Monotonic Flexural Testing of Corroded Reinforced Concrete Beams Database

User's Manual

(Version 1.0.0)

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1. DATABASE KEY

Table 1 summarizes all parameter descriptions, nomenclature, abbreviations, formulations, and relevant resources used to derive the variables in the accompanying database. Only those parameters requiring assumptions/calculation are reported here.

Table 1. Database input parameter descriptions.

Input Parameter	Description
Cross-Section	• *S* = Square cross-section. • *R* = Rectangular cross-section.
Test Type and Configuration	Test type is defined by the specific setup reported by the study: • *SS* = Simply Supported. • *CONT* = Continuous beam. • *FPB* = Four-point bending. • *TPB* = Three-point bending. • *MONO* = Monotonic loading. • *SUST* = Sustained loading (added to all decommissioned members). • *PREC* = Precracked.
Sustained Loading	Load is being sustained during corrosion exposure. Measured experimentally as percent ultimate load (uncorroded). Naturally corroded, decommissioned specimens that do not report service life design load are assumed to be 30 % (conservative lower-bound).
Test Length	Simply supported span length.
Reinforcement Design	Categorizes the longitudinal reinforcement layout of the beam specimen: • *T_C* = Tension-Compression layers • *ST* = Single tension layer. • *UT_C* = U-shaped tension-compression layers (no compression in midspan). • *T_M_C* = Tension-Mid-Compression layers.

Table 1. (cont.)

Input Parameter	Description
Longitudinal Bar Type	• *D* = Deformed (ribbed). • *P* = Plain (smooth). If no type is reported, the bar is assumed to be deformed.
Tension Bar End Anchorage	The end anchorage condition of the primary tension reinforcement (typically interpreted from supplied drawings): • *S* = Straight. • *H_90* = Hooked with a 90-degree bend. • *H_180* = Hooked with a 180-degree bend.
Lsplice (mm)	Lap spliced length for tensile reinforcement in mm. • *0* = No splice.
f_y Tensile Bars (MPa)	Yield stress of corroded tensile bars estimated using the empirical model developed by the authors using the database available at DOI: 10.5281/zenodo.8035720. $f_{y,c} = \begin{cases} (1.0 - 0.0183\eta_m)f_{y0}, & 0 < \eta_m < 27.5\ \%\ (\boldsymbol{A}) \\ (1.0 - 0.0101\eta_m)f_{y0}, & 0 < \eta_m < 27.5\ \%\ (\boldsymbol{N}) \\ (0.82 - 0.0086\eta_m)f_{y0}, & \eta_m \geq 27.5\ \%\ (\boldsymbol{C}) \end{cases}$ Where η_m is the average mass loss percentage, $f_{y,0}$ is the uncorroded yield capacity, (A) designates artificial corrosion, (N) natural corrosion, and (C) combined artificial and natural.
f_{su} Tensile Bars (MPa)	Ultimate tensile stress of corroded tensile bars estimated using the empirical model developed by the authors using the database available at DOI: 10.5281/zenodo.8035720. $f_{su,c} = \begin{cases} (1.0 - 0.0160\eta_m)f_{su0}, & 0 < \eta_m < 27.5\ \%\ (\boldsymbol{A}) \\ (1.0 - 0.0108\eta_m)f_{su0}, & 0 < \eta_m < 27.5\ \%\ (\boldsymbol{N}) \\ (0.86 - 0.0095\eta_m)f_{su0}, & \eta_m \geq 27.5\ \%\ (\boldsymbol{C}) \end{cases}$ Where η_m is the average mass loss percentage, $f_{su,0}$ is the uncorroded tensile capacity, (A) designates artificial corrosion, (N) natural corrosion, and (C) combined artificial and natural.

Table 1. (cont.)

