

**opdrachtgever:** onroerendgoed mij. wipmolen b.v.

**werk:** opslag- en expeditehal 2<sup>e</sup> fase  
te alphen a/d rijn voor b.v. rutges

**betreft:**

statische berekening staalkonstruktie.

**architect:** poulderoyen · van der heyden · sramota

tek.no. : 7708 - 003 . 004 en 005  
datum : 23 - 6 - 1977.

**adviesburo voor  
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get. 5-9-77  
RK

Opmerkingen:

-Van toepassing zijn de T.G.B. 1972 algemeen en staal.

-Materiaal Fe 360  $\gamma = 1,5$

Belastingaannamen:dak hal:

$q$  van e.g. stalen dakplaat, isolatie, dakleer

+leislag:  $1,5 \times 0,3$

=  $0,45 \text{ KN/m}^2$

van n.b. (sneeuw):  $1,50 \times 0,5$

=  $0,75 -$

$1,20 \text{ KN/m}^2$

met wind:

$q$  van e.g. dakkonstruktie

=  $0,45 \text{ KN/m}^2$

- wind:  $(0,4+0,3) \times 0,73 \times 1,5$

=  $0,77 -$

$1,22 \text{ KN/m}^2$

of  $q$  van e.g. dakkonstruktie

=  $0,45 \text{ KN/m}^2$

- wind:  $-(0,4+0,3) \times 0,73 \times 1,5$

=  $-0,77 -$

$0,32 \text{ KN/m}^2$

Luifel tussen A en E:

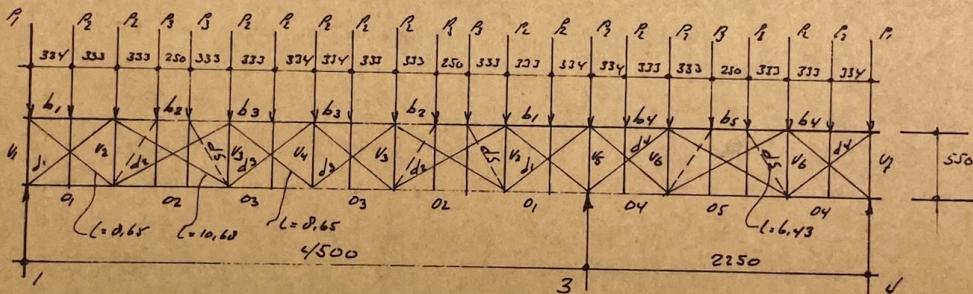
$q$  van e.g. gordingen en spanten:  $1,5 \times 0,2$

=  $0,3 \text{ KN/m}^2$

aan te houden de belastingen van het dak:

Opname Windbelastingen:

a) wind // as 1: (zie ook de gewichtsberekening blz. 2)



$q$  van wind per wind-ligger:  $0,5 \times 1,5 \times 5,25$

=  $3,94 \text{ KN/m}^2$

- stabiliteit per wind-ligger:  $\frac{64,00}{2} \times 0,005 \times (1,22+0,3)$

=  $0,24 -$

$4,18 \text{ KN/m}^2$

P1:  $1,92 \times 4,18 + 1,5 \times 7,15 \times 0,5$

=  $13,38 \text{ KN}$

P2:  $3,34 \times 4,18$

=  $13,96 \text{ KN}$

P3:  $2,915 \times 4,18$

=  $12,18 \text{ KN}$

Reakties: (per verband)

R1:	$13,38+4,5 \times 13,96+2 \times 12,18$	= 100,56 KN
R3:	$7,5 \times 13,96+3 \times 12,18$	= 141,24 KN
R4:	$13,38+2 \times 13,96+12,18$	= 53,48 KN

Staafkrachten:

Staven 01: nulstaaf

$$\text{Staven 02: } T = \frac{6,67 \times (100,56 - 13,38) - 3,33 \times 13,96}{5,50} = 97,3 \text{ KN}$$

$$\text{Staven 03: } T = \frac{15,83 \times (100,56 - 13,38)}{5,50} = 250,9 \text{ KN}$$

$$\text{minus: } \frac{(3,33 + 5,83) \times 12,18}{5,50} = -20,3 \text{ -}$$

$$\text{minus: } \frac{(9,16 + 12,49) \times 13,96}{5,50} = -54,9 \text{ -}$$

$$175,7 \text{ KN}$$

Staven 04: nulstaaf

$$\text{Staven 05: } T = \frac{6,67 \times (53,48 - 13,38) - 3,33 \times 13,96}{5,50} = 40,2 \text{ KN}$$

$$\text{Staven b1: } N' = -\text{staaf 02} = -97,3 \text{ KN}$$

$$\text{Staven b2: } N' = -\text{staaf 03} = -175,7 \text{ KN}$$

$$\text{Staven b3: } N' = \frac{-22,50 \times (100,56 - 13,38)}{5,50} = -256,6 \text{ KN}$$

$$\frac{+11,25 \times 2 \times 12,18}{5,50} = +49,8 \text{ -}$$

$$\frac{+11,25 \times 2 \times 13,96}{5,50} = +114,2 \text{ -}$$

$$192,6 \text{ KN}$$

$$\text{Staven b4: } N' = -\text{staaf 05} = -40,2 \text{ KN}$$

$$\text{Staven b5: } N' = -\text{staaf 05} = -40,2 \text{ KN}$$

$$\text{Staaf V1: } N' = -100,56 \text{ KN}$$

$$\text{Staaf V2: } N' = -100,56 + 13,38 + 13,96 = -73,22 \text{ KN}$$

$$\text{Staaf V3: } N' = -100,56 + (2 \times 13,38) + (2 \times 13,96) = -45,88 \text{ KN}$$

$$\text{Staaf V4: } N' = -13,96 \text{ KN}$$

$$\text{Staaf V5: } N' = -141,24 \text{ KN}$$

$$\text{Staaf V6: } N' = -53,48 + 13,38 + 13,96 = -26,14 \text{ KN}$$

$$\text{Staaf V7: } N' = -53,48 \text{ KN}$$

$$\text{Staaf d1: } T = \frac{8,65}{5,50} \times (100,56 - 13,38) = 137,1 \text{ KN}$$

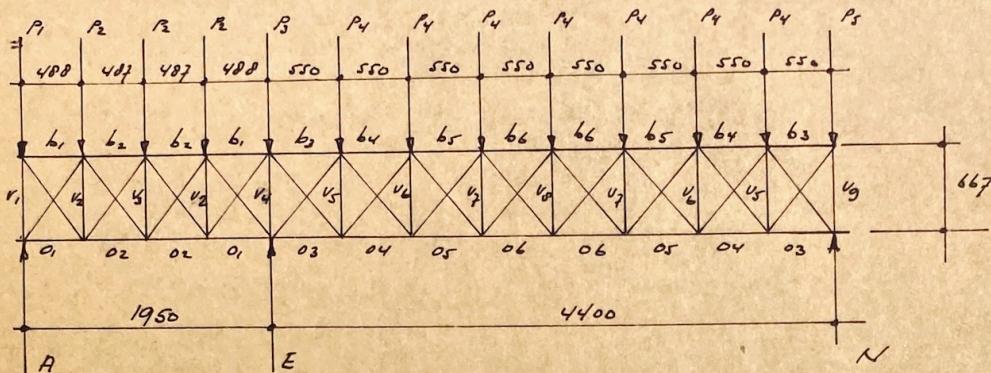
$$\text{Staaf d2: } T = \frac{10,68}{5,50} \times (100,56 - 13,38 - 13,96 - 13,96 - 12,18) = 91,4 \text{ KN}$$

$$\text{Staaf d2: } T = \frac{8,65}{5,50} \times 13,96 \times 0,5 = 10,9 \text{ KN}$$

$$\text{Staaf d4: } T = \frac{8,65}{5,50} \times (53,48 - 13,38) = 63,1 \text{ KN}$$

$$\text{Staven d5: } N' = -\frac{6,43}{5,50} \times 12,18 = -14,3 \text{ KN}$$

b) wind // as A: (Zie ook de gewichtsberekening blz. 3)



$$q_1 \text{ van wind per windlijgger: } 0,5 \times 6,90 \times 1,5 = 5,18 \text{ KN/m}^2$$

$$\begin{aligned} - \text{ stabilititeit: } & \frac{68,00}{2} \times 0,005 \times (1,22 + 0,3) \\ & = 0,26 - \\ & = 5,44 \text{ KN/m}^2 \end{aligned}$$

$$q_2 \text{ van wind per windlijgger: } 0,5 \times 5,40 \times 1,5 = 4,05 \text{ KN/m}^2$$

$$\begin{aligned} - \text{ stabilititeit} \\ & = 0,26 - \\ & = 4,31 \text{ KN/m}^2 \end{aligned}$$

$$P_1 = 2,95 \times 5,44 = 16,1 \text{ KN}$$

$$P_2: 4,875 \times 5,44 = 26,5 \text{ KN}$$

$$P_3: 2,44 \times 5,44 + 2,75 \times 4,31 + 0,5 \times 1,5 \times 7,75 = 30,9 \text{ KN}$$

$$P_4: 5,50 \times 4,31 = 23,7 \text{ KN}$$

$$P_5: 3,00 \times 4,31 + 0,5 \times 1,5 \times 7,75 = 18,7 \text{ KN}$$

#### Reakties: (per verband):

$$R_A = 16,1 + 1,5 \times 26,5 = 55,9 \text{ KN}$$

$$R_E = 1,5 \times 26,5 + 30,9 + 3,5 \times 23,7 = 153,6 \text{ KN}$$

$$R_N = 3,5 \times 23,7 + 18,7 = 101,7 \text{ KN}$$

#### Staafkrachten:

Staven 01: nulstaaf

$$\text{Staaf 02: } T = \frac{4,88 \times (55,9 - 16,1)}{6,67} = 29,1 \text{ KN}$$

Staven b1:  $N' = -\text{staaf 02}$

$$\text{Staven b2: } N' = \frac{-9,75 \times (55,9 - 16,1) + 4,87 \times 26,5}{6,67} = -38,8 \text{ KN}$$

Staven 03: nulstaaf

$$\text{Staven 04: } T = \frac{5,50 \times (101,7 - 18,7)}{6,67} = 68,4 \text{ kN}$$

