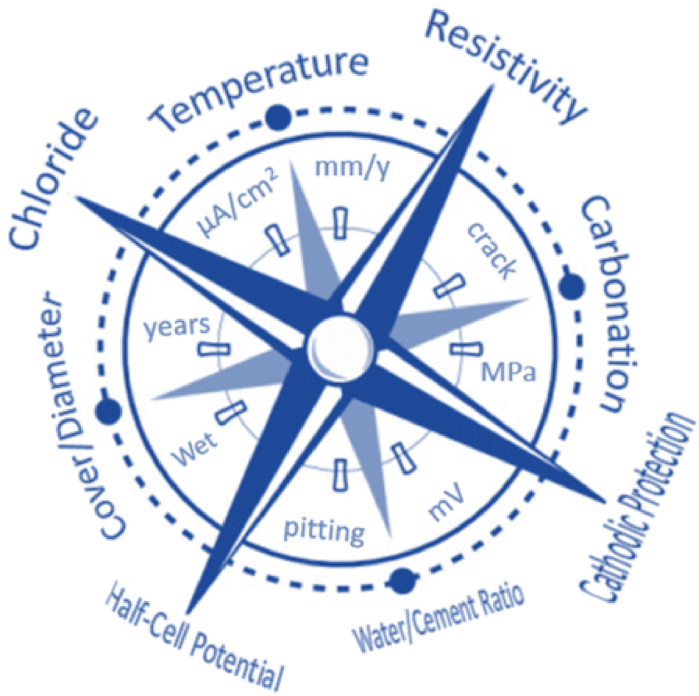

Corrosion Modeling Software and Corrosion Prediction Software

CP-Compass-Concrete®: Design Calculation for Cathodic Protection of Reinforced Concrete Structure

The Ultimate Software Solutions to Costly Concrete Corrosion

Version 9.21

☆ **Performance** ☆ **Functionality** ☆ **Usability**

Anytime	Anywhere	Any Device	Any OS
No USB dongles	No installation	No Browser Plug-ins	

Overview of CP-Compass-Concrete - Design Calculation for Cathodic Protection of Reinforced Concrete Structures

CP-Compass-Concrete is the only device and OS independent software tool on the market for design calculation for cathodic protection of reinforced concrete structures. Designers, architects, engineers, consultants, operation personnel, maintenance and inspection engineers can quickly determine the cathodic protection current requirement based on the current condition of the RC structure (Figure 1 below), anytime, anywhere, on any device running any OS without the need to install or download anything. CP-Compass-Concrete also predicts the effectiveness of cathodic protection and the minimum cathodic protection polarization required to reduce the corrosion rate to a level that can meet the design life of the RC structure.

Impressed current cathodic protection (ICCP) can be applied to reinforced concrete structures exposed to atmosphere, buried in soil, or submerged in water (Figure 1). Galvanic anode cathodic protection can be applied to the buried or submerged reinforced concrete structures (Figure 2).

Using CP-Compass-Concrete is as easy as 1-2-3.

(1) Enter the design data.

(2) Select the service environment.

(3) Review the design calculation results.

Figures below show the screen shots of CP-Compass-Concrete.

Galvanic Anode CP | ICCP

Design Calculation for Impressed Current Cathodic Protection of Reinforced Concrete Structures

Structure Location/ID	Building ABC at XYZ					28-Mar-2015
Design life	years	50		Rebar diameter	mm	20.000
Age of structure	years	15.000		Concrete cover thickness	mm	35.000
Code allowable maximum crack width	mm	0.300		Water cement ratio	w/c	0.500
Concrete compressive strength	MPa	40.000		Temperature of concrete	°C	10.00
Concrete tensile splitting strength	MPa	4.000		Concrete electrical resistivity	Ω.cm	20,000
Exposure Environment	Atmospheric exposure					

Service environment for assessment of carbonation if applicable (select from options A to D)		N/A
Dry or permanently wet	Concrete inside buildings with low air humidity; Concrete permanently submerged in water	A
Wet, rarely dry	Concrete surfaces subject to long-term water contact; Many foundations	B
Moderate humidity	Concrete inside buildings with moderate or high air humidity; External concrete sheltered from rain	C
Cyclic wet and dry	Concrete surfaces subject to water contact	D
Service environment for assessment of chloride-induced corrosion if applicable (select from options A to F)		D
Moderate humidity	Concrete surfaces exposed to airborne chlorides	A
Wet, rarely dry	Swimming pools; Concrete exposed to industrial waters containing chlorides	B
Cyclic wet and dry	Parts of bridges exposed to spray containing chlorides. Pavements, Car park slabs	C
Exposed to airborne salt but not in direct contact with sea water	Structures near to or on the coast	D
Permanently submerged in seawater	Parts of marine structures	E
Tidal, splash and spray zones	Parts of marine structures	F

