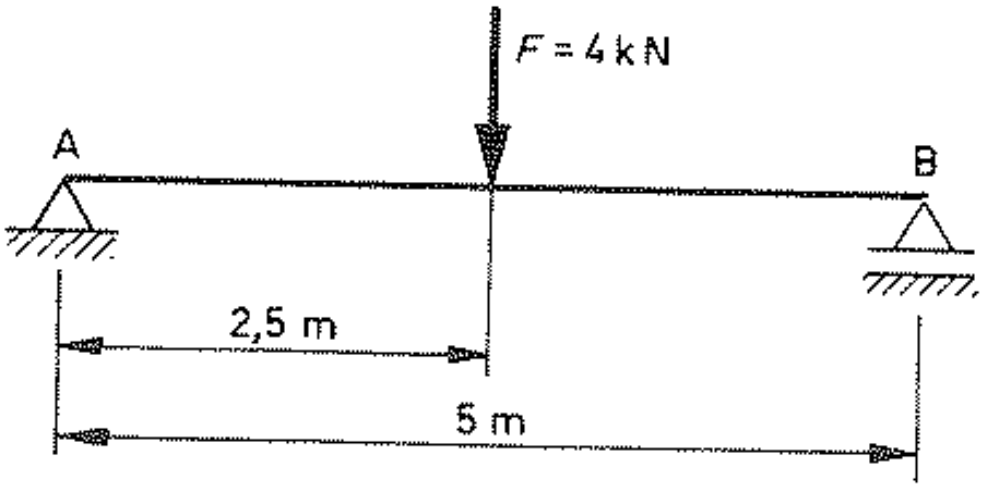
ribNat0a
natuurkunde - bijspijker

Huiswerkopdracht week 04

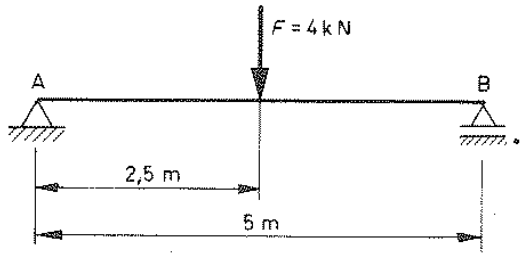
Naam Student:
Studienummer:

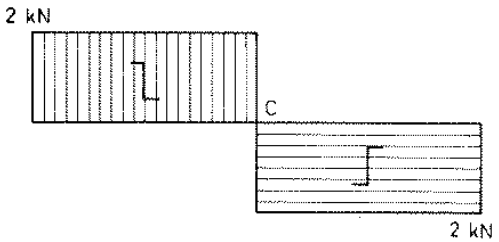
Opdracht 01

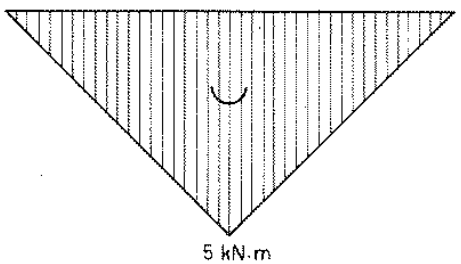


Bepaal voor deze constructie de dwarskrachten en momentenlijn

Uitwerking opdracht 1



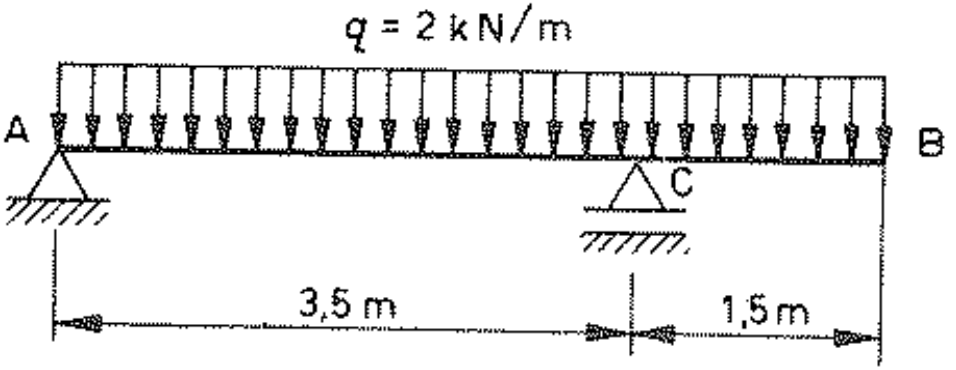




$$F_{A,v} = F_{B,v} = \frac{1}{2} F = 2\,\text{kN}$$

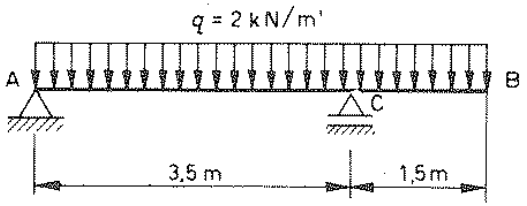
$$M_C = F_{A,v} \times 2{,}5\,\text{m} = 2\,\text{kN} \times 2{,}5\,\text{m} = 5\,\text{kN} \cdot \text{m}$$

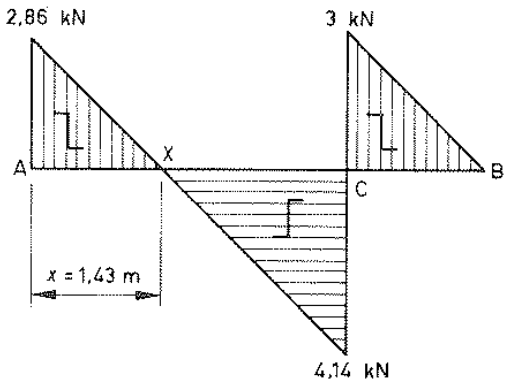
Opdracht 02

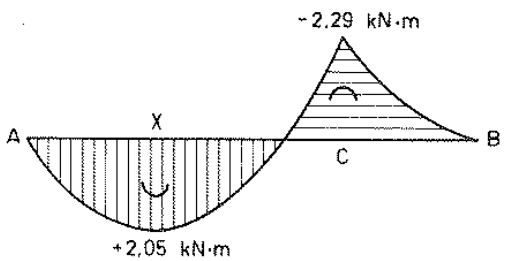


Bepaal voor deze constructie de dwarskrachten en momentenlijn

Uitwerking opdracht 2







$Q = 2\ \text{kN/m}' \times 5\ \text{m} = 10\ \text{kN}$

ΣM t.o.v. A $= 0$

$10\ \text{kN} \times 2{,}5\ \text{m} - F_{C,v} \times 3{,}5\ \text{m} = 0$

$$F_{C,v} = \frac{25\ \text{kN} \cdot \text{m}}{3{,}5\ \text{m}} = 7{,}14\ \text{kN (afgerond)}$$

$F_{A,v} = 10\ \text{kN} - 7{,}14\ \text{kN} = 2{,}86\ \text{kN}$

Stel $F_d = 0$ op x m afstand rechts van A. Dan geldt:

$$F_{A,v} - \frac{x}{5} \cdot Q = 0$$

$$2{,}86\ \text{kN} - \frac{x}{5} \cdot 10\ \text{kN} = 0$$

$$x = \frac{2{,}86\ \text{kN}}{2\ \text{kN}} = 1{,}43$$

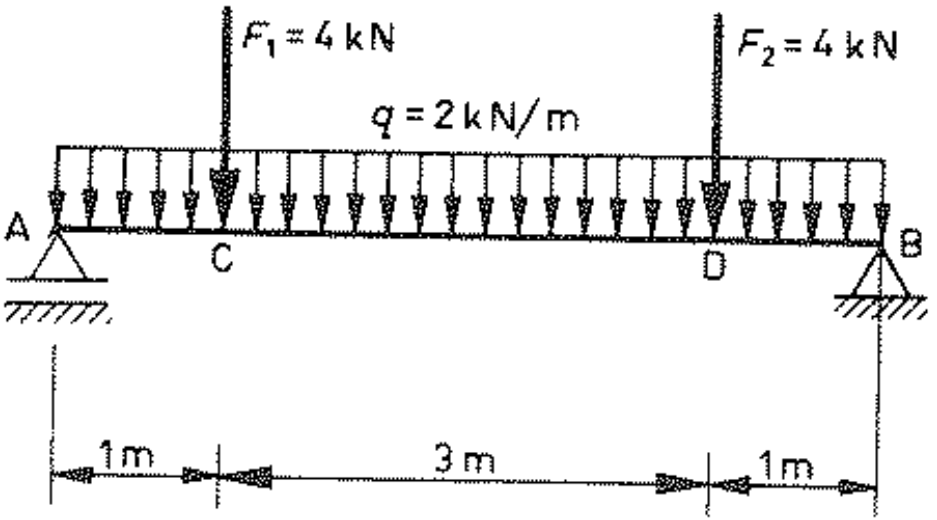
$$M_X = 2{,}86\ \text{kN} \times 1{,}43\ \text{m} - 2\ \text{kN/m}' \times 1{,}43\ \text{m} \times \frac{1{,}43\ \text{m}}{2}$$

$\text{m} = 2{,}05\ \text{kN} \cdot \text{m}$

$$M_C = 2{,}86\ \text{kN} \times 3{,}5\ \text{m} - 2\ \text{kN/m}' \times 3{,}5\ \text{m} \times \frac{3{,}5}{2}$$

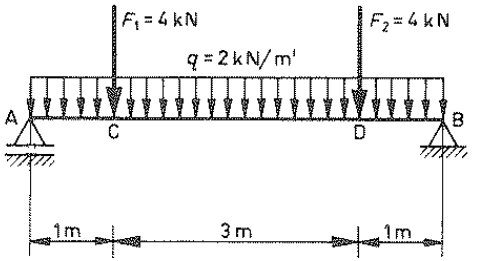
$\text{m} = -2{,}24\ \text{kN} \cdot \text{m}$

