Chapter 1- Introduction

In the present study the steel structure supporting the facade of the BANEASA TECHNOLOGY PARK building will be analyzed.

The elastic and anelastic analysis of the steel structure that is supported on the existing reinforced concrete structure follows. Furthermore, the structure of high bearing capacity which is supported on the steel structure that supports the facade according to the functional requirements.

The analysis as well as the design of the present construction was based on the latest guidelines. More specifically, the construction's design is based on the following guidelines:

Title	Year	Author
EUROCODE-3	1993	European Regulation
DIN 18008	2006	German Regulation

According to the above guidelines, all the required examinations were executed, in order to assure sufficient strength and functionality for the structure

The elements that will be used are:
Steel S235 for the steel structure.
Stainless steel 304 for the tension rod system

Chapter 2- Design Loads

The structure's nature demands the loading to be calculated according to the international bibliography, owners demand and guidelines as well as regulations.

The loading categories that are applied on the structure, which is to be examined, are the following:

- Dead loads G
- Live loads Q

The dead loads G that exist on the present structure are the following:

α/α	Cause	ρ (kN/m3)	t (m)
1)	Glass of 24 mm thickness (view)	25	0,024
2)	Glass of 26 mm thickness (roof)	25	0,026

The effective area computed according the next two figure. The effective area depends on the grid of the glass facade.

We have (view facade):

$$A1=\frac{1,46}{2}\times\frac{2,35}{2}=0,86m^2$$

$$A2=\frac{1,67+1,46}{2}\times\frac{2,35}{2}=1,84m^2$$

$$A3=1,67\times\frac{2,35}{2}=1,96m^2$$

$$A4=\frac{1,46}{2}\times 2,66=1,94m^2$$

$$A5=1,67\times 2,66=4,44m^2$$

$$A6=\frac{1,67+1,46}{2}\times 2,66=4,16m^2$$

$$A7 = 1{,}67 \times \frac{2{,}66 + 1{,}78}{2} = 3{,}71 m^2$$

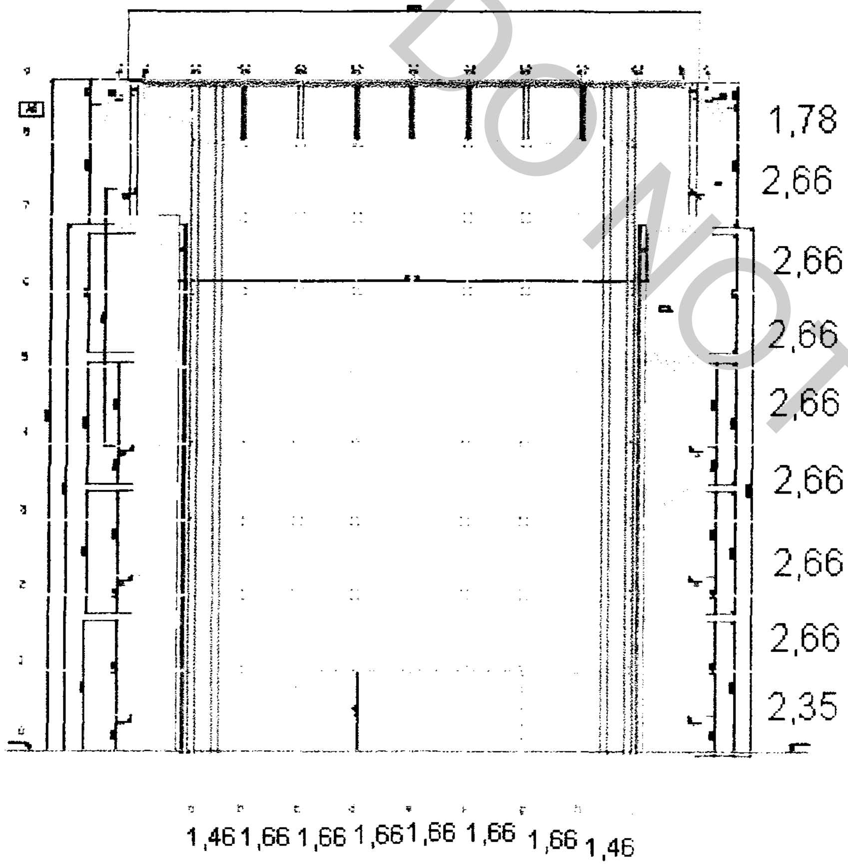
$$A8 = \frac{1{,}67 + 1{,}46}{2} \times \frac{2{,}66 + 1{,}78}{2} = 3{,}47 m^2$$

$$A9 = 1{,}67 \times \frac{1{,}78}{2} = 1{,}49 m^2$$

$$A10 = \frac{1{,}67 + 1{,}46}{2} \times \frac{1{,}78}{2} = 1{,}39 m^2$$

$$A11 = \frac{1{,}46}{2} \times \frac{1{,}78}{2} = 0{,}65 m^2$$

FRONT Facade A2-A1
VIEW FROM OUTSIDE



We have (roof facade):

$$A12=\frac{1,47}{2}\times\frac{1,22}{2}=0,45m^2$$

$$A13=1,47\times\frac{1,22}{2}=0,90m^2$$

$$A14=1,66\times\frac{1,22}{2}=1,02m^2$$

$$A15=\frac{1,47}{2}\times\frac{1,22+1,46}{2}=0,99m^2$$

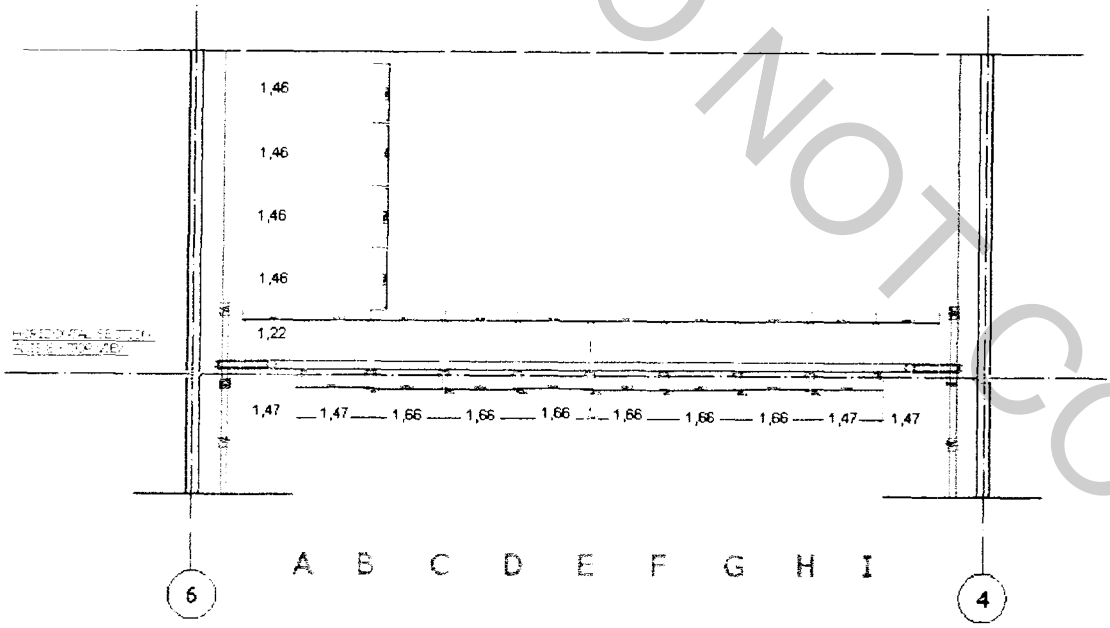
$$A16=1,47\times\frac{1,22+1,46}{2}=1,97m^2$$

