C1	21/03/08	EMISSIONE PER APPROVAZIONE E A SEGUITO COMMENTI CVN	JRA	LB	YE
C0	01/10/04	EMISSIONE PER APPROVAZIONE	JRA	MN	YE
REVISIONE		DESCRIZIONE	EL.	CON.	APP.

MINISTERO DELLE INFRASTRUTTURE

MAGISTRATO ALLE ACQUE

NUOVI INTERVENTI PER LA SALVAGUARDIA DI VENEZIA

CONVENZIONE REP. 7191 DEL 04-10-1991
ATTO ATTUATIVO REP. 8249 DEL 28-12-2007

INTERVENTI ALLE BOCCHE LAGUNARI PER LA REGOLAZIONE DEI FLUSSI DI MAREA

CUP: D51B02000050001

PROGETTO ESECUTIVO

WBS: MA.E1.14.PE

BOCCA DI MALAMOCCO
CONCA DI NAVIGAZIONE
PORTE E OPERE ELETTROMECCANICHE

STRUTTURA DELLE PORTE
RELAZIONE DI CALCOLO DETTAGLI
ALLEGATI – TOMO 1 di 3

ELABORATO	CONTROLLATO	APPROVATO
J.R. Augustijn	L. Bottigelli	Y. Eprim
N. ELABORATO	**CODICE FILE**	**DATA**
MV036P-PE-MAR-4003-C1	MV036P-PE-MAR-4003-C1.DOC	21 Marzo 2008

CONSORZIO "VENEZIA NUOVA"

COORDINAMENTO PROGETTAZIONE

VERIFICATO: S. Dalla Villa

CONTROLLATO: M. Brotto

CONSORZIO VENEZIA NUOVA

PROGETTAZIONE

IL RESPONSABILE: Ing. A. SCOTTI

CONSULENZA SPECIALISTICA

DOTT. ING. ALBERTO SCOTTI
Sez. A - Settori
a) civile e ambientale
b) industriale
c) dell'informazione
n° A 9782
MILANO

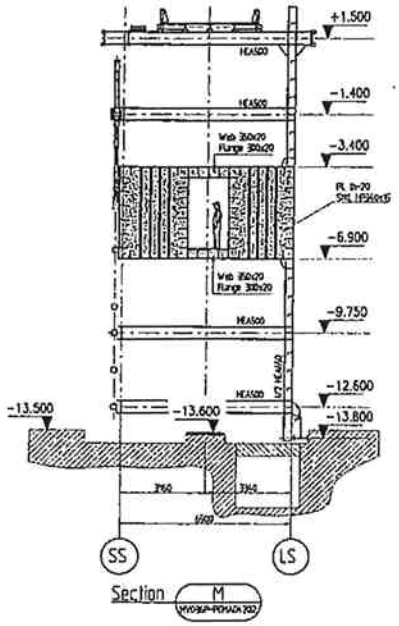
Addendum A Skin and sealing details

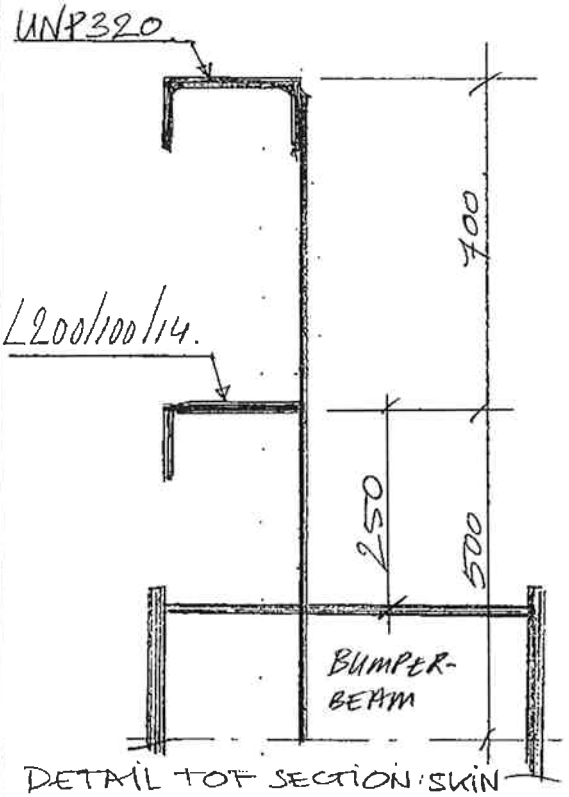
Contents

Project : MALAMOCCO NAV. LOCK GATE.

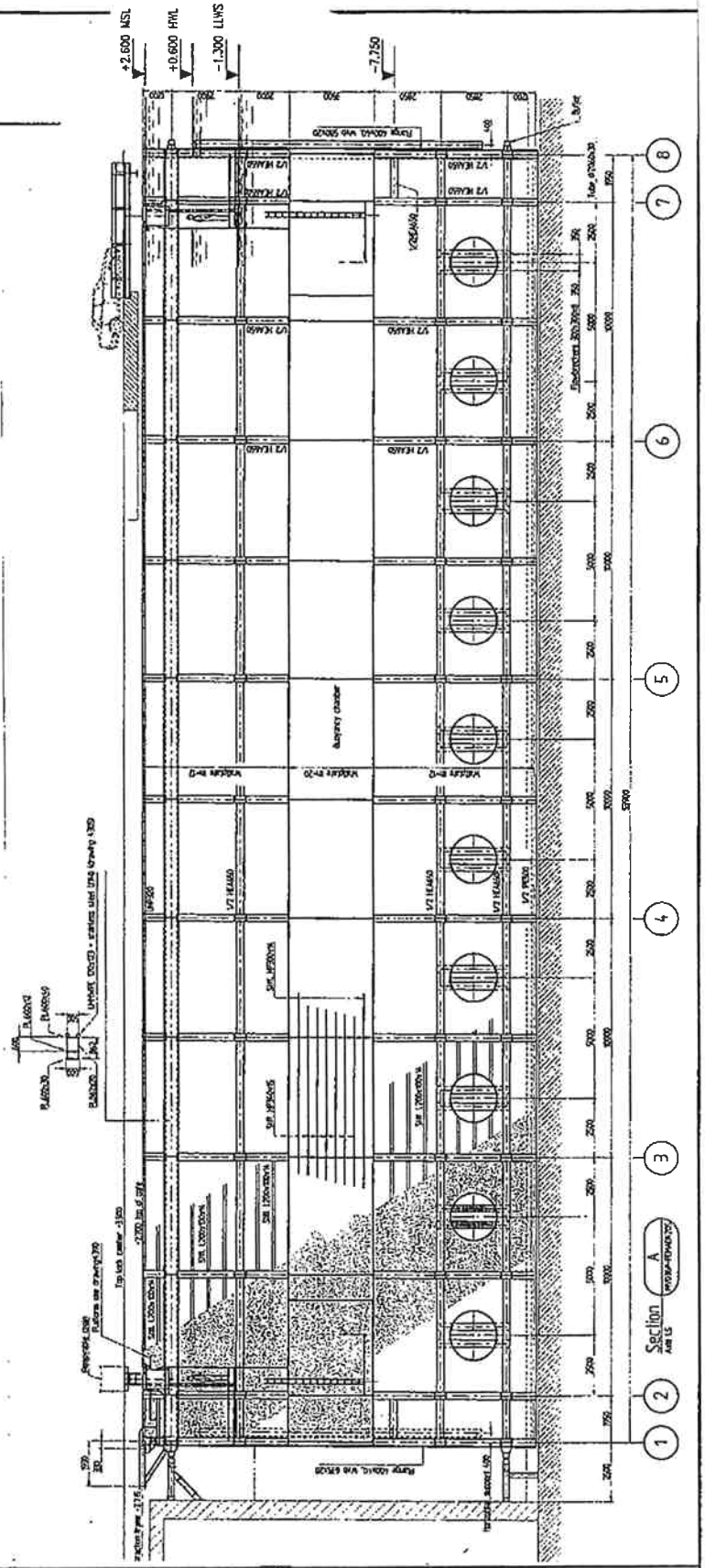
Onderdeel : SKIN.

A1. SKIN OVERVIEW.





DETAIL TOP SECTION SKIN



Opgesteld : A1SEMGEEST

Datum : 23-6604

Bladnummer : A1-1.

Rev. : A2

Project : MALAMOCCO NAV. LOCK GATE.

Onderdeel : SKIN.

SECTION PROPERTIES.

* SECTION TOP OF SKIN.
  → CLASSIFICATION AND DETERMINATION OF EFFECTIVE.
  SECTION AREA. ACC. EUROCODE.
  RESULTING IN CROSSSECTION PROPERTIES...

  → CLASSIFICATION: - LOCAL BUCKLING
  - GLOBAL BUCKLING.
  - REQUIREMENTS LONGITAL STIFFENER

NOTE: CONSERVATIVE APPROACH PLATE AREA'S.
→ FOR DETERMINATION STRESSES → RECONSIDERATION
[PAGE A1.-11.]

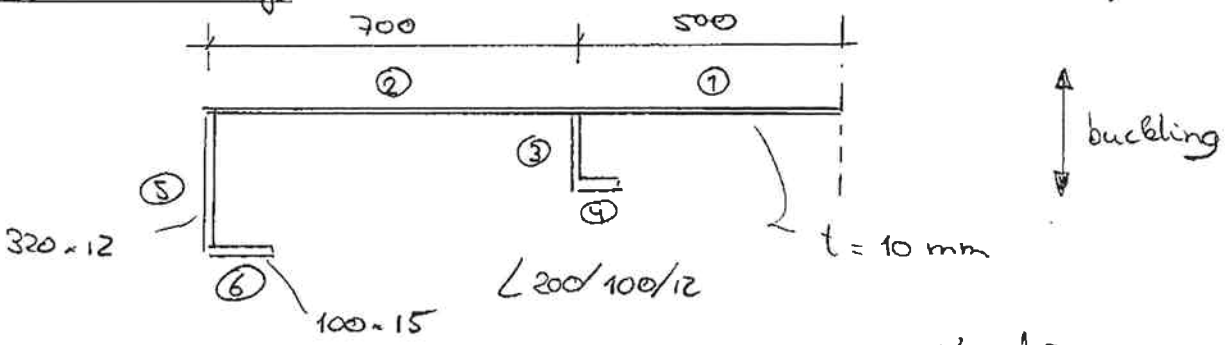
* AVERAGE SECTION OF SKIN
  REF. A1-15,

Opgesteld : WLA. Datum : 1-07-04 Bladnummer : A1.-2 Rev. : A2

Project : MALAMOCCO NAV LOCK GATE.

Onderdeel : SKIN.

Local buckling (incl. corrosion)



$\psi = 1.0$

① $(b - 3t_f)/t_f \leq 42\,\varepsilon$ (EN 1993-1-1 ; Table 5.3.1 (b))

$(500 - 3 \cdot 10)/10 = 47 \leq 42 \times 0.81 = 34$

⟶ class 4

$$\bar{\lambda}_p = \frac{b/t}{28.4 \cdot \varepsilon \cdot \sqrt{k_\sigma}} = \frac{500/10}{28.4 \times 0.81 \times \sqrt{4.0}} = 1.09$$

$$\rho = (\bar{\lambda}_p - 0.22)/\bar{\lambda}_p^2 = (1.09 - 0.22)/1.09^2 = 0.74$$

$$A_{eff} = \rho \times A = 0.74 \times 500 \times 10 = 3669\ mm^2$$

$$\eta_1 = \frac{122}{0.74 \times 355/1.1} = 0.51 < 1.0 \quad \text{O.K.}$$

② ⟶ class 4

$$\bar{\lambda}_p = \frac{700/10}{28.4 \times 0.81 \times \sqrt{4}} = 1.52$$

$$\rho = (1.52 - 0.22)/1.52^2 = 0.56$$

$$A_{eff} = \rho \cdot A = 0.56 \cdot 500 \times 10 = 3920\ mm$$

$$\eta_1 = \frac{122}{0.56 \times 355/1.1} = 0.68 < 1.0 \quad \text{O.K.}$$

③ $d/t_w \leq 42\varepsilon$ (EN 1993-1-1 ; table 5.3.1 (a))

$200/10 = 20 \leq 42 \times 0.81 = 34$

→ class 3

$\rho = 1$; $A_{eff} = A = 200 \times 10 = 2000\ mm^2$

④ $c/t_f \leq 15\varepsilon$ (EN 1993-1-1 ; table 5.3.1 (c))

$100/12 = 8.3 \leq 15 \times 0.81 = 12.1$

→ class 3 ; $A = 100 \times 12 = 1200\ mm^2$

⑤ formulas equal to ③

$320/12 = 26.6 \leq 34$ → class 3

$A = 3840\ mm^2$

⑥ formulas equal to ④

$100/15 = 6.7 \leq 12.1$ → class 3

$A = 1500\ mm^2$

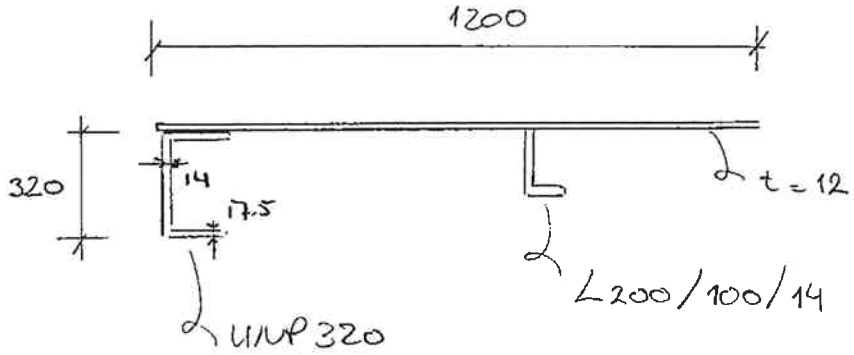
$$\beta_A = \frac{A_{eff}}{A_i} = \frac{0.74 \cdot 5000 + 0.56 \cdot 7000 + 2000 + 1200 + 3840 + 1500}{5000 + 7000 + 2000 + 1200 + 3840 + 1500}$$

$$\beta_A = \frac{16160}{20540} = 0.787$$

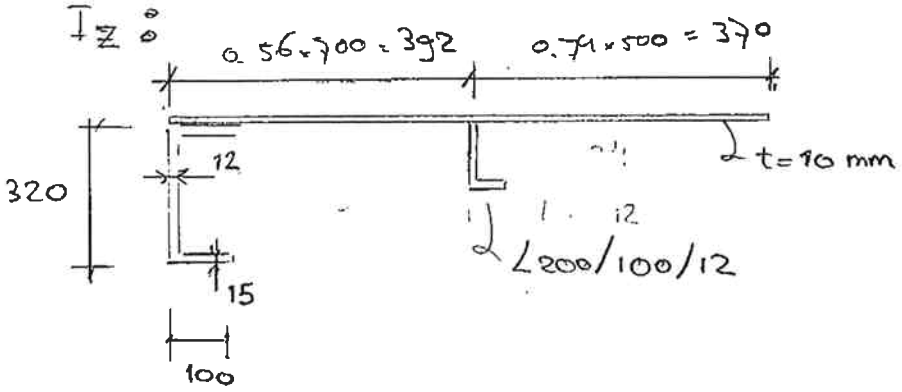
$A_{gross} = 20540\ mm^2$

Project : MALAMOCCO-NAV. LOCK GATE.

Onderdeel : Skin.



↘ 2 mm corrosion



$I_z \approx 1.86 \cdot 10^8 \text{ mm}^4$

Opgesteld : WLA | Datum : 230604 | Bladnummer : A1-5 | Rev. : A2

Global buckling - skin-plate (ENV 1993-1-5 : 1997)

$\psi = 1.0$ $\qquad \alpha = \frac{a}{b} = \frac{5000}{1200} = 4.17$

$I_x = 1.86 \cdot 10^8 \text{ mm}^4$ (see p.)

$I_p = \frac{bt^3}{12(1-\nu^2)} = \frac{1200 \times 10^3}{12(1-0.3^2)} = 1.10 \times 10^5 \text{ mm}^4$

$\delta = \frac{I_x}{I_p} = \frac{1.86 \times 10^8}{1.10 \times 10^5} = 1691 > 50$

$A_{sl} = 320 \times 12 + 100 \times 15 = 5340 \text{ mm}^2$

$A_p = b \cdot t = 1200 \times 10 = 12000 \text{ mm}^2$

$\gamma = \frac{A_{sl}}{A_p} = \frac{5340}{12000} = 0.445$

$\sqrt[4]{1+\delta} = \sqrt[4]{1692} = 6.41 > \alpha = 4.17$

$\longrightarrow k_{\sigma,p} = \frac{2((1+\alpha^2)^2 + \delta)}{\alpha^2(\alpha+1)(1+\gamma)}$

$k_{\sigma,p} = \frac{2((1+4.17^2)^2 + 1863}{4.17^2(1+1)(1+0.445)} = 47.1$

$\sigma_E = 18900\left(\frac{10}{1200}\right)^2 = 13.2 \text{ N/mm}^2$ (4.7)

$\sigma_{cr,p} = k_{\sigma,p} \times \sigma_E = 47.1 \times 13.2 = 621 \text{ N/mm}^2$ (4.6)

$\bar{\lambda}_p = \sqrt{\frac{\beta_A \cdot f_y}{\sigma_{cr,p}}} = \sqrt{\frac{0.787 \cdot 355/1.1}{621}} = 0.640$

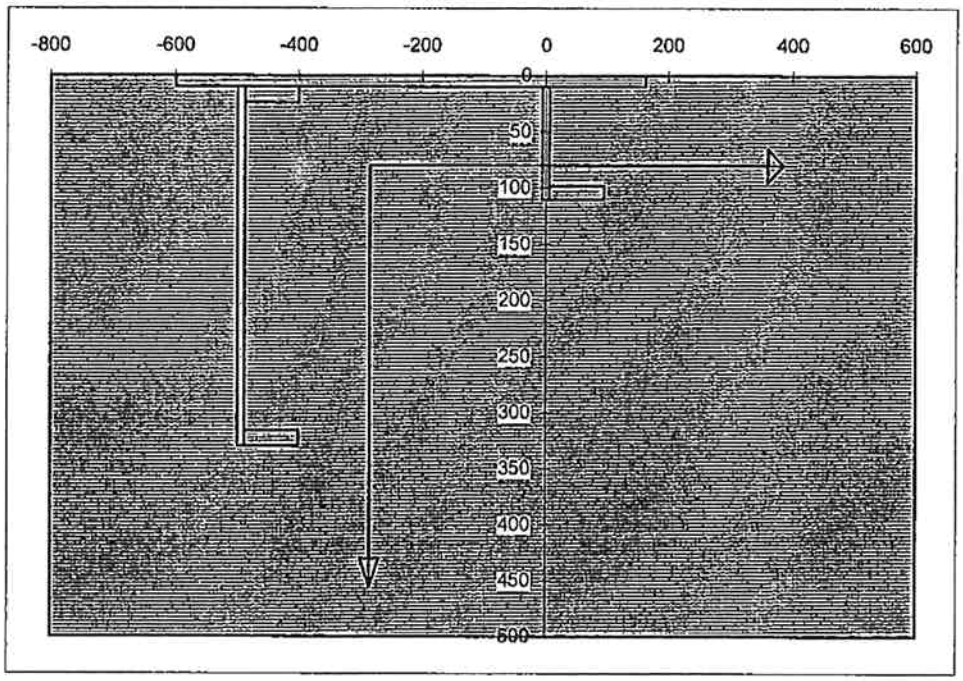
$\bar{\lambda}_p \leq 0.673 \longrightarrow \rho = 1$

$\Rightarrow$ Plate not sensitive for buckling.

uitvoer MALAMOCCO NAV. COCKGAT

Berekening statische waarden van een profiel
samengesteld uit plaatvormige doorsneden.

profielnaam : Skin1
referentie :



Uitwendige afmetingen

hoogte (z)	=	330	mm
breedte (y)	=	762	mm

Zwaartepuntsafstanden

$-e_y$	=	-315	mm
$+e_y$	=	447	mm
$-e_z$	=	-80	mm
$+e_z$	=	250	mm

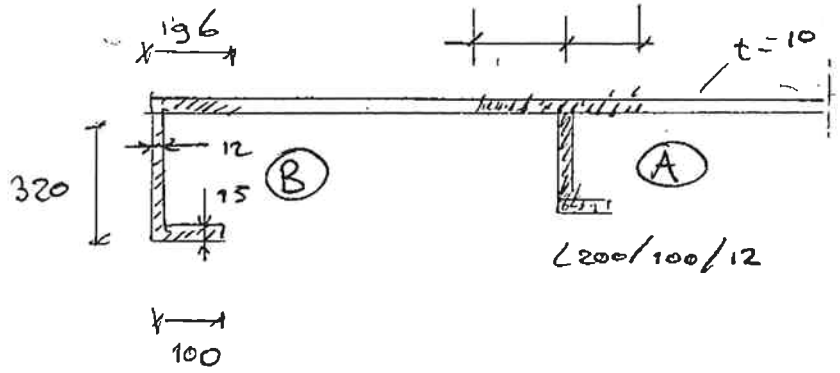
Statische waarden

oppervlak A	16180	mm^2
traagheidsmoment I_{yy}	1,866E+08	mm^4
weerstandsmoment $W_{y;el;b}$	-2,34E+06	mm^3
weerstandsmoment $W_{y;el;o}$	7,46E+05	mm^3
weerstandsmoment $W_{y;pl}$	1,41E+06	mm^3
traagheidsstraal i_y	107	mm
traagheidsmoment I_{zz}	8,502E+08	mm^4
weerstandsmoment $W_{z;el;l}$	-2,70E+06	mm^3
weerstandsmoment $W_{z;el;r}$	1,90E+06	mm^3
weerstandsmoment $W_{z;pl}$	3,39E+06	mm^3
traagheidsstraal i_z	229	mm

WLA

A1-7. A2.

$0.5 \times 700 \times 0.56 = 196$ $\quad 0.5 \times 500 \times 0.74 = 185$



incl. corrosion

(A) $I_{sl,A} = 4.69 \times 10^7 \text{ mm}^4$ $\quad (A_{sl,A} = 7266 \text{ mm}^2)$

(B) $I_{sl,B} = 1.14 \times 10^8 \text{ mm}^4$ $\quad (A_{sl,B} = 7120 \text{ mm}^2)$

Critical column buckling (ENV 1993-1-5-1997)

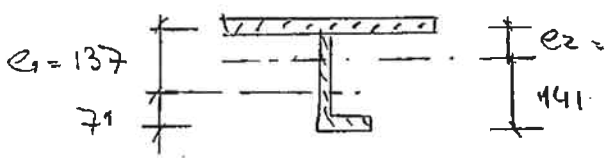
(A) $\sigma_{cr,c} = \dfrac{\pi^2 E I_A}{A_A s^2} = \dfrac{\pi^2 210000 \cdot 4.69 \cdot 10^7}{7266 \times 5000^2} = 535 \text{ N/mm}^2$

$\beta_{A,A} = \dfrac{A_{eff}}{A} = \dfrac{7266}{3588 + 2500 + 300 \cdot 12} = \dfrac{7266}{9600} = 0.756$

$\bar{\lambda}_c = \sqrt{\dfrac{\beta_{A,A} f_y}{\sigma_{cr,c}}} = \sqrt{\dfrac{0.756 \times 355/1.1}{535}} = 0.675$

$i_A = \sqrt{\dfrac{I_A}{A_A}} = \sqrt{\dfrac{4.69 \cdot 10^7}{7266}} = 80.3$

$\sigma_e = \sigma_0 + \dfrac{0.09}{b/e}$



$e = \max(e_1, e_2) = 137 \text{ mm}$

$$\sigma_{e} = \sigma_{0} + \frac{0.09}{\frac{\otimes}{e}}$$

$$= 0.49 + \frac{0.09}{80.3/1.37} = 0.644$$

ENV 1993-1-1 : 5.5.1.2

$$\Phi_c = 0.5\left(1 + \sigma_e\left(\bar{\lambda}_c - 0.2\right) + \bar{\lambda}_c^2\right)$$

$$= 0.5\left(1 + 0.644\left(0.675 - 0.2\right) + 0.675^2\right) = 0.881$$

$$\chi_c = \frac{1}{\Phi_c + \left(\Phi_c^2 - \bar{\lambda}_c^2\right)^{0.5}} = \frac{1}{0.881 + \left(0.881^2 - 0.644^2\right)^{0.5}}$$

$$\chi_c = 0.67$$

Final reduction (ENV 1993-1-5 : 1997) - 4.2.2.4

$$\rho_c = (\rho - \chi_c)\,\xi\,(2 - \xi) + \chi_c$$

$$\xi = \frac{\sigma_{cr,p}}{\sigma_{cr,c}} - 1 = \frac{621}{535} - 1 = 0.16$$

$$\rho_c = (1.0 - 0.67) \cdot 0.16\,(2 - 0.16) + 0.67$$

$$\rho_c = 0.097 + 0.67 = 0.77$$

ENV 1993-1-5 : 4.2.2.4

$$A_c = \Sigma A_{eff}\ (4.2.1(3)) = 16160\ mm^2$$

$$A_{c,eff} = \rho_c \times A_c = 0.77 \times 16160 = 12443\ mm^2$$

$$R_1 = \frac{81\ N/mm^2 \times 20540\ mm^2}{355\ N/mm^2 / 1.1 \times 12443\ mm^2} = 0.42 < 1.0 \quad O.K.$$

(Stress : determined on page A1-35)

Requirements for longitudinal stiffeners

EN 1993-1-5 : 4.2.2.7

$$I_T = \frac{1}{3}(t_f^3\, b + t_w^3\, h) = \frac{1}{3}(12^3 \cdot 100 + 12^3 \cdot 200) = 172800\ mm^4$$

$$I_p = I_y + I_z + A(h_y^2 + h_z^2)$$

$$= 1.45 \cdot 10^7 + 2.54 \cdot 10^6 + 3456(75^2 + 129^2)$$

$$= 7.53 \cdot 10^7\ mm^4$$

$$\frac{I_t}{I_p} \geq 11{,}0\left(\frac{t}{b}\right)^2 \quad \text{or} \quad \frac{I_t}{I_p} \geq 53\,\frac{f_y}{E}$$

$$\frac{I_t}{I_p} = \frac{172800}{7.53 \cdot 10^7} = 2.3 \cdot 10^{-3}$$

$$11.0\left(\frac{t}{b}\right)^2 = 11.0 \cdot \left(\frac{10}{700}\right)^2 = 2.24 \cdot 10^{-3} \qquad \text{O.K.}$$

check for UNP 320

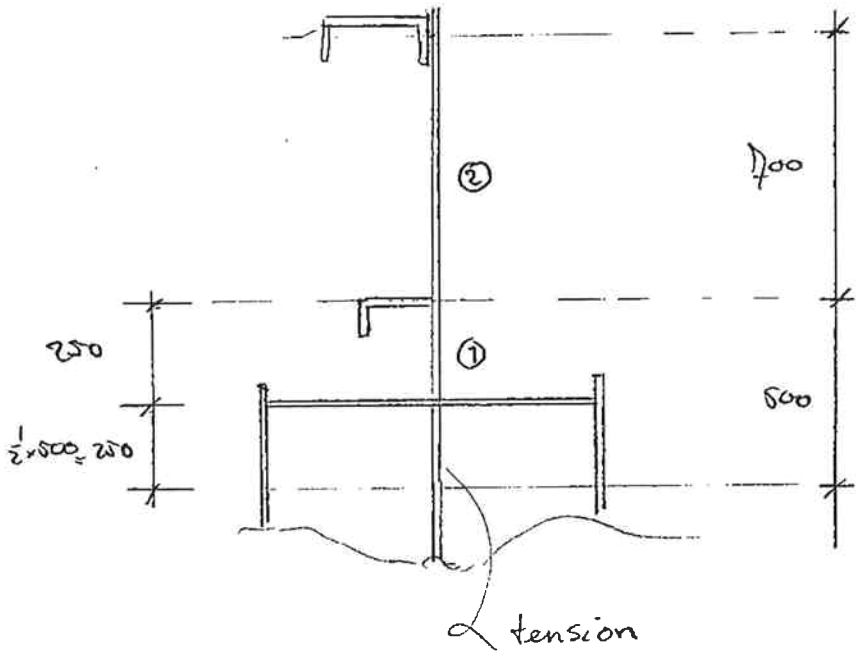
$I_t = 96.23 \cdot 10^4\ mm^4$

$I_p = I_y + I_z + A(h_y^2 + h_z^2) = 10869 \cdot 10^4 + 596.6 \cdot 10^4 + 7528 \cdot (60^2 + 26^2)$

$\frac{I_t}{I_p} = 30 \cdot 10^{-3} > 2.24 \cdot 10^{-3}$; OK.

⇒ Longitudinal stiffeners are OK.

⇒ No additional check for lateral torsional buckling required!



① $(b-3t_f)_{tf} \leq 32\,\varepsilon$ (EN-1993-1-1 : table 5.3.1.(6))

$\left(\frac{250 - 3 \cdot 10}{10}\right) = 22 \leq 42 \times 0.81 = 34$

⟶ class 3

② ⟶ class 4

$\bar{\lambda}_p = 1.52 \qquad \rho = 0.56$

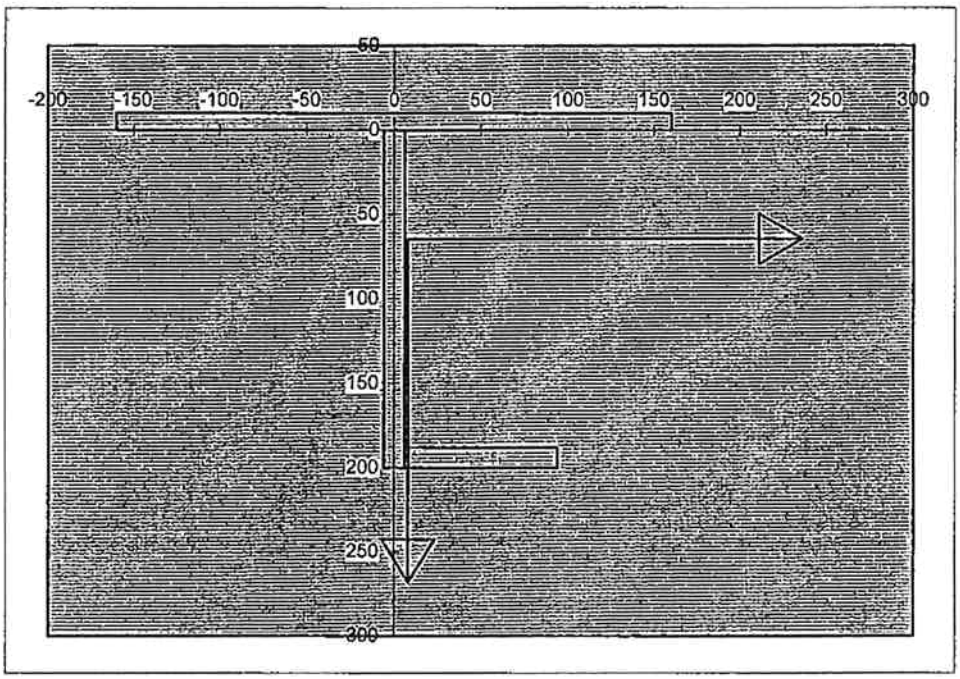
$A_{eff} = \rho \cdot A = 0.56 \times 700 \times 10 = 3920\ mm^2$

uitvoer

MAL. NAV. LOCK GATE

Berekening statische waarden van een profiel
samengesteld uit plaatvormige doorsneden.

profielnaam : Stiffener skin with plate
referentie :



Uitwendige afmetingen

hoogte (z)	=	210	mm
breedte (y)	=	320	mm

Zwaartepuntsafstanden

$-e_y$	=	-168	mm
$+e_y$	=	152	mm
$-e_z$	=	-74	mm
$+e_z$	=	136	mm

Statische waarden

oppervlak A	6656	mm^2
traagheidsmoment I_{yy}	4.423E+07	mm^4
weerstandsmoment $W_{y;el;b}$	-5.94E+05	mm^3
weerstandsmoment $W_{y;el;o}$	3.26E+05	mm^3
weerstandsmoment $W_{y;pl}$	4.94E+05	mm^3
traagheidsstraal i_y	82	mm
traagheidsmoment I_{zz}	3.024E+07	mm^4
weerstandsmoment $W_{z;el;l}$	-1.80E+05	mm^3
weerstandsmoment $W_{z;el;r}$	1.99E+05	mm^3
weerstandsmoment $W_{z;pl}$	3.20E+05	mm^3
traagheidsstraal i_z	67	mm

WLA 280604. A1-12. A2

Project : MALAMOCCO NAV. LOCK GATE.

Onderdeel : SKIN.

CHECK STRESS.

→ ACTING STRESSES SKIN:

1 + LOCAL BENDING OVER STIFFENERS ; σ_x ; 1:D [REF. A1-14]

+ LOCAL BENDING SKIN WITH STIFFENERS ; σ_y : 1:D [REF. A1-15]

2 + STRESSES FROM GLOBAL 3D-FRAME MODEL. σ_x; 2:D
σ_y; 2:D
τ_{xy} 2D.

AD 2 ; RESOLUTION OF DIAGONAL DUMMY FORCES

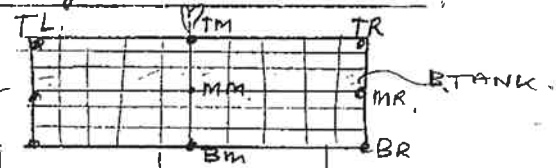
FOR ALL CONDITIONS WITH THEIR LOADCOMBINATIONS

IS PRESENTED FROM PAGE A1- .19/32
∴ AN EXAMPLE OF HOW STRESSES ARE DETERMINED → REF. A1-33.

OVERVIEW RESULTING Governing.. SKIN STRESSES ;

(- = COMPRESSION
+ = TENSION)

POSITION.



MAX. SITUATION	$-\sigma_{x2d}$	$+\sigma_{x:2:d}$	$-\sigma_{y2d}$	$+\sigma_{y2d}$	τ_{xy2d}
COMBI	2	10	2	10	11
CONDITION.	3	1	3	1	4
POSITION	T.M.	T.M.	T.M	T.M.	M.L
$-\sigma_{x2d}$	(-7)	↓	(-7)	↓	—
$+\sigma_{x2d}$	↓	(+15)	↓	+7	—
$-\sigma_{y2d}$	(-81)	—	(-81)	↓	—
$+\sigma_{y2d}$	↓	+30	↓	(+84)	—
τ_{xy2d}	2	3	2	2	(35)

Opgesteld : WLA

Datum : 280604.

Bladnummer : A1-13

Rev. : A2

Calculation skin with stiffeners

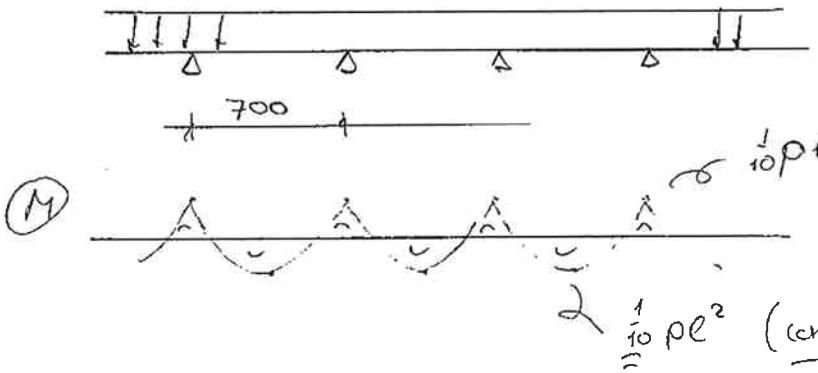
* Bending skin over stiffeners; LOCAL σ_x;

skin 12 mm; corrosion → $t = 10$ mm

c.t.c. stiffeners: 700 mm

hydrostatic load: $p = 30.9\ kN/m^2$ ($\Delta h = 3.0$ m)

→ load is similar for all stiffeners



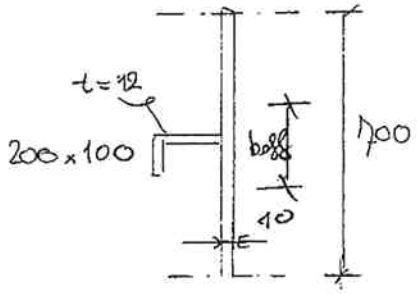
$M_{110} = \pm \frac{1}{10} \cdot 30.9 \times 0.7^2 = 1.5$ kNm

$\sigma_{x;1;d} = \frac{1.5 = \pm 1.5 \cdot 10^6}{1/6 \cdot 1000 \times 10^2} = \pm 135\ N/mm^2$

$V_d = \frac{1}{2}ql = \frac{1}{2} \cdot 30.9 \times 0.7 = 11$ kN

$\tau_d = \frac{V_d}{A_{web}} = \frac{1.5 \times 11 \cdot 10^3}{1000 \times 10} = 2\ N/mm^2$

* Bending skin with stiffener ; LOCAL Ty:1.



beff = 32 × t = 32 × 10 = 320 mm

↓

Aplate = 320 × 10 = 3200 mm²

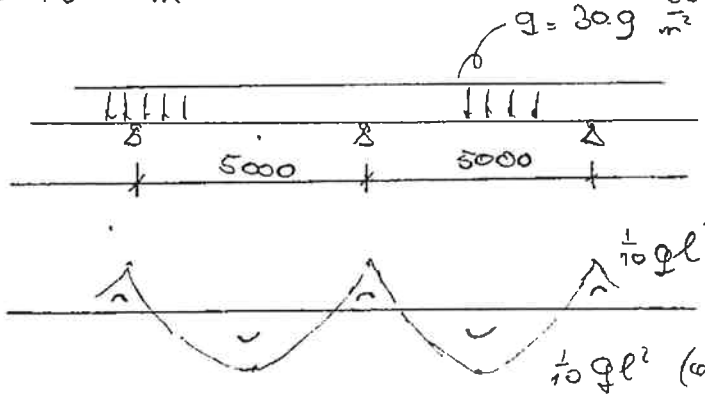
Astf = 3456 mm²

incl. corrosion
(see page A1-12)

$W_{b,} = 5.94 \times 10^5$ mm³

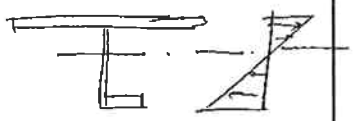
$W_o = 3.26 \times 10^5$ mm³

$I_y = 4.42 \times 10^7$ mm⁴



$M_d = 1.5 \cdot \frac{1}{10} \times 21.7 \frac{kN}{m} \times (5.0\ m)^2 = 81.4$ kNm

plate : $\sigma_{y:1:p} = \frac{M_d}{W_b} = \frac{\pm 81.4 \times 10^6}{5.94 \times 10^5} = \pm 138\ N/mm^2$



Stiffenerflange : $\sigma_{y:1:0.} = \frac{\pm 81.4 \times 10^6}{3.26 \cdot 10^5} = \pm 250\ N/mm^2$

Project : MAL. NAV. LOCK GATE.

Onderdeel : SKIN.

* Stress combinations

Plate (skin) MID SECTION TOP OF SKIN. GOVERNING.

* bending plate over stiffeners : $\sigma_{x,d,1} = \pm 135\ N/mm^2$
* bending plate at stiffener : $\sigma_{y,d,1} = \pm 138\ N/mm^2$
* results from EPW : $\sigma_{x,d,2} = \begin{cases} 15 & N/mm^2 \\ -7 & N/mm^2 \end{cases}$

$\sigma_{y,d,2} = \begin{cases} 69 & N/mm^2 \\ -77 & N/mm^2 \end{cases}$ CORRECTE REF. A2-18

τ_d = NEGECTABLE.

$$\sigma_{eq,d} = \sqrt{\sigma_{x,d}^2 + \sigma_{y,d}^2 - \sigma_{x,d} \cdot \sigma_{y,d} + 3 \cdot \tau_d^2}$$

Governing combination:

$\sigma_{x,d} = 135 + 15 = 150\ N/mm^2$

$\sigma_{y,d} = -138 - 77 = -215\ N/mm^2$

$\tau_d = -$

$$\sigma_{eq,d} = \sqrt{150^2 + 215^2 + 150 \times 215} = 318\ N/mm^2$$

U.C. $\dfrac{\sigma_{eq,d}}{f_{y,d}/\gamma_M} = \dfrac{318}{355/1.1} = 0,99 \approx 1.0$ O.K.

Opgesteld : WLA | Datum : 280604 | Bladnummer : A1-16 | Rev. : A2

Project : MAL. NAV. LOCK GATE.

Onderdeel : SKIN.

Flange stiffener

bending plate with stiffener $\sigma_{y;1;d} = \pm 250$ N/mm²

results from EPW $\sigma_{y;2;d} = \begin{cases} 69 \text{ N/mm}^2 \\ -77. \text{ N/mm}^2 \end{cases}$

$\Sigma \sigma_{y,d} = -250 - 77 = -327$ N/mm² (Field : 250+69 = 319 N/mm²)

Supp. U.C. $\frac{327}{355/1.1} = 1.01$; O.K.

Field : u.c. = $\frac{319}{355/1.1} = 0.99$; Ok.

=> weld to ½ HE650A-beams with ie-welds (Kellpen)

=> fatigue detail 21 ; $\Delta\sigma_R = 261$ N/mm² at 40000 rep's

Condition 3 is not a fatigue-load, the max fatigue-load will be $\frac{1.35}{1.5} \times (135 + 69) = 184$ N/mm² < 261 ; Ok.

Skin: Max. shear

Governing value can be found during gate movement combined with wave-load: $\tau_{xy;2;d} = 35$ N/mm²

u.c. = $\frac{35}{355/1.1 \times \sqrt{3}} = 0.19$

local eff. 0.64 ($\sigma_{y;1;d} = 250$ N/mm²)

0.83 < 1.0 ; Ok

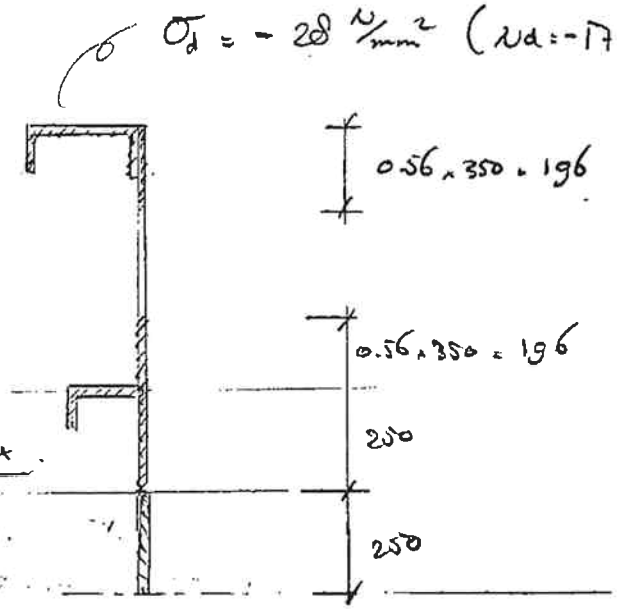
Opgesteld :	Datum :	Bladnummer :	Rev. :
WLA	280604	A1-17.	A2

Project : MAL. NAV. LOCK GATE.

Onderdeel : SKIN.

CORRECTION ON σ_y : 2 (stress-reduction) FOR TOP OF SKIN.

(RESULTING FROM ESA)



$\sigma_{y:2:0}$; COMPRESSION: MAX.

EFFECTIVE AREA (INCL. CORROSION ALLOWANCE)

$A_{tot,eff}$ = 6480 mm² (U/U P) + 2·[250+196]x 10 + (200+ 88) x 12 (⊿)

= 18.856 mm²

$N_{y:d}$ = - 1460. kN (DERIVED FROM ESA; $\sigma_{y:2:d}$ ESA = -81 N/mm², with t_{equ} = 15 mm.)

$\sigma_{y:2:d:c} = \frac{-1460 \cdot 10^3 \text{ N}}{18856}$ = - 77 N/mm²

$\sigma_{y:2:D}$: TENSION.

A_{tot} = 1200 · 10 + 6480 + (288 : 12) = 21936 mm²

$N_{y:d}$ = + 1507 kN (DERIVED FROM ESA; $\sigma_{y:2:d}$ ESA = +84 N/mm², with t_{equ} = 15 mm.)

$\sigma_{y:2:d:t} = \frac{1507 \cdot 10^3}{21936}$ = 69 N/mm².

→ Regular stiffeners are not governing, thus reduction can be applied in check on page A1-16/17

Opgesteld :	Datum :	Bladnummer :	Rev. :
WHA	2006 04	A1-18.	A2.

CONDITION (1)

Combi 9 Skin Members		Brace forces N (kN)	N (kN)	height mm	widht mm	length mm	Vy kN	Vx kN	Ny kN	Nx kN	σ_y N/mm²	σ_x N/mm²	τ_{xy} N/mm²	
1056	1079	-50	50	1200	1950	2289.7	15	9						1
1057	1078	50	50	1200	5000	5142.0	18	4	49	12	3	0		0
1058	1077	50	100	1200	5000	5142.0	67	16	49	12	3	0		1
1059	1076	150	100	1200	5000	5142.0	18	4	97	23	5	0		0
1060	1075	150	150	1200	5000	5142.0	32	8	146	35	8	1		1
1061	1074	150	150	1200	5000	5142.0	5	1	146	35	8	1		0
1062	1073	150	150	1200	5000	5142.0	5	1	146	35	8	1		0
1063	1072	150	150	1200	5000	5142.0	32	8	146	35	8	1		1
1064	1071	150	100	1200	5000	5142.0	18	4	97	23	5	0		0
1065	1070	50	100	1200	5000	5142.0	67	16	49	12	3	0		1
1066	1069	50	50	1200	5000	5142.0	18	4	49	12	3	0		0
1067	1068	-50	50	1200	1950	2289.7	15	9						1
592	662	-50	50	2900	1950	3494.6	29	43						1
593	663	50	-100	2900	5000	5780.1	110	64						2
594	664	-100	100	2900	5000	5780.1	132	77						3
595	665	100	-100	2900	5000	5780.1	110	64						2
596	666	-50	100	2900	5000	5780.1	60	35						1
597	667	50	50	2900	5000	5780.1	13	8	43	25	1	1		0
598	668	50	50	2900	5000	5780.1	13	8	43	25	1	1		0
599	669	-50	100	2900	5000	5780.1	60	35						1
600	670	100	-100	2900	5000	5780.1	110	64						2
601	671	-100	100	2900	5000	5780.1	132	77						3
602	672	50	-100	2900	5000	5780.1	110	64						2
603	673	-50	50	2900	1950	3494.6	29	43						1
604	674	50	100	2000	1950	2793.3	34	35	35	36	1	2		2
605	675	150	50	2000	5000	5385.2	119	48	46	19	2	0		2
606	676	100	200	2000	5000	5385.2	137	55	93	37	3	1		3
607	677	200	100	2000	5000	5385.2	96	39	93	37	3	1		2
608	678	150	200	2000	5000	5385.2	60	24	139	56	5	1		1
609	679	150	150	2000	5000	5385.2	20	8	139	56	5	1		0
610	680	150	150	2000	5000	5385.2	20	8	139	56	5	1		0
611	681	150	200	2000	5000	5385.2	60	24	139	56	5	1		1
612	682	200	100	2000	5000	5385.2	96	39	93	37	3	1		2
613	683	100	200	2000	5000	5385.2	137	55	93	37	3	1		3
614	684	150	50	2000	5000	5385.2	119	48	46	19	2	0		2
615	685	50	100	2000	1950	2793.3	34	35	35	36	1	2		2
626	696	150	50	2850	1950	3453.3	33	48	28	41	1	2		2
627	697	150	250	2850	5000	5755.2	68	39	130	74	3	1		1
628	698	300	300	2850	5000	5755.2	5	3	261	149	6	3		0
629	699	300	300	2850	5000	5755.2	32	18	261	149	6	3		1
630	700	300	350	2850	5000	5755.2	22	12	261	149	6	3		0
631	701	300	300	2850	5000	5755.2	9	5	261	149	6	3		0
632	702	300	300	2850	5000	5755.2	9	5	261	149	6	3		0
633	703	300	350	2850	5000	5755.2	22	12	261	149	6	3		0
634	704	300	300	2850	5000	5755.2	32	18	261	149	6	3		1
635	705	300	300	2850	5000	5755.2	5	3	261	149	6	3		0
636	706	150	250	2850	5000	5755.2	68	39	130	74	3	1		1
637	707	150	50	2850	1950	3453.3	33	48	28	41	1	2		2
638	708	50	-50	2850	1950	3453.3	17	25						1
639	709	50	50	2850	5000	5755.2	7	4	43	25	1	0		0
640	710	50	100	2850	5000	5755.2	45	25	43	25	1	0		1
641	711	100	50	2850	5000	5755.2	23	13	43	25	1	0		0
642	712	100	100	2850	5000	5755.2	16	9	87	50	2	1		0
643	713	100	100	2850	5000	5755.2	5	3	87	50	2	1		0
644	714	100	100	2850	5000	5755.2	5	3	87	50	2	1		0
645	715	100	100	2850	5000	5755.2	16	9	87	50	2	1		0
646	716	100	50	2850	5000	5755.2	23	13	43	25	1	0		0
647	717	50	100	2850	5000	5755.2	45	26	43	25	1	0		1
648	718	50	50	2850	5000	5755.2	8	4	43	25	1	0		0
649	719	50	-50	2850	1950	3453.3	17	25						1
650	720	50	-50	1200	1950	2289.7	14	8						1
651	721	50	50	1200	5000	5142.0	22	5	49	12	3	0		0
652	722	50	50	1200	5000	5142.0	7	2	49	12	3	0		0
653	723	50	50	1200	5000	5142.0	4	1	49	12	3	0		0
654	724	50	50	1200	5000	5142.0	2	0	49	12	3	0		0
655	725	50	50	1200	5000	5142.0	0	0	49	12	3	0		0
656	726	50	50	1200	5000	5142.0	0	0	49	12	3	0		0
657	727	50	50	1200	5000	5142.0	2	0	49	12	3	0		0
658	728	50	50	1200	5000	5142.0	4	1	49	12	3	0		0
659	729	50	50	1200	5000	5142.0	7	2	49	12	3	0		0
660	730	50	50	1200	5000	5142.0	20	5	49	12	3	0		0
661	731	50	-50	1200	1950	2289.7	15	10						1

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Combi 10 Skin Members		Brace forces N (kN)	N (kN)	height mm	widht mm	length mm	Vy kN	Vx kN	Ny kN	Nx kN	σ_y N/mm²	σ_x N/mm²	τ_{xy} N/mm²	
1056	1079	50	50	1200	1950	2289.7	22	14	43	26	2	1	1	
1057	1078	500	-50	1200	5000	5142.0	490	117					10	
1058	1077	500	1000	1200	5000	5142.0	499	120	486	117	27	2	10	
1059	1076	1350	950	1200	5000	5142.0	370	89	924	222	51	4	7	
1060	1075	1300	1550	1200	5000	5142.0	231	55	1264	303	70	6	5	
1061	1074	1650	1550	1200	5000	5142.0	102	24	1507	362	84	7	2	Combi
1062	1073	1650	1550	1200	5000	5142.0	102	24	1507	362	84	7	2	
1063	1072	1300	1550	1200	5000	5142.0	231	55	1264	303	70	6	5	
1064	1071	1350	950	1200	5000	5142.0	370	89	924	222	51	4	7	
1065	1070	500	1000	1200	5000	5142.0	499	120	486	117	27	2	10	
1066	1069	500	-50	1200	5000	5142.0	490	117					10	
1067	1068	50	50	1200	1950	2289.7	22	14	43	26	2	1	1	
592	662	-200	400	2900	1950	3494.6	312	464					16	
593	663	750	-450	2900	5000	5780.1	1022	593					20	
594	664	-50	1000	2900	5000	5780.1	849	492					17	
595	665	950	150	2900	5000	5780.1	702	407	130	75	3	2	14	
596	666	500	950	2900	5000	5780.1	379	220	433	251	10	5	8	
597	667	800	650	2900	5000	5780.1	141	82	562	326	13	7	3	
598	668	800	650	2900	5000	5780.1	141	82	562	326	13	7	3	
599	669	500	950	2900	5000	5780.1	379	220	433	251	10	5	8	
600	670	950	150	2900	5000	5780.1	702	407	130	75	3	2	14	
601	671	-50	1000	2900	5000	5780.1	849	492					17	
602	672	750	-450	2900	5000	5780.1	1022	593					20	
603	673	-200	400	2900	1950	3494.6	312	464					16	
604	674	-50	550	2000	1950	2793.3	387	397					20	
605	675	1100	-150	2000	5000	5385.2	1099	440					22	
606	676	500	1400	2000	5000	5385.2	854	342	464	186	15	4	17	
607	677	1500	800	2000	5000	5385.2	644	257	743	297	25	6	13	
608	678	1200	1600	2000	5000	5385.2	353	141	1114	446	37	9	7	
609	679	1550	1350	2000	5000	5385.2	183	73	1253	501	42	10	4	
610	680	1550	1350	2000	5000	5385.2	183	73	1253	501	42	10	4	
611	681	1200	1600	2000	5000	5385.2	353	141	1114	446	37	9	7	
612	682	1500	800	2000	5000	5385.2	643	257	743	297	25	6	13	
613	683	500	1400	2000	5000	5385.2	854	342	464	186	15	4	17	
614	684	1100	-150	2000	5000	5385.2	1099	440					22	
615	685	-50	550	2000	1950	2793.3	388	398					20	
626	696	500	-100	2850	1950	3453.3	298	435					15	
627	697	100	1150	2850	5000	5755.2	923	526	87	50	2	1	18	
628	698	1550	700	2850	5000	5755.2	741	423	608	347	14	7	15	
629	699	1000	1600	2850	5000	5755.2	512	292	869	495	20	10	10	
630	700	1750	1400	2850	5000	5755.2	287	164	1216	693	28	14	6	
631	701	1500	1700	2850	5000	5755.2	170	97	1303	743	30	15	3	
632	702	1500	1700	2850	5000	5755.2	170	97	1303	743	30	15	3	
633	703	1750	1400	2850	5000	5755.2	287	164	1216	693	28	14	6	
634	704	1000	1600	2850	5000	5755.2	510	291	869	495	20	10	10	
635	705	1550	700	2850	5000	5755.2	745	424	608	347	14	7	15	
636	706	100	1150	2850	5000	5755.2	925	528	87	50	2	1	19	
637	707	500	-100	2850	1950	3453.3	295	431					15	
638	708	200	-100	2850	1950	3453.3	128	188					7	
639	709	100	650	2850	5000	5755.2	474	270	87	50	2	1	9	
640	710	1050	650	2850	5000	5755.2	347	198	565	322	13	6	7	
641	711	950	1350	2850	5000	5755.2	313	179	825	470	19	9	6	
642	712	1500	1300	2850	5000	5755.2	179	102	1129	644	26	13	4	
643	713	1450	1500	2850	5000	5755.2	64	37	1260	718	29	14	1	
644	714	1450	1500	2850	5000	5755.2	64	36	1260	718	29	14	1	
645	715	1500	1300	2850	5000	5755.2	179	102	1129	644	26	13	4	
646	716	950	1350	2850	5000	5755.2	313	178	825	470	19	9	6	
647	717	1050	650	2850	5000	5755.2	343	195	565	322	13	6	7	
648	718	100	650	2850	5000	5755.2	482	275	87	50	2	1	10	
649	719	200	-100	2850	1950	3453.3	126	184					6	
650	720	100	50	1200	1950	2289.7	43	27	43	26	2	1	2	
651	721	-100	200	1200	5000	5142.0	239	57					5	
652	722	200	50	1200	5000	5142.0	185	44	49	12	3	0	4	
653	723	100	250	1200	5000	5142.0	155	37	97	23	5	0	3	
654	724	250	150	1200	5000	5142.0	94	23	146	35	8	1	2	
655	725	200	200	1200	5000	5142.0	30	7	194	47	11	1	1	
656	726	200	200	1200	5000	5142.0	30	7	194	47	11	1	1	
657	727	250	150	1200	5000	5142.0	94	23	146	35	8	1	2	
658	728	100	250	1200	5000	5142.0	156	37	97	23	5	0	3	
659	729	200	50	1200	5000	5142.0	185	44	49	12	3	0	4	
660	730	-100	200	1200	5000	5142.0	220	53					4	
661	731	50	-50	1200	1950	2289.7	63	39					3	

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Combi 13 Skin Members		Brace forces N (kN)	 N (kN)	height mm	widht mm	length mm	Vy kN	Vx kN	Ny kN	Nx kN	σ_y N/mm²	σ_x N/mm²	τ_{xy} N/mm²	
1056	1079	50	-50	1200	1950	2289.7	12	7						1
1057	1078	-200	-50	1200	5000	5142.0	181	44	-49	-12	-3	0		4
1058	1077	-200	-300	1200	5000	5142.0	83	20	-194	-47	-11	-1		2
1059	1076	-400	-250	1200	5000	5142.0	112	27	-243	-58	-14	-1		2
1060	1075	-350	-400	1200	5000	5142.0	32	8	-340	-82	-19	-2		1
1061	1074	-450	-400	1200	5000	5142.0	50	12	-389	-93	-22	-2		1
1062	1073	-450	-400	1200	5000	5142.0	50	12	-389	-93	-22	-2		1
1063	1072	-350	-400	1200	5000	5142.0	32	8	-340	-82	-19	-2		1
1064	1071	-400	-250	1200	5000	5142.0	112	27	-243	-58	-14	-1		2
1065	1070	-200	-300	1200	5000	5142.0	83	20	-194	-47	-11	-1		2
1066	1069	-200	-50	1200	5000	5142.0	181	44	-49	-12	-3	0		4
1067	1068	50	-50	1200	1950	2289.7	12	7						1
592	662	100	-200	2900	1950	3494.6	140	208						7
593	663	-350	250	2900	5000	5780.1	500	290						10
594	664	200	-300	2900	5000	5780.1	399	232						8
595	665	-250	150	2900	5000	5780.1	300	174						6
596	666	100	-200	2900	5000	5780.1	194	113						4
597	667	-150	-50	2900	5000	5780.1	85	49	-43	-25	-1	-1		2
598	668	-150	-50	2900	5000	5780.1	85	49	-43	-25	-1	-1		2
599	669	100	-200	2900	5000	5780.1	194	113						4
600	670	-250	150	2900	5000	5780.1	300	174						6
601	671	200	-300	2900	5000	5780.1	399	232						8
602	672	-350	250	2900	5000	5780.1	500	290						10
603	673	100	-200	2900	1950	3494.6	140	208						7
604	674	150	-200	2000	1950	2793.3	188	193						10
605	675	-250	300	2000	5000	5385.2	481	193						10
606	676	300	-200	2000	5000	5385.2	426	170						9
607	677	-200	250	2000	5000	5385.2	337	135						7
608	678	200	-100	2000	5000	5385.2	220	88						4
609	679	-50	100	2000	5000	5385.2	76	30						2
610	680	-50	100	2000	5000	5385.2	76	30						2
611	681	200	-100	2000	5000	5385.2	220	88						4
612	682	-200	250	2000	5000	5385.2	337	135						7
613	683	300	-200	2000	5000	5385.2	426	170						9
614	684	-250	300	2000	5000	5385.2	481	193						10
615	685	150	-200	2000	1950	2793.3	188	193						10
626	696	200	-50	2850	1950	3453.3	114	166						6
627	697	-100	450	2850	5000	5755.2	445	254						9
628	698	500	100	2850	5000	5755.2	350	199	87	50	2	1		7
629	699	200	450	2850	5000	5755.2	230	131	174	99	4	2		5
630	700	450	250	2850	5000	5755.2	150	85	217	124	5	2		3
631	701	350	400	2850	5000	5755.2	58	33	304	173	7	3		1
632	702	350	400	2850	5000	5755.2	58	33	304	173	7	3		1
633	703	450	250	2850	5000	5755.2	150	85	217	124	5	2		3
634	704	200	450	2850	5000	5755.2	229	131	174	99	4	2		5
635	705	500	100	2850	5000	5755.2	350	200	87	50	2	1		7
636	706	-100	450	2850	5000	5755.2	445	254						9
637	707	200	-50	2850	1950	3453.3	114	166						6
638	708	100	-50	2850	1950	3453.3	73	107						4
639	709	-100	250	2850	5000	5755.2	262	150						5
640	710	300	100	2850	5000	5755.2	175	100	87	50	2	1		3
641	711	150	350	2850	5000	5755.2	132	75	130	74	3	1		3
642	712	350	250	2850	5000	5755.2	88	50	217	124	5	2		2
643	713	300	350	2850	5000	5755.2	31	18	261	149	6	3		1
644	714	300	350	2850	5000	5755.2	31	18	261	149	6	3		1
645	715	350	250	2850	5000	5755.2	88	50	217	124	5	2		2
646	716	150	350	2850	5000	5755.2	132	75	130	74	3	1		3
647	717	300	100	2850	5000	5755.2	174	99	87	50	2	1		3
648	718	-100	250	2850	5000	5755.2	263	150						5
649	719	100	-50	2850	1950	3453.3	73	107						4
650	720	50	-50	1200	1950	2289.7	35	22						2
651	721	-50	100	1200	5000	5142.0	72	17						1
652	722	100	50	1200	5000	5142.0	46	11	49	12	3	0		1
653	723	50	100	1200	5000	5142.0	38	9	49	12	3	0		1
654	724	100	50	1200	5000	5142.0	23	6	49	12	3	0		0
655	725	100	100	1200	5000	5142.0	8	2	97	23	5	0		0
656	726	100	100	1200	5000	5142.0	8	2	97	23	5	0		0
657	727	100	50	1200	5000	5142.0	23	6	49	12	3	0		0
658	728	50	100	1200	5000	5142.0	39	9	49	12	3	0		1
659	729	100	50	1200	5000	5142.0	46	11	49	12	3	0		1
660	730	-50	100	1200	5000	5142.0	70	17						1
661	731	50	-50	1200	1950	2289.7	37	23						2

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Combi 14 Skin Members		Brace forces N (kN)	N (kN)	height mm	widht mm	length mm	Vy kN	Vx kN	Ny kN	Nx kN	σ_y N/mm²	σ_x N/mm²	τ_{xy} N/mm²	
1056	1079	50	50	1200	1950	2289.7	5	3	43	26	2	1	0	
1057	1078	150	-50	1200	5000	5142.0	153	37					3	
1058	1077	150	400	1200	5000	5142.0	222	53	146	35	8	1	4	
1059	1076	500	400	1200	5000	5142.0	138	33	389	93	22	2	3	
1060	1075	500	600	1200	5000	5142.0	106	26	486	117	27	2	2	
1061	1074	650	600	1200	5000	5142.0	34	8	583	140	32	3	1	
1062	1073	650	600	1200	5000	5142.0	35	8	583	140	32	3	1	
1063	1072	500	600	1200	5000	5142.0	107	26	486	117	27	2	2	
1064	1071	500	400	1200	5000	5142.0	139	33	389	93	22	2	3	
1065	1070	150	400	1200	5000	5142.0	222	53	146	35	8	1	4	
1066	1069	150	-50	1200	5000	5142.0	152	36					3	
1067	1068	50	50	1200	1950	2289.7	6	4	43	26	2	1	0	
592	662	-50	150	2900	1950	3494.6	67	99					3	
593	663	200	-50	2900	5000	5780.1	150	87					3	
594	664	250	400	2900	5000	5780.1	112	65	216	125	5	3	2	
595	665	400	250	2900	5000	5780.1	122	71	216	125	5	3	2	
596	666	400	450	2900	5000	5780.1	36	21	346	201	8	4	1	
597	667	450	450	2900	5000	5780.1	17	10	389	226	9	5	0	
598	668	450	450	2900	5000	5780.1	19	11	389	226	9	5	0	
599	669	400	450	2900	5000	5780.1	38	22	346	201	8	4	1	
600	670	400	250	2900	5000	5780.1	124	72	216	125	5	3	2	
601	671	250	400	2900	5000	5780.1	113	66	216	125	5	3	2	
602	672	200	-50	2900	5000	5780.1	149	86					3	
603	673	-50	150	2900	1950	3494.6	61	91					3	
604	674	100	200	2000	1950	2793.3	67	69	70	72	2	4	3	
605	675	450	200	2000	5000	5385.2	213	85	186	74	6	1	4	
606	676	600	650	2000	5000	5385.2	86	34	557	223	19	4	2	
607	677	800	750	2000	5000	5385.2	55	22	696	279	23	6	1	
608	678	950	950	2000	5000	5385.2	6	3	882	353	29	7	0	
609	679	1000	950	2000	5000	5385.2	48	19	882	353	29	7	1	
610	680	1000	950	2000	5000	5385.2	49	20	882	353	29	7	1	
611	681	950	950	2000	5000	5385.2	5	2	882	353	29	7	0	
612	682	800	750	2000	5000	5385.2	56	22	696	279	23	6	1	
613	683	600	650	2000	5000	5385.2	87	35	557	223	19	4	2	
614	684	450	200	2000	5000	5385.2	215	86	186	74	6	1	4	
615	685	100	200	2000	1950	2793.3	63	64	70	72	2	4	3	
626	696	450	-150	2850	1950	3453.3	297	434					15	
627	697	-150	1050	2850	5000	5755.2	1036	591					21	
628	698	1350	400	2850	5000	5755.2	858	489	348	198	8	4	17	
629	699	700	1350	2850	5000	5755.2	603	344	608	347	14	7	12	
630	700	1450	1050	2850	5000	5755.2	360	205	912	520	21	10	7	
631	701	1150	1350	2850	5000	5755.2	168	96	999	569	23	11	3	
632	702	1150	1350	2850	5000	5755.2	167	95	999	569	23	11	3	
633	703	1450	1050	2850	5000	5755.2	359	205	912	520	21	10	7	
634	704	700	1350	2850	5000	5755.2	601	343	608	347	14	7	12	
635	705	1350	400	2850	5000	5755.2	861	490	348	198	8	4	17	
636	706	-150	1100	2850	5000	5755.2	1036	592					21	
637	707	450	-150	2850	1950	3453.3	296	432					15	
638	708	200	-100	2850	1950	3453.3	150	220					8	
639	709	-50	650	2850	5000	5755.2	585	333					12	
640	710	1000	500	2850	5000	5755.2	444	253	434	248	10	5	9	
641	711	800	1200	2850	5000	5755.2	363	207	695	396	16	8	7	
642	712	1350	1050	2850	5000	5755.2	221	126	912	520	21	10	4	
643	713	1200	1300	2850	5000	5755.2	72	41	1043	594	24	12	1	
644	714	1200	1300	2850	5000	5755.2	71	41	1043	594	24	12	1	
645	715	1350	1050	2850	5000	5755.2	221	126	912	520	21	10	4	
646	716	800	1200	2850	5000	5755.2	362	206	695	396	16	8	7	
647	717	1000	500	2850	5000	5755.2	441	251	434	248	10	5	9	
648	718	-50	650	2850	5000	5755.2	590	337					12	
649	719	200	-100	2850	1950	3453.3	149	217					8	
650	720	100	-50	1200	1950	2289.7	56	34					3	
651	721	-100	200	1200	5000	5142.0	223	53					4	
652	722	200	50	1200	5000	5142.0	180	43	49	12	3	0	4	
653	723	100	250	1200	5000	5142.0	149	36	97	23	5	0	3	
654	724	200	150	1200	5000	5142.0	90	21	146	35	8	1	2	
655	725	200	200	1200	5000	5142.0	29	7	194	47	11	1	1	
656	726	200	200	1200	5000	5142.0	28	7	194	47	11	1	1	
657	727	200	150	1200	5000	5142.0	89	21	146	35	8	1	2	
658	728	100	250	1200	5000	5142.0	149	36	97	23	5	0	3	
659	729	200	50	1200	5000	5142.0	180	43	49	12	3	0	4	
660	730	-100	200	1200	5000	5142.0	209	50					4	
661	731	50	-50	1200	1950	2289.7	70	43					4	

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CONDITION (2)

Combi 5 Skin Members		Brace forces N (kN)	N (kN)	height mm	widht mm	length mm	Vy kN	Vx kN	Ny kN	Nx kN	σ_y N/mm²	σ_x N/mm²	τ_{xy} N/mm²	
1056	1079	50	50	1200	1950	2289.7	5	3	43	26	2	1	0	
1057	1078	250	-50	1200	5000	5142.0	207	50						4
1058	1077	200	450	1200	5000	5142.0	250	60	194	47	11	1	5	
1059	1076	650	450	1200	5000	5142.0	183	44	438	105	24	2	4	
1060	1075	650	750	1200	5000	5142.0	115	28	632	152	35	3	2	
1061	1074	800	750	1200	5000	5142.0	57	14	729	175	41	4	1	
1062	1073	800	750	1200	5000	5142.0	57	14	729	175	41	4	1	
1063	1072	650	750	1200	5000	5142.0	115	28	632	152	35	3	2	
1064	1071	650	450	1200	5000	5142.0	183	44	438	105	24	2	4	
1065	1070	200	450	1200	5000	5142.0	250	60	194	47	11	1	5	
1066	1069	250	-50	1200	5000	5142.0	207	50						4
1067	1068	50	50	1200	1950	2289.7	5	3	43	26	2	1	0	
592	662	-50	150	2900	1950	3494.6	97	144						5
593	663	250	-100	2900	5000	5780.1	270	157						5
594	664	200	400	2900	5000	5780.1	211	123	173	100	4	2	4	
595	665	450	250	2900	5000	5780.1	212	123	216	125	5	3	4	
596	666	400	500	2900	5000	5780.1	76	44	346	201	8	4	2	
597	667	500	450	2900	5000	5780.1	51	30	389	226	9	5	1	
598	668	500	450	2900	5000	5780.1	51	30	389	226	9	5	1	
599	669	400	500	2900	5000	5780.1	76	44	346	201	8	4	2	
600	670	450	250	2900	5000	5780.1	212	123	216	125	5	3	4	
601	671	200	400	2900	5000	5780.1	211	123	173	100	4	2	4	
602	672	250	-100	2900	5000	5780.1	271	157						5
603	673	-50	150	2900	1950	3494.6	97	144						5
604	674	50	200	2000	1950	2793.3	108	111	35	36	1	2	6	
605	675	500	150	2000	5000	5385.2	328	131	139	56	5	1	7	
606	676	500	700	2000	5000	5385.2	182	73	464	186	15	4	4	
607	677	800	650	2000	5000	5385.2	153	61	604	241	20	5	3	
608	678	900	900	2000	5000	5385.2	42	17	836	334	28	7	1	
609	679	1000	900	2000	5000	5385.2	72	29	836	334	28	7	1	
610	680	1000	900	2000	5000	5385.2	72	29	836	334	28	7	1	
611	681	900	900	2000	5000	5385.2	42	17	836	334	28	7	1	
612	682	800	650	2000	5000	5385.2	153	61	604	241	20	5	3	
613	683	500	700	2000	5000	5385.2	182	73	464	186	15	4	4	
614	684	500	150	2000	5000	5385.2	328	131	139	56	5	1	7	
615	685	50	200	2000	1950	2793.3	108	111	35	36	1	2	6	
626	696	400	-150	2850	1950	3453.3	274	400						14
627	697	-200	950	2850	5000	5755.2	940	536						19
628	698	1200	300	2850	5000	5755.2	766	436	261	149	6	3	15	
629	699	600	1250	2850	5000	5755.2	558	318	521	297	12	6	11	
630	700	1300	900	2850	5000	5755.2	322	183	782	446	18	9	6	
631	701	1050	1200	2850	5000	5755.2	157	89	912	520	21	10	3	
632	702	1050	1200	2850	5000	5755.2	157	89	912	520	21	10	3	
633	703	1300	900	2850	5000	5755.2	321	183	782	446	18	9	6	
634	704	600	1250	2850	5000	5755.2	557	318	521	297	12	6	11	
635	705	1200	300	2850	5000	5755.2	768	438	261	149	6	3	15	
636	706	-200	950	2850	5000	5755.2	941	537						19
637	707	400	-150	2850	1950	3453.3	272	398						14
638	708	200	-100	2850	1950	3453.3	132	193						7
639	709	-50	600	2850	5000	5755.2	526	300						11
640	710	950	450	2850	5000	5755.2	408	232	391	223	9	4	8	
641	711	750	1150	2850	5000	5755.2	333	190	652	371	15	7	7	
642	712	1250	1050	2850	5000	5755.2	192	110	912	520	21	10	4	
643	713	1200	1250	2850	5000	5755.2	69	39	1043	594	24	12	1	
644	714	1200	1250	2850	5000	5755.2	69	39	1043	594	24	12	1	
645	715	1250	1050	2850	5000	5755.2	192	110	912	520	21	10	4	
646	716	750	1150	2850	5000	5755.2	333	190	652	371	15	7	7	
647	717	950	450	2850	5000	5755.2	404	231	391	223	9	4	8	
648	718	-50	600	2850	5000	5755.2	531	303						11
649	719	200	-100	2850	1950	3453.3	130	190						7
650	720	50	-50	1200	1950	2289.7	44	27						2
651	721	-100	150	1200	5000	5142.0	208	50						4
652	722	200	50	1200	5000	5142.0	171	41	49	12	3	0	3	
653	723	100	200	1200	5000	5142.0	143	34	97	23	5	0	3	
654	724	200	100	1200	5000	5142.0	87	21	97	23	5	0	2	
655	725	150	200	1200	5000	5142.0	28	7	146	35	8	1	1	
656	726	150	200	1200	5000	5142.0	28	7	146	35	8	1	1	
657	727	200	100	1200	5000	5142.0	87	21	97	23	5	0	2	
658	728	100	200	1200	5000	5142.0	144	35	97	23	5	0	3	
659	729	200	50	1200	5000	5142.0	171	41	49	12	3	0	3	
660	730	-100	150	1200	5000	5142.0	195	47						4
661	731	50	-50	1200	1950	2289.7	58	36						3

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Combi 6 Skin Members		Brace forces N (kN)	 N (kN)	height mm	widht mm	length mm	Vy kN	Vx kN	Ny kN	Nx kN	σ_y N/mm²	σ_x N/mm²	τ_{xy} N/mm²	
1056	1079	50	50	1200	1950	2289.7	4	2	43	26	2	1	0	
1057	1078	250	-50	1200	5000	5142.0	220	53						4
1058	1077	200	500	1200	5000	5142.0	276	66	194	47	11	1		6
1059	1076	700	500	1200	5000	5142.0	230	55	486	117	27	2		5
1060	1075	700	750	1200	5000	5142.0	38	9	681	163	38	3		1
1061	1074	850	800	1200	5000	5142.0	44	11	778	187	43	4		1
1062	1073	850	800	1200	5000	5142.0	44	11	778	187	43	4		1
1063	1072	700	750	1200	5000	5142.0	38	9	681	163	38	3		1
1064	1071	700	500	1200	5000	5142.0	230	55	486	117	27	2		5
1065	1070	200	500	1200	5000	5142.0	276	66	194	47	11	1		6
1066	1069	250	-50	1200	5000	5142.0	220	53						4
1067	1068	50	50	1200	1950	2289.7	4	2	43	26	2	1	0	
592	662	-50	200	2900	1950	3494.6	119	177						6
593	663	200	-50	2900	5000	5780.1	166	96						3
594	664	250	300	2900	5000	5780.1	55	32	216	125	5	3	1	
595	665	350	300	2900	5000	5780.1	37	22	260	151	6	3	1	
596	666	600	400	2900	5000	5780.1	184	107	346	201	8	4	4	
597	667	650	450	2900	5000	5780.1	158	92	389	226	9	5	3	
598	668	650	450	2900	5000	5780.1	158	92	389	226	9	5	3	
599	669	600	400	2900	5000	5780.1	184	107	346	201	8	4	4	
600	670	350	300	2900	5000	5780.1	37	21	260	151	6	3	1	
601	671	250	300	2900	5000	5780.1	55	32	216	125	5	3	1	
602	672	200	-50	2900	5000	5780.1	166	96						3
603	673	-50	200	2900	1950	3494.6	119	177						6
604	674	150	200	2000	1950	2793.3	34	35	105	107	3	6	2	
605	675	400	250	2000	5000	5385.2	114	46	232	93	8	2	2	
606	676	600	550	2000	5000	5385.2	44	18	511	204	17	4	1	
607	677	700	750	2000	5000	5385.2	70	28	650	260	22	5	1	
608	678	1050	650	2000	5000	5385.2	361	145	604	241	20	5	7	
609	679	1000	900	2000	5000	5385.2	87	35	836	334	28	7	2	
610	680	1000	900	2000	5000	5385.2	87	35	836	334	28	7	2	
611	681	1050	650	2000	5000	5385.2	361	145	604	241	20	5	7	
612	682	650	750	2000	5000	5385.2	70	28	604	241	20	5	1	
613	683	600	550	2000	5000	5385.2	44	18	511	204	17	4	1	
614	684	400	250	2000	5000	5385.2	114	46	232	93	8	2	2	
615	685	150	200	2000	1950	2793.3	34	35	105	107	3	6	2	
626	696	400	-150	2850	1950	3453.3	296	432						15
627	697	-350	1050	2850	5000	5755.2	1143	651						23
628	698	1250	150	2850	5000	5755.2	977	557	130	74	3	1	20	
629	699	400	1300	2850	5000	5755.2	757	431	348	198	8	4	15	
630	700	1300	750	2850	5000	5755.2	480	274	652	371	15	7	10	
631	701	950	1150	2850	5000	5755.2	171	97	825	470	19	9	3	
632	702	950	1150	2850	5000	5755.2	170	97	825	470	19	9	3	
633	703	1300	750	2850	5000	5755.2	480	274	652	371	15	7	10	
634	704	400	1300	2850	5000	5755.2	756	431	348	198	8	4	15	
635	705	1250	150	2850	5000	5755.2	979	558	130	74	3	1	20	
636	706	-350	1050	2850	5000	5755.2	1144	652						23
637	707	400	-150	2850	1950	3453.3	294	430						15
638	708	200	-150	2850	1950	3453.3	156	228						8
639	709	-150	600	2850	5000	5755.2	631	360						13
640	710	900	300	2850	5000	5755.2	537	306	261	149	6	3	11	
641	711	550	1100	2850	5000	5755.2	451	257	478	272	11	5	9	
642	712	1200	850	2850	5000	5755.2	286	163	738	421	17	8	6	
643	713	1050	1150	2850	5000	5755.2	93	53	912	520	21	10	2	
644	714	1050	1150	2850	5000	5755.2	93	53	912	520	21	10	2	
645	715	1200	850	2850	5000	5755.2	286	163	738	421	17	8	6	
646	716	550	1100	2850	5000	5755.2	451	257	478	272	11	5	9	
647	717	900	300	2850	5000	5755.2	535	305	261	149	6	3	11	
648	718	-150	600	2850	5000	5755.2	634	362						13
649	719	200	-150	2850	1950	3453.3	155	227						8
650	720	50	-50	1200	1950	2289.7	58	35						3
651	721	-50	150	1200	5000	5142.0	161	43						4
652	722	200	50	1200	5000	5142.0	162	39	49	12	3	0	3	
653	723	50	200	1200	5000	5142.0	138	33	49	12	3	0	3	
654	724	200	100	1200	5000	5142.0	85	20	97	23	5	0	2	
655	725	150	200	1200	5000	5142.0	27	7	146	35	8	1	1	
656	726	150	200	1200	5000	5142.0	27	7	146	35	8	1	1	
657	727	200	100	1200	5000	5142.0	85	20	97	23	5	0	2	
658	728	50	200	1200	5000	5142.0	138	33	49	12	3	0	3	
659	729	200	50	1200	5000	5142.0	162	39	49	12	3	0	3	
660	730	-50	150	1200	5000	5142.0	172	41						3
661	731	50	-50	1200	1950	2289.7	66	41						3

