REUSE OF DOMESTIC WASTEWATER IN REINFORCED CEMENT CONCRETE - A SUSTAINABLE APPROACH

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ABSTRACT

With the current water crises in India there is a need as well as opportunities to look for alternative sources of water and its management in construction industry. This research aims at finding out the feasibility of wastewater to use in Reinforced Cement Concrete and finding out increase in rate of corrosion of steel by standard HCP measurement and chemical analysis of steel and concrete with increasing age.

Keywords: Chemical Analysis, Corrosion, Open Circuit Potential, Reinforced Cement Concrete, Wastewater

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INTRODUCTION

Water in India is primarily a state subject. Water is the main part of our life. It is a fact that if water is used there will be waste. So the waste water generation will never stop. Hence, the ultimate and last option will be treating the waste water and using it. But the humans have not accepted or will never accept the treated waste water for drinking purpose. So we can use this treated waste water in the construction industry where the large amount of share of water is used and save the freshwater. In construction industry concrete being the most widely used construction material, uses most of the water. This fresh potable water used in concrete can be replaced with wastewater. The use of wastewater in Reinforced Cement Concrete will develop some issues regarding corrosion of steel. As per provision of IS 10262-2009, 186 liters of water is required for 1m3 of concrete. On an average 150 liters of water is required for 1m3 of concrete. Approximately 3.76 billion cubic meter of concrete are used each year which results in large consumption of potable water being used for concreting which can be saved if, we use wastewater for concrete production. Previous research in this area shows that use of wastewater in Plain Cement Concrete has decreased its compressive strength but no experimental investigation has been done on the effect of wastewater on corrosion of steel. This paper gives fair idea about the research to be conducted in this field and associated work to be performed.

METHODOLOGY

An experimental investigation is to be carried out to evaluate the feasibility of wastewater in Reinforced Cement Concrete. For the purpose specimen of Reinforced cement concrete beam is casted with the use of Normal Water-NW (Potable), untreated waste water - UTWW (After Screening Process) and Primary Treated waste water - PTWW (After Coagulation Process) obtained from sewage Treatment Plant located in Mundhwa, Pune. Casting of beam specimen is done at the RMC plant of J.Kumar infrastructure ltd. situated near Hadapsar, Pune under the Guidance of RMC head Mr. Yusuf Inamdar. Chemical analysis on Concrete and Steel is being carried out at Durocrete material testing Lab on Sinhgad road, Pune.

EXPERIMENTAL WORK

CONSISTENCY OF CEMENT, INITIAL AND FINAL SETTING TIME OF CEMENT

Consistency of cement paste is found using Vicat apparatus. The procedure used to perform this experiment is followed by IS 4031(Part 4) after finding out Consistency of cement paste, Initial and Final setting time of cement paste is found. Following Fig. 1 shows the result of Standard consistency test and Fig. 2 shows results of initial and final setting time of cement.

