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VIBRATION CHARACTERISTICS AND SEISMIC RESPONSE OF F.E.U.P. NEW CAMPUS LIBRARY BUILDING

Rui C. Barros[1(*)], Silvia Couto[1,2], Manuel B. César[1,3]

[1]CONSTRUCT Research Unit, Faculdade Engenharia Universidade do Porto, Portugal
[2]A400 - Projectistas e Consultores de Engenharia Lda, Porto, Portugal
[3]Instituto Politécnico de Bragança (IPB), Bragança 5300-253, Portugal
[(*)]*Email:* rcb@fe.up.pt

ABSTRACT

This work determines the numerical vibration characteristics and verifies the seismic response of FEUP (School of Engineering of the University of Porto) new campus library building, through the application of new seismic regulations EN 1998-1 (Eurocode 8). The building under study was designed in 1995, so based on the previous design rules RSAEEP (Regulations on Safety and Actions for Structures of Buildings and Bridges) and REBAP (Regulations for Reinforced and Prestressed Concrete Structures). For the building characterization and seismic analysis and performance according to EN 1998-1, the respective numerical modeling was performed by using two distinct types of software: SAP2000 and Robot Structural Analysis. These enabled comparisons between the results obtained from each type of software. The analysis performed, showed that the shear walls mostly resist to earthquake action; this led to a new numerical formulation in which the contributions of the columns in the resistance to the seismic action was not accounted for.

Keywords: Eurocode 8, seismic analysis, numerical modeling of library building.

INTRODUCTION

The library building of FEUP new engineering campus (at *Asprela* in *Paranhos* neighbourhood, Porto) of the University of Porto (Portugal) is one of FEUP's most iconic structures (Figure 1), especially due to its intrinsic library infrastructure and services provided with international comparative quality. It is therefore fully understood that its damage or loss in a catastrophic event would constitute a double loss: as property, and as inherent source of engineering core depository of potential knowledge and know-how.

Fig. 1 - The Library building of the Asprela engineering campus FEUP of University of Porto

The library building was modelled in SAP 2000 (SAP) and in AutoDesk Robot (Robot) structural analysis software, which are based upon finite element discretization.

The library building structure was inserted through a grid methodology, defined in the X-Y-Z directions, which has the following advantages: homogenization of all input work, better control of insertion of structural elements, and better match of an almost geometric equality between the two numerical models. The structural elements are inserted at the alignments of their centre of gravity. In both software columns and beams were modelled using bar elements, while the stiffening walls were modelled by shell elements (Couto, 2013).

RESULTS AND CONCLUSIONS

The first three vibration mode shapes (out of five modes that will be envisioned) using SAP are shown in Figure 2, while the one's obtained using ROBOT are also similar and will be included in the final detailed paper. Their relative precision is ascertained calculating the MAC parameter for these modes (Allemang, 2003).

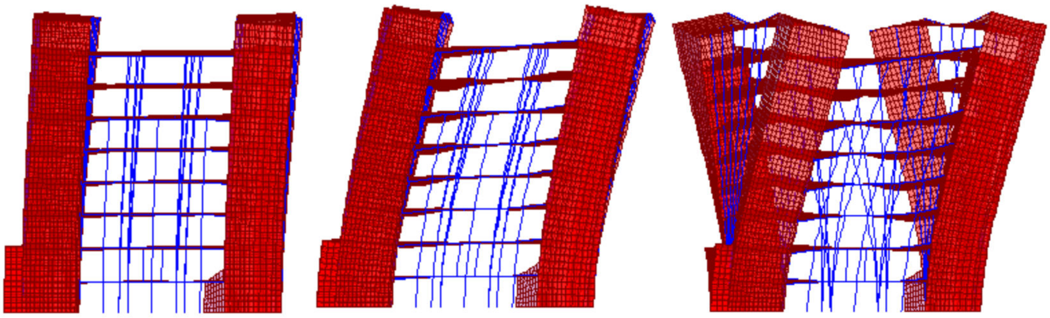

Fig. 2 - First three mode shapes evaluated by using SAP 2000

The distribution of seismic forces in the x and y horizontal directions, of the three dimensional (3D) modelling of FEUP's library building, is also calculated using SAP 2000 and using ROBOT. According to the Eurocode 8 (EN 1998-1, 2009) the columns can be considered as secondary level structural elements if they absorb less than 15% of the seismic action. Based on this it can be said that for all practical purposes the columns in the library building are secondary elements, and the major supporting elements assuring structural seismic performance and stability are the stiffening walls.

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