N-250 WINDSHIELD FINITE ELEMENT MODEL

MASDUKI SUWANDI

KURNIA WITONO

NURDIN

STRESS ANALYSIS DEPARTMENT

NUSANTARA AIRCRAFT INDUSTRY LTD., INDONESIA

ABSTRACT

In analyzing the windshield of N-250 , - Indonesian / IPTN 's latest aircraft product - one major issue is how to model the windshield glass panel and the distribution of the load to its mounting structure. This paper concentrates on this issue.

1. ***Introduction***

One thing to be considered in analyzing the N-250 windshield is how the load which transferred from the glass panel to the frames affects the stress around the windshield. Three different methods are described :

a. Using PLOAD card

b. By the plate elements theory, and

c. By modeling the glass panel.

In the first and the second methods, the ultimate inner pressure (12.3 psi) which is applied to the glass panel is represented by an equivalent set of loads applied to the mounting structure without modeling the glass itself. While in the third method glass panel is modeled as plate elements.

2. ***Structural Description and Load Transfer Detail***

The N-250 windshield which consists of three glass panels on each side of the aircraft center line and its corresponding FEM [1] are shown in Fig. 1 and Fig. 2.

The two aft glass panels are bolted to the mounting frames, allowing them to transfer the shear and inplane forces. According to this condition, these panels should be modeled as plate elements.

The third panel, the forward panel, is connected to the mounting structure as sketched in Fig. 3. This panel is not constrained in the plane of the mounting frames, so has no inplane stresses.

A study of the load transfer from these glass panels to their frames is provided by three different methods as follows :

First method - PLOAD

In this method the inner pressure which is applied to the glass panel is transferred to the mounting structure by PLOAD card [2].

Half of the pressure is applied at four grid points, IJKL, arranged vertically, while the other half is applied at four other grid points, abcd, arranged horizontally (Fig. 4).

Second method - Plate Theory

The windshield panel can be represented by an equivalent set of loads acting on the mounting structure. The loading for rectangular plate is shown in Fig 5a. & 5b. , in which [3] :

$$R = \psi . q_i . b \qquad \text{.......... (1)}$$

$$P_{max} = \delta_a . q_i . b \qquad \text{for edge a}$$

$$P_{max} = \delta_b . q_i . b \qquad \text{for edge b}$$

where :

$$q_i = \Delta p_{ultimate} \qquad \text{..........(2)}$$

ψ, δ = numerical factor for uniformly loaded (simply supported) [3]

The out of plane force is :

$$F = -q_i . a . b + 4R \qquad \text{..........(3)}$$

The total force along the edges a and b are :

$$\Phi_a = \frac{a}{2(a+b)} . F \qquad \text{..........(4)}$$

and

$$\Phi_b = \frac{b}{2(a+b)} . F \qquad \text{..........(5)}$$

The load acting at the grid points along the edges a and b are calculated based on an elliptical distribution.

Third method - By Modeling The Glass Panel

The glass panel is modeled by plate elements. Due to the flexibility of the seal , the windshield edge is assumed to be simply supported. Since the windshield is not constrained in the plane of the mounting frames, no inplane stresses will result. This glass panel FEM is connected to the structure by the elastic spring elements (CELAS).

The multilayered structure consisting of glass is shown in Fig. 3. The flexural rigidity of the glass and the equivalent thickness of the panel (equivalent to aluminum property) are calculated based on Szilard [4].

3. ***Analysis***

The first and second methods of load transfer described previously do not deal with the stiffness of the surrounding structure. The third method includes this parameter, so it is believed to be more realistic.

The diagrams in Fig. 6 to Fig. 12 show that these three methods give very slight different results, but tend to have the same pattern.

For static analysis the second method of load transfer is adequate, while for dynamic analysis the third method will be used.

However , to gain better confidence a static test should be performed.

4. ***Conclusion***

The three methods show very slight differences, but a static test will be used to support the analysis.

5. ***Reference***

[1] Budiyono, H., " N-250 Fuselage Section 41 Finite element Model " IPTN Technical note, Bandung, May, 1992.

