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Mechanical Properties of Concrete Using Waste Glass as Partial Replacement of Coarse Aggregate and M-Sand for Fine Aggregate

Muhaimin P[1], Sawab Ramees[2], Rajeswari N[3], Soundarya R[4], Mohamed Safwan[5], Dhivakar M R[6]

[1,2,3,4,5] IV[th] Year Students, Department of Civil Engineering, Achariya College of Engineering and Technology Pondicherry, India

[6]Assistant Professor, Department of Civil Engineering, Achariya College of Engineering and Technology, Pondicherry, India.

Abstract – *The broken glass as a substitute for coarse aggregate in concrete helps the society as one of the possible solutions to the increasing solid waste problem. The use of solid wastes in the production of concrete has most adoptable on aggregates because they make use of large quantities of waste materials. In this experimental study, Waste Glass gathered from scraps, beer bottles and other means was used as a partial replacement of coarse aggregates in the ratio of 0, 5,10,15,20,and 25 percentages with respect to the conventional coarse aggregate.*

The test including Compressive Strength, Split Tensile Strength and Flexural Strength of concrete is performed and the results are validated. Test results showed that all tested samples had true slump. The 28 days compressive strength results at 0, 5, 10, 15, 20 and 25% replacement of coarse aggregates were 27.06, 30.09, 30.89, 31.54, 32.06 and 31.30 N/mm² respectively. The results of this study indicate the waste glass is used for concrete at 20% optimum percentage of waste glass as a partial replacement of coarse aggregate in concrete.

Key Words: Waste Glass, Coarse Aggregate, Mechanical Properties, M Sand.

1.INTRODUCTION

The concrete is commonly and widely used in all construction fields. Other resources are very rare. Concrete produced by using other resources are very costly. So, if we want to reduce the cost of the concrete then we must go for low-cost materials or replace the conventional materials by some other means of waste materials considering their properties. Here, we planned to go for replacement of Coarse aggregate by waste glass. The waste glass is produced from the usage of industrials and commercial purposes. Most of the silica waste is produced from the sanitary items. Silica waste can be recycling using different methods of techniques. The waste glass is a material containing silica. These glasses are broken into pieces either by hand or by machine and passed through sieve in the size of 20mm and those retained in the sieve of 12.5mm are used in the concrete mix. The glass was water absorption value is near to zero and is suitable for replacement in place of conventional coarse aggregate of concrete. The main aim of the experiment is to make use of the waste glass other than dumping those scraps in land. The amount of waste glass that gets dumped in the earth will not allow the water to infiltrate into the earth thereby reducing the water level in the ground water table.

The glass is non-crystalline amorphous material. The glass is commonly and widely used material in the world, because of it has very sharp point, beautiful and transparent. The dumping of glass waste is increased daily, so it's very harmful for the earth. Because of that we planned to use the waste glass in the concrete. This helps in reducing the dumping of waste glass in nature.

The production of glass product also increased and it will be used in all works like Building constructions, Sanitary materials etc. Among the globally produced glasses, 45% accounts for waste glasses. The waste glass is most harmful; there is need of reducing of glass waste. It reduces cost and more adoptable for concrete. The waste glass when employed in construction gets reduced from the nature. The waste glass changes into the useful manner and recycling of waste glass is easily to possible.

2. MATERIAL & METHODOLOGY

Cement

In this work, Ordinary Portland cement (OPC) of Penna (43 grade) was used.

Table-1: Properties of Cement

SL NO:	PHYSICAL PROPERTIES	RESULTS
1	Consistency	32%
2	Initial setting time	30 min
3	Final setting time	590 min
4	Specific gravity	3.11

Fine Aggregate

Sand is used as fine aggregate because of its most available material in nature, but due to its depletion from nature and also considering the future in this work we adopted Manufactured sand (M-Sand), which is sieved through 4.75 mm sieve.

