



# Implementation of the Structural Eurocodes

After 25 years in preparation, the implementation of the structural Eurocodes for regular use in design in the UK has commenced. This is the biggest change to codified structural design ever experienced in this country

Change brings both opportunities and threats. The opportunities are for the UK to be in the forefront of this process; having maximum European influence on practical implementation and also creating significant opportunities for increasing export of design services, currently valued at £1.5 billion per year. The threats arise from inaction. Without proper investment in support, design costs will rise substantially; worse, mistakes may occur, with potential implications for safety. Without a strong and expert home market in design to the Eurocodes, existing exports of design services will decline.

In December 2003 the Office of the Deputy Prime Minister (ODPM) invited the Institution of Structural Engineers (IStructE) to submit a proposal to produce, within a three month period, a National Strategy to inform ODPM and other stakeholders of the guidance material and other training aids etc, required to ensure the successful implementation of the structural Eurocodes within the UK. The IStructE welcomed the timely invitation and a 'National Strategy for Eurocodes Committee', under the chairmanship of Professor David Nethercot, IStructE President, was established. Work commenced on 1 February 2004 and the final report, *National Strategy for Implementation of the Structural Eurocodes: Design Guidance*<sup>1</sup>, was submitted to ODPM on 30 April 2004. This article is a summary of the report.

## The structural Eurocodes

In 1975 the Commission of the European Community initiated a programme of work aimed at producing a set of technical rules for structural design, the structural Eurocodes, which would initially serve as an alternative to existing national rules and eventually replace them.

In 1989 the Commission decided to transfer the preparation and publication of the Eurocodes to the European Committee for Standardisation (CEN), whose members are the National Standards Bodies (in the UK this is the British Standards Institution (BSI)) so that they would have the status of European

Standards. The UK has taken an active part in the process of drafting the Eurocodes and considerable resources from both industry and government have been expended in support of this activity.

## Scope

The structural Eurocodes cover Basis of Structural Design, Actions (ie Loading), each of the main structural materials, geotechnical design and design for earthquake resistance.

Other than EN 1990, each of the codes is divided into a number of Parts covering specific aspects of the subject.

All of the Eurocodes relating to materials have a Part 1-1 which covers the design of buildings and civil engineering structures. They also have a Part 1-2 for fire design. The codes for concrete, steel, composite construction, timber and earthquake resistance have a Part 2 covering design of bridges. In each case Part 2 is to be used in combination with the appropriate Part 1.

The Eurocode Parts have been grouped into Packages, each of which must be published with their respective National Annex before full implementation of that set of Codes may begin. ENs 1990, 1991, 1997 and 1998 are material independent and are therefore included in each package.

## Programme for publication

All of the Eurocodes were initially published as trial codes, known as ENVs, intended for experimental use. In practice in the UK there was little real use of the ENVs, although there were some projects where a design using them was compared to that using British Standards, for the purpose of calibration.

A minimum of two years after publication of each ENV, National Standards Bodies submitted comments to CEN on its contents and use. These comments informed the drafting committees in converting them into the final, EN, codes. In many cases the EN will be significantly different from the corresponding ENV.

As a member of CEN, BSI is required to publish the Eurocodes and, in due course, subsequently withdraw conflicting national standards. Following approval of the final text of a Eurocode, it will be made available to BSI. This is known as the 'Date of Availability' (DAV). BSI then has a maximum period of two years in which to prepare the National Annex to accompany the code and publish the code as a National Standard. (Appendix C of reference 1 lists the dates by which it is currently anticipated that each of the parts of the Eurocodes will be published with its National Annex).

Following publication of each Eurocode together with its National Annex there will be a period (known as the coexistence period) during which they can be used alongside the existing British Standards as a means of demonstrating compliance with regulatory requirements. As the design of any structure will require reference to more than one of the Eurocodes they have been grouped together into packages related to different types of structure. The period of coexistence, which may last a maximum of three years for all of the Parts within a package, will not begin until the last Part included within it is published by BSI with its National Annex.

