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Replacement of fine aggregate by using glass material in concrete

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ABSTRACT

Glass powder (GP) used in concrete making leads to a greener environment. In shops, damaged glass sheets & sheet glass cuttings are going to waste, which is not recycled at present and usually delivered to landfills for disposal. Using GP in concrete is an interesting possibility for the economy on waste disposal sites and conservation of the environment. This project examines the possibility of using GP as a fine aggregate replacement in concrete. Natural sand was partially replaced (0%-20%) with GP in concrete. Compressive strength (cubes and cylinders) up to 28 days of age were compared with those of high-performance concrete made with natural sand.

Keywords—*Compressive strength, Durability, Split tensile strength, Waste glass concrete, Workability, Economy*

1. INTRODUCTION

Due to rapid industrialization and urbanization in the country, lots of infrastructure developments are taking place. This process has, in turn, led questions to mankind to solve the problems generated by this at high temperature followed by cooling where solidification occurs without crystallization .Glass is widely use in our lives through manufacture products such as sheet glass, bottles, glassware, and vacuum tubing. Glass is an ideal material for recycling.

The use of recycling glass saves a lot of energy and the increasing awareness of glass recycling speeds up to focus on the use of waste glass with different forms in various fields. One of its significant contributions in the construction fields where the waste glass was reused for concrete production. The application of glass in architectural concrete still needs improvement. Several studies have shown that waste glass that is crushed and screened is a strong, safe and economical alternative to sand used in concrete. During the last decade, it has been recognized that sheet glass waste is of large volume and is increasing year by year in the shops, construction areas, and factories. Using waste glass in the concrete the construction sector is advantageous, as the production cost of concrete will go down. The amount of waste glass is gradually increased over the years due to an ever-growing use of glass products. Most of the waste glasses have been dumped into landfill sites. The landfilling of waste glasses is undesirable because they are not biodegradable, which makes them environmentally less friendly. There is huge potential for using waste glass in the concrete construction sector.

When waste glasses are reused in making concrete products, the production cost of concrete will go down (Topco and Canbuz, 2004). Crushed glass or cullet, if properly sized and processed, can exhibit characteristics similar to that of gravel or sand.

1.1 Waste glasses

Quantities of waste glass have been on the rise in recent years due to an increase in industrialization and the rapid improvement in the standard of living. Over the next few years, the targets for waste glass recovery will significantly Increase in line with the packaging waste, End-of-life vehicle (ELV) and Waste Electrical and Electronic Equipment (WEEE) Directives. Whilst this recovered waste glass could theoretically be reused as 100% Feedstock for new glass manufacture, due to contamination tolerances and the Imbalance between production and arising of specific waste glass streams in the World. Unfortunately, the majority of waste glass is not being recycled but rather abandoned, and is, therefore, the cause of certain serious Problems such as the waste of natural resources and environmental pollution.

1.2 Objectives of the project

The objective of this study is to investigate the behavior of fresh Concrete partial replacement of cement with to investigate replacement is economical or not

- To compare the properties of concrete with partly replacement of Glass-Material.
- To investigate the workability of fresh concrete.
- To study the compressive strength of concrete by partial replacement of Glass-Material.
- To study the strength properties of concrete with various aspect ratios such as compressive strength, split tensile strength
- To compare the properties of concrete with for different % of glass material.
- To study the existing disposal method of waste glass in Jalgaon area.
- To increase the benefit-cost ratio for users.

2. LITERATURE REVIEW

2.1 Sadoon Abdullah, MiziFan, characteristics of concrete with glass as fine aggregate replacement International Journal of engineering and technical research ISSN: 2321-0896, Volume – 2, issue-6, Jun 2014.

This paper systematically investigates the characteristics of concrete containing finely crushed glass during its process, the best ratio of finely crushed glass which leads to the higher strength of concrete in order to produce concrete blocks, and the effect of waste glass replacement on the expansion caused by Alkali-silica reaction (ASR). The slump, unit weight, compressive strength, splitting tensile strength, flexural strength, modulus of elasticity, ultrasonic pulse velocity ,dry density, water absorption and Alkali-silica reaction(ASR) were analyzed in terms of waste glass content (0%, 5%, 15% and 20%) under different curing age of 7,14 and 28 days . It was found that the slump of concrete containing waste glass as fine aggregate replacement decreased with increases in the waste glass content but without loss of workability. The compressive, splitting tensile and flexural strength of concrete with 20% waste glass content increased by 5.28%, 18.38%, and 8.29% respectively at 28 days. The mixes with waste glass replacement showed a denser internal concrete structure or more consistent structure under ultrasonic pulse velocity assessment.

