EXPERIMENTAL VALIDATION OF A FINITE ELEMENT MODEL OF TRANSVERSALLY STIFFENED PANEL UNDER A DOUBLE PATCH LOADING

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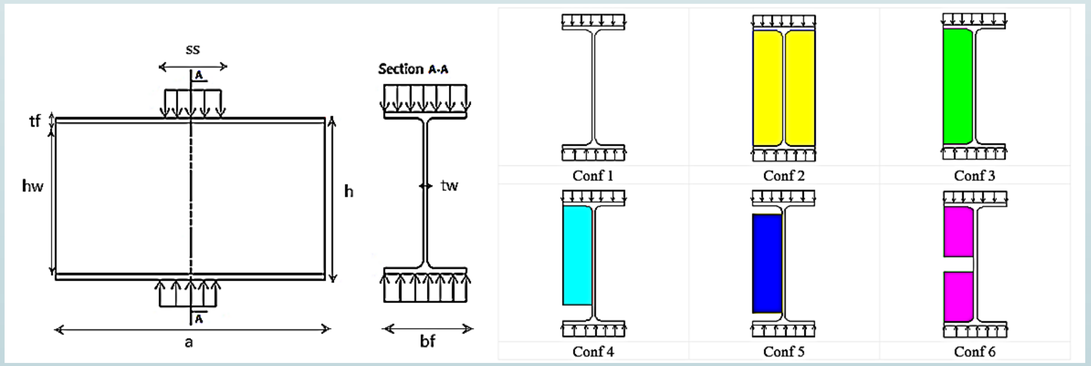
Introduction

The transverse stiffeners are widely used in the field of steel construction. However, their design methods are poorly developed. In this study, the influence of the transverse stiffeners on the behavior of a cross-section under double localized compression is analyzed. Five configurations of transverse stiffeners are studied. They cover single and double stiffeners over a part or the whole height of the web panel. The stiffeners are welded or not to the flange. Real tests are performed to observe the behavior and to obtain the load-displacement curve of each configuration. Then, a finite element model is developed using Cast3m software with consideration of geometric and material nonlinearities. This numerical model is validated on the basis of the test results considering the resistance and the buckling modes of the tested panels.



Configurations of tested transverse web stiffeners

Methods

TEST CAMPAIGN

Six specimens were tested at the MSGC platform (Pascal Institute and Polytech) of Clermont Auvergne University (dimensions summarized in the following table).

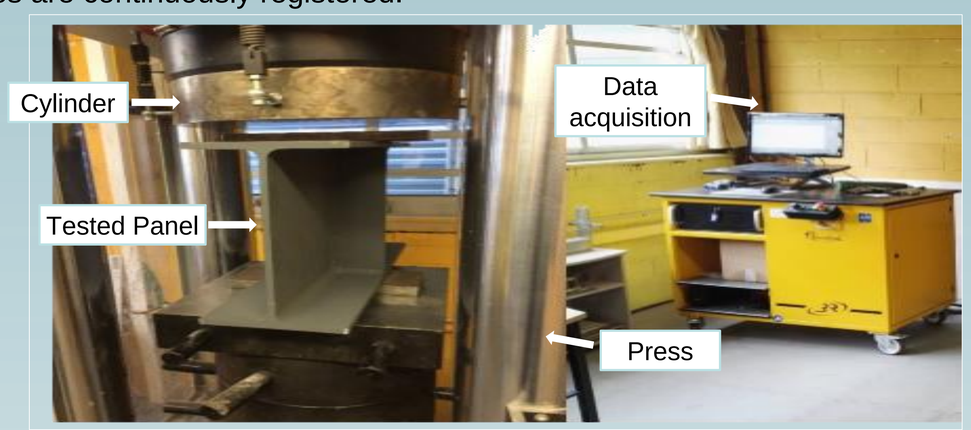
Geometric details of transverse web stiffeners

