Journal of Architecture and Construction
Volume 2, Issue 1, 2019, PP 35-41
ISSN 2637-5796

Modeling Compressive Strength of Concrete Pavement Influenced by Water Cement Ratios modified with Silica and Plasticizer

Eluozo S.N, Nwaobakata C

Department of Civil Engineering, College of Engineering Gregory University Uturu Abia State

***Corresponding Author:** Eluozo S.N, Nwaobakata C, Department of Civil Engineering, College of Engineering Gregory University Uturu Abia State*

Abstract

The study predict the compressive strength of concrete modified with silica and plasticizers, this is to monitor the strength growth rate of the concrete at different curing age, linear trend were observed from the study at different age to the optimum values that was recorded at ninety day of age, the influenced of the addictive on the mixed designed were observed as its reflects on the growth rate of the compressive strength, variation of water cement ratios were also monitored, this was at different ratios between (0.23-0.40), this study express various growth rate of strength development, but decrease of strength were experienced as the water cement ratios increase, the compressive strength experienced decrease in strength development, but the developed compressive strength are within the required strength targeted, the predictive values from the simulation were compared with experimental values, and both parameters experienced best correlation, the study has detailed the behavior of compressive state based on the target strength for concrete pavement,

Keywords: *Modeling, compressive strength, pavement silica and plasticizers*

Introduction

Cement being a major component of concrete, its generation contributes in damaging the earth, it should be a big driver of climate transform, accountable for 5% of man-made carbon dioxide (CO2) reported in Berndt, (2015). The decrease in the foundation of natural sand and the requirement for decrease in the cost of concrete manufacture has resulted in poor quality sand cause supplied and thus improved as it is require to identify substitute material to sand as fine aggregates in the manufacture of concrete especially in green concrete (Ankit and Jayesh, 2013Jaharatul 2017; Ode 2004; Ode and Eluozo 2015; Ode and Eluozo 2016a).

To conquer this crisis, the replacement of river sand with QD should be an economical option (Mohammad et al., 2015Ode and Eluozo 2016b; Ode and Eluozo 2016c). To improve the green concrete manufacture and conquer this crisis as mentioned above Venkata et al., (2013), more so partial replacements of fraction of the cement with Ground Granulated Blast Furnace Slag (GGBS), Fly Ash (PFA) and Silica Fume (SILICA) with 100 % including quarry dust (QD) it also observed that fine aggregates was evaluated (Linoshka and Hwang, 2016) and illustrated in Raharjo, (2013). Manassa (2010) and Sukesh *et al*., (2013) developed up to 20% of sand has been more efficient replaced by quarry dust in traditional concrete. Ilangovan *et al*., (2008), Sivakumar and Prakash (2011 Ilangovana *et al*., 2008, Poonam *et al*., 2015).It has have observed that strength development from of quarry dust concrete was comparably 10-12% more than of similar of conventional concrete.

Divakar *et al*., (2012; Safiuddin *et al*., 2007; Lohani*et al*., 2012Ode and Eluozo 2016dOde and Eluozo 2016e) have experimented on the behavior of the concrete with application of granite fines modified as partial replacement for sand up to 50% and obtained the positive results in strength More so, the durability- that definitely related to such properties of concrete can be enhanced applying quarry waste in the presence of silica fume (Safiudd in *et al*., 2000bOde and Eluozo 2016f). This was mentioned by Dilip and Amitava (2012).

Hameed and Sekar (2009) studied the feasibility of using quarry waste and marble sludge in concrete (Vishal and Pranita, 2014).

THEORETICAL BACKGROUND

Nomenclature

α = Constant

β = Compressive Strength

$A_{y\,(1-n)}$ = water cement Ratio

Φ^2 =Cementious Material/Additive's/void ratios and porosity

B_y = Concrete Slump

Y = Curing Age

$$\frac{dc\beta}{dy} + A_{(y)}C_{(d)} = B_{(y)}C_d{}^n ; n \geq 2 \qquad (1)$$

Divided by (1) through by C_d^{-n} we have obtain

$$C_d{}^{-n}\frac{d\beta}{dy} + A_{(y)}C_d{}^{1-n} = B_{(y)} \qquad (2)$$

Let $\alpha = C_d{}^{1-n}$

$$\frac{d\beta}{dy} = (1-n)C_d{}^{-n}\frac{d\beta}{dy}$$

Multiplying Equation (2a) through by (1- n)

$$(1-n)C_d{}^{1-n}\frac{d\beta}{dy} + (1-n)A_{(y)}C_d{}^{1-n} = (1-n)B_{(y)} \qquad (3)$$