$$A17=1,66\times\frac{1,22+1,46}{2}=2,22m^2$$

$$A18=\frac{1,47}{2}\times 1,46=1,07m^2$$

$$A19=1,47\times 1,46=2,15m^2$$

$$A20=1,66\times 1,46=2,42m^2$$



The point loads are:

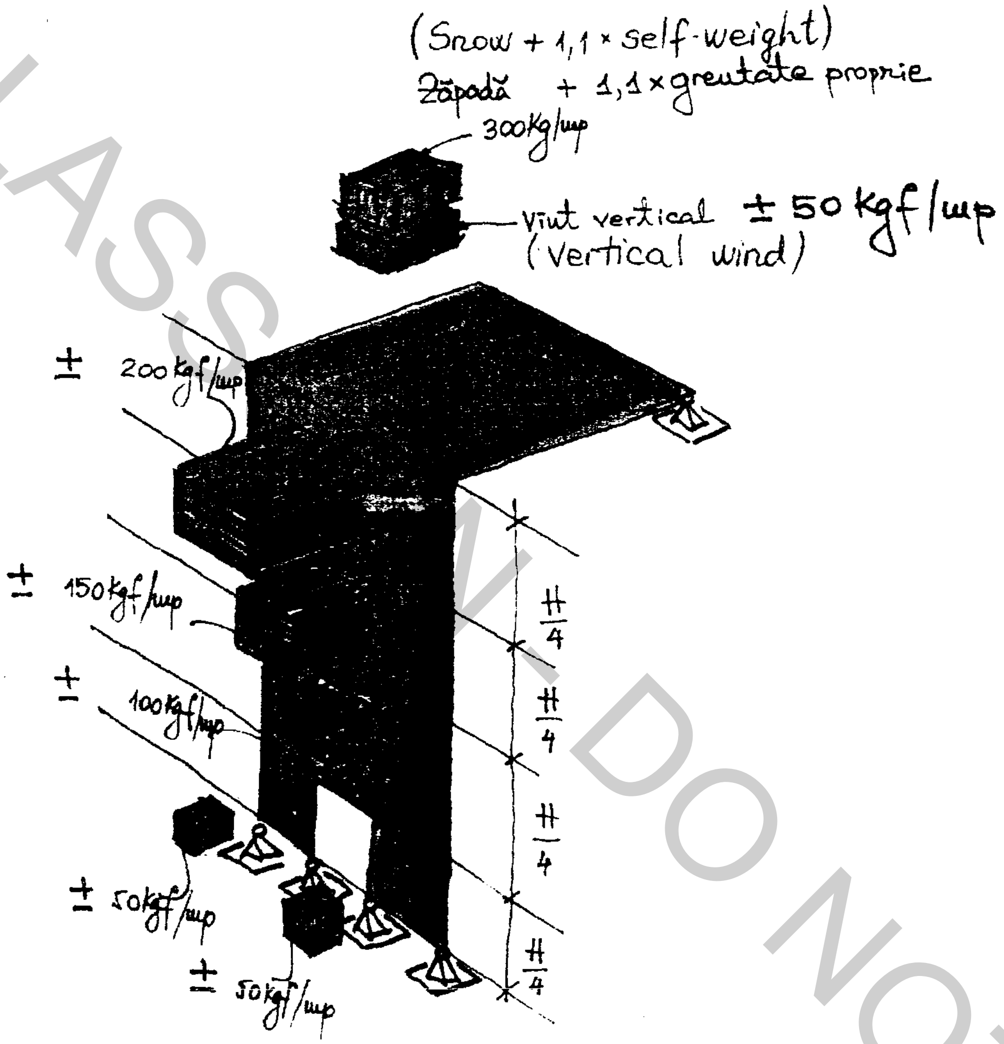
Dead load G			
View façade =		0,6	
Roof façade=		0,65	
Area	A (m2)	view kN	roof kN
A1	0,86	0,52	
A2	1,84	1,10	
A3	1,96	1,18	
A4	1,94	1,16	
A5	4,44	2,66	
A6	4,16	2,50	
A7	3,71	2,23	
A8	3,47	2,08	
A9	1,49	0,89	
A10	1,39	0,83	
A11	0,65	0,39	
A12	0,45		0,29
A13	0,90		0,59
A14	1,02		0,66
A15	0,99		0,64
A16	1,97		1,28
A17	2,22		1,44
A18	1,07		0,70
A19	2,15		1,40
A20	2,42		1,57

It should be mentioned that the weight of the steel construction is calculated automatically by the designing and analyses program that is used for the calculation of the structure's strength.

The live loads Q that exist on the present structure are the following:

α/α	Cause	Prediction kN/m2
1)	Wind	0,5-1,0-1,5-2,0
2)	Vertical wind	0,5
2)	Snow	1,92

The above values requested by the owner of the structure as shown in the next page.



BANEASA BUSINESS AND TECHNOLOGY PARK

- SNOW AND WIND LOADS ON SPIDER STRUCTURE

- Aseismic design

According to the Romanian Code the seismic loads are:
$Sr = crXG$
where:
$cr = a \cdot ks \cdot br \cdot \psi \cdot \varepsilon$
and

a=1.0
ks=0.2
br=2.5
ψ=0.65
ε=1.0

so $cr = 0{,}325$

according to EC the seismic loads E are:

$$Sr = R_{dT} XG$$

$$R_{dT} = \gamma \cdot A \cdot \frac{n \cdot \theta \cdot \beta}{q} = 0{,}46 > cr$$

The design and analysis done with the loads from EC.

