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Original Research Article

Concrete Strength Variations of Washed and Processed Coarse Aggregate Sizes in Alkalinity

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Abstract: This project was carried out to know the effects of both Salt water and Freshwater on concrete when you wash the different aggregates used are washed in it. Salt water has salinity of about 3.5%. In that, about 78% is sodium chloride and 15% is chloride and sulphate of magnesium. The result expected from the experiment being carried out will show different results from the mix design, casting, curing and crushing of different dates on each Cube. The compressive strength of each cube will also be determined. The concrete mixtures incorporate crushed limestone, aggregate sizes of ½" (12.5mm) and 1" (25mm). The materials used are granite (Processed coarse aggregate), Sand stones, sand, Cement and water all washed and mixed at same ratio. A total of sixty-four (64) concrete mixes were considered in this project and all were cured in fresh water. Thirty-two (32) had its aggregates washed in salt water before use and the other thirty two (32) were washed in fresh water. The concrete mixes were tested and crushed at ages 7, 14, 21 and 28 days. The mix ratio was 1:2:4 and water cement ratio of 0.5, with granite and local stones used as aggregates, the sizes of aggregate used were ½" (12.5mm) and 1" (25mm). The results of tests obtained after 7, 14, 21 and 28 days and the results of tests involved in the work and that of compressive strength tests were calculated and tabulated later in the project. From my result, it is observed that the strength of granite of different sizes is greater than sand stone of the same size. For sandstone (local stone), it is observed that the compressive strength increases as the coarse aggregate size increases. Concrete test results to determine the effect of aggregate sizes on comprehensive strength shows that concrete with a 12.5mm (1/2") maximum size aggregate yields higher comprehensive strength than concrete with 25mm (1") maximum size aggregate for Granite but for Sand Stone the concrete with 25mm (1") size yields higher comprehensive strength than concrete with 12.5mm (1/2").

Keywords: Aggregate, Compressive Strength, Concrete, Fresh water, Salt water

1. INTRODUCTION

Concrete is a mixture of cement, water and aggregates in a given proportions.

Concrete that is freshly mixed ready to be moulded or poured into is any formwork is called plastic or green concrete. The mix ratio of the cement aggregates and water which form a concrete controls its properties in the wet state as well as in the hardened state. Concrete may be defined as a solid mass made by the use of a cementing medium, generally the ingredients compose of cement, sand, gravel and water. Its success and popularity may be largely attribute to

1. Ease with which it can be cast into a variety of shapes and sizes.
2. Its relative economy and easy availability.

Concrete is strong in compression but it is equally weak in tension. Strength is the most desired quality of a good concrete. It should be strong enough, at hardened state, to resist the various stresses to which it would be subjected. There are the wide use of it in structures from buildings to factories, from bridges to airports, makes it one of the most investigated materials of this century.

One of the essential materials for concrete is aggregate; it is of great importance to consider the qualities. Aggregate when washed with salt water may limit the strength and structural performance of concrete.

Aggregate occupies over one-third (1/3) of the volume of concrete and research indicates that changes

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in aggregate can change the strength and fracture properties of concrete. To predict the behaviour of concrete under loading requires an understanding of the effects of aggregate type, aggregate size and aggregate content and that can be achieved only through extensive testing and observation.

This experiment helps in assessing the suitability of aggregate used in concrete because aggregate considered poor in more than one respect is unlikely to make a satisfactory concrete.
In conclusion, this project describes work that is aimed at improving the understanding of the role that coarse aggregate (when washed with non salt and salt water) plays in the compressive behaviour of concrete

1.2 AIM OF THE WORK

The aim of this work is to determine the effect of coarse aggregate sizes on concrete strength under alkalinity (salty water concentrations).

1.3 OBJECTIVE OF THE WORK

i. The objective of the study is to know the adverse negative effects both salt water or non salt water will have on concrete when the aggregates involved are washed.
ii. To investigate the effect of coarse aggregates of sizes ½" (12mm) and 1" (25mm) on concrete strength.
iii. To vary the salty contain of the water used in concrete production and to determine the corresponding concrete strength.

1.4 SCOPE OF THE WORK

The experiment will involve the investigation of coarse aggregate sizes of

i. ½" (12.5mm) aggregates.
ii. 1" (25mm) aggregates.
iii. For both Sand stone (karokaro) and granites (processed coarse aggregate).
iv. Concrete mix ratio of 1:2:4 will be used.

1.5 LIMITATION OF THE WORK

- The only source of the water for salty conditions used was difficult estimating the percentage quantity of salt contained in the water.
- I encountered difficulty in moving the cubes from the school laboratory to the crushing site due to the lack of crushing machine in the laboratory.
- The insufficient amount of moulds available in the laboratory made it hard to carry out this project effectively.

2. LITERATURE REVIEW

The strength of Concrete is its major characteristics. To study the effect of coarse aggregate type and size on the behaviour of concrete, prismatic specimens were tested in compression. The concrete mixtures incorporated aggregate sizes of ½" (12.5mm) Or 1" (25mm), cement and water.

According to *Mbadike and Elinwa (2011)*, Cement generally represents 12-14% of concrete weight. It plays an active part in the mixture by ensuring cohesion between aggregate grains and in doing so; it introduces a decisive contribution to concrete mechanical strengths. During the hardening process, it generates shrinkage and heat dissipation phenomena which lead to material cracking. Aggregates help to reduce shrinkage and heat dissipation during hardening and also contribute to increase in the mechanical strength of concrete.

Young and Sam (2008), also stated that smooth rounded aggregates was more workable but yielded a lesser compressive strength in the matrix than irregular aggregates with rough surface texture. They were also of the opinion that a fine coating of impurities such as silt on the aggregate surface could hinder the development of a good bond and thus affects the strength of concrete produced with the aggregates.

Chen and Liu, (2004) as well as *Rao and Prasad, (2002),* viewed aggregates as the skeleton of concrete and consequently persuaded that all forms of coatings should be avoided in order to achieve a good concrete. When a concrete mass is stressed, failure may originate within the aggregates, the matrix, or at the aggregate-matrix interface. The aggregate-matrix interface is an important factor determining the strength of concrete.

Abdullahi (2013), Established that aggregate type has effect on the compressive strength of normal concrete and concluded that concrete made from crushed quartzite demonstrates higher compressive strength at all ages compared to the concrete with granite as a coarse aggregate.

Shetty (2009), defined durability of concrete as "its ability to resist weathering action, chemical attacks, abrasion, or any other process of deterioration". The durability of the concrete can be affected by chemical attack through the actions of aggressive ions such as chlorides, sulphates and many other natural or industrial liquids and gases.

There is strong evidence that aggregate type is a factor in the strength of concrete. *Ezeldin and Aitcin (1991)* compared concretes with the same mix proportions containing four different coarse aggregate types. They concluded that, in high-strength concretes, higher strength Coarse aggregates typically yield higher compressive strengths, while in normal strength concrete, coarse aggregate strength has little effect on compressive strength.

Jimoh and Awe (2007) investigated the size of aggregate that will improve the properties of structural normal concrete and concluded that the use of quarry dust and 20mm granite improved the concrete strength by 34% over the strength produced by concrete with sand and gravel of 28mm maximum size. Also as coarse aggregates size increases, normal concrete strength decreases.

