



EFFECT OF LAGOON AND FRESH WATERS ON THE COMPRESSIVE AND SPLIT TENSILE STRENGTH OF GRADE 40 CONCRETE

**¹Igba U.T., ¹Akinyele J.O., ¹Alayaki F.M., ¹Adetiloye A., ¹Oluwatudimu O.E. and ²Ehikhuenmen S.O.*

¹Civil Engineering Department, Federal University of Agriculture Abeokuta, Nigeria

²Civil and Environmental Engineering Department, University of Lagos, Akoka, Lagos State Nigeria.

**Corresponding Email: igbaut@funaab.edu.ng*

Manuscript Received: 20/05/2018 Accepted: 30/06/2018 Published: September, 2018

ABSTRACT

A comparative study of effect of Lagoon water and fresh water on concrete was done to determine the effect of Lagoon water and fresh water on compressive and split tensile strength of concrete. A total specimen of 10 cubes and 10 cylinders including specimens for reference concrete were cast for both mixes and exposed to 28 days period of curing. The concrete samples was fully submerged in the lagoon and cured for 28days. For this concrete cubes and cylinders were cast with Portland limestone cement of 42.5-R using fresh water and cured using both fresh water and lagoon water. The result showed that the average compressive strength of concrete obtained using fresh water was 42.6N/mm² compared to 36.4N/mm² of Lagoon water and the average split tensile strength of concrete obtained using fresh water was 2.9N/mm² compared to 2.69N/mm² of Lagoon water. There was a reduction in strength for cubes and cylinders cured in lagoon compared to those cured in fresh water but there was an increment in weight after curing for 28 days for both cubes and cylinders cured in the lagoon compared to fresh water which may be due to salt crystallisation formation affecting the strength gain.

Keywords: *Fresh Water, Lagoon Water, Compressive Strength, Split Tensile Strength*

INTRODUCTION

Concrete is one of the major building materials used in modern day construction, because of its durability to cost ratio. Water is one of the ingredients that form concrete as it actively participates in chemical reactions with cement.

Adebakin (2003), described fresh water as that purified expanse of water, which is devoid of any form of impurities. Whereas seawater is considered as water containing high percentage of Sodium chloride, only 2.5 Percent of the world's water bodies is said to be fresh water, the remaining constitute seawater. Sea water (SW) is a complex solution of many salts containing living matter, suspended silt, dissolved gases and decaying organic material. On an average, sea water has total salinity of about 3.5% per litre of sea water. Water containing large quantities of chlorides from sea water tends to have an adverse effect such as persistent dampness and surface efflorescence of concrete.

Krishnam, *et al.*, (2014) suggested that there is no quantitative reduction in compressive strength compared to target strength when the concrete is exposed to both "potable water mixing and sea water curing" and "mixing and curing by sea water". There is an increase in 7 days Split tensile strength of concrete for "Potable water mixing and sea water curing" in M30 and M35.

Olutoge, *et al.*, (2014) suggested that it was observed that concrete cast and cured with seawater increases gradually for all curing days beyond the strength of control cast (FF). The compressive strength of concrete batches FF agrees with the value of the compressive strength of 1:2:4 mix at 28days, of about 20N/mm². The strength of concrete batches cast with salt water and cured with fresh water (SF) was also observed to have increased even at 28 days and 90days respectively. Hence the aim of this study is to determine the strength properties and performance of concrete cured in both fresh water and Lagoon water for a period of 28days using Grade 40 concrete mix using ratio cement, fine aggregate and coarse aggregates (1:1:1).

MATERIALS AND METHODS

Material Used

The following are details of concrete ingredients materials such that coarse aggregate, fine aggregate, cement and water used in the experimental investigation. Coarse aggregate, fine aggregate and cement purchased from nearest place.

Coarse Aggregate - Granite was used in concrete mixing in this experimental study. Granite is formed naturally from stone that was quarried and crushed to produce various sizes of aggregate, the coarse aggregate size used for this study was 12mm and 19mm (mixed).

Fine Aggregate (sand) - The fine aggregate that was used for concrete mixing was river sand (Ogun River

sharp sand). River sand was selected because it was free from clay, organic material and chemical but was not easier to obtain. The river sand was checked to ensure that it was free from other organic materials inside before used. Fine aggregate are basically sands won from the land or the marine environment. Fine aggregates generally consist of natural sand or crushed stone with most particles passing through a 9.5mm sieve.

