4.1.3

Pumping Station

CALCULATION FOR INTERMEDIATE PUMPING STATION

1.MATERIAL PROPERTIES AND SOIL CONDTION

Ground water level	GWL =	+0.2
Concrete: Grade 250,	Rn =	70 kg/cm^2
Reiforcement type JIS:	Rk =	3.6 kg/cm^2
	Ra =	1600 kg/cm^2
Backfill sand:	γ_s =	1.80 T/m^3
Coeficient of earth pressure at rest	K_o =	0.5
Internal friction angle		20°

2. SEFT LOAD

2.1 Slab at elevation +2.3m

As = [(20.6x 17.2)+ (20.6+ 24.4)/2x3.5+(9.1x 24.4) = 655.11m^2

Ws = [(20.6x 17.2)+ (20.6+ 24.4)/2x3.5+(9.1x 24.4) - 76]x 0.3x 2.5 = 434.33T

In control room: Thickness of sinder concrete is 0.2m

Wsi = 6.6x 8.2x 2.35x 0.2 = 33.53 T

2.2 Slab at elevation -3.7m

Thickness of reinforced concrete is 0.3m

Thickness of sinder concrete is 0.4m in electrical room

Ws =434.33+ (2.35x 0.4x 19.1x 12.3) = 655.16T

2.3 Slab at elevation -10m

Ws = [655.11- (11.55+ 17x 2.5)]x 0.3x 2.5 = 450.79T

2.4 Bottom slab

Wb = [655.11+ (20.6+24.4)/2x (4.6- 3.5)] x 1.2x 2.5 2039.58 T

2.5 Beams

Beam at elevation +2.3m

Wb = [(6.6+ 6.4+ 6.7+ 6.1)x 4+ 6.7+ 6.1]x 0.4x 0.7 81.2 T

0.4x 0.4x 18x 3.5x 2.5 = 25.2 T

Beam at elevation -10.0m

0.4x 0.7x 6.1x 2.5x 5 = 21.35 T

Beam at level -3.7m = 113.34 T

2.6 Columns

0.6x 0.6x (5+ 5.3)x 17x 2.5 = 157.59 T

0.8x 0.6x (5+ 5.3)x 5x 2.5 = 61.8 T

2.7 Walls

Wall at elevation -17m

0.6x 7x 6.7x 5x 2.5 = 351.75 T

Wall at elevation -14m

0.6x 10.5x 3.7x 3x 2.5 = 174.8 T

Wall thickness = 0.5m

3x 0.5x 3x 15.8x 2.5 = 177.75 T

Wall thickness = 0.6m

13.8x 2x 0.6x 3.7x 2.5 = 153.18 T

13.2x 15.5x 0.6x 2.5 = 306.9 T

5.3x (6.7+ 3.7)/2x 0.6x 2x 2.5 = 82.68 T

Total weight = 5320.93 T

3. LOADING AND CACULATION SCHEME

3.1 Loading to slab at elevation +2.5m

Thickness of reinforced concrete slab is 0.3m

$W_s = 0.3 \times 2.5$ = $0.75\ T/m^2$

Live load = $0.5\ T/m^2$

In control room

Reinforced concrete slab = $0.75\ T/m^2$

Thickness of sinder concrete is 0.2m : 0.2x2.35 = $0.47 T/m^2$

Live load + weight of equipment = $2.0\ T/m^2$

Total weight = $3.32\ T/m^2$

3.2 Loading to slab at elevation -3.7m

Total = $1.25\ T/m^2$

In electrical

Total = $3.69\ T/m^2$

3.3 Loading to slab at elevation -10m

Total = $1.25\ T/m^2$

3.4 Loading to bottom slab

Ground water pressure up to bottom slab: GWL = +0.2m

At elevation -18.2m

$P_w = (18.2 + 0.2) \times 1$ = $18.4\ T/m^2$

At elevation -15.2m

$P_w = (15.2 + 0.2) \times 1$ = $15.4\ T/m^2$

3.5 Loading due to building = 475 T

3.6 Loading due to equipment = 356.25 T

3.7Checking uplift that due to ground water

In case ground water level at +0.20

$P_{uplift} = P_{up1} + P_{up2} + P_{up3}$

20.6x16.9x15.4+(20.6+24.4)/2x3.5x(18.4+15.4)/2+

9.1x24.4x18.4 = 10777.7T

Total: $W_{of\ structure} + W_{of\ buil} + W_{of\ diaphragm}$

5320.93+475+36.5x1.5x(2.5-1)x10: 14492.97.54T>Puplift=10777.7T

The perimeter of diaphragm is 105.9m

Length of diaphragm is 36.5m

4. GRIT CHAMBER

4.1 Self load

Wall 1

[0.65x 0.15+ 0.4x 3.55+ (0.9x 0.15+ 0.4x 3.55)x

1.5+ 0.5x 22]x 24.4x 2.5 = 1145.37 T

2.9x 0.4x 3.6x 22x 2.5 = 229.7 T

Slab [4.2x (2.2+25.4)/2 + 2.5x 22+ 4x 22]x 0.3x 2.5 = 181.9 T

Wall 2 $(4.2^2 + 1.52^2)^{1/2} \times 2 \times 0.4 \times 2.9 \times 2.5$ = 25.9 T

0.4x2.5x2.9x5x2.5 = 36.25T

Bottom [(22+ 25.4)/2 x4.2+ 22x 2.5+ 4x 22]x 0.5x 2.5 = 261.92T

Total **1881.04T**

Load of water inside at elevation +0.61m

808.77x 2m = 1617.5 T

Load of equipment

21Tx 2 = 42 T

Live load to slab $=0.5T/m^2$

0.5x 1.3x 242.54 = 157.65 T

4.2 Loading and calculation scheme

4.2.1 Vehicle load

Horizontal vehicle load from both side of the grit chamber

$1\ T/m^2 \times 0.5$ = $0.5\ T/m^2$

4.2.2 Soil load

In case of water level = +0.2m

Ps = (1,8x 1.8x 0.5)+ (18- 1)x 1.95x 0.5 = 2.4 T/m^2

Pw = 1 T/m^{2}x 2 = 2.0 T/m^2

Pressure of ground water to bottom slab

Pr = 1 T/m^{3}x 2 = 2.0 T/m^2

4.3 Checking pressure to base soil

Total pressure to base soil

Ps = (1881.04+ 1617.5+ 42+ 157.65)/ 808.77 = 4.57 T/m^2

4.4Checking uplift that due to ground water

For the most dangerous case, ground water is up to level +0.2m and the grit chamber is empty, without considering load of equipments

Puplift =(0.2+1.9)x 1 = 2.1 T/m^2

Pself = 1881.04/ 808.77 = 2.33 T/m^2

Pself >Puplift

5 CALCULATION

In case no water outside

In case ground water level +0.2m

Refer to attached result sheet for calculation value of street, steel area for sheet, beam and column elements

Calculation for Intermediate pumping statation

(The calculation based on Japanese standard)

1-parameters for calculation:

Concrete: Grade 250, Rn = 70

RS= 3.6

Reinforcement type JIS: Ra= 1600

Back fill sand: γ_s= ; Coefficient of earth pressure at rest K_o= 0.5

Internal friction : = 20°

2-Load calculation (Base on Japanese standard):

3Calculation for bar arrangement:

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

$A_o = M/R_n b h_o^2$

h_o= (Element thickness-Cover thickness)

b: Width of calculated area(cm)

Required area of reinforcement:

$Fa = M/\gamma Raho$

Beams

AREA m2	Values (T.m)	Ao	γ	Fa (cm^2)	r arrangement φ(mm)	quantity
b=0.60	-69.010	0.1287	0.931	41.00	30	6
h=1.20	-59.950	0.1118	0.941	35.25	30	6
	39.780	0.0742	0.961	22.89	28	4
	37.980	0.0708	0.963	21.81	28	4
b=0.40	-29.210	0.1206	0.936	20.98	28	4
h=1.00	-25.000	0.1032	0.945	17.77	28	4
	19.950	0.0824	0.957	14.01	25	3
	12.100	0.0500	0.974	8.35	25	3
b=0.40	-18.000	0.1620	0.911	19.60	25	4
h=0.70	-12.820	0.1154	0.939	13.55	25	4
	10.070	0.0906	0.952	10.49	22	3
	9.550	0.0859	0.955	9.92	22	3

Checking shear forces:

-Height of hand for supporting coverslab s, so the section need to be checked shear bearing capacity is [c/2 + (h+s)/2]

- In case Q >= Rsxbxd so the below case is to be considered
- In case concrete is not enough to bear shearing force, stirrups will be considered

Sc/2 + Ss >= Q (shearing force at section calculated)

Where Sc: shearing bearing capacity of concrete (kg)

Ss: shearing bearing capacity of reinforcement (kg)

Ss=AsxRax|xd/a = Q - Sc/2

As: area of all stirrup in section considered

d: effective height of beam

a: pitch of stirrup (distance between two stirrups)

j: coefficient that consider safety factor (=1/1.15) =0.87

Frame element	height of beam h (m)	Width of beam b (m)	height of hand s (m)	height of column c (m)	c/2 + (h+s)/2	Values (T.m) (Q)	Capacity of concrete (ton)	Shearing stresses (Kg/cm2)	Degn Shearing strest (Sc) (Kg/cm2)	Compare &Conclude	Number of stirrup branches	Dia. Of stirrup (mm)	pitch of stirrup (cm)
474	0.7	0.4	0.2	0.6	0.75	15.88	9.07	6.30	3.6	NOT OK!	2	14	15.0
433	0.7	0.4	0.2	0.6	0.75	8.57	9.07	3.40	3.6	OK!!!	2	14	15.0
485	0.7	0.4	0.2	0.6	0.75	11.28	9.07	4.48	3.6	NOT OK!	2	14	15.0
175	1	0.4	0.2	0.5	0.90	20.33	13.39	5.47	3.6	NOT OK!	2	14	15.0
181	1	0.4	0.2	0.6	0.90	18.18	13.39	4.89	3.6	NOT OK!	2	14	15.0
235	1	0.4	0.2	0.6	0.90	14.59	13.39	3.92	3.6	NOT OK!	2	14	15.0
85	1.2	0.6	0.2	0.6	1.00	37.27	24.41	5.50	3.6	NOT OK!	2	14	15.0
186	1.2	0.6	0.2	0.6	1.00	45.99	24.41	6.78	3.6	NOT OK!	2	14	15.0
7	1.2	0.6	0.2	0.6	1.00	42.65	24.41	6.29	3.6	NOT OK!	2	14	15.0

COLUMNS

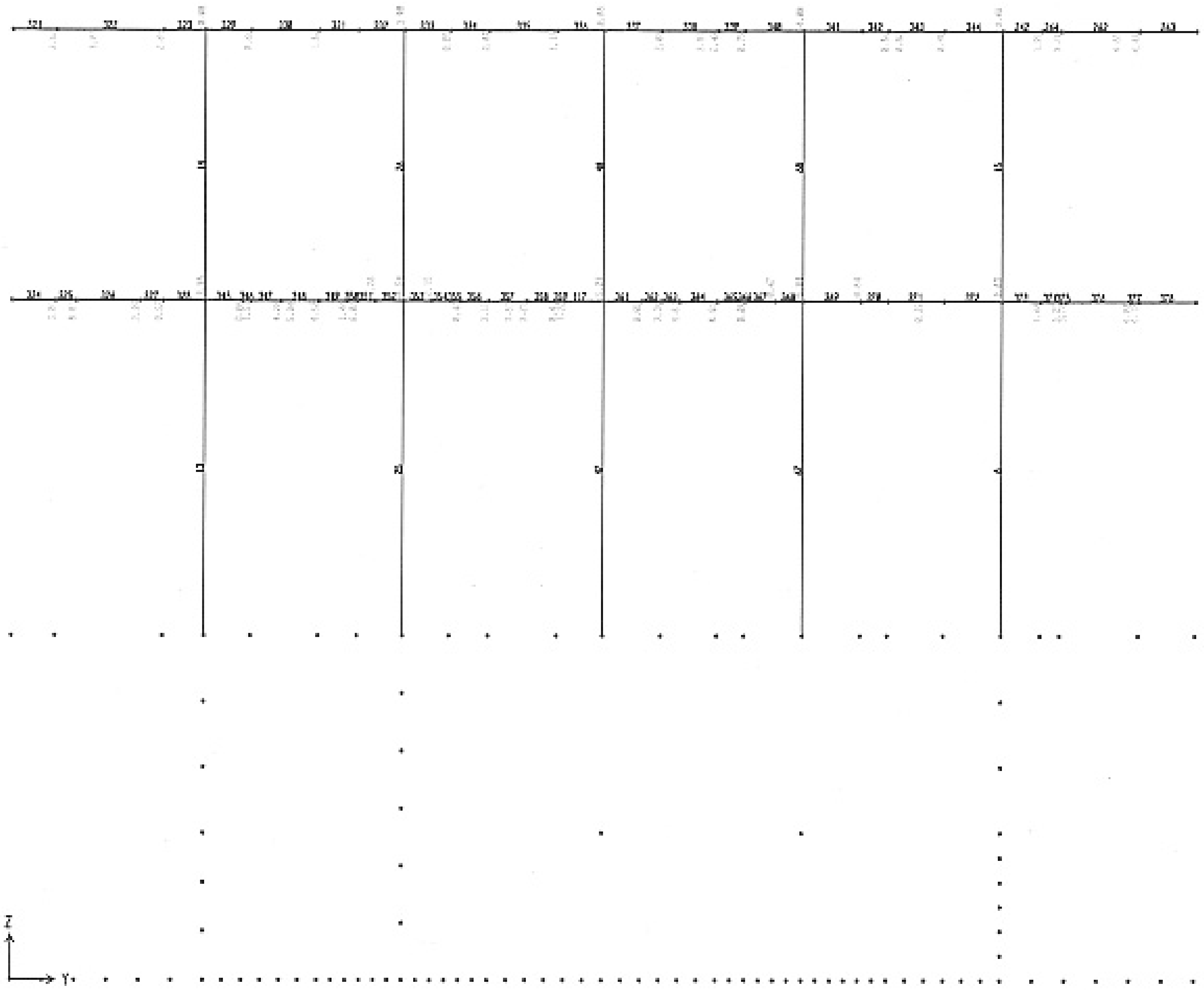
I.MATERIAL PROPERTIES

Concrete	Grade 250	Rn =	70 (Kg/cm2)
		Eb =	2E+05 (Kg/cm2)
Reinforcement	Type All	Ea =	2E+06 (Kg/cm2)
		Ra = R =	1600 (Kg/cm2)

II.CALCULATION:

NAME OF COLUMN	l (cm)	b (cm)	h (cm)	a=a' (cm)	h0 (cm)	l0 (cm)	l h	mb	Rn* (Kg/cm2)	a 0	A0	m gt (%)	Ja (cm4)	Jb (cm4)	M (Kg.m)	N (Kg)	e0 (cm)	e0/h
21	630	60	60	7	53	441	7.35	1.00	70	0.62	0.43	0.6	10093	1080000	2.42E+03	2.60E+05	3.3	0.056
43	630	60	60	7	53	441	7.35	1.00	70	0.62	0.43	0.6	10093	1080000	1.36E+03	2.68E+05	2.9	0.048
47	630	60	60	7	53	441	7.35	1.00	70	0.62	0.43	0.6	10093	1080000	9.73E+03	2.04E+05	7.2	0.119
23	630	60	80	7	73	441	5.5125	1.00	70	0.62	0.43	0.6	28619	2560000	2.00E+04	3.00E+05	9.9	0.123
48	630	60	80	7	73	441	5.5125	1.00	70	0.62	0.43	0.6	28619	2560000	2.04E+04	3.26E+05	9.5	0.118

S	Mdh (Kg.m)	Ndh (Kg)	Kdh	Nth (Kg)	η	h.eO (cm)	e0gh	e (cm)	x (cm)	αo.ho	x' (cm)	Fa=Fa' (cm2)	Seme orrangement Fa=Fa'
0.81	2.42E+03	2.60E+05	2.00	4.00E+06	1.070	3.56	16.86	26.6	61.9	32.9	54.7	**13.8**	3D28
0.84	1.36E+03	2.68E+05	2.00	4.13E+06	1.070	3.11	16.86	26.1	63.9	32.9	55.3	**15.2**	3D228
0.60	9.73E+03	2.04E+05	2.00	3.16E+06	1.069	7.66	16.86	30.7	48.7	32.9	48.5	**5.6**	3D28
0.59	2.00E+04	3.00E+05	2.00	7.72E+06	1.040	10.27	21.90	43.3	71.5	45.3	64.8	**18.4**	3D28
0.60	2.04E+04	3.26E+05	2.00	7.83E+06	1.043	9.86	21.90	42.9	77.5	45.3	65.4	**27.3**	5D28



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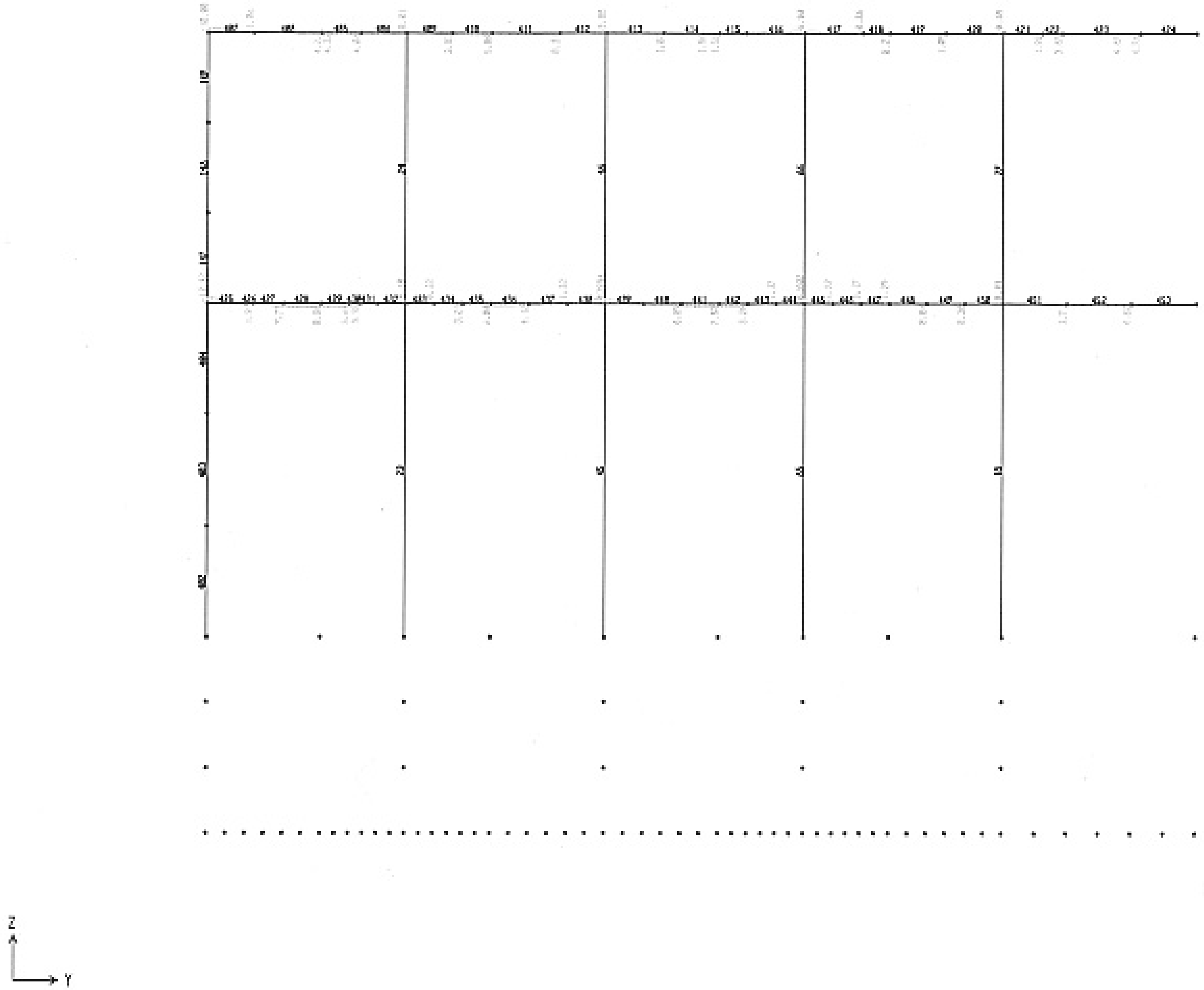

