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Mechanical Behaviour of Self Compacting Concrete by using M-sand & Rice Husk ash

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Abstract:- ***Rice husk ash (RHA) is an agricultural based pozzolanic material, which contains high amount of silica content. This experimental research was conducted on Self Compaction Concrete (SCC), to generate an economical concrete by using Manufactured Sand (M-sand) and Rice Husk Ash. Natural River sand usage is damaging the river beds, causing the drastic changes in ground water table and cost of river sand increasing day by day. To overcome this problems manufactured sand is used in SCC production. Rice husk Ash is very cheaper when compared to the Cement. It is extracted from Rice Husk which is a waste of Agricultural product. This material can be useful to generate a sustainable construction material. This paper presents the experimental results on development of mechanical properties of SCC with M-sand and Rice Husk Ash. Experiment conducted on 6 different mixes. i.e Partial Replacement with RHA (0%, 5%, 10%, 15%, 20%, 25%). For each mix Fresh properties (Slump flow & L-Box Test) & mechanical properties (Compressive strength, Split Tensile strength and Flexural strength) for 7days, 28days and 60days along with Density comparisons are compared.***

Keywords:- ***Self compacting Concrete, Rice Husk Ash, M-sand.***

I.INTRODUCTION

Self-Compacting Concrete was first developed in japan in 1988 for dense reinforced, Skin reinforced structures and deep shafts. SCC can flow through dense reinforcement under its own weight without any segregation and bleeding. It does not require any vibration. Due to its own weight it can flow and spread uniformly throughout the enclosed area.

Sand is major construction material. Day by day usage of concrete is increasing, accordingly sand mining is also increasing. This is also a threat to the biodiversity. Due to the heavy usage of sand, River beds losing their natural properties and ground water level decreasing. Manufactured sand is an alternative material to the Natural sand. It was more angular in shape and also cubical, which gives better strength and more interlocking capacity than natural sand. Its cost is very less when compared to the natural sand. 100% Replacement of Natural river sand is replaced by M-sand showing 19% more compressive strength & other mechanical properties also increasing [1]. Rice husk ash is highly reactive pozzolona which is a bi-product of Agriculture waste. Rice Husk contains high silicon during burning process it produces silica with oxygen. Silica is responsible for strength.

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RHA has high amount of Silica content. Using of RHA economize the construction materials. RHA having less density so concrete density also decreases. RHA improving the Strength properties within 90 days and giving acceptable results for workability tests as for EFNARC Guidelines [2].

II.MATERIALS USED

A. Cement

In this work Ordinary Portland Cement of 53 grade is used. It confirmed to requirements of IS:1229-1987. Physical properties of cement is as shown in Table.1.

Table.1 Physical properties of Cement

S.No	Property	Details
1	Specific gravity	3.12
2	Fineness	8%
3	Normal consistency	28%
4	Initial Setting time	37min
5	Final Setting time	450min

B. Mineral Admixture

Rice Husk Ash:-

It is collected from brick Manufacturers, Grinded and Sieved to required size. Specific gravity of RHA is 1.83 and grey in colour. Loss on ignition is 5%. Chemical properties of RHA is as shown in Table.2

Fig.1 Rice Husk Ash

Fig.2 GGBS

GGBS:-

GGBS is obtain by grinding Blast furnace slang. It is collected from nearest steel plant.

Its Specific Gravity is 2.8. Chemical properties of GGBS is as shown in Table.2

Table.2. Chemical Properties of RHA & GGBS

S. No	Compound	% By total mass	
		RHA	GGBS
1	SiO_2	92.39	35.4
2	Al_2O_3	0.54	13.97

3	Fe_2O_3	0.91	0.87
4	MgO	0.87	8.65
5	CaO	1.32	39.37
6	Others	3.97	1.74

C. Fine Aggregate

M-sand is used as Fine aggregate. Their properties are as shown in Table.3.

D. Coarse Aggregate

Maximum 12mm size Crushed aggregate is used for the preparation of SCC. Properties of Coarse aggregates are as shown in Table.3

Table.3 Properties of M-sand & Coarse Aggregates

Property	M-sand	C.A
Bulk Density (kg/m^3)	1580	1502
Specific Gravity	2.83	2.6
Surface water (%)	0.5	0.5
Water Adsorption (%)	5	0.2

All test on aggregates are conducted as per IS:2386(Part-3)-1963.

