Limited Liability Company
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QUALIFICATION CERTIFICATE

Series AP 000106 dated 29.03.2012

O.V. Shimanovsky

Zinteco LLC

The verification static calculation of
The delay tower H=23.0 m

METAL CONSTRUCTIONS

31656-KM

Chief Engineer of the Institute	V. L. Pasechniuk
Project Structural Engineer	O. S. Iliushenko
Head of Department	B. M. But

2016

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Signature and date
Inv. No of equip.

Копія

MINISTRY OF REGIONAL DEVELOPMENT, CONSTRUCTION AND HOUSING MAINTENANCE AND UTILITIES OF UKRAINE
CERTIFICATION ARCHITECTURAL AND CONSTRUCTION

Series AP   № 000106

QUALIFICATION CERTIFICATE OF

responsible executor of certain types of works (services), related to the creation of an object of architecture

Architect engineer
(name of profession)

issued on the fact that Shymanovsky Oleksandr Vitaliiovych
(name, surname, patronymic name)

held professional certification that confirms his (her) compliance with qualification requirements in the sphere of activities related to the creation of objects of architecture, professional specialization, the required level of skill and knowledge.

Category: Architect engineer.

The qualification certificate was issued according to the decision of Certification Architectural and Construction Commission (further on Commission) from ---- № ----

(by decision of the relevant section of the commission dated 22.03.2012 № 6 approved by the Presidium of the Commission 27.03.2012 № 6-ІП).

Registered in the Register of certified persons on March 29, 2012 under the number 106.

Works (services) related to the creation of architectural objects the implementation capacity of which is determined by the qualification certificate: engineering and construction design in terms of mechanical resistance and durability

Date issued 23.04 2012

Chairman (assistant chairman) of the Certification Architectural and Construction Commission

signature

Nepomniashchiy O.M.
full initials

Ministry of Regional Development, Construction and Housing Maintenance and Utilities of Ukraine* Kyiv* State Emblem of Ukraine

Limited Liability Company* Kyiv* V.M. Shimanovsky Ukrainian Research and Design Institute of Steel Construction* Identification code 36861591

Згідно з оригіналом

Head of Personnel Management of V.M. Shimanovsky Ukrinstalkon, LLC

Yu.B. Shumovska

31-05-2016 р.

Table of contents

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Changeable amount	Sheet № doc.	Signature	Date
Head Department	But		31.05.16
Project str. eng.	Iliushenko		31.05.16
Public inspection	Iliushenko		31.05.16
Head of group	Lirner		31.05.16

31656-KM

Content

Stage	Sheet	Sheets
P	2	83

V. M. Shimanovsky
Ukrinstalkon LLC, 2016

A4

GENERAL GUIDELINES

1 Initial data

1.1 The design work "Verification static calculation of the delay tower H = 23.0 m" was performed on the basis of:

- Agreement No. 31656 as of 28 April 2016"
- Technical task of Zinteco LLC (hereinafter referred to as the Customer);
- Drawings and technical data of the tower provided by the Customer.

1.2 According to the technical task, the operation of the tower is possible in all regions of Ukraine, the value of the wind load is taken P = 50 kg / m^2

1.3 The verification calculation was carried out in accordance with the current normative documents:

- DBN V. 1.2-2: 2006 "Loads and effects. Design standards";
- DSTU B V. 1.2-3:2006, "Deflections and displacements. Design requirements";
- DBN V. 2.6-198: 2014 "Steel constructions. Design standards";
- DSTU B V. 2.6-199:2014 "Steel structures. Manufacturing requirements";
- DSTU B V. 2.6-200:2014 "Metal structures. Installation requirements").

1.4 This documentation is intellectual property of V.M. Shimanovsky Ukrinstalkon LLC (Company) and can not be transferred for distribution to legal entities or individuals or otherwise used outside the Agreement without the consent of the Company. Any actions related to violation of personal non-property or property rights of the Company as a subject of copyright to this working documentation shall entail liability in accordance with the procedure established by law.

2. Delay tower features and design solutions

2.1 Delay tower is designed to serve mass concert and entertainment events. A General view and a constructive solution of the tower shown in the sheets of KM-6.. .13.

2.2 The tower is made in the form of a free-standing support with a height of 23 m, has the following structural elements:

- trunk of the tower;
- base with supports;
- cross-arms;
- guy-ropes.

2.2 The trunk of the tower is made in the form of a tetrahedral lattice prism, which consists of 4 sections. Each section is of 5.6 m high with a diagonal grid. The size of the faces of the trunk prism in the plan is 945 mm along the axes of the belts. The elements of the trunk lattice is welded to belts back to back.

In the vertical position, the tower is held by one tier of guy-ropes with a diameter of 14 mm in four directions. The upper fastening of the guy-ropes is carried out to the elements of the trunk at + 11.600, and the lower fastening is to the elements of the support.

2.3 Tower trunk elements:

- the belts are made of square pipe 80x80x6mm;
- inclined braces and spacers are made of square pipe 60x60x4mm

2.4 The sections of the trunk are interconnected by so-called "forks" and "fingers" with diameter of 35.5 mm.

2.5 The base of the delay tower is made in the form of a cross of separate structural elements (base, support, additional support), connected by bolts. The supports of the base of the tower are made in the form of a container to fill them with water as ballast. Additional supports are used to increase the stability of the facilities in the direction of maximum wind loads, as well as for use, if necessary, additional ballast from reinforced concrete blocks, etc.

2.6 At the mark +22,400 cross-arms are installed on the trunk of the tower, depending on the need for fixing technological equipment with a total maximum weight of 3t (screen, sound speakers, light projectors, etc.).

2.7 The screen is made in the form of a frame with dimensions 8mx4m (8m - vertically). The screen is suspended on two suspension rods to the console and is unfastened by means of two guy-ropes to the support elements.

3. Design fundamentals

3.1 Verification static calculation of delay tower H=23,0 m is performed according to the existing regulations in force on the territory of Ukraine, as well as the technical specifications of the Customer.

3.2 The tower calculation is designed for the following types of loads:

- own weight of metal structures of the tower;
- payload (weight of process equipment);
- wind load on the metal structure of the tower and guy-ropes.

A screen 8mx4m is selected for calculations for process equipment, the wind load on which will be the largest, the weight of the screen - 3 t.

3.3 The calculated value of the wind load in accordance with the task is taken P = 50 kg / m^2.

The dynamic factor for the calculation is adopted as 1.2.

3.4 Static calculations of elements of the trunk of the tower, as well as verification of their bearing capacity, are performed using the software SCAD.

3.5 The calculated combinations of loads are given on the sheet KM-15.

3.6 To check the bearing capacity of the sections of the tower elements adopted: steel grade steel structures - St245 (GOST 27772-88); ropes of guy-ropes are according to GOST 3063-80.

3.7 The results of the calculation are given on the sheet KM-83.

4. Conclusions and recommendations

4.1 According to DBN V.1.2-14-2008 "General Principles for the Reliability and Structural Safety of Buildings, Constructions, Structures and Foundations" (section 5, table 1) the delay tower with a height of 23 m belongs to the class CC2 (average consequences of liability) and III category of complexity, as an object of local level.

4.2 According to the results of calculations of the tower, three main indicators were estimated (see table on a sheet of KM-83), namely:

- bearing capacity of elements of the tower trunk and guy-ropes;
- horizontal movement of the top of the tower trunk;
- the presence of separation in the cross section support.

4.3 According to the analysis of the performed tower verification calculations for the given loads, the bearing capacity of the tower metal structures and guy-ropes is generally provided with the mandatory use of ballast on the supports. Horizontal movements do not exceed those that are permissible according to DBN V. 2.6-198:2014.

The separation that takes place in one direction of a cross-section support, will not lead to the tower changeover. But with maximum load equipment and critical wind (25 m/sec and more), we highly recommend you to use additional support with extra ballast – 1 tf (ton-force).

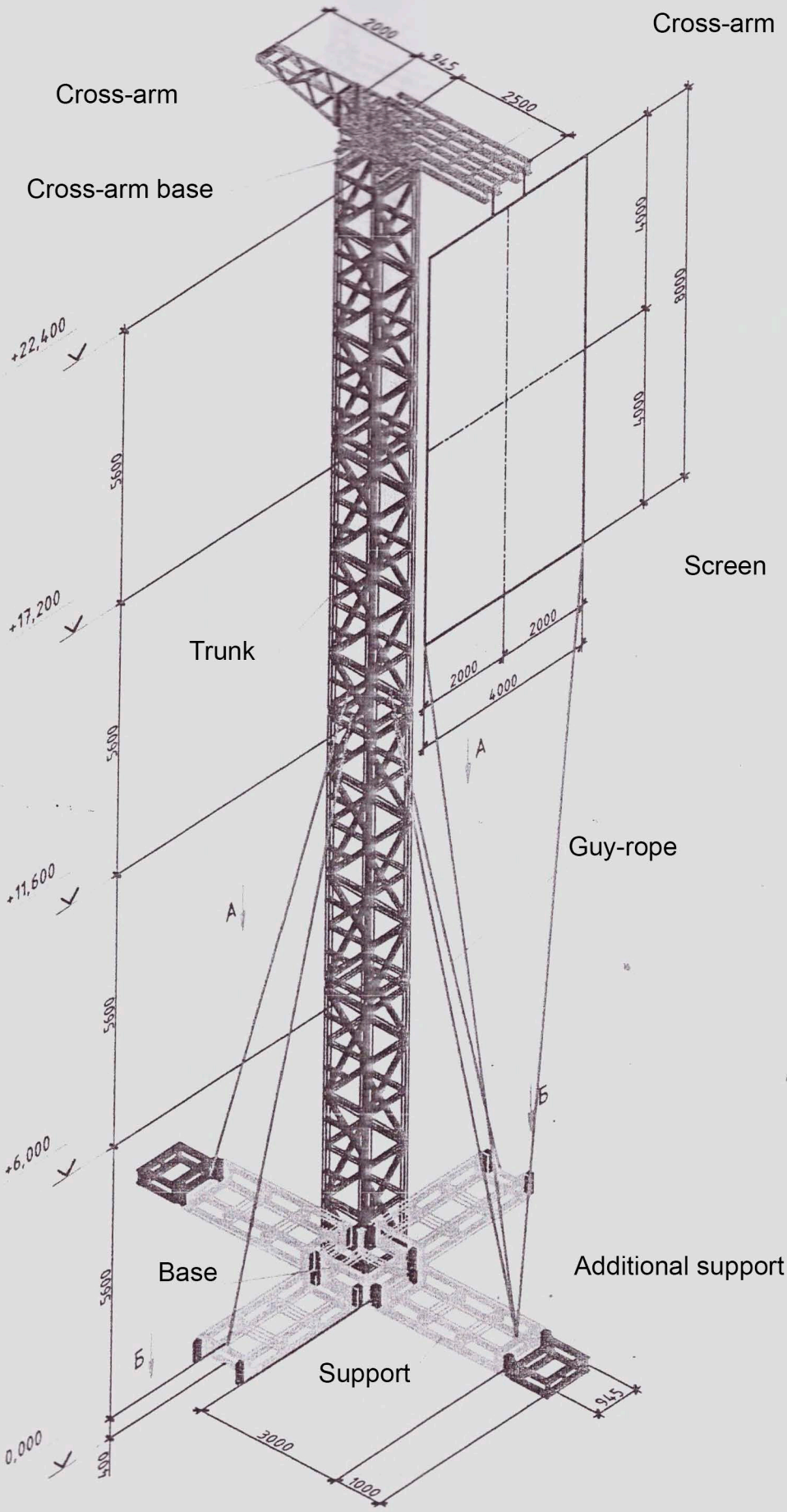
4.4 Taking into account that the calculated wind load of 50 kg /m^2 (according to the task) is not the largest in the territory of Ukraine according to DBN V. 1.2-2: 2006, when operating the facility in open areas and on the rivers or seaside where sharp changes of the direction and wind speed pressure are possible, in case of the warning about it in forecasts of meteorological services, we recommend to dismantle urgently the processing equipment for reduction of wind loading.

4.5 The fixing of the guy-ropes to the trunk of the tower shall be performed up to the belts near the junction zones of the lattice elements and belts. If fastening of guy-ropes is carried out to the spacers, it is necessary, at the level of the spacers, to install the diaphragm, the elements of which unfasten the points of the guy-ropes fixing.

4.6 When installing the guy-ropes, it is necessary to provide their pre-tension for a force of 0.6 t with the help of special devices (lanyards, screw tightening, etc.).

4.7 During operation of the facility, it is necessary during the regular inspection of structures to monitor places of fastening of the guy-ropes, the joints of the sections, the welds, the condition of anti-corrosion coatings. Perform anticorrosion protection of metal structures according to the instructions of DSTU B V. 2.6-193:2013 "Protection of Metal Structures against Corrosion".

Genaral view



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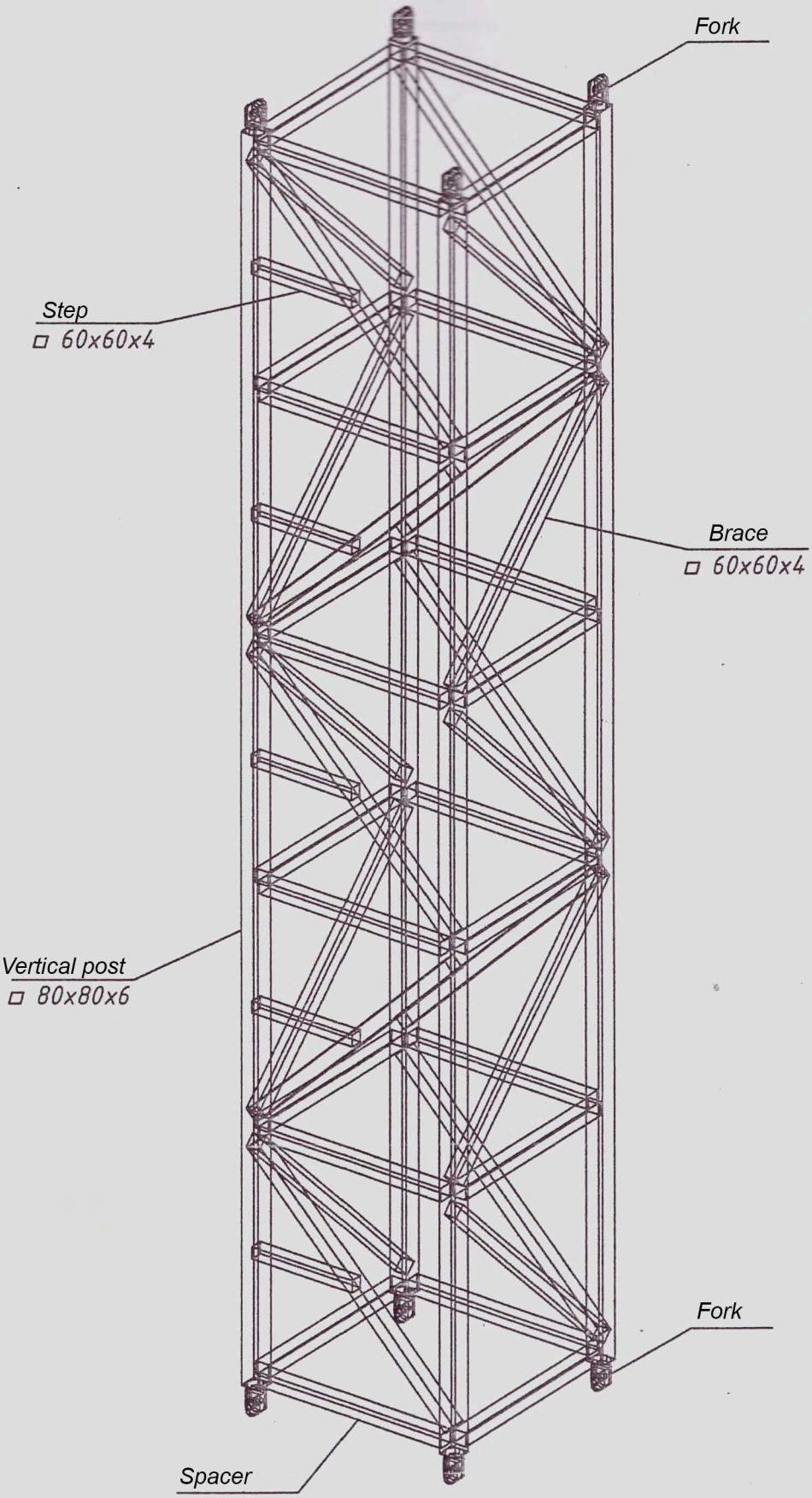
Content	Qty	Sheets	№ doc.	Signature	Date	31656-KM	Sheets 6

Trunk section



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31656-KM

Sheets 7

A4

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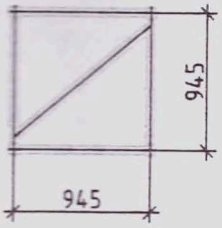

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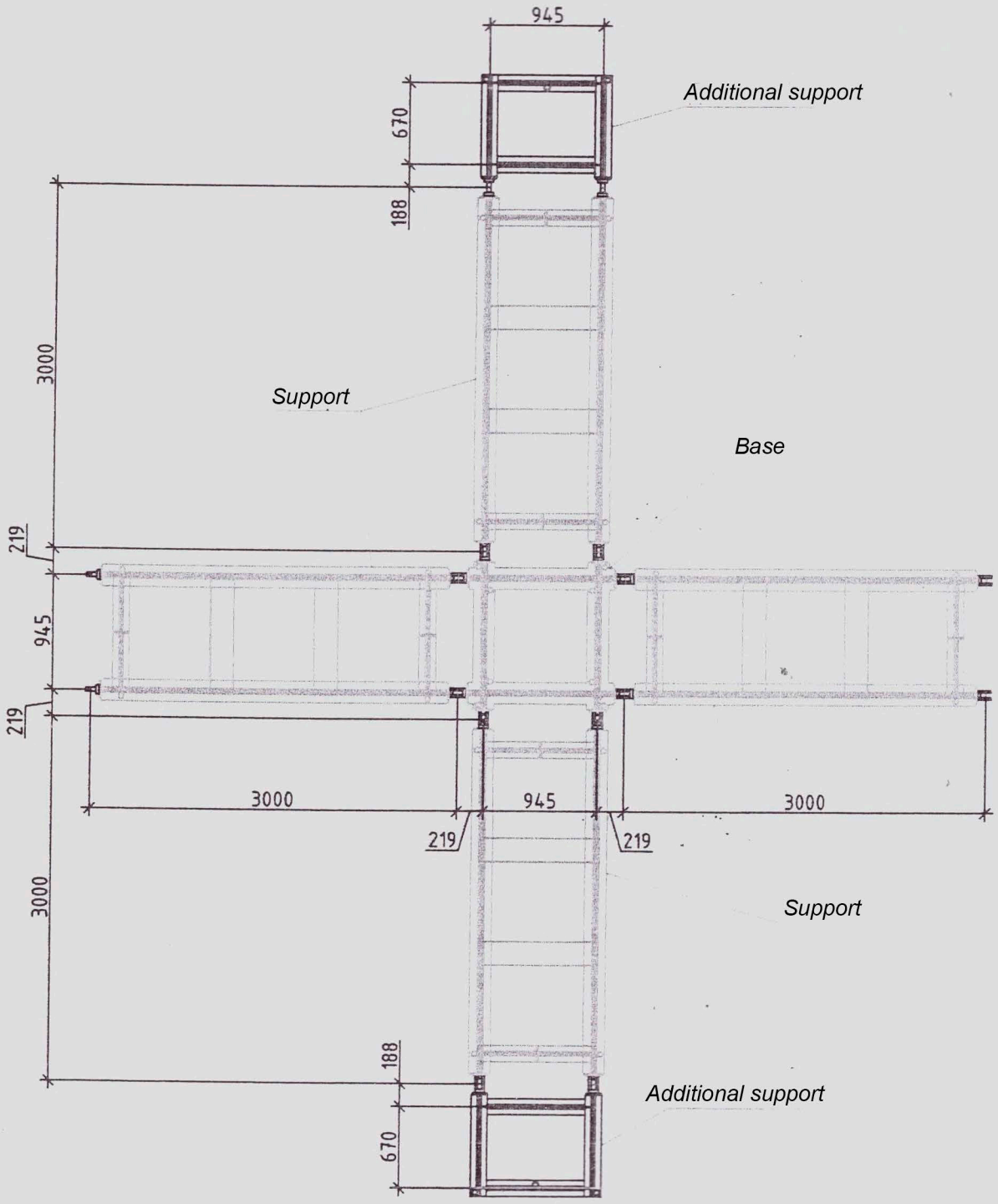

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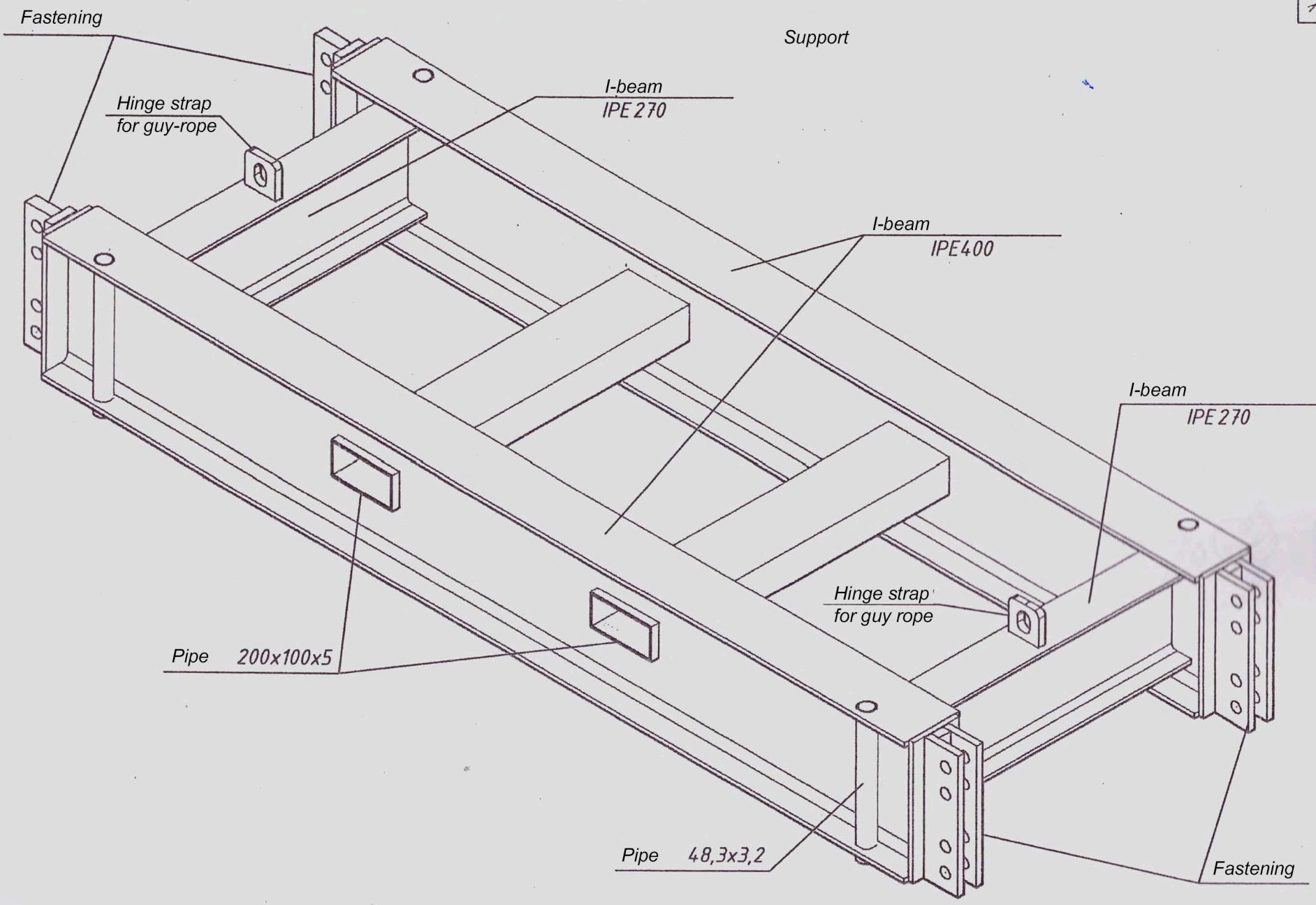
Content	Qty	Sheets	№ doc.	Signature	Date	31656-КМ	Sheets 8



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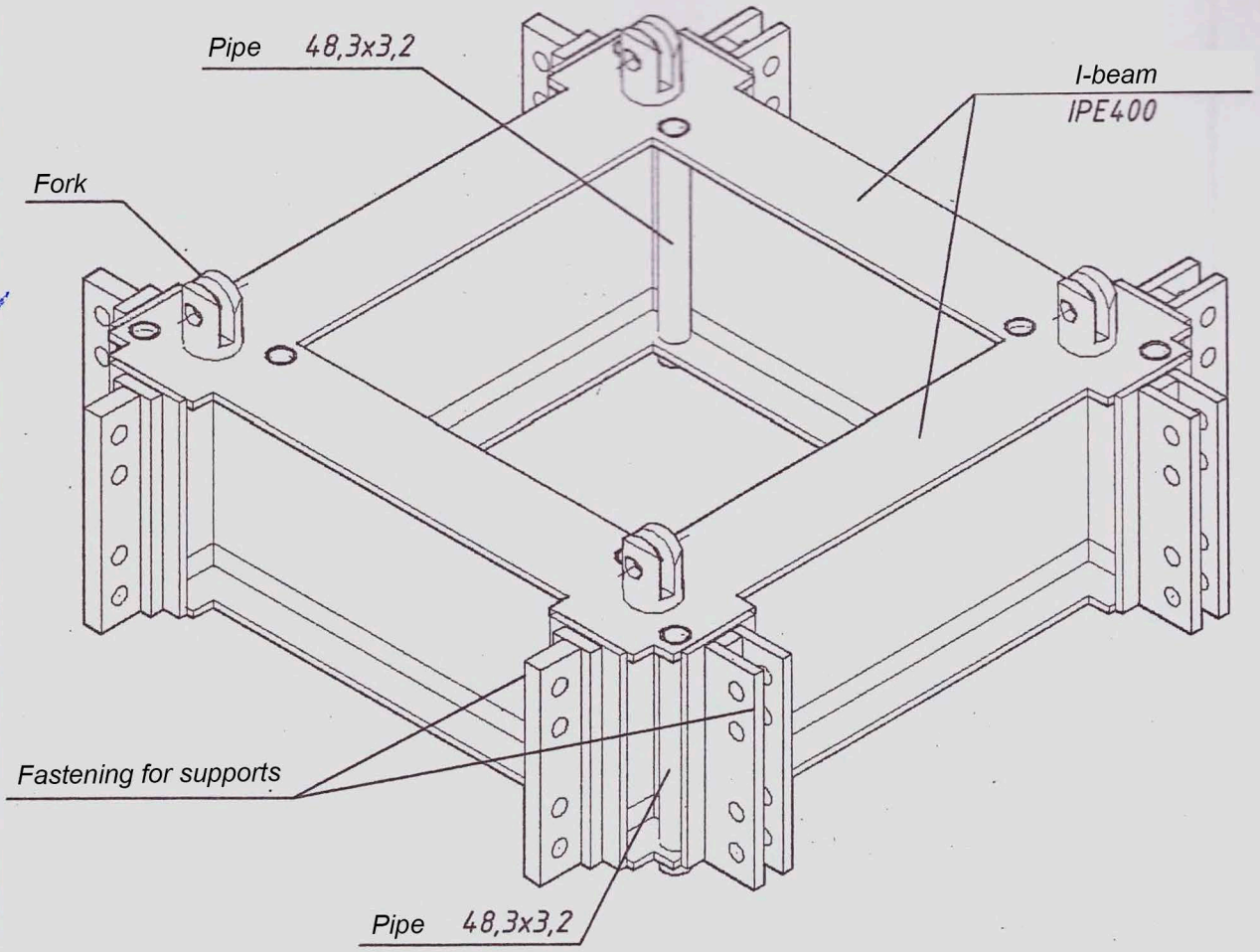
Content	Qty	Sheets	№ doc.	Signature	Date

