ANNALS of the ORADEA UNIVERSITY.
Fascicle of Management and Technological Engineering, Volume XI (XXI), 2012, NR1

THE FINITE ELEMENT MODELING OF THE BUSH CHAINS BOLT-BUSH CONTACTS

Lateş Mihai-Tiberiu
"Transilvania" University of Braşov
latesmt@unitbv.ro

Keywords: bush chain, mechanical contact, finite element.

Abstract: The bush chains are used in power transmissions and the main cause of their disuse is the wear of the components with relative motions. In order to reduce the wear, the stresses distributions in the mobile contacts are reduced. The finite element method allows achieving contacts modeling by using specific methods. The paper presents an analytical modeling of a bolt-bush contact, and then, different variants of contacts by using the finite element method are modeled. A comparison between the solutions indicates the variant which is the closest to the analytical results.

1. Introduction

One of the important issues of the chain drives is the wear [1], [5]. In order to reduce it, different constructive solutions for the chain drives are used. The bush chains are used in the distribution transmissions of the combustion engines cars. The components of a bush chains are presented in the figure 1 [2].

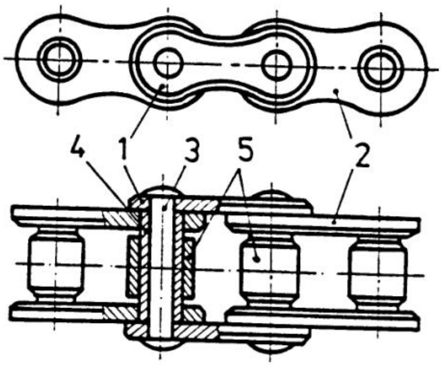

Figure 1: The bush chains components

The external links 1 are fitted on the bolts 3 and the internal links 2 are fitted on the bushes 4. The rollers 5 are mounted with clearance on the bushes 4 which are mounted also with clearance on the bolts 3.

The paper presents the finite element modeling of the bolt-bush contact, by using different finite element models, in order to find the solution which is the closest (as results) to the analytical model.

2. The analysis model

The analysis model is represented by a cylinder surface contact between a bush and a bolt (figure 2).

First, the crush stress is calculated based on the analytic model. The diameter of the bolt is 10 mm and the length, 40 mm. A force F=1000 N is acting on the lateral surface. The crushing stress is calculated with the relation

$$\sigma_s = \frac{F}{A}, \qquad (1)$$

where A represents the crushing area, depending on the bolt's diameter and on its length. According to these, the crushing stress is equal with 2.5 MPa.

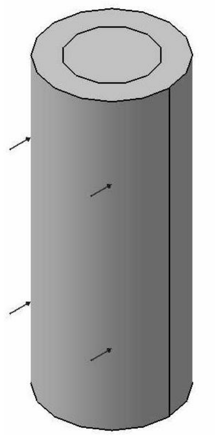

Figure 2: The analytical model

The finite element model (made in Catia V5R20) is presented in the figure 3. The size of the finite element (the maximum length) is 2 mm and the sag (the mesh error) is 1 mm. The bolt's ends are clamped, and the external force is acting on the bush.

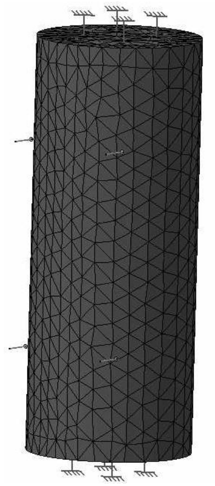

Figure 3: The finite element model

The problem is represented by the finite element modeling of the contact zone between the bolt and the bush; in order to achieve this modeling, different solution are presented as following.

The pressure fitting connection is a finite element which describes a fixed connection as a pressed assembly and it is associated to a contact or a coincidence type geometrical constrain [3, 4].

The smooth connection is a finite element which defines a fixed connection by considering the elasticity of the boundary zone between the connected elements [3, 4].

The fastened connection type finite element is defining a fixed connection between the assembled elements, by considering the contact's elasticity [3, 4].

The contact connection finite element is modeling a mobile contact connection between the assembled elements with the possibility of a relative motion between them [3, 4].