According to *Mehta and Monteiro (1993)*, Concrete is a mixture of cement, water and aggregates in a given proportions. Aggregate represents some 60-80% of concrete volume. They are inert grains bound together by means of a binder which is cement. Although inert, they introduce an important contribution to these major characteristics which make concrete the most favoured building material. Aggregates help to reduce shrinkage and heat dissipation. The compressive strength of both normal and high-strength concrete is affected by aggregate size.

The test carried out by *Soroka, (1993)*, revealed the variations between the compressive strengths of concrete made with crushed stone and uncrushed stone. He achieved a better compressive strength with the crushed stone than the uncrushed stone. This strength performance was as a result several factors like water/cement ratio, grading, surface texture, shape, strength, and stiffness of aggregates used.

Crushed stone produces much more angular and elongated aggregates, which have a higher surface-to-volume ratio, better bond characteristics but require more cement paste to produce a workable mixture *(Kosmatka and Panarese 1994)*.

"When the particles are of uniform size the spacing is the greatest, but when a range of sizes is used the void spaces are filled and the paste requirement is lowered. The more these voids are filled, the less workable the concrete becomes, therefore, a compromise between workability and economy is necessary" *(Nathan Philips 1999).*

Neville (1995), Stated that aggregates are inert materials that are dispersed throughout the cement paste whose strength depends majorly on its shape, surface texture and cleanliness. He further published his finding that entirely smooth coarse aggregates lowered the strength of concrete by 10% than when the aggregates were roughened.

All the methods of curing, except air curing (the control) produced concrete specimens that met the minimum compressive strength of 21 N/mm² at 28 days specified by National Building Code (2006).

There has not been much research on the effects of coarse aggregate content on the fracture energy of concrete. There is much controversy concerning the effects of coarse aggregate size on concrete, principally about the effects on fracture energy.

3. RESEARCH METHODOLOGY

A total of sixty-four (64) concrete mixes were considered in this project and all were cured in fresh water. Thirty-two (32) had its aggregates washed in salt water before use and the other thirty two (32) were washed in fresh water. The concrete mixes were tested and crushed at ages 7, 14, 21 and 28 days. The test specimens were casted using an ordinary Portland cement (Dangote 3x). The mix ratio was 1:2:4 with gravel and local stones used as aggregates. The sizes of the coarse aggregate used were ½" (12.5mm) and 1" (25mm). The water cement ratio taken was 0.50. The fresh water used for the mixing and curing the concrete specimens were drinking water, and the salt water was used. A target slump of 50-100mm was selected for all mixes and all the required materials for preparing concrete were weighed as per the required proportions. All dry materials were placed in the pan and mixed until uniform. All the specimens were remoulded after 24hours of casting and were kept in curing liquid up to the testing dates.

3.1 SIEVE ANALYSIS

The sieve analysis of the fine aggregate was performed to determine the particle size distribution. The samples collected were dried in the laboratory for seven days before carrying out the sieve analysis. The method adopted in this experiment was the dry sieving method. The results obtained from the analysis are presented in chapter four. Total mass sieved was 500g for Sand.

3.2 SLUMP TEST

Slump test is the most commonly used test to measure consistency of concrete. It is not good for very wet or very dry concrete. The equipment used for slump consists of a metallic mould in the form of a frustum of a cone and it is provided with suitable guides for vertical lifting. Always do your slump test before making your cubes to ensure the concrete is usable. If the slump test fails to meet the range limit as dictated by the British standard then the load should be rejected.

The concrete slump test measures the consistency of fresh concrete before it sets. It is performed to check the workability of freshly made concrete, and therefore the ease with which concrete flows. It can also be used as an indicator of an improperly mixed batch. The slump test is used to ensure uniformity for different loads of concrete under field conditions.

Procedures

The test is carried out using a metal mould in the shape of a conical frustum known as a slump cone or Abrams cone, which is open at both ends and has attached handles. The tool typically has an internal diameter of 100 mm at the top and 200mm at the bottom with a height of 300 mm. The cone is placed on a non porous base plate.

Clean the internal surface of the cone and apply oil. Place the cone on a smooth horizontal non-porous base plate. This cone is filled with fresh concrete in three stages. Each time, each layer is tamped 35 times with a 600 mm long metal rod measuring about 16 mm in diameter. At the end of the third stage, the concrete is struck off flush with the top of the mould and clean away the water leaked out between the mould and the base plate. The mould is carefully lifted vertically upwards, so as not to disturb the concrete cone, the concrete then slumps. The slump of the concrete is measured by measuring the distance from the top of the slumped concrete to the level of the top of the slump cone.

The slump concrete takes various shapes and according to the profile of slumped concrete, the slump is termed as true slump, shear slump or collapse slump *(Wikipedia)*. If collapse slump is achieved, a fresh sample should be taken and the test repeated, a collapse slump is an indication that the mix is too wet. Only a true slump is of any use in the test.

NOTE: This test should be carried out at a place free from vibrations or shock and within a period of 2 minutes after sampling.

3.3 CUBE TEST

The concrete cube size measuring 150mm X 150mm X 150mm in dimension was used. The batching of the concrete moulds was by weight. The concrete cubes were lubricated with oil before the mixed concrete was placed inside it in other to reduce friction between the concrete and the cubes.

When the concrete was properly mixed the concrete cubes were filled to one third of their height and compacted. The cubes were later filled to two third of their height and finally filled completely. In each of the layer, the concrete cubes were compacted 35 times respectively. For each of the hydration period, two cubes were tested and the average compressive strength recorded.

The mixing was carried out at the concrete laboratory department of Civil Engineering Nnandi Azikiwe University, Anambra state. In concrete engineering the techniques of mixing is by hand and machine. In hand mixing uniformity is more difficult to achieve, particular care and effort are necessary. However, the method adopted for this particular project is hand mixing. Tools used in this project includes; a hard surface platform, shovel, gallon of water, measuring cylinder, a bucket, hand trowel, scrapper and a mould.

Procedures

Cement, sand and washed gravel were carefully measured in the closet range of proportion given. The mix proportions used are 1:2:4 (1 represents Cement, 2 represents Sand and 4 represents Aggregate). The main procedures involved Mixing and Batching, Curing and Crushing.

NOTE:

> *Minimum of two specimens were tested at each selected age. The strength of any specimen varying more than 15% of the average strength was rejected. The average of two specimens gave the crushing strength of concrete.*

SUMMARY:

After the calculation the samples were weighed. After weighing the material was mixed properly with shovel, turning the mixture from side to side and cutting on the platform three times. The mixture was turned again, usually three times, until it appears uniform in colour and consistence. Remove the cubes from the mould after 24 hours and cure in fresh water till the day of crushing.

It's very important to uniquely identify each of the cubes and moulds and to record where they have come from. Usually companies will have a process of labelling or tracking the cubes so make sure you ask first and record it properly. Make sure the cube ID is transferred to the cube from the mould before placing into a curing tank and the cubes were fully submersed at all times in the tank.

