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RESEARCH ARTICLE OPEN ACCESS

Recycled Glass Powder replaces Fine Aggregate – Effect on Compressive Strength

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ABSTRACT
Utilization of recycled materials is the best choice in construction industry as it reduces disposal problems and is economical too. One such material which can be recycled and used in construction industry is glass. Glass is widely used in our day-to-day life but is least recycled material in India. Glass is non-biodegradable; landfills do not offer an appropriate solution for its safe disposal. Glass is predominantly composed of Silica. This paper aims to focus on replacing fine aggregate with different percentages of glass powder on different grades of concrete (M20, M25, M30, M35 and M40). For this purpose, fine aggregate replacement is done in the range of 10% to 50% at an interval of 10% and tested for compressive strength at age of 7 and 28 days. The optimal glass powder content to replace fine aggregate for different grades is obtained. The compressive test results indicated that recycled glass powder concrete gave better strength than conventional concrete. The best outcome of replacing fine aggregate with glass powder is at 20% but 30% replacement also showed marginal variation.
Keywords – fine aggregate replacement, glass powder, grades of concrete, sand

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I. INTRODUCTION

Recycling of waste materials provide alternative materials that aids in reducing the depletion rate of natural materials or resources, which are being overexploited. The natural materials like sand, which are utilized in manufacture of concrete are also exhausting. The construction industry requires huge amounts of sand to be utilized as fine aggregate in the process of concrete making. In this present scenario, there is a need to identify the demand of substitute materials for the sand to produce concrete.

Millions of tons of glass powder is produced every year throughout the world. An unprecedented level of waste glass is produced due to rise in population and its everyday use. The management of solid wastes is now an alarming threat for healthy environment. So, disposal of this non-biodegradable glass has become a crucial problem in view of environmental hazard. The best approach to reduce the influence of these glass wastes on the environment is by recycling them. So, utilization of glass powder in concrete as partial replacement of fine aggregate could be an economical as well as environmental friendly solution.

The objective of this paper is to project the results of experimental investigation conducted to know the compressive strength of different grades of glass concrete at 7 and 28 days. Natural fine aggregate is substituted with waste glass powder at 10, 20, 30, 40 and 50 percentages. The results of different percentages of glass powder in different grades of concrete are compiled and compared with conventional concrete.

II. MATERIALS USED

2.1 Cement

In the present work, Ordinary Portland Cement of 53 grade was used, which has specific gravity of 3.01

2.2 Fine Aggregate

The fine aggregate used in this analysis was river sand, conforming to grading zone II as per IS:383-2016. Its specific gravity is 2.64

2.3 Coarse Aggregate

In this study, aggregates passing through 20 mm sieve and retained in 10 mm sieve are used. The specific gravity of coarse aggregate is 2.60.

2.4 Glass Powder

Locally available waste glass powder, having particle size of glass powder is less than 150μ and sieved through 75μ, is used as a partial replacement for fine aggregate. The specific gravity is of glass powder used is 2.48.

2.5 Water

Clean potable water from Gandipet is used for both mixing and curing.

III. METHODOLOGY

3.1 Mix Design

Mix design was computed as per IS:10262-2009 for the following cases

1. Conventional concrete of different concrete grades M20, M25, M30, M35 and M40
2. M20 grade concrete for 10, 20, 30, 40 and 50 percent replacements of glass powder.
3. M25 grade concrete for 10, 20, 30, 40 and 50 percent replacements of glass powder.
4. M30 grade concrete for 10, 20, 30, 40 and 50 percent replacements of glass powder.
5. M35 grade concrete for 10, 20, 30, 40 and 50 percent replacements of glass powder.
6. M40 grade concrete for 10, 20, 30, 40 and 50 percent replacements of glass powder.

3.2 Experimental Program

Six cube specimens, of size 150mm x 150mm x 150mm were casted and cured in water, per batch for all the cases for which mix design has been done. Three of the six cubes were tested for compressive strength at 7days and three other were tested at 28 days.

IV. EXPERIMENTAL RESULTS

Concrete mixes of grades 20 MPa, 25 MPa, 30 MPa, 35 MPa, 40MPa with 0%, 10%, 20%, 30%, 40% and 50% glass powder replacing fine aggregate were tested to study the compressive strength and obtain optimum % of glass powder which gives better quality concrete compared to normal concrete. The test results of compressive strengths for all cases were tabulated and plotted in graphs

TABLE 1: COMPRESSIVE STRENGTH OF CUBE FOR M20

Sand Replacement %	**M20 - Compressive Strength (in MPa) at age of**	
	7 days	28 days
0	16.54	26.32
10	17.46	28.11
20	18.68	30.47
30	18.14	29.76
40	16.01	25.81
50	15.52	25.07

TABLE 2: COMPRESSIVE STRENGTH OF CUBE FOR M25

Sand Replacement %	**M25 -Compressive Strength (in MPa) at age of**	
	7 days	28 days
0	21.67	32.63
10	22.39	33.46
20	24.16	35.11
30	23.93	34.78
40	21.30	32.05
50	20.64	31.48

