



## STABILITY AND DUCTILITY OF STRUCTURES

### EDITORIAL

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This special issue of the *Journal of Civil Engineering and Management (JCEM)* contains expanded and significantly improved versions of selected papers presented at the International Conference *Stability and Ductility of Structures* – the Baltic Session of the International Colloquium held in Vilnius, Lithuania in September 2009 and sacred to commemorate the Millennium of the name of Lithuania for the first time mentioned in Saxon Quedlinburg annals.

The International Colloquia on Stability and Ductility of Structures have been sponsored by the Structural Stability Research Council (SSRC) for quite a long time and are intended to summarize progress considering theoretical, numerical and experimental research in the field of stability and ductility of steel and composite steel-concrete structures as well as taking into account the newly developed effective structural assemblages of components from different and new building materials. This International Colloquium series can be traced back to November 1972 (Paris, France) and their 20 editions took place in a broad range of countries and regions. The last three editions were held in Timișoara, Romania (September 1999), Budapest, Hungary (September 2002) and Lisbon, Portugal (September 2006). The next edition of the International Colloquium on Stability and Ductility of Steel Structures (SDSS' Rio 2010) will be held in Rio de Janeiro, Brazil (September 2010).

The Introduction to the Proceedings of the International Colloquium on Stability and Ductility of Structures held in Timișoara, Romania (Dubina and Iványi (Eds) 1999) gives information about decisions made at Nagoya, Japan (September 1997) edition: "In Nagoya, it was decided to continue the series of travelling colloquia by launching the Sixth Colloquium in September 1999 with the First Session to be held in the "Politechnica" University of Timișoara, Romania followed by the next session in the year 2000 at the Gediminas Technical University in Vilnius, Lithuania, a third one – during SSRC's Year 2000 Annual Meeting in the USA and fourth one in Australia or New Zealand". However, due to some unfavour-

able circumstances, a session foreseen to be held at Vilnius Gediminas Technical University in Lithuania in the year 2000 took place only in September 2009.

It is necessary to express the great gratitude to Professor of Budapest University of Technology and Economics, a member of the Structural Stability Research Council (SSRC) Miklós Iványi who was an initiator of decision-making to hold the Second session of the Sixth Colloquium at Gediminas Technical University in Vilnius, Lithuania.

Professor Miroslav Škaloud from the Institute of the Theoretical and Applied Institute of the Czech Academy of Sciences, a member of the Structural Stability Research Council (SSRC) was also one of most enthusiastic supporters and advisers for the organisers of the Colloquium session in Vilnius.

Professor W. Samuel Easterling, the Chairman of the Structural Stability Research Council (SSRC) expressed his happiness to help in organising the Colloquium session in Vilnius. Upon his recommendation, the Executive Committee voted to offer SSRC's support as a non-funding Co-Sponsor to the Colloquium session in Vilnius. This support was very important for ensuring the success of the session in Vilnius where interesting and important reports about different aspects evaluating the stability and ductility of structures were presented. These presentations were an important base for collecting the most important writings suggesting their authors to expand and improve the papers to be suitable for publishing in the *Journal of Civil Engineering and Management*. Such solution enabled to arrange this particular issue of JCEM.

The introduced edition would not have been possible without the enthusiastic support of Prof. E. K. Zavadskas for his capacity as the Editor-in-Chief of the Journal, and therefore expressing a very deep gratitude for his purposeful work is necessary.

Organising this special issue of JCEM is also based on the situation that different directions of investigating the stability and ductility of structures have been perma-

nently taken for quite a long time by the edited and published Lithuanian scientific and technical journals in the field of structural engineering. While mentioning publications prepared for the last 5 years, the following ones are worth being quoted: Doleček *et al.* 2009; Grigorjeva *et al.* 2008; Kala *et al.* 2005; Kreja *et al.* 2005; Kudzys and Kvedaras 2006; Kudzys and Kliukas 2008a, 2008b; Kudzys 2009; Kuranovas *et al.* 2009; Malesza and Miedzialowski 2006; Mang *et al.* 2009; Mazzolani *et al.* 2009; Samofalov and Šlivinskis 2009; Šapalas *et al.* 2005; Zergua and Naimi 2006; Žiliuklas *et al.* 2006; Žiliukas 2008.