Curing is an essential process that controls the loss of moisture from concrete either after it has been placed in position or during manufacture of concrete products, thereby providing time for the hydration of the cement to occur. The hydration continues for about days and even weeks, therefore curing is undertaken for a reasonable period of time if concrete is o achieve its potential strength and durability. Adequate curing of concrete is essential for the proper strength development and durability of concrete. With proper curing, concrete becomes stronger, more impermeable and more resistant to stress. The improvement is rapid at early ages but continues more slowly thereafter for an indefinite period.

All the methods of curing, except air curing (the control) produced concrete specimens that met the minimum compressive strength of 21 N/mm² at 28 days specified by National Building Code (2006).

Observation

A lot of turnings were observed which contributes to the strength of the concrete.

The mixing was done on a hot afternoon day. The cement platform was very dry, the dried surface absorbed water from the concrete mixture. Mixing time was adversely affected, in theory; the mixing time does not exceed two to three minutes, after water has been added. This theoretical time specified was greatly exceeded. The Concrete was compacted very well to prevent air void which helped improve the strength. The metal moulds were always firmly attached to its metal plate. The metal moulds were always washed and oiled always to resist friction. Made sure the ground for the mixing and casting of the cubes had no form of vibration.

4. RESULTS AND ANALYSIS

The results obtained from the laboratory are presented here.

4.1 COMPRESSIVE STRENGTH ANALYSIS

This project presents the statistical analysis of compressive strength of concrete specimen delivered at Anambra state material testing laboratory, Awka. The type of concrete was analyzed defined as C20. The results of tests obtained after 7, 14, 21 and 28 days and the results of tests involved in the work and that of compressive strength tests are summarised below.

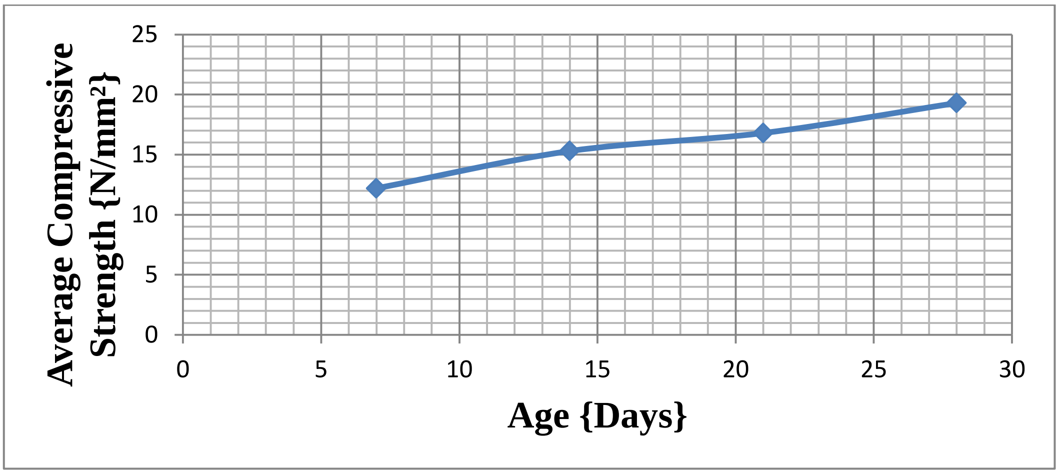

Figure 4.1: A Plot of the Compressive Strength of ½" (12.5mm) Local Stone washed with fresh water against Days Cured.

12.5mm Sand Stone washed with Fresh water, there is 20.26% increase in average compressive strength between 7 and 14 day, also an 8.93% increase between 14 and 21days and finally a 12.95% between 21 and 28 days of curing. This shows that between 7 and 14 days the concrete cube acquired least strength and between 21 and 28 days of curing the concrete cube acquired the highest strength but highest percentage increase in strength occurred between 7 and 14 days while the least occurred between 14 and 21 days.

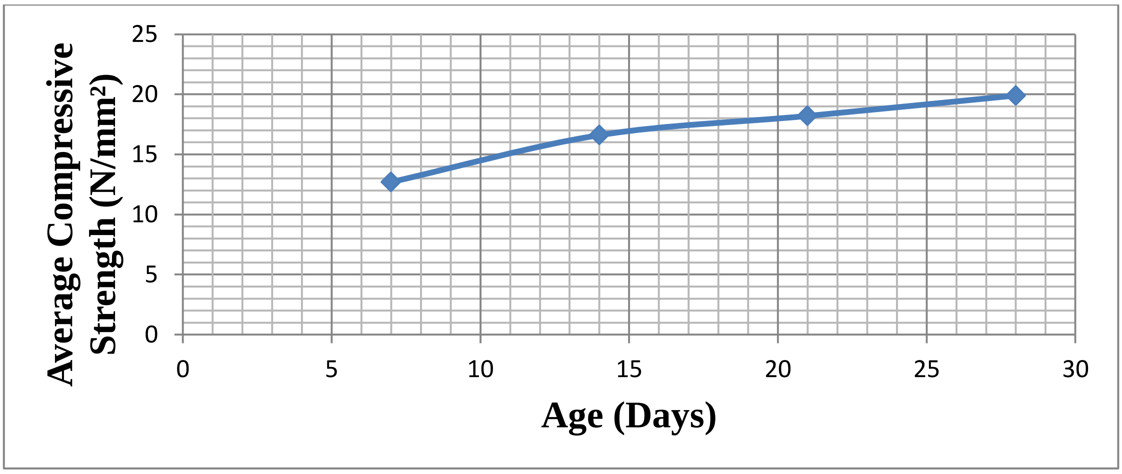

Figure 4.1: A Plot of the Compressive Strength of 1" (25mm) Local Stone washed with fresh water against Days Cured.

25mm Sand Stone washed with Fresh water, there was 23.49% increase in average compressive strength between 7 and 14 days, 8.79% increase in strength between 14 and 21 days curing and 8.54% increase in strength between 21 and 28 days curing. I observed that between 21 and 28 days the concrete cube gained the highest strength and the least strength between 7 and 14 days, but the highest percentage increase in strength occurred between 7 and 14 days while the least occurred between 14 and 21 days.

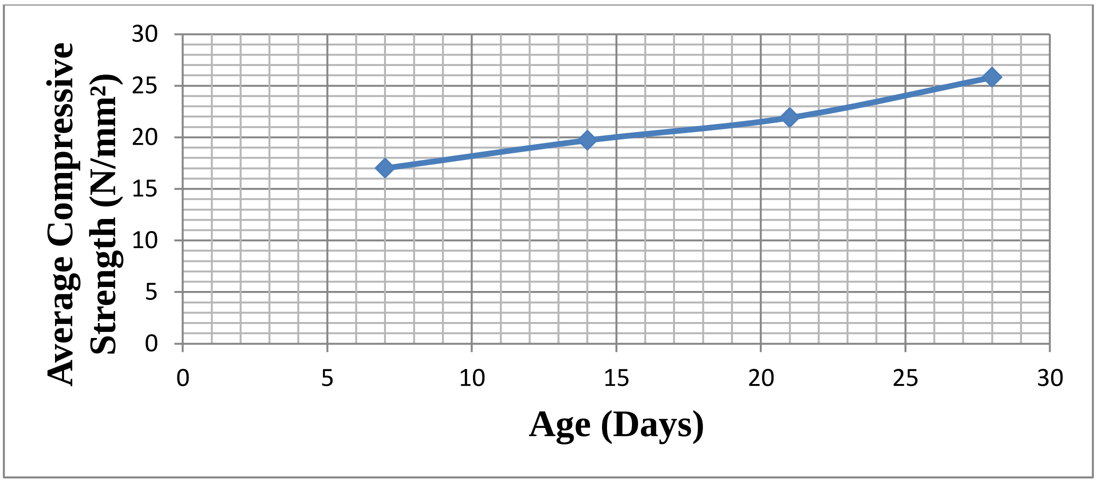

Figure 4.3: A Plot of the Compressive Strength of ½" (12.5mm) Granite washed with fresh water against Days Cured.