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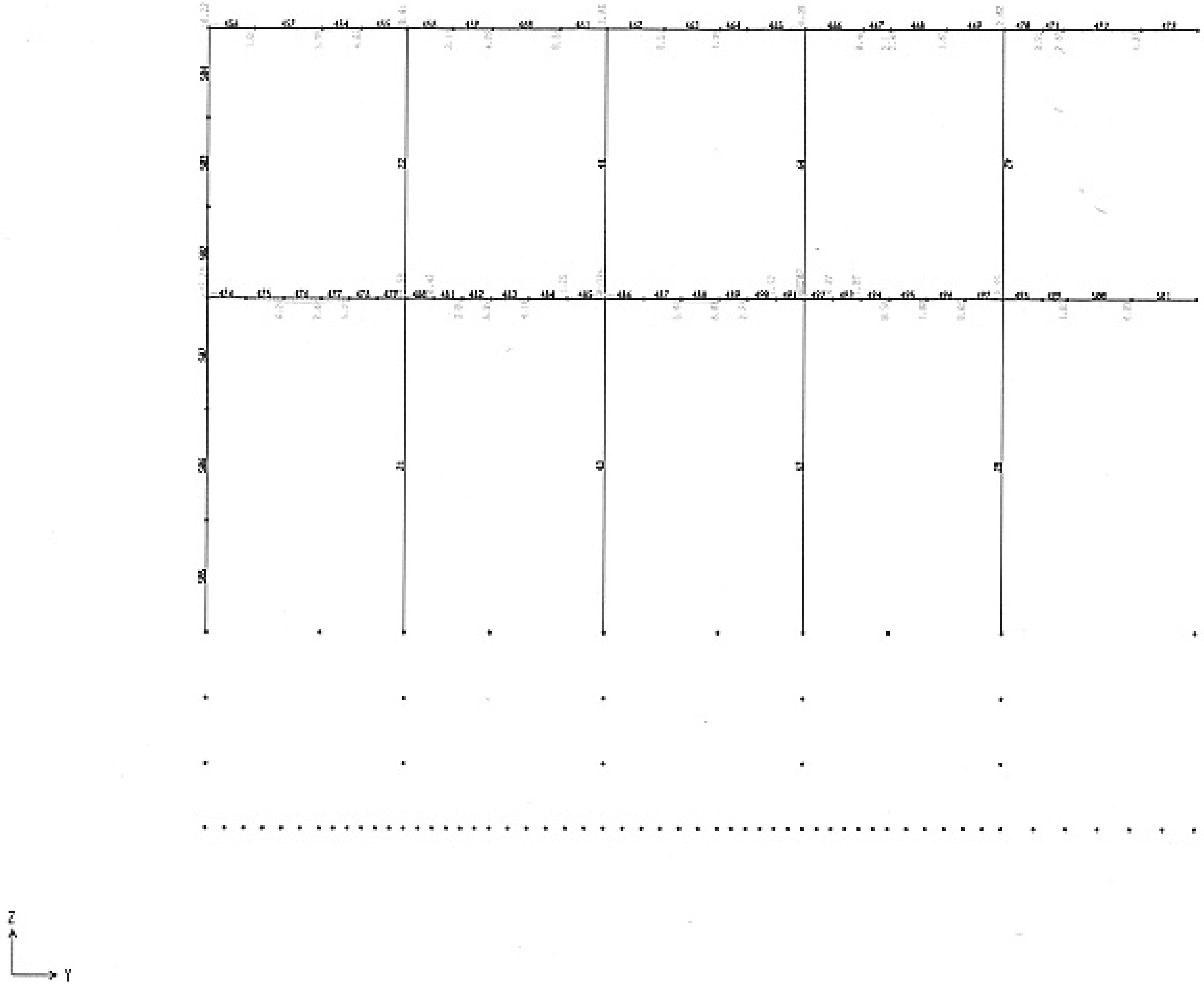

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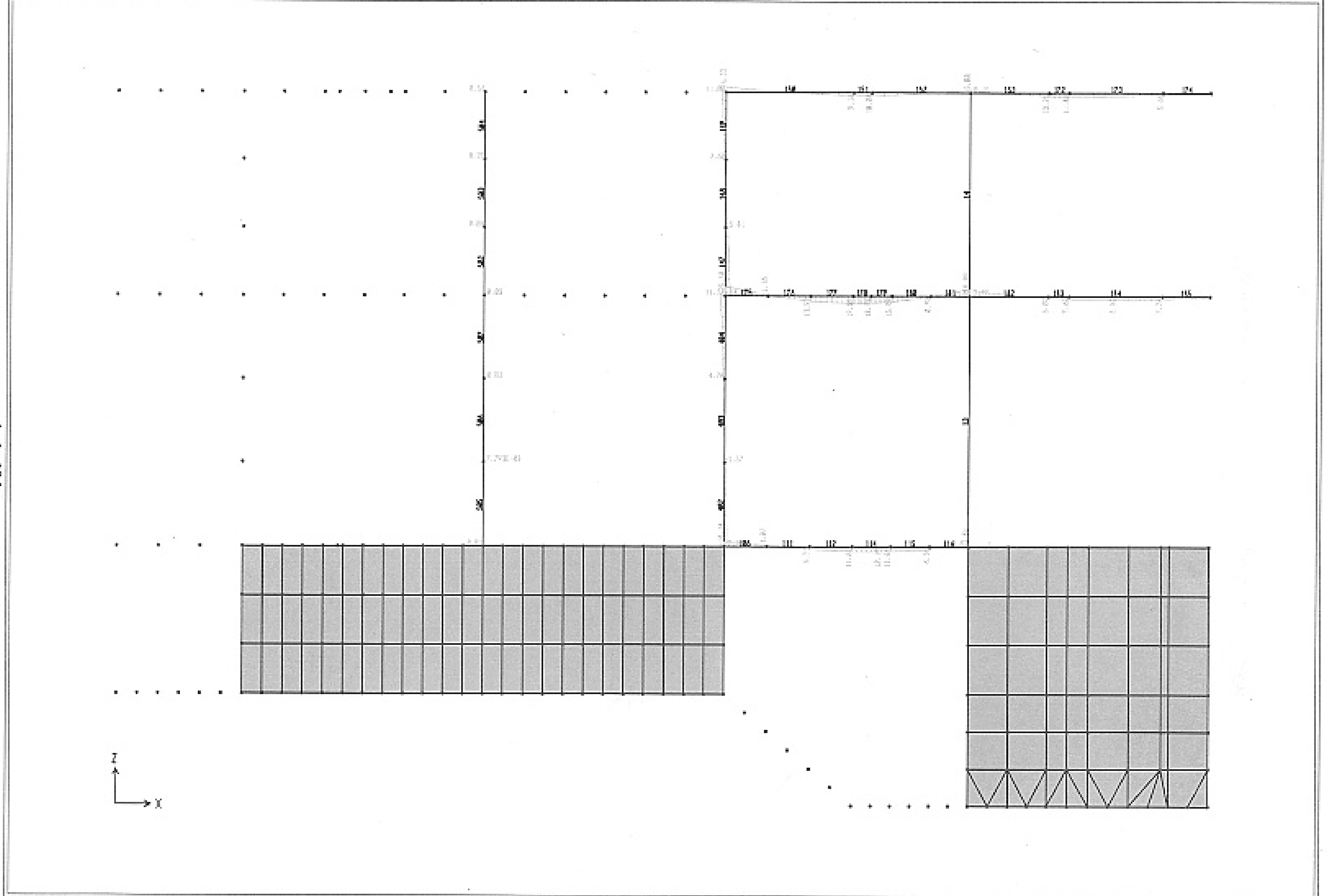

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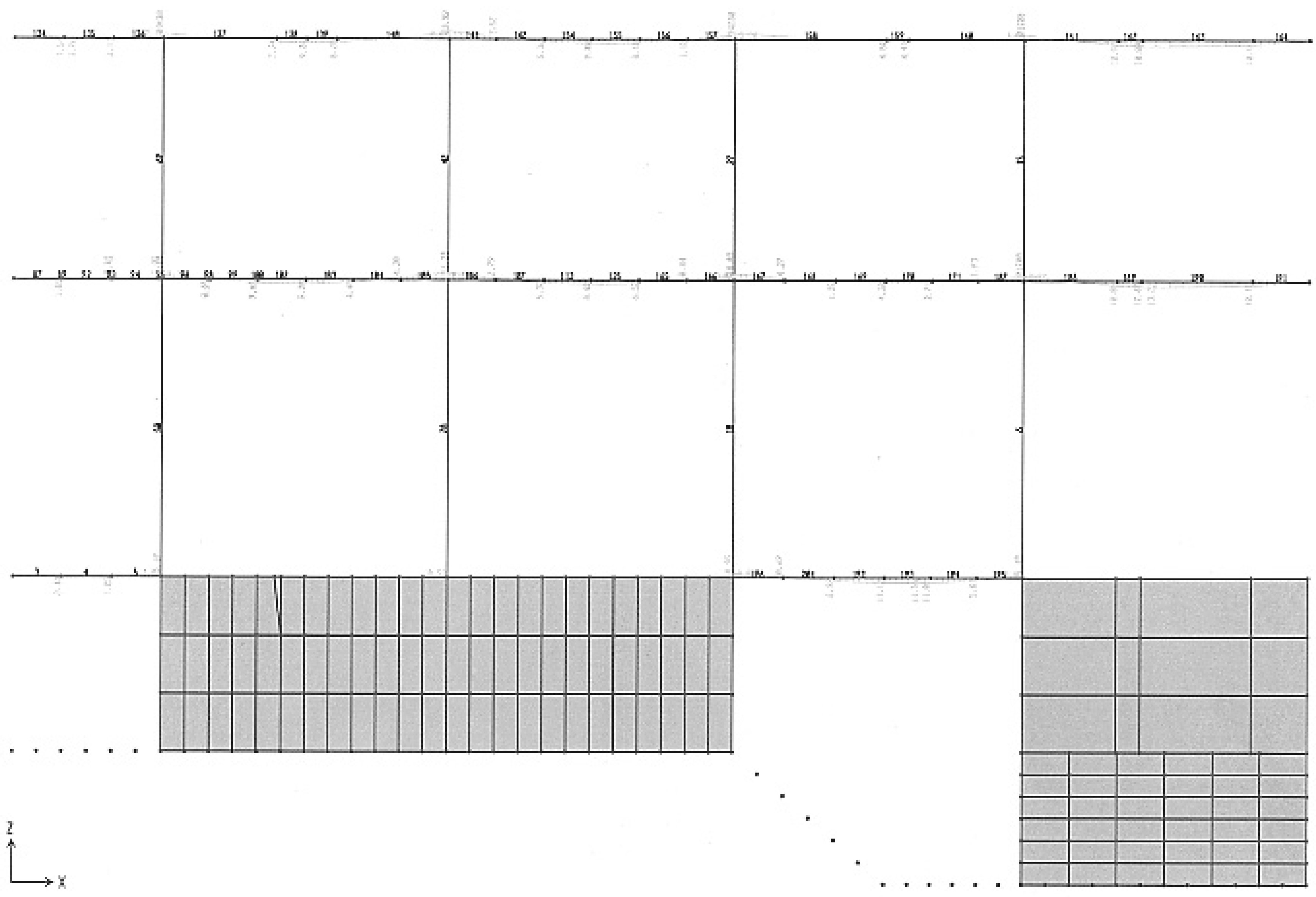

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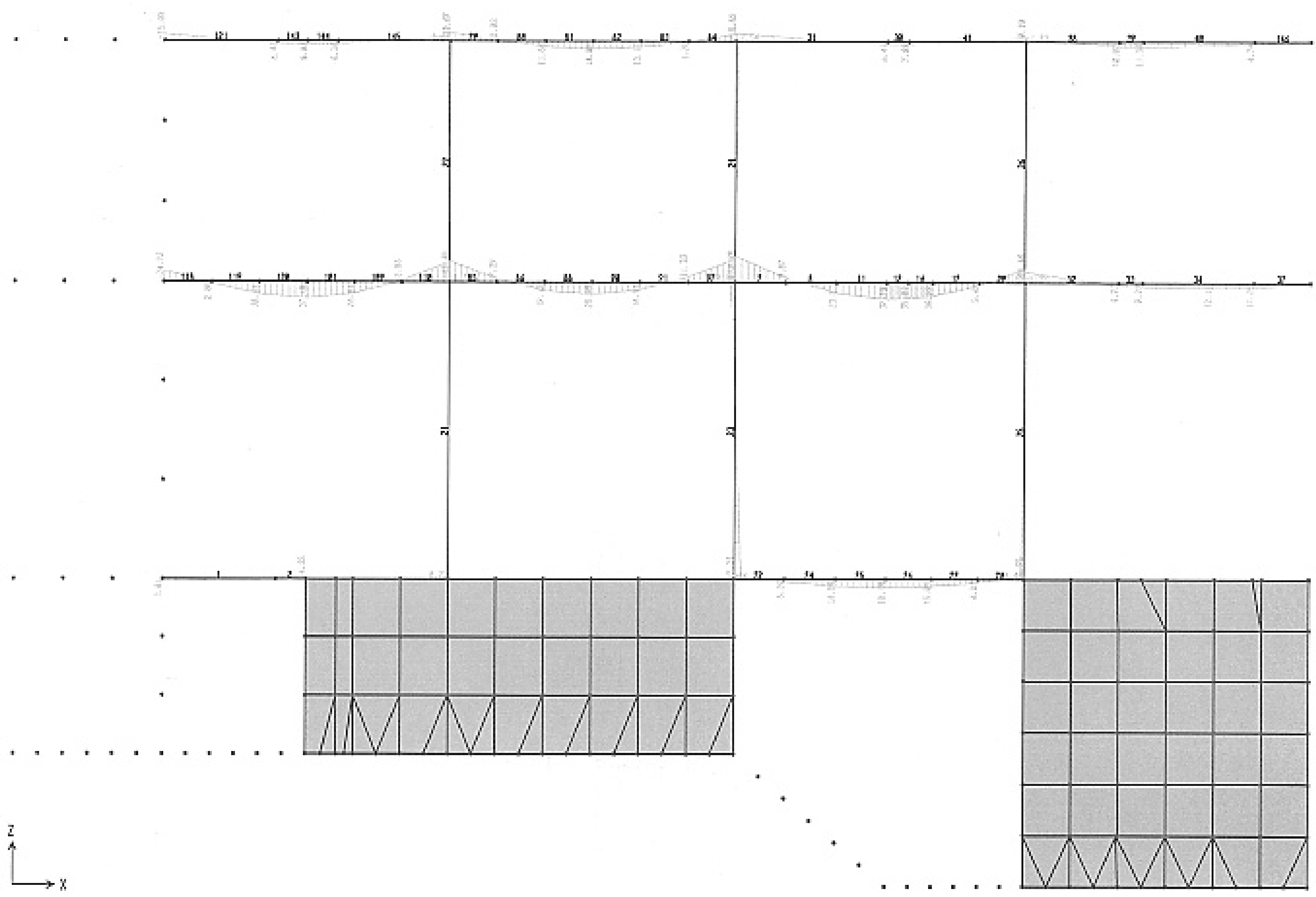

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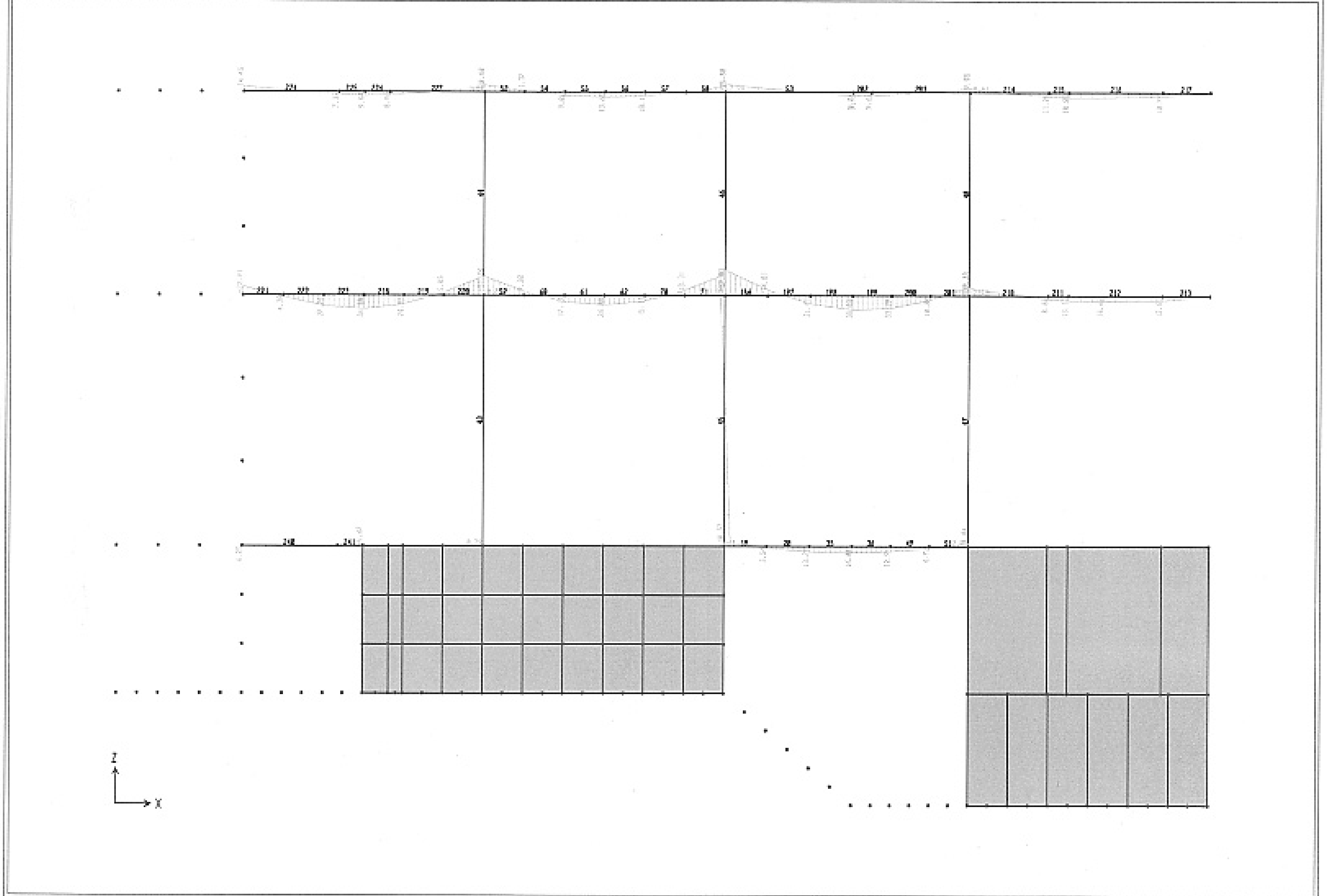

