

**Opmerkingen:** Zie §2.7, blz. 41 t/m 48

**Antwoorden 2.49-1:**

- $N = +(0,48 \text{ kN/m}^2)x^2 - (2,4 \text{ kN/m})x$   
 $u = \left\{ +(0,08 \text{ m}^{-2})x^3 - (0,6 \text{ m}^{-1})x^2 + (5 \text{ m}) \right\} \times 10^{-3}$
- Zie de figuren hiernaast
- $N_B = 0 \Rightarrow B_h = 0$  (de belasting vormt een evenwichtssysteem)
- $u_{\text{rol}} = 5 \text{ mm} \rightarrow$

**Toelichting:**

$$q = -\frac{2\hat{q}}{\ell}x + \hat{q}$$

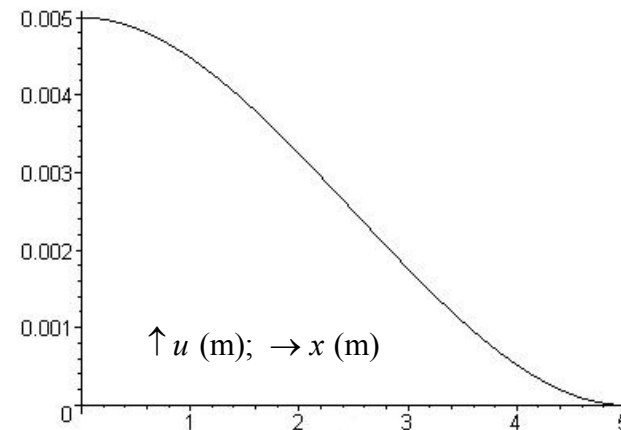
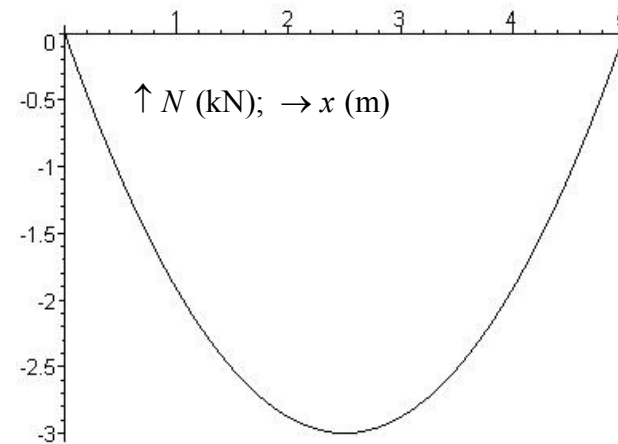
$$EAu'' = -q = +\frac{2\hat{q}}{\ell}x - \hat{q}$$

$$N = EAu' = +\frac{\hat{q}}{\ell}x^2 - \hat{q}x + C_1$$

$$EAu = +\frac{\hat{q}}{3\ell}x^3 - \frac{\hat{q}}{2}x^2 + C_1x + C_2$$

$$x = 0; N = 0 \Rightarrow C_1 = 0$$

$$x = \ell = 5 \text{ m}; u = 0 \Rightarrow C_2 = \frac{1}{6}\hat{q}\ell^2 = 10 \text{ kNm}$$



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**Antwoorden 2.49-2:**

- a.  $N = -\frac{12}{\pi} \sin \frac{\pi x}{(5 \text{ m})} \text{ kN}$
- $$u = +\frac{30 \times 10^{-3}}{\pi^2} \left( \cos \frac{\pi x}{(5 \text{ m})} + 1 \right) \text{ m}$$
- b. Zie de figuren hiernaast
- c.  $N_B = 0 \Rightarrow B_h = 0$  (de belasting vormt een evenwichtssysteem)
- d.  $u_{\text{rol}} = 6,1 \text{ mm} \rightarrow$

**Toelichting:**

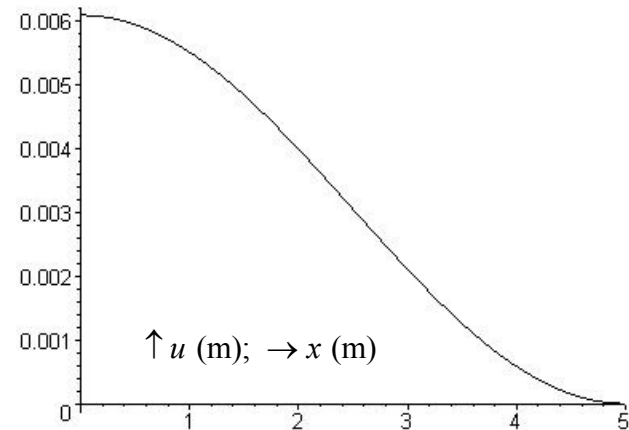
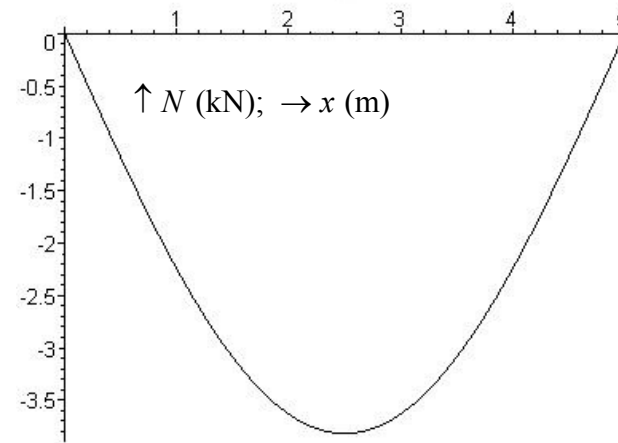
$$EAu'' = -q = -\hat{q} \cos \frac{\pi x}{\ell}$$

$$N = EAu' = -\frac{\hat{q}\ell}{\pi} \sin \frac{\pi x}{\ell} + C_1$$

$$EAu = +\frac{\hat{q}\ell^2}{\pi^2} \cos \frac{\pi x}{\ell} + C_1 x + C_2$$

$$x = 0; N = 0 \Rightarrow C_1 = 0$$

$$x = \ell = 5 \text{ m}; u = 0 \Rightarrow C_2 = \frac{\hat{q}\ell^2}{\pi^2} = \frac{60}{\pi^2} \text{ kNm}$$