Cathodic Protection Design

Design current density, mA/m2	BS EN ISO 12696		Min. CP polarization required to meet design life	mV	60.51
Steel to concrete surface area ratio		1.700	Protection criteria by polarization in this design	mV	100.00
Concrete surface area (one zone)	m2	500.000	Predicted corrosion reduction factor by CP	Vcorr/Vcp	60
Protection current required (one Zone)	A	8.500	Predicted corrosion rate under CP, Vcp	mm/y	0.0003
Resistance of anode conductors/cables/others	Ω	0.400	Remarks		
Total circuit resistance (one Zone)	Ω	0.828			
Rectifier Output Rating	Safety Factor, %	50			
Rectifier voltage 11 V	Current	9 A			

Remarks: Prestressing steel may be sensitive to hydrogen embrittlement and, due to the high tensile loading, failure can be catastrophic. It is essential that caution is exercised in any application of cathodic protection to prestressed elements. The steel/concrete potential should be kept below the potential limit of −900 mV vs. Ag/AgCl/0.5 M KCl (BS EN ISO 12696)

Anode Selection and Installation

Anode system meeting the design life should be selected and installed to provide a uniform current distribution to the rebar network.

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Figure 1 Concrete-Compass Predicts the rate of Concrete corrosion and the remaining life of RC structures.

Galvanic Anode CP | ICCP

Design Calculation for Galvanic Anode Cathodic Protection of Buried or Immersed Concrete Structures

Client:	Enter client info		PO#201706
Project:	Enter project title for reference		28-Mar-2015
Design Life, yrs	20	Anode Material	Zn
Exposure environemnt	Buried in soil	Anode Potential	-1.10 V(CSE)
Rebar diameter, mm	20.00	Driving Voltage	0.250 V
Concrete cover thickness, mm	35.00	Anode Length (packaged), mm	1,549
Concrete surface area (one Zone), m2	300.000	Anode Diameter (packaged), mm	152
Steel to concrete surface area ratio	1.700	Anode Weight (Bare), kg	14.500
Soil resistivity, Ω.cm	1,500	Anode Consumption Rate, kg/A-y	10.76
Design Current Density, mA/m2	3.0	Current Efficiency	0.90
Protection Potential, V(CSE)	-0.850	Utilization Factor	0.85
CP Current and Anode Weight Requirements			
CP Current Required	1.530 A	Total Anode Weight Required	430 kg
		Number of Anode by Weight	29.7
Anode Current Output		Vertical Installation	
Anode to Earth Resistance	5.242 Ω	Single Anode Current Output	47.696 mA
Anode Burial Depth	200 cm	Number of Anodes by Current	32.1
Number of Anodes Selected	32	Anode Life Calculation	**22 yrs**

The number of anodes selected meets the design life requirement.

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Figure 2 CP-Compass-Concrete Design calculation for galvanic anode cathodic protection of reinforced concrete structures.

CP-Compass-Concrete complies with applicable international standards and relevant industry best practices such as BS EN ISO 12696, NACE SP 0290, NACE SP 0187, and AS 2832-5. Users of CP-Compass-Concrete simply select the applicable standard from the dropdown list (Figure 3) and the software modeling engine will determine the optimized design current density based on the assessment of the current condition of the RC structure including the age, design parameters, exposure environment, service environment, and the remaining life. The software is also flexible, giving users the option to override the standards and specify the design current density (Figure 4).

