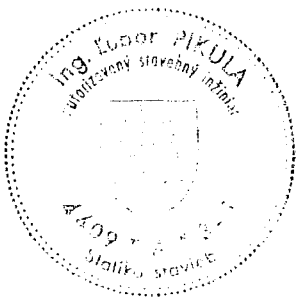
Názov stavby: Construction name:	**Kyslíkový aparát č.9** **Oxygen plant ASU No.9**
Investor:	**U.S. Steel, s.r.o. Vstupný areál U.S. Steel, Košice**
Stupeň: Level:	**Statické posúdenie** **Structural expert's option**
Účel: Scope:	**Posúdenie jestvujúceho základu pre nové zaťaženie LIN tankom** **Check of existing foundation for new LIN tank load**
Archívne číslo: Archival No.:	**RP - 147/2004**



Košice, 11/2004

2

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Obsah

Predmet, účel a rozsah posúdenia

Predmetom posúdenia je jestvujúci stolový základ určený pre novú nádrž LIN, ktorá bude súčasťou novej linky kyslíkového aparátu č.9. v areáli US Steel Košice.
Účelom posúdenia je posúdiť pôvodnú projektovú dokumentáciu pri zohľadnení aktuálneho stavu základu na nové zaťaženie a overiť statický výpočet firmy KMW pre nový stav.

Overovaná dokumentácia

- Statický výpočet – Static Calculation 7574, KMW Saarbrücen-Brebach, Oktober 2004
- Dostavba NHZ PC – kvapalinové hospodárstvo O2+N2 – objekt 322 – Základy skvapalňovača, zásobníkov a odparovačov, Hutný Projekt Košice, Jún 1978

Podklady, Použitá literatúra

- Technická správa č.70 04 0227 – Kontrola železobetónového základu pre LIN zásobník v U.S. Steel Košice, TSÚS pobočka Košice, Október 2004
- Podrobný inžiniersko-geologický prieskum - Záverečná správa, Montana s.r.o., máj 2004
- DIN 1045 (07.88) – Beton und Stahlbeton, Bemessung und Ausführung / Navrhovanie betónových konštrukcií
- STN 73 0035 – Zaťaženie stavebných konštrukcií
- STN 73 1001 – Základová pôda pod plošnými základmi
- STN 73 1201 – Navrhovanie betónových konštrukcií

Posúdenie základu

1) Statický výpočet

Po kontrolnom prepočte metódou konečných prvkov za použitia 3D modelu s uložením základu na pružnom podloží bolo zistené že vnútorné sily v mieste opretia stĺpov o dosku prekračujú únosnosť prierezu dosky. Pôvodný výpočet z roku 1978 bol realizovaný na báze tabuliek a rátal s kontinuálnym podoprením konštrukcie, nezohľadňoval však tuhosť prievlaku. Z toho dôvodu v pôvodnom výpočte nemohli byť zohľadnené lokálne špičky tangenciálnych ohybových momentov v miestach stĺpov vzniknutých od nižšej tuhosti prievlaku tak v spodnej ako aj hornej dosky.
Statický výpočet fy KMW zohľadnil tento nedostatok zavedením podoprenia medzi stĺpmi čím vzniklo spojité podoprenie oboch dosiek. Takýto model preukázal že doska je schopná prenášať zaťaženia od nového LIN tanku. Súčasne je však potrebné toto podoprenie zabezpečiť vymurovaním novej steny zo šalovacích tvárnic medzi stĺpmi.

2) Stav základu

No overenie skutočného stavu základu zrealizoval Technický a Skúšobný Ústav (TSÚS) skúšobné merania pevnosti betónu nedeštruktívnymi skúškami ako aj overenie stavu výstuže hornej dosky.

Skúškami bolo zistené že betón konštrukcie vykazuje vyššiu pevnosť ako bola predpokladaná v projekte. Trieda betónu predpísaná v projekte je BIII – v zmysle platnej STN je to betón triedy B25. Na stavbe dosiahnutý betón je triedy B35. Na hornom povrchu hornej dosky sa nachádza tenká vrstva jemnozrnného betónu ktorá je takmer úplne rozpadnutá. Použitá výstuž je v súlade s projektom 10425 (V). Výsledky prieskumu poukazujú na zlý stav hornej výstuže v hornej doske. Tá je miestami úplne bez krytia a korózia dosahuje až 2,5 mm čo v prepočte predstavuje úbytok až 53% plochy výstužného prúta.
Prepočet konštrukcie na nové zaťaženie preukázal schopnosť dosky prenášať zaťaženie avšak pri plnej ploche výstuže (využitie prierezu cez 90%). Zohľadnením úbytku plochy prúta je využite hlboko cez 100% a teda prierez nevyhovuje. Z toho dôvodu je potrebné prijať dodatočné opatrenia a konštrukciu v danom mieste sanovať a zosilniť.

Návrh opatrení

Sanácia hornej dosky sa zrealizuje nasledovne:

- odstráni sa vrstva porušeného betónu v hrúbke 50 mm
- povrch sa zdrsní
- skorodovaná výstuž sa odstráni
- neskorodovaná výstuž sa ponechá resp. čiastočne odstráni
- zrealizuje nová výstuž
- vybetónuje sa nová doska v hrúbke ca 20 cm
- pre zabezpečenie spolupôsobenia novej a starej dosky sa v celej ploche zrealizuje prepojenie šmykovými tŕňmi (vŕtané a lepené do jestvujúcej dosky)

Realizácia spojitej podpory

- medzi stĺpmi sa zrealizuje na celú výšku stĺpov a na šírku prievlaku nová stena z betónových šalovacích tvárnic vyplnených betónom a vystužených výstužou.
- hotová stena sa aktivizuje vyklinovaním a expanznou maltou

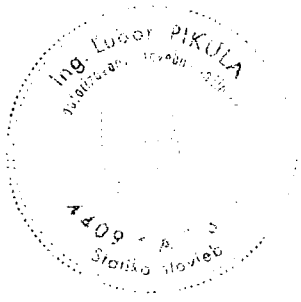
Ostatné časti základu

- celý povrch betónu v styku so vzduchom doporučujem sanovať vhodným sanačným materiálom

Záver

Existujúci základ je možné využiť pre nový LIN tank za predpokladu sanácie a úprav základu popísanej v predošlej časti. Pre tento účel bude vypracovaný samostatný projekt sanácie základu, ktorého súčasťou budú taktiež úpravy vynútené samotnou technológiu (kotvenie nádrže, atď).

Vypracoval: Ing. Ľubor Pikula
autorizovaný stavebný inžinier



Názov stavby: Construction name:	**Kyslíkový aparát č.9** **Oxygen plant ASU No.9**
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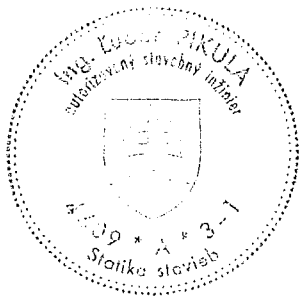

Košice, 11/2004

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Contents

Subject, Purpose and Scope of Opinion

The subject of opinion is existing table foundation for new LIN tank which will be as the part of new ASU unit in US Steel Košice area.
Purpose of opinion is to check the original project with considering of actual foundation condition under new load and to verify new structural analysis prepared by KMW

Documents to be verified

- Structural Analysis – Static Calculation 7574, KMW Saarbrücen-Brebach, October 2004
- Original project by Hutny Project: "Dostavba NHZ PC – kvapalinové hospodárstvo O2+N2 – objekt 322 – Základy skvapalňovača, zásobníkov a odparovačov" , June 1978

Used codes, Literature

- Technical Report No 70 04 0227 – Check of concrete foundation for LIN tank in US Steel Košice, civil Eng. Technical and Testing Institute (TSUS), October 2004
- Detailed Engineering Geological Survey – Final Report, Montana s.r.o., May 2004
- DIN 1045 (07.88) – Beton und Stahlbeton, Bemessung und Ausführung / Reinforced concrete structures, Design and construction
- STN 73 0035 – Zaťaženie stavebných konštrukcií / Actions on structures
- STN 73 1001 – Základová pôda pod plošnými základmi / Subsoil under shallow foundations
- STN 73 1201 – Navrhovanie betónových konštrukcií / Design of concrete structures

Opinion

1) Structural Analysis

After check analysis using of 3D FEM model with elastic bedding of foundation was discovered that internal forces in slab at column – slab connection are bigger than allowable for this place. Original project form 1978 was based on tables and calculated with full radial support. Different stiffness of main beam (in comparsion with column) was not considered. Therefore local tangential bending moments at columns due to lower main beam stiffness for both – bottom and top slabs could not be taken into consideration.
Structural Analysis provided by KMW considering this fact by additional bearing wall. This model shows that under these conditions it is able to use existing slab for new LIN tank. However it is necessary to provide new wall between columns. For the wall will be used system of concrete bricks filled with concrete – concrete brickwall.

2) Foundation quality

To get actual condition of foundation there was survey prepared by TSUS. There was provided non-destructive testing of concrete grade as well as the check of reinforcement.

Results show that concrete quality is higher than designed. Concrete grade in original project was BIII – according to valid STN standard it represents concrete grade B25. Real concrete grade is B35. On top surface is layer of poor concrete quality probably caused by finishing of concrete. This layer is almost completely crushed. Used reinforcement is same as designed – grade 10425 (V). Results shows that top layer of reinforcement on top slab is locally without concrete cover and corrosion is up to 2,5 mm. This represents reduction of reinforcement area up to 53%. Check calculation shows that slab has sufficient bearing capacity (over 90% capacity utilization) but with full reinforcement area. Taking the corrosion into consideration the section capacity is utilized much more than 100% and therefore section does not satisfy. Hence it is necessary to provide additional reinforcement and concrete reconstruction.

Reconstruction proposals

Top slab reconstruction:

- removing of crushed concrete in thickness of approx 50 mm
- surface roughing
- removing of corroded reinforcement
- healthy reinforcement remain or partially will be removed
- new layer of reinforcement
- new concrete layer in thickness of approx 200 mm
- for interconnection between old and new concrete will be provided shear anchoring

New radial continuous support

- between recent columns to full height and main beam width will be new wall provided by using of concrete bricks filled with concrete and reinforced with reinforcement
- finished wall will be activated with gussets and expansion mortar

Other parts of foundation

- whole surface of foundation will be rescued by using rescue paint or layer material

Conclusion

It is possible to use existing foundation for new LIN tank providing reconstruction and modifications mentioned above. For the reconstruction will be prepared new project which consider also modifications required by technology itself (tank anchorages, and so on).

Prepared: Ing. Ľubor Pikula
structural engineer

Static Calculation 7574

Part 2

Air Liquide AGS GmbH
Fütingsweg 34
47805 Krefeld

K70101, ASU No. 9 Kosice
Tank Farm existing foundation
1000 MT LIN-Storage Tank

Saarbrücken, im Oktober 2004
(statische Berechnung Seiten 1-53)

Ingenieurkammer des Saarlandes
397
Tragwerkplaner

KMW
Ingenieurgesellschaft mbH
Saarbrücker Straße 9
66130 Saarbrücken-Brebach
Telefon (0681) 8 83 13-0
Telefax (0681) 8 83 13-88
E-Mail info@kmw-ing.de

Remarks

The following structural (static) calculations provide the calculatory proof for the altered loads on the exist. LIN reserve tank foundation resulting from the new tank.

The existing foundation consists of a 1.0 m thick foundation slab with an 80 cm thick table slab standing on 8 reinforced concrete column legs on the foundation slab. The outside diameter of the table slab as well as that of the foundation slab amounts to 12.50 m.

According to the as-built foundation documents submitted, there is a reinforced concrete downstand beam w/d = 60 x 40 cm supporting the table slab which was included in the old calculations as linear load. Upon revew of the static calculation of the foundation it was discovered that occuring tangential forces on the table slab, exerted additionally on the vertical load were not taken into consideration in the original calculation. For the above-mentioned reason the exist. downstand beam is too weak, resp. reinforced incorrectly to support linear loads on the table slab.
The following calculations are based on the construction of solid brickwork walls to be constructed under the exist. downstand beam to support linear loads.

The following structural calculations determine the occuring tangential forces resulting from the new tank loads and compares these with the original calculations.
Accordingly the results of the calculations reveal that all dimensions calculated for the new tank loads are smaller than the dimensions of original structural calculations. In the calculation of the new tank loads the assumed loads were increased analog to the original calculations by safety factor of 1.2.

According to Air Liquide AGS GmbH loads resulting from earthquakes need not be taken into consideration.

The max. foundation pressure calculated for the new tank loads amounts to 250 kN/m^2. According to the soil report submitted the permissible soil pressure for the load bearing gravel layer and the exist. foundation dimensions amounts to approx. 500 kN/m^2.

Calculation are based on:

- Specifications through the Cotracting Agency
- any relevant regulations
- Load specifications CMO Arles, 783-101, dated July 28, 2004

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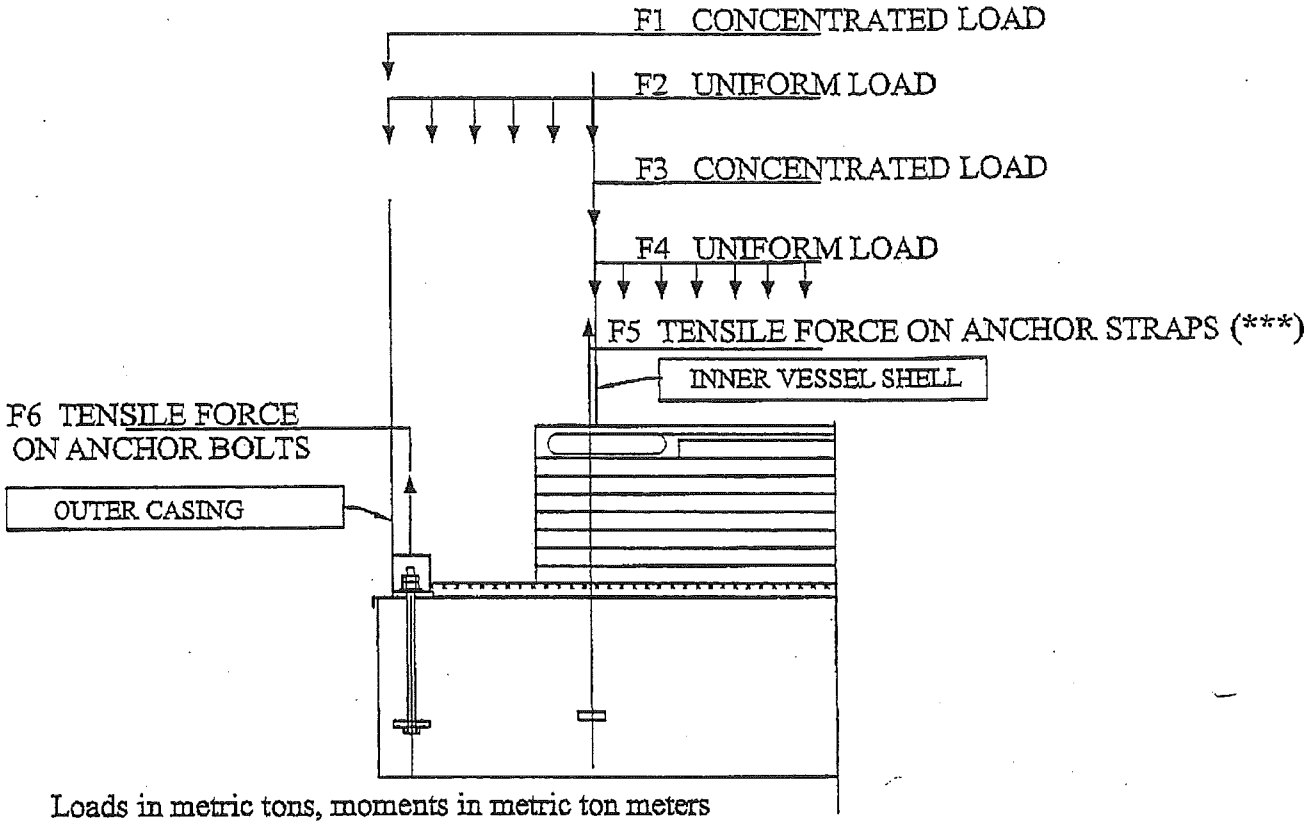

Loads in metric tons, moments in metric ton meters

A/ FULL OF LIQUID WITHOUT GAS PRESURE
F1=51 F2=55,1 F3=37.1 F4=1081.4 F5=0

B/ FULL OF LIQUID WITH GAS PRESURE
F1=51 F2=55,1 F3=0 F4=1234.4 F5=3.63x32=116.16

C/ HYDROPNEUMATIC TEST
F1=51 F2=6.8 F3=0 F4=1507.4 F5=5.03x32=160.96

D/ LOADS DUE TO THE SNOW(see note 5)
F1=18

E/ LOADS DUE TO WIND (see note 5)
SHEAR FORCE: 27 MOMENT(at 0.00CMP):290.8 F6=8x12=96

~~F/ LOADS DUE TO EARTHQUAKE (see note 5)~~
~~SHEAR FORCE: 142 MOMENT(at 0.00CMP):1223.9~~
~~F5=12.51x32=400.5 F6=3.9x12=46.8~~

(***) 10% of straps (with a mini of 4 straps, every 90°) shall be individually tested at the force of 12.4Tons , at time of slab acceptance.

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Dossier CMP Arles : 783

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Rev 0

Client / *Customer* : MESSER

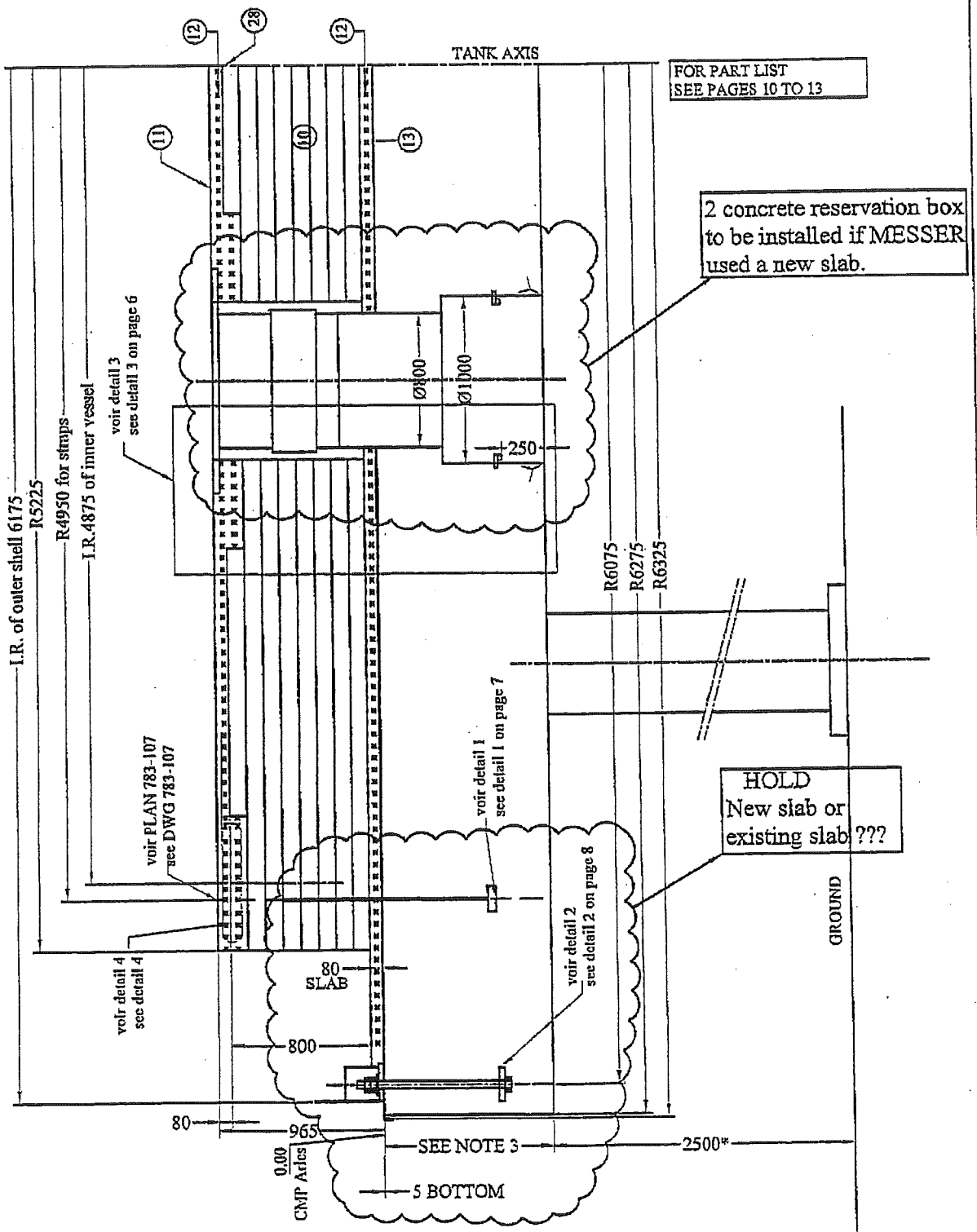
Engineered System N° :

Plan N° : 783-101

CIVIL ENGINEERING

ELEVATION

Echelle/*Scale*



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Dossier CMP Arles : 783

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Rev 0

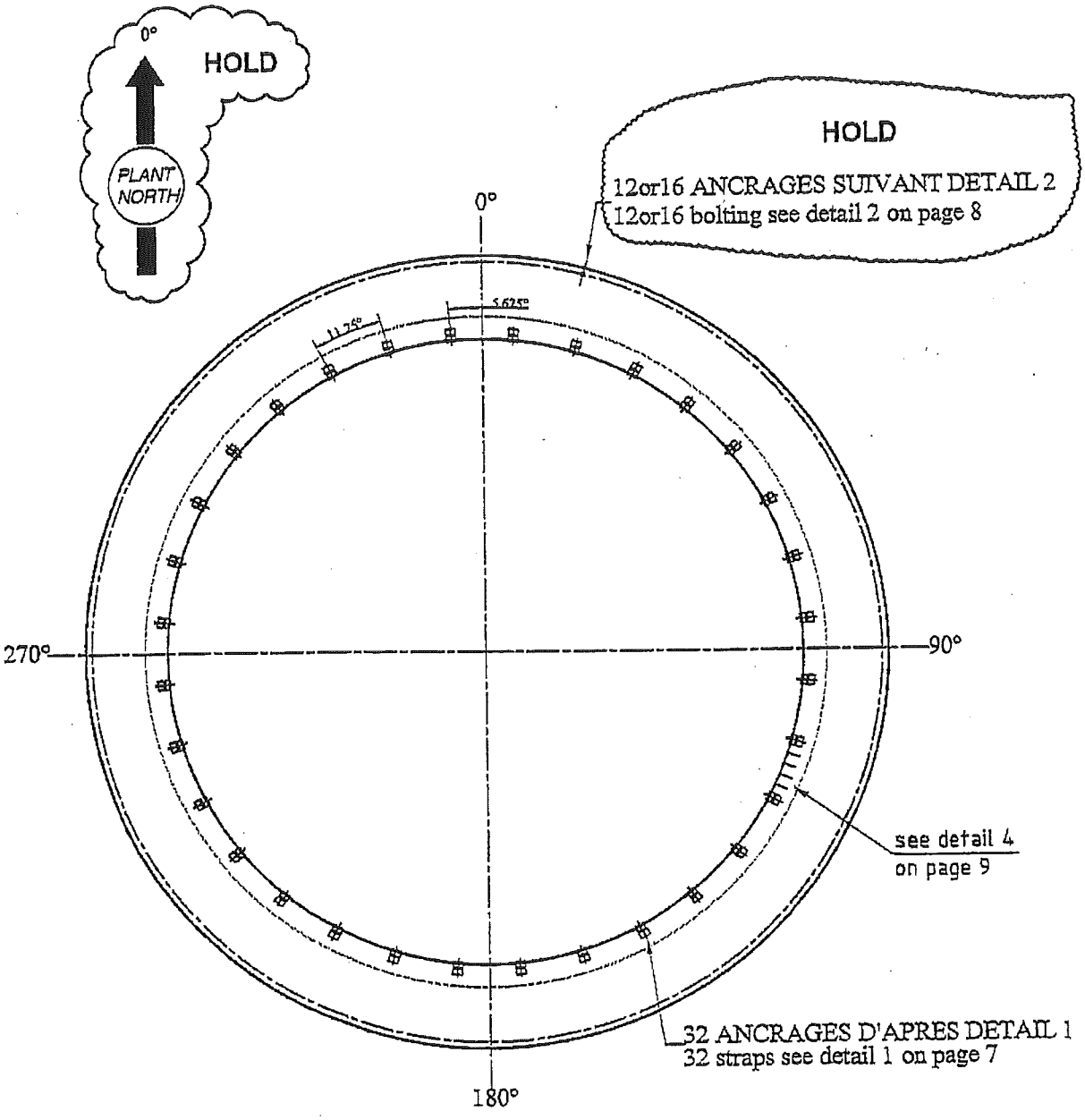
Client / *Customer* : MESSER

Engineered System N° :

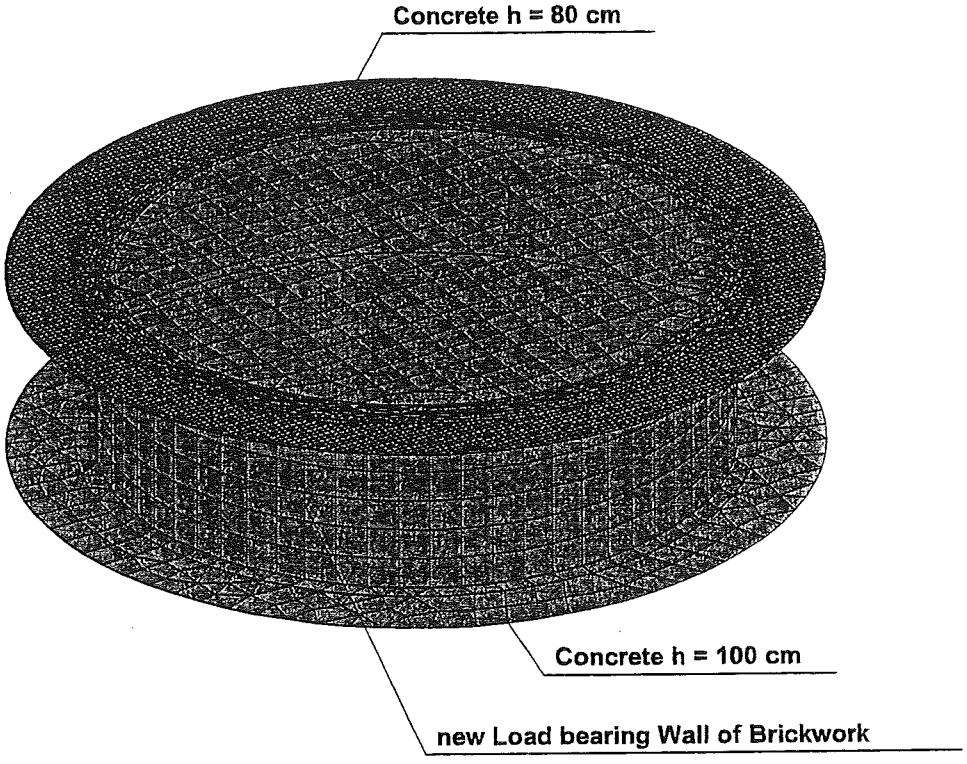
Plan N° : 783-101

CIVIL ENGINEERING ANCHOR ORIENTATIONS
(PLAN VIEW)

