Durability in the new Eurocode 2 and future EN206-100

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EUROCODES

EN 1992

Design
of concrete
structures

2nd generation of Eurocode 2 on concrete structures

Madrid, October 17th, 2023

ACHE Asociación Española de Ingeniería Estructural

HA HORMIGÓN y ACERO

DURABILITY IN CHAPTER 6

1. A small change in the definition of the XC2
    1. The Exposure classes are incorporated as "environmental actions"
2. Cover depths in fuction of the ERC's and the XC's and calibrated with durability models
    1. There will be an EN 206-100 for verification of durability
    2. The previous methodology will be allowed
    3. It is introduced a new LIMIT state in addition to depassivation
        1. Condition or Deterioration LS
        2. In includes a corrosion propagation period
            1. 50 µm of homogeneous attack
            2. 500 µm of localized attack
3. Cover depths for stainless steel bars.
4. Annex I Assessment of existing structures

PREVIOUS METHODOLOGY FOR DURABILITY DESIGN AND INTRODUCTION OF ERC'S

Exposure classes + Structural classes → cover depths

EN 1992-1-1:2004 (E)

Table 4.1: Exposure classes related to environmental conditions in accordance with EN 206-1

Class designation	Description of the environment	Informative examples where exposure classes may occur
1 No risk of corrosion or attack		
X0	For concrete without reinforcement or embedded metal: all exposures except where there is freeze/thaw, abrasion or chemical attack For concrete with reinforcement or embedded metal: very dry	Concrete inside buildings with very low air humidity
2 Corrosion induced by carbonation		
XC1	Dry or permanently wet	Concrete inside buildings with low air humidity Concrete permanently submerged in water
XC2	Wet, rarely dry	Concrete surfaces subject to long-term water contact Many foundations
XC3	Moderate humidity	Concrete inside buildings with moderate or high air humidity External concrete sheltered from rain
XC4	Cyclic wet and dry	Concrete surfaces subject to water contact, not within exposure class XC2
3 Corrosion induced by chlorides		
XD1	Moderate humidity	Concrete surfaces exposed to airborne chlorides
XD2	Wet, rarely dry	Swimming pools Concrete components exposed to industrial waters containing chlorides
XD3	Cyclic wet and dry	Parts of bridges exposed to spray containing chlorides Pavements Car park slabs
4 Corrosion induced by chlorides from sea water		
XS1	Exposed to airborne salt but not in direct contact with sea water	Structures near to or on the coast
XS2	Permanently submerged	Parts of marine structures
XS3	Tidal, splash and spray zones	Parts of marine structures
5. Freeze/Thaw Attack		
XF1	Moderate water saturation, without de-icing agent	Vertical concrete surfaces exposed to rain and freezing
XF2	Moderate water saturation, with de-icing agent	Vertical concrete surfaces of road structures exposed to freezing and airborne de-icing agents
XF3	High water saturation, without de-icing agents	Horizontal concrete surfaces exposed to rain and freezing
XF4	High water saturation with de-icing agents or sea water	Road and bridge decks exposed to de-icing agents Concrete surfaces exposed to direct spray containing de-icing agents and freezing Splash zone of marine structures exposed to freezing
6. Chemical attack		
XA1	Slightly aggressive chemical environment according to EN 206-1, Table 2	Natural soils and ground water
XA2	Moderately aggressive chemical environment according to EN 206-1, Table 2	Natural soils and ground water
XA3	Highly aggressive chemical environment according to EN 206-1, Table 2	Natural soils and ground water

Table 4.4N: Values of minimum cover, $c_{min,dur}$, requirements with regard to durability for reinforcement steel in accordance with EN 10080.

Environmental Requirement for $c_{min,dur}$ (mm)							
Structural Class	Exposure Class according to Table 4.1						
	X0	XC1	XC2 / XC3	XC4	XD1 / XS1	XD2 / XS2	XD3 / XS3
S1	10	10	10	15	20	25	30
S2	10	[illegible]	15	20	25	30	35
S3	10	10	20	25	30	35	40
S4	10	15	25	30	35	40	45
S5	15	20	[illegible]	35	40	45	50
S6	20	25	35	40	45	50	55

Table 4.5N: Values of minimum cover, $c_{min,dur}$, requirements with regard to durability for prestressing steel

Environmental Requirement for $c_{min,dur}$ (mm)							
Structural Class	Exposure Class according to Table 4.1						
	X0	XC1	XC2 / XC3	XC4	XD1 / XS1	XD2 / XS2	XD3 / XS3
S1	10	15	20	25	30	35	40
S2	10	15	25	30	35	[illegible]	45
S3	10	20	30	35	40	45	50
S4	10	25	35	40	45	50	55
S5	15	30	40	45	50	55	60
S6	20	35	45	50	55	60	[illegible]

(6) The concrete cover should be increased by the additive safety element $\Delta c_{dur,\gamma}$.

Note: The value of $\Delta c_{dur,\gamma}$ for use in a Country may be found in its National Annex. The recommended value is 0 mm.

