

Sample chapter

Design of Plated Structures

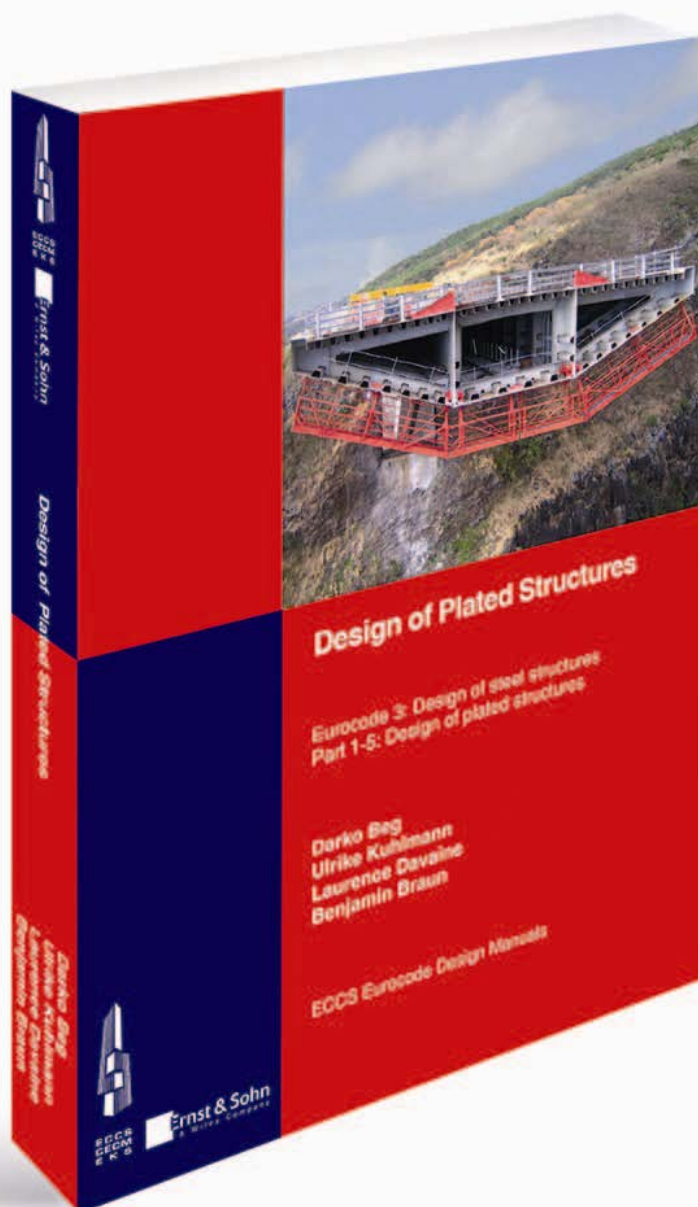
Eurocode 3: Design of Steel Structures. Part 1-5 Design of Plated Structures

Editor: ECCS - European Convention for Constructional Steelwork / Associacao

Portuguesa de Construcao Metalica e Mista

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ISBN: 978-3-433-02980-0



Wilhelm Ernst & Sohn
Verlag für Architektur und
technische Wissenschaften
GmbH & Co. KG
Rotherstraße 21, 10245 Berlin
Deutschland
www.ernst-und-sohn.de

Ernst & Sohn
A Wiley Company

Chapter 1

INTRODUCTION

1.1 PLATE BUCKLING IN STEEL STRUCTURES

State-of-the-art steel structures are characterised by a lightweight, slender and fabrication-optimised design. Especially the progress in welding technology since the 1930s has facilitated the increased application of steel plated structures, see Fig. 1.1. The significant knowledge gained since then has clearly influenced the design as well as the development of the design standards. With the Eurocodes, harmonised European rules have been established of which standard EN 1993-1-5 “Design of steel structures – Plated structural elements” (CEN, 2006a) deals with the design of plated structural elements in steel structures.