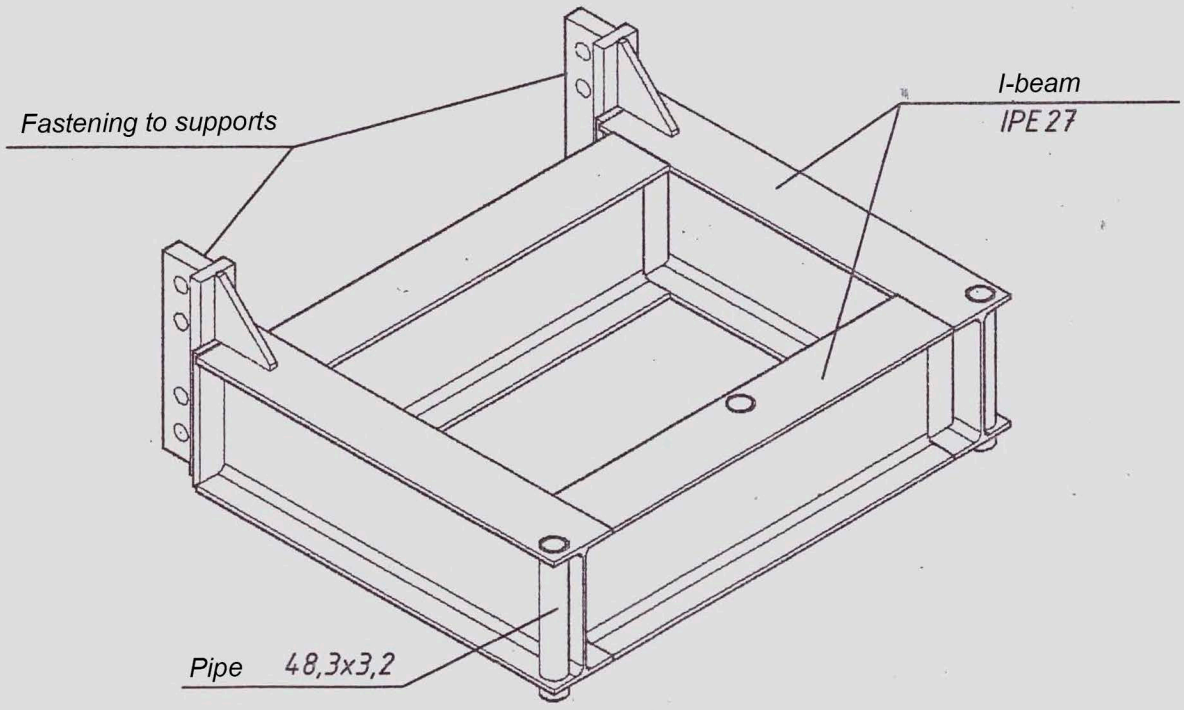
31656-KM

Sheet 9

Base



Additional support



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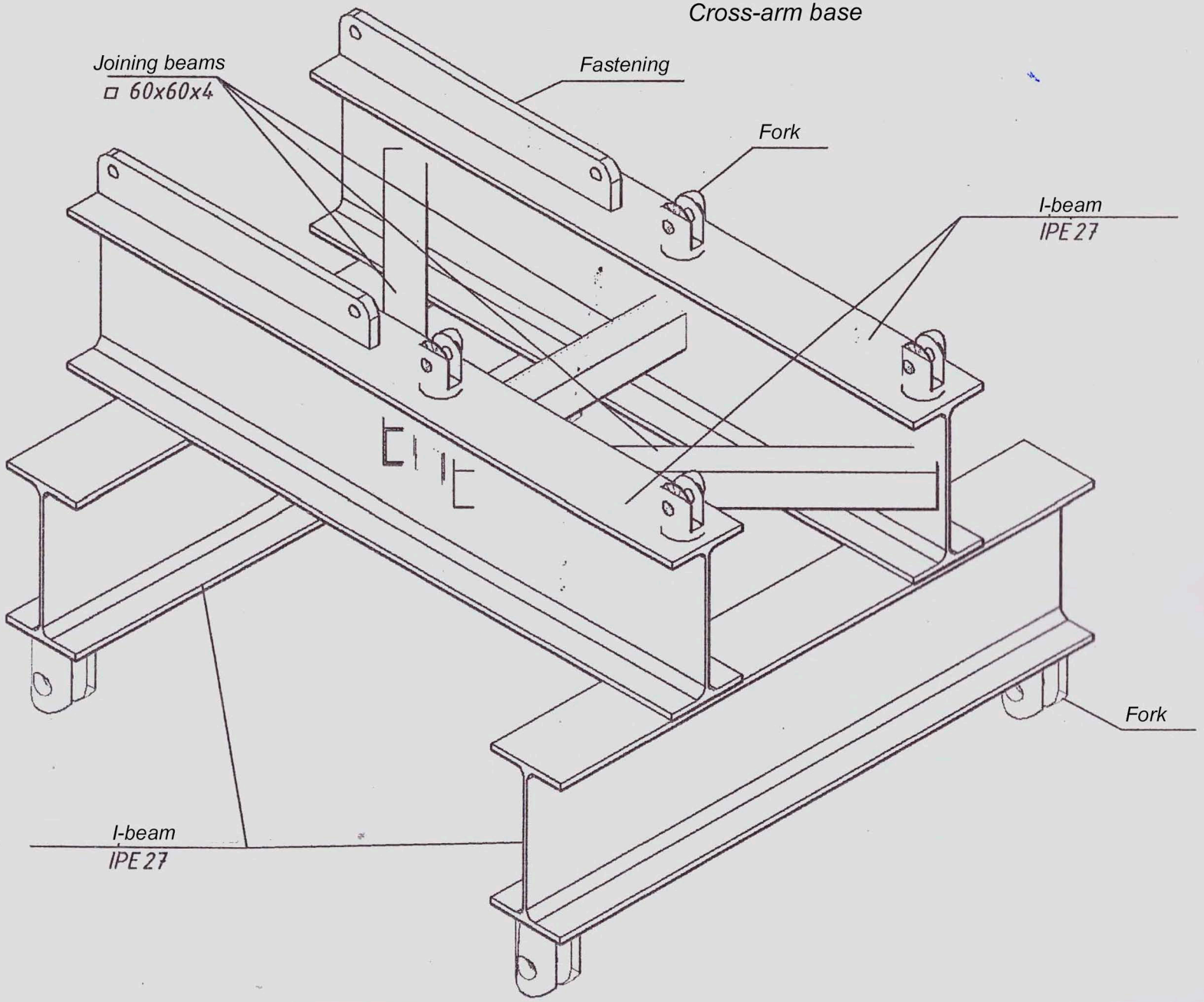
Content	Qty	Sheets	№ doc.	Signature	Date

31656-KM

Sheet 10

A4

Cross-arm base



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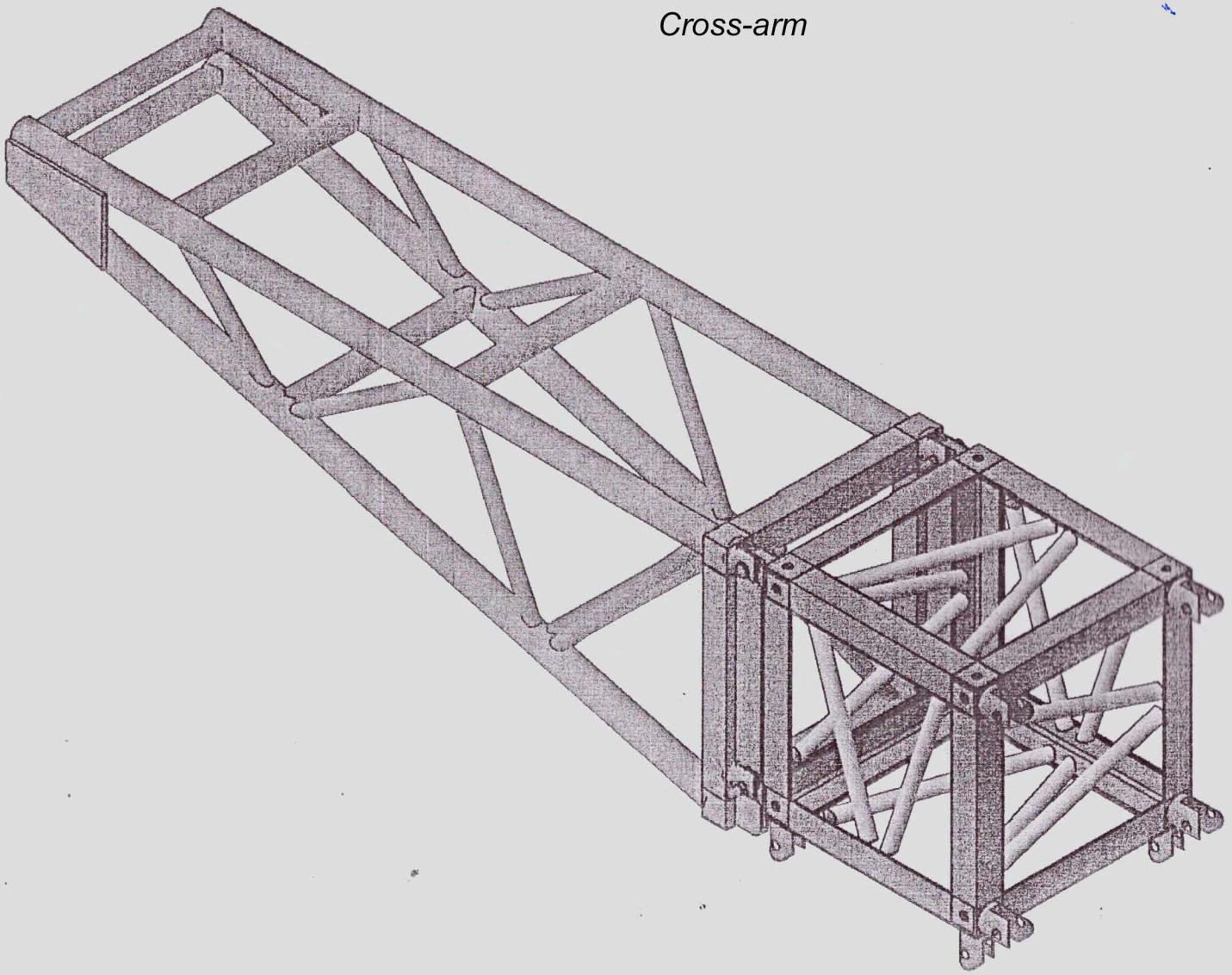
Content	Qty	Sheets	№ doc.	Signature	Date

31656-KM

Sheet 11

Cross-arm



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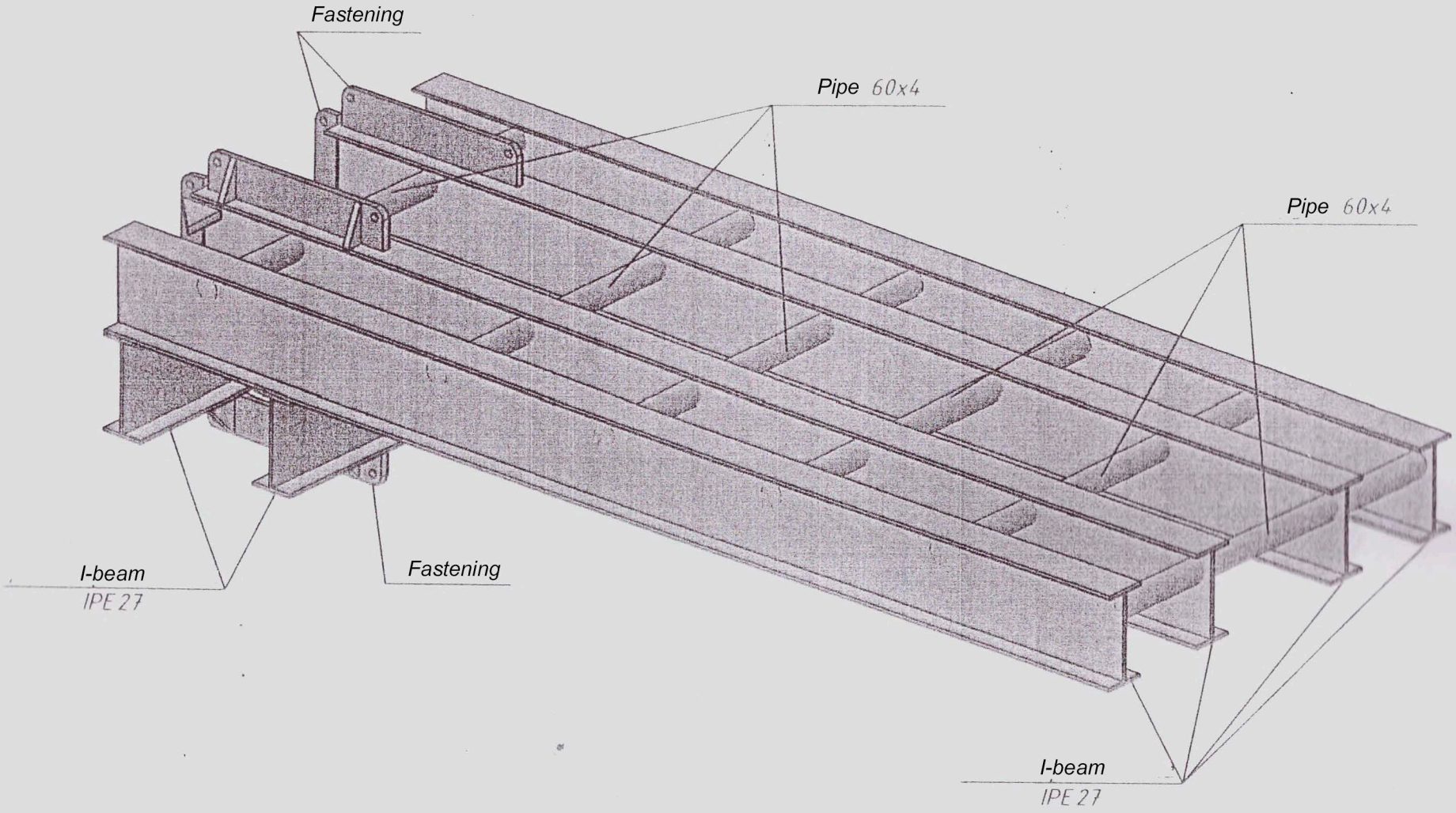
Content	Qty	Sheets	№ doc.	Signature	Date

31656-KM

Cross-arm



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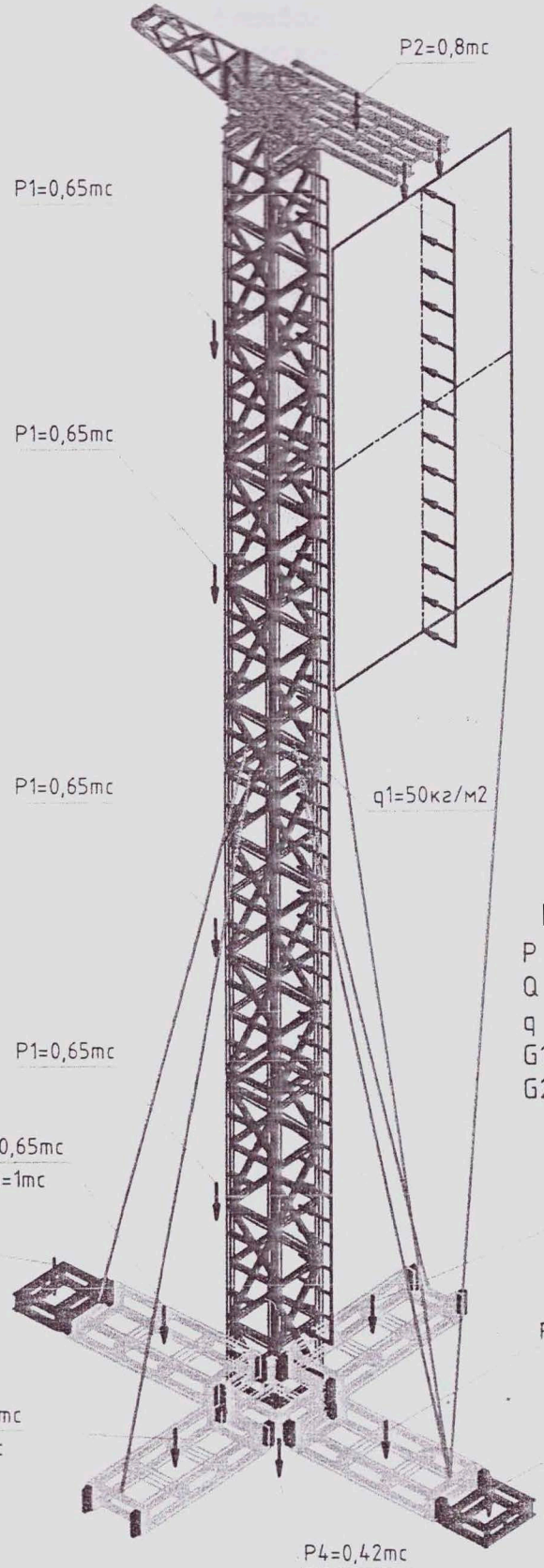
Content	Qty	Sheets	№ doc.	Signature	Date

31656-KM

Sheet

Schematic diagram of loads on tower



Load

P - Own weight
Q - Useful load
q - Wind load
G1 - Ballast weight
G2 - Additional ballast

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Inv. No of equip.

Content	Qty	Sheets	№ doc.	Signature	Date

31656-KM

Sheet 14

A4

Calculated load combinations

№ of combination	Name of load	Dynamic factor of wind load
1	Own weight P1...P4 + useful Q	-
2	Own weight P1...P4 + useful Q + Wind q1, q2	1,2
3	Own weight P1...P4 + useful Q + Wind q1, q2 (at an angle of 45°)	1,2
4	Own weight P1...P4 + useful Q +Wind q1, q2 + Ballast G1	1,2
5	Own weight P1...P4 + useful Q + Wind q1, q2 (at an angle of 45°) + Ballast G1	1,2
6	Own weight P1...P4+P5 + useful Q + Wind q1, q2 + Ballast G1	1,2
7	Own weight P1...P4+P5 + useful Q + Wind q1, q2 (at an angle of 45°) + Ballast G1	1,2

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Calculation of the tower using software SCADa

Loads on design diagram

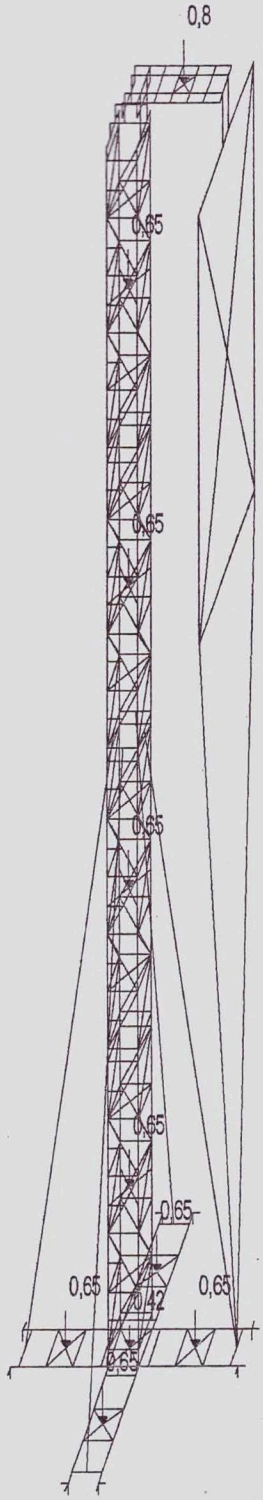


Fig. 1 - Load made by tower own weight

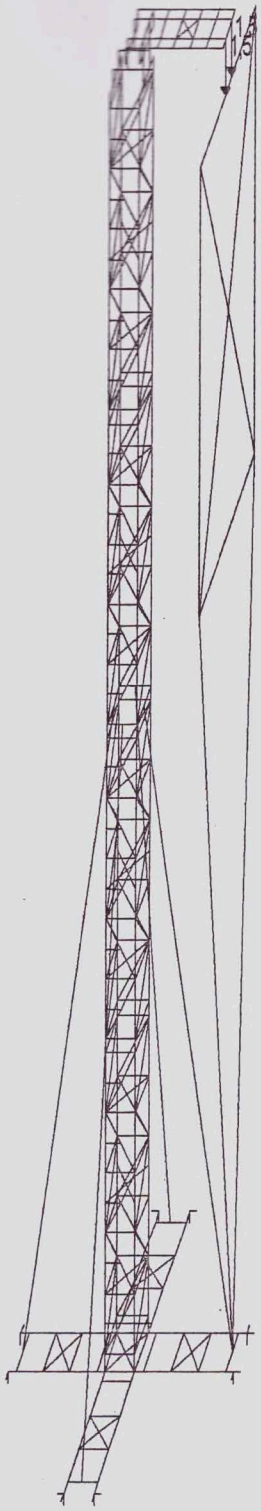


Fig.2 - Load made by screen weight

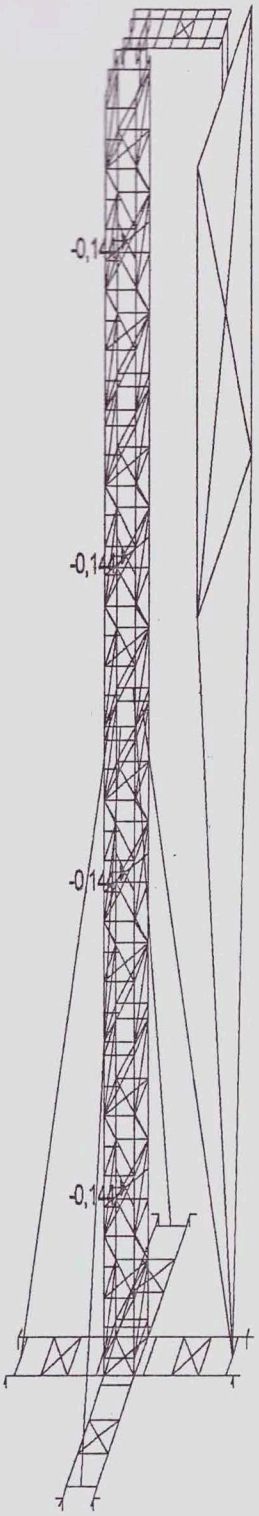


Fig. 3 - Load on the tower trunk made by wind

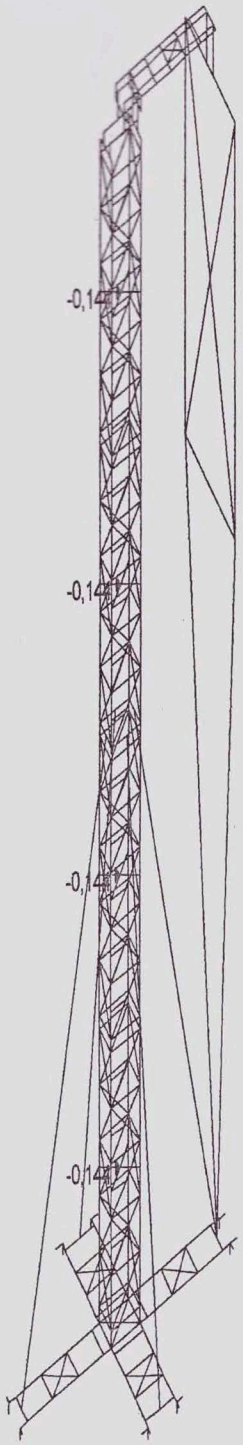


Fig. 4 - Load on the tower trunk at the angle of 45 degrees made by wind

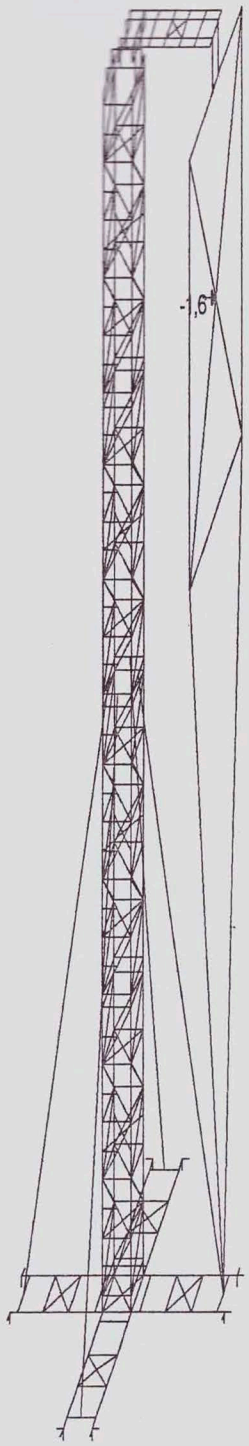


Fig. 5 - Load on screen made by wind

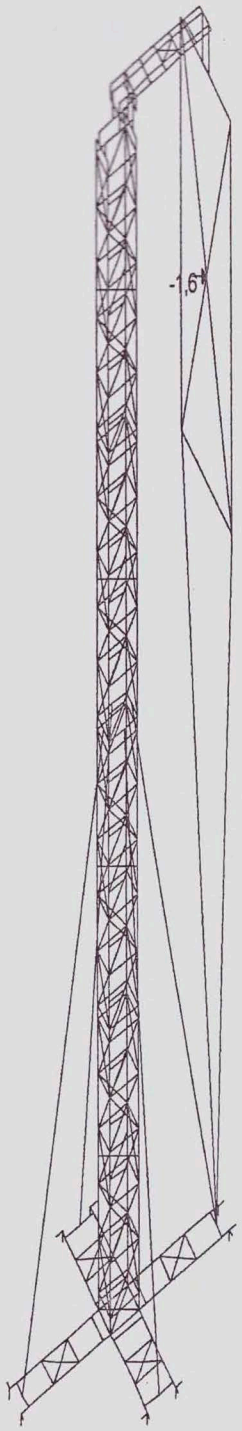


Fig.6 - Load on screen at the angle of 45 degrees made by wind

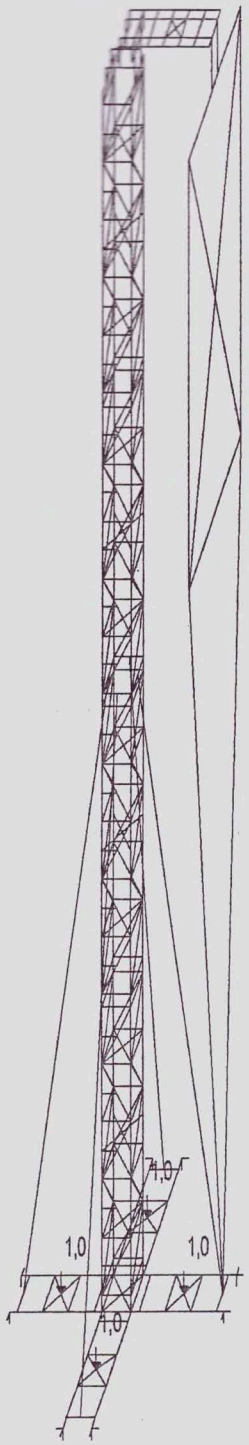


Fig. 7 - Load made by ballast

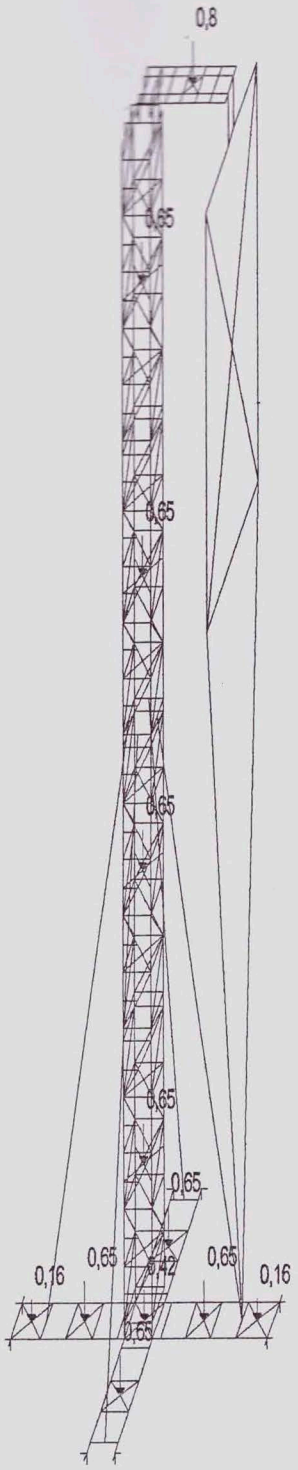


Fig. 8 - Own weight of the tower taking into consideration the additinal support

Subst. No of equip							
Signature and date							
Inv. No of equip.							
	Content	Qty	Sheets	№ doc.	Signature	Date	31656-KM