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**Antwoorden 2.49-3:**

- $N = +(0,128 \text{ kN/m}^3)x^3 - (0,960 \text{ kN/m}^2)x^2$   
 $u = \left\{ +(0,016 \text{ m}^{-3})x^4 - (0,16 \text{ m}^{-2})x^3 + (10 \text{ m}) \right\} \times 10^{-3}$
- Zie de figuren hiernaast
- $N_B = -8 \text{ kN} \Rightarrow B_h = 8 \text{ kN} \leftarrow$
- $u_{\text{rol}} = 10 \text{ mm} \rightarrow$

**Toelichting:**

$$q = -\frac{4\hat{q}}{\ell^2}x^2 + \frac{4\hat{q}}{\ell}x$$

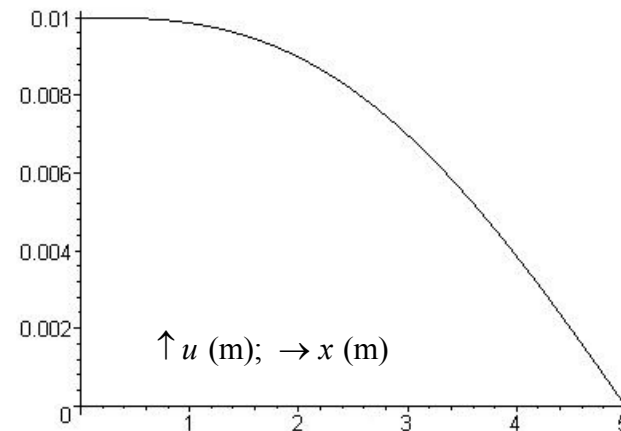
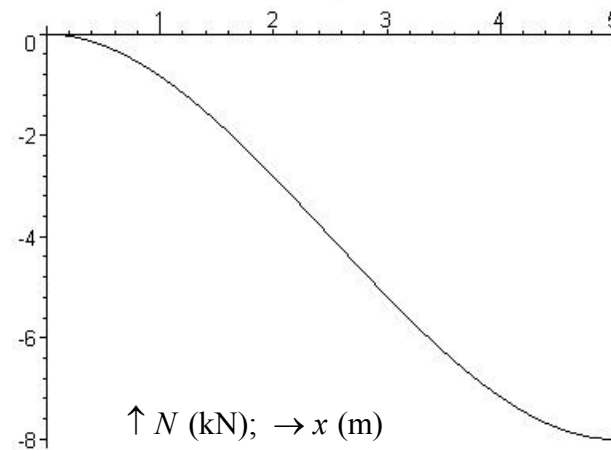
$$EAu'' = -q = +\frac{4\hat{q}}{\ell^2}x^2 - \frac{4\hat{q}}{\ell}x$$

$$N = EAu' = +\frac{4\hat{q}}{3\ell^2}x^3 - \frac{2\hat{q}}{\ell}x^2 + C_1$$

$$EAu = +\frac{\hat{q}}{3\ell^2}x^4 - \frac{2\hat{q}}{3\ell}x^3 + C_1x + C_2$$

$$x = 0; N = 0 \Rightarrow C_1 = 0$$

$$x = \ell = 5 \text{ m}; u = 0 \Rightarrow C_2 = \frac{1}{3}\hat{q}\ell^2 = 20 \text{ kNm}$$



**Opmerkingen:** Zie §2.7, blz. 41 t/m 48

**Antwoorden 2.49-4:**

a.  $N = \frac{12}{\pi} \left( \cos \frac{\pi x}{(5 \text{ m})} - 1 \right) \text{ kN}$

$$u = + \frac{30 \times 10^{-3}}{\pi^2} \left( \sin \frac{\pi x}{(5 \text{ m})} - \frac{\pi x}{(5 \text{ m})} + \pi \right) \text{ m}$$

b. Zie de figuren hiernaast

c.  $N_B = -\frac{24}{\pi^2} \text{ kN} \Rightarrow B_h = 7,64 \text{ kN} \leftarrow$

d.  $u_{\text{rol}} = 9,55 \text{ mm} \rightarrow$

**Toelichting:**

$$EAu'' = -q = -\hat{q} \sin \frac{\pi x}{\ell}$$

$$N = EAu' = + \frac{\hat{q}\ell}{\pi} \cos \frac{\pi x}{\ell} + C_1$$

$$EAu = + \frac{\hat{q}\ell^2}{\pi^2} \sin \frac{\pi x}{\ell} + C_1x + C_2$$

$$x = 0; N = 0 \Rightarrow C_1 = -\frac{\hat{q}\ell}{\pi} = -\frac{12}{\pi} \text{ kN}$$

$$x = \ell = 5 \text{ m}; u = 0 \Rightarrow C_2 = \frac{\hat{q}\ell^2}{\pi} = \frac{60}{\pi} \text{ kNm}$$

