

Effects Of Broken Glass As A Partial Replacement Of Granite In The Production Of Concrete

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ABSTRACT

The importance of coarse aggregate in concrete cannot be overemphasized. Glass forms a major component of solid waste in many countries and can be recycled after usage. Although, small proportion used by consumers has been recycled and reuse while about 70-80% is disposed to the land-fill and this constitutes to environmental waste. This paper investigated the suitability of glass as partial or full replacement of conventional aggregate (crushed granite) in the production of concrete.

The aggregate (fine) was spread uniformly on a hard, clean and non porous surface. Thereafter, cement was added until uniformity in mix was achieved. After which the coarse aggregates in the order (granite : glass) was added in varying proportion of 100:0, 80:20, 60:40, 40:60, 20:80. Water was applied gradually until uniformity in color and consistency was obtained. A total of 36 concrete cubes of size 150 x 150 x 150 mm were produced.

The compressive strength of concrete with 100% granite at 28 days is 23.78N/mm² and that with 20% is 12.67N/mm². The density of concrete with 0% and 80% glass is 2730kg/m³ and 2034kg/m³ respectively. The slump value of concrete sample with 100% granite fell by 40mm and that with 80% glass fell by 20mm.

It can be deduced that there is a reduction in the compressive strength of concrete as the percentage of glass increases. Concrete with 15-20% glass; having compressive strength of approximately 20N/mm² can be recommended for structural works while 60-80% is useful where aesthetics is required.

Keywords: concrete; Coarse aggregate; waste glass; compressive strength.

1.0 INTRODUCTION

Concrete is a composite inert material comprising of binder (cement), mineral filler (body) or aggregate and water (Oyenuga, 1995). It is the name given to a mixture of particles of stone bound together with cement. Because the major constituent of concrete is of particles of broken stones and sand, it is termed the aggregate occupying 60-70% of the total volume of concrete. The material which binds the aggregate is the cement. Portland cement was developed in 1824 and derives its name from Portland limestone in Dorset because of its resemblance to this rock. Raw materials used in Portland cement are Calcium carbonate (CaCO₃), Silica Alumina and Iron Oxide (clay or shale), and mart (Jackson and Dhir, 1988).

Glass is a hard, usually transparent substance formed by melting and cooling without crystallizing (Encarta Dictionaries). The usage of glass cannot be overemphasized as it is used in buildings, dishes and other domestic wares; by the construction industry in the shape of windows and mirrors; by the medical industry in the making of medical equipment and most importantly by the food and beverage industry to make millions of packaging bottles. As usage the of glass increases, so does the amount of waste glass generated. Although,

used glass can be recycled but it involves a lot of energy in doing so and this calls for disposal into landfills thereby constituting environmental pollution. Previous researches have shown that glass could serve as alternative material in place of conventional material (granite) in the production of concrete if properly cleaned, crushed and screened. The relative abundance of glass readily makes it available for use and consequently reduces the cost of producing concrete.

Weihua *et al.* (2000) suggested that the use of crushed waste glass as an aggregate in concrete has several advantages in terms of strength. The relative abundance of glass makes it available for production of concrete; this will consequently lead to low cost of production thereby making concrete structures (buildings) relatively cheap. On this note, the percentage of glass in concrete should not be much. Ground waste glass was used as aggregate for mortars and no reaction was detected with fine particle size, thus indicating the feasibility of the waste glass reuse as aggregate in mortars and concrete. Estimated cost for housing is more and some construction materials like natural aggregates are also becoming rare. Waste glasses are used as aggregates for Concrete.

2.0 MATERIAL AND METHODOLOGY

The materials used for this research work includes fine aggregate (sharp sand), coarse aggregate (granite and glass), binder (cement) and water. The coarse aggregate comprises of both crushed glass and crushed stone (granite) of sizes 10 to 12.5mm. Portable water was used for the mixing and curing. A water-cement ratio of 0.5 was used for the experiment and slump test was done at intervals to determine the amount of water in the mix and hence its workability.

The experimental procedure is a sequential approach in which the aggregate (fine) was spread uniformly on a hard, clean and non porous surface. Thereafter, cement was added until uniformity in mix was achieved. After which the coarse aggregates (glass and granite) was added in varying proportions of 100:0, 80:20, 60:40, 40:60 until 80% replacement of glass was obtained as against the 100% granite. Water was applied gradually until uniformity in color and consistency was obtained. A concrete mould of 150mm x 150mm x 150mm and 36 cubes was produced for the quality assurance. The compressive strength of concrete with broken glass as partial replacement was compared with that of the conventional concrete at the end of 7, 14 and 28 days of curing (soaked in clean water).

3.0 RESULT AND DISCUSSION

The Tables 1 & 2 below show the result of the quality control tests (compressive strength and slump values) of specimens produced in the course of this research work. In addition, plates 1, 2, 3 & 4 show the pictures of some of the laboratory works during the research. The figure 1 below is a bar chart showing the variation in

the strength of the concrete produced with 100% granite (control experiment) and concrete with varying percentage of glass (test experiment). The strength reduces as the percentage of glass replacement increases.

Also, the figure 2 below shows the particle size distribution curve of the fine sand used for the research. From the sieve analysis curve plotted, the uniformity coefficient (Cu) of the fine aggregate used is 2.60 and hence the sand is said to be well-graded.

