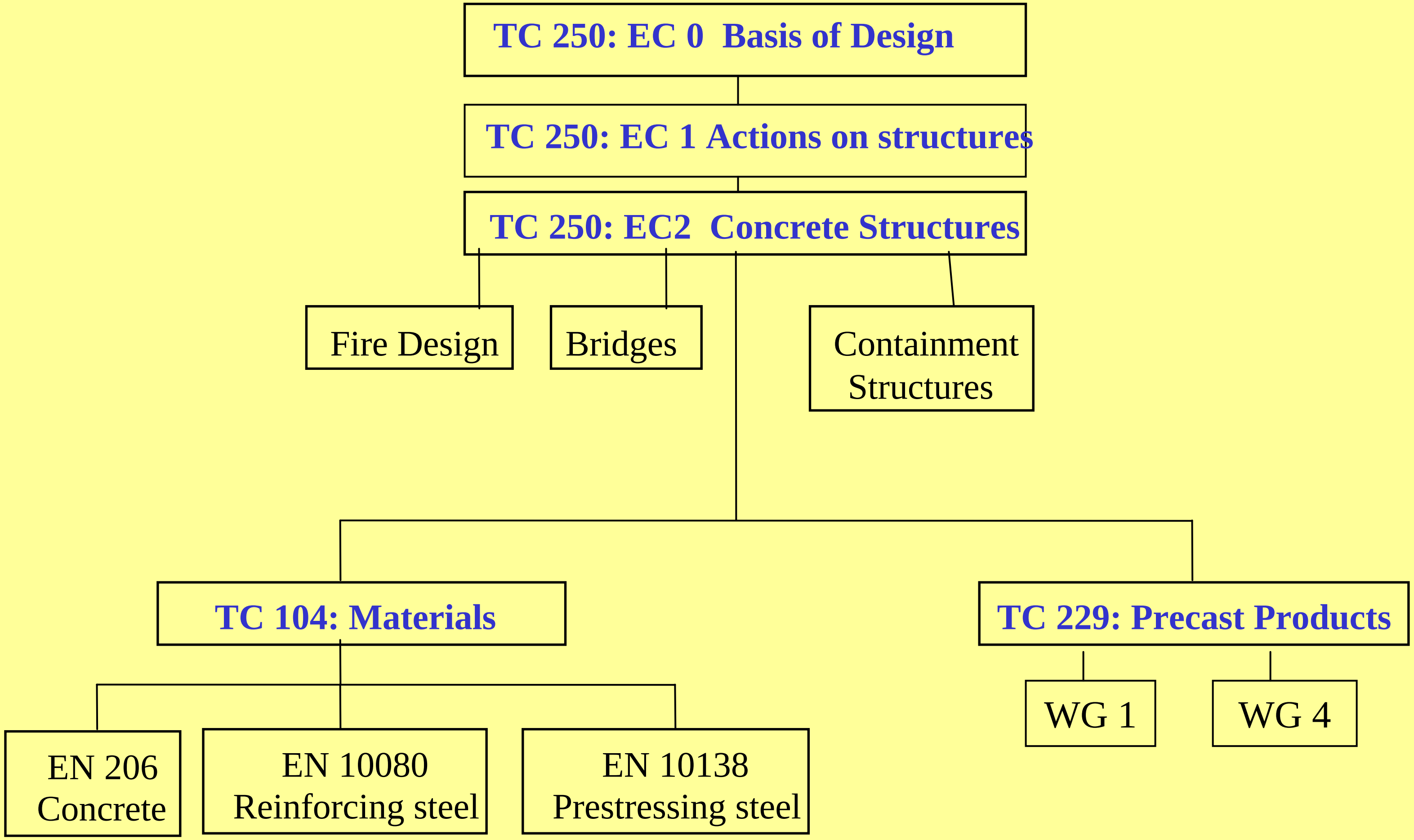
CEN and other international organisations