E. Super Plasticizer

MasterEase 3709 super plasticizer was used in this experiment. This plasticizer is the product of BASF. This plasticizer also contain viscosity modifying agents (VMA). VMA reduces the friction between particles and give high workability. It is available in liquid form and brown in colour.

F. Water

For mixing water should be free from impurities, oils, salts and acids. pH value should not be less than 6. It fulfil the requirements of IS:456-2000.

Fig.3 Super Plasticizer

III.III. MIX DESIGN

Nan-Su method of mix design is used for the SCC mix. It is a trial and error method. The mix which satisfy the requirements of fresh concrete are cured for 28days. Final mix design decided by its 28days Strength.

Final mix Design:-

Grade of concrete = M40

Cementitious material = 350+110 Kg/m^3

(Cement+GGBS)

Fine Aggregate (M-sand) = 920 Kg/m^3

Coarse Aggregate (10mm) = 807 Kg/m^3

Super plasticizer =1% of Total Binder

w/c ratio =0.3

Mix Proportions:-

Six mixes with 0%, 5%, 10%, 15%, 20%, 25% replacement of Cementitious material by RHA is used. They are designated as M-1, M-2, M-3, M-4, M-5 & M-6. Mix-1 is used as Conventional mix when comparing strength properties. Cementitious material contents are as shown in Table.4.

Table.4 Cementitious material contents

Mix	Cement (Kg/m^3)	GGBS (Kg/m^3)	RHA (Kg/m^3)
M-1	350	110	0
M-2	332.5	104.5	23
M-3	315	99	46
M-4	297.5	93.5	69
M-5	280	88	92
M-6	262.5	82.5	115

For each mix coarse aggregate is 920Kg/m^3 and M-Sand is 807Kg/m^3 are fixed. Percentage of Super Plasticizer dosage is 1% and w/c ratio is 0.3.

Specimen Used:-

A total of 162 specimen are casted where 54 no. of cubes are used to conduct the Compressive Strength, 54 no. of Cylinder used for Split Tensile Strength and 54 no. of Beams are used for the Flexural Strength

IV.EXPERIMENTAL RESULTS

Each mix tested for Fresh concrete properties and Hardened properties. Fresh properties of SCC are tested as per EFNARC Guidelines. Fresh properties of SCC are Flowing ability, passing ability & Filling ability which are decided by slump flow test, V-funnel test & L-box test respectively. Fresh properties are as shown in Table.5.

Table.5 Fresh Properties of SCC

Property	M-1	M-2	M-3	M-4	M-5	M-6
Slump (mm)	650	630	615	590	570	555
L-box (ratio)	0.9	0.86	0.81	0.75	0.7	0.64
V-funnel (sec)	10	11	12.5	14	16	18

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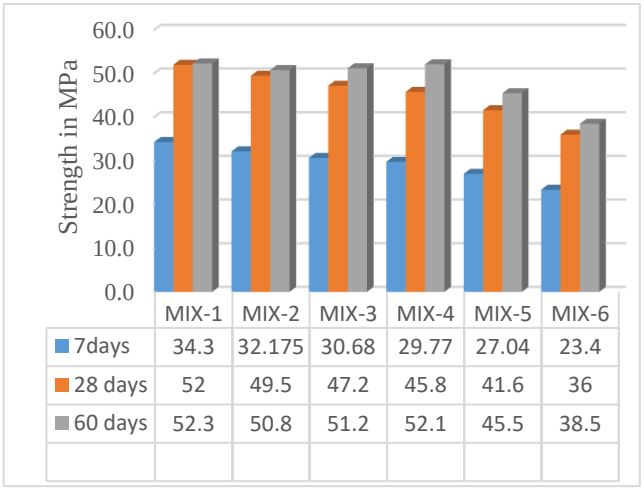
Hardened Properties:-

Strength test on concrete are conducted as per IS:516-1959. Compressive Strength, Split Tensile Strength and Flexural Strengths are shown graphically below. Each property tested for 7day, 28days and 60 days.

Compressive Strength

Compressive strength of concrete is strength of 150mm cube. It is calculated from 100mm cube by multiplying 100mm cube strength by conversion factor 0.9. At specified curing day cubes are tested by CTM and get compressive load from that compressive Strength calculated. Resulting Compressive strength data is as shown in the Fig.4.



