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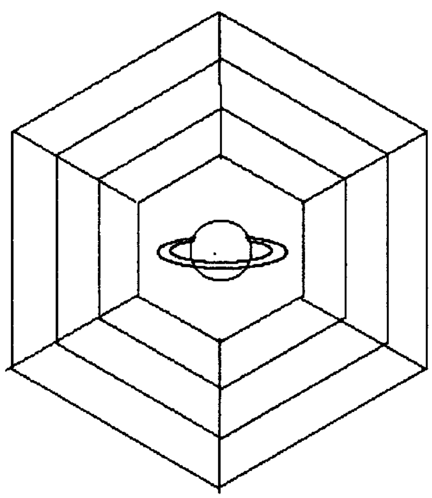
COLUMBUS PROJECT

MIRROR BLANK 8.4 meter f / 1.14

FINITE ELEMENT MODEL



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FINITE ELEMENT MODEL

1. Introduction.

In this report we describe the finite element model used for the 8.4 meter mirror blank analysis. The code used is SAP V.
The results of the structural analysis will be post-processed using opportune codes. In the following pages we initially describe the material and geometrical characteristics of the model and afterwords the finite element model used in our analysis.

For the data and results, if not differently specified, we shall use these units:
lenghts... millimeter
forces...Newton
angles.. radiant

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2. Model's characteristics.

2.1 Mechanical characteristics.

The material characteristics used for the finite elements analysis are:

Young modulus.................................57487 N/mm^2
Poisson ratio......................................0.195
Specific gravity.................................0.00002180 N/mm^3
Thermal expansion coefficient...........$2.8x10^{-6}$

2.2 Model geometrical characteristics.

The main geometrical dimensions of the 8.4 meter blank mirror are (see figure 4):
External radius................................. 4181.0 mm
Internal radius......................................536.0 mm

Upper plate thickness..........................28.0 mm
Lower plate equivalent thickness........20.15 mm
Real thickness....................................25.0 mm
Rib thickness.....................................12.0 mm
External rib thickness.........................15.0 mm

Exagonal cells (measured in the middle of the ribs)

Internal radius................................... 96.10 mm
External radius.................................. 110.97 mm
Back plate ventilation hole.................88.9 mm

As previous analysis, we neglect the back plate holes presence in the finite element model, considering a thinner lower plate (mass equivalence).
So in order to don't increase to much the degree of freedom number, we neglet these holes in all the model.
The "equivalent back plate thickness" can be computed by:

$t = V/A$

where: V = lower plate cell volume
A = lower plate cell area without hole

$V = (110.96 \times 96.1 \times 3 - \ \times 44.45 \times 44.45) \times 25 = 644608.2\ mm^3$

$A = (110.96 \times 96.1 \times 3) = 31991.4\ mm^2$

$$t = 20.15\ mm$$

The focal lenght is 9600 mm, obtained by parabola's equation shown in fig. 4b.

3. Numerical Model.

We modelled only one quarter of mirror by shell finite elements. The structure has two symmetry planes if the mirror is zenith pointing, a symmetry plane (x=0) and antisymmetry one (y=0) if horizon pointing and the loads always are symmetrical or antisymmetrical.
The blank mirror has been modelled using 8566 nodes (only 45% active) arranged in four layers.

The surfaces have been modelled using triangular and quadrilateral thin shell elements having the thickness specified at point 2.2. We haven't introduced nodes inside all cells of the upper surface as done in previous analysis on 8.00 meter f/1.2, because the dimension of this modelization is too large for capacity of our computer.

The contribution of the local bending displacements of the upper surface in each cell, considering the mirror zenith pointing, can be added to the results of analysis performed using such a global model. We adopted for the upper plate the same discretization used for the back plate as shown in figures 1 and 2.

The ribs have been modelled using quadrilateral shell elements. Each vertical wall is composed by three equally spaced elements.

The inner and outer overhangs of the two plates have been modelled using beam elements.

- Degrees of freedom for each node = 6
- Total degres of freedom number = 21738
- Max bandwidth = 678

4. Numerical model checks.

We are checking the finite element model, following the same procedure done for 8.00 meter case.
We shall enclose to the first analysis report about the displacements , the results of this numerical model checks.

5. Enclosures

Fig. 1a - Mesh of lower plate.

