Appendix to Chapter 1

Study Related Members

JICA Advisory Committee Members

Name	Position	Institution
Dr. Kimiro Meguro	Committee Leader	The University of Tokyo
Dr. Shuichi Takeya	Member	Ministry of Land, Infrastructure and Transport
Dr. Shingo Nagamatsu	Member	Disaster Reduction and Human Renovation Institution
Mr. Katsunori Ishida	Observer	Hyogo Prefecture Government

JICA Study Team

Name	Position
Mr. Itaru Mae	Team Leader
Mr. Ichiro Kobayashi	Deputy Team Leader / Urban Disaster Management
Mr. Osamu Nishii	Deputy Team Leader / Disaster Prevention and Management
Mr. Kanao Ito	Urban Planning (1)
Ms. Mihoko Ogasawara	Urban Planning (2)
Dr. Akio Hayashi	Building Structure
Mr. Ryoji Takahashi	Infrastructure and Lifeline
Dr. Nahoko Nakazawa	Community Disaster Prevention and Management (1)
Ms. Junko Okamoto	Community Disaster Prevention and Management (2)
Ms. Tomoko Show	Social Analysis
Mr. Masatoshi Kaneko	Economic Analysis
Mr. Schneider Klaus-Dieter	Organization and Institution for Disaster Management (1) / Project Implementation
Mr. Makoto Nakamura	Organization and Institution for Disaster Management (2)
Mr. Kazumi Akita	Disaster Rescue and Medical Response
Mr. Hiroyuki Maeda	GIS Specialist
Mr. Masahiro Satake	Disaster Information and Communication Management
Mr. Kazunori Seki	Reconstruction and Structure Plan
Mr. Shukyo Segawa	Seismology
Mr. Toshitsugu Shimodaira	Coordinator
Mr. Kazushige Mizui	Coordinator
The Study on Reconstruction Plan for Bam Water Supply System	
Mr. Ichiro Kobayashi	Deputy Team Leader / Urban Disaster Management
Dr. Akio Hayashi	Building Structure
Mr. Nobuyuki Gonohe	Water Supply and Facility Plan
Mr. Yarai Sato	Pipeline Network Design and Cost Estimate
Mr. Naoki Yasuda	Cost Estimate
Ms. Atsuko Tsuruta	Community Restoration
Ms. Hitomi Tomizawa	Agricultural Restoration Plan

Name	Position
Mr. Keigo Obara	Social Environment and Impact Survey
Mr. Shuichi Yoshida	Structure Planning and Construction Supervision (2)
Mr. Ichiro Tanaka	Groundwater Recourses Planning (1)
Mr. Hiroyoshi Yamada	Groundwater Resources Planning (2)
Mr. Osamu Abe	Operation and Maintenance Planning
Mr. Mamoru Nakamura	Construction Supervision (1)
Mr. Osamu Heki	Construction Supervision (3)

JICA Tokyo Headquarters

Name	Position
Mr. Itsu Adachi	Group Director, Group III (Water Resources and Disaster Management), Global Environment Department
Mr. Masafumi Nagaishi	Team Director, Water Resources and Disaster Management Team II, Group III (Water Resources and Disaster Management), Global Environment Department
Ms. Ai Yamazaki	Staff, Water Resources and Disaster Management Team II, Group III (Water Resources and Disaster Management), Global Environment Department

JICA Expert

Name	Position
Mr. Junji Wakui	JICA Expert, ODA Advisor in Iran

Major Activities of the Study

Date	Topics and Activities
January 2004	Preparatory mission
May 14 2004	Contract with Japan International Cooperation Agency (JICA)
May 24 2004	Commencement of the Study at Bam in Kerman province
June 20 2004	Signing on Minutes of Meeting on the objectives of the study, scope, schedule, reporting schedule, demarcation of the responsibilities between counterpart agencies in Iran and JICA Study Team
July 28 2004	Commencement of the construction of test boreholes
August 1 2004	Commencement of the construction of distribution reservoir
October 23 2004	Workshop for the Study on Draft Final Report
October 23 2004	Signing on Minutes of Meeting on the submission of the draft final report
October 2004	Completion of test boreholes
December 25 2004	Hand-over ceremony for distribution reservoir
March 9 2005	Submission of completion letter to WSCK

Appendix to Chapter 2

Structural Design of Baravat Reservoir

1. Introduction

A typical detailed design of ground type water reservoirs was published by Research and Technical Standard Office of Management and Planning Organization (MPO) in 1993. The package of the drawings proposed by MPO was widely used for detailed design of reservoirs in Iran. WSCK also follows the detailed design, using these drawings, proposed by MPO when constructing a new reservoir.

As for detailed design for new reservoir, volume of which is 2,000 m^3, in Baravat, application of these drawings was considered. However, in order to endure a future seismic event, JICA insisted to take into consideration the seismic condition, and the Study Team conducted structural design. The results of structural design were used for actual bidding documents for Baravat reservoir construction project.

2. Design Load

Three cases of design load are described below:

Case 1: ordinary condition (two basins: full of water)

Case 2: test condition (one basin: full of water, the other basin: empty of water)

Case 3: earthquake condition (two basins: full of water) (horizontal seismic coefficient: 0.3, vertical seismic coefficient: 0.15)

(1) Unit Weight

Unit Weight of Materials is as follows:

Reinforced concrete:	2.5 t/m^3
Covered soil (gravel):	1.8 t/m^3
Soil:	1.7 t/m^3
Water:	1.0 t/m^3

(2) Dead Load

(a) Top Slab

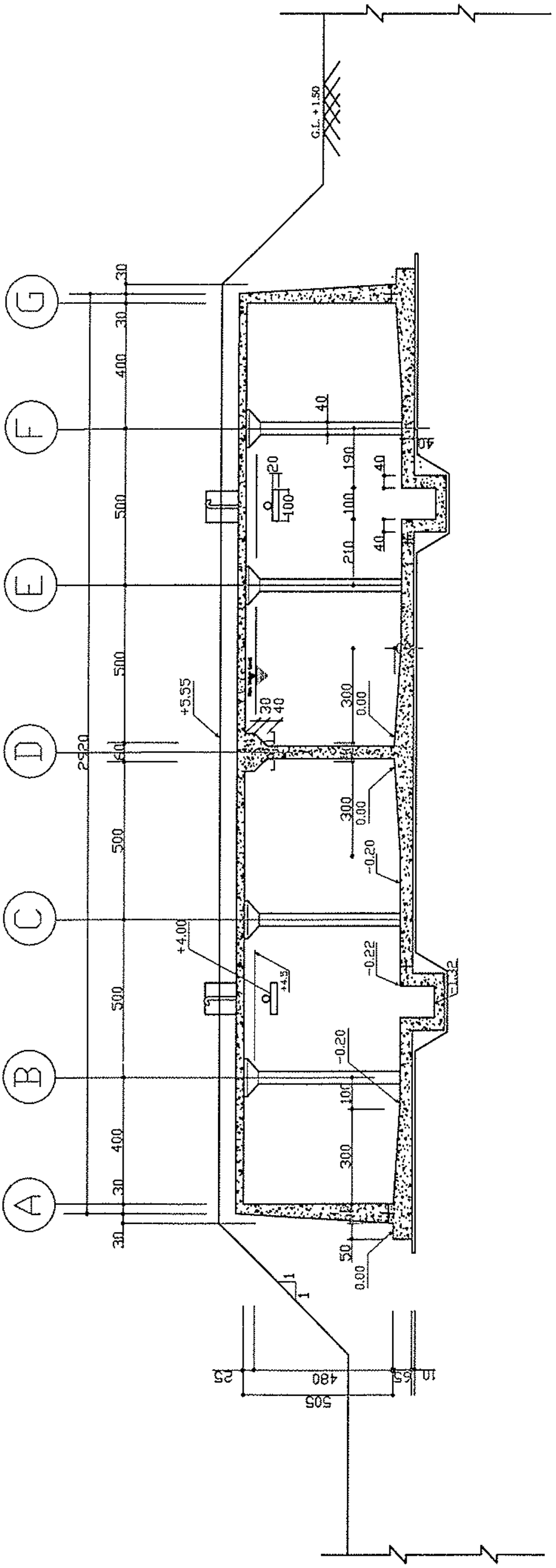
- Case 1&2

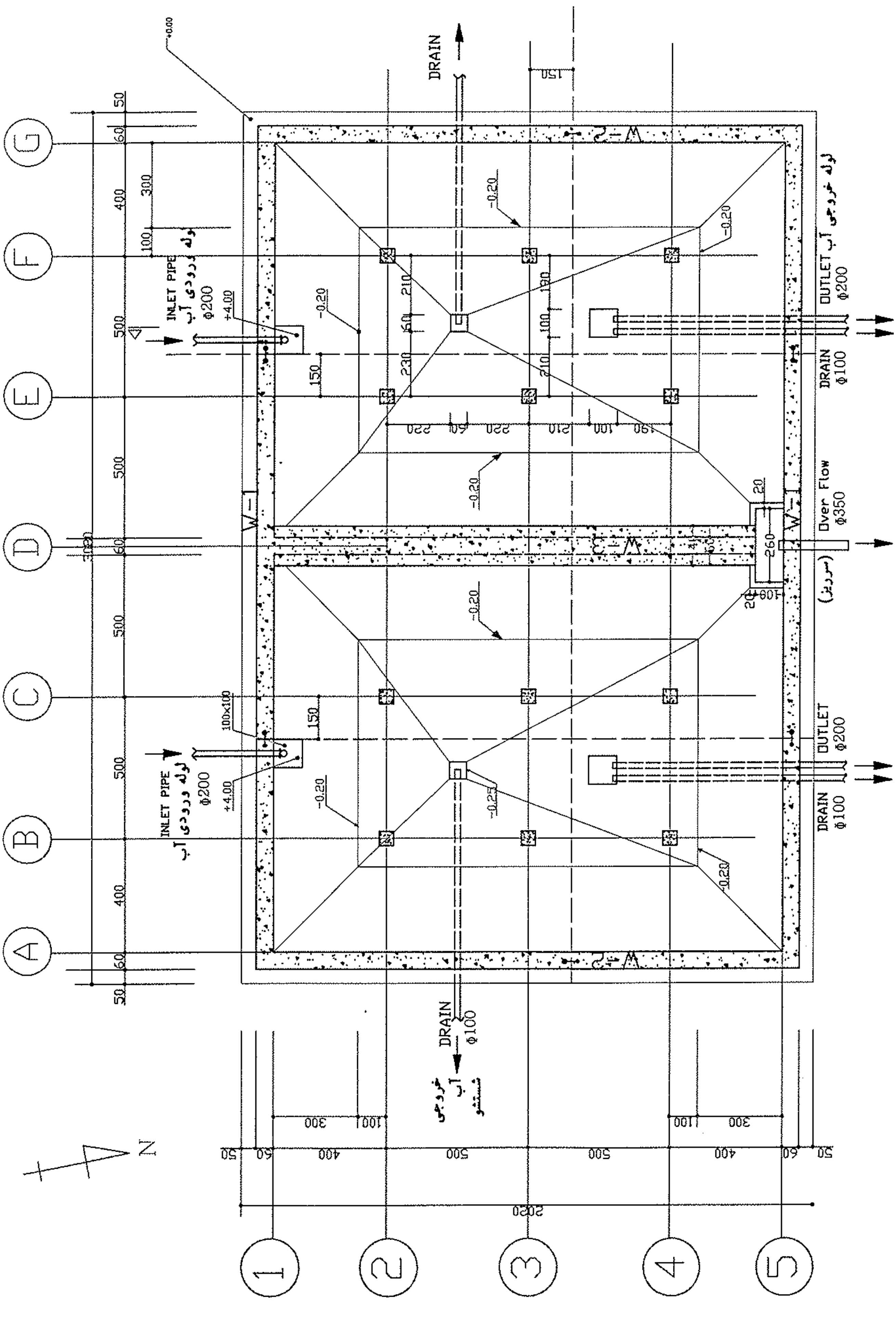
Dead load of Top slab is calculated by sum of those of top soil and reinforced concrete.

