EUROCODE 2
Hulpmiddelen, ervaring en evoluties naar 2020

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Onderzoekt • Ontwikkelt • Informeert

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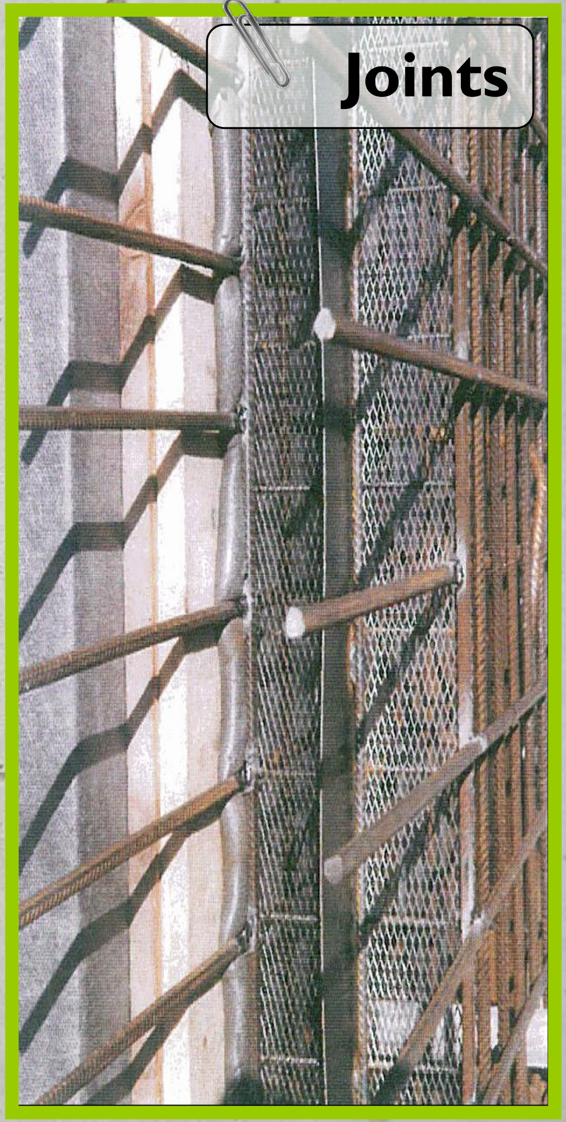
MENU

1. Experience with EC2-3
2. Evolutions EC2-1-1, focus on FRC
3. Toolbox EC's

Experience with EC2-3

SILOS & TANKS

Not only a « cracking » story



7.3 Cracking

Tightness class	Requirements for leakage
0	*Some degree of leakage acceptable, or leakage of liquids irrelevant*
1	*Leakage to be limited to a small amount. Some surface staining or damp patches acceptable*
2	*Leakage to be minimal. Appearance not to be impaired by staining*
3	*No leakage permitted*

7.3 Cracking

Tightness class	Requirements for crack control
0	*Cfr. EC2-1-1 (§7.3.1)*
1	*Cracks* $\leq w_{k1}$
2	*Full thickness not cracked*
3	*Special measures*

Cracks vs. leakage

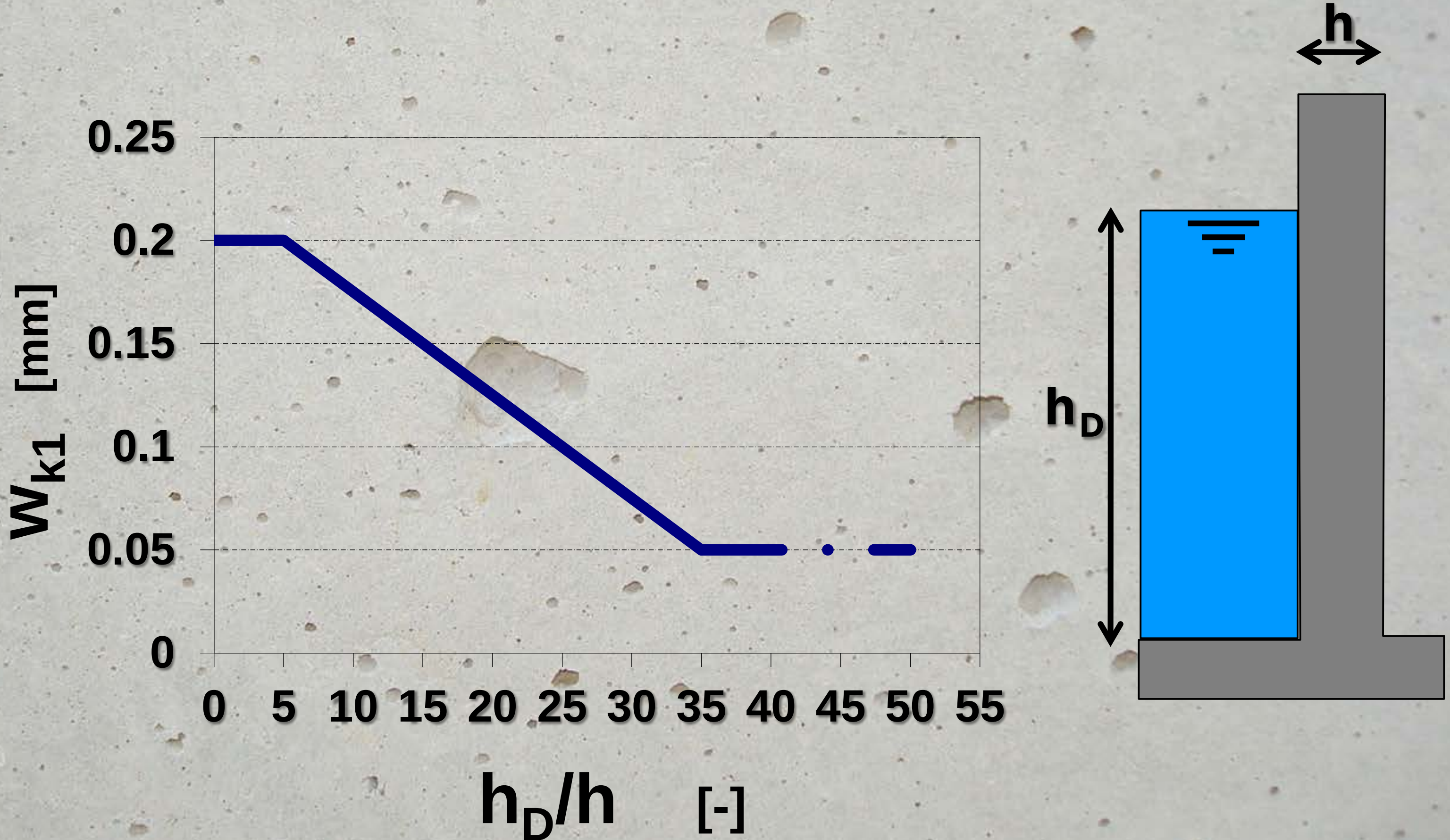
W ÷ 2

Q ÷ 8

Watertightness Class 1

CLASSE

1



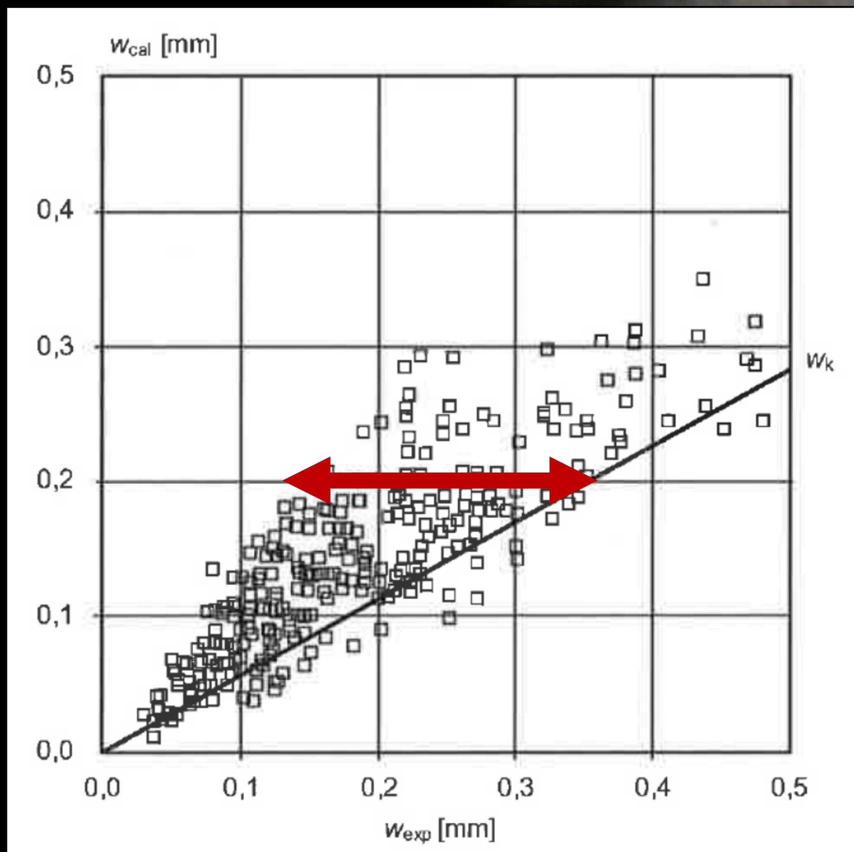
Calculated cracks vs. observed

- Non deterministic
- Influence factors
- Shrinkage not taken into account

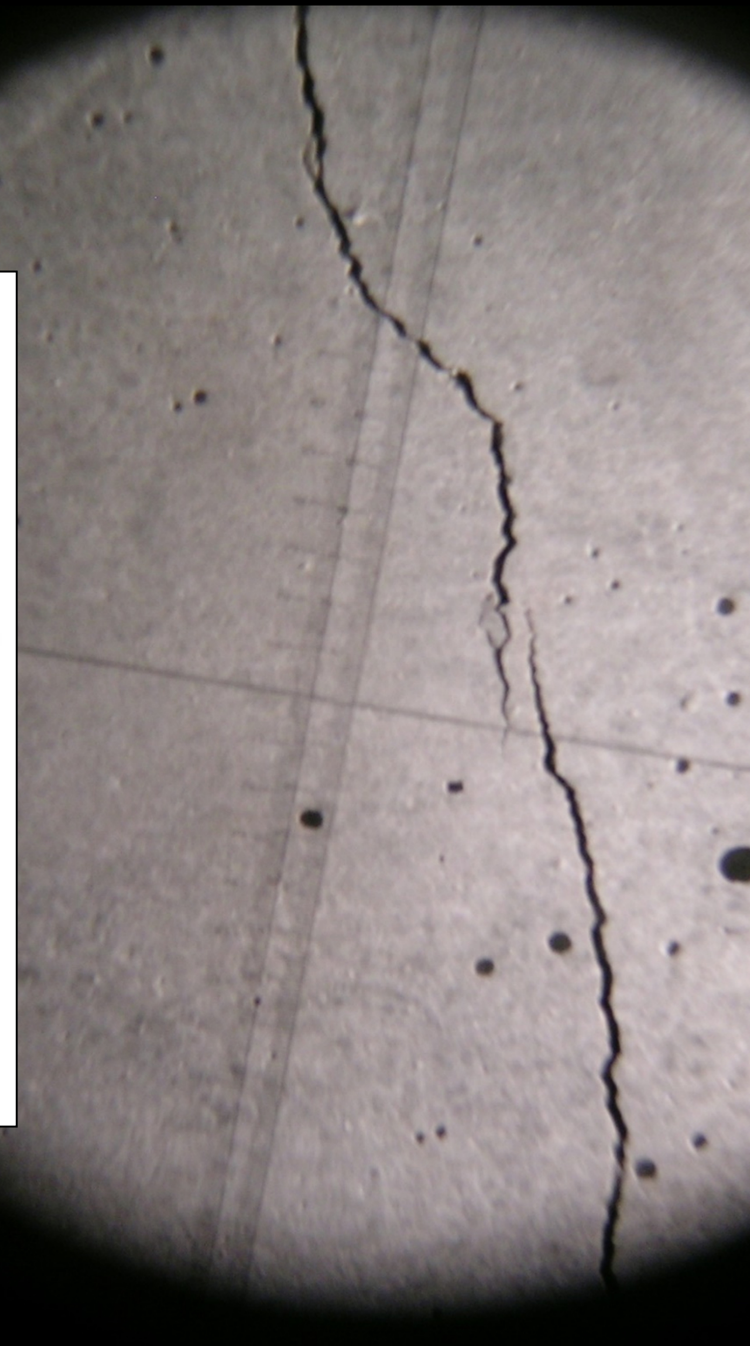
...