(7) Where stainless steel is used or where other special measures have been taken, the minimum cover may be reduced by $\Delta c_{dur,st}$. For such situations the effects on all relevant

	EXPOSURE CLASSES										
	No risk	Carbonation induced corrosion				Chloride induced corrosion					
						Sea water			Chloride other tan from sea water		
	X0	XC1	XC2	XC3	XC4	XS1	XS2	XS3	XD1	XD2	XD3
a/c	-	0.65	0.60	0.55	0.50	0.50	0.45	0.45	0.55	0.55	0.45
strength	C12/15	C20/25	C25/30	C30/37	C30/37	C30/37	C35/45	C35/45	C30/37	C30/37	C35/45
cement	-	260	280	280	300	300	320	340	300	320	340
Cover depth S4(mm)	10	15	25	25	30	35	40	45	35	40	45

THE STRUCTURAL CLASSES ARE SUBSTITUTED BY THE EXPOSURE RESISTANCE CLASSES (ERC)

COVER DEPTHS IN FUNCTION OF ERC's

mínimum cover Depth

carbonation

prEN 1992-1-1:2020 (E)

Table 6.3(NDP) — Minimum concrete cover $c_{min,dur}$ for carbon steel — Carbonation

ERC	Exposure class (carbonation)							
	XC1		XC2		XC3		XC4	
	Design service life (years)							
	50	100	50	100	50	100	50	100
XRC 0,5	10	10	10	10	10	10	10	10
XRC 1	10	10	10	10	10	15	10	15
XRC 2	10	15	10	15	15	25	15	25
XRC 3	10	15	15	20	20	30	20	30
XRC 4	10	20	15	25	25	35	25	40
XRC 5	15	25	20	30	25	45	30	45
XRC 6	15	25	25	35	35	55	40	55
XRC 7	15	30	25	40	40	60	45	60

NOTE 1 The designation of XRC classes for resistance against corrosion induced by carbonation is derived from the carbonation depth [mm] (characteristic value 90 % fractile) assumed to be obtained after 50 years under reference conditions (400 ppm CO_2 in a constant 65 %-*RH* environment and at 20 °C). XRC has the dimension of a carbonation rate [mm/$\sqrt{}$ (years)].

NOTE 2 The recommended minimum concrete cover values $c_{min,dur}$ assume execution and curing according to EN 13670 with at least Execution Class 2 and Curing Class 2.

NOTE 3 The minimum covers can be increased by an additional safety element $\Delta c_{dur,\gamma}$ considering special requirements (e.g. more extreme environmental conditions).

chlorides

Table 6.4(NDP) — Minimum concrete cover $c_{min,dur}$ for carbon steel — Chlorides

ERC	Exposure class (chlorides)											
	XS1		XS2		XS3		XD1		XD2		XD3	
	Design service life (years)						Design service life (years)					
	50	100	50	100	50	100	50	100	50	100	50	100
XRDS 0,5	20	20	20	30	30	40	20	20	20	30	30	40
XRDS 1	20	25	25	35	35	45	20	25	25	35	35	45
XRDS 1,5	25	30	30	40	40	50	25	30	30	40	40	50
XRDS 2	25	30	35	45	45	55	25	30	35	45	45	55
XRDS 3	30	35	40	50	55	65	30	35	40	50	55	65
XRDS 4	30	40	50	60	60	80	30	40	50	60	60	80
XRDS 5	35	45	60	70	70	—	35	45	60	70	70	—
XRDS 6	40	50	65	80	—	—	40	50	65	80	—	—
XRDS 8	45	55	75	—	—	—	45	55	75	—	—	—
XRDS 10	50	65	80	—	—	—	50	65	80	—	—	—

NOTE 1 The designation of XRDS classes for resistance against corrosion induced by chloride ingress is derived from the depth of chlorides penetration [mm] (characteristic value 90 % fractile), corres-ponding to a reference chlorides concentration (0,6 % by mass of bindercement + type II additions), assumed to be obtained after 50 years on a concrete exposed to one-sided penetration of reference seawater (30 g/l NaCl) at 20 °C. XRDS has the dimension of a diffusion coefficient [10^{-13} m^2/s].

NOTE 2 The recommended minimum concrete cover values $c_{min,dur}$ assume execution and curing according to EN 13670 with at least Execution Class 2 and Curing Class 2.

NOTE 3 The minimum covers can be increased by an additional safety element $\Delta c_{dur,\gamma}$ considering special requirements (e. g. more extreme environmental conditions).

(2) For temporary structures or for structures with a design service life of 30 years or less, $c_{min,dur}$ for a design service life of 50 years according to Table 6.3(NDP) and Table 6.4(NDP) may be reduced by $-\Delta c_{min,30}$.

NOTE 3 The reduction of the cover is $-\Delta c_{min,30} \leq 5$ mm unless a National Annex gives a different value.

STAINLESS STEEL

Q.4 Minimum cover for durability

(1) For durability design with stainless steel reinforcement, Stainless Steel Resistance Classes SSRC are defined in Table Q.2.

NOTE For an alternative approach to design cover for durability without use of Exposure Resistance Classes (ERC) see Annex P.

Table Q.2. Classification of corrosion resistance of stainless steel dependent on the Pitting Resistance Eqvivalent PRE

Stainless steel Resistance Class	Pitting Resistance Equivalent PRE[a]	Description	Informative examples EN 10088-1		
			Ferritic	Duplex	Austenitic
SSRC0	0 to 9	Carbon steel reinforcement	–	–	–
SSRC1	10 to 16	Chromium steels	1.4003	–	–
SSRC2	17 to 22	Chromium Nickel steels	–	1.4482	1.4301 1.4307
SSRC3	23 to 30	Chromium Nickel steels with Molybdenum	–	1.4362	1.4401 1.4404 1.4571
SSRC4	≥ 31	Steels with increased content of Chromium and Molybdenum	–	1.4462	1.4529

[a] Calculation of the Pitting Resistance Equivalent: PRE = Cr + 3,3 · Mo + n · N; Cr, Mo and N in M.- %. With: n = 0 for ferritic steels, n = 16 for Duplex steels and n = 30 for austenitic steels.

