Original Article

ISSN: 2349 - 4891

International
Journal of Recent Research and Applied Studies
(Multidisciplinary Open Access Refereed e-Journal)

Relation Between Flexural Strength and Aggregate/Cement Ratio for Concretes Made of Crushed Granite Chippings

Umeonyiagu Ikechukwu Etienne

Department of Civil Engineering, Chukwuemeka Odumegwu Ojukwu University, Uli.

Received 12th March 2019, Accepted 1st April 2019

Abstract

This paper verified the relation between flexural strength and aggregate/cement ratio for concretes made of granite chippings. The crushed granite chippings were from Abakaliki in Ebonyi State, Nigeria. By varying the aggregate/cement ratios, concrete beams of dimensions 600mm x 150mm x 150mm were made at water/cement ratios of 0.55 and 0.575 by weight respectively. These beams were then tested for their flexural strengths. The graphs of flexural strengths versus aggregate/cement ratios showed that the flexural strength decreased parabolically with increase in the aggregate/cement ratio. The regression equations of the graphs were polynomials of the second order. A z-test was used to prove the validity of these equations.

Keywords: Granite Chippings, Beams, Flexural Strength, Aggregate/Cement Ratio.

Introduction

Concrete is composed mainly of three materials, namely cement, water and aggregate, and an additional material, known as an admixture, is sometimes added to modify certain of its properties. Cement is the chemically active constituent but its reactivity is only brought into effect on mixing with water. The aggregate plays no part in chemical reactions but its usefulness arises because it is an economical filler material with good resistance to volume changes which take place within the concrete after mixing, and it improves the durability of the concrete[1]. Aggregates can be grouped into fine aggregates and coarse aggregates. The fine aggregates, often called sand, are not larger than 5 mm or 3/16 in., and the coarse aggregates, comprise materials at least 5 mm or 3/16 in. in size [2].

Materials and Method

Preparation, Curing and Testing Of Beam Samples

The aggregates were sampled in accordance with the methods prescribed in BS 812: Part 1:1975 [3]. The test sieves were selected according to BS 410:1986 [4]. The water absorption, the apparent specific gravity and the bulk density of the coarse aggregates were determined following the procedures prescribed in BS 812: Part 2: 1975 [5]. The Los Angeles abrasion test was carried out in accordance with ASTM. Standard C131: 1976 [6]. The sieve analyses of the fine and coarse aggregate samples were done in accordance with BS 812: Part 1: 1975 [3] and satisfied BS 882:1992[7]. The sieving was performed by a sieve shaker. The water used in preparing the experimental samples satisfied the conditions prescribed in BS 3148:1980 [8]. The required concrete beams of dimensions 600mm x 150mm x 150mm were made in threes in accordance with the method specified in BS 1881: 109:1983 [9]. These specimens were cured for 28 days in accordance with BS 1881: Part 111: 1983 [10]. The testing was done in accordance with BS 1881: Part 118:1983 [11] using flexural testing machine.

Correspondence
Umeonyiagu Ikechukwu Etienne
E-mail: umeonyiaguikechukwu@gmail.com

Testing the Fit of the Quadratic Polynomials

The polynomial regression equation developed was tested to see if the predicted values agreed with the actual experimental results. The null hypothesis denoted by H_0 assumed that the predicted values and the experimentally-obtained values are from the same population samples with variances that are not significantly different. The alternative hypothesis was denoted by H_1. The z-test was used to test the adequacy of the regression equations [12-13]. If the absolute value of z is lower than the z critical two-tail, then the null hypothesis would be accepted and the equations taken as adequate.

Results and Discussion

Physical and Mechanical Properties of Aggregates

Sieve analyses of both the fine and coarse aggregates were performed and the grading curves shown in Figures 1 and 2. These grading curves showed the particle size distribution of the aggregates. The maximum aggregate size for the granite chipping was 20 mm and 2mm for the fine sand. The granite chippings had water absorption of 2.7%, moisture content of 44.2%, apparent specific gravity of 2.26, Los Angeles abrasion value of 22% and bulk density of 2072.4 kg/m^3.

