

STATISCHE BEREKENING.
VAN PUNTDEUREN

ZUID-WILLEMSVAART: BERLICUM
SCHUNDEL
ERP
AARLE-RIKTEL
HELMOND
SOMEREN
SLUIS G
SLUIS H
SLUIS I

KANAAAL WESSEM-NEDERWEERT:

PANHEEL HOGE DEUR
PANHEEL LAGE DEUR

AUGUSTUS 1985

rijkswaterstaat directie bruggen

werk: ZUID-WILLEMSVAART EN
KANAAL WESSEN-NEDERWEERT
PUNTDEUREN

datum: AUG. 25

blz. 1

PUNT DEUR BERLICUM IS GELIJK AAN SLUIS G

" SCHIJNDEL " " " ERP

" AARLE-RIXTEL " " " SLUIS I

" SOMEREN " " " SLUIS H

" HELMOND

" PANHEEL HOOG

" PANHEEL LAAG

TOTAAL 7 VERSCHILLENDE DEUREN.

rijkswaterstaat directie bruggen

werk: ZUID-WILLEMSVAART EN
KANAAL WESSEM-NEDERWEERT
PUNTDEUREN

datum: AUG. '85

blz. 2

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ERP,
AARLE - RIXTEL
HELMOND
SOMEREN
SLUIS G
SLUIS H
SLUIS I

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werk: *ZUID-WILLEMSVAART EN
KANAAL WESSEM-NEDERWEERT
PUNTDEUREN*

datum: *AUG. '85*

blz. *3*

VERVOLG INDEX

UITGANGSPUNTEN VAN DE BEREKENING

ALGEMEEN:

DEZE BEREKENING IS GEBASEERD
OP DE TECHNISCHE GRONDSLAGEN VOOR DE
BEREKENING VAN BOUWKONSTRUKTIES
T.G.B 1972, NEN 3850 EN NEN 3851.

BELASTINGEN:

VOOR BELASTINGEN T.G.V DE WATERDRUK
ZIE INDEX.

VOOR BELASTING DOOR DUNPERS IS VOOR
ALLE DEUREN 310 KN AANGEHOUDEN.

UITVOERING:

BOVENDRAAIPUNT EN TAATS ZULLEN VOOR
ALLE DEUREN GELIJK UITGEVOERD WORDEN.

MATERIALEN:

DEURPLATEN, LIGGERS EN
VERSTIJVINGEN

FR 510 $\sigma_R = 360 \text{ N/mm}^2$

HALSPEN EN PASBOUTEN

FR 510 " "

TAATS EN TAATSSCHOEN

G.ST. 52 " = 240 N/mm^2

PASBOUTEN VOOR TAATSSCHOEN

FR 510 " = 360 N/mm^2

TAATSKOM EN KAPJE

MANGAANST.

$\sigma_0 = 1800 \text{ N/mm}^2$

ANKERS EN ANKER PLATEN

FR 510 $\sigma_R = 315 \text{ N/mm}^2$

HOUT AZOBÉ

$\sigma_d = 15 \text{ N/mm}^2$

rijkswaterstaat directie bruggen

LUID-NILLEMSVAART

werk: PUNTDEUREN

datum: AUG. '85

blz. 5

LAGE DEUR PANHEEL WESSEM-NEDERWEERT

Spa/Raacht PUNTDEUR ERP MAATGEVEND VOOR DE

DEUREN: BERLICUM

SCHIJNDEL

ERP

SLUIS 4

$$L = \frac{\sqrt{10} \times (6300 + 660)}{3} - 100 - \frac{130}{3}$$

$$= 7059,8 = 7060 \text{ mm.}$$

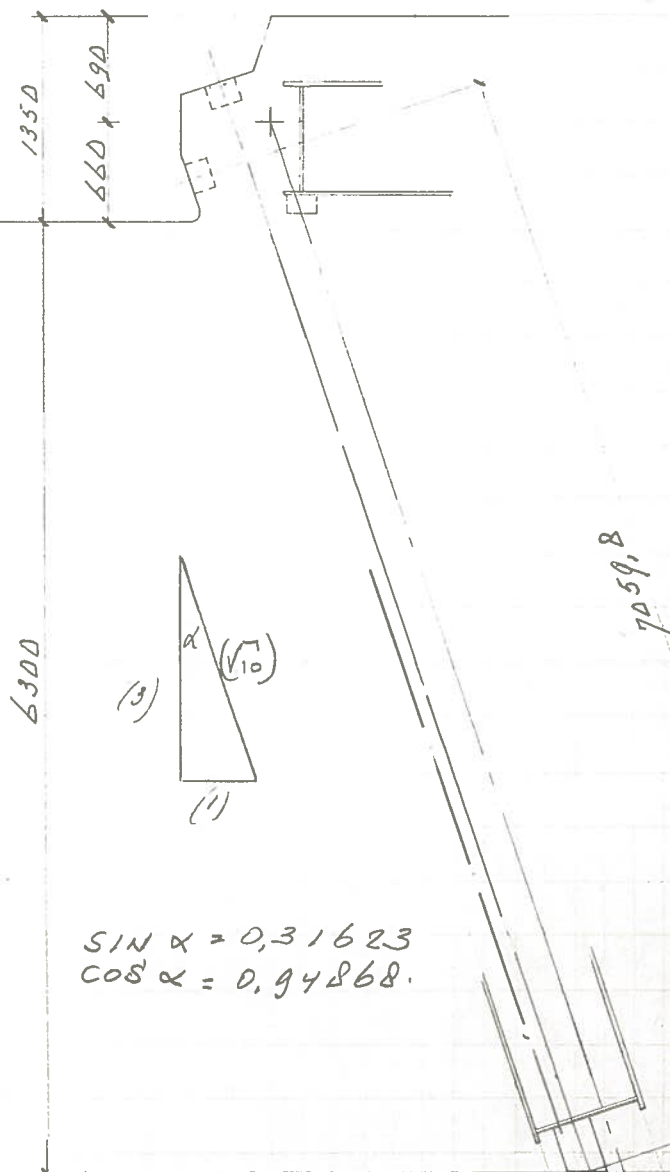
$$q_{\text{tot}} = 256,2 \times 7,060 = 1809 \text{ KN}$$

$$F = \frac{1}{2} \times q = 904 \text{ KN.}$$

$$R = 2 \cdot \cos \alpha \cdot F$$

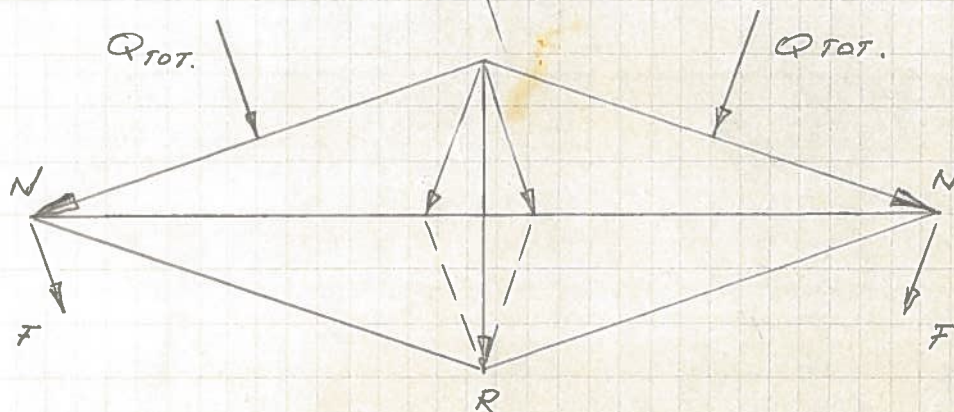
$$= 1715 \text{ KN.}$$

$$N = \frac{R}{2 \sin \alpha} = 2712 \text{ KN}$$



$$\sin \alpha = 0,31623$$

$$\cos \alpha = 0,94868.$$



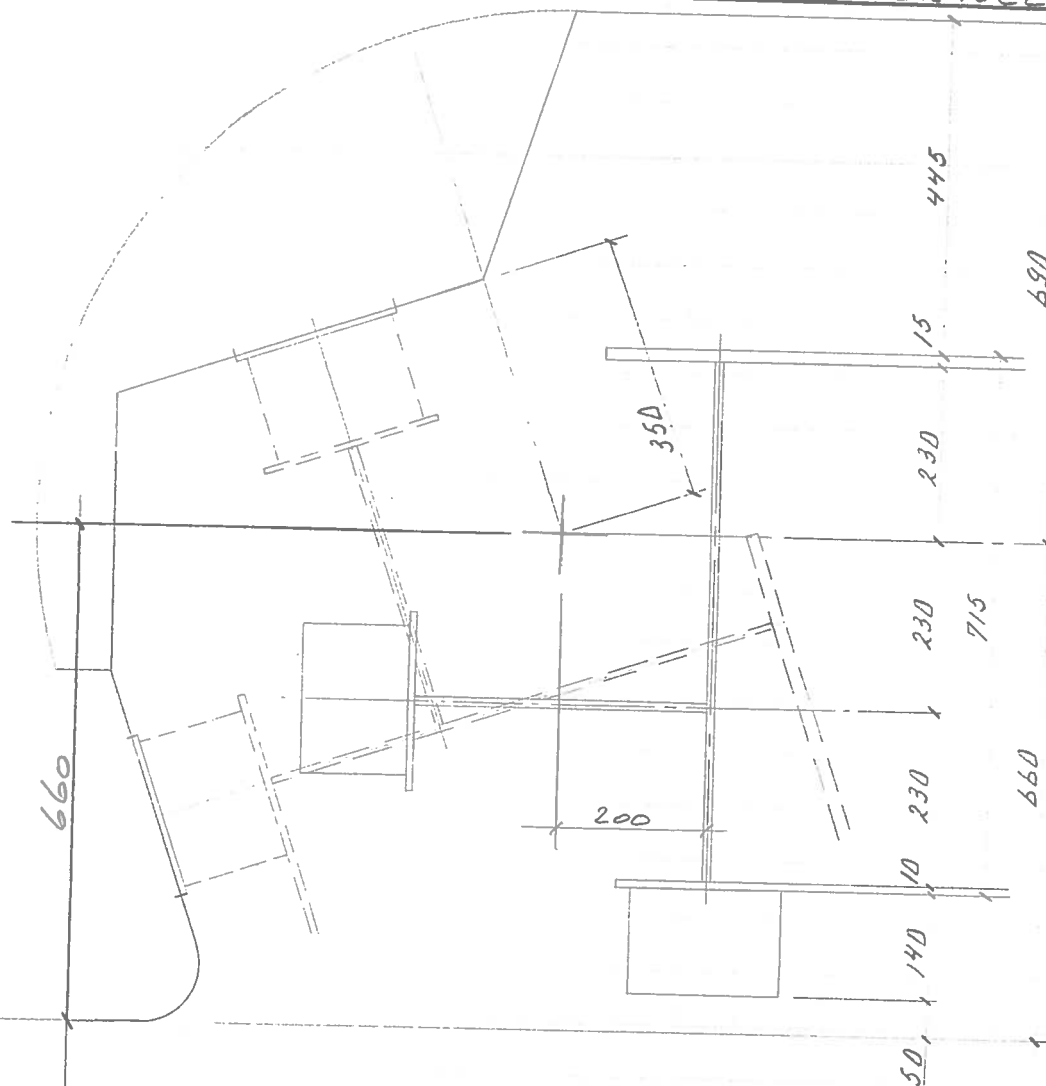
rijkswaterstaat directie bruggen

werk: Zuid-Willemsvaart

datum: Aug. '25

blz. 6

PUNTDEUREN + LAGE DEUR PANHEEL WESSEM-NEDERWEERT



SLUISBREEDTE 12,600

rijkswaterstaat directie bruggen

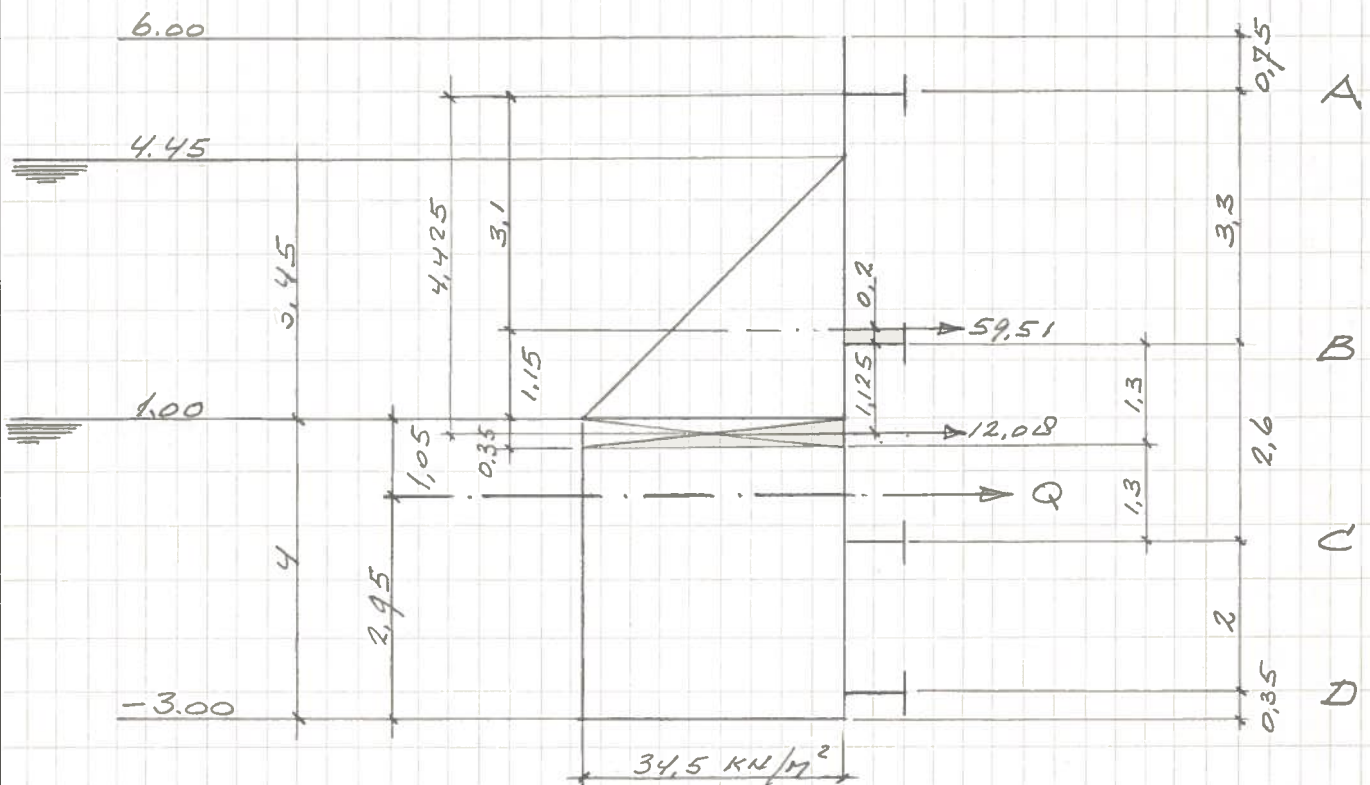
werk: LIJID-WILLEMSVAART
PUNTDEUREN.

datum: AUG. 85

blz. 4

WATERBELASTING OP DEUREN

BERLICUM.



$$Q = 4 \times 34,5 + 34,5 \times 3,45 \times 0,5 = \underline{197,5 \text{ kN/m}}$$

ZWAARTELIJN:

$$e = \frac{4 \times 34,5 \times 2 + 34,5 \times 3,45 \times 0,5 \times 5,15}{197,5} = \underline{2,95 \text{ m.}}$$

DRUK OP REGELS:

$$\text{REGEL A} = \frac{59,51 \times 0,2 - 12,08 \times 1,125}{3,3} = \underline{-0,51 \text{ kN/m'}}$$

$$\text{REGEL B} = \frac{12,08 \times 4,425 + 59,51 \times 3,1}{3,3} = \underline{72,1 \text{ kN/m'}}$$

$$\text{REGEL C} = (1,3 + 1) 34,5 = \underline{79,33 \text{ kN/m'}}$$

$$\text{REGEL D} = (0,35 + 1) 34,5 = \underline{46,58 \text{ kN/m'}}$$

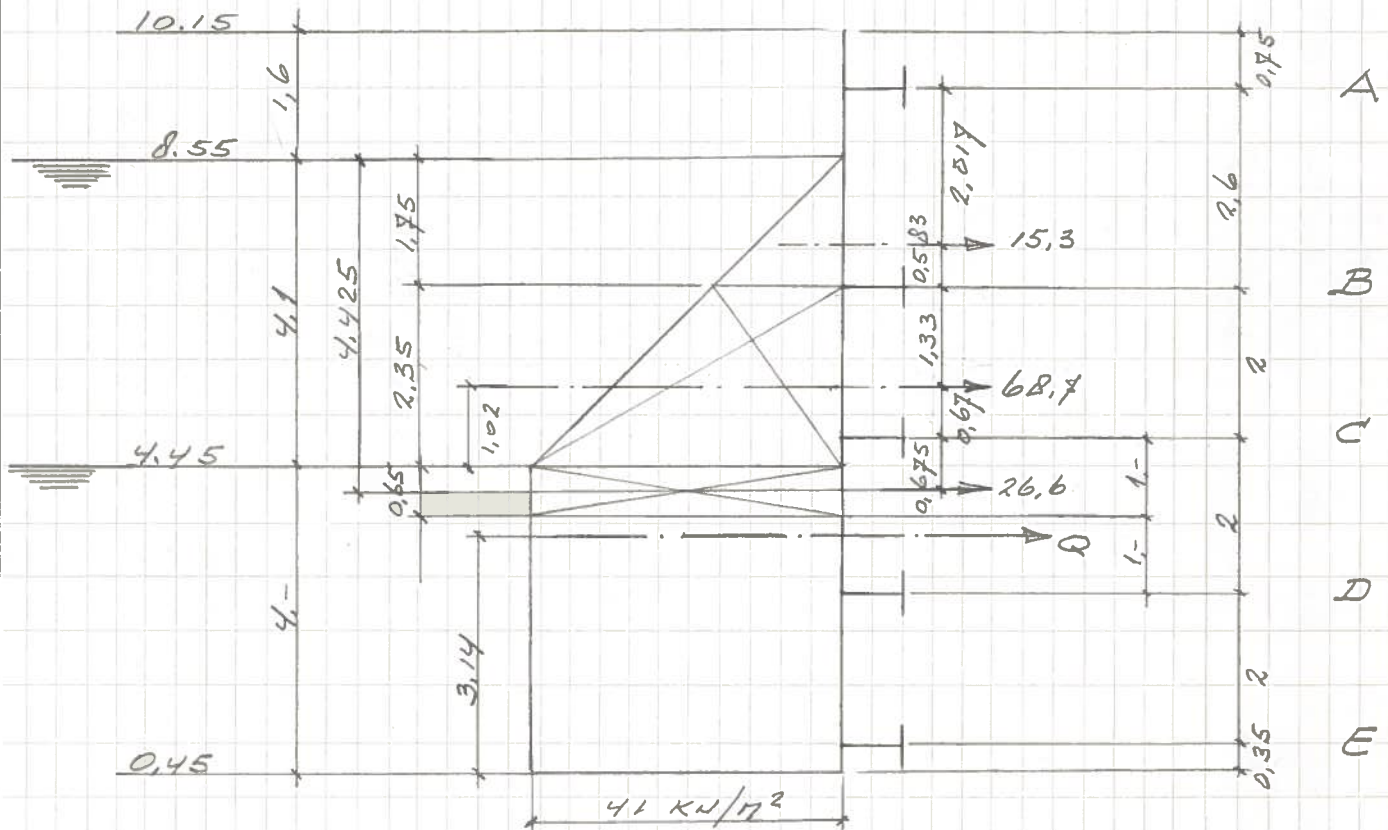
rijkswaterstaat directie bruggen

werk: LUID - WILLEMSKAART
PUNT DEUREN.