Table-2: Properties of Fine Aggregate

SL NO:	PHYSICAL PROPERTIES	RESULTS
1	Fineness modulus	4.425
2	Specific gravity	2.610
3	Bulk density (gm/cc)	1.55
4	Water absorption (%)	0.02

Table-3: Properties of M Sand

SL NO.	PHYSICAL PROPERTIES	TEST RESULT
1	Water absorption	1%
2	Fineness modulus	3.2
3	Specific gravity	2.5
4	Bulk density(g/cc)	1610.37 Kg/m^3

Coarse Aggregate

Coarse aggregate of size 20mm is sieved and used.

Table-4: Properties of Coarse Aggregate

SL NO.	PHYSICAL PROPERTIES	TEST RESULT
1	Maximum size	20
2	Fineness modulus	5.6
3	Specific gravity	2.768
4	Bulk density	1.61
5	Water absorption	0.50

Glass

The waste glass (silica waste) is used in this work, and it's sieved in the size of 20 mm. The glass is amorphous and transparent, so it's very easy to use.

Table-5: Properties of Waste Glass

SL NO.	PHYSICAL PROPERTIES	TEST RESULT
1	Maximum size	20
2	Fineness modulus	6.0
3	Specific gravity	2.850
4	Bulk density(g/cc)	1.63
5	Water absorption (%)	0.02

3. EXPERIMENTAL INVESTIGATION

Table -6: Compressive Strength Test Results

MIXES	PARTIAL REPLACEMENT OF GLASS	NO. OF CUBES CASTED			COMRESSIVE STRENGTH (N/mm²)		
		CURING PERIOD			CURING PERIOD		
		7 DAYS	14 DAYS	28 DAYS	7 DAYS	14 DAYS	28 DAYS
CA	0%	3	3	3	20	24.76	27.06
A1	5%	3	3	3	20.21	24.89	30.09
A2	10%	3	3	3	21.89	25.90	30.89
A3	15%	3	3	3	24.5	27.04	31.54
A4	20%	3	3	3	30.33	33.32	32.06

MIXES	PARTIAL REPLCEMENT OF GLASS	NO.OF PRISMS CASTED	FLEXURAL STRENGTH OBTAINED (N/mm²)
		CURING PERIOD	CURING PERIOD
		28 DAYS	28 DAYS
CP	0%	3	4.94
P1	5%	3	4.72
P2	10%	3	4.94
P3	15%	3	5.03

Table -7: Flexural Strength Test Results

Table -7: Flexural Strength Test Results

MIXES	PARTIAL RELACEMENT OF GLASS	NO. OF CYLINDERS CASTED	SPLIT TENSILE STRENGTH OBTAINED (N/mm²)
		CURING PERIOD	CURING PERIOD
		28 DAYS	28 DAYS
CC	0%	3	1.65
C1	5%	3	2.06
C2	10%	3	2.26
C3	15%	3	2.32
C4	20%	3	2.55
C5	25%	3	2.01

4. RESULT & DISCUSSION

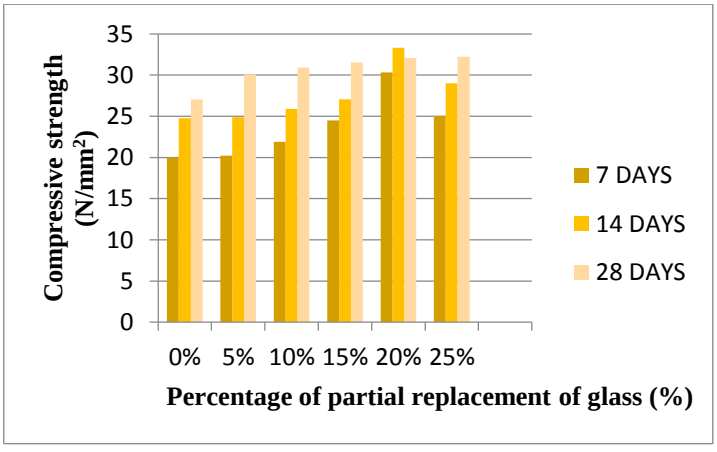

Chart -1: Compressive strength of concrete

From the above Chart 1 is showing the compression strength is increases at (7,14,28 days) with the percentage of partial replacement of aggregate. at 20% it will the maximum compression strength. After

28 days the compressive strength of cubes is started to slightly decreased.