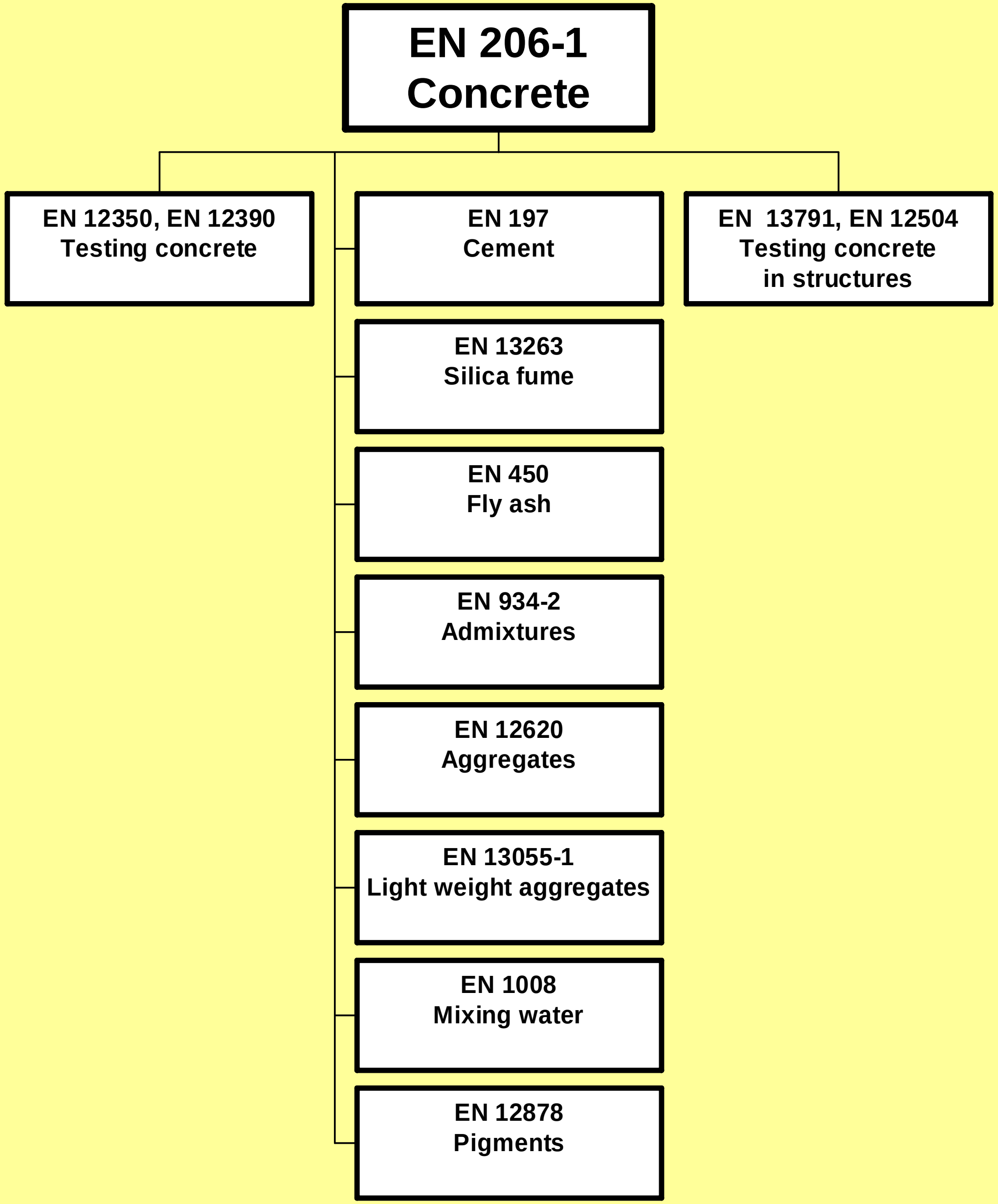
- **CEN TC 104 ”Concrete”**
- **CEN TC 250 ”Eurocodes”**
- **CEN TC 229 ”Precast concrete products”**