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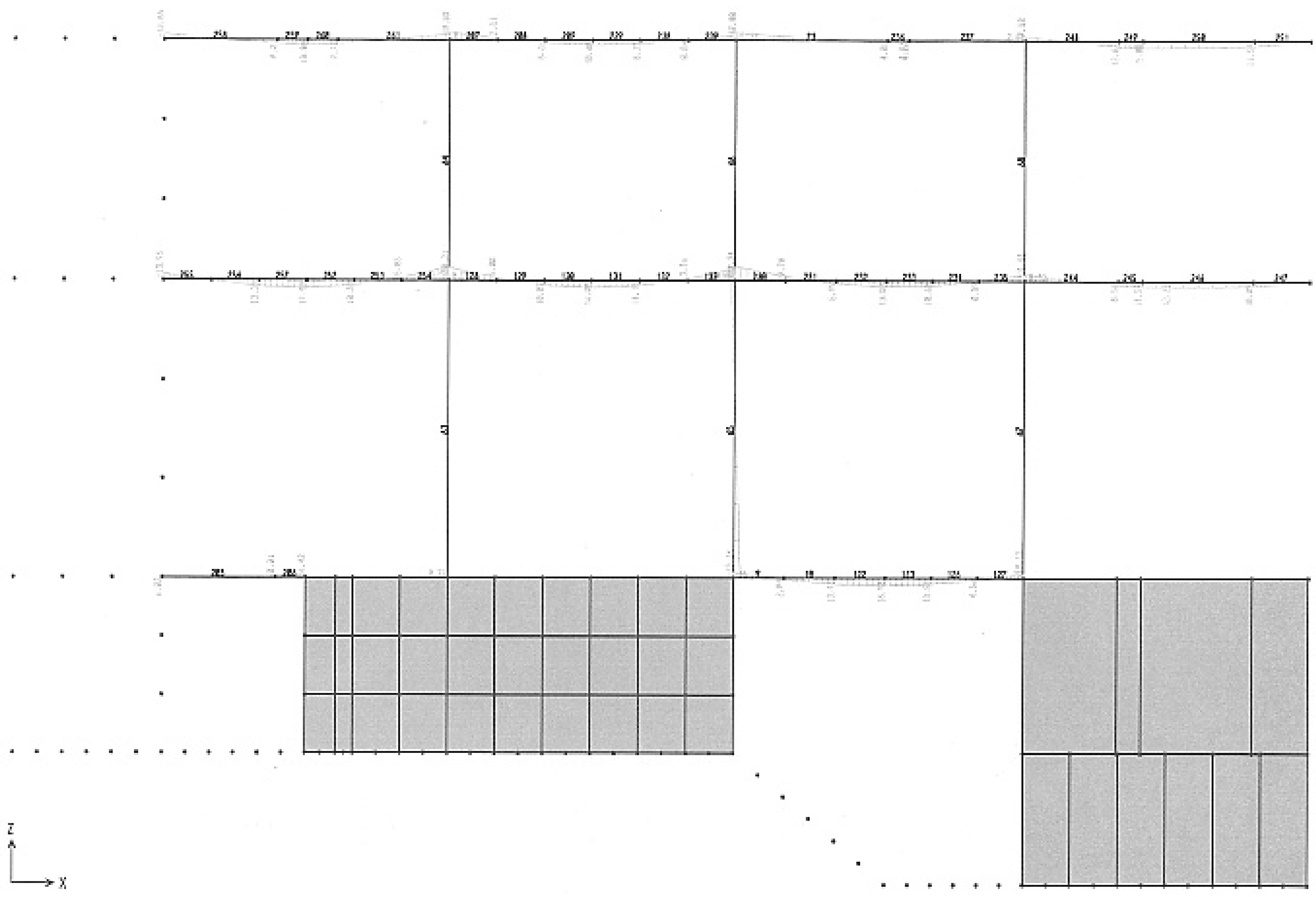

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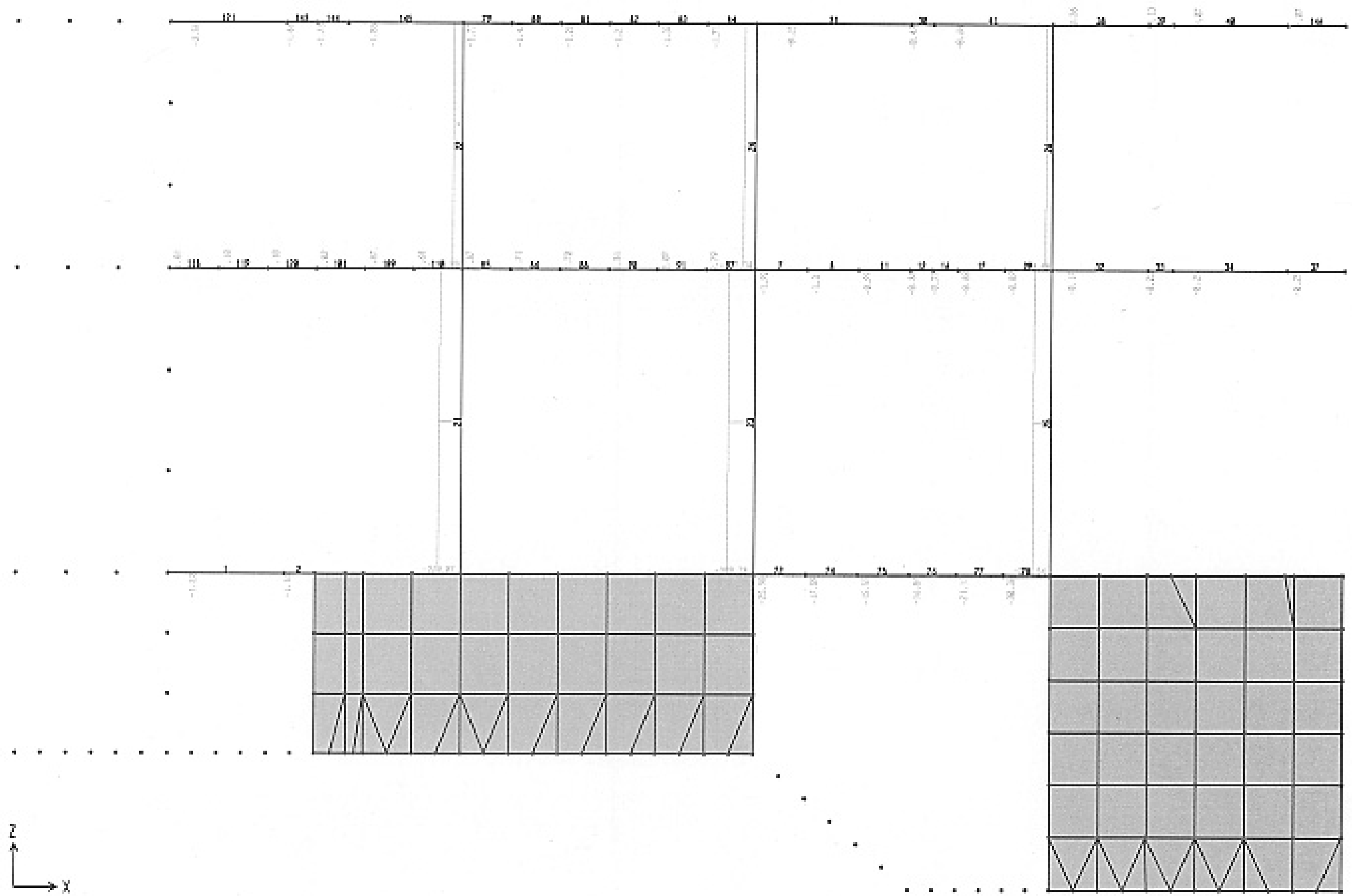

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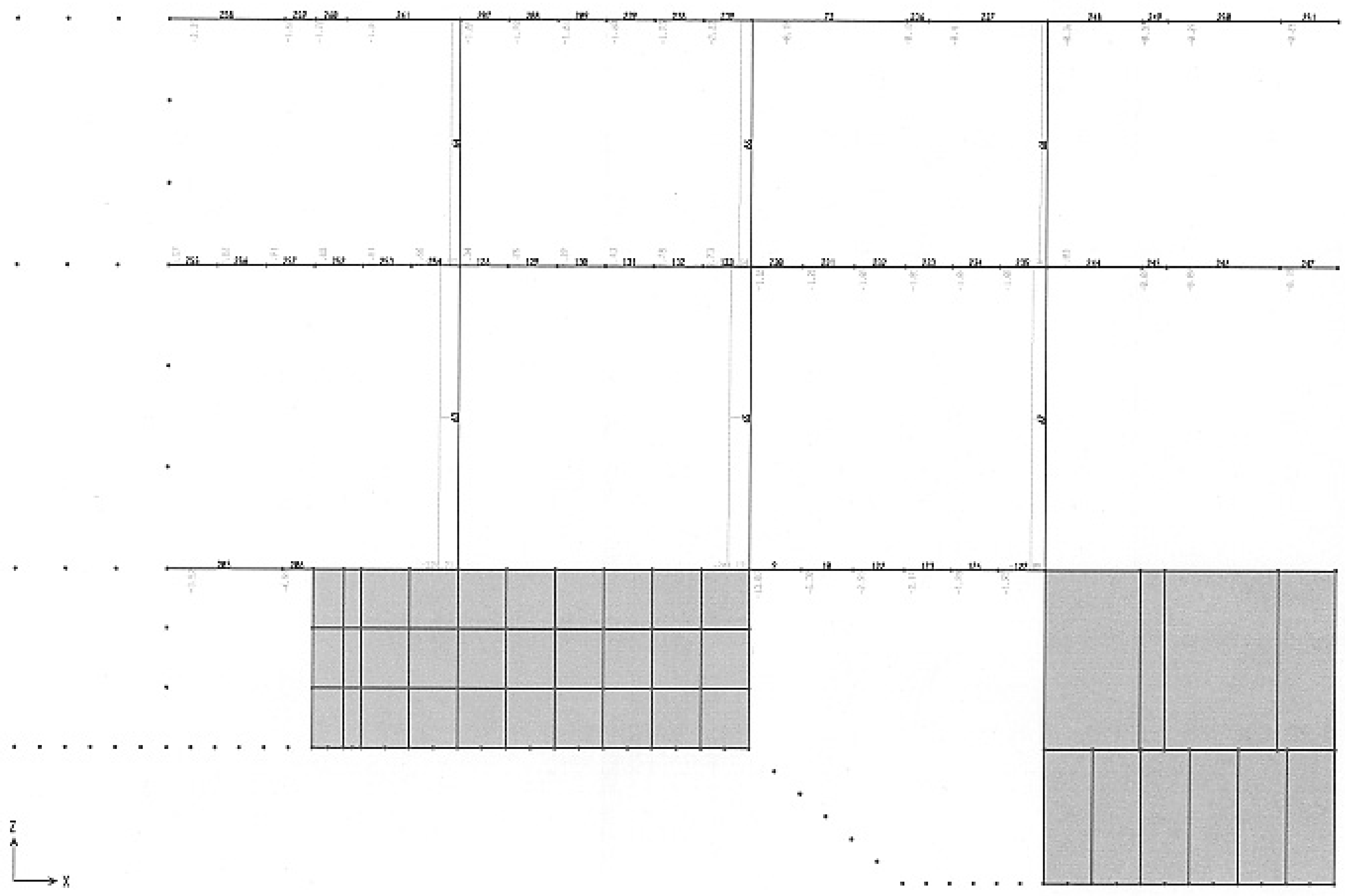

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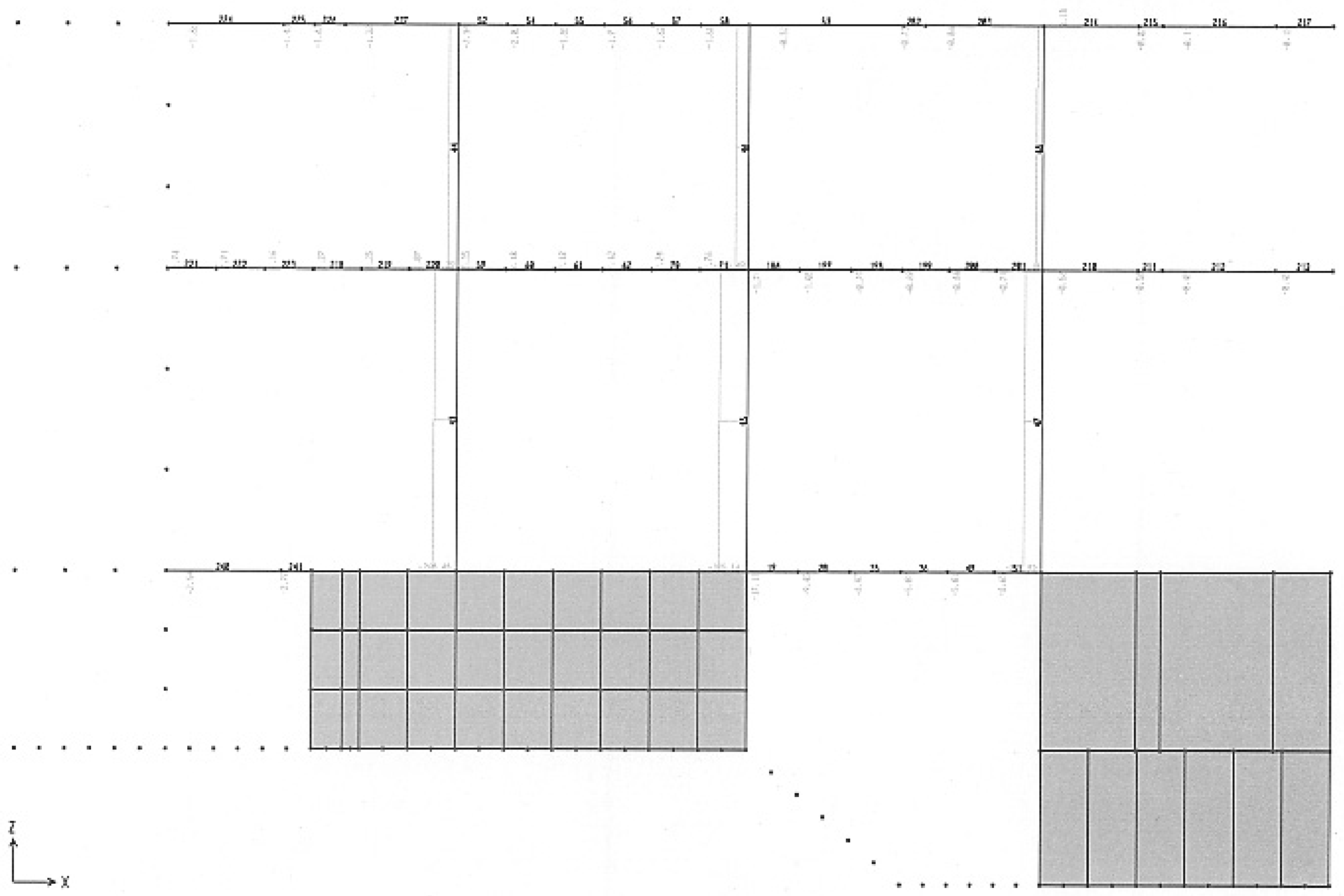

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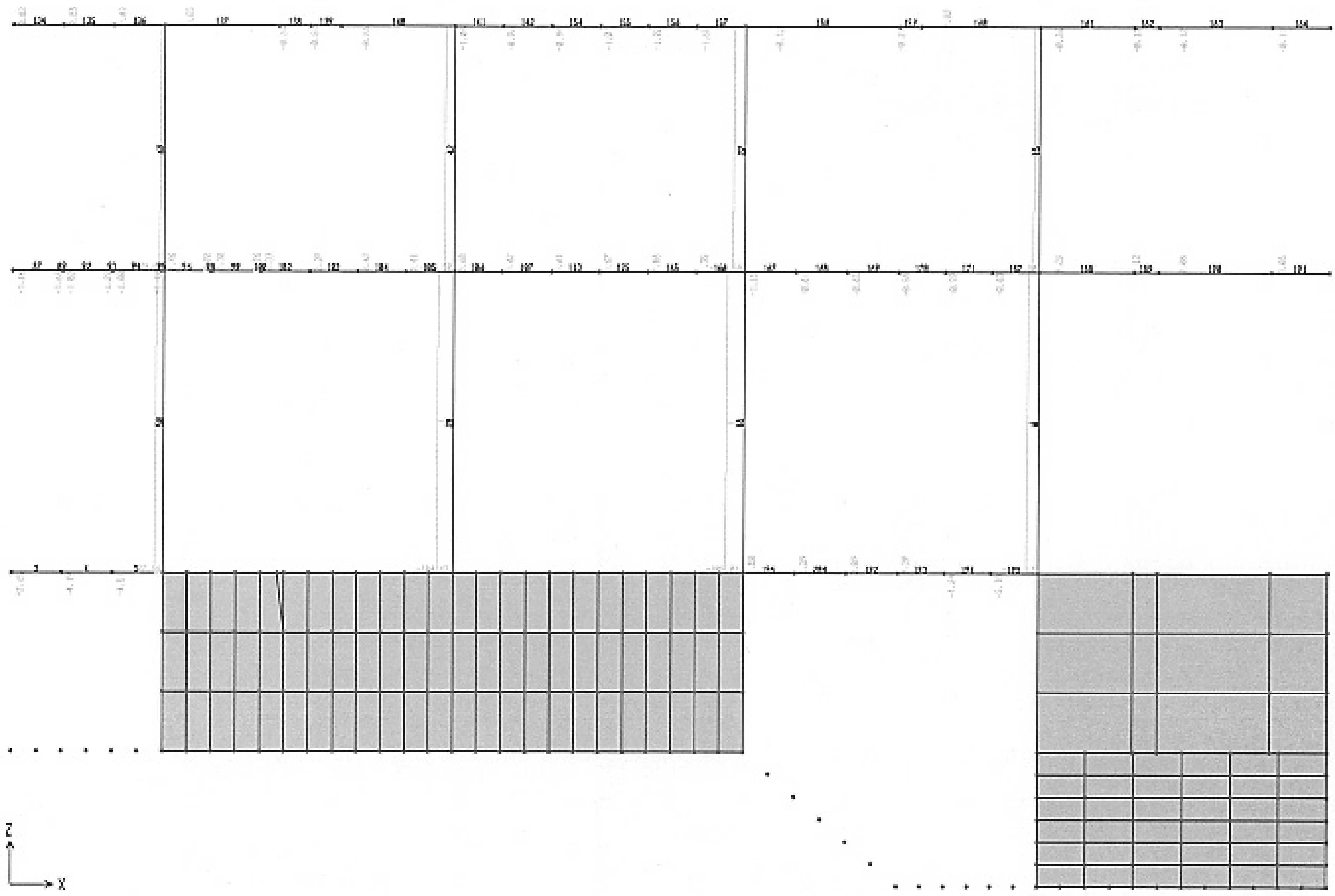