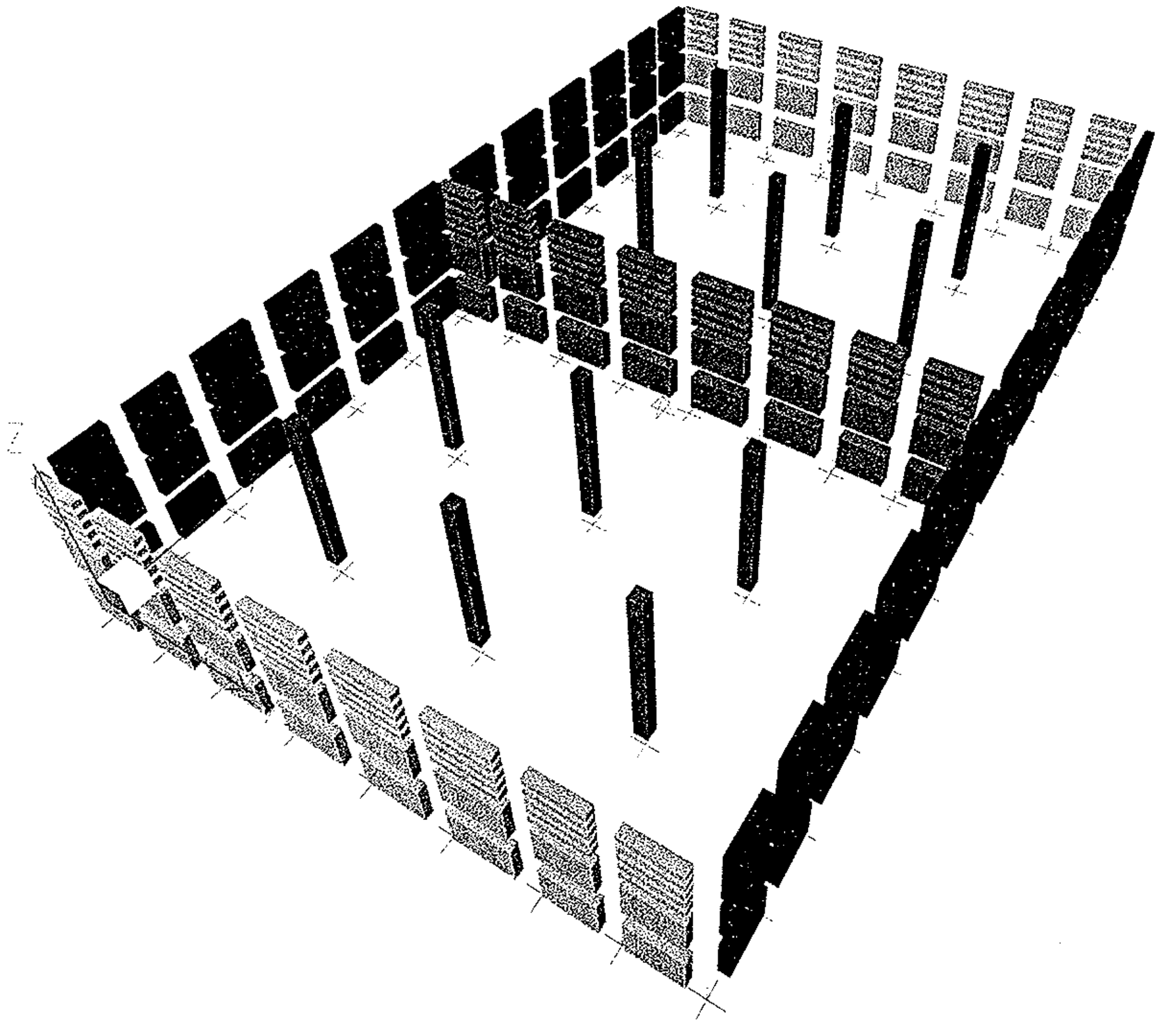
Top Soil:	0.5 m (height) x 1.8 t/m^3	= 0.9 t/m^2
Reinforced Concrete:	0.25 m (thickness) x 2.5 t/m^3	= 0.625 t/m^2
	Total	1.53 t/m^2

- Case 3

Design load at seismic condition is calculated with use of horizontal seismic coefficient (= 0.3)


A
B
C
D
E
F
G
G.L. +1.50
+5.55
+4.00
2920
30
400
500
300
100
190
210
40
20
0.00
-0.20
-0.22
50
480
505
25
65
10


DRAIN
DRAIN Φ100
INLET PIPE
لوله ورودی آب
Φ200
+4.00
OUTLET
لوله خروجی آب
Φ200
DRAIN Φ100
Over Flow Φ350
(سرریز)
خروجی آب شستشو
100x100
-0.20
-0.25
+0.00
W-1
A
B
C
D
E
F
G
1
2
3
4
5
N
2020
3000



ETABS v8.03 - File: RESERVOIR - July 3,2004 15:40
3-D View - Kgf-m Units

and vertical seismic coefficient (= 0.15) as follows:

Vertical load at seismic condition: $1.53 \times (1.0 + 0.15) = 1.76$ t/m^2

Horizontal load at seismic condition: $1.53 \times 0.3 = 0.46$ t/m^2

Therefore, dead load in each case is calculated as below.

(Unit: t/m^2)

Case	Vertical	Horizontal
Case 1&2	1.53	-
Case 3	1.76	0.46

(b) Bottom Slab

Reinforced Concrete: 0.5 m (average of height) x 2.5 t/m^3 = 1.25 t/m^2

The load is calculated in the same way as top slab calculation.

(Unit: t/m^2)

Case	Vertical	Horizontal
Case 1&2	1.25	-
Case 3	1.44	0.375

(c) Outside Wall (W-1 & W-2)

Reinforced Concrete: 0.45 m (average of width) x 1.0m x 2.5 t/m^3 = 1.13 t/m

(Unit: t/m)

Case	Vertical	Horizontal
Case 1&2	1.13	-
Case 3	1.30	0.34

(d) Partition Wall (W-3)

Reinforced Concrete: 0.6 m (average of width) x 1.0m x 2.5 t/m^3 = 1.50 t/m

(Unit: t/m)

Case	Vertical	Horizontal
Case 1&2	1.50	-
Case 3	1.73	0.45

(e) Column

Reinforced Concrete: 0.4 m x 0.4 m x 2.5 t/m^3 = 0.4 t/m

(Unit: t/m)

Case	Vertical	Horizontal
Case 1&2	0.4	-
Case 3	0.46	0.12

(3) Live Load

Live load by people on the top slab: = 0.1 t/m^2

(Unit: t/m^2)

Case	Vertical	Horizontal
Case 1	0.1	-
Case 2&3	-	-

(4) Horizontal Earth Pressure (PS)

Horizontal earthquake pressure is calculated as the following formula:

PS =K x γ x h

where:

K: coefficient 0.3 for case 1&2 (assumption)

0.5 for case 3 (assumption)

γ : unit weight of soil 1.7 t/m^3

h: depth from ground surface (elevation 5.55 m)

0.625 m at top slab

5.95 m at bottom slab

Therefore,

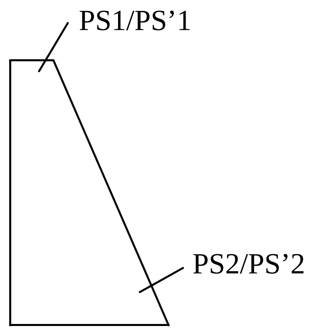
PS1=0.3 x 0.625 m x 1.7 =0.32 t/m^2

PS2=0.3 x 5.95 m x 1.7 =3.03 t/m^2

PS1'=0.5 x 0.625 m x 1.7 =0.56 t/m^2

PS2'=0.5 x 5.95 m x 1.7 =5.06 t/m^2

The following horizontal trapezoidal distributed load is working to the outside wall.



(Unit: t/m^2)

Case	Upper	Lower
Case 1&2	0.32	3.03
Case 3	0.56	5.06

(5) Water Pressure

(a) Hydrostatic Pressure (ordinary condition)

Hydrostatic pressure for ordinary condition is calculated as the following formula:

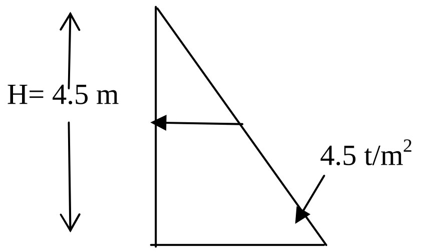
$P_w = w_0 \cdot h$

Where:

P_w: Hydrostatic pressure on depth h from surface water level (t/m^2)

w_0: Unit weight of water (t/m^3)   1.0

h: Depth from surface water level (m)



(b) Hydrodynamic pressure (earthquake condition)

The following distribution load is acting to wall inside additionally in case of earthquake.

Pdw = $\pm 7/8 \times K_h \times (H\ Y)$ ^0.5

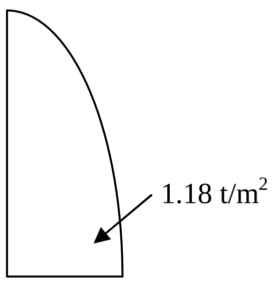
Where:

Pdw: Hydrodynamic pressure force (t/m^2)

K_h: Horizontal design seismic coefficient: 0.3

H: Water depth: 4.5 (m)

Y: depth from water surface

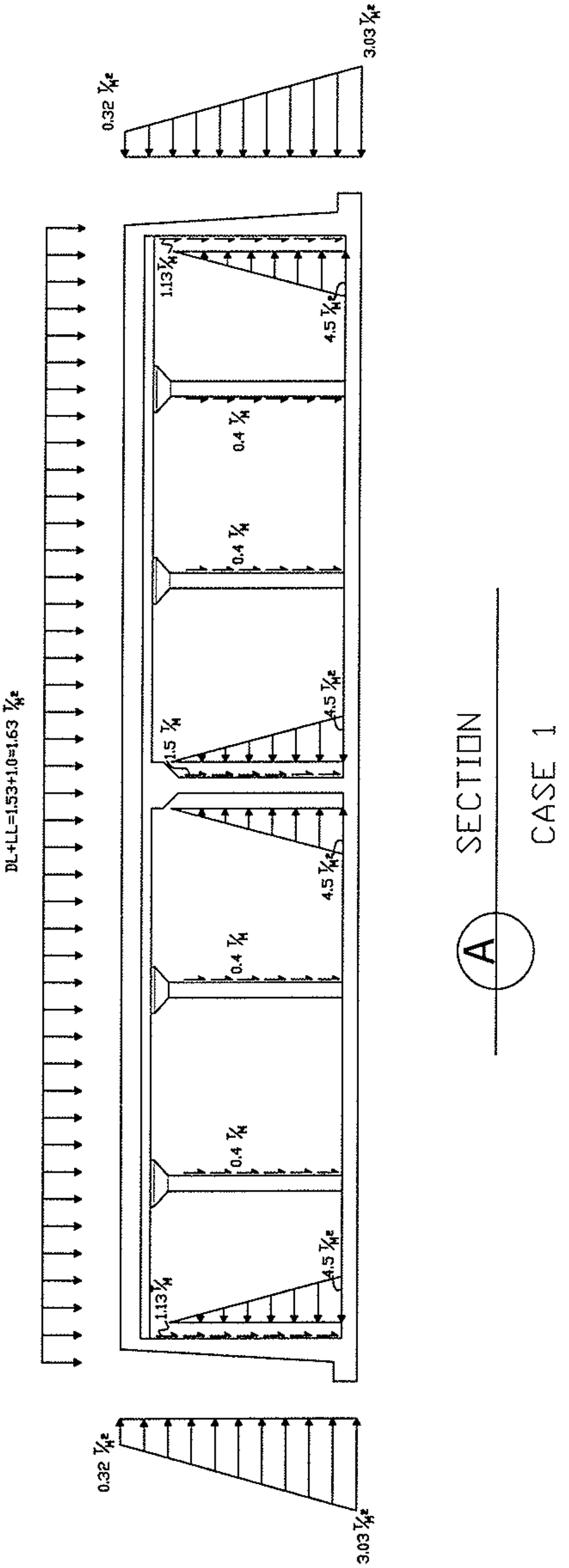


(Unit: t/m^2)

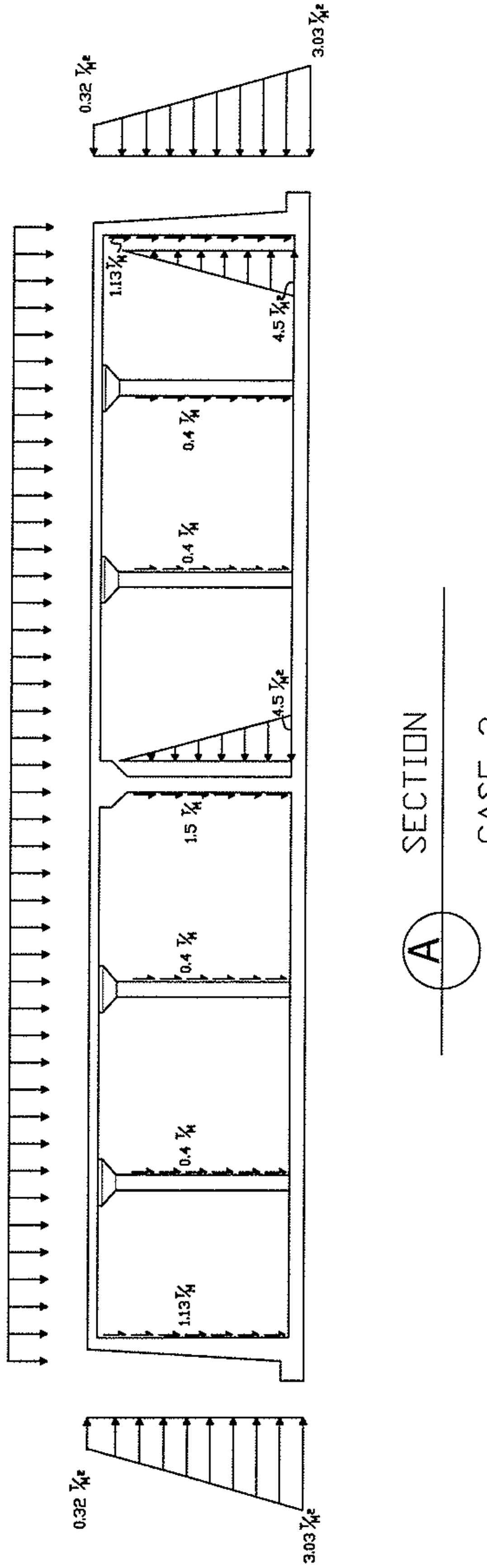
Case	Vertical	Horizontal
Case 1&2	4.5	0~4.5
Case 3	4.5	0~(4.5±1.18)

Load Combination (Vertical View)

