International Journal of Engineering Technology and Management Sciences
Website: ijetms.in Issue: 2 Volume No.8 March - April – 2024
DOI:10.46647/ijetms.2024.v08i02.024 ISSN: 2581-4621

EXPERIMENTAL INVESTIGATION ON SELF REPLACEMENT OF SAND BY SHEET GLASS POWDER IN CONCRETE

Ms.S.Thahira Banu[1], Dr.A.M. Arun Mohan[2], Mr.K.Kothalam[3]
[1]*Assistant professor, Civil Engineering, Sethu Institute of Technology, Kariapatti.*
[2]*Associate professor, Civil Engineering, Sethu Institute of Technology, Kariapatti.*
[3]*Final Year M.E Student, Department of Civil Engineering,*
Sethu Institute of Technology, Kariapatti.

ABSTRACT

For the hardened concrete, 150 mm × 150 mm × 150 mm cubic specimens and cylindrical specimens with a diameter of 100 mm and a height of 200 mm were tested to identify the compressive strength and splitting tensile strength of the concrete produced with waste glass. Next, a three-point bending test was carried out on samples with dimensions of 100 × 100 × 400 mm, and a span length of 300 mm to obtain the flexure behavior of different mixtures. According to the results obtained, a 20% substitution of WGP as cement can be considered the optimum dose. On the other hand, for concrete produced with combined WGP and crashed glass particles, mechanical properties increased up to a certain limit and then decreased owing to poor workability. Thus, 10% can be considered the optimum replacement level, as combined waste glass shows considerably higher strength and better workability properties. Furthermore, scanning electron microscope (SEM) analysis was performed to investigate the microstructure of the composition.

CHAPTER– 1

INTRODUCTION

1.1 General

The interest of the construction community in using waste or recycled materials in concrete is increasing because of the emphasis placed on sustainable construction. The waste glass from in and around the small shops is packed as a waste and disposed as landfill. Glass is an inert material which could be recycled and used many times without changing its chemical properties. Since the demand in the concrete manufacturing is increasing day by day, the utilization of river sand as fine aggregate leads to exploitation of natural resources, lowering of water table &sinking of the bridge piers. The most widely used fine aggregate for the making of concrete is the natural sand mined from the river beds. The present scenario demands identification of substitute materials for the river sand for making concrete because of the abundant scarcity it is facing.

Attempts have been made in using crushed glass as fine aggregate in the replacement of river sand. Studies have shown that finely ground glass does not contribute to alkali – silica reaction. In the recent, various attempts and research have been made to use ground glass as a replacement in conventional ingredients in concrete production as a part of green house management. In the current research, sand is partially replaced by glass powder in concrete. The sheet glass powder is obtained from crushing the wastage glass which is disposed as landfill by the industries.

International Journal of Engineering Technology and Management Sciences
Website: ijetms.in Issue: 2 Volume No.8 March - April – 2024
DOI:10.46647/ijetms.2024.v08i02.024 ISSN: 2581-4621

CHAPTER-2

LITERATURE REVIEW

Perkins (2009):

Has investigated on the development of concrete containing glass waste. Sand was replaced by glass powder in variations of 10%, 20% and 30%. The coarse aggregate used was 10 mm crushed limestone. The concrete was used to produce cubes of sizes 50 mm and 100 mm. Curing was done for 7, 14, 28 and 90 days. Compressive strength was tested at the end of days. The control at 28 days achieved a compressive strength of 49.1N/mm2 whereas the concrete containing glass aggregate achieved a compressive strength of 49.5N/mm2.

Mageswari et al (2010):

Has investigated on the use of SGP as fine aggregate replacement in concrete. The grade of cement used was OPC 53. The mix used was M20 mix. Sand was replaced by sheet glass powder at 7 levels i.e. 0%, 10%, 20%, 30%, 40% 50% and then 100%. Cubes of sizes 150mm x 150mm were cast. Cylinders of size 150mm x 300mm were cast. Beams of sizes 100mm x 100mm x 500mm were cast. Totally 500 specimens were cast and curing was done at the end of 28, 45, 60, 90 and 180 days. Tests were carried out at the end of curing and the following results were obtained.

