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REGARDING AT THE CIRCULAR PLATES RIGIDITY WITH RADIAL RIBS, NEGLECTING THE WELDING SEAMS INFLUENCE. RIBS WITH CONSTANT THICKNESS AND LINEAL VARIABLE HEIGHNESS ON LENGTH, PLACED JUST ON A FACE

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Abstract: *On base of obtained results in working [1], in a certain case one should take account the lineal chamfering of ribs upon the neutral fiber position and of the circular and plane plate bending rigiditybwith radial ribs. The illustration of the theoretical resultss is achieved on a given case.*

Keywords: *The circular plates rigidity, constant thickness,*

1. THEORETICAL CONSIDERATIOS

The ideea of economize mettalic materials, but, in the same time, of obtaining constructions as rigid as possible is taken into consideration in our case on a plane circular plate with radial ribs, equidistantly arranged on a face of this (Figure 1). Unlike the analyzed situation in working [1] it is considered in this case that the lineal chamfering of ribs having the same thickness an all their legth. Simultaneously, the effect of welding seams upon the neutral fiber position and the ribbed plate rigidity. The ortotropical structures theory is utilized further[2,3,4,5,6].

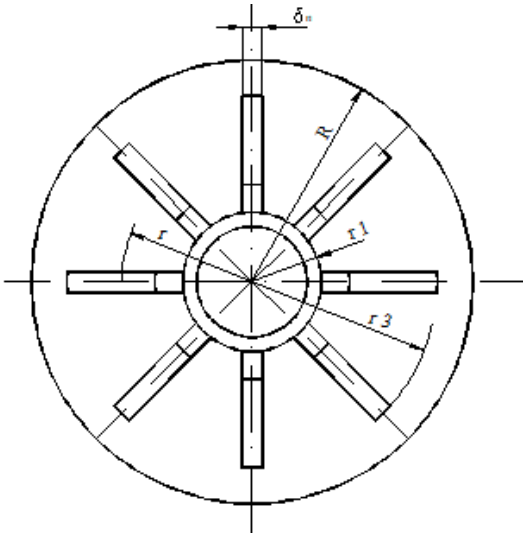


Figure 1. The plate geometry

The last-geometrical function what permits us the neutral fiber establishment of the plate with ribs, measured from its plane area (Figure 2) is presented in the shape of:

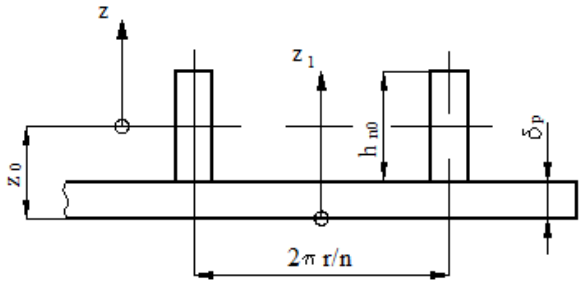


Figure 2. The ribs geometry

$$f_{3r} = \int_{-\delta_1}^{\delta_2} \frac{E \cdot k_r \cdot z \cdot dz}{1 - k_r \cdot k_\theta \cdot \nu^2}; \quad (1)$$

Where:

E - is longitudinal elastic modulus of the plate material (E_p) or of ribs (E_n);

Z - czrrently level inferred from the formula:

$$z = z_1 - z_0 \quad (2)$$

z_1 - currently level (Figure3);

z_0 - neutral fiber position;

k_r, k_Θ - coefficients of admission which have the significance:

$k_r = k_\theta = 1$, for plane plate;

$$k_r = \frac{n \cdot \delta_n}{2 \cdot \pi \cdot r},\ k_\theta = 0, \text{ for ribs area} \qquad (3)$$