Observed vs. Calculated

W_{cal}
[mm]



W_{exp}
[mm]



Summary design method

Simplified method & Imposed deformations

- Watertightness class 1 & $h_D/h=10$ => $W_{max} = 0{,}18mm$
- A_{ct} , f_{ctm}
- k_c & k
- Assumption on ∅ => ∅*
- σ_s based on tables (∅* vs. σ_s)
- $A_{s,min}$

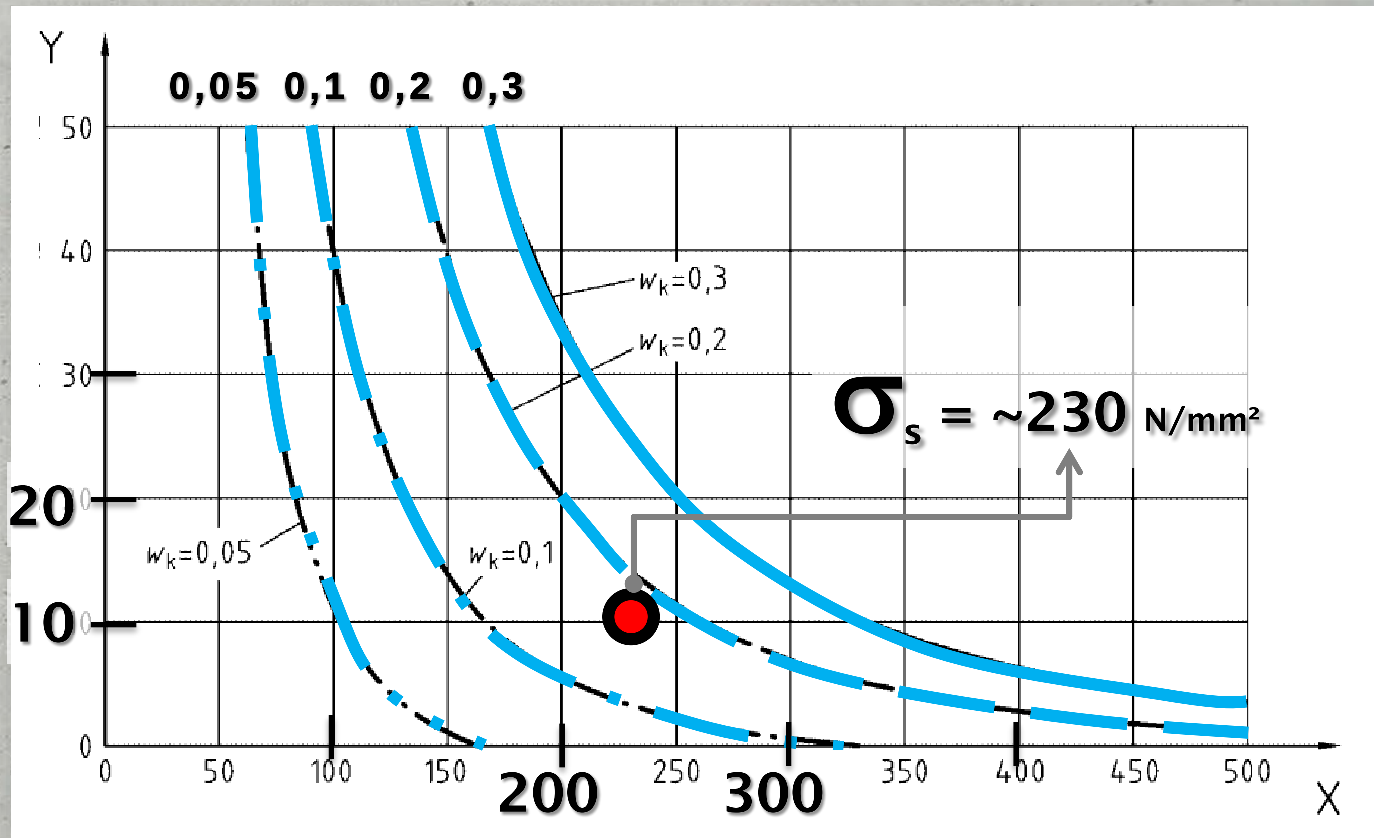
$$A_{s,\min} = \frac{k_c . k . f_{ct,eff} . A_{ct}}{\sigma_s}$$

Ex. : Wall 40cm – C30/37 - ∅10 ? – End restrained

c=35 mm

=> ∅* = 10.0 mm

∅*



σs

Wall – Example results

$$A_{s,\min} = \frac{k_c.k.f_{ct,eff}.A_{ct}}{\sigma_{s,\,figures}}$$

$$= \frac{1.0{,}93.2{,}9.400.1000}{230}$$

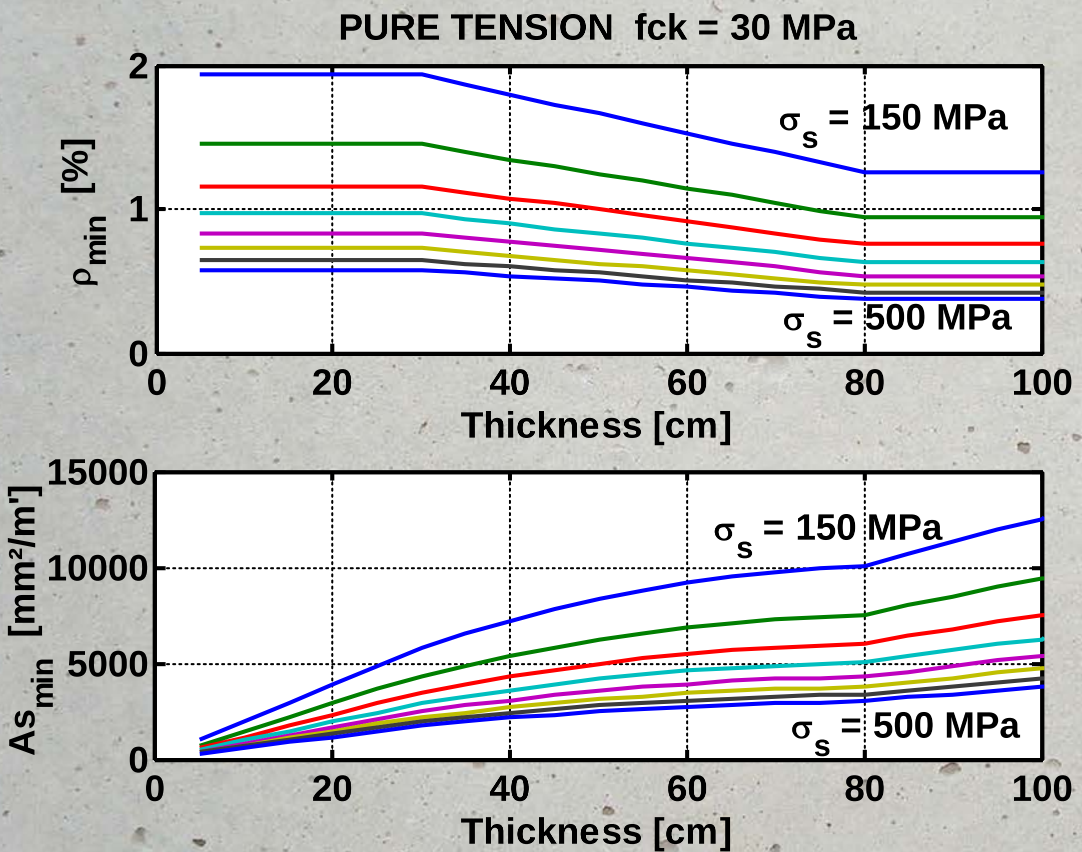
= **4690** mm²/m' (ρ = 1,17%)

Not possible with ∅10 !

5 options :

A. Calculate max stress and limit to $f_{ctk,0.05}$
B. Iterations on ∅ >> ➔ σ_s ➔ but A_s ↗
C. Joints, injections ?
D. Adapt A_{ct} => A_s will decrease
E. Reduce f_{ct}

Summary by figures (A_{ct} = full section)

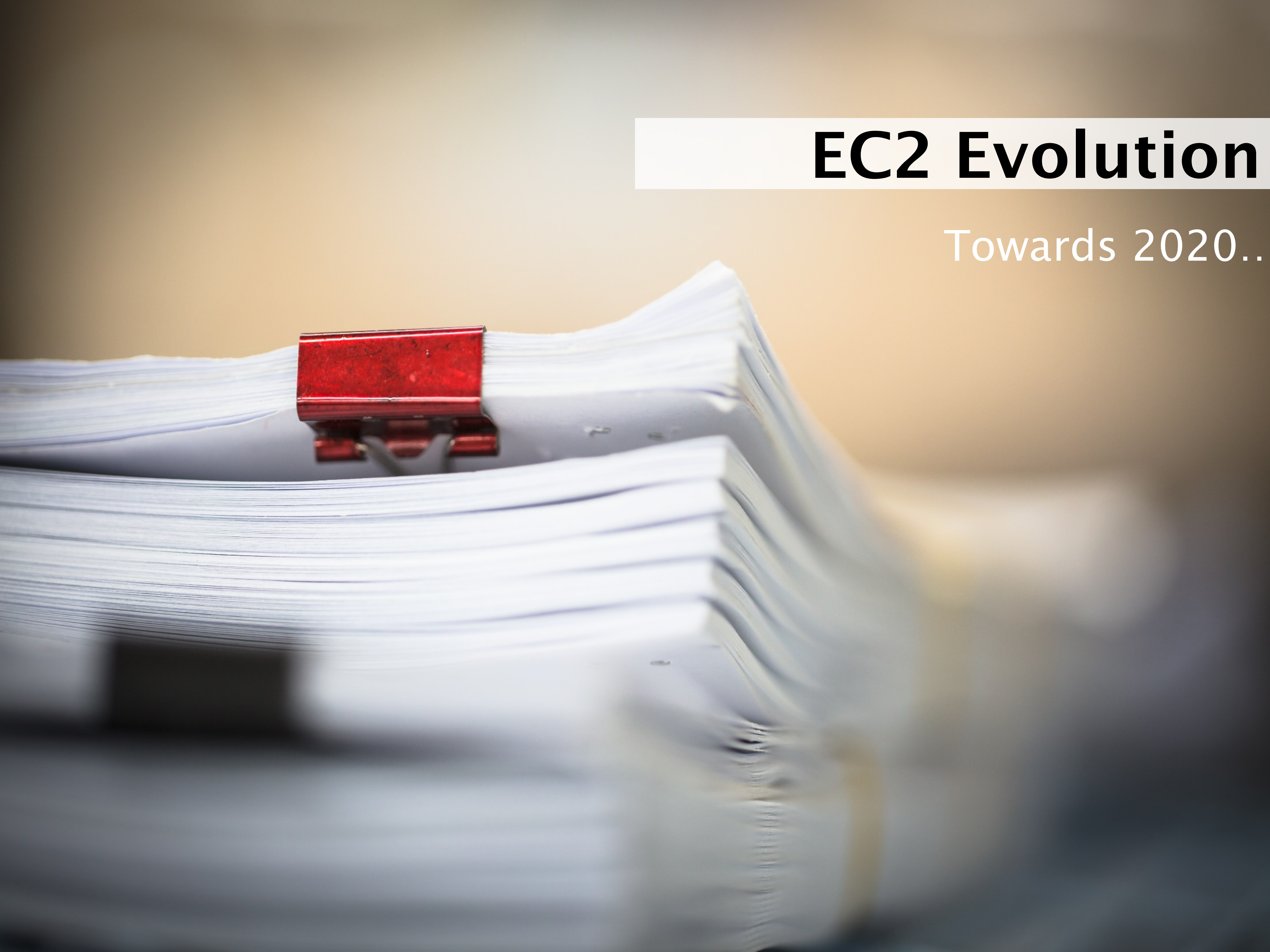


RECAP'

- Importance of classes prescription (=> w_{lim})
- Oberved vs. calculated cracks
- Dominant sollicitation ?
- Large reinforcement needed ! <> Practice

EC2 Evolution

Towards 2020..

