Combined Effect of Waste Glass Powder and Plastic Fiber on the Properties of Concrete

Rambabu Songra[1], Rahul Sharma[2]

[1]PG Student, Department of Civil Engineering, PITS, UJJAIN (M.P.), INDIA
[2]Associate Professor, Department of Civil Engineering, PITS, UJJAIN (M.P.), INDIA

Abstract

Commonly glasses are used in construction and industries work and huge amount of glasses are powdered daily. Also the plastic's use increases day by day and PET (polyethylene terephthalate) bottle have increased become necessary part of a common man life. Waste glass and plastic disposal are an environmental issue. Due to waste glass powder & plastic face to disposal problem. Now a day's cost of construction is more with using basic material such as cement, sand and coarse aggregate. In this study 0%, 10%, 20%, 30%, and 40% cement is replaced by glass powder and sand is replacing by waste plastic fiber (like waste plastic bottle, plastic bags) with partially replacing sand by 1%, 2%, 3%, and 4% of plastic fiber and combined cement and sand are replaced by waste glass powder and fibers plastic such as above percentage respectively. All above proportional are mix design for M30 concrete and compare properties of concrete with without replacement of waste material concrete mix. This project mainly studied includes compressive strength and flexural strength. The test results show that the slump value is reduced at higher percentage of glass powder and plastic fiber. But up to 20% glass powder and 2% plastic fiber the slump value is not hampered so much. At 20% glass powder and 2% plastic waste replacement, compressive and flexural strength obtained higher than other replacement.

Key Words: *Powdered waste glass, waste plastic fiber, workability, compressive strength, flexural strength and cost comparison.*

I. INTRODUCTION

For any construction in civil engineering concrete is a basic material. All basic ingredients which are used for concreting are natural. Concrete's properties can be change by adding some plasticizer and other material. Brittle material such as glass powder it is seen that compressive strength increases and fibers are also increase compressive strength and other properties. Due to environment pollution and global warming pollution the need to cut down energy consumption increased. Global warming's has impacted everyone. In India due to domestic waste plastics and industrial glasses is considerable damage to the environmental and hence currently required to use of waste material for improving properties of concrete. Disposal of waste glass and plastic are an environmental issue. The use of plastic has increase continuously all over the word and it creates large quantities of plastic based waste. Various glasses waste and non biodegradable plastic waste is one of the big problems to dispose and manage as it is non biodegradable material which is harmful to environment and human life. PET bottle are mostly used as container for raw material, water, household cleaner and oil and are thrown after single usage. Disposed of PET bottle are treated by landfill and burning which create environment problem and create waste disposal and management issue. In this way use of glass are also big problem for creating environment problem. Huge amount of glass powder are produced by manufacturing of glass frame, glass windows, bulb, and glass bottle and after damage of these waste material disposal are big problem.

For reducing environmental impact of waste glass and plastic waste recycling is best method in concrete for increasing mechanical properties.

II. OBJECTIVES

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 fibers in concrete mix.

- Effect on strength of the concrete by using both glass powder and plastic fiber.
- Evaluation of percentage saving of the cost in concrete construction.

III. MIX MATERIALS

The materials details are as follows-

1. Cement- For this research, locally available cement which is of the ordinary Portland cement type (43 grade) was used throughout the work.

Test	Result
Specific gravity	3.15
Initial setting time	65
Final setting time	206
7 days compressive strength	32.9
28 days compressive strength	45.32
Soundness	6mm
Fineness	6.5%
Consistency	25%

2. Fine aggregate- Locally available fine aggregate used was 4.75 mm size confirming to zone III. The testing of sand was conducted as per IS: 383-1970.

Test	Result
Specific gravity	2.63
Fineness modulus	3.175
Lose density	1579 kg/m^3
Compacted density	1590 kg/m^3
Grading zone	3

3. Coarse aggregate- Coarse aggregate used was 20mm and less size and testing of coarse aggregate was conducted as per IS: 383-1970.

Test	Result
Specific Gravity	2.853
Water Absorption	0.7%
Loose Density	1425 Kg/M^3
Compacted Density	1610 Kg/M^3
Aggregate Impact Value	7.78%

4. Water -The water used was potable, coloureless and odourless that is free from organic impurities of any type.

5. Glass powder- 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 in siyagung and collector office

Indore, 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.

6. PET Bottle- PET fiber is a waste material which is obtained from industries. we collect the pet bottle from the restaurants. They were cut after removing the top and bottom of the bottle. The length of fibers was kept 30 – 40 mm and the breadth was 2-3 mm. HDPE and LDPE has been used for various purposes in concrete mix. HDPE is 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 is milky white.