Table Q.3(NDP) — Minimum concrete cover $c_{min,dur}$ to stainless steel reinforcement

Exposure Class	Exposure resistance class ERC	Stainless steel resistance class[a]			
		SSRC1	SSRC2	SSRC3	SSRC4
XC1	≤ XRC9	0	0	0	0
XC2		0	0	0	0
XC3	≤ XRC5	0	0	0	0
	≤ XRC9	15	0	0	0
XC4	≤ XRC5	15	0	0	0
	≤ XRC9	20	0	0	0
XD1, XS1	≤ XRDS1,5	20	15	0	0
	≤ XRDS3,5	30	20	15	0
	≤ XRDS5,5	35	25	20	0
XD2, XD3, XS2, XS3	≤ XRDS1,5	35	25	20	0
	≤ XRDS3,5	45	35	25	15
	≤ XRDS5,5	55	45	35	25

NOTE 1 The tabulated cover values apply for a design service life of 50 years unless a National Annex excludes some classes or gives other values.

NOTE 2 For a design service life of 100 years $c_{min,dur}$ in Table Q.3(NDP) should be increased by +10 mm for all ERC classes unless a National Annex excludes some classes or gives other values.

NOTE 3 In case of combined action of carbonation and chloride induced corrosion, $c_{min,dur}$ in Table Q.3(NDP) should be increased by 20 mm or a higher stainless steel resistance class should be chosen unless a National Annex gives other values.

[a] For stainless steel corrosion resistance classes see Table Q.2.

THREE (INDEPENDENT) ROUTES FOR VERIFICATION OF DURABILITY (to use the cover depths)

ACTUAL EN206
XC/XS/XD

FUTURE ANNEX F
EN206
XRC/XRS/XRD

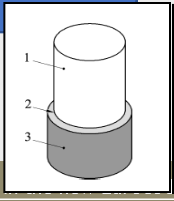
?

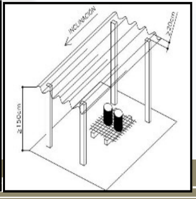
?

ANNEX P

CONCRETE
COMPOSITION

TESTING





DEFINITION of ERC EN-206-100

Testing at short term ⟷ Performance at 50/100 years

DESIGN → Fabrication TEST → Service life → 50 or 100 years

- NOTE 1: The designation of classes for resistance against corrosion induced by **carbonation (XRC)** is derived from the carbonation depth in mm (**characteristic value 90 % fractile**) assumed to be obtained after **50 years** under **reference conditions** (**400 ppm CO2 in a constant 65 % RH environment and at 20°**C). XRC has the **dimension of a carbonation rate (mm / sqrt(years)).**

- NOTE 2: The designation of classes for resistance against corrosion induced by **chloride ingress (XRDS)** is derived from the depth of chlorides penetration in mm (**characteristic value 90 % fractile),** corresponding to a reference chlorides concentration (**0.6 % by mass of cement + type II additions**), assumed to be obtained after **50 years** on a concrete exposed to one-sided penetration of **reference seawater (30 g/l NaCl) at 20°**C. XRDS has the dimension of a diffusion coefficient (10-13 m²/s).

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Table 6.3(NDP) — Minimum concrete cover $c_{min,dur}$ for carbon steel — Carbonation

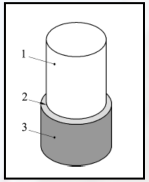
ERC	Exposure class (carbonation)							
	XC1		XC2		XC3		XC4	
	Design service life (years)							
	50	100	50	100	50	100	50	100
XRC 0,5	10	10	10	10	10	10	10	10
XRC 1	10	10	10	10	10	15	10	15
XRC 2	10	15	10	15	15	25	15	25
XRC 3	10	15	15	20	20	30	20	30
XRC 4	10	20	15	25	25	35	25	40
XRC 5	15	25	20	30	25	45	30	45
XRC 6	15	25	25	35	35	55	40	55
XRC 7	15	30	25	40	40	60	45	60

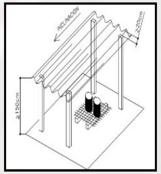
NOTE 1 The designation of XRC classes for resistance against corrosion induced by carbonation is derived from the carbonation depth [mm] (characteristic value 90 % fractile) assumed to be obtained after 50 years under reference conditions (400 ppm CO_2 in a constant 65 %-*RH* environment and at 20 °C). XRC has the dimension of a carbonation rate [mm/$\sqrt{}$(years)].

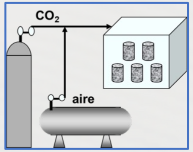
NOTE 2 The recommended minimum concrete cover values $c_{min,dur}$ assume execution and curing according to EN 13670 with at least Execution Class 2 and Curing Class 2.

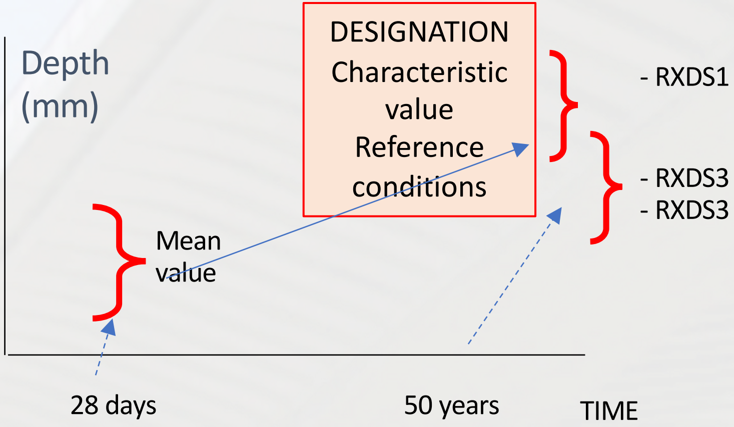
NOTE 3 The minimum covers can be increased by an additional safety element $\Delta c_{dur,\gamma}$ considering special requirements (e.g. more extreme environmental conditions).

