International Research Journal of Education and Technology
Peer Reviewed Journal
ISSN 2581-7795

PREVENTION OF CORROSION IN REINFORCED CONCRETE BRIDGES

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Abstract - his abstract sums up the progress made by the Federal Highway Administration's Corrosion Protection for Concrete Bridges program. The objectives of the program were to develop methods to decrease or halt the corrosion of steel in concrete bridges and to establish design and construction techniques to prevent corrosion in new structures.

Prevention of Corrosion of Steel Reinforcement in Concrete

This abstract outlines how to prevent corrosion of steel reinforcement in concrete, including:

1. Use of concrete additives like corrosion inhibitors and fly ash
2. Use of cathodic protection, such as zinc-based sacrificial anode

This abstract is to discuss how corrosion of steel in reinforced concrete bridges has emerged as a major concern regarding structural integrity and maintenance of highway infrastructure.

Corrosion Protection of Steel-Reinforced Concrete

This abstract discusses how prevention corrosion of reinforced concrete structure includes:

1. Forming the chloride ion barrier to prevent contacting steel surface
2. Formation that takes a longer time in permeation of chloride ion towards the concrete
3. Preventing Reinforced Concrete Corrosion.

1. INTRODUCTION

During the construction of concrete bridges in the United States, reinforcing steel was corroded, which has caused many of the bridges to be damaged before the anticipated design lifespan. The corrosion of reinforcing steels in these structures has posed huge economic burden on several state and local transportation authorities who are actively encasing the corrosion in power timbers due to the need of maximizing the service life of functional bridges rather than replacing them with new ones. Moreover, it has been established that the economic damage to the country caused by a large number of unsound bridges, as well as the danger posed to drivers, is very significant. The problem caused by corrosion of steel reinforcement is tremendous and adverse to the country and its inhabitants, which is why the Federal Highway Administration (FHWA) has included together with several other high-priority focus areas geared towards addressing the protection of concrete bridges from serious corrosion. In this research program other high-priority areas (HPAs) include:

- Geotechnical Engineering
- Hydraulic Engineering
- Corrosion Protection for Concrete Bridges
- Seismic Protection
- Non-Destructive Evaluation

1.1 METHOS TO PREVENT CORROSION IN REINFORCED CONCRETE BRIDGES

To prevent corrosion in steel reinforcement, several strategies can be implemented:

1. Concrete Additives:
   -Corrosion Inhibitors
   -Fly Ash
2. Cathodic Protection:
   -Zinc-based Sacrificial Anodes
3. Construction Practices:
   -Meticulous Concrete Mixing and Placement
   -Proper Curing and Maintenance

By employing these techniques, the longevity and structural integrity of reinforced concrete structures can be significantly enhanced.

2. LITERATURE REVIEW

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Aygör et al. (2016), Stainless steel is more resistant to corrosion than carbon steel. research has indicated that stainless steel reinforcement reduces the risk of corrosion in chloride-rich environments, although its higher cost limits its widespread use.

Sidharth et al. (2018), Applying a zinc coating to steel reinforcement can provide sacrificial protection, wherein the

zinc corrodes preferentially. Sidharth et al. (2018) concluded that galvanized steel reinforcements offer better corrosion resistance than uncoated steel, especially in aggressive environments.

Pascual et al. (2019), Glass Fiber Reinforced Polymer (GFRP): GFRP reinforcement is another promising alternative that is non-corrosive, especially in very aggressive environments. GFRP bars offer high corrosion resistance but are not widely used due to high cost and low mechanical properties compared to steel.

Tang et al. (2020), Surface applied inhibitors: these comprise organic inhibitors including amines as well as silane-based treatment. Surface applied inhibitors prevent corrosion initiation due to chlorides as they cover the steel in a thin layer of a protective film.

Tobias et al. 2021, inhibitors may be added directly in the mix. Calcium nitrite-based inhibitors have been reported to delay initiation of corrosion; however, the long-term performance under multifaceted field conditions merits further investigation.

3. METHODOLOGY

3.1 Materials:

1. Concrete Mix: (M 20)
2. Ordinary Portland Cement (OPC)
3. River sand
4. Coarse aggregate
5. Water
6. Corrosion inhibitor (if applicable)
7. Mild steel rebars of different diameters

3. 2 Specimen Preparation:

1. Concrete Mix Design:
2. Molding of Beams
3. Corrosion Simulation:
4. Accelerated Corrosion Testing:
5. Natural Exposure

3.3 Testing Procedures

1.Mechanical Testing

1.1 Flexural Strength Test

1.2 2Compressive Strength Test

2. Corrosion Assessment

2.1 Visual Inspection

2.2 Electrochemical Measurements

2.3 Weight Loss Measurements

3.4 Data Analysis

1.1 Statistical Analysis

1.2 Comparison of Results

1.3 Correlation Analysis

3.5 Numerical Modeling

1. Finite Element Analysis (FEA)
2. Consideration of Material Properties
3. Boundary Conditions

4. CALCULATIONS

Weight of Beams	No. of days	Flexural Strength (PL/bd*2)		Compressive strength(L/A)	
34.180kgs	7 days	crack	break	break	break
		150	180	390	413
36.980kgs	14 days	crack	break	crack	break
		225	240	400	410

Volume of 1 cube

0.792X0.18X0.18 =0.025 cubic meter

Aggregates weights

Cement = 1/0.0705

Cement =17.77kgs

Fine aggregate =1.5/0.0705

=26.66kgs

Coarse aggregate =3/0.0705

=53.33kgs

Amount of water = weight of cement X 0.5

=17.77kgs X0.5

=8.885litrs

1st batch beams casted on 5th November

Weight of each cube after curing (without mould)

W1=33.650kgs

Weight of cube after 7 days

W2=34.180kgs

Weight of cube after 14 days

W3=36.980kgs.

3. CONCLUSIONS

The experimental study, numerical modeling provides in the study, gives many such insights into the behavior of reinforced concrete structures to corrosion. This extensive effect of concrete quality, steel reinforcement, and environmental conditions on corrosion rates has been highlighted Anti – corrosion strategies, including the use of corrosion inhibitors, cathodic protection, and proper maintenance, will play a critical role in prolonging the life of hardened reinforced concrete structures. Future research should focus on the development of advanced materials, enhance numerical modeling, or optimize maintenance strategies to further improve the durability and sustainability of the reinforced concrete ecosystem.

ACKNOWLEDGEMENT

We thank our internal mentor, U. PRAVEEN GOUD, Assistant Professor sincerely for his valuable advice and encouraging words throughout this project. The expert supervision and insightful suggestions from Dr. S. M. SUBASH, Professor and Head of Civil Department, are also being acknowledged.

We thank Principal Dr. KODUGANTI VENKATA RAO and the management for providing the necessary facilities. We also thank the Civil Engineering staff and the lab technicians for their help.

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