

Editorial

Tak-Ming Chan BEng, MSc, DIC, PhD, PCAPP, CEng, MStructE, MASCE

Assistant Professor, Department of Civil and Environmental Engineering,
The Hong Kong Polytechnic University, Hong Kong



The second part of this two-part themed issue ‘High strength steel structures’ captures further the state of the art in design of high strength steel structures. Part I of this themed issue can be found on the virtual library (ICE, 2017). Part II features 8 papers on topics ranging from material characteristics at elevated temperature & under cyclic loads, residual stress patterns in fabricated box sections, cross-section behavior of hollow sections under different loading scenarios, assessment on Warren-type welded tubular trusses to structural performance of eccentrically braced frames with the use of dual steel grades.

The first two papers focus on the material characterisation of steel materials with nominal yield strengths of 690 MPa and 700 MPa. The first paper (Winful *et al.*, 2017) presents an experimental investigation on 690 MPa (quenched and tempered) and S700 MPa (thermo-mechanical control processed) steel materials under isothermal tests at temperatures between 20 and 800°C. Experimental results indicate the effect of chemical composition and processing route on their elevated temperature material performance. The comparison with the European design code is also discussed. The second paper (Wang *et al.*, 2017) illustrates the cyclic performance of steel materials with nominal yield strength of 690 MPa (quenched and tempered) with an aim to evaluating and predicting the cyclic characteristics. Results are assessed in relation to the characteristics of the normal strength steel materials in terms of the ductility requirements, the stress-strain hysteretic behaviours, cyclic hardening/softening behaviour. A combined trilinear isotropic and kinematic model is proposed for quenched and tempered steel materials with nominal yield strength of 690 MPa.

Moving from material characteristics to the effect of fabrication process on the residual stress patterns at cross-section level, the third paper (Somodi *et al.*, 2017) summarises the experimental and numerical investigations on the residual stress patterns on welded square box sections with a wide range of steel materials with nominal yield strength between 235 MPa and 960 MPa. The assessments are based on the same cross-section geometry and the same welding procedure that was used to form the box-shaped specimens. Results indicate the compressive residual stress pattern is dependent

on the cross-section geometry and independent of the yield strength. The measured maximum tensile residual stress reaches the yield strength for all steel grades in the assessment.

The subsequent three papers characterise the cross-section behavior of square hollow sections from different fabrication processes and at different loading conditions. The fourth paper (Gkantou *et al.*, 2017a) first presents a numerical investigation on hot-finished square/rectangular hollow section stub columns under concentric compression to assess the current cross-section classification system. Specimens are with nominal yield strength of 460 MPa and 690 MPa. Results indicate the applicability of the current European design rules on class 3 slenderness limits for square/rectangular hollow sections with nominal yield strength of 690 MPa. However, it is overly conservative for 460 MPa specimens and current continuous strength method has been extended to cover the performance of the square/square hollow section with nominal yield strength of 460 MPa with satisfactory prediction. In addition, an effective cross-section approach is proposed for class 4 cross-sections. The fifth paper (Pavlovic and Veljkovic, 2017) presents the results from the numerical investigation on cold-formed square and rectangular hollow section beams under four-point bending arrangement covering a wide range of steel materials with nominal yield strength from 355 MPa to 960 MPa. Considerations on the welding-induced imperfections were also taken into account in the numerical modelling. Slenderness limits in current cross-section classification system together with the material ductility requirements in European codes of practice are discussed and assessed. The sixth paper (Gkantou *et al.*, 2017b) complements the fourth paper and presents the experimental and numerical investigations on hot-rolled square and rectangular hollow section stub columns under combined compression and un-axial bending. Specimens are with nominal yield strength of 460 MPa and 690 MPa. Structural performance data are assessed with the interaction curves currently adopted in European code of practice for normal strength steel.

