CEN and other international organisations

- CEN TC 104 “Concrete”
- CEN TC 250 “Eurocodes”
- CEN TC 229 “Precast concrete products”

- BIBM
- fib
Organisation chart European Standards

TC 250: EC 0  Basis of Design

TC 250: EC 1 Actions on structures

TC 250: EC2  Concrete Structures
  - Fire Design
  - Bridges
  - Containment Structures

TC 104: Materials
  - EN 206  Concrete
  - EN 10080  Reinforcing steel
  - EN 10138  Prestressing steel

TC 229: Precast Products
  - WG 1
  - WG 4
Material standards for concrete

- EN 12350, EN 12390: Testing concrete
- EN 197: Cement
- EN 13263: Silica fume
- EN 450: Fly ash
- EN 934-2: Admixtures
- EN 12620: Aggregates
- EN 13055-1: Light weight aggregates
- EN 1008: Mixing water
- EN 12878: Pigments
- EN 206-1: Concrete
- EN 13791, EN 12504: Testing concrete in structures
EN 206 and national annex

• Exposure classes
• Concrete classes
Exposure classes

• XO  No risk of corrosion or attack
• XC1-XC4 Corrosion induced by carbonation
• XD1-XD3 Corrosion induced by chlorides
• XS1-XS3 Corrosion induced from sea water
• XF1-XF4 Frezze/thaw attack
• XA1-XA3 Chemical attack
## Exposure classes and recommended values for concrete mix

<table>
<thead>
<tr>
<th>Exposure classes</th>
<th>X0</th>
<th>XC 1</th>
<th>XC 2</th>
<th>XC 3</th>
<th>XC 4</th>
<th>XS 1</th>
<th>XS 2</th>
<th>XS 3</th>
<th>XD 1</th>
<th>XD 2</th>
<th>XD 3</th>
<th>XF 1</th>
<th>XF 2</th>
<th>XF 3</th>
<th>XF 4</th>
<th>XA 1</th>
<th>XA 2</th>
<th>XA 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Maximum w/c</strong></td>
<td></td>
<td>0.65</td>
<td>0.60</td>
<td>0.55</td>
<td>0.50</td>
<td>0.50</td>
<td>0.45</td>
<td>0.45</td>
<td>0.55</td>
<td>0.55</td>
<td>0.50</td>
<td>0.55</td>
<td>0.55</td>
<td>0.50</td>
<td>0.50</td>
<td>0.45</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Minimum strength class</strong></td>
<td>C12/15</td>
<td>C20/25</td>
<td>C25/30</td>
<td>C30/37</td>
<td>C30/37</td>
<td>C30/37</td>
<td>C35/45</td>
<td>C35/45</td>
<td>C30/37</td>
<td>C30/37</td>
<td>C30/37</td>
<td>C30/37</td>
<td>C30/37</td>
<td>C35/45</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Minimum cement content (kg/m³)</strong></td>
<td>260</td>
<td>280</td>
<td>280</td>
<td>300</td>
<td>300</td>
<td>320</td>
<td>340</td>
<td>300</td>
<td>300</td>
<td>320</td>
<td>300</td>
<td>300</td>
<td>320</td>
<td>340</td>
<td>300</td>
<td>320</td>
<td>360</td>
<td></td>
</tr>
<tr>
<td><strong>Minimum air content (%)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Notes

- Where the concrete is not air entrained, the performance of concrete should be tested according to an appropriate test method in comparison with a concrete for which freeze/thaw resistance for the relevant exposure class is proven.

- When SO₄²⁻ leads to exposure classes XA2 and XA3, it is essential to use sulfate-resisting cement. Where cement is classified with respect to sulfate resistance, moderate or high sulfate-resisting cement should be used in exposure class XA2 (and in exposure class XA1 when applicable) and high sulfate-resisting cement should be used in exposure class XA3.
## Concrete classes

