NAU Journal of Civil Engineering (NAUJCVE) November/December 2023
Nnamdi Azikiwe University Journal of Civil Engineering (NAUJCVE)

Volume-1, Issue-4, pp-99-106
www.naujcve.com
Research Paper Open Access

Assessment of the Split Tensile Strength of the Major Brands of Cement in Enugu Urban Markets

[1]Elogu, T.I. and [2]Aginam, C.H.

[1]Department of Civil Engineering, Madonna University, Nigeria, Akpugo Campus, Enugu, Nigeria. engrtielogu@madonnauniversity.edu.ng, +2348168852878.

[2]Department of Civil Engineering, Nnamdi Azikiwe University, Awka, Anambra State, Nigeria. aginam@unizik.edu.ng, +2348028079911.

ABSTRACT *: In Nigerian construction industry, the most commonly used cementitious material is the Ordinary Portland Cement (OPC). Of recent there has been controversy as to whether the brands of OPC used in the country can attain adequate strength. Contractors generally choose any brand of cement for use based on their own personal and previous experiences from past works but since construction works are different, it is necessary to make a clear finding on which brands should be preferably used for given projects. This cannot be done successfully without carrying out as many laboratory tests as possible to establish a scientific position for each brand based on research. The aggregates and other ingredients of the concrete were initially characterized to determine the properties. The split tensile strength of concrete cylinders produced with the various brands of Portland cements showed that BUA cement had the highest values of split tensile strength for all the ages of curing, followed closely by the Dangote cement while the Unicem cement had the least values of although, the difference in values of concretes produced with the various brand of cement is small. The polynomial function-based model developed adequately predicted the experimental observed split tensile strength with high accuracy.*

KEYWORDS: Cement, split tensile strength, brands, model, assessment

---

Date of Submission: 25-11-2023 Date of acceptance:28-11-2023

I. INTRODUCTION

Cement as a binder is the world's most utilized construction and maintenance material. There are so many brands of cement in production today that many are confused on which brand to use during construction work. In Nigeria, contractors generally choose any brand of cement for use based on their own personal and previous experiences from past works but since construction works are different, it is necessary to make a clear finding on which brands should be preferably used for given projects. The differences in quality must be examined critically in other to establish a position which justifies the appropriate use of each brand of cement under study by subjecting them to a series of similar tests and establishing their compressive strength, flexural strength and split tensile strength characteristics among other tests.

Olonade et al (2015) made a comparative quality evaluation of cement brands commonly used in Southwest Nigeria. The authors carried out tests on fineness, setting times, chemical composition, compressive and flexural strength tests of five (unnamed) brands of cement selected for their study, using British Standard, American Society for Testing Materials. Akanni et al (2014) compared the chemical properties of four brands of Ordinary Portland Cement (OPC) available in South West of Nigeria, namely: Dangote, Diamond, Elephant and Purechem Portland cement. Ogunbiyi et al (2017) made an assessment of the qualities of Dangote and Elephant (Portland) cement brands commonly used in Nigerian Construction Industry. Osagie et al (2017) compared the compressive strength and densities of six (6) commonly used brands of Cement in Nigeria. Arimanwa, et al (2016) examined the effect of chemical composition of OPC in the compressive strength of concrete. The major objective of the study is to investigate the strength of concretes produced with the major brands of Portland cements within Enugu metropolis.

II. MATERIALS AND METHOD

The cement that were used in this study as the binding agent in the concrete produced are BUA Portland cement, Dangote Portland cement and UNICEM Portland cement. These brands of cement are readily available in major markets in Enugu and their properties conform to BS 12 (1996). The fine aggregate used were sourced from a river in Akpugo in Enugu state. This river called NYABA is the major source of fine aggregates (sharp sand) for construction purposes around Akpugo. The granite aggregates were procured from crushed rock quarry in Abakaliki in Ebonyi state. The coarse aggregates (granite) were of high quality with maximum size of 20mm. The water used in this study was sourced from a borehole drilled inside Madonna university compound. The water is clean, colourless and odorless water that is free from organic materials that may affect the quality of concrete.

