

J. Wardenier, J.A. Packer, X.-L. Zhao and G.J. van der Vegte

# **HOLLOW SECTIONS IN STRUCTURAL APPLICATIONS**



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# PREFACE

The global construction market requires a world-wide coordination of product-, testing-, design- and execution-standards, so that contracts for delivery of products and for engineering- and construction services can be agreed on a common basis without barriers.

The mission of CIDECT is to combine the research resources of major hollow section manufacturers in order to create a major force in the research and application of hollow steel sections world wide. This forms the basis of establishing coordinated and consistent international standards.

For the ease of use of such standards, it is however necessary to reduce their content to generic rules and to leave more object-oriented detailed rules to accompanying non-conflicting complementary information, that have the advantage to be more flexible for the adaptation to recent research results and to be useable together with any international code.

The book by J. Wardenier, J.A. Packer, X.-L. Zhao and G.J. van der Vegte "Hollow sections in structural applications" is such a source, developed in an international consensus of knowledge on the topic. It incorporates the recently revised design recommendations for hollow sections joints of the International Institute of Welding, IIW (2009) and CIDECT (2008 and 2009). Both are consistent with each other and are the basis for the Draft ISO standard for Hollow Section Joints (ISO 14346) and may form the basis for future maintenance, further harmonisation and further development of Eurocode 3 (EN 1993-1-8), AISC (ANSI/AISC 360) and the CISC recommendations.

For the use together with EN 1993-1-8 and ANSI/AISC 360, both being based on the previous IIW (1989) recommendations, the main differences to these rules are highlighted.

The authors are all internationally recognized experts in the field of tubular steel structures, three of them having been chairmen of the IIW-Subcommission XV-E on "Tubular Structures" since 1981. This committee is the pre-eminent international authority producing design recommendations and standards for onshore tubular structures.

This book should therefore be an invaluable resource for lecturers, graduate students in structural, architectural and civil engineering, explaining the important principles in the behaviour of tubular steel structures. It is also addressed to designers of steel structures who can find in it the special items related to the use of hollow sections, in particular joints, their failure modes and analytical models as supplements to more general design codes.

Aachen, Germany, August 2010

Prof. Dr.-Ing. Dr.h.c. Gerhard Sedlacek

# ACKNOWLEDGEMENTS

This book gives the background to design with structural hollow sections in general and in particular for joints to hollow sections. For the latter, the recently updated recommendations of the International Institute of Welding (IIW, 2009) and CIDECT (2008 and 2009) are adopted.

The background to design recommendations with the relevant analytical models is especially important for students in Structural and Civil Engineering, whereas the design recommendations themselves serve more as an example. Since the available hours for teaching Steel Structures, and particularly Tubular Structures, vary from country to country, this book has been written in a modular form. The presentation generally follows European codes, but the material is readily adapted to other (national) codes.

Since the first edition of this book was used not only by students but also by many designers, this second edition was needed due to the recent update of the recommendations by IIW and the subsequent revision of the CIDECT Design Guides Nos. 1 and 3 in 2008 and 2009.

The new IIW (2009) recommendations and the revised CIDECT Design Guides Nos. 1 and 3 (2008 and 2009) are consistent with each other and are the basis for the Draft ISO standard for Hollow Section Joints (ISO 14346). Although the current Eurocode 3 (EN 1993-1-8, 2005) and AISC (2010) recommendations are still based on the previous IIW (1989) and CIDECT (1991 and 1992) recommendations, it is expected that in the next revision these will follow the new IIW and CIDECT recommendations presented in this book.

Besides the static design recommendations and background for hollow section joints, information is given for member design in Chapter 2, composite structures in Chapter 4, and fire resistance in Chapter 5. These chapters fully comply with the latest versions of the Eurocodes (EN 1993 and EN 1994). Further, fatigue design of hollow section joints is covered in Chapter 14.

We wish to thank our colleagues from the IIW Sub-commission XV-E "Tubular Structures" and from the CIDECT Project Working Group and the CIDECT Technical Commission for their constructive comments during the preparation of this book.

We are very grateful that Prof. J. Stark and Mr. L. Twilt were willing to check Chapters 4 and 5 respectively on composite members and fire resistance.

Appreciation is further extended to the authors of CIDECT Design Guides Nos. 1 to 9 and to CIDECT for making parts of these Design Guides or background information available for this book.

Finally, we wish to thank CIDECT for the initiative to update this book.

Delft, The Netherlands, September 2010

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Hollow structural sections. Dimensions and section properties. HSS Manufacturing Methods. The transformation of steel strip into hollow structural sections (HSS) is the result of a series of operations including forming, welding and sizing. Currently three methods are being used in North America for the manufacture of HSS. These methods are described below. Each method meets ASTM A-500 and CSA G-40.21-92 requirements for the manufacture of HSS, and the sizes listed in this brochure may be produced to either standard. Electric Resistance Welding (ERW) Process In the tube mill, at steel strip MSH structural hollow sections. circular, square, rectangular. p.2 / Vallourec / MSH structural hollow sections. Vallourec -your partner in success. Total competence in seamless hot rolled steel tube & pipe. Rectangular MSH sections Structural safety and reliability through uniform hardness distribution and low residual stresses A large range of sizes and extra-long mill lengths (standard manufacturing program with approximately 740 circular, 225 square and 450 rectangular MSH sizes in lengths up to 16 m) Tailor-made options featuring a wide range of steel grades (carbon structural steels, high-strength. Popular applications for Fortior® are e.g. highly stressed heavy-wall hydraulic cylinders and frame structures for agricultural machinery. Oceanfit. ®. A structure made of hollow sections and loaded by predominantly static loading should be designed in such a way that it has a ductile behaviour. This means that the critical members or joints should provide sufficient rotation capacity. In this case, secondary bending moments due to imposed deformations or due to the joint stiffness may be neglected in design. Connection detailing for both welded and bolted connections is given in CIDECT Design guide for structural hollow sections in mechanical applications, Chapter 6: Connection detailing [CIDECT, 1995]. Q&A 10.1 Circular Hollow Section Joints. What analytical models are used for calculating the resistance of CHS joints? \_