[2] MSC/NASTRAN User Manual, version 66, The MacNeal-Schwendler Corporation, Los Angeles, November, 1988.

[3] Timoshenko, S.P, and Krieger, S.W., *Theory of Plates and Shells,* 2nd ed., McGraw-Hill, 1959.

[4] Szilard, R., *Theory and Analysis of Plate , Classical and Numerical Methods , 10th ed.,* Prentice-Hall, 1974.

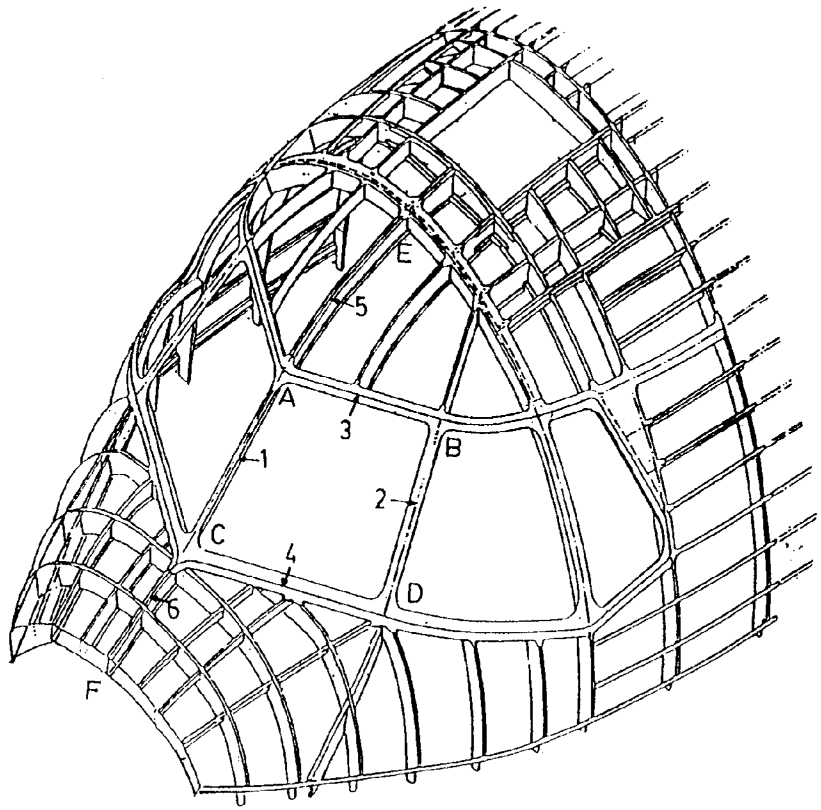

Figure 1: Windshield structure
1. Center post 3. Upper sill
2. Second post 4. Lower sill