With the three brands of cement selected, fine and coarse aggregates specified or chosen, and using mix ratio of 1:2:4, the split tensile strength test was carried out. Bulk density of the compacted fresh the density.

$$\rho = \frac{W2 - W1}{V} \quad (1)$$

Where; ρ is bulk density (in Kg/m^3), W1 is the mass of empty cylinder (in Kg), W2 is the mass of cylinder and sample (in Kg) and V is the volume of the cylinder (in m^3). Particle size distribution test (sieve analysis) was conducted in accordance with BS 812 pt. 103.1, (1985). The split tensile strength test was carried out on the concrete cylindrical specimen (200mm long x 100mm diameter) according to BS EN 12390-6 (2000) requirements. Five (5) cylindrical specimens were produced per experimental run using the mix ratio adopted for this study thus making a total of 60 specimens for the split tensile strength test.

A. Model Development

Models based on polynomial functions were developed to predict the split tensile strengths of concretes produced with three different brands of cements namely, BUA, UNICEM and DANGOTE Portland cements at various curing ages of 7, 14, 21 and 28 days. A polynomial function model of the form in Equation 2 was adopted for predicting split tensile strengths of concrete at various ages of curing.

$$F = A + Bt - Ct^2 \quad (2)$$

Where F is the split tensile strength (N/mm^2), t is the curing age (Days), A, B and C are constants.

Let $F = Y, t = x$ so that

$$Y = A + Bx - Cx^2 \quad (3)$$

By applying regressional approach, the constants A, B and C can be determined.

B. Statistical Assessment

The accuracy and reliability of the models developed was determined using suitable statistical evaluation criteria namely Coefficient of Determination R^2 and Coefficient of Correlation CORR.

III. RESULTS AND DISCUSSION

The particle size distribution of the fine aggregate used for the study in Fig. 1 shows size range from 0.08mm with percentage passing of 3% to 4.75mm with percentage passing of 95%, this is an indication that the fine aggregate used for the study belong to Zone IV according to BS. 882, 1973. The particle size distribution of the coarse aggregate used for the study in Fig. 2 shows size range from 4.75mm with percentage passing of 3% to a maximum aggregate size of 20mm.