The stresses distribution is shown by using a cutting plane which is parallel to the assembly's axis. In order to find out the distance between the cutting plane and the assembly's axis, a parabolic distribution of the theoretical crushing stress is considered. By considering the maximum value the theoretical one (2.5 MPa), the distribution function is established as

$$f(x) = -0.1x^2 + 2.5, \qquad (2)$$

where x is the coordinate about the x axis (figure 4). The cutting plane is defined in the position that the crushing stress has the average value of 1.25 MPa. According to that, the distance between the cutting plane and the assembly's axis is determined as equal with 3.53 mm.

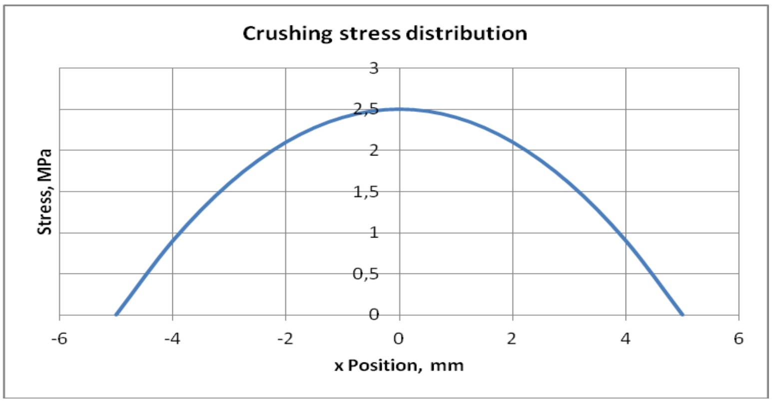

Figure 4: The crushing stress distribution

3. The analysis results

The distribution of the equivalent stresses, in the case of the smooth connection finite element and in the case of pressure fitting connection finite element, are presented in the figure 5 and figure 6, respectively.

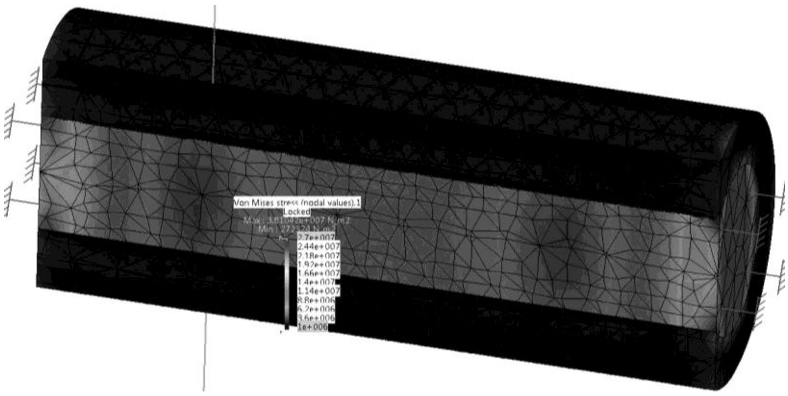

Figure 5: Stress distribution – smooth F. E.

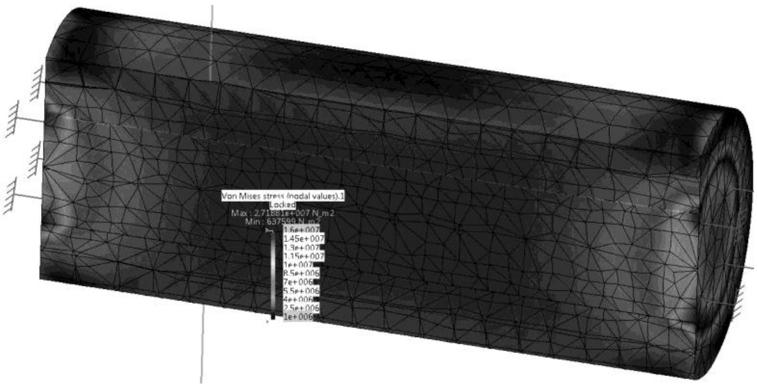

Figure 6: Stress distribution – pressure fitting F. E.

The distribution of the equivalent stresses, in the case of the fastened connection finite element and in the case of contact connection finite element, is presented in the figure 7 and figure 8, respectively.