Staven 05: T = $\frac{11,00 \times (101,7-18,7)-5,50 \times 23,7}{6,67}$	= 117,3 KN	4.
Staven 06: T = $\frac{16,50 \times (101,7-18,7)-16,5 \times 23,7}{6,67}$	= 146,7 KN	
Staven b3: N' = -staaf 04	= -68,4 KN	
Staven b4: N' = -staaf 05	= -117,3 KN	
Staven b5: N' = -staaf 06	= -146,7 KN	
Staven b6: N' = $\frac{-22,00 \times (101,7-18,7)}{6,67} + \frac{33,00 \times 23,7}{6,67}$	= -273,8 KN	
	= +117,3 -	
	156,5 KN	
Staaf V1: N'	= -55,9 KN	
Staaf V2: N' = -55,9+16,1	= 39,8 KN	
Staaf V3: N' =	= -26,5 KN	
Staaf V4: N' =	= -153,6 KN	
Staaf V5: N' = -101,7+18,7	= -83,0 KN	
Staaf V6: N' = -101,7+18,7+23,7	= -59,3 KN	
Staaf V7: N' = -101,7+18,7+23,7+23,7	= -35,6 KN	
Staaf V8: N' =	= -23,7 KN	
Staaf V9: N' =	= -101,7 KN	
Staaf d1: T = $\frac{8,26}{6,67} \times (55,9-16,1)$	= 49,3 KN	
Staaf d2: T = $\frac{8,26}{6,67} \times 0,50 \times 26,5$	= 16,4 KN	
Staaf d3: T = $\frac{8,65}{6,67} \times (101,7-18,7)$	= 107,6 KN	
Staaf d4: T = $\frac{8,65}{6,67} \times (101,7-18,7-23,7)$	= 76,9 KN	
Staaf d5: T = $\frac{8,65}{6,67} \times (101,7-18,7-2 \times 23,7)$	= 46,2 KN	
Staaf d6: T = $\frac{8,65}{6,67} \times 0,5 \times 23,7$	= 15,4 KN	

Kontrole diagonalen:

Wind // as 1:

staaf d1 T = 137,1 KN

profiel L 60x60x6 A netto = 691-6x18 = 583 mm<sup>2</sup>

$$\sigma = \frac{137,1 \times 10^3}{583} = 235 \text{ N/mm}^2$$

staaf d2 T = 91,4 KN

profiel L 55x55x6 A netto = 631-6x18 = 523 mm<sup>2</sup>

$$\sigma = \frac{91,4 \times 10^3}{523} = 175 \text{ N/mm}^2$$

staaf d4 T = 63,1 KN

profiel L 55x55x6 240 N/mm<sup>2</sup>

Wind // as A

staaf d3 T = 107,6 KN

profiel L 55x55x6 A netto = 523 mm<sup>2</sup>

$$\sigma = \frac{107,6 \times 10^3}{523} = 206 \text{ N/mm}^2$$

Staaf d4

5.

profiel L 55x55x6

T

= 76,9 KN

$$\sigma < 240 \text{ N/mm}^2$$

overige trekstaven praktisch L 55x55x6

Staaf d5 (wind // as 1) N'

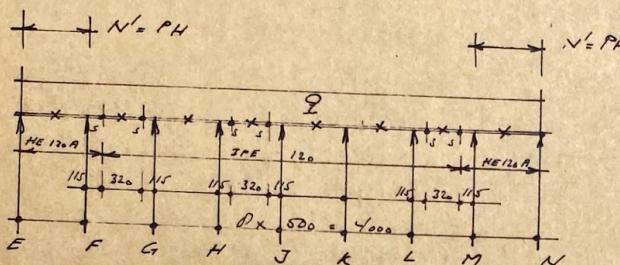
$$\text{profiel } \varnothing 101,6/4 \quad l_c = 6,43 \text{ m} \quad k = \frac{643}{3,49} = 184$$

= -14,3 KN

$$W = 6,55 \quad J = \frac{6,55 \times 14,3 \times 10^3}{899} = 104 \text{ N/mm}^2$$

Gordingen, B:

profiel HE 120A, resp. IPE 120



x = kipsteun

Belastingen:

q van e.g. ligger: 1,5x0,2

= 0,3 KN/m'

- dak: 3,34x1,22

= 4,07 -

4,37 KN/m'

= 13,96 KN

PH van wind

Eindvelden: profiel HE 120A

-MF = -MM =  $1,60 \times 4,37 \times 1,15 + 1,15^2 / 2 \times 4,37$

= 10,9 KNm

REF =  $2,75 \times 4,37 - 10,9 / 5,50$

= 10,0 KNm

+MEF =  $\frac{10,0^2}{2 \times 4,37}$

= 11,44 KNm

Spanningen:

-M max

$$\sigma = \frac{10,9 \times 10^6}{106 \times 10^3} = 103 \text{ N/mm}^2$$

= 10,9 KNm

+M max

$$\sigma = \frac{11,44 \times 10^6}{106 \times 10^3} = 108 \text{ N/mm}^2$$

= 11,44 KNm

$$\frac{1h}{be} = \frac{0,5 \times 5500 \times 114}{120 \times 8} = 327 \quad \sigma_{\text{kip}} = 230 \text{ N/mm}^2$$

$$\beta^* = \frac{+11,44 - 10,9}{-2 \times 1 / 12 \times 4,37 \times 2,75^2} = \frac{+0,54}{-5,5} = -0,10$$

$$\sigma_{\text{kip}} = 230 \text{ N/mm}^2$$

met normaalkracht:

$$1kx = 5,50 \text{ m} \quad k_x = \frac{550}{4,90} = 112 \quad W_{\max} = 2,45$$

$$1ky = 2,75 \text{ m} \quad k_y = \frac{275}{3,02} = 91 \quad \sigma_{EX} = 165 \text{ N/mm}^2$$

$$Mx1 = 0 \text{ KNm}$$

$$Mx2 = +11,44 \text{ KNm} \quad \Theta = \frac{5 \times 240}{230(8-3x \frac{0}{11,44})} = 0,65 \quad 1,0$$

$$\beta_x = 0,6 + 0,4x \frac{0}{11,44} = 0,6$$

$$MDX = \frac{2}{1/8 \times 4,37 \times 2,75^2} = 4,13 \text{ KNm}$$

$$nx = \frac{25,2 \times 10^2 \times 165}{13,96 \times 10^3} = 30,0$$

$$\sigma_{\max} = \frac{2,45 \times 13,96 \times 10^3}{25,2 \times 10^2} + 1,0x \frac{30,0}{29,0} \frac{(0,6 \times 11,44 + 4,13) \times 10^6}{106 \times 10^3} = \\ = 13,6 + 108 = 121,6 \text{ N/mm}^2$$

$$\text{of } \sigma_{\max} = \frac{2,45 \times 13,96 \times 10^3}{25,2 \times 10^2} + \frac{(11,44 + 4,13) \times 10^6}{10^6 \times 10^3} = \\ = 13,6 + 146,9 = 160,5 \text{ N/mm}^2$$

$$f = \frac{5 \times 4,37 \times 5,50^4 \times 10^{12}}{384 \times 2,1 \times 10^5 \times 606 \times 1,5 \times 10^4} = 27,3 \text{ mm}$$

$$\text{minus } \frac{0,0625 \times 5,50^2 \times 10^{12} \times 10,9}{2,1 \times 10^5 \times 606 \times 1,5 \times 10^4} = -10,8 \text{ mm} \\ 16,5 \text{ mm } (= 1/333 1)$$

Tussenvelden: profiel IPE 120

$$+Ms1-s2 = \frac{1}{8} \times 4,37 \times 3,20^2 = 5,59 \text{ KNm}$$

$$\sigma = \frac{5,59 \times 10^6}{53,0 \times 10^3} = 106 \text{ N/mm}^2$$

$$-MG = -MH = -MJ = -ML = 10,9 \text{ KNm}$$

$$-MK = \frac{1}{8} \times 4,37 \times 5,50^2 - 10,9 \times 0,5 = 11,07 \text{ KNm}$$

$$+MJK = +MKL = \frac{1}{8} \times 4,37 \times 5,50^2 - \frac{(10,9 + 110,7)}{2} = 5,52 \text{ KNm}$$

$$+MGH = \frac{1}{8} \times 4,37 \times 5,50^2 - 10,9 = 5,62 \text{ KNm}$$

$$\sigma_{\max} = \frac{11,07 \times 10^6}{53,0 \times 10^3} = 209 \text{ N/mm}^2$$

$$+M \text{ tussen de kipsteun} = \frac{1}{8} \times 4,37 \times 5,50^2 \times 0,75 - 10,9 = 1,49 \text{ KNm}$$

$$\sigma = \frac{1,49 \times 10^6}{53,0 \times 10^3} = 28,1 \text{ N/mm}^2$$

$$\frac{lh}{be} = \frac{2750 \times 120}{64 \times 6,3} = 818$$

$$\beta * = \frac{-10,9 + 5,52}{-2 \times 1/12 \times 4,37 \times 2,75^2} = \frac{-5,38}{-5,5} = 0,98$$

$$\sigma_{\text{kip}} = 1,98 \times 1,04 \times \frac{0,22 \times 2,1 \times 10^5}{818} = 116,3 \text{ N/mm}^2 (> 28,1 \text{ N/mm}^2)$$

$$f = \frac{5 \times 4,37 \times 5,50^4 \times 10^{12}}{384 \times 2,1 \times 10^5 \times 318 \times 1,5 \times 10^4} = 52,02 \text{ mm}$$

$$\text{minus } f = \frac{(10,9+11,07) \times 0,0625 \times 5,50^2 \times 10^{12}}{2,1 \times 10^5 \times 318 \times 1,5 \times 10} = -41,47 \text{ mm}$$

10,55 mm (= 1/521 1)

### Reakties:

$$RE = RN = 10,0 \text{ KN}$$

$$RF = RM = 5,50 \times 4,37 = 24,04 \text{ KN}$$

$$\frac{+10,9}{5,50} = 1,98 \text{ KN}$$

26,02 KN

$$RG = RH = 24,04 \text{ KN}$$

$$RJ = RL = 5,50 \times 4,37 + \frac{10,9-11,07}{5,50} = 24,04 \text{ KN}$$

$$RK = 5,50 \times 4,37 + 2 \times \frac{(11,07-10,9)}{5,50} = 24,04 \text{ KN}$$

