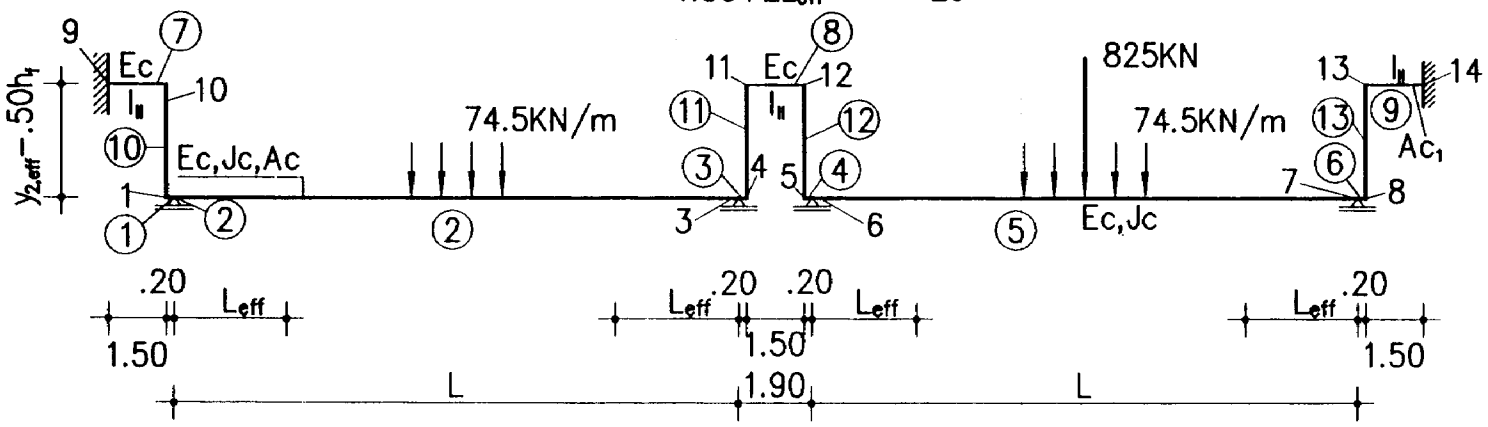
ΠΡΟΣΑΡΤΗΜΑ Β

ΠΑΡΑΜΕΤΡΙΚΗ ΔΙΕΡΕΥΝΗΣΗ ΛΕΙΤΟΥΡΓΙΚΟΥ ΠΡΟΒΛΗΜΑΤΟΣ

ΠΡΟΣΑΡΤΗΜΑ Β

ΠΑΡΑΜΕΤΡΙΚΗ ΔΙΕΡΕΥΝΗΣΗ ΛΕΙΤΟΥΡΓΙΚΟΥ ΠΡΟΒΛΗΜΑΤΟΣ

$$Ac_1 = \frac{1.50}{1.50+L_{eff}}\ 1.2As\frac{Es}{Ec} \qquad Ac_2 = \frac{1.50}{1.50+2L_{eff}}\ 1.2As\frac{Es}{Ec}$$



ΠΙΝΑΚΑΣ ΔΕΔΟΜΕΝΩΝ

L=33.0m	E_c =32 GPa
b=12.0m	a=6.25
$A_{c,eff}$=5.100m^2	g_1=30.7KN/m
$J_{c,eff}$=2.784m	q=43.8KN/m
h_b=2.15m	g_1+q=74.5KN/m
h_{ft}=0.275m	Q=825KN
$h_{f,eff}$=0.20m	A_{st}=986 cm^2(4φ14/75)
$h_{(πρ.)}$=0.075m	ρ=4,1%
$y_{2,eff}$ =0.73m	A_{sb}=10,3cm^2/m(φ14/15π.+φ14/15κ.)
	T=-60°/+70°C
ρ_b=0,006(φ14/150)	Leff= L/4

$I_{II} = 3.544\alpha_B b h_{f,eff}^3/12 = 0.1772\rho_b = 0{,}0011\ m^4$

```
PROG GENF
$ Dat : C:\...\sofistik\dat\it\133\12-7-02a\new.dat  (.#01)   09/11/2002
$ Job : 12-7-02a/TEGOS:002367                                      13:58
HEAD
HEAD
PAGE LINE 75 LANO 1 LANI 1 MARG 3 FIRS 1
ECHO FULL FULL
SYST OPTI NO
SYST SPAC
CONC 1 B    35  EC 32000
CONC 2 B    35  EC 32000
STEE 3 BST  500
LET#1 33.00
NODE  1  1.50 0.00 0.58
      2  1.70 ==
      3  1.70+#1 ==
      4  1.70+#1+0.20 ==
      5  1.70+#1+1.70 ==
      6  1.70+#1+1.90 ==
      7  1.70+#1+1.90+#1 ==
      8  1.70+#1+1.90+#1+0.20 ==
      9  0.00 0.00 0.00
      10 1.50 ==
      11 1.70+#1+0.20
      12 1.70+#1+1.70
      13 1.70+#1+1.90+#1+0.20
      14 1.70+#1+1.90+#1+1.70
NODE  (1  4 3) FIX PYYM
NODE  (2  3 1) FIX XPYM
NODE  (5  8 3) FIX PYYM
NODE  (6  7 1) FIX XPYM
NODE (10 13 1) FIX PYYM
NODE  (9 14 5) FIX PPMM
NODE 10 FIX KF NREF 2
     1  FIX KF NREF 2
     11 FIX KF NREF 3
     4  FIX KF NREF 3
     12 FIX KF NREF 6
     5  FIX KF NREF 6
     13 FIX KF NREF 7
     8  FIX KF NREF 7
$
SVAL NO 2 MNO 1 A 5.10   IY 2.784
SVAL NO 3 MNO 2 A 0.1138 IY 0.0011
SVAL NO 4 MNO 2 A 0.0616 IY 0.0011
$
BEAM 2  2  3   NCS 2
     5  6  7   NCS 2
     7  9 10   NCS 3
     8 11 12   NCS 4
     9 13 14   NCS 3
BSEC 2  8.10 2 SECT
BSEC 2 24.90 2 SECT
BSEC 5  8.10 2 SECT
BSEC 5 24.90 2 SECT
END
```

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

Number	X[m]	Y[m]	Z[m]	eq.PX	eq.PY	eq.PZ	eq.MX	eq.MY	eq.MZ	eq.MB
1	1.500	.000	.580	*	*	*	*	*	*	*
2	1.700	.000	.580		PY	PZ	MX		MZ	
3	34.700	.000	.580		PY	PZ	MX		MZ	
4	34.900	.000	.580	*	*	*	*	*	*	*
5	36.400	.000	.580	*	*	*	*	*	*	*
6	36.600	.000	.580		PY	PZ	MX		MZ	
7	69.600	.000	.580		PY	PZ	MX		MZ	
8	69.800	.000	.580	*	*	*	*	*	*	*
9	.000	.000	.000	PX	PY	PZ	MX	MY	MZ	
10	1.500	.000	.000	*	*	*	*	*	*	*
11	34.900	.000	.000	*	*	*	*	*	*	*
12	36.400	.000	.000	*	*	*	*	*	*	*
13	69.800	.000	.000	*	*	*	*	*	*	*
14	71.300	.000	.000	PX	PY	PZ	MX	MY	MZ	
MIN	.000	.000	.000							
MAX	71.300	.000	.580							

K I N E M A T I C C O N S T R A I N T S

Node	LV	type	reference	dx	dy	dz	df
10	1	KF	2	-.200	.000	-.580	
1	1	KF	2	-.200	.000	.000	
11	1	KF	3	.200	.000	-.580	
4	1	KF	3	.200	.000	.000	
12	1	KF	6	-.200	.000	-.580	
5	1	KF	6	-.200	.000	.000	
13	1	KF	7	.200	.000	-.580	
8	1	KF	7	.200	.000	.000	

M A T E R I A L S

No. 1 B 35 (DIN 1045)

Young-module	32000	[MPa]	Safetyfactor	1.00	[-]
Poisson-Ratio	.20	[-]	Strength fc	23.00	[MPa]
Shear-module	13333	[MPa]	Nominal Strength	35.00	[MPa]
Compress.module	17778	[MPa]	Tens.Str. fctm	3.21	[MPa]
Weight	25.0	[kN/m3]	Tens.Str. fctk	2.67	[MPa]
Weight buoyancy	.0	[kN/m3]	Tens.Str. fctk	3.85	[MPa]
Temperat. coeff.	1.00E-05	[-]	Compr.fail.ener.	20.00	[kN/m]
			Tens.fail.energ.	.05	[kN/m]
			Friction crack	.20	[-]

No. 2 B 35 (DIN 1045)

Young-module	32000	[MPa]	Safetyfactor	1.00	[-]
Poisson-Ratio	.20	[-]	Strength fc	23.00	[MPa]
Shear-module	13333	[MPa]	Nominal Strength	35.00	[MPa]
Compress.module	17778	[MPa]	Tens.Str. fctm	3.21	[MPa]
Weight	25.0	[kN/m3]	Tens.Str. fctk	2.67	[MPa]
Weight buoyancy	.0	[kN/m3]	Tens.Str. fctk	3.85	[MPa]
Temperat. coeff.	1.00E-05	[-]	Compr.fail.ener.	20.00	[kN/m]
			Tens.fail.energ.	.05	[kN/m]
			Friction crack	.20	[-]

No. 3 BST 500 (DIN 1045)

Young-module	210000	[MPa]	Safetyfactor	1.00	[-]
Poisson-Ratio	.30	[-]	Yield stress fy	500.00	[MPa]
Shear-module	80769	[MPa]	Tensile str. ft	550.00	[MPa]
Compress.module	175000	[MPa]	Plastic strain	10.00	[o/o]
Weight	78.5	[kN/m3]	Relaxation .70ft	.00	[-]
Weight buoyancy	.0	[kN/m3]	Relaxation .55ft	.00	[-]
Temperat. coeff.	1.20E-05	[-]	nat. bond coeff.	200.00	[-]
			EC2 bondcoeff K1	.80	[-]
			Hardening module	.00	[MPa]

C R O S S S E C T I O N S - S T A T I C P R O P E R T I E S

No	MNo / MNs	A[m2] / It[m4]	Ay/Az/Ayz [m2]	Iy/Iz/Iyz [m4]	ys/zs [m]	y/z-sc [m]	modules [MPa]	gam [kN/m3]
1	1	1.0000E+02		8.333E+02	.000	.000	32000	25.0
	3	1.400E+03		8.333E+02	.000	.000	13333	
	=	1000./1000. [cm]						
	=	(H-AS 100./100. [cm])						
2	1	5.1000E+00		2.784E+00	.000	.000	32000	25.0
		3.078E+00		2.784E+00	.000	.000	13333	
3	2	1.1380E-01		1.100E-03	.000	.000	32000	25.0
		1.931E-03		1.100E-03	.000	.000	13333	
4	2	6.1600E-02		1.100E-03	.000	.000	32000	25.0
		1.658E-04		1.100E-03	.000	.000	13333	

Summary of used sections in system

No.	Total Length [m]	Total Volume [t]	max. length [m]	Title
1	.000	.000	.000	1000./1000. [cm]
2	66.000	841.500	33.000	
3	3.000	.854	1.500	
4	1.500	.231	1.500	

B E A M E L E M E N T S

beam	node	x[m]	NoS	Ref	hinges	direction	local y-axis	
2	2	.000	2			.000	1.000	.000
		8.100	2					
		24.900	2					
	3	33.000	2					
5	6	.000	2			.000	1.000	.000
		8.100	2					
		24.900	2					
	7	33.000	2					
7	9	.000	3			.000	1.000	.000
	10	1.500	3					
8	11	.000	4			.000	1.000	.000
	12	1.500	4					
9	13	.000	3			.000	1.000	.000
	14	1.500	3					

```
  1 PROG STAR2
  2 $ Dat : C:\...\sofistik\dat\it\133\12-7-02a\new.dat  (.#03)   09/11/2002
  3 $ Job : 12-7-02a/TEGOS:002367                                      13:58
  4 HEAD ΕΝΤΑΤΙΚΑ ΜΕΓΕΘΗ
  5 PAGE FIRS 1 LINE 75 MARG 3 LANO 1 LANI 1
  6 ECHO FULL FULL
  7 ECHO NODE FULL
  8 CTRL I
  9 LC 1 TITL 'ΦΟΡΤΙΑ ΜΟΝΙΜΑ+ΚΙΝΗΤΑ'
 10 UL 2 PZ 74.50
 11 UL 5 PZ 74.50
 12 SL NO 5 TYPE PZ P 825 A 16.5
 13 $
 14 LC 2 TITL 'ΦΟΡΤ. ΜΟΝ.+ΚΙΝ.+(-70o C)'
 15 UL 2 PZ 74.50
 16 UL 5 PZ 74.50
 17 SL NO 5 TYPE PZ P 825 A 16.5
 18 UL 2 TS -70
 19 UL 5 TS -70
 20 UL (7 9 1) TS -70
 21 END
```

ΕΝΤΑΤΙΚΑ ΜΕΓΕΘΗ

L O A D C A S E 1 ΦΟΡΤΙΑ ΜΟΝΙΜΑ+ΚΙΝΗΤΑ
load - factor 1.000
factor dl-x .000
factor dl-y .000
factor dl-z .000

B E A M L O A D S

Beamno	type	a[m]	l[m]	load1	load2	[dim]	ya[m]	za[m]	ye[m]	ze[m]
2	ULPZ	.000	33.000	74.50		KN/M				
5	SLPZ	16.500		825.00		KN				
5	ULPZ	.000	33.000	74.50		KN/M				

L O A D C A S E 2 ΦΟΡΤ. ΜΟΝ.+ΚΙΝ.+(-70o C)
load - factor 1.000
factor dl-x .000
factor dl-y .000
factor dl-z .000

B E A M L O A D S

Beamno	type	a[m]	l[m]	load1	load2	[dim]	ya[m]	za[m]	ye[m]	ze[m]
2	ULPZ	.000	33.000	74.50		KN/M				
2	ULTS	.000	33.000	-70.00		K				
5	SLPZ	16.500		825.00		KN				
5	ULPZ	.000	33.000	74.50		KN/M				
5	ULTS	.000	33.000	-70.00		K				
7	ULTS	.000	1.500	-70.00		K				
8	ULTS	.000	1.500	-70.00		K				
9	ULTS	.000	1.500	-70.00		K				

Analysis has been selected:
for group: 0

K I N E M A T I C C O N S T R A I N T S

Node	LV	type	reference	dx	dy	dz	df
10	1	KF	2	-.200	.000	-.580	
1	1	KF	2	-.200	.000	.000	
11	1	KF	3	.200	.000	-.580	
4	1	KF	3	.200	.000	.000	
12	1	KF	6	-.200	.000	-.580	
5	1	KF	6	-.200	.000	.000	
13	1	KF	7	.200	.000	-.580	
8	1	KF	7	.200	.000	.000	

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

Number	X[m]	Y[m]	Z[m]	eq.PX	eq.PY	eq.PZ	eq.MX	eq.MY	eq.MZ
1	1.500	.000	.580	-7	-8	-9	-10	-11	-12
2	1.700	.000	.580	1	PY	PZ	MX	2	MZ
3	34.700	.000	.580	3	PY	PZ	MX	4	MZ
4	34.900	.000	.580	-19	-20	-21	-22	-23	-24
5	36.400	.000	.580	-31	-32	-33	-34	-35	-36
6	36.600	.000	.580	5	PY	PZ	MX	6	MZ
7	69.600	.000	.580	7	PY	PZ	MX	8	MZ
8	69.800	.000	.580	-43	-44	-45	-46	-47	-48
9	.000	.000	.000	PX	PY	PZ	MX	MY	MZ
10	1.500	.000	.000	-1	-2	-3	-4	-5	-6
11	34.900	.000	.000	-13	-14	-15	-16	-17	-18
12	36.400	.000	.000	-25	-26	-27	-28	-29	-30
13	69.800	.000	.000	-37	-38	-39	-40	-41	-42
14	71.300	.000	.000	PX	PY	PZ	MX	MY	MZ
MIN	.000	.000	.000	-48					
MAX	71.300	.000	.580	8					

M A T E R I A L S

ΕΝΤΑΤΙΚΑ ΜΕΓΕΘΗ

M A T E R I A L S

No. 1 B 35 (DIN 1045)

Young-module	32000	[MPa]	Safetyfactor	1.00	[-]
Poisson-Ratio	.20	[-]	Strength fc	23.00	[MPa]
Shear-module	13333	[MPa]	Nominal Strength	35.00	[MPa]
Compress.module	17778	[MPa]	Tens.Str. fctm	3.21	[MPa]
Weight	25.0	[kN/m3]	Tens.Str. fctk	2.67	[MPa]
Weight buoyancy	.0	[kN/m3]	Tens.Str. fctk	3.85	[MPa]
Temperat. coeff.	1.00E-05	[-]	Compr.fail.ener.	20.00	[kN/m]
			Tens.fail.energ.	.05	[kN/m]
			Friction crack	.20	[-]

No. 2 B 35 (DIN 1045)

Young-module	32000	[MPa]	Safetyfactor	1.00	[-]
Poisson-Ratio	.20	[-]	Strength fc	23.00	[MPa]
Shear-module	13333	[MPa]	Nominal Strength	35.00	[MPa]
Compress.module	17778	[MPa]	Tens.Str. fctm	3.21	[MPa]
Weight	25.0	[kN/m3]	Tens.Str. fctk	2.67	[MPa]
Weight buoyancy	.0	[kN/m3]	Tens.Str. fctk	3.85	[MPa]
Temperat. coeff.	1.00E-05	[-]	Compr.fail.ener.	20.00	[kN/m]
			Tens.fail.energ.	.05	[kN/m]
			Friction crack	.20	[-]

No. 3 BST 500 (DIN 1045)

Young-module	210000	[MPa]	Safetyfactor	1.00	[-]
Poisson-Ratio	.30	[-]	Yield stress fy	500.00	[MPa]
Shear-module	80769	[MPa]	Tensile str. ft	550.00	[MPa]
Compress.module	175000	[MPa]	Plastic strain	10.00	[o/o]
Weight	78.5	[kN/m3]	Relaxation .70ft	.00	[-]
Weight buoyancy	.0	[kN/m3]	Relaxation .55ft	.00	[-]
Temperat. coeff.	1.20E-05	[-]	nat. bond coeff.	200.00	[-]
			EC2 bondcoeff K1	.80	[-]
			Hardening module	.00	[MPa]

C R O S S - S E C T I O N S S T A T I C P R O P E R T I E S

No	MNo / MNs	A[m2] / It[m4]	Ay/Az/Ayz [m2]	Iy/Iz/Iyz [m4]	ys/zs [m]	y/z-sc [m]	modules [MPa]	gam [kN/m3]
1	1	1.0000E+02		8.333E+02	.000	.000	32000	25.0
	3	1.400E+03		8.333E+02	.000	.000	13333	
	=	1000./1000. [cm]						
	=	(H-AS 100./100. [cm])						
2	1	5.1000E+00		2.784E+00	.000	.000	32000	25.0
		3.078E+00		2.784E+00	.000	.000	13333	
3	2	1.1380E-01		1.100E-03	.000	.000	32000	25.0
		1.931E-03		1.100E-03	.000	.000	13333	
4	2	6.1600E-02		1.100E-03	.000	.000	32000	25.0
		1.658E-04		1.100E-03	.000	.000	13333	

B E A M E L E M E N T S

beam	node	x[m]	NoS	Ref	hinges	direction	local y-axis	
2	2	.000	2			.000	1.000	.000
		8.100	2					
		24.900	2					
	3	33.000	2					
5	6	.000	2			.000	1.000	.000
		8.100	2					
		24.900	2					
	7	33.000	2					
7	9	.000	3			.000	1.000	.000
	10	1.500	3					
8	11	.000	4			.000	1.000	.000
	12	1.500	4					
9	13	.000	3			.000	1.000	.000
	14	1.500	3					

ΕΝΤΑΤΙΚΑ ΜΕΤΕΘΗ

linear results Loadfactor 1.00

B E A M F O R C E S A N D M O M E N T S
Loadcase 1 ΦΟΡΤΙΑ ΜΟΝΙΜΑ+ΚΙΝΗΤΑ

beam No	X [m]	N [kN]	Q-Y [kN]	Q-Z [kN]	M-T [kNm]	M-Y [kNm]	M-Z [kNm]
2	.000	1600.3	.0	1233.8	.00	-1073.17	.00
	8.100	1600.3	.0	630.3	.00	6476.38	.00
	24.90	1600.3	.0	-621.3	.00	6552.28	.00
	33.00	1600.3	.0	-1224.7	.00	-924.08	.00
5	.000	1600.3	.0	1638.9	.00	-1061.47	.00
	8.100	1600.3	.0	1035.4	.00	9769.38	.00
	16.50	1600.3	.0	409.6	.00	15838.54	.00
	16.50	1600.3	.0	-415.4	.00	15838.54	.00
	24.90	1600.3	.0	-1041.2	.00	9720.97	.00
	33.00	1600.3	.0	-1644.6	.00	-1156.59	.00
7	.000	1600.3	.0	-126.3	.00	69.82	.00
	1.500	1600.3	.0	-126.3	.00	-119.69	.00
8	.000	1600.3	.0	-72.3	.00	-10.34	.00
	1.500	1600.3	.0	-72.3	.00	-118.81	.00
9	.000	1600.3	.0	199.1	.00	-188.57	.00
	1.500	1600.3	.0	199.1	.00	110.00	.00

B E A M D I S P L A C E M E N T S
Loadcase 1 ΦΟΡΤΙΑ ΜΟΝΙΜΑ+ΚΙΝΗΤΑ

beam No	X [m]	U [mm]	V-Y [mm]	V-Z [mm]	PHI-X [mrad]	PHI-Y [mrad]	PHI-Z [mrad]
2	.000	.043	.000	.000	.000	-1.063	.000
	8.100	.122	.000	7.926	.000	-.780	.000
	24.90	.287	.000	7.954	.000	.779	.000
	33.00	.366	.000	.000	.000	1.072	.000
5	.000	-.012	.000	.000	.000	-1.680	.000
	8.100	.068	.000	12.520	.000	-1.247	.000
	16.50	.150	.000	18.152	.000	.001	.000
	16.50	.150	.000	18.152	.000	.001	.000
	24.90	.232	.000	12.501	.000	1.248	.000
	33.00	.312	.000	.000	.000	1.674	.000
7	.000	.000	.000	.000	.000	.000	.000
	1.500	.659	.000	-.213	.000	-1.063	.000
8	.000	-.255	.000	-.214	.000	1.072	.000
	1.500	.963	.000	-.336	.000	-1.680	.000
9	.000	-.659	.000	-.335	.000	1.674	.000
	1.500	.000	.000	.000	.000	.000	.000

N O D A L R E A C T I O N S
Loadcase 1 ΦΟΡΤΙΑ ΜΟΝΙΜΑ+ΚΙΝΗΤΑ

nodes No	P-X [kN]	P-Y [kN]	P-Z [kN]	M-X [kNm]	M-Y [kNm]	M-Z [kNm]
2	.0	.0	-1360.1	.00	.00	.00
3	.0	.0	-1152.4	.00	.00	.00
6	.0	.0	-1711.2	.00	.00	.00
7	.0	.0	-1843.7	.00	.00	.00
9	-1600.3	.0	126.3	.00	-69.82	.00
14	1600.3	.0	199.1	.00	110.00	.00

N O D A L D I S P L A C E M E N T S
Loadcase 1 ΦΟΡΤΙΑ ΜΟΝΙΜΑ+ΚΙΝΗΤΑ

nodes No	V-X [mm]	V-Y [mm]	V-Z [mm]	PHI-X [mrad]	PHI-Y [mrad]	PHI-Z [mrad]
1	.043	.000	-.213	.000	-1.063	.000
2	.043	.000	.000	.000	-1.063	.000
3	.366	.000	.000	.000	1.072	.000
4	.366	.000	-.214	.000	1.072	.000
5	-.012	.000	-.336	.000	-1.680	.000
6	-.012	.000	.000	.000	-1.680	.000
7	.312	.000	.000	.000	1.674	.000

ΕΝΤΑΤΙΚΑ ΜΕΓΕΘΗ

N O D A L D I S P L A C E M E N T S
Loadcase 1 ΦΟΡΤΙΑ ΜΟΝΙΜΑ+ΚΙΝΗΤΑ

nodes No	V-X [mm]	V-Y [mm]	V-Z [mm]	PHI-X [mrad]	PHI-Y [mrad]	PHI-Z [mrad]
8	.312	.000	-.335	.000	1.674	.000
9	.000	.000	.000	.000	.000	.000
10	.659	.000	-.213	.000	-1.063	.000
11	-.255	.000	-.214	.000	1.072	.000
12	.963	.000	-.336	.000	-1.680	.000
13	-.659	.000	-.335	.000	1.674	.000
14	.000	.000	.000	.000	.000	.000

E L I M I N A T E D F O R C E S F R O M C O N S T R A I N T S
Loadcase 1 ΦΟΡΤΙΑ ΜΟΝΙΜΑ+ΚΙΝΗΤΑ

Nodeno	PX[kN]	PY[kN]	PZ[kN]	MX[kNm]	MY[kNm]	MZ[kNm]	MB[kNm2]
1	.0	.0	.0	.00	.00	.00	
4	.0	.0	.0	.00	.00	.00	
5	.0	.0	.0	.00	.00	.00	
8	.0	.0	.0	.00	.00	.00	
10	1600.3	.0	-126.3	.00	-119.69	.00	
11	-1600.3	.0	72.3	.00	10.34	.00	
12	1600.3	.0	-72.3	.00	-118.81	.00	
13	-1600.3	.0	-199.1	.00	188.57	.00	

S U M

	P-X [kN]	P-Y [kN]	P-Z [kN]
Loads	.0	.0	5742.0
Reactions	.0	.0	-5742.0

ΕΝΤΑΤΙΚΑ ΜΕΓΕΘΗ

linear results Loadfactor 1.00

B E A M F O R C E S A N D M O M E N T S
Loadcase 2 ΦΟΡΤ. ΜΟΝ.+ΚΙΝ.+(-70ο C)

beam No	X [m]	N [kN]	Q-Y [kN]	Q-Z [kN]	M-T [kNm]	M-Y [kNm]	M-Z [kNm]
2	.000	23688.3	.0	1227.5	.00	-13566.8	.00
	8.100	23688.3	.0	624.0	.00	-6068.19	.00
	24.90	23688.3	.0	-627.6	.00	-6097.99	.00
	33.00	23688.3	.0	-1231.0	.00	-13625.3	.00
5	.000	23688.3	.0	1645.2	.00	-13762.7	.00
	8.100	23688.3	.0	1041.7	.00	-2880.88	.00
	16.50	23688.3	.0	415.9	.00	3241.11	.00
	16.50	23688.3	.0	-409.1	.00	3241.11	.00
	24.90	23688.3	.0	-1034.9	.00	-2823.61	.00
	33.00	23688.3	.0	-1638.3	.00	-13650.2	.00
7	.000	23688.3	.0	150.3	.00	-83.06	.00
	1.500	23688.3	.0	150.3	.00	142.39	.00
8	.000	23688.3	.0	-72.3	.00	99.46	.00
	1.500	23688.3	.0	-72.3	.00	-9.01	.00
9	.000	23688.3	.0	-77.6	.00	73.51	.00
	1.500	23688.3	.0	-77.6	.00	-42.88	.00

B E A M D I S P L A C E M E N T S
Loadcase 2 ΦΟΡΤ. ΜΟΝ.+ΚΙΝ.+(-70ο C)

beam No	X [m]	U [mm]	V-Y [mm]	V-Z [mm]	PHI-X [mrad]	PHI-Y [mrad]	PHI-Z [mrad]
2	.000	9.441	.000	.000	.000	1.264	.000
	8.100	4.946	.000	-6.314	.000	.409	.000
	24.90	-4.375	.000	-6.325	.000	-.408	.000
	33.00	-8.869	.000	.000	.000	-1.268	.000
5	.000	9.224	.000	.000	.000	.660	.000
	8.100	4.730	.000	-1.760	.000	-.060	.000
	16.50	.069	.000	-1.097	.000	-.002	.000
	16.50	.069	.000	-1.097	.000	-.002	.000
	24.90	-4.592	.000	-1.739	.000	.059	.000
	33.00	-9.086	.000	.000	.000	-.653	.000
7	.000	.000	.000	.000	.000	.000	.000
	1.500	8.707	.000	.253	.000	1.264	.000
8	.000	-8.134	.000	.254	.000	-1.268	.000
	1.500	8.842	.000	.132	.000	.660	.000
9	.000	-8.707	.000	.131	.000	-.653	.000
	1.500	.000	.000	.000	.000	.000	.000

N O D A L R E A C T I O N S
Loadcase 2 ΦΟΡΤ. ΜΟΝ.+ΚΙΝ.+(-70ο C)

nodes No	P-X [kN]	P-Y [kN]	P-Z [kN]	M-X [kNm]	M-Y [kNm]	M-Z [kNm]
2	.0	.0	-1077.2	.00	.00	.00
3	.0	.0	-1158.7	.00	.00	.00
6	.0	.0	-1717.5	.00	.00	.00
7	.0	.0	-1560.7	.00	.00	.00
9	-23688.	.0	-150.3	.00	83.06	.00
14	23688.3	.0	-77.6	.00	-42.88	.00

N O D A L D I S P L A C E M E N T S
Loadcase 2 ΦΟΡΤ. ΜΟΝ.+ΚΙΝ.+(-70ο C)

nodes No	V-X [mm]	V-Y [mm]	V-Z [mm]	PHI-X [mrad]	PHI-Y [mrad]	PHI-Z [mrad]
1	9.441	.000	.253	.000	1.264	.000
2	9.441	.000	.000	.000	1.264	.000
3	-8.869	.000	.000	.000	-1.268	.000
4	-8.869	.000	.254	.000	-1.268	.000
5	9.224	.000	.132	.000	.660	.000
6	9.224	.000	.000	.000	.660	.000
7	-9.086	.000	.000	.000	-.653	.000

ΕΝΤΑΤΙΚΑ ΜΕΓΕΘΗ

N O D A L D I S P L A C E M E N T S
Loadcase 2 ΦΟΡΤ. ΜΟΝ.+ΚΙΝ.+(-70o C)

nodes No	V-X [mm]	V-Y [mm]	V-Z [mm]	PHI-X [mrad]	PHI-Y [mrad]	PHI-Z [mrad]
8	-9.086	.000	.131	.000	-.653	.000
9	.000	.000	.000	.000	.000	.000
10	8.707	.000	.253	.000	1.264	.000
11	-8.134	.000	.254	.000	-1.268	.000
12	8.842	.000	.132	.000	.660	.000
13	-8.707	.000	.131	.000	-.653	.000
14	.000	.000	.000	.000	.000	.000

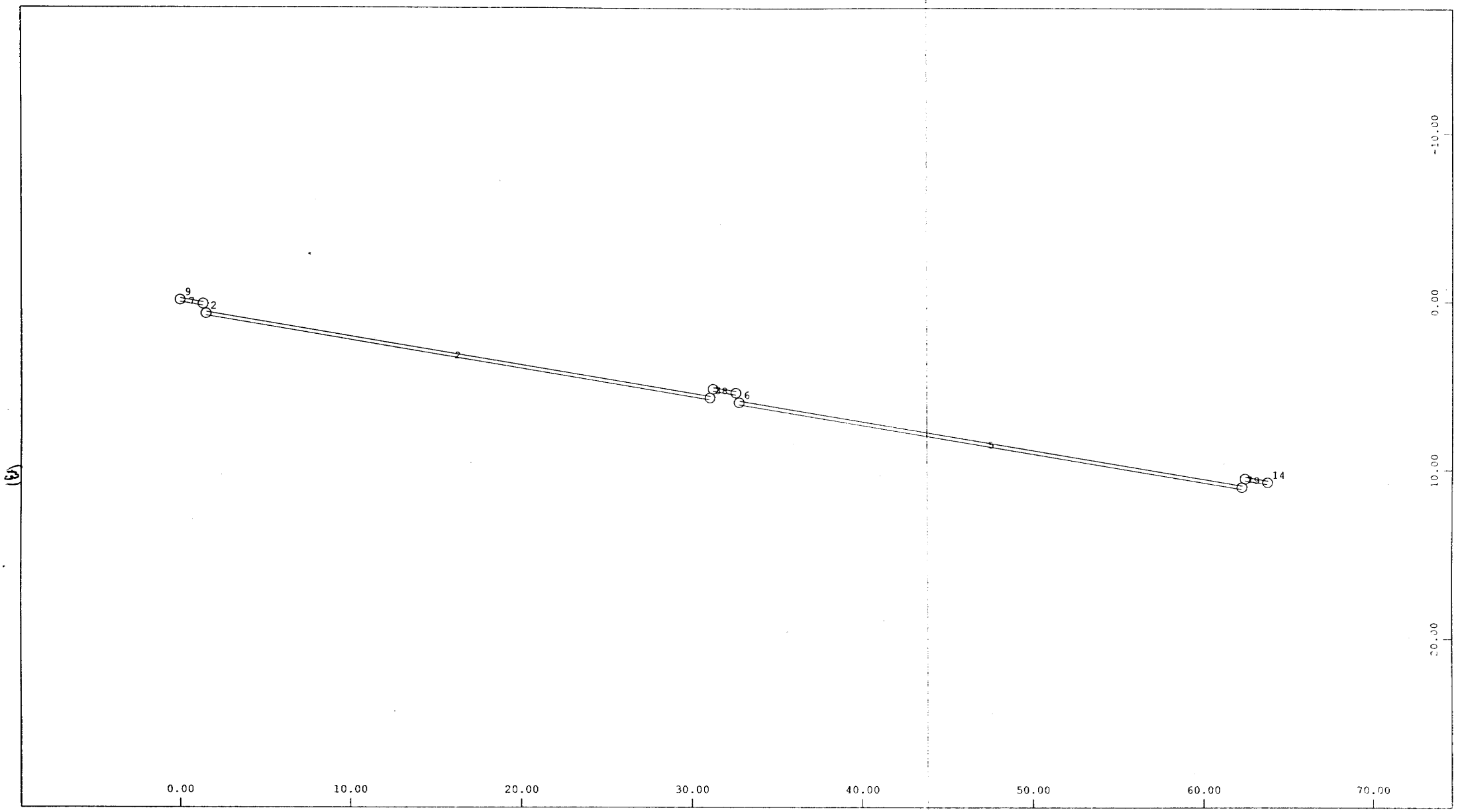
E L I M I N A T E D F O R C E S F R O M C O N S T R A I N T S
Loadcase 2 ΦΟΡΤ. ΜΟΝ.+ΚΙΝ.+(-70o C)

Nodeno	PX[kN]	PY[kN]	PZ[kN]	MX[kNm]	MY[kNm]	MZ[kNm]	MB[kNm2]
1	.0	.0	.0	.00	.00	.00	
4	.0	.0	.0	.00	.00	.00	
5	.0	.0	.0	.00	.00	.00	
8	.0	.0	.0	.00	.00	.00	
10	23688.3	.0	150.3	.00	142.39	.00	
11	-23688.3	.0	72.3	.00	-99.46	.00	
12	23688.3	.0	-72.3	.00	-9.01	.00	
13	-23688.3	.0	77.6	.00	-73.51	.00	

S U M

	P-X [kN]	P-Y [kN]	P-Z [kN]
Loads	.0	.0	5742.0
Reactions	.0	.0	-5742.0

METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9

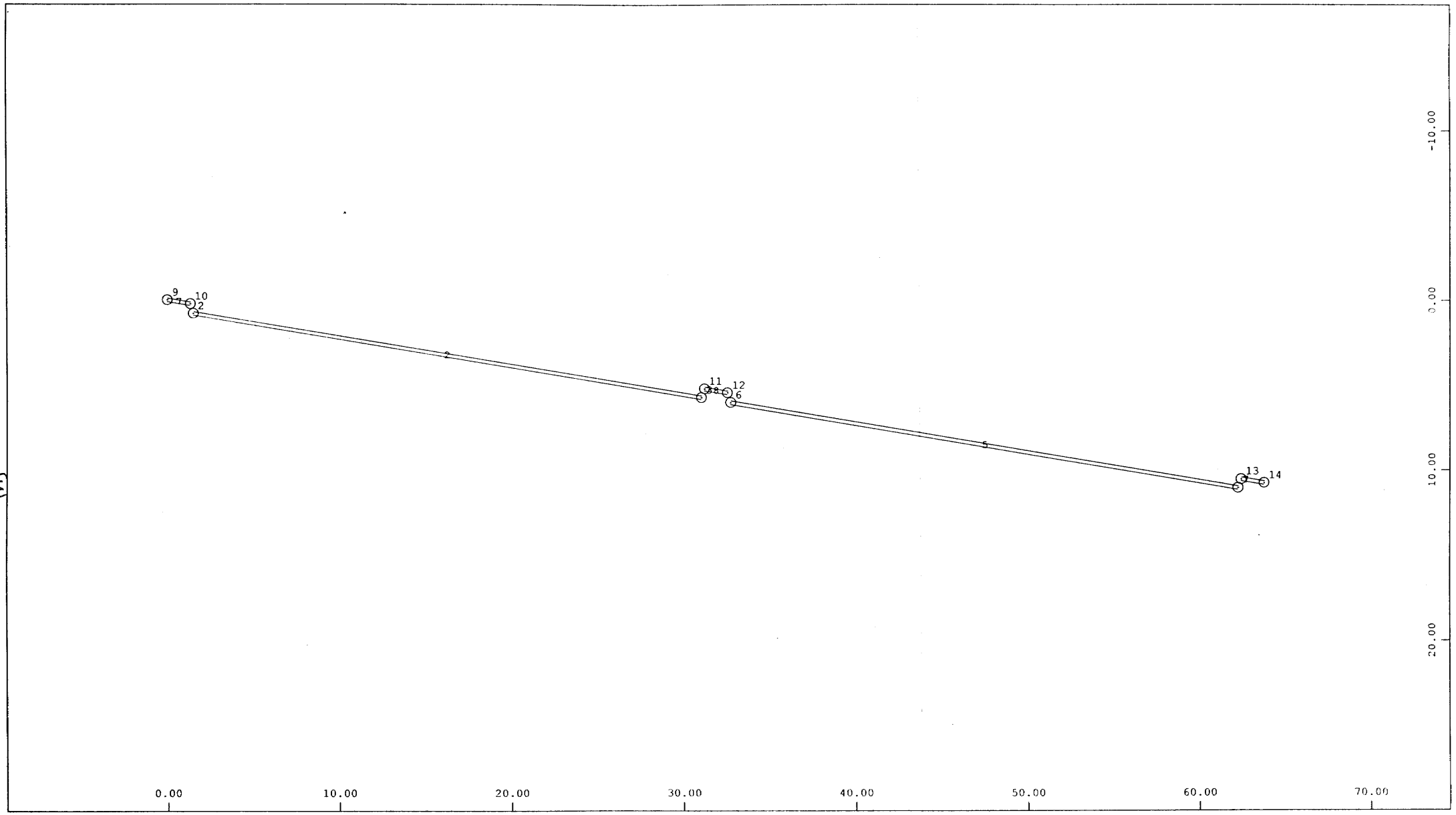


FINITE ELEMENT DISCRETIZATION
SECTOR OF SYSTEM, ELEMENT GROUP 0 1
ELEMENT NUMBERS

Y X Z

M 1 : 300
X * 0.907
Y * 0.539
Z * 0.942

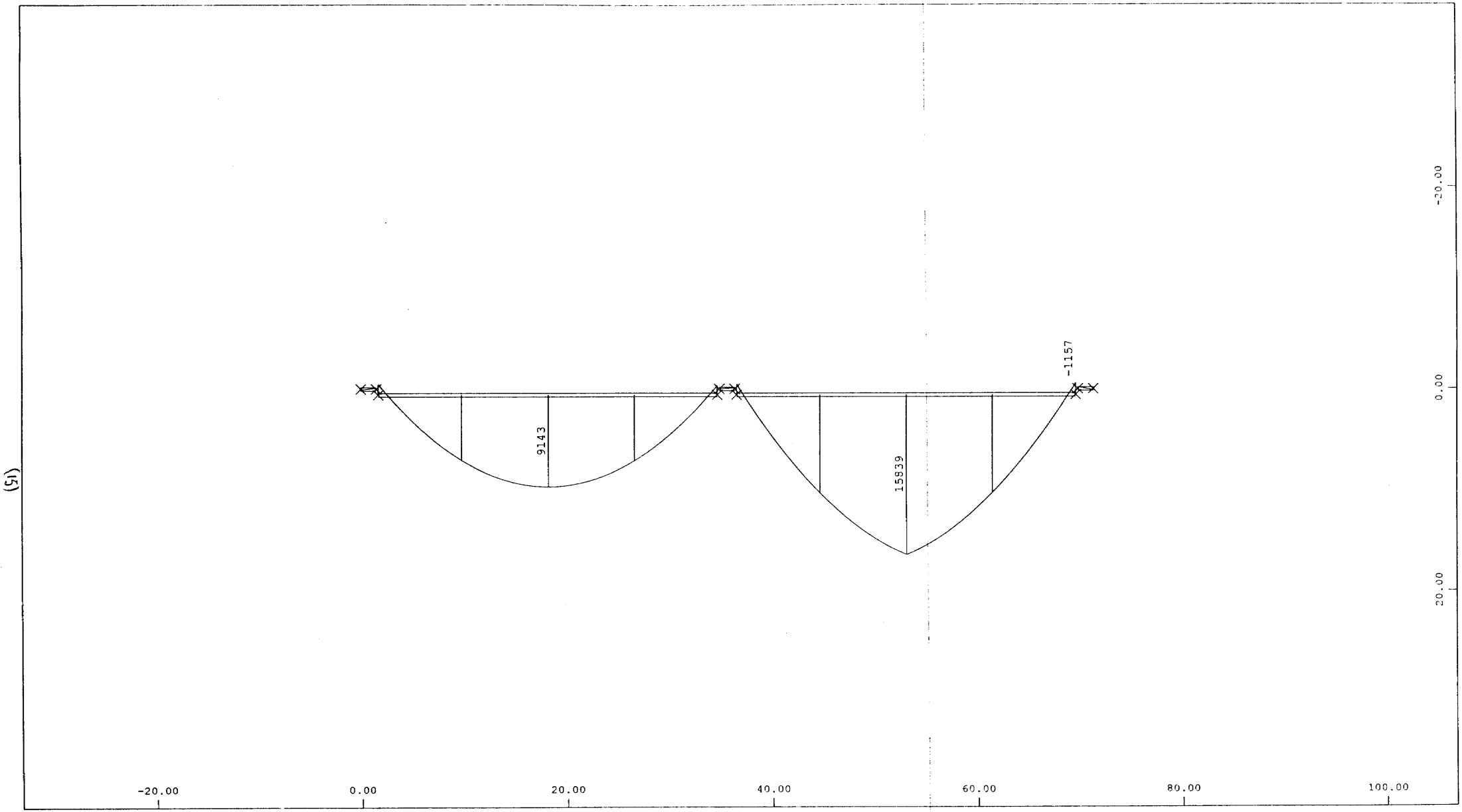
METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9



FINITE ELEMENT DISCRETIZATION
SECTOR OF SYSTEM, ELEMENT GROUP 0 1
NODE NUMBERS

M 1 : 300
X * 0.907
Y * 0.539
Z * 0.942

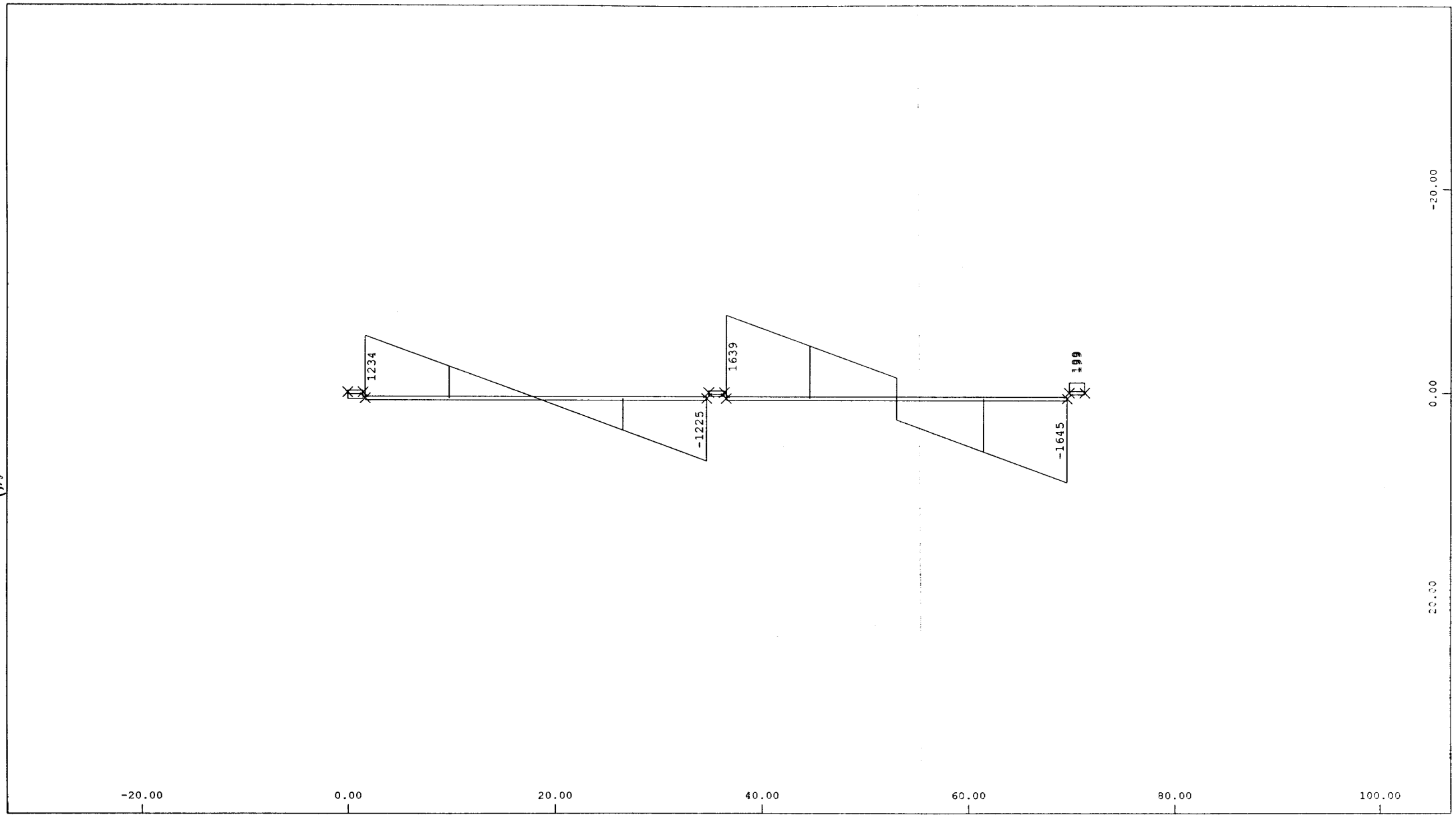
METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9



INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM MOMENTS MY LC 1 LOAD CASE 1 1 CM = 5000 kNm

M 1 : 500

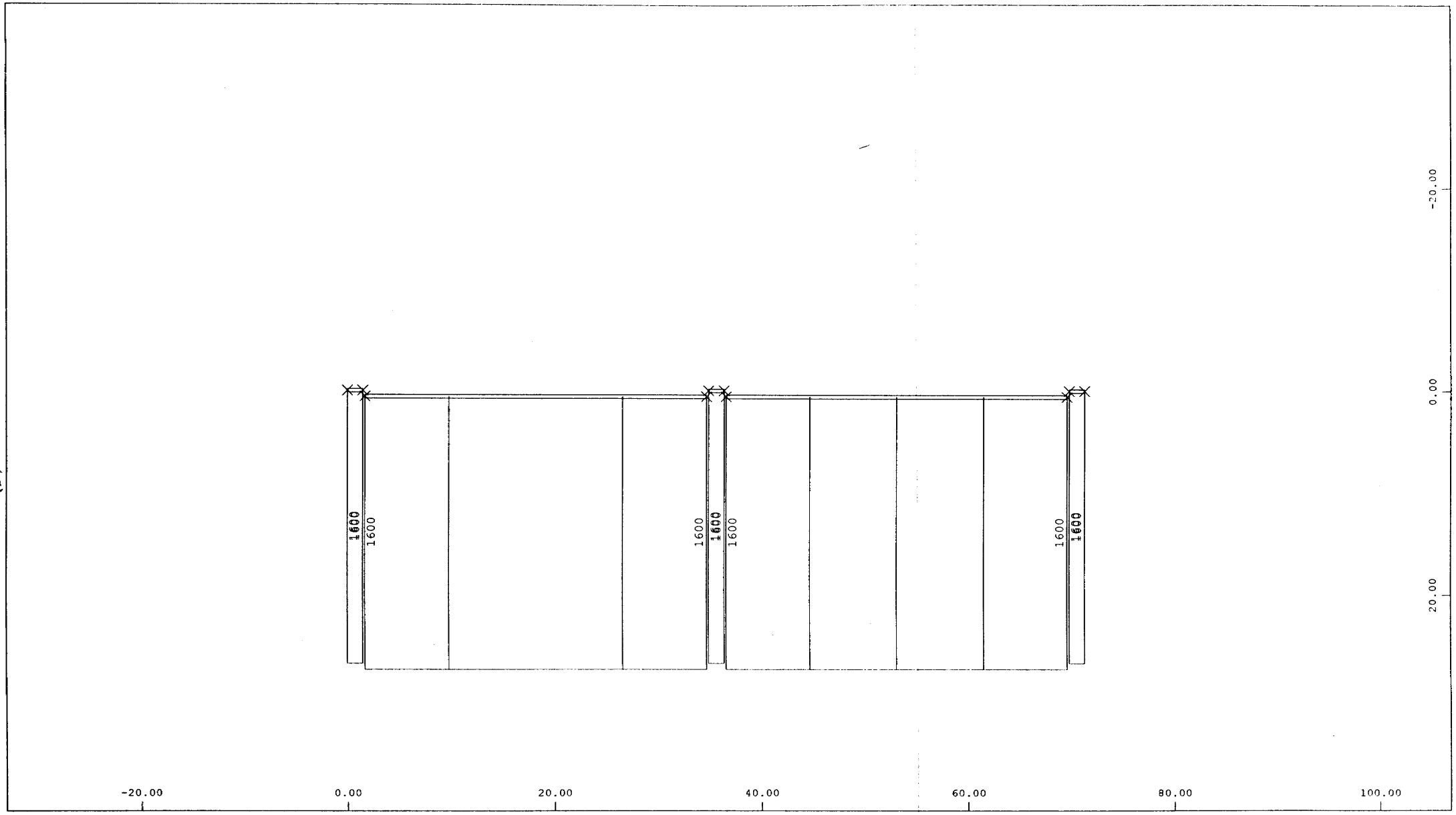
METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9



INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM SHEAR FORCES QZ LC 1 LOAD CASE 1 1 CM = 1000 kN

M 1 : 500

METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9



INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM NORMAL FORCES LC 1 LOAD CASE 1 1 CM = 300.0 kN

M 1 : 500

METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9

ΘΑΜΙΣΤΙΚΗ ΜΕΘΟΔΟΣ (ΔΙΑΔΟΧΙΚΩΝ ΠΡΟΣΕΓΓΙΣΕΩΝ)

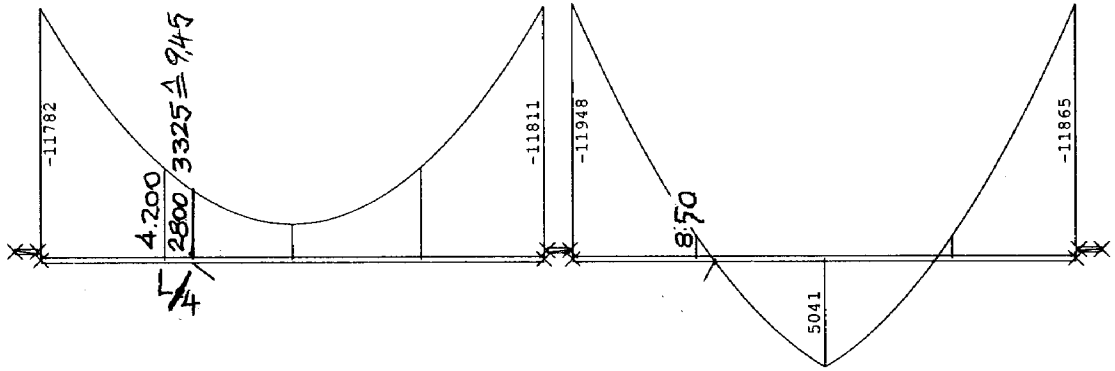
-60°C

$\pi\Delta M(x=L_{eff}) + (y_{2,eff} - 0.5\,h_{f,eff})\Delta N = \frac{J_{c,eff}}{y_{2,eff}}\left(f_{ctmi} - \frac{N+\Delta N}{A_{c,eff}}\right) \rightarrow 0{,}5(4.200+850)+(0{,}73-0{,}10)\Delta N_1 = \frac{2{,}784}{0{,}73}\left(3.500 - \frac{20.533}{5{,}1}\right) - \frac{2{,}784}{0{,}73}\Delta N_1 \rightarrow \Delta N_1 =$

$= -3.283\ kN \rightarrow N_1 = 20533 - 3.283 \approx 17.250\ kN \rightarrow \frac{17.250}{20.533} = \frac{2L_{eff}+2{,}65}{2L_{eff,1}+2{,}65} = \frac{19{,}15}{2L_{eff,1}+2{,}65} \rightarrow L_{eff,1} = 10{,}0\,m \rightarrow \pi\Delta M(x=10{,}0) = 0{,}5(2800+\varnothing) =$

$= 1400\ kNm \rightarrow 1400 + 200\mathcal{F} = 1{,}38\Delta N_2 \rightarrow \Delta N_2 = -2470\ kN \rightarrow N_2 = 18060\ kN \rightarrow \frac{18060}{20533} = \frac{19{,}15}{x_2} \rightarrow L_{eff,2} = 9{,}55\,m \rightarrow \pi\Delta M(x=9{,}55) =$

$= 0{,}5(3325+\varnothing) = 1660 \rightarrow 1660 + 200\mathcal{F} = 3670 \approx 1{,}38\Delta N_3 \rightarrow \Delta N_3 = -2660\ kN \rightarrow N_3 = 17.900\ kN \rightarrow x_3 = 21{,}95\,m \rightarrow L_{eff} = 9{,}55\,m$



ΣΥΓΚΡΙΣΗ ΜΕ ΠΕΡΙΠΤΩΣΗ Ε=31% & T=-60°C:

N = 17900 ≙ 16800

L_{eff} = 9,55 ≙ 7,65 m

Ήτοι: Αύξηση της ορθίσεως κατά 1/3 (από το 3,1 στο 4,1) αντιστοιχεί σε αύξηση του N κατά 1/15, δηλαδή αναλογία 1:5.

Με άλλα λόγια: Υπερβαίνη της τάσεως στο κέντρο κατά 20% απαιτεί αύξηση ορθίσεως $\frac{5}{4}\times 20 = 25\%$ όπου το 1/5 προφανώς δεν επαρκεί (απώλεια).