The loading combinations that will be examined during the analysis and the design of the structures according to the international guidelines are presented below:

1) Normal combination
$NormalCondition1 = G + WIND$

2) Normal combination
$NormalCondition2 = G + SNOW$

3) Normal combination
$NormalCondition = G - W$

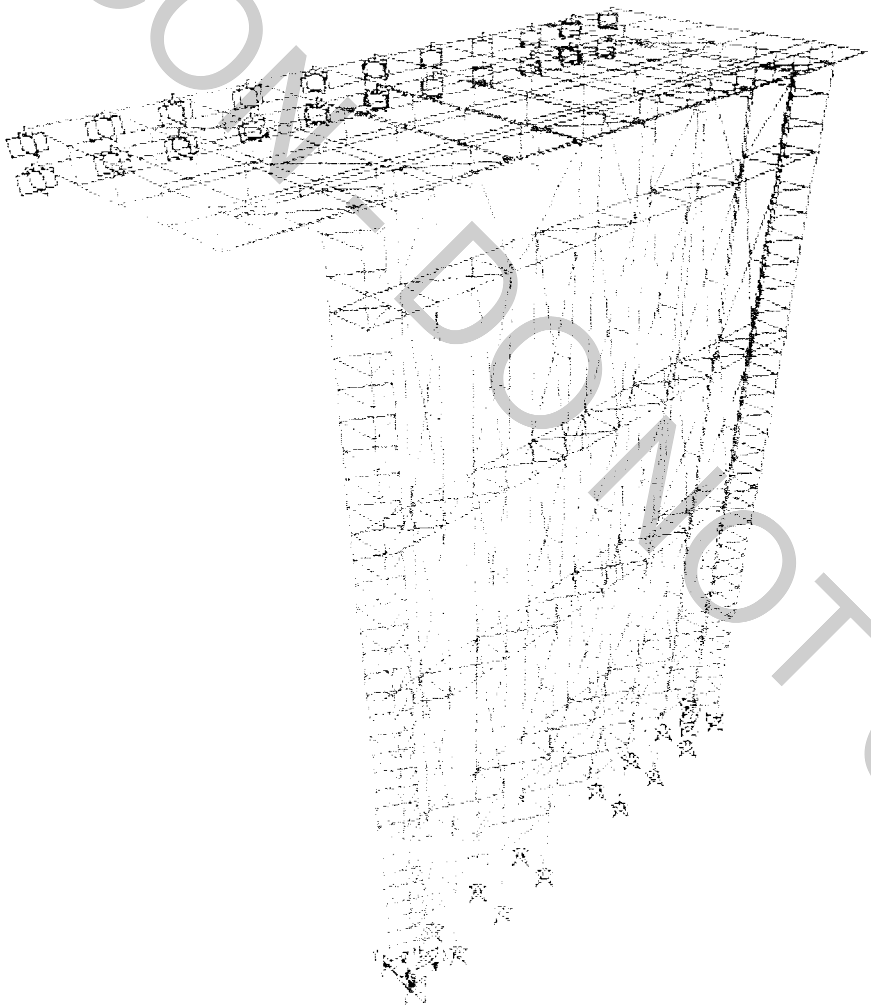
4) Aseismic combination
$E1 = G + 0{,}3W + E$
$E2 = G + 0{,}3S + E$

Chapter 3-Steel structure analysis

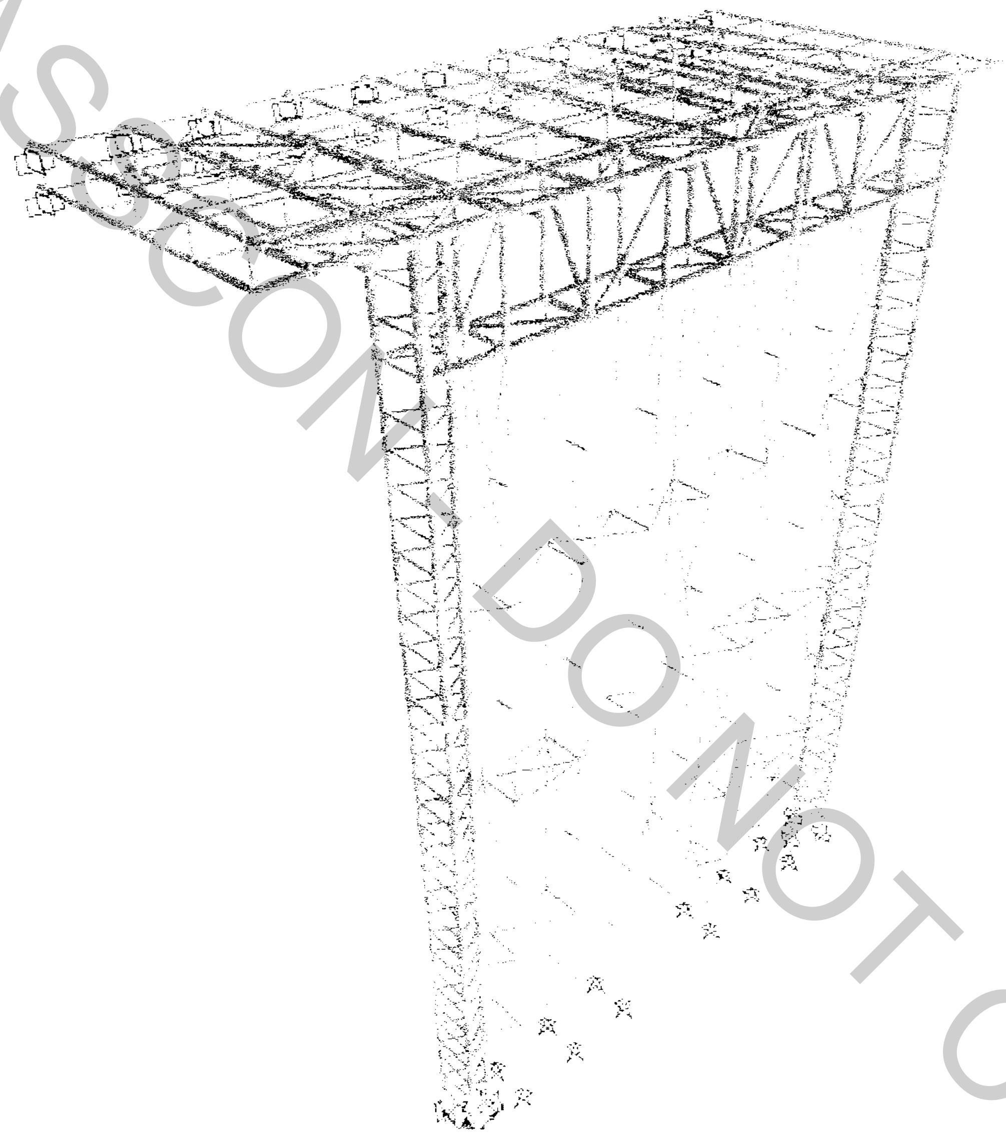
The program SAP2000 –that is based on both linear and non-linear analysis of fixed linear elements- will be used for the designing as well as analysis of the structure.

