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Assessment of Potentials of Bida Bush Gravel on Strength Properties of Self Compacting Concrete

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Abstract: **This paper presents the potentials of Bida bush gravel as coarse aggregate on strength properties of self compacting concrete. Bida Bush gravel is dominantly used as coarse aggregate in concrete production due to its availability and scarcity of conventional coarse materials. Self compacting concrete has emerged as a modern system of concrete production in nearly all the developed nations of the world. This system involved the use of high range of water reducing admixture to produce a flowing concrete, thus eliminating the need for external vibrator. Several materials such as granite, broken bricks, and glass has been used as coarse aggregate and obtained an encouraging result. Fresh property such as flowbility was tested with the aid of superplasticiser, while hardened properties such as compressive, tensile and flexural strength were tested at 7, 14, 28 and 56 days. The study revealed that the used of Bida bush gravel demonstrated good flowbility and high strength as compared to the control.**

Keywords: Self compacting concrete, Bida bush gravel, compressive strength, flowability

1. INTRODUCTION

Development of self-compacting concrete (SCC) and durability of concrete structures was a major topic of interest in Japan date back to 1983. The creation of durable concrete structures requires adequate compaction by skilled workers; however, the gradual reduction in the number of skilled workers in Japan’s construction industry had led to a similar reduction in the quality of construction work. One solution for the achievement of adequate consolidation in concrete work is the development of self-compacting concrete. In this system, concrete is compacted into every corner of formwork, purely by means of its own weight and without the need for external or internal vibrating. In 1986 as a solution to the growing durability concerns of the Japanese government, during his research, *Okamura* (1) found that the main cause of the poor durability performances of Japanese concrete in structures was the inadequate consolidation of the concrete in the casting operations.

However, type and quality of aggregate plays an important role in SCC. Studies have shown that size and fineness of aggregate promote the flow and passing ability of concrete in congested area of reinforcement. It is therefore necessary to note that the smaller the size of coarse aggregate the better the slump in terms of flow.

According to Bui et al. (2) and other researchers, a higher aggregate spacing requires a lower flow and higher viscosity of the paste to achieve satisfactory deformability and segregation resistance of SCC. Better results were also obtained with the same spacing and a smaller aggregate diameter. For SCC mixtures, a coarse aggregate size of 5 mm to 14 mm and quantities varying from 790 kg/m3 to 860 kg/m3 have been used with satisfactory results (3)

According to Okamura (4), if the coarse aggregate content in a SCC mixture exceeds a certain limit, blockage would occur independently of the viscosity of the mortar. Superplasticizer and water content are then determined to ensure desired self-compacting characteristics. Mata (5) reported that reducing the volume of coarse aggregates in a SCC mixture is more effective than decreasing the sand-to-paste ratio to increase the passing ability through congested reinforcement. The aggregate packing factor (i.e., the ratio of mass of aggregates of tightly packed state in SCC to that of loosely packed state in air) determines the aggregate content, and influences the strength, flowability and self-compacting ability (6).

The coarse aggregate should not contain clay seams that may produce excessive creep and shrinkage. Therefore, aggregates must be clean for incorporation in the mix (7). The moisture content of aggregates should be closely monitored and must be taken into account in order to produce SCC of constant quality (8).

Granite materials have been found to be more suitable coarse aggregate as in the conventional concrete. Although, Bida bush gravel has shown a tremendous performance in concrete works, there is very little information on this material in the technology of self compaction concrete. This research therefore is set to explore the potentials of Bida bush gravel in SCC.

2. MATERIALS AND METHOD

2.1 Materials

Ordinary Portland cement conforming to ASTM C150 (9)] was used in the study. A saturated surface dry river sand with fineness modulus of 2.9 passing through 4.75mm ASTM sieve with specific gravity and water absorption of 2.6 and 0.7% respectively was used as fine aggregate. The coarse aggregate (granite and Bida Bush gravel) used was of 10mm maximum size with specific gravity of 2.7 and water absorption of 0.5% as shown in Figure1. Concrete of grade 25MPa was designed using Department of Environment (DOE) mix design (6) and proportioned as shown in Table 1. Superplasiticer (SP) of sulfonated naphthalene formaldehyde derivative conforming to ASTM C494 (10) was added to concrete mix at 2% by weight of cement material.

