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Recycling Various Construction & Demolished Waste as Fine Aggregate by Adding Admixture

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Abstract: Use of recycled aggregate in concrete is helpful for environmental protection. Recycled aggregates are the materials for the long run. This paper reports the fundamental properties of recycled fine aggregate and compares these properties with natural fine aggregates. Fundamental changes in every aggregate property are resolved and their impacts on cementing work are examined finally. Similarly the properties of recycled aggregate concrete are also determined. In addition to that mineral admixture GGBS is also added to concrete by 20% substitution of its total volume. Basic concrete properties like compressive strength, split tensile strength are explained here for full replacement of recycled fine aggregate instead of natural fine aggregate, both with and without admixture.

Keywords: Construction & Demolished wastes, Recycled Fine Aggregate, Mineral Admixture, Compressive strength, Split tensile strength.

I. Introduction

Concrete is one of the most widely used construction materials in the world, mainly due to its favorable features such as durability, versatility, satisfactory compressive strength, cost effectiveness and availability. On the other hand Construction Demolition (C&D) wastes consist of the materials generated during the construction, renovation and demolition of buildings and other structures. In India a total quantum of 70.5 million tonnes of natural sand is dredged of the river beds every year for the construction usage. And it is manipulated that the C&D waste generated in India is about 165.70 million tonnes per annum as on 2017. In India, there's great demand of aggregates chiefly from engineering trade for road and concrete construction. However today it's terribly troublesome drawback for offered of fine aggregates. Demolished Construction Waste (Concrete & Brick-Mortar) is one in every of the materials that's thought-about as a waste that may have a promising future in housing industry as full or partial substitute of either Coarse combination or Fine combination.

The final word focus of this work is to understand the performance of Fine Aggregates containing Recycled dismantled Construction Wastes (Recycled Fine Aggregates or RFA) and compare it with the Natural Aggregates and also the method of improving the service with help of mineral admixture (GGBS).

A. *Objectives of using recycled fine aggregates (RFA):*

- To minimize the waste.
- To generate revenue.
- To minimize volumes accumulating and taking up space in the waste dumping yard.
- To reduce the costs of storage and disposal.
- To satisfy the customer demand for products for which fines are a byproduct.
- To achieve sustainability.
- To ensure landscape restoration.
- To reduce the extraction of natural sand.

B. *Scope of the work:*

The scope of the present work includes the study of the following topics:

- Characterization of recycled fine aggregates.
- Mix design for M25 grade concrete with full replacement with recycled fine aggregates.
- Study on properties of fresh and hardened concrete with the replacement of fine aggregate.
- Experimental studies on behavior of concrete with recycled fine aggregates.

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II. LITERATURE REVIEW

A. *An Innovative Study on Reuse of Demolished Concrete Waste*

Authors: *Yadhu G, S Aiswarya Devi*

It is explicit that the recycled construction demolished waste will be used as fine aggregate instead of natural stream sand or M-sand. The test results of the recycled fine aggregate from C&D waste is regarding 30.66N/mm2 for 28 days in M25. It is concluded that the crushed C&D wastes will be used as a replacement for typical sand as fine aggregate.

B. *Water demand of concrete recycled aggregates*

Authors: *Jacek Kubissa, Marcin Koper, Włodzimierz Koper, Wojciech Kubissa, Artur Koper*

Water demand for the recycled aggregates differs from the conventional aggregates. Aggregates (NCA) the formulas, among others, of Sterne's of Bolomey's are used learning the water demand of aggregates from its granulation, kind and consistence of concrete mixture. The RCA has larger permeability so a special water demand formula is obtained. The outlined dependency $w_{REC} - w_{rm}$ will be used to outline RCA water demand indicator and utilized in the method of designing the composition of concrete mixtures.

C. *"Ground Granulated Blast Slag (GGBS) In Concrete – A Review"*

Authors: *D. Suresh and K. Nagaraju*

GGBS has drawn the attention of investigators to explore new replacements of ingredients of concrete. It's a byproduct of steel and as an Eco friendly material while not dumping into the ground will be utilized as admixture in cement. The mineral composition of GGBS cement paste (with less aluminates and portlandite than Portland cement) most likely contributes to this resistance. It is seen that GGBS may be a smart replacement to cement in some cases and serves effectively however it can't replace cement fully. But on partial replacement it provides sensible results a greener approach in construction and sustainable development.