datum: AUG. 85

blz. 8

SCHIJNDEL



$$Q = 4 \times 41 + 41 \times 4.1 \times 0.5 = \underline{248 \text{ KN/M}}$$

ZNAARTELIJN:

$$e = \frac{4 \times 41 \times 2 + 41 \times 4.1 \times 0.5 \times 5.37}{248} = \underline{3.14 \text{ M}}$$

DRUK OP REGELS: $M_C = 26.6 \times 0.675 = 17.96 \text{ KNM/M}$

$$M_B = 8.45 \text{ KNM/M (CLAPEYRON VERG.)}$$

$$\text{REGEL A} = \frac{15.3 \times 0.583}{2.6} - \frac{8.45}{2.6} = \underline{0.18 \text{ KN/M'}}$$

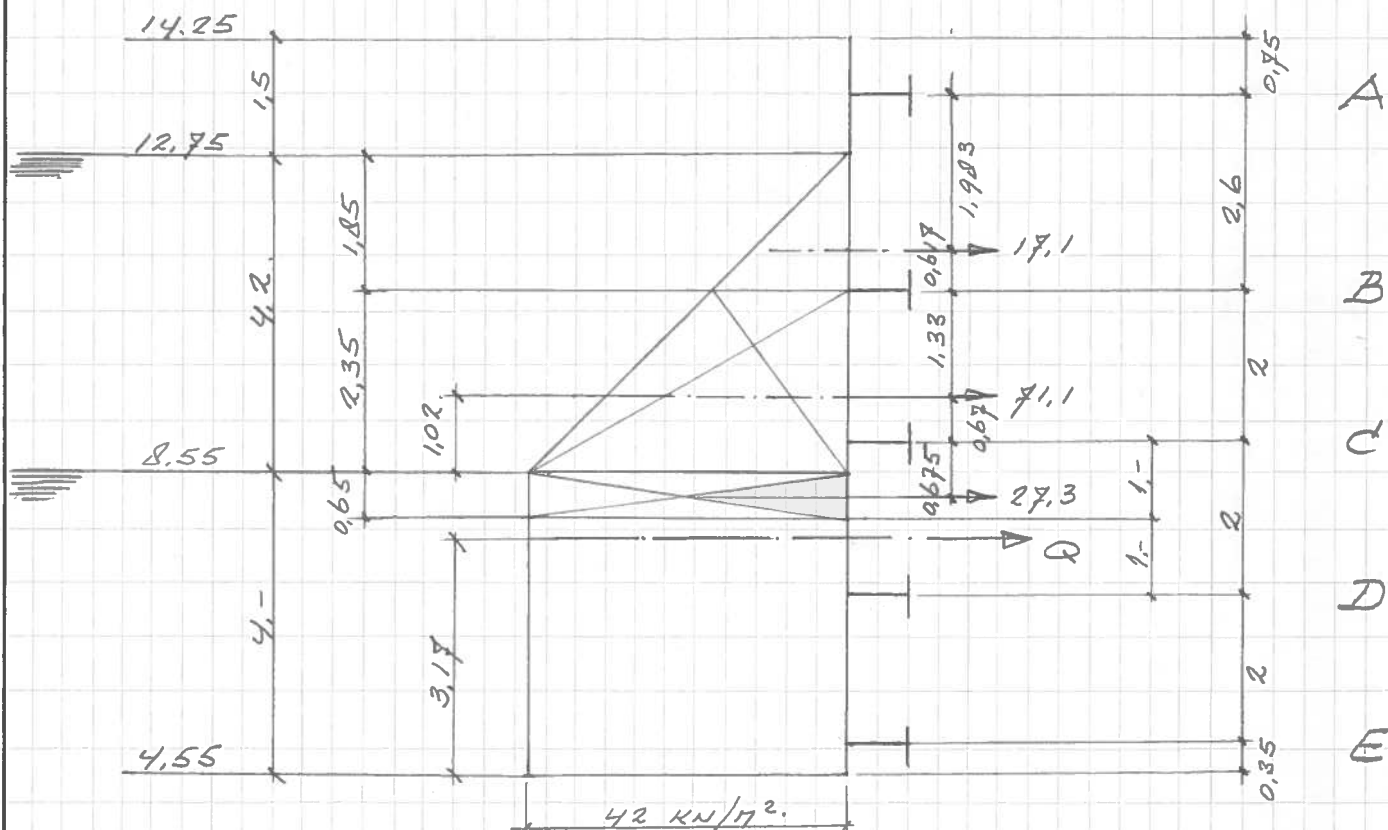
$$\text{REGEL B} = \frac{68.7 \times 0.67}{2} + \frac{15.3 \times 2.017}{2.6} + \frac{8.45}{2} + \frac{8.45}{2.6} - \frac{17.96}{2} = \underline{33.4 \text{ KN/M'}}$$

$$\text{REGEL C} = 26.6 + \frac{17.96}{2} + \frac{68.7 \times 1.33}{2} - \frac{8.45}{2} = \underline{77 \text{ KN/M'}}$$

$$\text{REGEL D} = 2 \times 41 = \underline{82 \text{ KN/M'}}$$

$$\text{REGEL E} = (0.35 + 1) 41 = \underline{55.4 \text{ KN/M'}}$$

ERP



$$Q = 4 \times 42 + 42 \times 4,2 \times 0,5 = \underline{256,2} \text{ kN/m}$$

ZWAARTELYN:

$$e = \frac{4 \times 42 \times 2 + 42 \times 4,2 \times 0,5 \times 5,4}{256,2} = \underline{3,17} \text{ m}$$

DRUK OP REGELS: $M_B = 9,2 \text{ kNm/m}$ (CLAPEYRON VERG.)

$$M_C = 27,3 \times 0,675 = 18,43$$

$$\text{REGEL A} = \frac{17,1 \times 0,617}{2,6} - \frac{9,2}{2,6} = \underline{0,52} \text{ kN/m'}$$

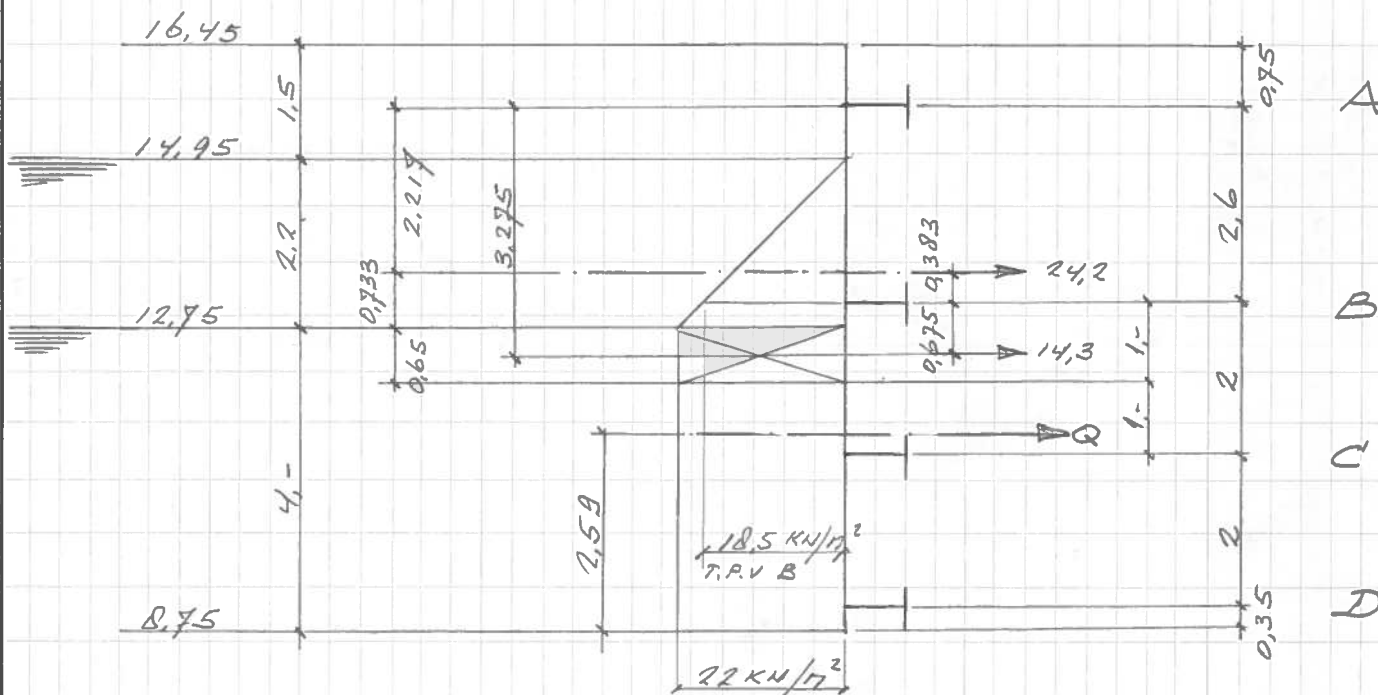
$$\text{REGEL B} = \frac{71,1 \times 0,67}{2} + \frac{17,1 \times 1,903}{2,6} + \frac{9,2}{2} + \frac{9,2}{2,6} - \frac{18,43}{2} = \underline{35,8} \text{ kN/m'}$$

$$\text{REGEL C} = 27,3 + \frac{18,43}{2} + \frac{71,1 \times 1,33}{2} - \frac{9,2}{2} = \underline{49,2} \text{ kN/m'}$$

$$\text{REGEL D} = 2 \times 42 = \underline{84} \text{ kN/m'}$$

$$\text{REGEL E} = (1 + 0,35) 42 = \underline{56,7} \text{ kN/m'}$$

AARLE-RIXTEL



$$Q = 4 \times 22 + 22 \times 2,2 \times 0,5 = \underline{112,2 \text{ KN/m}}$$

ZWAARTELIJN:

$$e = \frac{4 \times 22 \times 2 + 22 \times 2,2 \times 0,5 \times 4,733}{112,2} = \underline{2,59 \text{ M.}}$$

DRUK OP REGELS

$$\text{REGEL A} = \frac{24,2 \times 0,383 - 14,3 \times 0,675}{2,6} = \underline{-0,148 \text{ KN/m'}}$$

$$\text{REGEL B} = \frac{14,3 \times 3,275 + 24,2 \times 2,217}{2,6} = \underline{38,65 \text{ KN/m'}}$$

$$\text{REGEL C} = (1 + 1) 22 = \underline{44, - \text{ KN/m'}}$$

$$\text{REGEL D} = (0,35 + 1) 22 = \underline{29,7 \text{ KN/m'}}$$

rijkswaterstaat directie bruggen

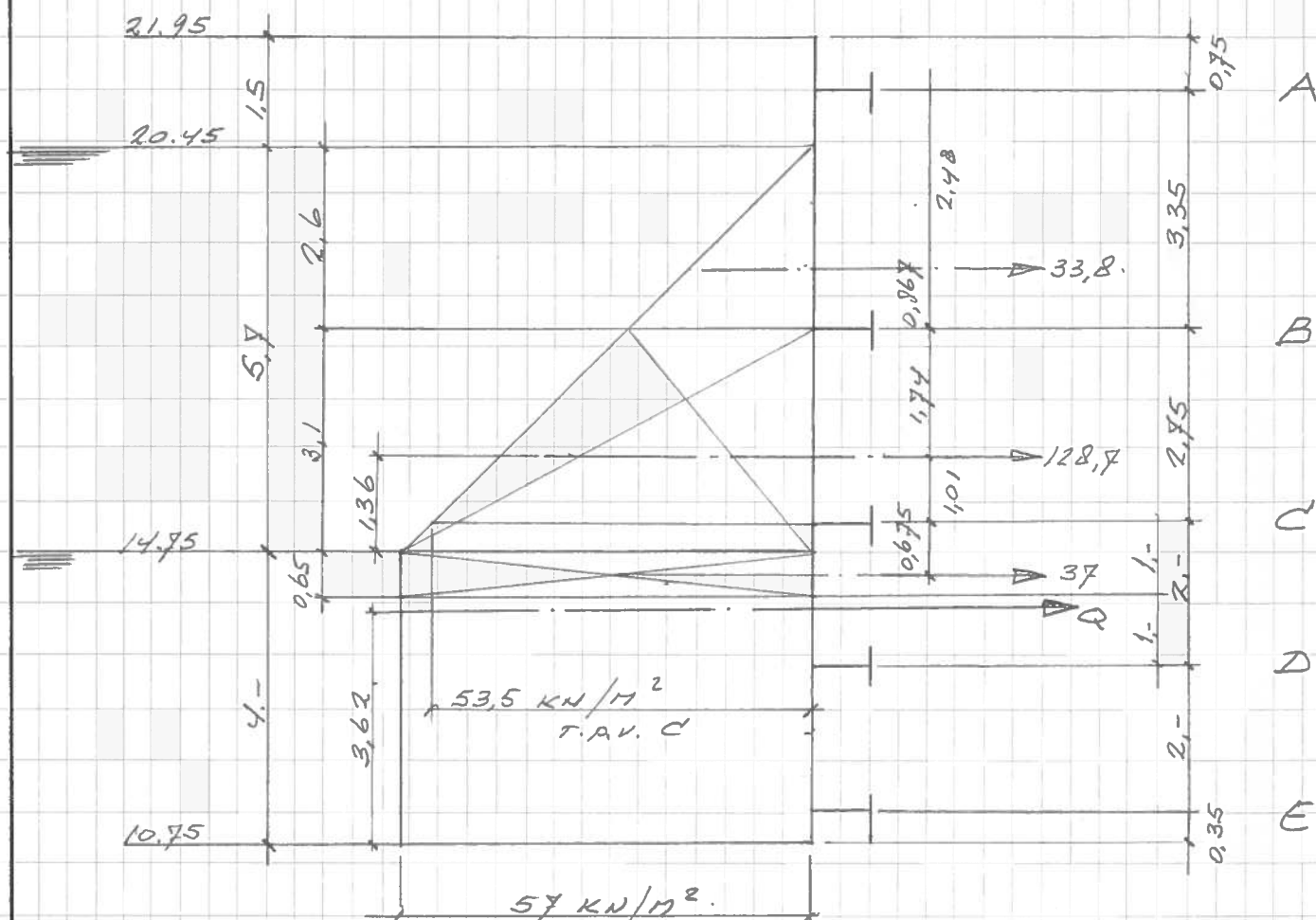
werk: ZUID-WILLEMSVAART

datum: AUG. 85

blz. 11

PUNTDEUREN

HELMOND



$$Q = 57 \times 5.7 + 57 \times 5.7 \times 0.5 = 390.5 \text{ KN/M.}$$

ZWAARTELIJN:

$$e = \frac{4 \times 57 \times 2 + 57 \times 5.7 \times 0.5 \times 5.9}{390.5} = 3.62 \text{ M.}$$

DRUK OP REGELS: $M_B = 30 \text{ KN/M}$ (CLAPEYRON VERG.)

$$M_C = 37 \times 0.675 = 25 \text{ KN/M}$$

$$\text{REGEL A} = \frac{33.8 \times 0.867}{3.37} - \frac{30.1}{3.35} = -0.24 \text{ KN/M}$$

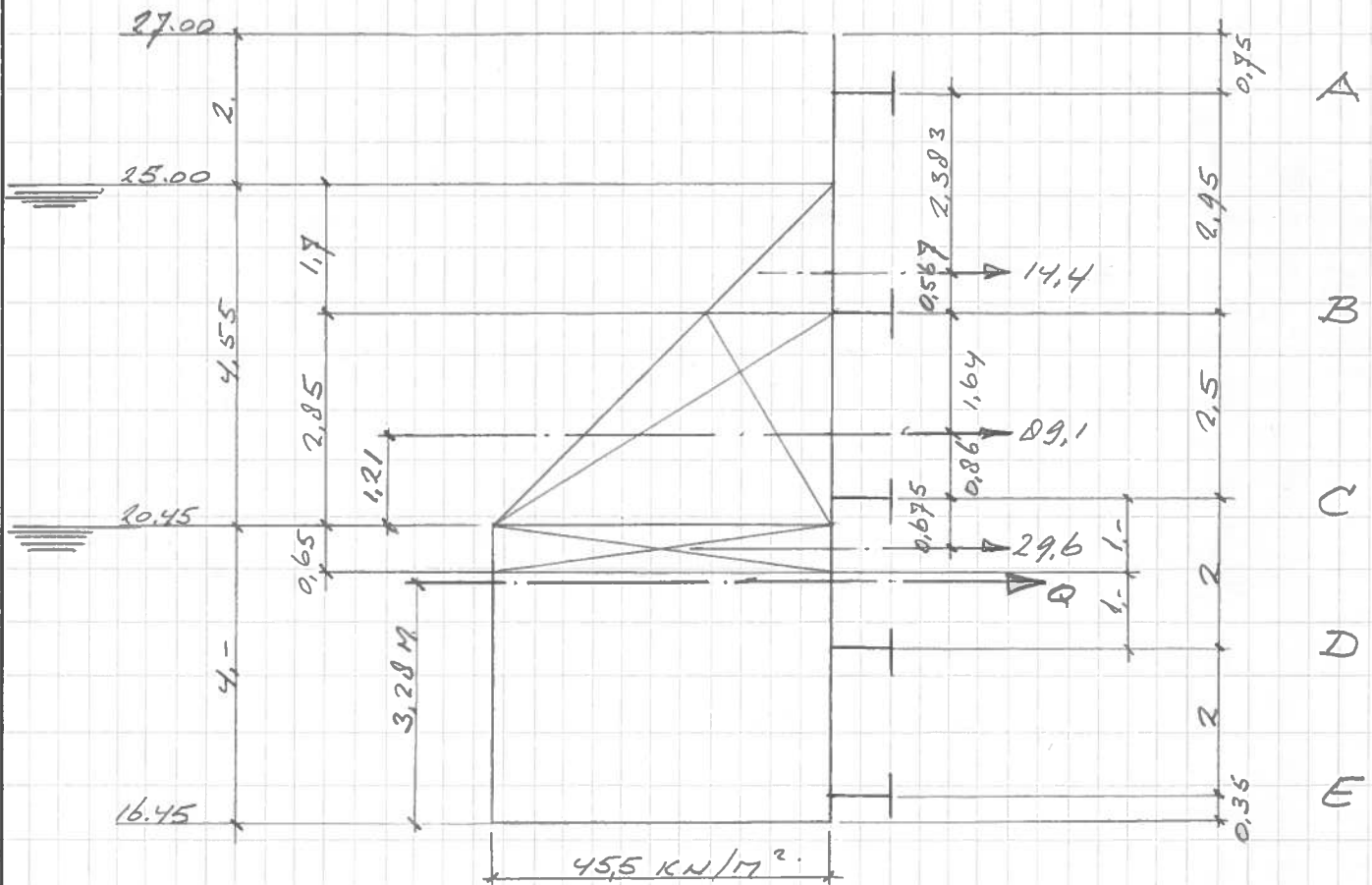
$$\text{REGEL B} = \frac{128.7 \times 1.01}{2.75} + \frac{33.8 \times 2.48}{3.35} + \frac{30.1}{3.35} - \frac{25}{2.75} = 83.1 \text{ KN/M}$$

$$\text{REGEL C} = 37 + \frac{25}{2.75} + \frac{128.7 \times 1.74}{2.75} - \frac{30.1}{2.75} = 116.5 \text{ KN/M}$$

$$\text{REGEL D} = 2 \times 57 = 114 \text{ KN/M}$$

$$\text{REGEL E} = (0.35 + 1) \times 57 = 77 \text{ KN/M}$$

SOMEREN



$$Q = 4 \times 45,5 + 45,5 \times 4,55 \times 0,5 = \underline{285,5 \text{ kN/m.}}$$