-20.00

20.00

(18)

-20.00 0.00 20.00 40.00 60.00 80.00 100.00

INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM MOMENTS MY LC 2 LOAD CASE 2 1 CM = 3500 kNm

M 1 : 500

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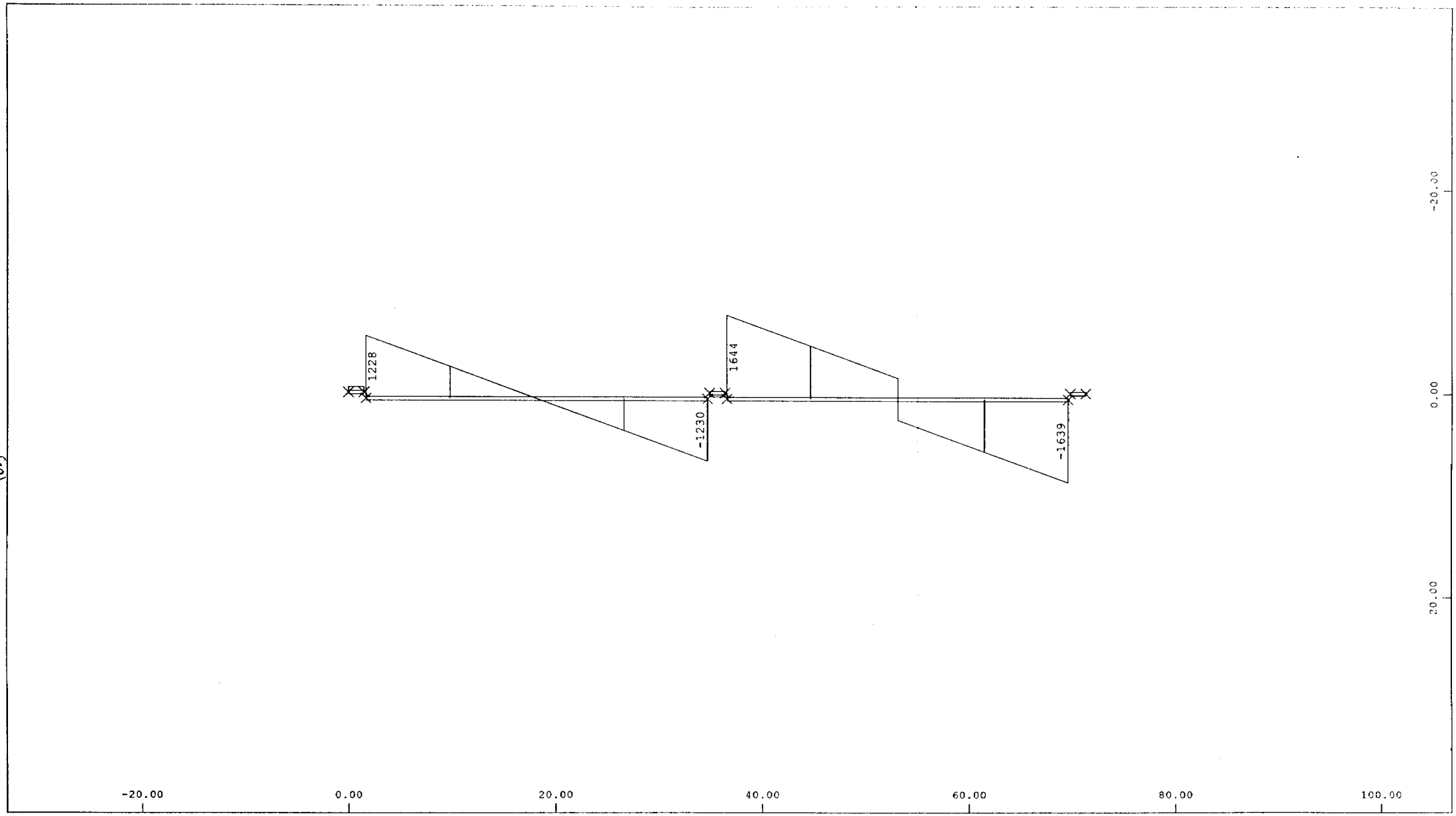

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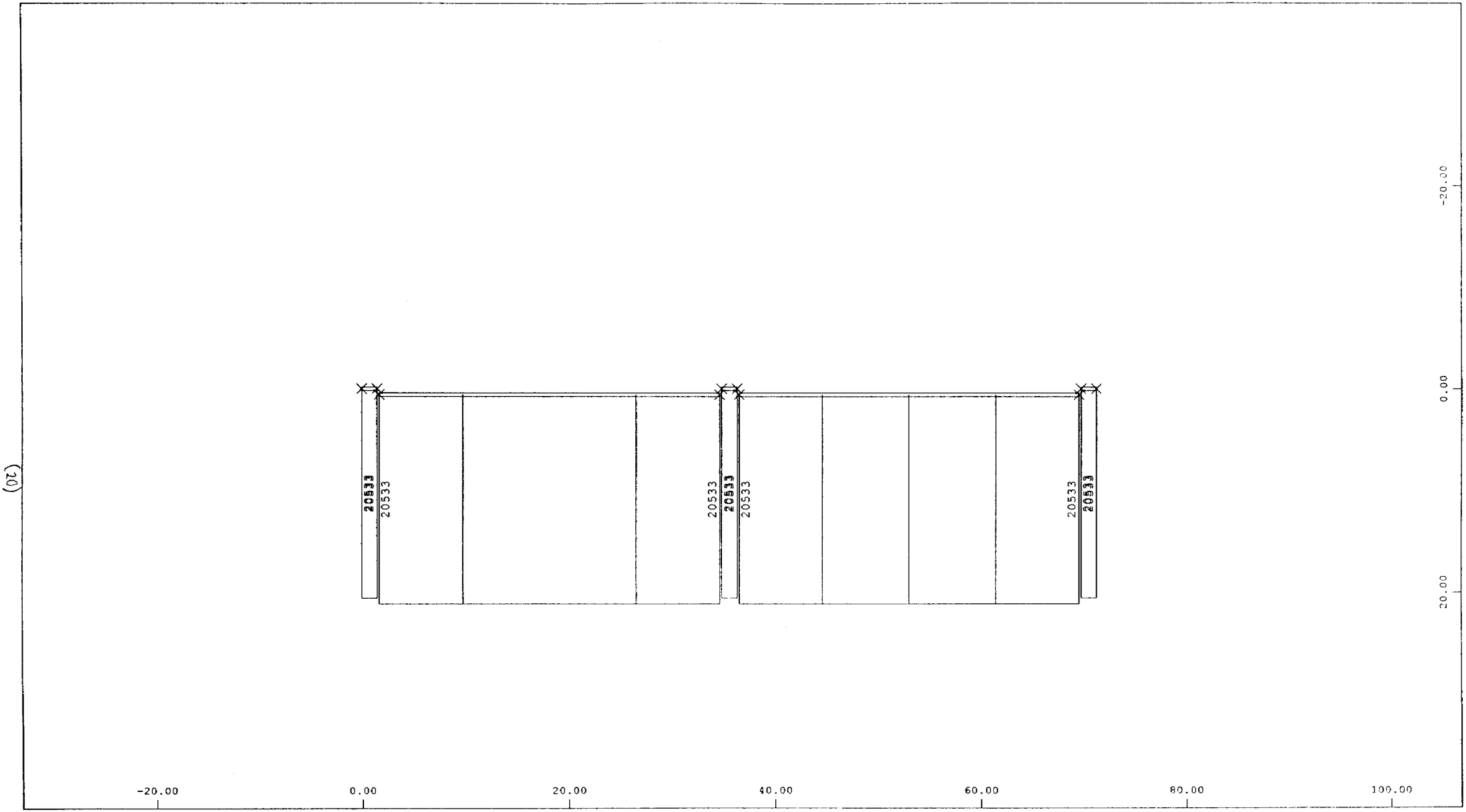
INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM SHEAR FORCES QZ LC 2 LOAD CASE 2 1 CM = 1000 kN

M 1 : 500

METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9



INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM NORMAL FORCES LC 2 LOAD CASE 2 1 CM = 5000 kN

M 1 : 500

METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9

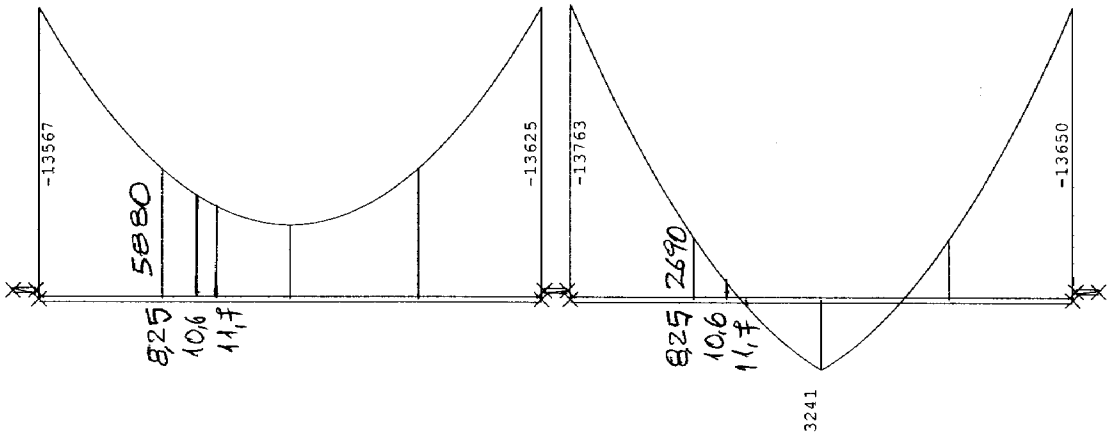
ΘΑΜΙΣΤΙΚΗ ΜΕΘΟΔΟΣ

$\sigma_n \Delta M(x=L/4) + (y_2 - 0{,}5\, h_{f,eff})\Delta N \le W_{2,eff}\left(f_{ctmi} - \frac{N+\Delta N}{A_{c,eff}}\right) \rightarrow 0{,}5(5880+2690)+4366 = -1{,}38\,\Delta N_1 \rightarrow \Delta N_1 = -6270$ 70°

$N_1 = 23688 - 6270 = 17.420$ kN $\rightarrow x_1 = 2{,}65 + 2L_{eff,1} = (2\times 8{,}25 + 2{,}65)\frac{23688}{17.420} = 26{,}05$ m $\rightarrow L_{eff,1} = 11{,}7$ m $\rightarrow \Delta M(x=11{,}5) = 0{,}5(4990 + \Phi) + 4366 = -1{,}38\,\Delta N_2 \rightarrow \Delta N_2 = -4720$ kN $\rightarrow N_2 = 23688 - 4720 = 18970$ kN $\rightarrow x_2 = 19{,}15 \times 23688/18970 = 23{,}90$ m $\rightarrow$

$L_{eff,2} = 10{,}60$ m $\rightarrow \Delta M(x=10{,}60) = 0{,}5(4620+420) = 2520$ kNm $\rightarrow 2520 + 4366 = -1{,}38\,\Delta N_3 \rightarrow \Delta N_3 = -4990$ kN $\rightarrow N_3 = 18.700$

$x_3 = 24{,}25$ m $\rightarrow L_{eff,3} = 10{,}80$ m



ΣΥΓΚΡΙΣΗ ΜΕ ΤΗΝ ΠΕΡΙΠΤΩΣΗ

$\rho = 3{,}1\%$ και $T = -70°C$

$N = 18.700 \triangleq 17.350$ kN

$L_{eff} = 10{,}80 \triangleq 8{,}75$ m

Η αύξηση της δ. ογλίσεως κατά 1/3 συνεπάγεται και αύξηση της επιβάσεως κατά 7,8% (απώλεια)

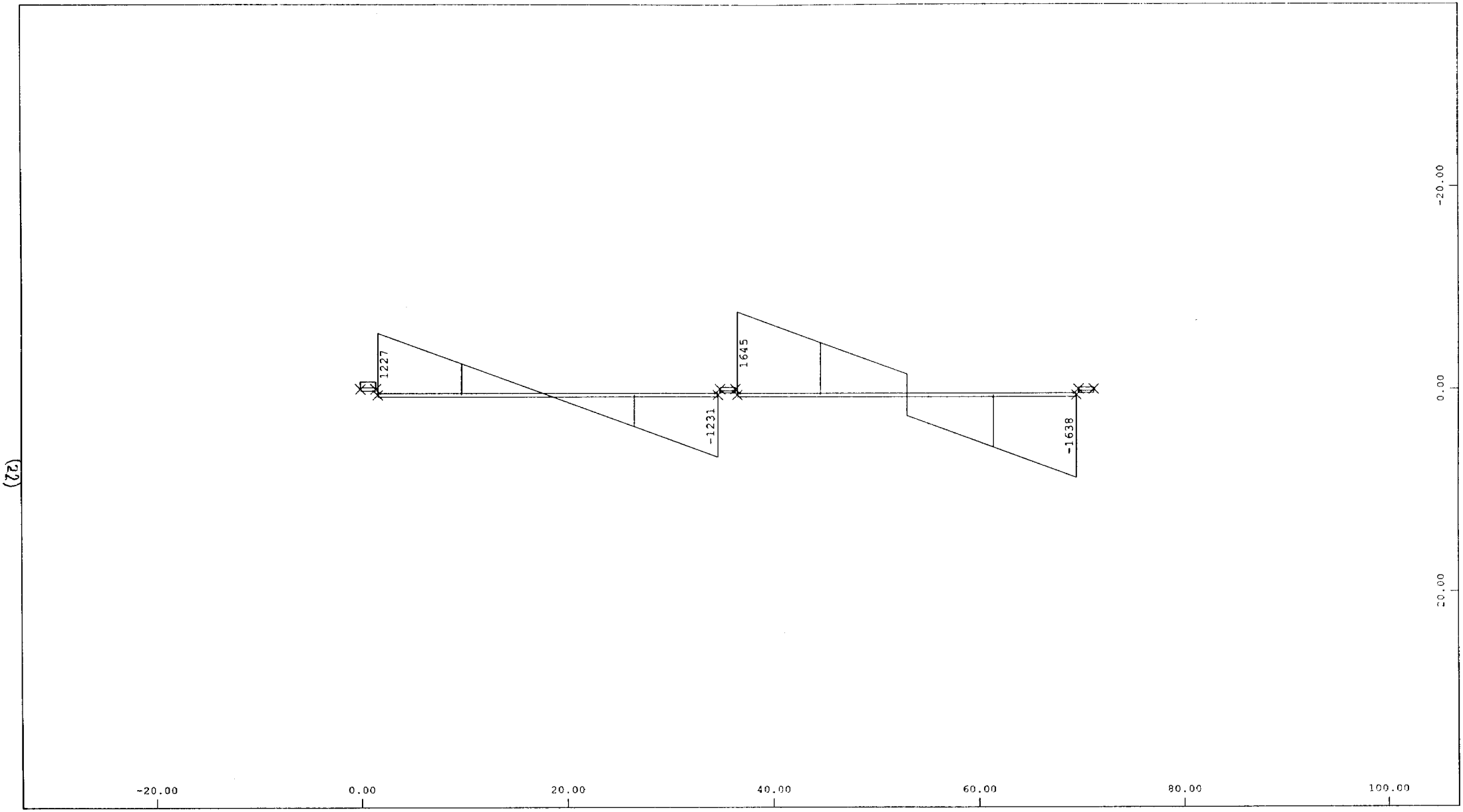
-20.00 0.00 20.00 40.00 60.00 80.00 100.00

-20.00 0.00 20.00

INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM MOMENTS MY LC 2 ΦΟΡΤ. ΜΟΝ.+ΚΙΝ.+ΘΕΡΜΟΚΡ. 1 CM = 3500 kNm

M 1 : 500

METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9

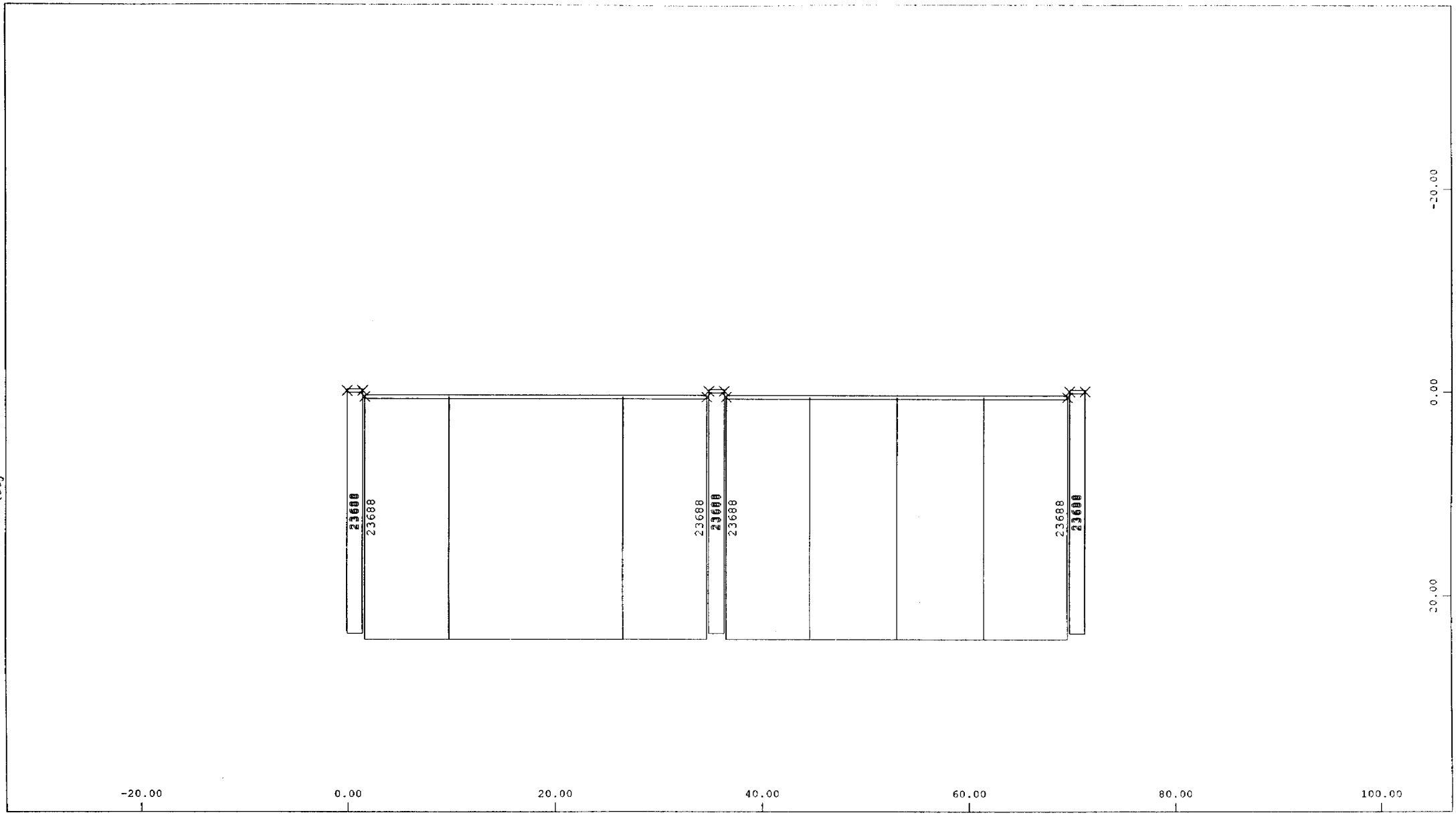


(22)

INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM SHEAR FORCES QZ LC 2 LOAD CASE 2 1 CM = 1000 kN

M 1 : 500

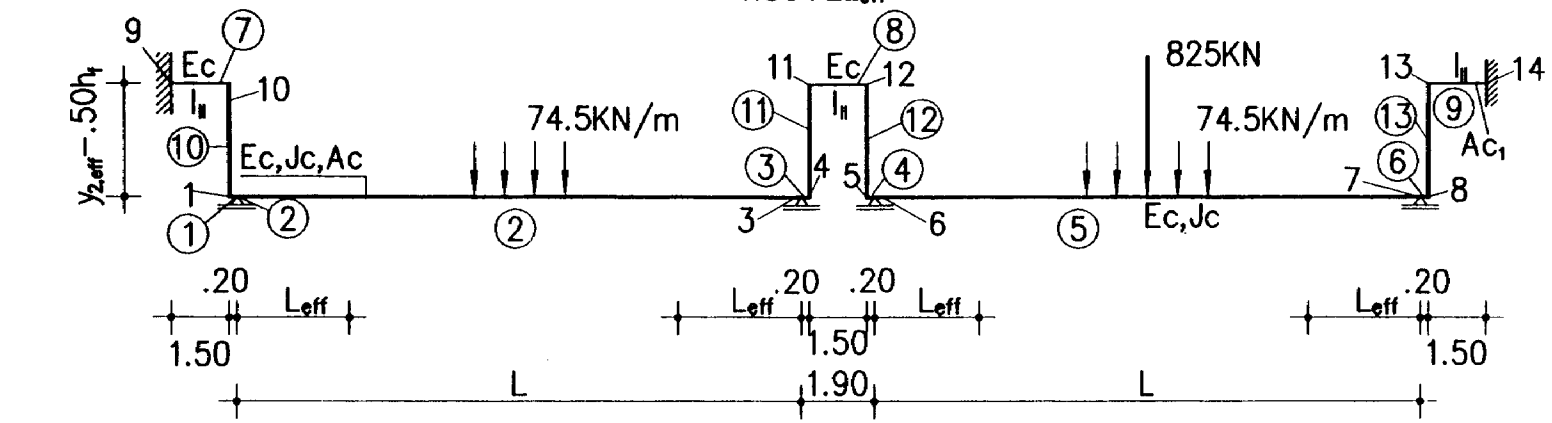
METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9



INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM NORMAL FORCES LC 2 LOAD CASE 2 1 CM = 5000 kN

M 1 : 500

$$Ac_1 = \frac{1.50}{1.50+L_{eff}}\,1.2As\frac{Es}{Ec} \qquad Ac_2 = \frac{1.50}{1.50+2L_{eff}}\,1.2As\frac{Es}{Ec}$$

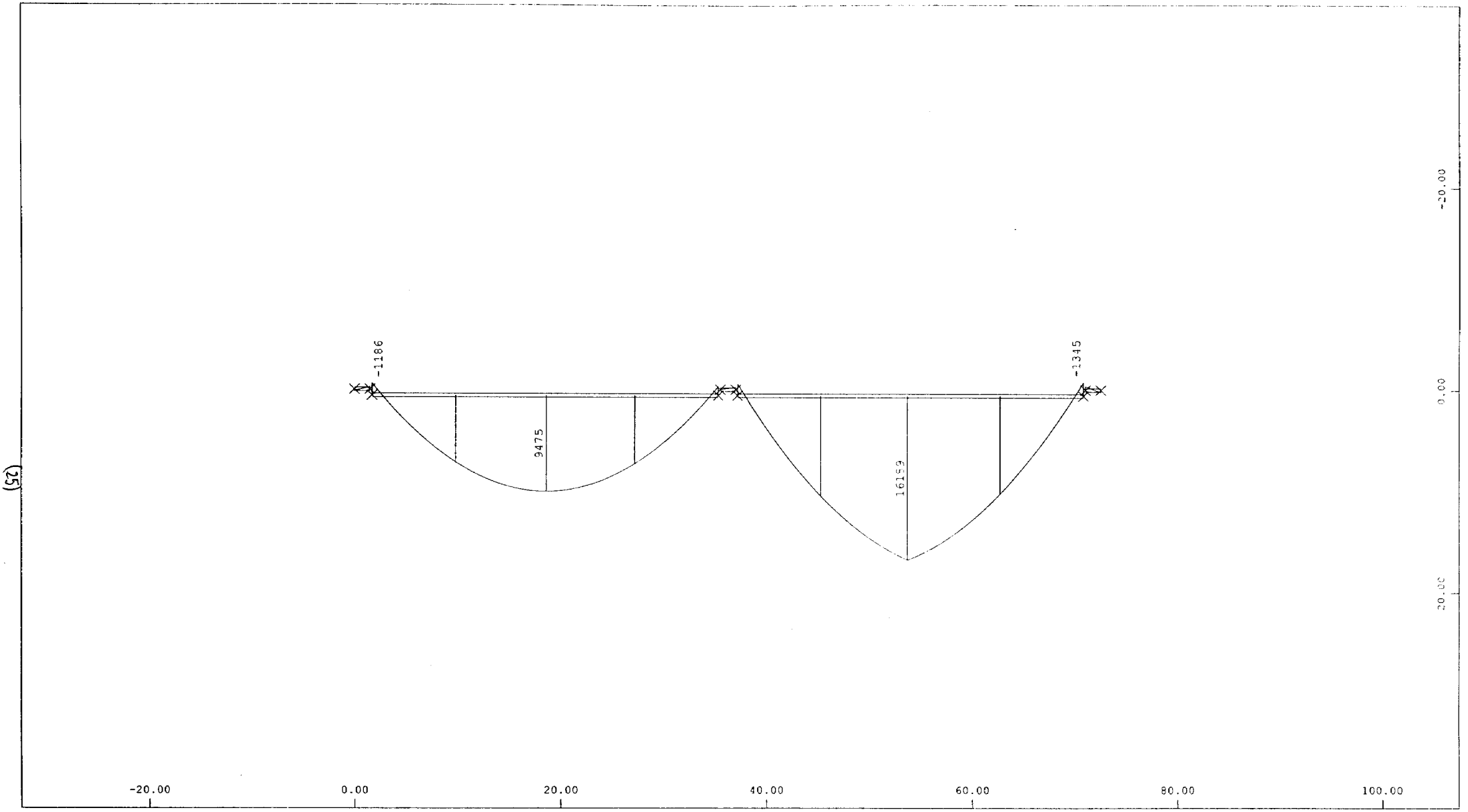


ΠΙΝΑΚΑΣ ΔΕΔΟΜΕΝΩΝ

L=33.0m	E_c =32 GPa
b=12.0m	a=6.25
$A_{c,eff}$ =5.100m^2	g_1 =30.7KN/m
$J_{c,eff}$=2.784m	q=43.8KN/m
h_b =2.15m	g_1 +q=74.5KN/m
h_{ft}=0.275m	Q=825KN
$h_{f,eff}$=0.20m	A_{st}=739cm^2(3Φ14/75)
$h_{(πρ.)}$=0.075m	ρ=3.1% +Φ14/75κ.)
$y_{2,eff}$ =0.73m	A_{sb}=20.5cm^2/m(Φ14/25π.
	T=-50°C
ρ_b=0,012 (Φ14/25)	Leff=L/5=6.6m

$I_{II}=3.544a\rho bh_{f,eff}^3/12=0.1772\rho \simeq 0{,}002/m^4$

METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9

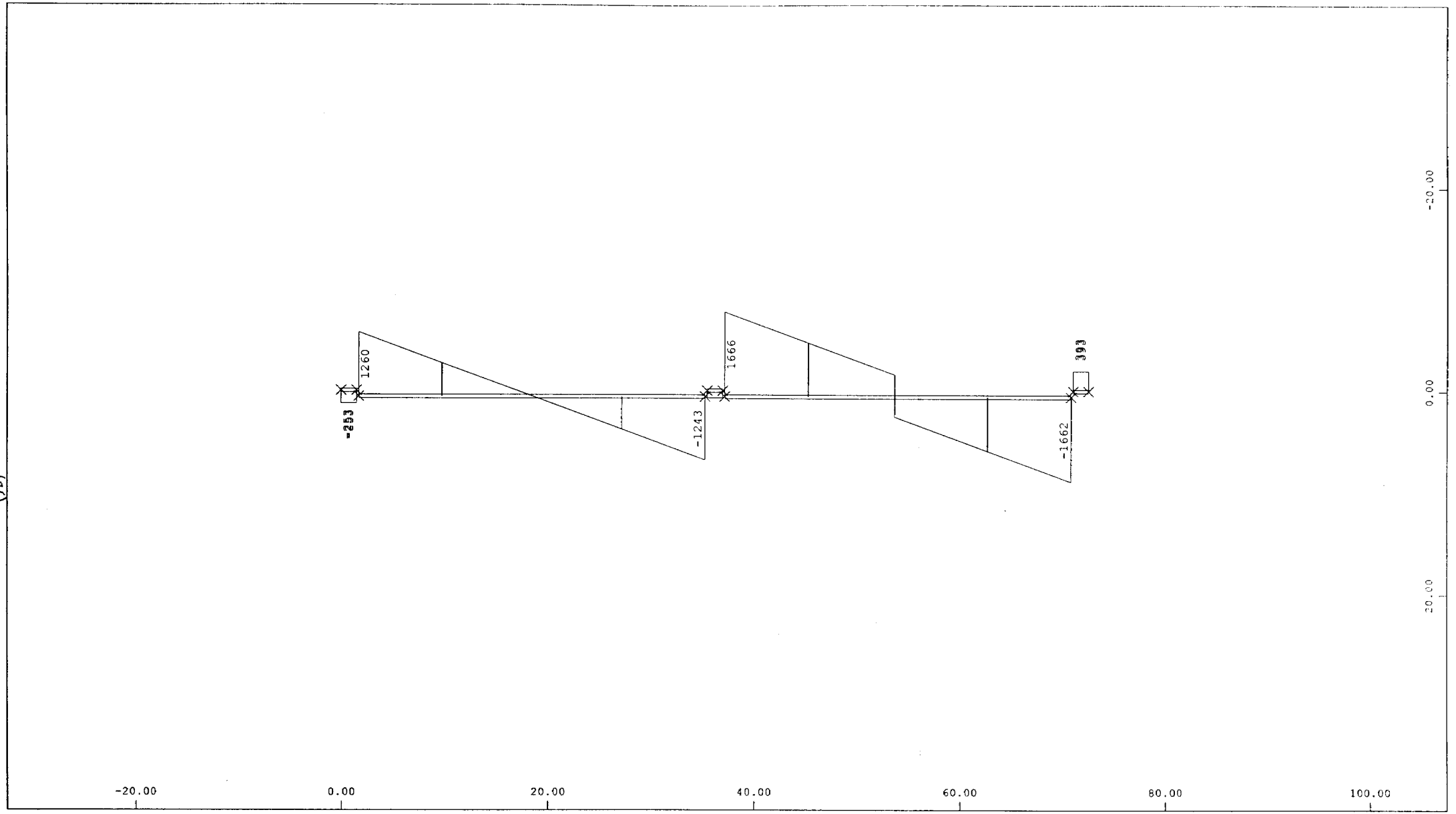


(25)

INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM MOMENTS MY LC 1 MONIMA+KINHTA ΦΟΡΤΙΑ 1 CM = 5000 kNm

M 1 : 500

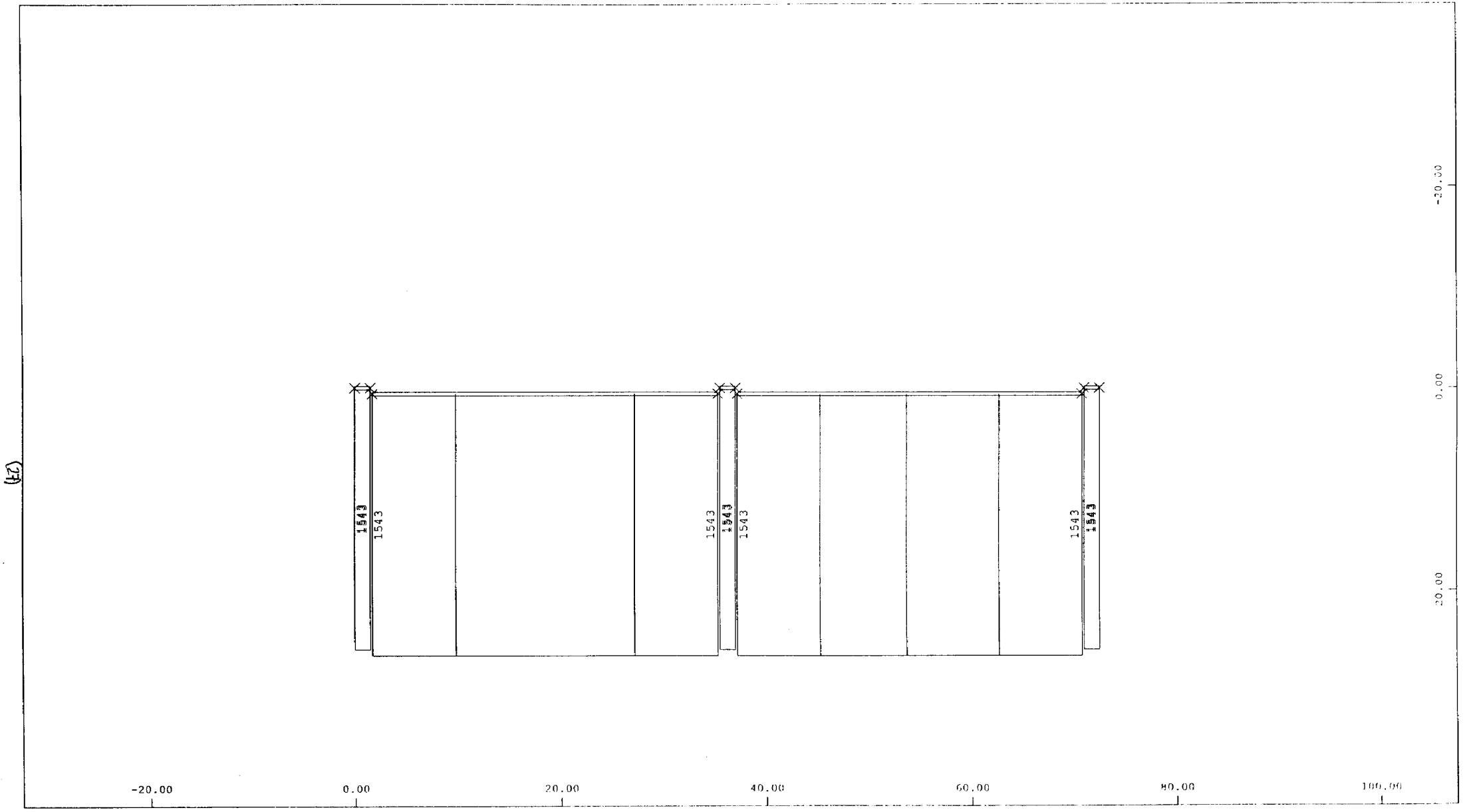
METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9



INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
————BEAM SHEAR FORCES QZ LC 1 MONIMA+KINHTA ΦΟΡΤΙΑ 1 CM = 1000 kN

M 1 : 500

METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9



INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM NORMAL FORCES LC 1 MONIMA+KINHTA ΦΟΡΤΙΑ 1 CM = 300.0 kN

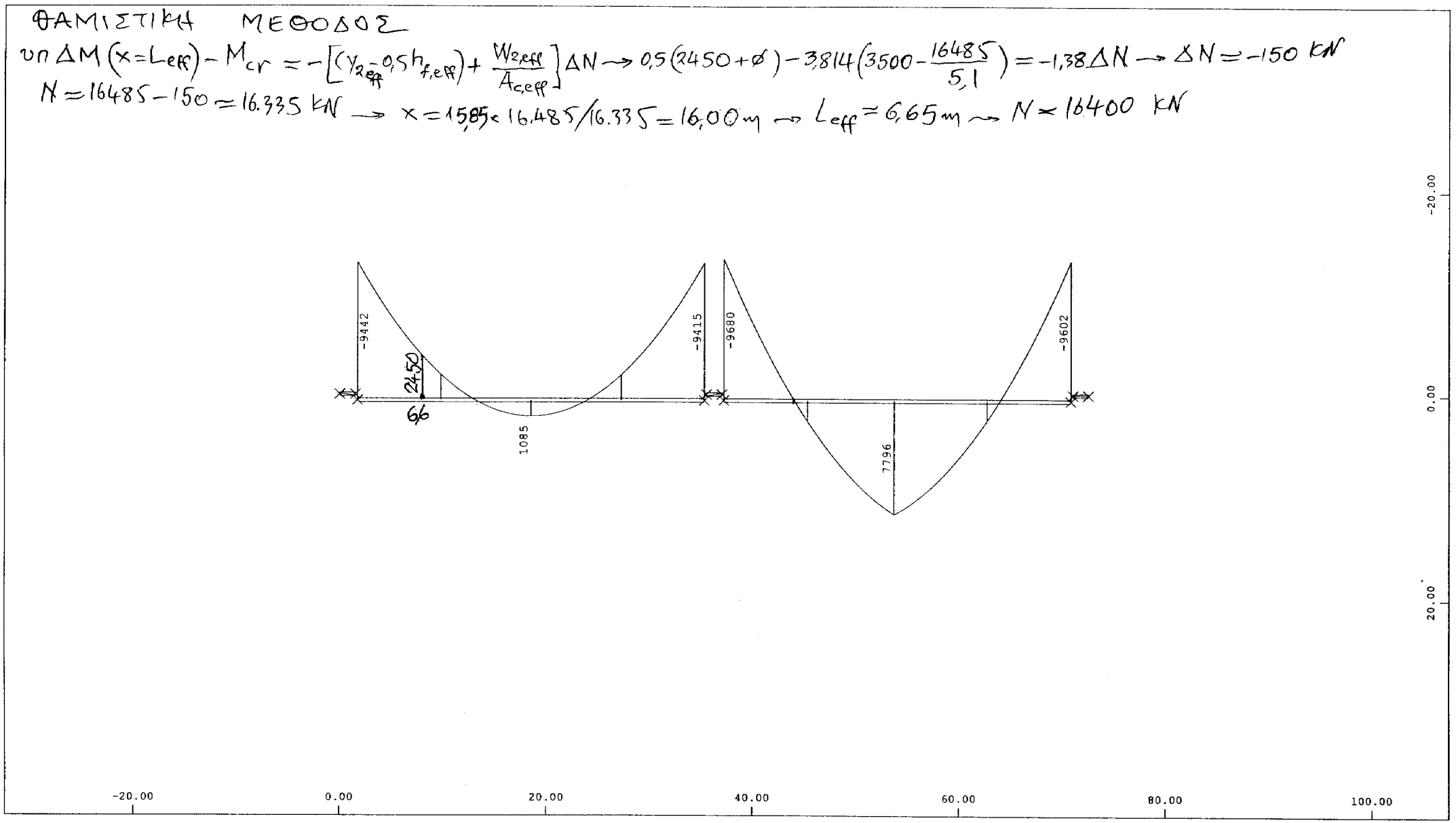
M 1 : 500

METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9

ΘΑΜΙΣΤΙΚΗ ΜΕΘΟΔΟΣ

υπ $\Delta M(x=L_{eff}) - M_{cr} = -\left[(y_{2eff} - 0{,}5h_{f,eff}) + \frac{W_{2,eff}}{A_{c,eff}}\right]\Delta N \rightarrow 0{,}5(2450+\varnothing) - 3{,}814\left(3500 - \frac{16485}{5{,}1}\right) = -1{,}38\Delta N \rightarrow \Delta N = -150$ kN

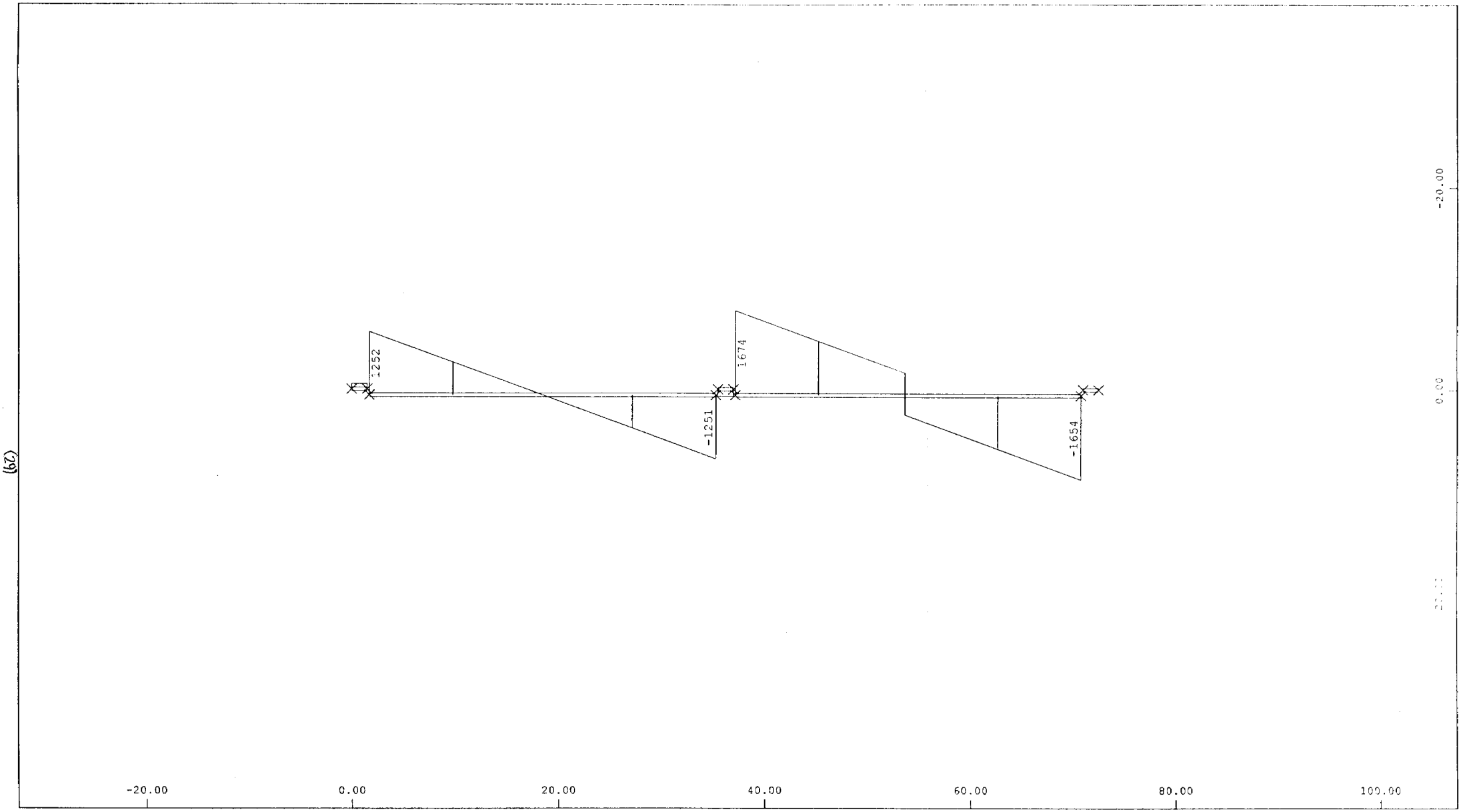
$N = 16485 - 150 = 16.335$ kN $\rightarrow x = 15{,}85 < 16.485/16.335 = 16{,}00$ m $\rightarrow L_{eff} = 6{,}65$ m $\rightarrow N = 16400$ kN



INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM MOMENTS MY LC 2 ΦΟΡΤ. ΜΟΝ.+ΚΙΝ.+ΘΕΡΜΟΚΡ. 1 CM = 3500 kNm

M 1 : 500

METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9



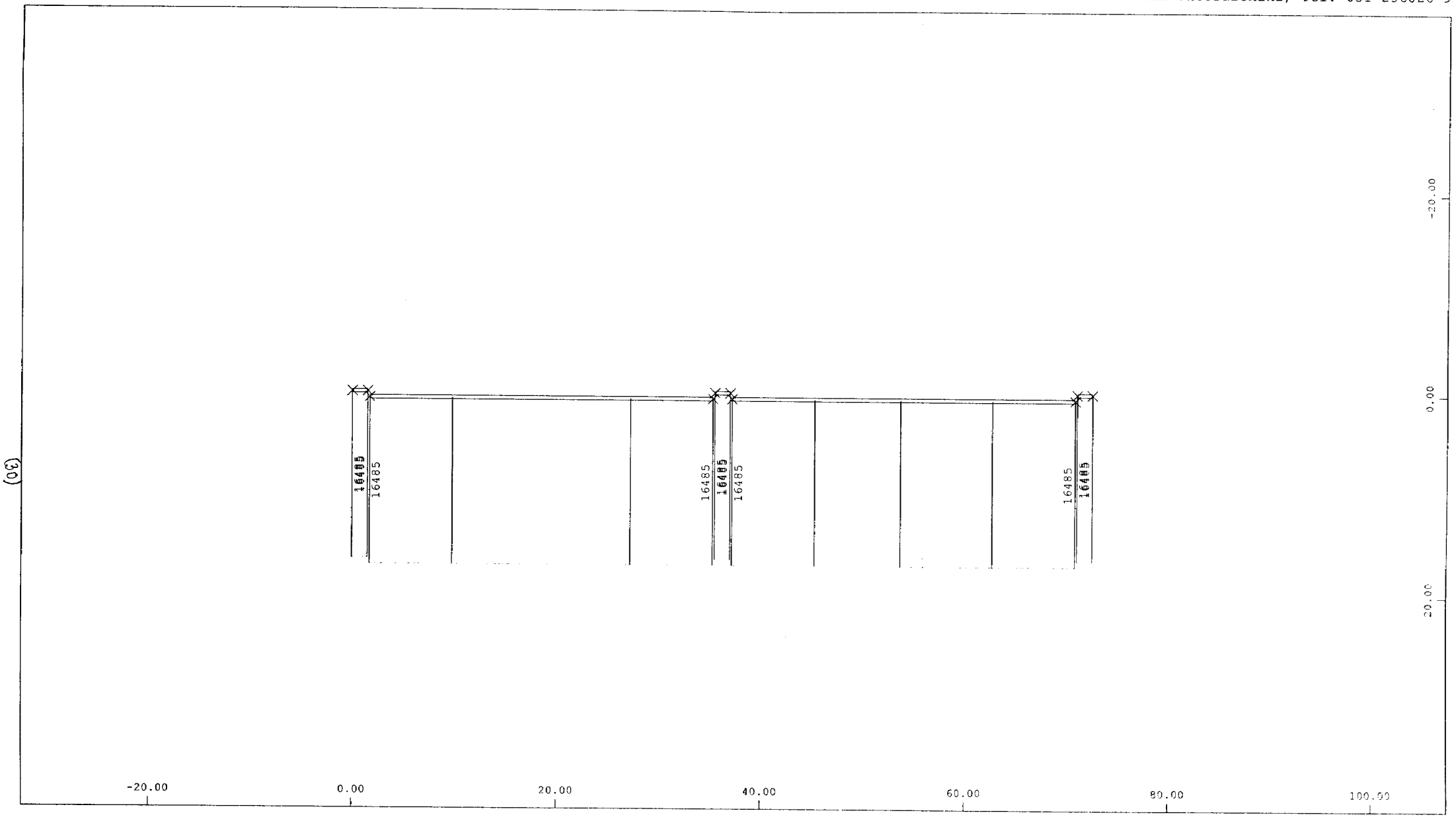
INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE

SECTOR OF SYSTEM, ELEMENT GROUP 0

———BEAM SHEAR FORCES QZ LC 2 ΦΟΡΤ. ΜΟΝ.+ΚΙΝ.+ΘΕΡΜΟΚΡ. 1 CM = 1000 kN

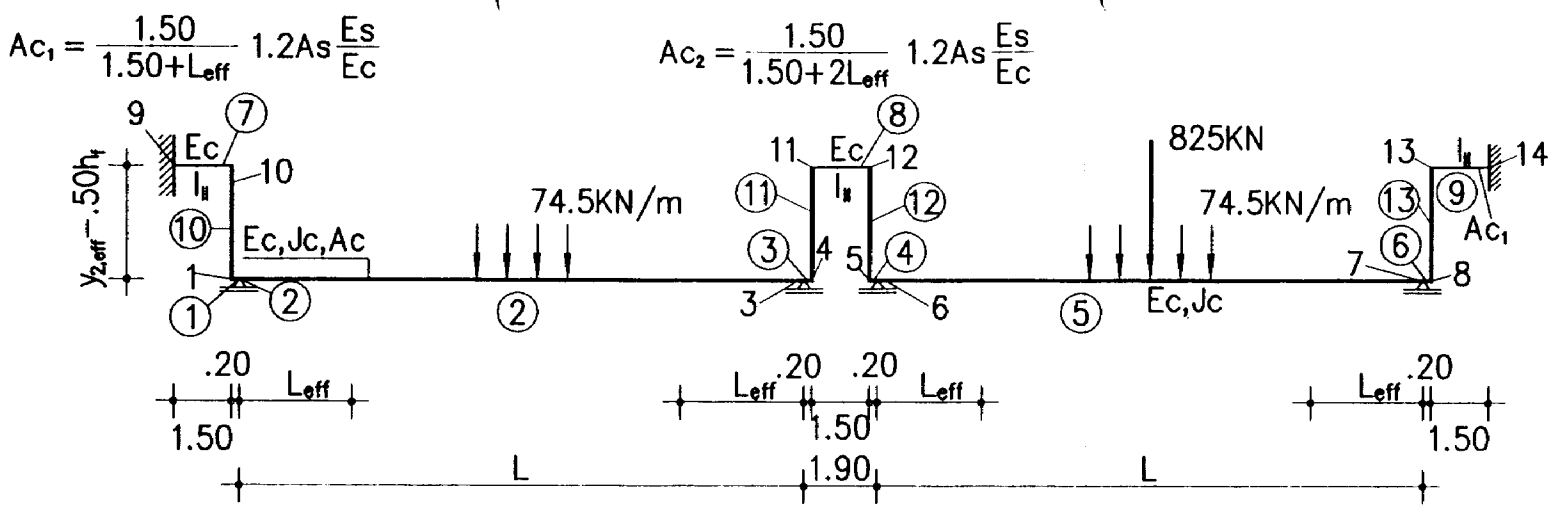
M 1 : 500

METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9



INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM NORMAL FORCES LC 2 ΦΟΡΤ. ΜΟΝ.+ΚΙΝ.+ΘΕΡΜΟΚΡ. 1 CM = 5000 kN

M 1 : 500

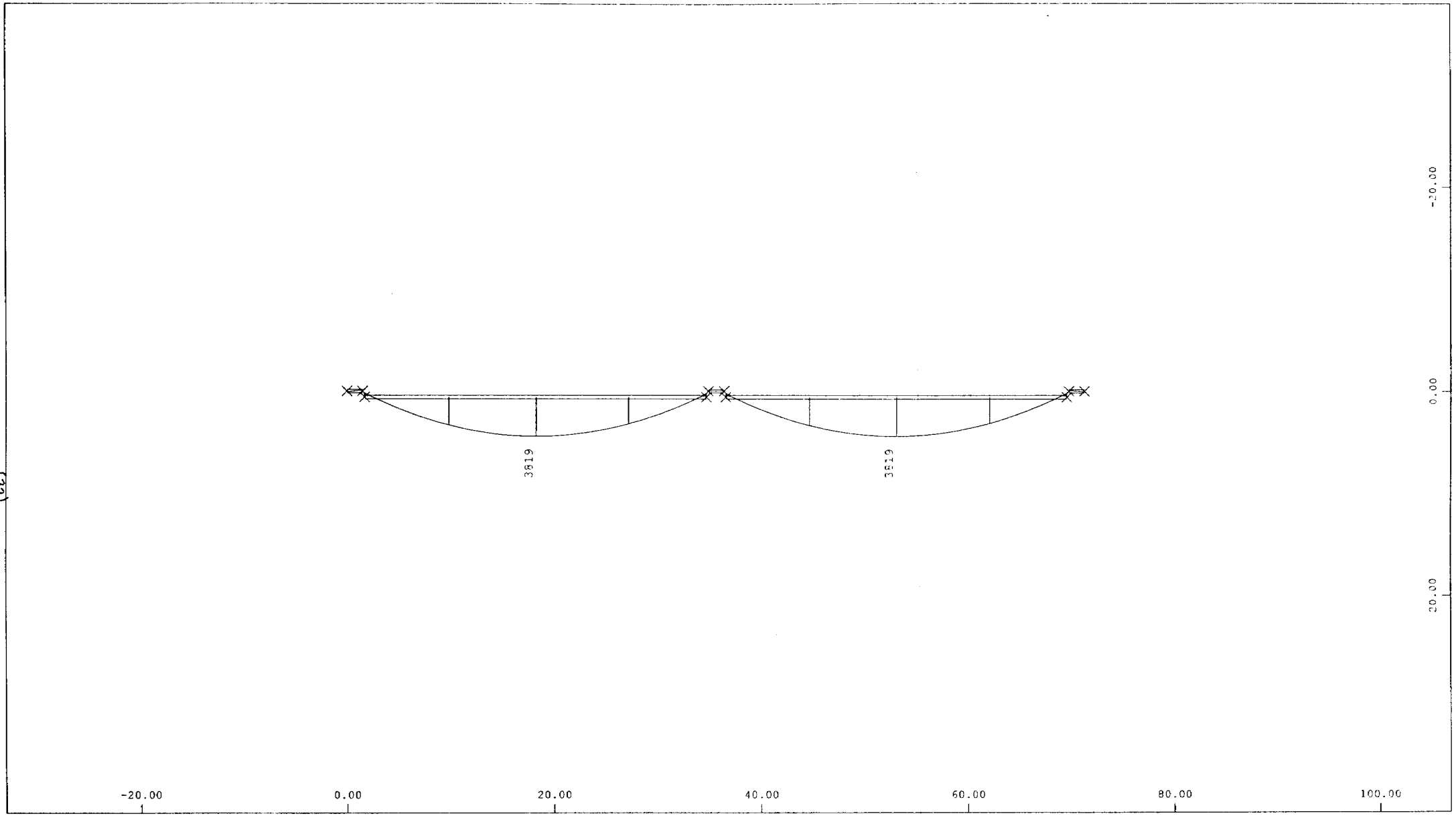


ΠΙΝΑΚΑΣ ΔΕΔΟΜΕΝΩΝ

L=33.0m	E_c =32 GPa
b=12.0m	a=6.25
$A_{c,eff}$ =5.100m^2	g_1 =30.7KN/m
$J_{c,eff}$=2.784m	q= Ø KN/m
h_b =2.15m	g_1 +q=30,7KN/m
h_{ft}=0.275m	Q= Ø KN
$h_{f,eff}$=0.20m	A_{st}=739(3Φ14/75)
$h_{(πρ.)}$=0.075m	ρ=3,1%
$y_{2,eff}$ =0.73m	A_{sb}=20,5cm^2/m_2(Φ14/75π.
	T=-50° C +Φ14/75κ.
ρ_b =0,012(Φ14/75)	Leff=L/5 =6,6

$I_{II}=3.544a\rho_b bh_{f,eff}^3/12=0.1772\rho_b=0,0021\ m^4$

METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9

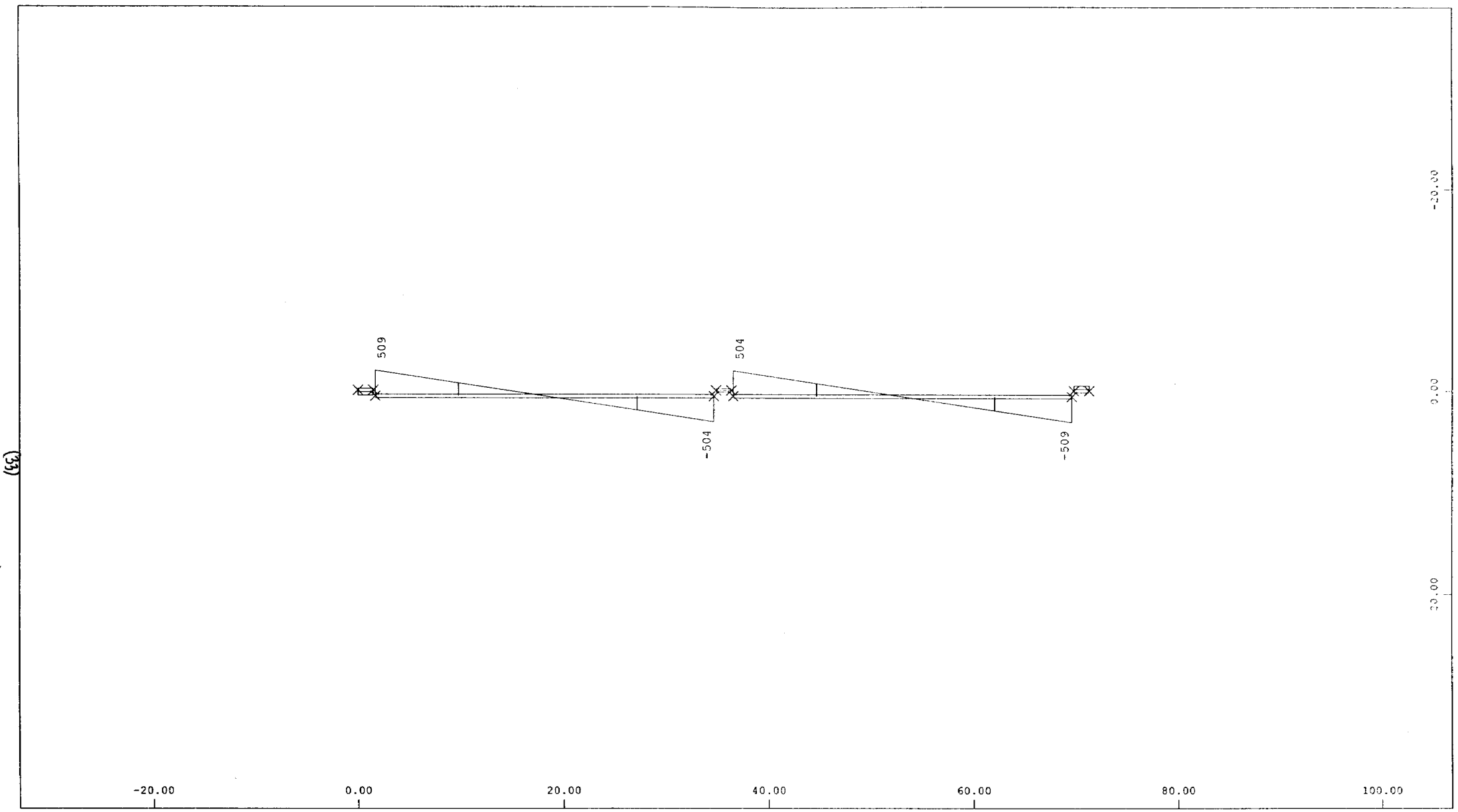


(32)

INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM MOMENTS MY LC 1 ΦΟΡΤΙΑ ΜΟΝΙΜΑ+ΚΙΝΗΤΑ 1 CM = 5000 kNm

M 1 : 500

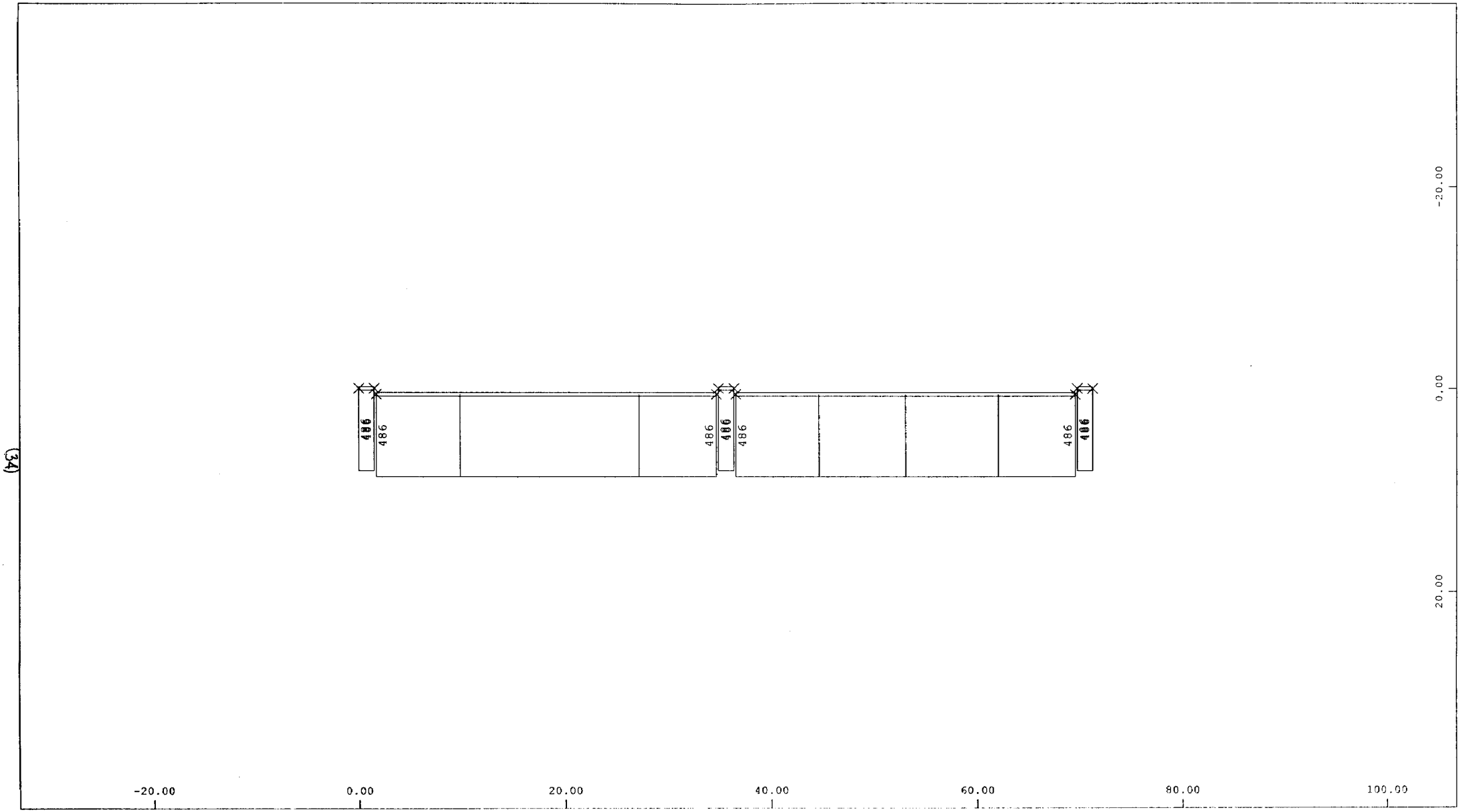
METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9



INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM SHEAR FORCES QZ LC 1 ΦΟΡΤΙΑ ΜΟΝΙΜΑ+ΚΙΝΗΤΑ 1 CM = 1000 kN

M 1 : 500

METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9



(34)

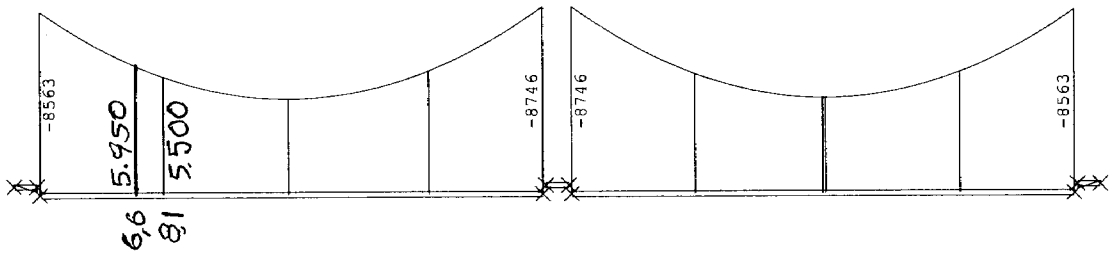
INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM NORMAL FORCES LC 1 ΦΟΡΤΙΑ ΜΟΝΙΜΑ+ΚΙΝΗΤΑ 1 CM = 300.0 kN

M 1 : 500

METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9

ΘΑΜΙΣΤΙΚΗ ΜΕΘΟΔΟΣ

υ $\Delta M(x=L/5) - 3{,}814\left(3500 - \frac{N}{5{,}1}\right) = -1{,}38\,\Delta N \rightarrow 5.950 - 3{,}814\left(3.500 - \frac{15.249}{5{,}1}\right) = -1{,}38\,\Delta N_1 \rightarrow \Delta N_1 = -2900\ KN \rightarrow N_1 = 15249 - 2900 =$
$= 12.350\ KN \rightarrow x_1 = (2\times 6{,}6 + 2{,}65)\frac{15249}{12.350} = 19{,}55\ m \rightarrow L_{eff,1} = 0{,}5(19{,}55 - 2{,}65) = 8{,}40\ m \rightarrow$ υη $\Delta M(x=8{,}40) = 5320\ KNm \rightarrow \Delta N_2 =$
$= (5320 - 1945)/1{,}38 = -2450\ KN \rightarrow N_2 = 15249 - 2450 = 12800\ KN \rightarrow x_2 = 15{,}85\times 15.249/12800 = 18{,}85\ m \rightarrow L_{eff,2} = 0{,}5(18{,}85$
$-2{,}65) = 8{,}10\ m \rightarrow$ υη $\Delta M(x=8{,}1) = 5500\ KNm \rightarrow \Delta N_3 = (5.500 - 1945)/1{,}38 = -2570\ KN \rightarrow N_3 = 15249 - 2570 = 12700\ KN \rightarrow$
$x_3 = 15{,}85\times 15249/12700 = 19{,}0\ m \rightarrow L_{eff,3} = 0{,}5(19{,}0 - 2{,}65) = 8{,}15\ m$



ΣΥΜΠΕΡΑΣΜΑ

Συγκριτικώς με την περίπτωση της πλήρως φορτισθείσης μιας κιονιδας, γίνεται παρατηρείται μια μείωση του εφελκ. N κατα 21% καθώς και μια αύξηση του Leff κατα επίσης 21%.

