Transilvania University of Brasov
FACULTY OF MECHANICAL ENGINEERING

ICMSAV2018 & COMAT2018 & eMECH2018
Brasov, ROMANIA, 25-26 October 2018

SOME ASPECTS ABOUT FINITE ELEMENT MODELING WITH BOLTS AND NONMETALLIC ELEMENTS OF A NEW ELASTIC COUPLING

Marilena GHIȚESCU[1], Ion-Marius GHIȚESCU[2], Sorin VLASE[3],
[1] Transilvania University of Brașov, Brasov, ROMANIA, marilenaradu@unitbv.ro
[2] Transilvania University of Brașov, Brasov, ROMANIA, marius.ghitescu@unitbv.ro
[3] Transilvania University of Brașov, Brasov, ROMANIA, svlase@unitbv.ro

Abstract: *The paper presents aspects regarding the construction of couplings with bolts using non-metallic elements, having different hardness, the elements involved in torque transmission, in this case elastic elements, having also different dimensions or forms, in the way to have a good elasticity and capacity of vibration absorbtion. In paper there are also presented: the construction of non-metallic elements, influence of material characteristics and limit and loading conditions on the states of displacements, Von Misses stress and principal tensions. The modeling of the nonmetallic element is made for different qualities of rubber, using FEM method.*
Keywords: *elastic coupling, normal bolts, non-metallic elements, finite element analyze.*

1. INTRODUCTION

The elastic couplings with non-metallic elements presented in [4, 5], accomplish the following functions: transmissions of rotation motion and moment torsion; damping of shocks and vibration; taking over axial, radial, angular/mixed deviations. The construction of coupling and elastic elements was also presented. Near the elastic longitudinal module, practical determined, it is necessary to establish the stress values, researches made on different qualities of rubber, or different forms of intermediary element.
In figure 1 is presented an original solution of an elastic coupling with intermediary non-metallic elements. The non-metallic element has various shapes and it is made of various qualities of rubber.

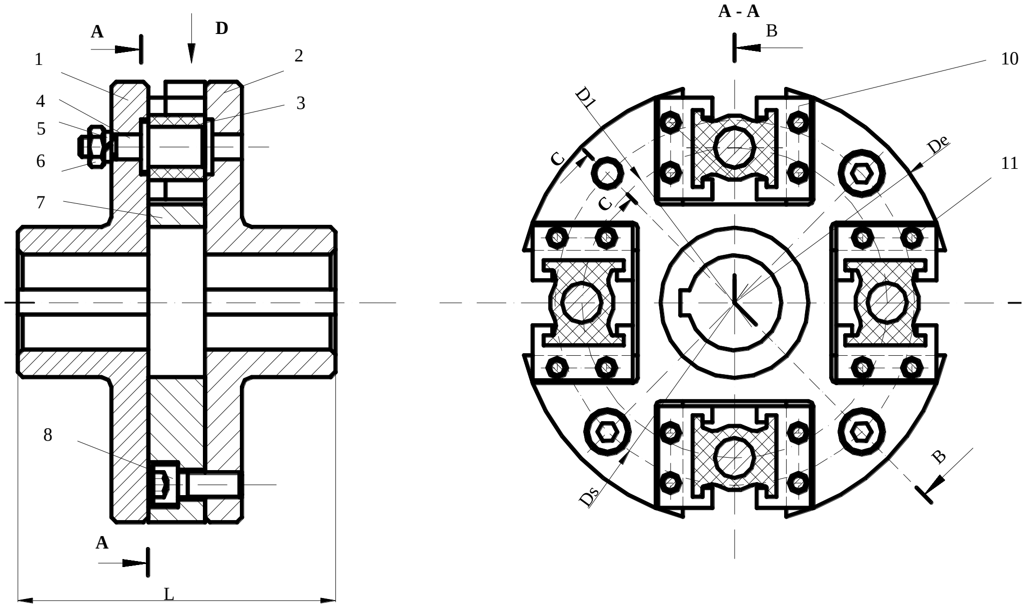
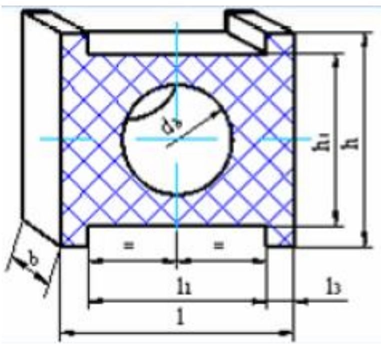


Figure 1: Elastic coupling with cylindrical bolts and intermediate non-metallic elements

The torque moment is transmitted from the driver semi coupling 1 to the non-metallic elements 3, of various shapes, through all the four cylindrical bolts 4, fixed rigidly on the driver semi coupling 1, and through the intermediary disc 7 to the driven semi coupling 2. The stresses which appear are compression in the sense of the motion, in the area in front of the bolts, crushing on the contact surface, and traction in the area defined by section B-B.

