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A Study of Properties on Concrete using Recycled Coarse Aggregates and GGBS

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Abstract: **- The basis of this research is to investigate the effects of using recycled materials in varying amounts on the fresh and hardened properties of concrete. The recycled materials used in this study are Ground granulated blast furnace slag (GGBS) and recycled concrete aggregates. GGBS was used as partial cement replacement and recycled aggregates as replacement for fine and coarse aggregate. The basic properties of natural and recycled aggregate were determined. The mix design was done to obtain a concrete mix of grade M40. Mixes were prepared by replacing 40% of recycled aggregates with normal aggregates. Then its fresh and mechanical properties were determined along with control mix. From test results concrete with 60% replacement of aggregate with recycled aggregates shows adequate strength compared to control mix. Mixes were prepared by replacing 10, 20 and 30% of cement with GGBS together with 40% replacement of recycled aggregates. From test results concrete with 10% and 20% replacement of cement with GGBS together with 40% replacement of recycled aggregates shows adequate strength compared to concrete mix.**

INTRODUCTION

Construction and demolitions are processes that go hand in hand. The demolished building rubble in India generally goes to waste in landfills. After few years construction and demolition waste will be more than half of the national total waste in most countries of the world. Recycling of these concrete waste materials from demolished building can provide a solution to this problem. Landfills are becoming increasingly difficult to find, are too remote from the demolition site, or are too costly to maintain. At the same time sources of supply of suitable aggregate for making concrete are continuously being exhausted. The recycling of demolished building demolition waste materials into new buildings can provide a solution to these problems. Recycling is the act of processing the used material for use in creating new product. In order to reduce the usage of natural aggregate, recycled aggregate can be used as the replacement materials. Recycled aggregate are comprised of crushed, graded inorganic particles processed from the materials that have been used in the constructions

Ground granulated blast furnace slag, limestone powder, fly ash and silica fume are successfully used in concrete as a cement replacement which are cement saving, energy saving and cost saving and moreover cause environmental and socioeconomic benefits.

Objectives

1.To determine properties of concrete by using ggbs mineral admixture for recycled aggregates

2.Tto determine compressive strength by using 40 % RCA.

3.To determine compressive strength using 10%, 20% and 30% GGBS

Literature review

Recycled coarse aggregates(RCA)

1. Basil Johny et al (2004)studied the properties of sustainable concrete using slag and recycled concrete aggregates. GGBS was replaced for 40%, 50% and 60% of cement and optimum percentage was found out. For the mixes prepared by replacing 50% cement with slag and 50% coarse aggregate, it satisfies the strength criteria required for an M30 mix.

2. M L Berndt (2004)studied the properties of sustainable concrete containing fly ash, slag and recycled concrete aggregates by replacing cement by a percentage of fly ash or slag and natural aggregates by recycled concrete aggregates. The mixes containing 50% slag gave best overall performance 3.Md Shakir Ahmed et al (2007) studied the strength of concrete with percentage replacement in natural coarse aggregate (NCA) with recycled concrete aggregates (RCA) for M20 mix concrete. The strength of concrete decreases as the percentage of RCA increases.

GGBS.

1. S Arivalagan(2008) used GGBS at various replacement levels and evaluated its efficiencies for M35 mix at different ages. M35 mix concrete is considered to perform the test by-weight basis by replacing 20%, 30% and 40% of cement by GGBS. It was observed that GGBS-based concretes have achieved an increase in strength for 20% replacement of cement at the age of 28 days

Materials properties

a) The specific gravity of given sample of recycled aggregate is 2.50.

b) The water absorbed by the given sample of recycled aggregate is 2.4%

c) The crushing value of given sample recycled aggregate is 26.03%.

d) The impact value of given sample of recycled aggregate is 33.55%

Mix preparation and specimen preparation

Preparation of control mix (M40) Preparation of mix with partial replacement of RCA for coarse aggregate (CA) (40%,) Preparation of concrete with the optimum percentage of RCA for CA and with GGBS as partial replacement for cement (10%, 20% and 30%) Specimens: Cubes of size

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150x150x150mm,are to be casted for testing compressive strength, of corresponding mixes. Age of the specimens for compressive strength is 7 and 28 days .