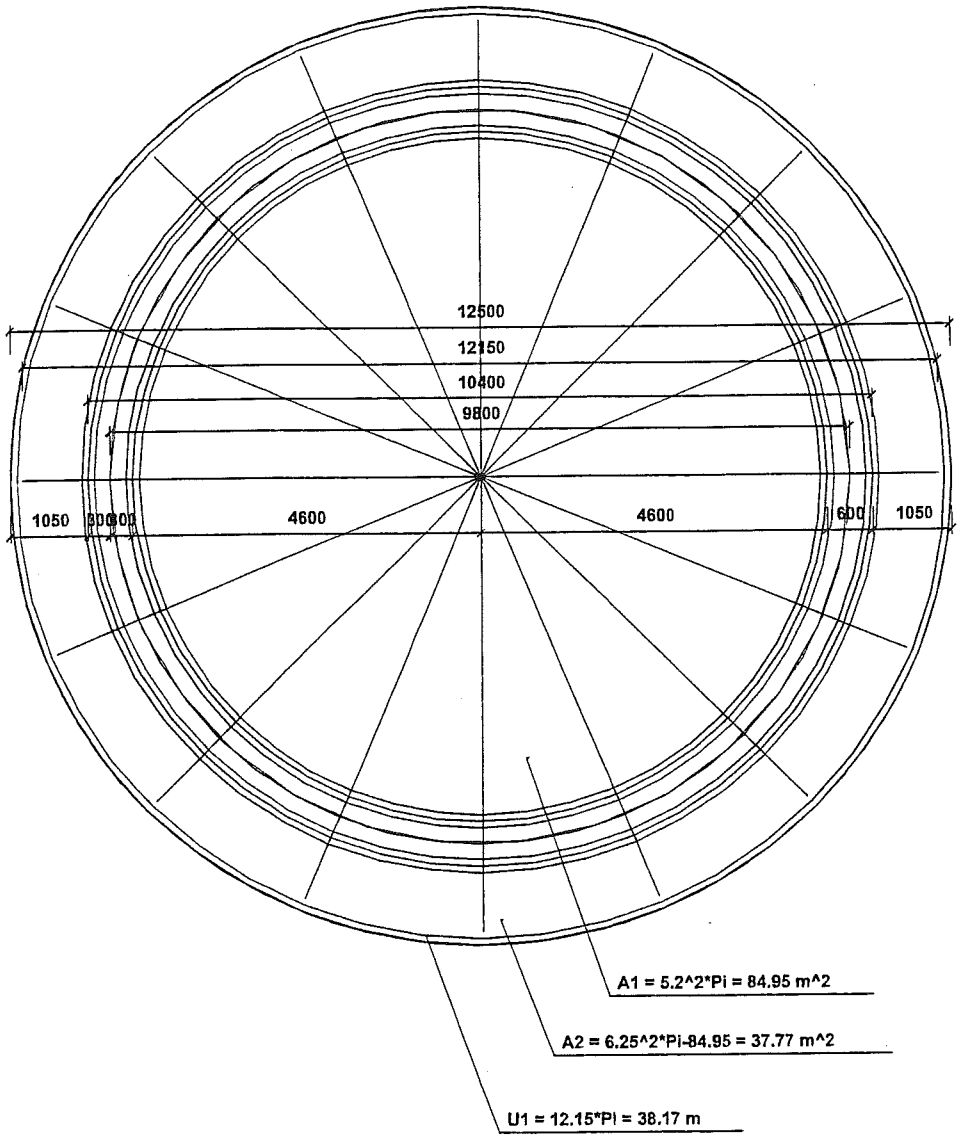
Echelle/*Scale* 1/100



Inhalt


Concrete h = 80 cm
Concrete h = 100 cm
new Load bearing Wall of Brickwork

System


12500
12150
10400
9800
1050
300
300
4600
4600
600
1050
A1 = 5.2^2*Pi = 84.95 m^2
A2 = 6.25^2*Pi-84.95 = 37.77 m^2
U1 = 12.15*PI = 38.17 m

Basic data
Type of structure : General XYZ

Number of nodes:	75
Number of members:	32
Number of 1D macros:	24
Number of bound. lines:	15
Number of 2D macros:	7
Number of profiles :	1
Number of cases:	8
Number of materials:	3

Material

Name:		
B 15		
	E modulus	26000.00 MPa
	Poisson coeff.	0.17
	Density	2500.000 kg/m^3
	Extensibility	0.01 mm/m.K
KS Mauerwerk		
	E modulus	11000.00 MPa
	Poisson coeff.	0.20
	Density	1600.000 kg/m^3
	Extensibility	0.01 mm/m.K
B 25 gewichtslos		
	E modulus	30000.00 MPa
	Poisson coeff.	0.20
	Density	0.000 kg/m^3
	Extensibility	0.01 mm/m.K

List of material
Group of members :
1/32

no.	Name:	quality	unit weight kg/m	length m	weight kg

List of material - Macro2D
Group of members :
1/13

no.	Name:	quality	unit volume weight kgm^3	volume m^3	weight kg
3	B 15	B 15	2500.00	220.76	551907.47
7	KS Mauerwerk	KS Mauerwerk	1600.00	22.16	35453.05

The total weight of the structure: 587360.52 kg

Nodes

node	X m	Y m	Z m
1	6.250	0.000	0.000
2	0.000	6.250	0.000
3	-6.250	0.000	0.000
4	0.000	-6.250	0.000
5	5.200	0.000	0.000
6	-2.600	4.503	0.000
7	-2.600	-4.503	0.000
8	0.000	5.200	0.000
9	-5.200	0.000	0.000
10	0.000	-5.200	0.000
11	4.600	0.000	0.000
12	-2.300	3.984	0.000
13	-2.300	-3.984	0.000
14	4.900	0.000	0.000
15	-2.450	4.244	0.000
16	-2.450	-4.244	0.000
17	0.000	4.600	0.000
18	-4.600	0.000	0.000
19	0.000	-4.600	0.000
20	6.250	0.000	-3.000
21	0.000	6.250	-3.000
22	-6.250	0.000	-3.000
23	0.000	-6.250	-3.000
24	5.200	0.000	-3.000
25	-2.600	4.503	-3.000
26	-2.600	-4.503	-3.000
27	0.000	5.200	-3.000
28	-5.200	0.000	-3.000
29	0.000	-5.200	-3.000
30	4.600	0.000	-3.000
31	-2.300	3.984	-3.000
32	-2.300	-3.984	-3.000
33	4.900	0.000	-3.000
34	-2.450	4.244	-3.000
35	-2.450	-4.244	-3.000
36	0.000	4.600	-3.000
37	-4.600	0.000	-3.000
38	0.000	-4.600	-3.000
39	0.000	4.900	-3.000
40	-4.900	0.000	-3.000
41	0.000	4.900	0.000
42	-4.900	0.000	0.000
43	-6.075	0.000	0.500
44	-0.000	0.000	0.500
45	6.075	0.000	0.500
46	-5.613	2.325	0.500
47	5.613	-2.325	0.500
48	-4.296	4.296	0.500
49	4.296	-4.296	0.500
50	-2.325	5.613	0.500
51	2.325	-5.613	0.500
52	0.000	6.075	0.500
53	-0.000	-6.075	0.500
54	2.325	5.613	0.500
55	-2.325	-5.613	0.500
56	4.296	4.296	0.500
57	-4.296	-4.296	0.500
58	5.613	2.325	0.500
59	-5.613	-2.325	0.500
60	-6.075	0.000	0.000
61	-5.613	2.325	0.000
62	-4.296	4.296	0.000
63	-2.325	5.613	0.000
64	0.000	6.075	0.000
65	2.325	5.613	0.000
66	4.296	4.296	0.000
67	5.613	2.325	0.000
68	6.075	0.000	0.000
69	5.613	-2.325	0.000
70	4.296	-4.296	0.000
71	2.325	-5.613	0.000
72	-0.000	-6.075	0.000
73	-2.325	-5.613	0.000
74	-4.296	-4.296	0.000
75	-5.613	-2.325	0.000

Members

macro	memb	node 1	node 2	length m	Rx deg	profile	quality
1	1	43	44	6.075	0.00	1 - KREIS (50.0)	B 25 gewichtslos
	2	44	45	6.075	0.00	1 - KREIS (50.0)	B 25 gewichtslos
2	3	46	44	6.075	0.00	1 - KREIS (50.0)	B 25 gewichtslos

macro	memb	node 1	node 2	length m	Rx deg	profile	quality
	4	44	47	6.075	0.00	1 - KREIS (50.0)	B 25 gewichtslos
3	5	48	44	6.075	0.00	1 - KREIS (50.0)	B 25 gewichtslos
	6	44	49	6.075	0.00	1 - KREIS (50.0)	B 25 gewichtslos
4	7	50	44	6.075	0.00	1 - KREIS (50.0)	B 25 gewichtslos
	8	44	51	6.075	0.00	1 - KREIS (50.0)	B 25 gewichtslos
5	9	52	44	6.075	0.00	1 - KREIS (50.0)	B 25 gewichtslos
	10	44	53	6.075	0.00	1 - KREIS (50.0)	B 25 gewichtslos
6	11	54	44	6.075	0.00	1 - KREIS (50.0)	B 25 gewichtslos
	12	44	55	6.075	0.00	1 - KREIS (50.0)	B 25 gewichtslos
7	13	56	44	6.075	0.00	1 - KREIS (50.0)	B 25 gewichtslos
	14	44	57	6.075	0.00	1 - KREIS (50.0)	B 25 gewichtslos
8	15	58	44	6.075	0.00	1 - KREIS (50.0)	B 25 gewichtslos
	16	44	59	6.075	0.00	1 - KREIS (50.0)	B 25 gewichtslos
9	17	60	43	0.500	0.00	1 - KREIS (50.0)	B 25 gewichtslos
10	18	61	46	0.500	0.00	1 - KREIS (50.0)	B 25 gewichtslos
11	19	62	48	0.500	0.00	1 - KREIS (50.0)	B 25 gewichtslos
12	20	63	50	0.500	0.00	1 - KREIS (50.0)	B 25 gewichtslos
13	21	64	52	0.500	0.00	1 - KREIS (50.0)	B 25 gewichtslos
14	22	65	54	0.500	0.00	1 - KREIS (50.0)	B 25 gewichtslos
15	23	66	56	0.500	0.00	1 - KREIS (50.0)	B 25 gewichtslos
16	24	67	58	0.500	0.00	1 - KREIS (50.0)	B 25 gewichtslos
17	25	68	45	0.500	0.00	1 - KREIS (50.0)	B 25 gewichtslos
18	26	69	47	0.500	0.00	1 - KREIS (50.0)	B 25 gewichtslos
19	27	70	49	0.500	0.00	1 - KREIS (50.0)	B 25 gewichtslos
20	28	71	51	0.500	0.00	1 - KREIS (50.0)	B 25 gewichtslos
21	29	72	53	0.500	0.00	1 - KREIS (50.0)	B 25 gewichtslos
22	30	73	55	0.500	0.00	1 - KREIS (50.0)	B 25 gewichtslos
23	31	74	57	0.500	0.00	1 - KREIS (50.0)	B 25 gewichtslos
24	32	75	59	0.500	0.00	1 - KREIS (50.0)	B 25 gewichtslos

Boundaries

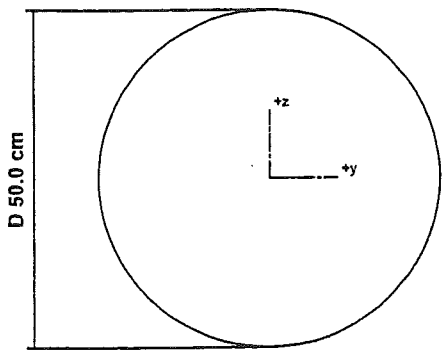
bound	line	type	node
1		Circle	1,2,3
2		Circle	5,6,7
3		Circle	5,8,9
4		Circle	11,12,13
5		Circle	14,15,16
6		Circle	11,17,18
7		Circle	20,21,22
8		Circle	24,25,26
9		Circle	24,27,28
10		Circle	30,31,32
11		Circle	33,34,35
12		Circle	30,36,37
13		Circle	33,39,40
14		Line	33,14
15		Circle	14,41,42

2D Macros

num	type
1	

num	type	
	B 15	Thickness 0.80 m
	Boundary:	1
	Nodes :	4,60,61,62,63,64,65,66,67,68,69,70,71,72,73,74,75
	1 Hole:	2
2		
	B 15	Thickness 0.80 m
	Boundary:	3
	Nodes :	10
	1 Hole:	4
	1 Inner line:	5
3		
	B 15	Thickness 0.80 m
	Boundary:	6
	Nodes :	19
4		
	B 15	Thickness 1.00 m
	Boundary:	7
	Nodes :	23
	1 Hole:	8
5		
	B 15	Thickness 1.00 m
	Boundary:	9
	Nodes :	29
	1 Hole:	10
	1 Inner line:	11
6		
	B 15	Thickness 1.00 m
	Boundary:	12
	Nodes :	38
7		
	KS Mauerwerk	Thickness 0.24 m
	Boundary:	13,14,15,14

Profiles



KREIS (50.0)

Profile no. 1 - KREIS (50.0)

Material : 8 - B 25 gewichtslos

A:	1.963495e+003 cm^2		
Ay/A:	0.850	Az/A:	0.850
Iy:	3.067962e+005 cm^4	Iz:	3.067962e+005 cm^4
Iyz:	3.896267e-009 cm^4	It:	6.135923e+005 cm^4
Iw:	0.000000e+000 cm^6		
Wely:	1.224073e+004 cm^3	Welz:	1.224073e+004 cm^3
Wply:	2.079339e+004 cm^3	Wplz:	2.079369e+004 cm^3
cy:	0.00 cm	cz:	0.00 cm
iy:	12.50 cm	iz:	12.50 cm
dy:	0.00 cm	dz:	0.00 cm
Outline :		156.88 cm	

Type for check: Untypical section

Hinges
The stiffeness values of line hinges are stated in 1 m´ of length

memb	2D macro/ bound	type	pos
17		fixfiyfiz	beg
18		fixfiyfiz	beg
19		fixfiyfiz	beg
20		fixfiyfiz	beg
21		fixfiyfiz	beg
22		fixfiyfiz	beg
23		fixfiyfiz	beg
24		fixfiyfiz	beg
25		fixfiyfiz	beg

memb	2D macro/ bound	type	pos
26		fixfiyfiz	beg
27		fixfiyfiz	beg
28		fixfiyfiz	beg
29		fixfiyfiz	beg
30		fixfiyfiz	beg
31		fixfiyfiz	beg
32		fixfiyfiz	beg
	7/13	fix	
	7/15	fix	

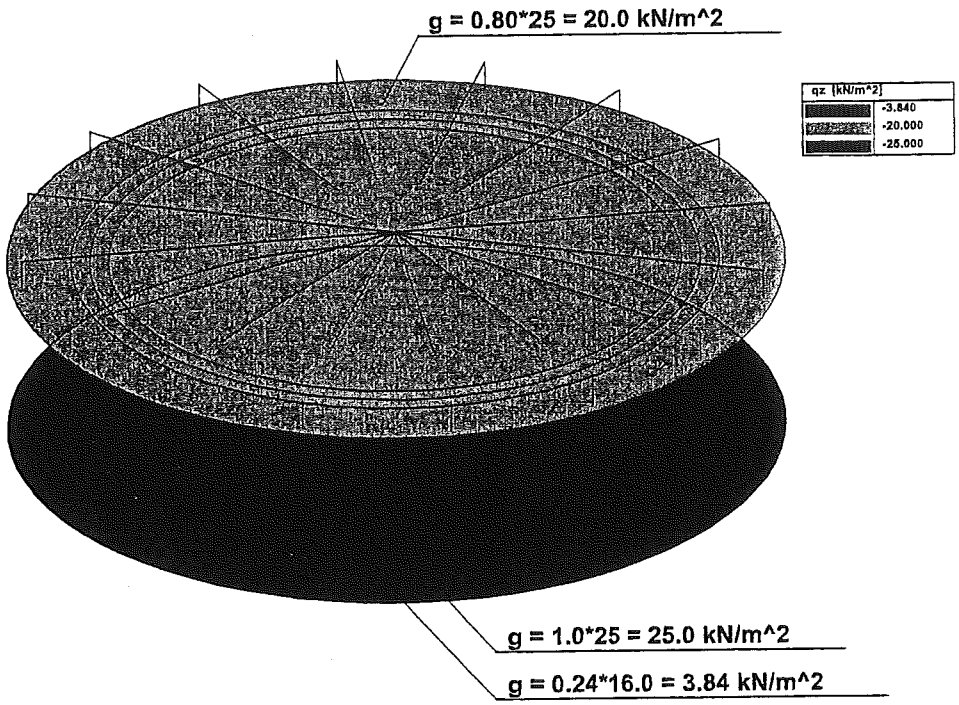
Soil - 2D macro

Index	2D macro	Name of subsoil
1	4	gemischtkörniger Sand
2	5	gemischtkörniger Sand
3	6	gemischtkörniger Sand

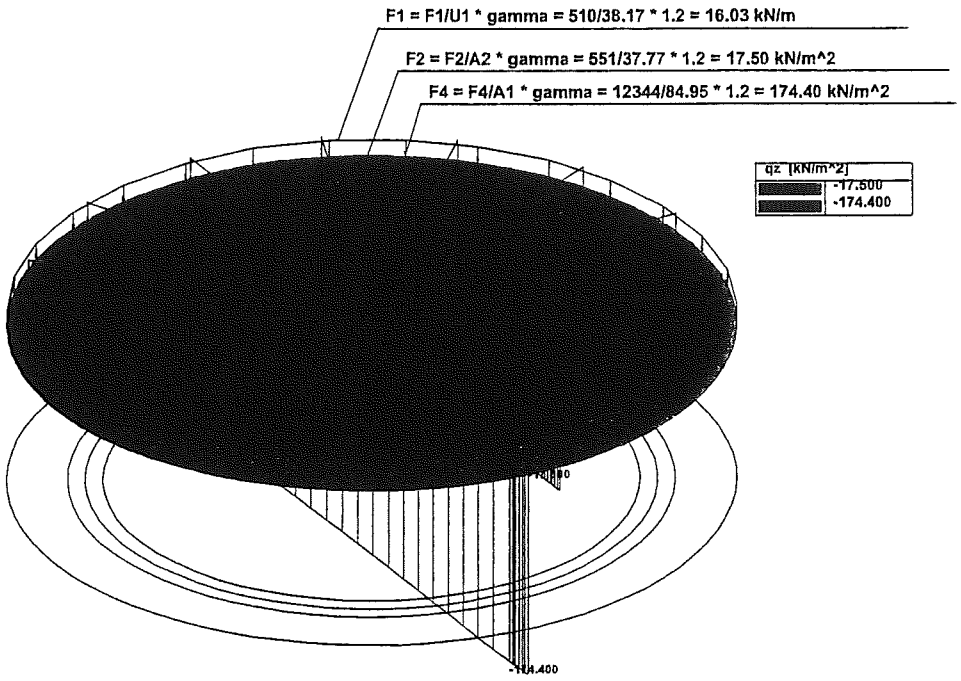
Loadcases

Case	Name:	Description
1	Weight Concrete	Self weight. Direction -Z
2	LC B: FULL OF LIQUIDE WITH GAS PRESURE	Variable - p Excl.
3	LC C: HYDROPNEUMATIC TEST	Variable - p Excl.
4	LC D: LOADS DUE TO THE SNOW	Variable - S
5	LC E-1: LOADS DUE TO WIND +X	Variable - WIND Excl.
6	LC E-2: LOADS DUE TO WIND -X	Variable - WIND Excl.
7	LC E-3: LOADS DUE TO WIND +Y	Variable - WIND Excl.

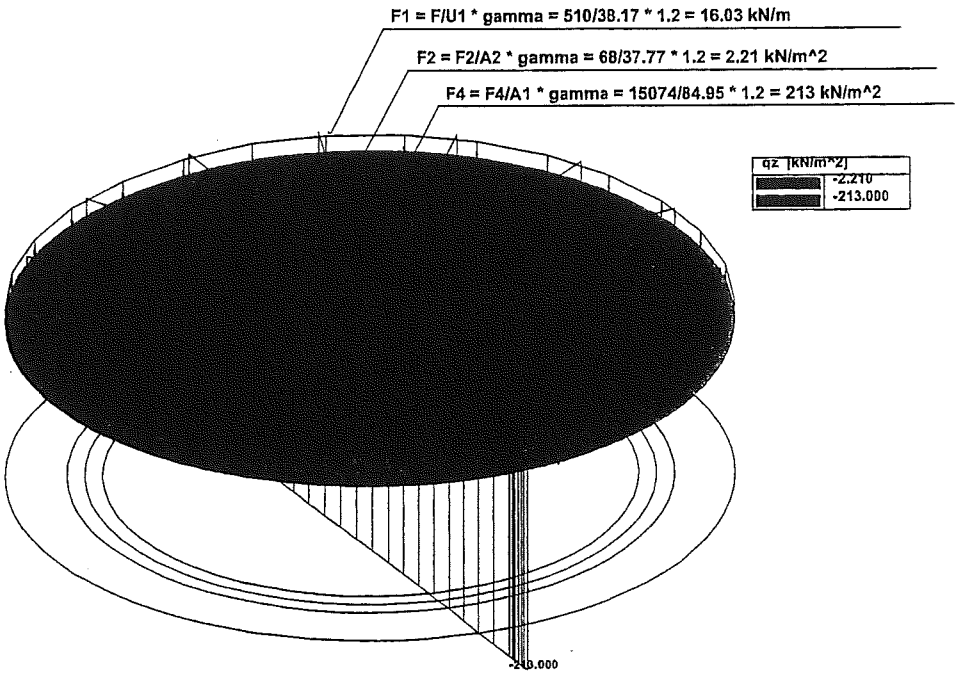
Case	Name:	Description
8	LC E-4: LOADS DUE TO WIND -Y	Variable - WIND Excl.



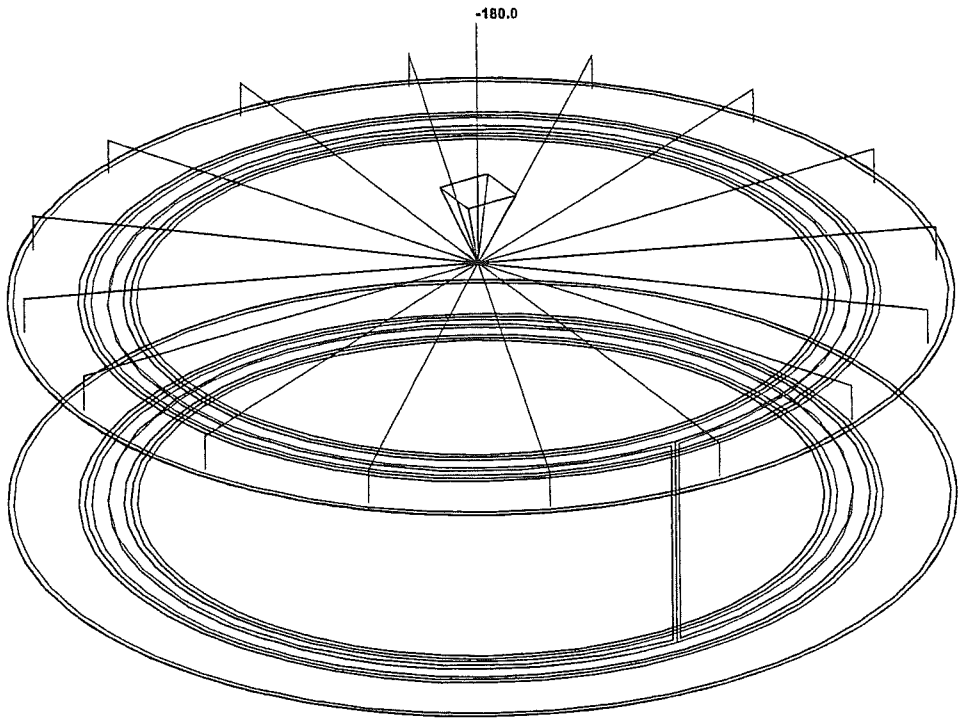
LC 1: WEIGHT OF CONCRETE



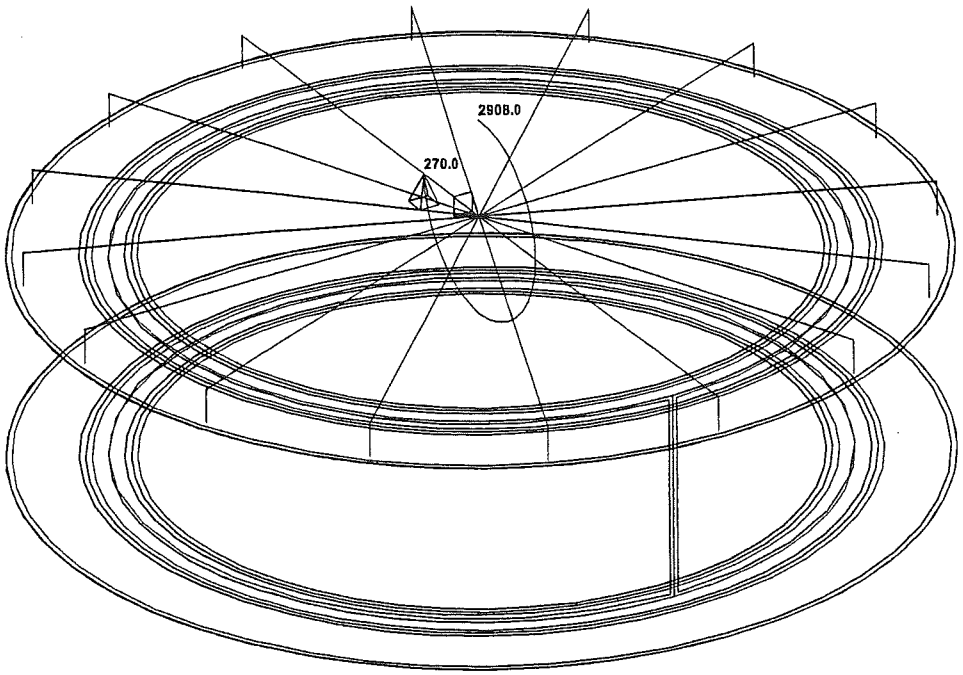
LC B: FULL OF LIQUIDE WITH GAS PRESURE



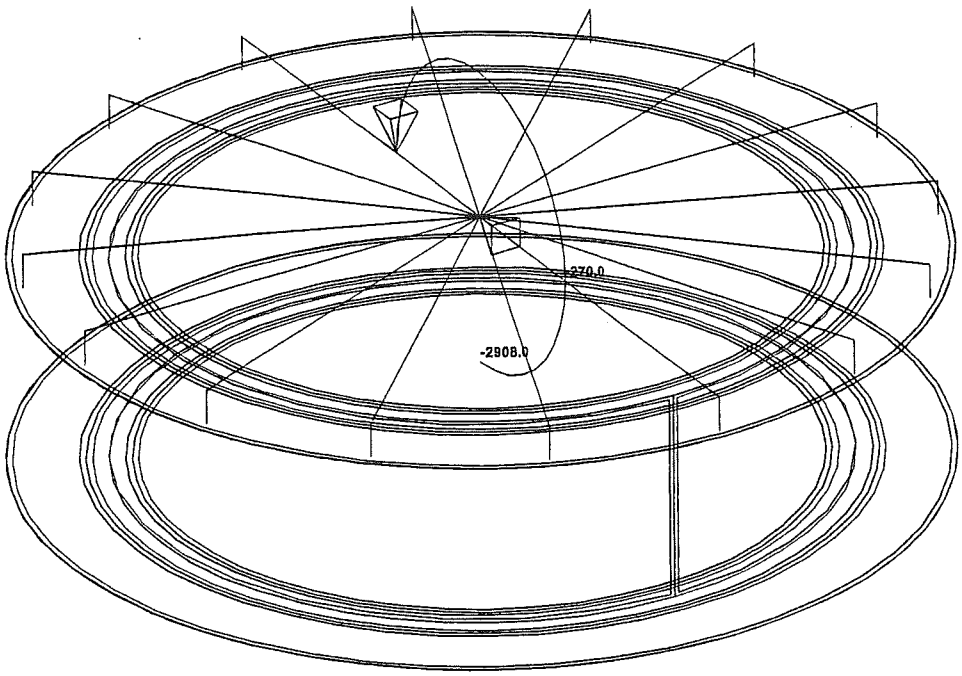
LC C: HYDROPNEUMATIC TEST



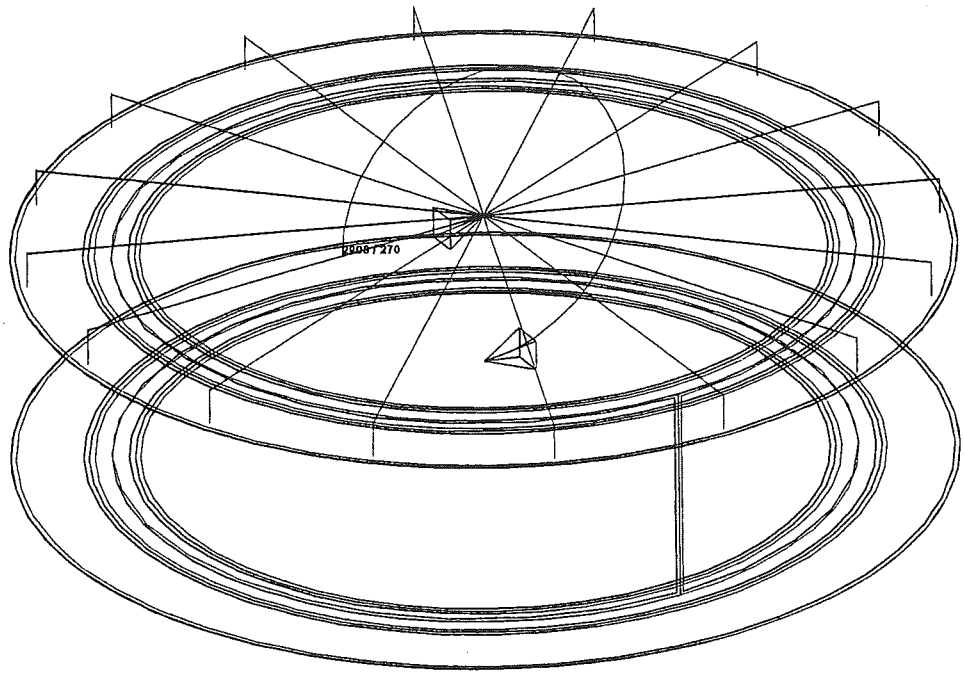
LC D: LOADS DUE TO THE SNOW



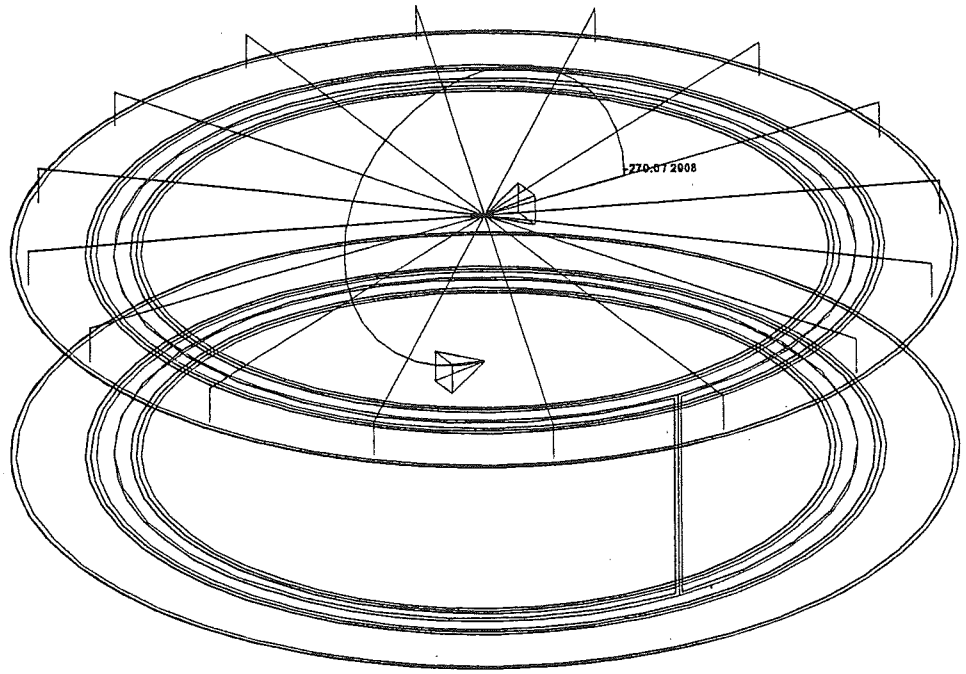
LC E-1: LOADS DUE TO WIND +X



LC E-2: LOADS DUE TO WIND -X



LC E-3: LOADS DUE TO WIND +Y



LC E-4: LOADS DUE TO WIND -Y

Variable loads group

Name:	
p	Excl.
S	
WIND	Excl.