<table>
<thead>
<tr>
<th>Compressive strength class</th>
<th>Minimum characteristic cylinder strength $f_{d_{k,\text{cyl}}}$ N/mm²</th>
<th>Minimum characteristic cube strength $f_{d_{k,\text{cube}}}$ N/mm²</th>
</tr>
</thead>
<tbody>
<tr>
<td>C8/10</td>
<td>8</td>
<td>10</td>
</tr>
<tr>
<td>C12/15</td>
<td>12</td>
<td>15</td>
</tr>
<tr>
<td>C16/20</td>
<td>16</td>
<td>20</td>
</tr>
<tr>
<td>C20/25</td>
<td>20</td>
<td>25</td>
</tr>
<tr>
<td>C25/30</td>
<td>25</td>
<td>30</td>
</tr>
<tr>
<td>C30/37</td>
<td>30</td>
<td>37</td>
</tr>
<tr>
<td>C35/45</td>
<td>35</td>
<td>45</td>
</tr>
<tr>
<td>C40/50</td>
<td>40</td>
<td>50</td>
</tr>
<tr>
<td>C45/55</td>
<td>45</td>
<td>55</td>
</tr>
<tr>
<td>C50/60</td>
<td>50</td>
<td>60</td>
</tr>
<tr>
<td>C55/67</td>
<td>55</td>
<td>67</td>
</tr>
<tr>
<td>C60/75</td>
<td>60</td>
<td>75</td>
</tr>
<tr>
<td>C70/85</td>
<td>70</td>
<td>85</td>
</tr>
<tr>
<td>C80/95</td>
<td>80</td>
<td>95</td>
</tr>
<tr>
<td>C90/105</td>
<td>90</td>
<td>105</td>
</tr>
<tr>
<td>C100/115</td>
<td>100</td>
<td>115</td>
</tr>
<tr>
<td>Packages</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>----------</td>
<td>---</td>
<td>---</td>
</tr>
</tbody>
</table>
## Adaptation time for Eurocodes

<table>
<thead>
<tr>
<th>Eurocodes</th>
<th>CEN process*</th>
<th>National calibration**</th>
<th>Coexistence period</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>9 months</td>
<td>24 months</td>
<td>36 months</td>
</tr>
</tbody>
</table>

* Formal vote and publishing
** Translation and fixing NDP
EN 1990  Basis of design

EN 1990 describes the principles and requirements for safety, serviceability and durability of structures. It’s based on the limit state concept used in conjunction with a partial factor method.

EN 1990 also gives guidelines for the aspects of structural reliability relating to safety, serviceability and durability.
Combination of actions

\[ \sum_{j \geq 1} \gamma_{G,j} G_{k,j} + \gamma_{P} P + \gamma_{Q,1} Q_{k,1} + \sum_{i > 1} \gamma_{Q,i} \psi_{0,i} Q_{k,i} \]  

or

\[ \begin{align*}
\left\{ \sum_{j \geq 1} \gamma_{G,j} G_{k,j} + \gamma_{P} P + \gamma_{Q,1} \psi_{0,1} Q_{k,1} + \sum_{i > 1} \gamma_{Q,i} \psi_{0,i} Q_{k,i} \right\} \\
\left\{ \sum_{j \geq 1} \xi_{j} \gamma_{G,j} G_{k,j} + \gamma_{P} P + \gamma_{Q,1} Q_{k,1} + \sum_{i > 1} \gamma_{Q,i} \psi_{0,i} Q_{k,i} \right\}
\end{align*} \]
Eurocode 1 – Actions on structures

- EN 1991-1-1 Self weight
- EN 1991-1-2 Fire
- EN 1991-1-3 Snow load
- EN 1991-1-4 Wind load
- EN 1991-1-5 Thermal actions
- EN 1991-1-6 Const. Load
- EN 1991-1-7 Accidental load
- EN 1991-2 Bridges
- EN 1991-3 Cranes
- EN 1991-4 Silos/tanks
EUROCODE 2
Concrete design
Important parts in EN 1992-1

• Partial safety factor method
• Safety level for national determination
• Concrete cover for national determination
• New design method for shear
• Placing of strands and anchorage of strands improved
• EN 1992-1 will be valid with a NDP (National Determined Parameters)
Shear

6.2.2 Members not requiring design shear reinforcement

(1) The design value for the shear resistance $V_{Rd,ct}$ is given by:

$$V_{Rd,ct} = [(0,18/\gamma_c)k(100\rho f_{ck})^{1/3} - 0,15\sigma_{cp}]b_wd$$

with a minimum of

$$V_{Rd,ct} = (0,4f_{cld} - 0,15\sigma_{cp})b_wd$$

$$V_{Rd,ct} = \frac{I \cdot b_w}{S} \sqrt{(f_{cld})^2 + \alpha_i \sigma_{cp} f_{cld}}$$
6.2.3 Members requiring design shear reinforcement

(1) The design of members with shear reinforcement is based on a truss model (Figure 6.5). Limiting values for the angle $\theta$ of the inclined struts in the web are given in 6.2.3 (2).