ZWAARTELYN.:

$$e = \frac{4 \times 45,5 \times 2 + 45,5 \times 4,55 \times 0,5 \times 5,517}{285,5} = \underline{3,28 \text{ m}}$$

DRUK OP REGELS: $M_B = 14,14 \text{ kNm/m}$ (CLAREYRON VERG.).

$$M_C = 29,6 \times 0,675 = 20 \text{ kNm/m.}$$

$$\text{REGEL A} = \frac{14,14 \times 0,567}{2,95} - \frac{14,14}{2,95} = \underline{-2,03 \text{ kN/m}}$$

$$\text{REGEL B} = \frac{89,1 \times 0,86}{2,5} + \frac{14,14 \times 2,383}{2,95} + \frac{14,14}{2,5} + \frac{14,14}{2,95} - \frac{20}{2,5} = \underline{44,7 \text{ kN/m}}$$

$$\text{REGEL C} = 29,6 + \frac{20}{2,5} + \frac{89,1 \times 1,64}{2,5} - \frac{14,14}{2,5} = \underline{90,4 \text{ kN/m}}$$

$$\text{REGEL D} = 2 \times 45,5 = \underline{91 \text{ kN/m}}$$

$$\text{REGEL E} = (0,35 + 1) 45,5 = \underline{61,4 \text{ kN/m}}$$

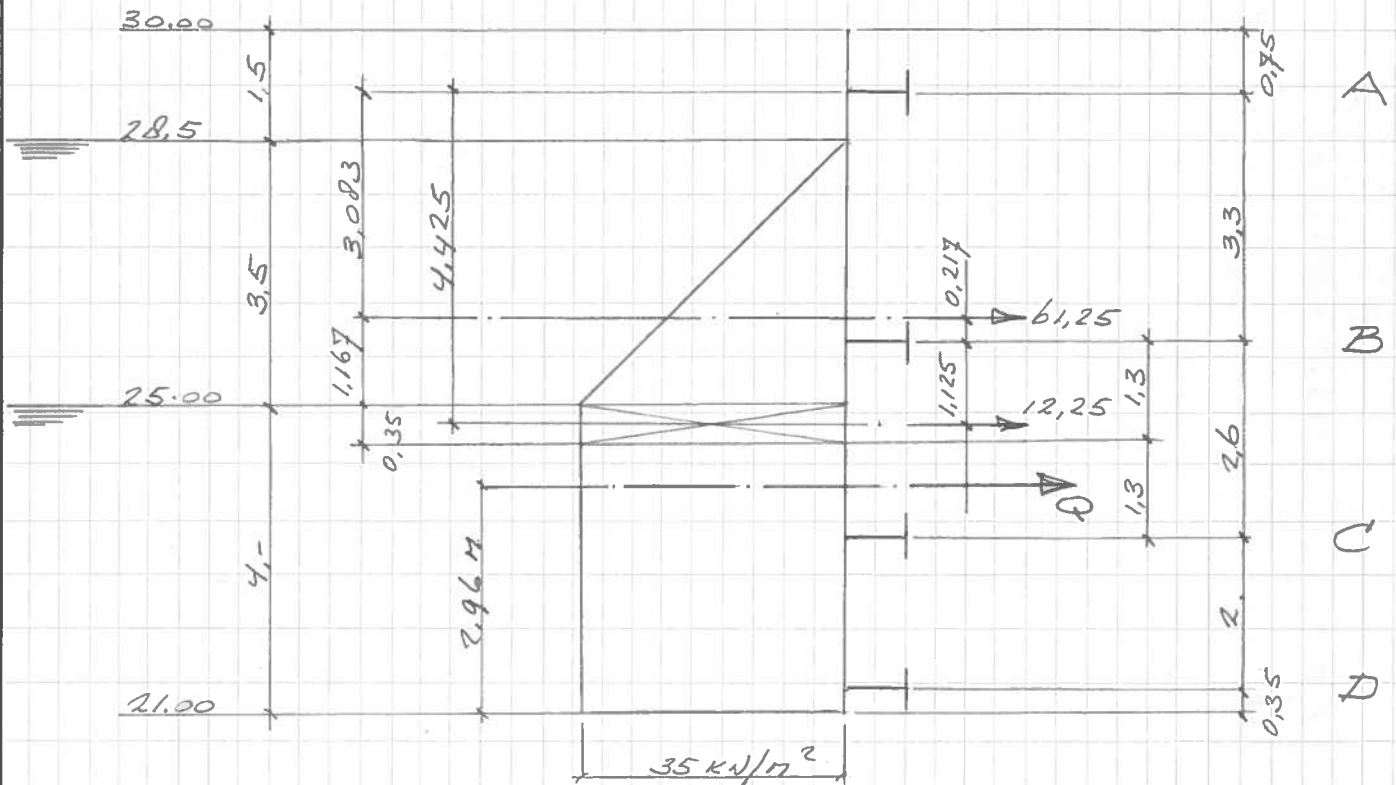
rijkswaterstaat directie bruggen

werk: ZUID-WILLEMSVAART
PUNTDEUREN

datum: AUG. 85

blz. 13

SLUIS G



$$Q = 4 \times 35 + 35 \times 3.5 \times 0.5 = 201.3 \text{ kN/m}$$

ZWAARTELYN:

$$e = \frac{4 \times 35 \times 2 + 35 \times 3.5 \times 0.5 \times 5.167}{201.3} = 2.96 \text{ m}$$

DRUK OP REGELS:

$$\text{REGEL A} = \frac{61.25 \times 0.217 - 12.25 \times 1.125}{3.3} = -0.15 \text{ kN/m'}$$

$$\text{REGEL B} = \frac{12.25 \times 4.425 + 61.25 \times 3.023}{3.3} = 73.6 \text{ kN/m'}$$

$$\text{REGEL C} = (1.3 + 1) 35 = 80.5 \text{ kN/m'}$$

$$\text{REGEL D} = (0.35 + 1) 35 = 47.3 \text{ kN/m'}$$

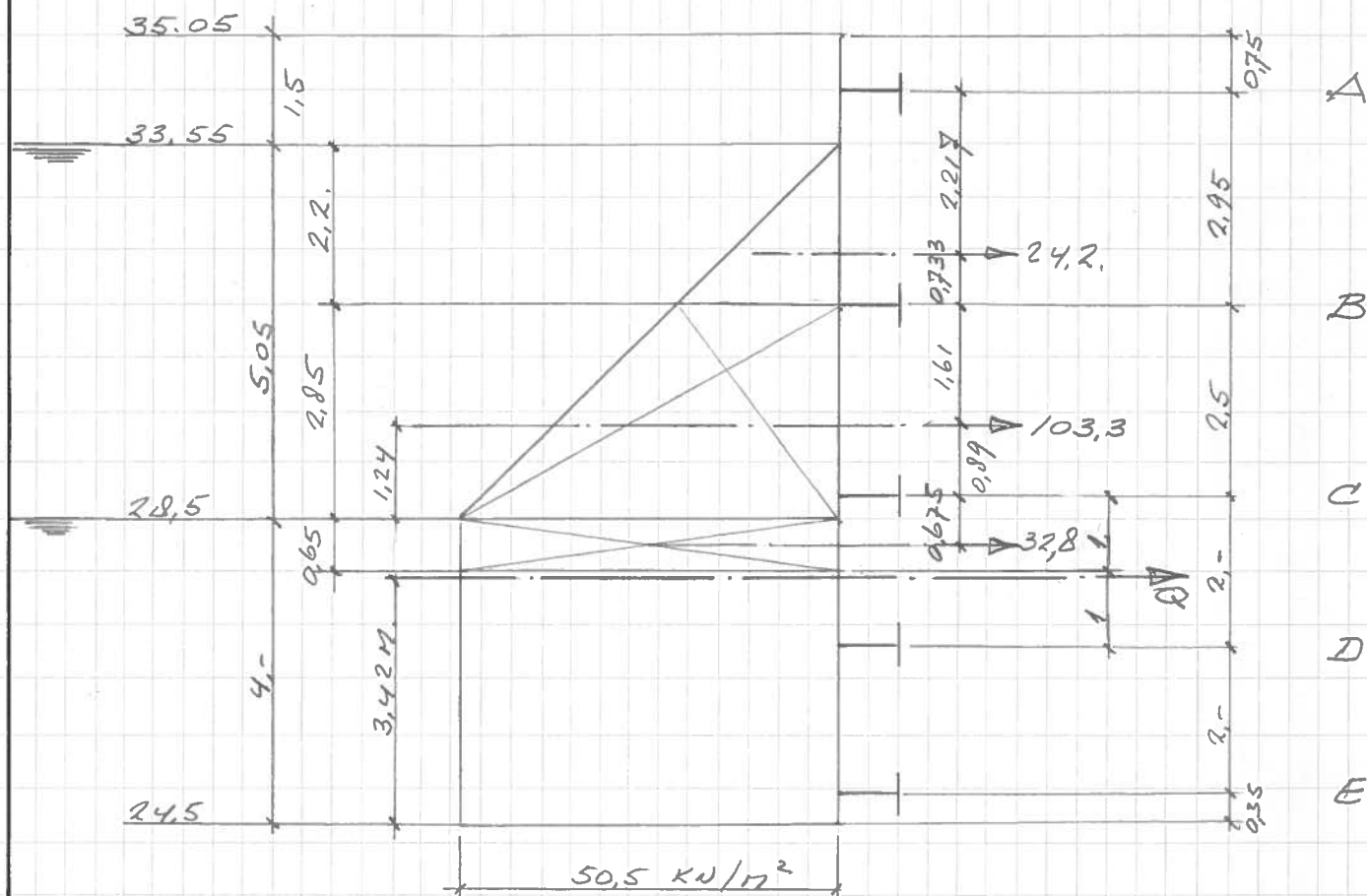
rijkswaterstaat directie bruggen

werk: ZUID-WILLENSVAART
PUNTDEUREN.

datum: AUG. 85

blz. 14

SLUIS H.



$$Q = 4 \times 50,5 + 50,5 \times 5,05 \times 0,5 = \underline{329,5 \text{ kN/m}}$$

ZWAARTELYN:

$$e = \frac{4 \times 50,5 \times 2 + 50,5 \times 5,05 \times 0,5 \times 5,683}{329,5} = \underline{3,42 \text{ m}}$$

DRUK OP REGELS: $M_B = 19,65 \text{ kNm/m}$ (CLAPEYRON VERS.)

$$M_D = 32,8 \times 0,675 = 22,14 \text{ kNm/m}$$

$$\text{REGEL A} = \frac{24,2 \times 0,733}{2,95} - \frac{19,65}{2,95} = \underline{-0,65 \text{ kN/m}}$$

$$\text{REGEL B} = \frac{103,3 \times 0,89}{2,5} + \frac{24,2 \times 2,217}{2,95} + \frac{19,65}{2,5} + \frac{19,65}{2,95} - \frac{22,14}{2,5} = \underline{60,6 \text{ kN/m}}$$

$$\text{REGEL C} = 32,8 + \frac{22,14}{2,5} + \frac{103,3 \times 1,61}{2,5} - \frac{19,65}{2,5} = \underline{100,3 \text{ kN/m}}$$

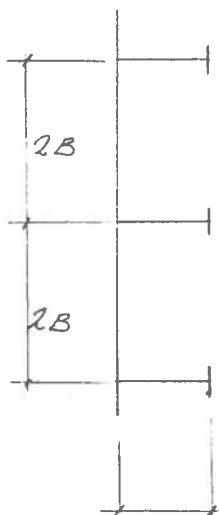
$$\text{REGEL D} = 2 \times 50,5 = \underline{101 \text{ kN/m}}$$

$$\text{REGEL E} = (0,35 + 1) 50,5 = \underline{68,2 \text{ kN/m}}$$

PUNTDEUREN.

MEENERKENDE PLAATBREEDTE

V.G.S. DIN 1078 BLATT I



LENGTE DEUR = 7.060 M. = L
OF 7.184 M.

$\frac{B}{L}$	0,05	0,10	0,15	0,20	0,25	0,30
λ	1,00	0,89	0,78	0,68	0,58	0,50

$$\frac{B}{L} > 0,30 \quad B_{GERED.} = 0,15 B$$

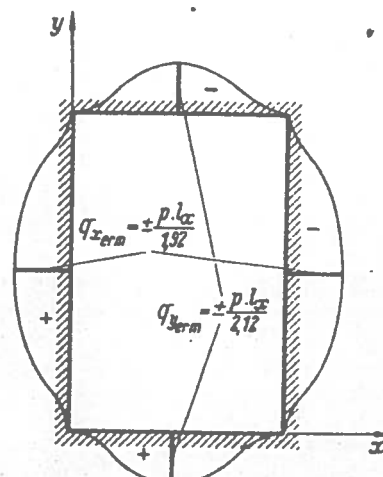
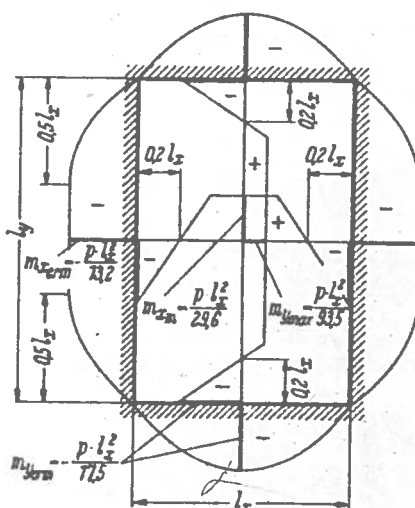
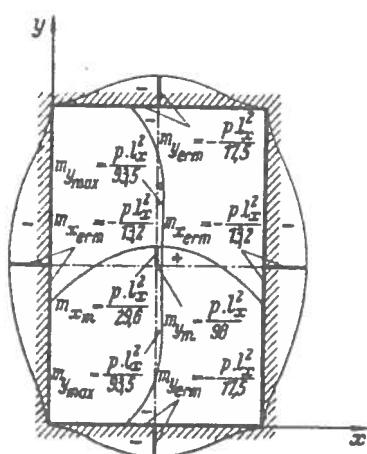
$$\frac{B}{L} < 0,05 \quad B_{GERED.} = B$$

$$0,30 > \frac{B}{L} > 0,05 \quad B_{GERED.} = \lambda \times B$$

2.2.6. Starre Einspannung der vier Ränder

$l_y : l_x$	1,00	1,05	1,10	1,15	1,20	1,25	1,30	1,35	1,40	1,45	1,50
$m_{x_{\text{erm}}} = -$	19,4	18,2	17,1	16,3	15,5	14,9	14,5	14,0	13,7	13,4	13,2
$m_{x_{\text{m}}} =$	56,8	50,6	46,1	42,4	39,4	37,0	34,8	33,3	31,9	30,6	29,6
$m_{y_{\text{erm}}} = -$	19,4	18,8	18,4	18,1	17,9	17,7	17,6	17,5	17,5	17,5	17,5
$m_{y_{\text{max}}} =$	56,8	58,2	60,3	62,6	65,8	69,4	73,6	78,4	83,4	89,4	93,5
$q_{x_{\text{erm}}} = \pm$	2,24	2,17	2,10	2,05	2,01	1,98	1,96	1,94	1,92	1,92	1,92
$q_{y_{\text{erm}}} = \pm$	2,24	2,20	2,16	2,14	2,12	2,11	2,10	2,09	2,09	2,10	2,12
$f_m = \frac{p \cdot l_x^4}{E \cdot d^3}$	0,0152	0,0167	0,0181	0,0195	0,0207	0,0219	0,0230	0,0240	0,0248	0,0257	0,0264

$l_y : l_x$	1,50	1,55	1,60	1,65	1,70	1,75	1,80	1,85	1,90	1,95	2,0
$m_{x_{\text{erm}}} = -$	13,2	13,0	12,8	12,7	12,5	12,4	12,3	12,2	12,1	12,0	12,0
$m_{x_{\text{m}}} =$	29,6	28,8	28,1	27,5	26,9	26,4	26,0	25,7	25,4	25,2	25,0
$m_{y_{\text{erm}}} = -$	17,5	17,5	17,5	17,5	17,5	17,5	17,5	17,5	17,5	17,5	17,5
$m_{y_{\text{max}}} =$	93,5	96,1	98,1	99,9	101,3	102,4	103,3	104,0	104,6	104,9	105,0
$q_{x_{\text{erm}}} = \pm$	1,92	1,92	1,92	1,92	1,91	1,91	1,91	1,91	1,91	1,91	1,91
$q_{y_{\text{erm}}} = \pm$	2,12	2,12	2,12	2,12	2,12	2,12	2,12	2,12	2,13	2,13	2,13
$f_m = \frac{p \cdot l_x^4}{E \cdot d^3}$	0,0264	0,0271	0,0277	0,0282	0,0287	0,0291	0,0294	0,0297	0,0300	0,0302	0,0304



$$q_{x_{\text{erm}}} = |q_{x_{\text{erm}}}|$$

$$q_{y_{\text{erm}}} = |q_{y_{\text{erm}}}|$$

Verlauf der Schnittgrößen für das Seitenverhältnis $l_y : l_x = 1,5$

BEREKENING PUNTDEUREN:

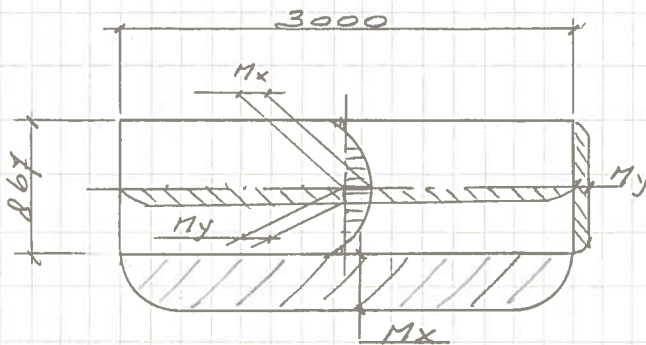
BERLICUM.	867	34,5
SCHUNDEL.	667	41
ERP	667	42
SLUIS G	867	35

CONTRÔLE DOORLOPENDE PLAAT $\delta = 10 \text{ mm}$.

SLUIS G MAATGEVEND.

PLAATVELD $3000 \times 2600 \text{ mm}$.

MET 2 HOR. VERSTIJVINGEN PLAATVELD WORDT $3000 \times 867 \text{ mm}$.
WATERDRUK = $0,035 \text{ N/mm}^2$.