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Evolutions – EC2 towards 2020

NORME EUROPÉENNE
EUROPÄISCHE NORM
EUROPEAN STANDARD

EN 1992-1-1

Décembre 2004

ICS 91.010.30; 91.080.40

Remplace ENV 1992-1-1:1991, ENV 1992-1-3:1994, ENV 1992-1-4:1994, ENV 1992-1-5:1994, ENV 1992-1-6:1994, ENV 1992-3:1998

Version Française

Eurocode 2: Calcul des structures en béton - Partie 1-1 : Règles générales et règles pour les bâtiments

Eurocode 2: Bemessung und konstruktion von Stahlbeton- und Spannbetontragwerken - Teil 1-1: Allgemeine Bemessungsregeln und Regeln für den Hochbau

Eurocode 2: Design of concrete structures - Part 1-1: General rules and rules for buildings

La présente Norme européenne a été adoptée par le CEN le 16 avril 2004.

Les membres du CEN sont tenus de se soumettre au Règlement Intérieur du CEN/CENELEC, qui définit les conditions dans lesquelles doit être attribué, sans modification, le statut de norme nationale à la Norme européenne. Les listes mises à jour et les références bibliographiques relatives à ces normes nationales peuvent être obtenues auprès du Centre de Gestion ou auprès des membres du CEN.

La présente Norme européenne existe en trois versions officielles (allemand, anglais, français). Une version dans une autre langue faite par traduction sous la responsabilité d'un membre du CEN dans sa langue nationale et notifiée au Centre de Gestion, a le même statut que les versions officielles.

Les membres du CEN sont les organismes nationaux de normalisation des pays suivants: Allemagne, Autriche, Belgique, Chypre, Danemark, Espagne, Estonie, Finlande, France, Grèce, Hongrie, Irlande, Islande, Italie, Luxembourg, Lettonie, Lituanie, Malte, Norvège, Pays-Bas, Pologne, Portugal, République Tchèque, Royaume-Uni, Slovaquie, Slovénie, Suède et Suisse.

COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG
EUROPEAN COMMITTEE FOR STANDARDIZATION

Centre de Gestion: rue de Stassart, 36 B-1050 Bruxelles

Réf. n° EN 1992-1-1:2004 F

Standards	# pages	# NDPs	# NDPs / # pages
EN 1990	120	54	0.45
EN 1991	770	292	0.38
EN 1992	**450**	**176**	0.39
EN 1993	1250	236	0.19
EN 1994	330	42	0.13
EN 1995	225	21	0.09
EN 1996	300	31	0.10
EN 1997	340	42	0.12
EN 1998	600	103	0.17
EN 1999	500	58	0.12

Objectives

EC2 update :

- Publication around 2021
- 2 phases (SC2.PT1 base | SC2.PT2 Fire | SC2.PT3 Innovations)
- GOAL :
  - ✓ Reduce # NDP's
  - ✓ Regrouping parts (bridges, silos/tanks)
  - ✓ Discourage use of informative annexes
  - ✓ Update acording to State of the Art
  - ✓ Improve Ease of use
  - ✓ Alignment with « product » standards
  - ✓ Taking national regulations/practice into account
  - ✓ Process with the « systematic review »
  - ✓ Develop a background doc

Reduce #NDPs

NDP's are not always legitimate !

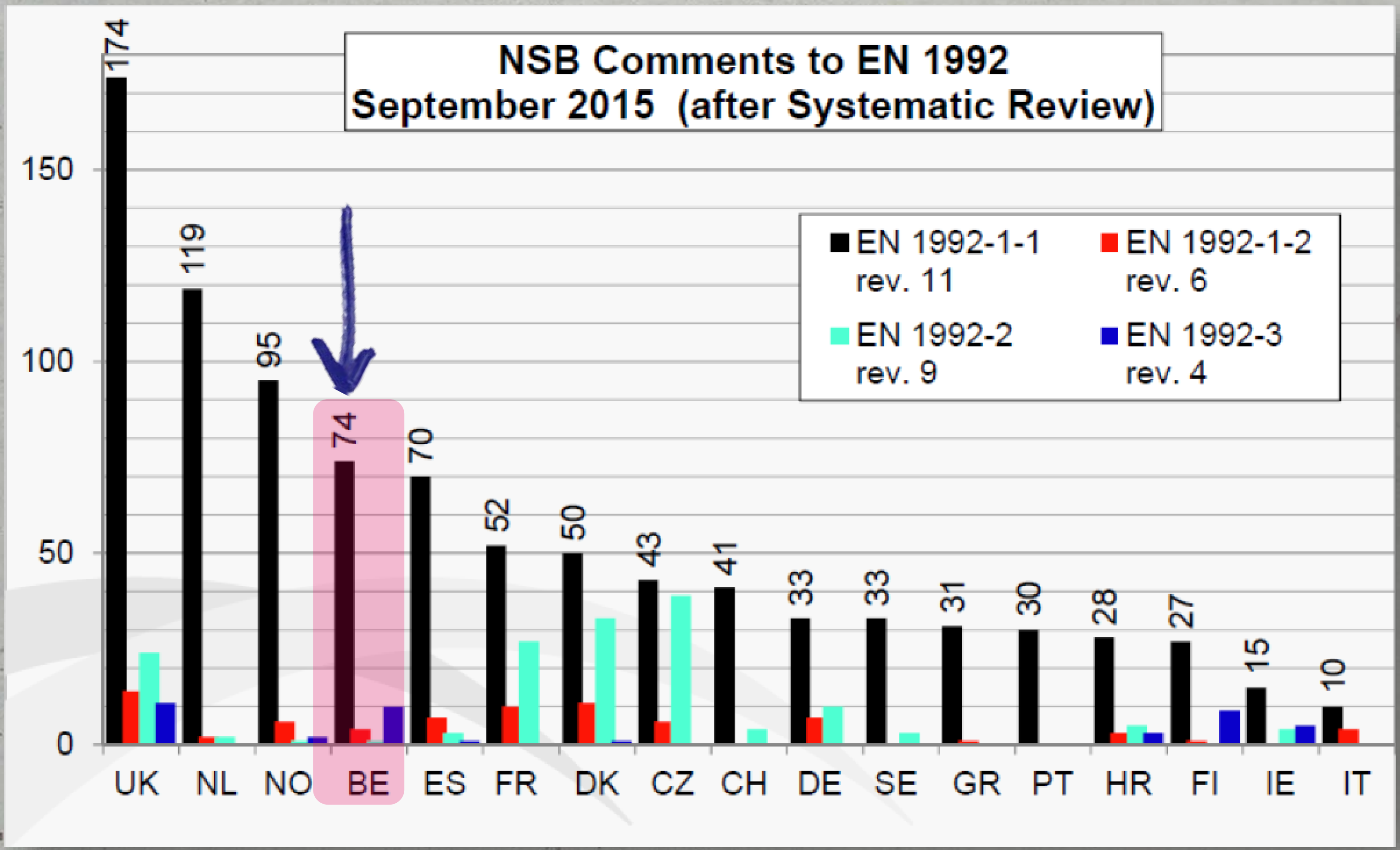
Assessment of NDPs in EN 1992-1-1 (Feedback of NSB)

Nr.	Section	Parameter	SL N283	UK N298	FR N296	PT N296	SE N296	NN	legiti-mate	illegiti-mate	question-able
61	6.8.4 (5)	k_2	illegitimate	legitimate	illegitimate	illegitimate	illegitimate		1	4	0
62	6.8.6 (1)	k_1	illegitimate	legitimate	legitimate	illegitimate	illegitimate		2	3	0
63	6.8.6 (1)	k_2	illegitimate	legitimate	illegitimate	illegitimate	illegitimate		1	4	0
64	6.8.6 (3)	k_3	illegitimate	legitimate	illegitimate	illegitimate	illegitimate		1	4	0
65	6.8.7 (1)	N, k_1	illegitimate	illegitimate	illegitimate	illegitimate	legitimate		1	4	0
66	7.2 (2)	k_1	illegitimate	illegitimate	illegitimate	illegitimate	illegitimate		0	5	[illegible]
67	7.2 (3)	k_2	illegitimate	illegitimate	illegitimate	illegitimate	illegitimate		[illegible]	[illegible]	[illegible]
68	7.2 (5)	k_3, k_4	illegitimate	legitimate	illegitimate	illegitimate	illegitimate		[illegible]	[illegible]	[illegible]
69	7.2 (5)	k_5	illegitimate	legitimate	illegitimate	illegitimate	[illegible]		[illegible]	[illegible]	[illegible]
70	7.3.1 (5)	w_{max}	legitimate	legitimate	legitimate	legitimate	[illegible]		[illegible]	[illegible]	[illegible]
71	7.3.2 (4)	$\sigma_{ct,p}$	illegitimate	illegitimate	illegitimate	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]
72	7.3.3 (2)	Tab. 7.2N, 7.3N	illegitimate	legitimate	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]
73	7.3.4 (3)	k_3, k_4	illegitimate	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]
74	7.4.2 (2)	l/d	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	4
75	8.2 (2)	k_1, k_2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	4	0
76	8.3 (2)	D	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		1	0	4
77	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		0	5	0
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	illegitimate		1	4	0
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	legitimate		5	0	0
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	questionable	questionable		1	0	4
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	illegitimate	illegitimate	illegitimate		1	4	0
[illegible]	[illegible]	[illegible]	[illegible]	legitimate	legitimate	illegitimate	illegitimate		2	3	0
[illegible]	[illegible]	[illegible]	illegitimate	legitimate	illegitimate	illegitimate	illegitimate		1	4	0
[illegible]	[illegible]	[illegible]	questionable	questionable	illegitimate	questionable	legitimate		1	1	3
[illegible]	[illegible]	$s_{l,max}$	questionable	questionable	legitimate	questionable	legitimate		2	0	3
86	9.2.2 (7)	$s_{b,max}$	questionable	questionable	questionable	questionable	legitimate		1	0	4
87	9.2.2 (8)	$s_{t,max}$	questionable	questionable	legitimate	questionable	legitimate		2	0	3
88	9.3.1.1 (3)	$s_{max, slabs}$	legitimate	legitimate	legitimate	legitimate	legitimate		5	0	0
89	9.5.2 (1)	ϕ_{min}	illegitimate	legitimate	illegitimate	illegitimate	legitimate		2	3	0

