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Use of Industrial Waste in Manufacturing of Self Compacted Concrete

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Abstract— **Self Compacting Concrete (SCC) is an innovative concrete that does not require vibration for placing and compaction. It is able to flow under its own weight, completely filling form work and achieving full compaction even in the presence of congested reinforcement. The hardened concrete is dense, homogenous and has the same engineering properties and durability as traditional vibrated concrete. Due to rice milling industry there is huge amount of rice husk ash is produced and due to infrastructural development demolished concrete waste is produced. So, and to reduce the cost of the construction also to make structure more durable, reduce problem of this material the project has been undertaken so that it can be used for construction fashion following points attempted. 1) To study the properties of rice husk ash. 2) To blend to mix or to replace partially cement by different % by rice husk ash. 3) To study properties of demolished concrete waste 4) To prepare the concrete by blending or by replacing partially coarse aggregate by different % by demolished concrete waste. 5) To study the comparativeness.**

So, it is the dire need to use this particular otherwise waste material for the constructive in such fashion in the case of concrete so that concrete which became cost effective as well as ecofriendly. And hence this project is attempted.

Keywords—*Self Compacting Concrete (SCC), Rice Husk Ash (RHA), Demolished Waste.*

I. INTRODUCTION

Self-compacting concrete is basically a concrete which is capable of flowing in to the formwork, without segregation, to fill uniformly and completely every corner of it by its own weight without any application of vibration or other energy during placing. There is no standard self-compacting concrete. Therefore, each self-compacting concrete has to be designed for the particular structure to be constructed. However, working on the parameters which affect the basic properties of self-compacting concrete such as plastic viscosity, deformability, flow ability and resistance to segregation, self-compacting concrete may be proportioned for almost any type of concrete structure.

To establish an appropriate mixture proportion for a self-compacting concrete the performance requirements must be defined taking into account the structural conditions such as shape, dimensions, reinforcement density and construction conditions. The construction conditions include methods of transporting, placing, finishing and curing. The specific requirement of self-compacting concrete is its capacity for self-compaction, without vibration, in the fresh state. Other performances such as strength and durability should be established as for normal concrete. To meet the concrete performance requirements the following three types of self-compacting concretes are available.

a) Powder type of self-compacting concrete:

This is proportioned to give the required self-Compact ability by reducing the water powder (material-0.1mm) ratio and provide adequate segregation resistance.

Super plasticizer and air entraining admixtures give the required Deform ability.

b) Viscosity agent type self-compacting concrete:

This type is proportioned to provide self-compaction by the use of viscosity modifying admixture to provide segregation resistance. Super plasticizers and air entraining admixtures are used for obtaining the desired deformability.

c) Combination type self-compacting concrete:

This type is proportioned so as to obtain self-compact ability mainly by reducing the water powder ratio, as in the powder type, and a viscosity modifying admixture is added to reduce the quality fluctuations of the fresh concrete due to the variation of the surface moisture content of the aggregates and their gradations during the production This facilitates the production control of the concrete.

II. PROPERTIES OF SCC

Fresh SCC Properties

The 3 main properties of SCC in plastic state are,

*1. **Filling ability (Excellent deformability)***

Self-compacting concrete must be able to flow into all the spaces within the formwork under its own weight. This is related to workability, as measured by slump flow or Orimet test.

The filling ability or flow ability is the property that characterizes the ability of the SCC of flowing into formwork and filling all space under its bwn weight, guaranteeing total covering of the reinforcement. The mechanisms that govern this property are high fluidity and cohesion of the mixture.

2. Passing ability (Ability to pass reinforcement without blocking)

Self-compacting concrete must flow through tight openings such as spaces between steel reinforcing bars under its own weight. The mix must not 'block' during placement.

The passing ability is the property that characterizes the ability of the SCC to pass between obstacles- gaps between reinforcement, holes, and narrow sections, without blocking.

The mechanisms that govern this property are moderate viscosity of the paste and mortar, and the properties of the aggregates, principally, maximum size of the coarse aggregate. Stability or resistance to the segregation is the property that characterizes the ability of the SCC to avoid the segregation of its components, such as the aggregates. Such a property provides uniformity of the mixture during transport placement and consolidation.

The mechanisms that govern this property are the viscosity and cohesion of the mixture.

3. High Resistance to Segregation

Self-compacting concrete must meet the requirements of 1 and 2 while its original composition remains uniform. The key properties must be, maintained at adequate levels for the required period of time (e-g.20 min) after completion of mixing. It is property 2 the passing ability and property 3 resistance to segregation that constitute the major advance, form a merely super plasticized fresh mix which may be more fluid than self-compacting concrete mix.

