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SIZE EFFECT OF AGGREGATE IN THE MECHANICAL PROPERTIES OF CONCRETE

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Abstract - *The utilisation of three sizes of aggregate for concrete work is investigated in this paper. Aggregate grading is an important element in concrete mixing and the resultant strength. This experiment is determining the effect of aggregate size on the compressive strength of concrete. The experiment had three treatments, which were the aggregate sizes (19mm, 25mm, and 37.5mm) and the control. A constant mix of 1:1.5:3 with water cement ratio of 0.5 used throughout the experiment. The specimens were subjected to curing in water for 28 days. The fresh concrete is formulated from the each size of the coarse aggregate and the slump tests were conducted for workability. The Tests were conducted included the compressive strength test, Split Tensile Strength and Flexural Strength was examined at 7 days, 14 days, and 28 days. The mean compressive strength for the 19mm, 25mm and 37.5mm were 19.81 N/mm², 22.76N/mm² and 22.28N/mm² respectively and split tensile strength were 2.01N/mm²,2.132N/mm² and 2.01N/mm² respectively. The mean concrete Compressive Strength and Split Tensile Strength increased with increasing aggregates size. 25mm size aggregate used concrete is more in the case of Compressive Strength and Split Tensile Strength is comparing the conventional concrete. Flexural strength of concrete beam is inversely affected by the increase in coarse aggregate size. Coarse aggregate size 19 mm, 25 mm, and 37.5 mm gave average Flexural Strength of 4.59 N/mm², 4.38 N/mm²and 3.98N/mm²respectively*

***Key Words*: Aggregate size, Concrete, workability, Compressive strength and flexural strength.**

1. INTRODUCTION

Concrete is a very important material and widely used construction material since ancient time. Concrete is no doubt an important building material, playing a part in all building structure. It is most environmental friendly construction material which offers the stability and flexibility in designing all building structures. Concrete are attractive for use as construction materials, due to its advantages such as built-in-fire resistance, high compressive strength and low maintenance. The coarse aggregate plays an important role in concrete. The Coarse aggregates are important in to the volume of concrete, and then research are indicates the changes in coarse aggregate can change the strength of concrete and fracture properties of concrete. This understanding can only be gained through extensive testing and observation. There is strong evidence that aggregate size is a factor in the strength of concrete. The number of concrete structures is around the globe cracks and loses stiffness when subjected to external load. The building industry needs to increase the load carrying capacity of structures by using concrete of high strength. the concrete structure in mix proportion of the different components together with the aggregate type and size determine the compressive.

1.1 Objectives

The investigate for effects of aggregate size on the compressive strength of concrete, with particular reference;

1. To determine the workability of concrete made from different sized coarse aggregates.

2. To study the effect of compressive strength and flexural strength of normal strength concrete using different size of coarse aggregate.

2. MATERIAL AND METHODS

The material used for this study include portland cement, fine aggregate (sharp sand), crush stone as coarse aggregate and water. The aggregate used were of sizes 19mm, 25mm and 37.5mm. The fine aggregate was sharp river sand .ordinary Portland cement was used clean water was used in all experiments. A constant mix proportion of 1:1.5:3 and a constant water to cement (w/c) ratio of 0.5 were used throughout the experiment. The freshly mixed was tested for workability (slump test) according to BS EN 12350-2:2009.The compressive strength and flexural strength tests were carried out on Universal Testing Machine –UTM in accordance with the procedures outlined in BS1881-116(1983)and BS 1881-118: (1983) respectively.

3. EXPERIMENTAL WORKS

3.1 SLUMP TEST

The fresh concrete is cast into a slump test cone in small amounts that were compacted per batch to determine its workability before being cast into the concrete cube moulds. The concrete slump value is used

to find out the workability of concrete and which indicate the water- cement ratio. There are various factors including properties of materials, mixing methods, admixtures etc. also affect the concrete slump value.

3.2 CONCRETE CUBE STRENGTH CALCULATION

The Compressive strength depends on water cement ratio, cement strength, quality of material, quality control during production of concrete Tests specimen of cube size is 150mm x 150mm x 150mm were casted and cured for 28 days in tap water. After specimens are dried in open air, subjected to cube compression testing machine.

The formula used to calculate the compressive strength of each of the concrete cube specimen is given by equation (1).

Cube strength =F/A (1)

Where:

F = Load at failure or crushing load (N)

A = Load Bearing area of the cube (mm^2)

3.3 FLEXURAL STRENGTH CALCULATION

Flexural Strength is the theoretical maximum tensile stress reached in the bottom fibre of a test beam during a flexural strength test. The formula is used to calculate the flexural strength of the beam and specimens are using the results of the three point flexural test is given by equation for a rectangular cross-section:

Flexural strength, $R = PL/bd^2$

Where,

R = modulus of rupture or flexural strength (N/mm^2)

P = Load at failure (kN)

L = span length (mm)

b = average width (mm)

d = average depth (mm)

4. RESULTS AND DICUSSION

4.1 Workability of Fresh Concrete:

This test were carried out in the determine the effect of different coarse aggregate size with constant water-cement ratio on the workability of fresh concrete. The results gotten are presented in Table 1.