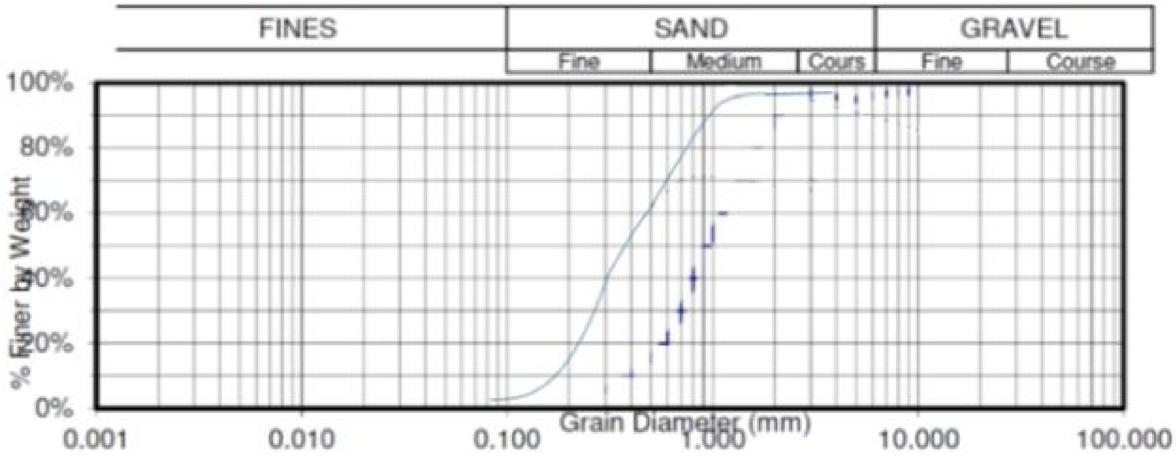

Fig. 1: Particle size distribution curve of the fine aggregate

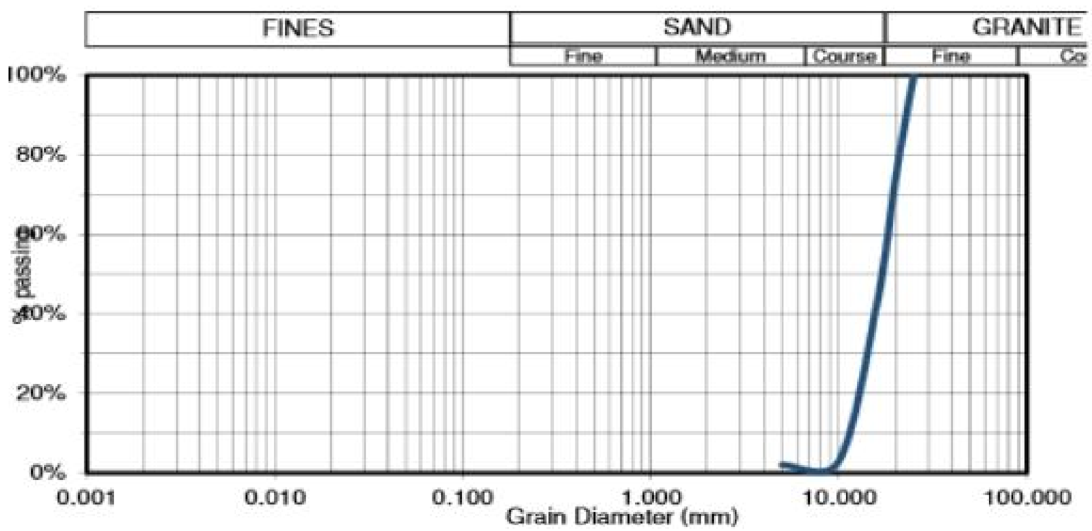

Fig. 2: Particle size distribution curve of the coarse aggregate

The average wet density of concrete cylinders produced with the various brands of Portland cements is shown in Fig. 3. Dangote brand had the highest average wet density of 2406.25 kg/m^3 at 7, 14 and 21 days and 2400 kg/m^3 at 28 days of curing. The average split tensile strength of concrete cylinders produced with the various brands of Portland cements is shown in Fig. 4. The concrete cylinders produced with BUA cement had the highest values of average split tensile strength for all the ages of curing, followed closely by the average split tensile strength values of cylinders produced with Dangote cement while the concrete cylinders produced with Unicem cement had the least values of average split tensile strength.

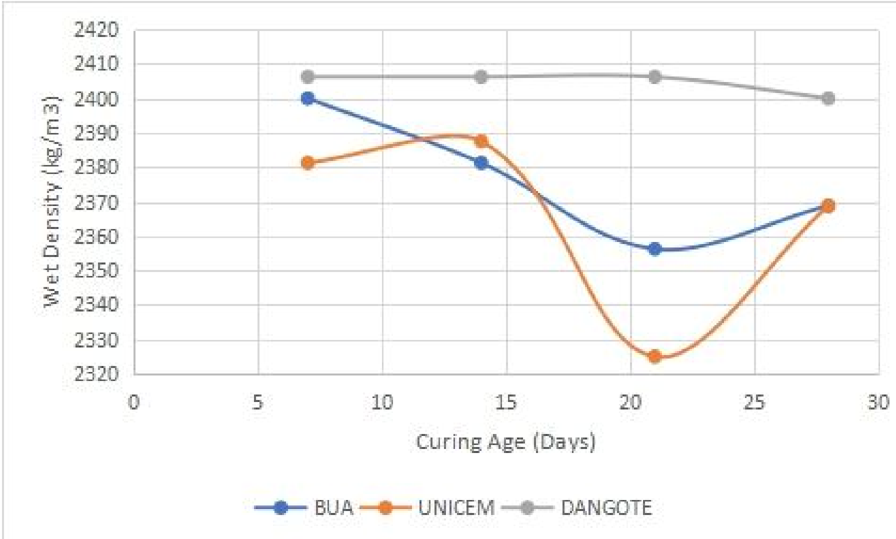

Fig. 3: Wet density at various curing ages of the concrete cylinders.

