An Experimental Study on the Effect of Corrosion on Steel Reinforcement of Concrete Column

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Abstract - Corrosion is the most significant factor to influence in completing the service life of concrete structures. In this experiment, the reinforced concrete specimens designed in small scale was subjected to accelerated corrosion test for 30 days under 1 ampere constant current. In the experiment, weight loss and strength reductions was obtained. Loss of strength in steel bars due to corrosion damage was found with experimental process. As a result of the evaluations, it was detected that corrosion damage produced substantial loss in horizontal load carrying capacity of the building. The corrosion situations show that corrosion in columns or beams changes collapse modes of the structure.

Keyword – Corrosion, RC columns, residual strength, corroded beam

1.0 Introduction

Corrosion of reinforcing steel is widely accepted as the primary cause of premature deterioration in Reinforced Concrete (RC) structures. Concrete, which is a composite material due to its structure, is formed as a result of chemical reactions. Due to the environmental factors, the chemical influences taken from outside cause significant changes in the structure of the concrete. Although the compressive strength of concrete is emphasized in our country, it is a fact that the durability and usability of the concrete is more important as it decreases the service life. The corrosion products occupy a larger volume and these induce stresses in the cover concrete resulting in cracking, delamination and spalling. In addition to loss of cover concrete, a RC member may undergo structural damage due to loss of bond between steel and concrete and loss of rebar cross-sectional area.

2.0 LITERATURE REVIEW

After surveying various research papers which has been related to study on corrosion, the short explanation about its approach, methodology and conclusions has discussed

J Revathy, K Saguna, PN Raghunath (2009) - In this paper,an experimental investigation was carried out on reinforced concrete columns with corroding reinforcement to assess the residual strength and ductility performance of columns.

O.O. Akinyemi, and O.J. Alamu (2009) - From the experiment results,

1. That the coating (i.e. bitumen, enamel paint, and local anti-rust paint) offered good protection against corrosion within the period of experimental investigations. However, this protection could not be guaranteed at longer period.

2. That the enamel paint coating has the best protection against corrosion, followed by bitumen coating, and lastly local anti-rust paint coating in the corrosive media used (i.e. sodium chloride solution).

3. That the concrete cover to reinforcing steels also offered good corrosion protection with the 50mm thickness having the best protection followed by 25mm thickness, and finally 10mm thickness.

O.S.I Fayomi and A.P.I Popoola (2012) - Proper electrodeposition of mild steel using zinc particle was carried out. The microhardness and corrosion behaviour of the resultant deposition were investigated with the following deductions:

1. The average increase in microhardness of the mild steel substrate was 55 HVN to deposited sample Zn 3 was 108 HVN, about twice the microhardness value of the mild steel was achieved.

2. The corrosion resistance of mild steel was improved after zinc deposition. The sample produced with the highest applied voltage displayed the best microhardness value, and had the highest corrosion resistance. This was featured by a decrease in corrosion current density and corrosion current, increase corrosion potential and the polarization resistance.

3. The pitting corrosion attack suffered by Zn 1 is attributed to fewer ionic migrations, meaning that only few hydrated ion(s) in the electrolyte migrated toward the cathode under the influence of the applied voltage.

4. The order of corrosion resistance is sample 3>2>1.

Aleksandra Bochenek (2012) - Presenting different cases of concrete corrosion it was shown that its durability is assured when three principles are observed:

1. Low permeability – low w/c ratio and high content of C-S-H gel which tighten pores; thus cements rich in pozzolana addition is promoted.

2. Suitable cement phase composition containing low C_3A content in Portland cement clinker.

3. Low alkalis content, principally potassium, because cement produced in Europe has, as a rule, low sodium content

Api Popoola, OE Olorunniwo and OO Ige (2014) - Selective modification methods such as dipping, spraying, sol-gel, vapour deposition among others of metals and components is possible through the application of anticorrosion coatings, therefore only the part which is at risk to degradation needs to be coated, leading to cost reduction as opposed to other traditional prevention methods. Material loss and component failures can be prevented with proper selection of coatings/ materials in most manufacturing industries. Adequate knowledge of these processes is therefore inevitable

Jin Xia, Ph.D.1; Wei-Liang Jin, Ph.D.2; and Long-Yuan Li (2015) - This paper presents an experimental investigation on the performance of RC columns with corroded reinforcing steel bars

Deepak Dwivedi,a Kateˇrina Lepkova´ and Thomas Beckerb (2016) - This article addresses the importance of material properties, such as surface texture, energy, morphology and defects in carbon steels used under corrosive conditions, and provides a critical review of the current state of surface analytical methods available for the carbon steel surfaces.