12.5mm Granite washed with Fresh water, a 13.71% increase- in Average compressive strength between 7 and 14 days curing, 10.05% strength increase between 14 and 21 days and a 15.12% increase in strength between 21 and 28days curing was witnessed. This shows that the highest strength gained was between 21 and 28 days but the least was between7 and 14 days. But the highest percentage strength gained was between 21 and 28 days while the least was between 14 and 21 days.

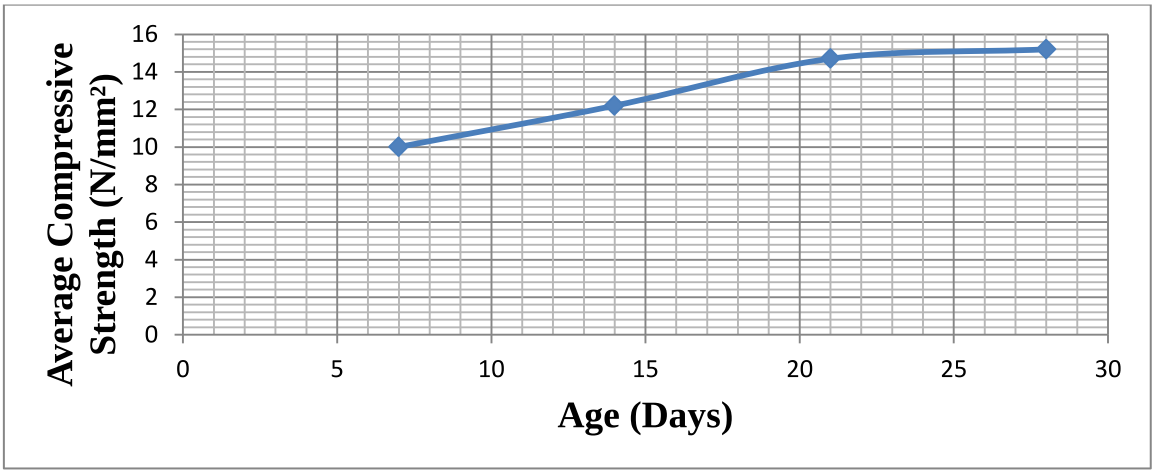

Figure 2.4: A Plot of the Compressive Strength of 1" (25mm) Granite washed with fresh water against Days Cured.

25mm Granite washed with Fresh water, the average compressive strength between the 7 and 14 days curing increased by 12.50%, a 13.62% strength increase was also seen between 14 and 21days and a 15.81% increase between 21 and 28 days. But the highest percentage strength increase occurred between 21 and 28 days while the least occurred between 7 and 14 days.

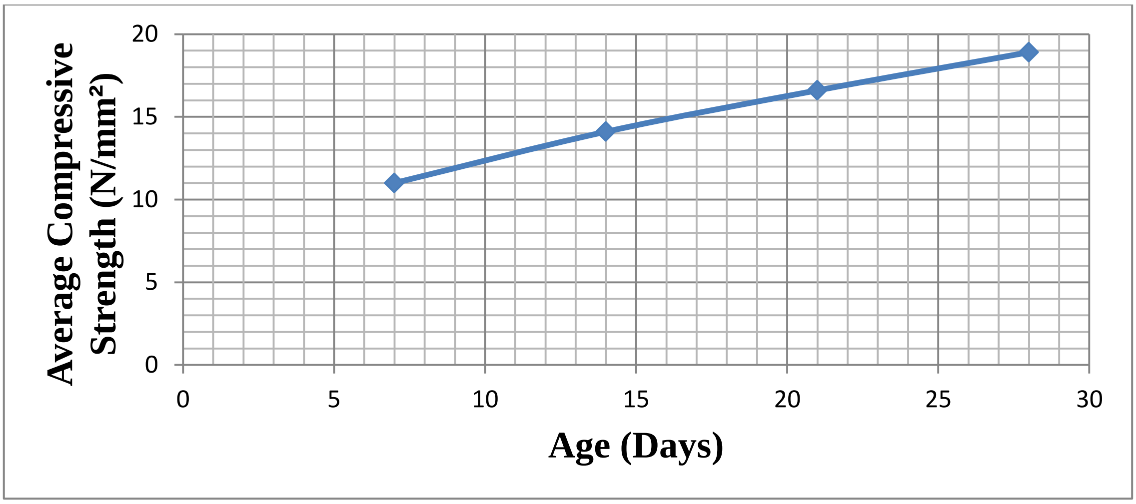

Figure 4.5: A Plot of the Compressive Strength of ½” (12.5mm) Local Stone washed with salt-water against Days Cured.

12.5mm Sand Stone washed with Salt water, a strength increase of 18.03% between 7 and 14 days curing, also a strength increase of 17.01% between 14 and 21 days and an increase of 3.29% between 21-28 days curing were witnessed. But the highest percentage increase occurred between 7 and 14 days while the least occurred between 21 and 28days.

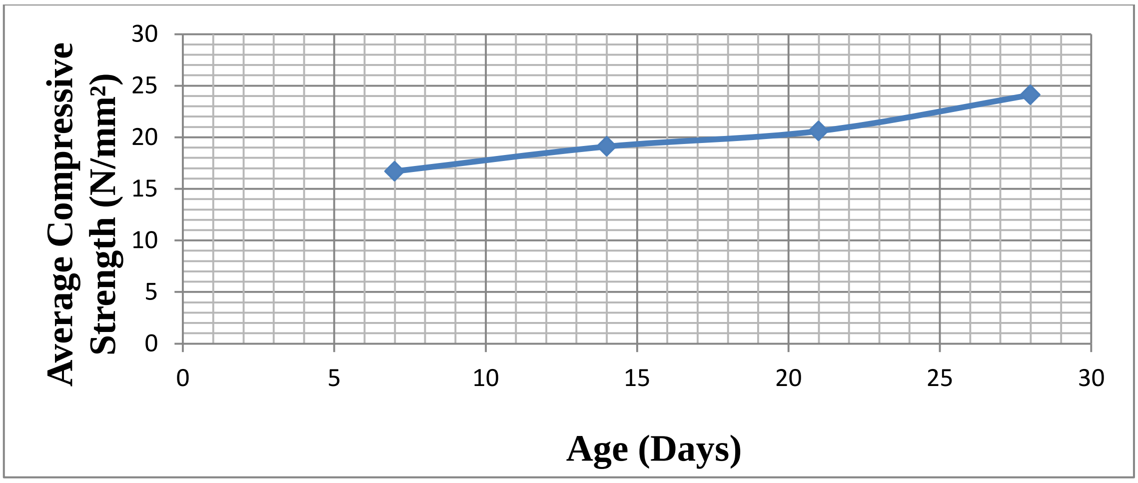

Figure 4.3: A Plot of the Compressive Strength of 1” (25mm) Local Stone washed with salt-water against Days Cured.