2. THE STRESS ANALISE ON NON-METALLIC ELEMENT

The method by analyze with finite element of elements from rubber has at base hypothesis of nonlinear viscous-elastic behaviour of material used for nonmetallic form. This method allows, from choosing of adequate theoretical model that a three-dimensional medium with viscous-elastic properties. In this mode is obtaining informations about material behaviour with high degree of precision. In frame of this step is realizing construction of model and is follow perfectly correspondence between realized model and real physical body.
The modeling of non-metallic element was realized with CATIA V5R8 software [1]. The studied form and dimensions of elastic element, is presented in figure 2 [5].
It's studying the drawing of piece which must be analyzed, establishing the geometrical dimensions; the place and size of solicitation, the mode of constrain and dissolved degrees of freedom. For modelling realization with finite elements, is to establish the type of finite element which will be use.



$h = 31$ mm;
$h_1 = 25$ mm;
$l = 34$ mm;
$l_1 = 26$ mm;
$b = 23$ mm;
$d_b = 16$ mm.

Figure 2: Elastic element dimensions

For the physical model presented in figure 2, there were defined the material characteristics corresponding for *Butadiene Acrilonitrilic Rubber* (NBR) - for the first modeling case, respectively *Etilen Propilendienic Rubber* (EPDM) – for the second case [5].
The geometrical interactions between the gasket by rubber and the elements with which come in contact the gasket, they are find on the analyze model under form of restrictions by displacing imposed the elements nodes by discretisation.
For establishment of loadings applied of model was realize a functionary analyze of group by component elements plates –gasket of rubber – bolt/bolts and it was imposed the restrictions presented in figures 3 and 4.
In figure 3 it may observe that non-metallic element was bearded in left side on lateral surface, to interior, of pin and fixed on your lateral surface situated to exterior in right side of this form.

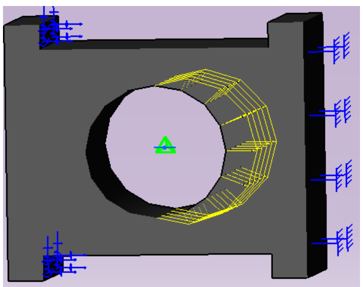


Figure 3: The restrictions and parabolic distribution of applied force

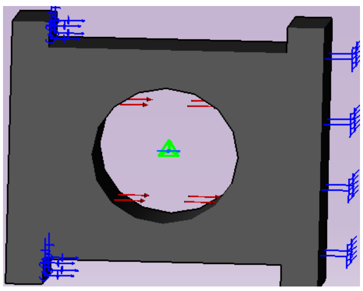


Figure 4: The same restrictions and uniform distribution of applied force

The loading of model is realized through introduction of forces (see figure 3 and figure 4). In figure 3 was applied a parabolic distribution of force, and in figure 4 was applied a uniform distribution of force.

So, for this form of non-metallic element was applied, in those two cases corresponding material characteristics of those two qualities of rubber (*Butadiene acrilonitrilic rubber* NBR, *Etilen Propilendienic Rubber EPDM*), a force by value $F=166\ N$, on the interior circularly surface, by $d_b = 16\ mm$ diameter; this force corresponds to the capable theoretical torsion moment, $M_t = 41360\ Nmm$.
The states of displacements and tensions, in case of material characteristic corresponded of butadiene acrilonitrilic rubber (NBR) form and parabolic distribution of force, are presenting in figures 5… 7.
As seen in figure 5, the maximum deflection of non-metallic element is 1,32 mm and it appears in the circular zone where it was applied the radial force, distributed parabolic [5, 7].
In non-metallic element appears Von Mises tensions (equivalent tensions, see figure 6), and different values between $2{,}14 \cdot 10^4 \ldots 1{,}12 \cdot 10^6$ N/m^2, but the principal tensions (compression/traction) as can be seen in figure 7, have a variation between - $2{,}01 \cdot 10^6 \ldots 1{,}68 \cdot 10^6$ N/m^2.