VERIFICATION BY TESTING STARTING FROM THE ITT
the mean value is extrapolated to fulfil the cover depth (90%)



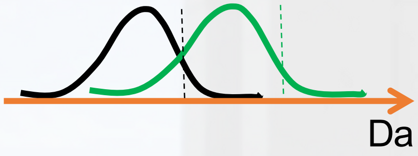






- **From reference conditions to each XC**

The test will be in standard conditions



7 % (Beta= 1.5) probability of failure

VERIFICATION BY COMPOSITION with annex F of EN 206

(Annex P of EC2)

	EXPOSURE CLASSES										
	No risk	Carbonation induced corrosion				Chloride induced corrosion					
						Sea water			Chloride other tan from sea water		
	X0	XC1	XC2	XC3	XC4	XS1	XS2	XS3	XD1	XD2	XD3
a/c	-	0.65	0.60	0.55	0.50	0.50	0.45	0.45	0.55	0.55	0.45
strength	C12/ 15	C20/ 25	C25/ 30	C30/ 37	C30/ 37	C30/ 37	C35/ 45	C35/ 45	C30/ 37	C30/ 37	C35/ 45
cement	-	260	280	280	300	300	320	340	300	320	340
Cover depth S4(mm)	10	15	25	25	30	35	40	45	35	40	45

Design step	Variant 1: New design concept with ERC	Variant 2: Current design concept without ERC
Exposure classes **XC, XD, XS, XF, XA, XM** related to environmental conditions	6.3 Environmental exposure conditions 6.3.3, Table 6.1 : Exposure classes **X**	
Exposure resistance classes **XCR, XRDS, XRF** related to concrete resistance against corrosion or abrasion attacks	6.4 Exposure Resistance Classes (**ERC**)	–
Minimum concrete strength	Depending on **new** concrete mixes in EN 206 or NAD, **new** Annex F	Depending on **current** concrete mixes in EN 206 or NAD, Annex F; P.3 Indicative strength classes for durability
Minimum cover c_{min}	6.5.2.1 General: $c_{min} = \max\{c_{min,dur} - \Delta c_{dur,red} + \Delta c_{dur,abr}; c_{min,b}; 10\text{ mm}\}$	
Minimum cover $c_{min,dur}$ for durability	$c_{min,dur}$ depending on : – XC, XD, XS and – **Exposure Resistance Class** XRC, XRDS and – design service life 50 y or 100 y 6.5.2.2 Minimum cover for durability – carbon and prestressing steel Q.2 Minimum cover for durability – stainless steel	$c_{min,dur}$ depending on : – XC, XD, XS and – **Structural class S** and – design service life 50 y or 100 y P.2 Minimum cover for durability – carbon, stainless and prestressing steel
Minimum cover $c_{min,b}$ for bond	6.5.2.3 Minimum cover for bond	
Allowance in design for deviation Δc_{dev}	6.5.3 Allowance in design for deviation, Table 6.7(NDP)	
Nominal cover c_{nom}	6.5.1 Nominal cover: $c_{nom} = c_{min} + \Delta c_{dev}$	
Description of concrete durability (examples):	**C35/45, XRC2, XRDS4, XRF, XA2, XM1….** c_{min} = 50 mm c_{nom} **= 60 mm**	**C35/45, XC4, XD3, XF2, XA2, XM1….** c_{min} = 50 mm c_{nom} **= 60 mm**

ANNEX I Assessment Existing Structures

Limited to non deteriorated with some comments on deteriorated structures

Annex I
(informative)

Assessment of Existing Structures

I.1 Use of this annex

(1) This informative annex supplements provisions in this Eurocode for the assessment of existing structures in plain, reinforced and prestressed concrete. Annex I covers also the assessment of the retained parts of existing concrete structures, that are being modified, extended, strengthened or retrofitted, in case of projects where new structural members are to be combined with retained parts of existing concrete structures.

I.2 Scope and field of application

(2) This informative annex covers:

— additional rules for materials and system not defined in Clause 5 (e.g. plain bars);

— additional rules for assessing existing structures where detailing does not comply

— with the provisions in Clauses 11 and 12;

— additional rules for anchorage of plain bars;

— considerations for deterioration of existing structures.

I.3 General

NOTE Unless noted otherwise, in Annex I all section/sub-section numbers and titles are similar as the relevant of the main part of this Eurocode. The prefix 'I' is added to clauses numbers to distinguish content that pertain to assessment of existing concrete structures. Annex I contains only sections/subsections of the main part of this Eurocode that include specific clauses for the assessment of existing concrete structures.

(1) All clauses of this Eurocode are generally applicable to the assessment of existing concrete structures, unless substituted by the provisions given in Annex I.

(2) Annex I does not provide predictive methods for estimating deterioration rates associated with the various deterioration mechanisms for concrete structures. These should be undertaken using methods specified by the relevant authority or, where not specified, as agreed for a specific assessment by the relevant parties.

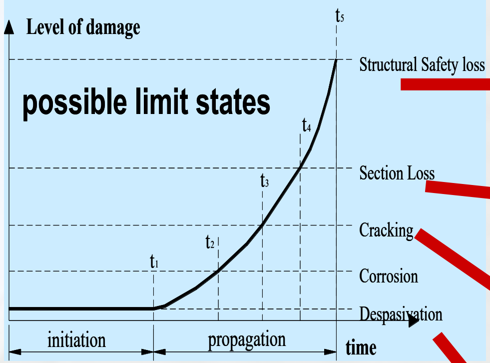
(3) Design values determined in accordance with this Eurocode may be interpreted as assessment values for the purpose of Annex I.

