IOP Conf. Series: Materials Science and Engineering **444** (2018) 062020 doi:10.1088/1757-899X/444/6/062020

Finite element analysis of displacements state for circular plates

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Abstract. The paper analyzes the states of displacements that are born in a smooth circular plate, compared with a circular plate with radial ribs placed on one side, under the action of a pressure. The study is done using the finite element method. Thus, in order to resist the same pressure, it will be deduced that the ribbed plate will have a thickness more half smaller compared to the smooth plate.

1. Introduction

The practical use of the circular plates with stiffening ribs is great, because:
- by ribbing results superior mechanical properties of their strength, stiffness and stability [1];
- materials with low mechanical properties are used, involving a low price, to obtain superior operating characteristics;
- substantially the mass of the plate is reduced.

The researches undertaken to determine displacements and stresses in ribbed rigid plates can be grouped into:

a) approximate methods of calculating displacements and strain states [1,2];

b) methods that reduce the study in the behavior of the component elements: plates and ribs, considered under different forms of support;

c) calculation methods that reduce the structural orthotropy to that of material;

d) numerical methods [3,4,5,6];

e) experimental methods [7,8,9].

In this paper is presented the displacement state at circular plates which can be plate or with ribs. In this view we employ finite element method, using COSMOSWORKS programs. We remark that the displacements from the ribbed plates are reduced with more half than the plane plates.

2. Finite element analysis of displacements state for the plane circular plates

We analyse with finite element method a plane plate with eight holes, which has the geometrical characteristics from figure 1. In this situation we consider that the plate is embed in the holes.

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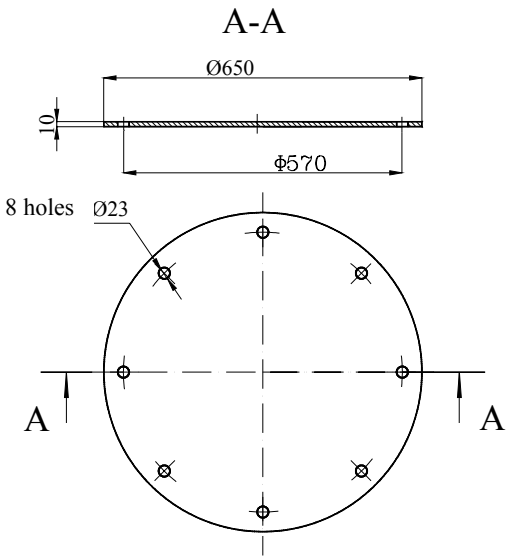

Figure 1. The geometrical characteristics of the plane plate with 8 holes

The respective plate is solicited at a pressure which has the value of 0,2 MPa and we obtain the resulted displacement from figure 2.

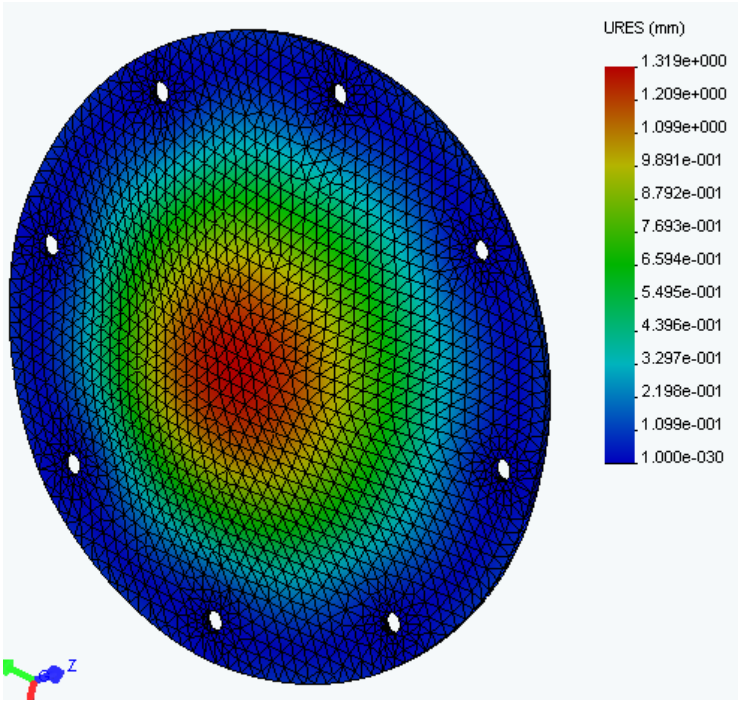

Figure 2. Resulted displacement of the plane plate with 8 holes

In figure 4 is analysed the plate which has the geometrical characteristics from figure 3, using COSMOSWORKS program and solicited at the same pressure. We can observe that the resulted displacement value declines.