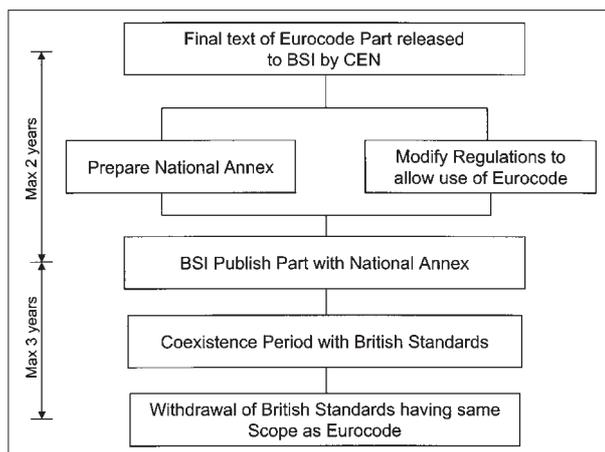
At the end of the coexistence period BSI is required to withdraw the British Standards having the same scope as the Eurocode Package.

The Public Procurement Directive<sup>2</sup> will mean that tenderers for contracts for public works must either offer technical solutions based on a European Standard (ie a Eurocode) where this exists (ie when the Eurocode and its National Annex have been published) or, alternatively base their offer on equivalent standards/Codes. ODPM will need to give clear guidance on

## The ten Eurocodes

- EN 1990 Basis of structural design
- EN 1991 Actions on structures
- EN 1992 Design of concrete structures
- EN 1993 Design of steel structures
- EN 1994 Design of composite steel and concrete structures
- EN 1995 Design of timber structures
- EN 1996 Design of masonry structures
- EN 1997 Geotechnical design
- EN 1998 Design of structures for earthquake resistance
- EN 1999 Design of aluminium structures

A list of the Parts of each of the Eurocodes and the Packages into which they have been grouped may be found in Appendix C of *National Strategy for Implementation of the Structural Eurocodes: Design Guidance*<sup>1</sup>.



**Figure 1**  
**Timetable from release of final text of a Eurocode from CEN to withdrawal of British Standards.**

prerogative. Consequently, some safety factors and a number of other parameters, such as those reflecting differences in climatic conditions, are left open in the Eurocodes for selection at a national level. These are termed Nationally Determined Parameters (NDPs).

The National Annex of each Eurocode Part lists the NDPs and other points on which an element of national choice exists, for example, where there is the possibility of a choice of different design methods. The National Annex may also include reference to non-conflicting complimentary information (NCCI), such as national standards or guidance documents.

The UK National Annexes will be developed under the auspices of BSI and will be issued as drafts for public comment before they are finalised.

**Implementation of the structural Eurocodes in the UK**

The implementation of the structural Eurocodes will be the most wide ranging change to the codification of structural design in the UK ever experienced by the construction industry. Whilst they will be in many ways the most technically advanced suite of design codes available anywhere in the world, the way in which they are presented and some of the terminology used will be unfamiliar to those used to working with British Standards.

The adoption of European standards offers significant opportunities in terms of export of UK design expertise and products. A number of countries outside Europe are also likely to adopt the Eurocodes and hence further increase these opportunities. In addition the introduction of the Eurocodes will allow increased competition for designers within the UK from designers from other European countries.

If the UK construction industry is to be in a position to make

which codes and standards are considered to be equivalent to the Eurocodes. As most projects will include elements constructed of several different materials covered by different Eurocode packages, guidance will also be required as to when the Public Procurement Directive will become applicable to different types of project.

**National Annexes**

National Standards Bodies are not permitted to change any part of the text in the core CEN document. However, they are allowed to add a National title page, a National Foreword and a National Annex.

As the Eurocodes are intended to be used as one approach to satisfy Building Regulations and other requirements that are not currently harmonised across the European Union they recognise the principle that the level of safety in a country remains its

