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A Research Paper on Use of Waste Glass Powder and Plastic Fibers in Concrete

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ABSTRACT

The mix design has been performing for M30 grade of concrete according to IS: 10262-2000 and IS: 456-2000. Proportion of cement, sand and aggregate is 1:1.57:3.18 and .42 w/c ratio, cube and beam has been casted for testing compressive and flexural strength. Standard size of cube is 150* 150* 150 mm and beam size is 100*100*500 mm. First of all the optimum dosage of plastic fibers is calculated by casting cubes and tested for 7 days and 28 days. 24 cubes and 24 beams have been casted by replacing both glass powder and plastic. In this way all cubes and beams has been testing for compressive strength and flexural strength. 53 grade of ordinary Portland cement as per IS: 8112-2013 and locally available sand which belong to zone3 FM 3.172 and maximum 20mm size angular aggregate were used for making concrete. Super plasticizer used for reducing w/c ratio. Concrete mix was placed in the standard size mould for around 24 hours. After removing cubes and beams from mould, each cubes and beams were kept in the immersion curing tank for a period of 7 days and 28 days for curing. After the 7 days and 28 days curing period, specimens were tested for compressive and flexural strength after completely draying them in sunlight. Which cubes and beams were made by without any replacement are compare with specimens were made by partial replacement of waste material.

Keywords: waste glass powder, plastic fibers, compressive strength, flexural strength, properties of concrete.

INTRODUCTION

The process of cement manufacturing large amount of CO_2 gas emitted in to the environment which is cause of global warming. It was seen in the manufacturing of cement process that 1 ton of cement emitted about 1 ton of CO_2. Many researcher are trying for reducing the environment pollution by replacing cement to other waste material which showing cementitious properties. Now a day's huge amount of waste glass powder is producing by using glass in various areas, silica is the component of glass powder which increases bond properties. So it can be used in concrete as a place of cement. By using waste glass powder in concrete, disposed problem of glass waste powder can be reduced. Glass powder is wasted of finishing, cutting and policing of glasses.

In this way waste plastic are causing major damage to the environment. Various types of plastic product are through after one time using like pet (polyethylene terephthalate), carry bag, domestic waste plastic etc. Day by day increase waste plastic, face to disposing problem of it. Due to issue related to limited natural resources like river sand, lime and stone. Due to various causes like disposing problem, limited resources and environment issue plastic fibers can be us as a place of fine aggregate in concrete. Both waste glass powder and plastic fibers are used in this experimental study for partial replacement of cement and sand. Glass powder is replacing from 0 to 30% in the incremental percentage range by 20% and plastic fibers is replacing from 0 to 3% in the incremental percentage range by 2% and combined glass powder and plastic fibers are replacing as an above range.

Concrete is made by natural resources such as sand, aggregate, lime stone (use in manufacturing of cement). Due to issue related to limited natural resources like river sand and stone, quantity of river sand decrease continuously and effect on environment. On other side, large quantity of plastic waste is being produced every day from domestic use plastic, plastic factories, carry bags and pet bottle etc. Plastic is non biodegradable material which is not easily decompose and create major environment impact and also faces to disposal and management problem due to huge amount of waste plastic. Similarly its estimate that million tons of waste glasses are produced yearly word wide. Some part of waste glass can be used in recycling and the remaining waste glass cannot be used for any purposes and waste glasses are disposing. On other side, along worldwide consumption of cement in concrete is very high and it is seen that the manufacturing process of cement consume more quantities of fuel and due to burning of filet large quantities of coz emitted in to the environment and increase global warming problem.

Due to consumption of large quantities of cement and sand, demand of it increase day by day. In order to fulfil demand of its, price of natural reassures increase and other hand quantities decrease. For decrease the demand of natural resources, many researcher has suggest for use of waste material like fly ash, saw dust, plastic sheets, steel fibers, recycled aggregate, rubber tyres, stone powder etc. The waste product from many e-waste products from many industries is dumped in the ground which ground which create dispose and management problem. This waste material have some properties for making

suitable concrete like glass powder show bonding due to silica contain and plastic show flexural. By using waste material in concrete not only the cost of construction reduced but also decrease consumption of natural recourses and environment problem. These waste materials have different effect on concrete so it can be use in concrete as partial replacement at the place of cement, sand and coarse aggregate. Glass powder and pet plastic bottle, plastic carry bags, domestic plastic are the waste material. Glass powder has cementations properties and plastic has flexural properties so that can be used as partial replacement for cement and send in concrete. Therefore, in this study, partial replacing both glass powder at the place of cement and waste plastic fibers at the place of sand.

OBJECTIVE

In this research focused on reducing the environmental pollution, dispose and management problem of waste material which is generated from industries and domestic and also trying to reduce cost of concrete construction by using waste material.

