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ISSN:2348-2079

Volume-7 Issue-2

International Journal of Intellectual Advancements and Research in Engineering Computations

Experimental investigation on concrete by partially replacing cement by GGBS and coarse aggregate by crushed tiles

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ABSTRACT

The paper deals with Experimental investigation on partially replacement of GGBS and crushed tile in concrete. Due to the day to day innovations and development in construction field, the use of natural aggregates is increased tremendously and at the same time, the production of solid wastes from the demolitions of constructions and industry waste is also quite high. Because of these reasons the reduce of demolished constructional waste like ceramic tile and due to increase in emission of CO2 the usage has to be limited. So that the byproduct of iron industry waste like GGBS are came into the picture to reduce solid waste and to reduce the usage of cement for making concrete. Studies show that about 20 -30% of materials prepared in the manufacturing plants are transforming into wastes. The ceramic waste crushed tiles were partially replaced in place of coarse aggregates by 0%, 10%, 20% and 30%, along with the ceramic coarse tile. M40 grade of concrete was designed and tested. The mix design for different types of mixes were prepared by replacing the coarse aggregates and cement at different percentages of Tile pieces and GGBS. Experimental investigations like workability, compressive strength test, spilt tensile strength test for different concrete mixes with different percentages of waste after 7 and 28 days curing period has done. It has been observed that the workability increases with increase in the percentage of replacement of GGBS increases.

Keywords: Cement, GGBS, Fine aggregate, Coarse aggregate, Ceramic tiles, Super plastizer, M-sand.

INTRODUCTION

Definition of concrete

Concrete is a composite material consist of mainly water, aggregate, and cement. The physical properties desired for the finished material can be attained by adding additives and reinforcements to the concrete mixture. A solid mass that can be easily moulded into desired shape can be formed by mixing these ingredients in certain proportions. Over the time, a hard matrix formed by cement binds the rest of the ingredients together into a single hard durable material with uses such as buildings, pavements etc…,

Definition of cement

A cement is binder, a substance used for construction that sets, and adheres to other materials, binding them together. Cement is seldom used on its own is quenched in water produces angular granules which are disposed of as waste or utilized as discussed below.

Definition of GGBS

The blast furnace slag is a by product of the iron manufacturing industry. Iron ore, coke and limestone are fed into the furnace and the resulting

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molten slag floats above the molten iron at a temperature of about 1500c to 1600c.

Definition of ceramic tiles

A tile made from clay that has been permanently hardened by heat, often having a decorative glaze.

MATERIAL

1) Cement
2) Coarse aggregate
3) Fine aggregate
4) Ceramic tiles
5) GGBS f) Water

Cement

Ordinary Portland Cement of 53-grade was used as it satisfied the requirements of IS: 12269-1987 and results have been tabulated in table.

Table.1 Properties of cement

Properties of cement	
Specific gravity	3.15
Consistency	32%
Initial Setting Time	60 minute
Final Setting Time	300 minutes

Coarse Aggregate

Coarse aggregate shall comply with the requirement of IS 383 as for as possible crushed Aggregate shall be used for ensuring adequate durability. The aggregate used for concrete the nominal maxi size of coarse aggregate used in Production of shall be 20 mm.

Fine aggregate

Fine aggregate shall conform to requirement of IS 383 for river sand

Table .2 Types of Aggregate

Test	Types of Aggregate	
	Coarse	Fine
Specific Gravity	2.78	2.60
Water Absorption	0.5%	3.5%
Fineness modulus	8.01	3.14

Ceramic tiles

Ceramic tile is very hard with low porosity Generally used for covering roofs, walls, showers or other objects specific gravity.

GGBS

GGBS is a by product of iron industry, consists silicate and alumina silicate of calcium and other bases. It is a nonmetallic product and its constitution helps in pozzolanic reaction in concrete.

Water

The water used for mixing concrete mix should be potable drinking water.