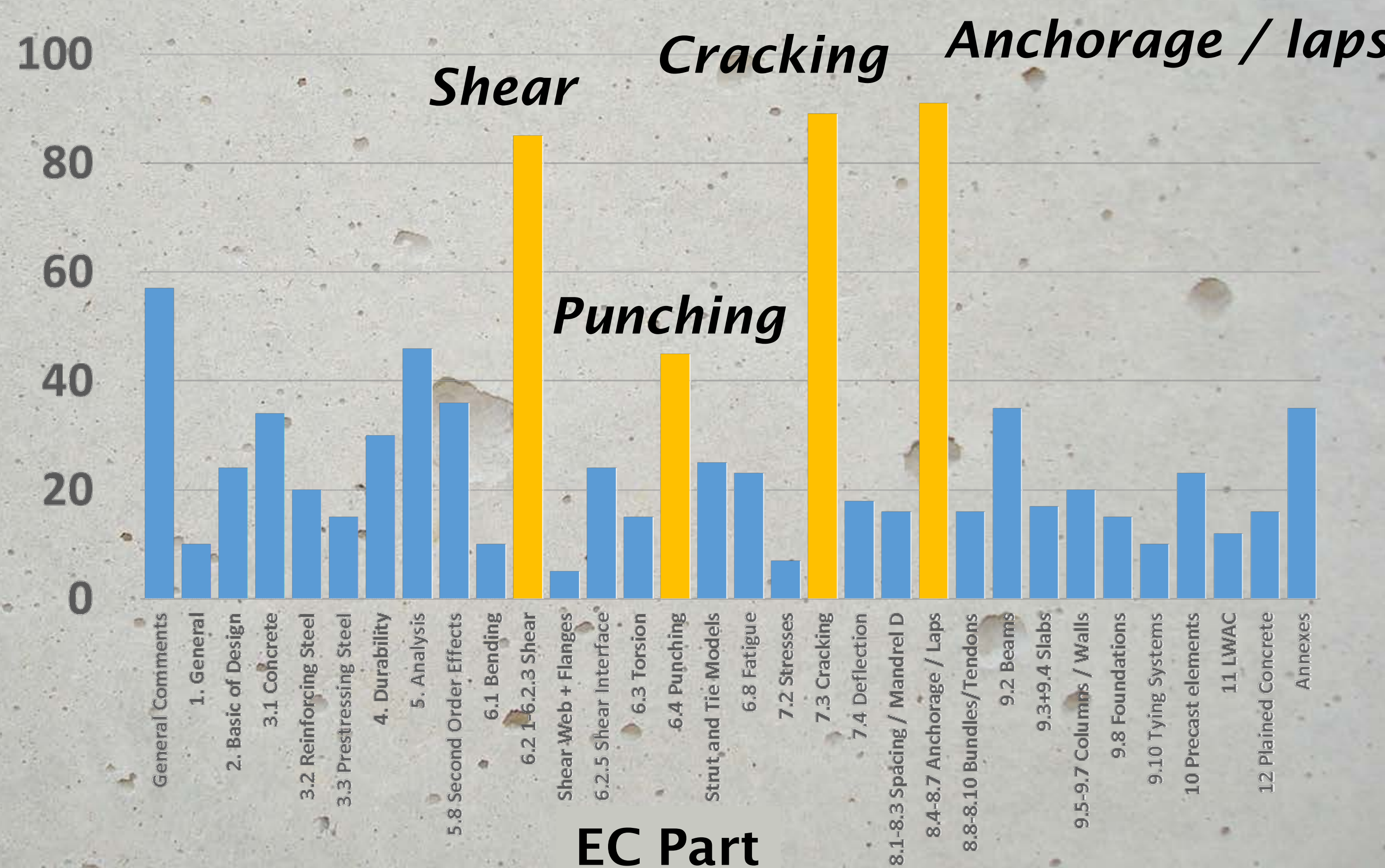
"Member States should use the recommended values provided by the Eurocodes when nationally determined parameters have been identified in the Eurocodes. They should diverge from those recommended values only where geographical, geological or climatic conditions or specific levels of protection make that necessary."

Process with the systematic review

Belgium was very concerned...



Comments from systematic review



Update according to SoA

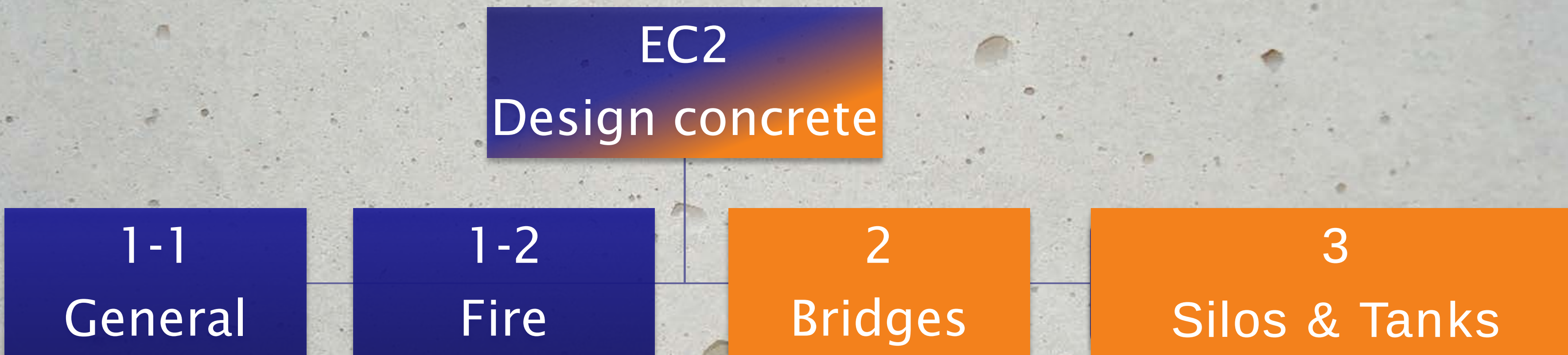
Stainless steel

Assessment ∃

FRP

FRC

Regrouping parts



Only 5p.
Specific for bridges !

[WG1/TG9]

Input from Model Code 2010

Some evolutions

(still in discussion !)

Section 2 - Basis of design

No big shot

Materials (new)

- RAC (Recycled Aggregates Concrete)
- Stainless steel
- FRP (Fibre Reinforced Polymer)
- FRC (Fibre Ceinforced Concrete)

DRAFT

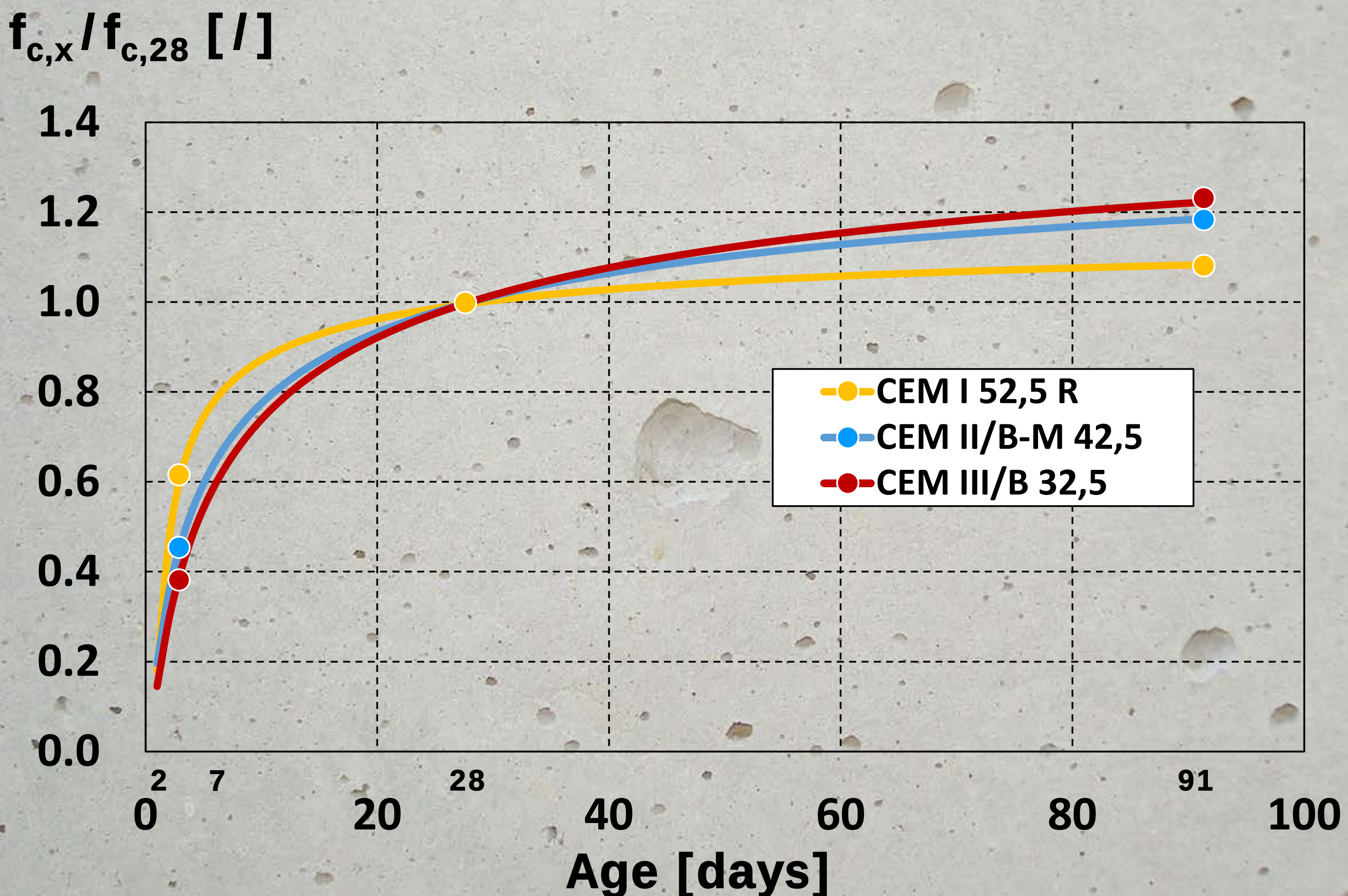
Resistance

- C100
- LC80
- RAC
- Steel grades (B400-B700)

<> EN 206

Section 3 - Materials

Resistance @**91d** vs. 28d ?



Section 3 - Materials

Resistance @<u>91d</u> vs. 28d ?

Pro's:

Sustainability etc.

- We should make sure that all efforts in improving the sustainability of concrete by reduction of CO_2 and other greenhouse gas emissions are appreciated and honored

Economy

- We should utilize the full strength potential of our concrete, not "give away" 35-50% strength increase

Technical

- Use correct strength when calculating minimum reinforcement not one that is 20-30% too low
- Use correct strength when assessing robustness and risk of brittle failure
- Use correct strength and stiffness in non-linear analyses where also overstrength is a concern
- Less early heat development is helpful to avoid early thermal cracking
- Simpler definition of in situ design strength that solves α_{cc} question
- Better reference point for scientific observations in research
- Use only one system common for all. Allowing on an individual basis taking account of additional gain of strength is a potential safety hazard for misunderstanding in communication between designer/user/producer and will only give a marginal effect in reduction of CO_2-footprint.

Con's:

Technical /Economical

- Slow strength development can reduce production rate on site
- Late confirmation of conformity on strength, note however that EN 206 already allow confirmation first after 3 respectively 6 months (§8.2.1.3.2(4)), but that early confirmation is possible for example by use of control charts which is allowed by EN 206 and will give confirmation within 7 days,
- Loss of "history", much research work becomes more difficult to refer to (this is however a problem inherent in getting new concretes anyhow)

Section 3 - Materials

RAC : max C30

- Max C30
- « deemed to satisfy » philosophy (EN 206)
- Link with exposure classes
- More applications if tested

Table 3.2: Maximum fraction of recycled coarse aggregates (4/32) in strength class C30 and lower, for exposure resistance classes documented by deemed to satisfy values in EN 206[1]

Recycled aggregates (4/32) Type according to EN 12620	RX0	RC40	RC30	RC20	RSD
Type A	30%	30%	30%	20%	0
Type B	30%	30%	20%	0%	
[1] Where the resistance class is documented by tests with the actual recycled aggregates the maximum value may be taken as 30%.					