IV. EXPERIMENTAL WORK AND TEST

1. Mix Design- Mix design carried out for M30 grade of concrete by IS 10262:2009, having mix proportion of 1:1.57:3.18 with water cement ratio of 0.42. Chemical admixtures are used in the work.

2. Compressive and Flexural Strength- Concrete prepared with different percentage replacement of cement by glass powder from 10 % to 40% and fine aggregate by plastic waste from 1% to 4% and cured under normal condition as per recommendations of IS and were tested at 7 days and 28 days for determining the compressive and flexural strength compared with the test results of conventional concrete.

V. TEST RESULTS

1. Compressive Strength- A cube compression test is performed on standard cubes of size 150 x 150 x 150 mm after 7 and 28 days of immersion in water for curing. The compressive strength of specimen is calculated by the following formula:

$$f_{ck} = Pc / A$$

Where P_c = Failure load in compression, KN
A = Loaded area of cube

2. Flexural Strength- Three beam section of size 100x100x500mm were casted and cured for 7 and 28 days. The flexural strength is determined by the

$$fcr = Pf\ L / bd2$$

Where,
fcr = Flexural strength, MPa
Pf = Central load through two point loading system, N
L = Span of beam, mm
b = Width of beam, mm d = Depth of beam, mm

Strength of concrete with cement replacement by glass powder

Type of mix	% Replacement of cement by glass powder	Compressive strength (N/mm^2)		Flexural strength (N/mm^2)	
		7 days	28 days	7 days	28 days

R	0	24.12	35.12	2.84	4.11
R1	10	22.68	33.19	2.72	3.98
R2	20	23.72	34.89	2.86	4.09
R3	30	22.31	32.78	2.68	3.87
R4	40	19.31	28.98	2.33	3.39

Strength of concrete with sand replacement by plastic waste

Type of mix	**% Replacement of sand by plastic waste**	**Compressive strength (N/mm^2)**		**Flexural strength (N/mm^2)**	
		7 days	**28 days**	**7 days**	**28 days**
R	0	24.12	35.22	2.84	4.11
R5	1	24.32	35.98	2.93	4.17
R6	2	23.91	34.13	2.91	4.12
R7	3	22.17	32.69	2.71	4.03
R8	4	19.09	27.02	2.20	3.24

Compressive and Flexural strength of concrete by using combined glass powder and plastic

Type of Mix	**% Replacement of Cement by Glass Powder**	**% Replacement of Sand by Plastic Waste**	**Compressive Strength (N/mm^2)**		**Flexural strength (N/mm^2)**	
			7 Days	**28 Days**	**7 Days**	**28 Days**
R	0	0	24.12	35.22	2.84	4.11
R9	10	1	23.31	34.28	2.62	3.82
R10	10	2	24.19	34.96	2.76	4.01
R11	10	3	22.38	33.02	2.50	3.71
R12	10	4	21.38	31.92	2.023	2.89
R13	20	1	24.12	34.92	2.89	4.18
R14	20	2	24.28	35.19	3.04	4.29
R15	20	3	22.91	33.26	2.86	4.12
R16	20	4	22.02	32.19	2.07	3.01
R17	30	1	21.59	32.12	2.60	3.81
R18	30	2	20.19	30.42	2.36	2.98
R19	30	3	18.62	29.10	1.89	2.61
R20	30	4	17.11	27.19	1.47	2.11

R21	40	1	18.87	26.21	2.08	2.98
R22	40	2	17.92	25.12	1.80	2.67
R23	40	3	15.41	21.01	1.66	2.31
R24	40	4	13.77	21.19	1.46	2.03

VI . CONCLUSION

Following conclusion can be drawn from this experimental study-

- Optimum strength seen at the 20% replacement of cement by glass powder.
- In case of plastic fiber, compressive strength and flexural strength increase at the 1% replacement but further increase of plastic, both strength are continuously decreases.
- The test results show that the slump value is reduced at higher percentage of glass powder and plastic fiber. But up to 20% glass powder and 2% plastic fiber the slump value is not hampered so much
- Optimum strength obtained in case of combine study at 20% glass powder and 2% pslastic fiber.
- The compressive strength obtained from the above case is nearly same to compressive strength of conventional concrete but flexural strength improved by 1.04 to 1.06%.
- The strength obtained in combine replacement (glass and plastic) is 1to 2 % more as compare to the individual glass powder replacement.
- Reduce the cost of construction about 10%.
- Avoid the disposal problem of plastic waste and glass powder.

Considering the strength criteria, the replacement of cement by glass powder and replacement of plastic fiber by sand is feasible. Hence it can be concluded that utilization of waste plastic and waste glass powder in concrete as sand and cement respectively.

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