Following are objective of this study

- Find out the effect on strength of the concrete by partial replacing cement with glass powder.
- Find out the effect on strength of the concrete by partial replacing sand with plastic fibers.
- To determine the optimum percentage of glass powder and plastic powder and plastic fibers in concrete mix.
- Effect on strength of the concrete by using both glass powder and plastic fibers.
- Evaluation of percentage saving of the cost in concrete construction.

MATERIAL USED

Cement:

Ordinary Portland cement 53-Grade was used in the entire research work which is available under the commercial name “Ultra tech cement”. It satisfy the requirement of IS: 1489(part-1)1991. Ordinary Portland cement and pozzolanic Portland cement are used in the form of their binding properties. OPC is most commonly use in PQC due to their higher strength. It is a mixture of various aliment silicates of calcium, which is produced by the interaction of various oxides during fusion.

Fine Aggregate (Sand):

Locally available fine aggregate (sand) was used to cast cubes and beam. Fine aggregate i.e. river sand passing through 4.75mm IS sieve is used throughout the project. Its properties have been tested as per IS 2386-2019 for specific gravity, sieve analysis and fineness of modulus.

Coarse Aggregate:

Locally available coarse aggregate will be used for this operation. 12mm and 20mm aggregate with angular dimensions were used. Its properties have been tested by specific gravity, sieve analysis and other tests according to IS: 383-1970. A coarse aggregate specific gravity of 2.853 was found. Coarse aggregate water absorption of 0.70% was measured.

Admixtures:

Admixture is a substance which can be added to concrete to attain or modify its properties like compressive strength, workability and durability. In addition to cement, water and aggregate, admixtures are added to concrete either before or during the mixing process. In present study admixture had been used to increase the workability and strength by reducing water-cement ratio. The dose of admixture used in present study was 0.6% weight of cement.

Glass Powder:

Glass is non- crystalline material which having high contain of silica. Glass is naturally occur, when high silicates rocks are melt at the high temperature and cool earlier they can from crystalline structure. Such as volcanic glass is well example of natural glass. Glass can be natural or manmade. When glass is manufacture by human, it is a mixture of silica, sand, lime and other content. There are many waste part of glass come out after using it, like glass powder, broken part, etc. One of the most waste products from glass is powder form, which is obtained after the cutting and polishing. In this study glass powder, which is waste is used as a cement replacement. Glass powder is collected from local factory and glass cutting shop which is locally available, which is sieved from 425 micron. Glass powder, which is finer than 425 micron is used for finding specific gravity and it is obtained 2.62.

Plastic waste:

there are many types of plastic such as polyethylene terephthalate(PET), Low density plastic polyethylene (DPE), highpolyvinyl density polyethylene (HDPE), unplasticised chloride(UPVC), plasticized polyvinyl chloride(PPVC), polypropylene(PP), polystyrene (PS), polyester(ESP) etc. all of them HDPE and LDPE has been used for various purpose in concrete mix. HDPE very common plastic, usually white or colored. One of the most examples of HDPE is oil bottle, milk bottle, shopping bag etc, LDPE is soft and flexible plastic which milky white. After the study of literature review it can be see

that waste plastic is used in concrete as an ingredient in various from. Plastics are commonly used as fine and coarse aggregate. By using plastic waste in concrete at a place of concrete ingredient is mainly controlled by economical and reduced the management problem of plastic waste.

Water-

Potable water is used for both mixing and curing in this piece. The water used for these experiments is free of all contaminants.

METHODOLOGY

The ingredients to be used in the study namely cement, fine & coarse aggregate, waste glass powder, plastic fibers, and water were collected from various sources. The laboratory tests on various ingredients were conducted in the laboratory. After testing of various ingredients the mixes of M30 were designed using IS 10262-2019. To find the optimum dose of plastic fibers trial studies on M30 grade of concrete was done.

The following steps are followed to achieve the objective of study-

- Collected all data, information and research paper related to the glass powder as a cement replacement and plastic waste as a fine aggregate replacement in the concrete and studied them for replacing.
- Also collect information related to combine use of glass powder and various plastic wastes.
- Collected sample of glass powder and after collecting glass powder sieved from 423 micron sieve.
- Brought sample of waste plastic pieces in shaded form having size 30 to 35 mm length and 4 to 6 mm width.
- Sieved for grading of sand and coarse aggregate.
- Mix design prepared for M30 grade of concrete with different proportion of glass powder and plastic waste. Various percentage of glass powder is 10%, 20%, and 30%, and plastic percentages are 0 to 3%.
- All the specimens are tested for compressive strength and flexural strength and experimental result are recorded for study.

All over experimental study is carried out in mainly three stages.

- For finding properties of material, various experiments are performed.
- Casting of various specimens.
- Testing of all cubes and beams for finding their compressive and flexural strength.