Weighing and Mixing

A careful procedure was adopted in the batching, weighing and mixing operations. The coarse aggregates and fine aggregates were first weighed with an accuracy of 0.5grams. The concrete mixture was prepared by hand mixing on a water tight platform. OPC having 53 grade was used in castingand Fine aggregates thoroughly mixed. After that coarse aggregates are added to it. Then water was added carefully so that no water was lost during mixing.Firstly calculated quantities of coarse aggregate & fine aggregate and foundry sand were added to the mixer. Then respective volume of plastic is taken and it is replaced by known percentage of sand. Then calculated quantity of cement was added and mixed in dry condition. Drum mixer is leaved until the ingredients homogeneously mixed.

Mixing

Casting of specimen

Based on the test results of various materials, the water quantity, cement, fine aggregate and coarse aggregate with ggbs and recycled aggregates required for design mix of M40 were calculated based on the procedure given in IS code method in IS10262 : 2009.

Casted Specimens

Curing

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The test specimens are stored in place free from vibrations, in moist air of at least 90% relative humidity & at a temperature of 27° ± 2° c for 24 hours ± 14hour from the time of addition of water to the dry ingredients. After this period, the specimens are marked & removed from the moulds and unless required for the test within 24 hours, immediately submerged in clean fresh water and kept there until taken out just prior to test. The water in which the specimens are submerged, are renewed every seven days and are maintained at a temperature of 27° ± 2° c. The specimens are not to be allowed to become dry at time until they have been tested

Curing of Specimen

Testing of specimens

Compressive strength test

Compressive strength tests were performed on compression testing machine of 1,000 KN capacities. Three cube of 150*150*150 mm from each batch were subject to this test. The comparative study was made on properties of concrete after percentage of replacement of recycled coarse aggregate byin the range of 0%, 40%, and 50%,60%.

Compression strength test for cube

Tested specimen

RESULTS AND DISCUSSION

A. Conventional mix (CM)

Conventional mixes for M40 grade were prepared as per the mix proportion. The fresh properties and mechanical properties of CM were determined.

a) Slump test

The conventional mix shows a slump of 110 mm.

b) Compacting factor test

The conventional mix shows a compacting factor 0.91

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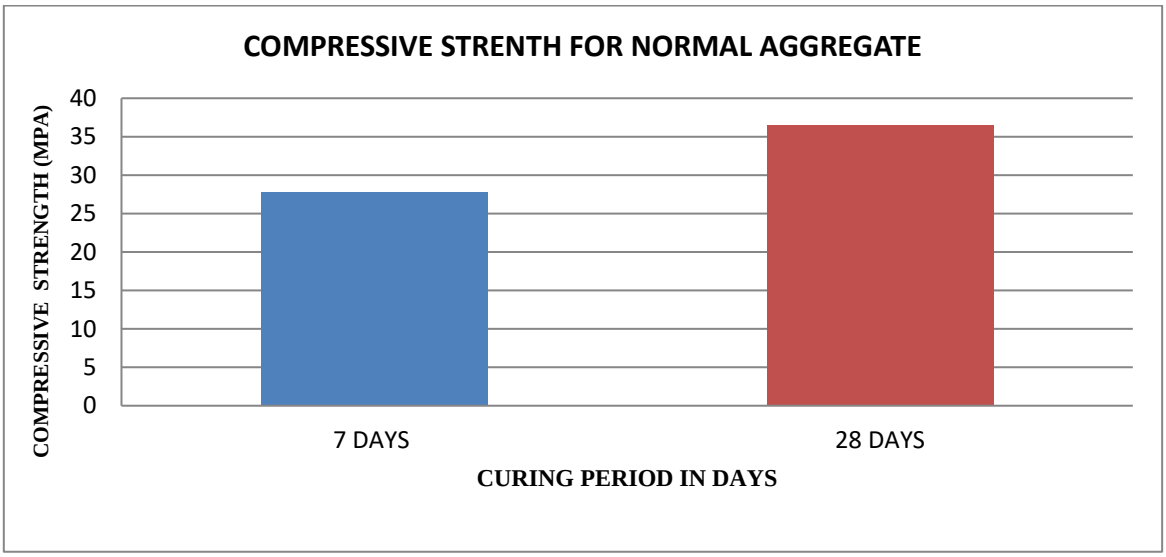
Tests on hardened concrete