Latest developments in accordance with the objectives of the European SCC project aim to limit the admixtures used for general purpose SCCs to only one by using new types and combinations of polymers. Experience has shown that such an admixture may have to add to generate and maintain compacting concrete using less liable materials.

III. RICE HUSK ASH

WHAT IS RICE HUSK ASH?

Rice milling industry generates a lot of rice husk during milling paddy which comes from the fields. This rice husk is mostly used as fuel in the boilers for processing of paddy. Rice husk is also used as a fuel or power generation. Rice husk ash (RHA) is about 25% by weight of rice husk when burnt in boilers.

Rice milling generates a byproduct know as husk. This surrounds the paddy grain. During milling of paddy about 78 % of weight is received as rice, broken rice and bran. Rest 22 % of the weight of paddy is received as husk. This husk is used as fuel in the rice mills to generate steam for the Par boiling process. This husk contains about 75 % organic volatile matter and the balance 25 % of the weight of the husk is converted in to ash during the firing process, is known as rice husk ash (RHA). This RHA in turn contains around 85 % -95 % amorphous silica.

So for every 1000 Kgs of paddy milled, about 220Kgs (22 %) of husk is produced and when this husk is burnt in the boilers, about 55kgs (25 %) of RHA is generated.

4. The Possibility Adding of the Rice Husk Ash (RHA) to the Conerete

In the last decades, the use of residue in civil construction, specially in addition to concrete, has been subject of many researches due to, besides to reduce the environmental polluter's factors, it may lead several improvements of the concrete properties. The world rice harvest is estimated in 500 million tons per year, and Brazil is the 8th producer. Considering that 20 % of the grain is husk, and 20 % of the husk after combustion is converted into ash, a total of 20 million tons of ash can be obtained. This paper evaluates how different contents of rice husk ash (RHA) added to concrete may influence its physical and mechanical properties. Samples with dimensions of 10 X 20 cm were tested, with 5 % e 10 % of RHA, replacing in mass the cement.

5. Rice Husk Ash Concrete: the Effect of RHA Average Particle Size on Mechanical Properties and Drying Shrinkage

This paper reports an experimental investigation on the influence of Rice Husk Ash (RHA) Average Particle Size (APS) on the mechanical properties and drying shrinkage of the produced RHA blended concrete. Locally produced RHA with three deferent APS (i.e., 31.3, 18.3, and 11.5 um, respectively) were used to replace cement by 20 % of its weight. Mixture proportioning was performed to produce high workability RHA mixture (200-240 mm slump) with target strength of 40 MPa. Incorporation RHA in concrete resulted in increased water demand, for the mechanical properties, inclusion of RHA provided similar or enhanced mechanical properties when compared to the control Ordinary Portland Cement (OPC) mixture, with finer RHA giving better improvement. Fine RHA exhibited the highest shrinkage value due to the effect of micro fine particles which increases its shrinkage values considerably.

6. Assessment of concrete strength using rice husk ash

In the ancient period construction work was mostly carried out with the help of mudstone rom industry. Fly ash is a by-product of burned rice husk at higher temperature from paper plant. Considerable efforts are being taken worldwide totalize natural waste and by-product as supplementary cementing materials to improve the properties of cement concrete. Rice husk ash (RHA) and Fly Ash (FA) is such materials. Rice Husk Ash is by-product of paddy industry. Rice Husk Ash is a highly Reactive Pozollanic material produced by control burning of rice husk. In this paper I started proportion from 30 % FA 0 % RHA mix together in concrete by replacement of cement , last p portion taken 0 % FA 30 % RHA , with gradual increase of RHA by 1 % and simultaneously gradual decrease of FA by 1%.lt is observed that though the strength of RHA concrete goes on decreasing after the l 5 % addition of RHA , the composition of 10 % RHA + 20 % FA gives maximum strength results as well as shows the potential to be used as useful material for different building materials.

IV. MATERIALS

1. Cement

Portland Cement Concrete is the most widely manufactured material. Judging from the modern trends, the failure of concrete looks brighter because for most purposes it offers suitable engineering properties at low cast combined with energy savings and ecological benefits. It is desirable that engineers know about than about building materials.

The word concrete came from Latin term "CONCRETEUS", which means meaning compact or condensed. Concrete solidifies and hardens after mixing with water and placement due to a chemical process known as hydration. The water reacts with the cement, which bonds the other components together, eventually creating robust granite like material.

Concrete is the most widely construction material, commonly made by mixing cement and sand, crushed granites and water. As per the study, the per-capital consumption of cement in India is 131 kg as against the world average of 348 kg. Human being consumes no material except water in such tremendous quantity.

