Low Cost Concrete

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Abstract: In a day to day life, demand for concrete is increasing and the excess use of concrete adversely affect environment. The ability to use Industrial waste in concrete is high. To reduce the undesirable environmental effect of concrete, the most effective ways is the uses of waste and by product of industries, factories, etc. as substitute of cement and aggregate in concrete. One such material is ceramic tiles (CT), 15-30% waste material is generated from ceramic industry which includes ceramic materials in the form of tiles, sanitary fittings, etc. CT can be used as a partial replacement of aggregate in concrete in order to cater the current and future demand leading to sustainable concrete design and greener environment. Waste material like fly ash is also used as a partial replacement in concrete. It is by product from combustion of pulverized coal of electricity power plants. Waste glass is a new research and not just waste. Normally beer, wine bottles and other food jars, etc. are among the few household glass items put into landfills every day and also the use of waste glass helps to sustain good product performance and meet recycling goals. Waste glass can be used as partial replacement of fine aggregate in concrete. An attempt has been made to make proper use of industrial waste as a substitute as much as possible in concrete. In this research study the fine aggregates was replaced by Waste Glass Powder in proportion of 0%, 15%, 20%, 25%, on the other hand the coarse aggregates was replaced by waste Ceramic Tiles in proportion of 0%, 10%, 20%, 30%, and the cement was replaced with Fly Ash at a constant proportion of 25% by volume of M35 grade of concrete. Test results of Compression test for 3, 7 and 28 days, Flexural test and Split Tensile test for 28 days were calculated and the workability and strength characteristics were compared to conventional concrete, and from the results achieved we reevaluated the optimum dosage which will be economical.

Index Terms* - Glass powder, ceramic tile, compressive strength, tensile strength, concrete, *etc.

1. INTRODUCTION

Due to the rapid growth of industries, excessive materials are manufactured along with the waste products. For sustainability, the vital aspect of the construction industry is the proper utilization of waste product. Innovation in substitution material used in concrete productions will help to achieve sustainability. Over the last few years, more attention has been received by sustainable construction. Most of the solid waste generated in the world is from construction activity like renovation, demolition and repairing work. Various construction materials such as ceramic tile, brick tile, roof tile and other ceramic products contribute at a higher percentage in the construction waste. To reduce the large amount of construction waste, it must be reuse or recycled. On the basis of previous studies, the waste ceramic tiles can be used in concrete as it is durable, hard and highly resistant to chemical, biological and physical degradation forces. WCT obtained from the construction site can be used has a partial replacement for fine aggregate as well as coarse aggregate in concrete. Also it can be used as partial replacement of cement in concrete as a supplementary addition to achieve desirable properties.

Greenhouse gas emission can be reduced by replacing Portland cement with fly ash. One ton of greenhouse gas is produced for every ton of cement manufactured. 1.7 ton of raw material must be miled and moved, for every ton of cement produced. Every year there is reduction in supply of suitable raw material, resulting in higher transportation energy use and cost.

In urban areas of developed countries, the recycling of waste glass is a major issue. Waste glass powder has been used as fine aggregate in concrete. It has been explored that using coarse glass powder there is improvement in hydration.

2. EXPERIMENTAL PROCEDURE

2.1 MATERIALS

2.1.1 Cement

Cement used is Ordinary Portland Cement (OPC 53 grade) as per IS 269-2016 showed in Fig. 3.2. The preliminary tests like fineness, specific gravity, initial and final setting time's results are taken from cement manufacturing quality control department. All properties of cement are tested by referring IS Specification for Ordinary Portland cement.

2.1.1 Fly Ash: (Class F)

The various types of fly ash are available in the market, mainly C-type and F-type fly ash. The classification of fly ash is based on fineness and CO_2 content present in it. Fly ash is pozzolanic aluminosilicate material having high alumina and silica content. This content is used to produce a geopolymerization process. The geopolymer brick made up of a mixture of low calcium-based fly ash (class f) with an Activated alkaline solution, has excellent compressive strength.

2.1.2. Sand

The river sand with zone I as per IS 383-2016, passing through 4.75mm sieve confirming IS 460-1962, Good quality river sand, free from silt and other impurities and which is locally available, was used in this study. It is economical if it is locally available.

2.1.3. Aggregate

The coarse aggregate used was a normal weight aggregate with a maximum size of 20mm and was obtained from the local supplier and it was tested in accordance with IS: 2386part 1,3 & 4: 1963.

2.1.4. Water

Portable water used is as per IS 10500-2012. The water used for mixing and curing should be clean and free from injurious quantities of alkalis, acid, oils, salt, sugar, organic materials, vegetable growth and other substances that may be deleterious bricks, stone, concrete or steel. Portable water is generally considered satisfactory for mixing. The pH value of water should be not less than 6. The amount of water in concrete controls many fresh and hardened properties in concrete including workability, compressive strengths, permeability and water tightness, durability and weathering, drying shrinkage and potential for cracking Upon hardening, the paste or glue consisting of the cementitious materials.