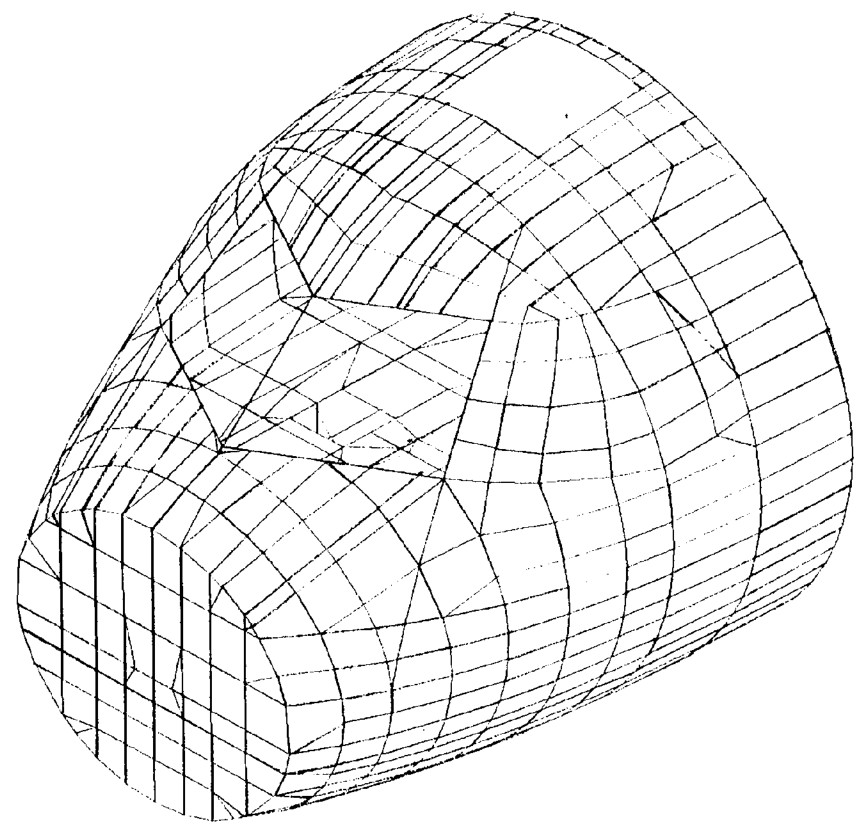

Figure 2: FEM of windshield structure
(isometric view)

