# Spotlight on Structures

Research Journal of The Institution of Structural Engineers

**In this new section of *The Structural Engineer*, we shine a spotlight on papers recently published in *Structures* – the Research Journal of The Institution of Structural Engineers.**

***Structures* is a collaboration between the Institution and Elsevier, publishing internationally-leading research across the full breadth of structural engineering which will benefit from wide readership by academics and practitioners.**

**Access to *Structures* is free to all during 2015. From 2016, Institution members will continue to receive free access as one of their membership benefits. The journal is available online at: www.elsevier.com/locate/structures**

---

The first papers published in *Structures* are already available online, with the journal officially launching later this month. In addition to an editorial from *Structures* Editor-in-Chief, Leroy Gardner, the first issue contains the following papers:

### High strength rubberized concrete containing silica fume for the construction of sustainable road side barriers

*Mohamed Elchalakani, Civil Engineering Department, Higher Colleges of Technology, Dubai Men's College, Dubai, United Arab Emirates*

This paper provides strength and durability test results for rubberized concrete that contains silica fume (microsilica) for road side barriers with the intent to reduce injuries and fatalities during crashes. New design guidelines in accordance with the Australian Bridge Design Code AS 5100 for strength and serviceability of rubberized concrete road side barriers were derived based on the test results. The newly derived design rules showed that shear strength is critical compared to the combined moment and axial thrust and the maximum rubber contents were 17% and 30% for normal and high strength concretes, respectively.

### Ultimate capacity of structural steel cross-sections under compression, bending and combined loading

*Andrew Liew and Leroy Gardner, Department of Civil and Environmental Engineering, Imperial College London, South Kensington Campus, London, UK*

The Continuous Strength Method (CSM) is a strain based structural steel design approach which allows for the beneficial influence of strain hardening. The method has been previously developed for predicting compression and bending resistances in isolation. This paper describes extension of the method to enable the prediction of the ultimate cross-section resistance of I-sections and box sections under combined loading. The resulting CSM design predictions have been compared with existing test data, and shown to give additional capacity over current design approaches and a reduction in scatter of the predictions.

### Characterization of concrete specimen fracture response: 2D numerical study

*N. Trivedi, R. K. Singh and J. Chattopadhyay, Reactor Safety Division, Bhabha Atomic Research Centre, Trombay, Mumbai, India*

The reported investigations undertaken so far on concrete fracture involve limited tests on laboratory size concrete specimens and provide a basic understanding of the fracture phenomenon, but the precise quantification of fracture parameters is still elusive. While performing the numerical study of concrete components using finite element method, mesh sensitivity is an extremely important issue which is investigated in this paper, through detailed analysis of geometrically similar three point bend (TPB) beams having constant length to depth ratio. The finite element modeling of the TPB concrete beams performed by incorporating the fracture energy based softening model predicted the results that are found to be mesh insensitive. In the present finite element analysis, the performance of triangular elements is investigated and observed to be superior over the quadrilateral elements.

### Engineering stress solutions for bolted and pressurized steel structures

*Nelli Aleksandrova, Centre of Exact Sciences and Engineering, Madeira University, Funchal, Madeira, Portugal*

Two geometrical models of bolted connections and pressurized containers are suggested. A unified analytical procedure for stresses is developed based on the Huber–Mises–Hencky yield criterion, elastic–perfectly plastic material behavior and plane stress assumption. To determine the minimum distance between centers of fasteners in bolted connections the limit load-carrying capacity criterion is proposed. The results obtained agree well with AISC specifications and on the safe side. For pressurized containers it is shown that stress distributions depend on Poisson's ratio which should be taken into account in a stability analysis since these structures are mostly vulnerable to the local loss of geometric stability.

### Economical design procedures for built-up box sections subject to compression and bi-axial bending

*Osama Bedair and P. Eng, NOVA Chemicals, Alberta, Canada*

The paper offers to practitioners economical procedures that can be utilized to optimize the design of built up box sections subject to compression and biaxial bending. The analysis methodology and structural idealization are first overviewed. Diagrams are presented showing buckling behavior of the section by accounting rotational and lateral restraints. The post-buckling response is also illustrated for various applied stress ratios. A design space concept is then introduced showing interaction of serviceability and strength limit states. These procedures are cost effective and appropriate for industrial implementation to optimize the structural design.

### Thermoelastic buckling and post-buckling of weakened columns

*Guotao Yang and Mark A. Bradford, Centre for Infrastructure Engineering and Safety, School of Civil and Environmental Engineering, The University of New South Wales, Sydney, Australia*

Structural columns in engineering practice may weaken over time as a result of corrosion, erosion, impact, fatigue cracking or similar effects that reduce their effective cross-section. The effect of the degradation of the cross-section may then lead to premature flexural buckling. This paper presents a solution for the buckling and post-buckling behaviours of such weakened columns under thermal loading.

### Sustainable reinforced masonry walls under lateral in-plane load: Experimental behavior and code-based predictions

*Richard P. Clarke, Department of Civil and Environmental Engineering, University of the West Indies, St. Augustine Campus, Trinidad, West Indies*

Reducing the quantities of materials is an effective means of increasing environmental sustainability. To improve the environmental sustainability of hollow unit reinforced masonry low-rise structures in hurricane or earthquake-prone regions, it is reasonable to use squat walls with horizontal reinforcement in the form of steel mesh. Eight near full-scale walls were tested with control variables as the type and amount of horizontal reinforcement – masonry mesh; fabric reinforcement, and hexagonal wire mesh. The investigation focused on the ultimate load conditions and code-based equations were used to determine theoretical failure loads for comparison with the test failure loads. Given the significance of shear to the response of squat walls, 7 shear strength equations from various codes and other studies were investigated, as well as a failure criterion that considers bending–shear interaction. The performance of the walls was favorable in terms of structural requirements.

### Using the vibration envelope as a damage-sensitive feature in composite beam structures

*Stavros Kasinos, Alessandro Palmeri and Mariateresa Lombardo, School of Civil and Building Engineering, Loughborough University, Loughborough, UK*

A novel approach of damage detection in composite steel–concrete composite beams is suggested. Based on the idea of using the envelope's profile deflections and rotations induced by a moving load, this approach can lead to a practical cost-effective alternative to the traditional use of accelerometers and laser vibrometers. When compared to shifts in the natural frequencies, it has been verified that the proposed approach generally enjoys a higher sensitivity (so damage can be detected at an early stage), is more effective when closer to the ends of the bridge (where shear studs are more likely to be damaged), and displays an ordered set of results (which would reduce the possibility of a false damage).