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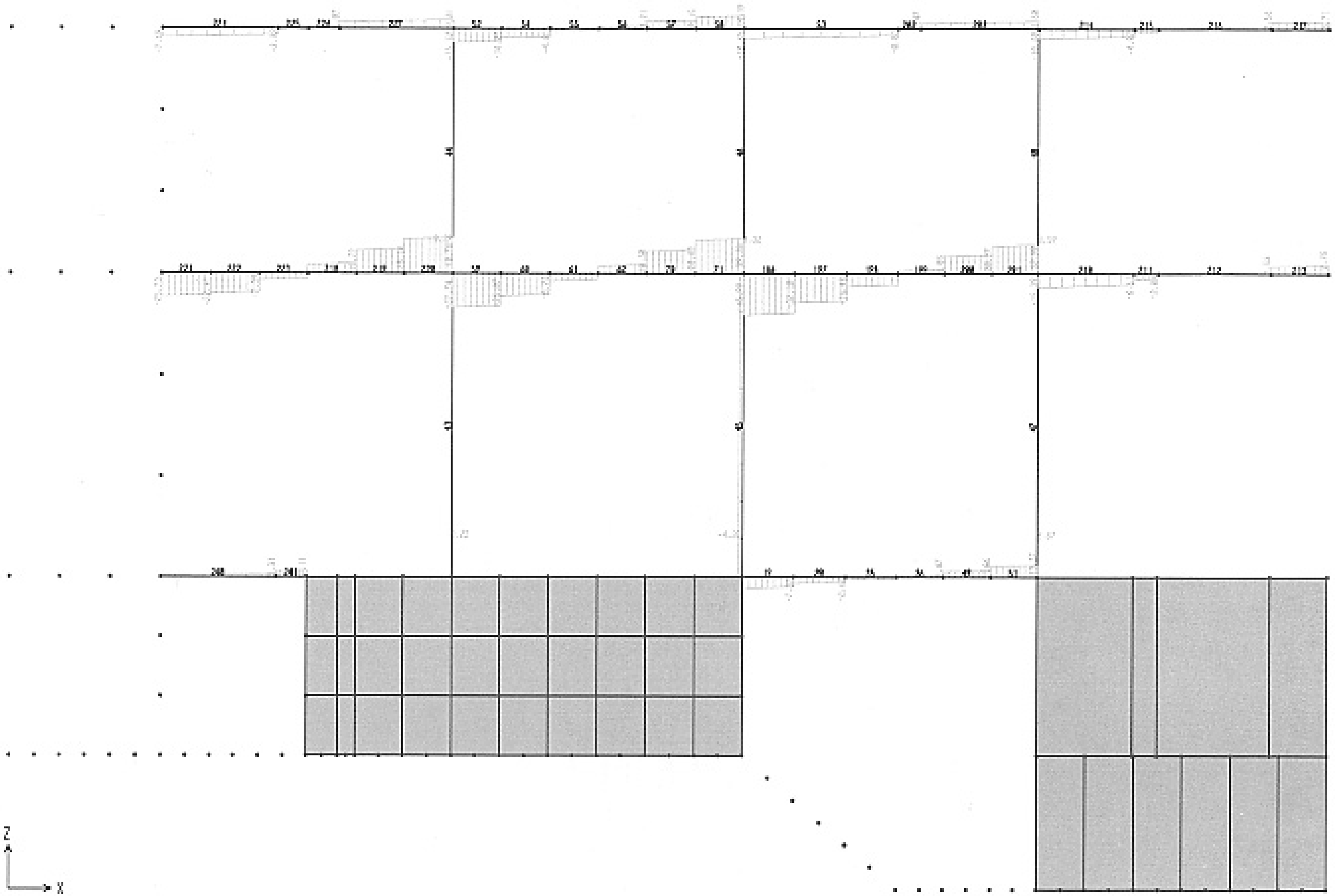

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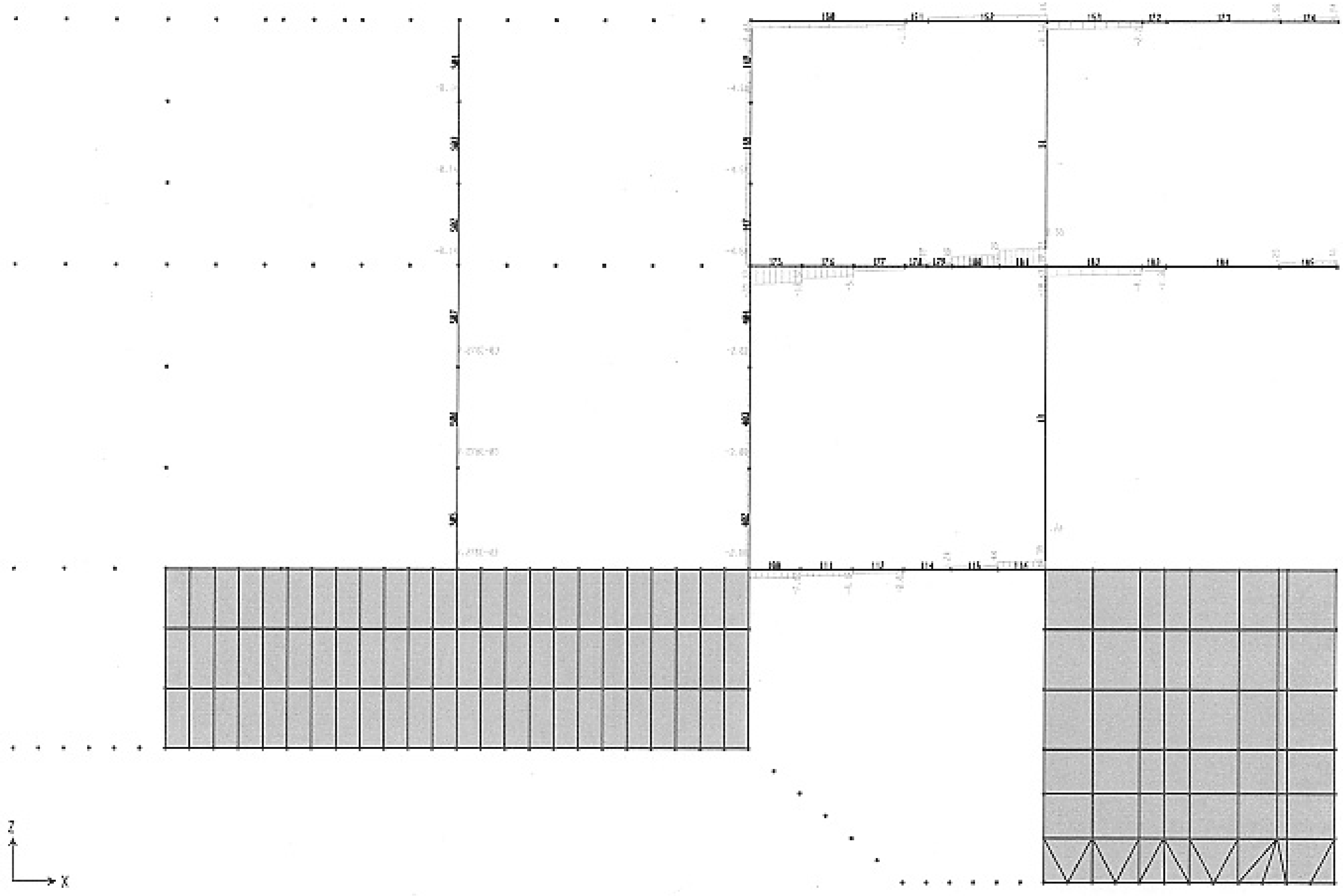

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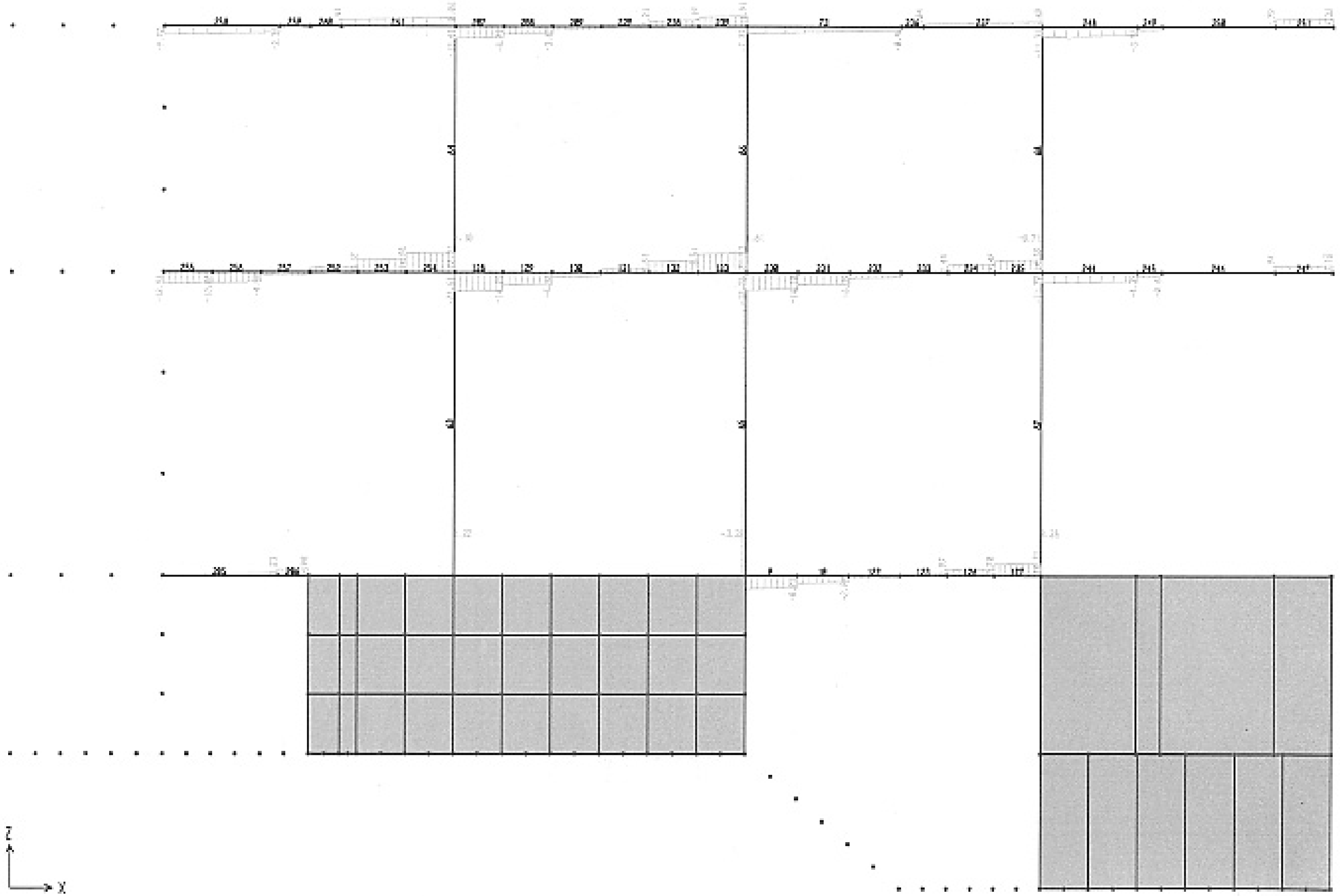

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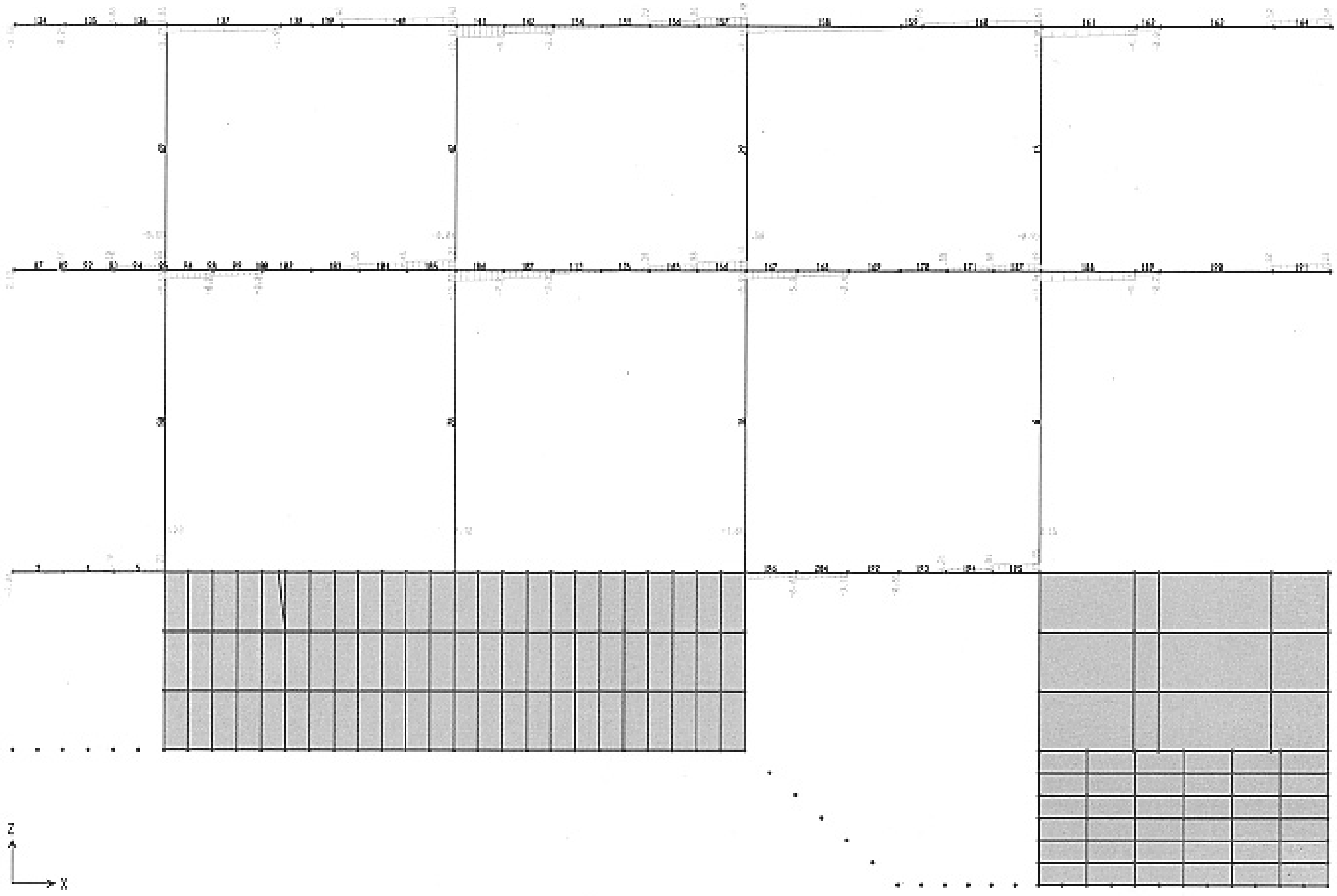

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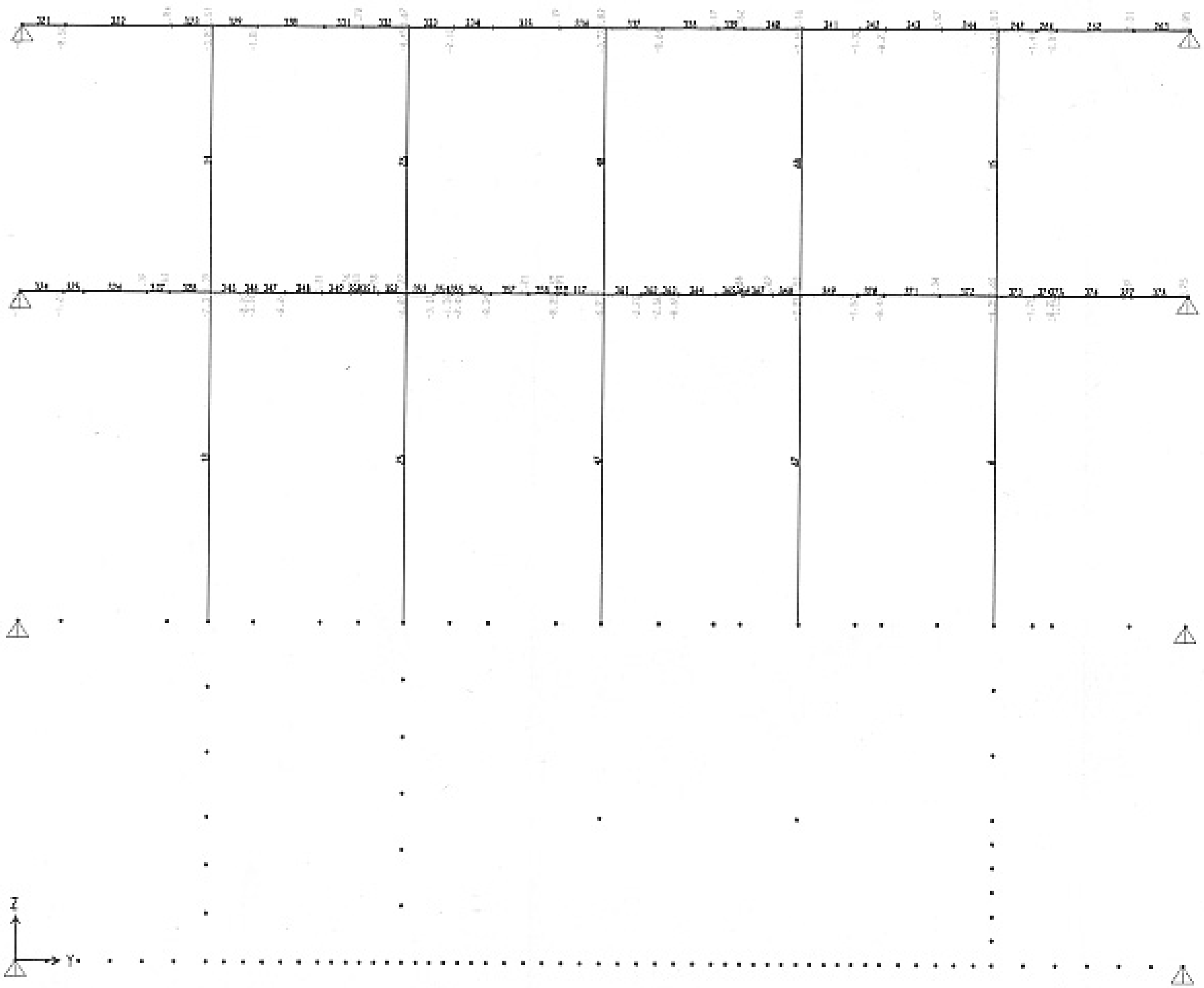