- **BIBM**
- ***fib***

Organisation chart European Standards



Material standards for concrete



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

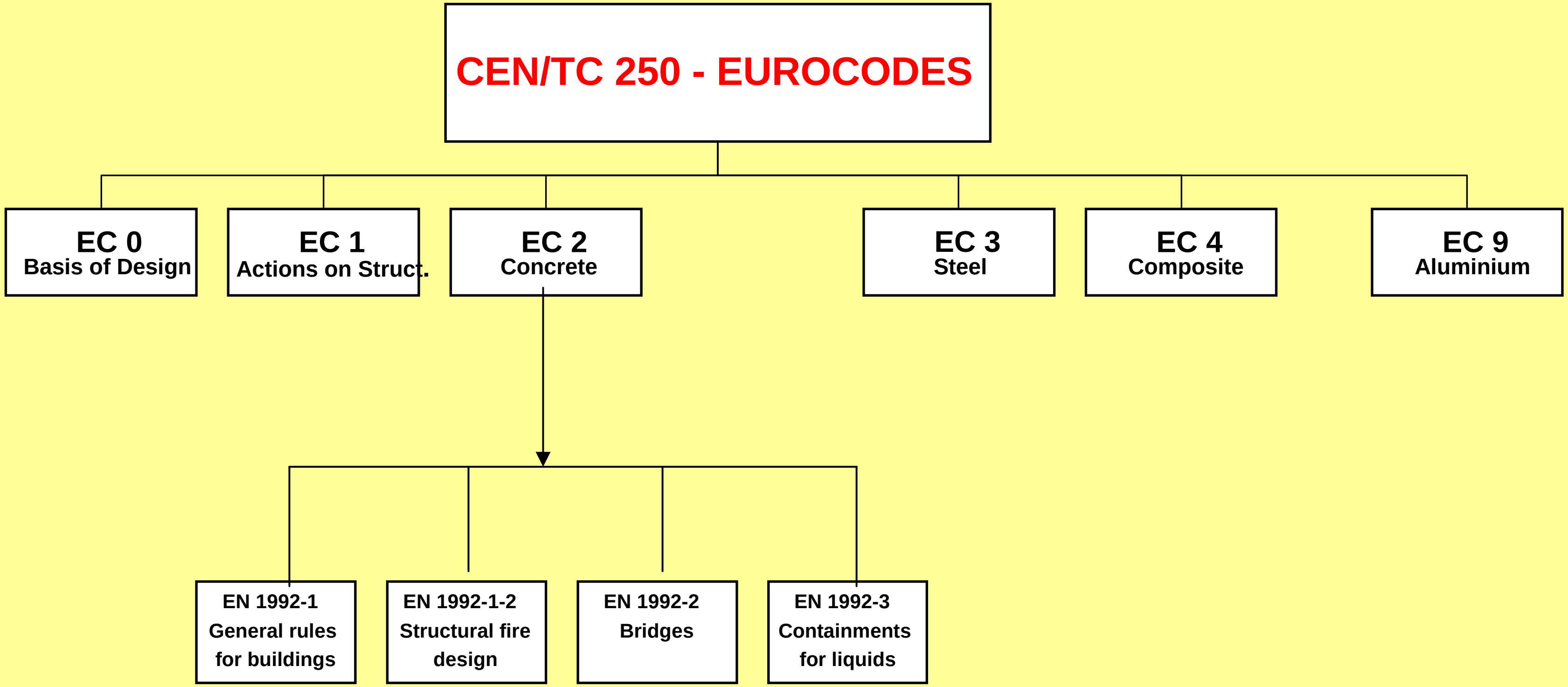
	Exposure classes																	
	No risk of corrosion or attack	Carbonation-induced corrosion				Chloride-induced corrosion						Freeze/thaw attack				Aggressive chemical environments		
						Sea water			Chloride other than from sea water									
	X0	XC 1	XC 2	XC 3	XC 4	XS 1	XS 2	XS 3	XD 1	XD 2	XD 3	XF 1	XF 2	XF 3	XF 4	XA 1	XA 2	XA 3
Maximum w/c	---	0,65	0,60	0,55	0,50	0,50	0,45	0,45	0,55	0,55	0,45	0,55	0,55	0,50	0,45	0,55	0,50	0,45
Minimum strength class	C12/15	C20/25	C25/30	C30/37	C30/37	C30/37	C35/45	C35/45	C30/37	C30/37	C35/45	C30/37	C25/30	C30/37	C30/37	C30/37	C30/37	C35/45
Minimum cement content (kg/m^3)	---	260	280	280	300	300	320	340	300	300	320	300	300	320	340	300	320	360
Minimum air content (%)	---	---	---	---	---	---	---	---	---	---	---	---	4,0[a]	4,0[a]	4,0[a]	---	---	---
Other requirements												Aggregate in accordance with prEN 12620:2000 with sufficient freeze/thaw resistance					Sulfate-resisting cement[b]	

[a] 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.

[b] When SO_4^{2-} 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

Compressive strength class	Minimum characteristic cylinder strength $f_{ck,cyl}$ N/mm^2	Minimum characteristic cube strength $f_{ck,cube}$ N/mm^2
C8/10	8	10
C12/15	12	15
C16/20	16	20
C20/25	20	25
C25/30	25	30
C30/37	30	37
C35/45	35	45
C40/50	40	50
C45/55	45	55
C50/60	50	60
C55/67	55	67
C60/75	60	75
C70/85	70	85
C80/95	80	95
C90/105	90	105
C100/115	100	115


CEN/TC 250 - EUROCODES
EC 0
Basis of Design
EC 1
Actions on Struct.
EC 2
Concrete
EC 3
Steel
EC 4
Composite
EC 9
Aluminium
EN 1992-1
General rules
for buildings
EN 1992-1-2
Structural fire
design
EN 1992-2
Bridges
EN 1992-3
Containments
for liquids