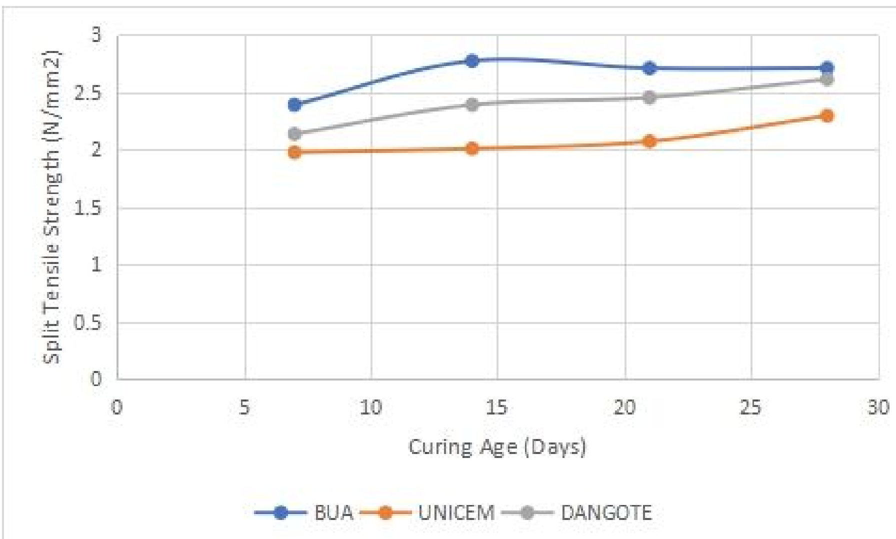

Fig. 4: Split Tensile strength of concrete cylinders against curing ages

A. Model Verification

Comparison of the plots of the average split tensile strength against curing age for the laboratory observed and those predicted using the model in Equation 4 are shown in Fig. 5 for concretes produced with BUA cement. It can be seen that the model developed made an accurate prediction of the average strength. The statistical assessment of the accuracy of the model gave coefficient of determination R^2 value of 1.00 as shown in Fig. 6, resulting to coefficient of correlation CORR value of 1.00. F_{SB} is the split tensile strength of concrete produced with BUA cement.

$$F_{SB} = -0.0019t^2 + 0.081t + 1.941 \quad (4)$$

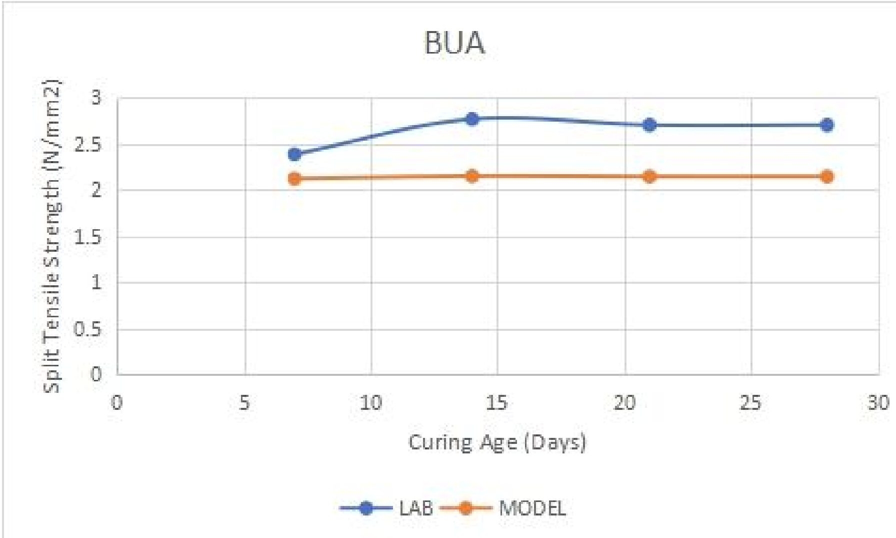

Fig. 5: Model verification of split tensile strength against curing age for BUA cement