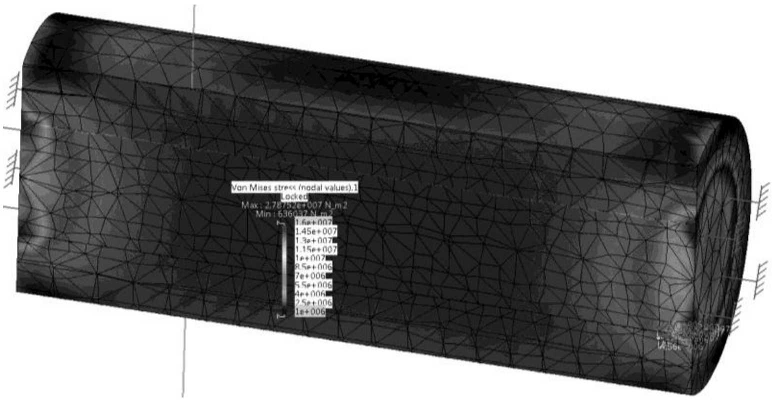

Figure 7: Stress distribution – fastened connection F. E.

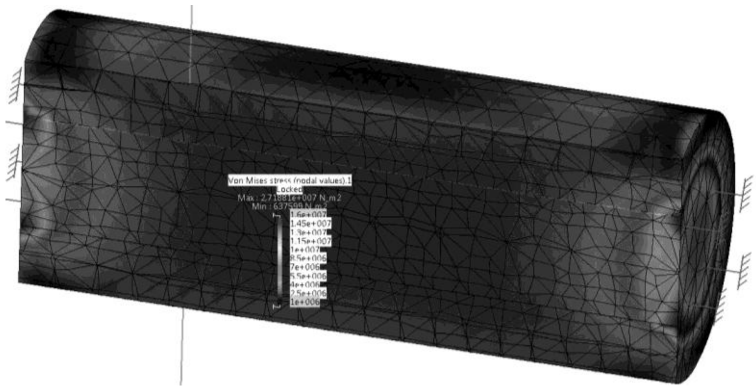

Figure 8: Stress distribution – contact connection F. E.

In the case of the smooth type finite element, the stresses are not distributed in the bush, so this type of finite element does not achieve a right one modeling.

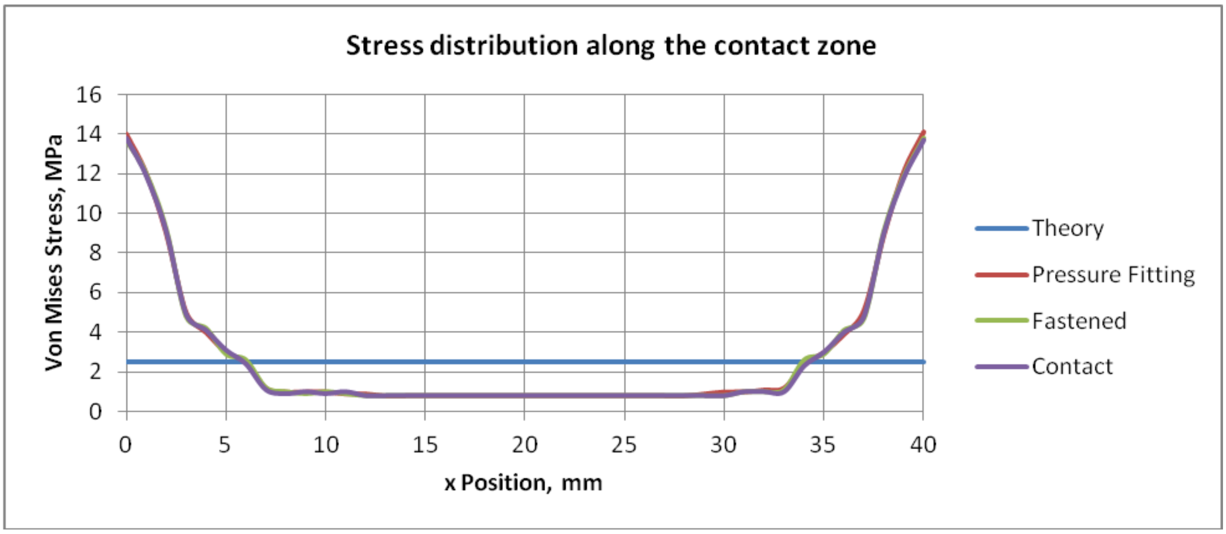

Figure 9: Stress distribution along the contact zone

Figure 9 shows the von Mises stress distribution along the contact zone between the bolt and the bush. The three allowable finite element types which can be used for the contact modeling, have the same distribution.

