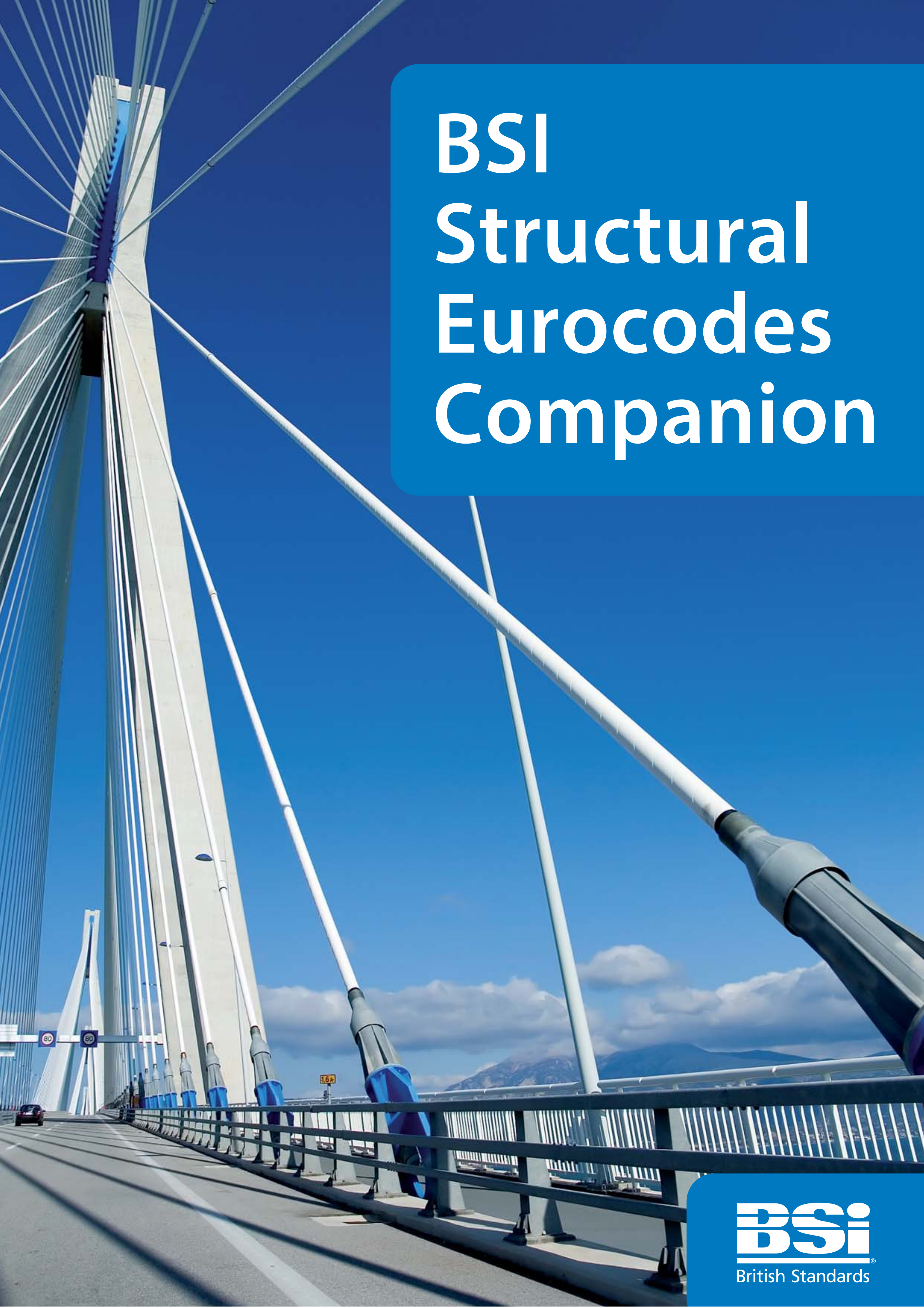
BSI Structural Eurocodes Companion



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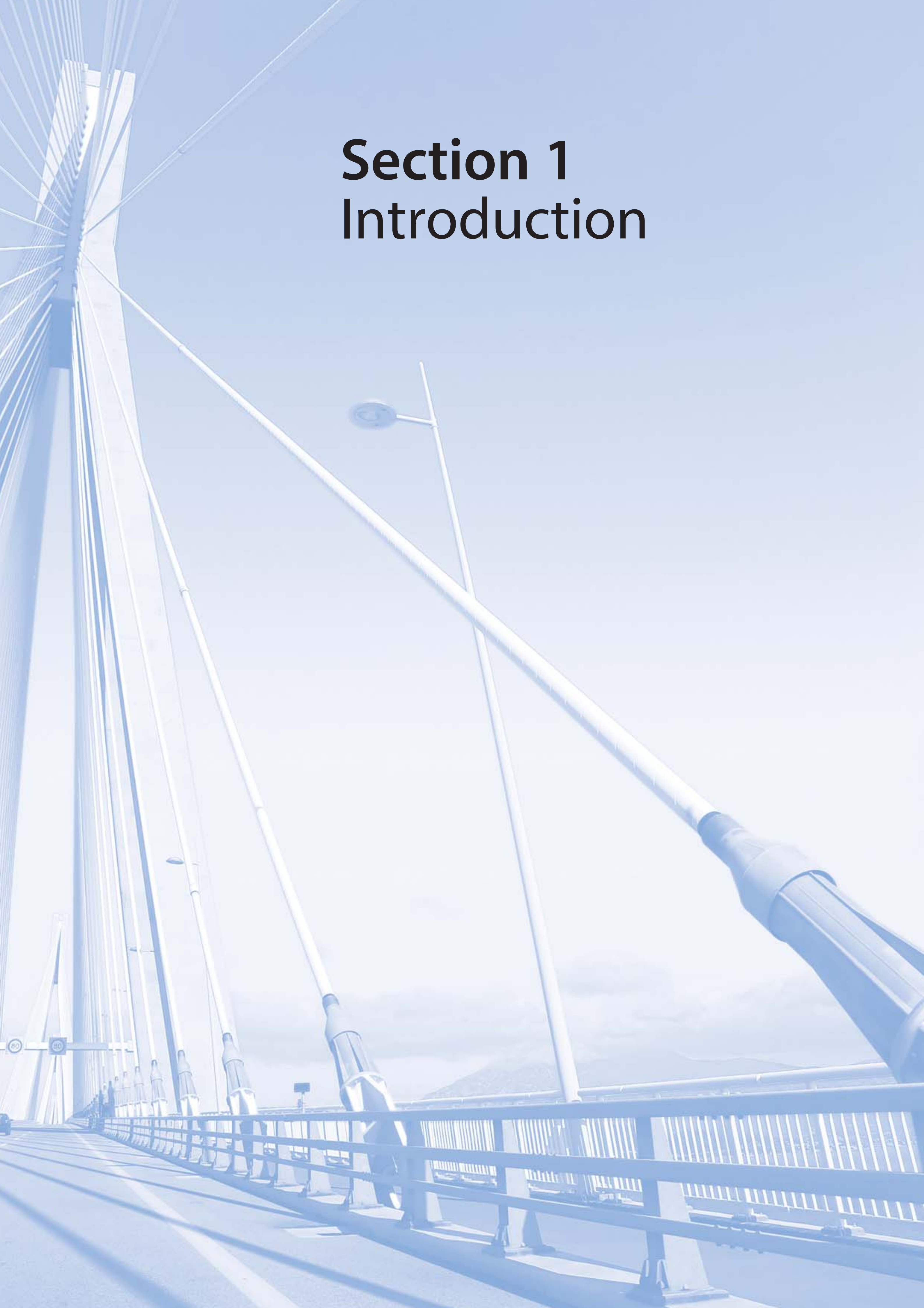


Foreword

Professor John Roberts, Principal, Technical Innovation Consultancy

Welcome to the 2009 BSI Structural Eurocodes Companion prepared in readiness for one of the most significant developments in construction standardization.

Structural Eurocodes are seen as leading the way in structural codes. Their flexibility enables adoption and use not only within Europe, but internationally. This feature has been recognized by several countries outside Europe and they are already committed to adopting Eurocodes.

The primary objectives of the Eurocodes are to:

- provide common design criteria and methods of meeting necessary requirements for mechanical resistance, stability and resistance to fire, including aspects of durability and economy;
- provide a common understanding regarding the design of structures between owners, operators and users, designers, contractors and manufacturers of construction products;
- facilitate the marketing and use of structural components and kits in EU Member States;
- facilitate the marketing and use of materials and constituent products, the properties of which enter into design calculations;
- be a common basis for research and development, in the construction industry;
- allow the preparation of common design aids and software;
- increase the competitiveness of the European civil engineering firms, contractors, designers and product manufacturers in their global activities.

Each of the Eurocode parts is produced by a subcommittee under the guidance and coordination of a technical committee (CEN/TC 250). Delegates of the 29 Comité Européen de Normalisation (CEN) members are represented on CEN/TC 250 and its subcommittees.

Drafts of the Eurocode parts are elaborated by project teams, which are selected by the appropriate subcommittees. A project team consists of about six experts who represent the subcommittee. A vast majority of the project teams include a UK-based expert.

A Eurocode is subject to extensive consultation before it is adopted. Progressive drafts are discussed and commented on by CEN members and their appointed experts. A Eurocode part is adopted only after a positive vote by CEN Members.

This BSI Structural Eurocodes Companion contains articles from leading academics and professionals to help you gain an understanding of the nature of the new codes and to ease your integration into the new approach being undertaken. ■

Introduction

Professor David Nethercot OBE FREng, Chairman, I Struct E, Standing Committee on the Implementation of Eurocodes

The Structural Eurocodes have been a feature of virtually the whole of my professional life. At my first technical conference held in Paris in 1972 I was introduced to several individuals, who subsequently became key figures in the preparation of a number of these documents; my research, teaching, advisory, professional and BSI activities have taken place against the backdrop of the writing of the ENV and EN documents and, more recently, I have been involved with several initiatives intended to facilitate their introduction and adoption.

In 1976 the UK signed up to the Treaty of Rome. This contained, as one of its essential tenets, the removal of artificial barriers to trade. The existence of national codes in each of the various member states for the design of structural works was seen as one example of such a barrier. Thus more than 30 years ago the UK committed to the eventual replacement of its national standards, prepared under the auspices of BSI, by the Eurocodes, prepared under the general direction of CEN. We have now reached the stage where that prospect has become the reality.

The suite of Structural Eurocodes will contain 58 documents, covering all structural materials including loading. Collectively they represent the biggest ever change for our structural engineering community – more significant than the transfer to limit states or the introduction of metric units. Should this be seen as a threat or an opportunity?

To adopt an insular, grudging and 'ignoring as far as possible' attitude would be to convert the Eurocodes into a threat. On the other hand to adopt a pragmatic, positive and 'how can we benefit' attitude sees the change as an opportunity. Of course, new Structural Codes are always unwelcome:

> *The onset of new or revised regulations invariably heralds a trying period of the unfortunate people who have to work such regulations. This applies both to those who have to comply with, and those who have to administer, such regulations.*

Whilst that quote might be thought to be a statement on the Eurocodes, it actually refers to the introduction some 50 years ago of a revision to BS 449 – a document that some would still regard as a paragon of all that codes should be. Given that the Structural Eurocodes have been prepared on a collaborative basis, they clearly cannot be expected to reflect the exact requirements of the UK. However, through substantial involvement with the drafting process, including chairmanship of several of the main committees, this country has ensured that the documents are far less unfamiliar than might otherwise have been the case. There are rules, agreements on terminology, and structures for the documents that do have to be followed and which, unsurprisingly, do not accord with BSI arrangements. However, within this framework, the material is rather less 'different' than might, at first sight, be thought to be the case.

The UK is now in the midst of a period of transferring the basis of structural design from an environment based on national standards to one founded on the Structural Eurocodes. This is a far from trivial task. It therefore needs to be accepted by UK industry as a body, by its member organizations and by individuals, that just like any engineering project, it requires planning, resourcing and effort to make it successful. For companies it should be regarded as akin to the purchase of a new computer system or the move to new premises. For individuals, it represents an important facet of operating as a professional person, i.e. recognizing that the operating climate will change over time and accepting the imperative to update skills and competences and to work with the new tools.

"Through substantial involvement with the drafting process, including chairmanship of several of the main committees, the UK has ensured that the documents are far less unfamiliar than might otherwise have been the case."

The suite of Structural Eurocodes represent:

- the most advanced technical views prepared by the best informed groups of experts in their fields across Europe;
- the most comprehensive treatment of the subjects, with many aspects not previously codified now being covered by agreed procedures;
- a design framework plus detailed implementation rules valid across Europe and likely to find significant usage worldwide.

What therefore should the structural engineering community do?

