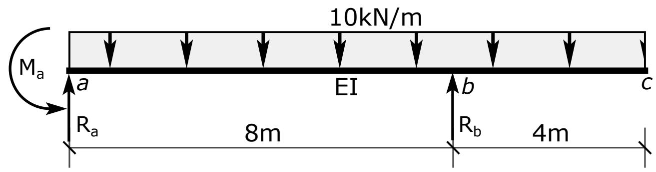
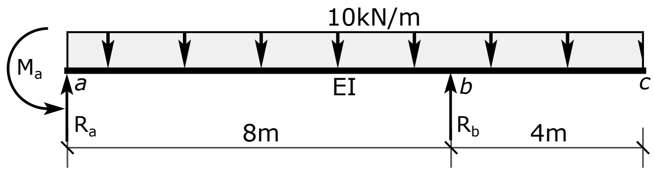
Real

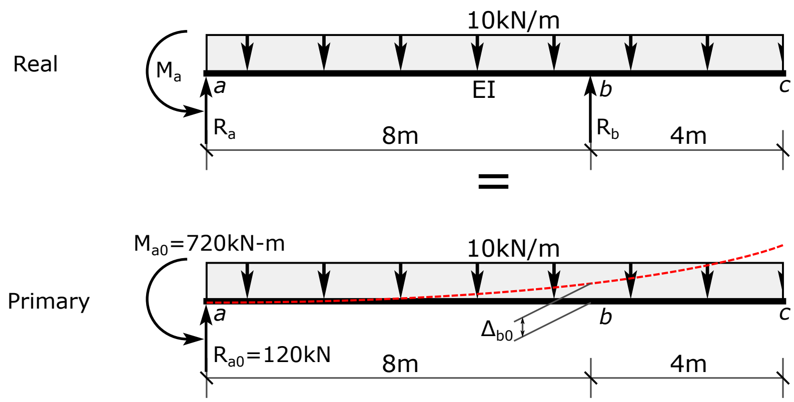


Real



1° S.I. Choose R_b as the redundant.

Because the displacement at b in the real structure is 0, it is not quite so tricky to get the signs right. $\Delta_b = 0$ is on one side of the compatibility equation, and it doesn't matter if it is $+0$ or -0. If support b settled or was elastic, more care would be required.



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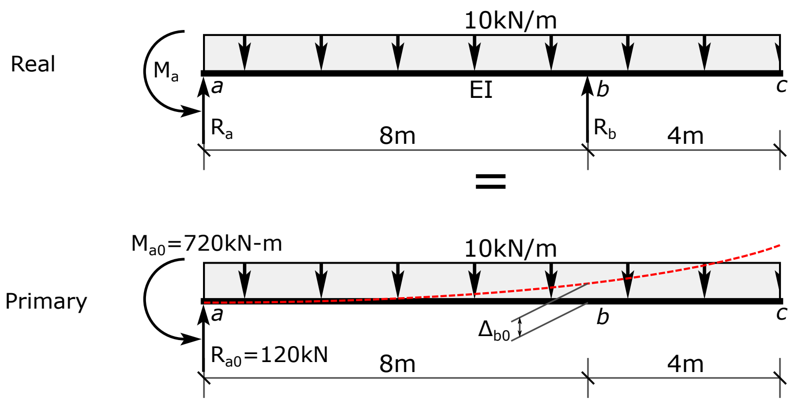

