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FEA STUDY ON THE BEHAVIOR OF SQUARE HALLOW PROFILES BEAMS SUBJECTED TO BENDING

BY

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Abstract. In many practical situations of life, not just in engineering it is necessary to use profiled beams in order to construct structures of various configurations. Although classical forms of profiles are known, there are also new shapes of profiles, in many cases a result of mass industrial production.

The paper compares by use of FEA the behavior at bending loading of two square profiles. Their shape is available in an open-source library. The analysis considered some parameters important in design: the deformation and the stress distribution. The study uses CAD and FEA open-source software packages.

Keywords: FreeCAD; FEA; CAELINUX; hallow profiles.

1. Introduction

Many engineering projects are based on the design and construction of a structure including profiled beams. Along with well known classical profiles shapes there is an important increase of new forms and shapes of hallow beams available in mass production, from metals or plastic materials.

The paper presents a CAD-FEA research on the behaviour at bending loading, considering two study-cases:

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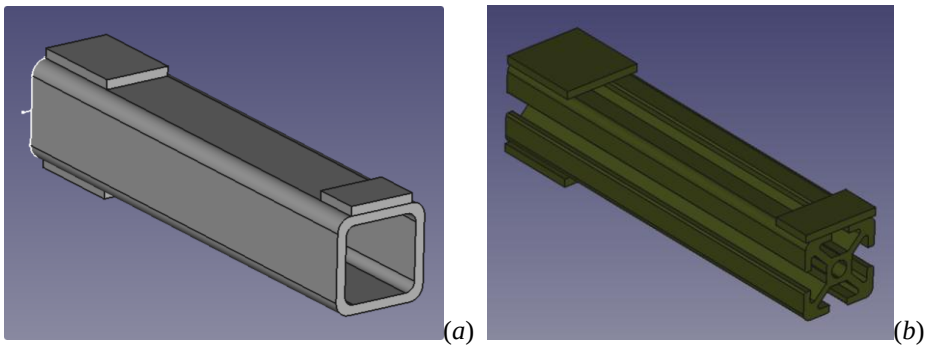
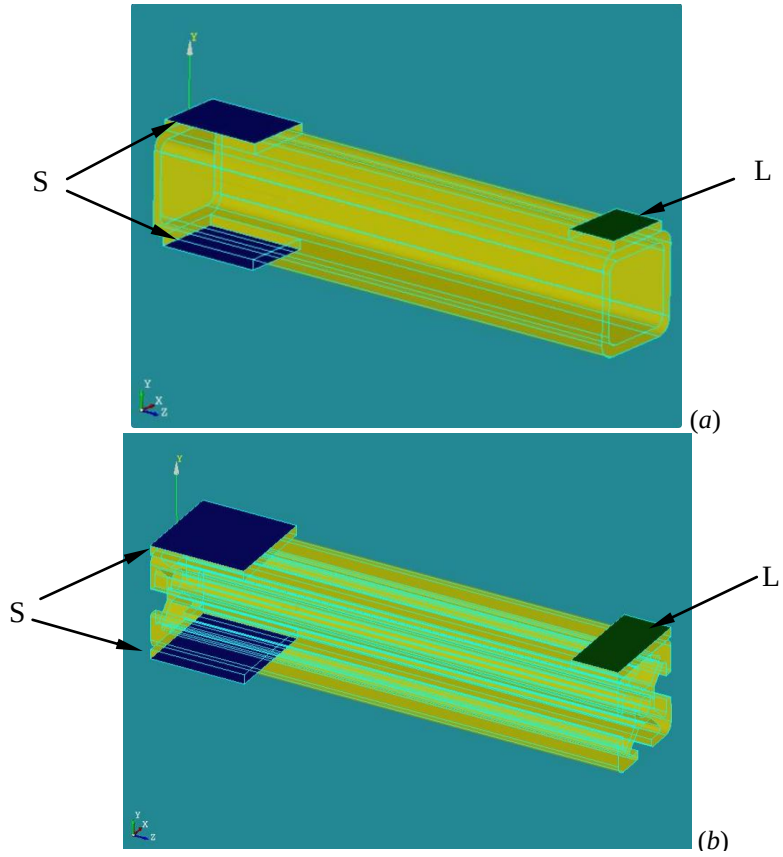
a) Case-study A: *Square hollow section 20x20x2 EN10219 S235JRH*
b) Case-study B: *Profile-20x20-I-Type_Slot5*, a classical form.



(*a*) (*b*)

Fig. 1 − The CAD models.



