Issue 2 vol 4 (sspace wardha) ISSN: 2321-8134

IJFEAT

INTERNATIONAL JOURNAL FOR ENGINEERING APPLICATIONS AND TECHNOLOGY

COMPARISON BETWEEN M20 & M40 GRADE CONCRETE USING WASTE GLASS POWDER

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Abstract

Glass industry is one of the rising industries in the construction as the same time waste coming from these industries and glass trash of municipal are becomes a serious problems. And day by day becoming critical. In this topic, attempt has been made to utilize glass powder, which is waste of glass industry. The research work is determination of the effect of the use of Glass powder as a replacement of cement to assess the pozzolanic nature of fine glass powder when mixed in concrete and compare the .The concrete in place of cement to some extent i.e., 10%, 20%,& 30% mechanical properties of M20, M40 (Design Mix) are investigated. Cube specimen of 36 numbers were cast for M40 **.** Reading of M20 is taken from already published research papers. We are casted and tested for 3, 7, and 28 days strength. Compression and split tensile was conducted and the results were compared. The finding revealed an increase in split tensile strength and compressive strength with the increase in the replacement of cement by Glass powder and also with increasing in different mix grade. To reduce the demand of cement, glass powder decreases the unit weight as well as the porosity as indicated by decrease in water absorption. It reduces the quantity of cement to be used in concrete. Also glass powder is proved to be economical and is considered as environmental friendly construction material.

Keyword : *Glass Powder, Replacement to PPC, compressive and tensile strength, cost effective material, M40 (Design Mix).*

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1. INTRODUCTION

1.1 General Information

Glass is a very useful member in the family of wastes found in most urban environments as well as some rural settlements. It is a result of several inorganic mineral raw materials, which after undergoing a process of controlled cooling becomes a hard homogenous, stable, inert, amorphous and isotropic material (Frederico and Chidiac, 2009). Presently, glass is being reused in several applications apart from its uses in the concrete and cement industry. This include majorly industrial (as filler in paints and other products, agricultural fertilizers, fiber glass insulation etc.) and craft applications (as in making of jewelries, vases, and other visually pleasing pieces by glass fusing). Waste glass, however, is majorly post-consumer glass and industrial waste glasses. Post- consumer glass can be found in various colours (especially green, brown and clear) and this affects the recycling process of waste glass as there is no economically friendly and automated equipment to sort the various colours. The difficulty of separating waste glass from other materials such as plastic bottles, ceramic plates and undifferentiated

 ISSN: 2321-8134

trash and more so into various colours has discouraged recycling glass into new containers.

The main reason of this study is to create a better environment that free from polluted space and also to find better solution for concrete mixture that can give higher strength to concrete from the waste glass product. Even it may give less cost of using this kind of admixture rather than buying expensive admixture to get great and higher strength in concrete now a days it's the admixture that in market are very expensive and often increased the cost of construction..

Each year about 62 million tons of waste glass is generated in the India, 77% of which is disposed of in landfills, accounting for 6 wt. % of the total municipal solid waste stream. Globally, about 5 wt. % of the 27.02 billion tons/year of municipal solid waste generated is glass. Postconsumer waste glass can be cost-effectively collected in mixed colour; there are, however, limited markets for mixed colour waste glass. Disposal of waste glass in landfills is costly, considering increasing tipping fees; the non - biodegradable nature of glass further complicates the environmental impact of its disposal in landfills. Stricter environmental regulations and the scarcity of landfill space are other factors encouraging diversion of waste glass from landfills for value-added use in new applications. The reuse of very finely ground waste glass in concrete has economical and technical advantages. If the glass could be ground to a very fine size, it could satisfy the active pozzolanic behaviour. Glass waste is recognized to be increasing year by year in a large volume from shops, construction areas and factories. These waste storage disposals are becoming a serious environmental problem.