For members not subjected to axial forces, and with vertical shear reinforcement the shear resistance should be taken as the lesser of:

$$V_{Rd, sy} = \frac{A_{sw}}{S} z f_{yw d} \cot \theta$$

and

$$V_{Rd, max} = b_w z \nu f_{cd} / (\cot \theta + \tan \theta)$$

Figure 6.5: Truss model and notation for shear reinforced members.
Placing of tendons

Minimum clear spacing

\[ c_{\text{nom}} = c_{\text{min}} + \Delta c \]

Minimum cover, \( c_{\text{min}} \), requirements with regard to bond

<table>
<thead>
<tr>
<th>Bond Requirement</th>
<th>Minimum cover ( c_{\text{min}} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of steel</td>
<td></td>
</tr>
<tr>
<td>Ordinary</td>
<td>Diameter of bar</td>
</tr>
<tr>
<td>Bundled</td>
<td>Equivalent diameter ((d_0))(see 8.9.1)</td>
</tr>
<tr>
<td>Post-tensioned</td>
<td>Circular duct for bonded tendons: diameter of the duct.</td>
</tr>
<tr>
<td></td>
<td>Rectangular duct for bonded tendons: lesser dimension or 1/2 greater dimension but not less than 50 mm.</td>
</tr>
<tr>
<td></td>
<td>There is no requirement for more than 80 mm for either type of duct.</td>
</tr>
<tr>
<td>Pre-tensioned</td>
<td>2.0 x diameter of strand or wire</td>
</tr>
<tr>
<td></td>
<td>3.0 x diameter of indented wire²</td>
</tr>
</tbody>
</table>

Note 1: If the nominal maximum aggregate size is greater than 32 mm, \( c_{\text{min}} \) should be increased by 5 mm to allow for compaction.

Note 2: A lower minimum cover may be subject to a National Annex or Material Code

Mar-11
Anchorage of prestressed tendons

8.10.2 Anchorage of pre-tensioned tendons

\[ l_{pt} = \alpha_1 \alpha_2 \phi \sigma_{pl} / f_{bpt} \]

where:

- \( \alpha_1 = 1,0 \) for gradual release
- \( \alpha_1 = 1,25 \) for sudden release
- \( \alpha_2 = 0,25 \) for tendons with circular cross section
- \( \alpha_2 = 0,19 \) for 7-wire strands
- \( \phi \) nominal diameter of tendon
- \( \sigma_{bi} \) stress in tendon just after release

\[ f_{bpt} = \eta_{p1} \eta_1 f_{ctd(t)} \]

\( \eta_{p1} \) takes into account the type of tendon and the bond situation at release
- \( \eta_{p1} = 2,7 \) for indented wires
- \( \eta_{p1} = 3,2 \) for 7-wire strands

\( \eta_1 \) = 1,0 for good bond conditions (see 8.4.2)
- \( \eta_1 = 0,7 \) otherwise, unless a higher value can be justified with regard to special circumstances in execution

\( f_{ctd(t)} = f_{ctk,0,05(t)} / \gamma_c \), design value of tensile strength, related to the compressive strength at the time of release according to Table 3.1

\[ l_{pt1} = 0,8 l_{pt} \]

or

\[ l_{pt2} = 1,2 l_{pt} \]

\[ l_{bpd} = l_{pt2} + \alpha_2 \phi (\sigma_{pd} - \sigma_{p\infty}) / f_{bpd} \]
Precast Concrete Products

CEN
TC 229

- WG 1: Strong link to EC 2
- WG 3: Weak link to EC 2
- WG 4
CEN TC 229

• Common rules

• Product standards

• CE marking
Common rules

• General rules for all precast products
• All product standards shall refer to CR and have the same structure (chapters).
• The product standard shall only contain specific rules for that specific product e.g. tolerances, design rules.
Important parts in CR
Reliability considerations

C.2 Reduction based on quality control and reduced tolerances

If factory production control (see 6.3 and Annex D) ensures that unfavourable deviations of cross sectional dimensions are within the tightened tolerances given in Table C.1, the partial safety factor for reinforcement may be reduced to

\[ \gamma_s = 1.10 \]

Under the condition given above, and if the coefficient of variation of the concrete strength is shown not to exceed 10%, the partial safety factor for concrete may be reduced to

\[ \gamma_c = 1.4 \]

Table C.1 Tightened tolerances

<table>
<thead>
<tr>
<th>Tightened tolerances (mm)</th>
<th>Cross section dimension</th>
<th>Position of reinforcement</th>
</tr>
</thead>
<tbody>
<tr>
<td>( h ) or ( b ) (mm)</td>
<td>( \pm \Delta h, \Delta b ) (mm)</td>
<td>( +\Delta c ) (mm)</td>
</tr>
<tr>
<td>( \leq 150 )</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>400</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>( \geq 2500 )</td>
<td>30</td>
<td>20</td>
</tr>
</tbody>
</table>

With linear interpolation for intermediate values.