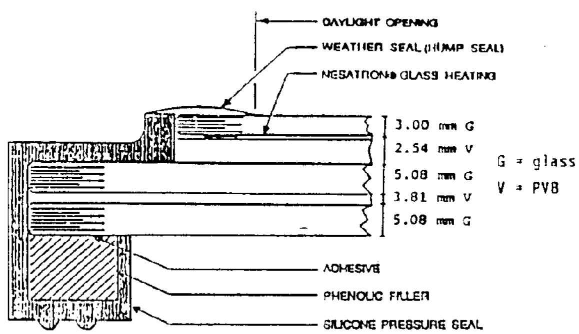

Figure 3: Connection between windshield and the mounting frame

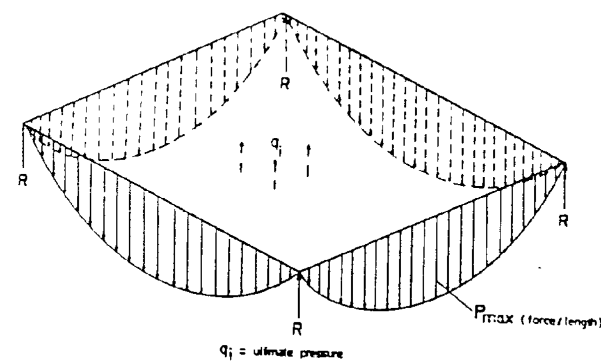

Figure 5a: Loading system

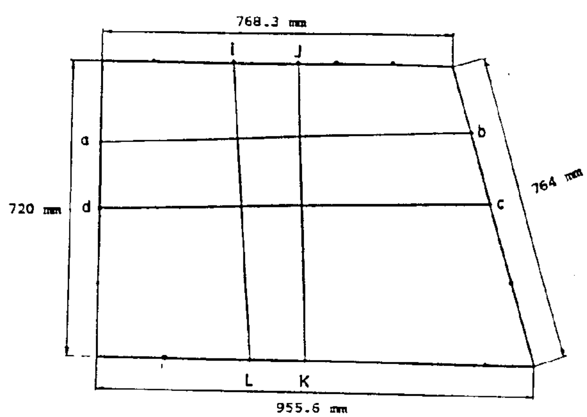