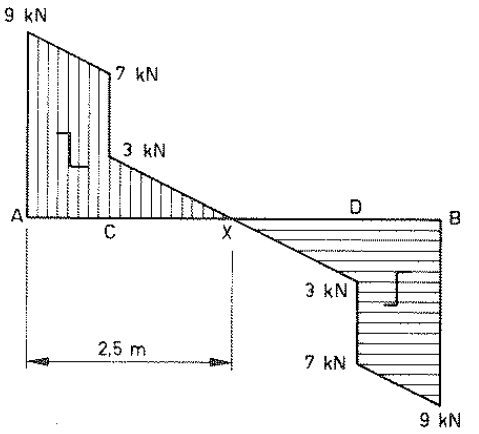
Opdracht 03

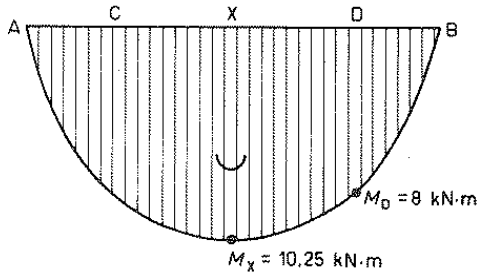


Bepaal voor deze constructie de dwarskrachten en momentenlijn

Uitwerking opdracht 3

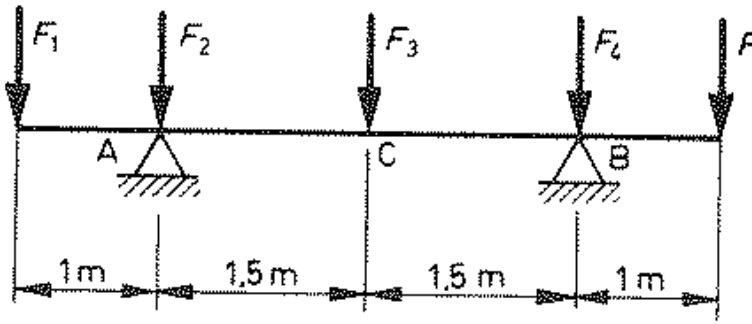






$F_{A,\,v} = F_{B,\,v} = 4\ \text{kN} + 2\ \text{kN/m}' \times 2{,}5\ \text{m} = 9\ \text{kN}$
(symmetrische belasting)
$F_d = 0$ in het midden X.
$M_X = 9\,\text{kN} \times 2{,}5\,\text{m} - 4\,\text{kN} \times 1{,}5\,\text{m} - 2\,\text{kN/m}' \times 2{,}5\,\text{m} \times$
$\times\ 1{,}25\,\text{m} = 10{,}25\,\text{kN} \cdot \text{m}$
$M_C = M_D = 9\,\text{kN} \times 1\,\text{m} - 2\,\text{kN/m}' \times 1\,\text{m} \times 0{,}5\,\text{m} =$
$= 8\,\text{kN} \cdot \text{m}$

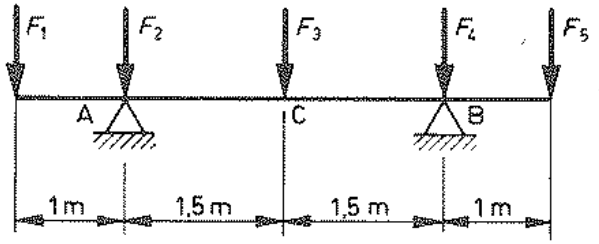
Opdracht 04



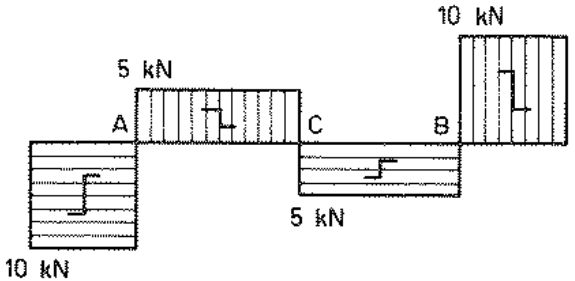
$F_1 = F_2 = F_3 = F_4 = F_5 = 10\,kN$

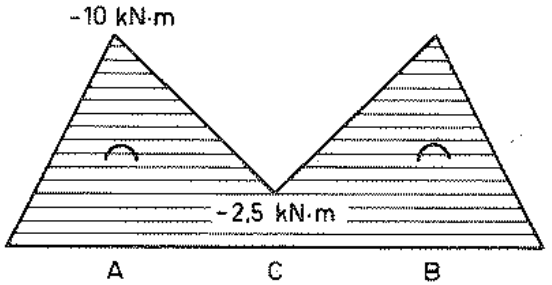
Bepaal voor deze constructie de dwarskrachten en momentenlijn

Uitwerking opdracht 4



$F_1 = F_2 = F_3 = F_4 = F_5 = 10\,\text{kN}$





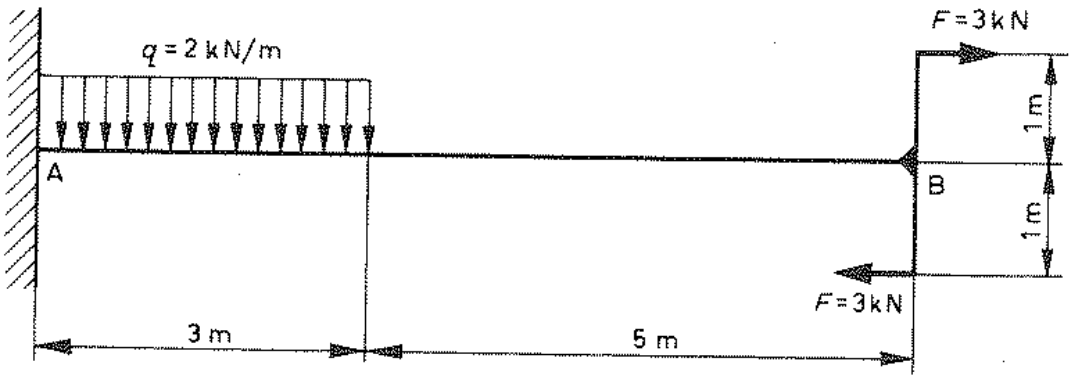
Er is weer sprake van een symmetrische belasting, zodat:

$$F_{A,v} = F_{B,v} = \frac{5 \times 10\,\text{kN}}{2} = 25\,\text{kN}$$

$$M_A = M_B = -10\,\text{kN} \times 1\,\text{m} = -10\,\text{kN} \cdot \text{m}$$

$$M_C = -10\,\text{kN} \times 2{,}5\,\text{m} + (25 - 10)\,\text{kN} \times 1{,}5\,\text{m} = -2{,}5\,\text{kN} \cdot \text{m}$$

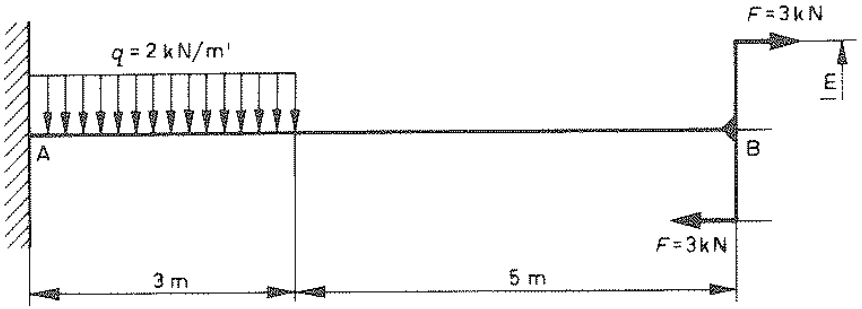
Opdracht 05

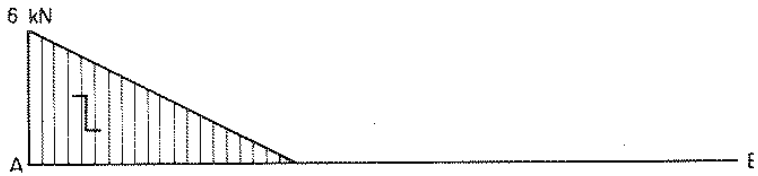


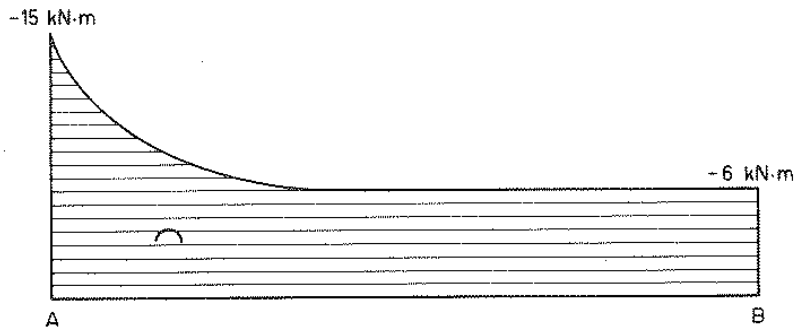
Hoe groot is het maximum moment.

Teken de D- en M-lijn

Uitwerking opdracht 5





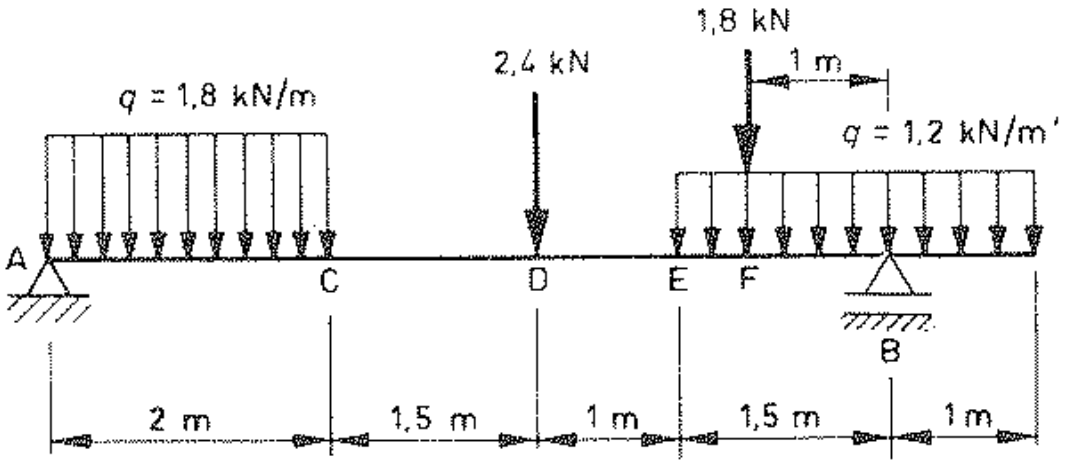


Het enige steunpunt bevindt zich in A. Dus:
$F_{A,v} = 2\ \text{kN/m}' \times 3\ \text{m} = 6\ \text{kN}.$

Het maximummoment is het inklemmingsmoment bij A.
Het koppel dat werkt aan het uiteinde B van de balk veroorzaakt een moment over de hele balk groot: 3 kN × × 2 m = 6 kN · m.
Het moment t.o.v. A tengevolge van de gelijkmatige belasting is: 2 kN/m′ × 3 m × 1,5 m = 9 kN · m.
Hieruit volgt voor het inklemmingsmoment:

$$\curvearrowleft M_A = -(6\ \text{kN} \cdot \text{m} + 9\ \text{kN} \cdot \text{m}) = -15\ \text{kN} \cdot \text{m}$$

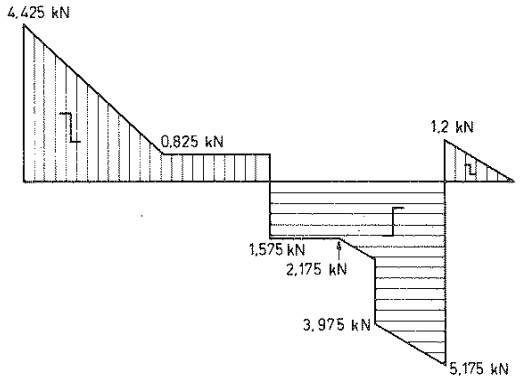
Opdracht 06

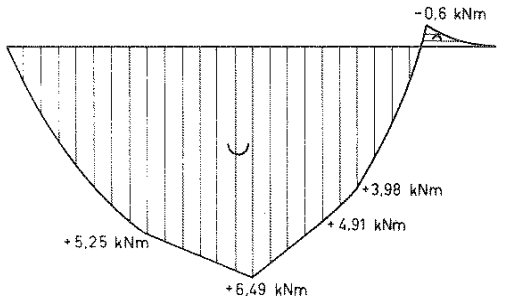


Hoe groot is het maximum moment.