2.1.5. Ceramic Tiles

Ceramic is produced in different form and in various property. So, in this project we used Vitrified Ceramic Waste type which has been collected from the construction site area.

2.1.6. Glass Powder

In this project we replaced fine aggregates partially using glass powder which is rich in silica at various proportions like 0%, 15%, 20%, 25%. In this project we used Toughened glass powder type.

2.2. MIX DESIGN (IS 10262: 2019)

Mix design is step by step procedure to work out the various proportions of the ingredients of the concrete and determining their relative proportion with object of producing concrete possessing certain desirable properties like workability in fresh state, minimum desirable strength and durability in hardened strength. Using the property of material, the mix design has been adopted from to design for M35 grade of concrete.

Table 2.1: Percentage Mix Proportions

MIX PROPORTIONS(%)							
Code	CM	GPA	GPB	GPC	TCA	TCB	TCC
RP-C/SAND	0	15	20	25	0	0	0
RP-CA1	0	0	0	0	10	20	30
OPC	75	75	75	75	75	75	75
Fly ash	25	25	25	25	25	25	25
C/sand	100	85	80	75	100	100	100
GP	0	15	20	25	0	0	0
CA1	100	100	100	100	90	80	70
CT	0	0	0	0	10	20	30
CA2	100	100	100	100	100	100	100
Water	100	100	100	100	100	100	100
Admixture	1	1	1	1	1	1	1

Table 2.1: Design Mix Proportion for Various Concrete

MATERIAL PERCENTAGE PER MIX PROPORTION							
	TRIAL 1	TRIAL 2	TRIAL 3	TRIAL 4	TRIAL 5	TRIAL 6	TRIAL 7
Code	CM	GPA	GPB	GPC	TCA	TCB	TCC
RP-C/SAND	0	15	20	25	0	0	0
RP-CA1	0	0	0	0	10	20	30
OPC	75	75	75	75	75	75	75
Fly ash	25	25	25	25	25	25	25
C/sand	35.75	30.39	28.60	26.81	35.75	35.75	35.75
GP	0.00	5.36	7.15	8.94	0.00	0.00	0.00
CA1	25.69	25.69	25.69	25.69	23.12	20.55	17.98
CT	0.00	0.00	0.00	0.00	2.57	5.14	7.71
CA2	38.56	38.56	38.56	38.56	38.56	38.56	38.56
Water	100	100	100	100	100	100	100
Admixture	1	1	1	1	1	1	1

2.3. EXPERIMENTAL METHODOLOGY

2.3.1. Workability

To determine workability of concrete, slump test was performed. Container was filled with concrete in three layers by Placing base on a smooth surface whose workability was to be tested. Each layer was tamped 25 times with a standard 16mmdiameter steel rod, rounded at the end. After the top layer has been tampered, the concrete was stuck off level with trowel and tamping rod. By lifting it slowly and carefully in a vertical direction, the mould was removed. This allows the concrete to subside. This subsidence is referred as slump concrete. The difference in level between the height of the mould and that of the highest point of the subsided concrete was measured. This difference in height in mm was taken as slump of concrete.

2.3.2. Compressive strength.

Compressive strength Different concrete mix with partial replacement of waste ceramic tiles with coarse aggregate, waste glass powder with fine aggregate and fly ash with cement was considered to perform the test. A compressive strength of concrete was determined for the concrete cube specimen having dimensions as (150 X 150 X 150) mm. All the component concrete was mixed thoroughly as per design code until uniform consistency was achieved. The concrete mixture was then place in a cube and cubes are properly compacted. After 24hrs the cubes were demoulded after casting. The specimen was properly cured in water for next 28 days. Compressive strength was to be noted at an age of 3,7 and 28 days on compressive strength testing machine.

2.3.3. Flexural strength

As mentioned above, different concrete mix was considered with partial replacement of concrete ingredients to perform the test. A concrete beam was considered as a specimen to determine flexural strength of concrete beams. A concrete beam is casted and proper compaction was done. After 24hrs specimen was removed from the mould and proper curing in water in the laboratory was done for 28 days. Flexural strength testing machine was used to calculate flexural strength after 28 days of curing.

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2.3.4. Tensile strength

After curing, wipe out water from the surface of specimen Using a marker, draw diametrical lines on the two ends of the specimen to verify that they are on the same axial place. Measure the dimensions of the specimen. Keep the plywood strip on the lower plate and place the specimen. Align the specimen so that the lines marked on the ends are vertical and centered over the bottom plate. Place the other plywood strip above the specimen and bring down the upper plate to touch the plywood strip. Apply the load continuously without shock at a rate of approximately 14-21 kg/cm2/minute. Write the breaking load (P).

