6th European Conference on Computational Mechanics (ECCM 6)
7th European Conference on Computational Fluid Dynamics (ECFD 7)
11 – 15 June 2018, Glasgow, UK

COMPUTATIONAL ASSESSMENT OF THE STRUCTURAL PERFORMANCE OF CONCRETE BEAMS WITH ENCASED STEEL JOIST

R. Ballarini[1], L. La Mendola[2], J. Le[3], and A. Monaco*[4]

[1] Dept. of Civil and Environmental Engineering, Cullen College of Engineering, Univ. of Houston, N127 Engineering Bldg. 1, Houston, TX 77204-4003, rballarini@uh.edu

[2] Dept. of Civil, Environmental, Aerospace and Material Engineering, Univ. of Palermo, Viale delle Scienze Edificio 8, 90128 Palermo, Italy, lidia.lamendola@unipa.it

[3] Dept. of Civil, Environmental, and Geo-Engineering, Univ. of Minnesota, 500 Pillsbury Dr. SE, Minneapolis, MN 55455-0116, jle@umn.edu

[4] Dept. of Civil, Environmental, Aerospace and Material Engineering, Univ. of Palermo, Viale delle Scienze Edificio 8, 90128 Palermo, Italy, alessia.monaco@unipa.it

Key Words: *FEM modelling, Fracture, Size and geometrical effects, Composite structures.*

This study concerns the computational assessment of the failure modes of hybrid beams made up of prefabricated steel truss encased within a concrete block and named hybrid steel trussed concrete beams (HSTCBs). The considered failure mode is under three-point bending and the adopted approach is developed by means of finite-element (FE) simulations of beams of different scaled sizes, whose design corresponds to current industrial practice. The FE model is based on well-established constitutive relations of both concrete and steel. In particular it employs a continuum damage model for concrete (concrete damaged plasticity model) and a classical elastic-plastic multi-linear behaviour for steel. As regards contact at the interface, two different approaches are used and compared: a simplified contact condition able to simulate perfect bond and a non-linear cohesive interaction capable of reproducing the progressive degradation of the initial contact condition. Furthermore, models are generated also employing finite elements of different type and order and, therefore, the computational efforts required by each model are compared in order to evaluate the efficacy of the simplest modelling type able to retain the salient features of the structural mechanism. Existing experimental data are used for validating the numerical results. The simulations on specimens of three different sizes show that, in the absence of three-dimensional geometrical similarity, the small-size beam exhibits shear failure while the large-size beams attain a more ductile failure under flexure. The numerical results allow observing a transition between different failure modes, which indicates the importance of employing a robust three-dimensional FE model for design extrapolation of HSTCBs across different sizes and geometries.

REFERENCES

[1] R. Ballarini, L. La Mendola, J. Le and A. Monaco, A computational study of failure of hybrid steel trussed concrete beams, *J. Struct. Eng.*, Vol. **143**(8), art. no. 04017060, 2017.

[2] Z. P.Bažant, and B.H. Oh, Crack band theory for fracture of concrete. *Mater. Struct.*, Vol. **16**(3), pp. 155–177, 1983.

[3] P. Colajanni, L. La Mendola and A. Monaco, Experimental Investigation on the Shear Response of Precast Steel-Concrete Trussed Beams, *J. Struct. Eng.*, Vol. **143**(1), art. no. 04016156, 2017.

[4] A. Monaco, Numerical prediction of the shear response of semi-prefabricated steel-concrete trussed beams, *Constr. Build. Mater.*, Vol. **124**, pp. 462-474, 2016.