Loadcase no. 4 - nodal loads

node	Fx kN	Fy kN	Fz kN	Mx kNm	My kNm	Mz kNm
44	0.00	0.00	-180.00	0.00	0.00	0.00

Loadcase no. 5 - nodal loads

node	Fx kN	Fy kN	Fz kN	Mx kNm	My kNm	Mz kNm
44	270.00	0.00	0.00	0.00	2908.00	0.00

Loadcase no. 6 - nodal loads

node	Fx kN	Fy kN	Fz kN	Mx kNm	My kNm	Mz kNm
44	-270.00	0.00	0.00	0.00	-2908.00	0.00

Loadcase no. 7 - nodal loads

node	Fx kN	Fy kN	Fz kN	Mx kNm	My kNm	Mz kNm
44	0.00	270.00	0.00	-2908.00	0.00	0.00

Loadcase no. 8 - nodal loads

node	Fx kN	Fy kN	Fz kN	Mx kNm	My kNm	Mz kNm
44	0.00	-270.00	0.00	2908.00	0.00	0.00

Loadcase no. 2 - distributed loads

bound	type	dx m	exY m	exZ m		X beg end	Y beg end	Z beg end
1	force kN/m	0.00 rel 1.00	0.00	0.00	glo len	0.00 0.00	0.00 0.00	-16.03 -16.03

Loadcase no. 3 - distributed loads

bound	type	dx m		exY m	exZ m		X beg end	Y beg end	Z beg end
1	force	0.00	rel	0.00	0.00	glo	0.00	0.00	-16.03
	kN/m	1.00				len	0.00	0.00	-16.03

Loadcase no. 2 - Distributed loads 2D

macro	qx kN/m^2	qy kN/m^2	qz kN/m^2
1	0.00	0.00	-17.50
2	0.00	0.00	-174.40
3	0.00	0.00	-174.40

Loadcase no. 3 - Distributed loads 2D

macro	qx kN/m^2	qy kN/m^2	qz kN/m^2
1	0.00	0.00	-2.21
2	0.00	0.00	-213.00
3	0.00	0.00	-213.00

Combinations

Combi	Norm	Case	coeff
1.	User-ultimate	1 Weight Concrete	1.00
		2 LC B: FULL OF LIQUIDE WITH GAS PRESURE	1.00
		3 LC C: HYDROPNEUMATIC TEST	1.00
		4 LC D: LOADS DUE TO THE SNOW	1.00
		5 LC E-1: LOADS DUE TO WIND +X	1.00
		6 LC E-2: LOADS DUE TO WIND -X	1.00
		7 LC E-3: LOADS DUE TO WIND +Y	1.00
		8 LC E-4: LOADS DUE TO WIND -Y	1.00

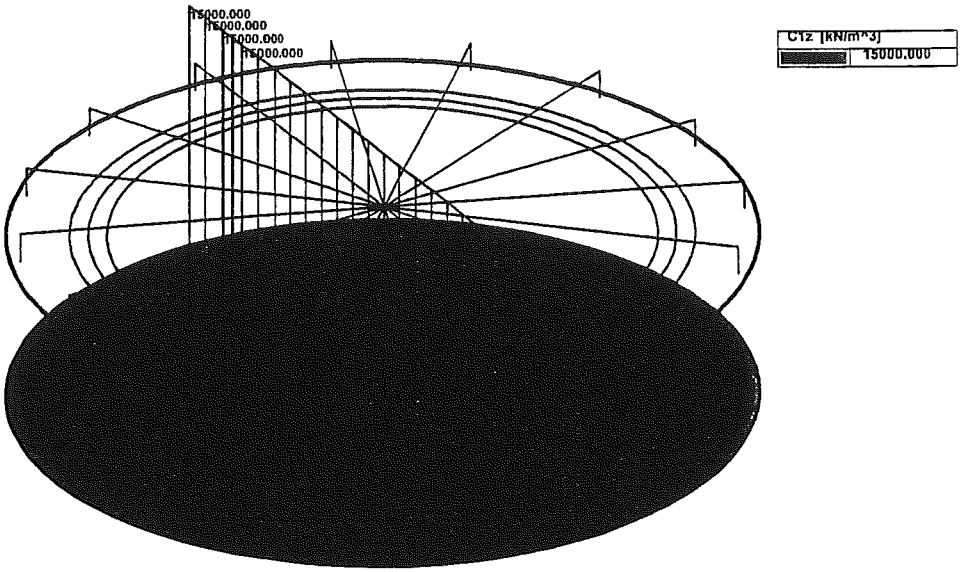
Basic rules for generation of ultimate load combinations:
1 : 1.00*LC1 / 1.00*LC2 / 1.00*LC3 / 1.00*LC4 / 1.00*LC5 / 1.00*LC6 / 1.00*LC7 / 1.00*LC8

List of extreme ultimate load combinations
1/ 1 : +1.00*LC1+1.00*LC5
2/ 1 : +1.00*LC1+1.00*LC6
3/ 1 : +1.00*LC1+1.00*LC7
4/ 1 : +1.00*LC1+1.00*LC8
5/ 1 : +1.00*LC1+1.00*LC3+1.00*LC5
6/ 1 : +1.00*LC1+1.00*LC3+1.00*LC6
7/ 1 : +1.00*LC1+1.00*LC4+1.00*LC5
8/ 1 : +1.00*LC1+1.00*LC2+1.00*LC7
9/ 1 : +1.00*LC1+1.00*LC4+1.00*LC6
10/ 1 : +1.00*LC1+1.00*LC3+1.00*LC7
11/ 1 : +1.00*LC1+1.00*LC2+1.00*LC8
12/ 1 : +1.00*LC1+1.00*LC4+1.00*LC7

13/ 1 : +1.00*LC1+1.00*LC3+1.00*LC8
14/ 1 : +1.00*LC1+1.00*LC4+1.00*LC8
15/ 1 : +1.00*LC1+1.00*LC3+1.00*LC4+1.00*LC5
16/ 1 : +1.00*LC1+1.00*LC3+1.00*LC4+1.00*LC6
17/ 1 : +1.00*LC1+1.00*LC2+1.00*LC4+1.00*LC7
18/ 1 : +1.00*LC1+1.00*LC3+1.00*LC4+1.00*LC7
19/ 1 : +1.00*LC1+1.00*LC3+1.00*LC4+1.00*LC8

Subsoils

Name:	Type of position	C1x kN/m^3	C1y kN/m^3	C1z kN/m^3	C2x kN/m	C2y kN/m	SigZpl kN/m^2
gemischtkörniger Sand	Under plate, block	1000.000	1000.000	15000.000	0.000	0.000	0.000



Subsoil - C1z

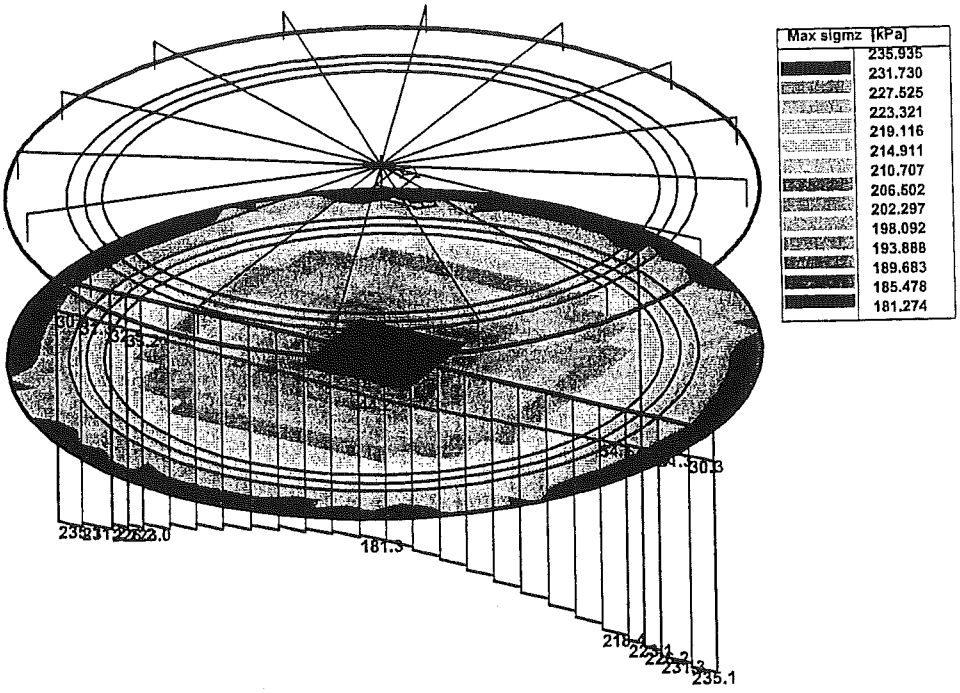
Calculation protocol.

Linear calculation

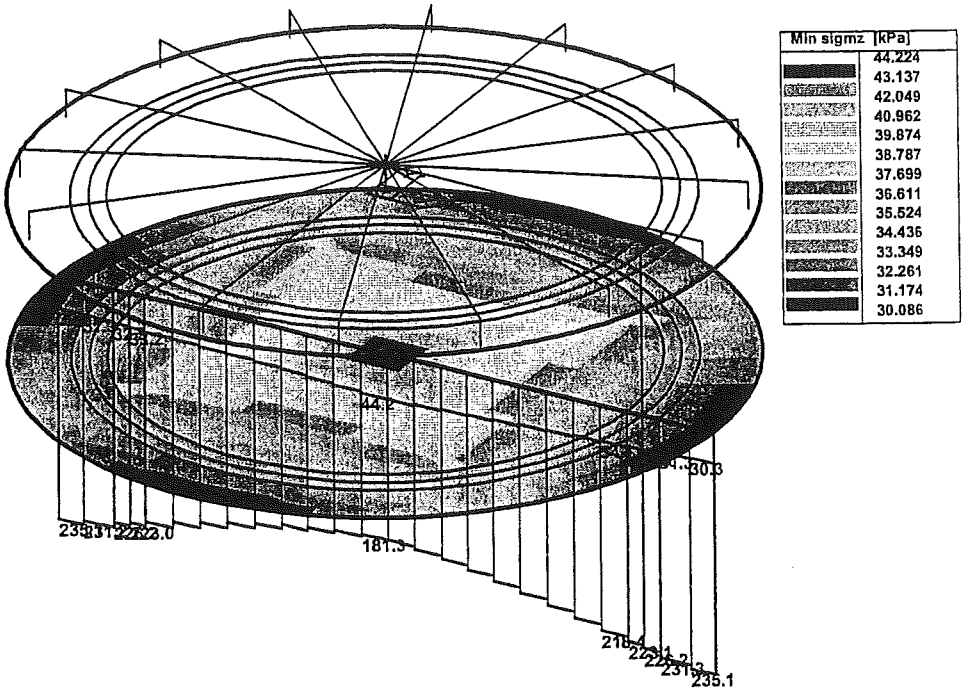
Number of 2D elements	7247
Number of 1D elements	32
Number of mesh nodes	6657
Number of equations	39942
Loadcases	LC 1 Weight Concrete
	LC 2 LC B: FULL OF LIQUIDE WITH GAS PRESURE
	LC 3 LC C: HYDROPNEUMATIC TEST
	LC 4 LC D: LOADS DUE TO THE SNOW
	LC 5 LC E-1: LOADS DUE TO WIND +X
	LC 6 LC E-2: LOADS DUE TO WIND -X
	LC 7 LC E-3: LOADS DUE TO WIND +Y
	LC 8 LC E-4: LOADS DUE TO WIND -Y
Bending theory	Mindlin
Start of calculation	07.10.2004 09:07
End of calculation	07.10.2004 09:08

Sum of loads and reactions.

			X	Y	Z
loadcase	1	loads	0.0	-0.0	-5873.6
		reactions	0.0	0.0	0.0
		contact	-0.0	0.0	5873.6
loadcase	2	loads	0.0	0.0	-16104.6
		reactions	0.0	0.0	0.0
		contact	-0.0	-0.0	16104.6
loadcase	3	loads	0.0	0.0	-18805.9
		reactions	0.0	0.0	0.0
		contact	-0.0	0.0	18805.9
loadcase	4	loads	0.0	0.0	-180.0
		reactions	0.0	0.0	0.0
		contact	0.0	0.0	180.0
loadcase	5	loads	270.0	0.0	0.0
		reactions	0.0	0.0	0.0
		contact	-270.0	0.0	-0.0
loadcase	6	loads	-270.0	0.0	0.0
		reactions	0.0	0.0	0.0
		contact	270.0	-0.0	0.0
loadcase	7	loads	0.0	270.0	0.0
		reactions	0.0	0.0	0.0
		contact	0.0	-270.0	-0.0
loadcase	8	loads	0.0	-270.0	0.0
		reactions	0.0	0.0	0.0
		contact	-0.0	270.0	0.0



Contact stress - max sigmz - FEM Combi : 1



Contact stress - min sigmz - FEM Combi : 1

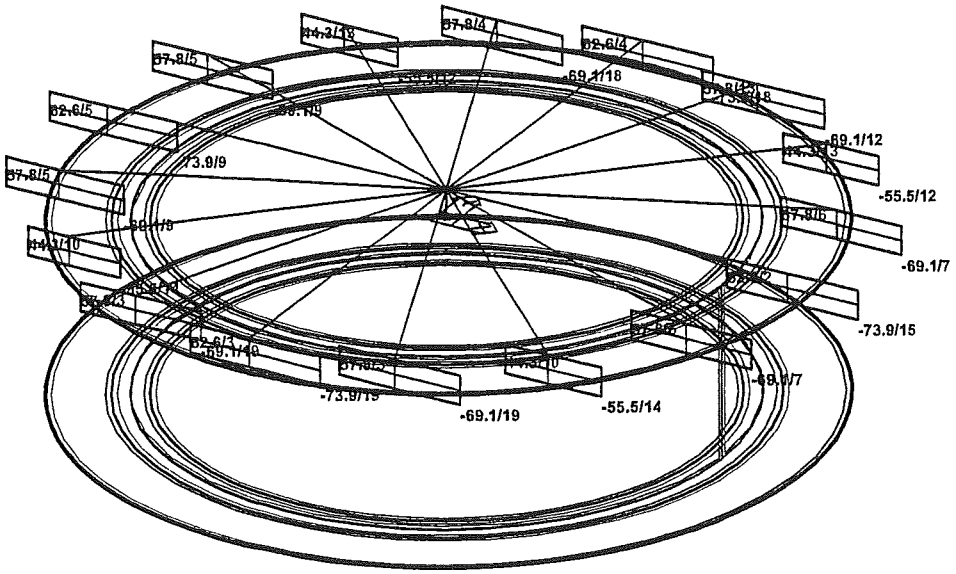
RESULTS : CONTACT STRESSES

FEM Combi:
C1 User-ultimate

Global extremes

elem	tauzx [kPa]	tauzy [kPa]	sigmz [kPa]
6272	-2.205	2.203	234.975
6224	-2.205	-2.203	30.861
6255	2.203	-2.205	234.170
6248	-2.202	-2.205	31.036
6203	2.201	2.205	235.935
	-2.203	-2.205	30.086

Selection was done for macros: 4/6

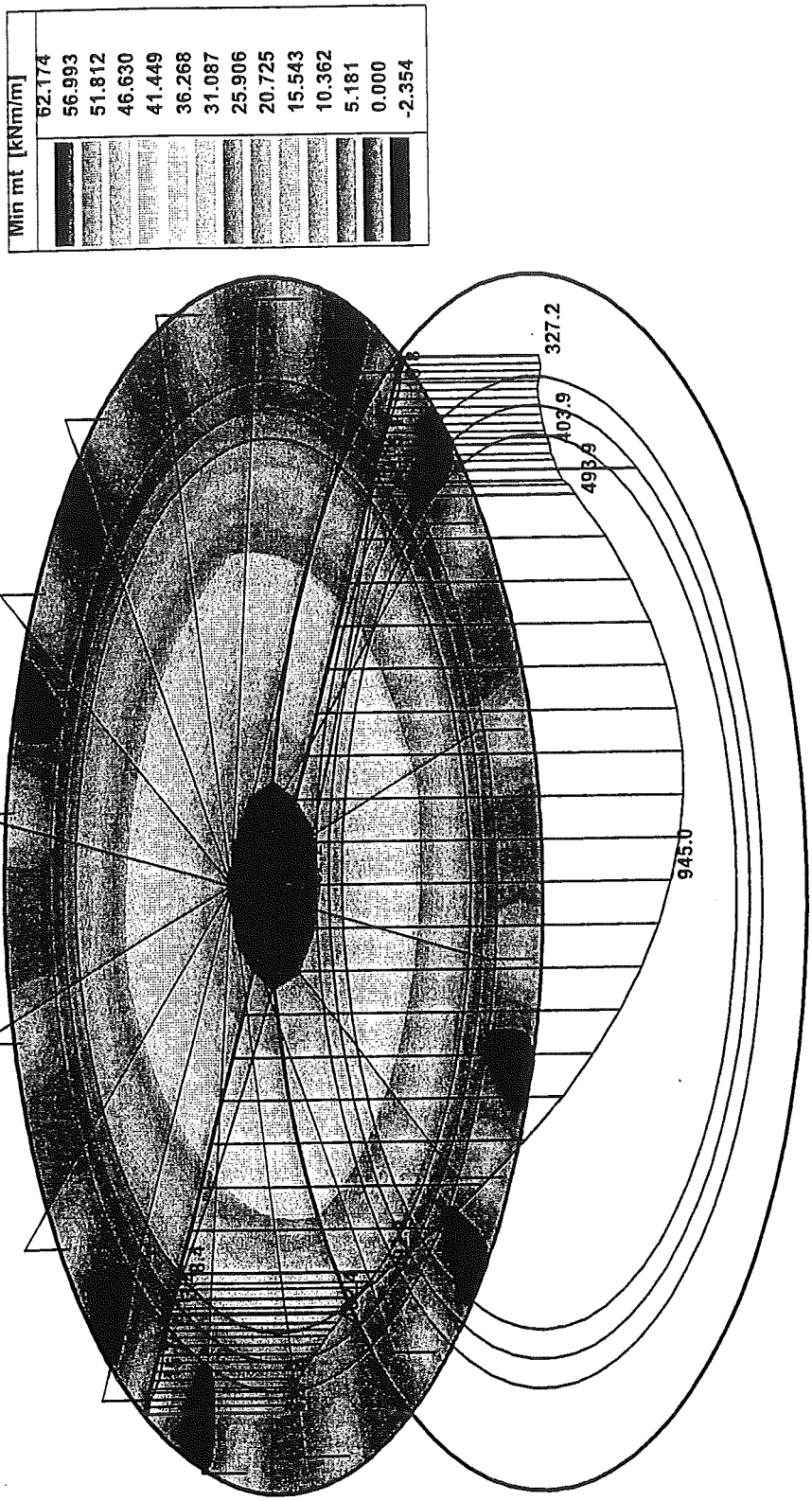


Internal forces - N on member(s). Ult. combi : 1/19

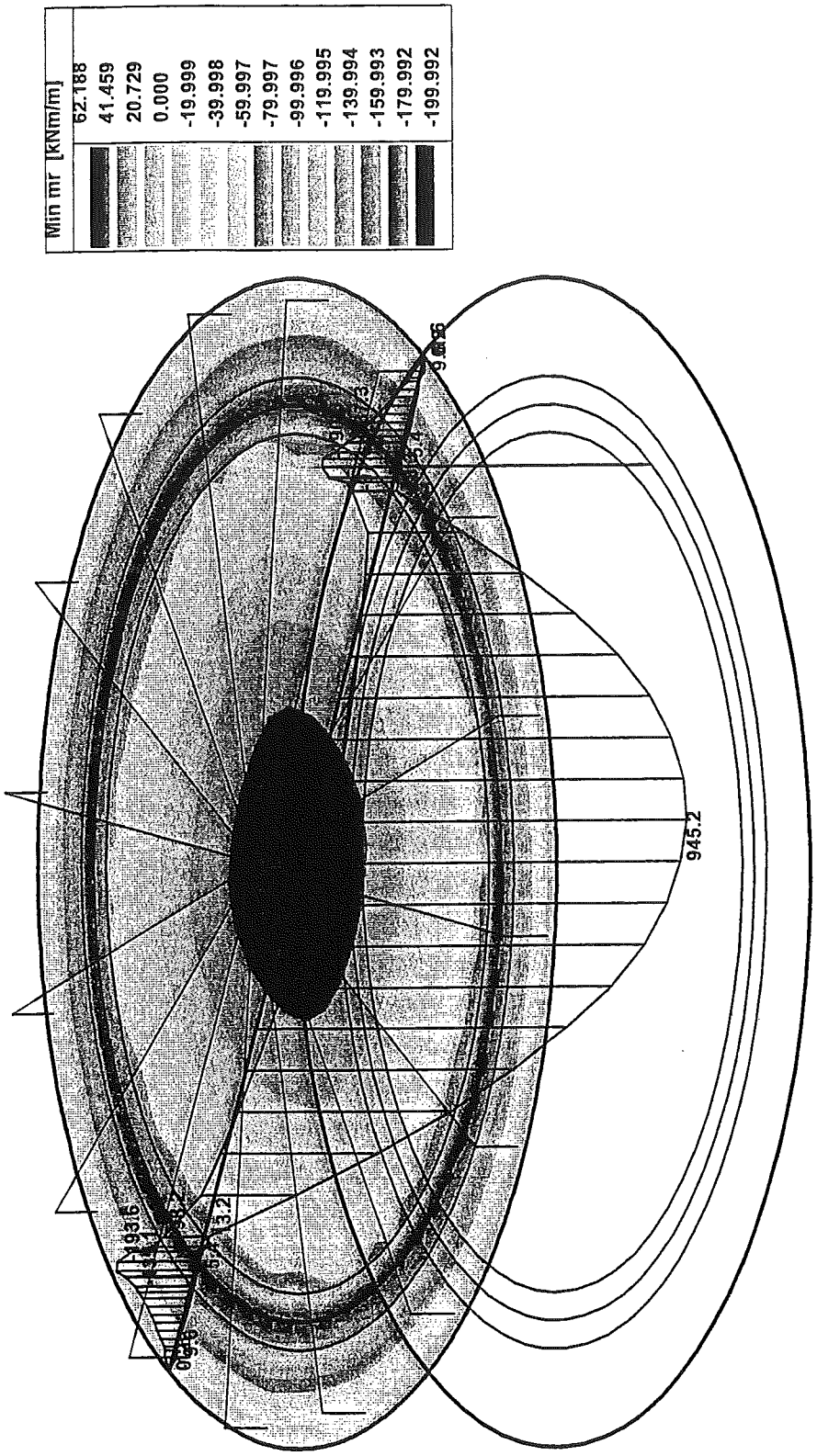
Internal forces on member(s). Member extreme

Linear static - extreme or all combinations
Group of member(s) :17/32
Group of ultimate combi :1/19

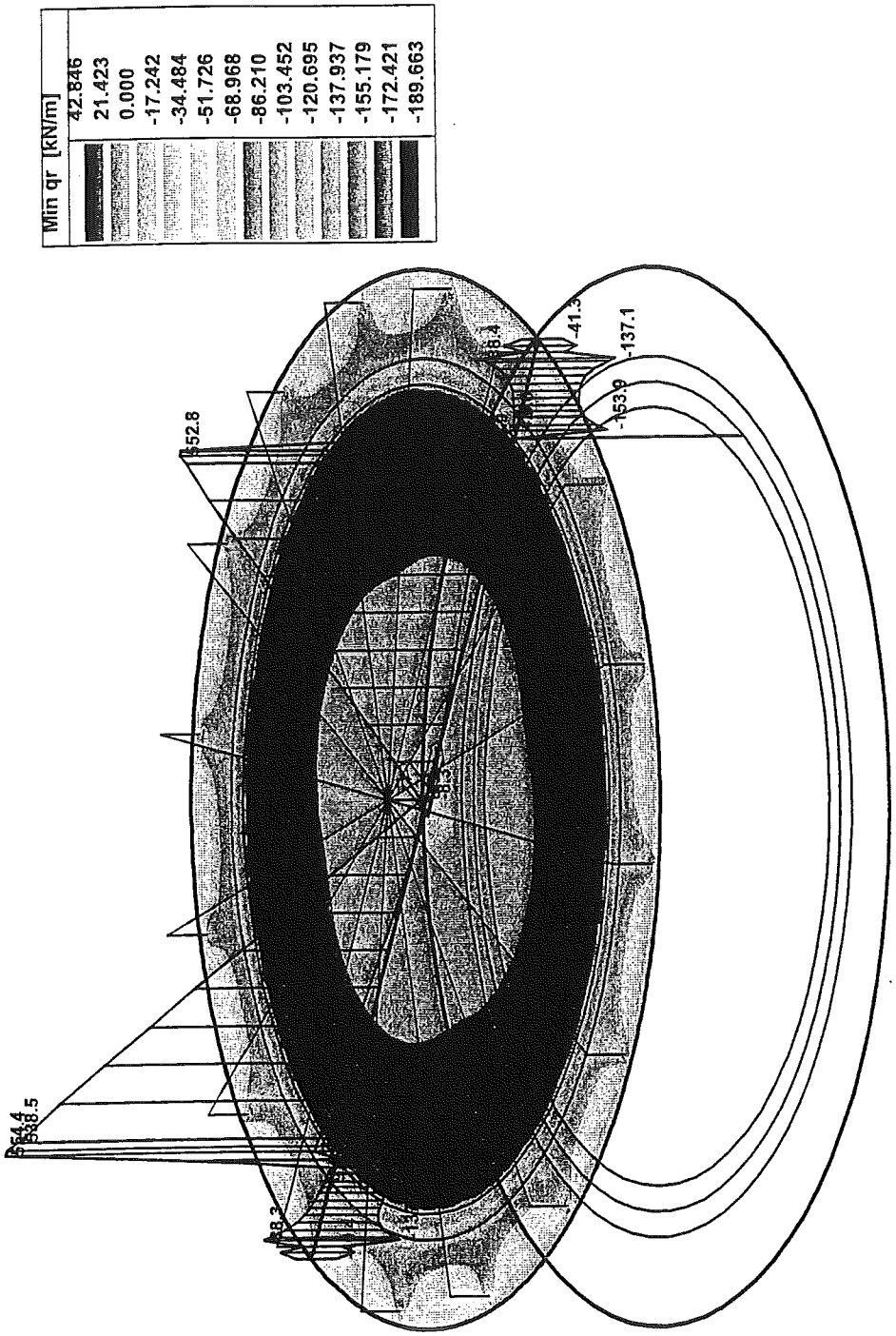
memb	cr.nr	combi	dx [m]	N [kN]	Vy [kN]	Vz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
17	1	5	0.000	62.61	0.00	40.43	0.00	0.00	-0.00
		9		-73.86	-0.00	-101.72	-0.00	-0.00	0.00
18		5		-57.85	16.64	33.56	0.00	0.00	0.00
		9		-69.10	-40.09	-90.17	-0.00	-0.00	-0.00
19		13		-44.28	16.93	23.55	-0.00	0.00	-0.00
		12		-55.53	-60.26	-66.88	0.00	-0.00	0.00
20		4		-57.85	33.50	16.62	-0.00	0.00	0.00
		18		-69.10	-90.12	-40.07	0.00	-0.00	-0.00
21		4		-62.61	40.36	0.00	0.00	0.00	0.00
		18		-73.86	-101.63	-0.00	-0.00	0.00	-0.00
22		13		-57.85	33.55	-16.64	0.00	-0.00	0.00
		12		-69.10	-90.15	40.08	-0.00	0.00	-0.00
23		13		-44.28	16.94	-23.55	0.00	-0.00	-0.00
		12		-55.53	-60.26	66.88	-0.00	0.00	0.00
24		6		-57.85	16.64	-33.56	-0.00	-0.00	0.00
		7		-69.10	-40.09	90.17	0.00	0.00	-0.00
25		2		-62.61	-0.00	-40.38	0.00	-0.00	0.00
		15		-73.86	0.00	101.67	-0.00	0.00	-0.00
26		6		-57.85	-16.64	-33.55	0.00	-0.00	-0.00
		7		-69.10	40.09	90.16	-0.00	0.00	0.00
27		10		-44.28	-16.93	-23.55	-0.00	-0.00	0.00
		14		-55.53	60.26	66.88	0.00	0.00	-0.00
28		3		-57.85	-33.50	-16.62	-0.00	-0.00	-0.00
		19		-69.10	90.10	40.06	0.00	0.00	0.00
29		3		-62.61	-40.36	0.00	-0.00	0.00	-0.00
		19		-73.86	101.62	-0.00	0.00	0.00	0.00
30		3		-57.85	-33.50	16.62	0.00	0.00	-0.00
		19		-69.10	90.11	-40.06	-0.00	-0.00	0.00
31		10		-44.28	-16.93	23.55	0.00	0.00	0.00
		14		-55.53	60.26	-66.88	-0.00	-0.00	-0.00
32		5		-57.85	-16.64	33.56	-0.00	0.00	-0.00
		9		-69.10	40.09	-90.17	0.00	-0.00	0.00