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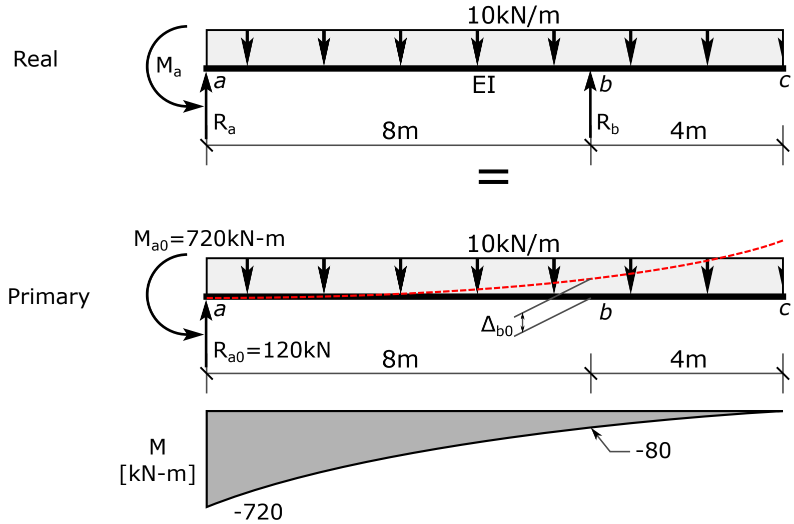
This sketch does *not* establish a sign convention for displacements. The direction of the unit virtual load does that.
We have sketched the displacement to be consistent with the sign we establish below, even though we suspect displacement will be downward. Δ_{b0} will come out with the proper sign.



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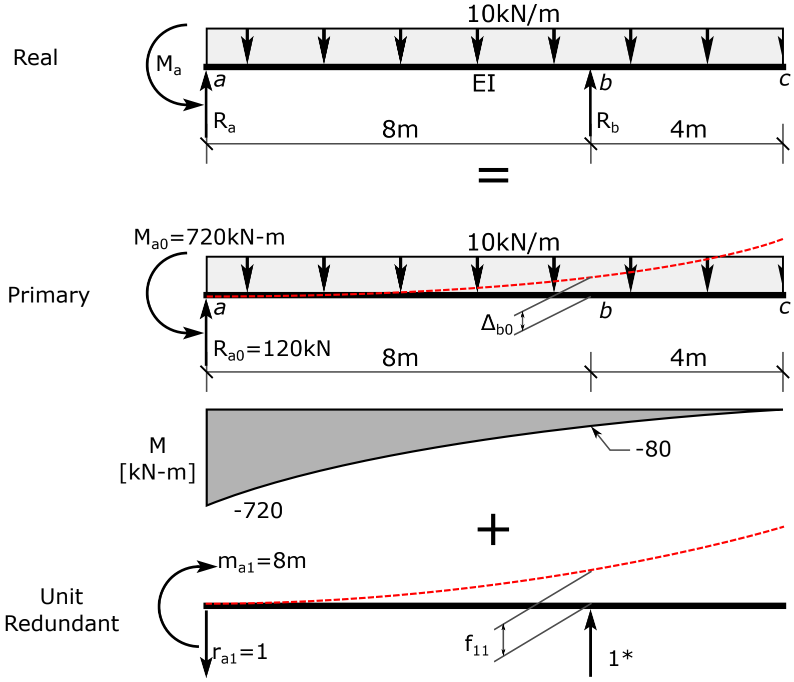