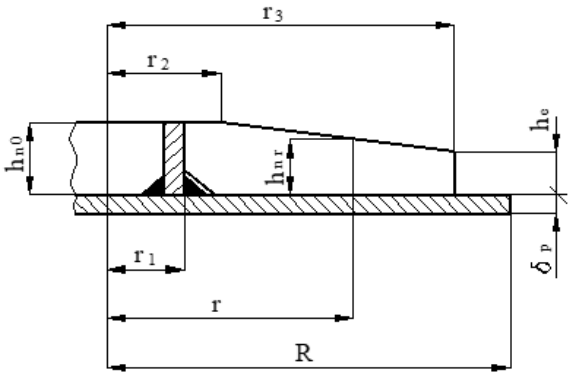


Figure 3. The ribs geometry on length

n – number of ribs;
δ_n – thickness of ribs;
r – currently radius;
ν - transversal contraction coefficient of the plate material (ν_p), respectively of ribs (ν_n).
Integral (1) taking account of the variable changing is turned into:

$$f_{3r} = \int_0^{\delta_p} \frac{E_p \cdot (z_1 - z_0)}{1 - \nu_p^2} \cdot dz_1 + \int_{\delta_p}^{\delta_p + h_{nr}} \frac{E_n \cdot \frac{n \cdot \delta_n}{2 \cdot \pi \cdot r} \cdot (z_1 - z_0)}{1 - \frac{n \cdot \delta_n}{2 \cdot \pi \cdot r} \cdot \nu_p^2} \cdot dz_1 \qquad (4)$$

From the condition $f_{3r} = 0$ one can infer that the neutral fibber position of the ribbed plate in relation with its plane area in accordance with:

a) for $r \in \lfloor r_1, r_2 \rfloor$ [1]:

$$z_0 = \frac{F_1(1)}{F_2(1)}, \qquad (5)$$

with:

$$F_1(1) = \frac{1}{\delta_p} + \frac{n}{2 \cdot \pi \cdot \delta_p} \cdot (1 - \nu_p^2) \cdot \frac{E_n}{E_p} \cdot \frac{\delta_n}{\delta_p} \cdot \frac{h_{n0}}{\delta_p} \cdot \frac{2 \cdot \delta_p + h_{n0}}{r}; \qquad (6)$$

$$F_2(1) = 2\left[1 + \frac{n}{2 \cdot \pi}(1 - \nu_p^2)\frac{E_n}{E_p} \cdot \frac{\delta_n}{\delta_p} \cdot \frac{h_{n0}}{r}\right] \qquad (7)$$

where $h_{n(0)}$ is the constant heighness of ribs in this zone;

b) for $r \in \lfloor r_2, r_3 \rfloor$:

$$z_0 = \frac{F_1(2)}{F_2(2)}, \qquad (8)$$

with:

$$F_1(2) = \frac{1}{\delta_p} + \frac{n}{2 \cdot \pi \cdot \delta_p} \cdot (1 - \nu_p^2) \cdot \frac{E_{nr}}{E_p} \cdot \frac{\delta_n}{\delta_p} \cdot \frac{h_{nr}}{\delta_p} \cdot \frac{2 \cdot \delta_p + h_{nr}}{r}; \qquad (9)$$

$$F_2(2) = 2\left[1 + \frac{n}{2 \cdot \pi}(1 - \nu_p^2)\frac{E_n}{E_p} \cdot \frac{\delta_n}{\delta_p} \cdot \frac{h_{nr}}{r}\right] \qquad (10)$$

where:

$$h_{nr} = h_e + \frac{r_3 - r}{r_3 - r_2} \cdot [h_{n0} - h_e] \qquad (11)$$

Bending rigidity for ribbed zone is established with formula:

$$f_{5r} = \int_{-\delta_1}^{\delta_2} \frac{E \cdot k_r \cdot z^2 \cdot dz}{1 - k_r \cdot k_\theta \cdot \nu^2}; \qquad (12)$$

