# Impressed Current Cathodic Protection to Reinforcement: A Review

Yash Srivastava[1] Ajay Radke[2] and Archanaa Dongre[3]

[1] MTech Student, Vidyavardhinis College of Engineering and Technology,Vasai,India

[2] Professor, Vidyavardhinis College of Engineering and Technology, Vasai, India

[3]Assistant Professor, Vidyavaridhinis College of Engineering and Technology, Vasai, India

**Abstract.**

The utilization of anodes for cathodic protection to treat corrosion damaged assets has advanced to the extent that a variety of choices can be considered in different cases. This study presents availability of anode innovations that can be applied in reinforced concrete structure and economic appraisals of the ICCP for different structures. The design of ICCP for specimen used in this study consists of external power supply and the establishment of electrical connection to semi or non-degrading anode. The M20 grade concrete specimens were tested after 28 days curing. The rebar used is of grade 550D steel bars. Some ICCP frameworks have been operated as both impressed current and sacrificial anode design framework. The possible corrosion risk during maintenance is attended by transforming the framework into a consumable anode framework. The initiation of possible underlying corrosion can be stopped by applying for impressed current protection. Results suggest that ICCP designed for structures in harsh environments are more economically justified. The HCP tests of the selected specimens revealed that the probability of active corrosion in non-protected cubes is much higher than the cubes protected by ICCP framework. The findings are evaluated so as to imply the practical applicability of ICCP to reinforced concrete structure.

Keywords: - Cathodic Protection, Corrosion, Impressed Current Cathodic Protection, Current Density, anodes, rectifier, magnesium.

## Introduction

Cathodic protection has been astronomically employed for guarding structures from erosion. The structure of cathodic Protection frameworks regularly depends on a mix of understanding, exploratory data. Be that as it may, issues and bummers of cathodic protection frameworks not just have a financial cost, it can also introduce a hazard to life and the soil. On- going progresses in PC demonstrating have enabled the prosecution of cathodic protection fabrics in icing metallic surfaces to be expected by reproducing nature and the electrochemical methods on the metallic shells, relate to figure 1.1. These advances have been connected to seaward and marine establishments, for illustration, seaward stages and ships. Cathodic protection is one of the strategies of

precluding erosion and is extensively applied in Naval and Underground channelizing systems. This strategy can be connected to Impressed Current Cathodic Protection to Reinforcement steel reinforcement in concrete to keep erosion inside the constrain. This system can be connected to any metallic structure in contact with the electrolyte. Its primary use is to ensure steel structures buried in soil or submerged in water. It protects the essence face by making it the cathode of an electrochemical cell. A straightforward strategy of protection, connecting the metal to be protected to a further effortlessly eroded" sacrificial essence" to act as the anode. The sacrificial metal also gets eroded rather of the protected metal.

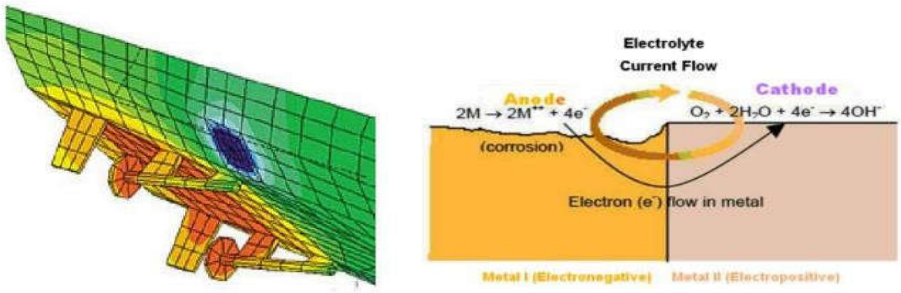


Figure 1.1 General Cathodic Protection Reaction

## Scope of work

RCC structures are susceptible to severe damage by corrosion and deterioration of rebars. The approach and the accuracy of rational results depend upon the systematic design of the ICCP for the structure and the environment of the structure. Impressed current cathodic protection can be applied to structures with a harsh environment by proper analysis of the structure and its surroundings and design of ICCP for the same, accordingly. That would help in minimizing damage or cracks in concrete that would incur due to corrosion of reinforcement. Thus, leading to less requirement of maintenance work resulting in longevity or increased life of the structure. By addressing critical challenges in structural engineering, this research contributes to the development of safer and more durable tall RCC structures, reducing maintenance costs and enhancing operational efficiency.

## Impressed Current Cathodic Protection to Reinforcement [ICCP]

For extensive structures or where basically cathodic security cannot be connected and galvanic anodes cannot financially convey sufficient current to give protection, Impressed Current Cathodic Protection (ICCP) fabrics are utilised. ICCP comprises of Anodes associated to a coordinate current control supply source, by and large transformer- rectifier associated to AC control. In the non-appearance of a control supply, choices similar as sun powered boards, wind control, or gas- powered thermoelectric creators are used. Anodes for ICCP frameworks are accessible in a multifariousness of shapes and sizes, as mentioned in the farther chapter.

