In the structure ABCDEF shown in the next figure, C is a pin, E and F are roller supports, and A is a simply support.

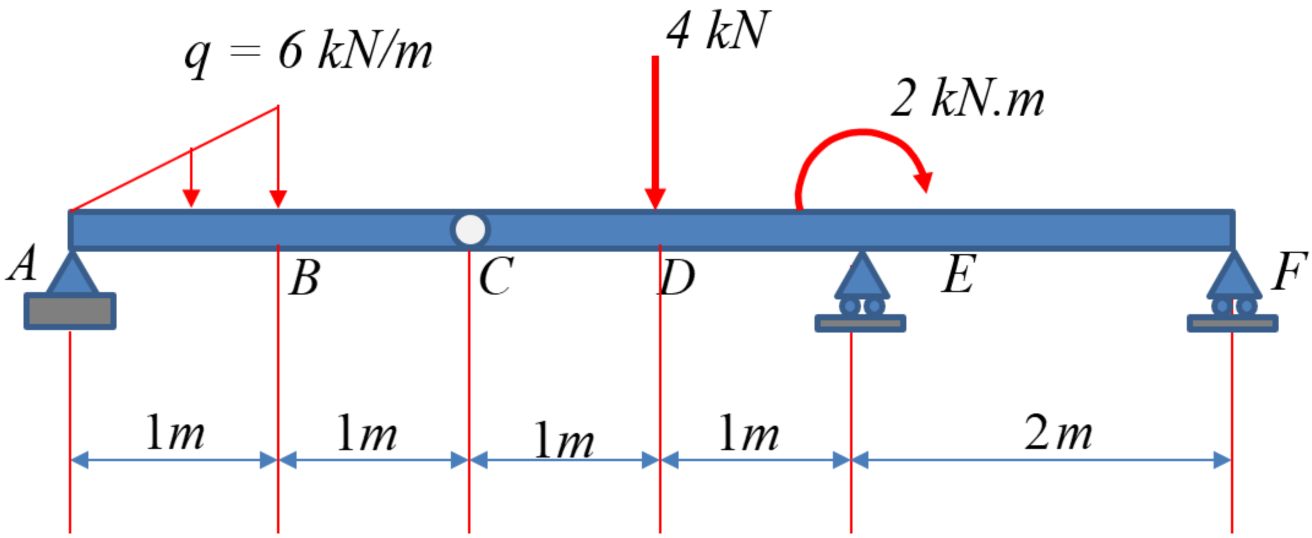
Determine:

a) Internal, external and global degree of static indeterminacy explaining clearly its implications.

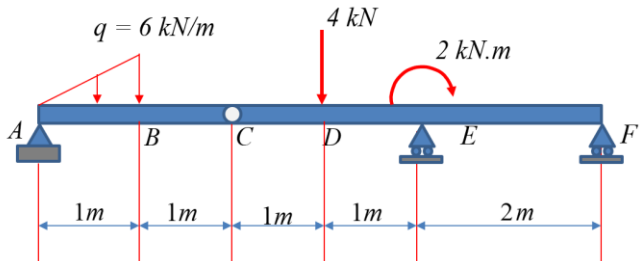
b) Reaction forces (**H_A, V_A, V_E, V_F**) using the equations of equilibrium**.**

c) Shear forces and Bending moment laws and diagrams of the beam.

d) Maximum value **q** that the triangular load could reach if the maximum bending moment at stretch AB is limited to 1 kN.m.



NOTE: The clarity in the answer and the justification of the results will be taken into account.



a) EDSI

$EDSI = 4 - 3 = 1$

$IDOF = 3(2 - 1) = 3$

$IL = 2(2 - 1) = 2$

$IDSI = 2 - 3 = -1$

$DSI = EDSI + IDSI = 1 - 1 = 0$

The structure is completely linked, and the reactions are statically determined.

b) Calculation of the reactions

$$\sum M_C = 0 \rightarrow 2V_A - ({}^{1}/_{2}).6.1.(1 + {}^{1}/_{3}) = 0$$

$\mathbf{V_A = 2\ kN;\ H_A = 0} \rightarrow \nexists F_x$

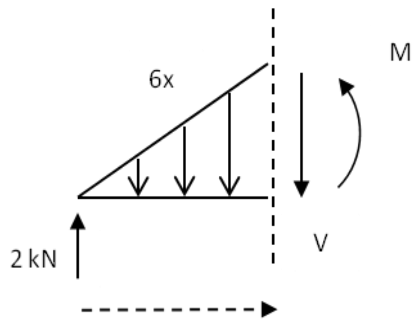
$$\sum M_F = 0 \rightarrow 6V_A - \frac{6.1}{2}.(5 + {}^{1}/_{3}) - 4.3 + 2V_E + 2 = 0$$

$\mathbf{V_E = 7\ kN}$

$$\sum F_y = 0 \rightarrow 7 + 2 + V_F = 3 + 4 \rightarrow \mathbf{V_F = -2\ kN}$$

c) Force laws

$0 \leq x \leq 1$



$$q(x) = q_0 \frac{x}{L} = 6\frac{x}{1} = 6x$$

$$V_T(x) = \int_0^x 6.\mathfrak{z}.d\mathfrak{z} = 3x^2$$

$$M_T(x) = \int_0^x 3\mathfrak{z}^2.d\mathfrak{z} = x^3$$

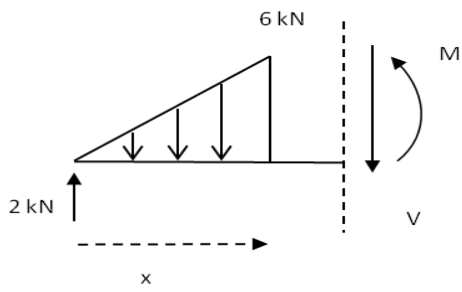
$\mathbf{V_1 = 2 - 3x^2\ kN}$

$\mathbf{M_1 = 2x - x^3\ kN.m}$

$$M_{max} \rightarrow \frac{dM(x)}{dx} = V(x) = 0 \rightarrow x = \sqrt{{}^{2}/_{3}}\ m$$

$$M_{max} = 2\sqrt{{}^{2}/_{3}} - ({}^{2}/_{3})^{{}^{3}/_{2}} = \mathbf{1,09\ kN.m}$$