Let $\frac{2}{2-\alpha} = \phi^2$

$$\beta = \frac{1}{\phi^2}\int(1-n)B(y)dy = \frac{1}{\phi^2}(1-n)B(y)Y + K_1 \qquad (4)$$

$$\left[\beta = \frac{(1-n)}{\phi^2}B(y)Y\right] \qquad (5)$$

MATERIALS AND METHOD

Experimental Procedures

Compressive Strength Test Concrete cubes of size 150mm×150mm×150mm were cast with and without copper slag. During casting, the cubes were mechanically vibrated using a table vibrator. After 24 hours, the specimens were remolded and subjected to curing for 1-90 days and seven day interval to 28 days in portable water. After curing, the specimens were tested for compressive strength using compression testing machine of 2000KN capacity. The maximum load at failure was taken. The average compressive strength of concrete and mortar specimens was calculated by using the following equation 5.1.

Compressive strength (N/mm2) = Ultimate compressive load (N)

Area of cross section of specimen (mm2)

Table1. *Predictive and Experimental Values of Compressive at Different Curing Age*

Curing Age	Predictive Values for Compressive Strength of Concrete Pavement (W/C of 0.23)	Experimental Values for Compressive Strength of Concrete Pavement (W/C of 0.23)
7	7.564392851	7.56
14	15.1287857	15.12
21	22.69317855	22.68
28	30.2575714	30.24
35	37.82196425	37.8
42	45.3863571	45.36
49	52.95074995	52.92
56	60.51514281	60.48
63	68.07953566	68.04
70	75.64392851	75.6
77	83.20832136	83.16
84	90.77271421	90.72
90	97.25647951	97.2

Table2. *Predictive and Experimental Values of Compressive at Different Curing Age*

Curing Age	Predictive Values for Compressive Strength of Concrete Pavement (W/C of 0.30)	Experimental Values for Compressive Strength of Concrete Pavement (W/C of 0.30)
7	6.88020459	6.874
14	13.76040918	13.748
21	20.64061377	20.622
28	27.52081836	27.496
35	34.40102295	34.37
42	41.28122754	41.244

49	48.16143213	48.118
56	55.04163672	54.992
63	61.92184131	61.866
70	68.8020459	68.74
77	75.68225049	75.614
84	82.56245508	82.488
90	88.4597733	88.38

Table3. *Predictive and Experimental Values of Compressive at Different Curing Age*

Curing Age	Predictive Values for Compressive Strength of Concrete Pavement (W/C of 0.35)	Experimental Values for Compressive Strength of Concrete Pavement (W/C of 0.35)
7	6.385516802	6.384
14	12.7710336	12.768
21	19.15655041	19.152
28	25.54206721	25.536
35	31.92758401	31.92
42	38.31310081	38.304
49	44.69861761	44.688
56	51.08413442	51.072
63	57.46965122	57.456
70	63.85516802	63.84
77	70.24068482	70.224
84	76.62620162	76.608
90	82.09950174	82.08

Table4. *Predictive and Experimental Values of Compressive at Different Curing Age*

Curing Age	Predictive Values for Compressive Strength of Concrete Pavement (W/C of 0.40)	Experimental Values for compressive Strength of Concrete Pavement (W/C of 0.40)
7	5.894331821	5.894
14	11.78866364	11.788
21	17.68299546	17.682
28	23.57732728	23.576
35	29.47165911	29.47
42	35.36599093	35.364
49	41.26032275	41.258
56	47.15465457	47.152
63	53.04898639	53.046
70	58.94331821	58.94
77	64.83765003	64.834
84	70.73198185	70.728
90	75.78426627	75.78

Table5. *Predictive Values of Compressive Strength Varying at Different water cement ratios*