D. *Partially Replacement of Fine Aggregate with GGBS*

Authors: *Baskaran.P, Karthickkumar.M, Krishnamoorthy.N, Saravanan.P, Hemath Naveen K.S, K.G.Vinothan*

Here the proportion of GGBS replacement is 0,5,10 and 15 % to natural sand for the standard w/c ratio of 0.4 is taken into account. By substitution the GGBS, to search out the strength, durability and corrosion resistance properties of concrete, the compressive, flexural and split tensile strength is tested for the partial replacement of GGBS and has attained 15 % higher strength on compared to the standard concrete and also the optimum proportion of replacement of GGBS is 15 %.

III. METHODOLOGY

Reclamation of recycled fine aggregate from old demolished concrete and brick waste

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Testing of material properties

⇩

Mix Design

⇩

Specimen & Casting

⇩

Interpretation of Results

⇩

Conclusion

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IV MATERIALS USED

Material specification for concrete preparation has been mentioned below,

A. Cement:

Cement is a combination of siliceous (containing silica), argillaceous (containing alumina) and carbonate (containing lime) material in a partial fusion, burnt at a temperature of 1400 to 1450°c. By doing so, a material known as clinker is obtained. It is cooled and then grounded to the specified fineness to get cement. Differing types of cement are obtained by varying the proportions of the raw materials and conjointly adding little proportion of different chemicals.

In the project we've used Ordinary Portland Cement (OPC) 53Grade.

B. Water:

Water used for preparation and curing concrete is free from injurious substances like oil, acid, alkali, sugar, salt, organic materials or different components harmful to concrete or steel. Portable water is appropriate for making concrete. Ocean water containing up to 35000 ppm of common salt and different salts is usually appropriate as combining water for plain concrete work.

C. Aggregate:

Aggregate is a composite, insoluble non cementitious particles that resists compressive stress are represented as aggregates. Such aggregates typically constitute from 50% to 80% of the quantity of typical concrete and will therefore greatly influence its properties. Aggregate shouldn't contain any constituent that affects the hardening of the cement and durability of the hardened concrete adversely. It ought to be free from organic matter that reduces the hydraulic activity of cement and affects its traditional setting and hardening. And it is classified as follows.

1) Coarse Aggregate:

Coarse aggregate is material that passes through 80 mm sieve and retained on a 4.75 mm sieve. It should be uncrushed gravel if it results from the natural disintegration of rock or crushed stone or crushed gravel if it is created by crushing arduous stone, gravel.

In the project we've used crushed stone as coarse aggregate.

2) Fine Aggregate:

Fine aggregate is material that passes through 4.75 mm sieve and retained on 75 micrometer sieve which occupies 60% to 70% of volume in the concrete and has a good durability, surface texture, abrasion, skid resistance and workability respectively.

In the project we’ve used C&D wastes as Recycled Fine Aggregates (RFA).

IV. TESTS CONDUCTED

We have compared the results of concrete made by crushed C&D wasted with normal concrete by conducting following tests.

A. Test Carried Out For Fine Recycled Aggregate

- Sieve analysis
- Specific gravity test
- Water absorption test
- Bulking of sand
- Silt content
- Bulk Density & Void Ratio

B. Concrete Load Bearing Capacity Test

- Compressive strength test
- Split tensile strength test

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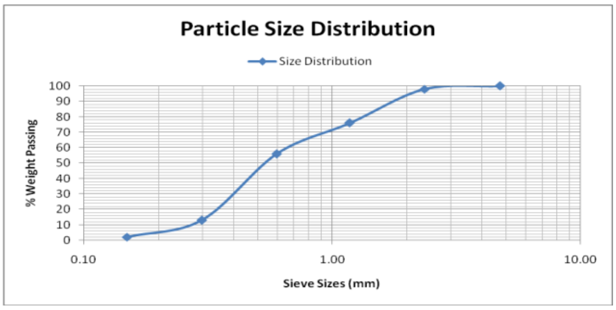
V. MATERIAL TEST RESULTS

A. *Sieve Analysis;*

IS Sieve Sizes	Recycled Fine Aggregate (Percentage Passing)	Remark
4.75 mm	100	Conforming to grading Zone III of Table 4 of IS : 383-1970
2.36 mm	100	
1.18 mm	75	
600 micron	60	
300 micron	12	
150 micron	2	