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Combi 3 Skin Members		Brace forces N (kN)	 N (kN)	height mm	widht mm	length mm	Vy kN	Vx kN	Ny kN	Nx kN	σ_y N/mm^2	σ_x N/mm^2	τ_{xy} N/mm^2	
1056	1079	100	-100	1200	1950	2289.7	130	80						7
1057	1078	-400	-50	1200	5000	5142.0	318	76	-49	-12	-3	0		6
1058	1077	-400	-650	1200	5000	5142.0	252	61	-389	-93	-22	-2		5
1059	1076	-900	-650	1200	5000	5142.0	262	63	-632	-152	-35	-3		5
1060	1075	-900	-1050	1200	5000	5142.0	172	41	-875	-210	-49	-4		3
1061	1074	-1150	-1050	1200	5000	5142.0	79	19	-1021	-245	-57	-5		2
1062	1073	-1100	-1050	1200	5000	5142.0	50	12	-1021	-245	-57	-5		1
1063	1072	-950	-1100	1200	5000	5142.0	144	34	-924	-222	-51	-4		3
1064	1071	-950	-700	1200	5000	5142.0	248	59	-681	-163	-38	-3		5
1065	1070	-400	-750	1200	5000	5142.0	324	78	-389	-93	-22	-2		6
1066	1069	-450	-50	1200	5000	5142.0	396	95	-49	-12	-3	0		8
1067	1068	50	-50	1200	1950	2289.7	56	34						3
592	662	350	-350	2900	1950	3494.6	361	537						19
593	663	-800	650	2900	5000	5780.1	1236	717						25
594	664	650	-750	2900	5000	5780.1	1172	680						23
595	665	-600	350	2900	5000	5780.1	781	453						16
596	666	150	-500	2900	5000	5780.1	535	311						11
597	667	-350	-100	2900	5000	5780.1	186	108	-87	-50	-2	-1		4
598	668	-350	-150	2900	5000	5780.1	167	97	-130	-75	-3	-2		3
599	669	150	-500	2900	5000	5780.1	527	306						11
600	670	-650	350	2900	5000	5780.1	851	494						17
601	671	550	-750	2900	5000	5780.1	1124	652						22
602	672	-850	700	2900	5000	5780.1	1285	745						26
603	673	300	-400	2900	1950	3494.6	340	505						17
604	674	300	-600	2000	1950	2793.3	579	593						30
605	675	-800	650	2000	5000	5385.2	1281	512						26
606	676	600	-750	2000	5000	5385.2	1236	494						25
607	677	-550	450	2000	5000	5385.2	847	339						17
608	678	250	-400	2000	5000	5385.2	536	214						11
609	679	-200	-50	2000	5000	5385.2	144	58	-46	-19	-2	0		3
610	680	-250	50	2000	5000	5385.2	201	80						4
611	681	250	-450	2000	5000	5385.2	580	232						12
612	682	-600	450	2000	5000	5385.2	918	367						18
613	683	600	-750	2000	5000	5385.2	1181	472						24
614	684	-800	650	2000	5000	5385.2	1270	508						25
615	685	250	-450	2000	1950	2793.3	461	473						24
626	696	250	-200	2850	1950	3453.3	216	316						11
627	697	-500	700	2850	5000	5755.2	1006	573						20
628	698	700	-350	2850	5000	5755.2	871	497						17
629	699	-100	650	2850	5000	5755.2	607	346						12
630	700	550	100	2850	5000	5755.2	367	209	87	50	2	1		7
631	701	300	400	2850	5000	5755.2	88	50	261	149	6	3		2
632	702	250	450	2850	5000	5755.2	149	85	217	124	5	2		3
633	703	550	100	2850	5000	5755.2	413	236	87	50	2	1		8
634	704	-150	600	2850	5000	5755.2	614	350						12
635	705	650	-350	2850	5000	5755.2	831	474						17
636	706	-450	650	2850	5000	5755.2	939	535						19
637	707	250	-150	2850	1950	3453.3	215	315						11
638	708	200	-150	2850	1950	3453.3	154	225						8
639	709	-250	500	2850	5000	5755.2	639	364						13
640	710	650	50	2850	5000	5755.2	511	291	43	25	1	0		10
641	711	250	650	2850	5000	5755.2	360	205	217	124	5	2		7
642	712	650	400	2850	5000	5755.2	221	126	348	198	8	4		4
643	713	550	600	2850	5000	5755.2	46	26	478	272	11	5		1
644	714	550	650	2850	5000	5755.2	86	49	478	272	11	5		2
645	715	700	400	2850	5000	5755.2	249	142	348	198	8	4		5
646	716	250	650	2850	5000	5755.2	360	205	217	124	5	2		7
647	717	600	50	2850	5000	5755.2	493	281	43	25	1	0		10
648	718	-250	500	2850	5000	5755.2	605	345						12
649	719	150	-150	2850	1950	3453.3	145	212						7
650	720	50	-50	1200	1950	2289.7	62	38						3
651	721	-50	150	1200	5000	5142.0	131	32						3
652	722	150	50	1200	5000	5142.0	123	29	49	12	3	0		2
653	723	50	150	1200	5000	5142.0	99	24	49	12	3	0		2
654	724	150	100	1200	5000	5142.0	59	14	97	23	5	0		1
655	725	150	150	1200	5000	5142.0	18	4	146	35	8	1		0
656	726	150	150	1200	5000	5142.0	19	5	146	35	8	1		0
657	727	150	100	1200	5000	5142.0	59	14	97	23	5	0		1
658	728	50	150	1200	5000	5142.0	98	24	49	12	3	0		2
659	729	150	50	1200	5000	5142.0	121	29	49	12	3	0		2
660	730	-50	150	1200	5000	5142.0	131	31						3
661	731	50	-50	1200	1950	2289.7	62	38						3

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CONDITION (3)

Combi 2 Skin Members		Brace forces N (kN)	N (kN)	height mm	widht mm	length mm	Vy kN	Vx kN	Ny kN	Nx kN	σ_y N/mm²	σ_x N/mm²	τ_{xy} N/mm²	
1056	1079	50	-100	1200	1950	2289.7	99	61						5
1057	1078	-550	-50	1200	5000	5142.0	490	118	-49	-12	-3	0		10
1058	1077	-550	-1000	1200	5000	5142.0	458	110	-535	-128	-30	-3		9
1059	1076	-1350	-950	1200	5000	5142.0	395	95	-924	-222	-51	-4		8
1060	1075	-1350	-1450	1200	5000	5142.0	133	32	-1313	-315	-73	-6		3
1061	1074	-1600	-1500	1200	5000	5142.0	80	19	-1459	-350	-81	-7		2
1062	1073	-1600	-1500	1200	5000	5142.0	80	19	-1459	-350	-81	-7		2
1063	1072	-1350	-1450	1200	5000	5142.0	133	32	-1313	-315	-73	-6		3
1064	1071	-1350	-950	1200	5000	5142.0	395	95	-924	-222	-51	-4		8
1065	1070	-550	-1000	1200	5000	5142.0	458	110	-535	-128	-30	-3		9
1066	1069	-550	-50	1200	5000	5142.0	490	118	-49	-12	-3	0		10
1067	1068	50	-100	1200	1950	2289.7	99	61						5
592	662	300	-500	2900	1950	3494.6	417	621						21
593	663	-850	600	2900	5000	5780.1	1242	720						25
594	664	450	-850	2900	5000	5780.1	1085	629						22
595	665	-750	250	2900	5000	5780.1	813	472						16
596	666	-200	-600	2900	5000	5780.1	344	200	-173	-100	-4	-2		7
597	667	-700	-300	2900	5000	5780.1	335	194	-260	-151	-6	-3		7
598	668	-700	-300	2900	5000	5780.1	335	194	-260	-151	-6	-3		7
599	669	-200	-600	2900	5000	5780.1	344	200	-173	-100	-4	-2		7
600	670	-750	250	2900	5000	5780.1	813	472						16
601	671	450	-850	2900	5000	5780.1	1085	629						22
602	672	-850	600	2900	5000	5780.1	1242	720						25
603	673	300	-500	2900	1950	3494.6	417	621						21
604	674	50	-550	2000	1950	2793.3	378	388						19
605	675	-800	450	2000	5000	5385.2	1120	448						22
606	676	400	-800	2000	5000	5385.2	1071	428						21
607	677	-750	200	2000	5000	5385.2	810	324						16
608	678	-250	-450	2000	5000	5385.2	225	90	-232	-93	-8	-2		5
609	679	-550	-300	2000	5000	5385.2	247	99	-279	-111	-9	-2		5
610	680	-550	-300	2000	5000	5385.2	247	99	-279	-111	-9	-2		5
611	681	-250	-450	2000	5000	5385.2	225	90	-232	-93	-8	-2		5
612	682	-750	200	2000	5000	5385.2	810	324						16
613	683	400	-800	2000	5000	5385.2	1071	428						21
614	684	-800	450	2000	5000	5385.2	1120	448						22
615	685	50	-550	2000	1950	2793.3	378	388						19
626	696	100	-100	2850	1950	3453.3	75	109						4
627	697	-300	400	2850	5000	5755.2	550	313						11
628	698	350	-250	2850	5000	5755.2	450	257						9
629	699	-100	250	2850	5000	5755.2	276	157						6
630	700	200	50	2850	5000	5755.2	138	79	43	25	1	0		3
631	701	100	150	2850	5000	5755.2	71	41	87	50	2	1		1
632	702	100	150	2850	5000	5755.2	71	41	87	50	2	1		1
633	703	200	50	2850	5000	5755.2	138	79	43	25	1	0		3
634	704	-100	250	2850	5000	5755.2	276	157						6
635	705	350	-250	2850	5000	5755.2	450	256						9
636	706	-300	400	2850	5000	5755.2	550	313						11
637	707	100	-100	2850	1950	3453.3	75	109						4
638	708	150	-100	2850	1950	3453.3	98	143						5
639	709	-200	350	2850	5000	5755.2	437	249						9
640	710	350	50	2850	5000	5755.2	264	150	43	25	1	0		5
641	711	200	350	2850	5000	5755.2	153	87	174	99	4	2		3
642	712	350	250	2850	5000	5755.2	85	48	217	124	5	2		2
643	713	350	350	2850	5000	5755.2	29	16	304	173	7	3		1
644	714	350	350	2850	5000	5755.2	29	16	304	173	7	3		1
645	715	350	250	2850	5000	5755.2	85	48	217	124	5	2		2
646	716	200	350	2850	5000	5755.2	153	87	174	99	4	2		3
647	717	350	50	2850	5000	5755.2	264	150	43	25	1	0		5
648	718	-200	350	2850	5000	5755.2	436	249						9
649	719	150	-100	2850	1950	3453.3	98	143						5
650	720	50	-50	1200	1950	2289.7	35	22						2
651	721	-50	100	1200	5000	5142.0	96	23						2
652	722	100	50	1200	5000	5142.0	89	21	49	12	3	0		2
653	723	50	100	1200	5000	5142.0	71	17	49	12	3	0		1
654	724	100	100	1200	5000	5142.0	40	10	97	23	5	0		1
655	725	100	100	1200	5000	5142.0	13	3	97	23	5	0		0
656	726	100	100	1200	5000	5142.0	13	3	97	23	5	0		0
657	727	100	100	1200	5000	5142.0	40	10	97	23	5	0		1
658	728	50	100	1200	5000	5142.0	71	17	49	12	3	0		1
659	729	100	50	1200	5000	5142.0	89	21	49	12	3	0		2
660	730	-50	100	1200	5000	5142.0	98	23						2
661	731	50	-50	1200	1950	2289.7	33	20						2

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Combi 4 Skin Members		Brace forces N (kN)	N (kN)	height mm	widht mm	length mm	Vy kN	Vx kN	Ny kN	Nx kN	σ_y N/mm²	σ_x N/mm²	τ_{xy} N/mm²	
1056	1079	-50	-50	1200	1950	2289.7	29	18	-43	-26	-2	-1	1	
1057	1078	-550	-50	1200	5000	5142.0	460	110	-49	-12	-3	0	9	
1058	1077	-450	-850	1200	5000	5142.0	356	85	-438	-105	-24	-2	7	
1059	1076	-1050	-750	1200	5000	5142.0	255	61	-729	-175	-41	-4	5	
1060	1075	-1000	-1150	1200	5000	5142.0	138	33	-972	-233	-54	-5	3	
1061	1074	-1200	-1150	1200	5000	5142.0	46	11	-1118	-268	-62	-5	1	
1062	1073	-1200	-1100	1200	5000	5142.0	74	18	-1070	-257	-59	-5	1	
1063	1072	-950	-1100	1200	5000	5142.0	158	38	-924	-222	-51	-4	3	
1064	1071	-1000	-700	1200	5000	5142.0	256	61	-681	-163	-38	-3	5	
1065	1070	-400	-750	1200	5000	5142.0	338	81	-389	-93	-22	-2	7	
1066	1069	-450	-50	1200	5000	5142.0	392	94	-49	-12	-3	0	8	
1067	1068	50	-50	1200	1950	2289.7	62	38					3	
592	662	200	-350	2900	1950	3494.6	273	406					14	
593	663	-850	600	2900	5000	5780.1	1226	711					25	
594	664	500	-800	2900	5000	5780.1	1080	627					22	
595	665	-750	350	2900	5000	5780.1	937	543					19	
596	666	150	-550	2900	5000	5780.1	560	325					11	
597	667	-350	-150	2900	5000	5780.1	203	118	-130	-75	-3	-2	4	
598	668	-350	-150	2900	5000	5780.1	181	105	-130	-75	-3	-2	4	
599	669	150	-550	2900	5000	5780.1	534	310					11	
600	670	-700	350	2900	5000	5780.1	852	494					17	
601	671	550	-750	2900	5000	5780.1	1107	642					22	
602	672	-850	650	2900	5000	5780.1	1245	722					25	
603	673	300	-400	2900	1950	3494.6	350	521					18	
604	674	150	-350	2000	1950	2793.3	288	295					15	
605	675	-750	550	2000	5000	5385.2	1136	454					23	
606	676	500	-700	2000	5000	5385.2	1098	439					22	
607	677	-700	400	2000	5000	5385.2	989	396					20	
608	678	250	-500	2000	5000	5385.2	633	253					13	
609	679	-300	-50	2000	5000	5385.2	247	99	-46	-19	-2	0	5	
610	680	-250	-50	2000	5000	5385.2	158	63	-46	-19	-2	0	3	
611	681	200	-450	2000	5000	5385.2	560	224					11	
612	682	-600	400	2000	5000	5385.2	899	360					18	
613	683	550	-750	2000	5000	5385.2	1153	461					23	
614	684	-750	600	2000	5000	5385.2	1201	480					24	
615	685	200	-450	2000	1950	2793.3	422	433					22	
626	696	200	-150	2850	1950	3453.3	153	223					8	
627	697	-450	600	2850	5000	5755.2	846	482					17	
628	698	550	-350	2850	5000	5755.2	742	423					15	
629	699	-150	550	2850	5000	5755.2	569	324					11	
630	700	500	50	2850	5000	5755.2	362	206	43	25	1	0	7	
631	701	250	400	2850	5000	5755.2	141	81	217	124	5	2	3	
632	702	250	350	2850	5000	5755.2	99	56	217	124	5	2	2	
633	703	450	100	2850	5000	5755.2	328	187	87	50	2	1	7	
634	704	-150	550	2850	5000	5755.2	557	317					11	
635	705	600	-350	2850	5000	5755.2	769	439					15	
636	706	-450	600	2850	5000	5755.2	876	500					18	
637	707	200	-150	2850	1950	3453.3	165	241					8	
638	708	150	-100	2850	1950	3453.3	132	193					7	
639	709	-300	450	2850	5000	5755.2	613	349					12	
640	710	550	-50	2850	5000	5755.2	446	254					9	
641	711	200	600	2850	5000	5755.2	322	183	174	99	4	2	6	
642	712	600	350	2850	5000	5755.2	215	123	304	173	7	3	4	
643	713	450	550	2850	5000	5755.2	83	47	391	223	9	4	2	
644	714	500	550	2850	5000	5755.2	54	31	434	248	10	5	1	
645	715	600	350	2850	5000	5755.2	196	112	304	173	7	3	4	
646	716	200	600	2850	5000	5755.2	319	182	174	99	4	2	6	
647	717	550	-50	2850	5000	5755.2	459	262					9	
648	718	-300	450	2850	5000	5755.2	626	357					13	
649	719	200	-100	2850	1950	3453.3	138	202					7	
650	720	50	-50	1200	1950	2289.7	44	27					2	
651	721	-50	100	1200	5000	5142.0	121	29					2	
652	722	150	50	1200	5000	5142.0	120	29	49	12	3	0	2	
653	723	50	150	1200	5000	5142.0	99	24	49	12	3	0	2	
654	724	150	100	1200	5000	5142.0	58	14	97	23	5	0	1	
655	725	100	150	1200	5000	5142.0	20	5	97	23	5	0	0	
656	726	100	150	1200	5000	5142.0	17	4	97	23	5	0	0	
657	727	150	100	1200	5000	5142.0	57	14	97	23	5	0	1	
658	728	50	150	1200	5000	5142.0	99	24	49	12	3	0	2	
659	729	150	50	1200	5000	5142.0	122	29	49	12	3	0	2	
660	730	-50	100	1200	5000	5142.0	122	29					2	
661	731	50	-50	1200	1950	2289.7	45	28					2	

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Combi 1 Skin Members		Brace forces N (kN)	N (kN)	height mm	widht mm	length mm	Vy kN	Vx kN	Ny kN	Nx kN	σ_y N/mm²	σ_x N/mm²	τ_{xy} N/mm²	
1056	1079	50	-100	1200	1950	2289.7	77	47						4
1057	1078	-500	-50	1200	5000	5142.0	448	107	-49	-12	-3	0		9
1058	1077	-500	-900	1200	5000	5142.0	386	93	-486	-117	-27	-2		8
1059	1076	-1150	-850	1200	5000	5142.0	318	76	-827	-198	-46	-4		6
1060	1075	-1150	-1350	1200	5000	5142.0	186	45	-1118	-268	-62	-5		4
1061	1074	-1400	-1300	1200	5000	5142.0	85	20	-1264	-303	-70	-6		2
1062	1073	-1400	-1300	1200	5000	5142.0	85	20	-1264	-303	-70	-6		2
1063	1072	-1150	-1350	1200	5000	5142.0	186	45	-1118	-268	-62	-5		4
1064	1071	-1150	-850	1200	5000	5142.0	318	76	-827	-198	-46	-4		6
1065	1070	-500	-900	1200	5000	5142.0	386	93	-486	-117	-27	-2		8
1066	1069	-500	-50	1200	5000	5142.0	448	107	-49	-12	-3	0		9
1067	1068	50	-100	1200	1950	2289.7	77	47						4
592	662	300	-450	2900	1950	3494.6	388	577						20
593	663	-850	600	2900	5000	5780.1	1209	701						24
594	664	450	-850	2900	5000	5780.1	1086	630						22
595	665	-800	250	2900	5000	5780.1	869	504						17
596	666	-50	-650	2900	5000	5780.1	535	310	-43	-25	-1	-1		11
597	667	-500	-300	2900	5000	5780.1	205	119	-260	-151	-6	-3		4
598	668	-500	-300	2900	5000	5780.1	205	119	-260	-151	-6	-3		4
599	669	-50	-650	2900	5000	5780.1	535	310	-43	-25	-1	-1		11
600	670	-800	250	2900	5000	5780.1	869	504						17
601	671	450	-850	2900	5000	5780.1	1086	630						22
602	672	-850	600	2900	5000	5780.1	1209	701						24
603	673	300	-450	2900	1950	3494.6	388	577						20
604	674	100	-550	2000	1950	2793.3	427	438						22
605	675	-850	500	2000	5000	5385.2	1190	476						24
606	676	400	-900	2000	5000	5385.2	1161	465						23
607	677	-850	200	2000	5000	5385.2	925	370						18
608	678	-100	-700	2000	5000	5385.2	568	227	-93	-37	-3	-1		11
609	679	-550	-350	2000	5000	5385.2	211	85	-325	-130	-11	-3		4
610	680	-550	-350	2000	5000	5385.2	211	85	-325	-130	-11	-3		4
611	681	-100	-700	2000	5000	5385.2	568	227	-93	-37	-3	-1		11
612	682	-850	200	2000	5000	5385.2	925	370						18
613	683	400	-900	2000	5000	5385.2	1161	465						23
614	684	-850	500	2000	5000	5385.2	1190	476						24
615	685	100	-550	2000	1950	2793.3	427	438						22
626	696	50	-200	2850	1950	3453.3	86	125						4
627	697	-500	500	2850	5000	5755.2	806	459						16
628	698	400	-450	2850	5000	5755.2	699	398						14
629	699	-300	250	2850	5000	5755.2	454	259						9
630	700	150	-250	2850	5000	5755.2	320	183						6
631	701	-100	-50	2850	5000	5755.2	59	34	-43	-25	-1	0		1
632	702	-100	-50	2850	5000	5755.2	59	34	-43	-25	-1	0		1
633	703	150	-250	2850	5000	5755.2	320	183						6
634	704	-300	250	2850	5000	5755.2	454	259						9
635	705	400	-450	2850	5000	5755.2	700	399						14
636	706	-500	500	2850	5000	5755.2	806	460						16
637	707	-50	-200	2850	1950	3453.3	85	124	-28	-41	-1	-2		4
638	708	50	-100	2850	1950	3453.3	62	91						3
639	709	-350	450	2850	5000	5755.2	676	385						14
640	710	350	-200	2850	5000	5755.2	443	253						9
641	711	-100	300	2850	5000	5755.2	275	157						6
642	712	250	-50	2850	5000	5755.2	199	113						4
643	713	150	150	2850	5000	5755.2	33	19	130	74	3	1		1
644	714	150	150	2850	5000	5755.2	33	19	130	74	3	1		1
645	715	250	-50	2850	5000	5755.2	199	113						4
646	716	-100	300	2850	5000	5755.2	275	157						5
647	717	350	-200	2850	5000	5755.2	442	252						9
648	718	-350	450	2850	5000	5755.2	680	387						14
649	719	50	-100	2850	1950	3453.3	60	88						3
650	720	50	100	1200	1950	2289.7	27	17	43	26	2	1		1
651	721	-50	100	1200	5000	5142.0	109	26						2
652	722	100	50	1200	5000	5142.0	42	10	49	12	3	0		1
653	723	50	100	1200	5000	5142.0	34	8	49	12	3	0		1
654	724	100	50	1200	5000	5142.0	19	5	49	12	3	0		0
655	725	50	100	1200	5000	5142.0	6	1	49	12	3	0		0
656	726	50	100	1200	5000	5142.0	6	1	49	12	3	0		0
657	727	100	50	1200	5000	5142.0	19	5	49	12	3	0		0
658	728	50	100	1200	5000	5142.0	34	8	49	12	3	0		1
659	729	100	50	1200	5000	5142.0	42	10	49	12	3	0		1
660	730	-50	100	1200	5000	5142.0	100	24						2
661	731	50	50	1200	1950	2289.7	16	10	43	26	2	1		1

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CONDITION (b)

Combi 11 Skin Members		Brace forces N (kN)	N (kN)	height mm	widht mm	length mm	Vy kN	Vx kN	Ny kN	Nx kN	σ_y N/mm²	σ_x N/mm²	τ_{xy} N/mm²	
1056	1079	-50	-50	1200	1950	2289.7	7	4	-43	-26	-2	-1	0	
1057	1078	-650	50	1200	5000	5142.0	635	152					13	
1058	1077	-550	-1050	1200	5000	5142.0	448	107	-535	-128	-30	-3	9	
1059	1076	-1200	-950	1200	5000	5142.0	254	61	-924	-222	-51	-4	5	
1060	1075	-1200	-1350	1200	5000	5142.0	166	40	-1167	-280	-65	-6	3	
1061	1074	-1400	-1350	1200	5000	5142.0	60	14	-1313	-315	-73	-6	1	
1062	1073	-1400	-1350	1200	5000	5142.0	78	19	-1313	-315	-73	-6	2	
1063	1072	-1150	-1350	1200	5000	5142.0	192	46	-1118	-268	-62	-5	4	
1064	1071	-1200	-900	1200	5000	5142.0	301	72	-875	-210	-49	-4	6	
1065	1070	-500	-950	1200	5000	5142.0	409	98	-486	-117	-27	-2	8	
1066	1069	-550	-50	1200	5000	5142.0	488	117	-49	-12	-3	0	10	
1067	1068	50	-100	1200	1950	2289.7	79	49					4	
592	662	300	-350	2900	1950	3494.6	316	471					16	
593	663	-1000	900	2900	5000	5780.1	1616	937					32	
594	664	700	-950	2900	5000	5780.1	1392	808					28	
595	665	-850	500	2900	5000	5780.1	1108	643					22	
596	666	250	-600	2900	5000	5780.1	667	387					13	
597	667	-350	-100	2900	5000	5780.1	200	116	-87	-50	-2	-1	4	
598	668	-350	-50	2900	5000	5780.1	265	154	-43	-25	-1	-1	5	
599	669	250	-600	2900	5000	5780.1	717	416					14	
600	670	-800	500	2900	5000	5780.1	1114	646					22	
601	671	800	-950	2900	5000	5780.1	1453	843					29	
602	672	-1050	850	2900	5000	5780.1	1627	944					33	
603	673	400	-550	2900	1950	3494.6	483	718					25	
604	674	450	-400	2000	1950	2793.3	579	594					30	
605	675	-1000	950	2000	5000	5385.2	1733	693					35	Combi-
606	676	800	-900	2000	5000	5385.2	1536	614					31	
607	677	-700	650	2000	5000	5385.2	1230	492					25	
608	678	450	-450	2000	5000	5385.2	797	319					16	
609	679	-200	150	2000	5000	5385.2	288	115					6	
610	680	-150	100	2000	5000	5385.2	181	73					4	
611	681	400	-400	2000	5000	5385.2	714	285					14	
612	682	-650	600	2000	5000	5385.2	1130	452					23	
613	683	750	-850	2000	5000	5385.2	1464	585					29	
614	684	-900	700	2000	5000	5385.2	1451	581					29	
615	685	200	-550	2000	1950	2793.3	486	499					25	
626	696	350	-250	2850	1950	3453.3	298	436					15	
627	697	-700	950	2850	5000	5755.2	1376	784					28	
628	698	950	-400	2850	5000	5755.2	1146	653					23	
629	699	-100	950	2850	5000	5755.2	871	497					17	
630	700	800	200	2850	5000	5755.2	520	297	174	99	4	2	10	
631	701	450	650	2850	5000	5755.2	171	97	391	223	9	4	3	
632	702	450	700	2850	5000	5755.2	199	113	391	223	9	4	4	
633	703	800	250	2850	5000	5755.2	487	278	217	124	5	2	10	
634	704	-100	900	2850	5000	5755.2	804	458					16	
635	705	950	-400	2850	5000	5755.2	1137	648					23	
636	706	-500	900	2850	5000	5755.2	1162	662					23	
637	707	400	-100	2850	1950	3453.3	253	369					13	
638	708	200	-150	2850	1950	3453.3	186	272					10	
639	709	-400	700	2850	5000	5755.2	886	505					18	
640	710	850	50	2850	5000	5755.2	682	389	43	25	1	0	14	
641	711	350	950	2850	5000	5755.2	507	289	304	173	7	3	10	
642	712	1000	600	2850	5000	5755.2	323	184	521	297	12	6	6	
643	713	800	950	2850	5000	5755.2	140	80	695	396	16	8	3	
644	714	850	900	2850	5000	5755.2	74	42	738	421	17	8	1	
645	715	950	650	2850	5000	5755.2	287	164	565	322	13	6	6	
646	716	400	900	2850	5000	5755.2	435	248	348	198	8	4	9	
647	717	800	50	2850	5000	5755.2	636	362	43	25	1	0	13	
648	718	-450	600	2850	5000	5755.2	873	498					17	
649	719	300	-150	2850	1950	3453.3	222	325					11	
650	720	50	-100	1200	1950	2289.7	95	59					5	
651	721	-50	200	1200	5000	5142.0	190	46					4	
652	722	200	50	1200	5000	5142.0	182	44	49	12	3	0	4	
653	723	50	250	1200	5000	5142.0	155	37	49	12	3	0	3	
654	724	200	150	1200	5000	5142.0	92	22	146	35	8	1	2	
655	725	200	200	1200	5000	5142.0	28	7	194	47	11	1	1	
656	726	150	200	1200	5000	5142.0	30	7	146	35	8	1	1	
657	727	200	150	1200	5000	5142.0	93	22	146	35	8	1	2	
658	728	50	250	1200	5000	5142.0	168	40	49	12	3	0	3	
659	729	250	-50	1200	5000	5142.0	209	50					4	
660	730	-100	150	1200	5000	5142.0	193	46					4	
661	731	100	-50	1200	1950	2289.7	52	32					3	

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Combi 12 Skin Members		Brace forces N (kN)	N (kN)	height mm	widht mm	length mm	Vy kN	Vx kN	Ny kN	Nx kN	σ_y N/mm²	σ_x N/mm²	τ_{xy} N/mm²	
1056	1079	-50	-50	1200	1950	2289.7	18	11	-43	-26	-2	-1	1	
1057	1078	-700	-50	1200	5000	5142.0	650	156	-49	-12	-3	0	13	
1058	1077	-600	-1050	1200	5000	5142.0	434	104	-583	-140	-32	-3	9	
1059	1076	-1250	-1000	1200	5000	5142.0	248	60	-972	-233	-54	-5	5	
1060	1075	-1200	-1400	1200	5000	5142.0	161	39	-1167	-280	-65	-6	3	
1061	1074	-1400	-1350	1200	5000	5142.0	53	13	-1313	-315	-73	-6	1	
1062	1073	-1400	-1350	1200	5000	5142.0	84	20	-1313	-315	-73	-6	2	
1063	1072	-1150	-1350	1200	5000	5142.0	192	46	-1118	-268	-62	-5	4	
1064	1071	-1200	-900	1200	5000	5142.0	302	72	-875	-210	-49	-4	6	
1065	1070	-500	-950	1200	5000	5142.0	410	99	-486	-117	-27	-2	8	
1066	1069	-550	-50	1200	5000	5142.0	489	117	-49	-12	-3	0	10	
1067	1068	50	-100	1200	1950	2289.7	80	49					4	
592	662	300	-300	2900	1950	3494.6	303	451					16	
593	663	-1050	850	2900	5000	5780.1	1603	930					32	
594	664	700	-950	2900	5000	5780.1	1401	812					28	
595	665	-850	500	2900	5000	5780.1	1124	652					22	
596	666	250	-600	2900	5000	5780.1	684	397					14	
597	667	-350	-100	2900	5000	5780.1	222	129	-87	-50	-2	-1	4	
598	668	-350	-100	2900	5000	5780.1	246	143	-87	-50	-2	-1	5	
599	669	250	-600	2900	5000	5780.1	699	406					14	
600	670	-800	500	2900	5000	5780.1	1101	638					22	
601	671	800	-950	2900	5000	5780.1	1442	836					29	
602	672	-1050	850	2900	5000	5780.1	1620	939					32	
603	673	400	-500	2900	1950	3494.6	480	713					25	
604	674	450	-400	2000	1950	2793.3	572	586					29	
605	675	-1000	900	2000	5000	5385.2	1720	688					34	
606	676	800	-900	2000	5000	5385.2	1535	614					31	
607	677	-750	650	2000	5000	5385.2	1241	497					25	
608	678	450	-500	2000	5000	5385.2	810	324					16	
609	679	-250	150	2000	5000	5385.2	305	122					6	
610	680	-150	100	2000	5000	5385.2	167	67					3	
611	681	400	-400	2000	5000	5385.2	697	279					14	
612	682	-650	600	2000	5000	5385.2	1118	447					22	
613	683	750	-850	2000	5000	5385.2	1454	582					29	
614	684	-900	700	2000	5000	5385.2	1449	580					29	
615	685	200	-550	2000	1950	2793.3	487	500					25	
626	696	350	-250	2850	1950	3453.3	296	433					15	
627	697	-700	950	2850	5000	5755.2	1384	789					28	
628	698	950	-450	2850	5000	5755.2	1158	660					23	
629	699	-150	950	2850	5000	5755.2	879	501					18	
630	700	800	200	2850	5000	5755.2	527	301	174	99	4	2	11	
631	701	450	650	2850	5000	5755.2	179	102	391	223	9	4	4	
632	702	450	700	2850	5000	5755.2	189	108	391	223	9	4	4	
633	703	800	250	2850	5000	5755.2	477	272	217	124	5	2	10	
634	704	-50	900	2850	5000	5755.2	792	451					16	
635	705	950	-400	2850	5000	5755.2	1121	639					22	
636	706	-500	900	2850	5000	5755.2	1151	656					23	
637	707	400	-100	2850	1950	3453.3	254	372					13	
638	708	200	-150	2850	1950	3453.3	189	277					10	
639	709	-400	700	2850	5000	5755.2	905	516					18	
640	710	850	50	2850	5000	5755.2	692	394	43	25	1	0	14	
641	711	350	950	2850	5000	5755.2	512	292	304	173	7	3	10	
642	712	1000	600	2850	5000	5755.2	328	187	521	297	12	6	7	
643	713	800	950	2850	5000	5755.2	144	82	695	396	16	8	3	
644	714	850	900	2850	5000	5755.2	69	39	738	421	17	8	1	
645	715	950	650	2850	5000	5755.2	281	160	565	322	13	6	6	
646	716	450	900	2850	5000	5755.2	428	244	391	223	9	4	9	
647	717	800	100	2850	5000	5755.2	625	356	87	50	2	1	12	
648	718	-400	600	2850	5000	5755.2	853	486					17	
649	719	250	-150	2850	1950	3453.3	219	321					11	
650	720	50	-100	1200	1950	2289.7	91	56					5	
651	721	-50	200	1200	5000	5142.0	189	45					4	
652	722	200	50	1200	5000	5142.0	184	44	49	12	3	0	4	
653	723	50	250	1200	5000	5142.0	157	38	49	12	3	0	3	
654	724	200	150	1200	5000	5142.0	93	22	146	35	8	1	2	
655	725	200	200	1200	5000	5142.0	28	7	194	47	11	1	1	
656	726	150	200	1200	5000	5142.0	30	7	146	35	8	1	1	
657	727	200	150	1200	5000	5142.0	92	22	146	35	8	1	2	
658	728	50	250	1200	5000	5142.0	166	40	49	12	3	0	3	
659	729	250	-50	1200	5000	5142.0	207	50					4	
660	730	-100	150	1200	5000	5142.0	193	46					4	
661	731	100	-50	1200	1950	2289.7	57	35					3	

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Combi 8 Skin Members		Brace forces N (kN)	N (kN)	height mm	widht mm	length mm	Vy kN	Vx kN	Ny kN	Nx kN	σ_y N/mm²	σ_x N/mm²	τ_{xy} N/mm²	
1056	1079	-100	100	1200	1950	2289.7	91	56						5
1057	1078	-500	100	1200	5000	5142.0	529	127						11
1058	1077	-400	-750	1200	5000	5142.0	329	79	-389	-93	-22	-2		7
1059	1076	-800	-700	1200	5000	5142.0	131	31	-681	-163	-38	-3		3
1060	1075	-800	-900	1200	5000	5142.0	98	24	-778	-187	-43	-4		2
1061	1074	-950	-900	1200	5000	5142.0	30	7	-875	-210	-49	-4		1
1062	1073	-950	-900	1200	5000	5142.0	49	12	-875	-210	-49	-4		1
1063	1072	-750	-900	1200	5000	5142.0	124	30	-729	-175	-41	-4		2
1064	1071	-800	-600	1200	5000	5142.0	188	45	-583	-140	-32	-3		4
1065	1070	-350	-600	1200	5000	5142.0	263	63	-340	-82	-19	-2		5
1066	1069	-400	-50	1200	5000	5142.0	332	80	-49	-12	-3	0		7
1067	1068	50	-50	1200	1950	2289.7	58	36						3
592	662	200	-150	2900	1950	3494.6	151	224						8
593	663	-700	700	2900	5000	5780.1	1174	681						23
594	664	550	-650	2900	5000	5780.1	977	567						20
595	665	-550	400	2900	5000	5780.1	817	474						16
596	666	250	-400	2900	5000	5780.1	484	281						10
597	667	-200	-50	2900	5000	5780.1	152	88	-43	-25	-1	-1		3
598	668	-200	50	2900	5000	5780.1	169	98						3
599	669	250	-350	2900	5000	5780.1	483	280						10
600	670	-550	400	2900	5000	5780.1	756	439						15
601	671	600	-650	2900	5000	5780.1	1005	583						20
602	672	-750	600	2900	5000	5780.1	1130	656						23
603	673	300	-400	2900	1950	3494.6	364	541						19
604	674	450	-200	2000	1950	2793.3	430	441						22
605	675	-700	800	2000	5000	5385.2	1357	543						27
606	676	700	-600	2000	5000	5385.2	1134	454						23
607	677	-500	550	2000	5000	5385.2	938	375						19
608	678	450	-300	2000	5000	5385.2	636	254						13
609	679	-100	250	2000	5000	5385.2	275	110						6
610	680	100	150	2000	5000	5385.2	45	18	93	37	3	1		1
611	681	350	-200	2000	5000	5385.2	440	176						9
612	682	-350	450	2000	5000	5385.2	724	290						14
613	683	550	-550	2000	5000	5385.2	970	388						19
614	684	-600	450	2000	5000	5385.2	911	364						18
615	685	100	-350	2000	1950	2793.3	290	297						15
626	696	250	-250	2850	1950	3453.3	253	370						13
627	697	-600	800	2850	5000	5755.2	1131	645						23
628	698	800	-300	2850	5000	5755.2	913	521						18
629	699	-100	800	2850	5000	5755.2	715	407						14
630	700	700	200	2850	5000	5755.2	432	246	174	99	4	2		9
631	701	400	600	2850	5000	5755.2	158	90	348	198	8	4		3
632	702	450	600	2850	5000	5755.2	132	75	391	223	9	4		3
633	703	650	300	2850	5000	5755.2	316	180	261	149	6	3		6
634	704	100	700	2850	5000	5755.2	543	310	87	50	2	1		11
635	705	750	-250	2850	5000	5755.2	807	460						16
636	706	-250	650	2850	5000	5755.2	751	428						15
637	707	400	50	2850	1950	3453.3	202	295	28	41	1	2		10
638	708	150	-150	2850	1950	3453.3	137	200						7
639	709	-300	550	2850	5000	5755.2	708	403						14
640	710	700	100	2850	5000	5755.2	548	312	87	50	2	1		11
641	711	300	800	2850	5000	5755.2	422	241	261	149	6	3		8
642	712	850	500	2850	5000	5755.2	277	158	434	248	10	5		6
643	713	650	800	2850	5000	5755.2	154	88	565	322	13	6		3
644	714	700	750	2850	5000	5755.2	14	8	608	347	14	7		0
645	715	800	600	2850	5000	5755.2	181	103	521	297	12	6		4
646	716	450	750	2850	5000	5755.2	271	155	391	223	9	4		5
647	717	600	150	2850	5000	5755.2	412	235	130	74	3	1		8
648	718	-300	400	2850	5000	5755.2	566	322						11
649	719	200	-150	2850	1950	3453.3	177	259						9
650	720	50	-100	1200	1950	2289.7	80	49						4
651	721	-50	150	1200	5000	5142.0	152	36						3
652	722	200	50	1200	5000	5142.0	144	35	49	12	3	0		3
653	723	50	200	1200	5000	5142.0	128	31	49	12	3	0		3
654	724	200	100	1200	5000	5142.0	78	19	97	23	5	0		2
655	725	150	150	1200	5000	5142.0	24	6	146	35	8	1		0
656	726	150	150	1200	5000	5142.0	23	5	146	35	8	1		0
657	727	200	100	1200	5000	5142.0	73	17	97	23	5	0		1
658	728	50	200	1200	5000	5142.0	136	33	49	12	3	0		3
659	729	200	-50	1200	5000	5142.0	175	42						3
660	730	-100	150	1200	5000	5142.0	157	38						3
661	731	50	-50	1200	1950	2289.7	44	27						2

A1-31

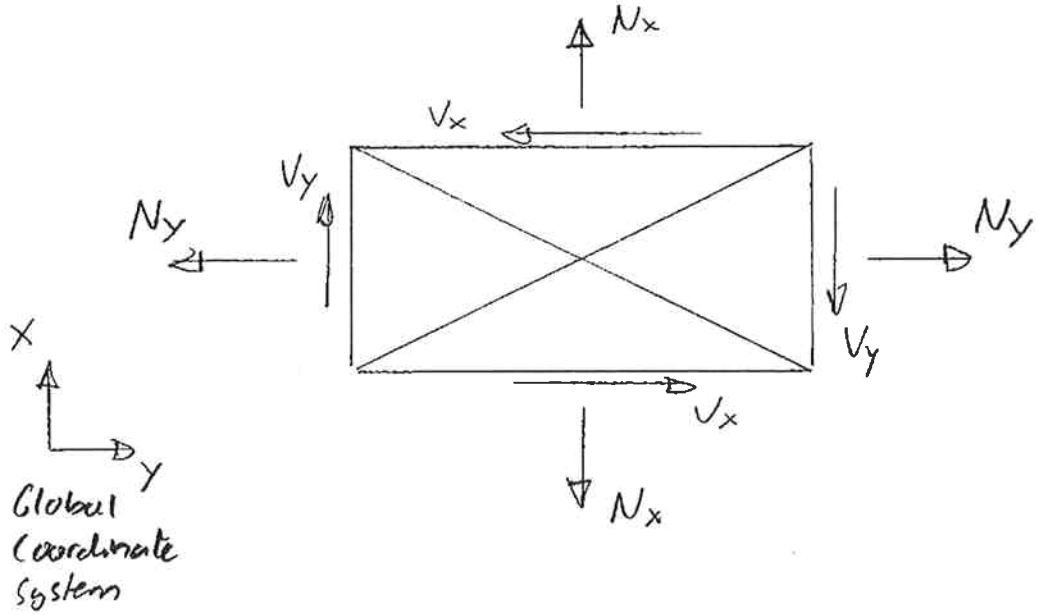
A2

Combi 7 Skin Members		Brace forces N (kN)	 N (kN)	height mm	widht mm	length mm	Vy kN	Vx kN	Ny kN	Nx kN	σ_y N/mm²	σ_x N/mm²	τ_{xy} N/mm²	
1056	1079	-50	-50	1200	1950	2289.7	26	16	-43	-26	-2	-1	1	
1057	1078	-550	-50	1200	5000	5142.0	473	114	-49	-12	-3	0	9	
1058	1077	-450	-800	1200	5000	5142.0	313	75	-438	-105	-24	-2	6	
1059	1076	-950	-750	1200	5000	5142.0	186	45	-729	-175	-41	-4	4	
1060	1075	-900	-1050	1200	5000	5142.0	118	28	-875	-210	-49	-4	2	
1061	1074	-1050	-1000	1200	5000	5142.0	39	9	-972	-233	-54	-5	1	
1062	1073	-1050	-1000	1200	5000	5142.0	63	15	-972	-233	-54	-5	1	
1063	1072	-850	-1000	1200	5000	5142.0	142	34	-827	-198	-46	-4	3	
1064	1071	-900	-650	1200	5000	5142.0	225	54	-632	-152	-35	-3	4	
1065	1070	-400	-700	1200	5000	5142.0	301	72	-389	-93	-22	-2	6	
1066	1069	-400	-50	1200	5000	5142.0	362	87	-49	-12	-3	0	7	
1067	1068	50	-50	1200	1950	2289.7	58	36					3	
592	662	200	-250	2900	1950	3494.6	227	337					12	
593	663	-750	650	2900	5000	5780.1	1166	677					23	
594	664	500	-700	2900	5000	5780.1	1022	593					20	
595	665	-650	350	2900	5000	5780.1	816	473					16	
596	666	150	-450	2900	5000	5780.1	496	288					10	
597	667	-300	-100	2900	5000	5780.1	158	92	-87	-50	-2	-1	3	
598	668	-300	-50	2900	5000	5780.1	185	107	-43	-25	-1	-1	4	
599	669	200	-450	2900	5000	5780.1	517	300					10	
600	670	-600	400	2900	5000	5780.1	810	470					16	
601	671	550	-700	2900	5000	5780.1	1059	614					21	
602	672	-800	650	2900	5000	5780.1	1191	691					24	
603	673	300	-400	2900	1950	3494.6	351	522					18	
604	674	350	-300	2000	1950	2793.3	418	428					21	
605	675	-750	650	2000	5000	5385.2	1245	498					25	
606	676	600	-650	2000	5000	5385.2	1115	446					22	
607	677	-550	450	2000	5000	5385.2	898	359					18	
608	678	300	-350	2000	5000	5385.2	582	233					12	
609	679	-200	100	2000	5000	5385.2	213	85					4	
610	680	-150	50	2000	5000	5385.2	133	53					3	
611	681	300	-350	2000	5000	5385.2	519	208					10	
612	682	-500	450	2000	5000	5385.2	827	331					17	
613	683	550	-650	2000	5000	5385.2	1073	429					21	
614	684	-650	550	2000	5000	5385.2	1075	430					21	
615	685	150	-400	2000	1950	2793.3	364	373					19	
626	696	250	-200	2850	1950	3453.3	214	313					11	
627	697	-500	700	2850	5000	5755.2	998	569					20	
628	698	700	-300	2850	5000	5755.2	834	476					17	
629	699	-100	700	2850	5000	5755.2	631	360					13	
630	700	600	150	2850	5000	5755.2	377	215	130	74	3	1	8	
631	701	350	500	2850	5000	5755.2	125	71	304	173	7	3	2	
632	702	350	500	2850	5000	5755.2	143	81	304	173	7	3	3	
633	703	600	150	2850	5000	5755.2	355	202	130	74	3	1	7	
634	704	-50	650	2850	5000	5755.2	586	334					12	
635	705	700	-300	2850	5000	5755.2	826	471					17	
636	706	-400	650	2850	5000	5755.2	856	488					17	
637	707	300	-50	2850	1950	3453.3	184	269					9	
638	708	150	-150	2850	1950	3453.3	138	202					7	
639	709	-300	500	2850	5000	5755.2	651	371					13	
640	710	650	50	2850	5000	5755.2	497	284	43	25	1	0	10	
641	711	250	700	2850	5000	5755.2	366	209	217	124	5	2	7	
642	712	700	450	2850	5000	5755.2	233	133	391	223	9	4	5	
643	713	600	700	2850	5000	5755.2	99	56	521	297	12	6	2	
644	714	600	650	2850	5000	5755.2	56	32	521	297	12	6	1	
645	715	700	450	2850	5000	5755.2	210	120	391	223	9	4	4	
646	716	300	650	2850	5000	5755.2	319	182	261	149	6	3	6	
647	717	600	50	2850	5000	5755.2	465	265	43	25	1	0	9	
648	718	-300	450	2850	5000	5755.2	637	363					13	
649	719	200	-150	2850	1950	3453.3	160	234					8	
650	720	50	-50	1200	1950	2289.7	67	41					3	
651	721	-50	150	1200	5000	5142.0	138	33					3	
652	722	150	50	1200	5000	5142.0	133	32	49	12	3	0	3	
653	723	50	150	1200	5000	5142.0	113	27	49	12	3	0	2	
654	724	150	100	1200	5000	5142.0	67	16	97	23	5	0	1	
655	725	150	150	1200	5000	5142.0	20	5	146	35	8	1	0	
656	726	150	150	1200	5000	5142.0	22	5	146	35	8	1	0	
657	727	150	100	1200	5000	5142.0	67	16	97	23	5	0	1	
658	728	50	150	1200	5000	5142.0	120	29	49	12	3	0	2	
659	729	200	-50	1200	5000	5142.0	150	36					3	
660	730	-50	100	1200	5000	5142.0	140	34					3	
661	731	50	-50	1200	1950	2289.7	40	25					2	

A1-32 A2

EXAMPLE DETERMINATION GLOBAL STRESSES

Stresses resulting from EPW-calculation



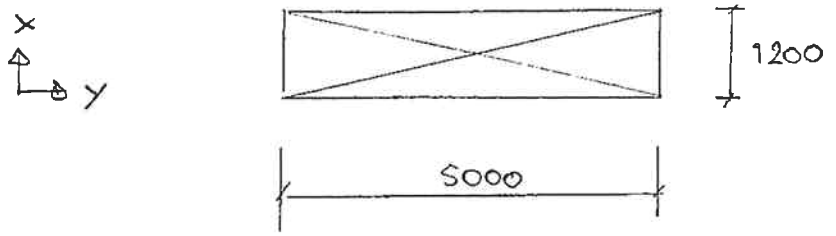
Governing plate forces

	loading condition	load combi	brace 1	brace 2
max. normal stress	3.	2	-157	-149
max. shear stress	4.	11	-11.7	8.2

NOTE. y is direction of stiffeners !

Max. normal stress

$N_{brace\,1,d} = -1571$ kN ; $N_{brace\,2,d} = -1489$ kN



$L_{brace} = \sqrt{5000^2 + 1200^2} = 5142$ mm

$N_{y,d} = \frac{5000}{5142} \times -1489$ kN $= -1448$ kN

$N_{x,d} = \frac{1200}{5142} \times -1489$ kN $= -347$ kN

$V_{y,d} = (1571 - 1489) \cdot \frac{5000}{5142} = 80$ kN

$V_{x,d} = (1571 - 1489) \cdot \frac{1200}{5142} = 19$ kN

* y-direction : Area of stiffeners are taken ato account.

$L\,200 \times 100 \times 14$; corrosion → $L\,200 \times 100 \times 12$

$A = (200 + 100) \times 12 = 3600\ mm^2$ c.t.c. 700 mm

$t_{eq} = 10 + \frac{3600\ mm^2}{700\ mm} = 10 + 5 = 15$ mm

Stresses:

$$\sigma_{y,d} = \frac{-1448 \cdot 10^3\ N}{15\ mm \times 1200\ mm} = -81\ N/mm^2$$

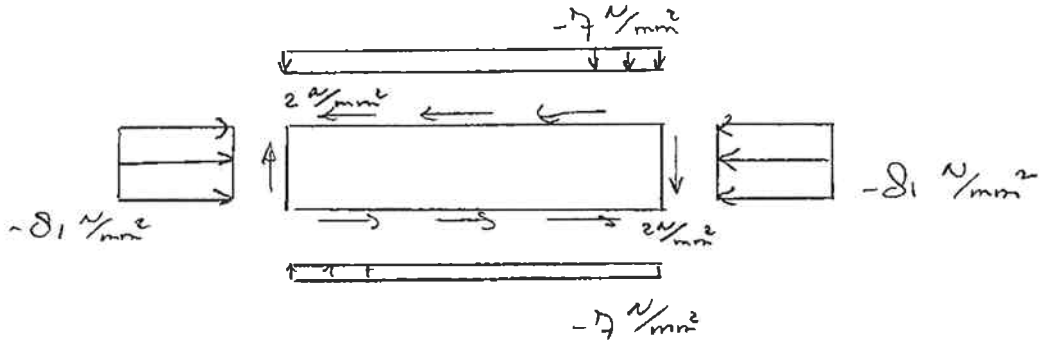
$$\sigma_{x,d} = \frac{-347 \cdot 10^3\ N}{10\ mm \times 5000\ mm} = -7\ N/mm^2$$

$$\tau_d = \frac{80 \cdot 10^3\ N}{5000 \times 10\ mm^2} = 2\ N/mm^2$$

check shear in other direction:

$$\tau_d = \frac{19 \cdot 10^3\ N}{1200 \times 10\ mm^2} = 2\ N/mm^2 \rightarrow O.K.$$

Stresses in plate following from brace forces EPW:

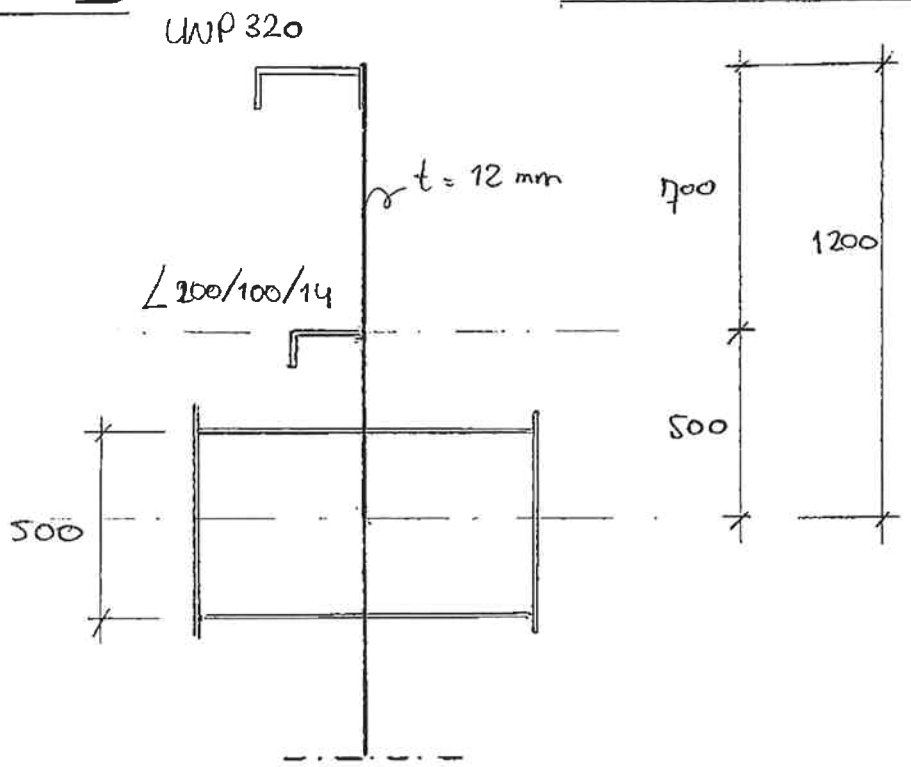


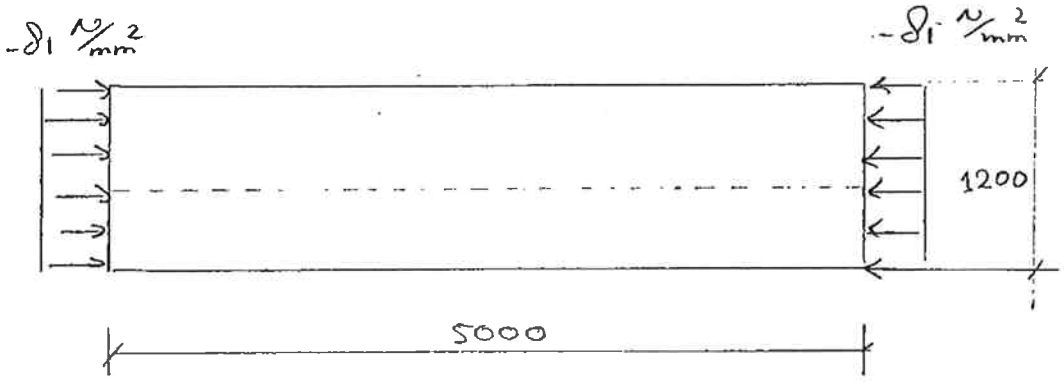
Project : MAL. NAV. Lock GATE.

Onderdeel : Skin.

Check stability

* corrosion : 2 mm.





Opgesteld : WLA

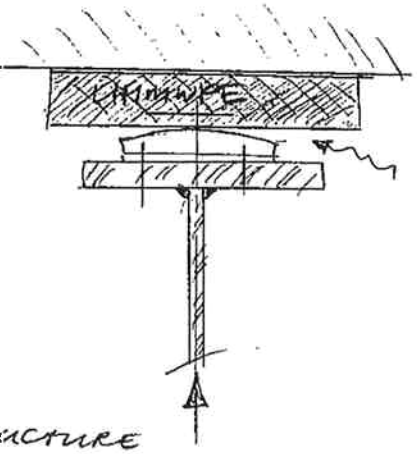
Datum : 280604

Bladnummer : A1-36

Rev. : A2

A2. SEALING DETAILS.

(1). DETAIL WATERSEALING VERTICAL BEARING



THE TOLERANCE OF THE GATESTRUCTURE AND THE GATECHAMBERWALL TOGETHER IS: ± 1 mm.

THE LOCAL DEFLECTION OF THE STEEL BEARING MEMBER IS NEGLECTABLE.

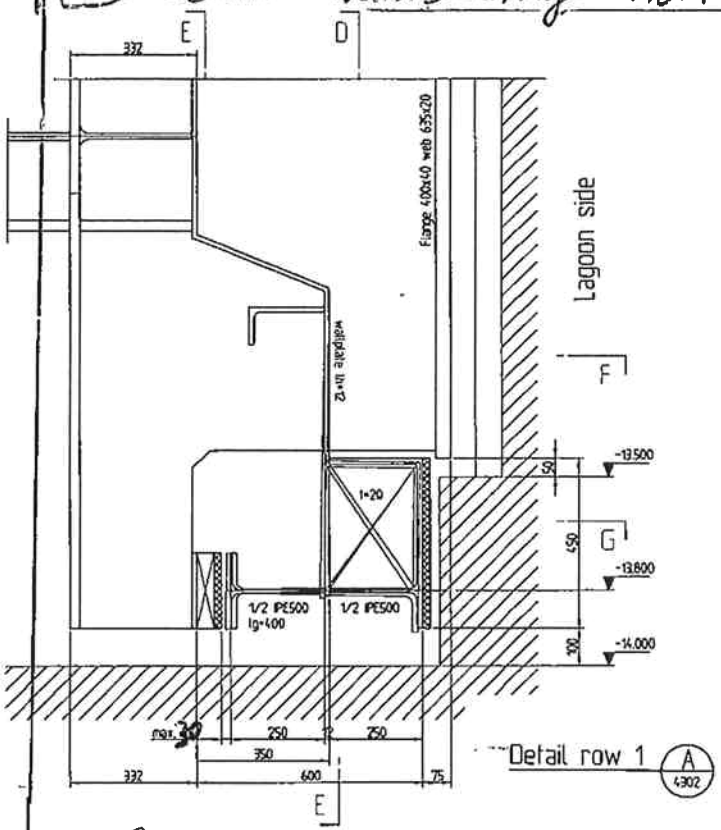
Because CONTACTSTRESS OF GATE STRUCTURE THE UHMWPE-BEARING WILL DEFORM AND SEAL OF THE POSSIBLE MENTIONED SPLIT.

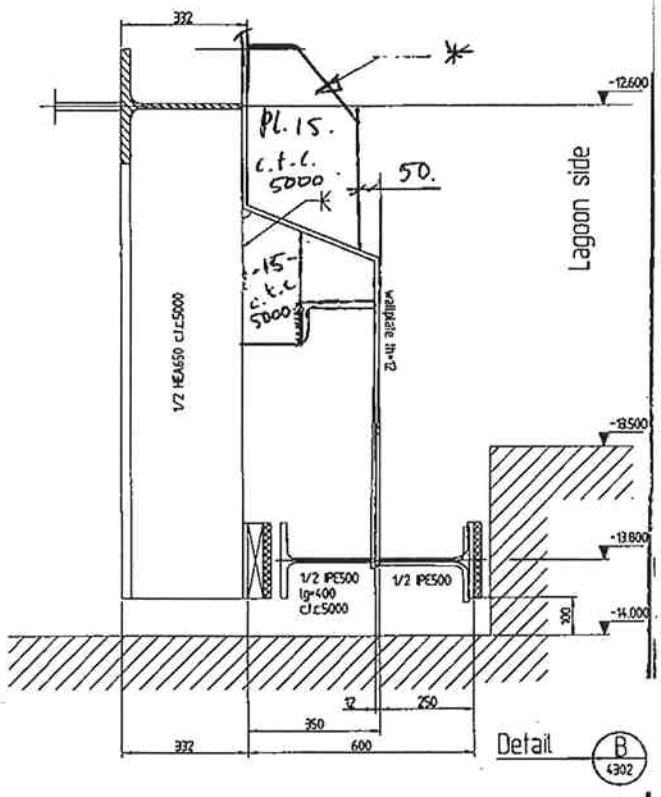
LEAKAGE is MINIMUM.

Project : Malamocco Nav. lock Gate

Onderdeel : Watersealing details

(2) Detail watersealing hor. beam (near threshold)





Flexible plate (skin), free over 700 mm and supported with L 200x100x12, in hor. direction

loads: $P_{rep} = \Delta h \times \rho_{water}$ $3.0 \times 10.3 = 30.9$ kN/m²

Δu → 10 mm tolerance in closed position (include ΔP)

25 mm tolerance gate moving (exclude ΔP)

Skin-plate $t = 12$ mm; corr. allowance 1 mm round.

$W = \frac{1}{6} \cdot 1000 \cdot 10^2 = 1.67 \cdot 10^4$ mm³/m'

$I = \frac{1}{12} \cdot 1000 \cdot 10^3 = 8.33 \cdot 10^4$ mm⁴/m

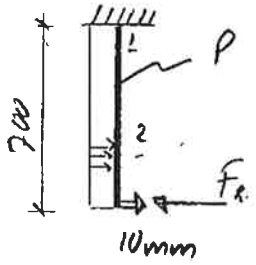
*NOTE: PRACTICAL FOR UPLIFT FLAP DUE TO WATERPRESSURE.

Opgesteld :	Datum :	Bladnummer :	Rev. :
J.A.	9/4/04	A2-2	A2

Project : Malamocco Nav. Lock Gate

Onderdeel : Waterproofing details

Situation 1 : Waterpressure and 10 mm tolerance



$$\Delta u = \frac{P\ell^4}{8EI} - \frac{F_R \ell^3}{3EI} \Rightarrow F_R = \left(\frac{P\ell^4}{8EI} - \Delta u\right) * \frac{3EI}{\ell^3}$$

$F_R = 6.6$ kN

$M_{1;rep} = \frac{1}{2} P \ell^2 - F_R \ell = 3$ kNm

$M_{2;rep} = \frac{9}{128} P \ell^2 = 1.1$ kNm, not governing.

$M_{1;d} = 3 * 1.5 = 4.5$ kNm

$M_{u;d} = f_{s;d} * W / \gamma_m = 5.4$ kNm

u.c. $= \frac{M_{1;d}}{M_{u;d}} = 0.83 < 1.0$ OK.

Situation 2 : 30 mm forced displacement

$$\Delta u = \frac{F_R \ell^3}{3EI} \Rightarrow F_R = \frac{3EI}{\ell^3} \Delta u$$

$F_R = 4.6$ kN

$M_{1;rep} = F_R \ell = 3.2$ kNm

$M_{1;d} = 3.2 \cdot 1.5 = 4.8$ kNm u.c. $= \frac{M_{1;d}}{M_{u;d}} = 0.89 < 1.0$

OK.

Displacement due to bending of gate: 27 mm in middle;

OK.

Opgesteld :	Datum :	Bladnummer :	Rev. :
J.A.	9/4/04	A2-3.	A2

L 200x100x10 stiffener

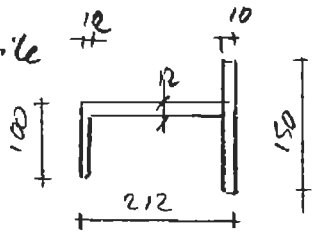
load : $q_{min} = p_{min} \cdot \Delta h = 30.9 \times \frac{1}{2} \times (-12.6 - -13.8) = 18.5$ kN/m

span : max. 5 m

$M_{max,r} = \frac{1}{8} q l^2 = 57.8$ kNm

$V_{max} = \frac{1}{2} q l = 46.3$ kN

Profile



$I_y = 3.33 \cdot 10^2$ mm⁴

$W_{beltg} = 2.97 \cdot 10^5$ mm³

$M_{u;d} = 2.97 \cdot 10^5 \cdot 355 / 1.1 = 95.9$ kNm

u.c. $= \frac{57.8 \cdot 1.5}{95.9} = 0.90 < 1.0$; Ok

Weld stiffener to L 200x100x10 ΔΔ a=5 l=150mm

$\tau_{wi;d} = \sigma_{wi;d} = \frac{46.3 \times 10^3 \times 1.5}{2.4 \cdot 150} = 58$ N/mm²

$f_{wu;d} = 260$ N/mm²

u.c. $= \frac{58}{260} = 0.22 < 1.0$; Ok

leakage

Despite the efforts taken to prevent leakage, some leakage is unavoidable. Because of high contact stresses between vertical beams and UHMWPE Leakage is prevented. For the threshold - beam an average leak - split of 1mm along half the length of the gate will be assumed.

The lower corners of the gate contain a leak-area of:

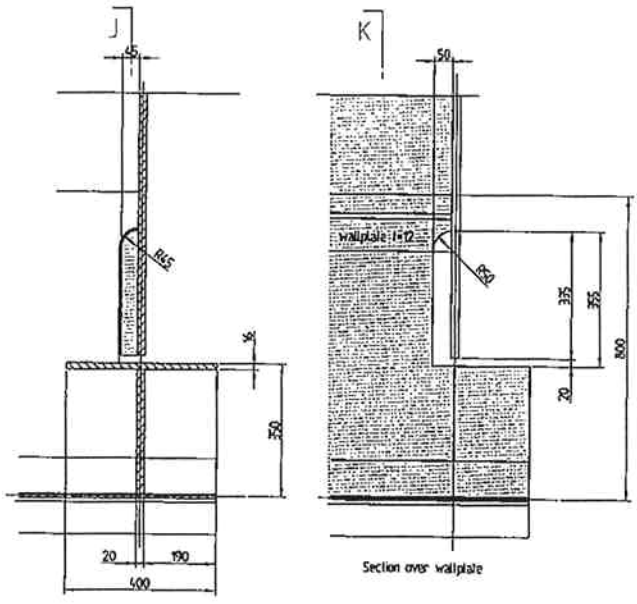
$20 \times 200 + 5 \times 335 = 5675 \text{ mm}^2$

hence; leakage area:

Corners : $2 * 5675 = 11350$

hor. split: $\frac{1}{2} \cdot 54 \times 10^3 \times 1 = 27000$ +

38350 mm^2



leakage :

$\Delta h = 2\ m$ (average)

$t = 20\ min$ (time of max. fall during lockcycle)

$A_{lock} = 370 * 50.4 \approx 18700\ m^2$ (surface water)

$A_{leak} = 0.04\ m^2$

$\mu = 0.58$ - flow-parameter

Flow: $q_v = \mu A_v \sqrt{2gh}$

$= 0.58 \cdot 0.04 \cdot \sqrt{2 \cdot 10 \cdot 2}$

$= 0.15\ m^3/s$

Volume / cycle :

$V = q_v \cdot \Delta t = 0.15 * 20 \cdot 60 = 180\ m^3$

rise surface in lock:

$\Delta h = V/A = 180 / 18700 = 10\ mm$

This is near the margin of the accuracy of measuring devices and thus acceptable (impoundage of 100 mm is assumed !)

This amount of leakage has no effect on the waterlevel in the lagoon !

Addendum B Truss connections / nodes

This addendum consists of the structural calculation the truss connections / nodes as indicated in the overview on the next pages.

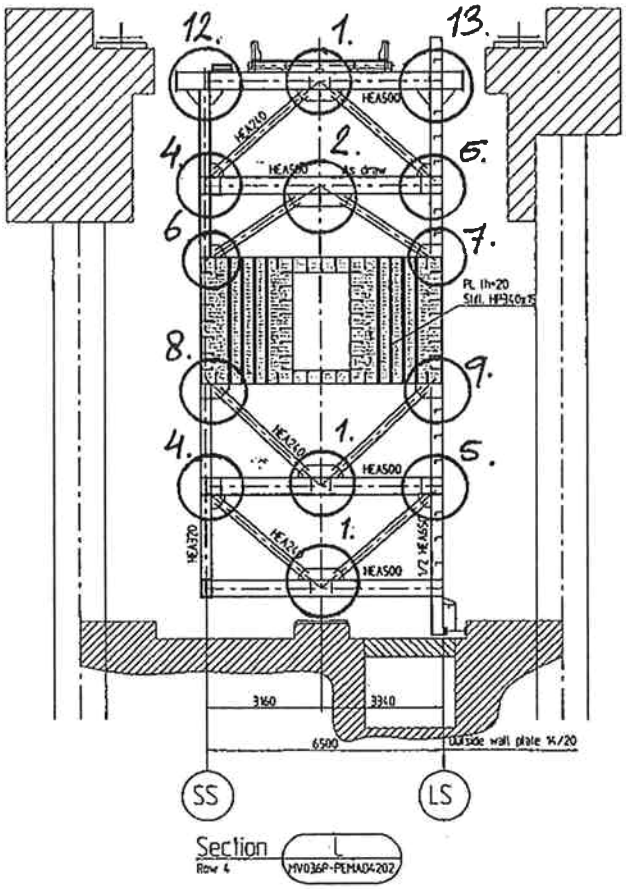
The calculations are based on the governing loads, directly taken from the EPW-model.
During the design-process, the EPW model has been updated several times. Due to model-changes, the calculations in this addendum have been checked for altered loads.
In the calculation the revised forces, and their effects are directly mentioned, indicated with a #.
For details with a significant increase of loading, an alternative check is added.

B1. Truss connections
B2. Check bumperbeam
B3. Welding details

Project : MALAMOCCO LOCK VENICE

Onderdeel : B1: TRUSSCONNECTIONS/NODES.

OVERVIEW DETAILS: ROW (1/8)* 2/3 + 4/5



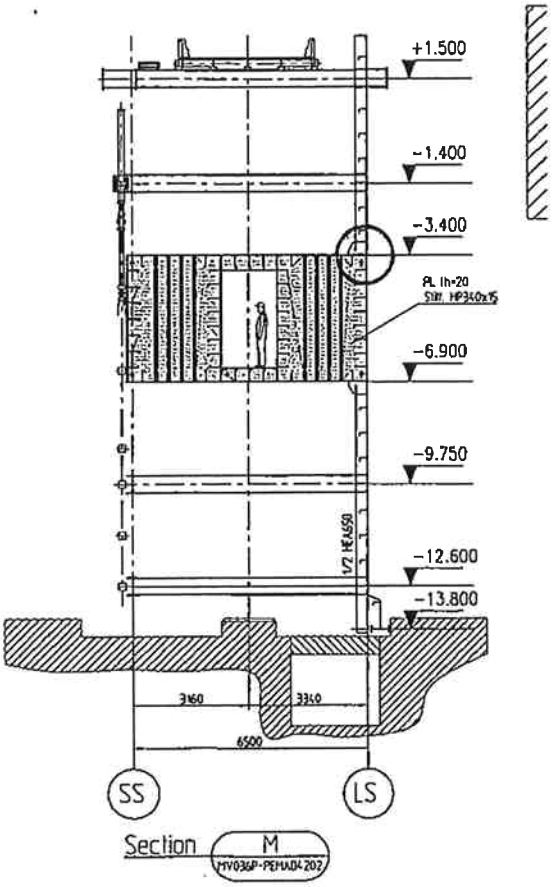
* NOTE: SECTIONS ARE SLIGHTLY DIFFERENT FOR UPPER PART OF STRUCTURE.

Opgesteld : GWJ Datum : 5/04 Bladnummer : B-1 Rev. : A2

Project : MALAMOCCO LOCK VENICE

Onderdeel :

OVERVIEW DETAILS : INTERMIDIATE ROWS

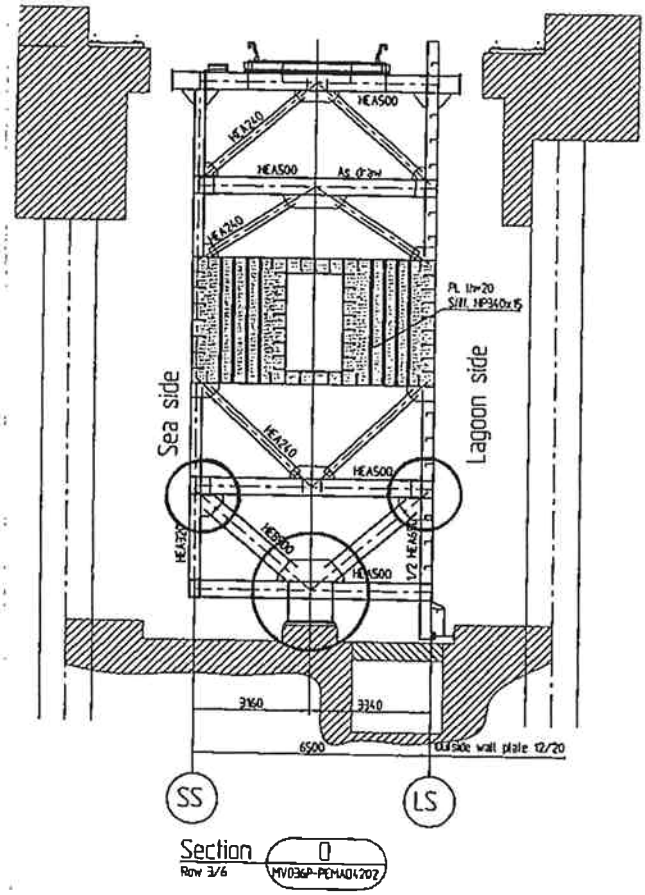


Opgesteld : GWJ Datum : 5/04 Bladnummer : B-2 Rev. : A2

Project : MALAMOCCO LOCK VENICE

Onderdeel :

OVERVIEW DETAILS ROW 3/6:

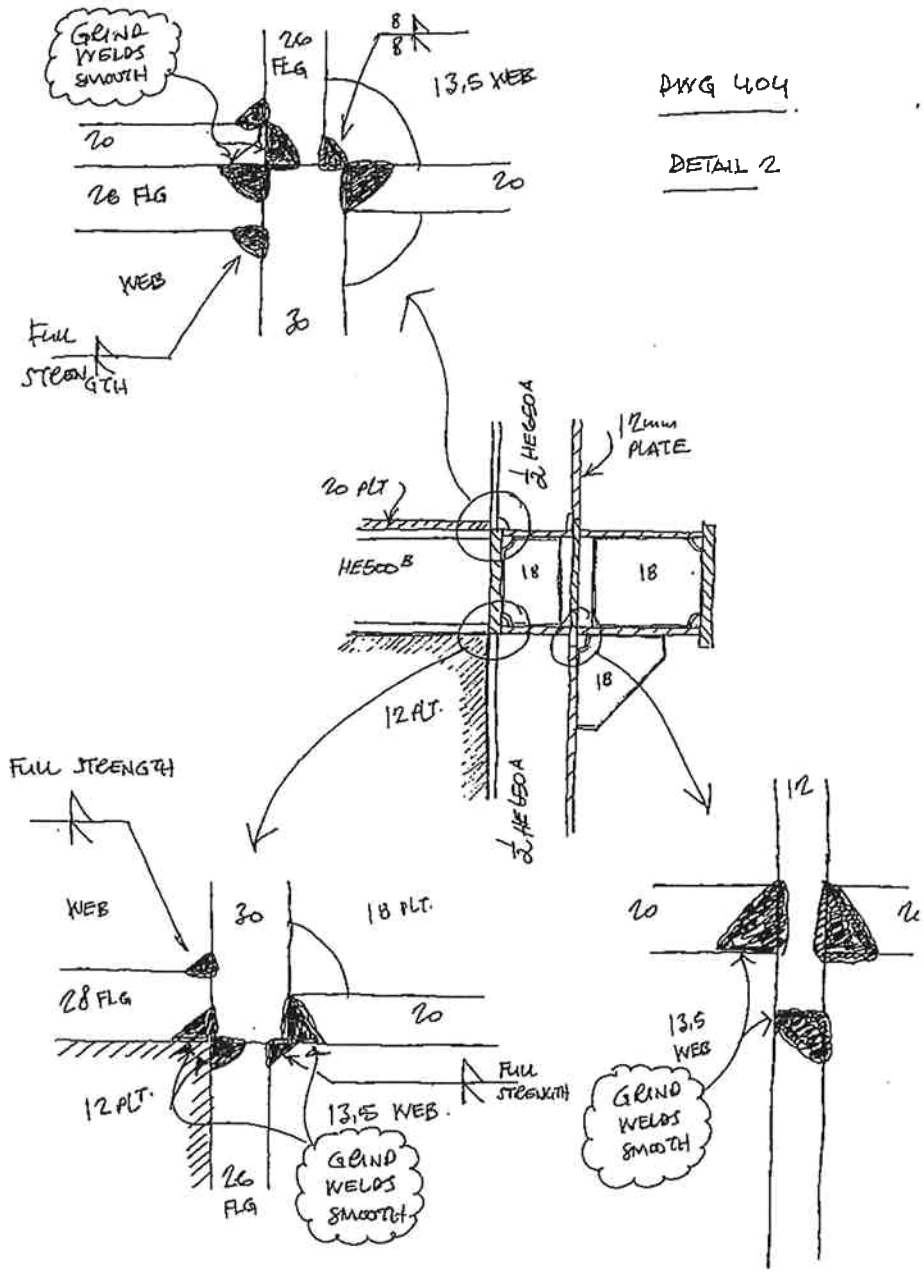


Opgesteld : GWJ Datum : 5/04 Bladnummer : B-3 Rev. : A2

Project : MALAMOCCO NAV. LOCK GATE

Onderdeel :

WELD DETAILS :



Opgesteld : GMJ

Datum : 5-04

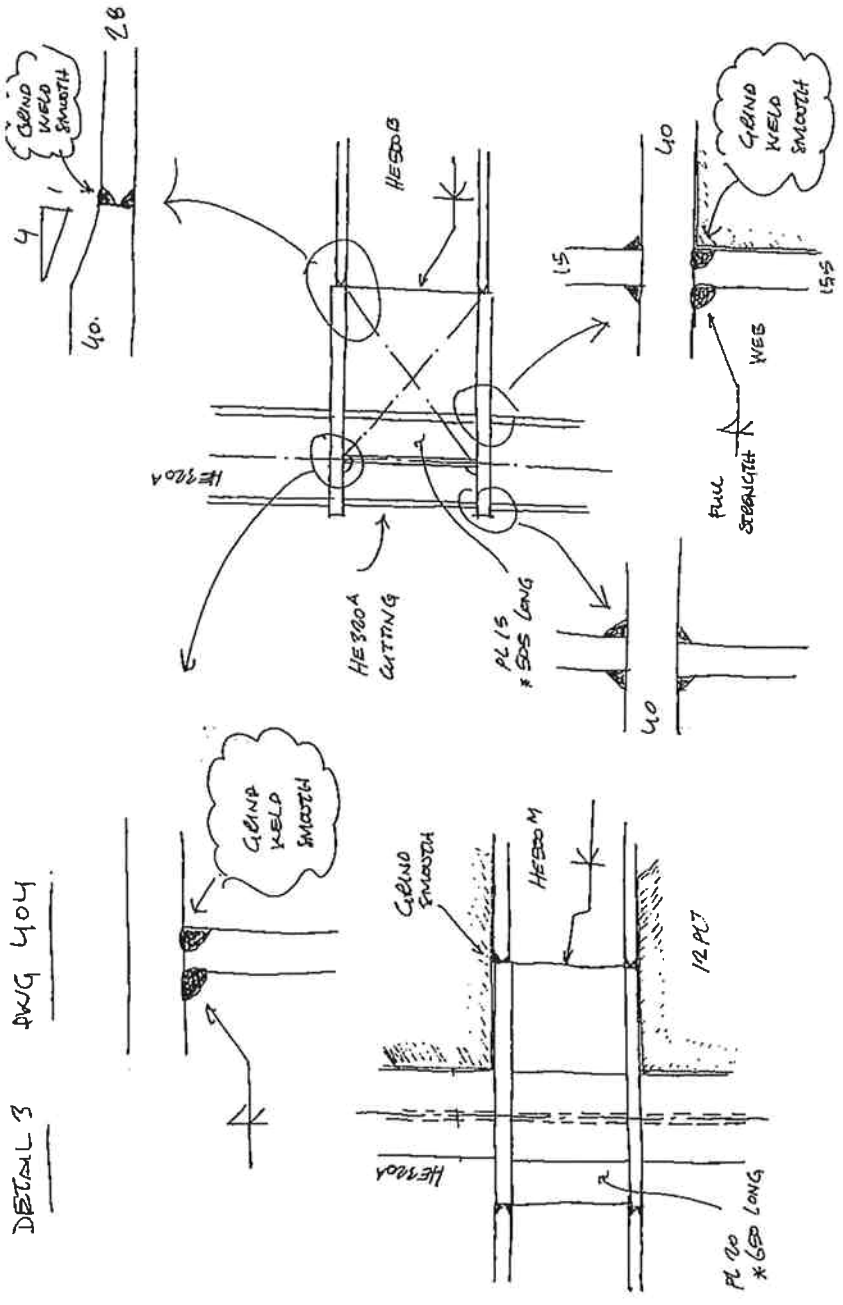
Bladnummer : B-4

Rev. : A2

Project : MALAMOCCO NAV. lock GATE.

