MODELING TENSILE STRENGTH OF CONCRETE ON PARTIAL REPLACEMENT OF CEMENT AND SAND WITH QUARRY DUST GROUND GRANULATED BLAST FURNACE AND SLAG SILICA FUMES

Abstract

Tensile strength of concrete were examined on its partial replacement of cement and sand using ground granulated blast furnace and quarry dust, the study examines its behaviour at different dimensions, this is to monitor the variation effect of these parameters on the growth rates of tensile to the optimum curing age, these includes non linear conditions of tensile state, non-elastic and its brittle behaviour at all times as it express zero conditions in tension, this means that it has the ability to with stand pull force, it also reflect its weak ability to handle shear stress thus tends to cause deformation in material as it has poor elasticity. The reflection of its brittle influence the rate of tensile behaviour from concrete ductility, these are known to be a material on modern mechanics of concrete. These also considered as quasi brittle material, this behaviour were reflected as the system considered evaluating the growth rate of tensile strength that replaced cement and sand with these locally sourced addictives. the developed model monitor other reflected influential parameters such as variation of concrete porosity due it compaction in placements, tensile behaviour reflects these effect that subject it to mechanical properties of concrete, the study expressed the reaction of these parameters in the simulation, the evaluation of these affected the details variation of tensile growth rate at different water cement ratios and curing age, the tensile behaviour that were monitored are based on these factors in the study, these derived model were validated with the researcher [24], and both parameters developed best fits correlation, the study is imperative because the system expressed the behaviour of tensile strength from concrete at different dimensions, experts can applied these concept to monitor tensile behaviour considering these parameters in its growth rates.

Keywords: Modeling Tensile Quarry Dust ground Granulated Blast Furnace, Slag and Silica Fumes.

1. Introduction

An observation were made were through investigation carried to identify substitute material to sand; these are known to be fine aggregates that generated green concrete [1, 2, 3, 4, 5]. These types of study's findings has developed conditions desirable to the application of waste by-product to produce high tensile strength from high strength concrete, these material are available and obtain cheap in localities, thus it has made the waste by-products environmentally friendly, more so the substitutes for cement and river sand are now preferably by-products. In other to conquer this crisis, the replacements of river sand with QD were applied that proof to be an economical alternative in the construction industries [6, 7, 8, 9, 10] The development of green concrete generations was overcome through this crisis that was mentioned above.[5,8,11,12] the generation of tensile strength are basically reflected from the tensile behaviour of the material as concrete formation. The application of these materials such as Fly Ash (PFA) Silica Fume (SILICA)including the addition of 100 % quarry dust (QD) as partial replacement for fine aggregates were accessed by these experts [10,8,13,15]. This study also was illustrated by these researchers [11, 14, 15, 17]. It explained progressive success of these materials by dosage that is up to 20% of sand, the observation express their various high rates of effective replacement using quarry dust in traditional concrete. More so these researchers [15, 16, 19, 20], explained the use of quarry waste as a substitute for sand in construction industries, it has definitely resolve the environmental problems that is caused by large-scale depletion of the natural sources such as river sand and it rates of mining [18 19,20 21,22,23].

2. Theoretical Background

$$\frac{dc_d}{dx} + V(y)c_d = \Phi(y)c_d^n \qquad (1.0)$$

Dividing equation (1.0) all through by c_d^nwe have

$$c_d^{-n}\frac{dc_d}{dx} + v(x)c_d^{1-n} = \Phi(y) \qquad (1.1)$$

Let

$$\text{P}=c_d^{1-n} \qquad (1.2)$$

$$\frac{dp}{dy} = (1-n)c_d^{-n}\frac{dc_d}{dy}$$

$$c_d^{-n}\frac{dc_d}{dy} = \frac{1}{1-n}\frac{dp}{dy} \qquad (1.3)$$

Substituting equation (1.2) and (1.3) into equation (1.1) we have that

$$\frac{1}{1-n}\frac{dp}{dx} + V(y)p = \Phi(y) \qquad (1.4)$$

Integrating both sides we have $\int d\left[e^{V(y)(1-n)y}p\right] = \Phi(y)(1-n)\int e^{V(y)(1-n)y}dy$

$$p = \frac{\Phi(y)}{Vu(y)} + Ae^{-Vu(y)(1-n)y} \qquad (1.5)$$

Substituting equation (1.2) into equation (1.13) we have

$$c_d^{1-n} = \frac{\Phi(y)}{Vu(y)} + Ae^{-Vu(y)(1-n)y} \qquad (1.6)$$

3. Materials and method

4. Testing machine.5.

Three cylinders (φ150mm & 300mm in height).
6-A jig for aligning concrete cylinder and bearing strips