Results of calculation. Load combination №1

Structure CAD® 11.1

Company	Ukrinstalkon LLC
Facility	Delay tower
Project	31656

Displacement X (mm) Combination 6 ((L1)*1+(L2)*1)

Displacement

Structure CAD® 11.1

Company	Ukrinstalkon LLC
Facility	Delay tower
Project	31656

Combination 6 ((L1)*1+(L2)*1)(T)

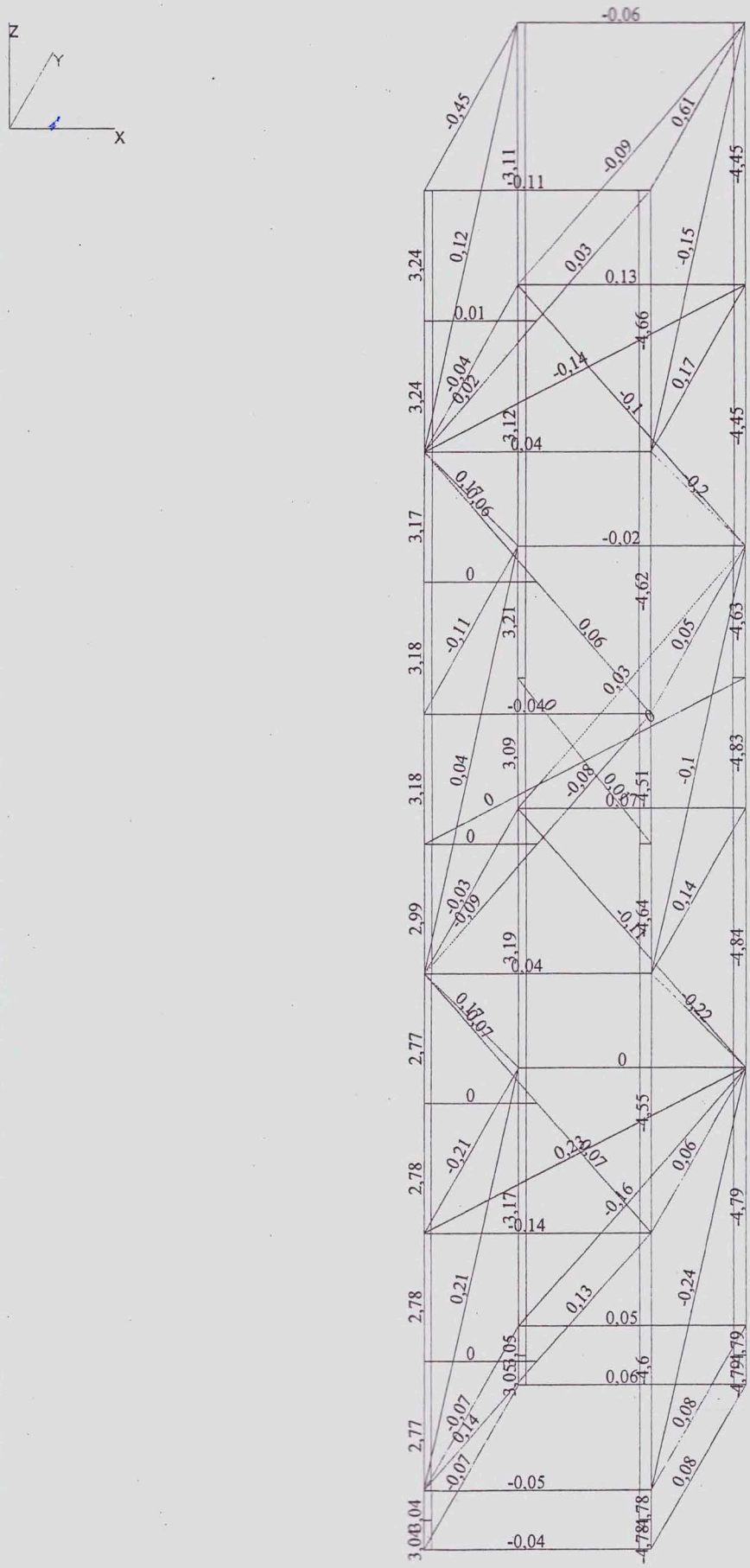
Efforts

Project file: S:\CDATA\Delay Tower H=23m\Tower.SPR

Structure CAD® 11.1

Company	Ukrinstalkon LLC
Facility	Delay tower
Project	31656

Combination 6 ((L1)*1+(L2)*1)(T)



Efforts Mark 22,4-17,2

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Structure CAD® 11.1

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Facility	Delay tower
Project	31656

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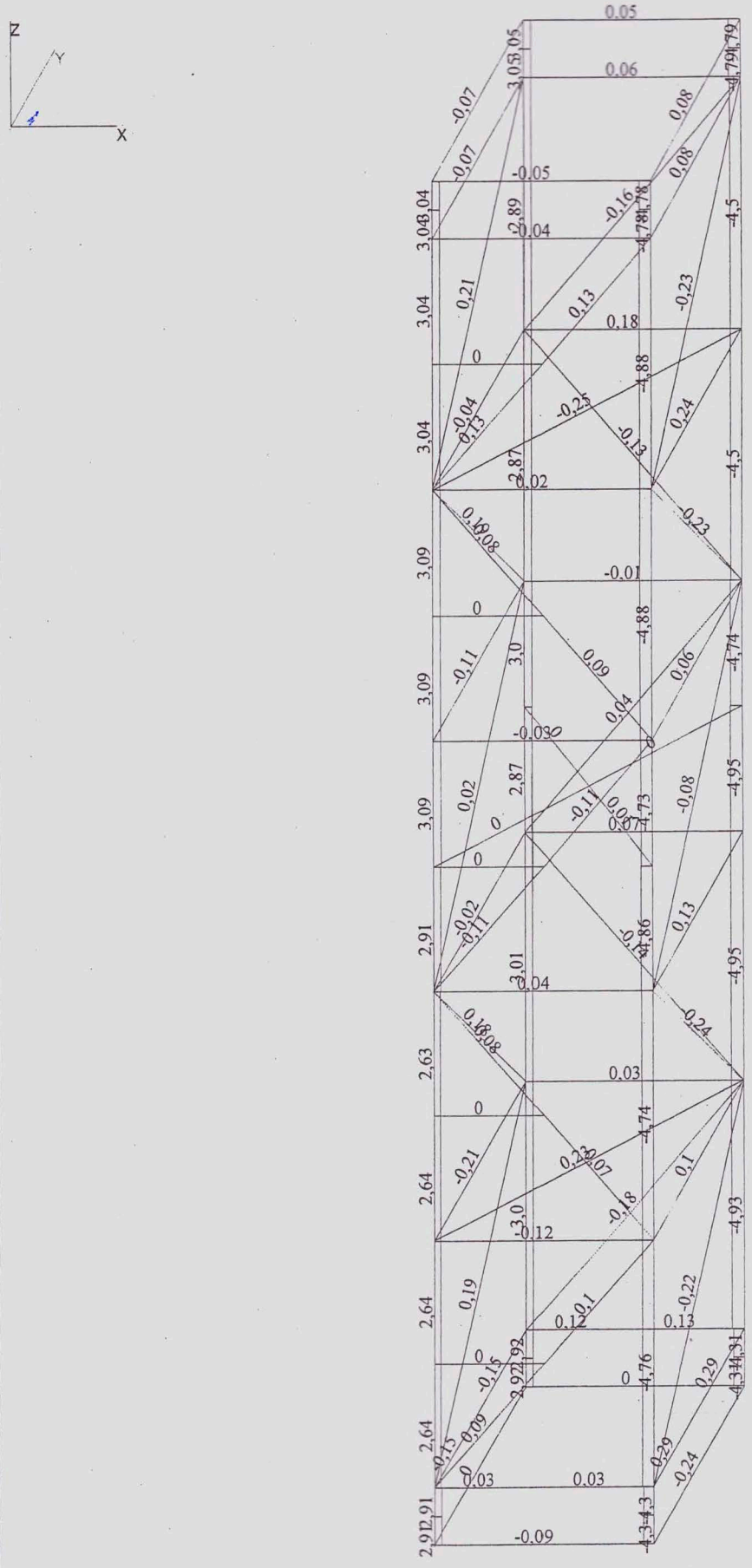

Efforts Mark 17,2-11,6

Structure CAD® 11.1

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Facility	Delay tower
Project	31656

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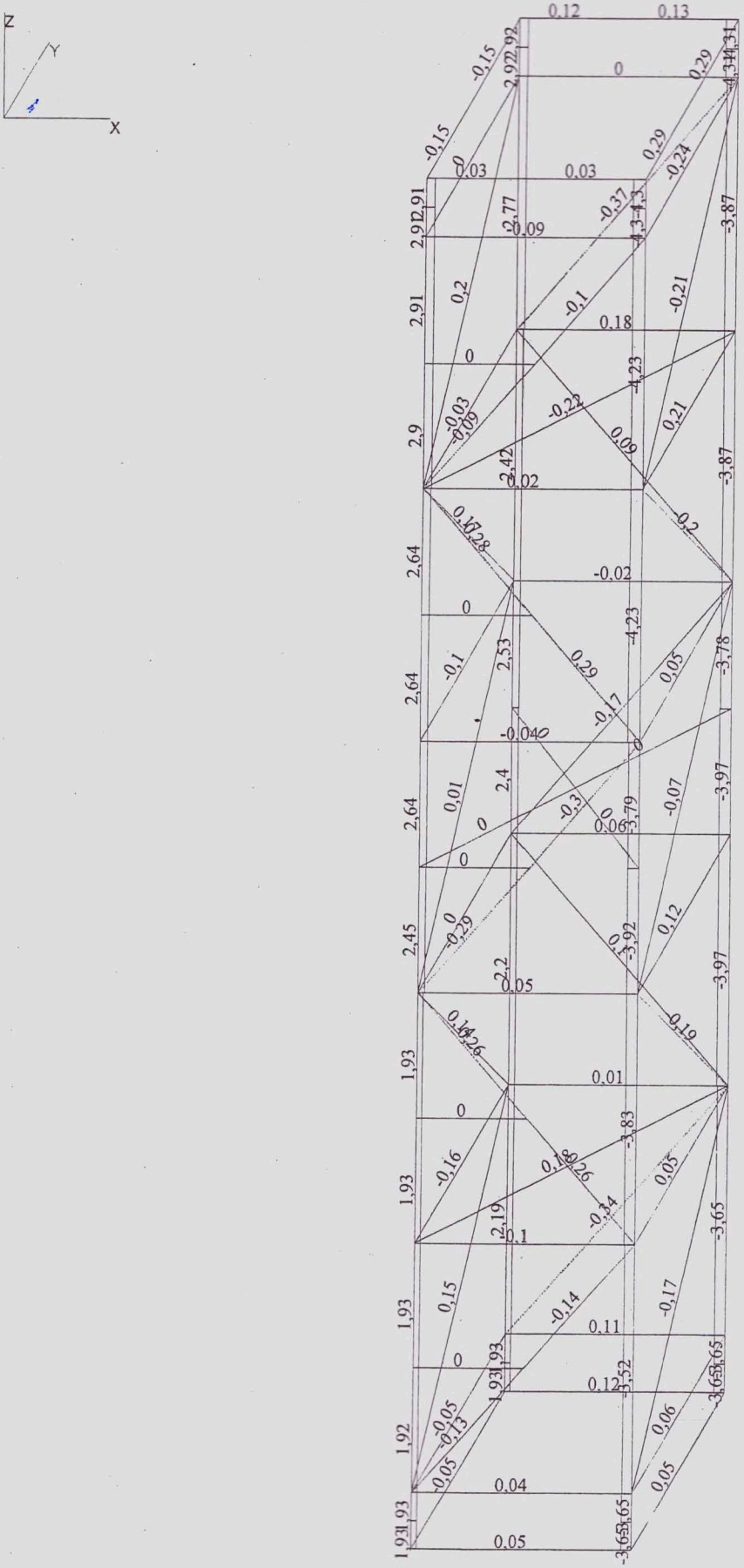
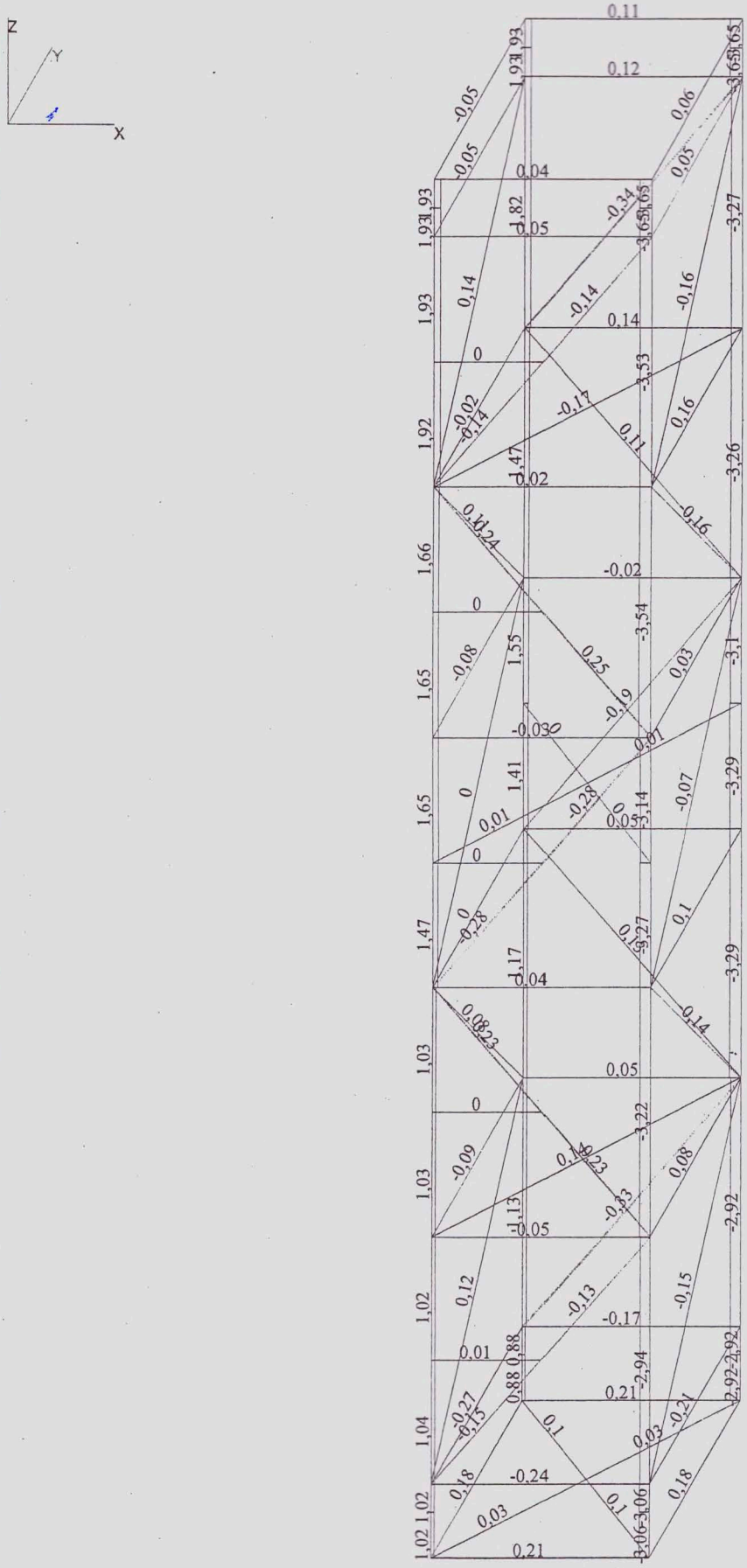


Efforts Mark 11,6-6

Structure CAD® 11.1

Company	Ukrinstalkon LLC
Facility	Delay tower
Project	31656

Combination 6 ((L1)*1+(L2)*1)(T)



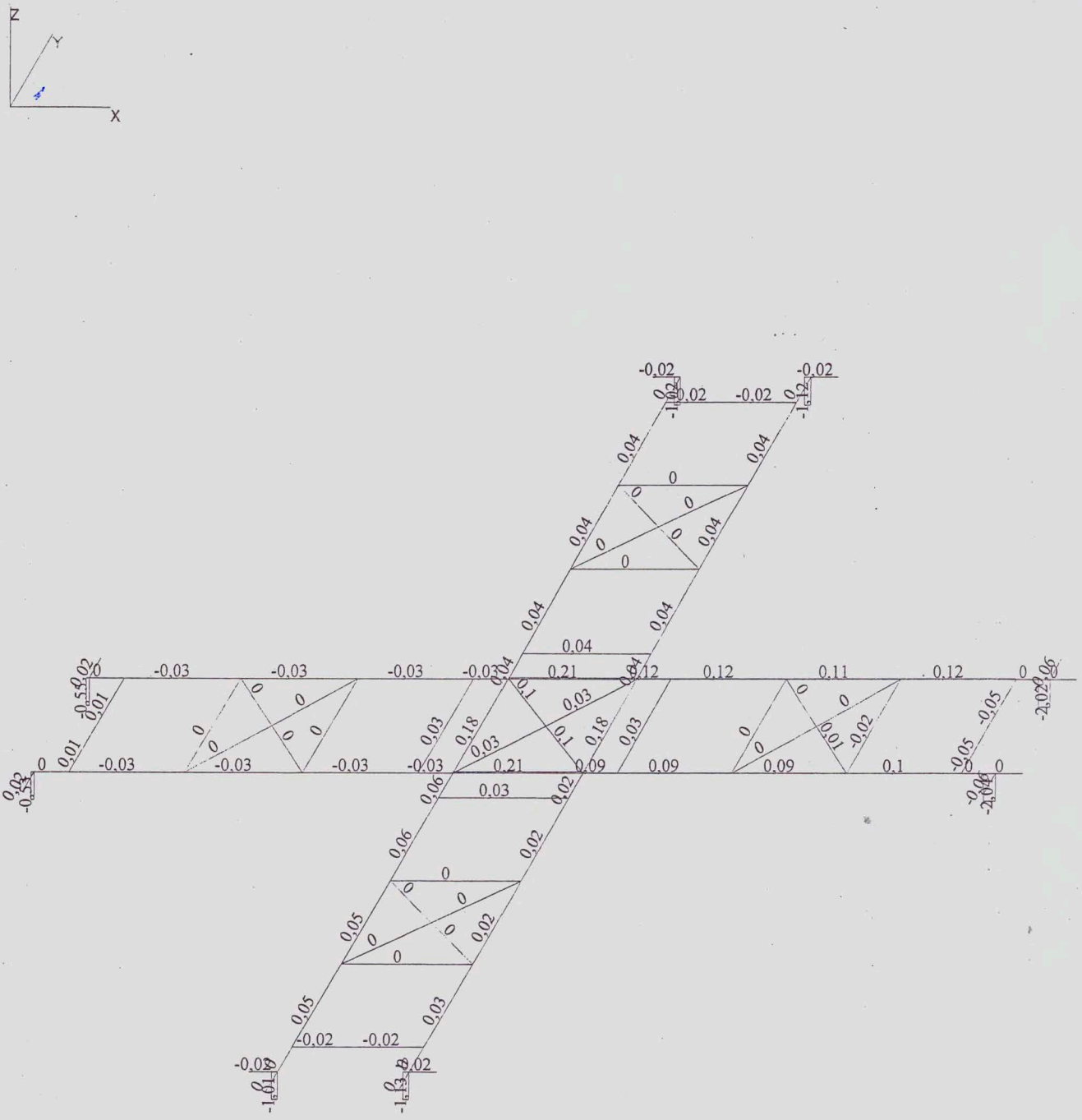
Efforts Mark 6-0

Project file: S:\CDATA\Delay Tower H=23m\Tower.SPR

Structure CAD® 11.1

Company	Ukrinstalkon LLC
Facility	Delay tower
Project	31656

Combination 6 ((L1)*1+(L2)*1)(T)



Efforts

Results of calculation
Load combination № 2

Structure CAD® 11.1

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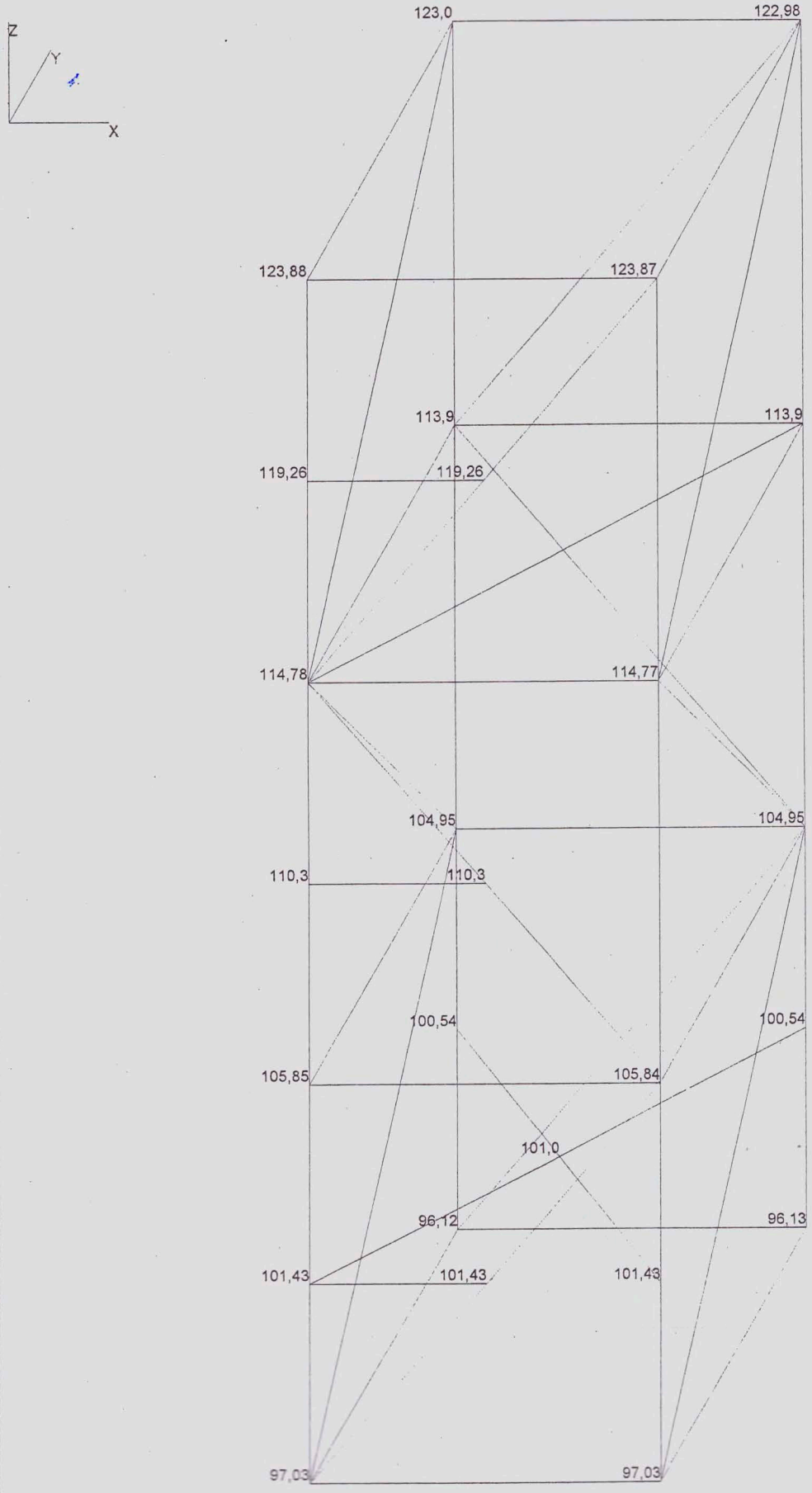
Facility	Delay tower.
Project	31656

Displacement X (mm) Combination 7 ((L1)*1+(L2)*1+(L3)*1.2+(L5)*1.2)



