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COMPARATIVE STUDY OF CLASSICAL METHODS VERSUS METHODS BASED ON ANALYZE WITH THE FINITE ELEMENTS OF DEFORMATIONS AND TENSIONS OF THE BRAKE RIM

POROVNÁVACÍ STUDIE KLASICKÉ METODY A METODY ZALOŽENÉ NA ANALÝZE METODY KONEČNÝCH PRVKŮ DEFORMACÍ A NAPĚTÍ BRZDOVÉHO VĚNCE

Abstract

In this paper are present/exists two methods of gravel rim's tensions and deformations under the pressure effect created of shoe-brake in the brake process. The first method so called the classic one has at the bottom of it known theory's from the discipline frame the material resistance and the second method has at the bottom of it the gravel with the finite elements help. Both methods presented are applied at the brakes with miner hoisting machines.

Abstrakt

V tomto článku jsou prezentovány 2 metody analýzy napětí a deformací brzdového věnce pod zatížením vytvořeným nožní brzdou při brzdění. První metoda, nazývaná klasická, má za základ ve známé teorii z odporu materiálu a základem druhé je metoda konečných prvků. Obě metody jsou aplikované na brzdách u hornických těžebních strojů.

1 THE CLASSIC METHOD OF TENSIONS AND DEFORMATIONS

1.1 The tensions

Considering the rim as a tub with thinly walls (thanks to the fact that the rapport between the rim's media thickness and the diameter of this is very grate/big) and representing a section of this into a co-ordinate system as in the figure 1, there has been graved bended moments on the rim's outline.[1]

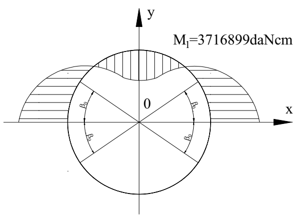

Fig.1 The diagram bended moments

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Noting with M the bended moment in the considerable section, with W the rim's module resistance and with $2\beta_0$ the covering angle of the shoe-brake on the rim, in the assumption that the pressure is uniform distributed on the contact arch ,the study will be made for the following cases[7]:

- for $\theta = 0\,0$.

$$M_i = p \cdot R^2 \left[\frac{1}{\pi} \left(\frac{\beta_0}{2} + \beta_0 \cdot \sin^2 \beta_0 + 1,5 \cdot \sin \beta_0 \right) - 0,5 \cdot \sin^2 \beta_0 \right]; \tag{1}$$

- for $\theta = \beta_0$, that means the extremes of the shoe-brake

$$M_{(\theta)} = -M_i - p \cdot R^2 \cdot 0,5 \cdot \sin^2 \beta_0 ; \tag{2}$$

- for $\beta_0 \le \theta \le \pi - \beta_0$

$$M_{(\theta)} = -M_i - p \cdot R^2 \left(\sin\theta \cdot \sin\beta_0 - \frac{1}{2} \cdot \sin^2 \theta \right). \tag{3}$$

It is obtained in this way the diagram of bended moments on the rim's outline presented in the figure 1.

In these cases the unitary efforts in the considerable sections is

$$\sigma_{(\theta)} = \frac{M_{(\theta)}}{W} . \tag{4}$$

1.2 The deformations of the rim

Thanks to the pressure created at the press of the shoe-breaks on the rim, there are produced deformations of this.[2]

Noting with:

- d_x, d_y – the deformation of the rim's ring on directions x and y(fig.2),
- I- the inertness moment of the rim,
- E- the resilience modulus of the material from which is manufactured the rim,

a) the deformation in the press forces direction d_y

$$d_y = \frac{p^4}{E \cdot I} \left[-\sin\beta_0 - \frac{\sin^3 \beta_0}{3} + \frac{1}{\pi} \left(\beta_0 + 3 \sin\beta_0 \cos\beta_0 + 2\beta_0 \sin^2 \beta_0 \right) \right]; \tag{5}$$

b) the deformation in the perpendicular direction on the press forces direction d_x

$$d_x = \frac{p^4}{E \cdot I} [\sin^2 \beta_0 - \beta_0 \sin\beta_0 - \frac{1}{3} \sin^2 \beta_0 \cdot \cos\beta_0 - \frac{2}{3} \cos\beta_0 + \frac{2}{3} + \tag{6}$$

$$+ \frac{\pi \sin\beta_0}{2} - \frac{1}{\pi} \left(2\beta_0 \cdot \sin^2 \beta_0 + 3 \sin\beta_0 \cos\beta_0 + \beta_0 \right)] \quad .$$

There are obtained the deformations present in figure 2.

At the end of the pressure effects for the hoisting machine's case it is obtained the following deformations according to both axes: d_x=0,0019552mm and d_y=0,006501.The resulting deformations beginning infinitesimal, the rim present the absolute rigidness.