EXPERIMENTAL DATA

Testing of Concrete

After the completion of curing time specimens are tested for Compressive strength test and flexural strength test for 7 days and 28 days. Steps of test adopted according to IS code method. Direct method is adopted for testing of specimens.

a) Compressive Strength Test

The compressive strength test was performed on concrete cubes of size 150mm×150mm×150mm by adding Plastic Fibers fibres (2%) and replacing cement with Waste Glass Powder (10%,20% and 30%). For each replacement level three cubes were cast, cured and tested at the age of 7 and 28 days. Final strength was taken by the average value of three specimens.

Compressive Strength test for 7 Days: - In Table No. 4.1 shows the 7 Days Compressive strength and Figure No. 4.1 shows the average Compressive strength of concrete for 7 days.

Table No 4.1: 7 Days Compressive Strength Test Results

S. No.	Plastic Fibers	Waste Glass Powder	Compressive Strength (N/mm^2)	Average Result ($N/mm^{2)}$
1	0%	0%	19.58	20.50
	0%	0%	21.22	
	0%	0%	20.71	
2	2%	10%	24.24	23.99
	2%	10%	24.19	

	2%	10%	23.54	
3	2%	20%	26.24	25.83
	2%	20%	24.28	
	2%	20%	26.98	
4	2%	30%	20.19	20.36
	2%	30%	21.42	
	2%	30%	19.48	

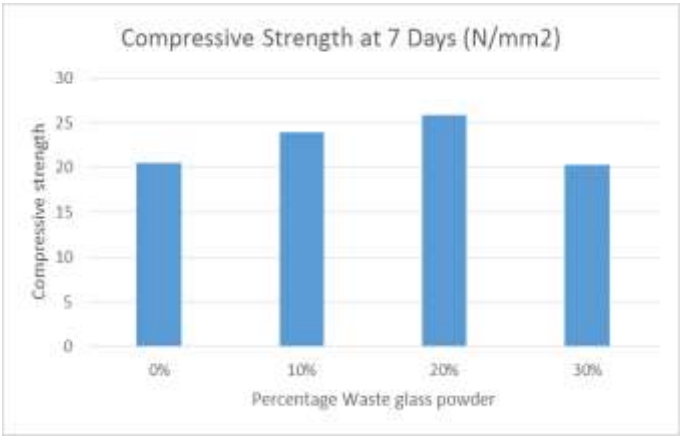

Figure No. 4.1 average Compressive strength of concrete for 7 days.

Compressive Strength Test for 28 Days: -In Table No. 4.2 shows the Compressive strength at 28 days and Figure No. 4.2 shows the average Compressive strength of concrete for 28 days.

Table No 4.2: 28 Days Compressive Strength Test Results

S. No.	**Plastic Fibers**	**Waste Glass Powder**	**Compressive Strength (N/mm^2)**	**Average Result (N/mm$^{2)}$**
1	0%	0%	30.08	30.99
	0%	0%	31.07	
	0%	0%	31.84	
2	2%	10%	31.67	32.55
	2%	10%	34.96	
	2%	10%	33.04	
3	2%	20%	38.47	35.69
	2%	20%	35.19	
	2%	20%	33.42	
4	2%	30%	30.52	30.77
	2%	30%	29.81	
	2%	30%	31.98	

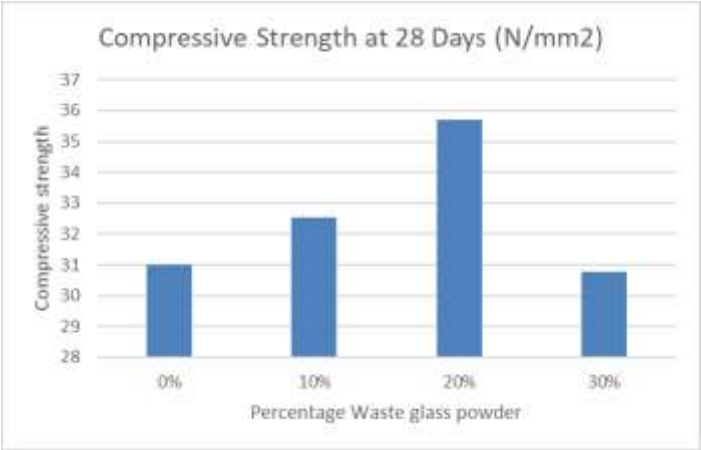

Figure No. 4.2 shows the average Compressive strength of concrete for 28 days.

b) Flexural Strength Test

The flexural strength Test was performed on concrete beam of size 100mmX100mmX500mm by adding plastic fibers (2%) and replacing cement with waste glass powder (10%,20% and 30%). For each replacement level three beams were cast, cured and tested at the age of 7 and 28 days. Final strength was taken by the average value of three specimens.