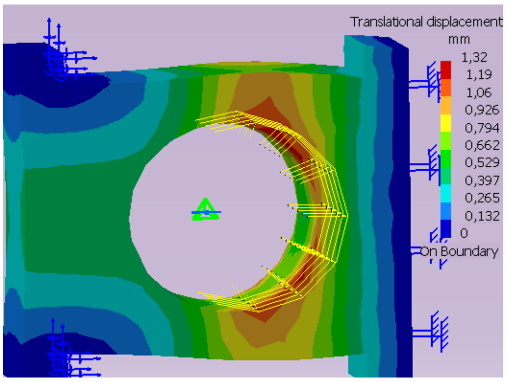


Figure 5: The displacement of nonmetallic element (NBR form - parabolic distribution of force)

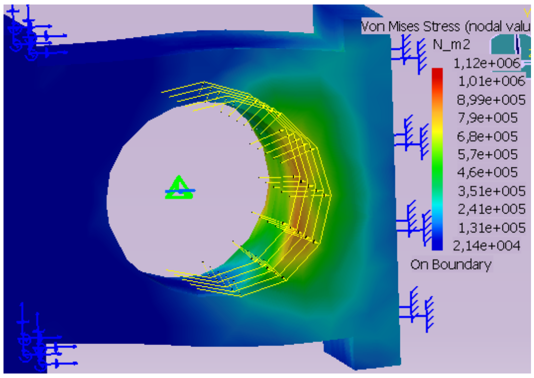


Figure 6: Von Mises Stress - NBR form

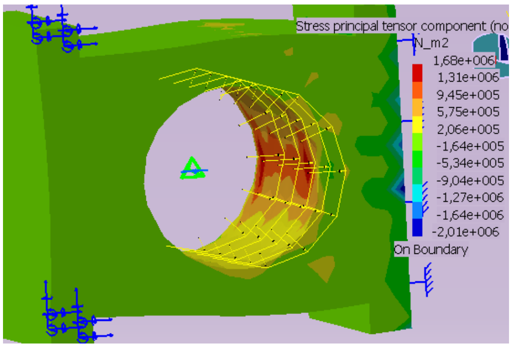


Figure 7: The principal tensions from nonmetallic element from NBR

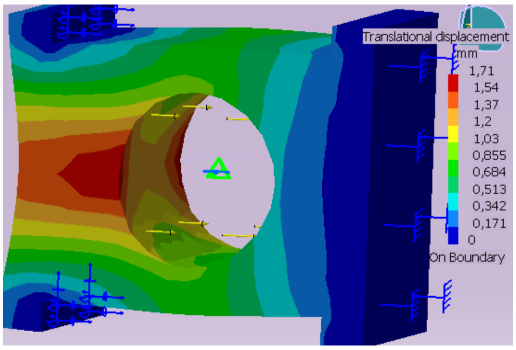


Figure 8.: The displacement of nonmetallic element (NBR form - uniform distribution of force)

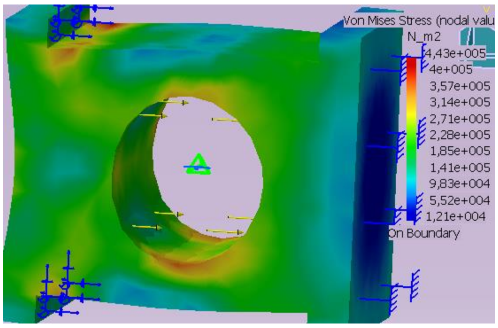


Figure 9: Von Mises Stress - NBR form

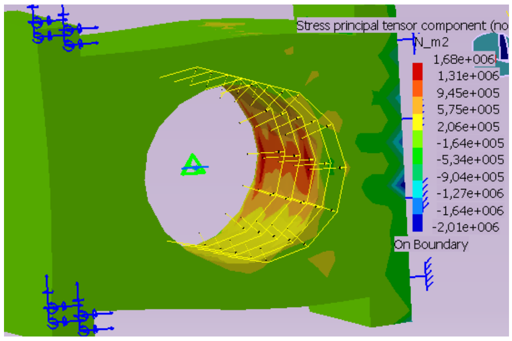


Figure 10: The principal tensions from nonmetallic element from NBR

The states of displacements and tensions, in case of material characteristic corresponded of butadiene acrilonitrilic rubber (NBR) form and uniform distribution of force, are presenting in figures 8… 10.
As seen in figure 8, the maximum deflection of non-metallic element is 1,71 mm and it appears in the circular zone where it was applied the uniform distribution of force. In non-metallic element appears Von Mises tensions

(equivalent tensions, see figure 9), and different values between 1,21*10^4...4,43*10^5 N/m^2, but the principal tensions (compression/traction) as can be seen in figure 10, have a variation between - 9,72*10^5 ... 8,69*10^5 N/m^2 [5].