Cement:- Dangote PortlandR limestone cement which is locally processed, produced and distributed by Dangote Group of Companies was used in this research work.. The quality of the PortlandR limestone cement was proved by SIRIM (certified to MS 522-1:2007) and BS EN 197-1:2000. The cement was stored away from air moisture in the workshop to ensure the material was in good condition during the experimental period.. The properties of the Cement are confirming to BS 12, 1991 Specifications.

Table 1: Properties of Material used.

S/No	Specific Gravity	Fineness Modulus
Coarse Aggregate	2.66	2.65
Fine Aggregate	2.45	4.17
Cement	2.89	1.89

Fresh Water - Ordinary clean portable water free from suspended particles and chemical substances was used for both mixing and curing of concrete specimens cast with fresh water.

Lagoon water: - Lagoon water is an area of shallow water separated from the sea by low sandy dunes. On average, seawater in the world's oceans has a salinity of about 3.5% (35 g/L). This means that every kilogram (roughly one litre by volume) of seawater has approximately 35 grams of dissolved salts (predominantly sodium (Na⁺) and chloride (Cl⁻) ions.

Table 2. Water analysis results for fresh water and lagoon water

Parameter	Lagoon Water	Fresh Water
Colour	Dirty Light Yellow	Colourless
Odour	Odourless	Unobjectionable
Sediment (Mg/l)	5.0	3.0
Oil & Fats (Mg/l)	0.001	ND
PH	7.2	7.2
Nitrate (Mg/l)	2.62	0.55
Zinc (Mg/l)	2.7	0.6
Phosphate (Mg/l)	0.01	0.01
Sulphate (Mg/l)	7.0	2.0
Chloride (Mg/l)	48	6
Iron (Mg/l)	0.1	0.03
TDS (ppm)	230	50
Salinity (ppt)	0.09	0.01

To investigate the effect of Lagoon water and Fresh water on the compressive strength of concrete, half of the concrete cubes were cast and cured with fresh water and half of the concrete cubes were cast with fresh water and cured with Lagoon water.

The concrete cube size measuring 150×150×150mm in dimension was used. The batching of the concrete was carried out by weight. The mix proportion was calculated for characteristic compressive strength of 40N/mm² using ratio cement, fine aggregate and

coarse aggregates (1:1:1) with water cement ratio of 0.45. The concrete cubes mould were filled in three layers. In each of the layer, the concrete cubes will be compacted 25 times respectively. The concrete cubes were cast and cured for 28 days and tested for compressive strength.

The cylindrical mould of size 150mm x 300mm in dimension was used. The concrete cylinder were cast and cured for 28days and tested for split tensile strength.



Plate 1: Casting of samples in Unilag



Plate 2: Casting of concrete cubes and cylinder in Unilag



Plate 3: Casting of samples in Unaab



Plate 4: Fine aggregate used for casting in Funaab

RESULTS AND DISCUSSION

The test was carried out confirming to BS EN 12390-3 (2009) to obtain compressive strength and Split tensile strength of concrete at the age of 28 days. The cubes using Compressive Testing Machine, cylinder were tested using Compressive Testing Machine. The result of compressive strength, and split tensile strength are tabulated in Table 5 and Table 6.

(i) Compressive Test



Figure 1: Average Compressive Strength of C-40 Concrete.

(ii) Split Tensile Test

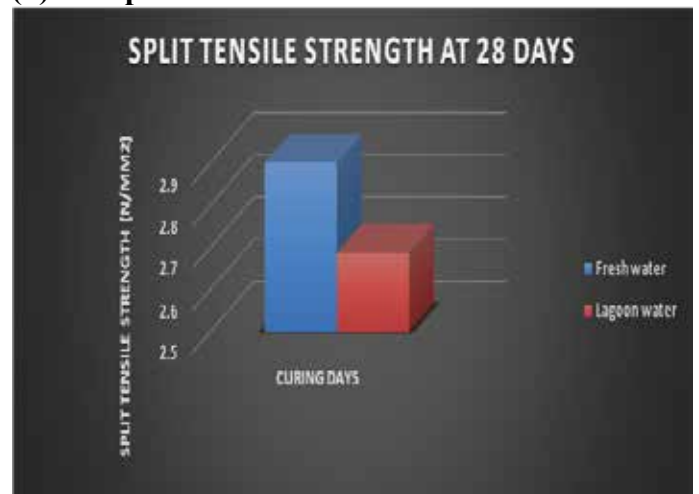


Figure 2: Average Split Tensile Strength of C-40 Concrete

Table 3: Density of Individual Materials

S/N	Lagoon water curing	Fresh/Potable water curing
Density of Cube	2397 kg/m ³	2361 kg/m ³
Density of Cylinder	2540 kg/m ³	2341 kg/m ³