The analysis and design of the steel structure is linear analysis and checked according to EC3. The material is steel S235 with fy=235MPa

The whole construction is simulated using linear fixed elements.



The tension rod system is supported to the steel structure, which we check to the next pages. The steel structure is consisting off two truss columns and a truss beam. The roof is constrained at the concrete *slab and* at the truss beam.



Input and output files presented to the next pages of chapter 3.

TABLE: Material Properties 01 - General							
Material	Type	DesignType	UnitMass	UnitWeight	E	U	A
Text	Text	Text	KN-s2/m4	KN/m3	KN/m2	Unitless	1/C
ALUM	Isotropic	Aluminum	2,7145	26,602	69637054,68	0,33	0,00002358
CLDFRM	Isotropic	ColdFormed	7,849	76,973	203395357,7	0,3	0,0000117
CONC	Isotropic	Concrete	2,4028	23,563	24821128,4	0,2	0,0000099
OTHER	Isotropic	None	2,4007	23,562	24821128,4	0,2	0,0000099
s235	Isotropic	Steel	0	78	210000000	0,3	0,0000117
ss304	Isotropic	Steel	0	78	193000000	0,3	0,0000117
STEEL	Isotropic	Steel	7,849	76,973	199947978,8	0,3	0,0000117

TABLE: Material Properties 03 - Design Steel			
Material	**Fy**	**Fu**	
Text	KN/m2	KN/m2	
s235	235000	360000	
ss304	290000	621000	
STEEL	248211,28	399895,96	

TABLE: Combination Definitions					
ComboName	ComboType	CaseType	CaseName	ScaleFactor	SteelDesign
Text	Text	Text	Text	Unitless	Yes/No
G+S	Linear Add	Linear Static	DEAD	1	Yes
G+S		Linear Static	glass	1	
G+S		Linear Static	s	1	
G+W	Linear Add	Linear Static	DEAD	1	Yes
G+W		Linear Static	glass	1	
G+W		Linear Static	w	1	
G-W	Linear Add	Linear Static	DEAD	1	Yes
G-W		Linear Static	glass	1	
G-W		Linear Static	-w	1	
E1	Linear Add	Linear Static	DEAD	1	Yes
E1		Linear Static	glass	1	
E1		Linear Static	E	1	
E1		Linear Static	w	0,3	
E2	Linear Add	Linear Static	DEAD	1	Yes
E2		Linear Static	glass	1	
E2		Linear Static	E	1	
E2		Linear Static	s	0,3	

TABLE: Combination Definitions					
ComboName	**ComboType**	**CaseType**	**CaseName**	**ScaleFactor**	**SteelDesign**
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G+S	Linear Add	Linear Static	DEAD	1	Yes
G+S		Linear Static	glass	1	
G+S		Linear Static	s	1	
G+W	Linear Add	Linear Static	DEAD	1	Yes
G+W		Linear Static	glass	1	
G+W		Linear Static	w	1	
G-W	Linear Add	Linear Static	DEAD	1	Yes
G-W		Linear Static	glass	1	
G-W		Linear Static	-w	1	
E1	Linear Add	Linear Static	DEAD	1	Yes
E1		Linear Static	glass	1	
E1		Linear Static	E	1	
E1		Linear Static	w	0,3	
E2	Linear Add	Linear Static	DEAD	1	Yes
E2		Linear Static	glass	1	
E2		Linear Static	E	1	
E2		Linear Static	s	0,3	

Chapter 4-Tension rod structure analysis

The program ANSYS -that is based on both linear and non-linear analysis of fixed elements- will be used for the designing as well as analysis of the structure.

The loads are according chapter 2.

LINK10 elements used to modeling the tension rods. The analysis is non-linear. These elements have the unique feature of a bilinear stiffness matrix resulting in a uniaxial tension-only element. Initial strain is given as input by Δ/L, where Δ is the difference between the element length (L) and the zero strain length Lo.

In our analysis the tension rod which diameter is 20mm are pretensioned with a value of initial strain of 0,0007 and the rods which diameter is 16mm are pretensioned with a value of initial strain of 0,0008.

The designer remind that the initial strain is the most important parameter of the stability of the structure, so the pretension must be checked before install the rods with specialized equipment.

The material is: stainless steel 304 with fy=290Mpa and fu=621MPa.

The chemical composition of the steel is:

C	0.08max
Mn	2.0
Si	0.75
P	0.045
S	0.03
Cr	16-18
Mo	2-3
Ni	10-14
N	0.1

The tension limit of the rods are:

$$\Phi 16: N_{max} = 0{,}9X2{,}011 \times 62{,}1 \;/\; 1{,}25 = 89{,}92kN$$

$$\Phi 20: N_{max} = 0{,}9X3{,}142 \times 62{,}1 / \; 1{,}1 = 140{,}49kN$$

The input and output files presented to the next pages of chapter 4.

Chapter 5-Glass façade analysis

The program ANSYS -that is based on both linear and non-linear analysis of fixed elements- will be used for the designing of the glass facade.

In our structure we are going to analyze three glass facade. Two for the view facade and one for the roof facade.

Our glass is securit/triplex with σ_u=12kN/cm^2

For the two glasses of the view facade we have that the internal glass is 8mm+8mm and the external glass is 8mm.