Some suggestions:

1. Accept the reality of the situation: Eurocodes are fact, there will be no more British Standards.
2. Understand the difference between the legal requirements of Building Regulations, Highways Agency requirements, etc. and the use of Structural Codes.
3. Treat migration from a design environment based on British Standards to one based on the Eurocodes as a project.
4. Recognize that the transition period will, in reality, extend over a number of years, with elements of parallel application.
5. Remember that actual methods of working on structural designs use a portfolio of aides, e.g. manuals, manufacturers' information, computer software, textbooks. Over time Eurocode-based material will replace the familiar and reassuring current British Standards-based items; this process is already in place with several items available but developing familiarity needs time.
6. Remember that code rules are there to assist structural designers not as a prescriptive 'recipe' approach, and that structural engineering knowledge and understanding is universal and can be applied in any design environment.
7. Remain sanguine and take a balanced view – be particularly cautious when reading claims of what 'must' be done; the climate within which structural engineering is practiced in the UK is far less prescriptive than some would have us believe.
8. Take courage from the example of those 'silver surfers' who have found new opportunities in the internet; Eurocodes are not about old dogs learning new tricks, they are about dogs of all ages performing much the same set of tricks but with a new and improved set of equipment. ■

View from the UK Committee Chairman

Howard P. J. Taylor FREng, Chair BSI Committee B525, Structural Design Codes (Mirror Committee to CEN TC 250)

I am pleased to be able to write an article for this important publication. The Eurocodes are a significant technical achievement as well as enabling real progress in the opening of the construction market in Europe.

The process was long and it is important to understand something of how the Eurocodes were written before a full understanding and appreciation can be gained. The regulation and codification of construction has a long history, the first Building Regulations in the UK were issued shortly after the Great Fire of London. Design codes as we understand them were introduced in the beginning of the 20th century and were based on an understanding of the underlying engineering science current at the time.

The approach relied upon the proportionality between load and displacement of elastic materials recorded by Hooke. In the mid-20th century, a new approach was introduced that relied upon the property of yield and plastic flow of elastic-plastic materials. The two theories allowed design rules to be written that were able to control service performance (the Elastic theory) and give accurate collapse and safety predictions (the Plastic theory). This new process called limit state design was capable of following the performance of a structure from its working load to an accurate prediction of collapse. Limit state design was first applied in the UK in the code for the design of concrete structures, CP110 in 1972, and the application to steel and masonry design soon followed.

The limit state design concept was developed by various international groups, although one of which, the Euro International Committee for Concrete (CEB), was particularly active. In 1964 recommendations for an international code of practice were published which were based on CEB and United States joint activities. The introduction to this publication mentions the aspiration for a European code of practice. It was this work that led to CP110 in 1972.

By 1980, the European Commission had a requirement for European design standards to fulfil its objectives of an open market for construction, construction products and for construction design services and turned to the work that was already being carried out by the then extensive network of voluntary practicing engineers and academics. Funding was provided for a period but by 1988 it was clear that a more structured approach was required and the Commission turned to CEN, the existing organization that coordinated standards work throughout Europe, and charged it with the final production of the Eurocodes. BSI as the UK national standards body is a member of CEN.

"European engineering and construction cultures are varied, some countries have a practical approach and in others the approach is more mathematical and academic."

CEN gave the responsibility of the Eurocode work to one of its many committees working on European standards, Committee TC 250. From that time, TC 250 with its many subcommittees has progressed the work and will continue to be responsible, now that the Eurocodes have all been published, for further development, including the maintenance and revision cycles.

That the work took nearly 50 years from a point when the concept of the process was established and 30 from the time that it became politically necessary seems disappointing, but there were very many great difficulties that the drafters and officials had to overcome.

European engineering and construction cultures are varied, some countries have a practical approach and in others the approach is more mathematical and academic. The position of design codes in the legal framework in the various member states is very different. In some states codes are seen as 'deemed to satisfy' documents which are referred to in brief national regulations, in others, codes are written into the countries legal code.

Europe has undergone two periods of enlargement while the work was being carried out, necessitating the consideration of new input. The time taken for the work to come to completion has meant that more than one generation of engineers has passed through the committees. The time has also allowed ideas from new research and practical experience to be incorporated

Although we still have to overcome the problem posed by the control of safety being the prerogative of the individual member states, which has brought about the requirement for national annexes, the 58 separate documents in the Eurocode suite are all identical in each member state.

I believe that this final achievement is remarkable. ■

View from the industry

Chris Hendy, Atkins plc

The Eurocodes are widely regarded as the most technically advanced suite of structural design codes available internationally. Why then is it often perceived that progress towards their adoption has been slow in the UK?

There is undoubtedly still some resistance from pockets of the UK structural community. Part of the inertia comes from the fact that the UK has extremely good British Standards already. For example, BS 5400 Part 3 is widely considered to be the most *comprehensive* steel code of practice in the world but few would describe it as the most *economic*. Some in the UK argue that the Eurocode rules go too far and are, in some isolated cases, unsafe. There is, however, no evidence of this, particularly when the UK National Annex has, in a few places, tightened up requirements where the Eurocode has permitted this to be done. Arguments that the Eurocodes are unsafe because they give different answers to previous British codes are simply unsound and in places the British Standards are far too conservative and are increasingly being shown to be so.

Other resistance stems from the perceived effort involved in the changeover. The Eurocode awareness seminars that have been held over the last few years may potentially have been counter productive. They have been intended to reassure, whilst at the same time demonstrate there is work to do. In some cases, pointing out a long list of differences in practice has made the process of adoption appear more daunting than perhaps it really is.

While there may be some resistance from within industry, BSI and the Highways Agency are actively driving implementation. The production of national annexes is proceeding at a pace and will be substantially complete by January 2009, which is on a par with or better than the progress made by much of mainland Europe; bridge design should be fully enabled in the UK by that date. In addition, an increasing number of consultants are using Eurocodes to form the basis of departures from standards in the assessment of existing structures because they can improve predicted load carrying resistance.

The state of readiness of industry bodies, software houses and institutions is also excellent by comparison with our other European counterparts. The Concrete Centre and Steel Construction Institute have produced, and continue to produce, much guidance and training material. Many of the big software houses are on top of software upgrades, waiting only for final national annexes to finalize releases. The ICE and IStructE are running seminars and training and publishing a comprehensive set of designers' guides to the various Eurocode parts.

"In places British Standards are far too conservative and are increasingly being shown to be so … If we are slow to adapt in the UK, others will not be and this brings potential threats to our industry."

Readiness amongst designers is, however, more patchy. Some of the big consultants have strategies in hand for helping their engineers to make the transition. Atkins, for example has already rolled out a series of four-day training courses to 60 'Champions' across the UK and ensured that all other staff have received a lower level of awareness training whilst being given access to the detailed training material. Other companies are planning similar strategies. However, a significant number of companies are only just starting to consider the issue.

Designers who are not prepared face a risky transition period. The introduction of Eurocodes will provide a common set of design codes for use across Europe and, as considered below, in a number of countries outside Europe. Apart from a unique national annex (which can provide very limited information and will thus be very easy to assimilate by foreign competitors), a design done in the UK will follow the same set of rules as one done elsewhere in Europe. This will facilitate competition by UK designers across a wide range of countries but, of course, the reverse will also be true. If we are slow to adapt in the UK, others will not be and this brings potential threats to our industry.

The threats will not only come from within Europe. Countries with an existing reliance on, or close link to, British Standards are either already committed to adopting Eurocodes (e.g. Malaysia and Singapore) or are weighing up the benefits of adopting them (e.g. Hong Kong). In addition, training is starting in these countries. For example, the Institution of Engineers Malaysia commissioned Atkins to run a two-day Eurocode concrete bridge design training course for 85 delegates in Kuala Lumpur in September 2007, then commissioned another for steel design in March 2008, and two further courses ran in East Malaysia in July 2008. There is no similar-scale external training taking place in the

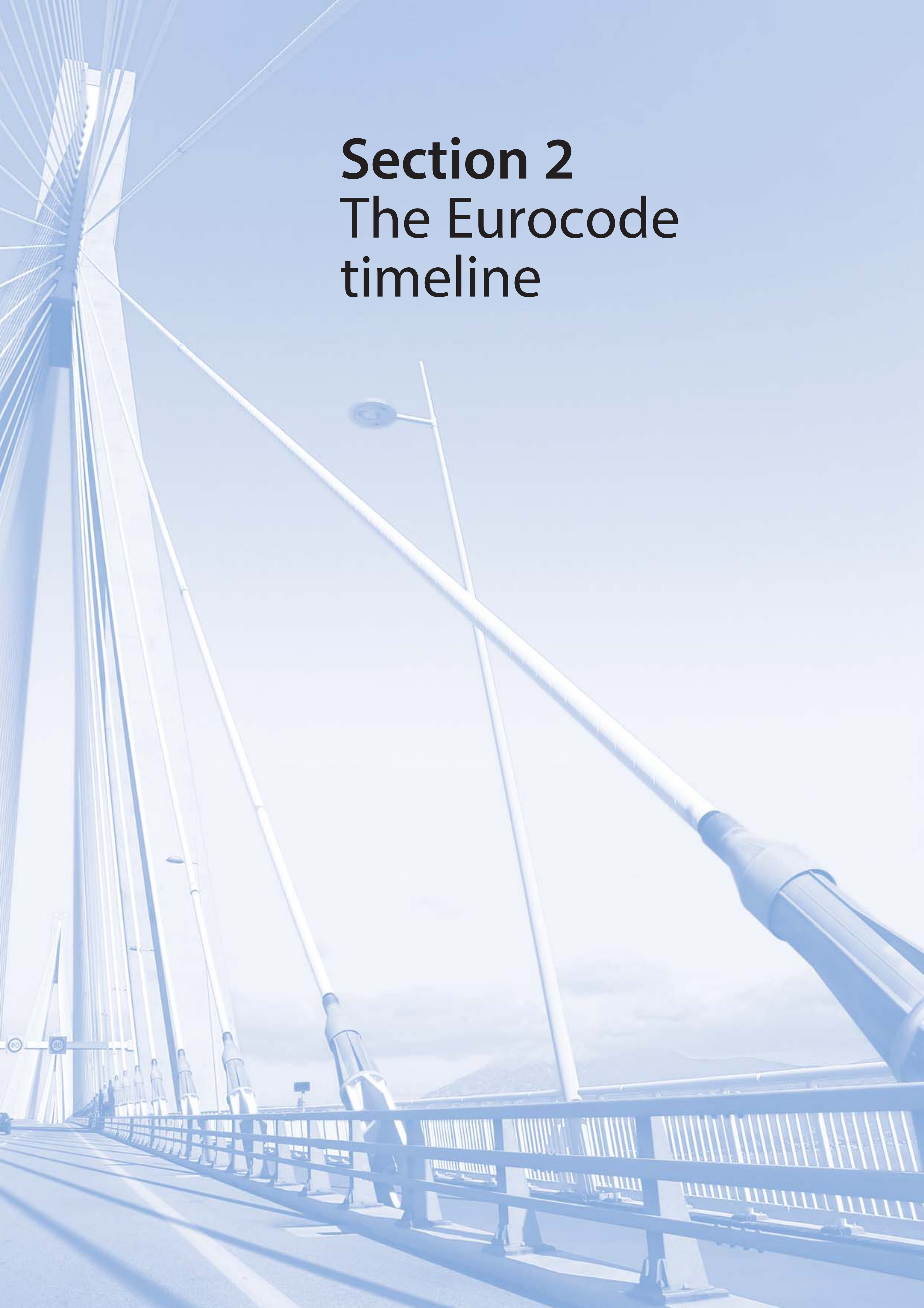
UK in bridge design. These countries may take a keen interest in UK opportunities.

The introduction of Eurocodes and the increased technical sophistication they bring is timely given the growing importance of the sustainability agenda and the drive for leaner construction. Many of the basic application rules in the Eurocodes lead to a modest but significant improvement in economy compared to existing British Standards. In many cases, this is derived from more recent research and testing. However, designers that follow the more complex methods of analysis permitted by the high level principles, such as non-linear analysis, may find very considerable improvements in economy. This will be the case, for example, for slender concrete piers or slender steel panels.

So to return to the original question, we shouldn't consider that the performance of UK plc has been sluggish. We should however recognize that the Eurocodes bring both opportunities and threats, and so to maximize the former and mitigate the latter now is the time to step up our preparation activities. ■

> **"Eurocodes lead to a modest but significant improvement in economy compared to existing British Standards."**

Section 2
The Eurocode timeline



Eurocodes publication schedule

The following tables show the publication dates for the Eurocodes and the corresponding UK National Annexes.

