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Rehabilitation and Maintenance of Rusted Reinforcement Bar in RCC Beam

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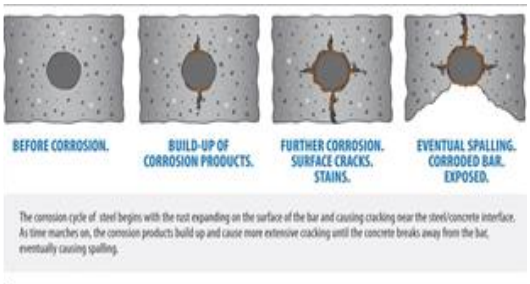
***Abstract*— Corrosion of the reinforcing steel in concrete is a worldwide problem that causes a range of economic, aesthetic and utilization issues. However with the passage of time, the structure starts getting older and starts showing some signs like cracking, splitting, delaminating and corrosion of steel etc .Corrosion of steel bars embedded in reinforced concrete (RC) structures reduces the service life and results in appearance of cracks in member thatby causes prior failure of structure, which costs the repair and maintenance of the RCC structure. Attention should be directed at corrosion reduction practices at the design and planning stages . Deterioration of rusted rebar can be overcomed by adopting a patch repair technique, which restores the undamaged state and it is shown clearly by adopting a patch repair technique with replacing rusted steel rebar . This research work aims to lighten the importance of monitoring corrosion in reinforcement and proposes the various methods for observing and evaluating the corrosion state of reinforced concrete structures, especially by using hal-cell potential method. This research work also presents techniques of protecting rcc structure from corrosion.**

***Index Terms*—Rusted reinforcement bar, corrosion, electrolyte, repair strategy, protection methods**

I. INTRODUCTION

Concrete is the most widely used and versatile construction material possessing several advantages and it has end up being practically basic to the present day development. Concrete has enough mechanical strength, yet it is prone to deterioration and thus gets negative effect over structure and sometimes even fails. This damage of the structures may be due to the weathering action of atmosphere, fire, soil strata failure, improper workmanship in construction and also because to natural disaster like flood, earthquake, tsunami etc. Reinforced concrete structure requires periodic maintenance and proper guidance. Rehabilitation is the process of restoring the structure to serve level , the same level once it had and now lost ,strengthening consist in endowing the structure with a service level ,basically it means retuning a building or a structure to useful state by means of renovation, maintenance and modification. These all are related to strength of the structure. Need for repair and rehabilitation of structures are

- Faulty design of the structure
- Improper execution and bad workmanship
- Extreme weathering and environmental conditions
- High degree of chemical attack
- Ageing of structures.



Corrosion of steel bars in RCC structure is the major cause of failure and about two tons of concrete is used per capita of the world population every year. Therefore, it has been perceived that most durable structures will reduce the cement consumption. Corrosion continuously reduces the strength and span life of rcc structures and in humid atmosphere corrosion causing substance from atmosphere percolates through the insufficient and porous concrete cover and results in corrosion of rebar. After the start of corrosion process in reinforcing steel bar, layer of corrosion over bar expand and occupies a volume of about 6 to 10 times greater than that of original steel which results in cracking of concrete cover and ultimately results in the failure of rcc structures. Penetration of corrosion causing reagent such as chloride ions & carbon dioxide deposited at the spot of cracks, which further causes the increase of corrosion .Its extent can be reduced by use of low permeable concrete and proper depth of effective cover which minimizes the penetration extent of corrosion inducing agent, and the high penetration resistance of concrete restricts the rate of corrosion by minimizing the current flow from anode to cathode.

A. Impact of Corrosion in Coastal Areas

Some of the reasons inducing corrosion in coastal areas are discussed below:

• Entrance of chloride and sulphate ions by diffusion or other penetration possibilities. Although it has been outcomed that combined effect of both chloride and sulphate ion attack causes corrosion in rc member but till now no experiment yet has revealed the combined mechanism of both ions acting together.

• Insufficient depth of cover over the steel reinforcement, or highly porous, concrete with high air content, will increase the risk of rusting. Moreover, in the presence of moisture & oxygen, rebar will start corroding immediately.

• Mineral contamination of water, aggregate or cement during construction, decreases quality of concrete. Worst cases of damages of rc member has been observed where sea water was used as water for hydration and workability in concrete .