Cement is the best bonding material. Cement- based materials are the most abundant of all man-made materials and are among the most important constructional materials and it is most likely that they will continue to have the same importance in the future; however these construction and engineering materials must meet new and higher demands. When facing issues of productivity, economy, quality and environment, they have to compete with other construction materials such as plastic, steel, wood. Concrete is the 2^{nd} largest of the most widely used materials; but there are environmental issues associated with its use which are needed to be taken under consideration and cannot be ignored. Concrete production uses large quantities of natural resources as aggregates and contributes to the release of carbon dioxide during the production of cement.

In sustainable construction importance of waste materials usage in concrete is increasing in manner. The waste glass from small shops is disposing it as a landfill waste. Without changing its chemical property the glass can be used so many times. This waste glass is used for water filtration, grit plastering, sand cover for sport turf and sand replacement in

Due to global warming the need to cut down energy consumption has increased. The effect of global warming has impacted everyone on the planet and is a well-recognized concept. The interest of construction community in using waste or recycled materials in concrete is increasing because of the emphasis placed on sustainable construction. Presently the waste glass in and around the small shops is packed as a waste and disposed as landfill. Waste glass contain high silica (SiO_2) i.e. 72%. Waste glass when ground to very fine powder (600 micron) reacts with alkalis in cement (pozzolanic reaction) and cementinious product that help contribute to the strength development.

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The main reason of this study is to create a better environment that free from polluted space and also to find better solution for concrete mixture that can give higher strength to concrete from the waste glass product. Even it may give less cost of using this kind of admixture rather than buying expensive admixture to get great and higher strength in concrete now a days it's the admixture that in market are very expensive and often increased the cost of construction..

1.2 The advantages of using glass powder concrete:

a. It helps to reduce alkali aggregate reaction, where it is encountered.
b. It generates reduced heat of hydration and that at a low rate.
c. It improves fire resistance qualities of the concrete.

d. In PPC, costly clinker is replaced by cheaper pozzolanic material, hence economical.

e. Soluble Calcium hydroxide is converted into insoluble cementations products resulting in improvement of permeability, ultimately durability of concrete.

Fig no 1: Glass powder sample

1.3 Glass powder

Glass is a transparent material produced by melting a mixture of materials such as silica, soda ash, and CaCO3 at high temperature followed by cooling during which solidification occurs without crystallization. Glass is widely used in our lives through manufactured products such as sheet glass, bottles, glassware, and vacuum tubing. The amount of waste glass is gradually increased over the recent years due to an ever-growing use of glass products. Most waste glasses have been dumped into landfill sites. The Land filling of waste glasses is undesirable because they are not biodegradable, which makes them environmentally less friendly. So we use the waste glass in concrete to become the construction economical as well as eco-friendly. Composition of cement and Glass Powder is as shown in Table I.

In order to address environmental effects associated with cement manufacturing, there is a need to develop alternative binders to make concrete. Consequently extensive research is on-going into the use of cement replacements, using many waste materials and industrial by products. Efforts have been made in the concrete industry to use waste glass as partial replacement of coarse or fine aggregates and cement. In this study, finely powdered waste glasses are used as a partial replacement of cement in concrete and compared it with conventional concrete. This work examines the possibility of using glass powder as a partial replacement of cement for new concrete. Glass powder was partially replaced as 5%, 10%, 15% and 20% and tested for its compressive, tensile and strength up to 28 days of age and were compared with those of conventional concrete; from the results obtained, it is found that glass powder can be used as cement replacement material up to particle size less than 90µm to prevent alkali silica reaction.

Table 1 : Chemical Composition of Glass Powder

Sr. No.	Chemical Constituents	Values	Units
1	Silicon Di Oxide	67	%
2	Aluminium Oxide	2.62	%
3	Ferric Oxide	1.42	%
4	Titanium Di Oxide	0.157	%
5	Calcium Oxide	13.45	%
6	Magnesium Oxide	2.664	%
7	Sodium Oxide	10.05	%
8	Potassium Oxide	0.927	%
9	Zirconium Oxide	0.020	%
10	Strontium Oxide	0.016	%
11	Phosphorous pent oxide	0.041	%
12	Nickel Oxide	0.014	**%**

1.4 PPC

PPC cement **-** PPC means Pozzolana Portland Cement is a fully automated and dry manufacturing process and also contains gypsum and pozzolanic materials. This cement is used for all types of constructions especially for dams & bridges where strong resistivity is required.