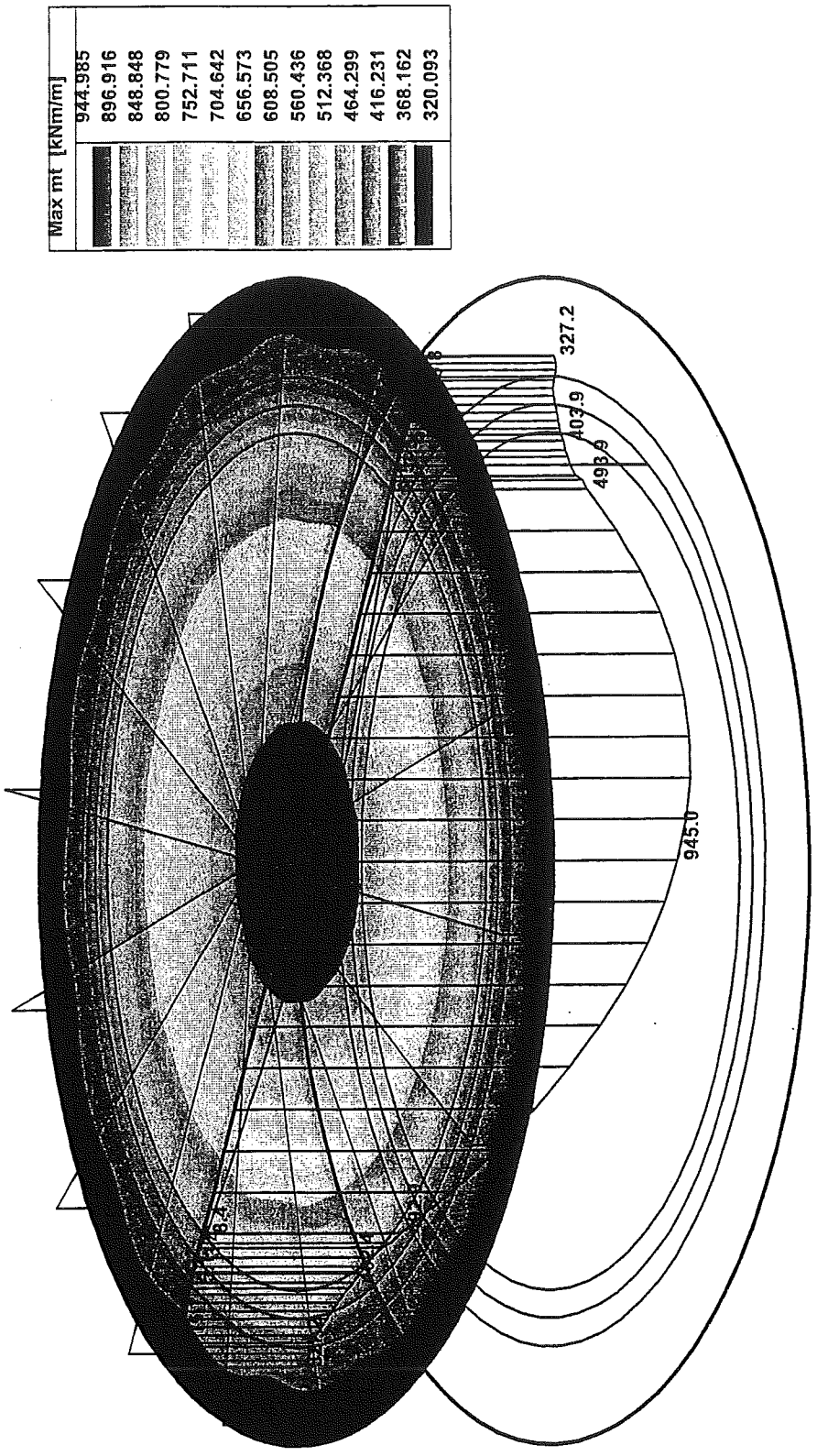
Internal force - min mt - FEM Combi : 1



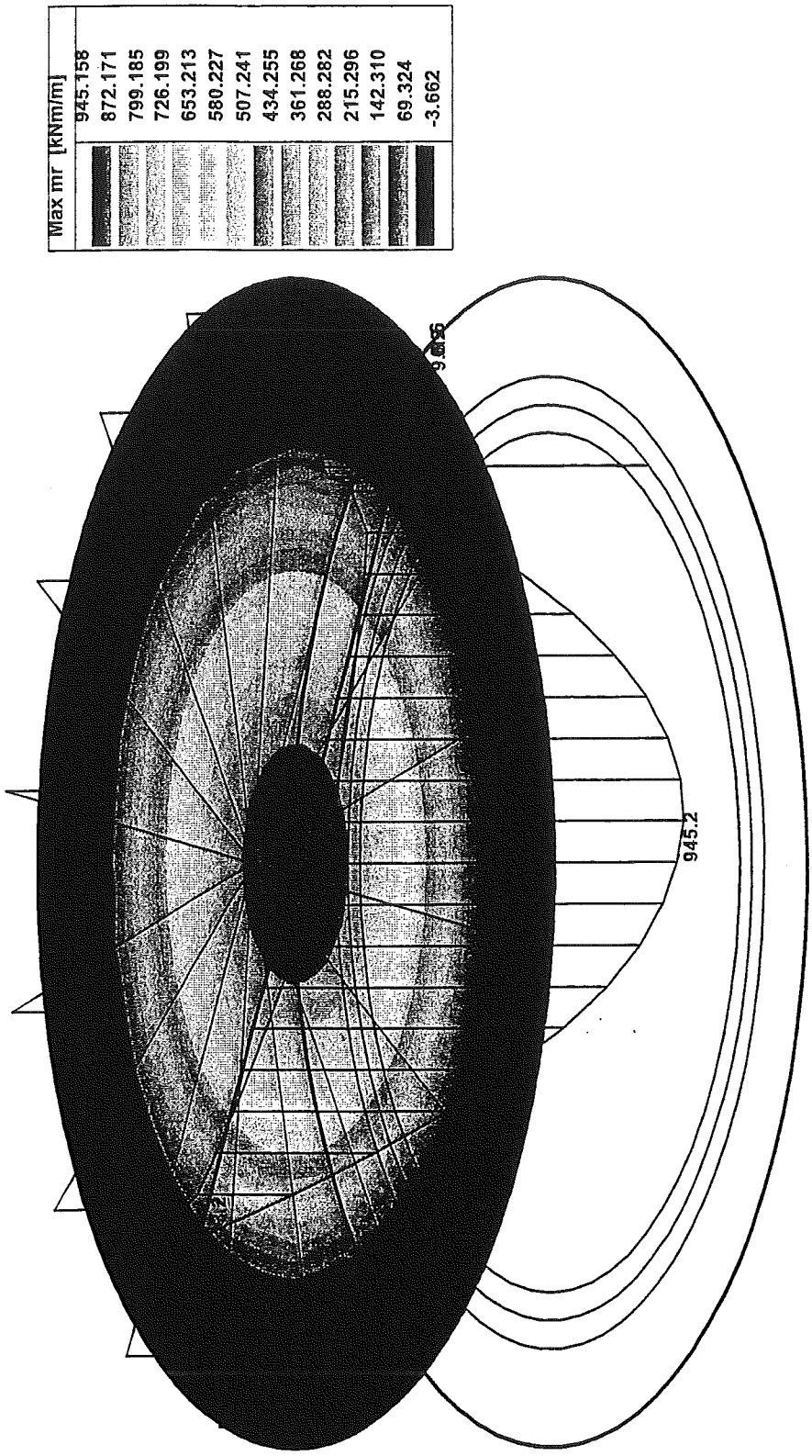
Internal force - min mr - FEM Combi : 1



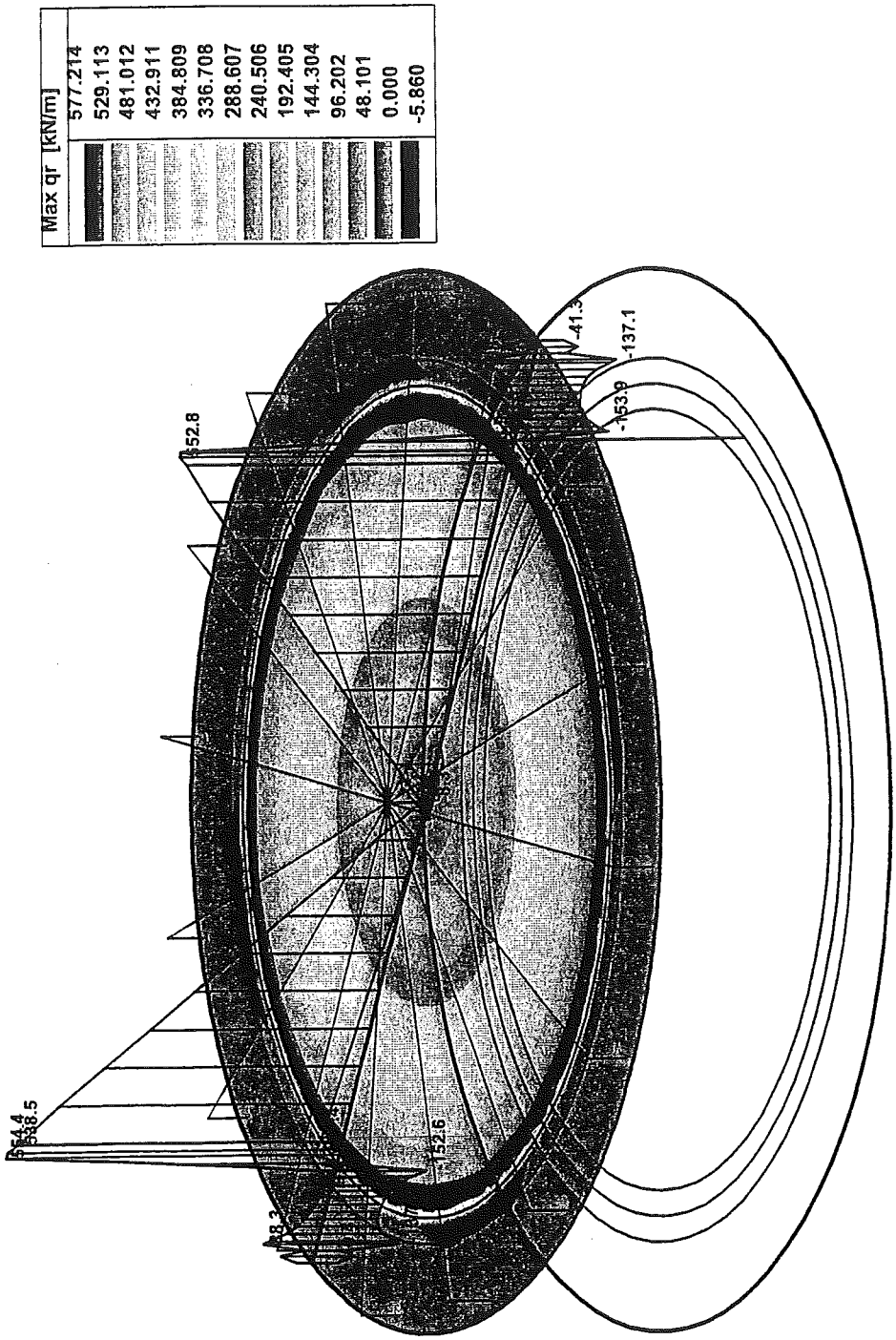
Internal force - min qr - FEM Combi : 1



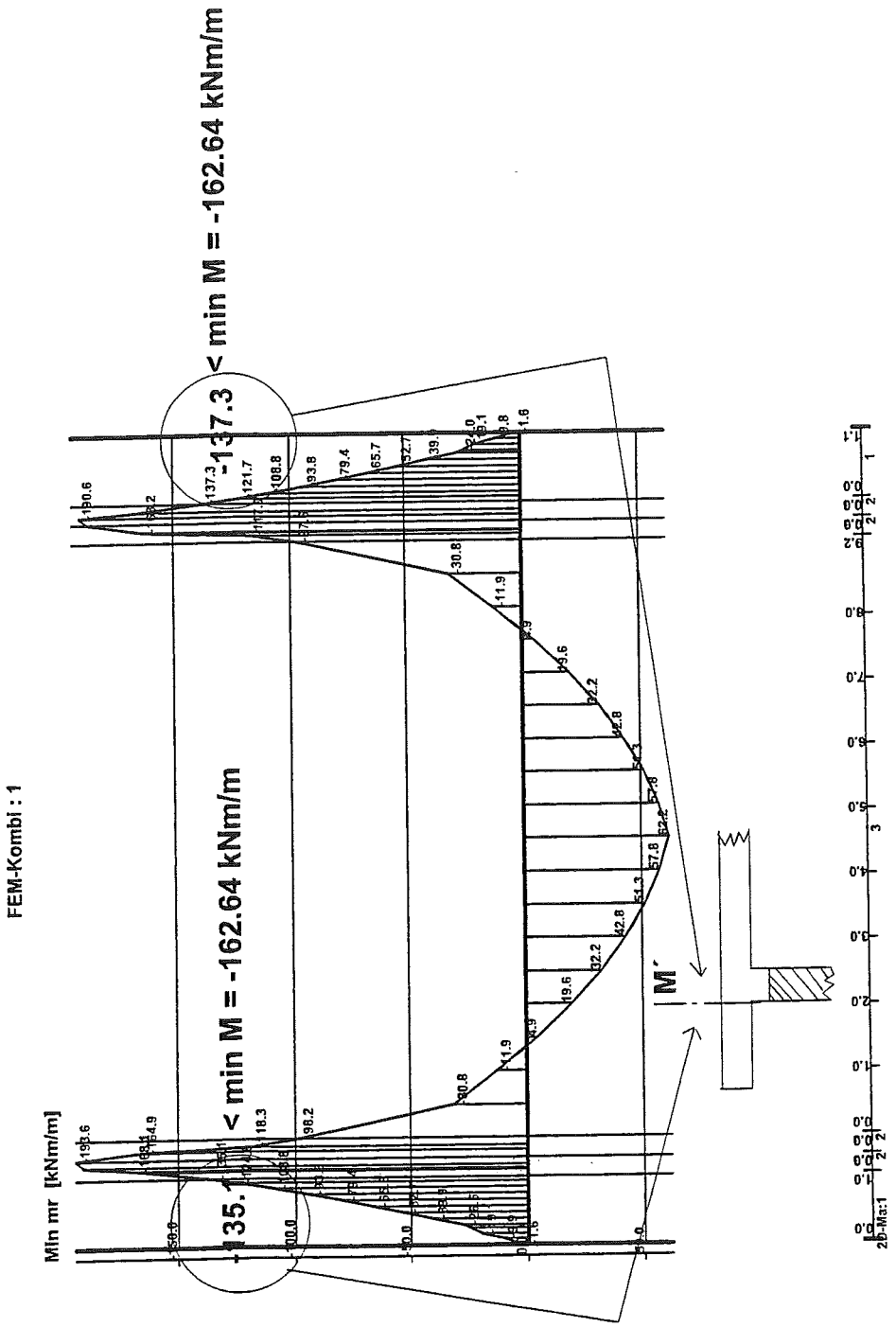
Internal force - max mt - FEM Combi : 1

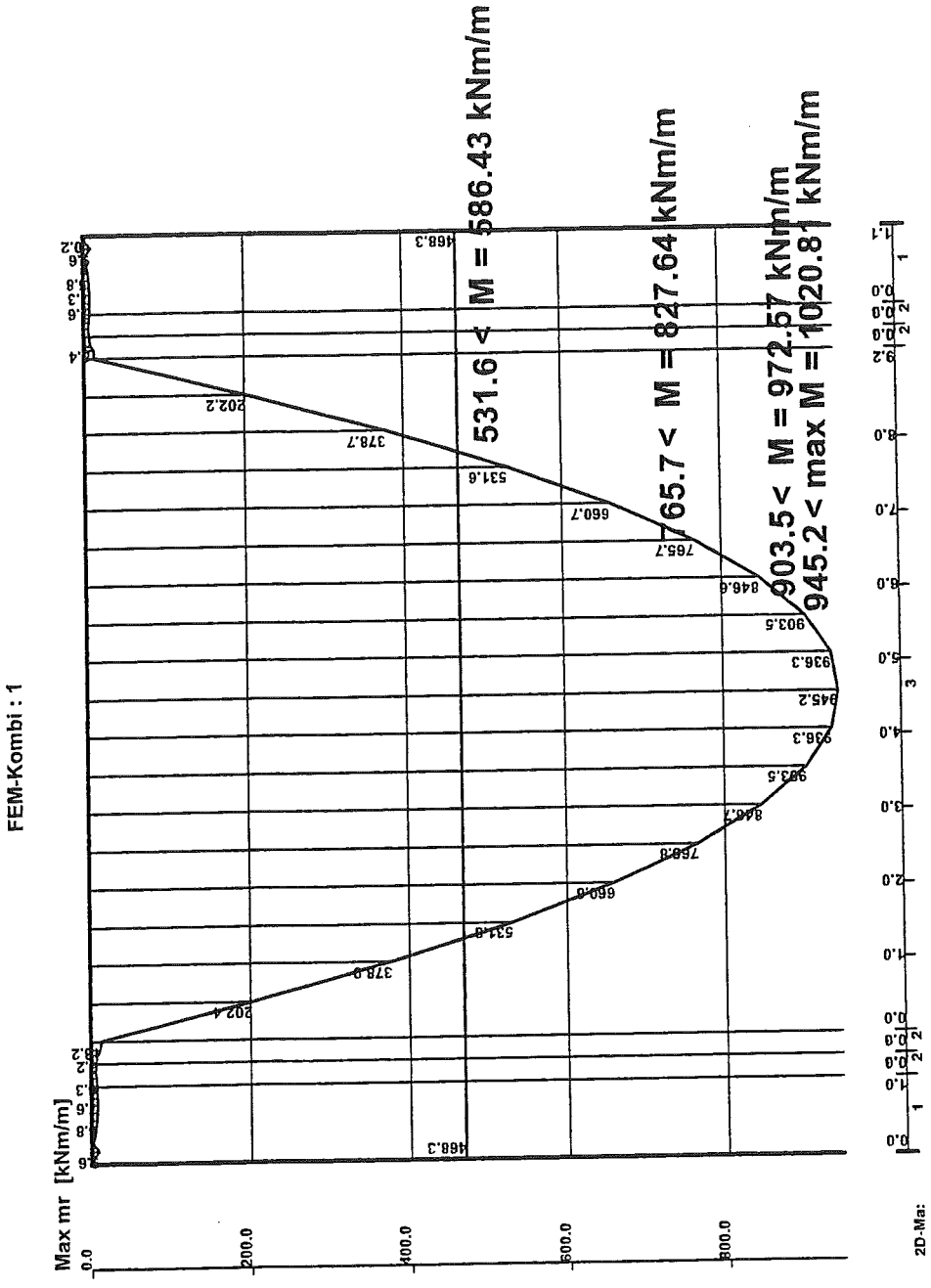


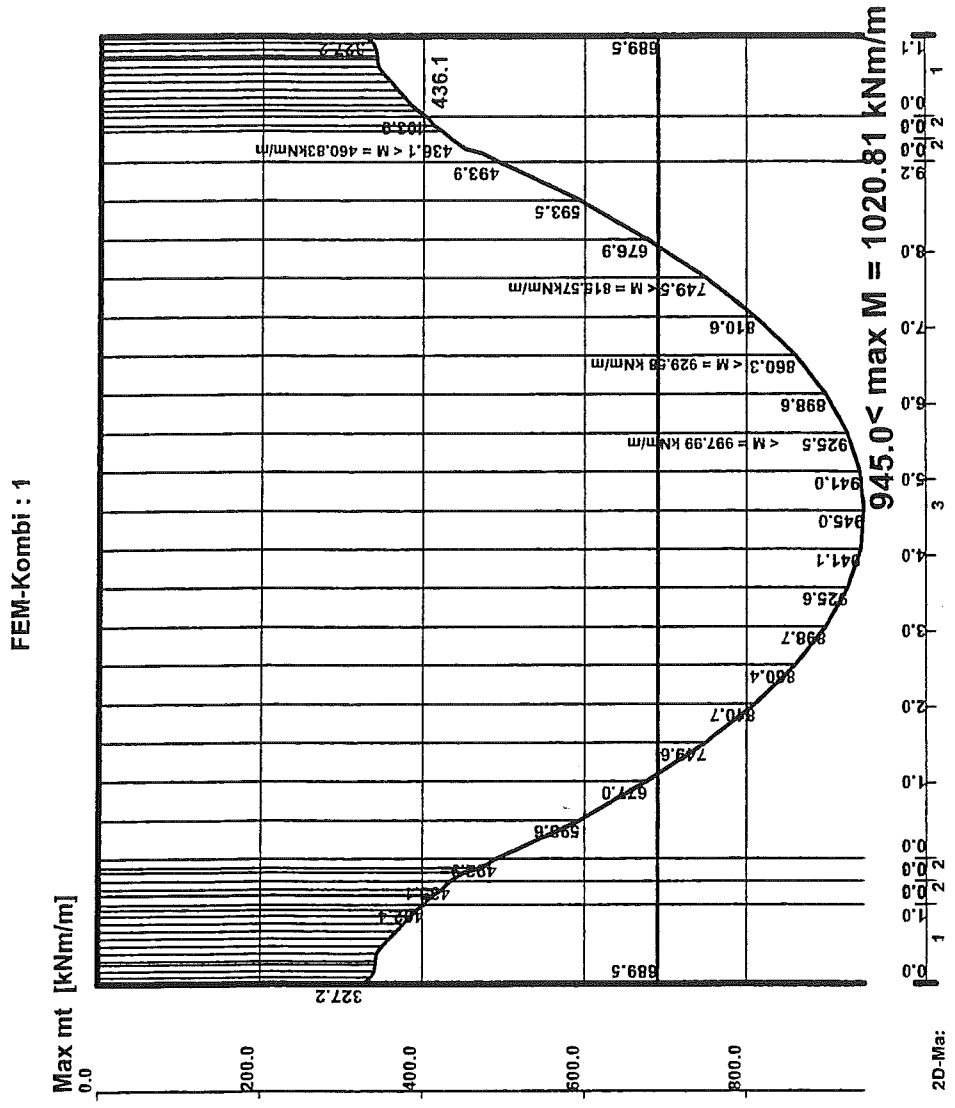
Internal force - max mr - FEM Combi : 1

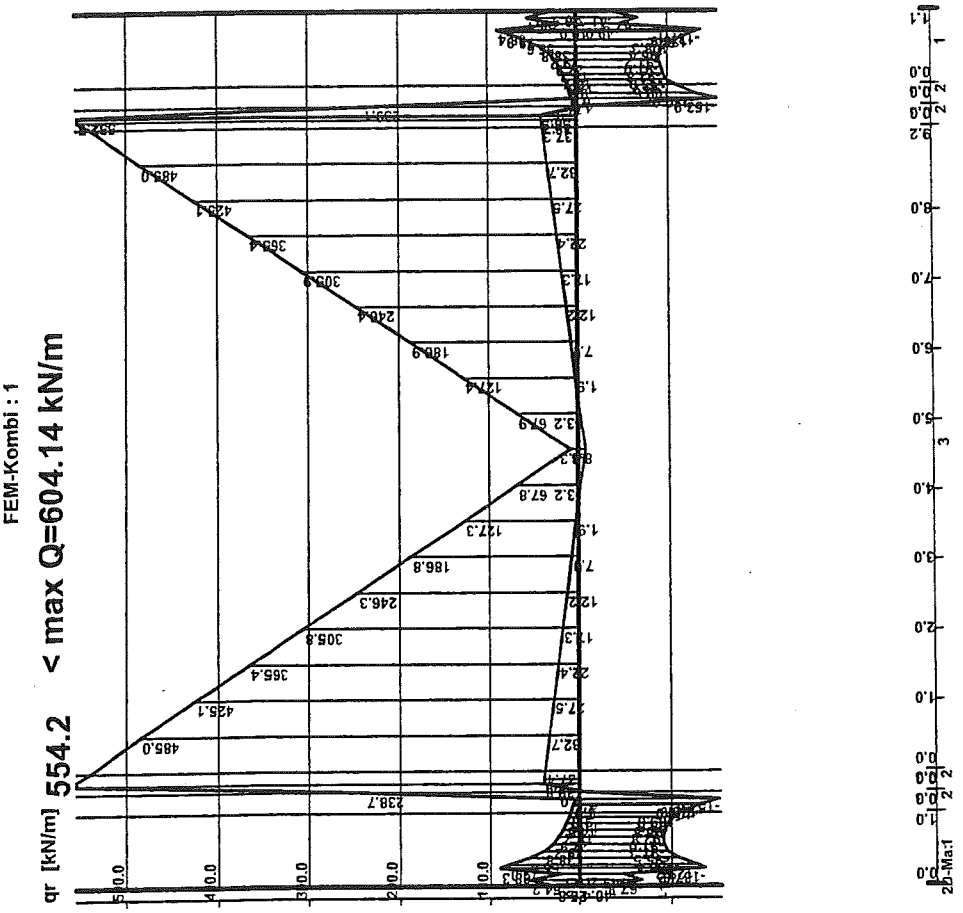


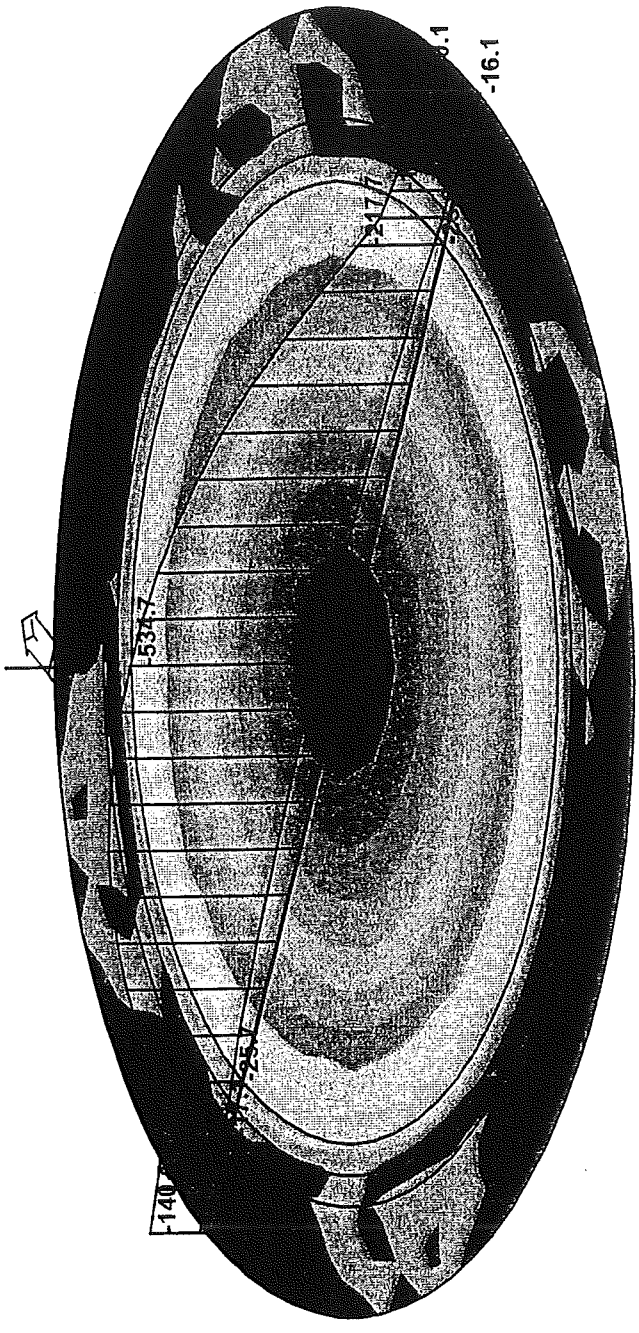
Internal force - max qr - FEM Combi : 1


< min M = -162.64 kNm/m
-137.3
< min M = -162.64 kNm/m
+135.1
FEM-Kombi : 1
Min mr [kNm/m]
M'
2D-Ma:1