Figure 4: PLOAD loading system

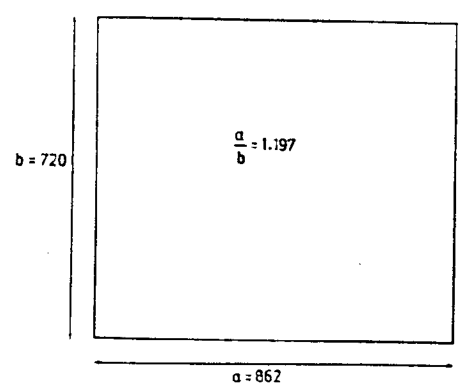

Figure 5b: Equivalent rectangular of glass panel

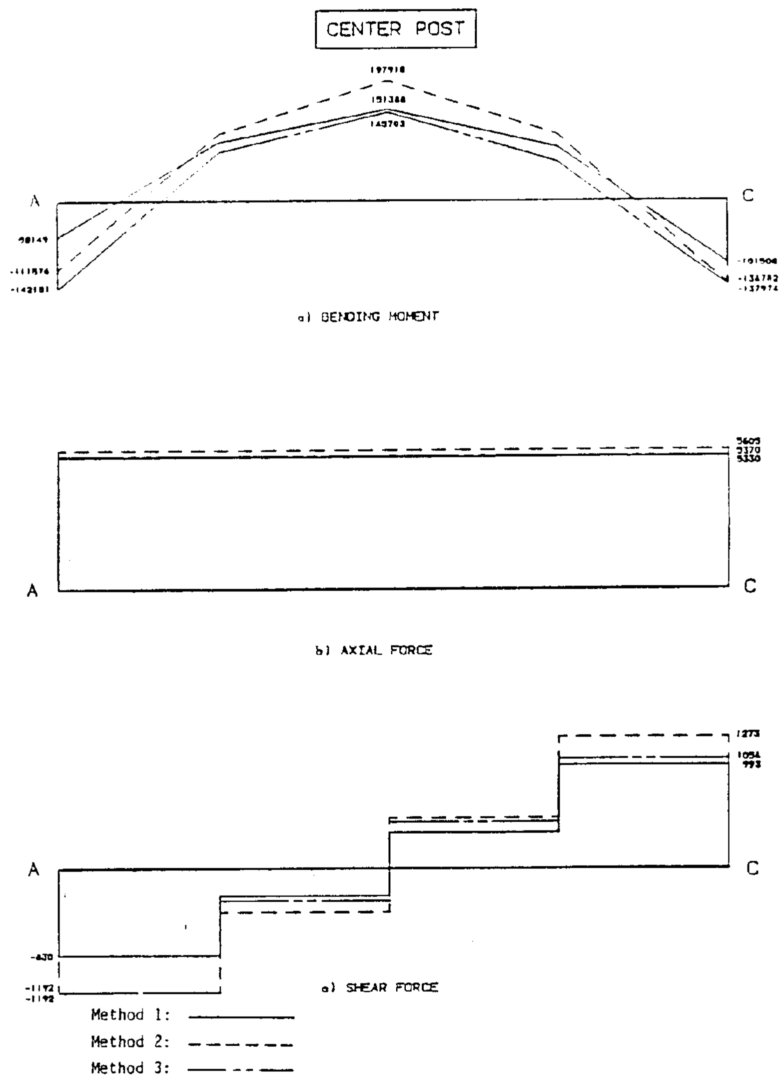

Figure 6: Center post forces