2.2 Mr. Ankit J. Patel, Mr. Sandip P. Patel, Mr. Daxesh Prajapati, Mr. Harsh Patel, different waste materials used in concrete Dec 2014 (Volume 1 issue 7)

Availability of raw material is very less due to higher use of concrete. The normal practice of concreting is batching of all raw materials, mixing (all raw materials), transporting, compaction at the site, finishing and curing is followed by industry. In a developed country like India used concrete in higher quantity and availability of raw material is very less. Total replacement of concrete is not possible due to no material plays the role of concrete in terms of strength, durability, and workability. We have to partial replace all the material to achieve desired properties of concrete in terms of workability, strength, and durability. This paper includes a survey of different waste materials used in the concrete from this survey we can understand the effect of different waste materials on the properties of concrete.

2.3 Nasser Almesfer1 and Jason Ingham, the effect of waste glass on the properties of concrete,

Crushed waste glass bottles accumulating in stockpiles around New Zealand are an environmental concern, but also provide an available resource for potential used in concrete by partially replacing course &fine natural aggregates. The objective of this study was to test the fundamental property of concrete that utilized 20% of waste glass as a partial replacement for the course & fine natural aggregates. It is demonstrated that the waste glass has a negative effect on concrete properties, including the problematic alkali-silica reaction. The used of supplementary cementations material such as fly ash or micro silica was found to improve the properties of concrete that utilized waste glass, especially with regards to inhibiting the alkali-silica reaction, &hence it was established that waste glass should be used with either fly ash or micro silica mainly due to concerns regarding the development of the alkali-silica reaction caused by the waste glass trailed in this study.

2.4 M. Iqbal Malik ISOR Journal of Engineering- ISSN: 2250-3021, Vol.3, Issue 7(July 2013)

They have studied on the issues of environmental & economic concern had addressed by the used of waste glass as a partial replacement of fine aggregate in concrete. Fine aggregate had replaced by waste glass powder as 10%, 20%, 30% and 40% by weight for M-25 Mix. The concrete specimens add tested for compressive strength, splitting in tensile strength, durability (water absorbs ion) and density at 28days of age and the results obtained had compared with those of normal concrete. They have resulted in the permissibility of using waste glass powder has a partial replacement of fine aggregate up to 30% by weight for the practical size of range 0-1.18mm.

3. MATERIALS USED

- Cement
- Fine aggregate
- Coarse aggregate
- Waste glass
- Water

3.1 Cement

Cement is an important binding material in concrete. portland cement is a common form of cement. Basic ingredients of concrete, mortar, and plaster. It consists of a mixture of an oxide of calcium, silicon, and aluminum. The cement of various strength is available. Depend on the requirement concrete it is to be chosen.

3.2 Fine aggregate

Aggregate characteristics such as specific gravity, bulk density, and particle Size distribution and moisture content is essential prior to the proportion of mixtures. Shape and surface texture has a major role in affecting the Rheological Properties of concrete, this characteristic may also be considered while proportioning. The particle shape should ideally be equi-dimensional i.e. not Elongated or flaky. Aggregates should be relatively free of flat and elongated Particles. Compared to roughly textured angular and elongated particles smooth and rounded aggregates require less of cement paste to produce flowing Concretes.

Fine aggregate shall consist of natural sand or manufactured sand or a Combination. Fine aggregates should be selected so as to reduce the water demand hence rounded particles are thus preferred to crushed rock fines where Possible. The finest fractions of fine aggregate are helpful to prevent segregation. It passes through 4.75mm IS sieve with a specific gravity of 2.701 and this came under III zone.

3.3 Coarse aggregate

The maximum size of 20mm is usually selected as coarse aggregates up to 20mm may be used in concrete. Aggregates should be strong and free of internal flaws or fracture.

Aggregates should be strong and free of internal flaws or fractures. Aggregates of high intrinsic strength are generally preferred. Granites, Basalt, lime stones and sandstones are being successfully used in concrete.

3.4 Waste glass

Using waste glass in the concrete construction sector is advantageous, as the production cost of concrete will go down. Waste glasses are used as fine aggregate for concrete.

The crushing of glass pieces is done by the crusher. Glass material is sieved in 2.36mm sieve. Then it is used by replacing fine aggregate in different percentages. Glass powder is taken in, 10% weight of fine aggregate and 20% weight of the fine aggregate.