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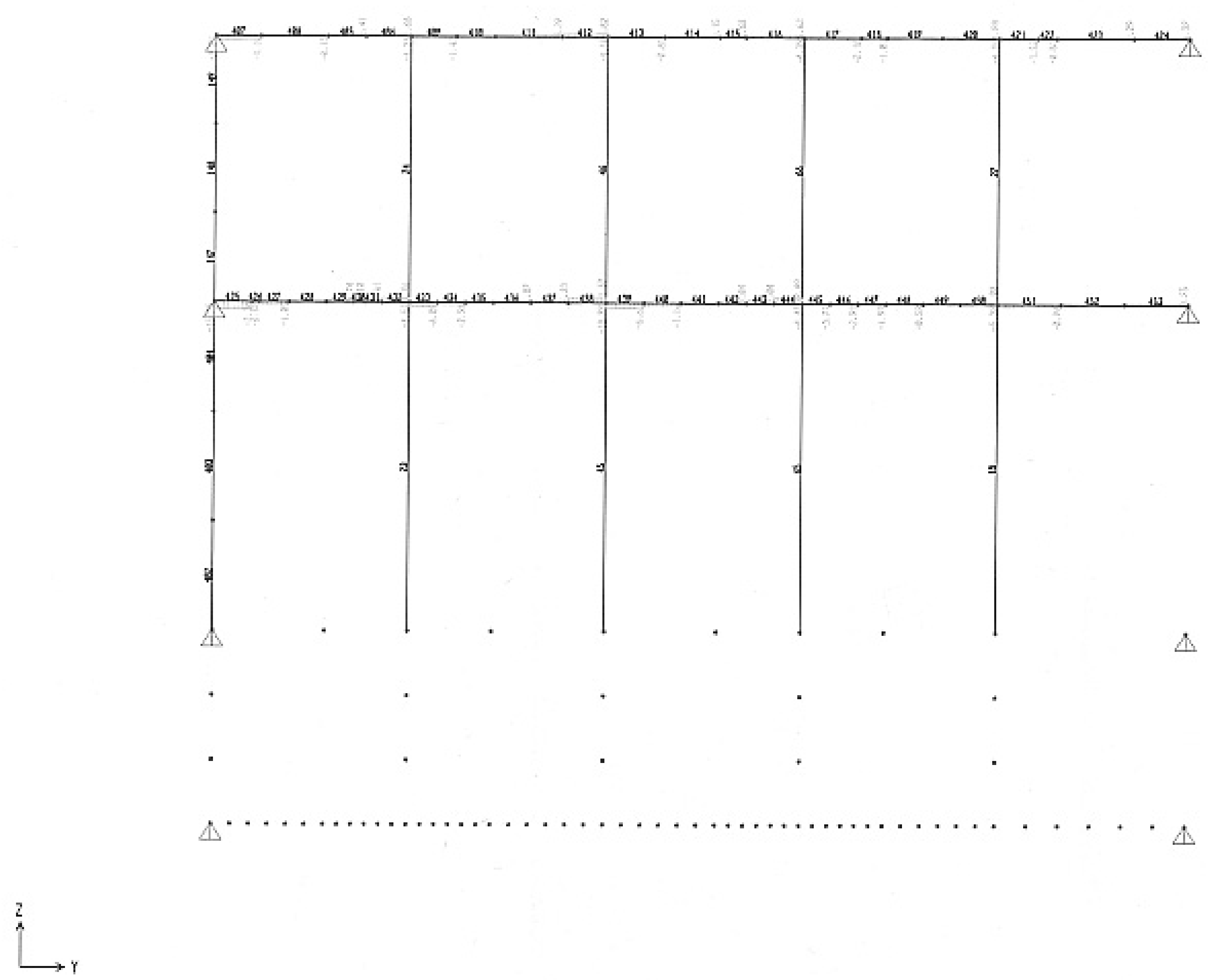
16, 23,35



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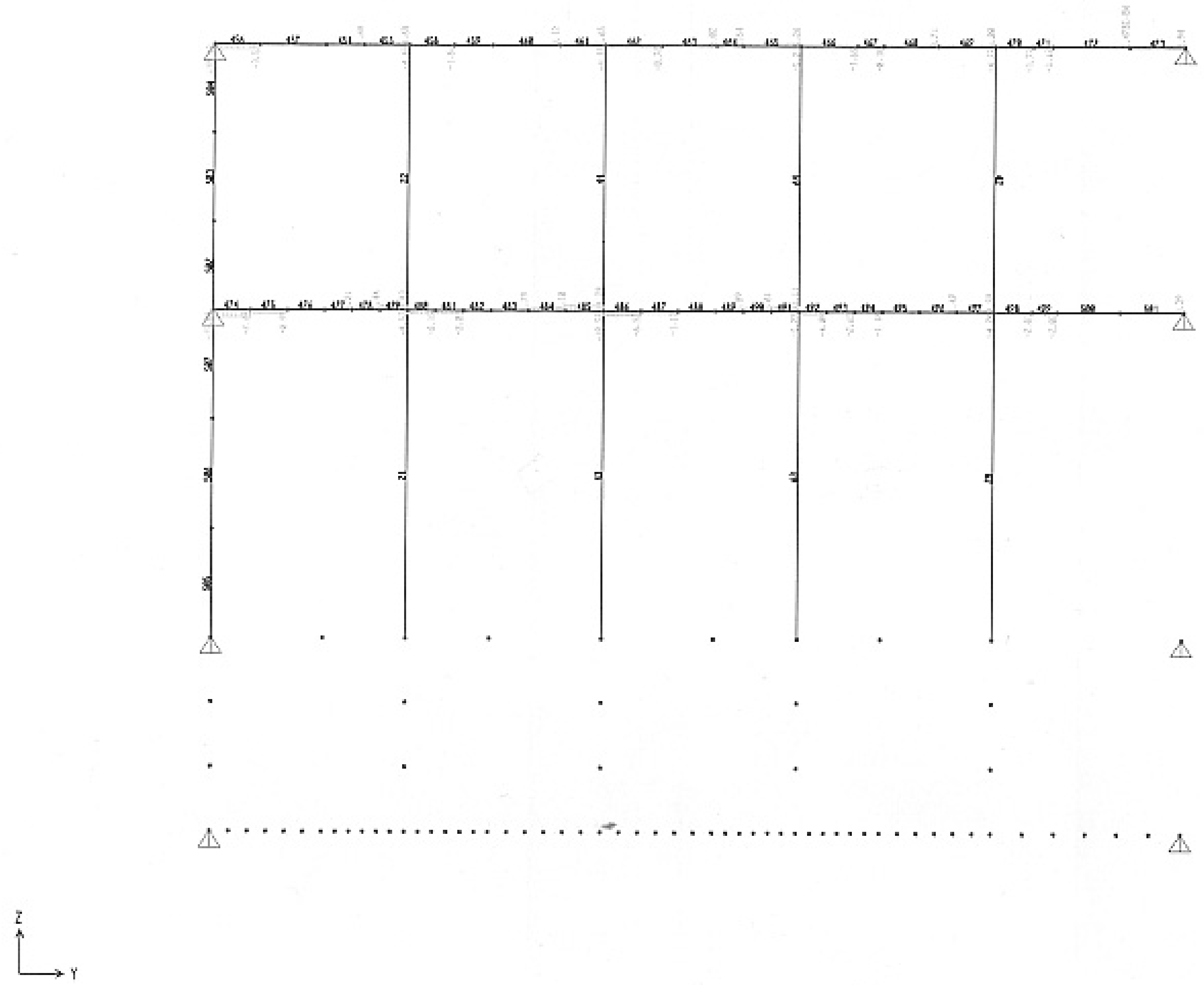


SAP2000 v6.11 - File:INTERMEDIATEWW - Shear Force 2-2 Diagram (WATER) - Ton-m Units

Calculation for Intermediate pumping station
(The calculation based on Japanese standard)

1-parameters for calculation:

Concrete: Grade 250, Rn = 70

RS= 3.6

Reinforcement type JIS: Ra= 1600

Back fill sand: γ_s= 1.80T/m3 ; Coefficient of earth pressure at rest K_o= 0.5

Internal friction 20deg

2-Load calculation (Base on Japanese standard):

3-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)

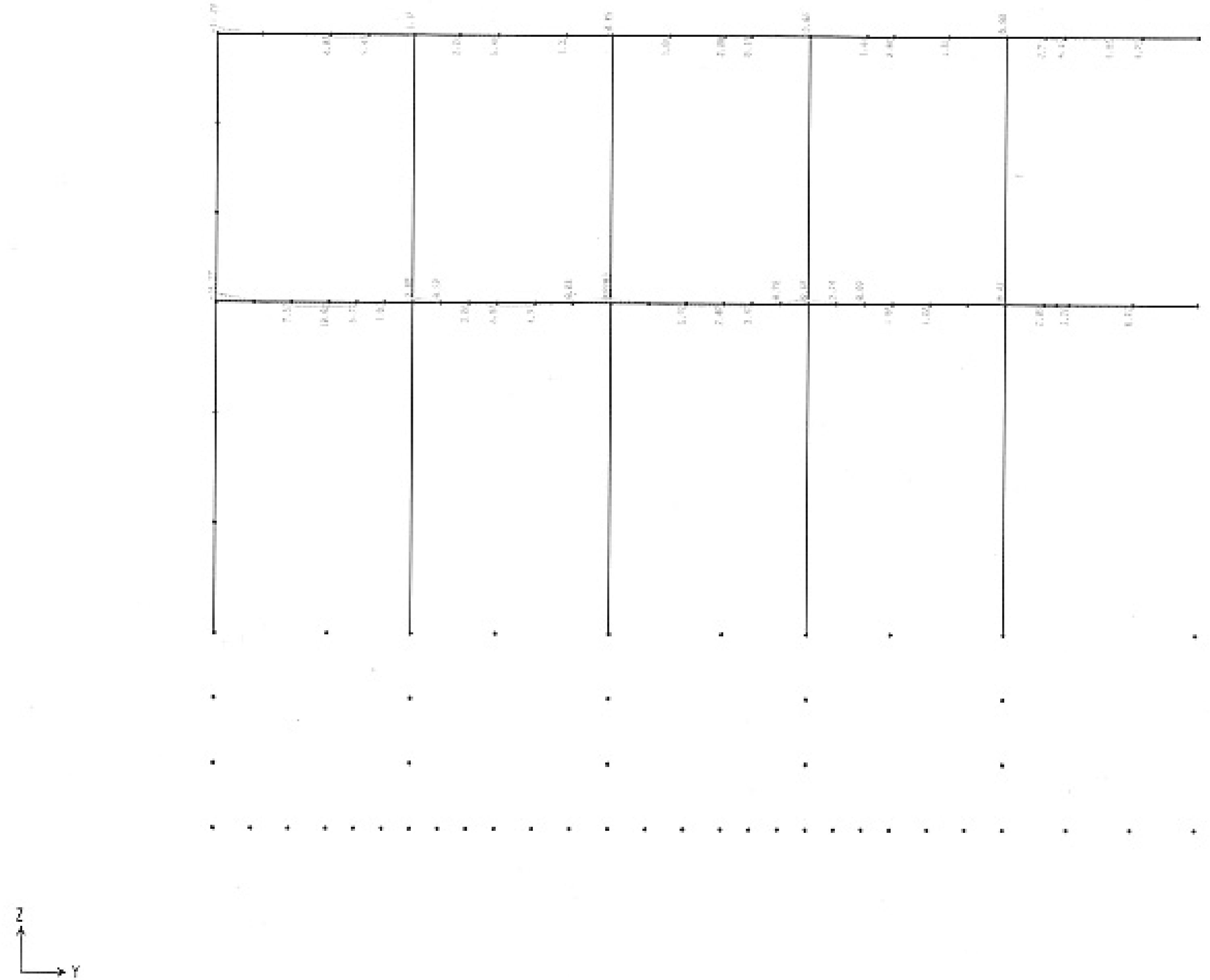
b: Width of calculated area(cm)

Required area of reinforcement:

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

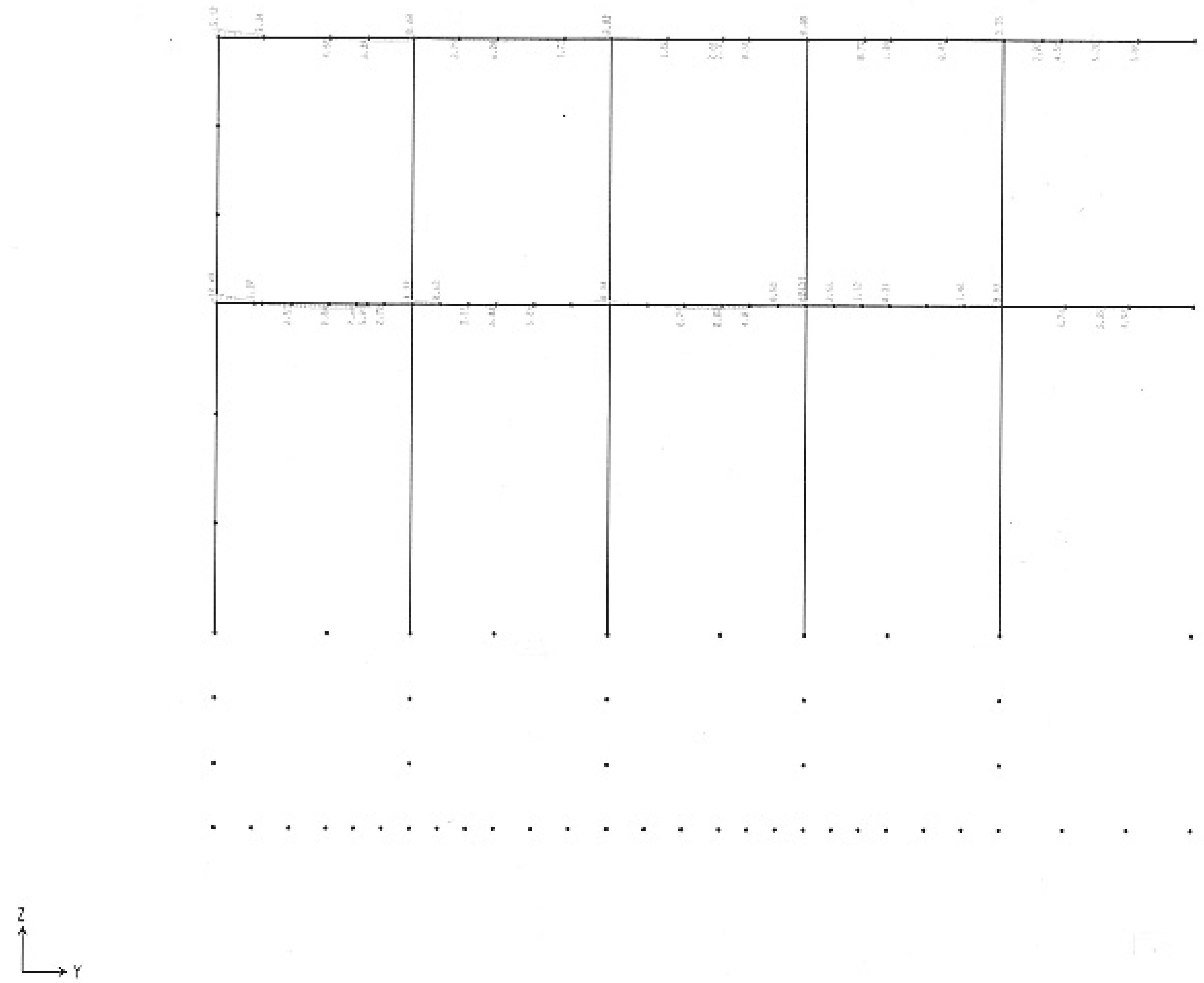
SLAB

AREA m2	LOCATION	Values (T.m)	Ao	γ	Fa (cm^2)	Bar arrangement ϕ(mm)	a
h=1.20	BOTTOM SLAB	52.970	0.0649	0.966	30.32	25	125
		50.990	0.0625	0.968	29.14	25	125
		36.660	0.0449	0.977	20.75	25	250
		19.710	0.0241	0.988	11.04	25	250
h=0.30	SLAB LEVEL 2.3	1.770	0.0478	0.976	4.93	14	250
		1.640	0.0443	0.977	4.56	14	250
		1.450	0.0392	0.980	4.02	14	250
		1.360	0.0367	0.981	3.77	14	250
h=0.30	SLAB LEVEL -3.7	4.160	0.1123	0.940	12.02	14	125
		3.740	0.1010	0.947	10.74	14	125
		2.100	0.0567	0.971	5.88	14	125
		1.930	0.0521	0.973	5.39	14	125
h=0.3	SLAB LEVEL -10	2.960	0.0799	0.958	8.39	14	125
		2.780	0.0751	0.961	7.86	14	125
		2.040	0.0551	0.972	5.71	14	250
		1.880	0.0508	0.974	5.25	14	250



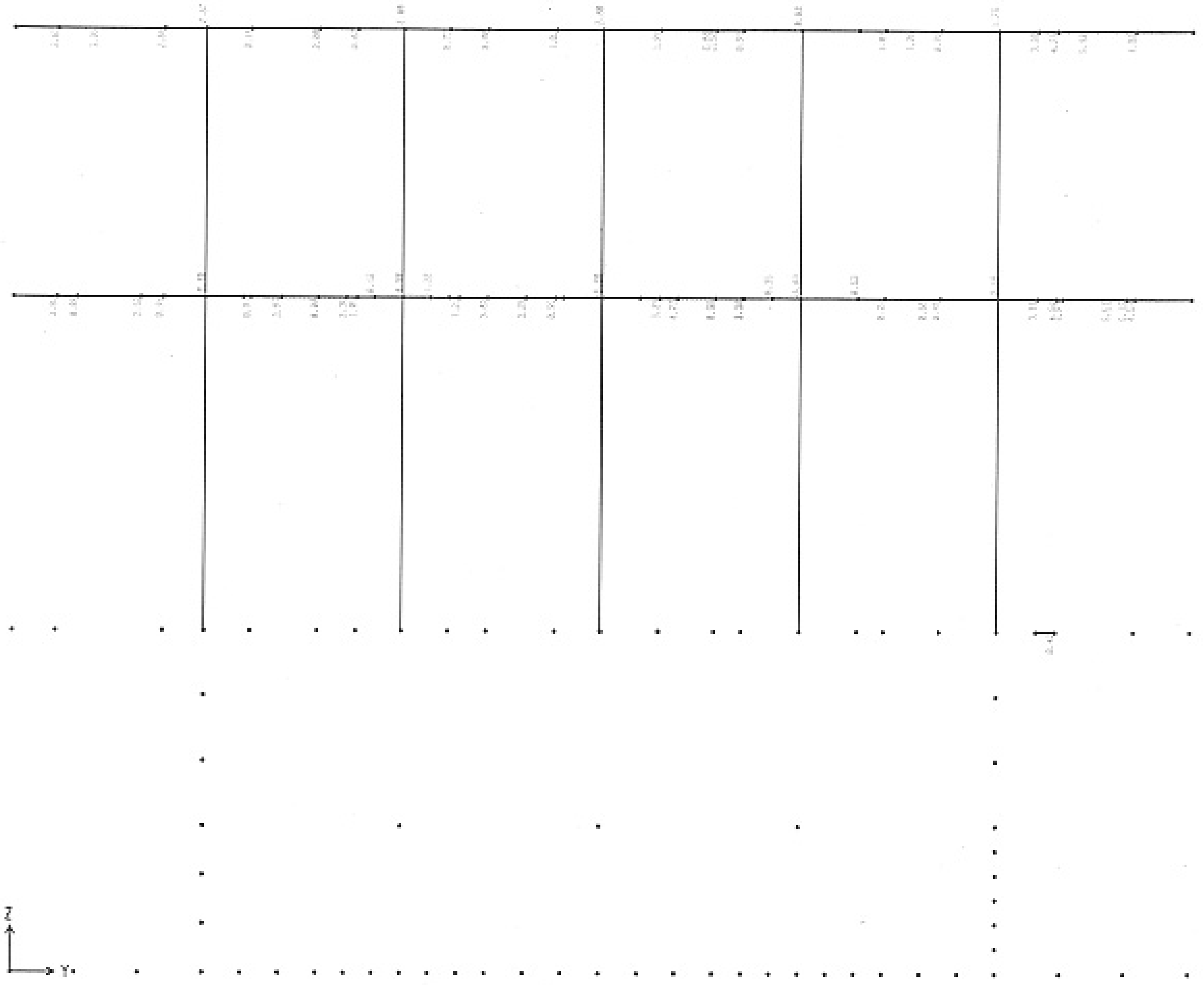
SAP2000 v6.11 - File:INTERMEDIATENW - Moment 3-3 Diagram (LOAD1) - Ton-m Units