Structure CAD® 11.1

Company	Ukrinstalkon LLC
Facility	Delay tower
Project	31656

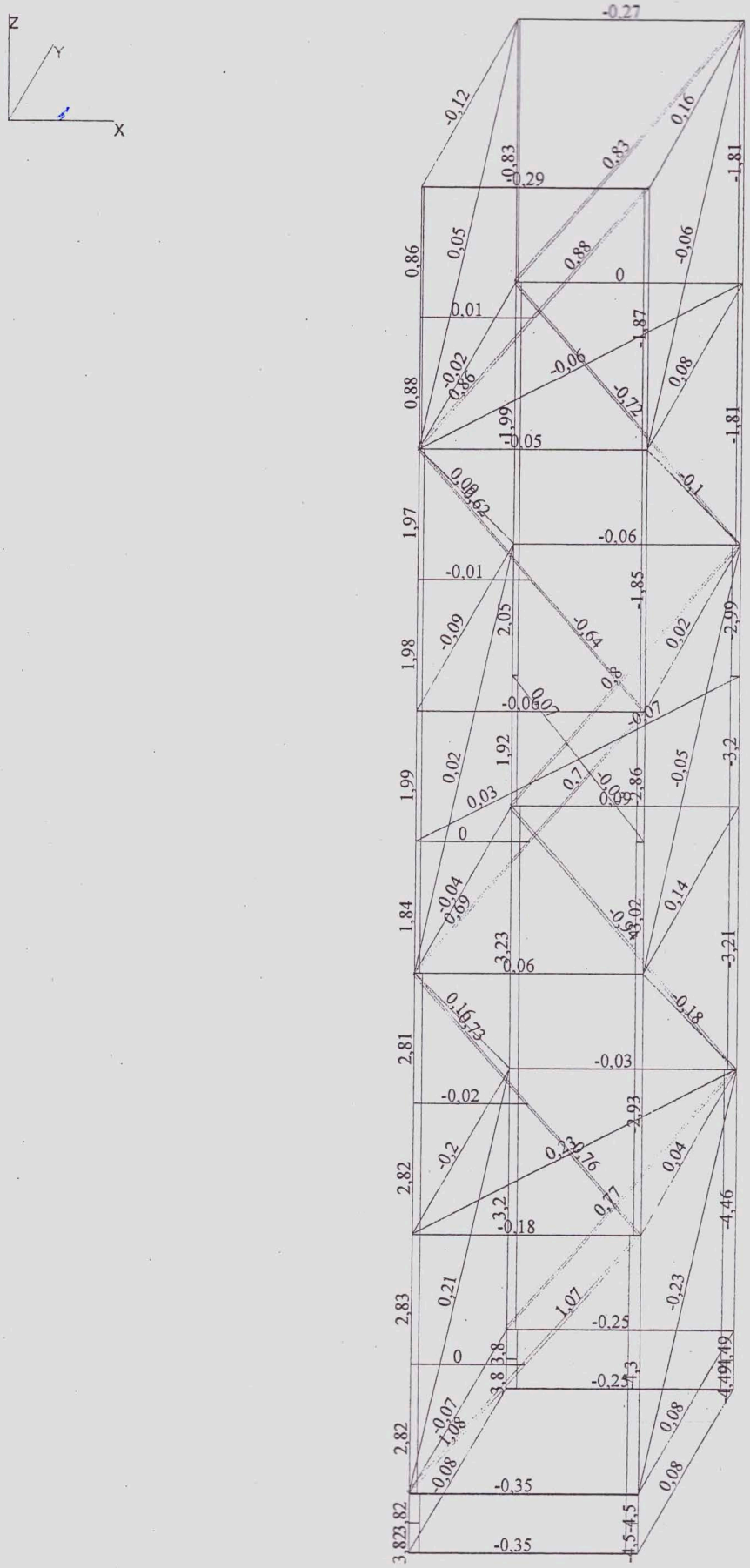
Combination 7 ((L1)*1+(L2)*1+(L3)*1.2+(L5)*1.2) (T)

Effort

Structure CAD® 11.1

Company	Ukrinstalkon LLC
Facility	Delay tower
Project	31656

Combination 7 ((L1)*1+(L2)*1+(L3)*1.2+(L5)*1.2) (T)



Effort Mark 22,4-17,2

Structure CAD® 11.1

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Facility	Delay tower
Project	31656

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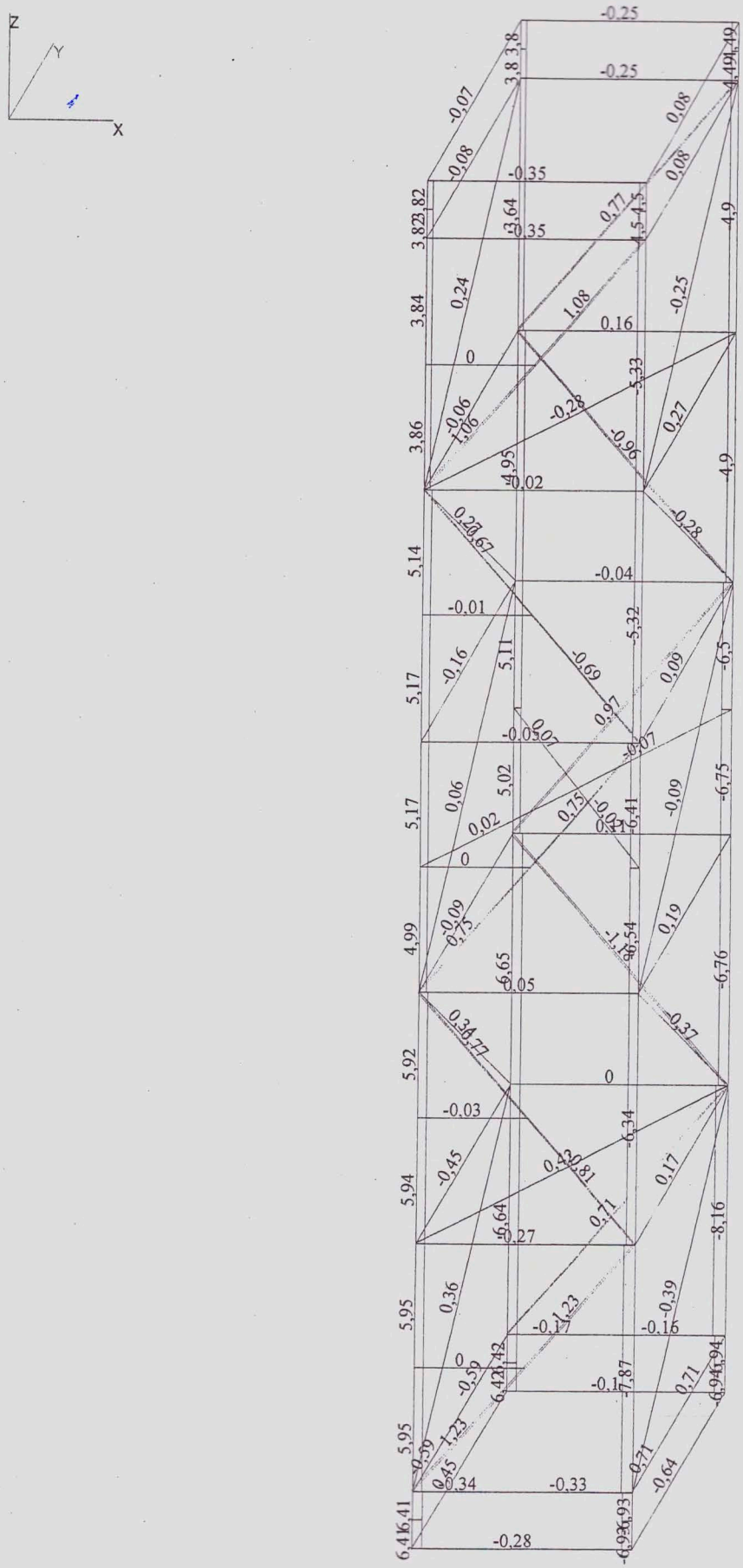

Effort Mark 17,2-11,6

Structure CAD® 11.1

Company	Ukrinstalkon LLC
Facility	Delay tower
Project	31656

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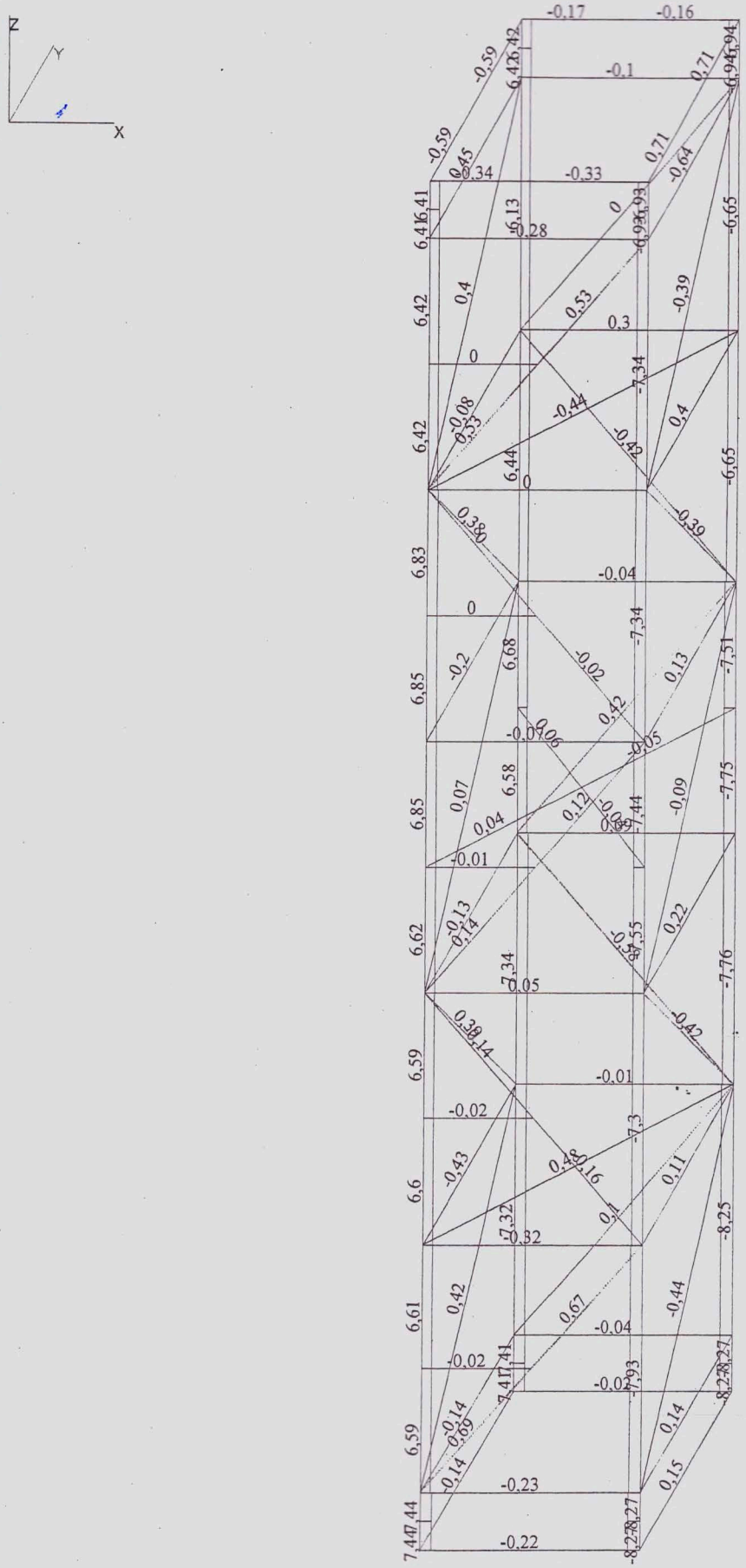


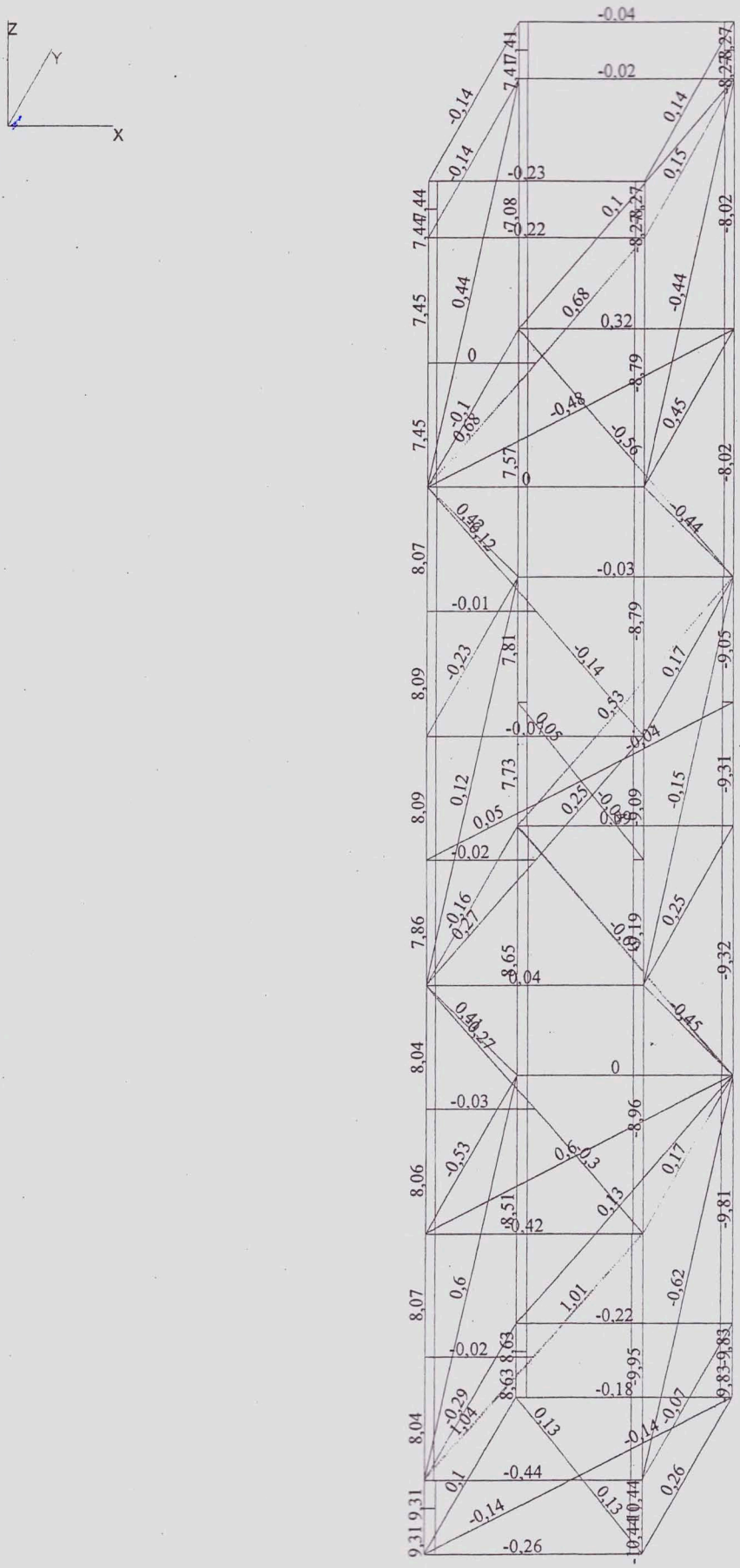
Effort Mark 11,6-6

Project file: S:\CDATA\Delay Tower H=23m\Tower.SPR

Structure CAD® 11.1

Company	Ukrinstalkon LLC
Facility	Delay tower
Project	31656

Combination 7 ((L1)*1+(L2)*1+(L3)*1.2+(L5)*1.2) (T)

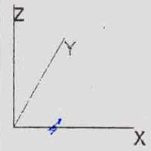


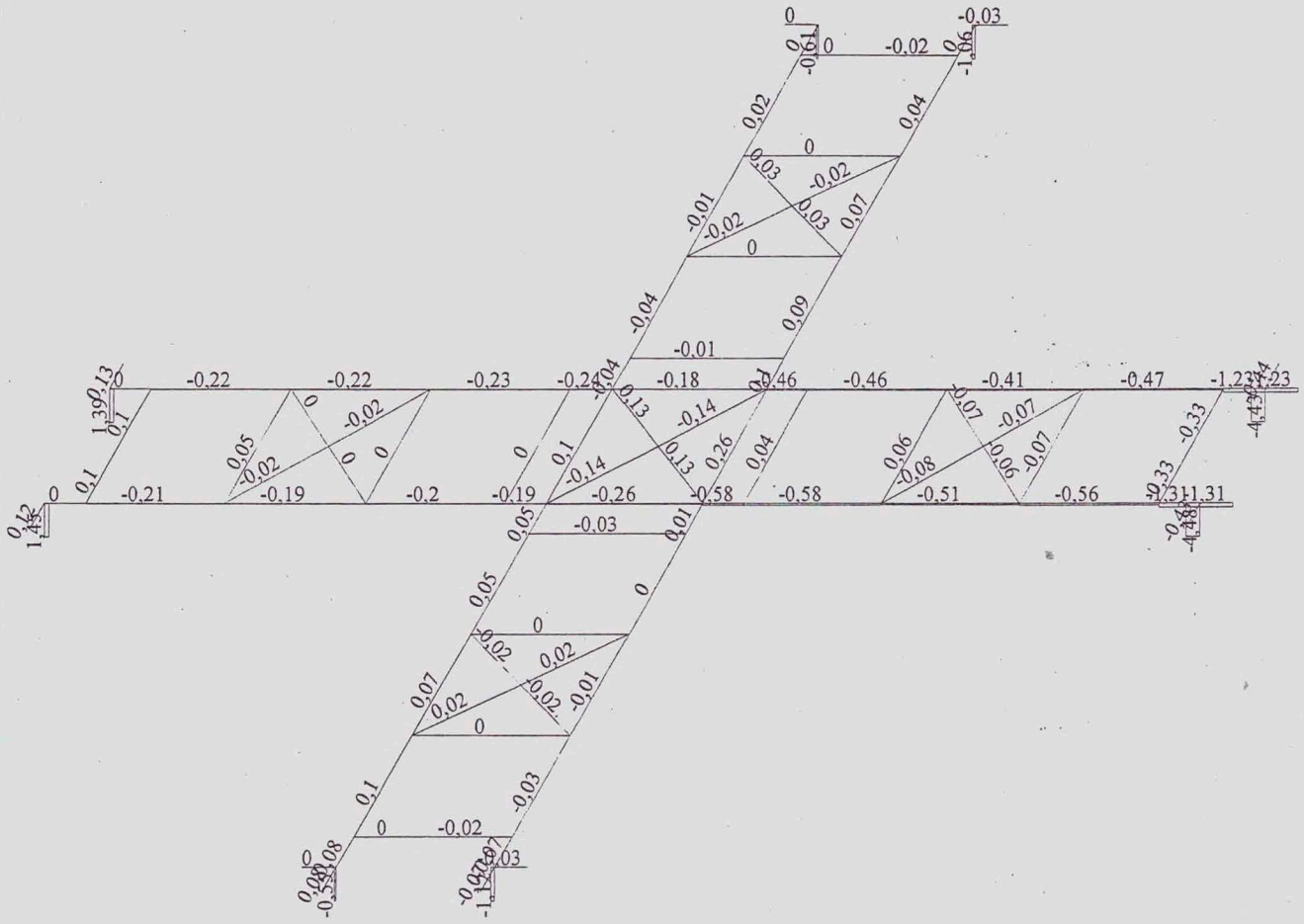
Effort Mark 6-0

Structure CAD® 11.1

Company	Ukrinstalkon LLC
Facility	Delay tower
Project	31656

Combination 7 ((L1)*1+(L2)*1+(L3)*1.2+(L5)*1.2) (T)





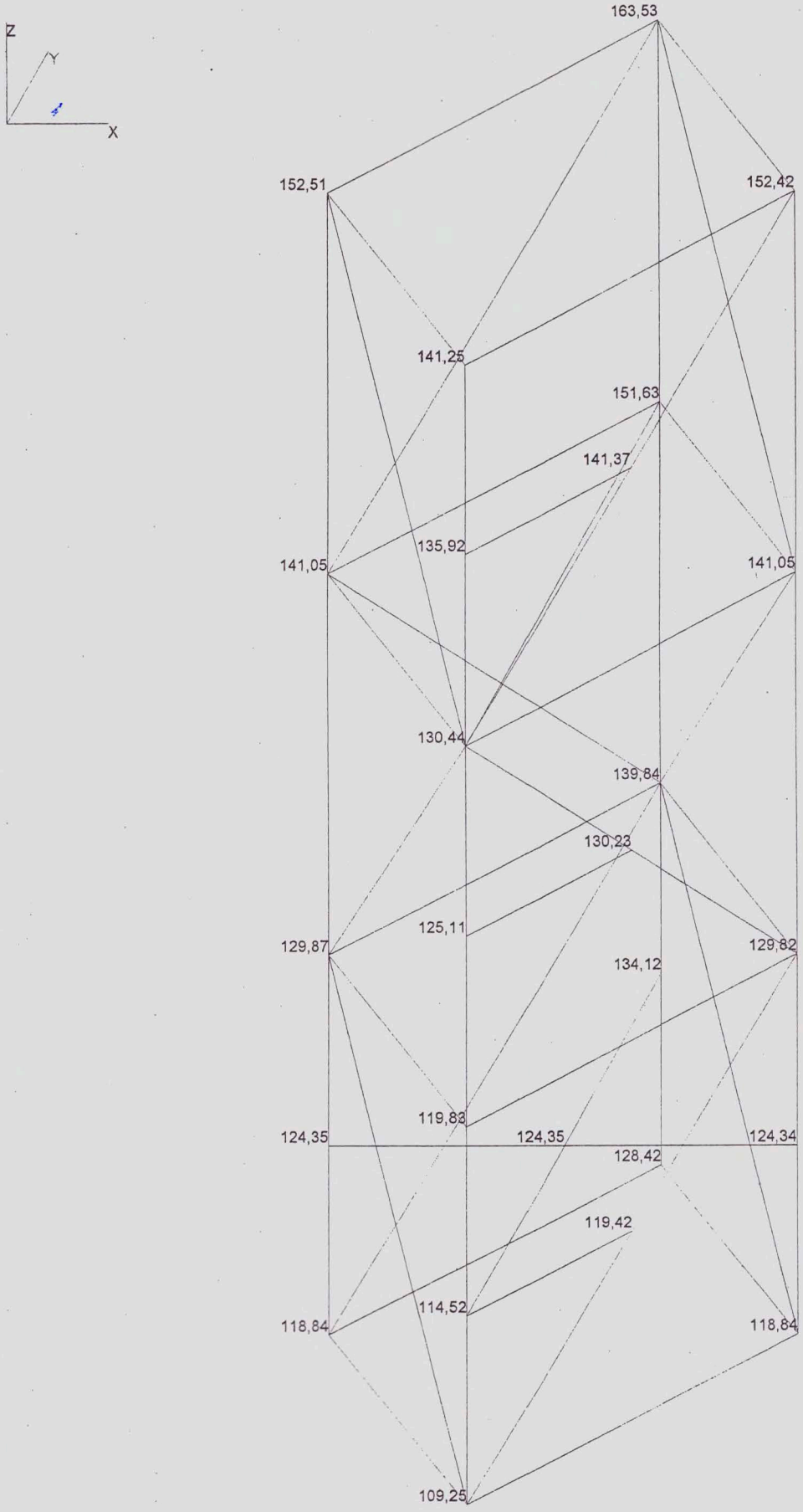
Effort

Results of calculation
Load combination № 3

Structure CAD® 11.1

Company	Ukrinstalkon LLC
Facility	Delay tower
Project	31656

Displacement X (mm) Combination 6 ((L1)*1+(L2)*1+(L3)*1.2+(L5)*1.2)



Displacement

Structure CAD® 11.1

Company	Ukrinstalkon LLC
Facility	Delay tower
Project	31656

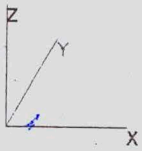
Combination **6 ((L1)*1+(L2)*1+(L3)*1.2+(L5)*1.2) (T)**

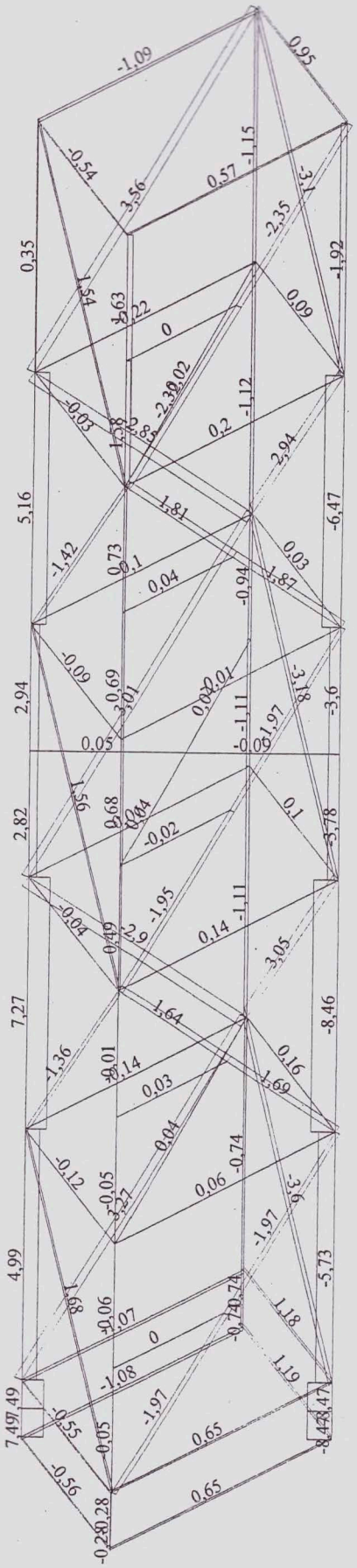
Effort

Structure CAD® 11.1

Company	Ukrinstalkon LLC
Facility	Delay tower
Project	31656

Combination 6 ((L1)*1+(L2)*1+(L3)*1.2+(L5)*1.2) (T)



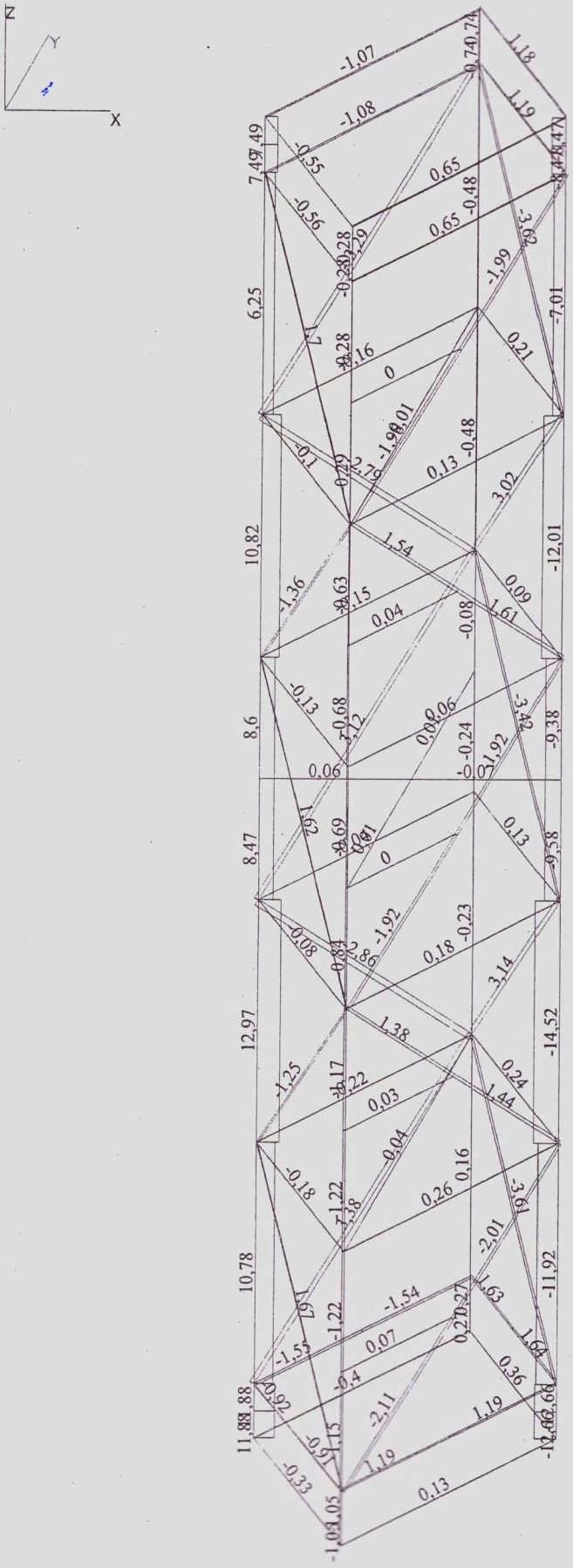


Effort Mark. 22,4-17,2

Structure CAD® 11.1

Company	Ukrinstalkon LLC
Facility	Delay tower
Project	31656

Combination 6 ((L1)*1+(L2)*1+(L3)*1.2+(L5)*1.2) (T)