### Gordingen C en H:

profiel HE 120B resp. HE 120A lt = 2x5,50 m

### Belastingen:

$$q \text{ van e.g. ligger + dak} = 4,37 \text{ KN}$$

$$N' \text{ max van wind // as A} = 156,5 \text{ resp. } 146,5 \text{ KN}$$

$$-M \text{ max} = \frac{1}{8} \times 4,37 \times 5,50^2 = 16,5 \text{ KNm}$$

$$+M \text{ max} = \frac{9}{128} \times 4,37 \times 5,50^2 = 9,3 \text{ KNm}$$

$$\text{t.p.v. } -M \text{ max} \rightarrow \sigma_{\max} = \frac{16,5 \times 10^6}{144 \times 10^3} + \frac{156,5 \times 10^3}{34,0 \times 10^2}$$

$$= 115 + 46 = 161 \text{ N/mm}^2$$

$$\text{t.p.v. veld: } Mx1 = 0 \text{ KNm} \quad Mx2 = +9,3 \text{ KNm}$$

$$\frac{1h}{be} = \frac{2750 \times 120}{120 \times 11} = 250 \quad \sigma_{\text{kip}} = 240 \text{ N/mm}^2$$

$$\Theta = \beta_x = 0,6$$

$$1kx = 5,50 \text{ m} \quad k_x = 550/5,04 = 109 \quad W = 2,34$$

$$1ky = 2,75 \text{ m} \quad k_y = 275/3,06 = 90 \quad \sigma_{\text{EX}} = 174 \text{ N/mm}^2$$

$$nx = \frac{174 \times 34,0 \times 10^2}{156,5 \times 10^3} = 3,8 \quad MDX = +4,13 \text{ KNm}$$

$$\sigma_{\max} = \frac{2,34 \times 156,5 \times 10^3}{34,0 \times 10^2} + 1,0x \frac{3,8}{2,8} \frac{(0,6 \times 9,3 + 4,13) \times 10^6}{144 \times 10^3}$$

$$= 108 + 91,5 = 199,5 \text{ N/mm}^2$$

$$\text{of } \sigma_{\max} = \frac{2,34 \times 156,5 \times 10^3}{34,0 \times 10^2} + \frac{(9,3 + 4,13) \times 10^6}{144 \times 10^3}$$

$$= 108 + 93,2 = 201,2 \text{ N/mm}^2$$

$$\text{t.p.v. } N' = -29,1 \text{ resp. } 38,8 \text{ resp. } 68,4 \text{ resp. } 73,22 \text{ resp.}$$

$$117,3 \text{ KN}$$

$$\beta_x = 0,6 \quad \Theta = 1,0 \quad nx = \frac{25,2 \times 10^2 \times 165}{117,3 \times 10^3} = 3,5$$

$$\sigma_{\max} = \frac{2,45 \times 117,3 \times 10^3}{25,2 \times 10^2} + 1,0x \frac{3,5}{2,5} \left( \frac{0,6 \times 9,3 + 4,13}{106 \times 10^3} \right) \times 10^6$$

$$= 114 + 128 = 242 \text{ N/mm}^2$$

$$\text{of } \sigma_{\max} = \frac{2,45 \times 117,3 \times 10^3}{25,2 \times 10^2} + \frac{1,0x(-9,3 + 4,13) \times 10^6}{106 \times 10^3}$$

$$= 114 + 126 = 241 \text{ N/mm}^2$$

doorbuiging niet maatgevend.

#### reakties:

R eind:	0,375x4,37x5,50x2	= 18,0 KN
R midden:	1,25x4,37x5,50	= 30,0 KN

#### Gording D:

profiel L-120 lt = 2x5,50 m

#### Belastingen-

q van e.g. ligger:	1,5x0,135	= 0,20 KN/m
- dak:	1,67x1,22	= 2,04 -
- lichtstraat:	1,25x1,22	= 1,53 -

$$3,77 \text{ KN/m}$$

$$-M_{\max} = 1/8x3,77x5,50^2 = 14,3 \text{ KNm}$$

$$\sigma = \frac{14,3 \times 10^6}{60,7 \times 10^3} = 235,6 \text{ N/mm}^2$$

$$+M_{\max} = 9/128x3,77x5,50^2 = 8,02 \text{ KNm}$$

$$\sigma = \frac{8,02 \times 10^6}{60,7 \times 10^3} = 132 \text{ N/mm}^2$$

$$\frac{lh}{be} = \frac{5500x120x0,5}{55x9} = 667 \quad \text{a)} \quad \sigma_{kip} = 176 \text{ N/mm}^2$$

$$\text{b)} \quad \beta^* = 1,315 \quad (\text{kip niet maatgevend})$$

$$f = \frac{5x3,77x5,50^4 \times 10^{12}}{384x2,1 \times 10^5 \times 364x10^9 \times 1,5} = 39,2 \text{ mm}$$

$$\text{minus: } \frac{0,0625x14m3x5,50^2 \times 10^{12}}{2,1 \times 10^5 \times 364x10^4 \times 1,5} = -23,6 \text{ mm}$$

$$15,6 \text{ mm} (= 1/356 1)$$

R eind:	0,375x3,77x5,50	= 7,78 KN
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R midden:	1,25x3,77x5,50	= 25,92 KN
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#### Gordingen E:

profiel HE 120A in eindvelden

IPE 120 in middenvelden.

a) eindvelden N' max in eindvelden =	= -73,22 KN
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→ zie gordingen C

b) tussenvelden → zie gording B

#### Gording F: (op as 3)

N' max van wind	= -141,24 KN
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profiel HE 120B zie gording C

Gordingen G:

profiel IPE 120 lt = 2x4,87 m

Belaastingen:

q van e.g. ligger: 1,5x0,105 = 0,16 KN/m'

- dak: 3,334x1,22 = 4,07 -

4,23 KN/m'

-M max = 1/8x4,23x4,87<sup>2</sup> = 12,5 KNm

$$\sigma = \frac{12,5 \times 10^6}{53,0 \times 10^3} = 236 \text{ N/mm}^2$$

+M max = 9/128x4,23x4,87<sup>2</sup> = 7,05 KNm

$$\sigma = \frac{7,05 \times 10^6}{53,0 \times 10^3} = 133 \text{ N/mm}^2$$

$$\frac{1h}{be} = \frac{4870x120x0,5}{64x6,3} = 725 \quad \text{a)} \quad \sigma_{\text{kip}} = 180 \text{ N/mm}^2$$

$$\text{b)} \quad \beta^* = 1,315 \quad (\text{kip niet maatgevend})$$

Moment tussen de kipsteunf: 0,375x4,23x4,87<sup>2</sup>x0,25 = 9,41 KNm

$$\text{minus: } \frac{(4,87x0,25)^2}{2} \times 4,23 = -3,14 - 6,27 \text{ KNm}$$

$$\sigma = \frac{6,27 \times 10^6}{53,0 \times 10^3} = 118 \text{ N/mm}^2 \quad (< 180,0 \text{ N/mm}^2)$$

$$f = \frac{5x4,23x4,87^4 \times 10^{12}}{384x2,1x318x10^9 \times 1,5} = 30,9 \text{ mm}$$

$$\text{minus: } \frac{0,0625x12,5x4,87^2 \times 10^{12}}{2,1x318x10^9 \times 1,5} = -18,5 - 12,4 \text{ mm} \quad (= 1/393 1)$$

$$R \text{ eind} = 0,375x4,23x4,87 = 7,72 \text{ KN}$$

$$R \text{ midden: } 1,25x4,23x4,87 = 25,75 \text{ KN}$$

Gordingen:

profiel L-120 lt = 2x4,87 m

Belaastingen:

q van e.g. gording: 1,5x0,135 = 0,20 KN/m'

- dak: 1,67x1,22 = 2,04 -

- lichtstraat: 1,25x1,22 = 1,53 -

3,77 KN/m'

-M max = 1/8x3,77x4,87<sup>2</sup> = 11,2 KNm

$$\sigma = \frac{11,2 \times 10^6}{60,7 \times 10^3} = 185 \text{ N/mm}^2$$

+M max = 9/128x3,77x4,87<sup>2</sup> = 6,3 KNm

$$\sigma = \frac{6,3 \times 10^6}{60,7 \times 10^3} = 104 \text{ N/mm}^2$$

$$\frac{1h}{be} = \frac{4870x120x0,5}{55x9} \quad 3= 590 \quad \text{a)} \quad \sigma_{\text{kip}} = 195 \text{ N/mm}^2$$

$$\text{b)} \quad \beta^* = \frac{+6,3-11,2}{-2x1/12x3,77x2,435^2} = \frac{+4,9}{3,73} = 1,315 \quad (\text{kip niet maatgevend.})$$

$$f = \frac{5x3,77x4,87^4x10^{12}}{384x2,1x364x10^9x1,5} = 24,1 \text{ mm}$$

$$\text{minus: } \frac{0,0625x11,2x4,87^2x10^{12}}{2,1x364x10^9x1,5} = -14,5 \text{ mm}$$

$$9,6 \text{ mm } (= 1/507 1)$$

$$R \text{ eind} = 0,375x3,77x4,87 = 6,88 \text{ KN}$$

$$R \text{ midden} = 1,25x3,77x4,87 = 22,95 \text{ KN}$$

Randgording op de assen 1 en 4: profiel HE 120B resp. HE 120A

maatgevend is het gedeelte tussen E en N ltv = 5,50 m

lth = 2,75 m

#### Belastingen:

$$\text{qv van e.g. ligger: } 1,50x0,30 = 0,45 \text{ KN/m}'$$

- dak: 1,92x1,22 = 2,34 -
- dakrand + gevel: 3,00x0,25x1,5 = 1,13 -

$$3,92 \text{ KN/m}'$$

$$\text{met wind // as 1 N' max in ligger} = 100,56 \text{ KN}$$

$$\text{met wind // as A qh} = 1,75x1,1x0,73x1,5$$

- N' max = -156,5 KN
- (in deel A-E) = -38,8 KN)

#### Wind // as A is maatgevend:

$$\text{gedeelte E-N} \quad -Mv = 1/8x3,92x5,50^2 = 14,8 \text{ KNm}$$

$$+Mv = 9/128x3,92x5,50^2 = 8,3 \text{ KNm}$$

$$\pm Mh = 1/10x2,1x2,75^2 = 1,6 \text{ KNm}$$

$$l_{cx} = 5,50 \text{ m} \quad k = 109 \quad W = 2,34 \quad \sigma_{EX} = 174 \text{ N/mm}^2$$

$$l_{cy} = 2,75 \text{ m} \quad k = 90 \quad \sigma_{EY} = 256 \text{ N/mm}^2$$

$$n_x = \frac{174x34,0x10^2}{156,5x10^3} = 3,8$$

$$n_y = \frac{256x34,0x10^2}{156,0x10^3} = 5,6$$

#### t.p.v. kipsteun:

$$\sigma = \frac{2,34x156,5x10^3}{34,0x10^2} + \frac{3,8}{2,8} \times \frac{8,3x10^6}{144x10^3} + \frac{5,6}{4,6} \times \frac{1,6x10^6}{53x10^3} =$$

$$= 108,0 + 78,0 + 37,0 = 223 \text{ N/mm}^2$$

#### t.p.v. middenoplegging:

$$\sigma = \frac{156,5x10^3}{34,0x10^2} + \frac{3,8}{2,8} \times \frac{14,8x10^6}{144x10^3} + \frac{5,6}{4,6} \times \frac{1,6x10^6}{53x10^3}$$

$$= 46,0 + 139,5 + 37,3 = 222,8 \text{ N/mm}^2$$

$$\text{Gedeelte A-E} - Mv = 1/8 \times 3,92 \times 4,87^2 = 11,6 \text{ KNm}$$

$$(\text{profiel HE 120A}) + Mv = 9/128 \times 3,92 \times 4,87^2 = 6,5 \text{ KNm}$$

$$+ Mh = 1/10 \times 2,1 \times 2,435^2 = 1,3 \text{ KNm}$$

$$l_{cx} = 4,87 \text{ m } \lambda = \frac{487}{4,90} = 99,4 \quad W = 2,04 \quad \sigma_{EX} = 210 \text{ N/mm}^2$$

$$l_{cy} = 2,435 \quad \lambda = \frac{243,5}{3,02} = 81 \quad \sigma_{EY} = 316 \text{ N/mm}^2$$

$$n_x = \frac{25,2 \times 210 \times 10^2}{38,8 \times 10^3} = 13,6 \quad n_y = \frac{25,2 \times 316 \times 10^2}{38,8 \times 10^3} = 20,5$$

t.p.v. kipsteun:

$$\sigma = \frac{2104 \times 38,8 \times 10^3}{25,2 \times 10^2} + \frac{13,6}{12,6} \times \frac{6,5 \times 10^6}{106 \times 10^3} + \frac{20,5}{19,5} \times \frac{1,3 \times 10^6}{38 \times 10^3}$$

$$= 31,4 + 66,2 + 36,0 = 133,6 \text{ N/mm}^2$$

t.p.v. middenoplegging:

$$\sigma = \frac{31,4}{2,04} + \frac{13,6}{12,6} \times \frac{11,6 \times 10^6}{106 \times 10^3} + 36,0 = 15,4 + 118 + 36,0 = 169,4 \text{ N/mm}^2$$