25mm Sand Stone washed with Salt water, a 21.99% increase in strength between 7 and 14 days curing, 15.06% increase between 14 and 21 days and a 12.17% increase in strength between 21 and 28 days curing was recorded. But the highest percentage strength increase was between 7 and 14 days while the least was between 21 and 28 days.

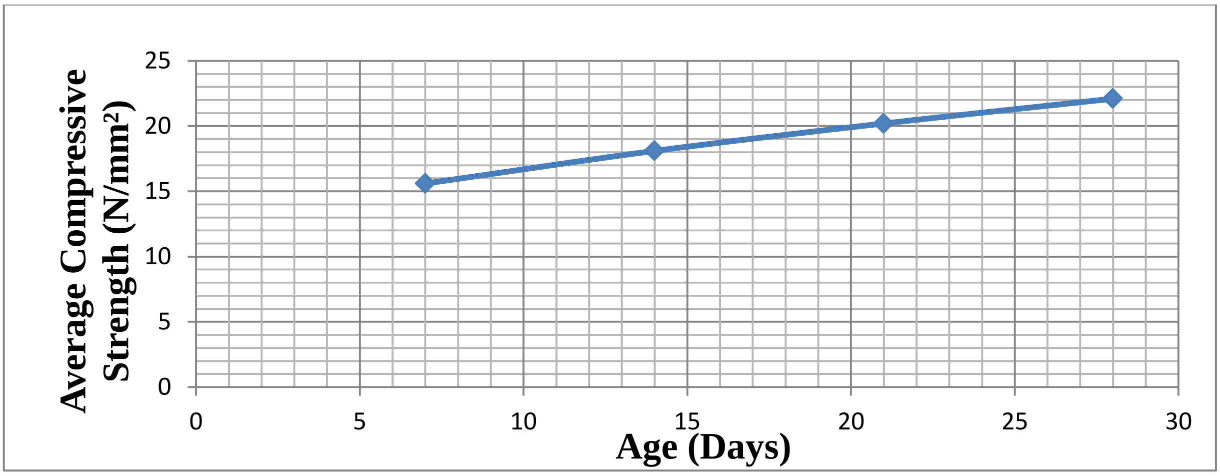

Figure 4.7: A Plot of the Compressive Strength of ½" (12.5mm) Granite washed with salt-water against Days Cured.

12.5mm Granite washed with Salt water, 12.57% increase in strength between 7 and 14 days curing, 7.28% increase between 14 and 21 days and 14.52% increase in strength between 21 and 28 days was recorded. But the highest percentage strength increase occurred between 21 and 28 days while the least occurred between 14 and 21 days.

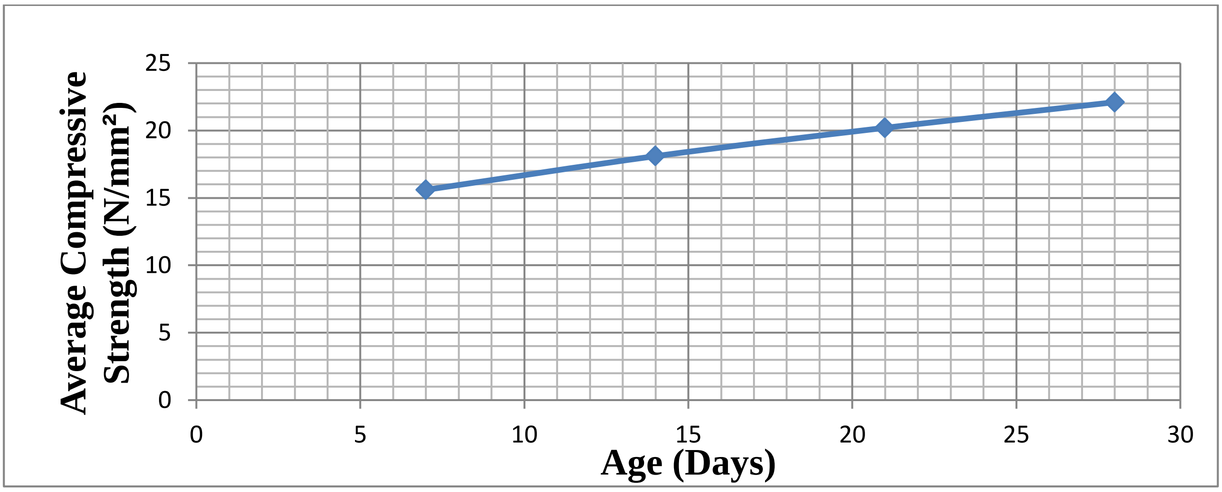

Figure 4.8: A Plot of the Compressive Strength of 1" (25mm) Granite washed with salt-water against Days Cured.

25mm Granite washed with Salt water, 13.81% increase in strength between 7 and 14 days curing, 10.40% increase in strength between 14 and 21days and 8.60% increase in strength between 21 and 28 days were recorded. But the highest percentage -strength increase occurred between 7 and 14 days while the least occurred between 21 to 28 days.

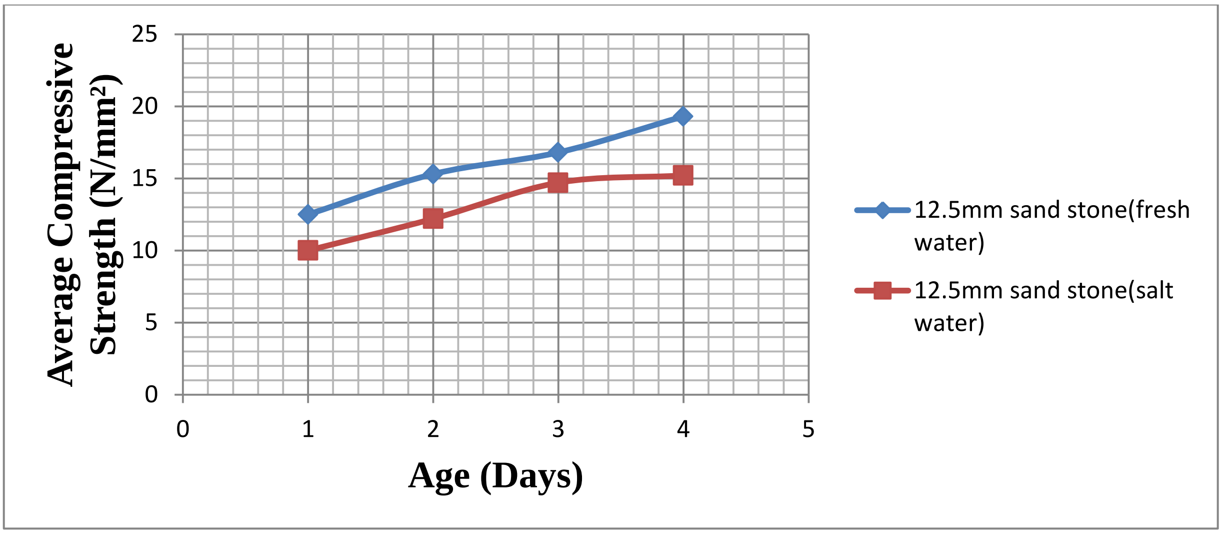

Figure 4.4: A Plot of Compressive Strength of ½" (12.5mm) Sand Stone both washed with fresh water and Salt-water against Days Cured.