• Carbonation – The chemical reaction between carbon dioxide and products of hydration of cement such as Calcium Hydroxide and CSH Gel phase – results to the formation of Calcium Carbonate, which lowers the alkalinity of concrete. It is termed as despassivation of steel and from here rusting starts to take place in low alkalinity concrete embeded steel .

II. METHODOLGY

A. Methods of e valuation of corrosion in steel reinforcement

Galvanostatic pulse method – it is done by polarizing rebar by the means of small steady current.

Linear polarization resistance (LPR)- Corrosiveness is related to electrical conductivity of fluid.

Half-cell potential- Electric potential of rebars indicate probability of corrosion and is measured corresponding to half cell.

Time domain reflectometry (TDR)- A transmission line is established by attaching a sensor wire alongside of the steel bar reinforcement. Physical defects of the steel bar in concrete will change the electromagnetic properties of the transmission line.

Ultrasonic guided waves- Based on ultrasonic waves propagation.

Atomic absorption and X-ray diffraction - Intensity of X-ray beams decreases while trasspassing in a material.

III. EXPERIMENT

This experiment is to remove corrosion from steel bars so that we can find the strength of steel in a building or a RCC structures. So here we are taking 16 mm (diameter) steel bar of length 2 meter ,this sample is taken from a 5inch thick slab (165mm),which is fully corroded. Corrosion of steel used in a structure significantly alters their properties and impacts their overall strength. The two major properties of steel that show their durability and capacity are tensile and compressive strength. So for sample, expirement is performed to find the tensile and compressive strength which is performed in UTM machine, if strength is acceptable the further process is continued

Reduction in X-X area of reinforcement in rcc is observed.

To calculate the corrosion rate from metal loss, use:

MI/Y=534x(W/DAT)

W=weight loss in milligrams,
D=metal density in g/cm3
A=area of the sample in inch2,
T=time of exposure of the metal sample in hours

A. PROCESS:

PREPRATION OF ELECTROLYTE SOLUTION :

1 table spoon of $NaHCO_3$ in 1 gallon of water
14.707ml of $NaHCO_3$ -4.546liter of H2O
32.355gm of $NaHCO_3$.-4.546liter of H2O
7.117gm of liter $NaHCO_3$.-1 liter of H2O
MOLARITY OF SOLUTION =7.117/84 =0.08M/L

PH Value: 8.34

Prepare an electrolyte solution with water and baking soda . A metal (copper or can) is used as anode and rusted steel will work as cathode and a 12volt power supply which is connected to the metal and steel/rebar which will act as an anode and cathode for de-rusting of rusted steel. Place the anode and cathode in a beaker which is filled with electrolyte solution and connect the metal with positive terminal and rusted steel with negative terminal which passes power of 12V. After 30min rust get accumulated around the metal can. Take out steel bar from the beaker and clean it, after that calculate the new weight which is corrosion free ,which is obviously be less than the original weight. By measuring the weight of steel, rate of penetration can be computed.

B. EXPERIMENT OUTCOMES:

Corrosion removed successfully from RCC corroded steel.

Chemical Changes:

No chemical composition changes in amount of carbon, Sulphur, Mn, Phosphorus, Silicon.

Physical Changes:

No Significant changes are observed in rcc steel like:
Tensile strength, compressive strength, ductility and hardness.

C. VERDICT:

CASE 1:
If obtained X-X area of steel after de-rusting < X-X Area required for member the member is to be demolished or extra reinforcement of required amount is to be added in the member.

CASE 2:
If obtained X-X area of steel after de-rusting >= X-X Area required for member the member can be used for desired load after treatment.

D. TREATMENT:

All the voided places in the member are to be removed and de-rusting solution is to be directly applied on the steel.
After de-rusting anticorrosion solution is applied on steel and proper effective cover is provided of desired thickness.

CONCULSION

The failure occurring from the rusting of embedded steel reinforcement in concrete structures is a major concern which results in loss of time and money . Hence, we need to understand the evolving cause of rapture before starting the repair work for efficient and effective remediation . There are some effective methods to find the corrosion state are corrosion current density, concrete resistivity and half-cell potential . Corrosion rate is governed by moisture content , Availability of O_2 and T°. So for the beneficial of RCC structure it is advised to repeat rate of corrosion measurement in an interval time.

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