Compressive strength for normal aggregates

COMPRESSIVE STRENGTH FOR NORMAL AGGREGATES							
Specimens	Sl.no	7 DAYS CURING			28 DAYS CURING		
		Load (Kg-f)	Compressive Strength (N/mm^2)	Density (Kg/m^3)	Load (Kg-f)	Compressive Strength (N/mm^2)	Density (Kg/m^3)
Cubes	1	62000	27.55	2325.50	84000	37.33	2325.92
	2	62200	27.64	2330.22	80000	35.55	2325.92
	3	63800	28.35	2314.81	82600	36.71	2311.95
		Average compressive strength=27.84 (N/mm^2)			Average compressive strength=36.53 (N/mm^2)		



Compressive strength variation for normal aggregate

Compressive strength for 40% Recycled aggregates

COMPRESSIVE STRENGTH FOR RECYCLED AGGREGATES							
Specimens	Sl.no	7 DAYS CURING			28 DAYS CURING		
		Load (Kg-f)	Compressive Strength (N/mm^2)	Density (Kg/m^3)	Load (Kg-f)	Compressive Strength (N/mm^2)	Density (Kg/m^3)
Cubes	1	57800	25.68	2358.6	79600	35.37	2360.0
	2	58000	25.77	2346.0	74600	33.15	2346.0
	3	58600	26.04	2350.0	80000	35.55	2360.0
		Average compressive strength=25.83 (N/mm^2)			Average compressive strength=34.69 (N/mm^2)		

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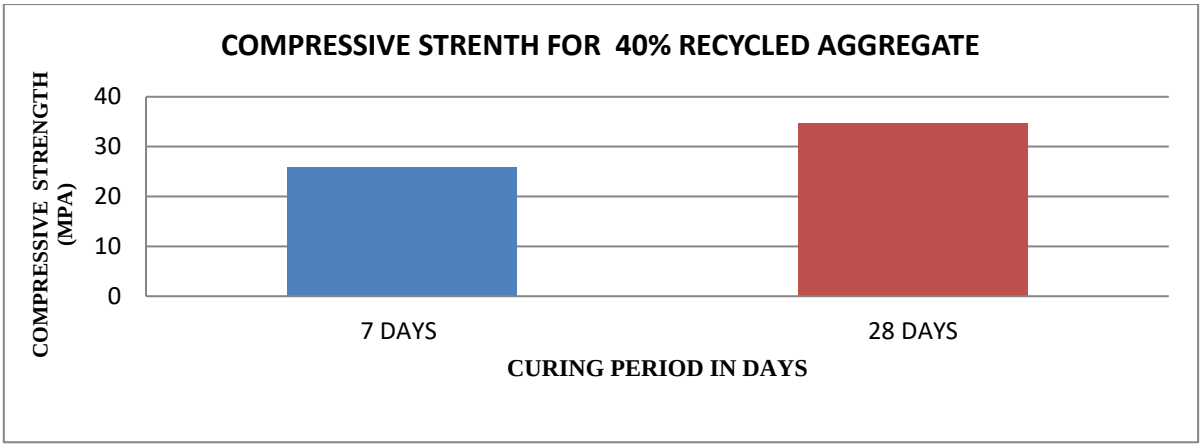
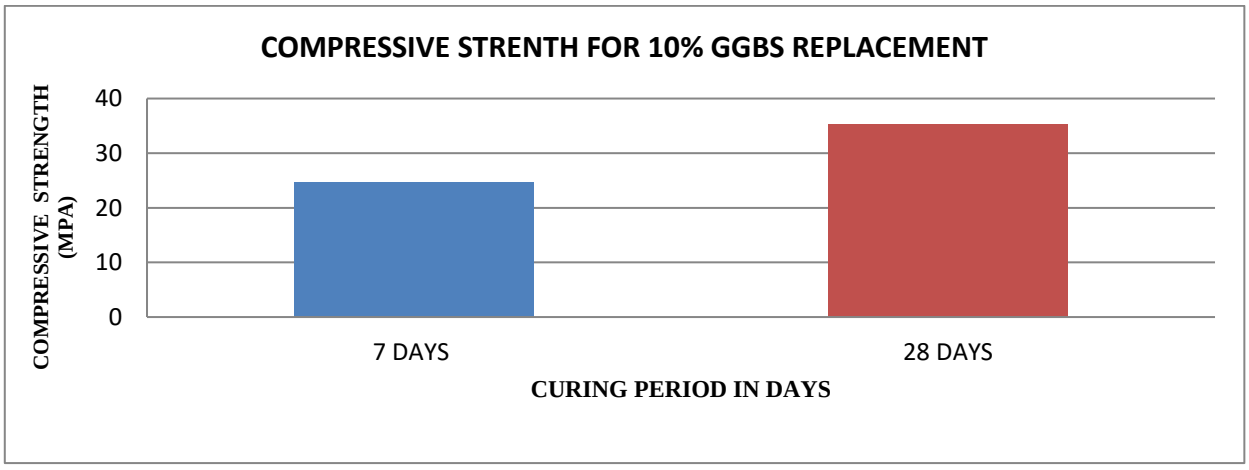