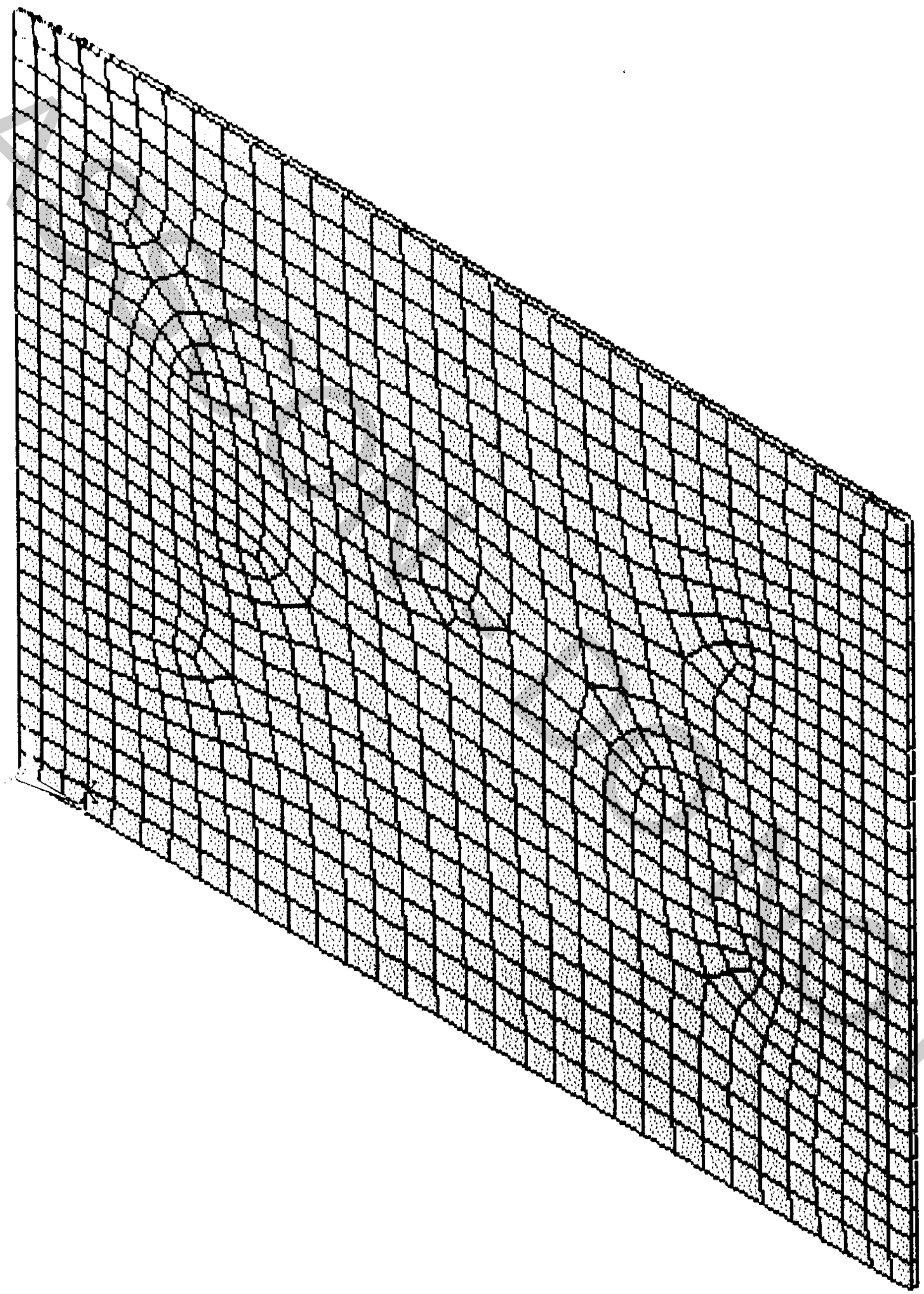
For the glass of the roof façade we have that the internal glass is 8mm+8mm and the external glass is 10mm.

In all cases only the internal glass is penetrated from the glass fitting.

The modeling of the glass facade made with the use of finite elements and the analysis was non-linear.

The glasses that will be analyzed are:
1) view glass:1,68X2,26 with four holes at the internal glass and wind force of 2kN/m^2
2) view glass:1,68X1,88 with four holes at the internal glass and wind force of 2kN/m^2
3) roof glass:1,68X1,46 with four holes at the internal glass and total force of 3kN/m^2

XN



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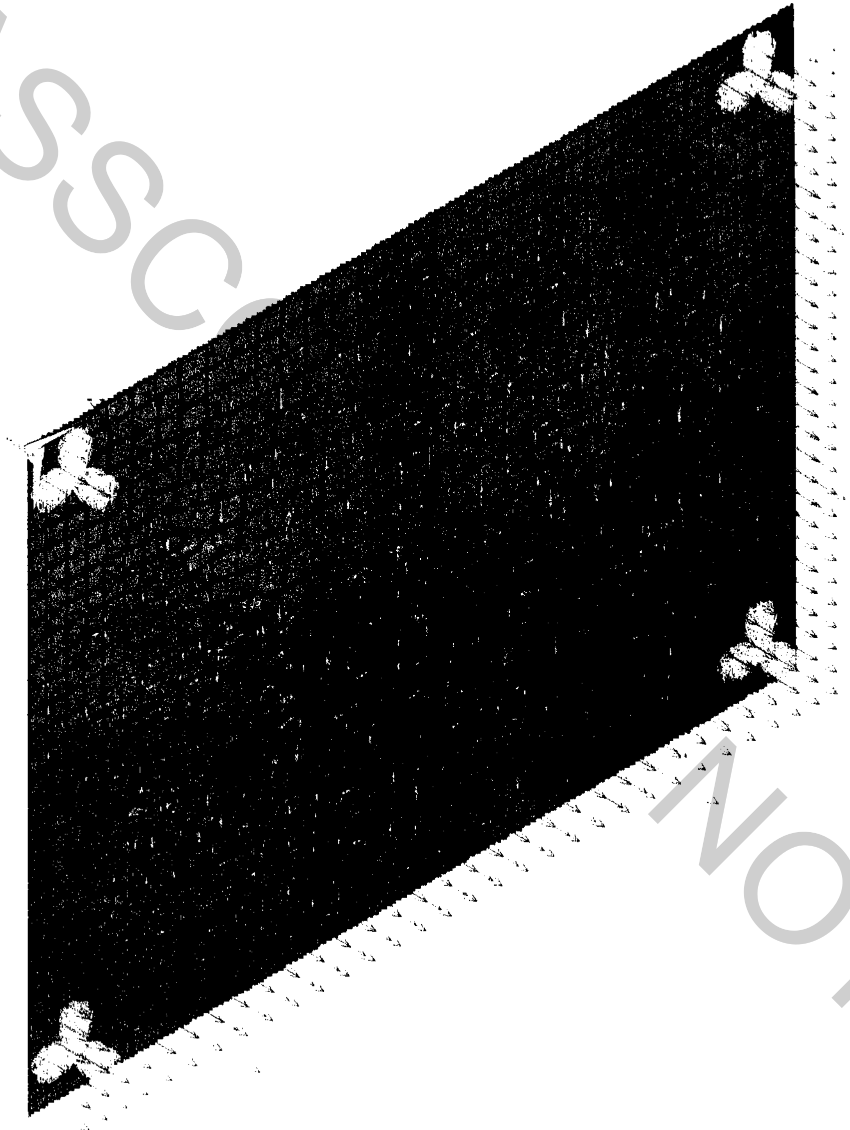
1) 1,60 x 2,36 m



