BULETINUL Universității Petrol – Gaze din Ploiești	Vol. LXVI No. 1/2014	9 – 12	Seria Tehnică

Stress Variation for a Finite Two-Dimensional Plate Loaded on the Perimeter of the Central Hole with Constant Pressure

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Abstract

This paper presents and compares the results obtained through using numerical determination and photoelasticity methods in the study state of stresses in a finite two-dimensional plate, made from a linear-elastic material, with inner hole subjected at constant pressure.

Key words: *photoelasticity, state of stresses, two-dimensional plate.*

Introduction

The study is done on a square plate having a central circular hole, Figure 1. Central circular hole is subjected at internal constant pressure p_i. The plate has a t thickness, and the dimensional ratio $k_x=Bx/Di$ $k_y=By/Di$ has values $k=2... 5$. For the plane plate was determined the state of stresses by using numerical and photoelastical methods.

Numerical analysis programs allow an easy, less expensive and fast assessment of study state of stresses in a finite two-dimensional plate.

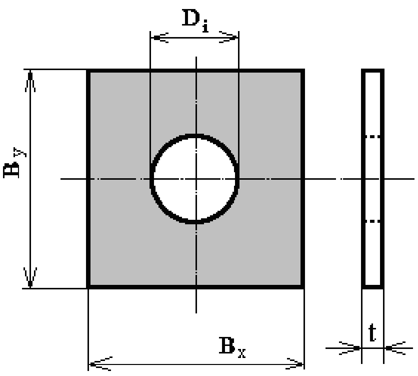

Fig. 1. Square plate having a central circular hole

Numerical Method

Thanks to geometrical and loading symmetry, for numerical method, we take into consideration a quarter of area which is limited by A, E, F, C, D points, Figure 2a.

How to load and conditions of the bonds are represented in Figure 2b.

Figures 3 to 6 show the equivalent stress variation diagrams calculated with Tresca's criterion.

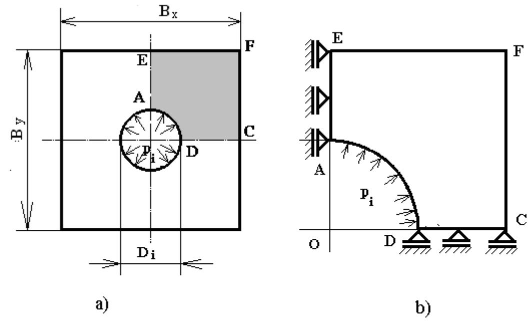

Fig. 2. Numerical model.

Stresses are produced by the inner constant pressure p_i=1 [MPa]