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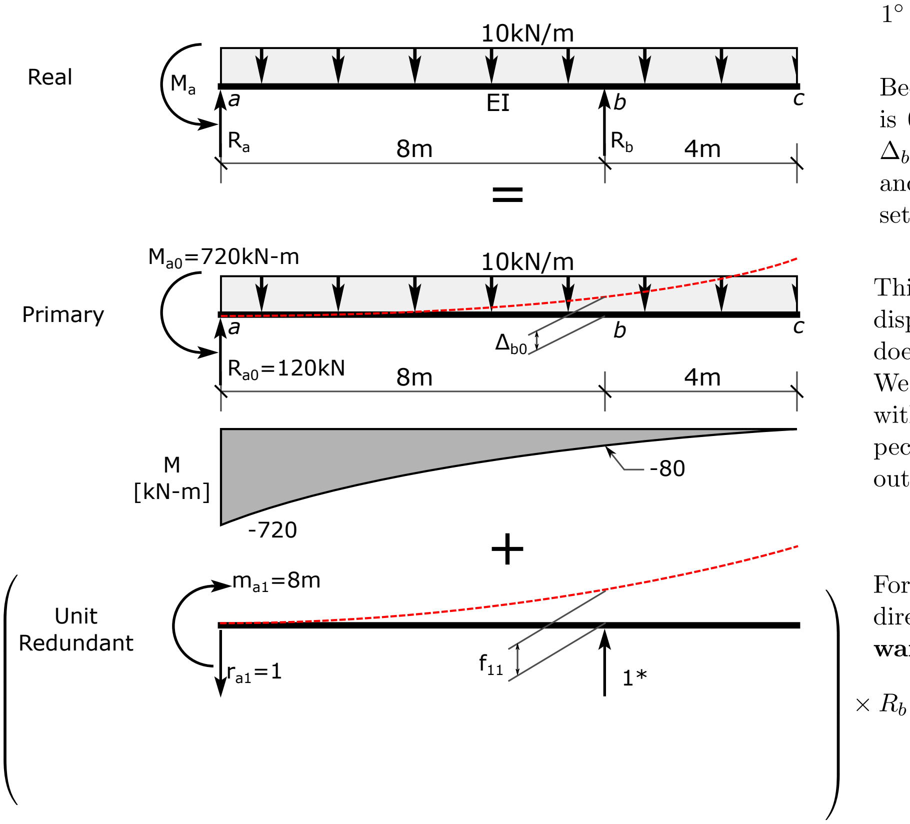
For convenience, the unit load is chosen in the same direction we assumed for R_b. This establishes **upward** displacements as being positive.



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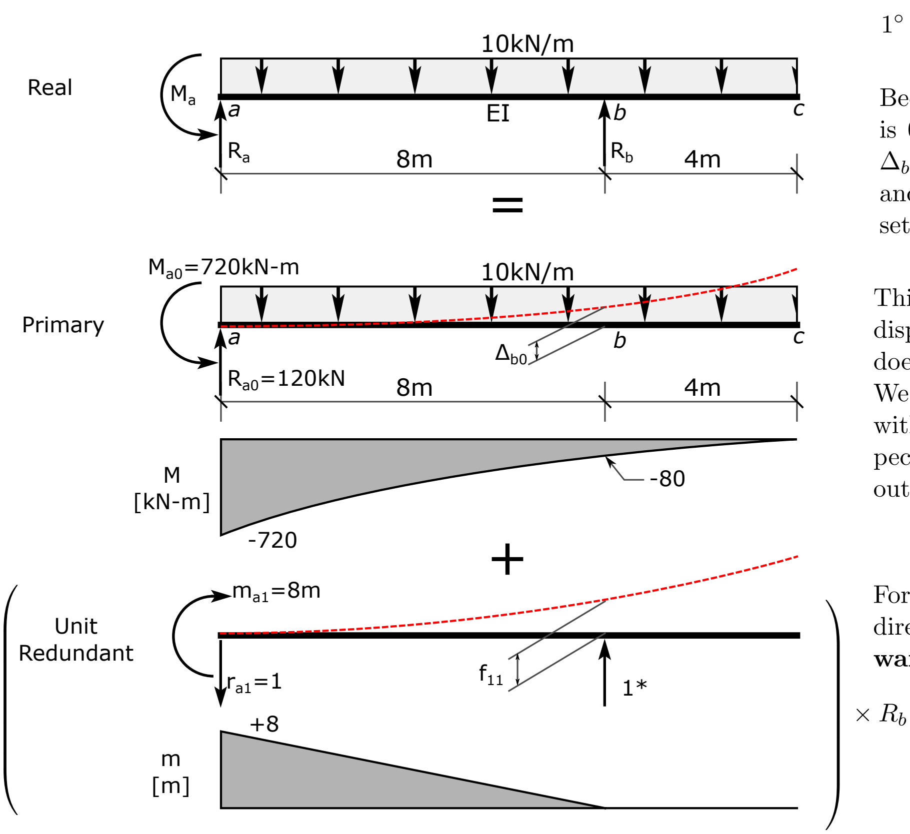