Design

- New formulae for f_{cd}
- Discussion on α_{cc}

$$f_{cd} = \alpha_{cc}\, \eta_{fc}\, f_{ck} / \gamma_C$$

$$\eta_{fc} = \left(\frac{30\ \text{MPa}}{f_{ck}}\right)^{1/3} \leq 1$$

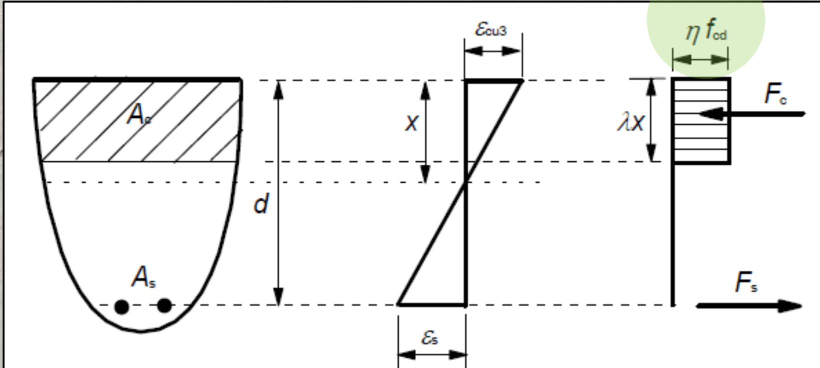


Figure 3.5: Rectangular stress distribution

Section 3 - Materials

Design

- New formulae for f_{cd}
- Discussion on α_{cc}

(2) The value of α_{cc} may conservatively be assumed to be 0,85.
Alternatively, the value may be based on an analysis of the proportion of the stress arising from permanent actions, as follows:

- α_{cc} =0,85 where the stress from permanent actions is >95% of the total stress
- α_{cc} =1,00 where the stress from permanent actions is <85% of the total stress

Intermediate values may be calculated by interpolation.

New exposure classes (cfr. CEN TC104 : EN 206)

Table 2 Definition of exposure resistance classes

Corrosion of reinforcement						Deterioration of concrete			
Carbonation Resistance Class			Chloride Resistance Class			Freeze/thaw Resistance Class		Chemical Aggressiveness Class (for later)	
RC40	RC30	RC20	RSD75	RSD60	RSD45	RF10	RF2	RCA	RCA
(Low)	(Medi-um)	(High)	(Low)	(Medi-um)	(High)	(Medium)	(High)	(Medium)	(High)
Definition of class is 50-years of exposure to XC3 (Rh 65%) with 10%-probability of carbonation front exceeding (mm) NOTE;			Definition of class is 50-years of exposure to XS2, with 10%-probability of chloride concentration exceeding 0,5% at depth (mm)			Definition of class is 50-years of exposure to XF4, with 10%-probability of scaling loss exceeding (kg/m^2) *or more probably it should be given in loss after N-cyles tested according to EN ZZZ*		*Definition of class is 50-years of exposure to XA3, ground water with $SO^2{}_4$ 6000mg/l and 10%-probability of loss exceeding (g/m^2)[??]*	
40	30	20	75	60	45	10	2	?	?

NOTE;
Low resistance - **high** ingress
High resistance - **low** ingress

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Section 4 - Durability

Impact on **cover** :

Table 4.4: Minimum concrete cover $c_{min,dur}$ dependant on design service life, exposure class and exposure resistance class

Preliminary values		Minimum cover for 50, 100 and 200 years design working life, recommended values (preliminary values)						
Exposure Class		RC20 [2]			RC30 [2]		RC40 [2]	
	(S4)[6]	50	100	200(?)	50	100	50	100
X0[1]	(10)	$c_{min,b}$	$c_{min,b}$	$c_{min,b}$	$c_{min,b}$	$c_{min,b}$	$c_{min,b}$	$c_{min,b}$
XC1	(15)	10	15	20	10	20	10	20
XC2	(25)	15	20	30	20	30	25	35
XC3	(25)	15	20	30	20	30	25	35
XC4	(30)	15	20	30	20	30	25	35
XD1[5]	(35)	30	35	45	35	45	40	50
XS1[5]	(35)	30	35	45	35	45	40	50
		RSD45			RSD60		RSD75	
XD1[5]	(35)	25	30	35	30	40	35	50
XS1[5]	(35)	25	30	35	30	40	35	50
XD2	(40)	45	55	65	55	70	70	NA
XS2[3]	(40)	45	55	65	55	70	70	NA
XD3[4]	(45)	55	65	75	70	NA	80	NA
XS3[3]	(45)	55	65	75	70	NA	80	NA

Section 5 – Structural analysis

Adaptations

- Use of non linear FE for conception or verification
- Effect of dimensions on plastic rotational capacity
- Second order effects

Section 6 – Ultimate limit states (ULS)

Not yet available ...

Section 7 – Serviceability limit states (SLS)

- Simplified methods
- Shrinkage in crack width calculation
- Effect of over-reinforcement
- Damping

New!

$$\phi_s = \phi_s^* \frac{f_{ct,ef}}{2,9} \frac{h_{cr}}{8(h-d)}$$

$$s_{\max} = s_{\max}^* \left(\frac{\phi_s}{\phi_s^*} \right)^2 \frac{300}{h(mm)}$$

The effect of over-reinforcement in the calculation of deflections has been formulated (request from UK):

$$\delta = \frac{1}{k_I} \left[k_\omega \delta_{LOADS} + k_S \delta_{\varepsilon_{cs}} \right]$$

$$k_\omega = \left(\frac{\omega_{prov}}{\omega} \right)^{0.6}$$

- Proposal for the definition for the values of the effective damping ratio for concrete. These values are based on measurements carried out in Laboratory conditions and on real structures:
  - ξ=1,0% for prestressed concrete structures
  - ξ=2,0% for reinforced concrete structures

Section 7 – Serviceability limit states (SLS)

For pure bending of rectangular sections:

$$A_{s,cc}\sigma_s = 0{,}2k_h f_{ct,ef} A_c \qquad (7.1)$$

For pure tension

$$A_{s,cc}\sigma_s = k_h f_{ct,ef} A_c \qquad (7.2)$$

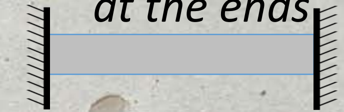
(2) The calculated surface crack width, $w_{k,cal}$, may be calculated from Expression (7.9):

$$w_{k,cal} = s_{r,\max,cal}\left(\varepsilon_{sm} - \varepsilon_{cm} - \eta_r \varepsilon_{cs}\right) \qquad (7.9)$$

Influence of boundary conditions

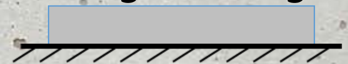
$$\varepsilon_{sm} - \varepsilon_{cm} = \frac{\sigma_s - k_t \dfrac{f_{ct,ef}}{\rho_{p,ef}}\left(1 + \alpha_e \rho_{p,ef}\right)}{E_s} \geq 0{,}6\frac{\sigma_s}{E_s}$$

at the ends



$$\varepsilon_{sm} - \varepsilon_{cm} - \eta_r \varepsilon_{cs} = R_{ax} \varepsilon_{free}$$

along one edge

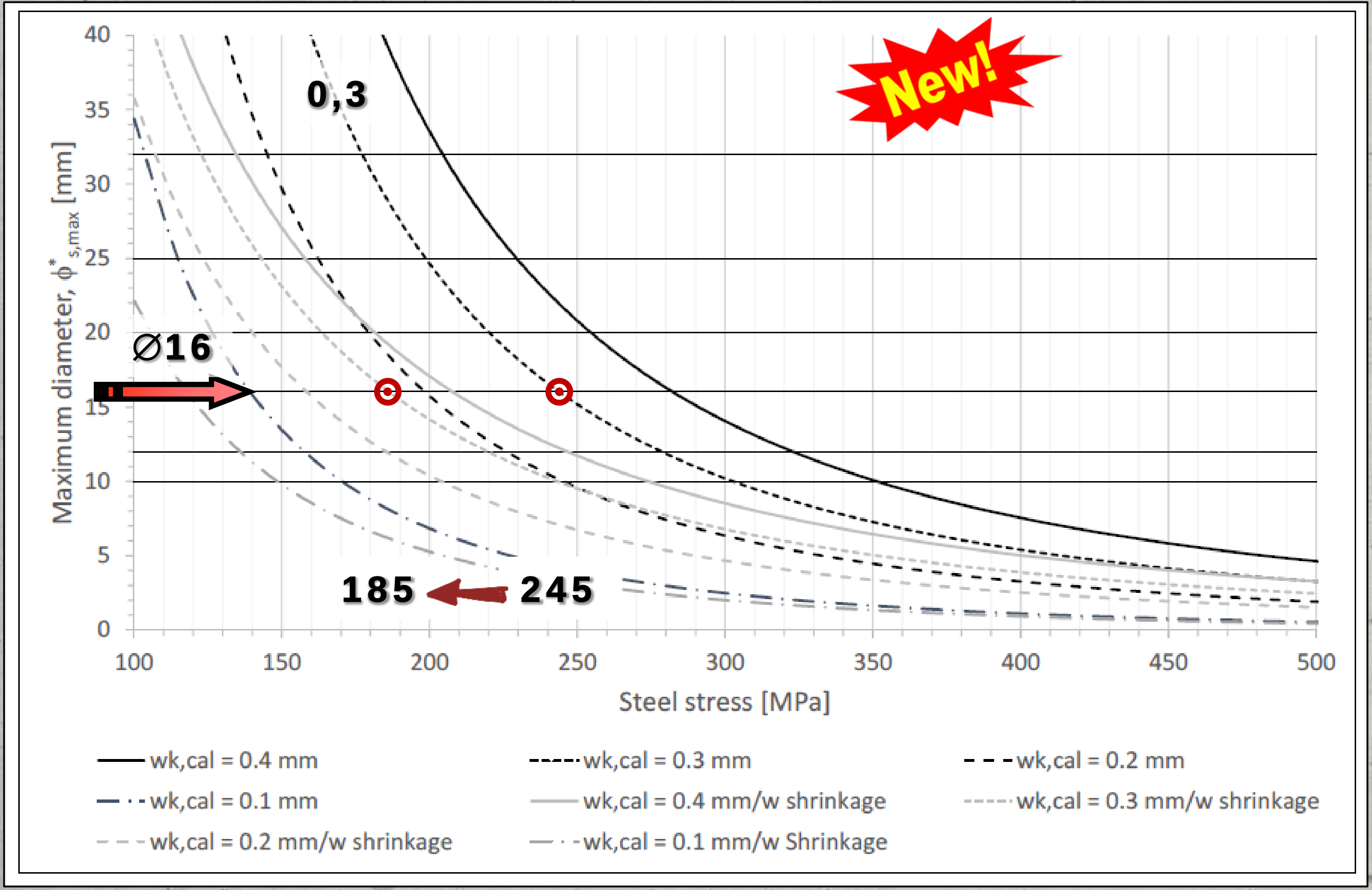


$$s_{r,\max} = 2c + 0.35 k_1 \phi / \rho_{p,ef}$$

Section 7 – Serviceability limit states (SLS)

