

# KEV - TENTAMEN 22 JANUARI 2008

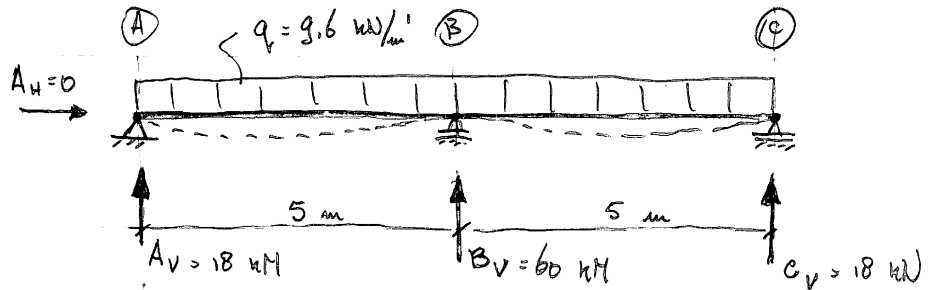
①

①. profiel HE140A  
 $p = 2,4 \text{ kN/m}^2$

$f_{y,d} = 235 \text{ N/mm}^2$   
 $f_{v,d} = 136 \text{ N/mm}^2$

$E = 210\,000 \text{ N/mm}^2$

$q = 2,4 \times 4,0$   
 $q = 9,6 \text{ kN/m}$



A. verplaatsingsmethode

ligger 1. S.O.

kies  $B_V$  als statisch onbepaalde

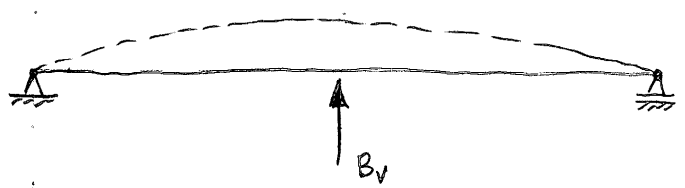
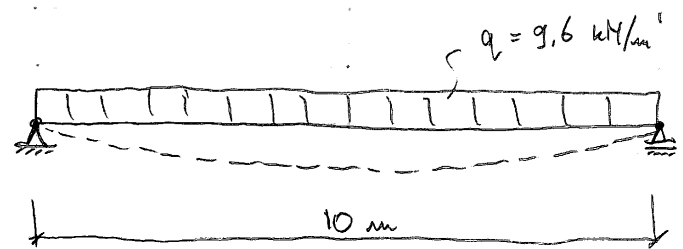
is:  $y_B = 0$

$$y_B = \frac{5}{384} \cdot \frac{9,6 \times 10\,000^4}{210\,000 \times 10\,33 \times 10^4}$$

$$y_B = 576 \text{ mm.} \quad (1)$$

$$y_B = \frac{B_V \times 10\,000^3}{48 \times 210\,000 \times 10\,33 \times 10^4}$$

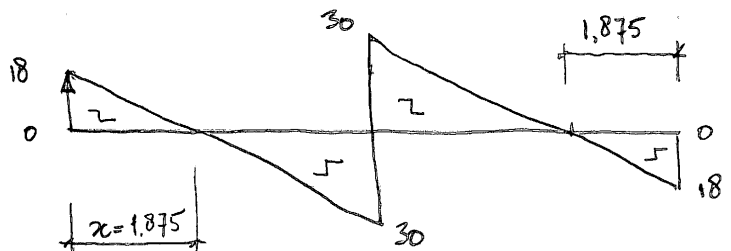
$$y_B = 0,0096 \times B_V \quad (2)$$



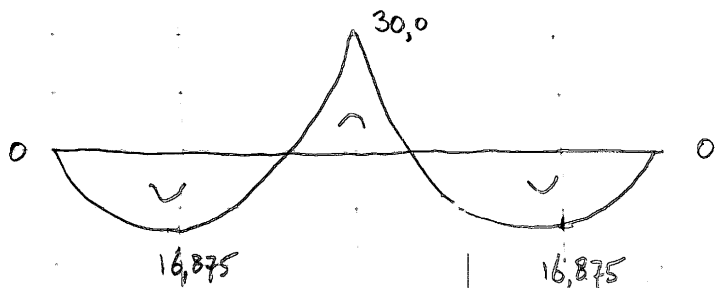
(1) = (2):  $B_V = 60\,000 \text{ N} = 60 \text{ kN.} \quad (\uparrow)$