Respectively taking account the equqlity (2):

$$f_{5r} = \int_0^{\delta_p} \frac{E_p \cdot (z_1 - z_0)^2}{1 - \nu_p^2} \cdot dz_1 + \int_{\delta_p}^{\delta_p + h_{nr}} \frac{E_n \cdot \frac{n \cdot \delta_n}{2 \cdot \pi \cdot r} \cdot (z_1 - z_0)^2}{1 - \frac{n \cdot \delta_n}{2 \cdot \pi \cdot r} \cdot \nu_p^2} \cdot dz_1 \qquad (13)$$

Following the calculation it result:

a) pentru $r \in \lfloor r_1, r_2 \rfloor$:

$$f_{5r} = k_{D1} \cdot \mathfrak{R}, \qquad (14)$$

$\mathfrak{R}$ beeing the bending rigidity for the circular plate, where:

$$k_{D1}=4\cdot\left[1-3\cdot\frac{z_0}{\delta_p}+3\cdot\left(\frac{z_0}{\delta_p}\right)^2\right]+\frac{6\cdot n\cdot\left(1-\nu_p^2\right)}{\pi}\cdot\frac{E_n}{E_p}\cdot\frac{\delta_n}{\delta_p}\cdot$$
$$\cdot\left[1+\frac{h_{n0}}{\delta_p}+\frac{1}{3}\left(\frac{h_{n0}}{\delta_p}\right)^2-\frac{z_0}{\delta_p}\left(2+\frac{h_{n0}}{\delta_p}\right)+\left(\frac{z_0}{\delta_p}\right)^2\right]\frac{h_{n0}}{r} \quad (15)$$

b) for $r\in\left\lfloor r_2, r_3\right\rfloor$:

$$f_{5r}=\Re\cdot k_{D2}, \quad (16)$$

where:

$$k_{D2}=4\cdot\left[1-3\cdot\frac{z_0}{\delta_p}+3\cdot\left(\frac{z_0}{\delta_p}\right)^2\right]+\frac{6\cdot n\cdot\left(1-\nu_p^2\right)}{\pi}\cdot$$
$$\frac{E_n}{E_p}\cdot\frac{\delta_n}{\delta_p}\cdot\left[\left(1+\frac{h_{nr}}{\delta_p}+\frac{1}{3}\cdot\left(\frac{h_{nr}}{\delta_p}\right)^2\right)-\right.$$
$$\left.-\frac{z_0}{\delta_p}\cdot\left(2+\frac{h_{nr}}{\delta_p}\right)+\left(\frac{z_0}{\delta_p}\right)^2\right]\cdot\frac{h_{nr}}{r} \quad (17)$$

2. ILLUSTRATION

One should take account the following geometrical and material specific feature: r_1 = 80 mm; r_2 = 105 mm; r_3 = 260 mm; h_e = 5 mm; δ_p = 10 mm; δ_n = 5 mm; R=325 mm; $E_p = E_n$ = 2,1 10^5 MPa; $\nu_p = \nu_n = \nu$ =0,3.

In order to note the influence of the height of the ribs, on the one hand, and the number of ribs, on the other hand, on the position of the median surface of the ribbed plate and its cylindrical bending rigidity, ribs from 6 to 12 pieces were considered (varying by two units), respectively heights from 10 mm to 40 mm (with height change from 10 to 10 mm). The analysis was done with the Mathematica program.

The figure 4 shows the variation of the position of the z_0 neutral fiber of the ribbed plate, in relation to the change in the r radius of the plate and the n number of ribs, for the $r\in\left\lfloor r_1, r_2\right\rfloor$ domain, the ribs having the height = 40 mm.

The figure 5 shows the variation of the z_0 position of the neutral fiber of the ribbed plate, depending on the r current radius of the plate and the n number of ribs, for the $r\in\left\lfloor r_2, r_3\right\rfloor$ domain, the ribs having a height of 40 mm.