Model	h_w (mm)	t_w (mm)	t_f (mm)	b_f (mm)	$h_s^{(1)}$ (mm)	$t_s^{(2)}$ (mm)	Description
Conf. 1	278.6	7.1	10.7	150	--	--	Unstiffened
Conf. 2	278.6	7.1	10.7	150	278.6	8	double stiffener, all height
Conf. 3	278.6	7.1	10.7	150	278.6	8	simple stiffener, all height
Conf. 4	278.6	7.1	10.7	150	232.2	8	simple stiffener welded to a flange and a part of the web
Conf. 5	278.6	7.1	10.7	150	232.2	8	simple stiffener welded to the middle of the web
Conf. 6	278.6	7.1	10.7	150	232.2	8	simple stiffener welded to the two flanges and a part of the web

(1) h_s : the height of the stiffener
(2) t_s : the thikness of the stiffener

OPERATING MODE

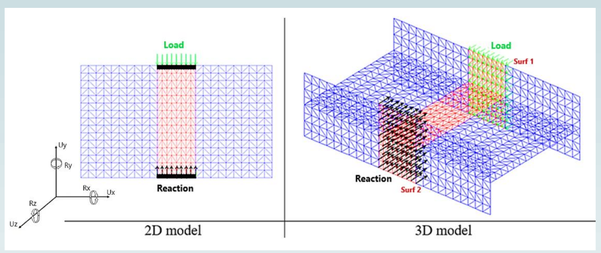
The load is applied controlling the displacement rate to observe the post-failure modes (Testing machine with a capacity of 3000 kN). The load-displacement curves are continuously registered.



Experimental tests setup

FINITE ELEMENT MODELING

The finite element model is three-dimensional consisting of three-node DKT shell elements. The geometry is defined by the mean plane of each panel with the associated thickness of each element. The mesh density was chosen on the basis of a convergence study. The stiffeners are added considering their dimensions. The red part of the flange represents the loaded zone.



Finite element model

Boundary conditions

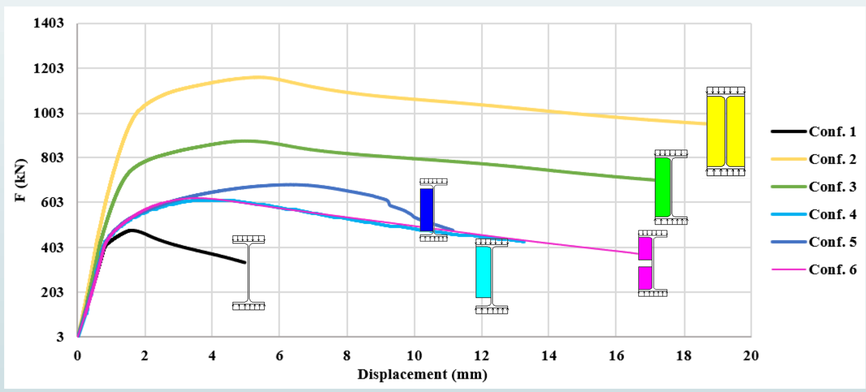
axis	Ux	Uy	Uz	Rx	Ry	Rz
Surf 1	⦿		⦿		⦿	
Surf 2	⦿	⦿	⦿	⦿	⦿	

⦿ : blocked

Results

EXPERIMENTAL RESULTS

The test results concern mainly the load-displacement curves.

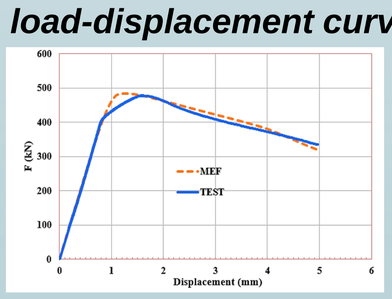


Load-displacement curves (experimental results)

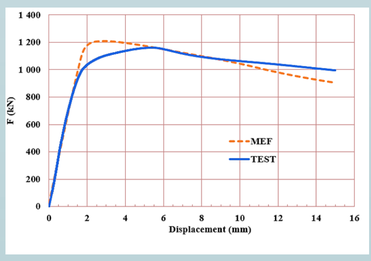
VALIDATION OF THE FINITE ELEMENT MODEL

The numerical model is validated by comparison of its results with those of the tests (the load-displacement curves and the buckling modes).

