

Eurocodes revision – an update

Like the other Eurocodes, Eurocode 2⁽¹⁾ is to be revised circa 2020. Charles Goodchild of MPA–The Concrete Centre gives an overview of progress.

The UK officially implemented the Eurocodes in 2010. Technically, they are regarded as the most advanced suite of structural design Standards. They facilitate common understanding and common design criteria across Europe and help international working.

Although their use is still not obligatory in the UK, the Eurocodes are increasingly being accepted as the most appropriate structural design Standards (see Figure 1) – even on the smallest of jobs. With the influx of a new generation of engineers and with the traditional old British design Standards not being maintained, there is now effectively little alternative.

The Eurocodes were some time in their gestation and now, as with all Standards, there comes a time when they need to be reviewed and, as necessary, revised and improved. And so it is that after a major review, CEN TC250 has embarked on a programme of revision and improvement. In due course, national Standards bodies such as BSI will have to review their National Annexes, etc.

TC250

TC250 is CEN's committee in charge of all the structural Eurocodes. Most of its current work revolves around the successful delivery of the programme developed in response to the European Commission's Mandate M/515 for 'amending existing Eurocodes and extending the scope of structural Eurocodes'. This work includes development of a new structural Eurocode on glass and revisions to the existing codes to cover:

- improving the ease of use, particularly for day-to-day calculations
- a reduction in the number of national by determined parameters (NDPs)
- assessment, reuse and retrofitting of existing structures
- improving requirements for robustness.

The committee is also concerned with essential maintenance and promotion.

Towards the end of 2014, a systematic review of all Eurocodes was undertaken and from this a programme of work was developed. The actual drafting of the revised Standards will be done by funded project teams. These have now been contracted and some started work towards the end of 2015.

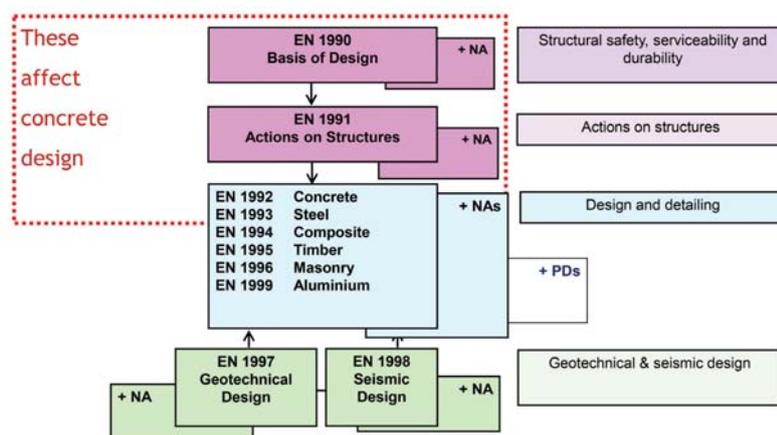


Figure 1: Eurocode hierarchy.

A chairman's advisory panel (CAP) set out priorities for the new and revised Eurocodes. Notably, it identified competent practising engineers as the primary audience. It was noted that in 75% of cases, recommended values for NDPs have been accepted across Europe.

Eurocode 2

Across the four parts of Eurocode 2⁽¹⁾, the systematic review elicited 1168 comments from CEN member countries. Some 220 of these comments came from the UK and most of those came through The Concrete Centre's Helpdesk. As may be surmised from Figure 2, most comments were on Part 1-1, *General rules and rules for building*, notably Section 6, Ultimate Limit State. All UK comments went through the relevant BSI committees before being included in BSI's contribution to the overall systematic review.

Our understanding of concrete design continues to evolve and the publication in 2013 of the *fib Model Code for Concrete Structures 2010 (MC2010)*⁽²⁾ has to be acknowledged as a step forward and a major, but not infallible, influence on the future revision of EN 1992.