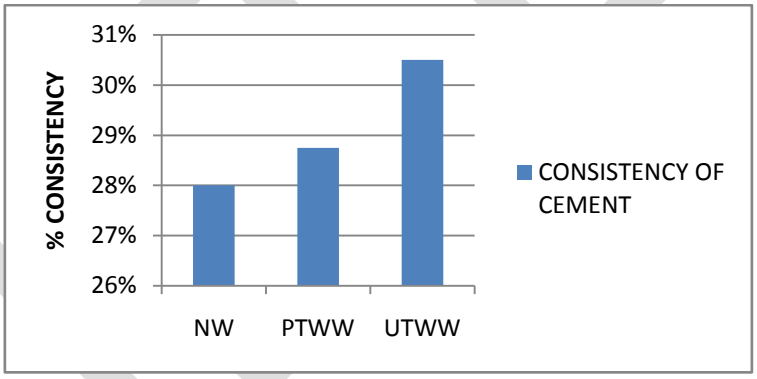


Fig.1 Consistency of Cement

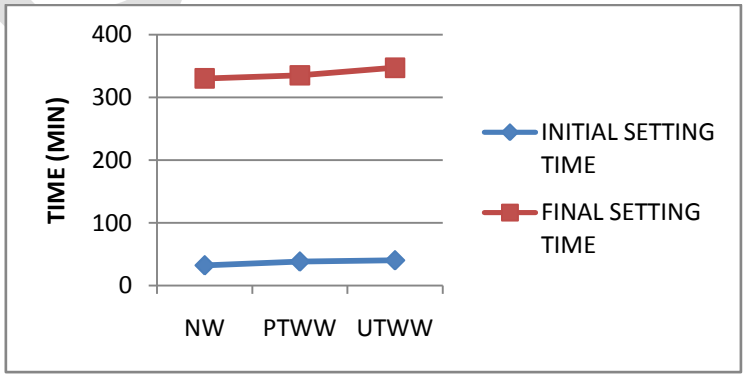


Fig.2 Initial and Final setting time of Cement

COMPRESSIVE STRENGTH OF CEMENT

Compressive strength of cement is obtained by preparing mortar cube of 53 grade to be cured for 28 days. The water used for casting was NW, UTWW and PTWW. The mortar is mixed according to the IS 4031:1988.Fig. 3 shows results of compressive strength of cement.

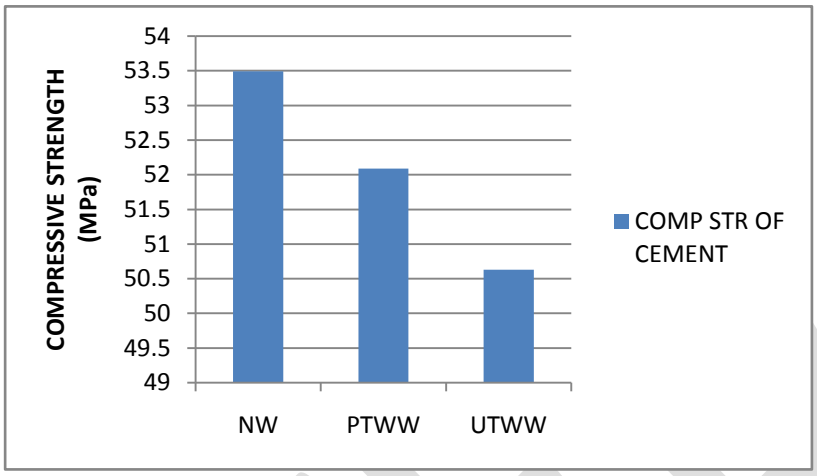


Fig.3 Compressive strength of Cement

CASTING OF BEAM SPECIMEN

A standard beam specimen of size 0.15 m x 0.15 m x 0.7 m are casted of commercial grade M-35 with steel reinforcement as shown in Fig 3 and 4. Eighteen numbers of beam specimen are casted, Six each with NW, UTWW, PTWW to be tested at 28 days interval.

Fig.4 Prepared beam specimen with reinforcement

Fig.5 Casted beams specimen with reinforcement

HALF CELL POTENTIAL (HCP) MEASUREMENT

The tendency of any material to react with an environment is indicated by the potential it develops in contact with the environment. In reinforced concrete structures, concrete acts as an electrolyte and the reinforcement will develop a potential depending on the concrete environment, which may vary from place to place. The schematic diagram for Open Circuit Potential measurement is as shown in Fig 4.