Onderdeel :

WELD DETAILS.



Opgesteld : CNJ

Datum : 05-04

Bladnummer : B-5

Rev. : A2

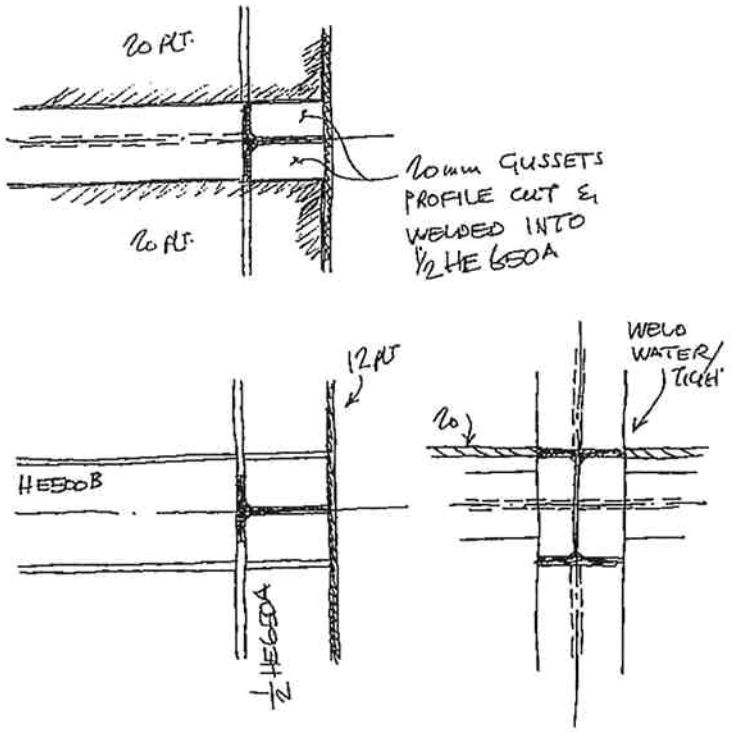
Project : MALAMOCCO NAV. LOCK GATE.

Onderdeel :

WELD DETAILS.

DWG 404.

DET 4.



Opgesteld : GWJ

Datum : 05-'04

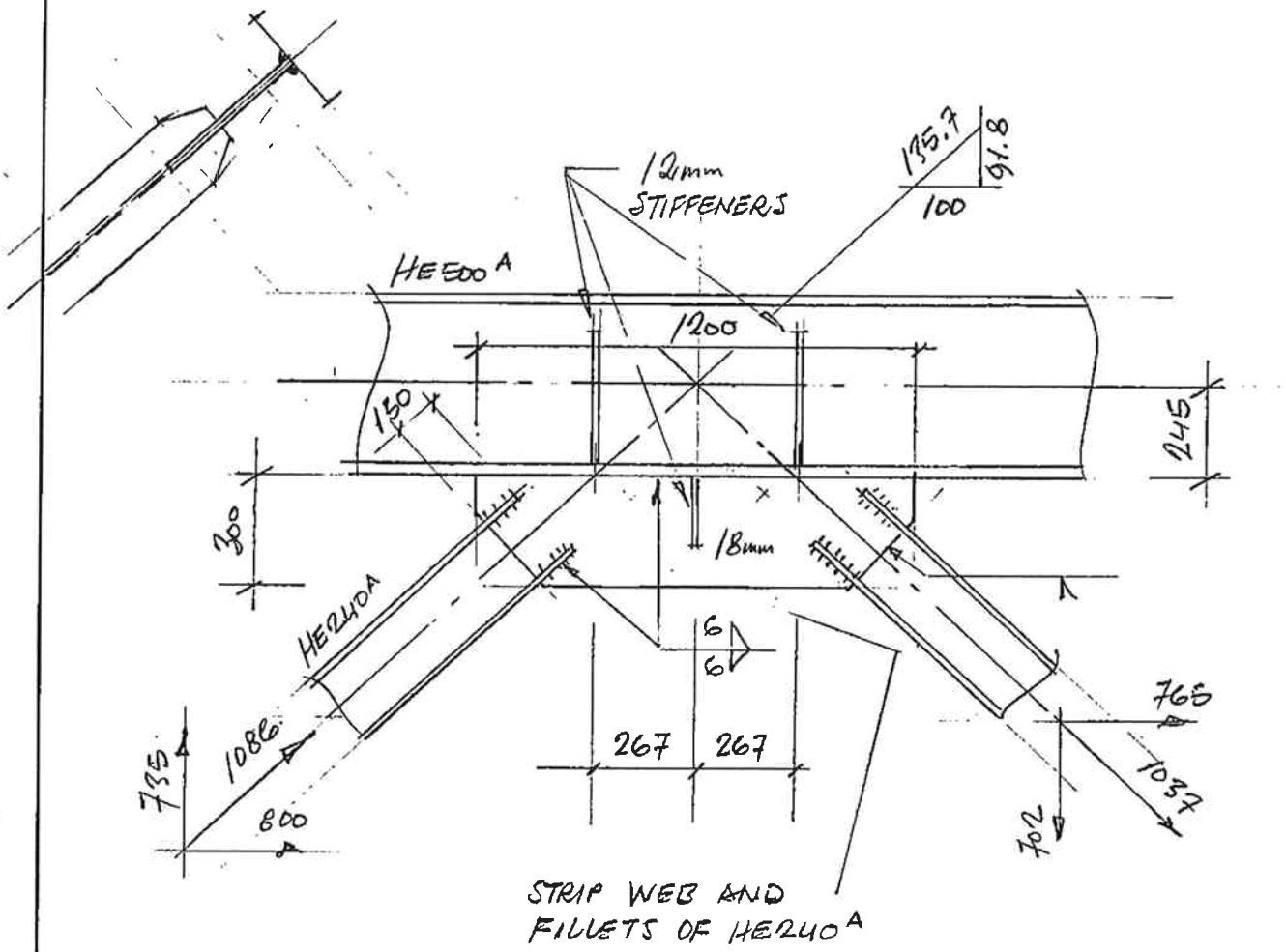
Bladnummer : B-6

Rev. : A2

Project : MALAMOCCO LOCK VENICE.

Onderdeel :

DETAIL 1.



LOADING CONDITION 2 – L1/COMB1 6. GRID LINE B.

MEMBER	N.	N#
371	-1086.	-1101
372	1037	1055

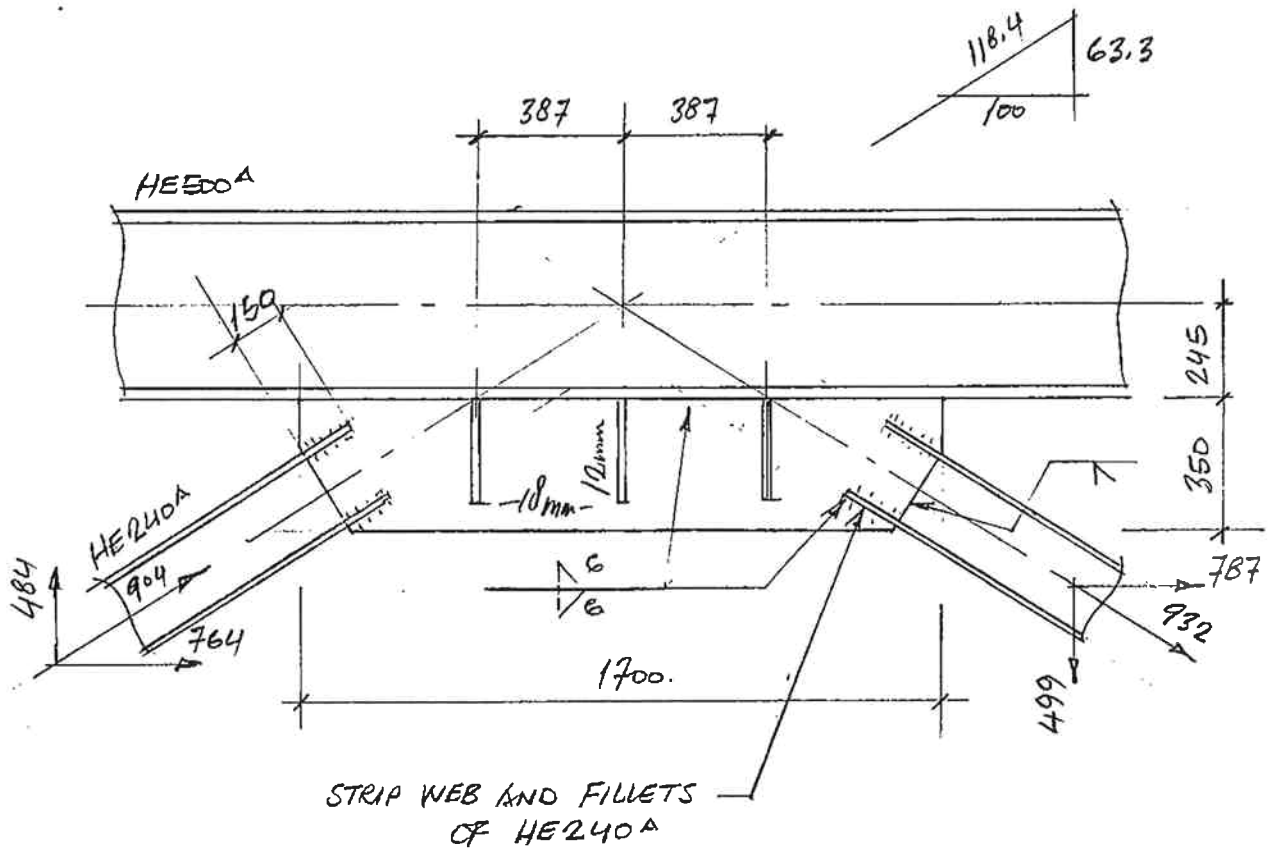
#: acc. most recent EPW-model

Opgesteld : GWJ Datum : 5/04 Bladnummer : B-7 Rev. : A2

Project : MALAMOCCO LOCK VENICE.

Onderdeel :

DETAIL 2



LOADING CONDITION 2 - L/COMBI 6. GRID LINE B.

MEMBER	N.	N#
369	-904	-916
370	932	942

Opgesteld : GWJ | Datum : 5/04 | Bladnummer : B-8 | Rev. : A2

CHECK LOAD TRANSFER

WEB $h_w = 230\,mm$ $t_w = 7.5\,mm$

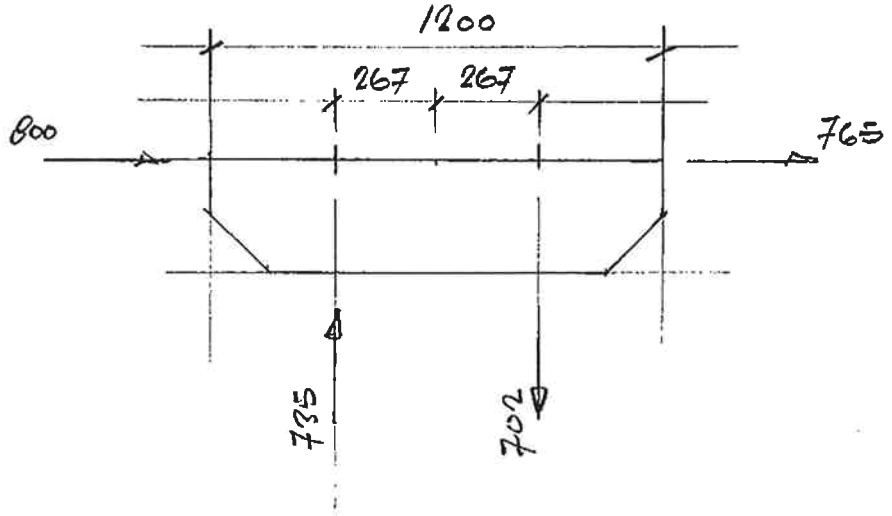
$h_e = 230 * 135.7/91.8 = 340\,mm$

$A_v = 7.5 * 340 = 2550\,mm^2$

$V_{pl,Rd} = 2.55\left(\frac{355}{\sqrt{3}}\right)/1.1 = 475\,kN$

$V_{Sd} = 800\,kN \quad (> 475). \longrightarrow$ NOT ok!

TRY SINGLE GUSSET PLATE.



$V_{Sd} = 800 + 765 = 1565\,kN$

$N_{Sd} = 735 - 702 = 33\,kN$

$M_{Sd} = 0.267(735 + 702) = 384\,kNm$

390

TRY 12 mm PLATE.

Allow 2mm CORROSION → 10mm PLATE.

$A = 10 * 1200 = 12000\ mm^2$

$W = 10 * 1200^2/6 = 2400 * 10^3 mm^3$

$\sigma_v = \frac{1565 * 10^3}{12000} = 131\ N/mm^2$

U.C. $\frac{131.}{355/\sqrt{3} * 1.1} = 0.70 < 1.00 \longrightarrow$ ok

0.71 ; ok.

$\sigma_b = \frac{384 * 10^3}{2400} = 160\ N/mm^2$

U.C. $\frac{160}{355/1.1} = 0.5 < 1.00 \longrightarrow$ ok

COMBINED BENDING AND SHEAR

$\sigma_e = \sqrt{160^2 + 3(131)^2} = 278\ N/mm^2$

U.C. $\frac{278}{355/1.1} = 0,86 < 1.00 \rightarrow$ USE 18mm GUSSET. (PRACTICAL)

0.87 ; Ok.

WELD 18 mm GUSSET TO HE500A

$L_W = 1200$ mm

CONSIDER 1mm STRIP

$W = \frac{1200^2}{6} = 240 * 10^3 mm^3$

SHEAR FORCE PER UNIT LENGTH $= \frac{1565}{1200} = 1.30$ kN/mm

NORMAL FORCE PER UNIT LENGTH $= \frac{384}{240} = 1.60$ kN/mm

RESULTANT FORCE PER UNIT LENGTH $= \sqrt{1.30^2 + 1.60^2} = 2.06$ kN/mm

$a_{REQ} = \frac{2.06 * 10^3}{2 * 262} = 3.9$ mm → USE $a = 6$ mm

WELD HE240A FLANGES TO 18 mm GUSSET.

ASSUME FULL FORCE IS TRANSFERRED THROUGH FLANGES ONLY.

F PER FLANGE $= 1086/2 = 543$ kN

WELD LENGTH $= 150$ mm

SHEAR FORCE PER UNIT LENGTH $= \frac{543}{150} = 3.62$ kN/mm

$a_{REQ} = \frac{3.62 * 10^3}{4 * 262} = 3.5$ mm → USE $a = 6$ mm

CHECK HE500^A WEB.

WEB CRIPPLING. (ART. 5.7.4).

t_w = 10mm (12mm)

t_f = 21mm (23mm).

d = 490 − 2(23 + 27) = 390mm

s_s = 0.2 × 390 = 78mm (EFFECTIVE)

$$R_{s,Rd} = \frac{0.5(10)^2\sqrt{E.f_y}}{1.1 * 10^3} * \left\{\sqrt{\frac{21}{10}} + 3\left(\frac{10}{21}\right)\left(\frac{78}{390}\right)\right\}$$

= 681 kN (< 735). ⟶ NOT ok!

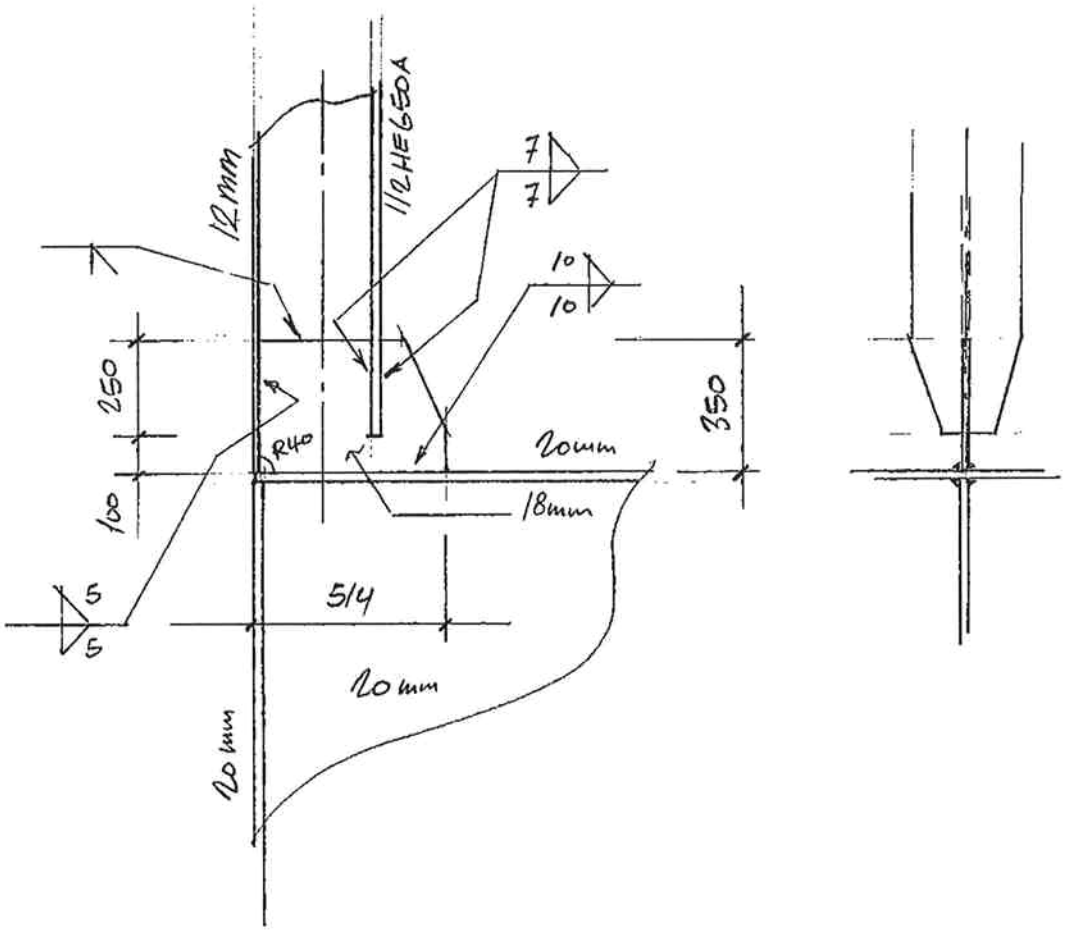
DETAIL 1 : PROVIDE WEB STIFFENERS 120 * 12mm

DETAIL 2 : 681 kN > 499 kN ; SUFFICIËNT.

Project : MALAMOCCO LOCK VENICE

Onderdeel :

DETAIL 3



Opgesteld : GWJ

Datum : 5/04

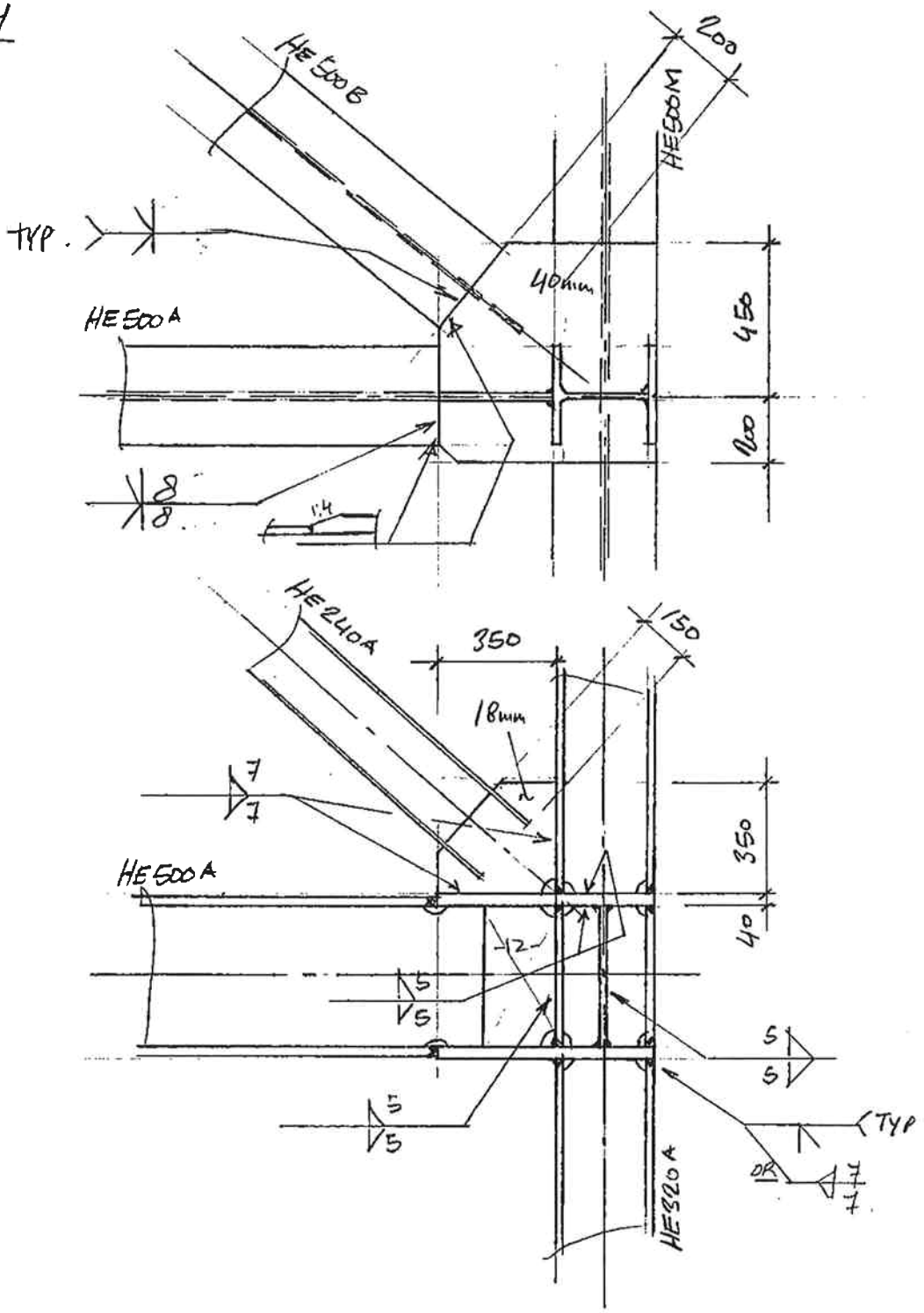
Bladnummer : B-73

Rev. : A2

Project : MALAMOCCO LOCK VENICE

Onderdeel :

DETAIL. 4



Opgesteld : GWJ

Datum : 5/04

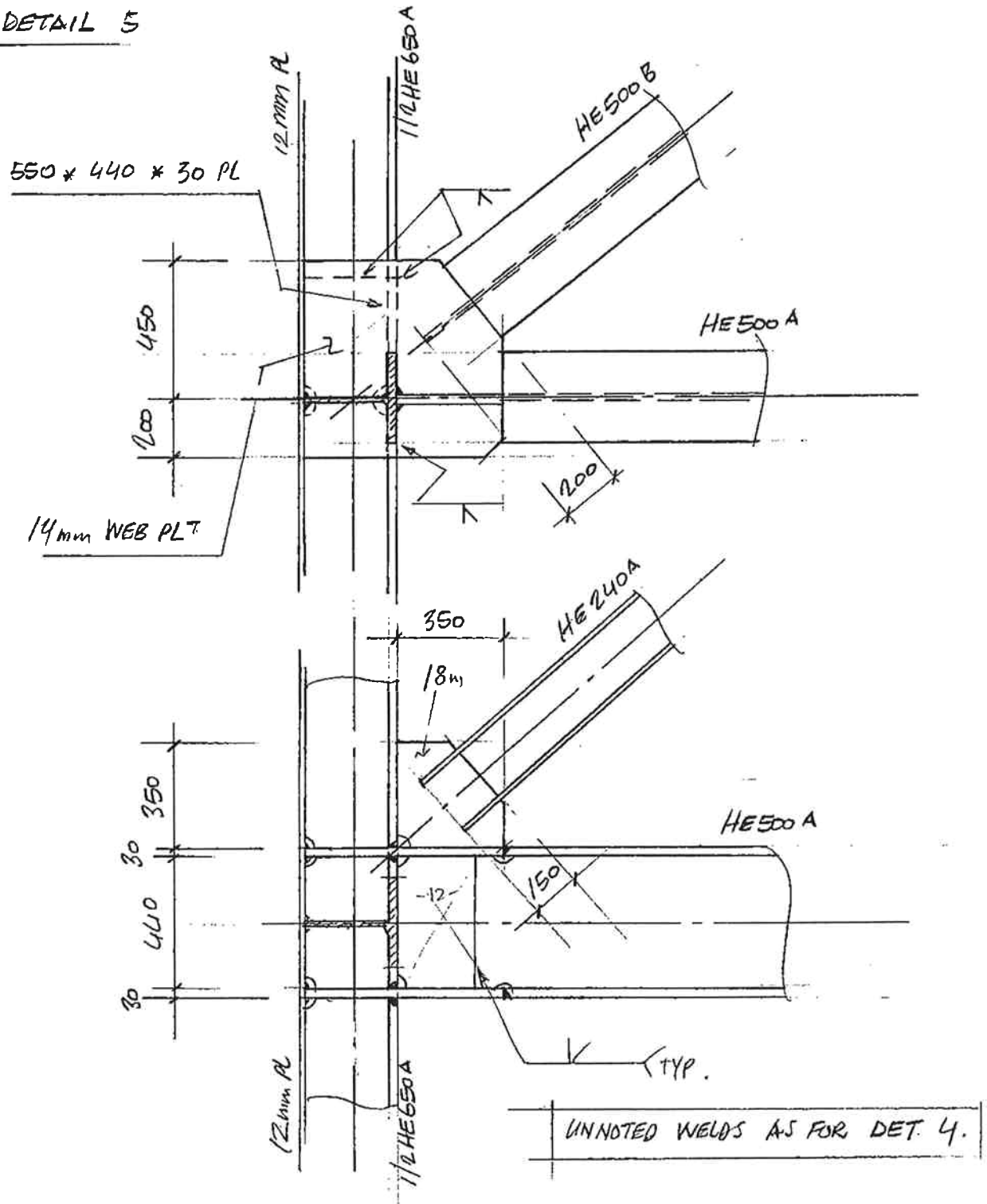
Bladnummer : B-14

Rev. : A2

Project : MALAMOCCO LOCK VENICE

Onderdeel :

DETAIL 5



UNNOTED WELDS AS FOR DET. 4.

Opgesteld : GWJ

Datum : 5/04

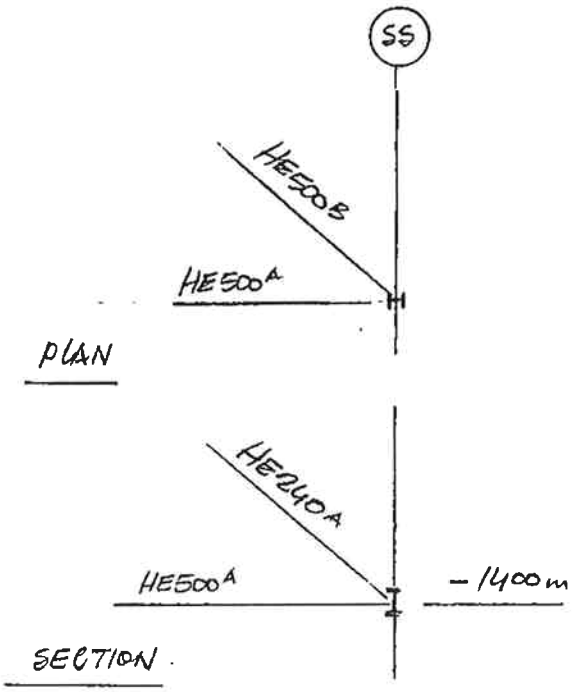
Bladnummer : B-15

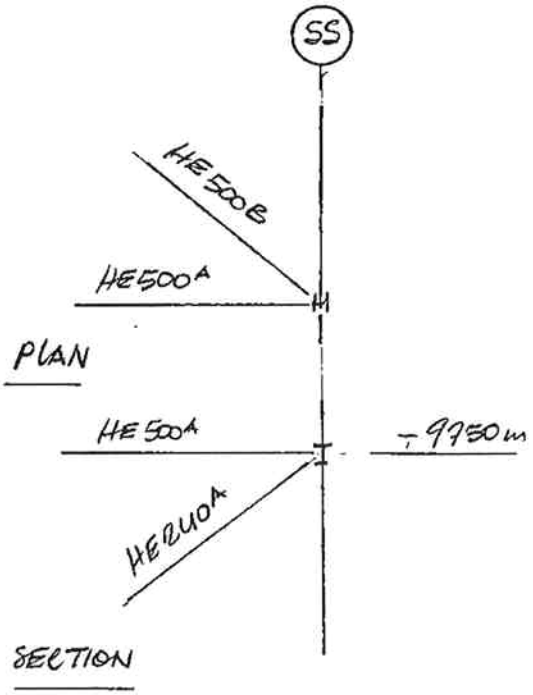
Rev. : A2

Project : MALAMOCCO LOCK VENICE

Onderdeel :

SEA SIDE





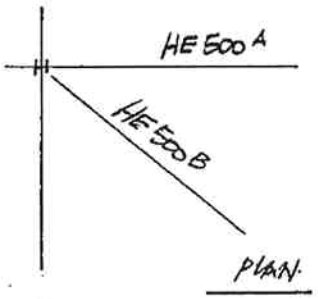
MEMBER	LEVEL	N	#	Vy	#	Vz	#	My	#	Mz
HE500A	-1400m	847	855	1		-43	39	-121	-124	3
		-882	-880	-2		-52	61	-164	171	-5
	-9750m	-469	-535	-2		-31		-65		-7
HE500B	-1400m	1560	1521	2	15	-50		0		0
		-521	-512							
	-9750m	1543	1478	0		10		0		0
		-405	-320							
HE240A	-1400m	1037	1055	0	1	0		0		0
		-1086	-1101							
	-9750m	150	100	2		-22		41		6
		-153	-126							

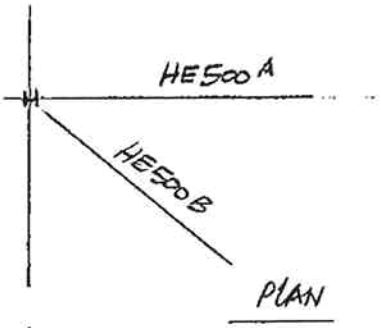
Opgesteld : GWJ Datum : 5/04 Bladnummer : B-16 Rev. : A2

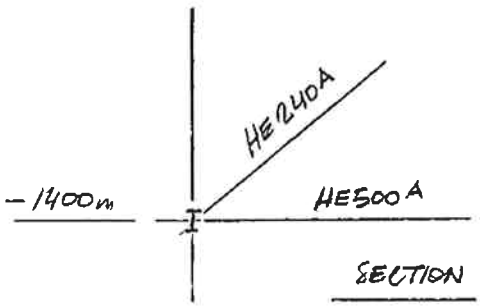
Project : MALAMOCCO LOCK VENICE

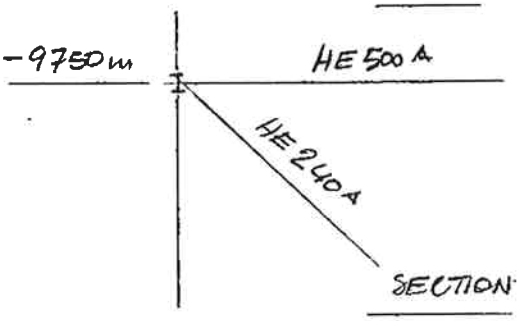
Onderdeel :

LAGOON SIDE









MEMBER	LEVEL	N		Vy		Vz		My		Mz	
			#		#		#		#		#
HE500A	-1400m	685	706	-2		62		-185	-189	6	
		-534	-490	-15	-17	-106	-105	73	70	13	16
	-9750m	787	820	0		7	8	2	4	1	
		-420	-367	4		9		-15	-14	15	-14
HE500B	REFER	TO		SEA		SIDE					
HE240A	"	"		"		"					

No essential changes, u.c.'s remain < 1.0

Opgesteld : GWJ Datum : 5/04 Bladnummer : B-17 Rev. : A2

HE 500 B DIAGONAL.

MAX FORCE N_{Sd} = 1566 kN (L/COMBI 10).

ASSUME FORCE TRANSFERRED THROUGH FLANGES ONLY.

B = 300 mm t_f = 28 mm

$A_f = 2 * 26 * 298 = 15496 \text{ mm}^2$

$N_{Rd} = 15,5 * 355/1,1 = 5002$ kN. (> 1566) → ok

WELD HE500B TO 40 mm GUSSET.

USE PARTIAL PENETRATION K- WELDS.

FORCE PER FLANGE = $\frac{1566}{2}$ = 783 kN → 800 kN.

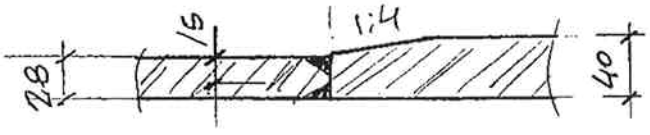
FORCE PER UNIT LENGTH = $\frac{800}{300}$ = 2,67 kN/mm

$a_{REQ} = \frac{2,67 * 10^3}{2 \cdot 262} = 5,1$ mm

a_{NOM} = 5 + 2 + 1 (CORROSION) = 8 → USE a = 8 mm

WELD RESISTANCE = $2.8 * 300 * 262 * 10^{-3}$ = 1257 kN

u.c. = 0,64.



HE240A DIAGONAL.

MAX FORCE – 1086 kN

ASSUME FORCE TRANSFERRED THROUGH FLANGES ONLY.

$B = 240\,mm \qquad t_f = 12\,mm$

$A_f = 2 * 10 * 238 = 4760\,mm^2$ (CORRODED).

$N_{Rd} = 4.76 * 355/1.1 = 1536\,kN \quad (> 1086) \qquad 0.71$

WELD HE240A FLANGES TO GUSSET

$L_w = 150\,mm$

SHEAR FORCE PER UNIT LENGTH $= \frac{1086}{150} = 7.24\,kN/mm$

$a_{REQ} = \frac{7.24 * 10^3}{8 * 262} = 3.5\,mm \longrightarrow$ USE $a = 5mm$

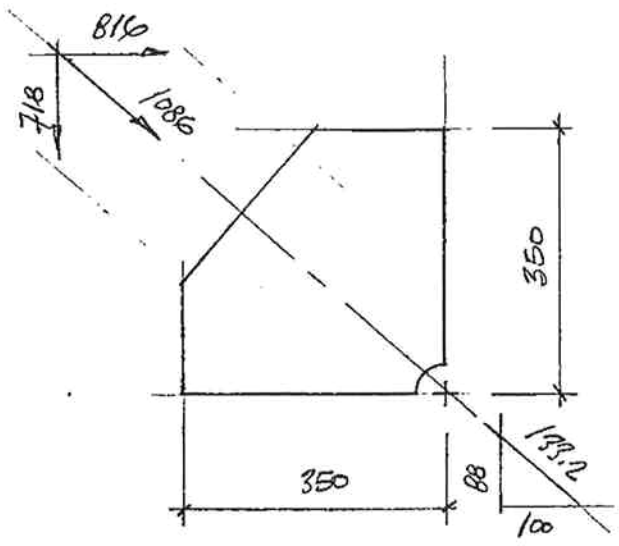
GUSSET PLATE.

MAX SHEAR = 816 kN

$t_{REQ} = \frac{816 * 10^3 * \sqrt{3} * 1.1}{310 * 355}$

$= 14.1\,mm$

USE $t = 18mm$



/8mm GUSSET MAX FORCE

$$V_{Rd} = \frac{16 * 308 * 355}{\sqrt{3} * 1.1 * 10^3} = 918\ kN \qquad U.C\ 0,89$$

WELD GUSSET PLATE TO FRAME

$L_W = 310\ mm$

SHEAR FORCE PER UNIT LENGTH = $\frac{816}{310} = 2,63\ kN/mm$

$$a_{REQ} = \frac{2,63 * 10^3}{2 * 262} = 5,0\ mm \longrightarrow$$ USE $a = 7mm$ WELDS.

WELD MAX FORCE

$$V_{Rd} = 2 * 6 * 308 * 262 * 10^{-3} = 968\ kN \qquad U.C\ 0,84$$

HE500A TRANSVERSAL.

MAX FORCES $N_{Sd} = 882$ kN
$M_{y,Sd} = 164$ kNm } L/COMB1 G.

ADDITIONAL MOMENT THROUGH ECCENTRICITY $e = 118$ mm

$$M = 1037 * \frac{100}{133.2} * 0.118 = 92 \text{ kNm}$$

$$M_{y,Sd} = 164 + 92 = 256 \text{ kNm}$$

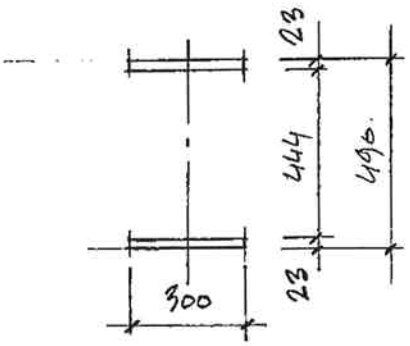
ASSUME FORCES TRANSFERRED THROUGH FLANGES ONLY.

$B = 300$ mm $t_f = 23$ mm

$$A_f = 2 * 23 * 300 = 13800 \text{ mm}^2$$

$$W_f = \frac{300(490^3 - 444^3)}{6(490)}$$

$$= 3073 * 10^3 \text{ mm}^3.$$



$$\sigma_a = \frac{882 * 10^3}{13800} + \frac{256 * 10^3}{3073}$$

$$= 64 + 84 = 148 \text{ N/mm}^2 < \frac{355}{1.1} = 322 \text{ N/mm}^2$$

U.C. 0.46.

WELD HE500A TO 40mm GUSSET.

TRY. PARTIAL PENETRATION BUTT WELDS

FORCE PER FLANGE $= \frac{882}{2} + \frac{256.}{0.467} = 441 + 549 = 990$ kN.

FORCE PER UNIT LENGTH $= \frac{990}{300} = 3.3$ kN/mm

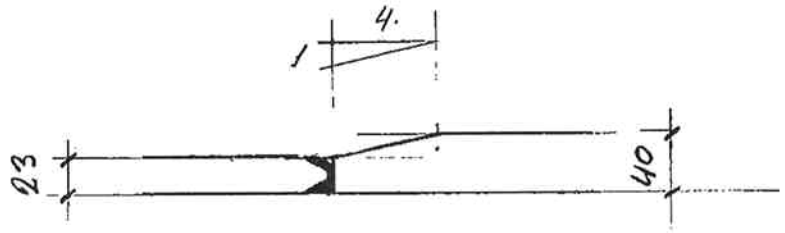
$a_{REQ} = \frac{3.3 * 10^3}{2 * 262} = 6.3$ mm

$a_{NOM} = 7 + 2 + 1$ (CORROSION) $= 10$ mm

USE FULL PENETRATION WELDS.

WELD RESISTANCE $= 2 * 21 * 300 * 262 * 10^{-3} = 3301$ kN

U.C. 0.3.



Project : MALAMOCCO LOCK VENICE

Onderdeel :

HE 320 A column section (sea side)

MAX LOADS

L/combi	N		V_y		V_z		M_y		M_z	
		#		#		#		#		#
Cond 3 : 2	635	620	86	85	+46	-46	48	-42	-86	85
2	-989	-1000	-26	-23	43	48	-57	-64	25	25
10	-175	-158	-5	3	233	260	352	397	2	-6
2	271	201	94	-28	10	-4	0	-4	-93	-60

No relevant changes; u.c.'s remain < 1.0

WEB SHEAR

t_w = 9 mm (calc. 7 mm) h_w = 225 mm

MAX V_z SHEAR = 233 kN

$$V_{Rd} = \frac{7 * 199 * 355}{\sqrt{3} * 1.1 * 10^3} = 260 \text{ kN} \qquad \text{u.c. } 0,89$$

DUE TO MINOR CHANGE IN MODEL. V_z = 260 kN.

u.c. = 1,0

WELD WEB

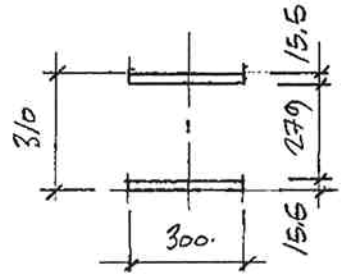
L_w = 199 mm

SHEAR FORCE PER UNIT LENGTH = $\frac{233}{199}$ = 1,17 kN/mm

USE a = 5 mm WELD.

Opgesteld : GWJ Datum : 5/04 Bladnummer : B-23. Rev. : A2

FLANGE STRESS.



$A_f = 2(15,5 * 300) = 9300\ mm^2$

$W_{fy} = \frac{300(310^3 - 279^3)}{6(310)}$

$= 1302 * 10^3\ mm^3$

$W_{fz} = \frac{2 * 15,5 * 300^2}{6}$

$= 465 * 10^3\ mm^3.$

FOR MAXIMUM $N_{Sd.} = -989\ kN$

$V_{z\,Sd} = 43\ kN$

$M_{y\,Sd} = -57\ kNm$

$M_{z\,Sd} = 25\ kNm$

$\sigma_a = \frac{989 * 10^3}{9300} + \frac{57 * 10^3}{1302} = 107 + .44 = 151\ N/mm^2$

$\sigma_b = \frac{25 * 10^3}{465} = 54\ N/mm^2$

$\tau = \frac{43 * 10^3}{9300} = 5\ N/mm^2$

$\sigma_e = \sqrt{151^2 + 54^2 - (151)(54) + 3(5)^2} = 133\ N/mm^2 < \frac{355}{1.1}$

U.C. 0.41

		DUE TO MINOR CHANGE IN MODEL:
FOR MAXIMUM	$M_{y\,Sd} = 352$ kNm	397 kNm
	$N_{Sd} = -175$ kN	-158 kN
	$V_{y\,Sd} = -5$ kN	3 kN
	$M_{z\,Sd} = 2$ kNm	-6 kN.

$$\sigma_a = \frac{175 * 10^3}{9300} + \frac{352 * 10^3}{1302} = 19 + 271 = 290\ N/mm^2 \quad (322\ N/mm^2)$$

$$\sigma_b = \frac{2 * 10^3}{465} = 5\ N/mm^2 \quad (13\ N/mm^2)$$

$$\tau = \frac{5 * 10^3}{9300} = 1\ N/mm^2 \quad (0{,}3\ N/mm^2).$$

$$\sigma_e = \sqrt{290^2 + 5^2 - (290)(5)} = 288\ N/mm^2 < \frac{355}{1.1}$$

$(316\ N/mm^2)$ u.c.= 0,98

FOR MINIMUM $N_{Sd} = 635$ kN

$V_{y\,Sd} = 86$ kN

$M_{y\,Sd} = 48$ kNm

$M_{z\,Sd} = -86$ kNm

$$\sigma_a = \frac{635 * 10^3}{9300} + \frac{48 * 10^3}{1302} = 69 + 37 = 106\ N/mm^2$$

$$\sigma_b = \frac{86 * 10^3}{465} = 185\ N/mm^2$$

$$T = \frac{86 * 10^3}{9300} = 10\ N/mm^2$$

$$\sigma_e = \sqrt{106^2 + 185^2 + (106)(185) + 3(10)^2} = 256\ N/mm^2$$

$$U.C. \quad \frac{256}{355/1.1} = 0,79$$

HEB50A TEE COLUMN SECTION (LAGOON SIDE)

MAX LOADS.

C/COMBI		N		V_y		V_z		M_y		M_z	
CONDITION			#		#		#		#		#
3	2	869	893	3	3	-63	-61	+107	-103	5	4
1/2	10	-1430	-1567	0	0	125	-341	-118	-150	0	0
1/2	3	-104	-113	16	17	15	13	16	14	19	20
1/2	10	-452	-243	7	13	307	84	73	-116	12	22
4	11	-156		3		86		+215		-4	
3	1	-245	-243	13	13	-84	-84	-117	-116	22	22

No relevant changes, max u.c. see B 28

WEB SHEAR

$t_w = 11,5$ mm $\quad h_w = 267$ mm

MAX V_z SHEAR $= 307$ kN

$$V_{Rd} = \frac{11,5 * 267 * 355}{\sqrt{3} * 1.1 * 10^3} = 571 \text{ kN} \quad \text{u.c. } 0,54.$$

WELD WEB $\quad L_w = 267 - 40 = 227$ mm

SHEAR FORCE PER UNIT LENGTH $= \frac{307}{227} = 1,35$ kN/mm

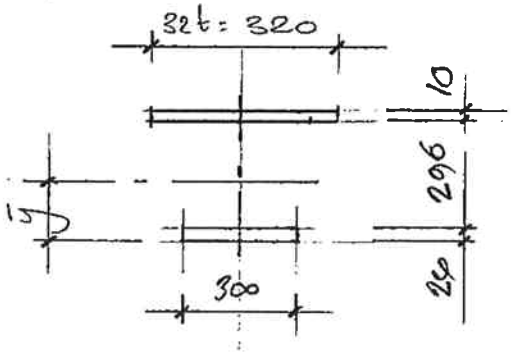
$$a_{REQ} = \frac{1,35 * 10^3}{2 * 262} = 2,6 \text{ mm}$$

USE a = 5 mm WELDS

Project : MALAMOCCO LOCK VENICE

Onderdeel :

FLANGE STRESS



$A_f = 24 * 300 = 7200$
$10 * 320 = 3200$
$10400\ mm^2$

$\bar{y} = 110$ mm

I_f $320 * 10^3/12$
$3200(215)^2$
$300 * 2^3/12$
$7200(110-12)^2$
$21744 * 10^4\ mm^4$

$W_{f14} = \frac{21744 * 10^4}{220} = 988 * 10^3\ mm^3$

$W_{f26} = \frac{21744 * 10^4}{770} = 1977 * 10^3\ mm^3$

MAXIMUM $N_{Sd} = -1430$ kN. $M_{ySd} = -118$ kNm

$\sigma_a = \frac{1430 * 10^3}{10400} + \frac{118 * 10^6}{988 \cdot 10^3} = 138 + 120 = 258\ N/mm^2$

$M_{zSd} = 0$ $V_{ySd} = 0$ u.c = 258 · 1.1/355 = 0,80

o.k.

** DUE TO MINOR CHANGE IN MODEL :

$M_{y;sd} = -150$ kNm

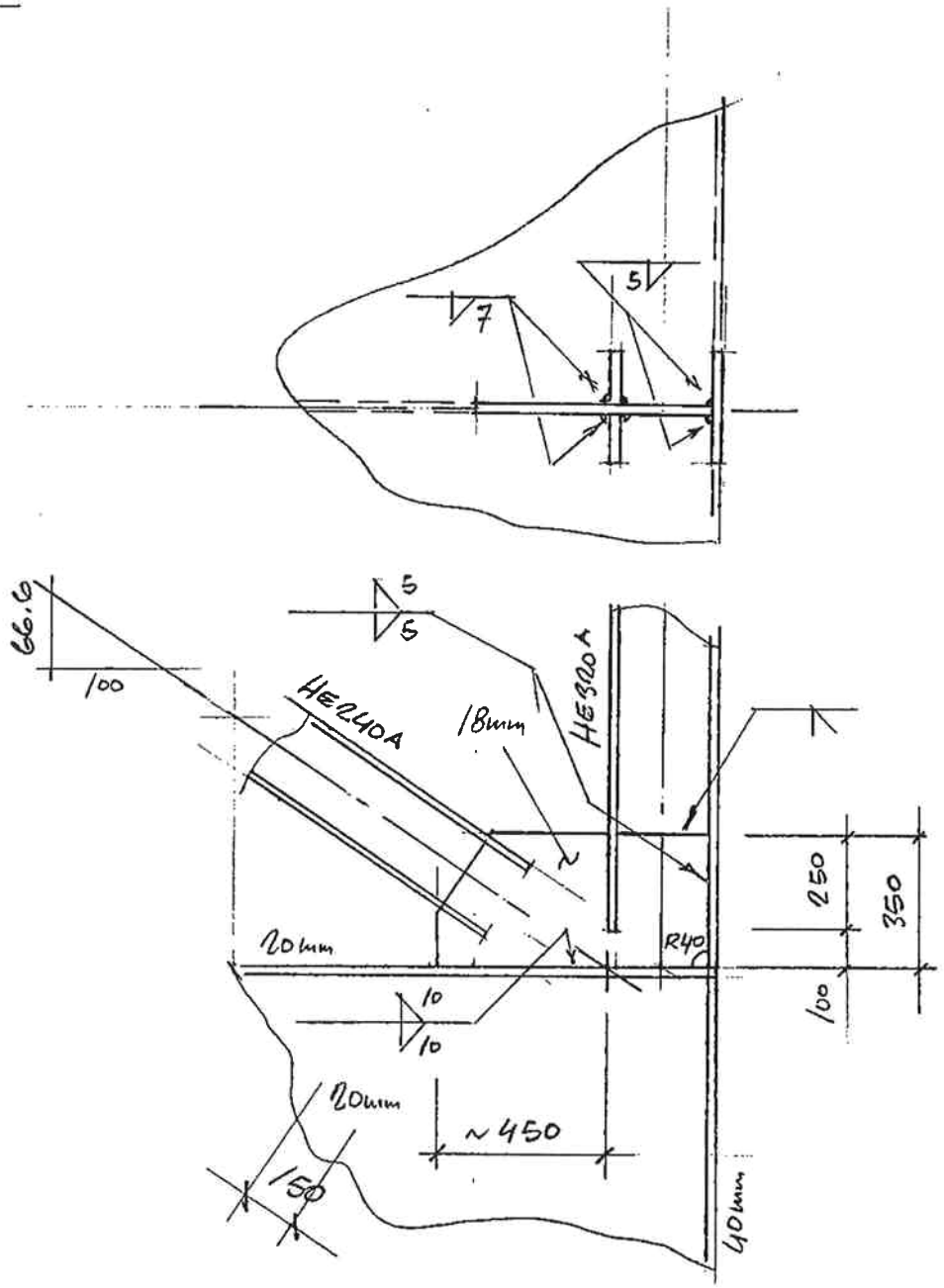
$N_{Sd} = -1567$ kN M.C. = 0,94

Opgesteld : GWJ Datum : 5/04 Bladnummer : B-28 Rev. : A2

Project : MALAMOCCO LOCK VENICE

Onderdeel :

DETAIL. 6



Opgesteld : GWJ

Datum : 5/04

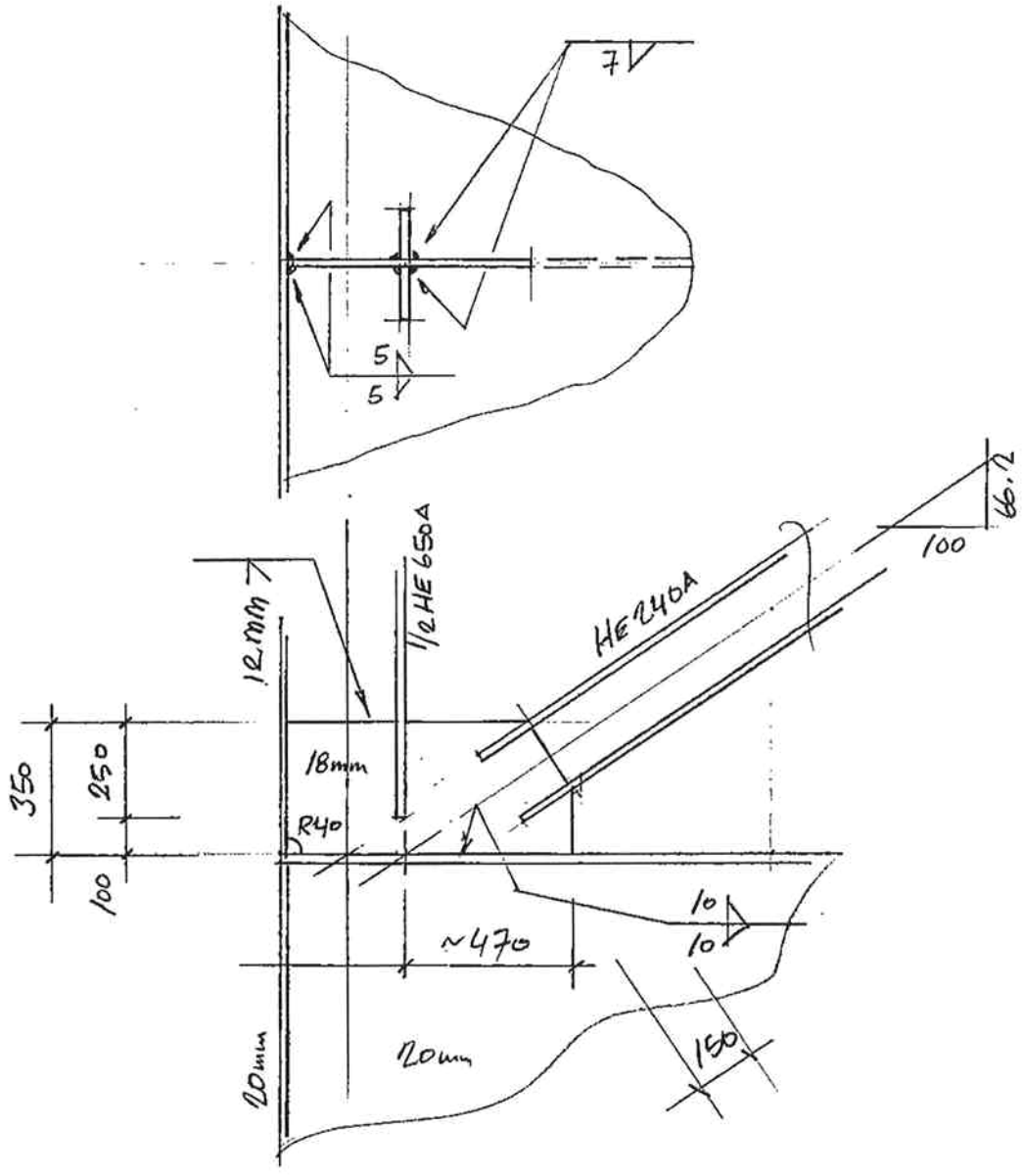
Bladnummer : B-29. A2

Rev. :

Project : MALAMOCCO LOCK VENICE

Onderdeel :

DETAIL 7



Opgesteld : GWJ

Datum : 5/04

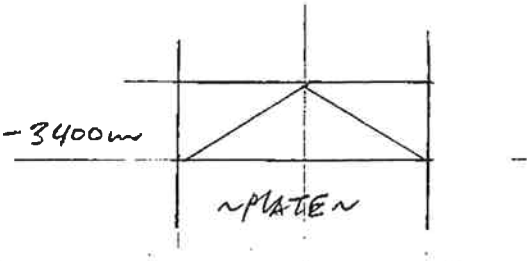
Bladnummer : B-30

Rev.: A2

Project : MALAMOCCO LOCK VENICE

Onderdeel :

LEVEL - 3400.



LOAD COND.	MEMB. TYPE.	MEMB. NO.	L/C	N	Vy	Vz	My	Mz
1.	GRID LINE 1			#		#	#	#
		345	13	180	-1	-3	-4	-2
		346	13	136	0	0	0	1
	GRID LINE 4							
		385	10	-433 | -444	0	15 | 15	-40 | -40	-1
		386	10	444 | 455	0	-28 | -32	36 | 41	0
	GRID LINE 6							
		377	10	-447 | -459	0	16 | 15	-41 | -40	0
		378	10	471 | 477	0	-29 | -28	37 | 42	0
	GRID LINE B							
		369	10	-447 | -459	0	16 | 15	-41 | -40	0
		370	10	471 | 477	0	-29 | -33	37 | 42	0
	GRID LINE 10							
		361	10	-433 | -444	0	15 | 15	-40	1
		362	10	444 | 453	0	-28 | -32	36 | 41	0
	GRID LINE 13							
		409	13	179	1	-3	-4	2
		338	13	136.	0	0	0	1

Opgesteld : GWJ Datum : 5/04 Bladnummer : B-37 Rev. : A2

Project : MALAMOCCO LOCK VENICE

Onderdeel :

LEVEL - 3400

LOAD COND.	MEMB. TYPE.	MEMB. NO	L/C	N	Vy	Vz	My	Mz
2	GRID LINE 1			#	#	#	#	#
		345	3	418 | 407	-2	-5 |	-9	-5
		346	3	303 | [illegible]	1	-4 | -5	-8	2
	GRID LINE 4							
		385	6	-391 | -403	0	7 |	-19 |	-1 |
		386	6	388 | 397	1	-13 | -17	18 | 410	0 | 3
	GRID LINE 6.							
		377	6	-904 | -916	0	7 |	-21 |	0 |
		378	6	932 | 940	0	-14 | -18	21 | -41	0 | 1
	GRID LINE B.							
		369	6	-904 | -916	0	7 |	-21 |	0 |
		370	6	932 | 940	0	-14 | -18	21 | -41	0 | -1
	GRID LINE 10							
		361	6	-391 | -403	0	7 |	-19 |	1 |
		362	6	388 | 397	-1	-13 | -17	18 | -40	0 | -3
	GRID LINE 13							
		409	3	409 | 396	3	-6	-8	7
		338	3	223 | 236	0	-5	-9	-1

Opgesteld : GWJ Datum : 5/04 Bladnummer : B-32 Rev. : A2

Project : MALAMOCCO LOCK VENICE

Onderdeel :

LEVEL - 3400 m

LOAD COND.	MEMB. TYPE.	MEMB. NO.	L/C	N	Vy	Vz	My	Mz
3	GRID LINE 1.			*	*	*	*	*
		345	4	343 | 335	-2	-5	-8	-5 |
		346	2	637 | 620	0	-6	-12	1 | 2
	GRID LINE 4							
		385	2	136 | 148	0	1 | 3	2 | -5	-2 |
		386	2	-126 | -141	-2	-2 | -1	-2 | -2	-4 | -5
	GRID LINE 6							
		377	2	644 | 655	0	3 | 3	-7 |	0
		378	2	-650 | -662	-1	-1 | 0	-2 | -1	-2 | -1
	GRID LINE B							
		369	2	644 | 655	0	3 | 3	7 |	0 |
		370	2	-650 | -661	1	-1 | 2	-2 | -3	2 | -1
	GRID LINE 10							
		361	2	136 | 148	0	1 | 3	2 | -5	2 |
		362	4	-148 | -147	1	-1 |	-1 | -1	2 | 3
	GRID LINE 13.							
		409	4	238 | 225	2 | 1	-4 | -3	-5 | -4	4
		338	2	637 | 620	0	-6 |	-12 |	-1.

Opgesteld : GWJ Datum : 5/04 Bladnummer : B-33. Rev. : A2

Project : MALAMOCCO LOCK VENICE

Onderdeel :

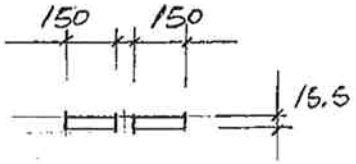
WELD HE320A TO 18mm GUSSET.

CONDITION	MEMBER	L/combi	N	Vy	Vz	My	Mz	APPENDIX
3	111.	2	-995	24	44	-57	-24.	E
1	107	10	-189.	-3.	-228	349.	1.	C

ASSUME AXIAL FORCE & My TRANSFERRED THROUGH FLANGES ONLY

t_f = 15,5mm (13.5 CORRODED)

$A_f = 2 \times 13,5 * 149 = 4023\ mm^2$



$$\text{FLANGE FORCE} = \frac{995}{2} + \frac{57}{0.295}$$

$$= 691\ kN$$

$$\text{OR} = \frac{189}{2} + \frac{349}{0,295}$$

$$= 1278\ kN.$$

$$\sigma = \frac{1278 * 10^3}{4023} = 318\ N/mm^2 < \frac{355}{1.1} \quad \text{u.c. } 0,99$$

WELD FLANGE TO GUSSET L_w = 250 mm

$$\text{SHEAR PER UNIT LENGTH} = \frac{1278}{250} = 5,1\ kN/mm$$

$$a = \frac{5.1 * 10^3}{4 * 262} = 4,9\ mm \longrightarrow \boxed{\text{USE } a = 7mm \text{ WELD}}$$

Opgesteld : GWJ Datum : 5/04 Bladnummer : B-34. Rev. : A2

Project : Malamocco Lock Venice

Onderdeel : #Re-check of gusset

* DUE TO MINOR CHANGE IN MODEL :

	CONDITION	MEMBER	L/combi	N	Vy	Vz	My	Mz
#	1	107	10	-158	3	-260	397	-6.

- PROFIL HE320 A.

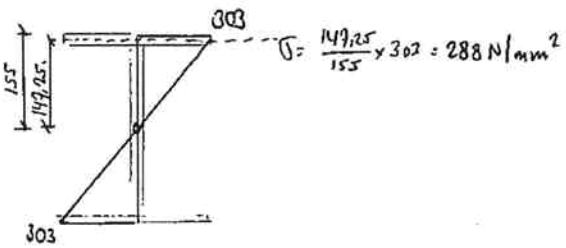
$I_y = 22929 \cdot 10^4 \ mm^4$

$I_{corroded} = 2\left(300 \times 2\right) \times \left(\frac{310-15,5}{2}\right)^2 = 2602 \cdot 10^4 \ mm^4$

$I_{HE320A;corroded} = 22929 \cdot 10^4 - 2602 \cdot 10^4 = 20327 \cdot 10^4 \ mm^4$

$W_{y;HE320;corroded} = \frac{I}{e} = \frac{20327 \cdot 10^4}{155} = 1311 \cdot 10^3 \ mm^3.$

e = h/2 = 310mm = 155 mm



STRESS DUE TO My:

$\sigma = \frac{M}{W} = \frac{397 \cdot 10^6}{1311 \cdot 10^3} = 303 \ N/mm^2$

STRESS DUE TO N

$\sigma = \frac{N}{A} = \frac{158 \cdot 10^3}{4023} = 39 \ N/mm^2$

A = Ap ; SEE PAGE B-34 : 4023 mm^2

$\sigma = 288 + 39 = 329 \ N/mm^2$

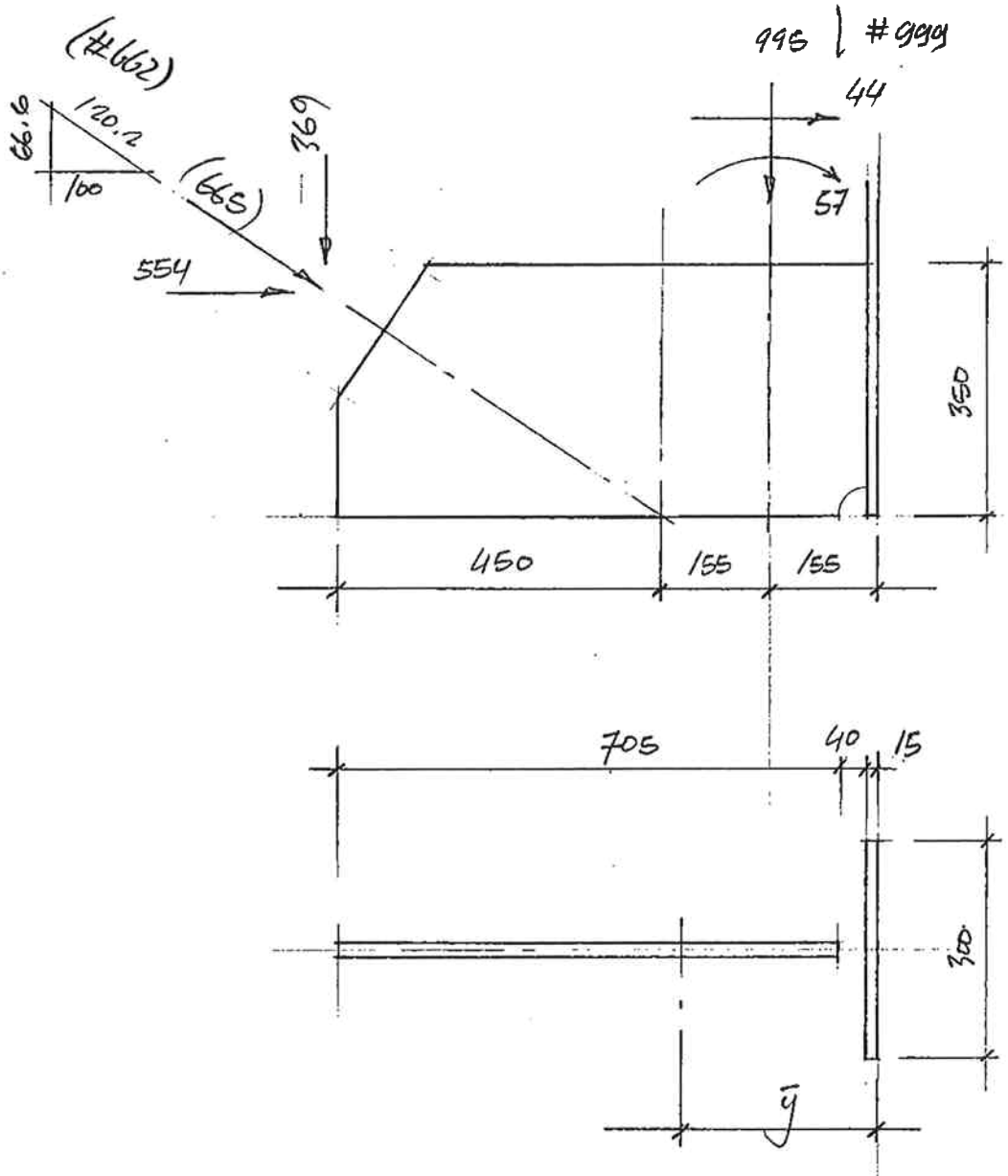
u.c = 1,0.

Opgesteld : MP

Datum : 28/6/10

Bladnummer : B-34a

Rev. :



changes are irrelevant for results, ucs remain <1.0

GUSSET PROPERTIES. (CORRODED)

AREA $705 * 16 = 11280$
$13 * 300 = 3900$

$15180\ mm^2$

NEUTRAL AXIS $11280 * 406 = 4579680$
$3900 * 6.5 = 25350$

4605030

$y = \frac{4605030}{15180} = 304\ mm$

I_y $16 * 705^3/12$
$3900 * (304 - 6.5)^2$

$81238 * 10^4\ mm^4$

I_z $705 * 16^3/12$
$13 * 300^3/12$

$2949 * 10^4\ mm^4$

$W_{y_L} = \frac{81238 * 10^4}{760 - 304} = 1782 * 10^3\ mm^3$

$W_z = \frac{2949 * 10^4}{150} = 196.6 * 10^3\ mm^3$

$W_{y_F} = \frac{81238 * 10^4}{304} = 2672 * 10^3\ mm^3$

$N_{Sd} = 995 + 369 = 1364\ kN$

$V_{Sd} = 554 + 44 = 598\ kN$

$M_{y_{Sd}} = 57 + 995(0,149) - 369(0,006) = 203\ kNm$

$M_{z_{Sd}} = 24\ kNm$

$$\sigma_a = \frac{1364 * 10^3}{15180} + \frac{203 * 10^3}{1782} = 90 + 114 = 204 \ N/mm^2$$

$$\tau = \frac{598 * 10^3}{16 * 705} = 53 \ N/mm^2$$

$$\sigma_e = \sqrt{204^2 + 3(53)^2} = 224 \ N/mm^2 < \frac{355}{1.1} \quad UC = 0,7$$

WELD 18mm GUSSET TO 20mm PLATE

SHEAR PER UNIT LENGTH $= \frac{598}{2*705} = 0,43 \ kN/mm$

NORMAL FORCE PER UNIT LENGTH $= 0.204 * \frac{16}{2} = 1,64 \ kN/mm$

RESULTANT FORCE $= \sqrt{0.43^2 + 1.64^2} = 1.7 \ kN/mm$

$a_{REQ} = \frac{1.70 * 10^3}{262} = 6.5 \ mm$ → USE $a = 10$ mm WELD

HE320A FLANGE

$W_{yf} = 2239 * 10^3 \ mm^3$

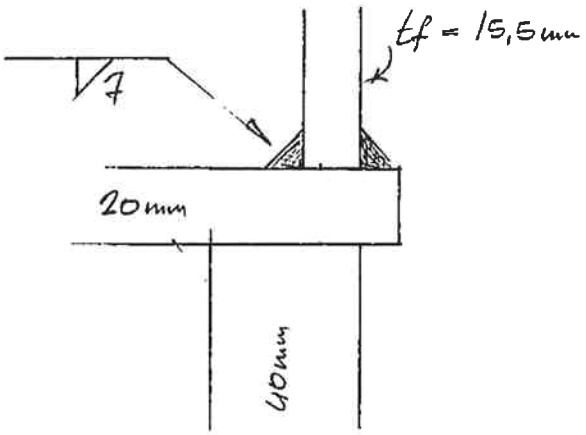
$$\sigma_a = 90 + \frac{203 * 10^3}{2672} = 166 \ N/mm^2$$

$$\sigma_b = \frac{24 * 10^3}{196.6} = 122 \ N/mm^2$$

$$\sigma_e = \sqrt{166^2 + 122^2 - (166)(122)} = 149 \text{ N/mm}^2$$

u.c. 0,47.

WELD FLANGE TO 20mm PLATE. (SEA SIDE)



WELD FORCE = 0,183 * 13,5 = 2,47 kN/mm

$$a_{REQ} = \frac{2,47 * 10^3}{262} = 9,5 \text{ mm}$$ → USE 2 * a = 7mm WELDS

WELD RESISTANCE = 2 * 6 * 262 * 10^{-3} = 3,1 kN/mm

u.c. 0,80

WELD ½ HE650A TO 18mm GUSSET.

L/COND.	MEMBER	L/COMBI.	N	V_y	V_z	M_y	M_z	APPENDIX.
3	934		902	-3	-62	-106	-5	E.
1	928		-1393	3	111	-131	3.	C.

ASSUME AXIAL FORCE & M_y TRANSFERRED THROUGH FLANGES ONLY

t_f = 26mm (24 CORRODED)

$A_f = 2 * 24 * 149 = 7152\ mm^2$ $A_g = 0{,}8 * 18382 = 14706\ mm^2$

FLANGE FORCE

AXIAL : $1393 * \frac{7152}{14706} = 678\ kN$

MOMENT : $\frac{131}{0{,}154} = 851\ kN$ $N = 678 + 851 = 1529\ kN$

$\sigma = \frac{1529 * 10^3}{7152} = 214\ N/mm^2 < \frac{355}{1.1}$ U.C 0,66

WELD FLANGE TO GUSSET $L_w = 250\ mm$

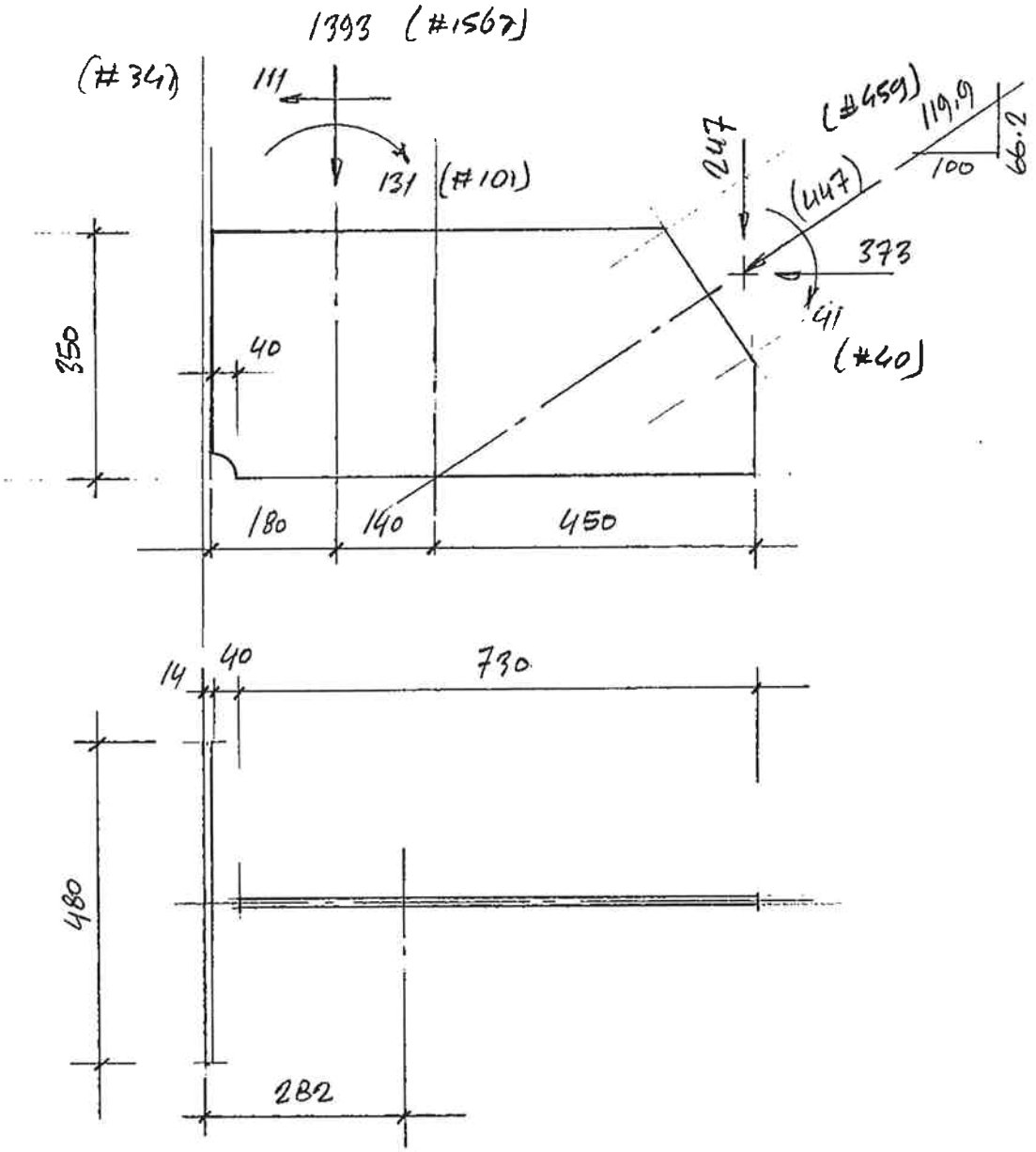
SHEAR PER UNIT LENGTH = $\frac{1529}{250} = 6{,}1\ kN/mm$

$a = \frac{6.1 * 10^3}{4 * 262} = 5{,}82\ mm$ → USE a = 7mm WELD

* DUE TO MINOR CHANGE IN MODEL a = 7 (N = 1812kN; M_y = 150kNm).