RANDSPANNING:

$$\frac{l_y}{l_x} = \frac{3000}{867} = 3,46$$

$$\varphi_x = 12$$

$$\varphi_y = 17,5$$

$$W = \frac{1}{6} \cdot 1 \cdot 10^2 = 16,7 \text{ mm}^3 \text{ PER mm.}$$

$$M_x = \frac{0,035 \times 867^2}{12} = 2192 \text{ Nmm} \quad M_y = \frac{0,035 \times 867^2}{17,5} = 1503 \text{ Nmm}$$

$$\sigma_x = \frac{2192 \times 1,5}{16,7} = 197 \text{ N/mm}^2 < 360 \quad \sigma_y = \frac{1503 \times 1,5}{16,7} = 135 \text{ N/mm}^2 < 360$$

SPANNING MIDDEN PLAAT:

$$\varphi_x = 25 \quad \varphi_y = 105$$

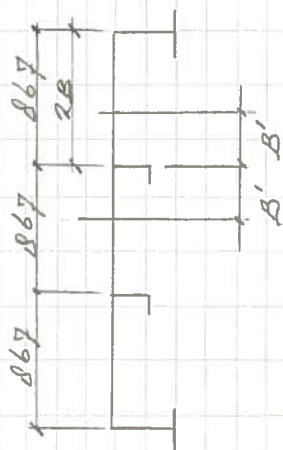
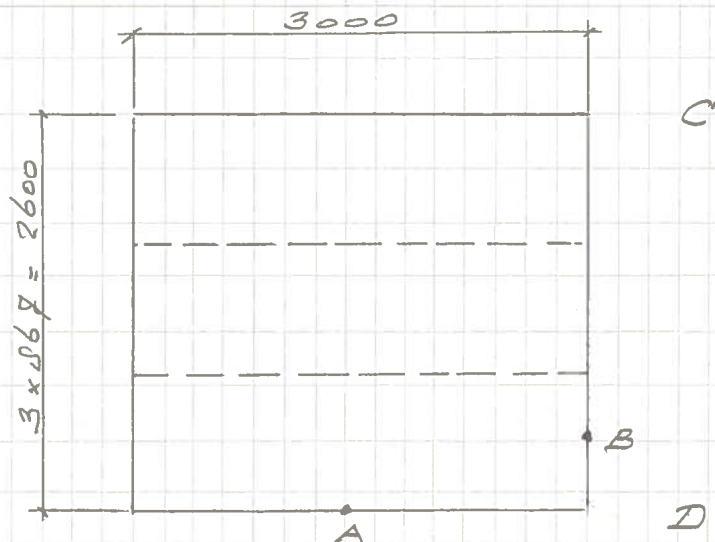
$$M_x = \frac{0,035 \times 867^2}{25} = 1052 \text{ Nmm} \quad M_y = \frac{0,035 \times 867^2}{105} = 251 \text{ Nmm}$$

$$\sigma_x = \frac{1052 \times 1,5}{16,7} = 95 \text{ N/mm}^2 < 360 \quad \sigma_y = \frac{251 \times 1,5}{16,7} = 23 \text{ N/mm}^2 < 360$$

DOORBUIGING MIDDEN PLAAT:

$$\delta_m = \frac{0,034 \times 0,035 \times 867^4}{2,1 \times 10^5 \times 10^3} = 3,2 \text{ mm} = \frac{l}{271}$$

PLAATVERSTUJVING:



$$2B = 867 \text{ mm. } B = 434 \text{ mm } L = 3000 \text{ mm.}$$

$$\frac{B}{L} = \frac{434}{3000} = 0,145 \rightarrow \lambda = 0,79$$

$$B' = 0,79 \times 434 = 343 \text{ mm.}$$

$$2B' = 686 \text{ mm.}$$

VERSTUJVING: L 150x75x10

$$A = 686 \times 10 + 1660 = 8520 \text{ mm}^2$$

$$A_1 = \frac{686 \times 10 \times 5 + 1660 \times 128,1}{8520} = 29 \text{ mm.}$$

$$A_2 = 131 \text{ mm.}$$

$$J = \frac{1}{12} \cdot 686 \cdot 10^3 + 686 \times 10 \times 24^2 + 1620000 + 1660 \times 99,1^2 = 2193 \times 10^4 \text{ mm}^4$$

$$W_{MIN.} = \frac{2193 \times 10^4}{131} = 167404 \text{ mm}^3$$

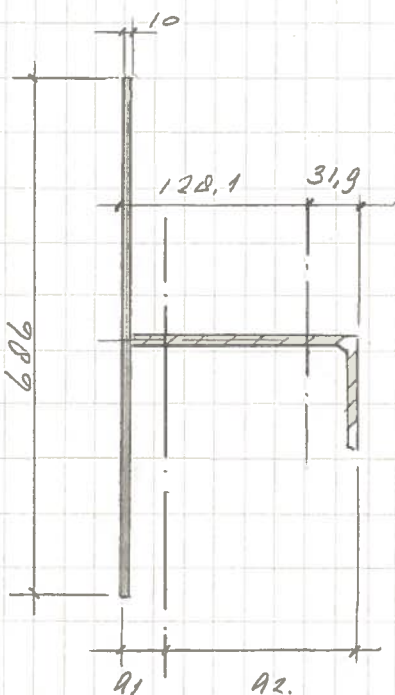
$$q = 0,867 \times 35 = 30,35 \text{ kN/m'}$$

$$M_{INKL.} = \frac{1}{12} \cdot 30,35 \cdot 3^2 = 22,8 \text{ kNm.}$$

$$\sigma_{MAX} = \frac{22,8 \times 10^6 \times 1,5}{167404} = 204 \text{ N/mm}^2 < 360$$

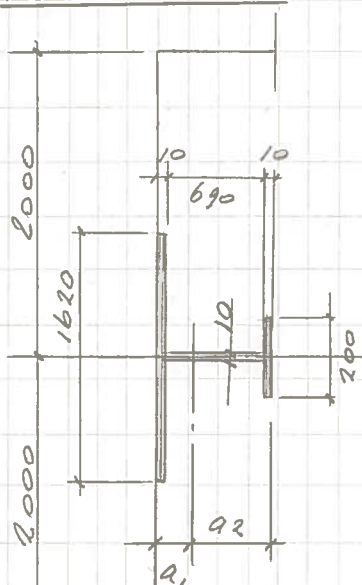
$$W_{MAX.} = \frac{2193 \times 10^4}{29} = 756206 \text{ mm}^3$$

$$\sigma_{MIN.} = \frac{22,8 \times 10^6 \times 1,5}{756206} = 45 \text{ N/mm}^2$$



REGEL DOORSNEDEN.

FLENS 200x10



$$L = 7060 \quad 2B = 2000 \quad B = 1000$$

$$\frac{B}{L} = \frac{1000}{7060} = 0,142 \rightarrow \lambda = 0,81$$

$$B' = 0,81 \times 1000 = 810$$

$$2B' = 1620 \text{ mm.}$$

$$A = 1620 \times 10 + 690 \times 10 + 200 \times 10 = 25100 \text{ mm}^2$$

$$a_1 = \frac{1620 \times 10 \times 5 + 690 \times 10 \times 355 + 200 \times 10 \times 705}{25100} = 157 \text{ mm.}$$

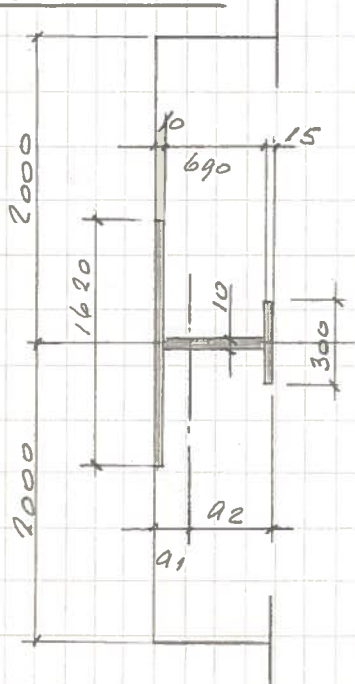
$$a_2 = 710 - 157 = 553 \text{ mm.}$$

$$J = \frac{1}{12} \cdot 1620 \times 10^3 + 1620 \times 10 \times 152^2 + \frac{1}{12} \cdot 10 \cdot 690^3 + 690 \times 10 \times 198^2 + \frac{1}{12} \cdot 200 \cdot 10^3 + 200 \times 10 \times 548^2 = 1519 \times 10^6 \text{ mm}^4$$

$$W_1 = \frac{1519 \times 10^6}{157} = 9675 \times 10^3 \text{ mm}^3 \quad W_2 = \frac{1519 \times 10^6}{553} = 2746 \times 10^3 \text{ mm}^3$$

$$i = \sqrt{\frac{1519 \times 10^6}{25100}} = 246 \quad \lambda = \frac{7060}{246} = 29 \rightarrow w = 1,06$$

FLENS 300x15



$$A = 1620 \times 10 + 690 \times 10 + 300 \times 15 = 27600 \text{ mm}^2$$

$$a_1 = \frac{1620 \times 10 \times 5 + 690 \times 10 \times 355 + 300 \times 15 \times 707,5}{27600} = 207 \text{ mm.}$$

$$a_2 = 715 - 207 = 508 \text{ mm.}$$

$$J = \frac{1}{12} \cdot 1620 \times 10^3 + 1620 \times 10 \times 207^2 + \frac{1}{12} \cdot 10 \cdot 690^3 + 690 \times 10 \times 148^2 + \frac{1}{12} \cdot 300 \cdot 15^3 + 300 \times 15 \times 545,5^2 = 2425 \times 10^6 \text{ mm}^4$$

$$W_1 = \frac{2425 \times 10^6}{207} = 11714 \times 10^3 \text{ mm}^3$$

$$W_2 = \frac{2425 \times 10^6}{508} = 4773 \times 10^3 \text{ mm}^3$$

$$i = \sqrt{\frac{2425 \times 10^6}{27600}} = 296 \quad \lambda = \frac{7060}{296} = 24$$

$$w = 1,024$$

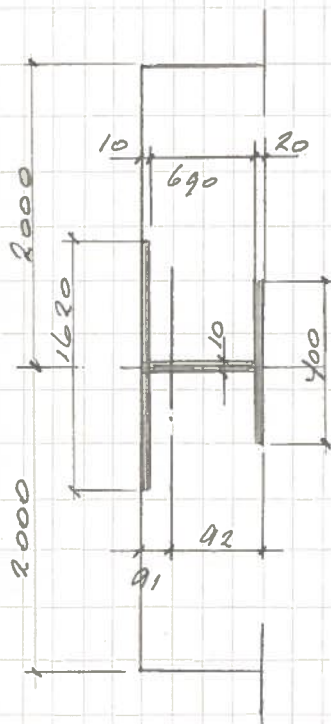
rijkswaterstaat directie bruggen

werk: ZUID-WILLEMSVAART
PUNT DEUREN.

datum: AUG. '85

blz. 21

FLENS 400x20



$$A = 1620 \times 10 + 690 \times 10 + 400 \times 20 = 31100 \text{ mm}^2$$

$$A_1 = \frac{1620 \times 10 \times 5 + 690 \times 10 \times 355 + 400 \times 20 \times 710}{31100} = 264 \text{ mm}$$

$$A_2 = 720 - 264 = 456 \text{ mm}$$

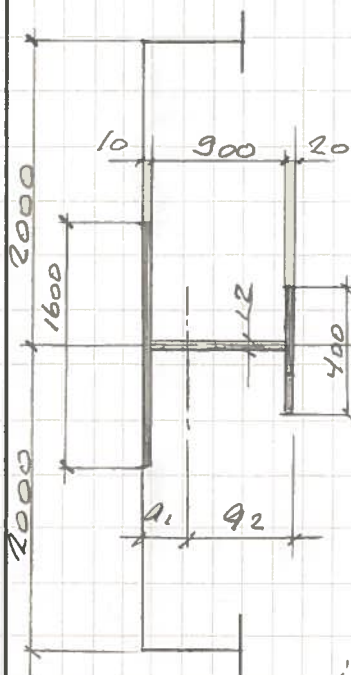
$$J = \frac{1}{12} \cdot 1620 \cdot 10^3 + 1620 \times 10 \times 259^2 + \frac{1}{12} \cdot 10 \cdot 690^3 + 690 \times 10 \times 91^2 + \frac{1}{12} \cdot 400 \cdot 20^3 + 400 \times 20 \times 446^2 = 3009 \times 10^6 \text{ mm}^4$$

$$W_1 = \frac{3009 \times 10^6}{264} = 11397 \times 10^3 \text{ mm}^3$$

$$W_2 = \frac{3009 \times 10^6}{456} = 6598 \times 10^3 \text{ mm}^3$$

$$i = \sqrt{\frac{3009 \times 10^6}{31100}} = 311 \quad \lambda = \frac{7060}{311} = 23 \quad \omega = 1,017$$

FLENS 400x20



$$L = 7184 \quad 2B = 2000 \quad B = 1000$$

$$\frac{B}{L} = \frac{1000}{7184} = 0,14 \rightarrow \lambda = 0,8$$

$$B' = 0,8 \times 1000 = 800 \text{ mm}$$

$$2B' = 1600 \text{ mm}$$

$$A = 1600 \times 10 + 900 \times 12 + 400 \times 20 = 34800 \text{ mm}^2$$

$$A_1 = \frac{1600 \times 10 \times 5 + 900 \times 12 \times 460 + 400 \times 20 \times 920}{34800} = 357 \text{ mm}$$

$$A_2 = 573 \text{ mm}$$

$$J = \frac{1}{12} \cdot 1600 \cdot 10^3 + 1600 \times 10 \times 352^2 + \frac{1}{12} \cdot 12 \cdot 900^3 + 900 \times 12 \times 103^2 + \frac{1}{12} \cdot 400 \cdot 20^3 + 400 \times 20 \times 563^2 = 5362 \times 10^6 \text{ mm}^4$$

$$W_1 = \frac{5362 \times 10^6}{357} = 15019 \times 10^3 \text{ mm}^3$$

$$W_2 = \frac{5362 \times 10^6}{573} = 9357 \times 10^3 \text{ mm}^3$$

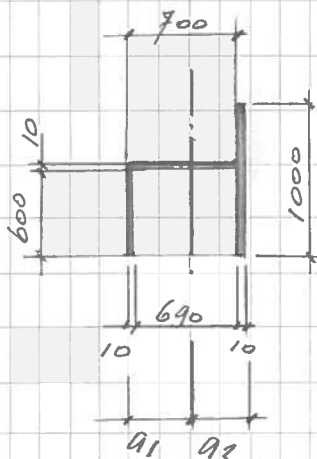
$$i = \sqrt{\frac{5362 \times 10^6}{34800}} = 392 \text{ mm} \quad \lambda = \frac{7184}{392} = 18$$

GEEN KNIK

PUNTDEUREN.

ONDERREGEL VOOR DEUR 690 MM DIK

FLENS 1000x10



$$A = 1000 \times 10 + 700 \times 10 + 600 \times 10 = \underline{23000} \text{ mm}^2$$

$$a_1 = \frac{600 \times 10 \times 5 + 700 \times 10 \times 350 + 1000 \times 10 \times 705}{23000} = 414 \text{ mm}$$

$$a_2 = 296 \text{ mm}$$

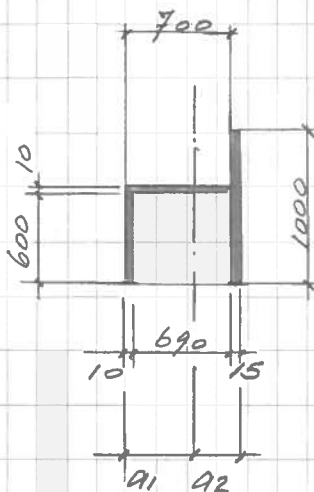
$$J = \frac{1}{12} \cdot 600 \cdot 10^3 + 600 \times 10 \times 409^2 + \frac{1}{12} \cdot 10 \cdot 700^3 + 700 \times 10 \times 64^2 + \frac{1}{12} \cdot 1000 \cdot 10^3 + 1000 \times 10 \times 291^2 = \underline{2165 \times 10^6} \text{ mm}^4$$

$$W_1 = \frac{2165 \times 10^6}{414} = \underline{5229 \times 10^3} \text{ mm}^3$$

$$W_2 = \frac{2165 \times 10^6}{296} = \underline{7314 \times 10^3} \text{ mm}^3$$

$$i = \sqrt{\frac{2165 \times 10^6}{23000}} = 306 \quad \lambda = \frac{7060}{306} = 23 \rightarrow w = 1,03$$

FLENS 1000x15



$$A = 1000 \times 15 + 700 \times 10 + 600 \times 10 = \underline{28000} \text{ mm}^2$$

$$a_1 = \frac{600 \times 10 \times 5 + 700 \times 10 \times 350 + 1000 \times 15 \times 707,5}{28000} = 468 \text{ mm}$$

$$a_2 = 247 \text{ mm}$$

$$J = \frac{1}{12} \cdot 600 \cdot 10^3 + 600 \times 10 \times 463^2 + \frac{1}{12} \cdot 10 \cdot 700^3 + 700 \times 10 \times 118^2 + \frac{1}{12} \cdot 1000 \cdot 15^3 + 1000 \times 15 \times 239,5^2 = \underline{2530 \times 10^6} \text{ mm}^4$$

$$W_1 = \frac{2530 \times 10^6}{468} = \underline{5405 \times 10^3} \text{ mm}^3$$

$$W_2 = \frac{2530 \times 10^6}{247} = \underline{10242 \times 10^3} \text{ mm}^3$$

$$i = \sqrt{\frac{2530 \times 10^6}{28000}} = 300 \quad \lambda = \frac{7060}{300} = 24 \rightarrow w = 1,03$$

rijkswaterstaat directie bruggen

werk: KANAAL NESSEM-NEDERWEERT datum: AUG. '85

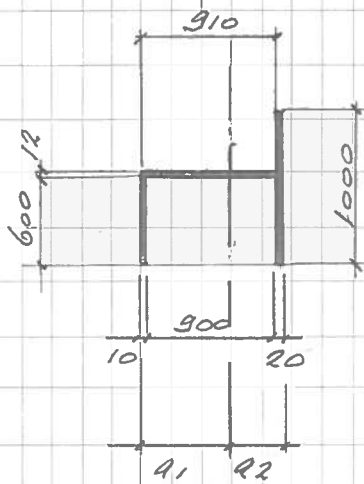
blz. 23

PUNTDEUREN

ONDERR GEL VOOR HOGE DEUR PANHEEL

FLENS 1000 x 20

LUFPLAAT 900 x 12



$$A = 1000 \times 20 + 910 \times 12 + 600 \times 10 = 36920 \text{ mm}^2$$

$$q_1 = \frac{600 \times 10 \times 5 + 910 \times 12 \times 455 + 1000 \times 20 \times 420}{36920} = 634 \text{ mm}$$

$$q_2 = 296 \text{ mm.}$$

$$J = \frac{1}{12} \cdot 600 \cdot 10^3 + 600 \times 10 \times 629^2 + \frac{1}{12} \cdot 12 \cdot 910^3 + 910 \times 12 \times 179^2 + \frac{1}{12} \cdot 1000 \cdot 20^3 + 1000 \times 20 \times 286^2 = 5113 \times 10^6 \text{ mm}^4$$

$$W_1 = \frac{5113 \times 10^6}{634} = 8064 \times 10^3 \text{ mm}^3$$

$$W_2 = \frac{5113 \times 10^6}{296} = 17273 \times 10^3 \text{ mm}^3$$

$$i = \sqrt{\frac{5113 \times 10^6}{36920}} = 372 \quad \lambda = \frac{7184}{372} = 19 \rightarrow \text{GEEN KNIK.}$$

BEREKENING REGELS:

BERLICUM.