* This schedule is correct at the time of going to print. For the very latest information please go to www.bsigroup.com/eurocodes. *

Eurocode. BS EN 1990 – Basis of structural design

Eurocode part	Title	UK National Annex publication status
BS EN 1990:2002	Basis of structural design	Published
BS EN 1990:2002 Annex A2	Basis of structural design including Amendment A1 for Annex A2 for Bridges	Expected 2009

Eurocode 1. BS EN 1991 – Actions on structures

Eurocode part	Title	UK National Annex publication status
BS EN 1991-1-1:2002	Actions on structures. General actions. Densities, self-weight, imposed loads for buildings	Published
BS EN 1991-1-2:2002	Actions on structures. General actions. Actions on structures exposed to fire	Published
BS EN 1991-1-3:2003	Actions on structures. General actions. Snow loads	Published
BS EN 1991-1-4:2005	Actions on structures. General actions. Wind actions	Published
BS EN 1991-1-5:2003	Actions on structures. General actions. Thermal actions	Published
BS EN 1991-1-6:2005	Actions on structures. General actions. Actions during execution	Published
BS EN 1991-1-7:2006	Actions on structures. General actions. Accidental actions	Published
BS EN 1991-2:2003	Actions on structures. Traffic loads on bridges	Published
BS EN 1991-3:2006	Actions on structures. Actions induced by cranes and machinery	Expected 2009
BS EN 1991-4:2006	Actions on structures. Silos and tanks	Expected 2009

PD 6688-1-1	Proposed title: Background paper to the UK National Annex to BS EN 1991-1-1	Expected 2009
PD 6688-1-2:2007	Background paper to the UK National Annex to BS EN 1991-1-2	Published
PD 6688-1-4	Proposed title: Background paper to the UK National Annex to BS EN 1991-1-4	Expected 2009
PD 6688-1-5	Proposed title: Background paper to the UK National Annex to BS EN 1991-1-5	Expected 2009
PD 6688-1-7	Recommendations for the design of structures to BS EN 1991-1-7	Published
PD 6688-2	Recommendations for the design of structures to BS EN 1992-2	Expected 2009

Eurocode 2. BS EN 1992 – Design of concrete structures

Eurocode part	Title	UK National Annex publication status
BS EN 1992-1-1:2004	Design of concrete structures. General rules and rules for buildings	Published Amd 1 in preparation, expected 2009
BS EN 1992-1-2:2004	Design of concrete structures. Fire design	Published
BS EN 1992-2:2005	Design of concrete structures. Concrete bridges. Design and detailing rules	Published
BS EN 1992-3:2006	Design of concrete structures. Liquid retaining and containing structures	Published
PD 6687:2006	Background paper to the UK National Annexes to BS EN 1992-1	Published
PD 6687-1	Background paper to the UK National Annexes to BS EN 1992-1 and BS EN 1992-3 (supersedes PD 6687:2006)	Published
PD 6687-2:2007	Recommendations for the design of structures to BS EN 1992-2	Published

Eurocode 3. BS EN 1993 – Design of steel structures

Eurocode part	Title	UK National Annex publication status
BS EN 1993-1-1:2005	Design of steel structures. General rules and rules for buildings	Published
BS EN 1993-1-2:2005	Design of steel structures. General rules. Structural fire design	Published
BS EN 1993-1-3:2006	Design of steel structures. General rules. Supplementary rules for cold-formed members and sheeting	Expected 2009
BS EN 1993-1-4:2006	Design of steel structures. General rules. Supplementary rules for stainless steels	Expected 2009
BS EN 1993-1-5:2006	Design of steel structures. Plated structural elements	Published
BS EN 1993-1-6:2007	Design of steel structures. General. Strength and stability of shell structures	Expected 2009
BS EN 1993-1-7:2007	Design of steel structures. General. Plated structures subject to out of plane loading	Expected 2009
BS EN 1993-1-8:2005	Design of steel structures. Design of joints	Published
BS EN 1993-1-9:2005	Design of steel structures. Fatigue strength	Published
BS EN 1993-1-10:2005	Design of steel structures. Material toughness and through-thickness properties	Published
BS EN 1993-1-11:2006	Design of steel structures. Design of structures with tension components	Published
BS EN 1993-1-12:2007	Design of steel structures. Additional rules for the extension of EN 1993 up to steel grades S 700	Published
BS EN 1993-2:2006	Design of steel structures. Steel bridges	Published
BS EN 1993-3-1:2007	Design of steel structures. Towers, masts and chimneys. Towers and masts	Expected 2009
BS EN 1993-3-2:2008	Design of steel structures. Towers, masts and chimneys. Chimneys	Expected 2009
BS EN 1993-4-1:2007	Design of steel structures. Silos, tanks and pipelines. Silos	Expected 2009
BS EN 1993-4-2:2007	Design of steel structures. Silos, tanks and pipelines. Tanks	Expected 2009
BS EN 1993-4-3:2007	Design of steel structures. Silos, tanks and pipelines. Pipelines	Expected 2009
BS EN 1993-5:2007	Design of steel structures. Piling	Expected 2009
BS EN 1993-6:2007	Design of steel structures. Crane supporting structures	Expected 2009

PD 6695-1-9	Proposed title: TBA	Published
PD 6695-1-10	Proposed title: TBA	Published
PD 6695-2	Proposed title: Recommendations for the design of structures to BS EN 1993-2:2006	Published

Eurocode 4. BS EN 1994 – Design of composite steel and concrete structures

Eurocode part	Title	UK National Annex publication status
BS EN 1994-1-1:2004	Design of composite steel and concrete structures. General rules and rules for buildings	Published
BS EN 1994-1-2:2005	Design of composite steel and concrete structures. General rules. Structural fire design	Published
BS EN 1994-2:2005	Design of composite steel and concrete structures. General rules and rules for bridges	Published
PD 6696-2:2007	Recommendations for the design of structures to BS EN 1994-2:2005	Published

Eurocode 5. BS EN 1995 – Design of timber structures

Eurocode part	Title	UK National Annex publication status
BS EN 1995-1-1:2004	Design of timber structures. General. Common rules and rules for buildings	Published
BS EN 1995-1-2:2004	Design of timber structures. General. Structural fire design	Published
BS EN 1995-2:2004	Design of timber structures. Bridges	Published

Eurocode 6. BS EN 1996 – Design of masonry structures

Eurocode part	Title	UK National Annex publication status
BS EN 1996-1-1:2005	Design of masonry structures. General rules for reinforced and unreinforced masonry structures	Published
BS EN 1996-1-2:2005	Design of masonry structures. General rules. Structural fire design	Published

BS EN 1996-2:2006	Design of masonry structures. Design considerations, selection of materials and execution of masonry	Published
BS EN 1996-3:2006	Design of masonry structures. Simplified calculation methods for unreinforced masonry structures	Published

Eurocode 7. BS EN 1997 – Geotechnical design

Eurocode part	**Title**	**UK National Annex publication status**
BS EN 1997-1:2004	Geotechnical design. General rules	Published
BS EN 1997-2:2007	Geotechnical design. Ground investigation and testing	Expected 2009
PD 6694-1:2007	Proposed title: Recommendations for the design of structures subject to traffic loading to BS EN 1997-1:2004	Expected 2009

Eurocode 8. BS EN 1998 – Design of structures for earthquake resistance

Eurocode part	**Title**	**UK National Annex publication status**
BS EN 1998-1:2004	Design of structures for earthquake resistance. General rules, seismic actions and rules for buildings	Published
BS EN 1998-2:2005	Design of structures for earthquake resistance. Bridges	Expected 2009
BS EN 1998-3:2005	Design of structures for earthquake resistance. Assessment and retrofitting of buildings	No NA to be published
BS EN 1998-4:2006	Design of structures for earthquake resistance. Silos, tanks and pipelines	Published
BS EN 1998-5:2004	Design of structures for earthquake resistance. Foundations, retaining structure and geotechnical aspects	Published
BS EN 1998-6:2005	Design of structures for earthquake resistance. Towers, masts and chimneys	Published
PD 6698:2009	Background paper to the UK National Annexes to BS EN 1998-1, BS EN 1998-2, BS EN 1998-4, BS EN 1998-5 and BS EN 1998-6	Expected 2009

Eurocode 9. BS EN 1999 – Design of aluminium structures

Eurocode part	Title	UK National Annex publication status
BS EN 1999-1-1:2007	Design of aluminium structures. General structural rules	Published
BS EN 1999-1-2:2007	Design of aluminium structures. Structural fire design	Published
BS EN 1999-1-3:2007	Design of aluminium structures. Structures susceptible to fatigue	Published
BS EN 1999-1-4:2007	Design of aluminium structures. Cold-formed structural sheeting	Published
BS EN 1999-1-5:2007	Design of aluminium structures. Shell structures	Published

Key aspects of the Eurocodes

- The Eurocodes support National Building Regulations and other national requirements for regulated work but remain subservient to them.
- National regulations set the appropriate level of safety through Nationally Determined Parameters (NDP). Certain other parameters can be set by individual countries.
- The clauses in the Eurocodes are divided into principles and application rules. Principles are identified by (P) after the clause number and cover items for which no alternative is permitted. Application rules are recommended methods of achieving the principles but alternative rules may also be used.
- There are two types of annex in the Eurocodes. Normative annexes are part of the requirements of the code.
- Informative annexes provide guidance that can be adopted or not on a country by country basis.
- The national annex is a special type of informative annex that contains the choices made by a particular country. Typically the national annex will state values and classes applicable to that country, provide value where only a symbol is given in the Eurocode and provide country specific data. The national annex also chooses when alternatives are given in the Eurocodes and indicates which informative annexes may be used. Finally it refers to non-contradictory complementary information (NCCI).
- An NCCI is a way of introducing additional guidance to supplement the Eurocodes without contradicting them. ■

Section 3
Focus on Eurocode materials

Eurocode: Basis of structural design

Professor Haig Gulvanessian CBE, Civil Engineering and Eurocode Consultant

BS EN 1990, *Eurocode: Basis of structural design*, is the head key code for the harmonized Structural Eurocodes. BS EN 1990 establishes for all the Structural Eurocodes the principles and requirements for safety and serviceability and provides the basis and general principles for the structural design and verification of buildings and civil engineering structures (including bridges, towers and masts, silos and tanks, etc.). BS EN 1990 gives guidelines for related aspects of structural reliability, durability and quality control. It is based on the limit state concept and used in conjunction with the partial factor method.

As shown in the figure, BS EN 1990 will be used with every Eurocode part for the design of new structures, together with:

- BS EN 1991 Eurocode 1: *Actions on structures*; and
- the design Eurocodes BS EN 1992 to BS EN 1999 (Eurocodes 2 to 9).

This is different to the situation adopted by the present British Standard codes of practice (e.g. BS 8110, BS 5950 and BS 5628) because with the design Eurocodes the requirements for achieving safety, serviceability and durability and the expressions for action effects for the verification of ultimate and serviceability limit states and their associated factors of safety are only given in BS EN 1990. Unlike the equivalent British Standard codes of practice the material Eurocodes (BS EN 1992, BS EN 1993, BS EN 1994, BS EN 1995, BS EN 1996 and BS EN 1999) only include clauses for design and detailing in the appropriate material; they require all the material-independent information for the design from BS EN 1990.

The principal objective of BS EN 1990 is that it sets out for every Eurocode part the *principles* and *requirements* for achieving safety, serviceability and durability of structures.

BS EN 1990 provides the information for safety factors for actions and combination for action effects for the verification of both ultimate and serviceability limit states. Its rules are applicable to the design of building and civil engineering structures including bridges, masts, towers, silos, tanks, chimneys and geotechnical structures.

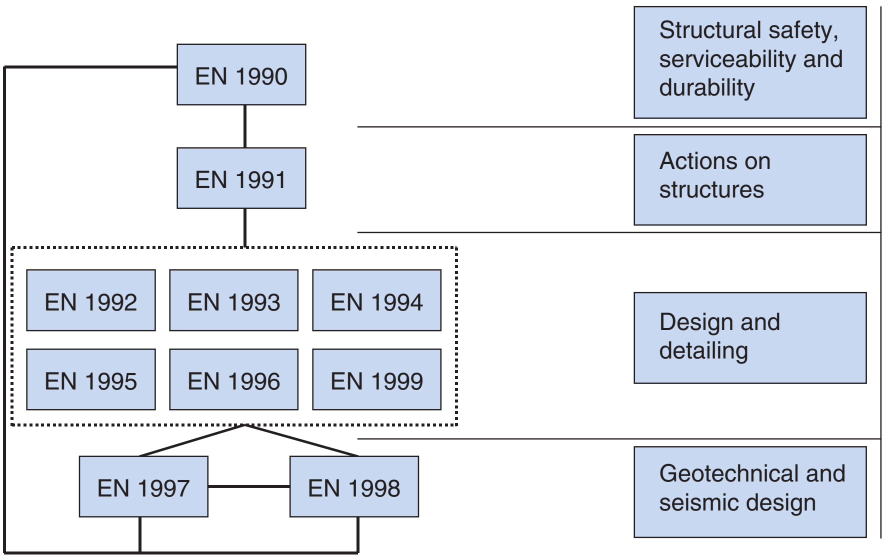
> **"The principal objective of BS EN 1990 is that it sets out for every Eurocode part the principles and requirements for achieving safety, serviceability and durability of structures."**

Furthermore construction products requiring CE marking (e.g. precast concrete products, metal frame domestic houses and timber frame housing) all need to use the principles and rules in BS EN 1990 together with the appropriate Eurocodes, thus ensuring a level playing field, as do the execution standards.

To achieve safety, serviceability and durability for structures BS EN 1990 has requirements to be adhered to by the complete Eurocode suite and construction product standards on:

- fundamental requirements (safety, serviceability, resistance to fire and robustness);
- reliability management and differentiation;
- design working life;
- durability;
- quality assurance and quality control.

BS EN 1990, as well as being the key Eurocode in setting recommended safety levels, also introduces innovative aspects (listed below) that encourages the design engineer to consider the safety of people in the built environment together with responsible considerations of economy.



The links between the Eurocodes

- BS EN 1990 allows reliability differentiation based on the consequences of failure.
- It introduces the concept of using the representative values of actions and not only the characteristic values as used for UK codes of practice. The loads used in the BS EN 1990 load combinations recognize the appropriate cases where rare, frequent, or quasi-permanent occurring events are being considered with the use of an appropriate reduction coefficient (ψ) applied to the characteristic load values, as appropriate. The use of the representative values for actions in the load combination expressions for ultimate and serviceability limit state verifications are logical and give economies for particular design situations.
- It provides an alternative load combination format, giving the choice to the designer of using either the expressions 6.10 or 6.10a/6.10b for the combination of actions for ultimate limit state verification. This choice provides opportunities for economy especially for the heavier materials, and can provide flexibility with regard to assessment.
- It permits the use of lower factors of safety for loads compared to British Standards. Although the effects of actions according to the Eurocodes are lower than UK national codes for ULS and SLS verification, this should not be a concern to the industry as the BS EN 1990 values are based on better science and better research.
- The use of advanced analytical techniques for the designer are encouraged, as are the use of probabilistic methods should the designer wish to use these for more specialized design problems.