Case 1

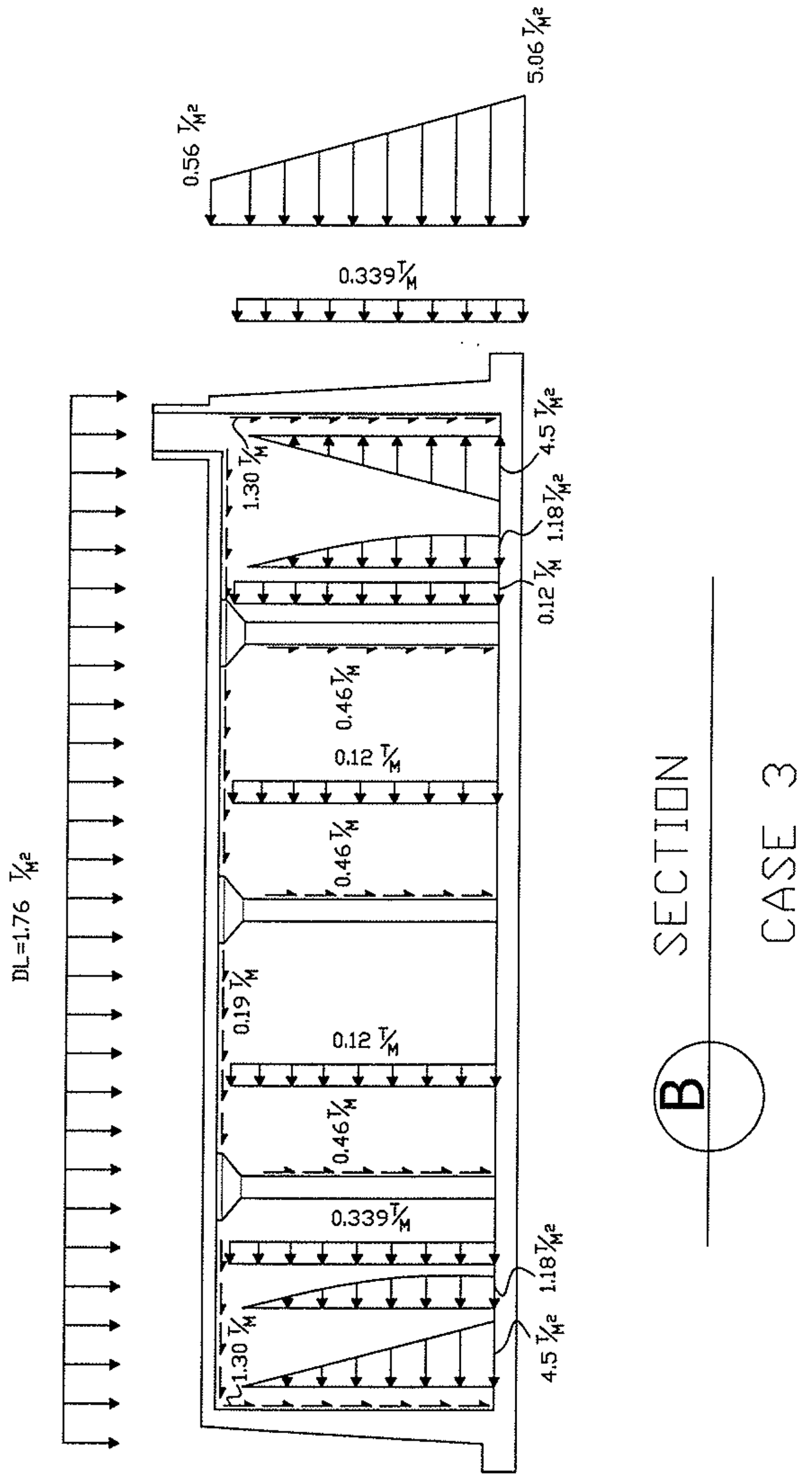


Case 2



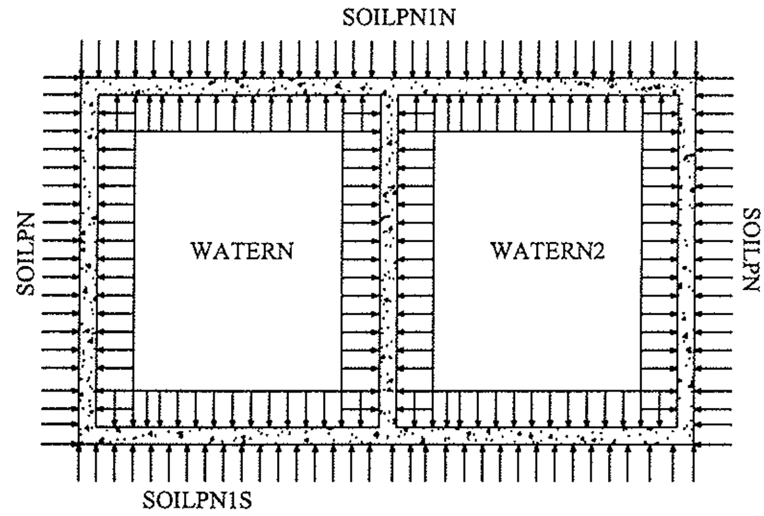
0.32 T/M²
3.03 T/M²
1.13 T/M
4.5 T/M²
0.4 T/M
0.4 T/M
4.5 T/M²
1.5 T/M
0.4 T/M
0.4 T/M
1.13 T/M
DL=1.53 T/M²
0.32 T/M²
3.03 T/M²
A
SECTION
CASE 2

Case 3

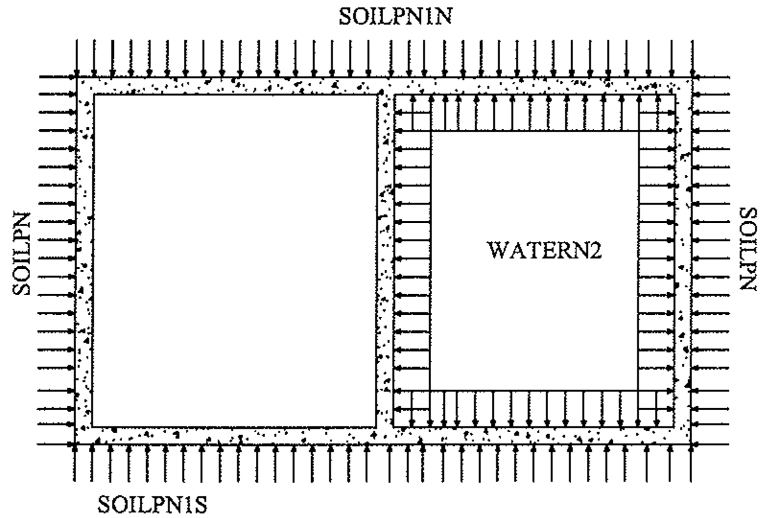


0.56 T/M²
5.06 T/M²
0.339 T/M
4.5 T/M²
1.30 T/M
1.18 T/M²
0.12 T/M
0.46 T/M
0.12 T/M
0.46 T/M
0.19 T/M
0.12 T/M
0.46 T/M
0.339 T/M
1.18 T/M²
1.30 T/M
4.5 T/M²
DL=1.76 T/M²
B
SECTION
CASE 3

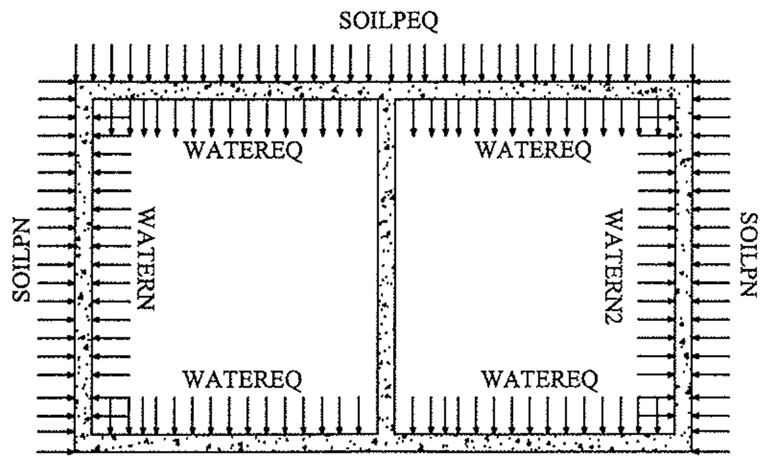
Load combination (Horizontal View)



Case 1

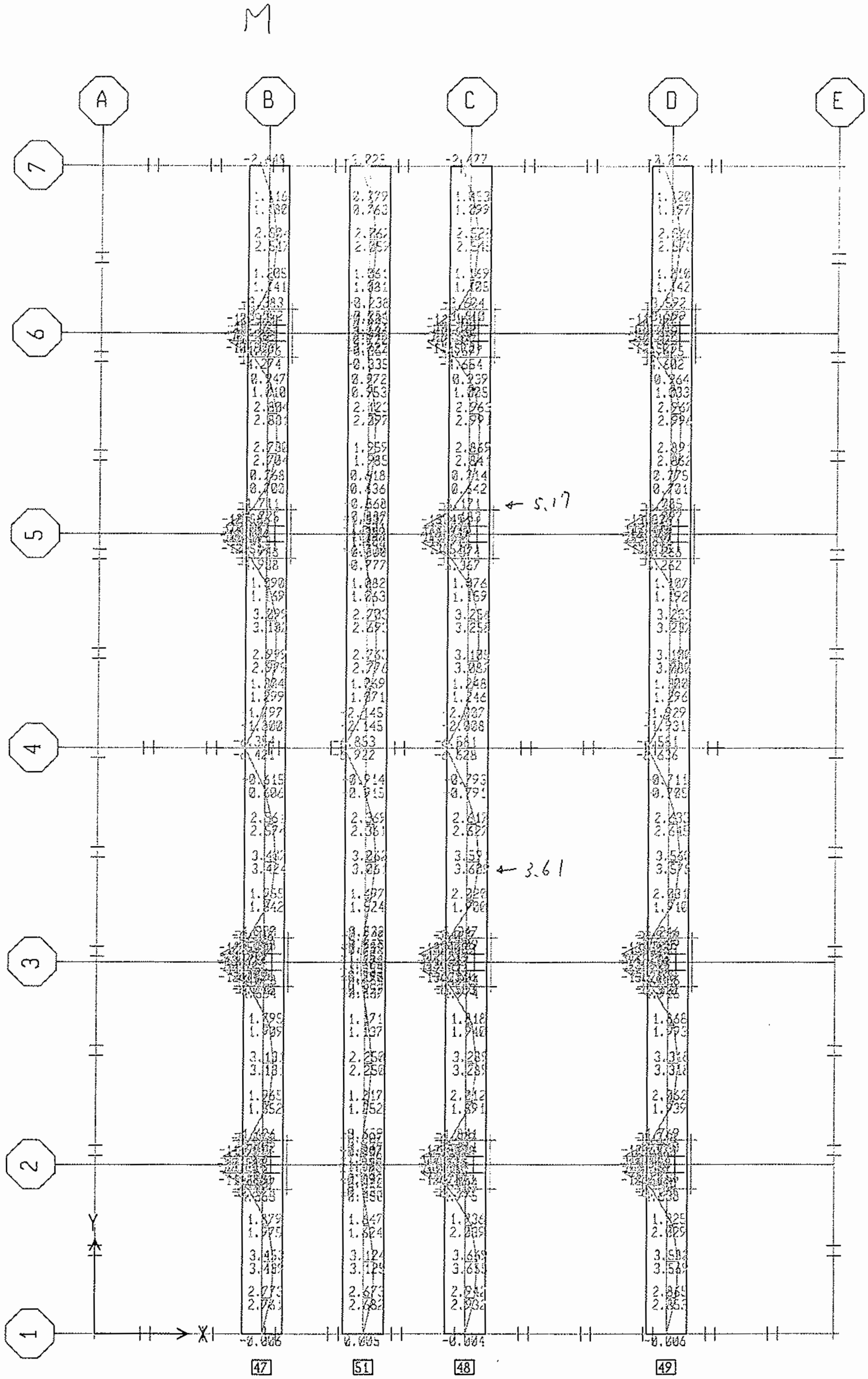


Case 2



Case 3

SAFE



A2-12

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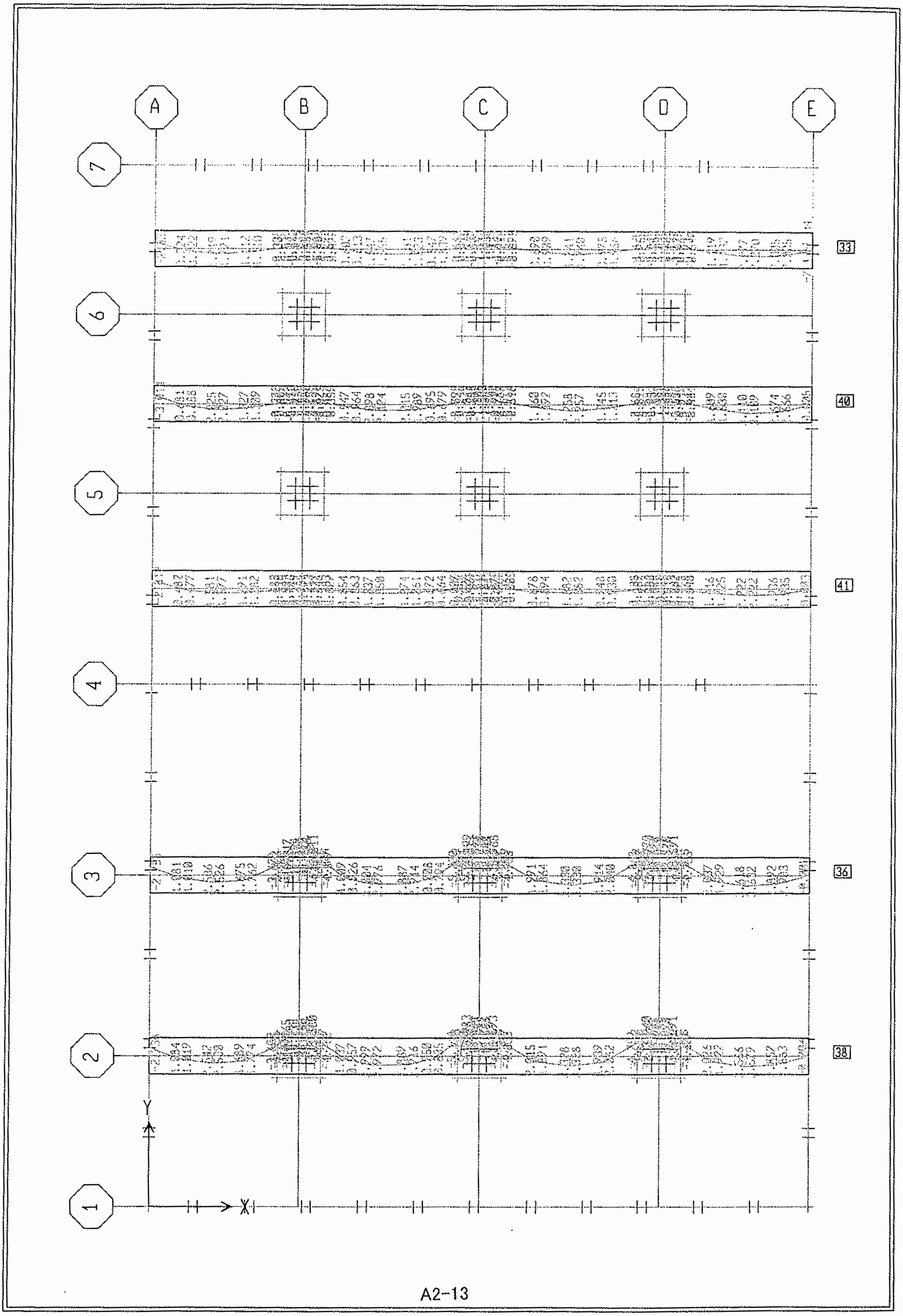
Y-Strip Moment Diagram - (CASE1) - Ton-m Units



