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Finite Element Analysis of Collision Phenomenon that Occurs during the Manufacturing Process of Axial Bearings Rollers

The paper presents the analysis of the collision phenomenon that occurs during the manufacturing process of axial bearings rollers. The manufacture of rollers is made on automatic production centers. During the transport process on automated lines, collisions occur between rollers. A study on cylindrical rollers Φ16 x L24, in the simplified cases of head-head collision and head- circular surface collision, was made in Solid Works Simulation. Stress and deformation results are presented.

Keywords: *elasto-plastic collision, stress, deformation, bearing rollers*

1. Introduction

Collision phenomenon occurs during the manufacturing process of axial bearing rollers on automatic centers.

The simplified route crossed by the rollers from the manufacturing machine (CP) to the container (MB) is shown in figure 1. The signification of the abbreviations used in figure 1 are: J – incline gutter (α=30°), O – incline gutter hole (connects the incline gutter and the container), G – weight of the roller, A – vertical limit position of the roller in the container, B – horizontal limit position of the roller in the container, h_1 – container height (up to incline gutter hole), h_2 – incline gutter hole diameter, h_3 – incline gutter height, h – total height of the system (h=430 mm), v – velocity of the rollers.

The collision phenomenon between rollers in the container shows o large diversity of relative position of rollers.

Two limit cases were studied:

A – Head to head collision;

B – Head to circular surface collision;

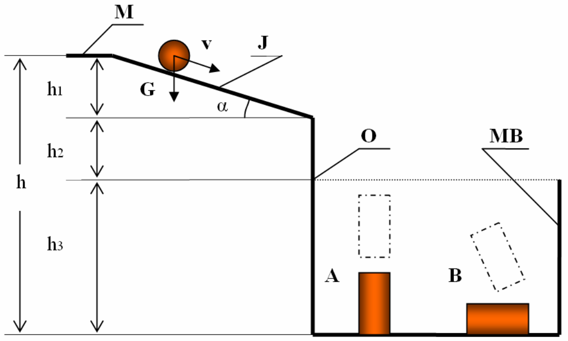


Figure 1. The transport system of the axial bearing rollers

In order to study the velocity of the rollers at the contact with the base of the container the low pf conservation of mechanical energy was used [1,2]:

$$E_p = E_c \tag{1}$$

Where:

E_p – potential energy of the roller a the start from manufacturing machine;

E_c – kinetic energy of the roller at the

The maximum velocity at impact results from (1):

$$v_{\max} = \sqrt{2gh} \tag{2}$$

Where:

$g = 9.8\left[\frac{m}{s^2}\right]$ (Gravitational acceleration);

$h = 0.43[m]$ (The maximum drop height);

For the analyzed cases the maximum velocity is:

$$v_{\max} = 2.903\left[\frac{m}{s}\right]$$

2. The impact coefficient Ψ

The rough analytical solve of the collision use also the low of energy conservation. Is defined as the coefficient of impact or dynamic multiplier (Ψ) the ratio of instantaneous force from the moment of shock, P, and weight, G, that falls from a height h. This weight distorts the solid body with a deformation, Δ_{din} measured in the direction of impact.

$$\Psi = \frac{P}{G} \tag{3}$$

Form the specialized literature was chosen the simplified relation of the impact coefficient used for very small deformations:

$$\Psi = \sqrt{\frac{2h}{\Delta_s}} \tag{4}$$

Where:

Δ_S - Static deformation;

3. The static analysis

The static and dynamic deformations and stresses are linked by the next equations:

$$\Delta_{din} = \Psi \cdot \Delta_S \tag{5}$$

$$\sigma_{din} = \Psi \cdot \sigma_S \tag{6}$$

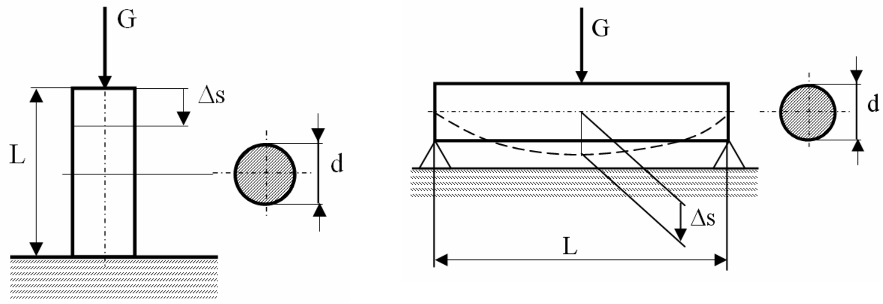
The loads and the constrains for the case A – the head to head collision and the case B – head to circular surface collision are presented in figure 2.