B. *Specific Gravity & Water Absorption*

Specific gravity (SG)	$= \frac{D}{C-(A-B)}$	**Where,** **A= Wt. of Pycnometer+Water+Sample** **B= Wt. of Pycnometer+Water** **C= Wt. of Sample taken** **D= Wt. of Oven dry Sample**
Apparent Specific gravity (ASG)	$= \frac{D}{D-(A-B)}$	
Water Absorption (WA)	**=((C-D)/D) ×100%**	

TRIAL	OBSERVATION (kg)				SG	Apparent SG	WA %
	A	B	C	D			
1	1.683	1.388	0.5	0.494	2.410	2.480	1.215
2	1.640	1.345	0.5	0.495	2.415	2.475	1.010
3	1.736	1.383	0.6	0.593	2.416	2.500	1.350
MEAN					**2.41**	**2.485**	**1.190**

C. *Bulking Of Sand*

TRIAL	Values of Y	Bulking of Sand %	Mean Value %
1	186.0	7.527	**7.623**
2	185.7	7.700	
3	185.8	7.643	

D. *Silt Content*

TRIAL	VOLUME OF SILT (mm)	VOLUME OF SAMPLE (mm)	SILT CONTENT %	MEAN VALUE %
1	3.0	197	1.52	**1.67**
2	3.5	196	1.88	
3	3.0	186	1.61	

E. *Bulk Density*

TRIAL	WEIGHT OF SAND (kg)	VOLUME OF SAMPLE (l)	BULK DENSITY (kg/l)	MEAN VALUE (kg/l)
1	4.26	3.0	1.42	**1.43**
2	4.358	3.0	1.45	
3	4.29	3.0	1.43	

F. *Void Ratio*

Percentage of voids = ((SG - Bulk Density)/ SG)×100%

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= ((2.41 – 1.43)/2.41)×100%
= 40.54%

VI. MIX DESIGN

Mix design as per (IS 10262::1982)

Mix design for M25 (***IS 10262:1982***)	
1:1.32:3.10	
WATER	191.60 kg/m^3
CEMENT	383.20 kg/m^3
RECYCLED FINE AGGREGATE	505.16 kg/m^3
NATURAL COARSE AGGREGATE	1190.73 kg/m^3

Mineral Admixture GGBS is added as 20% replacement to volume of concrete.

VII. COMPRESSIVE STRENGTH TEST RESULTS

Strength Results of Concrete with RFA (N/mm2)	**7 Days Compressive Strength**			**Mean Value**
	Trial 1	**Trial 2**	**Trial 3**	
Conventional Concrete	14.33	13.67	13.34	**13.78**
Without adding Admixture (GGBS)				
Without Removing Silt Content	10.36	10.33	11.32	**10.67**
After Removing Silt Content	11.62	11.36	11.67	**11.55**
With addition of GGBS with 20% by volume				
Without Removing Silt Content	15.45	15.78	15.45	**15.56**
After Removing Silt Content	14.67	15.64	14.36	**14.89**

Strength Results of Concrete with RFA (N/mm2)	**14 Days Compressive Strength**			**Mean Value**
	Trial 1	**Trial 2**	**Trial 3**	
Conventional Concrete	20.66	25.33	20.66	**22.22**
Without adding Admixture (GGBS)				
Without Removing Silt Content	15.67	16.03	14.98	**15.56**
After Removing Silt Content	16.45	16.74	17.28	**16.89**
With addition of GGBS with 20% by volume				
Without Removing Silt Content	24.33	21.63	22.05	**22.67**
After Removing Silt Content	23.25	24.45	22.98	**23.56**

Strength Results of Concrete with RFA (N/mm2)	**28 Days Compressive Strength**			**Mean Value**
	Trial 1	**Trial 2**	**Trial 3**	
Conventional Concrete	25.17	25.38	24.78	**25.11**
Without adding Admixture (GGBS)				

Without Removing Silt Content	17.79	22.67	20.86	**20.44**
After Removing Silt Content	23.33	23.32	20.67	**22.44**
With addition of GGBS with 20% by volume				
Without Removing Silt Content	27.65	25.36	28.32	**27.11**
After Removing Silt Content	27.66	27.36	28.32	**27.78**

