International Journal of Advances in Engineering and Management (IJAEM)
Volume 4, Issue 3 Mar 2022, pp: 1152-1154 www.ijaem.net ISSN: 2395-5252

Statistical Correlationof Flexural and Compressive Strength of Concrete for Predictionof MetakaolinHigh Strength Concrete

B.G. Jephter[1]&T.A LongJohn[2]
[1]Department of Civil Engineering, Rivers State University, Nigeria
[2]Department of Civil Engineering, Rivers State University, Nigerria

Submitted: 20-03-2022 Revised: 27-03-2022 Accepted: 30-03-2022

ABSTRACT
Assessment presented in this research is to establish the correlation between compressive strength of concrete and flexural strength of high strength concrete produced using metakaolin as a partial replacement of cement at different replacement level of 0%, 4.5%, 9%, 13.5% and 18%. The targeted strength of compressive strength wasachieved at 13.5% replacement with metakaolin and its resultant flexural strength of 5.90N/mm^2. This indicates that metakaolin is a good chemical additive to obtain high strength concrete for construction purposes. Linear Regression model was employed to establish the correlation between compressive strength and flexural strength of concrete and the emergedgraph showed a strong relationship with a coefficient of determination of 0.99 for 7days, 14days and 28days curing.
Keyword: Flexural strength, compressive strength, correlation, linear regression model

I. INTRODUCTION

Concrete is generally classified as Normal Strength Concrete (NSC), High Strength Concrete (HSC) and Ultra High Strength Concrete (UHSC). There are no clear cut boundaries for the above classification. HSC require high volume of cement at low water/cement ratio which causes autogenous shrinkage problem. To overcome this problem, other supplementary cementitious material such as Metakaolin (MK), Microsilica (MS) and lite are used to replace cement by weight. The application of MK as a partial substitution of PC could increase both the mechanical and durability properties of concrete, and also significantly minimize the ECO_2 emission by concrete [1-22].

This research is aimed at determiningand correlating the compressive strength and flexural strength of concrete made using metakaolinadditive to produced high strength concrete.

II. METHODOLOGY

Materials properties used in the previous research (Nwofor and Ukpaka, 2017) were used in this present study as our main aim here is to determinecorrelation between the compressive strength and flexural strength of concrete made using metakaolinadditive to produced high strength concrete.

2.5. Flexural Strength(ρ): Indian Standard IS 456:2000 gives the following relationship between the compressive strength and flexural strength.

Flexural Strength, $\rho = \sqrt[0.7]{\sigma}$ (1)

2.6. Compressive Strength (σ): The compressive strength of the concrete was determined using the expression below:

Compressive strength, $\sigma = \frac{F}{A}$ (2)

Where; σ = compressive strength (N/mm^2), F = maximum failed load (N), A = cross-sectional area of cube (mm^2).

Mix Design of Concrete

Trial mixtures were adopted and a targeted strength higher than $60^{N}/_{mm^2}$ for control mix at 28days of curing, $^{w}/_{b}$ for the mixture used were kept within 0.29 and partial replacement order 0%, 5%, 10%, 15%, 20% and 25% with addition of super plasticizer.

International Journal of Advances in Engineering and Management (IJAEM)
Volume 4, Issue 3 Mar 2022, pp: 1152-1154 www.ijaem.net ISSN: 2395-5252

III. RESULTS

The Regression Models

The study established the following models as shown below:

At 7 days curing,

$$Fstren = 0.048Cstren + 2.5401 \quad , \quad R^2 = 0.9981 \quad (3)$$

At 14 days curing,

$$Fstren = 0.048Cstren + 2.5024 \quad , \quad R^2 = 0.9692 \quad (4)$$

At 28 days curing,

$$Fstren = 0.0433Cstren + 2.8245 \quad , \quad R^2 = 0.9994 \quad (5)$$

Where Fstren represents flexural strength of concrete and Cstren is the compressive strength of concrete obtained at different replacement level with MC %, constant water-cement ratio of 0.29 and addition of super plasticizer.

Table 1: Determined of compressive and flexural strength of concrete produced using differential partial replacement levels at varying Curing Age.

AC(Days)	MC(%)	Cstren(N/mm^2)	Fstren(N/mm^2)
7,14,28	0	47,57,60.7	4.80,5.28,5.45
7,14,28	4.5	47.8,60,64.6	4.83,5.42,5.63
7,14,28	9	49.5,65,69	4.92,5.6,5.81
7,14,28	13.5	51,69,71	4.99,5.81,5.90
7,14,28	18	47,66,68	4.80,5.69,5.77

The trend of observations in the determined values of compressive strength and flexural strength at 7days curing and crushing at replacement level of 0%, 4.5%, 9%, 13.5%, and 18% of metakaolin sand substituted additive to cement to enhance strength of concrete. At 7days maximum compressive strength and flexural strength of concrete was gotten at 13.5% replacement. Table 1 and Equation(3-5) gives the Correlation between compressive strength and flexural strength of concrete produced 7days, 14days and 28days curing and crushing of concrete made. The predicting equation developed is suitable in scaling flexural strength of concrete for any given value of compressive strength of produced concrete.

IV. CONCLUSION

The study developed equations for correlations between flexural strength and compressive strength of high strength concrete at 7day, 14days and 28days of curing and crushing of concrete. The developed Equation (3)-(5) can be used to predict flexural strength of concrete upon established compressive strength of concrete produced at constant water-cement ratio of 0.29, MC% with addition of super plasticizer as acceptable correlations were established for the developed equations.