From the comparison of **12.5mm Sand Stone washed with Fresh and salt water** showed that the aggregate washed with Fresh water yielded higher strength in all days cured and a 20.26% strength increase between 7 and 14 days curing of aggregates washed with fresh water shows the highest percentage increase of both aggregates while a 3.29% increase between 21 and 28 days for aggregate washed with salt water shows the least percentage strength increase in both aggregates.

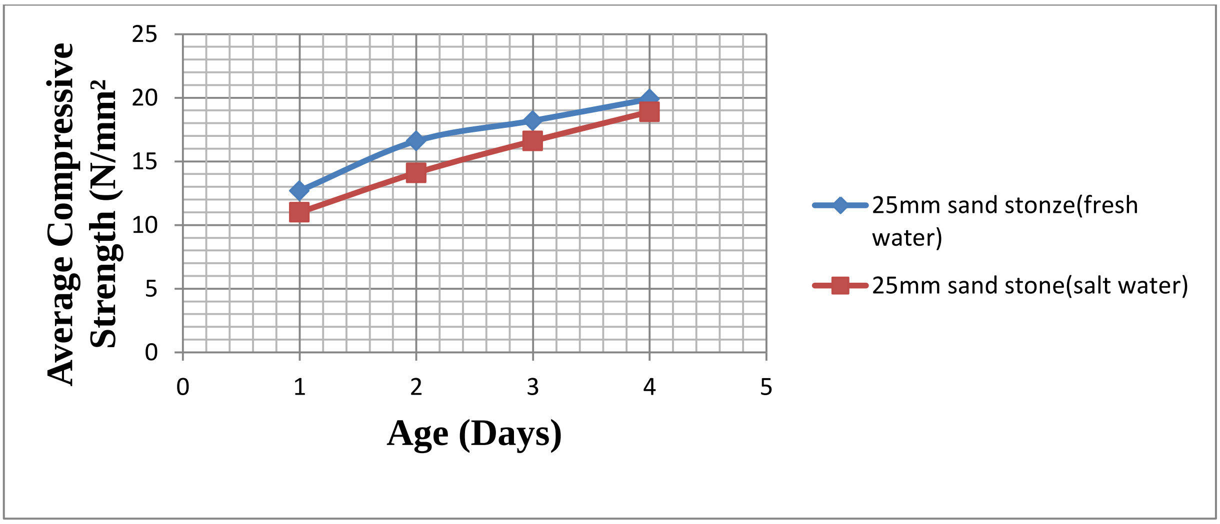

Figure 4.10: A Plot of Compressive Strength of 1" (25mm) Sand Stone both washed with fresh water and Salt-water against Days Cured.

From the comparison of **25mm Sand Stone washed with Fresh and salt water** showed that the aggregate washed with Fresh water yielded higher strength in all days cured and a 23.49% strength increase between 7 and 14 days curing of aggregates washed with fresh water shows the highest percentage increase of both aggregates while a 8.54% increase between 21 and 28 days for aggregate washed with fresh water shows the least percentage strength increase in both aggregates.

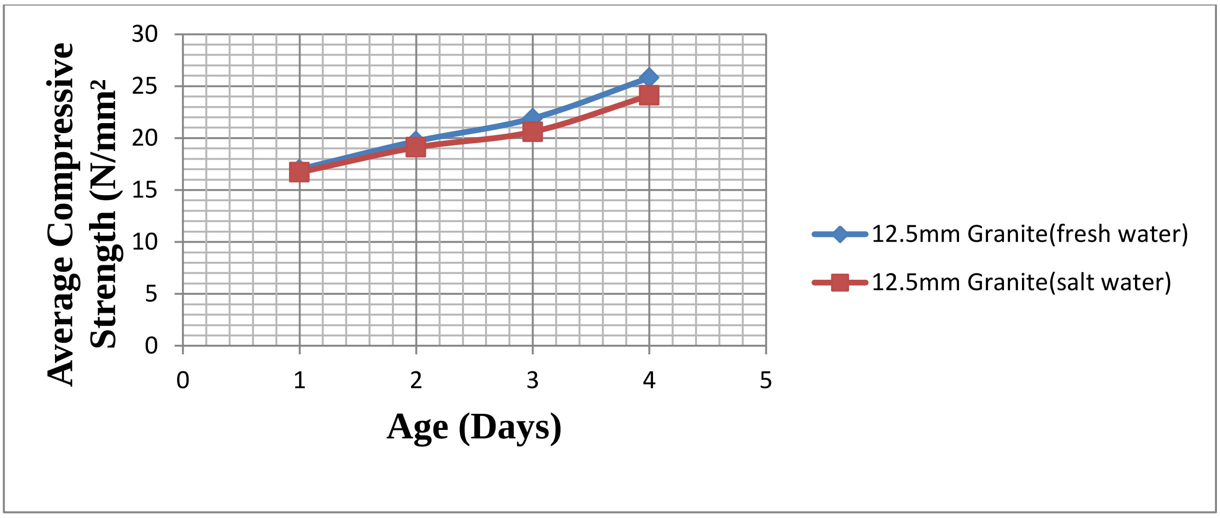

Figure 4.11: A Plot of Compressive Strength of ½" (12.5mm) Granite both washed with fresh water and Salt-water against Days Cured.

From the comparison of **12.5mm Granite washed with Fresh and salt water** showed that the aggregate washed with Fresh water yielded higher strength in all days cured and a 15.12% strength increase between 21 and 28 days curing of aggregates washed with fresh water shows the highest percentage increase of both aggregates while a 7.20% increase between 14 and 21 days for aggregate washed with salt water shows the least percentage strength increase in both aggregates.