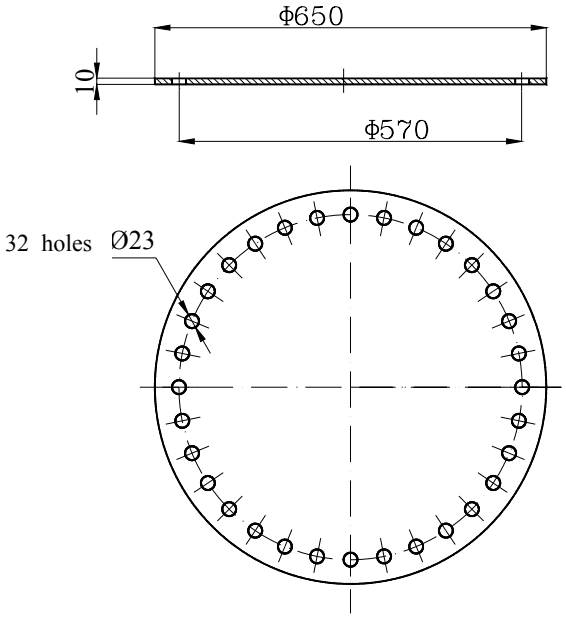

Figure 3. The geometrical characteristics of the plane plate with 32 holes

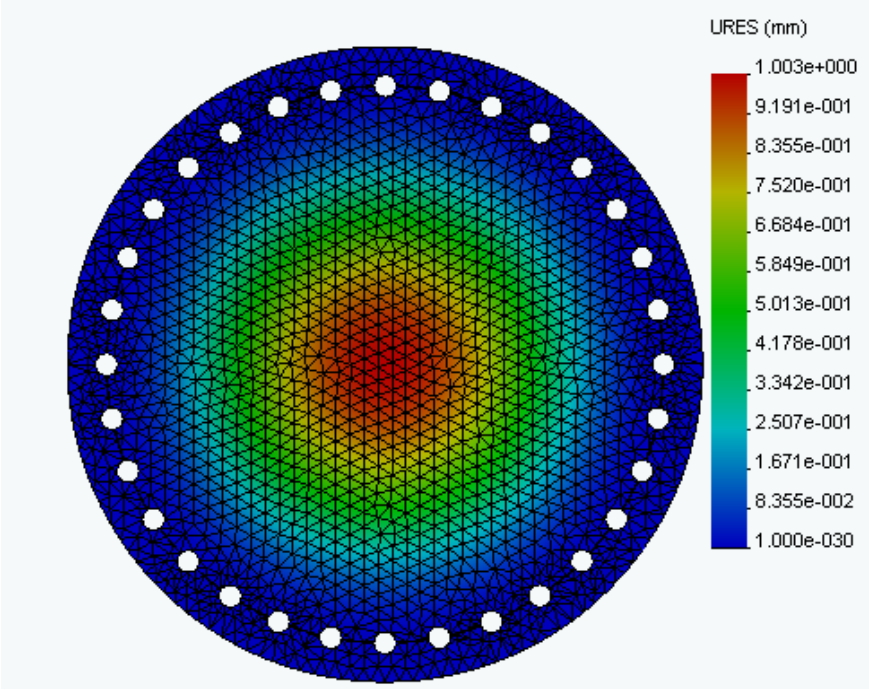

Figure 4. Resulted displacement of the plane plate with 32 holes

In figure 5 is presented the graphic which is obtained in COSMOSWORKS program, for the plane plate with 32 holes and in the table 1 are the values of the resulted displacements from the graphic.

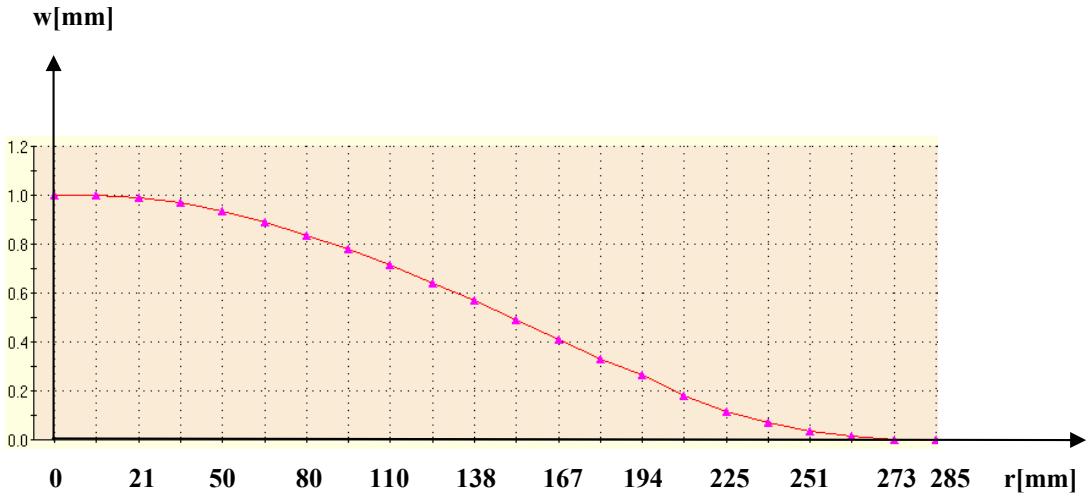

Figure 5. Resulted graphic in COSMOSWORKS program for the plane plate

Table 1. The resulted displacements of the bended plane plate, solicited at 0,2 MPa pressure

