INFLUENCE OF WATER/CEMENT RATIO ON THE FLEXURAL STRENGTH OF CONCRETE MADE WITH UNWASHED LOCAL GRAVEL

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ABSTRACT
This paper studied the influence of water/cement ratio on the flexural strength of concrete made with unwashed local gravel from Abagana in Anambra state. In the research work, concrete beams of dimensions 600mm x 150mm x150mm —three for each experimental point were made. The water/cement ratio, w/c ranged from 0.46 to 0.56 for the mix ratio of 1:1:2 and from 0.55 to 0.63 for the mix ratio of 1:2:4. The batching was by weight. These beams were then tested based on the procedures prescribed in BS 1881: Part 118:1983. The graphs of the flexural strengths against water/cement ratios were hyperbolic in nature. The equations of the graphs were $y = -636.6x^2 + 645.6x - 160.35$ *and* $y = -636.36x^2 + 752.41x - 219.62$ *for the mix ratios of 1:1:2 and 1:2:4 respectively, where y represented the flexural strength in* N/mm^2 *and x represented the water/cement ratio, w/c. As the water/cement ratio increased, the flexural strength of the samples rose to a peak before declining. The mix ratio of 1:1:2 had a peak flexural strength of 3.33* N/mm^2 *at w/c = 0.51 and the mix ratio of 1:2:4, a peak of 2.79* N/mm^2 *at w/c = 0.59.*

1.0 INTRODUCTION
In engineering practice, the strength of concrete at a given age and cured at a prescribed temperature is assumed to depend primarily on two factors only: the water/cement ratio and the degree of compaction [1]. Generally, water in concrete consists of that added to the mix and that held by the aggregate at the time when it enters the mixer. When concrete is fully-compacted its strength is taken to be inversely proportional to the water/cement ratio according to Duff Abrams [1]. From time to time the water/cement ratio rule has been criticized as not being sufficiently fundamental. Nevertheless, in practice the water/cement ratio is the largest single factor in the strength of fully-compacted concrete.

2.0 SIEVE ANALYSIS
This is the simple operation of dividing a sample of aggregate into fractions, each consisting of particles of the same size. In practice, each fraction contains particles between specific limits, these being the openings of standard test sieves [2]. The test sieves used for concrete aggregate have square openings and their properties are prescribed by BS 410: 1986 [3]. Sieves that are smaller than 4mm are normally made of wire cloth. The screening, that is area of the openings as a percentage of the gross area of the sieve, varies between 34 and 53 per cent [1]. Coarse test sieves (4mm and larger) are made of perforated mild steel plate, with a screening area of 44 to 65 per cent.

3.0 MATERIALS AND METHOD
The aggregates were sampled in accordance with the methods prescribed in BS 812: Part 1:1975 [4]. The test sieves were selected according to BS 410:1986 [3]. The sieve analyses of the aggregate samples were done in accordance with BS 812: Part 103:1983 [5] and satisfied BS 882:1992 [6]. Concrete beams of dimensions 600mm x 150mm x150mm each —three for each experimental point were made variously at water/cement

ratios ranging from 0.46 to 0.56 by weight for the mix ratio of 1:1:2 and 0.55 to 0.63 by weight for the mix ratio of 1:2:4 according to BS 1881: Part 109: 1983 [7]. The curing was done in a curing water tank for 28 days at a temperature of 20^0C in accordance with the methods specified in BS 1881: Part 111: 1983 [8]. The testing of the specimens was done while still wet after their removal from the curing tank in accordance with BS 1881: Part 118:1983 [9]. The specimens were tested for failure using flexural testing machines.