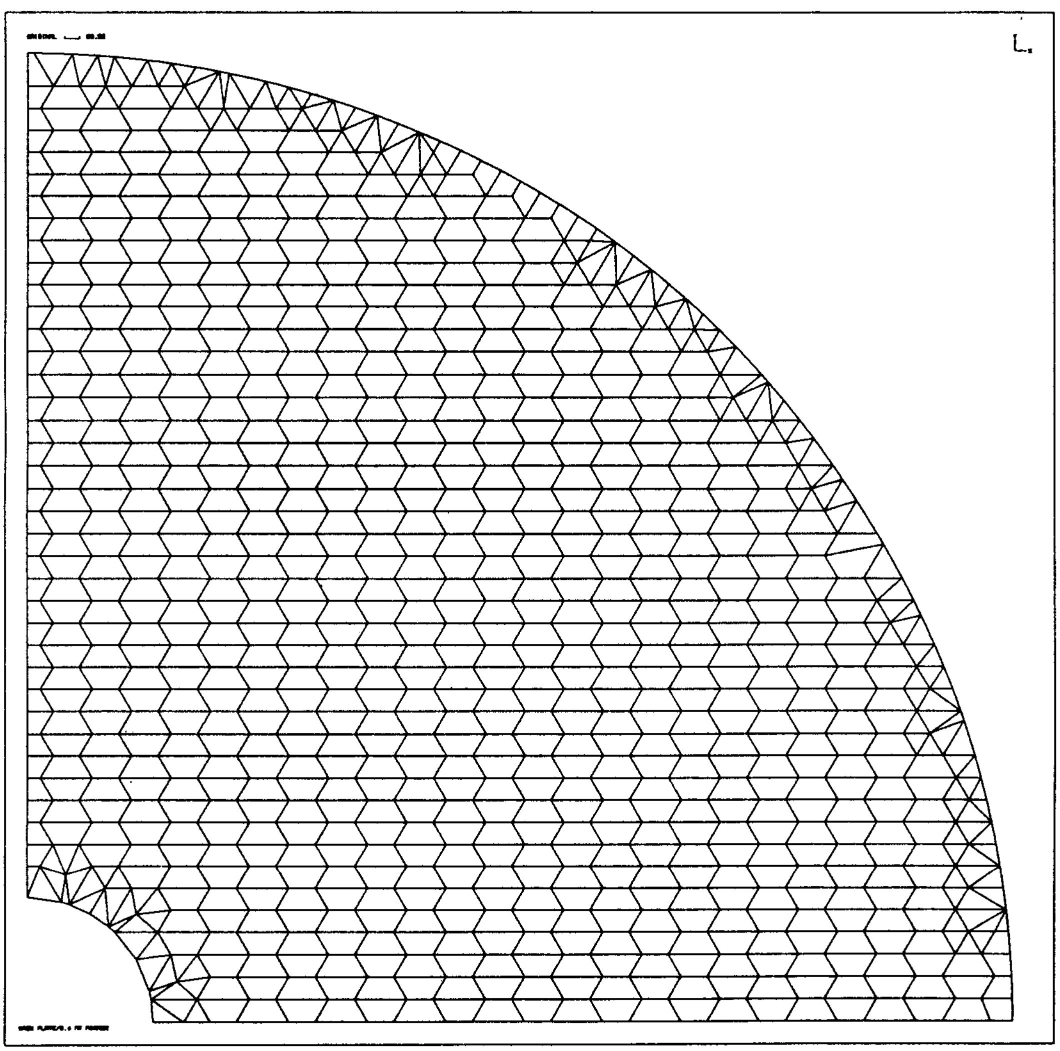


Fig. 1b - Mesh of lower plate.

