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"Performance of Recycled Aggregates using GGBS"

An Experimental Study

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Abstract – *In producing concrete aggregate is one of the main ingredients. It covers 75% of the total for any concrete mix. The strength of the concrete is dependent on used aggregates properties. So need of coarse aggregate arises with respect to time, for this solution an alternative source of coarse aggregate required. Main scope for this project was to determine the durability and strength characteristics of structural concrete by using recycled coarse aggregates with replace of natural coarse aggregates, which will give a better understanding on the properties of concrete with recycled aggregates. The purpose of this project was to investigate the possibility of using low cost recycled coarse aggregates as a substitute material to coarse aggregate in high strength structural concrete. The experimental investigation are carried out using detailed strength and durability related tests such as flexural strength test of beams , compressive strength test of cubes,. The supplementary cementitious material used in this study was GGBS without replacing cement. The tests were conducted by replacing the coarse aggregates in high strength concrete mixes by 0, 5, 10, 15, 20, 25 and 30% of recycled coarse aggregates and 5% of GGBS also used with the recycled aggregates mix.*

In this study used Recycled Aggregates as an aggregate in the production of new concrete was investigated. The performance of compressive strength produced by Recycled Aggregate Concrete and results were compared with the Natural Coarse Aggregate Concrete. The studies were conducted with an M25 mix with the selected w/c ratio: 0.46 and the development of compressive strength of the recycled aggregates concrete and natural aggregates concrete at the age of 7 & 28 days were studied.

Keywords: Recycled Coarse Aggregates (RCA), Ground Granulated Blast Furnance Slag (GGBS), Ordinary Portland Cement (OPC)

1. Introduction

Reuse and Recycling of construction & demolition wastes seems workable solution in rehabilitation and new constructions after the demolition of old construction. This becomes very important especially for those countries where national and local policies are strict for disposal of construction and demolition wastes with guidance, penalties etc. Central Pollution Control Board has estimated 52 million tons per annum solid waste generation in India out of which, waste from construction industry is more than 30%. The total amount of waste from construction industry is estimated to be 160 to 175 million tons per annum out of which 70-80 million tons are concrete and brick waste. The supplementary cementitious material used in this study was GGBS without replacing cement. The tests were conducted by replacing the coarse aggregates in high strength concrete mixes by 0, 5, 10, 15, 20, 25 and 30% of recycled coarse aggregates and 5% of GGBS also used with the recycled aggregates mix.

2. Literature Survey

Jayalakshmi Nair & Basil Johny (2016) [1], have study about the effects of using recycled materials in different quantity with concrete & GGBS on control design of M40. From these test results concrete with 40% and 50% replacement of cement with GGBS together with 50% replacement of recycled aggregates shows adequate strength compared to control mix. The maximum compressive strength of 28 days cubes is 49.33 N/mm^2 for 50% recycled aggregates used.

M. Manjunath & K. Prakash (2016) [2], also study on effect if supplementary cementitious materials on strength of recycled aggregates concrete. The study was based on reference concrete mix of grade M20 using natural aggregates and partially replacement of coarse aggregates by recycled aggregates. In this study supplementary materials evaluated are silica fume (SF), metakaolin (MK) and ground granulated blast furnace slag (GGBS) at 10% partial replacement to cement. The maximum compressive strength of 28 days cubes is 28.37 N/mm^2 for 0% recycled aggregates used and 10% GGBS replacement of cement.

S.K. Singh (2013) [3], As per research work compare some of the mechanical properties of recycled aggregate concrete (RAC) with the natural aggregate concrete (NAC). The two different mix proportions of characteristic strength of 20 N/ mm2 (M 20) and 25 N/mm2 (M 25) commonly used. The proportions of the ingredients constituting the concrete mixes are 1:1.5:2.9 and 1:1.2:2.4 with water cement ratio 0.50 & 0.45 respectively for M-20 & M-25 grade concrete.