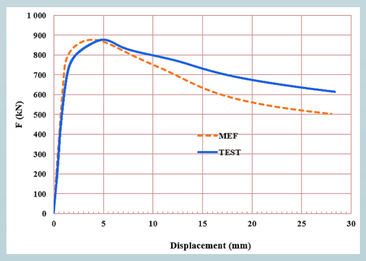
load-displacement curves



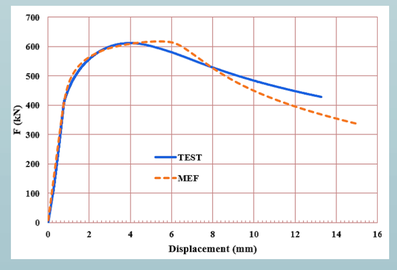
Load-displacement curves of Conf. 1



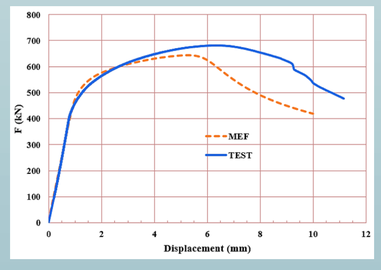
Load-displacement curves of Conf. 2



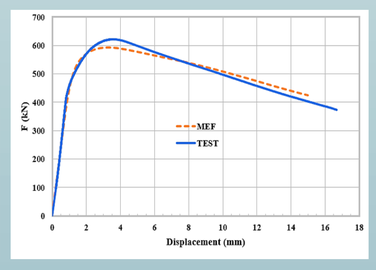
Load-displacement curves of Conf. 3



Load-displacement curves of Conf. 4



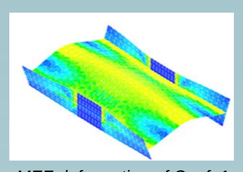
Load-displacement curves of Conf. 5



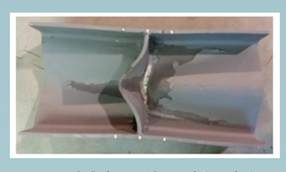
Load-displacement curves of Conf. 6

Buckling modes

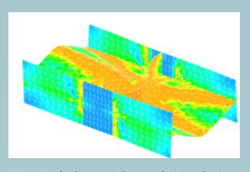
real deformation of Conf. 1



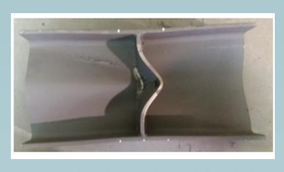
MEF deformation of Conf. 1



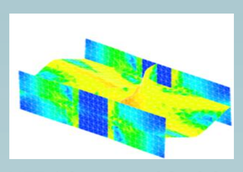
real deformation of Conf. 2



MEF deformation of Conf. 2

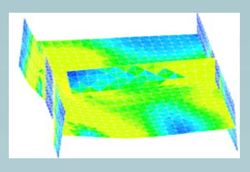


real deformation of Conf. 3

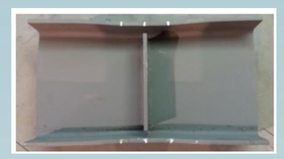


MEF deformation of Conf. 3

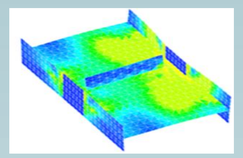
real deformation of Conf. 4



MEF deformation of Conf. 4

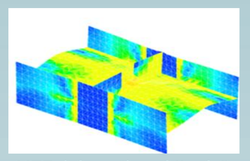


real deformation of Conf. 5



MEF deformation of Conf. 5

real deformation of Conf. 6



MEF deformation of Conf. 6

Conclusions

The present study analyzed the behavior of transverse stiffened web panels subjected to an opposite patch loading. A numerical model is developed using the CAST3M software and calibrated using the results of an experimental study. The behaviors of different shapes of stiffeners are examined showing that the addition of a transverse stiffener in all cases increases the strength of the panel. An analytical model is under development on the basis of a large parametric study performed using the validated finite element model.

Bibliography

1. **EN-1993-1-5 (2006), Eurocode 3 - Design of steel structures - Part 1-5: General rules: Plated structural elements.**
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4. **Sung C. Lee, Doo S. Lee, Chai H. Yoo, "Design of intermediate transverse stiffeners for shear web panels", Engineering Structures 75 (2014) 27-38.**