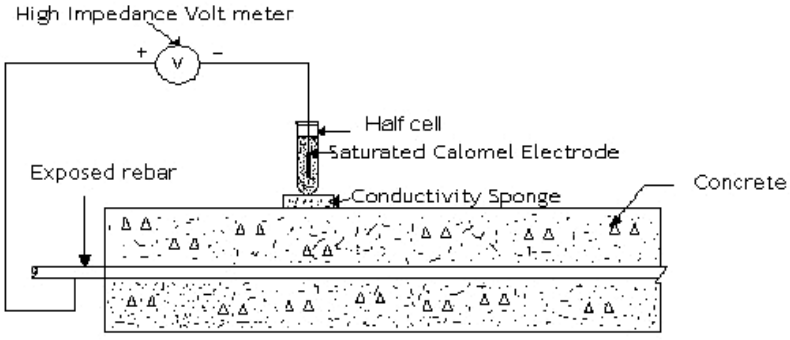
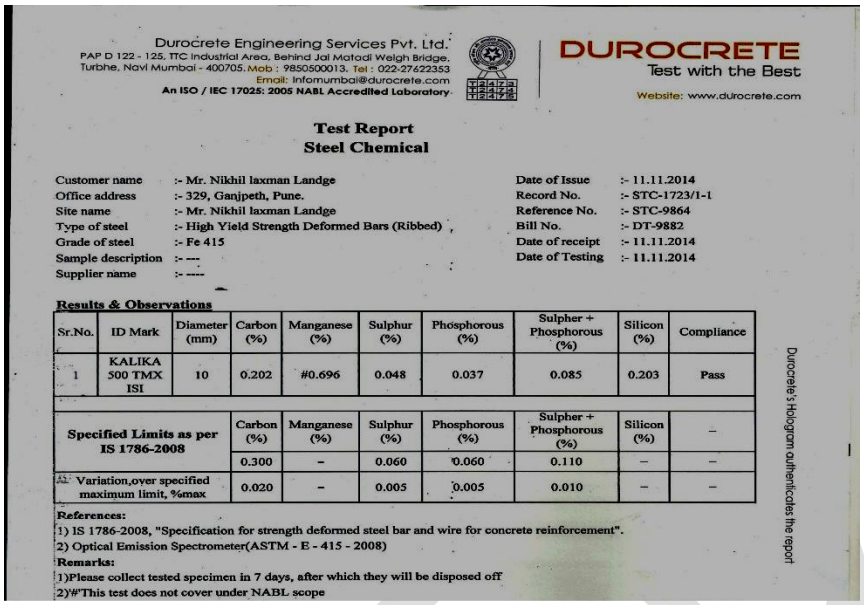


Fig.6 Schematic representation for Half Cell Potential (HCP) measurement

The principle involved in this technique is essentially measurement of corrosion potential of rebar with respect to a standard reference electrode, such as saturated calomel electrode (SCE), copper/copper sulfate electrode (CSE), silver/ silver chloride electrode etc. As per ASTM C 876 [6] standards. Measurements obtained by half cell potential measurement are shown in Fig.5 for four months.



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Test Report
Steel Chemical

Customer name	:- Mr. Nikhil laxman Landge	Date of Issue	:- 11.11.2014
Office address	:- 329, Ganjpeth, Pune.	Record No.	:- STC-1723/1-1
Site name	:- Mr. Nikhil laxman Landge	Reference No.	:- STC-9864
Type of steel	:- High Yield Strength Deformed Bars (Ribbed)	Bill No.	:- DT-9882
Grade of steel	:- Fe 415	Date of receipt	:- 11.11.2014
Sample description	:- ---	Date of Testing	:- 11.11.2014
Supplier name	:- ----		

Results & Observations

Sr.No.	ID Mark	Diameter (mm)	Carbon (%)	Manganese (%)	Sulphur (%)	Phosphorous (%)	Sulpher + Phosphorous (%)	Silicon (%)	Compliance
1	KALIKA 500 TMX ISI	10	0.202	#0.696	0.048	0.037	0.085	0.203	Pass

Specified Limits as per IS 1786-2008	Carbon (%)	Manganese (%)	Sulphur (%)	Phosphorous (%)	Sulpher + Phosphorous (%)	Silicon (%)	–
	0.300	–	0.060	0.060	0.110	–	–
Variation,over specified maximum limit, %max	0.020	–	0.005	0.005	0.010	–	–

References:
1) IS 1786-2008, "Specification for strength deformed steel bar and wire for concrete reinforcement".
2) Optical Emission Spectrometer(ASTM - E - 415 - 2008)
Remarks:
1)Please collect tested specimen in 7 days, after which they will be disposed off
2)#"This test does not cover under NABL scope