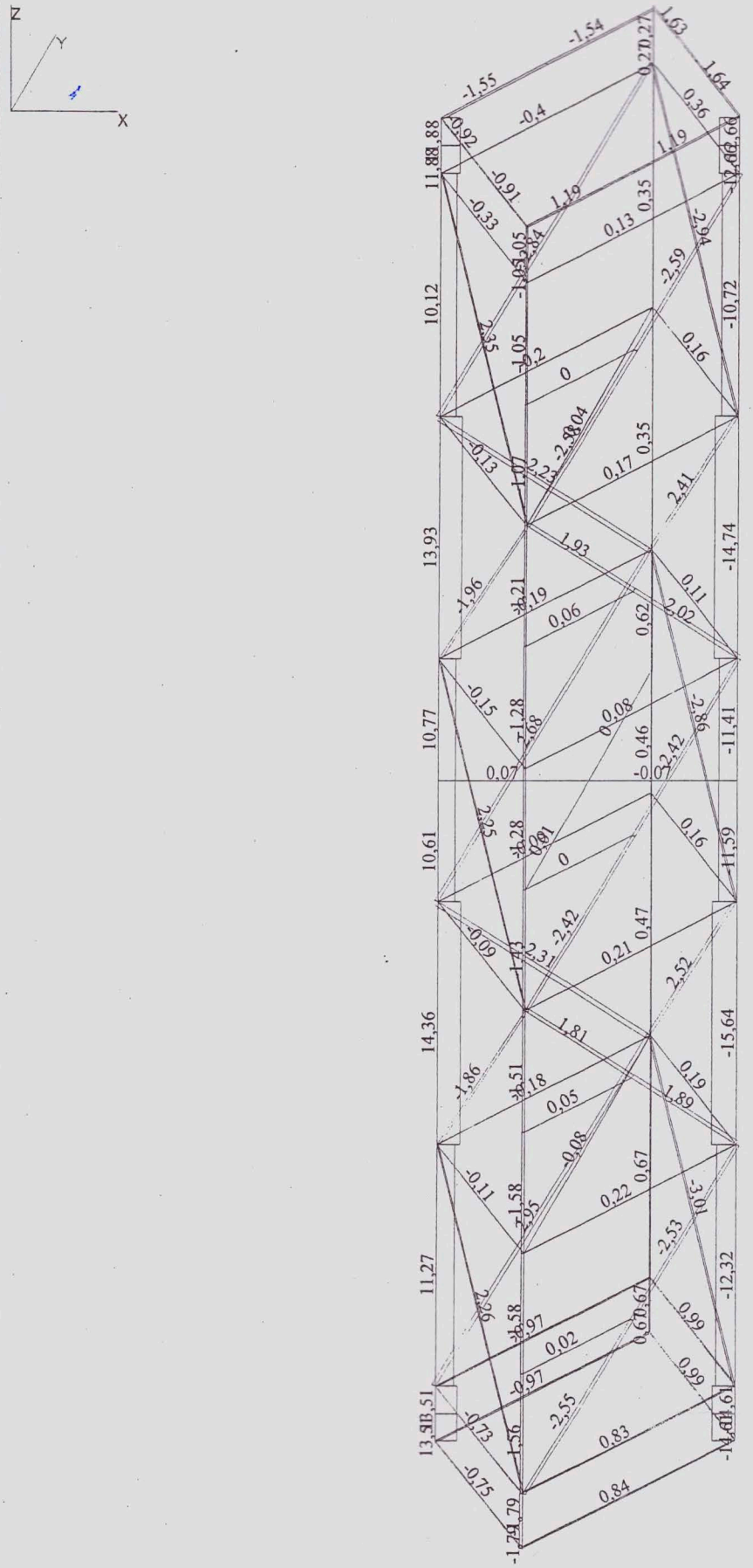


Effort Mark 17,2-11,6

Structure CAD® 11.1

Company	Ukrinstalkon LLC
Facility	Delay tower
Project	31656

Combination 6 ((L1)*1+(L2)*1+(L3)*1.2+(L5)*1.2) (T)



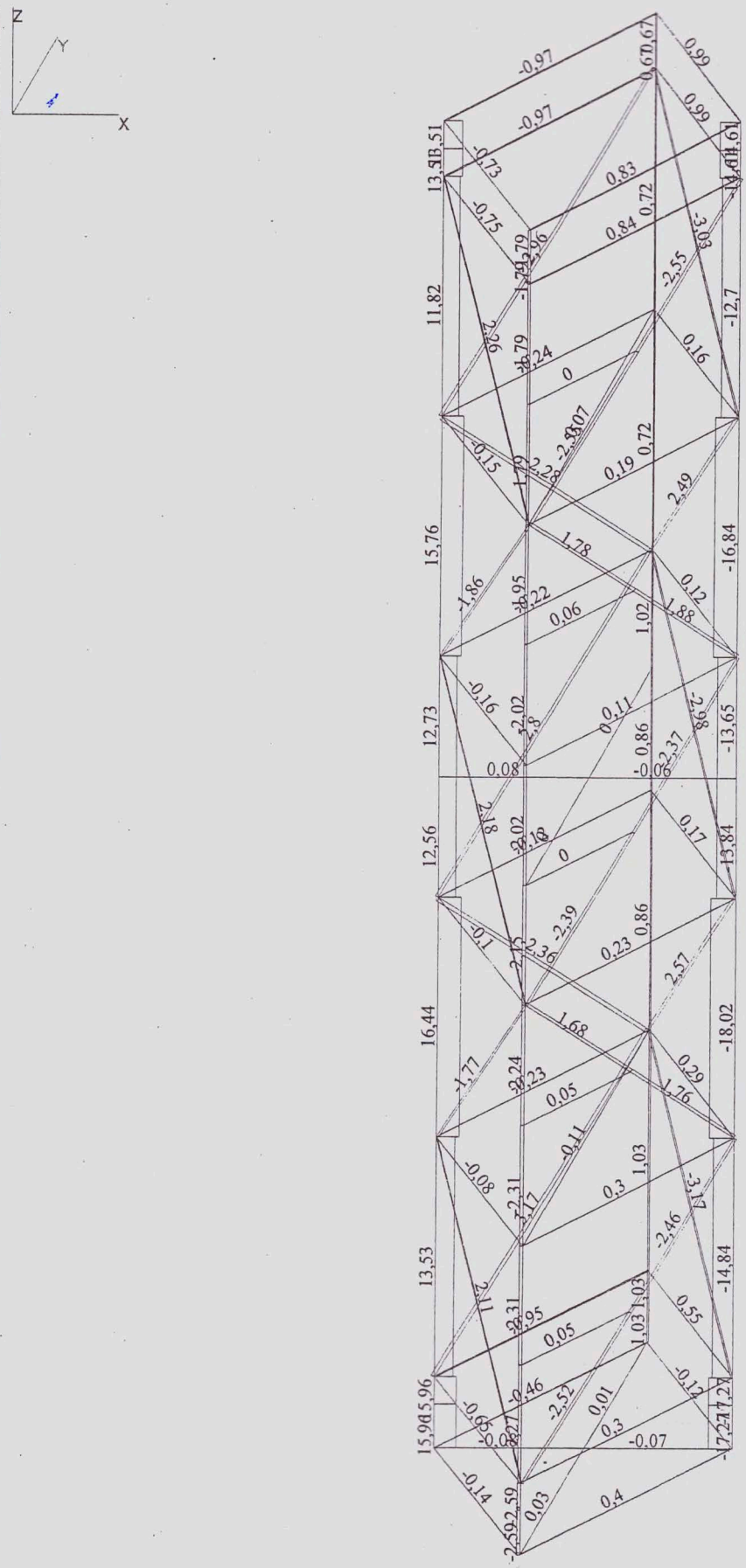
Effort Mark 11,6-6

Project file: S:\CDATA\Delay Tower H=23m\Tower 45.SPR

Structure CAD® 11.1

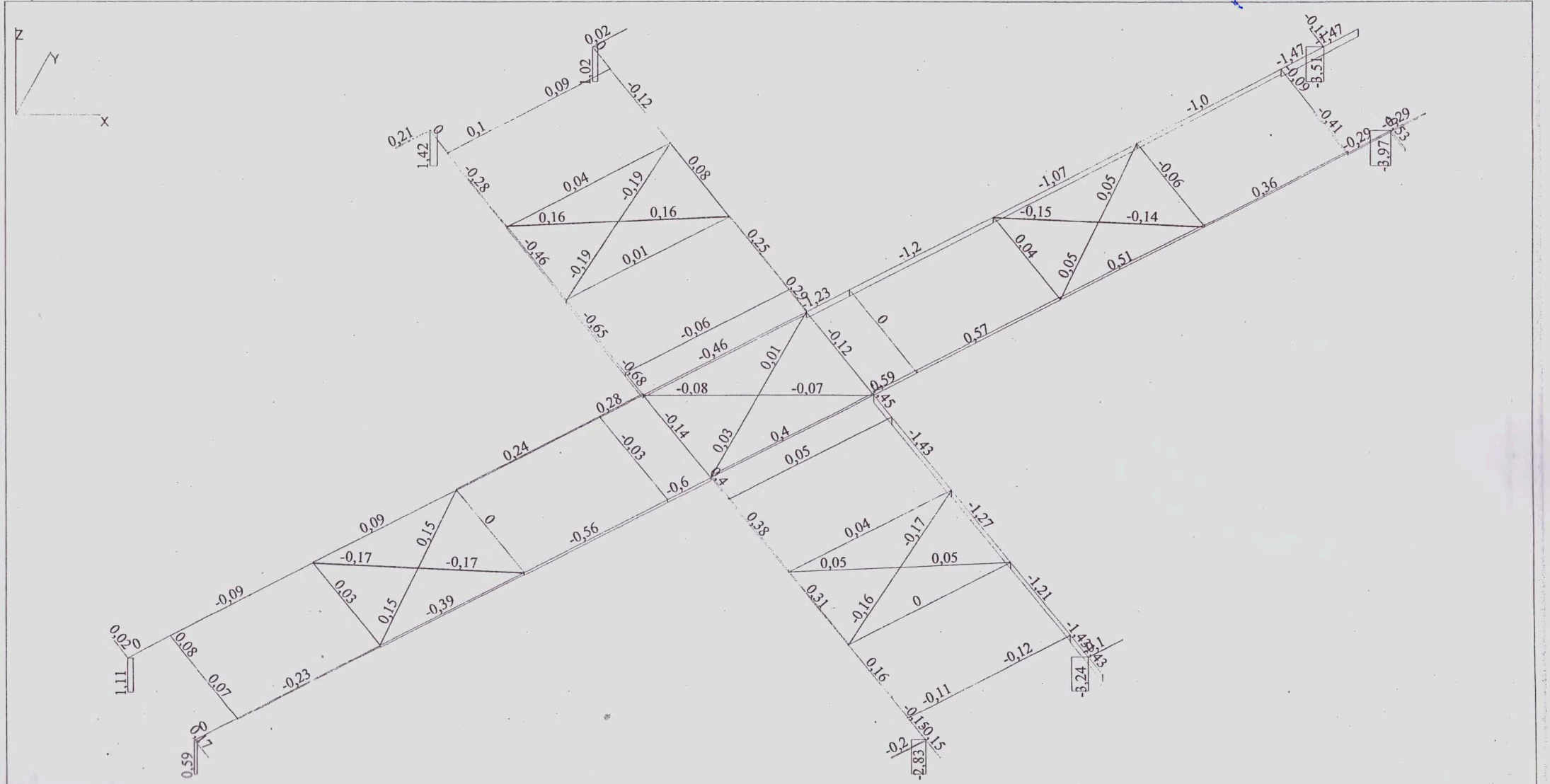
Company	Ukrinstalkon LLC
Facility	Delay tower
Project	31656

Combination 6 ((L1)*1+(L2)*1+(L3)*1.2+(L5)*1.2) (T)



Effort Mark . 6-0

Project file: S:\CDATA\Delay Tower H=23m\Tower 45.SPR



Combination 6 ((L1)*1+(L2)*1+(L3)*1.2+(L5)*1.2) (T)

Structure CAD® 11.1

Company	Ukrinstalkon LLC
Facility	Delay tower
Project	31656

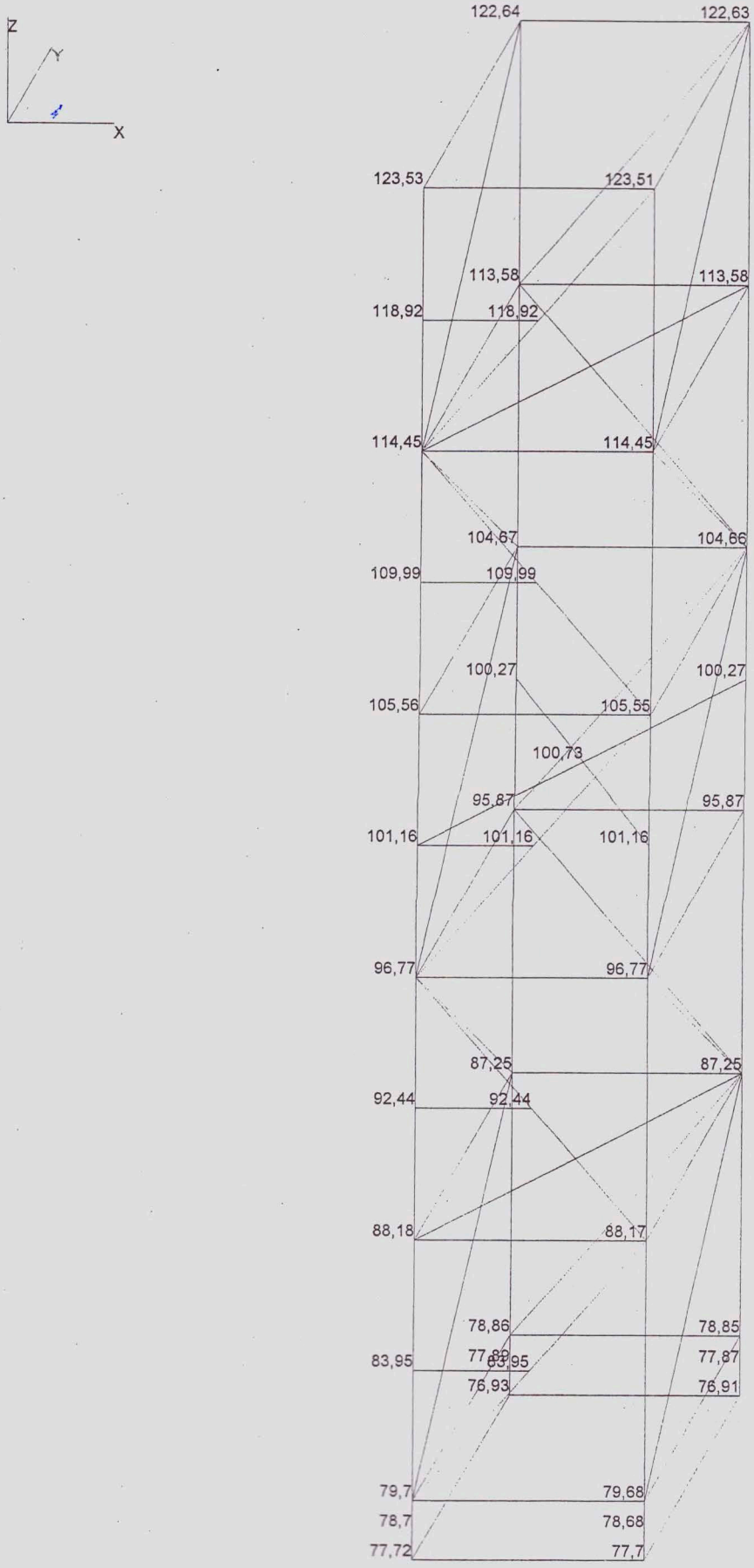
Efforts

Results of calculation
Load combination № 4

Structure CAD® 11.1

Company	Ukrinstalkon LLC
Facility	Delay tower
Project	31656

Displacement X (mm) Combination 5 ((L1)*1+(L2)*1+(L3)*1.2+(L5)*1.2+(L6)*1)



Displacement

Project file: S:\CDATA\Delay Tower H=23m\Tower .SPR

Structure CAD® 11.1

Company	Ukrinstalkon LLC
Facility	Delay tower
Project	31656

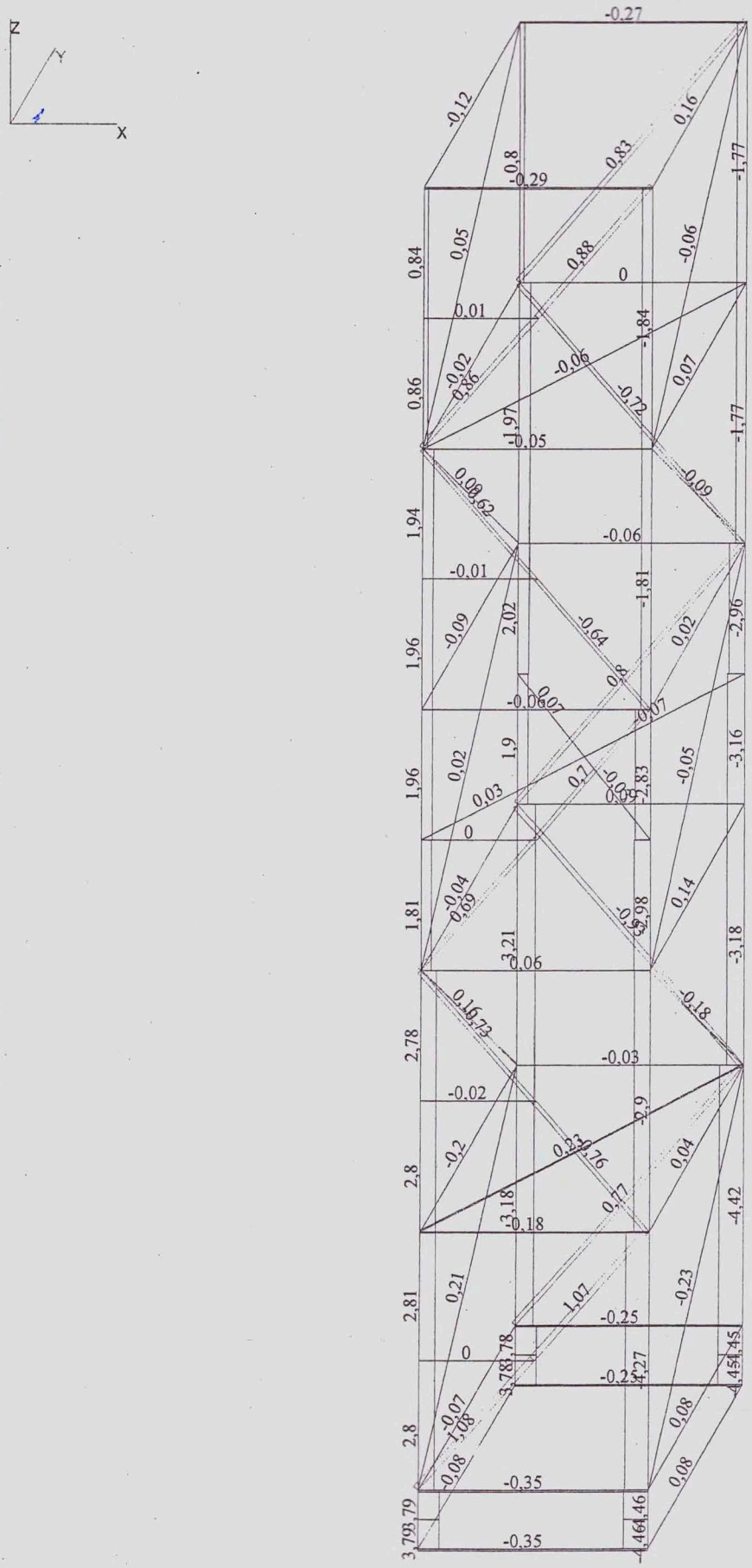
Combination **5** ((L1)*1+(L2)*1+(L3)*1.2+(L5)*1.2+(L6)*1) (T)

Effort

Structure CAD® 11.1

Company	Ukrinstalkon LLC
Facility	Delay tower
Project	31656

Combination 5 ((L1)*1+(L2)*1+(L3)*1.2+(L5)*1.2+(L6)*1) (T)

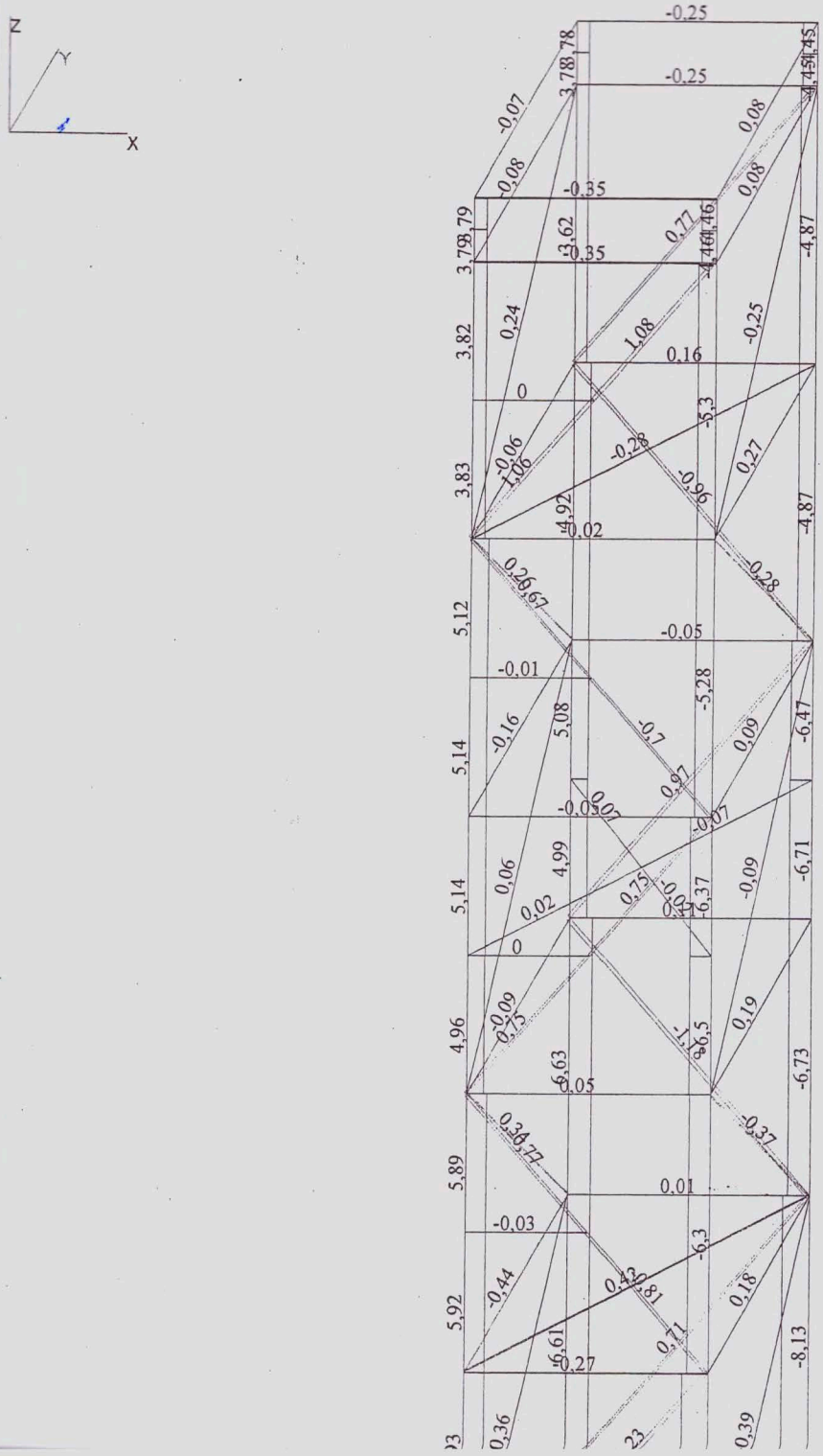


Effort Mark . 22,4-17,2

Structure CAD® 11.1

Company	Ukrinstalkon LLC
Facility	Delay tower
Project	31656

Combination **5** ((L1)*1+(L2)*1+(L3)*1.2+(L5)*1.2+(L6)*1) (T)

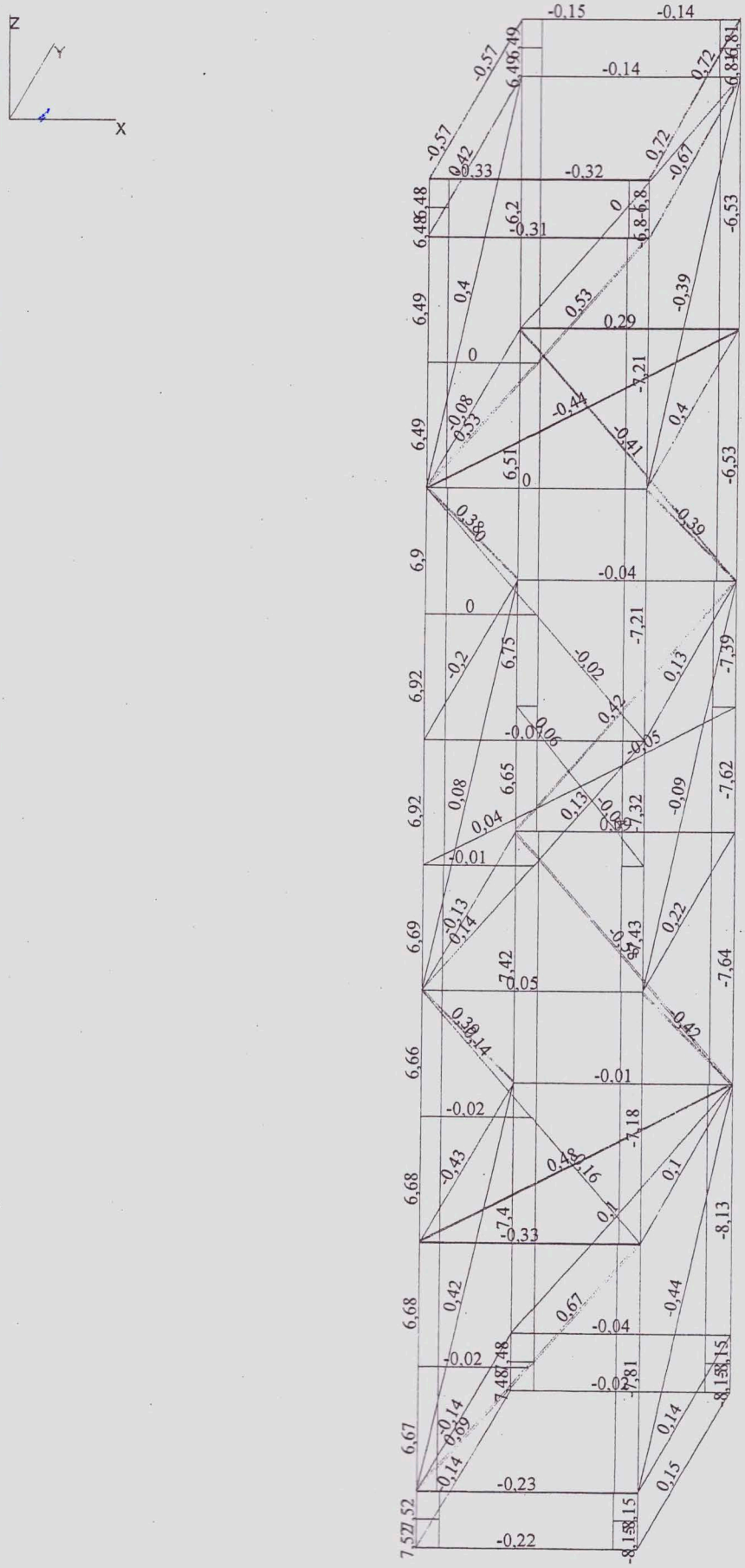


5

Structure CAD® 11.1

Company	Ukrinstalkon LLC
Facility	Delay tower
Project	31656

Combination 5 ((L1)*1+(L2)*1+(L3)*1.2+(L5)*1.2+(L6)*1) (T)