Eurocode block

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
	Basis	Self load	Fire	Snow load	Wind load	Thermal actions	Const. Load	Accidental	Bridges	Cranes	Silos/Tanks	General Rules	Fire	Bridges	Liquid Retain	General Rules	Fire	Thingauge	Stainless Steel	Plated Struct.	Shells	Out of Plane	Joints	Fatigue	Fractures	Cables	Bridges	Gnl Rules (2)	Silos	Tanks	Pipelines	Piling
<= Packages	**EN 1990**	**EN 1991-1-1**	**EN 1991-1-2**	**EN 1991-1-3**	**EN 1991-1-4**	**EN 1991-1-5**	**EN 1991-1-6**	**EN 1991-1-7**	**EN 1991-2**	**EN 1991-3**	**EN 1991-4**	**EN 1992-1-1**	**EN 1992-1-2**	**EN 1992-2**	**EN 1992-3**	**EN 1993-1-1**	**EN 1993-1-2**	**EN 1993-1-3**	**EN 1993-1-4**	**EN 1993-1-5**	**EN 1993-1-6**	**EN 1993-1-7**	**EN 1993-1-8**	**EN 1993-1-9**	**EN 1993-1-10**	**EN 1993-1-11**	**EN 1993-2**	**EN 1993-3**	**EN 1993-4-1**	**EN 1993-4-2**	**EN 1993-4-3**	**EN 1993-5**
Eurocode 2																																
2/1-Bldgs																																
2/2-Bridg.																																
2/3-Liquid																																
Eurocode 3																																
3/1-Bldgs																																
3/2-Bridg.																																
3/3-Silos																																
3/4-Piling																																
3/5-Crane																																

Adaptation time for Eurocodes

	CEN process*	National calibration**	Coexistence period
Eurocodes	9 months	24 months	36 months

*** Formal vote and publishing**

**** Translation and fixing NDP**

EN 1990 Basis of design

EN 1990 describes the principles and requirments for safety, seviceability and durability of structures. It's based on the limit state concept used in conjunction with a partialfactor method.

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

Combination of actions

$$\sum_{j\geq 1}\gamma_{G,j}G_{k,j}\text{"+"}\gamma_P P\text{"+"}\gamma_{Q,1}Q_{k,1}\text{"+"}\sum_{i>1}\gamma_{Q,i}\psi_{0,i}Q_{k,i} \qquad (6.10)$$

or

$$\begin{cases}\sum_{j\geq 1}\gamma_{G,j}G_{k,j}\text{"+"}\gamma_P P\text{"+"}\gamma_{Q,1}\psi_{0,1}Q_{k,1}\text{"+"}\sum_{i>1}\gamma_{Q,i}\psi_{0,i}Q_{k,i} & (6.10a)\\ \sum_{j\geq 1}\xi_j\gamma_{G,j}G_{k,j}\text{"+"}\gamma_P P\text{"+"}\gamma_{Q,1}Q_{k,1}\text{"+"}\sum_{i>1}\gamma_{Q,i}\psi_{0,i}Q_{k,i} & (6.10b)\end{cases}$$

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**	**Accidential 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 safefty factor method**
- **Safefty 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:

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

with a minimum of

$$V_{Rd,ct} = (0,4 f_{ctd} - 0,15 \sigma_{cp})\ b_w d$$

$$V_{Rd,ct} = \frac{I \cdot b_w}{S} \sqrt{(f_{ctd})^2 + \alpha_l \sigma_{cp} f_{ctd}}$$

Shear

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 θ 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:

$$V_{Rd,sy} = \frac{A_{sw}}{s} z\, f_{ywd} \cot\theta$$

and

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

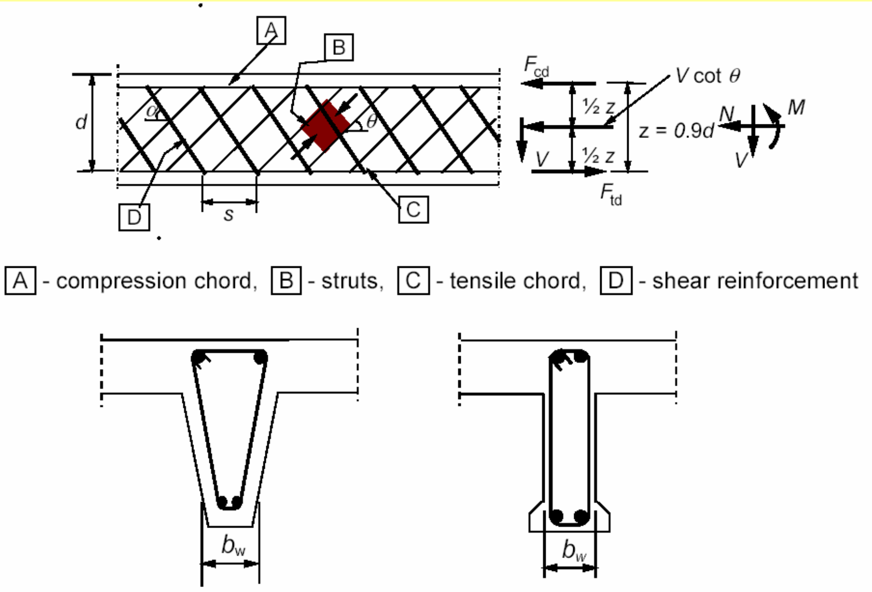
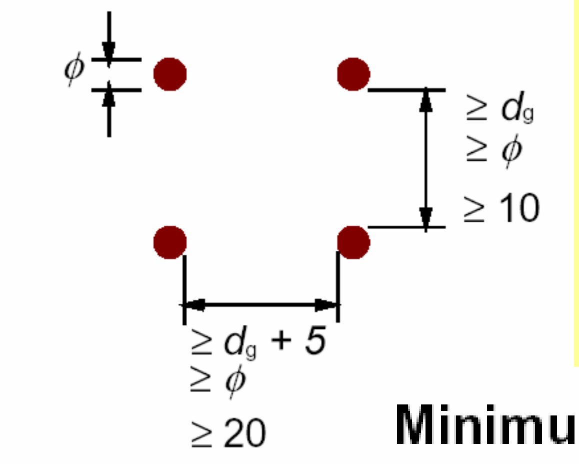