R[mm]	**0**	**7**	**21**	**36**	**50**	**66**	**80**	**95**	**110**	**124**	**138**
w[mm]	1,003	1,001	0,988	0,968	0,937	0,892	0,838	0,781	0,714	0,641	0,568

152	**167**	**178**	**194**	**211**	**225**	**239**	**251**	**262**	**273**	**285**
0,491	0,41	0,328	0,264	0,18	0,115	0,068	0,036	0,014	0	0

3. Finite element analysis of displacements state for the plane circular plates

The ribbed plate from the figure 6 is solicited at a loading pressure of 0,2 MPa. We use COSMOSWORKS program and we obtain the resulted displacements from the figure 7. In the figure 8 is presented the graphic which is obtained in COSMOSWORKS program and in the table 2 are the values of the resulted displacements for the ribbed plate.

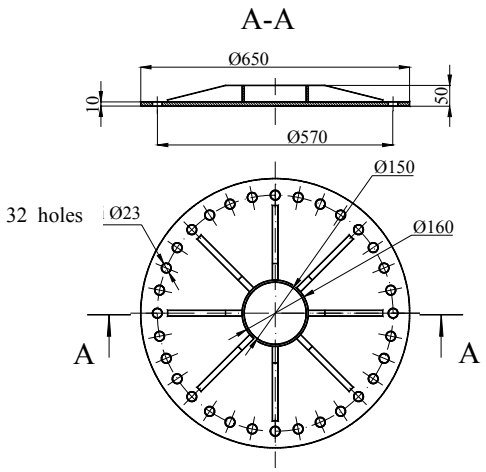

Figure 6. The geometrical characteristics of the ribbed plate

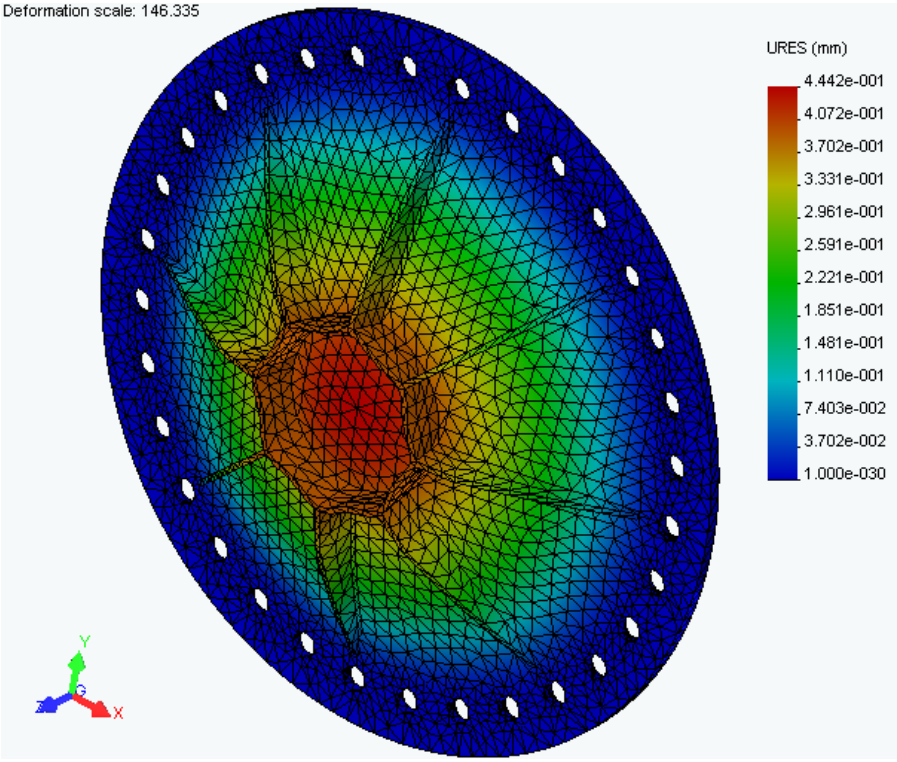

Figure 7. Resulted displacement of the ribbed plate

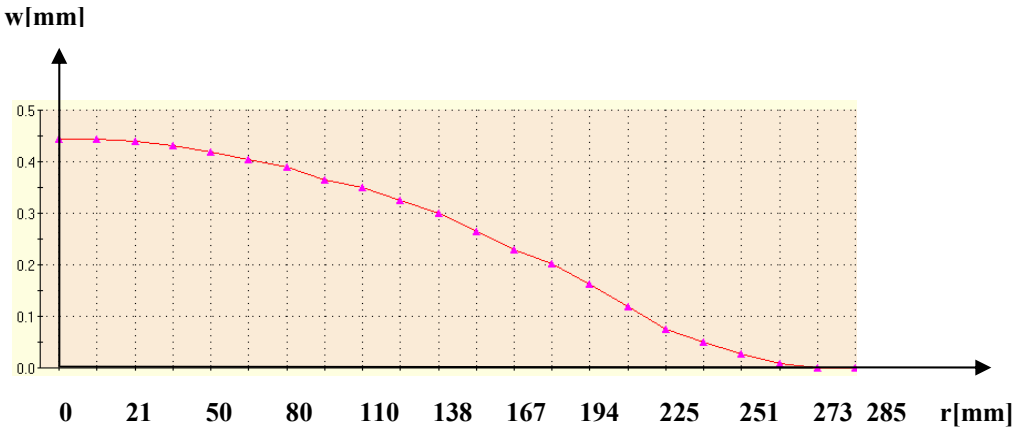

Figure 8. Resulted graphic in COSMOSWORKS program for the ribbed plate

Table 2. The resulted displacements of the bended ribbed plate, solicited at 0,2 MPa pressure

R[mm]	**0**	**7**	**21**	**36**	**50**	**66**	**80**	**95**	**110**	**124**	**138**
w[mm]	0,444	0,443	0,44	0,431	0,418	0,403	0,389	0,364	0,35	0,3246	0,3

152	**167**	**178**	**194**	**211**	**225**	**239**	**251**	**262**	**273**	**285**
0,265	0,228	0,202	0,1623	0,118	0.075	0,050	0,026	0,008	0	0

Table 3 presents the values for both plates, to see the difference in the marked points.

4. Results comparison

We take into account the deformations, which are produced in different points of the plate. It can be seen from Table 3 that the deformations for the ribbed plate are about 2 times smaller than for flat plane.

Table 3 The resulted displacements of the bended plane and ribbed plate, solicited at 0,2 MPa pressure

R[mm]	**0**	**7**	**21**	**36**	**50**	**66**	**80**	**95**	**110**	**124**	**138**