In this present investigation Ordinary Portland Cement of 43 Grade with a brand name Zuari cement is used. Tests are conducted in accordance with the Indian standards confirming to IS-8112:2013. The physical characteristic of the tested cement has been shown in table 1.

Table-1: Physical Characteristics of Cement.

PHYSICAL PROPERTIES OF CEMENT REFERENCE			
Sl. No.	**Test**	**Results**	**Requirements as per IS 8112: 2013**
1	Specific Gravity	3.10	3.15
2	Fineness of cement	3.50%	Less than 10%
3	Standard Consistency	30%	Not Specified
4	Soundness (Le- chatelier's)	0.5mm	Shall not be more than 10mm
5	Setting time (in minutes)		
	Initial Setting time	90	Shall not be less than 30 minutes
	Final Setting Time	365	Shall not be more than 600 minutes
6	Compressive Strength (MPa) (70.5x70.5x70.5mm cubes)		
	3 Days Strength	24.7 MPa	Shall not be less than 23.0 MPa
	7 Days Strength	35.8 MPa	Shall not be less than 33.0 MPa
	28 Days Strength	46.5 MPa	Shall not be less than 43.0 MPa

2. *Fine aggregate*

The fine aggregate (M Sand), obtained from nearby plant, and clear from all sorts of organic impurities was used in this experimental program. The fine aggregate was passing through 4.75 mm sieve and had a specific gravity of 2.73. The grading zone of fine aggregate was zone II as per Indian Standard specifications.

The test on fine aggregate was conducted in accordance with IS: 650-1966 & IS: 2386-1968 to determine specific gravity and fineness modulus.

Table-2: Physical Characteristics of Fine Aggregate.

Sl. No.	PARTICULAR OF TEST	RESULTS
1	Fineness Modulus	2.36
2	Specific Gravity	2.7
3	Bulk Density (kg/m^3)	1650
4	Zone	II

3. *Coarse aggregate*

Coarse aggregate are the crushed stone is used for making concrete. The commercial stone is quarried, crushed, and graded. Much of the crushed stone used is granite, limestone, and trap rock. The last is a term used to designate basalt, gabbro, diorite, and other dark- coloured, fine-grained igneous rocks. Graded crushed stone usually consists of only one kind of rock and is broken with sharp edges. The sizes are from 0.25 to 2.5 in (0.64 to 6.35 cm), although larger sizes may be used for massive concrete aggregate. Machine crushed granite broken stone angular in shape was used as coarse aggregate.

Table-3: Physical Characteristics of Coarse Aggregate.

Sl. No.	PARTICULAR OF TEST		RESULTS
1	Specific Gravity		2.56
2	Bulk Density (kg/m^3)		1500
3	Water Absorption		0.15%

4. *Water*

Potable water as obtained from water supply was used for the preparation of concrete mix. The pH of water is 7.0 and all other Physical Properties of the water are as per Indian Standards.

Table-4: Analysis of portable water.

SL. No	Type of Test Conducted	Results	Permissible Limits	Relevant BIS codes
1	pH value	7.00	Should not be less than 6	IS: 456-2000
2	Total Acidity	50 mg/l as $CaCO_3$	Should be less than 50 mg/l as $CaCO_3$	
3	Total Alkalinity	110 mg/l as $CaCO_3$	Should be less than 250 mg/l as $CaCO_3$	
4	Total dissolved solids Organic Inorganic	160 mg/l 260 mg/l	Less than 200 mg/l	
5	Chlorides	240 mg/l	Should not be more than 500 mg/l for PCC and not be more than 2000 mg/l for RCC	
6	Suspended Solids	60 mg/l	Should be less than 2000 mg/l	

5. *Fly ash*

Fly Ash is a by-product of coal-fired electric generating plants. Fly Ash is the most widely used pozzolonic material all over the world. Fly Ash is defined in Cement and Concrete Terminology (ACI Committee 116) as "the finely divided residue resulting from the combustion of ground or powdered coal, which is transported from the firebox through the boiler by flue gases".

Table-5: Physical properties of Fly ash.

Sl. No.	PARTICULAR OF TEST	RESULTS
1	Specific Gravity	2.06
From Thermal Power Plant, Raichur		

6. *Admixtures*

An admixture is an additional material added to concrete in order to improve a particular or desired property of concrete. It is also defined as a material other than cement water and aggregates used as an in gradient in concrete. Admixtures are added to modify the properties so as to make it more suitably for any situation. These days concrete is being used for wide varieties of purpose to make it suitable in different conditions. In these conditions ordinary concrete may fail to exhibit the required quality performance or durability. In such cases admixtures are used to modify the properties of ordinary concrete so as to make it more suitable for any situation.