Crushedgranite

Bida bush gravel

Fig. 1 Crushed granite and Bida bush gravel

Table 1 Concrete mix proportion

Sample	Cmt (kg)	Fine agg (kg)	Coarse agg (kg)	Sp (%)	W/C (0.45)
Crushed Granite	17.7	39.20	71.10	2	9.7
Bush gravel	17.7	39.10	71,10	2	9.7

2.2. *Preparation of test specimen*

Concrete cubes, 150 mm in size were cast for compressive strength in accordance with BS 1881: part116 (11), whereas 150mm x 300mm cylindrical mould was used for the determination of splitting tensile strength following the ASTM C469 (12). While 100 x 100x 500mm prisms were used for flexural testing. The number of specimen at each testing time was three. After casting, the specimen were covered with plastic sheet and were demolded after 24 h and were submerge into curing tank containing water at room temperature of 23±2oC until testing.

3. RESULTS AND DISCUSSION

3.1 *Sieve analysis of coarse aggregate*

The particle size distribution of crushed granite and Bida bush gravel is shown in Fig 2.

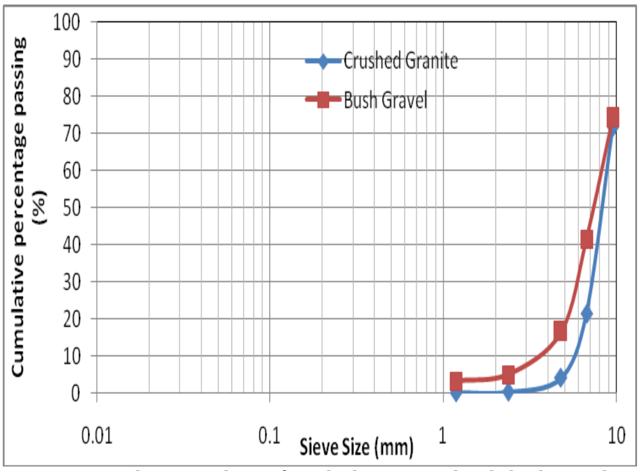

Fig 2. Particle size analysis of crushed granite and Bida bush gravel

From the figure it can be observed that the particle size distributions of the aggregates are similar. Although, at sieve aperture greater than 6mm, crushed granite has higher percentage passing.

3.2 *Frash property*

The slump of SCC concrete made of crushed grante and those made of Bida bush gravel were tested in terms of flow width and time of the flow as shown Fig 3, while spread and spread time values are shown in Table 2. From the table it can be seen that the slump (flow) of SCC made of crushed granite and Bida bush gravel were 600 and 400mm, with flow time of 21s respectively. Although, the flow was high in specimen made of crush granite, the flow values of the enter specimen were found to within the recommended value.

Fig 3. Slump of self-compacting conrete

Table 2 Flow width and flow time

Specmen	Flow width (mm)	Flow time (s)
Crshed granite	600	21
Bida bush grave	400	21

3.3 *Compressive strength*

The compressive strength of self compacting concrete made of Bida bush gravel and those of crushed granite is shown in figure 3. From the figure it can be observed that as the duration of the curing increases so also the strength increases for both samples. At 7 days for example, the compressive strength observed for SCC made of Bida bush gravel was 20N/mm^2, while those made with crushed granite was 18.5N/mm^2. Also, at 21 days compressive strength values of 24 and 23N/mm^2 were obtained for SCC made of granite and Bida bush gravel respectively. Similarly, a compressive strength of SCC made of crushed granite and those made of Bida bush gravel were 29 and 27N/mm^2 at 28 days respectively. The both specimen demonstrated similar strength increase at 58 days. From the results obtained, it can be perceived that strength development of SCC made with granite as coarse aggregate was found to be higher than those made with Bida bush gravel, but the difference was not significant. The result at 56days indicates that there was a continuous and significant improvement in strength gain. The increase in strength of the sample is, of course, is due to the continuous hydration,