w[mm] for plane plates	1,003	1,001	0,988	0,968	0,937	0,892	0,838	0,781	0,714	0,641	0,568
w[mm] for ribbed plates	0,444	0,443	0,44	0,431	0,418	0,403	0,389	0,364	0,35	0,3246	0,3

152	**167**	**178**	**194**	**211**	**225**	**239**	**251**	**262**	**273**	**285**
0,491	0,41	0,328	0,264	0,18	0,115	0,068	0,036	0,014	0	0
0,265	0,228	0,202	0,1623	0,118	0.075	0,050	0,026	0,008	0	0

5. References

[1] Meghare T, Jadhav P, *A simple higher order theory for bending analysis of steel beams*, International Journal of Civil Engineering, volume 2 Issue 4 pp-31-38, 2015
[2] Manzoor S, Vinay G, *A Study on Composite Steel Tubes*, International Journal of Civil Engineering, EFES, 2015
[3] Popa C, *Solicitation states at circular plates,* Modelling and optimization in the machines building field Bacau vol I MOCM 10 pp. 263-268, 2004
[4] Popa C, *Displacement analyze for circular plates,* Al III-lea Simpozion International "Mecatronica, Microtehnologii si Materiale Noi" Targoviste 2006
[5] Timoshenko S, Woinowsky-Krieger S, *Theory of plates and shells,* McGraw, 2010
[6] Cursaru D, Neagu M, Bogatu L, *Investigations on the Oxidation Stability of Biodiesel Synthesized from Different Vegetable Oils,* Revista de chimie, 64(4), pp 438-441, 2013
[7] Rusanescu C. O., Jinescu C., Rusanescu M., Enescu M. C. , F. V. Anghelina , E. V. Stoian , V. Despa, *Mathematical Modelling of the Stress-Strain Curve for 31VMn12 Ecological Steel*, Materiale Plastice , 54, No. 3 , 2017
[8] Constantin Alexandrina Mihaela ,*Theoretical concepts for physical preparation of athletes*, Scientific Journal of Education, Sports and Health, No 2 Supplement,vol. XVII, ISSN 2344 – 5645, ISSN-L 1453-0201,2016.
[9] Ardeleanu M, Despa V, Ivan A.I, *Modeling of a microgripper compliant joint using Comsol Multiphysics simulation,* The Scientific Bulletin of Electrical Engineering Faculty No.2(19) pp. 25-29, 2012.