1 Prepare three cylindrical concrete specimens following same steps as test No.32.

1. After moulding and curing the specimens for seven days in water, they can be tested.
2. Two bearings strips of nominal (1/8 in i.e. 3.175mm) thick plywood, free of imperfections, approximately (25mm) wide, and of length equal to or slightly longer than that of the specimen should be provided for each specimen.
3. The bearing strips are placed between the specimen and both upper and lower bearing blocks of the testing machine or between the specimen and the supplemental bars or plates.
4. Draw diametric lines an each end of the specimen using a suitable device that will ensure that they are in the same axial plane. Centre one of the plywood strips along the center of the lower bearing block.
5. Place the specimen on the plywood strip and align so that the lines marked on the ends of the specimen are vertical and centered over the plywood strip.
6. Place a second plywood strip lengthwise on the cylinder, centered on the lines marked on the ends of the cylinder.
7. . Apply the load continuously and without shock, at a constant rate within, the range of 689 to 1380 kPa/min splitting tensile, stress until failure of the specimen.
8. Record the maximum applied load indicated by the testing machine at failure. Note the type of failure and appearance of fracture.

3.1 Observations and calculations:

Calculate the splitting tensile strength of the specimen as follows:

$T = 2P/Ld$

Where: T: splitting tensile strength, N/mm^2P: maximum applied load indicated by testing machine, NL: Length of the specimen, mmd: diameter of the specimen, mm

Results and Discussion

Table 1: Predictive and Experimental Values of Split Tensile Strength at Different Curing Age

Curing Age	Predictive Values of Tensile Strength	Experimental Values of Tensile Strength 1
4	1.310212078	1.5
7	4.686365818	4.1
14	6.166288899	6.8
28	8.315436384	8.3
35	8.568282079	9.4
42	8.837108749	10.13
49	9.123683856	10.6
56	9.934873977	9.7

Table 2: Predictive and Experimental Values of Split Tensile Strength at Different Curing Age

Curing Age	Predictive Values of Tensile Strength	Experimental Values of Tensile Strength 1
4	1.310212078	2.72
7	4.686365818	3.62
14	6.166288899	5.51
28	8.315436384	8.408
35	8.568282079	9.416
42	8.837108749	10.13
49	9.123683856	10.55
56	9.934873977	10.676

Table 3: Predictive and Experimental Values of Split Tensile Strength at Different Curing Age

Curing Age	Predictive Values of Tensile Strength [W/C - 0.30]	Experimental Values of Tensile Strength [[W/C -0.30]
4	1.309637442	2.703
7	4.660702747	3.606
14	6.125799668	5.503
28	8.310856023	8.415
35	8.562687694	9.43
42	8.830561307	10.151
49	9.116248222	10.578
56	9.919379192	10.711

Table 4: Predictive and Experimental Values of Split Tensile Strength at Different Curing Age

Curing Age	Predictive Values of Tensile Strength	Experimental Values of Tensile Strength 1
4	1.269450029	1.25
7	3.994432574	3.87
14	4.94859046	4.58
28	7.373912408	7.11
35	7.767119794	7.69
42	8.20816596	8.19
49	8.336637998	8.74
56	8.468705713	8.82

Table 5: Predictive and Experimental Values of Split Tensile Strength at Different Curing Age

Curing Age	Predictive Values of Tensile Strength	Experimental Values of Tensile Strength 1

4	1.269450029	1.08176
7	3.994432574	2.29787
14	4.94859046	4.52296
28	7.373912408	7.03568
35	7.767119794	7.69375
42	8.20816596	8.19992
49	8.336637998	8.73941
56	8.468705713	9.49744

Table 6: Predictive and Experimental Values of Split Tensile Strength at Different Curing Age

Curing Age	Predictive Values of Tensile Strength [W/C-0.30]	Experimental Values of Tensile Strength [W/C-0.30]
4	1.267957163	1.583
7	3.961863271	2.441
14	4.894731436	4.233
28	7.368710289	6.935
35	7.760931679	7.845
42	8.201135787	8.461
49	8.328485787	8.783
56	8.459451226	8.811

Table 7: Predictive and Experimental Values of Split Tensile Strength at Different Curing Age

Curing Age	Predictive Values of Tensile Strength	Experimental Values of Tensile Strength
4	1.276826798	1.31
7	2.049100537	2.17
14	3.677452951	3.69
28	6.275314888	6.22
35	6.417774823	7.42
42	6.565956913	8.25
49	6.72031797	8.89
56	7.285212087	7.76

Table 8: Predictive and Experimental Values of Split Tensile Strength at Different Curing Age

Curing Age	Predictive Values of Tensile Strength	Experimental Values of Tensile Strength
4	1.276826798	1.287
7	2.049100537	2.031
14	3.677452951	3.627
28	6.275314888	6.231
35	6.417774823	7.239
42	6.565956913	8.051
49	6.72031797	8.667
56	7.285212087	9.087

Table 9: Predictive and Experimental Values of Split Tensile Strength at Different Curing Age

Curing Age	Predictive Values of Tensile Strength [W/C-0.30]	Experimental Values of Tensile Strength [W/C-0.30]
4	1.276252162	1.1646
7	2.047872245	1.9044
14	3.67288332	3.4626
28	6.269007256	5.8734
35	6.409971784	6.726
42	6.556702426	7.3434
49	6.709661505	7.7256
56	7.265147297	7.8726