(55)

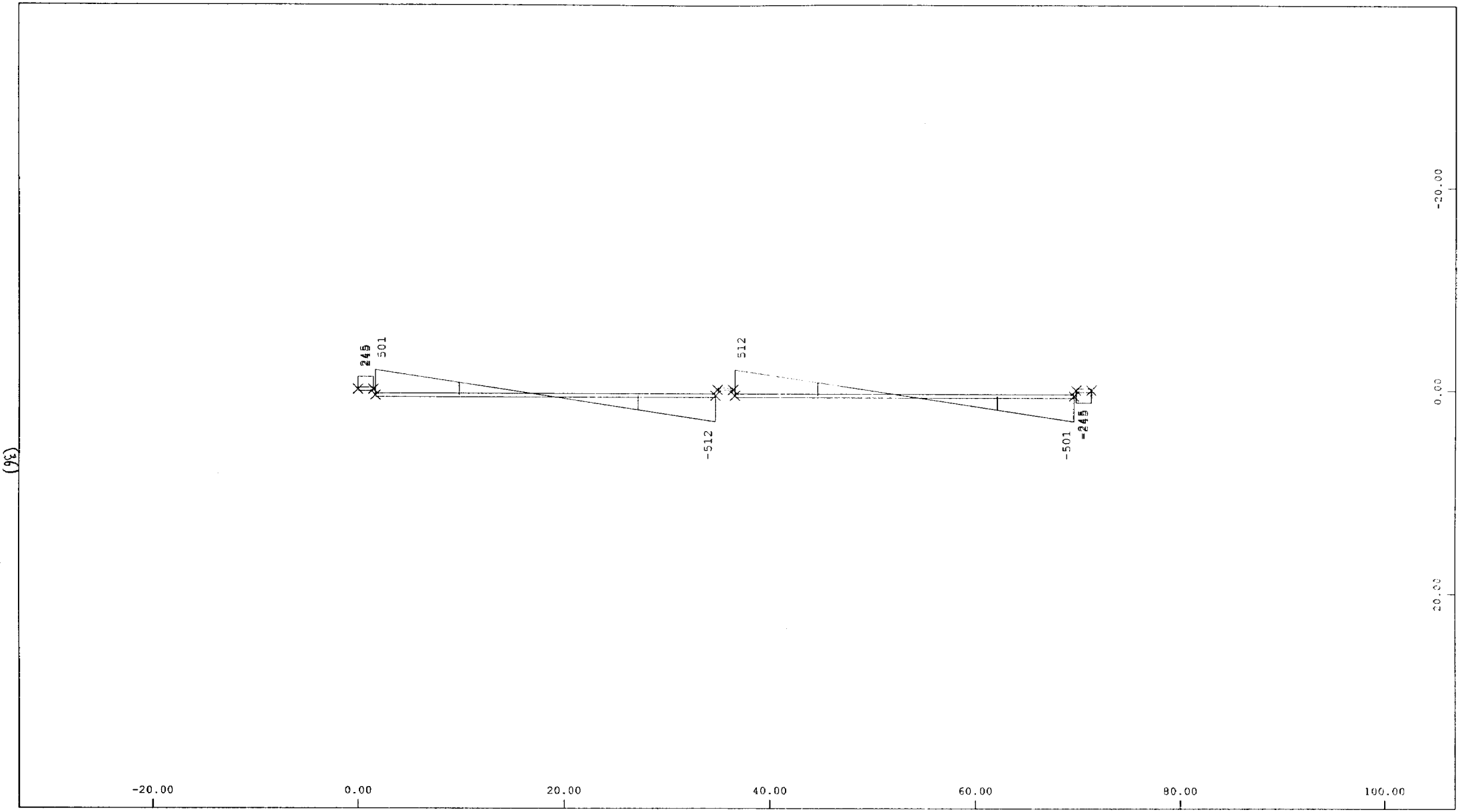
-20.00
0.00
20.00

-20.00 0.00 20.00 40.00 60.00 80.00 100.00

INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM MOMENTS MY LC 2 ΦΟΡΤ. ΜΟΝ.+ΚΙΝ.+ΘΕΡΜΟΚΡ. 1 CM = 3500 kNm

M 1 : 500

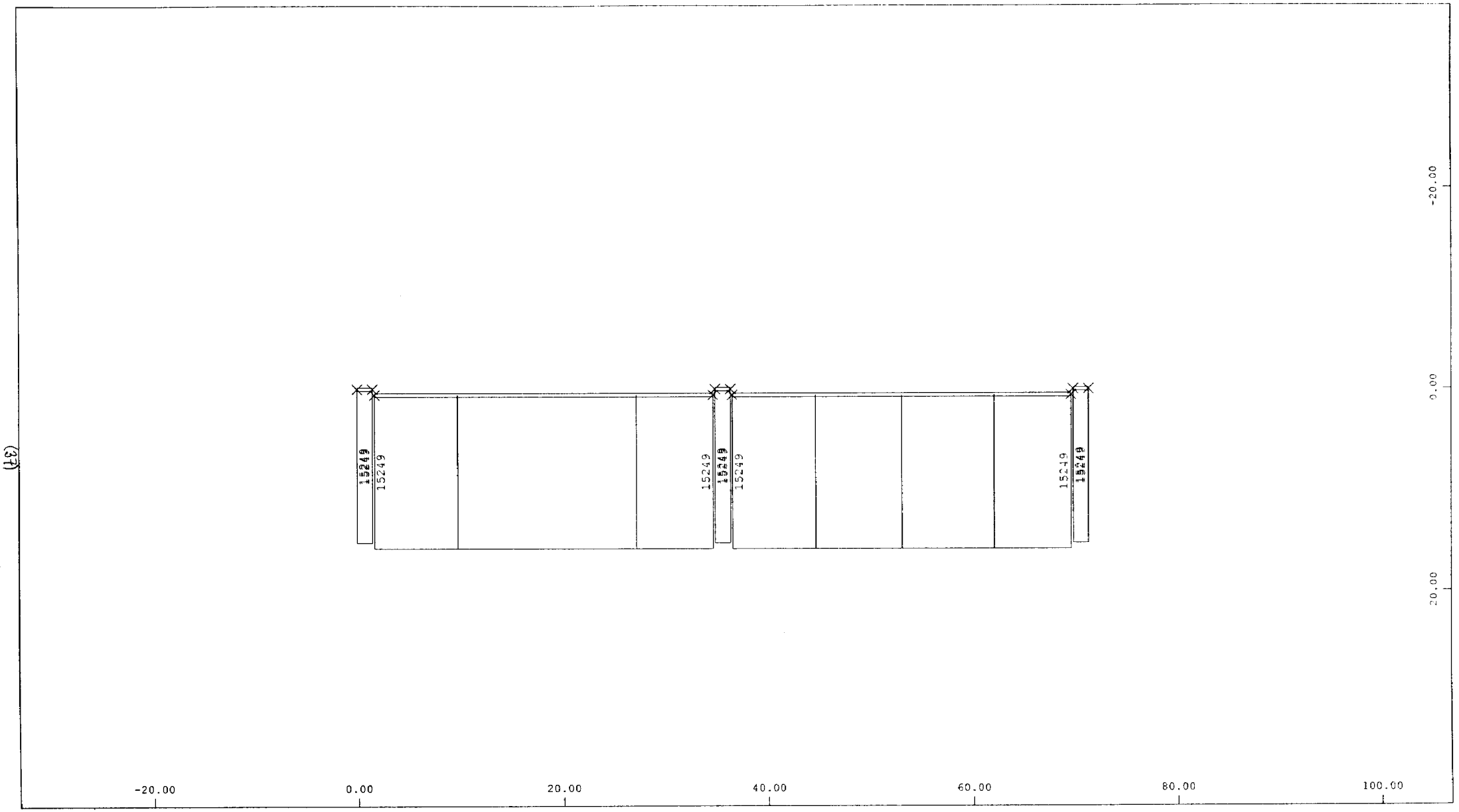
METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9



INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM SHEAR FORCES QZ LC 2 ΦΟΡΤ. ΜΟΝ.+ΚΙΝ.+ΘΕΡΜΟΚΡ. 1 CM = 1000 kN

M 1 : 500

METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9

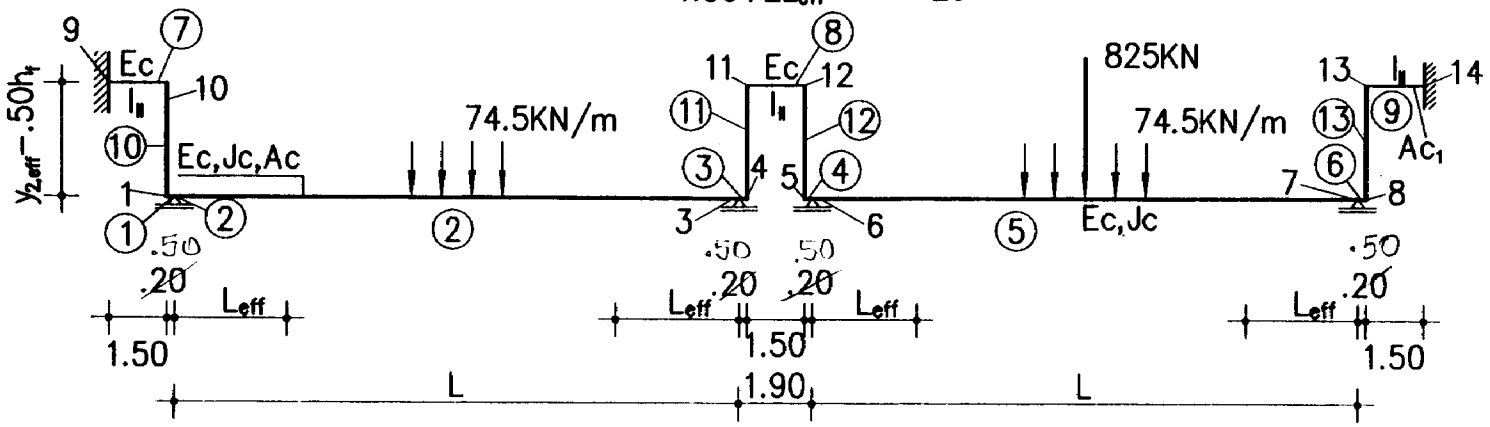


(37)

INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM NORMAL FORCES LC 2 ΦΟΡΤ. ΜΟΝ.+ΚΙΝ.+ΘΕΡΜΟΚΡ. 1 CM = 5000 kN

M 1 : 500

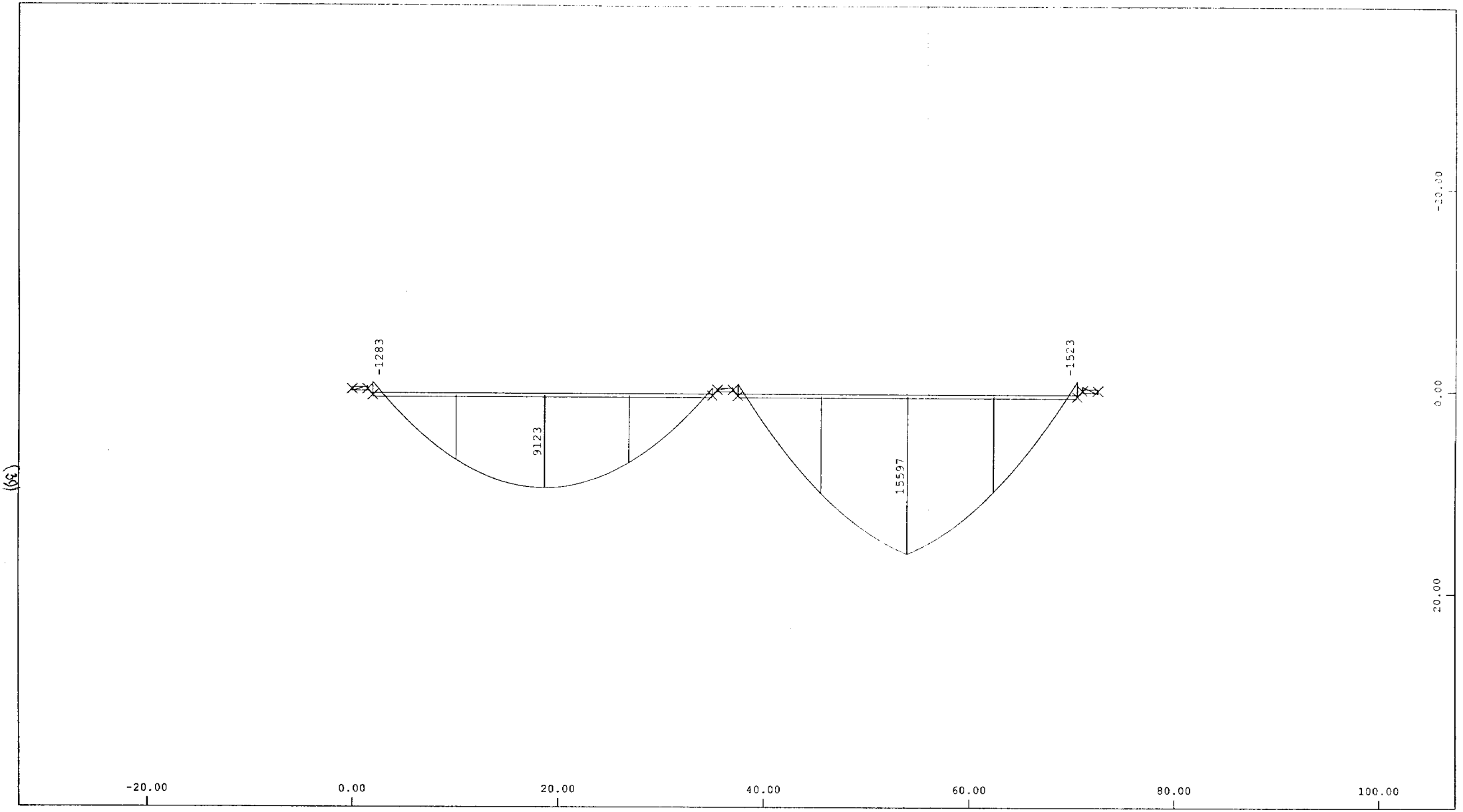
$$Ac_1 = \frac{1.50}{1.50+L_{eff}}\ 1.2As\frac{Es}{Ec} \qquad Ac_2 = \frac{1.50}{1.50+2L_{eff}}\ 1.2As\frac{Es}{Ec}$$



ΠΙΝΑΚΑΣ ΔΕΔΟΜΕΝΩΝ

L=33.0m	E_c =32 GPa
b=12.0m	a=6.25
$A_{c,eff}$ =5.100m^2	g_1 =30.7KN/m
$J_{c,eff}$=2.784m	q=43.8KN/m
h_b =2.15m	g_1 +q=74.5KN/m
h_{ft}=0.275m	Q=825KN
$h_{f,eff}$=0.20m	A_{st}=739cm^2(3Φ14/75)
$h_{(πρ.)}$=0.075m	ρ=3,1%
$y_{2,eff}$ =0.73m	A_{sb}=20,5$\frac{cm^2}{m}$(Φ14/75π.+ Φ14/75κ.
	T=-50°/-60°/-70°C
ρ_b=20,5/17,5 =0,012	Leff= L/5 = 6,6
$I_{II}=3.544a\rho_b bh_{f,eff}^3/12=0.1772\rho_b$=0,0021 m^4	

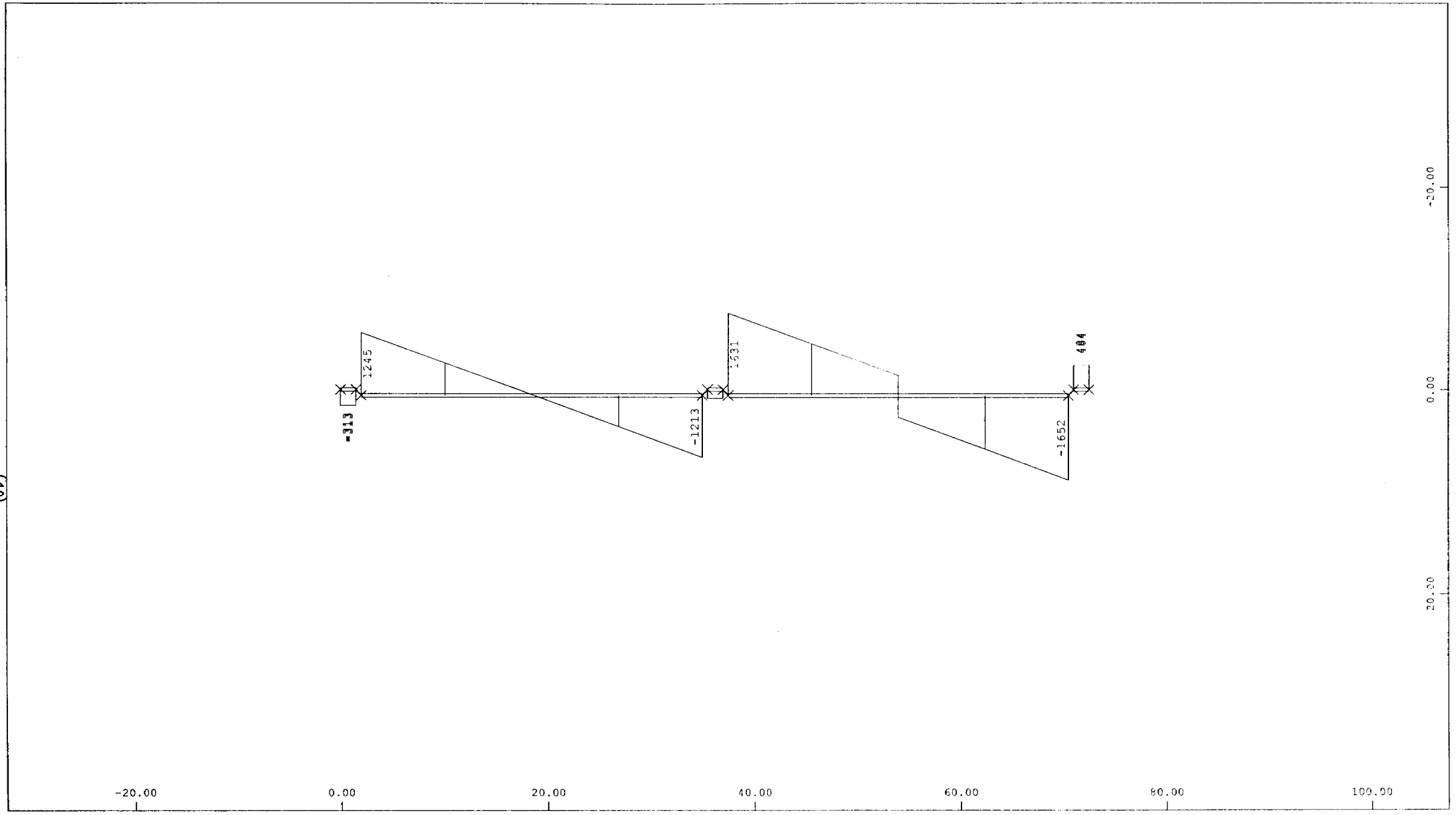
METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9



INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM MOMENTS MY LC 1 ΦΟΡΤΙΑ ΜΟΝΙΜΑ+ΚΙΝΗΤΑ 1 CM = 5000 kNm

M 1 : 500

METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9

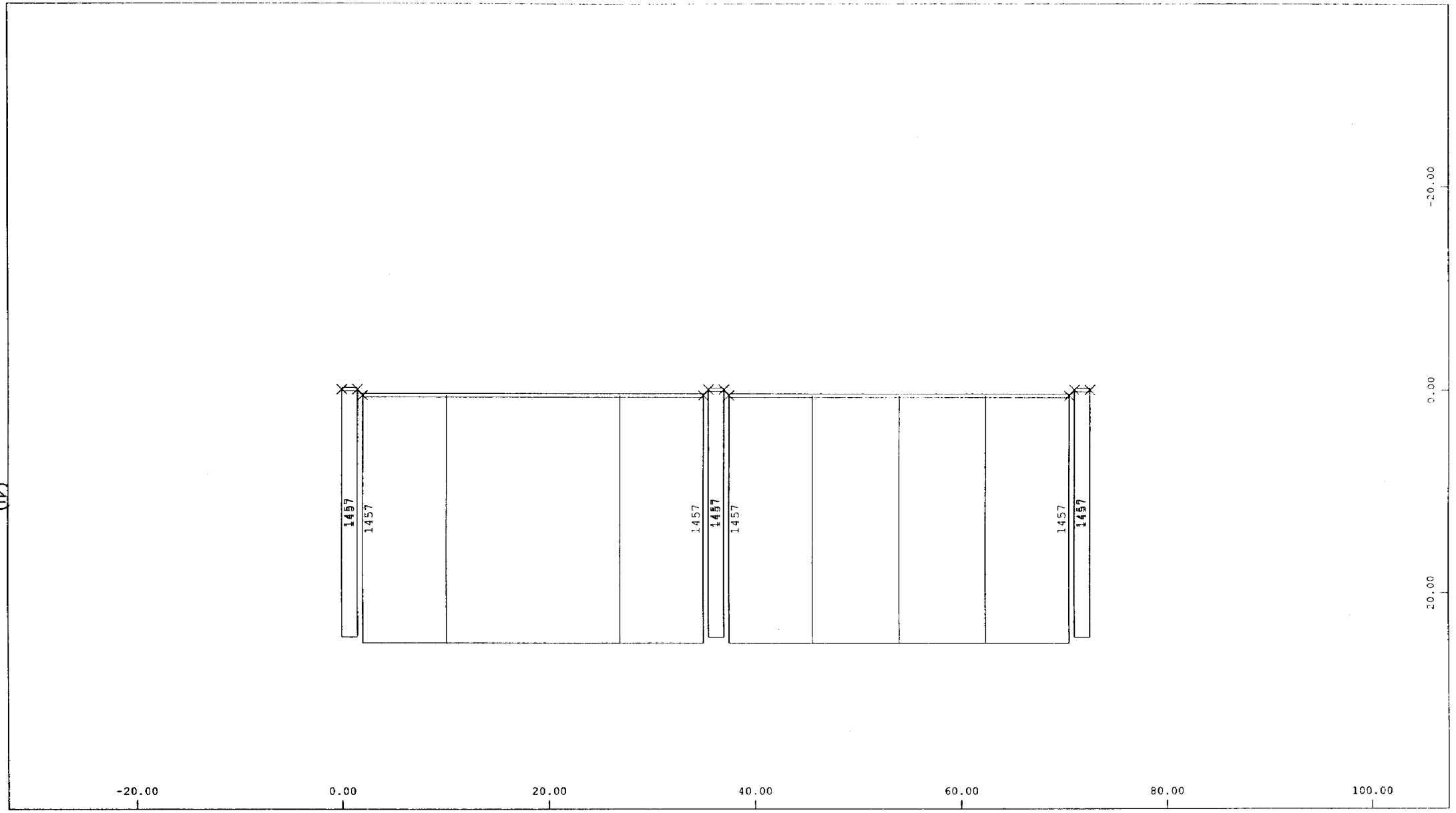


(40)

INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM SHEAR FORCES QZ LC 1 ΦΟΡΤΙΑ ΜΟΝΙΜΑ+ΚΙΝΗΤΑ 1 CM = 1000 kN

M 1 : 500

METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9



INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM NORMAL FORCES LC 1 ΦΟΡΤΙΑ ΜΟΝΙΜΑ+ΚΙΝΗΤΑ 1 CM = 300.0 kN

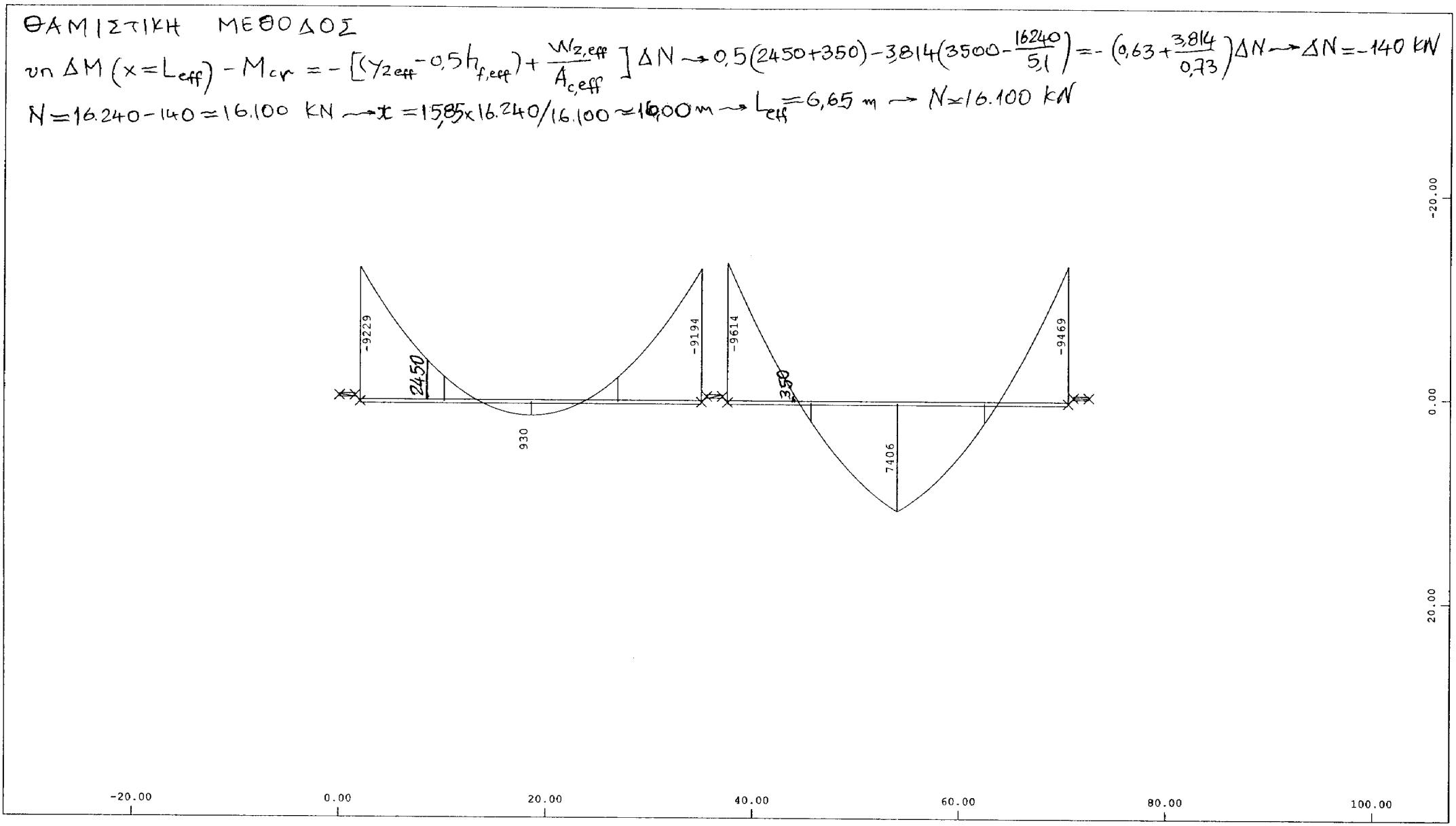
M 1 : 500

METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9

ΘΑΜΙΣΤΙΚΗ ΜΕΘΟΔΟΣ

$$\text{υπ}\ \Delta M(x=L_{eff}) - M_{cr} = -\left[(y_{2eff} - 0{,}5h_{f,eff}) + \frac{W_{2,eff}}{A_{c,eff}}\right]\Delta N \rightarrow 0{,}5(2450+350) - 3{,}814\left(3500 - \frac{16240}{5{,}1}\right) = -\left(0{,}63 + \frac{3{,}814}{0{,}73}\right)\Delta N \rightarrow \Delta N = -140\ kN$$

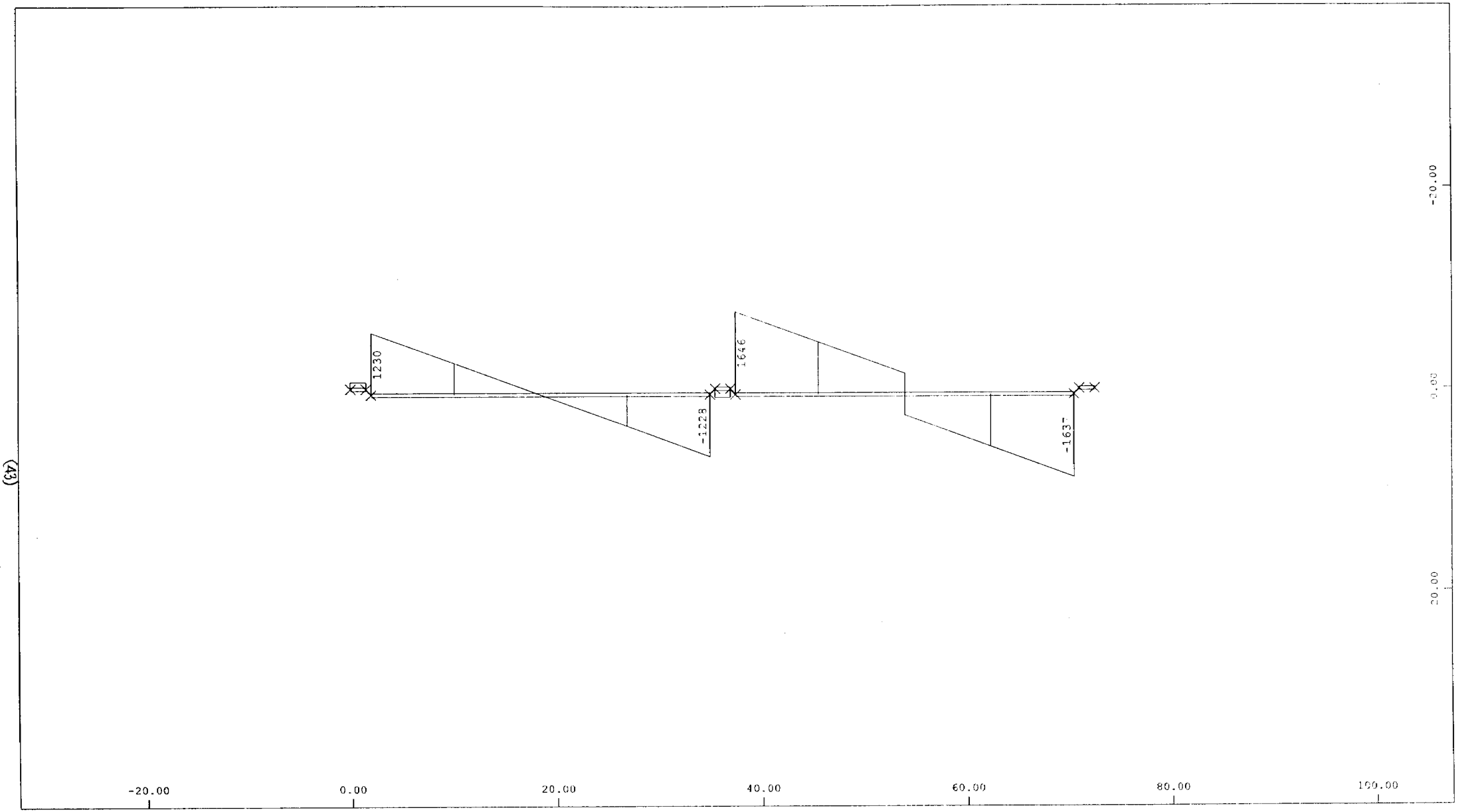
$$N = 16.240 - 140 = 16.100\ kN \rightarrow x = 1585 \times 16.240/16.100 \simeq 16{,}00\ m \rightarrow L_{eff} = 6{,}65\ m \rightarrow N \simeq 16.100\ kN$$



INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM MOMENTS MY LC 2 ΦΟΡΤ. ΜΟΝ.+ΚΙΝ.+ΘΕΡΜΟΚΡ. 1 CM = 3500 kNm

M 1 : 500

METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9

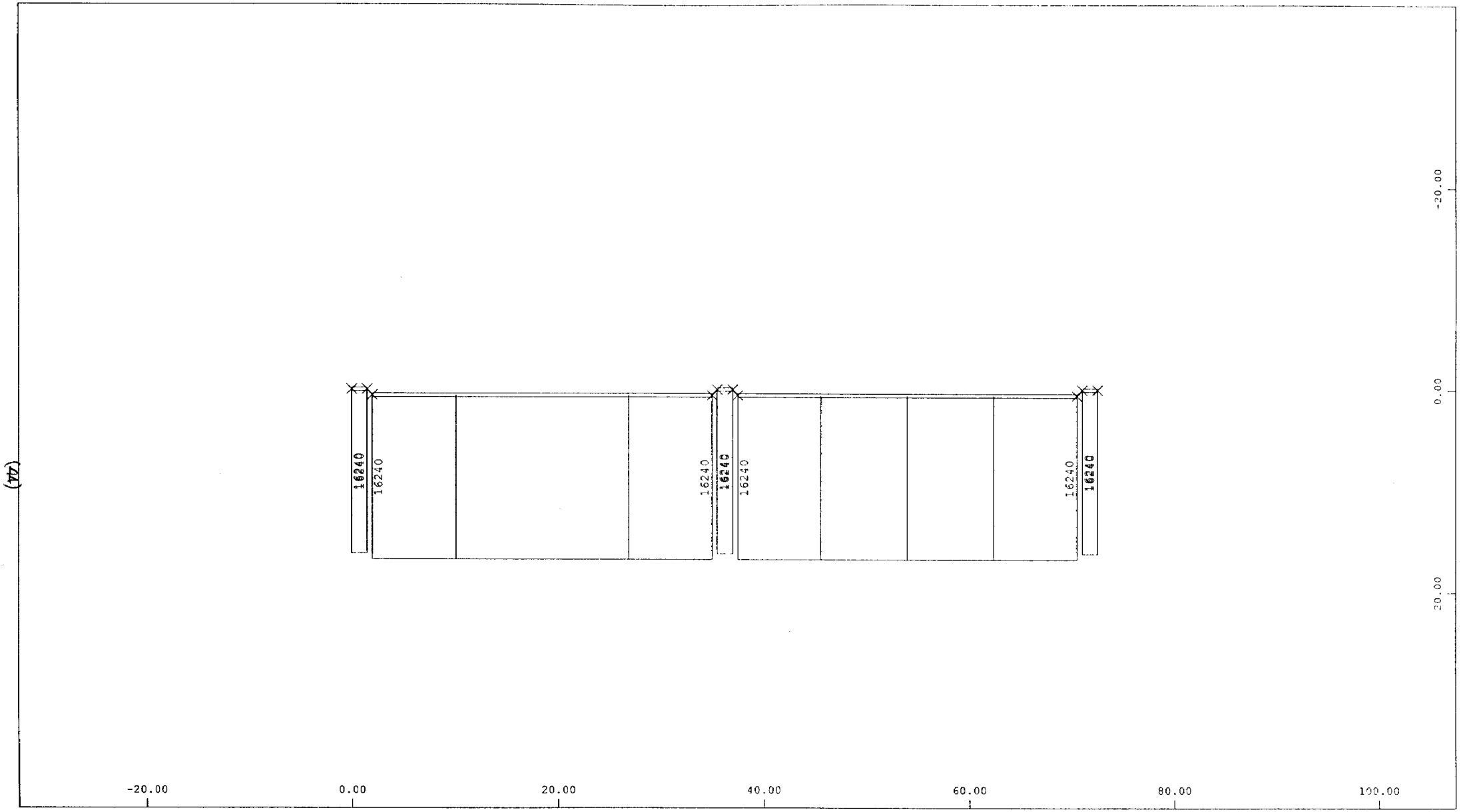


(43)

INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM SHEAR FORCES QZ LC 2 ΦΟΡΤ. ΜΟΝ.+ΚΙΝ.+ΘΕΡΜΟΚΡ. 1 CM = 1000 kN

M 1 : 500

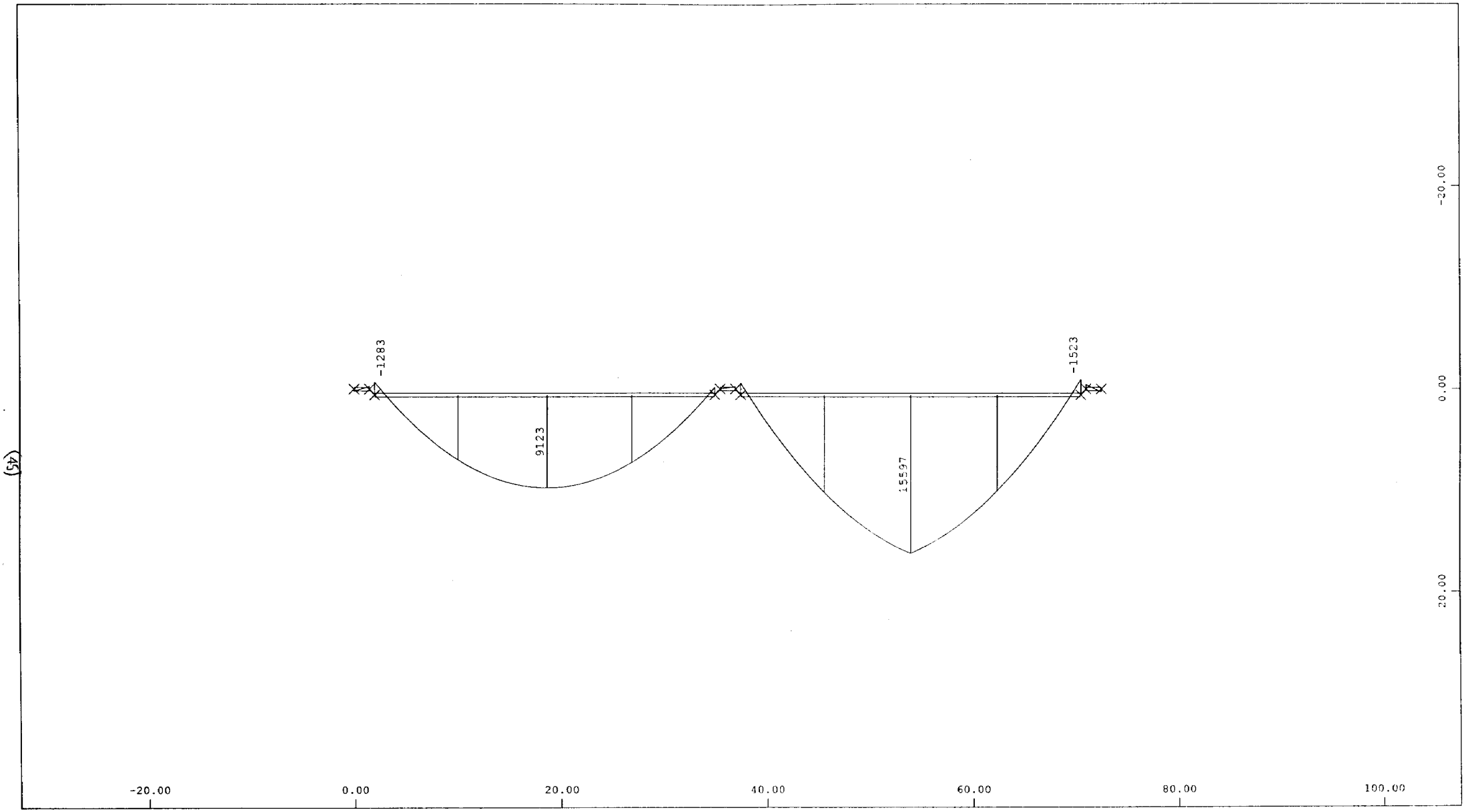
METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9



INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
————BEAM NORMAL FORCES LC 2 ΦΟΡΤ. ΜΟΝ.+ΚΙΝ.+ΘΕΡΜΟΚΡ. 1 CM = 5000 kN

M 1 : 500

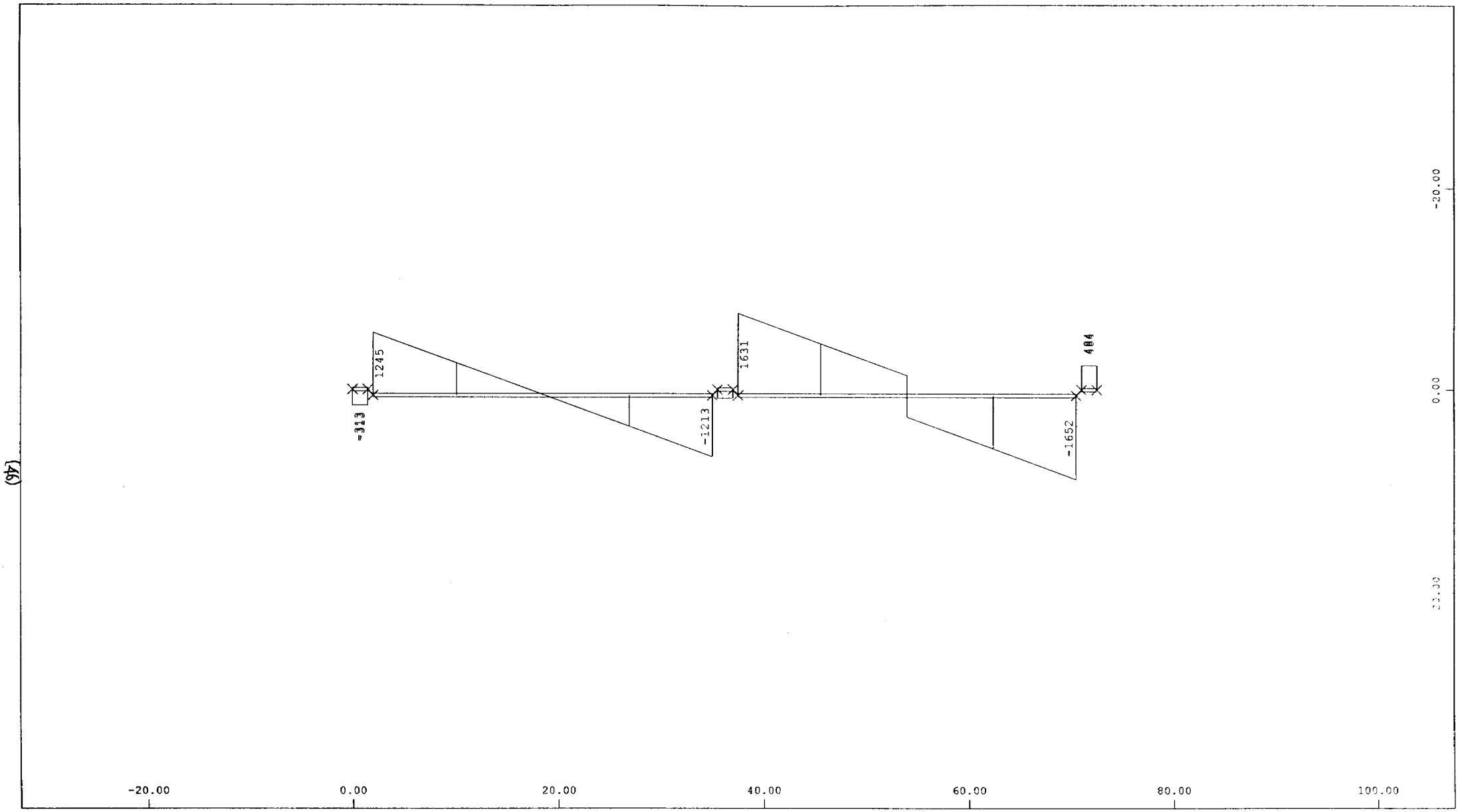
METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9



INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM MOMENTS MY LC 1 ΦΟΡΤΙΑ ΜΟΝΙΜΑ+ΚΙΝΗΤΑ 1 CM = 5000 kNm

M 1 : 500

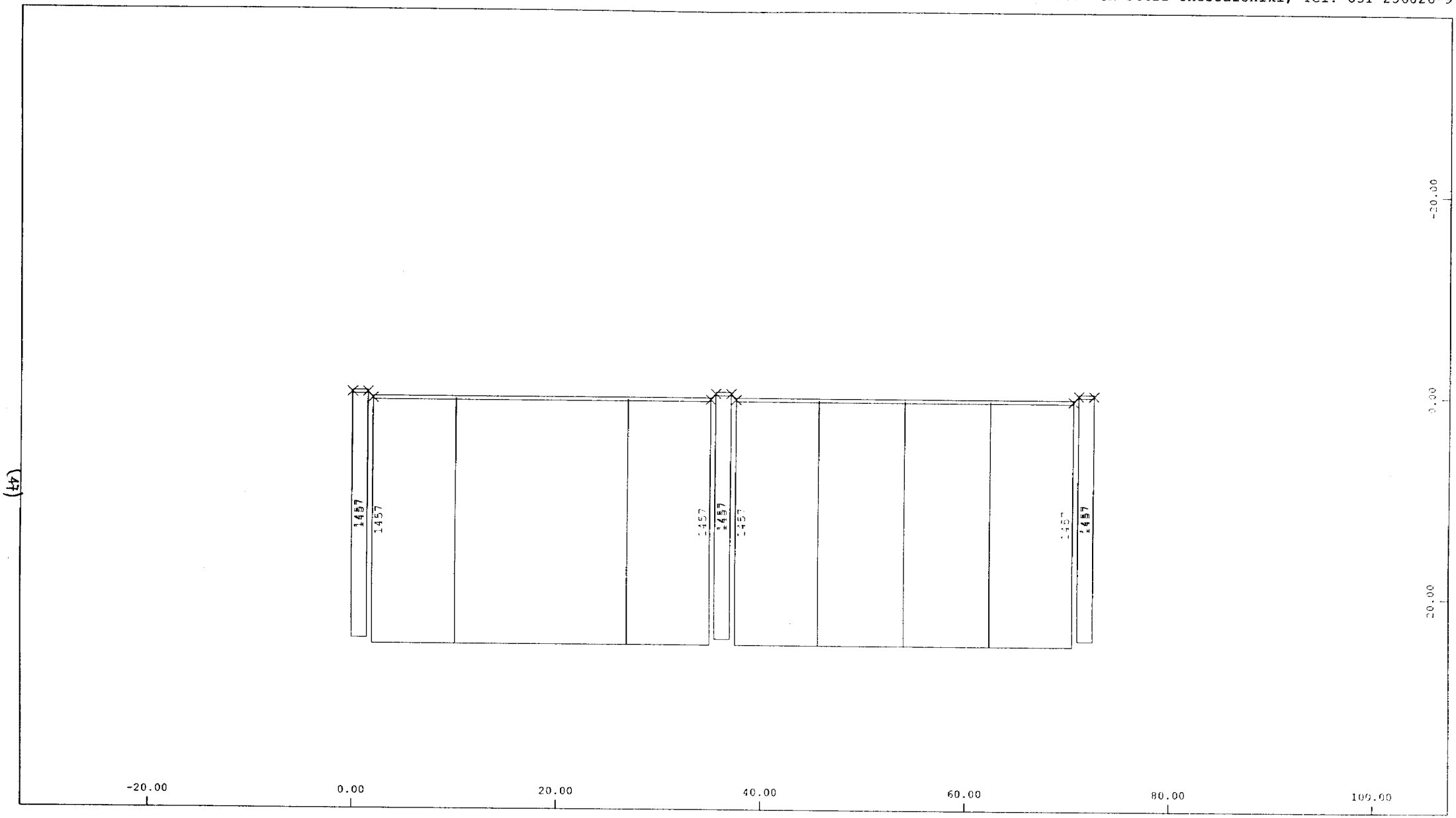
METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9



INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———— BEAM SHEAR FORCES QZ LC 1 ΦΟΡΤΙΑ ΜΟΝΙΜΑΣ ΚΙΝΗΤΑ 1 CM = 1000 kN

M 1 : 500

METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9



INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM NORMAL FORCES LC 1 ΦΟΡΤΙΑ ΜΟΝΙΜΑ+ΚΙΝΗΤΑ 1 CM = 300.0 kN

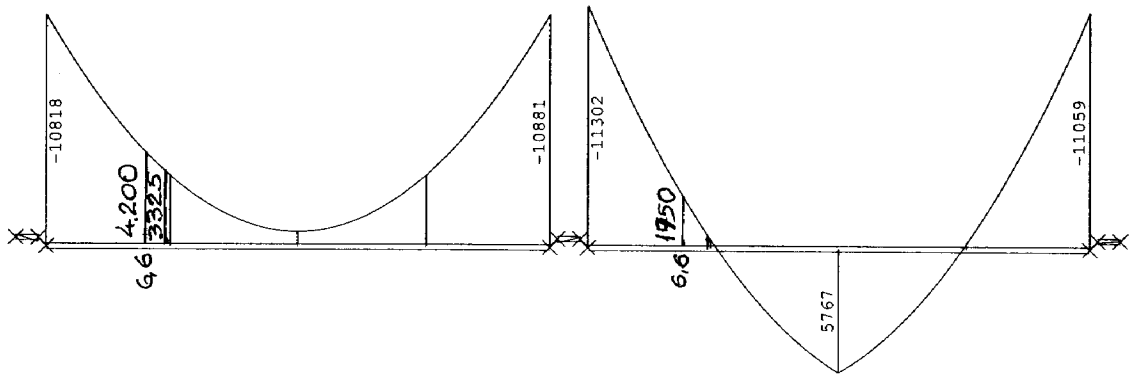
M 1 : 500

METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9

ΘΑΜΙΣΤΙΚΗ ΜΕΘΟΔΟΣ

υπ ΔΜ(x=Leff) − Mcr = −[(Y2 − 0,5 h_p,eff) + W2,eff / A_c,eff] ΔN → 0,5(4.200+1950) − 3,814(3.500 − 19197/5,1) = −1,38 ΔN1 → ΔN1 = −2960 kN → N1 = 19200 − 2960 = ≈ 16240 kN → X1 = 14,85×19200/16240 = 17,40 m → Leff,1 = 7,95 m → 0,5(3325+350) + 1010 = −1,38 ΔN2 → ΔN2 = −2060 kN → N2 = 19200 − 2060 = = 17.140 kN → X2 = 14,85×19200/17.140 = 16,45 m → Leff,2 = 7,50 m → 0,5(3500+875) + 1010 = −1,38 ΔN3 → ΔN3 = −2.320 kN → N2 = 16880 kN

X3 = 15,85×19.200/16880 = 18,0 m → Leff,3 = 7,70 m → N = 16.800 kN.

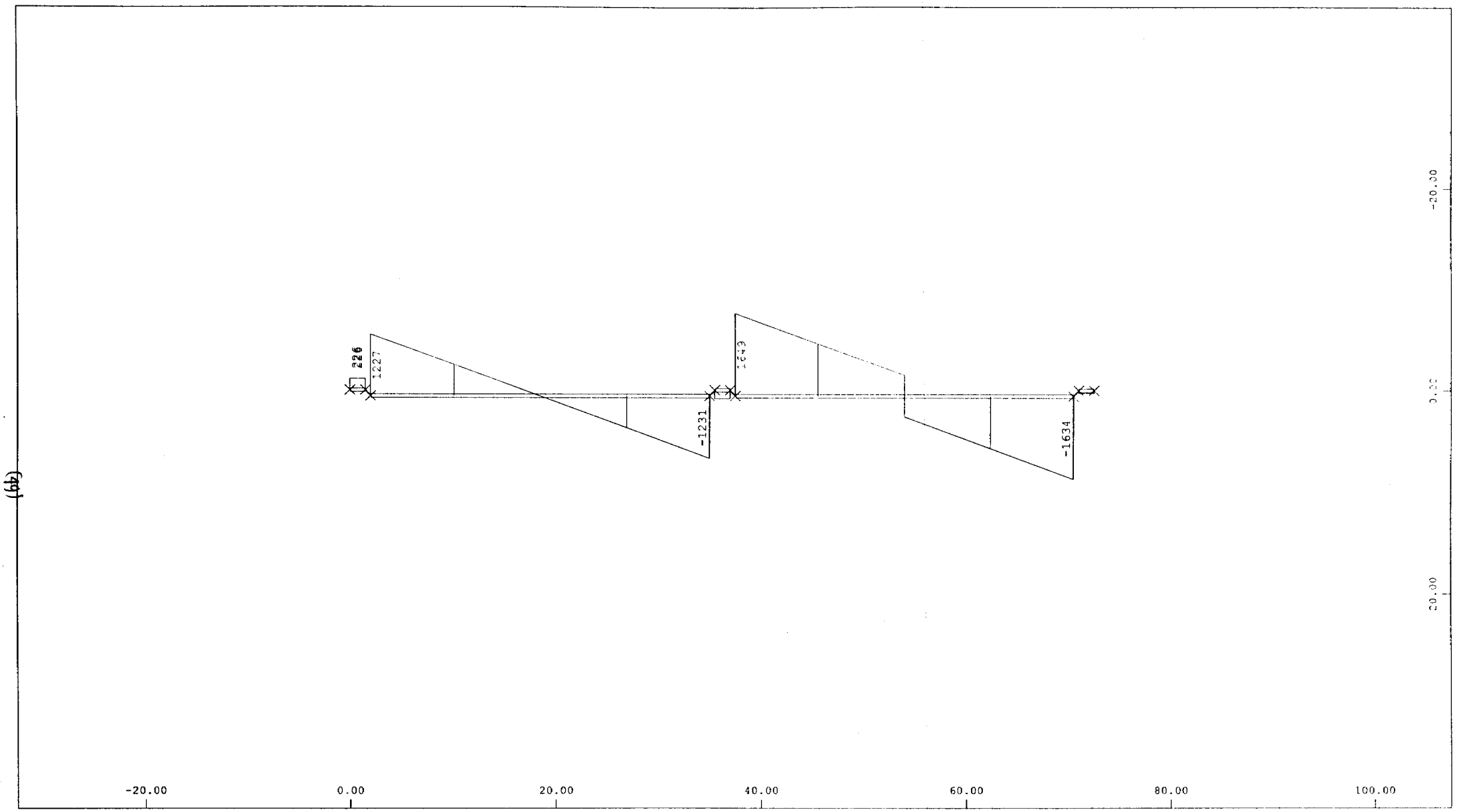


(48)

INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM MOMENTS MY LC 2 ΦΟΡΤ. ΜΟΝ.+ΚΙΝ.+ΘΕΡΜΟΚΡ. 1 CM = 3500 kNm

M 1 : 500

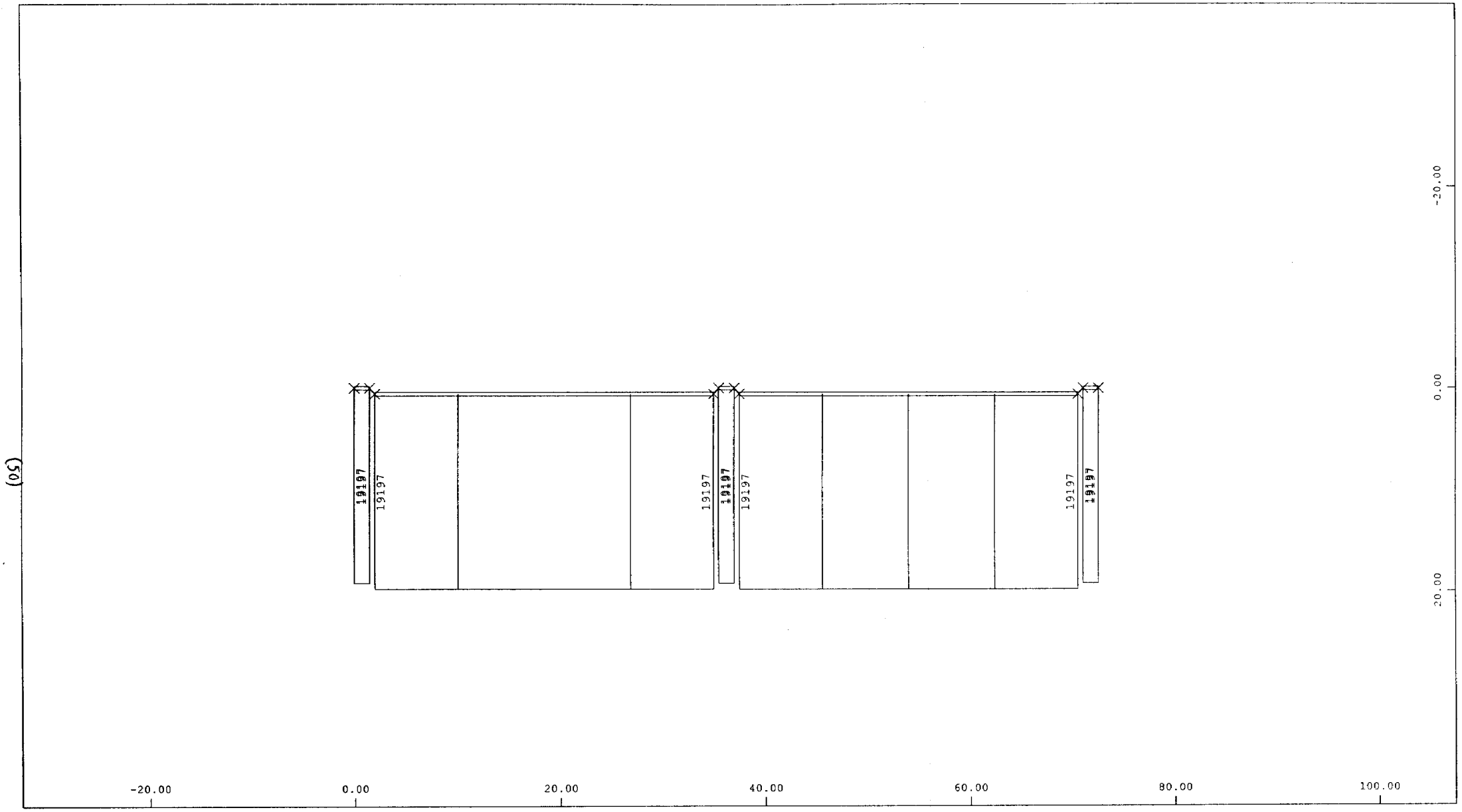
METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9



INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM SHEAR FORCES QZ LC 2 ΦΟΡΤ. ΜΟΝ.+ΚΙΝ.+ΘΕΡΜΟΚΡ. 1 CM = 1000 kN

M 1 : 500

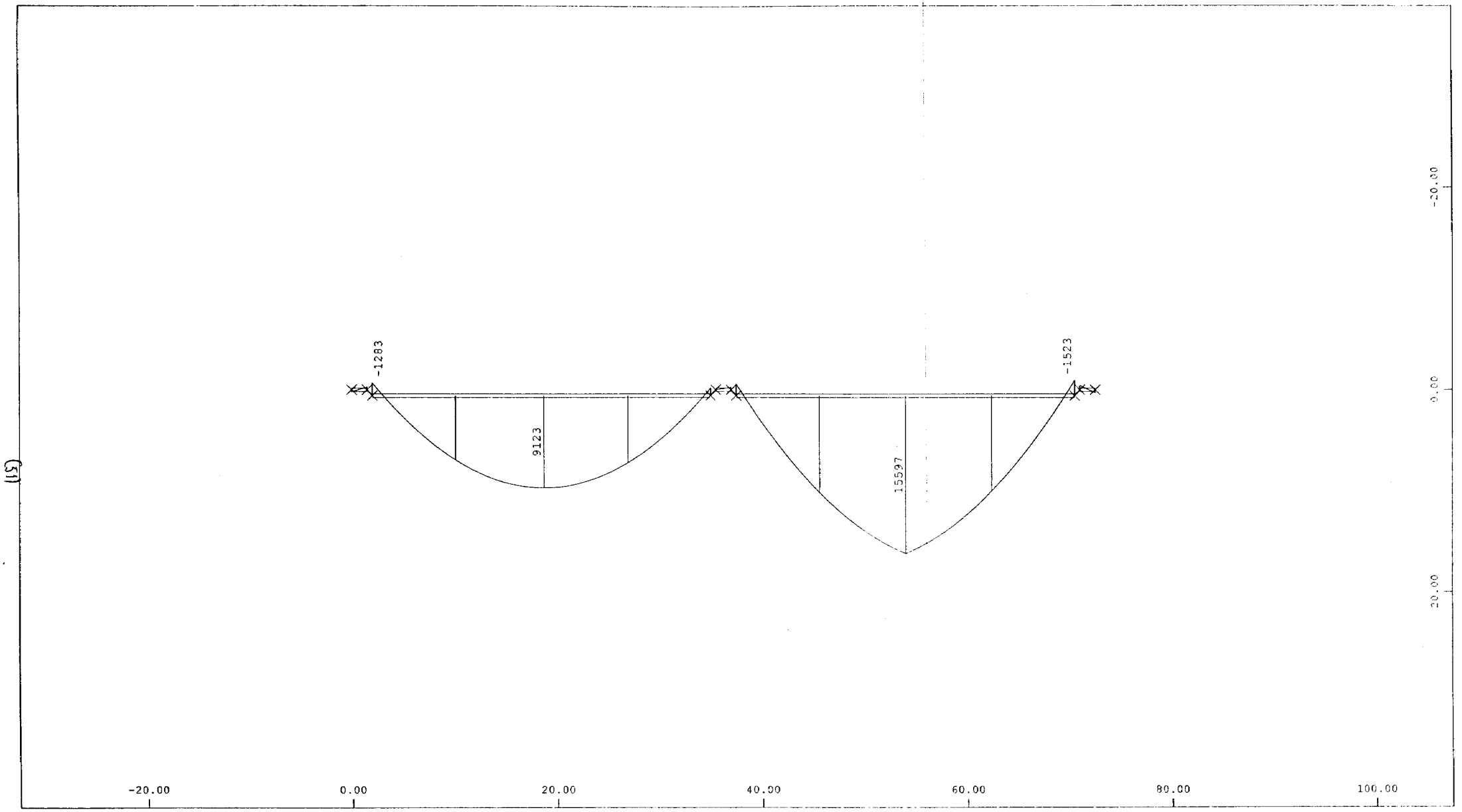
METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9



INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM NORMAL FORCES LC 2 ΦΟΡΤ. ΜΟΝ.+ΚΙΝ.+ΘΕΡΜΟΚΡ. 1 CM = 5000 kN