Workability increased as the percentage of sheet glass powder was increased but it got decreased at a particular percentage due to alkali silica reaction. The tensile strength displayed a considerable increase at 30%, 40% and 50%.The flexural strength showed an increase in 30%, 40%, 50% and 100%. The increase in compressive strength was at 10%, 20% and 100%.

Vijaykumar et al (2013):

Has investigated on study on glass powder as partial replacement of cement in concrete. The grade of cement used was OPC43 grade. 4.75mm was the maximum size of fine aggregate used. Coarse aggregates of two sizes were used. One was 16mm passing and 12.5mm retained and the other was 25mm passing and 20mm retained. Mix used was M20 mix. Sand was replaced by glass sheet powder at levels of 10%, 20%, 30% and 40%. Cubical specimens of 100mm x 100mm x 100mm were cast. Tests were carried out at the end of 28 days and 60 days.

On studying the results it was seen that there was an increase in compressive strength at 10% and 40% at the end of 60 days and at 40% at the end of 28 days. The increase in split tensile strength was at 40% at the end of 60 days and at 20% at the end of 28 days. The increase in flexural strength was at 40% at the end of both 28 days and 60 days.

CHAPTER - 3

3. PROPERTIES OF MATERIALS

- Cement
- Fine Aggregate
- Course Aggregate
- Water
- Glass Powder

Website: ijetms.in Issue: 2 Volume No.8 March - April – 2024
DOI:10.46647/ijetms.2024.v08i02.024 ISSN: 2581-4621

3.1 CEMENT

Ordinary Portland Cement of 53 grade conforming to IS 2269 (1987) was used. The properties of cement are given below.

i. Fineness index= 8%

ii. Normal consistency of cement = 31%.

iii. Initial setting time = 38 minutes

iv. Specific gravity = 3.12

3.2 FINE AGGREGATE

The fine aggregate used in this investigation was clean river sand, whose maximum size is 4.75 mm, conforming to grading zone II. The sand was dried, sieved and stored. Specific gravity of sand obtained was 2.39.Figure 3.2 shows fine aggregate used in concrete production.

3.3 COARSE AGGREGATE

The fractions from 80 mm to 4.75 mm are termed as coarse aggregates. The shape of the coarse aggregates chosen was as per IS 2386 Part 1 (1963). The surface texture characteristics are as per IS 383:1970. Specific gravity of coarse aggregate obtained was 2.71. Crushed gravel or stone is used as coarse aggregates. 10 mm size aggregates were used in this study. Figure 3.1 shows coarse aggregate normally used in concrete production.

3.4 WATER

Water is an important ingredient of concrete as it actually participates in the chemical reaction with cement. Since it helps to form the strength giving cement gel, the quantity and quality of water is required to be looked into very carefully.

3.5 GLASS POWDER

Glass powder is prepared by melting the raw materials, such as sodium carbonate (soda), lime, dolomite, silicon dioxide (silica), aluminum oxide (alumina), and small quantities of fining agents (e.g., sodium sulfate, sodium chloride) in a glass furnace at temperatures locally up to 1675°C. Ordinary soda-lime glass appears colorless to the naked eye when it is thin. Recent studies have shown the scope of using glass as partial replacement of both sand and cement in the production of concrete. Specific gravity of glass powder obtained was 2.64. Figure 3.3 shows glass powder used as partial replacement for sand.

CHAPTER- 4

4.1 TYPES OF TESTS

- Specimen Tests
- Durability Tests
- Sulphate Attack Test
- Acid Attack Test

International Journal of Engineering Technology and Management Sciences
Website: ijetms.in Issue: 2 Volume No.8 March - April – 2024
DOI:10.46647/ijetms.2024.v08i02.024 ISSN: 2581-4621

4.2 SPECIMEN TESTS

Cubes of dimension 100×100×100 mm were cast using natural aggregates and glass powder. Sand was replaced by glass at 10%, 25% and 50%. The cubes are immersed in water for curing and taken out at the end of 3, 7 and 28 days. Three numbers of sample in each of concrete were subjected to compression test using the compression testing machine shown in Figure 5.1. The result of the average strength of cubes is shown in Table 5.1. The concrete where sand was partially replaced by glass powder showed an increase in compressive strength. The compressive strength increased as the level of replacement of glass powder increased. The strength increased with the number of days of curing. The maximum compressive strength attained was 38.3 N/mm2for 50% replacement at the end of 28 days.