**Issues related to implementation**

Issue	Comment
Designers	Designers are unlikely to adopt the structural Eurocodes until they see a competitive advantage, are required to do so by clients or there is effectively no alternative because the British Standards have been withdrawn and references in the Approved Documents to the Building Regulations removed. The investment required to purchase the Eurocodes themselves and supporting guidance documents as well as provide the necessary training for staff will be significant. As an illustration, it has been estimated <sup>1</sup> that the cost (including loss of productivity) of adopting the structural Eurocodes within a consultancy with 16 fee earning staff will be approximately £0.25m. With their fee levels already under pressure, some designers are likely to resist making this expenditure for as long as possible.
Residual British Standards	At the end of the coexistence period BSI is required to withdraw those British Standards having the same scope as the Eurocode Package. However, the scope of each of the Eurocodes is such that in the vast majority of cases their content will not match precisely that of the corresponding British Standards. For each British Standard that will eventually be withdrawn a decision needs to be reached as to whether the material within it that is not superseded by the appropriate Eurocode should be retained for use in the UK. Such material might either be reissued as a new British Standard or incorporated into another publication such as a handbook. These documents will need to be available at the time of publication of the relevant Eurocode and its National Annex, or as soon as possible thereafter. The National Annex of each Eurocode is permitted to contain reference to Non-conflicting complimentary information (NCCI) which will assist designers in applying it in the UK. Much of the NCCI that it will be desirable to reference is likely to be from existing British Standards that will be withdrawn. If the finalisation of the National Annexes is not to be delayed, decisions on the fate of the material from these standards need to be reached quickly.
Non-conflicting complimentary information from sources other than British Standards	It is likely that the National Annexes will include reference to a wide variety of NCCI drawn from sources other than current British Standards. Much of the necessary material will be updated documents from the various bodies within the industry who regularly publish authoritative guidance. However, finalisation of the National Annexes will require that these organisations decide which documents will be updated to reflect the Eurocodes and to what timescale they will be produced.
National Annexes	Considerable work still remains to be carried out to calibrate the Eurocodes. Thus far most of the emphasis in preparing the National Annexes appears to have been on buildings but it is essential that the necessary work in connection with bridges and other types of structures is completed. Providers of guidance material and software need the National Annexes to be finalised before they will be able to do most of their work. Consequently it will not be possible for the majority of such material to be published until some time after the appropriate National Annex is finalised.
Background information and interpretation	Production of guidance documents and software will be greatly assisted if information related to the background of the provisions, for example the basis of formulae, of the Eurocodes could be gathered together and made available. Authoritative interpretation of some sections of the codes will be necessary to enable them to be used as intended by their authors.
BSI	Within the UK the copyright of the Eurocodes will rest with BSI. In order to be useful, guidance documents, in both paper and electronic format, will need to be able to quote extracts from them. It is also likely that material from existing British Standards not republished as residual standards will need to be incorporated in other forms of NCCI. It is therefore essential that arrangements are made which allow reproduction of what is required without unnecessary bureaucracy or prohibitive cost.

## Issues related to particular Eurocode or individual parts

Eurocode	Specific issues
Loading ENs 1990 and 1991	These Eurocodes will be used in conjunction with all the other Eurocodes and guidance on their application will be a crucial part of implementation of the entire suite of Eurocodes. However, they are not 'owned' by a particular sector of the industry. Consequently there is no natural focus for provision of what is required.
Concrete EN 1992	In general, when used in conjunction with the National Annex, EN1992 will not be particularly different from BS8110. However, it will give designers the opportunity to derive benefit from considerable advances in concrete technology over recent years.
Steel EN 1993	EN 1993 covers several topics including: Strength and stability of shells; Selection of steel for fracture toughness and through thickness properties; Design of structures with tension components not previously dealt with explicitly by British Standards.  It also distributes material traditionally found in a single British Standard between several parts, making the location and usage of the rules necessary for an actual design more troublesome.
Composite EN 1994	EN 1994 requires much more careful consideration of shrinkage, second order and thermal effects than BS5950-3. Manufacturers of profiled metal sheeting will need to reassess their test results for composite slabs and reinterpret them for use with EN 1994. In some cases additional tests may need to be carried out.
Timber EN 1995	Unlike the other Eurocodes relating to materials, the introduction of EN 1995 brings with it a change from permissible stress to limit state design. Implementation of EN 1995 is therefore a particularly substantial task and it is essential that guidance material is made available in a timely manner
Masonry EN 1996	When designing in masonry workmanship and choice of material are of particular importance so whilst not strictly structural matters guidance on these issues will be required to enable the successful implementation of EN 1996.
Geotechnics EN 1997	To date within the UK the extent to which geotechnical design has been codified has been much less than in other sectors. Consequently the introduction of EN 1997 will represent a marked change in UK practice and the needs of geotechnical designers in order to permit them to adapt to the change will be significant.  Whilst the National Annex for EN 1997 will stipulate that Design Approach 1 should be used in the UK, guidance on all three design approaches permitted by the code will be required in order to enable UK based engineers to work in other countries.  EN 1997-2 will represent a change in the way in which geotechnical parameters for design are developed from testing. Guidance will be needed on the derivation and application of characteristic values based on EN 1997-2 and how these fit with the EN 1997-1 framework of design approaches, partial factors and limit and serviceability state design.  Guidance on the design of temporary works will also be required.  There is no coherent geotechnical industry to fund the production of guidance.
Seismic EN 1998	It is not yet known whether or not EN 1998 will be mandatory in the UK, and UK needs depend to some extent on the outcome of this decision. However, a likely outcome is that the UK national foreword may use wording similar to that employed for the ENV version of the code: 'Within the UK, application of EN 1998 should not be necessary, unless the client or user of the works assesses that the associated seismic risk is such that it needs to be addressed'. If a similar form of words is used, then it is important that guidance material should be available addressing the circumstances in which seismic risk needs to be addressed in the UK.  Quite separately, technical guidance on the use of EN 1998 will be needed for designers working in seismic areas of Europe and (most likely) other seismically active parts of the world. UK expertise in this area gives a significant competitive advantage and is an important source of foreign earnings.
Aluminium EN 1999	Aluminium is used infrequently in comparison to other materials and hence EN 1999 is likely to receive limited use. Whilst it is difficult to justify any significant expenditure solely within the UK there is scope for any necessary guidance material to be produced collaboratively across Europe.
Bridges Annex A2 of EN 1990 and Parts 2 of ENs 1991, 1992, 1993, 1994, 1995 and 1998	Historically in the UK the design of bridges has been codified separately from buildings and other structures. However, within the Eurocodes the specific provisions for their design are presented in Part 2 of each of the appropriate codes (and Annex A2 of EN 1990). In each case Part 2 must be read in conjunction with the associated Part 1 rather than being a stand alone document. Consequently it is important that the impact on bridge design of decisions being reached in respect of the National Annexes for Part 1, largely from the perspective of buildings, are considered in some detail.