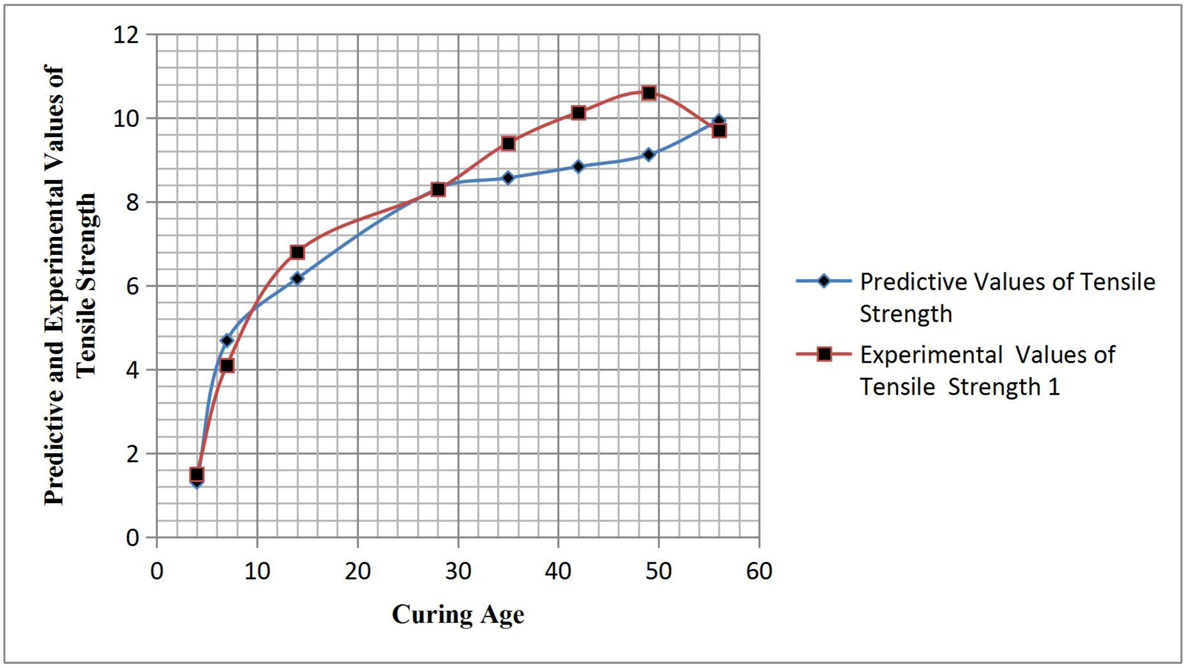

Figure 1: Predictive and Experimental Values of Split Tensile Strength at Different Curing Age

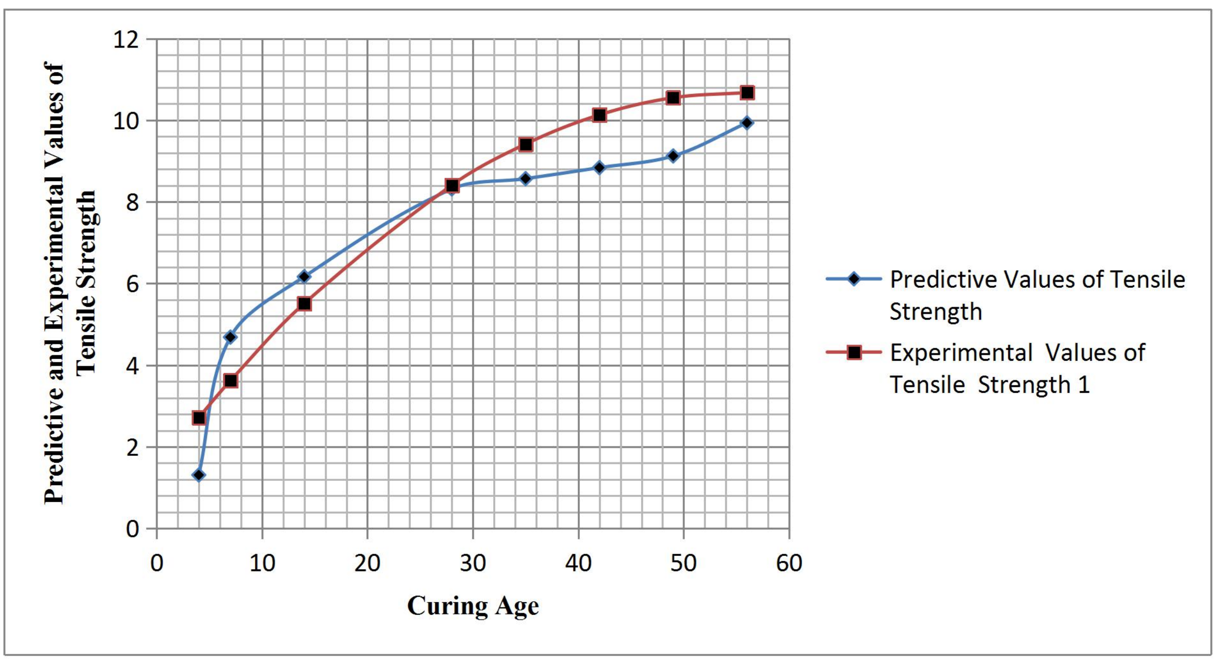

Figure 2: Predictive and Experimental Values of Split Tensile Strength at Different Curing Age