Project : MALAMOCCO LOCK VENICE

Onderdeel :



Opgesteld : GWJ

Datum : 5/04

Bladnummer : B-40. Rev. : A2

GUSSET PROPERTIES. (CORRODED)

AREA $730 * 16 = 11680$
$12 * 480 = 5760$
$17\,440\ mm^2$

NEUTRAL AXIS $11680 * 418 = 4882240$
$5760 * 6 = 34560$
$4\,916\,800$

$\bar{y} = \frac{4\,916\,800}{17440} = 282\ mm$

$I_y = 16 * 730^3/12 + 5760 * (282 - 6)^2$
$95746 * 10^4\ mm^4$

$W_{y_L} = \frac{95746 * 10^4}{784 - 282}$
$= 1907 * 10^3\ mm^3$

$W_{y_P} = \frac{95746 * 10^4}{282}$
$= 3395 * 10^3\ mm^3$

$N_{Sd} = 1393 + 247 = 1640\ kN$ (#1817)

$V_{Sd} = 373 + 111 = 484\ kN$ (#224)

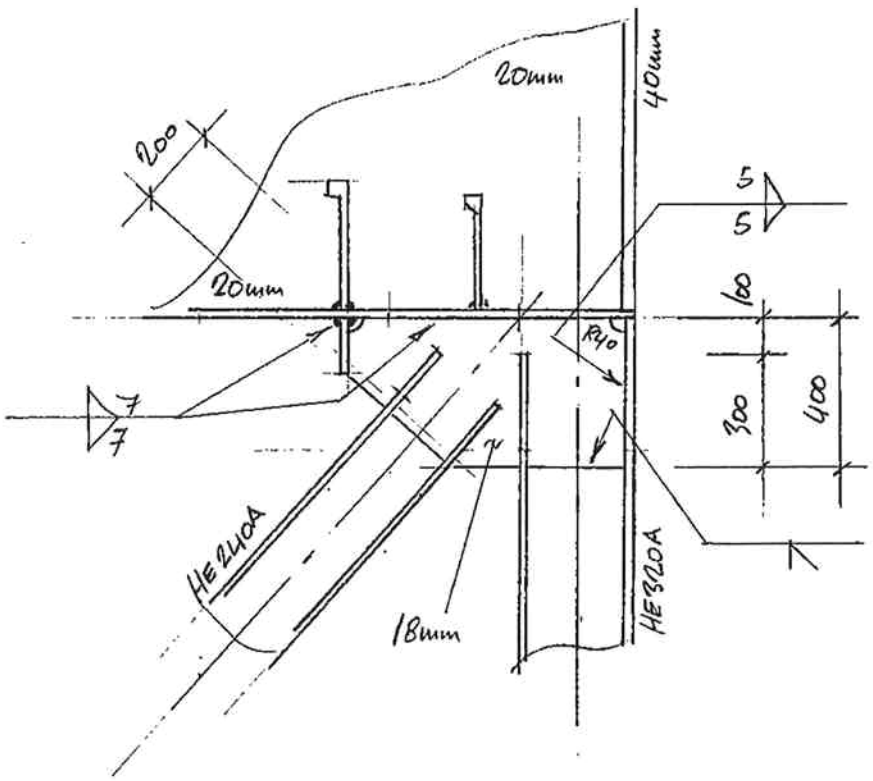
$M_{ySd} = 131 + 41 + 247(0{,}052) - 1393(0{,}088) = 63\ kNm$ (#66)

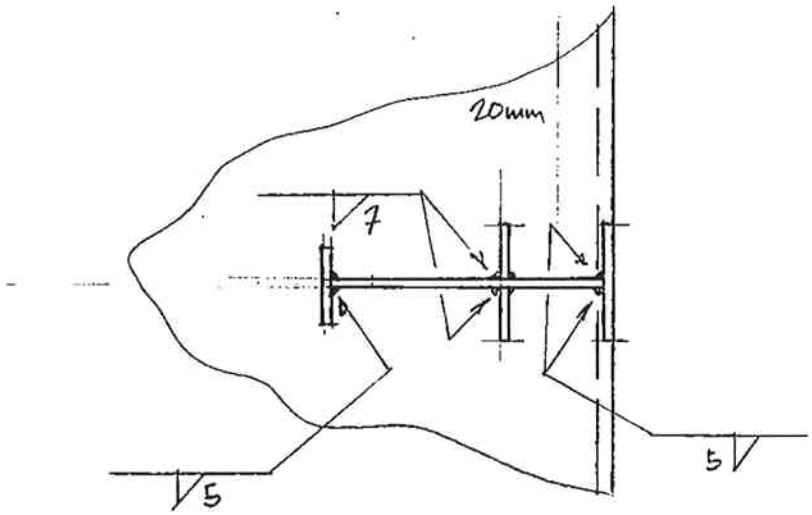
GUSSET ok (#ok)

Project : MALAMOCCO LOCK VENICE

Onderdeel :

DETAIL. B





Opgesteld : GWJ

Datum : 5/04

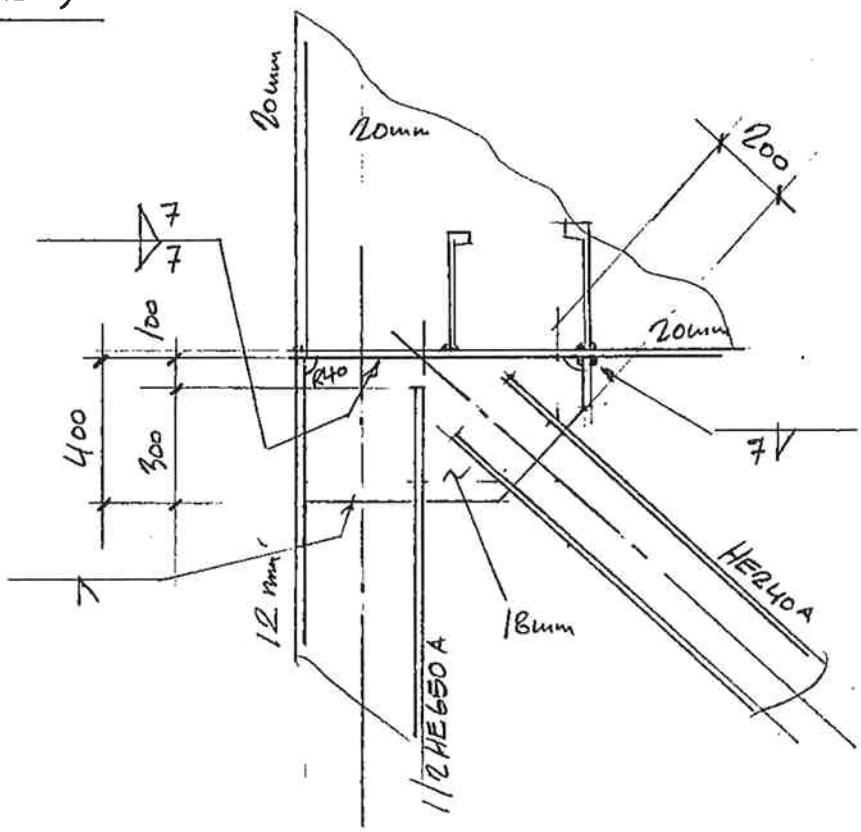
Bladnummer : B-42

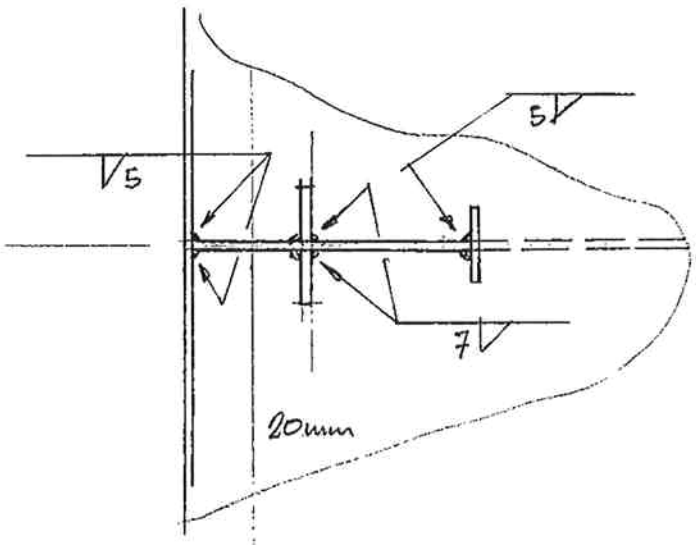
Rev. : A2

Project : MALAMOCCO LOCK VENICE

Onderdeel :

DETAIL 9



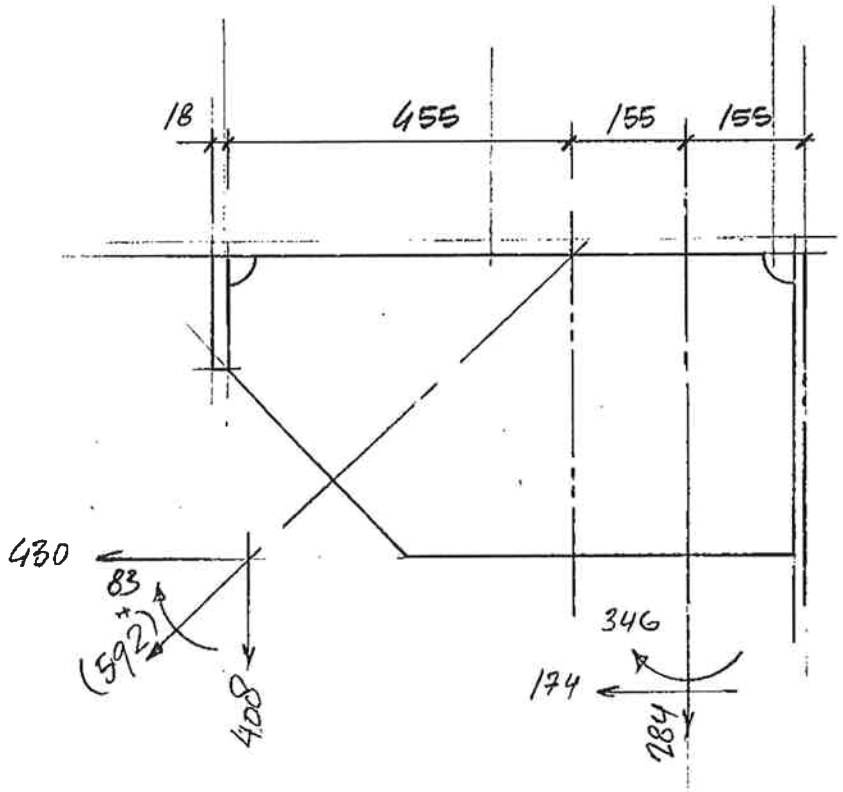


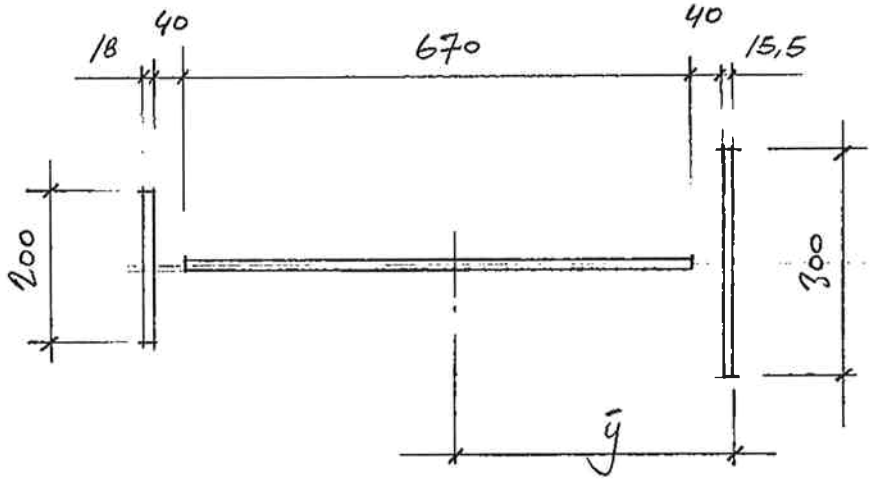
Opgesteld : GWJ Datum : 5/04 Bladnummer : B-43 Rev. : A2

Project : MALAMOCCO LOCK VENICE.

Onderdeel :

18mm GUSSET PLATE





*REF. PAGE B-47.

Opgesteld : GWJ

Datum : 5/04

Bladnummer : B-44. Rev. : A2

GUSSET PROPERTIES

AREA
$200 * 16 = 3200$
$300 * 13.5 = 4050$
$16 * 670 = 10720$

$17\,970\ mm^2$

NEUTRAL AXIS
$3200 * 774 = 2476800$
$4050 * 8 = 32400$
$10720 * 390 = 4180800$

$6\,690\,000$

$\bar{y} = 372\ mm$

I_y
$16 * 670^3/12$
$3200(774-372)^2$
$4050(372-8)^2$

$145\,476 * 10^4\ mm^4$

$W_y = \frac{145\,476 * 10^4}{783-372}$

$= 3540 * 10^3\ mm^3$

PLATE LOADS

$N_{Sd} = 284 + 408 = 692\ kN$

$V_{Sd} = 174 + 430 = 604\ kN$

$M_{ySd} = 346 + 83 + 284(0.217) + 408(0.062) = 516\ kNm$

} Lono combi. 10.

$M_{zSd} = 41\ kNm$ (LC 2)

$$\sigma_a = \frac{692 * 10^3}{7970} + \frac{516 * 10^3}{3540} = 39 + 146 = 185 \ N/mm^2$$

WELD FLANGE TO 20mm BUOYANCY TANK.

WELD FORCE = $0{,}185 * 16 = 2{,}98$ kN/mm

$$a_{REQ} = \frac{2{,}98 * 10^3}{2 * 262} = 5{,}9 \text{ mm} \longrightarrow$$ USE a = 7mm WELDS

WELD GUSSET (WEB) TO 20mm BUOYANCY TANK.

$$\text{SHEAR PER UNIT LENGTH} = \frac{604}{670} = 0{,}90 \text{ kN/mm}$$

FORCE PER UNIT LENGTH = 2,93 kN/mm

$$\text{RESULTANT FORCE} = \sqrt{0{,}90^2 + 2{,}93^2} = 3{,}07 \text{ kN/mm}$$

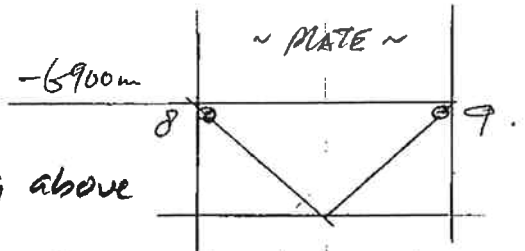
$$a_{REQ} = \frac{3{,}07 * 10^3}{2 * 262} = 5{,}9 \text{ mm} \longrightarrow$$ USE a = 7 mm WELDS

Project : MALAMOCCO LOCK VENICE

Onderdeel :

NODE (8) + (9).

LEVEL -6900m



*(load situations are not governing above weight - load on temp. support)

no relevant changes due to model-modification

LOAD COND.	MEMB. TYPE.	MEMB. NO.	L/C	N	V_y	V_z	M_y	M_z
1	GRID LINE 1							
		343	13	-86.	0	5	-6	0
		344	14	-200.	0	1	0	1
	GRID LINE 2							
		391	13	-120	0	14	45	3.
		392	14	-212	-1	8	-10	4.
	GRID LINE 4							
		383	10	-541	0	-19	-23	0
		384	10	566	0	27	81	1
	GRID LINE 6							
		375	10	-590	0	-19	-23	0.
		376	10	592	0	28	83	0
	GRID LINE 8							
		367	10	-591	0	-19	-23	0
		368	10	592	0	28	83	0.
	GRID LINE 10							
		359	10	-542	0	-19	-23	0
		360	10	567	0	27	81	-1.
	GRID LINE 12							
		349	14	-216.	1	-8	-10	4
		350	13	-120	-2	7	-10	3.
	GRID LINE 13							
		336	13	-86	0	5	-6	0
		337	14	-203	0	1	0	-1

Opgesteld : GWJ Datum : 5/04 Bladnummer : B-47. Rev. : A2

Project : MALAMOCCO LOCK VENICE

Onderdeel :

LEVEL - 6900 m

*

LOAD COND.	MEMB. TYPE.	MEMB. NO.	L/C	N	V_y	V_z	M_y	M_z
2	GRID LINE 1.							
		343	3	-143	0	2	-4	0
		344	6	-307	0	1	0	1
	GRID LINE 2							
		391	3	-229	3	3	-5	-6.
		392	3	-306	-1	3	-4	3
	GRID LINE 4							
		383	5	-361	0	-9	-10	0
		384	5	373	0	12	38	1
	GRID LINE 6.							
		375	5	-396.	0	-8	-10	0
		376	5	391	0	13	39	1.
	GRID LINE 8							
		367	5	-396.	0	-8	-10	0
		368	5	391	0	13	39	-1
	GRID LINE 10							
		359	5	-361	0	-9	-10	0
		360	5	373	0	12	38	-1
	GRID LINE 12							
		349	3	-386.	1	-3.	-4	3
		350	3	-138	-3	3.	-6	6
	GRID LINE 13							
		336	6	99	0	-1	-1	-1
		337	3	-335	-1	2	-2	3

Opgesteld : GWJ Datum : 5/04 Bladnummer : B-48. Rev. : A2

Project : MALAMOCCO LOCK VENICE

Onderdeel :

LEVEL - 6900

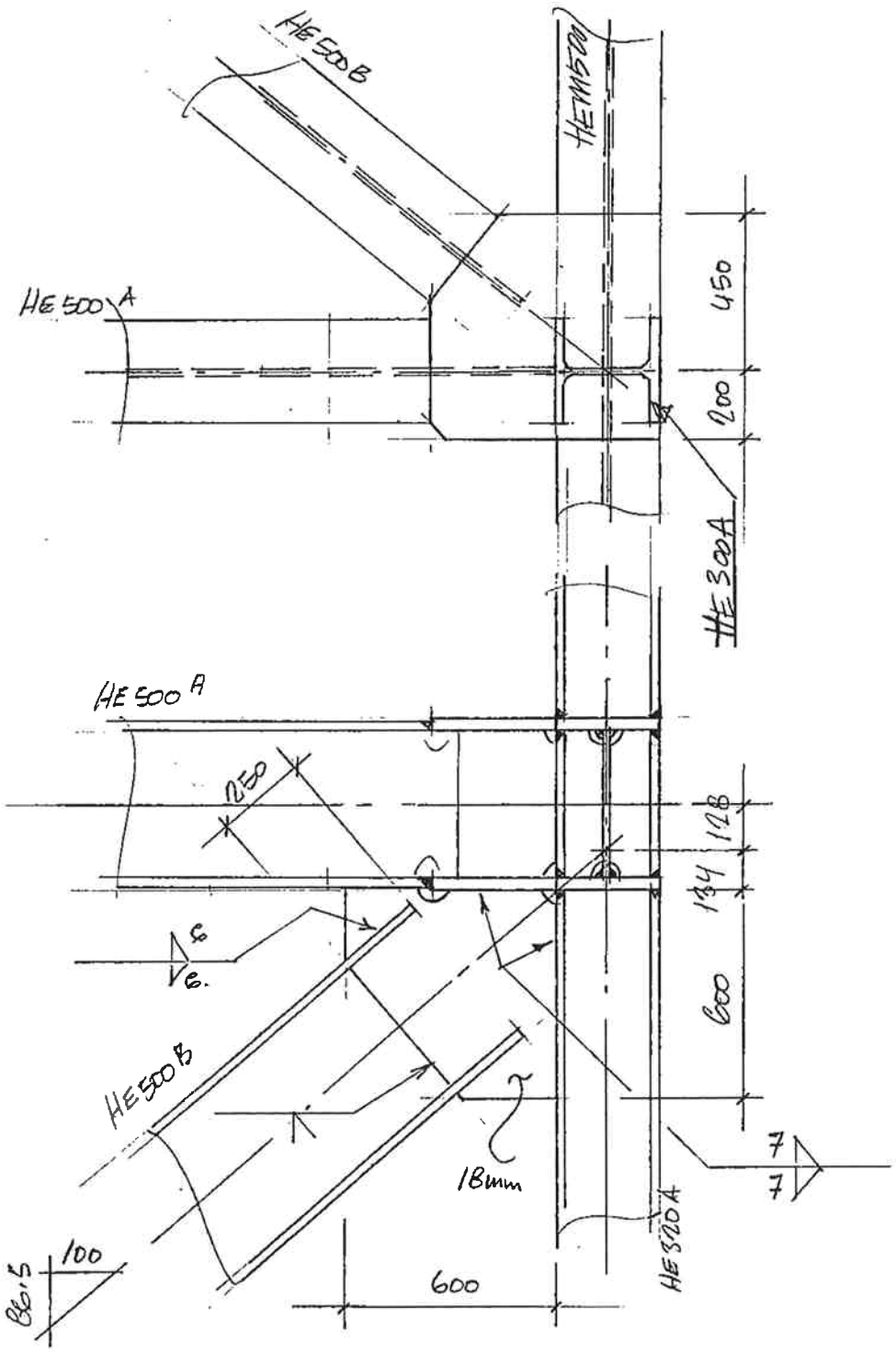
LOAD COND.	MEMB. TYPE.	MEMB. NO.	L/C	N	V_y	V_z	M_y	M_z
3.	GRID LINE 1.							
		343	4	-183	1	2	-2	-1
		344	1	-461	1	1	0	-3.
	GRID LINE 2							
		391	4	-277	3	3	-5	-7
		392	1	-490	-1	2	-2	2
	GRID LINE 4							
		383	1	121	0	1	-2	0
		384	1	-113	1	1	1	-1
	GRID LINE 6							
		375	1	259	0	2	-4	0
		376.	1	-262	0	0	2	0
	GRID LINE 8							
		367	1	259	0	2	-4	0
		368	1	-262	0	0	2	0
	GRID LINE 10							
		359	1	121	0	1	-2	0
		360	1	-113	-1	1	1	1
	GRID LINE 12							
		349	1	-490	1	-2	-2	2
		350	2	-270	-4	3	-6	9
	GRID LINE 13							
		336.	1	172	0	0	1	-1
		337	1	-460	-1	1	0	3

Opgesteld : GWJ Datum : 5/04 Bladnummer : B-49. Rev. : A2

Project : MALAMOCCO LOCK VENICE

Onderdeel :

DETAIL 10



Opgesteld : GWJ

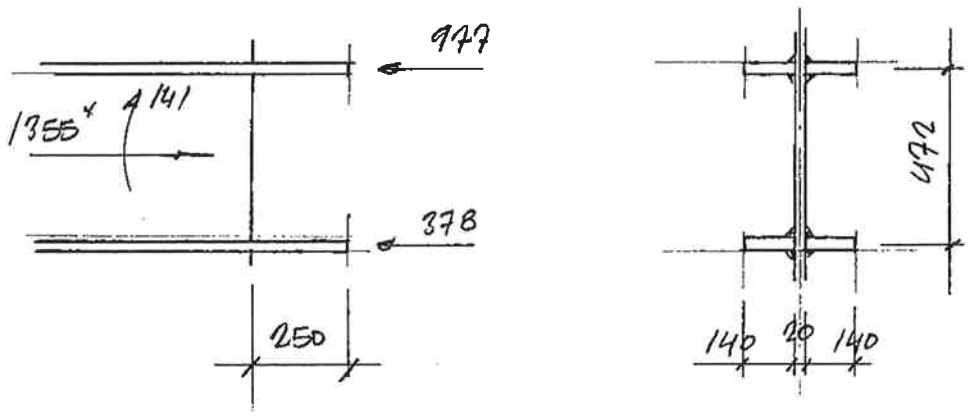
Datum : 5/04

Bladnummer : B-50

Rev. : A2

WELD HE 500 B VERTICAL BRACE TO GUSSET.

ASSUME LOAD TRANSFER THROUGH FLANGES ONLY!



FLANGE YIELD

$$A_e = 2 * 28 * 140 = 7840\ mm^2$$

$$\sigma_a = \frac{977 * 10^3}{7840} = 125\ N/mm^2 \longrightarrow ok$$

WELD FLANGE TO 18mm GUSSET

$$L_w = 250\ mm$$

$$a_{REQ} = \frac{977 * 10^3}{4 * 250 * 262} = 3{,}73\ mm \longrightarrow$$ USE $a = 6\ mm$

GUSSET SHEAR (18mm)

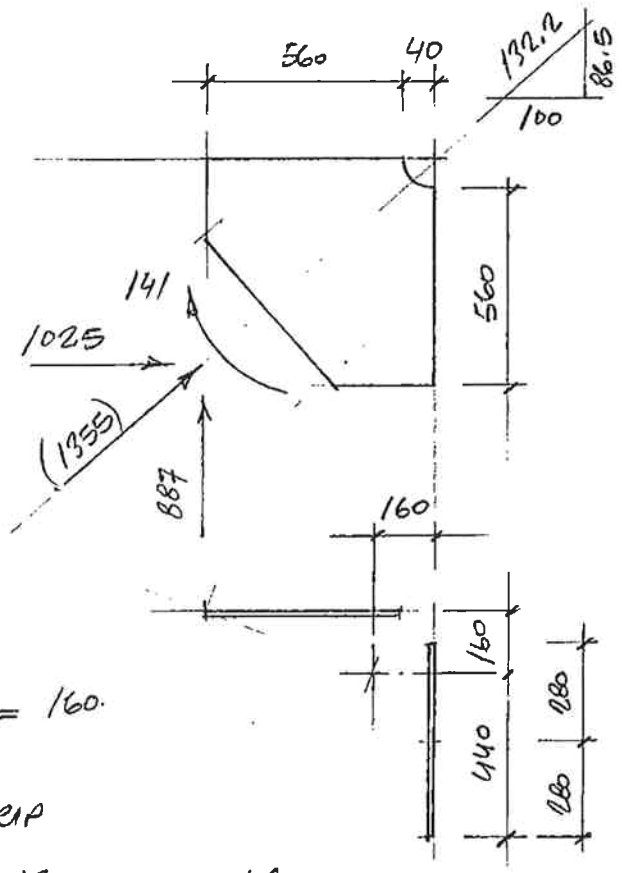
$$\tau = \frac{977 * 10^3}{2 * 250 * 16} = 122\ N/mm^2 < \frac{355}{\sqrt{3} * 1.1}$$ UC 0,66.

* PAGE B-53.

Project : MALAMOCCO LOCK VENICE

Onderdeel :

GUSSET PLATE



WELD GROUP CENTROID

$$x = \frac{560 * 320}{2 * 560} = 160.$$

CONSIDER 1mm WELD STRIP

$$I = \frac{560^3}{12} + 560(440 - 280)^2 = 28,97 * 10^6$$

$$W = \frac{28.97 * 10^6}{440} = 65.8 * 10^3 \text{ mm}^2$$

$$\sigma = \frac{141}{65.8} = 2.14 \text{ kN/mm}$$

$$\tau = \frac{1025}{560} = 1.83 \text{ kN/m}$$

$$R = \sqrt{2.14^2 + 1.83^2} = 2.82 \text{ kN/mm}$$

$$q_{REQ} = \frac{2,82 * 10^3}{2 * 262}$$

$$= 5.4 \text{ mm}$$

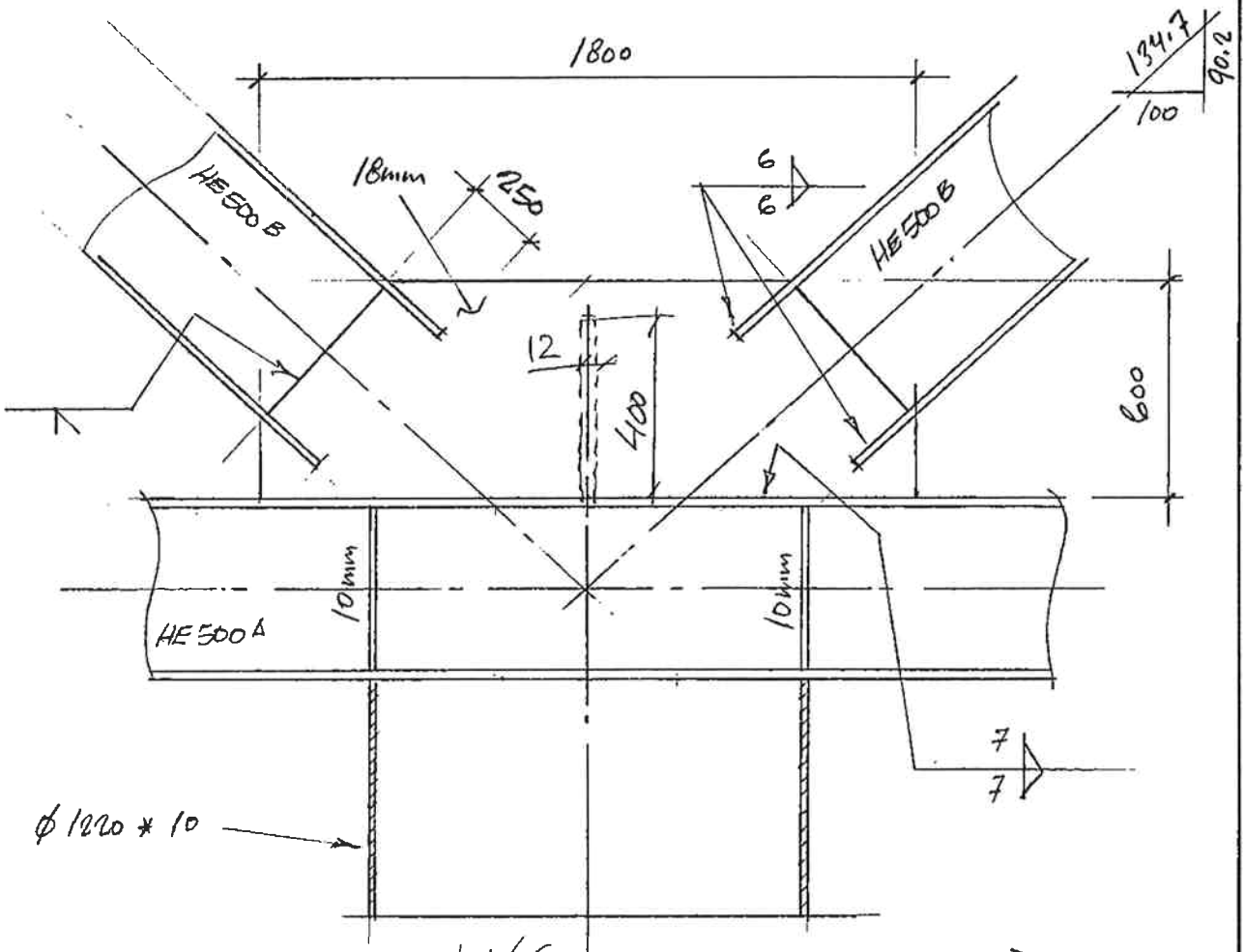
USE $a = 7$ mm WELDS.

Opgesteld : GWJ | Datum : 5/04 | Bladnummer : B-52 | Rev. : A2

Project : MALAMOCCO LOCK VENICE

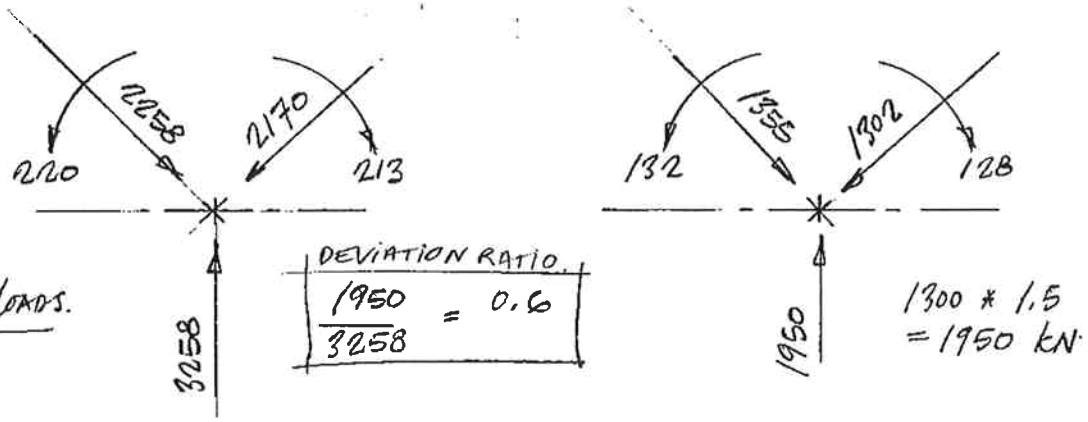
Onderdeel :

DETAIL 11



MAX. VERT. LOAD = 1300 kN (REF. DOC. 4002 PAGE 14)

DEVIATION LOAD OVER BRACES DERIVED FROM ACC. CASE IN EPW.



EPW LOADS.

DEVIATION RATIO.

$$\frac{1950}{3258} = 0.6$$

1300 * 1.5 = 1950 kN

Opgesteld : GWJ

Datum : 5/04

Bladnummer : B-53

Rev. : A2.

Project : MALAMOCCO LOCK VENICE

Onderdeel :

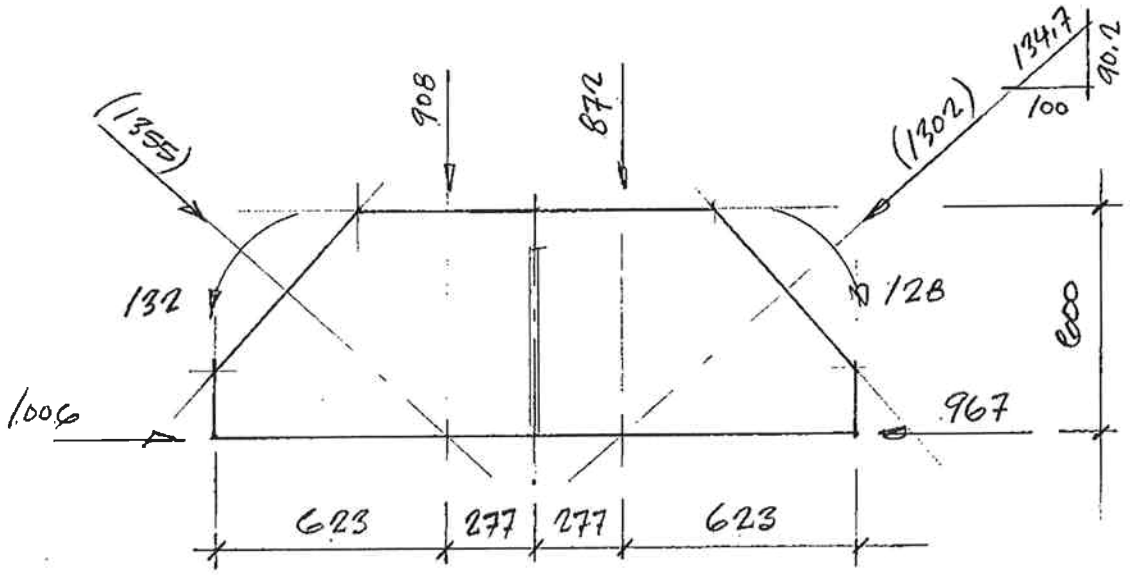


PLATE FORCES

$N_{L,Sd} = 1006$ kN

$N_{T,Sd} = 908 + 872 = 1780$ kN

$V_{Sd} = 1006 - 967 = 39$ kN

$M_{Sd} = 132 - 128 = 4$ kNm

TRY 18 mm PLATE.

ALLOW 2mm CORROSION ⟶ 16 mm

LONGITUDINAL STRESS.

$$\sigma_a = \frac{1006 * 10^3}{16 * 600} + \frac{132 * 10^6 * 6}{16 * 600^2}$$

$$= 105 + 138$$

$$= 243 \text{ N/mm}^2$$

Opgesteld : GWJ Datum : 5/04 Bladnummer : B-54. Rev. : A2

$$\tau = \frac{39 * 10^2}{16 * 1800} = 1.4 \ N/mm^2$$

TRANSVERSE STRESS

$$\sigma_q = \frac{1780 * 10^3}{16 * 1800} + \frac{4 * 10^6 * 6.}{16 * 1800^2}$$

$$= 62 + 1 = 63 \ N/mm^2$$

EQUIVALENT STRESS

$$\sigma_e = \sqrt{243^2 + 63^2 - (243)(63) + 3(1.4)^2}$$

$$= 219 \ N/mm^2 < \frac{355}{1.1} = 323 \qquad U.C. = 0,68$$

WELD 18 mm PLATE TO HE500 B HORIZONTAL

LONGITUDINAL SHEAR NEGLIGIBLE!

CONSIDER 1mm STRIP $W = 1800^2/6 = 540 * 10^3 mm^3$

NORMAL FORCE PER UNIT LENGTH –

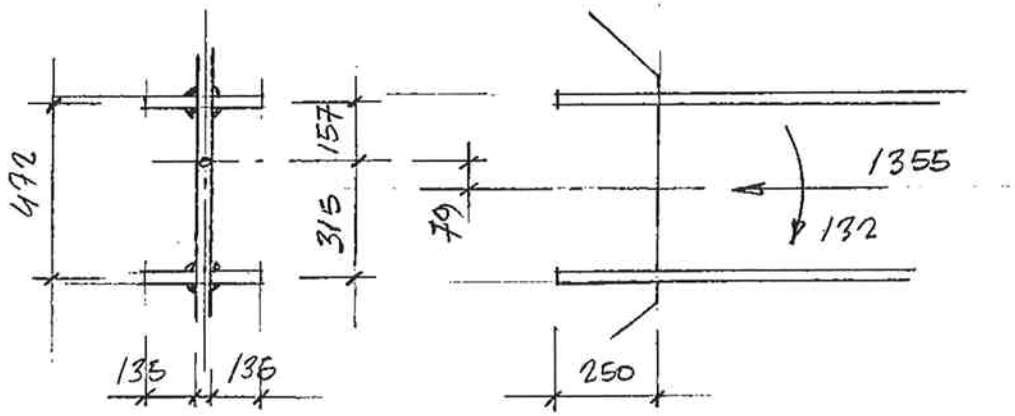
$$F_w = \frac{1780}{1800} + \frac{4}{540} = 0.99 + 0,01 = 1.00 \ kN/mm$$

$$a_{REQ} = \frac{1.00 * 10^3}{2 * 262} = 1.9 \ mm \longrightarrow$$ USE $a = 7$ mm

PRACTICAL.

WELD HE500^B BRACE TO 18 mm GUSSET.

ASSUME TRANSFER OF TOTAL FORCE THROUGH FLANGES.
(IGNORE SHEAR)



$$\text{FLANGE FORCE} = \frac{1355}{2} + \frac{132}{0.472} = 958\ \text{kN}$$

CHECK FLANGE YIELD.

$A_e = 2 * 28 * 135 = 7560 \text{ mm}^2$

$\sigma_a = \frac{958 * 10^3}{7650} = 125 \text{ N/mm}^2 \longrightarrow$ ok

WELD FLANGE TO 18mm GUSSET.

$L_w = 200 \text{ mm}$

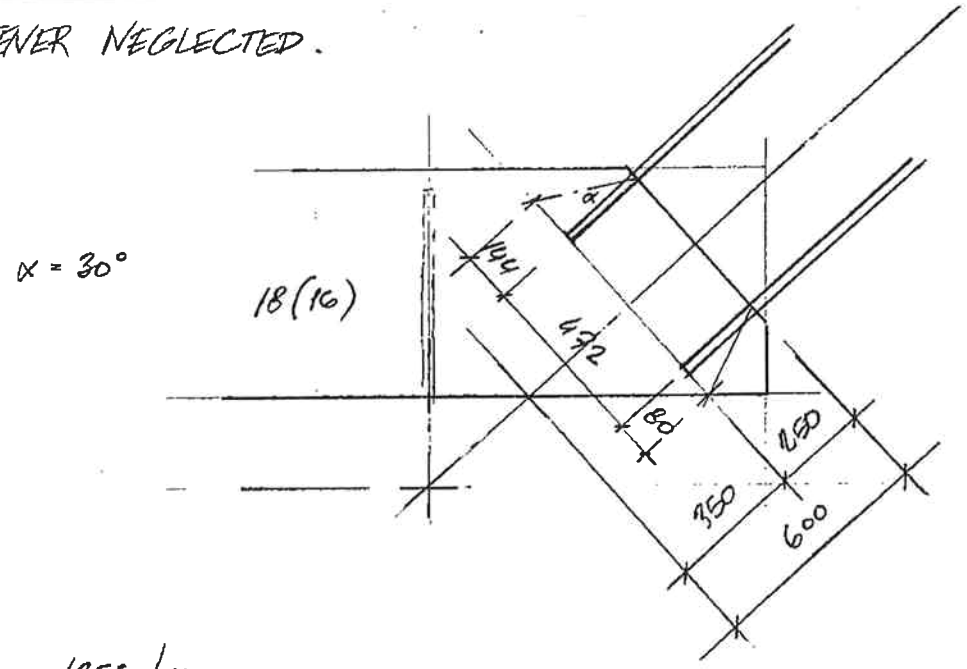
$a_{REQ} = \frac{958 * 10^3}{4 * 250 * 262} = 3.7 \text{ mm} \longrightarrow$ USE $a = 6$ mm

CHECK GUSSET SHEAR

$\tau = \frac{958 * 10^3}{2 * 250 * 16} = 120 \text{ N/mm}^2 \longrightarrow$ ok

CHECK GUSSET BUCKLING

STIFFENER NEGLECTED.



$N_{Sd} = 1355$ kN

BUCKLING LENGTH = 350 mm

$B_e = 144 + 472 + 80 = 696$ mm

$A_e = 696 * 16 = 11136$ mm^2

$\sigma_a = \frac{1355 * 10^3}{11136} = 122$ N/mm^2 $\quad f_a = \frac{0.4338 * 355}{1.1} = 140$ N/mm^2

$i = \frac{16}{\sqrt{12}} = 4.62$ mm

U.C. $\frac{122}{140} = 0.87$

$\lambda = \frac{1.2 * 350}{4.62} = 91$

∴ PLATE STABILITY OK

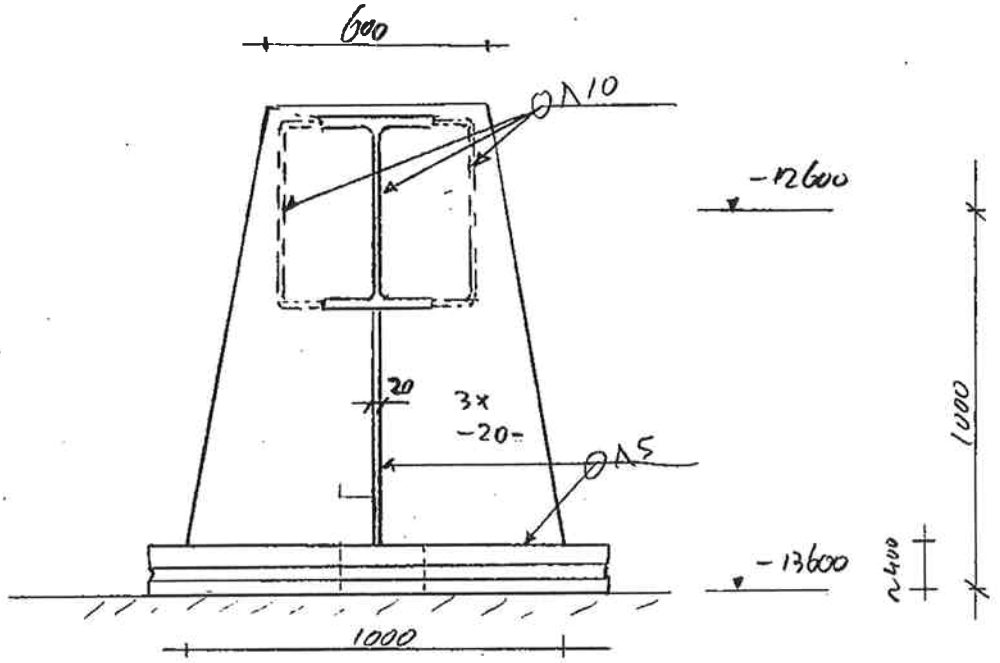
$\lambda_1 = 91/76.4 = 1.2$

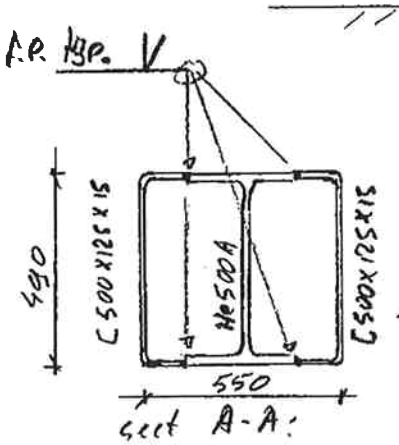
$\chi = 0.4338$

Project : Malamocco Lock Venice

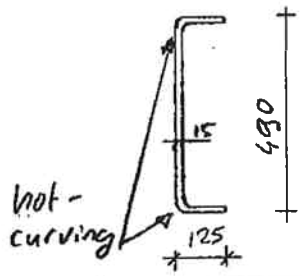
Onderdeel : Temp. support (vert. coll)

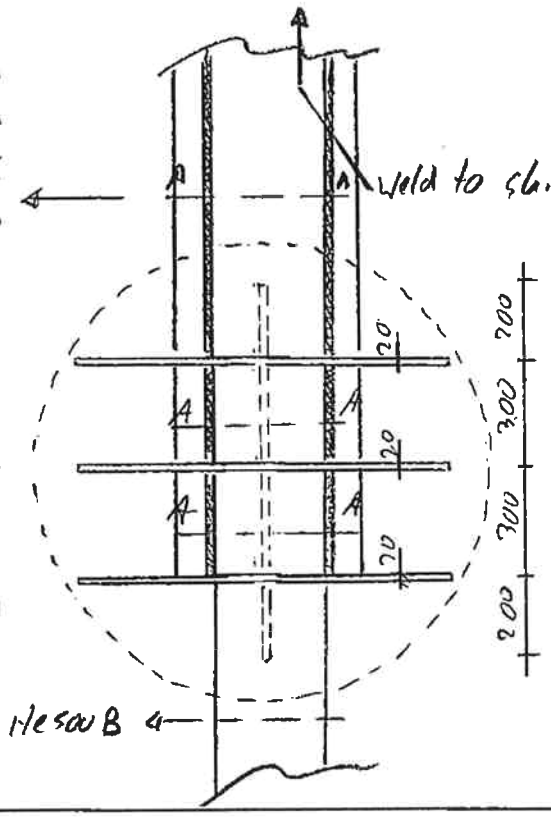
Connection temp. support to He 500 B structure





Box-girder
He 500 A with
curved side-profiles
t = 15 mm :



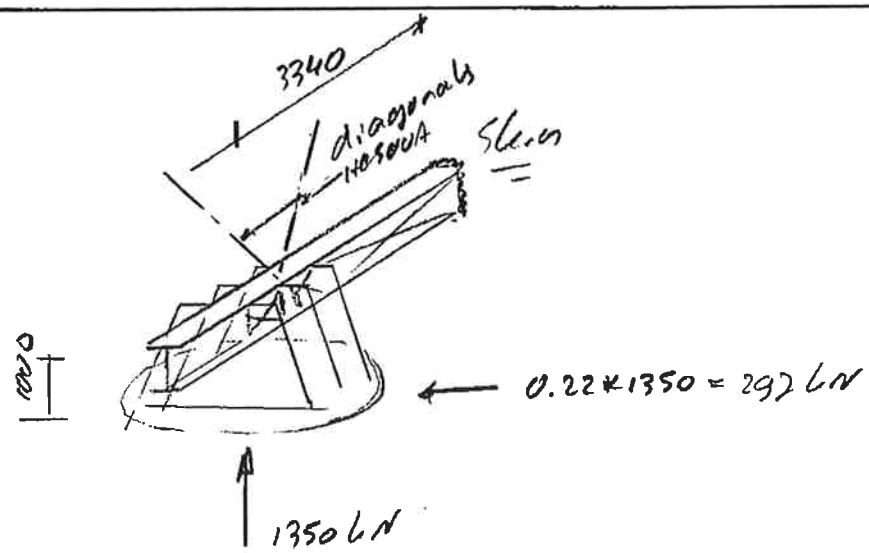


Note :
He 500 B is interrupted by shear plates. Weld box-girders between shearplates!

Opgesteld :	Datum :	Bladnummer :	Rev. :
JA	8/2/04	B 59	A3

Project : Malamocco Lock Venice

Onderdeel : Temp support



loads:

Shear $V_d = 297 * 1.5 =$ 446 kN

Normal force plates $\Sigma N_d = 1.5 * 1350 =$ 2025 kN

Moment plates $\Sigma M_d = 1.0 * 1.5 * 297 =$ 446 kNm

Torsional Moment box girder $M_d =$ 446 kNm

Checks:

* Vertical force to diagonals: angle 1.2 : 1

$F_{N;hor;d} = \frac{2025}{2} * 1.2 = 1215$ kN

$F_{N;vert;d} = \frac{2025}{2} = 1013$ kN

$N_d = \sqrt{1215^2 + 1013^2} = 1582$ kN

HE500B: $\sigma_d = N/A = 66$ N/mm²; stability no problem; Ok.

* Welds to baseplate: $a = 5$

$$\sigma_1 = \tau_1 = \frac{2025 \cdot 10^3 * \sqrt{2}}{2 * 6 * 4 * 1000} + \frac{446 \cdot 10^6 * 3}{\sqrt{2} * \frac{1}{2} * 6 * 4 * 1000^2} =$$

$60 + 79 = 140$ N/mm²

$$\tau_2 = \frac{446 \cdot 10^3}{6 * 4 * 1000} = 19 \text{ N/mm}^2$$

Opgesteld :	Datum :	Bladnummer :	Rev. :
J.A	8/7/04	B60	A3

$$\sigma_{w;i;d} = \frac{\sqrt{4 * 140^2 + 3 * 19^2}}{\sqrt{3}} = 163 \ N/mm^2$$

$f_{w;i;d} = 260 \ N/mm^2 \Rightarrow$ u.c. $= 0.64 < 1.0$: Ok.

* top shear plates

$A = 3 * 18 * 600 = 32400 \ mm^2$

$W = 3 * \frac{1}{6} * 18 * 600^2 = 3.24 \cdot 10^6 \ mm^3$

$$\sigma_d = \frac{2025 \cdot 10^3}{32400} + \frac{446 \cdot 10^6}{3.24 \cdot 10^6} = 200 \ N/mm^2$$

$$\tau_d = \frac{3}{2} \cdot \frac{446 \cdot 10^3}{32400} = 21 \ N/mm^2$$

$\sigma_{v;d} = \sqrt{200^2 + 21^2} = 201 \ N/mm^2 \Rightarrow$ u.c. $= 0.62 < 1.0$; Ok

* Welds to shear-plates & skin : $a = 10$ mm

Outside welds (torsion) : $\tau_{\perp d} = \frac{446 \cdot 10^6}{2 * 300 * 450 * 0.9} = 184 \ N/mm^2$

Web-welds (shear) : $\tau_{\parallel d} = \frac{\frac{1}{2} * 2025 \cdot 10^3}{2 * 500 * 0.9} = 113 \ N/mm^2$

u.c. max $= 0.64 < 1.0$; Ok (torsion)

* Deformation due to torsion :

Reaction-moment on rubber bearing-ring : 886 Nm at 0.006 rad

$$\theta = \frac{M_T \, l}{G \, I_t} = \frac{(292 - 88) \cdot 10^6 * (3340 - 300)}{81000 * 1.68 \cdot 10^9} = 0.005 \text{ rad} < 0.006 \text{ rad} ;$$

→ Ok for rubber-ring. (no additional combinations!)

* $I_t = \frac{2 \cdot 13^2 \cdot (490 - 13)^2 (550 - 13)^2}{490 \cdot 13 + 550 \cdot 13 - 2 \cdot 13^2} = 1.68 \cdot 10^9$

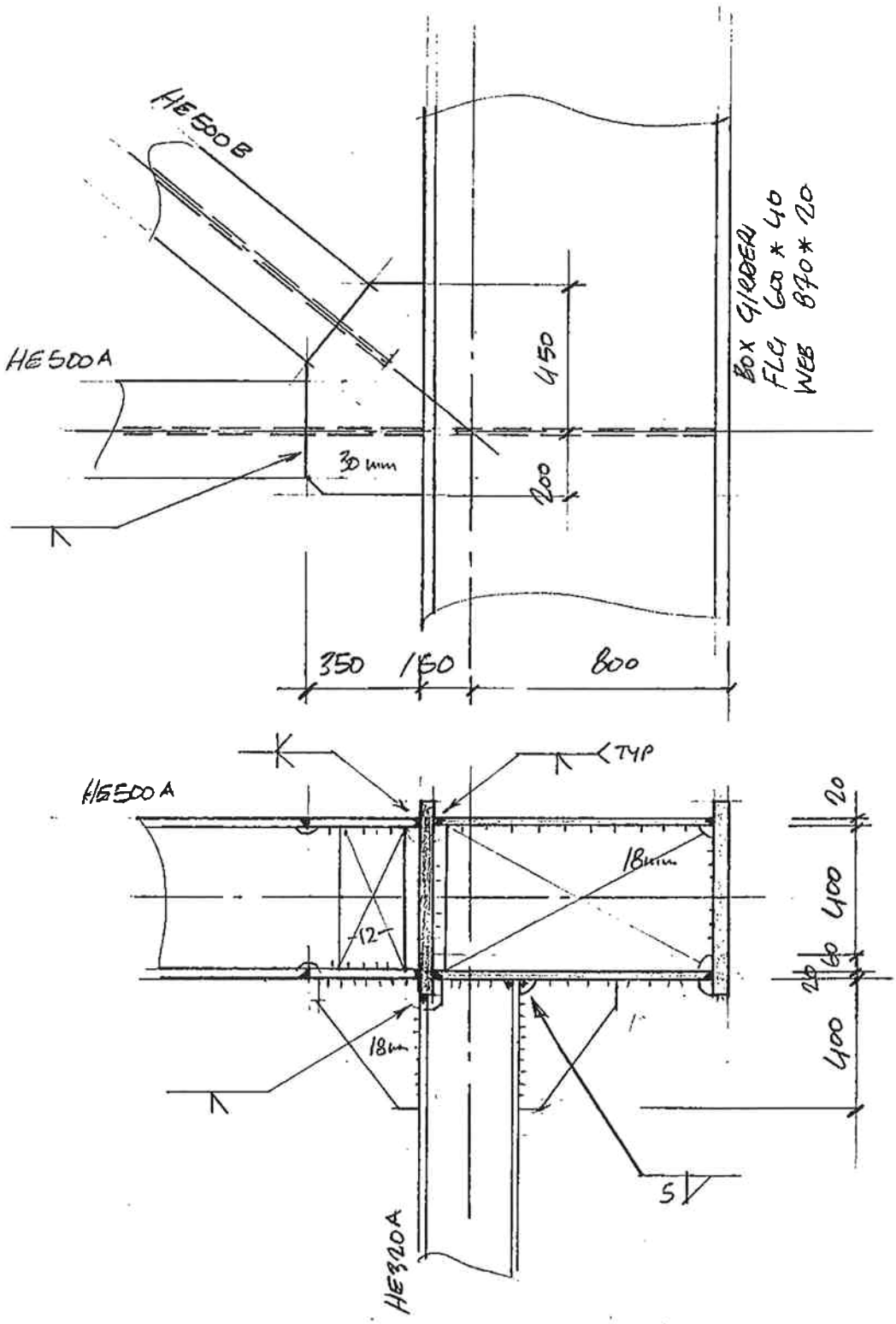
(assume $t = 15$ mm around − corrosion 2 mm)

Opgesteld :	Datum :	Bladnummer :	Rev. :
JA	8/2004	B61	A3

Project : MALAMOCCO LOCK VENICE

Onderdeel :

DETAIL 12



Opgesteld : GWJ

Datum : 5/04

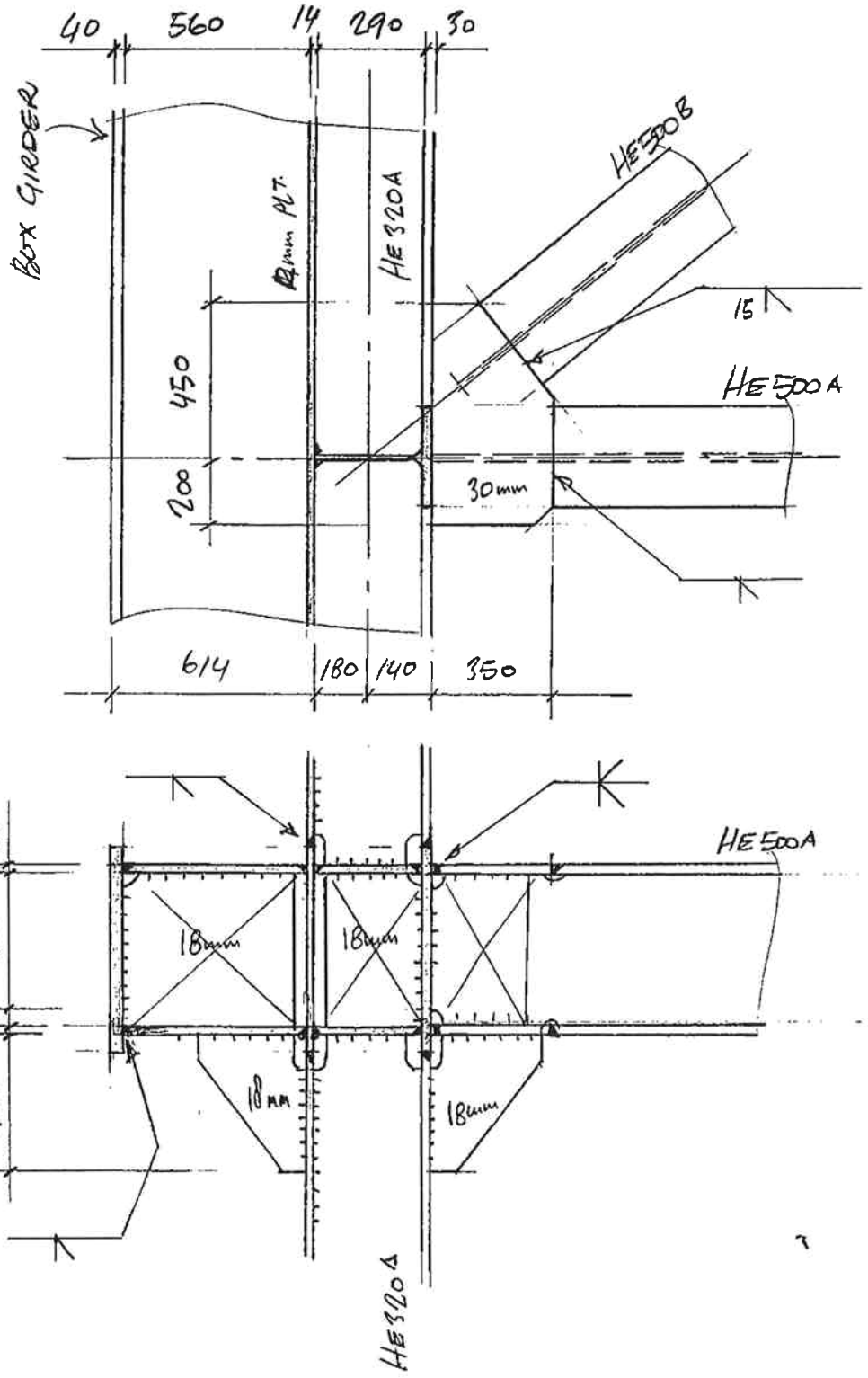
Bladnummer : B-62.

Rev. : A2

Project : MALAMOCCO LOCK VENICE

Onderdeel :

DETAIL 13



Opgesteld : GWJ

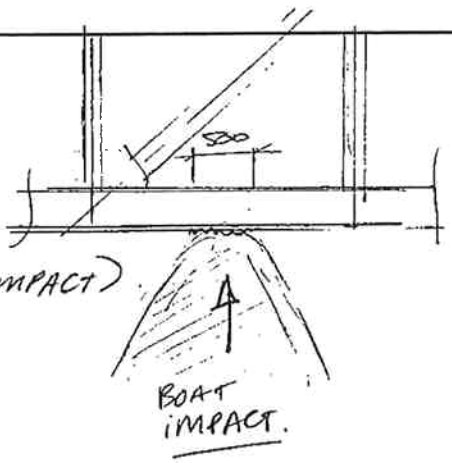
Datum : 5/04

Bladnummer : B-63.

Rev. : A2

Project : MALAMOCCO LOCK VENICE

Onderdeel :



BUMPER BEAM ~ DETAIL CALCULATIONS

SEA SIDE. MAX LOAD = 5000 kN (BOAT IMPACT)

CHECK WEB IN SPAN.

- WEB YIELD. $f_y = \frac{355}{1.1} = 322\ N/mm^2$

LENGTH OF STIFF BEARING = 500 mm (SAY).

$$\sigma = \frac{5000 * 10^3}{2 * 19 * 500} = 264\ N/mm^2 < 322 \qquad (0.82)$$

- WEB CRIPPLING

$t_w = 19\ mm$

$t_f = 39\ mm$

$d = 870\ mm$

$S_s = 0.2 * 870 = 174\ mm \quad (< 500)$

$$R_s = \frac{0.5 t_w^2 \sqrt{E.f_y}}{\gamma} \left\{ \sqrt{\frac{t_f}{t_w}} + 3\left(\frac{t_w}{t_f}\right)\left(\frac{S_s}{d}\right) \right\}$$

$$R_s = \frac{0.5(19)^2 \sqrt{E.f_y}}{1.1 * 10^3} \left\{ \sqrt{\frac{39}{19}} + 3\left(\frac{19}{39}\right)\left(\frac{174}{870}\right) \right\}$$

$R_s = 2444\ kN$ PER WEB.

SAFE LOAD = $2 * 2444 = 4888\ kN$ (1.02) → ACCEPT

CHECK WEB AT SUPPORTS

- WEB BUCKLING

LENGTH OF STIFF BEARING = 500mm (SAY)

$h = 870\ mm$

$b_e = \sqrt{870^2 + 500^2} = 1000\ mm$

$A_e = 19 * 1000 = 19000\ mm^2$

$\sigma_a = \frac{5000 * 10^3}{2 * 19000} = 132\ N/mm^2$

$i = \frac{19}{\sqrt{12}} = 5.5\ mm$

$\lambda = \frac{1.0 * 870}{5.5} = 158$

$\lambda_1 = \frac{158}{76.4} = 2.1 \qquad \chi = 0.18$

$f = \frac{0.18 * 355}{1.1} = 58\ N/mm^2 > 132$ (2.3)

WEBS UNSTABLE ∴ REQUIRE STIFFENERS.

Project : MALAMOCCO LOCK VENICE

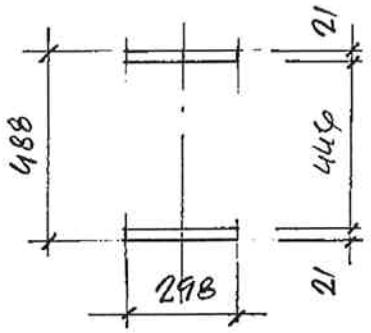
Onderdeel :

LOAD TRANSFER TO HE 500 A TRANSVERSAL

L/cond.	member	L/combi	N		V_y		V_z		M_y		M_z	Appendix
3	147	2	3459	3455 *	0		-48	-68	-49	-46 *	0	E
2	147	6.	-3432	-3430 *	55	56	151	-156	0.			D.

ASSUME AXIAL FORCE & MOMENT TRANSFERRED BY FLANGES ONLY.

PROPERTIES (CORRODED)



$A_e = 2 * 21 * 298 = 12516\ mm^2$

$W_e = \frac{298(488^3 - 446^3)}{6 * 488}$

$= 2798 * 10^3\ mm^3$

* assumption > modified EPW model

$\sigma_a = \frac{3500 * 10^3}{12516} + \frac{151 * 10^3}{2798}$

$= 280 + 54$

$= 334\ N/mm^2$ (1,04)

HE500A ok

NOTE: CALC. ON FLANGES ONLY, CONSERVATIVE.

SO STILL SUFFIENT.

Opgesteld : GWJ Datum : 5/04 Bladnummer : B-66 Rev. A2

Project : MALAMOCCO LOCK VENICE

Onderdeel :

CHECK BOX GIRDER WEBS (20 mm)

$A_e = 2 * 19 * 376 = 14288\ mm^2$

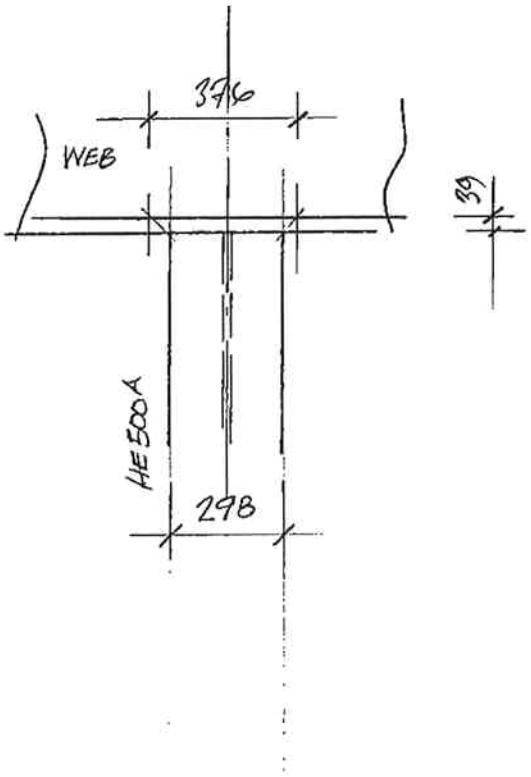
FORCE IN FLANGE =

$\frac{3500}{2} + \frac{50}{0,48} = 1854\ kN$

$\sigma_a = \frac{1854 * 10^3}{14288/2} = 260\ N/mm^2$

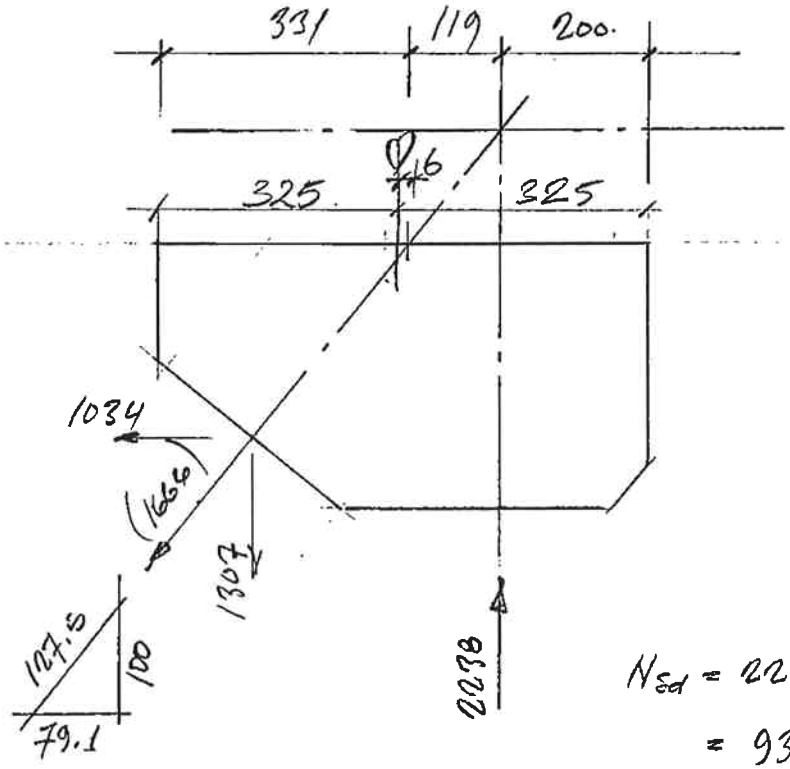
$(0,81)$

20mm WEBS ok



Opgesteld : GWJ Datum : 5/04 Bladnummer : B-67. Rev. : A2.

GUSSET PLATE (30 mm)



$N_{Sd} = 2238 - 1307$

$= 931$ kN

$M_{Sd} =$

LOADING.

L/COMBI	TRANSV.	DIAGL.
2	2140	-1578
6	-2238	1666.

$N_{Sd} = 2238 - 1307 = 931$ kN.

$M_{Sd} = 2238(0,125) + 1307(0,006) = 288$ kNm

$V_{Sd} = 1034$ kN

PLATE PROPERTIES (CORRODED)

$A_e = 28 * 650 = 18200\ mm^2$

$W_e = 28 * 650^2/6 = 1972 * 10^3\ mm^3$

$\sigma_q = \frac{931 * 10^3}{18200} + \frac{288 * 10^3}{1972} = 51 + 146 = 197\ N/mm^2$ (0,61)

$\tau = \frac{1034 * 10^3}{18200} = 57\ N/mm^2$ (0,31)

$\sigma_e = \sqrt{197^2 + 3(57)^2} = 221\ N/mm^2$ (0,69)

USE 30 mm GUSSET.

WELD GUSSET TO 40 mm FLANGE

$L_w = 650\ mm$ $W = 650^2/6 = 70,4 * 10^3\ mm^2$

SHEAR PER UNIT LENGTH $= \frac{1034}{650} = 1,59\ kN/mm$

FORCE PER UNIT LENGTH $= \frac{931}{650} + \frac{288}{70.4} = 5,52\ kN/mm$

RESULTANT $= \sqrt{1.59^2 + 5,52^2} = 5,74\ kN/mm$

$a_{REQ} = \frac{5,74 * 10^3}{2 * 262} = 11\ mm$ → USE FULL PEN WELDS K.

CHECK HE500A HORIZONTAL.

$N_{Sd} = -48\ kN$

$M_{y\,Sd} = 238\ kNm$

$V_{z\,Sd} = 95\ kN$

$$\sigma_a = \frac{48 * 10^3}{19754} + \frac{238 * 10^3}{3949}$$

$$= 3 + 61 = 64\ N/mm^2 \longrightarrow ok$$

CHECK HE 500B DIAGONAL. (381)

$N_{Sd} = -2250\ kN$

$M_{y\,Sd} = 235\ kN$

$V_{z\,Sd} = 101\ kN$

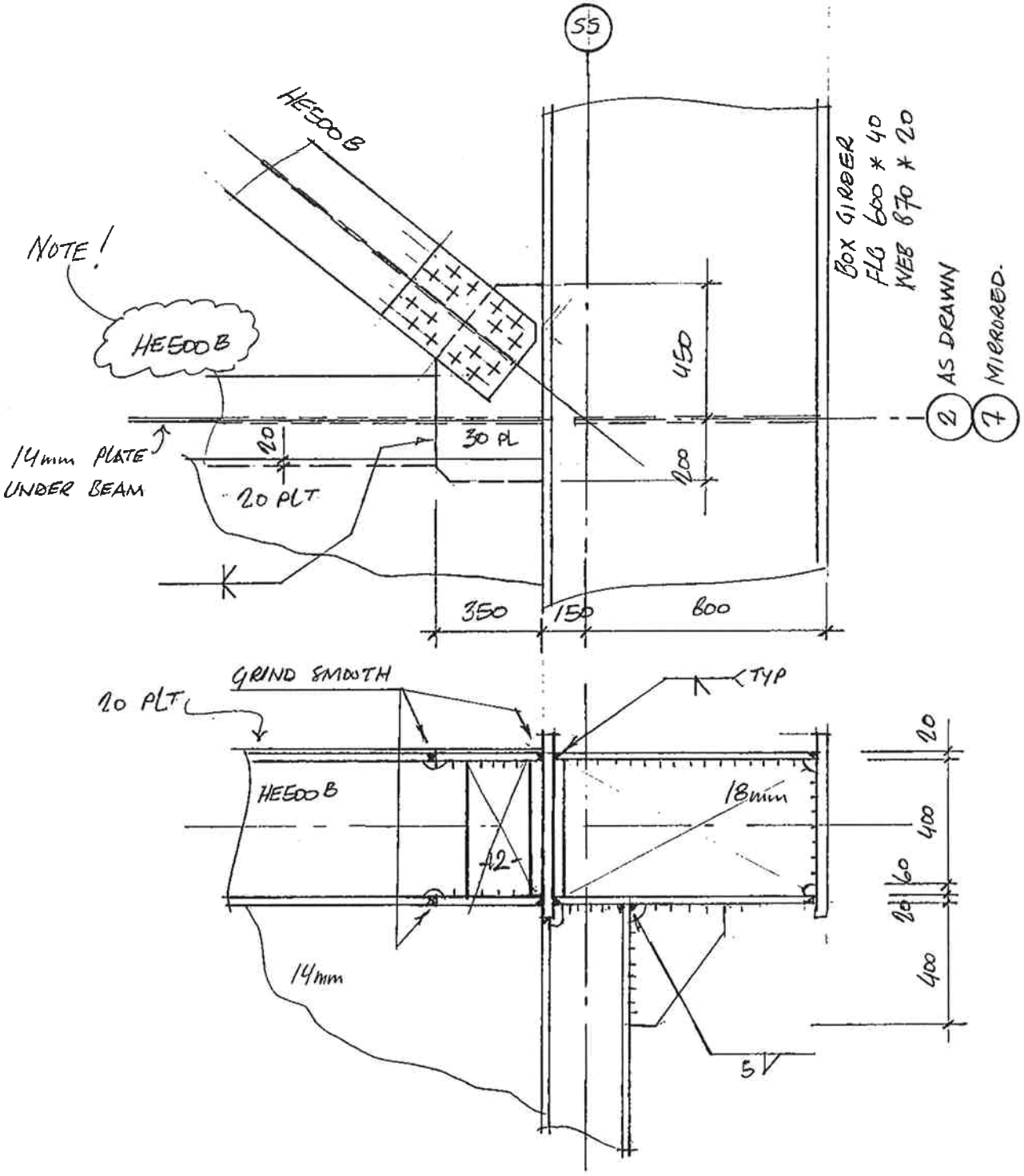
$$\sigma_a = \frac{2250 * 10^3}{23864} + \frac{235 * 10^3}{4815}$$

$$= 95 + 49 = 144\ N/mm^2 \longrightarrow ok$$

Project : MALAMOCCO LOCK VENICE.

Onderdeel :

DETAIL 14



Opgesteld : GWJ

Datum : 5/04

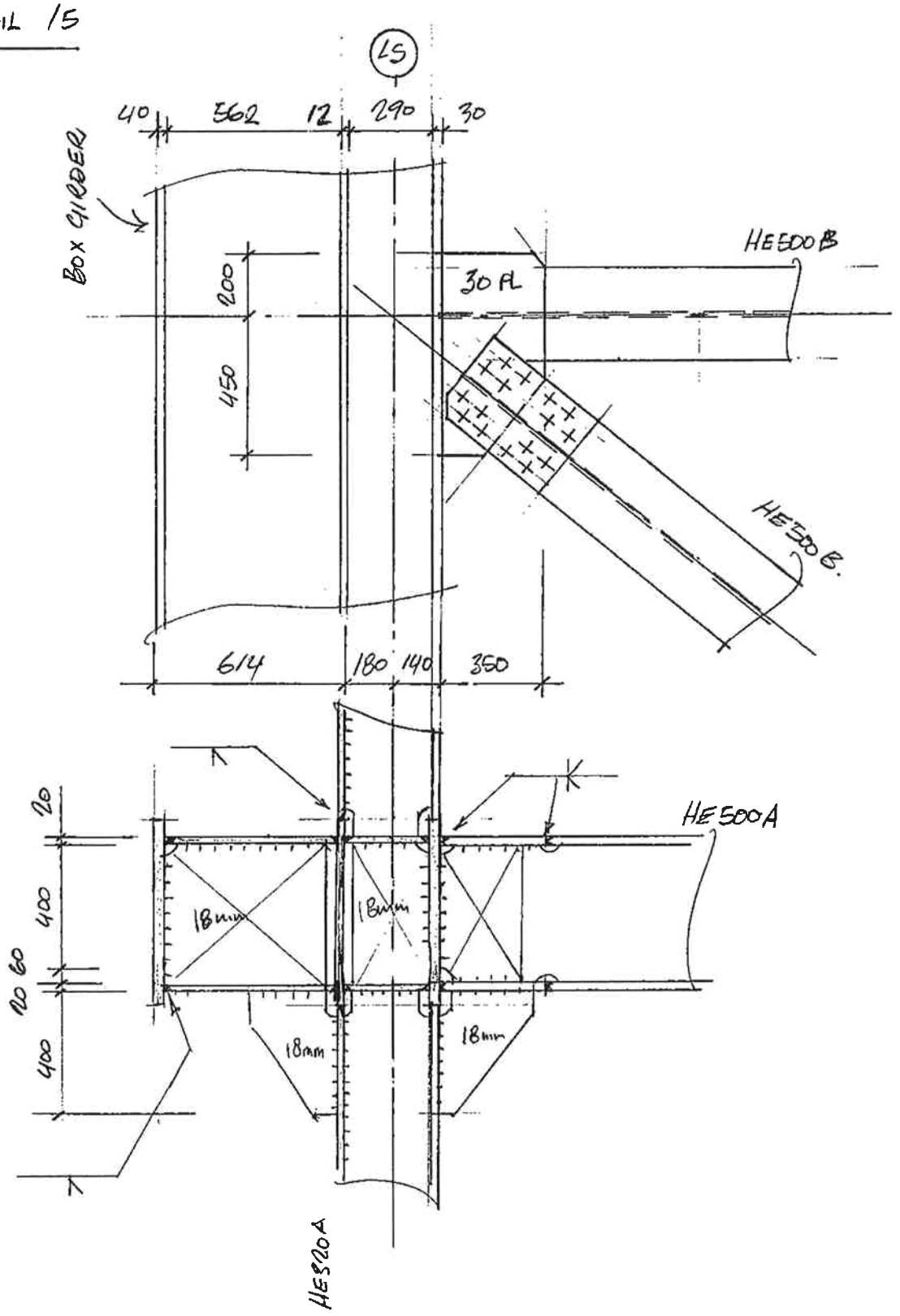
Bladnummer : B-71

Rev. : A2.

Project : MALAMOCCO LOCK VENICE

Onderdeel :

DETAIL 15



Opgesteld : GWJ

Datum : 5/04

Bladnummer : B-72.

Rev. A2

BOLTED CONNECTION.

BOLTS IN SHEAR & BEARING. $N_{Sd} = 2400$ kN.

M24 GR 8.8 BOLTS

$A = \frac{\pi (24)^2}{4} = 452 \text{ mm}^2$

$A_b = 0{,}8 * 452 = 360 \text{ mm}^2$

$f_u = 800 \text{ N/mm}^2$

$F_{V,Rd} = \frac{0.6 * 800 * 360}{1.25 * 10^3} = 138$ kN.