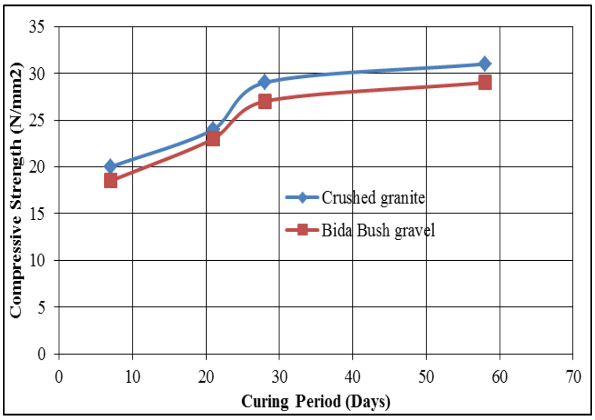

Fig. 4 Compressive strength of SCC

3.3 *Tensile strength*

The tensile strength of SCC specimen is shown in Table 3. From the table it can be observed that the tensile strength development of the specimen is similar to those of the compressive strength.

Table 3 Tensile strength of SCC

Sample	Age (days)	Av.weight (kN)	Stress (kN)	Tensile Strength (N/mm^2)
Crushed Granite	7	4000	47.5	6.05
	21	4180	57.5	7.32
	28	4000	47.5	6.05
Bush Gravel	7	4100	65	8.27
	21	4100	55	6.99
	28	4100	65	8.27

However, the tensile value of SCC made of Bida bush gravel was observed to be higher at 28 days as compared to those made with crush granite. This may attribute to the spherical shape of the aggregate, which developed high resistance to crushing load.

3.4 *Flexural strength*

Flexural strength of concrete made with granite and that of Bida bush gravel as coarse aggregate was determined also at the age of 7, 21, 28 and 56 days, and the results are illustrated in Figure 5. The development of flexural strength was somewhat similar to that observed in case of compressive and tensile strength i.e. Flexural strength increased with the increase in period of curing..

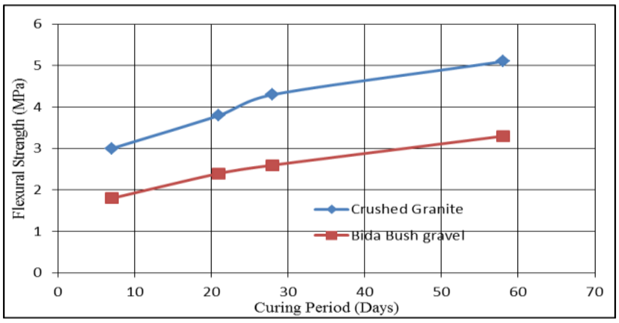

Fig. 5 Flexural strength SCC

The flexural strength of control sample at 7days for example, was 3MPa whereas that of the Bida bush gravel was 1.8MPa. Similarly at 21, 28 and 56 days the flexural strength of the crushed granite were, 3.8, 4.8 and 5.1, while that of Bida bush gravel were 2.4 2.6 and 3.3 MPa respectively. This means a reduction of 37 and 35%, respectively was observed in comparison to the strength of the control.

CONCLUSION

This paper highlights the potential benefits of Bida Bush gravel on strength properties of self compacting concrete in terms of flow, compressive, tensile and flexural strength. From the study, it was observed that the workability in terms of flow of Bida bush gravel compares favorably to those of crushed granite. Also, the strength developments observed in the study indicate that the bush gravel is a viable alternative of coarse aggregate to crushed granite in the production of self-compacting concrete.

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