BS EN 1990 is a fully operative code and the concept of a fully operative material-independent code is new to the European design engineer. It is certainly not a code that should be read once and then placed on the bookshelf. It is the key Eurocode that sets the requirements for design, material, product and execution standards. BS EN 1990 needs to be fully understood as it is key to designing structures that have an acceptable level of safety and economy, with opportunities for innovation.

A course and a designers guide for BS EN 1990 are available in the UK through Thomas Telford Ltd of the Institution of Civil Engineers.

Regarding implementation of BS EN 1990 in the UK, BS EN 1990 was published in April 2002 and the BSI National Annex for Buildings was published in 2004. The BSI National Annex for Bridges is due in 2009. ■

Eurocode 1: Actions on structures

Professor Haig Gulvanessian CBE, Civil Engineering and Eurocode Consultant

BS EN 1991, *Eurocode 1: Actions on structures*, provides comprehensive information and guidance on all actions that are usually necessary to consider in the design of building and civil engineering structures.

BS EN 1991 comprises 10 different EN parts (see p. 12). These Parts will provide the characteristic values for actions for use with BS EN 1990, *Eurocode: Basis of structural design*, and BS EN 1992 to BS EN 1999 as appropriate, for design and verification on the basis of the overall principles that are given in BS EN 1990.

The following is a brief summary of the scope, field of application and difference with UK practice for each part of BS EN 1991.

BS EN 1991-1-1, Densities, self-weight and imposed loads for buildings

BS EN 1991-1-1 covers the assessment of actions for use in structural design due to:

- the density of construction materials and stored materials;
- the self-weight of structural elements and whole structures, and some fixed non-structural items;
- imposed loads on floors and roofs of buildings (but excluding snow, which is covered by BS EN 1991-1-3, *Snow loads*).

The scope of BS EN 1991-1-1 is greater than for the appropriate UK national codes (BS 6399-1 and BS 648). There remain some topics (e.g. vertical loads on parapets and values for actions for storage and industrial use) that are not covered as comprehensively in BS EN 1991-1-1 when compared to BS 6399, and these topics will feature in a complementary document published by BSI, PD 6688-1-1, which will also provide background information.

BS EN 1991-1-2, Actions on structures exposed to fire

BS EN 1991-1-2 covers the actions to be used in the structural design of buildings and civil engineering works where there is a requirement to give adequate performance in fire exposure. It is intended for use with BS EN 1990 and with the parts on structural fire design in Eurocodes 2 to 6 and 9. For fire design, fire actions are the dominant action.

The national annex to BS EN 1991-1-2 will refer to a complementary document, PD 6688-1-2, which will provide background information to the national annex.

> **"BS EN 1991 gives unique guidance on a particular type of action."**

BS EN 1991-1-3, Snow loads

BS EN 1991-1-3 provides guidance for the calculation of:

- snow loads on roofs, which occur in calm or windy conditions;
- loads on roofs that occur where there are obstructions, and by snow sliding down a pitched roof onto snow guards;
- loads due to snow overhanging the cantilevered edge of a roof;
- snow loads on bridges.

BS EN 1991-1-3 applies to:

- snow loads in both maritime (i.e. UK) and continental climates;
- new buildings and structures;
- significant alterations to existing buildings and structures.

The scopes of BS EN 1991-1-3 and BS 6399-2 are similar. However, there are some differences: BS EN 1991-1-3 does not apply to sites at altitudes above 1500 m (the limit in BS 6399-2 is 500 m). In the BS EN 1991-1-3 snow map, the UK is divided into a number of zones. An expression is given to determine the snow load on the ground which depends upon the zone and the altitude of the site.

BS EN 1991-1-4, Wind actions

BS EN1991-1-4 is applicable to:

- building and civil engineering works with heights up to 200 m;
- bridges with spans of not more than 200 m (subject to certain limitations based on dynamic response criteria);
- land-based structures, their components and appendages.

The specific exclusions are:

- lattice towers with non-parallel chords;
- guyed masts and guyed chimneys;
- cable supported bridges;
- bridge deck vibration from transverse wind turbulence;
- torsional vibrations of buildings;
- modes of vibration higher than the fundamental mode.

The scope of BS EN 1991-1-4 is much wider than BS 6399-2, as it includes wind actions on other structures, which in the UK are given in a number of other British Standards and design guides. In some cases, there is no equivalent UK standard, e.g. dynamic response of certain buildings. The national annex to BS EN 1991-1-4 will refer to a complementary document, PD 6688-1-4, which will give background information to the national annex and other essential advice.

BS EN 1991-1-5, Thermal actions

BS EN 1991-1-5 gives principles, rules and methods of calculating thermal actions on buildings, bridges and other structures including their structural components. Principles for determining thermal actions for claddings and other appendages on the building are also provided.

Characteristic values of thermal actions are provided for the design of structures that are exposed to daily and seasonal climatic changes. Structures in which thermal actions are mainly a function of their use (e.g. chimneys, cooling towers, silos, tanks, warm and cold storage facilities, hot and cold services) are also treated. The characteristic values of isotherms of national minimum and maximum shade air temperatures are provided in the form of maps.

The guidance in this part, in particular the guidance relating to building structures, is not covered in UK loading standards. The national annex to BS EN 1991-1-5 will refer to a complementary document, PD 6688-1-5, which will provide background information to the national annex.

BS EN 1991-1-6, Actions during execution

BS EN 1991-1-6 covers assessment of actions, combinations of actions and environmental influences during the execution stage, including those actions applied to auxiliary construction works, e.g. scaffolding, propping and bracing, for use in structural design of buildings and bridges. The safety of people on construction sites due to construction accidents is not within the scope of this Eurocode part.

The guidance in this part is not covered in UK loading standards.

BS EN 1991-1-7, Accidental actions

BS EN 1991-1-7 describes safety strategies for accidental design situations. It recommends design values for the most common cases of accidental actions from impact and explosion; it gives design models and detailed provisions that may be used as alternatives to design verifications. It also provides more advanced impact and explosion design concepts than which were found in British Standards.

External explosions, warfare, sabotage or risk scenarios due to natural phenomena, such as tornadoes, extreme erosion or rock falls, are not in the scope of this Eurocode part.

Although aspects of accidental actions are covered in BS 6399-1 and BS 5400, BS EN 1991-1-7 comprehensively covers the topic of accidental actions in one document. A categorization scheme concerning the robustness of buildings, which has also been used in Approved Document A of the Building Regulations, is introduced in BS EN 1991-1-7. The UK design engineer will be familiar with the design requirements of this part although risk assessments will be required for some categories of structures.

The national annex to BS EN 1991-1-7 will refer to a complementary document, PD 6688-1-7, which will give background information to the National Annex, in particular to risk assessments on impacts to supporting structures for bridges.

BS EN 1991-2, Traffic loads on bridges

BS EN 1991-2 specifies imposed loads (models and representative values) associated with road traffic, pedestrian actions and rail traffic, that include, when relevant, dynamic effects and centrifugal, braking, acceleration and accidental forces. It also includes guidance on combinations with non-traffic loads on road and railway bridges, and on loads on parapets.

The national annex to BS EN 1991-2 will refer to a complementary document, PD 6688-2, which will give background information to the national annex.

BS EN 1991-3, Actions induced by cranes and machinery

BS EN 1991-4 specifies actions, self-weights and imposed loads (models and representative values) associated with hoists, crabs and cranes on runway beams, and static and dynamic actions induced in supporting structures by machinery.

BS EN 1991-4, Actions in silos and tanks

BS EN 1991-3 gives general principles and rules for determining actions arising from the storage of bulk materials and liquids in silos and tanks. The scope is restricted to:

- silos with limited eccentricity of inlet and outlet, with small impact effects caused by filling, and with discharge devices that do not cause shock or eccentricities beyond the given limitations;
- silos containing particulate materials which are free-flowing and have a low cohesion;
- tanks with liquids stored at normal atmospheric pressure.

Difference between BS EN 1991 and the UK system of loading codes

Each part of BS EN 1991 gives unique guidance on a particular type of action. Within each part guidance is provided for buildings and other construction works (e.g. bridges). This is different to the BSI system of loading codes where the codes are based on the ‘type’ of structure, e.g. BS 6399 for buildings and BS 5400 for bridges.

Industry initiatives

A course for BS EN 1991 is available in the UK through Thomas Telford Ltd of the Institution of Civil Engineers. Two designers’ guides, the first covering Actions on Buildings and the second covering Actions on Bridges will be published in 2009 by Thomas Telford Ltd. ■


The future starts here.
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Eurocode 2: Design of concrete structures

Dr Andrew Minson, The Concrete Centre

The Eurocode process began over 30 years ago and is nearing full implementation. The concrete sector has been leading the way with the new codes. Designers and engineers can now design using Eurocode 2. The full package of the code, including all its national annexes and supporting documentation, is in place and is being used on projects. The UK committee is no longer supporting BS 8110.

Like it or not, the introduction of the Eurocodes is inevitable so it seems best to accept this and resolve to make the change as easy as possible. With this in mind, The Concrete Centre as part of the Concrete Industry Eurocode 2 Group has not only developed a transition strategy but has delivered this via a wide range of resources. These include a companion guide *Concise Eurocode 2*, and a series of guides under the banner *How to design concrete structures using Eurocode 2*. The series of *How to...* leaflets was released in early 2006 and have now been gathered together and published as a compendium, which includes new chapters on Retaining Walls and Detailing. *Precast Eurocode 2: Design Manual* and *Precast Eurocode 2: Worked Examples*, have been published by British Precast. *Concise Eurocode 2 for Bridges* will be published by the Concrete Centre in early 2009. In addition, a dedicated website www.eurocode2.info has been set up. This site contains explanations, news, key information and downloads, and, in particular, a series of detailed worked examples.

The Concrete Centre together with the Modern Masonry Alliance has jointly published a series of three guides called *How to Design Masonry Structures Using Eurocode 6* explaining Eurocode 6. Eurocode 6 introduces a new classification of masonry units and also a new design approach for masonry members in compression.

Despite the cost of changing to the new codes, there will be economic benefits to be gained from their use. In concrete design it is expected that there will be material cost savings of up to 5% compared with using BS 8110. Furthermore, the Eurocodes are organized to avoid repetition, they are technically advanced and should offer more opportunities for UK designers to work throughout Europe. Plus any delay in implementing the Eurocodes will diminish the ability of UK designers and engineers to work on projects in the rest of Europe whilst permitting firms from Continental Europe to work over here.

> **"In concrete design it is expected that there will be material cost savings of up to 5% compared with using BS 8110."**

Moving over to Eurocode design is going to be a huge commitment but when designers want to make the transition the concrete industry is ready to help. The Concrete Centre's regional technical team have noticed that practices are adopting an arrangement of Eurocode implementation strategies.

The initial decision for a practice to make is whether to implement all the material Eurocodes at once or to choose one single material as the trailblazer. The advantage of this is that wrestling with all the non-material Eurocodes, such as basis of design, actions, geotechnics, is a big enough challenge itself, therefore to do this alongside just one material is a much simpler proposition. Concrete lends itself to being the trailblazer material for a number of reasons. Firstly, Eurocode 2 for concrete has only four parts, secondly, the national annexes are all published and guidance on them is readily available and thirdly, almost every project has concrete in it somewhere.

Another early decision is whether to train an individual or two, a group, or the majority of staff. In-house 'experts' can be sent on in-depth external courses and then relay the knowledge gained by acting as a conduit for Eurocode related queries within the office and subsequently training their colleagues. The risk with this strategy is that the expert may not be up to the task, they may leave the practice, or simply will not have the time to act as a mentor to the whole practice. The additional issue of who to choose as the potential Eurocode expert can be such a problem that this approach is often rejected.

Some practices are instead choosing to pioneer the Eurocodes through specific projects. This enables a broad base of expertise to develop and chooses the experts by default. Those sent on training courses can apply their knowledge at once on real life projects with help readily available from the structural engineering department at The Concrete Centre. Using Eurocodes for specific projects provides a broader base of expertise compared with having a single champion. A further advantage is that focusing on specific projects limits the practice's exposure to Eurocodes until more confidence and knowledge is gained. In the short term, this approach limits the inevitably increased design time to a single project, allows lessons to be learnt and permits an understanding on how to effectively train staff. The final option is to train all staff and implement on all projects commencing after a certain date.

Whatever strategy is implemented in the office, employees will need to be trained. This may be face-to-face, through self-learning or by distance learning. A range of courses has been developed by The Concrete Centre to meet the demands of face-to-face training (see box).

An alternative is to have a period of distance self-learning, using guidance and publications of worked examples with access to a helpline. This could prove beneficial if sandwiched between 'introduction' and 'lessons learnt' face-to-face sessions.