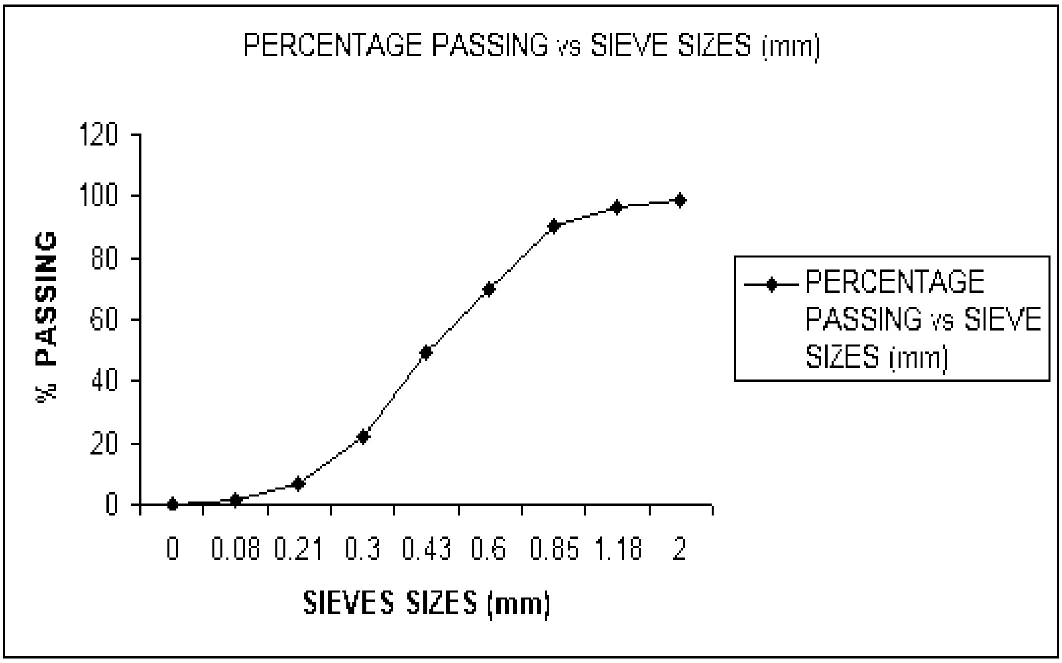

Figure 1
Grading Curve For The Fine Aggregat**e**

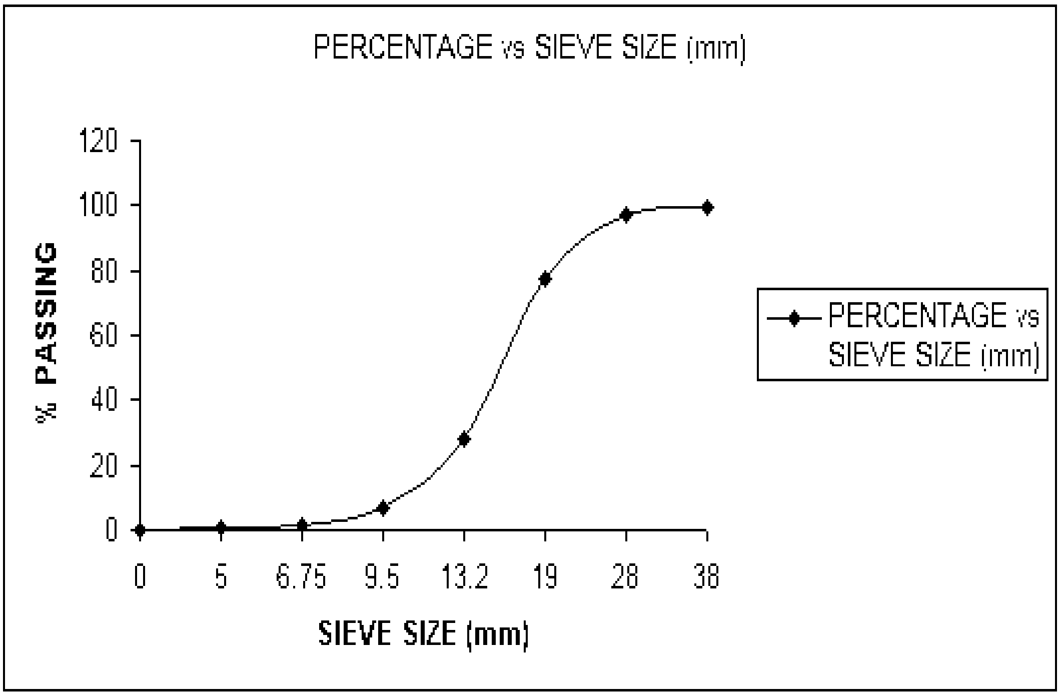

Figure 2
Grading Curve for the Crushed Granite Chippings

