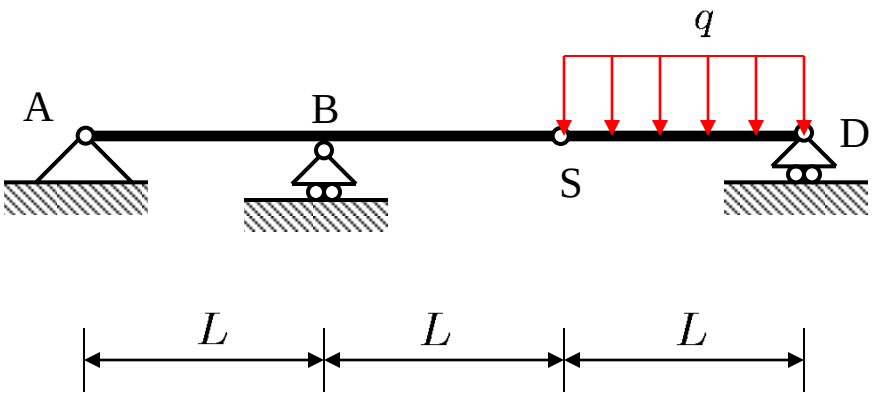
Today:

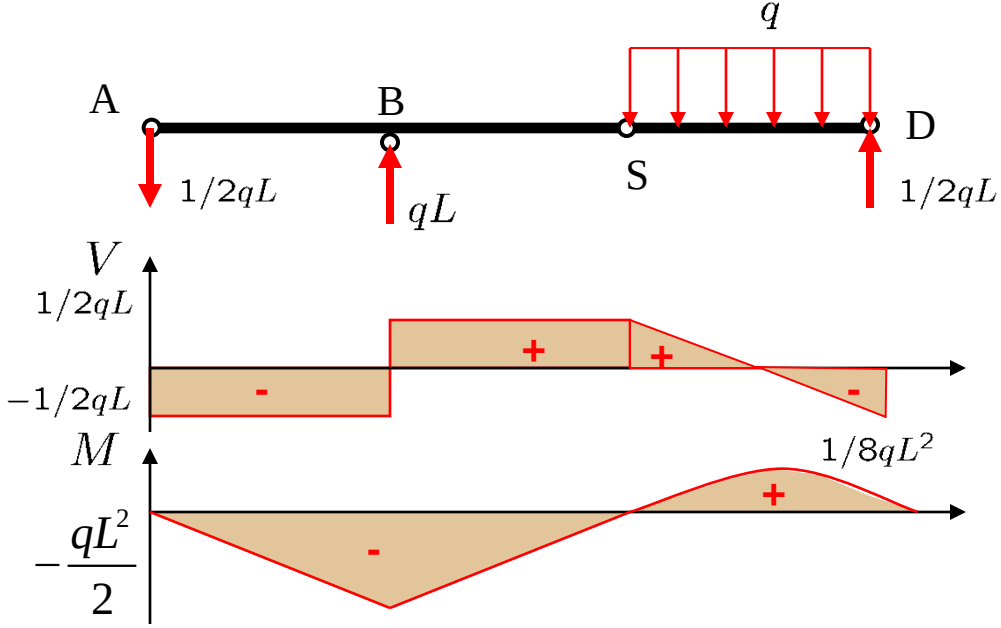
Internal effects in beams continued

- deformation signs

Book: hand outs

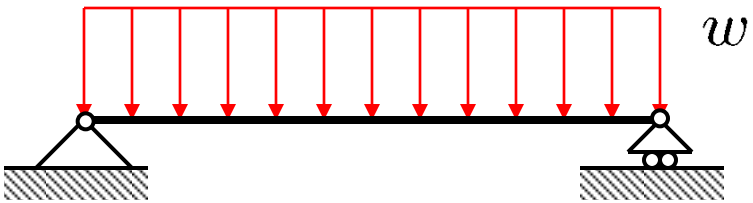


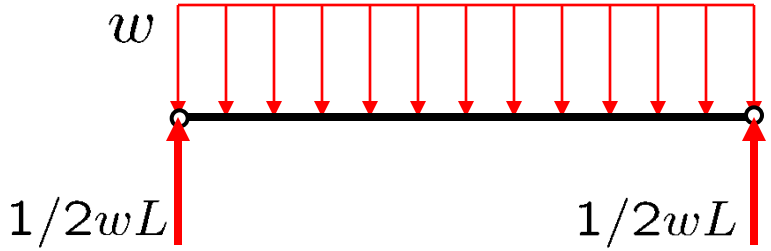
Determine the shear force and moment diagram of this structure. Note that S is a hinge.

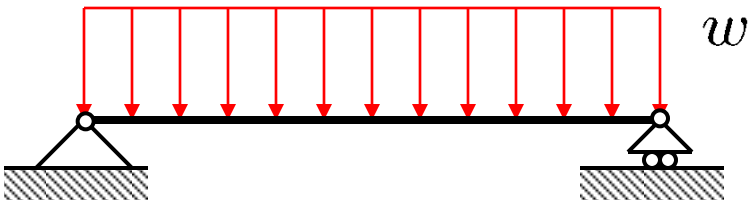

q
A
B
S
D
1/2qL
qL
1/2qL
V
1/2qL
−1/2qL
+
+
-
-
M
1/8qL²
+
-
−qL²/2

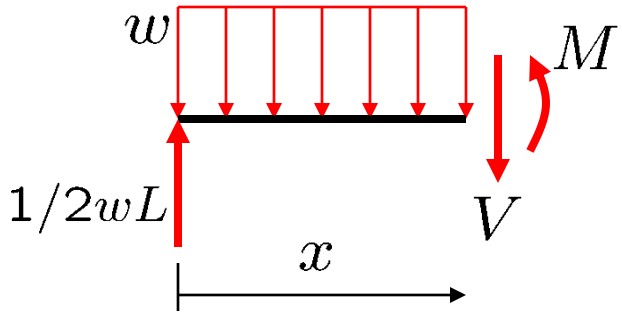
Three ways to derive the normal, shear and bending diagrams