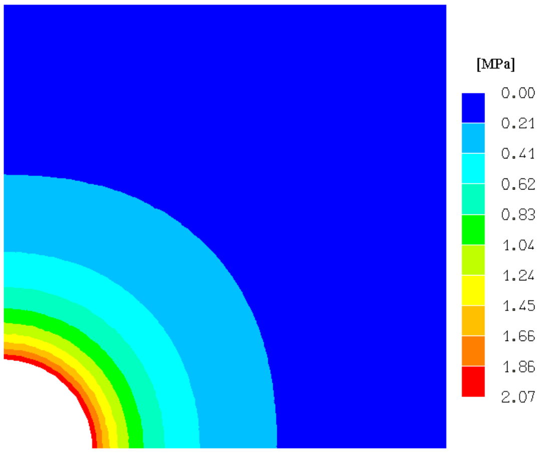

Fig. 3. Equivalent stresses with Tresca's criterion, for $k_x = k_y = 5$

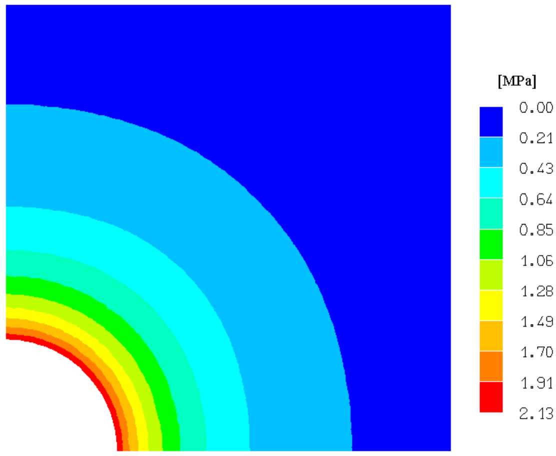

Fig. 4. Equivalent stresses with Tresca's criterion, for $k_x = k_y = 4$

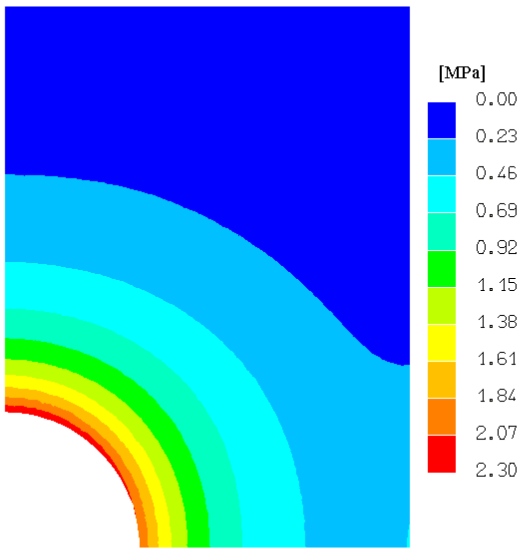

Fig. 5. Equivalent stresses with Tresca's criterion, for $k_x = 3$ and $k_y = 4$.

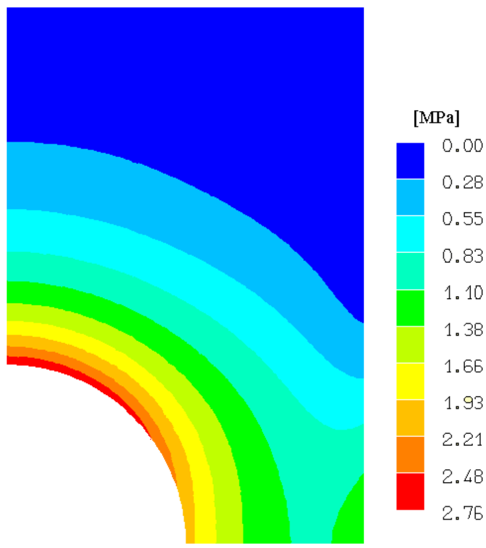

Fig. 6. Equivalent stresses with Tresca's criterion, for $k_x = 2$ and $k_y = 3$

The Photoelastical Analysis

The photoelastical type of plate has been made of Dinox 400 with a fringe constant of σ_0=2.3 MPa/fringe**.** The loading in the interior of circular hole has the internal pressure p_i=1.6 MPa**.** For loading circular hole of the photoelastical type of plate square we have used a loading device which is shown in Figure 7. The device applies a constant pressure at the inner outline of hole. The device components are:

- 1 exterior body of device;
- 2 rubber for tightness;
- 3 photoelastical plane plate;
- 4 interior body of device.

