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Study on Mechanical Properties of Concrete by Partial Replacement of Crushed Glass as Fine Aggregate with M 20 Grade

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Abstract - *Glass is vitally used in Human lives in terms of manufactured products such as sheet glasses, bottles, glassware, and vacuum tubing. Glass is a material which supports the process of recycling. It produces recycled glass which helps in energy saving. The growing Awareness of glass recycling speeds up researches on the use of waste glass with different forms in various fields. In our construction fields significant contributions is too utilized for concrete production. To identify the effects on workability and mechanical strength properties due to the addition of these waste crushed glass bottles. The waste crushed glass bottles was partially replaced in the ratio of 5%, 10% and 15% .The feasible mix grade of concrete is M20.The data presented in this paper showed that there is great potential for the utilization of waste Glass bottles which can be cost effective.*

Key Words: Glass bottle, Compression test, Split tensile test, etc

1. INTRODUCTION

Glass is a transparent material produced by melting a mixture of materials such as silica, soda ash, and $CaCo_3$ at high temperature followed by cooling where solidification occurs without crystallization [10]. Glass is an ideal material for Recycling. The waste glass bottles produced in the world is discarded, stockpiled or land filled once they are used. This pattern has influenced environmental organizations to pressure the professional community to lower the amount of glass being discarded as well as find use to the non recycled glass in a new application [11]. The waste crushed glass bottles is one of the issues of environmental Problem. In relation, the recycling of waste glass of a component in concrete gives waste glass a sustainable alternative to land filling and therefore makes it economically viable.

The waste glass is one of the issues of environmental problem. Glass is used in a variety of applications right from construction, automobiles, nose-diving bottles, soft-drink bottles, etc. Hence, the usage of glass has increased noticeably, which plays a major role in waste disposal. In addition, glass waste is considered as non-decaying material that pollutes the surrounding environment.

1.1 GLASS

The glass has been used as an engineering material since ancient times. But because of the rapid progress made in glass industry in recent times the glass has come out as the most versatile engineering material of the modern times. The first glass objects made by man were of natural glass such as obsidian and rock crystal.

1.2. CLASSIFICATION OF GLASS

The glass is a mixture of a number of metallic silicates, one of which is usually that of an alkali metal. It is an amorphous, transparent or translucent. It may also be considered as a solidified super cooled solution of various metallic silicates having infinite viscosity.

For the purpose of classification the glass may be grouped into the following two categories:

- Soda lime glass
- Borosilicate glass

1.2.1. SODA-LIME GLASS

This glass has good chemical as well as physical properties and it is suitable for the products that resist momentarily the impact of chemical medium and limitedly also temperature differences. Both types of pipettes are produced from the soda-lime glass.

1.2.2. BOROSILICATE GLASS

Physical and chemical properties of this type of glass enable using of this glass not only for production of laboratory glassware but for various other purposes, as for instance in the pharmacy (vials), medicine (glass syringes), at production of brilliant lighting unit, at various branches of the textile industry (fingers) and in other further ranges where is required higher temperature and chemical resistance.

1.3. PROPERTIES OF GLASS

The properties of glass are mainly governed by factors such as composition of the constitutions state of surface thermal treatment conditions dimensions of specimen etc.

Following are the properties of glass which have 3 made glass popular and useful:

- It absorbs, refracts or transmits light.
- It has no sharp melting point.
- It is affected by alkalis.
- It has no definite crystalline structure.
- It is extensively brittle.
- It is not usually affected by air and water.
- It is available in beautiful colures.
- It is available in clean and clear state.
- It is cheap.
- It is easily fusible at comparatively low temperature.

2. MATERIALS AND METHODS

The methodology comprised of preliminary investigations and experimental investigations carried out using the study material and the investigation are presented as follows:

2.1Preliminary Investigations

The preliminary investigations of cement, Fine aggregate, coarse aggregate, cursed glass particles were subjected to physical analyses to determine whether they are fulfill the criteria's of the standard used. The present investigation is an effort towards developing a better insight into the effect of compressive strength ,split tensile strength and flexural strength on varying proportion of crushed Glass , an water cement ratio of 0.40 and crushed Glass replacement percentages of 0, 5, 10, 15% respectively by weight of fine aggregate .

2.2. Experimental Investigations

Materials details

2.2.1Cement:

Ordinary Portland cement of 53 grades in one lot was procured and stored in air light container. The cement used was fresh i.e., used within three months of manufacture. It should satisfy the requirement of IS 12269. The properties of cement are determined as per the IS 4031: 1968 and results are tabulated in the Table 1.