Compressive strength variation for 40% Recycled aggregates

Compressive strength for 10% replacement of GGBS

10% REPLACEMENT OF GGBS							
Specimens	Sl.no	7 DAYS CURING			28 DAYS CURING		
		Load (Kg-f)	Compressive Strength (N/mm^2)	Density (Kg/m^3)	Load (Kg-f)	Compressive Strength (N/mm^2)	Density (Kg/m^3)
Cubes	1	56800	25.24	2340.74	79000	35.11	2355.55
	2	54400	24.17	2296.29	81000	36.00	2325.92
	3	55800	24.80	2311.11	78000	34.66	2315.15
		Average compressive strength= 24.73 (N/mm^2)			Average compressive strength=35.25 (N/mm^2)		



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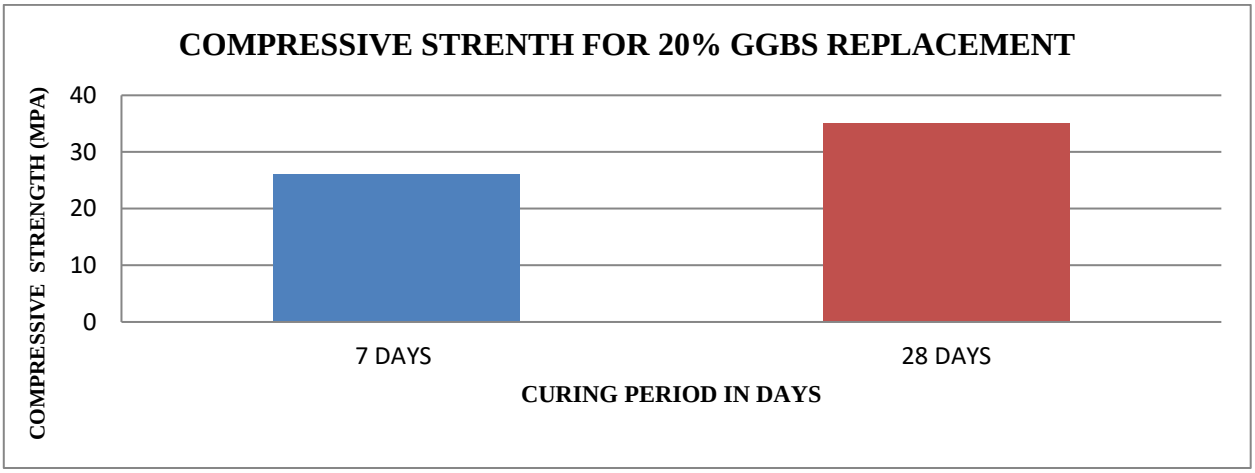
Compressive strength variation for 10% replacement of GGBS

Compressive strength for 20% replacement of GGBS

20% REPLACEMENT OF GGBS							
Specimens	Sl.no	7 DAYS CURING			28 DAYS CURING		
		Load (Kg-f)	Compressive Strength (N/mm^2)	Density (Kg/m^3)	Load (Kg-f)	Compressive Strength (N/mm^2)	Density (Kg/m^3)
Cubes	1	58000	25.77	2340.74	77800	34.57	2325.92
	2	59400	26.40	2355.55	78800	35.02	2325.92
	3	58800	26.11	2325.92	80400	35.73	2311.11
		Average compressive strength= 26.09 (N/mm^2)			Average compressive strength=35.10 (N/mm^2)		