X = 10,05



SAP2000 v6.11 - File:INTERMEDIATENW - Moment 3-3 Diagram (LOAD1) - Ton-m Units

X = 16,65



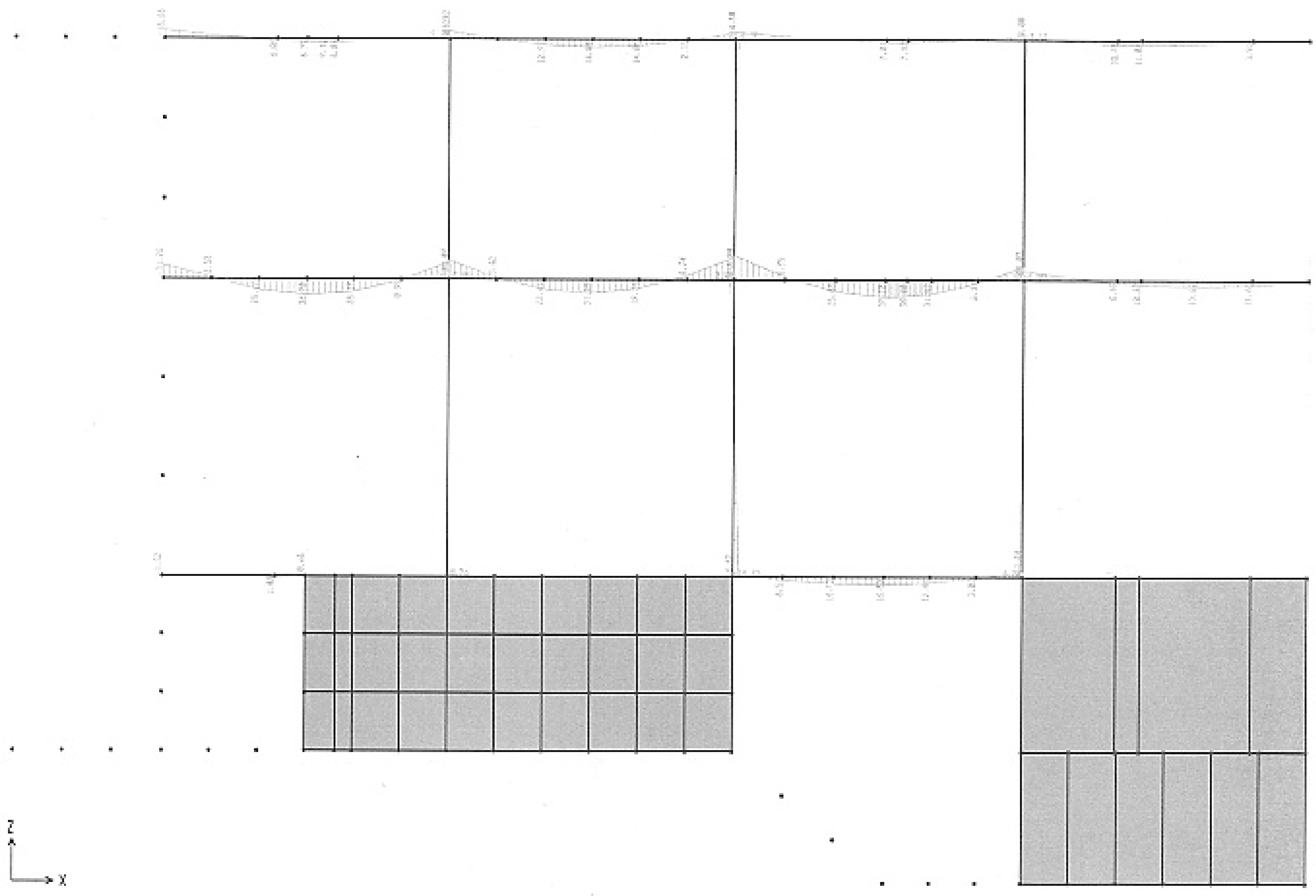
SAP2000 v6.11 - File:INTERMEDIATENW - Moment 3-3 Diagram (LOAD1) - Ton-m Units X = 23,35

SAP2000

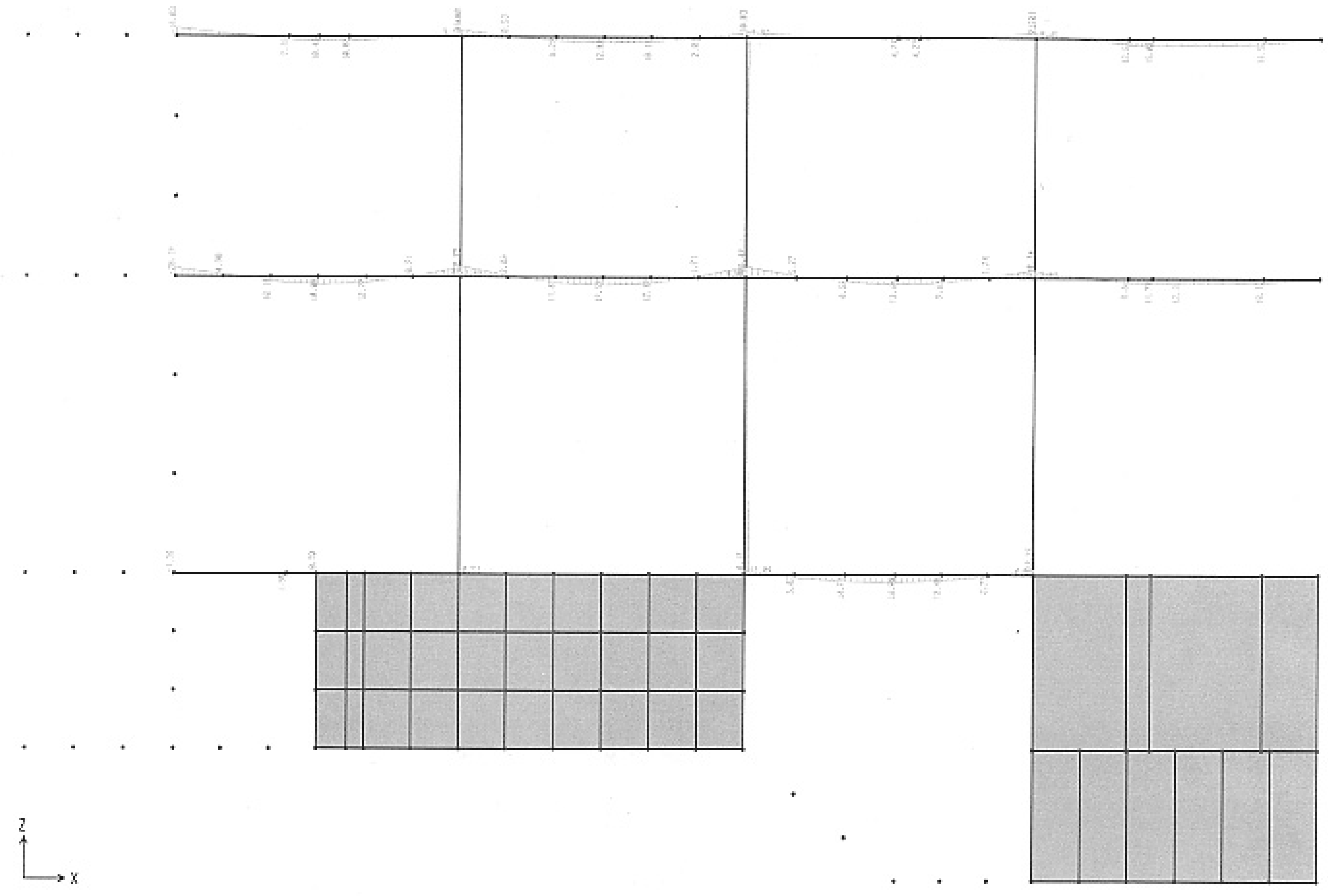
March 7,2001 16:11

SAP2000 v6.11 - File:INTERMEDIATENW - Moment 3-3 Diagram (LOAD1) - Ton-m Units

Y = 12,15

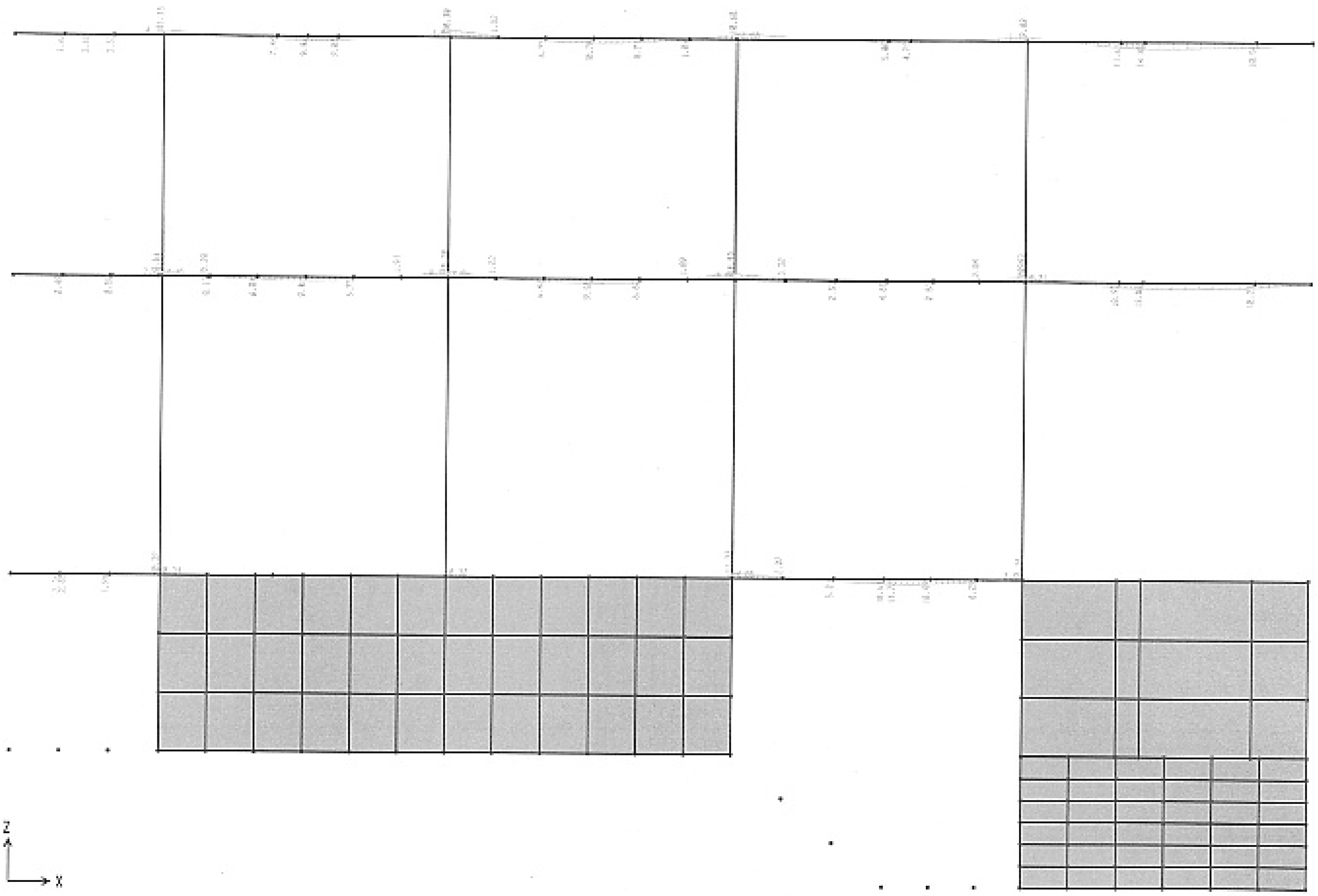


SAP2000 v6.11 - File:INTERMEDIATENW - Moment 3-3 Diagram (LOAD1) - Ton-m Units Y = 8,05



SAP2000 v6.11 - File:INTERMEDIATENW - Moment 3-3 Diagram (LOAD1) - Ton-m Units

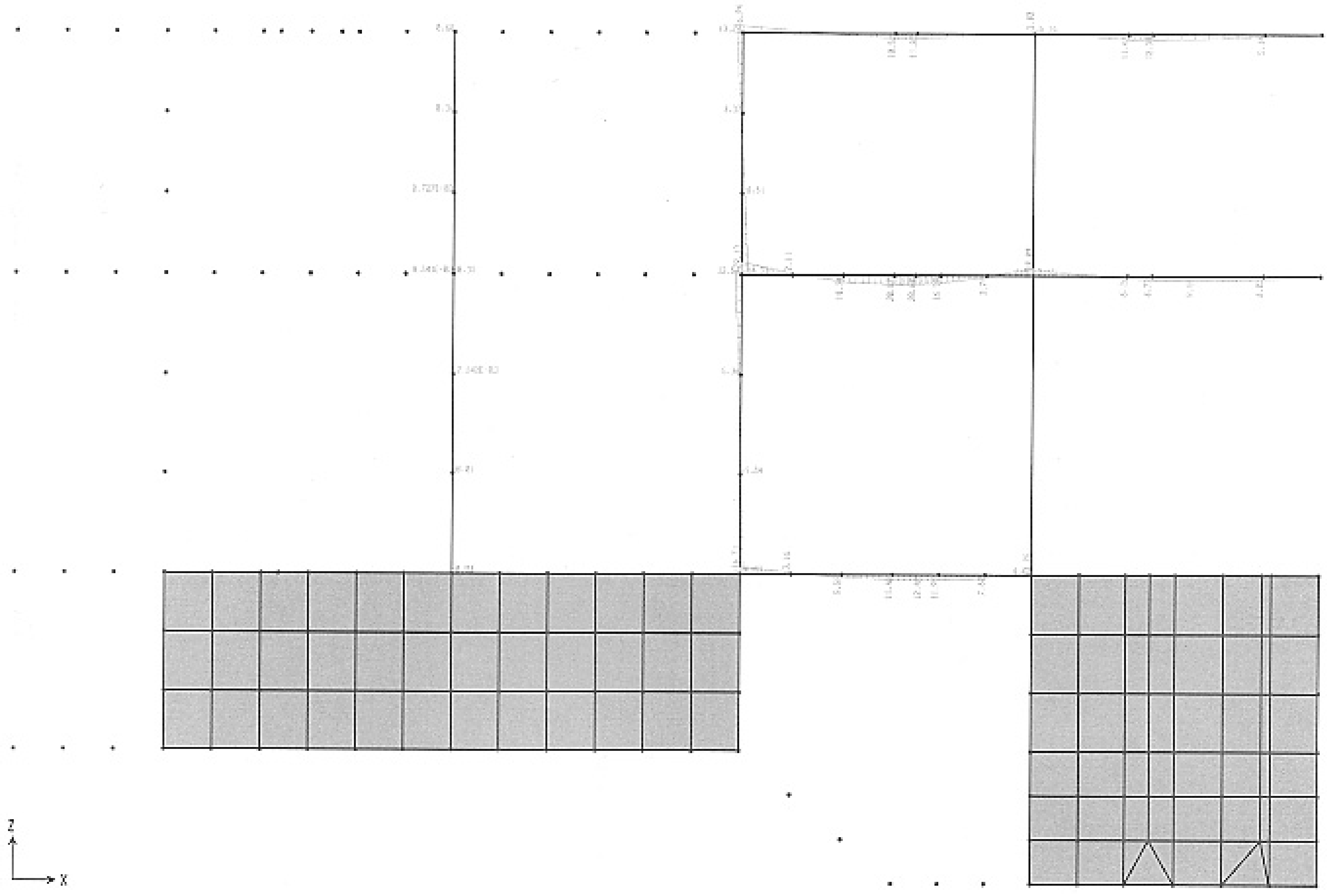
y = 16,25



SAP2000 v6.11 - File:INTERMEDIATENW - Moment 3-3 Diagram (LOAD1) - Ton-m Units Y= 20,35

SAP2000

March 7,2001 15:42



SAP2000 v6.11 - File:INTERMEDIATENW - Moment 3-3 Diagram (LOAD1) - Ton-m Units

Y=3,95

Calculation for bar arrangement for gritchamber

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

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

h_o: Effective depth of bearing area(cm)

h_o= (Element thickness-Cover thickness)

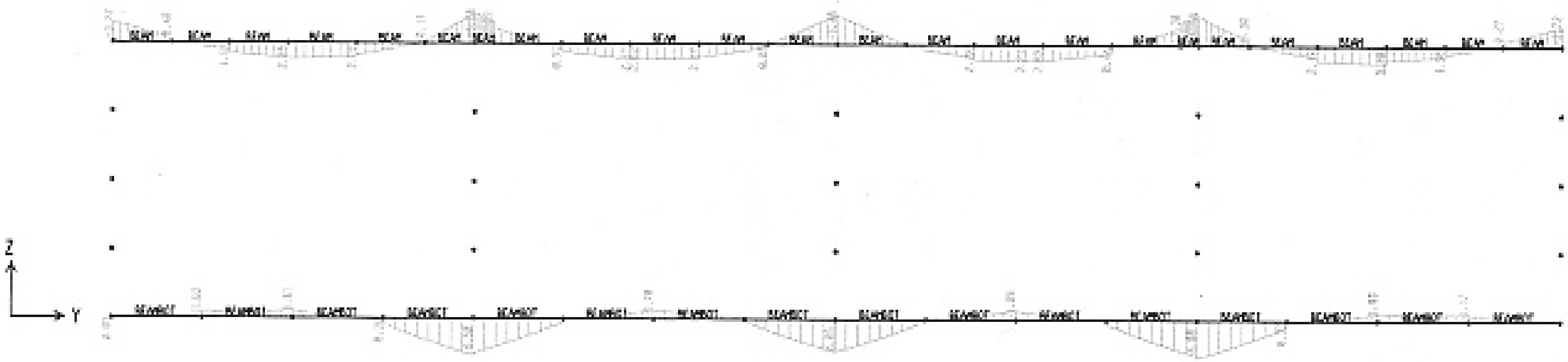
b: Width of calculated area(cm)

Required area of reinforcement:

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

Beams and Slabs

NAME OF ELEMENT	Values (T.m)	Ao	γ	Fa (cm^2)	Bar arrangement	
					φ(mm)	quantity
b=0.40 h=1.00 Beam 40x100	6.960 1.740	0.0307 0.0072	0.984 0.996	4.91 1.17	20 20	3 3
b=0.40 h=0.60 Beam 40x60	5.660 2.880	0.0720 0.0366	0.963 0.981	6.93 3.46	20 20	3 3
b=1.00 h=0.30 Slab thickness 0.3m	2.970 3.520	0.0802 0.0951	0.958 0.950	8.42 10.07	14 16	8 8
b=1.00 h=0.50 Bottom Slab	12.430 1.950	0.1230 0.0527	0.934 0.973	21.88 5.45	22 12	8 4
b=1.00 h=0.40 Waal thickness 0.4m	12.430 3.520	0.1631 0.0951	0.910 0.950	25.86 10.07	22 16	8 8