The states of displacements and tensions, in case of material characteristic corresponded of *Etilen Propilendienic Rubber* (*EPDM*) form are presented in figures 11 … 16.

In figures 11-13, it was applied the parabolic distribution of force and in figures 14-16 it was applied the uniform distribution of force. As seen in figure 11, the maximum deflection of non-metallic element is 1,02 mm and it appears in the circular zone where it was applied the radial force, distributed parabolic. In non-metallic element appears Von Mises tensions (equivalent tensions, see figure 12), and different values between 1,21*10^4…4,43*10^5 N/m^2, but the principal tensions (compression/traction) as can be seen in figure 13, have a variation between – 9,72*10^5 … 8,69*10^5 N/m^2 [5].

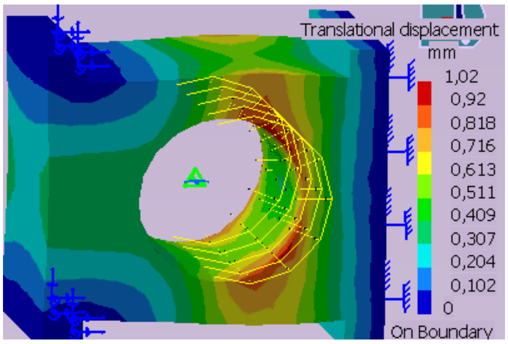


Figure 11: The displacement of nonmetallic element (EPDM form – parabolic distribution of force)

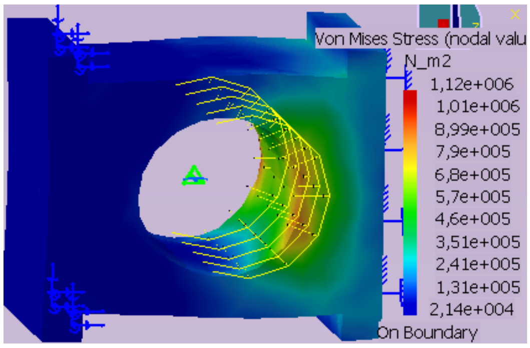


Figure 12: Von Mises Stress – EPDM form

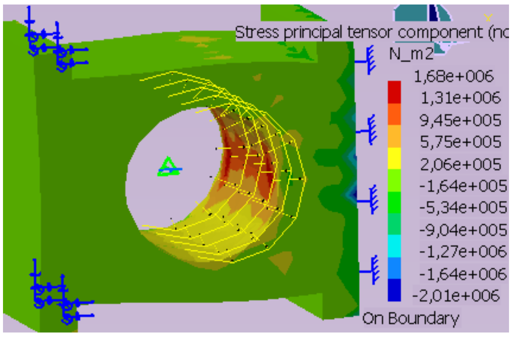


Figure 13: The principal tensions from nonmetallic element from EPDM

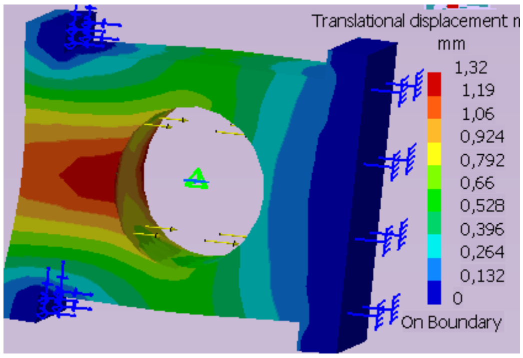


Figure14: The displacement of nonmetallic element (EPDM form – uniform distribution of force)