The new Eurocodes should be viewed as a challenging opportunity and the concrete sector has risen to the challenge and done much to develop a range of tools to help realize this opportunity. ■

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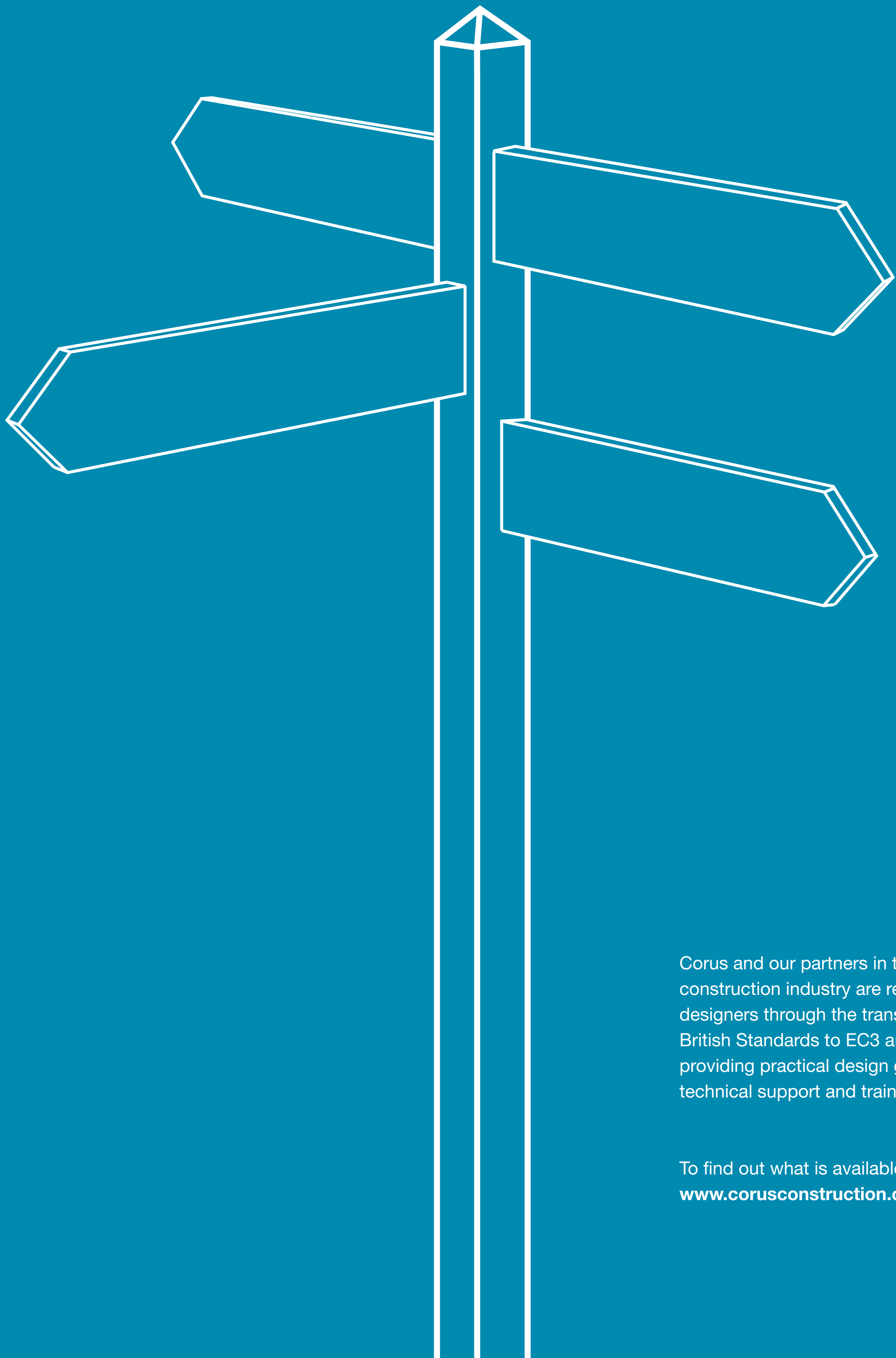


Eurocode 3: Design of steel structures

David Brown, Deputy Director, Steel Construction Institute

Introduction

The primary encouragement to UK designers is that the structural mechanics has not changed – the steel behaves in the same way, no matter which code is used to check resistance. The second encouragement is that familiarity with the Eurocode 3 (BS EN 1993-1-1) will bring the realization that the same design checks are being executed in BS 5950 and Eurocode 3, although the presentation may be slightly different.

Loading

Although this article primarily concerns resistance, the loading side of the relationship is also important. Load combinations are found in EN 1990, and together with the national annex for that code, the results will bring benefits to UK design. For strength design, most economy will be realized by using expression 6.10b (the nomenclature will become familiar in time) which will be the key expression in most circumstances. Under this load combination, elements that only experience vertical loads, such as floor beams, will be designed for 1.25 × permanent actions + 1.5 × variable actions. This is an immediate attraction compared to BS 5950, which would have floor beams designed for 1.4 × dead loads + 1.6 × imposed loads.

Systems carrying wind loads, such as bracing, will experience larger design loads, because in load combinations where the 'leading' variable action is identified as the wind, it will attract a load factor of 1.5. Additionally, the Eurocode equivalent to BS 5950's notional horizontal loads (NHF) – known as equivalent horizontal loads (EHF), appear in every load combination and in addition to the heavier wind loads.

Resistance

Three noticeable general changes are:

- the different nomenclature in EC3;
- the layout of the standard, which is arranged by structural phenomena, not design process and thus will be unfamiliar;
- the presentation of code checks by equation, rather than in look-up tables, and a lack of charts.

> **"The same design checks are being executed in BS 5950 and Eurocode 3, although the presentation may be slightly different."**

All are issues of presentation, and will be managed as designers become familiar with the standard. Engineers will recognize a close and transparent link with the underlying structural mechanics (which was often opaque in BS 5950), using values such as the Euler load, for example. In many cases simple spreadsheets can be used to re-create look-up tables if needed.

Frame stability

This is almost the same as BS 5950. λ_{cr} of BS 5950 becomes α_{cr} in EC3, with a very similar calculation. The familiar limit of 10, above which second order effects are small enough to be ignored, and below that an amplifier, which is the same in both standards. EHF are based on 1/200, which is of course the 0.5% of BS 5950.

Cross sectional resistance

As expected, there are no significant changes here. Shear resistance has almost trivial changes, with a modest change in the shear area. In BS 5950, the shear resistance involves a factor of 0.6 – in EC3 the factor is $1/\sqrt{3}$, which is 0.577. This illustrates that, often, the differences are very small.

Buckling

In both strut buckling and lateral torsional buckling, UK designers will find a different presentation. Slenderness for strut buckling is called $\bar{\lambda}$ calculated as $\bar{\lambda} = \sqrt{(A_{ft}/N_{cr})}$ where N_{cr} is the Euler buckling load. It can be demonstrated algebraically that the expression for $\bar{\lambda}$ is inextricably linked to l/r_{yy} as calculated in national standards – the Eurocode slenderness is l/r_{yy} divided by a factor – approximately 90. Either approach may be used to calculate the EC3 slenderness. Having calculated the slenderness, there is no absolute value of design stress calculated in the Eurocode. The resistance is always based on a reduction factor, multiplied by the yield strength. This means that a multitude of tables displaying values of p_c and p_b are not required – just two single expressions.

For strut buckling, values are very close to those determined in accordance with BS 5950. For lateral torsional buckling (LTB), the resistances according to the Eurocode are generally significantly higher – approximately 25% for middle range Universal Beams. Although LTB does not govern all members, the Eurocode has a valuable advantage when it does.

Combined axial load and bending

With an axial term, a mayor axis bending term and a minor axis bending term, the expressions in the Eurocode look innocent. Designers will find the interaction factors that precede the bending terms appear far from straightforward, but spreadsheets are already available to ease the calculation (www.steelbiz.org).

Connections

With one exception, no significant changes will be found in connection design. Bolts have very similar shear and tensile resistances, and weld strengths are similar to those in BS 5950. The resistance of standard flexible end plates is still governed by shear in the beam web, for example. The major change is in the bearing resistance of bolts, which is significantly higher than the national standard.

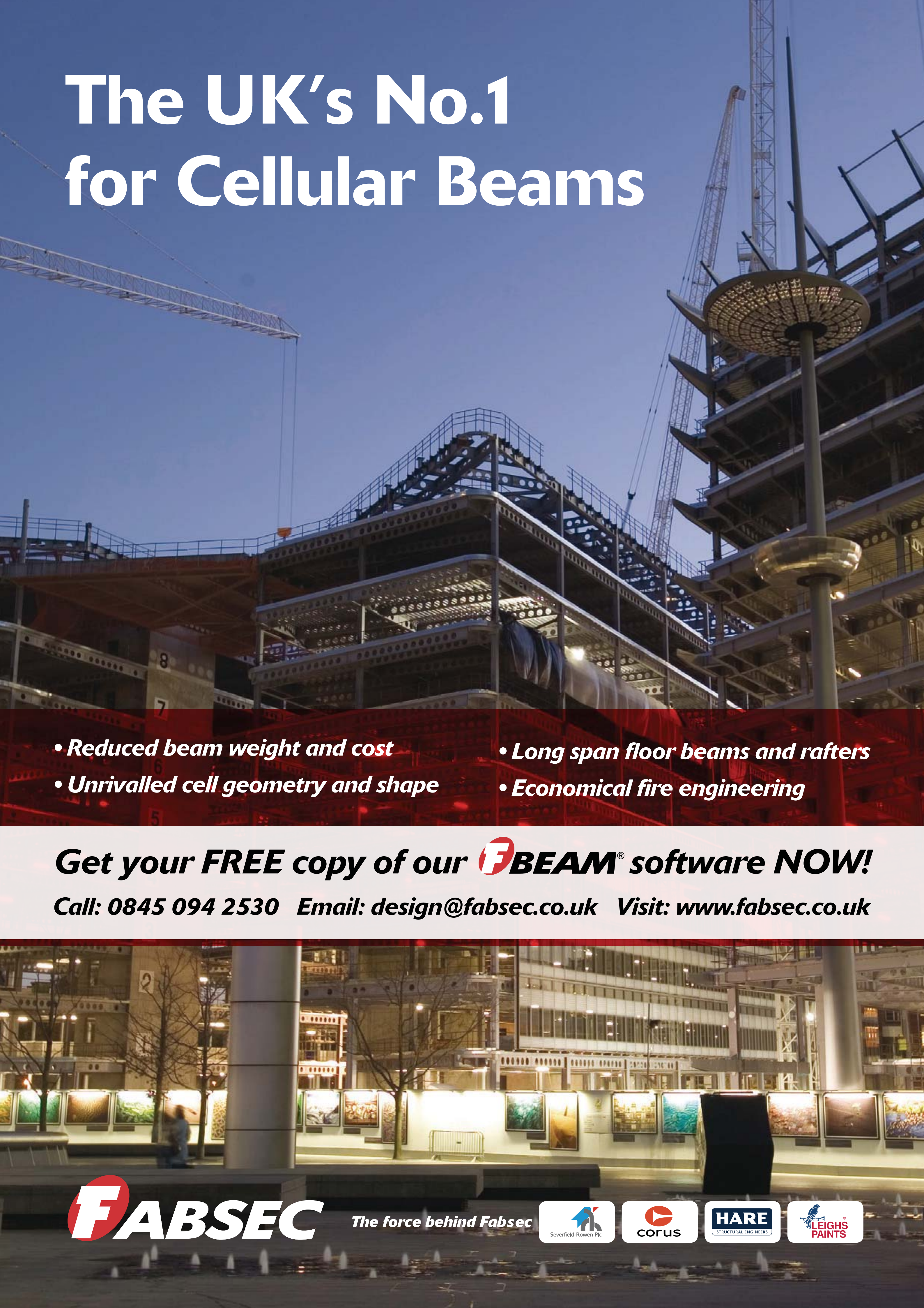
Support tools

Like most sectors, the steel community has been very active in preparing support materials. The ubiquitous 'Blue Book' will be available, alongside a whole series of other guides, including worked examples, a concise guide, connection guides and a guide to multi-storey frames. These are the first of many that will be produced (www.shop.steelbiz.org). Significant resources are available online (www.access-steel.com) and software will be available.

Conclusions

For the steel designer, once familiar with the appropriate documents (a significant task, as this includes the many parts of the Eurocodes, the national annexes and other support information), and familiar with the layout of the clauses within the Standard, the process will be reassuringly similar to design to BS 5950. This general observation has some exceptions, such as combined axial loads and bending, but with some thought, it is easy to see that the underlying principles of structural mechanics are the same in both standards. In many ways, more recent versions of BS 5950 have done a good job of introducing designers to issues such as frame stability, which will be seen in a very similar format in the Eurocode.

The steel knows no different, and the structural mechanics has not changed. In time, this new standard for steel design will become a familiar friend. ■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Eurocode 4: Design of composite steel and concrete structures

Dr Stephen Hicks, Manager Structural Systems, Heavy Engineering Research Association, Manukau City, New Zealand (formerly Senior Manager Building Engineering, Steel Construction Institute, UK)

Eurocode 4 brings both benefits and challenges to UK designers who are familiar with the earlier national standards for composite steel and concrete structures. Eurocode 4 consists of three parts: Part 1-1, *General rules and rules for buildings*; Part 1-2, *General rules – Structural fire design*; and Part 2, *General rules and rules for bridges*. To enable Eurocode 4 to be used, designers also need to make reference to the Eurocodes dealing with the design of concrete and steel structures, BS EN 1992 and BS EN 1993, respectively.

Before the Eurocodes can be used, designers need another document called the national annex (NA) which specifies the appropriate partial safety factors that need to be used for structures built in a particular country. In addition to partial safety factors, there are some choices given in the Eurocodes to allow different nations to control the design methods used in their territory; these parameters are called Nationally Determined Parameters (NDPs). The NA may also include reference to non-conflicting complementary information (NCCI), which provides designers with information that is not given in Eurocodes themselves, such as material from earlier national standards or design guides. For the design of steel structures, the website www.steel-ncci.co.uk will be listed in the UK NA to Eurocode 3 and Eurocode 4, and will provide all the necessary NCCI to these Eurocodes.