Water Cement Ratios	0.23	0.3	0.35	0.4
Fcu 7	7.564392851	7.434938631	6.385516802	5.894331821
Fcu 14	15.1287857	14.86987726	12.7710336	11.78866364
Fcu 21	22.69317855	22.30481589	19.15655041	17.68299546
Fcu 28	30.2575714	29.73975452	25.54206721	23.57732728
Fcu 35	37.82196425	37.17469315	31.92758401	29.47165911
Fcu 42	45.3863571	44.60963178	38.31310081	35.36599093
Fcu 49	52.95074995	52.04457041	44.69861761	41.26032275
Fcu 56	60.51514281	59.47950905	51.08413442	47.15465457
Fcu 63	68.07953566	66.91444768	57.46965122	53.04898639
Fcu 70	75.64392851	68.8020459	63.85516802	58.94331821
Fcu 77	83.20832136	75.68225049	70.24068482	64.83765003
Fcu 84	90.77271421	82.56245508	76.62620162	70.73198185
Fcu 90	97.25647951	88.4597733	82.09950174	75.78426627

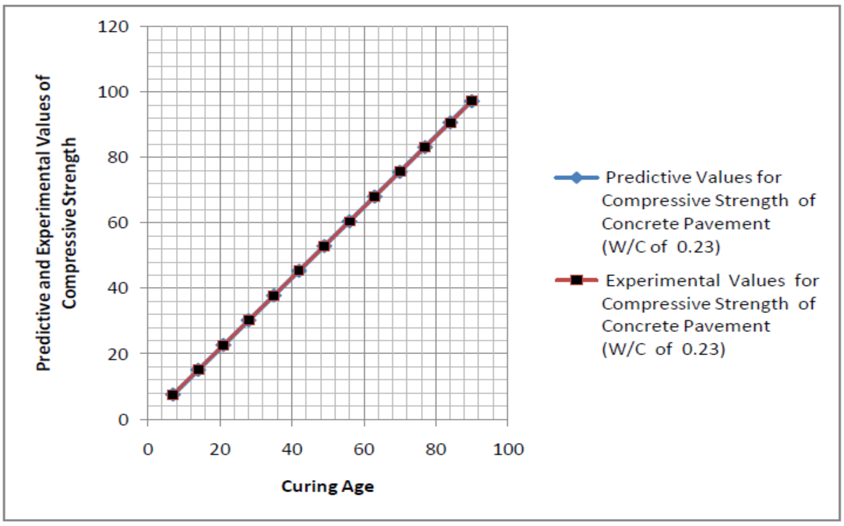

Fig1. *Predictive and Experimental Values of Compressive at Different Curing Age*

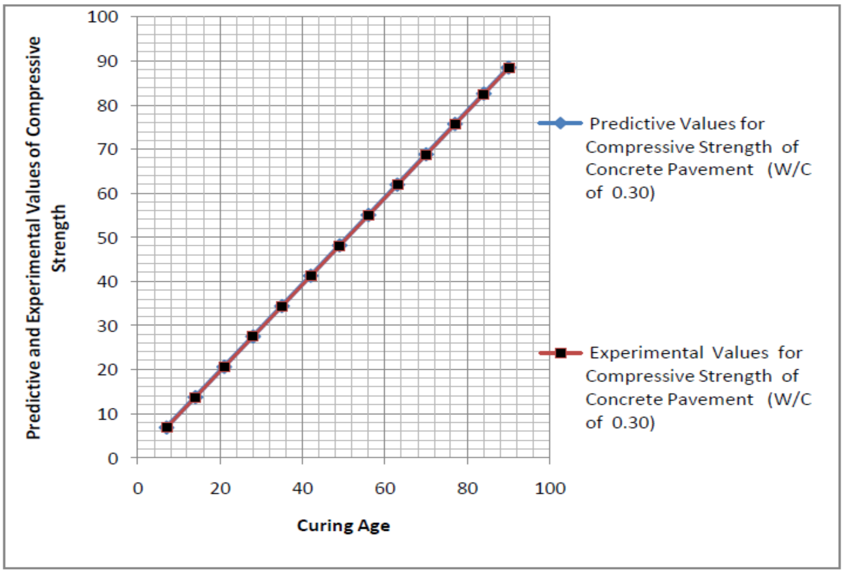

Fig2. *Predictive and Experimental Values of Compressive at Different Curing Age*