Teken de D- en M-lijn

Uitwerking opdracht 6





Som V:

(1,8 x 2) + 2,4 + 1,8 + (1,2 x 2,5) = 10,8 kN

Som M tov A

-(1,8 x 2 x 1) –(2,4 x 3,5) – (1,8 x 5) – (1,2 x 2,5 x 5,75) + 5 FB = 0

FB = 38,25 / 6 = 6,375 kN

FA = 10,8 – 6,375 = 4,425 kN

Dwarskrachten

D1 = 4,425 kN

D2 = 4,425 – (1,8 x 2) = 0,825 kN

D3 = 0,825 – 2,4 = - 1,575 kN

D4 = -1,575 – (1,2 * 0,5) = -2,175 Kn
D5 = -2,175 – 1,8 = - 3,975 kN

D6 = - 3,975 – (1 x 1,2) = - 5,175 kN

D7 = - 5,175 + 6,375 = 1,2 kN

D8 = 1,2 – (1,2 x 1) = 0 kN

Momenten

M1 = (3,6 x 2) / 2 + (0,825 x 2) = 5,25 kNm

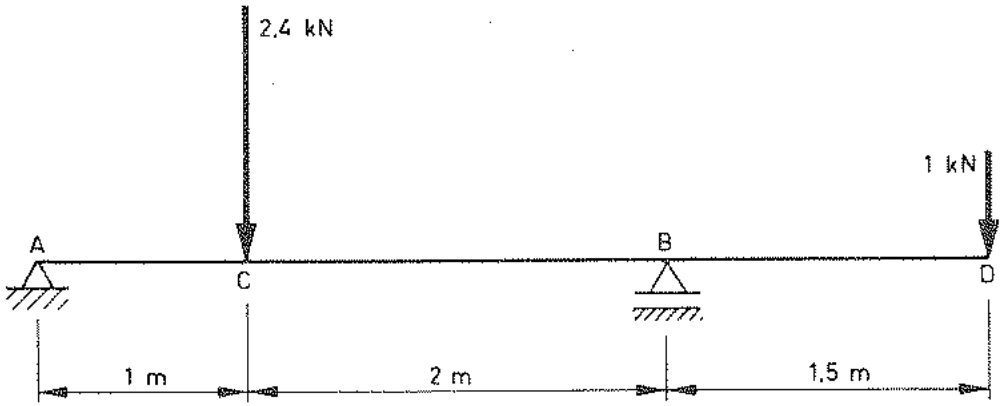
M2 = 5,25 + (0,825 x 1,5) = 6,4875 kNm

M3 = 6,4875 – (1,575 x 1) = 4,9125 kNm

M4 = 4,9125 – (0,5 x 1,575) – (0,6 * 0,5)/2 = 3,975 kNm
M5 = 3,975 – (3,975 x 1) – (1,2 x1) /2 = 0,6 kNm

M6 = 0,6 – (1,2 x 1) / 2 = 0 kNm

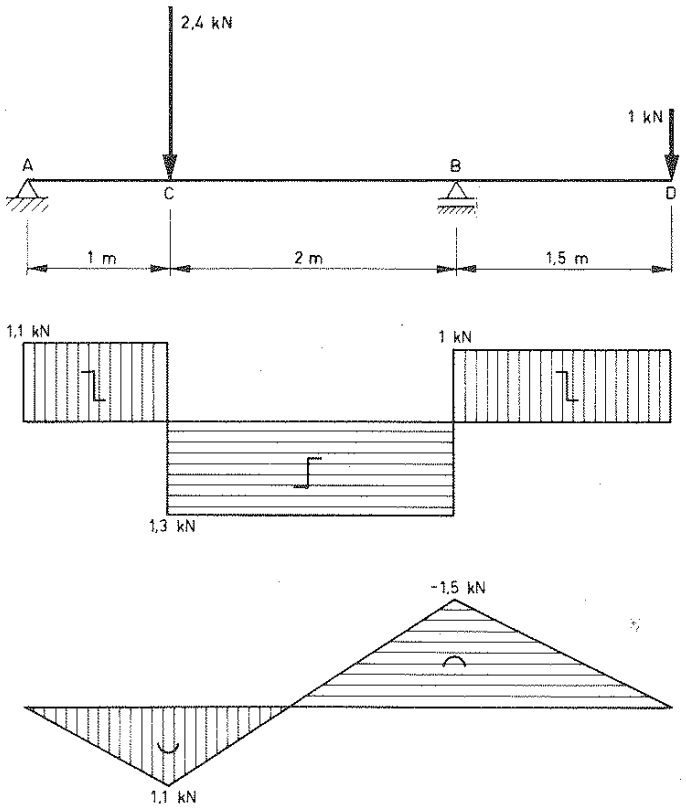
Opdracht 07



Hoe groot is het maximum moment.

Teken de D- en M-lijn

Uitwerking opdracht 7



ΣM t.o.v. A:

$$2{,}4\,\text{kN} \times 1\,\text{m} - F_{B,v} \times 3\,\text{m} + 1\,\text{kN} \times 4{,}5\,\text{m} = 0$$

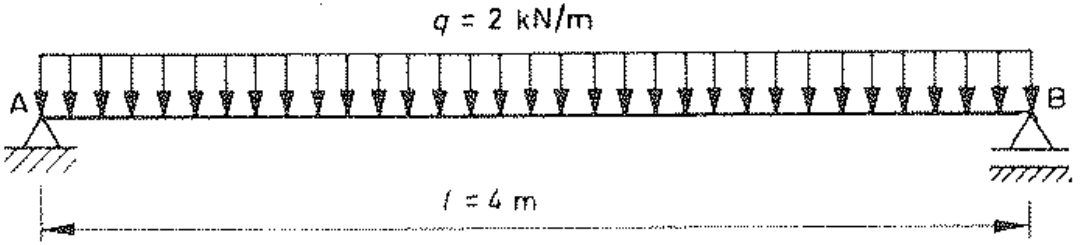
$$F_{B,v} = \frac{6{,}9\,\text{kN} \cdot \text{m}}{3\,\text{m}} = 2{,}3\,\text{kN}$$

$$F_{A,v} = 2{,}4\,\text{kN} - 2{,}3\,\text{kN} + 1\,\text{kN} = 1{,}1\,\text{kN}$$

$$M_C = 1{,}1\,\text{kN} \times 1\,\text{m} = 1{,}1\,\text{kN} \cdot \text{m}$$

$$M_B = 1{,}1\,\text{kN} \times 3\,\text{m} - 2{,}4\,\text{kN} \times 2\,\text{m} = -1{,}5\,\text{kN} \cdot \text{m}$$

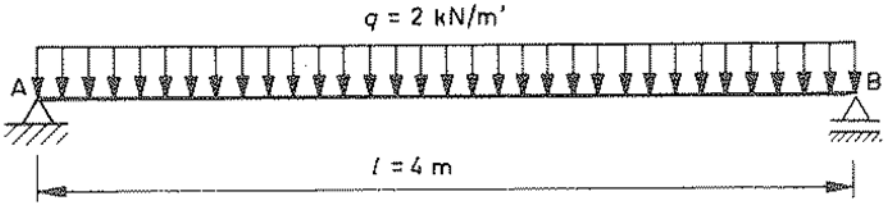
Opdracht 08

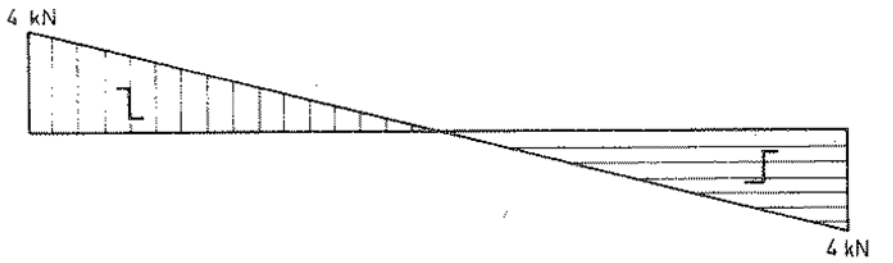


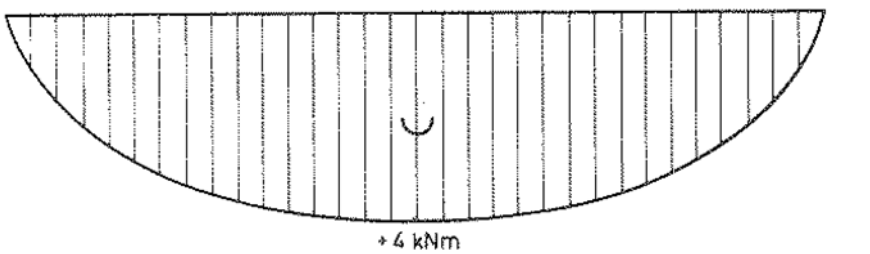
Hoe groot is het maximum moment.

Teken de D- en M-lijn

Uitwerking opdracht 8







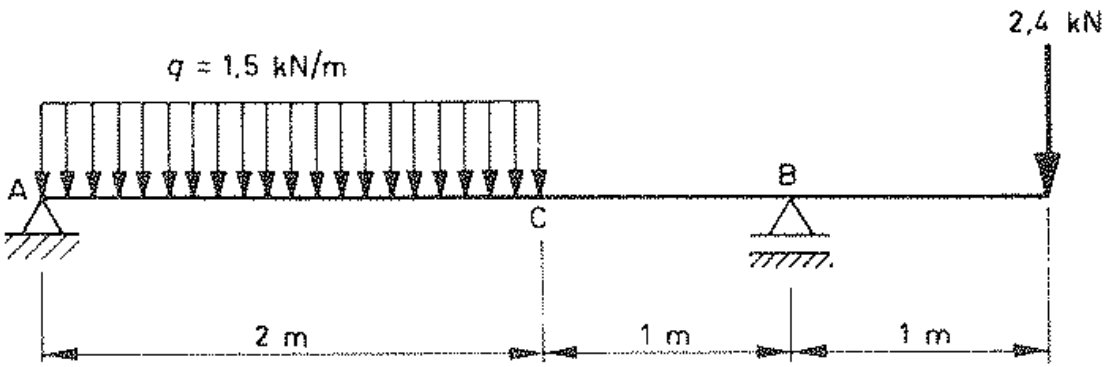
$$F_{A,v} = F_{B,v} = \frac{1}{2}\, q \cdot l = \frac{1}{2} \times 2\,\text{kN/m}' \times 4\,\text{m} = 4\,\text{kN}$$

Het buigend moment is maximaal in het midden:

$$M_{max} = \frac{1}{2}\, q \cdot l \cdot \frac{1}{2}\, l - \frac{1}{2}\, q \cdot l \cdot \frac{1}{4}\, l = \frac{1}{8}\, q l^2 = 4\,\text{kN} \cdot \text{m}$$

Opdracht 9

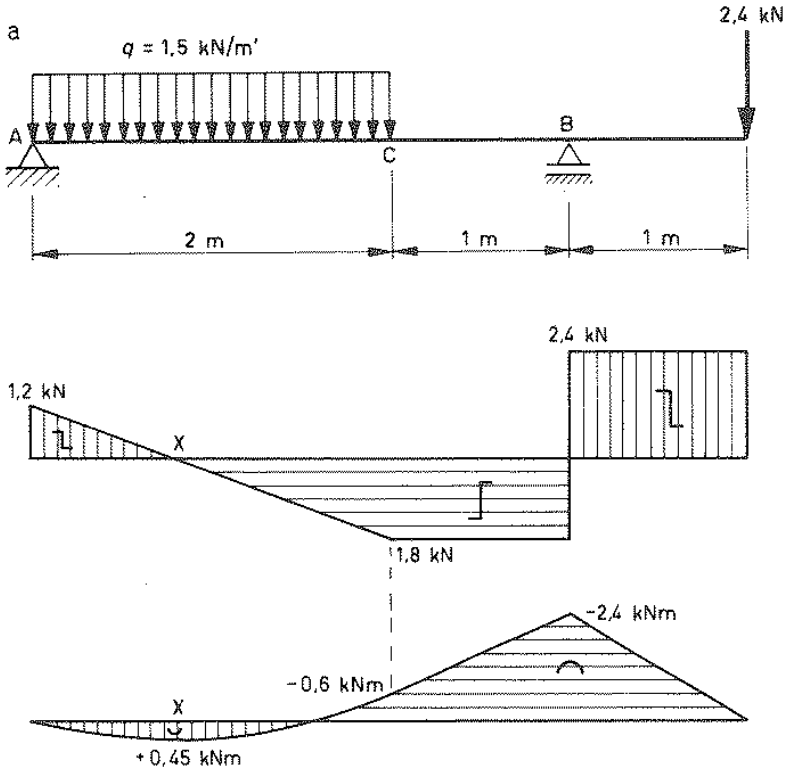
a



Hoe groot is het maximum moment.