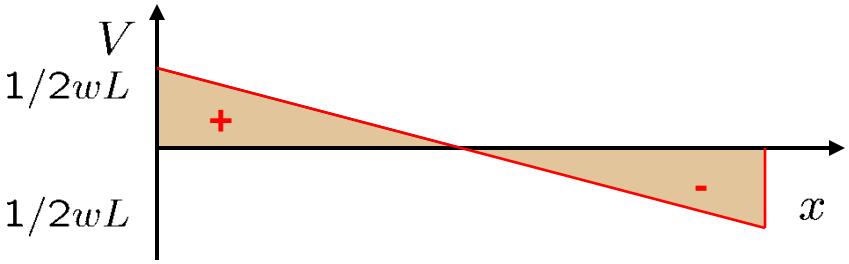
- Method of slices
- Differential equations
- Estimation method

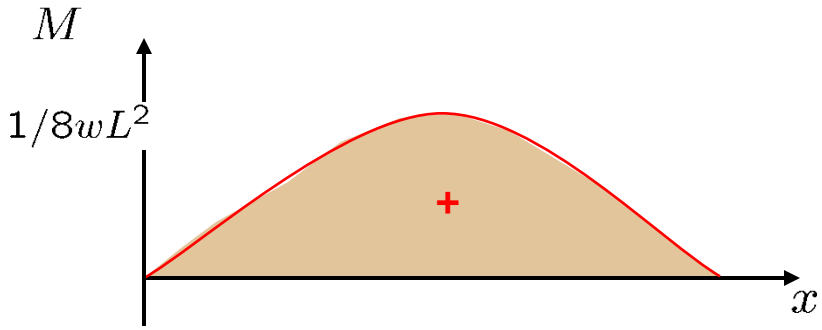

w


w
$1/2wL$
$1/2wL$


w


w
M
1/2wL
V
x


V
1/2wL
+
-
1/2wL
x


M
1/8wL²
+
x

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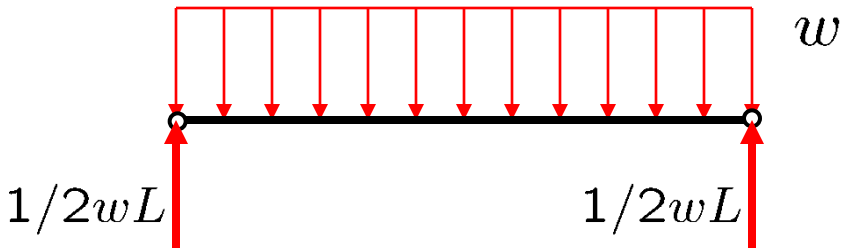
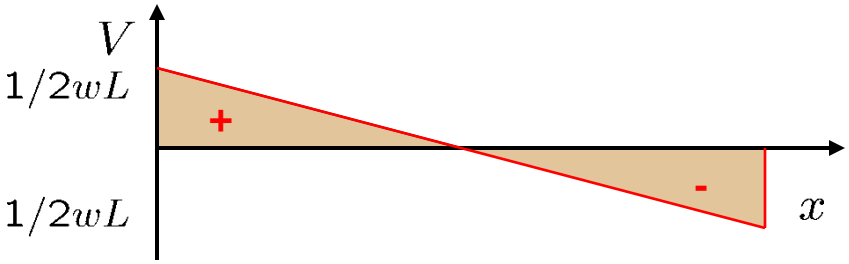
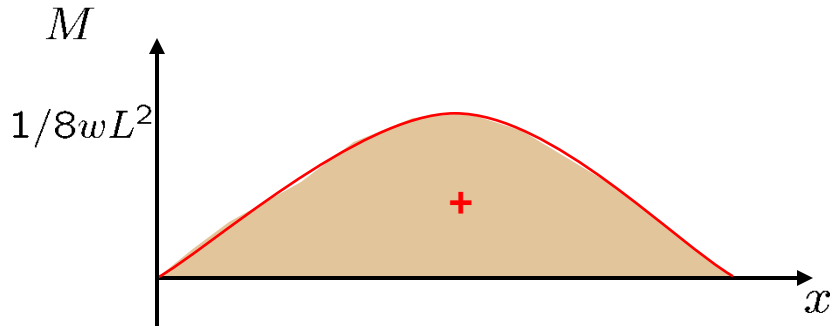