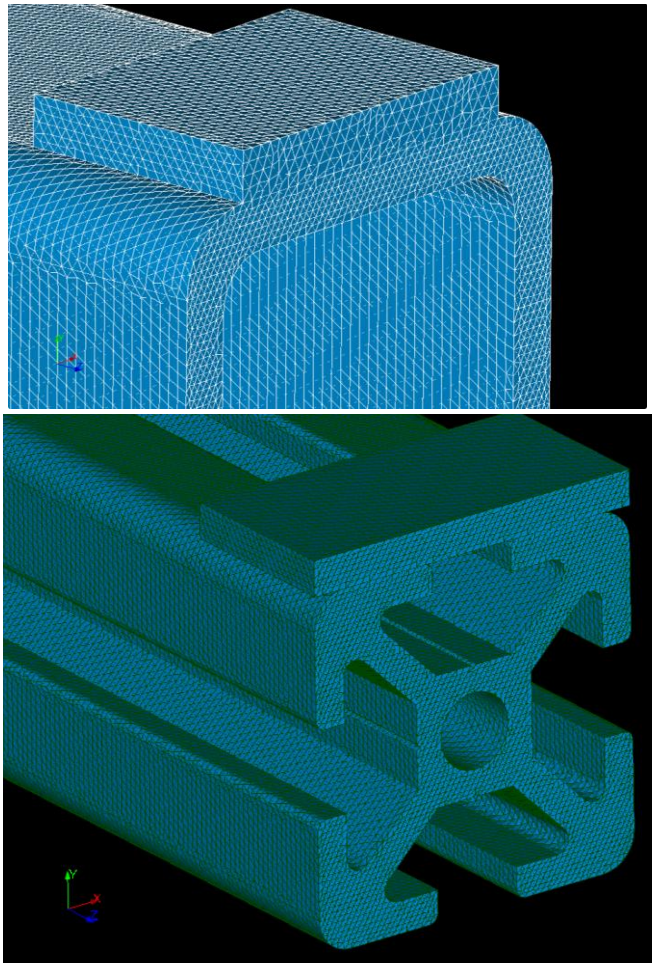
(*a*) (*b*)

Fig. 2 – Supports and loads.

2. The CAD-FEA Study

The CAD designs of both profiles are available in the FreeCAD-library (*FreeCAD*, 2019). They were transferred in Salome-Meca (*CAELINUX*, 2019). For each and every study-case it was designed, by use of FreeCAD, version 0.18.4 (*FreeCAD*, 2019), a test specimen. Their CAD models are presented in Fig. 1: (*a*) case-study A and (*b*) case-study B.

The boundary conditions for both FEA models are described in Fig. 2. S represents completely fixed surfaces and L is a surface on which there is applied a force of 200N considered as uniformly distributed on the entire surface.



(*a*)

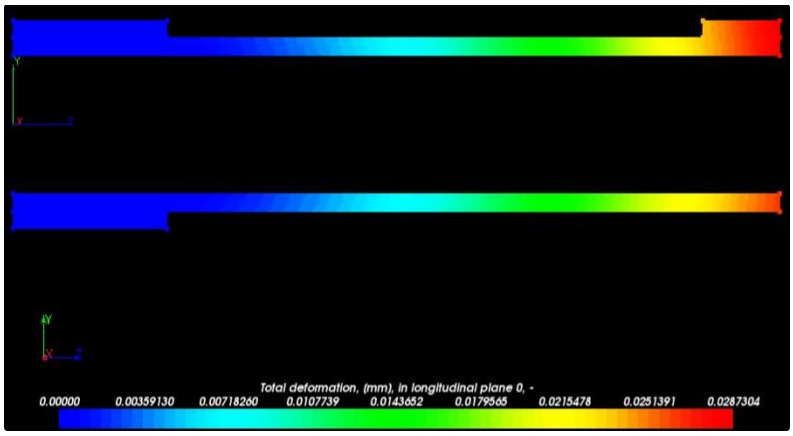
(*b*)

Fig. 3 − Mesh details of the FEA model (case study 4: H=40; W=20).

The most important characteristics of the FEA studies were:
– Case-study A: 580,273 linear tetrahedrals TETRA4, 137.088 nodes, 424.416 DOFs, Degrees of Freedom.
– Case-study B: 1,242,180 linear tetrahedrals TETRA4, 267,451 nodes, 849,813 DOFs, Degrees of Freedom.

No details concerning the mesh quality check were included in the paper, but, as presented in Fig. 3, the mesh has a quasi-uniform density.

Both models considered for FEA study a material type steel AISI 1010, (*Materials web resource*, 2019).