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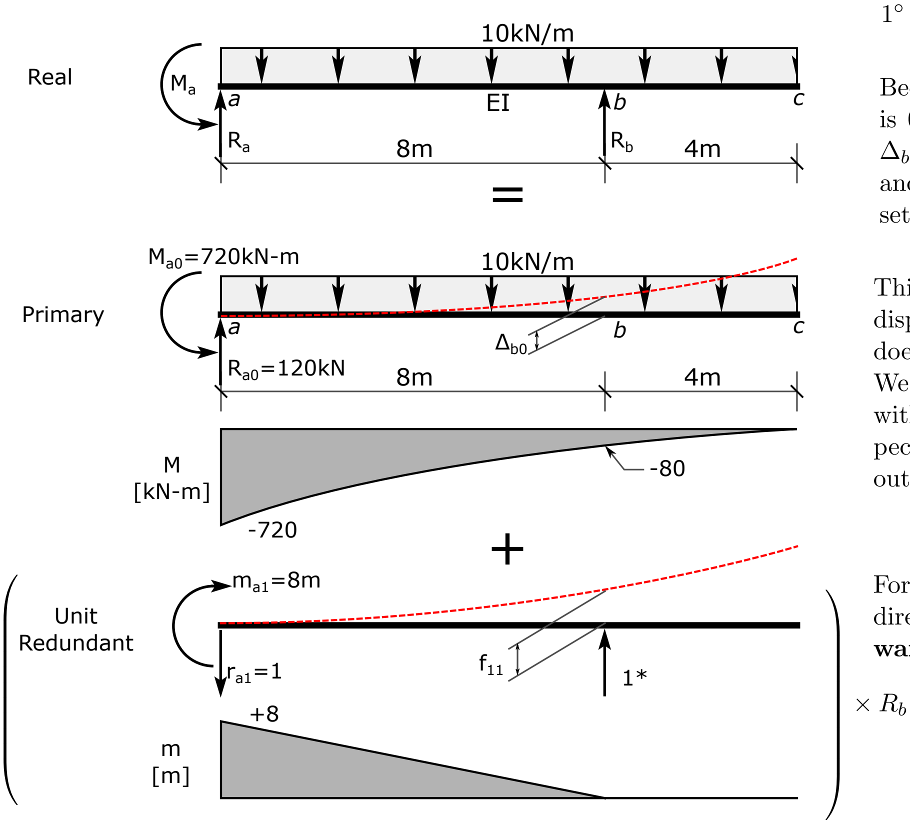

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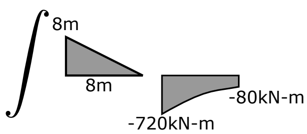
Displacements in the primary structure:

$$\Delta_{b0} = \int \frac{mM}{EI} = \frac{1}{EI} \int$$



$$= \frac{1}{EI}\left[\frac{8}{24}\left[8 \times (10 \times 8^2 + 8 \times -720 + 4 \times -80)\right] \mathrm{kN\,m^3}\right]$$

$$= \frac{-14507\,\mathrm{kN\,m^3}}{EI} \qquad (\therefore\downarrow)$$

This integral is not in the main part of the table, so we must use the most general case with $m_0 = 8$, $m_1 = 0$, $M_0 = -720$, $M_1 = -80$ and $w = 10$.

