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Briefing: Eurocodes implementation for highway bridges in the UK

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The implementation of structural Eurocodes is the biggest ever change to codified structural design in the UK. The new standards will replace British Standards for structural design, and will be implemented by the Highways Agency ('the Agency') for bridge design over the next four years. The Agency is committed to using Eurocodes for the design of all highway structures and will introduce the Eurocodes for all new procurement at an appropriate time after the respective UK National Annexes are published. This briefing note discusses the implementation aspects in more detail, outlining the Agency's Eurocodes strategy. This includes the effects on the *Design Manual for Roads and Bridges* and the design studies that have been carried out to ensure highway bridges continue to be designed safely and economically following implementation of the Eurocodes.

1. INTRODUCTION

The Eurocodes programme will soon enter its final phase. All of the Eurocode parts are scheduled for publication by the end of 2006, and all of the National Annexes are set to follow by the end of 2007. The publication of the National Annexes will herald the beginning of the coexistence period, during which both Eurocodes and British Standards can be used. The British Standards Institution (BSI) intends to withdraw all conflicting British Standards by 2010, and the intervening period is likely to see the gradual migration of all structural design from the British Standards to the Eurocodes.

The Public Procurement Directive, implemented in the UK by the Public Contracts Regulations 2006, will compel public bodies such as the Highways Agency to formulate technical specifications in contracts by reference to European Standards, as published by BSI. Therefore, the Agency has commenced a programme of implementation to prepare for the use of Eurocodes for highway bridge design.

In 2003 the Agency commissioned consultants Parsons Brinckerhoff and Atkins on a seven-year framework contract to assist with the implementation of Eurocodes. The consultants and their supply chain partners have been working with the Agency's specialists on wide-ranging activities related to Eurocodes implementation. This work has included the following activities.

(*a*) Assisting with the development and execution of a strategy for the implementation of structural Eurocodes on Agency projects.
(*b*) Developing the technical content of the Eurocodes-aligned *Design Manual for Roads and Bridges* (DMRB).
(*c*) Assisting with the calibration of UK nationally determined parameters for bridge-related UK National Annexes.
(*d*) Undertaking bridge design studies using Eurocodes.
(*e*) Developing and delivering training and seminars.
(*f*) Preparing worked examples.
(*g*) Ensuring that highway structures can be designed safely and economically using the Eurocodes.

2. HIGHWAYS AGENCY STRATEGY

The Agency has been preparing for the introduction of Eurocodes for several years and has adopted a strategy for their introduction with the following objectives.

(*a*) Ensure Eurocodes are safe and economic for use.
(*b*) Prepare the bridge-related UK National Annexes in conjunction with the BSI technical committees.
(*c*) Update Highways Agency technical requirements in line with the Eurocodes.

This strategy is being executed by the Agency in coordination with the overseeing organisations of Scotland, Wales and Northern Ireland, and in liaison with interested industry bodies.

The strategy translates into a number of different areas of work, which can be categorised in the following manner.

(*a*) National Annexes: contribute to the calibration of nationally determined parameters for bridge-related UK National Annexes through BSI working groups.
(*b*) *Design Manual for Roads and Bridges*: review and redraft the requirements of the overseeing organisations for the design of structures for consistency and alignment with the Eurocodes.
(*c*) Bridge design studies: undertake studies using the Eurocodes to design bridges to understand the effect of introducing Eurocodes on design practices, how they will affect the physical characteristics of structures, and inform the development of the DMRB.

(*d*) Training and seminars: develop and deliver seminars for technical approval authorities in the overseeing organisations and for the general public in association with the engineering institutions.

3. DESIGN MANUAL FOR ROADS AND BRIDGES

One of the most tangible changes for UK bridge engineers will be to the DMRB. The overseeing organisations will no longer be able to reproduce sections of standards in the DMRB with modifications in a manner familiar to users of standards such as BD37 or BD13. Instead the DMRB can only contain information that is complementary to the Eurocodes, along with the additional (non-contradictory) requirements of the overseeing organisations.

There are currently around 50 BDs and BAs related to the design of bridges and other highway structures. These are being scrutinised and categorised: some information relates solely to the British standards and will therefore be superseded; some information contains the additional requirements of the overseeing organisations and will be retained in a form that is complementary to the Eurocodes; some information is out of date and will be withdrawn; and some is useful guidance material, which will be retained in a complementary format.

Similarly, the Eurocodes have been examined to determine what additional requirements will be needed to meet the objectives of the overseeing organisations for bridges to be safe, economic, maintainable, adaptable and durable. There will also be a need for some additional guidance to help designers apply the Eurocodes.

Information that falls under the banner of 'guidance' will be promulgated using the most appropriate means. Consideration is being given to publishing some complementary information in the DMRB, but most will be published as BSI 'Published Documents' (documents published by BSI that do not have the status of a standard, denoted by the abbreviation PD). Recognising that some guidance is most effectively developed and maintained by industry bodies, the Agency will also be encouraging the industry to publish complementary guidance information for the Eurocodes.