Teken de D- en M-lijn

Uitwerking opdracht 9



ΣM t.o.v. A:

$1{,}5\ \text{kN/m}' \times 2\ \text{m} \times 1\ \text{m} - F_{B,v} \times 3\ \text{m} + 2{,}4\ \text{kN} \times 4\ \text{m} = 0$

$$F_{B,v} = \frac{12{,}6\ \text{kN} \cdot \text{m}}{3\ \text{m}} = 4{,}2\ \text{kN}$$

$F_{A,v} = 3\ \text{kN} - 4{,}2\ \text{kN} + 2{,}4\ \text{kN} = 1{,}2\ \text{kN}$

Stel $F_d = 0$ op x m afstand rechts van A. Dan geldt:

$F_{A,v} - 1{,}5\ \text{kN/m}' \times x\ \text{m} = 0$

$1{,}2\ \text{kN} - 1{,}5\ x\ \text{kN} = 0$

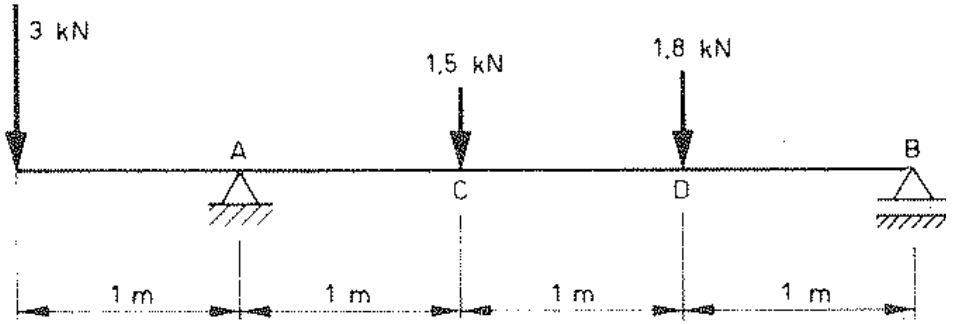
$$x = \frac{1{,}2\ \text{kN}}{1{,}5\ \text{kN}} = 0{,}8$$

$M_X = 1{,}2\ \text{kN} \times 0{,}8\ \text{m} - 1{,}5\ \text{kN/m}' \times 0{,}8\ \text{m} \times 0{,}4\ \text{m} =$
$= 0{,}48\ \text{kN} \cdot \text{m}$

$M_C = 1{,}2\ \text{kN} \times 2\ \text{m} - 1{,}5\ \text{kN/m}' \times 2\ \text{m} \times 1\ \text{m} = -$
$- 0{,}6\ \text{kN} \cdot \text{m}$

$M_B = 1{,}2\ \text{kN} \times 3\ \text{m} - 3\ \text{kN} \times 2\ \text{m} = -2{,}4\ \text{kN} \cdot \text{m}$

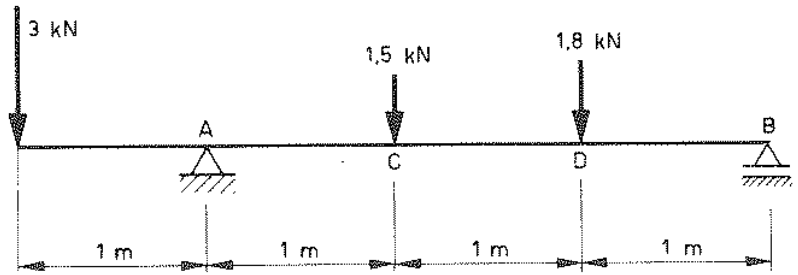
Opdracht 10

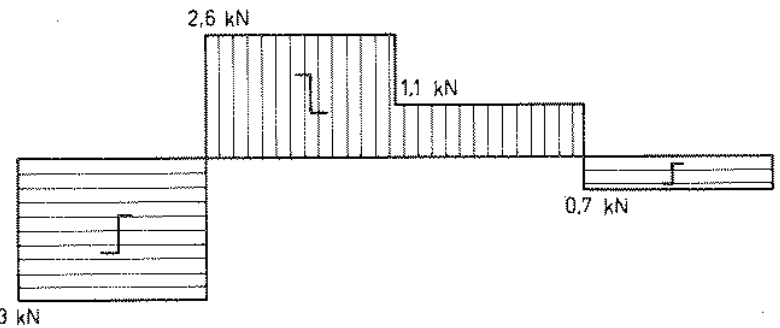


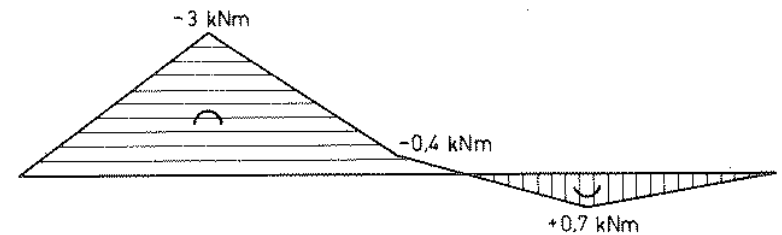
Hoe groot is het maximum moment.

Teken de D- en M-lijn

Uitwerking opdracht 10







ΣM t.o.v. A:

$-3\,\text{kN} \times 1\,\text{m} + 1{,}5\,\text{kN} \times 1\,\text{m} + 1{,}8\,\text{kN} \times 2\,\text{m} - F_{B,v} \times 3\,\text{m} = 0$

$$F_{B,v} = \frac{2{,}1\,\text{kN} \cdot \text{m}}{3\,\text{m}} = 0{,}7\,\text{kN}$$

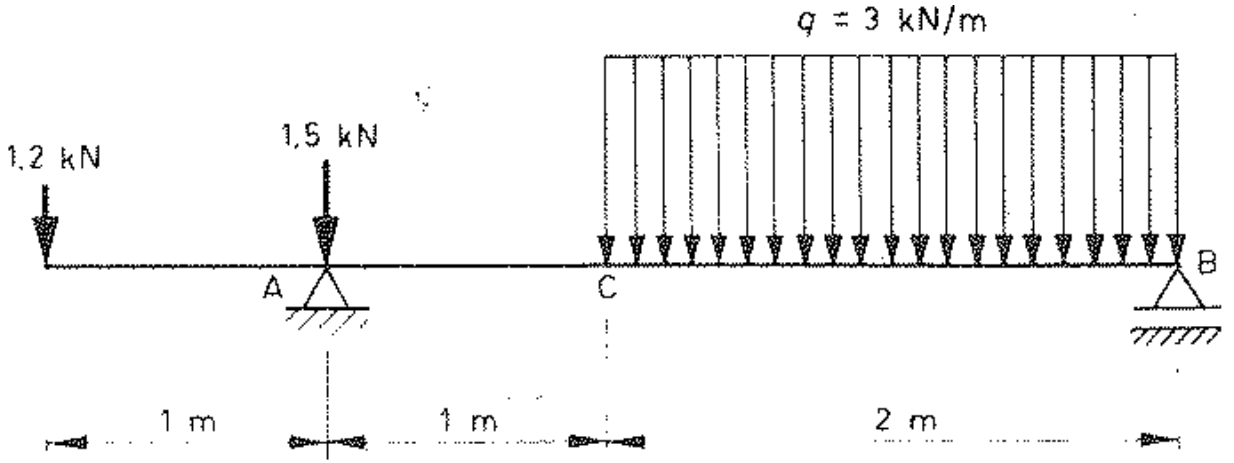
$F_{A,v} = 3\,\text{kN} + 1{,}5\,\text{kN} + 1{,}8\,\text{kN} - 0{,}7\,\text{kN} = 5{,}6\,\text{kN}$

$M_A = -3\,\text{kN} \times 1\,\text{m} = -3\,\text{kN} \cdot \text{m}$

$M_C = -3\,\text{kN} \times 2\,\text{m} + 5{,}6\,\text{kN} \times 1\,\text{m} = -0{,}4\,\text{kN} \cdot \text{m}$

$M_D = -3\,\text{kN} \times 3\,\text{m} + 5{,}6\,\text{kN} \times 2\,\text{m} - 1{,}5\,\text{kN} \times 1\,\text{m} = 0{,}7\,\text{kN} \cdot \text{m}$

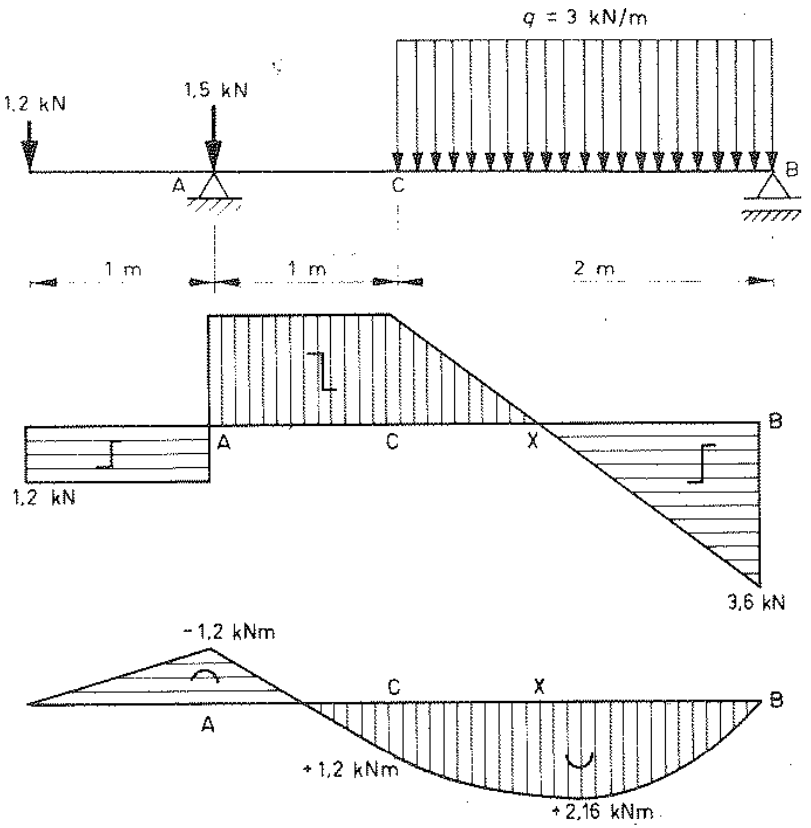
Opdracht 11



Hoe groot is het maximum moment.