To assist designers in understanding Eurocode 4, references [1], [2] and [3] provide background information on the origin and objectives of the code provisions; this is supplemented by a selection of worked examples that illustrate the use of a particular clause. In addition, background information is freely available through the Eurocodes website of the European Commission Joint Research Centre (http://eurocodes.jrc.ec.europa.eu).

One of the major changes for UK designers familiar with composite construction is that the Eurocodes make greater use of first principles and, owing to the fact that there is little duplication of material, a number of standards and their corresponding NAs will need to be consulted when designing a structural element. However, due to their much wider scope, the Eurocodes bring a number of advantages to designers when compared to earlier national standards. For example, asymmetric steel sections that possess a much larger bottom flange in relation to the top flange are very efficient when used in composite beams. As opposed to the earlier national standard for buildings, BS EN 1994-1-1 permits the designer to use steel sections of this type through rules for composite beams with partial shear connection. Moreover, for composite bridges, pilot studies undertaken for the Highways Agency have indicated that the new structural Eurocodes produce more economic designs compared to those using the earlier national standards [4].

As well as improving on rules contained in the earlier national standards, the Eurocodes also permit designs to be undertaken on structures where there previously had been an absence of codified rules. This is particularly true for composite columns, which, although popular internationally due to their slender lines and enhanced resistance for both normal and fire conditions, have not been widely used in UK buildings to date.

Following the publication of the UK NAs, the Steel Construction Institute (SCI) will be issuing a suite of design guides that provide advice on designing structural elements and frames using the Eurocode provisions, together with a full set of worked examples. In addition to the design guides, the European steel industry's multilingual Eurocode 3 and Eurocode 4 website, Access Steel (www.access-steel.com), provides free access to 50 interlinked modules on detailed design of elements, free element-design software, and interactive worked examples. To complement the design guides and electronic resources, training courses on Eurocode 4 are being provided by The Institution of Civil Engineers, The Institution of Structural Engineers and SCI.

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Eurocode 5: Design of timber structures

Arnold Page, Structural Timber Engineering Consultant

Introduction

BS EN 1995 is in three parts:

- Part 1-1: *General. Common rules and rules for buildings*
- Part 1-2: *General. Structural fire design*
- Part 2: *Bridges*

With BS EN 1990 and three standards which provide essential material properties (BS EN 338, *Structural timber – Strength classes*, BS EN 1194, *Timber structures – Glued laminated timber – Strength classes and determination of characteristic values*, and BS EN 12369, *Wood-based panels – Characteristic values for structural design*) Eurocode 5 will replace BS 5268, Parts 2, 3, 4 and 6.

Key changes

The key changes for designers familiar with BS 5268 will be:

- the differentiation between ultimate, serviceability and accidental limit states;
- the partial factor format, which requires safety factors to be applied manually to both loads and material properties, rather than having them all built into tabulated grade or basic values;
- new symbols and material strength modification factors;
- that BS EN 1995 is a theoretical design code rather than a code of best practice, so formulae replace tabulated values and most of the helpful advice given in BS 5268 has disappeared.

Principal benefits

- As with other Eurocodes, multinational companies will benefit by being able to use the same timber design code in many different countries both within and outside Europe [1].
- Using a similar design format to that used for other structural materials will help to make timber design more accessible.
- The separation of ultimate and serviceability design states permits the use of more rational design limits – a Buro Happold engineer stated that the award-winning Sheffield Winter Garden glulam roof could not have been designed to BS 5268.

"Major changes in timber usage and specification are unlikely"

- The separation of principles and application rules allows the engineer more freedom but requires more understanding on his or her part.
- The direct use of characteristic test values simplifies the adoption of new timber materials and components.
- The connection design formulae can cater for LVL, OSB and chipboard as well as for solid timber materials.
- The dedicated timber bridge design code should facilitate and encourage the use of timber in lightweight bridges.
- The formulaic approach facilitates the development of spreadsheets and software.

Chief disadvantages

- Structural calculations to EC5 are generally considerably more complex, particularly for the design of connections, floors, deflections and fire.
- The loss of much helpful guidance such as standard bracing for trussed rafter roofs, stable depth-to-breadth ratios for beams, and the wind shielding effect of masonry attached to timber frame buildings, means that supporting publications will be required.
- No guidance for the design of glued joints is provided – values have to be obtained from tests.
- The code and its numerous supporting standards will cost considerably more.

Challenges

Some challenges for designers will be:

- learning the new symbols;
- determining the critical load case for combined loads of different durations;
- remembering which material modification factors to use (in particular *reducing* the tabulated characteristic values to allow for load duration);
- designing trussed rafter roofs, which involves dozens of different load combinations and load cases;
- demonstrating the strength and stability requirements for timber frame walls with only minimal guidance;
- calculating the design resistance of connections.

Effects on the timber industry

Major changes in timber usage and specification are unlikely. However:

- characteristic strength properties for panel products and components such as timber I-joists and metal hardware must now be obtained in accordance with CEN testing standards;
- floors may have to be a little stiffer (i.e. more timber);
- large roof structures without brittle finishes may not require so much timber;
- there will have to be yet more reliance on software for the design of trussed rafters, connections and timber frame walls.

General guidance and publications

Various manuals and guidance documents have been published in the UK, and many of these are listed on the Eurocodes Expert website [2] under 'Timber/Publications'. STEP, which is a two-volume publication written by European experts, provides excellent background material and useful design examples. TRADA runs courses on Eurocode 5 in conjunction with the Institution of Structural Engineers, and during 2009 it will be completely updating its existing Eurocode 5 design aids, design examples and software. *Manual for the design of timber building structures to Eurocode 5* [3] includes a CD which has spreadsheets for connection design. Finally BSI intends to preserve the guidance in BS 5268, which would otherwise be lost, by producing a new publication of complementary information for use with Eurocode 5 (PD 6693).

Summary

With supporting information Eurocode 5 is a workable design code which is particularly useful for multi-national companies and the designers of larger engineering structures and bridges.

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Eurocode 6: Design of masonry structures

Professor John Roberts, Principal, Technical Innovation Consultancy

Eurocode 6 (BS EN 1996) follows the general presentation of the material Eurocodes in that Part 1-1 covers the design of plain and reinforced masonry whilst Part 1-2 deals with structural fire design. There are two further parts: Part 2 which deals primarily with the selection of materials and execution of masonry and Part 3, which covers simplified calculation methods for unreinforced masonry structures.

BS 5628 was the first limit state design code for masonry in the world and UK designers are very familiar with the principles that have now been encapsulated in Eurocode 6. There are, however, a few major changes that UK designers will need to become familiar with.

During the drafting of Eurocode 6, a way had to be found to deal with the wide range of masonry units used across Europe. This range not only includes different material such as clay, concrete and stone, but also a variety of configurations based upon the proportion and direction of any holes or perforations, web thickness etc. This has resulted in four groupings of masonry units. The UK only has experience of Group 1 and Group 2 masonry units but no doubt Group 3 and Group 4 units will find their way to the UK.

The characteristic compressive strength of masonry is no longer presented in the form of tables but as an equation. This equation includes the normalized strength of the masonry and the strength of the mortar. The normalized strength is new to the UK and relates the compressive strength of the unit determined by test to a standardized shape and moisture content. The designation of mortars has also changed with the need for a declaration based on strength rather than mix proportions. Thus an M12 mortar may be expected to have a strength of 12 N/mm^2.

A key aspect of the standards supporting Eurocode 6 is that only masonry units are referred to, leaving the various UK National Annexes to specify standard sizes for bricks and blocks and how to specify, using performance standards, such things as engineering bricks.

> **"BS 5628 was the first limit state design code for masonry in the world and UK designers are very familiar with the principles which have now been encapsulated in Eurocode 6."**

A further area of change for vertical load relates to the treatment of eccentricity where a frame analysis approach is used rather than the BS 5628 approach of assuming that any eccentricity at the top of the wall is zero at the bottom of the wall. The concept of an initial eccentricity to allow for any inaccuracies in the construction of the masonry is also introduced. Concentrated loads are also handled differently in Eurocode 6. Fortunately lateral load design is based on the BS 5628 approach and will be very familiar to UK designers.

Ancillary components are now dealt with in a more coherent way and suitable values of partial safety factors have been introduced.

Fire design will largely remain in the form of tables similar to those contained in BS 5628-3. The fire resistance of a load-bearing wall now comprises two values depending upon how highly loaded the wall is and is further enhanced if the wall is plastered.

Part 2 of Eurocode 6 (BS EN 1996-2) contains limited information of a very general nature on materials and execution. Five new exposure classifications MX1 to MX5 are defined. Part 2 is not, however, a replacement for the extensive guidance provided in BS 5628 and it is intended that this information, together with some guidance garnered from BS 5628-1 and -2, will form the basis of a PD to be published by BSI.

Part 3 (BS EN 1996-3) deals with simplified calculation methods for unreinforced masonry but it is not anticipated that this will be widely used in the UK where other guidance, for example Approved Document A of the Building Regulations for England and Wales, is likely to produce more cost effective outcomes.

UK consultants have responded positively to the introduction of Eurocode 6 and a number of short courses have been run to update designers with the requirements. The Institution of Structural Engineers have produced a concise design guide for plain masonry buildings designed to Eurocode 6 and The Concrete Centre, along with the Modern Masonry Alliance, have produced three guides on design to Eurocode 6. A website, www.eurocode6.org, has been set up to support users of Eurocode 6. ■

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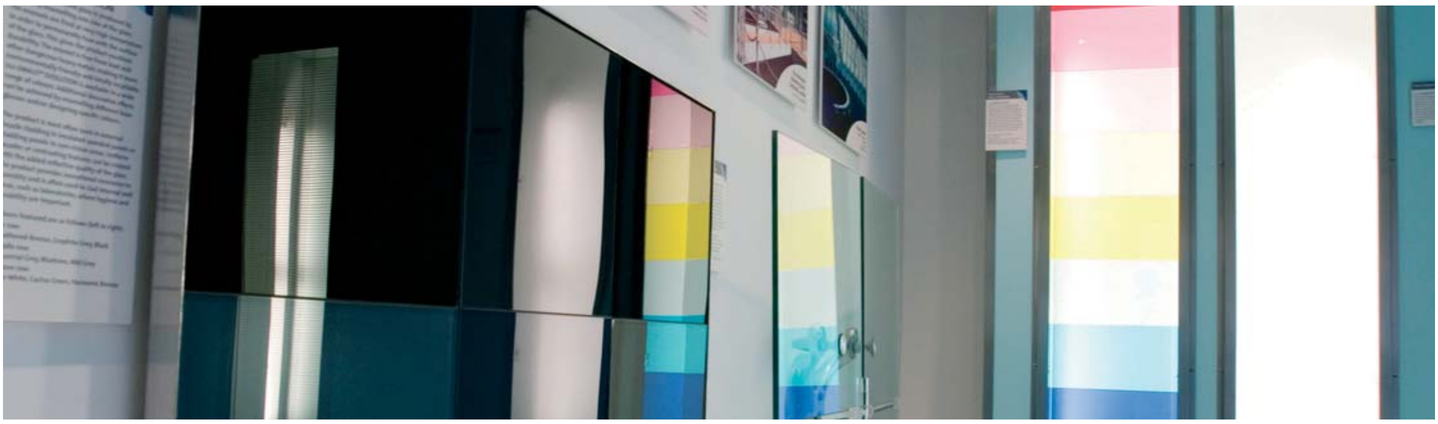

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Eurocode 7: Geotechnical design

Andrew Harris, Director, and Dr Andrew Bond, Director, Geomantix Ltd

Eurocode 7 covers geotechnical design and is provided in two parts: Part 1 – *General rules* (BS EN 1997-1) and Part 2 – *Ground investigation and testing* (BS EN 1997-2). Part 1 is divided into twelve sections and nine annexes and provides a general framework for geotechnical design, definition of ground parameters, characteristic and design values, general rules for site investigation, rules for the design of the main types of geotechnical structures, and some assumptions on execution procedures. Part 2 is divided into six sections and twenty-four annexes and provides detailed rules for site investigations, general test specifications, derivations of ground properties and the geotechnical model of the site, and examples of calculation methods based on field and laboratory testing.

For many geotechnical engineers across Europe, Eurocode 7 represents a major change in design philosophy, away from the traditional allowable (a.k.a. permissible) stress design involving a single, lumped factor of safety. The use of a single factor to account for all uncertainties in the analysis – although convenient – does not provide a proper control of different levels of uncertainty in various parts of the calculation. A limit state approach forces designers to think more rigorously about possible modes of failure and those parts of the calculation process where there is most uncertainty. This should lead to more rational levels of reliability for the whole structure. The partial factors in Eurocode 7 have been chosen to give similar designs to those obtained using lumped factors – thereby ensuring that the wealth of previous experience is not lost by the introduction of a radically different design methodology. The Eurocodes present a unified approach to all structural materials and should lead to less confusion and fewer errors when considering soil-structure interaction.

Limit states should be verified by calculation, prescriptive measures, experimental models and load tests, an observational method, or a combination of these approaches. Not every limit state needs to be checked explicitly: when one clearly governs, the others may be verified by a control check.