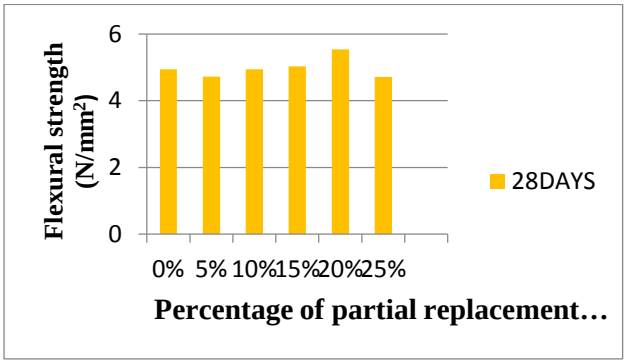

Chart -2: Flexural strength of concrete

From the above Chart 2 is showing the flexural strength is varying different with different percentage of partial replacement of glass. In 20% its shows the maximum strength 5.5 N/mm².

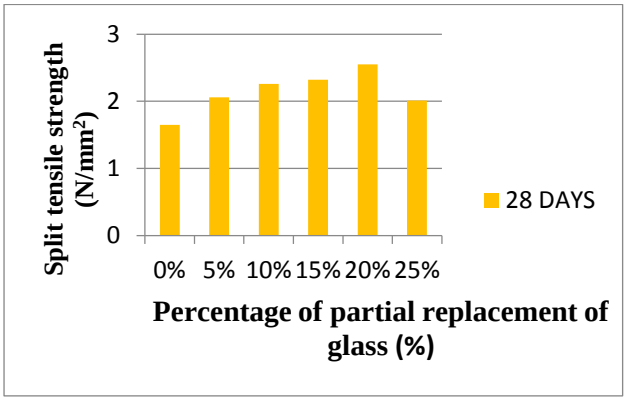

Chart -2: Flexural strength of concrete

From the above Chart 3 is showing the difference between different percentages of partial replacement of glass. The maximum strength is shows in 20% is 2.55 N/mm²In percentage 15 and 10 the graph shows slightly same value like 2.7 N/mm².After 20% its starts to decrease.

5. CONCLUSIONS

From the experiments and investigation in this research work we have concluded:

1. Due to non-availability of conventional coarse aggregate in concrete for various motives search for alternative material like glass waste which succeeds itself as a Suitable standby for concrete at low cost.
2. The 28 days compression strength of conventional concrete and glass waste replaced is found to be 27.06, 30.09, 30.89, 31.54, 32.06 and 31.30 N/mm².
3. The 20% replaced glass waste mix gives better compressive strength when compared with conventional concrete.
4. The 28 days flexural strength of conventional concrete and glass waste replaced concrete (5%,10%,15%,20%,25%) is found to be 4.94,4.72,4.94,5.03,5.54,4.80 N/mm².
5. The 20% replaced glass waste mix gives better flexural strength when compared with conventional concrete.
6. Compressive strength of 32.06 N/mm²; split tensile strength 2.55 N/mm² and flexural strength of 5.56 N/mm² at 28 days is achieved maximum for M25 grade concrete.
7. The replacement of coarse aggregate by glass waste by 15% resulted in a better compressive strength; flexural strength and split tensile strength than the control mix with 100% coarse aggregate.
8. Concrete mixes with glass waste powder increases the workability for the mix due to the presence of the more quantity of glass pieces
9. Therefore, it has concluded that glass waste can increase the complete strength of the concrete when used up to 20% of glass waste instead of sand replacement level. So it is further recommended to use granite powder in concrete manufacturing process.
10. It is not advisable to replace glass waste in place of coarse aggregate beyond 20% as it shows reduction in strength property.

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