Figure 6.5: Truss model and notation for shear reinforced members

Placing of tendons

Minimum clear spacing



$$c_{nom} = c_{min} + \Delta c$$

Minimum cover, c_{min}, requirements with regard to bond

Bond Requirement	
Type of steel	Minimum cover c_{min}[1]
Ordinary	Diameter of bar
Bundled	Equivalent diameter (ϕ_n)(see 8.9.1)
Post-tensioned	Circular duct for bonded tendons: diameter of the duct. Rectangular duct for bonded tendons[2]: lesser dimension or 1/2 greater dimension but not less than 50 mm. There is no requirement for more than 80 mm for either type of duct.
Pre-tensioned	2,0 x diameter of strand or wire 3,0 x diameter of indented wire[2]

Note 1: If the nominal maximum aggregate size is greater than 32 mm, c_{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

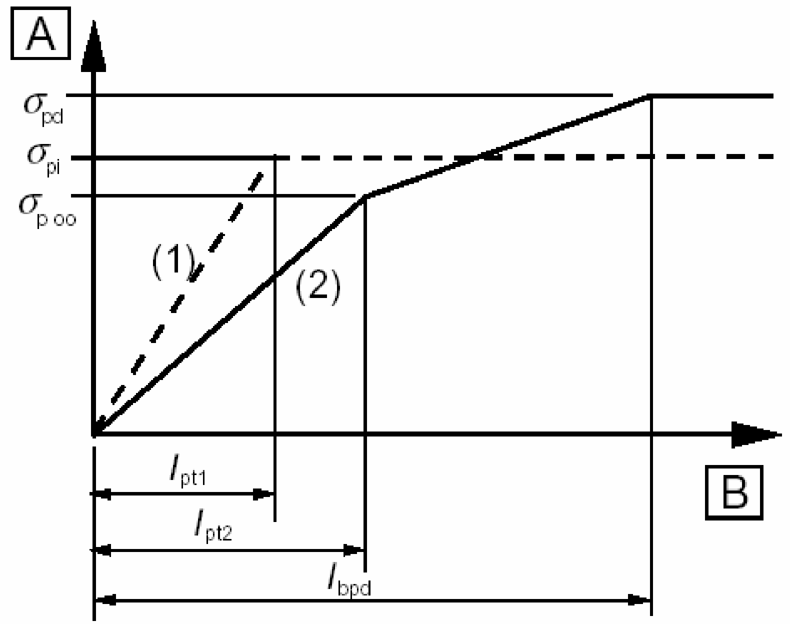
Anchorage of prestressed tendons

8.10.2 Anchorage of pre-tensioned tendons

$l_{pt} = \alpha_1 \alpha_2 \phi \sigma_{pi} / f_{bpt}$

where:

α_1	= 1,0	for gradual release
	= 1,25	for sudden release
α_2	= 0,25	for tendons with circular cross section
	= 0,19	for 7-wire strands
ϕ		nominal diameter of tendon
σ_{pi}		stress in tendon just after release



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

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

η_1 = 1,0 for good bond conditions (see 8.4.2)
= 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