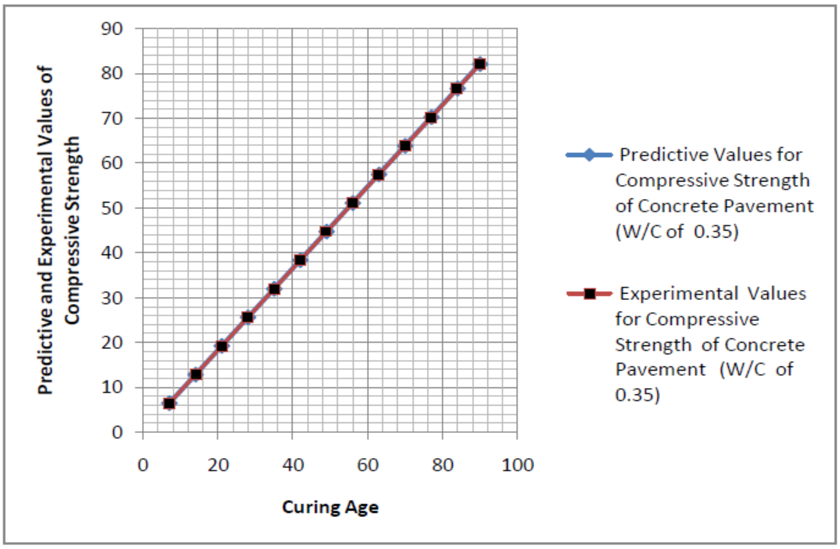

Fig 3. *Predictive and Experimental Values of Compressive at Different Curing Age*

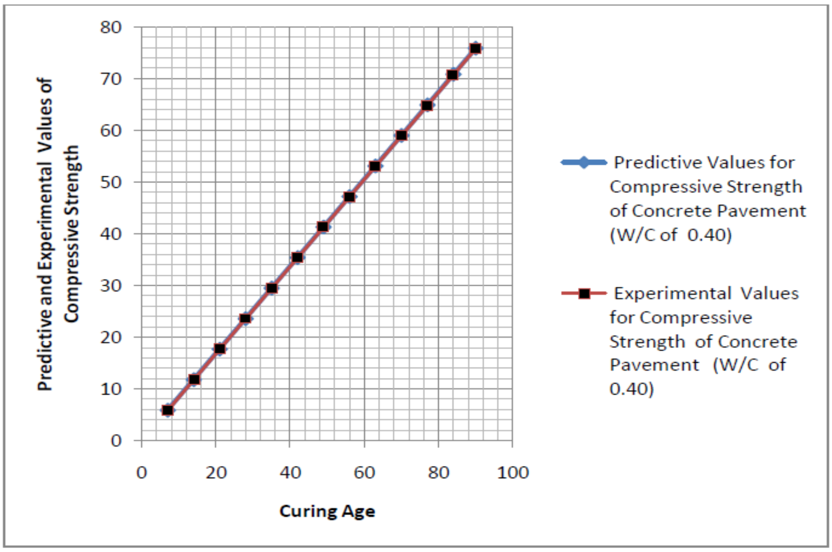

Fig4. *Predictive and Experimental Values of Compressive at Different Curing Age*

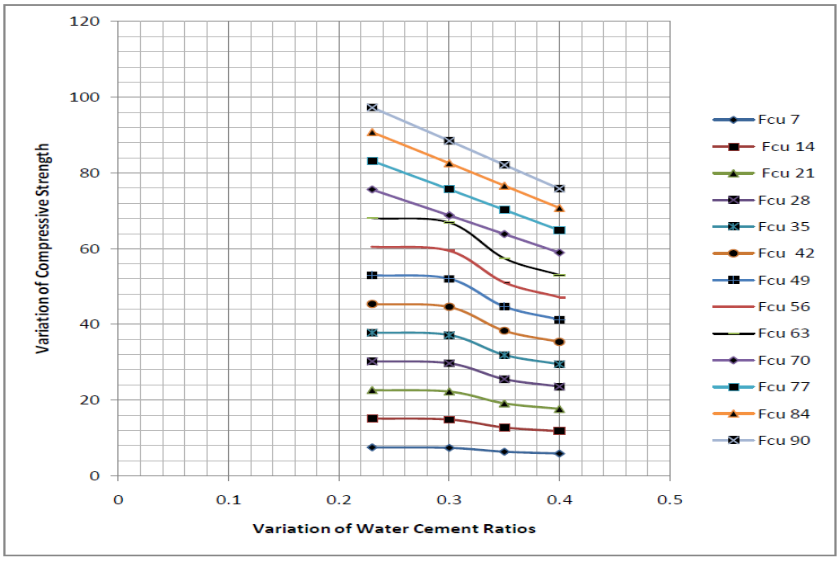

Fig5. *Predictive Values of Compressive Varying at Different Water Cement Ratios*