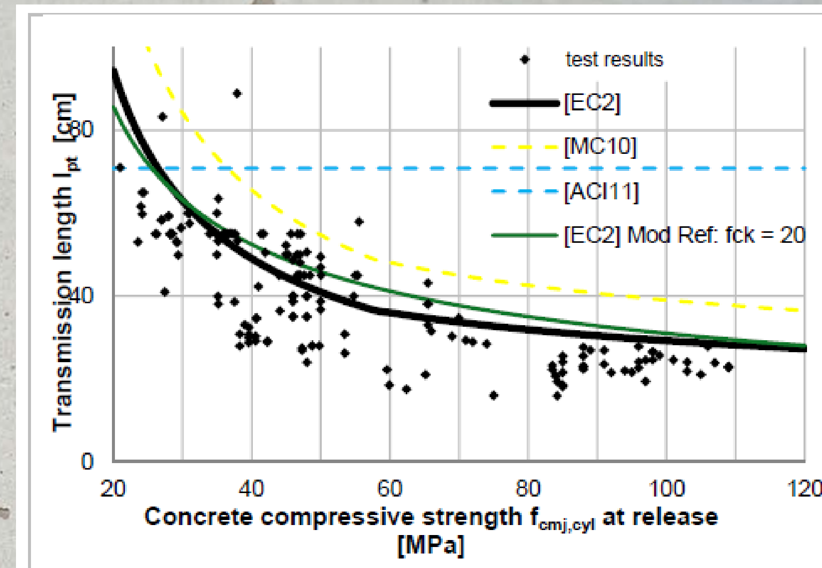
$\varnothing_{max}$ vs. steel stress

- Shrinkage taken into account

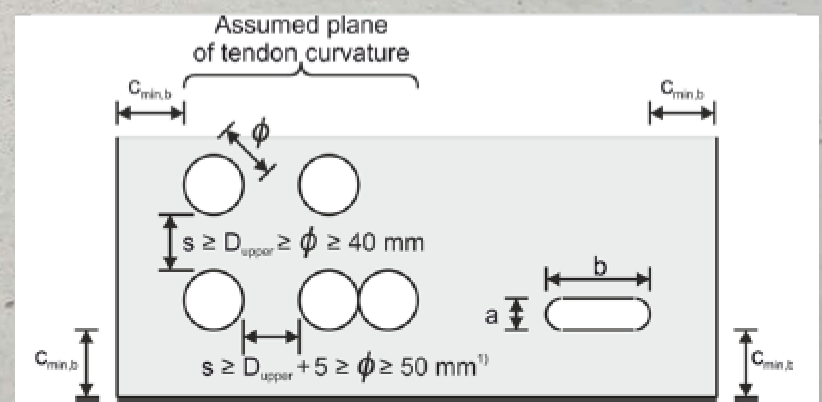


Prestressing (+harmon.)

- Transmission length ℓ_p



- Cover (special cases)



Section 9 – Detailing elements

$A_{s,min}$

~~$A_{s,max}$~~

9.2 Beams (New table for Detailing requirements for reinforcement in beams)

Description	Symbol	Requirement
Minimum tension reinforcement, longitudinal, shear and torsion	$A_{s,min}$	9.1(6)
Minimum bottom steel at inner supports		0,25 $A_{s,req\ span}$
Minimum bottom steel at end supports		0,25 $A_{s,req\ span} \geq A_{s,min}$
Minimum top steel at end supports, if monolitic		0,25 $A_{s,req\ span}$
Maximum longitudinal spacing of shear assemblies/stirrups	$s_{max,l}$	0,75d (1 + cot α) ≤300 mm[1]
Maximum longitudinal spacing of bent-up bars	$s_{max,bu}$	0,6d (1 + cot α)
Maximum transverse spacing of shear legs	$s_{max,tr}$	0,75d ≤ 600 mm
Minimum ratio of shear reinforcement in the form of stirrups	$\rho_{w,stir}$	0,5 $\rho_w \geq \rho_{w,min}$
Maximum stirrup spacing for torsion		u/8 ≤ the lesser of b and h
Maximum spacing of longitudinal surface reinforcement in beams with h≥700 mm		300 mm

[1] The absolute value of 300 mm applies to shear reinforcement at the surface

$A_{s,max}$ was deleted for the moment, it will be checked if it can be derived from other clauses before.

The maximum longitudinal spacing of bent-up-bars was adapted to 0,6d (1 + cot α)
Discussion with TG 4 needed

Robustness

9.4.1 Longitudinal reinforcement

Additional rules for robustness

- Bottom reinforcement of at least two bars
  - Minimum: $A_s f_{yk} = V_{Ed}$.
  - V_{Ed} is the design value of the acting shear force with γ_f=1,0.

Section 10 - Precast

Not yet available ...

Section 11- Lightweight concrete

Not yet available…

Stress-strain relationship

(2) When tensile stresses are considered for the design resistance of plain concrete members, the stress strain diagram (see 3.1.7) may be extended up to the tensile design strength using Expression (3.16) or a linear relationship.

$$f_{ctd,pl} = \alpha_{ct,pl} f_{ctk,0,05} / \gamma_C \qquad (12.1)$$

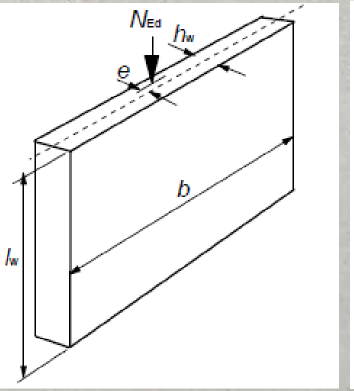
Comparison of NDPs:

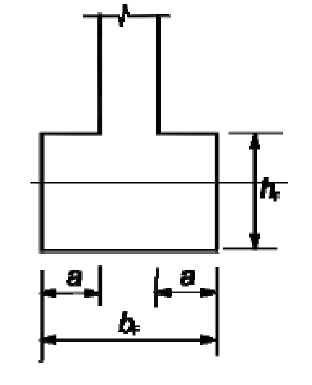
$\alpha_{cc,pl}$:
- United Kingdom 0,60
- Ireland 0,60
- Sweden 1,0
- Denmark 1,0
- Estonia 0,70
- Spain 0,85

$\alpha_{ct,pl}$:
- Sweden 0,50
- Denmark 1,0
- Estonia 0,60
- Finland 0,60
- Spain 0,85

Simplified method with creep excentricity eliminated

Strip footings deleted





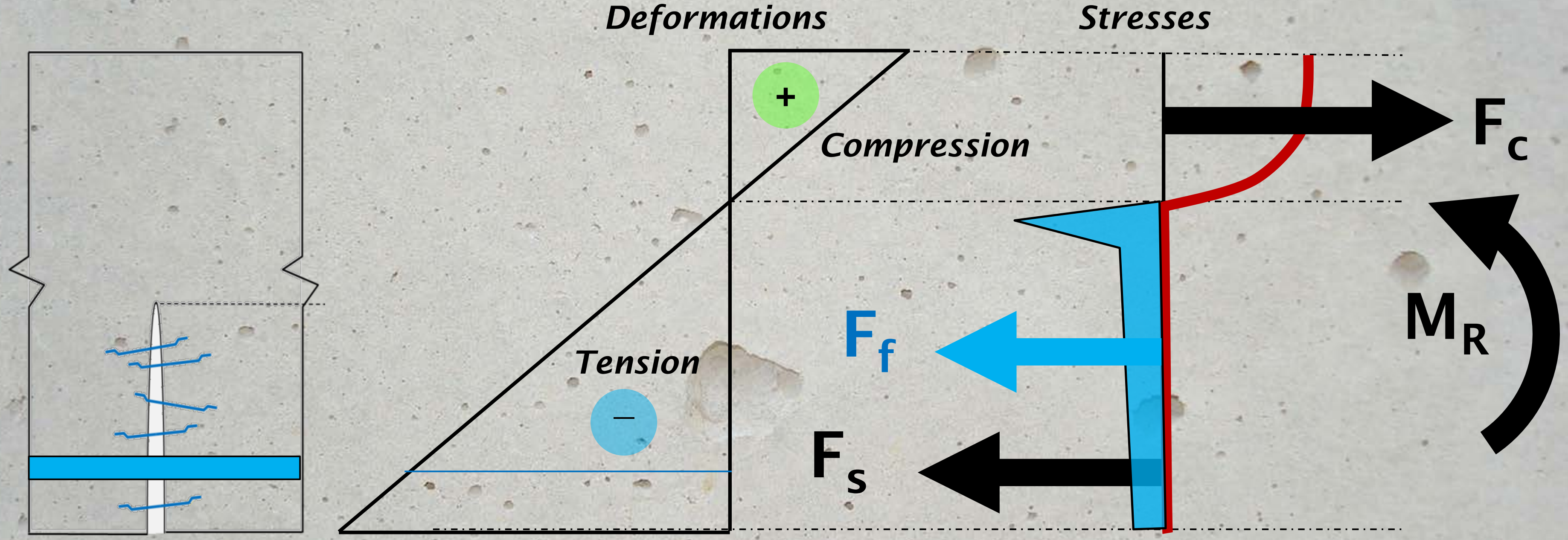
Evolutions – FRC (future Section 13/Annexe L ?)

Is this

reliable ?

FRC cross-section analysis

Traditional + fibres



Assumptions MC'10

FRC with/without traditional rebars

Behaviour in compression not influenced by fibres (V_f < 1%)

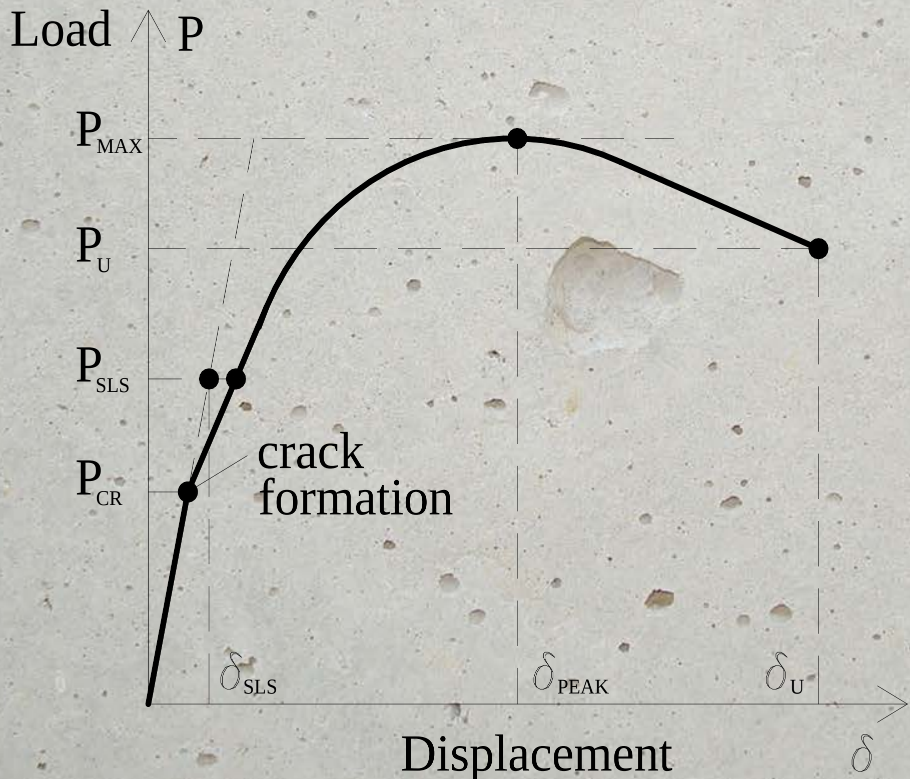
All fibre types but…

- Experience based on steel fibres
- « *Fibre materials with a Young's modulus which is significantly affected by time and/or thermo-hygrometrical phenomena are not covered by this Model Code.* »

Min. ductility (structure)

Ductility provided by traditional rebars

Ductility provided by FRC (no traditional rebars)



$$\begin{cases} \delta_u \geq 20\,\delta_{SLS} \\ \text{OF} \\ \delta_{peak} \geq 5\,\delta_{SLS} \end{cases}$$