The Agency is also taking the opportunity to consolidate and simplify the information that is in the bridge design parts (including soil–structure interaction, ancillary structures and components) of the DMRB. This will result in there being fewer, more-focused DMRB parts for the design of highway structures.

4. BRIDGE DESIGN STUDIES

Over the years numerous design studies have been carried out to develop and validate the rules in Eurocodes. These studies involved using the Eurocodes to redesign structures that had already been designed and built to current Highways Agency and British standards.

The Agency identified a number of objectives for these studies, including the following activities.

(*a*) Examine the impact on technical approvals.
(*b*) Identify specific issues and problems that will be encountered by engineers designing bridges to Eurocodes.
(*c*) Undertake a comparison of Eurocode actions (loads) and section capacities against British standards.
(*d*) Examine specification issues in the light of European product and execution standards.

For the bridges designed as part of the studies, the Eurocodes were found to have little or no effect on element sizes and, compared on a like-for-like basis, the Eurocodes generally resulted in sectional resistances that were within 10% of the results from the British standards. Some notable differences exist, particularly for shear in concrete: for sections without shear links the resistance in accordance with the Eurocodes is slightly lower, reflecting more recent work done in this area; for shear-reinforced sections the variable angle truss model in the Eurocodes offers notably higher shear resistance. Another noteworthy issue is that the Eurocodes treat prestressed concrete and reinforced concrete in a consistent manner, rather than the separate treatment as in BS 5400-4. Despite there being little overall difference to the design outcome in these studies, it should be noted that the Eurocodes do offer greater scope for innovation.

As stated earlier, the studies included a preliminary assessment of their impact on technical approval. The Eurocodes themselves do not change the role of the Technical Approval Authority (TAA), but will, of course, have an effect on the practices. There will be obvious effects on the BD2 Approval in Principle (AIP) form, such as the need to change the sections on loading from the current type HA and HB loads to the Eurocode traffic models, and the need to change the Technical Approval Schedule to reference the Eurocodes.

The outcomes from the studies also highlighted some common areas of UK practice that are not covered in the Eurocodes. This informed the work being done to develop additional complementary guidance. Of particular note is that the Eurocodes do not contain provisions for the distribution of wheel loads through fill, surcharge models, and do not explicitly cover integral bridges. Guidance on all of these aspects is at an advanced stage of development.

The studies involved a significant learning curve for the designers, as would be expected. They observed that the Eurocodes are generally more academic in style, with clauses expressed in a more 'mathematical' style than the British standards. The designers also found that although the design principles are generally clear, it is not always obvious how they should be satisfied. However, during the course of design all the designers involved in the studies quickly became conversant in the Eurocodes, and found them to be different but not necessarily more difficult.

Perhaps the most notable finding of the pilot studies, however, was that it is possible to design these common types of highway bridges using the Eurocodes and in some cases they are more logical to follow. However, further training and guidance will be necessary.

5. FUTURE ACTIVITIES

The Agency is engaged in a detailed programme of work to prepare for the introduction of Eurocodes. This principally involves the redrafting of the DMRB to align with the Eurocodes.

The publication of the Eurocodes-aligned DMRB has been programmed to ensure complementary information for designing highway structures and will be available during the period of coexistence.

The Agency's technical specialists and Eurocodes framework consultants will also continue to play an important role in the development of the National Annexes for bridges, most of which are scheduled for publication by July 2007.

The Agency, along with the overseeing organisations in Scotland, Wales and Northern Ireland, is also planning and undertaking studies using the Eurocodes to design bridges in parallel with the live design on highway improvement schemes. The outcomes of these studies will be used to examine the potential effects of the introduction of Eurocodes when they are introduced in live design situations, and to inform the development of guidance.

6. CONCLUSIONS

We will most likely see the Eurocodes beginning to be introduced for highway bridge design sometime in 2007, when all of the necessary documents are expected to be available. The Agency has engaged considerable time and resource on the development of Eurocodes, and therefore it is important that these are implemented as soon as practicable so that bridge designers take advantage of the most up-to-date information contained in these standards.

The bridge design studies highlighted that highway bridges can be designed successfully using the Eurocodes. The results of these studies also restated many of the challenges that the introduction of the Eurocodes will pose for designers. There will soon be little option but to use Eurocodes for the design of highway structures, and designers must be ready for their introduction and they must effectively manage the cost and programme implications of introducing new design standards.

Finally, as stated in the report of the Institution of Structural Engineers on the implementation of Eurocodes, change brings opportunities and threats. Within the next few years Eurocodes will become a reality, and UK designers must be ready to take advantage of the opportunities offered by their introduction or risk being left behind in comparison with their European counterparts.

7. ACKNOWLEDGEMENTS

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REFERENCES

1. British Standards Institution. *steel, concrete and composite bridges, Code of practice for design of concrete bridges*. BSI, London, 1990, BS 5400–4.