M 1 : 500

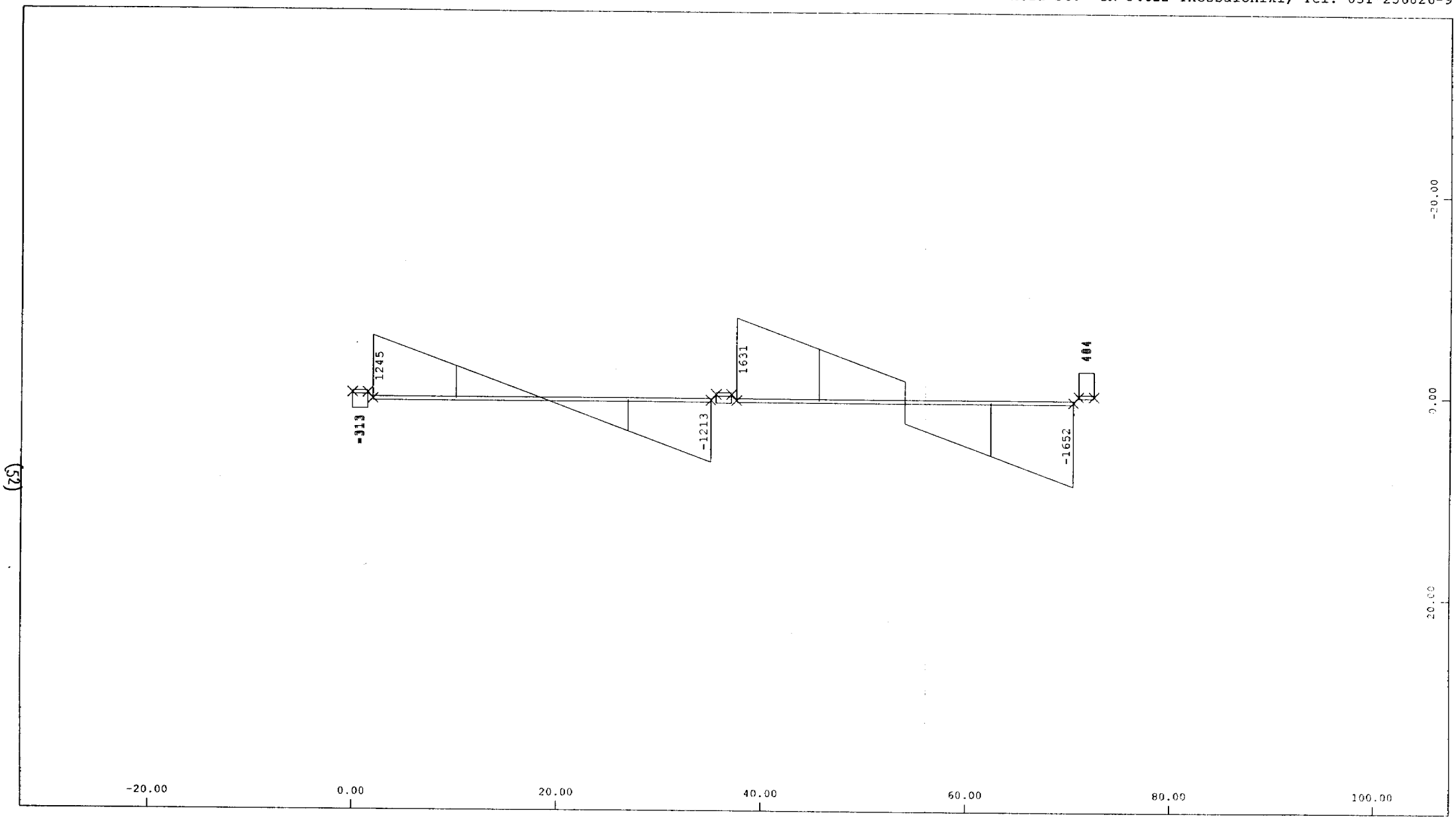
METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9



INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM MOMENTS MY LC 1 MONIMA+KINHTA ΦΟΡΤΙΑ 1 CM = 5000 kNm

M 1 : 500

METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9



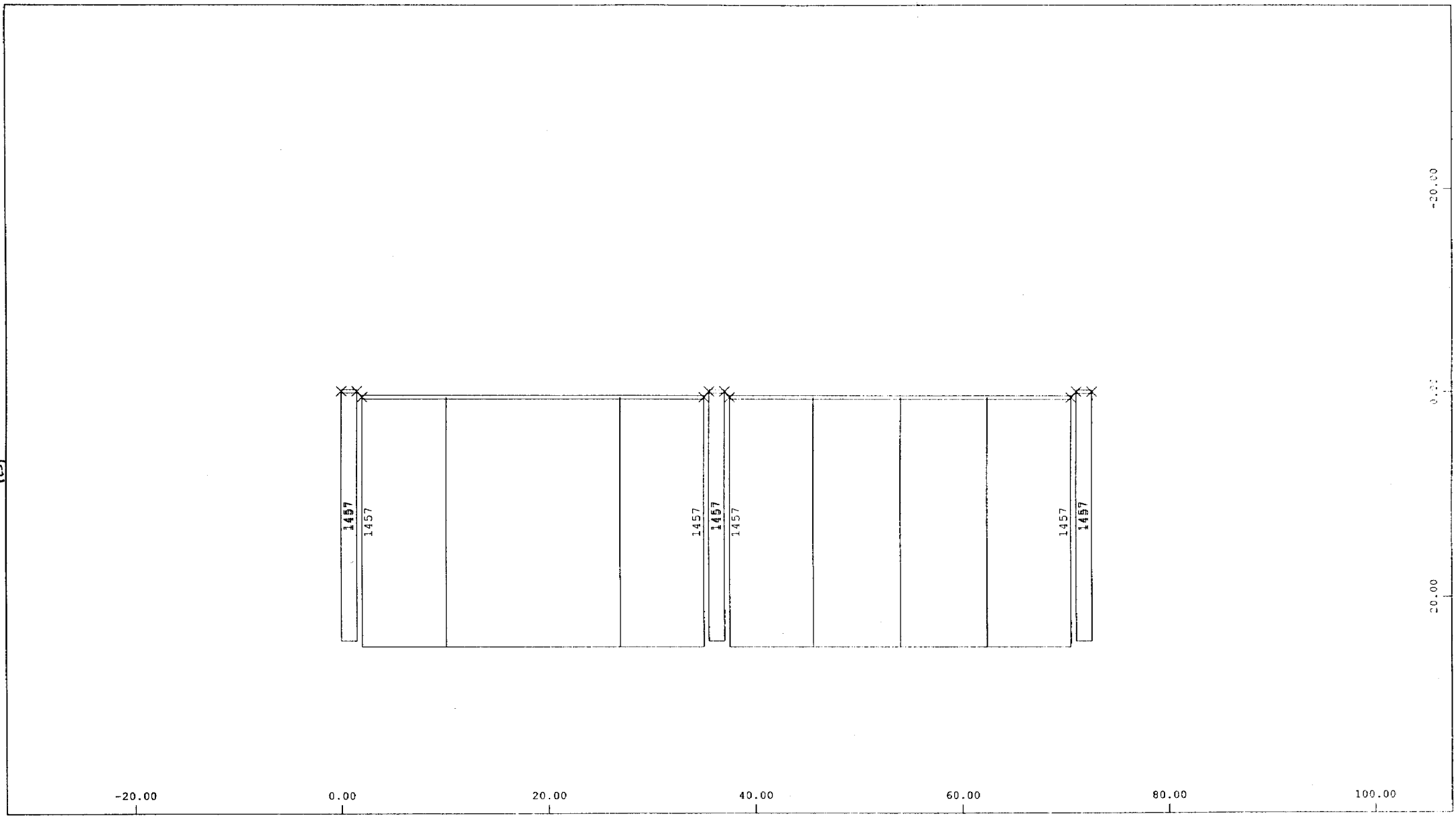
(52)

INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM SHEAR FORCES QZ LC 1 MONIMA+KINHTA ΦΟΡΤΙΑ 1 CM = 1000 kN

Y— x
z

M 1 : 500

METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9



INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM NORMAL FORCES LC 1 MONIMA+KINHTA ΦΟΡΤΙΑ 1 CM = 300.0 kN

M 1 : 500

METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9

ΘΑΜΙΣΤΙΚΗ ΜΕΘΟΔΟΣ

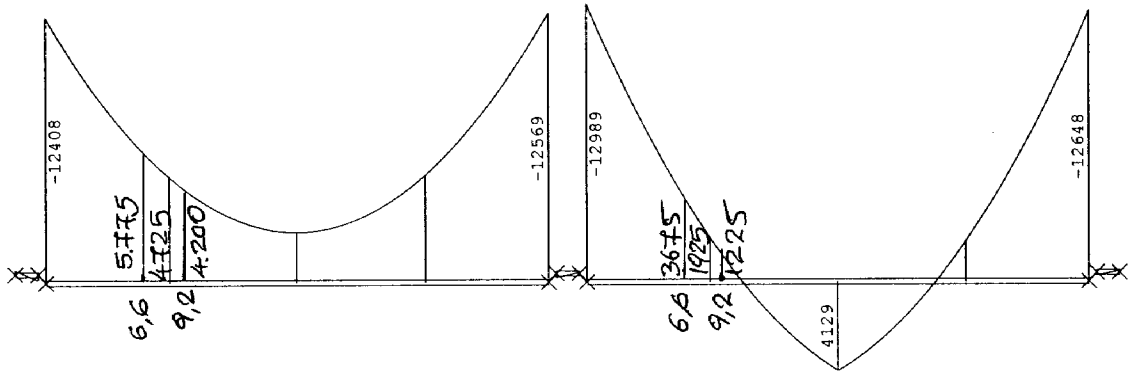
υπ $\Delta M(x=L_{eff}) - M_{cr} = -\left[\left(y_{2,eff} - \frac{h_{f,eff}}{2}\right) + \frac{W_{2eff}}{A_{c,eff}}\right]\Delta N \rightsquigarrow 0{,}5(5775+3675) - 3{,}814\left(3.500 - \frac{22154}{5{,}1}\right) = -1{,}38\,\Delta N_1 \rightarrow \Delta N_1 = -5750$ kN →

$N_1 = 22154 - 5750 = 16400$ kN → $x_1 = 15{,}85 \times 22154/16400 = 19{,}85$ m → $L_{eff,1} = 0{,}5(19{,}85 - 2{,}65) = 9{,}20$ m ⇝ $0{,}5(4200+1225) + 3.220 =$

$= -1{,}38\,\Delta N_2 \Rightarrow \Delta N_2 = -4.300$ kN → $N_2 = 17850$ kN → $x_2 = 15{,}85 \times 22154/17850 = 18{,}25$ m → $L_{eff,2} = 8{,}35$ m ⇝ $0{,}5(4725+1925) +$

$+ 3220 = -1{,}38\,\Delta N_3 \rightarrow \Delta N_3 = -4740$ kN → $N_3 = 17.400$ kN → $x_3 = 15{,}85 \times 22{,}154/17400 = 9{,}20$ m → $L_{eff,3} = 8{,}75$ m →

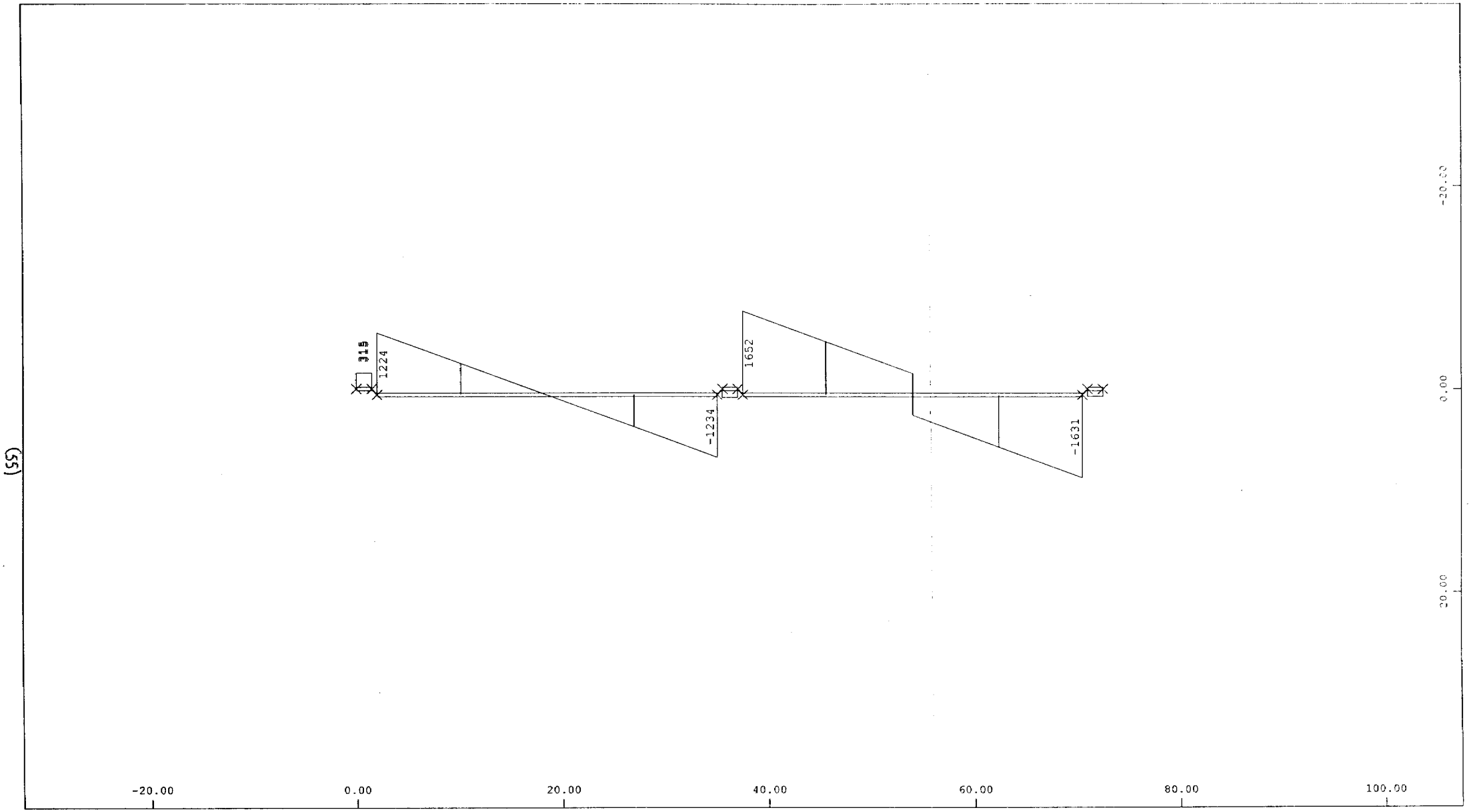
⇝ $N \approx 17.350$ kN.



INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM MOMENTS MY LC 2 ΦΟΡΤ. ΜΟΝ.+ΚΙΝ.+ΘΕΡΜΟΚΡ. 1 CM = 3500 kNm

M 1 : 500

METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9



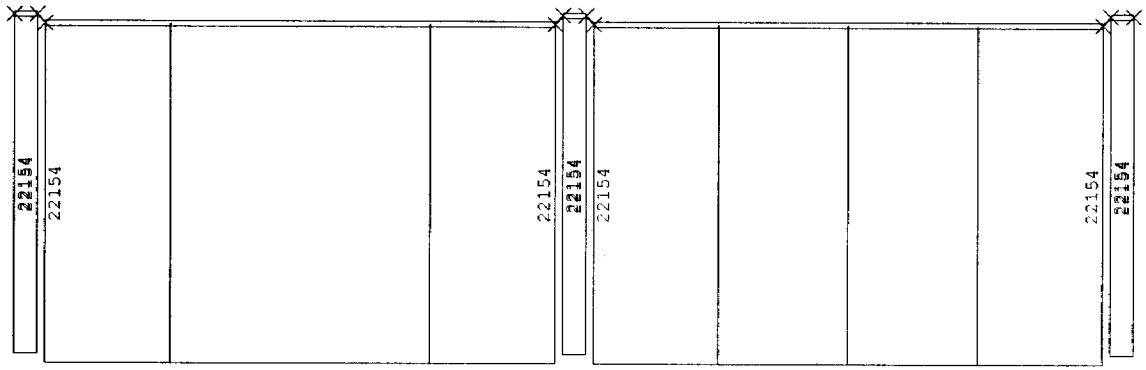
INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM SHEAR FORCES QZ LC 2 ΦΟΡΤ. ΜΟΝ.+ΚΙΝ.+ΘΕΡΜΟΚΡ. 1 CM = 1000 kN

M 1 : 500

METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9

ΘΑΜΙΣΤΙΚΗ ΜΕΘΟΔΟΣ

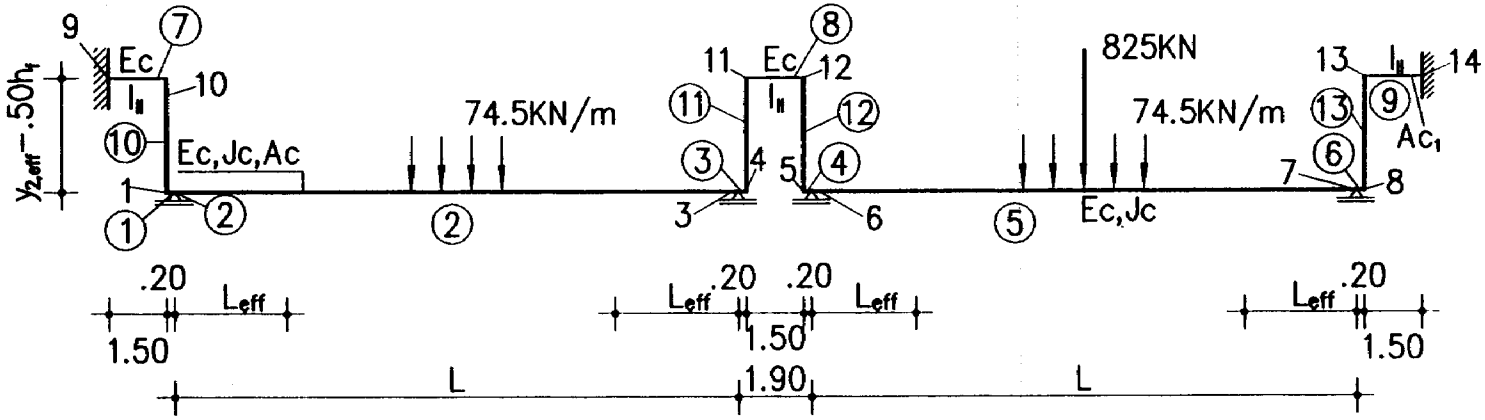
υπ $\Delta M(x = L_{eff}) - M_{cr} = -[(y_2 - 0{,}5\, h_{f,eff}) + \frac{W_{2,eff}}{A_{c,eff}}]\Delta N \rightarrow 0{,}5($



INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM NORMAL FORCES LC 2 ΦΟΡΤ. ΜΟΝ.+ΚΙΝ.+ΘΕΡΜΟΚΡ. 1 CM = 5000 kN

M 1 : 500

$$Ac_1 = \frac{1.50}{1.50+L_{eff}}\ 1.2As\frac{Es}{Ec} \qquad Ac_2 = \frac{1.50}{1.50+2L_{eff}}\ 1.2As\frac{Es}{Ec}$$

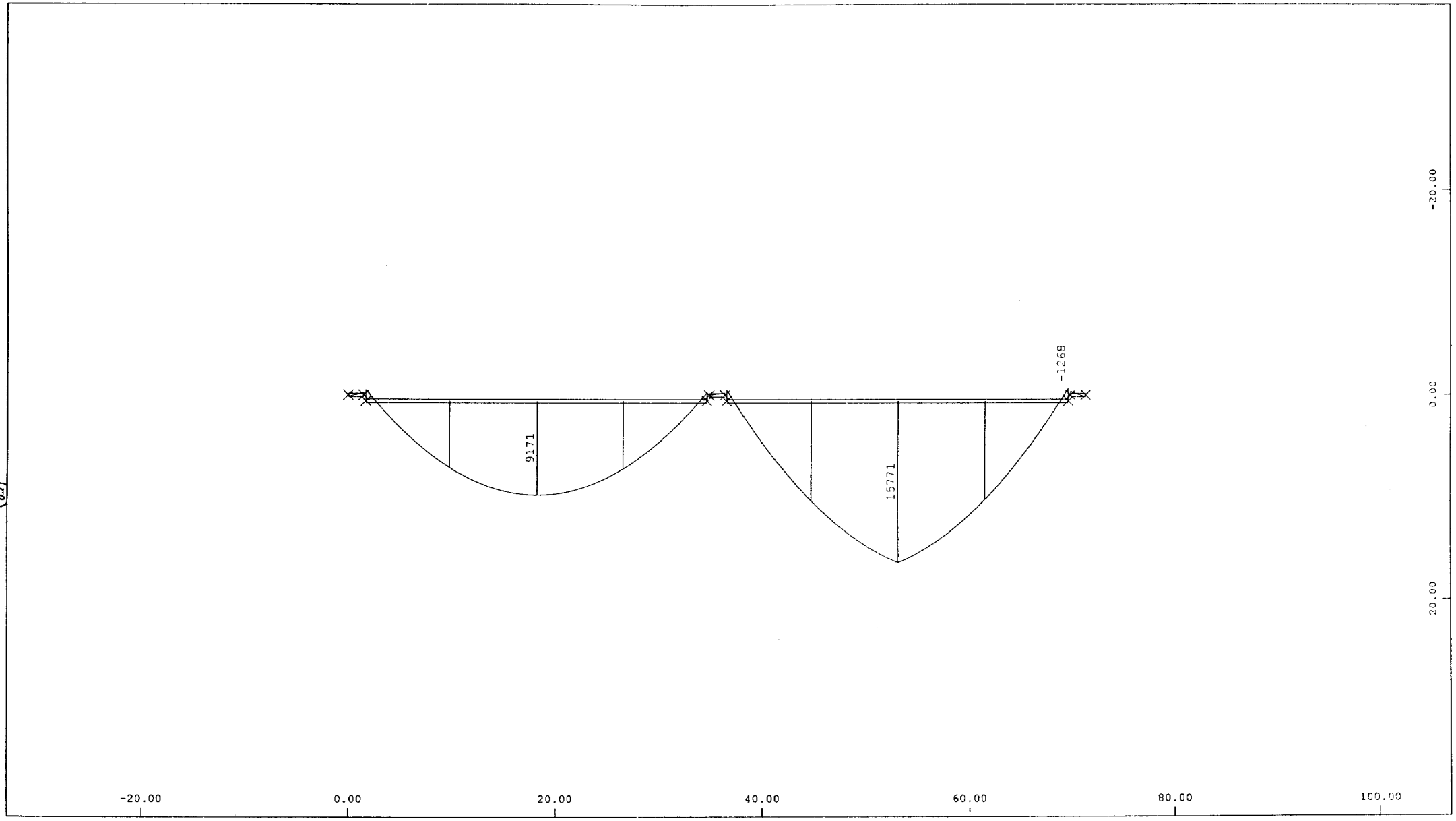


ΠΙΝΑΚΑΣ ΔΕΔΟΜΕΝΩΝ

L=33.0m	E_c =32 GPa
b=12.0m	a=6.25
$A_{c,eff}$ =5.100m^2	g_1 =30.7KN/m
$J_{c,eff}$=2.784m	q=43.8KN/m
h_b =2.15m	g_1 +q=74.5KN/m
h_{ft}=0.275m	Q=825KN
$h_{f,eff}$=0.20m	A_{st}= 887cm^2/m (3φ14/75+ 2φ14/300)
$h_{(πρ.)}$=0.075m	ρ=3.7%
$y_{2,eff}$ =0.73m	A_{sb}=20,5cm^2/m (φ14/75 π. +φ14 Κ.)
	T=-70° C
$\rho_b \simeq 0{,}012$ (φ14/75)	Leff= 8,55 m

$I_{II} = 3.544a\rho_b bh_{f,eff}^3/12 = 0.1772\rho \simeq 0{,}0021\ m^4$

METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9

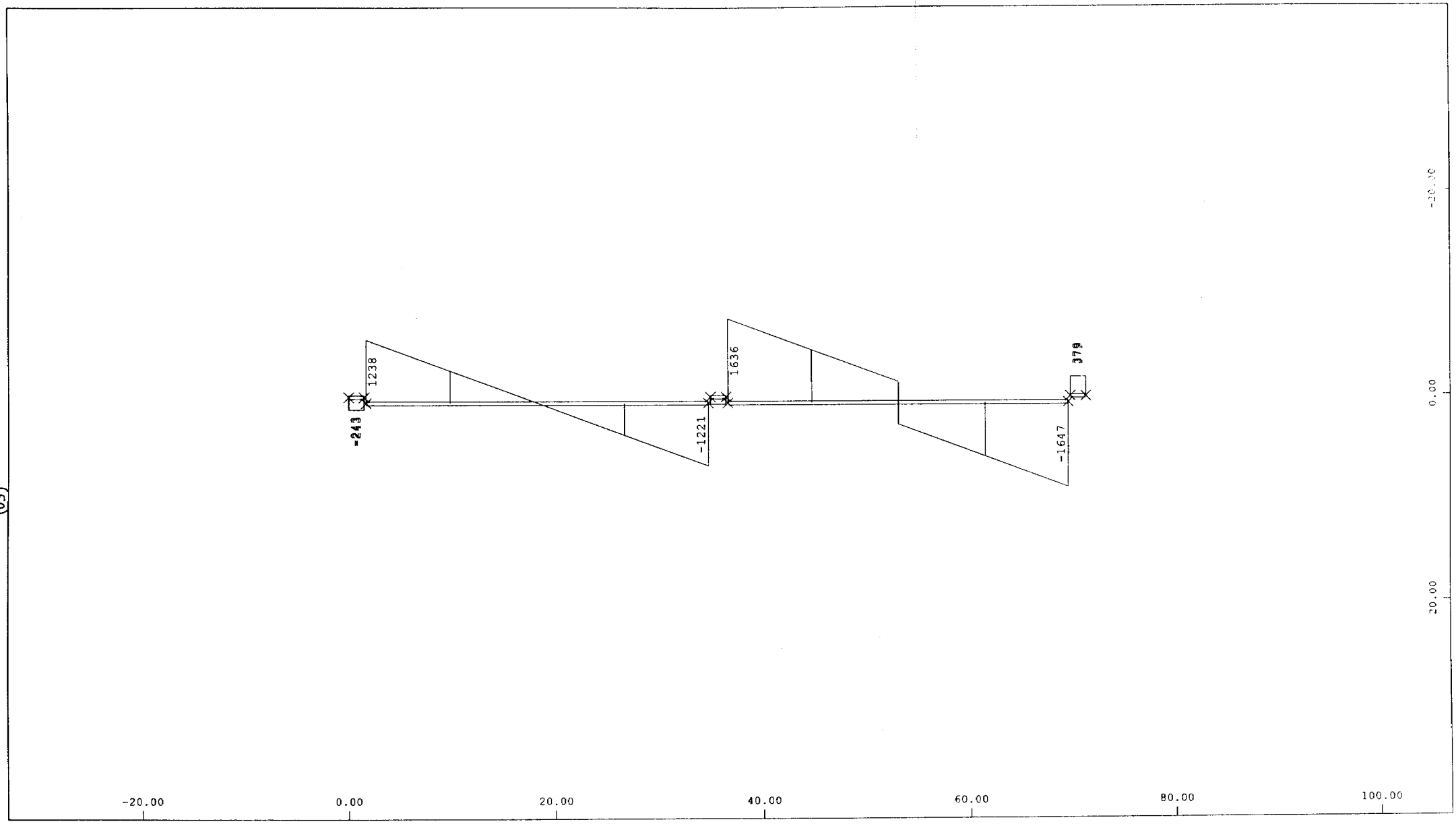


(58)

INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM MOMENTS MY LC 1 LOAD CASE 1 1 CM = 5000 kNm

M 1 : 500

METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9

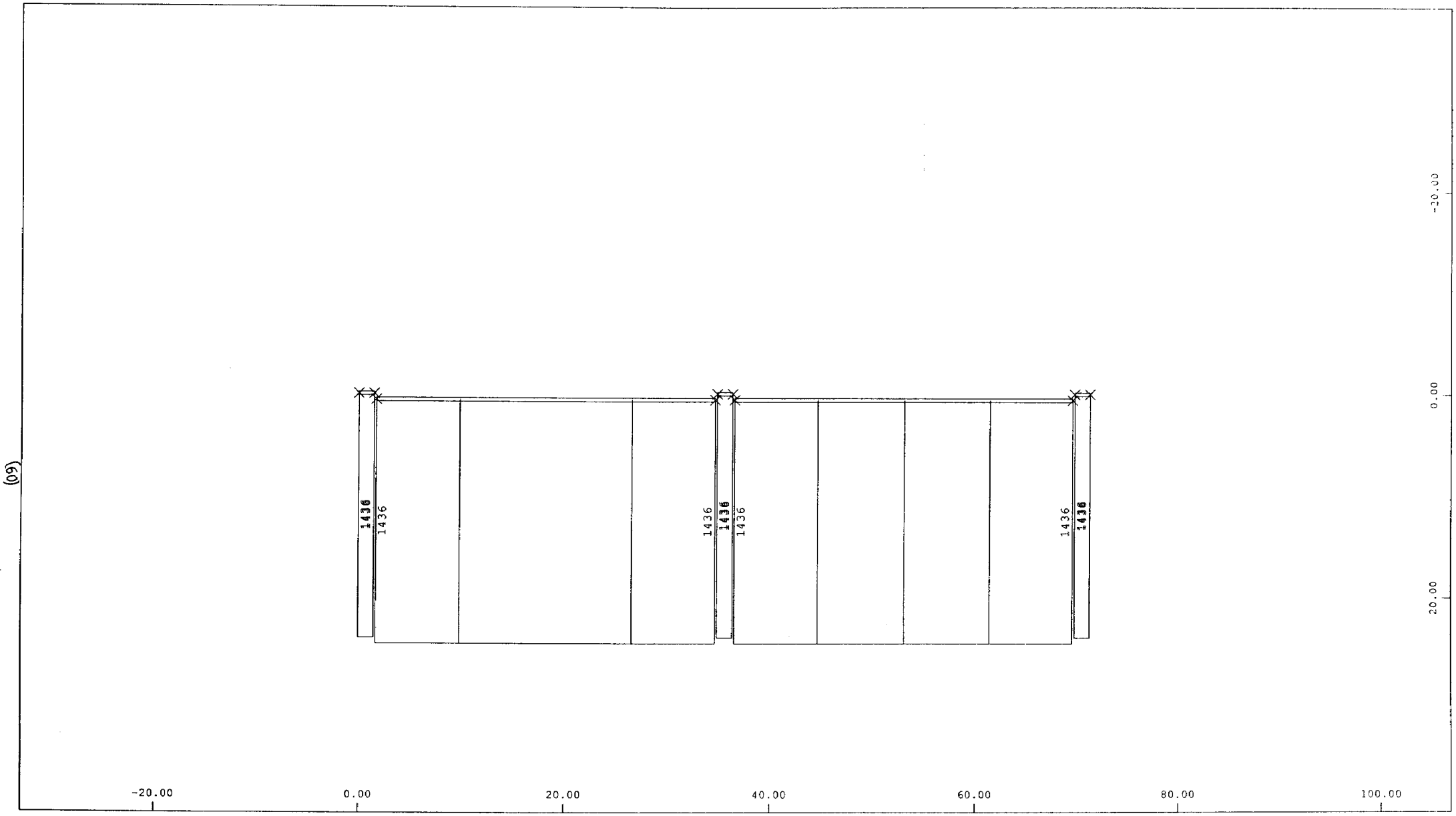


(59)

INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM SHEAR FORCES QZ LC 1 LOAD CASE 1 1 CM = 1000 kN

M 1 : 500

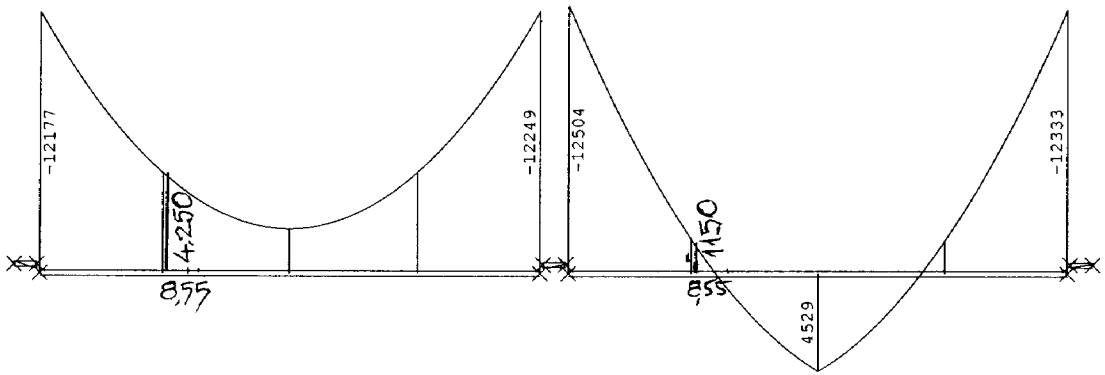
METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9



INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM NORMAL FORCES LC 1 LOAD CASE 1 1 CM = 300.0 kN

M 1 : 500

METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9



(19)

$\sigma\nu\ \Delta M(x=8{,}55) \simeq 0{,}5(4.250+1150) = 2.700$ kNm

$\sigma\nu\ \Delta M \simeq \frac{2.784}{0{,}73}\left(3500 - \frac{21.450}{5{,}1}\right) = -2.640$ "

$2700+2690 \simeq 5390 = -1{,}38\,\Delta N_1 \rightarrow \Delta N_1 = -3.910$ kN $\rightarrow N_1 = 21.450 - 3.910 = 17.540$ kN $\rightarrow x_1 = (2{,}65+2\times 8{,}55)\times\frac{21450}{17540} = 22{,}75$ m

$L_{eff,1} = 0{,}5(22{,}75 - 2{,}65) = 10{,}60$ m $\rightarrow 0{,}5(3325-525)+2690 = 4090 = -1{,}38\,\Delta N_2 \rightarrow \Delta N_2 = -2960$ kN $\rightarrow N_2 \simeq 21450 - 2960 \simeq 18.490$ kN

$x_2 = 19{,}75 \times 21450/18.490 = 21{,}60$ m $\rightarrow L_{eff,2} = 10{,}0$ m $\rightarrow 0{,}5(3500-200)+2690 = 4340 = -1{,}38\,\Delta N_3 \rightarrow \Delta N_3 = -3140$ kN

$N_3 = 21450 - 3140 = 18.300$ kN $\rightarrow x_3 = 23{,}10$ m $\rightarrow L_{eff,3} \simeq 10{,}25$ m

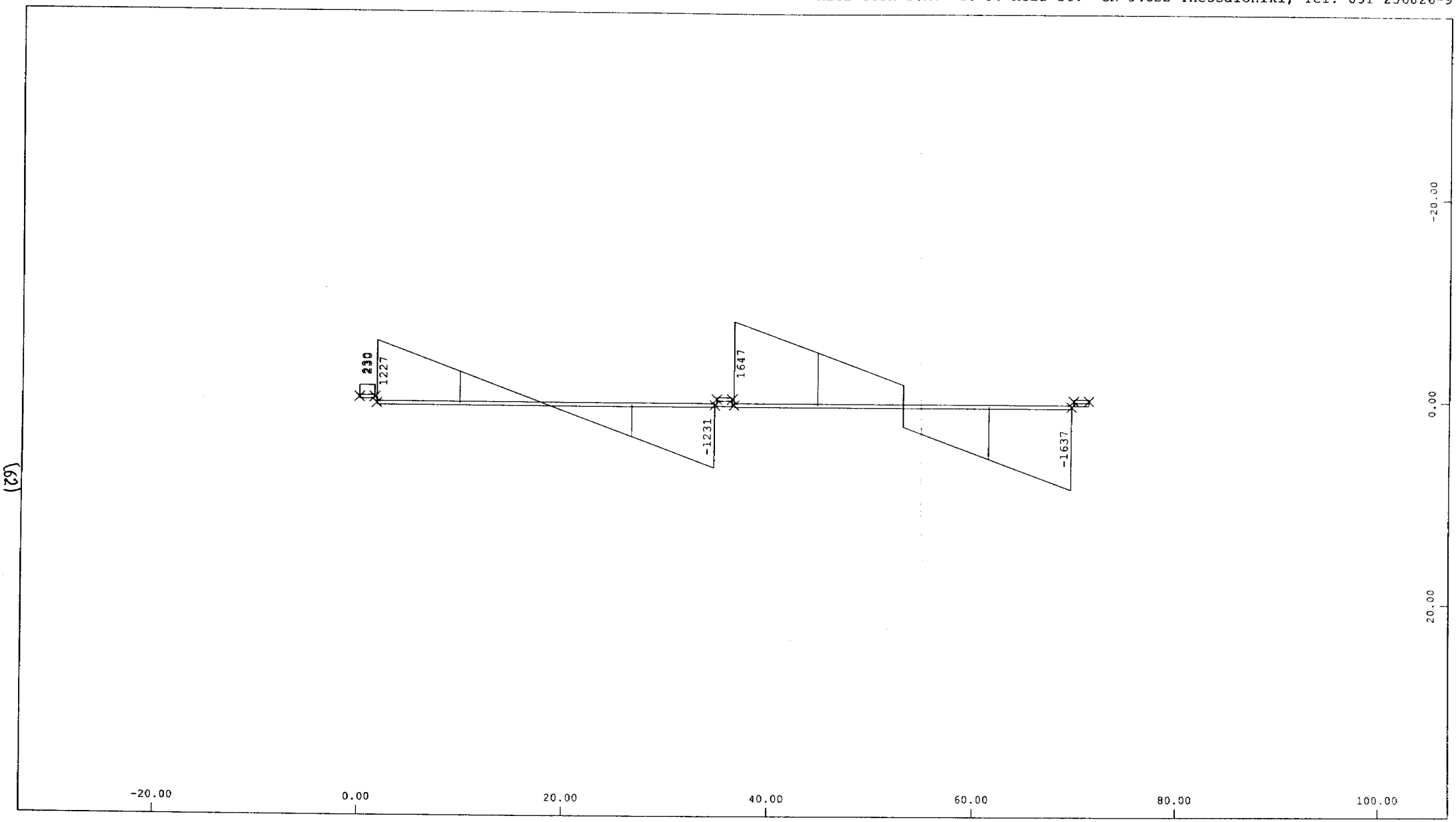
-20.00 0.00 20.00 40.00 60.00 80.00 100.00

-20.00 0.00 20.00

INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM MOMENTS MY LC 2 LOAD CASE 2 1 CM = 3500 kNm

M 1 : 500

METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9

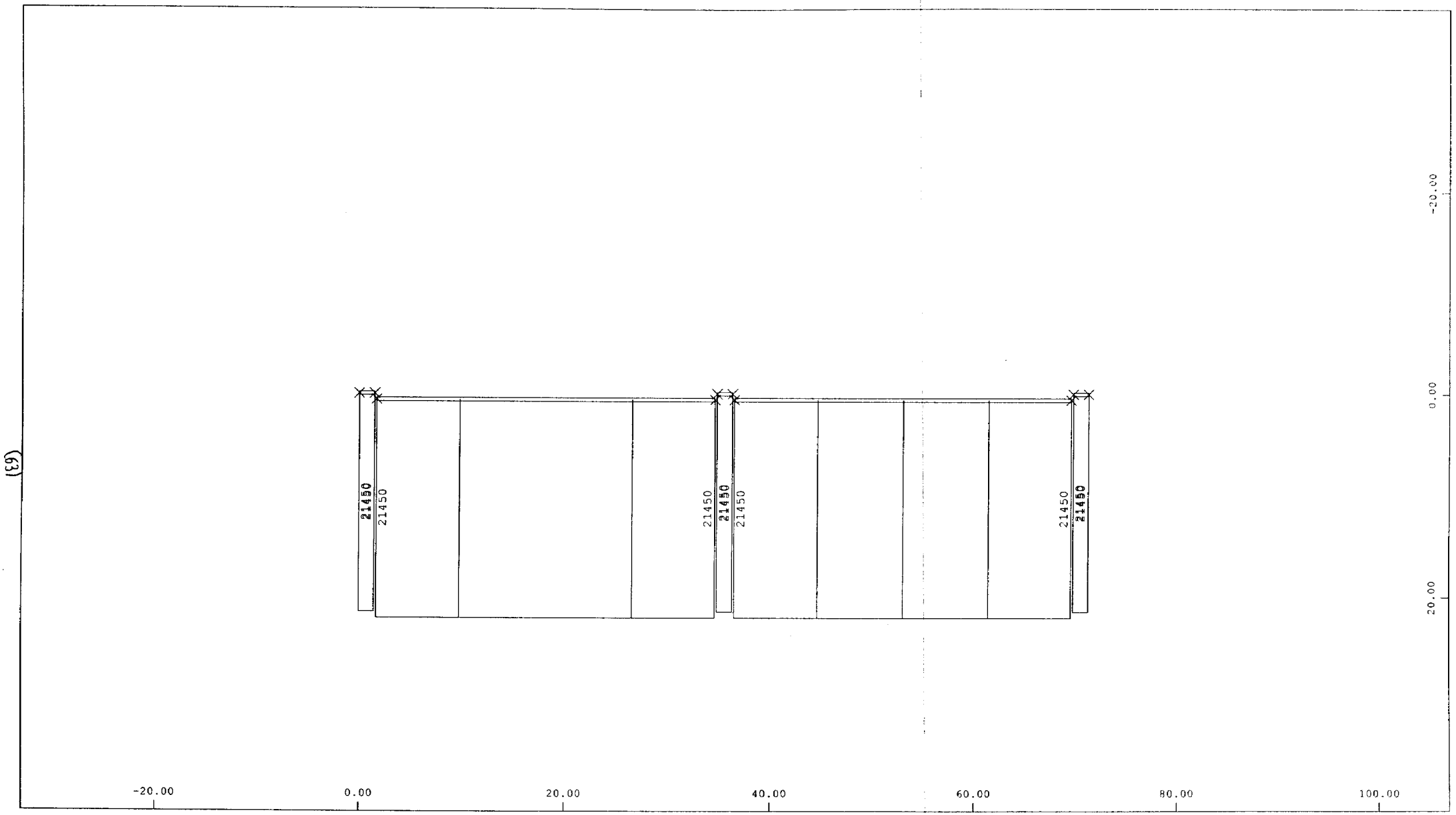


(62)

INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM SHEAR FORCES QZ LC 2 LOAD CASE 2 1 CM = 1000 kN

M 1 : 500

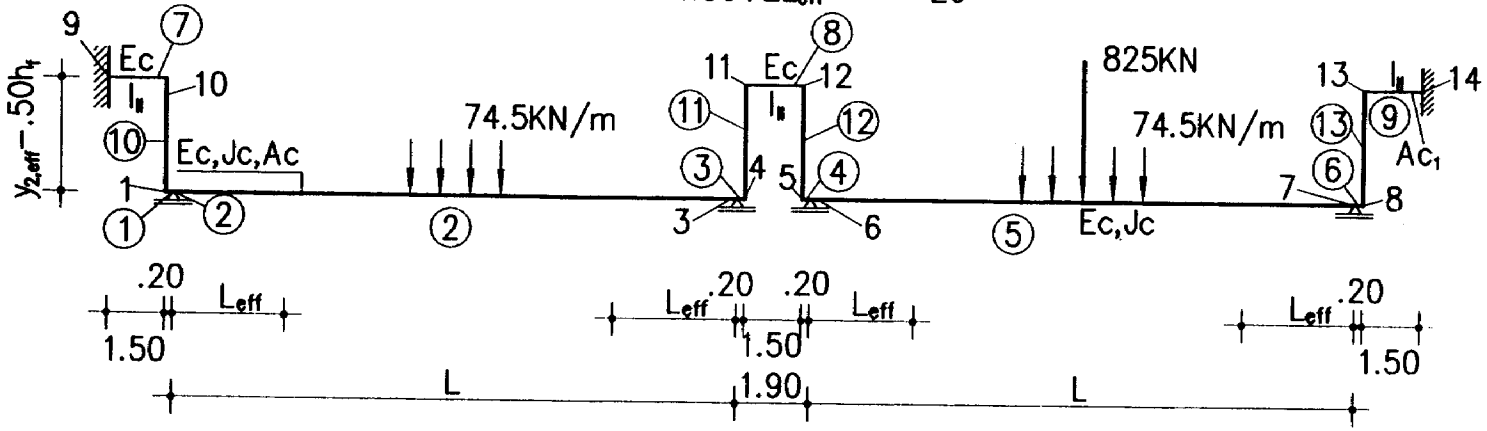
METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9



INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM NORMAL FORCES LC 2 LOAD CASE 2 1 CM = 5000 kN

M 1 : 500

$$Ac_1 = \frac{1.50}{1.50+L_{eff}}\ 1.2As\frac{Es}{Ec} \qquad Ac_2 = \frac{1.50}{1.50+2L_{eff}}\ 1.2As\frac{Es}{Ec}$$

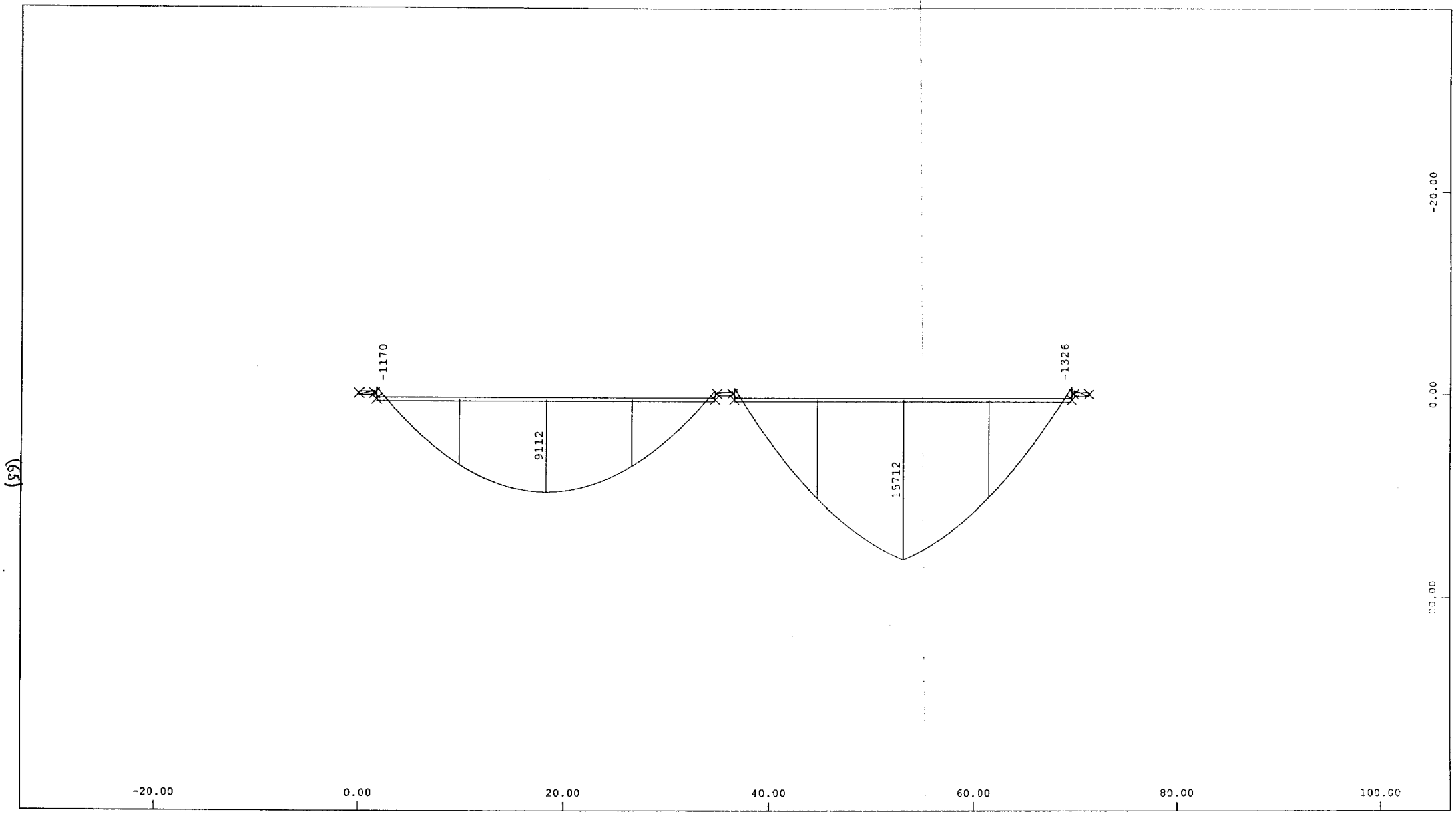


ΠΙΝΑΚΑΣ ΔΕΔΟΜΕΝΩΝ

L=33.0m	E_c =32 GPa
b=12.0m	α=6.25
$A_{c,eff}$ =5.100m^2	g_1 =30.7KN/m
$J_{c,eff}$=2.784m	q=43.8KN/m
h_b =2.15m	g_1 +q=74.5KN/m
h_{ft}=0.275m	Q=825KN
$h_{f,eff}$=0.20m	A_{st}=887cm^2 (3Φ14/75 +2Φ14/300 +Φ14/75κ)
$h_{(πρ.)}$=0.075m	ρ=3,7%
$y_{2,eff}$ =0.73m	A_{sb}=20,5cm^2/m (Φ14/75πτ
	T=-60° C
ρ_b=0,012	Leff=7,65 m

$I_{II} = 3.544\alpha\rho_b b h_{f,eff}^3/12 = 0.1772\rho_b$ =0,0021

METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9

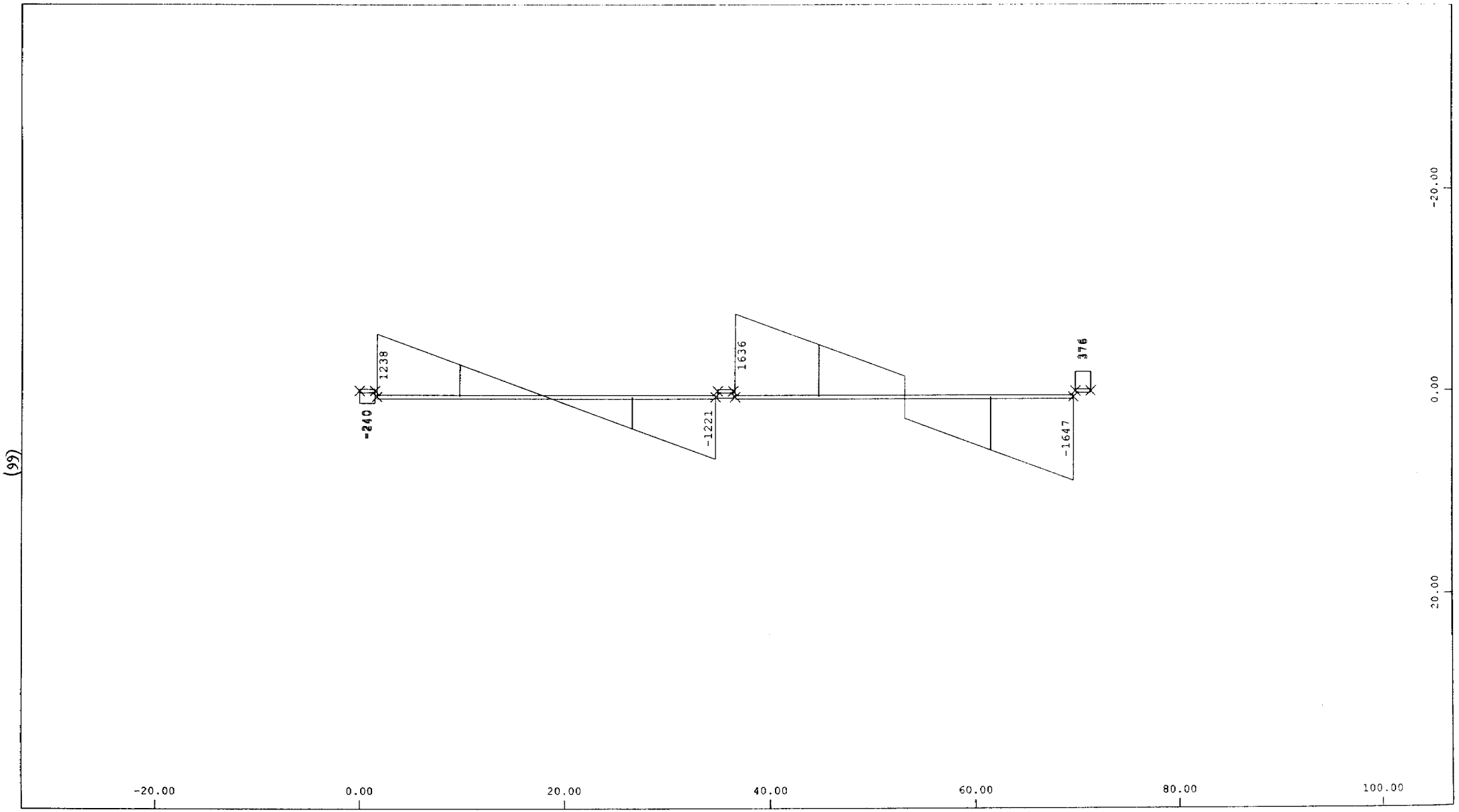


INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM MOMENTS MY LC 1 LOAD CASE 1 1 CM = 5000 kNm

y — x
z

M 1 : 500

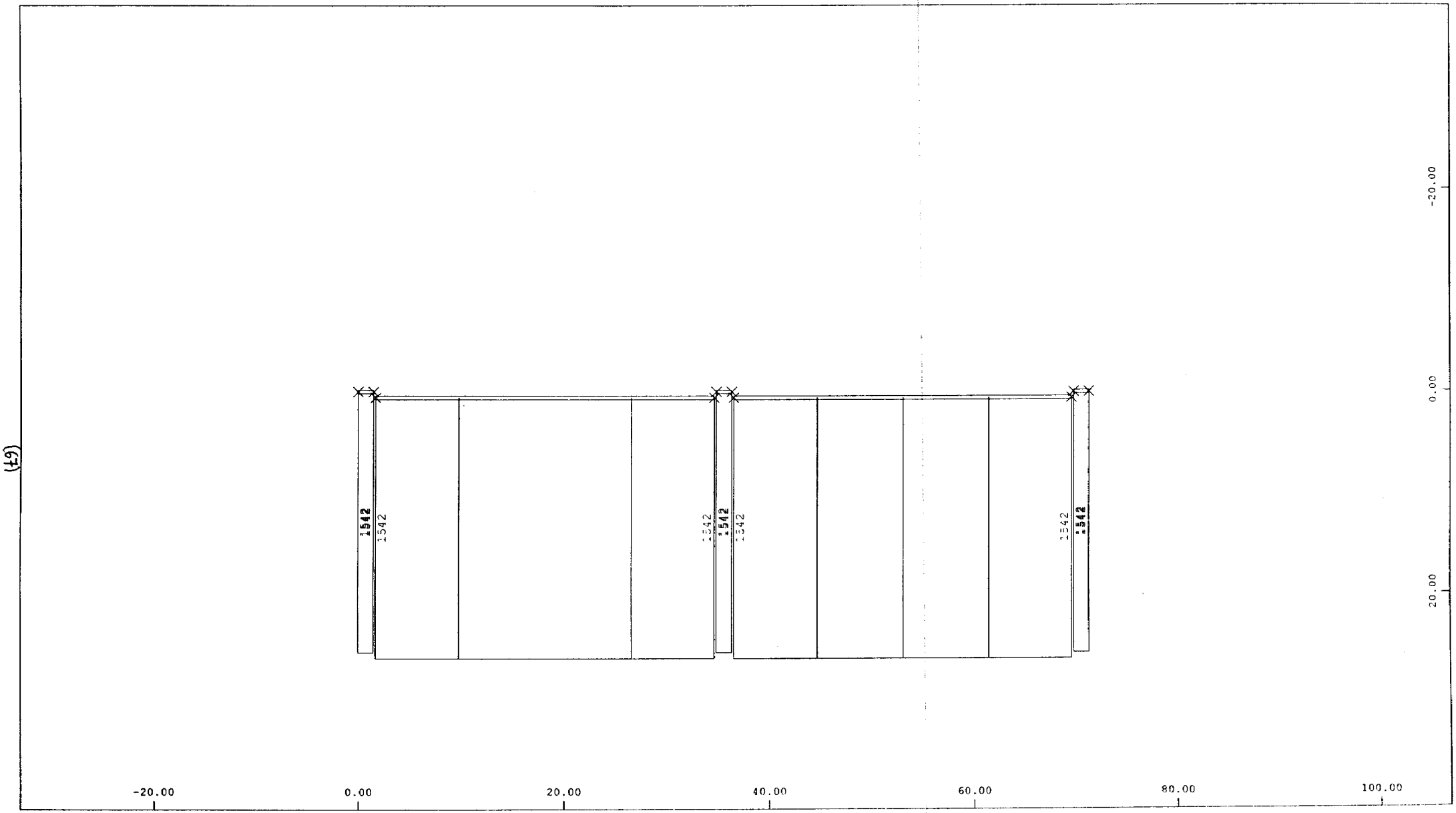
METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9



INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM SHEAR FORCES QZ LC 1 LOAD CASE 1 1 CM = 1000 kN

M 1 : 500

METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9



INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM NORMAL FORCES LC 1 LOAD CASE 1 1 CM = 300.0 kN

M 1 : 500

METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9

ΘΑΜΙΣΤΙΚΗ ΜΕΘΟΔΟΣ

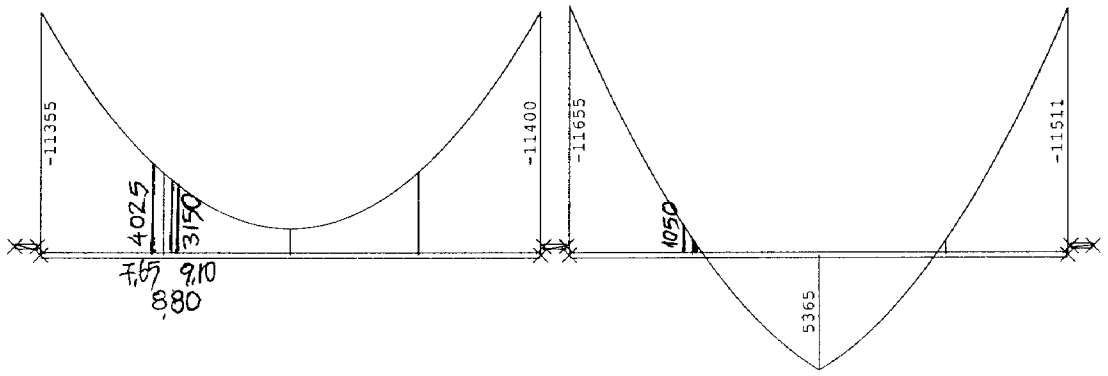
υπ ΔΜ (x=7,65) + 3,814 (3500 - 19962/5,1) = -1,38 ΔN₁ → 0,5(4025+1050)+1580 = -1,38 ΔN₁ → ΔN₁ = -2.980 kN → N₁ = 19962-2980 =

= 16980 kN → x₁ = 19962/16980 × 17,95 = 21,10 m → Leff,1 = (21,1-2,65)/2 = 9.10 m. → ΔM(x=9,10) = 0,5x(3150+Ø) = 1575 kNm

1575+1580 = -1,38 ΔN₂ → ΔN₂ = -2286 kN → N₂ = 19962-2286 = 17.680 kN → x₂ = 17,95x 19.962/17.680 = 20,25 m → Leff,2 = 8,80 m

ΔM(x=8,80) = 0,5(3325+175) = 1750 kN. → 1750+1580 = -1,38 ΔN₃ → ΔN₃ = -2412 kN → N₃ = 19962 - 2412 = 17550 kN

x₃ = 17,95 x 19.962 / 17550 = 20,40 m → Leff,3 = 8,85 m



(89)

-20.00 0.00 20.00 40.00 60.00 80.00 100.00

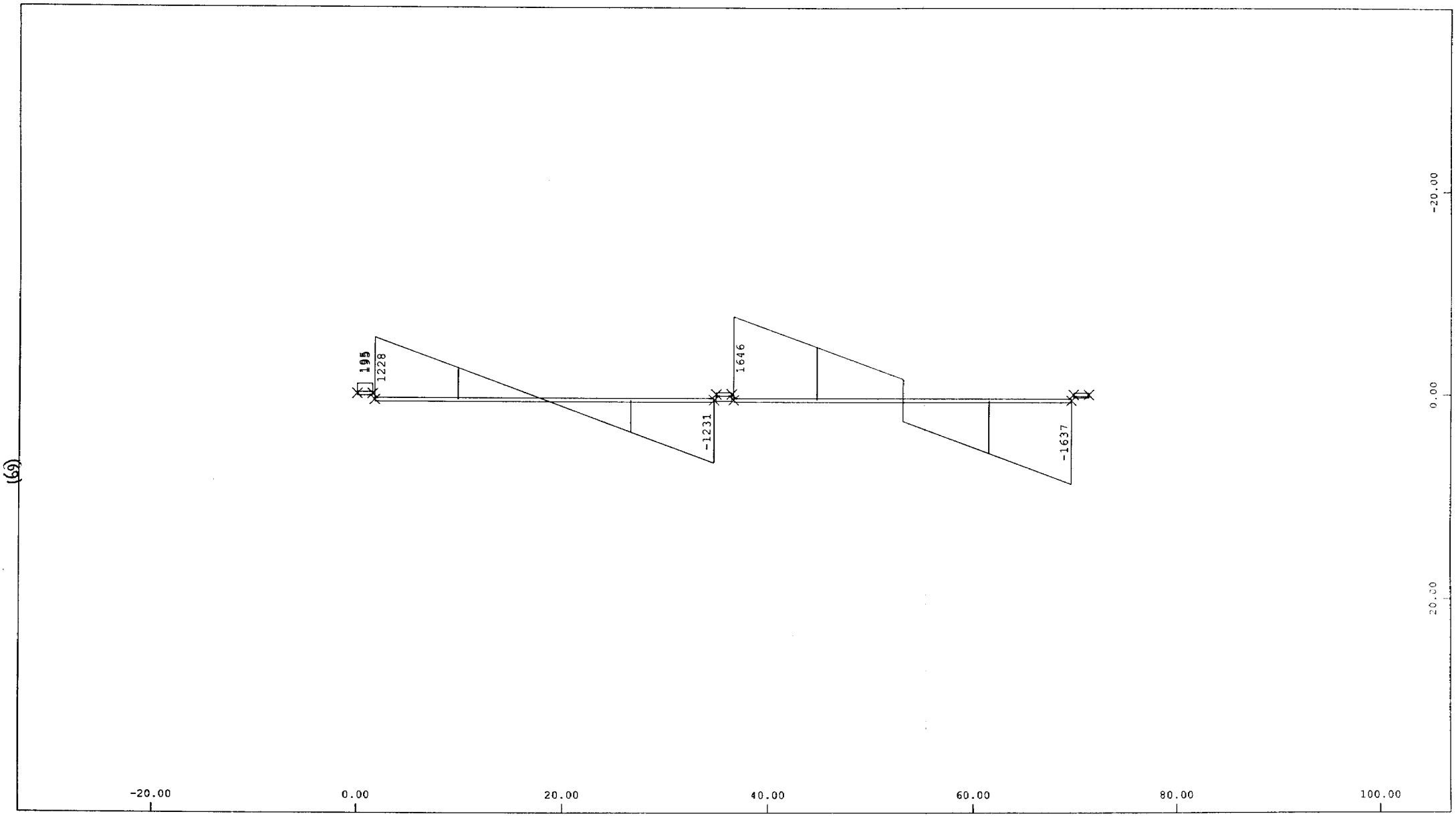
-20.00 0.00 20.00

INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM MOMENTS MY LC 2 LOAD CASE 2 1 CM = 3500 kNm