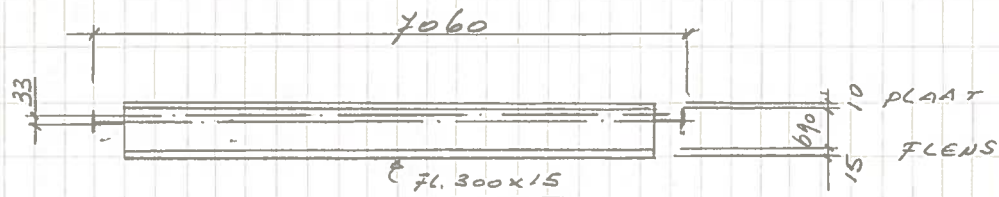
SCHUNDEL

ERP

SLUIS G

REGEL C END

(REGEL D
MAATGEVENDE)



$$q = 84 \text{ KN/M'}$$

$$N = \frac{1}{2} \cdot 84 \cdot 7.060 \times 3 = 890 \text{ KN.}$$

$$\text{DOOR WATER DRUK } M = \frac{1}{8} \cdot 84 \cdot 7.060^2 = 523,4 \text{ KNM.}$$

$$\text{" SPATKRACHT } M = 890 (0,240 - 0,207) = 29,4 \text{ "}$$

$$M_{\text{TOT}} = 553, - \text{ KNM.}$$

$$\sigma_{\text{PL.}} = \frac{553 \times 10^6 \times 1,5}{11714 \times 10^3} - \frac{890 \times 10^3 \times 1,5}{27600} = 22,4 \text{ N/MM}^2 \text{ TREK}$$

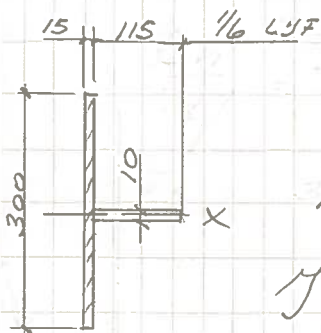
$$\text{DRUKFLENS. } \frac{h}{t_N} = \frac{715}{10} = 71,5 < 75 \text{ VORMVAST}$$

$$\text{" " } \frac{l}{h} = \frac{3000}{715} = 4,2 \text{ ONGESTEUNDE LENGTE = 3000 MM.}$$

$$1,25 \times \frac{b}{t_f} = 1,25 \times \frac{300}{15} = 25$$

$$4,2 < 25 \rightarrow \text{NIET VORMVAST}$$

KNIKKEN DRUKRAND: VLGS 2.8.3.



$$\sigma_{\text{FL}} = \frac{553 \times 10^6 \times 1,5}{4773 \times 10^3} + \frac{890 \times 10^3 \times 1,5 \times 1,024}{27600} = 223 \text{ N/MM}^2 \text{ DRUK}$$

$$F_{\text{FL}} = 0,223 \times 300 \times 15 = 1004 \text{ KN.}$$

$$J_x = \frac{1}{12} \cdot 15 \cdot 300^3 + \frac{1}{12} \cdot 115 \cdot 10^3 = 33 \times 10^6 \text{ MM}^4$$

$$A = 300 \times 15 + 115 \times 10 = 5650 \text{ MM}^2$$

rijkswaterstaat directie bruggen

werk: LUID - WILLEMSVAART
PUNTDEUREN.

datum: AUG. '85

blz. 25

$$W = \frac{33 \times 10^6}{150} = 220 \times 10^3 \text{ mm}^3$$

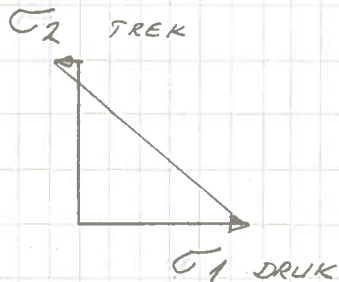
$$i = \sqrt{\frac{33 \times 10^6}{5650}} = 76 \text{ mm} \quad \lambda = \frac{3000}{76} = 40 \rightarrow w = 1,19 \text{ Fe 510.}$$

$$\sigma = 223 \times 1,19 = \underline{265 \text{ N/mm}^2} < 360.$$

DOORBUIGING REGEL D: ERP

$$\delta M = \frac{0,62 \times 0,4 \times 7,060^4 + 5,96 \times 29,4 \times 7,060^2}{2425 \times 10^2} \times 10 = \underline{\underline{\frac{5,7 \text{ mm}}{1238}}}$$

CONTRÔLE PLOOIEN LUF REGEL D



$$\sigma_1 = 223 \text{ N/mm}^2$$

$$\sigma_2 = 22,4 \text{ N/mm}^2$$

LUFDIKTE = 10 mm.

LENGTE PLAAT = 3000 mm.

BREEDTE " = 690 mm.

$$\psi = -\frac{22,4}{223} = -0,1 > -0,5 \quad (\text{GEEN REDUCTIE})$$

$$\alpha = \frac{3000}{690} = 4,35 \rightarrow K_d = 0,5$$

$$\text{VOOR } \alpha > 1 \rightarrow K_s = 5,35 + \frac{4}{4,35^2} = 5,56$$

$$DN. KR. = \frac{1}{2} \cdot 24 \cdot 7,060 = 297 \text{ kN.}$$

$$\bar{\sigma}_{\text{GEN.}} = \frac{297 \times 10^3 \times 1,5}{690 \times 10} = \underline{64,6 \text{ N/mm}^2} < 0,58 \sigma_e$$

$$\sigma_E = 19 \left(\frac{100 \times 10}{690} \right)^2 = 39,9 \text{ N/mm}^2.$$

$$\sigma_{KR.} = 0,5 \times 39,9 = 339 \text{ N/mm}^2.$$

$$\bar{\sigma}_{KR.} = 5,56 \times 39,9 = 222 \rightarrow 208 \text{ N/mm}^2 = 0,58 \sigma_e.$$

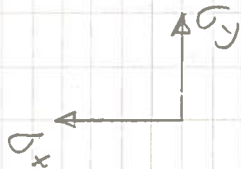
$$\sqrt{\left(\frac{223}{339} \right)^2 + \left(\frac{64,6}{208} \right)^2} = \underline{\underline{0,72}} < 1$$

GECOMBINEERDE SPANNINGEN REGEL D

ERP.

RANDSPANNINGEN PLAAT

PUNT A ZIE BLZ. 19

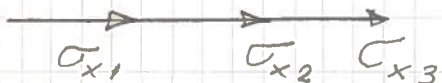


$$\sigma_x = 22,4 \text{ N/MM}^2 \text{ TREK} \quad \text{BLZ. 24.}$$

$$\sigma_y = 197 \text{ N/MM}^2 \text{ DRUK} \quad \text{BLZ. 18}$$

$$\sigma_{TOT.} = \sqrt{22,4^2 + 197^2 + 22,4 \times 197} = \underline{209 \text{ N/MM}^2} < 360$$

PUNT B



$$\sigma_{x1} = 22,4 \text{ N/MM}^2 \text{ TREK} \quad \text{BLZ. 24}$$

$$\sigma_{x2} = 135 \text{ N/MM}^2 \text{ TREK} \quad \text{BLZ. 18}$$

$$\sigma_{x3} = 45 \text{ N/MM}^2 \text{ TREK} \quad \text{BLZ. 19}$$

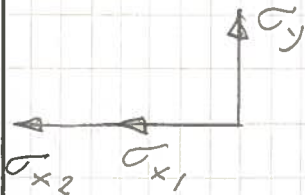
$$\sigma_{TOT.} = 22,4 + 135 + 45 = \underline{202 \text{ N/MM}^2} < 360$$

SPANNINGEN IN HET MIDDEN VAN DE PLAAT

$$\sigma_{x1} = 22,4 \text{ N/MM}^2 \text{ TREK} \quad \text{BLZ. 24}$$

$$\sigma_{x2} = 45 \text{ N/MM}^2 \text{ TREK} \quad \text{BLZ. 19}$$

$$\sigma_y = 95 \text{ N/MM}^2 \text{ TREK} \quad \text{BLZ. 18}$$



$$\sigma_{TOT.} = \sqrt{(22,4 + 45)^2 + 95^2 - (22,4 + 45) \times 95} =$$

$$= \underline{84 \text{ N/MM}^2}$$

$$< 360$$

BEREKENING LASSEN REGEL D (ERP)

$$q = 84 \text{ KN/M} \quad N = 890 \text{ KN} \quad A = 27600 \text{ mm}^2$$

KRACHT OP LYFPLAAT: $Q = 84 \times 7,060 = 593 \text{ KN}$

$$\sigma_{\perp} = \frac{593 \times 10^3 \times 1,5}{7060 \times 10} = 13 \text{ N/mm}^2$$

$$\sigma_{\parallel} = \frac{890 \times 10^3 \times 1,5}{27600} = 48,4 \text{ N/mm}^2$$

$$D_{\text{MAX}} = 1/2 \cdot 84 \cdot 7,060 = 297 \text{ KN}$$

$$\tau_{\text{MAX}} = \frac{297 \times 10^3 \times 1,5}{690 \times 10} = 65 \text{ N/mm}^2$$

LIGGER BIJ OPLEGGING: M = 0

$$\sigma_c = \sqrt{48,4^2 + 13^2 - 48,4 \times 13 + 3 \times 65^2} = 121 \text{ N/mm}^2$$

LIGGER OP 1/4 v.d. LENGTE:

$$M = 297 \times 1,765 - 1/2 \cdot 84 \cdot 1,765^2 + 29,4 = 423 \text{ KNM}$$

$$D = 297 \times 1/2 = 149 \text{ KN}$$

$$\sigma_b = \frac{423 \times 10^6 \times 1,5}{4773 \times 10^3} = 133 \text{ N/mm}^2$$

$$\sigma_{\perp} = 13 \text{ N/mm}^2$$

$$\sigma_{\parallel} = 48,4 \text{ N/mm}^2$$

$$\tau = \frac{149 \times 10^3 \times 1,5}{690 \times 10} = 23,4 \text{ N/mm}^2$$

$$\sigma_c = \sqrt{(133 + 48,4)^2 + 13^2 - (133 + 48,4) \times 13 + 3 \times 65^2} = 208 \text{ N/mm}^2$$

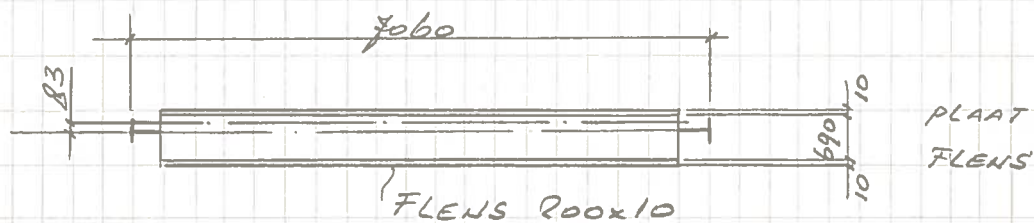
$< 1,2 \sigma_e$

LASSEN a = 4 mm TAB T1 ART. 3.3.

$$\sigma_{cl} = \frac{0,85 \times 10}{2 \times 4} \sqrt{2 \times 13^2 + 3 \times 65^2} = 121 \text{ N/mm}^2$$

< 360

REGEL A EN B (PUNTDEUR ERP)
REGEL B MAATGEVEND



$$q = 36 \text{ KN/M}^2$$

$$N = 1/2 \cdot 36 \cdot 7,060 \cdot 3 = 381 \text{ KN}$$

$$M = 1/8 \cdot 36 \cdot 7,060^2 = 224 \text{ KNM}$$

$$M = 381 (0,240 - 0,157) = 32 \text{ KNM}$$

$$M_{\text{TOT.}} = 256 \text{ KNM}$$

$$\sigma_{\text{PL.}} = \frac{256 \times 10^6 \times 1,5}{9675 \times 10^3} - \frac{381 \times 10^3 \times 1,5}{25100} = 16,9 \text{ N/MM}^2 \text{ TREK}$$

$$\text{DRUKFLENS } \frac{h}{t_w} = \frac{710}{10} = 71 < 75 \text{ VORMVAST}$$

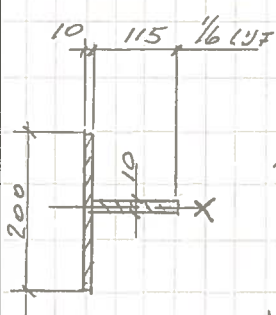
$$\text{ONGESTEUNDE LENGTE} = 3000 \text{ MM}$$

$$\frac{l}{h} = \frac{3000}{710} = 4,23$$

$$1,25 \times \frac{b}{t_f} = 1,25 \times \frac{200}{10} = 25$$

$$4,23 < 25 \rightarrow \text{NIET VORMVAST}$$

KNIKKEN DRUKRAND: VLG 2.7.3.



$$\sigma_{\text{FL.}} = \frac{256 \times 10^6 \times 1,5}{2746 \times 10^3} - \frac{381 \times 10^3 \times 1,5 \times 1,06}{25100} = 164 \text{ N/MM}^2 \text{ DRUK}$$

$$I_x = 1/12 \cdot 10 \cdot 200^3 + 1/12 \cdot 115 \cdot 10^3 = 6,6 \times 10^6 \text{ MM}^4$$

$$A = 200 \times 10 + 115 \times 10 = 3150 \text{ MM}^2$$

$$i = \sqrt{\frac{6,6 \times 10^6}{3150}} = 45,7 \quad \lambda = \frac{3000}{45,7} = 66 \rightarrow w = 1,62$$

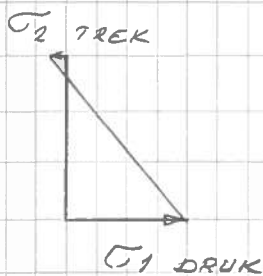
Fe 510.

$$\sigma = 16,4 \times 1,62 = 266 \text{ N/MM}^2 < 360$$

DOORBUIGING REGEL B (ERP)

$$\Delta M = \frac{0,62 \times 36 \times 7,060^4 + 5,96 \times 32 \times 7,060^3}{1519 \times 10^2} \times 10 = \underline{\underline{4,3 \text{ mm}}} = \frac{e}{1641}$$

CONTROLE PLOOIEN L4F REGEL B



$$\sigma_1 = 164 \text{ N/mm}^2$$

$$\sigma_2 = 16,9 \text{ N/mm}^2$$

$$L4F \text{ Dikte} = 10 \text{ mm}$$

$$\text{LENSTE PLAAT} = 3000 \text{ mm}$$

$$\text{BREEDTE} = 690 \text{ mm}$$

$$\psi = -\frac{16,9}{164} = -0,1 > -0,5 \quad (\text{GEEN REDUCTIE})$$

$$\alpha = \frac{3000}{690} = 4,35 \rightarrow K_d = 0,5$$

$$\text{VOOR } \alpha > 1 \rightarrow K_s = 5,35 + \frac{4}{4,35^2} = 5,56$$

$$Dw_{KR} = 12 \cdot 36 \cdot 7,060 = 127 \text{ kN}$$

$$\tau_{\text{GEM.}} = \frac{127 \times 10^3 \times 1,5}{690 \times 10} = 28 \text{ N/mm}^2$$

$$\sigma_E = 19 \left(\frac{100 \times 10}{690} \right)^2 = 39,9$$

$$\sigma_{KR} = 0,5 \times 39,9 = 339 \text{ N/mm}^2$$

$$\tau_{KR} = 5,56 \times 39,9 = 222 \rightarrow 208 \text{ N/mm}^2 = 0,58 \sigma_E$$

$$\sqrt{\left(\frac{164}{339} \right)^2 + \left(\frac{28}{208} \right)^2} = \underline{\underline{0,5}} < 1$$

VOOR GECOMBINEERDE SPANNINGEN VERGELYK REGEL D ERP

BEREKENING LASSEN REGEL B ERP.

$$q = 36 \text{ kN/m} \quad N = 381 \text{ kN} \quad A = 25100 \text{ mm}^2$$

KRACHT OP LIGFPLAAT: $Q = 36 \times 7,060 = 254 \text{ kN}$.

$$\sigma_{\perp} = \frac{254 \times 10^3 \times 1,5}{7060 \times 10} = 5,4 \text{ N/mm}^2$$

$$\sigma_{\parallel} = \frac{381 \times 10^3 \times 1,5}{25100} = 23 \text{ N/mm}^2$$

$$D_{\text{MAX.}} = \frac{1}{2} \cdot 36 \cdot 7,060 = 127 \text{ kN}$$

$$\tau_{\text{MAX.}} = \frac{127 \times 10^3 \times 1,5}{690 \times 10} = 28 \text{ N/mm}^2$$

LIGGER BIJ OPLEGGING: $M = 0$

$$\sigma_c = \sqrt{23^2 + 5,4^2 - 23 \times 5,4 + 3 \times 28^2} = 53 \text{ N/mm}^2$$

LIGGER OP $\frac{1}{4}$ V.D. LENGTE:

$$M = 127 \times 1,765 - \frac{1}{2} \cdot 36 \cdot 1,765^2 + 32 = 200 \text{ kNm}$$

$$D = 127 \times \frac{1}{2} = 64 \text{ kN}$$

$$\sigma_b = \frac{200 \times 10^6 \times 1,5}{2746 \times 10^3} = 109 \text{ N/mm}^2$$

$$\sigma_{\perp} = 5,4 \text{ N/mm}^2$$

$$\sigma_{\parallel} = 23 \text{ N/mm}^2$$

$$\tau = \frac{64 \times 10^3 \times 1,5}{690 \times 10} = 14 \text{ N/mm}^2$$

$$\sigma_{c'} = \sqrt{(109 + 23)^2 + 5,4^2 - (109 + 23) \cdot 5,4 + 3 \times 14^2} = 132 \text{ N/mm}^2 < 1,2 \sigma_c$$

LASSEN $a = 3 \text{ mm}$

$$\sigma_{c2} = \frac{0,25 \times 10}{2 \times 3} \sqrt{2 \times 5,4^2 + 3 \times 28^2} = 40 \text{ N/mm}^2 < \sigma_c$$

PUNTDEUREN

BEREKENING PUNTDEUREN:

HELMOND
SOMEREN
SLUIS H

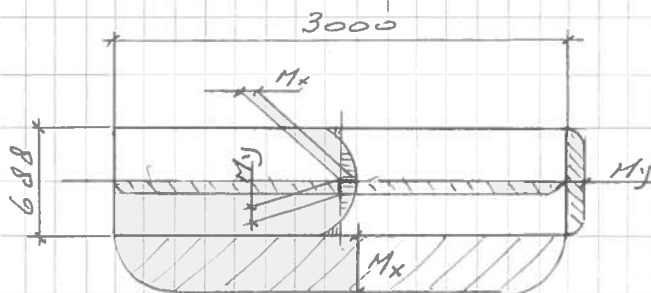
CONTROLE DOORLOPENDE PLAAT $\delta = 10 \text{ mm}$

HELMOND MAATGEVEND VELD B-C

PLAATVELD $3000 \times 2750 \text{ mm}$.

MET 3 HOR. VERSTUJVINGEN PLAATVELD WORDT $3000 \times 688 \text{ mm}$.

WATERDRUK = $0,0535 \text{ N/mm}^2$.