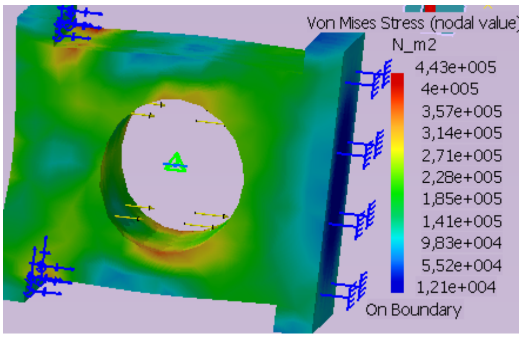


Figure 15: Von Mises Stress - EPDM form

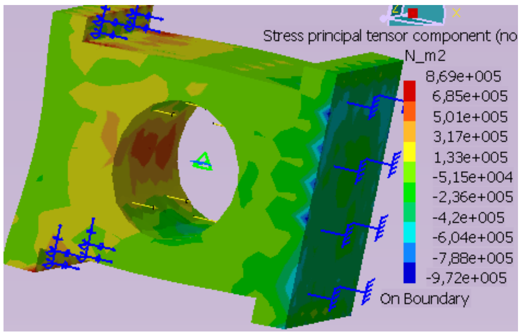


Figure 16: The principal tensions from nonmetallic element from EPDM

As seen in figure 14, the maximum deflection of non-metallic element is 1,32 mm and it appears in the circular zone where it was applied the radial force, distributed uniform.

In non-metallic element appears Von Mises tensions (equivalent tensions, see figure 15), and different values between 1,21*10^4...4,43*10^5 N/m^2, but the principal tensions (compression/traction) as can be seen in figure 16, have a variation between - 9,72*10^5 ... 8,69*10^5 N/m^2 [5].

3. CONCLUSION

The analyze using finite element method of nonmetallic elastic elements from componence of elastic coupling with cylindrical bolts and nonmetallic elements, designed, was very important. In modeling with finite element of non-metallic element was an analyze made on different materials, with different characteristics, the same limit conditions and realized analyzes for the same values of loading force, but different distribution of force and arrived following conclusions:

- through imposing of different limit and loading conditions, but also with different characteristics of material applied non-metallic element, is establish that the modifying of limit conditions, the displacement of non-metallic element is decreasing;
- there is an increasing deformation and a decrease tensions in case of application of the force uniform distributed;
- through applications of distributed uniform pressure on the interior circularly surface of analyzed element, force corresponded of capable theoretical torsion moment, with rise of Young modulus of applied material, it was establish a decreasing of analyzed element displacement, maximum displacement being obtained in the case of applying the material characteristics corresponding to the etilen butadiene acrilonitrilic rubber NBR and uniform distribution of force;
- the maximum deflection of non-metallic element is maximum in case of non-metallic element from etilen butadiene acrilonitrilic rubber NBR, that means that this element realized by NBR is elder elastic;
- by Von Mises stresses analyse the maximum values are for the case of non-metallic element made by etilen butadiene acrilonitrilic rubber NBR;
- the principal tensions which appear in analyzed non-metallic element for those two qualities of rubber and for limit conditions and imposed loading conditions, have maxim values, having a variation between -2,01...1,68*10^6 N/mm^2, values corresponding for analyzed element with material characteristics corresponding to etilen butadiene acrilonitrilic rubber NBR.

REFERENCES

[1] Catia®Software Corporation. Catia® Version 5.8. Copyright © Dassault Systemes 1994 -2002.
[2] Mogan, Gh.L., Finite elements Method in engineering – practice applications. Lux Libris Publishing, Brasov, 1997.
[3] Mogan, Gh.L., Finite elements Method in engineering – theoretic bases. Lux Libris Publishing, Brasov, 1999.
[4] Radu, M., A new elastic coupling with nonmetallic elements, 3rd International Conference, „Research and Development in Mechanical Industry”, RaDMI 2003, Herceg Novi, Serbia and Montenegro, p 1935-1939.
[5] Radu, M., Doctoral thesis - Theoretical and experimental studies as concerns couplings with nonmetallic elastic elements. Brasov, Transilvania University of Braşov, 2005.
[6] Radu M., Săvescu, D. Some aspects regarding materials used in non-metallic elements construction of elastic couplings (part I). The 3rd WSEAS International Conference on Manufacturing Engineering, Quality and Production Systems, Transilvania University of Braşov, Braşov, Romania, WSEAS Press, 2011, p. 211 - 214.
[7] Radu M., Săvescu, D. Some aspects regarding materials used in non-metallic elements construction of elastic couplings (part II). The 3rd WSEAS International Conference on Manufacturing Engineering, Quality and Production Systems, Transilvania University of Braşov, Braşov, Romania, WSEAS Press, 2011, p. 215 - 218.