Input Parameter	Description
Stirrup Bar Type	• D = Deformed • P = Plain (smooth) • W = Wire If no type is reported, stirrups are assumed to be plain.
Stirrup Spacing	Stirrup spacing in bending zone.
f_y Stirrups (MPa)	If no direct measurement of stirrup mass loss is provided, uncorroded characteristic strength is reported for all specimens. If the stirrup mass loss is reported, because of the straight profile of double-leg closed stirrups, the above $f_{y,c}$ relationship is assumed.
Cement Type	• *OPC* = Ordinary Portland Cement. • *OPC_HP* = OPC High Performance. • *PCT2* = Portland Cement Type II. • *PCT3* = Portland Cement Type III. • *UHTCC* = Ultra High Toughness Cementitious Composite. • *PCB40* = Portland Cement Blended 40. If no cement is specified, OPC is assumed.
Water/Cement Ratio	If not reported, the w/c ratio is estimated from the concrete compressive strength using Bolomey's formula (Li et al., 2020). Coefficients are determined for normal concrete with ordinary Portland cement. $$\frac{w}{c} = \frac{b_1}{f_c' + b_2}$$ $$b_1 = 33; \quad b_2 = 33$$
Compressive Strength Test Method	If no test method is specified, cylindrical compressive strength is assumed. Eurocode 2 (2004) and Lu et al. (2020) proposes conversions for concrete compressive strengths between cube and cylinder tests (not considered in this database).

Table 1. (cont.)

Input Parameter	Description
Corrosion Method	• *C* = Control (uncorroded). • *IC* = Impressed-current (artificially accelerated corrosion). • *EI* = Environmentally induced (typically salt spray or fog). • *N* = Natural (real structures).
Corrosion Zone Length, L_c (mm)	Parameter measuring partial or full corrosion from the experimental setup. All environmentally-induced or natural corrosion methods are assumed to have full-length corrosion.
Corrosion Current Density (μA/cm^2)	For environmentally induced or natural corrosion methods, the current density is estimated using Yu et al. (2015) based on reported average mass loss and age. $$i_{corr} = \frac{d_0(1-\sqrt{1-\eta_m})}{0.0230 * t}$$ Where t is the corrosion duration in years, η_m is the reported average mass loss (%), and d_0 is the initial nominal bar diameter. If not reported, estimated by back calculating from Faraday's Law.
Exposure Duration (days)	Duration of exposure to corrosive conditions. For naturally corroded members, the duration is taken as the reported member age.
Solution Concentration (% NaCl)	If not reported, assumed to be a standard saltwater concentration of 3.5 % NaCl. Naturally corroded specimens are assumed to be exposed to a standard saltwater concentration of 3.5 % NaCl. No consideration is made to NaCl added as part of the concrete mixture water content.
Immersion Depth (mm)	Accelerated corrosion parameter measuring the depth of immersion in NaCl solution. This will affect the rate and directionality of chloride diffusion and rebar deterioration. If a test setup only wets one surface of the member, immersion depth = 1 mm. No capillary action is considered. Environmentally induced and naturally corroded specimens are given full-depth immersions, representing full section exposure to chloride accumulation and diffusion.

Table 1. (cont.)

Input Parameter	Description
Wet/Dry Ratio (Days)	All specimens denoted N/A are assumed to be corroded under constant saturation conditions. All naturally corroded specimens are given a standard 1:1 ratio for chloride accumulation. All control specimens denoted N/A.
Average Mass Loss, η_m (%)	If the cross-sectional loss is reported, the value is converted to mass (m) through the physical relationship: $$m = V * \rho_{steel}$$ $$\eta_m = 1 - (1 - \eta_D)^2$$ Where V is the steel volume, ρ_{Fe} is the density of iron, and η_D is the reported cross-section loss.
Average Sample Length (mm)	If no sample length provided, it is assumed that the entire length of bar was extracted and reported.
Corrosion Penetration Depth, X_{aver} (mm)	Estimated using the relationship proposed by Torres-Acosta et al. (2004). $$X_{aver} = \frac{\Delta w_G * 10^3}{\rho_{Fe} * \pi * \varphi_0 * L_c}$$ $$X_{aver} = \frac{\eta_m * \varphi_0}{4}$$ Where Δw_G is the change in mass (g).
M_{ACI} (kNm)	Estimated theoretical design capacity of beams in uncorroded state, using ACI 318-19 ordinary strain compatibility analysis.
Elastic Stiffness, k (kN/mm)	$$k = \frac{P_y}{\Delta_y}$$
Displacement Ductility, μ_Δ	$$\mu_\Delta = \frac{\Delta_{ult}}{\Delta_y}$$

Failure Mode	Brittle failure designated at early rupture of the tensile reinforcement, causing a sharp decline in load-bearing capacity.

REFERENCES

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