HE500B $A = 23864 \text{ mm}^2$

WEB $A_w = 14.5 * 444 = 6438 \text{ mm}^2$ (0,27)

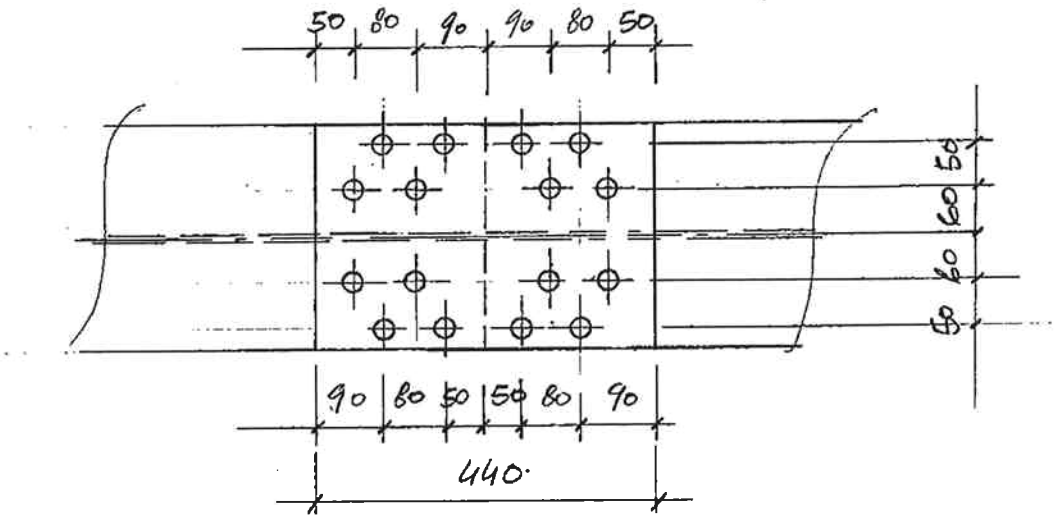
FLANGES $A_{ff} = 23864 - 6438 = 17426 \text{ mm}^2$ (0.73)

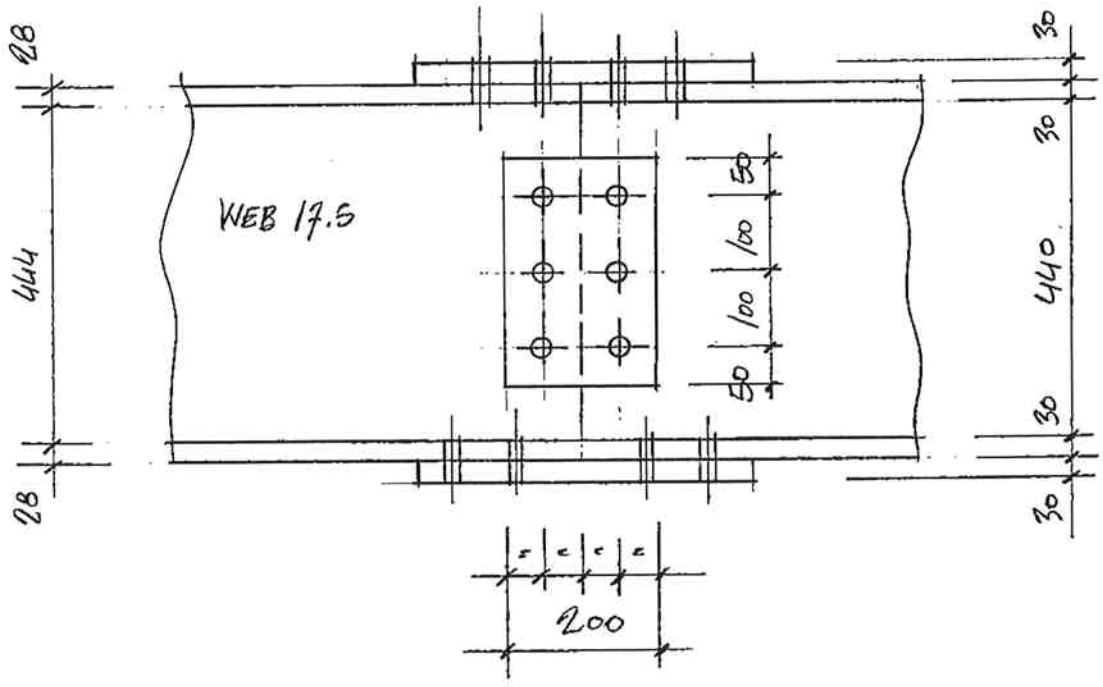
FORCE IN FLANGES = $0{,}73 * 2400 = 1752$ kN

FORCE IN WEB = $0.27 * 2400 = 648$ kN

Project : MALAMOCCO LOCK VENICE

Onderdeel :





Opgesteld : GWJ Datum : 5/04 Bladnummer : B-74. Rev. : A2

WEB BOLTS ~ 3 * M24 GR 8.8 DOUBLE SHEAR

$F_{v,Rd} = 2 * 3 * 138 = 828\ kN > 648\ (0,78)$

HE500B WEB ~ 17,5mm → 15,5mm (CORROSION ALLOWANCE)

$e_1 = 45mm$

$\frac{e_1}{3d_0} = \frac{45}{3 * 26} = 0,58.$

$F_{b,Rd} = \frac{3 * 2.5 * 0,58 * 800 * 24 * 15,5}{1.25 * 10^3} = 1035\ kN\ (0,63)$

CONNECTOR PLATES.

2 * PLATES 12mm THICK (10mm CORROSION ALLOWANCE)

$A = 2 * 10 * 300 = 6000\ mm^2$; $A_{NET} = 2 \cdot 10 \cdot (300 - 3 \cdot 26) = 4400\ mm^2$.

$N_{pl,Sd} = 4,4 * 355/1.25 = 1250\ kN > 648\ (0,52)$

FLANGE BOLTS ~ 8 * M24 GR 8.8 SINGLE SHEAR

$F_{v,Rd} = 2 * 8 * 138 = 2208\ kN > 1752\ (0,79)$

CONNECTOR PLATES

2 * PLATES 30 mm THICK (28mm CORROSION ALLOWANCE)

$A = 2 * 28 * 300 = 16800\ mm^2$

$N_{pl,Sd} = 16,8 * 355/1,25 = 4771\ kN > 1752\ (0,37)$

B2 BUMPER BEAM N SEA SIDE

BOAT LOAD 5000 kN

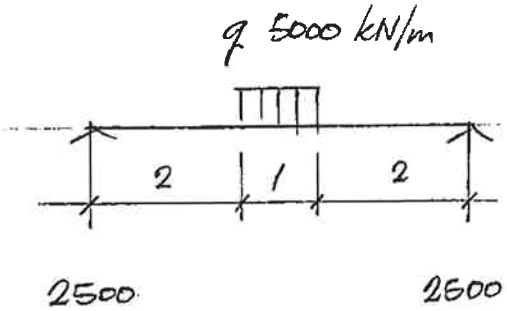
LOAD SPREAD ~ 1000 mm

$q = 5000$ kN/m.

MAX BM.

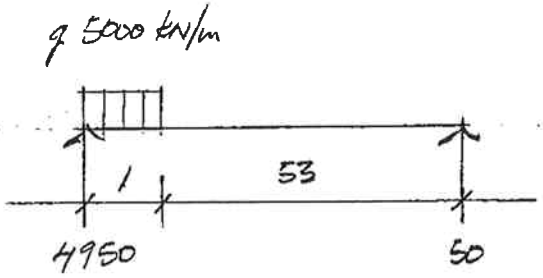
$M = \frac{5000}{4}(5 - 1/2)$

$= 5625$ kNm



MAX SHEAR

$V = 4950$ kN



BEAM FORCES

	LOAD @ GATE CENTRE			LOAD @ HYDRO-FOOT.		
	D.L.	WATER	BOAT.	D.L.	WATER	BOAT.
N	-120	-2850	-3550	-100	-1250	-500
M_z		350	5625		450	5625
V_y			2500			5000

GATE CENTRE

$N_c = 120 + 2850 + 3550 = 6520$ kN

$M_z = 350 + 5625 = 5975$ kNm

$V_y = 2500$ kN

NEAR HYDRO-FOOT.

$N_c = 100 + 1250 + 500 = 1850$ kN

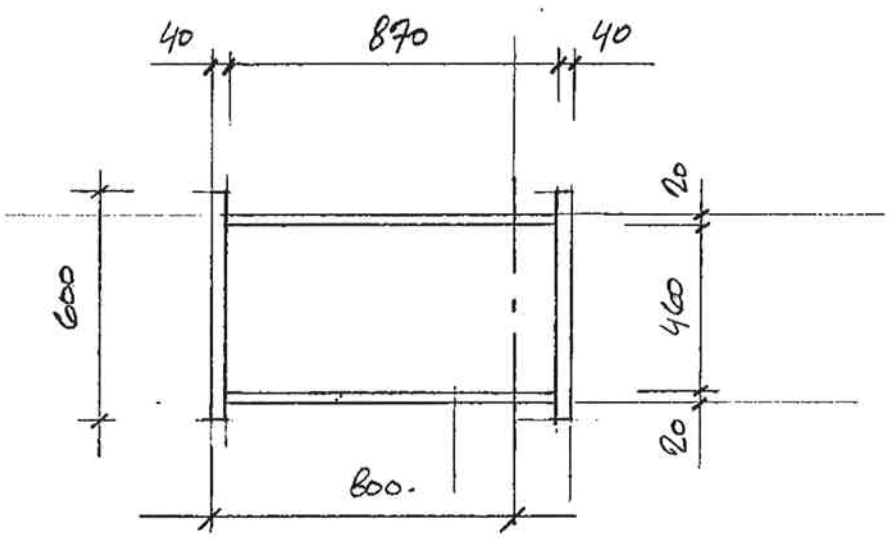
$M_z = 450 + 5625 = 6075$ kNm

$V_y = 5000$ kN

Project : MALAMOCCO LOCK VENICE

Onderdeel : BUMPER BEAMS

BOX GIRDER PROPERTIES. N SEA SIDE.



ALLOW 1mm CORROSION ON OUTSIDE.

AREA

$2 * 598 * 39 = 46\,644$
$2 * 19 * 870 = 33\,060$

$79\,704\ mm^2$

Project : MALAMOCCO LOCK VENICE

Onderdeel : BUMPER BEAMS

INERTIA I_z $*10^4 mm^4$

$598 * 39^3/12 * 2$	=	591
$46644 * 454,5^2$	=	963526
$19 * 870^3/12 * 2$	=	208526.
		1172643

INERTIA I_y.

$39 * 598^3/12 * 2$	=	139001.
$870 * 19^3/12 * 2$	=	100
$33060 * 239,5^2$	=	189633
		328734.

$$i_z = \sqrt{\frac{1172643 * 10^4}{79704}} = 384 \text{ mm}$$

$$i_y = \sqrt{\frac{328734 * 10^4}{79704}} = 203 \text{ mm}$$

$$W_z = \frac{1172643 * 10^4}{474} = 24739 * 10^3 \text{ mm}^3.$$

Opgesteld : GWJ Datum : 03/04. Bladnummer : Bz - 4 Rev. :

CROSS - SECTIONAL STRENGTH

SECTION CLASS

FLANGE $b/t = 460/40 = 11.5$

WEB. $d/t = 870/20 = 43.5$

$\varepsilon = \sqrt{235/356} = 0,81$

FLANGE : $11.5/0,81 = 14.2 < 33 \longrightarrow$ CLASS 1

WEB : $43.5/0,81 = 53.7$

$\psi = \frac{-166}{308} = -0.54 \quad \frac{42\varepsilon}{(0,67+0,33\psi)} = 69. \quad d/t < 69 \rightarrow$ CLASS 3.

LOAD COMBINATION ~ LOAD @ GATE CENTRE.

$N_{Sd} = 1.0(120) + 0.7(2850) + 1.0(3550) = 5665$ kN.

$M_{Sd} = 0.7(350) + 1.0(5625) = 5870$ kNm

$V_{Sd} = 1.0(2500) = 2500$ kN

LOAD COMBINATION ~ LOAD @ HYDRO FOOT

$N_{Sd} = 1.0(100) + 0.7(1250) + 1.0(500) = 1475$ kN

$M_{Sd} = 0.7(450) + 1.0(5625) = 5940$ kNm

$V_{Sd} = 1.0(5000) = 5000$ kN

Project : MALAMOCCO LOCK VENICE

Onderdeel : BUMPER BEAMS

CROSS - SECTIONAL CHECK

LOADING ~ @ GATE CENTRE

LONGITUDINAL STRESS

$$\sigma = \frac{5665 * 10^3}{79704} + \frac{5870 * 10^3}{24739}$$

$$= 71 + 237 = 308 \ N/mm^2 \qquad U.C. \ \frac{308}{355/1.1} = 0.96$$

LOADING ~ @ HYDROFOIL

LONGITUDINAL STRESS

$$\sigma = \frac{1475 * 10^3}{79704} + \frac{5940 * 10^3}{24739}$$

$$= 19 + 240 = 259 \ N/mm^2$$

SHEAR STRESS

$$\tau = \frac{5000 * 10^3}{2 * 20 * 870} = 144 \ N/mm^2 \qquad U.C. \ \frac{144\sqrt{3}}{355/1.1} = 0.78.$$

Opgesteld : GWJ Datum : 03/04 Bladnummer : B2 - 8 Rev. :

BUCKLING CHECK

$$\lambda_e = \pi\sqrt{\frac{E}{f_y}} = 76.4 \qquad (f_y = 355\ N/mm^2)$$

$l_y = 10000$ mm $\qquad \bar{\lambda}_y = 10000/203 * 76.4 = 0.65$

$l_z = 5000$ mm $\qquad \bar{\lambda}_z = 5000/384 * 76.4 = 0.17$

$\chi_y = 0,755$ (curve c)

$\chi_z = 1.000$

$\beta_{Mz} = 1.4$ (Fig 5.5.3)

$$\mu_z = \bar{\lambda}_z (2\beta_{Mz} - 4)$$

$$= 0.17(2 \times 1.4 - 4) = -0.2 \quad (< 0,9)$$

$$k_z = \frac{1 - \mu_z N_{sd}}{\chi_z A f_y} = \frac{1 + 0.2(5665)}{1.0(80)(355)} = 1.04 \quad (< 1.5)$$

U.C.

$$\frac{5665 * 1.1}{0.755 * 80 * 355} + \frac{1.04 * 5870 * 1.1}{24.739 * 355}$$

$0.29 + 0.77 = 1.06 > 1.0 \longrightarrow$ ACCEPT

[BEAM END STIFFNESS IGNORED — EFFECTIVE LENGTH < 10000 mm]

BUMPER BEAM ~ LAGOON SIDE

BEAM FORCES.

	GATE CENTRE		NEAR HYDROFOOT	
	DEAD LOAD	BOAT.	DEAD LOAD	BOAT.
N	-1850	-1750	-450	-600
M_z	—	5625	—	5625
V_y	—	2500.	—	5000

GATE CENTRE

$N_c = 1850 + 1750 = 3600$ kN

$M_z = 5625$ kNm

$V_y = 2500$ kN

NEAR HYDROFOOT.

$N_c = 450 + 600 = 1050$ kN

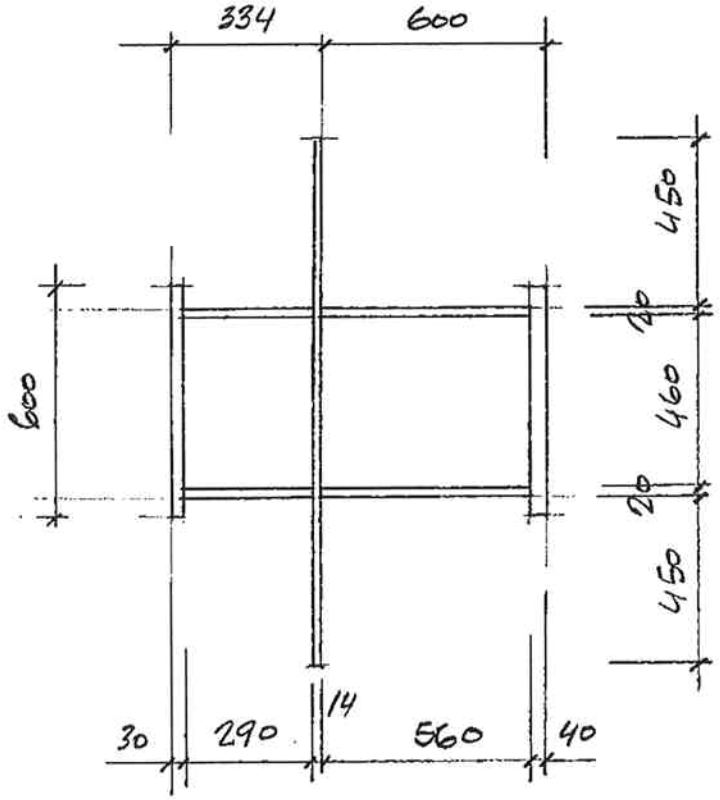
$M_z = 5625$ kNm

$V_y = 5000$ kN

Project : MALAMOCCO LOCK VENICE

Onderdeel : BUMPER BEAMS

BOX GIRDER PROPERTIES. N LAGOON SIDE.



ALLOW 1mm CORROSION ON OUTSIDE.

AREA			e	A.e
598 * 29	=	17342	14.5	251 459
500 * 14	=	7000	326	2282 000
2 * 450 * 12	=	10 800	326	3520 800
598 * 39	=	23 322	912.5	21 281 325
2 * 19 * 290	=	11 020	174	1 917 480
2 * 19 * 560	=	21 280	613	13 044 640
		90764 mm²		42297704

$$e_z = \frac{42297704}{90764} = 466 \text{ mm}$$

Opgesteld : GWJ Datum : 03/04 Bladnummer : B2 – 9 Rev. :

Project : MALAMOCCO lock VENICE

Onderdeel : BUMPER BEAMS

INERTIA I_z.

$*10^4\ mm^4$

$598 * 29^3/12$	+	$17342(466-14.5)^2$	=	353642
$500 * 14^3/12$	+	$7000(466-326)^2$	=	13731.
$450 * 12^3/12 * 2$	+	$10800(466-326)^2$	=	21181
$598 * 39^3/12$	+	$23322(912.5-466)^2$	=	465248
$19 * 290^3/12 * 2$	+	$11020(466-174)^2$	=	101684
$19 * 560^3/12 * 2$	+	$21280(613-466)^2$	=	101596.
				1057082

$$i_z = \sqrt{\frac{1057082 * 10^4}{90764}} = 341\ mm$$

$$W_z = \frac{1057082E4}{468} = 22587 * 10^3\ mm^3$$

CROSS SECTIONAL STRENGTH

$$\sigma_x = \frac{3700 * 10^3}{90764} + \frac{5625 * 10^3}{22587}$$

$$= 41 + 249 = 290\ N/mm^2$$

$$U.C. \quad \frac{290}{355/1.1} = 0{,}90$$

Opgesteld : GWJ Datum : 03/04 Bladnummer : BR-10 Rev. :

Project : MALAMOCCO LOCK VENICE

Onderdeel : BUMPER BEAMS

BUCKLING CHECK

$$\lambda_e = \pi\sqrt{\frac{E}{f_y}} = 76.4 \qquad (f_y = 355\ N/mm^2)$$

$l_z = 5000\ mm$ $\qquad \bar{\lambda}_z = 5000/341 * 76.4 = 0,19$

$\chi_z = 1,0000 \longrightarrow$ NO BUCKLING CHECK NECESSARY !

Opgesteld : GWJ Datum : 03/04. Bladnummer : B2 – 11 Rev. :

Project : Malamocco Lock Venice

Onderdeel : # Forces during situation 4 - wave load.

CONDITION	MEMBER	4/COMBI	N	V_y	V_z	M_y	M_z
4.	345	11	434	-3	-7	-11	-8
—	346	11	551	0	-6	-12	1
—	385	11	-125	-1	3	-7	0
—	386	11	132	-2	1	2	3
—	397	11	-107	-1	5	-10	0
—	398	11	123	-2	1	2	2
—	369	11	-75	0	5	-10	0
—	370	11	87	-1	1	2	1
—	361	11	-19	0	4	-7	1
—	362	11	20	0	1	1	0
—	409	11	606	2	-8	-13	6
—	338	12	375	-1	-6	-11	-4

The above - presented table shows the governing truss- loads during opening and closing (situation 4) combined with a wave - load (H = 0.7 m). The situation is new compared to when the original calc. was made, but none of the values is governing for the design

Opgesteld : DAL/JAN

Datum : 7/7/04

Bladnummer : B2-12

Rev. :

Project : MALAMOCCO NAV. LOCK GATE.

Onderdeel : WELDING DETAILS.

B3. WELDING DETAILS.

CONCERNING WELDS:

1. WELDS AT TRUSS CONNECTION DETAILS / BUMPER BEAM.
2. WELDS BUOYANCY TANK.
3. WELDS SKIN.
4. OTHERS

Opgesteld : A. SEMGEEST | Datum : 07-07-04 | Bladnummer : B3-1 | Rev. : A3

(1) WELDS AT TRUSSCONNECTIONS DETAILS / BUMPER BEAM.

THESE ARE ALREADY DETERMINED IN THEIR CALC. SECTION OF THIS DOCUMENT : ADDENDUM B1 + B2.

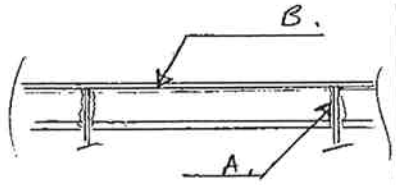
MISCELLANEOUS WELDS.

(2) WELDS BUOYANCY TANK.

A WELDS STIFFENERS TO BULKHEADS

CHECKED IN ADDENDUM. K2-8.

~~AA~~ a=8 ⇒ SUFFICIENT.



B. (NECK). STIFFENER TO SKIN:

$$t_p = \frac{V \cdot S}{b \cdot I}.$$

$V = 162,5 \cdot 0,467 \cdot 5,0 = 380\ kN$ [REF. K2-8]

GOVERNING STIFFENER: VERT. WALL SEAWARD SIDE 1st bulb [K2-9]

$I = 2,29 \cdot 10^5\ mm^4. \quad = 2,29 \cdot 10^8\ mm^4.$

$S = [467,5 \cdot 39] \cdot (64 - \frac{39}{2}) = 8,66 \cdot 10^5\ mm^3.$

$b = 2 \cdot 5$ (CALC. 4) $= 8\ mm.$

$t_p = 180\ N/mm^2.$

$\tau_u = 355/1,1 \cdot \sqrt{3} = 186\ N/mm^2$ } u.c. = 0,97.

~~AA~~ a=5; SUFFICIENT

2. MISCELLANEOUS WELDS.

WELDS STRESS RELATED FROM PLATE STRESS.

WITH CONSERVATIVE APPROACH FROM EC.3 – 6.6.5.3.

$$F_{w;Rd} = f_{v;w;d} \cdot a.$$

$$f_{v;w;d} = \frac{f_u/\sqrt{3}}{\beta_w \cdot \gamma_{MW}} = \frac{510/\sqrt{3}}{0.9 \cdot 1,25} = 262\ N/mm^2.$$

$$a = F_{w;Rd}/262.$$

$$F_{w;Rd} = \sigma_{pl;E} \cdot t_{pl}.$$

$$u.c.pl. = \sigma_{pl;E}/f_{y;d}. \rightarrow \sigma_{pl} = u.c.pl * 323 \quad (t_{pl} < 20)$$
$$\sigma_{pl} = u.c.pl * 313 \quad (t_{pl} > 20)$$

AS CAN BE ESTIMATED FROM THE CALCULATIONS MADE FOR EACH TYPE OF PLATE A MAX. U.C. CAN BE GIVEN.

$$a_{tot} = 17,23 \cdot u.c_{pl} \cdot t_{pl}. \quad (t_{pl} < 20)$$
$$= 1,2 \cdot u.c_{pl} \cdot t_{pl}. \quad (t_{pl} > 20)$$

t_{pl}.	u.c.pl.	a_{tot}	WELD	Comment
PL. 40	0.36	17.71	2 * 10	
PL. 25	0.31	9.53	2 * 10	reason: possible peak stresses
PL. 20	0.31 shear stress seepage UC2-8	7.44	2 * 8	reason: possible peak stresses

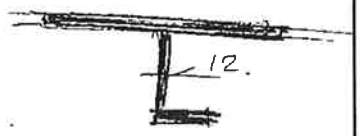
Project : MALAMOCCO NAV. LOCK GATE.

Onderdeel : WELDING DETAILS

(3) WELDS SKIN

(EQUAL TYPE AS BUOYANCY TANK)

A. FLANGE : $\sigma_{STIFF;FLANGE} = 323\ N/mm^2$ (CAPACITY).



$\sigma_1 = \tau_1 = 323 \cdot 12 \cdot \sqrt{2}/4 \cdot a$.

$\sigma_{1;MAX} = \sigma_{WISID} \cdot \sqrt{3}/2 = 226\ N/mm^2$

$a_{min} = \frac{323 \cdot 12 \cdot \sqrt{2}}{4 \cdot 226} = 6,1\ mm$.

WELD ⇒ FULL PEN (FAVOURABLE FOR FATIGUE → class 71)

WEB : FULL PEN; NOT GOVERNING.

B. (NECK) STIFFENERS TO SKIN.

REF. A1-12 :

$V_D = 1,5309 \cdot 0320 \cdot 5,0 = 74\ kN$.

$I = 4,42 \cdot 10^7\ mm^4$.

$S = [320 \cdot 12] \cdot (74 - \frac{12}{2}) = 261120\ mm^3$.

$b = 2 \cdot 5$ (calc 4.) $= 8\ mm$

$\tau = \frac{V \cdot S}{b \cdot I} = 55\ N/mm^2$

$\tau_{wid} = 186\ N/mm^2$

} U.C = 0,3 < 1,0 OK.

~~AA~~ a = 5 ; SUFFICIENT.

(4) OTHERS.

$\frac{1}{2}$ HEA 650 to SKIN.

$$\tau_2 = \frac{V \cdot S}{b \cdot I} = f_{w;u;d} = 262\ N/mm^2.$$

∴ SECTION PROPERTIES AND LOADS DERIVED FROM MAIN CALC. GIVEN ON 3 NEXT PAGES.

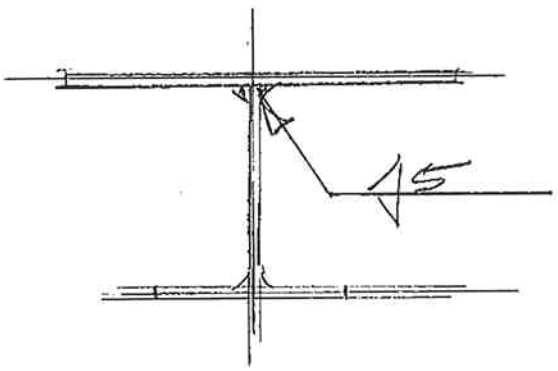
$V_{MAX;D} = 457\ kN.$

$S = A_{pl;a} = (14.448) \cdot 176. = 1103872\ mm^2.$

$b = 2 \cdot a_{WELD;min}.$

$I = 4{,}04 \cdot 10^8\ mm^4.$

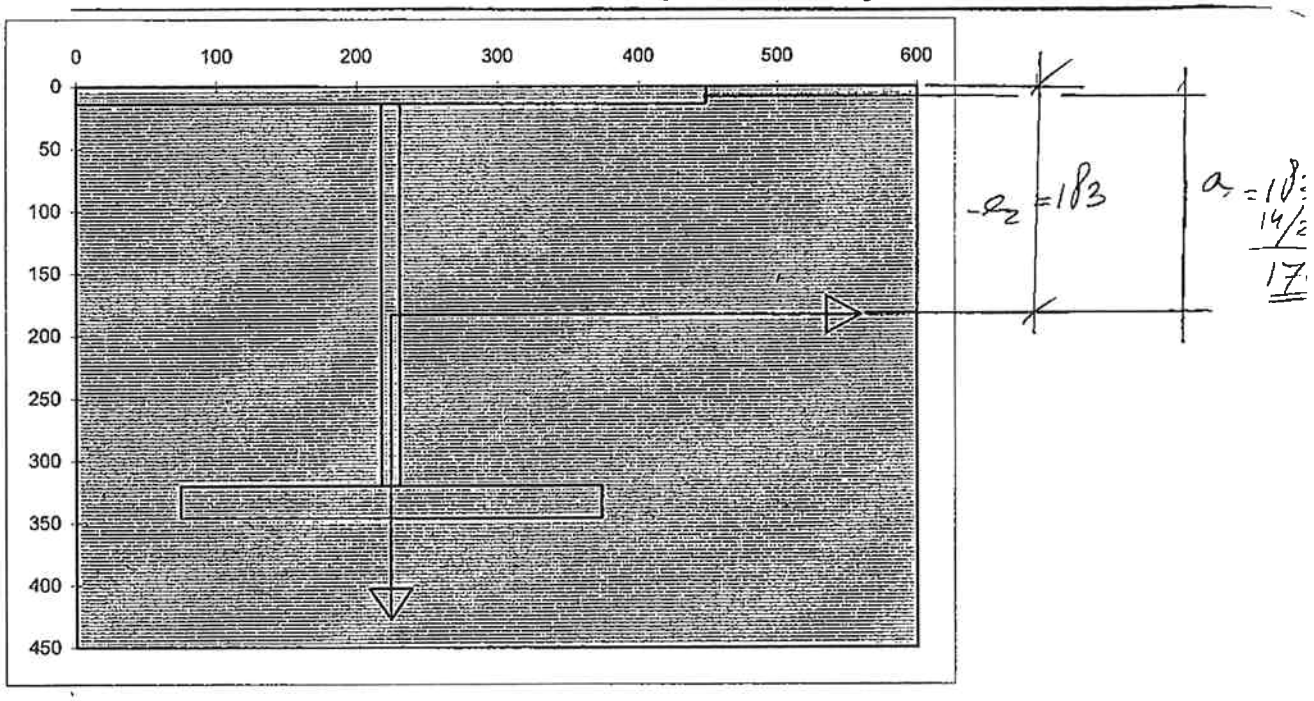
$a_{WELD;min} = 2{,}4$; USE TYPICAL WELD $\perp$ a = 5 mm.



Berekening statische waarden van een profiel
samengesteld uit plaatvormige doorsneden.

profielnaam :
referentie :

SECTIONPROPERTIES ½ HEA650 TO SKIN.



Uitwendige afmetingen

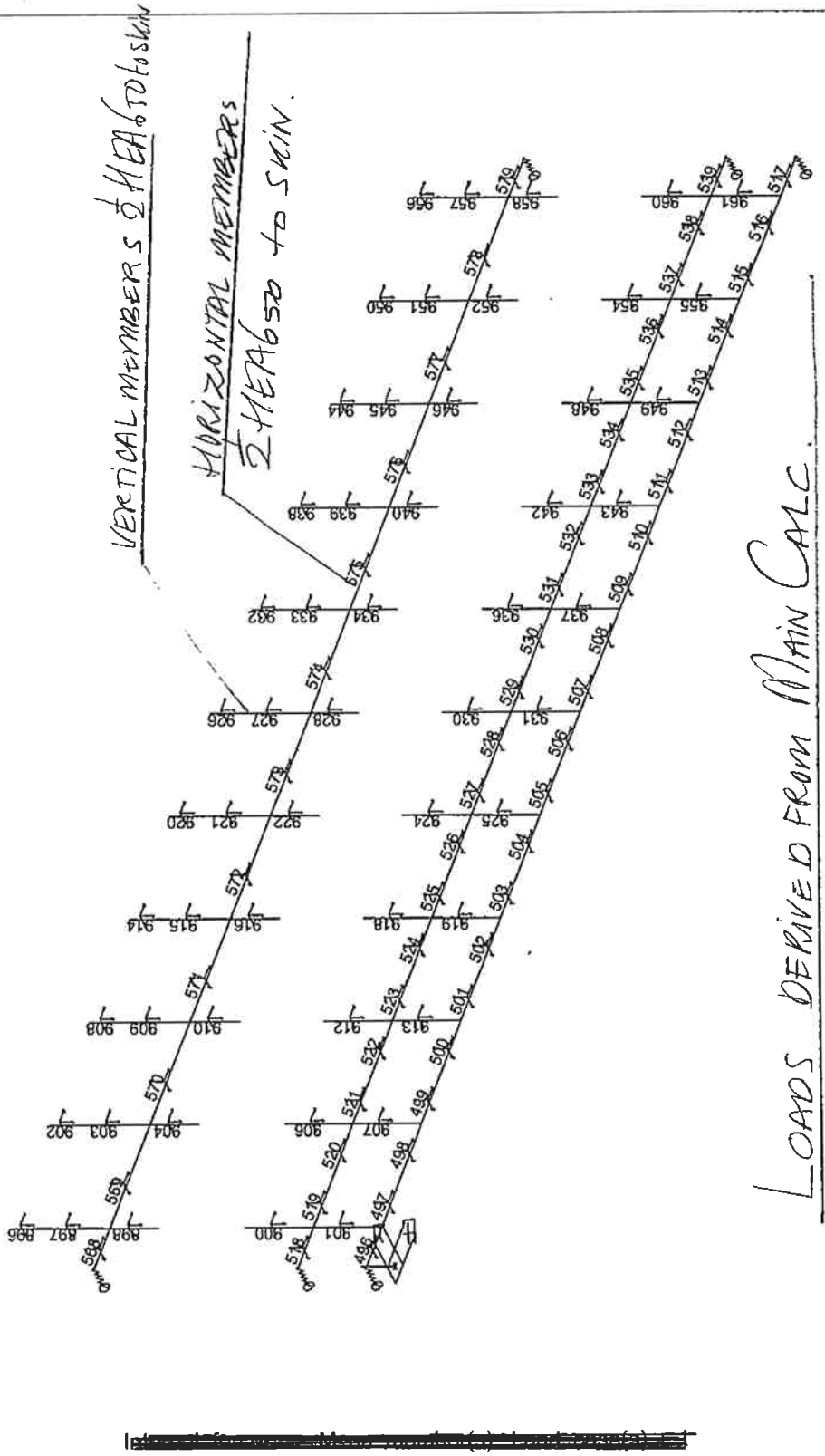
hoogte (z)	=	346	mm
breedte (y)	=	448	mm

Zwaartepuntsafstanden

$-e_y$	=	-224	mm
$+e_y$	=	224	mm
$-e_z$	=	-183	mm
$+e_z$	=	163	mm

Statische waarden

oppervlak A	18203	mm^2
traagheidsmoment I_{yy}	4,036E+08	mm^4
weerstandsmoment $W_{y;el;b}$	-2,21E+06	mm^3
weerstandsmoment $W_{y;el;o}$	2,48E+06	mm^3
weerstandsmoment $W_{y;pl}$	2,59E+06	mm^3
traagheidsstraal i_y	149	mm
traagheidsmoment I_{zz}	1,635E+08	mm^4
weerstandsmoment $W_{z;el;l}$	-7,30E+05	mm^3
weerstandsmoment $W_{z;el;r}$	7,30E+05	mm^3
weerstandsmoment $W_{z;pl}$	1,30E+06	mm^3
traagheidsstraal i_z	95	mm


VERTICAL MEMBERS 2 HEA 650 to skin.
HORIZONTAL MEMBERS 2 HEA 650 to SKIN.
LOADS DERIVED FROM MAIN CALC.

Internal forces on member(s). Global extreme

Linear static - extreme or all combinations
Group of member(s)
:896/898,900/904,906/910,912/916,918/922,924/928,930/934,936/940,942/946,948/952,954/958,
960/961
Group of ultimate combi :1/14

memb	cr.nr	combi	dx [mm]	N [kN]	Vy [kN]	Vz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
934	9	2	0.0	901.06	3.15	-61.98	0.03	18.34	-1.61
928		10	2000.0	-1428.81	-0.00	125.16	-0.00	-118.00	-0.00
958		11	0.0	-175.71	23.17	13.95	0.00	-8.90	-19.93
898				-144.25	-22.26	15.42	-0.00	-13.77	19.02
948		10	2850.0	-881.71	4.86	450.94	0.01	204.50	6.60
904			0.0	-669.83	10.96	399.86	0.04	173.20	-8.29
950		2		248.03	11.24	0.95	0.08	-34.65	-0.66
897		4		-18.55	-9.82	-26.55	-0.08	42.15	14.60
954		10	2850.0	-664.99	4.33	449.50	0.04	213.82	5.90
948			950.0	-878.01	4.86	10.62	0.01	233.98	-2.64
958		11	2000.0	-179.61	23.17	13.95	0.00	19.00	26.41
898				-148.15	-22.26	15.42	-0.00	17.06	-25.49

VERTICAL MEMBERS ½ HEA650 to SKIN

03-6

Internal forces on member(s). Global extreme

Linear static - extreme or all combinations
Group of member(s) :496/539,568/579
Group of ultimate combi :1/14

memb	cr.nr	combi	dx [mm]	N [kN]	Vy [kN]	Vz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
506	9	10	0.0	1090.43	-28.46	-6.42	-0.17	-30.33	43.47
574		2		425.63	10.70	1.72	-0.03	3.69	-6.19
503		10		959.08	49.18	-79.04	0.14	77.75	-55.90
510			2500.0	959.01	-49.17	79.05	-0.14	77.77	-55.88
514				516.62	-46.04	95.96	-0.09	117.09	-54.13
499			0.0	515.89	46.05	-96.16	0.09	117.75	-54.13
507				1090.42	46.63	-63.10	-0.17	40.51	-50.39
496			1950.0	-60.31	7.69	-18.90	-0.05	47.92	10.63
503			2500.0	959.08	31.01	-9.51	0.14	-32.93	44.34

HORIZONTAL MEMBERS ½HEA650 to JKN

Addendum C Levelling sluices

Contents:

Project : MALAMOCCO NAV. LOCK GATE.

Onderdeel : LEVELLING SLUICES.

C. LEVELLING SLUICES.

INDEX PAGE.

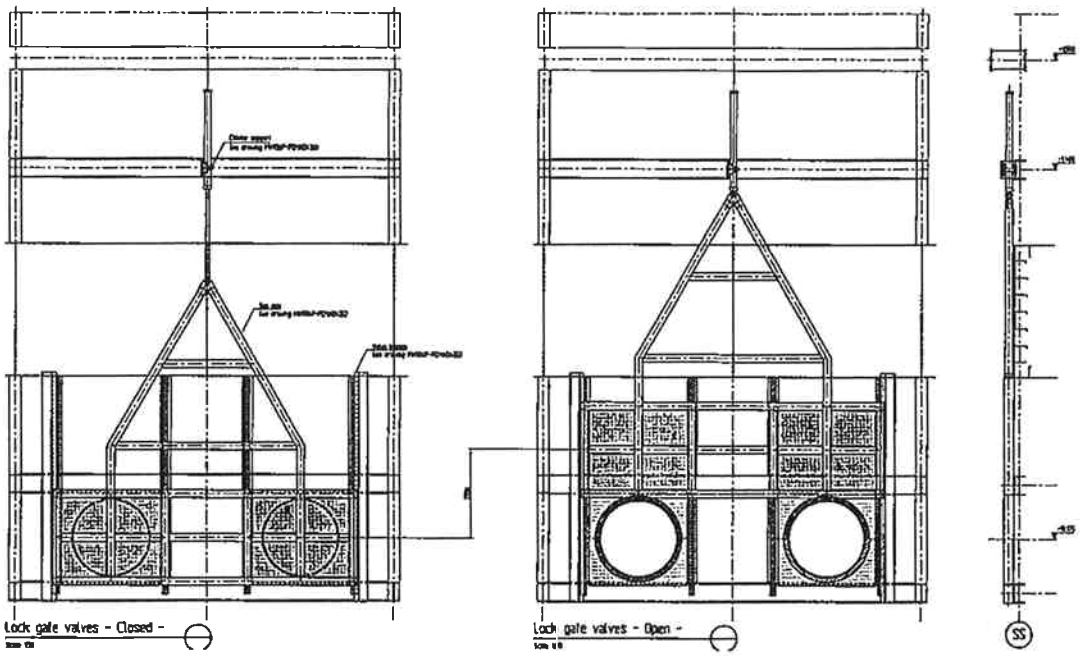
Opgesteld : ALSEMGEEST Datum : 7 JAN. '04 Bladnummer : C-INDEX Rev. : A2

Project : MALAMOCCO NAV. LOCK GATE.

Onderdeel : LEVELLING SLUICES.

C.1 OVERVIEW

- ALL STEEL : S355JR
- WELDS ; FRAME □200/10 a = th PLATE.
  ALL OTHER K a = 5 U.N.O.



Opgesteld : AMSEMGEEST Datum : 7 JAN 04 Bladnummer : C1-1 Rev. : A2

Project : MALLAMOCCO NAV. LOCK GATE.

Onderdeel : LEVELLING SLUICES.

C2 LOADS ACC. MV036P-PEMAR4001 REV. A1.

* SELFWEIGHT STEEL LEVELLING SLUICE:

Ø200/10: G = 58,8 kg/m'.

l_{tot} = 3 · (5 + 2 · 1,425*) = 23,6 m'

6 · (2-1,425) = 17,1 "

5,0 + 3,0 + [1,0 · 2] = 10,0 "

2 · √(2,5² + (2 · 2,165)²) = 10,0 " +

69,7 m'

m · Ø200/10 = G · l = 3510 kg.

PL. th = 1.2 G = 7850 kg/m³.

V = 2 · 4 · (1,225² · 14 · 10⁻³) = 0,17 m³.

$m_{pl.14}$ = G · V = 1335 kg.

+

TOT. SELFWEIGHT LEVELLING VALVE: ≃ 4845 kg

INCL. 5 % EXTRA (KATH. PROTECTION ETC) ≃ 5000 kg

Fg. = 50. kN.

* CONSERVATIVE.

Opgesteld :	Datum :	Bladnummer :	Rev. :
HSEMGEEST.	7 JAN 64	C-2-1	0

Project : MALAMOCCO NAV. LOCK GATE.

Onderdeel : LEVELLING SLUICES.

* MAX. HORIZONTAL POSITIVE FALL OVER GATE:

CLOSED EXTREEM SITUATION

$\Delta h_c = 3,0$ m.

$q_R = 30,9$ kN/m² (SLS; $\gamma = 1,0$)

$q_D = 46,4$ kN/m² (ULS: $\gamma = 1,5$)

OPENING SITUATION.

$\Delta h_o = 2,0$ m.

$= 20,6$ kN/m².

$= 30,9$ kN/m².

LOADED AREA OF VALVES : A_v.

2 VALVES PER LEVELLING SLUICE.

$A_{PER\,VALVE} = [2,850 * 2,366] = 6,75$ m²

$F_v = A_v \cdot q$

CLOSED:

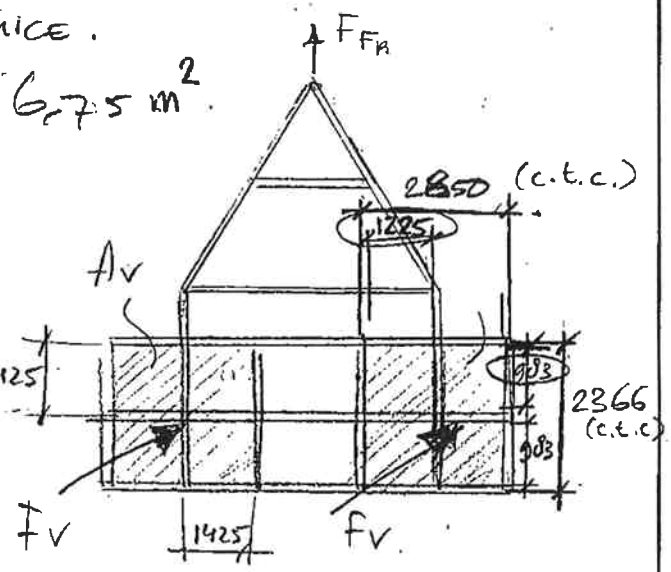
$F_{VALVE;C;R} = 6,75 \cdot 30,9 = 209$ kN,

$F_{VALVE;C;D} = 6,75 \cdot 46,4 = 314$ kN

OPENING:

$F_{VALVE;O;R} = 6,75 \cdot 20,6 = 139$ kN.

$F_{VALVE;O;D} = 6,75 \cdot 30,9 = 209$ kN.



* FRICTION FORCE AT OPENING VALVES.

$F_{FR} = \mu_{FR} \cdot F_{VALVE;O;TOT}$.

$\mu_{FR} = 0,22$ UHMWPE - STEEL (START MOVEMENT).

$F_{FR;R} = 0,22 \cdot [2 \cdot 139] = 61$ kN.

$F_{FR;D} = 0,22 \cdot [2 \cdot 209] = 92$ kN.

Opgesteld :	Datum :	Bladnummer :	Rev. :
ALSEMGEEST.	7 JAN 04	C2-2	0

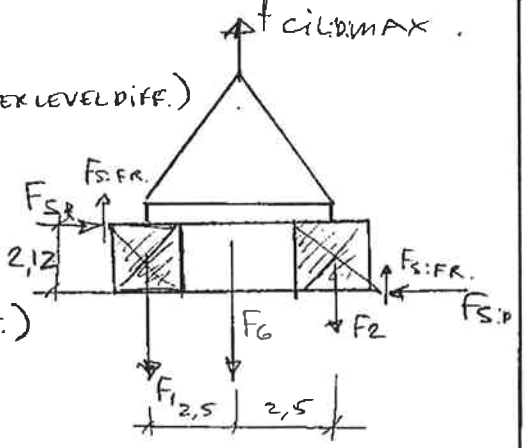
Project : MALAMOCCO NAT. LOCK GATE

Onderdeel : LEVELLING SLUICES.

* LOAD DURING OPENING / CLOSING

DERIVED FROM MECHANICAL CALC. DOC. MV036P-P-E-M-AR-5002

$F_{cil;D;MAX} = 219\ kN$. (WORKING LOAD: 16 MPa)



SLANTING WHEN OPENING: (2m' WATER LEVEL DIFF.)

MINIMUM RESISTANCE AT F_2.

MAXIMUM " AT F1. (STICKS)

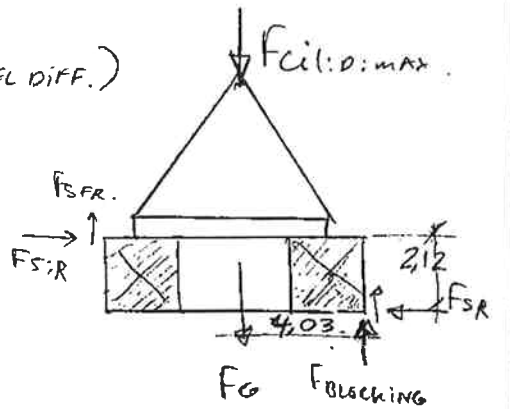
$F_{ON\ VALVE.} = 13.9\ kN$ (2m' WATER LEVEL DIFF.)

$F_{2;min} = \mu_{min} \cdot F_{2m'} = 13.9\ kN$.

$F_{1;MAX} = F_{cil;MAX} - F_G - F_{2min.} - 2 \cdot \mu \cdot F_S$.

$= 219 - 52 - 13,9 - 2 \cdot 0,22 \cdot F_S = 105\ kN$.

$F_{S;R} = (F_1 - F_2) \cdot 2,5/2,12 = 1,18 \cdot F_1 - 16,4 = 108\ kN$.



SLANTING WHEN CLOSING (NO WATER LEVEL DIFF.)

$F_{cil;D;MAX;our} = 101\ kN$ (16 MPa)

$F_{BLOCKING} + 2 \cdot \mu \cdot F_{S;d} = F_{cil} + F_G$.

$F_{S;R} = F_{BLOCKING} \cdot 4,03/2,12$.

$F_{BLOCKING}(1 + 2 \cdot 0,1 \cdot 4,03/2,12) = 219 + 52$.

$F_{BLOCKING} = 111\ kN \Rightarrow F_{S;R} = 211\ kN$.

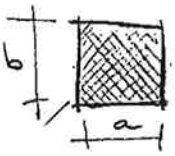
NOTE: FOR DETAIL STEELCHECK: ABOVE LOADS NEED TO BE FACTORED BY $\gamma = 1,5$.

Opgesteld: D. HAGENEST Datum: 24-03-04 Bladnummer: C2-3 Rev.: A2

C3.) SHEETING: PL. #1225 t=12 mm' (GOVERNING CLOSED SITUATION)

PLATE BENDING ACC. LIT. "YOUNG; FORMULES FOR STRESS AND STRAIN".

4-SIDES SIMPLY SUPPORTED PLATE (PAGE 458)



$a/b = 1183/983 = 1,2$.

$\sigma_{MAX} = \dfrac{\beta q_d \cdot b^2}{t^2}$ } $\beta = 0,3762$

$t_{pl} = 12$ mm → CALC. WITH $t = 10$ mm' DUE TO CORROSION. (IN STRESS CHECK ONLY)

$$\sigma_{MAX} = \frac{0,3762 \cdot 46,4 \cdot 10^3 \cdot (0,983)^2}{10^2} = 170 \text{ N/mm}^2.$$

$f_{yd} = 355/1,1 = 323 \text{ N/mm}^2$.

$u.c = 0,53 < 1,0$; O.K

WELD ⊠ $a = 5$;

$R_{MAX/m'} = \gamma \cdot q_d \cdot b$ } $0,455 \cdot 46,4 \cdot 0,983 = 21 \text{ kN/m}' = 21 \text{ N/mm}'$.

$\gamma = 0,455$

$\sigma_1 = \tau_1 = \dfrac{R \cdot \sqrt{2}}{2a} = 4 \text{ N/mm}^2$.

$\sigma_{ws;d} = 2 \cdot 4 / \sqrt{3} = 5 \text{ N/mm}^2 \ll f_{wd} = 262 \text{ N/mm}^2$ O.K.

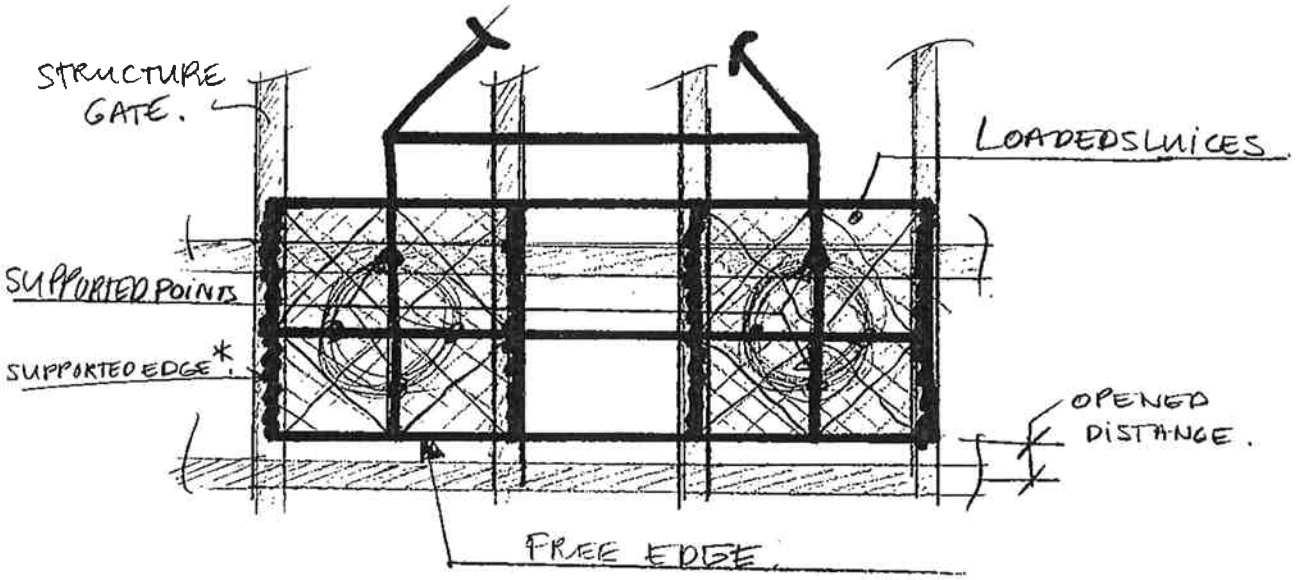
DEFLECTION :

NOT RELEVENT.

PLATES ARE PRESSED TO UHMWPE-SEAL AROUND SLUICE TUBES

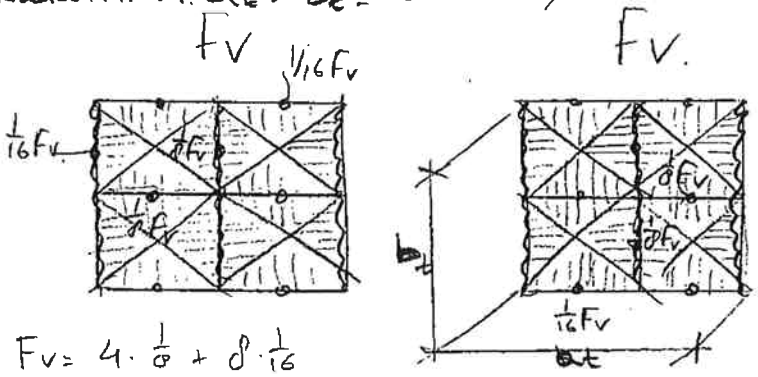
C4. VALVE FRAME + SUSPENSION

GOVERNING SITUATION: JUST AFTER OPENING SLUICE.



2 VALVES : $F_{PER\ VALVE;REPR} = 209$ kN (AS IN CLOSED SITUATION CONSERVATIVE).

LOAD TRANSLATED TO MEMBER FORCES:
(CONSERVATIVE: $a_L = b_L = 2850$mm)

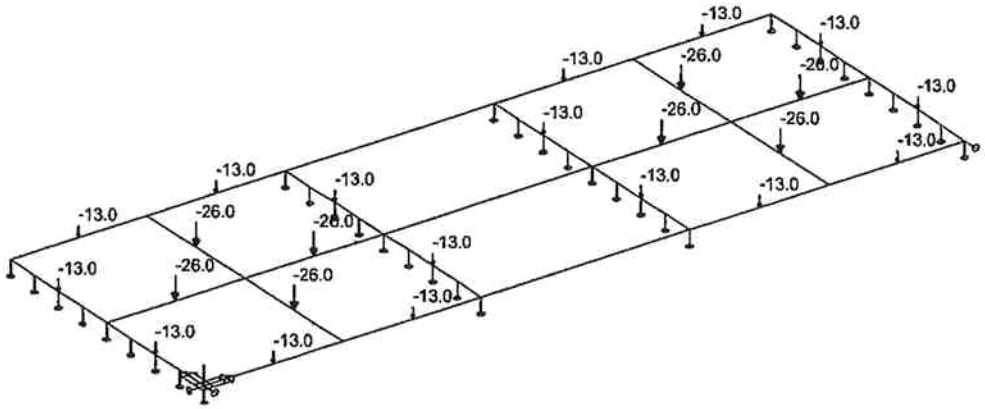


$\frac{1}{8} F_V = 26$ kN

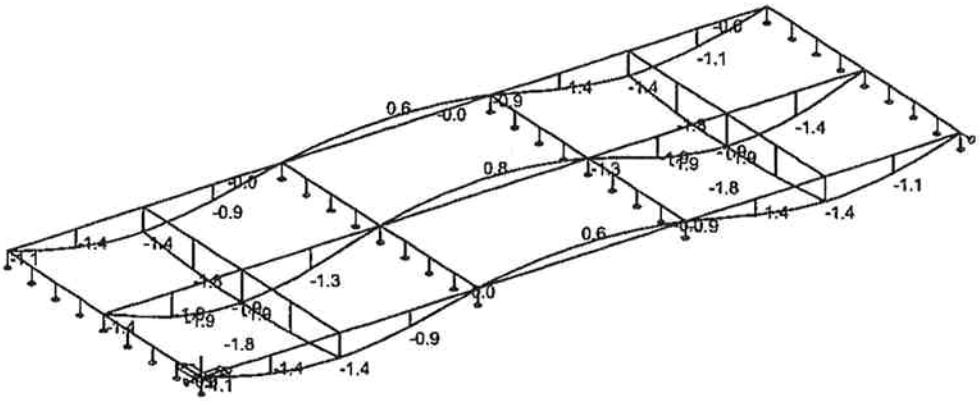
$\frac{1}{16} F_V = 13$ kN

BENDING MOMENTS (ULS) AND DEFORMATION (SLS) CALCULATED WITH FRAME PROGRAM. RESULTS ON NEXT PAGE.

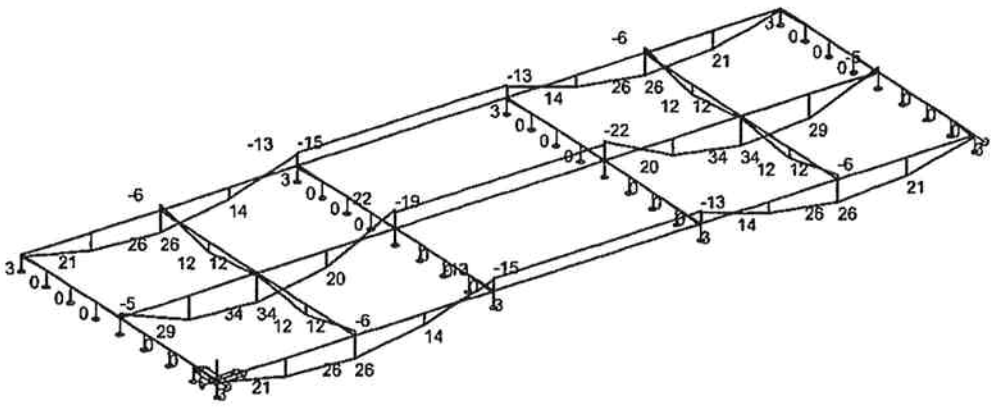
NOTE: * FRAME CALCULATED AS SUPPORTED ON EDGES (CONSERVATIVE).
IN NORMAL CONDITIONS SUPPORTED BY CONTACT AREAS FRAME – WATERPROOFING RING OF VALVES.



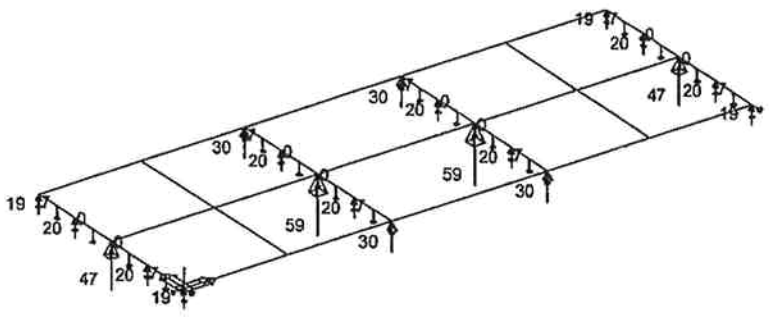
overview



Deformation - uz on member(s). Serv. combi ; loadfactor = 1,0



Internal forces - My on member(s). Ult. combi ; loadfactor = 1,5



Reactions. Ult. combi : loadfactor = 1,5

Project : MALLAMOCCO NAV. LOCK GATE.

Onderdeel : LEVELLING SLUICES.

FRAME I/200/10 :

BENDING CHECK IN ULS : *

$M_{S:D:MAX} = 42\ kNm'$.

$M_{u:d} = 355 \cdot 447 \cdot 10^3 / 1{,}1 = 144\ kNm$ } $u.c = 0{,}29$ ✓

DEFORMATION INSLS. *

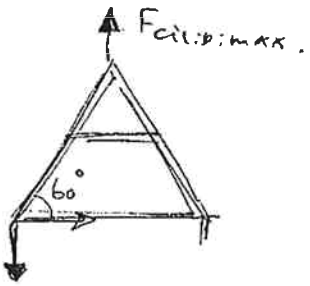
$u_{MAX} = 2{,}4\ mm'$.

$L = 2 \cdot 1425 = 2850\ mm'$ } $\frac{1}{1188} \cdot L.$; << ✓

Opgesteld : MSEMGEEST. Datum : 7 JAN. 04 Bladnummer : C4-14. Rev. : 0

SUSPENSION N° 200/10.

GOVERNING CHECK COMPRESSIVE SPREADER AT MAX. LOAD $F_{i;max;d} = 115$ kN (PAGE C2-3)



$F_{c;s;d} = 1{,}5 \cdot F_{i;max;d} / \tan 60° = 101$ kN.

$F_{c;u;d} \Rightarrow l_{buc.} = 5{,}0$ m'.

(acc. ENV1993-3 +TABLE 5.5.2) curve a

$\lambda = l/i = 5000/77{,}2 = 64{,}8$

$\lambda_1 = \pi\sqrt{2{,}1 \cdot 10^5/355} = 76{,}4$

$\lambda = 0{,}85$.

$\chi = 0{,}765$

$F_{c;u;d} = 0{,}765 \cdot 2418 = 1850$ kN.

u.c. = 101 / 1850 = 0,1 < 1,0 ; 8

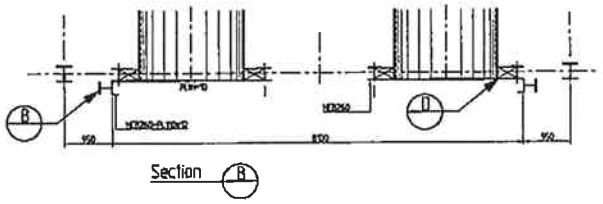
NOTE: CHECKS ARE MADE WITH FULL CROSSECTION PROPERTIES WITHOUT CORROSION-ALLOWANCE.

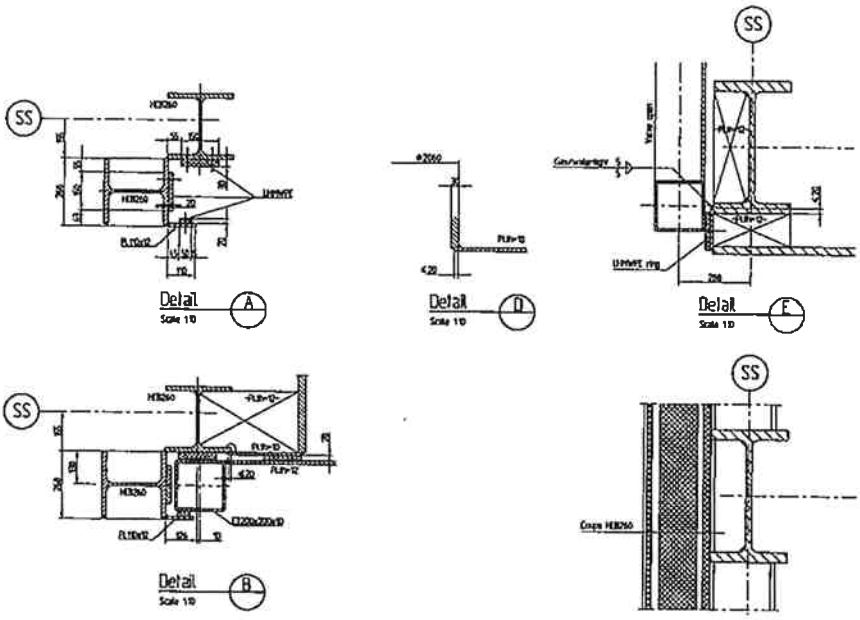
BECAUSE OF THE LOW UNITY CHECKS.

THIS IS WITHIN TOLERANCE (u.c. << 1,0).

C5. RAILS: HORIZONTAL GUIDANCE.

OVERVIEW.





LOADING

GOVERNING SITUATION = CLOSING VALVES.

ACC. C2-3 : $F_{S:0} = 1,5 \cdot 211 = 317$ kN.

NOTE: CALC. WITH CORROSION ALLOWANCE - 1mm -.

Project : MALAMOCCO NAV. LOCK GATE.

Onderdeel : LEVELLING SLUICES; RAIL.

CHECKS:

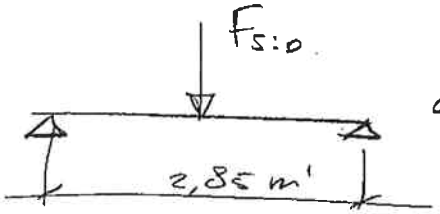
HEB260:

PROFILE SECTION PROPERTIES – 1mm' OF OUTLINE:

$W_{el:y} = 973 \cdot 10^3 \ mm^3$.

$A_{WEB} = 225 \cdot 8 = 1800 \ mm^2$.

MEMBER FORCES:



CONSERVATIVE.

$M_d = \frac{1}{4} \cdot F \cdot l = \frac{1}{4} \cdot 817 \cdot 2{,}85 = 225 \ kNm'$.

$V_d = R_d =$ 817 kN.

STRESS:

$\sigma_B = M_d / W_{el:y} = 225 \cdot 10^6 / 973 \cdot 10^3 = 231 \ N/mm^2$.

BEARING / LOADINTRODUCTION.

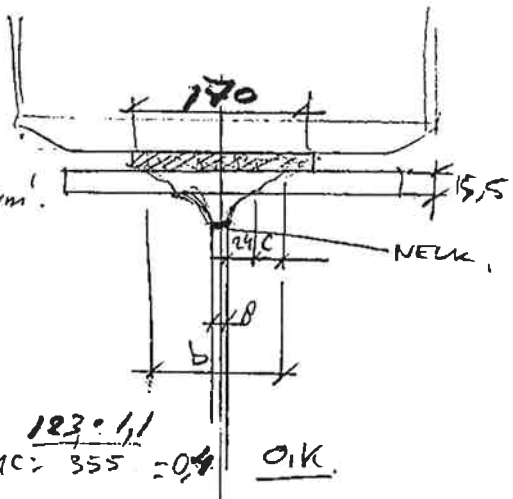
$f_{u:d:UHMWPE} = 8 \ N/mm^2$.

$c = 15{,}5 \cdot \sqrt{\frac{355}{3 \cdot 8 \cdot 1{,}1}} = 57 \ mm'$

$b = 2 \cdot c + 2 \cdot R + t_w = 114 + 48 + 8 = 170 \ mm'$.

$l_{SPR.} = F_{s:d} / (f_{u:d:UHMWPE} \cdot b)$

$= 817 \cdot 10^3 / 8 \cdot 170 = 233 \ mm'$.



CHECK NECK:

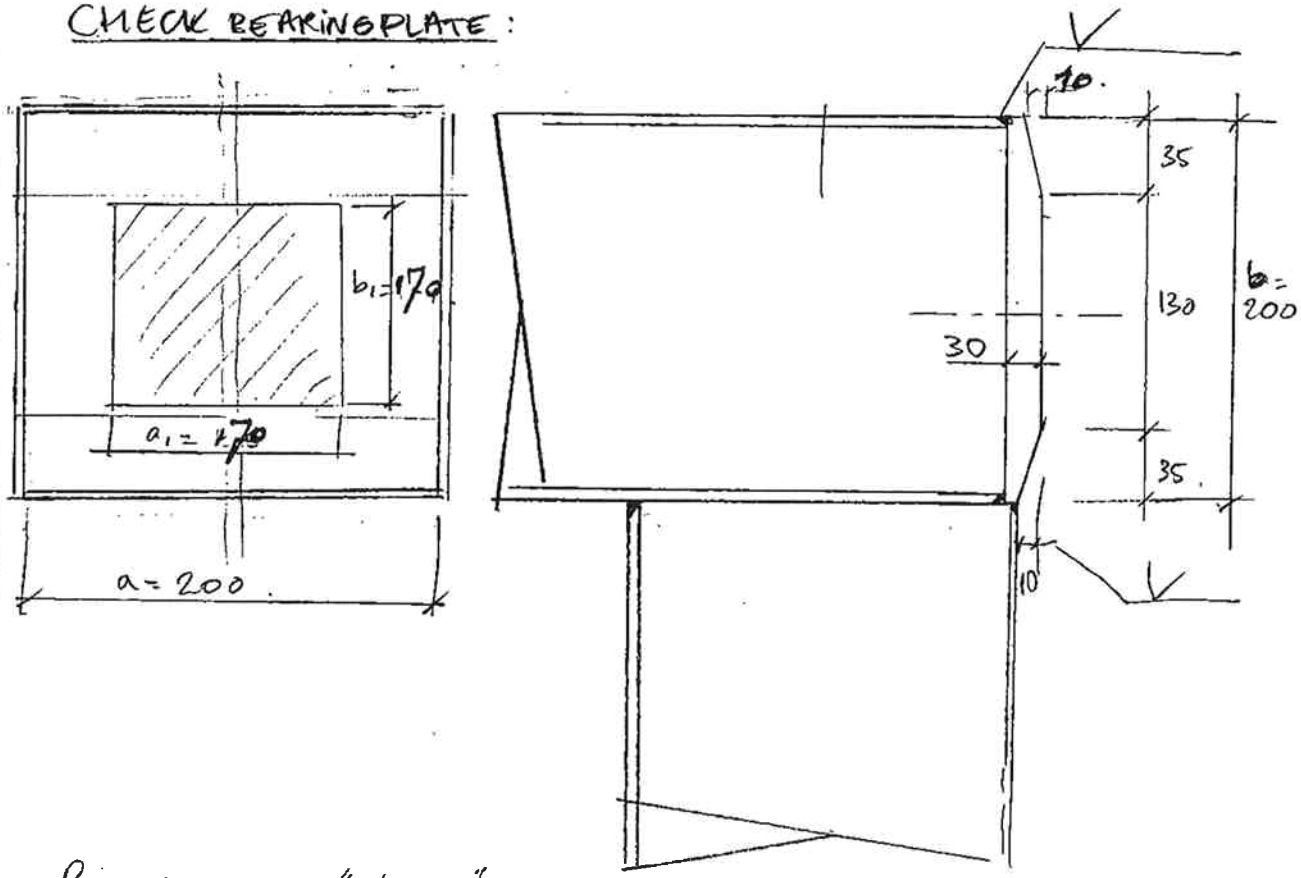
$\sigma = F_{s:d} / (8 \cdot [233 + 2 \cdot (15{,}5 + 24)]) = 123 \ N/mm^2$; $UC = \frac{123 \cdot 1{,}1}{355} = 0{,}4$ OK.

Opgesteld :	Datum :	Bladnummer :	Rev. :
ALSEMGEEST	03-04	C5-2	A2

Project : MALAMOCCO NAV. LOCK GATE

Onderdeel : LEVELLING SLUICES.

CHECK BEARINGPLATE :



BENDING ACC. LIT. "YOUNG"; FORMULAS FOR STRESS AND STRAIN. TABLE 26. 1C

$$\sigma_b = \frac{\beta W}{t^2} \rightarrow t_{ben.} = \sqrt{\frac{\beta \cdot W}{\sigma_b}}$$

$$W = q \cdot a_1 \cdot b_1 = 2000\ N$$

$$\beta \Rightarrow \begin{matrix} b_1/b = 0{,}6 \\ a_1/a = 0{,}6 \end{matrix} \Big\} \beta = 0{,}6.$$

$$t_{ben;gem} = \sqrt{\frac{0{,}6 \cdot 316 \cdot 10^3}{313}} = 25\ mm$$

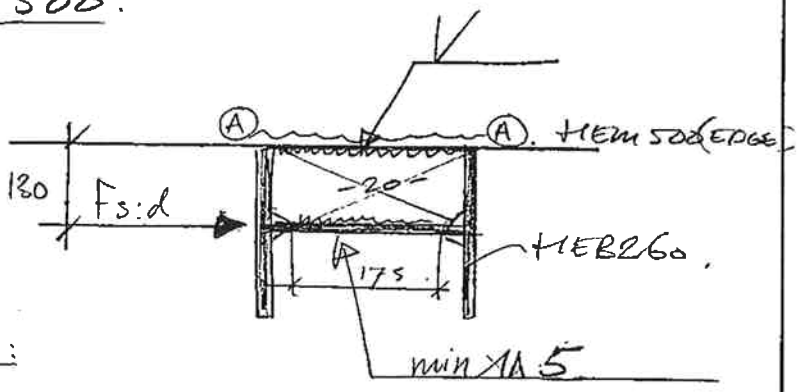
$$t = 30\ mm$$

} U.C. = 0,84 < 1.0.

O.K.

Opgesteld : ALGEMEEN Datum : 03-04 Bladnummer : C5-3 Rev. A2

CONNECTION TO HEM 500.



WELD A5 PL. 20 - HEB260:

$$t_2 = \frac{F_{s:d}}{2 \cdot a \cdot l} = \frac{316.10^3}{2 \cdot 4 \cdot 175} = 226\ N/mm^2$$

$f_{wd} = 262\ N/mm^2$ } u.c = 0,86. O.K.

PLATE - t = 20 -

$W_{el,y} = \frac{1}{6} \cdot 18 \cdot 225^2 = 151875\ mm^3.$

$A_v = 18 \cdot 225 = 4050\ mm^2$

$\sigma_b = M/W = 316.10^3 \cdot 130 / 151875 = 271\ N/mm^2.$

$t = F_{s:d}/A = 316.10^3 / 4050 = 78\ N/mm^2.$

$\sigma_{vgl} = \sqrt{\sigma_b^2 + 3t^2} = 303\ N/mm^2.$

$u.c = \frac{303 \cdot 1,1}{355} = 0,94$ O.K.

C6. HORIZONTAL SUPPORT:

SUPPORTS AROUND EDGE (CONSERVATIVE).

COMPRESSIVE AREA:

$A = 8 + 2 \cdot 15 = 38 \text{ mm}^2/\text{m}'$ (4mm - COROSSION ALLOWANCE)

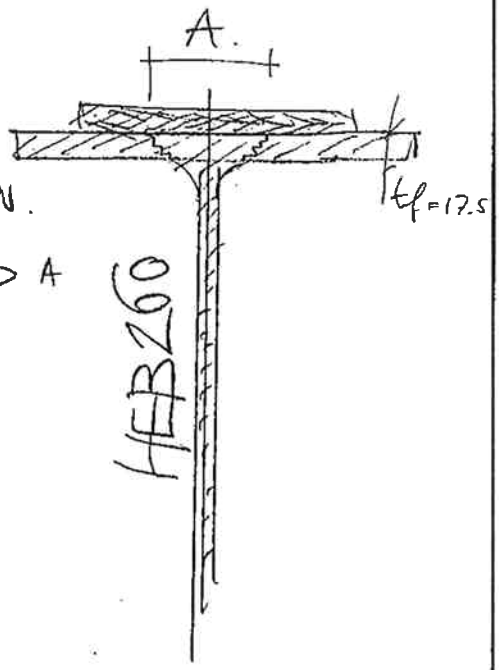
LOAD:

Σ REACTIONS ON ▽A200/10-EDGE. (PAGE C5-1)

$\Sigma R = 2 \cdot (30+20) + 50 = 154 \text{kN}$
$\ell = 2{,}85 \text{m}'$
$\Big\} q = 56 \text{ N/mm}^2$.

$\sigma_{c;s;d} = q/A = 56/38 = 2 \text{N/mm}^2$
$f_{cud} = 22/1{,}1 = 20 \text{N/mm}^2$
$\Big\}$ O.K. ($\alpha_{c.c.} = 0{,}7$).

NOTE: SEALING IS PROVIDED BY CONTACTPRESSURE BETWEEN LEVELLING SLUICE VALVE AND A HDPE-RING.
CHECKED ON NEXT PAGE.



HOR. SUPPORT AT. WATERPROOFING RING. (150×10).

$F_{VALVE;D} = 1,5 \cdot 209 = 314\ kN$ (REF C2-2)

$F_{PER\ PRINT} = \frac{314}{4} = 78,5\ kN.$

$b = 8 + 2 \cdot \left(8 \cdot \sqrt{\frac{355/1,1}{3 \cdot 20}}\right) = 26\ mm'.$

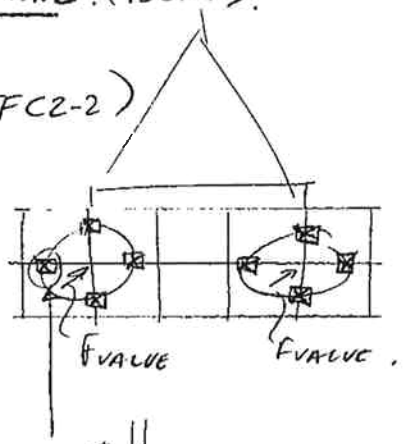
$l = 150\ mm'.$

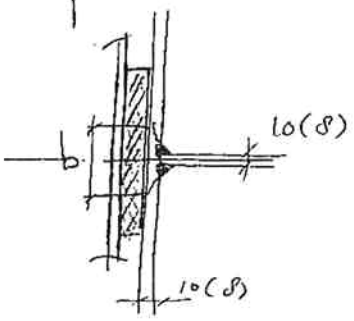
$f_{c;sid\ ULTIMATE} = 78,5 \cdot w^3 / 26\ 150$

$= 20\ N/mm^2.$

$f_{c;d} = 22/1,1 = 20\ N/mm^2$

u.c. = 1,0 ok.





NOTE: $F_{VALVE;D}$ CALC. ABOVE WITH CONSERVATIVE LOAD AREA.

REAL AREA IS: Ø VALVE: $\frac{1}{4} \pi (2,0)^2 = 3,14\ m^2.$

$F_{VALVE;D;ACTING} = \gamma \cdot q \cdot A = 30,9 \cdot 3,14 - 1,5 = 146\ kN.$

$F_{PER\ PRINT} = 146/4 = \underline{37\ kN}$

Project : MALAMOCCO NAV. LOCK GATE.

Onderdeel : LEVELLING SLUICES.

C7. SLUICE TUBES

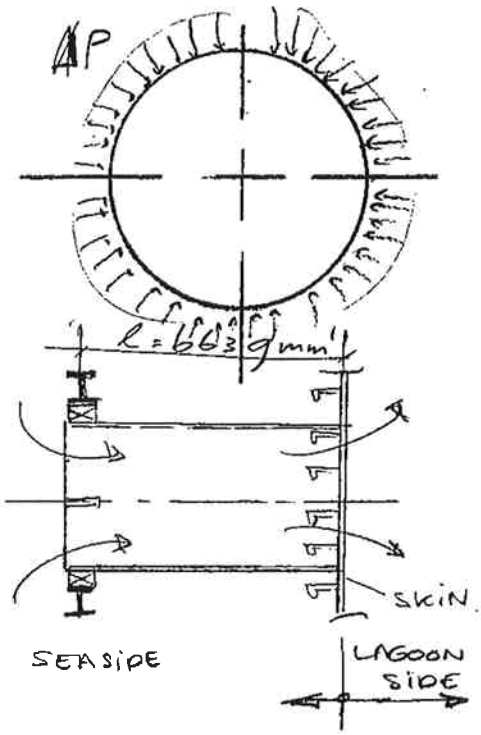
TUBE: ϕ 2060/30

LOADS:

1/ SELF WEIGHT..