$\sum V = 0$ :  $A_V = C_V = 18 \text{ kN} \quad (\uparrow)$

D-lijn  
 [kN]



M-lijn  
 [kNm]



### B. Krachtenmethode

hier  $M_B$  als statisch onbepaalde

eis:  $\varphi_{B,Li} = \varphi_{B,RE} (= 0 !)$

$$- \curvearrowright \quad \curvearrowright +$$

deel AB

$$\varphi_{B,Li} = - \varphi_{B,q} + \varphi_{B,M_B} = 0$$

links en rechts van B is constructie in belasting symmetrisch, dus

$$\varphi_{B,Li} = \varphi_{B,RE} = 0$$

$$\varphi_{B,Li} = - \frac{9,6 \times 5000^3}{24 \times 210000 \times 1033 \times 10^4} + \frac{M_B \times 5000}{3 \times 210000 \times 1033 \times 10^4} = 0$$

$$= - 0,0023 + 7,683 \times 10^{-10} \times M_B = 0$$

$$\rightarrow M_B = 30 \times 10^6 \text{ N}\cdot\text{mm} = 30 \text{ kN}\cdot\text{m}$$

$$\sum M_{\text{toev A}} = 0 : (9,6 \times 5) \times 2,5 + 30 - B_{V,1} \times 5 = 0$$