RANDSPANNING:

$$\frac{l_y}{l_x} = \frac{3000}{688} = 4,36$$

$$\varphi_x = 12$$

$$\varphi_y = 17,5$$

$$W = \frac{1}{6} \cdot 1 \cdot 10^2 = 16,7 \text{ mm}^3 \text{ PER mm.}$$

$$M_x = \frac{0,0535 \times 688^2}{12} = 2110 \text{ Nmm}$$

$$M_y = \frac{0,0535 \times 688^2}{17,5} = 1447 \text{ Nmm.}$$

$$\sigma_x = \frac{2110 \times 1,5}{16,7} = 190 \text{ N/mm}^2 < 360$$

$$\sigma_y = \frac{1447 \times 1,5}{16,7} = 130 \text{ N/mm}^2 < 360$$

SPANNING MIDDEN PLAAT:

$$\varphi_x = 25 \quad \varphi_y = 105$$

$$M_x = \frac{0,0535 \times 688^2}{25} = 1013 \text{ Nmm}$$

$$M_y = \frac{0,0535 \times 688^2}{105} = 241 \text{ Nmm.}$$

$$\sigma_x = \frac{1013 \times 1,5}{16,7} = 91 \text{ N/mm}^2 < 360$$

$$\sigma_y = \frac{241 \times 1,5}{16,7} = 22 \text{ N/mm}^2 < 360$$

DOORBUIGING MIDDEN PLAAT:

$$\delta M = \frac{0,034 \times 0,0535 \times 688^4}{2,1 \times 10^5 \times 10^3} = 1,94 \text{ mm.} = \frac{l.}{355}$$

rijkswaterstaat directie bruggen

werk: ZUID - WILLEMSVAART
PUNTDEUREN

datum: AUG. '85

blz. 32

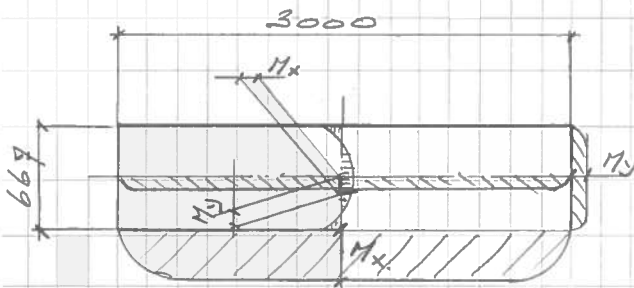
CONTROLE PLAAT VELD C-D MET 2 VERSTIJVINGEN.

HELMOND.

PLAATVELD 3000×2000 mm.

MET 2 VERSTIJVINGEN PLAATVELD WORDT 3000×667 mm.

WATERDRUK = $0,057$ N/mm²



RANDSPANNING:

$$\frac{l_y}{l_x} = \frac{3000}{667} = 4,5 \rightarrow \varphi_x = 12$$

$$\varphi_y = 17,5$$

$$W = \frac{1}{6} \cdot 1 \cdot 10^2 = 16,7 \text{ mm}^3 \text{ PER mm.}$$

$$M_x = \frac{0,057 \times 667^2}{12} = 2113 \text{ Nmm} \quad M_y = \frac{0,057 \times 667^2}{17,5} = 1449 \text{ Nmm.}$$

$$\sigma_x = \frac{2113 \times 1,5}{16,7} = \frac{190 \text{ N/mm}^2}{< 360} \quad \sigma_y = \frac{1449 \times 1,5}{16,7} = \frac{130 \text{ N/mm}^2}{< 360}$$

SPANNING MIDDEN PLAAT:

$$\varphi_x = 25 \quad \varphi_y = 105$$

$$M_x = \frac{0,057 \times 667^2}{25} = 1014 \text{ N/mm}^2 \quad M_y = \frac{0,057 \times 667^2}{105} = 242 \text{ Nmm.}$$

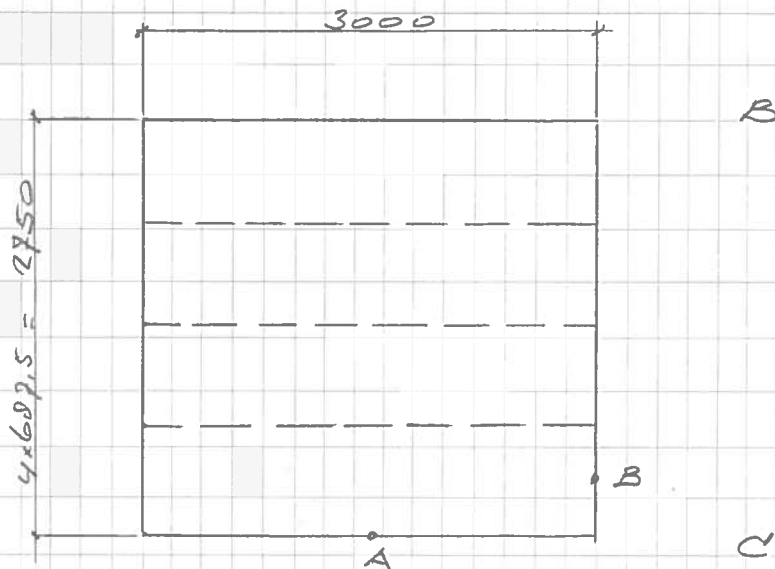
$$\sigma_x = \frac{1014 \times 1,5}{16,7} = \frac{91 \text{ N/mm}^2}{< 360} \quad \sigma_y = \frac{242 \times 1,5}{16,7} = \frac{22 \text{ N/mm}^2}{< 360}$$

DOORBUIGING MIDDEN PLAAT:

$$\delta_m = \frac{0,034 \times 0,057 \times 667^4}{2,1 \times 10^5 \times 10^3} = 1,83 \text{ mm.} = \frac{l}{364}$$

PLAATVERSTYVING.

HELMOND



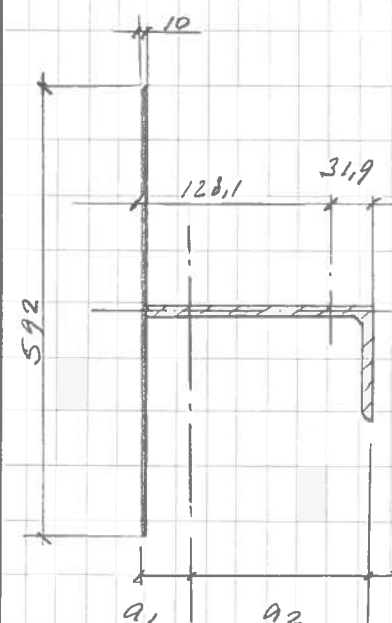
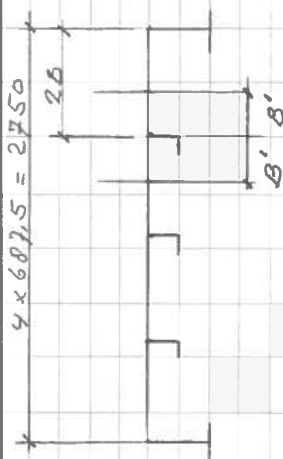
$$2B = 688 \quad B = 344 \quad L = 3000$$

$$\frac{B}{L} = \frac{344}{3000} = 0,115 \rightarrow \lambda = 0,86$$

$$B' = 0,86 \times 344 = 296 \text{ mm.}$$

$$2B' = 592 \text{ mm.}$$

VERSTYVING L 150.75.10



$$A = 592 \times 10 + 1660 = 7580 \text{ mm}^2.$$

$$Q_1 = \frac{592 \times 10 \times 5 + 1660 \times 128,1}{7580} = 32 \text{ mm.}$$

$$Q_2 = 128 \text{ mm.}$$

$$J = \frac{1}{12} \cdot 592 \cdot 10^3 + 592 \times 10 \times 27^2 + 1660 \times 0 + 1660 \times 96,1^2 = 2131 \times 10^4 \text{ mm}^4.$$

$$W_{MIN.} = \frac{2131 \times 10^4}{128} = 166484 \text{ mm}^3$$

$$q = 0,688 \times 53,5 = 36,8 \text{ kN/m}$$

$$W_{MAX.} = \frac{2131 \times 10^4}{32} = 665937 \text{ mm}^3$$

$$M_{INKL.} = \frac{1}{12} \cdot 36,8 \cdot 3^2 = 27,6 \text{ kNm.}$$

$$\sigma_{MA.} = \frac{27,6 \times 10^6 \times 1,5}{166484} = 249 \text{ N/mm}^2.$$

$$\sigma_{MIN.} = \frac{27,6 \times 10^6 \times 1,5}{665937} = 62 \text{ N/mm}^2 < 360$$

BEREKENING LASSEN VERSTUJVING: L 150.75.10

$$\left. \begin{aligned} \sigma_{bpl.} &= 62 \text{ N/mm}^2 \\ \sigma_{bfl.} &= 249 \text{ N/mm}^2 \end{aligned} \right\} \text{ BIJ DE INKLEMMING}$$

$$D = \frac{1}{2} \cdot 36,8 \times 3 = 55,2 \text{ KN}$$

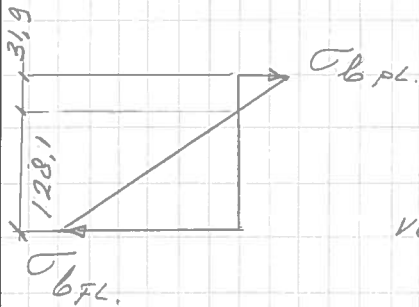
$$\sigma_{\text{MAX.}} = \frac{55,2 \times 10^3 \times \frac{1}{2} \times 128,1^2 \times 10}{10 \times 50 \times 10^4} = 90,4 \text{ N/mm}^2$$

VOOR GROOTSTE DRUKSPANNING GELDT:

$$a = 0,6 \times 10 \times \frac{249}{360} = 4,15 \text{ mm} \rightarrow \underline{\underline{5 \text{ mm}}}$$

VOOR GROOTSTE SCHUIFSPANNING GELDT:

$$a = \frac{0,85 \times 10}{2 \times 360} \sqrt{3 \times 90,4^2} = 1,85 \text{ mm} \rightarrow \underline{\underline{5 \text{ mm}}}$$

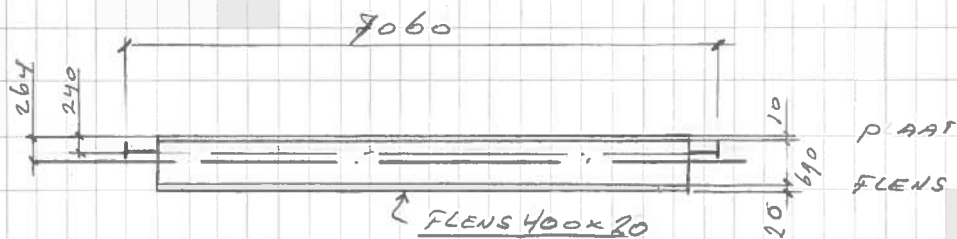


PUNTDEUREN

BEREKENING REGELS:

HELMOND → REGEL C EN D.
SOMEREN
SLUIS H.

REGEL C



$$q = 116,5 \text{ KN/M} \quad N = 1/2 \cdot 116,5 \cdot 7,060 \times 3 = 1234 \text{ KN}$$

$$\text{DOOR WATER DRUK} \quad M = 1/8 \cdot 116,5 \cdot 7,060^2 = 725,8 \text{ KNM}$$

$$\text{" SPATKRACHT} \quad M = 1234(0,240 - 0,264) = -30, -$$

$$M_{\text{TOT.}} = \underline{\underline{696}} \text{ KNM}$$

$$\sigma_{\text{PL.}} = \frac{696 \times 10^6 \times 1,5}{11397 \times 10^3} - \frac{1234 \times 10^3 \times 1,5}{31100} = \underline{\underline{32 \text{ N/MM}^2}} \text{ TREK}$$

$$\sigma_{\text{FL.}} = \frac{696 \times 10^6 \times 1,5}{6598 \times 10^3} + \frac{1234 \times 10^3 \times 1,5 \times 1017}{31100} = \underline{\underline{219 \text{ N/MM}^2}} \text{ DRUK}$$

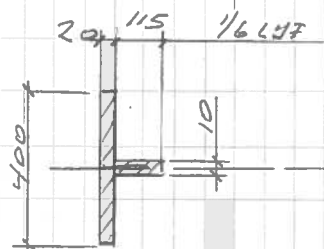
$$\text{DRUK FLENS: } \frac{h}{t_w} = \frac{720}{10} = 72 < 75 \rightarrow \text{VORMVAST}$$

$$\frac{l}{h} = \frac{3000}{720} = 4,17$$

$$1,25 \times \frac{b}{t_f} = 1,25 \times \frac{400}{20} = 25$$

$$4,17 < 25 \rightarrow \text{NIET VORMVAST}$$

KNIKKEN DRUKRAND:



$$I_x = 1/12 \cdot 20 \cdot 400^3 + 1/12 \cdot 115 \cdot 10^3 = 106 \times 10^6 \text{ mm}^4$$

$$A = 400 \times 20 + 115 \times 10 = 9150 \text{ mm}^2$$

$$i = \sqrt{\frac{106 \times 10^6}{9150}} = 107 \quad \lambda = \frac{3000}{107} = 28$$

$$w = 1,07$$

$$\sigma = 219 \times 1,07 = \underline{\underline{234 \text{ N/MM}^2}} < 360$$

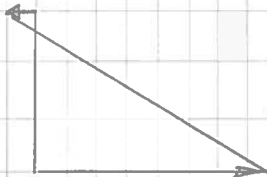
DOORBINGING REGEL C

HELMOND

$$\delta_M = \frac{0,62 \times 116,5 \times 7,060^4 - 5,96 \times 30 \times 7,060^2}{300,9 \times 10^2} \times 10 = \frac{5,7 \text{ MM}}{1238}$$

CONTROLE PLOOIEN LYF REGEL C

σ_2 TREK



σ_1 DRUK

$$\sigma_1 = 219 \text{ N/MM}^2$$

$$\sigma_2 = 32 \text{ N/MM}^2$$

LYFDIKTE = 10 MM

LENGTE PLaat = 3000 MM

BREEDTE " = 690 MM

$$\psi = -\frac{32}{219} = -0,146 > 0,5 \quad (\text{GEEN REDUCTIE})$$

$$\alpha = \frac{3000}{690} = 4,35 \rightarrow K_d = 9$$

$$\text{VOOR } \alpha > 1 \quad K_s = 5,35 + \frac{4}{4,35^2} = 5,56$$

$$D.W. KR. = \frac{1}{2} \cdot 116,5 \cdot 7,060 = 411 \text{ KN}$$

$$\tau_{\text{GEM.}} = \frac{411 \times 10^3 \times 1,5}{690 \times 10} = 89 \text{ N/MM}^2$$

$$\sigma_E = 19 \left(\frac{100 \times 10}{690} \right)^2 = 39,9 \text{ N/MM}^2$$

$$\sigma_{KR.} = 9 \times 39,9 = 359 \text{ N/MM}^2$$

$$\tau_{KR.} = 5,56 \times 39,9 = 222 \text{ N/MM}^2 \rightarrow 208 \text{ N/MM}^2 = 0,58 \sigma_E$$

$$\sqrt{\left(\frac{219}{359} \right)^2 + \left(\frac{89}{208} \right)^2} = 0,76 < 1$$

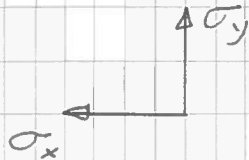
PUNTDEUREN

GEDOMBINEERDE SPANNINGEN REGEL C HELMOND

RANDSPANNINGEN PLAAT

PUNT A

ZIE BLZ 33.



$$\sigma_x = 32 \text{ N/MM}^2 \text{ TREK BLZ. 35}$$

$$\sigma_y = 190 \text{ N/MM}^2 \text{ DRUK BLZ. 31}$$

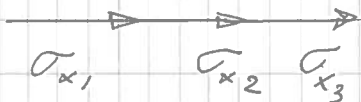
$$\sigma_{TOT} = \sqrt{32^2 + 190^2 + 32 \times 190} = \underline{207 \text{ N/MM}^2} < 360$$

PUNT B

$$\sigma_{x1} = 32 \text{ N/MM}^2 \text{ TREK BLZ. 35}$$

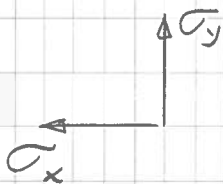
$$\sigma_{x2} = 62 \text{ N/MM}^2 \text{ TREK BLZ 33}$$

$$\sigma_{x3} = 130 \text{ N/MM}^2 \text{ TREK BLZ 31}$$



$$\sigma_{TOT} = 32 + 62 + 130 = \underline{224 \text{ N/MM}^2} < 360$$

SPANNING IN HET MIDDEN V.D. PLAAT



$$\sigma_{x1} = 32 \text{ N/MM}^2 \text{ TREK BLZ. 35}$$

$$\sigma_{x2} = 62 \text{ N/MM}^2 \text{ TREK BLZ 33}$$

$$\sigma_y = 91 \text{ N/MM}^2 \text{ TREK BLZ 31}$$

$$\sigma_{TOT} = \sqrt{(32+62)^2 + 91^2 - (32+62) \cdot 91} = \underline{93 \text{ N/MM}^2} < 360$$

REGEL A UITVOEREN FLENS 200x10

(ZIE REGEL A EN B ERP)

REGEL B UITVOEREN FLENS 300x15

(ZIE REGEL D ERP)

PUNTDEUREN

BEREKENING LASSEN REGEL C HELMOND.

$$q = 117 \text{ kN/m} \quad N = 1234 \text{ kN} \quad A = 31100 \text{ mm}^2$$

$$\text{KRACHT OP LIGFPLAAT: } Q = 117 \times 7,060 = 826 \text{ kN}$$

$$\sigma_{\perp} = \frac{826 \times 10^3 \times 1,5}{7060 \times 10} = 18 \text{ N/mm}^2$$

$$\sigma_{\parallel} = \frac{1234 \times 10^3 \times 1,5}{31100} = 60 \text{ N/mm}^2$$

$$D_{\text{MAX.}} = 1/2 \cdot 117 \cdot 7,060 = 413 \text{ kN}$$

$$\tau_{\text{MAX.}} = \frac{413 \times 10^3 \times 1,5}{690 \times 10} = 90 \text{ N/mm}^2$$

$$\text{LIGGER BIJ OPLEGGING: } M = 0$$

$$\sigma_c = \sqrt{60^2 + 18^2 - 60 \times 18 + 3 \times 90^2} = 165 \text{ N/mm}^2$$

LIGGER OP 1/4 V.D. LENGTE:

$$M = 413 \times 1,765 - 1/2 \cdot 117 \cdot 1,765^2 - 30 = 517 \text{ kNm}$$

$$D = 413 \times 1/2 = 207 \text{ kN}$$

$$\sigma_b = \frac{517 \times 10^6 \times 1,5}{6598 \times 10^3} = 118 \text{ N/mm}^2$$

$$\sigma_{\perp} = 18 \text{ N/mm}^2$$

$$\sigma_{\parallel} = 60 \text{ N/mm}^2$$

$$\tau = \frac{207 \times 10^3 \times 1,5}{690 \times 10} = 45 \text{ N/mm}^2$$

$$\sigma_c = \sqrt{(118+60)^2 + 18^2 - (118+60)18 + 3 \times 45^2} = 187 \text{ N/mm}^2 < 1,2 \sigma_c$$

LASSEN a = 4 mm

$$\sigma_{cl} = \frac{0,85 \times 10}{2 \times 4} \sqrt{2 \times 18^2 + 3 \times 90^2} = 168 \text{ N/mm}^2 < \sigma_c$$

BEREKENING PUNTDEUREN:

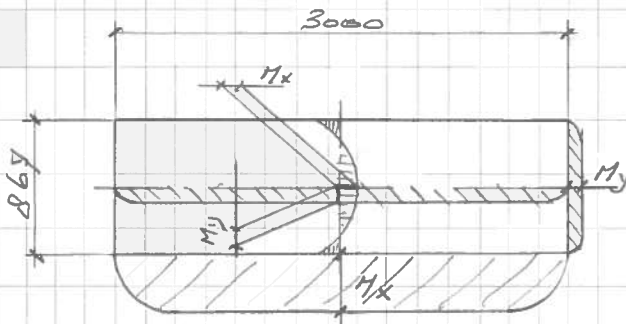
AARLE - RIXTEL SLUIS I

CONTROLE D ORLOPENDE PLAT $\delta = 10 \text{ mm}$.

AARLE-RIXTEL MAATGEVEND

PLAATVELD 3000×2600

MET 2 HOR. VERSTIJVINGEN, PLAATVELD WORDT $3000 \times 867 \text{ mm}$
WATER DRUK $= 0,085 \text{ N/mm}^2$.