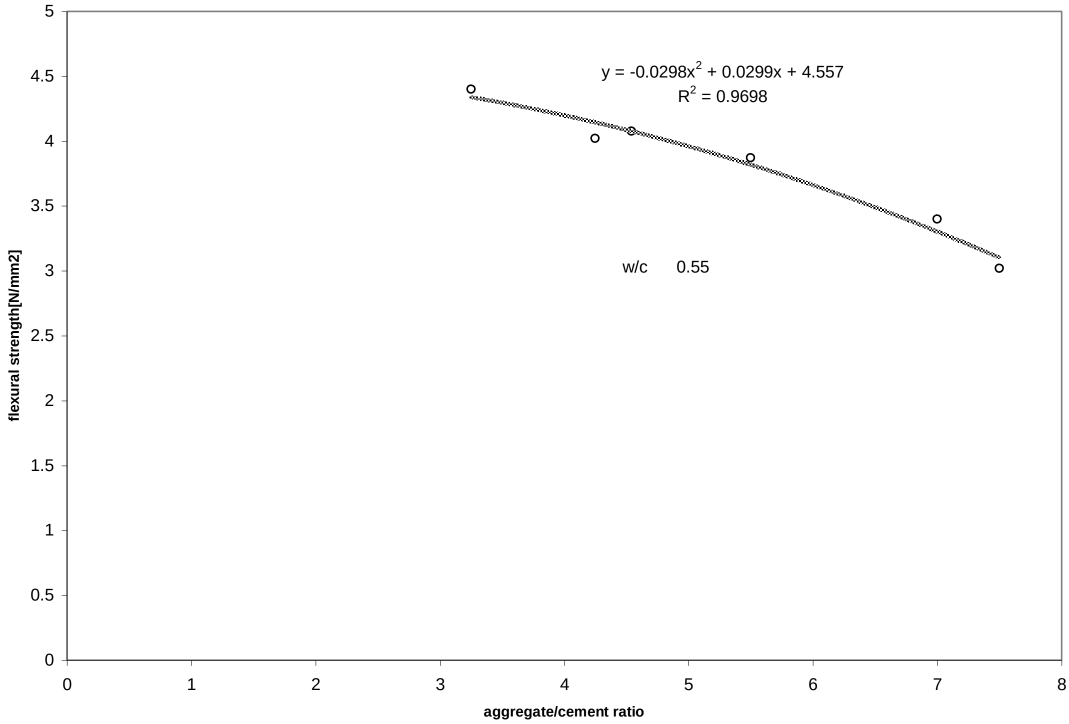

Figure 3
Flexural Strength Vs Aggregate/Cement Ratio [W/C=0.55]

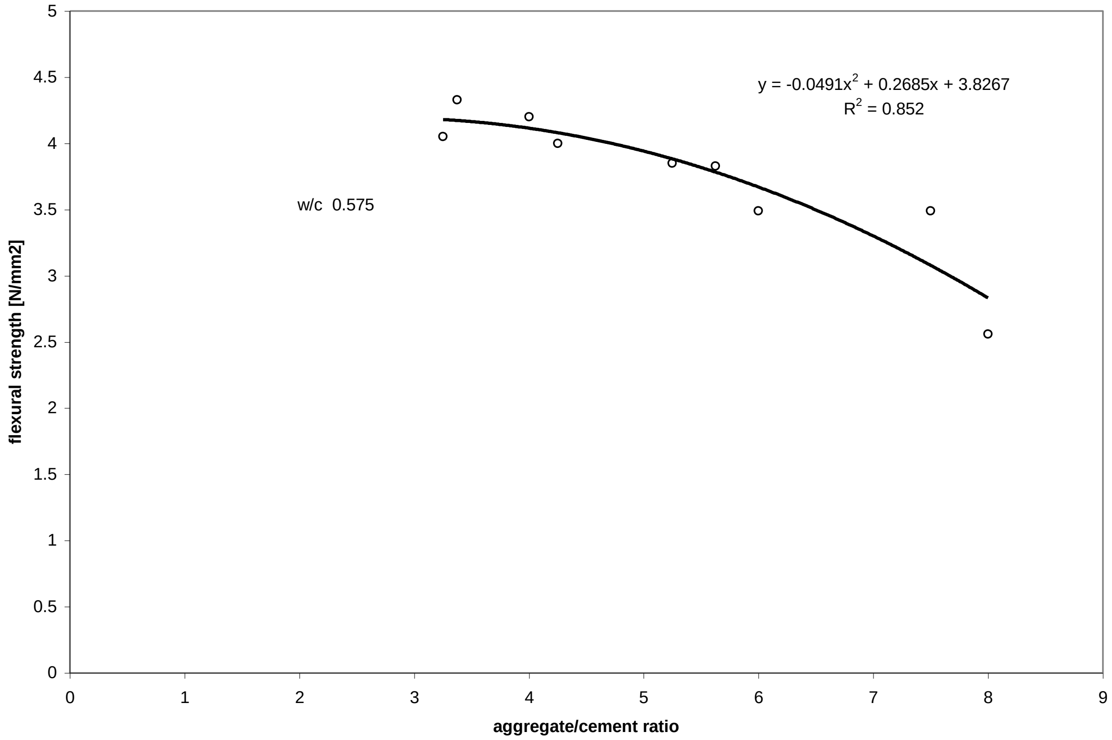

Figure 4
Flexural Strength Vs Aggregate/Cement Ratio [W/C=0.575]