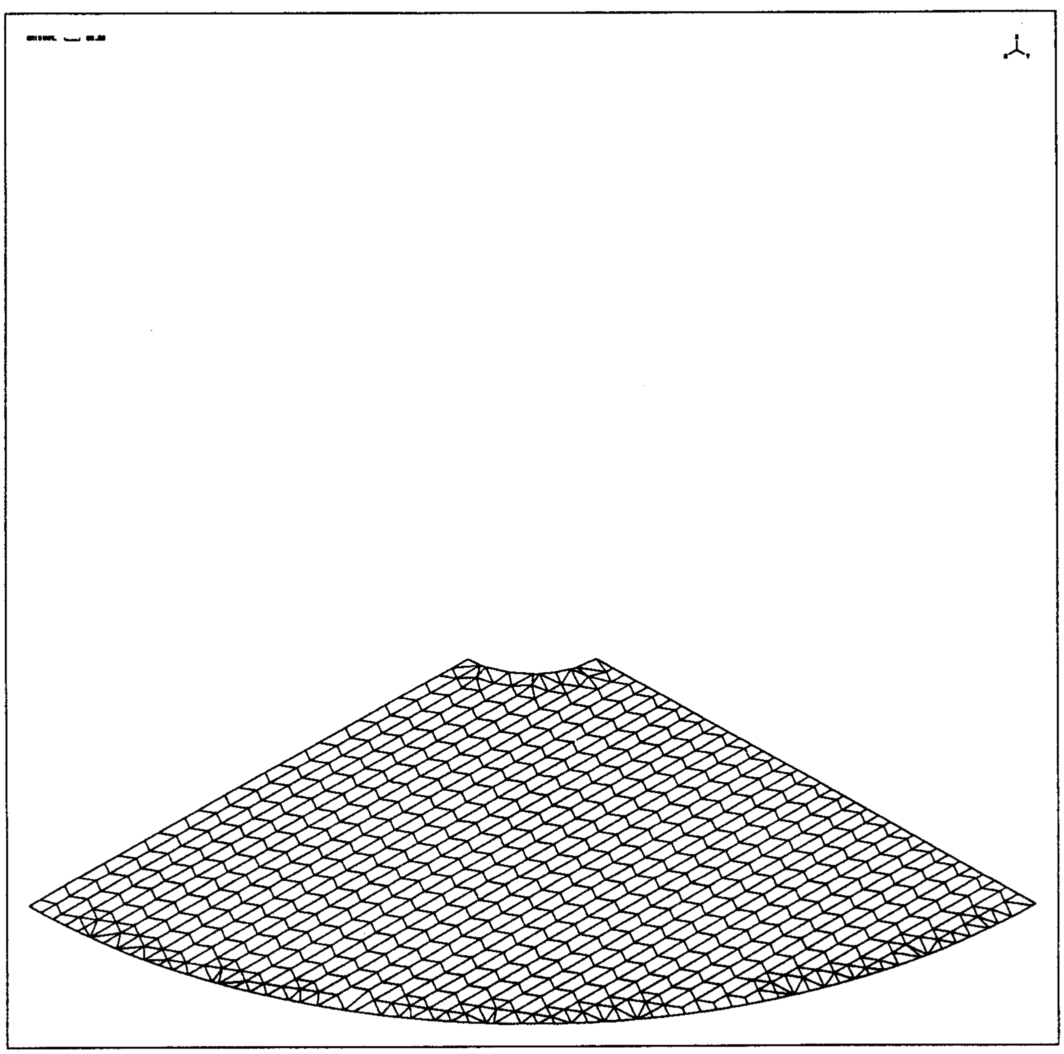


Fig. 2a - Mesh of upper plate.