Y — X
Z

M 1 : 500

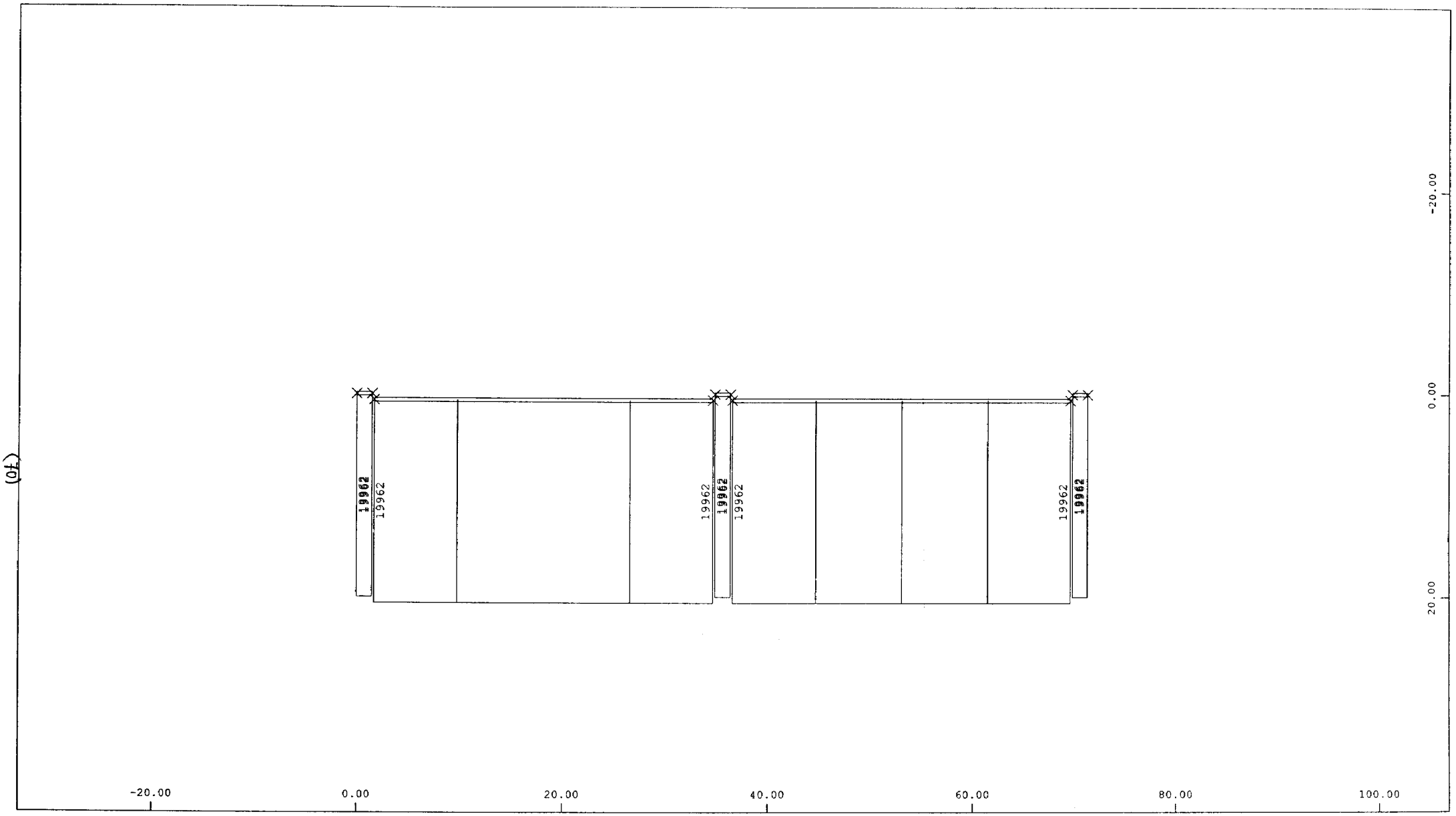
METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9



INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM SHEAR FORCES QZ LC 2 LOAD CASE 2 1 CM = 1000 kN

M 1 : 500

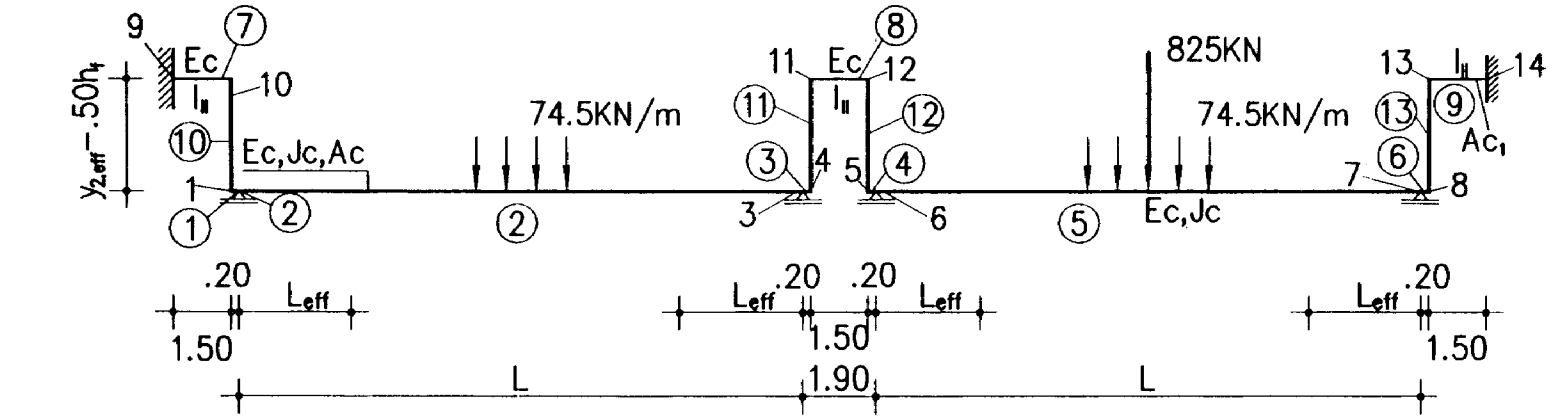
METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9



INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM NORMAL FORCES LC 2 LOAD CASE 2 1 CM = 5000 kN

M 1 : 500

$$Ac_1 = \frac{1.50}{1.50+L_{eff}}\ 1.2As\frac{Es}{Ec} \qquad Ac_2 = \frac{1.50}{1.50+2L_{eff}}\ 1.2As\frac{Es}{Ec}$$

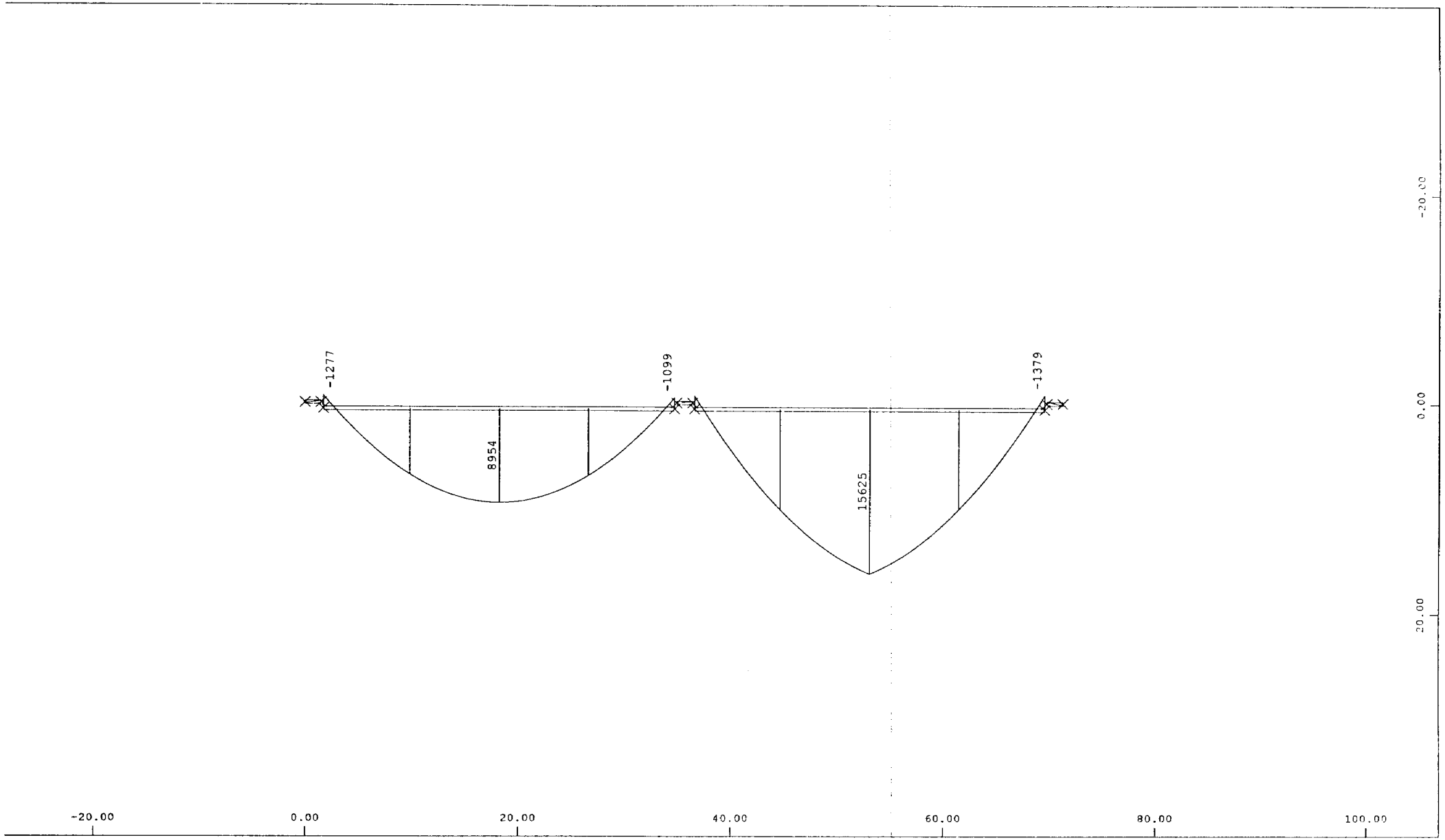


ΠΙΝΑΚΑΣ ΔΕΔΟΜΕΝΩΝ

L=33.0m	E_c =32 GPa
b=12.0m	a=6.25
$A_{c,eff}$ =5.100m^2	g_1 =30.7KN/m
$J_{c,eff}$=2.784m	q=43.8KN/m
h_b =2.15m	g_1 +q=74.5KN/m
h_{ft}=0.275m	Q=825KN
$h_{f,eff}$=0.20m	A_{st}=1280cm^2/m (4φ16/75)
$h_{(np.)}$=0.075m	ρ=5,3%
$y_{2,eff}$ =0.73m	A_{sb}=13,3 cm^2/m (φ16/150m + φ16/150 κ.
	T=-60°/-70°C
ρ_b=0,0076(φ16/150)	Leff=L/4=8,25

$I_{II} = 3.544\alpha\rho_b b h_{f,eff}^3/12 = 0.1772\rho_b \simeq 0,00135\ m^4$

METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9

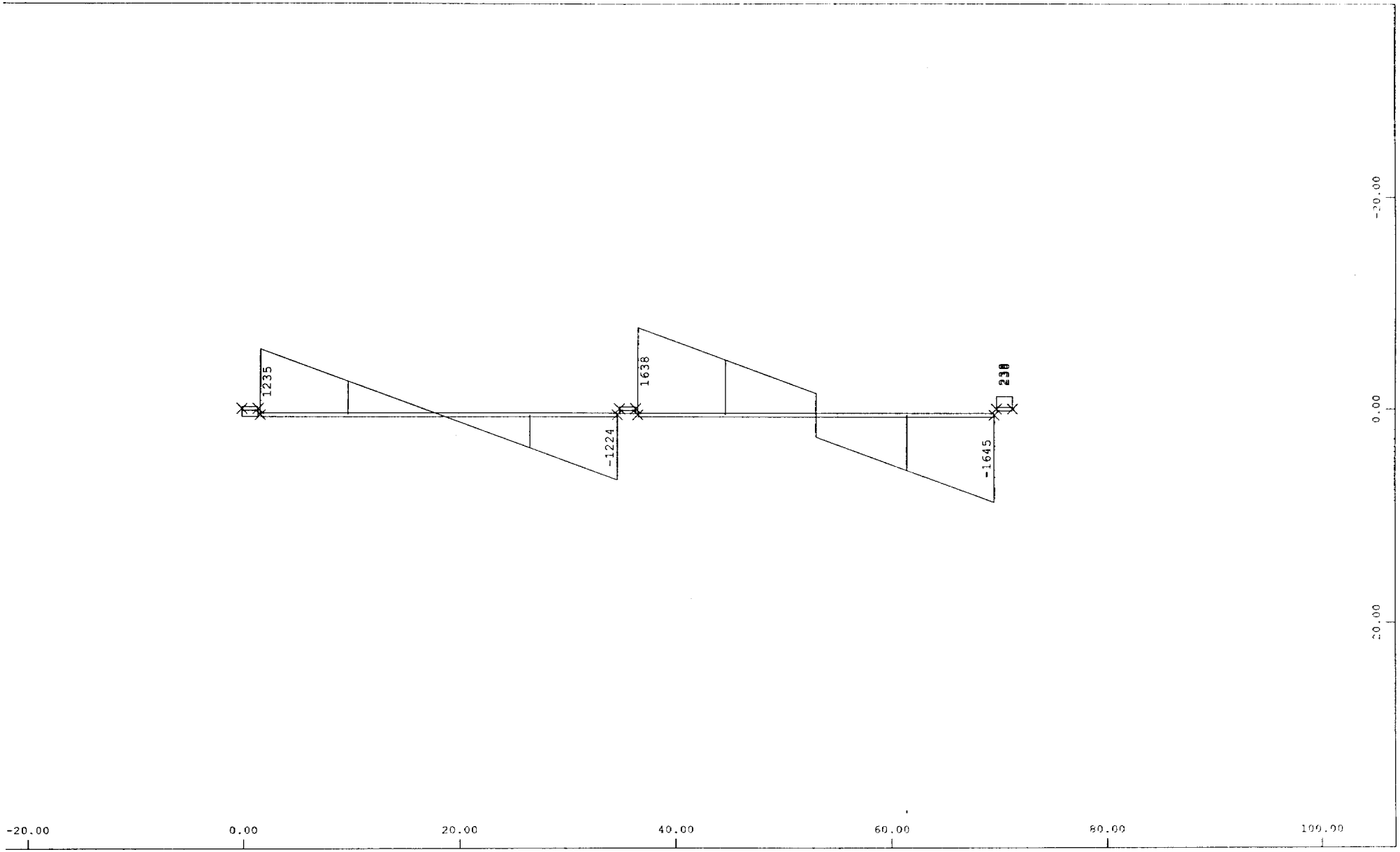


(12)

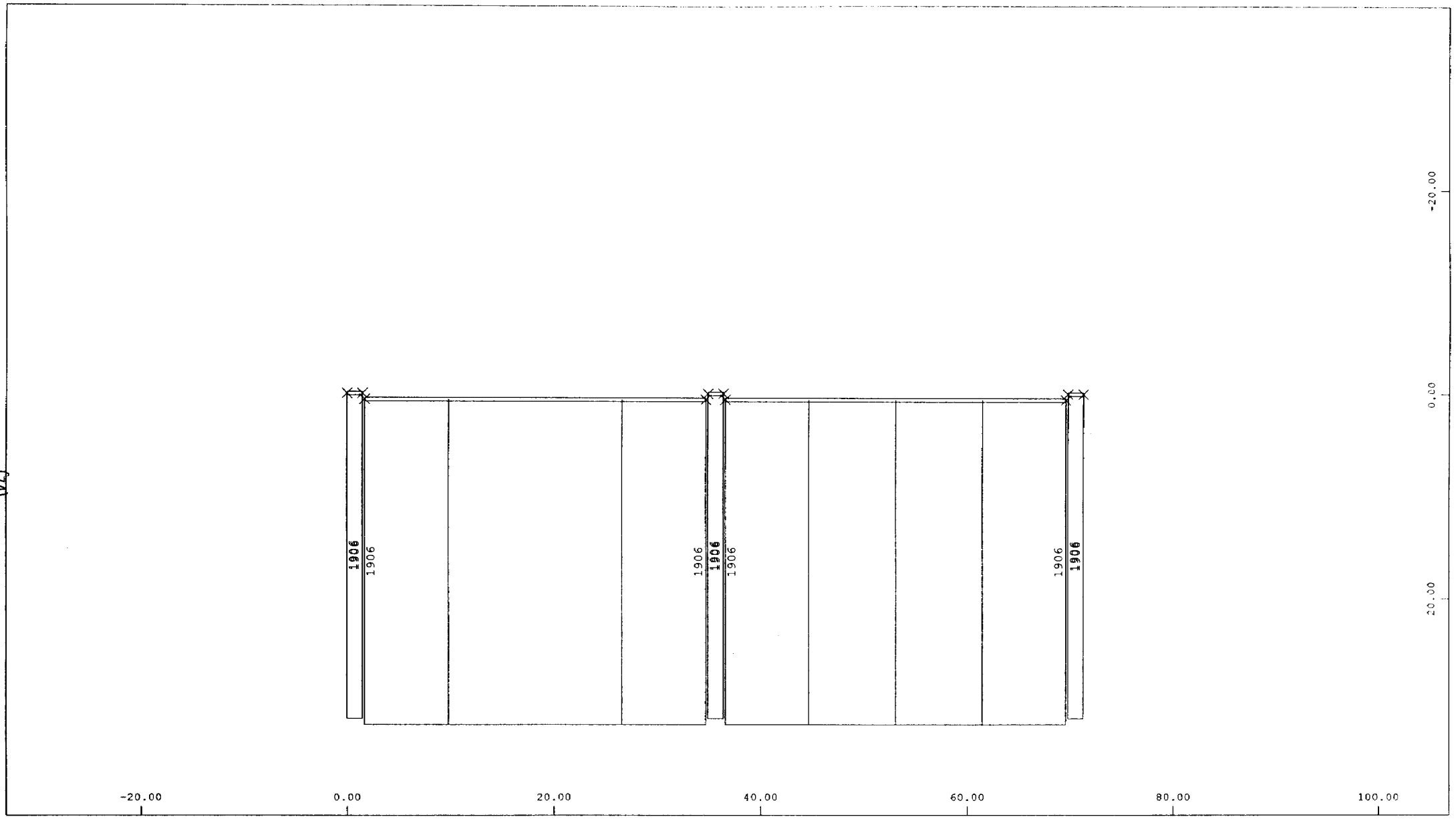
INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
— x SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM MOMENTS MY LC 1 LOAD CASE 1 1 CM = 5000 kNm

M 1 : 500

METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9



METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9



INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM NORMAL FORCES LC 1 LOAD CASE 1 1 CM = 300.0 kN

M 1 : 500

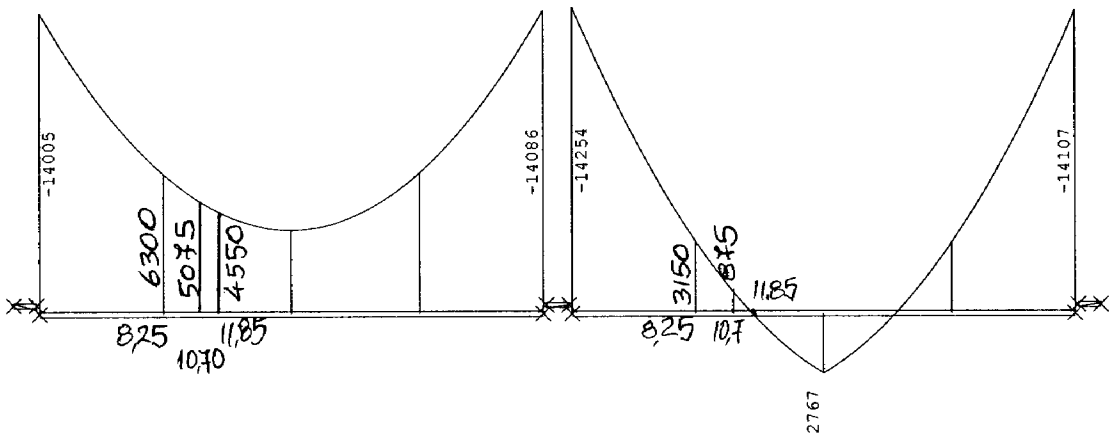
METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9

ΘΑΜΙΣΤΙΚΗ ΜΕΘΟΔΟΣ

$0,5(6.300+3.150)-3,814\left(3.500-\frac{24.535}{5,1}\right)=-1,38\Delta N_1 \rightarrow \Delta N_1=-7050\ kN \rightarrow N_1=24535-7050=17490\ kN \rightarrow x_1=(2\times 8,25+2,65)\times$ 60°C

$\times 24.535/17.490=25,25m \rightarrow L_{eff,1}=11,85\ m \rightarrow 0,5(4550+\varnothing)+5000=-1,38\Delta N_2 \rightarrow \Delta N_2=-5270\ kN \rightarrow N_2=19.260\ kN \rightarrow x_2=18,15\times 24.535/$

$/19.260\simeq 22,90m \rightarrow L_{eff,2}=10,70\ m \rightarrow 0,5(5075+875)+5000=-1,38\Delta N_3 \rightarrow \Delta N_3=-5780\ kN \rightarrow N_3=18.750\ kN \rightarrow L_{eff,3}=11,0\ m$



(75)

-20.00
0.00
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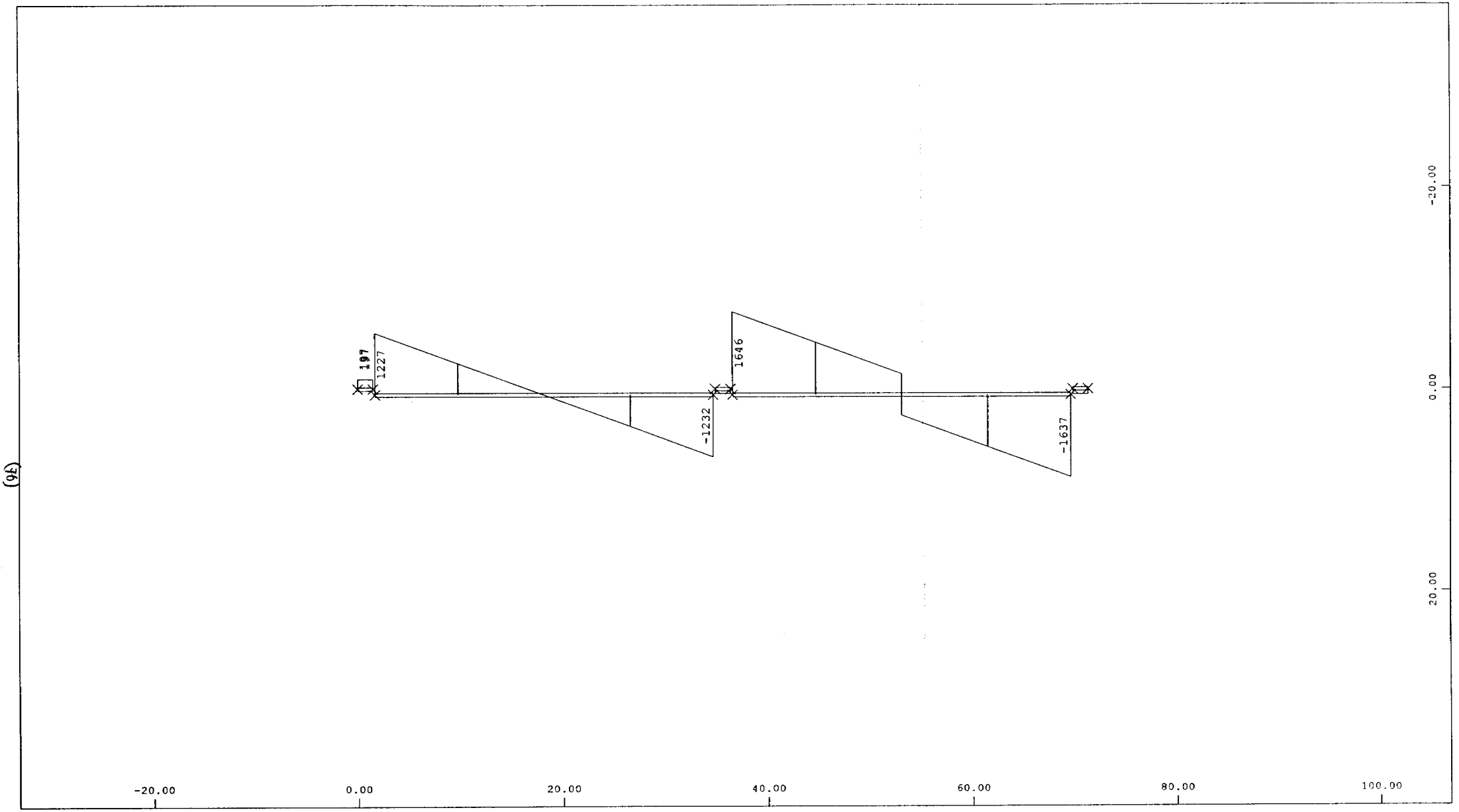
-20.00 0.00 20.00 40.00 60.00 80.00 100.00

INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM MOMENTS MY LC 2 LOAD CASE 2 1 CM = 3500 kNm

M 1 : 500

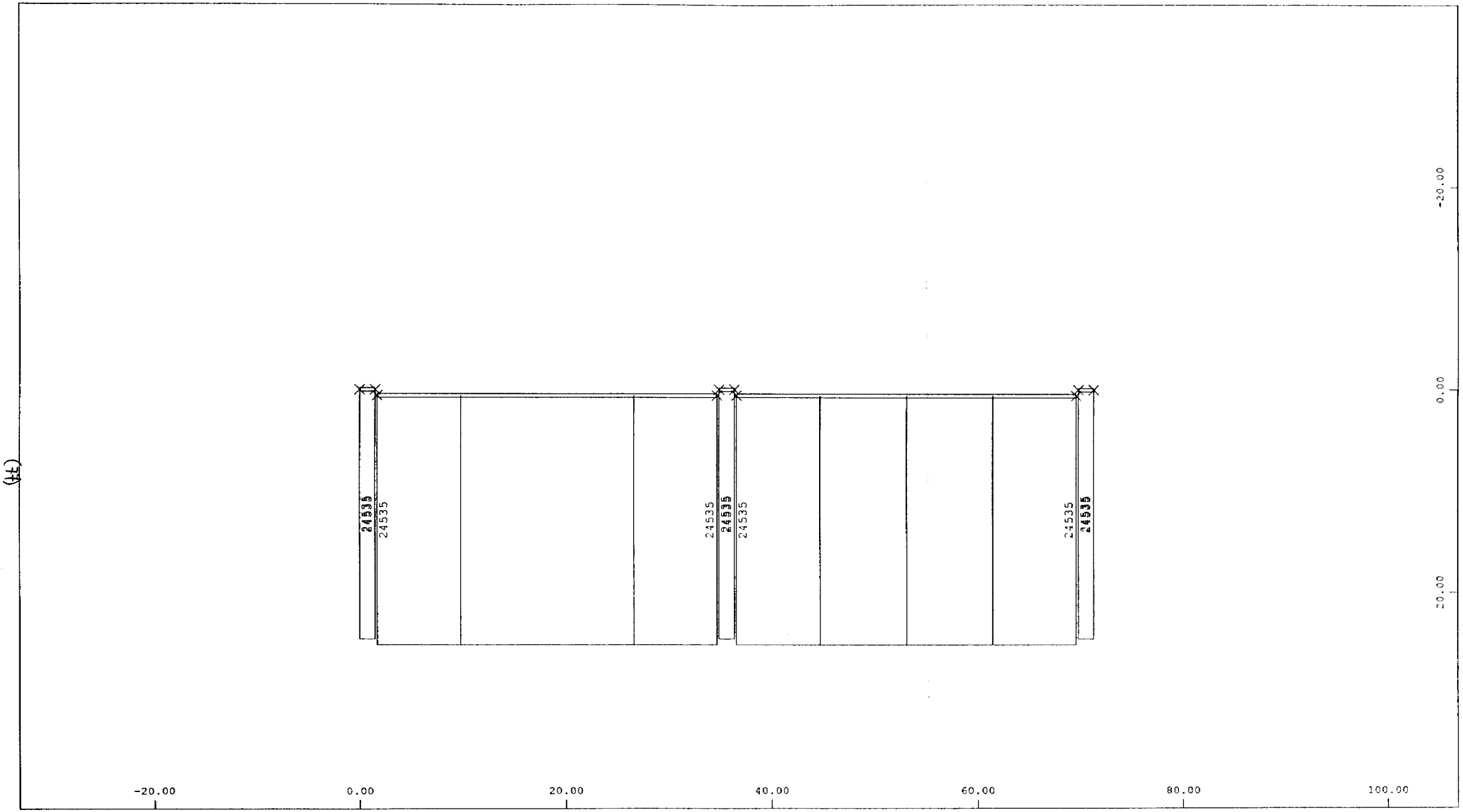
METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9



INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM SHEAR FORCES QZ LC 2 LOAD CASE 2 1 CM = 1000 kN

M 1 : 500

METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9

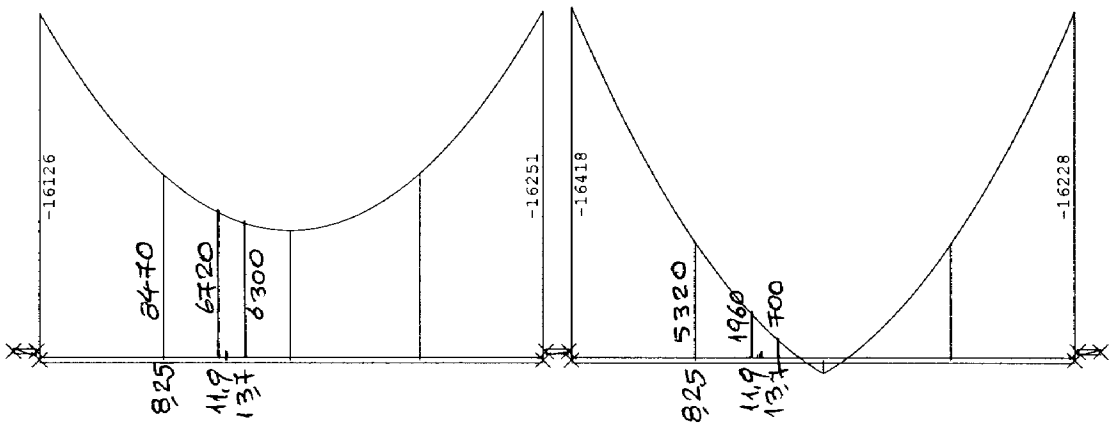


INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM NORMAL FORCES LC 2 LOAD CASE 2 1 CM = 5000 kN

M 1 : 500

METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9

70°C



ΘΑΜΙΣΤΙΚΗ ΜΕΘΟΔΟΣ

$0,5(8470+5320)-3,814\left(3500-\frac{28.307}{5,1}\right)=6895+7820=14.715=-1,38\,\Delta N_1 \rightarrow \Delta N_1=-10663 \rightarrow N_1=28.307-10.663=17.640$ kN

$X_1=(2\times 8,25+2,65)\,28.307/17.640=28,90$ m $\rightarrow L_{eff,1}=0,5(28,90-1,5)=13,70$ m $\rightarrow 0,5(6300+700)+7820=-1,38\,\Delta N_2 \rightarrow$

$\Delta N_2=-8200$ kN $\rightarrow N_2=28.307-8200=20.100$ kN $\rightarrow X_2=19,15\times 28.307/20.100=25,35$ m $\rightarrow L_{eff,2}=11,90$ m $\rightarrow$

$0,5(6720+1960)+7820=-1,38\,\Delta N_3 \rightarrow \Delta N_3=-8810$ kN $\rightarrow N_3=19.500$ kN $\rightarrow X_3=26,15$ m $\rightarrow L_{eff,3}=12,3$ m $\rightarrow$

$N_3=19.500$ kN $\rightarrow X_3=23,15$ m $\rightarrow L_{eff,3}=12,3$ m $\rightarrow N=19.600$ kN , $L_{eff}=12,25$ m

(8t)

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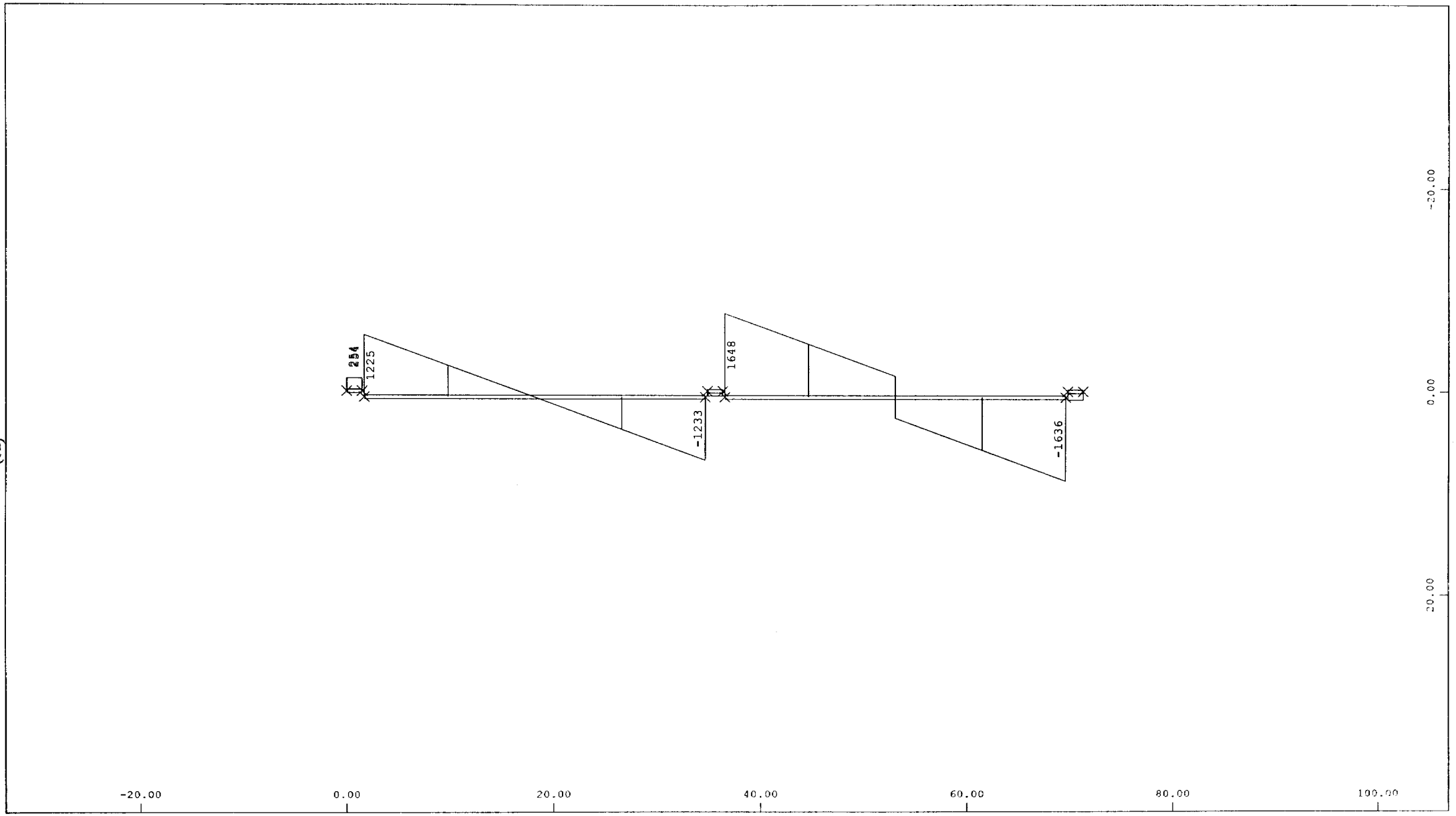
-20.00 0.00 20.00

INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM MOMENTS MY LC 2 LOAD CASE 2 1 CM = 3500 kNm

M 1 : 500

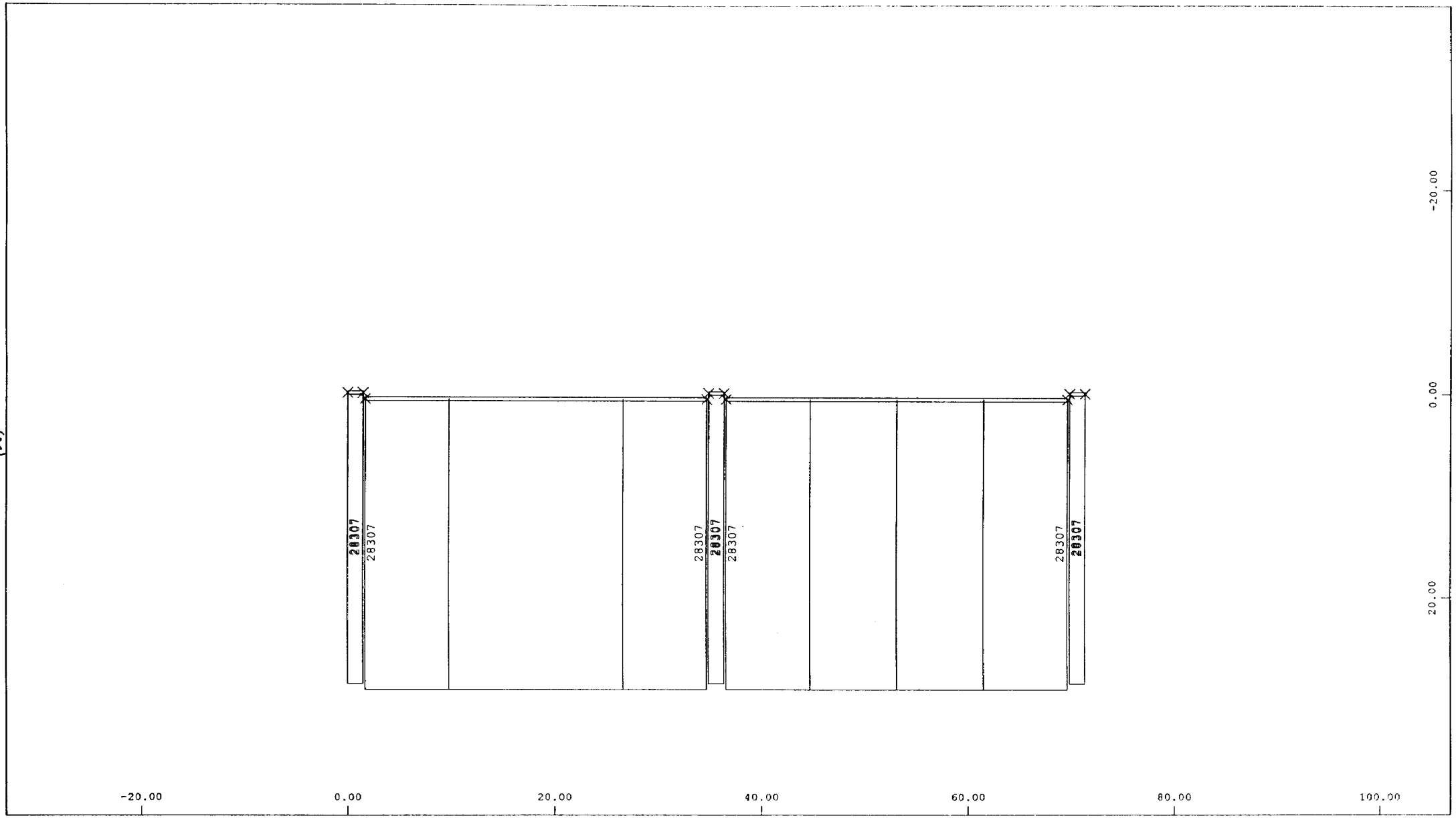
METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9



INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM SHEAR FORCES QZ LC 2 LOAD CASE 2 1 CM = 1000 kN

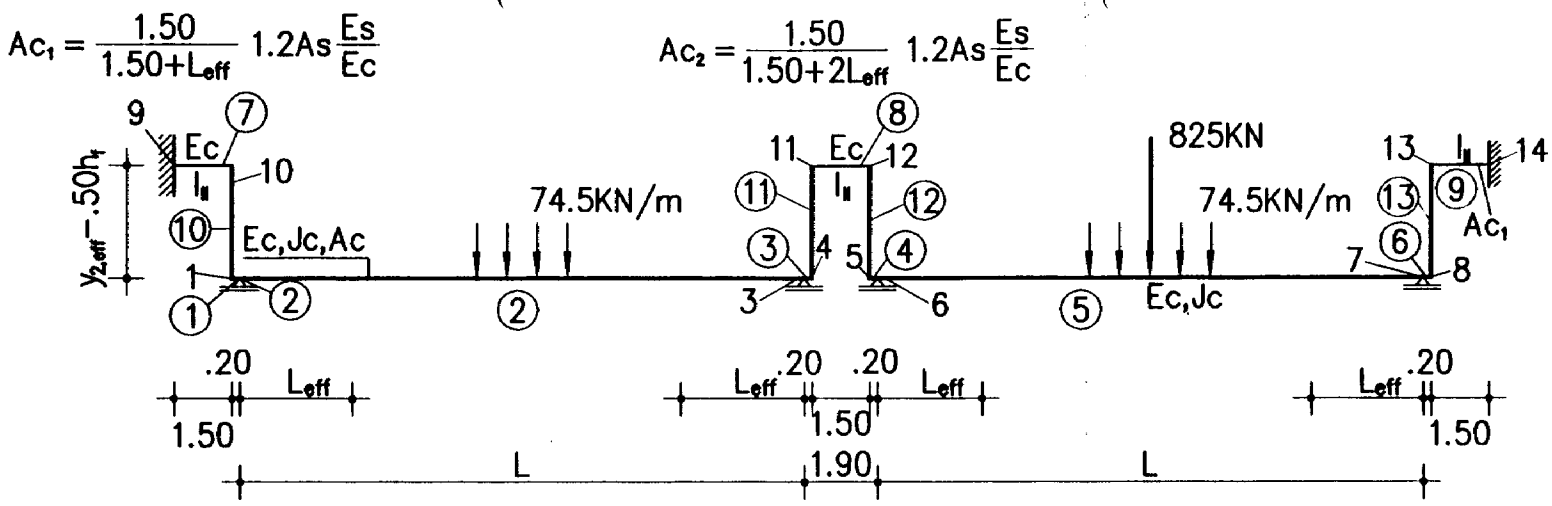
M 1 : 500

METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9



INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM NORMAL FORCES LC 2 LOAD CASE 2 1 CM = 5000 kN

M 1 : 500

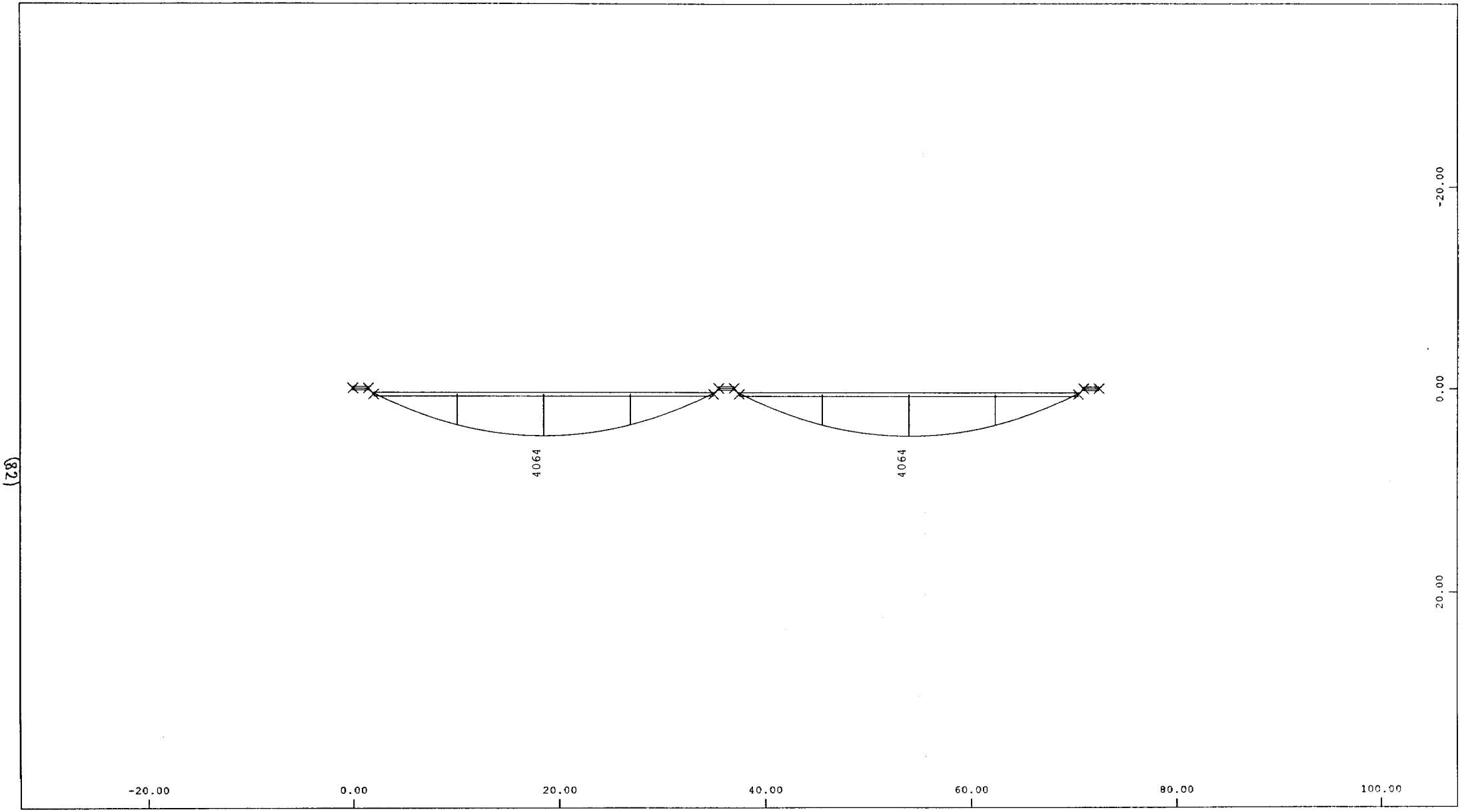


ΠΙΝΑΚΑΣ ΔΕΔΟΜΕΝΩΝ

L=33.0m	E_c =32 GPa
b=12.0m	a=6.25
$A_{c,eff}$ =5.100m^2	g_1 =30.7KN/m
$J_{c,eff}$ =2.784m	q= ∅ KN/m
h_b =2.15m	g_1 +q=30,7 KN/m
h_{ft} =0.275m	Q= ∅ KN
$h_{f,eff}$ =0.20m	A_{st} =3ΤΤ(3φ10/75)
$h_{(πρ.)}$ =0.075m	ρ=0,016
$y_{2,eff}$ =0.73m	A_{sb} =
	T= -50°C
	Leff= L/3 = 11 m

$I_{II} = 3.544 a\rho b h_{f,eff}^3/12 = 0.1772\rho \sim \phi$

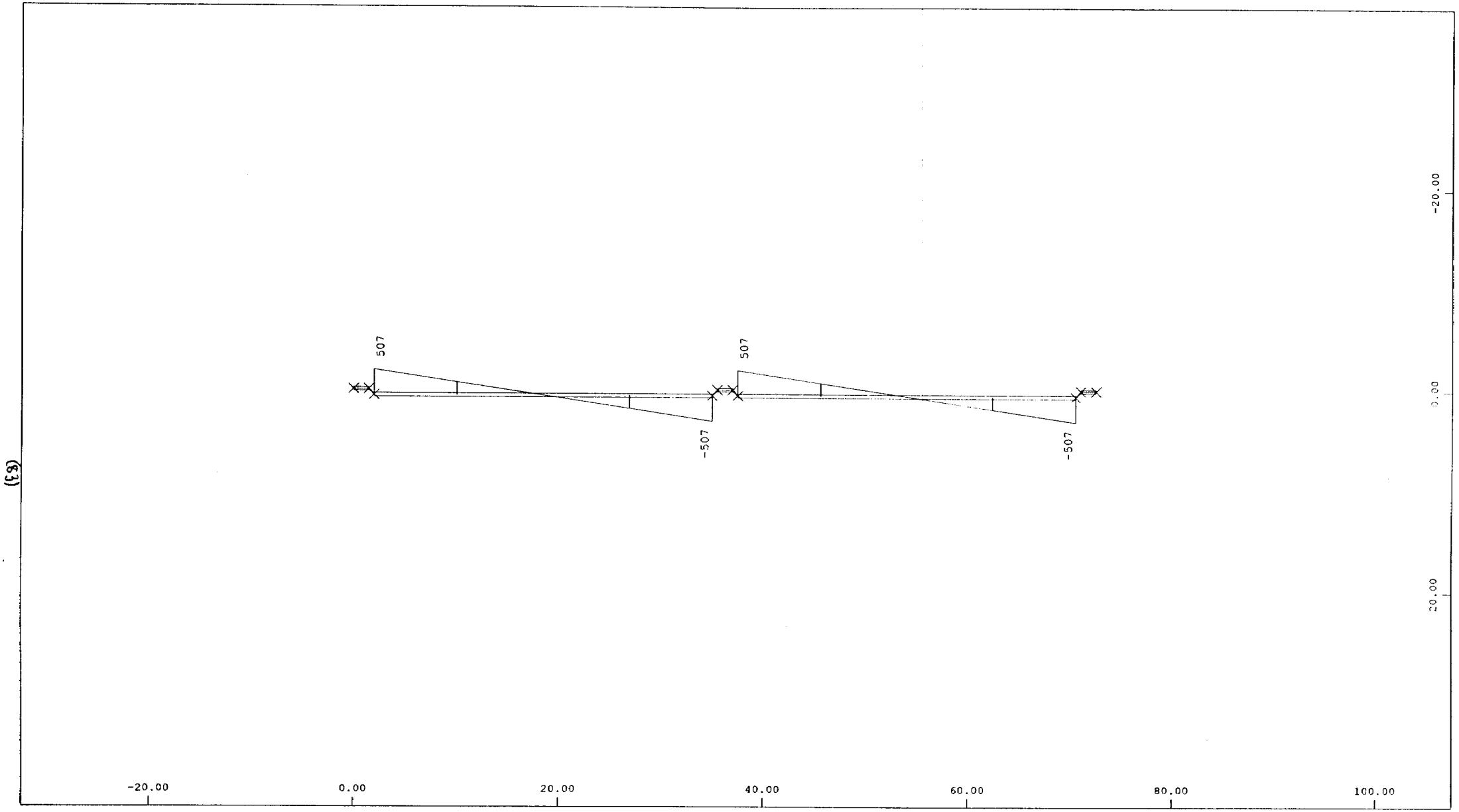
METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9



INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM MOMENTS MY LC 1 LOAD CASE 1 1 CM = 5000 kNm

M 1 : 500

METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9

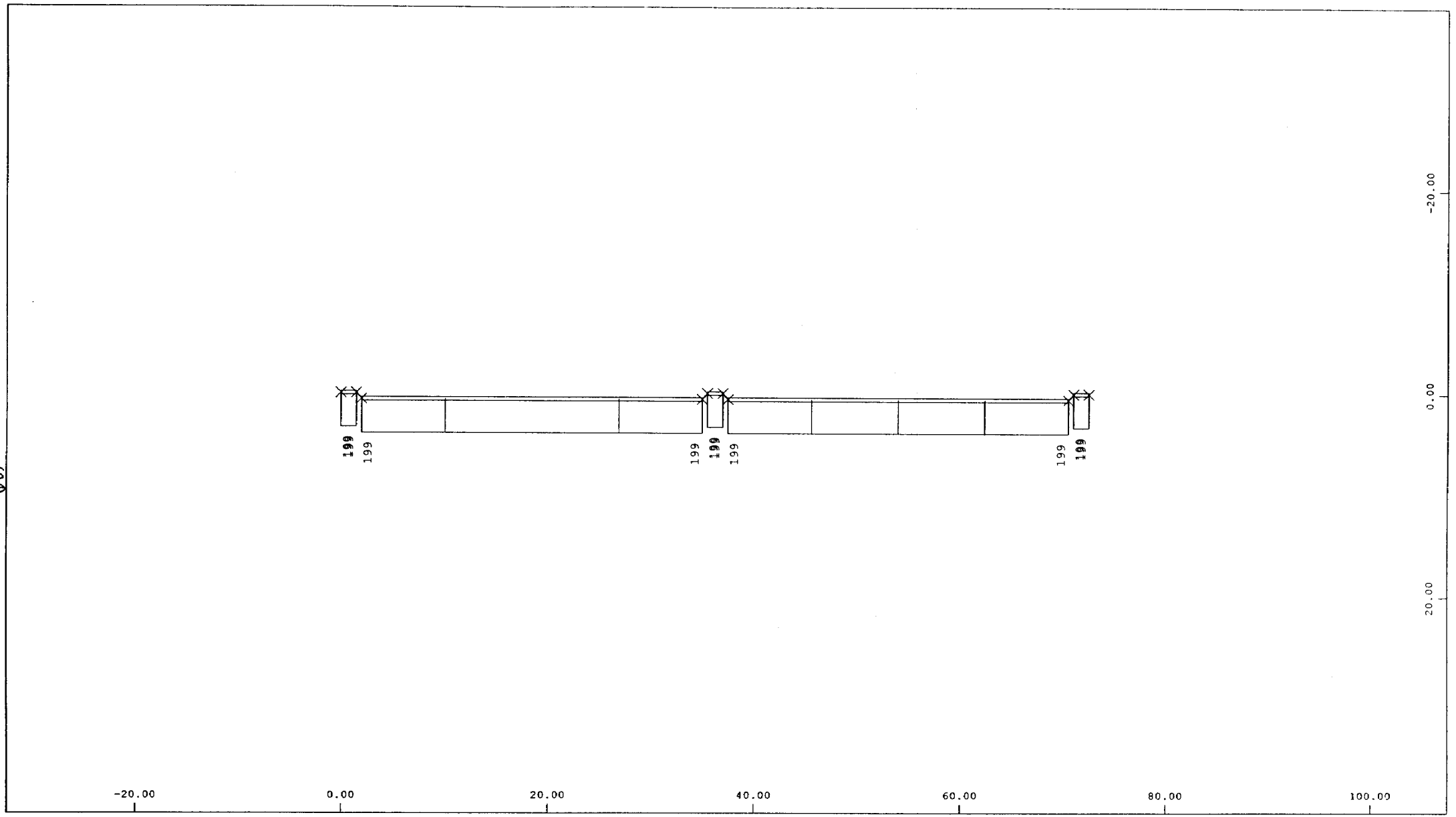


(83)

INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM SHEAR FORCES QZ LC 1 LOAD CASE 1 1 CM = 1000 kN

M 1 : 500

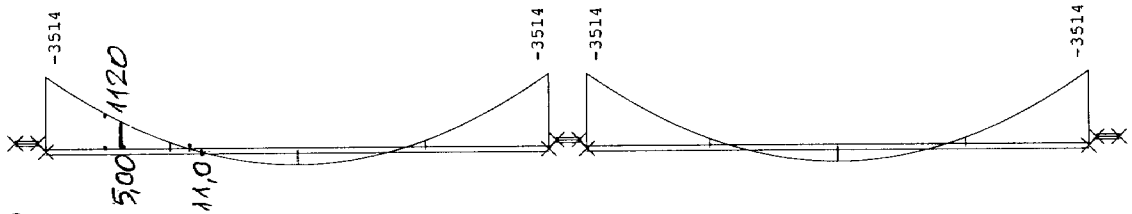
METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9



INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM NORMAL FORCES LC 1 LOAD CASE 1 1 CM = 300.0 kN

M 1 : 500

METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9



ΘΑΜΙΣΤΙΚΗ ΜΕΘΟΔΟΣ

$\text{or } \Delta M(x=L_{eff}) - M_{cr} \simeq -\left(y_{2,eff} - 0{,}5\,h_{f,eff} + \frac{W_{2,eff}}{A_{c,eff}}\right)\Delta N \rightarrow 0-3,814\left(3500-\frac{6059}{5{,}1}\right) = -1{,}38\,\Delta N_1 \rightarrow \Delta N_1 = 6390\ kN$

$N_1 = 6059+6390 = 12449\ kN \rightarrow x_1 = (2\times 11{,}0+2{,}65)\times 6059/12449 = 11{,}45\ m \rightarrow L_{eff} = 4{,}97\ m \rightarrow 1120-8820 = -1{,}38\,\Delta N_2 \rightarrow$

$\Delta N_2 = 5580\ kN \rightarrow N_2 = 11640\ kN \rightarrow x_2 = 24{,}65\times 6059/11640 = 12{,}25\ m \rightarrow L_{eff,2} = 5{,}35\ m \rightarrow 1050-8820 = -1{,}38\,\Delta N_3 \rightarrow$

$\Delta N_3 = 5630\ kN \rightarrow N_3 = 5630+6059 = 11690\ kN \rightarrow x_3 = 12{,}20\ m \rightarrow L_{eff} = 5{,}30\ m \rightarrow N = 11700\ kN$

-20.00 0.00 20.00 40.00 60.00 80.00 100.00

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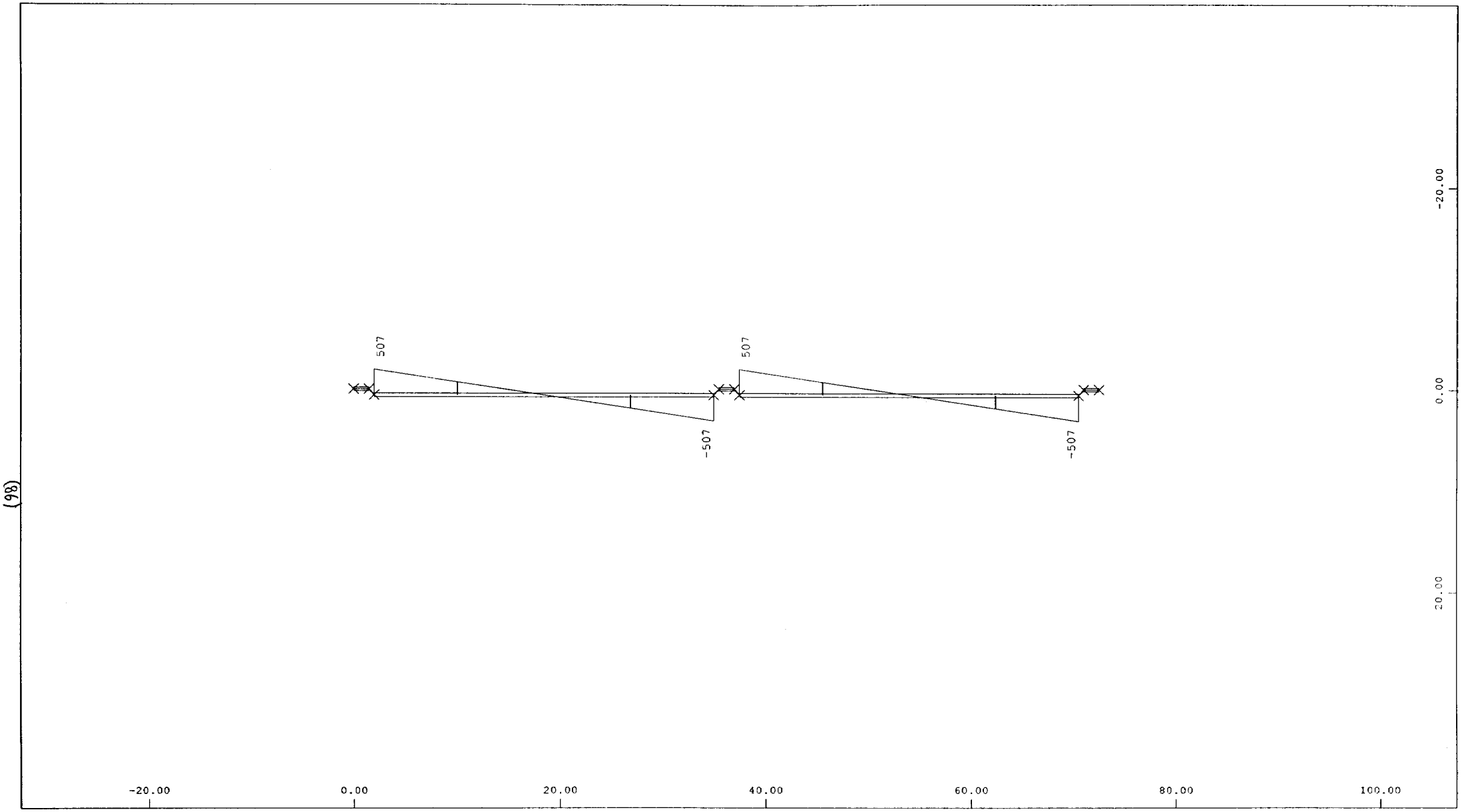
INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM MOMENTS MY LC 2 LOAD CASE 2 1 CM = 3500 kNm