Flexural Strength Test for 7 days: - In Table No. 4.3 shows the flexural strength of concrete at the age of 7 days and Figure No. 4.3 shows the average flexural strength of concrete for 7 days.

Table No 4.3: 7 Days Flexural Strength Test Result

S. No.	Plastic Fibers	Waste Glass Powder	Flexural Strength (N/mm^2)	Average Result ($N/mm^{2)}$
1	0%	0%	2.10	2.20
	0%	0%	2.20	
	0%	0%	2.31	
2	2%	10%	2.36	2.43
	2%	10%	2.50	
	2%	10%	2.45	
3	2%	20%	3.04	3.03
	2%	20%	2.97	
	2%	20%	3.1	
4	2%	30%	2.10	2.09
	2%	30%	2.20	
	2%	30%	1.98	

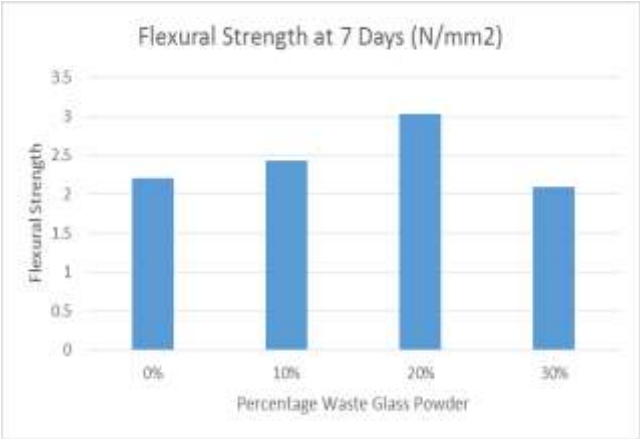

Figure No. 4.3 shows the average flexural strength of concrete for 7 days.

Flexural strength Test for 28 days: - In Table No. 4.4 shows the flexural strength of concrete at the age of 28 days and Figure No. 4.4 shows the average flexural strength of concrete for 28 days.

Table No. 4.4: 28 Days Flexural Strength Test Result

S. No.	Plastic Fibers	Waste Glass Powder	Flexural Strength (N/mm^2)	Average Result ($N/mm^{2)}$
1	0%	0%	3.40	3.37
	0%	0%	3.51	
	0%	0%	3.20	
2	2%	10%	3.40	3.52
	2%	10%	3.60	
	2%	10%	3.57	
3	2%	20%	4.29	4.17
	2%	20%	4.15	
	2%	20%	4.09	

4	2%	30%	2.96	2.95
	2%	30%	2.81	
	2%	30%	3.10	

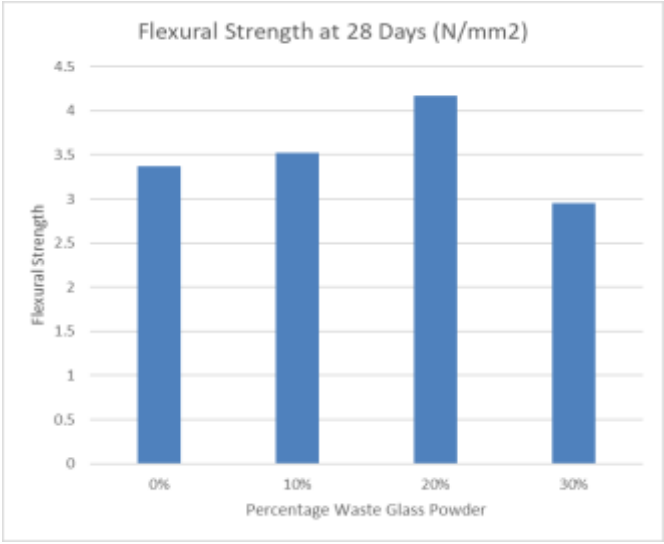

Figure No. 4.4 shows the average flexural strength of concrete for 28 days.

CONCLUSION

On the basis of experiments, it concludes that replacement of cement with Waste Glass Powder and Plastic Fibers the Compressive strength as well as Flexural strength of concrete increases. The following are the conclusions are found from this study as below.

1. Optimum Strength is seen at 20% replacement of cement with glass fibers.
2. In case of Plastic Fibers, Compressive strength and Flexural strength increases at 2% replacement but further increases in plastic fibers both strength are continuously decreases.
3. Optimum strength obtained in case of combine study at 20% glass powder and 2% plastic fibers.
4. The compressive Strength and Flexural Strength of waste glass powder and plastic fibers is higher than normal concrete.
5. The Strength obtained in combine replacement (waste glass powder and plastic fibers) is 1 to 2% more as compare to the individual glass powder replacement.
6. Reduction in Cost of construction about 10%.
7. Avoid disposal problem of plastic waste and glass powder.

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