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DESIGN OF PLATED STRUCTURES

Eurocode 3: Design of Steel Structures
Part 1-5 – Design of Plated Structures

Darko Beg
Ulrike Kuhlmann
Laurence Davaine
Benjamin Braun

ECCS CECM EKS

Ernst & Sohn
A Wiley Company

Design of Plated Structures

1st Edition, 2010

Published by:
ECCS – European Convention for Constructional Steelwork
publications@steelconstruct.com
www.steelconstruct.com

Sales:
Wilhelm Ernst & Sohn Verlag für Architektur und technische Wissenschaften GmbH & Co. KG, Berlin

ISBN (ECCS): 978-92-9147-100-3
ISBN (Ernst & Sohn): 978-3-433-02980-0
Legal dep.: 320032/10- Printed in Multicomp Lda, Mem Martins, Portugal
Photo cover credits: Vincent de Ville de Goyet

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FOREWORD

Plated structures are large steel structures commonly made from steel plates welded together. A typical use is for bridge girders and girders for heavy overhead cranes. Compared to steel structures of rolled profiles, plated structures are more prone to local buckling and therefore require design rules to cover such phenomena. In Eurocode 3 such rules are collected in Part 1-5 "Plated structures", EN 1993-1-5. I was the convener of the project team that wrote the standard, and this team was made up of some very knowledgeable specialists. We spent many years on comparing and finding the best methods of dealing with the most common buckling phenomena. These have attracted a lot of research efforts not only due to some spectacular bridge failures, but also because buckling of plates, and particularly stiffened plates, are scientifically interesting and have attracted the attention of many sharp brains. The result of our efforts was published as a standard in 2006, but the implementation in the different member countries of CEN follows different time tables.

Already before the standard was published we had many requests for background information. The reason was probably that the project team had collected design rules from different sources and chosen the ones that best fitted available information. Some of those were unfamiliar to many engineers and the requests of background information were reasonable. The contract with the EU commission did not include the task of delivering background documents but the academic participants in the project team decided to write one on their own expense. This document can be found on the ECCS web site with the URL http://www.steelconstruct.com/. It is described as a commentary to EN 1993-1-5 and includes background to the design rules and some explanations. There are also some design examples.

As a third step, ECCS has taken on the task of publishing the present manual that you have in your hands. It is intended for engineers who shall apply the rules of EN 1993-1-5 and I have to admit that it is needed. That does not mean that I think we did a bad job with the standard but that the text in the standard is quite brief and in order to interpret it correctly one needs experience and insight in the problems to be dealt with. This manual will be of great importance for engineers to aid them to apply the standard correctly thanks to its explanations and design examples. The authors have done a very good job and after reviewing the text I fully support it as a proper interpretation of the standard.

Bernt Johansson
Professor Emeritus Steel Structures

PREFACE

Plate buckling related problems in steel structures are inherently linked to complex solution strategies and design procedures. They involve stability analysis in the post-critical state, interaction of different failure modes, imperfection sensitivity, etc.

Eurocode standard EN 1993-1-5 gives a unique opportunity to deal with these problems, at least for typical geometrically more or less regular structural components, by means of fairly simple and consistent set of design procedures, suitable for hand calculations. The main advantage of these design procedures is that generally they were derived from available test results and despite their relative simplicity very often they can be more reliable than advanced numerical simulations. The latter heavily depend on the quality of the applied software tool, the way of modelling, experience of the user, correct interpretation of the results, etc. But even when an experienced design engineer applies advanced numerical simulations for plate buckling problems, a check by means of EN 1993-1-5 design procedures provides comfort and confidence in the results.

The main aim of this Design Manual is to provide practical advice to designers of plated structures for correct and efficient application of EN 1993-1-5 design rules, including several design examples. No deeper theoretical background is given and in this respect the reader is directed to other literature.

The initiative for this Design Manual came from the ECCS that included this Manual into the comprehensive action of preparing the ECCS Eurocode Design Manuals.

The four authors: Darko Beg (University of Ljubljana, Slovenia), Laurence Davaine (SNCF – French National Railway Service), Ulrike Kuhlmann and Benjamin Braun (University of Stuttgart, Germany) worked in close cooperation helping each other and carefully proof-reading parts of the text prepared by other authors. Nonetheless, the leading authors of individual chapters are:

Chapters 2.2, 2.4, 2.9 and all short numerical examples in Chapter 2: Darko Beg
Chapters 1, 2.5, 2.6, 2.10, 3: Ulrike Kuhlmann and Benjamin Braun
Chapters 2.3, 2.7, 2.8, 2.11: Laurence Davaine
Chapter 4: Laurence Davaine and Benjamin Braun

It should be mentioned that Franci Sinur and Blaž Čermelj helped in the preparation of the short numerical examples of Chapter 2 and Primož Može and Mojca Jelančič helped at the final editing of the text, all four coming from the University of Ljubljana.

At the end of this short Preface it is important to express strong wishes and expectations of the authors that this Manual will find a place on the working desks of design engineers helping them design excellent plated structures. In the authors' opinion the manual will also be helpful to students of structural engineering on their way of getting familiar with plated structures.

Darko Beg
Ulrike Kuhlmann
Laurence Davaine
Benjamin Braun