International Journal of Latest Research in Engineering and Technology (IJLRET)
ISSN: 2454-5031
www.ijlret.com || Volume 04 - Issue 08 || August 2018 || PP. 80-83

Partial Replacement of Coarse Aggregate by Broken Glass Bottles

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Abstract: Concrete is the most important building constituent during 20th century and also it is the versatile material giving architectural freedom. Continuous use of traditional raw materials for concrete reduces the natural resources. Global nations interested in sustainable development are carrying out researches to find out new raw materials which are easily available and capable of producing enough strength. Such researches are carried out with recycled tire rubber, plastic powder, coconut shell etc. Disposal of waste glass in the open environment cause tremendous issues, .By utilizing these waste glasses as an ingredient of concrete ,environmental issues can be reduced to a certain extent .At the same time this will become a nice solution for the scarcity of natural ingredients.In this project, coarse aggregate has been replaced by broken glass accordingly in the range of 5%- 15% by weight for M-20 mix. The concrete specimens were tested in two series of test such. It as compression test and modulus of elasticity test carried out up to 28 days. It was observed that both the compressive strength and modulus of elasticity values are higher than normal concrete up to 10% replacement of coarse aggregate with glass and further increase in glass reduces the strengths gradually.
Keywords: Concrete, broken glass bottles, partial replacement as coarse aggregate

I. INTRODUCTION

Concreteis a composite material composed of fine and coarse aggregate bonded together with a fluid cement (cement paste) that hardens over time. Most concretes used are lime-basedconcretessuch as Portland cement concrete or concretes made with other hydraulic cements, such as calcium aluminates cements. However, asphalt concrete, which is frequently used for road surfaces, is also a type of concrete, where the cement material is bitumen, and polymer concretes are sometimes used where the cementing material is a polymer.

In order to make concrete industry sustainable, the use of waste materials in place of natural resources is one of the best alternatives. Materials such as fly ash, silicafumes, recycled tire rubber, rice husk ash, coconut fibre etc are used as replacements for different raw materials in concrete.

Glass is a universal material in use, even though it is found to be brittle it posses good compressive strength and durability. An investigation is conducted to study on the viability of using waste glass as an alternative material applied as partial replacement of aggregates in manufacturing concrete. Americans waste (landfill, litter, and incinerate) about 425 beverage containers per capita per year--twice as many as we recycle.

A lot of studies have been conducted about the possibility of using ground waste glass since 1960s,1970s and 1980s , as aggregates or cement replacement **(**Pike(1960), Schmidt (1963), Phillips (1972) and Johnston (1974)

Many studies and attempts had been conducted in recent years to use crushed wastes glass as a partial replacement for both coarse and fine aggregates. This studies showed some conclusion like using crushed waste glass by good method making them has a good resistance for abrasion and lower shrinkage in dry situation comparing with plain concrete. Furthermore, the concrete with waste glass has lower ability to water absorption compared with plain concrete. **Shayan (2005)** [1] in this study the author pointed out that not more than 50% by weight of the normal aggregate could be replaced with a mixture of coarse glass aggregate for structural and non-structural applications. **Meyer (2000)** [2] reported that the presence of glass as aggregate will affect the mechanical properties of concrete, due to the lower adhesion and bond strength between glass aggregate and cement paste, due to the relatively smooth surfaces of glass comparing with relatively rough surfaces of natural aggregate.

In our study,aggregates were replaced by glass aggregate as 5%,10% and 15% by M20grades of concrete.The concrete cubes were tested for compressive strength at 7and 28 days is obtained at room temperature. Modulus of elasticity of concrete are found at the age of 28 days. For this project we use waste glass from beverages industry particularly saying, the broken glass pieces of Beer bottles having the size of 20 mm.

The aim of this study is to investigate the feasibility of broken beer bottles glass as partial replacement of coarse aggregate in concrete.

Table1Properties of Cement

Properties	Coarse Aggregate	**Glass**	Limits as per IS 2386
Bulk Density	1.37g/cc	1.615g/cc	1.2 -1.8 g/cc
Specific Gravity	2.72	2.61	2.6-2.8
Fineness modulus	6.9	6.65	6.5-8

The objectives of this work are:
1. To determine the physical properties of all materials and to compare the physical properties of conventionally used coarse aggregate with that of glass aggregate.
2. To determine the physical properties of fresh concrete using broken glass as partial replacement of coarse aggregate and to compare with that of conventional concrete mix.
3.To compare the compressive strength and modulus of elasticity of glass mixed concrete with that of conventional concrete.

II. METHEDOLOGY

First stage of the project is to collect all the raw materials such as cement, fine aggregate, broken glass, coarse aggregate and water. Then various tests were conducted on these materials and results were checked with IS specification.

Table 2 Properties of Fine Aggregate

Properties	**Value Obtained**	**Limits as per IS 4031**
consistency	33%	26% - 33%
Initial Setting Time	70 minutes	> 30
Fineness	7 %	< 10 %
Final setting time	300 minutes	< 600

Table 3 Properties Of Coarse Aggregate

properties	**Values obtained**	**Limits as per IS 2386**
Specific Gravity	2.706	2.6-2.8
Bulk Density	1.78g/cc	1.2-1.8 g/cc
Fineness modulus	2.83	2.6-2.9 medium sand

Based on IS10262:2009, a suitable mix proportion is achieved. According to the mix proportion, the concrete mix was prepared and the workability test was conducted.The amount of various ingredients for the preparation of one cube and cylinder is as shown on table

Table 4 Mix Proportion

Cement	394 kg/m^3	1
Fine aggregate	687 kg/m^3	1.74
Coarse aggregate	1138 kg/m^3	2.88
Water	197 litre	0.5

The required numbers of specimens were prepared and they were demoulded and cured. Finally test on hardened concrete were done.