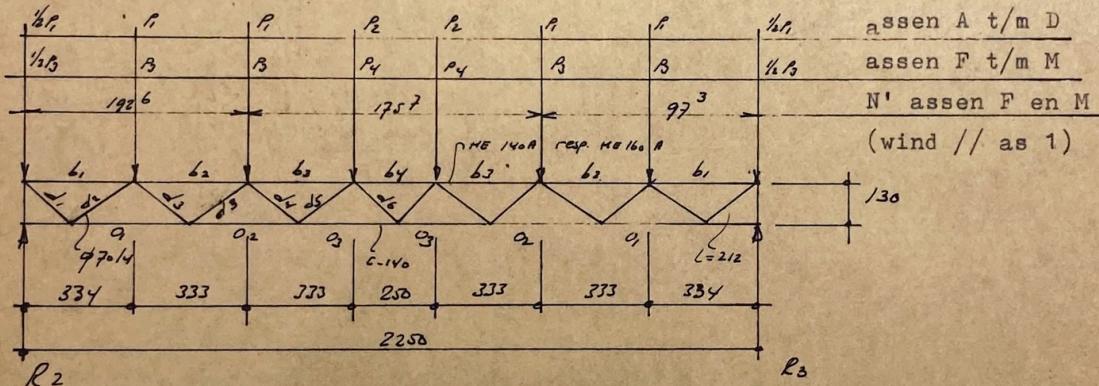
pijp achter randlijgger:

$$\text{profiel } \varnothing 057/2,9 \quad N' = 2,75 \times 2,1 \times 1,1 = 6,4 \text{ KN}$$

$$l_{c} = 3,34 \text{ m } \lambda = \frac{334}{1,92} = 174 \quad W = 5,83$$

$$\sigma = \frac{5,83 \times 6,4 \times 10^3}{4,93 \times 10^2} = 75,7 \text{ N/mm}^2$$

Vakwerkliggers op de assen A t/m D en F t/m M (tussen 2 en 3)



Belastingen:

maatgevend zijn de assen B-D, F-M ( ) de assen C, G, H, J, K, L.

$$\text{e.g. spant: } 1,50 \times (0,249 + 0,162 + \frac{2,12}{1,67} \times 0,0829) = 0,78 \text{ KN/m}'$$

$$P1 = 3,34 \times 0,78 + 25,75(15,42) = 28,36 \quad (18,13) \text{ KN}$$

$$P2 = 2,915 \times 0,78 + 22,95(13,76) = 25,22 \quad (16,03) \text{ KN}$$

$$P3 = 3,34 \times 0,78 + 26,02(24,04) = 28,63 \quad (26,65) \text{ KN}$$

$$P4 = 2,915 \times 0,78 + 25,95(15,56) = 28,19 \quad (17,83) \text{ KN}$$

Staafkrachten t.g.v. vertikale belastingen:

$$\text{Staaf 01: } \rightarrow T = \frac{85,45 \times 3,34}{1,30} = 219,5 \text{ KN}$$

$$\text{Staaf 02: } \rightarrow T = \frac{85,45 \times 6,67}{1,30} - \frac{3,33 \times 28,63}{1,30} = 365,0 \text{ KN}$$

$$\text{Staaf 03: } \rightarrow T = \frac{85,45 \times 10,00}{1,30} - \frac{3,33 \times 28,63}{1,30} - \frac{6,66 \times 28,63}{1,30} = 437,3 \text{ KN}$$

$$\text{Staaf b1: } \rightarrow N' = \frac{85,45 \times 1,67}{1,30} = -109,8 \text{ KN}$$

$$\text{Staaf b2: } \rightarrow N' = \frac{85,45 \times 5,05}{1,30} - \frac{1,665 \times 28,63}{1,30} = -292,3 \text{ KN}$$

$$\text{Staaf b3: } \rightarrow N' = \frac{85,45 \times 8,335}{1,30} - \frac{1,665 \times 28,63}{1,30} - \frac{4,995 \times 28,63}{1,30} = -401,2 \text{ KN}$$

$$\text{Staaf b4: } \rightarrow N' = \frac{85,45 \times 11,25}{1,30} - \frac{1,25 \times 28,19}{1,30} - \frac{4,58 \times 28,60}{1,30} - \frac{7,91 \times 28,63}{1,30} = -437,3 \text{ KN}$$

$$\text{Staaf d1: } \rightarrow \frac{2,12}{1,30} \times (2 \times 28,63 \times 28,19) = 139,4 \text{ KN}$$

Spanningen:

$$\text{onderrand: } \sigma = \frac{437,3 \times 10^3}{20,4 \times 10^2} = 214 \text{ N/mm}^2$$

$$\text{diagonaal: } \lambda = \frac{212}{2,7} = 79 \quad W = 1,60$$

$$\sigma = \frac{1,60 \times 139,4 \times 10^3}{10,6 \times 10^2} = 210,0 \text{ N/mm}^2$$

bovenrand:

$$\text{profiel HE 160A: staaf b2 N' max} = -292,3 - 192,6 = -484,6 \text{ KN}$$

$$l_{cx} = l_{cy} = 3,33 \text{ m} \quad \text{max} = \frac{333}{3,98} = 84 \quad W = 1,71$$

$$\sigma = \frac{1,71 \times 484,6 \times 10^3}{38,8 \times 10^2} = 214 \text{ N/mm}^2$$

$$\text{Staaf b3: N' max} = -401,2 - 175,7 = -576,9 \text{ KN}$$

$$W = 1,71$$

$$\sigma = \frac{1,71 \times 576,9}{38,8 \times 10^2} = 241 \text{ N/mm}^2$$

$$\text{Staaf b4: N' max} = -437,3 - 175,7 = -613 \text{ KN}$$

$$l_{cx} = l_{cy} \sigma = \frac{1,38 \times 613 \times 10^3}{38,8 \times 10^2} = 218 \text{ N/mm}^2 \quad \lambda_{\text{max}} = \frac{250}{3,98} = 63 \quad W = 1,38$$

$$\text{profiel HE 140A Staaf b2 N' max} = -292,3 \text{ KN}$$

$$\text{Staaf b3 N' max} = -401,2 \text{ KN}$$

$$l_{cx} = l_{cy} = 3,33 \text{ m} \quad \lambda = \frac{333}{3,52} = 95 \quad W = 1,91$$

$$\sigma = \frac{1,91 \times 401,2 \times 10^3}{31,4 \times 10^2} = 242 \text{ N/mm}^2$$

Staaf b4 N' max

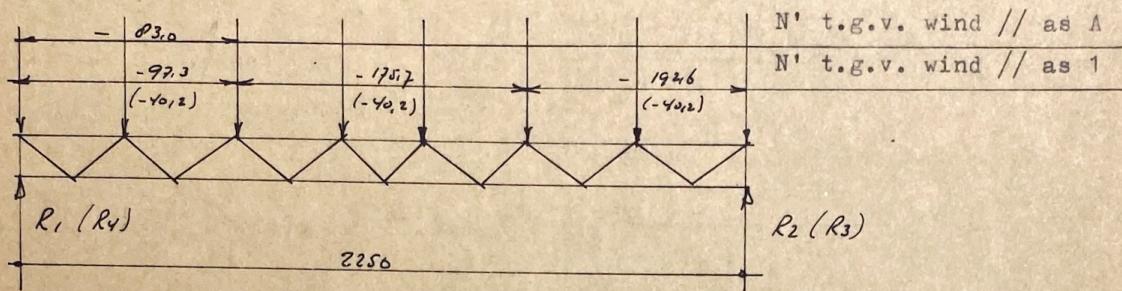
=-437,3 KN

$$l_{cx} = l_{cy} = 2,50 \text{ m} \quad \lambda = \frac{250}{3,52} = 71 \quad v = 1,50$$

$$\sigma = \frac{1,50 \times 437,3 \times 10^3}{31,4 \times 10^2} = 209 \text{ N/mm}^2$$

Reakties op hoofdspannen:

RB-2 = RB-3 = RD-2 = RD-3 = 2,5x28,36+25,29	= 96,12 KN
RC-2 = RC-3 = 2,5x18,13+16,03	= 61,36 KN
RF-2 = RF-3 = RM-2 = RM-3 = 2,5x28,63+28,19	= 99,8 KN
RG-2 = RG-3 = RL-2 = RL-3 = 2,5x26,65+17,83	= 84,5 KN
RH-2 = RH-3 = RK-2 = RK-3 = 2,5x26,65+28,19	= 94,8 KN
RJ-2 = RJ-3 = 2,5x26,65+17,83	= 84,46 KN

Vakwerkligger op de assen A t/m D en F t/m M (tussen 1-2 en 3-4)

profielen als voorgaande spanten

belastingen als voorgaande spanten, behoudens de normaalkrachten t.g.v. wind.

Spanningen:

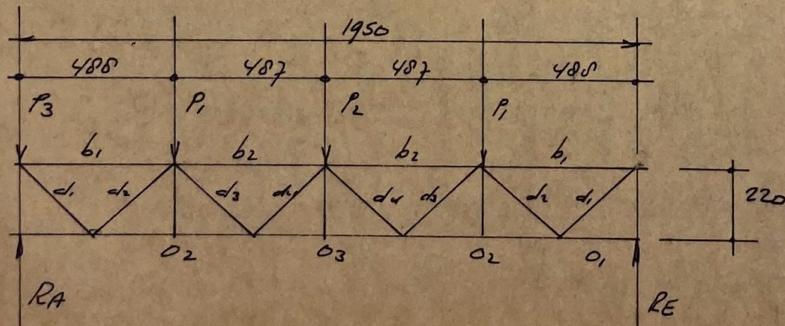
onderrand: als voorgaande spanten

diagonalen: als voorgaande spanten

bovenrand: toe te passen HE 160A, spanningen als voorgaande spanten met bovenregel HE 160A.

Reakties:

als voorgaande spanten, behoudens de reakties R11 en R4 daar deze nog moeten worden vermeerderd met de belasting. uit dakrand en gevelbeplating.