Table No 2 : Chemical composition of PPC cement.

Compound	PPC
SiO_2	28-32 %
Al_2O_3	7.0-10.0 %
Na_2O	-
CaO	41-43%
MgO	1.0-2.0
K_2O	-

1.5 Super Plasticizer

A substance which imparts very high workability with a large decrease in water content (at least 20%) for a given workability. A high range water reducing admixture(HRWRA) is also referred as Super plasticizer, which is capable of reducing water content by about 20 to 40 percent has been developed. These can be added to concrete mix having a low-to- normal slump and water cement ratio to produce high slump flowing concrete. The effect of Super plasticizer lasts only for 30 to 30 minutes, depending on compositions and dosages and is followed by rapid loss in workability.

One of the important factors that govern the issue water-cement ratio during the manufacture of concrete, lower the water-cement ratio lower will be the capillary pores and hence lower permeability and enhanced durability.

Although Super plasticizer are essential to produce a truly high performance concrete characterized by low water-cement ratio and workability level without high cement content. Concrete are being produced with w/c of as low as 0.25 or even 0.20 enabled the production of highly durable high performance concrete. The workability also increases with an increase in the maximum size of aggregate. But smaller size aggregate provides larger surface area for bonding with the mortar matrix, which increase the compressive strength. For concrete with higher w/c ratio use of larger size aggregate is beneficial.

1.6 Action of Super Plasticizers

The action of plasticizers is mainly to fluidify the mix and improve the workability of concrete, mortar or grout. The mechanisms that are involved.

The Super plasticizers are classified based on their chemical composition

- Sulphonated melamine – Formaldehyde condensates
- Sulphonated naphthalene - Formaldehyde condensates
- Modified lignosulphonates
- Carboxylated acrylic esters copolymers
- Others like sulphuric-acid esters, amide polysaccharide mixtures, carbohydrate esters etc.

Sulphonated naphthalene based plasticizers are more preferable for high ambient temperatures. Therefore they are more suitable for Indian conditions.

The Plasticizers are generally used to achieve the following

In Fresh Concrete

- Increase workability and / or pump ability without increasing the water/cement ratio.
- Improved cohesiveness and thereby reducing segregation or bleeding.
- Improve to some extent set retardation.

In Hardened Concrete

- Increase Strength by reducing the water/cement ratio, maintaining same workability.
- Reduce permeability and improve durability by reducing water/cement ratio.
- Reduce heat of hydration and drying shrinkage by reducing cement content.

II. STRENGTH

1. **Compression Strength test**
2. **Split Tensile Strength test**

1. Compressive Strength Test

a) Preparation of specimen

The specimen consists of a cube of size 150 mm. The fresh concrete is poured into the moulds, which are greased or oiled. Concrete is placed into the mould, the concrete is compacted on vibrator. Care should be taken that the concrete should not segregate while placing and compacting.

b) Test Procedure

The testing is carried out on a compression testing machine as per IS:516-1959 code. The cubes should not be loaded on the face other than the face from where it is casted.

ISSN: 2321-8134

The load is applied and the load at which the specimen fails is noted down.

c) Calculation of Strength

$$\text{Compressive strength} = \frac{\text{Load}}{\text{Cross-sectional area}}$$

$$= \frac{P}{150 \times 150}\ \text{N/mm}^2$$

Where,

P = load at failure

Fig 2. : Compression test on Cube

Table No 4 : Compression Strength Test For M40

%Glass powder	*7Day's*	*14TH DAYS*	*28 Day's*
0%	41.483	49.90	63.82
10%	31.382	43.41	48.28
20%	29.328	43.50	45.12
30%	27.391	36.60	42.14

Table No 3 : Compression Strength Test For M20

%Glass powder	*7Day's*	*14TH DAYS*	*28 Day's*
0%	34.53	35.53	39.98
10%	**30.63**	34.69	36.86
20%	**24.79**	32.69	32.12
30%	**23.83**	28.46	28.79