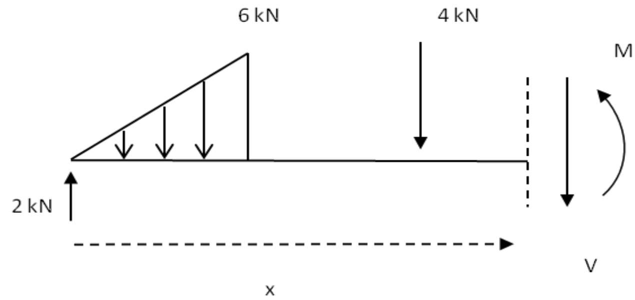
$1 \leq x \leq 3$



$$2 - \frac{1.6}{2} - V_2 = 0 \rightarrow \mathbf{V_2 = -1\ kN}$$

$$2x - 3\left(x - \frac{2}{3}\right) - M_2 = 0; \rightarrow \mathbf{M_2 = x - 2\ kN.m}$$

$3 \leq x \leq 4$

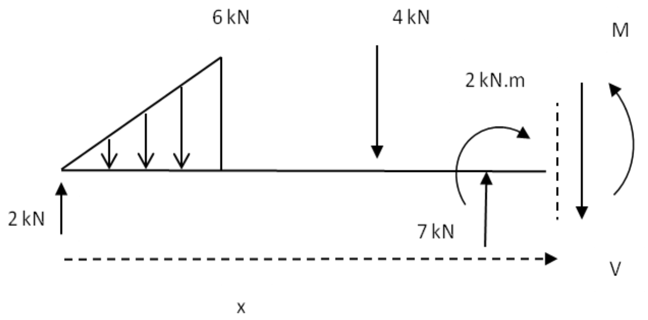


$$2 - \frac{1.6}{2} - 4 - V_3 = 0 \rightarrow \mathbf{V_3 = -5\ kN}$$

$$2x - 3\left(x - \frac{2}{3}\right) - 4(x - 3) - M_3 = 0;$$

$\mathbf{M_3 = -5x + 14\ kN.m}$

$4 \leq x \leq 6$

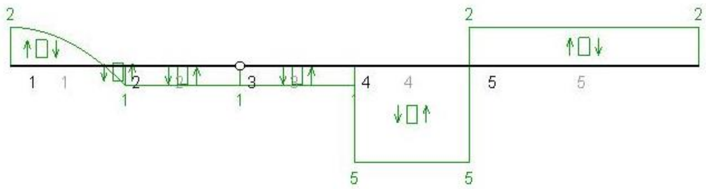


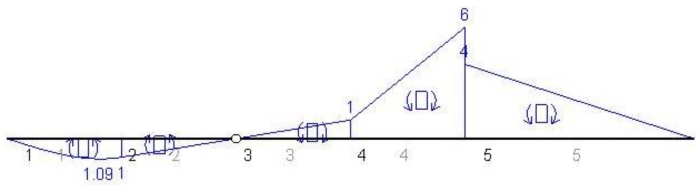
$$2 - (1/2).6 - 4 + 7 - V_4 = 0 \rightarrow \mathbf{V_4 = 2\ kN}$$

$$2x - 3\left(x - \frac{2}{3}\right) - 4(x-3) - 7(x-4) + 2 - M_4 = 0$$

$$\mathbf{M_4 = 2x - 12\ kN.m}$$

<u>Diagrams</u>





d) <u>Value of q</u>

$$\sum M_c = 0 \rightarrow 2V_A - (1/2).q.1.(1 + 1/3) = 0$$

$$V_A = \frac{q}{3};\ q(x) = q\frac{x}{L} = qx$$

$$V_1 = \frac{q}{3} - \frac{q}{2}x^2$$

$$M_1 = \frac{qx}{3} - \frac{q}{6}x^3 = \frac{qx}{3}\left(1 - \frac{x^2}{2}\right)$$

$$M_{max} \rightarrow \frac{dM(x)}{dx} = V(x) = 0 \rightarrow x = \sqrt{\frac{2}{3}}\ m$$

$$M_{max}\left(x = \sqrt{\frac{2}{3}}\right) = \frac{q}{3}\sqrt{\frac{2}{3}}\left(1 - \frac{2/3}{2}\right) = \frac{q}{3}\sqrt{\frac{2}{3}}.\frac{2}{3}$$

$$M_{max} = \frac{q}{3}\left(\frac{2}{3}\right)^{3/2} = 1 \rightarrow q = \frac{3}{\sqrt{\frac{2}{3}}.\frac{2}{3}} = \frac{9\sqrt{3}}{2\sqrt{2}} \cong \mathbf{5.51\ \frac{kN}{m}}$$

<u>Note:</u> if the value of 1.09 kN/m was previously determined and because there is linearity, it could have also been calculated as:

$$\frac{6}{1.09} = \frac{q}{1} \rightarrow \mathbf{q \cong 5.51\ \frac{kN}{m}}$$