Vakwerkliggers op de assen 2 en 3 (tussen de assen A t/m D):

<u>Belastingen:</u>		= 7,31 KN
P1 van e.g. spant:	4,87x1,0x1,5	= 192,24 -
- spanten:	2x96,12	199,55 KN
		= 7,31 KN
P2 van e.g. soant		= 122,72 -
- spanten:	2x61,36	130,03 KN
		= 78,0 KN
P3 =	0,60xP2	
RA op kolom =	78,0+199,55+0,5x130,03	= 342,6 KN
RE op kolom =	199,55+0,5x130,03+3,6	= 268,2 KN

#### Staafkrachten:

Staaf 01:	nulstaaf	
Staaf 02:	$T = \frac{4,88x(342,6-78,0)}{2,20}$	= +587,0 KN
Staaf 03:	$T = \frac{9,75x(342,6-78,0)-4,87x199,55}{2,20}$	= +730,0 KN
Staaf b1:	$N' = \frac{-2,44x(342,6-78,0)}{2,20}$	= -293,0 KN
Staaf b2:	$N' = \frac{-7,315x(342,6-78,0)+2,435x199,55}{2,20}$	= -659,0 KN
Staaf d1, d2 =	$T = N' = \frac{3,29}{2,20} x (342,6-78,0)$	= +396 KN

Spanningen:  
onderrand: profiel HE140A  $\sigma = \frac{730x10^3}{31,4x10^2} = 232,6 \text{ N/mm}^2$

diagonaal profiel  $\not\equiv 125x125x6^3$  1c = 3,29 m  $\lambda = \frac{329}{4,80} = 69$

W = 1,46

$$\sigma = \frac{1,46x396,0x10^3}{28,9x10^2} = 200,0 \text{ N/mm}^2$$

bovenrand: profiel HE 200A N' max  
1c = 4,87 m  $\lambda = \frac{487}{4,98} = 98$  W = 1,96

$$\sigma = \frac{1,96x659,0x10^3}{53,8x10^2} = 240 \text{ N/mm}^2$$

vertikalen: prakt. profiel HE 140A

#### Kolom t.p.v. RA:

profiel HE "200A" 1cy = 6,00 m N' max = 342,6 KN

$$\lambda = \frac{600}{4,98} = 120 \quad W = 2,8$$

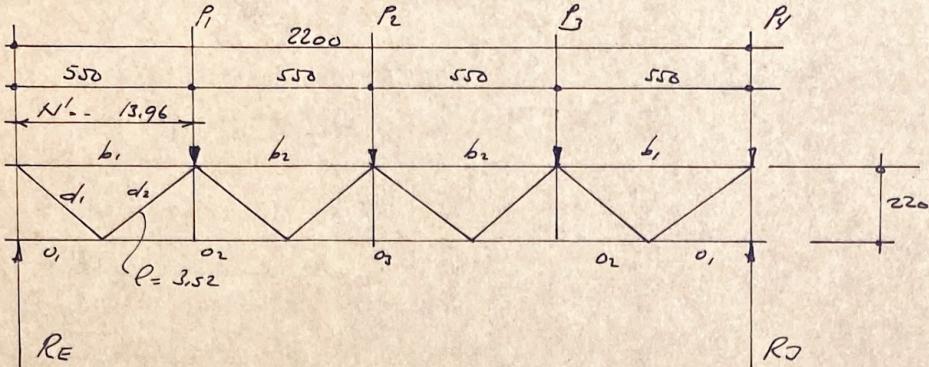
$$\sigma = \frac{2,80x342,6x10^3}{53,8x10^2} = 178,3 \text{ N/mm}^2$$

Vakwerkliggers op de assen 1 en 4 (tussen de assen A t/m D):

belasting x0,5 de belasting van het voorgaande spant.

om praktische redenen wordt hetzelfde spant toegepast.

Vakwerkliggers op de as 2: (tussen de assen E t/m N)



Belastingen:

P1 van e.g. spant:	5,50x1,0x1,5	= 8,25 KN
- spanten:	2x99,8	<u>= 199,6 -</u>
		207,85 KN
P2 van e.g. spant		= 8,25 KN
- spanten:	2x84,5	<u>= 169,0 -</u>
		177,25 KN
P3 van e.g. spant		= 8,25 KN
- spanten:	2x94,8	<u>= 189,6 -</u>
		197,85 KN
P4 van e.g. spant		= 4,13 KN
- spanten:	2x84,5x0,5	<u>= 84,50 -</u>
		88,63 KN
RE = 4,13+0,25x197,85+0,50x177,25+0,75x207,85		= 298,1 KN
RJ = 0,25x207,85+0,50x177,25+0,75x197,85+88,63		= 377,6 KN

Staafkrachten:

Staaf 01:	nulstaaf	
Staaf 02: T =	<u>5,50x298,1</u> 2,20	= + 745 KN
Staaf 03: T =	<u>11,00x298,1-5,50x207,85</u> 2,20	= + 971 KN
Staaf b1: N' =	<u>2,75x298,1</u> 2,20	= -372,6 KN
Staaf b2: N' =	<u>-8,25x298,1+2,75x207,85</u> 2,20	= 858,0 KN
Staaf d1, d2 = T =	<u>3,52</u> 2,20 x298,1	= 477,0 KN

Spanningen:

onderrand: profiel HE 180A  $\sigma = \frac{271 \times 10^3}{45,3 \times 10^2} = 214 \text{ N/mm}^2$

diagonaal: profiel  $\square$  125x125x8 lc = 3,52 m

$$k = \frac{352}{4,72} = 75 \quad W = 1,54$$

$$\sigma = \frac{1,54 \times 477 \times 10^3}{35,8} = 205 \text{ N/mm}^2$$

bovenrand: profiel HE 240A  $l_c = 5,50 \text{ m}$   $k = \frac{550}{6,00} = 92$

$$W = 1,83 \quad \sigma = \frac{1,83 \times 858 \times 10^3}{76,8 \times 10^2} = 204 \text{ N/mm}^2$$

vertikalen: prakt. profiel HE 140A.

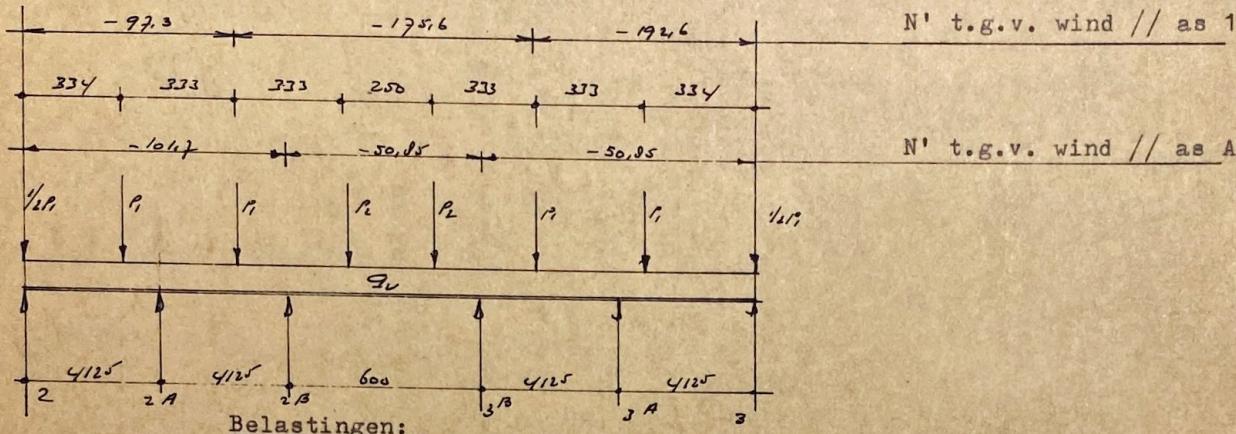
#### Kolom t.p.v. RJ:

profiel HE 240A  $l_c = 6,00 \text{ m}$   $N' = 2 \times 377,6$   $= 755,2 \text{ KN}$

$$k = \frac{600}{6,00} = 100 \quad W = 2,04$$

$$\sigma = \frac{2,04 \times 755,2 \times 10^3}{76,8 \times 10^2} = 200,6 \text{ N/mm}^2$$

Ligger op as N: profiel HE 140A



q<sub>v</sub> van e.g. ligger:  $1,50 \times 0,3 = 0,45 \text{ KN/m}'$

- dakrand + gevel:  $3,00 \times 0,25 \times 1,5 = 1,13 -$

$1,58 \text{ KN/m}'$

P1 van gordingen  $= 10,0 \text{ KN}$

P2 van gordingen  $= 7,78 \text{ KN}$

N' in ligger: zie Schema.

#### Momenten bij vrije oplegging:

Velden 2-2<sup>A</sup>, 3-3<sup>A</sup>

$$R2-2^A = 2,06 \times 1,58 + \frac{0,785}{4,125} \times 10,0 = 5,16 \text{ KN}$$

$$R2^A-2 = 3,26 \times 8,1 = 11,36 \text{ KN}$$

$$+Mo = \frac{5,16^2}{2 \times 1,58} = 8,42 \text{ KNm}$$

Velden  $2^A - 2^B, 3^A - 3^B$ 

$$\begin{aligned} R2^A - 2^B &= 2,06 \times 1,58 + \frac{1,58}{4,125} \times 10,0 & = 7,1 \text{ KN} \\ R2^B - 2^A &= 3,3 + 6,2 & = 9,5 \text{ KN} \\ +Mo &= 2,545 \times 7,1 - \frac{2,545^2}{2} \times 1,58 & = 12,95 \text{ KNm} \end{aligned}$$

Veld  $2^B - 3^B$ 

$$\begin{aligned} Mo &= \frac{1/8 \times 1,58 \times 6,00^2}{1,75 \times 7,78} & = 7,11 \text{ KNm} \\ & & = 13,6 \text{ -} \\ & & = 20,71 \text{ KNm} \end{aligned}$$

$$\begin{aligned} \text{reken } +M3^A - 3 &= 0,8 \times 8,42 & = 6,74 \text{ KNm} \\ -M3^A &= 0,6 \times 12,95 & = 7,77 \text{ KNm} \end{aligned}$$

$$l_{cx} = 4,125 \text{ m } l_x = \frac{412,5}{5,73} = 72 \quad \sigma_{EX} = 400 \text{ N/mm}^2$$

$$l_{cy} = 3,34 \text{ m } l_y = \frac{324,0}{3,52} = 95 \quad W = 1,91$$

$$n_x = \frac{400 \times 31,4 \times 10^2}{192,6 \times 10^3} = 6,5$$

$$\begin{aligned} \sigma_{max} &= \frac{1,91 \times 192,6 \times 10^3}{31,4 \times 10^2} + \frac{6,5}{5,5} \times \frac{7,77 \times 10^6}{155 \times 10^3} = \\ &= 117 + 59,2 = 176,2 \text{ N/mm}^2 \end{aligned}$$

$$\text{reken } +M2^B - 3^B = -M2^B = -M3^B = 0,6 \times 20,71 = 12,4 \text{ KNm}$$

$$l_{cx} = 6,00 \text{ m } l_x = \frac{600}{5,72} = 105 \quad W = 2,18 \quad \sigma_{EX} = 188 \text{ N/mm}^2$$

$$l_{cy} = 3,34 \text{ m } l_y = 95$$

$$n_x = \frac{188 \times 31,4 \times 10^2}{175,6 \times 10^3} = 3,4$$

$$\begin{aligned} \sigma_{max} &= \frac{2,18 \times 175,6 \times 10^3}{31,4 \times 10^2} + \frac{3,4}{2,4} \times \frac{12,4 \times 10^6}{155 \times 10^3} = \\ &= 122 + 113 = 235 \text{ N/mm}^2 \end{aligned}$$

