BULETINUL INSTITUTULUI POLITEHNIC DIN IAŞI
Publicat de
Universitatea Tehnică „Gheorghe Asachi” din Iaşi
Volumul 66 (70), Numărul 2, 2020
Secţia
CONSTRUCŢII DE MAŞINI

FEA STUDY ON AN OPEN-SOURCE PROJECT OF A BEAM CONNECTOR

BY

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Received: April 17, 2020
Accepted for publication: June 23, 2020

Abstract. Beam couplings are essential elements in many projects in mechanical engineering. The technical literature presents many possibilities and recommendations for starting a new design or using an offer present on the market. An alternative is to use an already existing project. The paper presents an open-source project of a beam connector designed by use of FreeCAD. The project is available in Internet. A preliminary FEA study was performed for two study cases: considering an eccentricity and an axial load. The state of distribution of the stress field and the deformations were analyzed on exterior of the main body and in various sections. The user could modify/adapt the existing project to actual needs within the open-source FreeCAD environment.

Keywords: FEA; FreeCAD; Beam connector; Open-source project.

1. Introduction

Flexible couplings are often used in mechanical engineering when it is necessary to transmit a torque while misalignment (axial, radial, angular) could be possible. The technical literature, (Mott Robert, 2004; Mott Robert *et al*., 2018), presents support for starting a new design for a specific project. There

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are also indications of Internet websites where the most important manufacturers on the market present their products in this field. Another alternative is to consider the open-source project option.

The paper presents a preliminary FEA study on the open-source project Beam-coupling-5mm-5mm, available in FreeCAD-library, (FreeCAD, 2019).

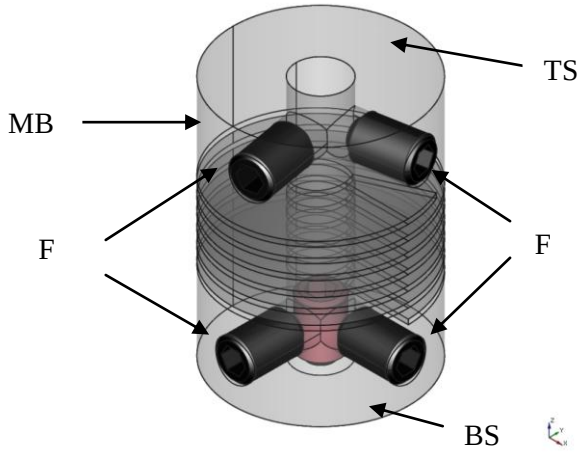


Fig. 1 − The initial full CAD model.

2. The CAD-FEA Study

The CAD model, Fig. 1, was designed within FreeCAD, (FreeCAD, 2019). The FEA study was performed on a simplified model, by removing the four fixtures F, used for connecting the two beams.

The assumed material for the beam connector was AISI1010 steel, (Materials web resource, 2019).

The geometry of the main body, MB was imported from FreeCAD to Salome-Meca, (*CAELINUX*, 2019). Due to this process, the convenient system of units used during the FEA study was meter, [m] for lengths, Newton, [N] for forces and [N/m^2] for stresses and pressures.

FEA study considered two study-cases:

Case1: Boundary conditions for top surface, TS, Fig. 1:

– eccentricity, applied in DX direction, of Dx = 0.001 m

– symbolic traction of 10^{-10} N/m^2 uniformly distributed on TS.

Case2: Boundary conditions for top surface, TS, Fig. 1:

– traction load of 10 N, uniformly distributed on TS.

In both study-cases, the bottom surface, BS, Fig. 1, was considered a fully fixed support surface.