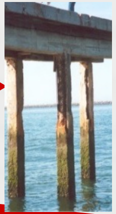
(4) The following assumptions apply for the assessment of existing concrete structures:

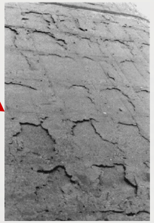
— Reasonable skill and care appropriate to the circumstances is exercised in the assessment, based on the knowledge and good practice generally available at the time the structure is assessed.

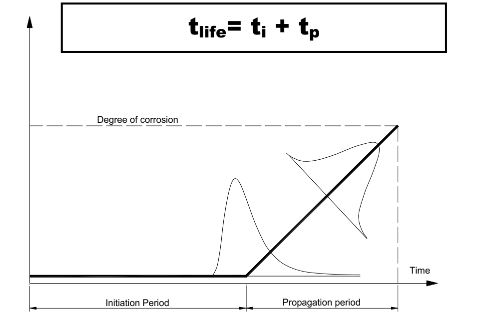
— The assessment of the structure is made by appropriately qualified and experienced personnel.

NEW LIMIT STATE (the same in MC2020)



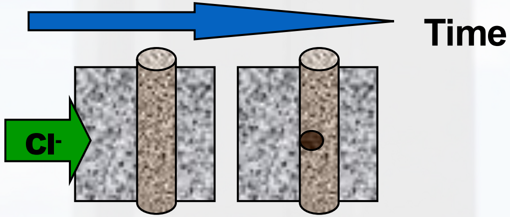






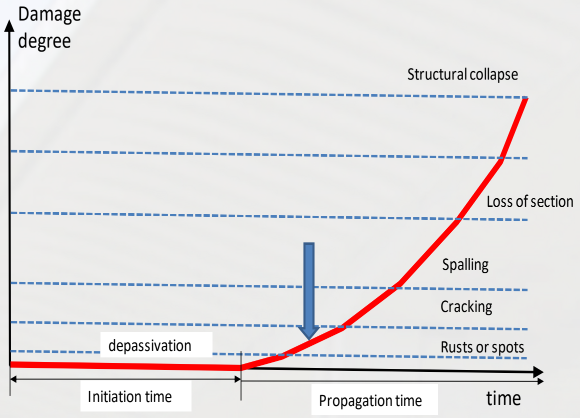
The reason is that in practice the depassivation onset **CANNOT BE VERIFIED** unless permanente sensors are used

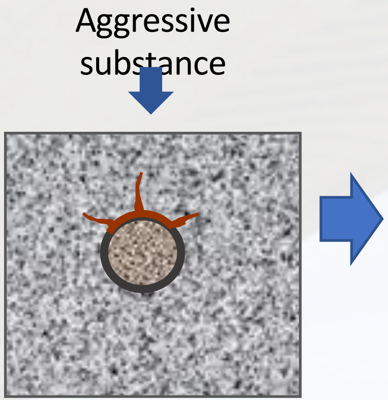
CEN does not accept requirements that are not verifiable

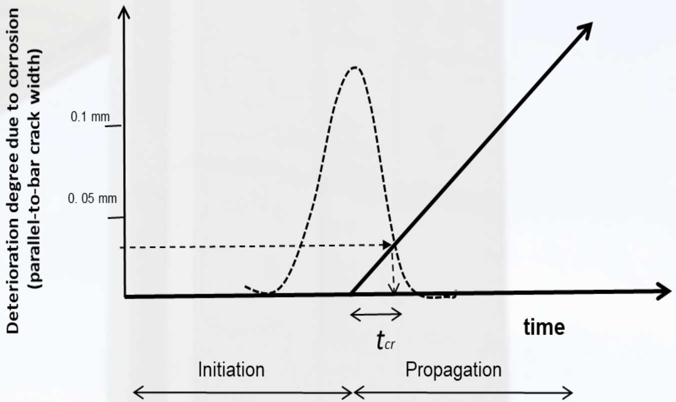


END OF SERVICE LIFE

Corrosion propagation is part of the service life until a corrosion depth of 50 µm (general corrosion) or 500 µm (localized corrosion with a probability of failure of 7-8% (β= 1.5)





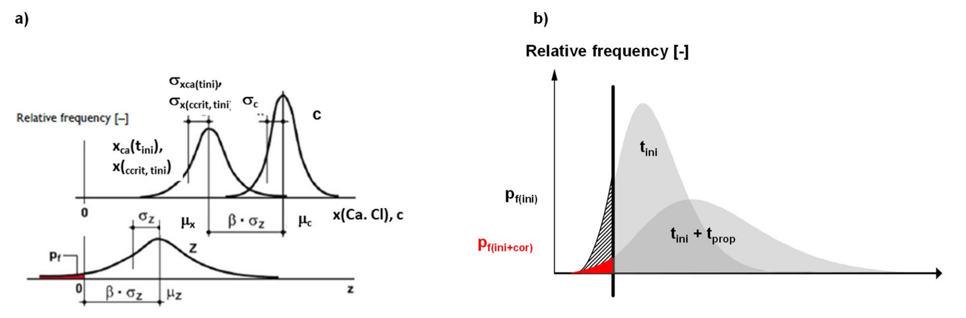


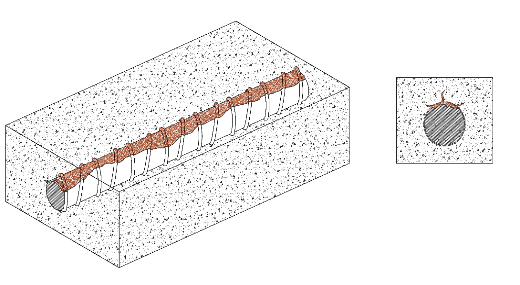
BACKGROUND DOCUMENT EXPLAINING THE CALCULATION OF THE NEW LS AND THE COVER DEPTHS