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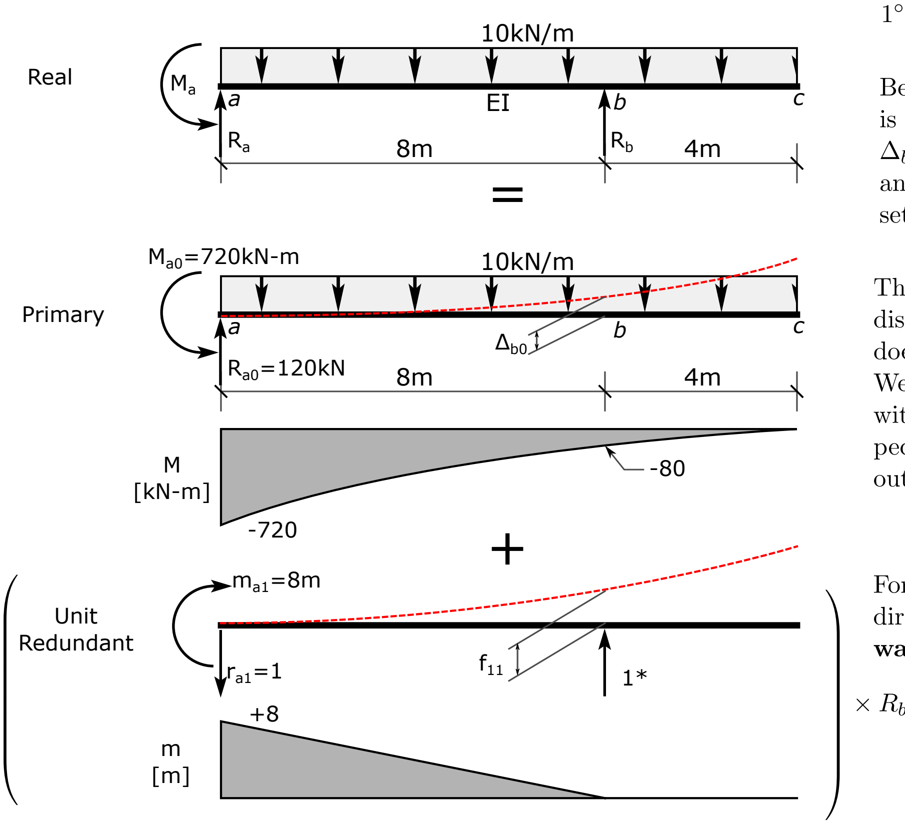

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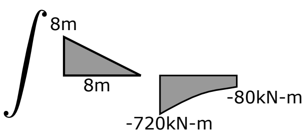

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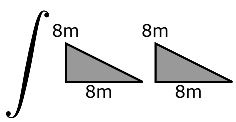
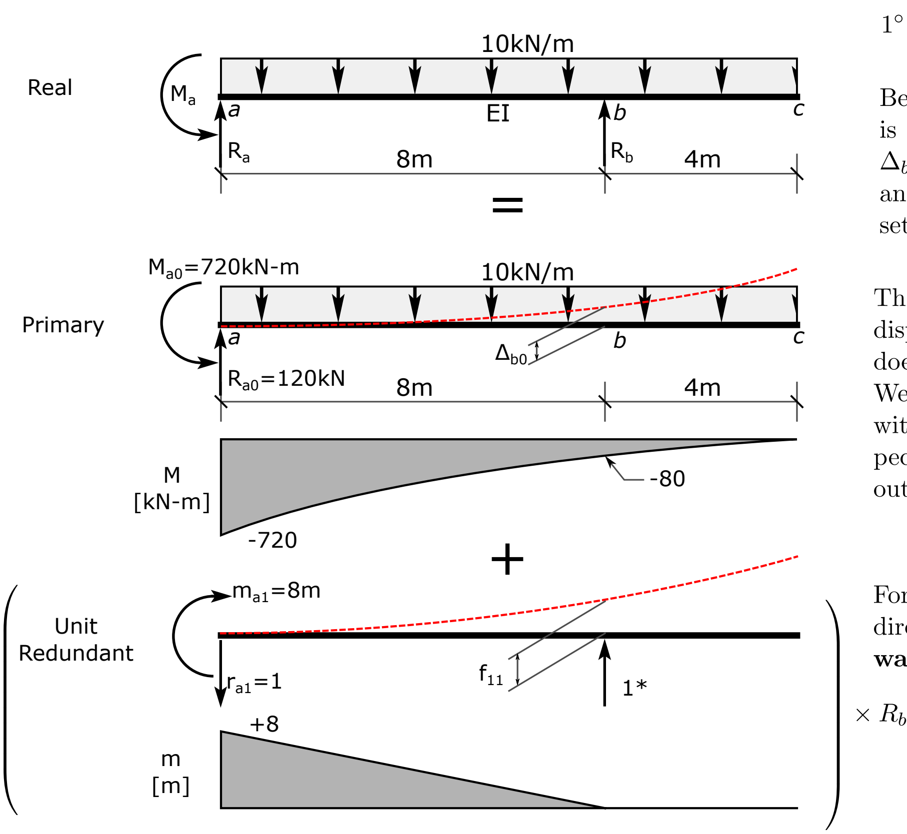
Flexibility coefficients (displacements due to unit redundants):