S. D. Thanvi & Alok Kumar (May 2016) [4], aim of this study is to evaluate the performance affect on concrete of mineral admixture such as silica fume & fly ash (as partial replacement of cement) as mineral admixture in concrete when it is mixed in cement concrete for workability, durability and strength of concrete using OPC (43 grade). This study investigates the performance of concrete under influence of silica fume and fly ash in terms of slump, compressive strength for 7days and 28 days, Flexural strength of beam 28 days and Splitting tensile strength of Cylinder for 28 days respectively.

Mirza and Saif (2013) [5], studied the effect of silica fume on recycled aggregate concrete characteristics. The percentages of recycled aggregate replacements of natural aggregate used by weight were 0, 50, and 100%, whereas the percentages of silica fume replacements of cement used by weight Ire 5, 10, and 15%. The result of this study shows that the compressive and tensile strengths values of the recycled concrete aggregate increase as the recycled aggregate and the silica fume contents increase.

S. Arivalagan (2014) [6], In this review quality of ground granulated blast furnace slag (GGBS) at different substitution rate and assess its efficiencies in ordinary cement. This research assesses the quality and quality proficiency components of solidified cement, by in part supplanting cement by different rates of ground granulated blast furnace slag for M35 review of cement at various ages. This review reasons that, since the grain size of GGBS is not as much as that of OPC, its quality at early ages is low, however it keeps on picking up quality over a long time.

Mr. Tushar R Sonawane & Prof. Dr. Sunil S. Pimplikar [7], reported that the properties of recycled aggregates concrete compare to these properties with natural aggregates. The reduction in strength USE of recycled aggregate concrete compare to NAC is in order of 8-14% and 10-16% for M-30 & M-40 concretes respectively.

3. Materials

Ordinary Portland Cement (OPC) of 43 grade Ambuja Cement was used throughout the course of investigation. Specific gravity of this cement is 3.15.

Natural coarse aggregates were obtained from Gunawata (Rajasthan). Specific gravity of these aggregates were 2.8.

Recycled Aggregates obtained from lab waste which specific gravity was 2.62.

Natural sand used Specific gravity was 2.50, sieve analysis = III zone.

Ground Granulated Blast Furnance Slag (GGBS) was obtained by dousing fluid iron slag (a by aftereffect of iron and steel-generation) from an Blast furnace in water or steam, to make a smooth, granular thing that is then dried and ground into a fine powder. Grade of Admixure was 1503 and found in form of white grey powder.

4. Experimental Investigation

The experimental investigation was planned to know the effect of GGBS addition as a 5% weight of Ordinary Portland cement (43 grade) and replacing of natural aggregate by recycled concrete aggregate in the tune of 0 to 30%. Concrete sample were prepared using 150x150x150 mm cube mould for compressive strength & 150x150x700 mm beam mould for Flexure strength for M25 grade of concrete mix was designed as per IS 10262:2009.

Table-1: Control Mix

Raw Material	Weight of Material (Kg per m^3)
Cement	394
Coarse aggregate	1150
River Sand	730.80
Water	168
Admixture	3.65
W/C	0.46

Table-2: Details of Mix Combined with Recycled Aggregates and GGBS

Mix	Cement (Kg)	CA (Kg)		RA (Kg)		FA (Kg)	GGBS (Kg)
		10 mm	20 mm	10 mm	20 mm		
C.M.	13.85	16.86	25.39	0	0	26.88	.6925
Mix1	13.85	16.02	24.12	0.843	1.270	26.88	.6925
Mix2	13.85	15.17	22.85	1.686	2.539	26.88	.6925
Mix3	13.85	14.33	21.58	2.529	3.809	26.88	.6925
Mix4	13.85	13.49	20.31	3.372	5.078	26.88	.6925
Mix5	13.85	12.65	19.04	4.215	6.348	26.88	.6925
Mix6	13.85	11.80	17.77	5.058	7.617	26.88	.6925

Table-3: Details of Compressive strength Combined with Recycled Aggregates and GGBS