Table -1: Properties of Cement

Properties Values	
Grade of cement	53 MPA
Specific gravity	3.15
Initial Setting Time	30 minutes
Final Setting Time	10 hours
Standard Consistency	29 %

2.2.2. Fine Aggregate:

The fine aggregate used for casting is clean river sand from karur and it was clean and dry. It is of size pass through 1.19 mm sieve. It should satisfy the requirement of IS 383. The properties of the fine aggregates are given in Table 2.

Table -2: Properties of Fine Aggregate

Properties Values	
Size	Passing through 4.75mm sieve
Specific gravity	2.65
Water Absorption	1.0%
Fineness Modulus	3.5

2.2.3 Coarse Aggregate:

The coarse aggregate used was broken granite-crushed stone and it was free from clay, lumps, weeds, and other organic matters are non-porous. The water absorption capacity is less than 1%. The size of which pass through 26 mm sieve and retained on 19 mm sieve. The properties of the coarse aggregate are given in Table 3.

Table -3: Properties of Coarse Aggregate

Properties Values	
Size	12 mm
Specific gravity	2.6
Water Absorption	0.55%
Fineness Modulus	7.3

2.1.4. Water:

Potable water was used for casting all specimens of this investigation. The quality of water was found to satisfy the requirement of IS 456-2000.

2.1.5 Crushed glass

Glass is a transparent material produced by melting a mixture of materials such as silica, soda ash, and $CaCO_3$ at high temperature followed by cooling during which solidification occurs without crystallization. It is widely used in our day today life. It can be found in many forms, including container glass, flat glass such as windows, bulb glass and cathode ray tube glass. The use of glass as aggregates in concrete has a great potential for high quality concrete development. Its shape and size have potential benefit in obtaining a good particle size distribution in glass concrete. The properties of the fine aggregates are given in Table 4.

Table -4: properties of crushed glass

Properties	Values
SiO_2 %	70.22
CaO%	11.13
Fe_2O_3%	0.52
Al_2O_3%	1.64
Na_2O_3%	15.26
Loss of ignition%	0.80
Density	2.42
Specific gravity	2.65

2.2 METHODS:

2.2.1 CASTING

Metal moulds were arranged and oil was applied for easy remolding of specimens. Materials were weighed according to the mix ratio and were dropped in the mixer machine in the order of coarse aggregate, fine aggregate and cement. They were mixed in dry form initially and then water was added to make it a wet mix. Waste crushed glass bottles is partially replaced as the last material in the mixing and to get Concrete. After thorough mixing, the concrete was transferred to the cubical. Concrete was placed in three layers and each layer was compacted by tamping rod. The casting of cylinders and prisms followed the same pattern as that of cube casting.

CUBES

Size of cubes 150mm x 150mm x 150mm for each Waste glass bottles powder. Concrete mix, namely 0%, 5%, 10% and 15% were cast.

CYLINDERS

Diameter of cylinders 100mm and height 150mm for each Waste glass bottles powder. concrete mix, namely 0%, 5%, 10% and 15% were cast.

PRISM

The size of prism 400mm x 100mm x 100mm for each Waste glass bottles powder concrete mix, namely 0%, 5%, 10% and 15% were cast.

2.3. CURING

The final process is a curing process. Curing process is increase the strength of concrete. Curing is the process in which the concrete is protected from loss of moisture and kept within a reasonable temperature range. The result of this process is increased strength and decreased permeability. Curing is also a key player in mitigating cracks in the concrete, which severely impacts durability. Cracks allow open access for harmful materials to bypass the low Permeability concrete near the surface. Good curing can help mitigate the appearance of unplanned cracking. With proper curing, concrete becomes stronger, more impermeable, and more resistant to stress, abrasion, and freezing and thawing. The improvement is rapid at early ages but continues more slowly thereafter for an indefinite period. After remolding of specimens there were placed in curing tank containing portable water for proper curing until testing period of 7 days, 14 days, and 28 days.