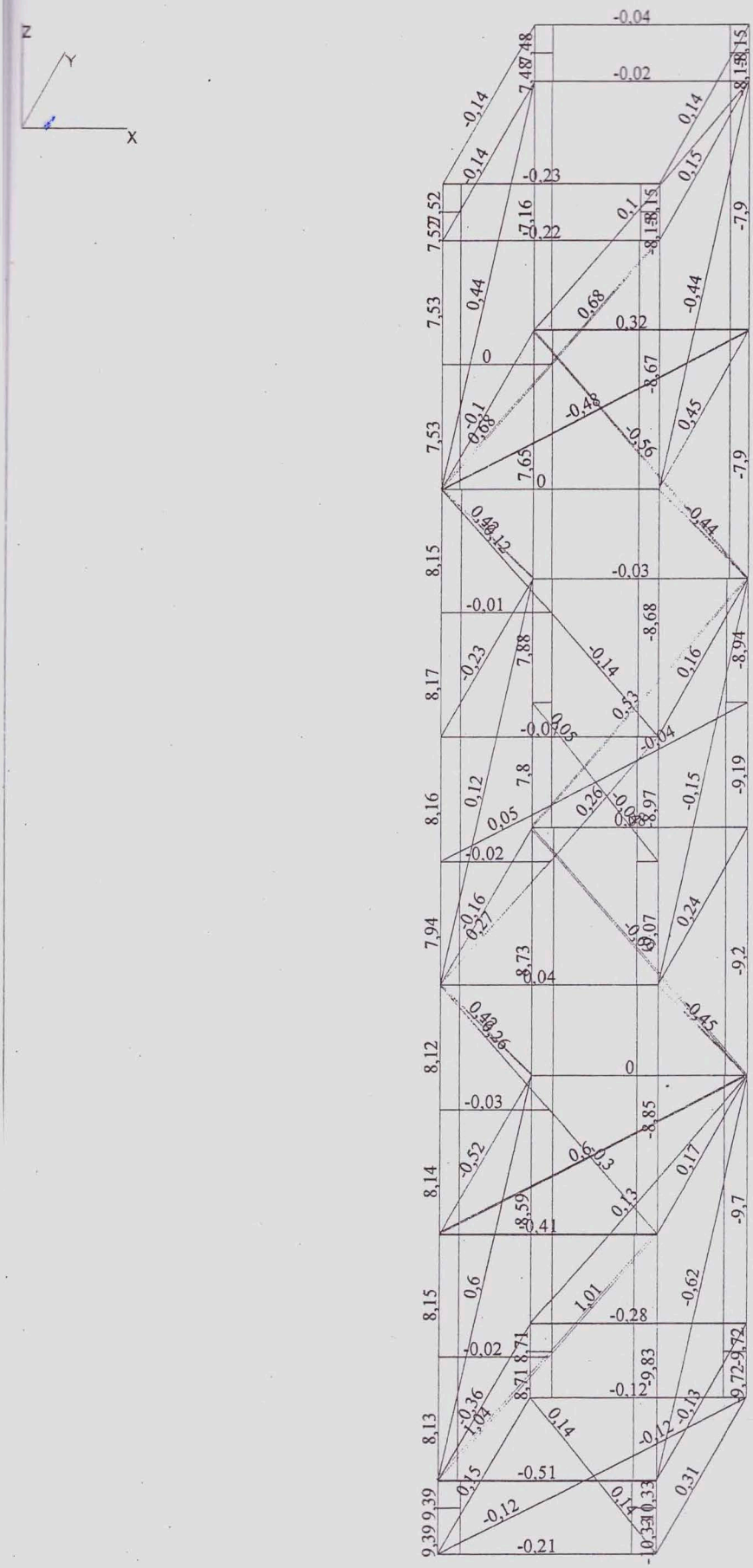
Effort Mark .11,6-6

56

Structure CAD® 11.1

Company	Ukrinstalkon LLC
Facility	Delay tower
Project	31656

Combination 5 ((L1)*1+(L2)*1+(L3)*1.2+(L5)*1.2+(L6)*1) (T)

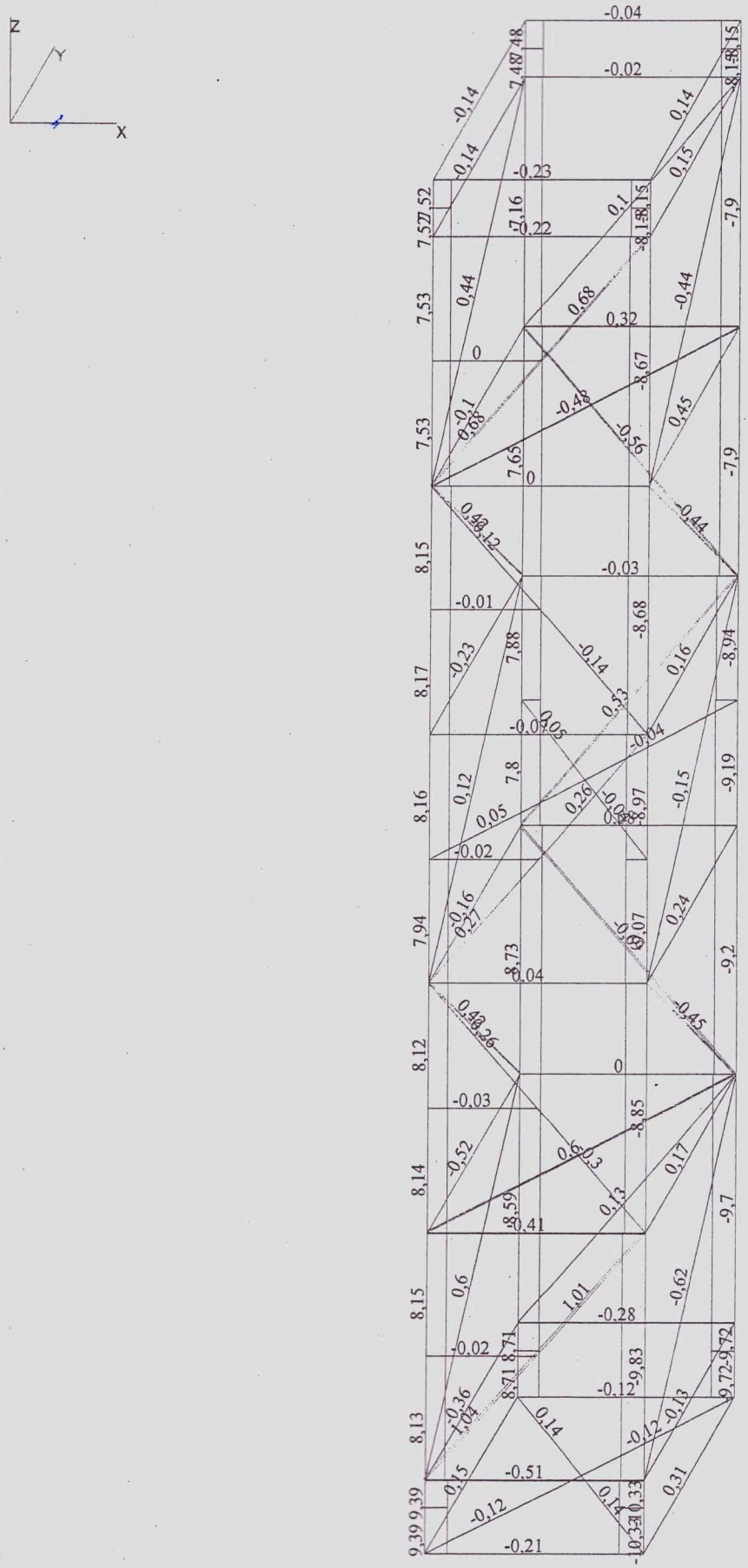


58

Structure CAD® 11.1

Company	Ukrinstalkon LLC
Facility	Delay tower
Project	31656

Combination 5 ((L1)*1+(L2)*1+(L3)*1.2+(L5)*1.2+(L6)*1) (T)



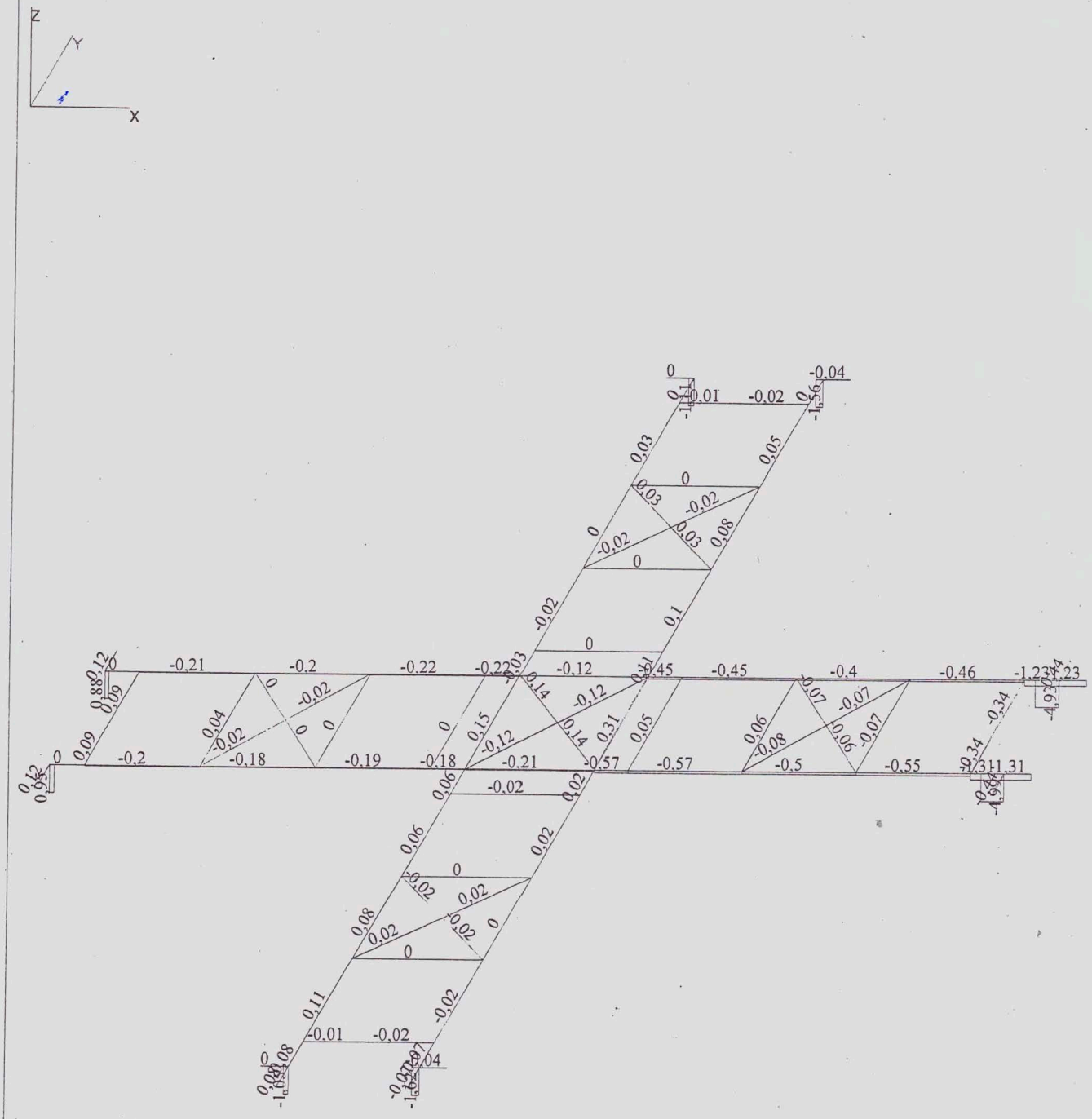
Effort Mark .6-0

57

Structure CAD® 11.1

Company	Ukrinstalkon LLC
Facility	Delay tower
Project	31656

Combination 5 ((L1)*1+(L2)*1+(L3)*1.2+(L5)*1.2+(L6)*1) (T)



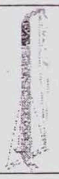
Effort

Results of calculation
Load combination № 5

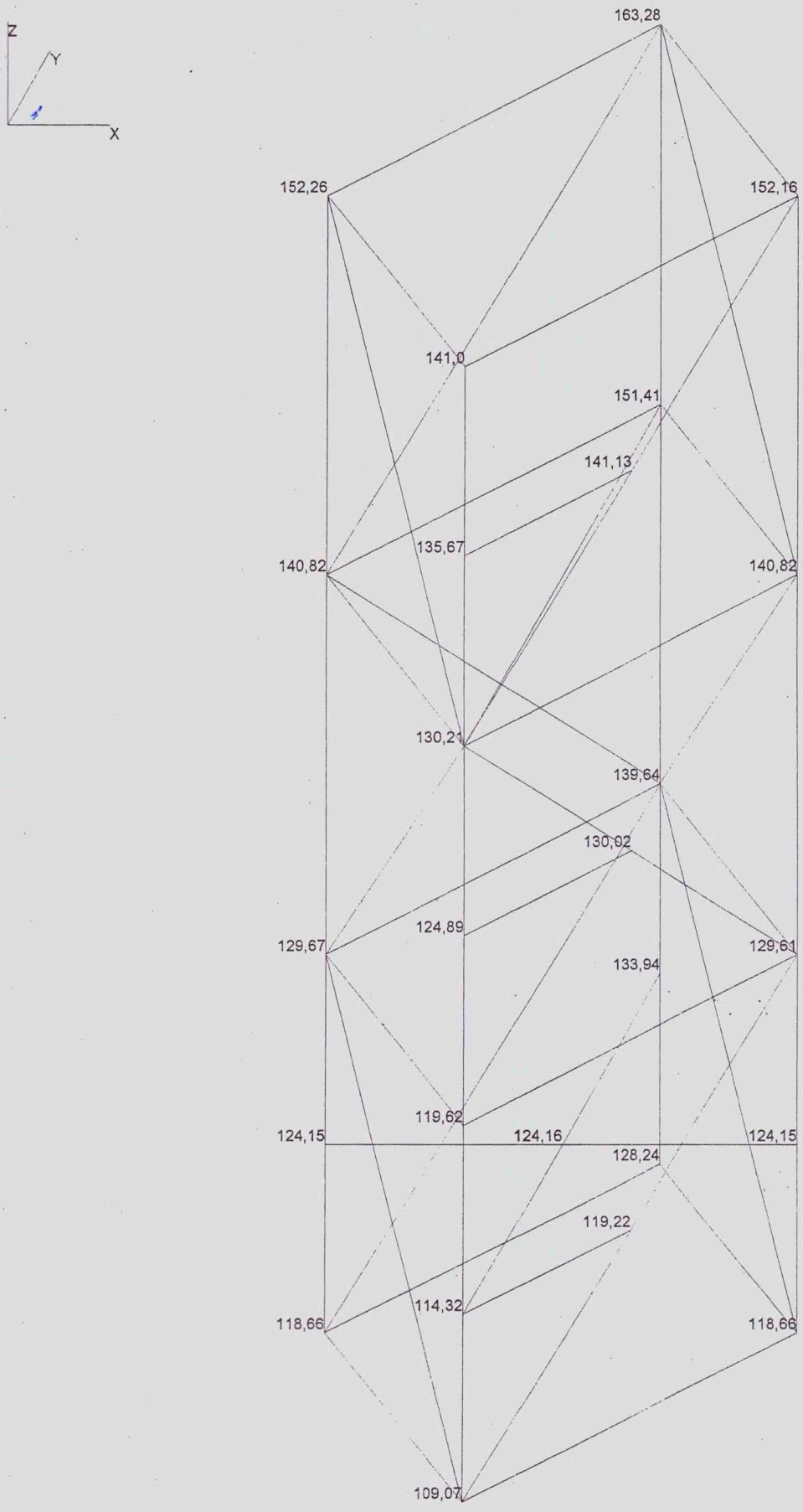
Project file: S:\CDATA\Delay Tower H=23m\Tower 45.SPR

Structure CAD® 11.1

Company	Ukrinstalkon LLC
Facility	Delay tower
Project	31656



Displacement X (mm) Combination 5 ((L1)*1+(L2)*1+(L3)*1.2+(L5)*1.2+(L6)*1)



Displacement

Structure CAD® 11.1

Company	Ukrinstalkon LLC
Facility	Delay tower
Project	31656

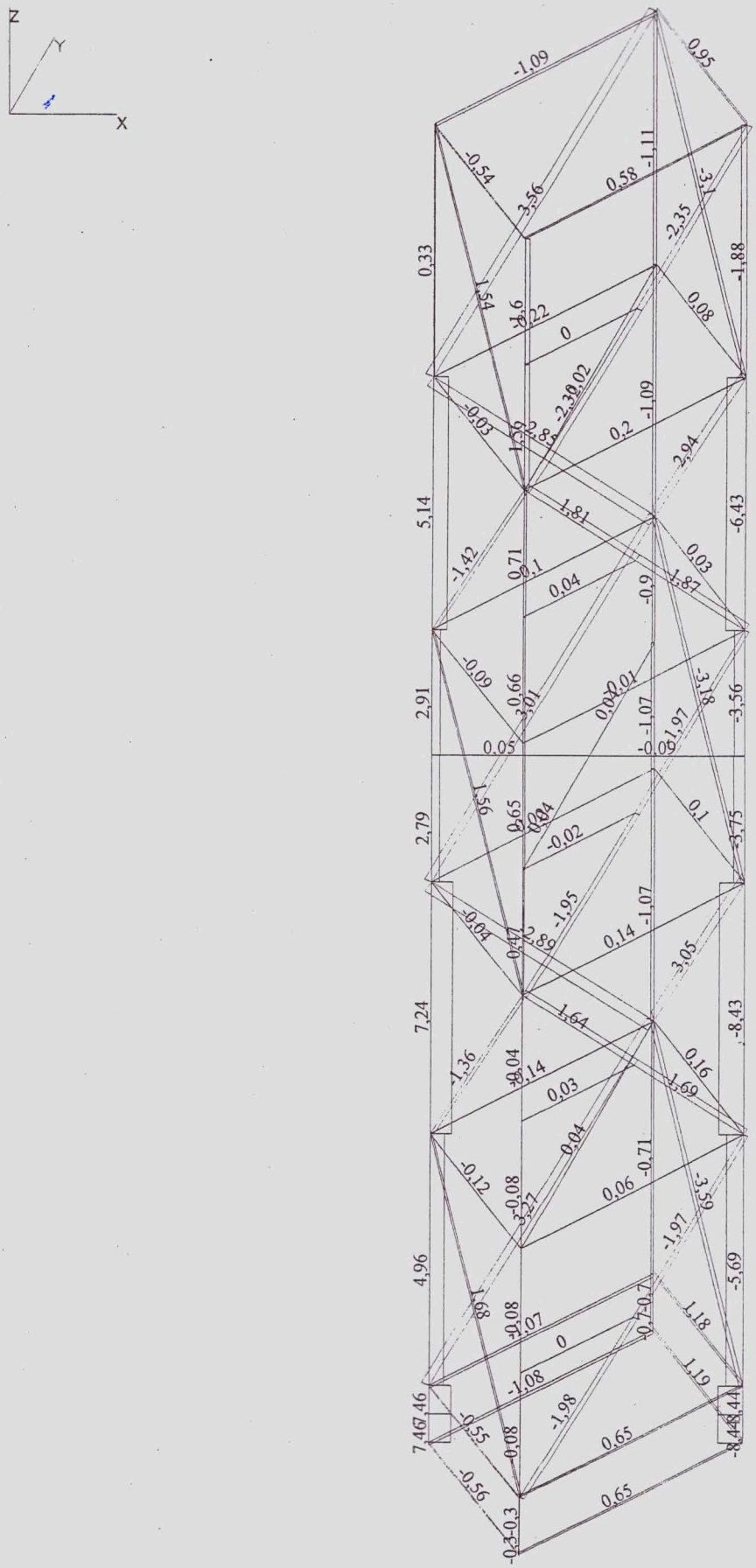
Combination 5 ((L1)*1+(L2)*1+(L3)*1.2+(L5)*1.2+(L6)*1) (T)

Effort

Structure CAD® 11.1

Company	Ukrinstalkon LLC
Facility	Delay tower
Project	31656

Combination 5 ((L1)*1+(L2)*1+(L3)*1.2+(L5)*1.2+(L6)*1) (T)



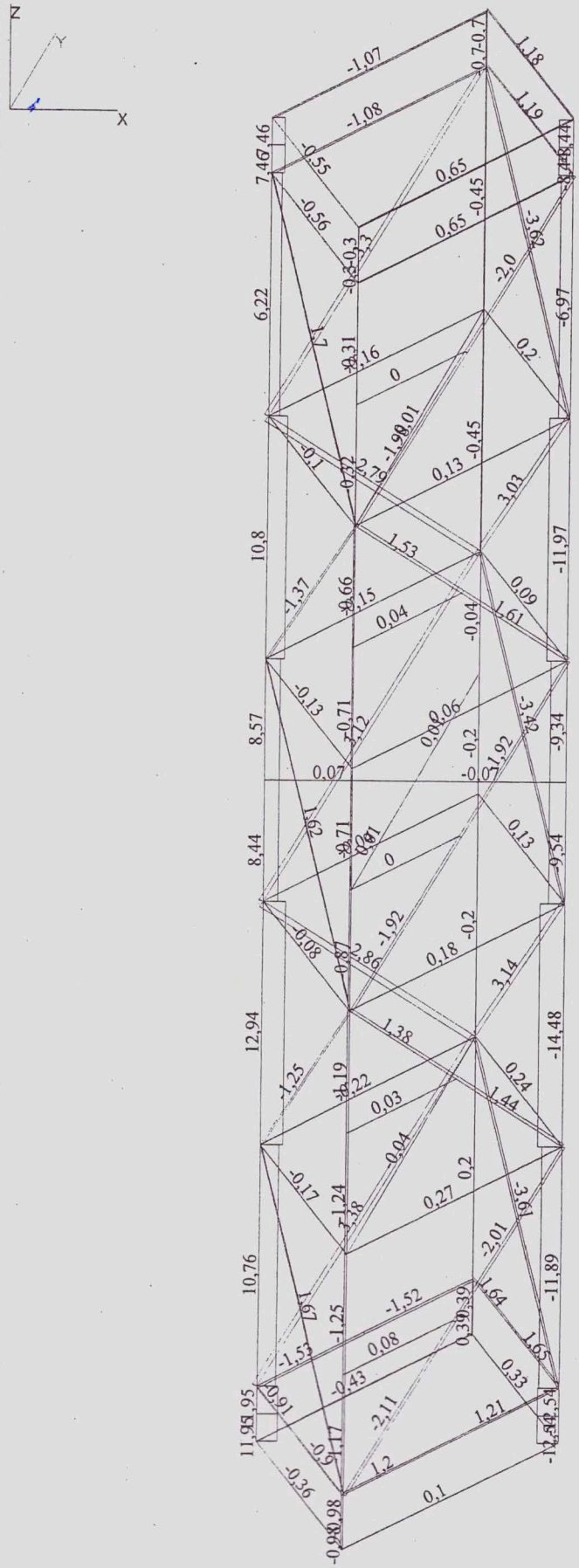
Effort Mark 22,4-17,2

Project file: S:\CDATA\Delay Tower H=23m\Tower .SPR

Structure CAD® 11.1

Company	Ukrinstalkon LLC
Facility	Delay tower
Project	31656

Combination 5 ((L1)*1+(L2)*1+(L3)*1.2+(L5)*1.2+(L6)*1) (T)



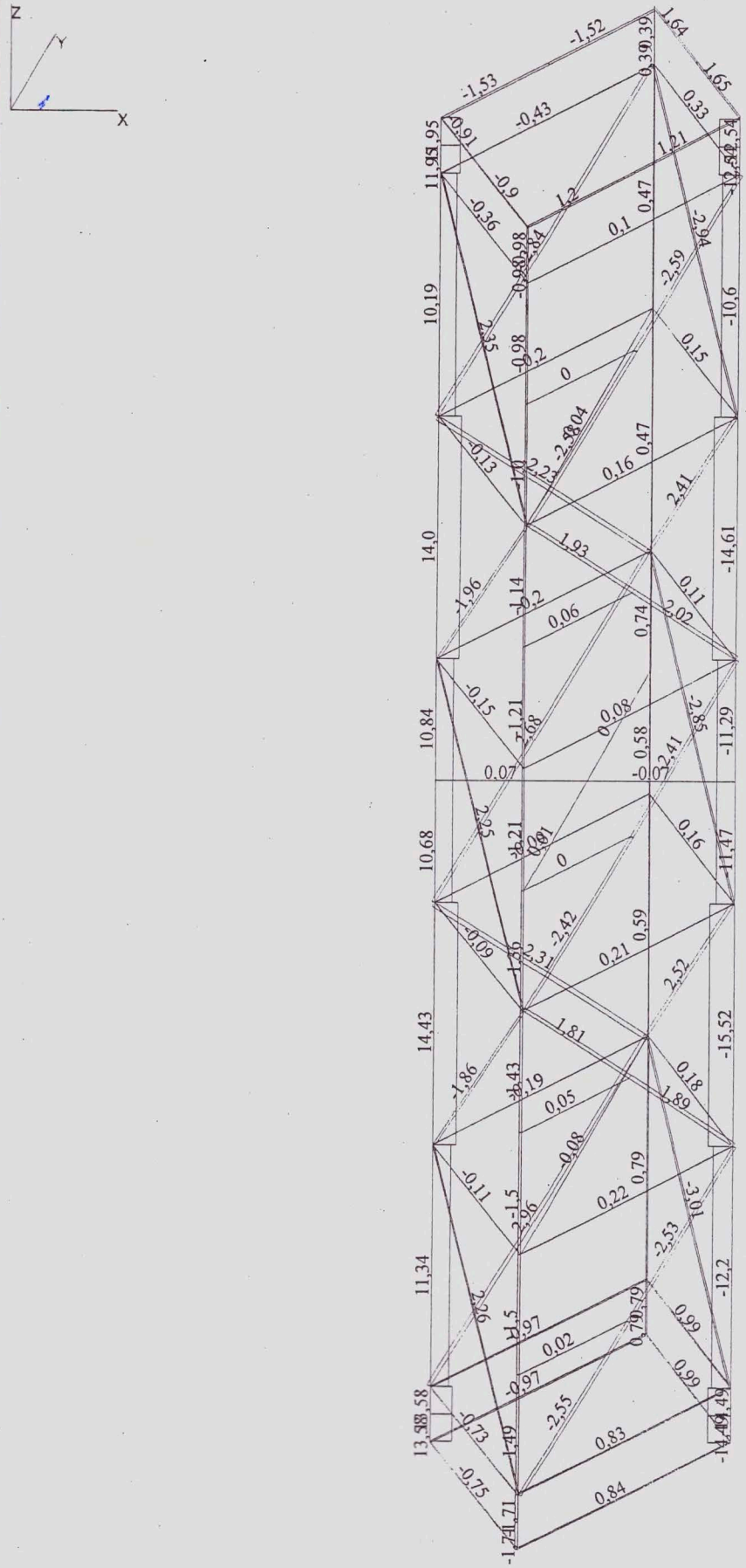
Effort Mark 17,2-11,6

Project file: S:\CDATA\Delay Tower H=23m\Tower 45.SPR

Structure CAD® 11.1

Company	Ukrinstalkon LLC
Facility	Delay tower
Project	31656

Combination 5 ((L1)*1+(L2)*1+(L3)*1.2+(L5)*1.2+(L6)*1) (T)