Table .3

As per design M40 Grade Material Requirement for 1 M3	
Material	**Quantity in kg**
Cement	50
Sand	400
Aggregate	650
Water	30 litre
Tiles	20
GGBS	20
Super plastizer	250 ml

DESIGN MIX

The considering recommendations, design mix M40 grade concrete was prepared by partially replacement of cement and coarse aggregate with four percentages of GGBS and Broken tiles (10%,20%,30%,40%). The mix proportion for M40 grade of concrete is carried out using the Indian standard code 10262:2009. For which the water cement ratio is kept as the least value of 0.40 for the slump value is assumed as 100mm, the fine aggregate of Zone II, coarse aggregate of 20mm size and below.

- Cement = 350 Kg/m3
- Water = 140 liter
- Fine Aggregate = 696.384 Kg/m3
- Coarse Aggregate = 1238.16 Kg/m3
- Admixture = 2% of Super plasticizer
- Ceraplast 300
- The proportion for the mix is **1:1.98:3.53:0.40**

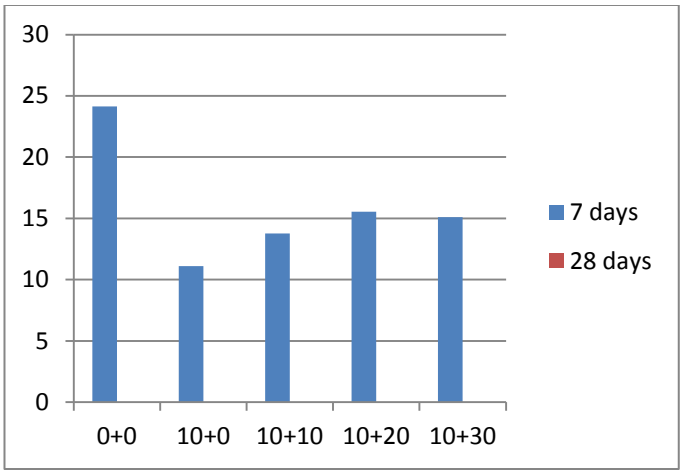
EXPERIMENTAL RESULTS

The strength test that are considered for are Compressive strength, split tensile and the flexural strength test.

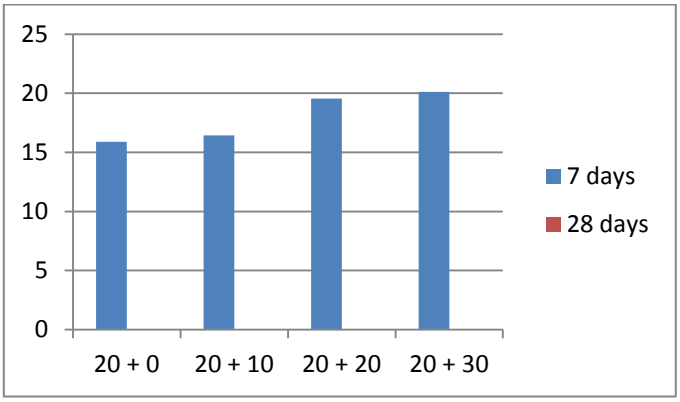
Compressive Strength Test

Table .4

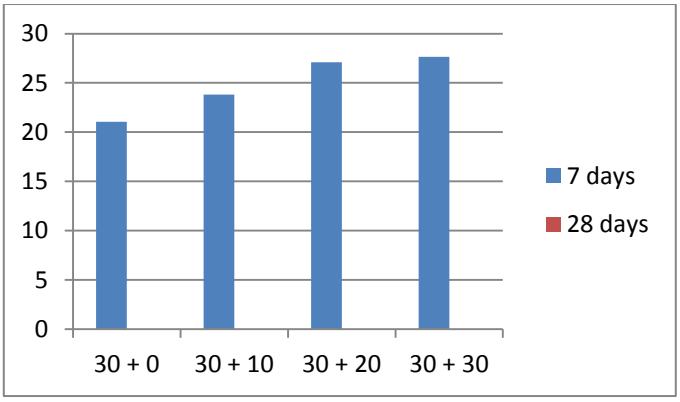
Compressive strength of cubes N/mm^2			
Specimens	**Replacement Of GGBS**	**Replacement Of Tiles**	**7 days 28 days**
Convertional	-	-	24.15
Trail 1	10%	0%	11.11
		10%	13.77
		20%	15.55
		30%	15.11
Trail 2	20%	0%	15.90
		10%	16.44
		20%	19.55
		30%	20.11
Trail 3	30%	0%	21.05
		10%	23.80
		20%	27.11
		30%	27.65