2 FRICTION WATER WHEN LEVELLING.

3 IMPOUNDAGE 3 m'.



1 SELFWEIGHT:

$$A = \frac{2060^2 - 2000^2}{4}\pi = 191323\ mm^2.$$

$$m' = G \cdot A \cdot 7850 \cdot 191323 \cdot 663g \cdot 10^{-9} = 10000\ kg.$$

$$F_{G;D} = 1,5 \cdot 10000 \cdot 10 = 150\ kN.$$

2 FRICTION WATER WHEN LEVELLING.

- NOSIGNIFICANT LOAD.
- SLUICE TUBE IS HELD HORIZONTALLY BY CONNECTION TO SKINSTIFFENERS AT LAGOONSIDE AND GUSSETS(4x) AT SEASIDE

3 $F_{imp.} = 10,3\ kN/m'$

Δh = 3 m' impoundage

RINGLOAD SLUICETUBE:

$\Delta P_{;D} = 30,9 \cdot 1,5 = 47\ kN/m^2$

REACTIONFORCE ON VALVE CONNECTION DUE TO IMPOUNDAGE ON LEVELLING SLUICE : $F_{PERPRINT} = 37\ kN$ (REF. C6-2)

Opgesteld: M SEMGEEST. Datum: 05-04 Bladnummer: C7-1. Rev.: A2

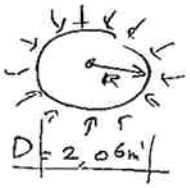
Project : MALAMOCCO NAV. LOCK GATE.

Onderdeel : LEVELLING SLUICES.

CHECK RINGSTRESS SLUICETUBE WALL

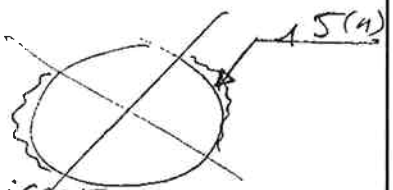
$t_{WALL} = 30\ mm$ (calc 28).

$$\sigma_{RING} = \frac{\Delta p_d \cdot R}{t_{WALL}}$$



$$= \frac{47 \cdot 10^{-3} \cdot 1030}{28} = 2\ N/mm^2 \text{ ; NOT SIGNIFICANT.}$$

SUSPENSION TUBE LAGOONSIDE

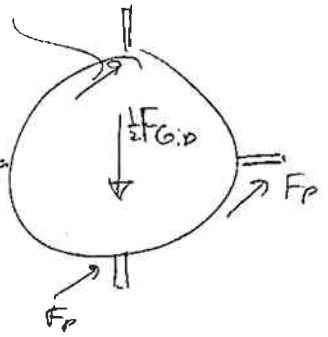


$\ell_{SHEARWELD} = \pi \cdot 2000/2 = 3140\ mm.$

$$\tau_d = \frac{\frac{1}{2} F_{G;D}}{3140} = 6\ N/mm^2 \text{ ; NOT SIGNIFICANT.}$$

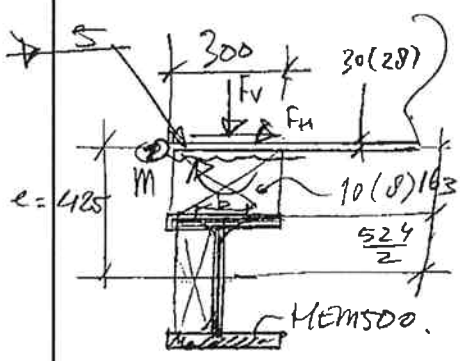
SUSPENSION TUBE SEASIDE

$F_{PRINT} = 37,4\ kN$



VERTICAL SUSPENSION:

SECTION ①:



$F_V = \frac{1}{2} \cdot \frac{1}{2} F_{G;D} = \frac{150}{4} = 37,5\ kN$

$F_H = 37\ kN.$

$M = F_H \cdot e = 37 \cdot 0,42 = 16\ kNm.$

pl. 10(8): $A = 300 \cdot 8 = 2400\ mm^2$

$W_{el} = \frac{1}{6} \cdot 8 \cdot 300^2 = 120000\ mm^3.$

$$\sigma_D = M/W + F_V/A = 133 + 16 = 140\ N/mm^2 \quad u.c. = 140 \frac{11}{355} =$$

INTRODUCTION NECK: $b = 20 + 2 \cdot [27 + 39] = 152mm.$

$\sigma_N = F_V/A_{neck} = 37,5 \cdot 10^3 / 152 \cdot 8 = 31\ N/mm^2$; ok.

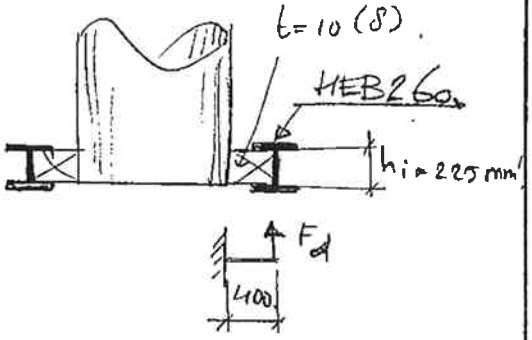
HORIZONTAL SUSPENSION AT SEASIDE.

F_d = 37 kN = F PER PRINT.

M_d = 37 · 0,4 = 14,8 kNm.

$W_{el} = \frac{1}{6} \cdot t \cdot h_i^2$

$= \frac{1}{6} \cdot 8 \cdot 225^2 = 67500\ mm^3$.



$\sigma_d = M_d / W_{el} = 219\ N/mm^2$.

$\tau_d = F_d / A_v = 37 \cdot 10^3 / 8 \cdot 225 = 21\ N/mm^2$.

U.C = 219 · 1,1 / 355 = 0,7; OK.

C8. FLOW DIFFUSER BEAMS

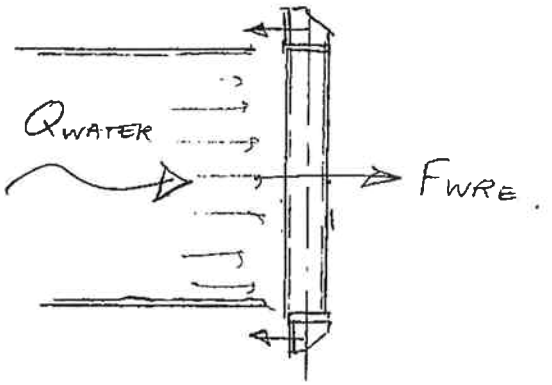
LOAD ON BEAM

FORCE ON DIFFUSER BEAM DUE TO WATERRESISTANCE ATLEVELLING.

$$F_{WRE} = \tfrac{1}{2} \rho \cdot v^2 \cdot C_d \cdot A$$

$\rho = 1030 \ kG/m^3$.

SHAPEFACTOR $C_d = 2,0$.



$A = h \cdot b = 2,85 \cdot 0,3$

$= 0,765 \ m^2$.

$v = Q / A_{OPENING}$.

$Q_{max} = 82 \ m^3/sec.$ ACC. CONCEPT DESIGN. DOC. A594R1 APP.B

$A_{OPENING} = 10 \cdot \left(\frac{\pi}{4} \cdot 2^2\right) = 31,4 \ m^2$.

$v = 2,62 \ m/s$. (max).

$F_{WRE} = \frac{1}{2} \cdot 1030 \cdot (2,62)^2 \cdot 2,0 \cdot 0,765 =$ **5,4 kN** PER BEAM.

CONNECTION PRACTICAL

Project : MALAMOCCO NAV. LOCK GATE.

Onderdeel : FLOW DIFFUSER BEAMS.

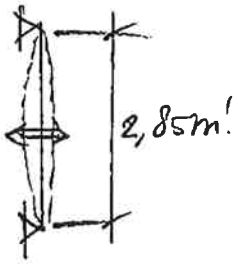
DYNAMIC CHECK DIFFUSER BEAMS:

1ST NATURALFREQUENCY:

$$w = \sqrt{k/m}$$

$$k = \frac{48EI}{l^3} \quad ; \quad I_{\square 300/8} = 132{,}9 \cdot 10^6 \text{ mm}^4.$$

$$A_{\square 300/8} = 9344 \text{ mm}^2.$$



$$k = 57870 \text{ N/mm'}.$$

$$m = \rho \cdot A\ell = 7850 \cdot 10^{-9} \cdot 9344 \cdot 2850 = 209 \text{ kg}.$$

$$w = \sqrt{\frac{57870}{209}} = 526 \text{ RAD/s}.$$

$$f = \frac{w}{2\pi} = 84 \text{ Hz}$$

FOR RECTANGULAR SECTIONS OF ABOUT 2m' THE FOLLOWING CRITICAL "STROUHAL" VALUE IS GIVEN:

$0{,}08 < S < 0{,}15$; FOR FLUTTER (KARMANN WHIRTS *).

$S \leq 0{,}05$; FOR GALLOPING *)

$$S = \frac{n \cdot D}{V}$$ WHERE $n = 1^{st}$ NATURAL FREQ $= 84$ Hz

$D =$ DIAMETER $= 0{,}3$ m'

$V = 2{,}62$ m/s.

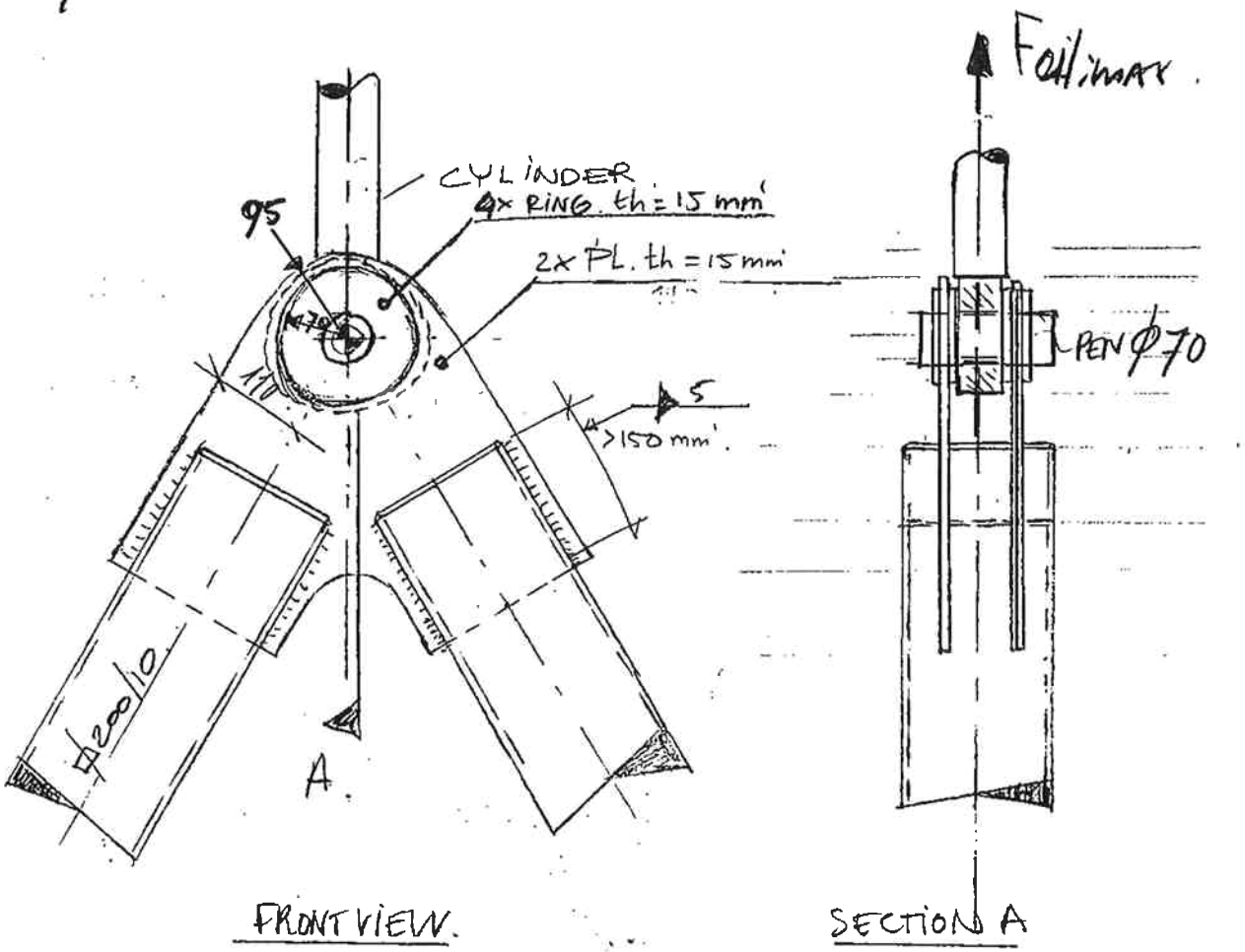
$S = 9.6 \gg 0{,}15$: O.K

*) SOURCE: "DELFT UNIVERSITY OF TECHNOLOGY"

Project : MALAMOCCO NAV-LOCK GATE.

Onderdeel : LEVELLING SLUICES.

C9. CONNECTION CILINDER TO FRAME.



STEELGRADE : PIN : Stainless steel 431 S29 CWN 1.4057.

OTHERS : S355JR.

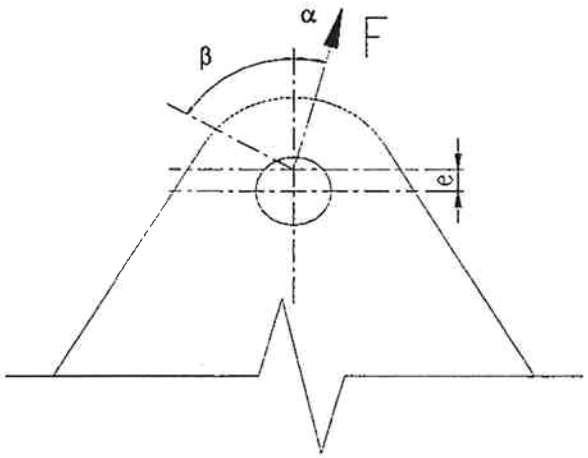
$F_{cil;max} = 1{,}5 \cdot 219 = 330$ kN.

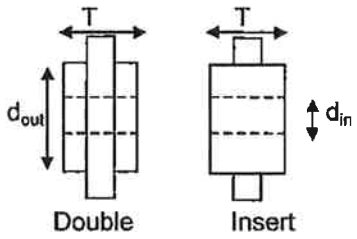
Opgesteld : A. SEMGEEST Datum : 12 JAN '04 Bladnummer : C9-1 Rev. : 0.

Project : Mallamocco Nav. Lock Gate

Onderdeel : Levelling Sluices; Connection cilinder to frame

Calculation restrained eye with: Double cheeck





GEOMETRY

Outer eye diam.	D_{out}	190 mm	R	95 mm
Hole diameter	d_{in}	71 mm	r	35,5 mm
Eccentricity inside-outside	e	1 mm		
Shape of eye (ß<=90)	β	60 °		
Mainplate thickness	t	13 mm	A_{av}	1547 mm^2
Type of restrainment		1 Double cheeck		
Outside diameter 'ring'	d_{out}	140 mm		
Cheek plates	t cheek	13 mm		
Totale Eye tickness	T	39 mm		

MATERIALPROPERTIES

Yield stress	$\sigma_{0.2}$	355 N/mm²
Model factor	γ_M	1,1
Yield stress incl. γ_M	$\sigma_{0.2}/\gamma_M$	323 N/mm²

LOADS

Total load on eye	F	219 kN	
Angle of load	α	0,00 °	
Load mainplate	F_{main}	93 kN	
Load per cheekplate	F_{cheek}	63 kN	
Safety factor	γ	1,5	NOTE: taken into account on material side!

Opgesteld :	Datum :	Bladnummer :	Rev. :
D.W. Alsemgeest	31-03-2004	C9-2	A2

Project : Mallamocco Nav. Lock Gate

Onderdeel : Levelling Sluices; Connection cilinder to frame

CHECK SIDE OF HOLE

Average stress		σ_{av}	66	N/mm²	
Stress concentration factor		k_t	3,16		[D_{out}, d_{in}, t]
Stress concentration factor		k_t	2,70		[d_{out}, d_{in}, (T-t)]
Force factor		$\eta(\alpha)$	1,00		
Shape factor	β <= 90°	$\eta(\beta)$	0,92		
Max. stress		σ_{eye}	190	N/mm²	
Allowable stress	$\sigma_{eye;a}$ = 0,9	$\sigma_{0.2}/\gamma_M$	290	N/mm²	(conservative)
unity check			**0,65**		***OK***

CHECK SHEAR

Shearstress	mainplate	τ_{main}	59	N/mm²	
	cheekplate	τ_{cheek}	68	N/mm²	
	Insert	τ_{insert}		N/mm²	
Shearstress	governimg	τ_{main}	68	N/mm²	
Allowable stress		τ_a	83	N/mm²	
unity check			**0,82**		***OK***

CHECK BEARINGSURFACE PIN/HOLE

Surface pressure	$\sigma_{surface}$	79	N/mm²	
Allowable stress	$\sigma_{surface;a}$	215	N/mm²	
unity check		**0,37**		***OK***

CHECK WELD CALCULATION (cheekplate / insert to main plate)

Fillet weld				
Throat	a	5	mm	
length weld (projected length in line of fol		198,0	mm	=1,41d_{out} (conservative)
Load on weld	F_{cheeck}	63	kN	
Shearstress mainplate	τ_{main}	64	N/mm²	
Allowable stress	τ_a	175	N/mm²	
unity check		**0,36**		***OK***

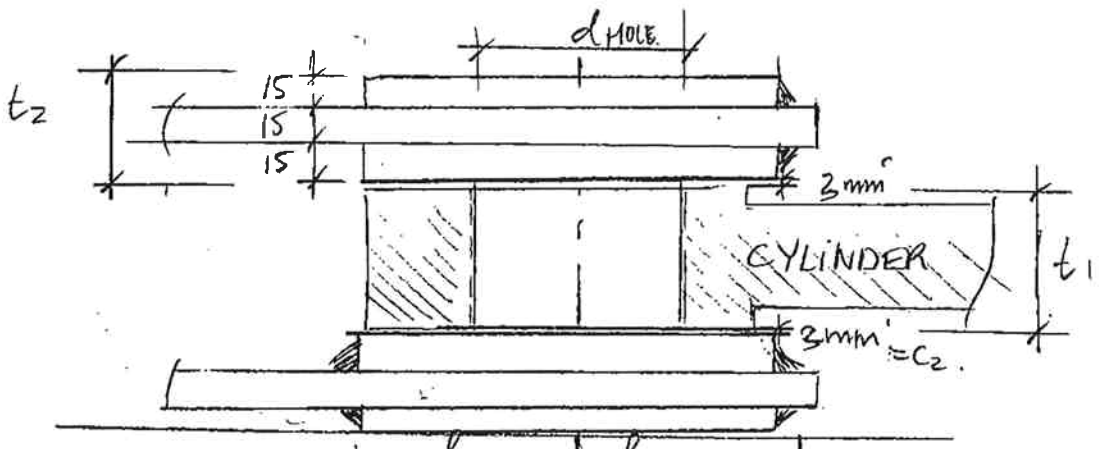
Opgesteld :	Datum :	Bladnummer :	Rev. :
D.W. Alsemgeest	31-03-2004	C9-3	A2

Project : MALAMOCCO NAV. LOCK GATE.

Onderdeel : LEVELLING SLUICES:

PIN CONNECTION ACC. ENV 1993-1-1; 6.5.13.

* STEELGRADE :- PLATES : S355 JR 1)
- PIN : 431 S29 2)
* PINDIAMETER : d_{PIN} = 70 mm'.
* HOLEDIAMETER = d_{HOLE} = 71 mm'.
* PLATESTHICKNESS = t_1 = 65 mm'
* t_2 = 45 mm' (3*15)
*



1) ULT. STRESS.	fy	fu		
S355 JR ;	355	510.	N/mm²	
2) 431 S29 SS (W.N. 1.4057	check doc.: MV036-PE-M-M-R-5003			

Opgesteld : Alsemgeest Datum : 12 JAN 04 Bladnummer : C9-4 Rev. : 0

ACTING LOADS.

$F_{z;D} = 1,5 * 210 = 330\ kN$ (PAGE C2-3)

$M_{s;D} = \frac{330 \cdot 10^3}{8} \cdot (63 + 4 \cdot 3 + 2 \cdot 43) = 6,65\ kNm$

CAPACITY:

$F_{BR;D} = 1,5 \cdot 63 \cdot 70 \cdot 355 / 1,25 = 1879\ kN.$

$F_{VR;D} = 0,6\left(\frac{\pi}{4} \cdot 70^2\right) \cdot 900 / 1,25 = 1662\ kN.$

$M_{R;D} = 0,8\left[\frac{\pi}{64} \cdot 70^3\right] 650 / 1,25 = 7,30\ kNm$

CHECKS:

* BEARING PLATE + PIN : U.C. = $339/1879 = 0,18 < 1,0$ O.K
* BENDING PIN : U.C. = $6,64/7,3 = 0,91 < 1,0$ O.K
* COMB. BENDING + SHEAR : U.C. = $0,91^2 + \left(\frac{330}{1662}\right)^2 = 0,87 < 1,0$ O.K

NOTE :- PLATE DIMENSIONS WITH -1 mm- CORROSION ALLOWANCE.

-PIN DIMENSIONS NO CORROSION.

TUBES TO PLATE PL.-15-; WELDS ⋆5⋆

$\tau_{plate} = 355/1,1\sqrt{3} = 186\ N/mm^2 \rightarrow \times 13 = 2,42\ kN/mm'$

$t_{WELD} = 510/\sqrt{3}/0,9 \cdot 1,25 = 262\ N/mm^2 \rightarrow \times (2 \cdot 4) = \boxed{2,10}\ kN/mm'$

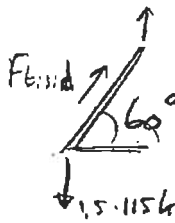
* WELD GOVERNING;

∓ CAP. CONNECTION ONE TUBE :

4 WELDS x l_{min} = 150 mm' = 600 mm' (600 DIA INTRODUCTION).

$F_{CAP} = 2,10 \cdot 600 = 1260\ kN.$

$F_{t;s;d} = 115 \cdot 1,5 / \sin 60° = 200\ kN.$



u.c = 0,16 < 1,0 ; OK.

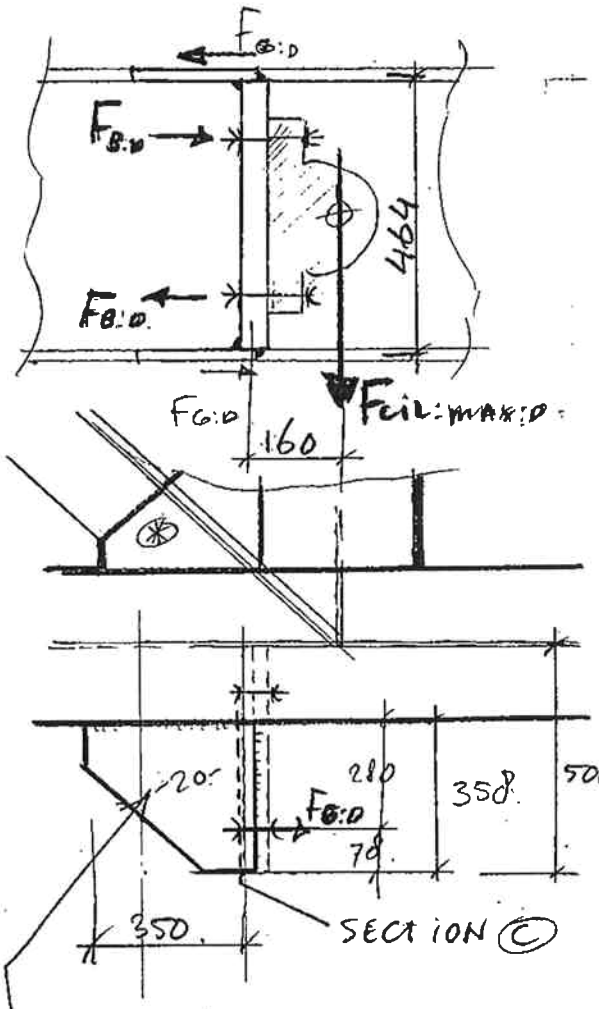
NOTE: CORROSION-ALLOWANCE: -1 mm'-OFF OUTLINE.

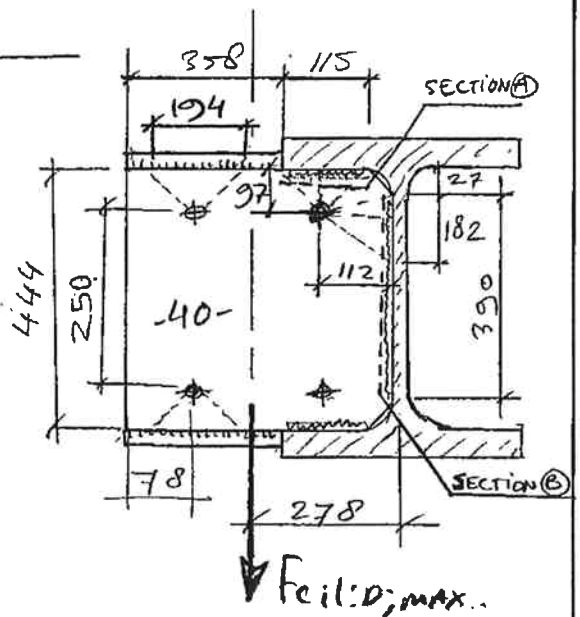
Project : MALAMOCCO NAV. LOCK GATE.

Onderdeel : CONNECTION TO GATE.

C10. CONNECTION CILINDER TO GATE.

OVERVIEW :





* CALC. WITH - 1mm - OFF OUTLINE COROSSION ALLOWANCE.

* STEEL: $t \leq 40$; $f_{y;d} = \frac{355}{1,1} = 323\ N/mm^2$

$t > 40$; $f_{y;d} = \frac{345}{1,1} = 314\ N/mm^2$

* WELDS: $f_{wu;d} = 262\ N/mm^2$

GUSSET PLATE AT SIDE OF DIAGONAL BRACE-CONNECTION ⊛.

Project : MALAMOCCO NAV. LOCK GATE.

Onderdeel : CONNECTION TO GATE.

LOADING.

$F_{cil;D;MAX} = 219 \cdot 1,5 = 332\ kN$ (acc. PAGE C-4).

$F_{B;D} = F_{cil:D:MAX} \cdot \frac{160}{250} / 2 = 106\ kN$. ⊛

$F_{G:D} = F_{cil:D:MAX} \cdot \frac{160}{464} / 2 = 57\ kN$.

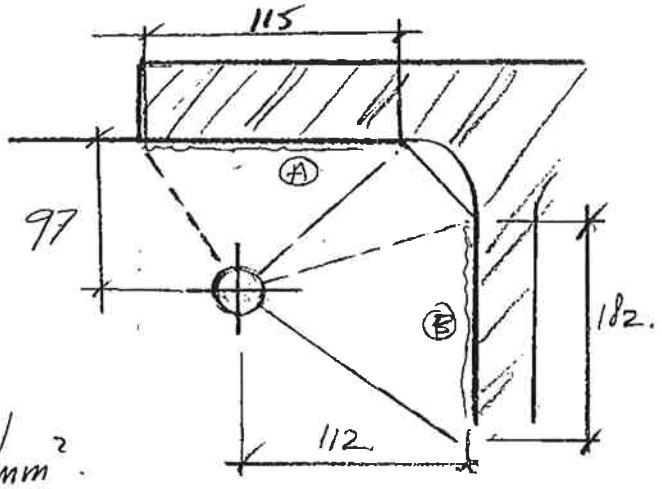
SECTION Ⓐ : $\ell = 115\ mm$.

PLATE -40- (CALC. $t = 38$)

SHEAR IN PLANE:

$F_{sip} = M / h_i = F_{cil:D:MAX} \cdot 278 / 444 = 207\ kN$.

$\tau_{i:p} = F_{s:ip} / 115 \cdot 38 = 48\ N/mm^2$.



SHEAR OUT PLANE.

Ⓐ = $97/115 = 0,84$

Ⓑ = $112/182 = 0,76$.

DISTRIBUTION TO Ⓐ = $\frac{0,84}{(0,84+0,76)} \cdot F_{B:D}$

$= 0,53\ F_{B:D}$

$\tau_{o:p} = 0,53\ F_{B:D} / 115 \cdot 38 = 13\ N/mm^2$.

⊛NOTE: $F_{B;D} = 106\ kN \rightarrow$ TAKE M20 8.8

$F_{b:u:d} = 141\ kN$; U.C = 0,75 ok.

Opgesteld : ALSEMGEEST | Datum : 25-05-04 | Bladnummer : C10-2 | Rev.: A2

Project : MALAMOCCO NAV. LOCK GATE.

Onderdeel : CONNECTION TO GATE.

WEAK AXIS BENDING:

$\sigma_b = M/W = \frac{0{,}53 \cdot 10^6 \cdot 10^2}{\frac{1}{6} \cdot 115 \cdot 38^2} = \frac{5{,}5 \text{ kNm}}{2767 \text{ mm}^3} = 200 \text{ N/mm}^2$.

VON MISES:

$\sigma_{v.m.} = \sqrt{200^2 + 3 \cdot 48^2 + 3 \cdot 13^2} = 218 \text{ N/mm}^2$.

CHECK: $u.c. = \sigma_{vm}/f_{yd} = \frac{218}{314} = \underline{0{,}70}$ O.K.

WELD: $\triangle$ 10 (calc. 8)

SHEAR IN PLANE:

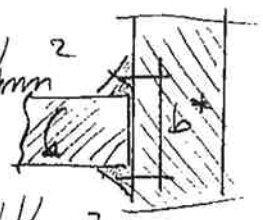
$\tau_2 = 207 \cdot 10^3 / 2 \cdot 8 \cdot 115 = 113 \text{ N/mm}^2$.

SHEAR OUT PLANE:

$\sigma_1 = \tau_1 = \frac{0{,}53 \cdot 10^6 \cdot 10^3 \sqrt{2}}{4 \cdot 8 \cdot 115} = 22 \text{ N/mm}^2$.

WEAK AXIS BENDING:

$\sigma_1 = \tau_1 = \frac{5{,}5 \cdot 10^6}{8 \cdot 115 \cdot \sqrt{2} \cdot (40 + \frac{2}{3} \cdot 10\sqrt{2})} = 86 \text{ N/mm}^2$



$\sigma_{w:s:d} = \frac{\sqrt{4 \cdot (22+86)^2 + 173^2}}{\sqrt{3}} = 168 \text{ N/mm}^2$.

CHECK: $u.c. = \sigma_{w:s:d}/f_{w:u:d} = 168/262 = 0{,}64$ O.K.

Opgesteld: ALSEMGEEST | Datum: 25-03-04 | Bladnummer: C10-3 | Rev.: A2

Project : MALAMOCCO NAV. LOCK GATE.

Onderdeel : CONNECTION TO GATE.

SECTION (B) : $\ell = 182$ mm.

PLATE -40- (CALC. 38.)

REF. TO SECTION (A) !

$\sigma_{i;p} = F_{cil;D;MAX} / A = 330 \cdot 10^3 / 38 \cdot 390 = 23 \ N/mm^2$.

$\sigma_{i;p;sect.(B)} < \sigma_{i;p;sect.(A)}$.

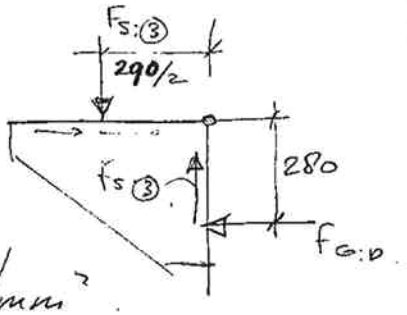
DISTRIBUTION $F_{B;D}$ TO (B) = 9,47 % } SECTION (B) NOT GOVERNING.

SECTION (C) : LOCAL CHECK.

PLATE -20- (CALC. 8)

CONTACT

$\sigma_c = F_{G;D} / A_{local} = 57 \cdot 10^3 / 20 \cdot 194 = 15 \ N/mm^2$.



SHEAR :

$F_{S;③} = F_{G;D} \cdot 280 / 145 = 110 \ kN$

$\tau = F_{S③} / A_{tot} = 110 \cdot 10^3 / 20 \cdot 358 = 16 \ N/mm^2$.

VON MISES :

$\sigma_{vm} = \sqrt{\sigma_c^2 + 3 \cdot \tau^2} = 27 \ N/mm^2$

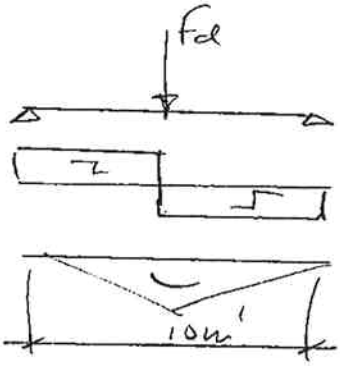
CHECK = $\sigma_{vm} / f_{yd} = 27 / 323 =$ —.

WELDS : PRACTICAL.

Opgesteld : ALSEMGEEST. Datum : 25-05-04 Bladnummer : C10-4. Rev. : A2

CHECK STRESS INCREASE MAIN STEEL DUE TO CONNECTION CILINDER.

CILINDER IS CONNECTED, c.t.c. 10m' TO THE HORIZONTAL TRUSS-GIRDERBEAM AT LEVEL +1400.
ON NEXT PAGES GIVEN THE ACTING MEMBERFORCES IN THE HOR. TRUSS-GIRDERBEAM. (DESIGN-VALUES) DERIVED FROM MAIN CALC. MV036P-P-E-M-AR 4002.
THIS LOAD IS INCREASED BY THE LOAD FROM THE LEVELLING SLUICES. $F_d = 1{,}5 \cdot 219 = 330\ kN$.



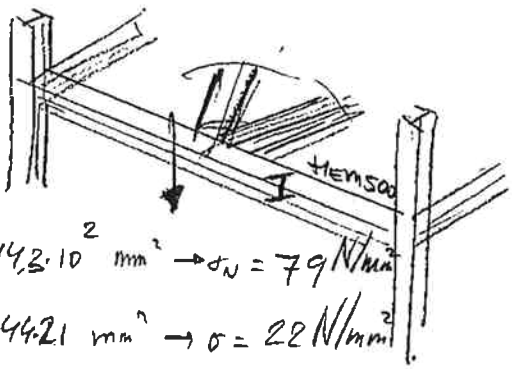
CONSERVATIVE APPROACH:

$M_E = \frac{1}{4} F_d \ell = \frac{10}{4} \cdot 330 = 825\ kNm.$

$V_d = \frac{1}{2} F_d = 165\ kN.$

$M_T = 0$; NO TORSION, THE BEAM IS HELD AGAINST TORSION DUE TO HORIZONTAL BEAM.

CONSERVATIVE CHECK ON SECTION WITH COMBINED ALL EXTREME LOADS



$N = -2697\ kN \rightarrow A = 344{,}3 \cdot 10^2\ mm^2 \rightarrow \sigma_N = 79\ N/mm^2$

$V_z = 35 + 165 = 200\ kN. \rightarrow A_{vz} = 44421\ mm^2 \rightarrow \sigma = 22\ N/mm^2$

$M_y = 81 + 825 = 906\ kNm. \rightarrow W_{ely} = 6180 \cdot 10^3\ mm^3 \rightarrow \sigma_m = 147\ N/mm^2.$

$\sigma_{c;d} = \sqrt{(79+147)^2 + 22^2} = 230\ N/mm^2$ $\quad u.c. = \frac{230 \cdot 1{,}1}{345} = 0{,}73.$ OK

Internal forces on member(s) 13/24, ULS. C9/10,13/..., end sections, global extremes.
CHORD - Sea Side
Group of member(s) :13/24
Group of ultimate combi :9/10,13/14

memb	cr.nr	combi	dx [m]	N [kN]	Vy [kN]	Vz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
18	6	10	0.000	**-2697** *)	3	35	0	-81	-4
14	6	10	0.000	-1307	**6**	-3	0	19	-12
23	6	10	0.000	-1307	**-6**	22	-0	-41	**19**
22	6	9	0.000	-72	1	**70**	-0	**-143**	-1
23	6	13	5.000	-125	-1	**-74**	-0	-132	-2
22	6	10	0.000	-1784	0	4	**0**	-19	3
15	6	10	0.000	-1784	-0	14	**-0**	-42	3
23	6	13	0.000	-125	-1	-49	-0	**162**	3
23	6	10	5.000	-1307	-6	-3	-0	17	**-12**

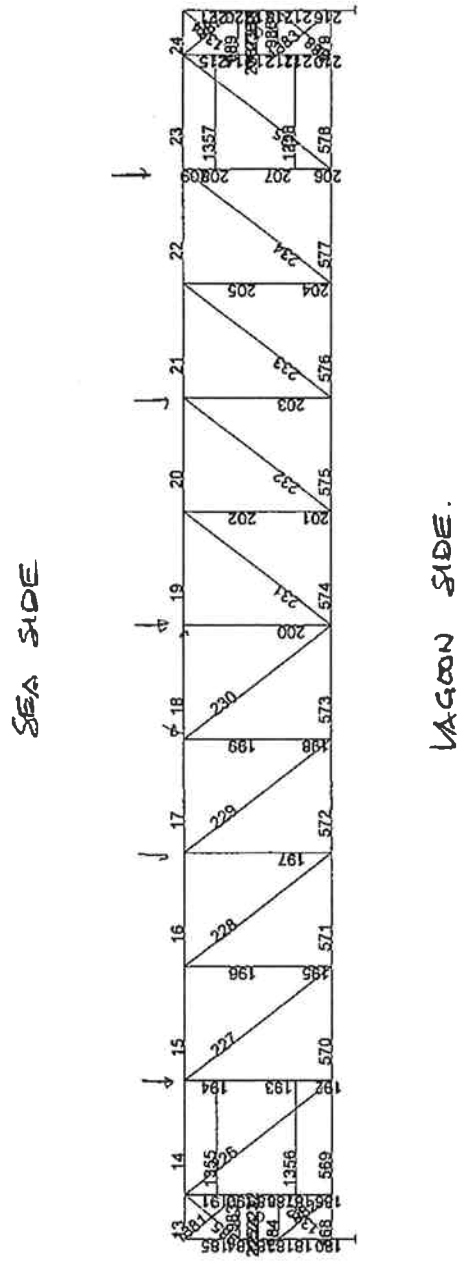
*) DUE TO CHANGE IN MODEL LOAD HAS DECREASED TO -2554 kN

Internal forces on member(s) 568/579, ULS. C9/10,13/..., end sections, global extremes.
CHORD - Lagoon Side
Group of member(s) :568/579
Group of ultimate combi :9/10,13/14

memb	cr.nr	combi	dx [m]	N [kN]	Vy [kN]	Vz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
573	9	10	0.000	**725**	16	-3	-0	-2	-12
574	9	13	0.000	**-55**	16	0	-0	-0	-13
578	9	10	0.000	121	**19**	-3	**0**	6	**-20**
569	9	10	5.000	121	**-19**	3	-0	6	-20
570	9	10	0.000	397	15	**6**	0	**-26**	-9
577	9	10	0.000	397	18	**-6**	-0	5	-17
569	9	10	0.000	121	14	3	**-0**	-8	-6
578	9	14	0.000	48	17	-3	0	**6**	-14
579	9	10	1.950	170	6	-4	0	-25	**9**

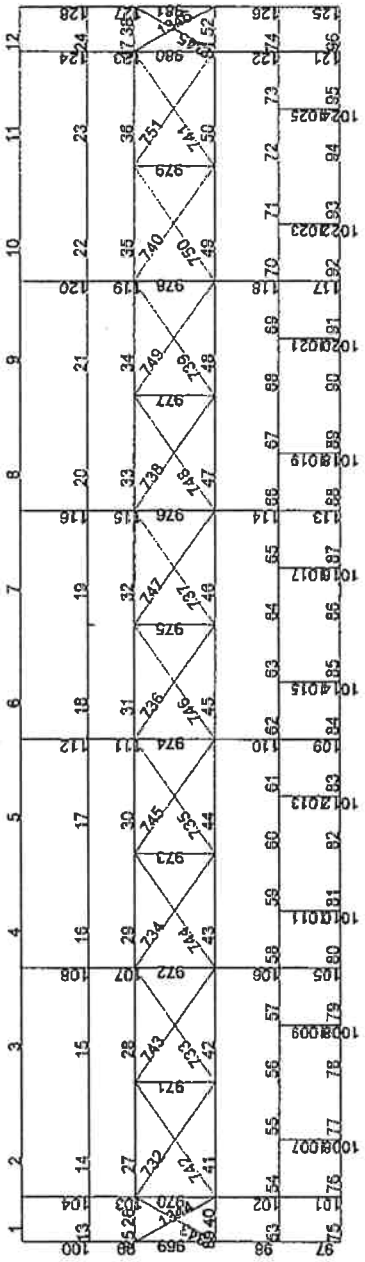
Internal forces on macro(s) 64/73, ULS C9/10,13/..., end sections, global extremes.
DIAGONAL Members
Group of macro(s) :64/73
Group of ultimate combi :9/10,13/14

macro	memb	combi	dx [m]	N [kN]	Vy [kN]	Vz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
73	235	10	8.201	**1566**	0	-32	-0	-0	-0
67	229	13	0.000	**-30**	0	10	-0	-0	-0
64	226	14	8.201	1077	**1**	-26	0	-0	0
73	235	14	0.000	1077	**-1**	26	-0	-0	0
64	226	9	0.000	121	0	**50**	0	-0	-0
73	235	9	8.201	121	-0	**-50**	-0	-0	-0



Member Numbers -- Level -1400m

03-'04 C10-7.



Member Numbers – Grid Line SS

03-'04 C10-8

Addendum D Traction frame

Contents:

Note:
In detail calculations a corrosion-allowance is taken into account of 1 mm around the outer outline of the profiles. In the main calculation no corrosion-allowance is taken into account directly.
Max. unity check < 0,5.; therefor this is in de margin.

D TRACTION FRAME.

INDEX. PAGE.

TAKEN INTO ACCOUNT IN CALCULATIONS:

CORROSION-ALLOWANCE: REDUCED PROFILE AREA WITH 1mm AROUND OUTLINE.

→ IN MAIN CALCULATION: U.C. MAX = 0,9 ALLOWABLE.

→ IN DETAILCALCULATION: REDUCED CROSS-SECTION PROPERTIES.

Project : MALAMOCCO NAV. LOCK GATE.

Onderdeel : TRACTION FRAME

D1. LOADS

LOADS WORKING ON TRACTION FRAME:

DEADLOAD:

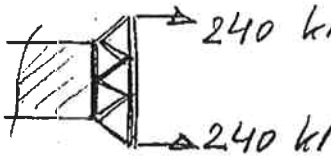
* SELFWEIGHT FRAME: GENERATED BY CALC. SOFTWARE ESAPRIMAWIN (SEE MAIN CALC. D2-3)

* SELF WEIGHT TRACTIONCABLE + CONN. PLATE. (ρ_{STEEL}: 78,5 kN/m³)
  - CABLE ϕ38 $l_{c.t.c\ SHIEVES} \doteq 60m$: $\frac{1}{2} q l_{PER\ SIDE} = \frac{1}{2} \cdot 0{,}1 \cdot 60 = 3{,}0$ kN
  - PLATE: $(260 \cdot 700 \cdot 70) \cdot 10^{-9} \cdot 78{,}5$ = 1,0 kN +
  - TOTAL PER SIDE (INCL. 10% CONTINGENCY) 1,1 * 4,0 = 4,5 kN

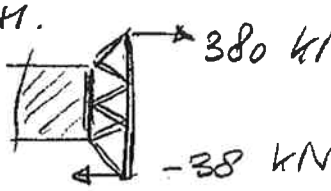
* LIVELOAD:

(DERIVED FROM NEXT PAGES WITH CONTINGENCY OF 10%)

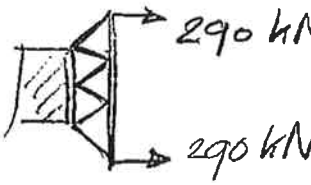
SIT. 1. FULLY OPERATING



SIT. 2. MALFUNCTIONING WINCH.



SIT. 3 MALFUNCTIONING HYDROFOOT



D1. Determination Traction loads

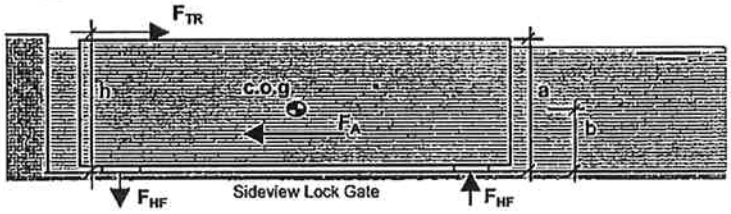
Situation: Waterlevel: + 2600 Description: Maximum Surge Level

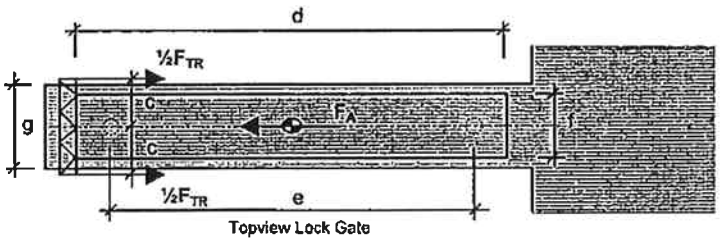
The gate will be opened or closed by a traction device.
In this calculation the acting forces during the shifting progress are determined:

Acting forces:

F_{TR}: Forces on traction devices (total)
F_{HF}: Added and reduced (vertical) force on hydrofeet due to excentricity traction

Situation:





Dimensions

a	height of gate	16,5	m
b	c.o.g. gate above bottom sealing	9,1	m
c	centreline gate - workline traction cable	4,94	m
d	length of gate	53,9	m
e	centre to centre distance hydrofeet	51,95	m
f	width of gate	6,5	m
g	width of gate chamber	9,12	m
h	workline traction cable above bottom sealing	16,5	m
i	distance b.o.s.gate - slide path	0,3	m

Weight and volumes

Total mass of the structure incl. water ballast:
$m_{structure} + m_{ballast}$ 12762 + 3964 = 16726 kN

Total netto downward force underwater G_{netto} 1000 kN
Total underwater volume of the structure $V_{gate;under}$ 1515 m^3

Project : Malamocco Navigation lock-gates

Onderdeel : Determination Traction loads in MSL sit.+2600

Forces to be overcome by traction device (F_A):

F_{WFE}:	Water resistance depanding on dragfactor, traction velocity and waterflow velocity
F_{HFFR}:	Friction of hydrofeet on sliding path
$F_{IMP;H;T}$:	Friction due to impoundage of water at seaside of gate during movement
$F_{IMP;H;L}$:	Impoundage of water (bow wave) ahead of gate during movement
F_{IN}:	Inertia of lock gate mass including water mass in ballast tanks
F_{MIS}:	Horizontal misalignement of sliding path
F_{MAL}:	Friction due to 1 malfunctioning winch as friction due to skew force at bearings + friction due to resistance 'idle' malfunctioning winch

Combinations of these forces to be considered: **with starting points:**

Situation 1: **fully operational lock gate at start movement**

$F_{A;1} = \Sigma$

F_{WFE}:	traction velocity	$v_{t;1}$	0,35	m/s
F_{HFFR}:	max. friction-factor functioning hydrofoot	η_{HFFR}	0,07	
$F_{IMP;H;T}$:	max. waterlevel difference during movement	$\Delta h;T$	0,1	m
	dynamic friction-factor (*steel-UHMWPE)	$\eta_{IMP;H}$	0,2	
$F_{IMP;H;L}$:	max. waterlevel diff. long. during movement	$\Delta h;L$	0,1	m
F_{IN}:	the maximum velocity of gate reached in	$t_{v;max}$	15	sec.
F_{MIS}:	possible misalignement	φ	0,8	mm/m

Situation 2: **operational lock gate at start movement; 1 malfunctioning winch**

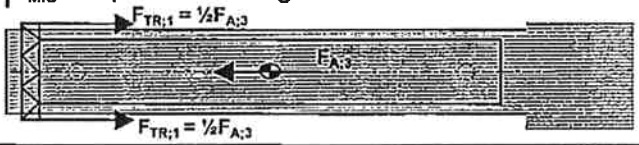
$F_{A;2} = \Sigma$

F_{WFE}:	traction velocity	$v_{t;2}$	0,06	m/s
F_{HFFR}:	max. friction-factor functioning hydrofoot	η_{HFFR}	0,07	
$F_{IMP;H;T}$:	max. waterlevel diff. transv. during movement	$\Delta h;T$	0,1	m
	dynamic friction-factor (*steel-UHMWPE)	$\eta_{IMP;H}$	0,2	
$F_{IMP;H;L}$:	max. waterlevel diff. long. during movement	$\Delta h;L$	0	m*
F_{IN}:	the maximum velocity of gate reached in	$t_{v;max}$	15	sec.
F_{MIS}:	possible misalignement	φ	0,8	mm/m
F_{MAL}:	max. friction-factor horizontal bearings (*)	μ_{MAL}	0,22	
	resistance 'idle' malfunctioning winch	x	0,1	* F_{TR}

Situation 3: **malfunctioning of hydrofoot**

$F_{A;3} = \Sigma$

F_{WFE}:	traction velocity	$v_{t;3}$	0,06	m/s
F_{HFFR}:	max. friction-factor functioning hydrofoot	η_{HFFR}	0,22	
$F_{IMP;H;T}$:	max. waterlevel diff. transv. during movement	$\Delta h;T$	0,1	m
	dynamic friction-factor (*steel-UHMWPE)	$\eta_{IMP;H}$	0,2	
$F_{IMP;H;L}$:	max. waterlevel diff. long. during movement	$\Delta h;L$	0	m*
F_{IN}:	the maximum velocity of gate reached in	$t_{v;max}$	15	sec.
F_{MIS}:	possible misalignement	φ	0,8	mm/m



* : because of slow movement

F_{WFE}: Water resistance

$$F_{WRE} = \Sigma \tfrac{1}{2} \rho v_{tot}^{2} C_d A_i$$

ρ	density of water: 1030 kg/m^3	
v_{tot}	traction velocity (v_t) inclined with the additional waterflow velocity (v_{WATER})	see page 6
C_d	drag factor (values adopted from Det Norske Veritas classification notes No.30.5	
Ai	frontal area of object i to be towed through the water	
h	line of action above bottom sealing (ref.height = -13.800 m)	

Situation 1: fully operational lock gate at start movement

$v_{tot} = v_{t;1} + v_{WATER}$ = 0,35 + 0,08 = **0,43 m/s**

Part	b [m]	h [m]	A_i [m^2]	amount	A_{tot} [m^2]	C_d	F_D [kN]	h [m]	F_D*h [kNm]
ballasttank	6,5	3,5	22,75	1	22,8	0,75	1,6	8,65	14,1
control-compartiments	6,5	4,9	31,85	2	63,7	0,75	4,6	13,60	62,0
water-inletshielding	3,8	1	3,8	2	7,6	1,00	0,7	6,23	4,5
sluice-tubes	6,5	2	13	10	130	1,00	12,4	2,63	32,6
hydrofeet (lower part)	6,9	1,4	9,66	2	19,3	1,00	1,8	3,45	6,4
valves (upper part)	7	0,2	1,4	5	7	2,00	1,3	12,90	17,2
valves (midd part)	5,33	0,2	1,066	10	10,7	2,00	2,0	6,71	13,7
valves (lower part)	2,85	0,2	0,57	30	17,1	2,00	3,3	2,63	8,6
breakerbeams	2,85	0,2	0,57	20	11,4	2,00	2,2	2,63	5,7
vert. beams section E	11,4	0,31	3,534	8	28,3	1,60	4,3	8,65	37,3
	5,7	0,25	1,425	20	28,5	1,60	4,4	4,05	17,6
vert. beams section A	12,6	0,32	4,032	13	52,4	1,60	8,0	8,20	65,6
vert. beam lagoonside	16,4	0,6	9,84	2	19,7	1,60	3,0	8,20	24,6
hor. beams section II	6,5	0,49	3,185	13	41,4	1,60	6,3	15,30	96,7
	6,5	0,5	3,25	10	32,5	1,60	5,0	15,30	75,9
hor. beams section III	6,5	0,49	3,185	13	41,4	1,60	6,3	12,40	78,4
	6,5	0,5	3,25	10	32,5	1,60	5,0	12,40	61,5
hor. beams section VI	6,5	0,49	3,185	13	41,4	1,60	6,3	4,05	25,6
	6,5	0,5	3,25	10	32,5	1,60	5,0	4,05	20,1
hor. beams section VIII	6,5	0,49	3,185	13	41,4	1,60	6,3	1,20	7,6
	6,5	0,5	3,25	10	32,5	1,60	5,0	1,20	6,0
diag. beams sect. G,H,R,S	3,5	0,23	0,805	32	25,8	1,60	3,9	6,80	26,8
diag. beams sect. K,O	3,5	0,23	0,805	12	9,66	1,60	1,5	9,68	14,3
	3,5	0,5	1,75	4	7	1,60	1,1	2,63	2,8
diag. beams sect. L,N	3,5	0,23	0,805	16	12,9	1,60	2,0	8,20	16,1
Totals							103,2		741,8

Total horizontal force due to water friction $F_{WRE;1}$ = **103 kN**

Line of action of F_{WRE} above the bottom sealing $h_{WRE;1}$ = **7,2 m**

Situation 2: **operational lock gate at start movement; 1 malfunctioning winch**
+ Situation 3: **malfunction of hydrofoot**

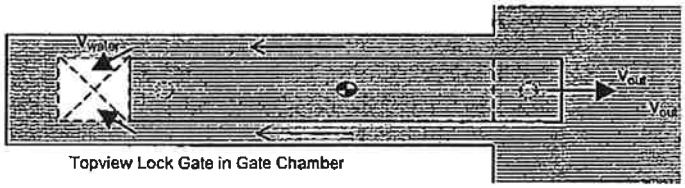
$v_{tot} = v_{t;2/3} + v_{WATER}$ = 0,06 + 0,01 = **0,07 m/s**

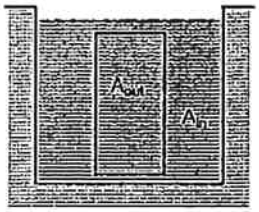
Part	b [m]	h [m]	A_i [m²]	amount	A_{tot} [m²]	C_d	F_D [kN]	h [m]	F_D*h [kNm]
ballasttank	6,5	3,5	22,75	1	22,8	0,75	0,0	8,65	0,4
control-compartiments	6,5	4,9	31,85	2	63,7	0,75	0,1	13,60	1,8
water-inletshielding	3,8	1	3,8	2	7,6	1,00	0,0	6,23	0,1
sluice-tubes	6,5	2	13	10	130	1,00	0,4	2,63	1,0
hydrofeet (lower part)	6,9	1,4	9,66	2	19,3	1,00	0,1	3,45	0,2
valves (upper part)	7	0,2	1,4	5	7	2,00	0,0	12,90	0,5
valves (midd part)	5,33	0,2	1,066	10	10,7	2,00	0,1	6,71	0,4
valves (lower part)	2,85	0,2	0,57	30	17,1	2,00	0,1	2,63	0,3
breakerbeams	2,85	0,2	0,57	20	11,4	2,00	0,1	2,63	0,2
vert. beams section E	11,4	0,31	3,534	8	28,3	1,60	0,1	8,65	1,1
	5,7	0,25	1,425	20	28,5	1,60	0,1	4,05	0,5
vert. beams section A	12,6	0,32	4,032	13	52,4	1,60	0,2	8,20	1,9
vert. beam lagoonside	16,4	0,6	9,84	2	19,7	1,60	0,1	8,20	0,7
hor. beams section II	6,5	0,49	3,185	13	41,4	1,60	0,2	15,30	2,8
	6,5	0,5	3,25	10	32,5	1,60	0,1	15,30	2,2
hor. beams section III	6,5	0,49	3,185	13	41,4	1,60	0,2	12,40	2,3
	6,5	0,5	3,25	10	32,5	1,60	0,1	12,40	1,8
hor. beams section VI	6,5	0,49	3,185	13	41,4	1,60	0,2	4,05	0,8
	6,5	0,5	3,25	10	32,5	1,60	0,1	4,05	0,6
hor. beams section VIII	6,5	0,49	3,185	13	41,4	1,60	0,2	1,20	0,2
	6,5	0,5	3,25	10	32,5	1,60	0,1	1,20	0,2
diag. beams sect. G,H,R,S	3,5	0,23	0,805	32	25,8	1,60	0,1	6,80	0,8
diag. beams sect. K,O	3,5	0,23	0,805	12	9,66	1,60	0,0	9,68	0,4
	3,5	0,5	1,75	4	7	1,60	0,0	2,63	0,1
diag. beams sect. L,N	3,5	0,23	0,805	16	12,9	1,60	0,1	8,20	0,5
Totals							3,0		21,8

Total horizontal force due to water friction $F_{WRE;2} = F_{WRE;3}$ = **3 kN**

Line of action of F_{WRE} above the bottom sealing $h_{WRE;2} = h_{WRE;3}$ = **7,2 m**

v_{WATER}: Additonal waterflow velocity





Shifting the gate with $v_{traction}$ out of the gate chamber with volume V_{out} means a certain flowrate (Q_{out})
$Q_{out} = A_{out} * v_{out}$

This volume V_{out} will immidiatelly be filled with water to retain the flowrate equilibrium $Q_{in} = Q_{out}$
Therefor the water flows through the netto area between gate chamber and gate.

Determination of v_{WATER}

$Q_{in} = Q_{out}$

$A_{in} * v_{in} = A_{out} * v_{out}$

A_{out} = Average section area of gate

$A_{out} = V_{gate} / d$	=	1515	/	53,9	=	28 m²

Netto flow area gate chamber
$A_{in} = A_{gate\ chamber} - A_{out}$

$A_{gate\ chamber}$	=	9,12	*	16,5	=	150 m²
A_{in}					=	122 m²

$v_{in} = v_{out} * (A_{out} / A_{in})$ 0,23 * v_{out}

$v_{WATER} = v_{in}$ 0,23 * v_t

v_{WATER} in different situations

$v_{WATER;1}$	**0,08 m/s**
$v_{WATER;2}$	**0,01 m/s**
$v_{WATER;3}$	**0,01 m/s**

This produces a dragforce along the profiles of the gate to be added to the waterfriction force.
The dragforce is taken into account into F_{WRE} by inclining the velocity: $v_{tot;i} = v_{t;i} + v_{WATER;i}$

F_{HFFR}: Friction of hydrofeet

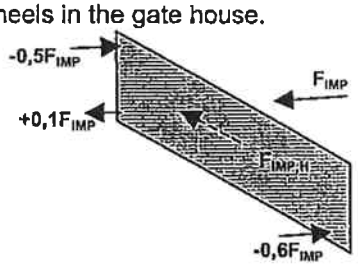
Friction of hydrofeet on sliding path

$F_{HFFR} = \eta_{HFFR} * G_{netto}$

Total netto downward force underwater	G_{netto}	1000 kN
max. friction-factor functioning hydrofoot	$\eta_{HFFR;1,2}$	0,07
max. friction-factor malfunctioning hydrofoot	$\eta_{HFFR;3}$	0,22
Total horizontal force due to friction of hydrofeet in different situations	$F_{HFFR;1,2}$ =	**70 kN**
	$F_{HFFR;3}$ =	**220 kN**
Line of action of F_{HFFR} above the bottom sealing in all situations	h_{HFFR} =	**0,3 m**

$F_{IMP;H;T}$: Friction due to impoundage of water at seaside of gate during movement

Coincidental unequal waterlevel Δh during the operation of opening / closing the lock gate may lead to additional friction on the bottom bearings and the guiding wheels in the gate house.



Total Load on bearings causing friction
$R_{IMP} = (0,5+0,6+0,1) * F_{IMP} = 1,2 * F_{IMP}$
direved from calculation MV036P-PEMAR4002 appendix A

$F_{IMP;H;T} = R_{IMP} * \eta_{IMP}$

water density				ρ	10,3 kN/m³
waterlevel difference				Δh_1	0,1 m
				$\Delta h_{2,3}$	0,1 m
pressure difference				Δq_1	1,03 kN/m²
				$\Delta q_{2,3}$	1,03 kN/m²
Area lock gate (d * a)	53,9	*	16,5 m	A	889 m²
Total force on lock gate				$F_{IMP;1}$	916 kN
				$F_{IMP;2,3}$	916 kN
max. friction-factor (steel-UHMWPE)				η_{IMP}	0,2
Total horizontal force due to impoundage water in different situations				$F_{IMP;H;T;1}$ =	**220 kN**
				$F_{IMP;H;T;2,3}$ =	**220 kN**
Line of action of $F_{IMP;H;T}$ above the bottom sealing in all situations				$h_{IMP;H;T}$ =	**8,25 m**

$F_{IMP;H;L}$: Impoundage of water (bow wave) ahead of gate during movement

Impounding-bow wave $\Delta h;L$ = 0,1 m

(Irrelevant for sit. 2 & 3 as the speed will reduce due to limited motor couple.Overload prevented by max. motor couple)

$F_{IMP;H;L} = \Delta h * A * \rho$ = **0,1 * 7 * 8 * 10,3 =** **58 kN**

A = width gate * height waterlevel to bottom buoyancy tank

Line of action of $F_{IMP;H;L}$ above the bottom sealing $h_{IMP;H;T}$ = **11 m**

F_{IN}: Inertia force

The acceleration of the gate causes inertia-forces
$F_{IN} = m*a$

The maximum velocity of gate reached in $t_{v;max}$ 15 sec.

acceleration in situation	1	v = a * t =	0,35 m/s	a_1	0,023 m/s²
	2	v = a * t =	0,06 m/s	a_2	0,004 m/s²
	3	v = a * t =	0,06 m/s	a_3	0,004 m/s²

Total mass of the structure incl. water ballast:
$m_{structure} + m_{ballast}$ 12762 + 3964 = 16726 kN = 1672600 kg

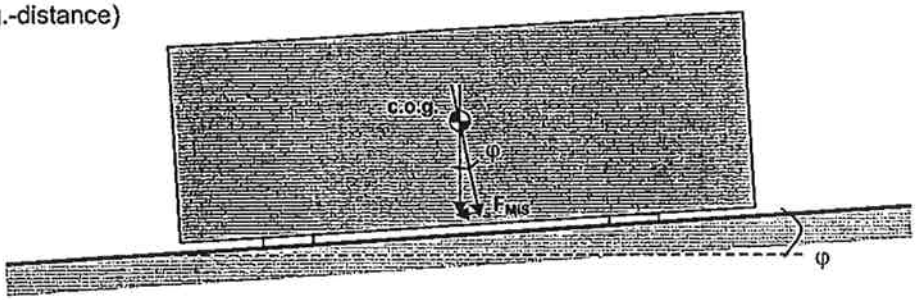
Total horizontal Inertia force	$F_{IN;1}$ =	**39,0 kN**
	$F_{IN;2}$ =	**6,7 kN**
	$F_{IN;3}$ =	**6,7 kN**
Line of action of F_{IN} above the bottom sealing (= c.o.g.-distance)	h_{IN} =	**9,1 m**

Note: Inertia force is NOT governing above waterfriction and -impoundage in sit. 1. and will not act at same time

F_{MIS}: Horizontal misalignement of sliding path

Horizontal misalignement can cause a horizontal component of the gravity force te raise the tow force.
$F_{MIS} = G_{netto} * \sin\varphi$

Possible misalignement of sliding path	φ	0,8 mm/m 0,046 deg
Total netto downward force underwater	G_{netto}	1000 kN
Total horizontal force due to misalignement in all situations	F_{MIS} =	**0,8 kN**
Line of action of F_{MIS} above the bottom sealing (= c.o.g.-distance)	h_{MIS} =	**9,1 m**



F_{MAL}: Friction due to 1 malfunctioning winch

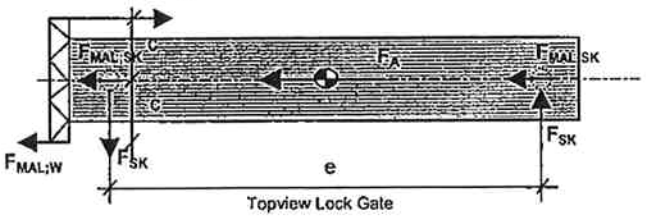
Friction force due to 1 malfunction winch (situation 2):

F_{MAL} = 2* $F_{MAL;SK}$ + $F_{MAL;W}$

where:

$F_{MAL;SK}$	friction due to skew force at bearings	= F_{SK} * η_{MAL}
$F_{MAL;W}$	friction due to resistance 'idle' malfunction winch	= x * F_{TR}

situation



F_{TR}	force on traction device	
$F_A = F_{A;2}$ excl. F_{MAL}	total resistance Force for situation 2 excl. F_{MAL}	300 kN; page 9
F_{SK}	skew force on hor. bearings due to excentric forces F_{TR} and $F_{MAL;W}$	
η_{MAL}	max. friction-factor horizontal bearings	0,22
x	resistance 'idle' malfunction winch	0,1 (* F_{TR})
c	centreline gate - workline traction cable	4,94 m
e	centre to centre distance hydrofeet	51,95 m

$$F_{TR} = F_A + F_{MAL;W} + 2 \cdot F_{MAL;SK} \qquad \text{with} \qquad F_{SK} = \frac{F_A \cdot c + F_{MAL;W;} \cdot 2c}{e}$$

$$F_{TR} = F_A + xF_{TR} + 2\eta \cdot F_{SK} \qquad F_{SK} = \left[F_A + 2x \cdot F_{TR}\right] \cdot \frac{c}{e}$$

$$F_{TR} = F_A + xF_{TR} + 2\eta \cdot \left[F_A + 2x \cdot F_{TR}\right] \cdot \frac{c}{e}$$

$$\left[1 - x - 4\eta x \frac{c}{e}\right] F_{TR} = \left[1 + 2\eta \cdot \frac{c}{e}\right] F_A$$

0,89 F_{TR} = 1,0418 F_A

F_{TR} = 1,1685 F_A

F_A	300 kN
F_{TR}	351 kN
F_{SK}	35 kN
$F_{MAL;SK}$	**8 kN**
$F_{MAL;W}$	**35 kN**

Total horizontal force due to malfunctioning winch F_{MAL} = **51 kN**

Line of action of F_{SKEW} above the bottom sealing $h_{MAL;SK}$ = **0,3 m**

$h_{MAL;W}$ = **16,5 m**

F_{TR}: Tractionforces on winchwork

Situation 1: fully operational lock gate at start movement

$F_{A;1} = \Sigma$	F_{WFE}:	103 kN
	F_{HFFR}:	70 kN
	$F_{IMP;H;T}$:	220 kN
	$F_{IMP;H;L}$:	58 kN
	F_{MIS}:	1 kN +
	$F_{A;1}$:	452 kN

$F_{TR;1} = ½ F_{A;1}$ $F_{TR;1}$: 226 kN

Situation 2: operational lock gate at start movement; 1 malfunctioning winch

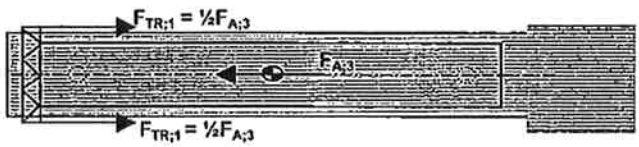
$F_{A;2} = \Sigma$	F_{WFE}:	3 kN
	F_{HFFR}:	70 kN
	$F_{IMP;H;T}$:	220 kN
	F_{IN}:	7 kN
	F_{MIS}:	1 kN
	F_{MAL}:	51 kN +
	$F_{A;2}$:	351 kN

$F_{TR;2} = F_{A;2}$ $F_{TR;2}$: 351 kN

Situation 3: malfunctioning of hydrofoot

$F_{A;3} = \Sigma$	F_{WFE}:	3 kN
	F_{HFFR}:	220 kN
	$F_{IMP;H;T}$:	220 kN
	F_{IN}:	7 kN
	F_{MIS}:	1 kN +
	$F_{A;3}$:	450 kN

$F_{TR;3} = ½ F_{A;3}$ $F_{TR;3}$: 225 kN



F_{HF}: Added and reduced force on hydrofeet due to excentricity traction

Situation 1: fully operational lock gate at start movement

$M_{A;1} = \Sigma$	F_{WFE}:	103 kN	x	h_{WFE}:	7,2 =	742 kNm	
	F_{HFFR}:	70 kN	x	h_{HFFR}:	0,3 =	21 kNm	
	$F_{IMP;H;T}$:	220 kN	x	$h_{IMP;H}$:	8,25 =	1814 kNm	
	$F_{IMP;H;T}$:	58 kN	x	h_{IN}:	11 =	638 kNm	
	F_{MIS}:	1 kN	x	h_{MIS}:	9,1 =	7 kNm +	
					$M_{A;1}$:	3222 kNm	

$h_{FA;1} = M_{A;1} / F_{A;1}$ 7,1 m

h_{TR} Line of action of F_{TR} above bottom sealing 16,5 m

$M_{HF;1}$ Forward moment lock gate $F_{A;1}*(h_{TR}-h_{FA;1})$ 4231 kNm

$F_{HF;1} = M_{HF;1} / e$ $F_{HF;1}$ 81 kN

Situation 2: operationail lock gate at start movement; 1 malfunctioning winch

$M_{A;2} = \Sigma$	F_{WFE}:	3 kN	x	h_{WFE}:	7,2 =	22 kNm	
	F_{HFFR}:	70 kN	x	h_{HFFR}:	0,3 =	21 kNm	
	$F_{IMP;H;T}$:	220 kN	x	$h_{IMP;H}$:	8,25 =	1814 kNm	
	F_{IN}:	7 kN	x	h_{IN}:	9,1 =	61 kNm	
	F_{MIS}:	1 kN	x	h_{MIS}:	9,1 =	7 kNm	
	F_{MAL}:	51 kN	x	h_{MAL}:	0,3 =	15 kNm +	
					$M_{A;2}$:	1940 kNm	

$h_{FA;2} = M_{A;2} / F_{A;2}$ 5,5 m

h_{TR} Line of action of F_{TR} above bottom sealing 16,5 m

$M_{HF;2}$ Forward moment lock gate $F_{A;2}*(h_{TR}-h_{FA;2})$ 3852 kNm

$F_{HF;2} = M_{HF;2} / e$ $F_{HF;2}$ 74 kN

Situation 3: malfunctioning of hydrofoot

$M_{A;3} = \Sigma$	F_{WFE}:	3 kN	x	h_{WFE}:	7,2 =	22 kNm	
	F_{HFFR}:	220 kN	x	h_{HFFR}:	0,3 =	66 kNm	
	$F_{IMP;H;T}$:	220 kN	x	$h_{IMP;H}$:	8,25 =	1814 kNm	
	F_{IN}:	7 kN	x	h_{IN}:	9,1 =	61 kNm	
	F_{MIS}:	1 kN	x	h_{MIS}:	9,1 =	7 kNm +	
					$M_{A;3}$:	1970 kNm	

$h_{FA;3} = M_{A;3} / F_{A;3}$ 4,4 m

h_{TR} Line of action of F_{TR} above bottom sealing 16,5 m

$M_{HF;3}$ Forward moment lock gate $F_{A;3}*(h_{TR}-h_{FA;3})$ 5461 kNm

$F_{HF;3} = M_{HF;3} / e$ $F_{HF;3}$ 105 kN

D1. Determination Traction loads

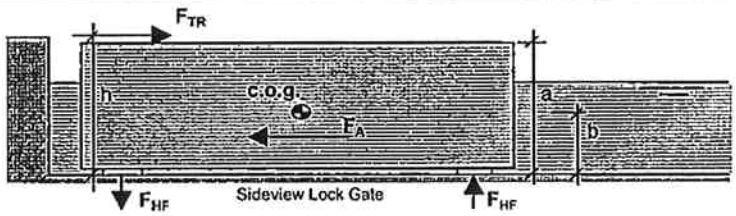
Situation: Waterlevel: -1.300 Description: Low Water Level

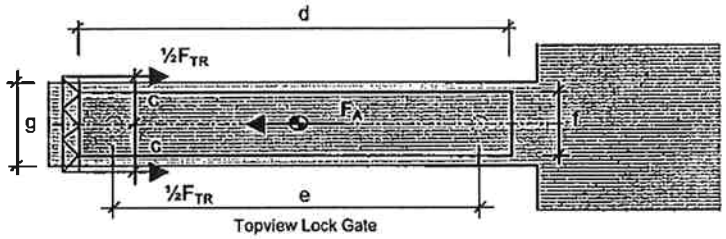
The gate will be opened or closed by a traction device.
In this calculation the acting forces during the shifting progress are determined:

Acting forces:

F_{TR}: Forces on traction devices (total)
F_{HF}: Added and reduced (vertical) force on hydrofeet due to excentricity traction

Situation:





Dimensions

a	height of gate	16,5	m
b	c.o.g. gate above bottom sealing	9,1	m
c	centreline gate - workline traction cable	4,94	m
d	length of gate	53,9	m
e	centre to centre distance hydrofeet	51,95	m
f	width of gate	6,5	m
g	width of gate chamber	9,12	m
h	workline traction cable above bottom sealing	16,5	m
i	distance b.o.s.gate - slide path	0,3	m

Weight and volumes

Total mass of the structure incl. water ballast:
$m_{structure} + m_{ballast}$ 12762 + 3964 = 16726 kN

Total netto downward force underwater G_{netto} 2400 kN
Total underwater volume of the structure $V_{gate;under}$ 1515 m^3

Project : Malamocco Navigation lock-gates

Onderdeel : Determination Traction loads in LLWS sit. -1300

Forces to be overcome by traction device (F_A):

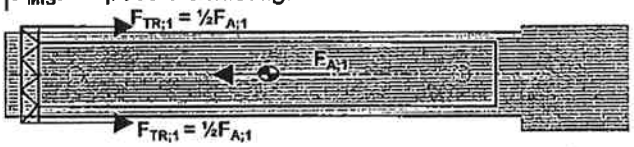
F_{WFE}:	Water resistance depanding on dragfactor, traction velocity and waterflow velocity	
F_{HFFR}:	Friction of hydrofeet on sliding path	
$F_{IMP;H;T}$:	Friction due to impoundage of water at seaside of gate during movement	
$F_{IMP;H;L}$:	Impoundage of water (bow wave) ahead of gate during movement	
F_{IN}:	Inertia of lock gate mass including water mass in ballast tanks	
F_{MIS}:	Horizontal misalignement of sliding path	
F_{MAL}:	Friction due to 1 malfunctioning winch as	friction due to skew force at bearings + friction due to resistance 'idle' malfunctioning winch

Combinations of these forces to be considered: **with starting points:**

Situation 1: **fully operational lock gate at start movement**

$F_{A;1} = \Sigma$

F_{WFE}:	traction velocity	$v_{t;1}$	0,35	m/s
F_{HFFR}:	max. friction-factor functioning hydrofoot	η_{HFFR}	0,07	
$F_{IMP;H;T}$:	max. waterlevel difference during movement	$\Delta h;T$	0,05	m
	dynamic friction-factor (*steel-UHMWPE)	$\eta_{IMP;H}$	0,2	
$F_{IMP;H;L}$:	max. waterlevel diff. long. during movement	$\Delta h;L$	0,1	m
F_{IN}:	the maximum velocity of gate reached in	$t_{v;max}$	15	sec.
F_{MIS}:	possible misalignement	φ	0,8	mm/m



Situation 2: **operational lock gate at start movement; 1 malfunctioning winch**

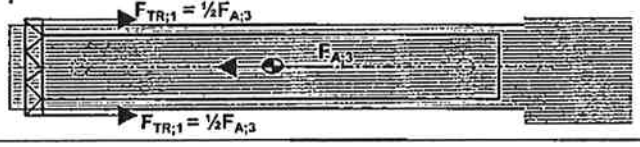
$F_{A;2} = \Sigma$

F_{WFE}:	traction velocity	$v_{t;2}$	0,06	m/s
F_{HFFR}:	max. friction-factor functioning hydrofoot	η_{HFFR}	0,07	
$F_{IMP;H;T}$:	max. waterlevel diff. transv. during movement	$\Delta h;T$	0,05	m
	dynamic friction-factor (*steel-UHMWPE)	$\eta_{IMP;H}$	0,2	
$F_{IMP;H;L}$:	max. waterlevel diff. long. during movement	$\Delta h;L$	0	m*
F_{IN}:	the maximum velocity of gate reached in	$t_{v;max}$	15	sec.
F_{MIS}:	possible misalignement	φ	0,8	mm/m
F_{MAL}:	max. friction-factor horizontal bearings (*)	μ_{MAL}	0,22	
	resistance 'idle' malfunctioning winch	x	0,1	* F_{TR}

Situation 3: **malfunctioning of hydrofoot**

$F_{A;3} = \Sigma$

F_{WFE}:	traction velocity	$v_{t;3}$	0,06	m/s
F_{HFFR}:	max. friction-factor malfunctioning hydrofoot	η_{HFFR}	0,22	
$F_{IMP;H;T}$:	max. waterlevel diff. transv. during movement	$\Delta h;T$	0,05	m
	dynamic friction-factor (*steel-UHMWPE)	$\eta_{IMP;H}$	0,2	
$F_{IMP;H;L}$:	max. waterlevel diff. long. during movement	$\Delta h;L$	0	m*
F_{IN}:	the maximum velocity of gate reached in	$t_{v;max}$	15	sec.
F_{MIS}:	possible misalignement	φ	0,8	mm/m



* : because of slow movement

F_{WFE}: Water resistance

$$F_{WRE} = \Sigma \tfrac{1}{2} \rho v_{tot}^{2} C_d A_i$$

ρ	density of water: 1030 kg/m^3	
v_{tot}	traction velocity (v_t) inclined with the additional waterflow velocity (v_{WATER})	see page 17
C_d	drag factor (values adopted from Det Norske Veritas classification notes No.30.5	
Ai	frontal area of object i to be towed through the water	
h	line of action above bottom sealing (ref.height = -13.800 m)	

Situation 1: fully operational lock gate at start movement

$v_{tot} = v_{t;1} + v_{WATER}$ = 0,35 + 0,08 = **0,43 m/s**

Part	b [m]	h [m]	A_i [m²]	amount	A_{tot} [m²]	C_d	F_D [kN]	h [m]	F_D*h [kNm]
ballasttank	6,5	3,5	22,75	1	22,8	0,75	1,6	8,65	14,1
control-compartiments	0	0	0	2	0	0,75	0,0	13,60	0,0
water-inletshielding	3,8	1	3,8	2	7,6	1,00	0,7	6,23	4,5
sluice-tubes	6,5	2	13	10	130	1,00	12,4	2,63	32,6
hydrofeet (lower part)	6,9	1,4	9,66	2	19,3	1,00	1,8	3,45	6,4
valves (upper part)	0	0	0	5	0	2,00	0,0	12,90	0,0
valves (midd part)	5,33	0,2	1,066	10	10,7	2,00	2,0	6,71	13,7
valves (lower part)	2,85	0,2	0,57	30	17,1	2,00	3,3	2,63	8,6
breakerbeams	2,85	0,2	0,57	20	11,4	2,00	2,2	2,63	5,7
vert. beams section E	11,4	0,31	3,534	8	28,3	1,60	4,3	8,65	37,3
	5,7	0,25	1,425	20	28,5	1,60	4,4	4,05	17,6
vert. beams section A	12,6	0,32	4,032	13	52,4	1,60	8,0	8,20	65,6
vert. beam lagoonside	16,4	0,6	9,84	2	19,7	1,60	3,0	8,20	24,6
hor. beams section II	0	0	0	13	0	1,60	0,0	15,30	0,0
	0	0	0	10	0	1,60	0,0	15,30	0,0
hor. beams section III	6,5	0,49	3,185	13	41,4	1,60	6,3	12,40	78,4
	6,5	0,5	3,25	10	32,5	1,60	5,0	12,40	61,5
hor. beams section VI	6,5	0,49	3,185	13	41,4	1,60	6,3	4,05	25,6
	6,5	0,5	3,25	10	32,5	1,60	5,0	4,05	20,1
hor. beams section VIII	6,5	0,49	3,185	13	41,4	1,60	6,3	1,20	7,6
	6,5	0,5	3,25	10	32,5	1,60	5,0	1,20	6,0
diag. beams sect. G,H,R,S	3,5	0,23	0,805	32	25,8	1,60	3,9	6,80	26,8
diag. beams sect. K,O	3,5	0,23	0,805	12	9,66	1,60	1,5	9,68	14,3
	3,5	0,5	1,75	4	7	1,60	1,1	2,63	2,8
diag. beams sect. L,N	3,5	0,23	0,805	16	12,9	1,60	2,0	8,20	16,1
Totals							86,1		489,9

Total horizontal force due to water friction $F_{WRE;1}$ = **86 kN**

Line of action of F_{WRE} above the bottom sealing $h_{WRE;1}$ = **5,7 m**

Situation 2: **operational lock gate at start movement; 1 malfunctioning winch**
+ Situation 3: **malfunction of hydrofoot**

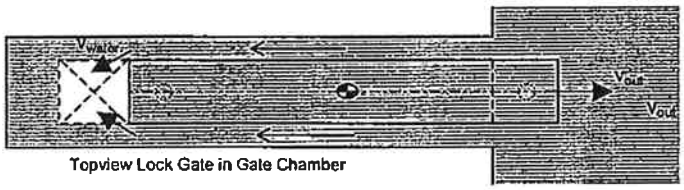
$v_{tot} = v_{t;2/3} + v_{WATER}$ = 0,06 + 0,01 = **0,07 m/s**

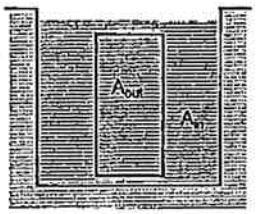
Part	b [m]	h [m]	A_l [m²]	amount	A_{tot} [m²]	C_d	F_D [kN]	h [m]	F_D*h [kNm]
ballasttank	6,5	3,5	22,75	1	22,8	0,75	0,0	8,65	0,4
control-compartiments	0	0	0	2	0	0,75	0,0	13,60	0,0
water-inletshielding	3,8	1	3,8	2	7,6	1,00	0,0	6,23	0,1
sluice-tubes	6,5	2	13	10	130	1,00	0,4	2,63	1,0
hydrofeet (lower part)	6,9	1,4	9,66	2	19,3	1,00	0,1	3,45	0,2
valves (upper part)	0	0	0	5	0	2,00	0,0	12,90	0,0
valves (midd part)	5,33	0,2	1,066	10	10,7	2,00	0,1	6,71	0,4
valves (lower part)	2,85	0,2	0,57	30	17,1	2,00	0,1	2,63	0,3
breakerbeams	2,85	0,2	0,57	20	11,4	2,00	0,1	2,63	0,2
vert. beams section E	11,4	0,31	3,534	8	28,3	1,60	0,1	8,65	1,1
	5,7	0,25	1,425	20	28,5	1,60	0,1	4,05	0,5
vert. beams section A	12,6	0,32	4,032	13	52,4	1,60	0,2	8,20	1,9
vert. beam lagoonside	16,4	0,6	9,84	2	19,7	1,60	0,1	8,20	0,7
hor. beams section II	0	0	0	13	0	1,60	0,0	15,30	0,0
	0	0	0	10	0	1,60	0,0	15,30	0,0
hor. beams section III	6,5	0,49	3,185	13	41,4	1,60	0,2	12,40	2,3
	6,5	0,5	3,25	10	32,5	1,60	0,1	12,40	1,8
hor. beams section VI	6,5	0,49	3,185	13	41,4	1,60	0,2	4,05	0,8
	6,5	0,5	3,25	10	32,5	1,60	0,1	4,05	0,6
hor. beams section VIII	6,5	0,49	3,185	13	41,4	1,60	0,2	1,20	0,2
	6,5	0,5	3,25	10	32,5	1,60	0,1	1,20	0,2
diag. beams sect. G,H,R,S	3,5	0,23	0,805	32	25,8	1,60	0,1	6,80	0,8
diag. beams sect. K,O	3,5	0,23	0,805	12	9,66	1,60	0,0	9,68	0,4
	3,5	0,5	1,75	4	7	1,60	0,0	2,63	0,1
diag. beams sect. L,N	3,5	0,23	0,805	16	12,9	1,60	0,1	8,20	0,5
Totals							2,5		14,4

Total horizontal force due to water friction $F_{WRE;2} = F_{WRE;3}$ = **3 kN**

Line of action of F_{WRE} above the bottom sealing $h_{WRE;2} = h_{WRE;3}$ = **5,7 m**

v_{WATER}: Additonal waterflow velocity





Shifting the gate with $v_{traction}$ out of the gate chamber with volume V_{out} means a certain flowrate (Q_{out})
$Q_{out} = A_{out} * v_{out}$

This volume V_{out} will immidiatelly be filled with water to retain the flowrate equilibrium $Q_{in} = Q_{out}$
Therefor the water flows through the netto area between gate chamber and gate.