Teken de D- en M-lijn

Uitwerking opdracht 11



ΣM t.o.v. A:

$-1{,}2\ \text{kN} \times 1\ \text{m} + 3\ \text{kN/m}' \times 2\ \text{m} \times 2\ \text{m} - F_{B,v} \times 3\ \text{m} = 0$

$$F_{B,v} = \frac{10{,}8\ \text{kN} \cdot \text{m}}{3\ \text{m}} = 3{,}6\ \text{kN}$$

$$F_{A,v} = 1{,}2\ \text{kN} + 1{,}5\ \text{kN} + 6\ \text{kN} - 3{,}6\ \text{kN} = 5{,}1\ \text{kN}$$

Stel $F_d = 0$ op x m afstand rechts van C. Dan geldt:

$1{,}2\ \text{kN} + 1{,}5\ \text{kN} - F_{A,v} + 3\ \text{kN/m}' \times x\ \text{m} = 0$

$2{,}7\ \text{kN} - 5{,}1\ \text{kN} + 3x\ \text{kN} = 0$

$$x = \frac{2{,}4\ \text{kN}}{3\ \text{kN}} = 0{,}8$$

$M_A = -1{,}2\ \text{kN} \times 1\ \text{m} = -1{,}2\ \text{kN} \cdot \text{m}$

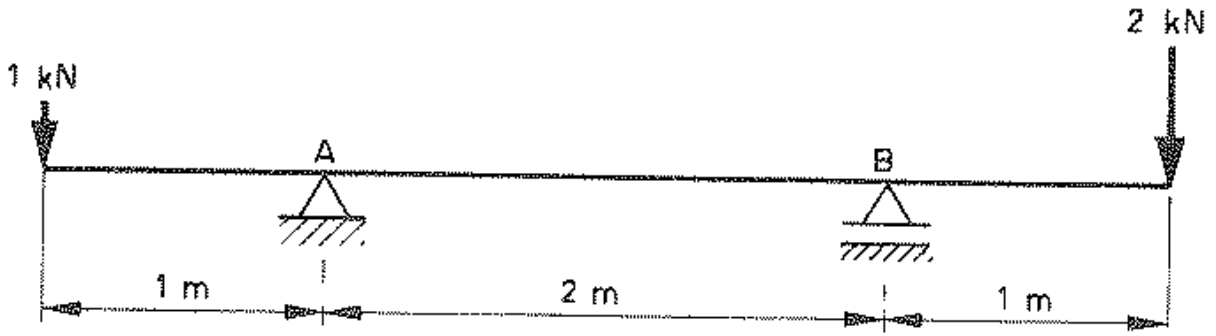
$M_C = -1{,}2\ \text{kN} \times 2\ \text{m} - 1{,}5\ \text{kN} \times 1\ \text{m} + 5{,}1\ \text{kN} \times 1,\ \text{m} =$

$= 1{,}2\ \text{kN} \cdot \text{m}$

$M_X = -1{,}2\ \text{kN} \times 2{,}8\ \text{m} - 1{,}5\ \text{kN} \times 1{,}8\ \text{m} + 5{,}1\ \text{kN} \times 1{,}8\ \text{m}$

$-3\ \text{kN/m}' \times 0{,}8\ \text{m} \times 0{,}4\ \text{m} = 2{,}16\ \text{kN} \cdot \text{m}$

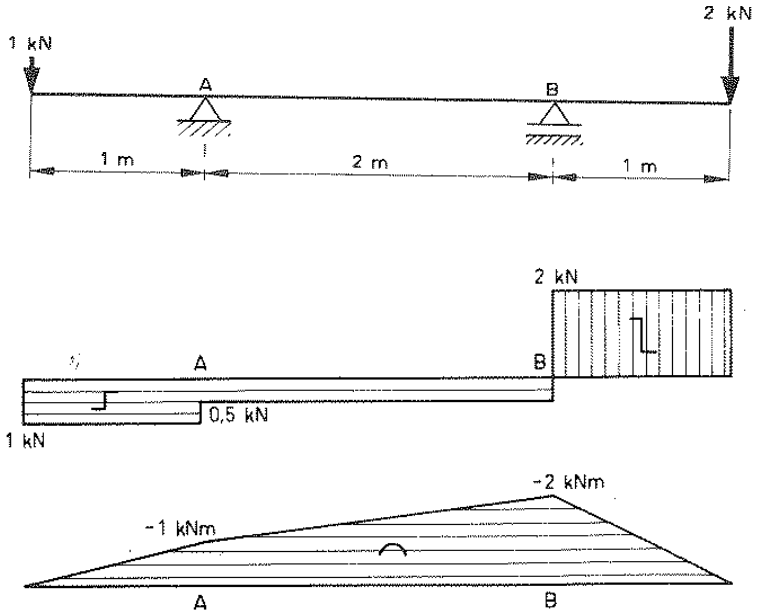
Opdracht 12



Hoe groot is het maximum moment.

Teken de D- en M-lijn

Uitwerking opdracht 12



ΣM t.o.v. A:

$$-1\,\text{kN} \times 1\,\text{m} - F_{B,v} \times 2\,\text{m} + 2\,\text{kN} \times 3\,\text{m} = 0$$

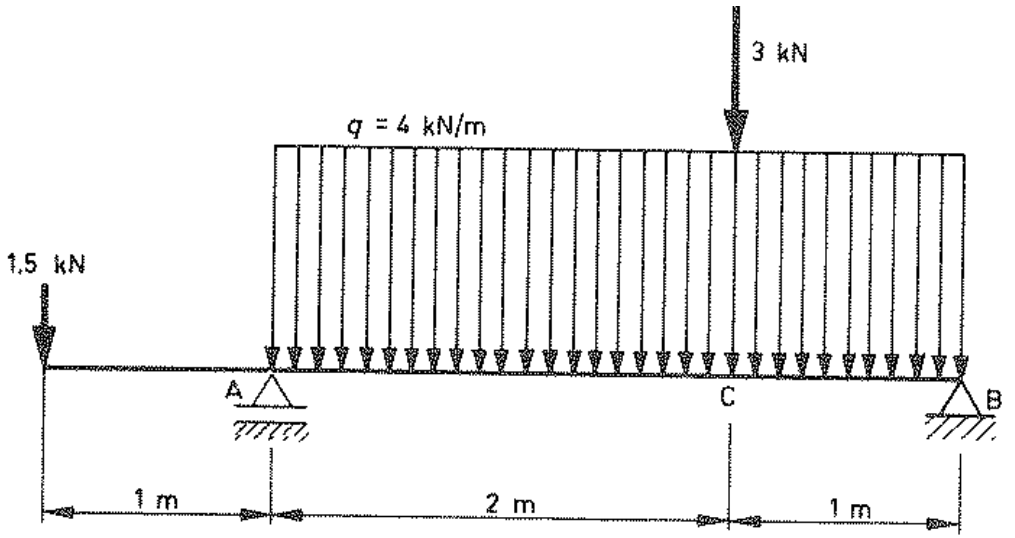
$$F_{B,v} = \frac{5\,\text{kN} \cdot \text{m}}{2\,\text{m}} = 2{,}5\,\text{kN}$$

$$F_{A,v} = 1\,\text{kN} - 2{,}5\,\text{kN} + 2\,\text{kN} = 0{,}5\,\text{kN}$$

$$M_A = -1\,\text{kN} \times 1\,\text{m} = -1\,\text{kN} \cdot \text{m}$$

$$M_B = -1\,\text{kN} \times 3\,\text{m} + 0{,}5\,\text{kN} \times 2\,\text{m} = -2\,\text{kN} \cdot \text{m}$$

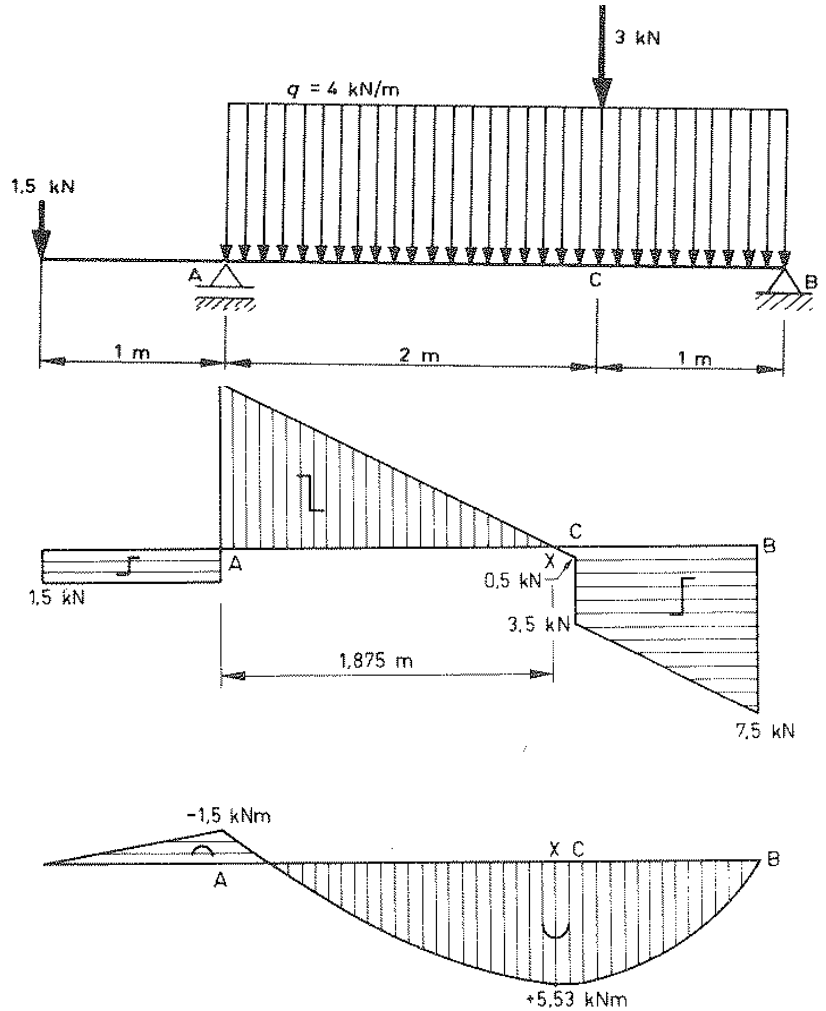
Opdracht 13



Hoe groot is het maximum moment.