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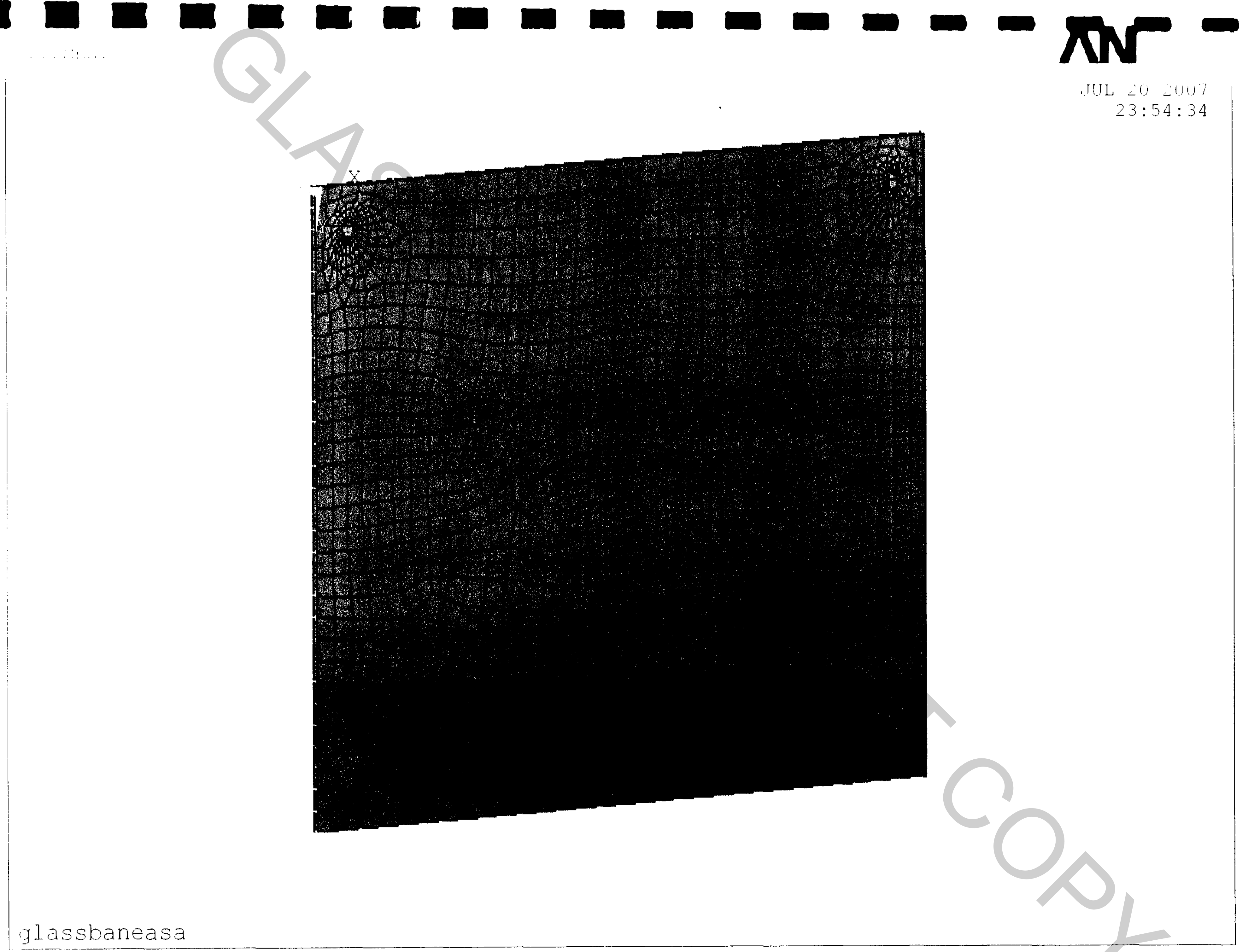
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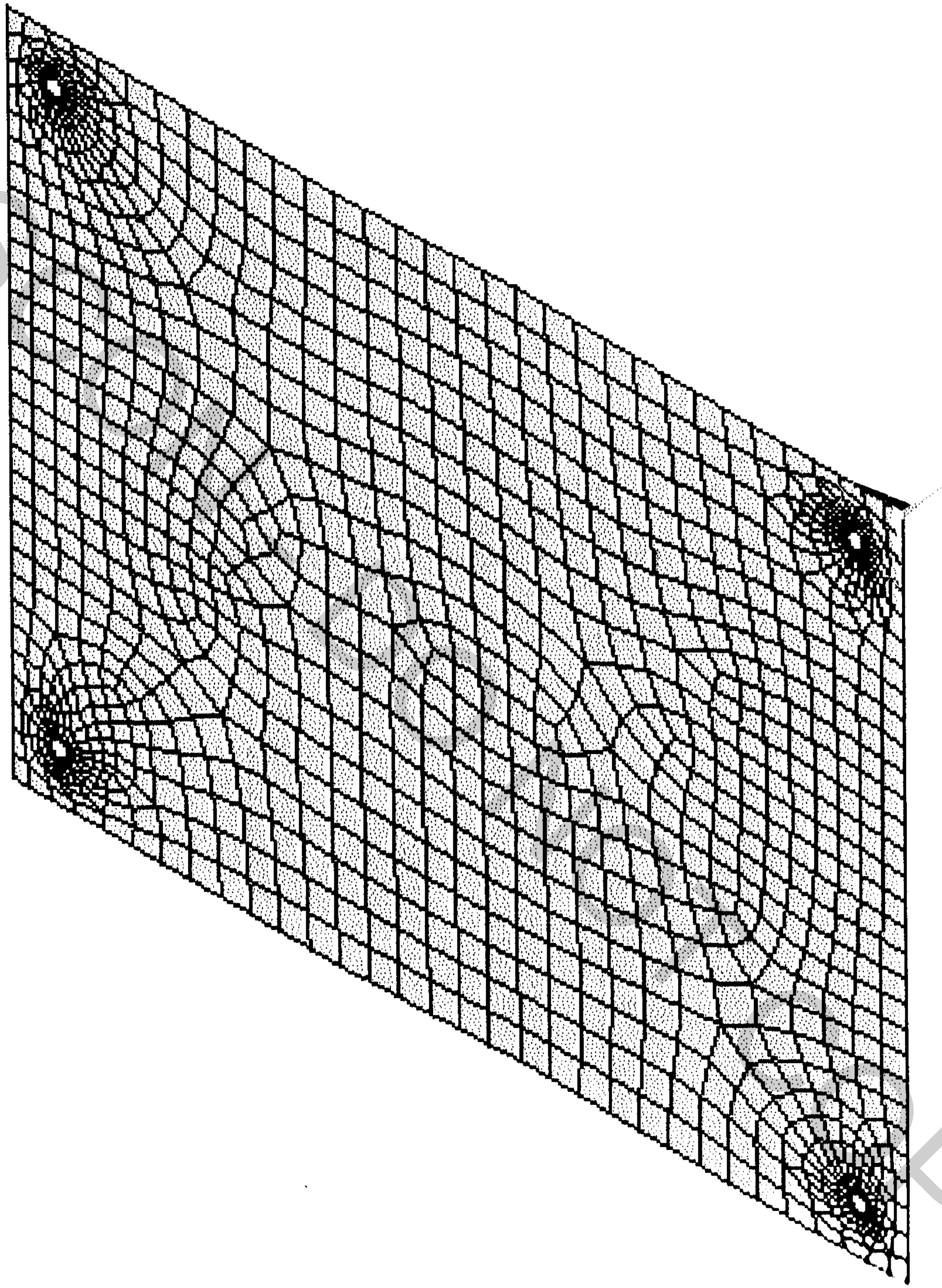