$$B_{V,1} = 30 \text{ kN } (\uparrow)$$

$$B_{V,2} = 30 \text{ kN } (\uparrow)$$

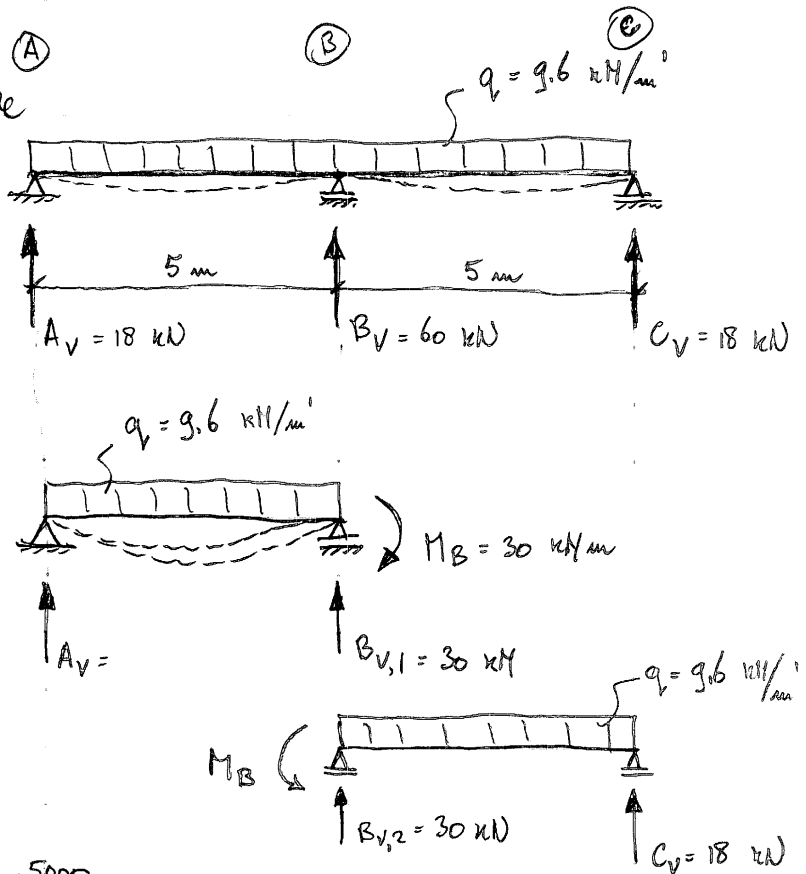
$$B_V = 60 \text{ kN } (\uparrow)$$

$$\sum V = 0 : A_V - (9,6 \times 5) + 30 = 0$$

$$A_V = 18 \text{ kN } (\uparrow)$$

$$\text{en } C_V = 18 \text{ kN } (\uparrow)$$

D- en M-lijen zie blad 1



b. sterkte van de ligger - controleer  $\sigma$  en  $\tau$

$$\sigma_{max} = \frac{M_{max}}{W_y} \leq f_{y,d}$$

$$\sigma_{max} = \frac{30 \times 10^6}{155,4 \times 10^3} = 193 \text{ N/mm}^2 < 235 \text{ N/mm}^2 \quad [\text{OK}]$$

$$\tau_{max} = \frac{D_{max}}{A_{lijf}} \leq f_{v,d}$$

$$\tau_{max} = \frac{30000}{638} = 47 \text{ N/mm}^2 < 136 \text{ N/mm}^2 \quad [\text{OK}]$$

$$A_{lijf} = (133 - 2 \times 8,5) \times 5,5 = 638 \text{ mm}^2$$

c. doorbuiging van M

$$E = 210000 \text{ N/mm}^2$$

$$I_y = 1033 \times 10^4 \text{ mm}^4$$

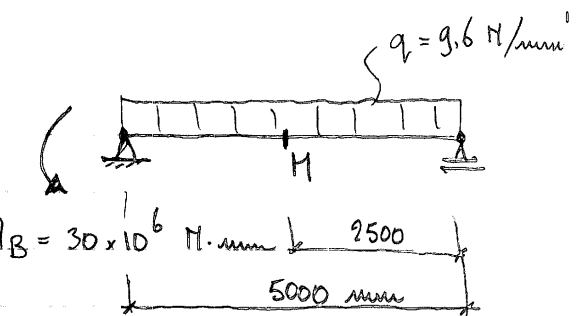
$$E \cdot I = 2,1693 \times 10^{12} \text{ N} \cdot \text{mm}^2$$

$$y_{H,q} = \frac{5 \times 9,6 \times 5000^4}{384 \times 2,1693 \times 10^{12}} = 36 \text{ mm} \quad (\downarrow)$$

$$y_{H,M_B} = \frac{30 \times 10^6 \times 5000^2}{16 \times 2,1693 \times 10^{12}} = 22 \text{ mm} \quad (\uparrow)$$

$$y_H = 14 \text{ mm} \quad (\downarrow) < 25 \text{ mm} \quad [\text{OK}]$$

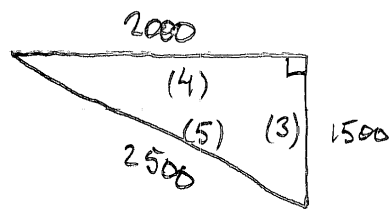
toelaatbaar:  $y_H = 0,005 \times l$   
 $y_H = 0,005 \times 5000 \text{ mm}$   
 $y_H = 25 \text{ mm}$



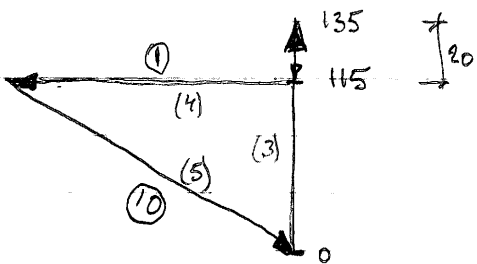
(gecontroleerd met Matrix Frame)

②  
 a. reactiekrachten:  $A_v = 135 \text{ kN}$   
 $B_v = 115 \text{ kN}$

verhouding driehoeken:



staaf ① en ⑩:



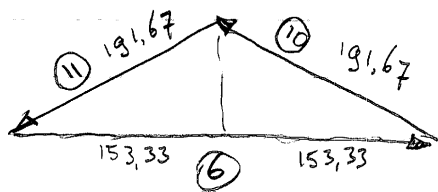
$(3) : (4) = 115 : ①$   
 $① = 153,33 - \text{DRUK}$   
 $(3) : (5) = 115 : ⑩$   
 $⑩ = 191,67 - \text{TREK}$

Samenvatting

staaf	
1	- 153,33
10	191,67
11	- 191,67
6	306,67
3	- 420,0
14	- 25,0
7	440,0

staaf ⑪ en ⑥:

$⑪ = 191,67 - \text{DRUK}$   
 $⑥ = 306,67 - \text{TREK}$

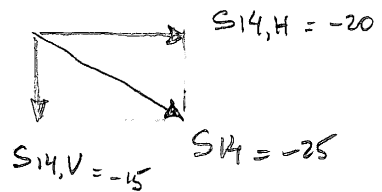
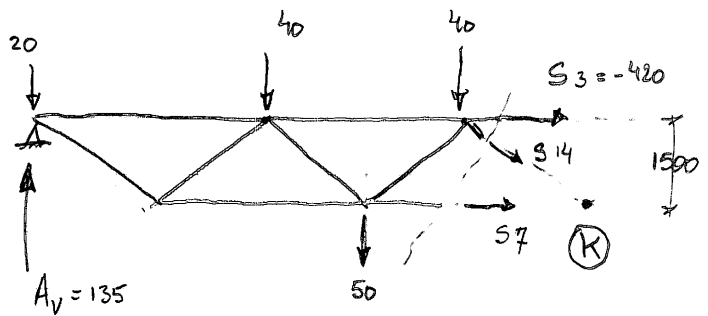


b.  $\sum M_{\text{lov. k}} = 0 :$

$135 \times 10 - 20 \times 10 - 40 \times 6 - 40 \times 2 - 50 \times 4 + S_3 \times 1,5 = 0$   
 $S_3 = -420 \text{ kN (DRUK)}$

$(+\uparrow) \sum V = 0 : 135 - 20 - 40 - 40 - 50 - S_{14,V} = 0$   
 $S_{14,V} = -15 \text{ kN}$   
 $S_{14} = -25 \text{ kN (DRUK)}$

$(+\rightarrow) \sum H = 0 : -420 - 20 + S_7 = 0$   
 $S_7 = 440 \text{ kN (TREK)}$



c. staaf 7: HE160 A, S235,  $f_{y,d} = 235 \text{ N/mm}^2$   
 $F_t = 480 \text{ kN}$

toets:  $\frac{N_{t,s,d}}{N_{t,u,d}} \leq 1 \rightarrow 0,53 < 1 \quad [\text{OK}]$

-  $N_{t,s,d} = 480 \text{ kN}$

-  $N_{t,u,d} = 3877 \times 235 \times 10^{-3} = 911 \text{ kN}$

d. staaf 3: HE160 A, S235,  $f_{y,d} = 235 \text{ N/mm}^2$   
 $F_d = 450 \text{ kN}$   
 $l_{\text{sys}} = l_{\text{buc}} = 4000 \text{ mm}$

toets:  $\frac{N_{c,s,d}}{w_{\text{buc},z} \times N_{c,u,d}} \leq 1 \rightarrow 0,99 < 1 \quad [\text{OK}]$

-  $N_{c,s,d} = 450 \text{ kN}$

-  $N_{c,u,d} = N_{t,u,d} = 911 \text{ kN}$

-  $w_{\text{buc},z}$ , toetsen om zwakke as.

$$\lambda_z = \frac{l_{\text{buc}}}{i_z} = \frac{4000}{39,8} = 100,5$$

$$\lambda_e = 93,91$$

$$\lambda_{z,\text{rel}} = 1,07 \rightarrow w_{\text{buc}} = 0,50$$

$$\left. \begin{aligned} \frac{h}{b} &= \frac{152}{160} = 0,95 \\ t &= 9 < 80 \end{aligned} \right\}$$

z-z.as: slanke c