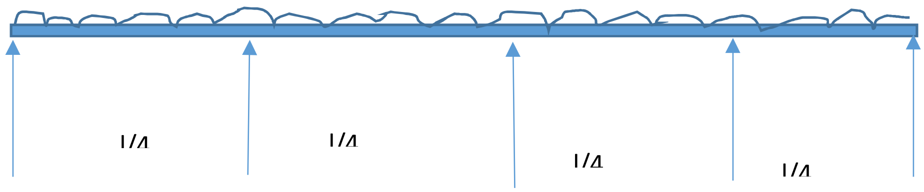
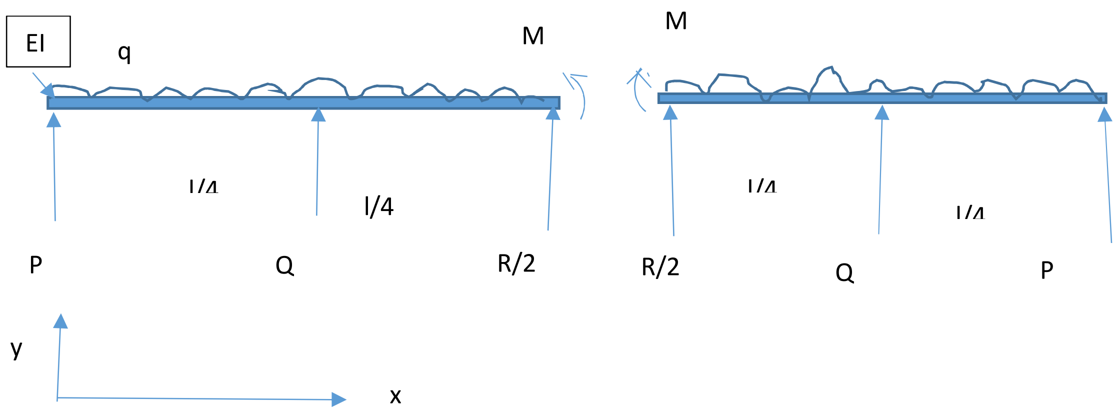
We use symmetry to reduce the number of unknowns.



Equivalent configuration:



Using left half of above

From equilibrium of forces:

$$P + Q + \frac{R}{2} - q\frac{l}{2} = 0 \qquad (1)$$

From equilibrium of moments(wrt midpoint):

$$P\frac{l}{2} - \left(q\frac{l}{4}\right)\left(\frac{l}{4} + \frac{l}{8}\right) + Q\frac{l}{4} - \left(q\frac{l}{4}\right)\left(\frac{l}{8}\right) - M = 0 \qquad (2)$$

The singularity function for deflection is

$$EIy'' = Px - \frac{qx^2}{2} + Q < x - \frac{l}{4} > -M$$

Integrating

$$EIy' = P\frac{x^2}{2} - q\frac{x^3}{6} + Q\frac{< x - \frac{l}{4} >^2}{2} - Mx + C_1$$

Integrating again

$$EIy = P\frac{x^3}{6} - q\frac{x^4}{24} + Q\frac{< x - \frac{l}{4} >^3}{6} - M\frac{x^2}{2} + C_1x + C_2$$

Boundary conditions:

$$y(0) = 0, C_2 = 0$$

From symmetry of beam,

$$y'\left(\frac{l}{2}\right) = 0$$

$$P\frac{l^2}{8} - q\frac{l^3}{48} + Q\ \frac{l^2}{32} - M\frac{l}{2} = 0 \qquad (3)$$

$$y\left(\frac{l}{4}\right) = 0$$

$$P\frac{l^3}{384} - q\frac{l^4}{6144} - M\frac{l^2}{32} + C_1\frac{l}{4} = 0 \qquad (4)$$

$$y\left(\frac{l}{2}\right) = 0$$

$$P\frac{l^3}{48} - q\frac{l^4}{384} + Q\frac{l^3}{384} - M\frac{l^2}{8} + C_1\frac{l}{2} = 0 \qquad (5)$$

We have 5 unknowns (P,Q,R, M and C_1) and 5 equations. So we can solve for the unknowns.

After we get forces and moments is is easy to draw BMD and SFD.