Teken de D- en M-lijn

Uitwerking opdracht 13



ΣM t.o.v. A:
$-1{,}5\ \text{kN} \times 1\ \text{m} + 4\ \text{kN/m}' \times 3\ \text{m} \times 1{,}5\ \text{m} + 3\ \text{kN} \times 2\ \text{m} - - F_{B,v} \times 3\ \text{m} = 0$

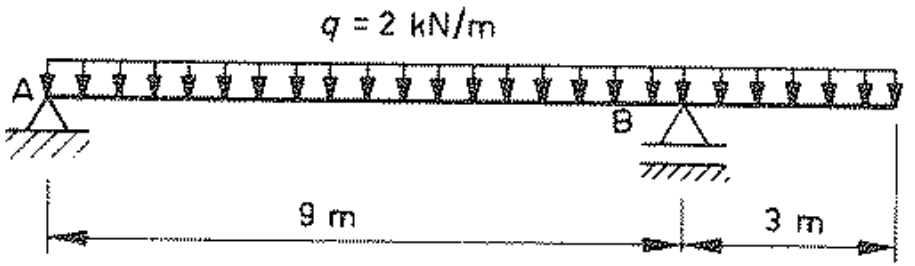
$$F_{B,v} = \frac{22{,}5\ \text{kN} \cdot \text{m}}{3\ \text{m}} = 7{,}5\ \text{kN}$$

$F_{A,v} = 1{,}5\ \text{kN} + 12\ \text{kN} + 3\ \text{kN} - 7{,}5\ \text{kN} = 9\ \text{kN}$
Stel $F_d = 0$ op x m afstand rechts van A. Dan geldt:
$1{,}5\ \text{kN} - 9\ \text{kN} + 4\ \text{kN/m}' \times x\ \text{m} = 0$

$$x = \frac{7{,}5\ \text{kN}}{4\ \text{kN}} = 1{,}875$$

$M_A = -1{,}5\ \text{kN} \times 1\ \text{m} = -1{,}5\ \text{kN} \cdot \text{m}$
$M_X = -1{,}5\ \text{kN} \times 2{,}875\ \text{m} + 9\ \text{kN} \times 1{,}875\ \text{m} - 4\ \text{kN/m}' \times$
$\times 1{,}875\ \text{m} \times 0{,}9375\ \text{m} = 5{,}53\ \text{kN} \cdot \text{m}$ (afgerond)
$M_C = -1{,}5\ \text{kN} \times 3\ \text{m} + 9\ \text{kN} \times 2\ \text{m} - 4\ \text{kN/m}' \times 2\ \text{m} \times 1\ \text{m}$
$= 5{,}5\ \text{kN} \cdot \text{m}$

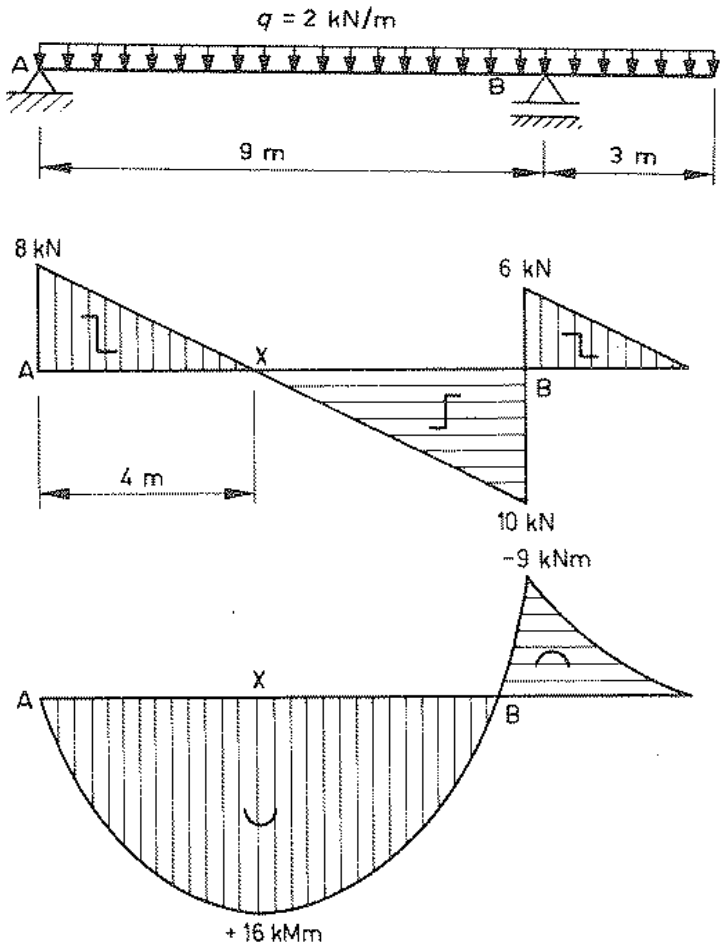
Opdracht 14



Hoe groot is het maximum moment.

Teken de D- en M-lijn

Uitwerking opdracht 14



ΣM t.o.v. A:

$2\,\text{kN/m}' \times 12\,\text{m} \times 6\,\text{m} - F_{B,v} \times 9\,\text{m} = 0$

$$F_{B,v} = \frac{144\,\text{kN}\cdot\text{m}}{9\,\text{m}} = 16\,\text{kN}$$

$F_{A,v} = 24\,\text{kN} - 16\,\text{kN} = 8\,\text{kN}$

Stel $F_d = 0$ op x m afstand rechts van A. Dan geldt:

$$-8\,\text{kN} + 2\,\text{kN/m}' \times x\,\text{m} = 0 \qquad x = \frac{8\,\text{kN}}{2\,\text{kN}} = 4$$

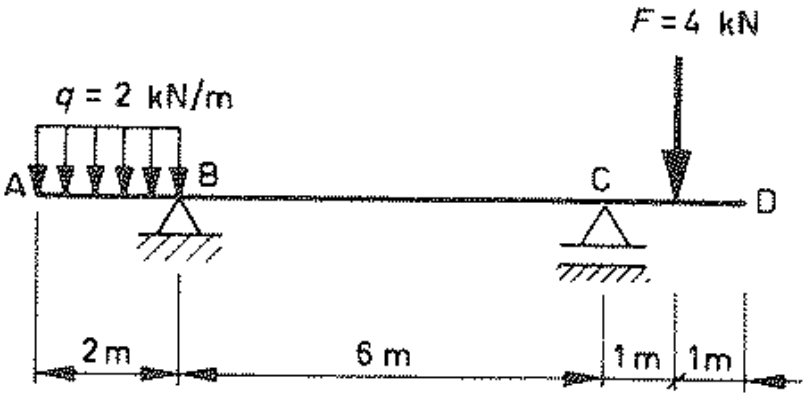
$M_X = 8\,\text{kN} \times 4\,\text{m} - 2\,\text{kN/m}' \times 4\,\text{m} \times 2\,\text{m} = 16\,\text{kN}\cdot\text{m}$

$M_B = 8\,\text{kN} \times 9\,\text{m} - 2\,\text{kN/m}' \times 9\,\text{m} \times 4{,}5\,\text{m} = -9\,\text{kN}\cdot\text{m}$

of:

$M_B = M_{B,\text{rechts}} = -2\,\text{kN/m}' \times 3\,\text{m} \times 1{,}5\,\text{m} = -9\,\text{kN}\cdot\text{m}$

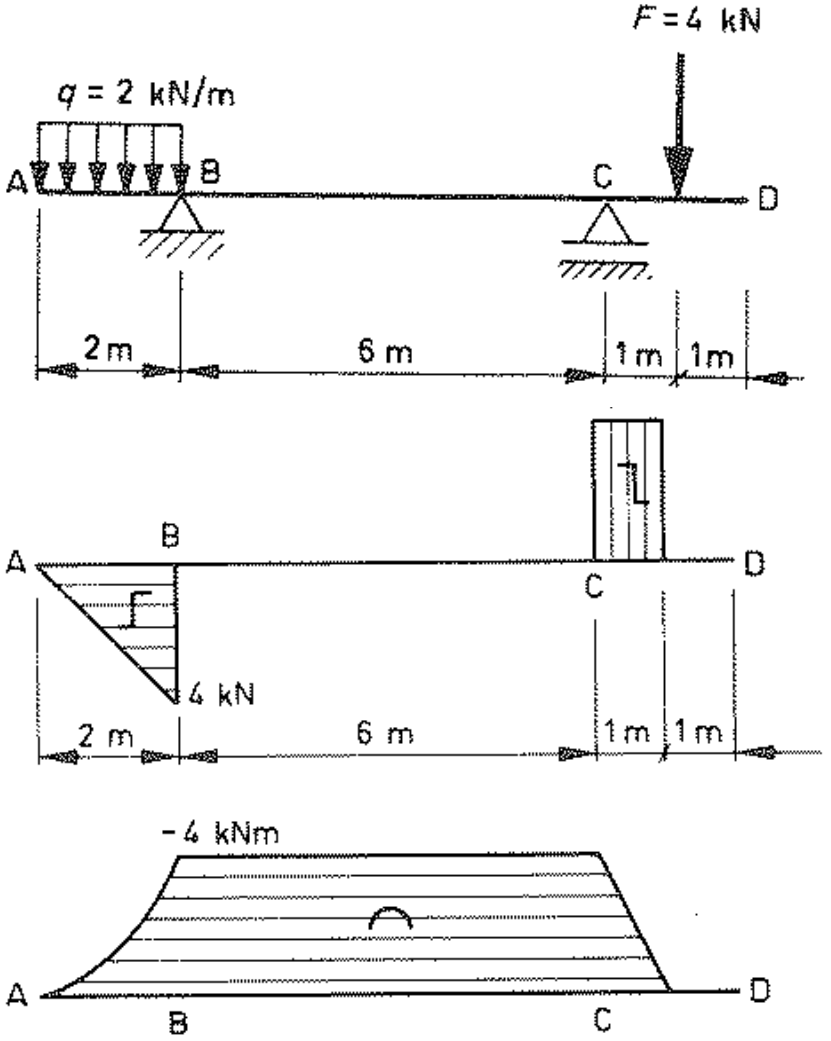
Opdracht 15



Hoe groot is het maximum moment.