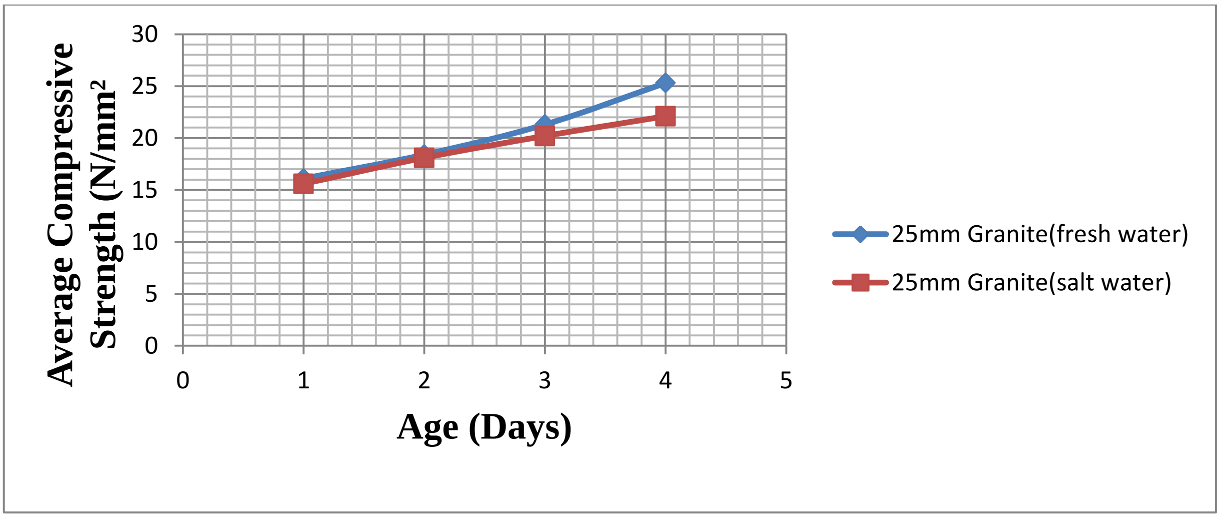

Figure 4.12: A Plot of Compressive Strength of 1" (25mm) Granite both washed with fresh water and Salt-water against Days Cured.

From the comparison of **25mm Granite washed with Fresh and salt water** showed that the aggregate washed with Fresh water yielded higher strength in all days cured and a 15.81% strength increase between 21 and 28 days curing of aggregates washed with fresh water shows the highest percentage increase of both aggregates while a 8.60% increase between 21 and 28 days for aggregate washed with salt water shows the least percentage strength increase in both aggregates.

4.2 DISCUSSIONS

The following were observed from the results gotten;

1. The result gotten from crushing of the cubes shows that the compressive strength tends to increase as the days of curing increases.
2. The result showed that aggregates washed with fresh water have high compressive strength than aggregates washed with salt water.
3. The result shows that the smaller the aggregate size in Granite, the higher the compressive strength.
4. The result shows that the bigger the aggregate size in Local Stone, the higher the compressive strength.
5. The percentage increase in strength for sand stones is higher between the 7 and 14 days and the lowest between 21 and 28 days except for

12.5mm washed with fresh water which fall between 14 and 21 days.

6. The percentage increase in strength for granite is higher between 21 and 28 days and the lowest vary between the days.
7. Salt water slightly accelerates the early strength of concrete, but it reduces the 28days strength of concrete by 7-15%.
8. The chemical reactions between cement and water that cause the parts to harden and bind the aggregates together require time. The reactions take place very rapidly at first and the time slows down.
9. Irregularity in shape of the cube affected the compressive strength of the concrete which involved wooden moulds.

5 CONCLUSIONS

Based on the investigation of the effect of aggregate sizes on the concrete strength, analyzed above, the following conclusions can be drawn:

i. Concrete test results to determine the effect of aggregate sizes on comprehensive strength shows that concrete with a 12.5mm (1/2") maximum size aggregate yields higher comprehensive strength than concrete with 25mm (1") maximum size aggregate in Granite.
ii. The workability of the different aggregate sizes at the same water-cement ratio of 0.5 decreases as the aggregate size increases.
iii. For sandstone (local stone), it is observed that the compressive strength increases as the coarse aggregate size increases
iv. From my result, it is observed that the strength of granite of different sizes is greater than sand stone of the same size.
v. For granite the compressive strength increase as coarse aggregate sizes decreases.
vi. To get the highest compressive strength of concrete it is advisable to allow it cure over a long period.
vii. Salt water reduces the strength of concrete and can possibly lead to corrosion of reinforcement in certain cases.
viii. The percentage strength increase of sand stone in concrete are always highest between 7 and 14 days.
ix. For granite the increase in compressive strength are mostly highest between 21 and 28 days.

5.2 RECOMMENDATIONS

1. Coarse aggregates with the appropriate size must be used in the production of concrete in accordance with the specified concrete strength and workability.
2. Mix ratio design, batching and mixing of materials must be effectively monitored and supervised by professional engineers to ensure that the right quantity and sizes of materials are employed as this is a critical aspect of quality control.
3. Mixing of concrete materials should be by machines (batching plants) since most often manual mixing does not produce concrete with high workability.
4. Granites are better type of coarse to be used in concrete construction than sand stones.
5. Wooden mould should not be used for casting of concrete because it gives a poor compressive strength when the concrete is been crushed.
6. For heavy duty structures lower aggregate sizes should be used in the concrete mix.
7. Salt water should not be used for reinforced concrete to avoid corrosion of the reinforcement.

REFRENCES

1. Abd-Hamid N.A. And. Abas, N.F (2015*): "A study on effects of size coarse aggregates in concrete". Journal Technology, University Technology, Malaysia.*
2. Abdulahhi, M. (2013): "*Effects of aggregate type on compressive strength of concrete*" *International journal of Civil and Structural Engineering.*
3. Aginam, C.H, Chidolue, C.A. and Nwakire, C. (2013): "*Investigating the Effects of coarse Aggregates Types on the Compressive Strength of Concrete".*
4. Ajagbe W. And Adewole K. (2005): "*Determination of Appropiate mix ratios for Concrete grades using Nigerian Portland limestone grades 32.5 and 42.5".*
5. BS 1377; Part 2, (1990): "*Methods for Test of Soils for Civil Engineering Purposes, British Standard Institute".*
6. BS 8110 (1997): "*Structural use of concrete: - Code of practice for design and Construction. Part1. British Standard Institute. London".*
7. BS 812 (1995*): "Aggregate test: - Method for determination of particle size distribution. Part103 British Standard Institute. London"*.
8. BS EN 1008 (2002): "*Mixing water for concrete: - Specification for sampling, testing and assessing the suitability of water, including water recovered from processes in the concrete industry, as mixing water for concrete. British Standard Institute London".*
9. BS EN 12350 (2000): "*Testing Fresh Concrete-Slump test. Part 2. British Standard Institute London"*.
10. Chen, B. and Liu, J. (2004): "*Construction and Building Materials"*.
11. Cook, Gabriel W., (2017): *"Effects of Wash Water on the Compressive Strength of Concrete"*.
12. Ezeldin and Aitcin (1991): "*Effect of Coarse Aggregate on the Behaviour of Normal and Normal Strength Concretes".*
13. Fowler D.W. and Quiroga P. (2004): "*The Effects of Aggregates characteristics on the Portland cement Concrete".*