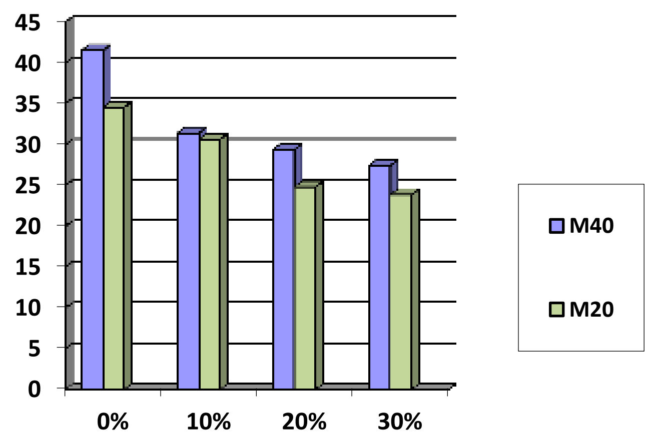


FIG 3:- COMPRESSIVE STRENGTH FOR (7 DAYS)

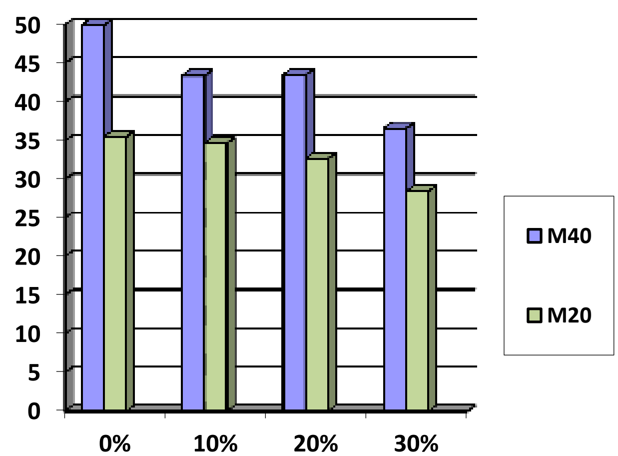


FIG 4:- COMPRESSIVE STRENGTH FOR (14 DAYS)

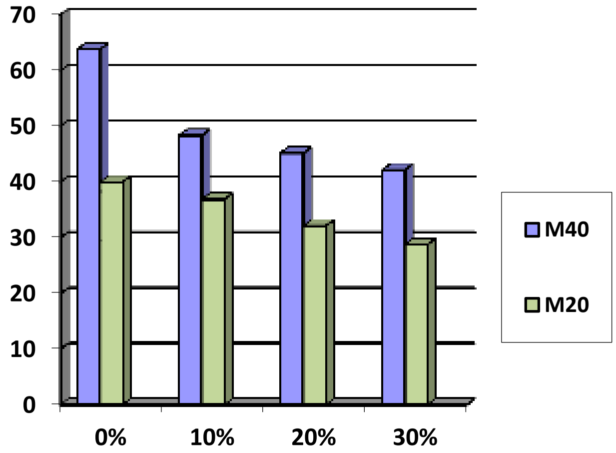


FIG 5:- Compression Test Strength for (28days)

2. Split Tensile Strength Test

a) Preparation of specimen

The specimen consists of a cylindrical of dimension 150 mm & 300 mm length. The fresh concrete is poured into the mould, which are greased or oiled before concrete is compacted with the help of vibrator. Care should be taken that the concrete should not segregate while placing and compacting.

b) Test procedure

The testing carried out on a compression-testing machine. Placing the cylindrical specimen horizontally between the loading plates of the comp testing machine and the load is applied in that position i.e. along the specimen fails. The load at failure is noted down.