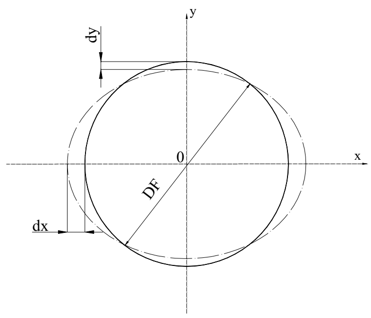

Fig. 2 The diagram of the rim's deformations

2 STUDY OF TENSIONS AND DEFORMATIONS OF COUPLE ELEMENTS OF SHOE-BRAKE-RIM WITH THE METHOD HELP WITH FINITE ELEMENTS

It was realized the analyze with finite elements and the deformations of the hoisting machine's rim 2T3,5X1,7A.The determinations were realized for the uniform distribution of pressures on the rim's surface.

The stages of the analyze achievement [3][8]:

- the achievement of the three-dimensional draw
- the preparation of the model for the analyze, stage in which it was realized the surface delimitation on which the pressures are apply and it were indicated the properties of the elements material
- for the problem solve was made the automatic definition of the knots and of structure net's finite elements
- the reports generator

2.1 The analyze with the finite elements of deformations and tensions of the rim

The analyze was realized with the program help CATIA.[10] The deformations and the tensions were determinate for the compound require of bending and torsion. For the require simulation of bending the pressures were distributed on the action surface and for the require simulation of rim's torsion was embedded at the shoe-brake level. For illustrate is presented the following application for the hoisting machine. In case of regime braking the push pressure of the shoe-brake on the rim is 3,5 daN/cm^2 and the torsion moment at which the rim is required (created by the difference of static tension in rest state) is about 9761 daN m. The deformations and the tensions resultant are represented in fig.3 and 4.The effected analyze with method help with finite elements indicate the fact that the intern tensions and rim's deformations are in admissible limits.

Name: StaticSet.1
Restraint: RestraintSet.1
Load: LoadSet.1
Strain Energy : 1.349e+001 J
Equilibrium

Components	**Applied Forces**	**Reactions**	**Residual**	**Relative Magnitude Error**
Fx (N)	1.2346e+003	-1.2346e+003	-2.4441e-008	1.5606e-012
Fy (N)	-2.6756e+003	2.6756e+003	-4.4538e-008	2.8439e-012
Fz (N)	-1.5747e+004	1.5747e+004	-5.8662e-009	3.7457e-013
Mx (Nxm)	-3.4770e+003	3.4770e+003	-1.9626e-008	7.4150e-013
My (Nxm)	6.7322e+004	-6.7322e+004	-1.2908e-008	4.8768e-013
Mz (Nxm)	-5.4351e+002	5.4351e+002	-2.1285e-007	8.0420e-012

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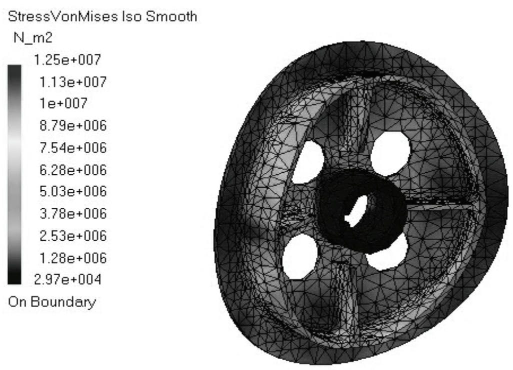

Fig.3 Rim's tension

Name: StaticSet.1
Restraint: RestraintSet.1
Load: LoadSetFIFFI.1
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Equilibrium

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3 CONCLUSIONS

If both rim's deformations presented methods are compared, the classic method and the finite elements method, it is observed the fact that bigger numbered values are obtained with the second method for studied cases, but in admissible limits.

The analyze method proposed presents the advantage that allow the determination of high pressure of contact between the shoe-brake and the rim so the tensions and the deformations of the rim to be in admissible limits

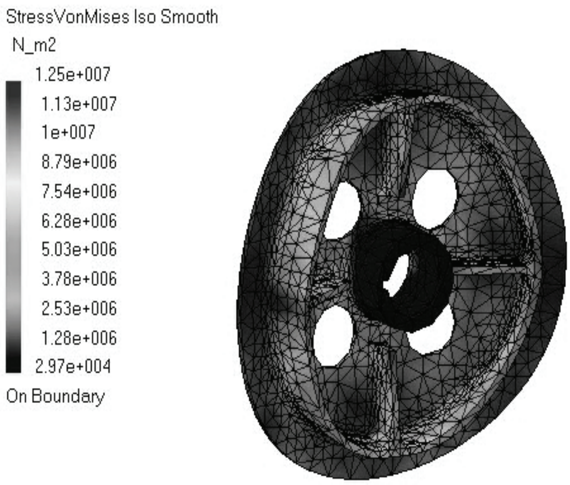

Fig. 4 Rim's deformations

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