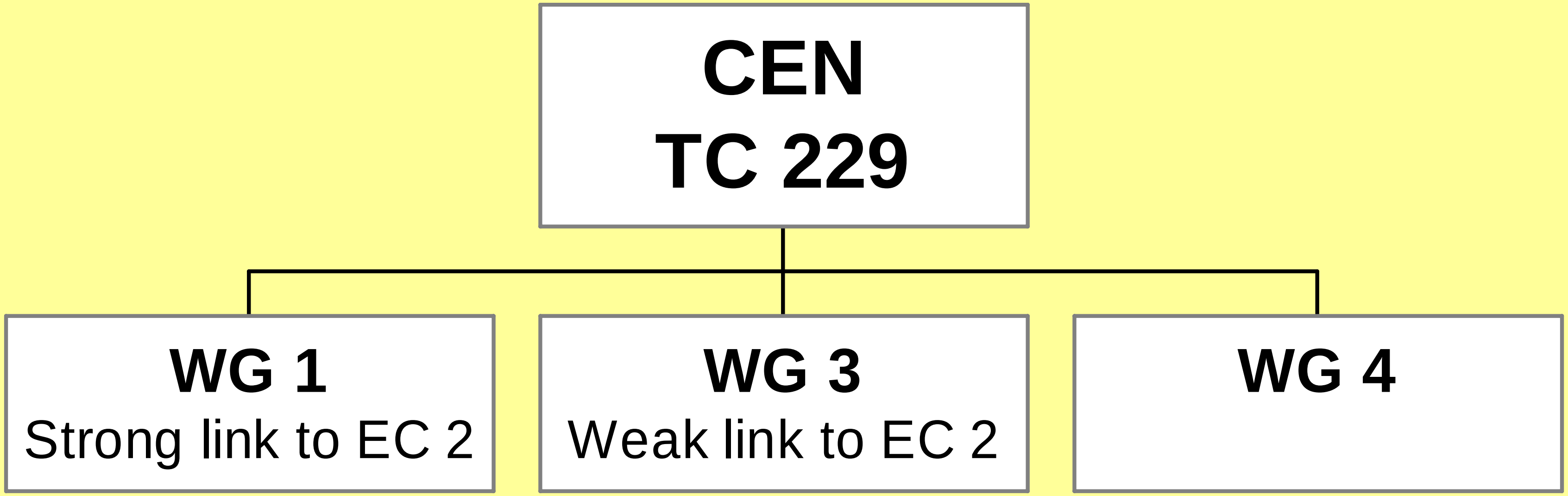
$l_{pt1} = 0{,}8\ l_{pt}$

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

- **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

Relibility 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

	Tightened tolerances (mm)	
h or *b* (mm)	Cross section dimension $\pm\Delta h$, Δb (mm)	Position of reinforcement $+\Delta c$ (mm)
≤ 150	5	5
400	10	10
≥ 2500	30	20
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, γ_c may be reduced with the conversion factor η; normally $\eta = 0,85$ may be assumed.

The value of γ_c to which this reduction is applied may already be reduced according to C.2 or C.3. However, the resulting value of γ_c should not be less than 1,30.

C.5 Reduction of γG based on control of self weight

Partial safety factor for self weight of precast product γ_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 γ_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

Product environments (EN 206-1 exposure classes)	Table 3 — Conditions for accelerated hydration Maximum mean concrete temperature [a]
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: Na_2O_{eq} ≤ 3,5 kg/m^3, cement : SO_3 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)

C_{min}	C_0	Exposure Class	Slab reinforcing bars		Other reinforcing bars		Slab pretensioned tendons		Other pretensioned tendons	
			$\geq C_0$	$<C_0$	$\geq C_0$	$<C_0$	$\geq C_0$	$<C_0$	$\geq C_0$	$<C_0$
C20/25	C30/37	A	10	10	10	10	10	10	10	10
C20/25	C30/37	B	10	10	10	10	15	15	15	20
C25/30	C35/45	C	10	15	15	20	20	25	25	30
C30/37	C40/50	D	15	20	20	25	25	30	30	35
C30/37	C40/50	E	20	25	25	30	30	35	35	40
C30/37	C40/50	F	25	30	30	35	35	40	40	45
C35/45	C45/55	G	30	35	35	40	40	45	45	50

Inspection schemes

Table D.4 - Finished product inspection

	SUBJECT	METHOD	PURPOSE	FREQUENCY
D.4.1 - Product Testing [a]				
1	Water absorption [b]	Intended value (see 4.3.7.4 and annex G)	Testing according to annex G	Each five production days per type of hardened concrete used
2	Final inspection	Reference tests as described in the product standard (or correlated indirect testing)	Conformity with the requirements of this standard and the requirements for the manufacturer declared properties	Depending on product and property
3	Marking/ Labelling	Visual check	Conformity with the requirements of this standard	Daily
4	Storage	Visual check	Conformity with the requirements of this standard	Daily
			Segregation of non-conforming products	
5	Delivery	Visual check	Correct delivery age, loading and loading documents	Daily

[a] This inspection may be adapted and/or completed for specific product purposes.

[b] 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.