A2-13

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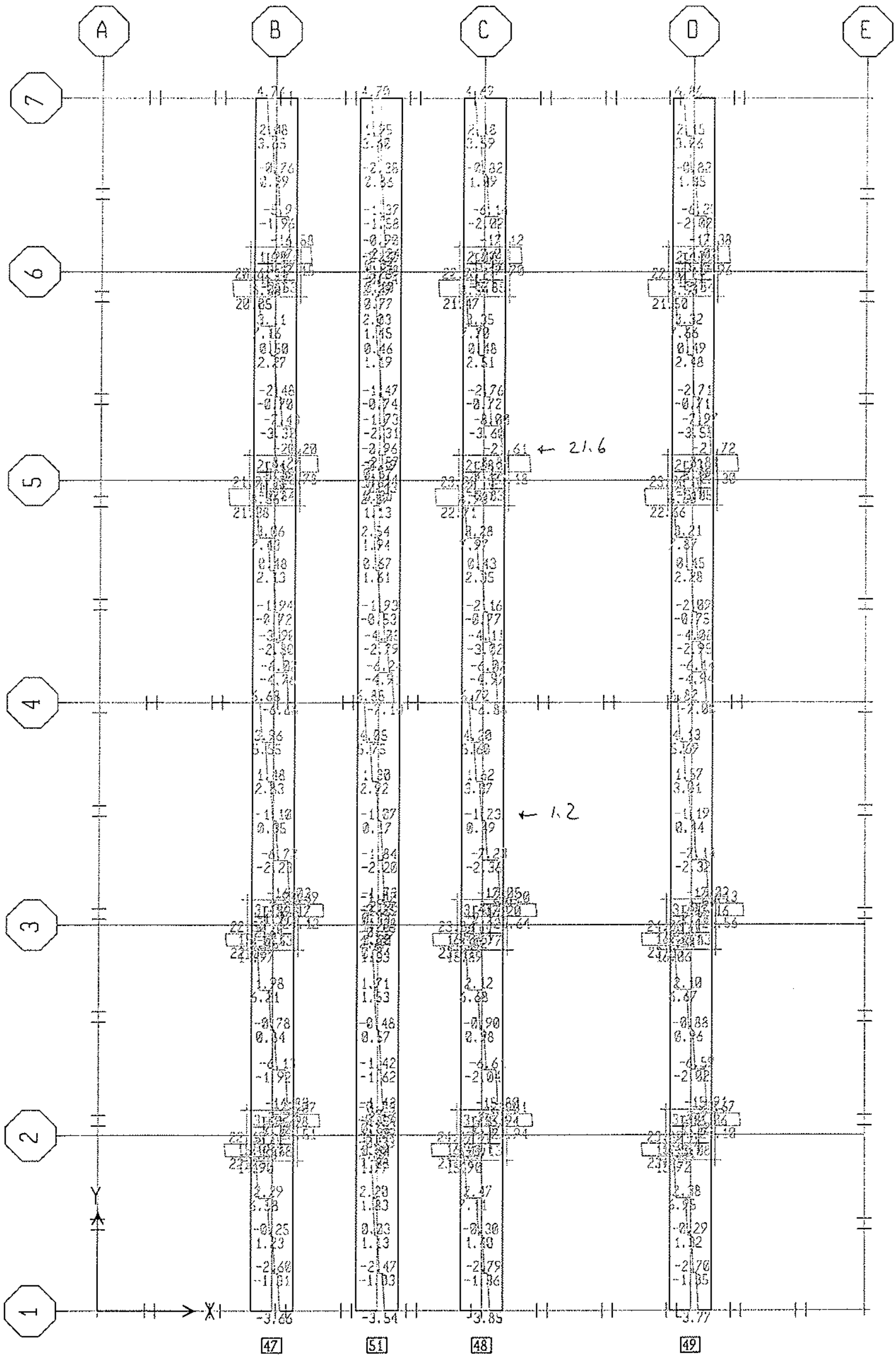
X-Strip Moment Diagram - (CASE1) - Ton-m Units

SAFE



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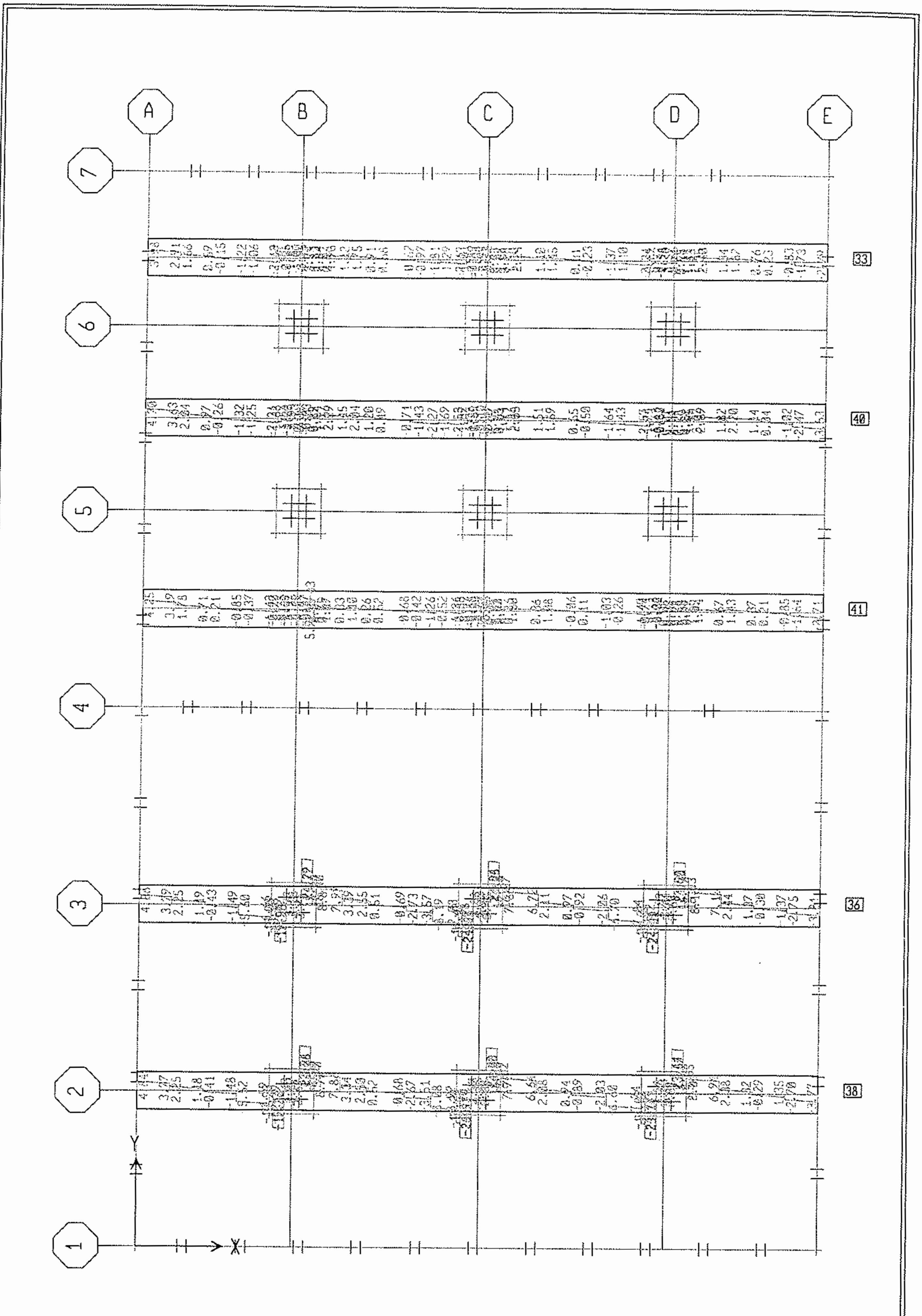

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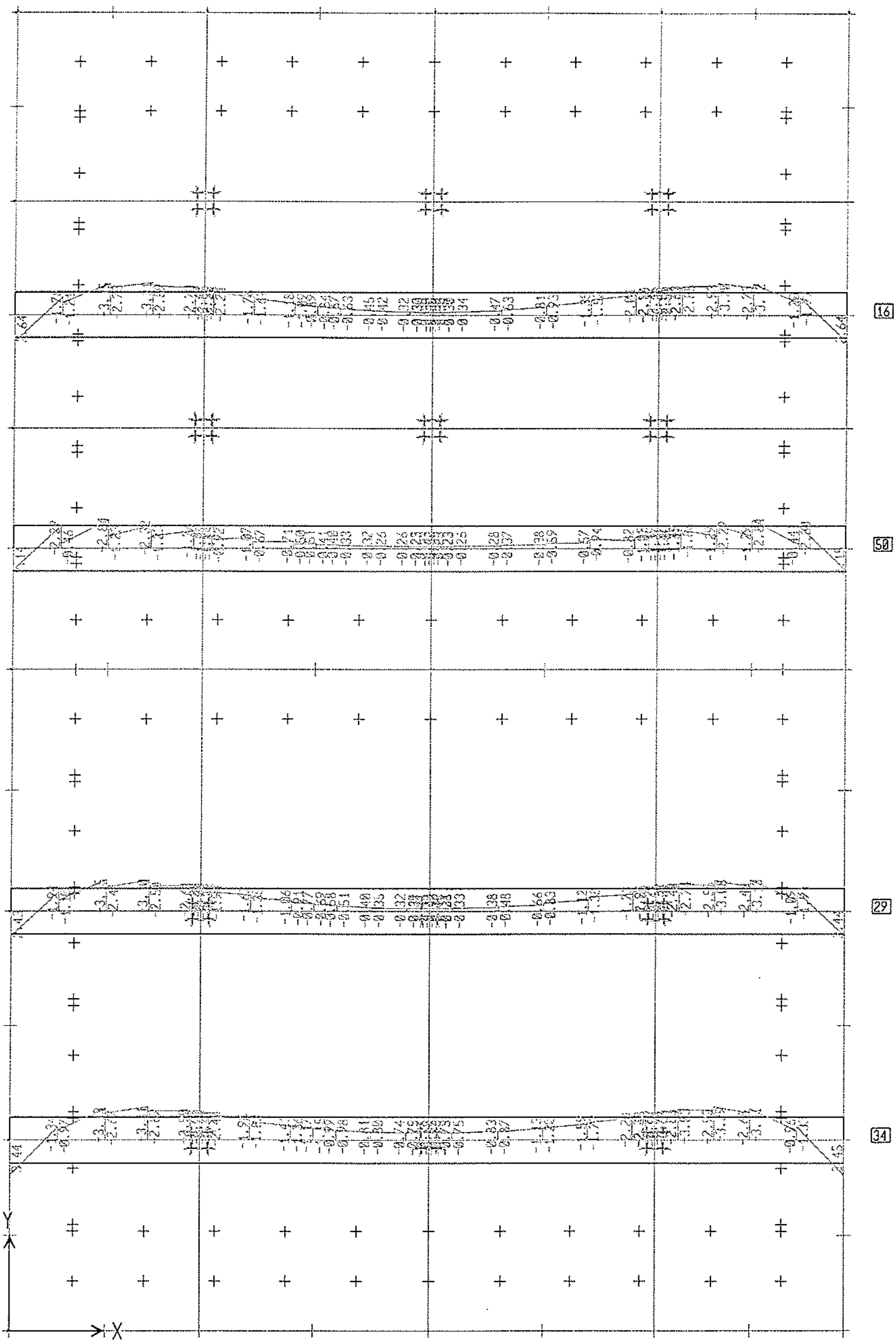
X-Strip Shear Diagram - (CASE1) - Ton-m Units