Teken de D- en M-lijn

Uitwerking opdracht 15



ΣM t.o.v. B:

$-2\ \text{kN/m}' \times 2\ \text{m} \times 1\ \text{m} - F_{C,v} \times 6\ \text{m} + 4\ \text{kN} \times 7\ \text{m} = 0$

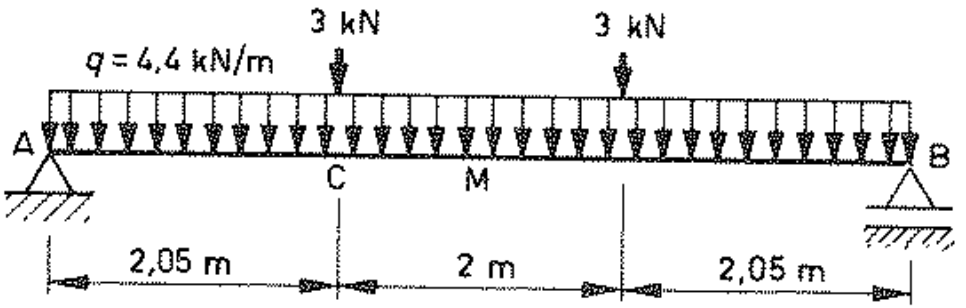
$$F_{C,v} = \frac{24\ \text{kN} \cdot \text{m}}{6\ \text{m}} = 4\ \text{kN}$$

$F_{B,v} = 4\ \text{kN} - 4\ \text{kN} + 4\ \text{kN} = 4\ \text{kN}$

$M_B = -2\ \text{kN/m}' \times 2\ \text{m} \times 1\ \text{m} = -4\ \text{kN} \cdot \text{m}$

$M_C = -2\ \text{kN/m}' \times 2\ \text{m} \times 7\ \text{m} + 4\ \text{kN} \times 6\ \text{m} = -4\ \text{kN} \cdot \text{m}$

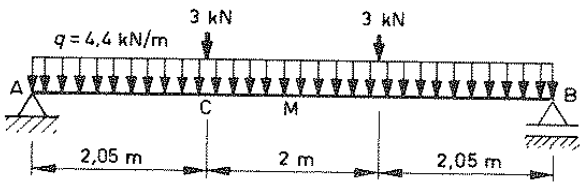
Opdracht 16

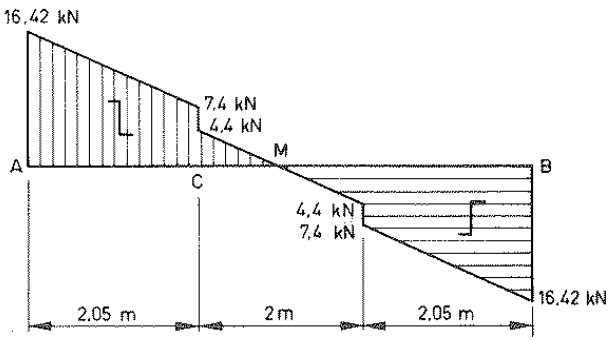


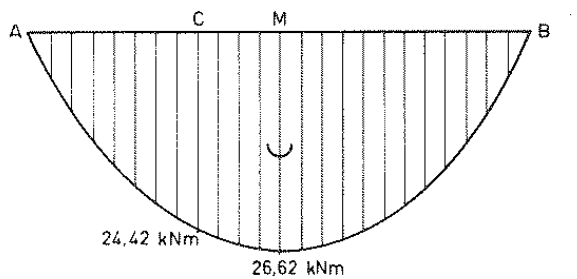
Hoe groot is het maximum moment.

Teken de D- en M-lijn

Uitwerking opdracht 16







Totale belasting: 3 kN + 4,4 kN/m′ × 6,1 m + 3 kN = 32,84 kN

Vanwege de symmetrische belasting is:

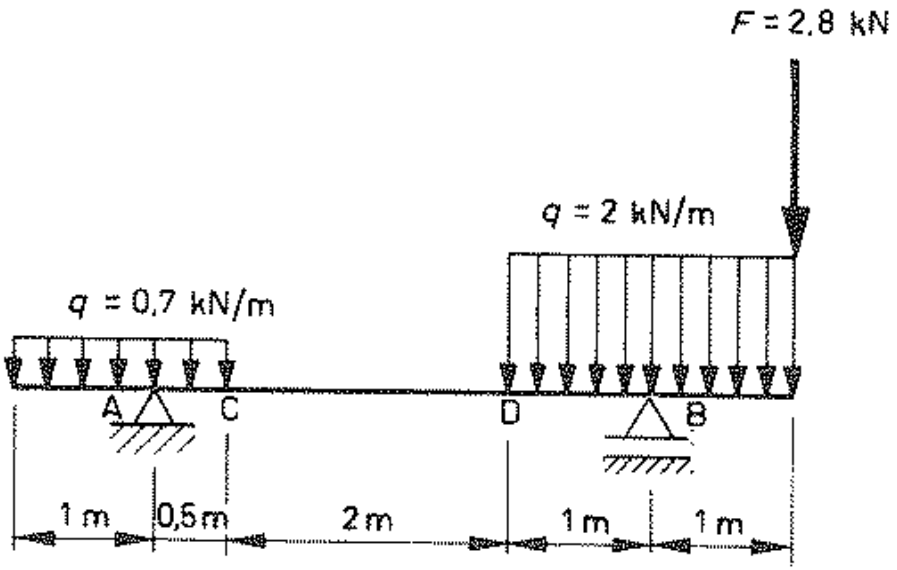
$$F_{A,v} = F_{B,v} = \frac{32{,}84\ \text{kN}}{2} = 16{,}42\ \text{kN}$$

Eveneens vanwege de symmetrie is $F_d = 0$ in het midden M.

$M_M = 16{,}42\ \text{kN} \times 3{,}05\ \text{m} - 3\ \text{kN} \times 1\ \text{m} - 4{,}4\ \text{kN/m}' \times \times 3{,}05\ \text{m} \times 1{,}525\ \text{m} = 26{,}62\ \text{kN} \cdot \text{m}$ (afgerond)

$M_C = 16{,}42\ \text{kN} \times 2{,}05\ \text{m} - 4{,}4\ \text{kN/m}' \times 2{,}05\ \text{m} \times 1{,}025\ \text{m} = 24{,}42\ \text{kN} \cdot \text{m}$ (afgerond)

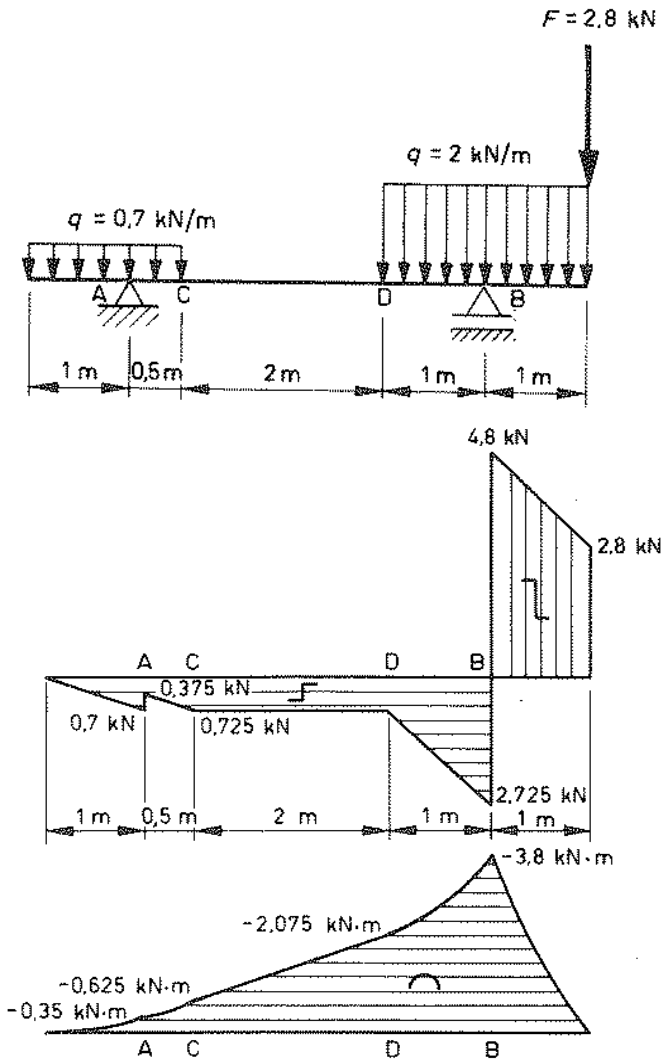
Opdracht 17



Hoe groot is het maximum moment.

Teken de D- en M-lijn

Uitwerking opdracht 17



ΣM t.o.v. A:

$-1{,}05\ \text{kN} \times 0{,}25\ \text{m} + 4\ \text{kN} \times 3{,}5\ \text{m} - F_{B,v} \times 3{,}5\ \text{m} + 2{,}8\ \text{kN} \times 4{,}5\ \text{m} = 0$

$$F_{B,v} = \frac{26{,}3375\ \text{kN} \cdot \text{m}}{3{,}5\ \text{m}} = 7{,}525\ \text{kN}$$

$F_{A,v} = 1{,}05\ \text{kN} + 4\ \text{kN} - 7{,}525\ \text{kN} + 2{,}8\ \text{kN} = 0{,}325\ \text{kN}$

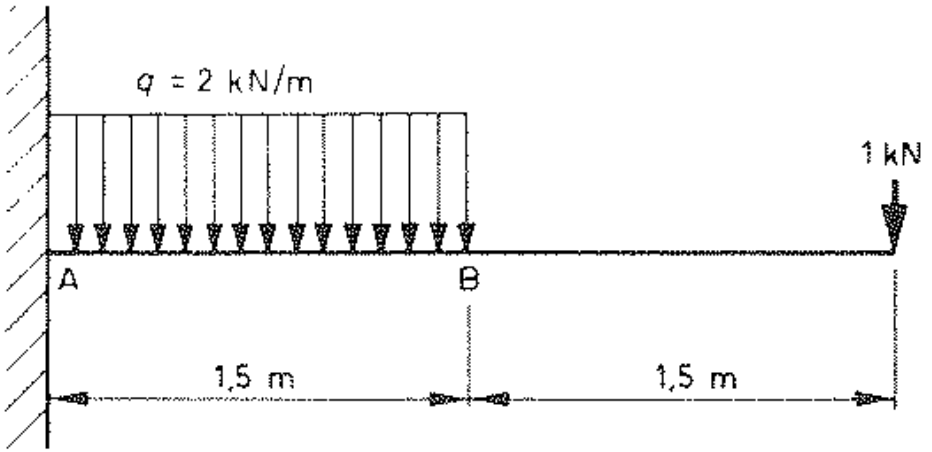
$M_A = -0{,}7\ \text{kN} \times 0{,}5\ \text{m} = -0{,}35\ \text{kN} \cdot \text{m}$

$M_C = -1{,}05\ \text{kN} \times 0{,}75\ \text{m} + 0{,}325\ \text{kN} \times 0{,}5\ \text{m} = -0{,}625\ \text{kN} \cdot \text{m}$

$M_D = -1{,}05\ \text{kN} \times 2{,}75\ \text{m} + 0{,}325\ \text{kN} \times 2{,}5\ \text{m} = -2{,}075\ \text{kN} \cdot \text{m}$

$M_B = -M_{B,\text{rechts}} = -2\ \text{kN} \times 0{,}5\ \text{m} - 2{,}8\ \text{kN} \times 1\ \text{m} = -3{,}8\ \text{kN} \cdot \text{m}$

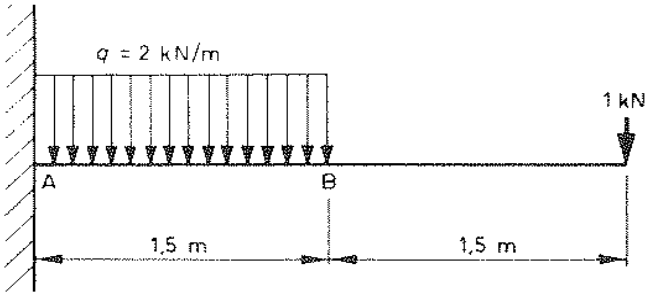
Opdracht 18

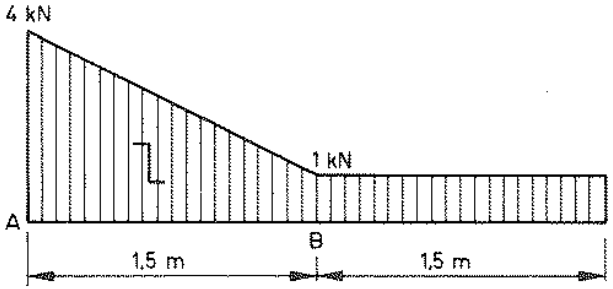


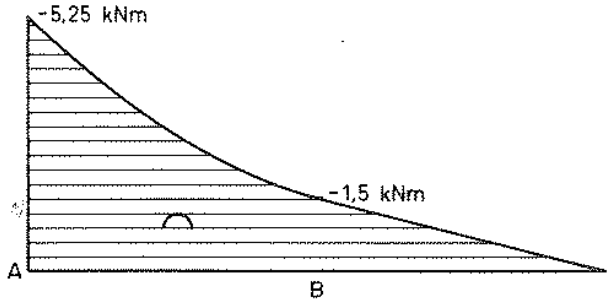
Hoe groot is het maximum moment.

