Evaluation of the influence of the thin-walled beams placement in the sandwich panels roof construction

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Abstract. The problem of the interaction between C- and Z-thin-walled beams cross sections with sandwich panels with polyurethane foam core have been taken into consideration. The designation of the influence of the cross section shape and placement of the thin-walled beams stabilized by sandwich panel on the beam buckling form has been the main considered problem. All of various numerical experiments have been carried out within the Abaqus/CEA environment with the Newton-Raphson procedure taking into account geometrical and material nonlinearity.

PROBLEM FORMULATION

In recent times, thin-walled beams are more and more frequently used as elements of a steel halls system (purlins, wall beams, construction of casing and eaves beams). The main advantage of thin-walled beams is a favourable mass to bearing capacity and stiffness ratio. On the other hands, they also have negative effects, due to the large slenderness of its walls, thin-walled cross sections are susceptible to the local loss of stability. Both local loss of stability (local buckling) as well as distortional buckling and global buckling (flexural, torsional, lateral-torsional and flexural-lateral) are the most common forms of the thin-walled beams buckling.

The EN 1993-1-3 code contains guidelines which describe the interaction between thin-walled beams and trapezoidal sheets. Over the last decade, there have been carried out some researches by Dürr 2008, Dürr and Misiek 2011 which confirm that not only the trapezoidal sheets but also sandwich panels can provide the lateral restrain of the thin-walled elements. The influence of a placement method (Fig. 1b) of thin-walled beams stabilized by sandwich panel on thin-walled beam buckling form have been analysed in this research. The analysis consisted of type Z- and C-cross sections with different size as presented in the Fig. 1a.

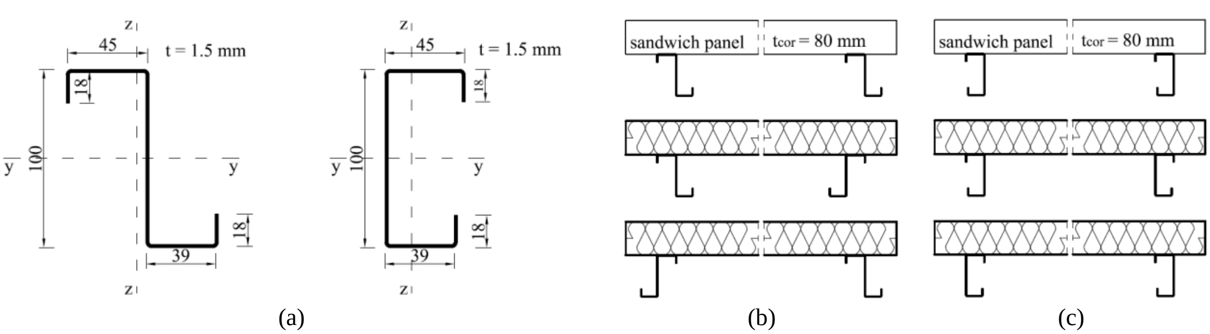

FIGURE 1. Analysed cross-sections: a) dimensions, b) Z-beams placement, c) C-beams placement.

NUMERICAL MODEL

The initial numerical model had been defined and analysed by Ciesielczyk and Studziński 2017 within the Abaqus/CEA environment. The numerical model had been verified and validated by the laboratory experiments. The verification and validation testbed has been presented in the Fig.2. The numerical model consists of: angle cleats, thin-walled beams with various shapes and placement, sandwich panels and a I-beam travers which converts concentrated load to uniformly distributed load.

Structural steel elements, such as: thin-walled beams, sandwich panels steel facings and angle cleats have been modelled as S4R shell elements. Whereas, the polyurethane foam core the I-beam travers have been modelled as brick solid elements. The significant steel properties of mentioned elements used in the numerical model have been defined as they were used in the research testbed.

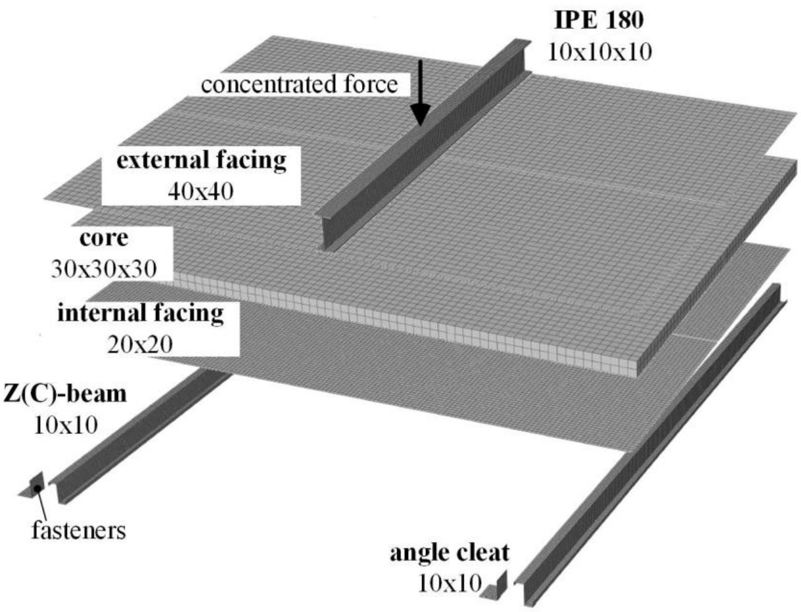

FIGURE 2. The numerical model scheme with the dimensions of the mesh elements (given in mm).

ACKNOWLEDGMENTS

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