Replaced Recycled Aggregates Percentage	Compressive Strength in MPa			
	Concrete without GGBS		Concrete with GGBS (5% of Cement)	
	7 Days	28 Days	7 Days	28 Days
0%	20.08	31.73	21	31.97
5%	19.55	30.55	20.77	31.18
10%	19.03	29.64	20.21	30.58
15%	18.67	28.22	19.53	29.73
20%	18.18	27.31	18.74	28.81
25%	17.33	25.78	17.96	27.08
30%	16.32	24.13	17.42	26.29

Table-4: Flexural strength of beams for 28days

Sr. No.	Mix Name	Strength (N/mm²)
1	Coarse Aggregate + Recycled aggregates (100+0)	4.08
2	Coarse Aggregate + Recycled aggregates (95 + 05)	4.05
3	Coarse Aggregate + Recycled aggregates (90 + 10)	4.01
4	Coarse Aggregate + Recycled aggregates (85+15)	3.99
5	Coarse Aggregate + Recycled aggregates (80+20)	3.96
6	Coarse Aggregate + Recycled aggregates (75+25)	3.91
7	Coarse Aggregate + Recycled aggregates (70+30)	3.83

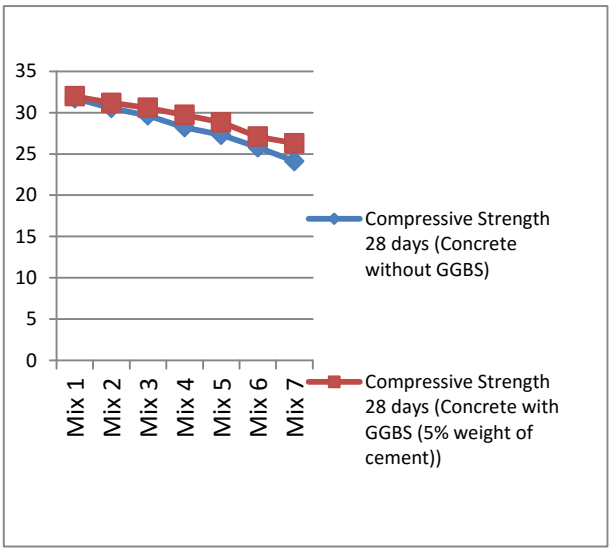

Chart 1: Compressive strength at 28 days

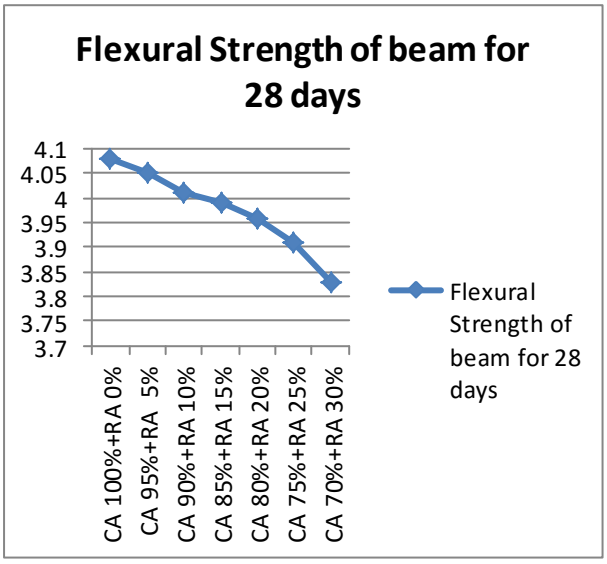

Chart 2: Flexural strength at 28 days

5. Conclusion

- By using recycled coarse aggregate from field demolished concrete, blended with natural aggregate, it's possible to achieve desire strength & durability properties through the use of supplementary materials.
- With the addition of ground granulated blast furnace slag (as a additional of cement weight by 5%), it is possible to replace natural coarse aggregates by recycled aggregates up to 20%, without affecting strength and durability properties of concrete.

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