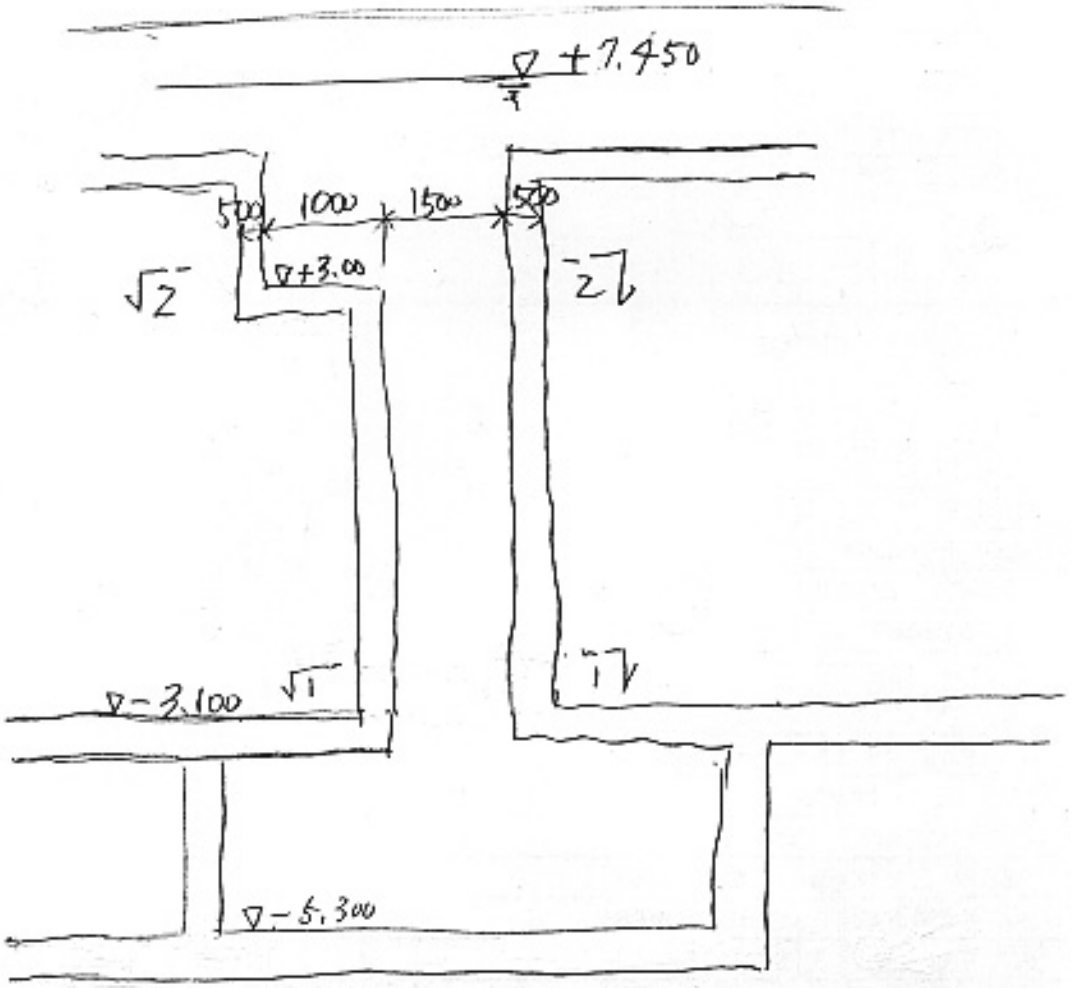
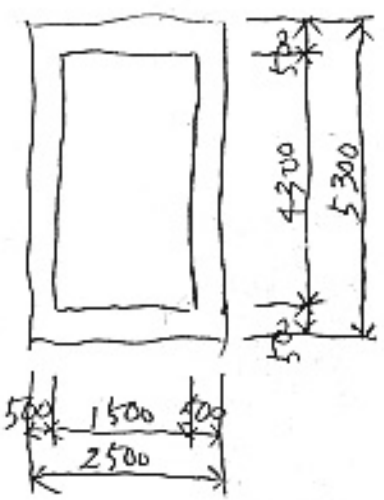
### *7.1.4*

### *Distribution Tank*

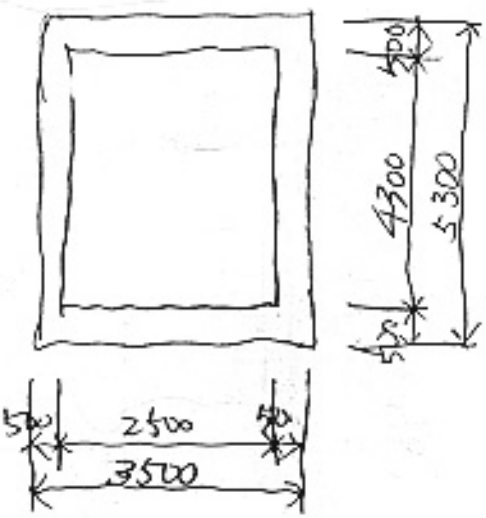
# Distribution Tank Structure Calculation




SECTION 1-1




SECTION 2-2



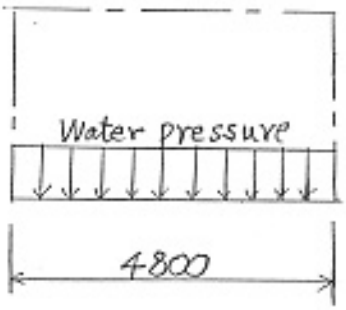
1. Section 1-1 Calculation

Calculate by 2 side fixed type

Calculation point is $\frac{1}{2} \times \ell$ ($\ell = 4.30^{m}$, $\frac{\ell}{2} \fallingdotseq 2.00^{m}$) upper point from bottom.

Lower side from this point is 3 sides fixed type, so Stress is less than this point.

$P_W$ (Water pressure) $= 7.45 + 3.10 - 2.00 = 8.55\ ^{t/m^2}$




$$M_{(end)} = \frac{8.55 \times 4.80^2}{12} = 16.42\ ^{t \cdot m}$$

$$M_{(center)} = \frac{8.55 \times 4.80^2}{24} = 8.21\ ^{t \cdot m}$$

$$\text{Shearing force} = \frac{8.55 \times 4.80}{2} = 20.52^{t}$$

Necessary Reinforcement

$$A_{s\,(end)} = \frac{16.42 \times 10^5}{1600 \times 0.9 \times 43} = 26.52\ ^{cm^2}$$

D25 @ 125 $A_s = 39.27\ ^{cm^2}$

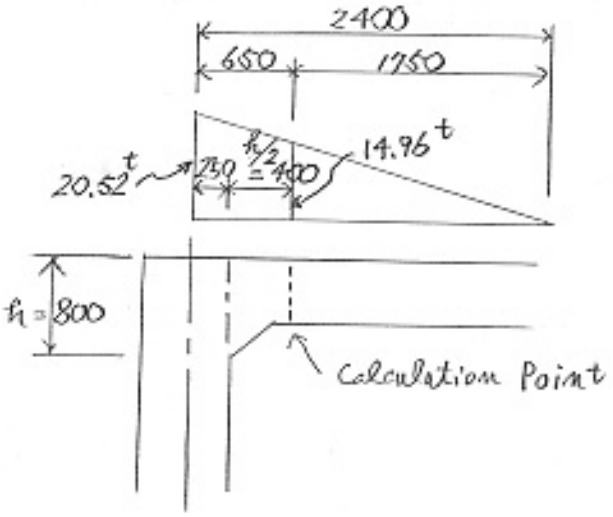
$$A_{s\,(center)} = \frac{8.21 \times 10^5}{1600 \times 0.9 \times 43} = 13.26\ ^{cm^2}$$

D18 @ 125 $A_s = 20.36\ ^{cm^2}$



2

Shearing Stress




$$\tau = \frac{14.96 \times 10^3}{100 \times 43} = 3.5\ kg/cm^2 < 3.6\ kg/cm^2 \quad O.K$$

2. Section 2-2 Calculation

$$Pw = 7.45 - 3.00 = 4.45\ t/m^2$$

$$M_{(end)} = \frac{4.45 \times 4.80^2}{12} = 8.54\ t \cdot m$$

$$M_{(center)} = \frac{4.45 \times 4.80^2}{24} = 4.27\ t \cdot m$$

$$S = \frac{4.45 \times 4.80}{2} = 10.68\ t$$

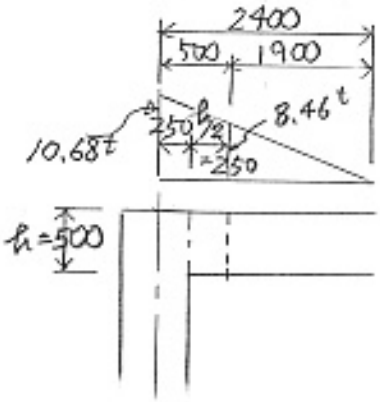
Necessary Reinforcement

$$As_{(end)} = \frac{8.54 \times 10^5}{1600 \times 0.9 \times 43} = 13.8\ cm^2$$

D16 @125 $As = 16.08\ cm^2$

$$As_{(center)} = \frac{4.27 \times 10^5}{1600 \times 0.9 \times 43} = 6.9\ cm^2$$

D12 @125 $As = 9.05\ cm^2$




$$\tau = \frac{8.46 \times 10^3}{100 \times 43} = 2.0\ kg/cm^2 < 3.6\ kg/cm^2 \quad O.K$$



3

### *7.1.5*

### *Disinfection Tank*

## CALCULATION FOR WATER TREAMENT PLANT STRUCTURES

**DISINFECTION TANK**

(The calculation based on Japanese standard)

### 1-GEOMETRY DIMENSIONS FOR CALCULATION

(As shown on drawings attached):

| | | |
|---|---|---|
| Ground level: | GL = | 2.20 |
| Bottom level of disinfection tank: | BL = | -2.23 |
| Water level of disinfection tank: | | 3.27 |
| Thickness of final sedimentation tank | | 0.70 m |

*And all other dimensions shown on the drawing attached*

### 2-PARAMETERS FOR CALCULATION:

Concrete: Grade C21, Rn = 70 (Kg/cm2)

RS= 3.6 (Kg/cm2)

Reinforcement type AII: Ra= 1600 (Kg/cm2)

Back fill sand: $\gamma_s$= 1.80T/m3 ; Coeficient of earth pressure at 0.5

Internal friction 20deg

### 3-LOAD CALCULATION (BASE ON JAPANESE STANDARD):

#### *3.1-Water load*

According to highest water level and bottom level as inlustrated in the drawing, water loads to be calcul and shown on the attached drawing.