3. RESULT

3.1. Workability test

Table 3.1: Workability test results

3.2. Compressive Strength:

Table 3.2: Compressive strength test results

	AVERAGE COMPRESSIVE STRENGTH (N/mm2)		
TRIALS	**3 days**	**7 days**	**28 days**
CM	20.44	34.24	44.21
GPA	22.31	38.53	50.71
GPB	21.11	39.56	52.68
GPC	22.25	42.80	57.76
TCA	21.26	35.11	46.65
TCB	21.47	36.21	47.10
TCC	21.70	38.55	49.67

With the use of 0%, 15%, 20% & 25% of glass powder and 0%, 10%, 20% & 30% of ceramic tiles, the compressive strength of concrete found to be increased by 14.71%,19.71& 23.97% of glass powder and 5.53%,6.53% & 12.37% of ceramic tiles respectively when compared with CM. The strength found to be 50.7, 52.7, 54.8 MPa with the replacement of 15%, 20% &25% of glass powder and 46.7, 47.1, 49.7 MPa with replacement of 10%, 20% & 30% of ceramic tiles. At 28 days, maximum compressive strength is 52.7 with replacement of 30% glass powder and 49.7 with replacement of 30% of ceramic tiles respectively.

3.3. Flexure and Split Tensile Strength

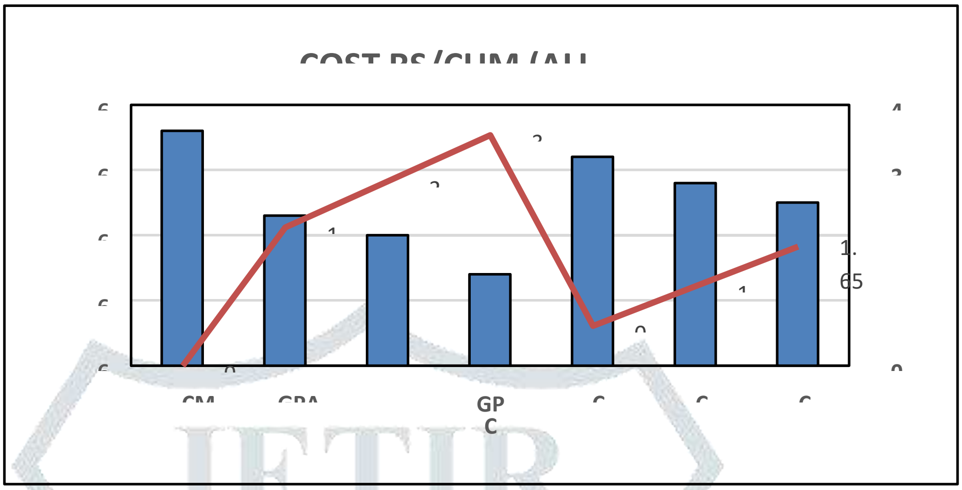
Table 3.3: Flexural and Split Tensile strength at 28 days (N/mm2)

TRIALS	FLEXURE STRENGTH	SPLIT TENSILE STRENGTH
CM	6	2.34
GPA	6.52	2.73
GPB	6.81	2.91
GPC	6.89	3.05
TCA	6.81	2.6
TCB	7.04	2.7
TCC	8.52	2.72

With the replacement of 30% Ceramic tiles and 25% of glass powder, the flexure strength is found to be maximum i.e5 8.52 MPa and 6.89 MPa respectively at 28 days. With the replacement of 25% Glass powder and 30% ceramic tiles, the split strength is found to be maximum i.e. 3.05 MPa and 2.72 MPa respectively at 28 days.

3.4. Cost Analysis

Table 3.4: Cost Rs/ cum of all trials



For 25% of partial replacement of glass powder as fine aggregate and 30% of partial replacement of ceramic tiles as coarse aggregate, the strength is on higher side and the cost is less. With the increase % of glass powder, the strength increases and also cost decreases with 3.2 % as there is high gaining of strength even after curing for more days under constant water content. With increase % of ceramic tiles, there is slightly increase in strength as compared to glass powder as well as control mix and also impact on cost is less about 1% to 1.5%.

4. CONCLUSION:

- The optimum dosage of GP is obtained at 25% as a replacement of fine aggregate in concrete.
- The optimum dosage of CT is obtained at 30% as a replacement of coarse aggregate in concrete.
- By using GP at 25% replacement of fine aggregate, the cost effect on concrete is reduced by 3.18%.
- By using CT at 30% replacement of coarse aggregate, the cost effect on concrete is reduced by 1.65%.
- Utilization of waste products like ceramic tiles and glass powder can be used for making concrete.

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