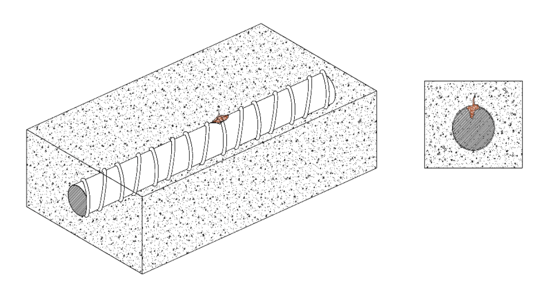
Background Document for prEN1992-1-1:2020 D7 clause 6 - Durability

List of content, updated 2021-03-04
Only main sections listed

(The author/-s of each section and the current TG10 doc N are indicated in parentheses.)







COVER CALIBRATION FOR NEW EN1992-1-1

- **Limit state definition**

$$t_L = t_i + t_p$$

  - **t_L = 50 yrs for tables**
  - **t_p = Propagation time required to achieve 50μm / 500μm under exposure**
  - **t_i = Required initiation time**
- **Modelling:**

$$X_c = \sqrt{2 \cdot k_e \cdot k_c \cdot \frac{D_{Co2}}{a}} \left(\frac{t_0}{t}\right)^w = \sqrt{\frac{2 \cdot k_e \cdot k_c}{R_{carb}}} \left(\frac{t_0}{t}\right)^w$$

$$X_c = V_{CO2} \cdot t^{\frac{(1-2w)}{2}}$$

$$V_{Co2} = \sqrt{\frac{2 \cdot k_e \cdot k_c}{R_{carb}}} (t_0)^w$$

$$t_{desp} = \left(\frac{c}{V_{CO2}}\right)^{\frac{2}{(1.-2w)}}$$

$$Conc(x,t) := C_0 + (C_s - C_0) \cdot \left(1 - erf\left(\frac{x - \Delta x}{2 \cdot \sqrt{D_{app}(t) \cdot t}}\right)\right)$$

$$D_{app}(t) = D(t_0) \cdot \left(\frac{t_0}{t}\right)^n$$

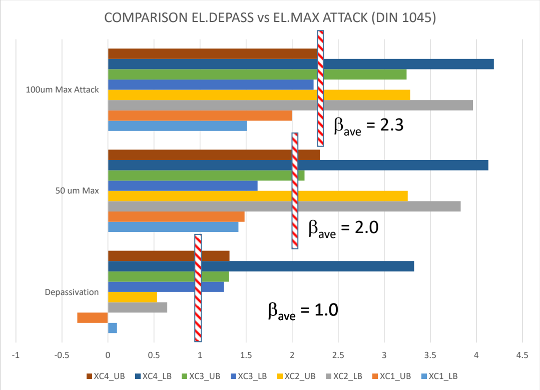
$$V(t) = erf^{-1}(1 - \xi) \left[2 \sqrt{D(t_0) \cdot (t_0)^n} \right.$$

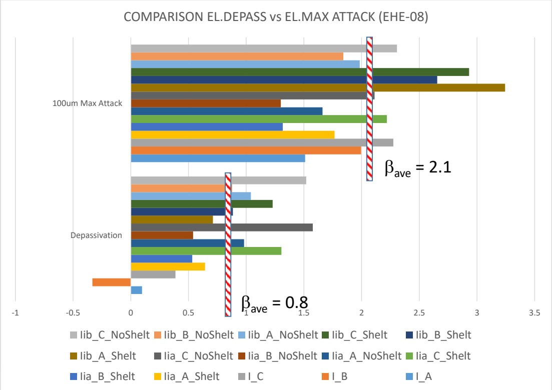
$$\xi = \frac{C_{cr} - C_0}{C_s - C_0}$$