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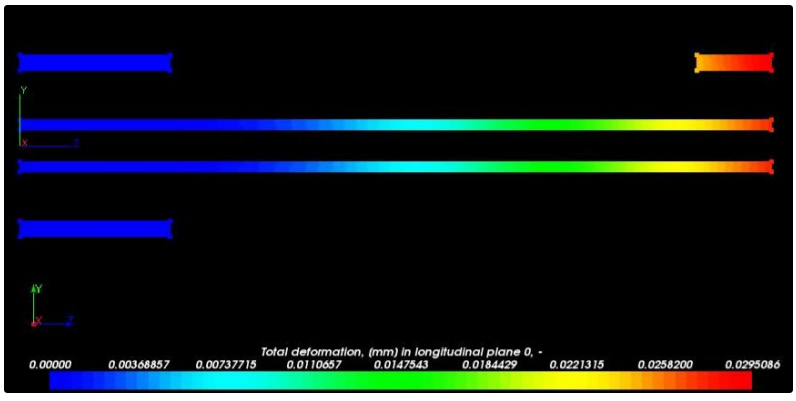
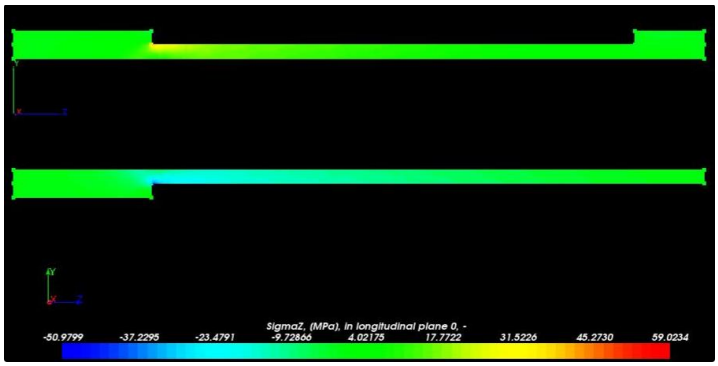


(*b*)

Fig. 4 – Total deformation.

The post processed information presented for both study-cases concerns the total deformation, Fig. 4, and the stress distribution: σ_z, Fig. 5 and $\sigma_{\text{von Mises}}$, Fig. 6. The stress distribution is presented both in longitudinal section and also in multiple parallel cross sections.



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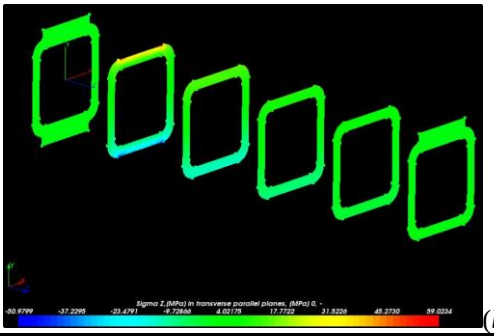

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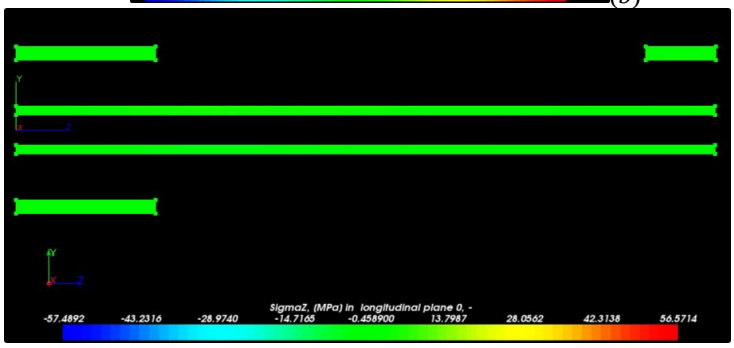

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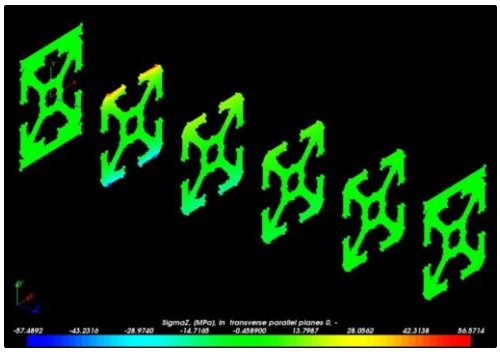