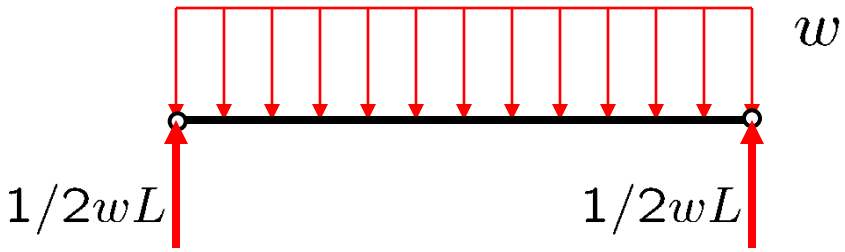
$$V = \int -w dx = -wx + C_0$$

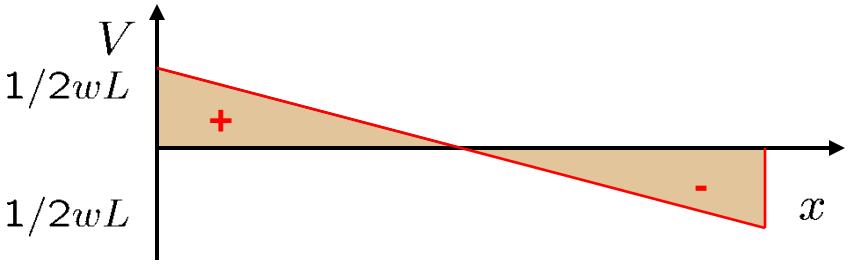
$$V(0) = -wx + C_0 = 1/2wL$$

$$C_0 = 1/2wL$$





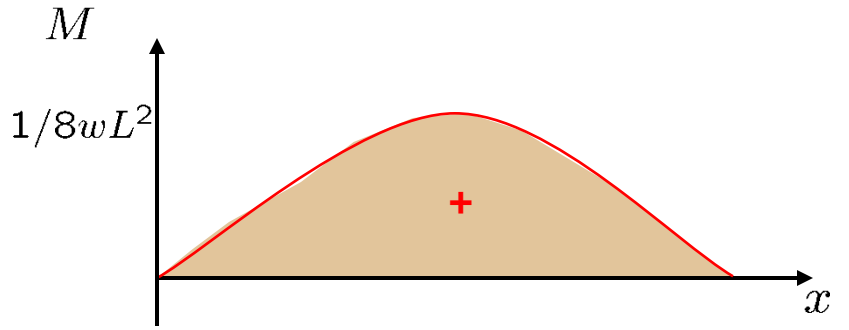




$$M = \int V dx = -1/2wx^2 + 1/2wLx + C_1$$

$$M(0) = 0$$

$$C_1 = 0$$



Three ways to derive the normal, shear and bending diagrams

- Method of slices
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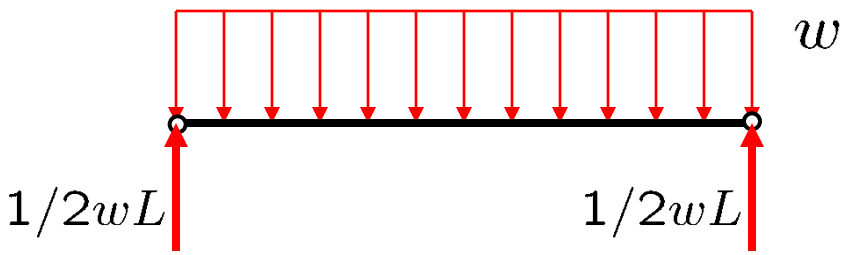
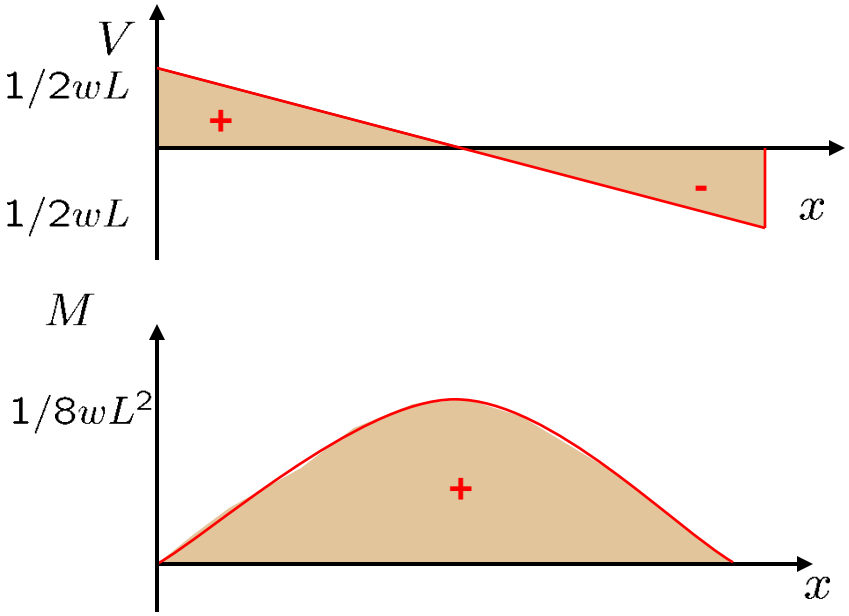
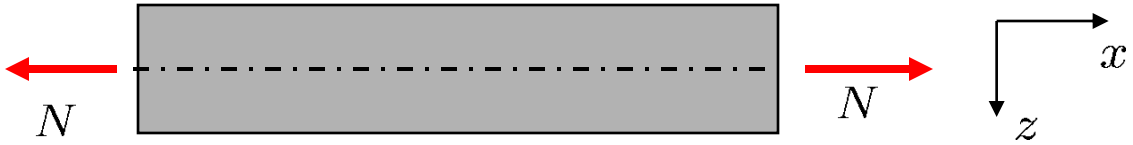
- Estimation method

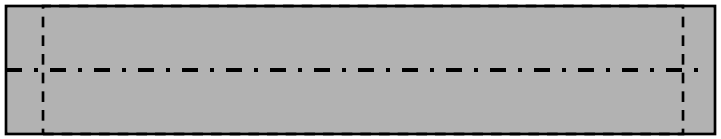

w
1/2wL
1/2wL


V
1/2wL
+
-
1/2wL
x
M
1/8wL²
+
x

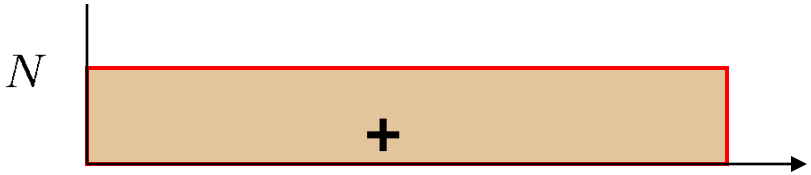
Deformation signs



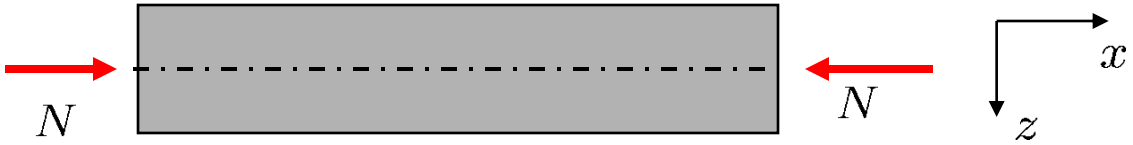
Deformation:



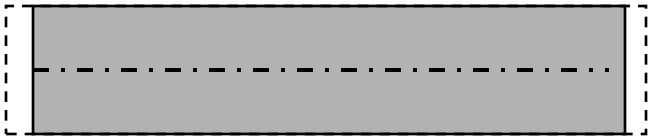
Normal force diagram:



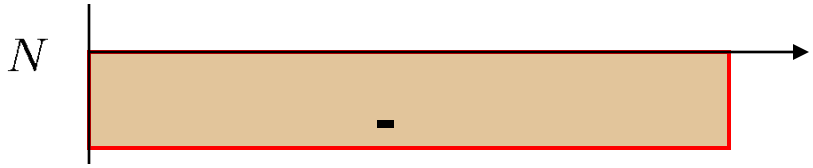
Deformation signs



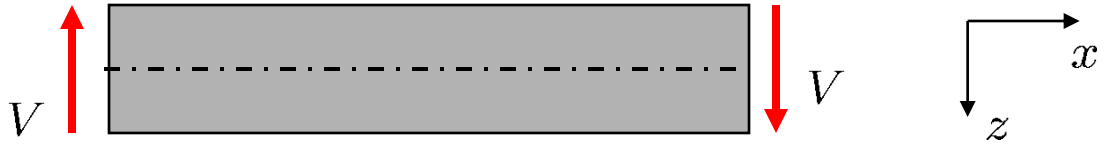
Deformation:



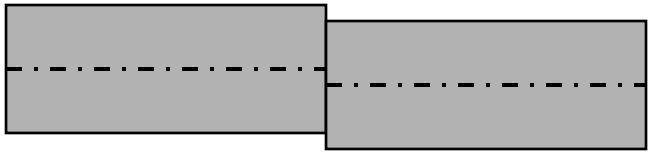
Normal force diagram:



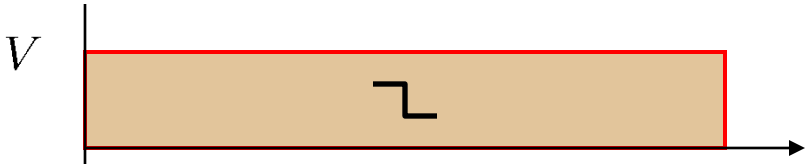
Deformation signs



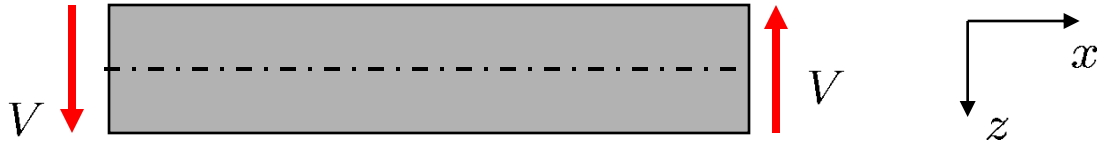
Deformation:



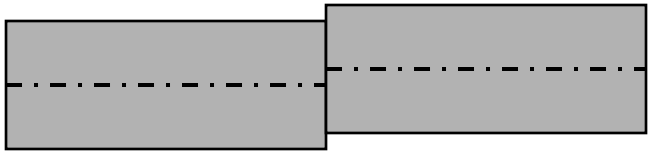
Shear diagram:



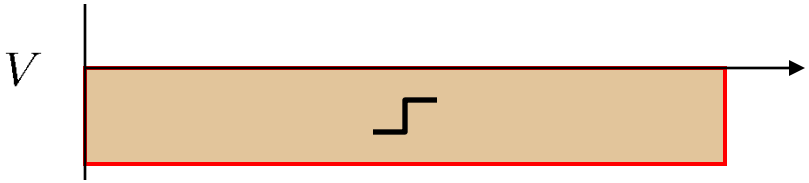
Deformation signs



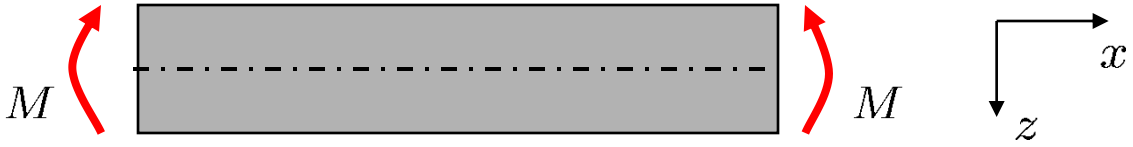
Deformation:



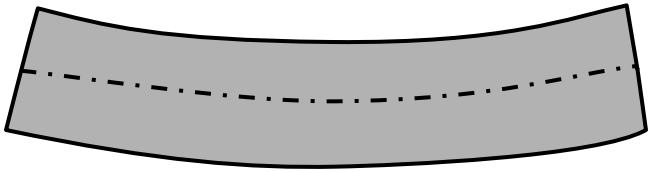
Shear diagram:



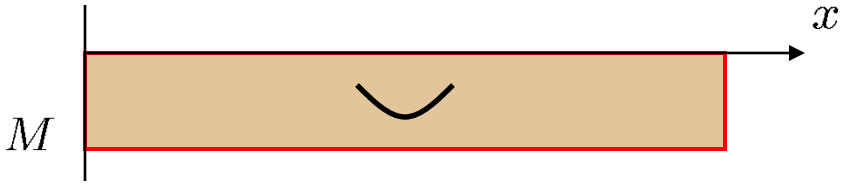
Deformation signs



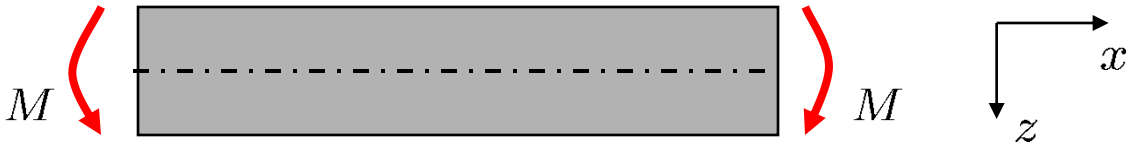
Deformation:



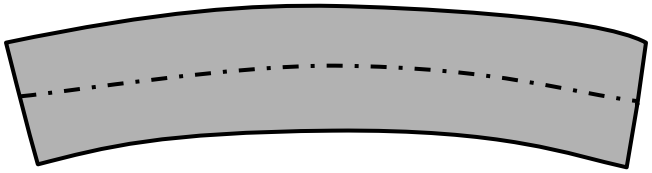
Moment diagram:



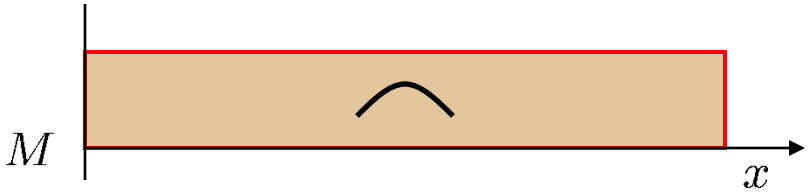
Deformation signs



Deformation:

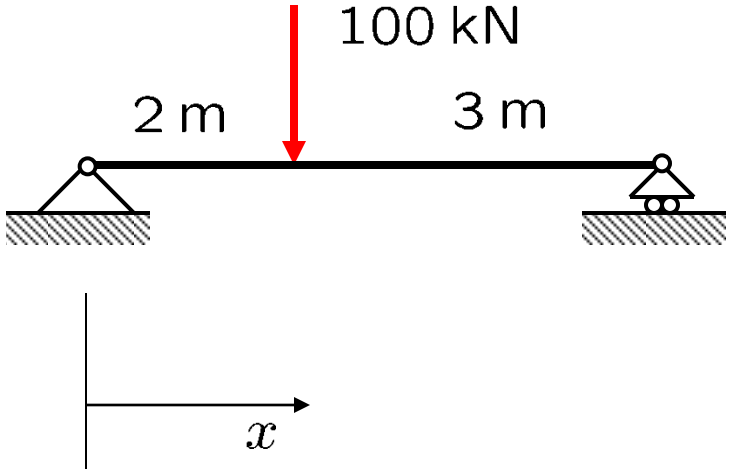


Moment diagram:

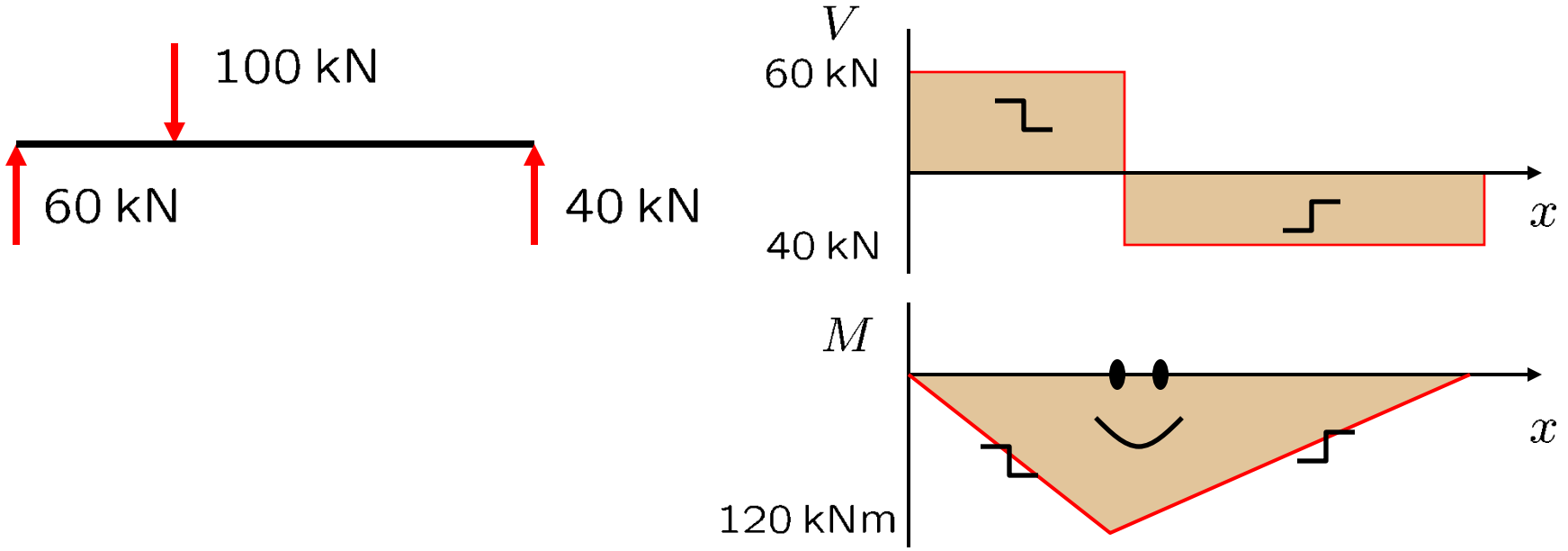


Drawing conventions

- Positive normal- and shear-force diagrams may be drawn on either side of the beam.
- Moment diagram is drawn on the side of the beam where the bending moment gives rise to a tensile stress.

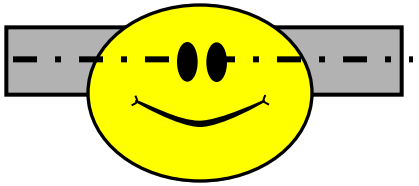


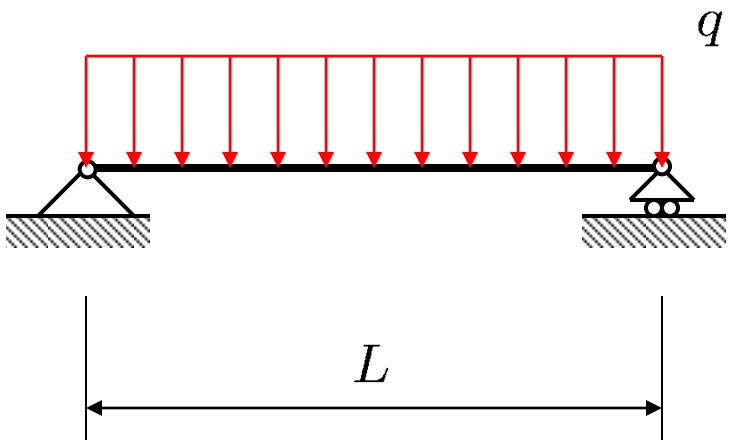
Derive the shear force and bending moment diagrams for this beam. Use the deformation signs.