Table 1: Chemical combination of the glass

SiO2	69.50%
Na2o	14.58%
K_2O	0.41%
CaO	8.75%
Al_2O_3	1.10%
Fe_2O_3	0.22%
MgO	3.97%

3.5 Water

Water is an important ingredient of concrete as it actively participates in a chemical reaction with cement. Clean potable water conforming to IS 456-2000 was used, the water used in the preparation of mortar should not necessarily be distilled water, but must be free of all acids, based and others dissolved salts.

4. METHODOLOGY

- Collection of Materials
- Properties of Materials
- Casting of specimens with replacement of 0%,10% & 20%
- Curing of specimens
- Testing of specimens
- Analysis of result.

5. RESULTS AND DISCUSSIONS

5.1 Workability

Workability value for concrete is obtained by carrying out a slump cone test. The variation in the slump value arises due to the replacements of waste glass. Table 2 shows the slump value with respect to the replacement of waste glass. For conventional concrete, the slump value is higher workability value gets reduced when the percentage of replacement of waste glass content with coarse aggregate.

Table 2: Workability of concrete

Workability					
	Replacement of glass in concrete as fine aggregate	0%	10 %	20%	30%
Slump		80 mm	87 mm	93 mm	95 mm

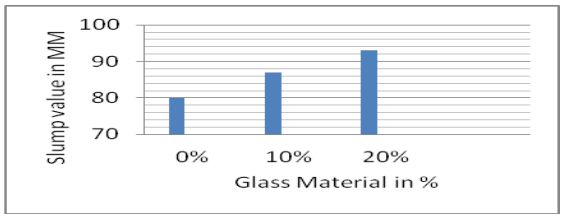

Fig. 1: Slum value

Table 3: Compressive strength

Sr. No.	% of waste glass	Compressive strength in MPA		
		7 Days	14 Days	28 Days
1	0%	23.3	30.9	33.8
2	10%	24.3	33.2	34.7
3	20%	28.4	31.6	38.3
4	25%	25	27.3	32.2
5	30%	21.1	24.8	28

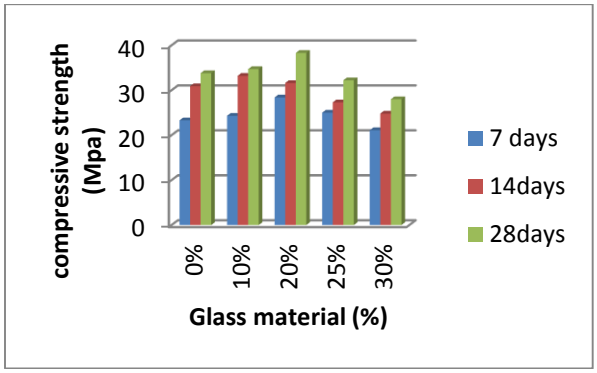

Fig.2: Comparison graph for compressive strength

5.2 Split tensile strength

The mean split tensile strength of concrete cylinder, using waste glass as replacement of fine aggregate. Were determine at the age of 28 days in the mix proportion of 1:2.27:3.06 were reported in Table.4. The split tensile strength of concrete with the waste glass is considerable higher than the conventional concrete. The tensile strength increases greatly with 10% replacement of waste glass as fine aggregate and gradually decreases as the glass quantity increases in 7 days and 14days. In 28days, 10% replacement of fine aggregate and gives an increased split tensile strength and more replacement shows ups and downs.

Table 4: Split Tensile strength of cylinders

Sr. No.	% of waste glass	Tensile strength of cubes in N/mm²		
		7 days	14 days	28days
1	0%	2.8	2.9	2.9
2	5%	3.6	3.7	3.83
3	10%	3.59	3.7	3.8

5.3 Flexural strength

The mean flexural strength of concrete beams, using waste glass as replacements for coarse aggregate and fine aggregate was determined at the age of 28days in the mix proportion of 1:1.5:3 were reported. The flexural strength of concrete with waste glass in considerable higher than the conventional concrete. In 28days, the optimum % i.e. 10% replacement gives an increased flexural strength.

Table. 5: Flexural strength of beams by replacement

Sr. No.	% of waste glass	Flexural strength of beams @28dys in n/mm²
1	0%	10.73
2	10%	14.4

6. CONCLUSION

Waste glass can be transformed into useful of fine aggregate separately. The compressive strength of Conglasscrete is more than twice of the compressive strength of the conventional concrete. Conglasscrete possesses higher tensile strength than conventional concrete. The 10% & 20% replacement of fine aggregate by the waste glass was found to be optimum for

cement concrete. In M20 grade of concrete with 10% & 20% replacement gives 80% more in compressive strength. In M20 grade of concrete with 10% replacement gives 34% more in flexural strength. So, we can use these concrete in a massive structure like bridges, dams and also used in foundation.

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