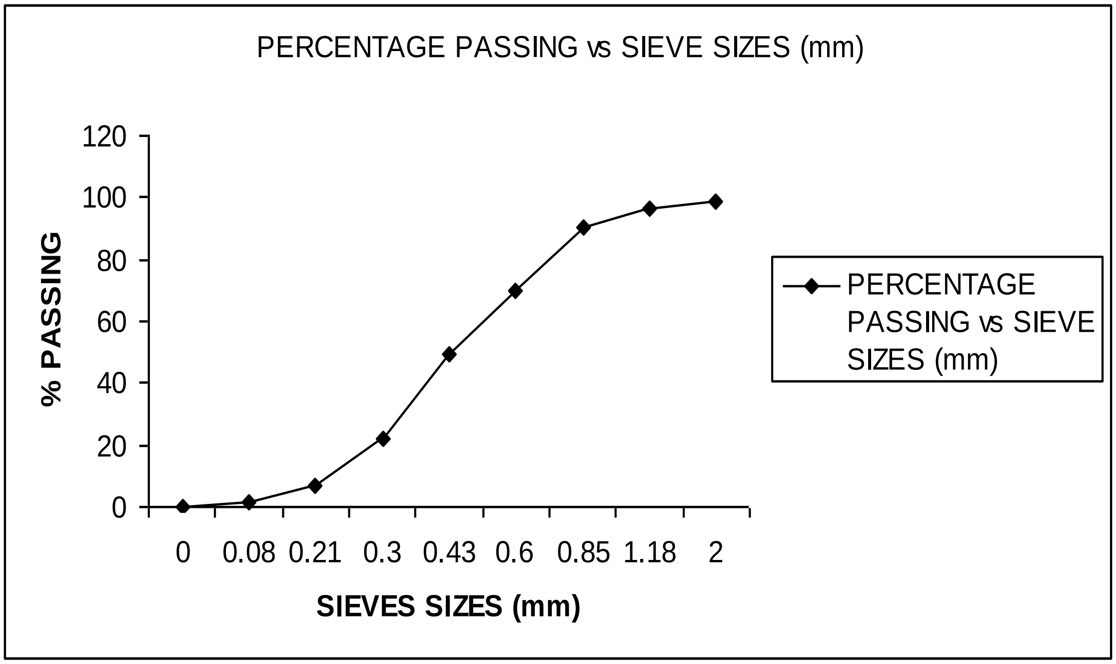

FIGURE 1: GRADING CURVE FOR THE RIVER SAND

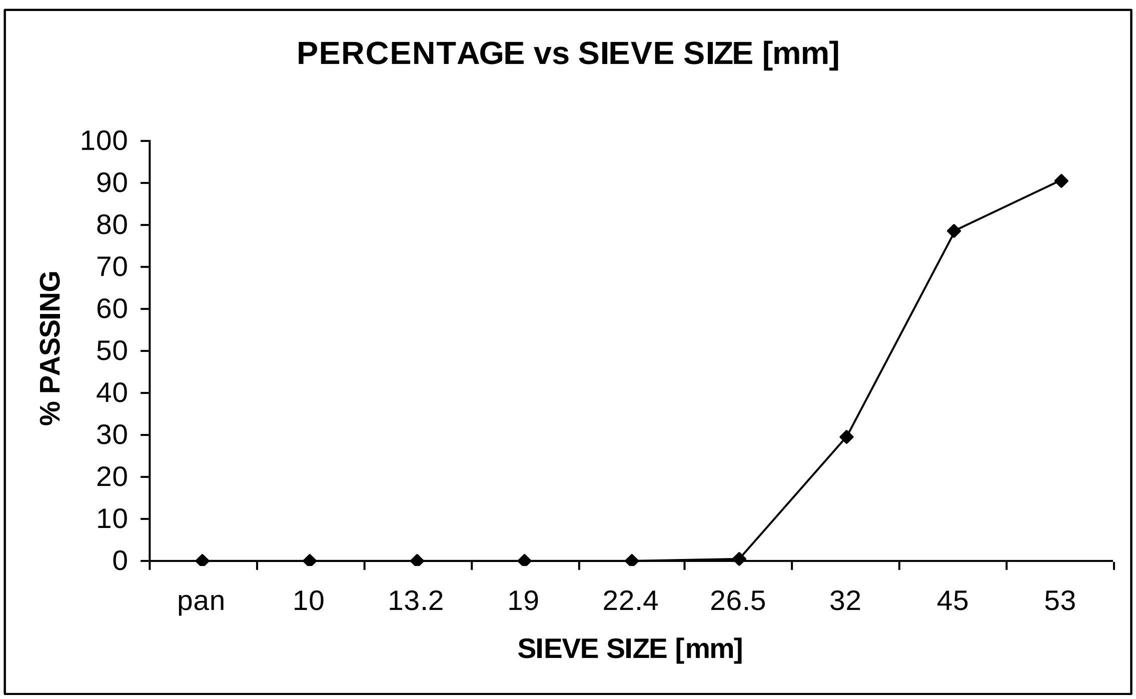

FIGURE 2: GRADING CURVE FOR THE UNWASHED LOCAL GRAVEL

4.0 RESULTS AND DISCUSSION

Figure 1 and figure 2 show the particle size distributions of the aggregates— river sand and granite chippings respectively. The river sand has a maximum aggregate size of 2 mm. The washed local aggregate had a maximum aggregate size of 53mm. Figure 3 shows a graph of flexural strength versus water/cement ratio for unwashed local gravel mix of 1:1:2. The water/cement ratio varied between 0.46 and 0.56 with the maximum flexural strength of 3.33 N/mm^2 occurring at a water/cement ratio of 0.51. The equation of the graph is y = -636.6x2 + 645.6x - 160.35 where y represents the flexural strength in N/mm^2 and x represents the water/cement ratio, w/c. Figure 4 shows a graph of