Table 4.2.1 Compressive Strength Results For Conventional Concrete Vs Glass Powder Concrete (N/Mm2)

No. of days	Replacement Levels of Glass Powder			Conventional concrete
	10%	25%	50%	
3	22.5	26.5	28.5	20.17
7	26.4	29.9	34.7	21.07
28	35.8	36.3	38.3	35.43

Table 4.2.2 Split Tensile Strength Results For Conventional Concrete And Glass Powder Concrete

No. of days	Replacement Levels of Glass Powder			Conventioal concrete
	10%	25%	50%	
3	2.17	1.77	1.52	1.11
7	2.47	1.91	1.69	2.11
28	3.22	2.78	2.35	3.02

4.3 DURABILITY TESTS

Reinforced concrete structures are exposed to harsh environments. For reinforced concrete bridges, one of the major forms of environmental attack is chloride ingress, which leads to corrosion of the reinforcing steel and a subsequent reduction in the strength, serviceability and aesthetics of the structure. This may lead to early repair or premature replacement of the structure. A common method of preventing such deterioration is to prevent chlorides from penetrating the structure to the level of the reinforcing steel bar by using relatively impenetrable concrete. The ability of chloride ions to penetrate the concrete must then be known for design as well as quality control purposes.

International Journal of Engineering Technology and Management Sciences
Website: ijetms.in Issue: 2 Volume No.8 March - April – 2024
DOI:10.46647/ijetms.2024.v08i02.024 ISSN: 2581-4621

Table 4.3.1 Amount Of Current Passing Through Concrete

Type of concrete	Current Passing (coloumbs)
Glass powder Concrete	3133.13
Conventional Concrete	2368.73

Table 4.3.2 RCPT ratings (as per ASTM C1202)

Charge Passed (coulombs)	Chloride Ion Penetrability
> 4,000	High
2,000-4,000	Moderate
1,000-2,000	Low
100-1,000	Very low
< 100	Negligible

4.4 SULPHATE ATTACK TEST

The test is performed to determine the resistance of concrete to sulphate attack. The test method involves preparing the concrete cubes of sizes 150×150×150 mm. Three samples of conventional concrete and three samples of glass powder concrete are prepared. It is kept for curing under water for 28 days. After the curing period all the samples are weighed and the weights are noted down. The samples are then immersed in 5% sodium sulphate solution and cured for another 28 days. Then the samples are taken out and the surfaces are cleaned. The weights of the samples are again taken and percentage decrease in weights is tabulated. Next the samples are tested for its compressive strengths and the percentage decrease in strength is noted down. Table 5.6 shows the reduction of weight in concrete specimens kept under curing in Sodium Sulphate solution.

4.4.1 Change in weight of Concrete

Type of concrete	Initial weight (kg)	Weight taken after curing (kg)	Reduction in weight (%)
Conventional concrete	8.71	8.58	1.49
Glass powder concrete	8.83	8.73	1.13

4.4.2 Change in compressive strength of concrete

Type of concrete	Initial compressive strength (N/mm2)	Compressivestrength after curing (N/mm2)	Reduction in compressive strength (%)

International Journal of Engineering Technology and Management Sciences
Website: ijetms.in Issue: 2 Volume No.8 March - April – 2024
DOI:10.46647/ijetms.2024.v08i02.024 ISSN: 2581-4621

Conventional concrete	35.43	34.26	3.3
Glass powder concrete	38.3	37.1	3.13

4.5 ACID ATTACK TEST

The test is performed to determine the resistance of concrete to acid attack test. The test method involves preparing the concrete cubes of sizes 150× 150×150 mm. Three samples of conventional concrete and three samples of glass powder concrete are prepared. It is kept for curing under water for 28 days. After the curing period all the samples are weighed and the weights are noted down. The samples are then immersed in 5% concentrated sulphuric acid solution and cured for another 28 days. Then the samples are taken out and the surfaces are cleaned. The weights of the samples are again taken and percentage decrease in weights is tabulated.

