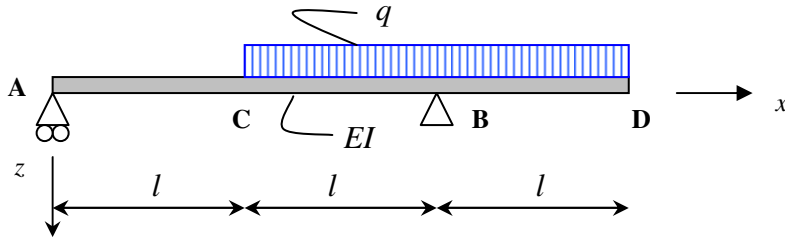# Exercise 1 : WORK AND ENERGY

Investigate the sensitiveness of the displacement at D for changing stiffnesses. Answer the following questions and use the *work method with unit load*.


Questions:

   a) Draw the bending moment diagram as a result of the given distributed load q.
   b) Determine the deflection at D.
   c) Check your result with the *Forget-me-nots*.

To reduce the deflection at D, it has been proposed to increase the bending stiffness *EI* of a part of the beam to *2EI*. You can chose one of the following parts:
   1) part AC
   2) part CB
   3) part BD

   d) Which part of the beam would be your choice? (Motivate this answer with a short explanation based on your former calculations)

a) The bending moment diagram for the distributed load q and the bending moment diagram for the unit load 1.0 kN at the point of interest (where the deflections should be determined).

$\frac{1}{2}ql^2$

$\frac{1}{8}ql^2$

M-diagram

A

C   B   D

z

l l l

l

m-diagram
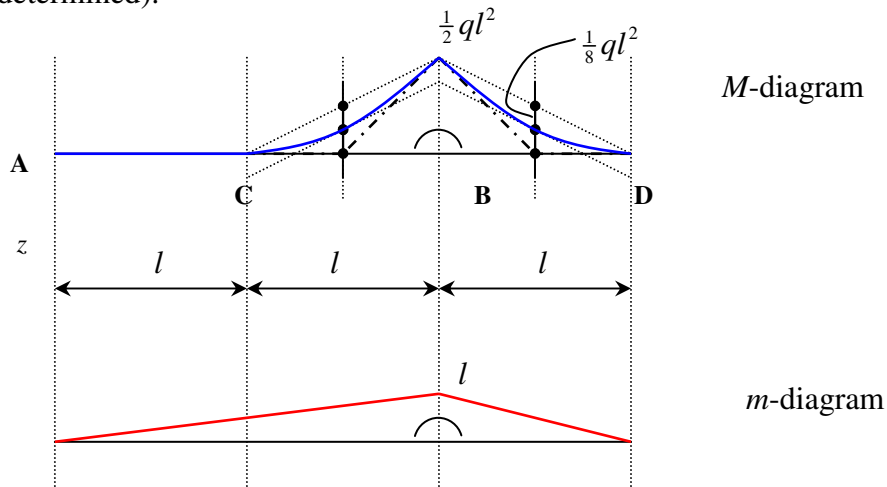
b) Apply: $$w = \int_{x=0}^{3l} \frac{m(x) \times M(x)\,dx}{EI}$$

HINT : Split the construction in 3 parts and determine for every part the contribution to this integral.

Part 1: $(0 < x < l)$

$$M(x) = 0$$
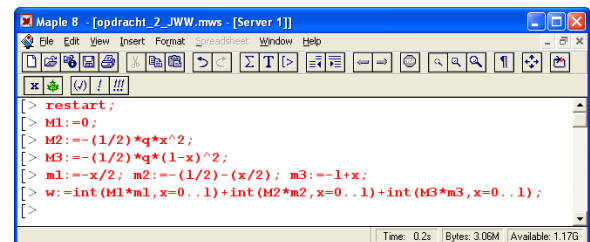
$$m(x) = -\frac{x}{2}$$

Part 2: $(0 < x < l)$

$$M(x) = -\frac{1}{2}qx^2$$

$$m(x) = -\frac{l}{2} - \frac{x}{2}$$

Part 3: $(0 < x < l)$

$$M(x) = -\frac{1}{2}q(l-x)^2$$

$$m(x) = -l + x$$


```
restart;
M1:=0;
M2:=-(1/2)*q*x^2;
M3:=-(1/2)*q*(1-x)^2;
m1:=-x/2; m2:=-(1/2)-(x/2); m3:=-1+x;
w:=int(M1*m1,x=0..1)+int(M2*m2,x=0..1)+int(M3*m3,x=0..1);
```

c) $w = \dfrac{13ql^4}{48EI}$, check this ......

d) Have a look at the explanation of question b) and draw the conclusion that part CB is the best choice.