APPLICABILITY OF RCPT FOR PERFORMANCE-BASED DURABILITY DESIGN OF REINFORCED CONCRETE STRUCTURES

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Concrete is an extensively used composite material in the construction industry, known for its heterogeneous nature. In the context of structural service life predictions, the durability of concrete plays a vital role, especially with the advancement of new constituent materials. Among various factors contributing to concrete deterioration, corrosion of reinforcement poses a significant challenge to durability. Chloride ingress is one of the primary factors that cause corrosion of reinforcements. Therefore, this research paper focuses mainly on the impact of chloride-induced corrosion which is the major cause of corrosion of reinforcement. There are several tests that are still available to evaluate that kind of corrosion. The Rapid Chloride Penetration Test (RCPT) serves as a quick measure of chloride ion penetration resistance, which relies on the characteristics of pore structure and pore solution. The standard RCPT (ASTM C1202) is done under certain conditions. But there are limitations and drawbacks of RCPT due to certain conditions. In that way, the significant effect of RCPT results can be evaluated by changing the voltage, cathodic solution, and time. Therefore, this study investigates the influence of the cathodic solution changing with natural seawater to represent more actual conditions. The chloride content of that seawater was 10% w/w.

The standard RCPT gave 2401 C while the modified method gave 3122 C as the charge pass. Once the RCPT procedure concludes, concrete powder samples were collected at various depths to determine the chloride profile. These obtained profiles were then subjected to nonlinear regression analysis to calculate chloride penetration depths. By applying Fick's second law to the chloride profile and penetration depth, the chloride diffusion coefficient was determined. Finally, a performance-based design approach was proposed, linking RCPT values with the Fib Model Code 2010, to predict the service life of uncracked concrete affected by corrosion. Then results were compared with the results which were obtained by a standard method for chloride diffusion coefficient**.** That standard method used for this study was RCMT (according to NT BUILD 492). Then the obtained diffusion coefficient values were 21.43 mm^2/year, 20.97 mm^2/year, and 21.02 mm^2/year for the standard RCPT, the modified method and the RCMT, respectively. The errors were 0.2% and 1.9%, for the modified method and standard RCPT when compared with RCMT result. On the other hand, the predicted service lives for standard RCPT and modified methods were 44.32 years and 42.84 years, respectively. The RCMT gave the service life as 40 years. So, the percentage in errors were 10.8% and 7.1% for standard RCPT and modified methods when compared with RCMT result. In conclusion, standard RCPT should be modified by using sea water from actual environment instead of 3% NaCI solution if the structure is contact with sea water. RCPT can be used for performance-based durability designs. However, further investigations are required to establish the correlation between RCPT values and chloride diffusion coefficient for different grades of concrete.

Keywords: Concrete Durability, Chloride Penetration, RCPT, Service Life Prediction, Modifications for RCPT

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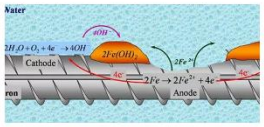
Applicability of RCPT for performance-based durability design of reinforced concrete structures

Durability of a structure



Corrosion of Reinforcement

Chloride Induced Corrosion

Performance-based durability Design (RCPT)

Experimental program

Cylinder casting

Preconditioning

Prepare samples

RCPT & RCMT

Sample drilling

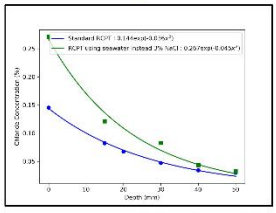
Titration

Service life prediction of RCPT Samples

RCPT → Chloride Depth(Chloride Profile)

Chloride Diffusion Coefficient

$$D_{app} = \frac{1}{\beta}\left(\frac{d - \alpha\sqrt{d}}{t}\right)$$



Chloride Profile

Service Life prediction(Fib Model code 2010)

$$C(x,t) = C_s - (C_s - C_i)\left[\mathrm{erf}\left(\frac{x}{2\sqrt{D_{app}(t)t}}\right)\right]$$

Results & Analysis

Sample Condition	Charge Passed (C)	D_{app} $(\frac{mm^2}{years})$	Variation	Service Life *Years*	Variation
Standard Method (RCMT)	-	21.02	-	40.009	-
Standard Method	2401.1	21.43	1.9%	44.32	10.8%
Sea water instead of NaCl	3121.5	20.97	0.2%	42.84	7.1%

Conclusion

- RCPT can be used for performance-based durability designs
- Standard RCPT should be modified by seawater instead of 3% NaCl