Teken de D- en M-lijn

Uitwerking opdracht 18







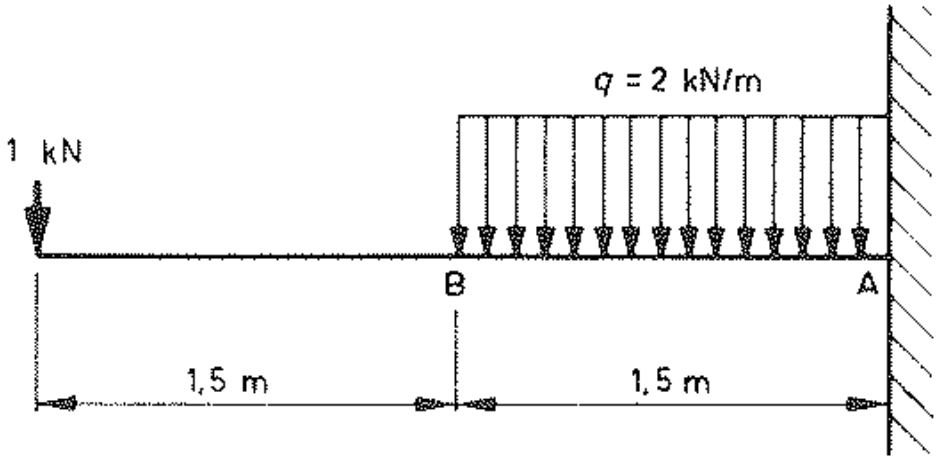
$F_{A,v} = 3\ \text{kN} + 1\ \text{kN} = 4\ \text{kN}$

Inklemmingsmoment bij A:

$-3\ \text{kN} \times 0{,}75\ \text{m} - 1\ \text{kN} \times 3\ \text{m} = -5{,}25\ \text{kN} \cdot \text{m}$

$M_B = -M_{B,\text{rechts}} = -1\ \text{kN} \times 1{,}5\ \text{m} = -1{,}5\ \text{kN} \cdot \text{m}$

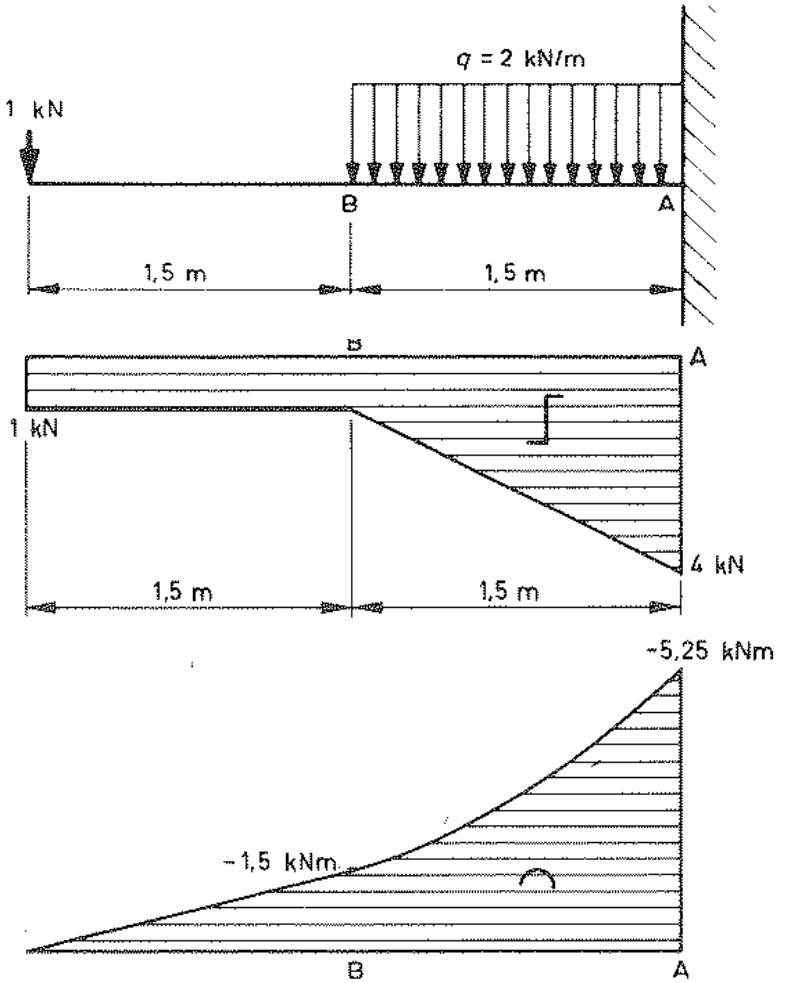
Opdracht 19



Hoe groot is het maximum moment.

Teken de D- en M-lijn

Uitwerking opdracht 19



$F_{A,v} = 3\ \text{kN} + 1\ \text{kN} = 4\ \text{kN}$

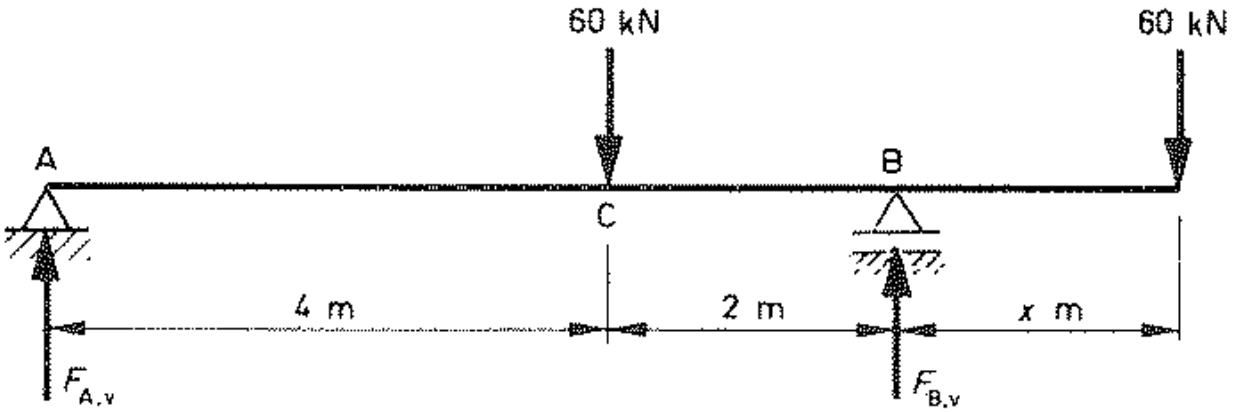
Inklemmingsmoment bij A:

$3\ \text{kN} \times 0{,}75\ \text{m} + 1\ \text{kN} \times 3\ \text{m} = 5{,}25\ \text{kN} \cdot \text{m}$

Dus $M_A = M_{A,\text{links}} = -5{,}25\ \text{kN} \cdot \text{m}$

$M_B = -1\ \text{kN} \times 1{,}5\ \text{m} = -1{,}5\ \text{kN} \cdot \text{m}$

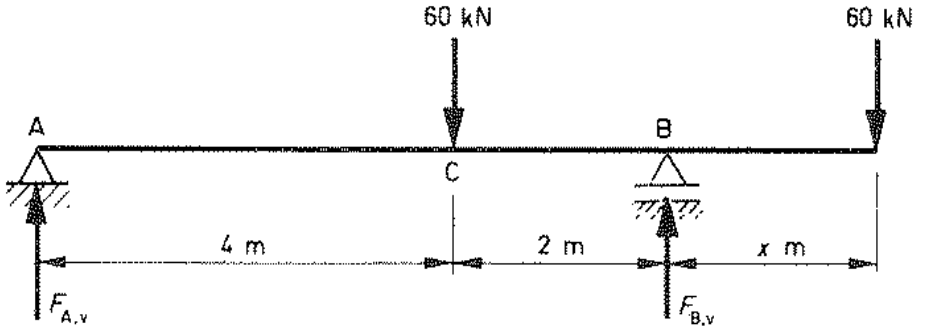
Opdracht 20

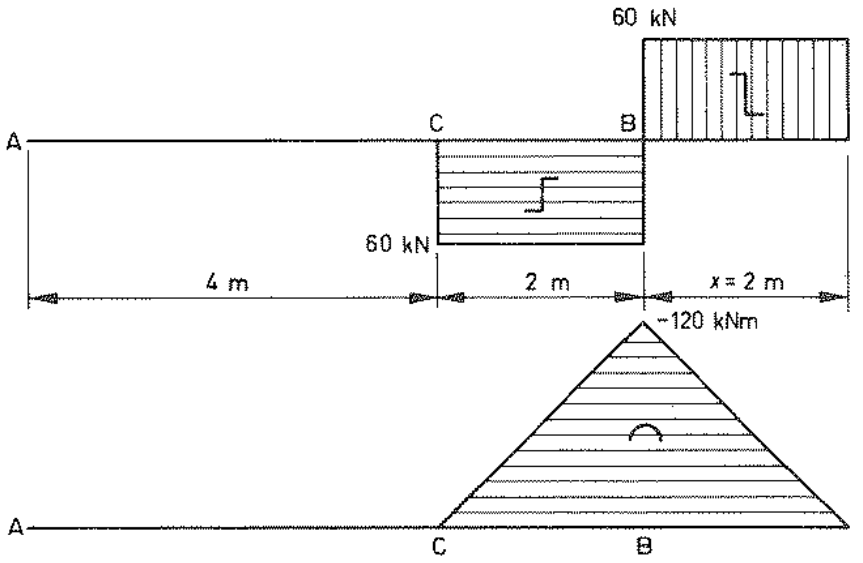


Hoe groot is het maximum moment.

Teken de D- en M-lijn

Uitwerking opdracht 20





a ΣM t.o.v. B:

$60\ \text{kN} \times 2\ \text{m} - 60\ \text{kN} \times x\ \text{m} = 0 \Rightarrow x =$

$$= \frac{120\ \text{kN} \cdot \text{m}}{60\ \text{kN} \cdot \text{m}} = 2$$

b $F_{B,v} = 60\ \text{kN} + 60\ \text{kN} = 120\ \text{kN}$

c $M_C = 0\ \text{kN} \cdot \text{m}$

$M_B = -60\ \text{kN} \times 2\ \text{m} = -120\ \text{kN} \cdot \text{m}$