Admixture (Super-Plasticizer & VMA) used is Auramix 400.

7. Demolished concrete waste

Building materials account for about half of all materials used and about half the solid waste generated worldwide. They have an environmental impact at every step of the building process extraction of raw materials, processing, manufacturing, transportation, construction and disposal at the end of a building's useful life.

Construction and demolition (C&D) waste is a general term for a diverse range of materials that, when segregated, can include high-value materials and resources for new construction, The definition of C&D waste used in this report is from the National Waste Report 2010. Waste produced by demolition and building activities, including road and rail construction and maintenance and excavation of land associated with construction activities.

V. EXPERIMENTAL TESTS

It is important to appreciate that none of the test methods for SCC has yet been standardized. The methods presented here are descriptions rather than fully detailed procedures. They are mainly adhoc methods, which have devised specifically for SCC. Hence for the validation of concrete these tests have not been considered.

7. Slump Flow Test

This is simple, rapid test procedure, though two people are needed if the T50 time is to be measured. It can be used on site, though the size of the base plate is somewhat unwieldy and level ground is essential. It is most commonly used test, and gives a good assessment of filling ability. It gives no indication of the ability of the concrete to pass between reinforcement without blocking, but may give some indication of resistance to segregation. It can be argued that the completely free flow, unrestrained by any boundaries, is not representative of what happens in practice in concrete construction, but the test can be profitably be used to assess the consistency of supply of ready-mixed concrete to a site from load to load.

8. L Box Test

This is widely is used test, suitable for laboratory, and perhaps site use. It assesses filling and passing ability of SCC, and serious lack of stability (segregation) can be detected Segregation may also be detected by subsequently sawing and inspecting sections of the concrete in the horizontal section. Unfortunately, there is no agreement on materials, dimensions, or reinforcing bar arrangement, so it is difficult to compare test results. There is no evidence of what effect the wall of the apparatus and the consequent 'wall effect' might have on concrete flow, but this arrangement does, to some extent, replicate what happens to concrete on site when it is confined within formwork. Two operators are required if times are measured, and a degree of operator error is inevitable.

9. V Funnel Test

Though the test is designed to measure flow ability, the result is affected concrete properties other than flow. The inverted cone shape will cause any liability of concrete to block to be reflected in the result - if, for example there is too much coarse aggregate. High flow time can also be associated with low deformability due to high paste viscosity, and with high inter-particle friction.

10. J Ring Test

These combinations of tests are considered to have great potential, though there is no general view on exactly how results should be interpreted. There are number of options- for instance it may be instructive to compare the slump-flow/J Ring spread with the unrestricted slump flow: to what extent is it reduced?

Like the slump flow test, these combinations have the disadvantage of being unconfined, and therefore do not reflect the way concrete is placed and moves in practice. The Orimet option has the advantage of being dynamic test, also reflecting placement in practice, though it suffers from requiring two operators.

VI. TEST RESULTS

I. Test results of SCC containing the combination of admixtures, rice husk ash and demolished concrete waste.

Table-6: Compressive strength of SCC with different combination in percentage of rice husk ash and demolished concrete waste after 14 days.

% of RHA	% of DCW	Failure load (kN)	Area (mm^2)	Compressive strength (MPa)
0	0	676.575	22500	30.07
10	10	555.200	22500	24.67
	20	603.315	22500	26.82
	30	589.600	22500	26.21
	40	618.030	22500	27.47
20	10	617.000	22500	27.43
	20	603.315	22500	26.82
	30	588.600	22500	26.16
	40	554.170	22500	24.63
30	10	593.505	22500	26.38
	20	603.315	22500	26.82
	30	637.650	22500	28.34
	40	495.405	22500	22.02

Table-7: Compressive strength of SCC with different combination in percentage of rice husk ash and demolished concrete waste after 28 days.

% of RHA	% of DCW	Failure load (kN)	Area (mm^2)	Compressive strength (MPa)
0	0	1051.200	22500	46.72
10	10	837.450	22500	37.22
	20	760.275	22500	33.79
	30	694.800	22500	30.88
	40	682.200	22500	30.32
20	10	672.750	22500	29.90
	20	661.950	22500	29.42
	30	599.175	22500	26.63
	40	576.675	22500	25.63
30	10	582.525	22500	25.89
	20	470.025	22500	20.89
	30	441.675	22500	19.63
	40	417.150	22500	18.54

Table-8: Tensile strength of SCC with different combination in percentage of rice husk ash and demolished concrete waste after 28 days.