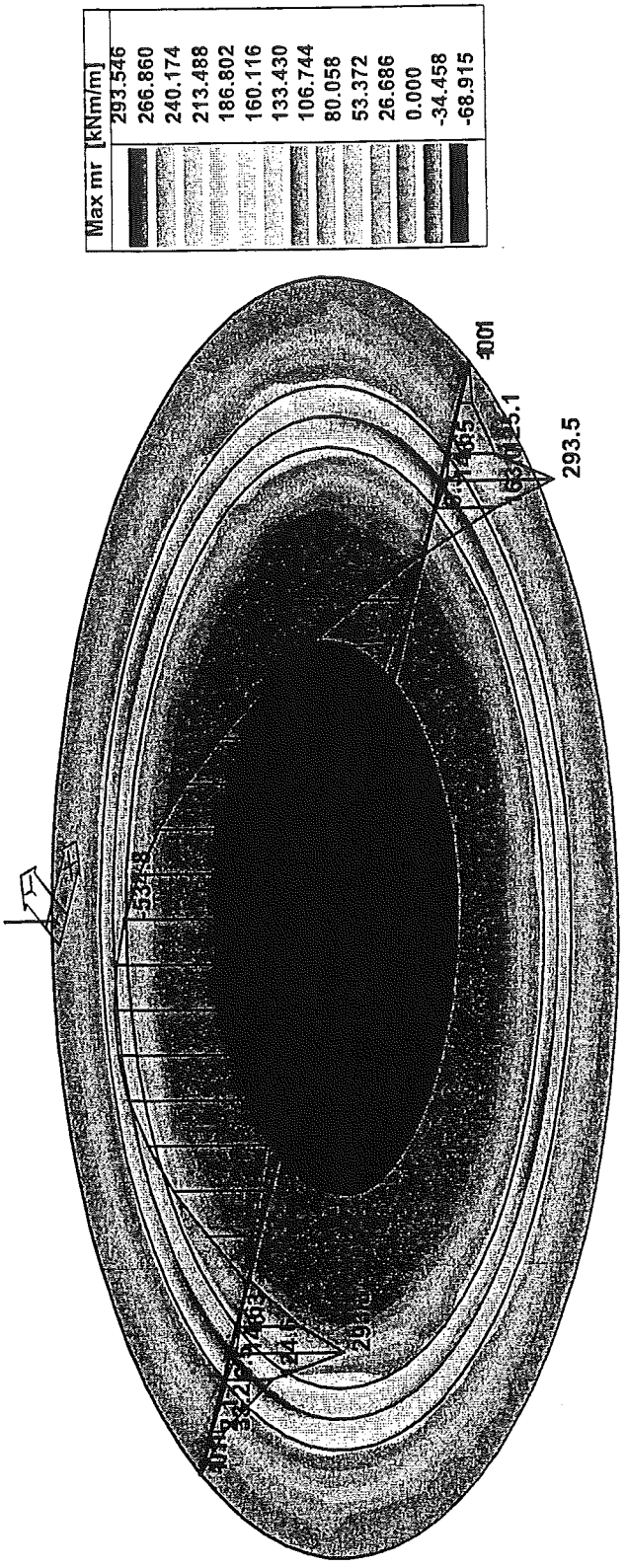

531.6 < M = 586.43 kNm/m
765.7 < M = 827.64 kNm/m
903.5 < M = 972.57 kNm/m
945.2 < max M = 1020.8 kNm/m
FEM-Kombi : 1
Max mr [kNm/m]
0.0
200.0
400.0
600.0
800.0
2D-Ma:


945.0< max M = 1020.81 kNm/m
FEM-Kombi : 1
Max mt [kNm/m]
0.0
200.0
400.0
600.0
800.0
2D-Ma:
436.1
436.1 < M = 460.83kNm/m
749.5< M = 816.57kNm/m
860.3 < M = 929.59 kNm/m
925.5 < M = 997.99 kNm/m
689.5
327.2

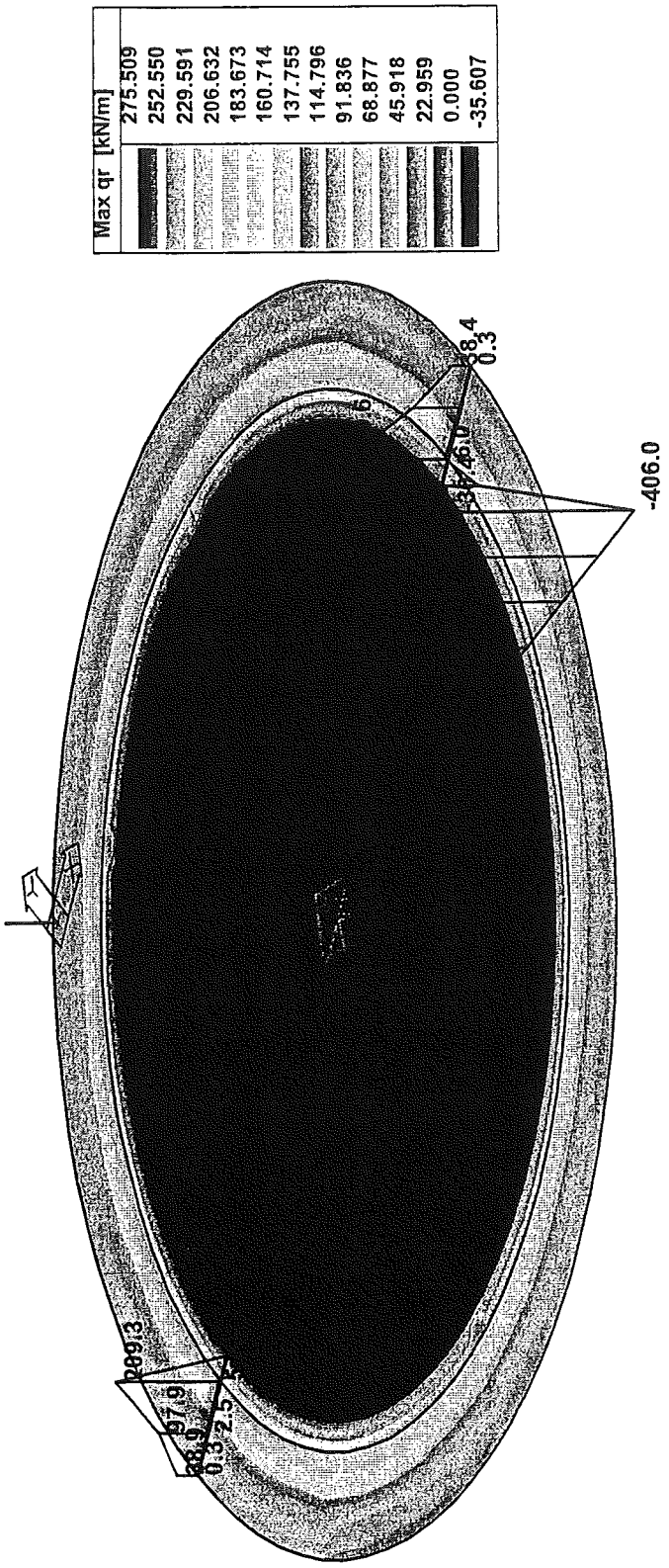

FEM-Kombi : 1
< max Q=604.14 kN/m
qr [kN/m] 554.2
485.0
435.1
365.4
305.8
246.3
186.8
127.3
67.8
3.2
238.7
0.0
2b-Ma:1



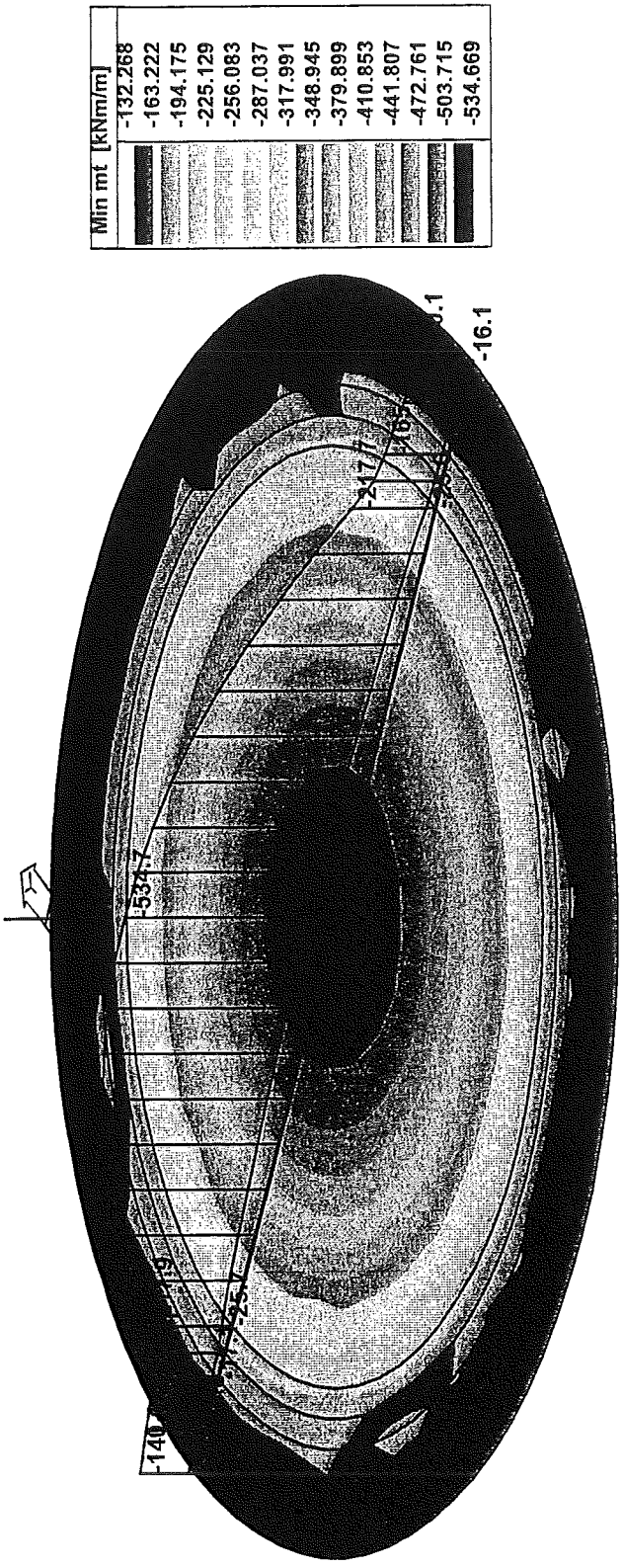
Internal force - max mt - FEM Combi : 1



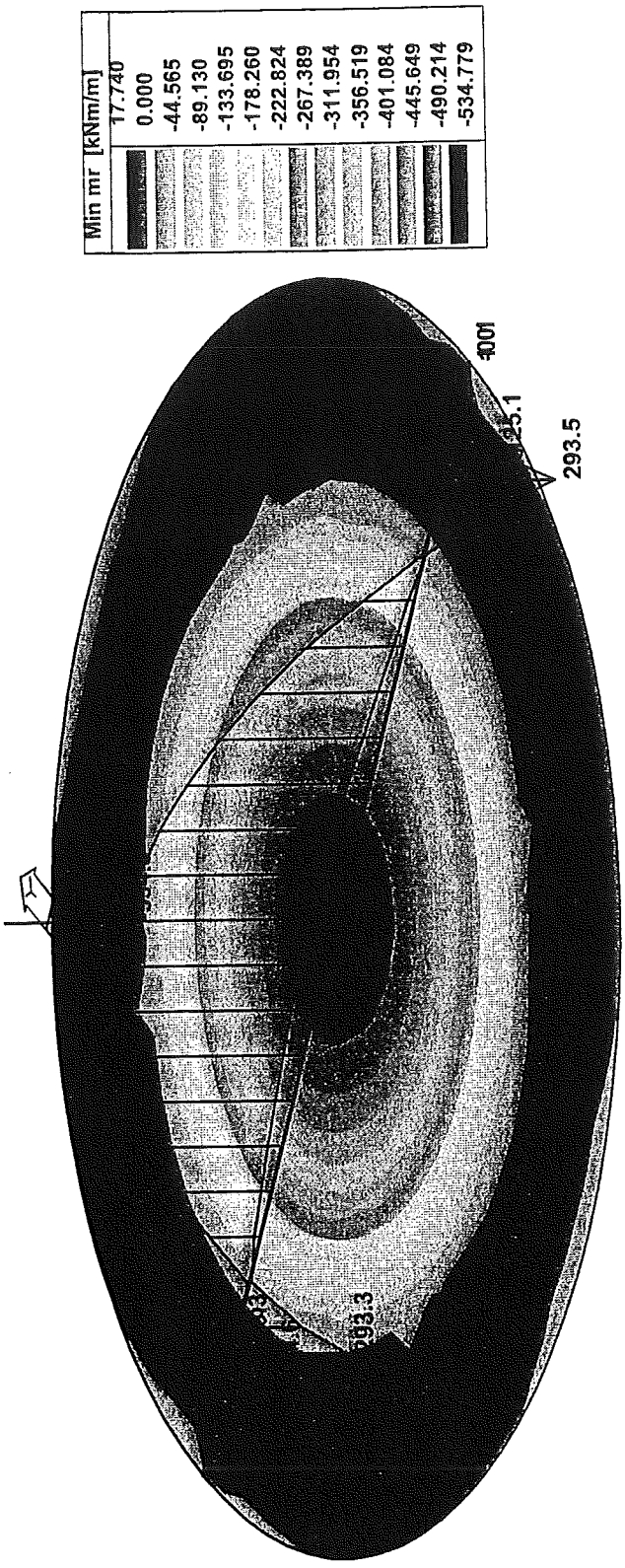
Internal force - max mr - FEM Combi : 1



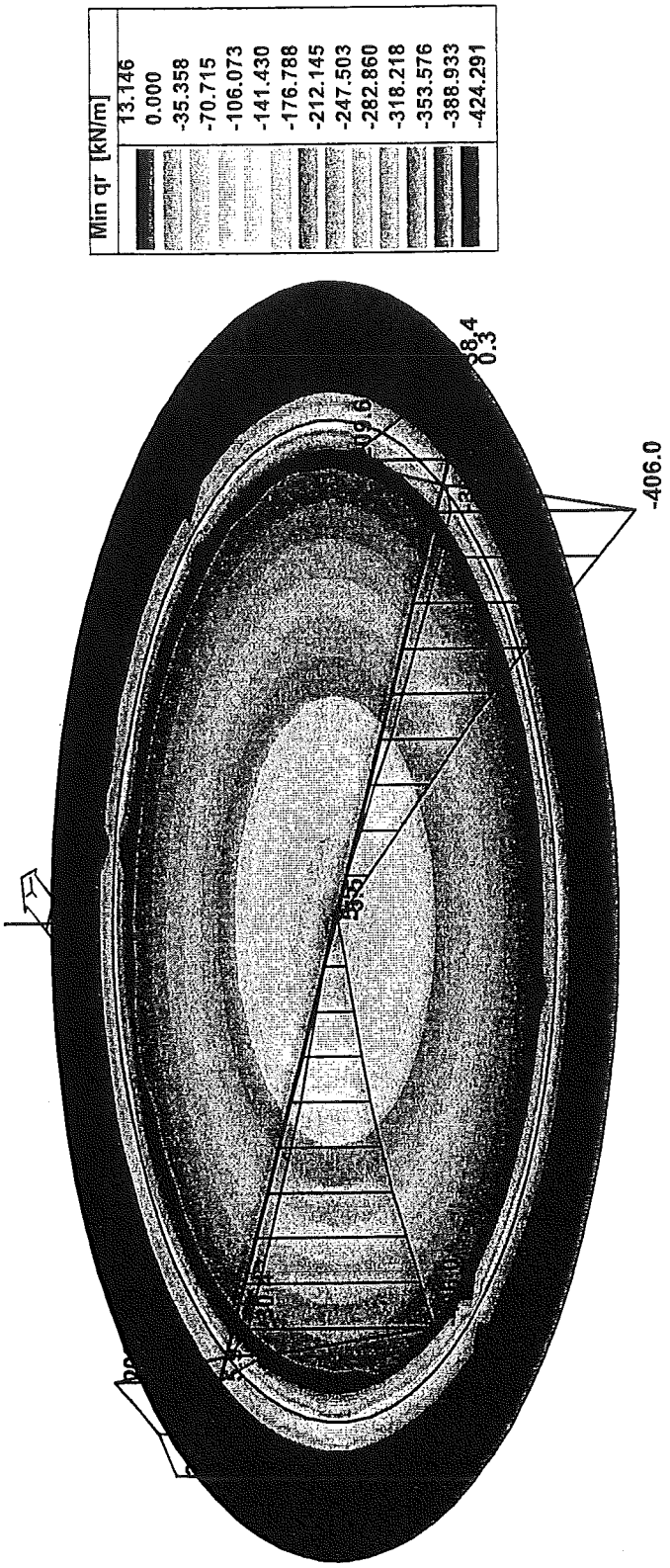
Internal force - max qr - FEM Combi : 1



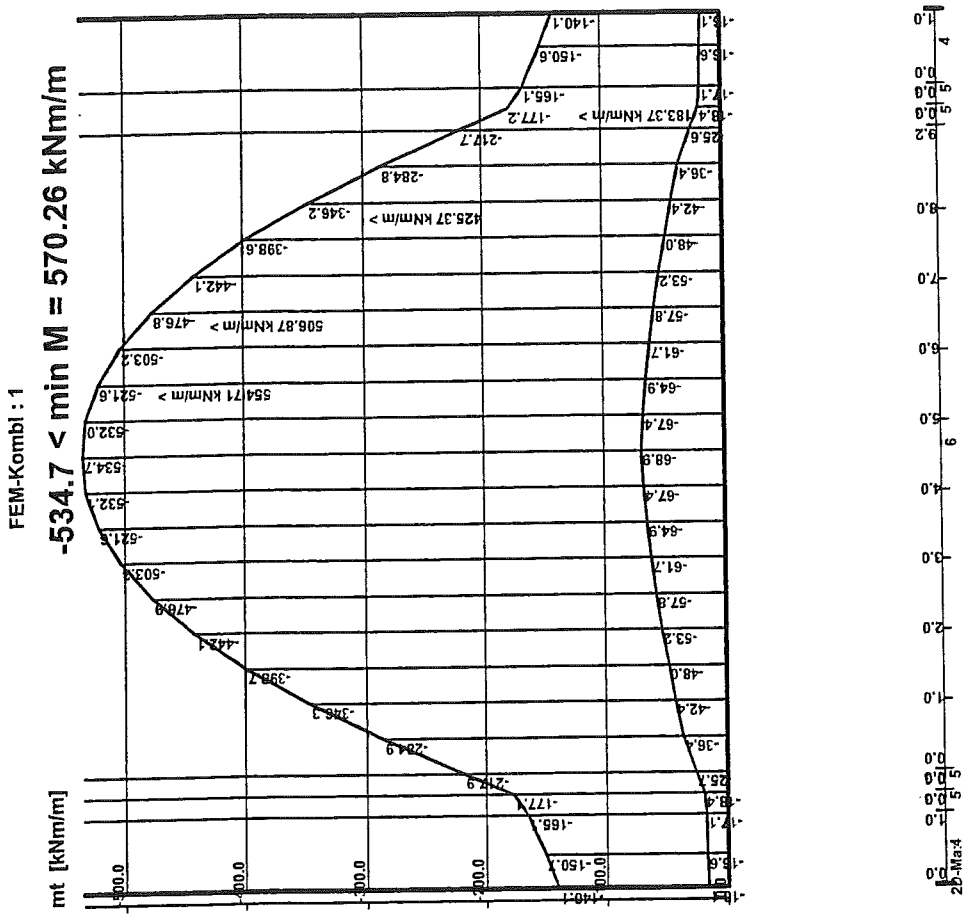
Internal force - min mt - FEM Combi : 1

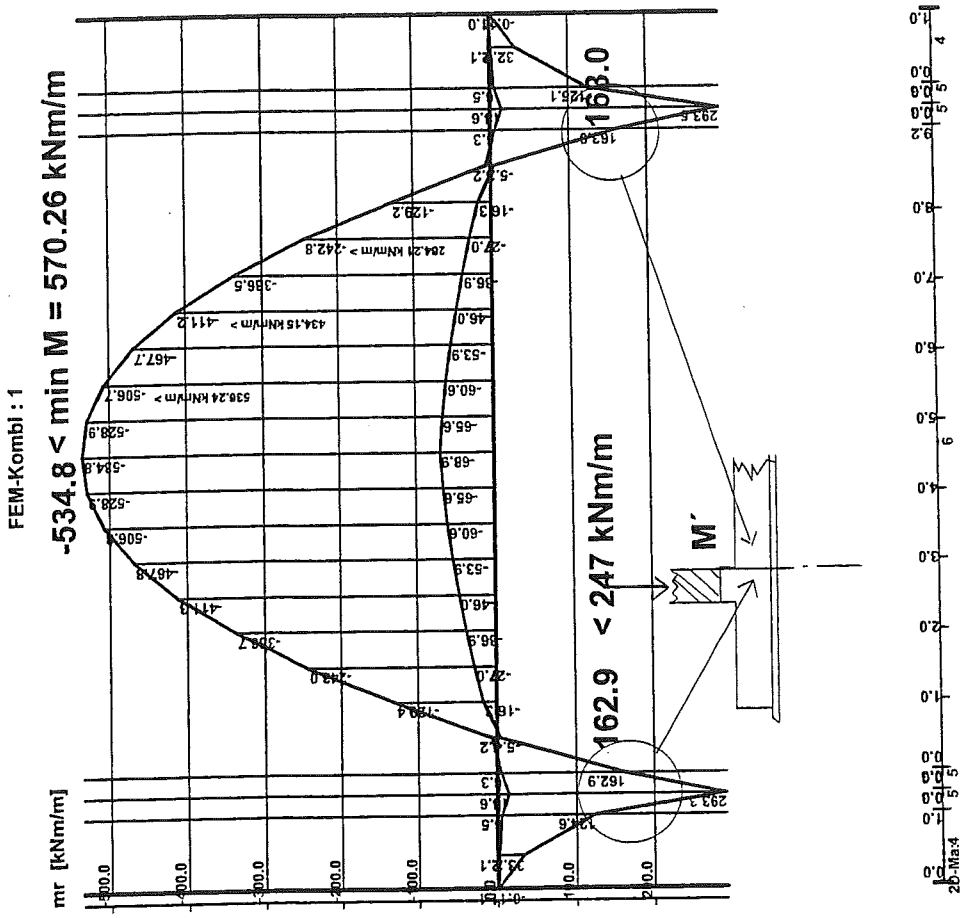


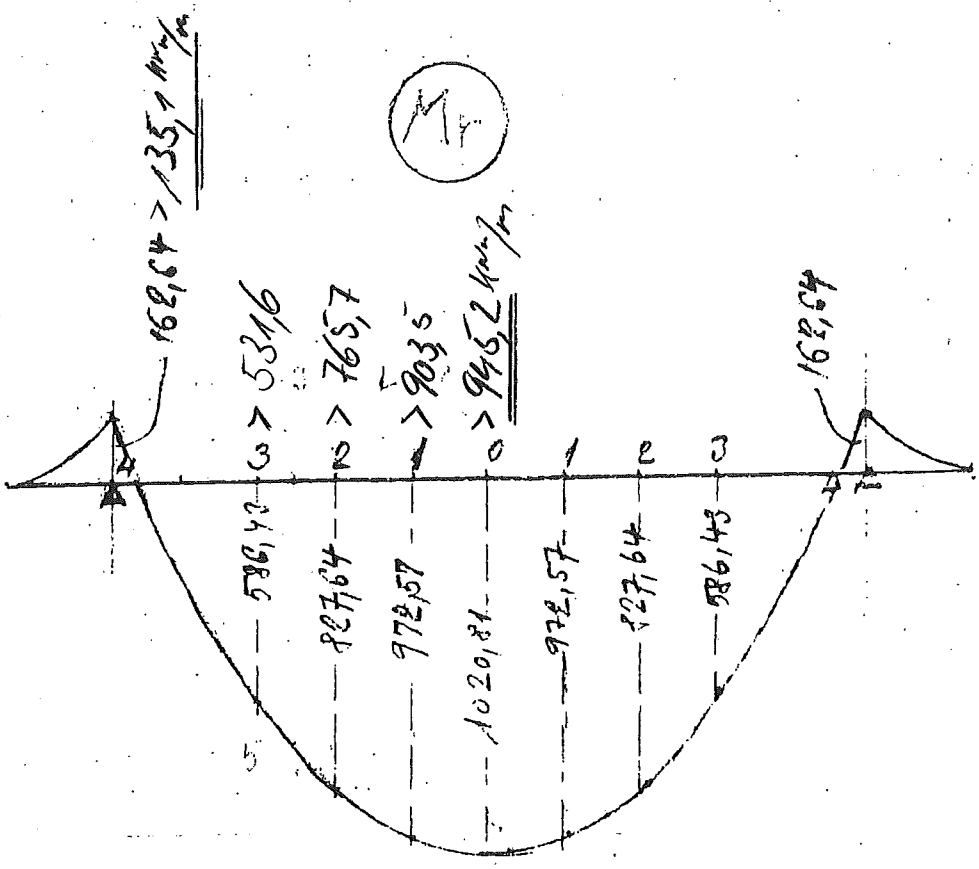
Internal force - min mr - FEM Combi : 1

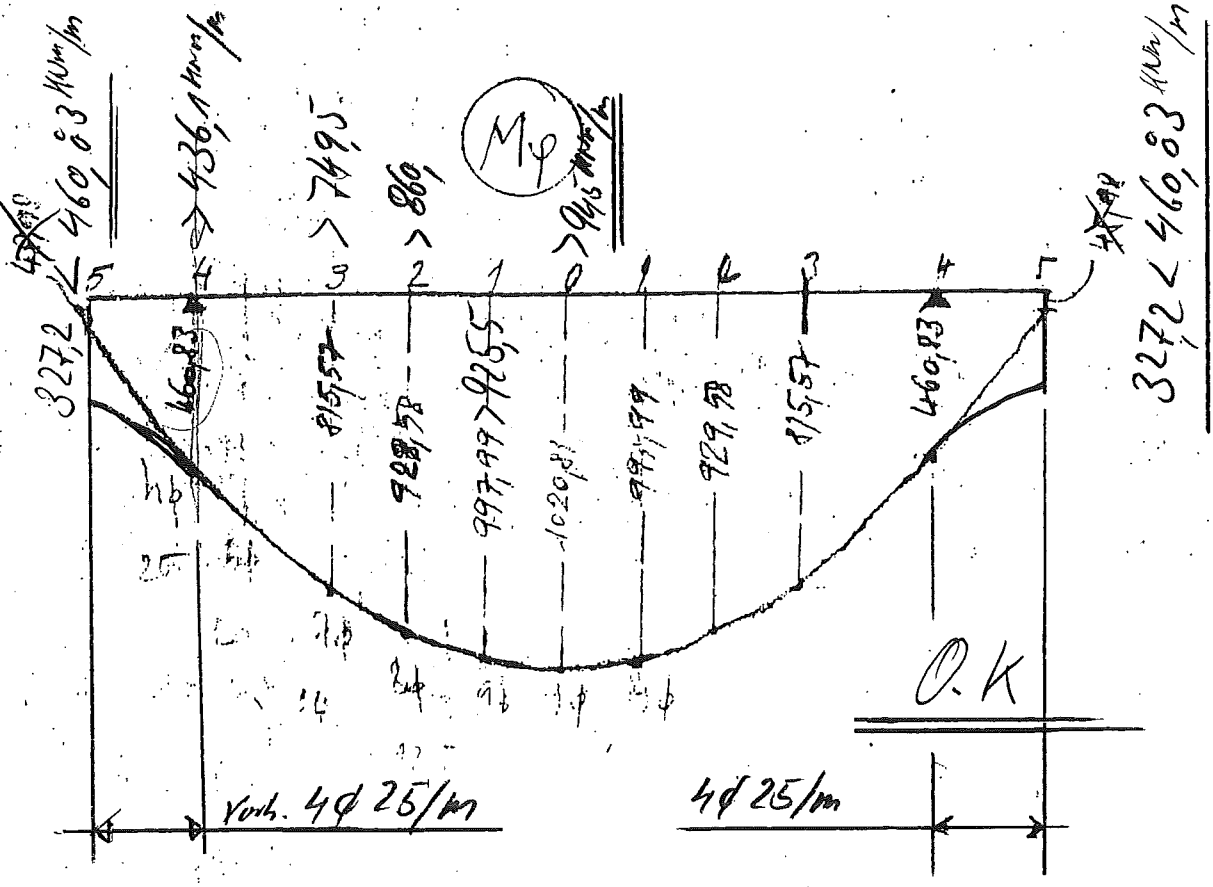


Internal force - min qr - FEM Combi : 1


FEM-Kombi : 1
-534.7 < min M = 570.26 kNm/m
mt [kNm/m]
554.71 kNm/m >
506.87 kNm/m >
425.37 kNm/m >
183.37 kNm/m >
2D-Max:4