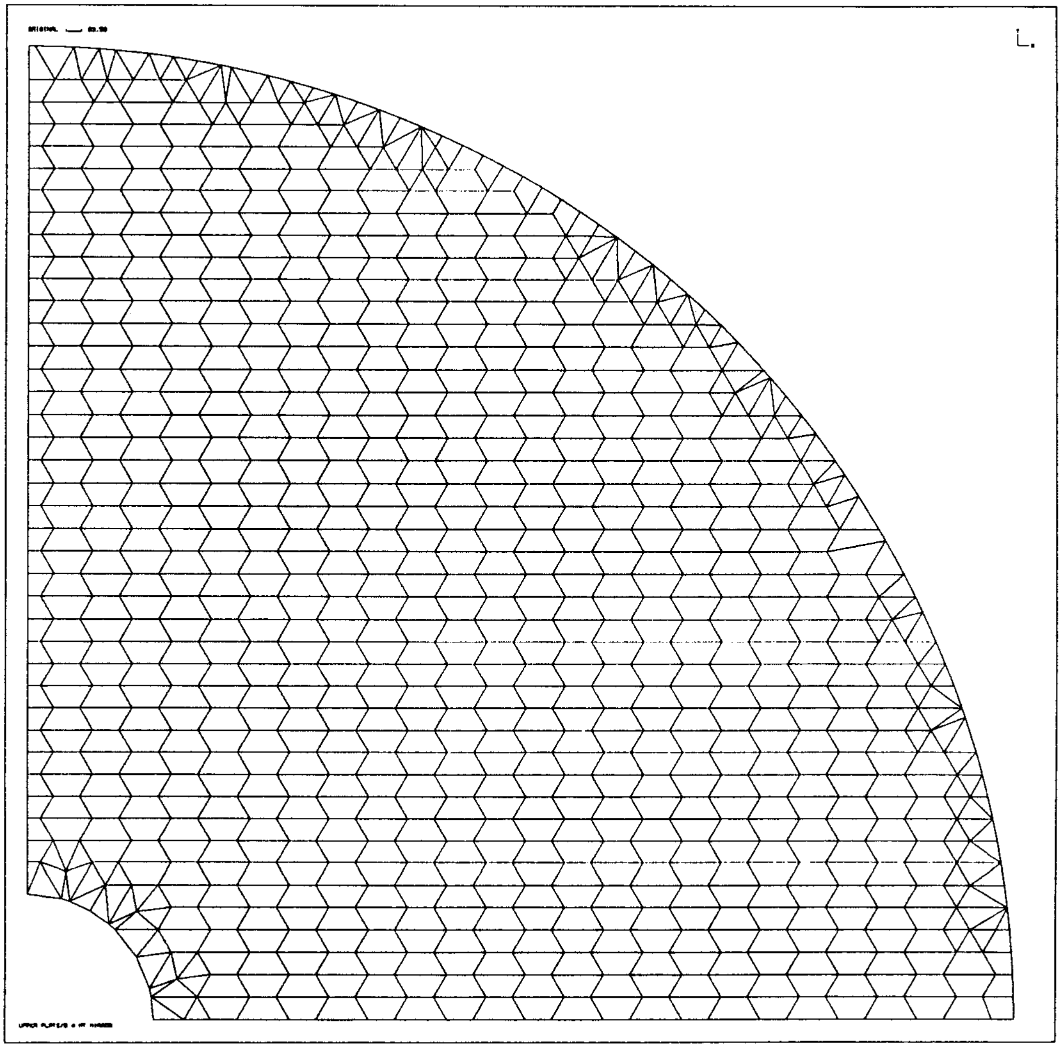


Fig. 2b - Mesh of upper plate.