In order to reduce the magnitude of the high compression stress near the points of application of the load, packing strips/ plates of suitable material are placed between the specimen and loading plates of the testing machine.

b) Calculation of tensile strength

Tensile strength $= \dfrac{2P}{\pi LD}$

Where,

P = load at failure

L = length of cylinder

D = diameter of cylinder

Fig 6 : Split tensile test on cylinder

Table No 5 : Split Tensile strength for Test *28 Day's*

%Glass powder	*M40*	*M20*
0%	5.3	2.3
10%	5.4	4.87
20%	3.9	5.74
30%	2.9	3.25

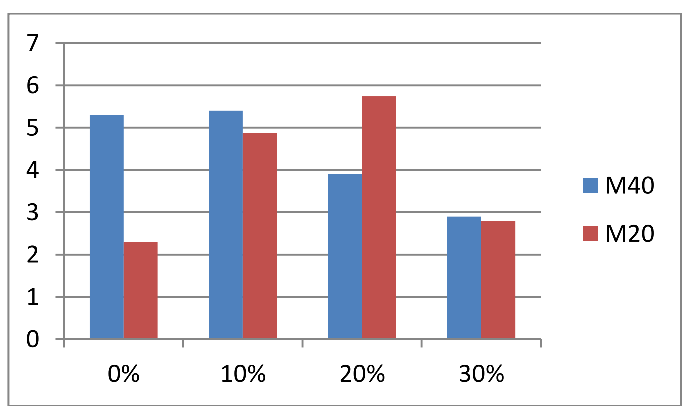
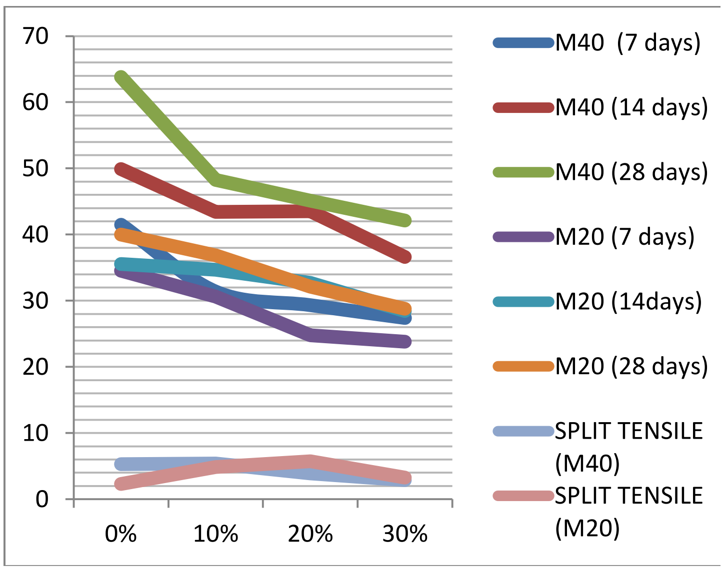


Fig no 7 : Split Tensile Test STRENGTH

III. RESULT

Table No 8 :Compression & Tension Strength Test For M40

%Glass powder	COMPRESSION	TENSION
0%	68.82	5.3
10%	48.28	5.4
20%	45.12	3.9
30%	42.14	2.9



As per Graph we can see the strength is decreasing after 10% if we are consider as per IS 456-2000 page no. 29 is say's The individual variation should not be more than ± **15%.**

IV. CONCLUSION

From the above graphs, we concluded that

1) As per research paper for M20 grade concrete, when we have used glass powder after 30% strength will decrease but for M40 grade concrete we can use up to 10% replace.
2) If we are using glass powder for any M40 design strength will be same but cost as compare to conventional concrete decrease.
3) Compressive strength of concrete at 28 days without super plasticizer reduced gradually up to 10% of replacement and increased at 15% replacement. But target strength can be achieved up to 5%.
4) With super plasticizer, compressive strength with zero (0%) glass powder was less than that of without super plasticizer. It also gradually reduced up to 10% replacement then at 15% it is slightly increased and further at 20% it is reduced but more 40 N/mm². But target strength can be achieved up to 5%.
5) Split Tensile strength reduced gradually with increase in percentage of glass powder
6) Finally, it can be concluded that to achieve target strength PPC can be replaced up to 10% in M40 and up to 30% in M20 with glass powder.
7) If we are using up to 10% and 30% Glass powder when cost of concrete will decrees as compare to Normal concrete.
8) The main Aim of our Experimental study is to reduced they cost as compare to conventional concrete.

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