#### *3.2-Live load:*

-Live load for all operating floor and walking way : $q_{live}$ = 0.50T/m2

-Horizontal uniform load due to surcharge load on ground surface:

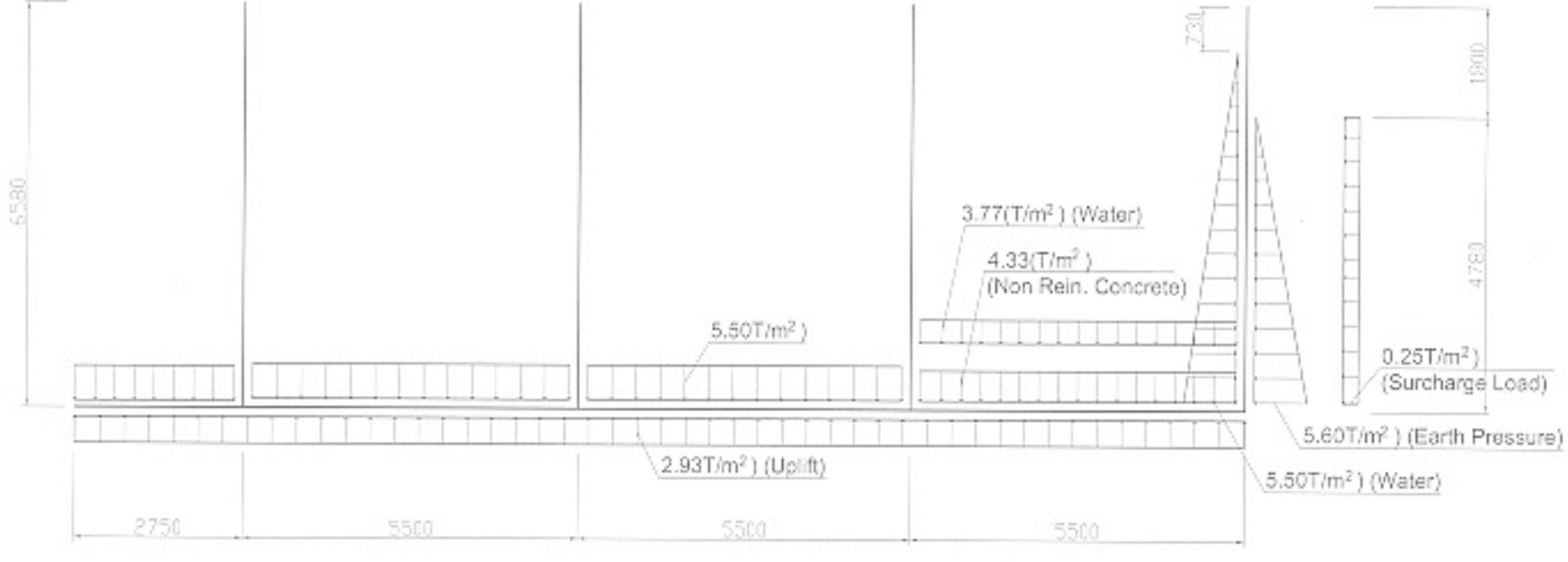
$p_{h\text{-}surch}$= 0.50T/m2xKo = 0.25T/m2

### 4-ANALYSING BY SAP 2000: THERE ARE 3 COMBOS FOR ANALYSING AS ATTACHED HEREAFTER:

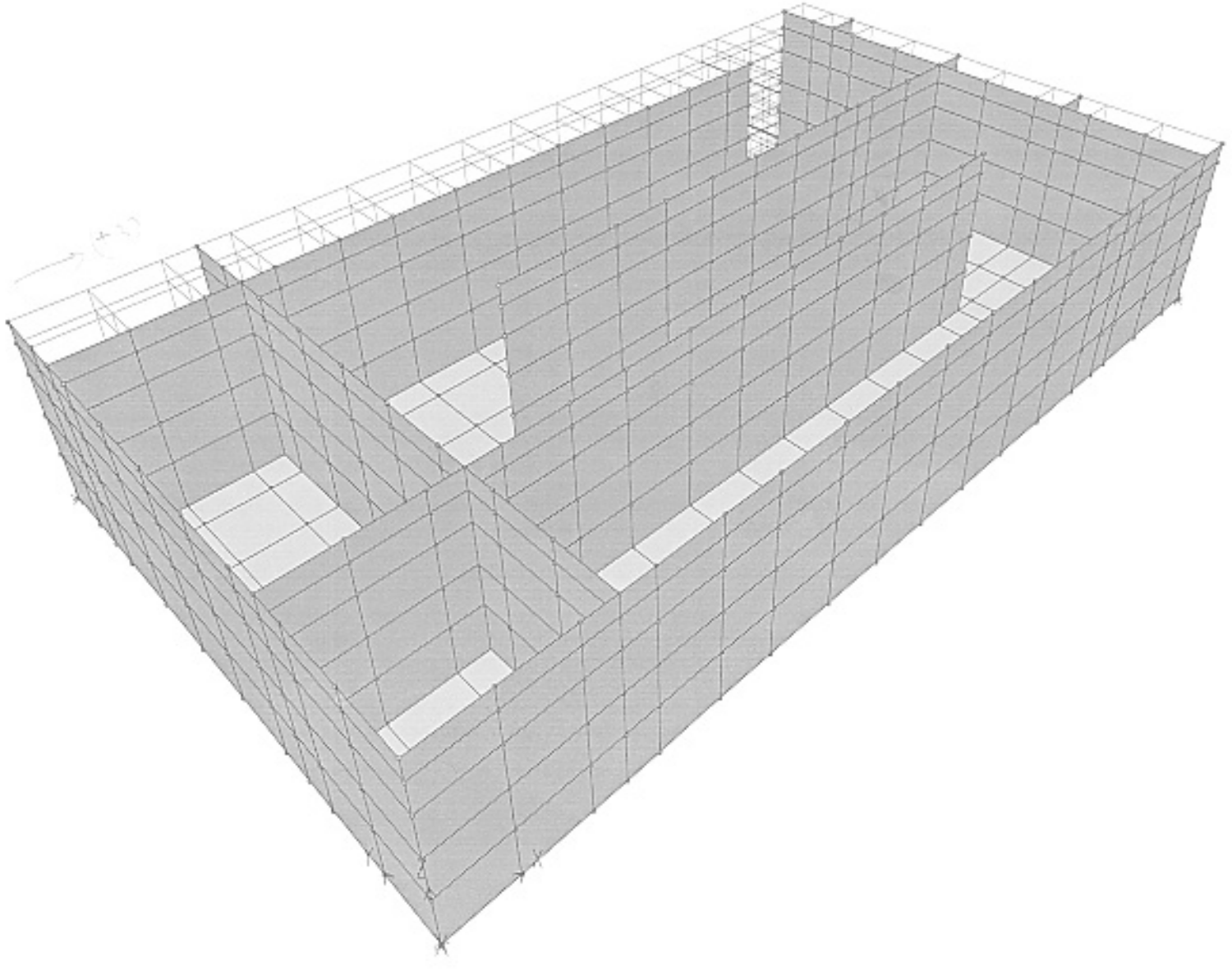
ALL THE LOADS, FACTORS, AND OTHER INPUT DATUM TO BE TAKEN IN ANALYSIS AND CALCULATED BY SAP 20

*According to combo UPLIFT, the disinfection tank can not be uplifted.*

# DISINFECTION TANK




NOTE: THIS FOR VALUES OF LOADS ONLY, COMBOS ARE TO BE CONSIDERED IN ANALYSIS BY SAP 2000



LOAD COMBINATION MULTIPLIERS

| COMBO | TYPE | CASE | FACTOR | TYPE | TITLE |
|---|---|---|---|---|---|
| COMB1 | ADD | | | | Bypass water way full of water, Disinfection tank empty |
| | | BYPASSWA | 1.0000 | STATIC(OTHER) | |
| | | SOIL | 1.0000 | STATIC(OTHER) | |
| | | SURCHARG | 1.0000 | STATIC(LIVE) | |
| | | SELF | 1.0000 | STATIC(DEAD) | |
| | | CINDERCO | 1.0000 | STATIC(DEAD) | |
| COMB2 | ADD | | | | Disinfection tank full of water, Bypass water way empty |
| | | WATER | 1.0000 | STATIC(OTHER) | |
| | | SOIL | 1.0000 | STATIC(OTHER) | |
| | | SURCHARG | 1.0000 | STATIC(LIVE) | |
| | | SELF | 1.0000 | STATIC(DEAD) | |
| | | CINDERCO | 1.0000 | STATIC(DEAD) | |
| COMB3 | ADD | | | | all tank full of water |
| | | WATER | 1.0000 | STATIC(OTHER) | |
| | | SOIL | 1.0000 | STATIC(OTHER) | |
| | | SURCHARG | 1.0000 | STATIC(LIVE) | |
| | | SELF | 1.0000 | STATIC(DEAD) | |
| | | CINDERCO | 1.0000 | STATIC(DEAD) | |
| | | BYPASSWA | 1.0000 | STATIC(OTHER) | |
| ENVE | ENVE | | | | MAX MIN OF ALL COMBOS FOR CALCULATING BAR ARRANGEMENT |
| | | COMB1 | 1.0000 | COMBO | |
| | | COMB2 | 1.0000 | COMBO | |
| | | COMB3 | 1.0000 | COMBO | |

**5-CALCULATION FOR BAR ARRANGEMENT:**

**Base on attached results of shell forces analised by SAP2000, choosing the most dangerous forces for calculation:**

$A_o = M/R_n b h_o^2$ Where, M: Maximum bending moment(T.m)

$h_o$: Effective depth of bearing area(cm)

$h_o$= (Element thickness-Cover thickness)

b: Width of calculated area(cm)

Required area of reinforcement:

Fa= M/γRaho Where: $\gamma = 0.5 + ((1-2Ao)^{1/2})/2$

**5-1 SLABS AND WALLS:**

| Moments | Values (T.m) | Ao | γ | $F_a$ ($cm^2$) | Bar arrangement | | Remarks |
|---|---|---|---|---|---|---|---|
| | | | | | ϕ(mm) | a(mm) | |
| (Bottom | 21.150 | 0.0898 | 0.953 | 23.92 | 24 | 150 | *125* |
| Slab level | 13.400 | 0.0482 | 0.975 | 14.81 | 24 | 250 | |
| -2.23) | -20.220 | 0.0728 | 0.962 | 20.85 | 20 | 125 | |
| 0.7 | -5.600 | 0.0202 | 0.990 | 5.61 | 20 | 250 | |

| Moments | Values (T.m) | Ao | γ | $F_a$ ($cm^2$) | Bar arrangement | | Remarks |
|---|---|---|---|---|---|---|---|
| | | | | | ϕ(mm) | a(mm) | |
| Outside wall | 20.200 | 0.1561 | 0.915 | 32.10 | 24 | 125 | |
| (longitudinal | -21.250 | 0.1642 | 0.910 | 33.95 | 24 | 125 | |
| wall) | -8.700 | 0.0672 | 0.965 | 13.10 | 16 | 125 | |
| 0.5 | 13.600 | 0.1051 | 0.944 | 20.93 | 20 | 125 | *not in dwg* |
| Wall of | 10.700 | 0.0827 | 0.957 | 16.25 | 18 | 125 | |
| bypass | -5.500 | 0.0425 | 0.978 | 8.17 | 14 | 150 | *125* |
| Water way | 6.400 | 0.0494 | 0.975 | 9.54 | 14 | 125 | |
| 0.5 | -7.600 | 0.0587 | 0.970 | 11.39 | 14 | 125 | |
| Partition | 19.500 | 0.1507 | 0.918 | 30.88 | 24 | 125 | |
| Wall | 11.600 | 0.0896 | 0.953 | 17.69 | 18 | 125 | |
| | -18.900 | 0.1460 | 0.921 | 29.84 | 22 | 125 | |
| 0.5 | -11.420 | 0.0882 | 0.954 | 17.40 | 18 | 125 | |
| Temporary | -14.800 | 0.1143 | 0.939 | 22.91 | 20 | 125 | |
| Wall | 10.600 | 0.0819 | 0.957 | 16.10 | 16 | 100 | |
| | -10.500 | 0.0811 | 0.958 | 15.94 | 16 | 125 | |
| 0.5 | 11.100 | 0.0858 | 0.955 | 16.89 | 18 | 125 | *not in dwg* |

## 6- CALCULATION FOR PILE QUANTITY (as attached sheets):

(Pile number to be decided by pile calculation sheet, please refer to pile calculation sheet for more information)

## 7- CHECKING UPLIFT IN CASE GROUND WATER LEVEL UPTO +2.2

SAP2000 v6.11 File: DISIN_PILE Ton-m Units PAGE 1
March 28, 2001 11:25
L O A D C O M B I N A T I O N M U L T I P L I E R S

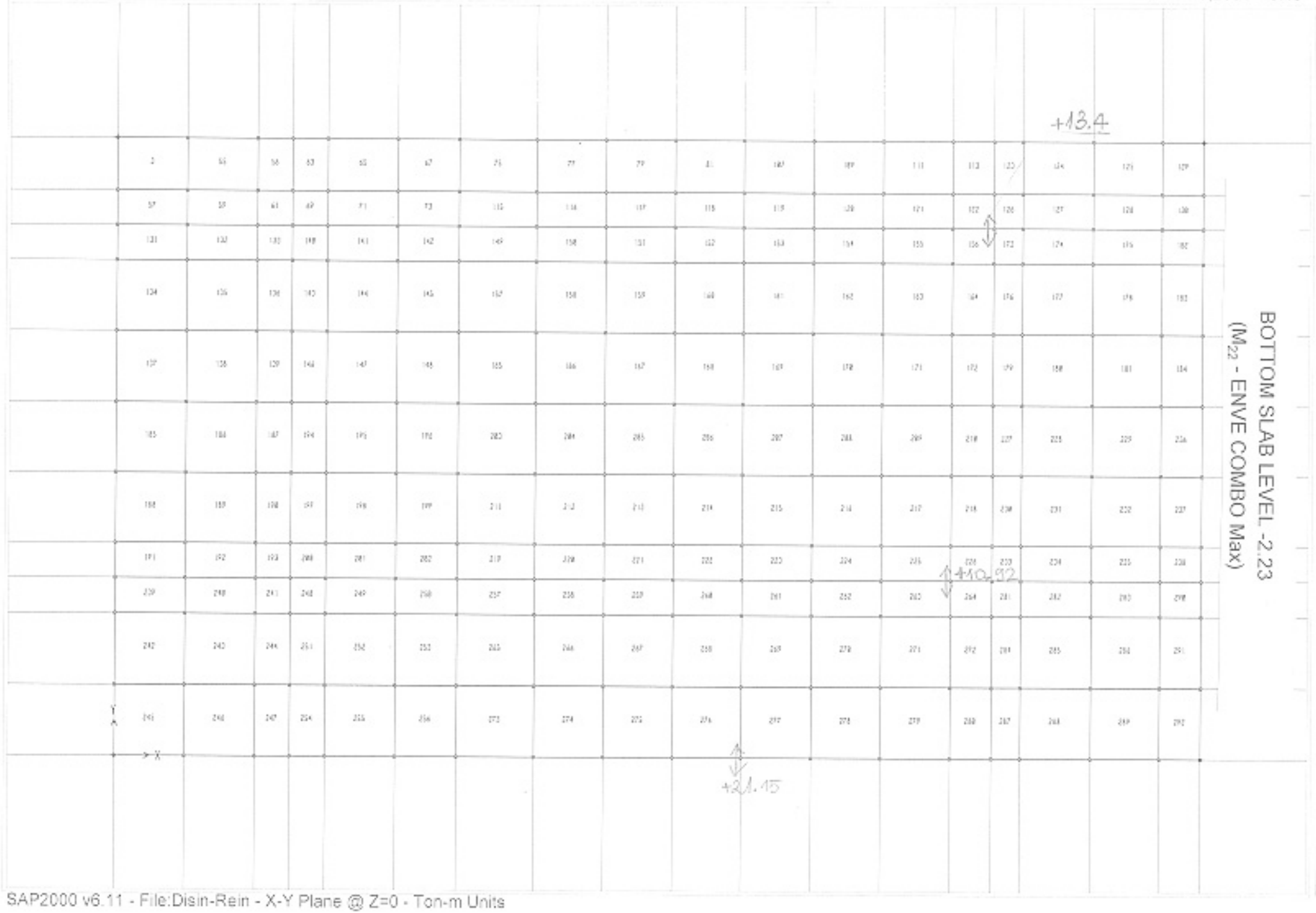
| COMBO | TYPE | CASE | FACTOR | TYPE | TITLE |
|---|---|---|---|---|---|
| UPLIFT | ADD | | | | Checking uplift , when ground water level up to +2.2 |
| | | SELF | 1.0000 | STATIC(DEAD) | |
| | | CINDERCO | 1.0000 | STATIC(DEAD) | |
| | | UPLIFT | 1.0000 | STATIC(OTHER) | |

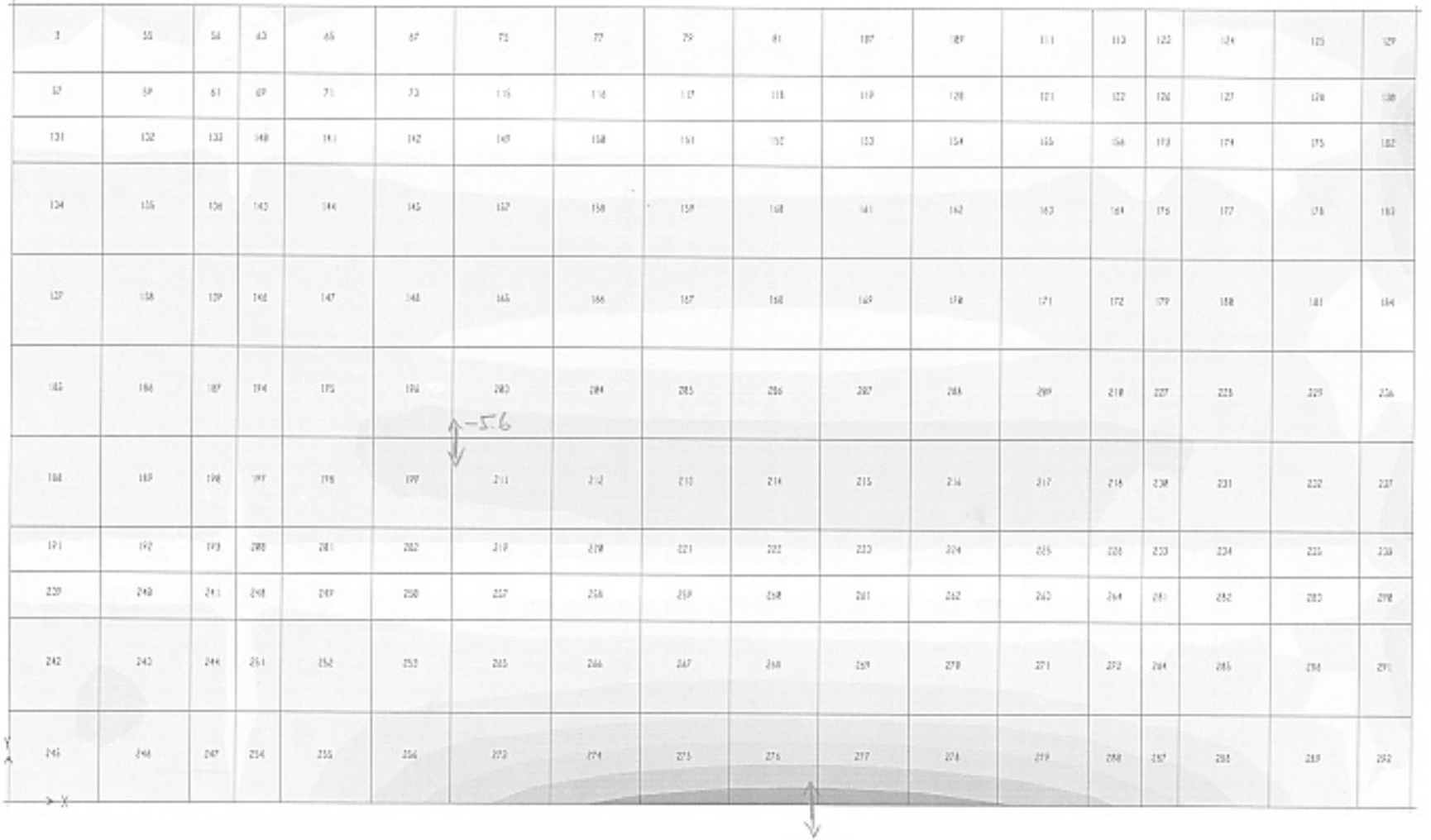
SAP2000 v6.11 File: DISIN_PILE Ton-m Units PAGE 2
March 28, 2001 11:25