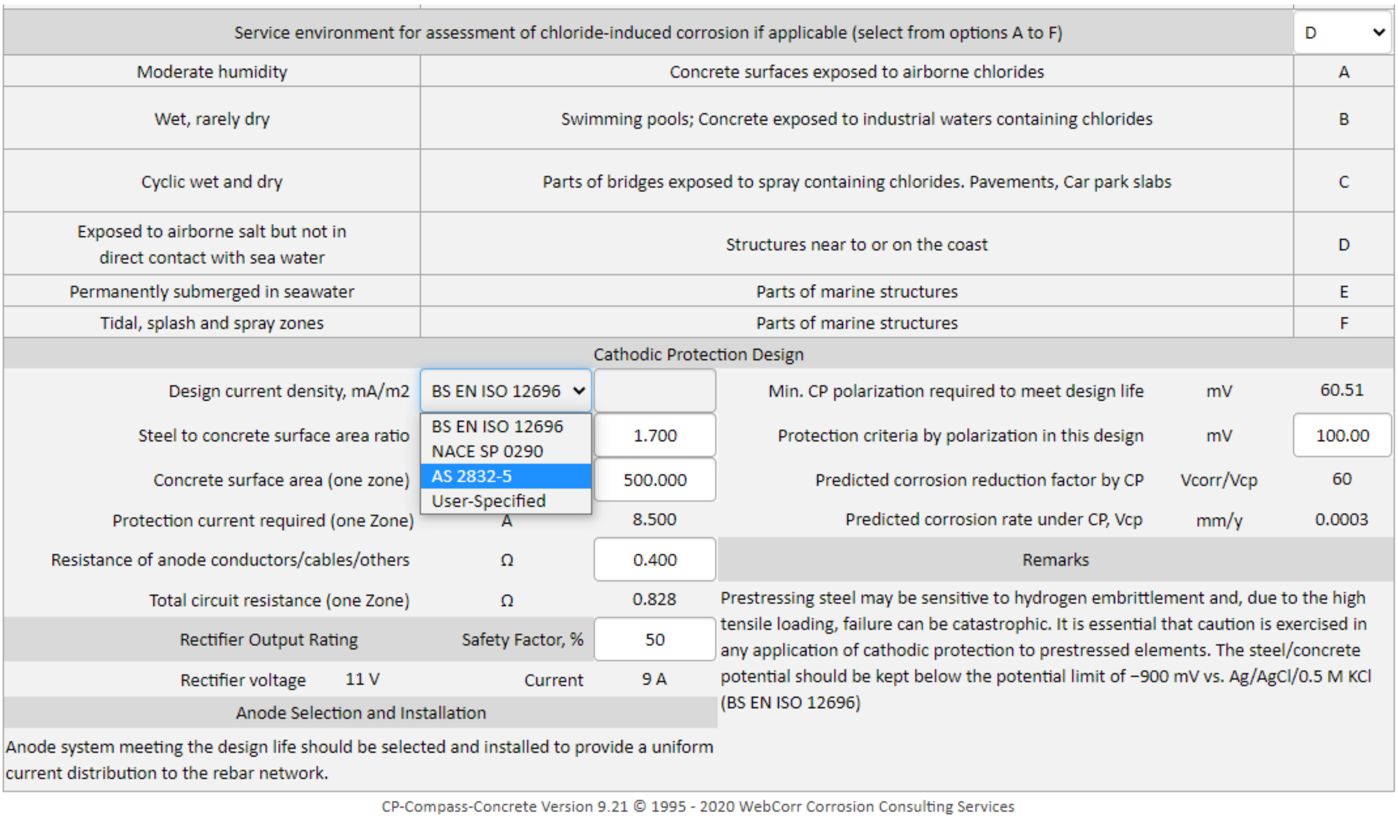

Figure 3 CP-Compass-Concrete complies with international standards for cathodic protection of reinforced concrete structures.

Service environment for assessment of chloride-induced corrosion if applicable (select from options A to F)		D
Moderate humidity	Concrete surfaces exposed to airborne chlorides	A
Wet, rarely dry	Swimming pools; Concrete exposed to industrial waters containing chlorides	B
Cyclic wet and dry	Parts of bridges exposed to spray containing chlorides. Pavements, Car park slabs	C
Exposed to airborne salt but not in direct contact with sea water	Structures near to or on the coast	D
Permanently submerged in seawater	Parts of marine structures	E
Tidal, splash and spray zones	Parts of marine structures	F

Cathodic Protection Design

Design current density, mA/m2	User-Specified	10.000	Min. CP polarization required to meet design life	mV	60.51
Steel to concrete surface area ratio		1.700	Protection criteria by polarization in this design	mV	100.00
Concrete surface area (one zone)	m2	500.000	Predicted corrosion reduction factor by CP	Vcorr/Vcp	60
Protection current required (one Zone)	A	8.500	Predicted corrosion rate under CP, Vcp	mm/y	0.0003
Resistance of anode conductors/cables/others	Ω	0.400	Remarks		
Total circuit resistance (one Zone)	Ω	0.828	Prestressing steel may be sensitive to hydrogen embrittlement and, due to the high tensile loading, failure can be catastrophic.		
Rectifier Output Rating	Safety Factor, %	50			
Rectifier voltage 11 V	Current	9 A			

Anode Selection and Installation

Anode system meeting the design life should be selected and installed to provide a uniform current distribution to the rebar network.

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Figure 4 CP-Compass-Concrete gives users the option to override the standards and specify the design current density.

The predictive engine in CP-Compass-Concrete also assesses the existing condition of the concrete structure and determines the minimum CP polarization required to meet the design or remaining life of the RC structure. As shown in Figures 1 & 4 above, for the 15-year old RC structure, the minimum CP polarization required to meet the design life of 50 years (or the remaining life of 35 years) is 60.51 mV. The protection criteria by design is 100 mV. The corrosion reduction factor at the 100 mV CP polarization is 60 and the corrosion rate of the reinforcement under cathodic protection is 0.0003 mm/y (0.3 um/y). Cautionary remarks pertaining to hydrogen embrittlement of prestressing steels are also provided.

The powerful applications of CP-Compass-Concrete are truly unlimited in engineering design, concrete corrosion prediction and modeling, cathodic protection design and optimization, and remaining life prediction of RC structures under the various service environments.

Click here to contact us for licensing details and experience the power of CP-Compass-Concrete.

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