FEM-Kombi : 1
-534.8 < min M = 570.26 kNm/m
162.9 < 247 kNm/m
M´
mr [kNm/m]





NÁZOV STAVBY:	HPK- 5229.322.1SV	LIST 8
OBJEKT ČÍSLO:		

VTK 2 62504-77

$Q_{r0} = -\frac{1941,0 \cdot 4,95}{2} \cdot 0 = 0$

$Q_{r4} = -\frac{1941,0 \cdot 4,95}{2} \cdot 0,202 - \frac{50 \cdot 4,95}{2} \cdot 0,202 = 122,03\ kN$

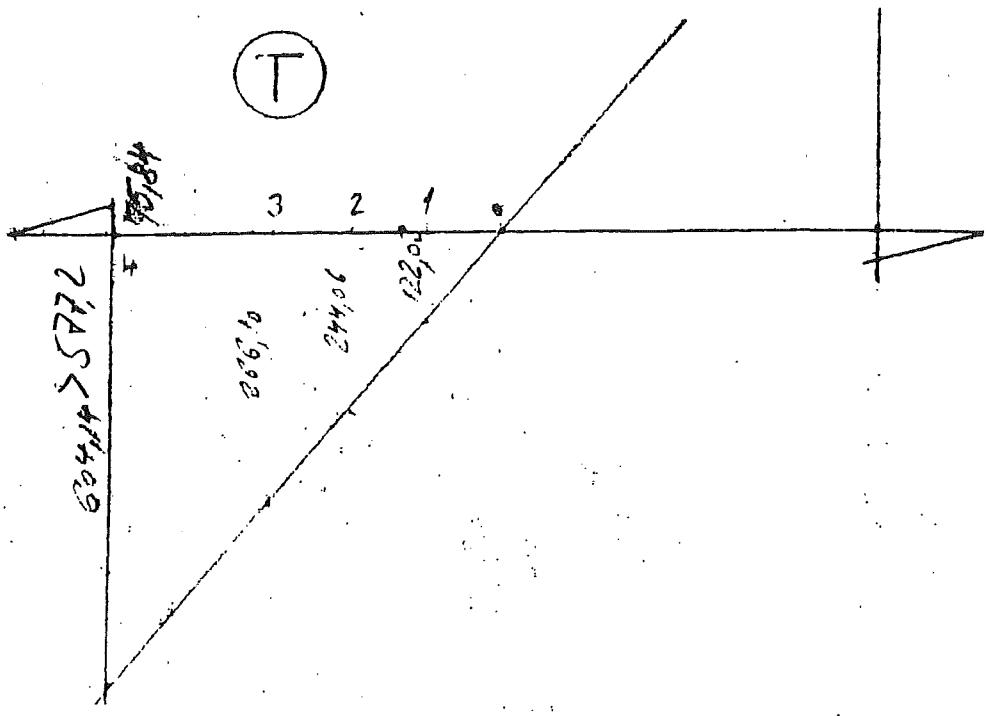
$Q_{r2} = -\frac{1941,0 \cdot 4,95}{2} \cdot 0,404 - \frac{50 \cdot 4,95}{2} \cdot 0,404 = 244,06\ kN$

$Q_{r3} = -\frac{1941,0 \cdot 4,95}{2} \cdot 0,606 - \frac{50 \cdot 4,95}{2} \cdot 0,606 = 366,10\ kN$

$Q_{r4p} = -\frac{1941,0 \cdot 4,95}{2} \cdot 1,0 - \frac{50 \cdot 4,95}{2} \cdot 1,0 = 604,14\ kN/m'$

$Q_{r5} = \frac{50 \cdot 4,95}{2}\left(\frac{1,27^2}{1,27} - 1,27\right) = 0\ kN$

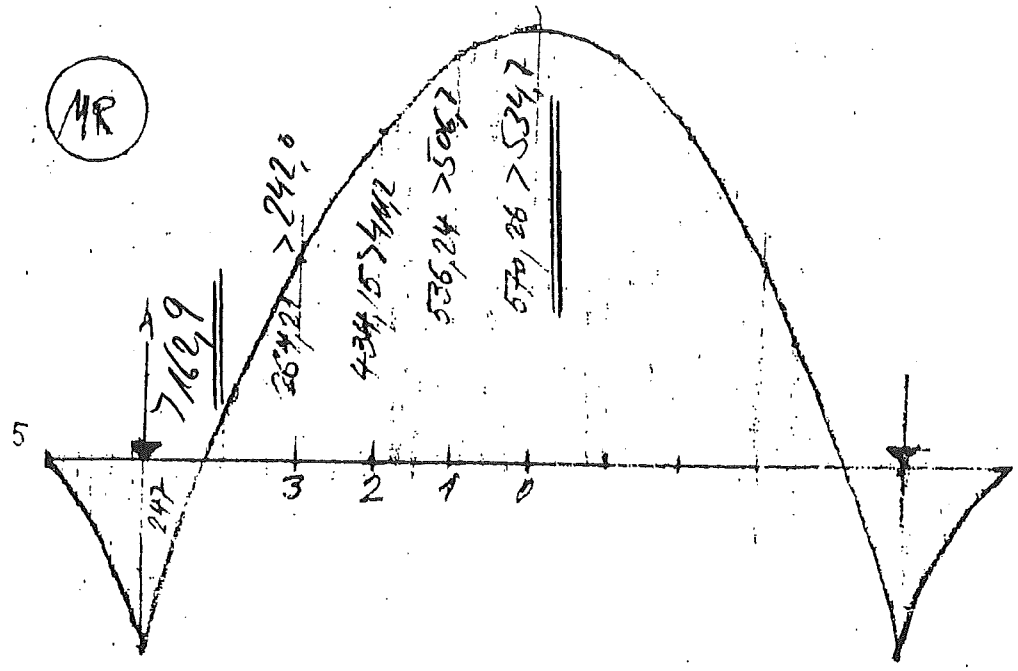
$Q_{r4L} = \frac{50 \cdot 4,95}{2}\left(\frac{1,27^2}{1,0} - 1,0\right) = 75,84\ kN/m'$

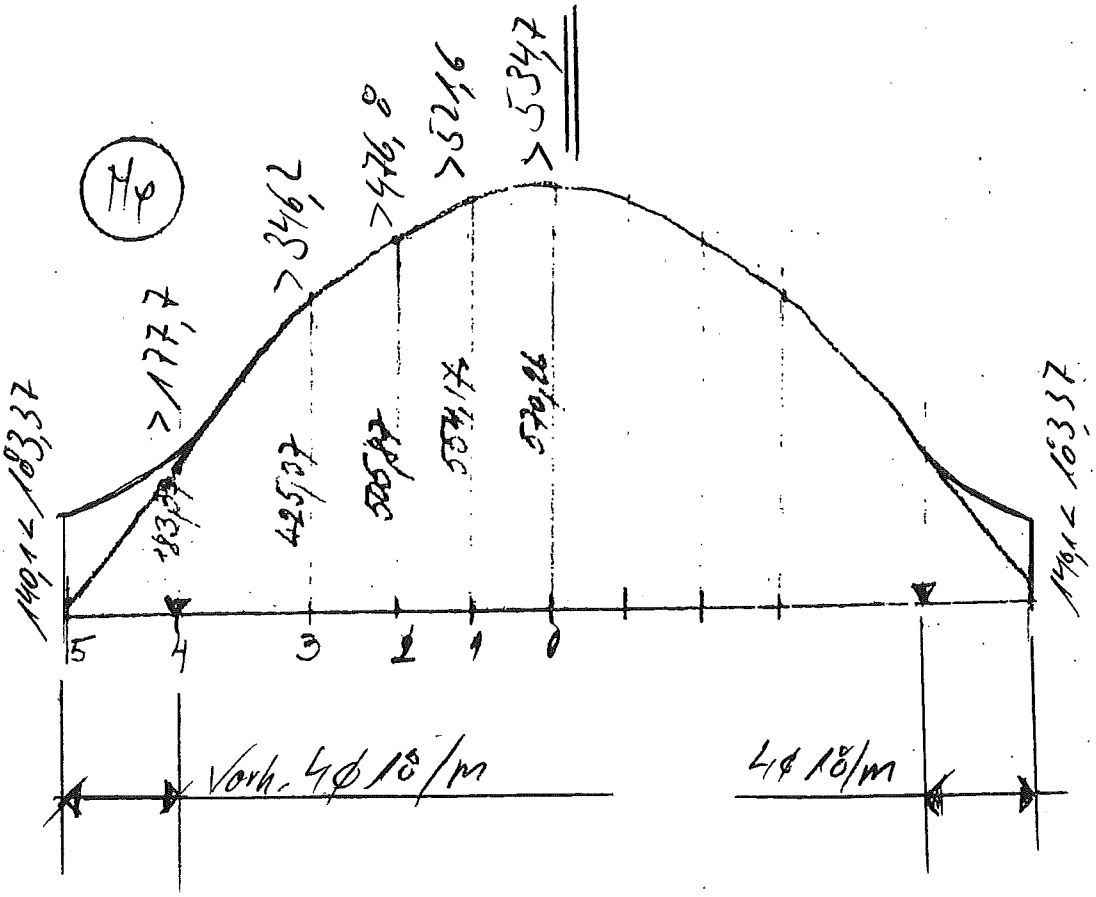


O.K

$Q_4 = 75,84 + 604,14 = 679,98\ kN/m'$

	NÁZOV STAVBY:	HPK- 5229 322 15v	LIST 9
	OBJEKT ČÍSLO:		


MR
>242,0
>534,2
5
3
2
1
0

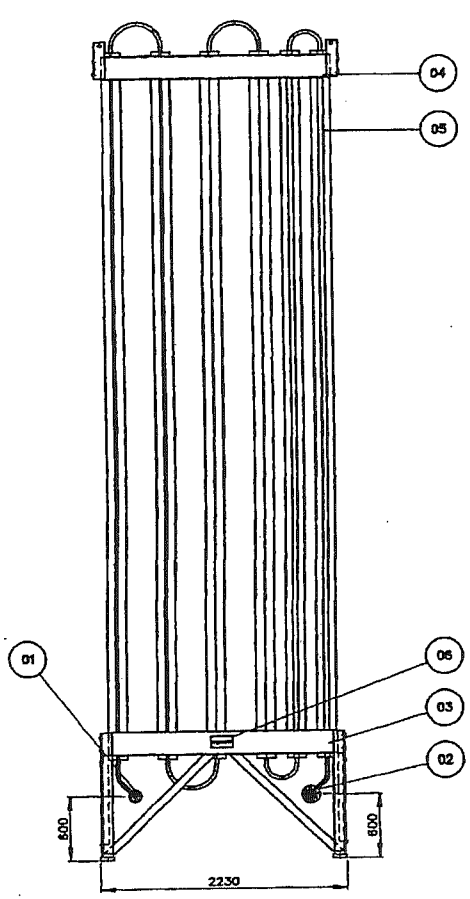

Mp
>346,2
>476,8
>521,6
>534,2
5
4
3
2
1
0
Vorh. 4Ø18/m
4Ø18/m

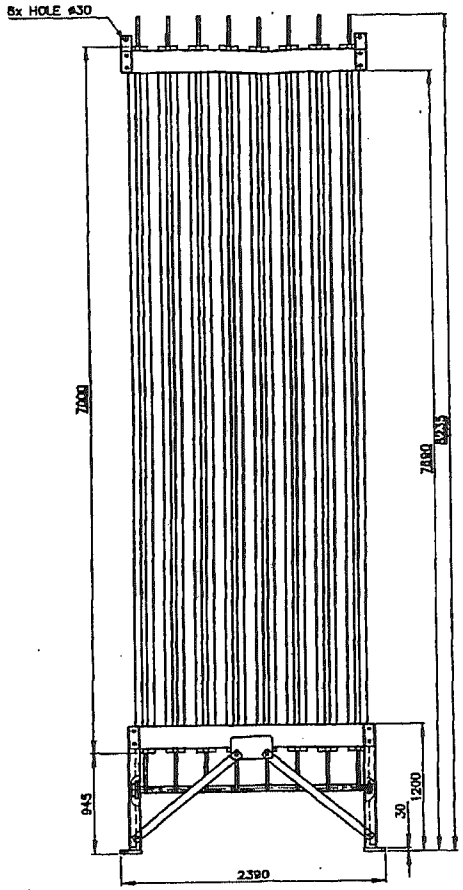
Chapter C

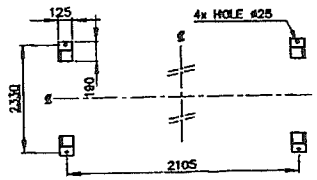
Foundation HP-LIN Vaporizer

W74101, W74201, W74301, W74401

KMA
Ingenieurgesellschaft mbH
Saarbrücker Straße 9
66130 Saarbrücken-Brebach
Telefon (0681) 8 83 13-0
Telefax (0681) 8 83 13 89







FOUNDATION

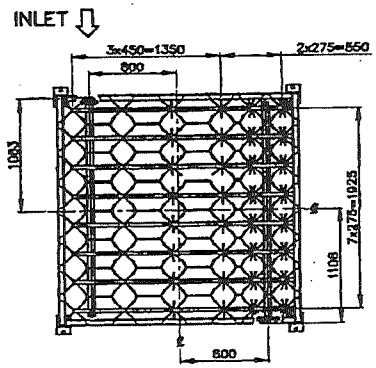
GENERAL NOTES

NOM. CAPACITY	: 1750 Nm³/hr.
MEDIA	: O_2–N_2–Ar–CO_2.
WEIGHT	: ±1800 KGS.
MAX. WORKING PRESSURE	: 40 BAR.
TEST PRESSURE	: 44 BAR
TOLERANCE ON DIMENSIONS	±3MM.

CLEANED FOR OXYGEN USE.
FLANGE OUTSIDE DIAMETER AND BOLTCIRCLE ACC. TO DIN 2635 PN40.

G = 18kW

TOP VIEW



74401

W74401-74404

POS.	QUANT.	NAME/DESCRIPTION	DRGNR.	MATERIAL	REMARKS
06	1	NAMEPLATE	CN4193-4	ALUMINIUM	–
05	1	VAPORISER BLOCK	CN4309-2	ALUMINIUM	–
04	1	UPPER FRAME	CN4099-1	ALUMINIUM	–
03	1	BASE FRAME	CN4099-1	ALUMINIUM	–
02	1	OUTLET FLANGE WITH MATING FLANGE DN80	1583-A3 / ITEM F	ALU./AISI / BRASS	–
01	1	INLET FLANGE WITH MATING FLANGE DN40	1583-A3 / ITEM B	ALU./AISI / BRASS	–

Fo Rey 25/04/04

REV.	DESCRIPTION	DRWN.	CHK.	DATE
A	CHECKED	JB		10-07-00

CNLP 8x6x7000
AMBIENT AIR VAPORISER

DRWN: A.BROUWER | SCALE: 1:25
CHECKED: JB | DATE: 10-07-00
CN4307-2

cryonorm bv

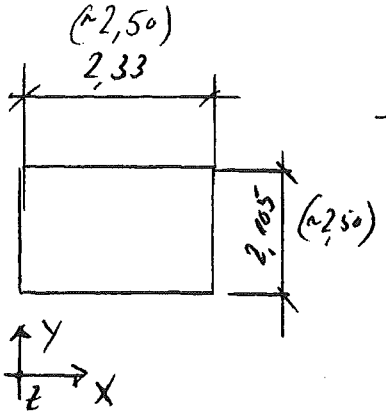
REPLACED

-C2-

Loadcase

Weight

$G = \underline{10{,}0\ kN}$



Wind ± x + ± y

$w_{max} \simeq 80\ m \rightsquigarrow q_{50} = 0{,}50\ kN/m^2$

$C = 1{,}3$

$q_{wx} \leq 1{,}3 \cdot 0{,}5 \cdot 2{,}50 = \pm 1{,}625\ kN/m$

KMW
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66130 Saarbrücken-Brebach
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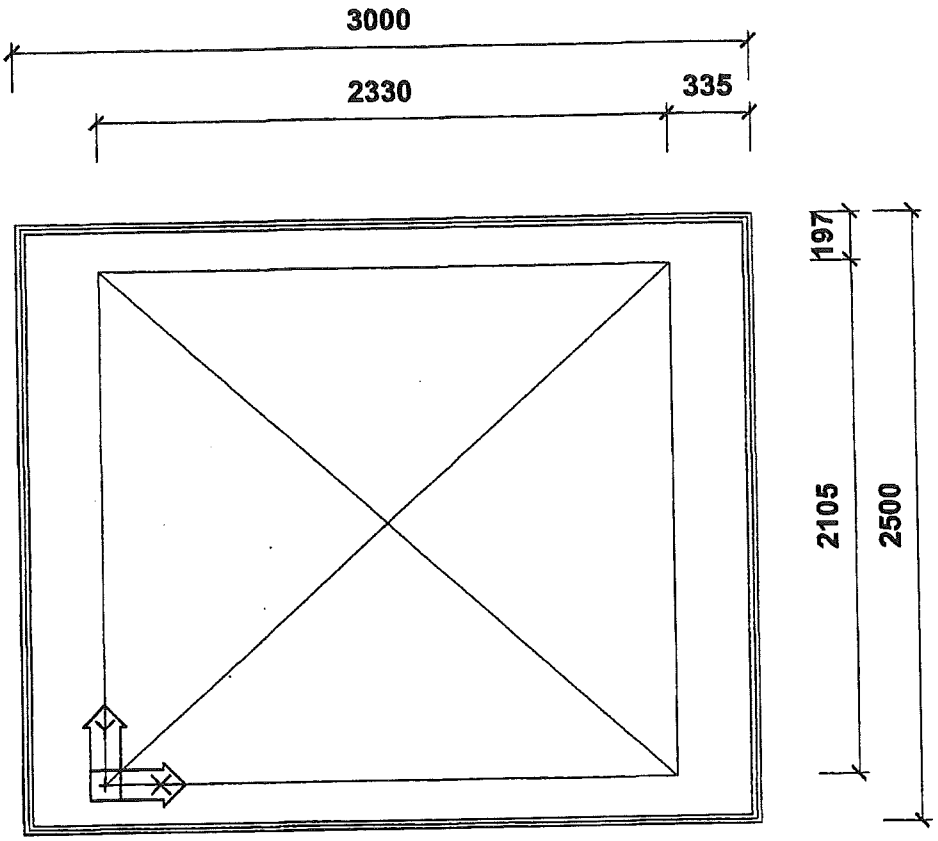
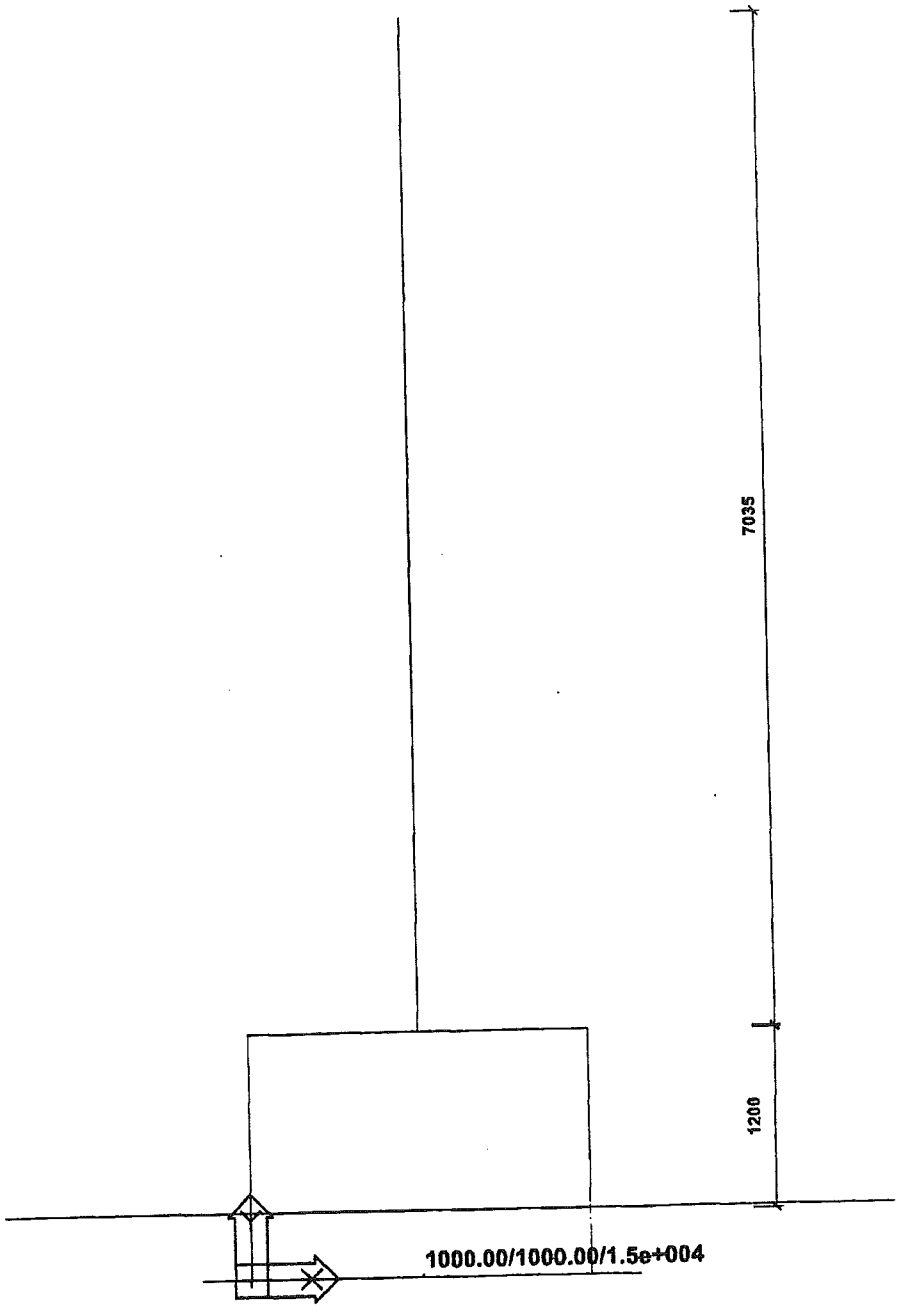
Telefax (0681) 8 83 13-88
E-Mail info@kmw-ing.de



B25 / d = 1.20 m

Draufsicht



System

Basic data
Type of structure : General XYZ

Number of nodes:	14
Number of members:	13
Number of 1D macros:	7
Number of bound. lines:	4
Number of 2D macros:	1
Number of profiles :	1
Number of cases:	6
Number of materials:	2

Material

Name		
B 25		
	E modulus	30000.00 MPa
	Poisson coeff.	0.20
	Density	2500.000 kg/m^3
	Extensibility	0.01 mm/m.K
B 25 gewichtslos		
	E modulus	30000.00 MPa
	Poisson coeff.	0.20
	Density	0.000 kg/m^3
	Extensibility	0.01 mm/m.K

List of material
Group of members :
1/13

no.	Name:	quality	unit weight kg/m	length m	weight kg

List of material - Macro2D
Group of members :
1/1

no.	Name:	quality	unit volume weight kgm^3	volume m^3	weight kg
4	B 25	B 25	2500.00	9.00	22500.00

The total weight of the structure: 22500.00 kg

Nodes

node	X m	Y m	Z m
1	0.000	0.000	0.000

node	X m	Y m	Z m
2	0.000	0.000	1.700
3	2.330	0.000	0.000
4	2.330	0.000	1.700
5	0.000	2.105	0.000
6	0.000	2.105	1.700
7	2.330	2.105	0.000
8	2.330	2.105	1.700
9	1.165	1.053	1.700
10	1.165	1.053	8.735
11	-0.335	-0.198	0.000
12	2.665	-0.198	0.000
13	2.665	2.303	0.000
14	-0.335	2.303	0.000

Members

macro	memb	node 1	node 2	length m	Rx deg	profile	quality
1	1	1	2	1.700	0.00	1 - Lasteinleitung (Numerica...	B 25 gewichtslos
2	2	3	4	1.700	0.00	1 - Lasteinleitung (Numerica...	B 25 gewichtslos
3	3	5	6	1.700	0.00	1 - Lasteinleitung (Numerica...	B 25 gewichtslos
4	4	7	8	1.700	0.00	1 - Lasteinleitung (Numerica...	B 25 gewichtslos
5	5	2	9	1.570	0.00	1 - Lasteinleitung (Numerica...	B 25 gewichtslos
	6	9	8	1.570	0.00	1 - Lasteinleitung (Numerica...	B 25 gewichtslos
6	7	6	9	1.570	0.00	1 - Lasteinleitung (Numerica...	B 25 gewichtslos
	8	9	4	1.570	0.00	1 - Lasteinleitung (Numerica...	B 25 gewichtslos
	9	4	8	2.105	0.00	1 - Lasteinleitung (Numerica...	B 25 gewichtslos
	10	8	6	2.330	0.00	1 - Lasteinleitung (Numerica...	B 25 gewichtslos
	11	6	2	2.105	0.00	1 - Lasteinleitung (Numerica...	B 25 gewichtslos
	12	2	4	2.330	0.00	1 - Lasteinleitung (Numerica...	B 25 gewichtslos
7	13	9	10	7.035	0.00	1 - Lasteinleitung (Numerica...	B 25 gewichtslos

Boundaries

bound.	line	type	node
1		Line	11,12
2		Line	12,13
3		Line	13,14
4		Line	14,11

2D Macros

num	type		
1			
	B 25	Thickness	1.20 m

num	type
Boundary:	1,2,3,4
Nodes :	1,3,5,7

Profiles

Profile no. 1 - Lasteinleitung (Numerical)
Material : 8 - B 25 gewichtslos

A:	1.000000e+002 cm^2		
Ay/A:	1.000	Az/A:	1.000
Iy:	1.000000e+005 cm^4	Iz:	1.000000e+005 cm^4
Iyz:	0.000000e+000 cm^4	It:	1.000000e+005 cm^4
Iw:	1.000000e+005 cm^6		
Wely:	1.000000e+003 cm^3	Welz:	1.000000e+003 cm^3
Wply:	1.000000e+003 cm^3	Wplz:	1.000000e+003 cm^3
cy:	0.00 cm	cz:	0.00 cm
iy:	31.62 cm	iz:	31.62 cm
dy:	0.00 cm	dz:	0.00 cm
Outline :		0.00 cm	