J O I N T R E A C T I O N S

| JOINT | LOAD | F1 | F2 | F3 | M1 | M2 | M3 |
|---|---|---|---|---|---|---|---|
| 11 | UPLIFT | 87.2393 | 82.1116 | -272.8340 | 0.0000 | 0.0000 | 0.0000 |
| 29 | UPLIFT | -100.3916 | 145.8210 | -218.5379 | 0.0000 | 0.0000 | 0.0000 |
| 31 | UPLIFT | -122.3266 | -89.5038 | 93.7949 | 0.0000 | 0.0000 | 0.0000 |
| 32 | UPLIFT | 135.4789 | -138.4288 | 88.5533 | 0.0000 | 0.0000 | 0.0000 |

Total uplift upto the bottom slab = -309.02 Ton
Tensile capacity of one pile as calculated is 20 ton (In case the pile be pulled up)
So the number of piles needed for preventing structure from uplifting is : 15.5 piles
, but as number of piles calculated and arranged on DWG No.: PE-254-01 is 144 piles
for disinfection tank of phase 1, so uplift will never occur

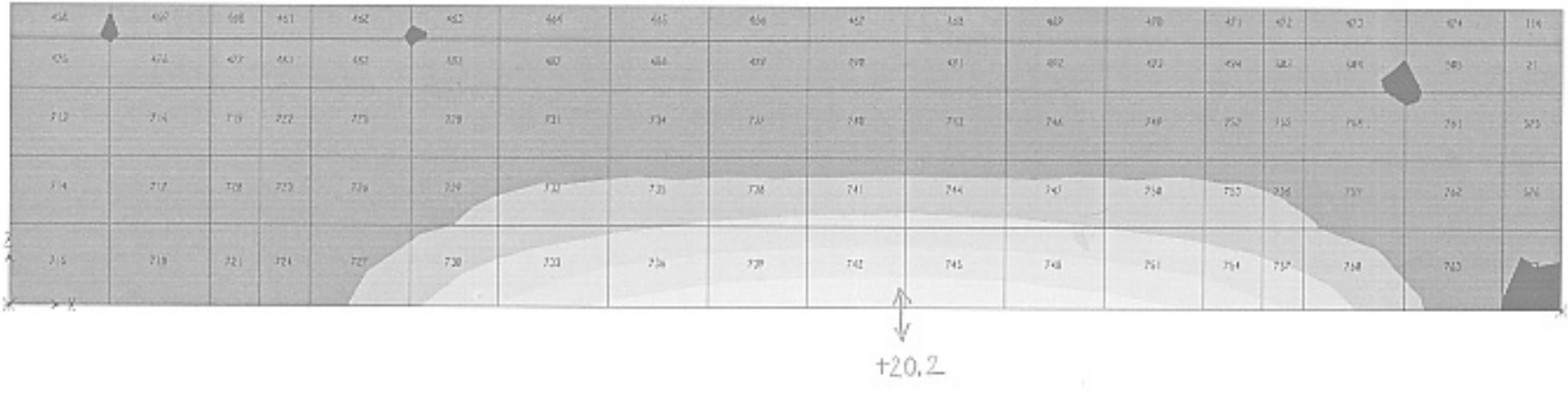

+13.4
+10.92
+21.15
BOTTOM SLAB LEVEL -2.23
(M22 - ENVE COMBO Max)
Y
X




BOTTOM SLAB LEVEL -2.23
($M_{22}$ - ENVE COMBO Min)

-21.0 -17.5 -14.0 -10.5 -7.0 -3.5 0.0 3.5 7.0

SAP2000 v8.11 - File:Disin-Rein - Resultant M22 Diagram (ENVE) - Ton-m Units

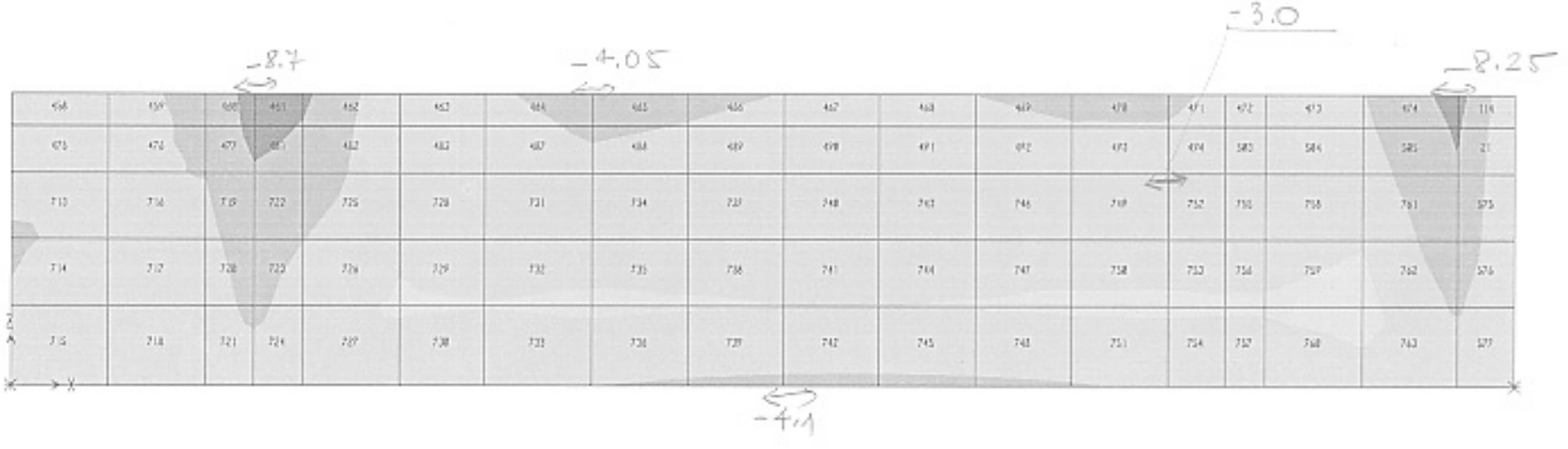



OUTSIDE WALL (Y=0)

( ENVE COMBO Max ($M_{22}$ ))

0.0 4.0 8.0 12.0 16.0 20.0 24.0 28.0 32.0

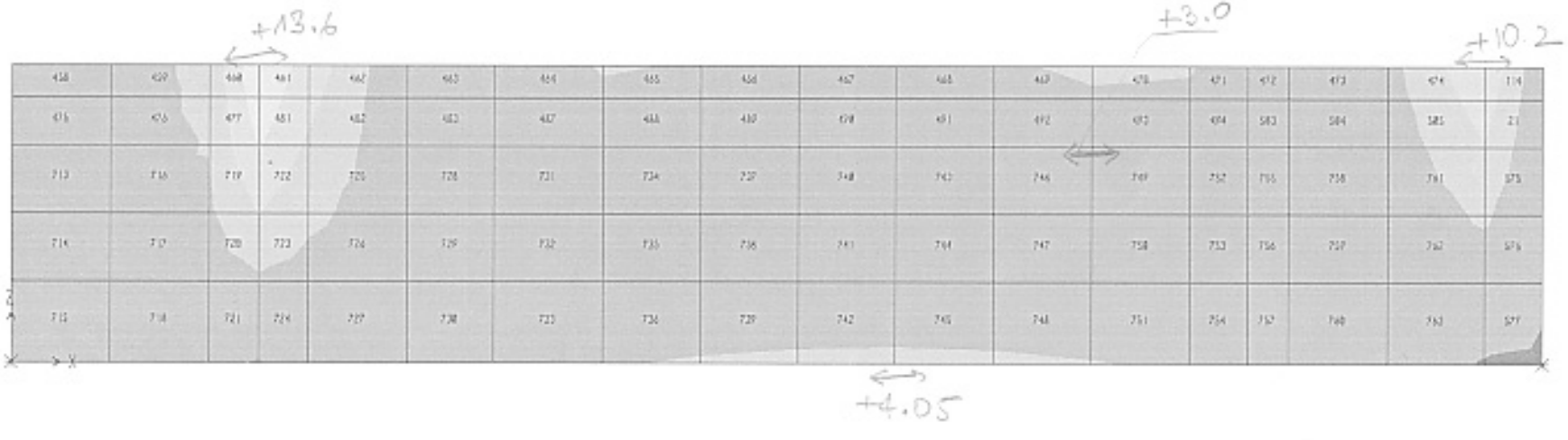
SAP2000 v6.11 - File:Disin-Rein - Resultant M22 Diagram (ENVE) - Ton-m Units




OUTSIDE WALL (Y=0)
( ENVE COMBO Min ($M_{11}$ ))

-10.5 -7.0 -3.5 0.0 3.5 7.0 10.5 14.0 17.5

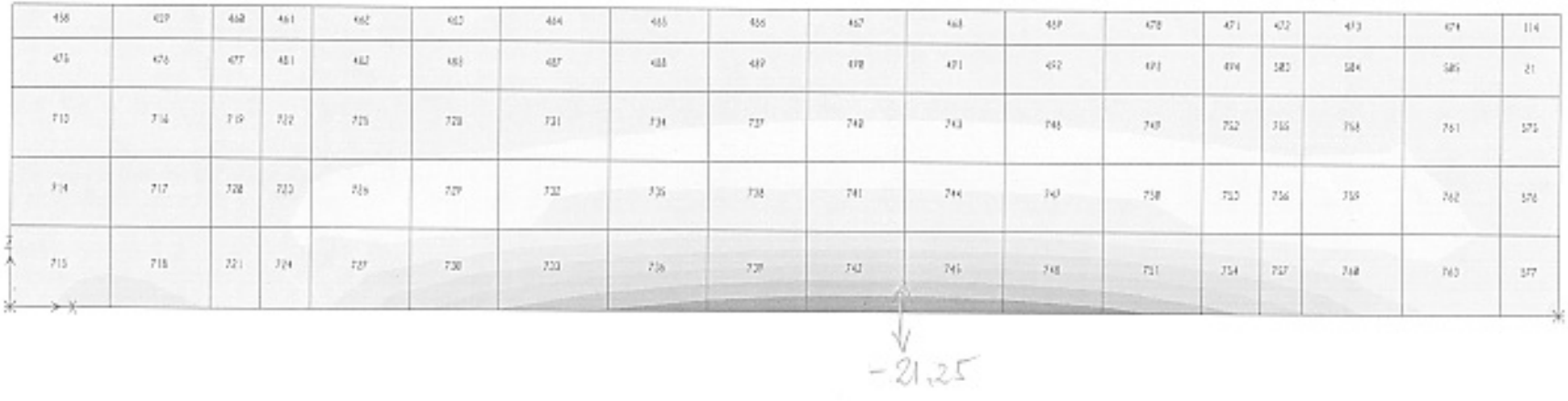
SAP2000 v6.11 - File:Disin-Rein - Resultant M11 Diagram (ENVE) - Ton-m Units