The submitted extended versions of the papers underwent a rigorous International peer review procedure. Quality was the sole criterion for accepting publications.

At the beginning of this issue (Bjorhovde 2010), the paper presents an overview of the Evolution and State-of-the-Art of Column Stability Criteria. The strength and stability of steel columns have been the subjects of a great many studies since the original works done by Leonhard Euler in 1744 and 1759. Numerous examinations on elastic buckling of perfectly straight columns were conducted during the 19<sup>th</sup> century the most famous of which are the studies by Engesser and Considère containing several series of column tests attempting to find an agreement between theory and physical behaviour. Research work continued in the 20<sup>th</sup> century examined the influence of material and member imperfections, including the famous tangent modulus work of Shanley and the resolution of effects on material non-linearity, residual stress and column out-of-straightness. The definitive solutions were only obtained in 1970-s when modelling and numerical solutions were allowed for incorporating all nonlinear effects. Since that time, reliability and probabilistic solutions have provided state-of-the-art criteria for the limit state treatment of the column problem. These principles are now the basis for designing standards of columns all over the world. The paper focuses on the major points of evolution and especially on work made over the last 40 years. The realistic treatment and representation of the strength of columns in actual structures have now been achieved by the engineering profession.

The next paper (Pasternak and Kubieniec 2010) deals with the behaviour evaluation of Plate Girders with Corrugated Webs. Especially for the main frames of single-storey steel buildings, the use of corrugated web beams, mainly with sinusoidal corrugation, has been substantially increased during the last years. Due to the thin web of 1.5 mm to 3 mm, corrugated web beams afford a significant weight reduction compared with hot rolled profiles or welded I-sections. Buckling failure of the web is prevented by corrugation. Buckling resistance of the presently used sinusoidal corrugated webs is comparable with the plane webs of 12 mm thickness or more. Due to improvements in the automatic fabrication process, corrugated webs up to 6 mm thickness became possible. Therefore, the field of applying this beam type has been considerably extended. Even short span bridges are possible now. Dimensioning corrugated web beams is ruled by the EN 1993-1-5 Annex D covering only web thicknesses up to 3 mm. In the last years, many tests and finite

element simulations have been carried out. Regarding this background, these EN rules are discussed and extended. Furthermore, additional proposals for patch loading and lateral-torsional buckling of girders with sinusoidal webs are given

The paper (Virdi and Azzi 2010) describes the Behaviour of Parallel Girders Stabilised with U-Frames. Lateral torsional buckling is a key factor in designing steel girders. Stability can be enhanced by cross-bracing reducing effective length and thus increasing ultimate capacity. U-frames are an option often used to brace girders when designing the required type of bridges and where overhead bracing is not practical. This paper investigates the effect of U-frame spacing on the stability of parallel girders. Eigenvalue buckling analysis using four different spacing of U-frames was undertaken. The obtained results were extracted from finite element analysis and interpreted and conclusions were drawn.

The paper (Pavlovčič *et al.* 2010) presents tests on slender thin-walled box columns susceptible to the instability of both types including global Euler buckling and local buckling of steel plates. Eight full-scale tests on different global slenderness of welded and cold-formed columns subjected to centric and eccentric compression were carried out. For the purpose of profound numerical simulations of the tests, material properties were also tested and the initial column geometry and residual stresses were carefully measured. The results of FEA simulations show a good agreement with the test results. Considering the verified numerical model, the influence of different initial imperfections was studied.

The paper (Kudzys *et al.* 2010) discusses the expediency of using probability-based approaches in the analysis of beams subjected to lateral-torsional buckling. The values of buckling resistance moments and their uncertainties for rolled and equivalent welded sections as particular members of designed structures are analyzed. The safety margins of buckling steel sections exposed to permanent and variable vertical loads are modelled. The survival probability and reliability index of the sections exposed to lateral-torsional buckling are considered. Predictions for the probability-based safety of the rolled and welded beams in buildings and civil engineering works are provided and illustrated by numerical examples.