RANDSPANNING:

$$\frac{l_y}{l_x} = \frac{3000}{867} = 3,46$$

$$\psi_x = 12$$

$$\psi_y = 17,5$$

$$W = \frac{1}{6} \cdot 1 \cdot 10^2 = 16,7 \text{ mm}^3 \text{ PER mm.}$$

$$M_x = \frac{0,085 \times 867^2}{12} = 1158 \text{ Nmm} \quad M_y = \frac{0,085 \times 867^2}{17,5} = 795 \text{ Nmm.}$$

$$\sigma_x = \frac{1158 \times 1,5}{16,7} = \frac{104 \text{ N/mm}^2}{< 360} \quad \sigma_y = \frac{795 \times 1,5}{16,7} = \frac{71 \text{ N/mm}^2}{< 360}$$

SPANNING MIDDEN PLAAT

$$\psi_x = 25 \quad \psi_y = 105$$

$$M_x = \frac{0,085 \times 867^2}{25} = 556 \text{ Nmm} \quad M_y = \frac{0,085 \times 867^2}{105} = 132 \text{ Nmm}$$

$$\sigma_x = \frac{556 \times 1,5}{16,7} = \frac{50 \text{ N/mm}^2}{< 360} \quad \sigma_y = \frac{132 \times 1,5}{16,7} = \frac{12 \text{ N/mm}^2}{< 360}$$

DOORBUIGING MIDDEN PLAAT:

$$\delta m = \frac{0,034 \times 0,085 \times 867^4}{2,1 \times 10^5 \times 10^3} = 1,7 \text{ mm} = \frac{0}{510}$$

rijkswaterstaat directie bruggen

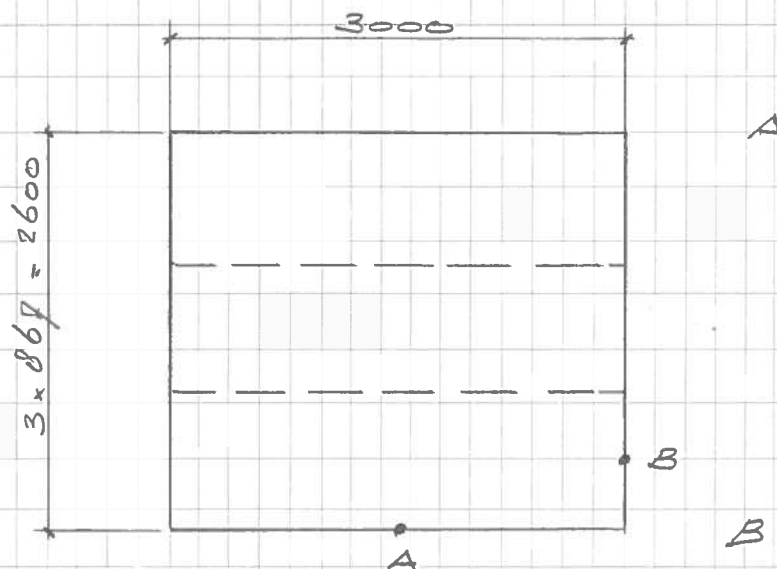
werk: ZUID - WILLEMS VAART

datum: AUG. '85

blz. 40

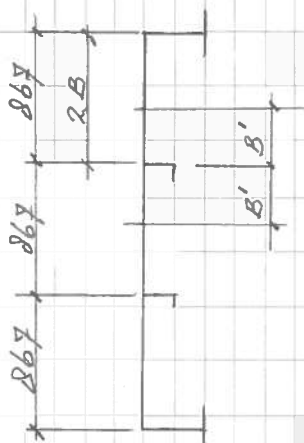
PUNT-DEUREN

PLAATVERSTUJVING



WATERDRUK

$$= 0,0125 \text{ N/mm}^2$$



$$2B = 867 \quad B = 434 \text{ mm} \quad L = 3000 \text{ mm.}$$

$$\frac{B}{L} = \frac{434}{3000} = 0,145 \rightarrow \lambda = 0,79$$

$$B' = 0,79 \times 434 = 343 \text{ mm.}$$

$$2B' = 686 \text{ mm.}$$

VERSTUJVING L 150 x 75 x 10 ZIE BLZ 16

$$A = 8520 \text{ mm}^2$$

$$a_1 = 29 \text{ mm} \quad a_2 = 131 \text{ mm.}$$

$$I = 2193 \times 10^4 \text{ mm}^4.$$

$$W_{\text{MIN.}} = 167404 \text{ mm}^3$$

$$W_{\text{MAX.}} = 756206 \text{ mm}^3.$$

$$q = 0,867 \times 10,5 = 16 \text{ kN/m'}$$

$$M_{\text{INKL.}} = \frac{1}{12} \cdot 16 \cdot 3^2 = 12 \text{ kNm.}$$

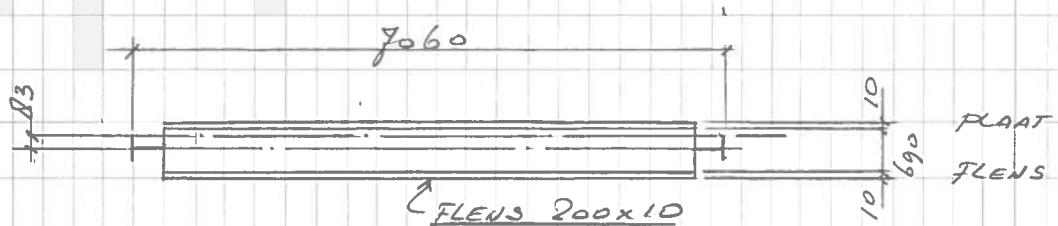
$$\sigma_{\text{MIN.}} = \frac{16 \times 10^6 \times 1,5}{756206} = 32 \text{ N/mm}^2.$$

$$\sigma_{\text{MAX.}} = \frac{16 \times 10^6 \times 1,5}{167404} = 143 \text{ N/mm}^2$$

≤ 360

BEREKENING REGELS:

AARLE-RIJTEL → REGEL A-B-C EN D (REGEL C MAATGEVENDE)
SLUIS I



$$q = 44 \text{ KN/M} \quad N = 12.44 \cdot 7.060 \cdot 3 = 466 \text{ KN.}$$

DOOR WATERDRUK $M = 12.44 \cdot 7.060^2 = 274 \text{ KNM.}$

" SPATKRACHT $M = 466 (0.240 - 0.157) = 39$

$M_{\text{TOT.}} = 313 \text{ KNM.}$

$$\sigma_{\text{PL}} = \frac{313 \times 10^6 \times 1.5}{9675 \times 10^3} - \frac{466 \times 10^3 \times 1.5}{25100} = 21 \text{ N/MM}^2 \text{ TREK}$$

$$\sigma_{\text{FL}} = \frac{313 \times 10^6 \times 1.5}{2746 \times 10^3} + \frac{466 \times 10^3 \times 1.5 \times 1.06}{25100} = 200 \text{ N/MM}^2 \text{ DRUK}$$

DRUKFLENS: PROFIEL NIET VORMVAST ZIE BLZ 22.

KNIKKEN DRUKRAND: ZIE BLZ. 22.

$$\sigma_{\text{KN}} = 200 \times 1.62 = 324 \text{ N/MM}^2 < 360$$

rijkswaterstaat directie bruggen

werk: ZUID-WILLEMSVAART
PUNTDEUREN

datum: AUG. '85

blz. 42.

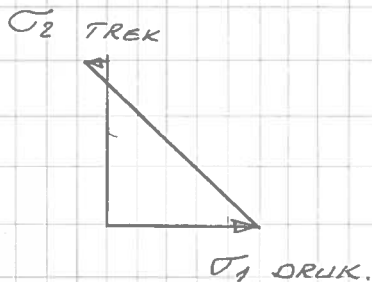
DOORBUIGINGS REGEN C

AARLE-RIXTEL

$$\delta_M = \frac{0,62 \times 44 \times 7,060^4 + 5,96 \times 39 \times 7,060^2}{1519 \times 10^2} \times 10 = 5,39 \text{ mm.}$$

$$= \frac{e.}{1310}$$

CONTROLE PLOOIEN LYF REGEN C



$$\sigma_1 = 200 \text{ N/mm}^2$$

$$\sigma_2 = 21 \text{ N/mm}^2$$

LYFDIKTE = 10 mm.

LENGTE PLAAT = 3000 mm.

BREEDTE = 690 mm

$$\psi = \frac{21}{200} = -0,106 \rightarrow > -0,5 \quad (\text{GEEN REDUCTIE})$$

$$\alpha = \frac{3000}{690} = 4,35 \rightarrow K_\alpha = 0,6$$

$$\text{VOOR } \alpha > 1 \quad K_S = 5,35 + \frac{4}{4,35^2} = 5,56$$

$$\text{DW.KR.} = 1/2 \times 44 \times 7,060 = 155 \text{ kN.}$$

$$\bar{\sigma}_{\text{gem.}} = \frac{155 \times 10^3 \times 1,5}{690 \times 10} = 34 \text{ N/mm}^2.$$

$$\sigma_E = 39,9 \text{ N/mm}^2$$

$$\sigma_{KR.} = 0,6 \times 39,9 = 239 \text{ N/mm}^2.$$

$$\bar{\sigma}_{KR} = 5,56 \times 39,9 = 222 \text{ N/mm}^2 \rightarrow 208 \text{ N/mm}^2 = 0,58 \sigma_E$$

$$\sqrt{\left(\frac{200}{343}\right)^2 + \left(\frac{34}{208}\right)^2} = 0,6 < 1$$

rijkswaterstaat directie bruggen

werk: ZUID-WILLEMSVAART

datum: AUG. '85

blz. 43

PUNT DEUREN.

GECOMBINEERDE SPANNINGEN REGEL C AARLE - RIJTEL

RANDSPANNING PLAAT

PUNT A

ZIE BLZ 40



$$\sigma_x = 21 \text{ N/MM}^2 \text{ TREK}$$

ZIE BLZ. 41

$$\sigma_y = 104 \text{ N/MM}^2 \text{ DRUK}$$

" 39

$$\sigma_{\text{TOT.}} = \sqrt{21^2 + 104^2 + 21 \times 104} = 116 \text{ N/MM}^2 < 360$$

$$\sigma_{x1} = 21 \text{ N/MM}^2 \text{ TREK. ZIE BLZ 41}$$

$$\sigma_{x2} = 104 \text{ N/MM}^2 \text{ TREK. ZIE BLZ 39}$$

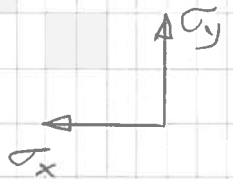
$$\sigma_{x3} = 32 \text{ N/MM}^2 \text{ TREK. ZIE BLZ 40}$$

PUNT B



$$\sigma_{\text{TOT.}} = 21 + 104 + 32 = 157 \text{ N/MM}^2 < 360$$

SPANNING IN HET MIDDEN V.D. PLAAT



$$\sigma_{x1} = 21 \text{ N/MM}^2 \text{ TREK. BLZ. 41}$$

$$\sigma_{x2} = 32 \text{ N/MM}^2 \text{ TREK. BLZ 40}$$

$$\sigma_y = 50 \text{ N/MM}^2 \text{ TREK. " 39}$$

$$\sigma_{\text{TOT.}} = \sqrt{(21+32)^2 + 50^2 - (21+32)50} = 89 \text{ N/MM}^2 < 360$$

REGEL A, B EN D UITVOEREN ALS REGEL C (FL. 200x10)

BEREKENING LASSEN REGEL C

AARLE - RIJTEL

$q = 44 \text{ kN/m}$ $N = 466 \text{ kN}$ $A = 25100 \text{ mm}^2$
 KRACHT OP LUFPLAAT: $Q = 44 \times 7,060 = 311 \text{ kN}$.

$$\sigma_{\perp} = \frac{311 \times 10^3 \times 1,5}{7060 \times 10} = 6,6 \text{ N/mm}^2$$

$$\sigma_{\parallel} = \frac{466 \times 10^3 \times 1,5}{25100} = 28 \text{ N/mm}^2$$

$$D_{\text{MAX.}} = 1/2 \cdot 44 \cdot 7,060 = 155 \text{ kN}$$

$$\tau_{\text{MAX.}} = \frac{155 \times 10^3 \times 1,5}{690 \times 10} = 34 \text{ N/mm}^2$$

LIGGER BIJ OPLEGGING: $M = 0$

$$\sigma_c = \sqrt{28^2 + 6,6^2 - 28 \times 6,6 + 3 \times 34^2} = 64 \text{ N/mm}^2$$

LIGGER OP 1/4 V.D. LENGTE

$$M = 155 \times 1,765 - 1/2 \cdot 44 \cdot 1,765^2 + 39 = 244 \text{ N/mm}^2$$

$$D = 155 \times 1/2 = 78 \text{ kN}$$

$$\sigma_b = \frac{244 \times 10^6 \times 1,5}{2746 \times 10^3} = 133 \text{ N/mm}^2$$

$$\sigma_{\perp} = 6,6 \text{ N/mm}^2$$

$$\sigma_{\parallel} = 28 \text{ N/mm}^2$$

$$\tau = \frac{78 \times 10^3 \times 1,5}{690 \times 10} = 17 \text{ N/mm}^2$$

$$\sigma_c = \sqrt{(133 + 28)^2 + 6,6^2 - (133 + 28) \cdot 6,6 + 3 \times 17^2} = \underline{\underline{161 \text{ N/mm}^2}}$$

$< 1,2 \sigma_e$

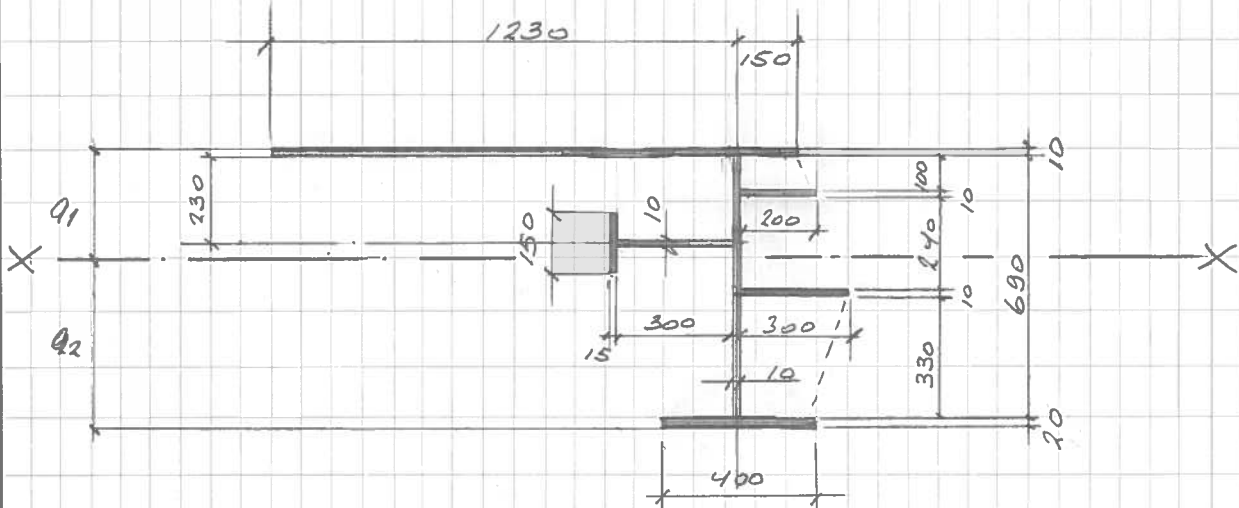
LASSEN a = 3

$$\sigma_{cl} = \frac{0,85 \times 10}{2 \times 3} \sqrt{2 \times 6,6^2 + 3 \times 34^2} = \underline{\underline{84 \text{ N/mm}^2}}$$

$< \sigma_e$

DOORSNEDE VOORHAR

HELMOND



$$L = 11200 \text{ mm} \quad 2B = 3000 \text{ mm} \quad B = 1500 \text{ mm} \quad \frac{B}{L} = \frac{1500}{11200} = 0,134$$

$$\lambda = 0,82$$

$$B' = 0,82 \times 1500 = 1230 \text{ mm}$$

$$A = 1380 \times 10 + 690 \times 10 + 200 \times 10 + 300 \times 10 + 300 \times 10 + 150 \times 15 + 400 \times 20 = 38950 \text{ mm}^2$$

$$Q_1 = \frac{1380 \times 10 \times 5 + 690 \times 10 \times 355 + 200 \times 10 \times 115 + 300 \times 10 \times 365}{38950} +$$

$$+ \frac{300 \times 10 \times 240 + 150 \times 15 \times 240 + 400 \times 20 \times 710}{38950} = 277 \text{ mm}$$

$$Q_2 = 720 - 277 = 443 \text{ mm}$$

$$I_x = \frac{1}{12} \cdot 1380 \cdot 10^3 + 1380 \times 10 \times 272^2 + \frac{1}{12} \cdot 10 \cdot 690^3 + 690 \times 10 \times 78^2 + \frac{1}{12} \cdot 200 \cdot 10^3 + 200 \times 10 \cdot 162^2 + \frac{1}{12} \cdot 300 \cdot 10^3 + 300 \times 10 \times 88^2 + \frac{1}{12} \cdot 300 \cdot 10^3 + 300 \times 10 \times 37^2 + \frac{1}{12} \cdot 15 \cdot 150^3 + 150 \times 15 \times 37^2 + \frac{1}{12} \cdot 400 \cdot 20^3 + 400 \times 20 \times 433^2 = 2924 \times 10^6 \text{ mm}^4$$

$$W_1 = \frac{2924 \times 10^6}{277} = 10555 \times 10^3 \text{ mm}^3$$

$$W_2 = \frac{2924 \times 10^6}{443} = 6600 \times 10^3 \text{ mm}^3$$

rijkswaterstaat directie bruggen

werk: ZUID-WILLEMSVAART
PUNTDEUREN.

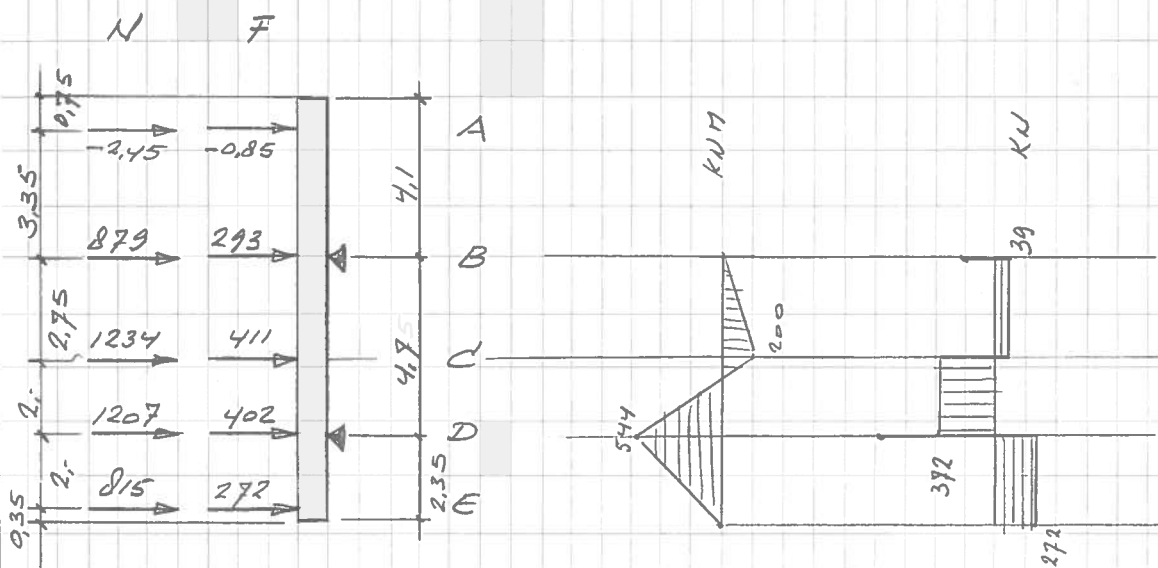
datum: AUG. 85

blz. 46

VERVOLG VOORHAR

HELMOND.

