Steel Construction Ausgabe 02/2023

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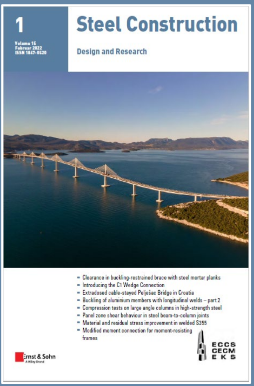

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Steel Construction publishes peer reviewed papers covering the entire field of steel construction research. In the interests of “construction without depletion”, it skillfully combines steel with other forms of construction employing concrete, glass, cables and membranes to form integrated steelwork systems. Since 2010 Steel Construction is the official journal for ECCS- European Convention for Constructional Steelwork members. You will find more information about membership on the ECCS homepage.

Topics

Dieter Ungermann, Tim Lemanski, Bettina Brune

A new Eurocode-compliant design approach for cold-formed Steel Sections

Thin-walled, cold-formed steel sections are used in a wide range of areas from industrial steel construction to special applications like viticulture. The variety of individual, user-specific sections with or without perforations is large.
The great advantages of the individual design of cold-formed sections are accompanied by great difficulties in the realistic assessment of the ultimate limit state. EN 1993-1-3 is available for design purposes of cold-formed members and sheetings. However, this was developed essentially for C- and Z-shaped purlins, so that its applicability is limited for the multitude of cold-formed profiles. In addition, the design is time-consuming and complicated due to the highly complex, coupled instability modes.
The research project presented in this paper deals with the development of a new, Eurocode-compliant design approach by avoiding the complicated effective width method and using finite strip software for eigenvalue analysis. The calculation of the cross-sectional resistance is essentially based on the user-friendly Direct Strength Method, which is part of the American standardisation AISI. The design for global or coupled instabilities fallows EN 1993-1-3.
Tests were carried out on various C-, Z- and Ω-shaped sections under compressive and bending loads for verification of the new design approach. Numerical parameter studies extend the experimental program. The results are promising, so that an alternative design approach will be provided.

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Topics

Jonas Nonn, Vera Wilden, Markus Feldmann

A consistent approach for stability verification of steel structures

The "General Method" according to chapter 6.3.4 of EN1993-1-1 or 8.3.4 of prEN1993-1-1 deals with the verification of stability problems of frame and beam structures with loadings in-plane. The "General method" according to Eurocode is intended for the general case of a combined moment and normal force. For the choice of the reduction factor χop, there are two options for applying the reduction curve, either the minimum of lateral torsional buckling (LTB) and flexural buckling (FB) or a weighted combination of both. With the use of analytical derivations, it can be shown that this approach leads to inconsistencies which can possibly lead to incorrect results. In this paper an alternative approach is presented and leads to unification and fully mechanical justification in verification. The approach allows e.g. the verification of stability of an entire frame system directly and without interaction factors (as in the equivalent member method). In addition, the issue of a consistent equivalent imperfection is addressed. With the use of the General Method non-linear analyses of structures showing out-of-plane instability can be omitted; only an in-plane calculation and a determination of the critical load is necessary. Finally, examples are presented in this paper that demonstrate the application of the approach shown.

André Dias Martins, Pedro Borges Dinis, Ben Young

Local-Distortional Interaction in CFS Lipped Channel Beams

This paper reports an experimental investigation on the behaviour and strength of cold-formed high-strength steel (G450-G500) lipped channel beams susceptible to local-distortional interaction. The experimental campaign comprised 36 tests involving simply supported beams bent about the major-axis, exhibiting various ratios between their distortional and local critical buckling moments (1.09 to 1.46) and acted by either uniform (20 tests) or non-uniform (trapezoidal – 16 tests) bending diagrams. The results presented and discussed consist of equilibrium paths, photos providing the evolution of the beam deformed configurations and failure moments. The paper also includes a few remarks on the design, using the Direct Strength Method, of the beams under consideration.

Topics

Aljoscha Buchholz, Marc Seidel

Gap height prediction for bolted ring flange connections based on measurements

Previous investigations have shown that initial parallel gaps between L-flange connections can increase fatigue load of the connecting fasteners significantly. Wind turbine towers and their flange connections are highly fatigue loaded structures. Initial gaps between unloaded flanges result from their respective flatness of the contact surfaces. Flange flatness has to comply with limitations given in relevant standards and therefore must be measured after the manufacturing process. More than 1900 flatness measurements of several Offshore Wind projects were collected and used to determine initial gaps between flanges analytically. A statistical evaluation allows to determine the distribution of expected gap sizes. The increase of gap height with increasing gap length can be described with linear correlations. Further, the distributions of gap heights are approximated with log-normal distributions. Parameters for generic log-normal distributions are derived considering all performed mating simulations. Following the described methodology, gaps can be determined from any large number of flatness measurements. It is proposed to consider the results for flange design.

Ngoc Hieu Pham

Investigation of sectional capacities of cold-formed perforated steel channel sections

Web holes are commonly seen in cold-formed steel channel sections to accommodate the technical services. The presence of the web holes has resulted in the reduction of the sectional capacities of the cold-formed steel sections and has been considered in the design according to the American Specification AISI S100-16 using a new approach in the design called the Direct Strength Method (DSM). This article, therefore, will use this design method to investigate the sectional capacities of perforated channel sections under compression or bending with the variation of hole sizes in relation to those of gross channel sections. Elastic buckling analysis – a compulsory requirement for application of the DSM – can be conducted using a module CUFSM software program recently developed by the American Iron and Steel Institute. The investigated channel sections are taken from the availably commercial sections. The obtained sectional capacities are seen as the opposite trends for local and distortional buckling modes, although a downtrend of the sectional capacities is found in general with the increase of hole dimensions. It was found that perforated channel sections with smaller hole height and longer hole lengths were recommended to obtain the optimum section capacities in terms of the same web hole area, but the opposite trend was seen for these sections under bending with long hole lengths.

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