14. James, T., Malachi, A., Gadzama, E.W., and Anametemfiok, V. (2011): "*Effects of Curing Methods on the Compressive Strength of Concrete*", *Nigerian Journal of Technology*, ***Vol.*** *30.*
15. Jimoh A. A and Awe S. S (2007*): "A study on the influence of aggregate size and type on the compressive strength of concrete", Journal of Research Information in Civil Engineering.*
16. Joseph O.U., Maurice, E.E., and Godwin, A.A. (2012): "*Compressive Strength of Concrete Using Lateritic Sand and Quarry Dust as Fine Aggregate", ARPN Journal of Engineering and Applied Sciences.*
17. Kosmatka H. And Panarese S. (1994): "*Design and Control of Concrete Mixtures".*
18. Mbadike E.M. and Elinwa A. U. (2011): "*Effects of salt water in the Production of Concrete".*
19. Monteiro J.M. and Mehta K. (1993): "*Concrete: Microstructure, properties and Materials".*
20. Nathan P.J (1999): "*Effect of Concrete Materials on Permeability of concrete Mixes used in paving Projects".*
21. Neville, A.M. (1995): "*Properties of Concrete (Third Edition)" Longman Group Ltd. London, UK.*
22. Obi, L.E. (2017*): "Evaluation of Effects of Coarse Aggregate Sizes on Concrete Quality".*
23. Shetty M.S. (2009): "*Concrete Technology Theory and Practices", Chad and Company Ltd., Ram Nagar, New Delhi, Edition.*
24. Soroka, I. (1993): "*Concrete in Hot Environments", Alden Press, London UK.*
25. Tumidajski P. J. And Gong B. (2006): *Journal of Civil engineering on* "*Effect of Coarse Aggregate size on Strength and Workability of Concrete".*
26. Udoeyo, F. F. (2006): "*Strength performance of Laterized Concrete Construction and Building Material".*
27. Young, T.L. and Sam, A.R.M. (2008*): "Performance of Concrete Containing Engine Oil", Thesis Submitted to the University of Technology, Kuala Lupur, Malaysia.*

APPENDICES

Table 4.1: ½" (12.5mm) Local Stone washed with fresh water

S/N	PARAMETER	7Days		14Days		21Days		28Days	
1	Cross Sectional Area (mm²)	22500	22500	22500	22500	22500	22500	22500	22500
2	Mass Of Cube (kg/m³)	8.65	8.60	8.95	8.90	8.90	8.60	8.60	8.50
3	Maximum Crushing Load (kN)	261.4	288.3	339.6	350.5	376.0	383.2	428.2	442.1
4	Compressive Strength (N/mm²)	11.6	12.8	15.0	15.5	16.7	17.0	19.0	19.6
AVERAGE COMPRESSIVE STRENGTH (N/mm²)		12.2		15.3		16.8		19.3	

Table 4.2: 1" (25mm) Local Stone washed with fresh water

S/N	PARAMETER	7Days		14Days		21Days		28Days	
1	Cross Sectional Area (mm²)	22500	22500	22500	22500	22500	22500	22500	22500
2	Mass Of Cube (kg/m³)	8.90	8.95	8.95	9.00	9.00	9.10	9.00	9.05
3	Maximum Crushing Load (kN)	302.6	281.0	369.9	378.5	414.3	406.9	446.1	452.0
4	Compressive Strength (N/mm²)	13.4	12.0	16.4	16.8	18.4	18.0	19.8	20.1
AVERAGE COMPRESSIVE STRENGTH (N/mm²)		12.7		16.6		18.2		19.9	

Table 4.3: ½" (12.5mm) Granite washed with Fresh water

S/N	PARAMETER	7Days		14Days		21Days		28Days	
1	Cross Sectional Area (mm²)	22500	22500	22500	22500	22500	22500	22500	22500
2	Mass Of Cube (kg/m³)	9.30	9.25	9.35	9.20	9.35	9.30	9.35	9.20
3	Maximum Crushing Load (kN)	389.1	379.8	435.8	435.4	487.2	498.0	592.4	569.0
4	Compressive Strength (N/mm²)	17.2	16.8	19.3	20.1	21.6	22.1	26.3	25.2
AVERAGE COMPRESSIVE STRENGTH (N/mm²)		17.0		19.7		21.9		25.8	

Table 4.4: 1" (25mm) Granite washed with Fresh water

S/N	PARAMETER	7Days		14Days		21Days		28Days	
1	Cross Sectional Area (mm²)	22500	22500	22500	22500	22500	22500	22500	22500
2	Mass Of Cube (kg/m³)	9.10	9.25	9.20	9.15	9.00	9.15	9.00	9.15
3	Maximum Crushing Load (kN)	358.9	366.4	406.8	424.2	466.4	490.9	580.4	558.6
4	Compressive Strength (N/mm²)	15.9	16.2	18.0	18.8	20.7	21.8	25.7	24.8
AVERAGE COMPRESSIVE STRENGTH (N/mm²)		16.1		18.4		21.3		25.3	

Table 4.5: ½" Local Stone washed with salt-water

S/N	PARAMETER	7Days		14Days		21Days		28Days	
1	Cross Sectional Area (mm²)	22500	22500	22500	22500	22500	22500	22500	22500
2	Mass Of Cube (kg/m³)	8.90	8.95	8.70	8.60	8.65	8.70	8.60	8.65
3	Maximum Crushing Load (kN)	223.8	229.7	268.2	281.8	329.2	335.0	340.3	348.1
4	Compressive Strength (N/mm²)	9.9	10.2	11.9	12.5	14.6	14.8	15.1	15.4
AVERAGE COMPRESSIVE STRENGTH (N/mm²)		10.0		12.2		14.7		15.2	

Table 4.6: 1" Local Stone washed with salt-water

S/N	PARAMETER	7Days		14Days		21Days		28Days	
1	Cross Sectional Area (mm²)	22500	22500	22500	22500	22500	22500	22500	22500
2	Mass Of Cube (kg/m³)	8.95	9.15	9.00	9.00	9.10	9.25	9.00	9.15
3	Maximum Crushing Load (kN)	230.8	268.2	313.4	321.8	364.1	384.2	425.9	426.8
4	Compressive Strength (N/mm²)	10.2	11.9	13.9	14.3	16.1	17.0	18.9	18.9
AVERAGE COMPRESSIVE STRENGTH (N/mm²)		11.0		14.1		16.6		18.9	

Table 4.7: ½" (12.5mm) Granite washed with salt-water

S/N	PARAMETER	7Days		14Days		21Days		28Days	
1	Cross Sectional Area (mm²)	22500	22500	22500	22500	22500	22500	22500	22500
2	Mass Of Cube (kg/m³)	9.30	9.25	9.40	9.40	9.15	9.25	9.30	9.25
3	Maximum Crushing Load (kN)	371.0	384.3	442.6	418.6	478.2	452.7	546.2	538.0
4	Compressive Strength (N/mm²)	16.4	17.0	19.6	18.6	21.2	20.1	24.2	23.9
AVERAGE COMPRESSIVE STRENGTH (N/mm²)		16.7		19.1		20.6		24.1	

Table 4.8: 1" (25mm) Granite washed with salt-water

S/N	PARAMETER	7Days		14Days		21Days		28Days	
1	Cross Sectional Area (mm²)	22500	22500	22500	22500	22500	22500	22500	22500
2	Mass Of Cube (kg/m³)	9.50	9.40	9.40	9.50	9.30	9.50	9.40	9.00
3	Maximum Crushing Load (kN)	350.0	352.7	406.4	409.4	467.4	442.4	480.7	514.6
4	Compressive Strength (N/mm²)	15.5	15.6	18.0	18.1	20.7	19.6	21.3	22.8
AVERAGE COMPRESSIVE STRENGTH (N/mm²)		15.6		18.1		20.2		22.1	