The paper (Kliukas *et al.* 2010) looks at the expediency of reinforcing precast spun concrete members of annular cross sections reinforced by high-strength steel bars. Test materials, mechanical properties, production and testing procedures of plain and reinforced spun concrete specimens are presented. The quasi-ductile strength and strain features of concentrically and eccentrically loaded specimens are considered. Modelling the bearing capacity of the beam-columns of annular cross sections is based on the concepts of bending with concentric force and compression with a bending moment. A comparison of modelling is drawn and test data on spun concrete beam-columns is analysed.

The paper (Venskuskis *et al.* 2010) delivers an elastic-plastic axisymmetric steel bending plate subjected to the repeated variable load. The worked out solution to the

problem of load optimization at shakedown is complicated because the stress-strain state of dissipative systems (e.g. plastic deformation of the plate) depends on their loading history. A new algorithm for the problem of load optimization combining von Mises and Tresca yield criterion based on the Rosen project gradient method is proposed. The results of optimization are obtained integrating the existing software and that created by the authors.

The paper (Baikovs and Rocēns 2010) investigates the preservation of the initial shape of timber composite material sheets using reinforced plastic reinforcement. A calculation model for determining the thickness of a rational reinforcement anticlastic sheet providing a change in the original bending radius under variable moisture conditions within the limits of preferable intervals is developed by the authors using the finite element method. An opportunity to provide an original shape of anticlastic timber composite material sheets using glass fibre reinforced plastic reinforcement under variable moisture conditions and not exceeding 5 percent difference has been demonstrated.

The paper (Goode *et al.* 2010) considers the analysis of experimental data on 1817 concrete-filled steel tubes – CFSTs. These results are compared with the predicted results of the load-bearing capacity of calculating slender elements according to the methods suggested by Eurocode 4. The types of tested CFSTs such as circular and rectangular hollow section stub and long columns fully filled with concrete including or excluding the applied moments at the ends of specimen were analysed. The test results of load bearing capacity for circular concrete-filled steel tubular columns correspond with the calculated values based on the methods presented by Eurocode 4. The experimental values of load bearing capacity for the members of concrete-filled rectangular hollow sections strongly agree with theoretical values where concrete cylinder strength is below 75 N/mm<sup>2</sup>. The performed analysis has demonstrated that preloading concrete-filled hollow section members does not influence load bearing capacity.

The paper (Sliseris and Rocēns 2010) demonstrates that an option on reducing material consumption in bent construction is flat plate replacement with a curved or saddle shaped plate (shell). This option applies to a plywood sheet provided that the curved or saddle shaped plates are made of widely used multilevel plywood presses with parallel shelves using layers with appropriate physical properties, geometric dimensions and orientation creating a structurally asymmetrical sheet relative to mid-surface. The improved currently used method for calculating curvature taking into account curvature interaction effect and elastic characteristic changes into the moisture changing process. The obtained results are compared applying the improved method and the finite element method. Using the improved method, the values of the curvature of a sheet having different geometrical properties and moisture conditions are calculated.

The paper (Šapalas 2010) deals with a theoretical and numerical analysis of the local stability of the web of tapered beams subjected to a pure bending moment. A

standard FEM code COSMOS/M has been used for a numerical estimation of a critical load multiplier. It has been assumed that the critical stress of the web of the tapered beam could be calculated in an analogous way as for a uniform member only with an additional correction factor  $\alpha_{b,w}$ . A large number of simulations carried out within a wide range of the ratios of the second moment of area allowed to determine the proper values of the factor. The paper investigated the influence of steel grade, relative slenderness and beam end cross-section moments of inertia ratio to the local stability of the web of the tapered beam subjected to pure bending.

The paper (Daniūnas and Urbonas 2010) analyzes semi-rigid beam-to-beam end-plate bolted joints subjected to bending and tension or compression axial force. The level of axial forces in the joints of structures can be significant and has a significant influence on the characteristics of semi-rigid joints. The extension of the component method for evaluating the influence of a bending moment and axial force on the rotational stiffness and moment resistance of a joint is introduced in the paper.

In the last paper (Rasiulis and Gurkšnyš 2010), the main objective of the presented investigations is to identify the stress/strain state of the wall tank with local imperfections from the ideal cylindrical surface taking into account the membrane theory of shells using the finite element method.

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