ENERGY DISPERSIVE SPECTROSCOPY (EDS)

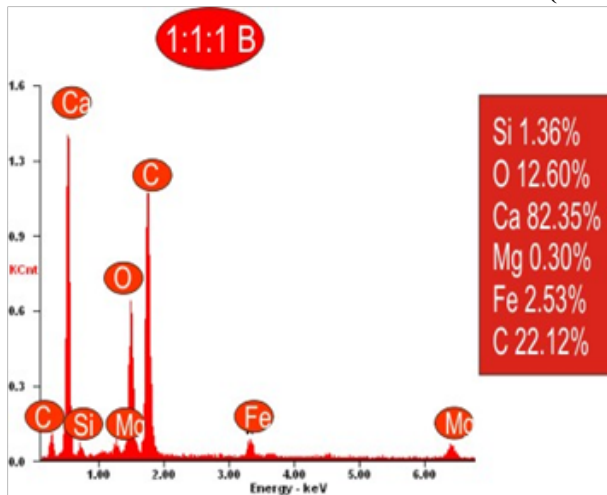


Fig3: 28days Grade 40 EDX Analysis Lagoon Water

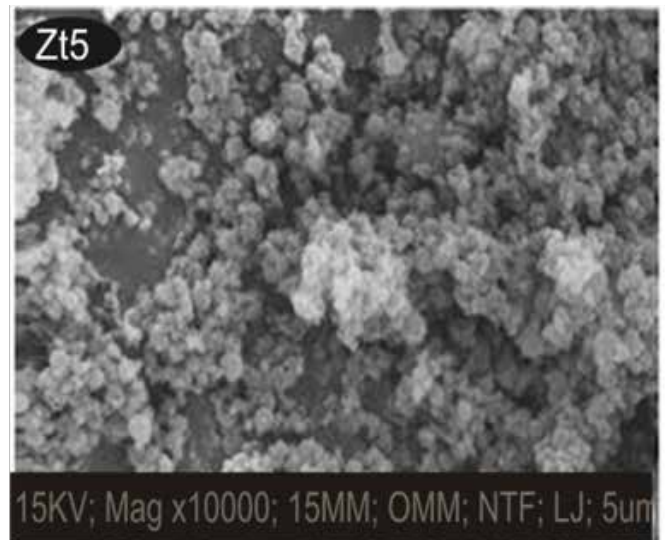


fig 6: 28days Grade 40 Funaab Potable Water

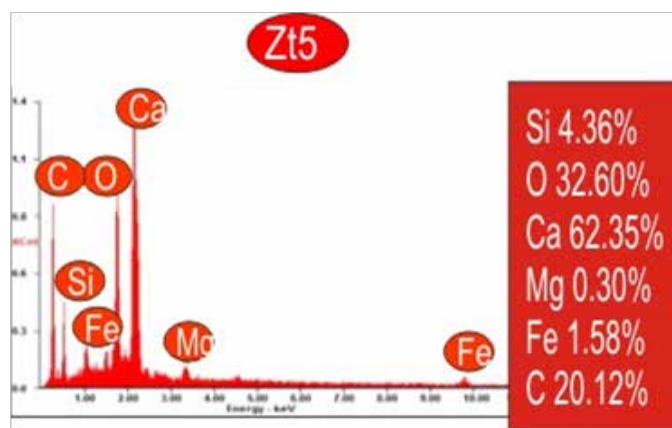


fig 4: 28days Grade 40 EDX Analysis potable Water

The result from the Quantitative and Qualitative Element analysis of the concrete samples: the X-Ray Fluorescence presented in element and elemental content while the energy dispersive spectroscopy (EDS) feature of the Skyray EDXRF 3600B presented a qualitative picture of the elemental composition using a graphical representation, with each peak labelled after the element it represents. The result showed that Calcium was the predominant element having 61.62% for Grade 40 for concrete sample cured in potable water and 82.35% for Grade 40 in the concrete sample cured using lagoon water.