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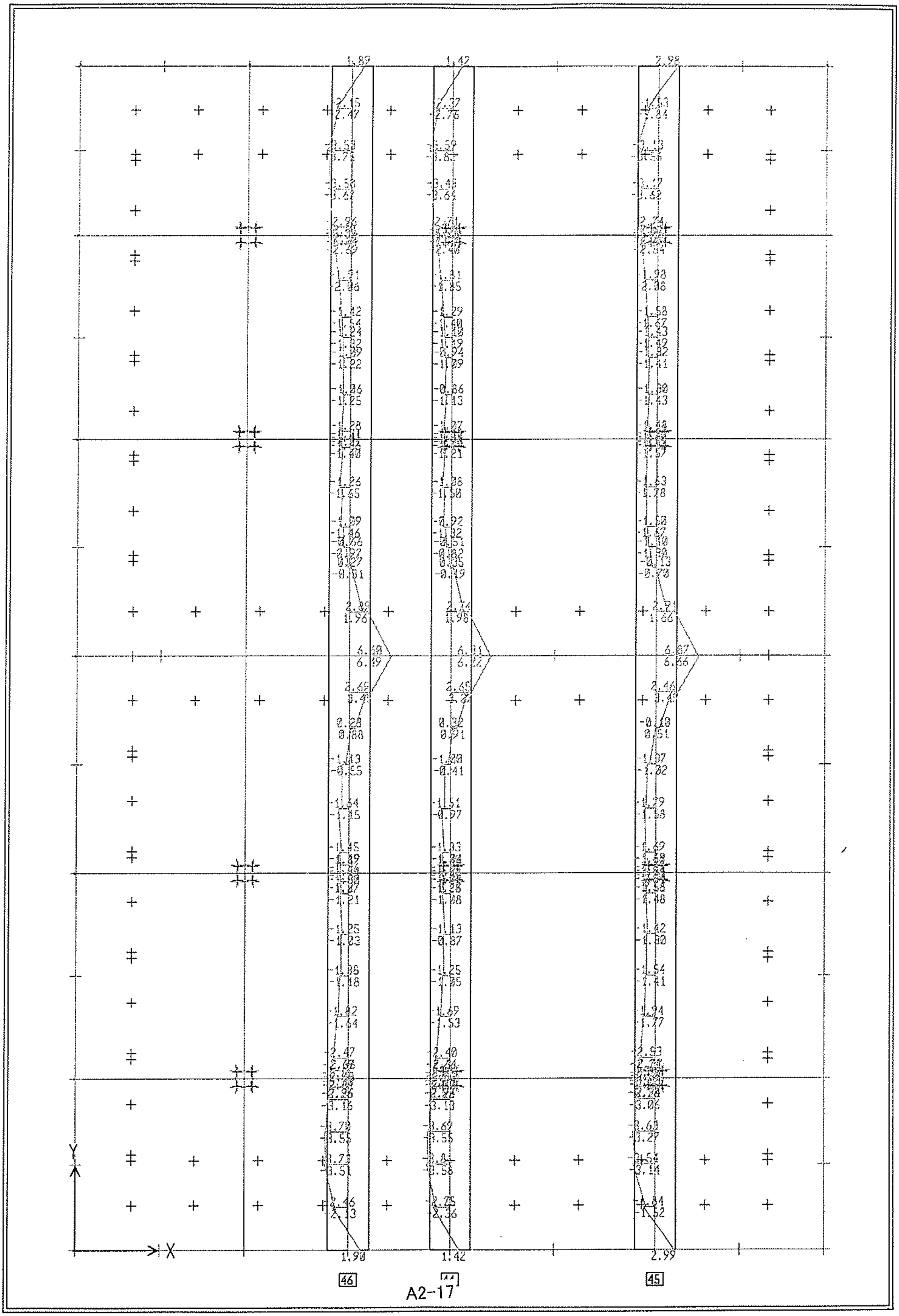
X-Strip Moment Diagram - (CASE1) - Ton-m Units

SAFE

JICA



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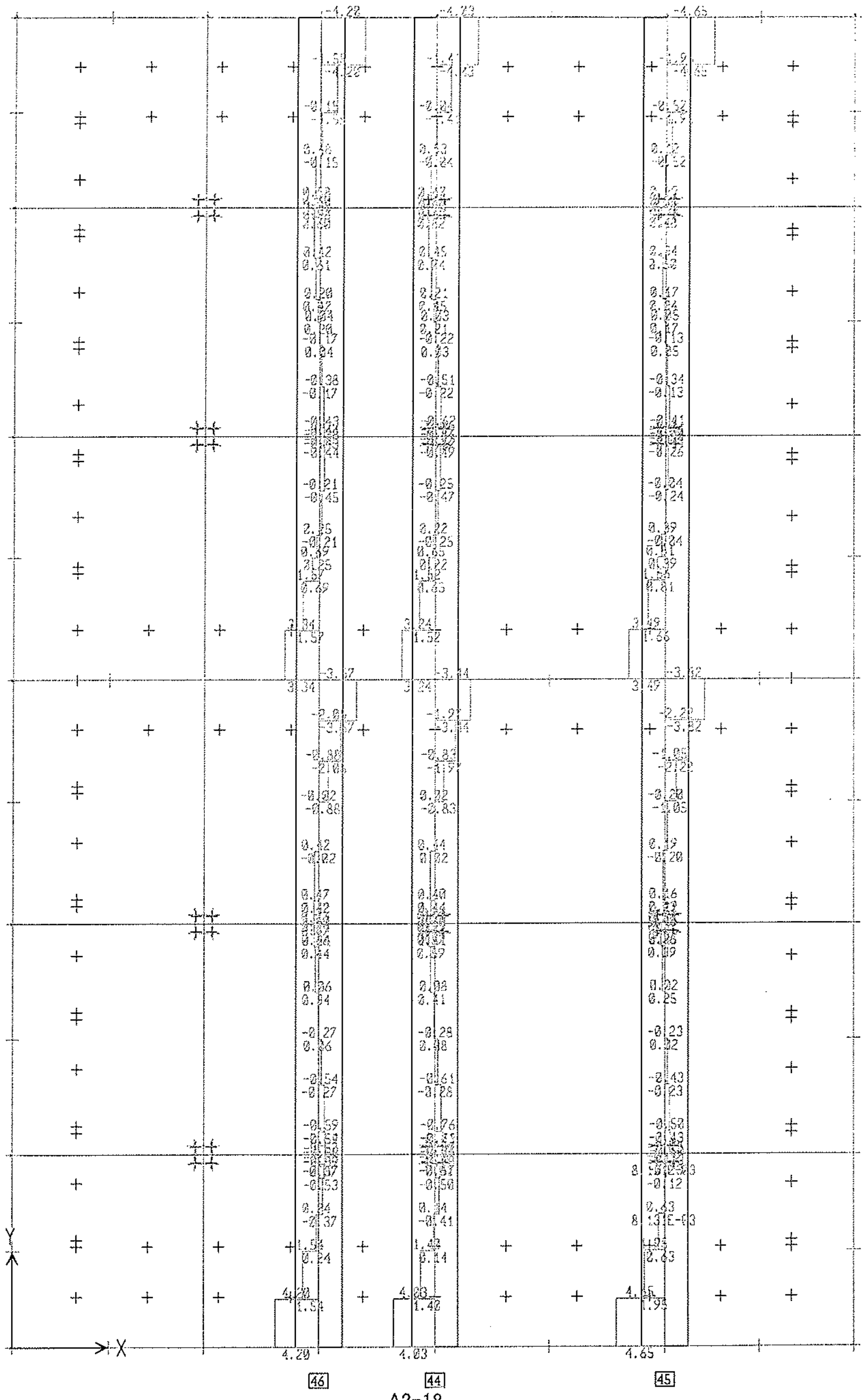
Y-Strip Moment Diagram - (CASE1) - Ton-m Units



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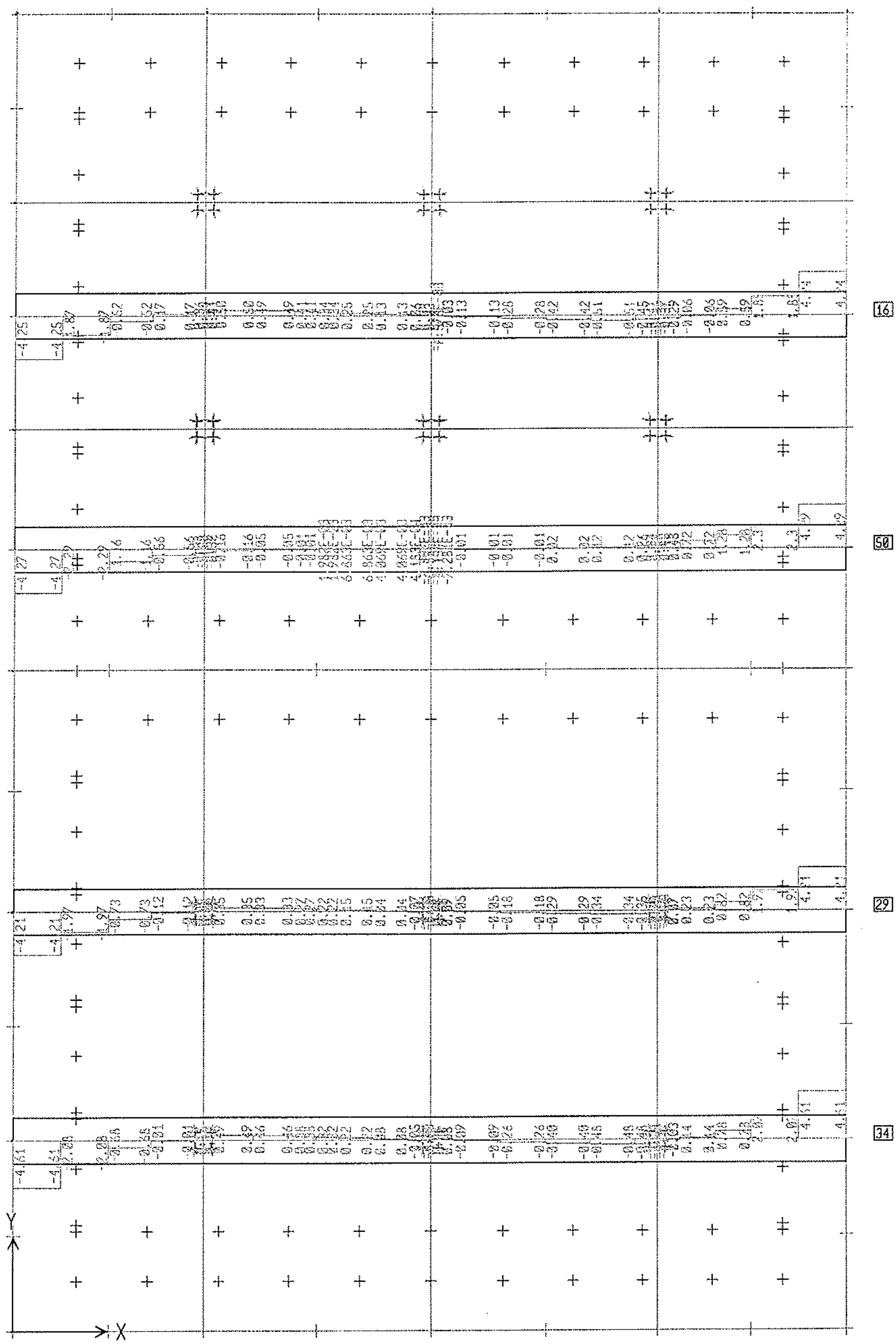
Y-Strip Shear Diagram - (CASE1) - Ton-m Units



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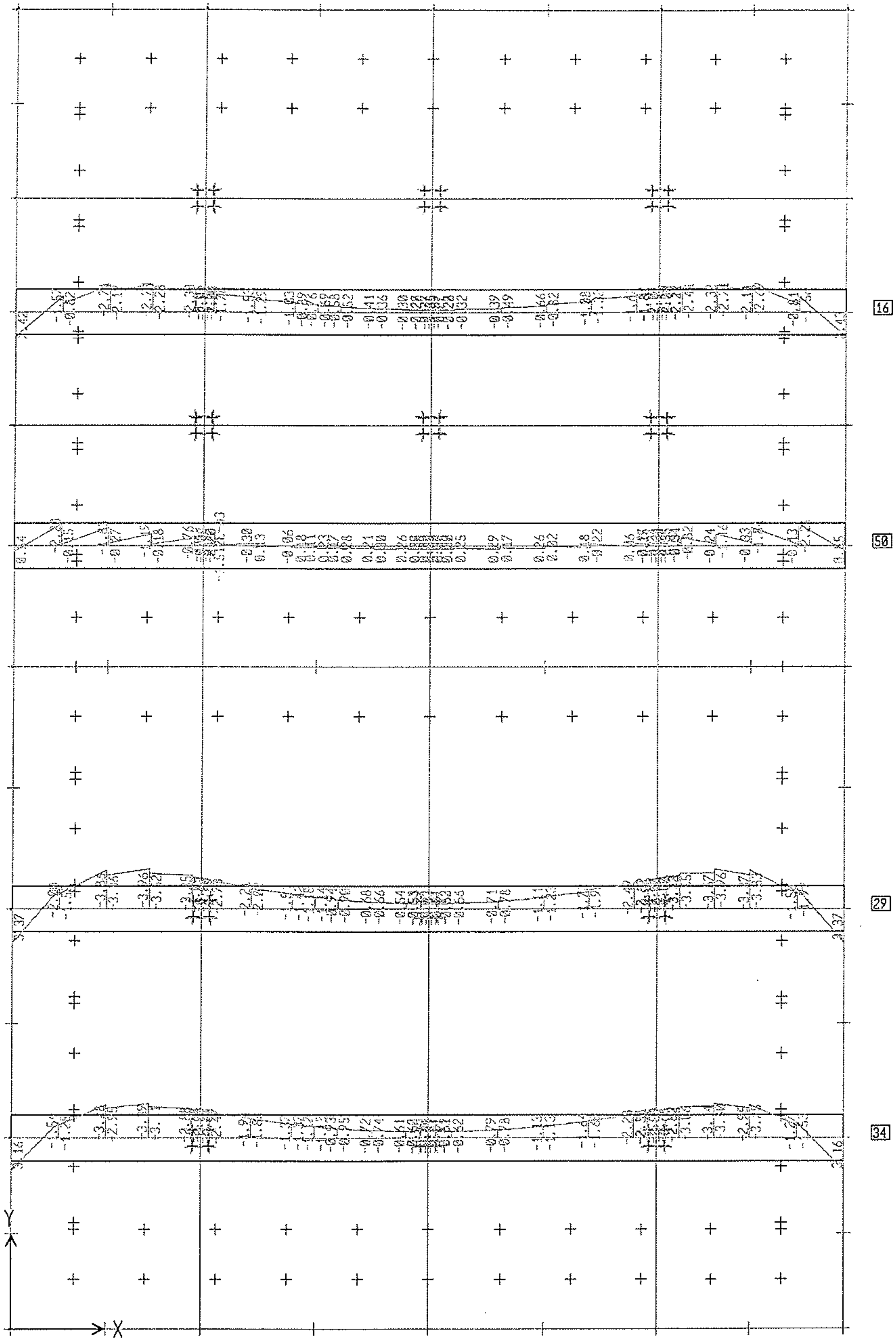
X-Strip Shear Diagram - (CASE1) - Ton-m Units