SAP2000 v6.11 - File:gritchamber15-3 - Moment 3-3 Diagram (LOAD1) - Ton-m Units

Calculation of shear connector

1. Bottom Slab

Shearing Force 20 t (from structure calculation)

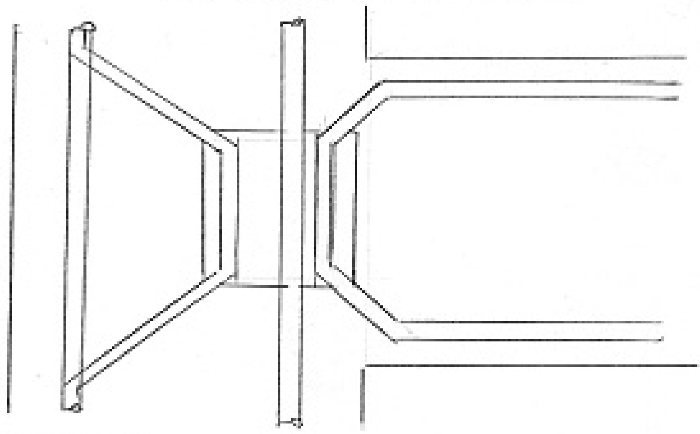
(1) Calculation of anchor bar

qa = fsa × a

Here a : Effective Area of Bolt (cm^2, Reinforcement Bar)

Fsa : Allowable Shearing Stress of Bolt

(800 kg/cm2, Reinforcement Bar)



2 bars for 1 plate

Necessary Bolt area (cm2)

Arec = 20,000kg / 800 kg = 25.0 cm2

Use D 30 (A = 7.07 cm2)

25.0 cm2 / 7.07 cm2 = 3.54 → use 2 plates / 1m

(2) Necessary area of plate

Allowable shearing stress of plate 800 kg / cm2 (SS400)

Necessary area

Arec = 20,000kg / 800 kg = 25.0 cm2

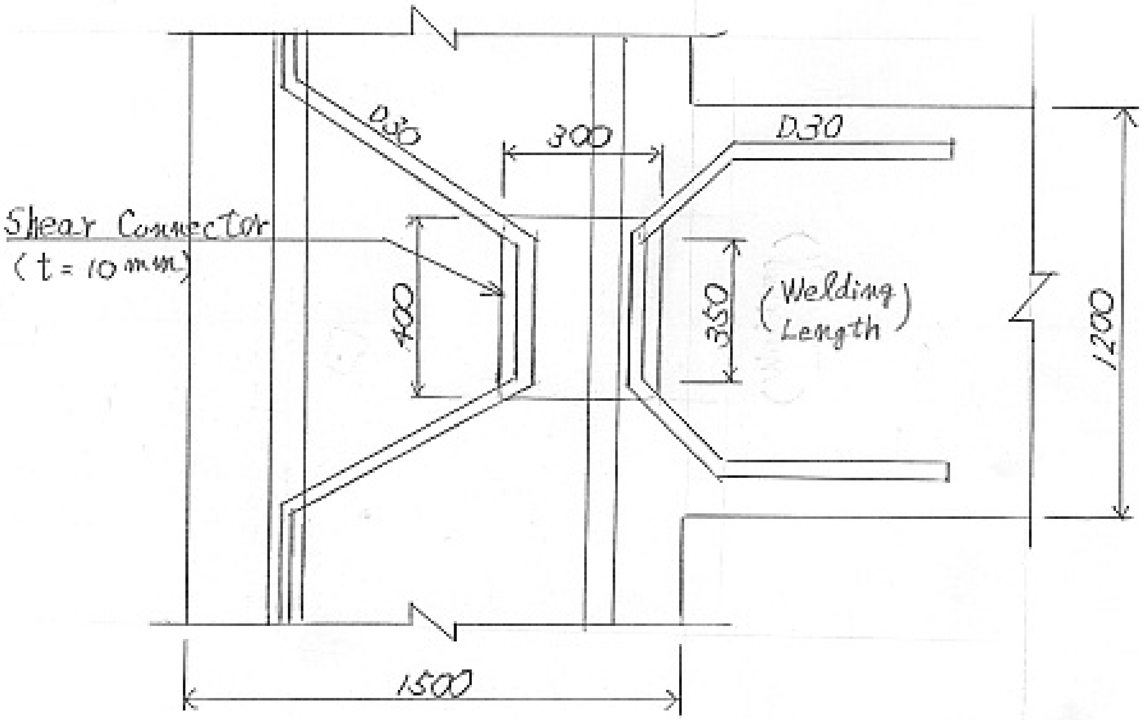
Use L = 25.0 cm, t = 1.0 cm

(3) Necessary welding length

Allowable shearing stress of welding spot 720 kg / cm2 (SS400)

Thickness of welding a (4mm ×both side = 8 mm (0.8cm))

L = 20,000 kg / (720 × 0.8 cm) = 34.7 cm use 35 cm

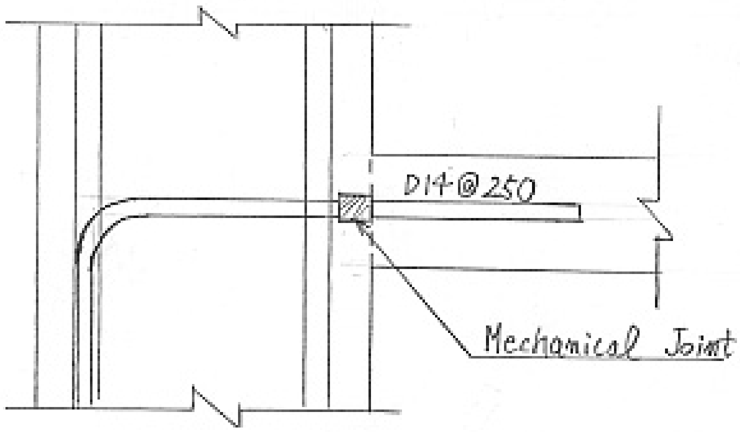


2. B2 Slab (- 10.00 m)

Shearing force 2.0 t (Including slab weight)

Anchor Bar (Shear Bar) D 14 space 250mm (A = 1.54 cm2/1bar)

1.54 cm2 × 800 kg/m2 × 4 = 4.98 t/m > 2.0 t/m



3. B1 Slab (- 3.70 m)

(1) Beam and slab

(1) - 1 Electric room part

Beam shearing force 15.88 t

D 28 (A = 6.16 cm2) n = 4

6.16 cm2 × 800 kg/m2 × 4 = 19.71 t/m > 15.88 t/m

Slab shearing force 5.00 t

D 16 (A = 2.01 cm2) space 250

2.01 cm2 × 800 kg/m2 × 4 = 6.43 t/m > 5.00 t/m

(1) - 2 Other part

Beam shearing force 10.75 t

D 22 (A = 3.80 cm2) n = 4

3.80 cm2 × 800 kg/m2 × 4 = 12.16 t/m > 10.75 t/m

Slab shearing force 2.00 t

D 14 (A = 2.01 cm2) space 250

1.54 cm2 × 800 kg/m2 × 4 = 4.98 t/m > 2.00 t/m

4. 1F Slab (+ 2.30 m)

(1) Beam

Beam shearing force 10.13 t

D 22 (A = 3.80 cm2) n = 4

3.80 cm2 × 800 kg/m2 × 4 = 12.16 t/m > 10.13 t/m

(2) Beam

Slab shearing force 2.00 t

D 14 (A = 2.01 cm2) space 250

1.54 cm2 × 800 kg/m2 × 4 = 4.98 t/m > 2.00 t/m

4.1.4

Spread Foundation

Spread Foundation Calculation

(a) Condition of soil of IWPS site

Typical soil condition of IWPS site is shown in bellow.

DSP-01

+1.40 m Existing GL

OH Layer (Upper Layer)

rw = 1.40 t/m3 ▽ GL=1.20 m (WL)

−2.10 m (Average)

OH Layer (Lower Layer)

rw = 2.00 t/m3
C = 0 t/m2 (asuming)

N = 5 (Average)
Assuming of internal friction angle
Equation in Japan
ϕ = 15 + square root(15 × N) = 23.6
Equation of Peck
ϕ = 0.3 × N + 27 = 28.5
Equation of Dunham
ϕ = 15 + square root(12 × N) = 22.7

Use ϕ = 20 °

−7.10 m

CL Layer (Clayer Sand)

rw = 2.00 t/m3
C = 0 t/m2 (assuming)

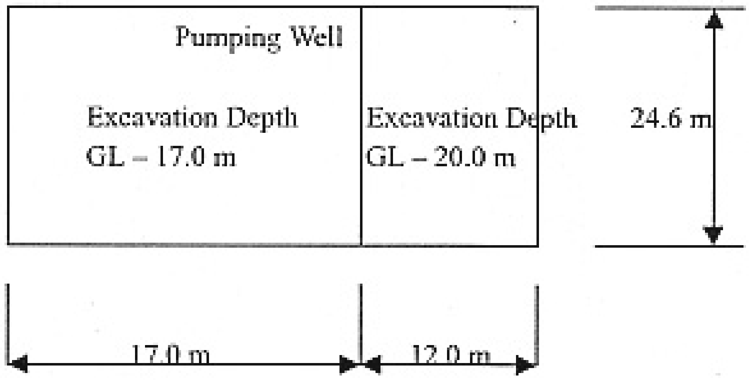
N = 10 (Base slab depth)
Assuming of internal friction angle
Equation in Japan
ϕ = 15 + square root(15 × N) = 27.2
Equation of Peck
ϕ = 0.3 × N + 27 = 30.0
Equation of Dunham
ϕ = 15 + square root(12 × N) = 26.0

Use ϕ = 25 °

(b) Allowable Bearing Capacity calculation

- Pumping Well Part

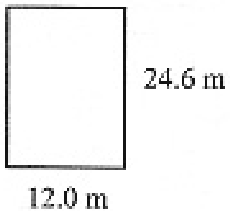
* Calculation Condition



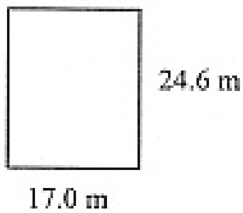
* Allowable Bearing Capacity of Soil

$$qa = 1/3 \ (\ \alpha \times C \times Nc \ + \beta \times r1 \times B \times Nr \ + \ r2 \times Df \times Nq \ )$$

Rectangular foundation case 1



Case 2



Case 1

$\alpha = 1.0 + 0.3 \times 12.0/24.6 = 1.15$, $\beta = 0.5 - 0.1 \times 12.0/24.6 = 0.45$

C = 0 t/m2, r1 = 0.9 t/m3, r2 = 1.0 t/m3, Df = 20.0 m

$\phi = 25°$ then Nc = 9.9, Nr = 3.3, Nq = 7.6

B = 12.0 m

$$qa = 1/3 \ (\ 1.15 \times 0 \times 9.9 + 0.45 \times 0.9 \times 12.0 \times 3.3 \ + \ 1.0 \times 20 \times 7.6)$$
$$= 52.7 \text{ t/m2}$$

Case 2

$\alpha = 1.0 + 0.3 \times 17.0/24.6 = 1.21$, $\beta = 0.5 - 0.1 \times 17.0/24.6 = 0.43$

$C = 0$ t/m2, $r1 = 0.9$ t/m3, $r2 = 1.0$ t/m3, $Df = 17.0$ m

$\phi = 25°$ then $Nc = 9.9$, $Nr = 3.3$, $Nq = 7.6$

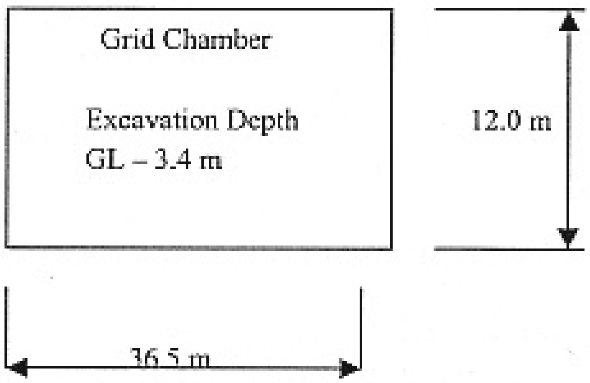
$B = 17.0$ m

$qa = 1/3\ (1.21 \times 0 \times 9.9 + 0.45 \times 0.9 \times 17.0 \times 3.3 + 1.0 \times 17 \times 7.6)$

$= 50.6$ t/m2 > 11.70 t/m2 OK

- Grit Chamber Part

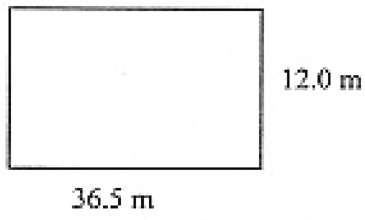
Calculation Condition



Allowable Bearing Capacity of Soil

$qa = 1/3\ (\alpha \times C \times Nc + \beta \times r1 \times B \times Nr + r2 \times Df \times Nq)$

Rectangular foundation



$\alpha = 1.0 + 0.3 \times 12.0/36.5 = 1.10$, $\beta = 0.5 - 0.1 \times 12.0/36.5 = 0.47$

$C = 0$ t/m2, $r1 = 1.0$ t/m3, $r2 = 0.74$ t/m3, $Df = 3.4$ m

$\phi = 20°$ then $Nc = 7.9$, $Nr = 2.0$, $Nq = 5.9$

$B = 22.0$ m

$qa = 1/3\ (1.10 \times 0 \times 7.9 + 0.47 \times 1.0 \times 12.0 \times 2.0 + 0.74 \times 3.4 \times 5.9)$

$= 8.70$ t/m2 > 4.56 t/m2 OK

4.1.5

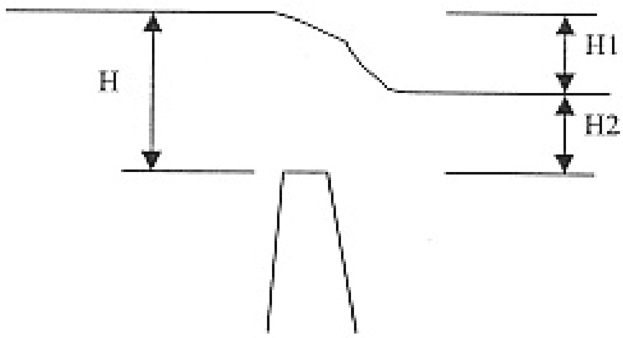
Grit Chamber Over Flow Weir

Calculation of Grit Chamber Weir

(a) Design Flow Rate (Hourly Maximum)
Design hourly maximum flow rate is shown in bellow.

Phase 1	191,621 m3/day	(2.218 m3/s)
Phase 2	639,800 m3/day	(7.405 m3/s)
Final phase	698,618 m3/day	(8.086 m3/s)

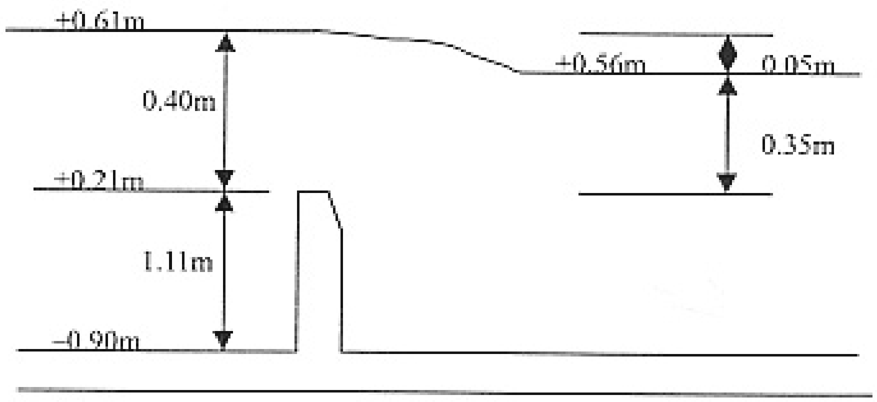
(b) Result of Calculation of Weir Length
Weir length is calculated as submerged weir.



L = Q / 1.8 (H1 +1.4 × H2) ×SQRT H1

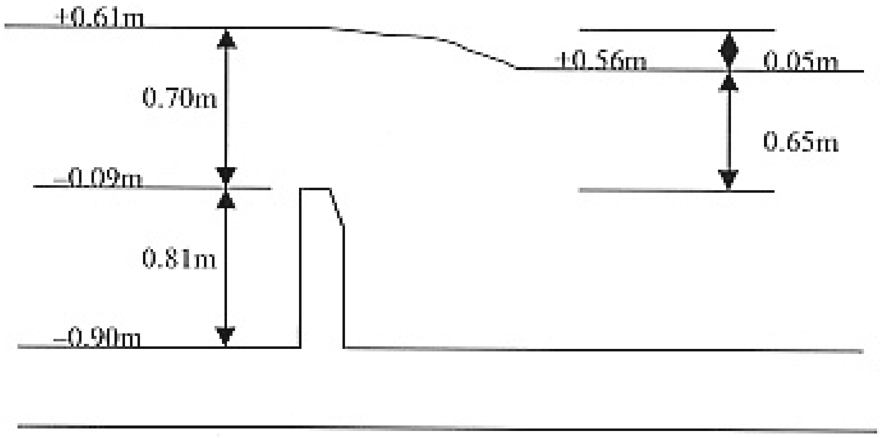
(c) Result of calculation

• Phase 1



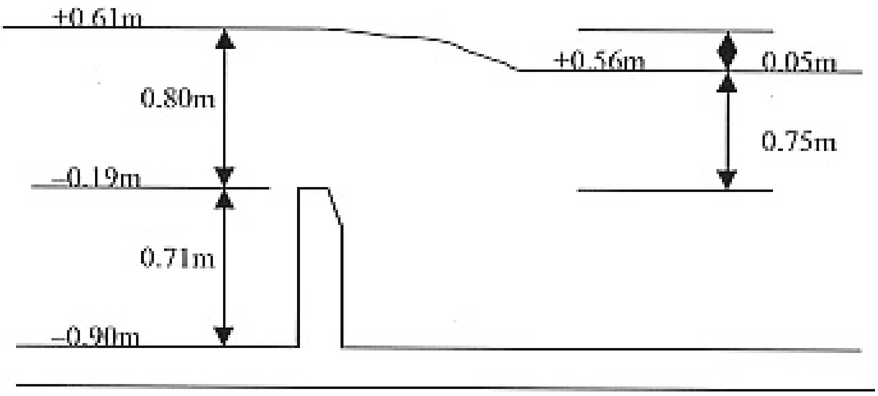
Necessary Weir Length L = 10.2 m

• Phase 2



Necessary Weir Length L = 19.1 m

• Final Phase



Necessary Weir Length L = 18.3 m

(c) Calculation of Weir Length

• Phase 1
H = 0.40m, H1 = 0.05m

L = 2.218 (m3/s) / 1.8 (0.05 + 1.4 × 0.35) × SQRT 0.05 = 10.2 m

• Phase 2

H = 0.70m, H1 = 0.05m

L = 7.405 (m3/s) / 1.8 (0.05 + 1.4 × 0.65) × SQRT 0.05 = 19.1 m

• Final Phase

H = 0.80m, H1 = 0.05m

L = 8.086 (m3/s) / 1.8 (0.05 + 1.4 × 0.75) × SQRT 0.05 = 18.3 m

4.1.6

Slope Sliding

Slope stability analysis

Slope stability analysis is used to examine a stability of soil slope of open cut method or to examine a stability of soil slope of filling of soil.