Compressive strength variation for 20% replacement of GGBS

Compressive strength for 30% replacement of GGBS

30% REPLACEMENT OF GGBS							
Specimens	Sl.no	7 DAYS CURING			28 DAYS CURING		
		Load (Kg-f)	Compressive Strength (N/mm^2)	Density (Kg/m^3)	Load (Kg-f)	Compressive Strength (N/mm^2)	Density (Kg/m^3)
Cubes	1	55200	24.53	2311.11	74600	33.15	2325.92
	2	52800	23.46	2396.29	76000	33.77	2325.92
	3	53000	23.55	2340.29	75200	33.42	2370.37
		Average compressive strength=23.84 (N/mm^2)			Average compressive strength=33.44 (N/mm^2)		

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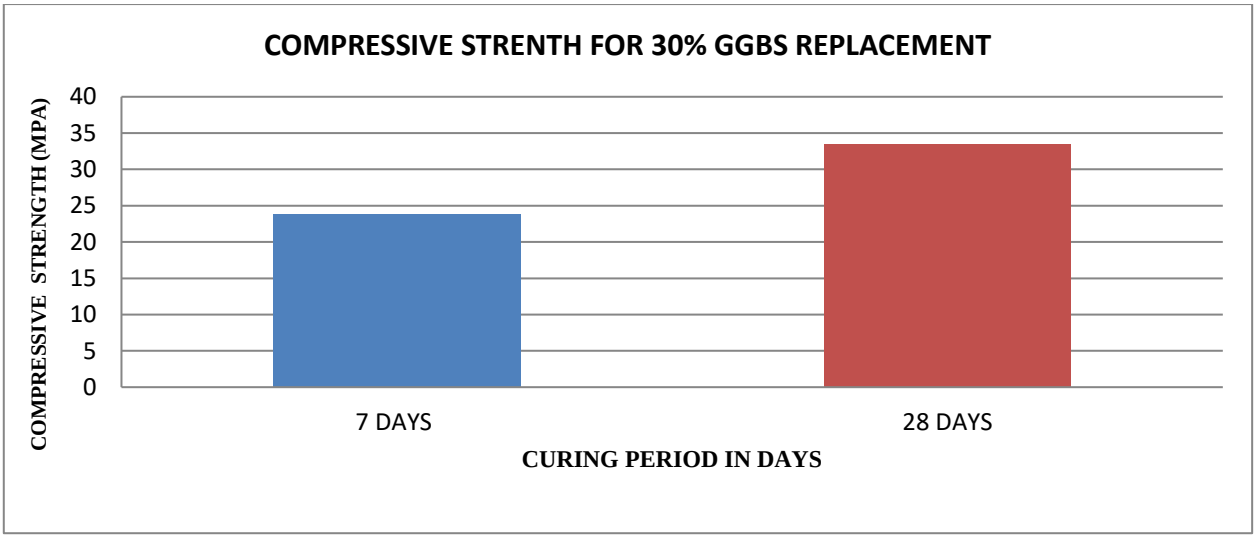

CONCLUSION

- ✓ Slump test and compaction factor test were conducted to find out the workability of concrete. All the mixes used for the study shows adequate workability.
- ✓ Density of recycled coarse aggregate is less than that of natural aggregates. This is an advantage in the design of structures where the light weight concrete is performed.
- ✓ The recycled coarse aggregates have relatively fine particles than natural coarse aggregates due to the crushing of old concrete. The surface texture of recycled coarse aggregate is more porous and rough due to adherence of old porous mortar. This may increase the water demand and reduce the workability.
- ✓ Reduced slump flow diameter and increased V-funnel time indicates the high values of water absorption when compare to normal aggregates.
- ✓ Increased slump flow diameter and decreased V-funnel time i.e workability of fresh concrete with recycled aggregates is due to addition of mineral admixtures and chemical admixtures.
- ✓ Compressive strength of Concrete using recycled aggregates at 7 days and 28 days is decreased by 7.21% and 5.03% respectively, when compared to compressive strength of concrete using normal aggregates .
- ✓ The compressive strength of concrete for 30% replacement of GGBS at 28 days decreases by 5.13% and 4.7% when compared to concrete of 10% and 20% replacement of GGBS respectively.

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