$$f_{11} = \int \frac{mm}{EI} = \frac{1}{EI}$$



$$= \frac{1}{EI}\frac{8\,\mathrm{m}}{3} \times 8\,\mathrm{m} \times 8\,\mathrm{m}$$

$$= \frac{512\,\mathrm{m^3}}{3EI} \qquad (\therefore\uparrow)$$



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Displacements in the primary structure:

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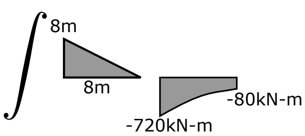

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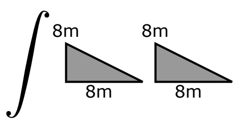

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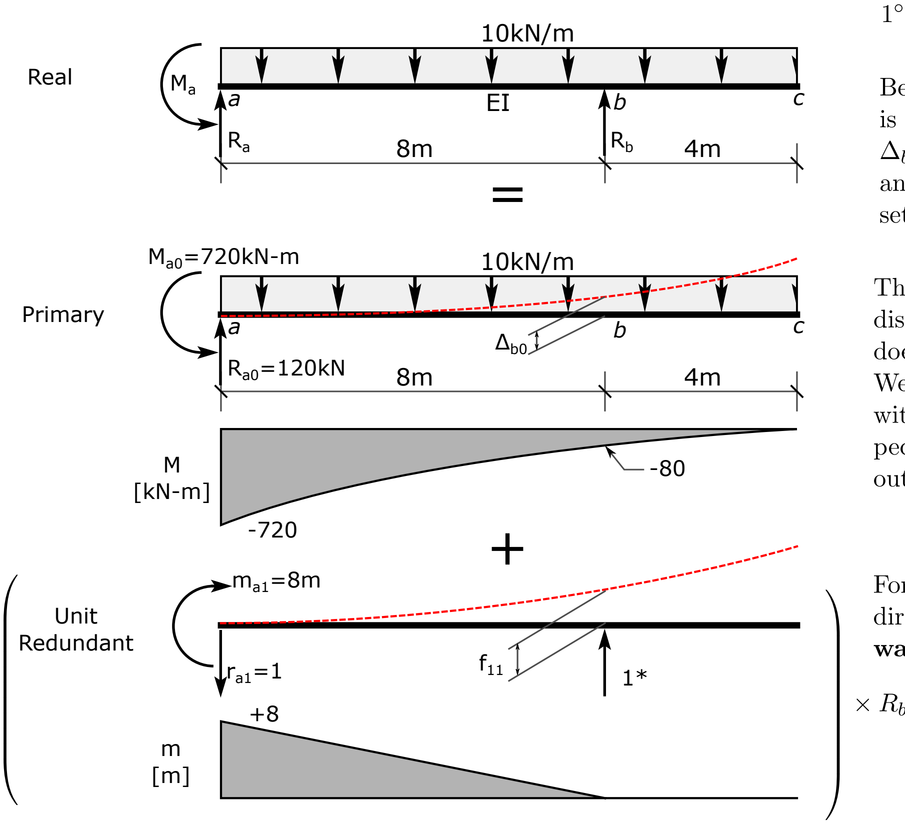
Compatibility Equation (wrt displacement at b):

$$\Delta_b = \Delta_{b0} + R_b f_{11} = 0$$

$$\frac{-14507\,\mathrm{kN\,m^3}}{EI} + R_b \times \frac{512\,m^3}{3EI} = 0$$

The sign convention for displacements is +ive **upwards**.