Dimensions in millimetre

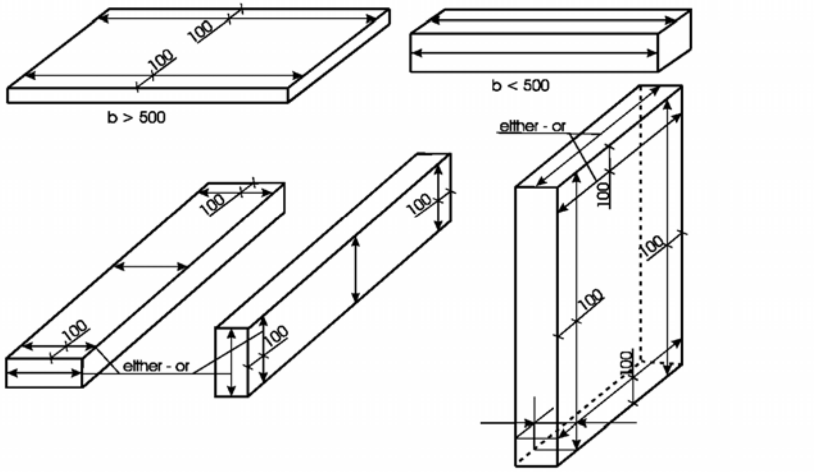
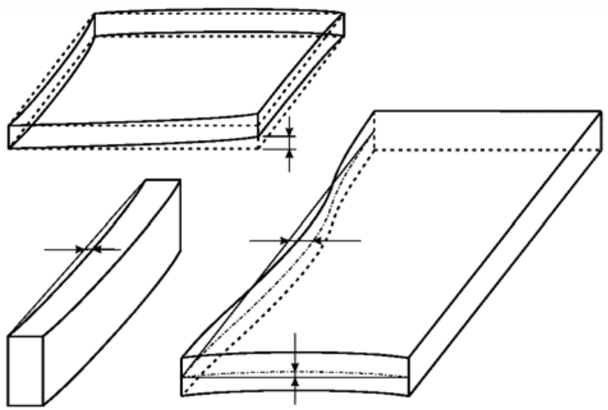
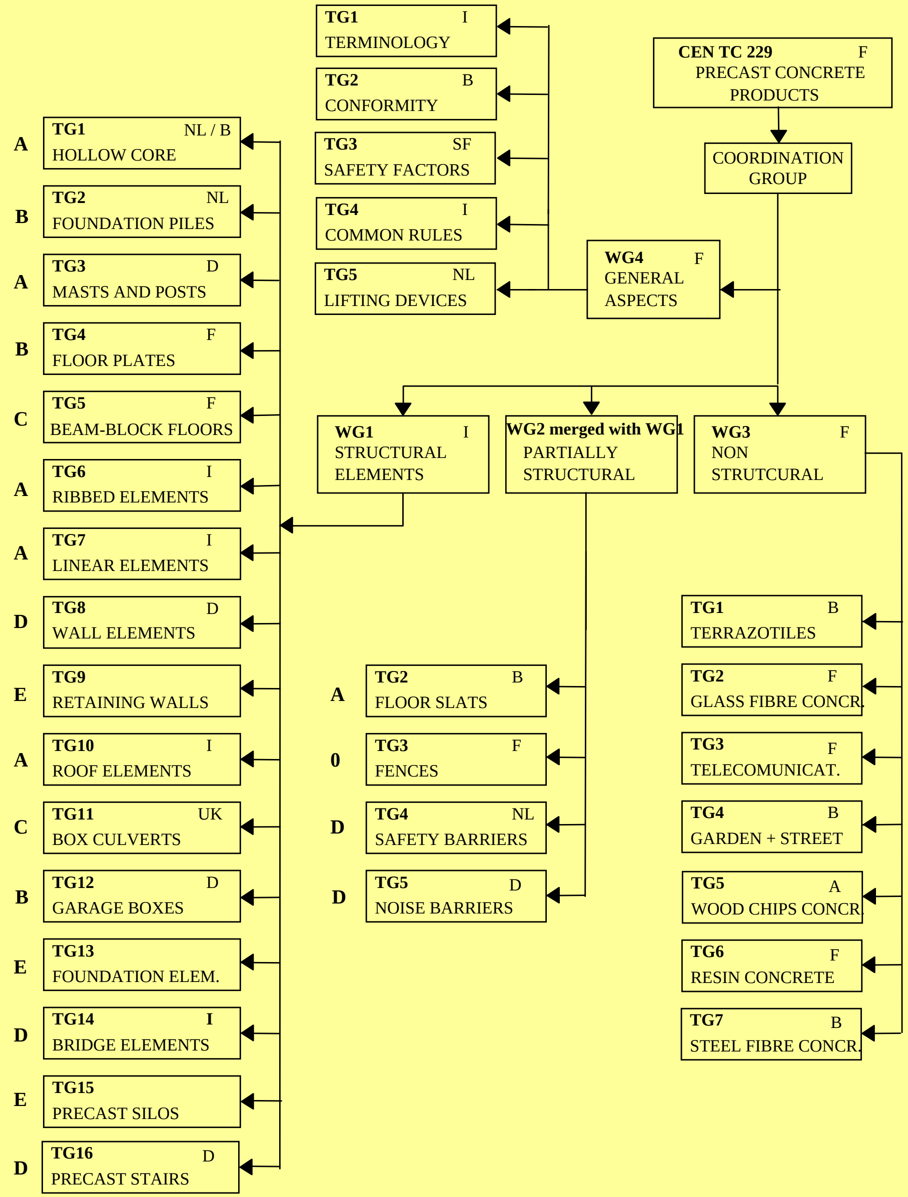