$$t_{dep} = \left(\frac{C - \Delta x}{V_{cl}(t)}\right)^{\frac{2}{1-n}}$$

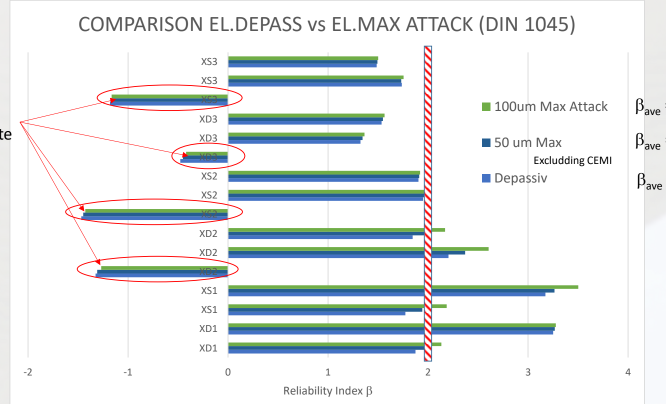
COVER CALIBRATION FOR NEW EN1992-1-1

- **Autocalibration procedure (β_t)**

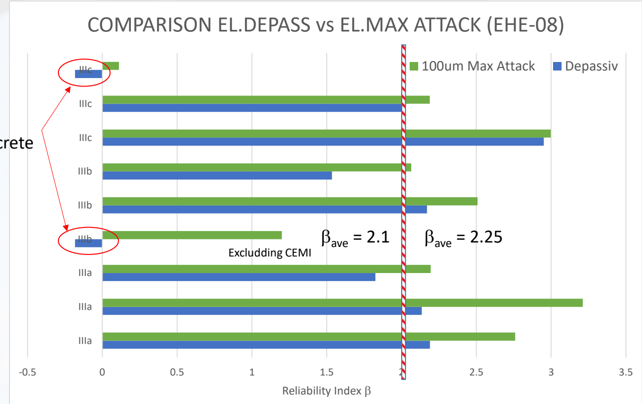




CEM I concrete



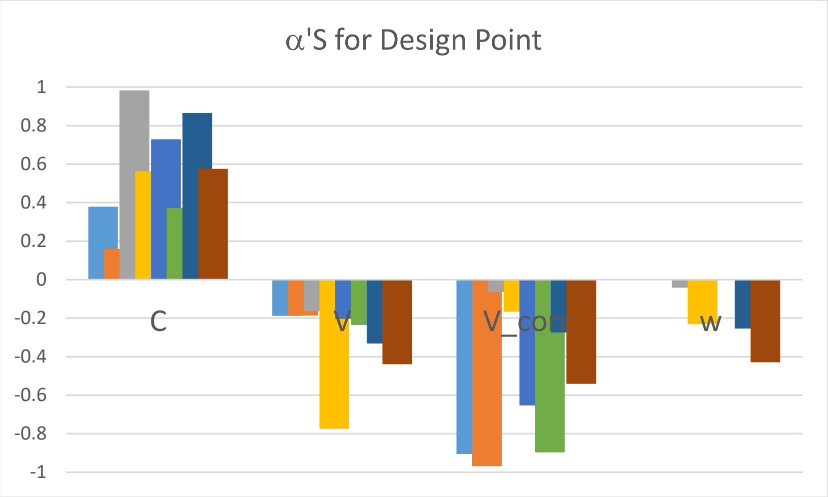
CEM I concrete



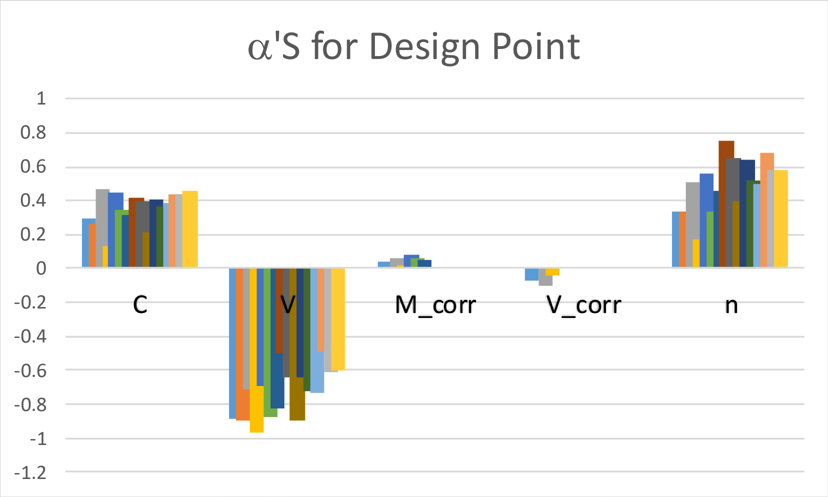
COVER CALIBRATION FOR NEW EN1992-1-1

- **Autocalibration procedure (Sensitivity factors) α_i**

Carbonation induced corrosion



Chloride induced corrosion



Note: $\alpha > 0$ "resistance" Variable
$\alpha < 0$ "action" Variable

COVER CALIBRATION FOR NEW EN1992-1-1

- **Service life propagation time uncoupling**

$$V_{corr_d} = \mu_{V_{corr}}^{-\begin{pmatrix}0.70\\0.30\end{pmatrix}\cdot\beta\cdot CoV}$$

Expossure	V_{corr} [μm/y]	CoV (%)	$V_{corr,D}$ β=1,5	Tpr[yr] β=1,5	$t_{ini,D}$ β=1,5
XC1	1	65	2.0	25	25
XC2	4	65	5.4	9	41
XC3	2	65	4.0	13	37
XC4	5	90	12.9	4	46
XS1	30	60	56.3	1	49
XS2	10	60	13.1	4	46
XS3	70	90	105.0	0	50

Only some exposure cases merit a calculation of propagation time t_p, in other cases propagation time is negligible.