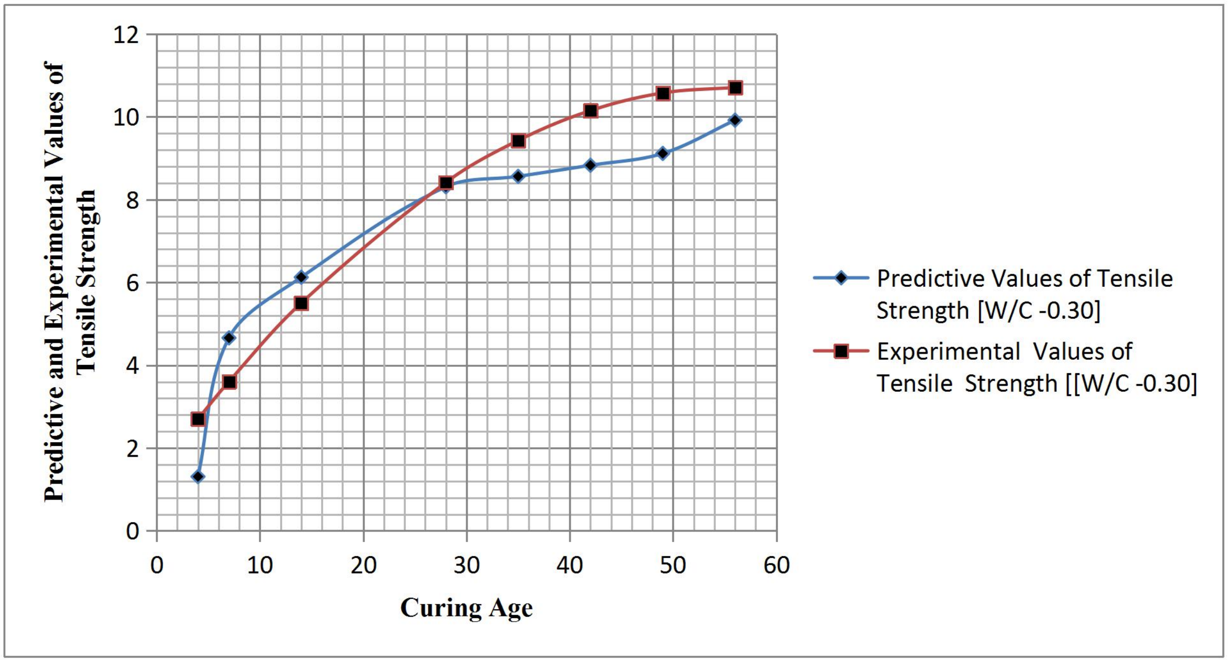

Figure 3: Predictive and Experimental Values of Split Tensile Strength at Different Curing Age