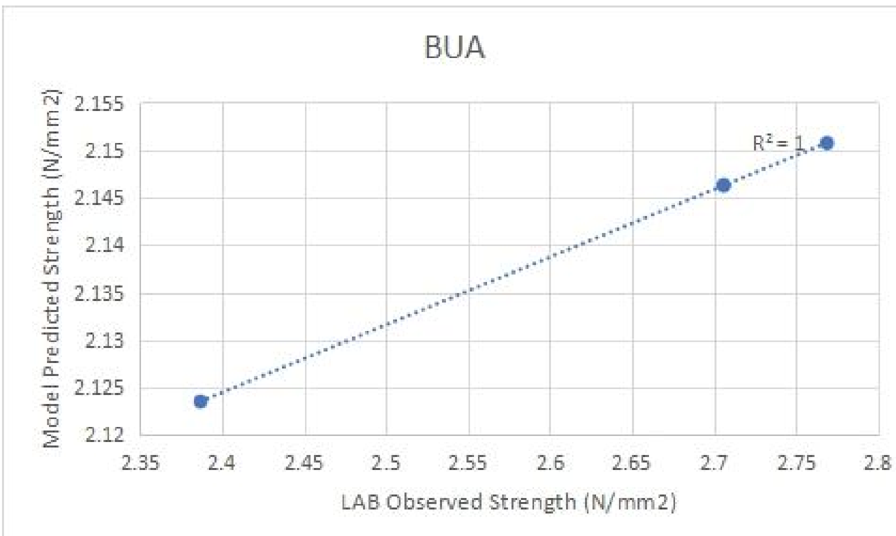

Fig. 6: Coefficient of determination of model for BUA cement.

Comparison of the plots of the average split tensile strength against curing age for the laboratory observed and those predicted using the model in Equation 5 are shown in Fig. 7 for concretes produced with UNICEM cement. It can be seen that the model developed made an accurate prediction of the average strength. The statistical assessment of the accuracy of the model gave coefficient of determination R^2 value of 1.00 as shown in Fig. 8, resulting to coefficient of correlation CORR value of 1.00. F_{SU} is the split tensile strength of concrete produced with Unicem cement.

$$F_{SU} = 0.001t^2 + 0.0195t + 2.069 \qquad (5)$$

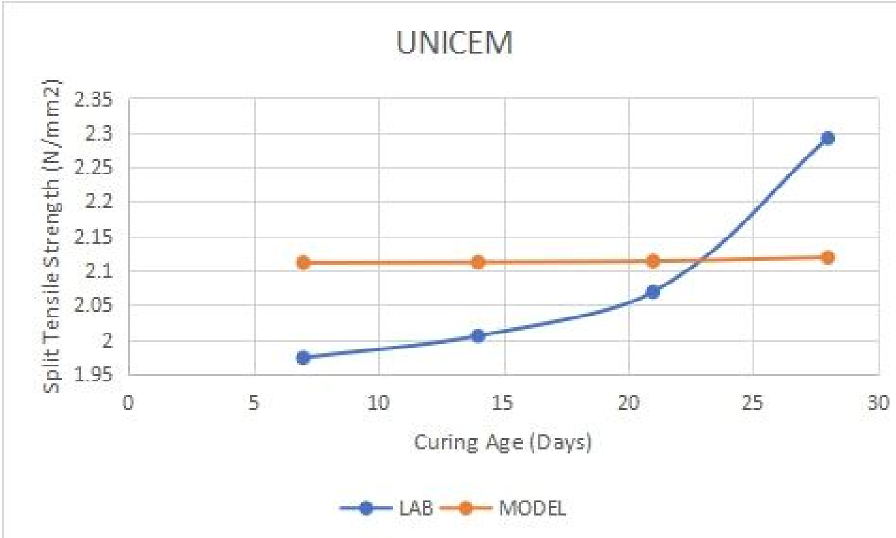

Fig. 7: Model verification of split tensile strength against curing age for UNICEM cement