M 1 : 500

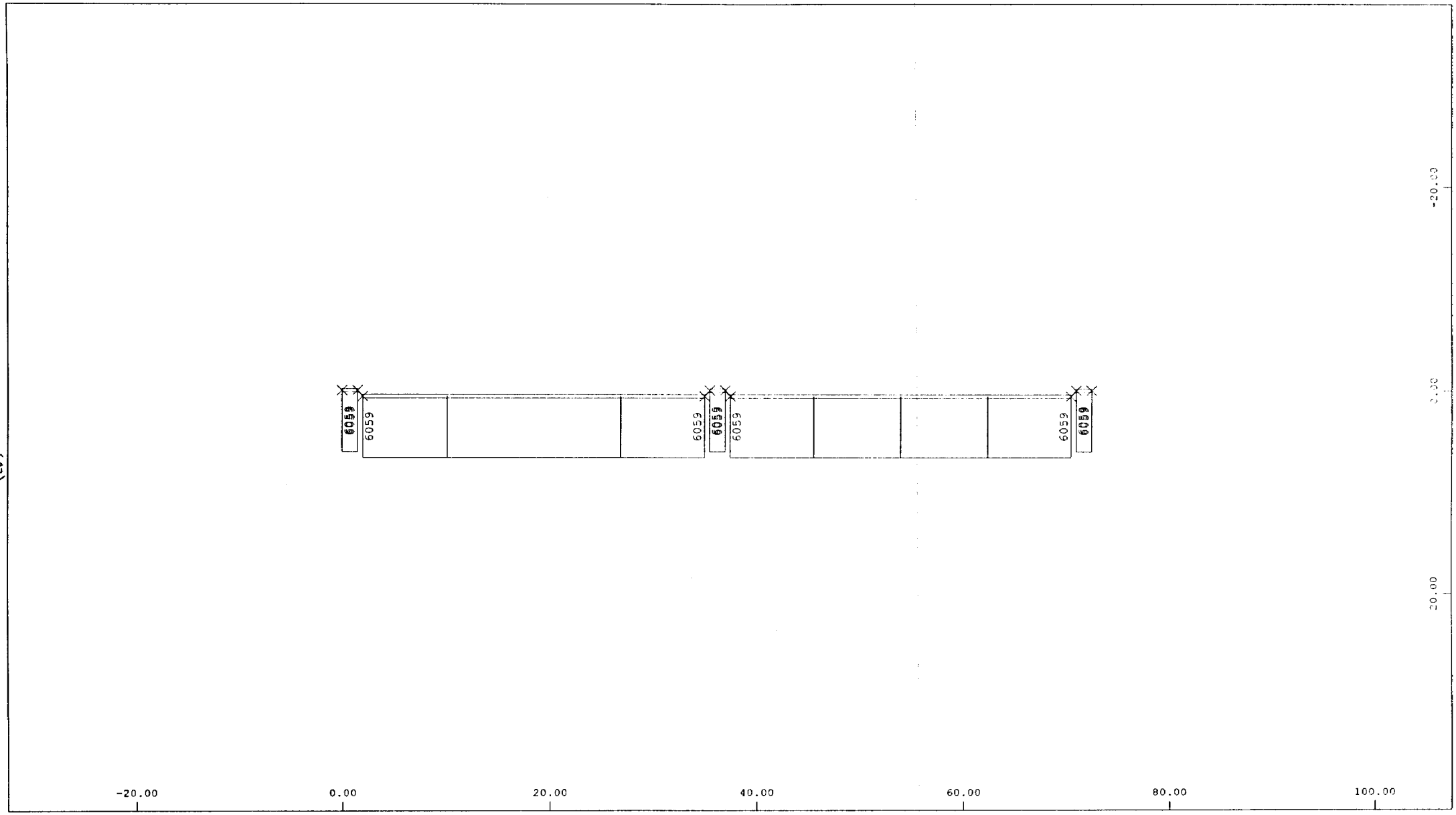
METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9



INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM SHEAR FORCES QZ LC 2 LOAD CASE 2 1 CM = 1000 kN

M 1 : 500

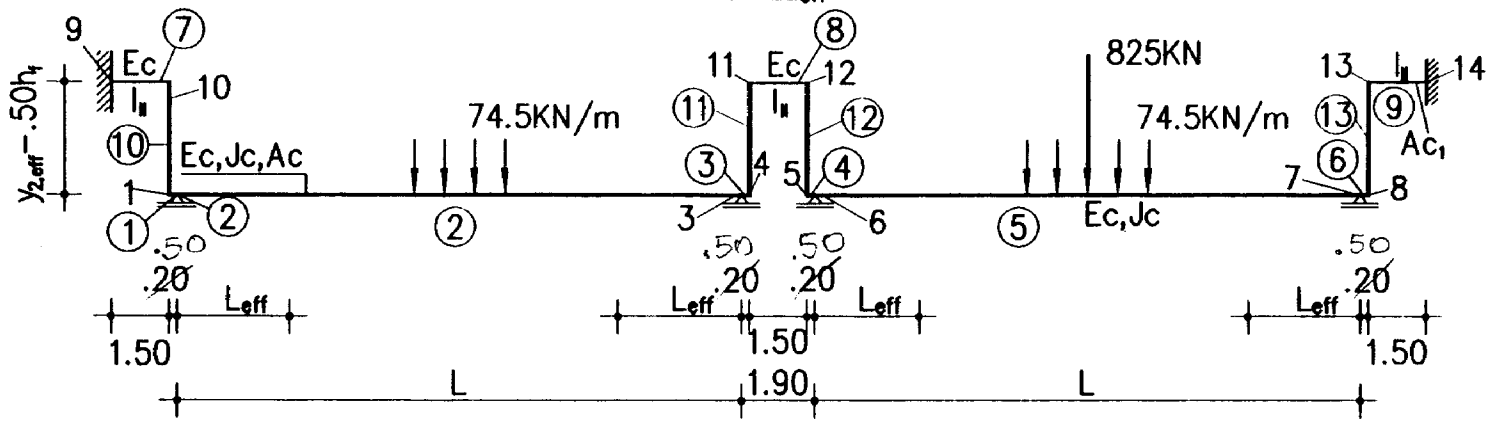
METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9



INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM NORMAL FORCES LC 2 LOAD CASE 2 1 CM = 5000 kN

M 1 : 500

$$Ac_1 = \frac{1.50}{1.50+L_{eff}}\ 1.2As\frac{Es}{Ec} \qquad Ac_2 = \frac{1.50}{1.50+2L_{eff}}\ 1.2As\frac{Es}{Ec}$$

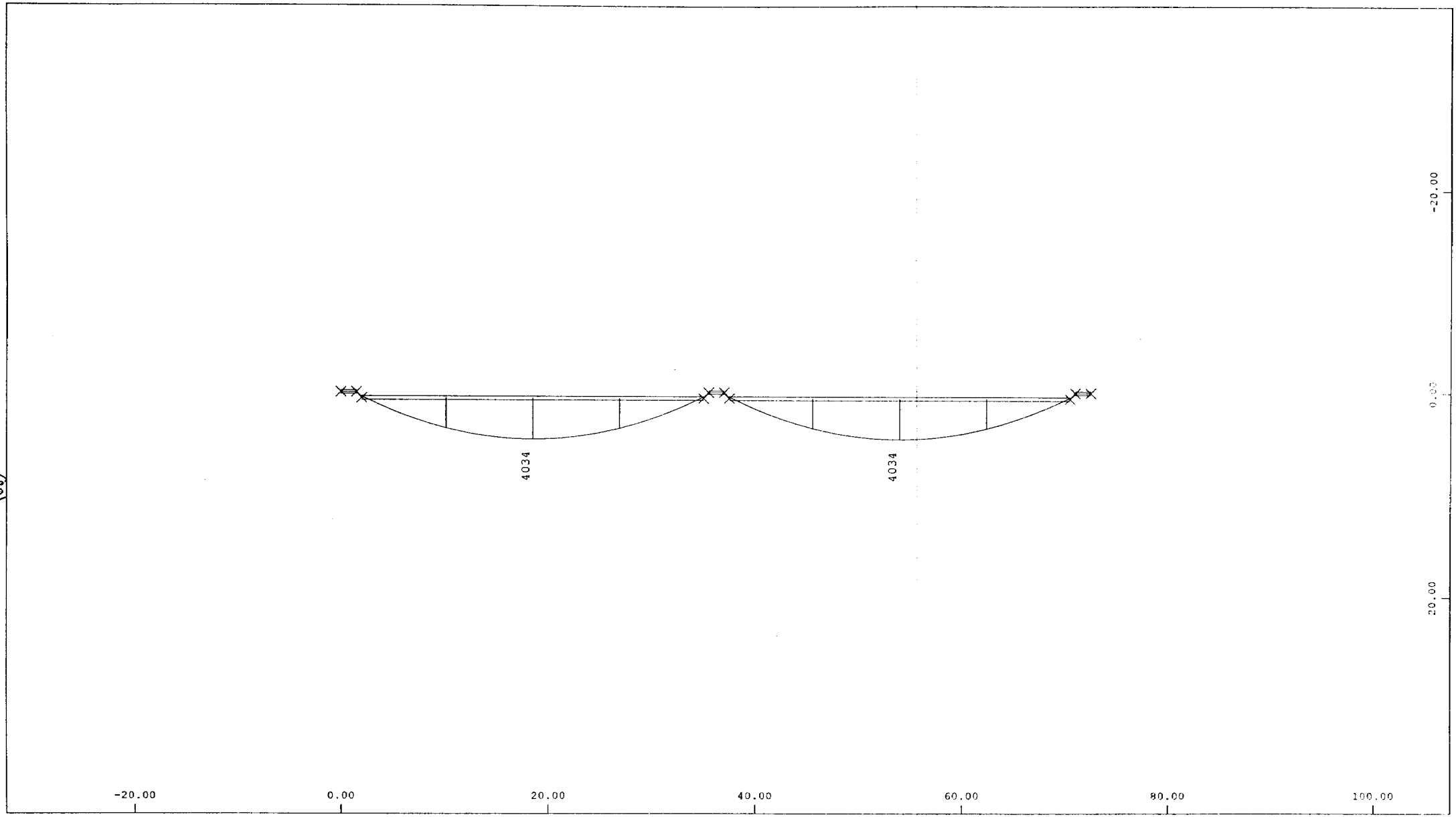


ΠΙΝΑΚΑΣ ΔΕΔΟΜΕΝΩΝ

L=33.0m	E_c =32 GPa
b=12.0m	a=6.25
$A_{c,eff}$ =5.100m^2	g_1 =30.7KN/m
$J_{c,eff}$=2.784m	q= ∅ KN/m
h_b =2.15m	g_1 +q=30,7 KN/m
h_{ft}=0.275m	Q= ∅ KN
$h_{f,eff}$=0.20m	A_{st}= 37.7 cm^2 (3ø10/75)
$h_{(np.)}$=0.075m	ρ=0,016
$y_{2,eff}$ =0.73m	A_{sb}=∅
	T=-50°C
	Leff=L/4=8,25

$I_{II}=3.544a\rho bh_{f,eff}^3/12=0.1772\rho\approx\varnothing$

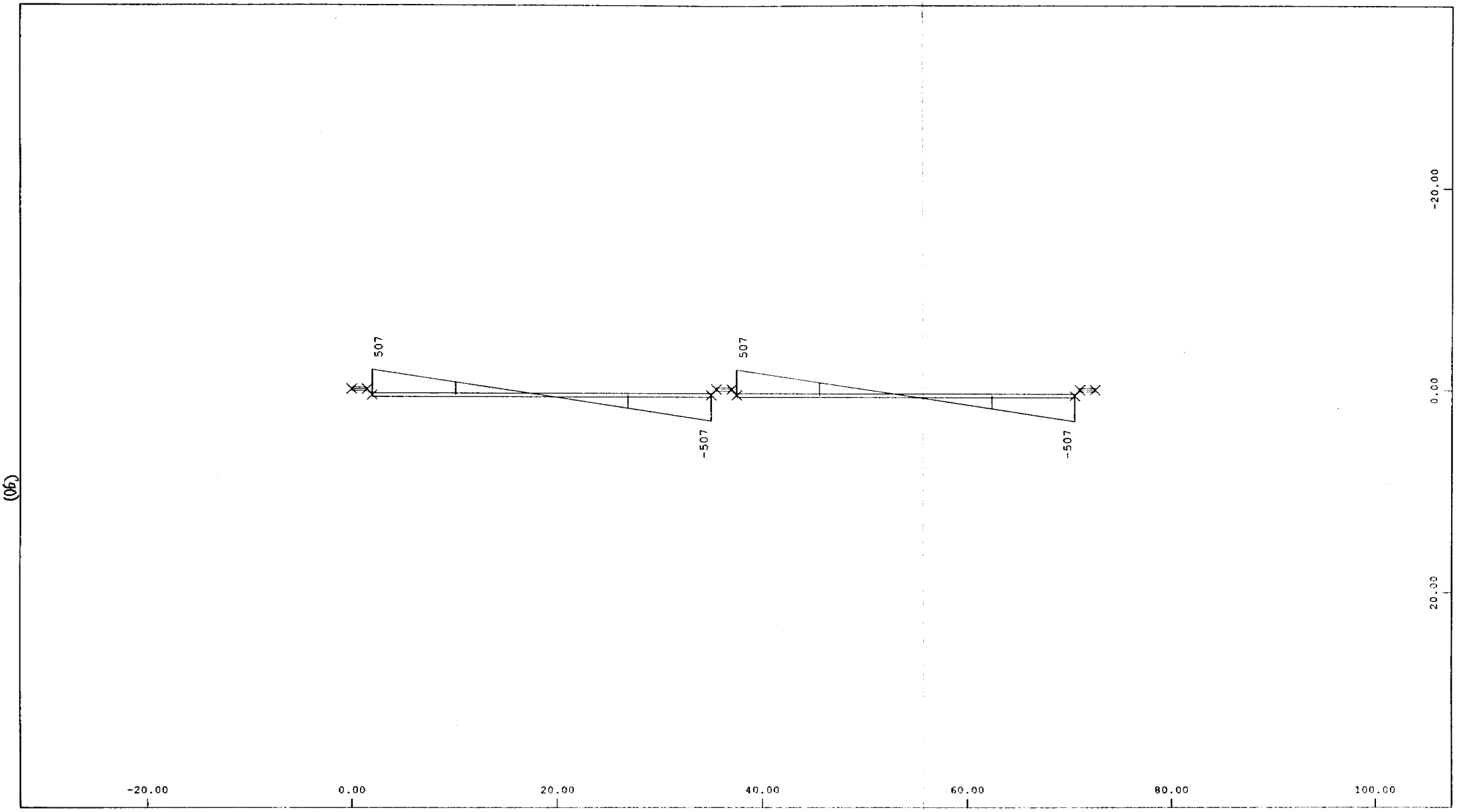
METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9



INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM MOMENTS MY LC 1 LOAD CASE 1 1 CM = 5000 kNm

M 1 : 500

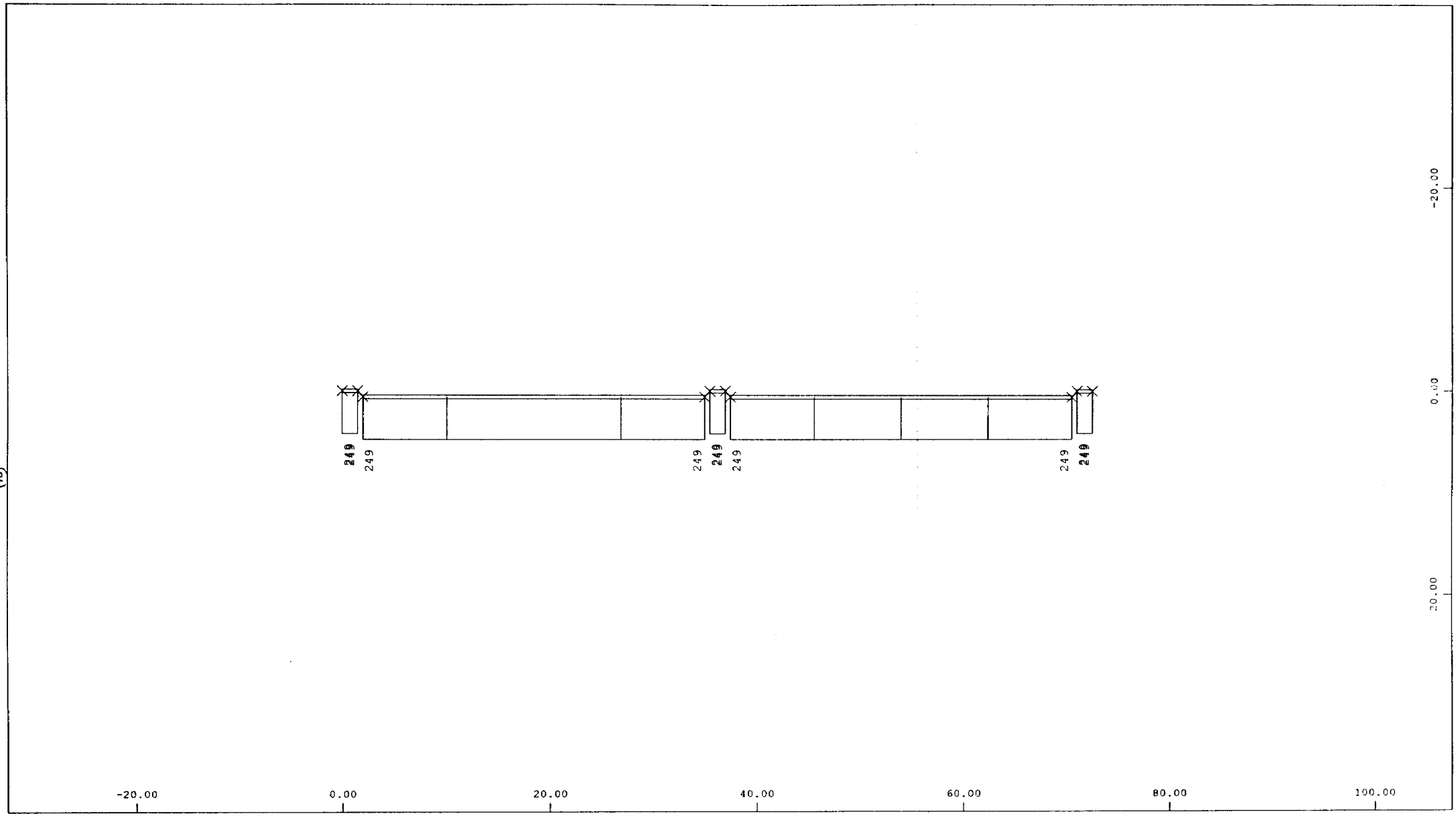
METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9



INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM SHEAR FORCES QZ LC 1 LOAD CASE 1 1 CM = 1000 kN

M 1 : 500

METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9



INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM NORMAL FORCES LC 1 LOAD CASE 1 1 CM = 300.0 kN

M 1 : 500

METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9

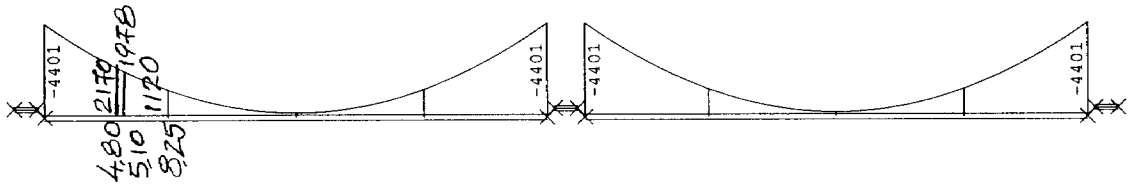
ΘΑΜΙΣΤΙΚΗ ΜΕΘΟΔΟΣ

$\nu\alpha\ \Delta M(x=L_{eff}) - M_{cr} \simeq -\left[(y_{2,eff} - 0{,}5 h_{f,eff}) + \frac{W_{2,eff}}{A_{c,eff}}\right]\Delta N \rightarrow 1120 - 3{,}814\left(3500 - \frac{7.588}{5{,}1}\right) = -1{,}38\,\Delta N_1 \rightarrow \Delta N_1 = 4750\ kN$

$N_1 = 7588 + 4750 = 12338\ kN \rightarrow x_1 = (2\times 8{,}25 + 2{,}65)\times 7.588/12338 \simeq 11{,}05\ m \rightarrow L_{eff,1} = (11{,}05 - 2{,}65)/2 = 4{,}80\ m \rightarrow$ 2150 − 7675 =

$= -1{,}38\,\Delta N_2 \rightarrow \Delta N_2 = 3990\ kN \rightarrow N_2 \simeq 11.580\ kN \rightarrow x_2 = 19{,}15 \times 7588/11580 \simeq 11{,}65\ m \rightarrow L_{eff,2} \simeq 5{,}10\ m \rightarrow$ 1978 −

$-7675 = -1{,}38\,\Delta N_3 \rightarrow \Delta N_3 \simeq 4130\ kN \rightarrow N_3 = 11.720\ kN \rightarrow x_3 = 11{,}65\ m \rightarrow L_{eff,3} = 5{,}10\ m \rightarrow N = 11.700\ kN$



(92)

-20.00
0.00
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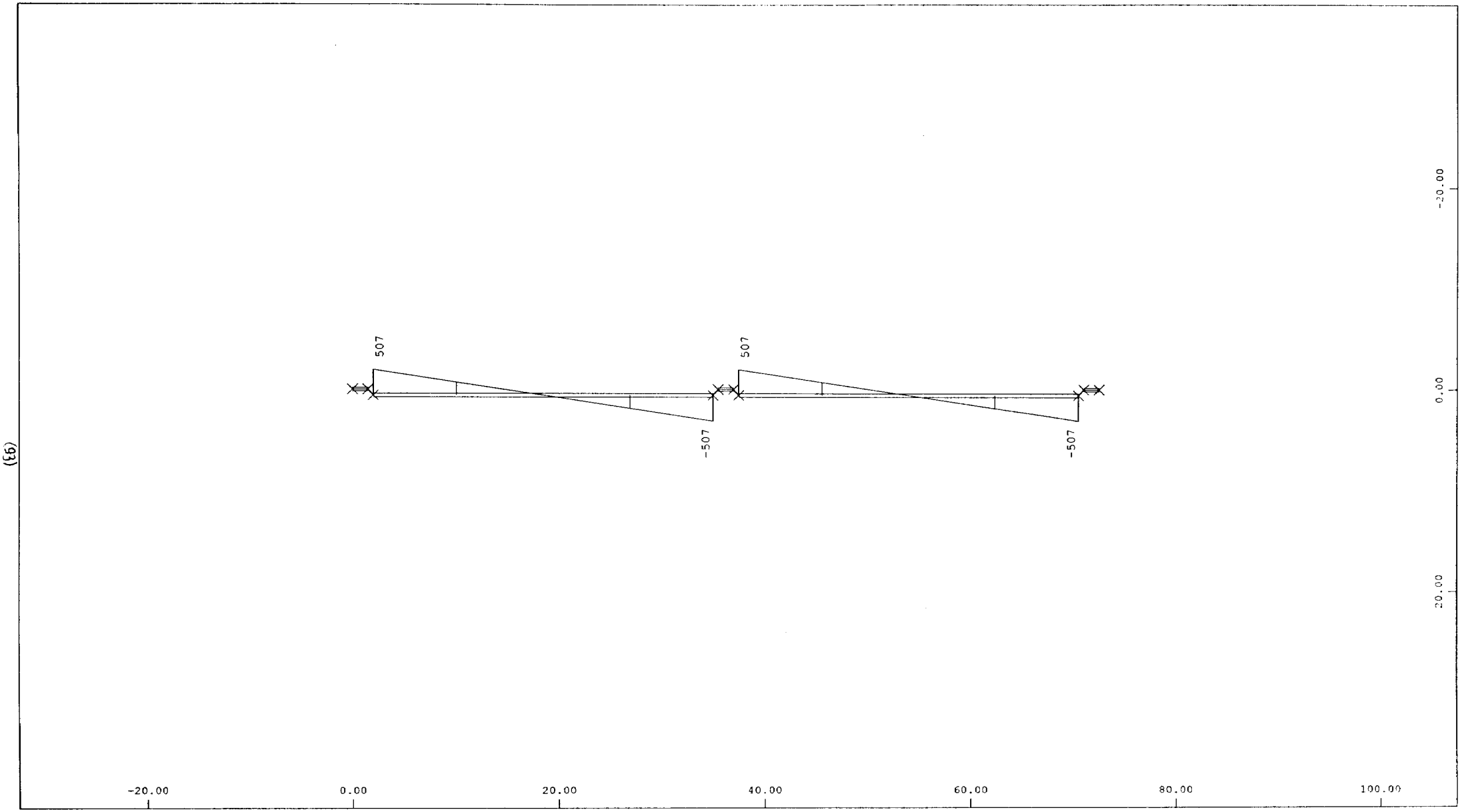
-20.00 0.00 20.00 40.00 60.00 80.00 100.00

INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM MOMENTS MY LC 2 LOAD CASE 2 1 CM = 3500 kNm

M 1 : 500

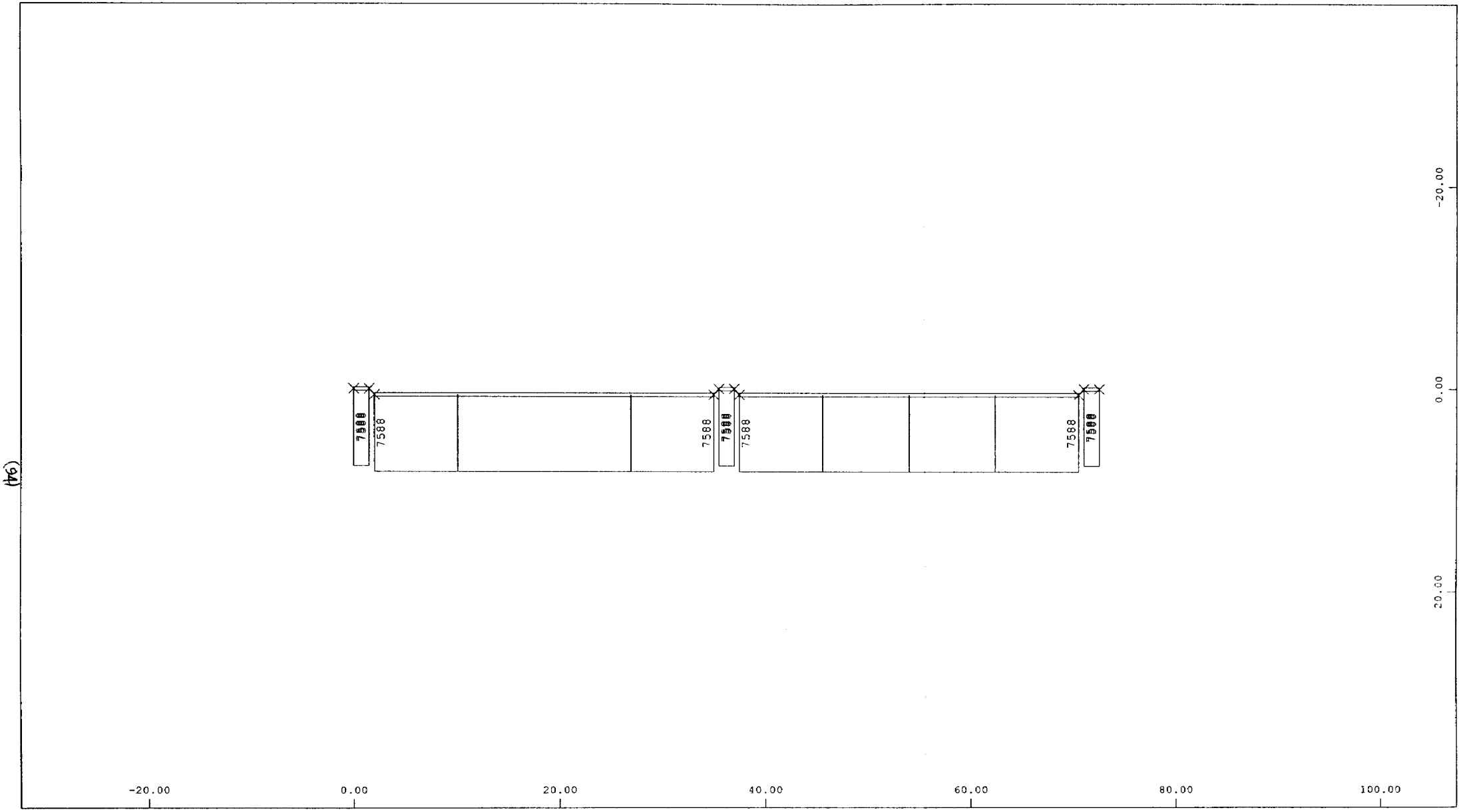
METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9



INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM SHEAR FORCES QZ LC 2 LOAD CASE 2 1 CM = 1000 kN

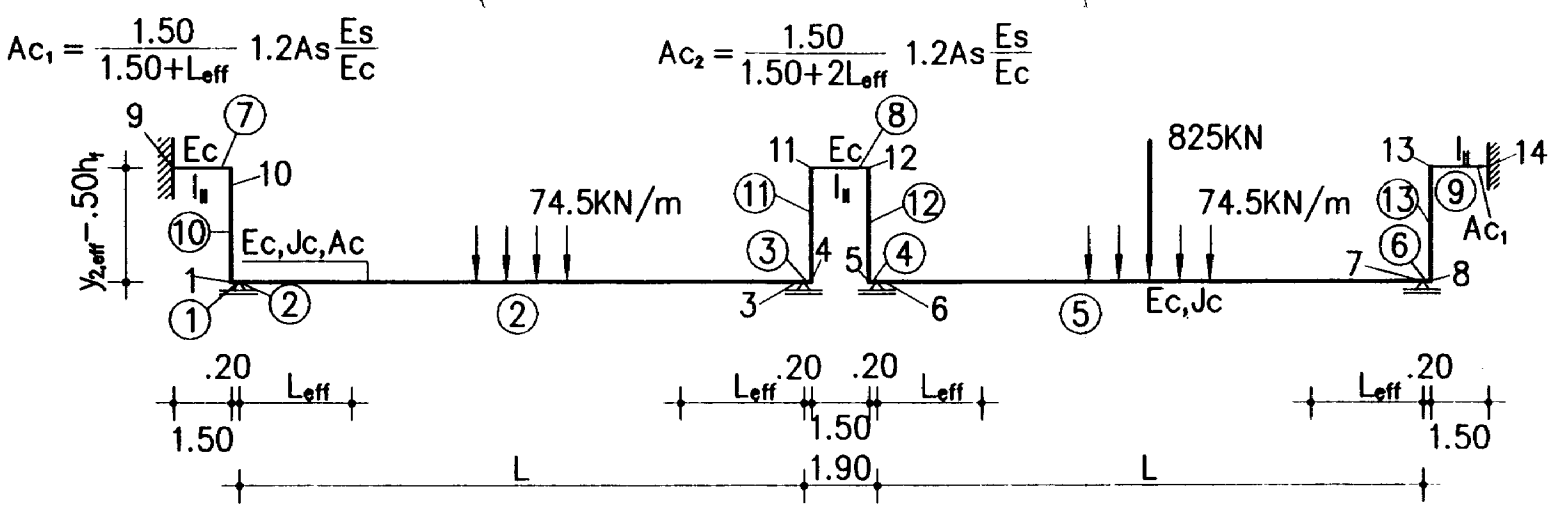
M 1 : 500

METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9



INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM NORMAL FORCES LC 2 LOAD CASE 2 1 CM = 5000 kN

M 1 : 500

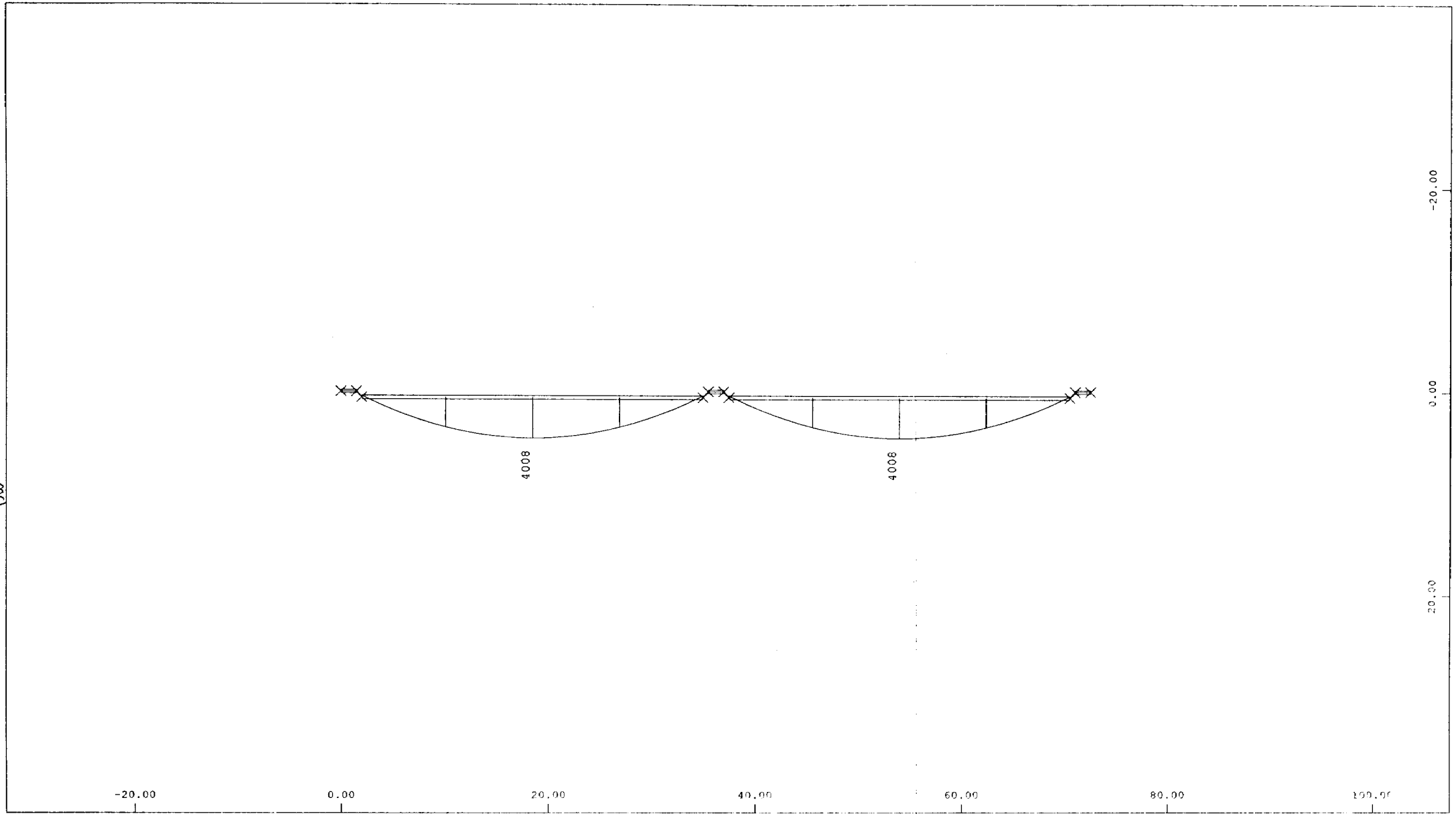


ΠΙΝΑΚΑΣ ΔΕΔΟΜΕΝΩΝ

L=33.0m	E_c =32 GPa
b=12.0m	a=6.25
$A_{c,eff}$ =5.100m^2	g_1 =30.7KN/m
$J_{c,eff}$=2.784m	q= ∅ KN/m
h_b =2.15m	g_1 +q=30.7 KN/m
h_{ft}=0.275m	Q= ∅ KN
$h_{f,eff}$=0.20m	A_{st}=37.7cm^2(3φ10/75)
$h_{(πρ.)}$=0.075m	ρ=0,016
$y_{2,eff}$ =0.73m	A_{sb}= ∅
	T=-50°C
	Leff=L/5 = 6.6m

$I_{II} = 3.544a\rho bh_{f,eff}^3/12 = 0.1772\rho \simeq \varnothing$

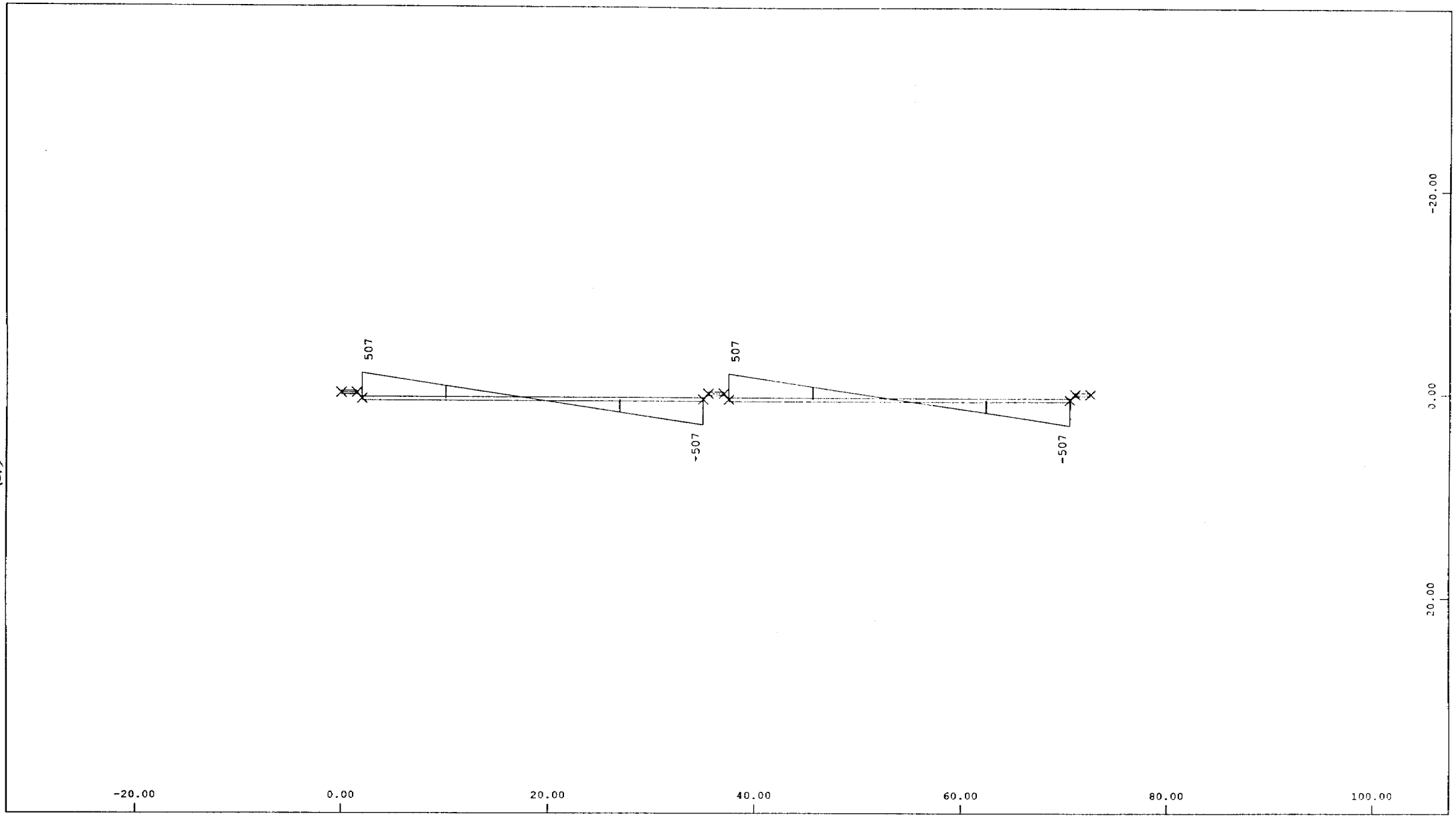
METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9



INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM MOMENTS MY LC 1 LOAD CASE 1 1 CM = 5000 kNm

M 1 : 500

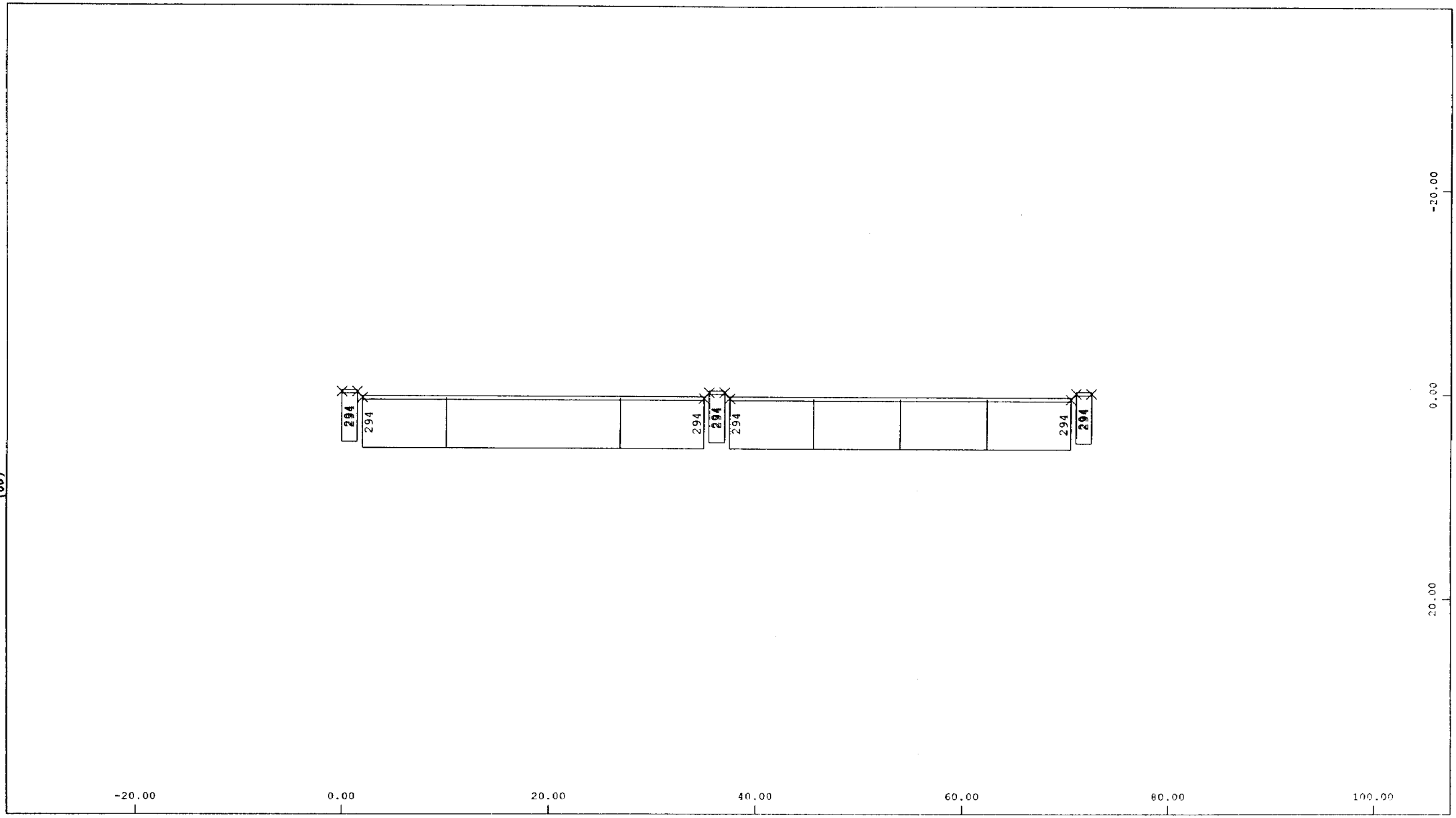
METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9



INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM SHEAR FORCES QZ LC 1 LOAD CASE 1 1 CM = 1000 kN

M 1 : 500

METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9



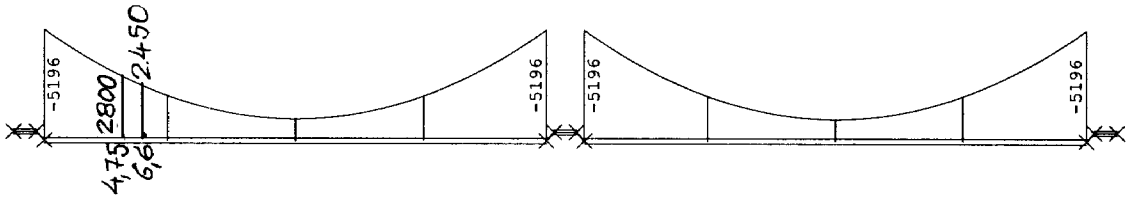
INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM NORMAL FORCES LC 1 LOAD CASE 1 1 CM = 300.0 kN

M 1 : 500

ΕΛΕΓΧΟΣ ΠΛΑΚΑΣ ΕΛΚΥΣΤΗΡΑ

$N \simeq 11650 \simeq 11700$ kN , $A_c = 377\ cm^2$

$\sigma_s = 11700/377 = 31\ kN/cm^2 = 310\ MPa < 315\ MPa \triangleq w_k = 0{,}1$ mm (ΠΙΝ. 15.1 ΚΟΣ)



ΘΑΜΙΣΤΙΚΗ ΜΕΘΟΔΟΣ

για $\Delta M(x = L_{eff}) - M_{cr} = -\left[\chi_{2,\infty} - 0{,}5\, h_{f,eff} + \frac{W_{2,eff}}{A_{c,eff}}\right]\Delta N \rightarrow 2450 - 3{,}814\left(3500 - \frac{8959}{5{,}1}\right) = -1{,}38\Delta N_1 \rightarrow \Delta N_1 = 3043$ kN

$N_1 = 8959 + 3043 \simeq 12000$ kN. $\rightarrow x_1 = (2 \times 6{,}6 + 2{,}65) \times 8959/12000 = 11{,}0$ m $\rightarrow L_{eff,1} \simeq 0{,}5(11{,}0 - 2{,}65) = 4{,}75$ m $\rightarrow 2800 - 6650 =$

$= -1{,}38\Delta N_2 \rightarrow \Delta N_2 = 2790$ kN $\rightarrow N_2 \simeq 11.750$ kN $\rightarrow x_2 = 15{,}85 \times 8959/11750 = 11{,}20$ m $\rightarrow L_{eff,2} \simeq 4{,}85$ m

$2975 - 6650 = -1{,}38\Delta N_3 \rightarrow \Delta N_3 \simeq 2663$ kN, $N_3 = 11620$ kN $\rightarrow x_3 = 11{,}35$ m $\rightarrow L_{eff,3} = 4{,}90$ m $\rightarrow N \simeq 11650$ kN

ΠΑΡΑΤΗΡΗΣΗ

Για τα N κ Leff προκύπτουν τα ίδια αποτελέσματα, ως αναμένονταν, με τις δύο άλλες περιπτώσεις στις οποίες υπήρξαν διαφορετικές τιμές εκκίνησης για το Leff.

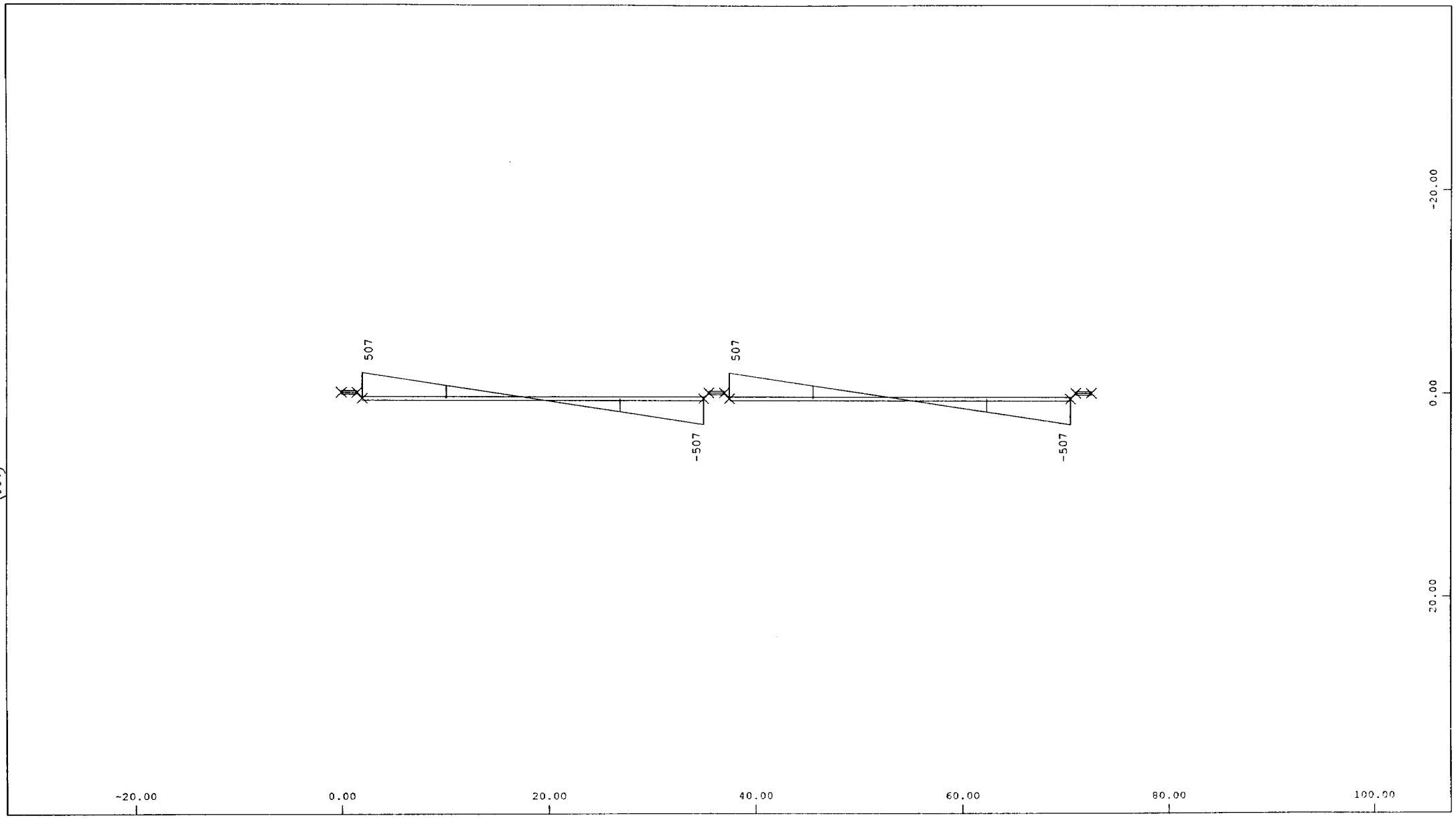
-20.00 0.00 20.00 40.00 60.00 80.00 100.00

-20.00 0.00 20.00

INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM MOMENTS MY LC 2 LOAD CASE 2 1 CM = 3500 kNm

M 1 : 500

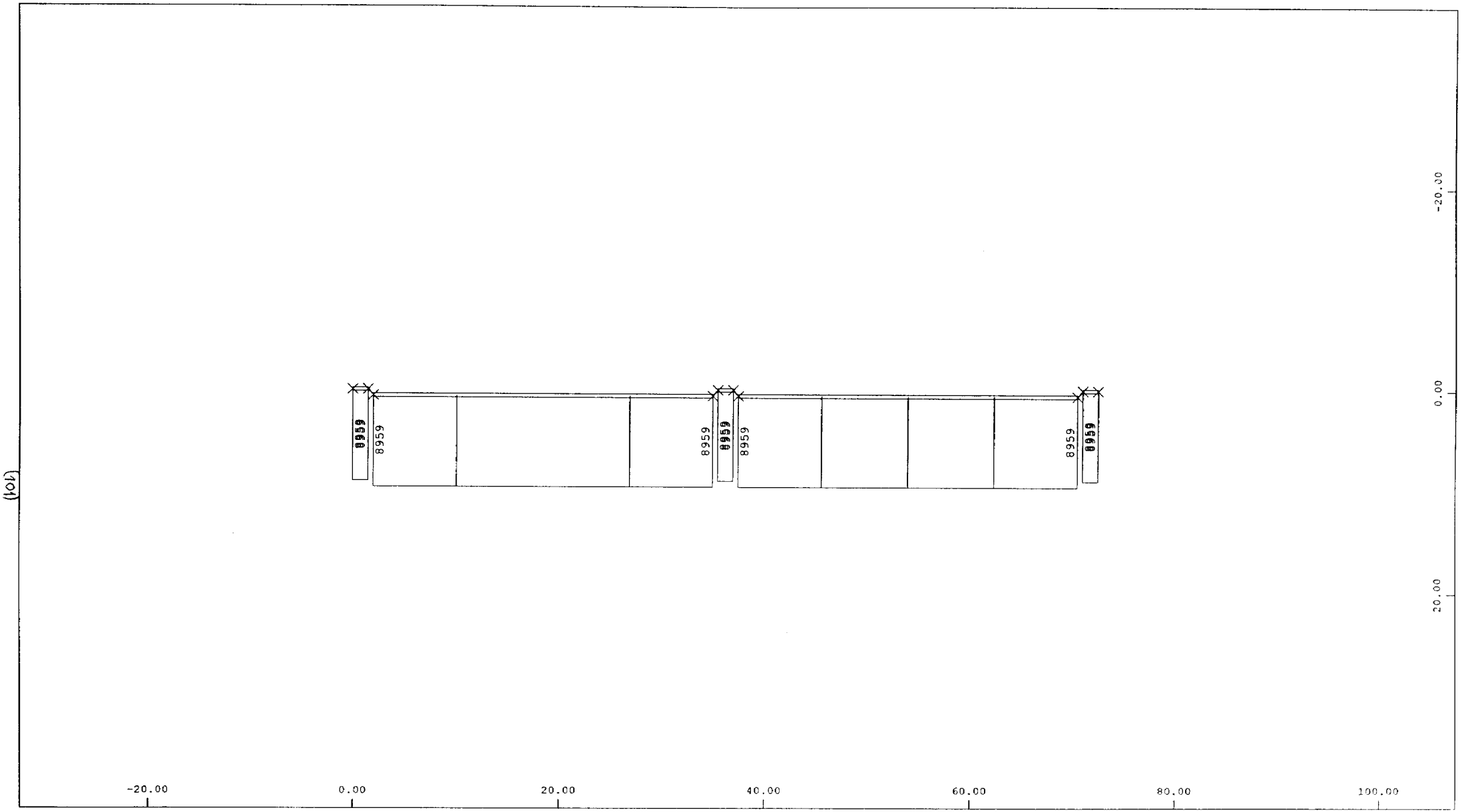
METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9



INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM SHEAR FORCES QZ LC 2 LOAD CASE 2 1 CM = 1000 kN

M 1 : 500

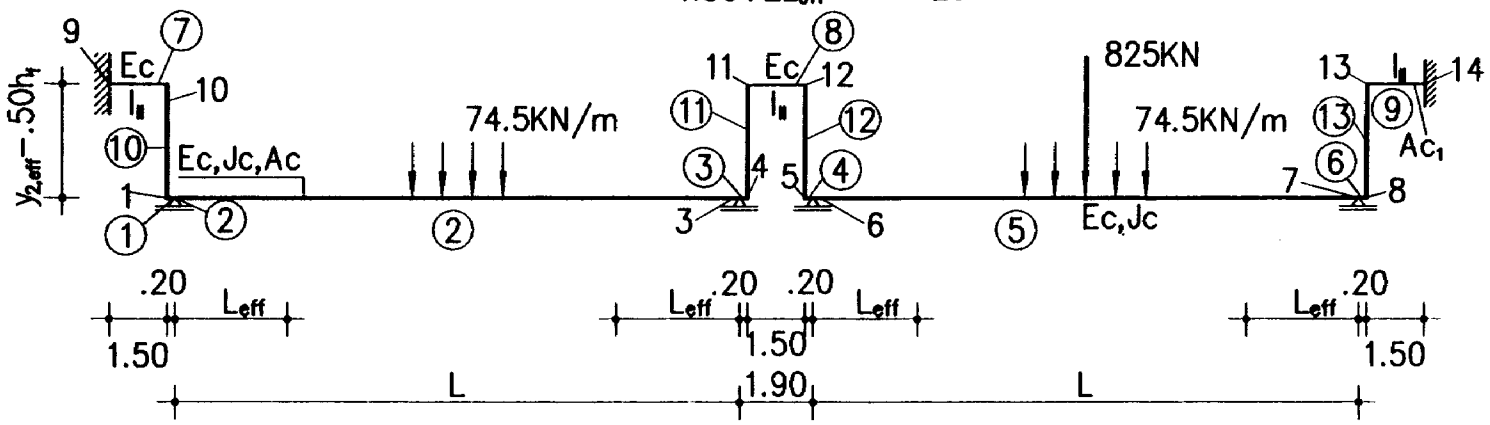
METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9



INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM NORMAL FORCES LC 2 LOAD CASE 2 1 CM = 5000 kN

M 1 : 500

$$Ac_1 = \frac{1.50}{1.50+L_{eff}}\ 1.2As\frac{Es}{Ec} \qquad Ac_2 = \frac{1.50}{1.50+2L_{eff}}\ 1.2As\frac{Es}{Ec}$$

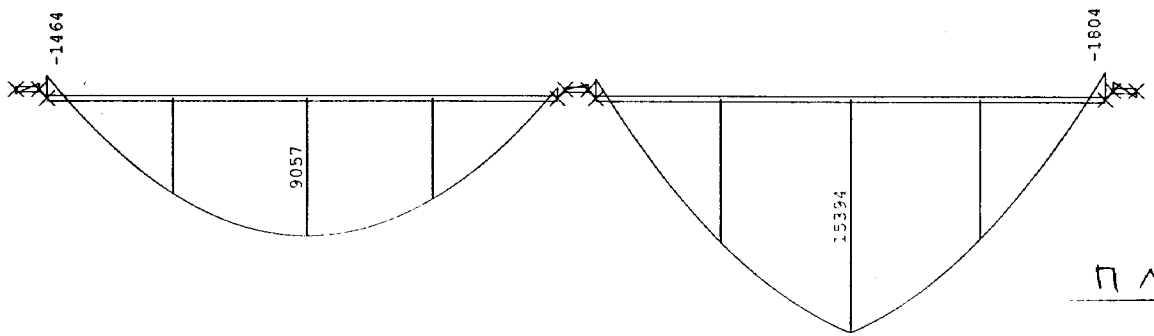


ΠΙΝΑΚΑΣ ΔΕΔΟΜΕΝΩΝ

L=33.0m	E_c =32 GPa
b=12.0m	a=6.25
$A_{c,eff}$ =5.100m^2	g_1 =30.7KN/m
$J_{c,eff}$=2.784m	q=43.8KN/m
h_b =2.15m	g_1 +q=74.5KN/m
h_{ft}=0.275m	Q=825KN
$h_{f,eff}$=0.20m	A_{st}=73cm^2/m(3Φ14/75)
$h_{(πρ.)}$=0.075m	ρ=3.1%
$y_{2,eff}$ =0.73m	A_{sb}=20,5cm^2/m(Φ14/75 n.t. Φ14/75 κ.
	T=-50° C
	Leff= L/5≈6,6m

I_{II} =3.544αρb$h^3_{f,eff}$/12=0.1772ρ≈I_I/1,5=0,0053m^4

METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9



ΠΛΑΚΑ

ΚΑΜΠΤΙΚΟΣ ΥΠΟΛΟΓΙΣΜΟΣ ΕΝΑΝΤΙ ΦΟΡΤΙΣΗΣ ΒΑΡΥΤΗΤΟΣ

$$m = \frac{M - \chi_{2,eff}\, N_{g,tq,Q}}{b} = \frac{1804 - 0{,}63 \times 1430}{12{,}0} = 7.5 \text{ kNm/m}$$

$$m_s = 75 - 0{,}075 \times \frac{1430}{12{,}0} = 66 \text{ kNm/m}$$

$$a_s = 4{,}2 \times \frac{66}{17{,}5} + \frac{119}{26} = 19 < 2 \times 20{,}5 = 41{,}0 \text{ cm}^2/\text{m}$$