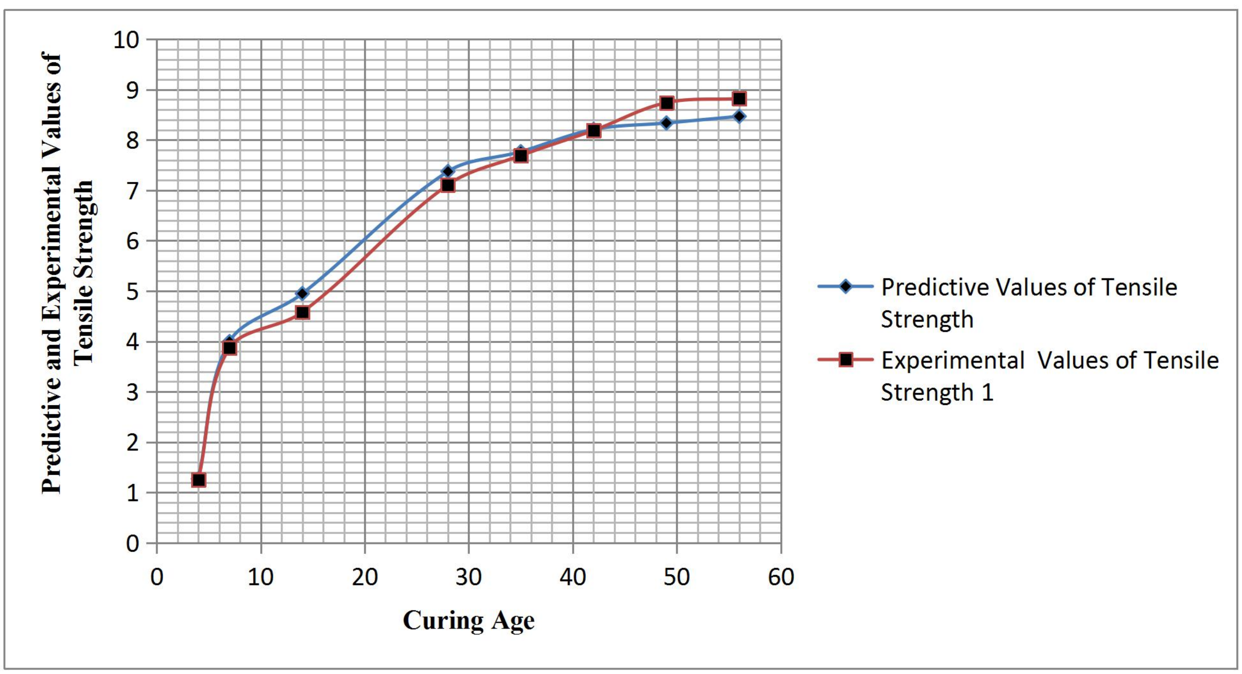

Figure 4: Predictive and Experimental Values of Split Tensile Strength at Different Curing Age

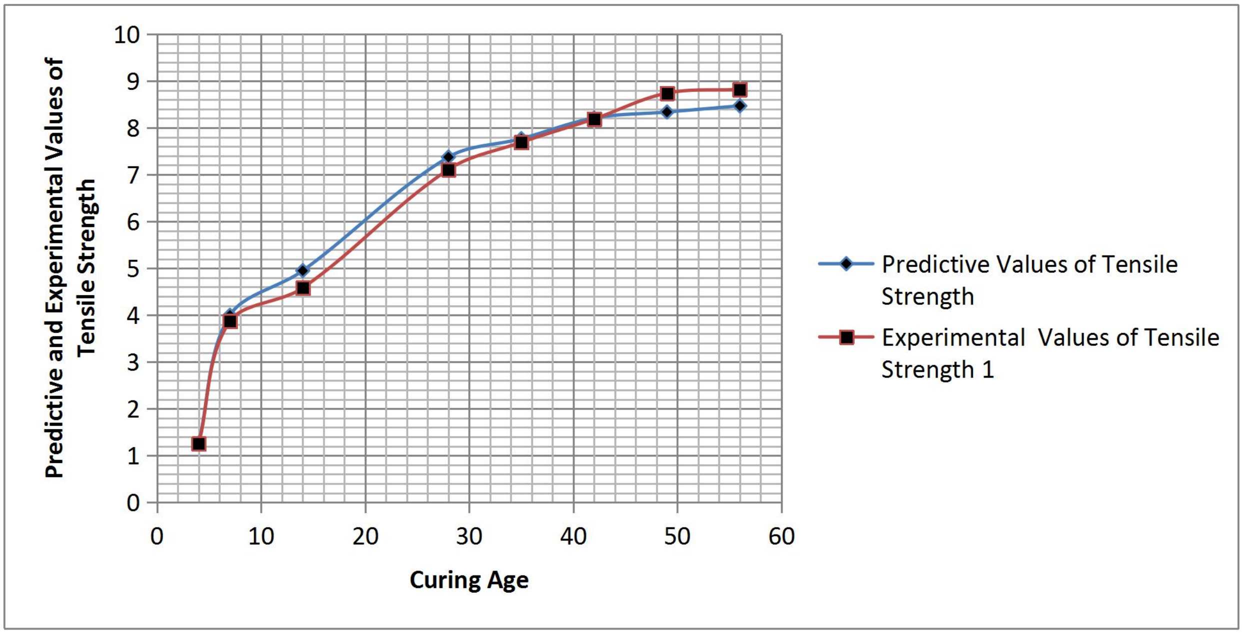

Figure 5: Predictive and Experimental Values of Split Tensile Strength at Different Curing Age