From material to structure

1. Characterization
2. Performance classes
3. Constitutive laws
4. Design calculations

Performance classes

EN 14651

Proposal MC 2010

Class 2a

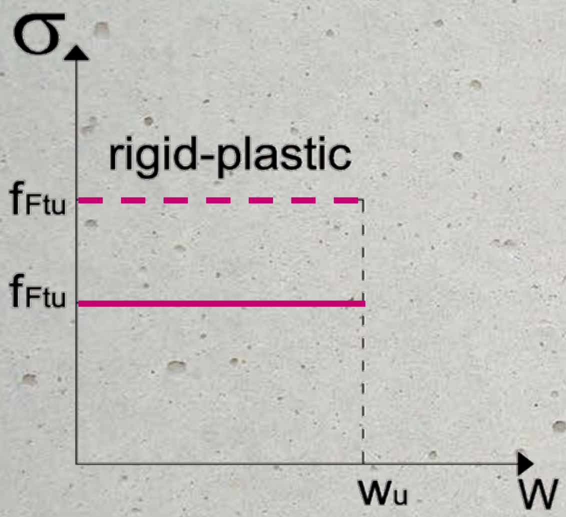
$f_{R1,k}$ [MPa]

1.0
1.5
2.0 *$2.0 \leq f_{R1,k} \leq 2.5$*
2.5
3.0
4.0
5.0
6.0
7.0
8.0
…

- **a** : $0.5 < f_{R3,k}/f_{R1,k} < 0.7$
- **b** : $0.7 \leq f_{R3,k}/f_{R1,k} < 0.9$
- **c** : $0.9 \leq f_{R3,k}/f_{R1,k} < 1.1$
- **d** : $1.1 \leq f_{R3,k}/f_{R1,k} < 1.3$
- **e** : $1.3 \leq f_{R3,k}/f_{R1,k}$

Constitutive law in uni-axial tension

Simplified « normative » approach



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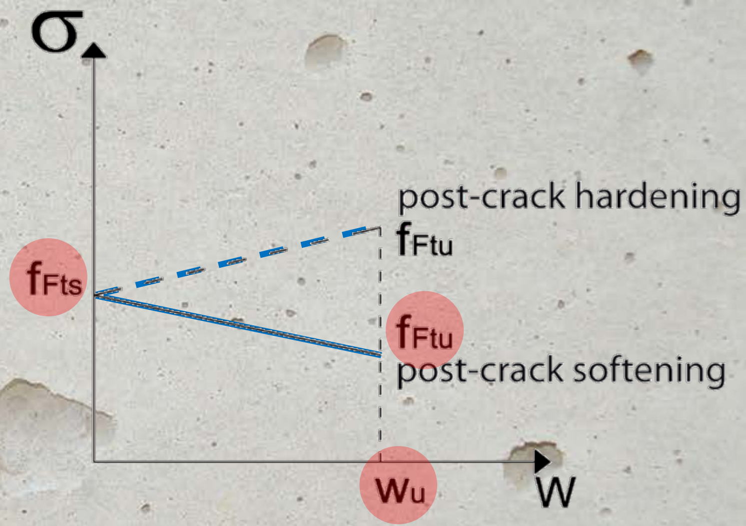
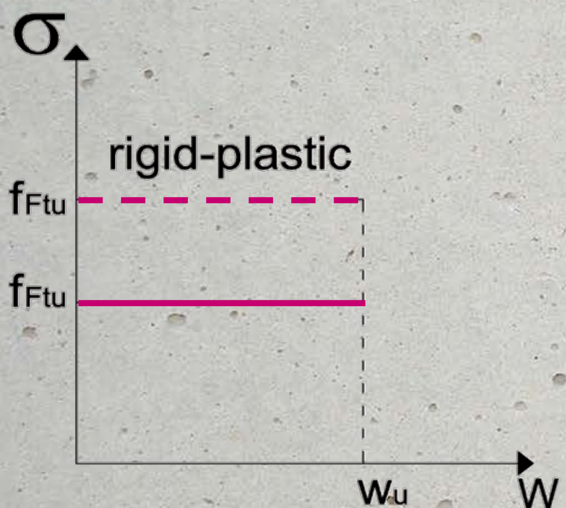


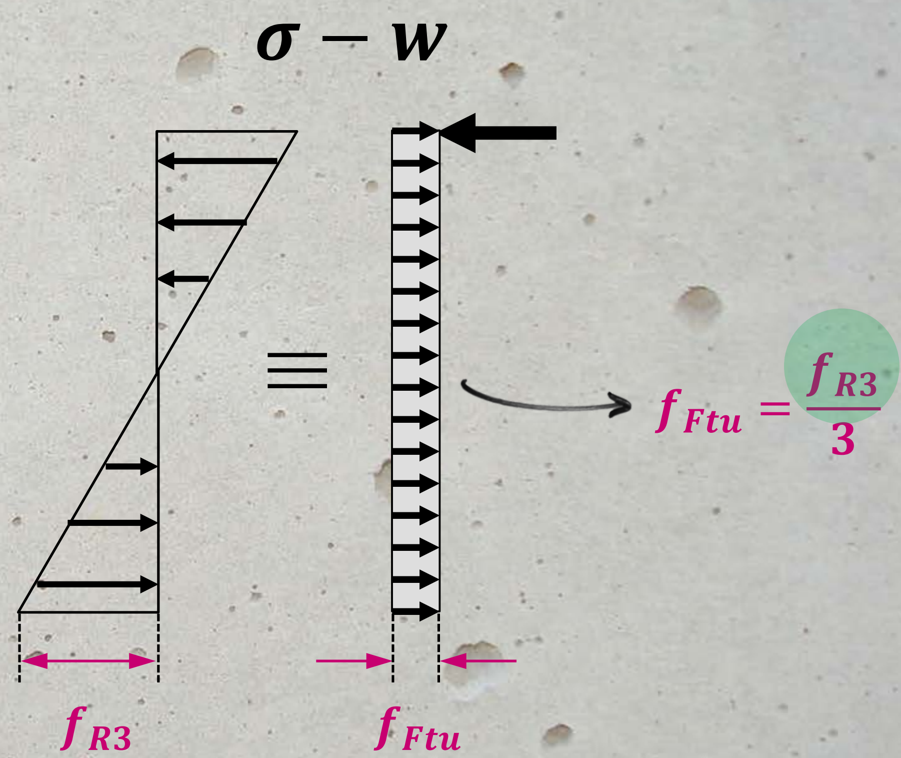
$$f_{Ftu} = \frac{f_{R3}}{3}$$

$$\begin{cases} f_{Fts} = 0.45 f_{R1} \\ f_{Ftu} = f_{Fts} - \dfrac{w_u}{CMOD_3}(f_{Fts} - 0.5 f_{R3} + 0.2 f_{R1}) \end{cases}$$

Constitutive law in uni-axial tension

Approach *fib* MC 2010 : 1) Rigid-plastic Model





Drafting EC2 for FRC

K_O is for taking orientation of fibres into account

K_G is for volume effects

α_{tx} is for conversion based on (real) stress distribution assumption (~0,37 for f_{Ftu})

3.1.6 Design compressive and tensile strengths **{new clause (3)}**

(3)P The values of the design residual tensile strength, f_{Ftsd} and f_{Ftud} are defined as

$$f_{Ftsk} = \kappa_O \cdot \kappa_G \cdot \alpha_{t1} \cdot f_{R,1k} \qquad (3.16a)$$

$$f_{Ftuk} = \kappa_O \cdot \kappa_G \cdot \alpha_{t3} \cdot f_{R,3k} \qquad (3.16b)$$

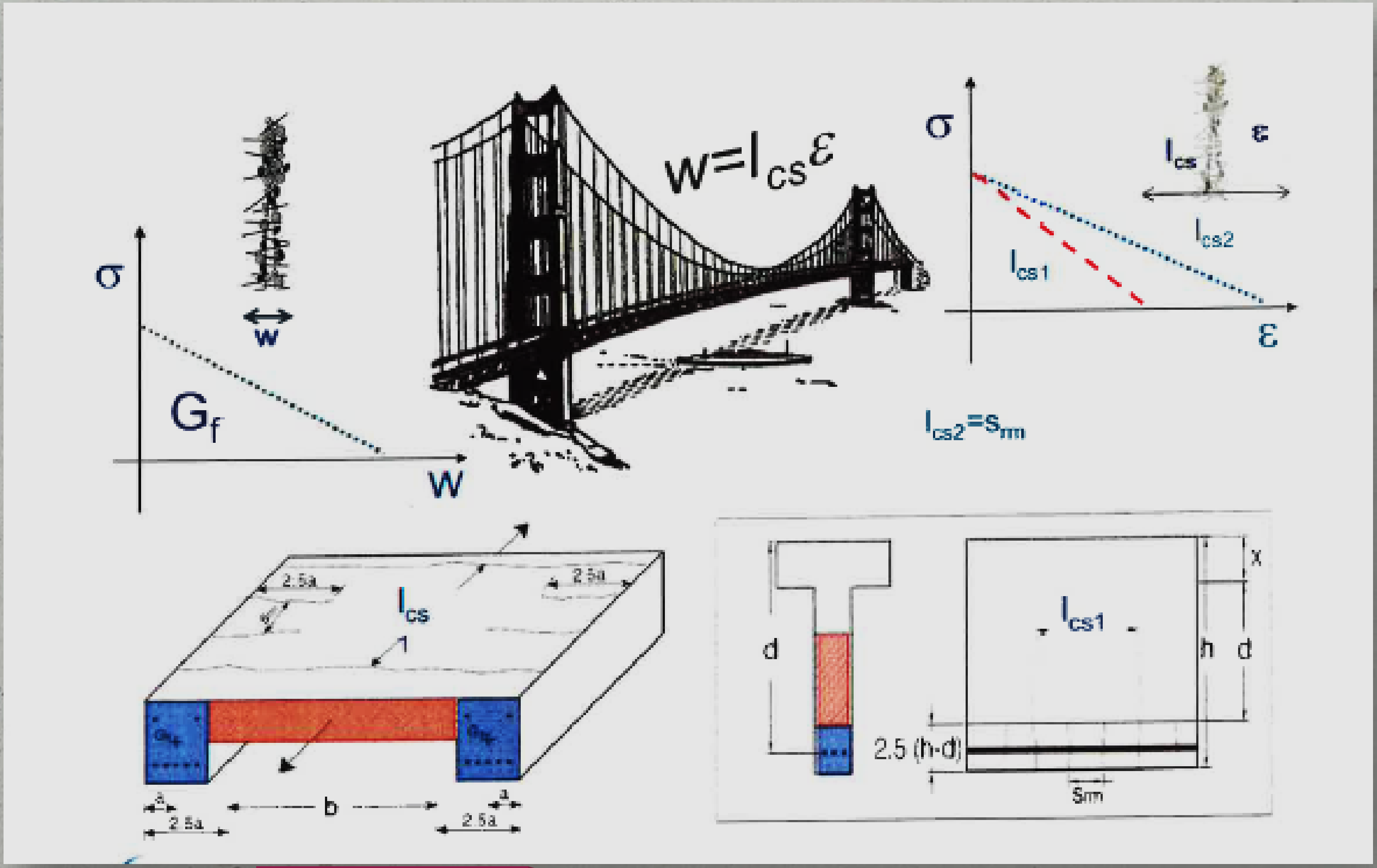
$$f_{Ftsd} = f_{Ftsk}/\gamma_{SF} \qquad (3.16c)$$

$$f_{Ftud} = f_{Ftuk}/\gamma_{SF} \qquad (3.16d)$$

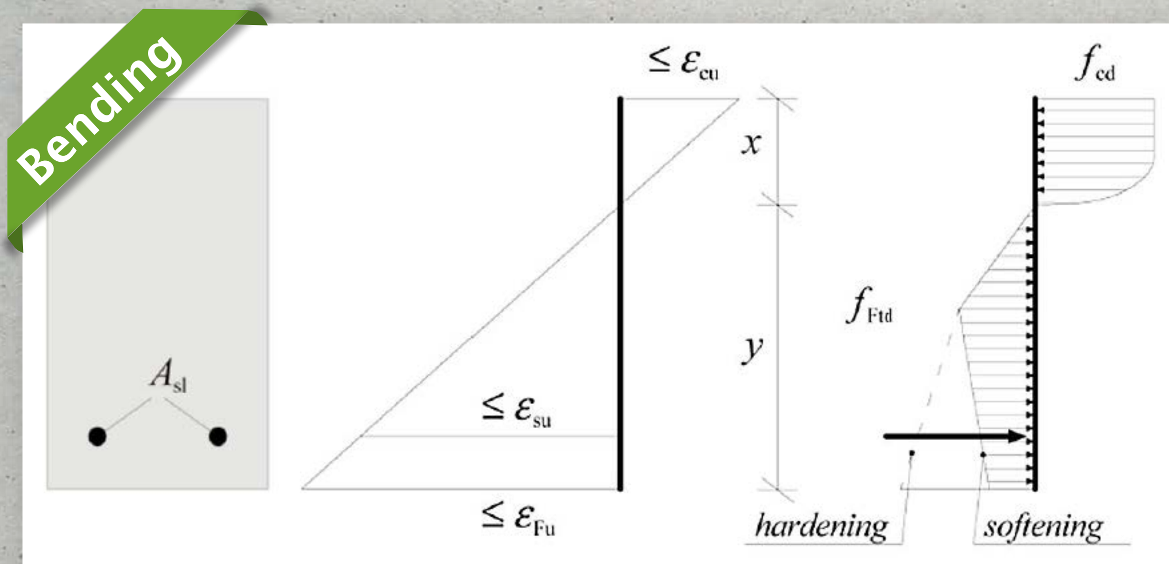
Towards stress-strain relationship $\sigma - \varepsilon$