Table 1: Slump Test Result for Different Aggregate Sizes with the Same Water Cement Ratio and Mix Proportion

S.No.	Aggregate Size (mm)	Slump(mm)
1	19	135
2	25	147
3	37.5	168

W/c ratio was 0.5 and mix ratio was 1:1.5:3

4.2 Effect of Coarse Aggregate Size on Concrete Compressive Strength

The compressive test results are presented in the Table 2 and figure 1.

Table 2: Compressive Strength Result after 28 Days of Curing

S.No	Aggregate size (mm)	Compressive Strength (N/mm^2)
2	19	20.17
3	25	22.97
4	37.5	23.13

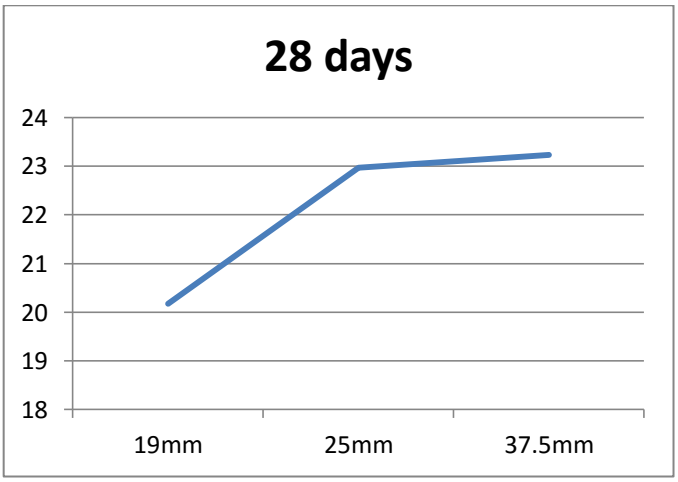

Fig 1 Compressive Strength Result after 28 Days of Curing

illustrates the effect of varying coarse aggregate size on compressive strength of the hardened concrete after 28-days of curing. It was observed that 28-days compressive strength of concrete increases relatively with increase in coarse aggregate size. With increase in coarse aggregate size from 19 mm to 25 mm aggregate size compressive strength was found to increase significantly. Compressive strength for 1:1.5:3 mix at 28 days should not be less than 20 N/mm.

4.3 Effect of Coarse Aggregate Size on Concrete Flexural Strength

The Flexural Strength is measured maximum tensile stress of concrete and the stress reached in the bottom fibre of a test beam during a flexural strength test. The flexural test measures the force required to bend a beam under single point loading conditions. The test was conducted on 3 different difference coarse aggregate sizes, and the final results are as presented in Table 3 and Figure 2.

Table 3: Flexural Strength Result after 28 Days of Curing

S.No.	Aggregate size (mm)	Flexural Strength (N/mm²)
1	19	4.59
2	25	4.38
3	37.5	3.98

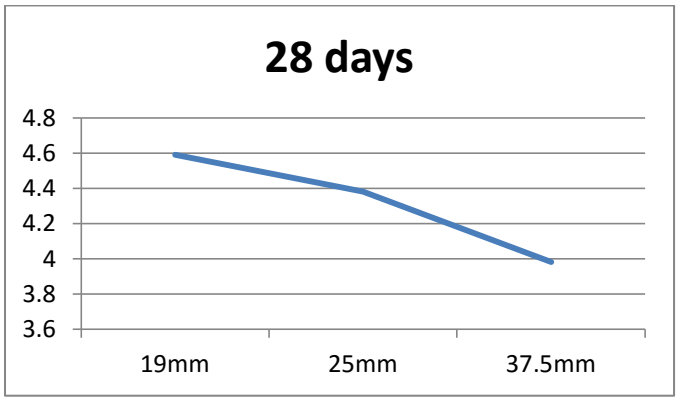

Fig 2 Flexural Strength Result after 28 Days of Curing

5. CONCLUSIONS

Conclusions and Recommendations
The effect of coarse aggregate size on the compressive and the flexural strength of concrete beam were explored in this research. The following are the conclusions and recommendations.

5.1 Conclusions

The following conclusions are drawn from the output of this research and can be summarized as follows:

(1) Coarse aggregate size is directly proportional to the slump (workability) of a fresh concrete with constant water cement ratio.

(2) Compressive strength of a concrete increases with increase in coarse aggregate size. Coarse aggregate size 19 mm, 25 mm, and 37.5 mm gave average compressive strength of 20.17 N/mm², 22.97 N/mm² and 23.13N/mm² respectively.

(3) Flexural strength of concrete beam is inversely affected by the increase in coarse aggregate size Coarse aggregate size 19 mm, 25 mm, and 37.5 mm gave average flexural strength of 3.59 N/mm², 3.48 N/mm2and 3.38N/mm2respectively.

(4) The Compressive strength is inversely proportional to flexural strength of concrete for the coarse aggregate size increases when subjected to the same conditions.

5.2 Recommendations

The recommendations are fallow:
The reinforced concrete beam, 19 mm and 25 mm coarse aggregate size could be adopted as they give appreciable flexural strength and compressive strength and it also appropriate for minimum bar spacing in beam.

(1) The good grade size of aggregate in concrete mix is important as proper compaction of fresh concrete in the order to prevent honey comb which can result to loss of stiffness of the structural component and consequently result on flexural crack. Thus concrete mix should be well compacted.

(2) The Concrete is mostly used to resist the flexural stresses should be made of finer coarse aggregates.

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