Impact of Water Quality on Compressive Strength of Reinforced Concrete

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***Abstract*-This study adopt laboratory controlled experimental approach, in order to find out impact of water quality on compressive strength of reinforce concrete. To assess the impact two samples of reinforce concrete mix were prepared, one with fresh water and another one with 5% of saline water. The comparative assessment has been performed on these two samples to find out impact of water quality. Reinforced concrete elements were casted using both saline and fresh water using a mix ratio of 1:2:4 for experiment. Compressive strength is observed for 120 days. The strength was estimated of fresh water sample was 13.08N/mm2 and 12.10N/mm2 for saline water sample on 14th day, whereas strength was observed 13.98 N/mm2 for saline water and 14.89 N/mm2 fresh water on 28th day. The compressive strength observed on 40th day was 17.60 N/mm2 for fresh water and 16.02 N/mm2 for saline water respectively. In the last compressive strength was estimated on 120th day, the value was very much significantly impacting strength as 24.05 N/mm2 for fresh water and 21.01 N/mm2 for saline water. The study revealed that saline water has impact on compressive strength and due to salinity structure may have cracks in future as time pass after concrete. Therefore it is recommended in this research that a rich mix of 1:2:4 strictly enforced on construction sites for concrete under saline attack, increase concrete cover be used for protection against corrosion, and that non destructive test be carried out on all formworks under vertical loads like slabs and beams before they are stripped.**

Keywords: Reinforce Concrete, Salinity, Compressive Strength.

I. INTRODUCTION

Concrete and steel have established their ways so functional and very dominant in the building component. According to Oyenuga (2004), reinforced concrete is a mixture of two dissimilar but complementary materials, namely concrete and steel. Concrete has significant crushing strength, durable and good resistance to fire but has poor strength in tension. On the other side, steel has a very good tensile an shear strength, but poor resistance to fire. Therefore combination of concrete and steel provide good tensile and compressive strength, durability and good resistance to fire and shear. Concrete is a composite material of cement, sand, coarse aggregate (gravel or crushed stone) and water. It has good workability and allows it to be easily used in any shape choices from bulky dam wall, foundation to very thin shell roof (Cohen et al 1988; Tiwari et al 2014). The quality of concrete is considered as a cause that could be responsible for the deterioration of concrete. In deterioration of concrete, the salinity effect plays a significant role especially when water which used as constituent is reach in salts.

The chemical action of high salinity water on concrete is mainly due to attack by magnesium sulphate ($MgSO_4$) (Michael et al 1978; Falah 2010). This may be worsened if chloride present in the water which retards the swelling that usually characterized by the attack of sulphates and which becomes whitish in appearance. More severe attack subjects the set concrete to expansion which leads to cracking. Bryant, M. (1964) stated in his paper that potassium and magnesium sulphates (K_2SO_4, $MgSO_4$) present in salt water can cause sulphate attack in concrete since they readily react with calcium hydroxide ($Ca(OH)_2$) present in the set cement through the hydration of C_3S and C_2S.

This study explored the worst scenario of concrete mix and determines the consequent effect on reinforced concrete element. A mix ratio of 1:2:4 was adopted for the experiment. Reinforced concrete elements were casted using saline water with different concentration of salt while fresh water was used as a control experiment. Characteristics observed for a period of 150 days. Both the fresh water and salty water samples were tested for compressive strength in UTM machine. Compressive strength is measured at 7th, 14th, 28th, 40th and 120th day. On 14th day fresh water sample has 17.48N/mm2 as against 12.10N/mm2 and 12.55N/mm2 recorded for saline water sample.The findings revealed that concrete sample cast and cured with fresh water gained appreciable compressive strength over 150 days period while sample cast and cured with saline water (containing 3% to 5% salt) slowly increase in strength but lower when compared with fresh water reinforced concrete element.

II. MATERIALS AND METHODS

The research methodology is to investigate the effects of salts presents in water on both reinforced and mass concrete structures. The primary data for the research work comprises review of researches conducted on concrete while the secondary data includes the relevant past laboratory record and then laboratory experiment was conducted to determine saline water effects on compressive strength of concrete.

