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Jeffrey A. Packer
Bahen/Tanenbaum Professor, Department of Civil Engineering, University of Toronto, Ontario, Canada

Leroy Gardner
Reader, Department of Civil and Environmental Engineering, Imperial College London, UK

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Editorial

J. A. Packer MSc, PhD, DSc, PEng, CEng, FICE, FASCE and L. Gardner MSc, PhD, DIC, CEng, MICE, MIStructE

This themed issue on tubular structures has been timed to coincide with the pre-eminent conference on this topic – the 13th International Symposium on Tubular Structures, or ISTS13, in Hong Kong, China in December 2010. Since its inception in 1984, this Symposium has become the principal showcase for manufactured (or on-shore) tubing and the prime international forum for discussion of research, developments and applications in this field. After the 12th International Symposium on Tubular Structures, in Shanghai, China in 2008, the International Programme Committee for ISTS12 believed that a number of the recent developments in this field should be reviewed and consolidated in a more definitive publication. This themed issue is the result of that genesis. The seven papers included herein are authored by 21 of the contemporary international 'personalities' in tubular structures, with all being current or former academic researchers.

The lead paper by Zhao *et al.* (2010) describes the current static design recommendations for welded tubular joints, the facet of tubular construction that is the main 'problem area' for structural design engineers. A technical committee of the International Institute of Welding (IIW) – Subcommission XV-E on 'Tubular Structures' – has produced several design recommendations for tubular joints, since its conception in 1964, including three editions of static design recommendations in 1981, 1989 and 2009. This paper describes the latter, which is already a draft international (ISO 14346) standard, and relates the changes and developments back to the previous 1989 edition (which is the basis of most national and regional design rules in existence today). A number of design guides currently available are also described and related to the IIW recommendations.

The following article by Packer *et al.* (2010) deals with the many materials that are available worldwide for tubular structures and the influential properties that should govern the choice. A large number of hollow-section production specifications are surveyed, predominantly for cold-formed tubing, and their strengths and weaknesses are elaborated. The ability to galvanise cold-formed, square and rectangular hollow sections, and the choice of material for energy-dissipating tubular members under severe seismic loading, are two topics given much consideration. A series of large-scale experiments is described which supports the ability of either hot-formed or cold-formed, circular hollow-section members to be used as diagonal braces (the lateral load-resisting elements) in steel braced frames under severe seismic loadings, *provided* the tubes meet cross-sectional slenderness limits (i.e. are sufficiently stocky).

Design with elliptical hollow sections is then reviewed by Chan *et al.* (2010). The elliptical-shaped hollow section, with an aspect ratio of 2:1, was introduced as the newest member of the structural steel tube family in the 1990s. Since then, it has had much architectural appeal and a great deal of research has taken place to define its structural behaviour, particularly under compression, bending, and the combination of compression and bending. A thorough state-of-the-art review is given of cross-sectional behaviour and (code) classification, shear response, member performance, connections and even concrete-filled elliptical hollow sections, with numerous recommendations for structural design purposes.

Castings have seen a renaissance in the steel construction industry and there are now a large number of examples in off-shore jacket structures, buildings and bridges. Herion *et al.* (2010) review the international scene from North America, to Europe and China, but Europe still represents the forefront of casting standardisation and the majority of applications. Custom castings for buildings, customised nodes for fatigue-critical bridges and mass-produced castings for standardised applications are all featured. Amongst the latter category, the use of cast steel connectors in buildings, for which seismic loading is the governing criterion, is an interesting development. In steel braced frames castings have been used as elastic connectors (to connect to yielding elements) or as energy-dissipating inelastic elements themselves (and thereby enabling adjacent members and connections to remain elastic).

As mentioned previously, both the current (2010) and previous (2008) International Symposia on Tubular Structures have been held in China. This is symbolic of the important role that China plays in the steel world today, both in terms of its exports and domestic consumption of steel products, including tubes. The use of steel tubes in building construction is reportedly increasing at a rate of 20% per year. The fifth review article, by Shen and colleagues from Tongji University in Shanghai (Shen *et al.*, 2010), is thus devoted to a state-of-the-art report on tubular construction in China. In addition to remarkable landmark structures (such as for the Beijing 2008 Olympic Games), long-span roofs, space frames, tubular trussed towers and electricity transmission line towers are featured amongst

their impressive case studies. Their review of Chinese tubular structures work, mostly undertaken at Tongji University, is useful, particularly the novel tests on welded joints under inelastic cyclic (seismic) loading. Commentary on the imminent *Chinese Technical Specification for Structures with Steel Hollow Sections* is very timely and useful in an international marketplace. The authors interestingly note that, despite the nine chapters of this specification 'there are no design guidelines on FE modelling'.

This subject of finite-element (FE) modelling is the very topic of the next paper, in which van der Vegte *et al.* (2010a) review current 'best practices' for FE analysis of welded and bolted hollow-section joints. Numerical modelling, generally by FE analysis, has become commonplace in tubular structures research nowadays and this is the preferred mode for examining the influence of particular parameters or variables. Experimental research, on the other hand, frequently now fills the role of validating FE models, prior to their use for parametric studies. In addition to research purposes, FE modelling is often used by design teams in conjunction with large, one-of-a-kind structures. Even experienced FE analysts will benefit from the review of element types, material and geometric non-linearity, options for weld modelling and failure criteria. Most FE analysis is still currently performed using *implicit* analysis (based on static equilibrium), but the alternate *explicit* approach (using dynamic equilibrium) – which avoids the construction and solution of a global stiffness matrix – is well presented and shows considerable advantages for FE models with a very large number of nodes and elements.

The final paper, by van der Vegte *et al.* (2010b), re-examines the capacity of welded circular hollow-section T, Y and X joints loaded by brace (branch) in-plane or out-of-plane bending moments. The international database is assembled and carefully screened, resulting in recommended new moment capacity equations for such joints. These design rules have been incorporated into the 2009 International Institute of Welding (IIW) *Static Design Procedure for Welded Hollow Section Joints – Recommendations*, which are described in the first paper (Zhao *et al.*, 2010). This study by van der Vegte *et al.* (2010b) is a perfect example of the rigour that has been exercised in re-analysing all design equations against available databases, when generating the latest IIW (2009)/ISO 14346 international standards.

The papers in this issue have surveyed a large number of topical aspects of current tubular steel construction. In addition to the usual journal focus towards the readership of researchers, this issue should be of great practical use to design engineers and people involved in the steel industry.

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