Type for check: Untypical section

Hinges
The stiffeness values of line hinges are stated in 1 m´ of length

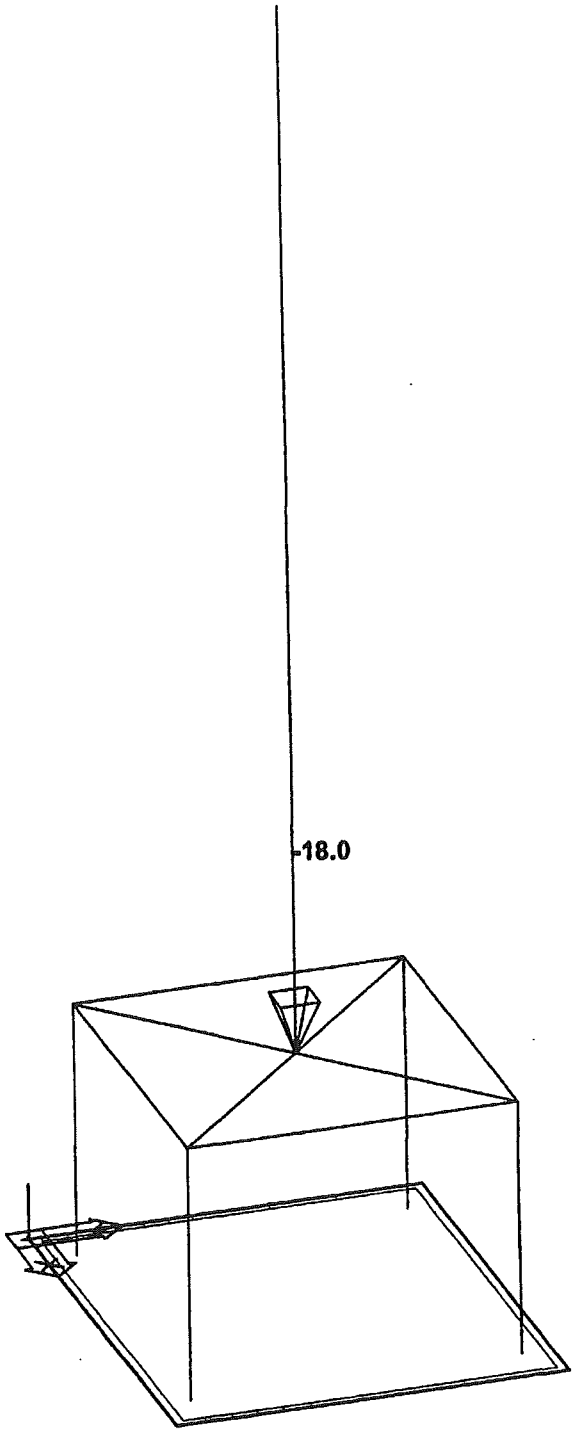
memb	type	pos
1	fiyfiz	beg
2	fiyfiz	beg
3	fiyfiz	beg
4	fiyfiz	beg

Soil - 2D macro

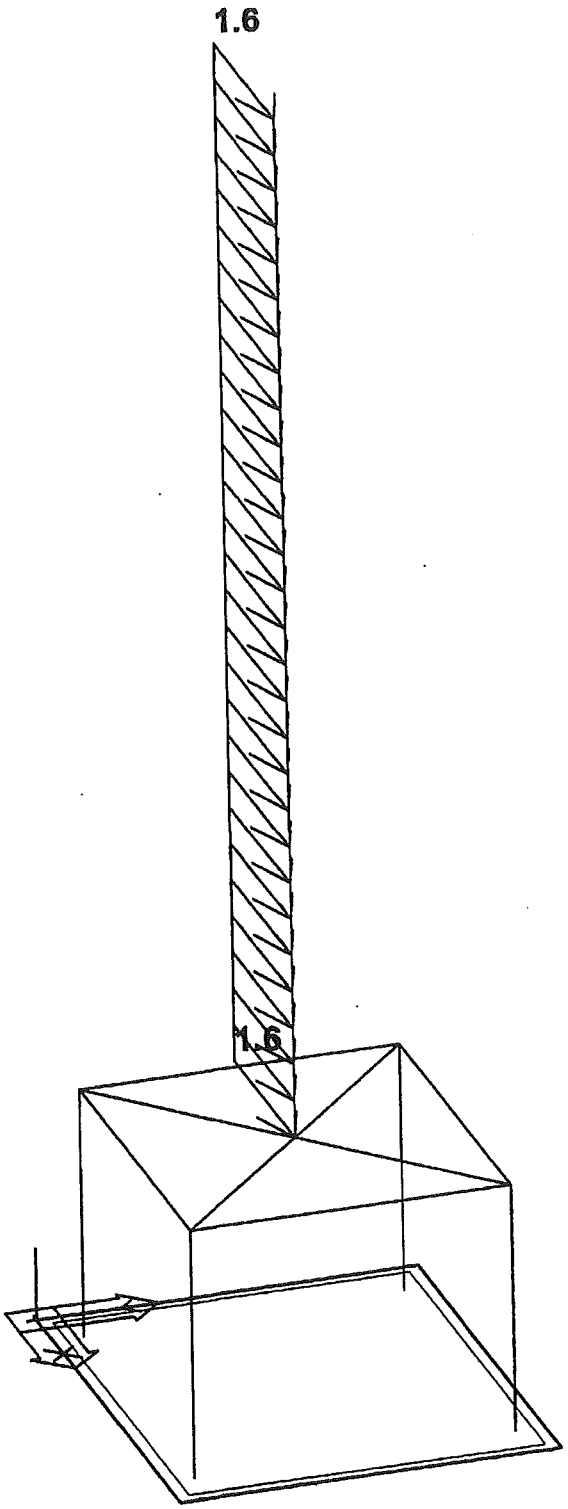
Index	2D macro	Name of subsoil
1	1	Sand/Clean/Moderate

Loadcases

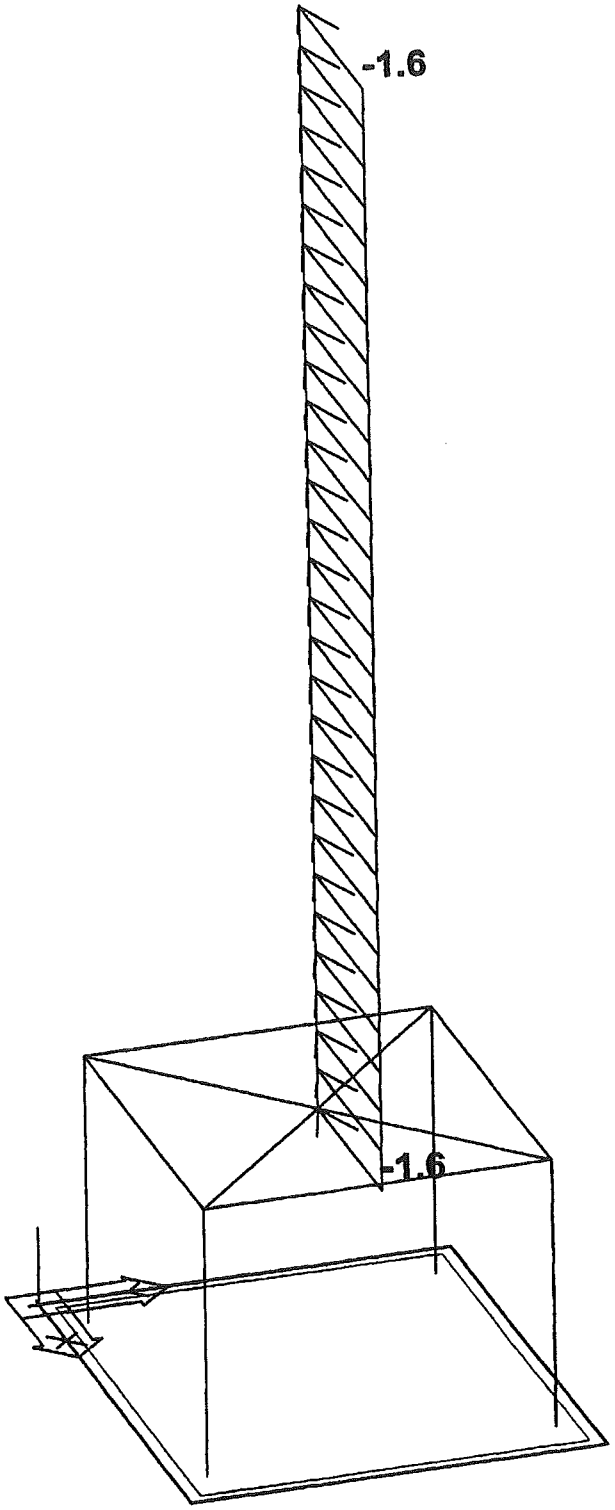
Case	Name:	Description
1	Weight concret	Self weight. Direction -Z
2	Weight	Permanent - Loads
3	Wind +X	Variable - Wind Excl.
4	Wind -X	Variable - Wind Excl.
5	Wind +Y	Variable - Wind Excl.
6	Wind -Y	Variable - Wind Excl.



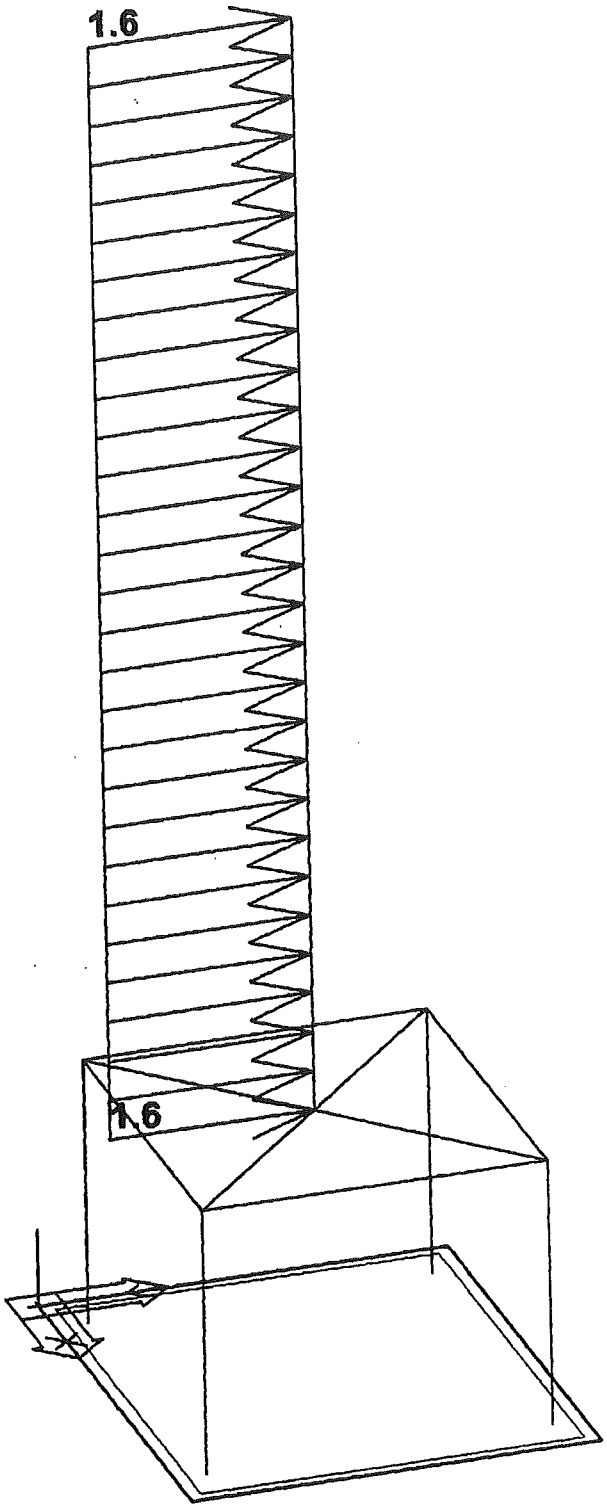
2. Weight



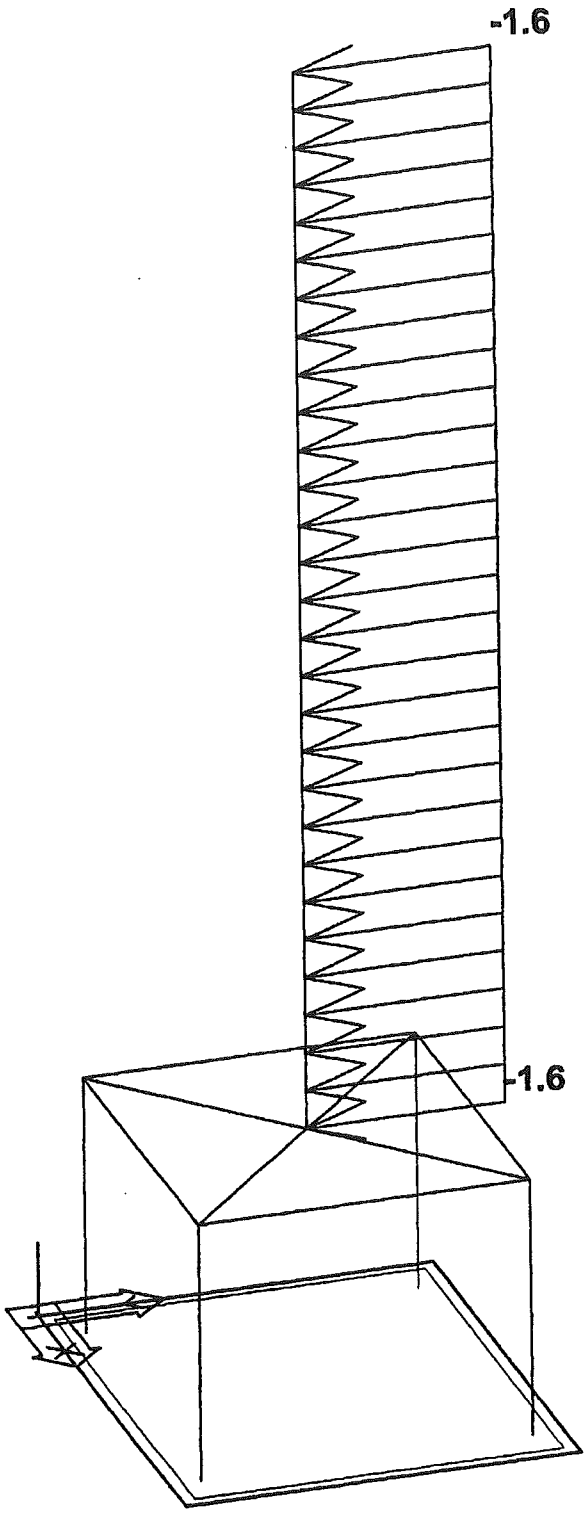
3. Wind +X



4. Wind -X



5. Wind +Y



6. Wind -Y

Loadcase no. 2 - nodal loads

node	Fx kN	Fy kN	Fz kN	Mx kNm	My kNm	Mz kNm
9	0.00	0.00	-18.00	0.00	0.00	0.00

Loadcase no. 3 - distributed loads

macro	type	dx m	exY m	exZ m		X beg end	Y beg end	Z beg end
7	force	0.00 rel	0.00	0.00	glo	1.63	0.00	0.00
	kN/m	1.00			len	1.63	0.00	0.00

Loadcase no. 4 - distributed loads

macro	type	dx m	exY m	exZ m		X beg end	Y beg end	Z beg end
7	force	0.00 rel	0.00	0.00	glo	-1.63	0.00	0.00
	kN/m	1.00			len	-1.63	0.00	0.00

Loadcase no. 5 - distributed loads

macro	type	dx m	exY m	exZ m		X beg end	Y beg end	Z beg end
7	force	0.00 rel	0.00	0.00	glo	0.00	1.63	0.00
	kN/m	1.00			len	0.00	1.63	0.00

Loadcase no. 6 - distributed loads

macro	type	dx m	exY m	exZ m		X beg end	Y beg end	Z beg end
7	force	0.00 rel	0.00	0.00	glo	0.00	-1.63	0.00
	kN/m	1.00			len	0.00	-1.63	0.00

Combinations

Combi	Norm	Case	coeff
1.	User-ultimate	1 Weight concret	1.00
		2 Weight	1.00
		3 Wind +X	1.00
		4 Wind -X	1.00
		5 Wind +Y	1.00
		6 Wind -Y	1.00

Basic rules for generation of ultimate load combinations:
1 : 1.00*LC1 / 1.00*LC2 / 1.00*LC3 / 1.00*LC4 / 1.00*LC5 / 1.00*LC6

List of extreme ultimate load combinations
1/ 1 : +1.00*LC1+1.00*LC2+1.00*LC3
2/ 1 : +1.00*LC1+1.00*LC2+1.00*LC4

3/ 1 : +1.00*LC1+1.00*LC2+1.00*LC5
4/ 1 : +1.00*LC1+1.00*LC2+1.00*LC6

Subsoils

Name:	Type of position	C1x kN/m^3	C1y kN/m^3	C1z kN/m^3	C2x kN/m	C2y kN/m	SigZpl kN/m^2
Sand/Clean/Moderate	Under plate, block	1000.000	1000.000	15000.000	0.000	0.000	0.000

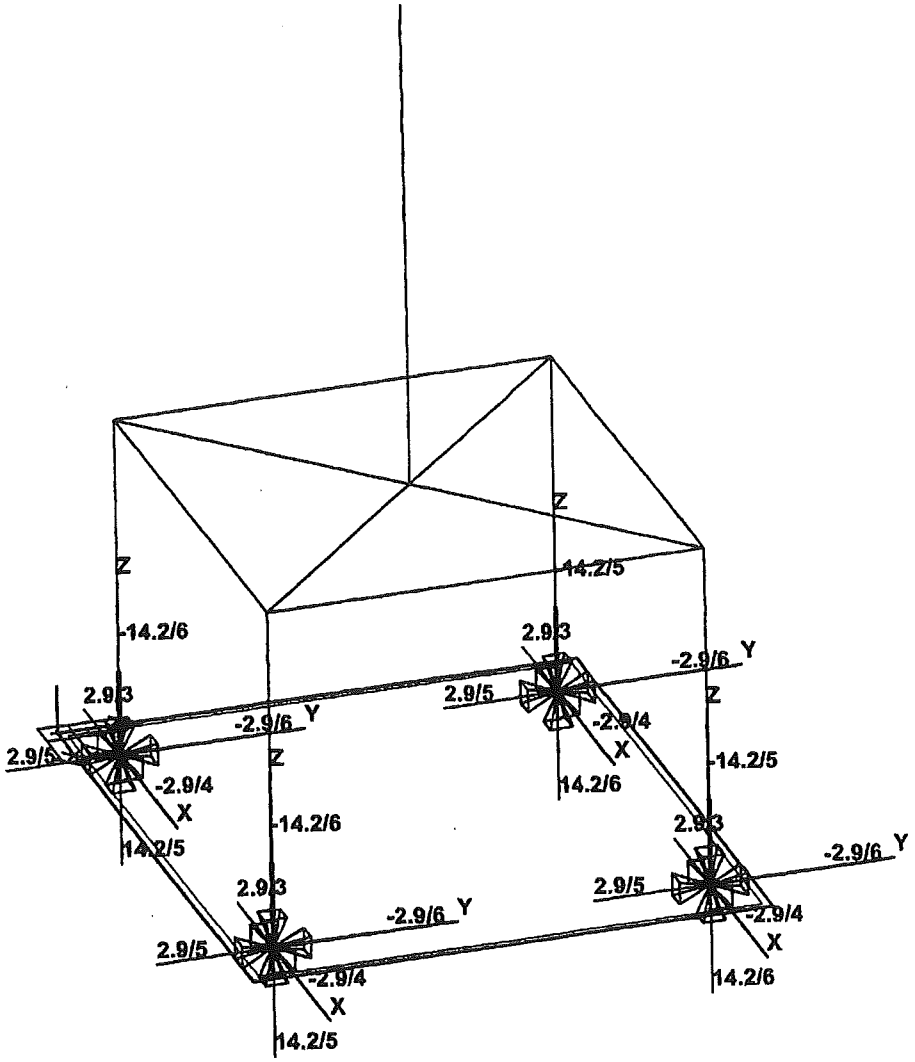
Calculation protocol.

Linear calculation

Number of 2D elements	208
Number of 1D elements	13
Number of mesh nodes	242
Number of equations	1452
Loadcases	LC 1 Weight concret
	LC 2 Weight
	LC 3 Wind +X
	LC 4 Wind -X
	LC 5 Wind +Y
	LC 6 Wind -Y
Bending theory	Mindlin
Start of calculation	04.10.2004 15:51
End of calculation	04.10.2004 15:51

Sum of loads and reactions.

			X	Y	Z
loadcase	1	loads	0.0	0.0	-225.0
		reactions	0.0	0.0	0.0
		contact	0.0	-0.0	225.0
loadcase	2	loads	0.0	0.0	-18.0
		reactions	0.0	0.0	0.0
		contact	0.0	-0.0	18.0
loadcase	3	loads	11.4	0.0	0.0
		reactions	0.0	0.0	0.0
		contact	-11.4	0.0	0.0
loadcase	4	loads	-11.4	0.0	0.0
		reactions	0.0	0.0	0.0
		contact	11.4	-0.0	-0.0
loadcase	5	loads	0.0	11.4	0.0
		reactions	0.0	0.0	0.0
		contact	0.0	-11.4	-0.0
loadcase	6	loads	0.0	-11.4	0.0
		reactions	0.0	0.0	0.0
		contact	-0.0	11.4	0.0



in node(s). Load case(s) : 1/6

Force in connection coordinate system.

Group of load case(s) :1/6

1 - a

Node - 3. Position of connection coordinate system related to node : : x : 0.00 m,y : 0.00 m,z : 0.00 m

case	memb	Fx [kN]	Fy [kN]	Fz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
1	2	-0.00	0.00	0.00	-0.00	0.00	-0.00
	sum :	-0.00	0.00	0.00	-0.00	0.00	-0.00
2	2	0.74	-0.64	-4.50	-0.00	0.00	-0.00
	sum :	0.74	-0.64	-4.50	-0.00	0.00	-0.00
3	2	2.86	-0.97	-12.80	-0.00	0.00	-0.04
	sum :	2.86	-0.97	-12.80	-0.00	0.00	-0.04
4	2	-2.86	0.97	12.80	-0.00	-0.00	0.04
	sum :	-2.86	0.97	12.80	-0.00	-0.00	0.04
5	2	-1.11	2.86	14.17	-0.00	-0.00	-0.06
	sum :	-1.11	2.86	14.17	-0.00	-0.00	-0.06
6	2	1.11	-2.86	-14.17	-0.00	0.00	0.06
	sum :	1.11	-2.86	-14.17	-0.00	0.00	0.06

2 - b

Node - 7. Position of connection coordinate system related to node : : x : 0.00 m,y : 0.00 m,z : 0.00 m

case	memb	Fx [kN]	Fy [kN]	Fz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
1	4	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
	sum :	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
2	4	0.74	0.64	-4.50	-0.00	-0.00	0.00
	sum :	0.74	0.64	-4.50	-0.00	-0.00	0.00
3	4	2.86	0.96	-12.80	-0.00	-0.00	0.04
	sum :	2.86	0.96	-12.80	-0.00	-0.00	0.04
4	4	-2.86	-0.97	12.80	-0.00	-0.00	-0.04
	sum :	-2.86	-0.97	12.80	-0.00	-0.00	-0.04
5	4	1.11	2.86	-14.17	-0.00	-0.00	-0.06
	sum :	1.11	2.86	-14.17	-0.00	-0.00	-0.06
6	4	-1.11	-2.86	14.17	-0.00	-0.00	0.06
	sum :	-1.11	-2.86	14.17	-0.00	-0.00	0.06

3 - c

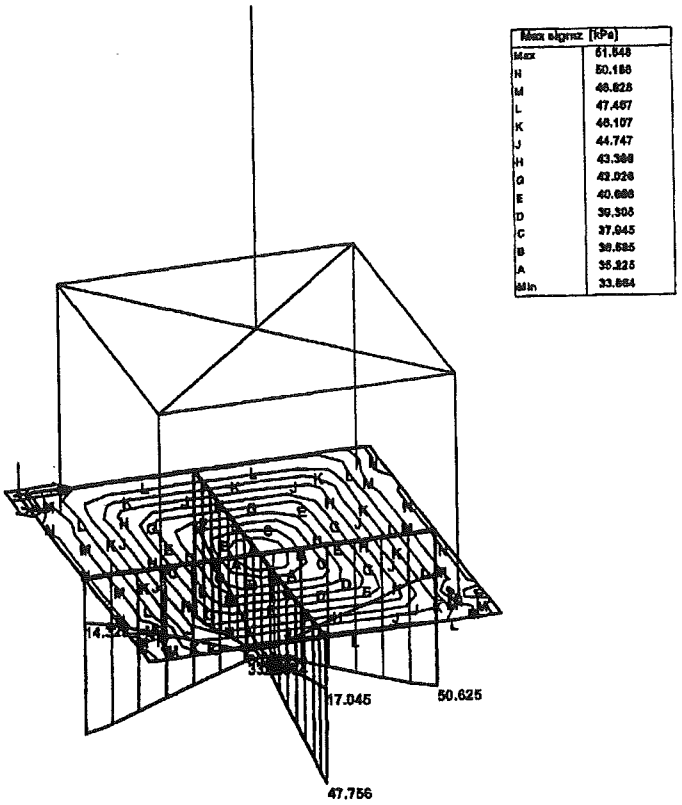
Node - 5. Position of connection coordinate system related to node : : x : 0.00 m,y : 0.00 m,z : 0.00 m

case	memb	Fx [kN]	Fy [kN]	Fz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
1	3	0.00	-0.00	0.00	0.00	-0.00	-0.00
	sum :	0.00	-0.00	0.00	0.00	-0.00	-0.00
2	3	-0.74	0.64	-4.50	-0.00	-0.00	-0.00
	sum :	-0.74	0.64	-4.50	-0.00	-0.00	-0.00
3	3	2.86	-0.97	12.80	0.00	-0.00	0.04
	sum :	2.86	-0.97	12.80	0.00	-0.00	0.04
4	3	-2.86	0.96	-12.80	-0.00	-0.00	-0.04
	sum :	-2.86	0.96	-12.80	-0.00	-0.00	-0.04
5	3	-1.11	2.86	-14.17	-0.00	-0.00	0.06
	sum :	-1.11	2.86	-14.17	-0.00	-0.00	0.06
6	3	1.11	-2.86	14.17	0.00	-0.00	-0.06

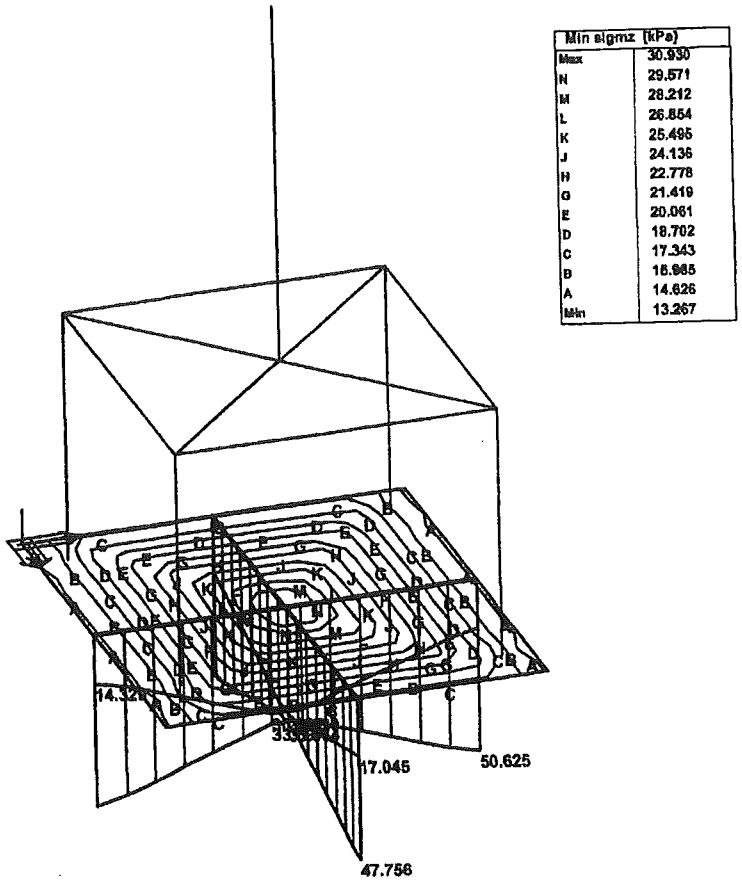
case	memb	Fx [kN]	Fy [kN]	Fz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
	sum :	1.11	-2.86	14.17	0.00	-0.00	-0.06