Determination of v_{WATER}

$Q_{in} = Q_{out}$

$A_{in} * v_{in} = A_{out} * v_{out}$

A_{out} = Average section area of gate

$A_{out} = V_{gate} / d$	=	1515	/	53,9	=	28 m²

Netto flow area gate chamber
$A_{in} = A_{gate\ chamber} - A_{out}$

$A_{gate\ chamber}$	=	9,12	*	16,5	=	150 m²
A_{in}					=	122 m²

$v_{in} = v_{out} * (A_{out} / A_{in})$ 0,23 * v_{out}

$v_{WATER} = v_{in}$ 0,23 * v_t

v_{WATER} in different situations

$v_{WATER;1}$	**0,08 m/s**
$v_{WATER;2}$	**0,01 m/s**
$v_{WATER;3}$	**0,01 m/s**

This produces a dragforce along the profiles of the gate to be added to the waterfriction force.
The dragforce is taken into account into F_{WRE} by inclining the velocity: $v_{tot;i} = v_{t;i} + v_{WATER;i}$

Project : Malamocco Navigation lock-gates

Onderdeel : Determination Traction loads in LLWS sit. -1300

F_{HFFR}: Friction of hydrofeet

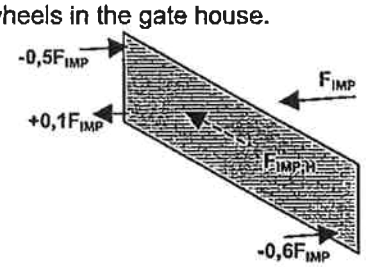
Friction of hydrofeet on sliding path

$F_{HFFR} = \eta_{HFFR} * G_{netto}$

Total netto downward force underwater	G_{netto}	2400	kN
max. friction-factor functioning hydrofoot	$\eta_{HFFR;1,2}$	0,07	
max. friction-factor malfunctioning hydrofoot	$\eta_{HFFR;3}$	0,22	
Total horizontal force due to friction of hydrofeet in different situations	$F_{HFFR;1,2}$ =	**168**	**kN**
	$F_{HFFR;3}$ =	**528**	**kN**
Line of action of F_{HFFR} above the bottom sealing in all situations	h_{HFFR} =	**0,3**	**m**

$F_{IMP;H;T}$: Friction due to impoundage of water at seaside of gate during movement

Coincidental unequal waterlevel Δh during the operation of opening / closing the lock gate may lead to additional friction on the bottom bearings and the guiding wheels in the gate house.



Total Load on bearings causing friction
$R_{IMP} = (0,5+0,6+0,1) * F_{IMP} = 1,2 * F_{IMP}$
direved from calculation MV036P-PEMAR4002 appendix A

$F_{IMP;H} = R_{IMP} * \eta_{IMP}$

water density				ρ	10,3 kN/m³
waterlevel difference				Δh_1	0,05 m
				$\Delta h_{2,3}$	0,05 m
pressure difference				Δq_1	0,515 kN/m²
				$\Delta q_{2,3}$	0,515 kN/m²
Area lock gate (d * a)	53,9	*	12,6 m	A	679 m²
Total force on lock gate				$F_{IMP;1}$	350 kN
				$F_{IMP;2,3}$	350 kN
max. friction-factor (steel-UHMWPE)				η_{IMP}	0,2
Total horizontal force due to impoundage water in different situations				$F_{IMP;H;1}$ =	**84 kN**
				$F_{IMP;H;2,3}$ =	**84 kN**
Line of action of $F_{IMP;H}$ above the bottom sealing in all situations				$h_{IMP;H}$ =	**6,3 m**

$F_{IMP;H;L}$: Impoundage of water (bow wave) ahead of gate during movement

Impounding-bow wave $\Delta h;L$ = 0,1 m

(Irrelevant for sit. 2 & 3 as the speed will reduce due to limited motor couple.Overload prevented by max. motor couple)

$F_{IMP;H;L} = \Delta h * A * \rho =$ 0,1 * 7 * 5,5 * 10,3 = **40** kN

A = width gate * height waterlevel to bottom buoyancy tank

Line of action of $F_{IMP;H;L}$ above the bottom sealing $h_{IMP;H;T}$ = **10** m

Author :	Date :	page :	Rev. :
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F_{IN}: Inertia force

The acceleration of the gate causes inertia-forces
$F_{IN} = m*a$

The maximum velocity of gate reached in $t_{v;max}$ 15 sec.

acceleration in situation	1	v = a * t =	0,35 m/s	a_1	0,023 m/s²
	2	v = a * t =	0,06 m/s	a_2	0,004 m/s²
	3	v = a * t =	0,06 m/s	a_3	0,004 m/s²

Total mass of the structure incl. water ballast:

$m_{structure}$ + $m_{ballast}$					
12762	+	3964	=	16726 kN =	1672600 kg

Total horizontal Inertia force

$F_{IN;1}$ = 39,0 kN
$F_{IN;2}$ = 6,7 kN
$F_{IN;3}$ = 6,7 kN

Line of action of F_{IN} above the bottom sealing (= c.o.g.-distance) **h_{IN} = 9,1 m**

Note: Inertia force is NOT governing above waterfriction and -impoundage in sit. 1. and will not act at same time

F_{MIS}: Horizontal misalignement of sliding path

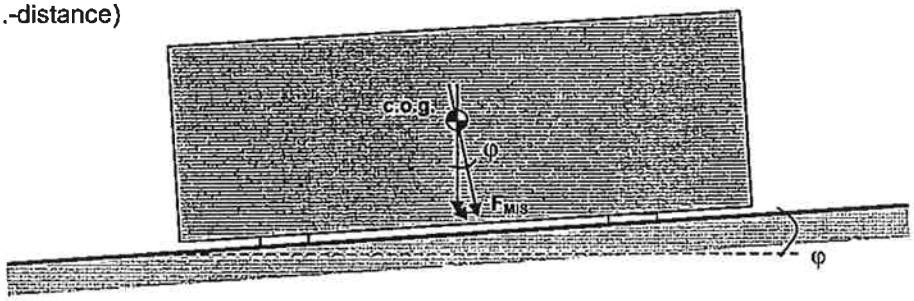
Horizontal misalignement can cause a horizontal component of the gravity force te raise the tow force.
$F_{MIS} = G_{netto} * \sin\varphi$

Possible misalignement of sliding path φ 0,8 mm/m
0,046 deg

Total netto downward force underwater G_{netto} 2400 kN

Total horizontal force due to misalignement in all situations **F_{MIS} = 1,9 kN**

Line of action of F_{MIS} above the bottom sealing (= c.o.g.-distance) **h_{MIS} = 9,1 m**



F_{MAL}: Friction due to 1 malfunctioning winch

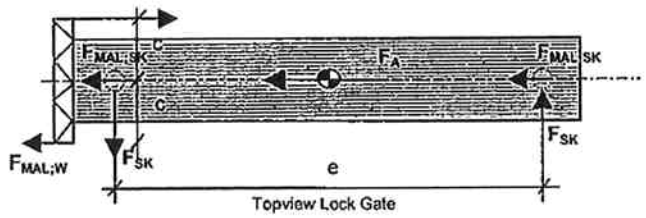
Friction force due to 1 malfunction winch (situation 2):

$F_{MAL} = 2 * F_{MAL;SK} + F_{MAL;W}$

where:

$F_{MAL;SK}$	friction due to skew force at bearings	$= F_{SK} * \eta_{MAL}$
$F_{MAL;W}$	friction due to resistance 'idle' malfunction winch	$= x * F_{TR}$

situation



F_{TR}	force on traction device	
$F_A = F_{A;2}$ excl. F_{MAL}	total resistance Force for situation 2 excl. F_{MAL}	264 kN; page 9
F_{SK}	skew force on hor. bearings due to excentric forces F_{TR} and $F_{MAL;W}$	
η_{MAL}	max. friction-factor horizontal bearings	0,22
x	resistance 'idle' malfunction winch	0,1 (* F_{TR})
c	centreline gate - workline traction cable	4,94 m
e	centre to centre distance hydrofeet	51,95 m

$$F_{TR} = F_A + F_{MAL;W} + 2 \cdot F_{MAL;SK} \qquad \text{with} \qquad F_{SK} = \frac{F_A \cdot c + F_{MAL;W;} \cdot 2c}{e}$$

$$F_{TR} = F_A + xF_{TR} + 2\eta \cdot F_{SK} \qquad F_{SK} = \left[F_A + 2x \cdot F_{TR}\right] \cdot \frac{c}{e}$$

$$F_{TR} = F_A + xF_{TR} + 2\eta \cdot \left[F_A + 2x \cdot F_{TR}\right] \cdot \frac{c}{e}$$

$$\left[1 - x - 4\eta x \frac{c}{e}\right] F_{TR} = \left[1 + 2\eta \cdot \frac{c}{e}\right] F_A$$

0,89 $F_{TR} = 1,0418 \; F_A$

$F_{TR} = 1,1685 \; F_A$

F_A	264 kN
F_{TR}	308 kN
F_{SK}	31 kN
$F_{MAL;SK}$	**7 kN**
$F_{MAL;W}$	**31 kN**

Total horizontal force due to malfunctioning winch F_{MAL} = **44 kN**

Line of action of F_{SKEW} above the bottom sealing

$h_{MAL;SK}$ = **0,3 m**

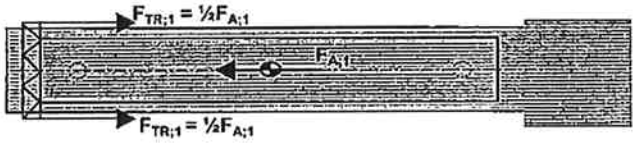
$h_{MAL;W}$ = **16,5 m**

F_{TR}: Tractionforces on winchwork

Situation 1: fully operational lock gate at start movement

$F_{A;1} = \Sigma$	F_{WFE}:	86 kN
	F_{HFFR}:	168 kN
	$F_{IMP;H;T}$:	84 kN
	$F_{IMP;H;L}$:	40 kN
	F_{MIS}:	2 kN +
	$F_{A;1}$:	380 kN

$F_{TR;1} = ½ F_{A;1}$ $F_{TR;1}$: 190 kN



Situation 2: operational lock gate at start movement; 1 malfunctioning winch

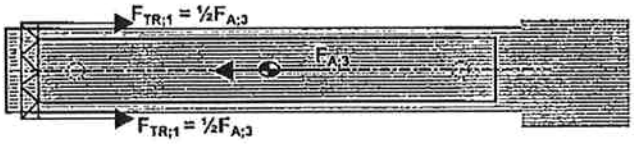
$F_{A;2} = \Sigma$	F_{WFE}:	3 kN
	F_{HFFR}:	168 kN
	$F_{IMP;H;T}$:	84 kN
	F_{IN}:	7 kN
	F_{MIS}:	2 kN
	F_{MAL}:	44 kN +
	$F_{A;2}$:	308 kN

$F_{TR;2} = F_{A;2}$ $F_{TR;2}$: 308 kN

Situation 3: malfunctioning of hydrofoot

$F_{A;3} = \Sigma$	F_{WFE}:	3 kN
	F_{HFFR}:	528 kN
	$F_{IMP;H;T}$:	84 kN
	F_{IN}:	7 kN
	F_{MIS}:	2 kN +
	$F_{A;3}$:	624 kN

$F_{TR;3} = ½ F_{A;3}$ $F_{TR;3}$: 312 kN



F_{HF}: Added and reduced force on hydrofeet due to excentricity traction

Situation 1: fully operational lock gate at start movement

$M_{A;1} = \Sigma$	F_{WFE}:	86 kN	x	h_{WFE}:	5,7 =	490 kNm	
	F_{HFFR}:	168 kN	x	h_{HFFR}:	0,3 =	50 kNm	
	$F_{IMP;H;L}$:	84 kN	x	$h_{IMP;H}$:	6,3 =	529 kNm	
	$F_{IMP;H;T}$:	40 kN	x	h_{IN}:	10 =	400 kNm	
	F_{MIS}:	2 kN	x	h_{MIS}:	9,1 =	17 kNm	+
					$M_{A;1}$:	1487 kNm	

$h_{FA;1} = M_{A;1} / F_{A;1}$ 3,9 m

h_{TR} Line of action of F_{TR} above bottom sealing 16,5 m

$M_{HF;1}$ Forward moment lock gate $F_{A;1}*(h_{TR}-h_{FA;1})$ 4781 kNm

$F_{HF;1} = M_{HF;1} / e$ $F_{HF;1}$ 92 kN

Situation 2: operationail lock gate at start movement; 1 malfunctioning winch

$M_{A;2} = \Sigma$	F_{WFE}:	3 kN	x	h_{WFE}:	5,7 =	17 kNm	
	F_{HFFR}:	168 kN	x	h_{HFFR}:	0,3 =	50 kNm	
	$F_{IMP;H;T}$:	84 kN	x	$h_{IMP;H}$:	6,3 =	529 kNm	
	F_{IN}:	7 kN	x	h_{IN}:	9,1 =	61 kNm	
	F_{MIS}:	2 kN	x	h_{MIS}:	9,1 =	17 kNm	
	F_{MAL}:	44 kN	x	h_{MAL}:	0,3 =	13 kNm	+
					$M_{A;2}$:	688 kNm	

$h_{FA;2} = M_{A;2} / F_{A;2}$ 2,2 m

h_{TR} Line of action of F_{TR} above bottom sealing 16,5 m

$M_{HF;2}$ Forward moment lock gate $F_{A;2}*(h_{TR}-h_{FA;2})$ 4394 kNm

$F_{HF;2} = M_{HF;2} / e$ $F_{HF;2}$ 85 kN

Situation 3: malfunctioning of hydrofoot

$M_{A;3} = \Sigma$	F_{WFE}:	3 kN	x	h_{WFE}:	5,7 =	17 kNm	
	F_{HFFR}:	528 kN	x	h_{HFFR}:	0,3 =	158 kNm	
	$F_{IMP;H;T}$:	84 kN	x	$h_{IMP;H}$:	6,3 =	529 kNm	
	F_{IN}:	7 kN	x	h_{IN}:	9,1 =	61 kNm	
	F_{MIS}:	2 kN	x	h_{MIS}:	9,1 =	17 kNm	+
					$M_{A;3}$:	783 kNm	

$h_{FA;3} = M_{A;3} / F_{A;3}$ 1,3 m

h_{TR} Line of action of F_{TR} above bottom sealing 16,5 m

$M_{HF;3}$ Forward moment lock gate $F_{A;3}*(h_{TR}-h_{FA;3})$ 9506 kNm

$F_{HF;3} = M_{HF;3} / e$ $F_{HF;3}$ 183 kN

Project : MALAMOCCO NAV. LOCK GATE.

Onderdeel : DETERMINATION TRACTION LOAD.

NOTE :

PREVIOUS DETERMINATION OF THE TRACTION LOAD IS BASED ON THE MAXIMUM WATERFRICTION WHILE THE GATE ACCELERATION IS COMBINED WITH ONLY THE MASS OF THE GATESTRUCTURE TO BE SET IN MOTION.

THE MASS OF THE WATER ENCLOSED BY THE GATE STRUCTURE AT ZERO SPEED IS IGNORED IN THE CALCULATION, BECAUSE THE MAXIMUM WATERFRICTION IS NOT YET PRESENT AT ZERO SPEED. WATERFRICTION (F_{WRE}) IS GOVERNING ABOVE THE FORCE REQUIRED TO SET THE TOTAL MASS (GATE+ WATER) IN MOTION AT START OF MOVEMENT (F_m)

AS PRESENTED BELOW FOR SIT. 1 FROM PREVIOUS CALC :

$F_m = m \cdot a$ $\quad m$ = NEGLECTED WATER MASS $\hat{=} 4000.10^3$ kg.

$= 92$ kN. $\quad a$ = ACCELERATION $= 9{,}023\ m/s^2$

$F_{WRE} = 103$ kN.

$F_{WRE} > F_m$; CALC. BASES IS SUFFICIENT.

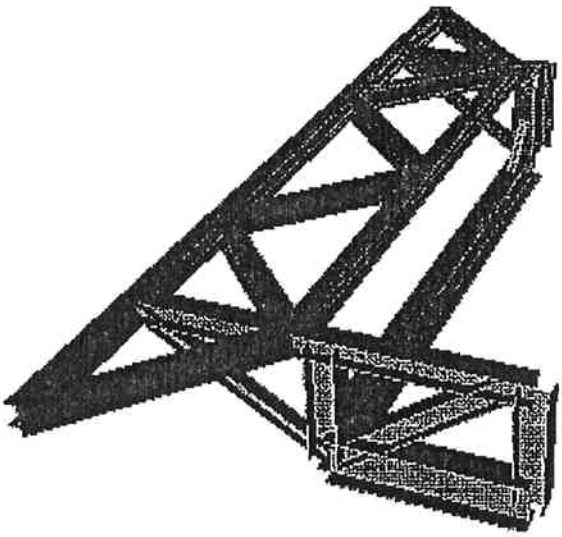
IN SITUATION 2 AND 3 THE ACCELERATION IS NOT SIGNIFICANT. AND RESULTS FROM THE PRESENT WINCH FORCE, THUS THE GOVERNING TRACTION FORCE IN PREVIOUS CALC. OF 351 kN WILL NOT BE EXCEEDED.
THIS ALSO COUNTS for the BOW-wave, which is negligable for the gate max. speed on situation

Opgesteld :	Datum :	Bladnummer :	Rev. :
JRA	14-04-64	D1-23	A2

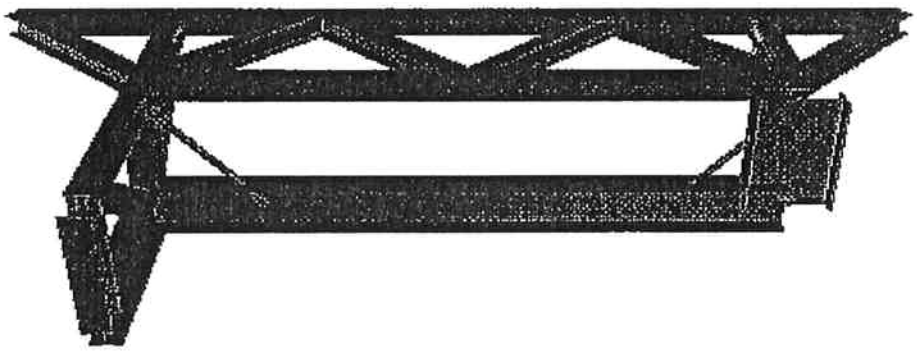
D2. Traction Frame: Main Calculation

Contents

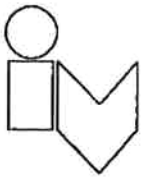
1. 3D overview of model



3D rendering of model (sideview SS)



3D rendering of model (topview)



2. Input (numerical)

Basic data
Type of structure : Frame XYZ

Number of nodes:	22
Number of members:	35
Number of 1D macros:	20
Number of bound. lines:	0
Number of 2D macros:	0
Number of profiles :	7
Number of cases:	6
Number of materials:	1

Material

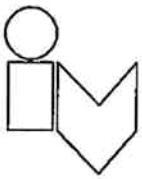
Name:
S 355

Ultimate strength	510.000 MPa
Yield design	355.000 MPa
E modulus	210000.00 MPa
Poisson coeff.	0.30
Density	0.000 kg/mm^3
Extensibility	1.2e-005 mm/mm.K

List of material
Group of members :
1/35

no.	Name:	quality	unit weight kg/mm	length mm	weight kg
1	HEB240	S 355	0.08	38205.65	3179.09
2	HEB300	S 355	0.12	2430.00	284.42
3	HEA500	S 355	0.16	6500.00	1010.29
4	HEB900	S 355	0.29	1215.00	354.14
5	HEA160	S 355	0.03	4510.53	137.38
6	2 LT (H50/50/5,10)	S 355	0.01	3415.39	25.74
7	HEB500	S 355	0.19	1950.00	365.24

The total weight of the structure: 5356.30 kg
Surface for painting: 85990027.81 mm^2



Nodes

node	X mm	Y mm	Z mm
1	2275	50	0
2	3900	50	0
3	5525	50	0
4	7150	50	0
5	8775	50	0
6	495	1650	0
7	2275	1650	0
8	3900	1650	0
9	5525	1650	0
10	7150	1650	0
11	8775	1650	0
12	10375	1650	0
13	2275	-250	-1215
14	8775	-250	-1215
15	2275	-2200	0
16	2275	-2200	-1215
17	2275	-250	0
18	8775	-250	0
19	3475	-250	-1215
20	7575	-250	-1215
21	2275	-1963	0
22	2275	-310	-1215

Members

macro	memb	node 1	node 2	length mm	Rx deg	profile	quality
1	1	6	7	1780	0.00	1 - HEB240	S 355
1	2	7	8	1625	0.00	1 - HEB240	S 355
1	3	8	9	1625	0.00	1 - HEB240	S 355
1	4	9	10	1625	0.00	1 - HEB240	S 355
1	5	10	11	1625	0.00	1 - HEB240	S 355
1	6	11	12	1600	0.00	1 - HEB240	S 355
2	7	6	1	2393	0.00	1 - HEB240	S 355
3	8	1	2	1625	0.00	1 - HEB240	S 355
3	9	2	3	1625	0.00	1 - HEB240	S 355
3	10	3	4	1625	0.00	1 - HEB240	S 355
3	11	4	5	1625	0.00	1 - HEB240	S 355
4	12	5	12	2263	0.00	1 - HEB240	S 355
5	13	1	7	1600	0.00	1 - HEB240	S 355
6	14	5	11	1600	0.00	1 - HEB240	S 355
7	15	13	7	2255	0.00	5 - HEA160	S 355
8	16	14	11	2255	0.00	5 - HEA160	S 355
9	17	13	17	1215	90.00	2 - HEB300	S 355
10	18	14	18	1215	0.00	4 - HEB900	S 355
11	19	15	21	237	0.00	1 - HEB240	S 355
11	20	21	17	1713	0.00	1 - HEB240	S 355
11	21	17	1	300	0.00	1 - HEB240	S 355
12	22	13	19	1200	0.00	3 - HEA500	S 355
12	23	19	20	4100	0.00	3 - HEA500	S 355
12	24	20	14	1200	0.00	3 - HEA500	S 355
13	25	15	13	2298	0.00	1 - HEB240	S 355
14	26	8	1	2280	0.00	1 - HEB240	S 355
15	27	8	3	2280	0.00	1 - HEB240	S 355
15	28	3	10	2280	0.00	1 - HEB240	S 355
15	29	10	5	2280	0.00	1 - HEB240	S 355
16	30	16	15	1215	90.00	2 - HEB300	S 355
17	31	18	5	300	0.00	1 - HEB240	S 355
18	32	17	19	1708	0.00	6 - 2 LT (H50/50/5,10)	S 355
19	33	20	18	1708	0.00	6 - 2 LT (H50/50/5,10)	S 355
20	34	16	22	1890	0.00	7 - HEB500	S 355
20	35	22	13	60	0.00	7 - HEB500	S 355

Profiles

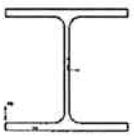
HEB240

Profile no. 1 - HEB240
Material : 12 - S 355

A:	1.060000e+004 mm^2		
Ay/A:	0.658	Az/A:	0.197
Iy:	1.126000e+008 mm^4	Iz:	3.923000e+007 mm^4
Iyz:	1.355253e-008 mm^4	It:	1.027000e+006 mm^4
Iw:	4.883871e+011 mm^6		
Wely:	9.383000e+005 mm^3	Welz:	3.269000e+005 mm^3
Wply:	1.054000e+006 mm^3	Wplz:	5.000000e+005 mm^3
cy:	120.00 mm	cz:	120.00 mm
iy:	103.07 mm	iz:	60.84 mm
dy:	-0.00 mm	dz:	0.00 mm
Outline :		1420.00 mm	

Type for check: I section

Height	240.00 mm	Width	240.00 mm
Thickness of flange	17.00 mm	Thickness of web	10.00 mm
Radius	21.00 mm		



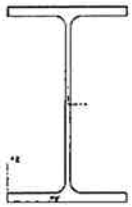
HEB300

Profile no. 2 - HEB300
Material : 12 - S 355

A:	1.491000e+004 mm^2		
Ay/A:	0.659	Az/A:	0.196
Iy:	2.517000e+008 mm^4	Iz:	8.563000e+007 mm^4
Iyz:	2.710505e-008 mm^4	It:	1.850000e+006 mm^4
Iw:	1.692785e+012 mm^6		
Wely:	1.678000e+006 mm^3	Welz:	5.709000e+005 mm^3
Wply:	1.868000e+006 mm^3	Wplz:	8.720000e+005 mm^3
cy:	150.00 mm	cz:	150.00 mm
iy:	129.93 mm	iz:	75.78 mm
dy:	-0.00 mm	dz:	0.00 mm
Outline :		1778.00 mm	

Type for check: I section

Height	300.00 mm	Width	300.00 mm
Thickness of flange	19.00 mm	Thickness of web	11.00 mm
Radius	27.00 mm		



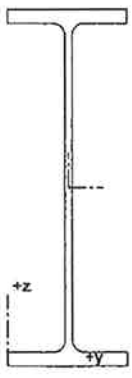
HEA500

Profile no. 3 - HEA500
Material : 12 - S 355

A:	1.980000e+004 mm^2		
Ay/A:	0.600	Az/A:	0.276
Iy:	8.700000e+008 mm^4	Iz:	1.040000e+008 mm^4
Iyz:	-1.084202e-007 mm^4	It:	3.090000e+006 mm^4
Iw:	5.677887e+012 mm^6		
Wely:	3.550000e+006 mm^3	Welz:	6.910000e+005 mm^3
Wply:	3.940000e+006 mm^3	Wplz:	1.060000e+006 mm^3
cy:	150.00 mm	cz:	245.00 mm
iy:	209.62 mm	iz:	72.47 mm
dy:	-0.00 mm	dz:	0.00 mm
Outline :		2156.00 mm	

Type for check: I section

Height	490.00 mm	Width	300.00 mm
Thickness of flange	23.00 mm	Thickness of web	12.00 mm
Radius	27.00 mm		



HEB900

Profile no. 4 - HEB900
Material : 12 - S 355

A:	3.713000e+004 mm^2		
Ay/A:	0.492	Az/A:	0.421
Iy:	4.941000e+009 mm^4	Iz:	1.582000e+008 mm^4
Iyz:	-2.168404e-007 mm^4	It:	1.137000e+007 mm^4
Iw:	3.005059e+013 mm^6		
Wely:	1.098000e+007 mm^3	Welz:	1.054000e+006 mm^3

A:	3.713000e+004 mm^2		
Wply:	1.258000e+007 mm^3	Wplz:	1.660000e+006 mm^3
cy:	150.00 mm	cz:	450.00 mm
iy:	364.79 mm	iz:	65.27 mm
dy:	-0.00 mm	dz:	0.00 mm
Outline :		2963.00 mm	

Type for check: I section

Height	900.00 mm	Width	300.00 mm
Thickness of flange	35.00 mm	Thickness of web	18.50 mm
Radius	30.00 mm		

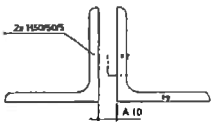
HEA160

Profile no. 5 - HEA160
Material : 12 - S 355

A:	3.880000e+003 mm^2		
Ay/A:	0.646	Az/A:	0.208
Iy:	1.670000e+007 mm^4	Iz:	6.160000e+006 mm^4
Iyz:	0.000000e+000 mm^4	It:	1.220000e+005 mm^4
Iw:	3.150259e+010 mm^6		
Wely:	2.200000e+005 mm^3	Welz:	7.700000e+004 mm^3
Wply:	2.460000e+005 mm^3	Wplz:	1.180000e+005 mm^3
cy:	80.00 mm	cz:	76.00 mm
iy:	65.61 mm	iz:	39.85 mm
dy:	0.00 mm	dz:	-0.00 mm
Outline :		932.00 mm	

Type for check: I section

Height	152.00 mm	Width	160.00 mm
Thickness of flange	9.00 mm	Thickness of web	6.00 mm
Radius	15.00 mm		



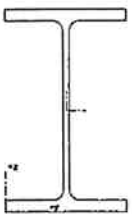
2 LT (H50/50/5,10)

Profile no. 6 - 2 LT (H50/50/5,10)
Material : 12 - S 355

1 H50/50/5 - S 355
2 H50/50/5 - S 355

A:	9.605763e+002 mm^2		
Ay/A:	0.500	Az/A:	0.500
Iy:	2.192589e+005 mm^4	Iz:	5.673035e+005 mm^4
Iyz:	0.000000e+000 mm^4	It:	7.916666e+003 mm^4
Iw:	0.000000e+000 mm^6		
Wely:	6.096441e+003 mm^3	Welz:	1.031461e+004 mm^3
Wply:	1.123107e+004 mm^3	Wplz:	1.828451e+004 mm^3
cy:	-5.00 mm	cz:	14.00 mm
iy:	15.11 mm	iz:	24.30 mm
dy:	0.00 mm	dz:	0.00 mm
Outline :		400.00 mm	

Type for check: Untypical section



HEB500

Profile no. 7 - HEB500
Material : 12 - S 355

A:	2.386000e+004 mm^2		
Ay/A:	0.601	Az/A:	0.277
Iy:	1.072000e+009 mm^4	Iz:	1.262000e+008 mm^4
Iyz:	-5.421011e-008 mm^4	It:	5.384000e+006 mm^4
Iw:	7.072522e+012 mm^6		
Wely:	4.287000e+006 mm^3	Welz:	8.416000e+005 mm^3
Wply:	4.820000e+006 mm^3	Wplz:	1.290000e+006 mm^3
cy:	150.00 mm	cz:	250.00 mm
iy:	211.96 mm	iz:	72.73 mm
dy:	-0.00 mm	dz:	0.00 mm
Outline :		2171.00 mm	

Type for check: I section

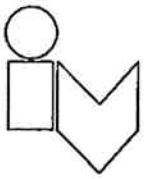
Height	500.00 mm	Width	300.00 mm
Thickness of flange	28.00 mm	Thickness of web	14.50 mm
Radius	27.00 mm		

Hinges

memb	type	pos
7	fiyfiz	beg
7	fiyfiz	end
12	fiyfiz	beg
12	fiyfiz	end
15	fiyfiz	beg
15	fiyfiz	end
16	fiyfiz	beg
16	fiyfiz	end
17	fiz	beg
17	fiyfiz	end
26	fiyfiz	beg
26	fiyfiz	end
27	fiyfiz	beg
27	fiyfiz	end
28	fiyfiz	beg
28	fiyfiz	end
29	fiyfiz	beg
29	fiyfiz	end
32	fiyfiz	beg
32	fiyfiz	end
33	fiyfiz	beg
33	fiyfiz	end

Supports

support	node	type	Size mm
1	13	XZ	200.00
2	14	YZRxRy	200.00
3	16	XYZRxRyRz	200.00
4	18	YRx	200.00



Loadcases

Case	Name:	Description
1	self weight	Self weight. Direction -Z
2	fully operational lock gate	Variable - traction force
3	operational; 1 malfunctioning winch SS	Variable - traction force
4	operational; 1 malfunctioning winch LS	Variable - traction force
5	malfunctioning hydrofeet	Variable - traction force
6	self weight traction cable	Permanent - Loads

Loadcase no. 2 - nodal loads

node	Fx kN	Fy kN	Fz kN	Mx kNm	My kNm	Mz kNm
6	0.00	240.00	0.00	0.00	0.00	0.00
12	0.00	240.00	0.00	0.00	0.00	0.00

Loadcase no. 3 - nodal loads

node	Fx kN	Fy kN	Fz kN	Mx kNm	My kNm	Mz kNm
6	0.00	-38.00	0.00	0.00	0.00	0.00
12	0.00	380.00	0.00	0.00	0.00	0.00

Loadcase no. 4 - nodal loads

node	Fx kN	Fy kN	Fz kN	Mx kNm	My kNm	Mz kNm
6	0.00	380.00	0.00	0.00	0.00	0.00
12	0.00	-38.00	0.00	0.00	0.00	0.00

Loadcase no. 5 - nodal loads

node	Fx kN	Fy kN	Fz kN	Mx kNm	My kNm	Mz kNm
6	0.00	290.00	0.00	0.00	0.00	0.00
12	0.00	290.00	0.00	0.00	0.00	0.00

Loadcase no. 6 - nodal loads

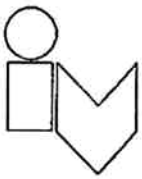
node	Fx kN	Fy kN	Fz kN	Mx kNm	My kNm	Mz kNm
6	0.00	0.00	-4.50	0.00	0.00	0.00
12	0.00	0.00	-4.50	0.00	0.00	0.00

Combinations

Combi	Norm	Case	coeff
1.	Linear-ultimate	1 self weight	1.00
1.	Linear-ultimate	2 fully operational lock gate	-1.50
2.	Linear-ultimate	1 self weight	1.00
2.	Linear-ultimate	3 operational; 1 malfunctioning winch SS	-1.20
3.	Linear-ultimate	1 self weight	1.00
3.	Linear-ultimate	4 operational; 1 malfunctioning winch LS	-1.20
4.	Linear-ultimate	1 self weight	1.00
4.	Linear-ultimate	5 malfunctioning hydrofeet	-1.20
5.	Linear-ultimate	1 self weight	1.35
5.	Linear-ultimate	2 fully operational lock gate	1.50
5.	Linear-ultimate	6 self weight traction cable	1.35
6.	Linear-ultimate	1 self weight	1.35
6.	Linear-ultimate	3 operational; 1 malfunctioning winch SS	1.20
6.	Linear-ultimate	6 self weight traction cable	1.35
7.	Linear-ultimate	1 self weight	1.35
7.	Linear-ultimate	4 operational; 1 malfunctioning winch LS	1.20
7.	Linear-ultimate	6 self weight traction cable	1.35
8.	Linear-ultimate	1 self weight	1.35
8.	Linear-ultimate	5 malfunctioning hydrofeet	1.20
8.	Linear-ultimate	6 self weight traction cable	1.35

Basic rules for generation of ultimate load combinations:
1 : 1.00*LC1 / -1.50*LC2
2 : 1.00*LC1 / -1.20*LC3
3 : 1.00*LC1 / -1.20*LC4
4 : 1.00*LC1 / -1.20*LC5
5 : 1.35*LC1 / 1.50*LC2 / 1.35*LC6
6 : 1.35*LC1 / 1.20*LC3 / 1.35*LC6
7 : 1.35*LC1 / 1.20*LC4 / 1.35*LC6
8 : 1.35*LC1 / 1.20*LC5 / 1.35*LC6

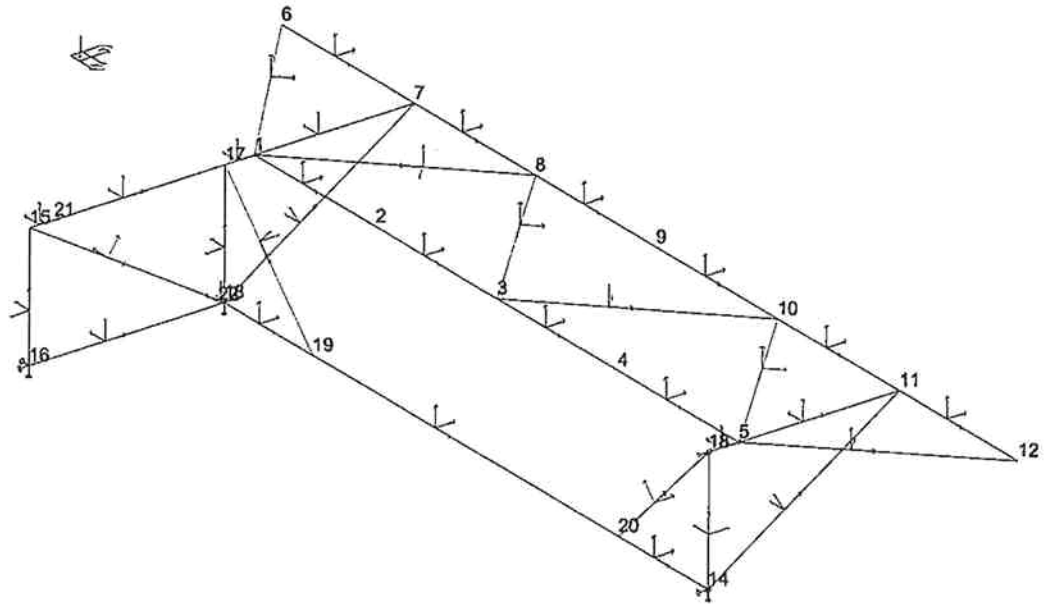
List of extreme ultimate load combinations
1/ 2 : +1.00*LC1-1.20*LC3
2/ 3 : +1.00*LC1-1.20*LC4
3/ 4 : +1.00*LC1-1.20*LC5
4/ 1 : +1.00*LC1-1.50*LC2
5/ 6 : +1.35*LC1+1.20*LC3+1.35*LC6
6/ 7 : +1.35*LC1+1.20*LC4+1.35*LC6
7/ 8 : +1.35*LC1+1.20*LC5+1.35*LC6
8/ 5 : +1.35*LC1+1.50*LC2+1.35*LC6



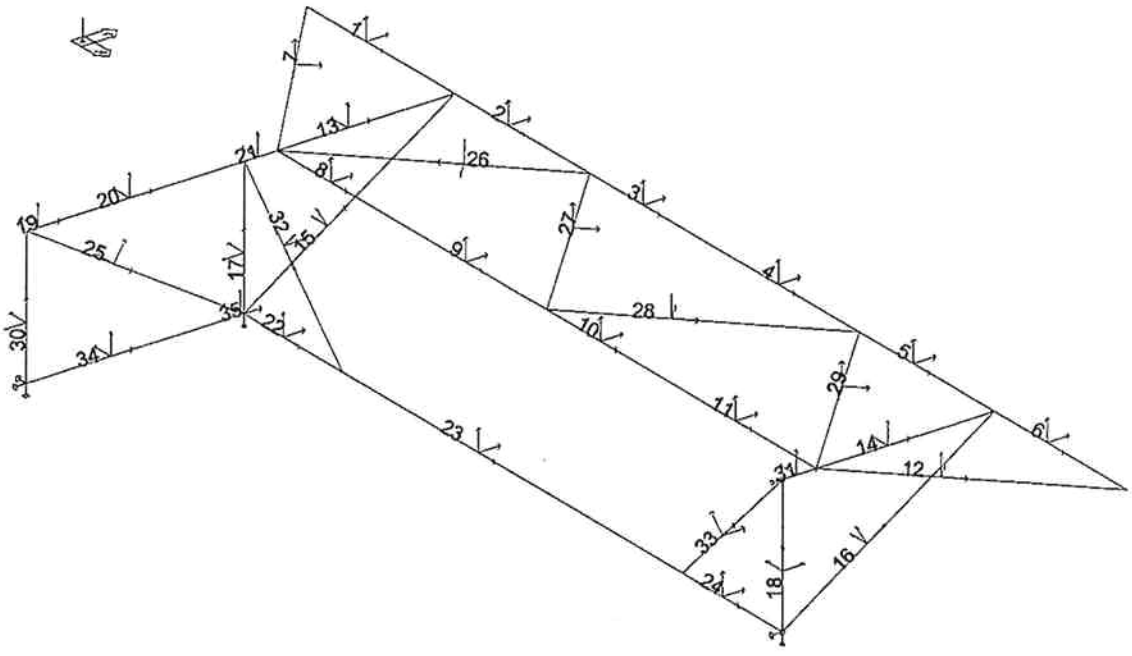
Buckling length

memb	k yz	k ltb	swayY	swayZ	load pos	k	kw
8	1.00	1.00	0	0	center	1.0	1.0
9	1.00	1.00	0	0	center	1.0	1.0
10	1.00	1.00	0	0	center	1.0	1.0
11	1.00	1.00	0	0	center	1.0	1.0
1	1.00	1.00	1	0	center	1.0	1.0
2	1.00	1.00	0	0	center	1.0	1.0
3	1.00	1.00	0	0	center	1.0	1.0
4	1.00	1.00	0	0	center	1.0	1.0
5	1.00	1.00	0	0	center	1.0	1.0
6	1.00	1.00	1	0	center	1.0	1.0
7	1.00	1.00	0	0	center	1.0	1.0
12	1.00	1.00	0	0	center	1.0	1.0
13	1.00	1.00	0	0	center	1.0	1.0
14	1.00	1.00	0	0	center	1.0	1.0
15	1.00	1.00	0	0	center	1.0	1.0
16	1.00	1.00	0	0	center	1.0	1.0
21	1.00	1.00	0	1	center	1.0	1.0
24	1.00	1.00	0	0	center	1.0	1.0
18	1.00	1.00	0	0	center	1.0	1.0
17	1.00	1.00	0	0	center	1.0	1.0
25	1.00	1.00	0	0	center	1.0	1.0
26	1.00	1.00	0	0	center	1.0	1.0
27	1.00	1.00	0	0	center	1.0	1.0
30	1.00	1.00	0	1	center	1.0	1.0
28	1.00	1.00	0	0	center	1.0	1.0
29	1.00	1.00	0	0	center	1.0	1.0
20	1.00	1.00	0	1	center	1.0	1.0
22	1.00	1.00	0	0	center	1.0	1.0
23	1.00	1.00	0	0	center	1.0	1.0
32	1.00	1.00	0	0	center	1.0	1.0
33	1.00	1.00	0	0	center	1.0	1.0
19	1.00	1.00	0	1	center	1.0	1.0
34	1.00	1.00	0	0	center	1.0	1.0

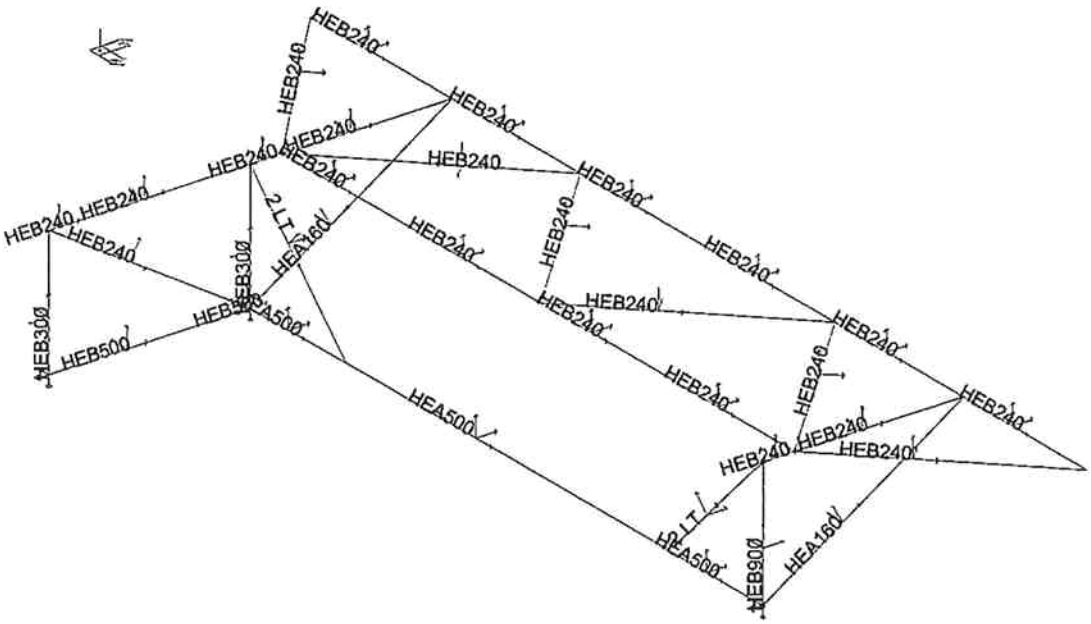
3. Input (graphical)



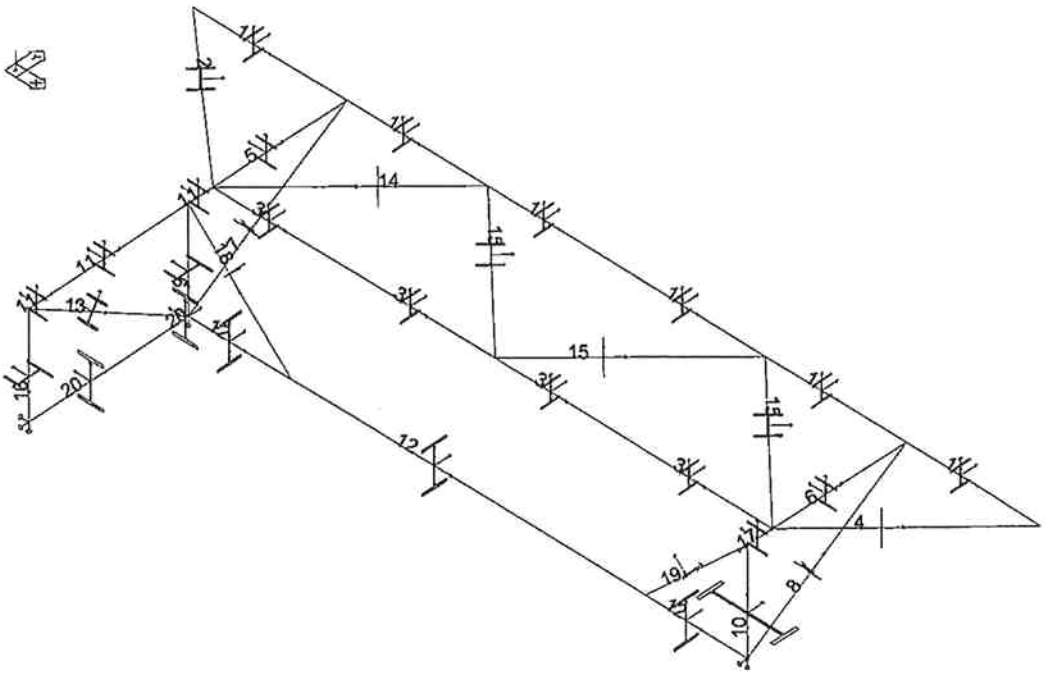
overview model (with nodenumbers, local axis)



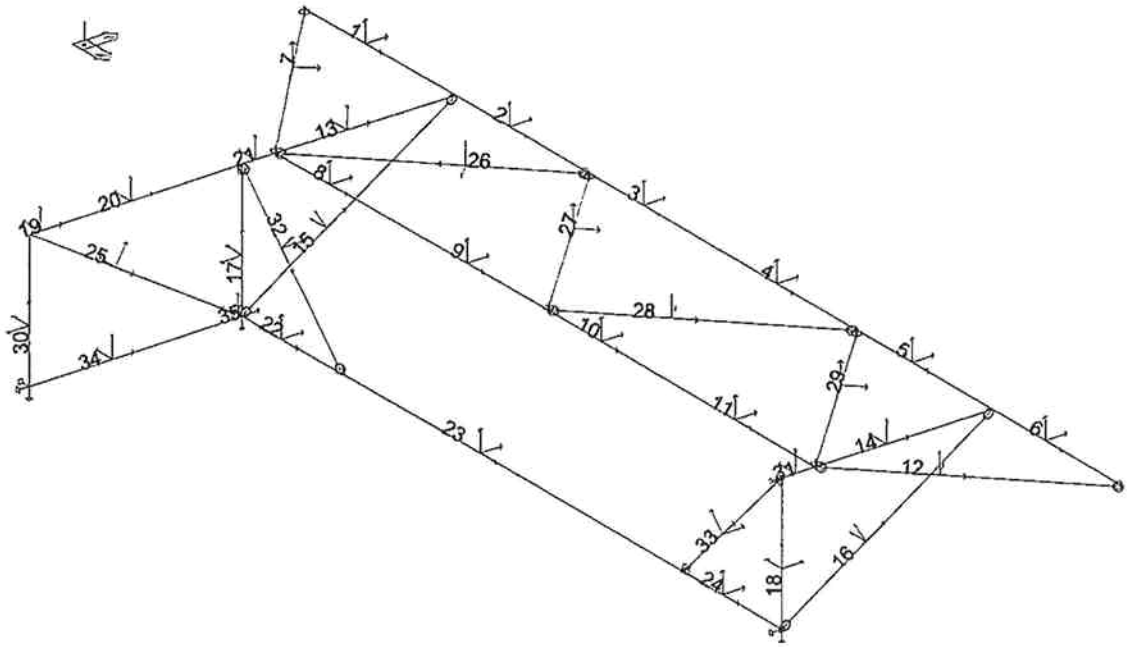
overview model (with membernumbers)



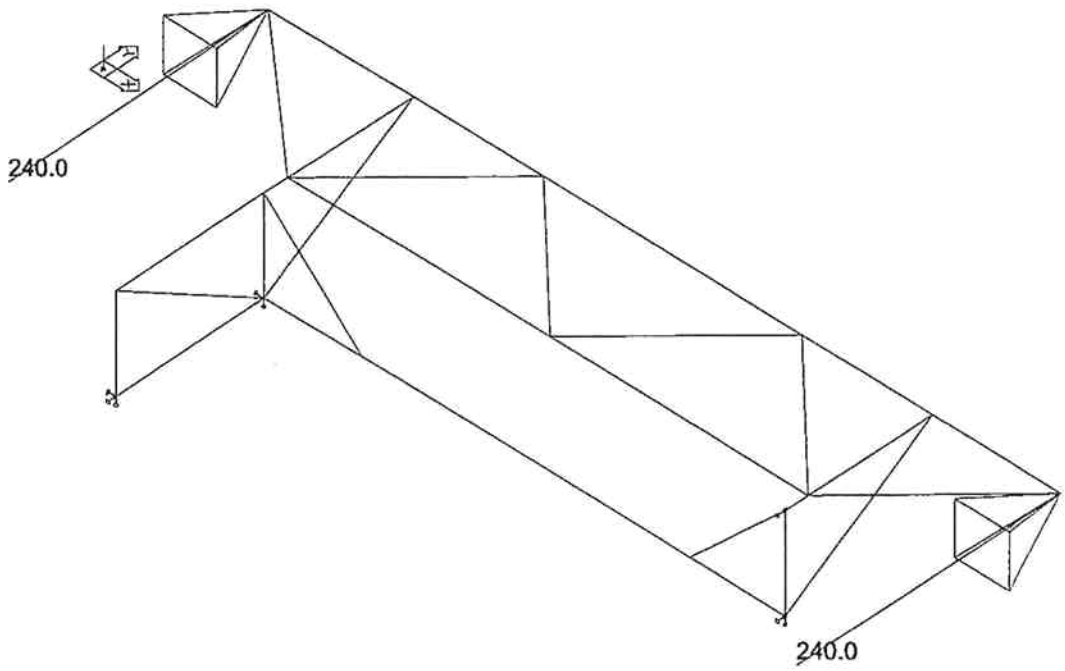
overview model (with profile names)



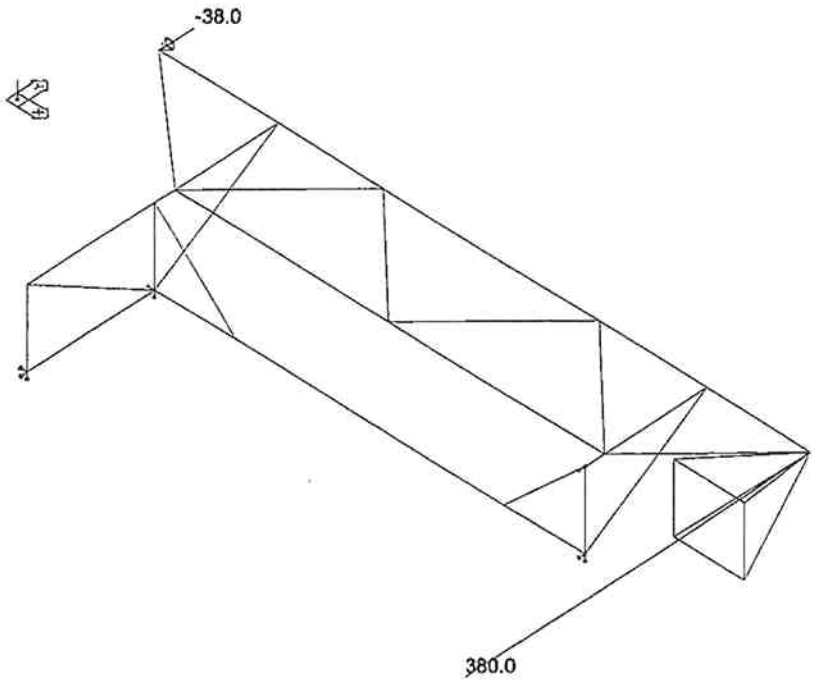
overview model (with macronumbers and profile orientation)



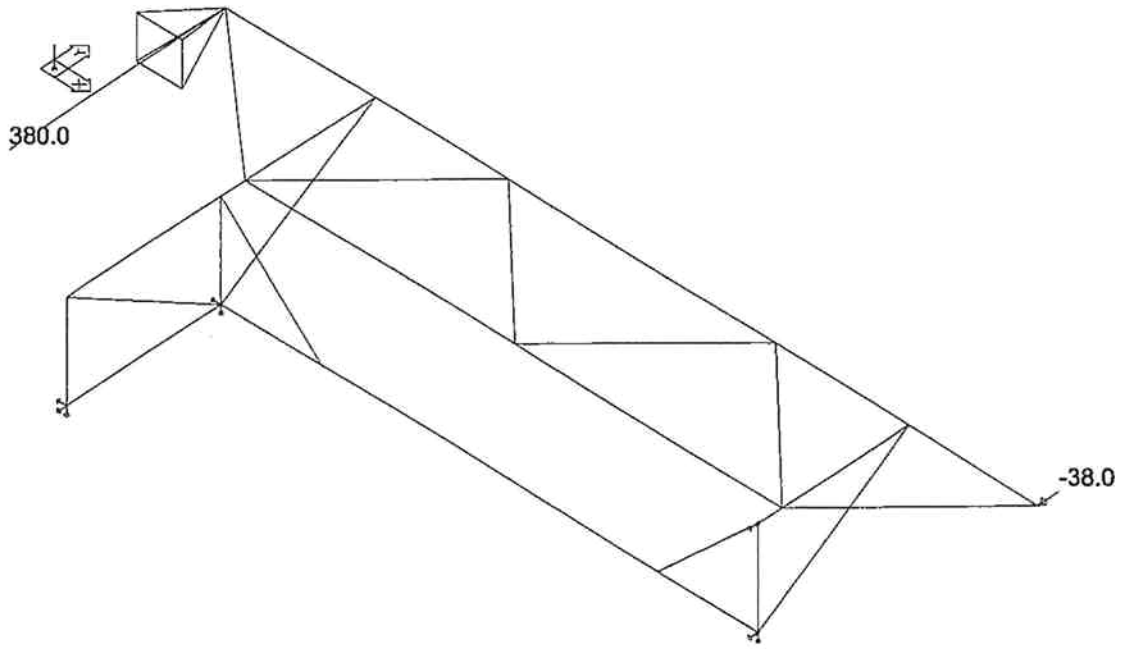
overview model (with member numbers and hinges)



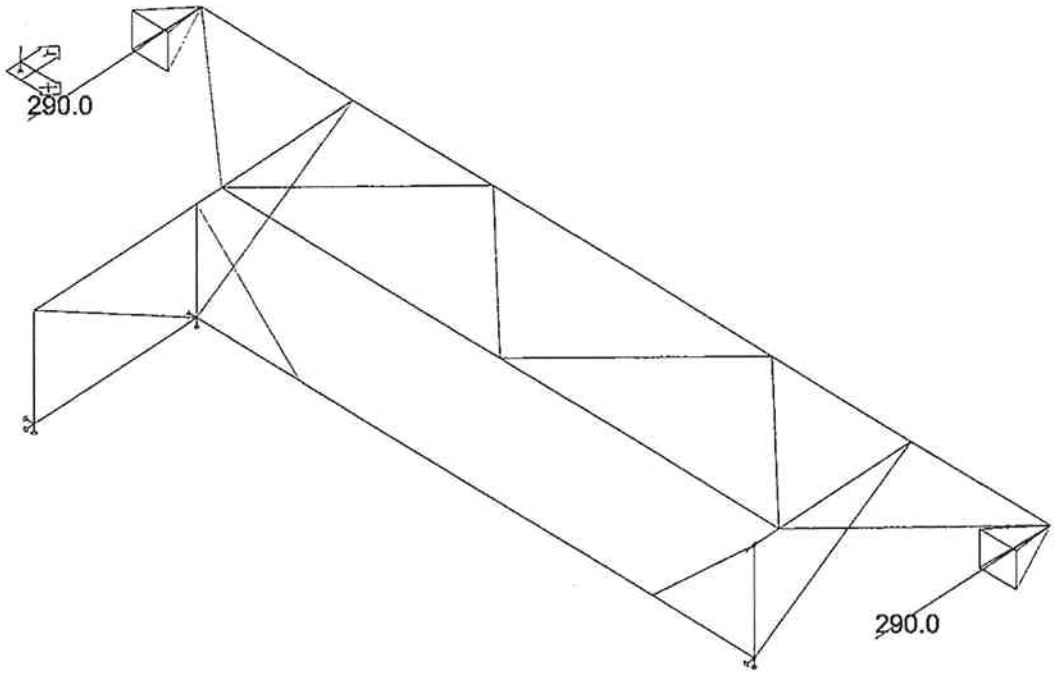
Nodal loads.Loadcases - 2 fully operating lock gate



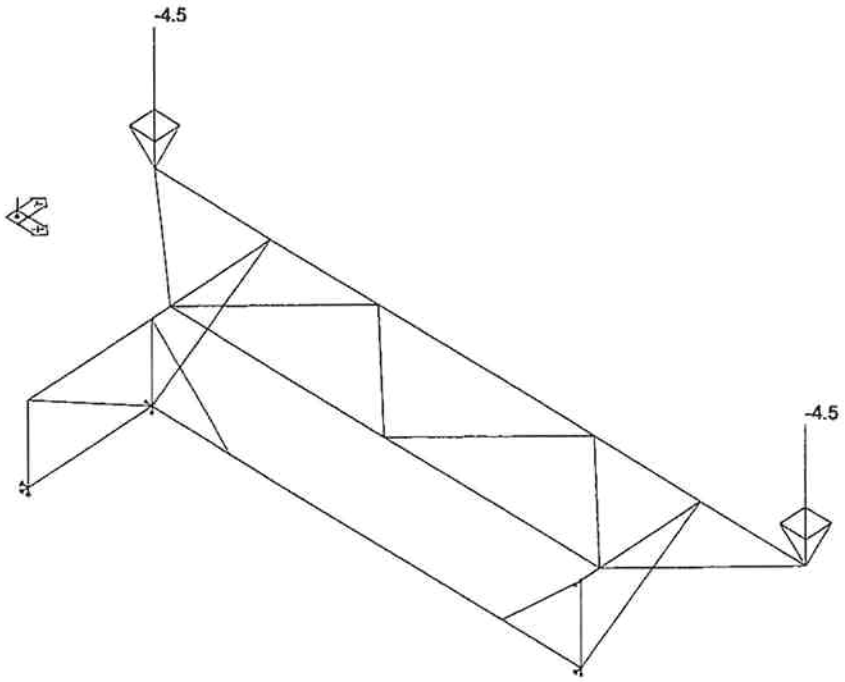
Nodal loads.Loadcases - 3 operational; 1 malfunctioning winch SS



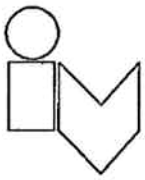
Nodal loads.Loadcases - 4 operational; 1 malfunctioning winch LS



Nodal loads.Loadcases - 5 malfunctioning hydrofeet



Nodal loads.Loadcases - 6 self weight traction cable



4. Output

Calculation protocol.

Linear calculation

Number of 2D elements	0
Number of 1D elements	35
Number of mesh nodes	22
Number of equations	132

Loadcases	LC 1 self weight
	LC 2 fully operational lock gate
	LC 3 operational; 1 malfunctioning winch SS
	LC 4 operational; 1 malfunctioning winch LS
	LC 5 malfunctioning hydrofeet
	LC 6 self weight traction cable
Start of calculation	19.04.2004 09:58
End of calculation	19.04.2004 09:58

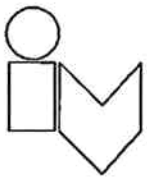
Sum of loads and reactions.

			X	Y	Z
loadcase	1	loads	0.0	0.0	-53.6
		reactions	0.0	-0.0	53.6
		contact	0.0	0.0	0.0
loadcase	2	loads	0.0	480.0	0.0
		reactions	0.0	-480.0	-0.0
		contact	0.0	0.0	0.0
loadcase	3	loads	0.0	342.0	0.0
		reactions	-0.0	-342.0	0.0
		contact	0.0	0.0	0.0
loadcase	4	loads	0.0	342.0	0.0
		reactions	0.0	-342.0	-0.0
		contact	0.0	0.0	0.0
loadcase	5	loads	0.0	580.0	0.0
		reactions	0.0	-580.0	-0.0
		contact	0.0	0.0	0.0
loadcase	6	loads	0.0	0.0	-9.0
		reactions	0.0	-0.0	9.0
		contact	0.0	0.0	0.0

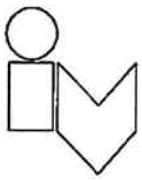
4.1. Memberforces

Truss Girderframe; Internal forces on member(s)1/14,21,...ult. comb (all), extremes.
Group of member(s) :1/14,21,26/29,31
Group of ultimate combi :1/8

memb	cr.nr	combi	dx [mm]	N [kN]	Vy [kN]	Vz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
1	1	2	0.0	**502**	**-5**	-1	-0	0	0
1	1	6	0.0	**-502**	**5**	-7	-0	0	-0
1	1	5	1780.0	49	-1	**-9**	-0	-15	-2
1	1	5	0.0	49	-1	-7	**-0**	**0**	0
1	1	6	1780.0	-502	5	-9	-0	**-15**	**8**
1	1	2	1780.0	502	-5	-2	-0	-3	**-9**
2	1	2	0.0	**496**	**6**	5	**0**	-3	**-9**
2	1	6	0.0	**-496**	**-5**	6	**-0**	-15	**9**
2	1	5	0.0	**51**	2	**6**	-0	**-15**	-2
2	1	1	1625.0	-51	-2	3	-0	**3**	-1
3	1	4	0.0	**370**	-0	1	0	3	-1
3	1	8	0.0	**-369**	0	2	-0	-6	1
3	1	6	0.0	-223	**0**	2	**-0**	-6	0
3	1	2	0.0	224	**-0**	1	**0**	3	-0
3	1	5	0.0	-197	-0	**2**	0	**-6**	1
3	1	2	1625.0	224	-0	0	0	**5**	-1
3	1	8	1625.0	-369	0	0	-0	-4	1
3	1	4	1625.0	370	-0	0	0	5	**-1**
4	1	4	0.0	**370**	-0	0	0	5	-1
4	1	8	0.0	**-369**	0	0	-0	-4	1
4	1	6	0.0	-223	**0**	0	**-0**	-4	1
4	1	2	0.0	224	**-0**	0	**0**	**5**	-1
4	1	5	0.0	-197	-0	**0**	0	-4	1
4	1	6	1625.0	-223	0	**-2**	-0	**-5**	1
4	1	8	1625.0	-369	0	-2	-0	-5	**1**
4	1	4	1625.0	370	-0	-1	0	4	**-1**
5	1	1	0.0	**448**	**-5**	-3	0	4	-0
5	1	5	0.0	**-447**	**5**	-4	0	-5	0
5	1	6	1625.0	46	-2	**-6**	-0	**-13**	-2
5	1	2	0.0	-45	2	-3	**0**	**4**	-1
5	1	6	0.0	46	-2	-4	**-0**	-5	1
5	1	5	1625.0	-447	5	-6	0	-13	**8**
5	1	1	1625.0	448	-5	-5	0	-3	**-8**
6	1	1	0.0	**451**	**5**	2	0	-3	**-9**
6	1	5	0.0	**-451**	**-5**	9	**0**	-13	**8**
6	1	6	0.0	44	2	**9**	0	**-13**	-2
6	1	5	1600.0	-451	-5	7	0	**0**	-0
7	1	6	0.0	**675**	0	1	0	-0	0
7	1	2	0.0	**-675**	-0	1	0	-0	-0
7	1	5	0.0	-66	0	**1**	**0**	-0	-0
7	1	6	2393.4	675	0	-1	0	-0	0
7	1	5	1196.7	-66	0	**0**	0	**1**	-0
7	1	8	2393.4	534	0	-1	0	**-0**	0
8	1	8	0.0	**346**	**3**	5	-0	-0	**-4**
8	1	4	0.0	**-350**	**-3**	4	0	-0	**4**
8	1	6	0.0	340	1	**5**	**-0**	**-0**	-2
8	1	2	0.0	-344	-1	4	**0**	-0	1
8	1	5	1625.0	52	2	3	-0	**6**	-1
9	1	8	0.0	**346**	**3**	3	-0	6	0
9	1	4	0.0	**-350**	**-3**	2	0	5	-0
9	1	6	0.0	340	1	**3**	**-0**	6	**1**
9	1	2	0.0	-344	-1	2	**0**	**5**	-1
9	1	5	1625.0	52	2	1	-0	**10**	2
9	1	8	1625.0	346	3	1	-0	10	**4**
9	1	4	1625.0	-350	-3	1	0	7	**-4**
10	1	8	0.0	**327**	**-2**	-1	-0	10	**4**
10	1	4	0.0	**-331**	**2**	-1	0	7	**-4**
10	1	5	1625.0	305	-1	**-3**	0	6	1



memb	cr.nr	combi	dx [mm]	N [kN]	Vy [kN]	Vz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
10	1	2	0.0	-69	2	-1	0	7	-3
10	1	6	0.0	66	-2	-1	-0	10	3
10	1	5	0.0	305	-1	-1	0	10	2
11	1	8	0.0	327	-2	-3	-0	6	0
11	1	4	0.0	-331	2	-2	0	5	-1
11	1	5	1625.0	305	-1	-5	0	-0	-0
11	1	2	0.0	-69	2	-2	0	5	0
11	1	6	0.0	66	-2	-3	-0	6	-1
11	1	2	1625.0	-69	2	-4	0	-0	3
11	1	6	1625.0	66	-2	-5	-0	-0	-4
12	1	5	0.0	637	-0	1	-0	-0	0
12	1	1	0.0	-637	0	1	-0	-0	-0
12	1	6	2262.7	-62	-0	-1	-0	-0	-0
12	1	6	1131.4	-62	-0	-0	-0	1	-0
12	1	7	0.0	488	-0	1	-0	-0	0
13	1	5	0.0	27	1	-1	0	4	-2
13	1	8	0.0	23	7	7	0	-10	-10
13	1	4	0.0	15	-6	-5	0	9	10
13	1	6	0.0	21	6	11	0	-16	-9
13	1	2	1600.0	17	-6	-10	0	-0	-1
13	1	2	0.0	17	-6	-9	0	15	9
14	1	5	0.0	32	-3	3	-0	-4	6
14	1	4	0.0	6	4	1	-0	0	-6
14	1	8	0.0	28	-4	3	-0	-3	7
14	1	1	1600.0	3	3	-1	-0	-0	-1
14	1	1	0.0	3	3	0	-0	1	-5
21	1	6	0.0	602	-22	19	-0	-22	-4
21	1	2	0.0	-564	19	-3	-0	16	5
21	1	4	0.0	-347	32	1	-0	9	4
21	1	8	0.0	386	-35	15	-0	-15	-4
21	1	2	300.0	-564	19	-3	-0	15	10
21	1	4	300.0	-347	32	0	-0	9	14
21	1	8	300.0	386	-35	15	-0	-10	-14
26	1	6	0.0	187	0	1	0	-0	-0
26	1	2	0.0	-187	-0	1	-0	-0	0
26	1	5	0.0	-172	0	1	0	-0	0
26	1	6	2280.5	187	0	-1	0	-0	0
26	1	8	1140.3	13	0	-0	0	1	0
27	1	2	0.0	195	-0	1	-0	-0	0
27	1	6	0.0	-195	0	1	0	-0	-0
27	1	5	0.0	176	-0	1	0	-0	0
27	1	6	2280.5	-195	0	-1	0	-0	0
27	1	1	0.0	-176	0	1	-0	-0	-0
27	1	8	1140.3	-17	0	-0	0	1	0
28	1	6	0.0	190	0	1	-0	-0	0
28	1	2	0.0	-191	-0	1	0	-0	-0
28	1	5	2280.5	-179	-0	-1	-0	-0	-0
28	1	1	0.0	179	0	1	0	-0	-0
28	1	5	0.0	-179	-0	1	-0	-0	0
28	1	8	1140.2	10	-0	0	-0	1	0
29	1	2	0.0	187	0	1	-0	-0	0
29	1	6	0.0	-187	-0	1	-0	-0	-0
29	1	8	2280.5	-13	-0	-1	-0	-0	-0
29	1	5	0.0	172	-0	1	-0	-0	0
29	1	8	1140.3	-13	-0	-0	-0	1	-0
31	1	5	0.0	603	20	11	0	-7	0
31	1	1	0.0	-568	-16	6	0	-1	-0
31	1	8	0.0	373	35	11	0	-6	-0
31	1	4	0.0	-338	-32	6	0	-2	0
31	1	6	0.0	-157	22	10	0	-4	-0
31	1	1	300.0	-568	-16	6	0	1	-5
31	1	8	300.0	373	35	10	0	-3	10
31	1	4	300.0	-338	-32	6	0	0	-9



Hor. Beam HEB240; Internal forces on member(s) 19/20, ult. comb (all), extremes.
Group of member(s) :19/20
Group of ultimate combi :1/8

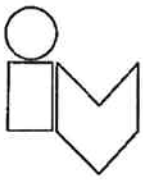
memb	cr.nr	combi	dx [mm]	N [kN]	Vy [kN]	Vz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
19	1	6	0.0	**546**	**-3**	-21	-0	**20**	2
19	1	2	0.0	**-511**	**3**	**19**	-0	**-19**	-2
19	1	6	237.0	546	-3	**-21**	-0	15	1
19	1	8	0.0	350	-3	-13	**-0**	13	**2**
19	1	4	0.0	-315	3	**11**	-0	**-11**	**-2**
20	1	6	0.0	**546**	**-3**	-21	-0	15	1
20	1	2	0.0	**-511**	**3**	**18**	-0	-14	-1
20	1	6	1713.0	546	-3	**-23**	-0	**-22**	**-4**
20	1	8	0.0	350	-3	-14	**-0**	10	2
20	1	2	1713.0	-511	3	17	-0	**16**	**5**

Vert. Beam HEB300 (SS) ; Internal forces on member(s) 17,30, ult. comb (all), extremes.
Group of member(s) :17,30
Group of ultimate combi :1/8

memb	cr.nr	combi	dx [mm]	N [kN]	Vy [kN]	Vz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
17	2	4	1215.0	**38**	0	-32	0	-0	0
17	2	8	0.0	**-65**	-0	36	-0	-44	0
17	2	6	0.0	-63	-0	**57**	0	**-69**	0
17	2	2	0.0	34	0	**-53**	-0	**64**	-0
17	2	1	0.0	-3	0	17	**0**	-20	-0
17	2	5	0.0	-26	-0	-13	**-0**	16	0
30	2	6	1215.0	**315**	-2	82	-0	29	1
30	2	2	0.0	**-298**	**2**	**-78**	0	**67**	-4
30	2	6	0.0	313	**-2**	**82**	-0	**-71**	3
30	2	4	0.0	-184	2	-48	**0**	41	**-4**
30	2	8	0.0	200	-2	52	**-0**	-45	**3**

Brace HEB240; Internal forces on member(s) 25, ult. comb (all), extremes.
Group of member(s) :25
Group of ultimate combi :1/8

memb	cr.nr	combi	dx [mm]	N [kN]	Vy [kN]	Vz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
25	1	2	0.0	**514**	**-1**	**6**	**0**	**-9**	2
25	1	6	2297.5	**-551**	**1**	**-7**	-0	-5	1
25	1	8	0.0	-352	**2**	-3	-0	5	**-3**
25	1	4	0.0	317	**-1**	4	0	-6	**3**
25	1	6	0.0	-549	1	-5	**-0**	**9**	-2