BS EN 1997-2 refers extensively to a new suite of international and European standards, prepared jointly by ISO technical committee TC 182 and CEN TC 341. Two of these groups of standards (BS EN ISO 14688 and BS EN ISO 14689) are concerned with the identification and classification of soil and rock. Four of the groups of standards (EN ISO 22282, BS EN ISO 22475, BS EN ISO 22476 and EN ISO 22477) cover field testing. Finally, one group of standards (EN ISO TS 17892) deals with laboratory testing. Each of the standards within each group is divided into a number of parts. The entire suite comprises nearly 50 standards or specifications and over the next few years will replace equivalent British Standards such as BS 5930, *Code of practice for site investigation*, BS 1377, *Methods of test for soils for civil engineering purposes*, BS 8002, *Code of practice for earth retaining structures*, and BS 8004, *Code of practice for foundations*. The Eurocodes will take precedence where there is any conflict between the requirements of the Eurocodes and British Standards.

"Eurocode 7 represents a major change in design philosophy"

Unfortunately, many engineers' initial reaction to Eurocode 7 is to bury their heads in the sand and hope it will go away. The views of many engineers are based on limited knowledge of the Eurocodes and even less experience of using them in practice. However, the Eurocodes provide a unified approach to civil and structural engineering design and bring greater consistency to our treatment of the ground and other structural materials (such as steel and concrete). As engineers become familiar with the numerous documents involved, any antipathy towards them is likely to dissolve.

In order for the Eurocodes to become accepted and their principles to be understood and applied correctly, there needs to be an ongoing programme of education and training. Over the next few years a series of publications will become available to explain the application of the Eurocodes. These will include books, open lectures, teaching materials, case studies and research papers. Each document will provide fresh levels of insight into the subject and will help to uncover any inconsistencies. It is very unlikely that one publication or suite of training events will cater for all needs.

There will be pressure on geotechnical software houses to make their computer programs compatible with BS EN 1997. This task is made more difficult by ongoing debate about how partial factors should be applied to water pressures, passive earth pressures, etc. There will inevitably be a delay before fully consistent and reliable programs become available.

For a detailed explanation of Eurocode 7 and its application to structural engineering reference may be made to Bond, A. J. and Harris, A. J. *Decoding Eurocode 7*, Taylor & Francis, ISBN 10 0-415-40948-9, 2008. ■

Eurocode 8: Design of structures for earthquake resistance

Edmund Booth, Consulting Engineer

The six parts of Eurocode 8 form a comprehensive set of requirements that provide a unified approach to the seismic design of structures and their foundations. Eurocode 8 covers not only building structures, but also bridges and other facilities such as chimneys, towers, tanks and pipelines (both buried and above ground). Concrete, steel, steel-concrete composite, timber and masonry construction is covered. There is also a part dealing with the assessment and retrofit of existing buildings, which is an important issue for seismic regions of the world, where there are many buildings for which construction predated modern seismic design codes or is seismically inadequate in other ways. The use of base isolation bearings to provide seismic protection is also covered. Dams, nuclear power stations and long span suspension bridges are however specifically excluded from its scope.

Eurocode 8 therefore provides a unified approach to the seismic design of a very wide range of structural types and construction materials. It covers the selection of design ground motions, seismic analysis, special seismic detailing requirements and geotechnical issues such as design of retaining walls and assessment of the liquefaction potential of soils. Eurocode 8 is of course fully integrated with the rest of the Eurocode suite, to which reference is needed for non-seismic aspects of design. The comprehensive scope of Eurocode 8, and its ability to form part of a uniform basis for all aspects of design, is an important feature of the code that will be of benefit to UK designers. The clear and rational basis for its provisions and the advanced nature of many of its procedures will also assist designers.

Guidance material on Eurocode 8 includes the IStructE manual [1] and the Designers' Guide [2]. The Society for Earthquake and Civil Engineering Dynamics (www.SECED.org.uk), in association with Imperial College London, runs a regular series of two day courses on Eurocode 8.

Eurocode 8 is mainly intended for design in areas of high to moderate seismicity, such as parts of southern Europe or Turkey, and it is likely that UK designers will make most use of it for projects in such regions. For areas of low or very low seismicity, including the UK, seismic design is only likely to be required in structures where there are very severe consequences of failure. The UK National Forewords to all parts of Eurocode 8 state:

> *There are generally no requirements in the UK to consider seismic loading, and the whole of the UK may be considered an area of very low seismicity in which the provisions of EN 1998 need not apply. However, certain types of structure, by reason of their function, location or form, may warrant an explicit consideration of seismic actions. Further guidance on the circumstances where an explicit seismic design should be considered is provided in PD 6698: 2008.*

Nuclear power plants are the prime example of 'high consequence of failure' structures, and have been designed seismically in the UK since the 1980s; major dams have also been subject to seismic checks for many years. Both types of structures are specifically excluded from the scope of Eurocode 8, because there are particular aspects of their design that are not covered. However, many features of Eurocode 8 are still relevant, and it is likely that Eurocode 8 will influence the practice of UK designers undertaking nuclear and dam design work. Certain petrochemical facilities, such as liquified natural gas (LNG) tanks and high pressure gas pipelines, and important bridges are other examples where seismic design has been carried out in the past, and Eurocode 8 covers seismic aspects of their design. The UK National Annexes to Eurocode 8 advise that seismic loading should be considered in consequence category CC3 structures, which are defined in BS EN 1990 as those having high consequences of failure, while the normal and low consequence categories CC1 and CC2 can be considered as adequately covered by the robustness provisions of other parts of the Eurocode. PD 6698: 2008 [3] gives further advice on seismic design to Eurocode 8 in the UK and (for the first time) provides seismic hazard zoning maps of the UK suitable for code based designs.

References

[1] Institution of Structural Engineers. *Manual for the seismic design of steel and concrete buildings to Eurocode 8*, London, publication expected 2009

[2] Fardis M., Carvalho E., Elnashai A., Faccioli E., Pinto P. and Plumier A. *Designers' guide to EN 1998-1 and 1998-5. Eurocode 8: Design Provisions for Earthquake Resistant Structures*, Thomas Telford, London, 2005

[3] PD 6698:2009, *Background paper to the UK National Annexes to BS EN 1998-1, BS EN 1998-2, BS EN 1998-4, BS EN 1998-5 and BS EN 1998-6.* British Standards Institution, London

Eurocode 9: Design of aluminium structures

Phil Tindall, UK Technical Director (Bridges), Hyder Consulting

Eurocode 9 has five parts;

- Part 1-1 gives general structural rules and is largely equivalent to BS 8118-1;
- Part 1-2 gives design for fire resistance, which was not covered by a British Standard;
- Part 1-3 relates to structures susceptible to fatigue and was included in BS 8118-1;
- Parts 1-4 and 1-5 give design rules for cold-formed structural sheeting and shell structures respectively; neither subject was covered by a British Standard in any great detail.

Eurocode 9, in common with other Eurocodes, makes considerable cross-reference to other European standards. In particular, it is based on the principles contained in BS EN 1990 and refers to Eurocode 1 for loading. BS EN 1090-3 gives rules for execution (fabrication and erection) and will replace BS 8118-2.

The Eurocodes are more theoretical than British Standards and have the advantages in allowing designers, where necessary, to go back to first principles. This can result in higher allowable loads and more economical structures. Presently many designers use commercial software or in-house spreadsheets for code compliance checking, consequently more complex checks are now not necessarily an issue.

The national annexes to Eurocode 9 give UK-specific partial factors and choices. The use of the UK National Annexes is a prerequisite for the use of Eurocode 9.

It is anticipated that BS 8118 will be withdrawn in 2010.

BSI is issuing two documents to assist UK designers using Eurocode 9 in the UK. These are PD 6702-1 and PD 6702-2. These documents give important guidance on matters where choice is given in Eurocode 9 or BS EN 1090-3, together with additional background data referred to in the national annexes.

The BSI committee responsible for Eurocode 9 considered that some of the fatigue detail categories in BS EN 1999-1-3 could be subject to misinterpretation, or could give fatigue safe lives that are only achievable with unrealistic expectations regarding internal defects. The published guidance document gives alternatives to the informative annexes in Eurocode 9. The alternative category information uses data previously issued in prENV 1999-2, published in the UK in 2000 as a Draft for Development.

Opportunities and challenges

Many of the Eurocode 9 rules are similar to those in BS 8118, albeit they are more extensive and allow greater refinement of the design, which can lead to more economical structures. In common with other Eurocodes, the additional clauses and the need to reference other standards increases the required design effort. Comparative exercises between Eurocode 9 and BS 8118 show that the difference in allowable loads for static design of typical members and details are small.

The use of Eurocode 1 for loading and a common philosophy for load factors and partial safety factors, irrespective of whether working in steel, aluminium, timber, concrete, on a building, a bridge or on foundations, will be welcomed by designers. The different factors for each material/application in British Standards added a layer of complication.

BS EN 1999-1-2 gives comprehensive rules for determining the fire resistance of aluminium members in structures. This is a welcome addition as the subject was not previously covered by British Standards and the detailed knowledge of fire resistance was confined to a small group of experts.

Applications that need extended fire resistance should have insulation applied in a similar manner to steel structures.

BS 8118 calculated fatigue design based on 'safe life' principles. BS EN 1999-1-3 uses a similar methodology for calculating a fatigue safe life. The UK recommendation is not to use the detailed categories contained in the informative annexes.

The Eurocode also allows a damage-tolerant approach to fatigue design, i.e. some cracking is allowed to occur in service, provided that there is stable, predictable crack growth and a suitable inspection regime in place. The damage tolerant approach should only be used in conjunction with the approval of the owner of the structure. This approval can, in certain circumstances, be beneficial.

BS EN 1999-1-4 is a welcome addition due to the increasing design requirements for cold-formed structural sheeting that has a light weight and excellent corrosion resistance.

BS EN 1999-1-5 has a series of very complex analyses for shell structures. This Part 1-5 requires considerable expertise in shell structures and the ability of the designer to use correctly complex finite element computer software. ■

Section 4
Business matters: software and risk

Software to the Eurocodes

Alan J Rathbone, Chief Engineer CSC(UK) Ltd

Choosing the right moment to release design software for the Eurocodes is a matter of judgement. In reality it makes no sense to make software available (other than perhaps for training purposes) before all the appropriate national annexes are available. For some materials these are ready, whilst for steel the latest proposed publication date for the main ones is the end of 2008. Across the whole range of Eurocodes there are some national annexes that will not be ready until 2009.

The question of need is a serious one. In bridge design where there are a few, strong clients keen to move forward, some software is already available. It is anticipated that the bridge fraternity will consider proposals for design using the Eurocodes once all the appropriate national annexes are available. In building design with a mixed client base there is less incentive. For some material sectors an economic advantage can be seen whilst in others the reverse is more likely. This is not a climate for rapid uptake. To allow all of the supporting documents to be in place (not just the national annexes but other industry produced guidance) and a period of 'settlement' it is anticipated that software for integrated building design will start to become available in 2009. It is a massive task to redevelop all software to allow for Eurocode design – CSC have estimated that updating the full suite of Fastrak, Orion and TEDDS is of the order of 20–25 man years – so it is likely that all of the software will not be ready at one instant in time but will be phased.

It is clear that developing, testing and documenting new software for Eurocodes is a massive and costly task for each software house. Commercially this cannot simply be absorbed but how it is passed on will no doubt depend upon the software house and the type of package on offer.

The amount of training required following the introduction of the new Eurocode software will also depend upon the type of software on offer. For example, probably no training will be necessary for a simple steel beam calculation used to assist understanding and to compare results between British Standard and Eurocode designs. In this case, individuals should be able to work out how to use the software and determine how the answers are derived. On the other hand integrated building design software will almost certainly require users to undertake some training – not in the use of the software since much of the user interface will not change but in setting up the model and in interpreting the results. Diligent software houses will provide this training to run alongside and be complimentary to training provided by industry bodies.

> **"It is a massive task to redevelop all software to allow for Eurocode design … it is likely that software will not be ready at one instant in time but will be phased."**

Almost certainly it will be possible to run Eurocode and BS codes in parallel and importantly this is exactly what you should do but NOT on a live job. The probable advice from the software houses would be to start on a small, simple building that has already been designed to British Standards. This is downtime for the designer; it is not fee-earning but will pay dividends later.

New software is likely to be reliable although it must be recognized that with any new major software development there may be some snags. CSC has robust procedures for testing software, for reporting 'bugs' and for updating software. Hence, it is (always) important that you keep the programs up to date with the latest versions or downloads. Of more concern than bugs should be snags associated with changes in approach within Eurocodes – for example both cylinder and cube strength are used to define concrete strength. This could easily trip up (or snag) the unwary.

If you wish to continue to use your in-house software then it will need to be modified or perhaps, particularly in the case of spreadsheets, completely rewritten. In both cases you should follow a quality process – define what the software/spreadsheet should do, do it, and then test that it does what it should.