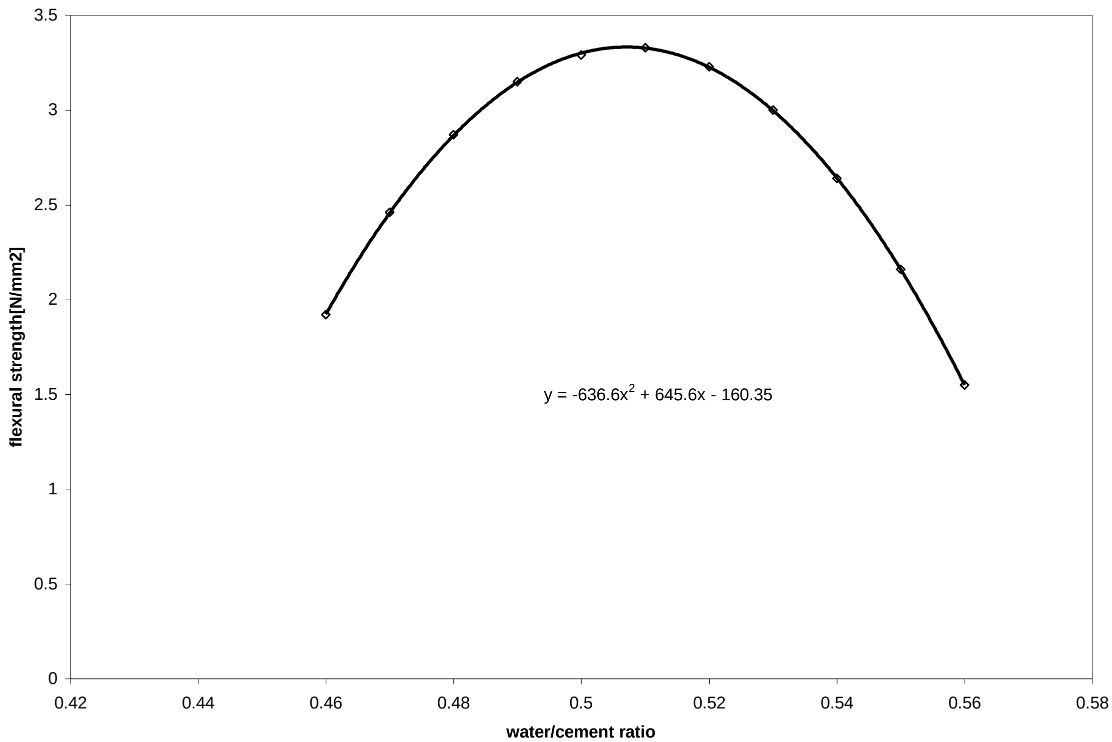

FIGURE 3: FLEXURAL STRENGTH VS. WATER/CEMENT RATIO FOR 1:1:2 MIX

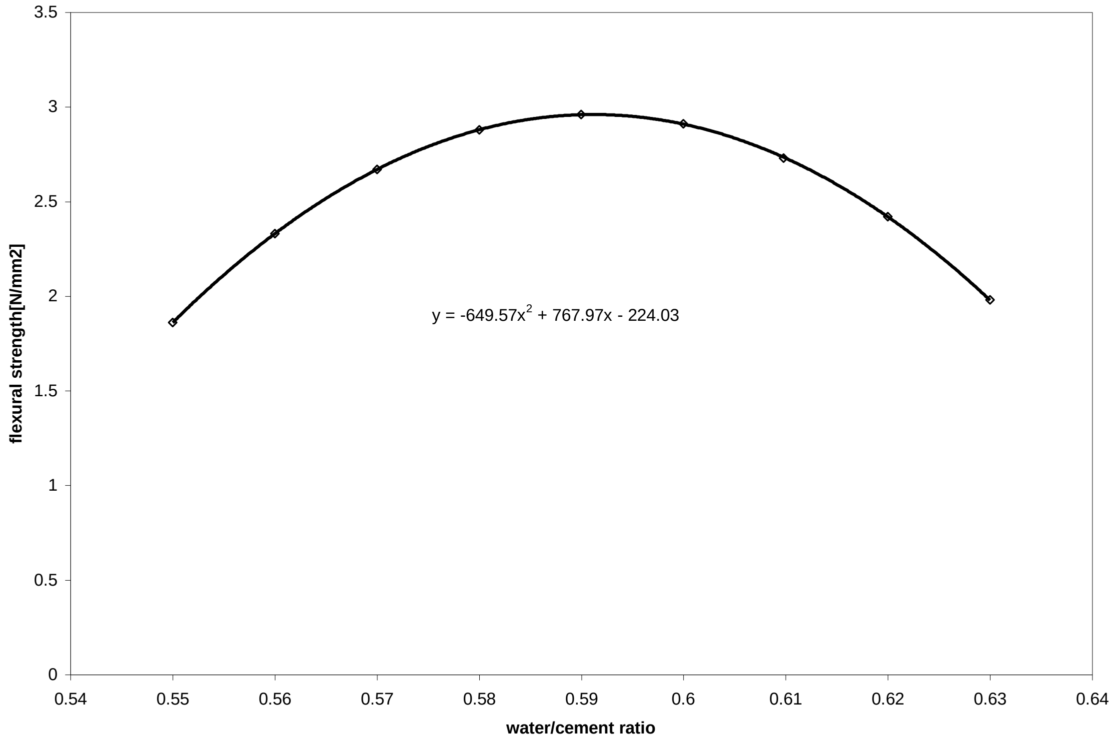

FIGURE 4: FLEXURAL STRENGTH VS. WATER/CEMENT RATIO FOR 1:2:4 MIX

flexural strength against water/cement ratio for the mix ratio of 1:2:4. The water-cement ratio ranged from 0.55 to 0.63, with the maximum flexural strength of 2.79 N/mm^2 at the water/cement ratio of 0.59. The equation of the graph is y = -636.36x2 + 752.41x - 219.62 where y represents the flexural strength in N/mm^2 and x represents the water/cement ratio, w/c These graphs show a hyperbolic relationship between the flexural strengths and the water/cement ratios.

CONCLUSIONS

- The relationship between the flexural strength and w/c is hyperbolic.
- The mix ratio of 1:1:2 has a peak flexural strength of 3.33N/mm^2 at w/c = 0.51
- The mix ratio of 1:2:4 has a peak flexural strength of 2.79 N/mm^2 at w/c = 0.59.

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