OUTSIDE WALL (Y=0)
( ENVE COMBO Max ($M_{11}$ ))

-3.5 0.0 3.5 7.0 10.5 14.0 17.5 21.0 24.5

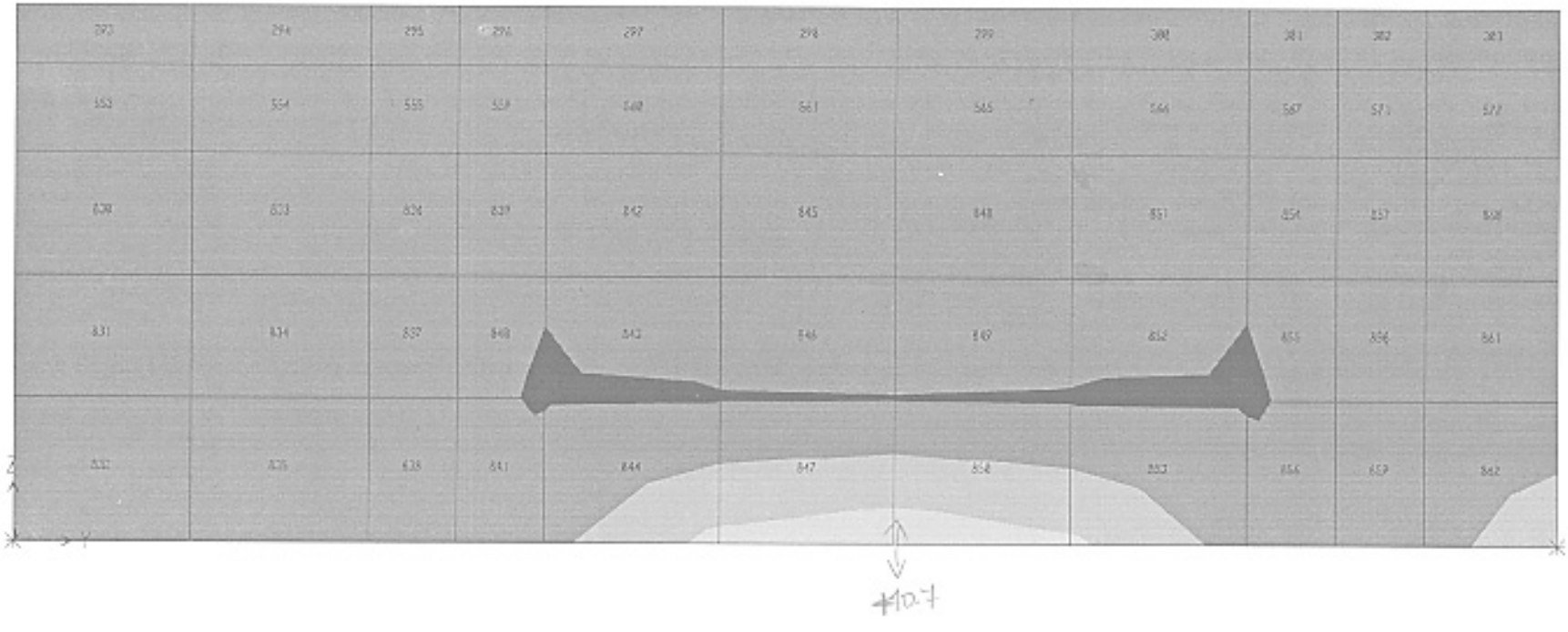
SAP2000 v6.11 - File:Disin-Rein - Resultant M11 Diagram (ENVE) - Ton-m Units




OUTSIDE WALL (Y=0)
( ENVE COMBO Min ($M_{22}$ ))

-21.0 -17.5 -14.0 -10.5 -7.0 -3.5 0.0 3.5 7.0

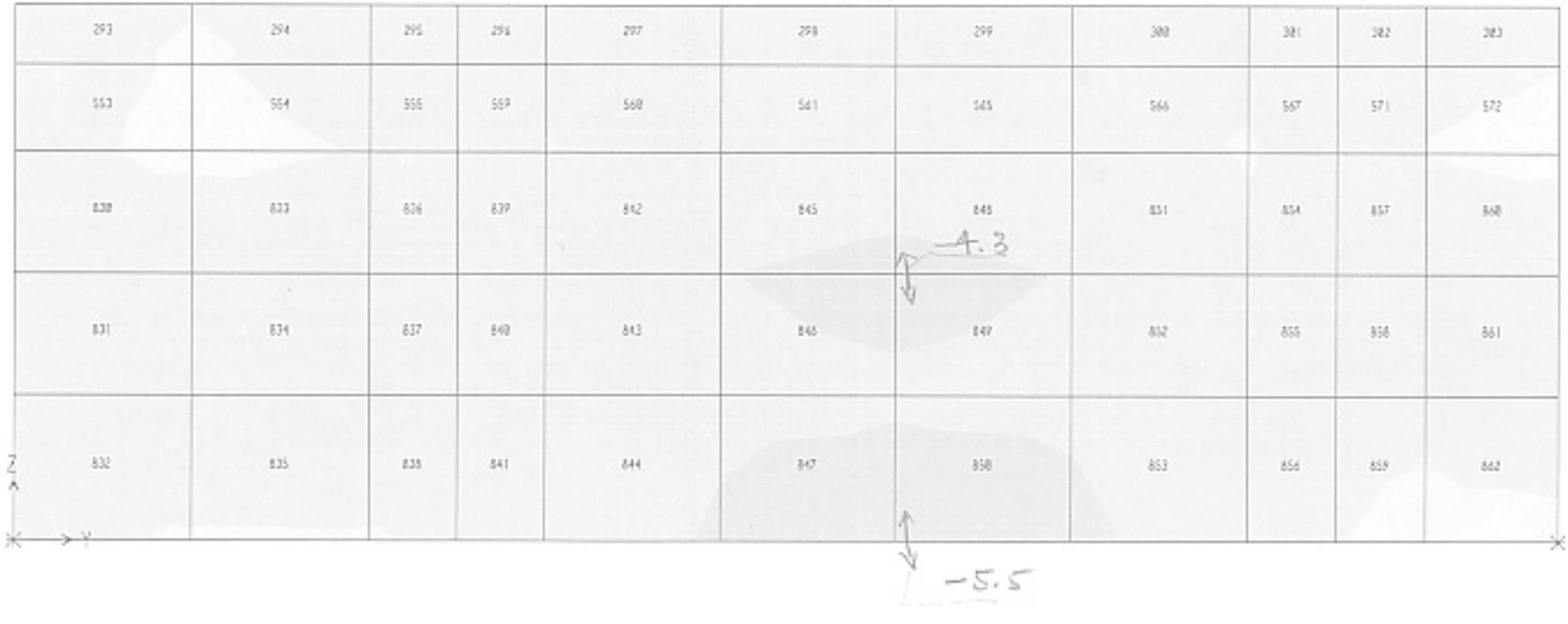
SAP2000 v6.11 - File:Disin-Rein - Resultant M22 Diagram (ENVE) - Ton-m Units



OUTSIDE WALL OF BYPASS WATER WAY (X=0)
( ENVE COMBO Max ($M_{22}$ ))

0.0 4.0 8.0 12.0 16.0 20.0 24.0 28.0 32.0

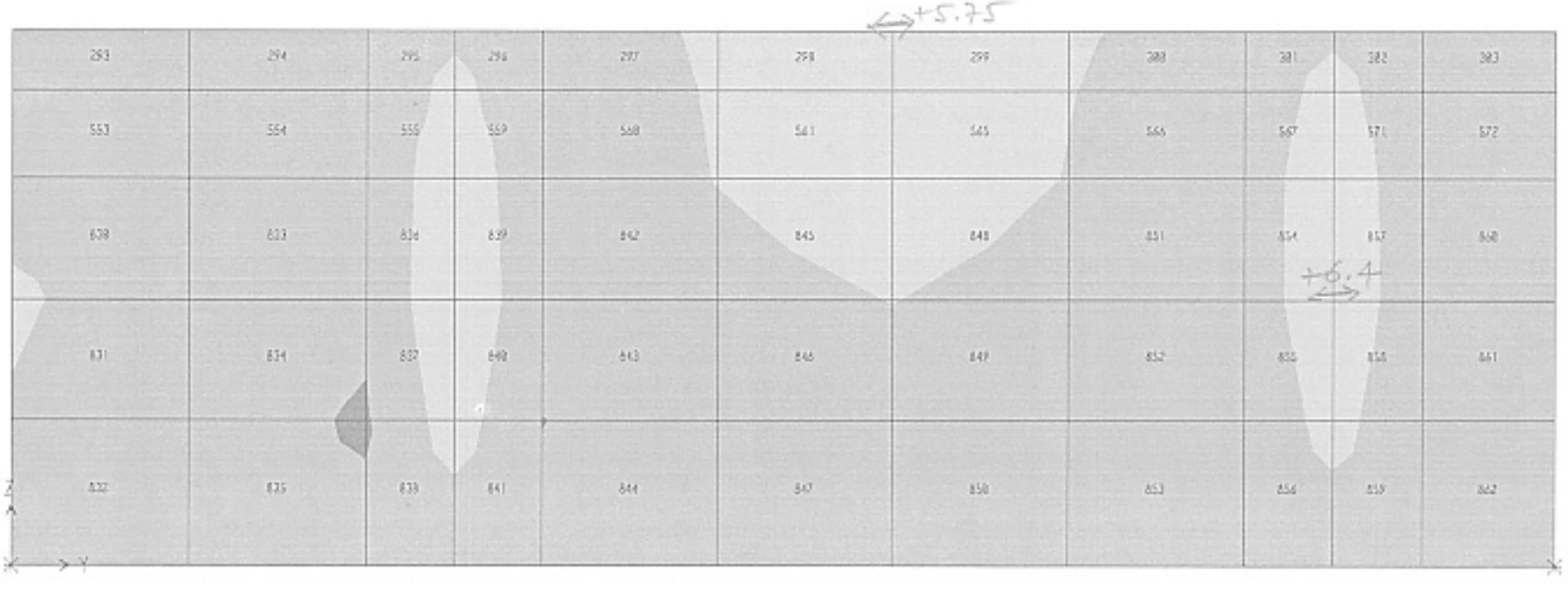
SAP2000 v6.11 - File:Disin-Rein - Resultant M22 Diagram (ENVE) - Ton-m Units