Scanning Electron Microscope (SEM) Analysis

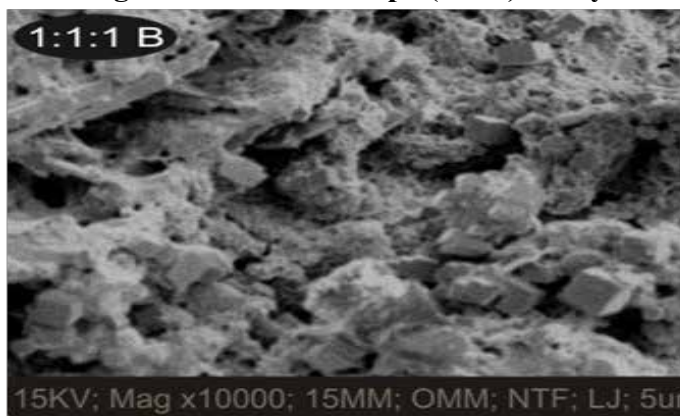


Fig 5: 28days Grade 40 Unilag Lagoon Water

The calcium-silica-hydrate (C-S-H) is a major phase present. The factors that influence the mechanical behavior of C-S-H phases are: size and shape of the particles, distribution of particles, particle concentration, particle orientation. The bright and dark matter in the images stands for C-S-H gel/paste and inert aggregates respectively.

The important point to be noted in the micrograph is that the C-S-H gel i.e. the bright masses with nodules and big chalky gel parts are spread over the entire micrograph.

CONCLUSION

Based on the results from this study, it is clear that the average strength of concrete cubes cast and cured in fresh water at 28 days was found to be higher in strength with a compressive strength of 42.6 N/mm², compared to 36.4 N/mm² the strength of concrete cubes cast with fresh water and cured in lagoon water at 28 days. Also, the average strength of concrete cylinders cast and cured in fresh water at 28 days was found to have a higher split tensile strength of 2.9 N/mm², compared to 2.6879 N/mm² the strength of concrete cylinders cast with fresh water and cured in lagoon water at 28 days. The microanalysis results showed that there was deterioration for concrete cylinder submerged in the Lagoon the split tensile strength reduced as the age of curing days increased unlike the concrete cylinder cured in potable waters where the split tensile strength increased as the age of curing days increased. The results showed that a higher percentage of Chlorine 48 mg/l to 6 mg/l, Salinity 0.09 ppt to 0.01 ppt, Sulphate 7 mg/l to 2 mg/l, Nitrate 2.62 mg/l to 0.55 mg/l, Zinc 2.7 mg/l to 0.6 mg/l and Total dissolved solid (TDS) 230 ppm to 50 ppm was found in Lagoon water compared to Fresh water. Overall, there was higher strength noticed in concrete specimen cast and cured using fresh water compared to the one cast with fresh water and cured in Lagoon water. An increase in density after 28 days for concrete cube and cylinder samples cured in the lagoon compared to those cured in fresh water was also observed.

REFERENCES

- Adebakin, H. I. (2003). Effect of Salinity on Compressive Strength on Concrete.
- Akinkurolere, O.O. *et.al.* (2007). *Journal of Engineering and Applied Sciences* 2(2). *Medwell Journals*, p 412-415.
- British Standard Institution. BS 12: 1991. Specification for Portland Cements. BSI. London.
- British Standard Institution. BS EN 197: 1. 2000. Cement Composition specifications and conformity criteria for common cements.
- British Standard Institute. BS EN 12390: 3-6. 2009. Testing of Hardened Concrete, Making and curing Specimens for Strength, Shape Dimension and Other Requirement for Specimens and Mould. BSI, London.
- Krishanam, P.R, Ravindra, V, Bhanusingh. M, (2014): Investigation on strength of concrete for marine works using opc and sea water.
- MS 522:Part 1:2007, Cement – Part 1: Compositions, specifications and conformity criteria for common cements .
- Olutoge, F. A. and Amusan, G. M. (2014). The Effect of Sea Water on Compressive Strength of Concrete.
- Osei, Y. A. (2000). Neutralization, New School Chemistry” African First Publisher Onitsha Nigeria.
- Swati, M. and Ashutosh, P. (2015): An Experimental Review of Effect of Sea Water on Compressive Strength of Concrete. *International Journal of Emerging Technology and Advanced Engineering (IJETAE)*, 5(3), pp 155-160.
- Water Encyclopaedia. (2012). Earth: The water Planet, (Ed). Earth Sylvia. Retrieved from [www.waterencyclopedia.com/ Da-En/ Earth- The water-planet.html](http://www.waterencyclopedia.com/Da-En/Earth-The-water-planet.html) # b.