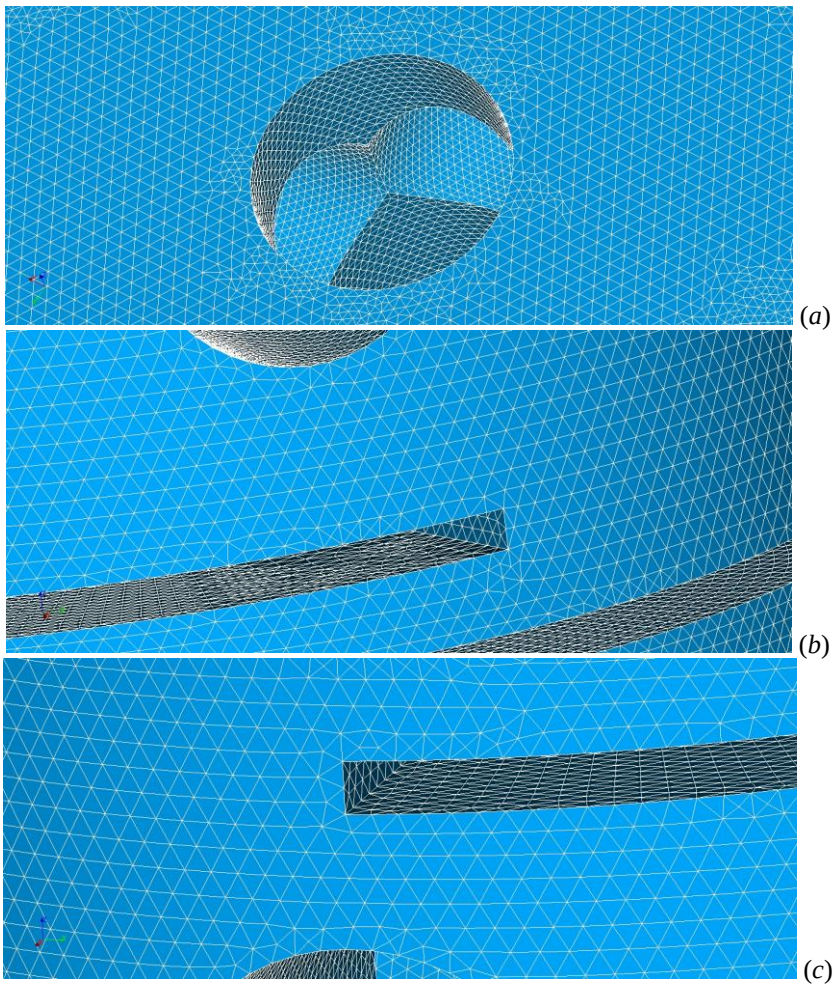


Fig. 2 – Details of the meshed model.

The mesh was performed automatically. Some statistical information concerning the mesh:

– 1,036,012 linear tetrahedral finite elements

– total number of nodes: 270,581

– total number of equations: 775,213.

The mesh density is relatively uniform, Fig. 2. The presented details were focused on the areas where geometry shapes changes:

– the top area for beam connection, Fig. 2*a*

– the top end of the helical shape of the elastic element, Fig. 2*b*

– the bottom end of the helical shape of the elastic element, Fig. 2*c*.

The mesh quality was analysed using several tools included in Salome-Meca. Fig. 3 presents the distribution of the parameters: minimum angle (*a*) and the aspect ratio 3D, (*b*).

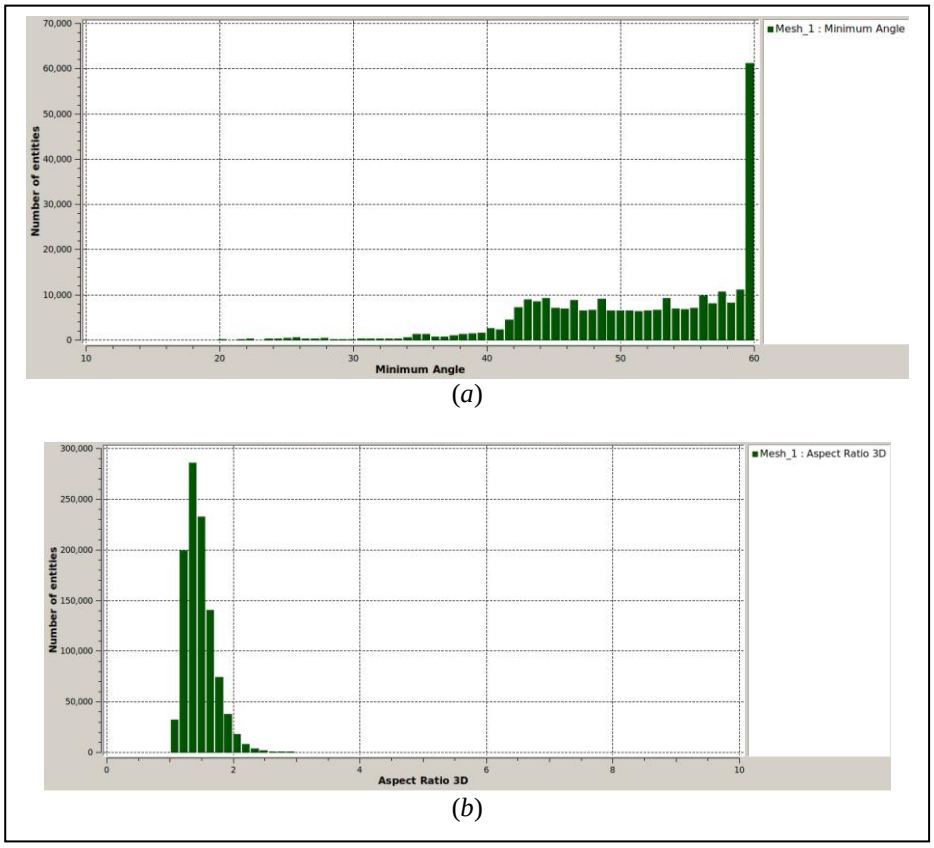
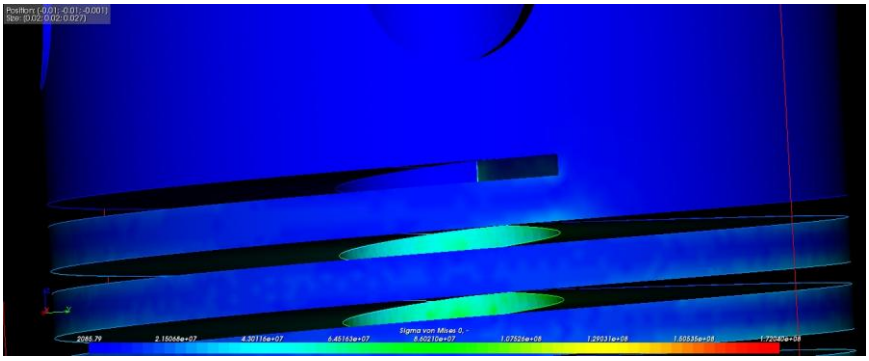