-20.00 0.00 20.00 40.00 60.00 80.00 100.00

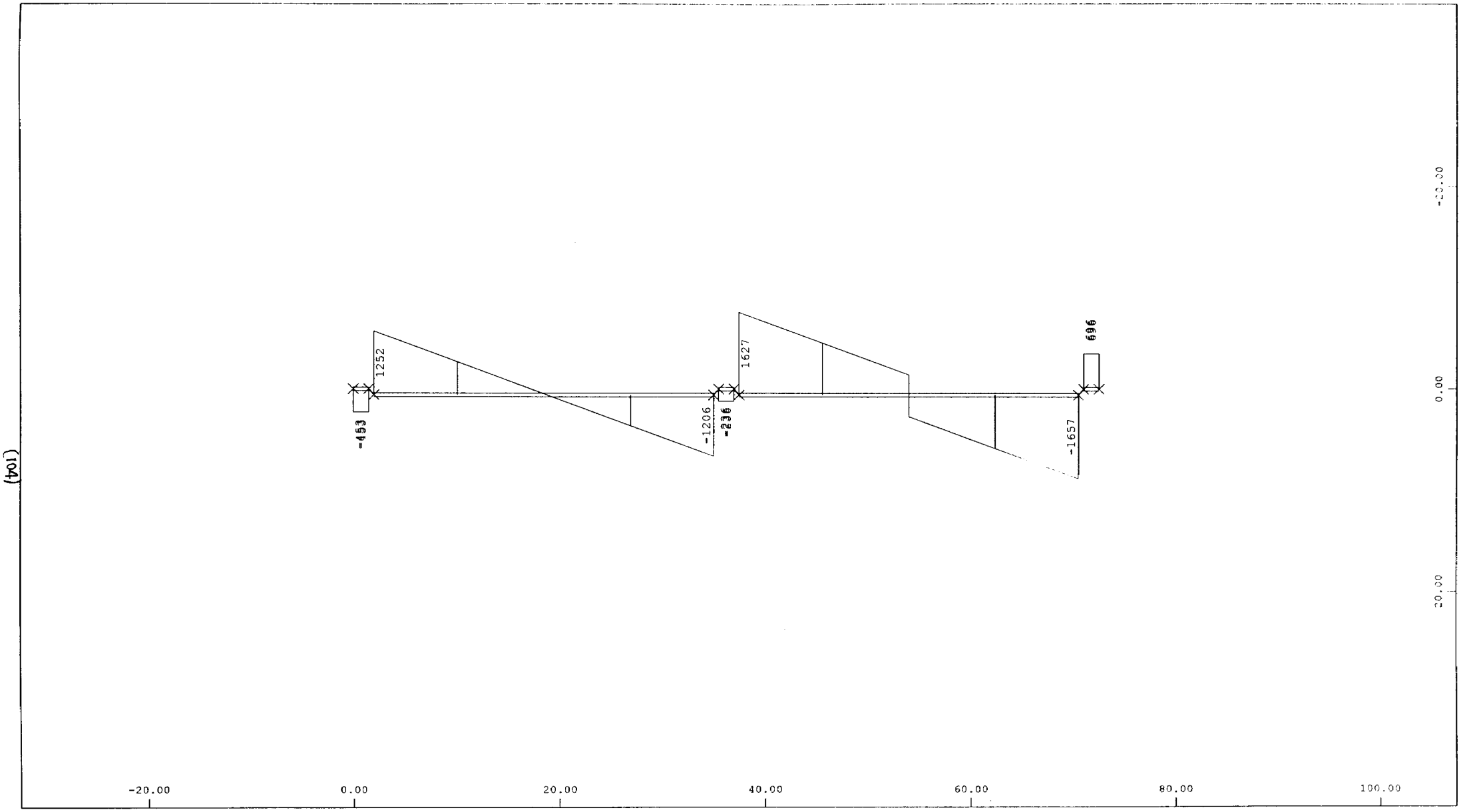
-20.00 0.00 20.00

(103)

INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM MOMENTS MY LC 1 LOAD CASE 1 1 CM = 5000 kNm

M 1 : 500

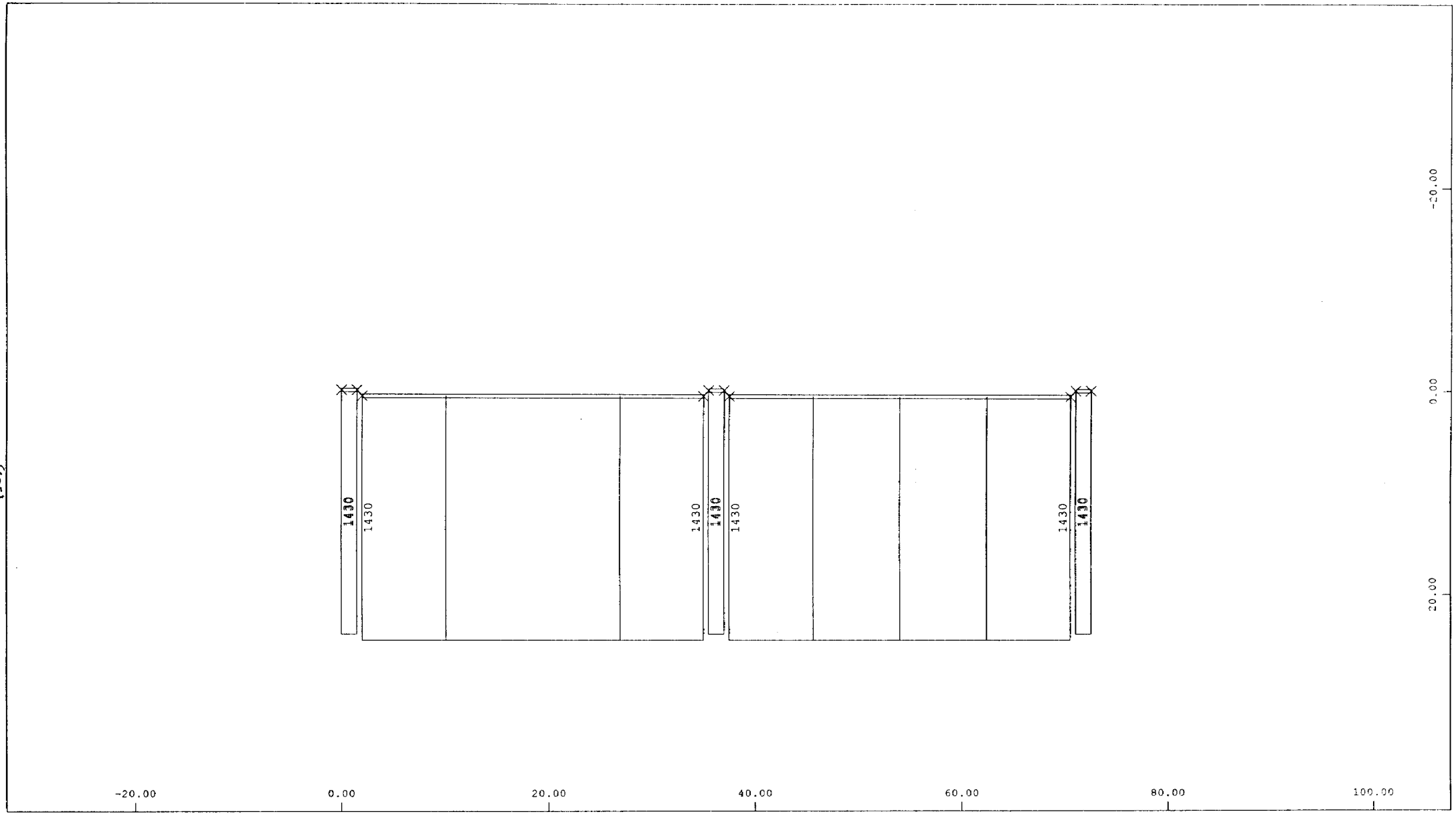
METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9



INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM SHEAR FORCES QZ LC 1 LOAD CASE 1 1 CM = 1000 kN

M 1 : 500

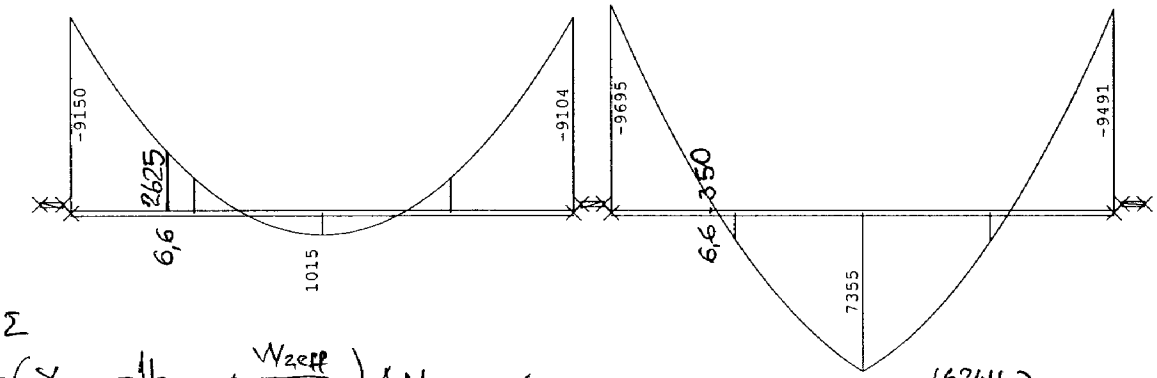
METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9



INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM NORMAL FORCES LC 1 LOAD CASE 1 1 CM = 300.0 kN

M 1 : 500

METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9



(901)

ΘΑΜΙΣΤΙΚΗ ΜΕΘΟΔΟΣ

υπ $\Delta M(x=L_{eff}) - M_{cr} = -\left(Y_{2,eff} - \frac{1}{2}h_{f,eff} + \frac{W_{2eff}}{A_{c,eff}}\right)\Delta N \rightarrow$ 0,75(2625+350)−3,814$\left(3500 - \frac{16244}{5,1}\right)$ = 1488 − 1201 = −1,38ΔN → ΔN_1 = −208 kN

N = 16244 − 208 = 16036 kN → x = 15,85 × 16244/16036 = 14,90 m → L_{eff} = 6,7 m → N = 16050 kN (κατά τι μικρότερο λόγω καμπτικής επιεροής της πλάκας)

ΚΑΜΠΤΙΚΟΣ ΕΛΕΓΧΟΣ ΠΛΑΚΑΣ ΓΙΑ ΚΑΘΟΛΙΚΗ ΕΝΤΑΣΗ

M = 9695 − 0,63 × 16244 = 539 kNm , e = 539/16244 = 0,033 m < Y_s = 0,075 m

υπ A_s = 739 + 492 = 1231 cm^2 , υπ $\sigma_s = \frac{16244}{1231}\left(1 + \frac{0,033}{0,075}\right) = 19 < 26$ kN/cm^2 (αποδοχή σε εύρος ρωγμής w_k = 0,1 mm)

ΠΑΡΑΤΗΡΗΣΗ: Επειδή 16244 ≈ N = 16050 kN δεν χρειάστηκε επιδιόρθωση του διαγράμματος

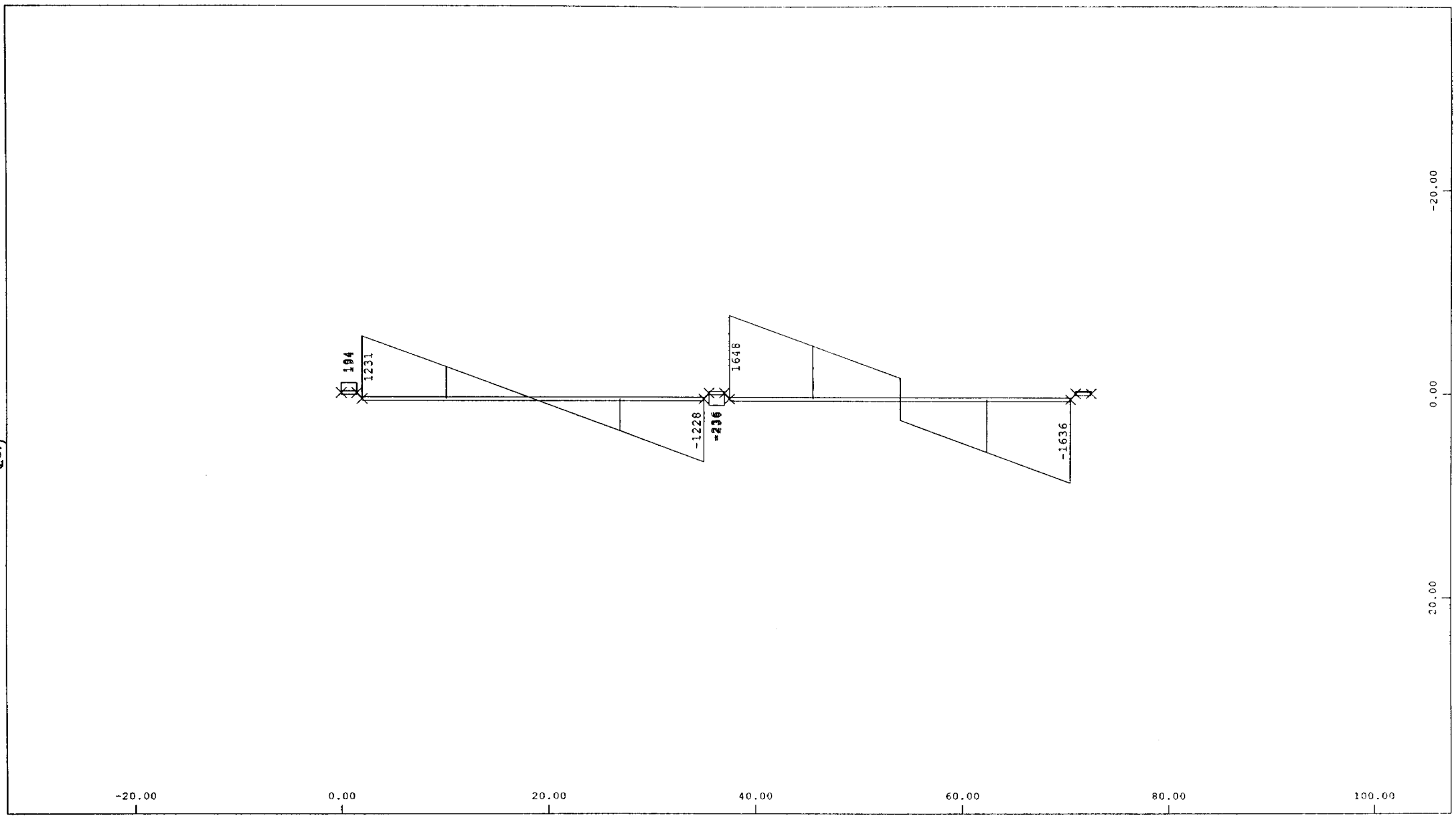
-20.00 0.00 20.00 40.00 60.00 80.00 100.00

-20.00 0.00 20.00

INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM MOMENTS MY LC 2 LOAD CASE 2 1 CM = 3500 kNm

M 1 : 500

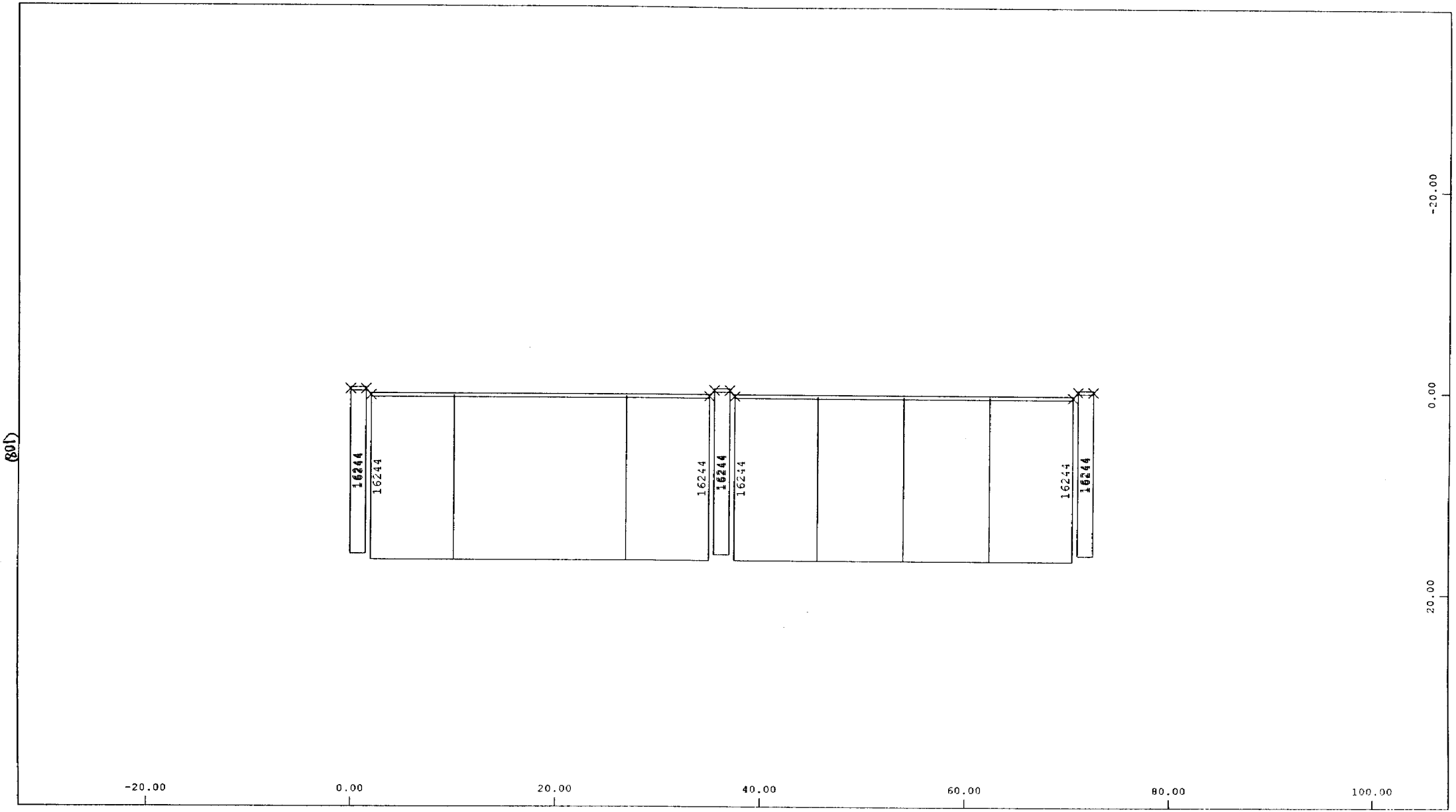
METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9



INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM SHEAR FORCES QZ LC 2 LOAD CASE 2 1 CM = 1000 kN

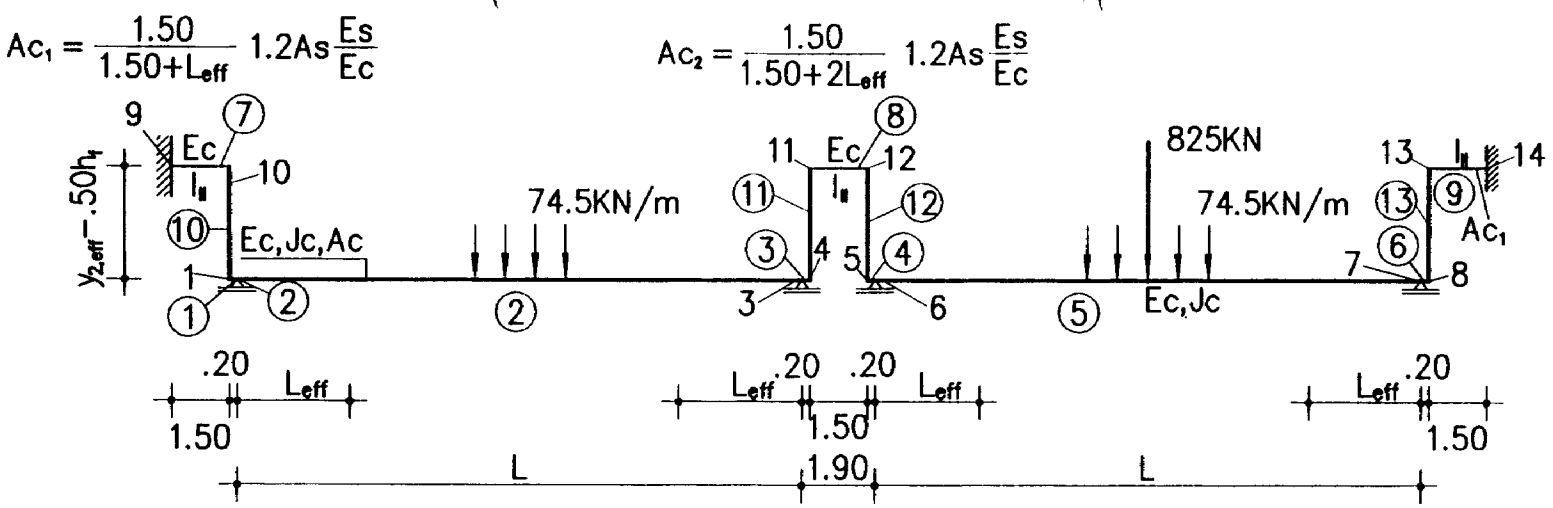
M 1 : 500

METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9



INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM NORMAL FORCES LC 2 LOAD CASE 2 1 CM = 5000 kN

M 1 : 500

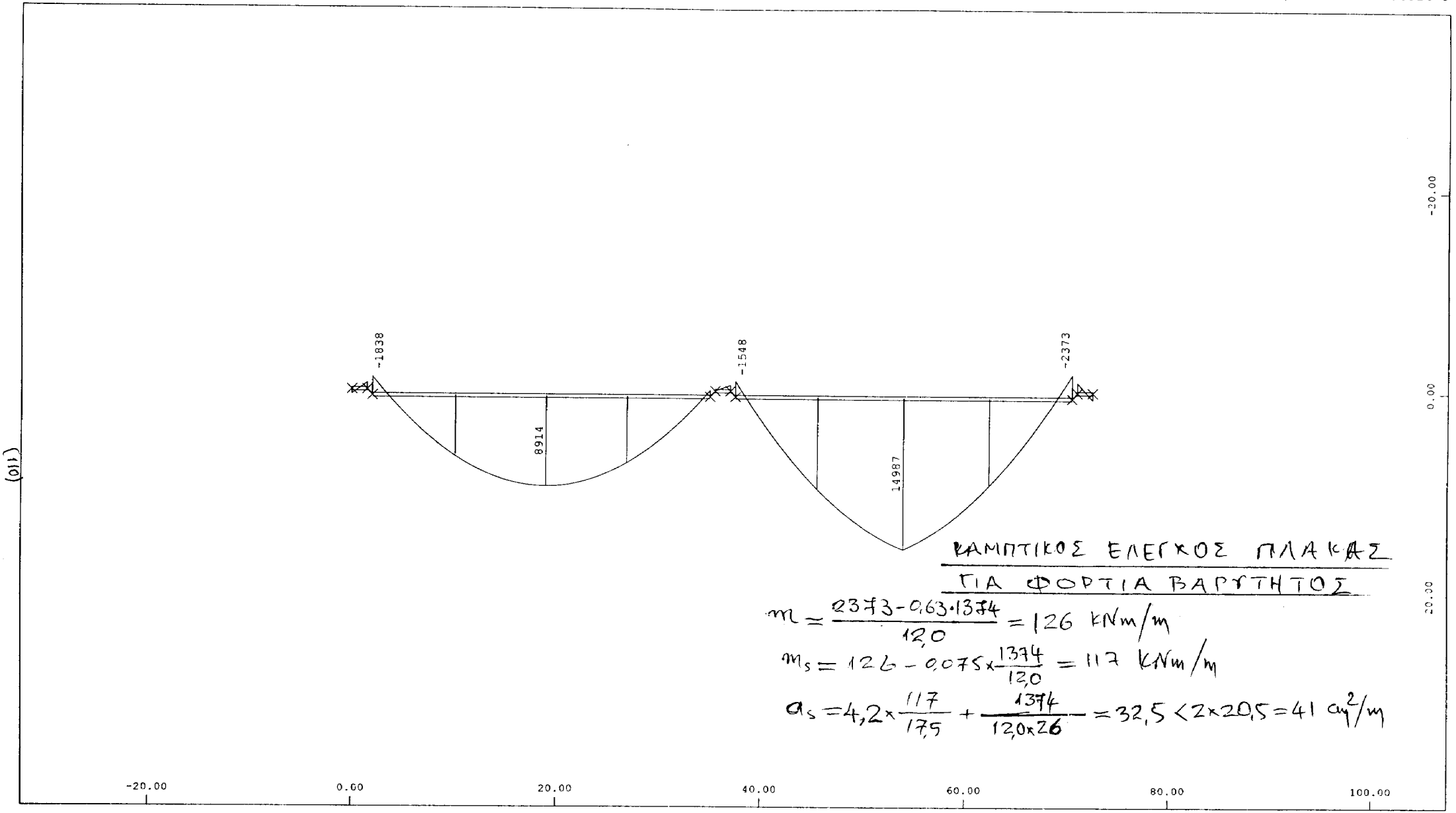


ΠΙΝΑΚΑΣ ΔΕΔΟΜΕΝΩΝ

L=33.0m	E_c =32 GPa
b=12.0m	a=6.25
$A_{c,eff}$ =5.100m^2	g_1 =30.7KN/m
$J_{c,eff}$=2.784m	q=43.8KN/m
h_b =2.15m	g_1 +q=74.5KN/m
h_{ft}=0.275m	Q=825KN
$h_{f,eff}$=0.20m	A_{st}= 739cm^2 (3φ14/75
$h_{(πρ.)}$=0.075m	ρ=3.1%
$y_{2,eff}$ =0.73m	A_{sb}=20,5cm^2/m (φ14/75π + φ14/75κ
	T=-50° C
	Leff=L/5=6,6 m

$I_{II} = 3.544\alpha\rho b h_{f,eff}^3/12 = 0.1772\rho \simeq I_I/2,5 = 0.0031 m^4$

METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9



ΚΑΜΠΤΙΚΟΣ ΕΛΕΓΧΟΣ ΠΛΑΚΑΣ

ΓΙΑ ΦΟΡΤΙΑ ΒΑΡΥΤΗΤΟΣ

$$m = \frac{2373 - 0{,}63 \cdot 1374}{12{,}0} = 126 \text{ kNm/m}$$

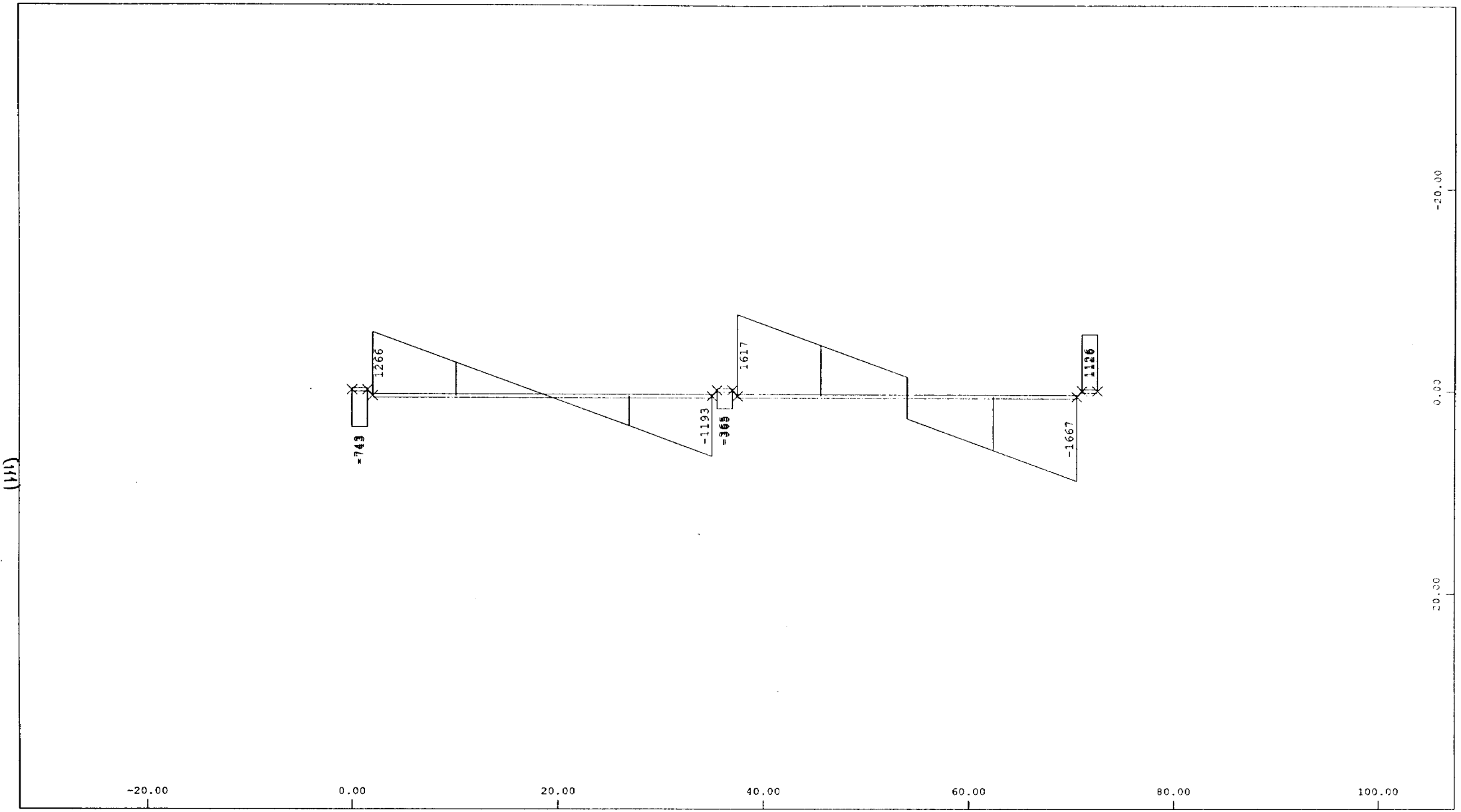
$$m_s = 126 - 0{,}075 \times \frac{1374}{12{,}0} = 117 \text{ kNm/m}$$

$$a_s = 4{,}2 \times \frac{117}{17{,}5} + \frac{1374}{12{,}0 \times 26} = 32{,}5 < 2 \times 20{,}5 = 41 \text{ cm}^2/\text{m}$$

INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
BEAM MOMENTS MY LC 1 LOAD CASE 1 1 CM = 5000 kNm

M 1 : 500

METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9

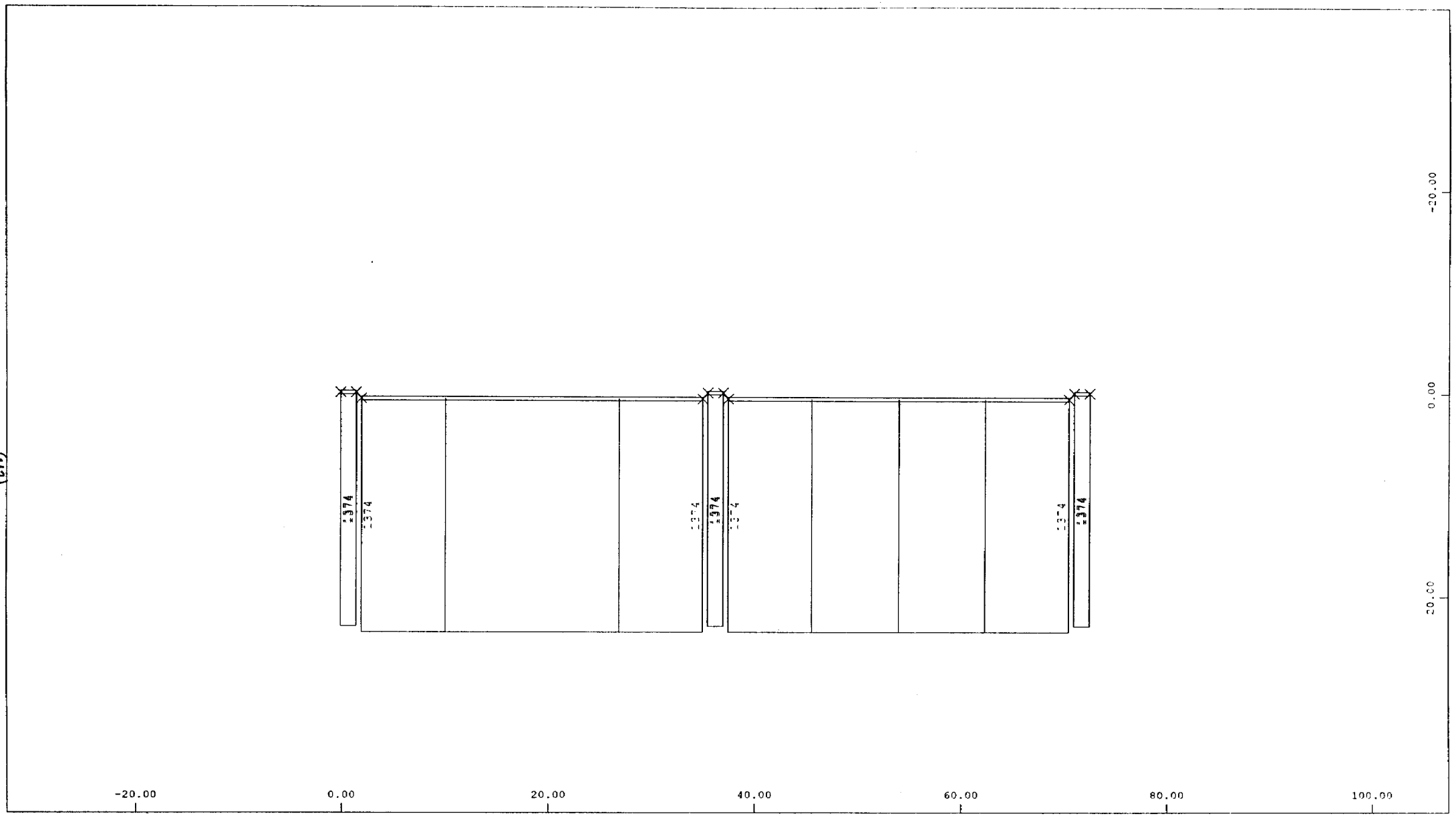


(111)

INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM SHEAR FORCES QZ LC 1 LOAD CASE 1 1 CM = 1000 kN

M 1 : 500

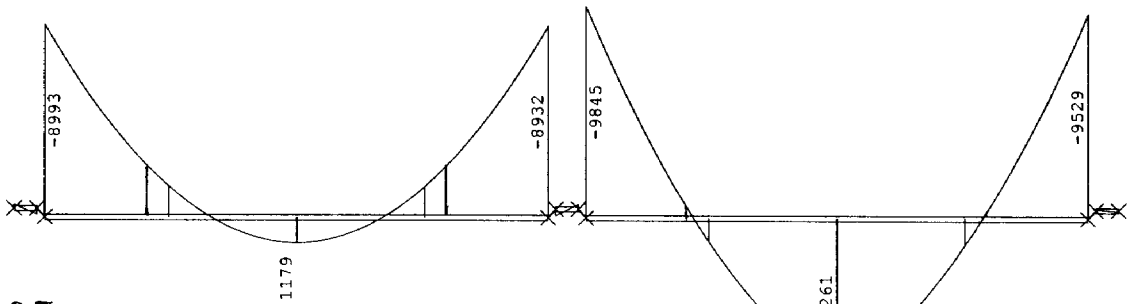
METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9



INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM NORMAL FORCES LC 1 LOAD CASE 1 1 CM = 300.0 kN

M 1 : 500

METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9



ΘΑΜΙΣΤΙΚΗ ΜΕΘΟΔΟΣ

$\text{για } \Delta M(x=L_{eff}) - M_{cr} = -\left(y_{2,eff} - 0{,}5\,h_{f,eff} + \frac{W_{2,eff}}{A_{c,eff}}\right)\Delta N \rightarrow 0{,}5(2205+400) - 3{,}814\left(3500 - \frac{16251}{5{,}1}\right) = -1{,}38\,\Delta N_1 = -1196 = 107 \rightarrow$

$\Delta N_1 = -77\ kN \rightarrow N_1 = 16251 - 77 = 16175\ kN \rightarrow x_1 = 15{,}85 * 16251/16175 = 15{,}90\ m \rightarrow L_{eff} = 6{,}6\ m \rightarrow N = 16.200\ kN$

ΚΑΜΠΤΙΚΟΣ ΕΛΕΓΧΟΣ ΠΛΑΚΑΣ ΓΙΑ ΜΕΓΙΣΤΗ ΕΝΤΑΣΗ

$M = 9845 - 0{,}63 \times 16251 = 393\ kNm$, $e = 393/16251 = 0{,}024\ m < y_s = 0{,}075\ m$

$\text{για } A_s = 739 + 492 = 1231\ cm^2 \rightarrow \sigma_s = \frac{16251}{1231}\left(1 + \frac{0{,}024}{0{,}075}\right) = 18 < 26\ kN/cm^2 \Rightarrow w_k = 0{,}1\ mm$

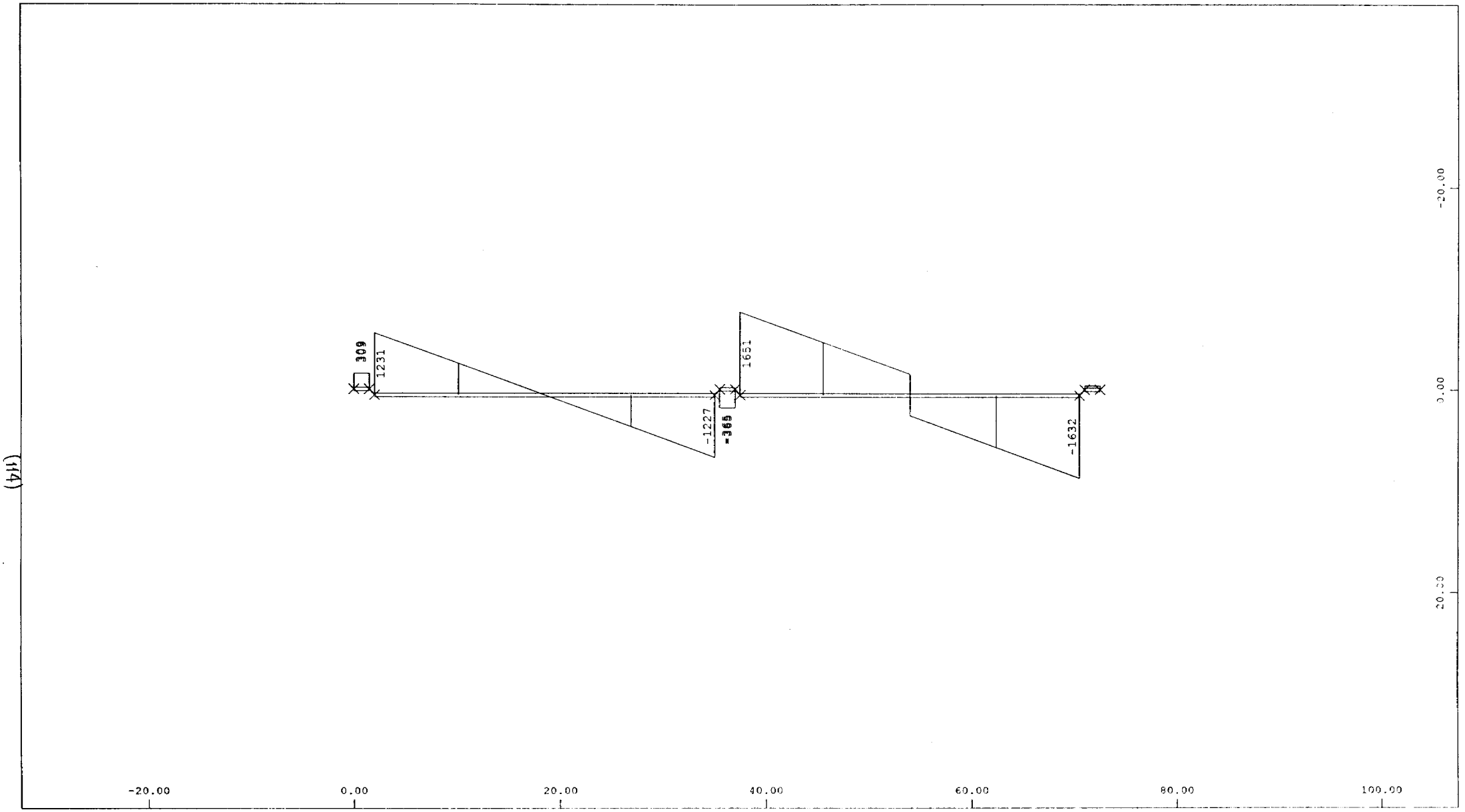
-20.00 0.00 20.00 40.00 60.00 80.00 100.00

-20.00 0.00 20.00

INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM MOMENTS MY LC 2 LOAD CASE 2 1 CM = 3500 kNm

M 1 : 500

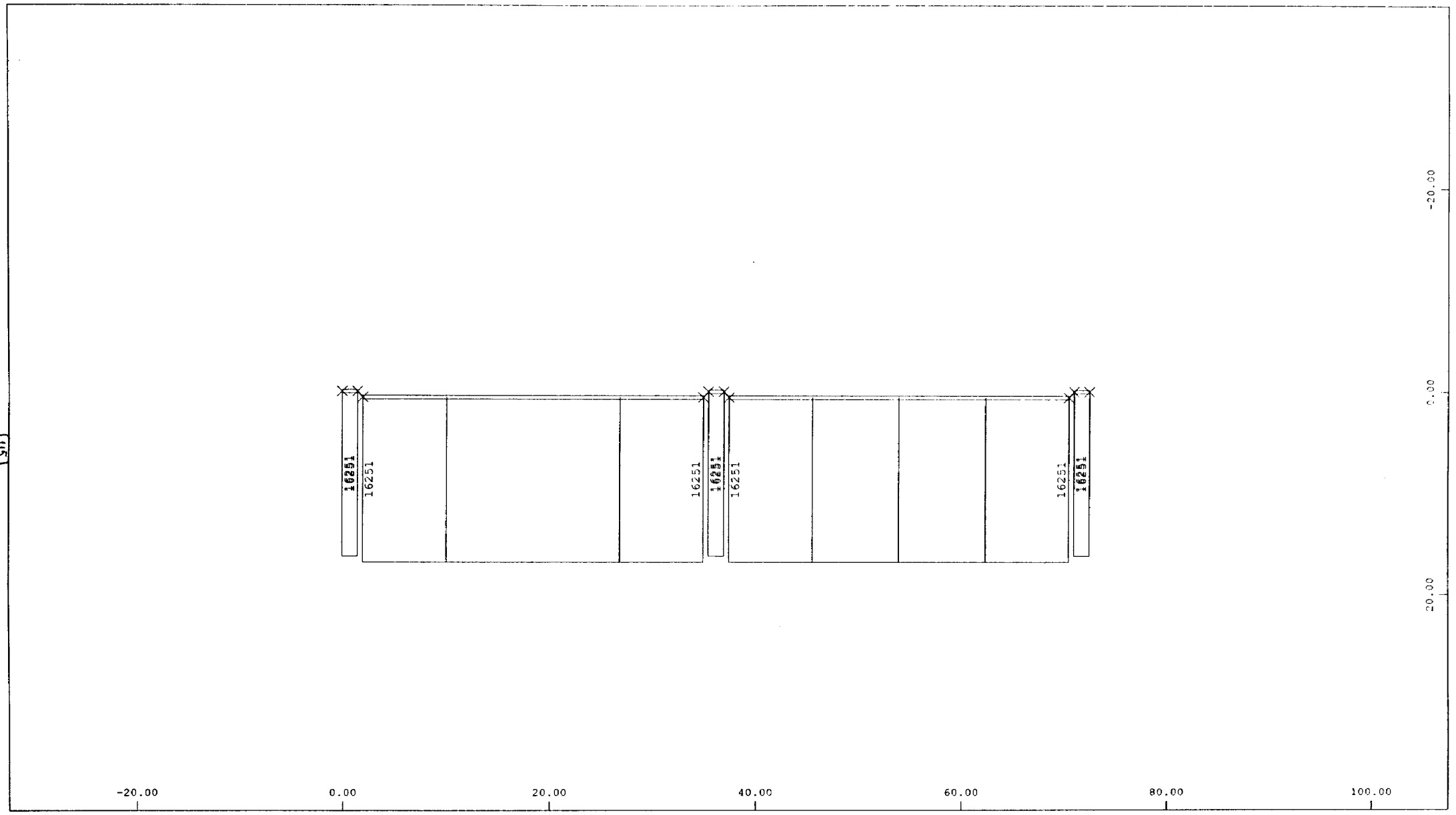
METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9



INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM SHEAR FORCES QZ LC 2 LOAD CASE 2 1 CM = 1000 kN

M 1 : 500

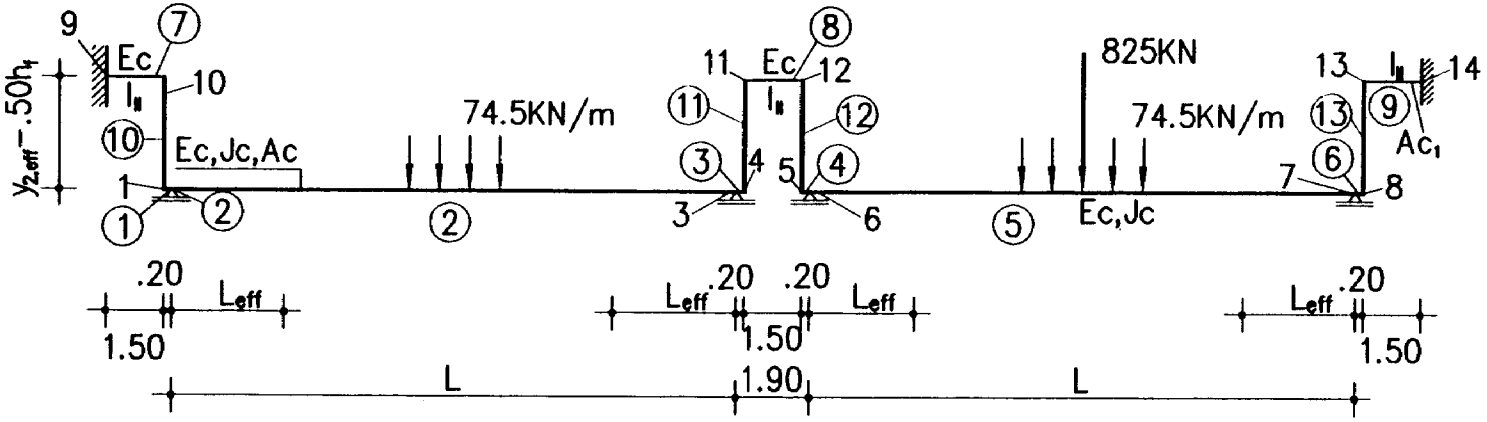
METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9



INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM NORMAL FORCES LC 2 LOAD CASE 2 1 CM = 5000 kN

M 1 : 500

$$Ac_1 = \frac{1.50}{1.50+L_{eff}}\ 1.2As\frac{Es}{Ec} \qquad Ac_2 = \frac{1.50}{1.50+2L_{eff}}\ 1.2As\frac{Es}{Ec}$$

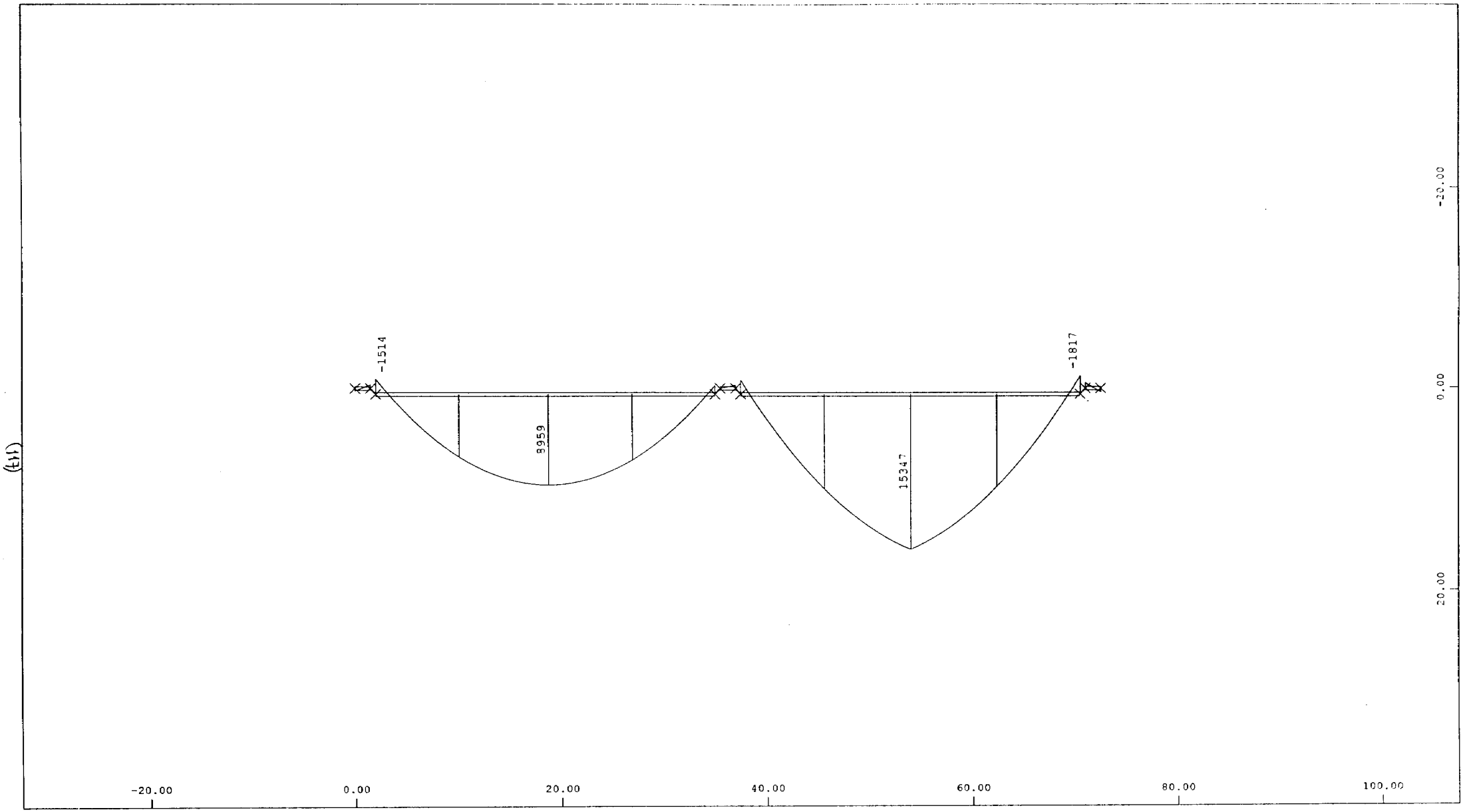


ΠΙΝΑΚΑΣ ΔΕΔΟΜΕΝΩΝ

L=33.0m	E_c =32 GPa
b=12.0m	a=6.25
$A_{c,eff}$ =5.100m^2	g_1 =30.7KN/m
$J_{c,eff}$=2.784m	q=43.8KN/m
h_b =2.15m	g_1 +q=74.5KN/m
h_{ft}=0.275m	Q=825KN
$h_{f,eff}$=0.20m	A_{st}=98cm^2 (4φ14/75)
$h_{(πρ.)}$=0.075m	ρ=4,1 %
$y_{2,eff}$ =0.73m	A_{sb}=20,5cm^2/m (φ14/75π. 4φ14/75κ.
	T=-50° C
	Leff= L/5 ≃ 6,6 m

$I_{II}=3.544\alpha\rho b h_{f,eff}^3/12=0.1772\rho \simeq 0{,}0030\,m^4 \simeq I_I/2{,}5$

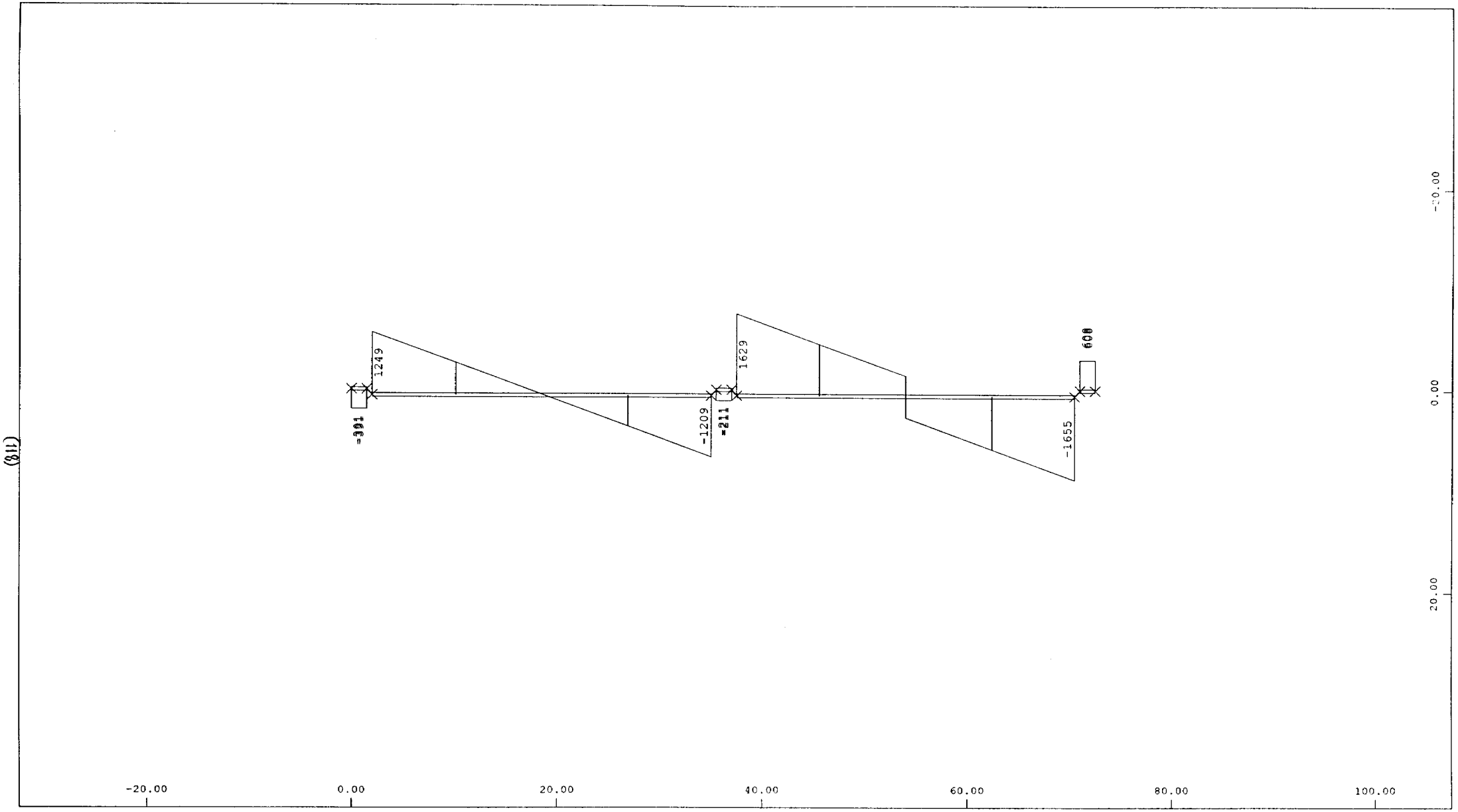
METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9



INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
BEAM MOMENTS MY LC 1 LOAD CASE 1 1 CM = 5000 kNm

M 1 : 500

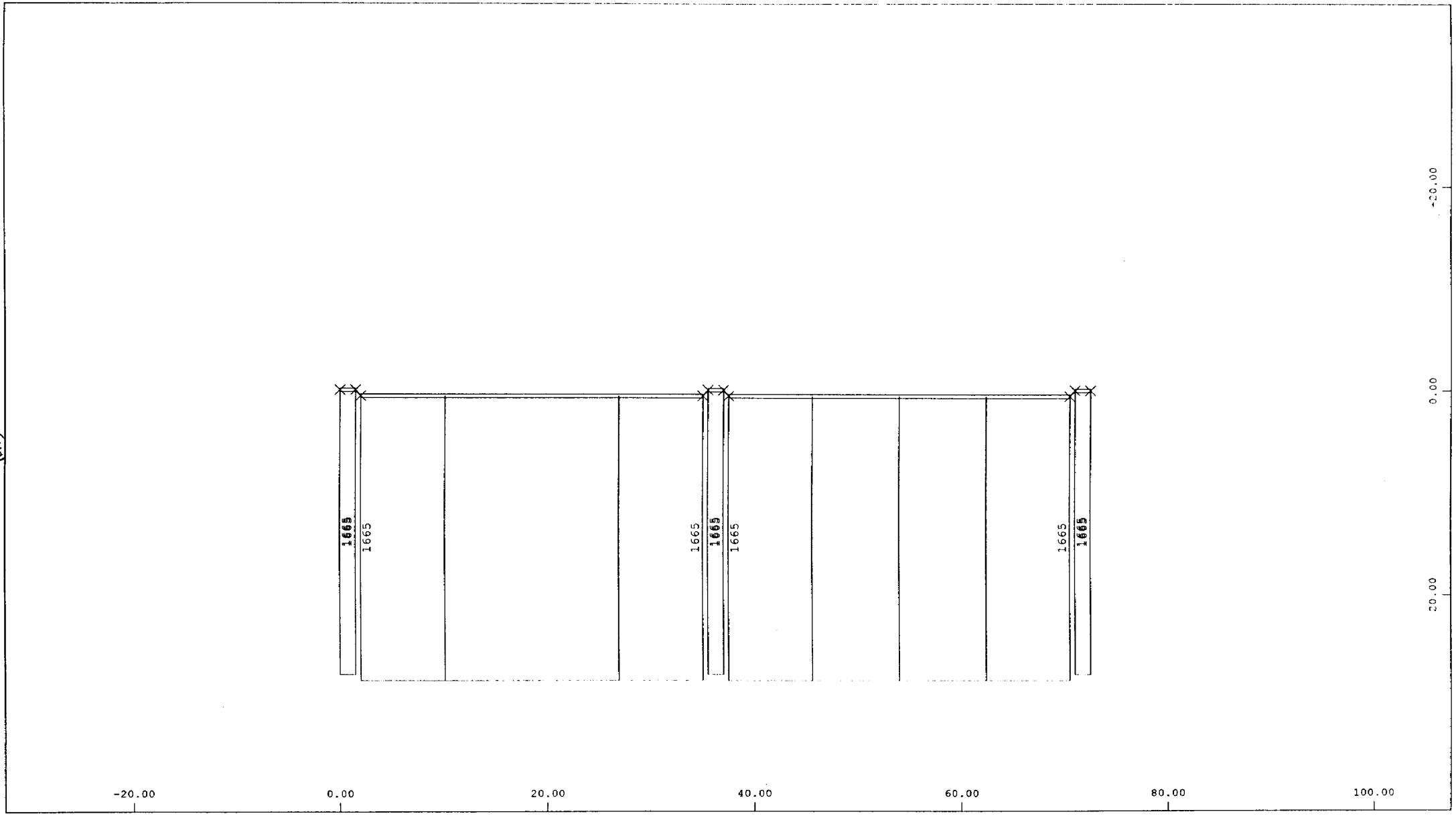
METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9



INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM SHEAR FORCES QZ LC 1 LOAD CASE 1 1 CM = 1000 kN

M 1 : 500

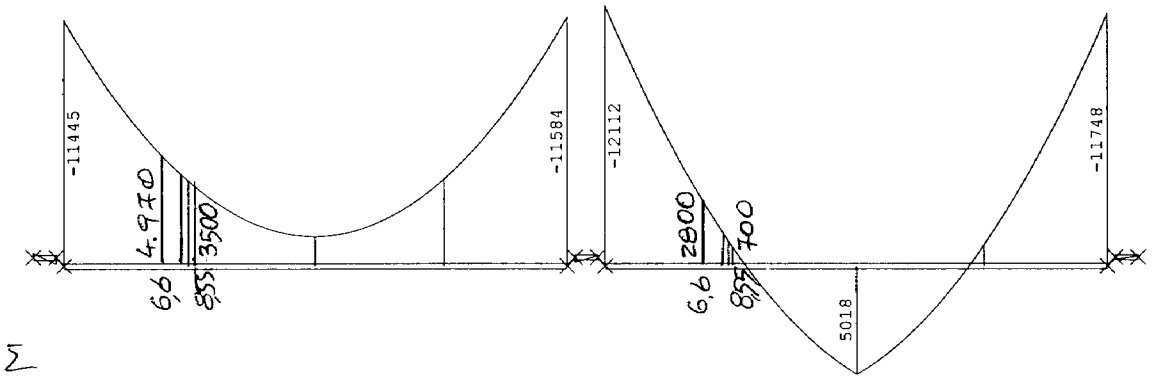
METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9



INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM NORMAL FORCES LC 1 LOAD CASE 1 1 CM = 300.0 kN

M 1 : 500

METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9



(120)

ΘΑΜΙΣΤΙΚΗ ΜΕΘΟΔΟΣ

$\Delta M(x=L_{eff}) - M_{cr} = -\left(y_{2,eff} - 0{,}5\,h_{f,eff} + \frac{W_{2,eff}}{A_{c,eff}}\right)\Delta N \rightarrow 0{,}5(4.970+2800) - 3814\left(3500 - \frac{20550}{5{,}1}\right) = 3885 + 2019 = 5904 = -1{,}38\Delta N_1$

$\Delta N_1 = -4278\ kN \rightarrow N_1 = 16272\ kN \rightarrow x_1 = 15{,}85 \times 20550/16272 \simeq 18{,}56\ m \rightarrow L_{eff,1} = 8{,}55\ m \rightarrow 0{,}5(3500+700)+2.109 = -1{,}38\,\Delta N_2 \rightarrow$

$\Delta N_2 = -2985\ kN \rightarrow N_2 \simeq 17565\ kN \rightarrow x_2 = \ \ /17965 = 17{,}20\ m \rightarrow L_{eff,2} \simeq 7{,}85 m \rightarrow 0{,}5(4130+1330)+2109 = -1{,}38\,\Delta N_3$

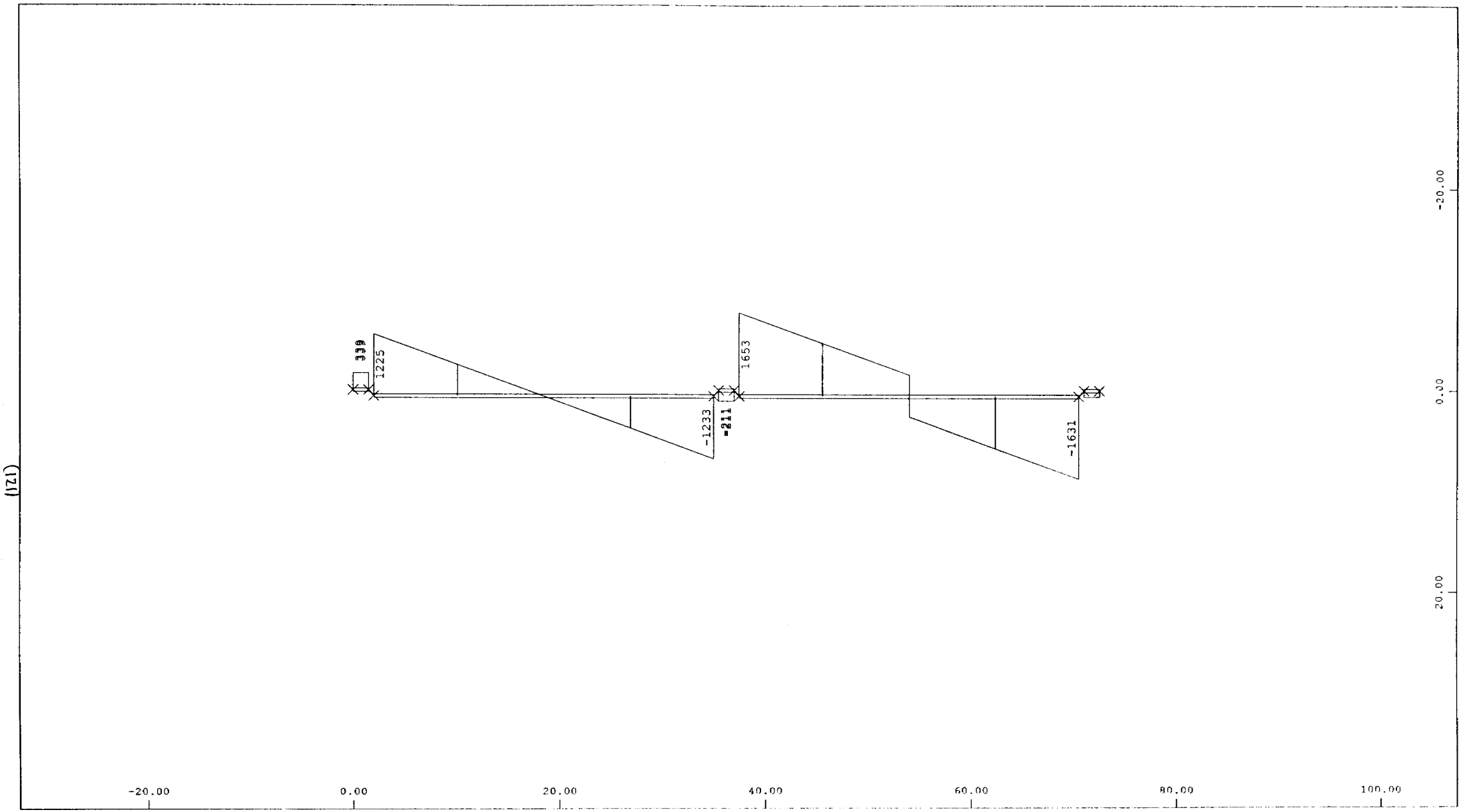
$\Delta N_3 = -3.441\ kN \rightarrow N_3 \simeq 17110\ kN \rightarrow x_3 = \ \ /17110 = 17{,}65\ m \rightarrow L_{eff,2} \simeq 8{,}10 m \rightarrow N = 17150\ kN$

-20.00 0.00 20.00 40.00 60.00 80.00 100.00

INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM MOMENTS MY LC 2 LOAD CASE 2 1 CM = 3500 kNm

M 1 : 500

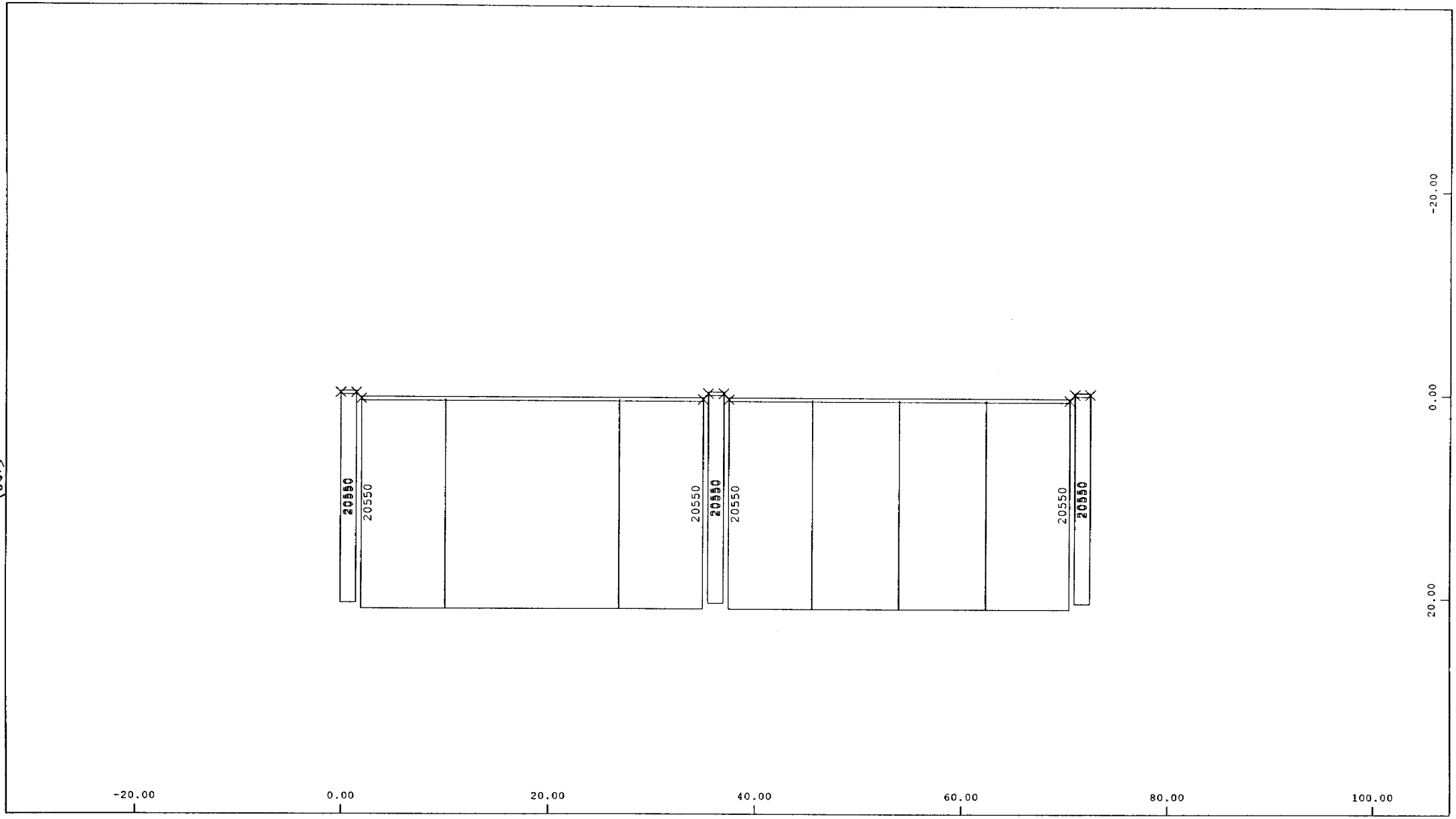
METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9



INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM SHEAR FORCES QZ LC 2 LOAD CASE 2 1 CM = 1000 kN

M 1 : 500

METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9

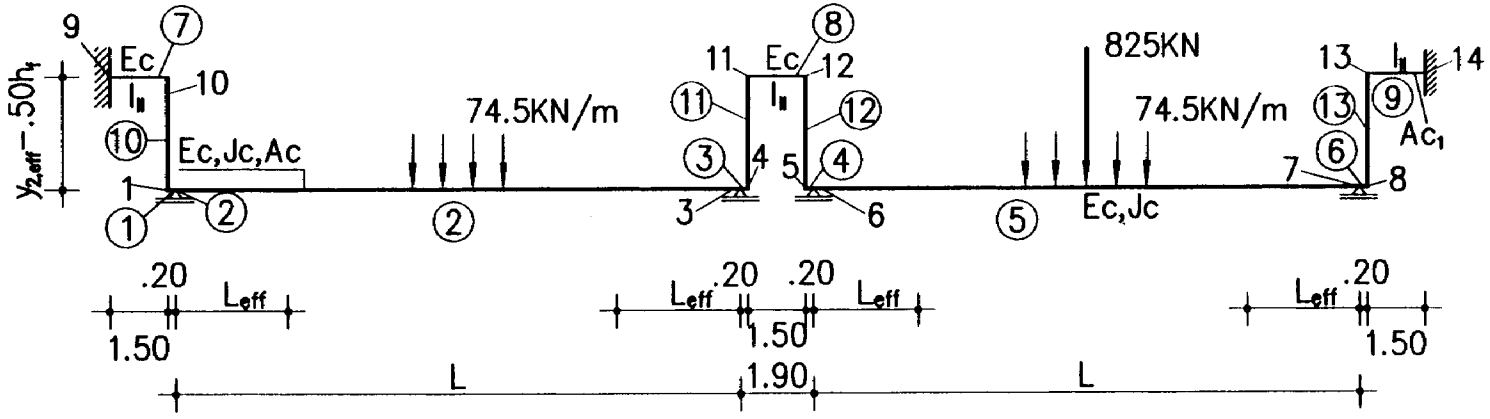


(122)

INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM NORMAL FORCES LC 2 LOAD CASE 2 1 CM = 5000 kN

M 1 : 500

$$Ac_1 = \frac{1.50}{1.50+L_{eff}}\ 1.2As\frac{Es}{Ec} \qquad Ac_2 = \frac{1.50}{1.50+2L_{eff}}\ 1.2As\frac{Es}{Ec}$$



ΠΙΝΑΚΑΣ ΔΕΔΟΜΕΝΩΝ

L=33.0m	E_c =32 GPa
b=12.0m	a=6.25
$A_{c,eff}$ =5.100m^2	g_1 =30.7KN/m
$J_{c,eff}$=2.784m	q=43.8KN/m
h_b =2.15m	g_1 +q=74.5KN/m
h_{ft}=0.275m	Q=850KN
$h_{f,eff}$=0.20m	A_{st}=986cm^2(4φ14/75)
$h_{(πρ.)}$=0.075m	ρ=4.1 ‰
$y_{2,eff}$ =0.73m	A_{sb}=20,5cm^2/m (φ14/75π. φ14/75 κ
	T= -50° C
	Leff= L/6 = 5,5 m

I_{II} =3.544αρb$h^3_{f,eff}$/12=0.1772ρ =0,0030 $m^4 = \frac{I_x}{2,5}$

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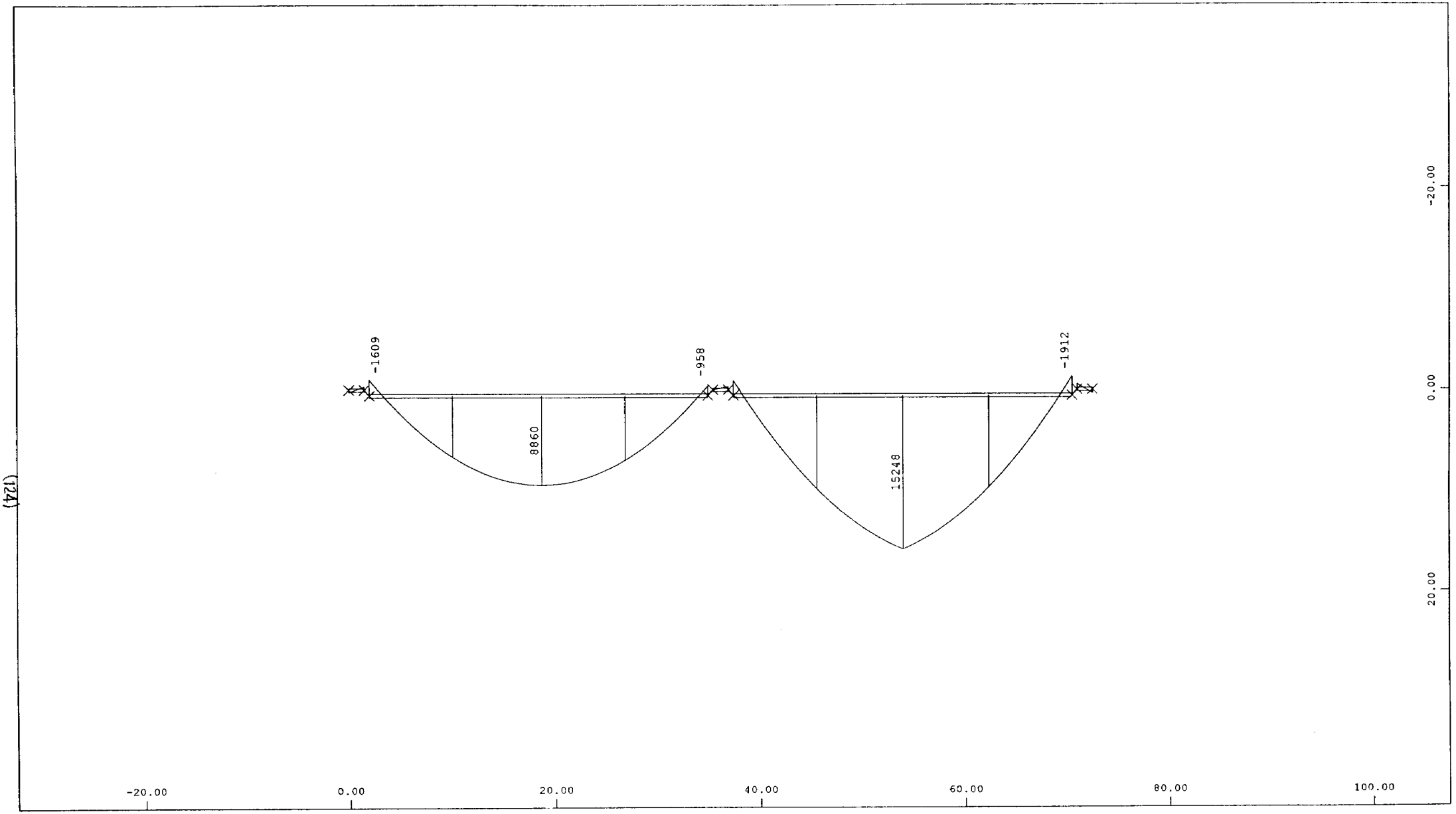
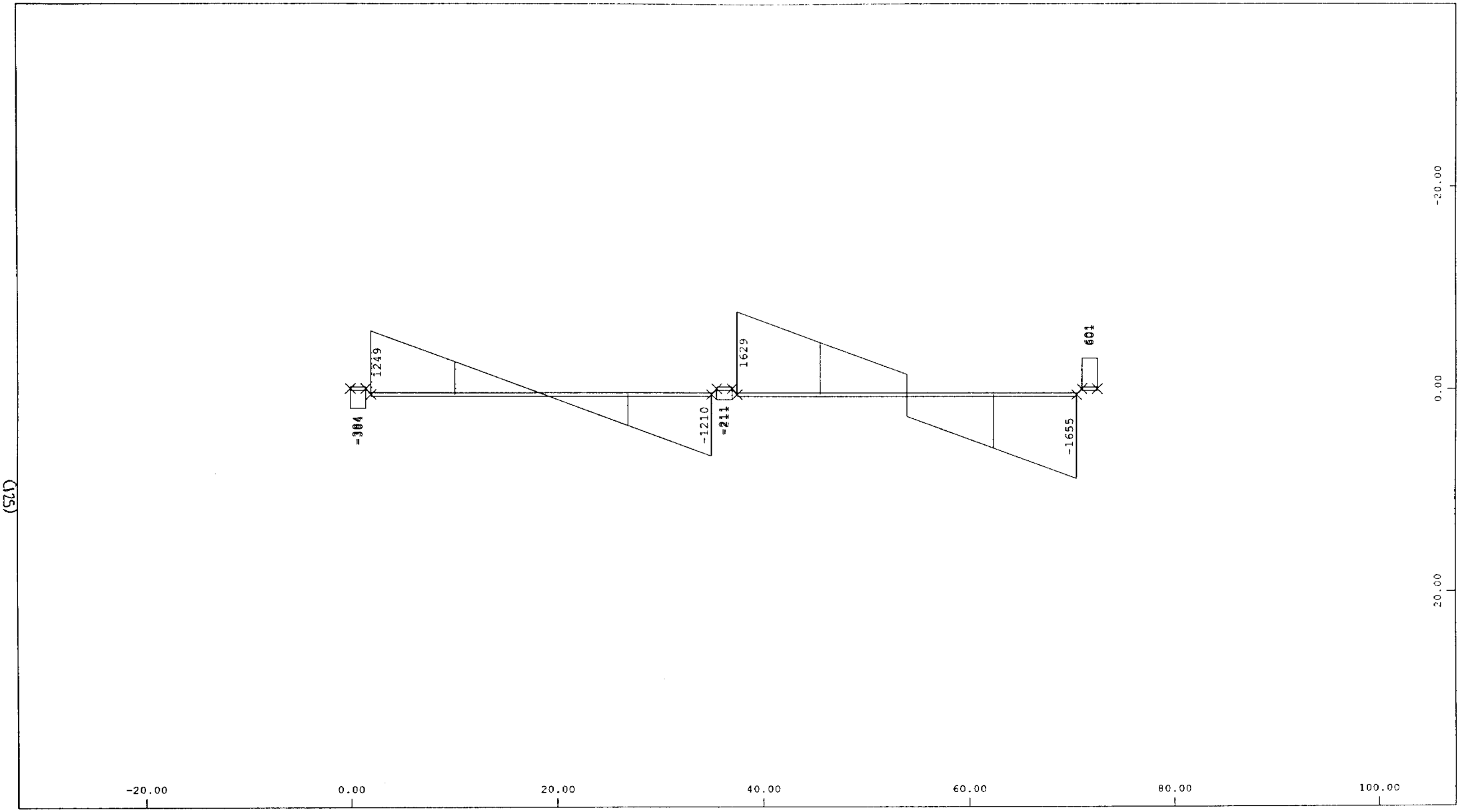


(124)

INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM MOMENTS MY LC 1 LOAD CASE 1 1 CM = 5000 kNm

M 1 : 500

METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9

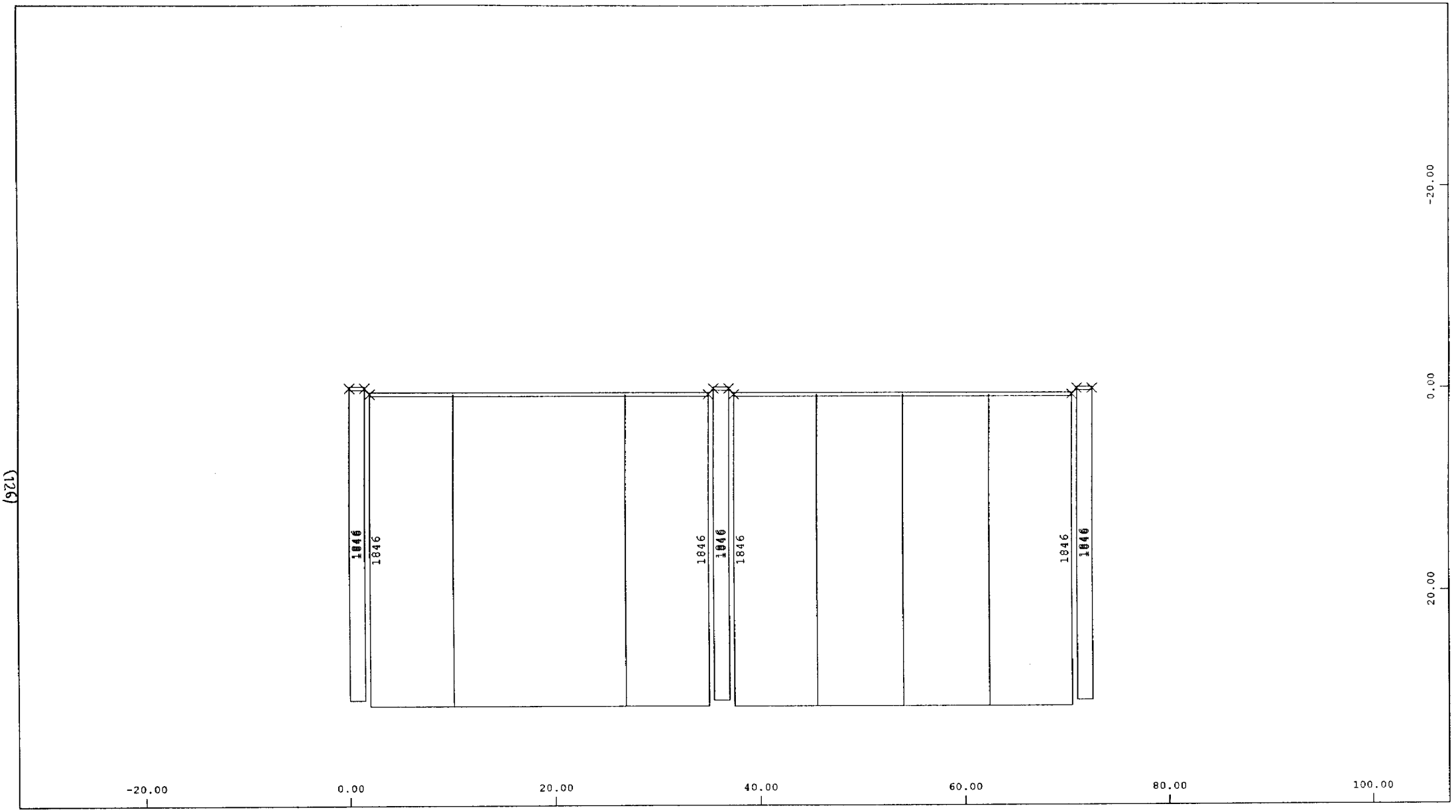


(125)

INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM SHEAR FORCES QZ LC 1 LOAD CASE 1 1 CM = 1000 kN

M 1 : 500

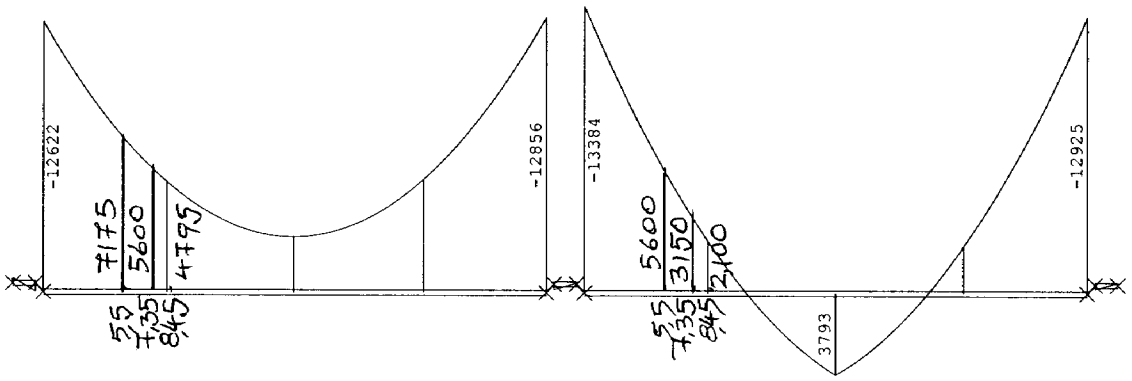
METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9



INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM NORMAL FORCES LC 1 LOAD CASE 1 1 CM = 300.0 kN

M 1 : 500

METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9



ΘΑΜΙΣΤΙΚΗ ΜΕΘΟΔΟΣ

$\Delta M(x=L_{eff}) \rightarrow M_{cr} = -(y_{2,eff} - 0{,}5\,h_{f,eff} + \frac{N_{2,eff}}{A_{c,eff}})\,\Delta N \rightarrow 0{,}5(7175+5600)+3{,}814\left(3500-\frac{22.788}{5{,}1}\right) = -1{,}38\,\Delta N_1 \rightarrow$

$\Delta N_1 = -7304\ kN \rightarrow N_1 = 22.788 - 7304 = 15484\ kN \rightarrow x_1 = (2\times 5{,}5+2{,}65)\frac{22788}{15484} = 19{,}50\ m \rightarrow L_{eff,1} = 8{,}45\ m \rightarrow$

$0{,}5(4795+2100)+3693 = -1{,}38\,\Delta N_2 \rightarrow \Delta N_2 = -5174\ kN \rightarrow N_2 = 17164 \rightarrow x_2 = (2\times 5{,}5+2{,}65)\cdot\frac{22.788}{17614} = 17{,}10\ m$

$L_{eff,2} = 0{,}5\,(17{,}10-2{,}25) = 7{,}35\ m \rightarrow 0{,}5(5.600+3150)+3693 = -1{,}38\,\Delta N_3 \rightarrow \Delta N_3 = -5846\ kN \rightarrow N_3 = 16940\ kN$

$x_3 = 13{,}5\times 22788/16940 = 17{,}85\ m \rightarrow L_{eff,3} = 0{,}5(17{,}85-2{,}65) = 7{,}80 \rightarrow$ $N = 17.100\ kN$

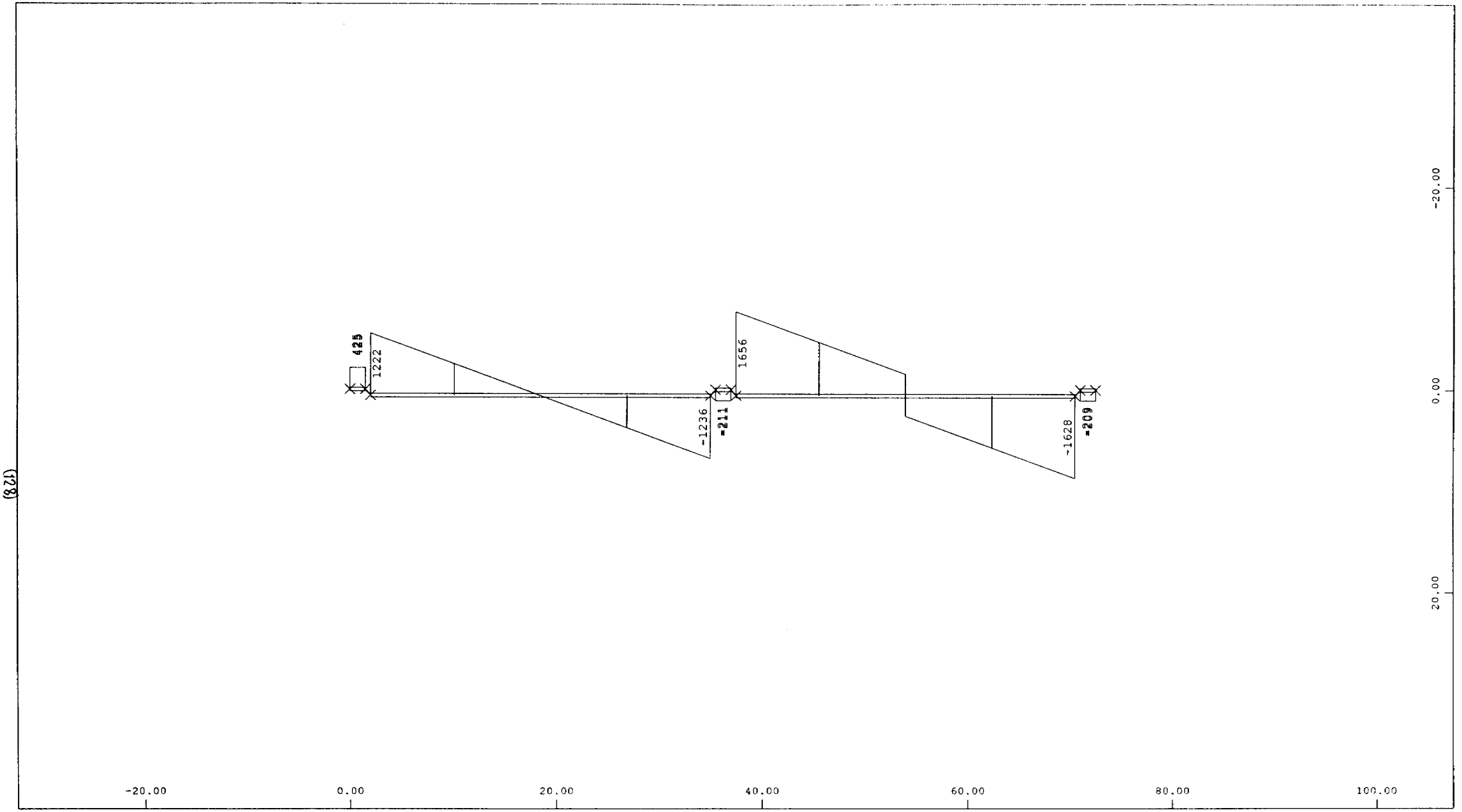
(121)

-20.00 0.00 20.00 40.00 60.00 80.00 100.00

INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM MOMENTS MY LC 2 LOAD CASE 2 1 CM = 3500 kNm

M 1 : 500

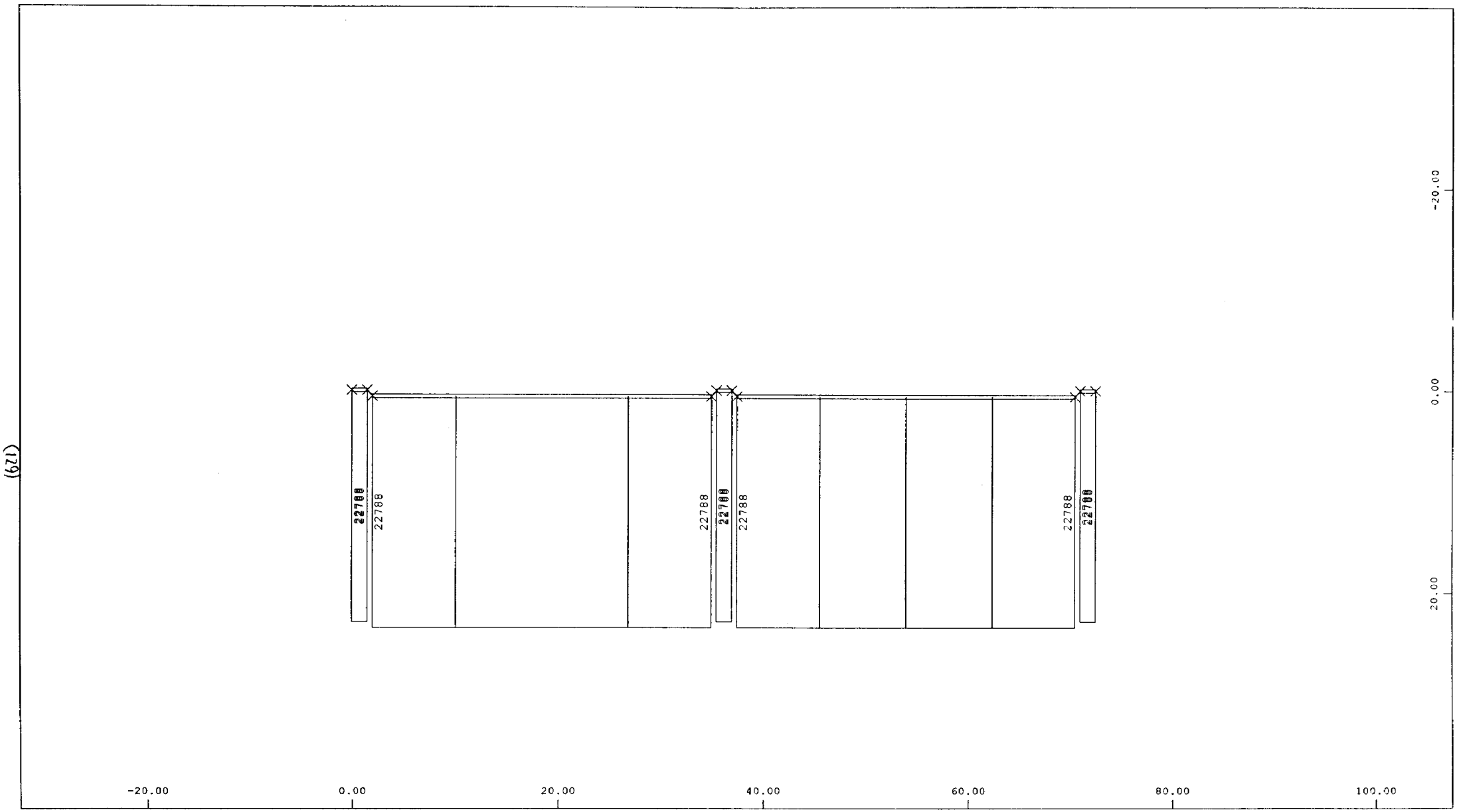
METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9



INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
————BEAM SHEAR FORCES QZ LC 2 LOAD CASE 2 1 CM = 1000 kN

M 1 : 500

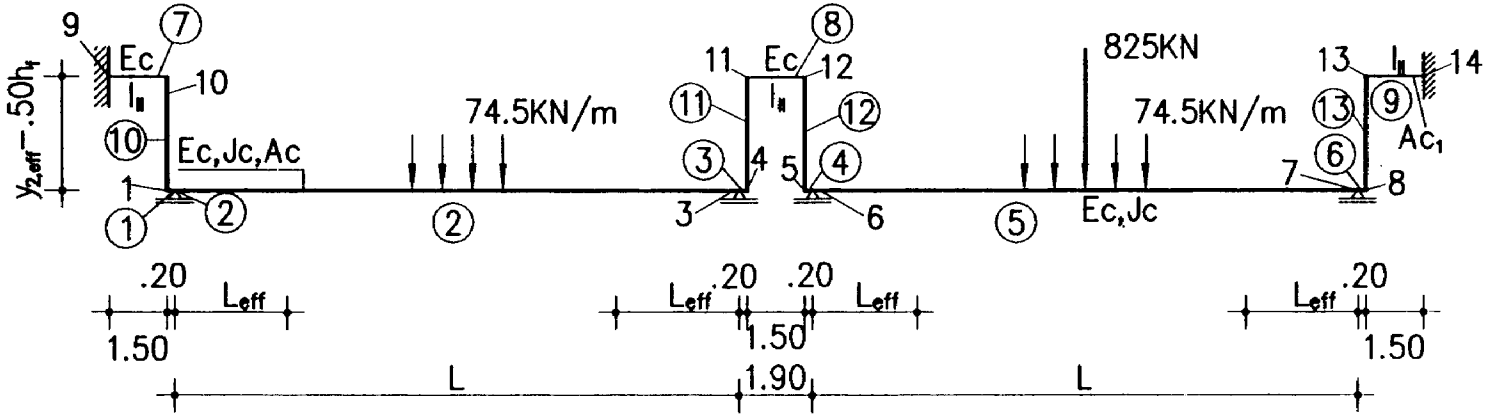
METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9



INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM NORMAL FORCES LC 2 LOAD CASE 2 1 CM = 5000 kN

M 1 : 500

$$Ac_1 = \frac{1.50}{1.50+L_{eff}}\,1.2As\frac{Es}{Ec} \qquad Ac_2 = \frac{1.50}{1.50+2L_{eff}}\,1.2As\frac{Es}{Ec}$$



ΠΙΝΑΚΑΣ ΔΕΔΟΜΕΝΩΝ

L=33.0m	E_c =32 GPa
b=12.0m	a=6.25
$A_{c,eff}$ =5.100m^2	g_1 =30.7KN/m
$J_{c,eff}$=2.784m	q=43.8KN/m
h_b =2.15m	g_1 +q=74.5KN/m
h_{ft}=0.275m	Q=825KN
$h_{f,eff}$=0.20m	A_{st}=1232cm^2/m (5φ14/25
$h_{(np.)}$=0.075m	ρ=5,1%
$y_{2,eff}$ =0.73m	A_{sb}=20,5cm^2/m (φ14/75π. φ14/75κ.
	T=-50° C
	Leff= L/6 ≃ 5,5 m

$I_{II}=3.544\alpha\rho b h_{f,eff}^3/12=0.1772\rho = I_I/1.5 = 0.0053\,m^4$

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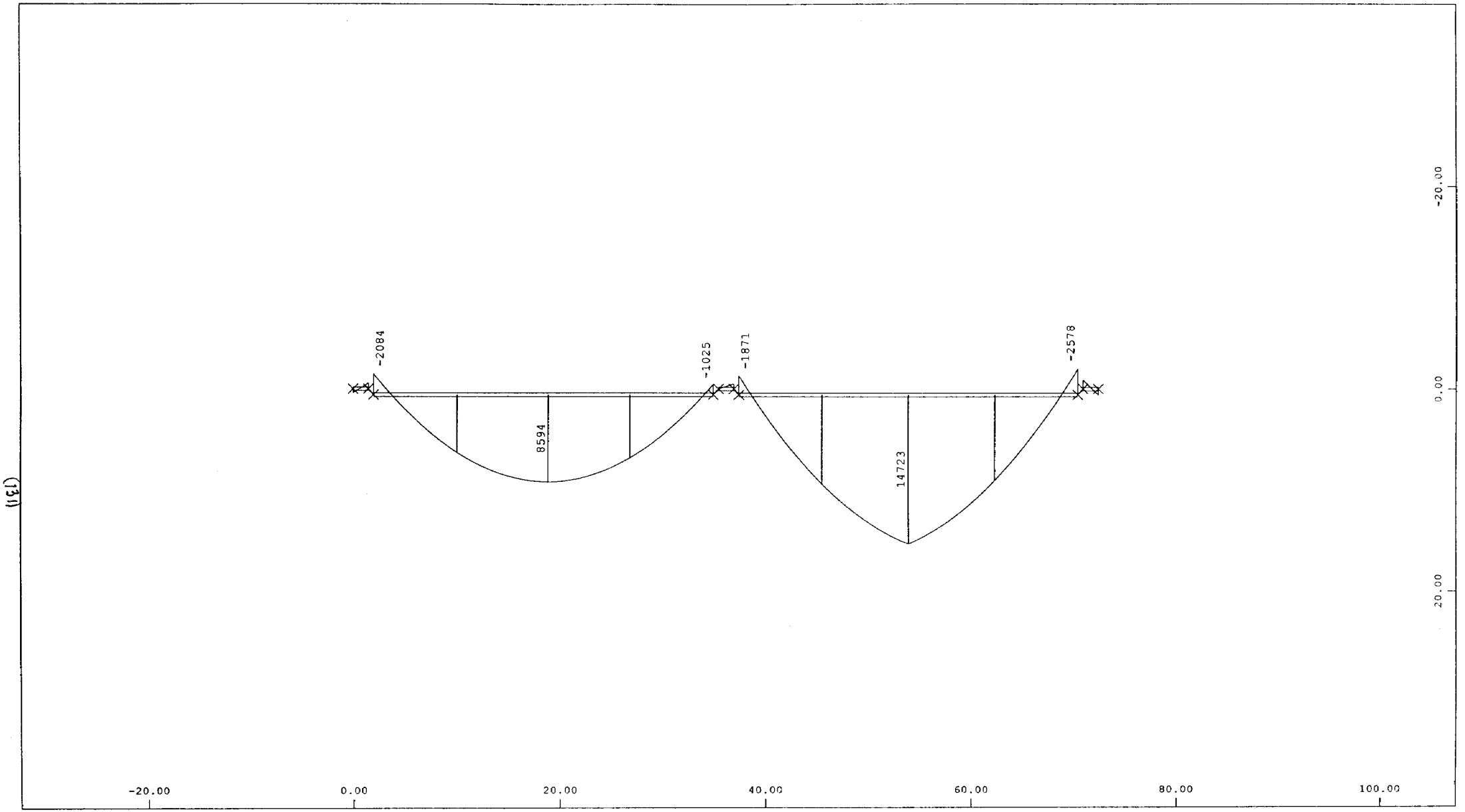
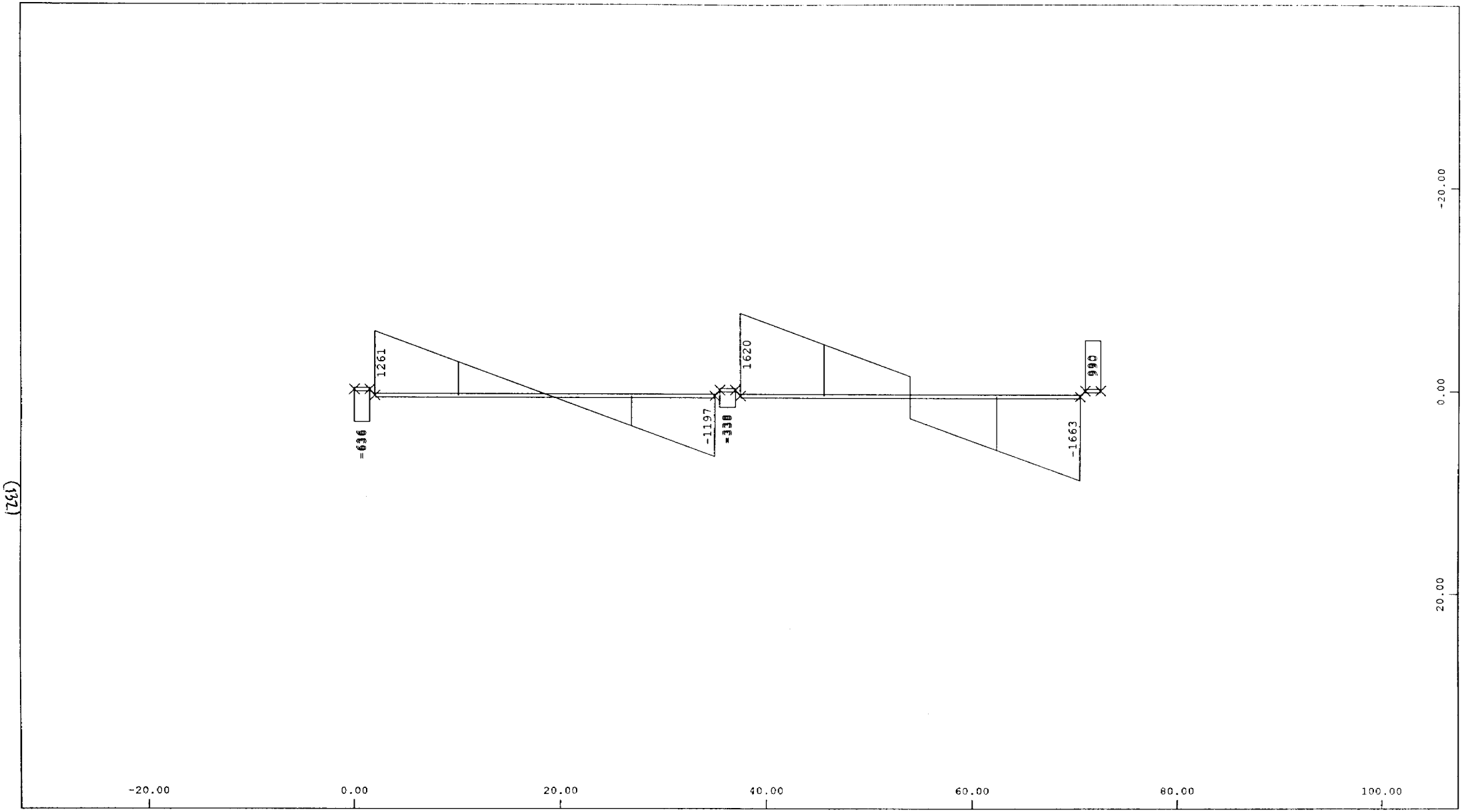


INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM MOMENTS MY LC 1 LOAD CASE 1 1 CM = 5000 kNm

M 1 : 500

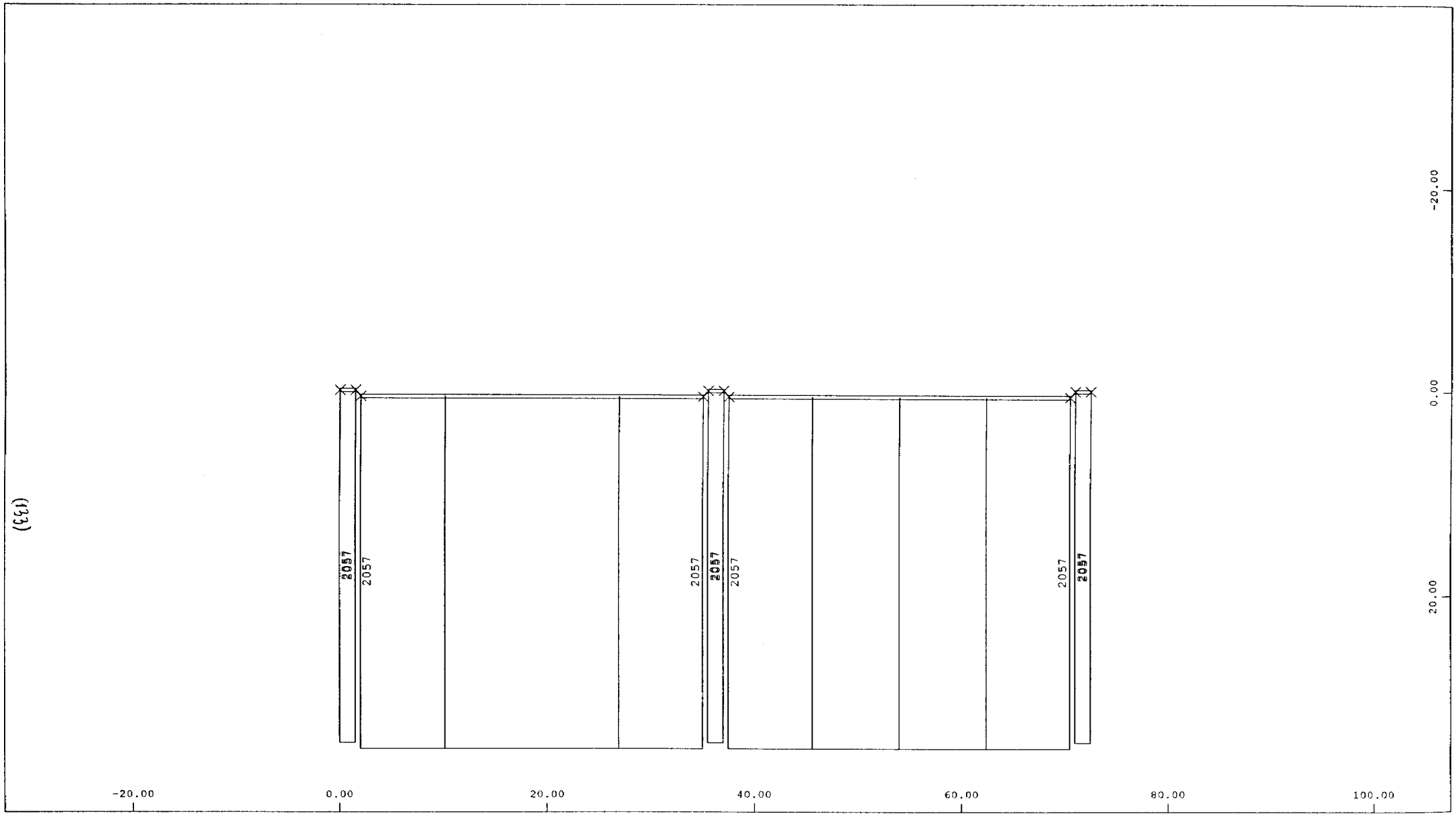
METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9



INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM SHEAR FORCES QZ LC 1 LOAD CASE 1 1 CM = 1000 kN

M 1 : 500

METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9

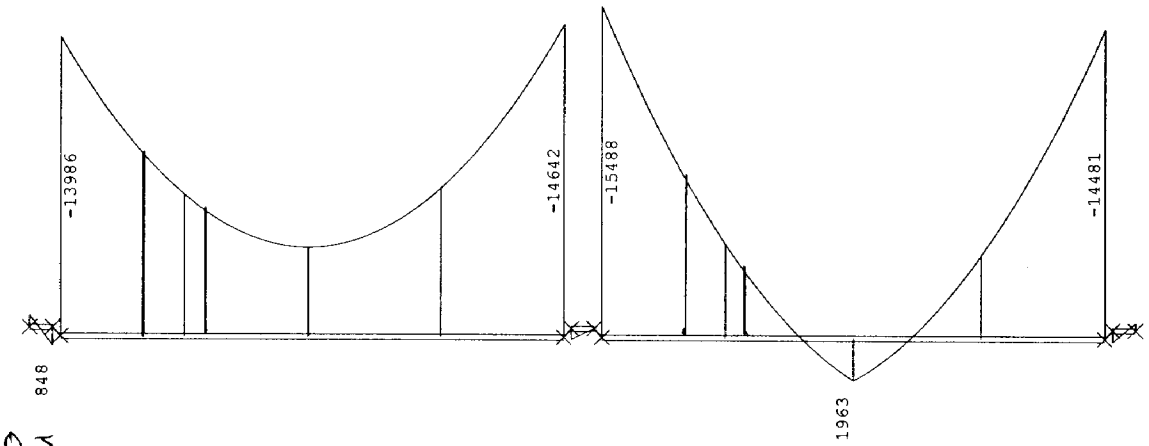


(133)

INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM NORMAL FORCES LC 1 LOAD CASE 1 1 CM = 300.0 kN

M 1 : 500

METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9



(124)

ΘΑΜΙΣΤΙΚΗ ΜΕΘΟΔΟΣ

$\Delta M(L_{eff}) - M_{cr} = -\left(y_{2,eff} - 0{,}5 h_{f,eff} + \frac{W_{2,eff}}{A_{c,eff}}\right)\Delta N \rightarrow 0{,}5(8400+7175)+3{,}814\left(3500-\frac{26388}{5{,}1}\right) = 7787+6385 = -1{,}38\,\Delta N_1$

$\Delta N_1 = -10.270$ kN, $N_1 = 26388 - 10.270 = 16.118$ kN $\rightarrow x_1 = 13{,}65 \times 26.388/16.118 = 21{,}70$ m $\rightarrow L_{eff,1} = 9{,}70$ m $\rightarrow 0{,}5(5740+2975)+$

$+6385 = -1{,}38\,\Delta N_2 \rightarrow \Delta N_2 = -7784$ kN $\rightarrow N_2 = 18600$ kN $\rightarrow x_2 = 13{,}65 \times 26.388/18.600 = 18{,}80$ m $\rightarrow L_{eff,2} = 8{,}25$ m

$0{,}5(6475+4200)+6385 = -1{,}38\,\Delta N_3 \rightarrow \Delta N_3 = -8494$ kN $\rightarrow N_3 = 17.900$ kN $\rightarrow x_3 = 13{,}65 \times 26.388/17.900 = 19{,}55$ m

$L_{eff} \simeq 8{,}65$ m, $N \simeq 18.000$ kN

INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM MOMENTS MY LC 2 LOAD CASE 2 1 CM = 3500 kNm

M 1 : 500

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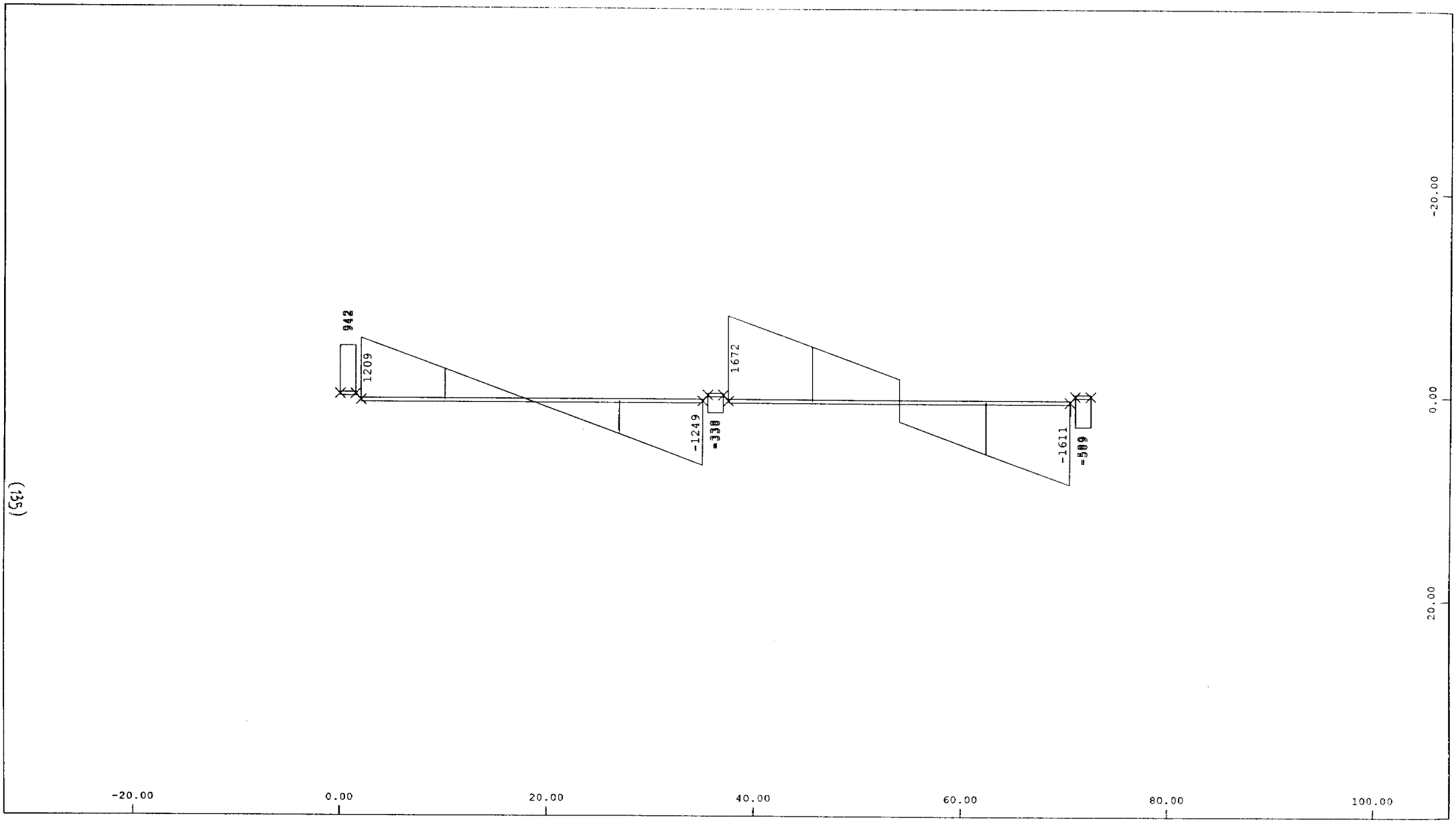
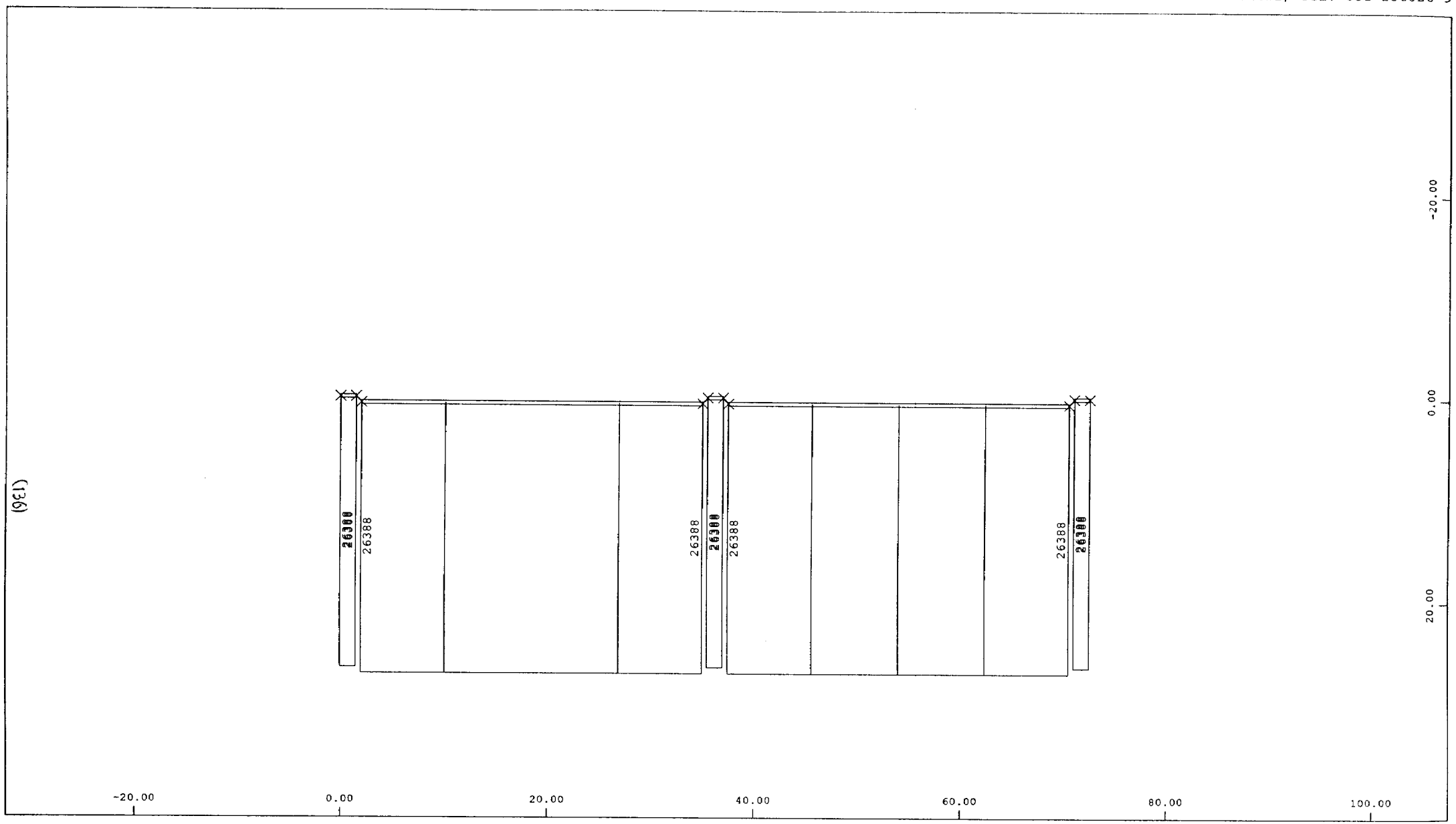


(135)

INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM SHEAR FORCES QZ LC 2 LOAD CASE 2 1 CM = 1000 kN

M 1 : 500

METE SYSM S.A. 18 P. Mela St. GR 54622 Thessaloniki, Tel. 031-256826-9



INTERNAL FORCED OF BRIDGE SUPERSTRUCTURE
SECTOR OF SYSTEM, ELEMENT GROUP 0
———BEAM NORMAL FORCES LC 2 LOAD CASE 2 1 CM = 5000 kN

M 1 : 500