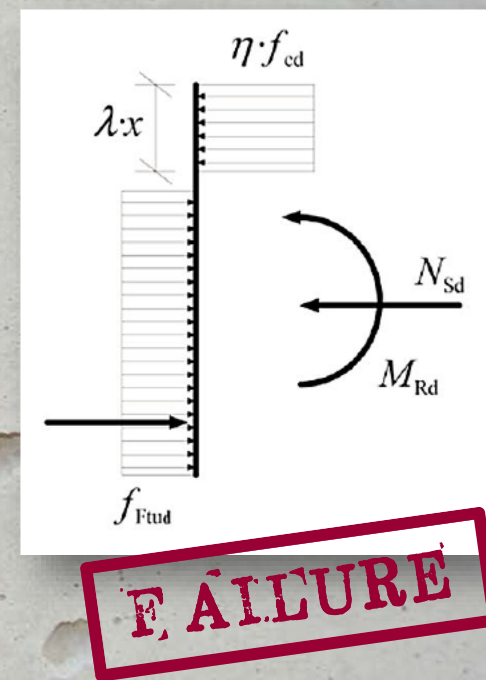
Characteristic structural length (ℓ_{cs})

$$\varepsilon = \frac{w}{l_{cs}}$$



Simplified stress-strain relationship MC'10





- *Max deformation in compression* (ε_{cu2})
- *Max deformation in rebar* (ε_{ud})
- *Max deformation FRC* (ε_{Fu})

Toolbox « Eurocodes »

www.normes.be/eurocodes

cstc.be
Recherche • Développe • Informe

economie
SPF Economie, P.M.E., Classes moyennes et Energie

Onze diensten

KMO Normen-Antennes

NA Constructieve Eurocodes

- Algemeen
- Fiches Eurocodes
- Rekenmodules
- Publicaties en normen
- Links
- Contacteer ons

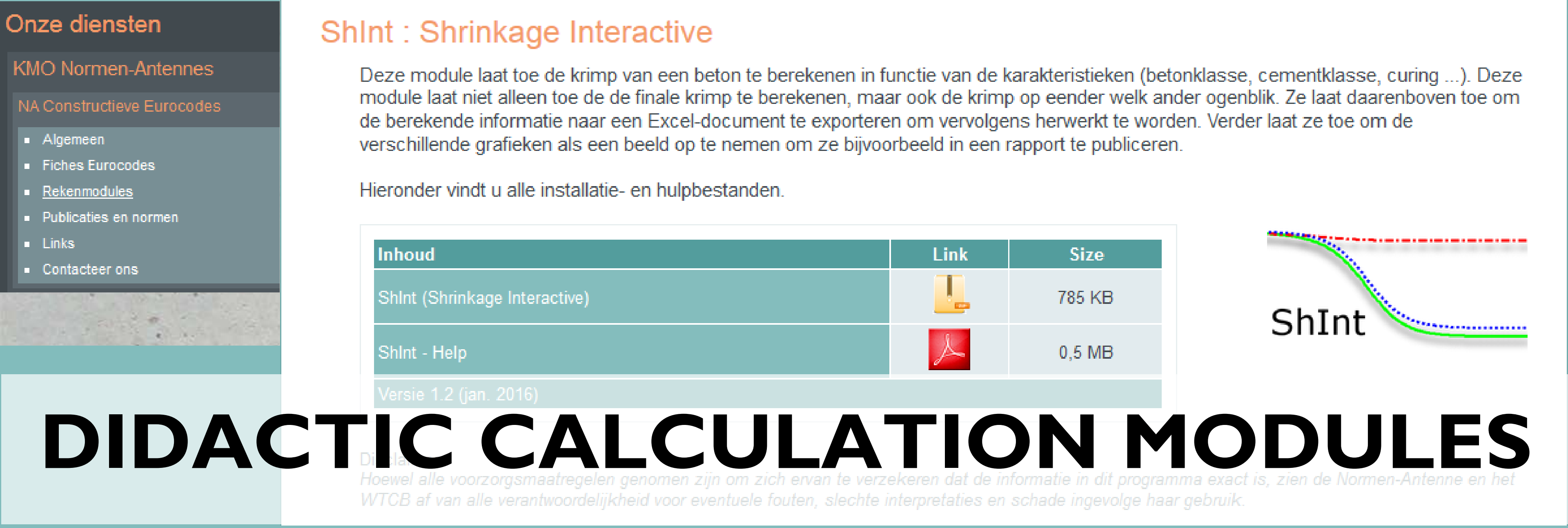
Fiches Eurocodes

De onderstaande tabel geeft een overzicht van de publicatiedatum van de Eurocodes, van hun Nationale Bijlagen (ANB) en van de publicatie van de corrigerende documenten (AC = corrigendum en A1 = addendum).

De laatste kolom van de tabel geeft bovendien toegang tot de detailfiches van de Eurocodes opgesteld door de Normen-Antenne Eurocodes.

Deel	Nederlandstalige titel	Publicatie EN	Publicatie ANB	Corrigenda (AC)* Addenda (A1)**	Fiches
NBN EN 1990 : Eurocode 0 : Grondslagen van het constructief ontwerp:					
	Grondslagen van het constructief ontwerp	sept. 2002	jan. 2013	A1:2006 AC:2010	
NBN EN 1991 : Eurocode 1 : Belastingen op constructies:					
-1-1	Algemene belastingen - [illegible]	sept. 2002	[illegible]	AC:2009	
-1-2	Algemene belastingen - Belasting bij brand	juni 2003	jan. 2009	AC:2013	
-1-3	Algemene belastingen - Sneeuwbelasting	nov. 2003	2007	AC:2009 A1:2015	
-1-4	Algemene belastingen - Windbelasting	nov. 2005	dec. 2010	AC:2010 A1:2010	
-1-5	Algemene belastingen - Thermische belasting	jan. 2004	mei 2009	AC:2009	
-1-6	Algemene belastingen - Belasting tijdens uitvoering	nov. 2005	dec. 2010	AC:2013	
-1-7	Algemene belastingen - Buitengewone belastingen : stootbelastingen en ontploffingen	dec. 2006	feb. 2012	AC:2010 A1:2014	
-2	Verkeersbelasting op bruggen	jan. 2004	okt. 2011	AC:2010	
-3	Belastingen veroorzaakt door kranen en machines	nov. 2006	okt. 2011	AC:2012	
-4	Silo's en opslagtanks	nov. 2006	okt. 2011	AC:2012	

RECAP TABLES & SHEETS



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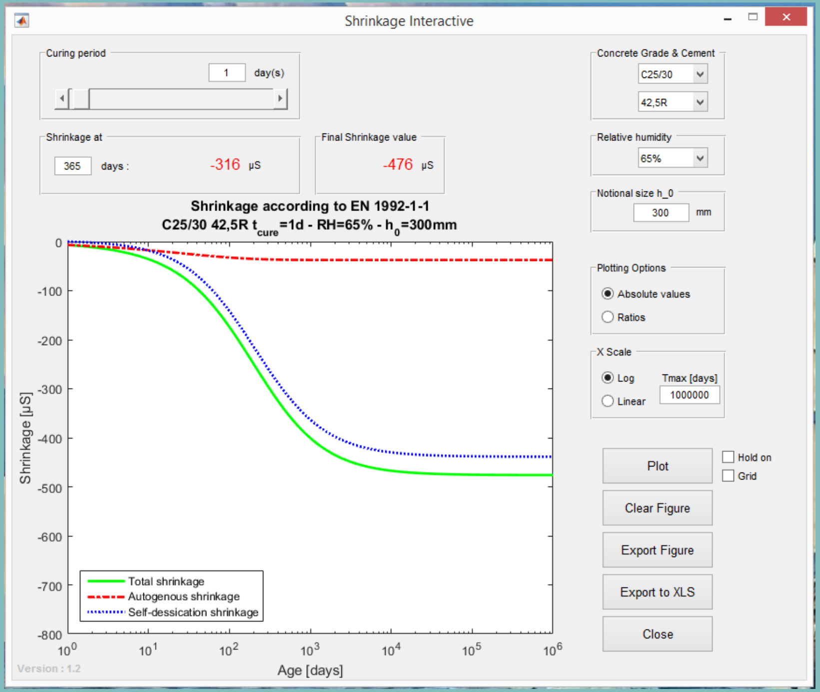

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	Standard number	Year of edition	Title		PDF EN	PDF FR	PDF DE	PDF NL
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	NBN EN 1992-1-1/A1	2015	Eurocode 2: Design of concrete structures - Part 1-1: General rules and rules for buildings					
	NBN EN 1992-2 ANB	2014	Eurocode 2 : Design of concrete structures - Concrete bridges - Design and detailing rules - National annex					
	NBN EN 1992-3 ANB	2013	Eurocode 2 - Design of concrete structures - Part 3 : Liquid retaining and containment structures - National annex					
	NBN EN 1992-3 NL	2011	Eurocode 2 - Design of concrete structures - Part 3: Liquid retaining and containment structures					
	NBN EN 1992-1-1 ANB	2010	Eurocode 2: Design of concrete structures - Part 1-1: General rules and rules for buildings					
	NBN EN 1992-1-2 ANB	2010	Eurocode 2 : Design of concrete structures - Part 1-2 : General rules - Structural fire design - National annex					
	NBN EN 1992-3	2006	Eurocode 2 - Design of concrete structures - Part 3: Liquid retaining and containment structures					
	NBN EN 1992-1-1	2005	Eurocode 2: Design of concrete structures - Part 1-1: General rules and rules for buildings					
	NBN EN 1992-2	2005	Eurocode 2 - Design of concrete structures - Concrete bridges - Design and detailing rules					
	NBN ENV 1992-1-2	2003	Eurocode 2 - Design of concrete structures - Part 1-2: General rules - Structural fire design					
	NBN ENV 1992-1-4	2001	Eurocode 2: Design of concrete structures - Part 1-4: General rules - Lightweight aggregate concrete with closed structure					
	NBN ENV 1992-3	1999	Eurocode 2: Design of concrete structures - Part 3: Concrete foundations					
	NBN ENV 1992-4	1999	Eurocode 2: Design of concrete structures - Part 4: Liquid retaining and containment structures					


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