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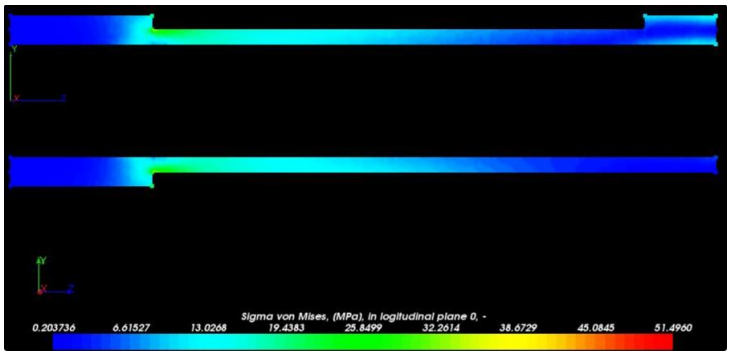
Fig. 5 − Details of σ_z distribution.



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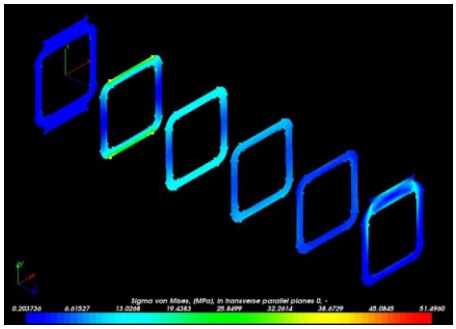

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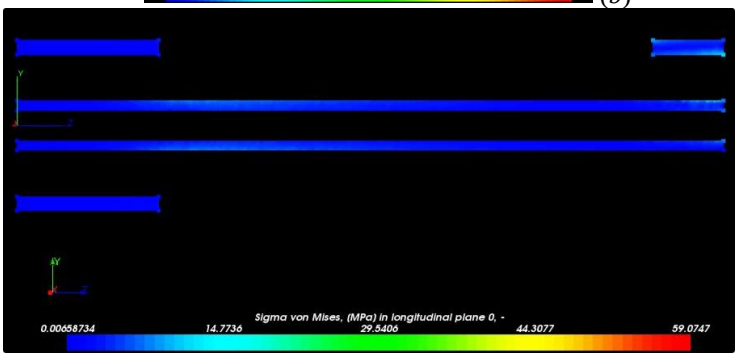

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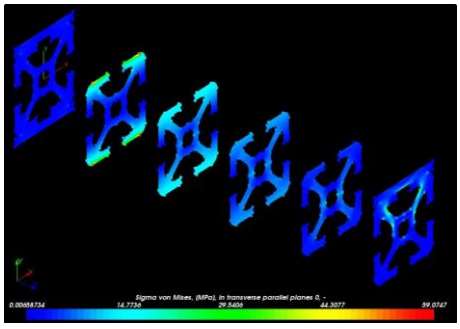

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Fig. 6 − Details of $\sigma_{\text{von Mises}}$ distribution.

3. Discussions and Conclusions

The use of the new hollow shape analysed, case-study B, caused, by comparison with the classical shape, case study A, the following effects:

– The total deformation increases with 2.7%. Case B beam is not more rigid than the case A.

– The values for σ_z are reduced by -4.15%. Considering a classical calculus known from the Strength of materials (Mareş, 2017) case B is a little more convenient.

– In the case of $\sigma_{von\ Mises}$ case B presenting an increase of 14.7%, definitely not very convenient.

– For comparison purposes, the volume of the test specimens of the two test case studies was evaluated by use of the facilities of Salome-Meca. Case B has a volume 31.2% greater than case A.

REFERENCES

Mareş M., *Rezistenţa materialelor* – Iaşi, Tehnopress, 2017.
*** *CAELINUX*, www.caelinux.com, accessed 1.11.2019.
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STUDIU FEA PRIVIND COMPORTAREA LA ÎNCOVOIERE A UNOR PROFILE DE BARE CU PEREŢI SUBŢIRI

(Rezumat)

În multe aplicaţii practice din viaţa de zi cu zi, nu doar în inginerie, este necesar să se utilizeze bare profilate pentru a construi structuri cu configuraţii dintre cele mai variate. Deşi formele clasice de profile sunt cunoscute, există de asemenea multe forme noi de profiluri, care în multe cazuri sunt produse industrial în serie.

Lucrarea compară, pe baza unor simulări FEA, comportarea la solicitarea de încovoiere a două profiluri pătrate. Forma lor este disponibilă într-o bibliotecă open-source. Analiza a urmărit câţiva parametri importanţi în proiectare: distribuţia deformaţiilor şi a tensiunilor. Studiul foloseşte pachete open-source CAD şi FEA.