Reakties:

$$R2 = R3 = 5,16 - \frac{6,74}{4,125} + 5,0 = 8,55 \text{ KN}$$

$$R2^A = R3^A = 11,36 + 7,1 + \frac{6,74 + 6,74 \cdot 12,4}{4,125} = 18,7 \text{ KN}$$

$$\begin{aligned} R-2^B R3^B &= 9,5 + 3,0 \times 1,58 + 7,78 = 22,02 \text{ KN} \\ &\quad - \frac{56,74 + 12,40}{4,125} = -1,37 \text{ -} \\ &\quad = 23,39 \text{ KN} \end{aligned}$$

Hoeklijn op de gording:

t.p.v. as N

$$= 1,13 \text{ KN/m'}$$

qv van gevel

$$= 1,81 \text{ KN/m'}$$

qh van wind:

$$1,50 \times 1,1 \times 0,73 \times 1,5$$

$$= 1,26 \text{ KNm}$$

 $\pm Mv =$ 

$$1/10 \times 1,13 \times 3,34^2$$

$$= 2,02 \text{ KNm}$$

 $\pm Mh =$ 

$$1/10 \times 1,81 \times 3,34^2$$

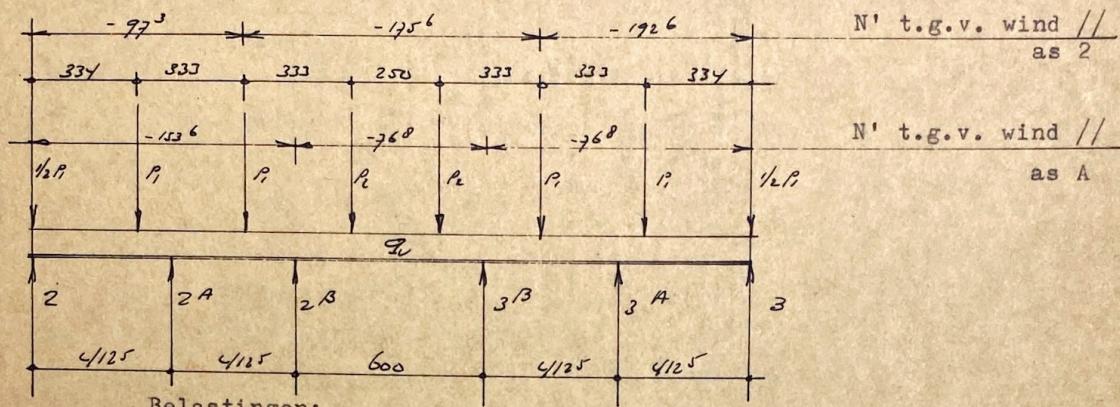
$$\text{profiel L}80 \times 80 \times 10 \quad \sigma_{\max} = \frac{1,26 \times 10^6}{15,5 \times 10^3} + \frac{2,02 \times 10^6}{15,5 \times 10^3} = \\ = 81 + 130 = 211 \text{ N/mm}^2$$

t.p.v. as E

profiel C-120

$$\sigma_{\max} = \frac{1,26 \times 10^6}{60,7 \times 10^3} + \frac{2,02 \times 10^6}{11,1 \times 10^3} = 20,8 + 182 = 202,8 \text{ N/mm}^2$$

Ligger op as E: profiel HE 140B



## Belastingen:

$$\begin{array}{lll}
 \text{qv van e.g. ligger: } & 1,50 \times 0,3 & = 0,45 \text{ KN/m} \\
 - \text{ gevel: } & 3,00 \times 0,25 \times 1,5 & = 1,13 - \\
 & & \hline
 & & 1,58 \text{ KN/m}
 \end{array}$$

$$P_1 \text{ van gordingen: } 10.0 + 7.72 = 17.72 \text{ KN}$$

P2 van gordingen: 7.78+6.88 = 14.66 VN

N' in ligger: zie schema

#### Momenten bij vrije oplegging:

Velden 2-2<sup>A</sup>, 3-3<sup>A</sup>

$$R2-2^A = 2,06 \times 1,58 + \frac{0,785}{4,125} \times 17,72 = 6,63 \text{ KN}$$

$$R^2_A - 2 = 3.26 + 14 \cdot 35 = 17.61 \text{ KN}$$

$$M_o = 3,34 \times 6,63 - \frac{3,34^2}{2} \times 1,58 = 13,3 \text{ KNm}$$

Velden  $2^A - 2^B$ ,  $3^A - 3^B$

$$R2^A - 2^B = 2,06 \times 1,58 + \frac{1,58}{4,125} \times 17,72 = 10,1 \text{ KN}$$

$$R^2_{-2}{}^B - 2^A = 3,26 + 10.9 = 14.2 \text{ KV}$$

$$+ Mo = 2,545 \times 10,1 - \frac{2,545^2}{2} \times 1,58 = 20.6 \text{ KNm}$$

Veld 2<sup>B</sup>-3<sup>B</sup>

$$\begin{array}{lcl} Mo = & 1/8 \times 1,58 \times 6,00^2 + 1,75 \times 14,66 & = 7,11 \text{ KNm} \\ & & = 25,66 - \\ & & 32,77 \text{ KNm} \end{array}$$

$$\begin{array}{lll} \text{reken } +M_3^A-3 = & 0,8 \times 13,3 & = 10,64 \text{ KNm} \\ -M_3 A = & 0,6 \times 20,6 & = 12,36 \text{ KNm} \end{array}$$

$$l_{cx} = 4,125 \text{ m} \quad k_x = \frac{412,5}{5,93} = 70 \quad J_{EX} = 423 \text{ N/mm}^2$$

$$l_{cy} = 3,34 \text{ m} \quad k_y = \frac{334}{3,58} = 93 \quad W = 1,85$$

$$n_x = \frac{4,23 \times 43,0 \times 10^2}{192,6 \times 10^3} = 9,4$$

$$J_{\max} = \frac{1,85 \times 192,6 \times 10^3}{43,0 \times 10^2} + 9,4 \quad \frac{12,36 \times 10^6}{216 \times 10^3} \\ = 82,9 + 64 = 146,9 \text{ N/mm}^2$$

$$\text{reken } +M_2^B-3^B = -M_2^B = -M_3^B = 0,6 \times 32,77 = 19,66 \text{ KNm}$$

$$l_{cx} = 6,00 \text{ m} \quad k_x = \frac{600}{5,93} = 103 \quad W = 2,12 \quad EX = 195 \text{ N/mm}^2$$

$$l_{cy} = 3,34 \text{ m} \quad k_y = 93$$

$$n_x = \frac{195 \times 43,0 \times 10^2}{175,6 \times 10^3} = 4,8$$

$$J_{\max} = \frac{2,12 \times 175,6 \times 10^3}{43,0 \times 1,2} + \frac{4,8}{3,8} \quad \frac{19,66 \times 10^6}{216 \times 10^3} \\ = 87,0 + 115 = 202 \text{ N/mm}^2$$

Reakties:

$$R_2 = R_3 = 6,63 + 8,86 - \frac{12,36}{4,125} = 18,49 \text{ KN}$$

$$R_2^A = R_3^A = 17,61 + 10,1 + \frac{12,36 + 12,36 - 19,66}{4,125} = 28,94 \text{ KN}$$

$$R_2^B = R_3^B = 14,1 + 3,00 \times 1,58 + 14,66 + \frac{19,66 - 12,36}{4,125} = 33,6 \text{ KN}$$

$$= 1,8 -$$

$$35,4 \text{ KN}$$

Gevelregels op de assen 1 en 4:

1t = 2x5,50 m profiel L-140

Belastingen:

$$q \text{ van wind: } 3,50 \times 1,1 \times 0,71 \times 1,5 = 4,1 \text{ KN/m}^2$$

$$-M_{\max} = 1/8 \times 4,1 \times 5,50^2 = 15,5 \text{ KNm}$$

$$J = \frac{15,5 \times 10^6}{86,4 \times 10^3} = 179 \text{ N/mm}^2$$

doorbuiging: niet maatgevend.

Gevelregels op de assen E en N:

1t = 2x4,125 m profiel L-120

Belastingen:

$$q \text{ van wind} = 4,1 \text{ KN/m}^2$$

$$-M = 1/8 \times 4,1 \times 4,125^2 = 8,7 \text{ KNm}$$

$$\sigma = \frac{8,7 \times 10^6}{60,7 \times 10^3} = 144 \text{ N/mm}^2$$

doorbuiging: niet maatgevend.

Horizontale regel achter de deur:

lt = 6,00 m profiel L-180

Belastingen:

$$q \text{ van wind: } 3,50 \times 1,1 \times 0,71 \times 1,5 = 4,1 \text{ KN/m}$$

$$M = 1/8 \times 4,1 \times 6,00^2 = 18,45 \text{ KNm}$$

$$\sigma = \frac{18,45 \times 10^6}{150 \times 10^3} = 123 \text{ N/mm}^2$$

$$f = \frac{5 \times 4,1 \times 6,00^4 \times 10^{12}}{384 \times 10^9 \times 1350 \times 1,5} = 16,3 \text{ N/mm}^2 (= 1/368 1)$$

Vertikale regel onder de deur:

lt = 4,125 - 6,00 - 4,125 m profiel L-140

Belastingen:

$$q \text{ van e.g. ligger: } 1,5 \times 0,30 = 0,45 \text{ KN/m}$$

$$P \text{ van deur} = 5,0 \text{ KN}$$

$$-M = \begin{aligned} & 1/12 \times 0,45 \times 6,00^2 \times 0,52 = 0,70 \text{ KNm} \\ & 1/8 \times 0,45 \times 4,125^2 \times 0,48 = 0,46 \text{ -} \\ & 1/8 \times 5,0 \times 6,00 \times 0,52 = 3,9 \text{ -} \\ & \hline 5,06 \text{ KNm} \end{aligned}$$

$$+M = \begin{aligned} & 1/8 \times 0,45 \times 6,00^2 - 0,70 - 0,46 = 0,87 \text{ KNm} \\ & 1/4 \times 5,0 \times 6,00 - 3,9 = 3,6 \text{ -} \\ & \hline 4,47 \text{ KNm} \end{aligned}$$

$$\sigma_{\max} = \frac{5,06 \times 10^6}{86,4 \times 10^3} = 58,6 \text{ N/mm}^2$$