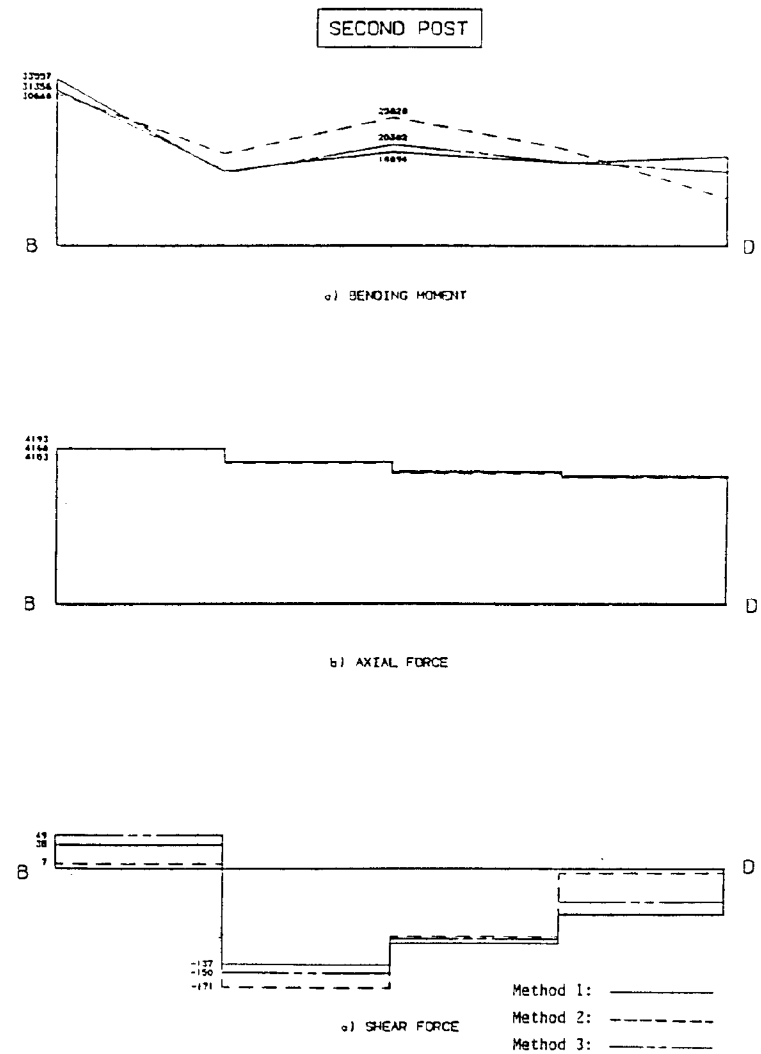

Figure 7: Second post forces

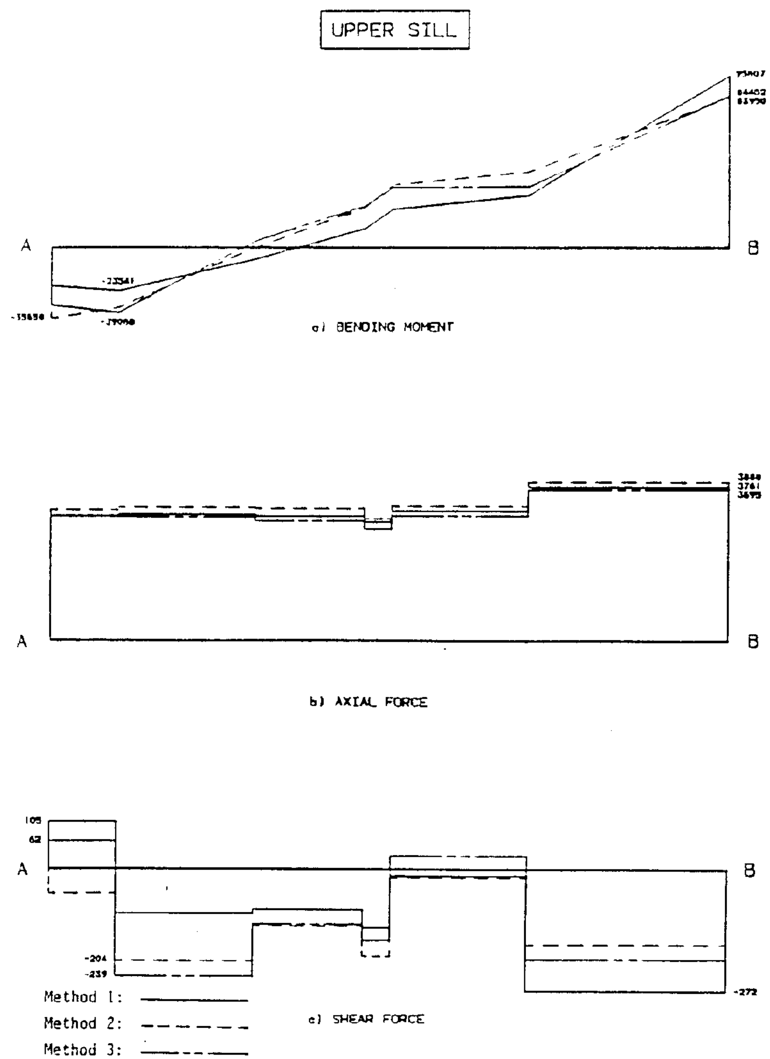

Figure 8: Upper sill forces

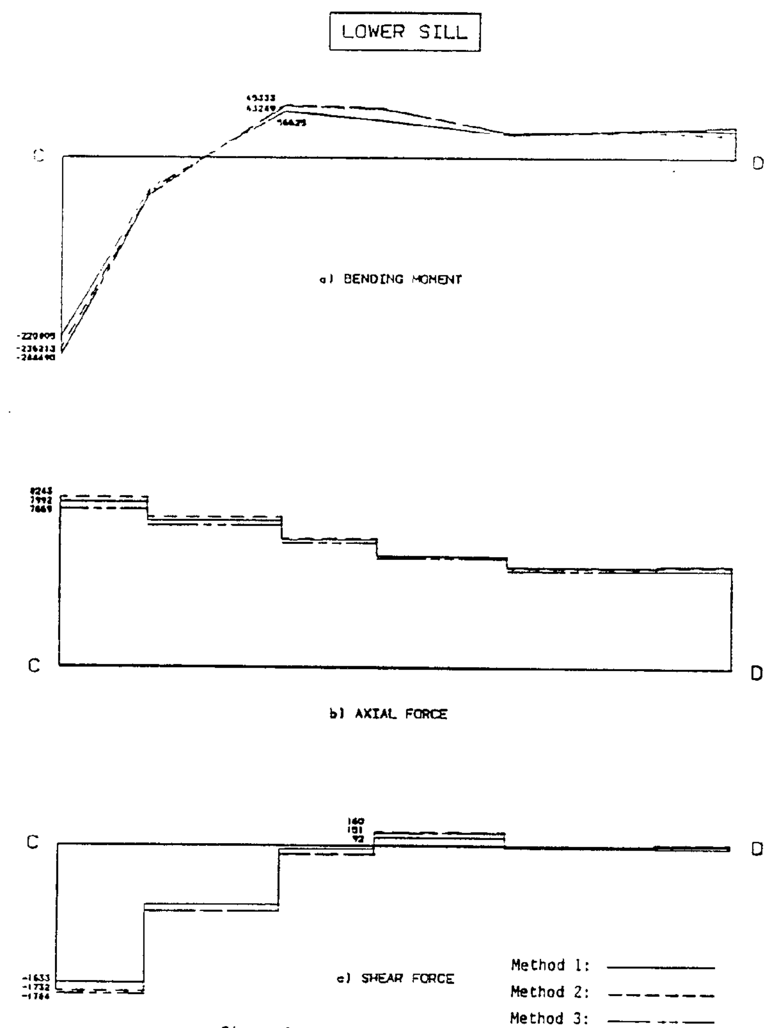

Figure 9: Lower sill forces