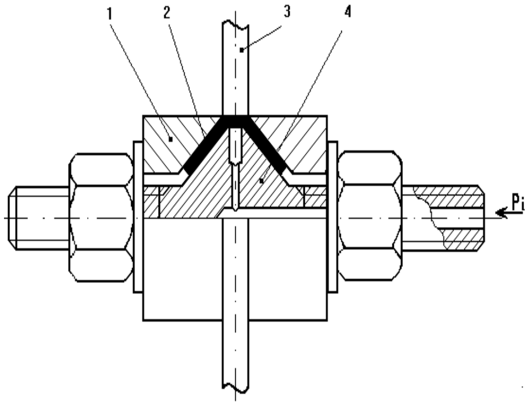

Fig. 7. The loading device for inner pressure

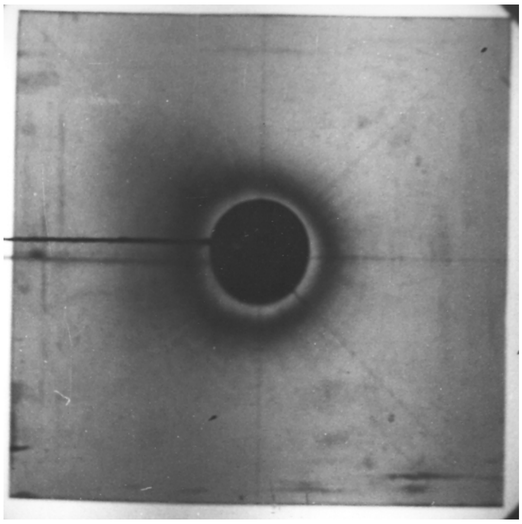

Fig. 8. Isocromat fringes for $k_x = k_y = 5$

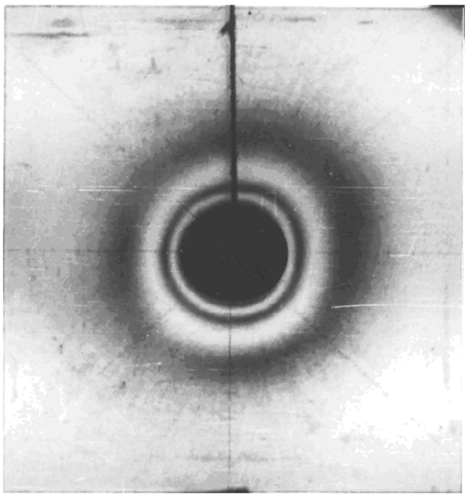

Fig. 9. Isocromat fringes for $k_x = k_y = 4$

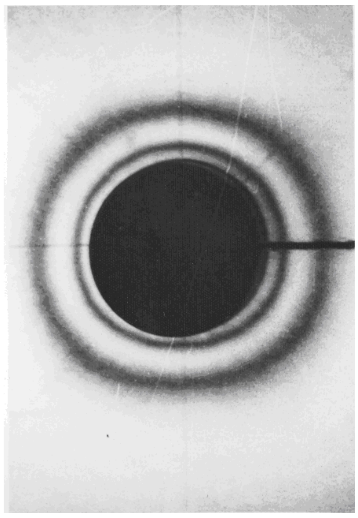

Fig. 10. Isocromat fringes for $k_x = 2$, $k_y = 3$

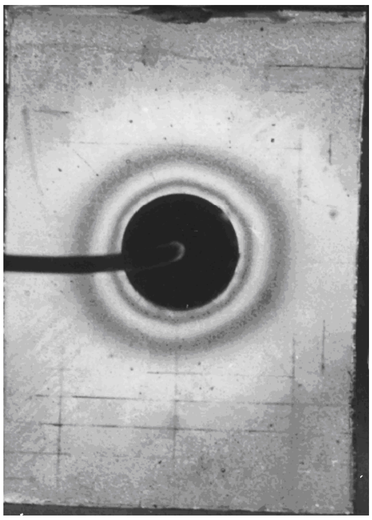

Fig. 11. Isocromat fringes for $k_x = 3$, $k_y = 4$

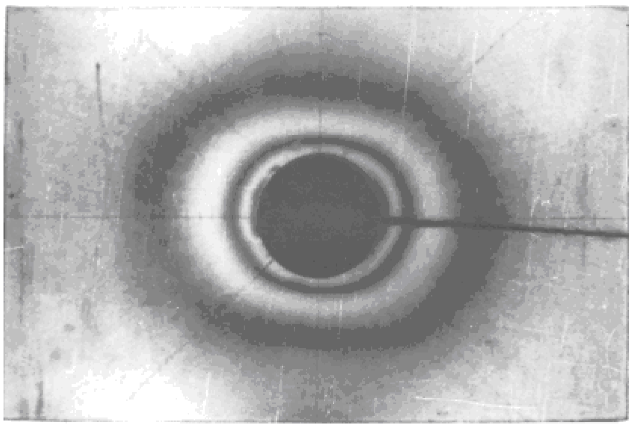

Fig. 12. Isocromat fringes for $k_x = 3.5$, $k_y = 5$

Conclusions

There is a good match between the numerical and experimental results. In the case in which the value of $k_x = k_y > 2$, between the two methods of the analysis the differences are up to 4% out of the experimentally determined value. For values of dimensional factor between $k_x = k_y = 2$ and $k_x = k_y = 3.5$ the effect of the discontinuity of the corner, will cause a variation in the direction of circumferential stress which acts on the inner contour of the holes 20...36% as compared to the case where the section may be ring.

References

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Variația tensiunilor la o placă de dimensiuni finite, încărcată pe conturul găurii interioare cu presiune şi deplasare radială

Rezumat

În lucrare este prezentată analiza tensizunilor produse la o placă de dimensuni finite prevăzută cu o gaură circulară încărcată pe contur cu presiune constantă. Tensiunile sunt determinate prin metoda numerică şi prin utilizarea fotoelasticității.