VIII. SPLIT TESNSILE STRENGTH TEST RESULTS

Strength Results of Concrete with RFA (N/mm2)	**7 Days Split Tensile Strength**			**Mean Value**
	Trial 1	**Trial 2**	**Trial 3**	
Conventional Concrete	1.49	1.63	1.56	**1.56**
Without adding Admixture (GGBS)				
Without Removing Silt Content	1.38	1.46	1.39	**1.41**
After Removing Silt Content	1.96	2.10	2.09	**2.05**
With addition of GGBS with 20% by volume				
Without Removing Silt Content	1.69	1.72	1.69	**1.7**
After Removing Silt Content	2.36	2.42	2.42	**2.4**

Strength Results of Concrete with RFA (N/mm2)	**14 Days Split Tensile Strength**			**Mean Value**
	Trial 1	**Trial 2**	**Trial 3**	
Conventional Concrete	1.76	1.85	1.91	**1.84**
Without adding Admixture (GGBS)				
Without Removing Silt Content	1.60	1.58	1.71	**1.63**
After Removing Silt Content	2.32	2.11	2.35	**2.26**
With addition of GGBS with 20% by volume				
Without Removing Silt Content	2.01	1.87	2.06	**1.98**
After Removing Silt Content	2.54	2.78	2.75	**2.69**

Strength Results of Concrete with RFA (N/mm2)	**28 Days Split Tensile Strength**			**Mean Value**
	Trial 1	**Trial 2**	**Trial 3**	
Conventional Concrete	1.98	2.06	2.11	**2.05**
Without adding Admixture (GGBS)				
Without Removing Silt Content	1.86	1.96	2.12	**1.98**
After Removing Silt Content	2.56	2.39	2.25	**2.40**

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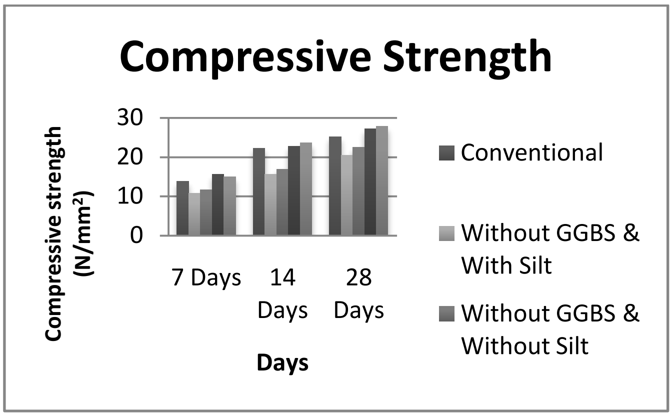
With addition of GGBS with 20% by volume				
Without Removing Silt Content	2.26	2.36	2.37	**2.33**
After Removing Silt Content	2.78	2.86	2.85	**2.83**

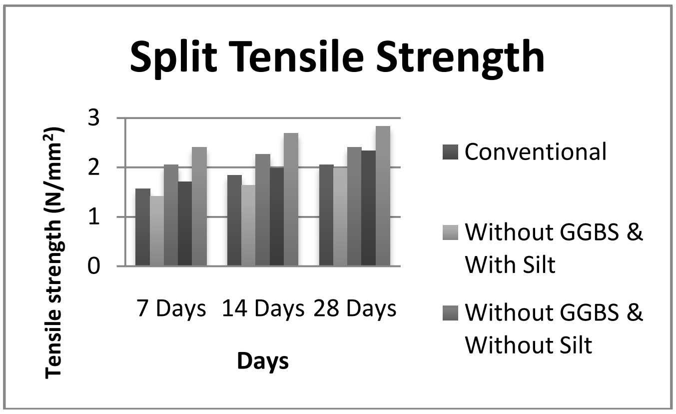
IX. INTERPRETATION OF RESULTS

Results obtained from the above tests are compared with the conventional M25 mix concrete in the below chart.

A. Compairsion Of Compressive Strength



B. Comparision Of Split Tensile Strength



X. CONCLUSION

Test results anticipates that the concrete made using RFA gives almost as much as strength as normal concrete (about 27.81(N/mm^2) for 28 days with addition of 20% GGBS) in M25. From our study, we have concluded that the RFA can be used as a replacement for conventional sand as fine aggregate. Additional study should be done to know how extensively we can use the RFA in construction of reinforced components.

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