Kolommen op de assen E en N naast de deur:

profiel L-220

$$N' \text{ max van dakregel} = 35,4 \text{ KN}$$

$$- \text{ deuren} = 5,0 \text{ -}$$

$$40,4 \text{ KN}$$

$$q \text{ van wind: } 5,06 \times 1,1 \times 0,71 \times 1,5 = 5,9 \text{ KN/m}$$

$$M = 1/8 \times 5,9 \times 6,80^2 = 34,1 \text{ KNm}$$

$$l_{cx} = 6,80 \text{ m } k_x = \frac{680}{8,48} = 84 \quad \sigma_{EX} = 293 \text{ N/mm}^2$$

$$l_{cy} = 4,50 \text{ m } k_y = \frac{450}{2,30} = 195 \quad w = 7,34$$

$$n_x = \frac{293 \times 37,4 \times 10^2}{40,4 \times 10^3} = 37,2$$

$$\sigma_{\max} = \frac{7,34 \times 40,4 \times 10^3}{37,4 \times 10^2} + \frac{27,2}{26,2} \times \frac{34,1 \times 10^6}{245 \times 10^3}$$

$$= 80 + 145 = 225 \text{ N/mm}^2$$

Overige kolommen op de assen E en N:

op de as 3:

$$\begin{array}{lll} N' \text{ max van spant A-E} & = 268,2 \text{ KN} \\ - \text{ daklijger: } 2x28,94 & = 57,9 \text{ -} \\ - \text{ gording} & = 10 \text{ -} \end{array}$$

$$M_{exc.} = 0,26 \times 268,2 = 69,7 \text{ KNm}$$

$$q \text{ van wind: } 4,125 \times 1,1 \times 0,71 \times 1,5 = 4,83 \text{ KN/m}^2$$

$$M = 1/8 \times 4,83 \times 5,10^2 = 15,7 \text{ KNm}$$

$$\text{profiel HE 240A } l_{cx} = 5,80 \text{ m } k_x = \frac{580}{10,1} = 57 \text{ } \zeta_{EX} = 637 \text{ N/mm}^2$$

$$n_x = \frac{637 \times 76,8 \times 10^2}{336,1 \times 10} = 14,6 \quad l_{cy} = 4,50 \text{ m } k_y = \frac{450}{6,00} = 75 \quad W = 1,54$$

$$\zeta_{max} = \frac{1,54 \times 336,1 \times 10^3}{76,8 \times 10^2} + \frac{14,6}{13,6} \times \frac{(15,7 + 69,7 \times 0,85) \times 10^6}{675 \times 10^3}$$

$$= 67,0 + 120 = 187 \text{ N/mm}^2$$

op as 3: t.p.v. E

$$N' \text{ max van spant A-E} = 268,2 \text{ KN}$$

$$- \text{ daklijger} = 57,9 \text{ -}$$

$$- \text{ gording} = 10 \text{ -}$$

$$- \text{ spant E-3} = 298,1 \text{ -}$$

$$634,1 \text{ KN}$$

$$q \text{ van wind} = 4,83 \text{ KN/m}^2$$

$$M_{exc.} = 0,375 \times 268,2 - 0,115 \times 298,1 = 66,3 \text{ KNm}$$

t.p.v. N

$$N' \text{ max van spant} = 298,1 \text{ KN}$$

$$- \text{ daklijger: } 2x8,55 = 17,1 \text{ -}$$

$$315,2 \text{ KN}$$

$$q \text{ van wind} = 4,83 \text{ KN/m}^2$$

t.p.v. as E: profiel HE 240A  $n_x = 7,7$

$$\zeta = \frac{1,54 \times 634,1 \times 10^3}{76,8 \times 10^2} + \frac{7,7}{6,7} \frac{(15,7 + 66,3 \times 0,85) \times 10^6}{675 \times 10^3}$$

$$= 127 + 112,7 = 239,7 \text{ N/mm}^2$$

$$\text{t.p.v. as E: profiel HE180A } M = 1/8 \times 4,83 \times 5,10 = 15,7 \text{ KNm}$$

$$l_{cx} = 5,80 \text{ m } k_x = \frac{580}{7,45} = 78 \quad \zeta_{EX} = 3,40 \text{ N/mm}^2$$

$$l_{cy} = 4,50 \text{ m } k_y = \frac{450}{4,52} = 100 \quad W = 2,04$$

$$n_x = \frac{340 \times 45,3 \times 10^2}{315,2 \times 10^3} = 4,9$$

$$\sigma_{\max} = \frac{2,04 \times 315,2 \times 10^3}{45,3 \times 10^2} + \frac{4,9}{3,9} \times \frac{15,7 \times 10^6}{294 \times 10^3}$$

$$= 142 + 67 = 209 \text{ N/mm}^2$$

t.p.v. de windbokken:N' max uit daklijger:  $2 \times 28,94$ 

= 57,9 KN

van wind:  $\frac{7,30 \times 76,8}{8,25 \times 0,5}$

= 136,0 -

193,9 KN

q van wind

M =  $\frac{1/8 \times 4,83 \times 7,30^2}{\text{profiel HE 180A } l_{cx} = 7,30 \text{ m } k_x = \frac{730}{7,45} = 98 \sigma_{\text{EX}} = 216 \text{ N/mm}^2}$  = 32,2 KNm

$l_{cy} = 4,50 \text{ m } k_y = \frac{450}{4,52} = 100 \quad W = 2,04$   
 $n_x = \frac{216 \times 45,3 \times 10^2}{193,9 \times 10^3} = 5,0$

$\sigma_{\max} = \frac{2,04 \times 193,9 \times 10^3}{45,0 \times 10^2} + \frac{5,0}{4,0} \times \frac{32,2 \times 10^6}{294 \times 10^3}$   
= 87,0 + 137 = 224 N/mm<sup>2</sup>

Kolommen op de assen 1 en 4:

N' max van dakspant

= 99,8 KN

- dakrand:  $3,00 \times 5,50 \times 0,25 \times 1,5$

= 6,2 -

106 KN

van wind:  $\frac{7,30 \times 100,56}{5,50}$

= 133,5 -

239,5 KN

q van wind:  $5,50 \times 1,1 \times 0,71 \times 1,5$ 

= 6,44 KN/m

M =  $\frac{1/8 \times 6,44 \times 6,00^2}{\text{profiel HE 180A } \rightarrow \sigma_{\text{EX}} = 240 \text{ N/mm}^2}$

= 29,0 KNm

profiel HE 180A  $\rightarrow \sigma_{\text{EX}} = 240 \text{ N/mm}^2$ tussenkolommen op as 3:

profiel IPE 240

N' max van spanten:  $2 \times 99,8$ 

= 199,6 KN

- gording:

= 18,0 -

- wind:  $\frac{7,30 \times 141,24}{5,50}$

= 187,4 -

405,0 KN

q van wind:  $5,50 \times 0,7 \times 0,71 \times 1,5$ 

= 4,1 KN/m

M  $\frac{1/8 \times 4,1 \times 6,0^2}{\text{lx } = 6,00 \text{ m } k_x = \frac{600}{9,97} = 60 \sigma_{\text{EX}} = 575 \text{ N/mm}^2}$

= 18,5 KNm

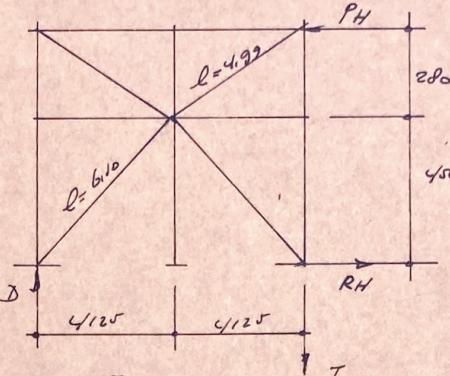
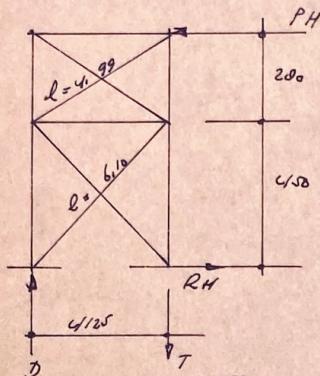
$l_{cy} = 2,80 \text{ m } k_y = \frac{280}{2,69} = 105 \quad W = 2,18$

$n_x = \frac{575 \times 39,1 \times 10^2}{217,6 \times 10^3} = 10,3$

$\sigma = \frac{2,18 \times 405,0 \times 10^3}{39,1 \times 10^2} = 226 \text{ N/mm}^2$

of  $\sigma = \frac{2,18 \times 217,6 \times 10^3}{39,1 \times 10^2} + \frac{10,3}{9,3} + \frac{18,5 \times 10^6}{324 \times 10^3} = 121,0 + 63,2 = 184,2 \text{ N/mm}^2$

Windbokken  
op as E en N:



PH van wind is: op as E  
 op as N

$$= 76,8 \text{ KN}$$

$$= 50,85 \text{ KN}$$

met diagonaalkrachten:

$$S = \frac{4,99}{4,125} \times 76,8 (50,85) = 92,9 (61,5) \text{ KN}$$

$$S = \frac{6,10}{4,125} \times 76,8 (50,85) = 113,6 (75,2) \text{ KN}$$

voor  $S = 113,6 \text{ KN}$  profiel  $\neq 80 \times 10 \text{ A}$  netto  $= 580 \text{ mm}^2$

$$\sigma = \frac{113,6 \times 10^3}{580} = 196 \text{ N/mm}^2$$

voor  $S = 92,9 \text{ KN}$  profiel  $\neq 70 \times 10 \text{ A}$  netto  $= 480 \text{ mm}^2$

$$\sigma = \frac{92,9 \times 10^3}{480} = 194 \text{ N/mm}^2$$

voor  $S = 75,2 \text{ KN}$  profiel  $\neq 60 \times 10 \text{ A}$  netto  $= 380 \text{ mm}^2$

$$\sigma = \frac{75,2 \times 10^3}{380} = 198 \text{ N/mm}^2$$

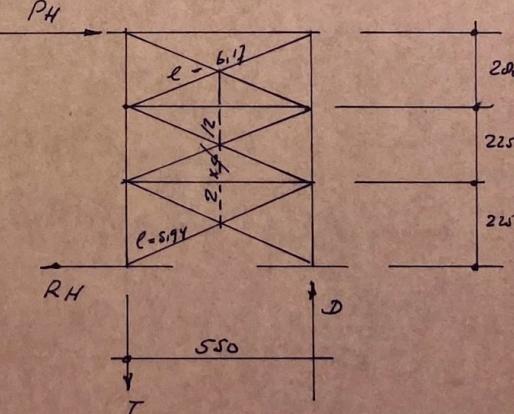
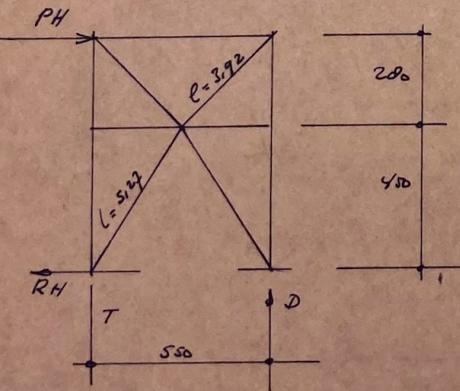
voor  $S = 61,5 \text{ KN}$  profiel  $\neq 60 \times 8 \text{ A}$  netto  $= 304 \text{ mm}^2$

$$\sigma = \frac{61,5 \times 10^3}{304} = 202 \text{ N/mm}^2$$

Op as 1,3 en 4:

as 1-4:

as 3:



as 1, PH	= 100,56 KN
as 4, PH	= 53,48 KN
as 3, PH	= 141,24 KN

max. diagonaalkrachten:

as 1:  $S = \frac{5,27}{2,75} \times 100,56$  = 192,7 KN  
profiel  $\neq 120x10$  A netto = 980 mm<sup>2</sup>

$$\sigma = \frac{192,7 \times 10^3}{980} = 197 \text{ N/mm}^2$$

as 4,  $S = \frac{5,27}{2,75} \times 53,48$  = 102,5 KN  
profiel  $\neq 70x10$  A netto = 480 mm<sup>2</sup>

$$\sigma = \frac{102,5 \times 10^3}{480} = 214 \text{ N/mm}^2$$

as 3:  $S = \frac{6,17}{5,50} \times 141,24 = 158,4 \text{ KN}$   
profiel  $2x\neq 60x10$  A netto = 760 mm<sup>2</sup>  
 $\sigma = \frac{158,4 \times 10^3}{760} = 208 \text{ N/mm}^2$