Figure J.1 - Measuring points for length, height, width and thickness

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

	CEN process*	National calibration	Coexistence period
Product standard	9 months	-	21 months

*** Formal vote and publishing**

Product standard

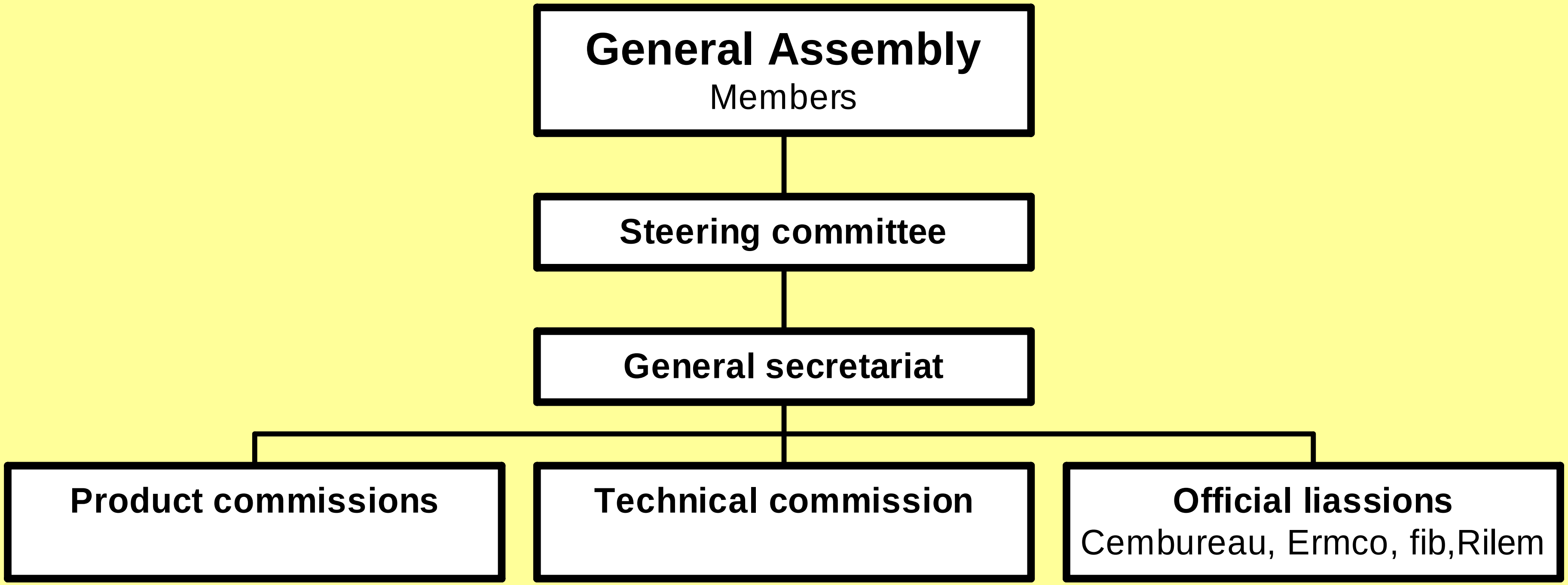
- **Scope**
- **Normative references**
- **Terms and definitions**
- **Requirements**
- **Test methods**
- **Evaluation of conformity**
- **Annexes (normative or informative)**
- **Annexes ZA and Y**

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



BIBM - TC

- **Preparation of TC 229 meetings**
- **Project ”Eurocodes”**
- **Project ”Fire”**
- **New program for prenormative research**
  - **-** proabilistic approach on model uncertainties
  - energy consumption in concrete buildings linked to thermal inertia
  - fire safety in concrete buildings
  - sustainability in concrete buildings

fib

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, asthetic and environmental performance of concrete structures**
- **Wordwide 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