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Fig. 1.1: Assembly of Haseltal road bridge near Suhl, Germany

Based on EN 1993-1-5 the designer can choose, considering national allowance, mainly between two different types of design methods according to Fig. 1.2. The effective width method, also comprising resistance models for shear force and transverse force, is very efficient for standard geometries because it accounts not only for the post-critical reserve in a single plate element but also for load shedding between cross sectional elements. The reduced stress method abstains from load shedding between cross sectional elements, but it fully accounts for the post-critical reserve in a single plate element. Beyond that, its general format facilitates its use for serviceability verifications and for the design of non-uniform members such as haunched beams, beam webs with openings and plates with non-orthogonal stiffeners. In addition, a verification methodology based on the finite element method is given in section 2.11. It is the most versatile verification method, however, it requires a lot of experience. It can be used for the determination of the “real” buckling resistance by means of a nonlinear analysis considering imperfections and for the calculation of elastic critical stress values by means of a linear bifurcation analysis.

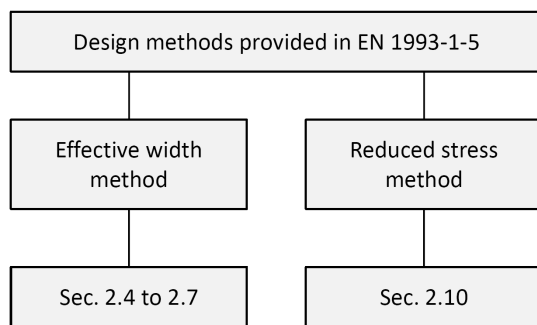


Fig. 1.2: Overview of design methods in EN 1993-1-5 and their references to the sections in this book

1.2 PURPOSE OF THIS BOOK

This book intends to provide the designer of steel plated structures with a practically oriented guide to assess EN 1993-1-5 (CEN, 2006a). This design manual is part of a comprehensive series of ECCS publications dealing with accompanying documentation to the Eurocodes. Its aim is to complement the comprehensive theoretical background given in the

Commentary to EN 1993-1-5 (Johansson *et al*, 2007) with practical knowledge for daily usage. Nevertheless, fundamental knowledge of structural mechanics is expected.

This book gives explanations and examples, advice and warnings, all of which intend to give the user considerably more insight and confidence in applying the rules of EN 1993-1-5. In order not to prejudice the use of EN 1993-1-5 where national choices are possible, Eurocode recommendations have been adopted throughout. This has to be kept in mind and, if required, the nationally determined parameters have to be adjusted when applying EN 1993-1-5 in the various member states.

1.3 STRUCTURE OF THIS BOOK

The layout of this book deliberately follows the layout of EN 1993-1-5 in order to allow for easy navigation and reference.

Chapter 2 gives a concise overview of the stability behaviour of plates in steel structures and the corresponding design rules in EN 1993-1-5. Relevant knowledge and terms about load-carrying mechanisms in plates and plated structures under direct stress, shear stress and transverse stress are introduced in order to ease the understanding of the design rules. The main components of Chapter 2 are the explanations of the verification methods which correspond to sections in this book as shown in Fig. 1.2. In this book, small design examples in each section address specific issues of these design rules.

In addition, chapters 3 and 4 present two comprehensive design examples of a crane runway beam and a box-girder bridge. In both examples not only the verification methods are illustrated, but also the big picture of the whole design is given. Besides general information on geometry and material properties, firstly loads and governing internal forces are determined. Based on cross section classification, and while adhering to the objective of this book, the examples finally focus on the plate buckling verifications.

Design of Plated Structures

Eurocode 3: Design of steel structures.

Part 1-5: Design of plated structures.



The main aim of this book is to provide practical advice to designers of plated structures for correct and efficient application of EN 1993-1-5 design rules. It includes a large number of examples.

In chapter 1 the purpose, the scope and the structure of the book is explained.

In chapter 2 a rather detailed and commented overview of EN 1993-1-5 design rules is given following the structure of the standard. Shear lag effect as well as plate buckling problems due to direct stresses, shear forces, transverse forces and interactions of these effects are covered. This chapter also includes a reduced stress method and a finite element analysis approach to plate buckling problems. A large number of design examples illustrate the proper application of individual design rules. Chapter 3 and 4 bring two complete design examples on a crane runway and a box-girder bridge.

(272 pages with 139 figures. Softcover. January 2011)

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