Graph 1 Compressive strength for trail 1



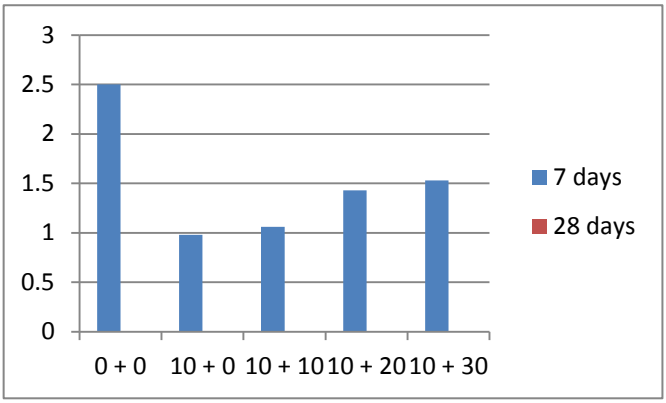
Graph 2 Compressive strength for trail 2



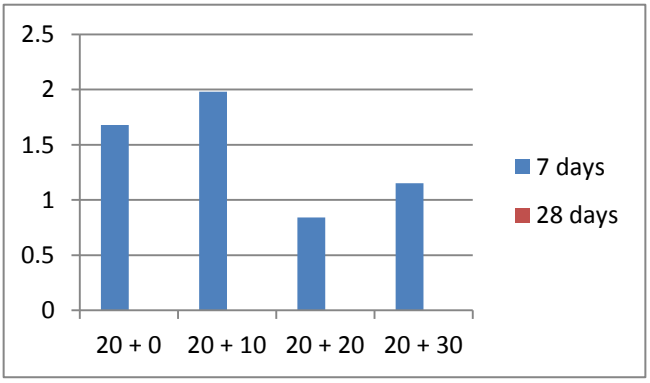
Graph 3 Compressive strength for trail 3

Table.5 Split Tensile Test

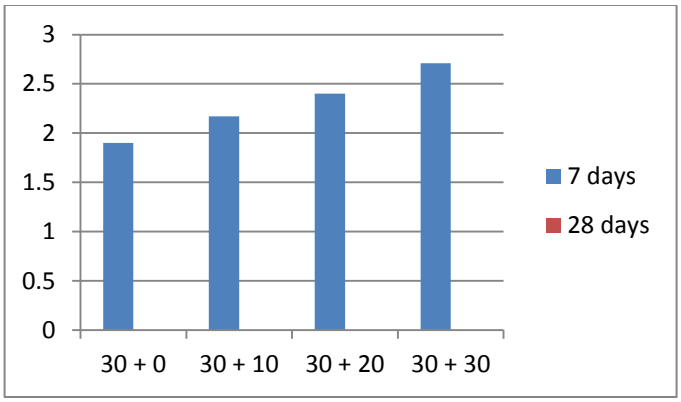
Split tensile test N/mm^2			
Specimens	**Replacement Of GGBS**	**Replacement Of Tiles**	**7 days 28 days**
Convertional	-	-	2.5
Trail 1	10%	0%	0.98
		10%	1.06
		20%	1.43
		30%	1.53
Trail 2	20%	0%	1.68
		10%	1.98
		20%	0.84
		30%	1.15
Trail 3	30%	0%	1.90
		10%	2.17
		20%	2.40
		30%	2.71