OUTSIDE WALL OF BYPASS WATER WAY
( ENVE COMBO Min ($M_{22}$ ))

-21.0 -17.5 -14.0 -10.5 -7.0 -3.5 0.0 3.5 7.0

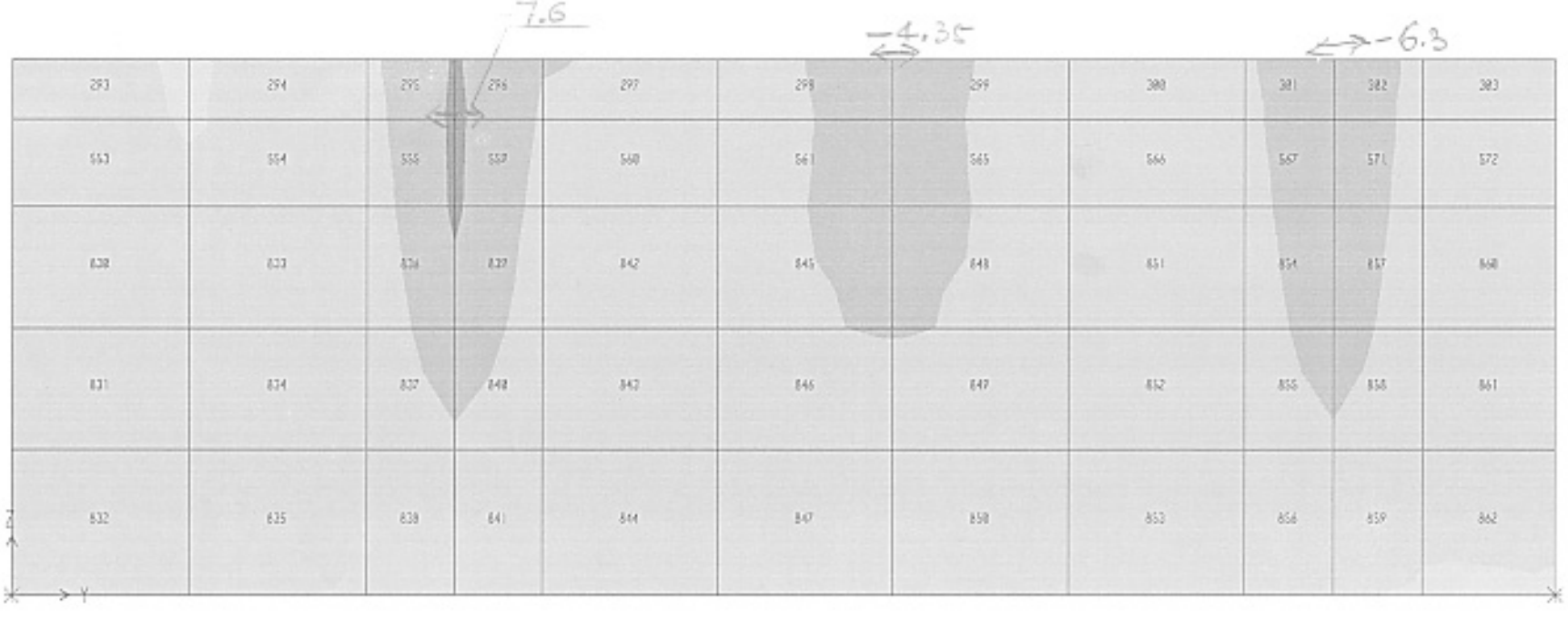
SAP2000 v6.11 - File:Disin-Rein - Resultant M22 Diagram (ENVE) - Ton-m Units




OUTSIDE WALL OF BYPASS WATER WAY
( ENVE COMBO Max ($M_{11}$ ))

-3.5 0.0 3.5 7.0 10.5 14.0 17.5 21.0 24.5

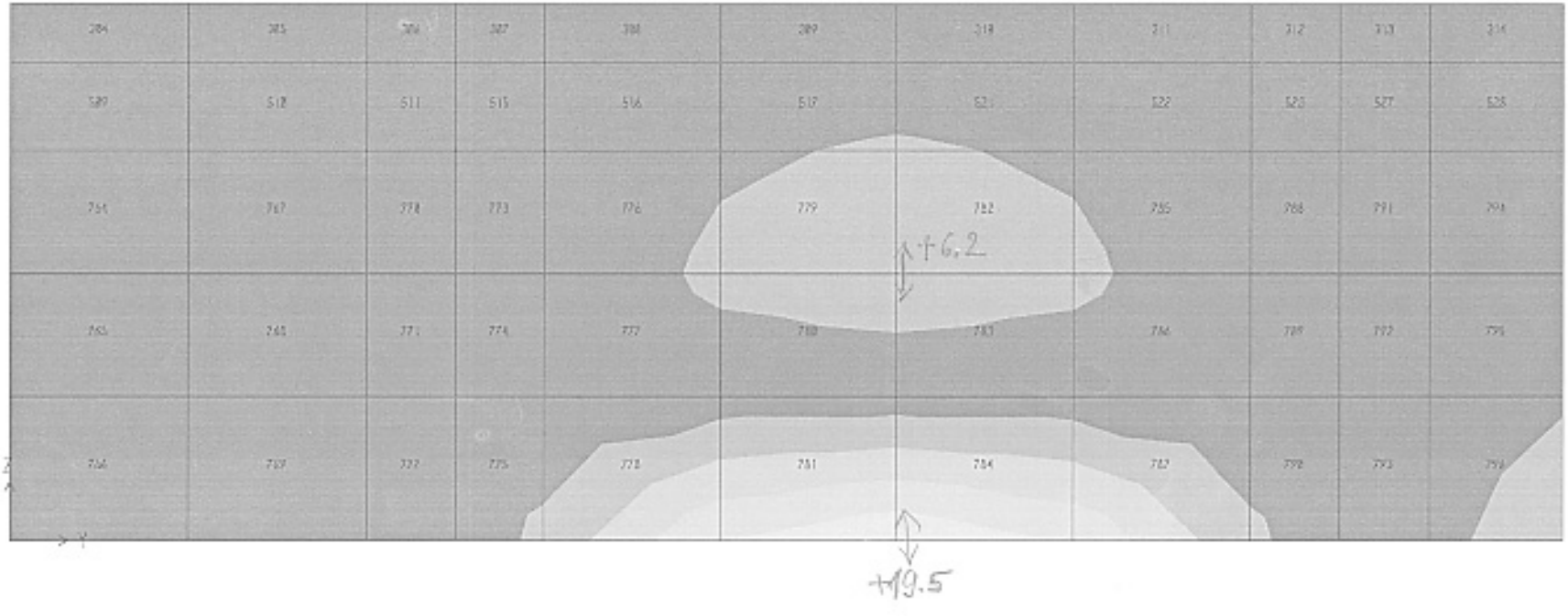
SAP2000 v6.11 - File:Disin-Rein - Resultant M11 Diagram (ENVE) - Ton-m Units




OUTSIDE WALL OF BYPASS WATER WAY (X=0)
( ENVE COMBO Min ($M_{11}$ ))

-10.5 -7.0 -3.5 0.0 3.5 7.0 10.5 14.0 17.5

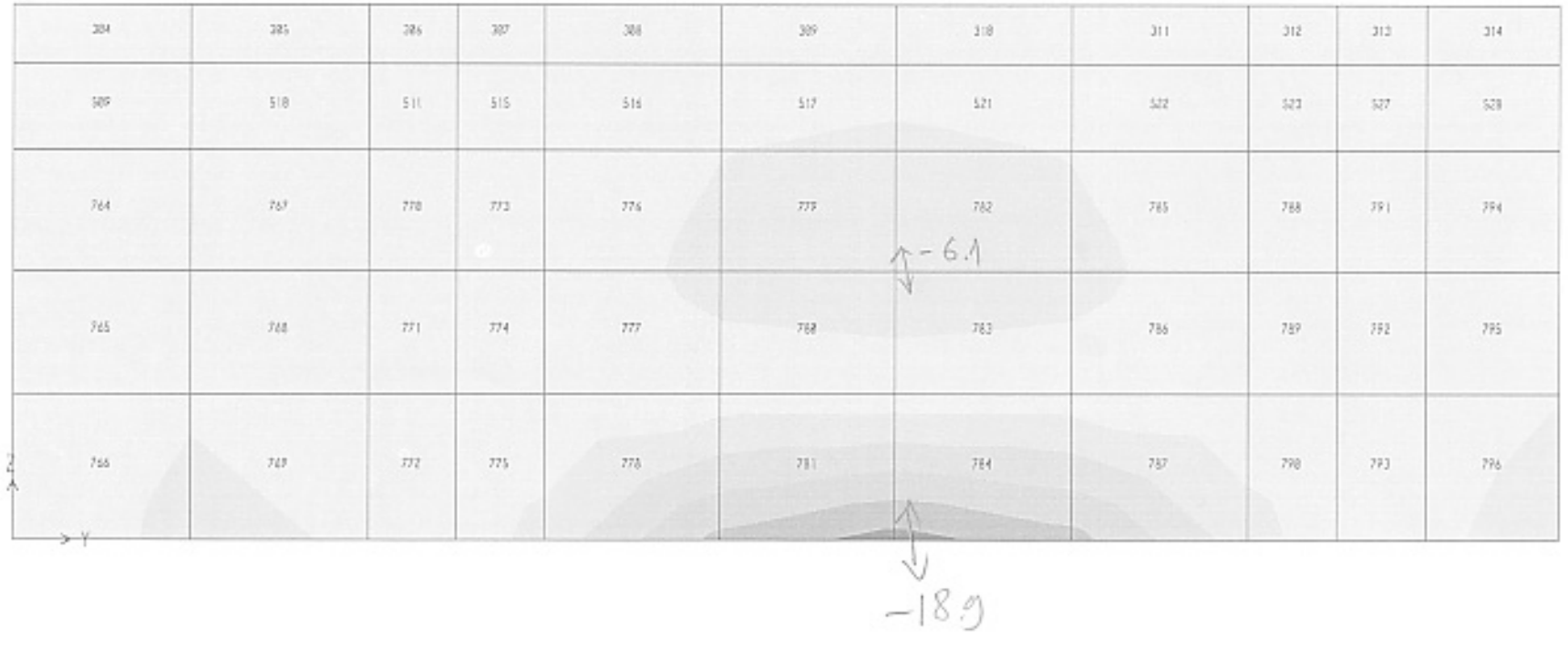
SAP2000 v6.11 - File:Disin-Rein - Resultant M11 Diagram (ENVE) - Ton-m Units