4.5.1 Change in weight of concrete

Type of concrete	Initial weight (kg)	Weight taken after curing (kg)	Reduction in weight (%)
Conventional concrete	8.71	8.11	7.24
Glass powder concrete	8.83	8.19	6.8

4.5.2 Change in compressive strength of concrete

Type of concrete	Initial compressive strength (N/mm2)	Compressive strength after curing (N/mm2)	Reduction in compressive strength (%)
Conventional concrete	35.43	33.42	5.66
Glass powder concrete	38.3	36.24	5.36

CHAPTER – 5

5. RESULT AND DISCUSSION

As a part of experimental investigation various tests were conducted on the material to test their properties and also to find out the strength and durability characteristics of the concrete. Compressive strengths, flexural strengths and tensile strengths were measured using a compression testing machine with a maximum capacity of 2000kN. For all tests, each value was taken as the average of three samples. Test results for conventional concrete and glass powder concrete for 3,7 and 28 days curing were tabulated. The following tests were conducted to determine the property of materials.

DOI:10.46647/ijetms.2024.v08i02.024 ISSN: 2581-4621

6.CONCLUSION

Maximum compressive strength was achieved at 50% replacement. Compressive strength of concrete increased by 7.5% when 50% sand was replaced by glass powder. Tensile strength achieved its peak value when sand was replaced by glass powder at 10% replacement level. Tensile strength was increased by 6.2%Flexural strength attained its maximum value at 10% replacement level and the increase was by 13.8%Rapid Chloride Penetration Test was conducted to study the chloride ion penetration. On conducting the experiment the chloride ion permeability was found to be moderate. Acid attack and alkalinity attack conducted on the concrete showed a decrease in weight and compressive strength. Acid attack showed a reduction of weight by 6.8% for conventional concrete and 7.24% for glass powder concrete. The reduction in compressive strength for conventional concrete was by 5.66% and that for glass powder concrete was by 5.66%.

REFERENCES

1.Chandramouli K., Srinivasa Rao P., Seshadri Sekhar T., Pannirselvam N.and Sravana P.(2010), ‘Rapid chloride permeability test for durability studies on glass fibre reinforced concrete’, ARPN Journal of Engineering and Applied Sciences, Vol. 5, pp 67-71.

2.Civil Engineering Research Unit, Division of Civil & Mechanical Engineering, Faculty of Advanced Technology, University of Glamorgan.

3.IS 383 (1970), Indian Standard for specification for coarse and fine aggregates from naturals sourced from concrete(second revision), reaffirmed February 1997.

4.IS 12269 (1987), Indian Standard for specification for 53 grade OPC, reaffirmed January 1999.IS 10262:2009, Indian Standard for concrete mix proportioning.

5.Journal of Emerging Technology and Advanced Engineering, Volume 3, Issue 2, pp 78-82.

6.J.M. Khatib, E.M. Negim, H.S. Sohl and N. Chileshe. (2012), ‘Glass powder utilisation in concrete production’, European Journal of Applied Sciences, Vol. 4, pp 173-176.

7.Mageswari M.and Dr. Vidivelli B. (2010), ‘The use of sheet glass powder as fine aggregate replacement in concrete’, The Open Civil Engineering Journal, Vol. 4,pp 65-71.

8.S Unnikrishna Pillai and Devdas Menon, Reinforced Concrete Design, New Delhi, India, Tata McGraw Hill Education Pvt Ltd, 2012, pp 36-45.

9.Shetty MS, Concrete technology-theory and practice, New Delhi, India, S.Chand & Company Ltd; 2006, pp 128-133.

10.Vijayakumar, Vishaliny and Govindarajulu (2013), ‘Studies on glass powder as partial replacement of cement inconcrete production’, International Journal of Emerging Technology and Advanced Engineering, Volume 3, Issue 2, pp 78-82.