III. RESULT AND DISCUSSION

In order to find workability, slump cone test was done for all the mixes and compressive strength test and modulus of elasticity test were done on hardened concrete. These results help to arrive at a conclusion regarding the project.

1. Slump Cone Test

Slump test is the most commonly used method of measuring consistency of concrete whichcan be employed either in laboratory or at site of work. It is not a suitable method for very wet or very dry concrete. It does not measure all factors contributing to workability, nor is it always representative of the placability of the concrete. If the concrete slumps evenly it is called true slump. If one half of the cone slides down, it is called shear slump. In case of a shear slump, the slump value is measured as the difference in height between the height of the mould and the average value of the subsidence.

Table 5 Slump Test Results

% Of Glass In The Mix	0%	5%	10%	15%
Slump (mm)	95	65	50	48

2. Analysis of Compressive Strength

150* 150* 150 mm cube sample were used for compressive strength test of concrete. A total of 4 concrete mixes were made , one corresponding to normal concrete and three other with 5%, 10% and 15% of broken glass. The total mixing time was 5 minutes the specimen were compacted manually and then levelled. After 24 hours they were demoulded and then placed for curing, until the day of test.

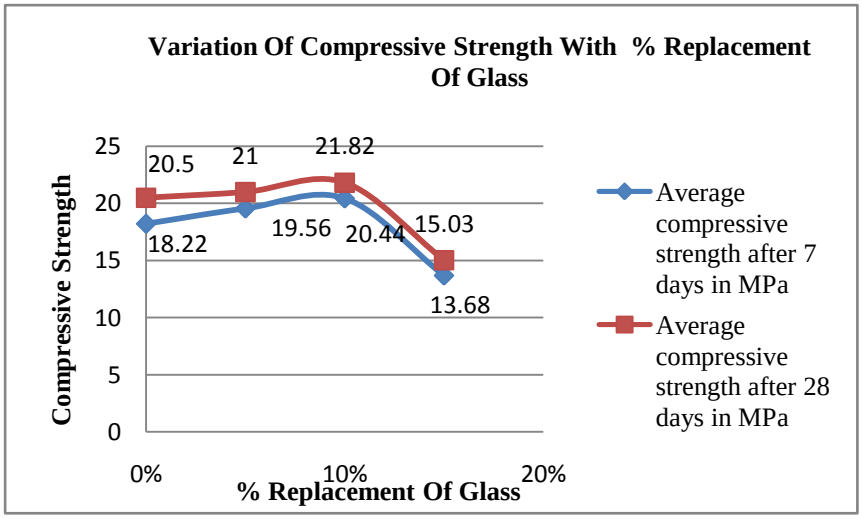

Fig 1Variation Of Compressive Strength With % Replacement Of Glass

IV. Analysis Of Modulus Of Elasticity

The Young's modulus of elasticity values are calculated from the test on 150mm*300mm cylinders and stress strain diagram. The stress strain curve for different replacements of glass are plotted to find the optimum replacement.

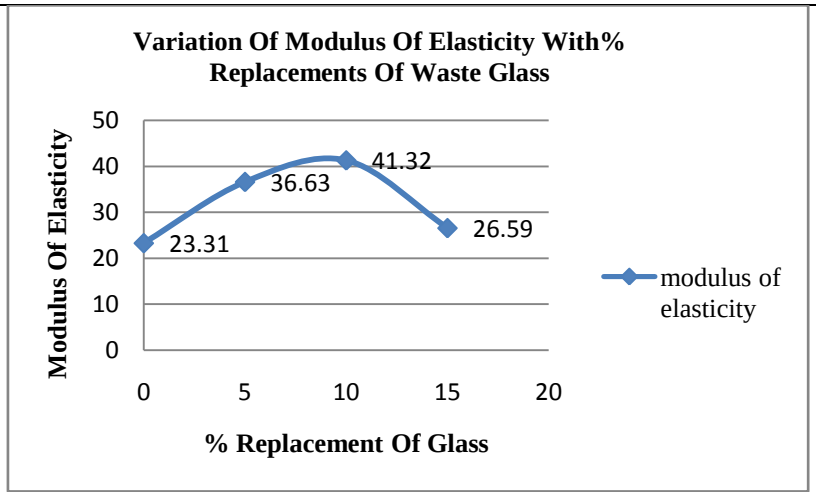

Fig 2Variation Of Modulus Of Elasticity With % Replacement Of Glass

V. CONCLUSION

The main objective of the present investigation was to study the behaviour of concrete when broken beer bottle glass waste is incorporated in M20 mix of concrete. From the present investigation various mixes of concrete with various percentage replacements of glass waste were prepared. The compressive strength and modulus of elasticity of these mixes were studied and the results were compared with that of the ordinary concrete.

The conclusions of our study are the following.

1. Replacement of coarse aggregate with glass waste has slightly reduced the workability of concrete, however the workability shows greater variation on 15% replacement.
2. The compressive strength of hardened concrete has increased for 5% and 10% replacements. Maximum compressive strength was obtained on 10% replacement.
3. The modulus of elasticity of concrete mixes has increased for 5% and 10% replacements. Maximum modulus of elasticity was obtained on 10 % replacement.
4. The glass waste material has a future role in concrete industry as a sustainable building material.

From the present scope of study, more research is needed in the area of glass waste concrete. The following are the few suggestions for future work:

- Studies can be done by partially replacing cement with fine waste glass powder and checking it's properties
- Studies can be extended to find out the sustainability of glass waste for the construction of reinforced cement concrete.
- Durability of glass mixed concrete can also be checked during future work.

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