Table 1: Workability of the specimens produced

Specimen (%) Granite: Glass	Mix ratio	Water/Cement ratio				Slump (mm)
1 0 0 : 0	1 : 2 : 4	0	.	5	5	4
8 0 : 2 0	1 : 2 : 4	0	.	5	5	3
6 0 : 4 0	1 : 2 : 4	0	.	5	5	3
4 0 : 6 0	1 : 2 : 4	0	.	5	5	2
2 0 : 8 0	1 : 2 : 4	0	.	5	5	2

Table 2: Compressive strength and Density of the specimens produced

Specimen (%) Granite: Glass	Average Density (Kg / m3)			Average Compressive Strength (N/mm2)		
	7 Days	14 Days	28 Days	7 Days	14 Days	28 Days
A (100:0)	2 7 1 8	2 7 2 2	2 7 3 0	1 6 . 6 7	1 8 . 6 7	2 3 . 7 8
B (80:20)	2 6 3 6	2 6 1 1	2 6 1 7	1 3 . 0 2	1 4 . 4 4	1 9 . 9 1
C (60:40)	2 3 9 3	2 4 0 0	2 3 8 2	1 2 . 2 2	1 2 . 5 8	1 4 . 3 6
D (40:60)	2 2 1 2	2 2 7 0	2 2 0 3	1 1 . 6 9	1 2 . 1 3	1 3 . 2 4
E (20:80)	1 9 8 2	2 0 0 3	2 0 3 4	1 1 . 2 4	1 1 . 6 8	1 2 . 6 7



Plate 1: Weighing of crushed glass sample



Plate 2: Grading of the crushed glass



Plate 3: weighing of concrete cube



Plate 4: Compression testing of concrete cube

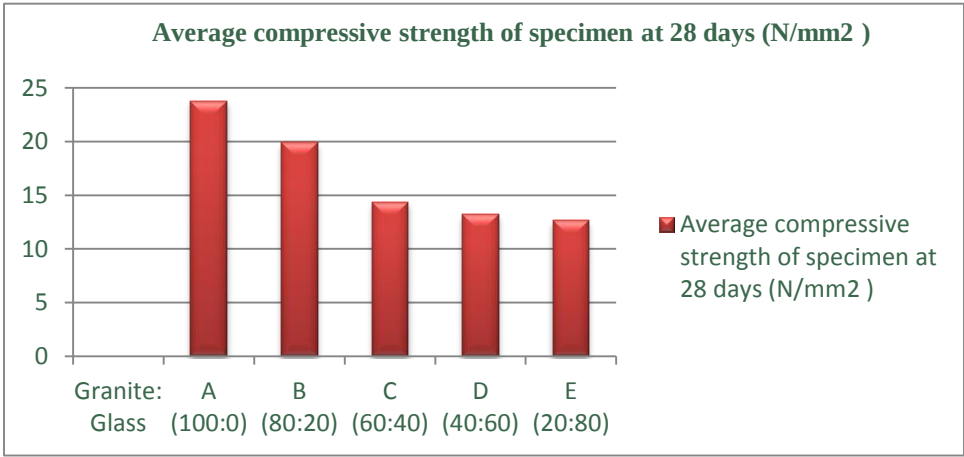


Figure 1: Compressive strength of concrete with varying percentage of glass as coarse aggregate

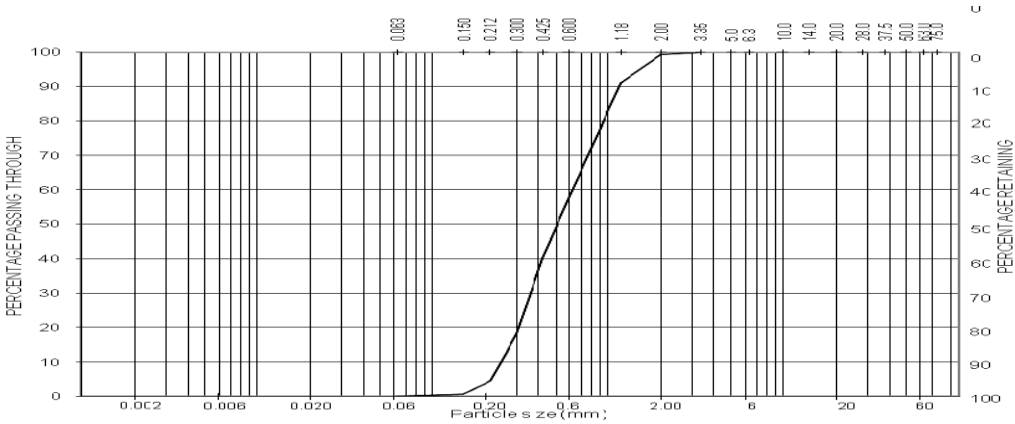


Figure 2: Particle size distribution curve of the fine aggregate (fine sand) used for the research

4.0 CONCLUSION AND RECOMMENDATION

From Table 2 above, it can be observed that as the percentage of glass increases, there is decrease in the weight of the cube and consequent decrease in the density of the cube, this support the production of light weight concrete. Although, concrete with 15-20% replacement of broken glass is adequate as a compressive strength of approximately 20N/mm^2 was obtained at 28days of curing and can be recommended for construction purposes, concrete with 25- 40% replacement of glass can be used for lintels in building and non-load bearing structures while 60-80% can be used where beautification is of importance (aesthetic).

5.0 REFERENCES

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