100 kN
60 kN
40 kN
V
60 kN
40 kN
x
M
x
120 kNm

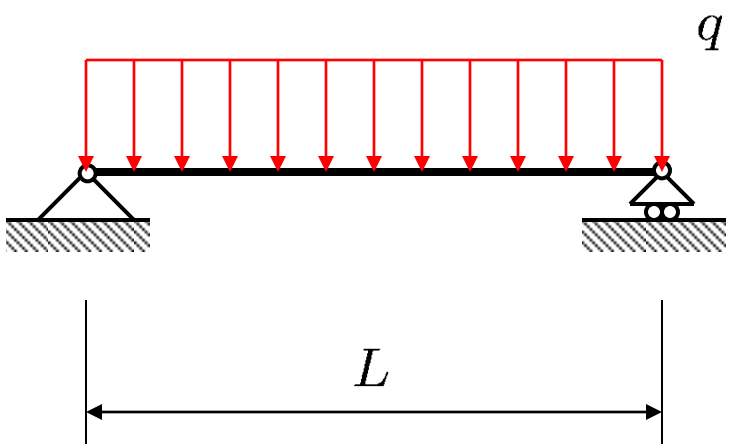
Sign conventions

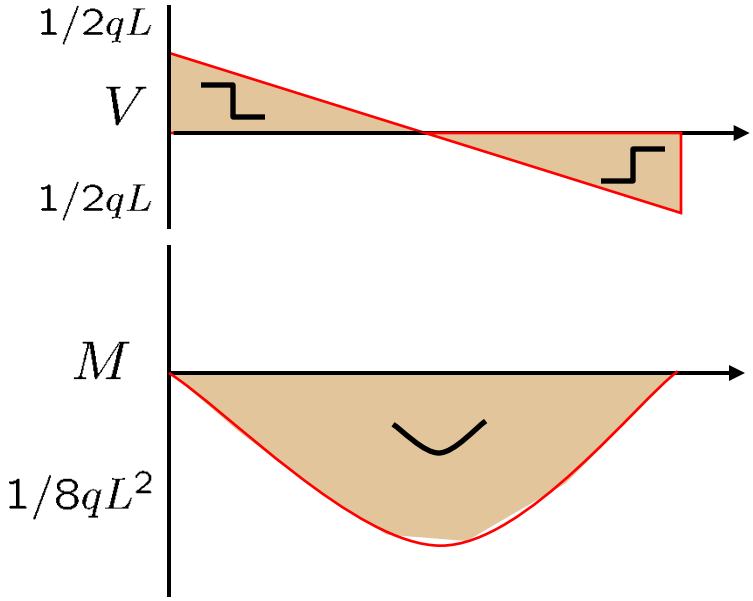
- Moment diagram is drawn on the side of the beam where the bending moment gives rise to a tensile stress.
- Direction of the moment line follows deformation sign of shear force line (staircase).
- Both ends of the bending deformation sign point towards the beam (Smiley).

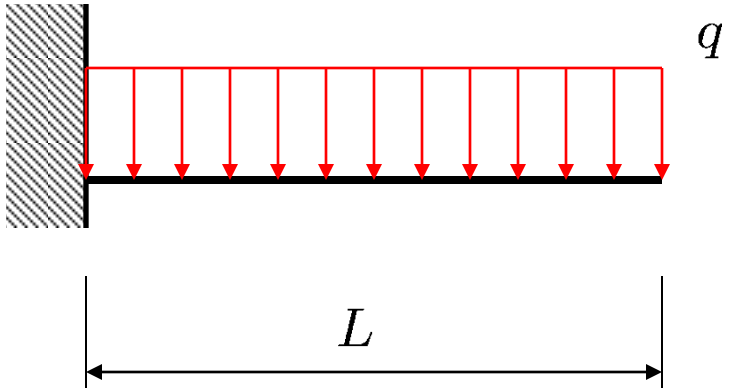




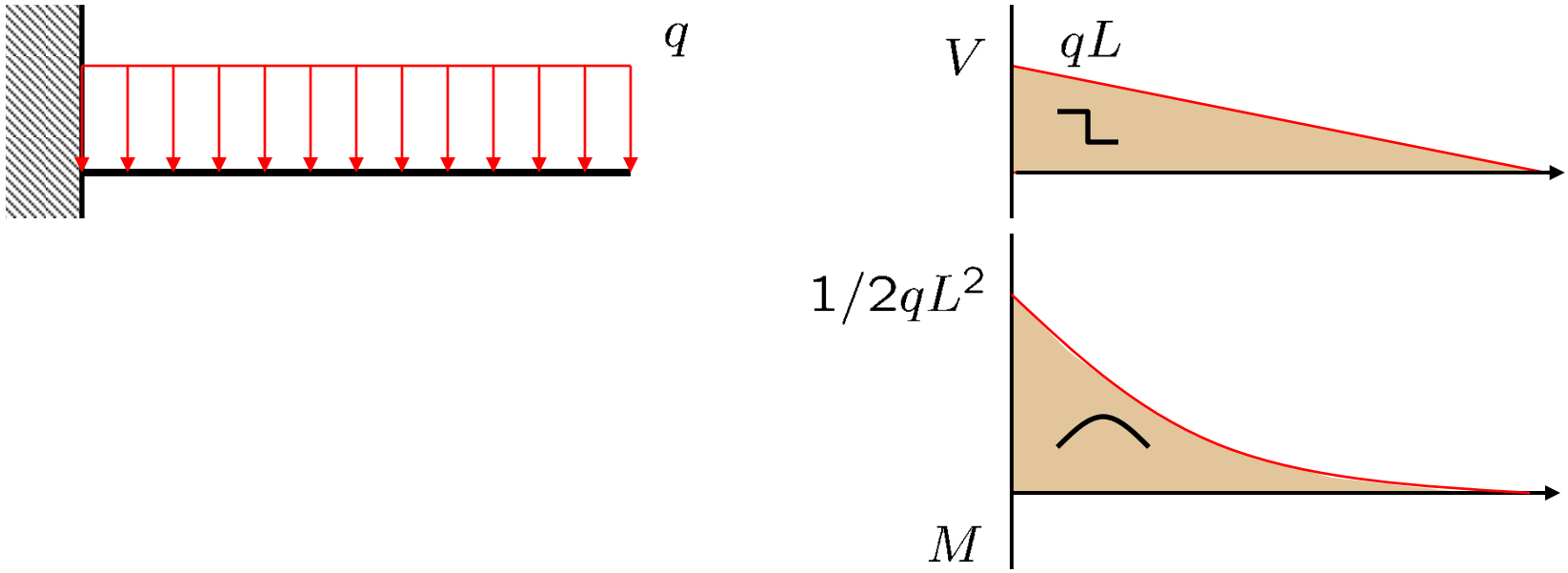
Derive the shear force and bending moment diagrams for this beam. Use the deformation signs.