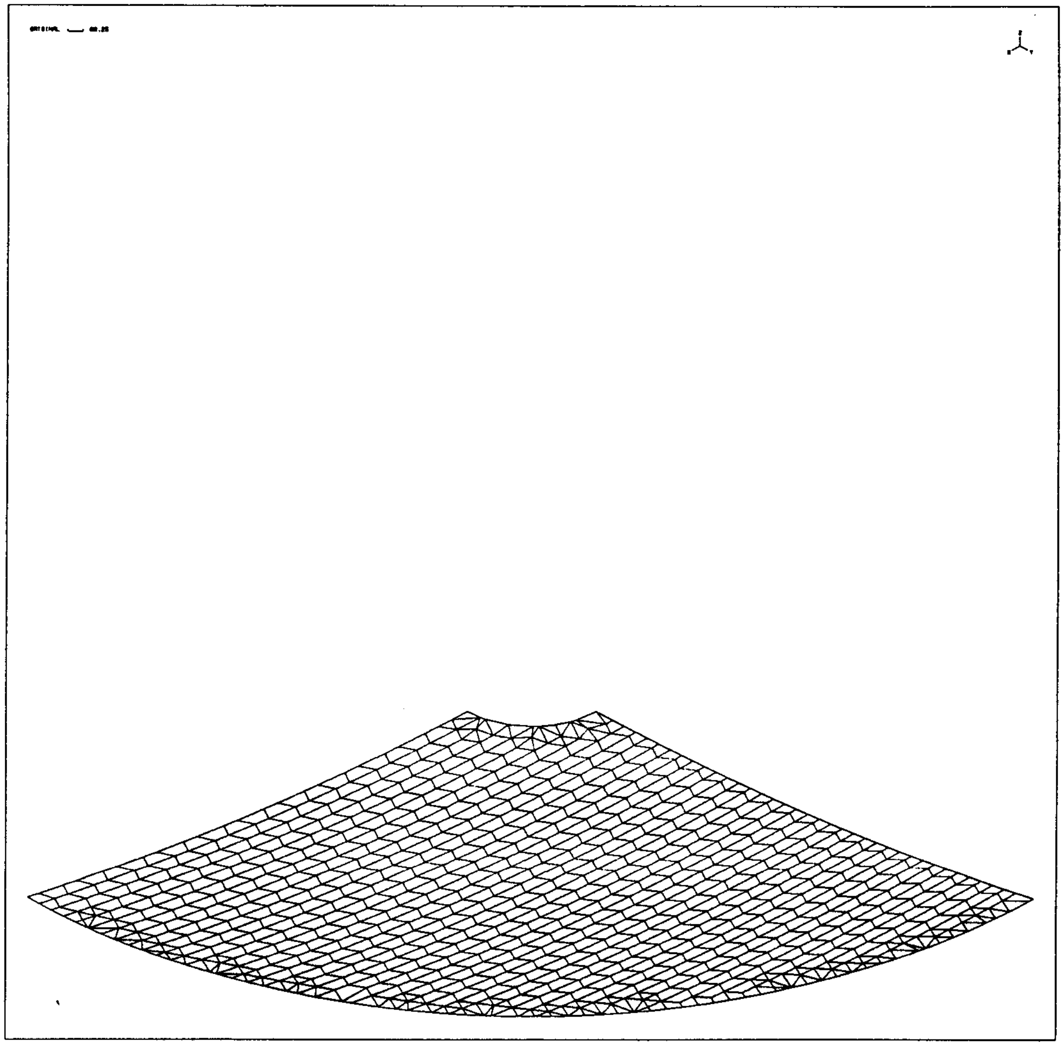


Fig. 3a - Mesh of one ribs elements layer.