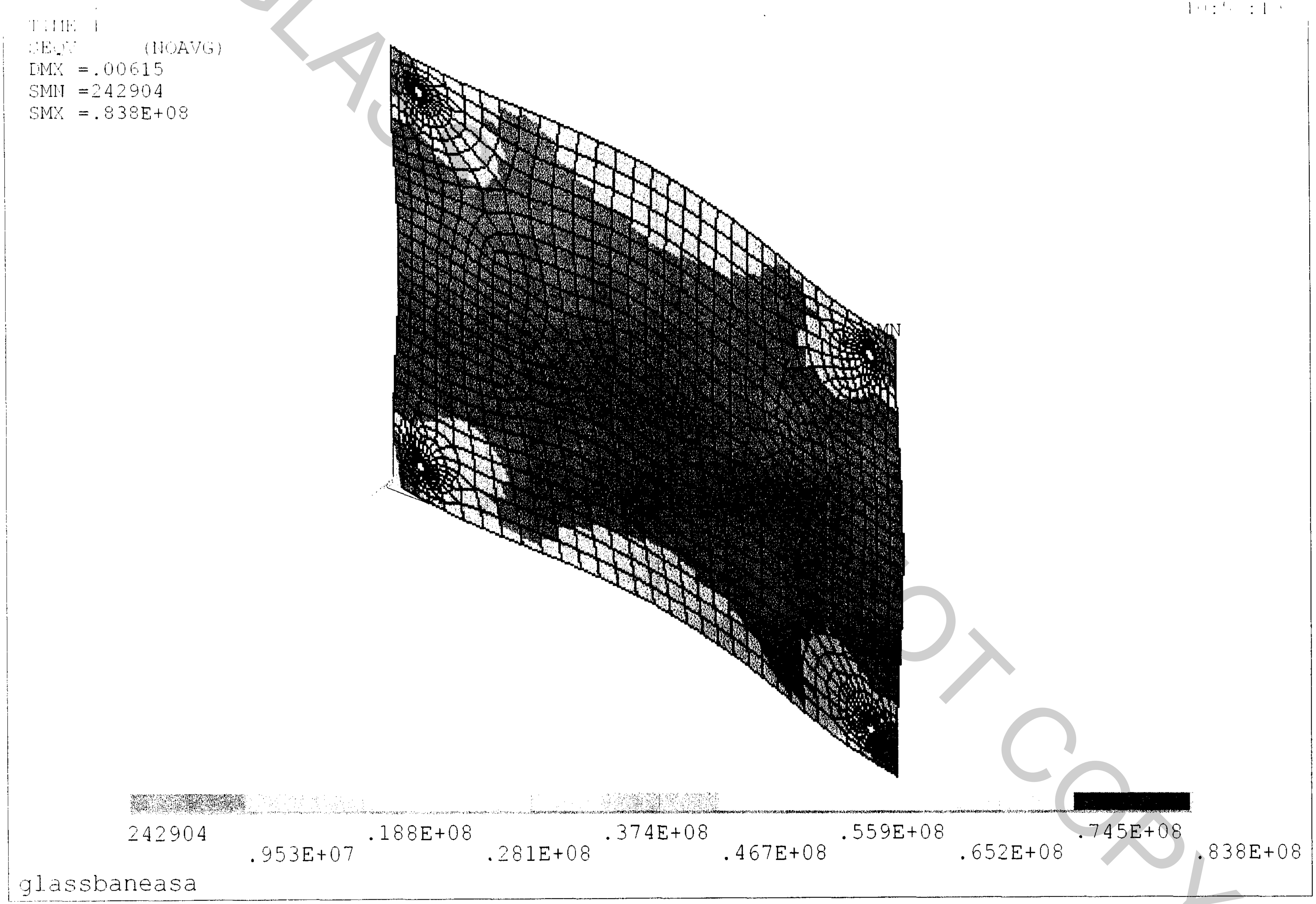
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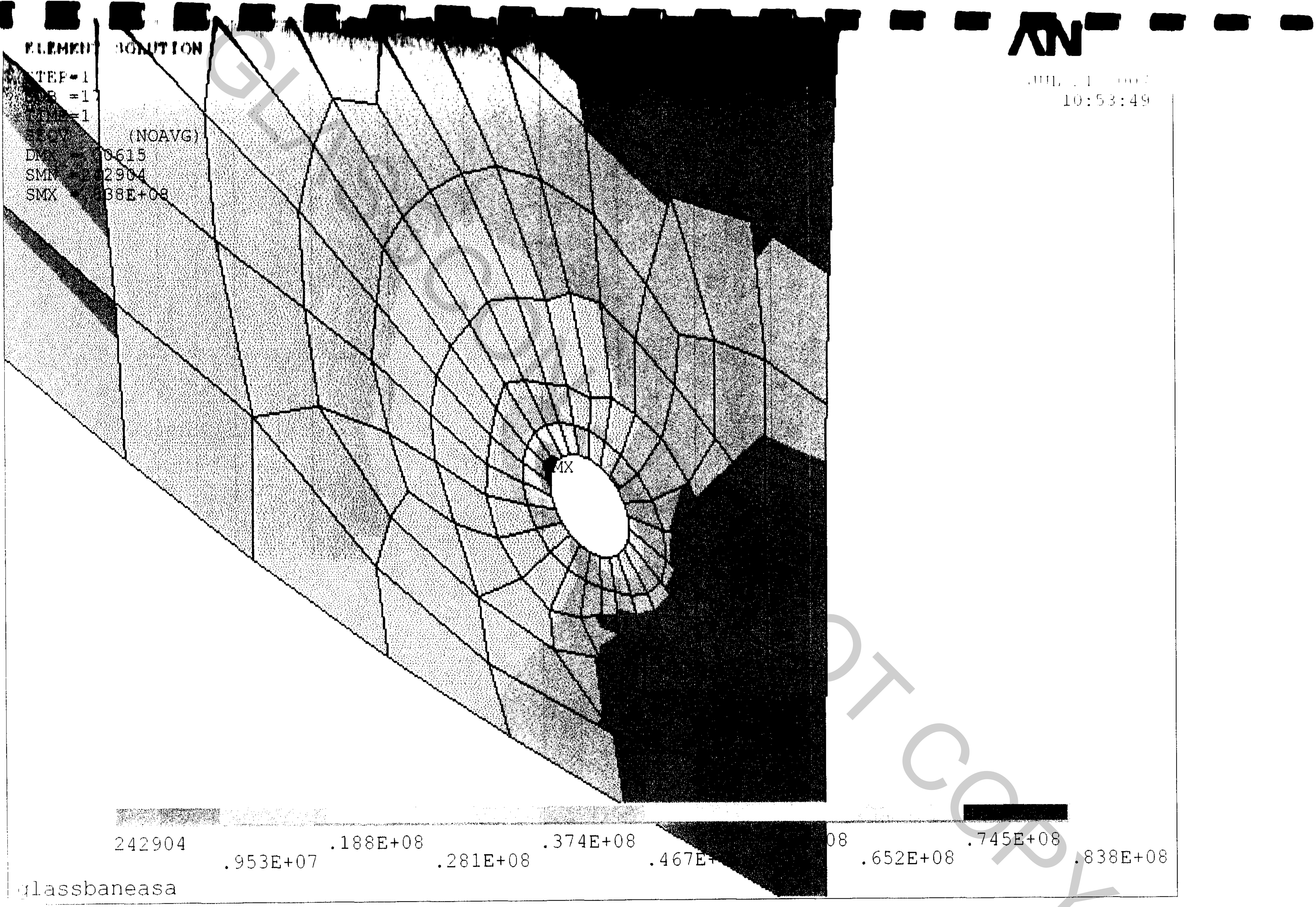