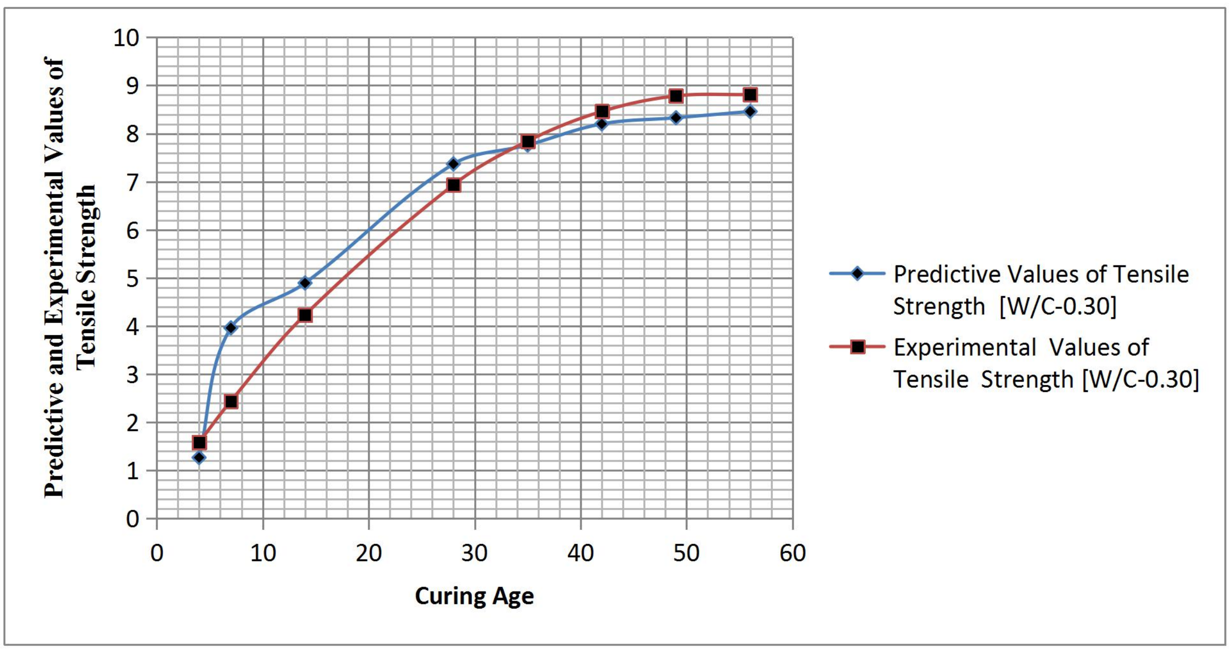

Figure 6: Predictive and Experimental Values of Split Tensile Strength at Different Curing Age

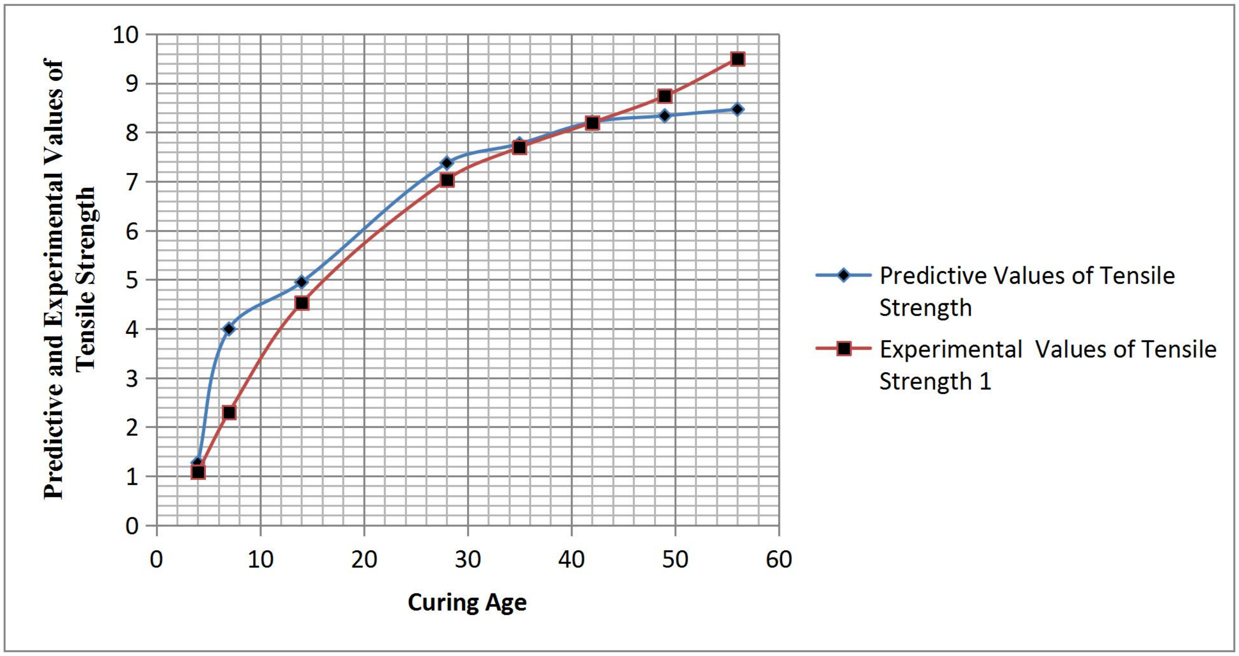

Figure 7: Predictive and Experimental Values of Split Tensile Strength at Different Curing Age