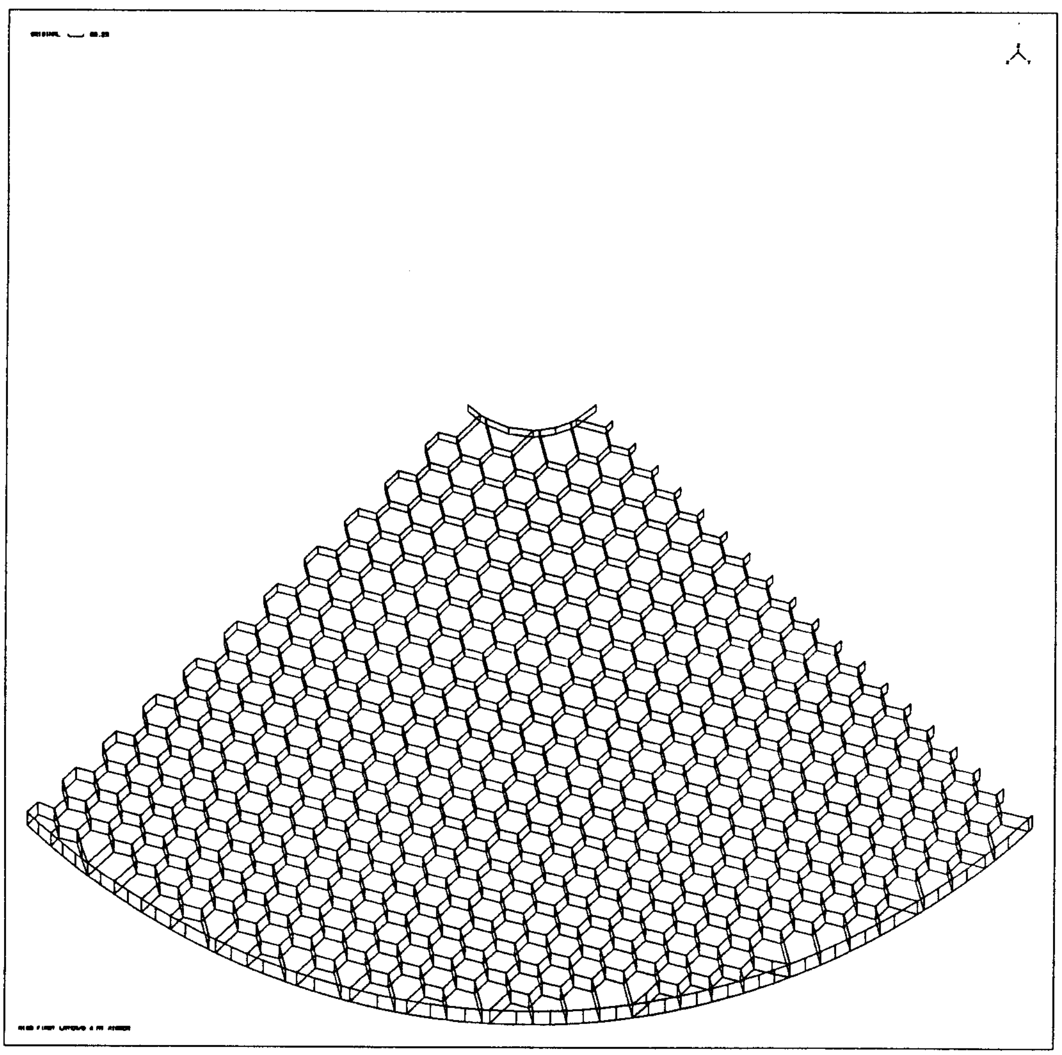
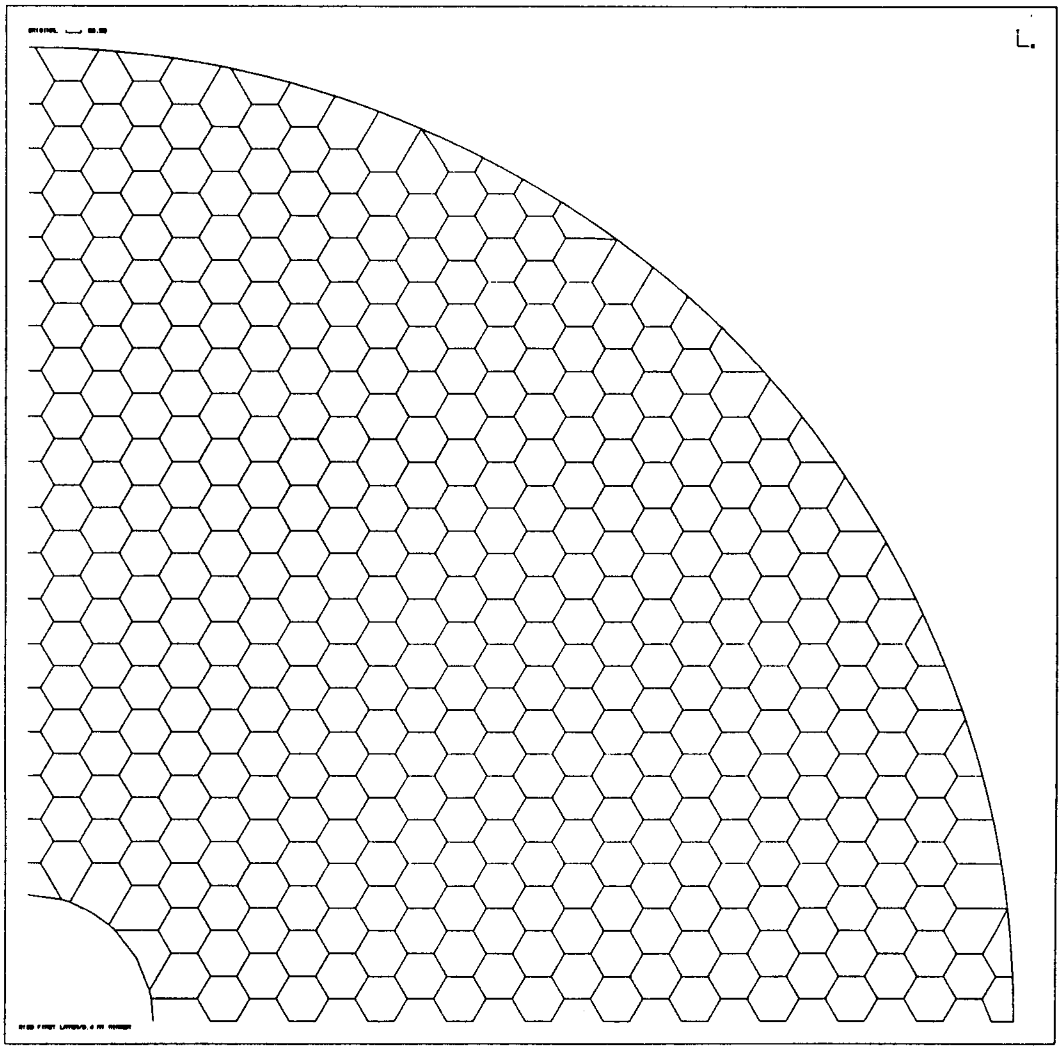