% of RHA	% of DCW	Failure load (kN)	Tensile strength (MPa)
0	0	213.468	3.02
10	10	144.900	2.05
	20	116.630	1.65
	30	110.268	1.56
	40	103.200	1.46
20	10	85.520	1.21
	20	72.098	1.02
	30	65.030	0.92
	40	62.720	0.82
30	10	53.720	0.76
	20	42.220	0.64
	30	36.756	0.52
	40	36.045	0.51

Table-9: Flexural strength of SCC with different combination in percentage of rice husk ash and demolished concrete waste after 28 days.

% of RHA	% of DCW	Failure load (kN)	Flexural strength (MPa)
0	0	121.2	6.06
10	10	109.3	5.465
	20	101.5	5.075
	30	83.60	4.180
	40	79.50	3.975
20	10	79.10	3.915
	20	76.40	3.82
	30	76.10	3.805
	40	72.40	3.62
30	10	71.00	3.55
	20	66.40	3.32
	30	65.80	3.29
	40	60.20	3.01

II. Flow test results of effect of addition of red mud in various percentages on the properties of self-compacting concrete containing an admixture combination of (SP+VMA)

The test results are as Shown below in Table-10,

Table-10: Flow test results.

% of RHA	% of DCW	Slump test		V-Funnel flow time (sec)	J-Ring flow time (sec)			L-Box test		
		Flow (mm)	Time (sec)			H_1 (mm)	H_1 (mm)	Blocking ratio (H_2/H_1)	Time taken to reach 200mm T20(sec)	Time taken to reach 400mm T40(sec)
0	0	730	8.36	8.22	5.44	600	550	0.91	8.12	14.43
10	10	720	8.03	8.16	5.05	600	485	0.80	6.78	10.21
	20	710	8.26	8.20	5.24	600	510	0.85	6.93	10.64
	30	710	8.41	8.28	5.44	600	520	0.90	7.21	11.54
	40	710	8.62	8.34	5.50	600	570	0.95	7.49	11.89
20	10	710	8.07	8.19	5.16	600	495	0.82	6.80	10.32
	20	710	8.33	8.26	5.30	600	520	0.86	6.99	10.76
	30	700	8.54	8.36	5.49	600	545	0.90	7.27	11.58
	40	710	8.80	8.47	5.74	600	580	0.96	7.58	11.92
30	10	730	8.50	8.40	5.19	600	510	0.85	6.89	10.47
	20	720	8.76	8.76	5.54	600	525	0.87	7.12	10.84
	30	710	9.05	8.90	5.79	600	555	0.92	7.32	11.68
	40	700	9.56	8.99	5.94	600	590	0.98	7.67	13.24

III. CONCLUSION

In present scenario there is a greater need for self-compacting concrete due to sickness of member and architectural requirement, also to improve durability of de structure.

Based on the experimental investigation concerning the compressive strength, split tensile strength and flexural strength of the concrete, the following observation are made regarding the partial replacement of cement by RHA and partial replacement of coarse aggregate by DCW,

1. Addition of rice husk ash decreases the compressive strength, split tensile strength & flexural strength because rice husk ash decreases the density of concrete.
2. Demolished concrete waste also decreases the strength because the demolished waste consists of cementitious particle which are loosely bonded, the proper bonding between the fresh cement with the old concrete waste was not very good as original aggregate.
3. Flow ability of SCC decreases with the increase in the % age of RHA & DCW which is concluded by Slump flow test and V funnel test.
4. Blocking reinforcement of SCC decreases by the increase in the % age of RHA & DCW which is concluded by L Box test.
5. The passing ability of SCC is increased by increase in % age of RHA.

6. Though there is no increase in strength with partial replacement combination we suggest this because, if we go on utilizing the natural resources they will be lost in few decades.
7. Thus, waste was utilized and makes more environmentally friendly.

SCOPE FOR FURTHER STUDY

The following experimental studies can be conducted in future with respect to Self-compacting concrete,

- The effect of partial replacement of rice husk ash & demolished concrete waste on the durability characteristics of self-compacting concrete containing more than three admixtures.
- The effect of high temperature on the properties of self-compacting concrete containing more than three admixtures with rice husk ash and demolished concrete waste.
- The effect of partial replacement of rice husk ash & demolished concrete waste on the shrinkage and the creep properties of self-compacting concrete containing more than two admixtures.
- Similarly, there are lot more mineral admixtures which are the wastage of the industry. The other type of ingredients wastages used for manufacturer of concrete to reduce the problems of environmental attack.

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