Durocrete's Hologram authenticates the report

Fig.7 Sample report of Chemical analysis of Steel

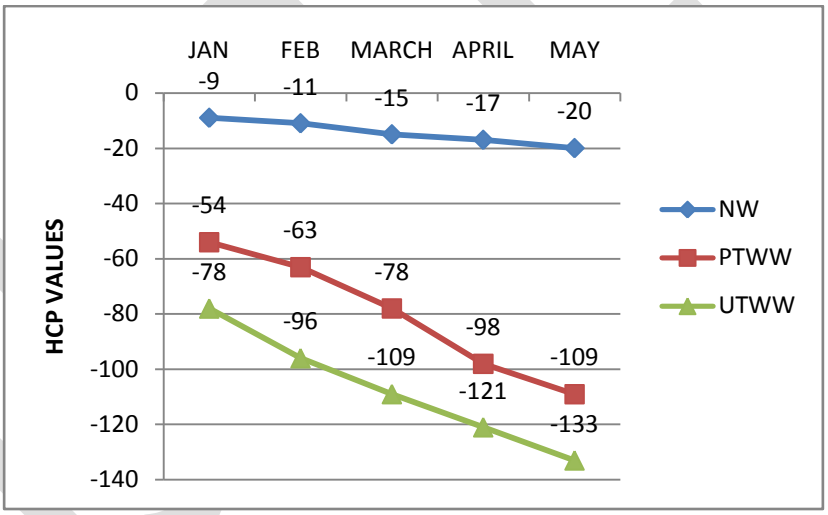

Fig.8 Effect of Mixing water on Corrosion

CHEMICAL TESTS ON CONCRETE AND STEEL

Chemical tests on concrete includes finding out PH, Chloride and Sulphates of aged concrete and chemical testing on Steel will give elements such as Carbon, manganese, Sulphur, Phosphorus and silicon. Fig 6 shows test result of carbon percentage variation over time obtained by chemical analysis of Steel and Figure 7 shows sample report of Chemical Analysis

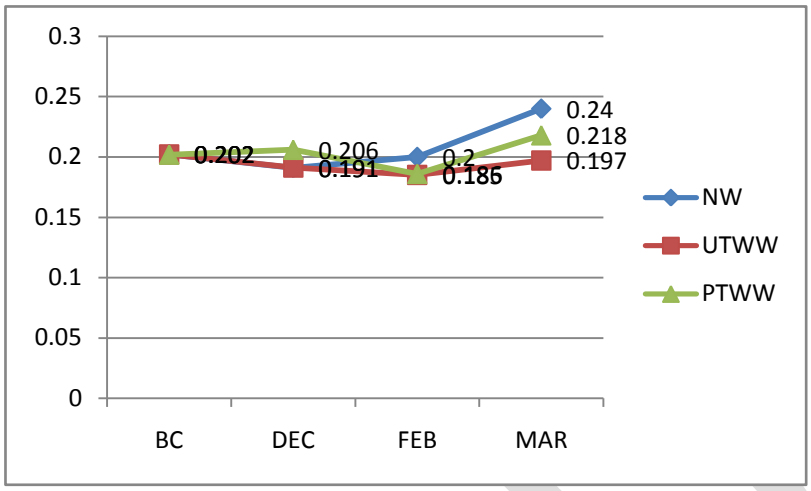

Fig.9 Variation of Carbon % over time in Steel

CONCLUSION

- All steel constituents have increased with decrease in Iron content which shows that corrosion rate has increased.
- The value of corrosion increases in case of UTWW and PTWW due to harmful effect of chemical properties.
- A result of chemical analysis agrees with Electrical analysis which supports that rate of corrosion has increased.

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STANDARD CODES

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[6] IS 10262:2009 'Concrete Mix Proportioning- Guidelines'

[7] IS 4031:1988

[8] ASTM C 876 [6] Standard test method for Half-cell potentials of uncoated Reinforcing steel in Concrete