Fig. 3b - Mesh of one ribs elements layer.



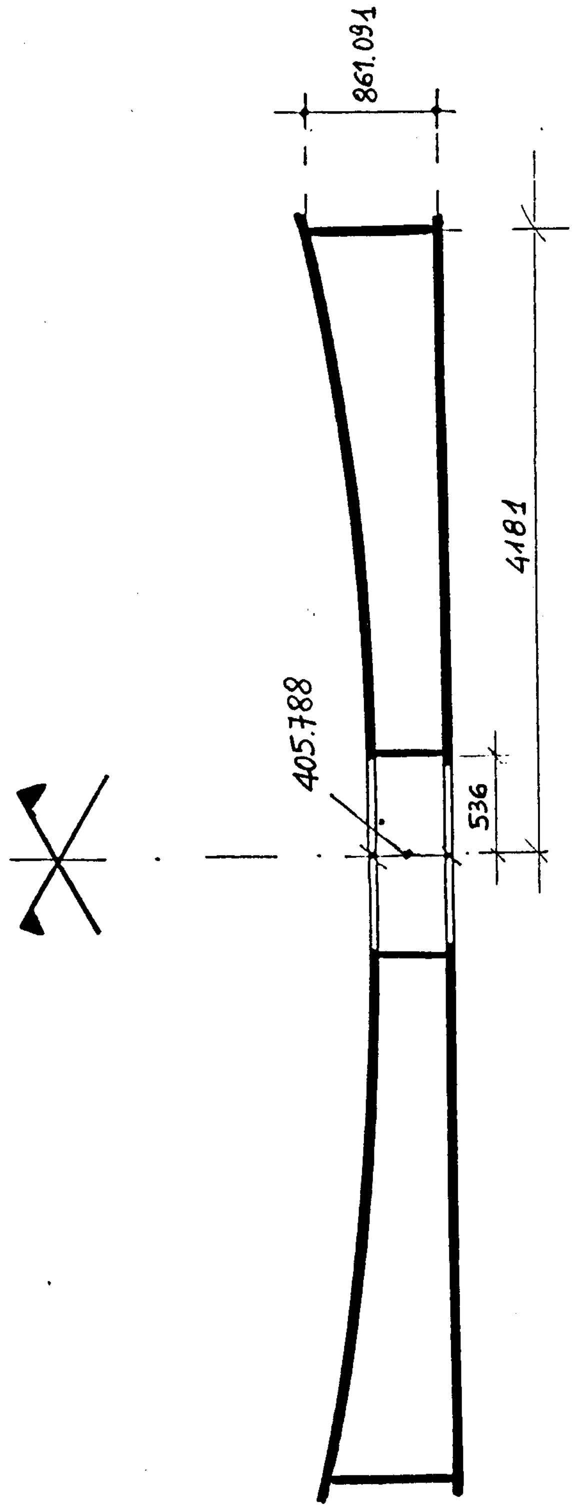
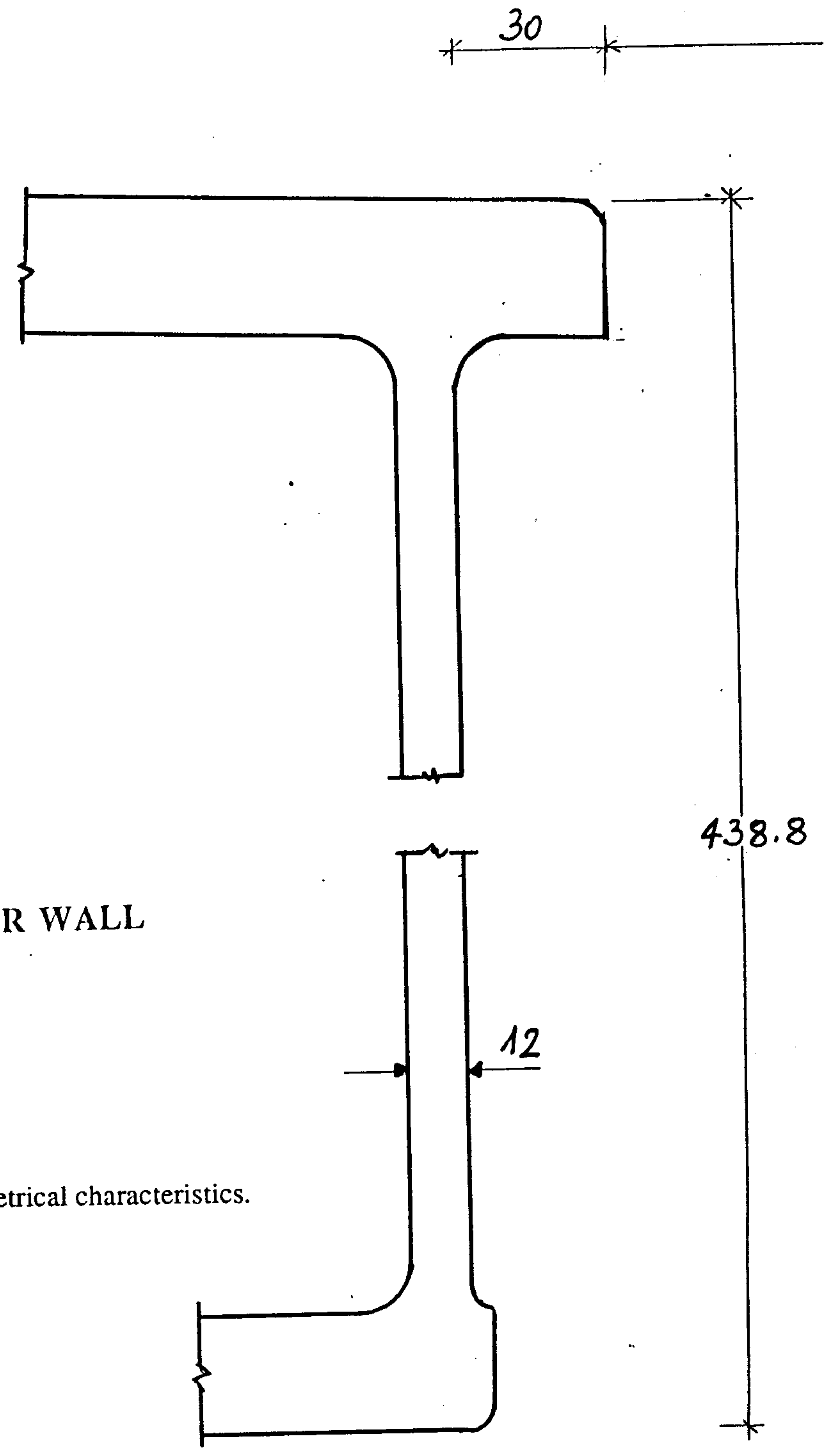


Fig. 4 - Our model's geometrical characteristics.