DE HARREN DRUKKEN ALLEEN T.P.V. DE STEUNPUNTEN.
BEN D TEGEN ELKAAR



OPLEGDRUKKEN UIT REGELS T.G.V. WATERDRUK

REGEL A: $F = -\frac{1}{2} \cdot 0,24 \cdot 7,060 = -0,85 \text{ KN}$	$N = -2,52 \text{ KN}$
" B: $F = \frac{1}{2} \cdot 0,3 \cdot 7,060 = 293 \text{ KN}$	$N = 879 \text{ KN}$
" C: $F = \frac{1}{2} \cdot 116,5 \cdot 7,060 = 411 \text{ KN}$	$N = 1234 \text{ KN}$
" D: $F = \frac{1}{2} \cdot 114 \cdot 7,060 = 402 \text{ KN}$	$N = 1207 \text{ KN}$
" E: $F = \frac{1}{2} \cdot 77 \cdot 7,060 = 272 \text{ KN}$	$N = 815 \text{ KN}$

$$R_B = \frac{293 \times 4,75 + 411 \times 2 - 272 \times 2,35}{4,75} = 331 \text{ KN}$$

$$R_D = 1046 \text{ KN}$$

$$M_C = -272 \times 4 - 402 \times 2 + 1046 \times 2 = 200 \text{ KNM}$$

$$M_D = -272 \times 2 = 544 \text{ KNM}$$

$$D_{\text{MAX}} = 1046 - 272 - 402 = 372 \text{ KN}$$

DOOR SPATKRACHT:

$$R_B = 3 \times 331 = 993 \text{ KN}$$

$$R_D = 3 \times 1046 = 3138 \text{ KN}$$

PUNTDEUREN

$$\sigma_{b \max} = \frac{544 \times 10^6 \times 1,5}{6600 \times 10^3} = 124 \text{ N/mm}^2 < 360$$

$$\tau = \frac{372 \times 10^3 \times 1,5}{690 \times 10} = 81 \text{ N/mm}^2 < 0,58 \times 360$$

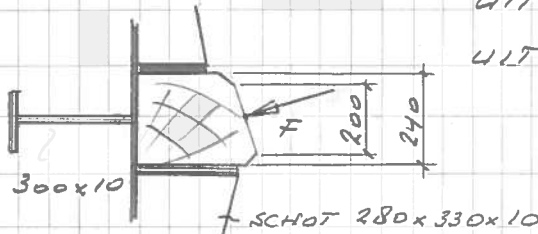
$$\sigma_d = \sqrt{124^2 + 3 \times 81^2} = 187 \text{ N/mm}^2 < 1,2 \times 360$$

DRUKSPANNING OP HOUTEN BALK I.P.V. REGEL D.

UIT VOORHAR BELASTING:

UIT WATERDRUK $F_1 = 1046 \text{ KN}$

UIT SPATKRACHT $F_2 = 3138 \text{ KN}$



$$F = \sqrt{1046^2 + 3138^2} = 3308 \text{ KN}$$

LENGTE HOUT WAAROVER DE DRUK WORDT UITGEOEFEND:

$$L = 2000 \text{ mm}$$

HOUTSPANNING $\sigma_d = \frac{3308 \times 10^3}{2000 \times 200} = 8,3 \text{ N/mm}^2 < 15$

STAAL SPANNING OP VERSTEVING 300×10 :

$$\sigma_d = \frac{3308 \times 10^3 \times 1,5}{2000 \times 10} = 248 \text{ N/mm}^2 < 360$$

PLOOIEN SCHOT $280 \times 330 \times 10$

$$H.O.H. = \frac{2000}{3} = 667 \text{ mm}$$

$$\text{HOUTSPANNING OVER 2M} = \frac{1046 \times 10^3}{2000 \times 280} = 1,9 \text{ N/mm}^2$$

UIT HOUTSPANNING: $F = 2 \times 280 \times \frac{667}{1000} = 374 \text{ KN}$

$$\sigma_d = \frac{374 \times 10^3 \times 1,5}{10 \times 280} = 200 \text{ N/mm}^2$$

$$\psi = \frac{-200}{-200} = 1 \quad \alpha = \frac{330}{280} = 1,2 \rightarrow K_d = 4$$

$$K_s = 4 + \frac{5,35}{1,2^2} = 7,7 \quad \sigma_{\text{GET.}} = \frac{374 \times 10^3 \times 1,5}{330 \times 10} = 170 \text{ N/mm}^2 < 0,58 \times 360$$

$$\sigma_E = 19 \left(\frac{100 \times 10}{280} \right)^2 = 242 \text{ N/mm}^2$$

$$\sigma_{KR} = 4 \times 242 = 968 \rightarrow 360 \text{ N/mm}^2$$

$$\sigma_{KR} = 7,7 \times 242 = 1863 \rightarrow 208 \text{ N/mm}^2$$

$$\sqrt{\left(\frac{248}{360} \right)^2 + \left(\frac{170}{208} \right)^2} = 1,07 > 1$$

SCHOTTEN 12 MM DIK MAKEN!

PUNTDEUREN

CONTRÔLE REGEL D DOOR BELASTING UIT VOORHAR.
HELDOND. (2 PUNTS OPLEGGING

VOORHAR)

VOOR SCHETS ZIE REGEL C. BLZ. 35

$$q = 114 \text{ KN/M} \quad N = 3138 \text{ KN}$$

DOOR WATERDRUK: $M = 18 \cdot 114 \cdot 7,060^2 = 710 \text{ KNM.}$

" SPATKRACHT: $M = 3138(0,240 - 0,264) = -75 "$

$M_{TOT.} = \underline{\underline{635 \text{ KNM.}}}$

$$\sigma_{pl.} = \frac{635 \times 10^6 \times 1,5}{11397 \times 10^3} - \frac{3138 \times 10^3 \times 1,5}{31100} = -68 \text{ N/MM}^2 \quad \text{DRUK}$$

$$\sigma_{fl.} = \frac{635 \times 10^6 \times 1,5}{6598 \times 10^3} - \frac{3138 \times 10^3 \times 1,5}{31100} = -296 \text{ N/MM}^2 \quad \text{DRUK}$$

KNIKKEN DRUKRAND: ZIE OOK REGEL C BLZ. 35

$$\sigma = 296 \times 1,07 = \underline{\underline{317 \text{ N/MM}^2}} < 360$$

GECOMBINEERDE SPANNINGEN REGEL D HELMOND BIJ 2 PUNTJES OPLEGGING VOORHAR.

UIT REGEL D $\sigma_x = -68 \text{ N/MM}^2$ DRUK BLZ 48
UIT RANDSPANNING PLAAT $\sigma_y = 190 \text{ N/MM}^2$ TREK BLZ 32



$$\sigma_{TOT.} = \sqrt{68^2 + 190^2 + 68 \times 190} = \underline{232 \text{ N/MM}^2} < 360$$

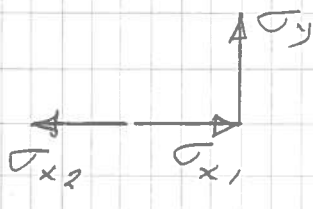
UIT REGEL D $\sigma_{x1} = -68 \text{ N/MM}^2$ DRUK BLZ 48
UIT RANDSPANNING PLAAT: $\sigma_{x2} = -130 \text{ N/MM}^2$ DRUK BLZ 32.
UIT VERSTUIVING: $\sigma_{x3} = 62 \text{ N/MM}^2$ TREK BLZ 33



$$\sigma_{TOT.} = -68 - 130 + 62 = -136 \text{ N/MM}^2 < 360$$

SPANNING IN HET MIDDEN V.D. PLAAT:

UIT REGEL D $\sigma_{x1} = -68 \text{ N/MM}^2$ DRUK BLZ 48
UIT VERSTUIVING $\sigma_{x2} = 62 \text{ N/MM}^2$ TREK BLZ 33
UIT MIDDEN PLAAT $\sigma_y = 91 \text{ N/MM}^2$ TREK BLZ 31



$$\sigma_{TOT.} = \sqrt{(68-62)^2 + 91^2 + (68-62)91} = \underline{94 \text{ N/MM}^2} < 360$$

rijkswaterstaat directie bruggen

werk: ZUID-WILLEMSVAART
PUNTDEUREN.

datum: AUG. '85

blz. 50

BEREKENING LASSEN VOORHAR.

HELROND.

GROOTSTE SPANNINGEN TREDEN OP BIJ VERST. PL. 300 x 10 MM

SPATKRACHT REGEL C = 1234 KN

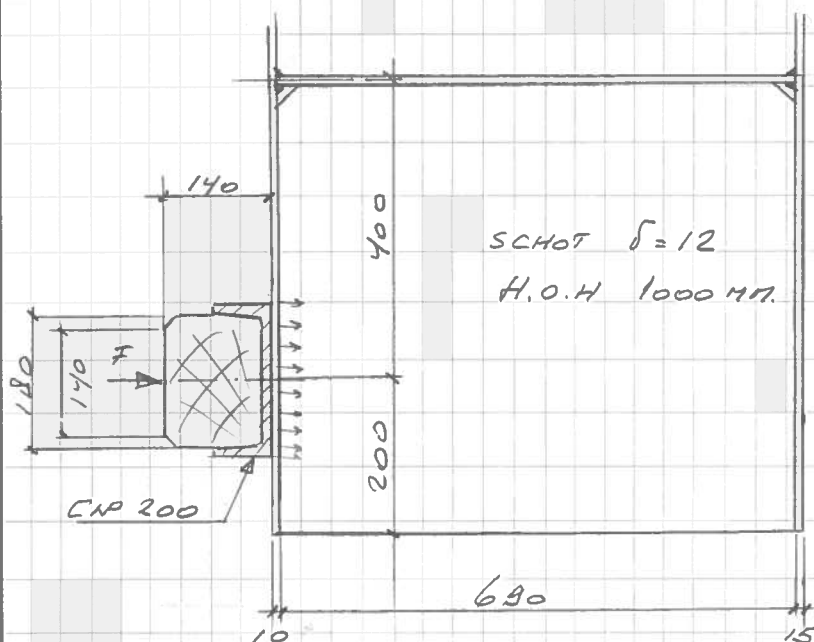
$$\sigma_{dl} = \frac{1234 \times 10^3 \times 1,5}{2000 \times 10} = \underline{93 \text{ N/MM}^2} < \sigma_e$$

LASSEN a = 4 MM.

$$\sigma_{ol} = \frac{0,25 \times 10}{2 \times 4} \sqrt{2 \times 93^2} = \underline{\underline{140 \text{ N/MM}^2}} < \sigma_e$$

ONDERRECEL E (ALLE DEUREN, BEHALVE HOGE
DEUR PANHEEL)

DEZE RECEL WORDT OVER DE GEHELE LENGTE
GESTEUUND DOOR DE ONDERAFDICHTING TEGEN DE
DREMPEL



MAATGEVENDE IS
ONDERRECEL E
HELMOND

$$q = 77 \text{ kN/m'}$$

TOTALE DRUK OP DEUR $Q = 77 \times 7,060 = 544 \text{ kN.}$

BALK LENGTE = 2000 mm.

DRUK OP HOUT: $\sigma_d = \frac{544 \times 10^3}{2000 \times 140} = 2 \text{ N/mm}^2 < 15$

KRACHT OP SCHOT $F = \frac{544}{2} = 272 \text{ kN.}$

DRUK OP PLAAT: $\sigma_d = \frac{272 \times 10^3 \times 45}{200 \times 12} = 170 \text{ N/mm}^2 < 360$

DEZE DRUK WORDT GEACHT OVER DE GEHELE HOOGTE VAN
HET SCHOT OP TE TREDEN

PLAAT VEILIGHEID-SCHOT: $a' = 690$ $b' = 600$

$\alpha = \frac{690}{600} = 1,15$ $\psi = \frac{-170}{-170} = 1$ $\sigma_E = 19 \left(\frac{100 \times 12}{600} \right)^2 = 76 \text{ N/mm}^2$

$\tau = \frac{272 \times 10^3 \times 1,5}{690 \times 12} = 49 \text{ N/mm}^2$ $K_S = 4 + \frac{5,35}{1,15^2} = 8,04$

$K_\alpha = 4$

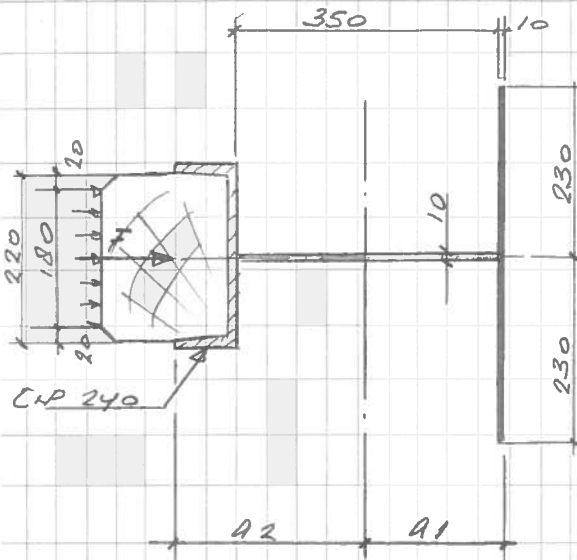
$\sigma_{KR} = 4 \times 76 = 304 \text{ N/mm}^2$

$\sigma_{KR} = 8,04 \times 76 = 611 \text{ N/mm}^2 \rightarrow 208 \text{ N/mm}^2$

$\sqrt{\left(\frac{170}{304} \right)^2 + \left(\frac{49}{208} \right)^2} = 0,61 < 1$

ACHTERHAR

(HELMOND)



DOORSNEDE BEREKENING
ZONDER SCHOTTEN.

$$A = 460 \times 10 + 350 \times 10 + 4230 = 12330 \text{ mm}$$

$$q_1 = \frac{460 \times 10 \times 5 + 350 \times 10 \times 185}{12330} + \frac{4230 \times 382}{12330} = 185 \text{ mm}$$

$$q_2 = 260 \text{ mm.}$$

$$I = \frac{1}{12} \cdot 460 \cdot 10^3 + 460 \times 10 \times 180^2 + \frac{1}{12} \cdot 10 \cdot 350^3 + 248 \times 10^4 + 4230 \times 197^2 = 351 \times 10^6 \text{ mm}^4$$

$$W_1 = \frac{351 \times 10^6}{185} = 1897 \times 10^3 \text{ mm}^3$$

$$W_2 = \frac{351 \times 10^6}{260} = 1350 \times 10^3 \text{ mm}^3$$

REGEL C. BALK LENGTE = 2000 mm.

$$\text{SPATKRACHT OP ACHTERHAR } F = \frac{1}{2} \cdot 117 \cdot 7,060 \times 3 = 1239 \text{ kN}$$

$$\text{DRUK OP HOUT: } \sigma = \frac{1239 \times 10^3}{2000 \times 180} = 3,44 \text{ N/mm}^2 < 15$$

$$\text{DRUK OP PLAAT } 350 \times 10: \sigma = \frac{1239 \times 10^3 \times 1,5}{2000 \times 10} = 93 \text{ N/mm}^2 < 360$$

$$M = \frac{1}{8} \cdot 1239 \cdot 2 = 310 \text{ kNm.}$$

$$\sigma_{PL} = \frac{310 \times 10^6 \times 1,5}{1897 \times 10^3} = 245 \text{ N/mm}^2 < 360$$

$$\sigma_{PROF} = \frac{310 \times 10^6 \times 1,5}{1350 \times 10^3} = 344 \text{ N/mm}^2 < 360$$

$$\text{DN. KRACHT} = \frac{1239}{2} = 620 \text{ kN}$$

$$\bar{\sigma} = \frac{620 \times 10^3 \times 1,5}{350 \times 10 + 2 \times 85 \times 13} = 163 \text{ N/mm}^2 < 0,58 \times 360$$

PLOOI VEILIGHEID PLAAT 350x10

PLAAT LENGTE 2000 MM $\alpha = \frac{2000}{350} = 5,7$

$\psi = -\frac{245}{344} = -0,71 \rightarrow K_d = 17,4$

$K_S = 5,35 + \frac{4}{5,7^2} = 5,47$

$\sigma_E = 19 \left(\frac{100 \times 10}{350} \right)^2 = 155 \text{ N/mm}^2$

$\sigma_{KR} = 17,4 \times 155 = 2697 \text{ N/mm}^2 \rightarrow 360 \text{ N/mm}^2$

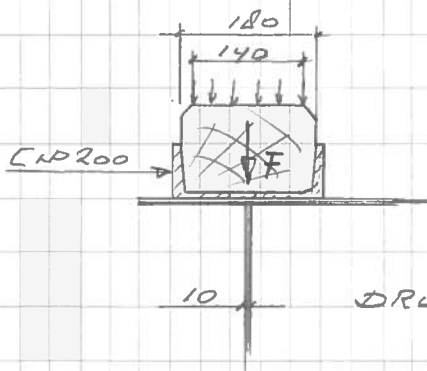
$\sigma_{KR} = 5,47 \times 155 = 848 \text{ N/mm}^2 \rightarrow 208 \text{ N/mm}^2$

$$\sqrt{\left(\frac{344}{360} \right)^2 + \left(\frac{163}{208} \right)^2} = 1,24 > 1$$

VOLDOET NIET.

PLOOISCHOTTEN TOEPASSEN $\sqrt{s} = 10 \text{ mm}$ H.O.H. $\sim 680 \text{ mm}$

ZIJDELINGSE ONDERSTEUNING



WATERDRUK UIT REGEL C

$F = 1/2 \cdot 117 \cdot 7,060 = 413 \text{ kN}$

BALK LENGTE = 2000 mm.

DRUK OP HOUT: $\sigma_d = \frac{413 \times 10^3}{2000 \times 140} = 1,5 \text{ N/mm}^2 < 15$

DRUK OP PLAAT = $\frac{413 \times 10^3 \times 1,5}{2000 \times 10} = \underline{31 \text{ N/mm}^2} < 360$

BEREKENING LASSEN ACHTERHAR (HELMOND)

$$\sigma_{b \text{ MAX.}} = 344 \text{ N/MM}^2$$

$$N = 1234 \text{ KN.}$$

DRUK OP PLAAT 300x10 + SCHOTTEN

$$\sigma_d = \frac{1234 \times 10^3 \times 1,5}{2000 \times 10 + 2 \times 190 \times 10} = 78 \text{ N/MM}^2$$

$$\tau = 163 \text{ N/MM}^2 \text{ BIJ OPLEGGING.}$$

$$\tau = 12 \times 163 = 82 \text{ N/MM}^2 \text{ OP 1/4 V.D. PLAATLENGTE}$$

$$\sigma_d = \sqrt{344^2 + 78^2 - 344 \times 78 + 3 \times 82^2} = \underline{\underline{343 \text{ N/MM}^2}} < 1,2 \sigma_e$$

LASSEN $a = 4 \text{ MM.}$

$$\sigma_{OL} = \frac{0,85 \times 10}{2 \times 4} \sqrt{2 \times 78^2 + 3 \times 163^2} = 322 \text{ N/MM}^2 < \sigma_e$$