Casting and curing of the concrete cubes (150mmx150mmx150mm) samples using both fresh water

and saline water and then assessment of compressive strength using universal testing machine of these samples. Concrete beams of the (450x150x150) are casted and cured samples using both fresh water and saline water and universal testing machine is used to test axial compression. Concrete samples were cast in a moulds of size 150mmx150mmx150which are available in our laboratory. All the cubes were cured by total submersion in water. The mixes were prepared in the laboratory in the ratio 1:2:4 of cement, sand and coarse aggregates. Two cubes were casted as reinforced concrete samples with reinforcing bars of diameter 16mm using both fresh water and saline water. These specimens were observed for 7days. These specimens were observed for 7 days, 14 days, 28 days and40 days up to 120 days to allow for compressive strength development before crushing under crushing machine.

III. RESULTS AND DISCUSSION

At the expiration of 120days of the research work, the following observations were noted as listed below:

Concrete samples (cubes) casted and cured with fresh water gained appreciable strength with age. Though, there was a slight decrease in the strength but later on, the strength was improved and the increase in strength became steady. The samples casted and cured with saline water (containing 3% to 5% salt) slowly increase in strength. The strength increment continued over the period of the experiment but the values were lower when compared with the fresh water concrete. The strength of concrete eventually increase due to the presence of salt content but its resultants effect on reinforcement will be alarming if proper care is not taken. Table 1 is showing comparative compressive strength under saline and fresh water. The strength was estimated of fresh water sample was 13.08N/mm2 and 12.10N/mm2 for saline water sample on 14th day, whereas strength was observed 13.98 N/mm2 for saline water and 14.89 N/mm2 fresh water on 28th day. The compressive strength observed on 40th day was 17.60 N/mm2 for fresh water and 16.02 N/mm2 for saline water respectively. In the last compressive strength was estimated on 120th day, the value was very much significantly impacting strength as 24.05 N/mm2 for fresh water and 21.01 N/mm2 for saline water.

Table 1 showing compressive strength in Fresh water and Saline Water

Compressive strength	**Compressive strength**
Fresh Water	Saline Water
8.02 N/mm2 (7 days)	7.05N/mm2 (7days)
13.08 N/mm2 (14days)	12.10 N/mm2 (14 days)
14.89 N/mm2 (28 days)	13.98 N/mm2 (28 days)
17.60 N/mm2 (40 days)	16.02 N/mm2 (40 days)
24.05 N/mm2 (120 days)	21.01 N/mm2 (120 days)

The saline water used for the experiment was also found to have effect on the compressive strength of the concrete from the result of the experiment. Well compaction is required for concrete work under saline condition and adequate cover in order to prevent ingress of salty water through the voids touching the reinforcement. Concrete cast and cured with fresh water increases in strength in gradual manner. The result quite agrees with the value of the compressive strength of the mix generally acceptable standard in 28 days. Acceptable strength of between 23N/mm2 25N/mm2 to be reached with mix ratio 1:2:4, it was observed that the same number of days (28 days) will not suffice the strength. The strength required will not be achieved on the same specified day for 1:2:4 concrete mix. Hence, the above is imperative in the stripping of the individuals section of reinforced concrete structure.

Special cement like sulphate resisting should be used in any environment where there are possibilities of ingress of salt containing chloride or sulphate ions. Strict adherence should be given to specifications most especially in any issue concerning reinforced concrete structures. The designed strength of each element of reinforced concrete structure should be attained before stripping of the forms for the members.

REFERENCES

[1] M. Bryant, “Effects of Seawater on Concrete”, U.S. Army Engineers, Miscellaneous Vol. 6, pp. 690, 1964.

[2] M. D. Cohen, and A. Bentur, “Durability of Portland cement Silica fume paste Magnesium Sulphate and Sodium Sulphate solution”, Material Journal, Vol. 89(6), pp. 85-98, 1988.

[3] P. Tiwari, R. Chandak and R. K. Yadav, “Effect Of Salt Water On Compressive Strength Of Concrete”, International Journal of Engineering Research and Applications, Vol. 4(4), pp. 38-42, (2014).

[4] M. W. Falah, “Effect of seawater for mixing and curing on structural concrete”, The IES Journal Part A: Civil & Structural Engineering, Vol. 3(4), pp. 235-243, 2010.

[5] V. O. Oyenuga, “Design and Construction of Foundations (A practical approach)” , 1st Edition by Asros Ltd. Lagos Nigeria, 2004.

[6] A. T. Michael, and S. Kuwaini, “Effect of ocean water salt on the compressive Strength of the Compressive strength of concrete”, Cement and Concrete Research, Vol. 8, pp. 492-500, 1978.