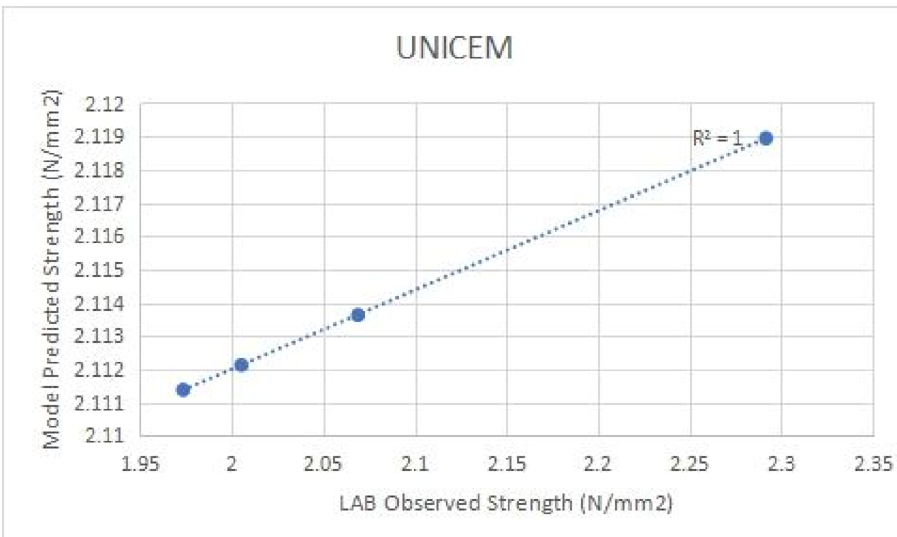

Fig. 8: Coefficient of determination of model for UNICEM cement.

Comparison of the plots of the average split tensile strength against curing age for the laboratory observed and those predicted using the model in Equation 6 are shown in Fig. 9 for concretes produced with DANGOTE cement. It can be seen that the model developed made an accurate prediction of the average strength. The statistical assessment of the accuracy of the model gave coefficient of determination R^2 value of 1.00 as shown in Fig. 10, resulting to coefficient of correlation CORR value of 1.00. F_{SD} is the split tensile strength of concrete produced with Dangote cement.

$$F_{SD} = -0.005t^2 + 0.0383t + 1.9026 \qquad (6)$$

www.naujcve.com. All Rights Reserved 2023.

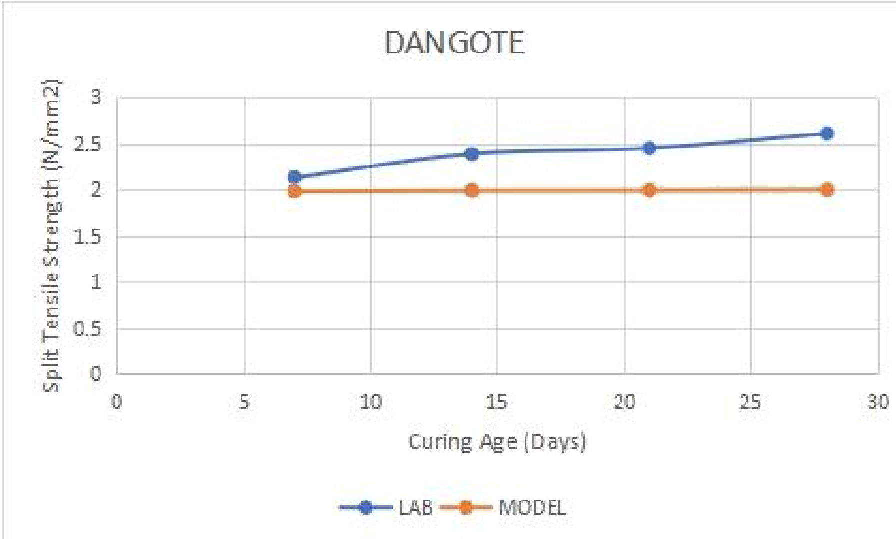

Fig. 9: Model verification of split tensile strength against curing age for DANGOTE cement