Fig -1: Curing

3. RESULTS & DISCUSSION

Strengths were measured at 7, 14 and 28 days on samples of cube, cylinder, prism . The values at age levels of 7, 14 and 28 days have been presented in table. The table shows the compressive strengths, split tensile strength and flexural strength at different (0, 5, 10 and 15% by Fine aggregate) with water cement ratio of 0.40. The 7, 14 and 28 days moist curing gives higher compressive strength, split tensile strength and flexural strength when Fine aggregate replaced with 5% . In other hand, when fine aggregate is replaced with crushed glass of percentage 10 and 15% with FA replacement the results is reduce compare to the other .

compressive strengths, split tensile strength and flexural strength graphs are shown in figure 1 to 5

Table -3: Compressive Strength of Concrete (M20 Grade)

Percentage Of Waste crushed glass bottles	Compressive strength N/mm²		
	7 days	14 days	28 days
0 %	13.9	16.7	22.5
5 %	14.5	16.2	23.2
10 %	12.2	16.14	22.3
15 %	10.8	13.5	21.38

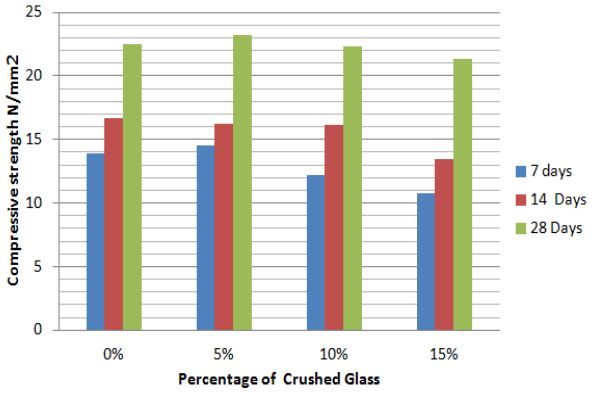

Fig -1: Compressive Strength Results

Table -3: Split tensile Strength of Concrete (M20 Grade)

Percentage Of Waste crushed glass bottles	Split tensile strength N/mm²		
	7 days	14 days	28 days
0 %	1.8	2.3	2.9
5 %	1.7	2.2	3.1
10 %	1.5	2.1	2.74
15 %	0.9	1.2	1.9

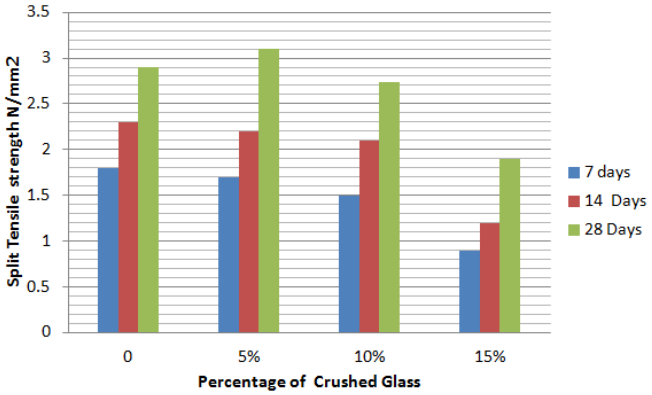

Fig -2: Split tensile Strength Results

Table -3: Flexural Strength of Concrete (M20 Grade)

Percentage Of Waste crushed glass bottles	Flexural strength N/mm²		
	7 days	14 days	28 days
0 %	4.4	4.9	5.5
5 %	4.6	4.9	6
10 %	3.7	3.9	4.7
15 %	3.32	3.74	4.21

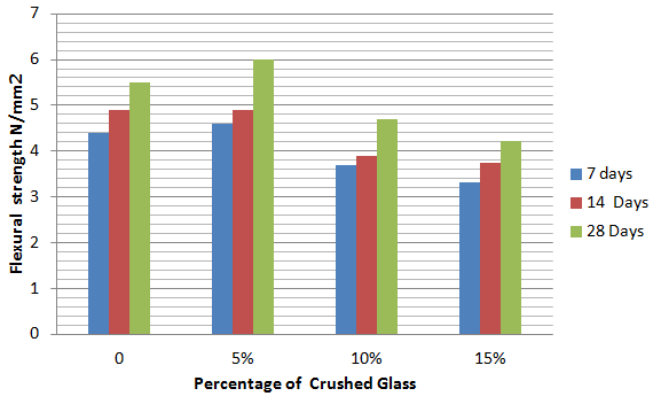

Fig -3: Flexural Strength Results

3. CONCLUSIONS

To justify my objective 3 test has been conducted: Compression, Split tensile strength and Flexural strength. Four different ratio mixtures are taken as basis for the purpose of evaluation to prove my result. In the entire three tests together 5% mixture of glass with other materials has been proved to be the best combination when compared to other ratio mixtures. In general, considering the similar performance with replaced material, glass addition can reduce cost of cement production also. In addition, production of every six ton glass powder concrete results in the reduction of each ton CO_2 emission from cement production and save the environment significantly by reducing green-house gas and particulate production.

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