For the analytical calculation static stresses and deformations are determined with:

$$\sigma = \frac{G}{A} \tag{7}$$

$$\Delta_s = \frac{G \cdot L}{E \cdot A} \tag{8}$$

Where E – Young's modulus;



a) b)

Figure 2. The loads and constrains in case A the head to head collision (a) and case B – head to circular surface collision (b)

4. Finite element method analysis

The finite element analysis was performed with Solid Works Simulation [2]. In order to use a static study was determined the value of the dynamic force (the force of the collision):

$$F_{din} = \Psi \cdot F_S \tag{9}$$

Where: $F_S = \Psi \cdot G$

The results of the numerical simulation are presented in table 1 and figures 3 4, 5 and 6.

Table 1

Parameter Name	**Type**	**Min**	**Max**
Stress case A	VON: von Mises Stress	19.013 MPa Node: 53276	480.326 MPa Node: 61141
Displacement case A	UY: Y Displacement	-0.0148 mm Node: 49699	0 mm Node: 116
Stress case B	VON: von Mises Stress	3.473 MPa Node: 9370	579.323 MPa Node: 1044
Displacement case B	UX: X Displacement	0 mm Node: 32	0.0228 mm Node: 578

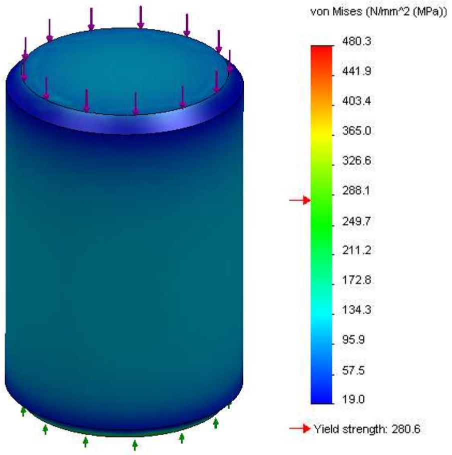


Figure 3. Von Misses stresses for case A of collision

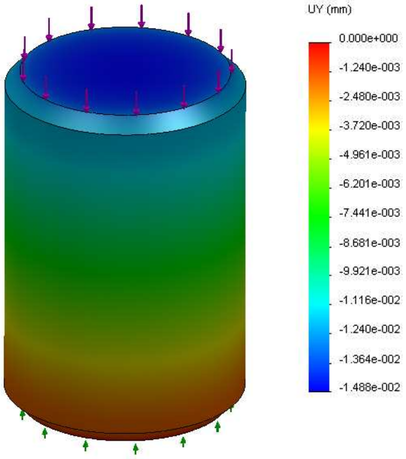


Figure 4. U_Y deformation for case A of collision

The Von Mises stresses reach high values for the case B of collision but these values are on very small areas. The deformations are significant in the both cases (0.014 mm, case A and 0.022 mm for case B). These values affect the precision of the final product and a geometry modification is recommended at the manufacturing center.

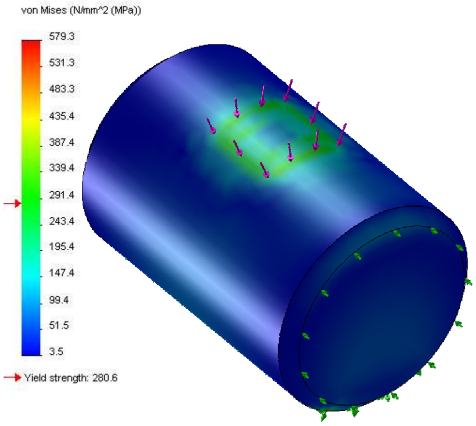


Figure 5. Von Misses stresses for case B of collision

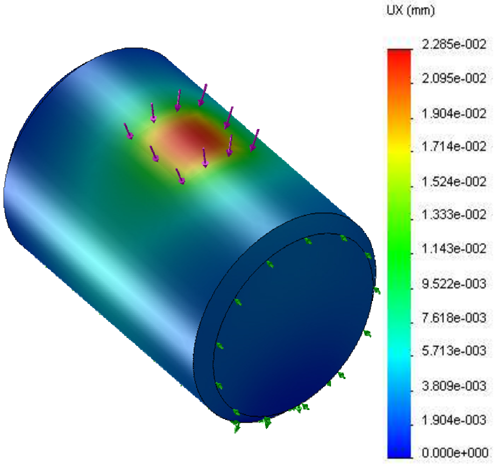


Figure 6. U_X deformation for case B of collision

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