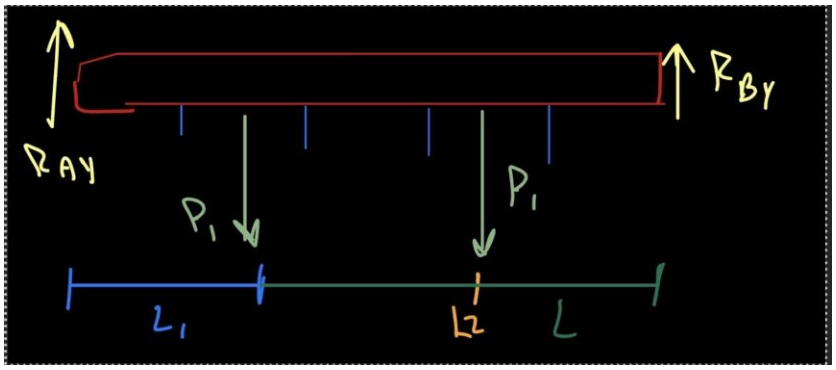
Scenario

The horizontal beam carries a load from two swings and transfers it to ground. This analysis will focus on the on the vertical supports, max bending moment and maximum bending stress on the beam.



Assumptions

The beam is simply supported at A and B. each swing is has a force applied where they are mounted, signifying that someone is sitting on it. The reference point to measure the lengths will be placed at A. Both loads are the same value and the beam's unknown weight will not be included.

Solving Support Reactions

1) Apply equilibrium equations in the vertical direction.

$$\Sigma F_y = 0 \; ; \; R_{AY} + R_{BY} - 2P_1 = 0$$

2) Take Moments about A

$$\Sigma M_A = 0 \; ; \; R_{By}L - P_1L_1 - P_1L_2 = 0$$

$$R_{By} = P_1(L_1 + L_2)/L$$

$$R_{Ay} = 2P_1 - P_1(L_1 + L_2)/L$$

These are all of the vertical reactions on this beam.

Maximum Bending Moment

This beam primarily has point loads, nothing distributed. This means that the bending moment is linear between point loads. Since that is the case, the maximum moment happens at either of the two point loads focused at the swings.

The following equations will be used to evaluate these moments:

$$M_1 = R_{AY*} L_1$$

$$M_2 = R_{AY}*L_2 - P_1(L_2 - L_1)$$

The magnitudes of th3se moments will be evaluated and the math should indicate which is the maximum bending moment, which should be both.

Maximum bending stress

In order to calculate the maximum bending stress, the process must begin with the following formula:

$$\sigma_{b,max} = M_{max}*C/I$$

The next phase is to find the value of C for the cross-sectional area of the beam. Since the beam has a rectangular cross-section, finding C will be a breeze.

The distance from the neutral axis to the top surface and bottom surface is:

$$c = h/2$$

From there, the bending moment of inertia equation must be used for this beam, which is:

$$I = bh^3/12$$

Now that all of the values for the beam equation are derived, they can directly substituted into it, which will give the following equation:

$\sigma_{b,max} = 6M_{max}/(bh^2)$