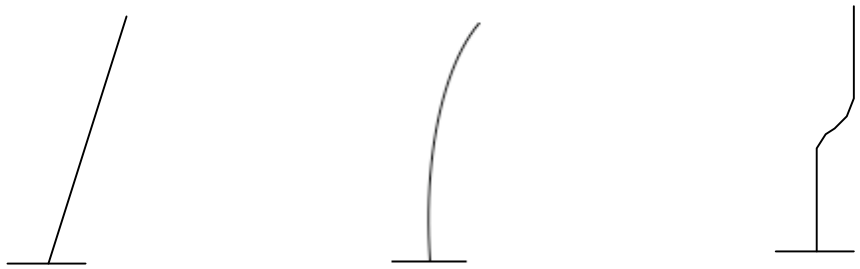
Tall Buildings & Earthquakes
Extension Worksheet

During an earthquake buildings shake. The maximum deflection they can undergo without structural damage or major risk to the people inside is important to consider. Engineers can model the deflection of buildings using *mode shapes*. In this investigation three mode shapes will be used and their different predictions compared. The method is a simpler version of what would be used in practice.

Mode shape 1 Straight line	Mode shape 2 Cantilever	Mode shape 3 Buckle



In order to predict the displacements, equations are needed for the mode shapes. Three possible equations are given below where u is the displacement and x is the distance from the ground:

$u_1 = \frac{Lx}{3}$

$u_2 = \frac{Lx^2}{15}$

$x \le \frac{2L}{5}$ $u_3 = 0$ $\qquad \frac{2L}{5} \le x \ge \frac{3L}{5}$ $u_3 = \frac{L}{6}(x-\frac{2L}{5})$ $\qquad x \ge \frac{3L}{5}$ $u_3 = \frac{L^2}{30}$

1. Plot these three mode shapes on a single graph for L=10. Plot x on the x-axis and u on the y-axis.

2. Which mode shape gives the largest deflection?

3. Which mode shape gives the smallest deflection?

4. Which mode shape do you think is most realistic? Give reasons for your answer.

5. In practice the actual deflections are also determined by the stiffness of the materials. What factors may affect the deflection of the building?