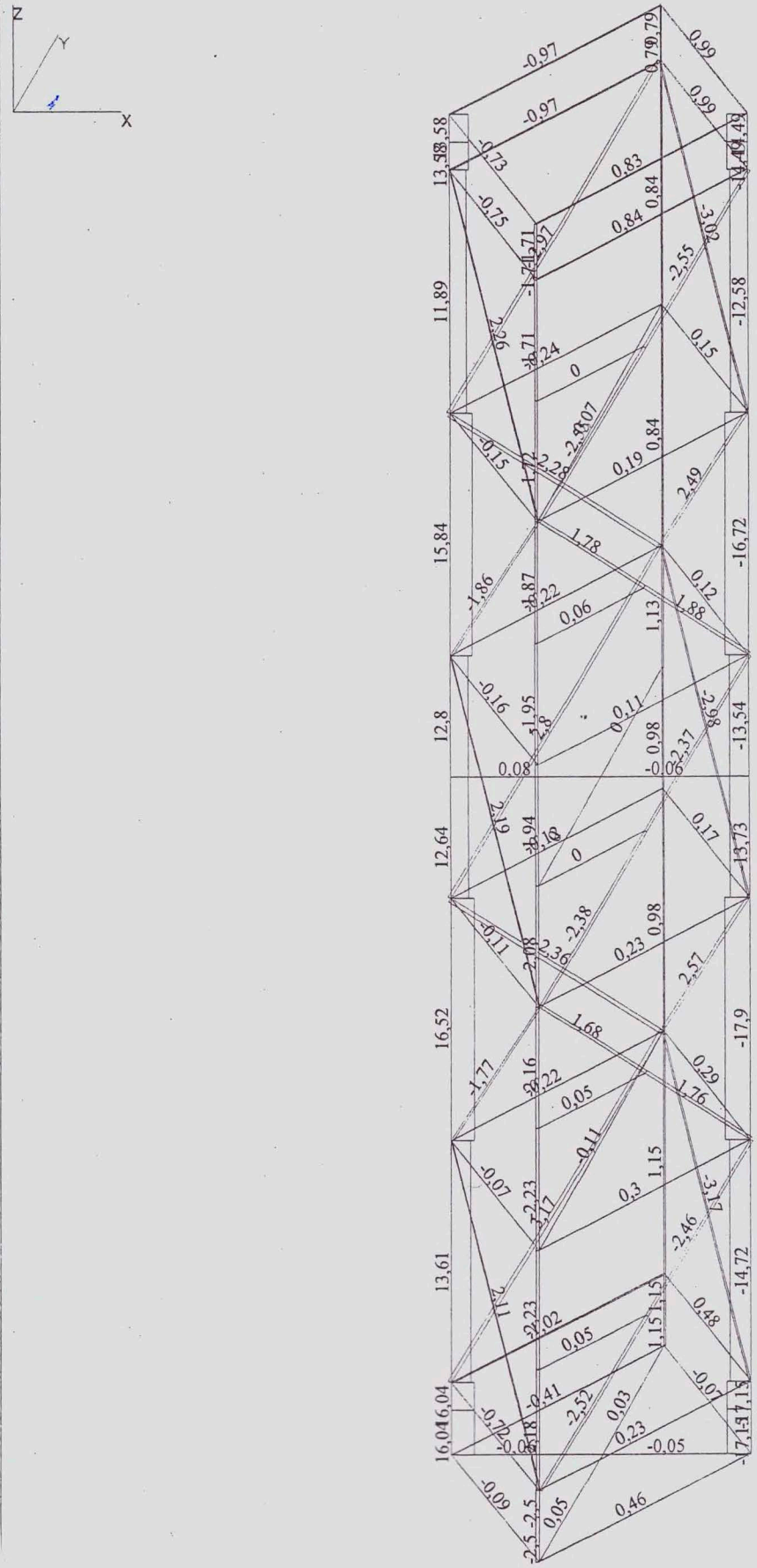


Effort Mark 11,6-6

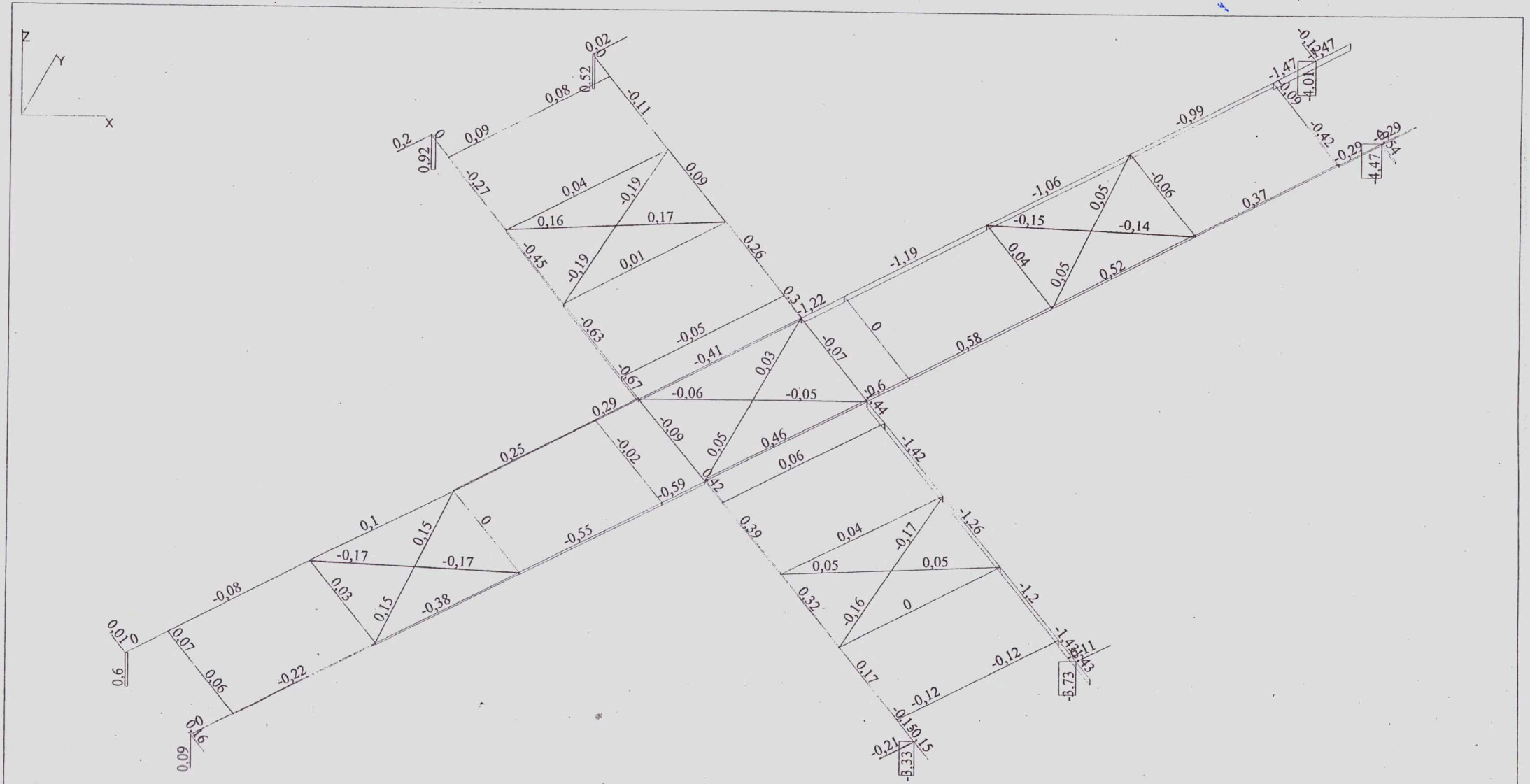
Structure CAD® 11.1

Company	Ukrinstalkon LLC
Facility	Delay tower
Project	31656

Combination: 5 ((L1)*1+(L2)*1+(L3)*1.2+(L5)*1.2+(L6)*1) (T)



Project file: S:\CDATA\Delay Tower H=23m\Tower 45.SPR



Combination 5 ((L1)*1+(L2)*1+(L3)*1.2+(L5)*1.2+(L6)*1) (T)

Structure CAD® 11.1

Company	Ukrinstalkon LLC
Facility	Delay tower
Project	31656

Effort

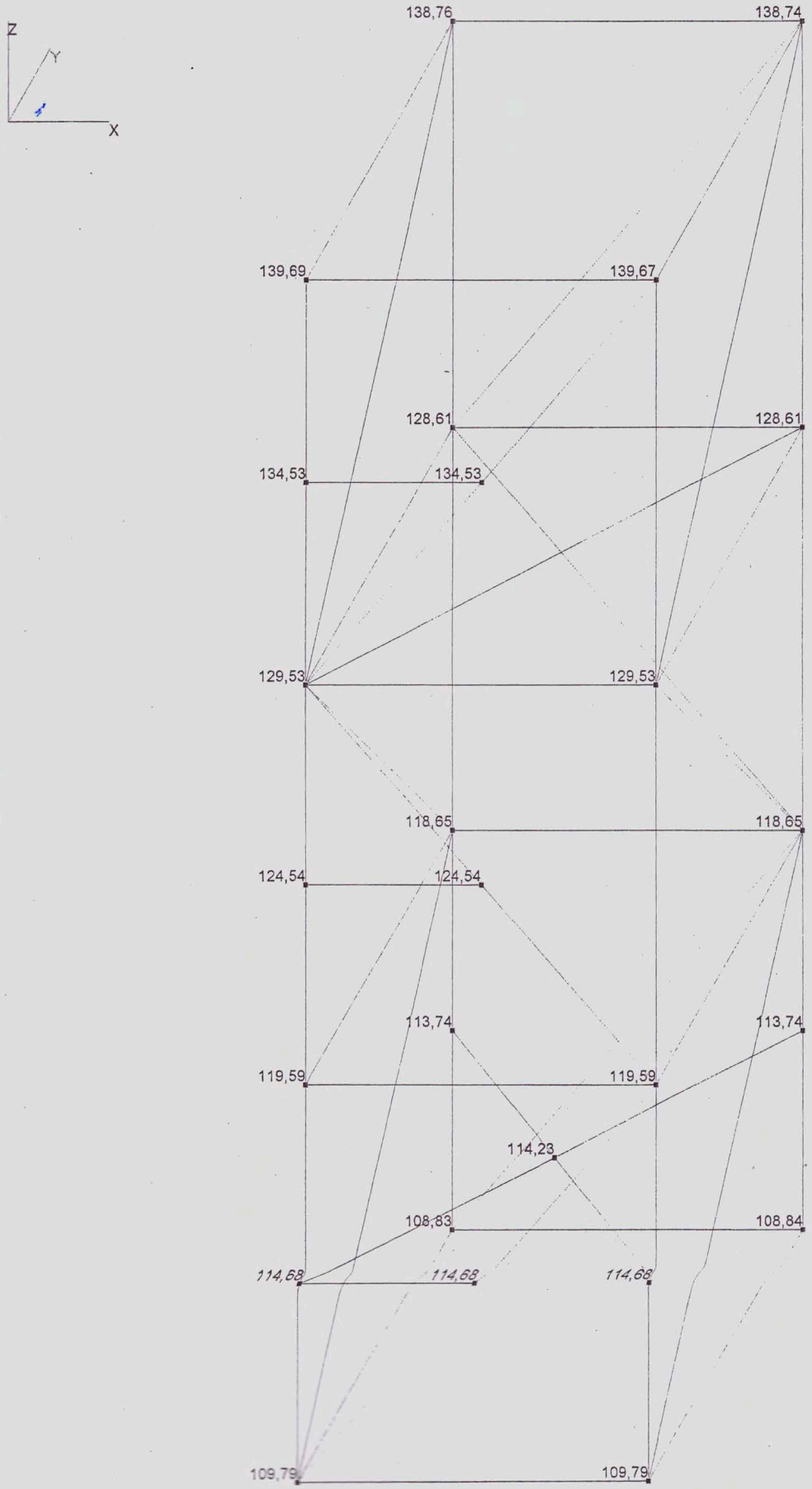
Results of calculation.
Load combination № 6

Project file: S:\CDATA\Delay Tower H=23m\, Additional support.SPR

Structure CAD® 11.1

Company	Ukrinstalkon LLC
Facility	Delay tower
Project	31656

Displacement X (mm) Combination 5 ((L1)*1+(L2)*1+(L3)*1.2+(L5)*1.2+(L6)*1)



Displacement

Structure CAD® 11.1

Company	Ukrinstalkon LLC
Facility	Delay tower
Project	31656

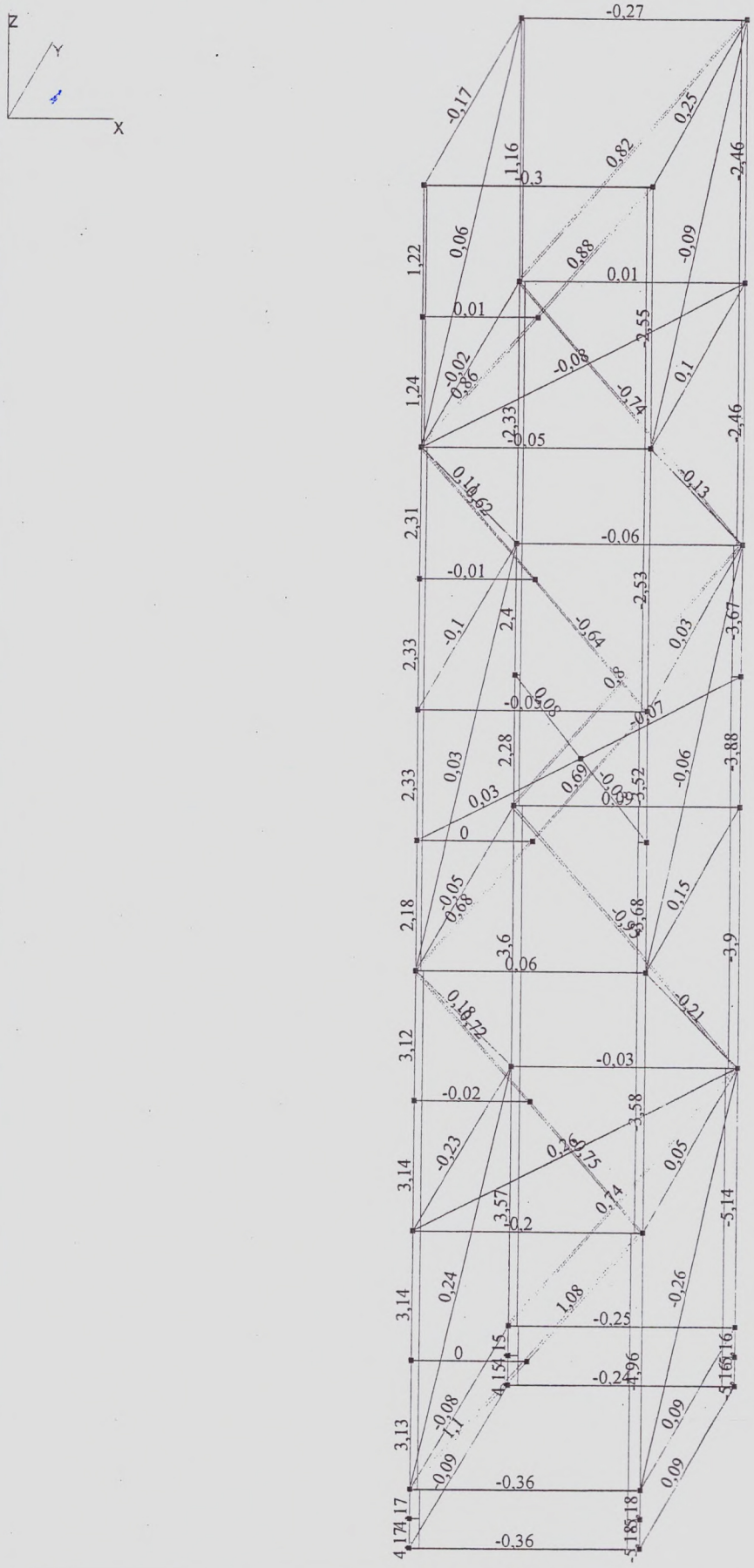
Combination 5 ((L1)*1+(L2)*1+(L3)*1.2+(L5)*1.2+(L6)*1) (T)

Effort

Structure CAD® 11.1

Company	Ukrinstalkon LLC
Facility	Delay tower
Project	31656

Combination 5 ((L1)*1+(L2)*1+(L3)*1.2+(L5)*1.2+(L6)*1) (T)