Figure one to five presented express the growth rate of compressive strength at different curing age, linear trend were observed base on the growth rate of compressive strength at different age, the figures also observed the efficiency of the addictive as partial replacement for cement, the materials attaining such variation of compressive strength which is high strength growth, it shows the rate of effective reflection on the addictive, , variation of dosage on the developed mixed designed also express its level of efficiency on the workability of the concrete target strength, the predictive values were compared with experimental values, thus both parameters developed best fits correlation.

The figures also express the influenced on variation of water cement ratios with compressive strength of the concrete, the developed model values at different age including mixed designed of various water cement ratios were expressed through graphical, it also show decrease in compressive strength as observed at different age, .although the variation of water cement applied in the mixed designed generated compressive strength within the rate of high compressive strength for rigid pavement.

CONCLUSION

The study expressed the rate of strength development on generation of concrete for rigid pavement, most area investigated were observed in most environment will always recommend rigid pavement, such condition may seriously need concrete pavement modified with additive's, the study developed mathematical model that predict compressive strength for high strength concrete, the simulation valued generated various growth rates of linear compressive strength, this observation shows the influences of addictive thus replacement of cement, the strength development for concrete pavement express the developed concrete grades for rigid pavement, the study has definitely defined the rate of influence of mixed designed target strength for rigid pavement, the effect of water cement ratios variation on compressive strength were observed, the effect of water cement ratios from the simulations were within high concrete strength, such strength development were also monitored with variations of curing age where linear trend were observed, this shows the homogeneous strength developed to the optimum rate at ninety days. Predictive and experimental values expressed correlation fits

REFERENCES

[1] JaharatulDini Karen Lee Abdullah1*, Nazri Ali1, Roslli Noor Mohamed1 & Mohammed Mu'azu Abdullahi the effect of quarry dust with cement by-products on properties of concrete Malaysian Journal of Civil Engineering 30(3):415-428 (2017)

[2] Berndt, M.L. (2015). Inflluence of concrete mix design on CO2 emissions for large wind turbine foundations. Renewable Energy, 83: 608-614

[3] Dilip Kumar SinghaRoyl, AmitavaSil (2012). Effect of Partial Replacement of Cement by Silica Fume on Hardened Concrete. Inter. J. Emerging Tech. and Advanced Engineering, 2(8): 472-475.

[4] Divakar, Y., Manjunath, S., and Aswath, M. U. (2012). Experimental Investigation on Behavior of Concrete with the use of Granite Fines. International Journal of Advanced Engineering Research and Studies, 1(4): 84- 87.

[5] Hameed and Sekar. (2009). Properties of Green Concrete Containing Quarry Rock Dust and Marble Sludge Powder as Fine Aggregate.

[6] Ilangovan, R., Mahendran, N. and Nagamani, K. (2008). Strength and Durability Properties of Concrete containing Quarry Rock Dust as Fine Aggregates. ARPN Journal of Engineering and Applied Science. .3(5): 20-26

[7] AnkitNilesh Chandra Patel, Jayesh Kumar Pitroda, (2013). Stone Waste: Effective Replacement of Cement for Establishing Green Concrete, Inter. J. Innovative Tech. And Exploring Engineering, 2(5): 24-27.

[8] Mohammad Iqbal Malik, Syed Rumysa Jan, Junaid A. Peer, S., AzharNazir, KhubbabFa Mohammad. (2015). Study of Concrete Involving Use of Quarry Dust as Partial Replacement of Fine Aggregates. 5(2): 2278-8719.

[9] Poonam, AnoopBishnoi, and ManjuBala. (2015). Effect of Quarry Dust as Partial Replacement of Sand in Concrete. International Journal of All Research Education and Scientific Methods 3(6):1-5.