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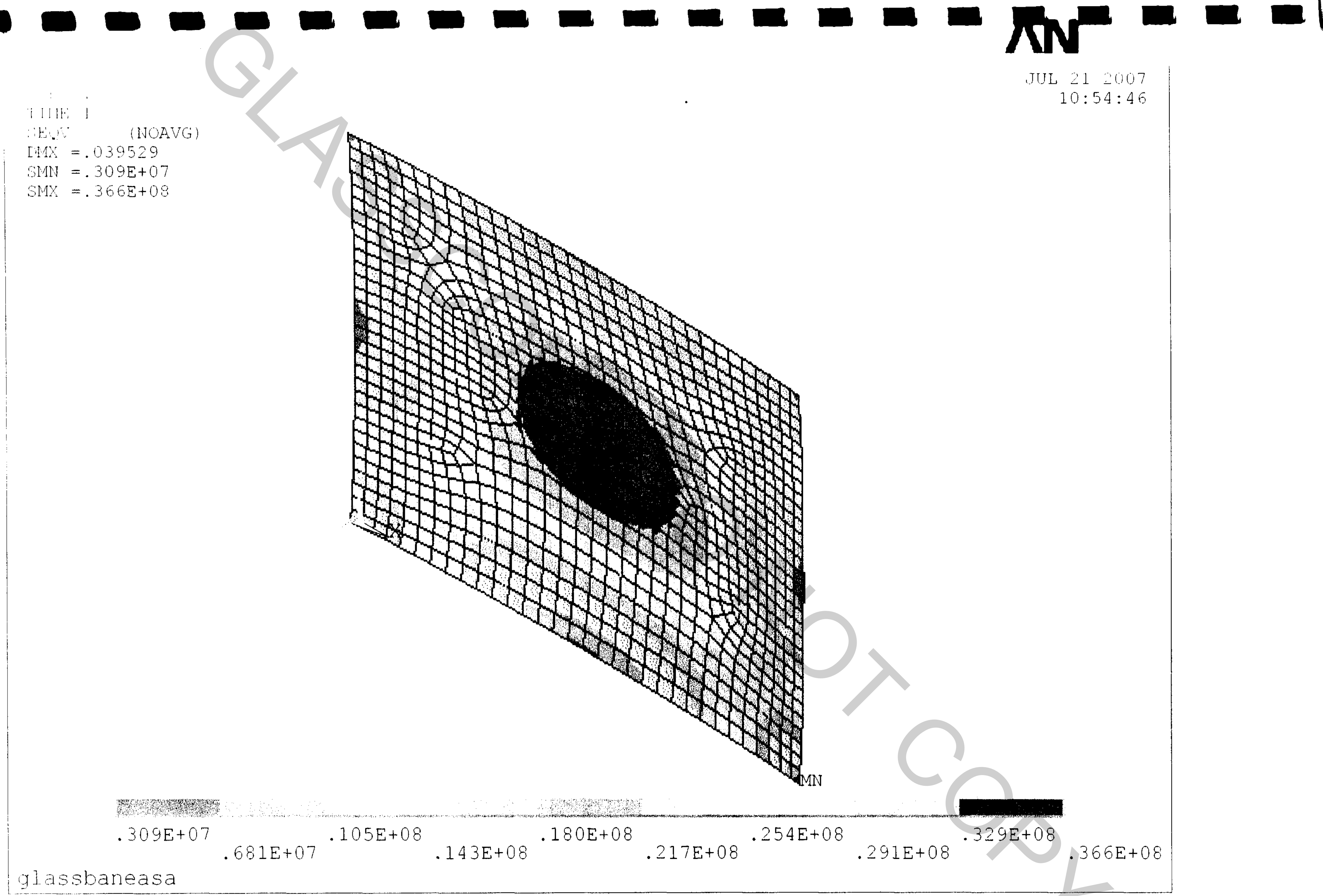

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