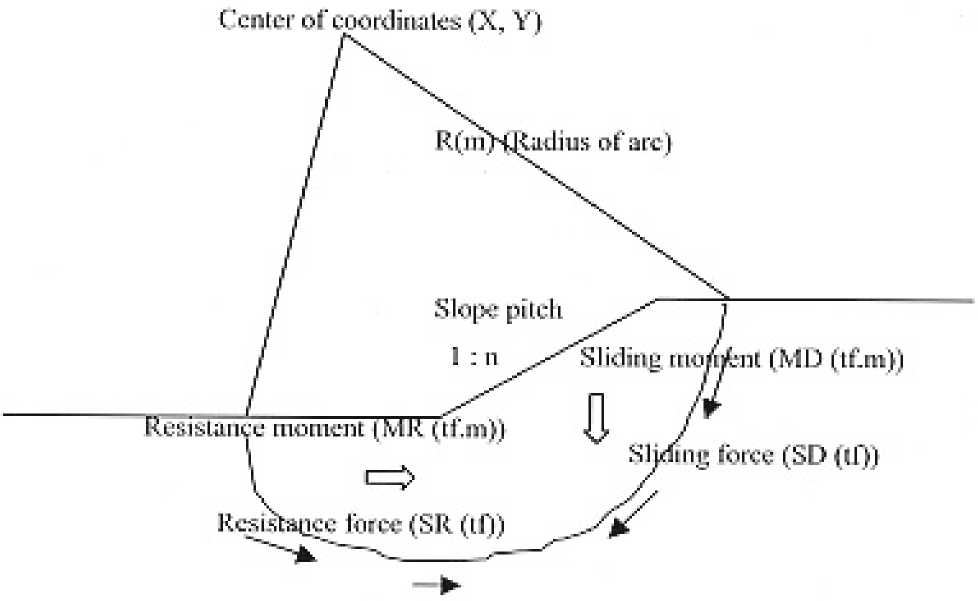
It is calculated as a slope sliding of soil.

The result of calculation is checked by comparison of sliding force (moment) and resistance force (moment). Safety factor (SF) is a ratio of sliding moment and resistance moment.

Necessary safety factor is

For permanent structure	Fs ≥ 1.2
For temporary structure	Fs ≥ 1.0

The typical calculation section is shown below



The calculation is done to meet a minimum safety factor in condition of assumed coordinates (X, Y) and radius of arc (m). Also each soil condition is considered.

Result of calculation for Grid chamber part is shown in next page.

Calculation conditions are

Existing Ground Level	+ 1.40 m
Excavation Level	- 2.30 m
Slope Pitch	1 : 1.0

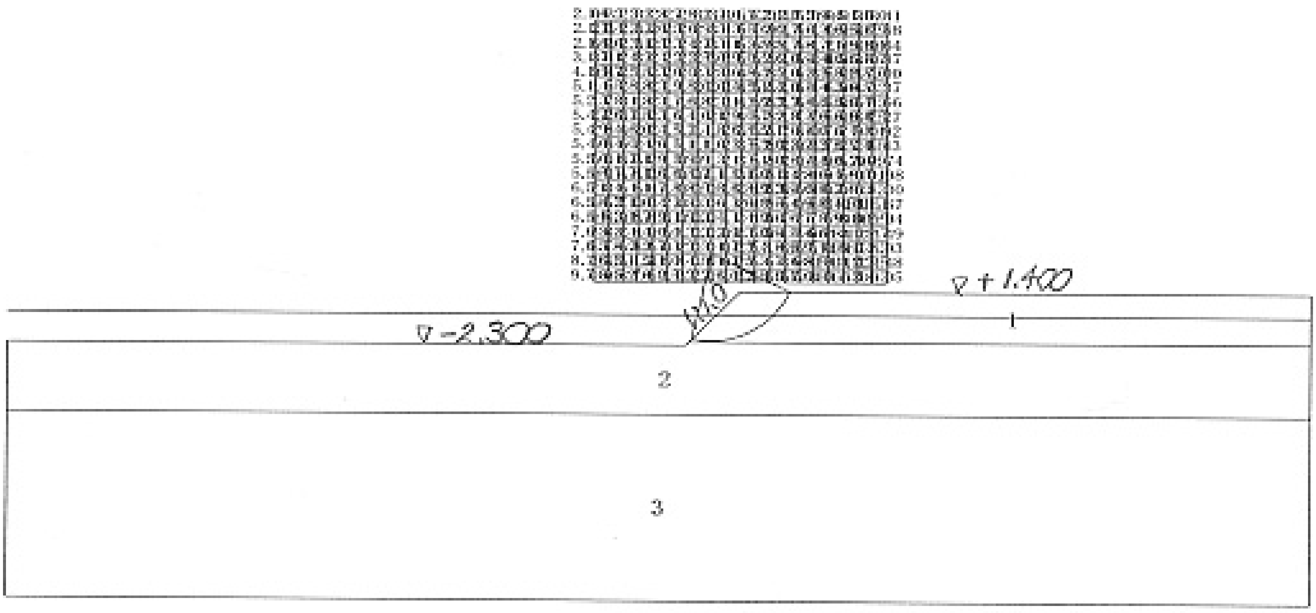
SF = 1.01 (For temporary structure O K)

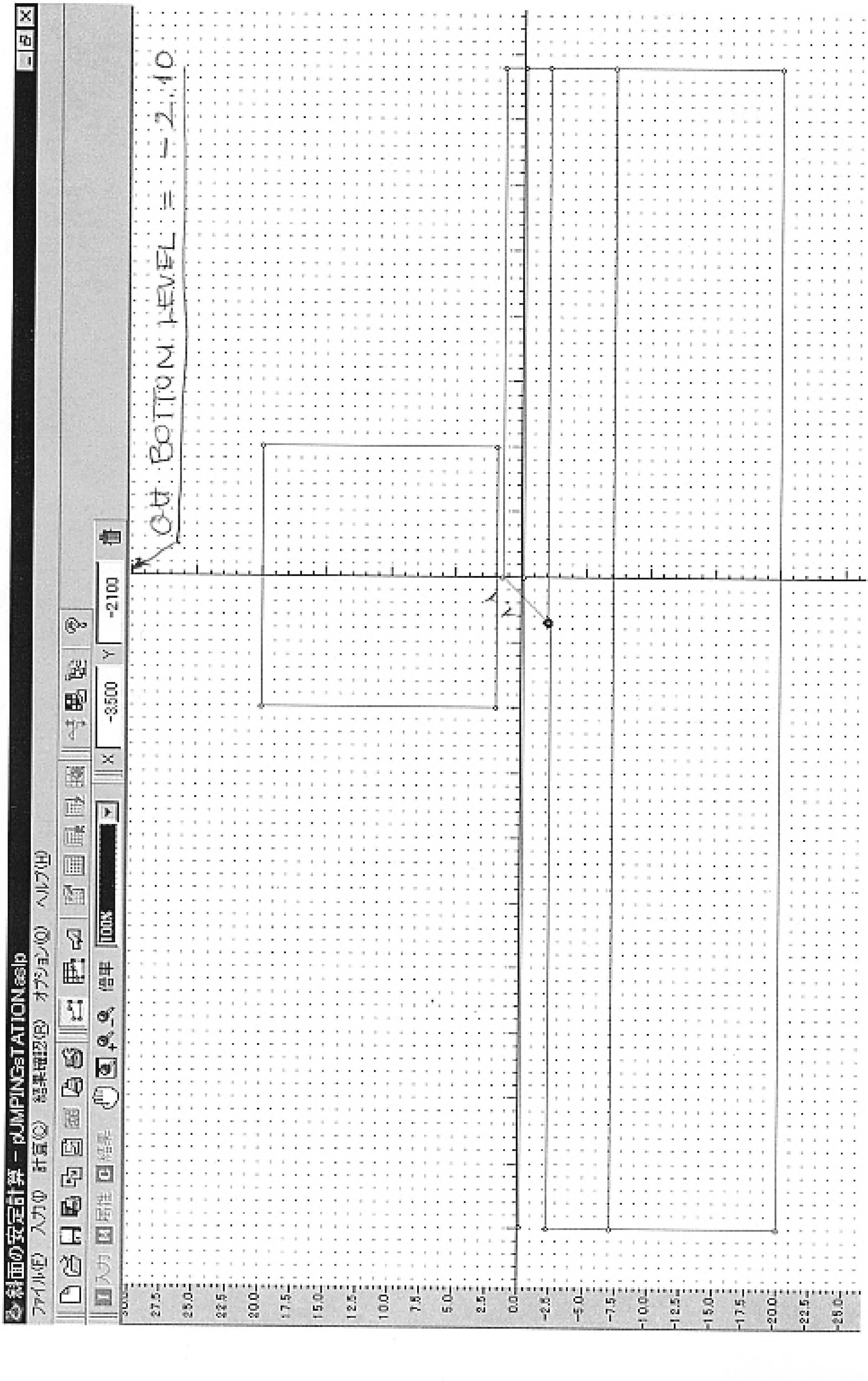
Intermediate Pumping Station
Grit Chamber Slope Sliding Calculation

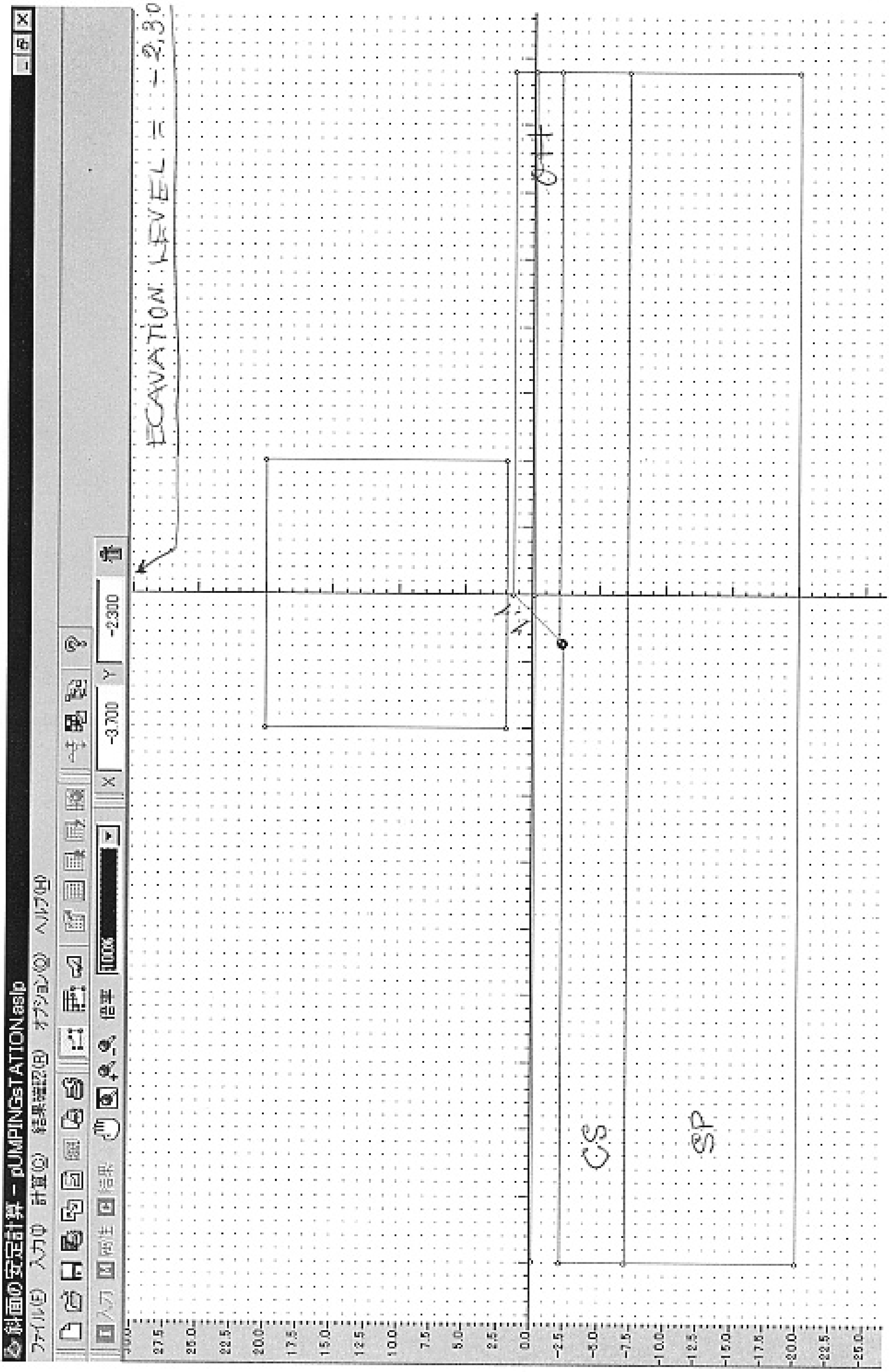
Pump－1per1

安全率(モーメントの比)	Fs	1.01	(Minimum safety factor)
円弧中心座標	X (m)	-2.00	(Cordinate of the center)
円弧中心座標	Y (m)	4.00	(〃)
円弧半径	R (m)	6.00	(Radius of arc)
抵抗力	SR(tf)	4.81	(Resistance force)
抵抗モーメント	MR(tf ·m)	28.84	(Resistance moment)
滑り力	SD(tf)	4.81	(Sliding force)
起動モーメント	MD(tf ·m)	28.62	(Sliding moment)
抑止力	(tf)	0.01	(Deterrent)

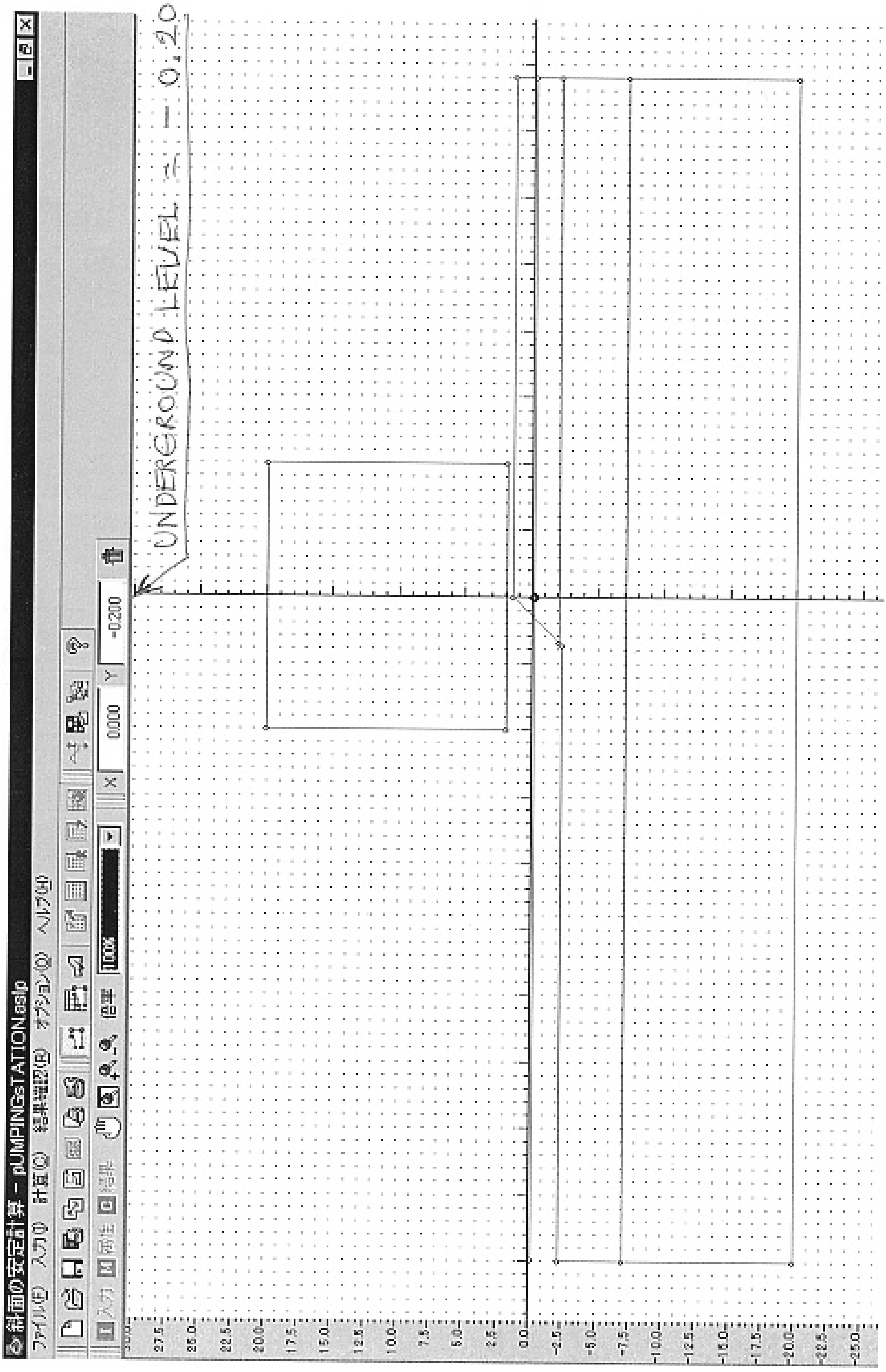
No	ブロック名称	γt(tf/ m³)	C0(tf/ m²)	k1(tf/ m³)	φu(度)
1	oh (layer)	1.40	0.60	0.00	0.00
2	cs (layer)	2.00	2.20	0.00	0.00
3	s (layer)	2.00	0.00	0.00	30.00




斜面の安定計算 - pUMPINGsTATION.aslp
ファイル(F) 入力(I) 計算(C) 結果確認(R) オプション(O) ヘルプ(H)
入力 属性 結果 倍率 100%
X -3500 Y -2100
OGL BOTTOM LEVEL = -2.10
27.5
25.0
22.5
20.0
17.5
15.0
12.5
10.0
7.5
5.0
2.5
0.0
-2.5
-5.0
-7.5
-10.0
-12.5
-15.0
-17.5
-20.0
-22.5
-25.0



斜面の安定計算 - pUMPINGsTATTION.aslp
ファイル(F) 入力(I) 計算(C) 結果確認(R) オプション(O) ヘルプ(H)
倍率
X -3.700 Y -2.300
ECAVATION LEVEL = -2,30
CS
SP



斜面の安定計算 － pUMPINGsTATION.aslp
ファイル(F) 入力(I) 計算(C) 結果確認(R) オプション(O) ヘルプ(H)
入力 属性 結果
倍率 100%
X 0.000 Y -0.200
UNDERGROUND LEVEL ≒ − 0.20
27.5 25.0 22.5 20.0 17.5 15.0 12.5 10.0 7.5 5.0 2.5 0.0 -2.5 -5.0 -7.5 -10.0 -12.5 -15.0 -17.5 -20.0 -22.5 -25.0

ENGINEERING GEOLOGY CROSS SECTION A-A

Intermediate Sewage Pumping Station Site

SCALE: Vertical 1/300

Horizontal 1/500