Anil Kumar (2016) - The present investigation tried to explore types of inhibitors, nature of inhibitors, their mechanism and also to explore whether the simple polarization technique can be used to compare the efficiency of most prevalent inhibitors. The findings indicate that performance wise

(a) Nitrate salts are more efficient than nitrite salts (sodium and calcium).

(b) Calcium salts are more effective.

(c) Further, it was observed that molar concentration wise calcium salts offer greater efficiency.

Pusuluri Sri harsha, Sumith Kumar, Birudala Raga Harshith Reddy, Rontala Saketh Reddy (2017) - In this paper, a detailed study of ceramic coatings, the mechanism of corrosion and different forms corrosion is also studied to explain the importance to ceramic coatings in providing the corrosion resistance to the materials. Many works are studied and summarised their results.

Aizada Kalmagambetova Tatyana Bogoyavlenskaya (2019) - A comparative analysis of the nature of the demolition of the specimens showed that there is demolition along the edge.

Majid H. Abdulmajeed, Hiba A. Abdullah, Slafa I. Ibrahim, Ghaith Z. Alsandooq (2019) - Producing eco-friendly coating was done by applying polypyrrole coating doped by coumarin on carbon steel. Some techniques were confirmed the obtaining compact and adhesive film. Addition of coumarin to coating gave more roughness and average diameter due to the difference in size of molecules and polymer chains.

3.0 Conclusion

After reviewing a lot of research papers that are based on the experimental study on the effect of corrosion on steel reinforcement of concrete column. From the current experimental study, the following results were found

1. Corrosion of the main steel bar causes surface concrete cracking.

2. Corrosion usually results in a weakened bond which usually takes place at the interface of concrete and corroded bars.

3. Corrosion is the major causes of failure in concrete structure and mostly affected through the cover zone.

4. The corrosion damaged concrete columns unsuccessful in brittle manner at higher levels of corrosion.

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References

1. J. Revathy, K. Suguna and P.N. Raghunath (2009), " Effect of Corrosion Damage on the Ductility Performance of Concrete Columns", American J. of Engineering and Applied Sciences 2 (2): 324-327, 2009 ISSN 1941-7020.

2. O.O. Akinyemi, and O.J. Alamu (2009), "Effect of 0.05M NaCl on Corrosion of Coated Reinforcing Steels in Concrete", Pacific Journal of Science and Technology.

3. O.S.I Fayomi* and A.P.I Popoola* (2012) "An Investigation of the Properties of Zn Coated Mild Steel",International journal of electrochemical science

4. Aleksandra Bochenek (2012) "Three principles of concrete corrosion prevention", Cement, Wapno, Beton.

5. Api Popoola, OE Olorunniwo and OO Ige (2014) "Corrosion Resistance Through the Application of Anti- Corrosion Coatings", American J. of Engineering and Applied Sciences.

6. Jin Xia, Ph.D.1; Wei-Liang Jin, Ph.D.2; and Long-Yuan Li (2015) "Performance of Corroded Reinforced Concrete Columns under the Action of Eccentric Loads", International Journal of Scientific Research in Science, Engineering and Technology.

7. Deepak Dwivedi,a Kateˇrina Lepkova´*a and Thomas Beckerb (2016) "Carbon steel corrosion: a review of key surface properties and characterization methods",RSC Advances.

8. Anil Kumar (2016)- "Introduction of Inhibitors, Mechanism and Application for Protection of Steel Reinforcement Corrosion in Concrete",Engineering and Technology Journal.

9. Pusuluri Sri harsha, Sumith Kumar, Birudala Raga Harshith Reddy, Rontala Saketh Reddy (2017) " A Review on corrosion resistance of ceramic coated materials", IJSRSET | Online ISSN : 2394-4099 Themed Section: Engineering and Technology.

10. Aizada KALMAGAMBETOVA Tatyana BOGOYAVLENSKAYA (2019) "Corrosion-Preventive compounds for increasing the durability", IJEAT.

11. Majid H. Abdulmajeed, Hiba A. Abdullah, Slafa I. Ibrahim, Ghaith Z. Alsandooq (2019) "Investigation of Corrosion Protection for Steel by Eco-Friendly Coating", Engineering and Technology Journal.