INNER WALL

Fig. 5a - Mirror's geometrical characteristics.

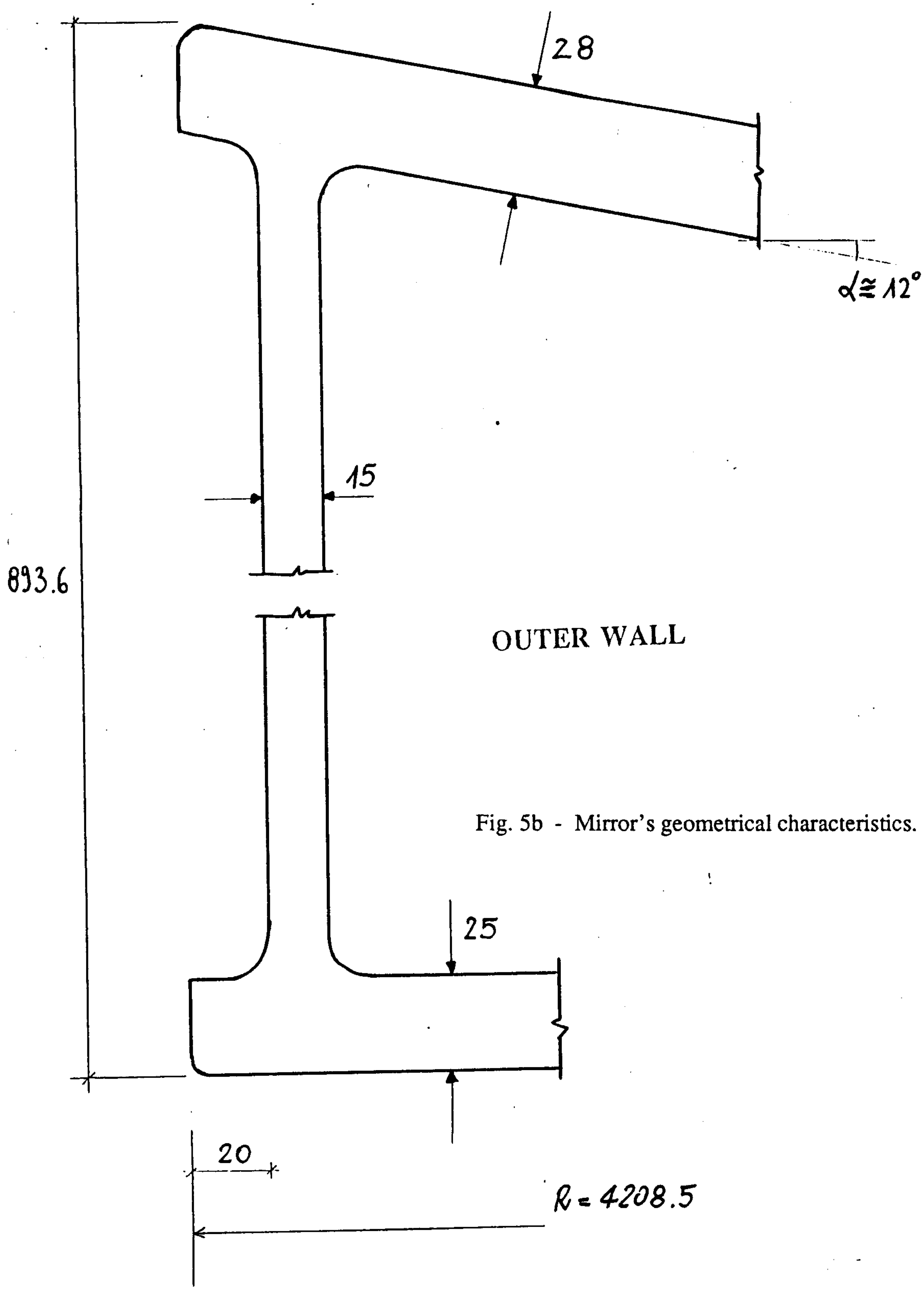


Fig. 5b - Mirror's geometrical characteristics.