[10] Raharjo, D., Subakti, A., and Tabvio. (2013). Mixed Concrete Optimization using Fly Ash,Silica Fume and Iron Slag on the SCC's Compressive Strength. Procedia Engineering, 54: 827-839.

[11] Safiuddin, M, Zain, M. F. M, Yusof, K. M. (2000b). Development of High Performance Concrete Using Quarry Dust as a Partial Replacement of Sand. In: Proceedings of the PCI/FHWA/FIB International Symposium on High Performance Concrete, Orlando, Florida, USA. pp. 173-182.

[12] Sivakumar, A., and Prakash, M. (2011). Characteristic studies on the mechanical prop erties of quarry dust addition in conventional concrete. Journal of Civil Engineering and Construction Technology. 2(10): 218-235.

[13] Sukesh, C., Krishna, K. B., SaiTeja, P. S. L., and Rao, J. K. (2013). Partial Replacement of Sand with Quarry in Concrete. Int. Journal of Innovative Technology and Exploring Engineering. 2(6): 254- 258.

[14] Lohani, T. K., Padhil M., Dash K. P., and Jena S. (2012). Optimum Utilization of Quarry Dust as Partial Replacement of Sand in Concrete. Inter. Journal of Applied Sciences. 1(2): 391-404.

[15] Vishal, S. G., Pranita, S...B. (2014). Influence of Silica Fume in Concrete. IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE), 44-47.

[16] Venkata Sairam Kumar, N., PandurangaRao, B., and Krishna Sai M. L. N. (2013). Experimental Study on Partial Replacement of Cement with Quarry Dust. International Journal of Civil Engineering and Technology (IJCIET), 2(3): 136-137.

[17] Linoshka, S.P., and Hwang. (2016). Mix design and Pollution Control Potential of Pervious Concrete with Non-compliant Waste Fly ash, Journal of Environmental Management. 176:112-118.

[18] Ode .T. and Eluozo S.N. Predictive Model on Compressive Strength of Concrete Made with Locally 3/8 Gravel from Different Water Cement Ratios and Curing Age; International Journal of Scientific and Engineering Research, Volume 7, issue 1 January- 2016 pp1528-1551.

[19] Ode .T. and Eluozo S.N. Model Prediction to Monitor the Rate of Water Absorption of Concrete Pressured by Variation of Time and

Water Cement Ratios International Journal of Scientific and Engineering Research, Volume 7, issue 1 January- 2016 pp1514-1527

[20] Ode .T. and Eluozo S.N. Calibrating the Density of Concrete from Washed and Unwashed Locally 3/8 Gravel Material at Various Curing Age International Journal of Scientific and Engineering Research, Volume 7, issue 1 January- 2016 pp1514-1552-15574

[21] Ode .T. and Eluozo S.N; Compressive Strength Calibration of Washed and Unwashed Locally Occurring 3/8 Gravel from Various Water Cement Ratios and Curing Age; International Journal Engineering and General Science Volume 4 Issue 1, January-February,2016 pp462-483.

[22] Ode .T. and Eluozo S.N; Predictive Model to Monitor Variation of Concrete Density Influenced by Various Grade from Locally 3/8 Gravel at Different Curing Time International Journal Engineering and General Science Volume 4 Issue 1, January-February,2016 pp 502-522.

[23] Ode .T. and Eluozo S.N; Predictive Model to Monitor Vitiation of Stress –Strain Relationship of 3/8 Gravel Concrete with Water Cement Ration [0.45] at Different Load International Journal Engineering and General Science Volume 4 Issue 1, January-February,2016 pp409-418.

[24] Ode, T. (2004). Structural properties of Concrete made with locally occurring 3/8 gravel. M.TECH. Thesis Rivers State University of Science and Technology.

[25] Ode. T. and Eluozo S.N. (2015). Predictive Model to Monitor the Variation of Concrete Density Influenced by various Grades from Locally 3/8 gravel at different curing time

Citation: *Eluozo S.N, Nwaobakata C, "Modeling Compressive Strength of Concrete Pavement Influenced by Water Cement Ratios modified with Silica and Plasticizer" Journal of Architecture and Construction, 2(1), 2019, pp. 35-41.*