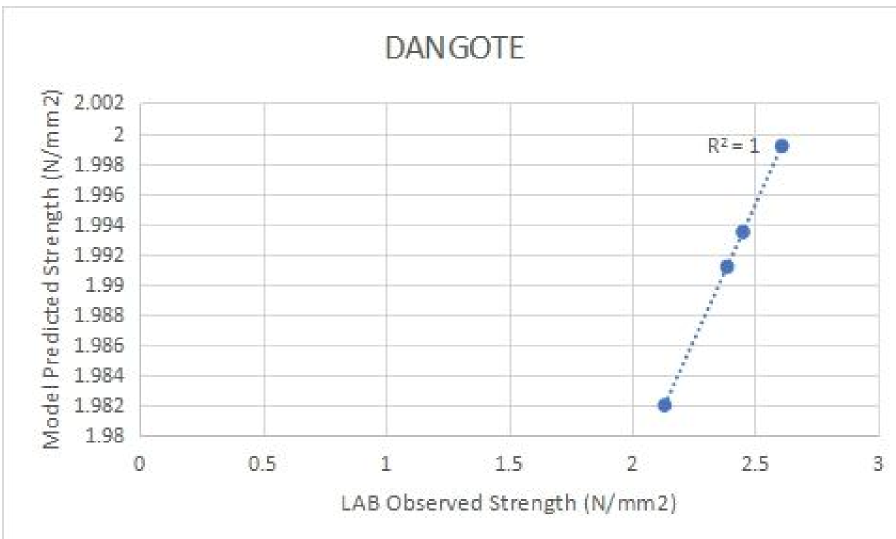

Fig. 10: Coefficient of determination of model for DANGOTE cement.

IV. CONCLUSION

The characterization of the aggregates used for the study showed fine aggregate belonging to sand Zone IV. The maximum coarse aggregate size used for the study is 20mm. The wet densities of concrete cylinders produced with the various brands of cement showed that Dangote cement had the highest values for all ages of curing. The concrete cylinders produced with BUA cement exhibited the highest values of split tensile strength for all ages of curing, followed by the Dangote cement and the Unicem cement having the least values of split tensile strength. However, the difference in split tensile strength values of concretes produced with the various brand of cement is small. The polynomial function-based model developed adequately predicted the experimental observed split tensile strength with high accuracy.

.

References

BS 12 (1996) Specification for Portland cement.

BS 812, Part 103.1, "Testing Aggregates, Methods for Determination of Particle Size Distribution", British Standard Institution, London. 1985.

BS. 882, 1973 Specification for aggregates from natural sources for concrete

BS 1881, Part 107, "Method of Determination of Density of Compacted Fresh Concrete", British Standard Institution, London. 1983.

BS EN 12390-6 (2000). Testing hardened concrete Tensile Splitting Strength of test specimens.

Akanni, A. O., Awofadeju, A. S., Adeyemi, B. G.(2014). *Comparative analysis of the chemical composition of various brands of Portland cement available in South- western parts of Nigeria.* IJERT 2014 pp. 1679-1684.

Arimanwa, M. C., Onwuka, D. O. and Arimanwa, J. I. (2016) *Effect of Chemical Composition of Ordinary Portland cement on the Compressive Strength of Concrete.* International Refereed Journal of Engineering and Science (IRJES) ISSN (Online) 2319-183X, (Print) 2319-1821 Volume 5, Issue 3 (March 2016), pp.20-31.

Ogunbiyi, M., Olawale, S., Alabi, O., Thanni, M. (2017). *Assessment of the Qualities of Dangote and Elephant (Portland) Cement Brands commonly used in the Nigerian Construction Industry***.** International Journal of Innovative Research in Science, Engineering and Technology.(ijirset) Vol. 6, Issue 3, March 2017 pp. 3888-3895.

Olonade, K. A., Jaji, M. B., Rasak, S. A. and Ojo, B. A (2015). *Comparative quality evaluation of cement brands used in South West Nigeria.* Academy Journal of Science and Engineering 9 (1), 2015 pp.53-63.

Osagie, I., Taofiq, B., Asuquo, A. E., Idris, F. W., Okougha, F. A., Umanah, I. I., Ugonna, M. C., . Nwaigwe, D. N. (2017). *Comparative-study of Compressive-strengths and Densities of Concrete Produced with Different Brands of Ordinary Portland Cement in Nigeria*. International Journal of Scientific & Engineering Research Volume 8, Issue 9, September-2017 1260 ISSN 2229-5518 pp 1260-1275.