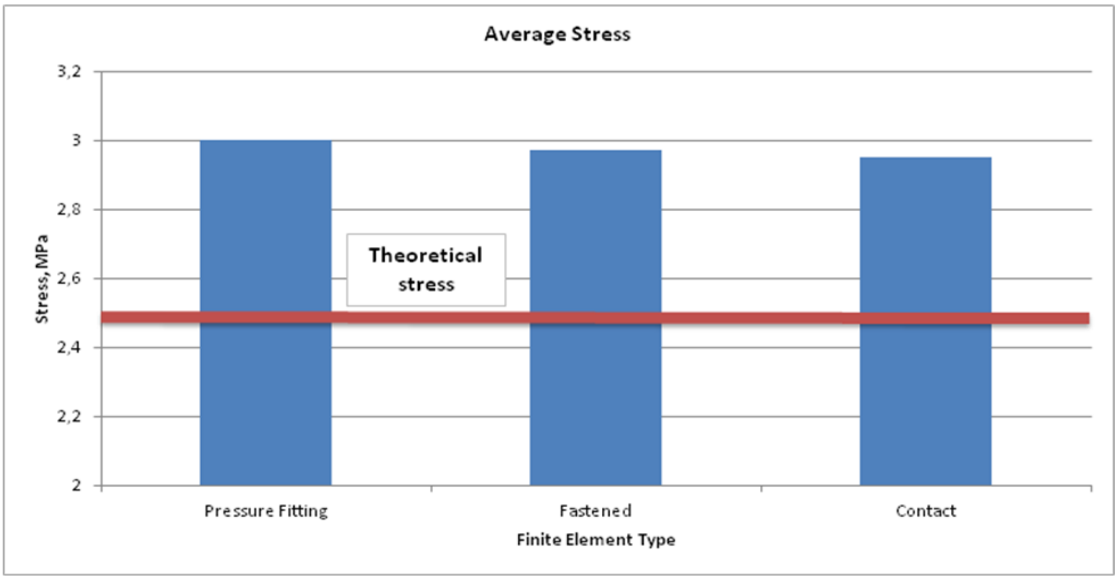

Figure 10: The average stress

According to the theoretical crushing stress (2.5 MPa), the contact type finite element has the closest value (2.95 MPa) (figure 10); the other two finite elements have close values, also. The differences between the values of the theoretical model and the finite elements models are obtained due to the equivalent stresses (the stresses in the case of the finite element model are represented by the von Mises stresses which are including all the stresses, not only the crushings).

4. Conclusions

The main reason of the bush chains disuse is the wear of the elements with relative motions. One solution to reduce the wear is to assure a well done lubrication between the parts with relative motions.

The finite elements analysis of the bush chains is important in order to find out the maximum crushing stresses which are appearing in the mobile contacts. In these areas is important to limit the stresses to allowable values which assure that the lubricant is not expulsed.

The finite element modeling by using Catia software allows achieving the modeling of the elements in contact by using different pre-defined finite elements. The papers offers important conclusions regarding the pressure fitting, fastened and contact type finite elements. All of these elements can be used to model the mechanical contacts and the contact type finite element offers solutions which are the closest to the theoretical model.

The results and the conclusions will be used for further modeling of the bush chains.

References:

[1] G. Fratila, M., Fratila, S. Samoila. Automobile. Editura Didactica si Pedagogica, Bucuresti, (2007).

[2] M. T. Lates, A., Jula. Organe de masini si transmisii mecanice. Editura Universităţii Transilvania din Braşov, (2005).

[3] M. T. Lates. Metoda Elementelor Finite. Aplicatii. Editura Universităţii Transilvania din Braşov, (2008).

[4] G. L. Mogan, S. L. Butnariu. Metoda Elementelor Finite. Editura Universităţii Transilvania din Braşov, (2007).

[5] R. Velicu. Planetary multiplicator with belt or chain drive. Design methodology. Proceedings of the International Conference TehnoNav'08, Constanta (CD) (2008).