Review

Alasdair Beal finds this manual useful for those keen to understand the background to Eurocode 3, but unsuitable for engineers seeking practical guidance on connection design.

Design of joints in steel structures (UK ed.)

Authors: Jean-Pierre Jaspart and Klaus Weynand
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In recent years, there have been a disturbing number of major steel frame collapses in the UK caused by connection failures, so the publication of this ECCS Design Manual to Eurocode 3 Part 1-8 is timely. The authors rightly stress the importance of joint design to steel structural behaviour, safety and economy and the book summarises some of the ideas incorporated in EC3 1-8 and also some ideas of their own.

Unfortunately, the book has not been translated from 'Eurocode English', so the reader must first learn the meanings of 'header plate' (endplate), 'the component method' (consideration of all possible failure modes in a connection to determine its capacity) and 'fit bolts' (close tolerance bolts).

An obscure distinction is made between the words 'connection' and 'joint': according to EC3 1-8 cls. 1.4.2 and 1.4.4, a 'connection' is the 'location at which two or more members meet' and a 'joint' is the 'zone where two or more members are interconnected'. However, Jaspart and Weynand state that a 'connection' is 'the set of the physical components which mechanically fasten the connected elements' and a 'joint' is the combination of this with 'the corresponding zone of interaction between the connected members'. This is as clear as mud.

The authors argue that connection design should be integrated into the whole design process, but sadly this idea is stymied by the decision to remove connection design from BS EN 1993-1-1 and put it in BS EN 1993-1-8. How many Eurocode engineers therefore assume that part 1-8 is 'something they can leave to the fabricator'?

The authors' 'big idea' is semi-rigid design, where the analysis takes into account the flexibility of connections to modify the design moments. Although EC3 does not say much about semi-rigid design, most of the first 66 pages of this book and a large part of the remainder are devoted to it. The authors describe it as a 'new approach', apparently unaware that, although rarely used in practice, it has been included in UK codes since BS 449:1959. The main reason semi-rigid design has failed to catch on is probably because most of its claimed economic benefits can be achieved more simply by plastic design with rigid connections.

The useful technical content of the book starts around page 100. EC3 1-8 largely abandons the traditional theoretical approach to connection design in favour of empirical or semi-empirical design rules based on experimental results and yield-line theory. This can lead to greater economy, but it means that only a limited range of situations is covered.

The empirical and semi-empirical rules also provide little information about how load is transferred through the joint and there can be a lot of plastic redistribution. To ensure the necessary ductility and avoid problems, for many types of connections EC3 1-8 effectively requires all welds to be full-strength (e.g. cls. 4.9, 6.2.3, 7.3.1). An engineer designing a truss made from 5mm thick tubes may be surprised to find that EC3 requires 10mm fillet welds on all the connections unless stiffeners or gusset plates are provided.

Yield-line theory is an upper-bound analysis, so assuming the wrong yield-line pattern will lead to the strength of the connection being overestimated. Unfortunately, the authors do not warn about this and some of the diagrams in the book show yield-line patterns which are unlikely to predict the correct failure load. The coverage of bolt prying forces is also poor and the concept of a 'load path', which is critical to good connection design, is not mentioned at all.

The final section on 'design strategies' includes some worked examples. However, these are rather strange: the example for a portal frame eaves connection advocates removing stiffeners to reduce cost without considering the consequences this loss of connection strength will have for the design. Presumably, either the 'more economical' connection will be inadequate to resist the applied moment, or else the column size is heavier than necessary, but these issues are not discussed.

For those who are keen on using EC3 and understanding its background, this book is essential reading. However, engineers seeking practical guidance on designing safe, practical connections will have to look elsewhere.

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