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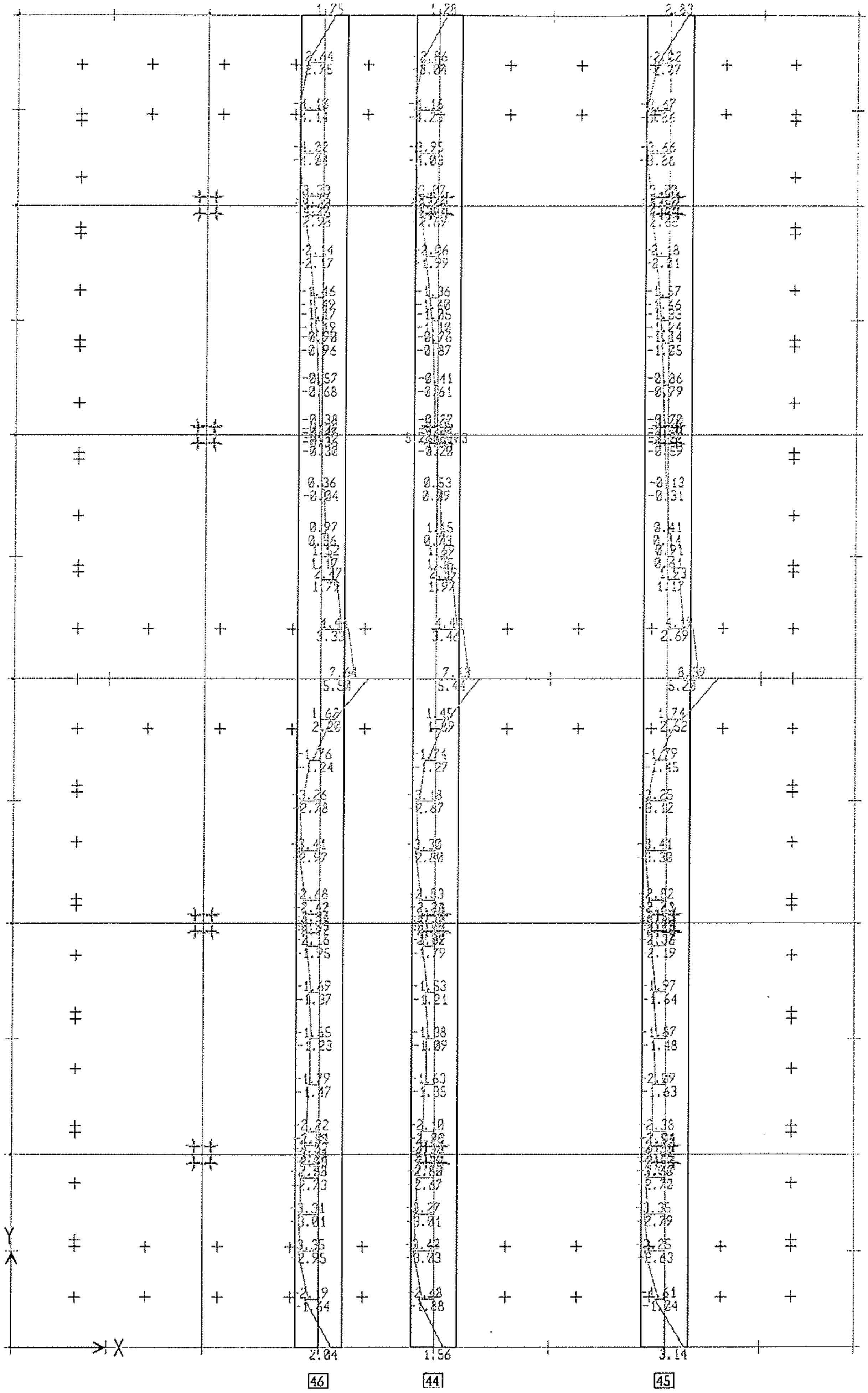
X-Strip Moment Diagram - (CASE2) - Ton-m Units



A2-21

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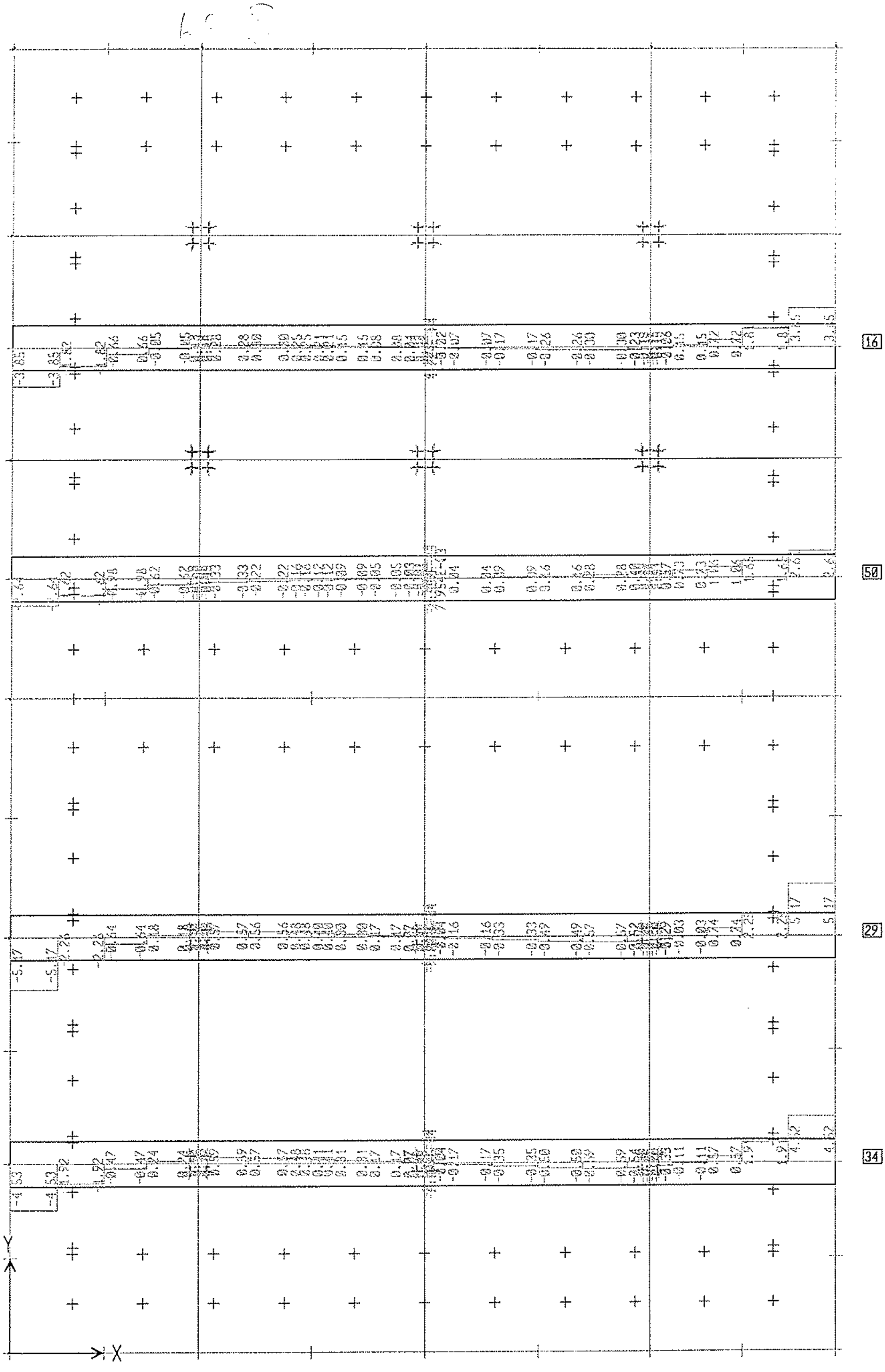
Y-Strip Moment Diagram - (CASE2) - Ton-m Units



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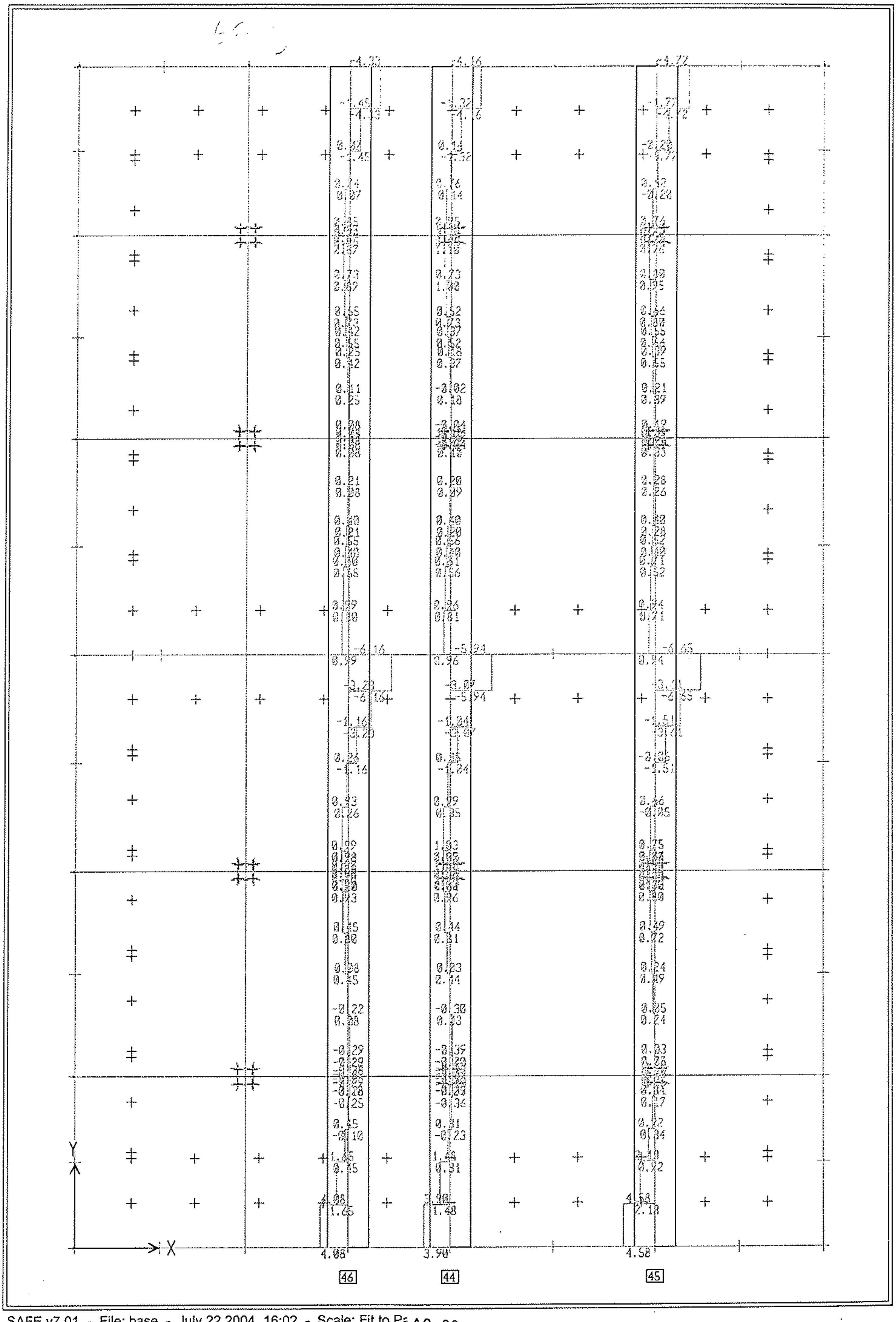
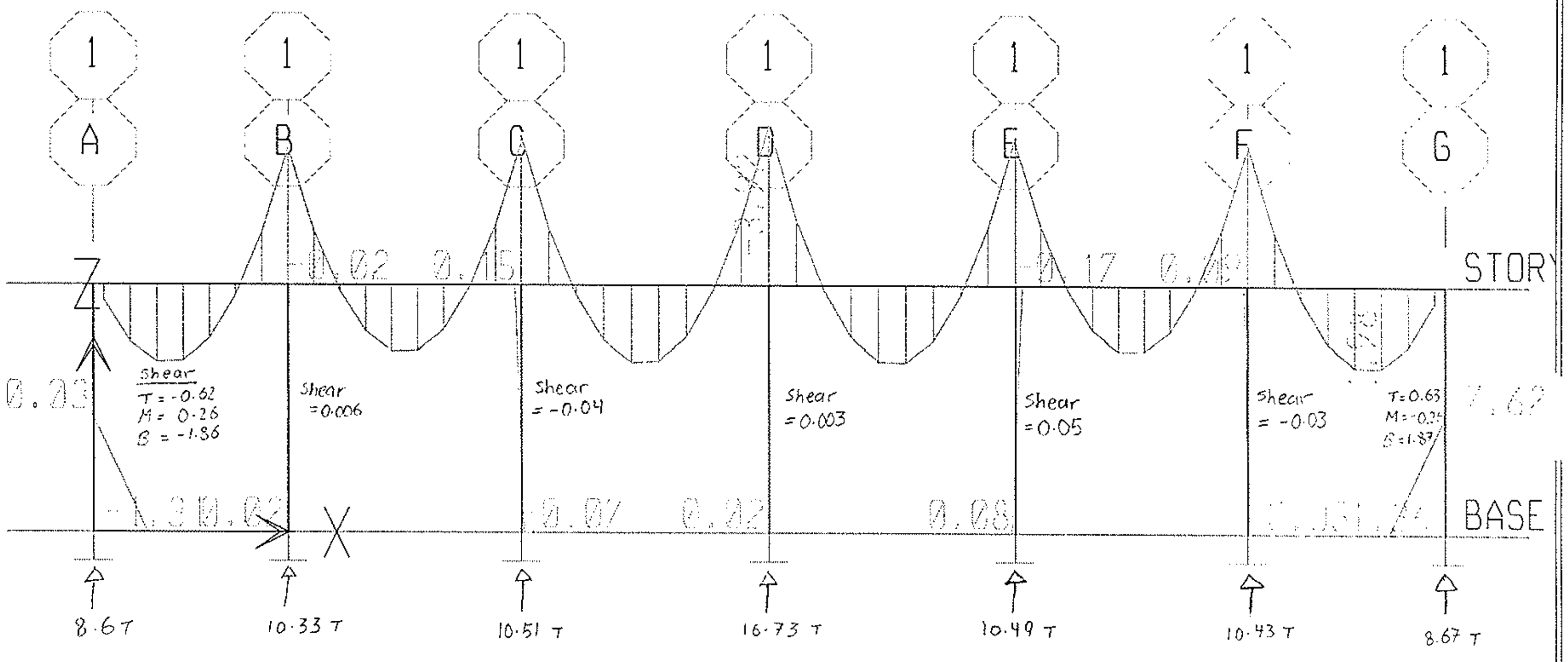
X-Strip Shear Diagram - (CASE2) - Ton-m Units