Perhaps this is a time to review your strategy for the development of in-house software/spreadsheets, and, if necessary, turn to alternatives from commercial software houses. ■

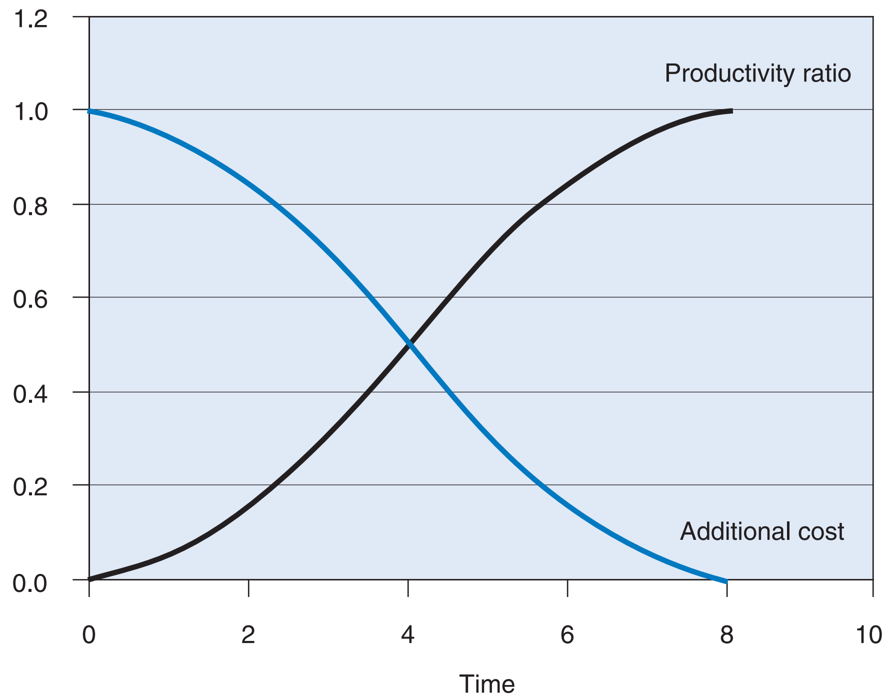
Implementing Eurocodes: the benefits of computer-based training

Chris Austin, Bestech Ltd

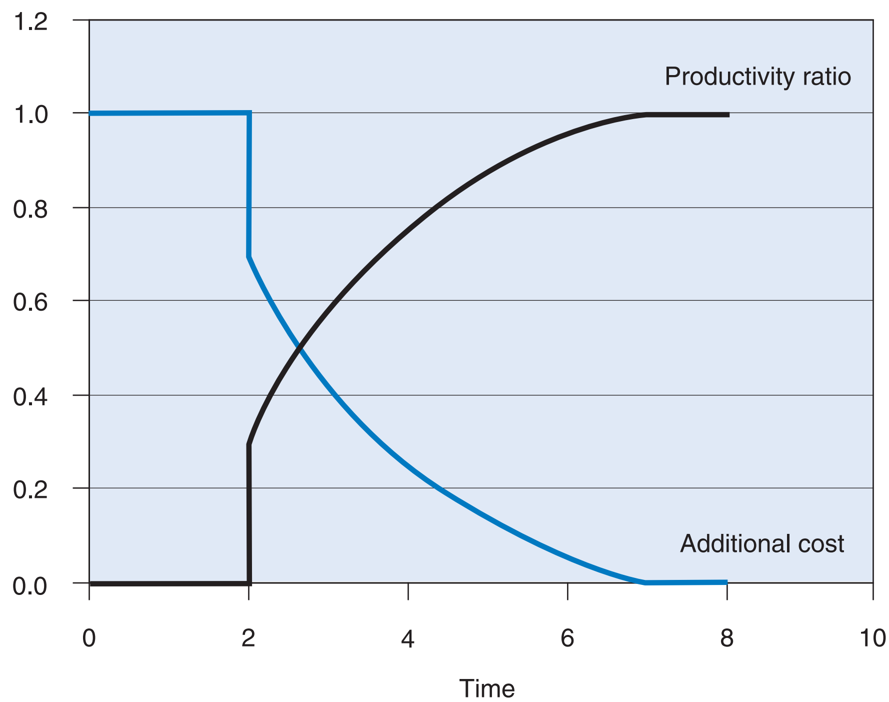
There is no doubt that implementing Eurocodes will cost every organization both in terms of time and of money. The key is to reduce them to a minimum. In a hypothetical example, let us assume that the steepness of engineers' learning curves vary with time, and so as a result their productivity compared with their normal productivity ('productivity ratio') gradually approaches unity as time progresses, as in Example 1. At the same time, the additional cost of these engineers goes from one times usual cost (i.e. no generated revenue) to zero (i.e. full revenue). The total additional cost is the area under the Additional Cost curve, which in this case is approximately 4.5 units.

"There is no doubt that implementing Eurocodes will cost every organization both in terms of time and of money. The key is to reduce them to a minimum."

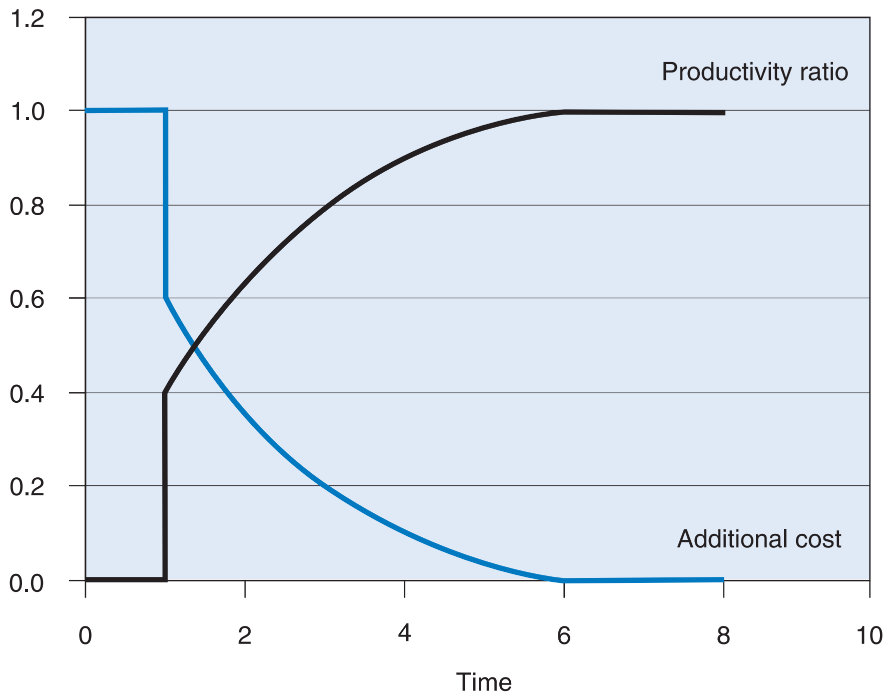
One way to accelerate the learning curve is to 'Minimize the Novel', and one technique is to run a pilot design on a project that has been done before in another code: obviously one would want to select a small project! During the time of the pilot, the productivity ratio will be zero, but afterwards the learning will start with a higher productivity ratio, and will take less overall time, and in Example 2 the total additional cost has been reduced to about 3.7 units.



Example 1 – Natural learning



Example 2 – Pilot project



Example 3 – Pilot project plus computer-based training

In both the preceding examples, the productivity ratio increases as a result of experience, formal training, external conferences and courses, etc. If it was possible to make the experience easier to acquire, and the training more effective, then the pilot project would take less time, and the learning curve would be even steeper, so full productivity would be achieved in less time and at less total additional cost, which in Example 3 is down to approximately 2.5 units.

Making the training more effective and the experience easier to acquire is relatively easy provided that the right software is available.

Formal training often consists of a lecture, and maybe some worked examples, as in the typical university lecture on the theory of structures. The 'students' do not learn very much until they come to try it for themselves, and in the work environment this means either doing homework (literally), or waiting until the need arises and trying desperately to remember which lecture covered the issue at hand, and what the recommendation was. If students do the examples during the lecture, then much time is wasted as the lecturer handles queries on a one-on-one basis, and much less material can be covered.

"Making training more effective and the experience easier to acquire is relatively easy provided that the right software is available."

However, if the lecture is based around a carefully chosen set of examples that are worked out by software, then many simple examples can be covered in a lecture, each with a small number of learning points. If the software is sufficiently well written, most queries on the operation of the new design code will be handled by the online help system, thus freeing up the lecturer for really important queries such as code interpretation issues.

By definition, hand worked examples can take time to perform, and so it is difficult to assess the importance of various assumptions, but with software the calculations are instantaneous (almost) and it is easy to see the effect of changing the value of a parameter from (say) 1.15 to 1.25, and so the students can quickly develop the experience of knowing which parameters are important (or sensitive) or not so important (or insensitive). This makes the experience quicker and easier to acquire.

The lectures not only deliver knowledge about the Eurocodes, but also they inspire confidence in the use of the software, and this means that the software can be used immediately on real projects. With the online help system giving day-to-day guidance, the learning process becomes available full time, and the total learning time is dramatically reduced. In fact, one could proceed with a design without having full knowledge of the code, because one could be confident that most queries could be handled quickly and easily online. Of course overall guidance would still be required, but it could be given in bigger and higher level chunks and at shorter intervals, because the details could be covered simply and easily whilst doing productive work. ■

Insurance and the Eurocodes

Peter Sharp, Aon Ltd

Construction professionals must ensure that they use the new Eurocodes when required to do so by their clients, as failure to keep up to date could impinge on their future professional indemnity costs.

As has been outlined earlier in this publication, Structural Eurocodes for the construction industry are the European Union's replacement for national design standards, such as those published by the British Standards Institution. As the Eurocodes are integral to the Building Regulations, consultants in the construction industry will usually need to make sure that their work meets the new Eurocode standards. These changes will affect architects, engineers, chartered surveyors and also design and build contractors. Failure to use the new standards could result in an increased risk of being sued for negligence if an old British Standard has been used and work is required to rectify any mistakes. This could lead to an increase in claims against consultants' and contractors' professional indemnity insurance which in turn could prompt a possible rise in the cost of insurance, bigger excesses and/or additional restrictions in their policy terms and conditions.

Promoting free movement

As a replacement for the British Standards, which currently provide the UK's codes of practice, the Structural Eurocodes are a pan European initiative that establish a set of codes for construction. Covering 57 design standards they include a number of key areas such as the basis of structural design, steel, concrete, timber, masonry, aluminium, specialist glass, geotechnical and seismic design, and will ensure that construction standards across Europe will be harmonized. The thinking behind the Structural Eurocodes is that they will encourage the free movement of construction products and services around the European Union. This will improve competitiveness both within European Member States and also for European firms working outside Europe recognizing the critical role that the construction sector has throughout Europe.

The changeover may, however, present a problem to construction consultants who will be used to complying with the old British Standards and may not be aware that they could face significant financial penalties from negligence claims if they do not incorporate the new Structural Eurocodes in their work when required to do so by their clients. So how can the professional consultant prepare to minimize the impact on their business both from a cost and an operational perspective?

> **"Eurocodes will encourage the free movement of construction products and services around the European Union."**

Take responsibility

It is the consultant's responsibility to ensure that all their designs, specified materials and products meet the required standard. Fortunately due to the comparatively high benchmark of the existing British Standards to the rest of Europe, it is possible that consultants in this country will be near to achieving the required standard. This does not mean they can be complacent or ignore the change.

A sensible start point would be an assessment of what the differences are from the current British Standards and how the changes can be incorporated in their risk management procedures and internal IT systems. Good risk management practice should ensure that the possibility of making a mistake from the use of an old standard is minimized. Making a start now can further reduce the risk while the British Standards and Structural Eurocodes are going through a period of co-existence.

Avoiding claims

In the past, claims have been made under professional indemnity insurance policies against consultants who have failed to adhere to existing British Standards. This is often when a British Standard has changed but a failure of internal procedures has meant that it was not updated within the practice's procedures. It is likely that the introduction of the Structural Eurocodes will make this scenario more of a risk and could result in a corresponding rise in the number of claims. Whilst professional indemnity insurance will provide indemnity under these circumstances underwriters keep a keen eye on those areas that produce large numbers of claims. Consultants and contractors with a poor claims record where they have failed to maintain up-to-date standards may well see insurance costs rise or face getting less cover for a higher premium.

If you are involved in a professional role in the construction sector, 2010 represents a significant milestone and a useful deadline for updating your standards. Failure to ensure the new standards are incorporated will not only impact on your clients and your reputation but could also have an adverse effect on your professional indemnity cover in the future. ■

Structural Eurocodes – what they say

"The Eurocodes are recognized as the most technically advanced suite of civil and structural engineering codes in the world and they will present significant opportunities to the UK Construction Industry."

Professor Haig Gulvanessian CBE, Civil Engineering and Eurocode Consultant

"The structural eurocodes are the culmination of many years work by hundreds of experts throughout Europe and will enable designers to work with consistent codes across the borders between European Countries."

Barry Haseltine MBE, UK delegate to TC 250 and past Chairman of CEN/TC 250/SC 6 "Design of Masonry Structures"

"Structural Eurocodes form a coherent package of codes that are technically up to date and internally consistent. They are rigorous and yet flexible allowing their adoption not only within Europe but also internationally."

Professor Nary Narayanan, past Chairman of CEN/TC 250/SC 2 "Design of Concrete Structures Committee"

"Managing the transition from working to British Standards to the adoption of the new Eurocodes will of course represent a challenge but one that should provide new and enhanced markets for UK Structural Engineering."

Professor David Nethercot OBE, Chair of the IStructE Eurocodes Implementation Committee

"Eurocodes contain the most up to date design information covering all civil engineering structures. For the first time there will be uniform design rules across Europe. The sooner we start using Eurocodes, and face the challenges of a new set of standards, the more equipped we will be to grab the opportunities of a wider European Market."

Sibdas Chakrabarti, formerly, the Highways Agency Eurocodes Project Manager

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