Fig. 3 − Mesh statistical details.

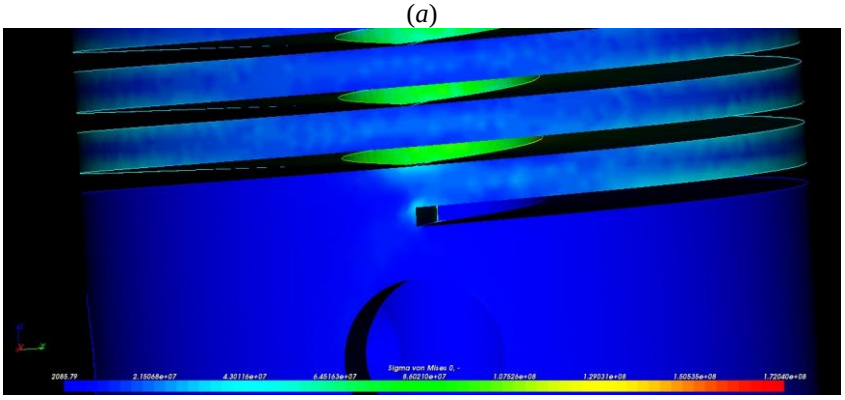
The post-processing of the FEA results made possible to evaluate the behavior of both study-cases. The next figures present a selection of the results obtained:

Fig. 4 presents for the study-case 1 the distribution of the von Mises stress at the limits of the helical part, at the top, (*a*), at the bottom, (*b*), and also in the axial section Oxz, (*c*).

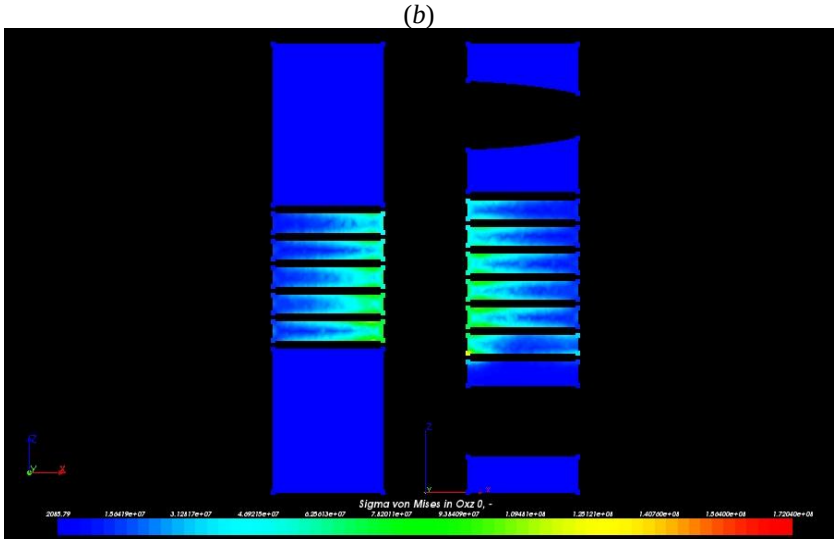
Fig. 5 presents for the study-case 2 the distribution of the von Mises stress for the entire beam-coupling body, (*a*), and an axial section in plan Oxz, (*b*). For the same study-case, Fig. 6 presents the displacement distributions in axial section Oxz.



(*a*)



(*b*)



(*c*)

Fig. 4 − Details of $\sigma_{\text{von Mises}}$ distribution, study- case 1.