CEN's TC250/SC2/WG1

TC250's subcommittee SC2 deals with structural concrete and SC2's Working Group 1 (WG1) became the co-ordination and editorial panel for the revision of EN 1992 in May 2012. Even before the systematic review was undertaken, WG1 was considering

comments and setting up ten task groups (TGs) to deal with particular issues. After 15 meetings, 300 papers and co-ordinating the TGs, proposed revisions to existing text have started to appear and be considered.

The UK has representation on each one of the task groups and they too have been busy. At the beginning of 2016 the position was as follows:

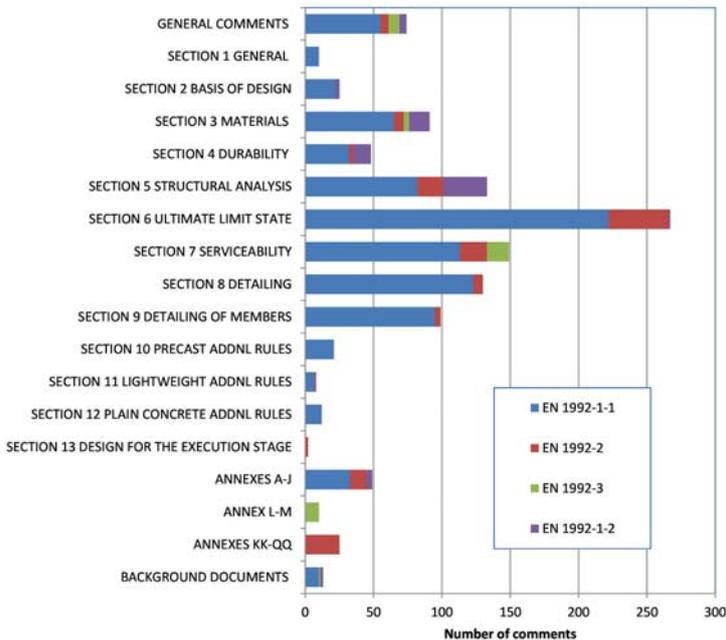
TG1 Fibre-reinforced polymers: Proposals for FRP reinforcement are more or less complete: they are based on German methods. Rules for strengthening are moving towards a final draft annex. Proposals for shear may depend on outcomes from TG4.

TG2 Steel fibres: Steel-fibre concrete can be used as a structural material and rules are being developed (industrial floors are currently out of scope). Characteristic residual strengths for design should be available from a table. Shear rules await the outcome of discussions within TG4 (current structural usage is commonly up to $40\text{kg/m}^3 \equiv 5.5 \times 10^{-3} \text{m}^3$ of fibres/ $\text{m}^3 \equiv 0.5\%$).

TG3 Assessment: The scope of this TG is to comply with EN 1990⁽³⁾ and deal with departures from EN 1992. Having done a lot of information gathering and thinking, the TG awaits outcomes from SC250/WG2 on Assessment across all materials. WG2 is using a JRC report⁽⁴⁾ on assessment rules across CEN countries as a basis for further work. Many areas are contentious, as there are many different national practices.

TG4 Shear: Punching shear continues to be another contentious subject. There seem

Figure 2: Comments from all CEN countries on EN 1992 within the systematic review.



Notes:

a) To January 2015 according to TC250/SC2/WG1 papers N215, N207, N208, N195 and N145.

b) For EN 1992-1-2 and EN 1992-3, section headings are not necessarily as indicated. For instance, Section 5 of EN 1992-1-2 (Fire) is tabulated data.

to be three broad options, namely:

- to leave the code as it is and to make improvements and rectify omissions as required
- the EPFL (Swiss Federal Institute Of Technology Lausanne) proposal (as *MC2010*, basic perimeter at 0.5d)
- the Aachen University proposal (basic perimeter at 0.5d).

The merits and usability of each approach are being discussed. A database of test results has been created.

There are two new proposals for beam shear. One is similar to the *MC2010* approach. The second is acknowledged as being accurate but complicated (although simplification may be possible). The third and most likely option is to keep beam shear provisions as they are. Discussion concerning concentrated loads near supports (aka shear enhancement) continues.