DISINFECTION TANK PARTITION WALL (X=+5.5)
( ENVE COMBO Max ($M_{22}$ ))

0.0 4.0 8.0 12.0 16.0 20.0 24.0 28.0 32.0

SAP2000 v6.11 - File:Disin-Rein - Resultant M22 Diagram (ENVE) - Ton-m Units

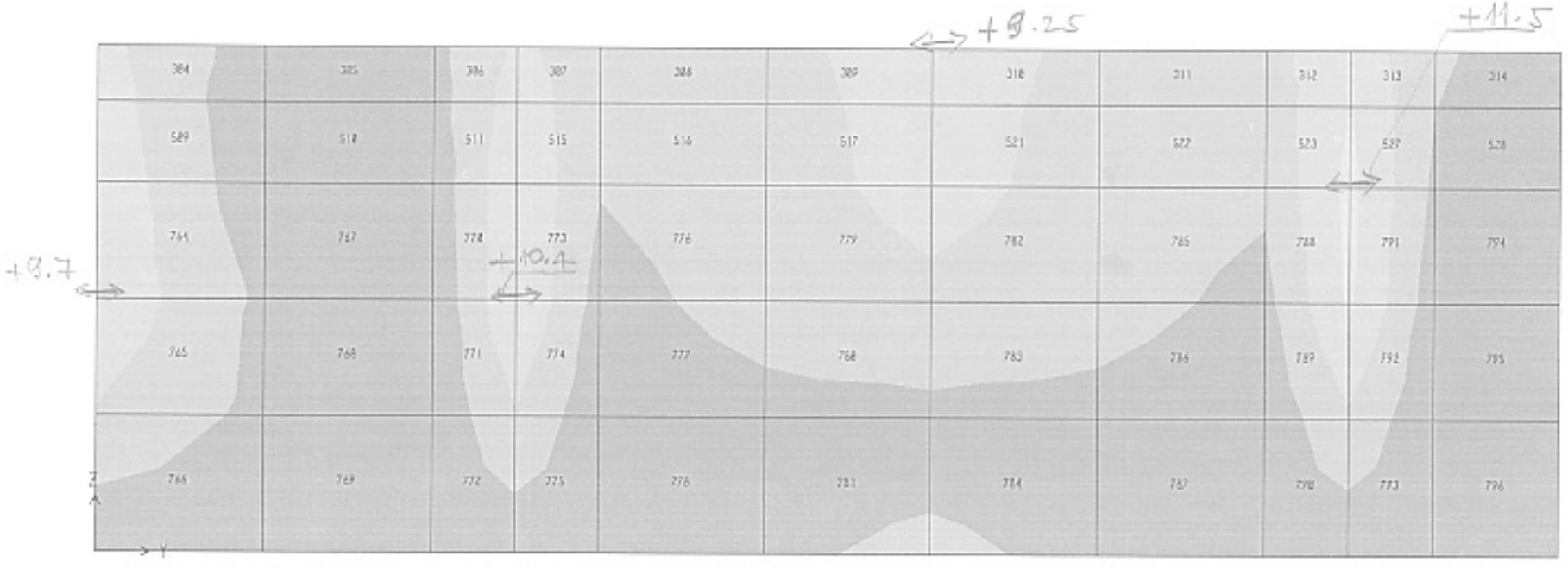



DISINFECTION TANK PARTITION WALL (X=+5.5)

( ENVE COMBO Min ($M_{22}$ ))

-21.0 -17.5 -14.0 -10.5 -7.0 -3.5 0.0 3.5 7.0

SAP2000 v6.11 - File:Disin-Rein - Resultant M22 Diagram (ENVE) - Ton-m Units

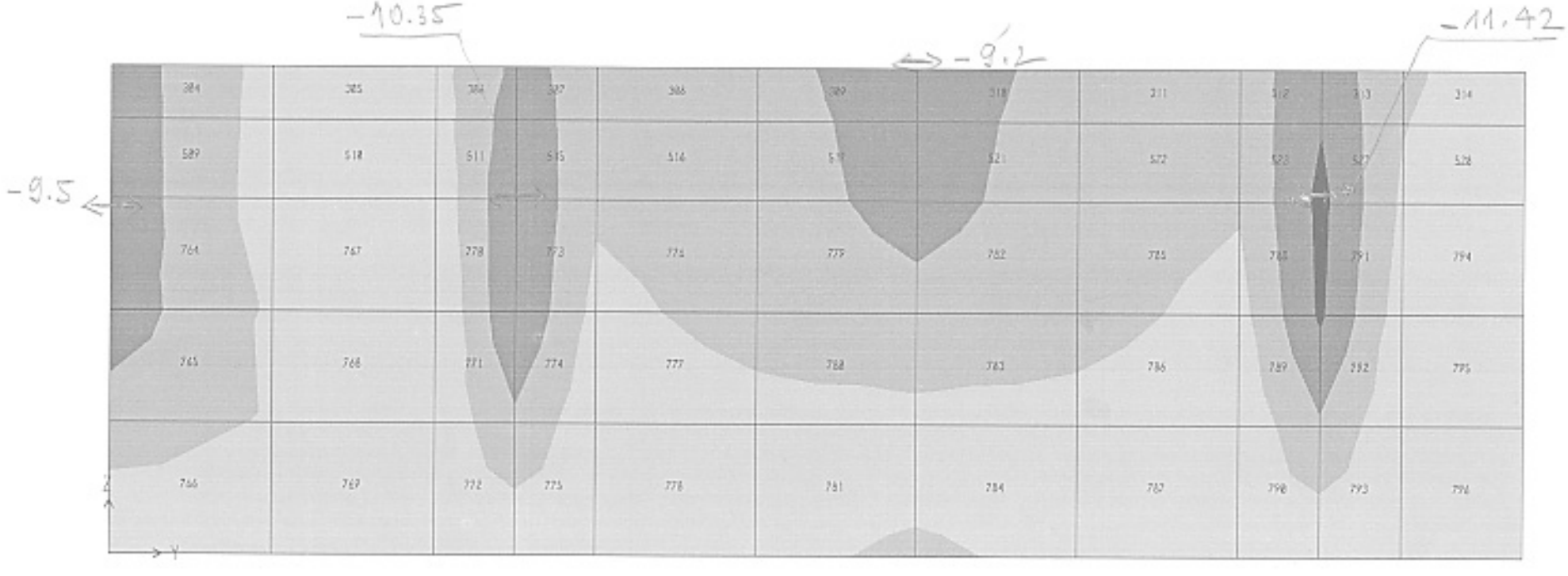



DISINFECTION TANK PARTITION WALL (X=+5.5)

( ENVE COMBO Max ($M_{11}$ ))

-3.5 0.0 3.5 7.0 10.5 14.0 17.5 21.0 24.5

SAP2000 v6.11 - File:Disin-Rein - Resultant M11 Diagram (ENVE) - Ton-m Units




DISINFECTION TANK PARTITION WALL (X=+5.5)
( ENVE COMBO Min ($M_{11}$ ))

-10.5 -7.0 -3.5 0.0 3.5 7.0 10.5 14.0 17.5

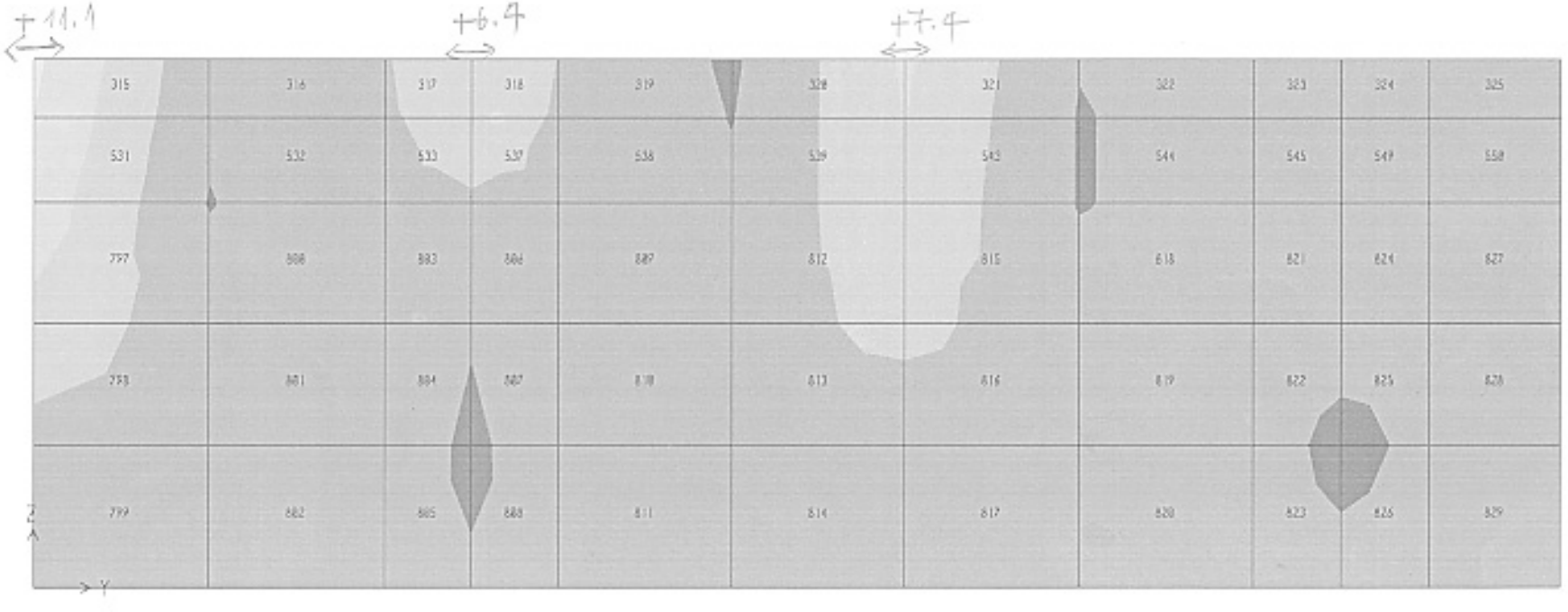
SAP2000 v6.11 - File:Disin-Rein - Resultant M11 Diagram (ENVE) - Ton-m Units