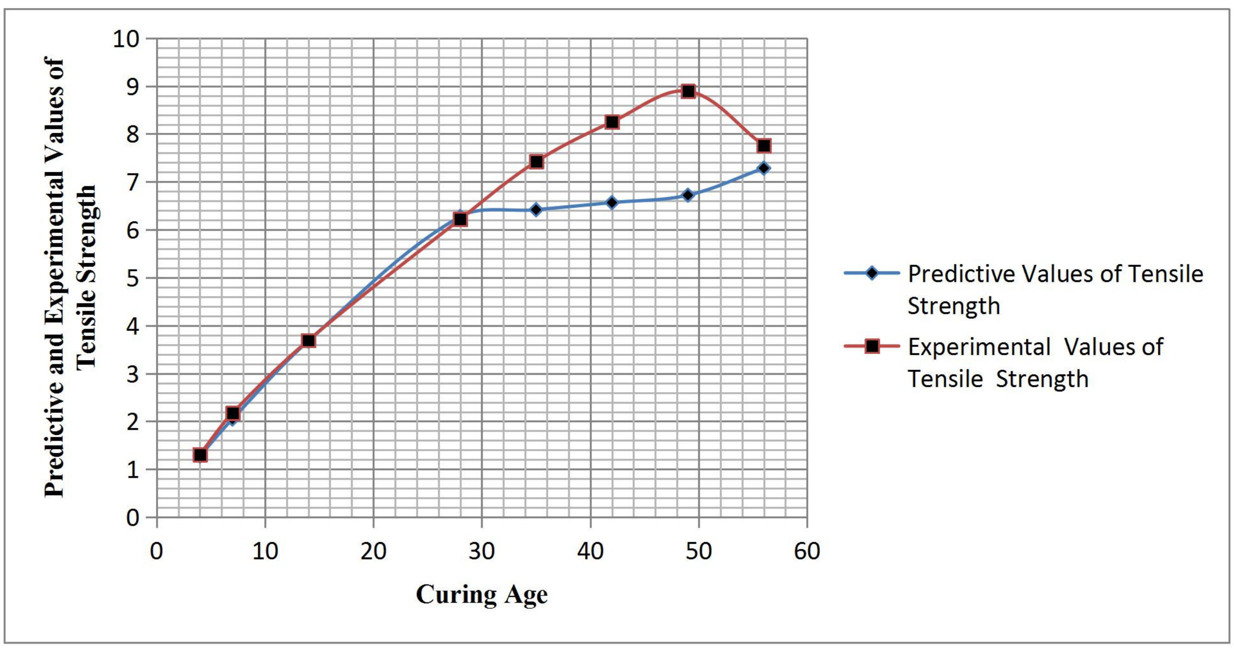

Figure 8: Predictive and Experimental Values of Split Tensile Strength at Different Curing Age

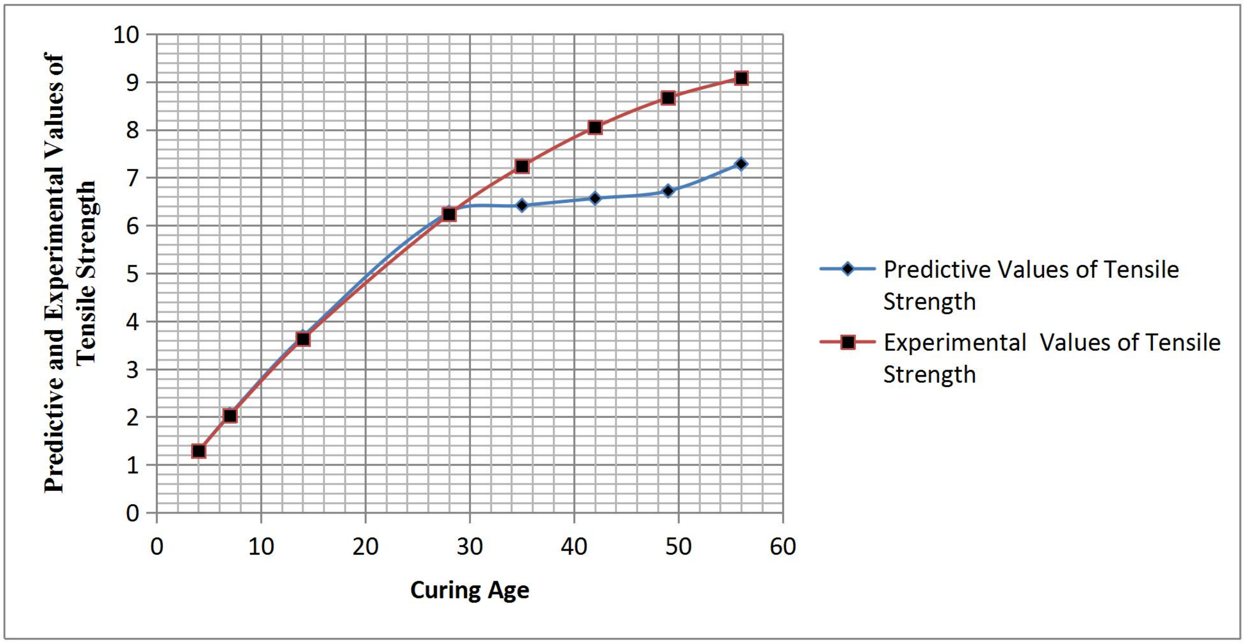

Figure 8: Predictive and Experimental Values of Split Tensile Strength at Different Curing Age