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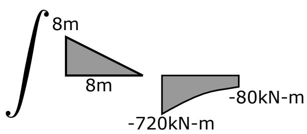

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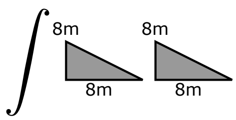

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Solving:

$R_b = 85.0$ kN

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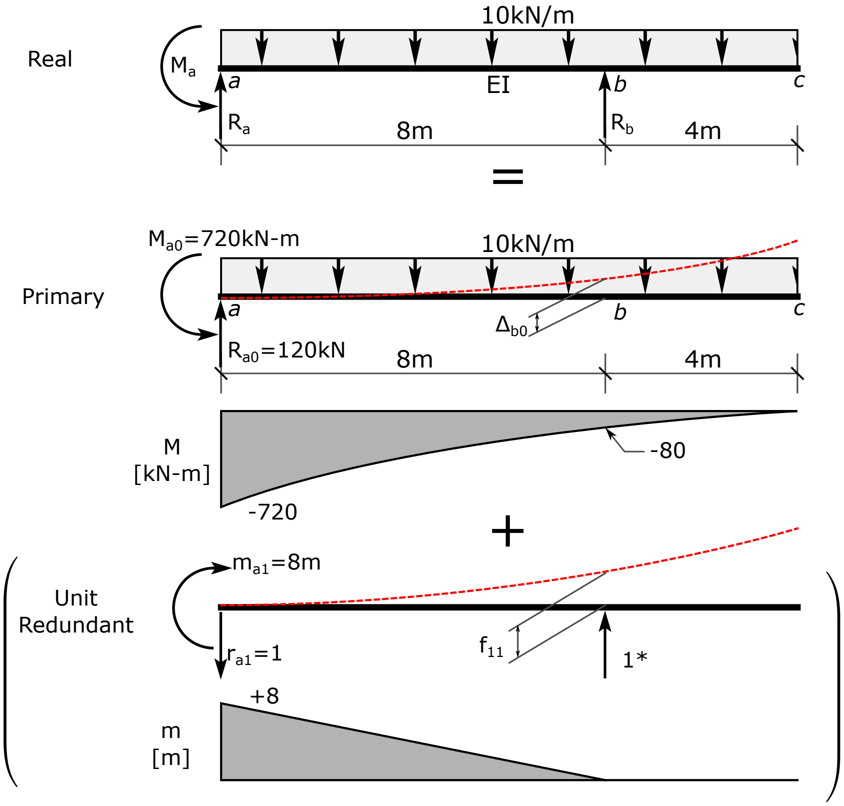

$\times R_b$

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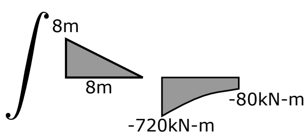

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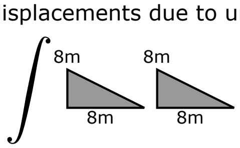

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The sign convention for displacements is +ive **upwards**.

Solving:

$$R_b = 85.0\ \mathrm{kN}$$

Superposition to determine other reactions:

$$M_a = M_{a0} - m_{a1}R_b = 720 - 8\times 85 = 40\,\mathrm{kN\,m}$$

$$R_a = R_{a1} - r_{a1}R_b = 120 - 1\times 85 = 25\,\mathrm{kN}$$