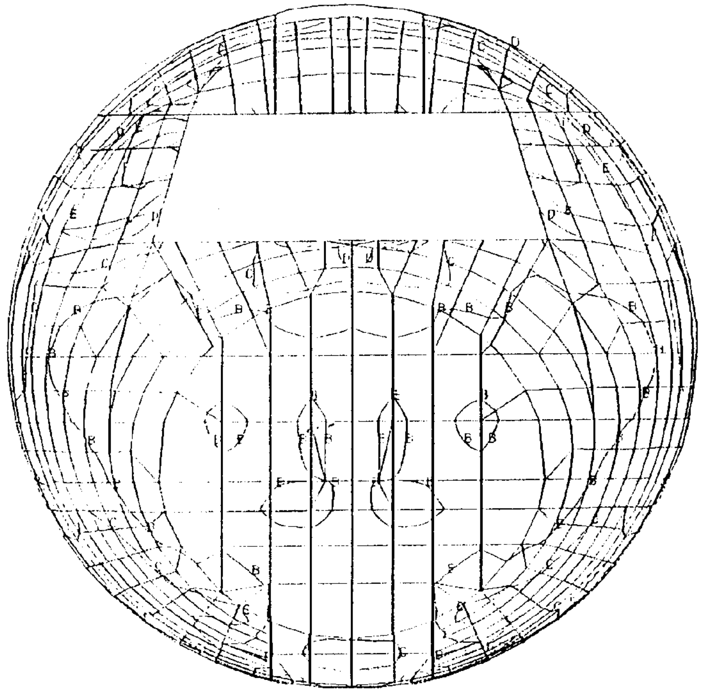

Figure 10: Stress contour, method 1

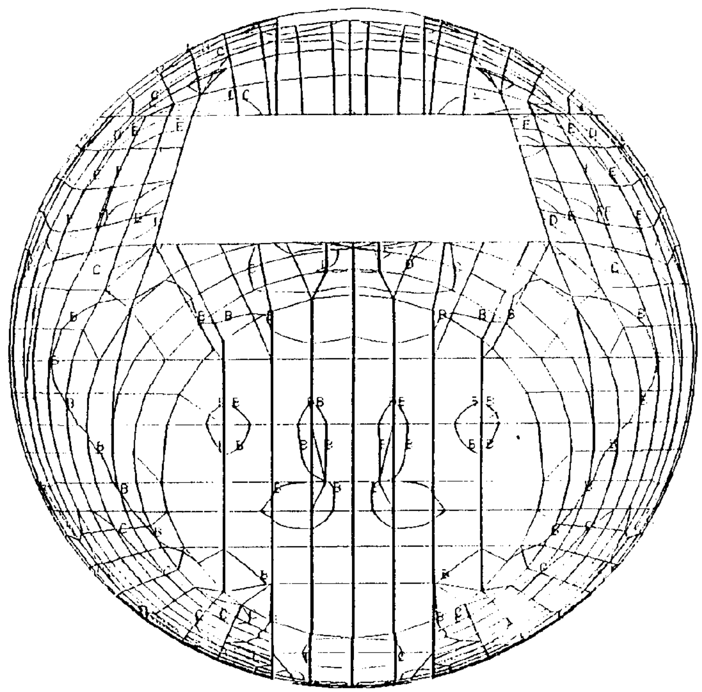

Figure 11: Stress contour, method 2

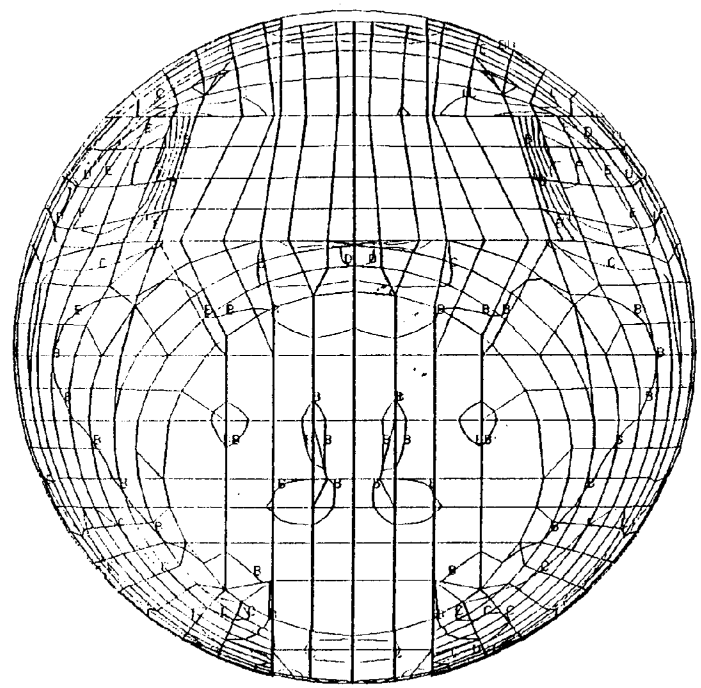

Figure 12: Stress contour, method 3