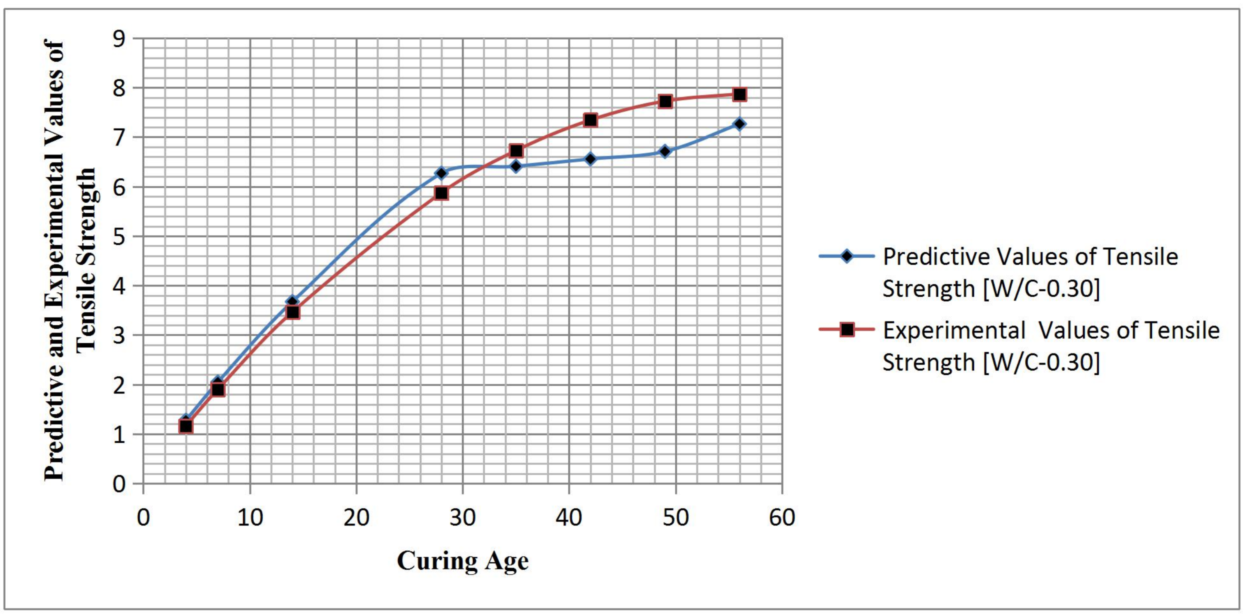

Figure 9: Predictive and Experimental Values of Split Tensile Strength at Different Curing Age

Figure one to nine shows the variation growth rate of tensile strength from the concrete grades, the tensile from this design concrete grades reflects the output of the model concrete that were partially sand and cement with quarry dust granulated blast furnance and silica fumes, the materials developed the required tensile strength based on the addictive applied and quarry dust used, the behaviour of these materials reflect the variation growth in concrete tensile, the exponential increase in strength observed, shows the gradual strength attained from the improved setting time of the materials, such by-product integrated to obtained the required tensile behaviour of the material that expressed the variation of the mechanical properties generated from the concrete formation, since tensile strength is important properties due to its vulnerable to tensile cracking at different influence on applied load, this condition influence the behavior of the tensile rate of the concrete based on the reflection from the applied addictive and quarry dust as partial replacements for sand and cement, this also shows the variation in performance as reflected in the trend whereby the tensile experienced slight fluctuation based on these stated factors, the tensile known to be ability to withstand pull force, the trend in all the figures observed gradual growth rate with slight fluctuation based on the compaction variation of the concrete at different placement, these were observed to reflect on its tensile strength, the behaviour of the growth rate also where influenced by the percentage variation of concrete porosity through the heterogeneity of compaction on different mix design.

5. Conclusion

The study has definitely examining various trend of tensile growth rates, these are developed from significant considered property of concrete, because structure are highly vulnerable to tensile cracking, this observation are known to be due to various kinds of influence and the applied loading, however tensile strength of concrete is very low compared to its compressive strength, the behaviour of tensile strength from concrete structure are basically from its mechanical properties, these properties includes shrinkage and creep, compressive strength, flexural strength, modulus of elasticity and the concrete tensile, the study carry out from variations of tensile affects concrete that partially replace sand and cement with addictives, these were monitored effect considering these partial replacements, the study examined the behaviour of tensile from concrete structure based on the facts that these materials is non linear, non elastic and brittle, due to its strong in compression and weak in tension, the behaviour of tensile strength growth from these partial replacement determined its variations on performance, these are to examined the materials based of the dosage of partial replacements on the addictives for cement, the derived model that monitor the heterogeneity from tensile strength generated the theoretical values from the simulation, the parameters that reflect concrete behaviour were considered in the system, the influence of these parameters were observed on the tensile behaviour, the predictive values were compared with experimental values, and both parameters developed best fits correlation.

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