TEMPORARY WALL (X=+32.95)
( ENVE COMBO Max ($M_{22}$ ))


TEMPORARY WALL (X=+32.95)
( ENVE COMBO Min ($M_{22}$ ))

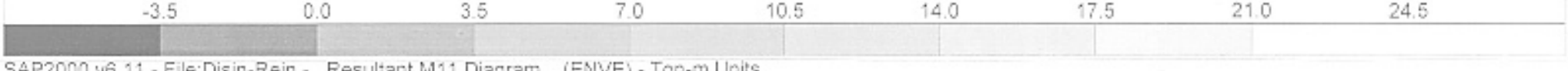
-21.0 -17.5 -14.0 -10.5 -7.0 -3.5 0.0 3.5 7.0

SAP2000 v6.11 - File:Disin-Rein - Resultant M22 Diagram (ENVE) - Ton-m Units

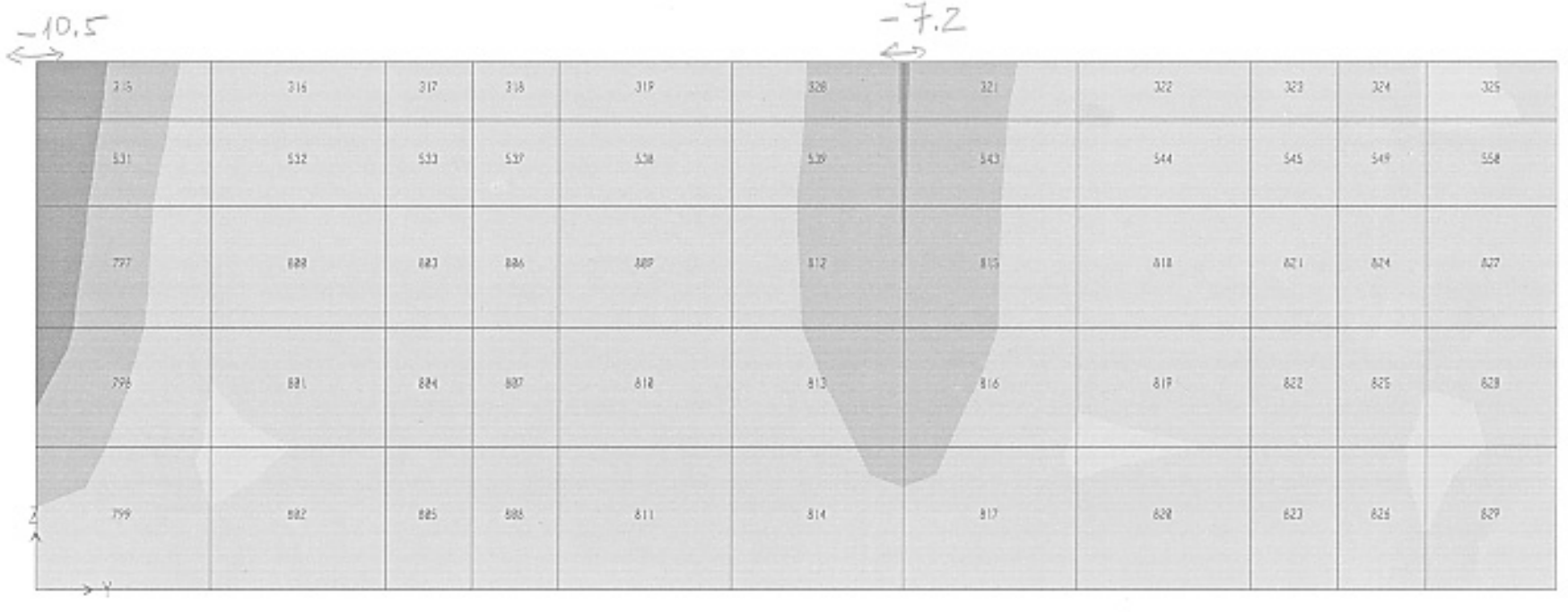



TEMPORARY WALL (X=+32.95)

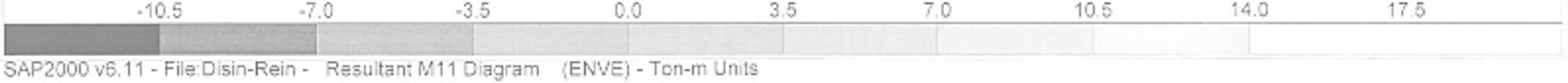
( ENVE COMBO Max ($M_{11}$ ))




SAP2000 v6.11 - File:Disin-Rein - Resultant M11 Diagram (ENVE) - Ton-m Units




TEMPORARY WALL (X=+32.95)
( ENVE COMBO Min ($M_{11}$ ))




SAP2000 v6.11 - File:Disin-Rein - Resultant M11 Diagram (ENVE) - Ton-m Units

SAP2000 v6.11 File: DISIN_PILE Ton-m Units PAGE 1
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DISINFECTION TANK
REACTIONS FOR CALCULATING PILE QUANTITY

L O A D  C O M B I N A T I O N  M U L T I P L I E R S

| COMBO | TYPE | CASE | FACTOR | TYPE | TITLE |
|---|---|---|---|---|---|
| PILECOM | ADD | | | | all tanks full of water |
| | | BYPASSWA | 1.0000 | STATIC(DEAD) | |
| | | WATER | 1.0000 | STATIC(DEAD) | |
| | | SELF | 1.0000 | STATIC(DEAD) | |
| | | CINDERCO | 1.0000 | STATIC(DEAD) | |

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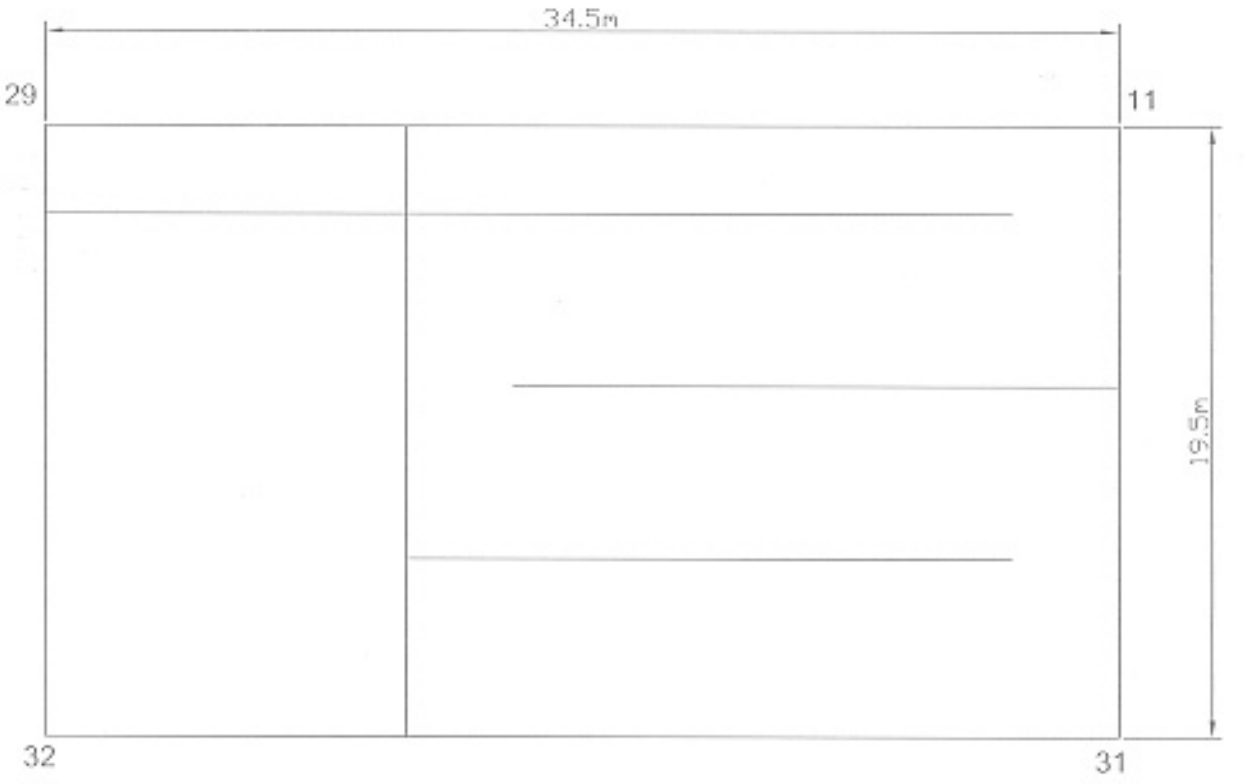
J O I N T  R E A C T I O N S

| JOINT | LOAD | F1 | F2 | F3 | M1 | M2 | M3 |
|---|---|---|---|---|---|---|---|
| 31 | PILECOM | -326.6234 | -365.8300 | 1351.1119 | 0.0000 | 0.0000 | 0.0000 |
| 29 | PILECOM | 409.0375 | -911.5520 | 1434.6942 | 0.0000 | 0.0000 | 0.0000 |
| 31 | PILECOM | -1527.1986 | 375.0677 | 1335.3442 | 0.0000 | 0.0000 | 0.0000 |
| 32 | PILECOM | 1444.7845 | 1220.0893 | 1304.1404 | 0.0000 | 0.0000 | 0.0000 |

$\Sigma = 6425.912$




Preaction = $\frac{6425.912}{34.5*19.5}$ =9.552(T/m²)

Pile capacity = 45 ton⇒ one pile can be used for an area of 4.71m²

⇒ R.C pile to be arranged as on drawing No. -PE - WWTP - 254 - 01