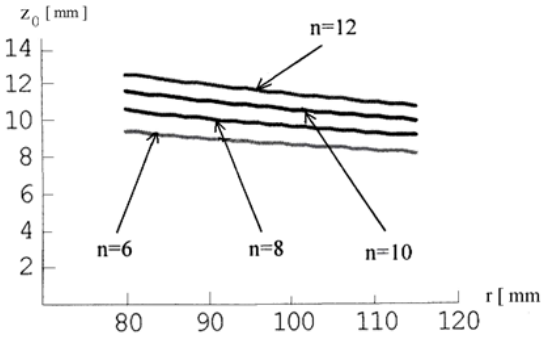


Figure 4. The variation of the z_0 position of the neutral fiber of the ribbed plate, for the $r\in\left\lfloor r_1, r_2\right\rfloor$ field

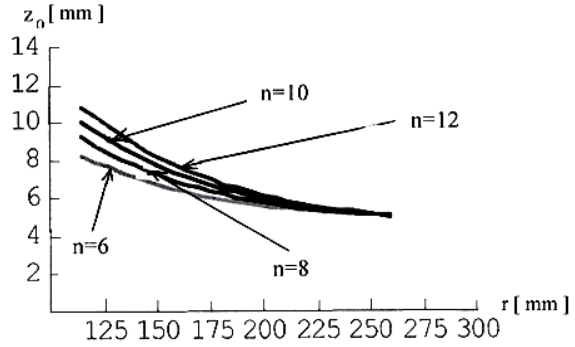


Figure 5. The variation of the z_0 position of the neutral fiber of the ribbed plate, for the $r\in\left\lfloor r_2, r_3\right\rfloor$ domain

The variation of the k_{D1} rigidity multiplication factor of the ribbed plate, depending on the r radius of the plate and the n number of ribs, for $r\in\left\lfloor r_1, r_2\right\rfloor$ is shown in figure 6. The height of the ribs is 40 mm.

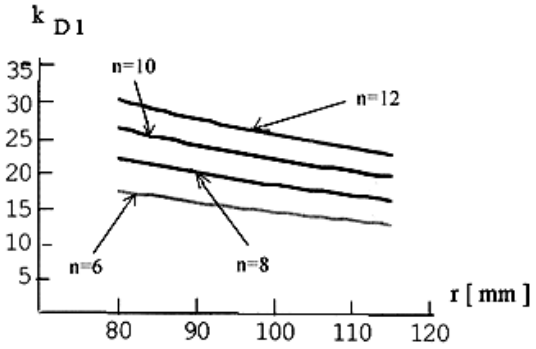


Figure 6. The variation of the k_{D1} rigidity multiplication factor of the ribbed plate, for $r\in\left\lfloor r_1, r_2\right\rfloor$

The figure 7 shows the variation of the $k_{D\,2}$ rigidity multiplication factor , depending on the r radius of the plate and the n number of ribs, for the circular sector characterized by $r \in \left[r_2, r_3\right]$, the ribs also having the maximum height of 40 mm.

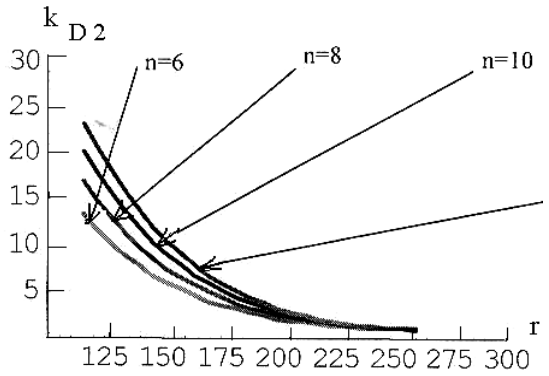


Figura 7.The variation of the $k_{D\,2}$ rigidity multiplication factor, for $r \in \left[r_2, r_3\right]$

3. CONCLUSIONS

It is established a diminution of z_0 values and of the plate bending rigidity, at the same time with the growth of the r radius. The above analysis was realized according to the number of ribs and their height. The z_0 and k_D values depend straightly on n and $h_{n(0)}$.

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