Finally, the last two papers focus on the structural system in which hybrid use of steel materials are adopted in a Warren-type welded tubular truss and an eccentrically braced frame.

The seventh paper (Tiainen *et al.*, 2017) presents the assessment on the effect of steel grade on weight and cost of Warren-type welded tubular trusses made up of cold-formed square hollow sections. The hollow sections are with nominal yield strength of 355 MPa, 500 MPa, 700 MPa and 960 MPa. The assessment is based on the current design provision from European code of practice for normal strength steel. Results indicate the beneficial effects of using different strength steel in braces and chords. The eighth paper (Duan and Su, 2017) presents the experimental investigation on the hybrid use of steel with nominal yield strengths of 355 MPa and 460 MPa in eccentrically braced frames. Steel with nominal yield strength of 460 MPa was adopted for the frames and braces while 355 MPa steel was adopted for the vertical links in the system which were failed by either shear or flexural dominant failures. Results indicate the adoption of dual materials in the system which demonstrates satisfactory structural performance.

In this two-part themed issue ‘High strength steel structures’, there are 15 papers in total with authors from Australia, China, Czech Republic, Finland, Germany, Hong Kong, Hungary, Singapore, the Netherlands, and the United Kingdom. I sincerely hope you benefit from reading this themed issue and share our thoughts in congratulating the authors for their achievements and contributions to date.

REFERENCES

- Duan L and Su M (2017) Seismic testing of high-strength steel eccentrically braced frames with a vertical link. *Proceedings of the Institution of Civil Engineers – Structures and Buildings* **170(11)**: 874–882, <https://doi.org/10.1680/jstbu.16.00100>.
- Gkantou M, Theofanous M, Antoniou N and Baniotopoulos C (2017a) Compressive behaviour of high-strength steel cross-sections. *Proceedings of the Institution of Civil Engineers – Structures and Buildings* **170(11)**: 813–824, <https://doi.org/10.1680/jstbu.16.00101>.
- Gkantou M, Theofanous M, Wang J, Baniotopoulos C and Gardner L (2017b) Behaviour and design of high strength steel cross-sections under combined loading. *Proceedings of the Institution of Civil Engineers – Structures and Buildings* **170(11)**: 841–854, <https://doi.org/10.1680/jstbu.16.00114>.
- ICE (Virtual Library) (2017) <http://www.icevirtuallibrary.com/toc/jstbu/170/9> (accessed 26/09/2017).
- Pavlovic M and Veljkovic M (2017) Compact cross-sections of mild and high-strength steel hollow-section beams. *Proceedings of the Institution of Civil Engineers – Structures and Buildings* **170(11)**: 825–840, <https://doi.org/10.1680/jstbu.16.00124>.
- Somodi B, Kollár D, Kövesdi B, Néző J and Dunai L (2017) Residual stresses in high-strength steel welded square box sections. *Proceedings of the Institution of Civil Engineers – Structures and Buildings* **170(11)**: 804–812, <https://doi.org/10.1680/jstbu.16.00139>.
- Tiainen T, Mela K, Jokinen T and Heinisuo M (2017) The effect of steel grade on weight and cost of Warren-type welded tubular trusses. *Proceedings of the Institution of Civil Engineers – Structures and Buildings* **170(11)**: 855–873, <https://doi.org/10.1680/jstbu.16.00112>.
- Wang YB, Li GQ, Sun X, Chen S and Hai LT (2017) Evaluation and prediction of cyclic response of Q690D steel. *Proceedings of the Institution of Civil Engineers – Structures and Buildings* **170(11)**: 788–803, <https://doi.org/10.1680/jstbu.16.00115>.
- Winful DA, Cashell KA, Afshan S, Barnes AM and Pargeter RJ (2017) Elevated temperature material behavior of high-strength steel. *Proceedings of the Institution of Civil Engineers – Structures and Buildings* **170(11)**: 777–787, <https://doi.org/10.1680/jstbu.16.00213>.