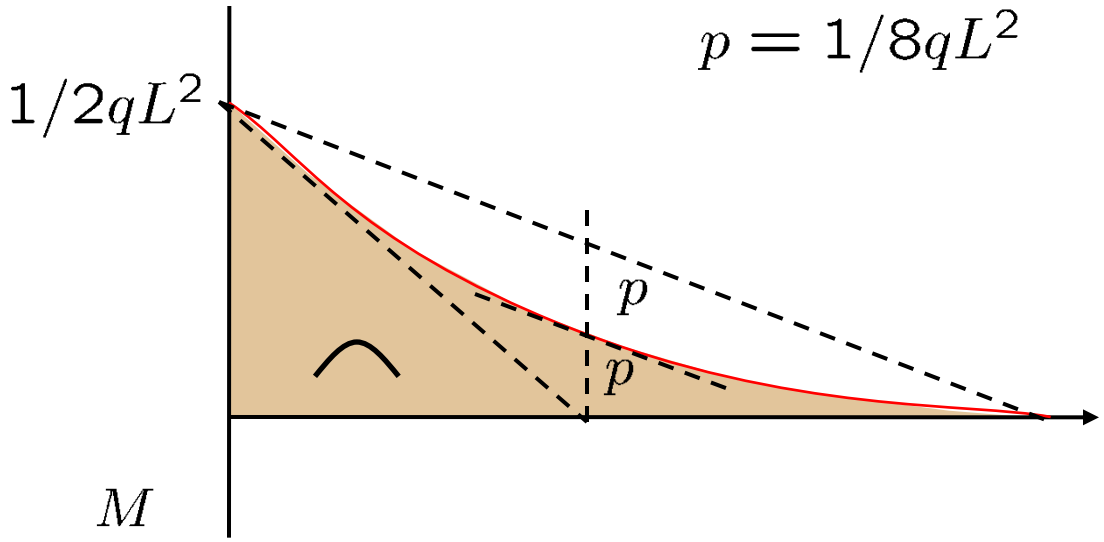

q
L

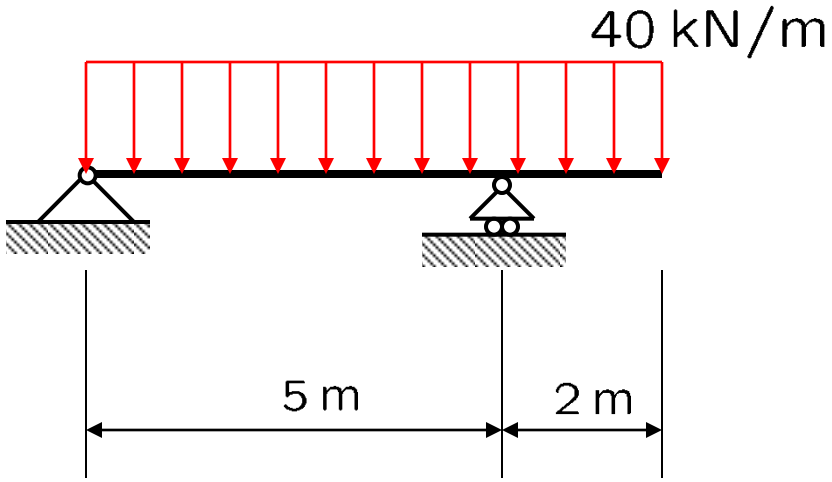

1/2qL
V
1/2qL
M
1/8qL²



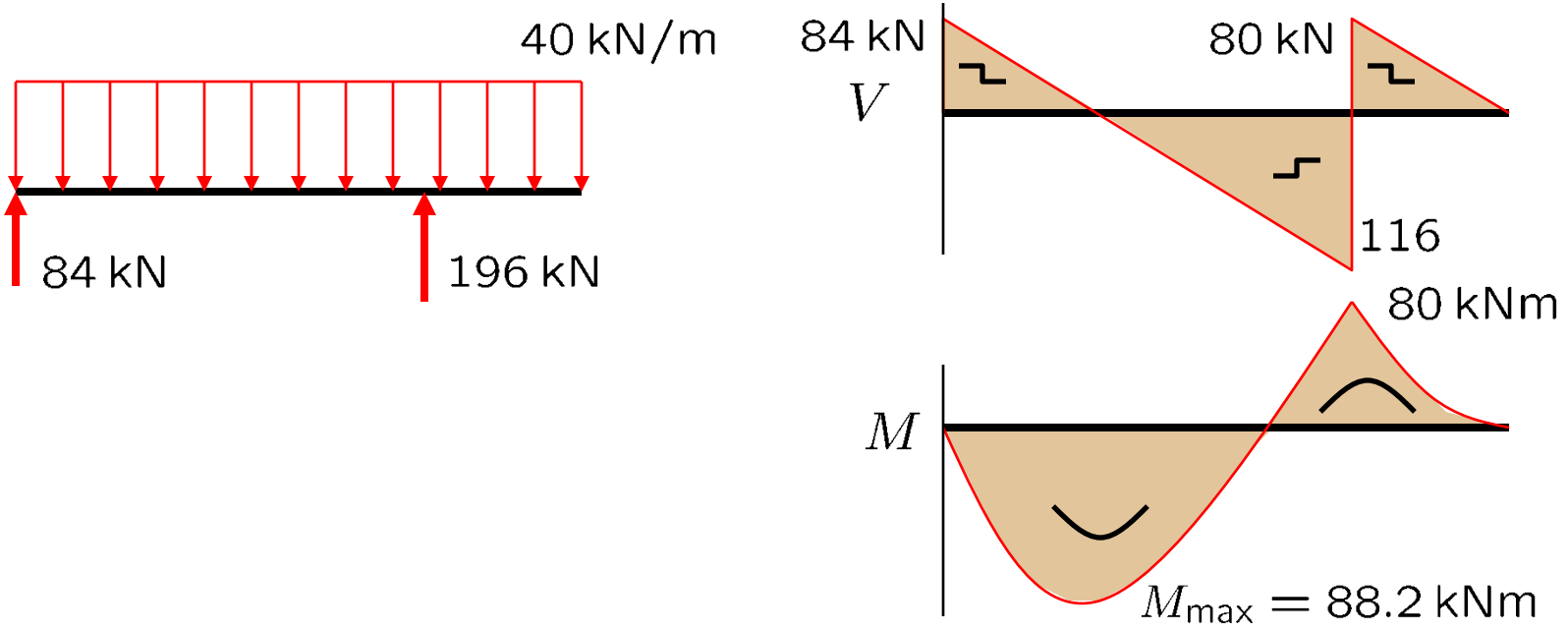
Derive the shear force and bending moment diagrams for this beam. Use the deformation signs.

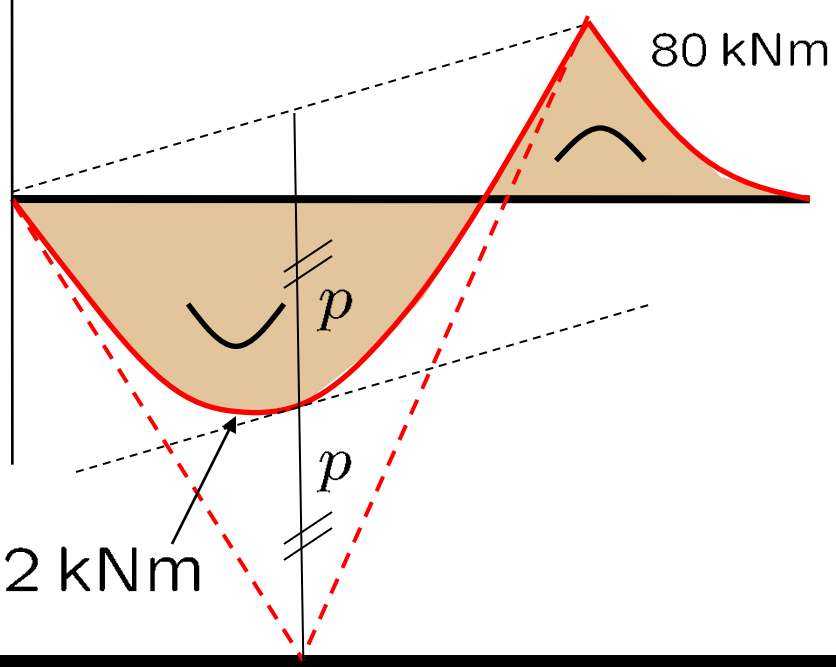

q
V
qL
1/2qL²
M


$p = 1/8qL^2$
$1/2qL^2$
p
p
M