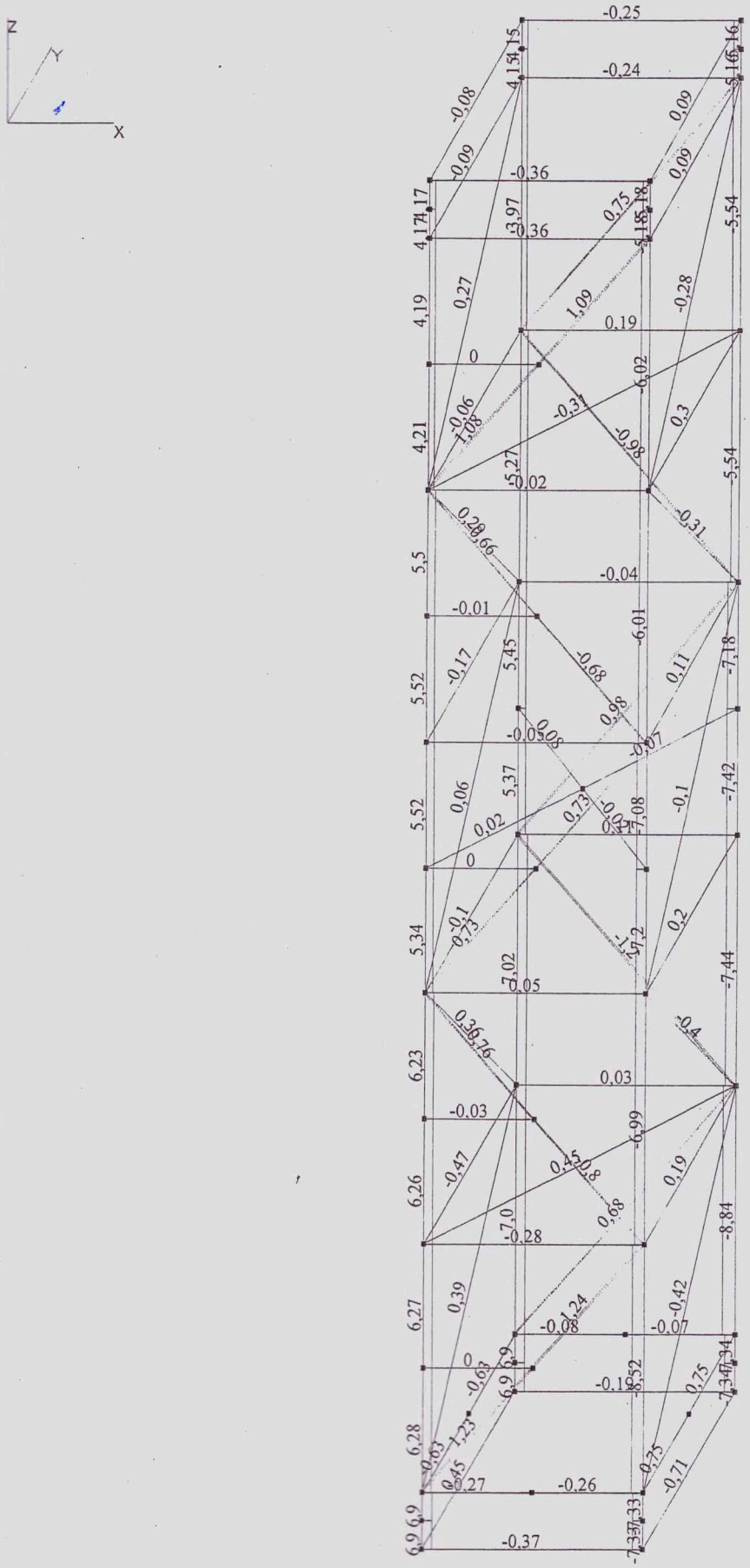


Effort Mark 22,4-17,2

Structure CAD® 11.1

Company	Ukrinstalkon LLC
Facility	Delay tower
Project	31656

Combination **5 ((L1)*1+(L2)*1+(L3)*1.2+(L5)*1.2+(L6)*1) (T)**

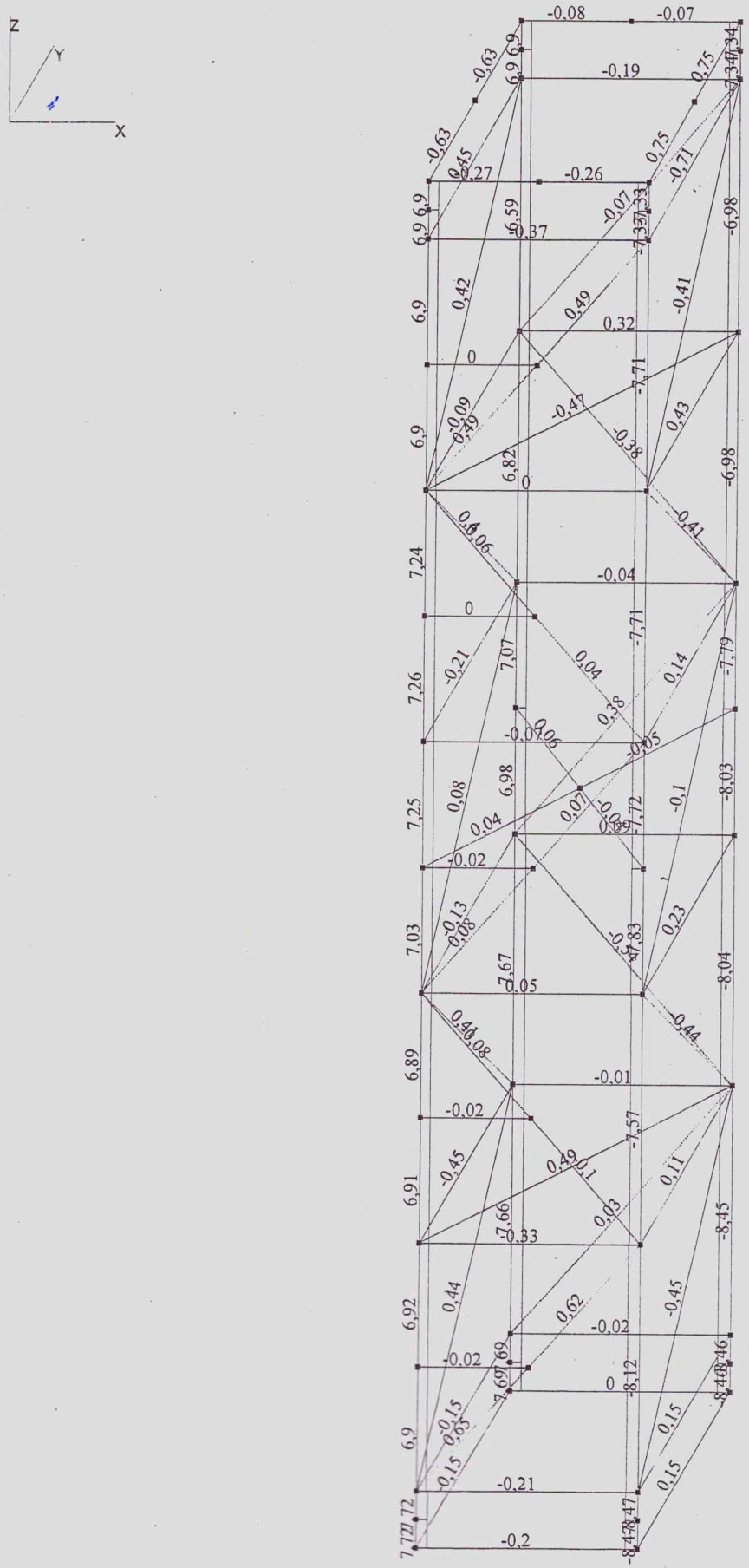


Effort Mark 17,2-11,6

Structure CAD® 11.1

Company	Ukrinstalkon LLC
Facility	Delay tower
Project	31656

Combination **5 ((L1)*1+(L2)*1+(L3)*1.2+(L5)*1.2+(L6)*1) (T)**

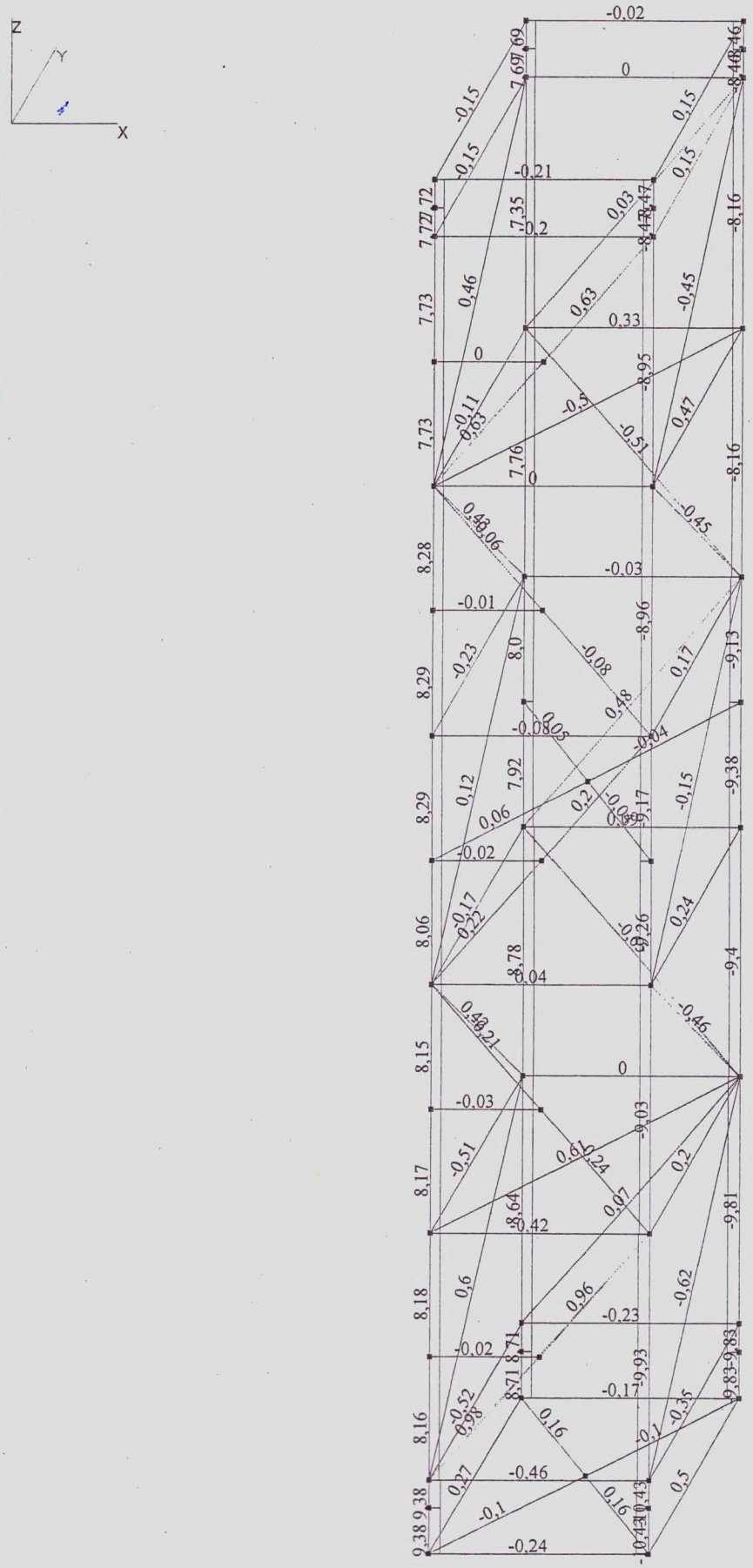


Effort Mark 11,6-6

Structure CAD® 11.1

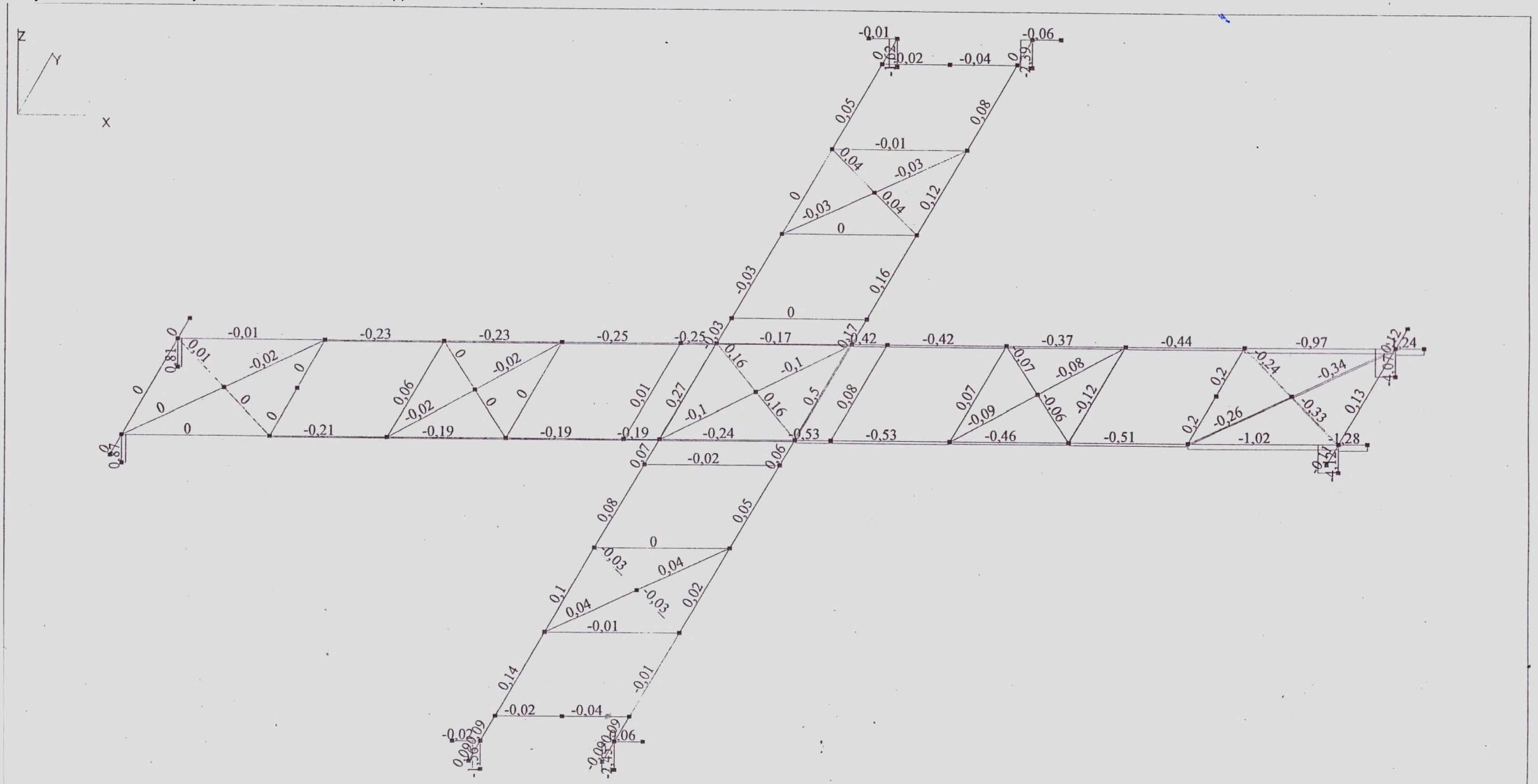
Company	Ukrinstalkon LLC
Facility	Delay tower
Project	31656

Combination 5 ((L1)*1+(L2)*1+(L3)*1.2+(L5)*1.2+(L6)*1) (T)



Effort Mark 6-0

Project file: S:\CDATA\Delay Tower H=23m\, Additional support.SPR



Combination 5 ((L1)*1+(L2)*1+(L3)*1.2+(L5)*1.2+(L6)*1) (T)

Structure CAD® 11.1

Company	Ukrinstalkon LLC
Facility	Delay tower
Project	31656

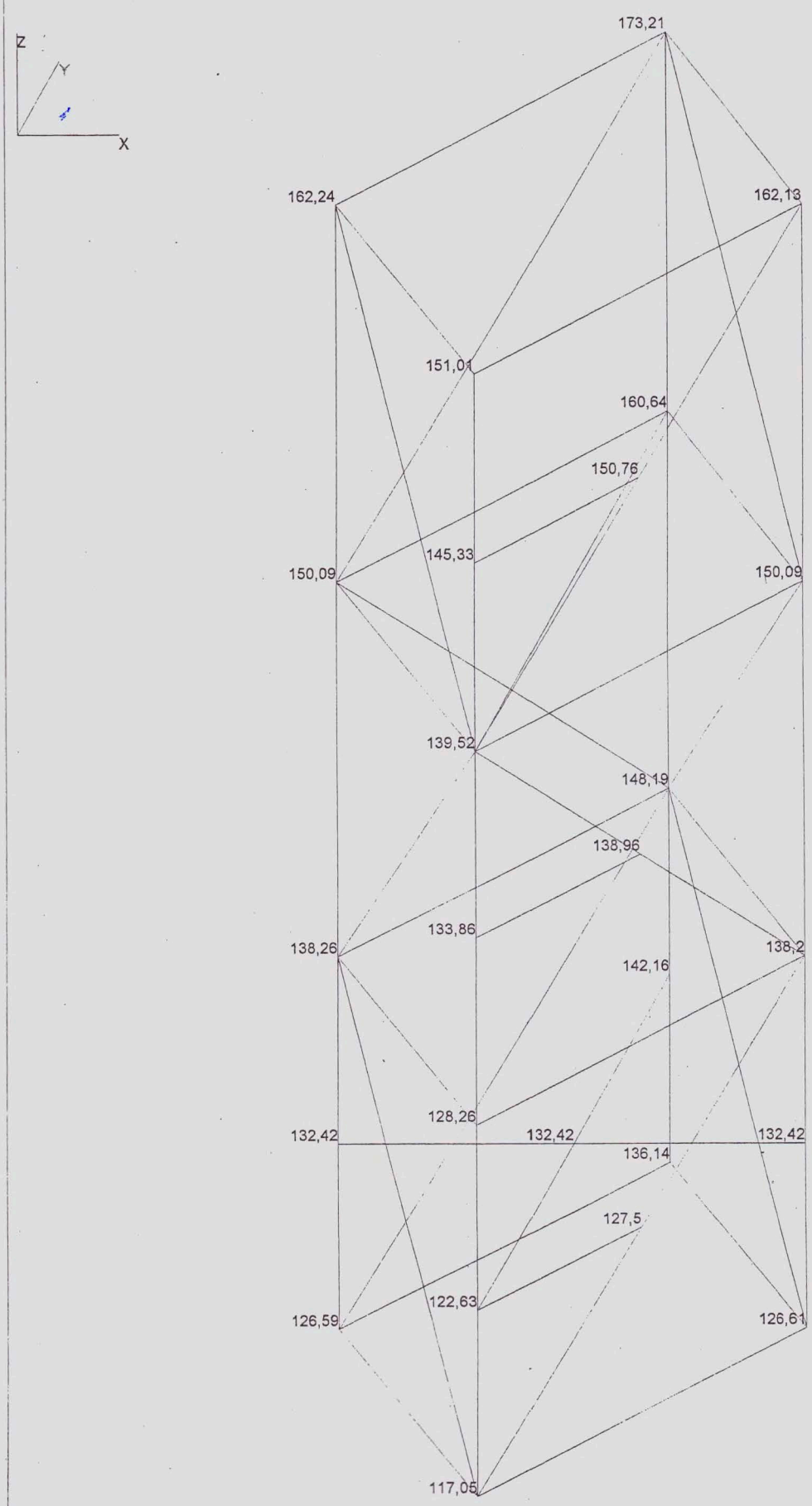
Effort

Results of calculation
Load combination № 7

Structure CAD® 11.1

Company	Ukrinstalkon LLC
Facility	Delay tower
Project	31656

Displacement X (мм). Combination 5 ((L1)*1+(L2)*1+(L3)*1.2+(L5)*1.2+(L6)*1)



Displacement

Structure CAD® 11.1

Company	Ukrinstalkon LLC
Facility	Delay tower
Project	31656

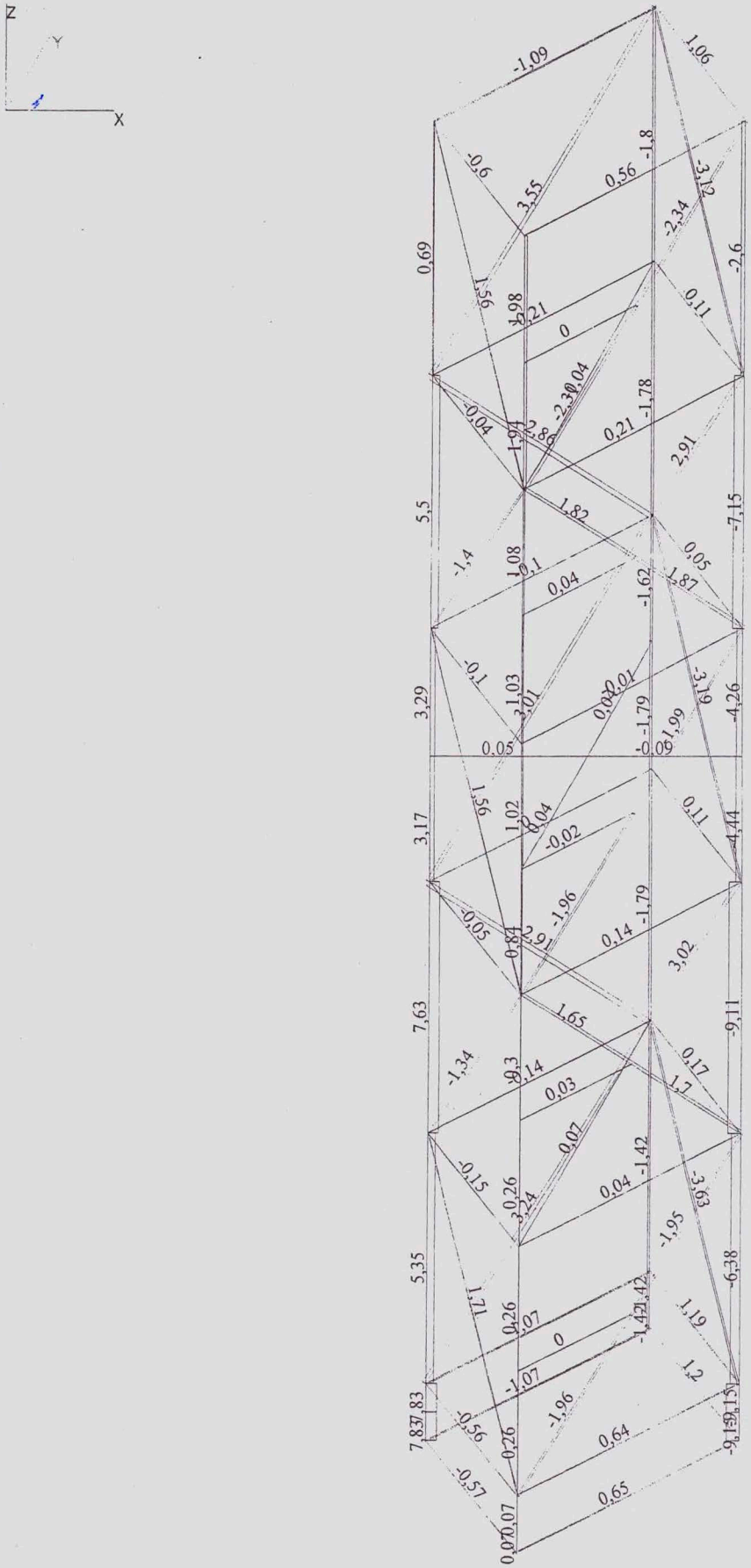
Combination 5 ((L1)*1+(L2)*1+(L3)*1.2+(L5)*1.2+(L6)*1) (T)

Effort

Structure CAD® 11.1

Company	Ukrinstalkon LLC
Facility	Delay tower
Project	31656

Combination 5 ((L1)*1+(L2)*1+(L3)*1.2+(L5)*1.2+(L6)*1) (T)



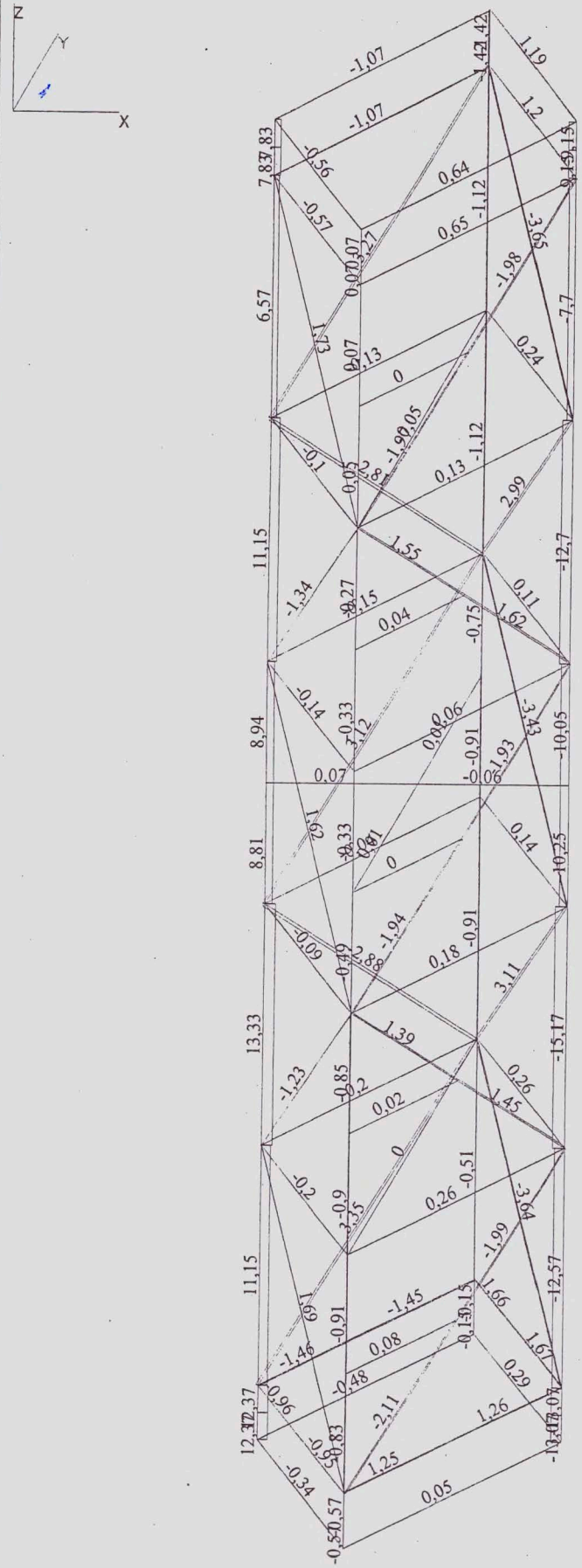
Effort Mark. 22,4-17,2

Project file: S:\CDATA\Delay Tower H=23m\, Additional support45.SPR

Structure CAD® 11.1

Company	Ukrinstalkon LLC
Facility	Delay tower
Project	31656

Combination 5 ((L1)*1+(L2)*1+(L3)*1.2+(L5)*1.2+(L6)*1) (T)



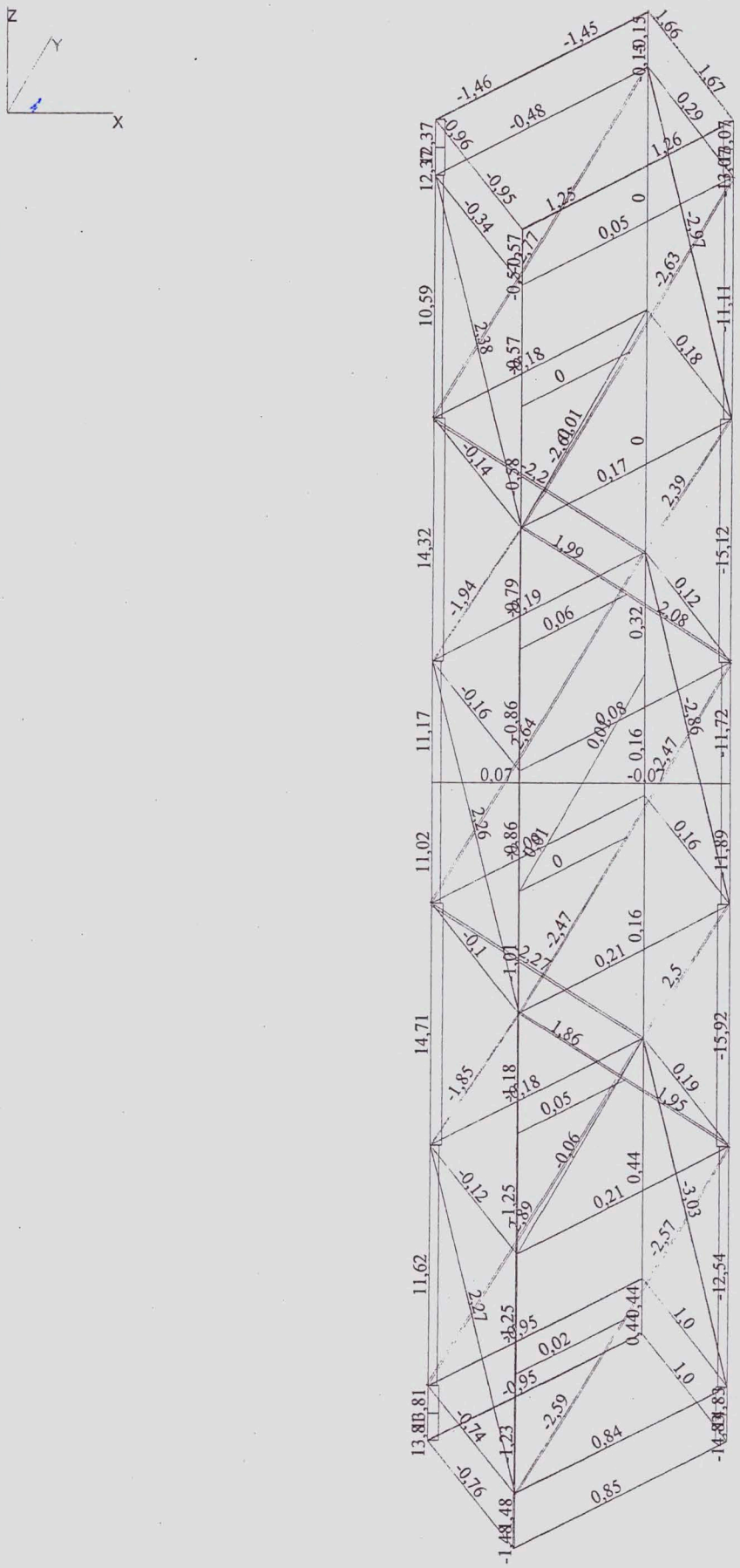
Effort Mark 17,2-11,6

Project file: S:\CDATA\Delay Tower H=23m\, Additional support45.SPR

Structure CAD® 11.1

Company	Ukrinstalkon LLC
Facility	Delay tower
Project	31656

Combination 5 ((L1)*1+(L2)*1+(L3)*1.2+(L5)*1.2+(L6)*1) (T)



Effort Mark 11,6-6

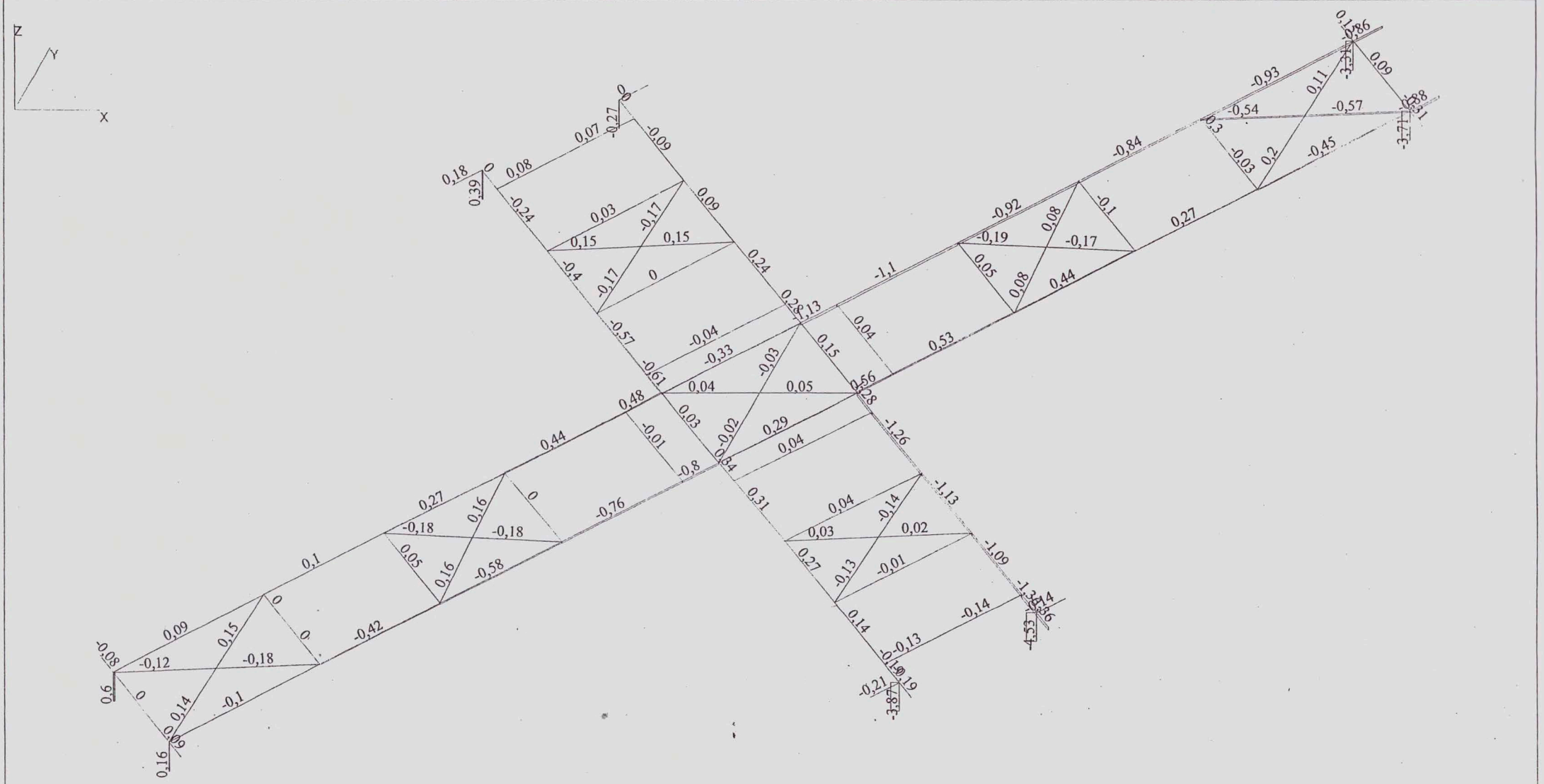
Structure CAD® 11.1

Company	Ukrinstalkon LLC
Facility	Delay tower
Project	31656

Combination 5 ((L1)*1+(L2)*1+(L3)*1.2+(L5)*1.2+(L6)*1) (T)

Effort Mark . 6-0

Project file: S:\CDATA\Delay Tower H=23m\, Additional support45.SPR



Combination 5 ((L1)*1+(L2)*1+(L3)*1.2+(L5)*1.2+(L6)*1) (T)

Structure CAD® 11.1

Company	Ukrinstalkon LLC
Facility	Delay tower
Project	31656

Effort

The overall results of Tower calculation

№ combin.	Name of load	Name of element	Maximum efforts, tf	Carrying capacity, tf	Horizontal displacements (tower top) m	Maximum effort in the support elements of design diagram (tf)
1	Own weight P1...P4 + useful Q	belt	±4,95	-30,9	0,045	-2,04 -0,53
		brace	±0,28	-15,4		
		spacer	±0,29	-16,6		
		guy-rope	+3,43	+5,8		
2	Own weight P1...P4 + useful Q + Wind q1, q2	belt	±10,4	-30,9	0,124	-4,48 +1,45
		brace	±1,23	-15,4		
		spacer	±0,71	-16,6		
		guy-rope	+5,02	+5,8		
3	Own weight P1...P4 + useful Q + Wind q1, q2 (at an angle of 45°)	belt	±18,0	-30,9	0,164	-3,97 +1,42
		brace	±3,62	-15,4		
		spacer	±1,64	-16,6		
		guy-rope	+4,88	+5,8		
4	Own weight P1...P4 + useful Q +Wind q1, q2 + Ballast G1	belt	±10,3	-30,9	0,124	-4,99 +0,95
		brace	±1,23	-15,4		
		spacer	±0,72	-16,6		
		guy-rope	+4,91	+5,8		
5	Own weight P1...P4 + useful Q + Wind q1, q2 (at an angle of 45°) + Ballast G1	belt	±17,9	-30,9	0,164	-4,47 +0,92
		brace	±3,62	-15,4		
		spacer	±1,65	-16,6		
		guy-rope	+4,78	+5,8		
6	Own weight P1...P4+P5 + useful Q + Wind p1, p2 + Ballast G1	belt	±10,43	-30,9	0,140	-4,12 +0,87
		brace	±1,24	-15,4		
		spacer	±0,75	-16,6		
		guy-rope	+5,04	+5,8		
7	Own weight P1...P4+P5 + useful Q + Wind p1, p2 (at an angle of 45°) + Ballast G1	belt	±18,13	-30,9	0,173	-4,53 +0,6
		brace	±3,65	-15,4		
		spacer	±1,67	-16,6		
		guy-rope	+4,56	+5,8		

Notes:
1. The efforts in the support rods with the sign "+" means the presence of separation.
2. The maximum allowable displacement – 0.23 m.

Inv. No of equip. | Signature and date | Subst. No of equip