the transition to the Eurocodes in an efficient, cost effective manner and therefore to be well placed to capitalise on the opportunities which they present, their implementation must be coordinated across the industry. Guidance on the use of Eurocodes and the actions that they need to take will be required by various groupings within the industry including clients, designers, regulators, contractors, academics and suppliers.

In the lead up to and throughout the period of transition to the Eurocodes a wide range of authoritative information, Residual Standards, guidance material and design aids will need to be prepared and disseminated.

### Issues related to implementation

Issues that will have an effect on the implementation of the structural Eurocodes have been identified; each is summarised in the table 'Issues related to implementation'.

### Initiatives already in place

The professional institutions, research associations, trade associations, and other bodies have already started to prepare the industry for the transition to the Eurocodes. A list of the guidance material that is either already available or being

prepared, that the Committee was able to identify, is presented in Appendix D of Reference 1.

### Needs of industry

The Committee considered the information needs of the various stakeholders in the industry in respect of each of the Eurocodes and these are tabulated in the report<sup>1</sup>. It should be noted that some sectors of the industry, particularly those with organisations providing a focus within the sector, already have a reasonably clear list of what is likely to be required by their sector. In others the thinking is currently less well advanced. It is inevitable that the requirements will change and develop during the transition period.

The Committee was also able to identify some specific points relating to either particular Eurocodes or the needs of some of the different users. These are summarized in the tables 'Issues related to particular Eurocodes or individual parts' and 'Needs of specific user groups'.

### Recommendations

The principal recommendations of the Committee are:

- The UK Structural Engineering community must be properly

## Needs of specific user groups

Group	Specific issues
Non-technical users	Guidance on the process and effect of implementation of the Eurocodes will need to be provided to enable designers and others to explain the transition to non-technical users such as clients and insurers. In addition to general information of this type a handbook to EN 1990 setting down the philosophy and basis of the Eurocodes, written specifically for clients to ensure that they are aware of the implied safety provisions in the Eurocodes, such as reliability levels, is required.
Designers and regulators	Designers and regulators will need access to a clear, jargon free, programme with dates of: publication of the Eurocodes; publication of the National Annexes; availability of guidance documents; availability of design aids; withdrawal of British Standards.  As it is inevitable that some of these dates will change the programme will need to be updated on a regular basis. Also is the timely provision of appropriate guidance material required including worked examples, software and cost effective training. A helpdesk to provide assistance with interpretation or other difficulties in using the codes is also essential.
Academia and those providing training	The particular requirements of academics and trainers are: Teaching notes to minimise the effort required to update their current material; Access to a concise version of the Eurocodes. A single document with extracts from the material and loading Eurocodes would be particularly useful (it is understood that the document of this type being prepared by BSI contains much material drawn from draft versions of the codes and so it will be of limited use); Textbooks to Eurocodes; Background information to the Eurocodes so that the principles behind design methods can be explained.
Software producers	The provision of software to the Eurocodes in certain sectors i.e. concrete, steel and composite design, is absolutely key to the successful implementation and acceptance of the Eurocodes. The size of the task is such that it will not be possible to produce the software required all at once.  The engineering specification of a software development project can only be undertaken effectively when the final version of the appropriate Eurocode(s), National Annex(es), Residual Standards and other NCCI is accessible (although not necessarily published) and all interpretation issues resolved. For commercial software houses, this engineering specification represents about 30% of the whole software development project. Hence, after the right information is available and incorporated there is still 70% of the job left for the software developer to complete.