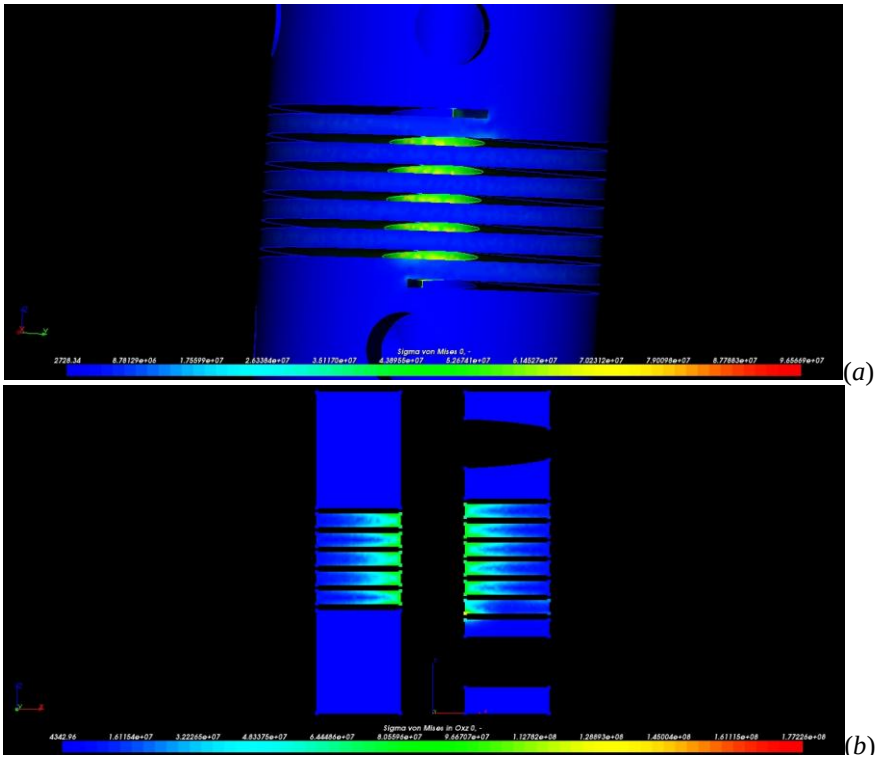


Fig. 5 − Details of $\sigma_{\text{von Mises}}$ distribution, study-case 2.

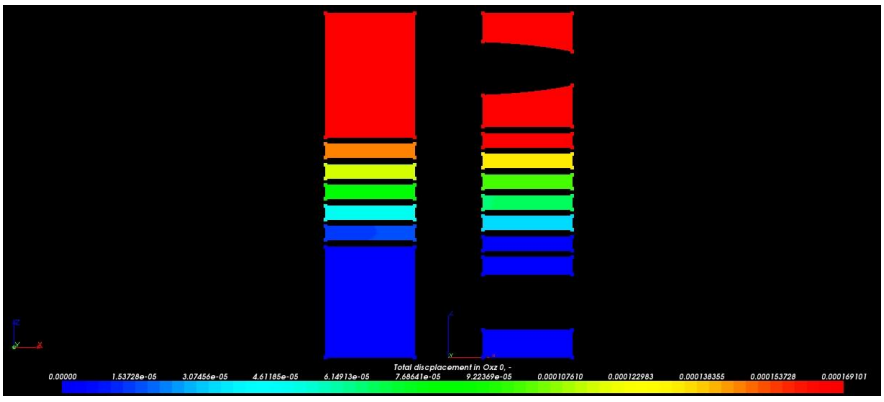


Fig. 6 – Displacements field for case study 2.

3. Discussions and Conclusions

Practically for both study cases:

– The areas at the limits of helical part of the beam coupler are not stress concentrators for the structure.

– The maximum von Mises stress was noticed on the interior radius of the helical part.

– The displacements field is relatively uniform.

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STUDIU FEA AL UNUI PROIECT OPEN-SOURCE DE CUPLAJ PENTRU BARE

(Rezumat)

Cuplajele sunt elemente importante în multe proiecte din ingineria mecanică. Literatura tehnică de specialitate prezintă multe posibilităţi şi recomandări de specialitate pentru a realiza un proiect nou sau a alege şi utiliza un produs industrial din producţia curentă de pe piaţă. O altă alternativă este de a utiliza un proiect deja existent. Lucrarea prezintă un proiect open-source pentru un dispozitiv care permite cuplarea barelor, care a fost realizat cu ajutorul pachetului FreeCAD. Proiectul acestui cuplaj este disponibil pe Internet. A fost realizat un studiu FEA preliminar care a considerat două cazuri de studiu: efectul unei excentricităţi şi al unei sarcini axiale. Au fost analizate distribuţiile câmpului deformaţiilor şi al tensiunilor pe suprafaţa exterioară a corpului principal şi în diferite secţiuni. Utilizatorul poate modifica/adapta proiectul existent în funcţie de cerinţele proprii în cadrul mediului FreeCAD.