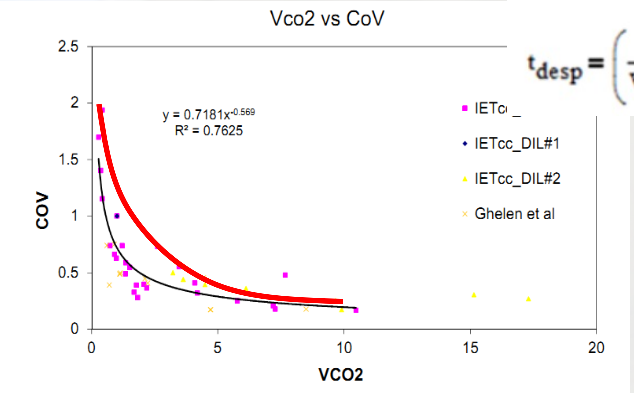
COVER CALIBRATION FOR NEW EN1992-1-1

- **Cover calculation for tables**
  - **Carbonation**

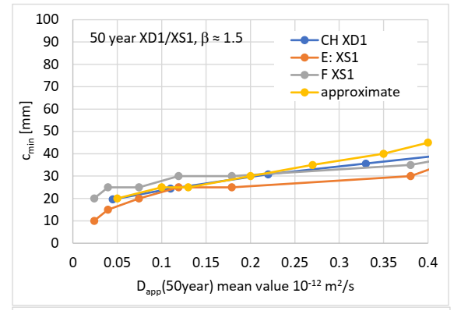
Chlorides

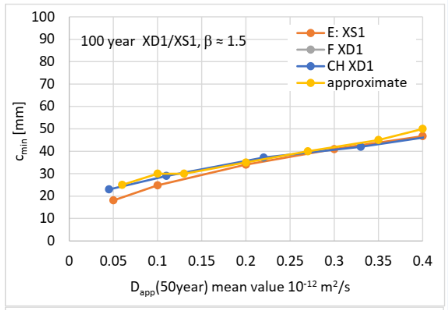
$$t_{dep} = \left(\frac{C - \Delta x}{V_{cl}(t)} \right)^{\frac{2}{1-n}}$$

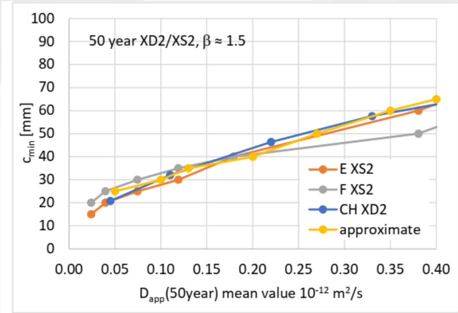
Calculated values for XC3 & XC4 are provided for RH = 75%, which may correspond to Central Europe but not for Mediterranean countries

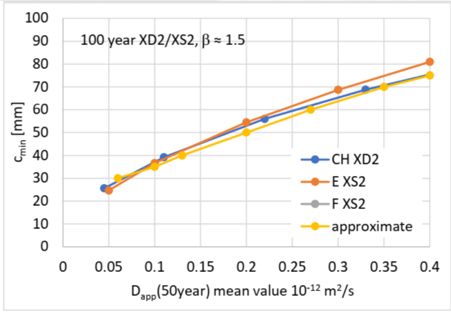


$$t_{desp} = \left(\frac{C}{V_{CO2}} \right)^{\frac{2}{(1.-2w)}}$$







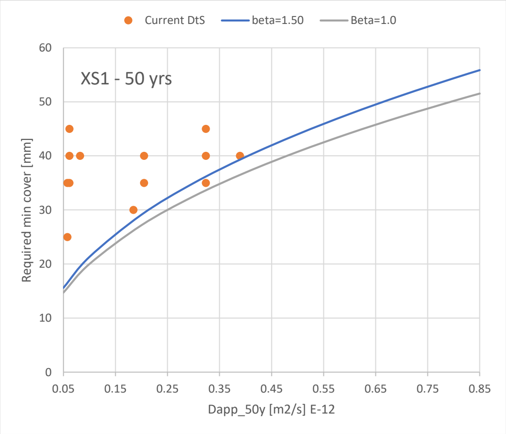


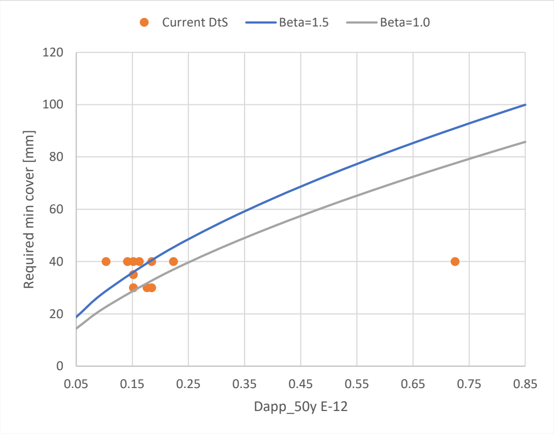
Relation average carbonation rate and 90% fractile is computed using following eq.

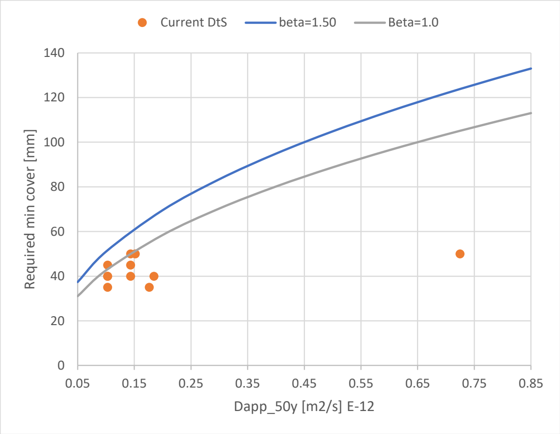
COVER CALIBRATION FOR NEW EN1992-1-1

- Cover calculation for tables
    - Chloride induced corrosion

$$t_{dep} = \left(\frac{C - \Delta x}{V_{cl}(t)}\right)^{\frac{2}{1-n}}$$







With current proposal, durable concrete should not be achieved using CEMI cement in XS/XD2 & XS/XD3

COVER CALIBRATION FOR NEW EN1992-1-1

- Minimum cover provided tables
  - Provided as NDP
  - Calibrated for 50 and 100 yrs, including 50μm/ 500μm rebar corrosion
  - Calibrated for HR = 75% (XC3/XC4), values for Mediterranean Countries may differ
  - a priori deviations for the 90% fractile calculations
  - Additional allowance for different construction tolerances (NDP)

Thank you for your attention

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