\( +\Delta c \) refers to the mean value of reinforcing bars or prestressing tendons in the cross section or over a width of one meter (e.g. slabs and walls).
Reliability considerations

C.4 Reduction based on assessment of concrete strength in finished structure

For concrete strength values based on testing of direct structural strength as defined in 4.2.2, $\gamma_c$ may be reduced with the conversion factor $\eta$; normally $\eta = 0.85$ may be assumed.

The value of $\gamma_c$ to which this reduction is applied may already be reduced according to C.2 or C.3. However, the resulting value of $\gamma_c$ should not be less than 1.30.

C.5 Reduction of $\gamma_G$ based on control of self weight

Partial safety factor for self weight of precast product $\gamma_G$ may be reduced by factor 0.95 when the weighted or evaluated volume weight of the product does not exceed that used in design calculations (normally 2500 kg/m$^3$). Evaluated volume weight is calculated from nominal dimensions, mean value of concrete density, measured from the strength test specimens, and the amount of reinforcement (expressed in kg/m$^3$).

Partial safety factor for self weight of precast product $\gamma_G$ may be reduced by factor 0.90 when statistical 95 % fractile of weighted or evaluated weight does not exceed that used in design calculations.

Tightened tolerances should be used and controlled systematically, see Table C.1.
# Accelerated curing

## Table 3 — Conditions for accelerated hydration

| Product environments (EN 206-1 exposure classes) | Maximum mean concrete temperature  
|-----------------------------------------------|----------------------------------|
| Predominantly dry in use or moderate humidity | - ≤ 85 °C;  
- When 70 °C < 85 °C initial tests shall have demonstrated that the required strength is fulfilled at 90 days;  
- When > 85 °C suitability of higher temperature treatment than 85 °C shall have been demonstrated by long term positive experience with the durability of the concrete under the specified environment. |
| Wet and cyclic wet | - ≤ 65 °C.  
- When > 65 °C suitability of higher temperature treatment than 65 °C shall have been demonstrated by long term experience with the durability of the concrete under the specified environment;  
In case of no long term positive experience, the suitability of the higher temperature treatment shall be demonstrated, the following limits b may be a basis for this demonstration (concrete: Na2Oeq ≤ 3,5 kg/m3, cement : SO3 content ≤ 3,5 % by mass) |

---

a is the maximum mean temperature within the concrete, individual values may be 5 °C higher.

b The limits for Na2Oeq and SO3 content, may be changed in value or other constituents limited according to the results of scientific or technical experience and the latest knowledge should be taken into account for the product standards.

c Depending on material and climatic conditions, more restricted requirements may apply to the heat treatment of outdoor elements in certain areas. These requirements may be found in the National Annex of this standard.
## Minimum concrete cover

**Table A.2 — Minimum cover (mm)**

<table>
<thead>
<tr>
<th>$C_{\text{min}}$</th>
<th>$C_0$</th>
<th>Exposure Class</th>
<th>$\geq C_0$</th>
<th>$&lt; C_0$</th>
<th>$\geq C_0$</th>
<th>$&lt; C_0$</th>
<th>$\geq C_0$</th>
<th>$&lt; C_0$</th>
<th>$\geq C_0$</th>
<th>$&lt; C_0$</th>
</tr>
</thead>
<tbody>
<tr>
<td>C20/25</td>
<td>C30/37</td>
<td>A</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>C20/25</td>
<td>C30/37</td>
<td>B</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>20</td>
</tr>
<tr>
<td>C30/37</td>
<td>C40/50</td>
<td>D</td>
<td>15</td>
<td>20</td>
<td>20</td>
<td>25</td>
<td>25</td>
<td>30</td>
<td>30</td>
<td>35</td>
</tr>
<tr>
<td>C30/37</td>
<td>C40/50</td>
<td>E</td>
<td>20</td>
<td>25</td>
<td>25</td>
<td>30</td>
<td>30</td>
<td>35</td>
<td>35</td>
<td>40</td>
</tr>
<tr>
<td>C30/37</td>
<td>C40/50</td>
<td>F</td>
<td>25</td>
<td>30</td>
<td>30</td>
<td>35</td>
<td>35</td>
<td>40</td>
<td>40</td>
<td>45</td>
</tr>
<tr>
<td>C35/45</td>
<td>C45/55</td>
<td>G</td>
<td>30</td>
<td>35</td>
<td>35</td>
<td>40</td>
<td>40</td>
<td>45</td>
<td>45</td>
<td>50</td>
</tr>
</tbody>
</table>
## Inspection schemes