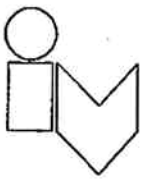


Steel of Gate Door; Internal forces on member(s)18,22/24...ult. comb (all), extremes.
Group of member(s) :18,22/24,34
Group of ultimate combi :1/8

memb	cr.nr	combi	dx [mm]	N [kN]	Vy [kN]	Vz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
18	4	5	0.0	-18	-0	18	-0	-22	0
18	4	1	0.0	-12	0	-18	0	23	-0
18	4	8	0.0	-17	-0	34	0	-41	0
18	4	4	0.0	-12	0	-34	-0	41	-0
18	4	6	0.0	-16	0	20	0	-24	-0
18	4	2	0.0	-13	-0	-20	-0	25	0
22	3	6	0.0	3	-0	-9	-0	-0	-0
22	3	2	0.0	-3	0	15	0	0	0
22	3	4	0.0	-3	-0	25	0	0	0
22	3	8	1200.0	3	-0	-21	-0	-24	-0
22	3	4	1200.0	-3	-0	23	0	29	0
22	3	2	1200.0	-3	0	13	0	17	0
22	3	6	1200.0	3	-0	-11	-0	-12	-0
23	3	8	0.0	35	-0	11	-0	-24	-0
23	3	4	0.0	-32	-0	-6	0	29	0
23	3	2	0.0	-19	0	-2	0	17	0
23	3	6	0.0	22	-0	8	-0	-12	-0
23	3	4	4100.0	-32	-0	-12	0	-9	0
23	3	2	4100.0	-19	0	-9	0	-6	0
23	3	6	4100.0	22	-0	-1	-0	2	-0
24	3	8	0.0	34	-0	4	-0	5	-0
24	3	4	0.0	-34	-0	-10	0	-9	0
24	3	2	0.0	-20	0	-7	0	-6	0
24	3	6	0.0	20	-0	1	-0	2	-0
24	3	4	1200.0	-34	-0	-12	0	-22	0
24	3	8	1200.0	34	-0	1	-0	9	-0
24	3	2	1200.0	-20	0	-9	0	-15	0
24	3	6	1200.0	20	-0	-2	-0	1	-0
34	7	6	0.0	509	-1	-34	0	7	0
34	7	2	0.0	-513	0	37	-0	-8	-0
34	7	6	1890.0	509	-1	-39	0	-62	-1
34	7	8	0.0	317	-0	-21	0	4	0
34	7	4	0.0	-321	0	24	-0	-5	-0
34	7	2	1890.0	-513	0	33	-0	58	1

Braces 2*L; Internal forces on member(s) 32/33, ult. comb (all), extremes.
Group of member(s) :32/33
Group of ultimate combi :1/8

memb	cr.nr	combi	dx [mm]	N [kN]	Vy [kN]	Vz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
32	6	8	0.0	46	0	0	-0	-0	-0
32	6	4	1707.7	-41	-0	-0	0	-0	-0
32	6	6	0.0	27	0	0	-0	-0	-0
32	6	8	1707.7	46	0	-0	-0	-0	0
32	6	4	0.0	-40	-0	0	0	-0	0
32	6	8	853.9	46	0	-0	-0	0	0
33	6	4	1707.7	3	0	-0	-0	-0	0
33	6	8	0.0	2	-0	0	0	-0	-0
33	6	5	1707.7	2	0	-0	-0	-0	0
33	6	6	0.0	2	-0	0	0	-0	-0
33	6	2	0.0	2	0	0	-0	-0	0
33	6	8	853.8	2	-0	0	0	0	-0



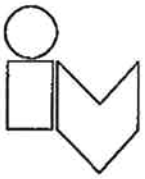
Struts HEA160 Internal forces on member(s) 15/16, ult. comb (all), extremes.
Group of member(s) :15/16
Group of ultimate combi :1/8

memb	cr.nr	combi	dx [mm]	N [kN]	Vy [kN]	Vz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
15	5	5	0.0	**-37**	-0	0	0	**-0**	0
15	5	6	0.0	-13	0	**0**	**0**	-0	**-0**
15	5	5	2255.3	-36	-0	**-0**	0	-0	0
15	5	2	0.0	-33	**-0**	0	**-0**	-0	0
15	5	5	1127.6	-36	-0	0	0	**0**	0
15	5	8	0.0	-20	0	0	0	**-0**	-0
16	5	6	0.0	**-29**	-0	0	-0	-0	-0
16	5	5	0.0	-26	-0	**0**	**-0**	-0	0
16	5	6	2255.3	-29	-0	**-0**	-0	-0	-0
16	5	1	0.0	-16	0	**0**	**0**	-0	-0
16	5	6	1127.6	-29	-0	0	-0	**0**	-0
16	5	8	0.0	-27	-0	0	-0	**-0**	0

4.2. Deflections

Deflection at winch connection ends; Deformation in node(s) 6,12, load case(s) (all).
Group of node(s) :6,12
Group of load case(s) :1/6

node	case	Ux [mm]	Uy [mm]	Uz [mm]
6	1	0.0	0.0	0.3
6	2	0.5	2.4	-1.0
6	3	-0.6	-0.6	0.6
6	4	1.3	3.9	-2.0
6	5	0.6	2.9	-1.2
6	6	0.0	0.0	-2.4
12	1	0.0	-0.0	0.4
12	2	-0.6	1.2	0.1
12	3	-1.3	2.1	-0.2
12	4	0.4	-0.4	0.4
12	5	-0.7	1.5	0.2
12	6	0.0	-0.0	-2.0



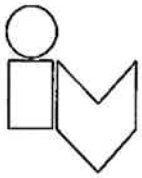
4.3. Connection Forces

4.3.1. Beam-Beam connections
Force in connection coordinate system.
Group of ultimate combi :1/8
1 - vert. HEB300 onto HEB500 (SS- innerconn.)
Node - 16. Position of connection coordinate system related to node : : x : 0.00 mm,y : 0.00 mm,z : 0.00 mm

combi	memb	Fx [kN]	Fy [kN]	Fz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
1	30	0	24	91	-21	1	-0
1	sum :	0	24	91	-21	1	-0
2	30	2	-78	-298	67	4	-0
2	sum :	2	-78	-298	67	4	-0
3	30	2	-47	-178	40	4	-0
3	sum :	2	-47	-178	40	4	-0
4	30	2	-48	-184	41	4	-0
4	sum :	2	-48	-184	41	4	-0
5	30	0	-20	-76	17	-0	0
5	sum :	0	-20	-76	17	-0	0
6	30	-2	82	313	-71	-3	0
6	sum :	-2	82	313	-71	-3	0
7	30	-2	51	194	-44	-3	0
7	sum :	-2	51	194	-44	-3	0
8	30	-2	52	200	-45	-3	0
8	sum :	-2	52	200	-45	-3	0

2 - vert. HEB300 onto HEB500 (SS- outerconn.)
Node - 13. Position of connection coordinate system related to node : : x : 0.00 mm,y : 0.00 mm,z : 0.00 mm

combi	memb	Fx [kN]	Fy [kN]	Fz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
1	17	-0	17	-3	-20	0	-0
1	sum :	-0	17	-3	-20	0	-0
2	17	-0	-53	34	64	0	0
2	sum :	-0	-53	34	64	0	0
3	17	-0	-31	35	38	0	-0
3	sum :	-0	-31	35	38	0	-0
4	17	-0	-32	36	39	0	-0
4	sum :	-0	-32	36	39	0	-0
5	17	-0	-13	-26	16	0	0
5	sum :	-0	-13	-26	16	0	0
6	17	-0	57	-63	-69	0	-0
6	sum :	-0	57	-63	-69	0	-0
7	17	-0	35	-64	-43	0	0
7	sum :	-0	35	-64	-43	0	0
8	17	-0	36	-65	-44	0	0
8	sum :	-0	36	-65	-44	0	0

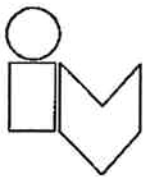


3 - hor. HEB240 onto vert. HEB300 (SS- innerconn.)
Node - 15. Position of connection coordinate system related to node : : x : 0.00 mm,y : 0.00 mm,z : 0.00 mm

combi	memb	Fx [kN]	Fy [kN]	Fz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
1	19	1	162	6	6	0	-1
1	sum :	1	162	6	6	0	-1
2	19	3	-511	-19	-19	0	-2
2	sum :	3	-511	-19	-19	0	-2
3	19	3	-304	-11	-11	0	-2
3	sum :	3	-304	-11	-11	0	-2
4	19	3	-315	-11	-11	0	-2
4	sum :	3	-315	-11	-11	0	-2
5	19	-0	-127	-4	-5	0	1
5	sum :	-0	-127	-4	-5	0	1
6	19	-3	546	21	20	0	2
6	sum :	-3	546	21	20	0	2
7	19	-3	339	13	13	0	2
7	sum :	-3	339	13	13	0	2
8	19	-3	350	13	13	0	2
8	sum :	-3	350	13	13	0	2

4 - brace 2*L upperconn. (SS)
Node - 17. Position of connection coordinate system related to node : : x : 0.00 mm,y : 0.00 mm,z : 0.00 mm

combi	memb	Fx [kN]	Fy [kN]	Fz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
1	32	-16	0	16	-0	0	0
1	sum :	-16	0	16	-0	0	0
2	32	-15	0	15	-0	0	0
2	sum :	-15	0	15	-0	0	0
3	32	-27	0	28	-0	0	0
3	sum :	-27	0	28	-0	0	0
4	32	-28	0	29	-0	0	0
4	sum :	-28	0	29	-0	0	0
5	32	19	0	-20	-0	0	-0
5	sum :	19	0	-20	-0	0	-0
6	32	19	0	-19	-0	0	-0
6	sum :	19	0	-19	-0	0	-0
7	32	31	0	-31	-0	0	-0
7	sum :	31	0	-31	-0	0	-0
8	32	32	0	-33	-0	0	-0
8	sum :	32	0	-33	-0	0	-0

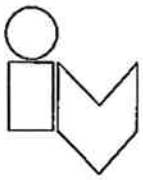


5 - strut HEA160 lowerconn. (ss)
Node - 13. Position of connection coordinate system related to node : : x : 0.00 mm,y : 0.00 mm,z : 0.00 mm

combi	memb	Fx [kN]	Fy [kN]	Fz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
1	15	-0	-8	-6	-0	0	0
1	sum :	-0	-8	-6	-0	0	0
2	15	-0	-28	-18	-0	0	0
2	sum :	-0	-28	-18	-0	0	0
3	15	-0	-22	-14	-0	0	0
3	sum :	-0	-22	-14	-0	0	0
4	15	-0	-22	-14	-0	0	0
4	sum :	-0	-22	-14	-0	0	0
5	15	-0	-31	-20	-0	-0	-0
5	sum :	-0	-31	-20	-0	-0	-0
6	15	-0	-11	-8	-0	-0	-0
6	sum :	-0	-11	-8	-0	-0	-0
7	15	-0	-17	-11	-0	-0	-0
7	sum :	-0	-17	-11	-0	-0	-0
8	15	-0	-17	-11	-0	-0	-0
8	sum :	-0	-17	-11	-0	-0	-0

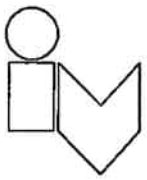
6 - brace HEB240
Node - 15. Position of connection coordinate system related to node : : x : 0.00 mm,y : 0.00 mm,z : 0.00 mm

combi	memb	Fx [kN]	Fy [kN]	Fz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
1	25	-0	-137	87	2	1	1
1	sum :	-0	-137	87	2	1	1
2	25	-1	433	-277	-9	1	2
2	sum :	-1	433	-277	-9	1	2
3	25	-1	258	-165	-6	1	2
3	sum :	-1	258	-165	-6	1	2
4	25	-1	267	-171	-6	1	2
4	sum :	-1	267	-171	-6	1	2
5	25	1	107	-70	-3	-1	-1
5	sum :	1	107	-70	-3	-1	-1
6	25	1	-464	295	9	-1	-2
6	sum :	1	-464	295	9	-1	-2
7	25	2	-288	183	5	-1	-2
7	sum :	2	-288	183	5	-1	-2
8	25	2	-298	188	5	-1	-2
8	sum :	2	-298	188	5	-1	-2



4.3.2. Truss girderframe- Gate connections
Internal forces on member(s).
Linear static - extreme or all combinations
Group of member(s) :21,31
Group of ultimate combi :1/8

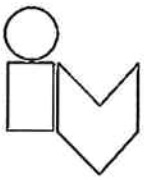
memb	cr.nr	dx [mm]	combi	N [kN]	Vy [kN]	Vz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
21	1	0.0	1	178	16	9	-0	-8	-0
21	1	0.0	2	-564	19	-3	-0	16	5
21	1	0.0	3	-335	31	1	-0	9	4
21	1	0.0	4	-347	32	1	-0	9	4
21	1	0.0	5	-140	-20	6	-0	2	0
21	1	0.0	6	602	-22	19	-0	-22	-4
21	1	0.0	7	374	-34	15	-0	-15	-4
21	1	0.0	8	386	-35	15	-0	-15	-4
31	1	0.0	1	-568	-16	6	0	-1	-0
31	1	0.0	2	192	-19	7	0	-4	0
31	1	0.0	3	-327	-31	6	0	-2	0
31	1	0.0	4	-338	-32	6	0	-2	0
31	1	0.0	5	603	20	11	0	-7	0
31	1	0.0	6	-157	22	10	0	-4	-0
31	1	0.0	7	362	34	11	0	-6	-0
31	1	0.0	8	373	35	11	0	-6	-0



4.4. Reactions

Reactions (all), ult. comb (all).
Group of node(s) :1/22
Group of ultimate combi :1/8

support	node	combi	Rx [kN]	Ry [kN]	Rz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
1	13	1	-0	0	125	0	0	0
1	13	2	3	0	-310	0	0	0
1	13	3	2	0	-179	0	0	0
1	13	4	2	0	-187	0	0	0
1	13	5	0	0	-37	0	0	0
1	13	6	-2	0	398	0	0	0
1	13	7	-2	0	268	0	0	0
1	13	8	-2	0	275	0	0	0
2	14	1	0	13	29	0	38	0
2	14	2	0	11	29	-0	40	0
2	14	3	0	12	32	-0	62	0
2	14	4	0	12	33	-0	64	0
2	14	5	0	22	34	-0	-24	0
2	14	6	0	24	34	0	-26	0
2	14	7	0	23	31	0	-48	0
2	14	8	0	23	30	0	-50	0
3	16	1	0	-170	-100	19	-1	-0
3	16	2	-3	591	334	-59	-4	0
3	16	3	-2	357	201	-35	-4	0
3	16	4	-2	369	208	-36	-4	0
3	16	5	-0	170	87	-14	0	-0
3	16	6	2	-591	-347	63	3	-0
3	16	7	2	-357	-214	39	3	-0
3	16	8	2	-369	-221	41	3	-0
4	18	1	0	568	0	1	0	0
4	18	2	0	-192	0	4	0	0
4	18	3	0	327	0	2	0	0
4	18	4	0	338	0	2	0	0
4	18	5	0	-603	0	7	0	0
4	18	6	0	157	0	4	0	0
4	18	7	0	-362	0	6	0	0
4	18	8	0	-373	0	6	0	0



5. Results

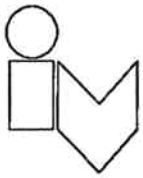
5.1. Checks acc Eurocode 3

- Brief output; max. unity check for all members
- Extended output ; for governing check

EC3. Member all. UC all.

EC3 Code Check

Macro	Member	Section	Position m	Ult. comb	sect. chk.	stab chk.
1	1	HEB240	1.78	6	0.25	0.35
1	2	HEB240	0.00	6	0.26	0.32
1	3	HEB240	0.00	8	0.12	0.16
1	4	HEB240	1.63	8	0.12	0.16
1	5	HEB240	1.63	5	0.23	0.28
1	6	HEB240	0.00	5	0.23	0.33
2	7	HEB240	1.20	2	0.18	0.24
3	8	HEB240	0.00	4	0.13	0.18
3	9	HEB240	1.63	4	0.15	0.21
3	10	HEB240	0.00	4	0.15	0.20
3	11	HEB240	1.63	4	0.12	0.16
4	12	HEB240	1.13	1	0.17	0.22
5	13	HEB240	0.00	6	0.14	0.14
6	14	HEB240	0.00	8	0.08	0.08
7	15	HEA160	1.13	5	0.03	0.04
8	16	HEA160	1.13	6	0.02	0.04
9	17	HEB300	0.00	6	0.13	0.14
10	18	HEB900	0.00	8	0.01	0.01
11	19	HEB240	0.00	2	0.21	0.31
11	20	HEB240	1.71	2	0.23	0.33
11	21	HEB240	0.30	2	0.29	0.41
12	22	HEA500	1.20	4	0.02	0.03
12	23	HEA500	0.00	4	0.03	0.04
12	24	HEA500	1.20	4	0.02	0.03
13	25	HEB240	0.00	6	0.19	0.22
14	26	HEB240	1.14	2	0.05	0.07
15	27	HEB240	1.14	6	0.05	0.07
15	28	HEB240	1.14	2	0.05	0.07
15	29	HEB240	1.14	6	0.05	0.07
16	30	HEB300	0.00	2	0.19	0.21
17	31	HEB240	0.30	5	0.22	0.07
18	32	2 LT	0.85	4	0.13	0.42
19	33	2 LT	0.85	6	0.01	0.01
20	34	HEB500	1.89	2	0.10	0.11
20	35	HEB500	0.06	2	0.10	0.11



EC3. Member all. UC all. Extended output for governing check

EC3 Code Check

Macro 18 **Member 32** **2 LT** **S 355** **Ult. comb 4** **0.42**

Basic data EC3

partial safety factor Gamma M0 for resistance of cross-sections	1.00
partial safety factor Gamma M1 for resistance to buckling	1.10
partial safety factor Gamma M2 for resistance of net sections	1.25

Material data

yield strength fy	355.00	MPa
tension strength fu	510.00	MPa
fabrication	welded	

SECTION CHECK

The critical check is on position 0.85 m

Axis definition :
- local y- axis in this code check is referring to the local z axis in EPW
- local z- axis in this code check is referring to the local y axis in EPW

Internal forces

NSd	-40.53 kN
Vy.Sd	-0.00 kN
Vz.Sd	-0.00 kN
Mt.Sd	0.00 kNm
My.Sd	0.00 kNm
Mz.Sd	-0.02 kNm

Only elastic check

Compression check
according to article 5.4.4. and formula (5.16)
Section classification is 3.

Table of values

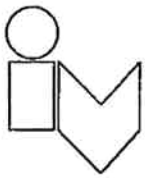
Nc.Rd	341.00 kN
unity check	0.12

Combined bending, axial force and shear force check
according to article ENV 1993-1-3 : 5.7 and formula ENV 1993-1-3: (5.11a,b,c)
Section classification is 3.

Table of values

sigma N	42.19 MPa
sigma Myy	0.00 MPa
sigma Mzz	3.17 MPa
Tau z	-0.00 MPa
Tau z	-0.00 MPa
Tau t	0.00 MPa

ro 0.00 place 9
unity check 0.13
Element satisfies the section check !



STABILITY CHECK

Buckling parameters	yy	zz	
type	non-sway	non-sway	
Slenderness	70.27	113.03	
Reduced slenderness	0.92	1.48	
Buckling curve	c	c	
Imperfection	0.49	0.49	
Reduction factor	0.59	0.32	
Length	1.71	1.71	m
Buckling factor	1.00	1.00	
Buckling length	1.71	1.71	m
Critical Euler load	403.21	155.84	kN

Buckling check
according to article 5.5.1. and formula (5.45)

Table of values	
Nb.Rd	99.62 kN
Beta A	1.00
unity check	0.41

Torsional-flexural buckling check
according to article ENV 1993-1-3 : 6.2.3 and formula (6.1) (6.4a-b)(6.5a-b)(6.6)

Table of values	
Nb.Rd	108.50 kN
Beta A	1.00
Reduced slenderness	1.48
Reduction factor	0.35
sigma,cr,T	812.93 MPa
sigma,cr,TF	162.24 MPa
Torsional buckling length	1.71 m
unity check	0.37

Compression and bending check
according to article 5.5.4. and formula (5.53)

Table of values	
ky	1.07
kz	1.50
muy	-0.37
muz	-2.07
BetaMy	1.80
BetaMz	1.30

unity check = 0.41 + 0.00 + 0.01 = 0.42

Compression, bending and LTB check
according to article 5.5.4. and formula (5.54)

Table of values	
klt	0.91
kz	1.50
mult	0.25
muz	-2.07
BetaMlt	1.80
BetaMz	1.30

unity check =0.41 + 0.00 + 0.01 = 0.42
Element satisfies the stability check !

D3. DETAIL CALCULATION.

INDEX.

NOTE: CALCULATION BUFFERS; REFFERED TO ANNEX J.

Project : MALAMOCCO NAV. LOCK GATE.

Onderdeel : DETAILS SEASIDE.

REDUCED CROSS-SECTION PROPERTIES. (OUTLINE-1mm)

PROFILE	b	h	t_w	t_f	r	A	I_y	$W_{el;y}$
HEB240	238	238	7	14	18	8134	$8,91 \cdot 10^7$	$7,49 \cdot 10^5$
HEB260	258	258	8	16	24	10064	$1,29 \cdot 10^8$	$9,98 \cdot 10^5$
HEB300	298	298	9	17	25	12508	$2,141 \cdot 10^8$	$1,44 \cdot 10^6$
HEB500	298	498	12	26	27	20848	$9,52710^8$	$3,83 \cdot 10^6$
HEB160	158	158	6	11	13	4292	$2,0 \cdot 10^7$	$2,54 \cdot 10^5$
2×L50/50/8	50	50	6	6	7	1138	$10,68 \cdot 10^4$ (IV)	$7,224 \cdot 10^3$
	mm	mm	mm	mm	mm	mm^2	mm^4	mm^3.

CAPACITY BOLTED CONNECTIONS

CONN. M30 8.8. : $e_{1\,min} = 40$ mm $\quad p_1 = 120$ mm
$t_{pl\,min} = t_{f;HEB240} = 14$ mm.

SHEAR: $F_{v;Rd} = 0,6 \cdot f_{ub} \cdot A_s / \gamma_{mb}$.
$= 0,6 \cdot 800 \cdot 561 / 1,25 = 215$ kN.

BEARING: $F_{b;Rd} = 2,5\,\alpha \cdot f_u \cdot d \cdot t_{min} / \gamma_{mb}$ → $\frac{e_1}{3d_0} = \frac{40}{3 \cdot 32} = 0,42$
$= 2,5 \cdot (0,42)\, 490 \cdot 30 \cdot 14 / 1,25 = 172$ kN.

TENSION: $F_{t;Rd} = 0,9\, f_{ub} \cdot A_s / \gamma_{mb}$.
$= 0,9 \cdot 800 \cdot 561 / 1,25 = 323$ kN.

CONN. M16.8.8: $e_{1\,min} = 70$ mm $\quad p_1 = 120$ mm.
$t_{pl;min} = 15$ mm.

SHEAR: $F_{v;Rd} = 0,6 \cdot 800 \cdot 157 / 1,25 = 60$ kN.

BEARING: $f_{b;Rd} = 2,5 \cdot 1,29 \cdot 490 \cdot 16 \cdot 13 / 1,25 = 263$ kN.

TENSION: $F_{t;Rd} = 0,9 \cdot 800 \cdot 157 / 1,25 = 90$ kN.

CAPACITY STEEL. ($t \leq 40$ mm)

$f_{y;d} = f_y / \gamma_m = 355 / 1{,}1 = 322 \ N/mm^2$.

$\tau_{u;d} = f_y / \gamma_m \cdot \sqrt{3} \qquad 187 \ N/mm^2$.

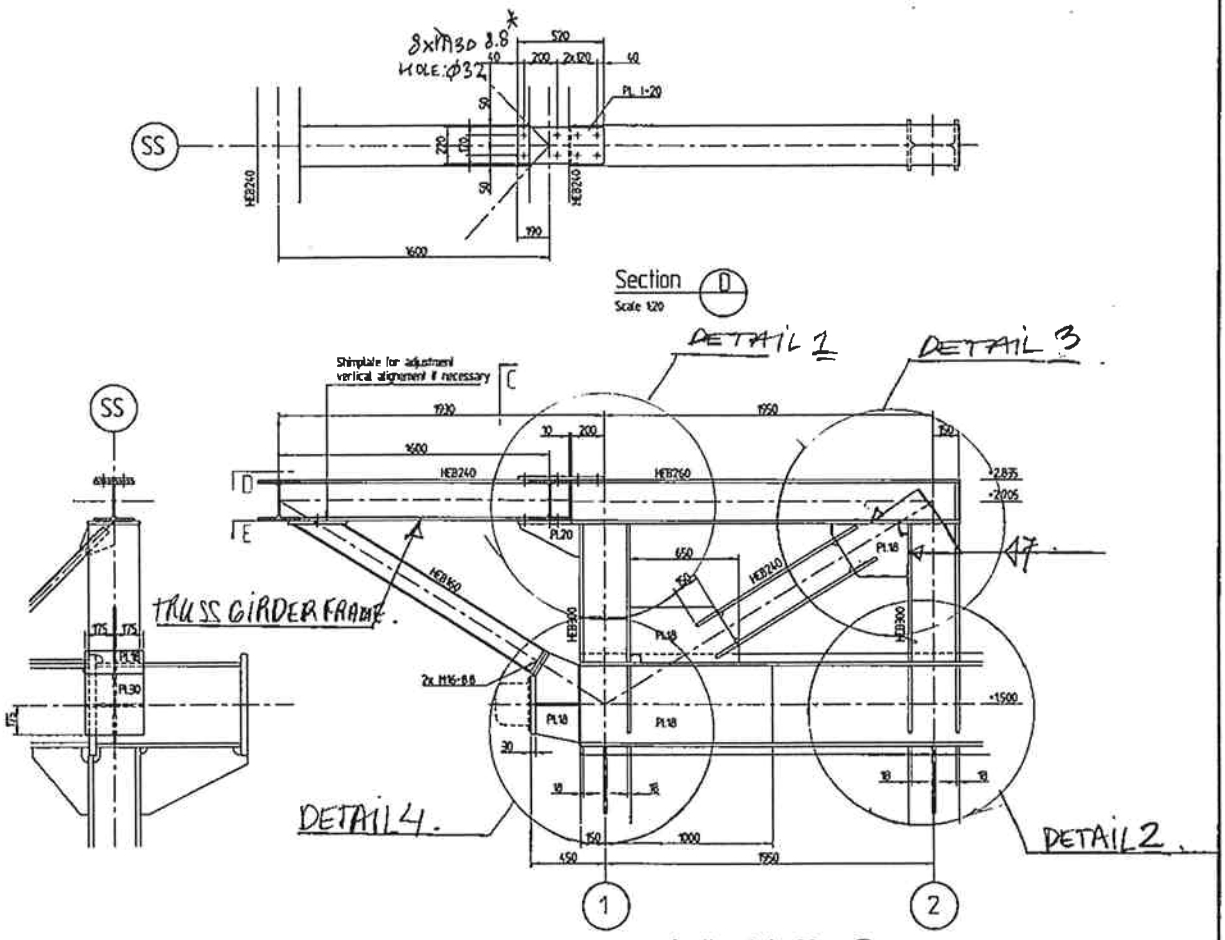
CAPACITY WELDS

$$f_{vw;d} = \frac{f_u / \sqrt{3}}{\beta_w \cdot \gamma_{Mw}} = \frac{510 / \sqrt{3}}{0{,}9 \cdot 1{,}25} = 262 \ N/mm^2.$$

Project : MALAMOCCO NAV. LOCK GATE.

Onderdeel : DETAIL SEASIDE.

DETAILS TRACTION FRAME SEASIDE.



STEEL : S355 JR.

WELDS : a=5 U.N.O.

*M30: BOLTS : SLIP RESISTANT ; PRELOADING = 0,7 · fub · Ab.
= 314kN.

Opgesteld : D. Alsemgeest | Datum : 29-01-04 | Bladnummer : D3-4 | Rev. : A2

Project : MALAMOCCO NAV. LOCK GATE.

Onderdeel : DETAILS SEASIDE

DET. 1: CONN. TRUSS GIRDER FRAME – GATE

ULTIMATE LOAD: MALFUNCTIONING WINCH.

LOADS DERIVED FROM MAINCALC. D2-27:

$N_z = 602$ kN

$V_y = 22$ kN

$V_z = 19$ kN

$M_y = 22$ kNm

$M_z = 4$ kNm

(DESIGN VALUES)

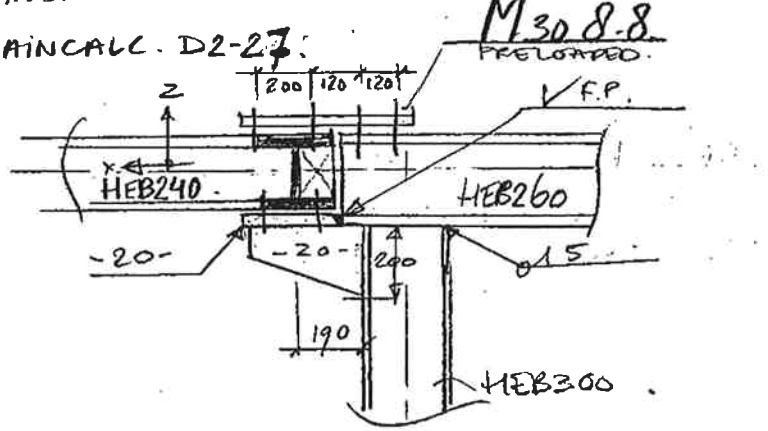


PLATE 220*20

$A = 218 * 18 = 3924$ mm²

$W_y = \frac{1}{6} \cdot 218 \cdot 18^2 = 11772$ mm³

$W_z = \frac{1}{6} \cdot 218^2 \cdot 18 = 142572$ mm³.

$N_{pl.} = N/2 + M_y/0{,}24 = \boxed{378\ kN}$.

$\sigma_{pl.} = N_{pl.}/A + M_z/W_z = 96 + 28 = 125\ N/mm^2$.

$\tau_{pl} = V_y/A = 7\ N/mm^2 \ll$

$u.c = 125/355 \cdot 1{,}1 = \underline{0{,}32} < 1.0$ ℓ

GUSSET PLATE 20 x 200.

$A = 18 \cdot 198 = 3564$ mm².

$W_y = \frac{1}{6} \cdot 18 \cdot 198^2 = 117612$ mm³.

$M = V_z \cdot 0{,}19 = 4{,}2$ kNm.

$\sigma_{pl} = M/W_y = 36\ N/mm^2$. } u.c = 0,1

$\tau_{pl} = V_z/A = 5\ N/mm^2$ } ℓ

WELD ΔΔ 5 ℓ = 200.

$\sigma_{w.s.d} = 36 \cdot 18/2 \cdot 5 = 65\ N/mm^2$

$f_{w.u.d} = 262\ N/mm^2$.

u.c = 0,25 ; ℓ

Opgesteld : D.A

Datum : 29-01-'04

Bladnummer : D3-5

Rev. : A2

Project : MALAMOCCO NAV. LOCK GATE.

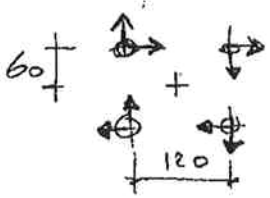
Onderdeel : DETAILS SEASIDE.

BOLTS M30 8.8: (BEARING GOVERNING ABOVE SHEAR.)

SHEAR: $N_{pl}/4 = 378/4 = 95$ kN.

$V_y/8 = 22/8 = 3$ kN.

$M_z/8 \cdot 0{,}06 = 4/8 \cdot 0{,}06 = 9$ kN.



$F_{v;s;d} = \sqrt{(95+9)^2 + (3+9^2)^2} = 105$ kN.

$F_{v;u;d} = 172$ kN (D3-2)

$u.c = \frac{F_{v;s;d}}{F_{v;d}} = 0{,}61 < 1{,}0$ OK

SLIDING RESISTANCE: M30 8.8.

PRELOADING: $F_{p;Cd} = 0{,}7 f_{ub} \cdot A_s$

$= 314$ kN.

DESIGN SLIP RESISTANCE = $F_{s;Rd} = \frac{k_s \cdot n \cdot \mu}{\gamma_{ms}} \cdot F_{p;Cd}$.

$= \frac{1{,}0 \cdot 1 \cdot 0{,}3}{1{,}25} \cdot 314 = 75{,}4$ kN.

$u.c = F_{v;s;d}/F_{s;Rd} = 105/75{,}4 = 1{,}4 > 1{,}0$

NOTE: CONNECTION IS SLIPED, BUT BEARING STILL SUFFICIENT IN ULTIMATE LOAD CONDITION WITH MALFUNCTIONING WINCH. STILL THE CONNECTION MUST NOT SCIP UNDER ULTIMATE OPERATING LOAD CONDITION, CHECKED ON NEXT PAGE.

Opgesteld: D.A. Datum: 29-01-04 Bladnummer: D3-6 Rev.: A2

CHECK SLIP CONNECTION UNDER ULTIMATE OPERATING LOAD CONDITIONS.

LOAD DERIVED FROM D2-27. (LOADCOMB 8):

$N = 386$ kN

$V_y = 35$ kN

$V_z = 15$ kN

$M_y = 15$ kNm

$M_z = 4.$ kNm.

(CALC. AS IN D3-5)

$N_{PL} = N/2 + M_y/0{,}24 = 256$ kN.

F V:S:d: PER BOLT

$N_{PL}/14 = 256/14 = 64$ kN

$V_y/8 = 35/8 = 5$ kN.

$M_y/8 \cdot 0.06 = 4/8 \cdot 0{,}06 = 9$ kN.

$F_{V:S:d:\,PER\,BOLT} = \sqrt{(64+9)^2+(5+9)^2} = 75$ kN.

$F_{S:Rd}$ (D3-6) = SLIP RESISTANCE = 75,4 kN.

U.C = 1,0; O.K.

CONNECTION DOES NOT SLIP DURING NORMAL OPERATING UNDER ULTIMATE LOADCONDITION.

Project : MALAMOCCO NAV. LOCK GATE.

Onderdeel : DETAILS SEA SIDE.

DETAIL 2 : HEB300 - BUMPERBEAM (S.S. INNERCONNECTION ROW ②)

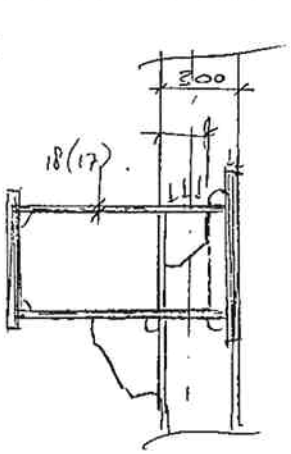
LOADS DERIVED FROM MAIN CALC. D2-24

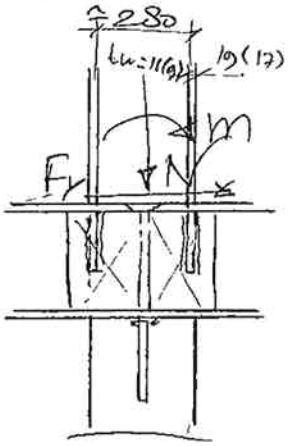
$N = 313$ kN

$M_x = -71$ kNm

$F_y = 82$ kN.

(DESIGN VALUES)





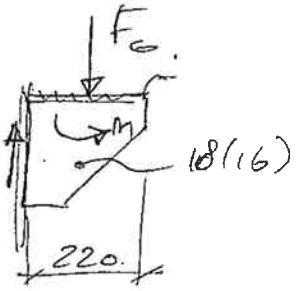
TOTAL LOAD THROUGH FLANGES:

$F_{FLANGE\ HEB300} = N^*_{FLANGE} + M/h = 109 + \frac{71}{0{,}28} = 363$ kN.

$\sigma_{s:D.} = 363\,10^3/300 \cdot 17 = 71\ N/mm^2$.

$F_{GUSSET} = 71 \cdot 240 \cdot 17 = 290$ kN.

$M_G = F_{GUSSET} \cdot 220/2 = 32$ kNm.



$\sigma_{pl} = M_G/W + \sigma_{s:D}$

$= 32 \cdot 10^6/\frac{1}{6} \cdot 16 \cdot 220^2 + 71 = 319\ N/mm^2$

$f_{y:d} = 355/1{,}1 = 323\ N/mm^2$

} U.C = 0,99 : OK.

WELDS : F.P.

NOTE : $N_{FLANG} = (N_{TOTAL} - N_{DIRECT\ WEB})/2 = 313 \cdot 10^3 - 220) 9 \cdot (3 \cdot 16)/2 = 109$ kN.

Opgesteld : ALSEMGEEST | Datum : 05-04 | Bladnummer : D3-8. | Rev. : A2

DETAIL 3: UPPER CONNECTION SEASIDE ROW (2).

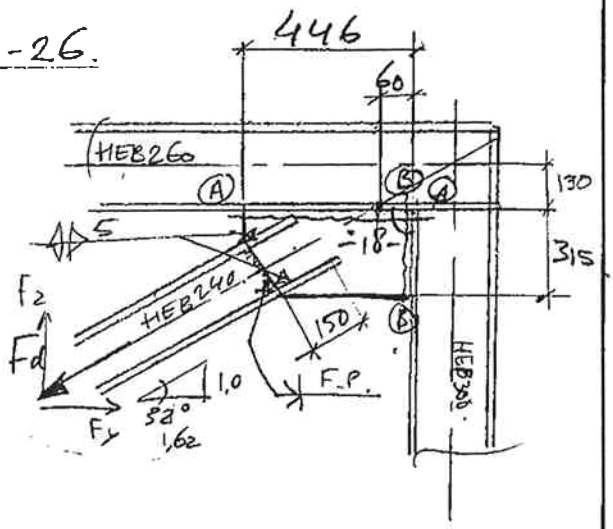
LOADS DERIVED FROM MAIN CALC. D2-26.

$F_y = 464$ kN

$F_z = 295$ kN.

$F_d = \sqrt{F_y^2 + F_z^2} = 550$ kN.

$M_x = 9$ kNm.



FLANGE CONNECTION BRACE HEB240.

$F_{FLANGE} = F_d/2 + M_x/h_F =$

$= 550/2 + 9,0/(240-14)\cdot 10^{-3} = 275 + 40 = 315$ kN.

$\sigma_{FLANGE} = F_{FLANGE}/A_{FLANGE}$

$= 315\cdot 10^3/14\cdot 238 = 95\ N/mm^2 < f_{y;d}$;

$l_{WELD} = 150$ mm.

SHEAR PLATE:

* $\tau_{pl.} = F_{FLANGE}/[l\cdot t_{pl}\cdot 2] = 75\ N/mm^2$

$u.c = \tau_{pl}/\tau_{u;d} = \frac{75\cdot 1,1\cdot\sqrt{3}}{355} = 0,4$ OK.

* $\tau_{WELD} = \tau_{pl}\cdot t_{pl}/2\cdot a$

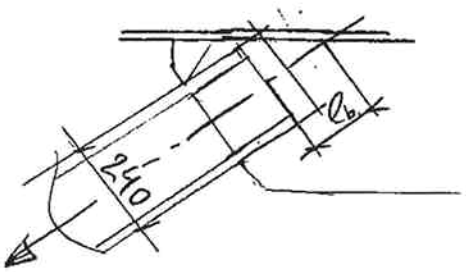
$= 75\cdot 14/2\cdot 4 = 131\ N/mm^2$ u.c = $131/262 = 0,5 < 1,0$ O.K.

INTRODUCTION PLATE:

CONSERVATIVE: $\sigma = F_d / A_b$

$= 550 \cdot 10^3 / 16.240$

$= 143 N/mm^2$.



$l_b = 222$ mm.

$i = \sqrt{\frac{I}{A}} = \sqrt{\frac{1}{12} \cdot 16^2} = 4,6$.

$\lambda = 220 / 4,6 = 48$.

$\bar{\lambda} = 48 / 76,1 = 0,63$.

$\chi = 0,76$ (curve c).

$\sigma_{buck} = 0,76 \cdot \frac{355}{1,1} = 245 N/mm^2$.

u.c. $= 143 / 245 = 0,6$ o.k.

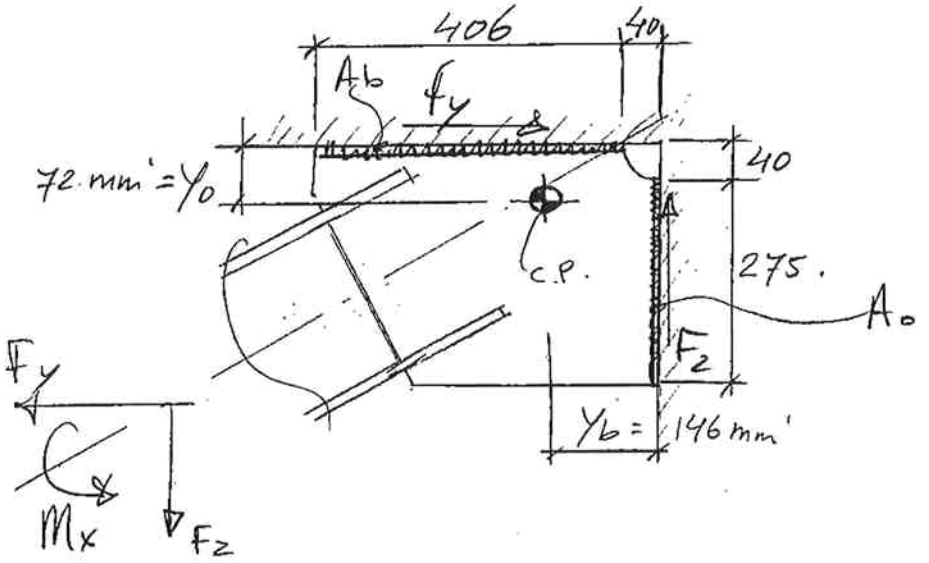
Project : MALAMOCCO NAV. LOCK GATE.

Onderdeel : DETAIL SEASIDE.

CONNECTION PLATE t_{pl} = 18 mm. WELD ~~AX~~ 5.

CALCULATED : t_{PL} = 16 mm'

WELD ~~AX~~ 4 mm'.



F_y = 464 kN

F_z = 295 kN

$M_x = 9 + F_z \cdot y_b - F_y \cdot y_o = 9 + 295 \cdot 146 - 464 \cdot 72 = 19$ kNm'.

∴ ALL LOADS TRANSFERRED AS SHEAR:

$A_{b/mm'}$ = 406 mm' $A_b/A_{tot} = 0{,}6 \rightarrow$

$A_{o/mm'}$ = 275 mm' + $A_o/A_{tot} = 0{,}4 \uparrow$

$A_{tot/mm'}$ = 681 mm'

$M_{x;b} = 0{,}6 \cdot 19 = 11{,}5$ kNm

$M_{x;o} = 0{,}4 \cdot 19 = 7{,}5$ "

$F_x = M_x / y_{qi} \Rightarrow$ $F_{x;L} = M_{x;b}/72 = 160$ kN.

$F_{x;o} = M_{x;o}/146 = 51$ kN.

Opgesteld : ALSEMGEEST Datum : 25-04-04 Bladnummer : D3-11 Rev. : A2.

∴ TOTAL SHEAR IN SECTIONS:

HOR. CONNECTION:

$$F_{S:H:D} = F_y + F_{x;b} = 464 + 160 = 624\ kN.$$

VERT. CONNECTION

$$F_{S:V:D} = F_z + F_{x;0} = 295 + 51 = 346\ kN.$$

∴ CHECK PLATE:

$$t_{HOR.CONN:} = F_{S:H:D}/16.406 = 96\ N/mm^2.$$

$$t_{VERT.CONN:} = F_{S:V:D}/16.275 = 79\ N/mm^2.$$

$$U.C = 96 \cdot 1.1/355\sqrt{2} = 0{,}52 \quad \underline{O.K}.$$

∴ CHECK WELD:

$$t_{HOR.CONN.} = 96 \cdot 16/2.4 = 192\ N/mm^2.$$

$$t_{VERT.CONN.} = 79 \cdot 16/2.4 = 158\ N/mm^2.$$

$$U.C. = 192/262 = 0{,}74 \quad \underline{O.K}.$$

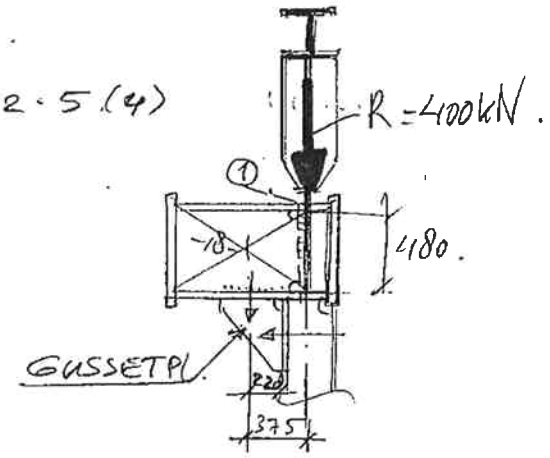
DET. 4 LOWER CONNECTION ROW (1).

GOVERNING LOAD DERIVED FROM D2-28.

$R_{MAX;D} = 400\ kN$ (NODE 13).

SECTION (1): PL. 18(16); WELDS 2·5(4)

$\tau_w = \frac{400 \cdot 10^3}{8 \cdot (480 - 2 \cdot 40)} = 125\ N/mm^2$.



GUSSETPL. EQUAL.

$\sigma_1 = \tau_1 = \frac{400 \cdot 10^3 \cdot \sqrt{2}}{4 \cdot 4 \cdot 360} = 100\ N/mm^2$.

$\tau_2 = \frac{400 \cdot 10^3}{2 \cdot 4 \cdot 360} = 138\ N/mm^2$ (CALC. CUTOUTS 40 mm')

$\sigma_{wsd} = \frac{\sqrt{4 \cdot 100^2 + 3 \cdot 138^2}}{\sqrt{3}} = 181\ N/mm^2$

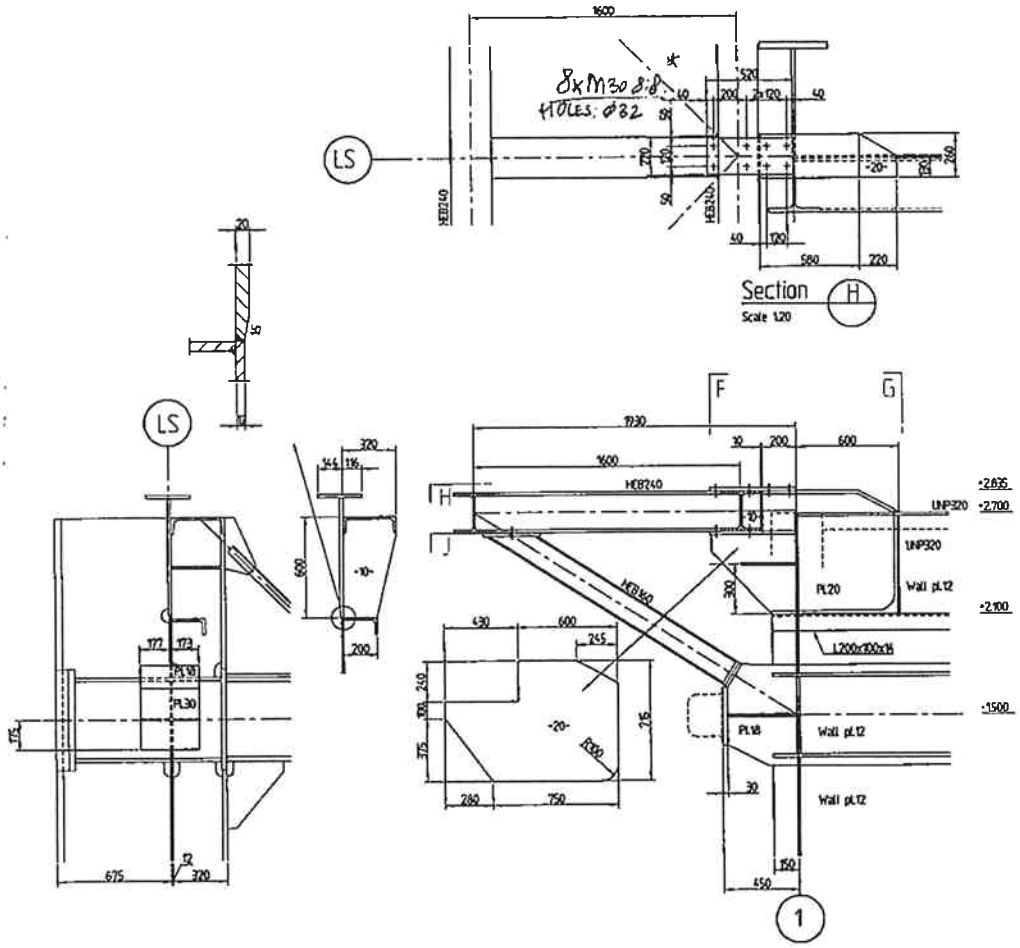
$f_{wnd} = 262\ N/mm^2$

} u.c. = 0.69 < 1.0 O.K.

Project : MALAMOCCO NAV. LOCK GATE.

Onderdeel : DETAILS LAGOON SIDE.

DETAILS TRACTION FRAME LAGOONSIDE



STEEL : S355 JR

WELDS : a = 5 ▷◁ U.N.O.

M30-BOLTS*; SLIPRESISTANT; PRELOADING = 0,7 fub A_{bs} = 314 kN.

Opgesteld : ALSEMGEEST | Datum : 20-04-04 | Bladnummer : D3-14. | Rev. : A2

DET. 5. CONN. TRUSS GIRDER FRAME - GATE.

LOADS TAKEN FROM SEASIDE (GOVERNING) (D3-5)

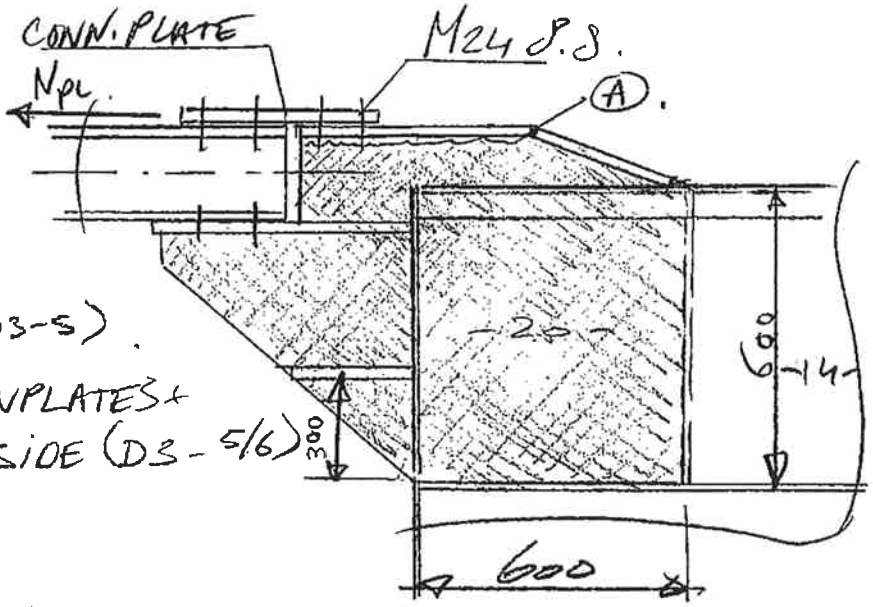
$N = 602$ kN

M_y N

$M_y = 22$ kNm

$N_{pl} = 378$ kN (D3-5).

CHECK CONNECTIONPLATES + BOLTS, SEE SEASIDE (D3-5/6)



CHECK PLATE DIMENSIONS WITH COMPRESSION.

CLASSIFICATION: ENV 1993-1-1 TABLE 5.3.1.

CLASS 3: $b/t \leq 42\alpha_y$.

$b = 600$, $t = 20$, $\alpha_y = 0{,}81$ } $b/t \cdot \alpha_y = 37 < 42$; CLASS 3: ok

(A) CHECK SHEAR:

WELD GOVERNING.

$\ell_w = 378 \cdot w^3 / 2 \cdot 5 \cdot 262 = 144$ mm'

$\ell_{PRESENT.} \pm 500$mm: ok

Project : MALCOMOCCO NAV. LOCK GATE.

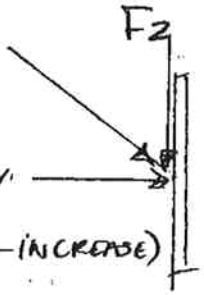
Onderdeel : DETAILS TRACTION FRAME.

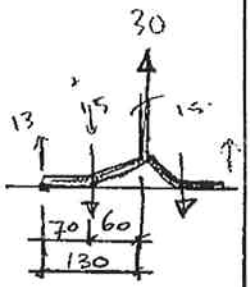
CONNECTION STRUT HEB160.

2 x M16 8.8. WITH PLATE t = 15 mm'

NETTO PLATE DIMENSIONS -1mm' OFF: h * b * t = 178 * 258 * 13.

LOAD DERIVED FROM MAINCALC. (D2-26)





F_y = 30 kN

F_z = 19 kN = $F_{v;s;d}$.

$F_{t;s;d} = \chi * F_y = \frac{130}{70} \cdot 30$ (PRYING FORCE - INCREASE)

$= 56$ kN

GOVERNING CHECK: SHEAR + TENSION.

(CAPACITY: SEE D3-2).

$$1{,}4 * \frac{F_{t;s;d}}{F_{t;R;d}} + \frac{F_{v;s;d}}{F_{v;R;d}} = 1{,}4 \cdot \frac{36}{2 \cdot 90} + \frac{19}{2 \cdot 60} = 0{,}44 + 0{,}16 = 0{,}6 < 1$$

$F_{t;s;d}$ PER BOLT = 56/2 = 28 kN

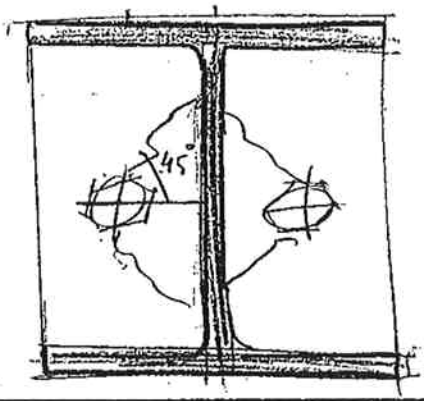
PLATE BENDING t = 15 !

SPREADING 45°:

$$t_{min} = \sqrt{\frac{6 F_{NORMAL}}{2 \cdot f_{y;d}}} = \sqrt{\frac{6 \cdot 15 \cdot 10^3}{2 \cdot 355/1{,}1}}$$

t_{min} = 12 mm'.

$t_{PRESENT}$ - 1mm CORROSION = 15 - 2 = 13; O.K

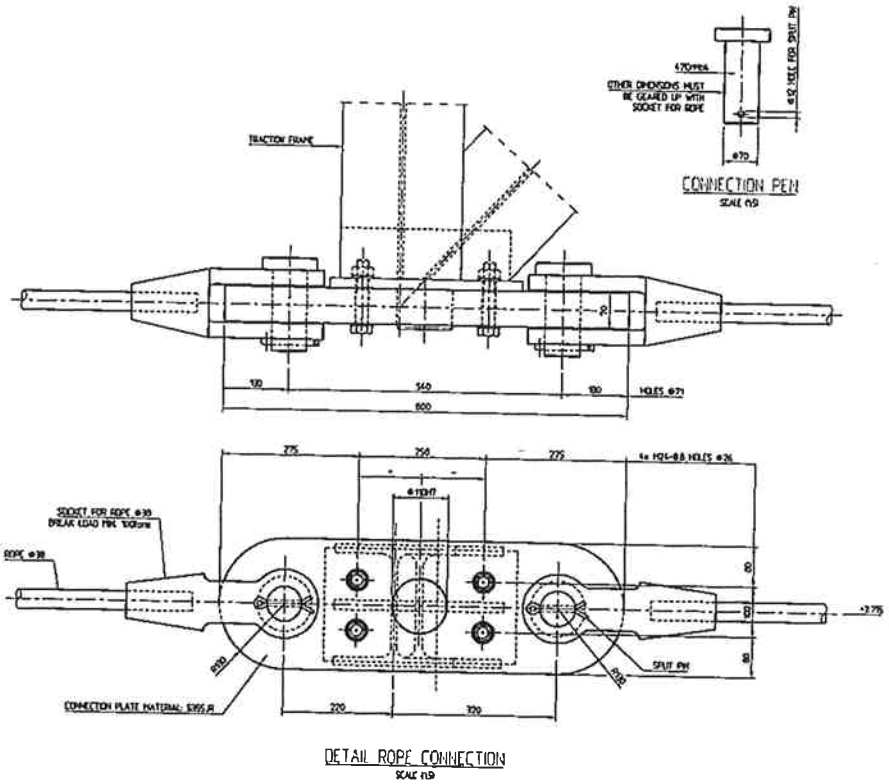


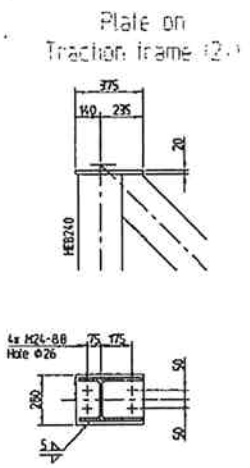
Opgesteld: DA Datum: 29-01-04 Bladnummer: D3-16 Rev.: A2

Project : MALAMOCCO NAVIGATION LOCK GATE

Onderdeel : DETAILSTRACTION FRAME .

DETAIL CALC. CABLE CONNECTION.





- ALL STEEL : S355 JR.
- PINS : SS 431 329 (WN.: 1.4057)
- WELDS : ~~Ø~~ 5.

Opgesteld : MSEMGEEST | Datum : 20 JAN '04 | Bladnummer : D3-17. | Rev. : A2

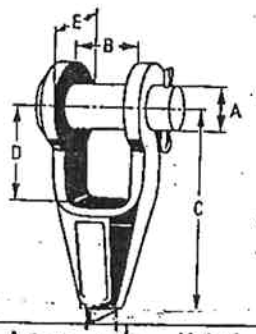
Project : MALAMOCCO NAV. LOCK GATE.

Onderdeel : DETAIL CABLE CONNECTION.

CHECK PINCONNECTION ACC. ENV. 1993-1-1; 6.5.13

* CABLE : : ϕ38

* CABLE SOCKET TYPE: "MENNENS" ART. 20103118



KABELSOCKETS
MODEL GAFFEL OF OPEN SOCKETS
Fabrikaat: Crosby-Laughlin (CL),
(open spelter sockets) en
Volgens NEN 2729 van Augustus 1989
Gebruiksfactor (5) = γ

Art.nr.	Kabel	Type	Max	Afm.				
	ø		WLL	A	B	C	D	E
(CL=G416)	mm		t	mm	mm	mm	mm	mm
20103118	36-39	NEN	20,0	70	76	314	162	137
33190040	40-42	CL	28,0	76	76	330	165	146
20103120	40-42	NEN	28,0	76	76	330	165	146
33190043	44-48	CL	40,0	89	89	369	178	165

ϕ38

* CAPACITY SOCKET INCL. $\gamma = 5,0$ = 20 TON = 200 kN.

↳ $\gamma = 1,0$ = 1000 kN.

* ACTING FORCE REPRESENTATIEF (D1-1) = 380 kN.

PRESENT SAFETY $\gamma_p = \frac{1000}{380} = 2,64$; O.K

Opgesteld : FHSEMGEEST

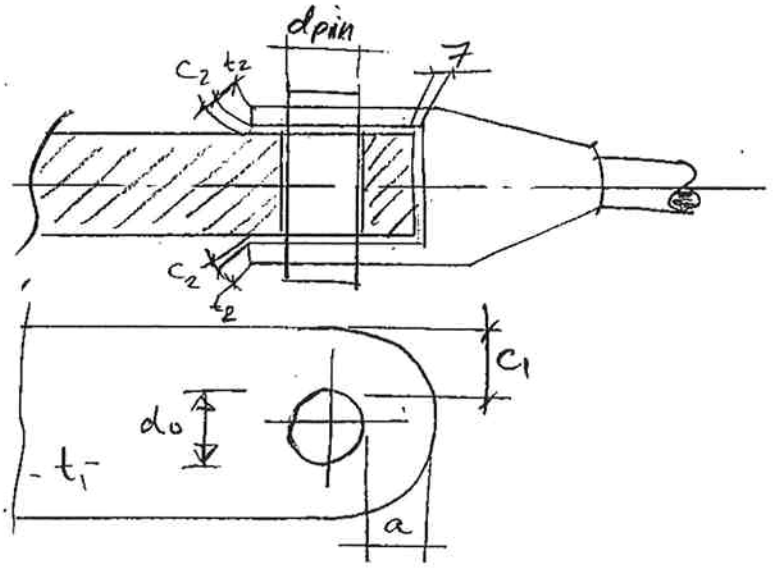
Datum : 20 JAN 04

Bladnummer : D3-18

Rev. : A2

Project : MALAMOCCO NAV. LOCK GATE.

Onderdeel : CABLE CONNECTION



* STEELGRADE : PLATE; S355 $f_y = 355\ N/mm^2$ $f_u = 510\ N/mm^2$

PIN : 431/529 $\sigma_{0,2} = 600\ N/mm^2$ $f_u = 900\ N/mm^2$

* PIN DIAMETER ; d_{PIN} = 70 mm. (CALC: 70 mm; NO CORROSION) HIGH STEELGRADE
* HOLE DIAMETER; d_0 = 71 mm.
* PLATE THICKNESS: t_1 = 70 mm. (CALCULATED: 68 mm)
* c_1 = (240 + 20 − 71)/2 = 95 mm.
* c_2 = 3 mm
* a = $130 - \frac{71}{2} = 94$ mm.
* t_2 = 15 (CONSERVATIVE)

Opgesteld : Alsemgeest. Datum : 20 JAN 04 Bladnummer : D3-19 Rev. : A2

Project : MALAMOCCO NAV. LOCK GATE.

Onderdeel : CABLE CONNECTION.

ACTING LOADS:

* TRACTIONFORCE (FROM D1) + PRETENSION = 350 + 30 = 380 kN EQUAL TO (D-

$F_D = 1{,}2 \cdot 380^* = 456$ kN

$M_{S:D} = \frac{456 \cdot 10^3}{8} \cdot (70 + 4 \cdot 3 + 2 \cdot 15) = 6{,}38$ kNm'

CAPACITY: (NO CORROSION TAKEN INTO ACCOUNT FOR PIN.)

$F_{ER:D} = 1{,}5 \cdot 68 \cdot 70 \cdot 355/1{,}25 = 2027$ kN.

$F_{VR:D} = 0{,}6 \left(\frac{\pi}{4} \cdot 70^2\right) \cdot 900/1{,}25 = 1663$ kN.

$M_{RD} = 0{,}8 \left(\frac{\pi}{64} \cdot 70^3\right) \cdot 600/1{,}25 = 6.5$ kNm'.

CHECKS.

* SHEAR PIN. ; U.C. = $456/1663 = 0{,}27 < 1{,}0$
* BENDING PIN ; U.C = $6{,}4/6{,}5 = 0{,}98 < 1{,}0$
* COMB. BENDING + SHEAR; U.C. = $0{,}98^2 + 0{,}27^2 = 1{,}02 < 1{,}0$

loads are conservative OK

PLATE DIMENSIONS CHECK:

$a \geq \frac{456 \cdot 10^3 \cdot 1{,}25}{2 \cdot 70 \cdot 355} + \frac{2 \cdot 71}{3} = 12 + 47 = 59$ mm

$c_1 \geq 12 + \frac{1}{2} \cdot 47 = 36$ mm

a: 94 > 59; ∴ o.k.

c_1: 95 > 36; ∴ o.k.

Opgesteld : ALSEMGEEST Datum : 20 JAN 04 Bladnummer : D3-20. Rev. : A2

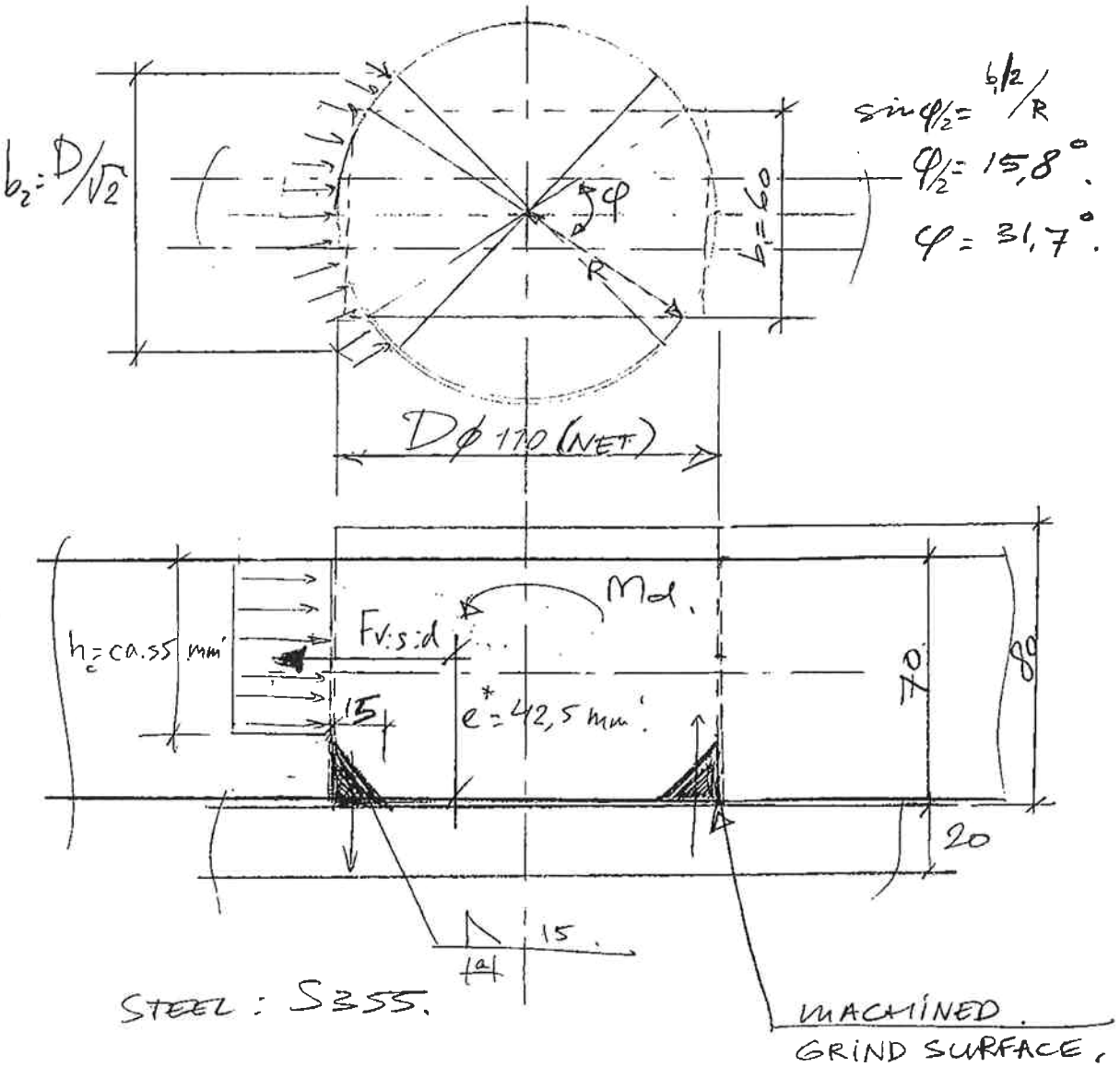
Project : MALAMOCCO NAV. LOCK GATE.

Onderdeel : SHEARHEAD.

SHEARKEY.

Dø GROSS = ø115 mm | FOR MACHINING.

Dø NET = ø110 mm | FITTING H7/d5.



* IN CALCULATION CONSERVATIVE APPROACH NO CONTACT AT WELD.

Opgesteld : ARSENGEEST | Datum : 27-04-04 | Bladnummer : D3-21 | Rev. : A2

Project : MALAMOCO · NAV. LOCK GATE.

Onderdeel : SHEAR HEAD.

LOAD:

$F_{v;s;d} = 380 \cdot 1,2 = 456$ kN.

$M_d = F_{vsd} \cdot e = 456 \cdot 0,0425 = 20$ kNm.

SHEARHEAD (S 355)

• CONTACT:

$\sigma_c = F_{v;s;d} / h_i b_2 = 456 \cdot 10^3 / 55 \cdot (110/\sqrt{2}) = 107$ N/mm².

$f_{y;d} = 315 / 1.1 = 287$ N/mm²

u.c. = 0,4 ok.

• BENDING GLOBAL.

$W = \frac{1}{6} \cdot b_1 \cdot (0,95 \cdot D)^2 = 109203$ mm³.

$\sigma_b = M_d / W = 20 \cdot 10^6 / 109203 = 183$ N/mm².

u.c. = 183/287 = 0,64 o.k.

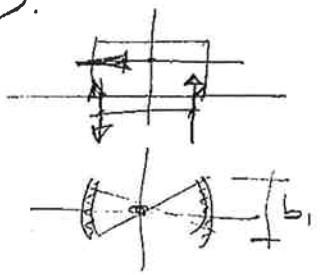
NORMAL STRESS AT WELD. (a = 15 calc. 14).

$F_{N;s;d} = M_d / 0,95 \cdot D = 192$ kN.

$A_{local} = b_1 \cdot a = 60 \cdot 14 = 840$ mm².

$\sigma_N = F_{Nsd} / A_{local} = 228$ N/mm².

u.c. = 228/287 = 0,8.



Opgesteld : ALSEMGEEST | Datum : 27-04-04 | Bladnummer : D3-22 | Rev. : A2

WELD $a = 15$ (calc. 14).

* SHEAR :

$$t_2 = F_{v;s;d} / 2 \cdot a \cdot (D/\sqrt{2}) = 456 \cdot 10^3 / 2 \cdot 14 \cdot (770/\sqrt{2})$$

$$= 209 \ N/mm^2.$$

$$f_{w;u;d} = f_u/\sqrt{3} / \beta \cdot \gamma_{mw} = 510/\sqrt{3} / 0,9 \cdot 1,25 = 262 \ N/mm^2.$$

$$u.c. = 209/262 = 0,80 < 1,0 \quad \underline{O.K.}$$

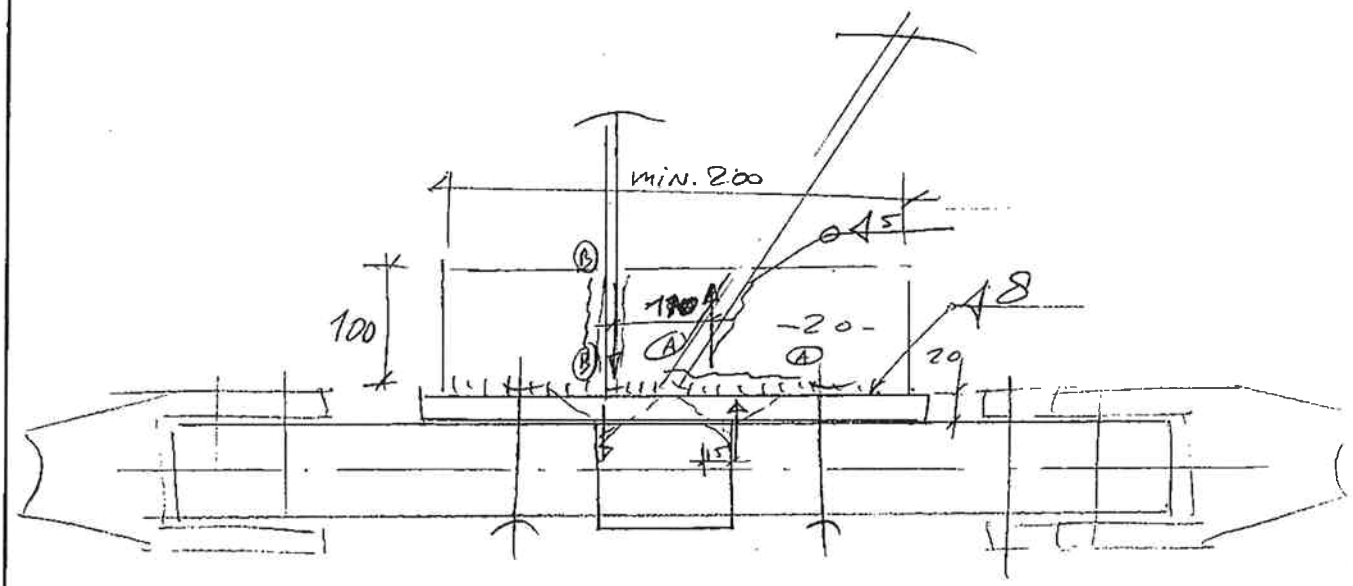
* NORMAL FORCE FROM BENDING :

$F_N = 228$ (PREVIOUS PAGE).

$$u.c. = 228/262 = 0,87 < 1,0 \quad \underline{O.K.}$$

Project : MALAMOCCO NAV. LOCK GATE.

Onderdeel : SHEARHEAD.



BEARING CHECK SECTION (A)-(A).

PLATE tpl. 20 (CALC. 18).

$l = 15 + 2 \cdot 20 = 55$ mm.

$\sigma_N = F_{N;Sd}/l \cdot t_{pl} = 192 \cdot 10^3/55 \cdot 18 = 194 \text{ N/mm}^2$.

u.c. $= 194/(355/1{,}1) = 0{,}6$ O.K.

WELD: $a = 8$ (calc. = 7).

$\sigma_N = 194 \cdot 18/2 \cdot 7 = 250 \text{ N/mm}^2$

u.c. $= 250/262 = 0{,}95$ O.K.

SHEAR SECTION (B)-(B): WELD a = 5 (calc. 4)

$F_{N;Sd} = 192$ kN.

$\tau = F_{N;Sd}/4 \cdot a \cdot l = 192 \cdot 10^3/4 \cdot 4 \cdot 100 = 120 \text{ N/mm}^2$.

u.c. $= 120/262 = 0{,}46$; OK

NOTE: SHEAR $F_{V;Sd}$ IS TRANFERED OVER FLANGES.

Opgesteld : Alsemgeest | Datum : 27-04-04 | Bladnummer : D3-24 | Rev. : A2

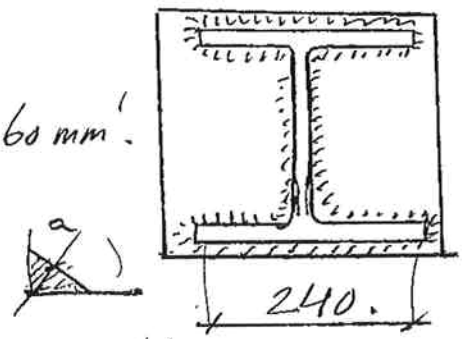
Project : MALAMOCCO NAV. LOCK GATE.

Onderdeel : DETAIL CABLE CONNECTION.

CONNECTION: WELD PLATE th=20 ON HEB240.

$F_D = 456$ kN.

$l_{WELD} = 2 \times 2 \times 240 = 960$ mm.



TAKE: WELD: a = 5

$$t = \frac{456 \cdot 10^3}{960 \cdot 5} = 95 \text{ N/mm}^2.$$

$f_{w;wd} = 262$ N/mm².

: u.c. = 0,36 < 1,0 : OK...

Opgesteld: MSEMGEEST Datum: 20 JAN. 04 Bladnummer: D3-25 Rev.: A2.

Project : MALAMOCCO NAV. LOCK GATE.

Onderdeel : DETAILS LAGOON SIDE.

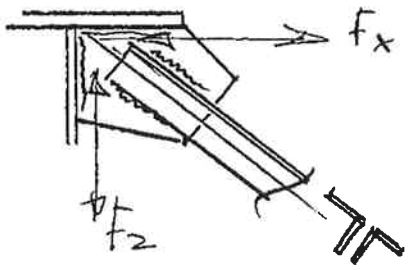
BRACE ⊥L CONNECTION OUT OF PLANE.

LOADS DERIVED FROM MAIN CALC. (D2-27):

F_x = 32 kN

F_z = 32 kN

F_{BRACE} = 45 kN.

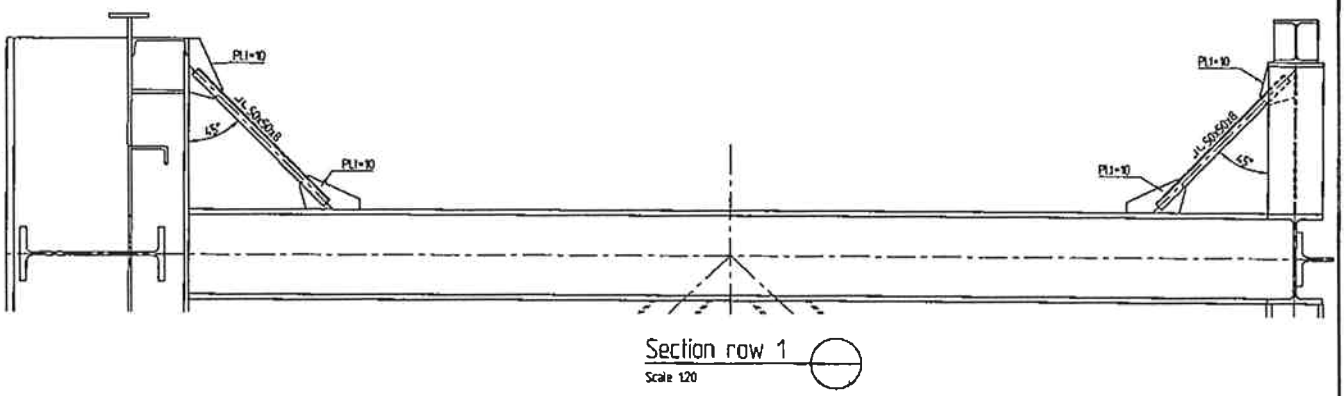


- ALL WELDS : ◢ a = 5 mm'.
- PLATE NETTO; t = 8 mm

$l_{WELD\ min} = 45 \cdot w^3/2 \cdot 8 \cdot (355/1,1) = 7\ mm'$.

$= 32 \cdot w^3/8\,(355/1,1) = 12\ mm'$

MIN LENGTHS PRACTICAL : $l_{min} = \underline{100\ mm'}$.



Section row 1
Scale 1:20

Opgesteld : DA. Datum : 29-01-04 Bladnummer : D3.26 Rev. : A2