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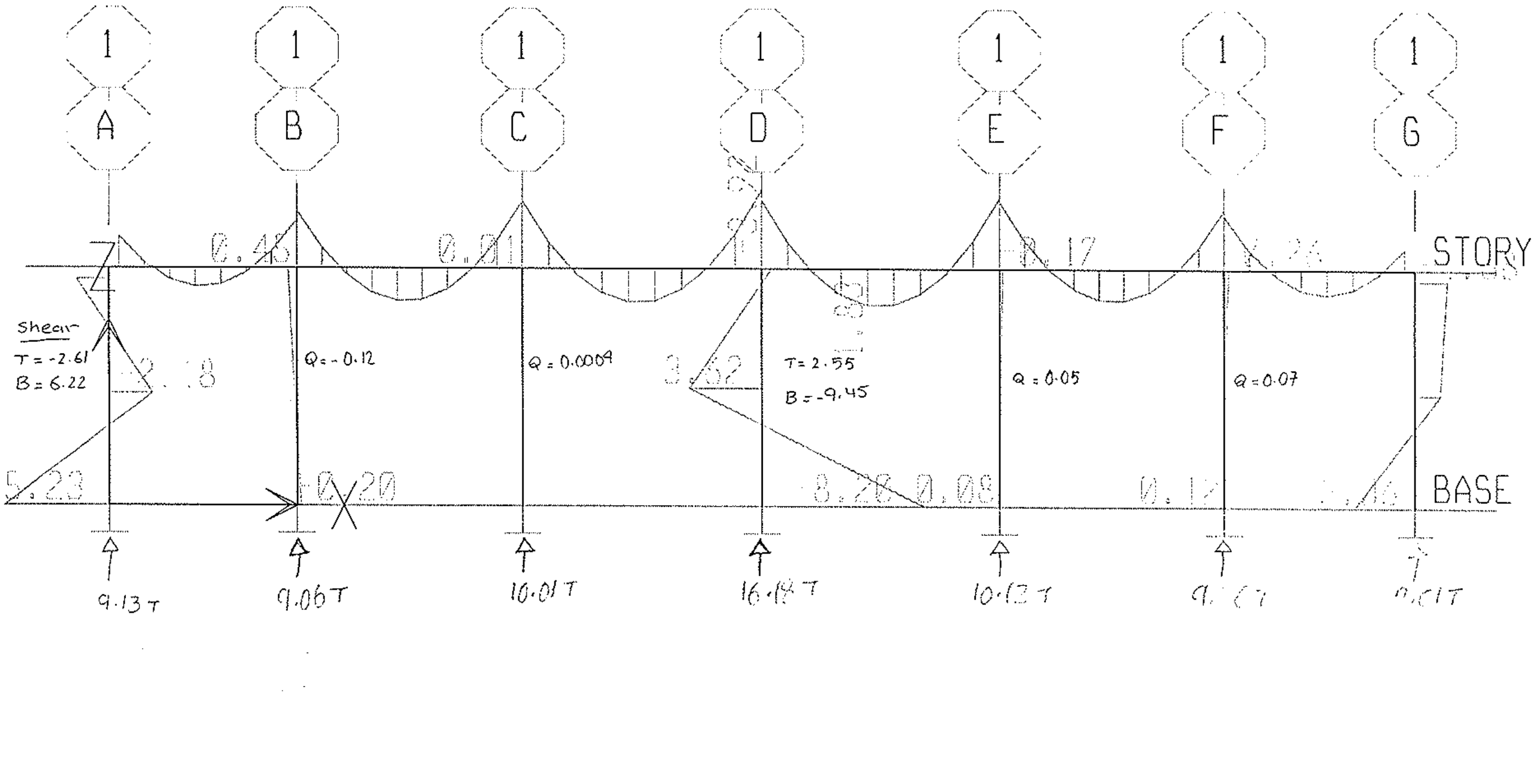
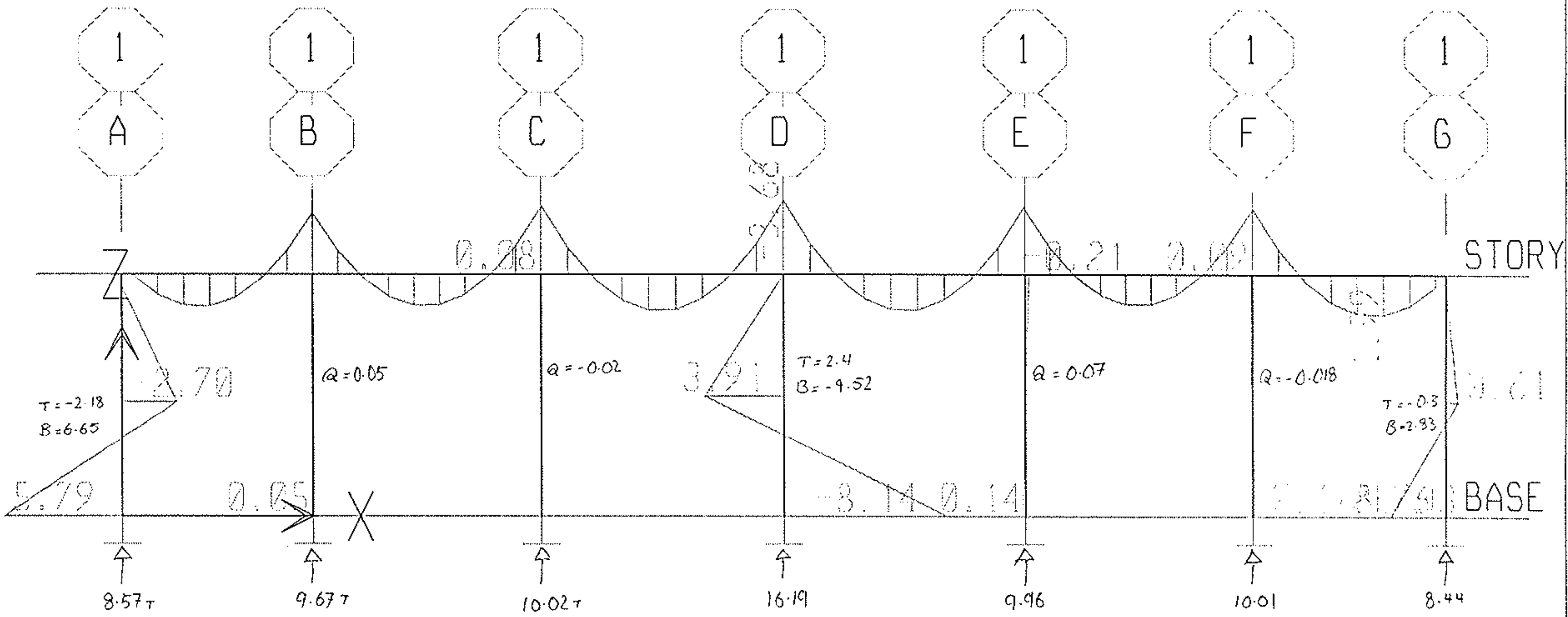
Elevation View - 1 Moment 3-3 Diagram (CASE1) - Ton-m Units



ETABS v8.03 - File: r2D - July 24,2004 17:49
Elevation View - 1 Moment 3-3 Diagram (CASE2) - Ton-m Units



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Elevation View - 1 Moment 3-3 Diagram (CASE2) - Ton-m Units

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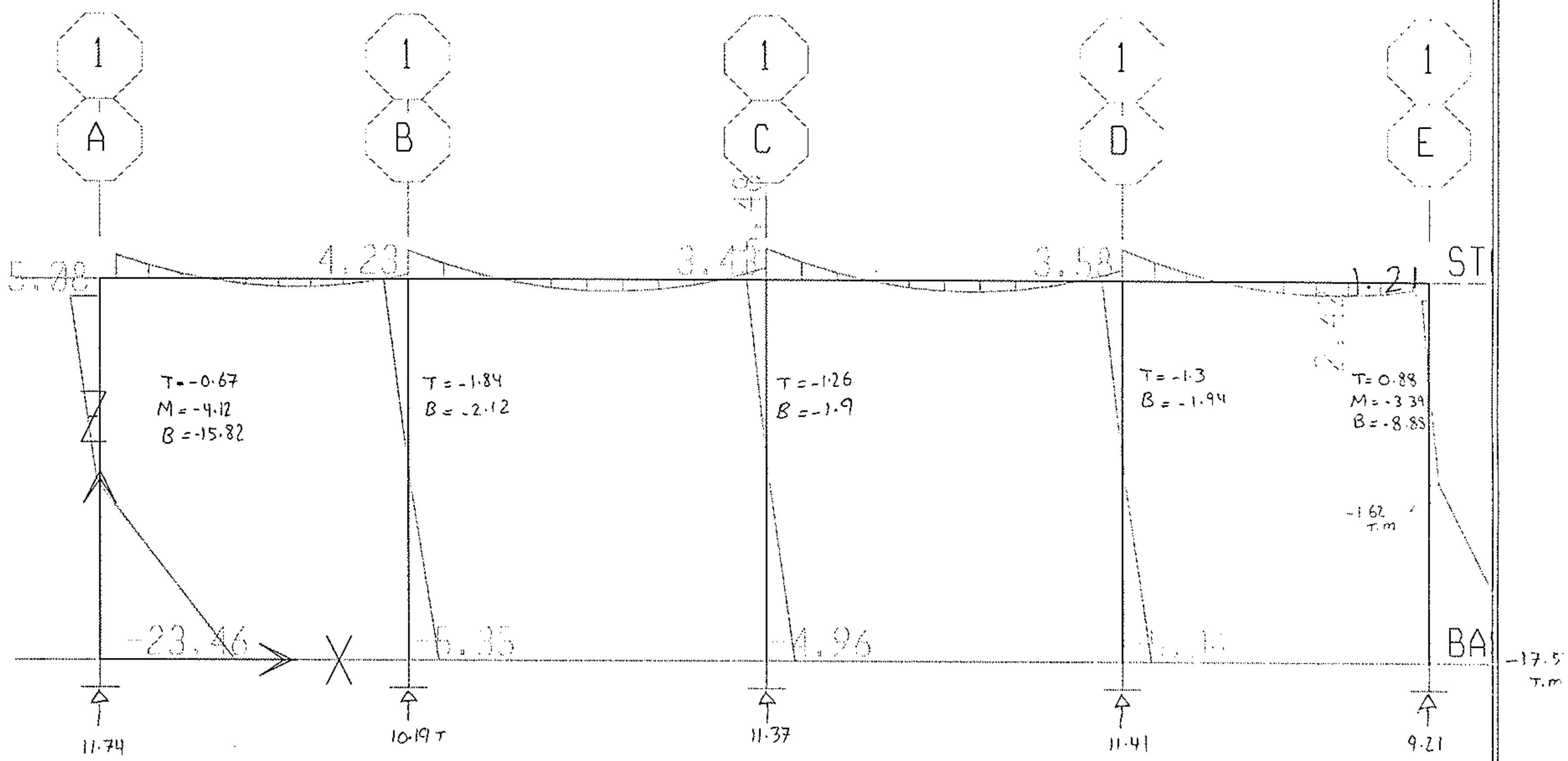