TABLE 3: COMPRESSIVE STRENGTH OF CUBE FOR M30

Sand Replacement %	**M30 -Compressive Strength (in MPa) at age of**	
	7 days	28 days
0	27.1	37.49
10	27.64	38.91
20	28.45	40.62
30	28.28	40.14
40	26.83	37.08
50	26.09	36.13

TABLE 4: COMPRESSIVE STRENGTH OF CUBE FOR M35

Sand Replacement %	**M35 -Compressive Strength (in MPa) at age of**	
	7 days	28 days
0	31.68	42.00
10	32.12	43.14
20	33.35	45.29
30	32.89	44.76
40	31.03	41.42
50	30.41	40.84

TABLE 5: COMPRESSIVE STRENGTH OF CUBE FOR M40

Sand Replacement %	**M40 -Compressive Strength (in MPa) at age of**	
	7 days	28 days
0	36.48	51.78
10	37.12	52.35
20	38.63	54.67
30	38.06	54.20
40	36.27	51.22
50	35.51	50.43

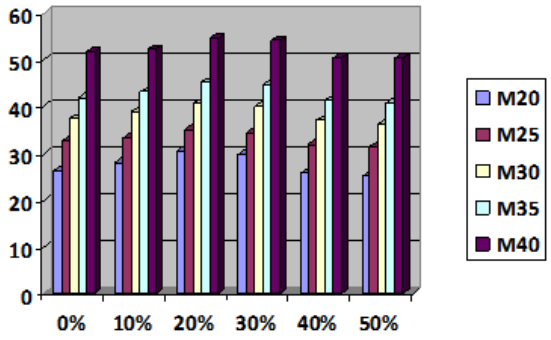
TABLE 6: COMPRESSIVE STRENGTH (IN MPa) FOR ALL MIXES (7days)

% replacement of glass powder	0%	10%	20%	30%	40%	50%
M20	16.54	17.46	18.68	18.14	16.01	15.52
M25	21.67	22.39	24.16	23.93	21.30	20.64

M30	27.10	27.64	28.45	28.28	26.83	26.09
M35	31.68	32.12	33.35	32.89	31.03	30.41
M40	36.48	37.12	38.63	38.06	36.27	35.51

TABLE 7: COMPRESSIVE STRENGTH (IN MPa) FOR ALL MIXES (28days)

% replace-ment of glass powder	0%	10%	20%	30%	40%	50%
M20	26.32	28.11	30.47	29.76	25.81	25.07
M25	32.63	33.46	35.11	34.78	32.05	31.48
M30	37.49	38.91	40.62	40.14	37.08	36.13
M35	42.00	43.14	45.29	44.76	41.42	40.84
M40	51.78	52.35	54.67	54.20	51.22	50.43



GRAPH 1: COMPRESSIVE STRENGTH AT 28 DAYS FOR DIFFERENT GRADES OF CONCRETE AT VARIOUS PERCENTAGES OF GLASS POWDER

V. DISCUSSION OF RESULTS

Based on the experimental test results, it was understood that glass powder up to 30% gives better compressive test results than the conventional concrete with respect to 7 and 28 days. This can be attributed to the angular shape of glass particles, which impart better interlocking between particles and there by enhances bonding property of glass concrete, finally leading to improved compressive strength.

However, a decrease in strength was noticed beyond 30% glass powder replacements. This may be because of reduction in availability of sand, giving scope for more voids, which results in decreased strength at higher levels of glass powder

VI. CONCLUSIONS

1. The best possible glass powder replacing fine aggregate percent was inferred to be 20%
2. However, 30% glass powder replacement showed nearby results to that of 20%
3. All the cases considered for compressive strength followed similar pattern of result with 20% being the highest, followed by 30%, very close to the peak value.
4. The compressive strength of glass powder replaced concrete of 40 and 50 percents has lesser strength than the conventional concrete
5. Glass powder can be suggested as fine aggregate substitute up to 30% and not advisable beyond that

REFERENCES

[1]. IS: 10262–2009, "Indian Standard Recommended Guidelines for concrete mix design," Bureau of Indian Standards, New Delhi.

[2]. IS: 383-2016, "Specification for coarse and Fine Aggregate from Natural source for concrete," Bureau of Indian Standards, New Delhi.

[3]. IS: 516-1959, "Methods of tests for strength of concrete", Bureau of Indian Standards

[4]. T O Ogundairo, D D Adegoke, I I Akinwumi and O M Olofinnade, Sustainable use of recycled waste glass as an alternative material for building construction – A review, *1st International Conference on Sustainable Infrastructural Development, IOP Conf. Series: Materials Science and Engineering 640* (2019) 012073

[5]. Oluwarotimi M. Olofinnade, Anthony N. Ede, Julius M. Ndambuki, Ben U. Ngene, Isaac I. Akinwumi & Olatokunbo Ofuyatan | Sanjay Kumar Shukla (Reviewing editor) Strength and microstructure of eco-concrete produced using waste glass as partial and complete replacement for sand, *Cogent Engineering, 5:1,* DOI: 10.1080/23311916.2018.1483860

[6]. Yanru Wang, Yubin Cao, Peng Zhang 1, and Yuwei Ma, Effective Utilization of Waste Glass as cementitious Powder and Construction Sand in Mortar, *Materials, mdpi,* 2020, 13, 707; DOI:10.3390/ma13030707