TG5 Fire: The main items of discussion concern columns, thermal conductivity, explosive spalling, revision of the zone method (algorithm for temperature in concrete), checks on plastic rotation, recycled aggregates.

TG6 Analysis: A lot of focus has been on the application of non-linear finite-element analysis (FEM) and safety formats, but this has rather stalled pending the development of a general approach within EN 1990. Most of the comments considered by the TG were on Section 5.8, Analysis of second order effects with axial load (ie, columns). This section has been provisionally redrafted and clarified.

TG7 Time-dependent effects: Proposed changes will improve estimation of drying shrinkage (currently up to 50% out); estimation of creep (currently 5% out); soundness of modelling and overall consistency. The basis will change such that: strain = shrinkage strain + initial elastic strain + creep strain. Early-age thermal effects have yet to be looked at.

TG8 Fatigue: There are fundamental issues such as: 'when do you need to check?'; the relevant combination of actions and the significance of $\gamma_{F, \text{fat}}$; and the effect of fatigue on shear. A draft section on the effect of fatigue on bond is being prepared. There may be simplified rules for bridges but the increasing numbers of wind turbines has focused minds into new areas. Discussions continue.

TG9 Bridges: This task group has analysed and reviewed the comments received and the vast majority have been directed to WG1 and the TGs dealing with EN 1992-1-1. New sections covering external prestress, cable stays and extradosed bridges have been proposed but may prove inappropriate for the code. There is a possibility that EN 1992-2 might be subsumed into EN 1992-1-1.

TG10 Durability: A joint working group between SC2 and SC104 (concrete) has been looking at ways of matching resistance classes of concretes to exposure classes of elements and structures. The UK supports introducing this 'service-life design'. While it is considered as ideal, it is recognised that there are enormous hurdles to overcome. The newly constituted SC2/WG1/TG10 will

concentrate on providing tables for inclusion in EN 1992-1-1, while an SC104 task group will deal with modelling and testing etc. If the background work cannot be completed in time, then it is likely that current requirements will remain.

Detailing – An *ad hoc* group has been set up to deal with the acknowledged problems with detailing. For instance, there are pressing issues with laps – even the rules in *MC2010* are acknowledged to be very conservative. The aim is to provide rationale for simple rules that will lead to more economic details and detailing.

Programme

The intention is that a very preliminary draft of the revised Eurocodes will be available for internal consumption by April 2017 and final drafts will be available in April 2018. Beyond that, the approvals and comment processes will take at least another two years. The aim is to publish in 2020.

Within that same programme, the work on Eurocode 2 has two phases. Phase I will include: reduction in numbers of national choices (NDPs), enhanced ease of use, durability, design by non-linear FEM, size effects and early-age thermomechanical design. A separate Phase II project team will start a year later and will deal with stainless steel and fire design. Other 'unfunded' revisions will be incorporated at the same time.

Concluding remarks

As may be imagined, the revision of the Eurocodes is a massive undertaking and the programme is ambitious. It takes a lot of effort and most of the effort described above is voluntary. There are many people involved, representing many different countries. Each has their own viewpoint and opinion. The UK may not always get its own way but certainly those involved are determined that Eurocode 2 will become an even better Standard for the design of structural concrete. ■

References:

1. BRITISH STANDARDS INSTITUTION, BS EN 1992-1-1. *Eurocode 2. Design of concrete structures. General rules and rules for buildings*. BSI, London, 2004+A1:2014.
2. FÉDÉRATION INTERNATIONALE DU BÉTON. *Model Code for Concrete Structures 2010*. Ernst & Sohn, Berlin, 2013.
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4. JOINT RESEARCH CENTRE. *New European Technical Rules for the Assessment and Retrofitting of Existing Structures*. Publications Office of the European Union, available at: <https://ec.europa.eu/jrc>.

Acknowledgement:

An earlier version of this paper was given to the CBDG Annual Conference, June 2015.