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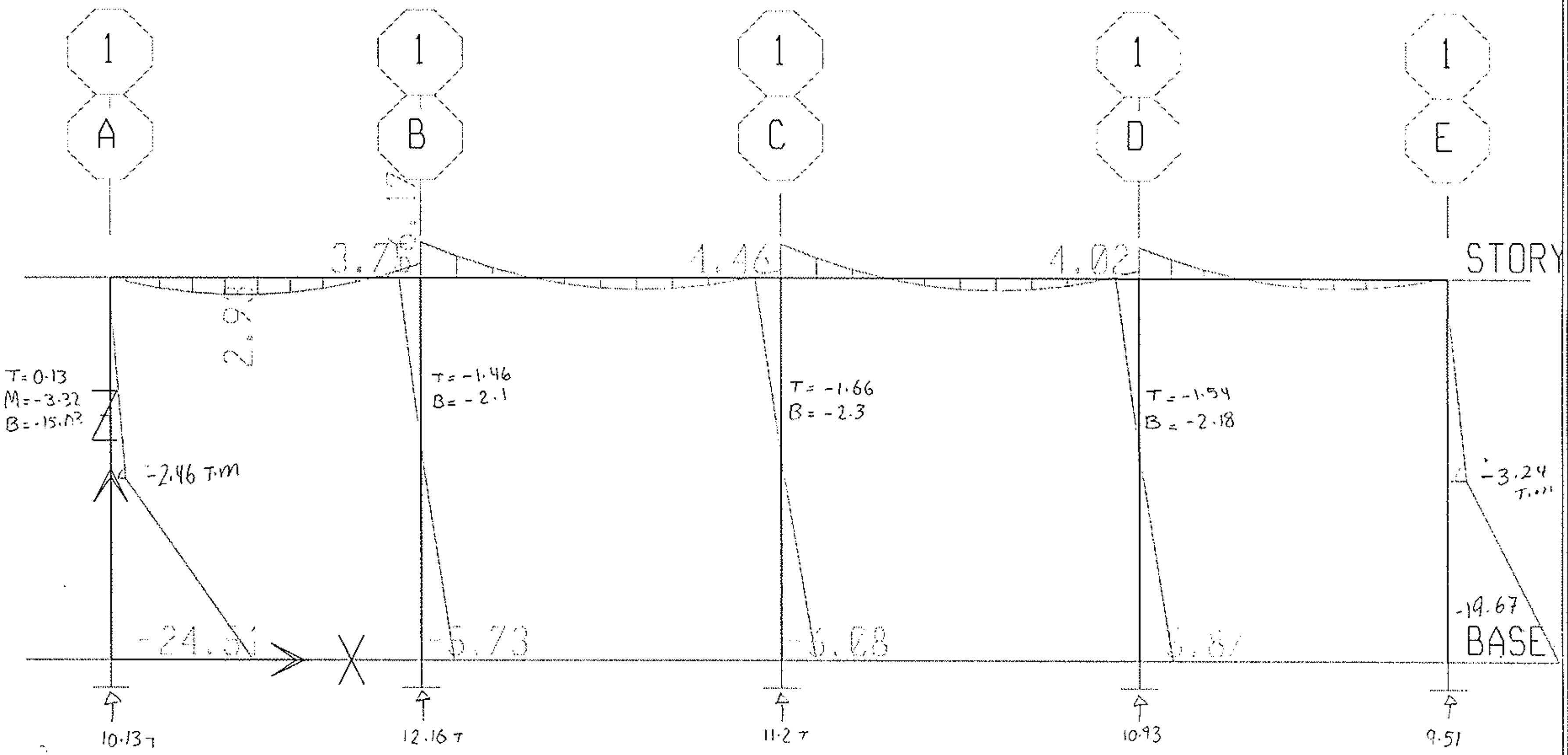
Elevation View - 1 Moment 3-3 Diagram (CASE3) - Ton-m Units



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Elevation View - 1 Moment 3-3 Diagram (CASE3) - Ton-m Units

Table Stress by Load Case

Member		Slab		Bottom Slab				Wall 1&2	
Check Point		column	middle	column zone		middle zone		lower	
Load case		1	1	1	2	1	2	2	3
M	t-m	5.17	3.61	6.87	8.39	3.83	4.23	7.18	24.51
N	t	-	-	-	-	-	-	8.44	10.13
Q	t	21.6	1.2	3.82	6.65	1.41	1.32	2.83	15.03
width	cm	100	100	100	100	100	100	100	100
height	cm	25	25	60	60	45	50	60	60
covering	cm	5	5	5	5	5	5	5	5
bar arrangement		D14@75	D14@150	(D10+D12) @150	(D10+D12) @150	D16@150	D16@150	D25@200	D25@200
bar AS	cm2	20.53	10.27	12.78	12.78	13.4	13.4	24.55	24.55
C (nomogram))		4.5	5.9	8.5	8.5	7.1	7.5	5.1	6.1
compressive (M'/b*d^2)*C	kg/cm2	58	53	19	24	17	16	16	55
allowable	kg/cm2	90	90	90	112.5	90	112.5	112.5	90
S(nomogram)		7.5	14.5	30	30	21	25	9.5	13
tensile (M'/b*d^2)*S*n	kg/cm2	1,454	1,963	1022	1248	754	783	483	1743
allowable	kg/cm2	1,800	1,800	1800	2250	1800	1800	2250	2700
Z		1.17	1.13	1.08	1.08	1.09	1.09	1.08	1.09
shear (Q/b*d)*Z	kg/cm2	12.6	0.7	0.8	1.3	0.4	0.3	0.6	3.0
allowable	kg/cm2	18.0	2.4	2.4	3.0	2.4	3.0	2.4	3.6

Member		Wall 1&2		Wall 3		Column			
Check Point		upper		bottom	middle	lower		upper	
Load case		2	3	2	2	1	3	1	3
M	t-m	1.68	5.08	8.2	3.91	0.08	6.08	0.45	4.46
N	t	3.02	4.82	16.19	12.19	10.49	11.2	6.93	8.75
Q	t	-	-	-	-	-	2.3	-	1.66
width	cm	100	100	100	100	40	40	40	40
height	cm	30	30	60	60	40	40	40	40
covering	cm	5	5	5	5	5	5	5	5
bar		D18@200	D18@200	D25@200	D18@200	3xD18	3xD18	3xD16	3xD16
bar AS	cm2	12.75	12.75	24.55	12.75	7.65	7.65	6.03	6.03
C(nomogram)		5.4	5.08	4.5	4.5	2.9	4.8	3	5.3
compressive (M'/b*d^2)*C	kg/cm2	17	52	18	10	10	76	9	62
allowable	kg/cm2	90	135	90	112.5	90	135	90	135
S(nomogram)		10	12	6.5	5	1.5	8	1	9.5
tensile (M'/b*d^2)*S*n	kg/cm2	475	1,601	395	173	76	1,900	46	1,678
allowable	kg/cm2	2,250	2,700	2,250	2,250	1,800	2,700	1,800	2,700
Z		-	-	-	-	-	1.11	-	1.10
shear	kg/cm2	-	-	-	-	-	1.8	-	1.3
allowable	kg/cm2	-	-	-	-	-	3.6	-	3.6

Table Stress Calculation Sheet

Member		Slab		Footing				Wall 1&2	
Check point		Column Zone	Middle Zone	Column Zone		Middle Zone		Lower Part	
Load Case		1	1	1	2	1	2	2	3
As	cm2	20.53	10.27	12.78	12.78	13.40	13.40	24.55	24.55
b	cm	100	100	100	100	100	100	100	100
d	cm	20	20	55	55	40	45	55	55
p=As/b*d		0.01027	0.00514	0.00232	0.00232	0.00335	0.00298	0.00446	0.00446
n*p=15p		0.15398	0.07703	0.03485	0.03485	0.05025	0.04467	0.06695	0.06695
N (axial force)	t	–	–	–	–	–	–	8.44	10.13
C	nomogram	4.5	5.9	8.5	8.5	7.1	7.5	5.1	6.1
M (bending moment)	t-m							7.18	24.51
M'	t-m	5.17	3.61	6.87	8.39	3.83	4.23	9.29	27.04
Compressive	M'*C/(b*d^2)	58	53	19	24	17	16	16	55
S	nomogram	7.5	14.5	30.0	30.0	21.0	25.0	9.5	13.0
Tensile	M'*S/(b*d^2)	1,454	1,963	1,022	1,248	754	783	438	1,743
Q (Shear)	t	21.6	1.2	3.82	6.65	1.41	1.32	2.83	15.03
Z	nomogram	1.17	1.13	1.08	1.08	1.09	1.09	1.08	1.09
Shearing	Q*Z/(b*d)	12.6	0.7	0.8	1.3	0.4	0.3	0.6	3.0

Member		Wall 1&2		Wall 3		Column			
Check point		Upper		Lower	Middle	Lower		Upper	
Load case		2	3	2	2	1	3	1	3
As	cm2	12.75	12.75	24.55	12.75	7.65	7.65	6.03	6.03
b	cm	100	100	100	100	40	40	40	40
d	cm	25	25	55	55	35	35	35	35
p=As/b*d		0.00510	0.00510	0.00446	0.00232	0.00546	0.00546	0.00431	0.00431
n*p=15p		0.07650	0.07650	0.06695	0.03477	0.08196	0.08196	0.06461	0.06461
N (axial force)	t	3.02	4.82	16.19	12.19	10.49	11.20	6.93	8.75
C	nomogram	5.4	5.9	4.5	4.5	2.9	4.8	3.0	5.3
M (bending moment)	t-m	1.68	5.08	8.20	3.91	0.08	6.08	0.45	4.46
M'	t-m	1.98	5.56	12.25	6.96	1.65	7.76	1.49	5.77
Compressive	M'*C/(b*d^2)	17	52	18	10	10	76	9	62
S	nomogram	10.0	12	6.5	5.0	1.5	8.0	1.0	9.5
Tensile	M'*S/(b*d^2)	475	1,601	395	173	76	1,900	46	1,678
Q (Shear)	t	–	0.67	–	–	–	2.3	–	1.66
Z	nomogram	–	1.09	–	–	–	1.11	–	1.1
Shearing	Q*Z/(b*d)	–	0.3	–	–	–	1.8	–	1.3

3. Conclusion

The following bar arrangement revisions were made against the MPO typical design for new reservoir construction project in Baravat.

Item	Original	After Revision
Top Slab	D12/10	D14
Bottom Slab	D24	D25
Column Lower Part	8 x D16	8 x D18
Shearing Bar of Top Slab around columns	Not specify	2352 (196 x 12) shearing bars are installed

The structure type of top slab of the MPO typical design is nearly flat slab. However, drop panel is not installed in typical design. Therefore, many shearing bars are necessary around column capital. JICA Study Team recommends introduction of the following drop panels in the next version of typical design of reservoir by MPO :

Column Span (ctc)	Area	Thickness
4.5 m	1.8 m x 1.8 m	150 mm
5.0 m	2.0 m x 2.0 m	150 mm
5.5 m	2.2 m x 2.2 m	150 mm

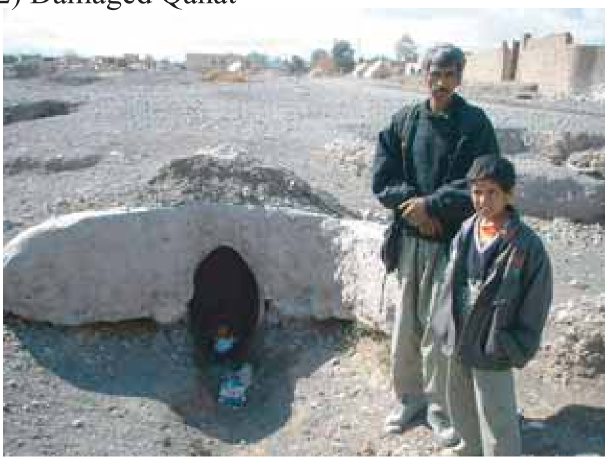
Photo Album

1. Bam Earthquake Damage

1) Building Damage

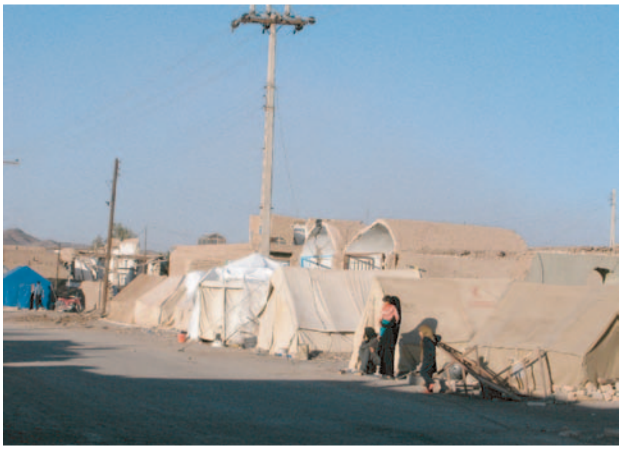



2) Damaged Qanat



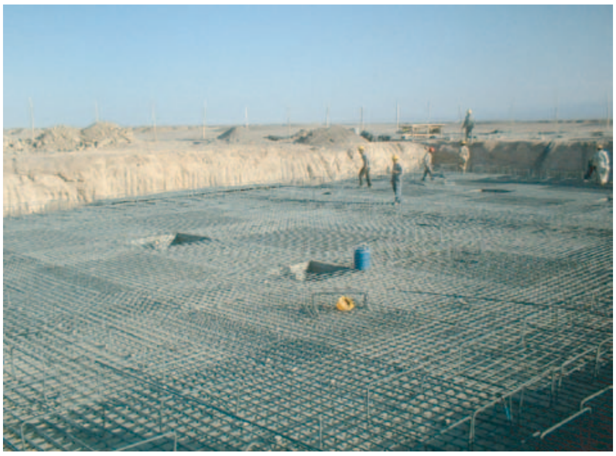

3) Damaged Water Pipe

4) Earthquake Victims



5) International Assistance

2. Reconstruction of Reservoir



3. Reconstruction of Water Pipe Line

4. Formulation of Long Term Water Supply System

5. Observation of Water Level