Table 1

z-Test: Two Sample for Means(w/c = 0.55)

	EXPERIMENTAL VALUE	*THEORETICAL VALUE*
Mean	3.797666667	3.799140887
Known Variance	0.25	0.24
Observations	6	6
Hypothesized Mean Difference	0	
z	-0.005158695	
P(Z<=z) one-tail	0.497941987	
z Critical one-tail	1.644853627	
P(Z<=z) two-tail	0.995883975	
z Critical two-tail	1.959963985	

Table 2

z-Test: Two Sample for Means(w/c = 0.575)

	EXPERIMENTAL VALUE	*THEORETICAL VALUE*
Mean	3.755555556	3.755312153
Known Variance	0.28	0.24
Observations	9	9
Hypothesized Mean Difference	0	
z	0.001012617	
P(Z<=z) one-tail	0.499596024	
z Critical one-tail	1.644853627	
P(Z<=z) two-tail	0.999192049	
z Critical two-tail	1.959963985	

The Regression Equations For The Flexural Strength Tests Results

With the water/cement ratio = 0.55, the regression equation was $y = -0.0298x^2 + 0.0299x + 4.557$, where y represented the flexural strength measured in N/mm^2 and x, the aggregate/cement ratio (Figure 3). The regression analysis of the equation produced a coefficient of determination, $R^2 = 0.97$. With the water/cement ratio, w/c = 0.575, the regression equation was $y = -0.0491x^2 + 0.2685x + 3.8267$ and $R^2 = 0.852$ (Figure 4). The high values of R^2 for both equations indicated that the relationship was very strong.

z -Test

Table 1 shows the z-test analysis for w/c = 0.55. The experimental values and predicted values produced variances that are not significantly different. With the alpha = 0.05, the value of z is -0.0052 and z critical two-tail, 1.96. Since the absolute value of z is less than z critical two-tail, the regression equation is adequate thereby satisfying the null hypothesis, $H_{0.}$ P(Z <= z) two-tail, the probability of a z-value further from 0 in the same direction as the observed z-value when there is no difference between the population means, was 0.996. Table 2 shows the z-test analysis for w/c = 0.575. The experimental values and predicted values produce variances that are not significantly different. With the alpha = 0.05 and P (Z <= z) two-tail= 0.999, the value of z is -0.0010 and z critical two-tail, 1.64. Since the absolute value of z is less than z critical two-tail, this regression equation is also adequate.

Conclusions

The relationship between the flexural strength of the granite chippings and the aggregate/cement ratio is a polynomial of the second-order. The flexural strength decreases parabolically with increase in the aggregate/cement ratio. Since the absolute value of z is less than z critical two-tail, these regression equations are adequate.

References

1. Jackson, N. and Dhir, R. K., (1988).*Civil Engineering Materials,* Macmillan, Hampshire RG21 2XS, England.
2. Neville, A. M., (1995) *Properties of Concrete, Third Edition,* Pitman, London.

3. BS 812: Part 1 (1975)*Sampling, shape, size and classification*. Methods for sampling and testing of mineral aggregates, sands and fillers. British Standards Institution Publication, London.
4. BS 410 (1986)*Specification for test sieves.* British Standards Institution Publication, London.
5. BS 812: Part 2 (1975)Methods for sampling and testing of mineral aggregates, sands and fillers. *Physical properties*. British Standards Institution Publication, London.
6. ASTM. Standard C 131 (1976)*Tests for Resistance to Abrasion of Small Size Coarse Aggregate by Use of the Los Angeles Machine.* American Society for Testing and Materials Publication, New York.
7. BS 882 (1992) *Specification for aggregates from natural sources for concrete.* British Standards Institution Publication, London.
8. BS 3148 (1980) *Tests for water for making concrete.* British Standards Institution Publication, London.
9. British Standard 1881: Part 109(1983) *Method for making test beams from fresh concrete.* British Standards Institution Publication, London.
10. British Standard 1881: Part 111 (1983) *Method of normal curing of test specimens (20 ^{o}C).* British Standards Institution Publication, London.
11. British Standard 1881: Part 118 (1983) *Method for determination of flexural strength* British Standards Institution Publication, London.
12. Devore, Jay L., (1995) *Probability and Statistics for Engineering and the Sciences*. 4th ed. Wadsworth Publishing.
13. Sokal, Robert R., and James, Rohlf. (1995) *Biometry: The Principles and Practice of Statistics in Biological Research*. 2nd ed. New York: W. H. Freeman.

Please cite this article as: Umeonyiagu Ikechukwu Etienne (2019). Relation between Flexural Strength and Aggregate/Cement Ratio for Concretes Made Of Crushed Granite Chippings. International Journal of Recent Research and Applied Studies, 6, 4(1), 1-5.