### Table D.4 - Finished product inspection

<table>
<thead>
<tr>
<th>SUBJECT</th>
<th>METHOD</th>
<th>PURPOSE</th>
<th>FREQUENCY</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>D.4.1 - Product Testing</strong>&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Water absorption&lt;sup&gt;b&lt;/sup&gt;</td>
<td>Intended value (see 4.3.7.4 and annex G)</td>
<td>Testing according to annex G</td>
</tr>
<tr>
<td>2</td>
<td>Final inspection</td>
<td>Reference tests as described in the product standard (or correlated indirect testing)</td>
<td>Conformity with the requirements of this standard and the requirements for the manufacturer declared properties</td>
</tr>
<tr>
<td>3</td>
<td>Marking/ Labelling</td>
<td>Visual check</td>
<td>Conformity with the requirements of this standard</td>
</tr>
<tr>
<td>4</td>
<td>Storage</td>
<td>Visual check</td>
<td>Conformity with the requirements of this standard</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Segregation of non-conforming products</td>
</tr>
<tr>
<td>5</td>
<td>Delivery</td>
<td>Visual check</td>
<td>Correct delivery age, loading and loading documents</td>
</tr>
</tbody>
</table>

---

<sup>a</sup> This inspection may be adapted and/or completed for specific product purposes.

<sup>b</sup> Only if the property is specified.
Tolerances

Measurement of dimensions

J.1 Length, height, width and thickness
Dimensions should not be measured along the edges.

Figure J.1 - Measuring points for length, height, width and thickness

J.2 Warp and straightness
Product standards
TC 229 – Formal vote

- 2003-07-01 (compulsory 2005-12-01)
  - Common rules (launched to Jan. 2004)
  - Ribbed floors
  - Linear elements
  - Hollow core slabs
  - Roof elements
  - Floor slats
  - Masts and poles

- 2003-12-01 (compulsory 2006-06-01)
  - Foundation piles
  - Floor plates (3 st)
  - Garages
  - Terazzo tiles (2 st)
TC 229 – FORMAL VOTE

- 2004-06-01 (compulsory 2006-12-31)
  - Stairs
  - Beam and block
  - Walls
  - Bridge elements
  - Box culverts

- 2004-12-01 (compulsory 2007-06-01)
  - Noise barriers
  - Lightweight frames
  - Silos
  - Safety barriers
  - Foundation supports
  - Retaining walls
Produktstandarder för formal vote
Adaptation time for a product standard

<table>
<thead>
<tr>
<th>Product standard</th>
<th>CEN process*</th>
<th>National calibration</th>
<th>Coexistence period</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>9 months</td>
<td>-</td>
<td>21 months</td>
</tr>
</tbody>
</table>

* Formal vote and publishing
Product standard

- Scope
- Normative references
- Terms and definitions
- Requirements
- Test methods
- Evaluation of conformity
- Annexes (normative or informative)
- Annexes ZA and Y
CE marking

- Rules in annex ZA and Y
- Conformity system 2+
- Third party control
- Mandated performances shall be declared
- Three methods to verify conformity
  - geometrical data and material requirem.
  - reference to characteristics acc. to Eurocode
  - reference to design documents or clients order
BIBM
International federation of precast concrete producer

General Assembly
Members

Steering committee

General secretariat

Product commissions

Technical commission

Official liaisons
Cembureau, Ermco, fib, Rilem
BIBM - TC

• Preparation of TC 229 meetings
• Project ”Eurocodes”
• Project ”Fire”
• New program for prenormative research
  - probabilistic approach on model uncertainties
  - energy consumption in concrete buildings linked to thermal inertia
  - fire safety in concrete buildings
  - sustainability in concrete buildings
Federation Internationale du béton (merger CEB - FIP)

General Assembly - Council

President and Praesidium

Steering Committee

Secretary General

Commissions and Task Groups
C 1 Structures
C 2 Safety and performance concept
C 3 Environmental aspects
C 4 Modelling of structural behaviour
C 5 Structural service life aspects
C 6 Prefabrication
C 7 Seismic design
C 8 Concrete
C 9 Reinforcing and prestressing systems
C 10 Construction

Special Activity Groups
Model Code 2005
fib

• To develop at international level the study of scientific and practical matters capable of advancing the technical, economic, aesthetic and environmental performance of concrete structures

• Worldwide organisation (39 countries)
• Ten permanent commissions
• Special activity groups
• Merge between CEB and FIB
Commission C6 - Prefabrication

• Chairman Gunnar Rise
• 35 members from 21 countries
• Task groups
  - Hollow core slabs
  - Connections
  - Precast bridges
  - Precast concrete railway track systems
  - Model code 2005- Part precast concrete