- supported during the transition process, which can be expected to occupy a minimum of five years. If not, much competitive advantage, in terms of both defending the UK home market and enabling exports overseas, will be lost.
- Guidance material related to EN 1990 and EN 1991 is essential and, in the absence of an associated industry sector, 100% Government funding will be required to provide it.
  - Partnerships between government, industry and independent bodies are needed for the preparation of guidance to EN 1992 to EN 1998. It is not reasonable to expect industry to carry all these costs. Government, as a major client for construction, should provide at least matching cash funding to ensure it obtains maximum value from the transition.
  - A group should be established to monitor the process of implementation of the structural Eurocodes in the UK and advise on changes to the strategy that become necessary as the process progresses.
  - BSI needs to urgently address:
    - The strategy for calibration of National Annexes
    - The need for residual standards and the programme for their production
    - Copyright policy with regard to the Eurocodes, the National Annexes and information currently available in British Standards that will be needed beyond the withdrawal of those Standards.
  - ODPM needs to issue clear guidance on the use of Eurocodes for contracts for public works.
  - The structural engineering community requires a clear timetable for the transition from British Standards to Eurocodes so that it can plan for the necessary changes to its ways of working.
  - A user friendly, web based, source of up-to-date information on the publication schedule of the Eurocodes and associated guidance material is required.
  - A technical helpdesk should be established. It must be seen as the National source of authoritative guidance.
  - The professional institutions, research associations and trade associations who provide authoritative design guidance should prepare a prioritised schedule for those items related to the

Eurocodes that they intend to produce.

- A comprehensive programme of education, utilising a number of different means of dissemination, for both students and practitioners should be drawn up.
- The UK should support the formation of maintenance groups for the Eurocodes, if necessary with BSI taking the lead in CEN to ensure that this happens. Government funding needs to be available to enable UK participation in these groups.
- The UK strategy set out herein needs to be continually re-assessed, updated and supported.

### References

1. Institution of Structural Engineers National Strategy for Implementation of the Structural Eurocodes: Design Guidance, report prepared for the Office of the Deputy Prime Minister, IStructE, 2004. ([www.istructe.org.uk/eurocodes](http://www.istructe.org.uk/eurocodes))
2. Council Directive 98/4/EC of 16 February 1998 amending Directive 93/38/EEC coordinating the procurement procedures of entities operating in the water, energy, transport and telecommunications sectors.

## Members of the committee

Professor D A Nethercot, <i>Chairman</i>	<i>Masonry Society</i>
Professor D Anderson, <i>representing the Institution of Structural Engineers</i>	Dr D B Moore, <i>representing the Building Research Establishment</i>
Dr A J Bond, <i>representing the Institution of Civil Engineers</i>	Dr G W Owens, <i>representing the Steel Construction Institute</i>
E D Booth	A J Rathbone
S M Brown	J L Redmond
S Chakrabarti, <i>representing the Highways Agency</i>	B W Smith
Dr P S Chana, <i>representing the British Cement Association</i>	P J Steer, <i>representing the UK Timber Engineering Group</i>
Professor L A Clark	Dr H P J Taylor
S Edwards, <i>representing TRADA Technology Ltd</i>	R Thawrani, <i>representing Eurocode Expert/Thomas Telford Ltd</i>
C H Goodchild, <i>representing The Concrete Centre</i>	A J Todd, <i>representing CORUS</i>
M Greenley, <i>representing the British Standards Institution</i>	P Watt, <i>representing the Brick Development Association</i>
G T Harding, <i>representing the Office of the Deputy Prime Minister</i>	D B Williams, <i>representing the British Standards Institution</i>
B A Haseltine, <i>representing the British</i>	<b>Secretary to the Committee</b>
	Dr S M Doran, <i>the Institution of Structural Engineers</i>