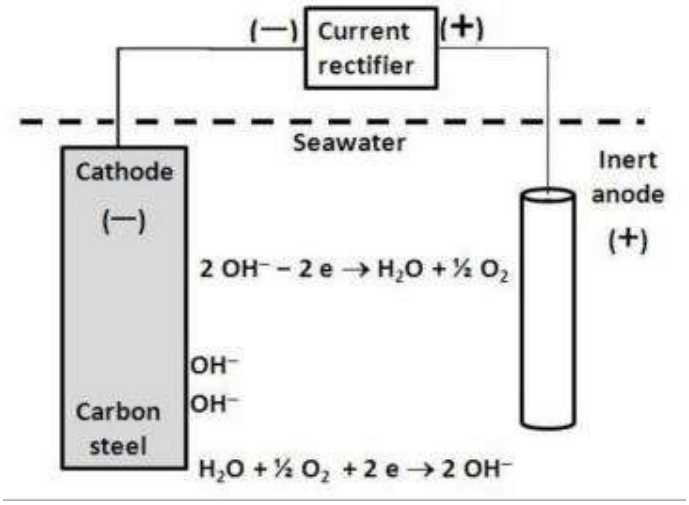


*Figure 1.2: ICCP Schematic Diagram*

In an ICCP framework, an outside current is connected so that metal to be secured gets more electron and gets to be anionic due to which further attack of environment does not influence the material and hence, erosion is anticipated A lived figure 1.2 the protection of the steel is accomplished by providing direct current to the steel bars inserted in the concrete which induces a cathodic polarisation of the steel bars It strengths the potential to move to a more negative level, where corrosion can neither start nor propagate

## Critical Appraisal

The yield current should always be more than the required current for the ICCP to work efficiently and effectively. The service life of galvanic cathodic protection systems is governed by the quantity of anode used. To assess the feasibility of cathodic protection, the condition of the structure and deterioration mechanisms should be determined. Cathodic-protection systems are monitored effectively by the measurement of structure-to-electrolyte potentials, using a high input impedance voltmeter and suitable half-cell. Cathodic protection is designed to halt all the active corrosion and prevent new sites from developing. Successful implementation of cathodic protection using DCS helps to centralize monitoring and control of pipeline corrosion. When the economics of a CP are considered, the installation cost is always the dominating number. As a general rule of thumb, impressed current systems seem practicable when current requirements exceed 400 – 500 Amperes and/or when water depth exceeds 200 meters. The anodes used in CP systems for buried and immersed structures are well established while the technology of the anodes for atmospherically exposed concrete structures is still evolving. The design of cathodic protection systems relies on a combination of experience, experimental data.

## Conclusion

After studying, designing, and analysing ICCP models and structures, feasibility, and economic considerations, in reinforced concrete structures are summarized as, Corrosion in the steel reinforcement protected by ICCP in the atmospherically exposed condition is 5-10 % whereas in saline water condition it is 15-20%. This is due to the presence of high NaCl content in the solution. This is estimated in accordance with standard electrochemical parameters. No cracks are found in concrete as ICCP prevented longitudinal stress that would have been raised by rebars due to corrosion. If planned, installed, and operated effectively, ICCP can result in sufficient corrosion protection to reinforcement and extend the service life of the structure. Satisfactory results are obtained. Corrosion in the subjected steel reinforcement is reliably limited due to formation of hydroxide ions leading to increase in pH level which has a stabilizing effect on the passive film of reinforcement. The ICCP practice works effectively, but its superior merit has not been fully explored in this study; this might be largely attributed to the insufficient corrosion level and the limited ICCP period. Cathodic protection can be perceived as a method for avoiding corrosion in existing as

well as proposed structures, where 35% of capital investment of total replacement cost can attain desirable duration of the structure without repeatedly and costly repairs.

**References**


1. A.S. YARO et al. (2011). Study for Prevention of Steel Corrosion by Sacrificial Anode Cathodic Protection. Theoretical Foundations of Chemical Engineering, 2013, Vol. 47, No. 3, pp. 266–273.
2. A. MATHIAZHAGAN. (2010). Design and Programming of Cathodic Protection for SHIPS. International Journal of Chemical Engineering and Applications, Vol.1, no. 3
3. GOPALAKRISHNAN et al. (2014). Cathodic Protection of Pipeline Using Distributed Control System. Hindawi Publishing Corporation Chinese Journal of Engineering Volume 2014, Article ID 681908, page 7.
4. GITESH JHA. (2017). Cathodic protection system for internal surfaces of piping pipeline. Paper No. CAP14.
5. YONG-SANG et al. (2017). Optimizing the sacrificial anode cathodic protection of the rail. Engineering Analysis with Boundary Elements, 77 (2017) 36–48.
6. ALAN R. BIRD et al. Repair and Maintenance of Marine Structures by Cathodic Protection. 15th Australasian Coastal and Ocean Engineering Conference, the 8th Australasian Port and Harbour Conference (pp. 230-235).
7. JIM BRITTON. (2001). Impressed Current Retrofits on Offshore Platforms: The Good, The Bad and The Ugly. In CORROSION. One Petro.
8. B. LAOUN et al. (2008). Cathodic protection of a buried pipeline by solar energy. Revue des Energies Renouvelables Vol. 12 N°1 (2008) 99 – 104.
9. ES. AMEH et al. (2017). Pipelines Cathodic Protection Design Methodologies for Impressed Current and Sacrificial Anode Systems. Nigerian Journal of Technology (NIJOTECH) Vol. 36, No. 4, pp. 1072 – 1077.
10. ALAN R BIRD. Cathodic Protection of Reinforced Concrete Structures.

11. RAHUL PATEL. (2019). Prevention of corrosion of Steel Reinforcement in Concrete. International Conference on Sustainable Materials and Structures for Civil Infrastructures (SMSCI2019) AIP Conf. Proc. 2158, 020035-1–020035-7.
12. Department of Civil Engineering, MIT SOE 59
13. Impressed Current Cathodic Protection to Reinforcement
14. BINGBING GUO. et al. (2021). Impressed current cathodic protection of chloride contaminated RC structures with cracking: A numerical study. Journal of Building Engineering, 44, 102943.
15. Project ID 4724. Report of Bureau of Reclamation's Research and Development office. (ST-2018-4724-01, 8540-2018-18)
16. AASHTO T358-151. (2021). American Association of State Highway and Transportation Officials. Standard Test Method for Surface Resistivity Indication of Concrete's Ability to resist Chloride Ion Penetration.