4 - d
Node - 1. Position of connection coordinate system related to node : : x : 0.00 m,y : 0.00 m,z : 0.00 m

case	memb	Fx [kN]	Fy [kN]	Fz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
1	1	-0.00	-0.00	-0.00	0.00	-0.00	-0.00
	sum :	-0.00	-0.00	-0.00	0.00	-0.00	-0.00
2	1	-0.74	-0.64	-4.50	0.00	-0.00	0.00
	sum :	-0.74	-0.64	-4.50	0.00	-0.00	0.00
3	1	2.86	0.97	12.80	-0.00	0.00	-0.04
	sum :	2.86	0.97	12.80	-0.00	0.00	-0.04
4	1	-2.86	-0.97	-12.80	0.00	-0.00	0.04
	sum :	-2.86	-0.97	-12.80	0.00	-0.00	0.04
5	1	1.11	2.86	14.17	-0.00	0.00	0.06
	sum :	1.11	2.86	14.17	-0.00	0.00	0.06
6	1	-1.11	-2.86	-14.17	0.00	-0.00	-0.06
	sum :	-1.11	-2.86	-14.17	0.00	-0.00	-0.06



Contact stress - max sigmz - FEM Combi : 1



Contact stress - min sigmz - FEM Combi : 1

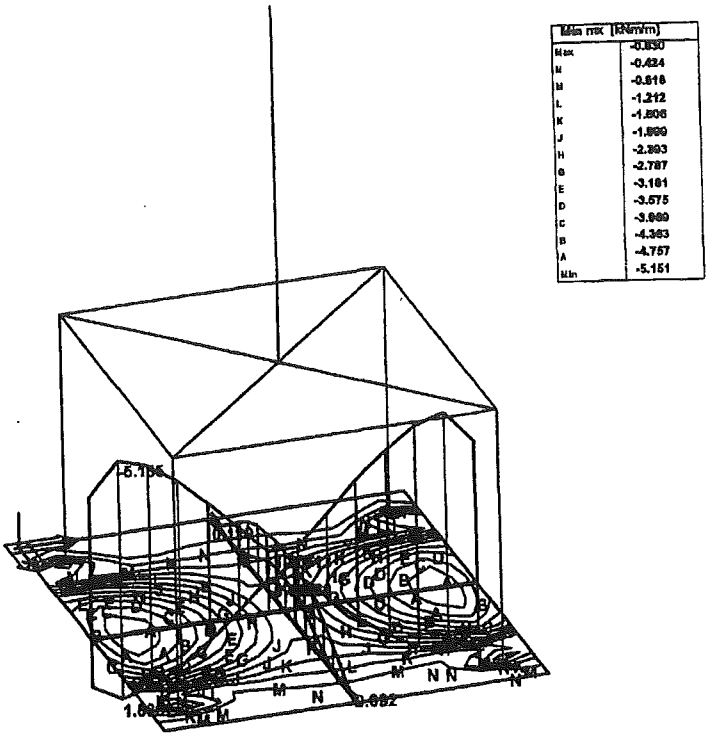
RESULTS : CONTACT STRESSES

FEM Combi:
C1 User-ultimate

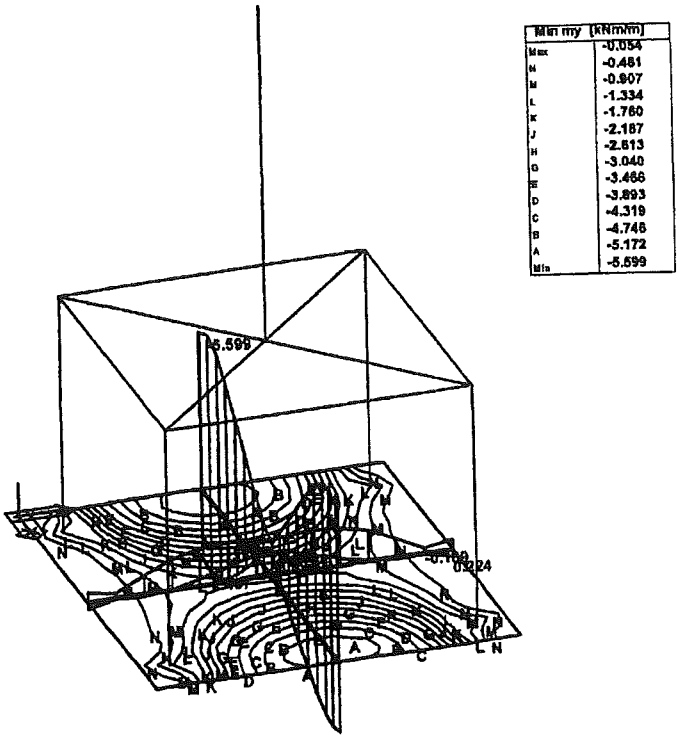
Global extremes

node	tauzx [kPa]	tauzy [kPa]	sigmz [kPa]
11		1.524	50.692
12		-1.524	14.422
3	1.524		49.578
7	-1.524		16.720
163	1.524	1.524	
175	-1.524	-1.524	

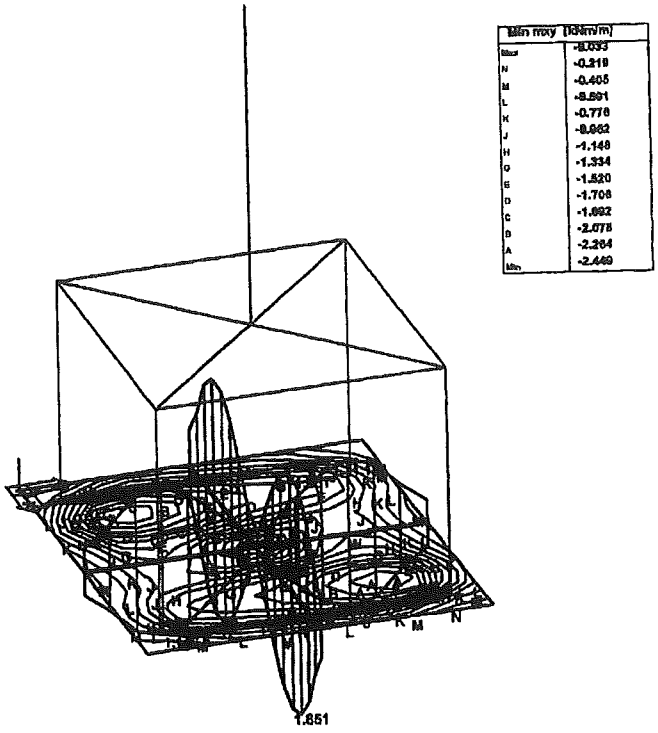
Selection was done for macros: 1



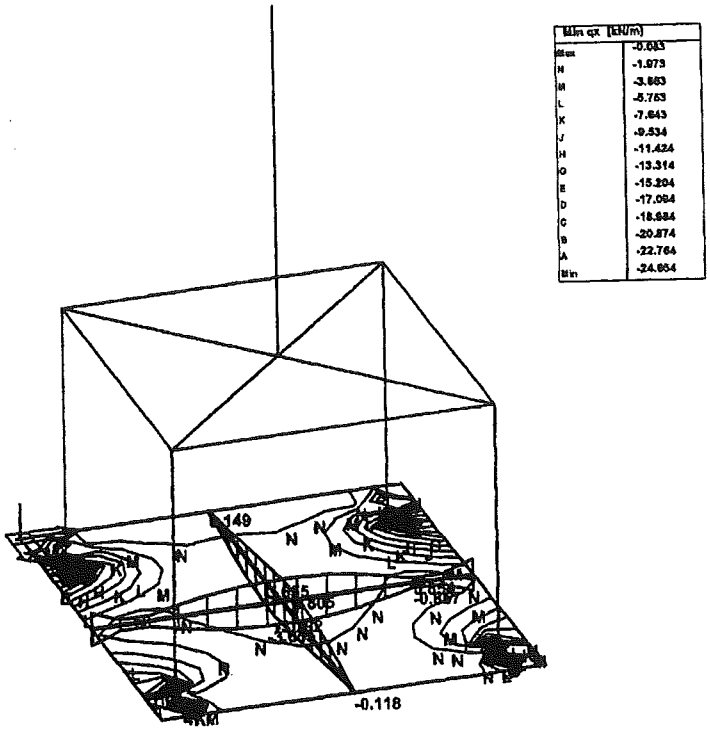
Internal force - min mx - FEM Combi : 1



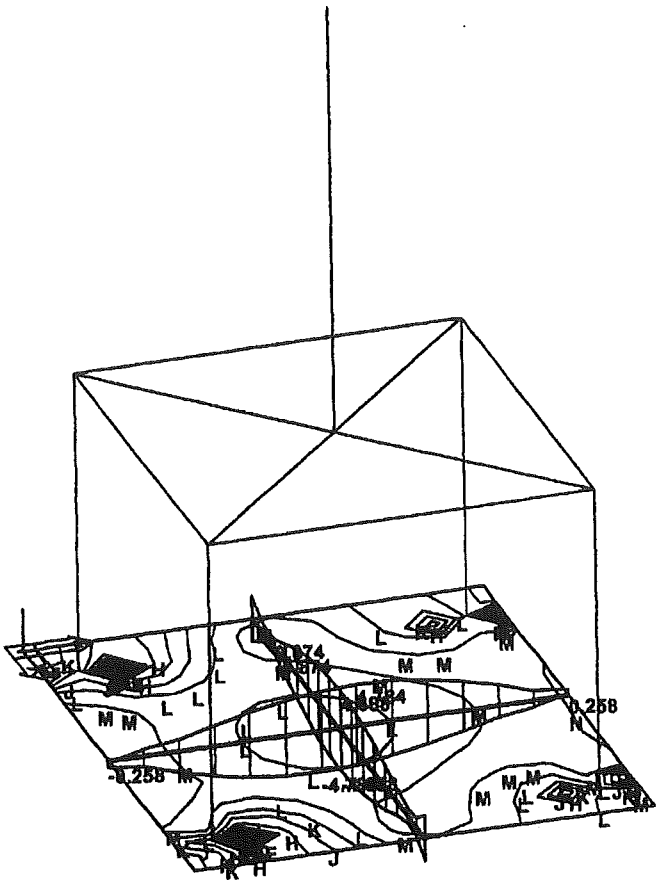
Internal force - min my - FEM Combi : 1



Internal force - min mxy - FEM Combi : 1



Internal force - min qx - FEM Combi : 1



Internal force - min qy - FEM Combi : 1

RESULTS : INTERNAL FORCES

FEM Combi:
C1 Eigen-Tragfähigk.

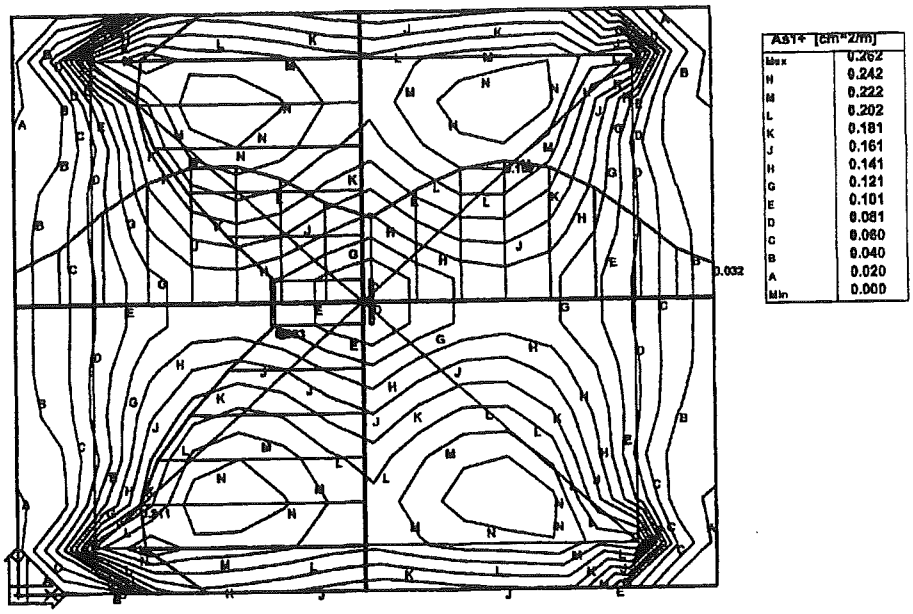
Global extremes

Rotation of the local system: No
Basic magnitudes - bending, membrane

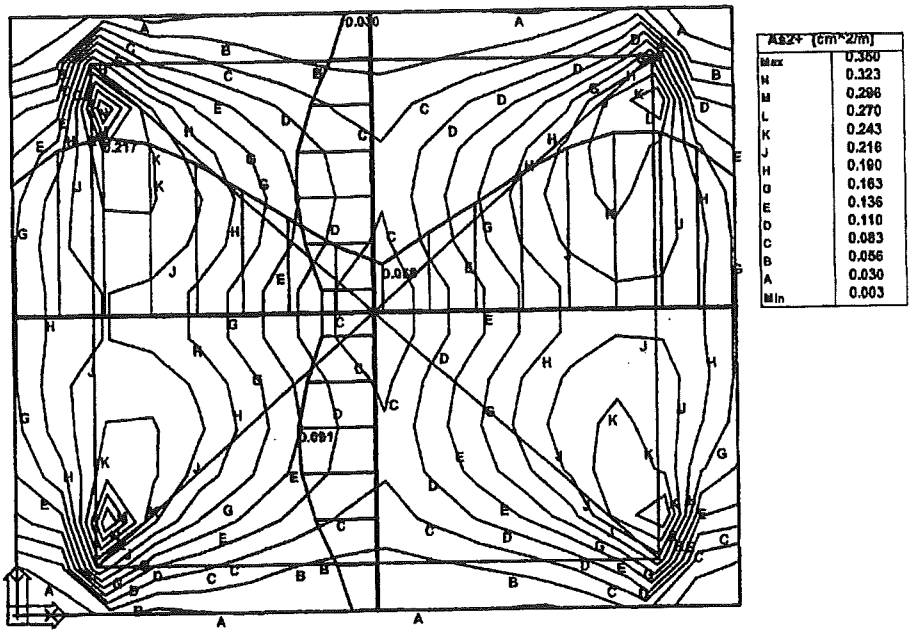
node	mx [kNm/m]	my [kNm/m]	mxy [kNm/m]	qx [kN/m]	qy [kN/m]	nx [kN/m]	ny [kN/m]	qxy [kN/m]
5		2.452	0.971	1.456	7.750	2.766	2.931	0.710
159		-0.192	-0.648	-0.628	-1.175	0.576	-0.162	-0.500
67	0.020		0.933	0.362	0.621	0.255	0.982	0.327
	-0.161		-1.014	-0.990	-1.346	-0.230	-0.288	-0.317
32	0.398	0.970		5.408	2.272	1.147	1.464	1.151
133	-1.802	-2.485		-2.361	-2.271	-0.231	-0.499	-1.151
176	0.996	1.078	1.331		1.602	8.954	0.983	2.793
150	-1.355	-0.584	-0.834		-2.017	-4.149	-0.512	-3.924
148	1.909	0.799	0.841	3.096		0.542	8.422	5.159
35	-1.112	-1.778	-0.840	-1.309		-0.396	-5.042	-5.156

node	mx [kNm/m]	my [kNm/m]	mxy [kNm/m]	qx [kN/m]	qy [kN/m]	nx [kN/m]	ny [kN/m]	qxy [kN/m]
176	0.996	1.078	1.331	28.283	1.602		0.983	2.793
222	-0.815	-0.764	-0.243	-8.844	-3.274		-1.323	-2.013
35	1.909	0.800	1.364	3.083	11.619	0.539		3.373
137	-1.134	-1.724	-1.043	-6.801	-11.334	-1.831		-5.971
21	1.721	0.770	1.043	3.210	11.334	3.148	8.360	
137	-1.134	-1.724	-1.043	-6.801	-11.334	-1.831	-5.263	

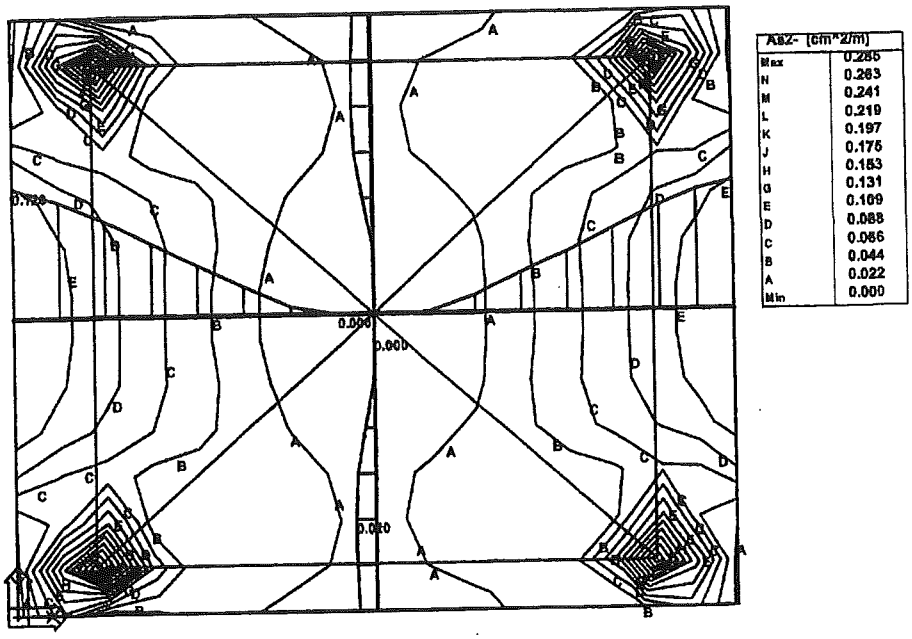
Selection was done for macros: 1



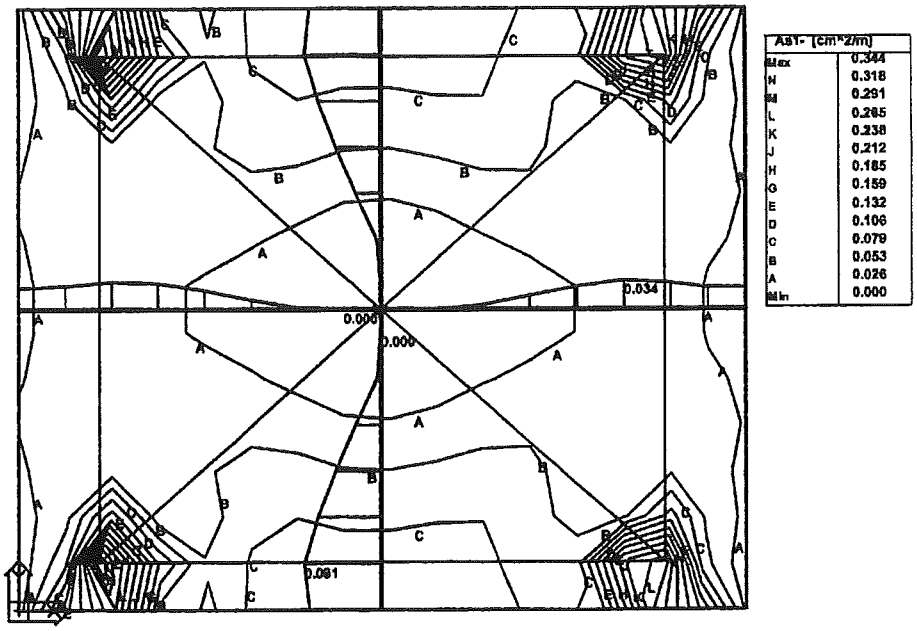
2D reinforcement - As1+



2D reinforcement - As2+



2D reinforcement - As2-



2D reinforcement - As1-

Code for calculation: DIN 1045 7/88

Explanation of concrete symbols

Abbreviation	Explanation
betaWN	Concrete cube compression strength.
betaR	Design concrete compression strength.
Tau01	1st shear stress limit according Table 13.
Tau02	2nd shear stress limit according Table 13.
Tau03	3rd shear stress limit according Table 13.

Concrete characteristics

	B 25
betaWN	25000.000 kPa
betaR	17500.000 kPa
Tau011_1 plates	350.000 kPa
Tau011_2 plates	500.000 kPa
Tau02 plates	1800.000 kPa
Tau012 beams	750.000 kPa
Tau02 beams	1800.000 kPa
Tau03 beams	3000.000 kPa

Explanation of reinforcement steel symbols

Abbreviation	Explanation
betaS	Characteristic yield strength of reinforcement

Steel characteristics

	BSt 420
betaS	420000.000 kPa
E modulus	200000000.000 kPa

Input parameters

Description	Percentage
Maximum % of reinforcement	9.00
Minimum % of net reinforcement	0.00
Minimum % of pressure reinforcement	0.50
Minimum % of tension reinforcement	0.00
Minimum % of transverse reinforcement	20.00

Shear mode
Tension reinforcement is partially anchored in the field.

Description	Value
height < 7 cm represents increase of internal forces (§ 17.2.1 (6))	ON
Structural reinforcement of deep beam	OFF

Global extremes

Necessary areas

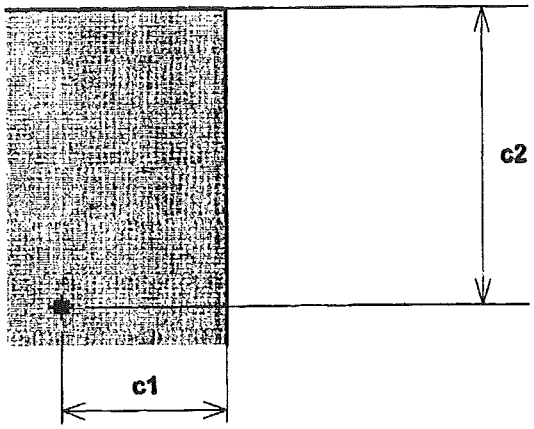
node	As1+ [cm^2/m]	As2+ [cm^2/m]	As3+ [cm^2/m]	As3- [cm^2/m]	As2- [cm^2/m]	As1- [cm^2/m]	Ass [cm^2/m^2]	tau [MPa]	tau0 [MPa]
18		0.139	-	-	0.030	0.065	0.000	0.00	0.01
11		0.003	-	-	0.014	0.013	0.000	0.00	0.00
137	0.120		-	-	0.130	0.147	0.000	0.00	0.01
11	0.000		-	-	0.014	0.013	0.000	0.00	0.00
1	0.215	0.216	-	-		0.344	0.000	0.00	0.01
72	0.095	0.082	-	-		0.000	0.000	0.00	0.00
5	0.215	0.216	-	-	0.285		0.000	0.00	0.01
72	0.095	0.082	-	-	0.000		0.000	0.00	0.00
1	0.215	0.216	-	-	0.285	0.344		0.00	0.01
	0.215	0.216	-	-	0.285	0.344		0.00	0.01
	0.215	0.216	-	-	0.285	0.344	0.000		0.01
	0.215	0.216	-	-	0.285	0.344	0.000		0.01
150	0.261	0.106	-	-	0.080	0.133	0.000	0.00	
221	0.017	0.012	-	-	0.083	0.155	0.000	0.00	

Selection was done for macros: 1

Anchor fastening design for HST-M20

As per ETAG Annex C method

Positioning

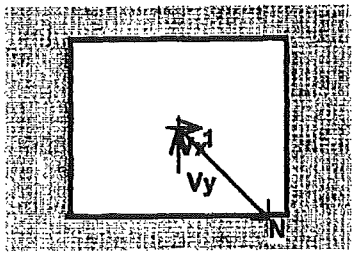


Anchoring plate:

Single anchor
lx=125 mm ly=100 mm
c1: 190.0 cm c2: 335.0 cm

+ Anchor

Loads (design values)



Tensile Load:

N_d=15.2 kN (1.35*-4.5 kN + 1.50*14.2 kN)

Shear Load:

Vx_d=2.7 kN (1.35*0.7 kN + 1.50*1.1 kN)
Vy_d=5.2 kN (1.35*0.6 kN + 1.50*2.9 kN)

Concrete

Compressive class: C20/25
tensile zone / cracked concrete
Thickness of base material: 120.0 cm
no edge reinforcement
close reinforcement (close reinforcement (s <= 15 cm))

Tension Load N

HST-M20

Anchor 1
Design value of tension load $N_{Sd,i}$ 15.2 kN

Design value of anchor group $N^g_{Sd} = \sum N_{Sd,i}$ = 15.2 kN

Steel failure

Characteristic value for one anchor $N_{Rk,s}$ = 75.0 kN
Partial safety factor γ_{Ms} = 1.60

Design value of resistance $N_{Rd,s} = \frac{N_{Rk,s}}{\gamma_{Ms}}$ = 46.9 kN Check $\frac{N^h_{Sd}}{N_{Rd,s}}$ = 0.32

Pullout failure

Characteristic value for one anchor $N_{Rk,p}$ = 30.0 kN
Partial safety factor γ_{Mp} = 1.80

Design value of resistance $N_{Rd,p} = \frac{N_{Rk,p}}{\gamma_{Mp}}$ = 16.7 kN Check $\frac{N^h_{Sd}}{N_{Rd,p}}$ = 0.91

Concrete cone failure

Initial value of the anchor resistance	$N^0_{Rk,c}$	= 36.5 kN		
Actual area of concrete cone	$A_{c,N}$	= 91809 mm²		
Reference area of concrete cone	$A^0_{c,N}$	= 91809 mm²		
Factor for disturbance of stressed distribution	$\psi_{s,N}$	= 1.00		
Shell spalling factor	$\psi_{re,N}$	= 1.00		
Eccentricity of the resulting tensile load	$e_{N,x}$	= 0 mm	$e_{N,y}$	= 0 mm
Factors for eccentrical loading	$\psi_{ec,N,x}$	= 1.00	$\psi_{ec,N,y}$	= 1.00
Factors for the position of the anchorage	$\psi_{ucr,N}$	= 1.00		

Characteristic value for the anchor group

$$N_{Rk,c} = N^0_{Rk,c} \cdot \frac{A_{c,N}}{A^0_{c,N}} \cdot \psi_{s,N} \cdot \psi_{re,N} \cdot \psi_{ec,N,x} \cdot \psi_{ec,N,y} \cdot \psi_{ucr,N} = 36.5 \text{ kN}$$

Partial safety factor γ_{Mc} = 1.80

Design value of resistance $N_{Rd,c} = \frac{N_{Rk,c}}{\gamma_{Mc}}$ = 20.3 kN Check $\frac{N^g_{Sd}}{N_{Rd,c}}$ = 0.75

Shear Load V

HST-M20

Anchor		1
Design value of shear in x	$V_{Sd,x,i}$	2.7 kN
Design value of shear in y	$V_{Sd,y,i}$	5.2 kN

Design value of anchor group: $V^g_{Sd,x} = \sum V_{Sd,x,i} = 2.7$ kN $V^g_{Sd,y} = \sum V_{Sd,y,i} = 5.2$ kN

Resulting design value of shear: $V_{Sd,i}$ 5.8 kN

Steel failure without lever arm

Characteristic value for one anchor: $V_{Rk,s} = 55.0$ kN
Partial safety factor: $_{Ms} = 1.33$

Design value of resistance: $V_{Rd,s} = \frac{V_{Rk,s}}{Ms} = 41.4$ kN Check $\frac{V^h_{Sd}}{V_{Rd,s}} = 0.14$

Concrete edge failure

Initial value of the anchor resistance	$V^0_{Rk,c}$	= —		
Actual area of concrete cone	$A_{c,V}$	= 0 mm²		
Reference area of concrete cone	$A^0_{c,V}$	= 0 mm²		
Factor for disturbance of stressed distribution	$_{s,V}$	= 1.00		
Factor for member thickness	$_{h,V}$	= 1.00		
Factor for load direction	$_{,V}$	= 1.00		
Eccentricity of the resulting shear load	$e_{V,x}$	= 0 mm	$e_{V,y}$	= 0 mm
Factors for eccentrical loading	$_{ec,V,x}$	= 1.00	$_{ec,V,y}$	= 1.00
Factors for the position of the anchorage	$_{ucr,V}$	= 1.0		

Characteristic value for the anchor group

$V_{Rk,c} = V^0_{Rk,c} \cdot \frac{A_{c,V}}{A^0_{c,V}} \cdot {}_{s,V} \cdot {}_{h,V} \cdot {}_{,V} \cdot {}_{ec,V} \cdot {}_{ucr,V}$ $V_{Rk,c,x} =$ — $_{Mc} = 0.00$

Design value of resistance: $V_{Rd,c} = \frac{V_{Rk,c}}{Mc} =$ — Check $\frac{V^g_{Sd}}{V_{Rd,c}} = 0.00$

Concrete pryout failure

HST-M20

Factor for short stiff anchors	k= 2.0
Characteristic value for the anchor group	$N_{Rk,c}$ = 36.5 kN
Characteristic value for the anchor group	$V_{Rk,c}$ = 73.1 kN
Partial safety factor	$_{Mc}$ = 1.80

Design value of resistance $V_{Rd,c} = \frac{V_{Rk,c}}{Mc} = 40.6$ kN Check $\frac{V_{Sd}^{g}}{V_{Rd,c}} = 0.14$

Splitting failure due to loading

$\frac{N_{Sd}^{g}}{N_{Rd,sp}} = 0.50$

Combined tension and shear load

$_{N} = 0.91 < 1.0$ $_{V} = 0.14 < 1.0$ $(_{N} + _{V})/1.2 = 0.88 < 1.0$ $_{N} + _{V} = 0.92 < 1.0$