Horizontale regel op as 3: N' max = 141,24 KN  
profiel L-240 lcx = 5,50 m  $\lambda = \frac{550}{9,22} = 60,0$

$$\text{lcy} = 2,75 \text{ m } \lambda = \frac{275}{2,42} = 114 \text{ W} = 2,51$$

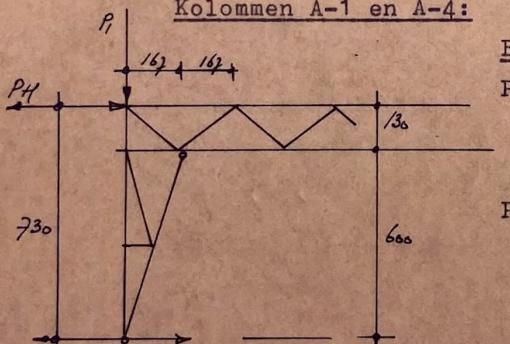
$$\sigma = \frac{2,51 \times 141,24 \times 10^3}{42,3 \times 10^2} = 83,8 \text{ N/mm}^2$$

Horizontale regel op de assen E en N:

profiel HE 100A N' max = 76,8 KN

$$\text{lc} = 4,125 \text{ m } \lambda = \frac{412,5}{2,51} = 164 \text{ W} = 5,2$$

$$\sigma = \frac{5,2 \times 76,8 \times 10^3}{21,2 \times 10^2} = 188 \text{ N/mm}^2$$

Kolommen A-1 en A-4:Belastingen:

P1 van e.g. + n.b. =  $0,50 \times 342,6 = 171,3 \text{ KN}$

- gevel:  $9,75 \times 3,5 \times 0,5 \times 1,5 = 25,6 \text{ - }$

196,9 KN

= 55,9 KN

N' in kolom:  $\frac{6,00 \times 55,9}{1,67} + 196,9 = 400,0 \text{ KN}$

profiel HE 200A lcx = 5,00 m  $\lambda_x = \frac{500}{8,28} = 60 \text{ W} = 1,34$

$$\sigma = \frac{1,84 \times 400,0 \times 10^3}{53,8 \times 10^2} = 100 \text{ N/mm}^2$$

$$\text{lc}_y = 3,00 \text{ m } \lambda_y = \frac{300}{4,98} = 60$$

overige profielen: praktisch.

Konstruktie luifel:Belastingaannamen:

q op dak hal en luifel

$$= 1,22 \text{ KN/m}^2$$

Windbelastingen:

Wind // as 1

$$q \text{ volgens de gew.ber. blz. 7: } 1,50x \frac{227,8}{19,40x2}$$

$$= 8,8 \text{ KN/m}^2$$

$$M \text{ in windverband: } 1/8x8,80x19,00^2$$

$$= 397,1 \text{ KNm}$$

$$T = D =$$

$$\frac{397,1}{5,625}$$

$$= 70,6 \text{ KN}$$

$$N' \text{ max in gording: } 2,50x3,18x8,8$$

$$= 69,9 \text{ KN}$$

$$T \text{ in diagonaal: } \frac{6,46}{5,625} \times 69,9$$

$$= 80,3 \text{ KN}$$

$$P \text{ op windbok: }$$

$$\frac{227,8}{4} \times 1,5$$

$$= 85,4 \text{ KN}$$

Wind // as A

$$q =$$

$$3,30x1,2x0,73x1,5$$

$$= 4,34 \text{ KN/m}^2$$

$$19,15x0,04x0,73x1,5$$

$$= 0,84 -$$

$$5,18 \text{ KN/m}^2$$

$$M =$$

$$1/8x5,18x22,50^2$$

$$= 327 \text{ KNm}$$

$$T = D =$$

$$\frac{327}{3,18}$$

$$= 102,0 \text{ KN}$$

$$N' \text{ max in spant}$$

$$22,50x5,18$$

$$= 117 \text{ KN}$$

Gordingen:

profiel HE 120A, IPE 120

Belastingen:

q van e.g. ligger

$$= 0,30 \text{ KN/m}^2$$

$$- \text{ dak: }$$

$$3,18x1,22$$

$$= 3,9 -$$

$$4,2 \text{ KN/m}^2$$

N' max in gording

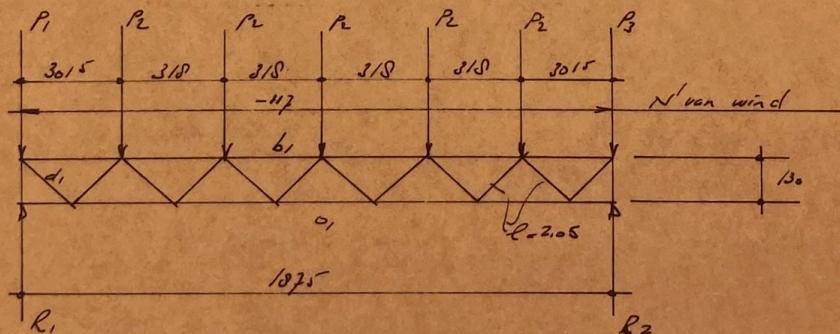
$$= -83,3 \text{ KN}$$

eindvelden HE 120A zie hal.

tussenvelden IPE 120 zie hal.

t.p.v. windliggers HE 120A zie hal.

Windverbanden prakt. profiel L55x55x6

Spannen t.p.v. gordingen:

Belastingen:

P1 van e.g. spant	=	1,2 KN
- gording:	=	13,0 -
- rand:	=	1,9 -
		16,1 KN

P2 van gording	=	26,0 KN
- e.g. spant	=	2,4 -
		28,4 KN

P3 =	=	14,2 KN
R1 =	=	87,1 KN
R2 =	=	85,2 KN

Staafkrachten:

$$\text{Staaf 01: } T = \frac{9,375x(87,1-16,1)-2x28,4x4,77}{1,30} = + 304 \text{ KN}$$

$$\text{Staaf b1: } N' = \frac{7,785x(87,1-16,1)-2x3,18x28,4}{1,30} = - 286 \text{ KN}$$

$$\text{Staaf d1: } T = \frac{2,05}{1,30} x (87,1-16,1) = + 112 \text{ KN}$$

Spanningen:

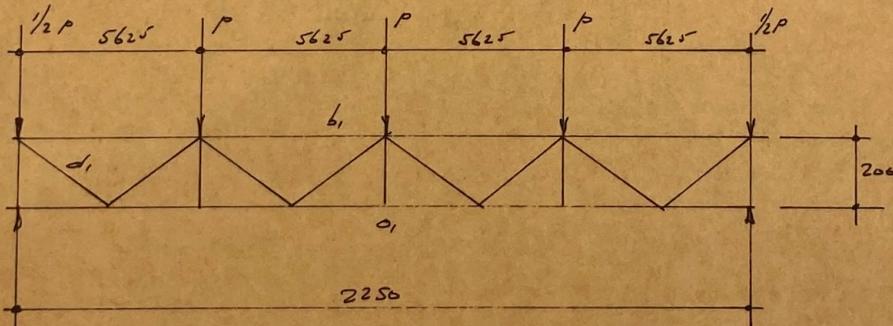
$$\text{bovenrand: HE 140A } \lambda = \frac{318}{3,52} = 90 \quad W = 1,80$$

$$\sigma = \frac{1,80x(280+117)x10^3}{31,4x10^2} = 231 \text{ N/mm}^2$$

$$\text{onderrand: L-120 } \lambda = \frac{304x10^3}{17,0x10^2} = 179 \text{ N/mm}^2$$

$$\text{diagonaal } \lambda = \frac{205}{2,29} = 90 \quad W = 1,80$$

$$\sigma = \frac{1,80x112x10^3}{8,69x10^2} = 232 \text{ N/mm}^2$$

Hoofdspannen:Belastingen:

P van e.g. spant	=	8,5 KN
- spant	=	87,1 -

RL = RR =	=	95,6 KN
	=	191,2 KN

Staafkrachten:

$$\text{Staaf 01: } T = \frac{11,25x(191,2-47,8)-5,625x95,6}{2,00} = 538 \text{ KN}$$

$$\text{Staaf b1: } N' = \frac{-1,9x5,625x(191,2-47,8)+2,81x95,6}{2,00} = -471 \text{ KN}$$

$$\text{Staaf d1: } N' = \frac{3,45}{2,00} x(191,2-47,8) = -248 \text{ KN}$$

Spanningen:

$$\text{bovenrand: HE 200A } I_c = 5,625 \text{ m}^4 \lambda = \frac{562,5}{4,98} = 113$$

$$W_o = 2,45 \quad \sigma = \frac{2,45x471x10^3}{53,8x10^2} = 215 \text{ N/mm}^2$$

$$\text{onderrand: HE 120A} \quad \sigma = \frac{538x10^3}{25,2x10^2} = 214 \text{ N/mm}^2$$

$$\text{diagonaal } \not\perp 110x110x5 \quad \lambda = \frac{345}{4,29} = 80 \quad W = 1,62$$

$$\sigma = \frac{1,62x248x10^3}{21,0x10^2} = 189 \text{ N/mm}^2$$

$$\text{Kolommen: profiel HE 200A } N' = 2x191,2 = 382,4 \text{ KN}$$

$$I_{cx} = 6,20 \text{ m} \quad \frac{620}{8,28} = 75$$

$$I_{cy} = 5,60 \text{ m} \quad \frac{560}{4,98} = 112 \quad W = 2,40$$

$$\sigma = \frac{2,40x382,4x10^3}{53,8x10^2} = 171 \text{ N/mm}^{12}$$

$$\text{t.p.v. windbok: } N' = \frac{7,30x85,4}{5,625} + 95,6x2 = 302,3 \text{ KN}$$

diagonalen:

$$S = \frac{7,94}{5,625} x 85,4 = 120,5 \text{ KN}$$

$$\text{profiel } \not\perp 80x10 \quad A \text{ netto} = 580 \text{ mm}^2$$

$$\sigma = \frac{120,5x10^3}{580} = 208 \text{ N/mm}^2$$

Rotterdam, 23 juni 1977.

Ing. T.A. van Hattem.