Hence, for a given value of a compressive strength of concrete at a given partial replacement of foundry waste sand, the flexural strength can be simulated using the model developed. The maximum flexural strength of concrete was determined as $3.14\,N/mm^2$ at 15% replacement level.

REFERENCE

[1]. Nwofor, T.C. &Ukpaka, C. (2017). A Mathematical Model for Prediction of Metakaolin- Silica Fume High Strength Concrete. Journal of Civil Engineering Research, 7(5):137-142

[2]. Saber, F.,& Mahdi, N. (2017). Mechanical Properties and Durability of High-Strength Concrete Containing Macro-Polymeric and Polypropylene Fibers with Nano-Silica Fume. Journal of Construction and Building Materials,132 (2017) 170-187.

[3]. Sata, V., Jaturapitakkul, C., &Kiattikomol, K. (2007). Influence of Pozzolan from Various Byproduct Materials on Mechanical Properties of High Strength Concrete, Construction and Building Materials, 21(7), 1589-1598.

[4]. Schmidt, M., Fehling, E., &Geisenhanslüke C. (2004).Ultra High Performance Concrete (UHPC) International Symposium on Ultra High Performance Concrete Conferences 13-15 September.

[5]. Scrivena, K.I, &Kirkpatrick, R. (2007). Innovation in Use and Research on Cementitious Material. In: 12th International Congress of Chemistry of Cement, Montreal, Canada; 2007.

[6]. Seok-Joon, J.,& Hyun-Do, Y. (2018). Combined Effects Of Steel Fiber and Coarse Aggregate Size on the Compressive and Flexural Toughness Of High-Strength Concrete. Journal of Composite Structures, 185, 203-211.

[7]. Serkan, S. (2009). Prediction of Mechanical Properties of Cement Containing Class C Fly Ash By Using Artificial Neural Network and Regression Technique.Scientific Research and Essay. 4(4), 289-297.

[8]. Shah, A. A. (2004). Experimental Investigation of High Performance/High Strength Concrete Columns with Intervening Normal Strength Concrete Slabs. Ph.D. Thesis. LeipzigUniversity.

[9]. Sheikh, S.A., &Uzumeri, S.M. (1982). Analytical Model for Concrete Confinement in Tied Columns.Journal of the Structural Division, ASCE, 108(12), 2703-2722.Special Publication No. Coren/2017/016/RC, Concrete Mix Design Manual. 11

[10]. Tantawy, M. M. (2009). Artificial Neural Network for Prediction and Control of Blasting Vibrationsin Assiut (Egypt) Limestone Quarry. Int. J. Rock Mech. Mining Sci. 46, 426-431.

[11]. Tiwari, A. K., & Bandyopadhyay, P. (2003). High Performance Concrete with Indian Metakaolin. in International Symposium on Innovative World of Concrete, 19–21 September. Pune: Indian Concrete Institute.

[12]. Topcu, I.B., &Saridemir, M. (2008). Predict Ion of Rubberized Concrete Properties Using Artificial Neural Network and Fuzzy Logic, Construction and Building Materials, 22, 532-540.

[13]. Topçu, B., &Sarıdemir, M. (2008a). Prediction of Compressive Strength of Concrete Containing Fly Ash Using Artificial Neural Network and Fuzz Logic. Comput. Mater. Sci. 41(3), 305-311.

[14]. Unala, O., Demir, F., &Uygunoglua, T.(2007). Fuzzy Logic Approach to Predict Stress– Strain Curves of Steel Fiber-Reinforced Concretes in Compression, Building and Environment, 42, 3589- 3595.

[15]. Vahid, A. F.&Togayozba, L. (2015). Mechanical and Durability Properties of High- Strength Concrete Containing Steel and Polypropylene Fibers. Journal of Construction and Building Materials, 94, 73-82.

[16]. Varona, F. J.,Baeza, D. & Bru, S. I. (2018). Influence of High Temperature on the Mechanical Properties of Hybrid Fibre Reinforced Normal and High Strength Concrete. Journal of Construction and Building Materials. 159, 73-82.

[17]. Wasim, A. M., Tqbal, K., &Shehab, M. (2018). Evaluation of Mechanical Properties of Steel Fiber Reinforced Concrete. Journal of Construction and Building Materials, 1, 556-569.

[18]. Wasin, A. M., Iqbal, K., & Shehab, M. (2018). Evaluation of Mechanical Properties of Steel Fiber Reinforced Concrete with Different Strengths of Concrete. Journal of Construction and Building Materials 168, 556-569.

[19]. Wild, S., & Khatib, J. M. (1997). Portlandite Consumption of Metakaolin Cement Pastes and Mortars. Cement and Concrete Research, 27(1), 137–146.

[20]. Wild, S., Khatib, J. M., & Jones, A. (1996). Relative Strength, Pozzolanic Activity and Cement Hydration in Super plasticised Metakaolin Concrete. Cement and Concrete Research, 26(10), 1537–1544.

[21]. Zadeh, L.A. (1962). From Circuit to System Theory, Roc. of Institute of RatioEng., 50(1962), 856-865.

[22]. Zain, M. F. M., Safiuddin, M., & Yusof, K. M. (1999). A Study on the Properties of Freshly Mixed High Performance Concrete, Cement and Concrete Research, 29(9), 1427–1432.