Chloride Ingress to Rebar: Corrosion Initiation Time

Time for chlorides to reach the corrosion threshold at the rebar from cover depth, surface chloride and apparent diffusion coefficient by Fick's second law.

Method: Fick's second law for chloride ingress (initiation period)

Input parameters

Unit system: SI

Parameter	Value	Unit
Concrete cover	50.000	mm
Apparent chloride diffusion coefficient	31.558	mm²/a
Surface chloride (by mass of binder)	3.0000	%
Initial chloride	0.10000	%
Critical (threshold) chloride	0.40000	%
Service life to check	50.000	a

Calculated results

Parameter	Value	Unit
Corrosion initiation time	14.938	a
Chloride at the rebar at the service life	1.1830	%
Cover needed to reach the service life	91.475	mm

Notes for this case

• C(x,t) = C_i + (C_s − C_i)[1 − erf(x/2√(D_at))] (Fick's second law, constant D_a and C_s). Initiation when C reaches the threshold at the bar: t_i = x²/(4D_az²), erf z = 1 − (C_crit − C_i)/(C_s − C_i). Doubling cover quadruples initiation time. Real D_a falls with age (fly ash and slag concrete especially), so constant-D results are conservative for good mixes; propagation time after initiation is extra.

Formula and method

$$C(x,t) = C_i + (C_s - C_i)\left[1 - \operatorname{erf}\frac{x}{2\sqrt{D_a t}}\right], \quad t_i = \frac{x^2}{4 D_a z^2}$$

Variables

x	Concrete cover	m
D_a	Apparent chloride diffusion coefficient	m²/s
C_s	Surface chloride (by mass of binder)	-
C_i	Initial chloride	-
C_{crit}	Critical (threshold) chloride	-
t_s	Service life to check	s
t_i	Corrosion initiation time	s
$C(x,t_s)$	Chloride at the rebar at the service life	-
x_{min}	Cover needed to reach the service life	m

Method and standards

Chloride ingress.

Assumptions and limits

- Constant D_a and surface chloride; one-dimensional diffusion; uncracked concrete.

References

Fick's second law for chloride ingress (initiation period)

Report details

Report reference	FCC-S8ST-5TJZ (the same inputs always give the same reference)
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Release checks	3 reference cases of this calculator, computed independently, are checked on every release

Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

This calculator online

https://calc.firecad.com/materials/corrosion/chloride-ingress-rebar-corrosion

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.