Graph 4 split tensile test trail 1



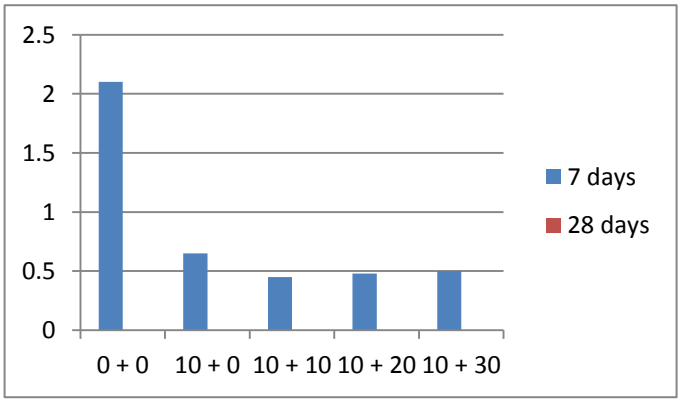
Graph 5 split tensile test trail 2



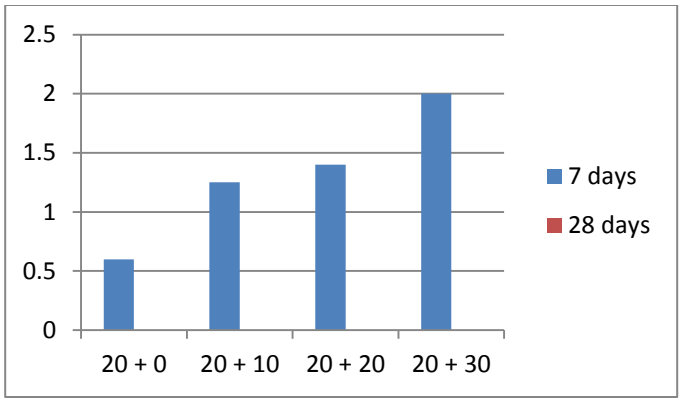
Graph 6 split tensile test trail 3

Table.6 Flexural strength

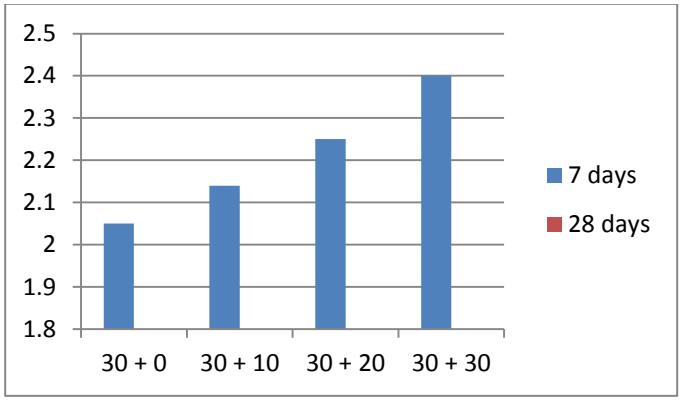
Flexural strength N/mm^2			
Specimens	**Replacement Of GGBS**	**Replacement Of Tiles**	**7 days 28 days**
Convertional	-	-	2.1
Trail 1	10%	0%	0.65
		10%	0.45
		20%	0.48
		30%	0.5
Trail 2	20%	0%	0.6
		10%	1.25
		20%	1.4
		30%	2
Trail 3	30%	0%	2.05
		10%	2.14
		20%	2.25
		30%	2.4



Graph 7 Flexural Strength test trail 1



Graph 8 Flexural Strength test trail 2



Graph 9 Flexural Strength test trail 3

CONCLUSION

Based on experimental investigations of compressive strength, Water absorption, Durability and of solid concrete blocks cast with different proportion GGBS.

- Results show that optimum GGBS and Ceramic Waste replacement for higher compressive strength is 20% and 30% respectively at 28 days compare to the standard solid concrete blocks.
- For replacement of GGBS with cement when increasing the percentage of the GGBS and in solid concrete blocks water absorption solid concrete blocks gives negligible change.
- Ceramic Waste absorbs less water compare to the Cement and also effect of heat of Hydration Decrease.
- With increasing the percentage of GGBS and Ceramic waste in solids concrete blocks are decreasing the total cost per block.

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