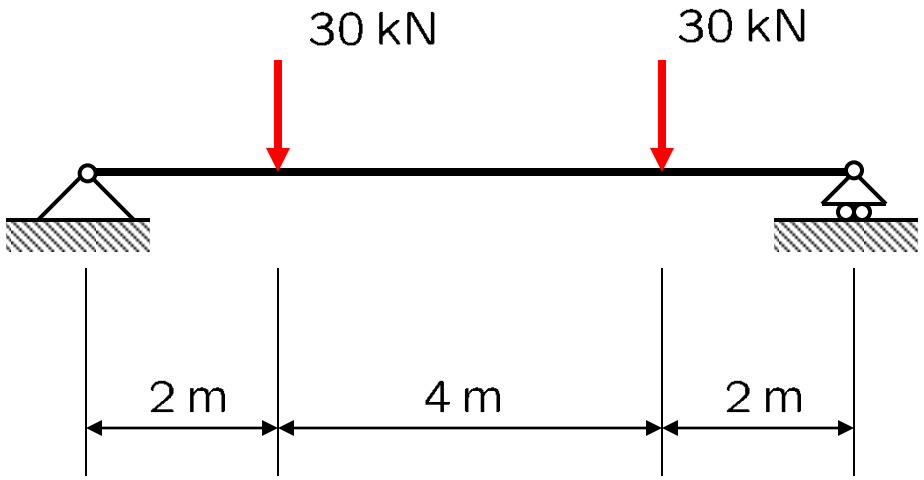


Derive the shear force and bending moment diagrams for this beam. Determine the maximum bending moment.


40 kN/m
84 kN
196 kN
84 kN
V
80 kN
116
80 kNm
M
$M_{max} = 88.2$ kNm



$M_{\max} = 88.2\,\text{kNm}$



Derive the shear force and bending moment diagrams for this beam. Determine the maximum bending moment.