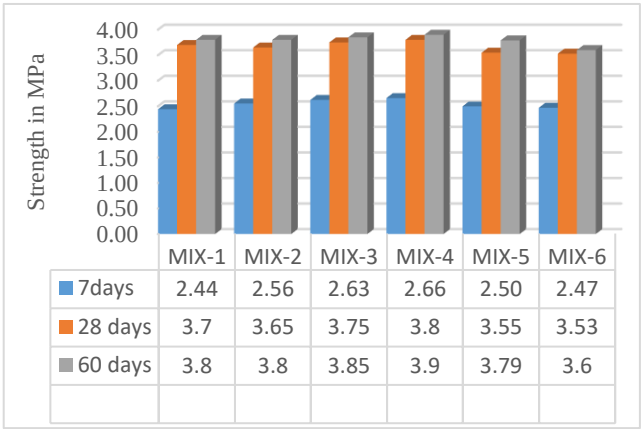
	MIX-1	MIX-2	MIX-3	MIX-4	MIX-5	MIX-6
7days	34.3	32.175	30.68	29.77	27.04	23.4
28 days	52	49.5	47.2	45.8	41.6	36
60 days	52.3	50.8	51.2	52.1	45.5	38.5

Fig.4 Compressive Strength of concrete

Reactivity of Mix-4 is high after 28 days, and it gained full strength as much of conventional one when compared with all other mixes Compressive Strength.

Split Tensile Strength

Cylinder with 100mm diameter and 200mm height is used for Split tensile test because maximum size of coarse aggregate used is 12mm. Cylinder casted and cured for 28 days. At specified curing day Cylinder tested by CTM and get load. From that loads Split Tensile Strengths are calculated by using Specified formula. Split tensile strength data is as shown in the Fig.5.



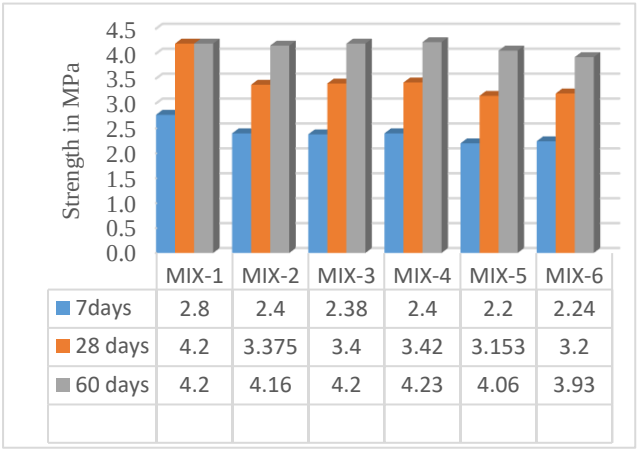
	MIX-1	MIX-2	MIX-3	MIX-4	MIX-5	MIX-6
7days	2.44	2.56	2.63	2.66	2.50	2.47
28 days	3.7	3.65	3.75	3.8	3.55	3.53
60 days	3.8	3.8	3.85	3.9	3.79	3.6

Fig.5 Split Tensile Strength of concrete

Split Tensile strength of all mixes are in one range but 15% replacement showing slightly more strength for 28 & 60 Days.

Flexural Strength

Beam with 100mm Square cross section and 500mm length are casted and cured for specified days for Flexural strength and tested for four point loading using Flexure Testing Machine. The obtained Flexural strengths are as shown in the Fig.6.



	MIX-1	MIX-2	MIX-3	MIX-4	MIX-5	MIX-6
7days	2.8	2.4	2.38	2.4	2.2	2.24
28 days	4.2	3.375	3.4	3.42	3.153	3.2
60 days	4.2	4.16	4.2	4.23	4.06	3.93

Fig.6 Flexural Strength of concrete

Flexural strength of Mix-4 got more Strength than conventional mix for 60 days and 28 day strength also in allowable range only.

V.CONCLUSION:

1. Workability of SCC decreases with an increase in percentage Replacement of Cementitious material with RHA. All mixes except M-6 satisfying the SCC fresh properties as per EFNARC guidelines.
2. By using RHA Self weight of structure also decreases because each 5% replacement of RHA, 0.56% weight is decreasing.
3. Strength variations clearly showing that the Mix -4 is better for long term strength requirements.
4. The mix with 15% replacement is most suggestible and weight of this mix is 1.7% less compared to the conventional mix.
5. 15% replacement of cement by RHA giving light weight and economical concrete.

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List of codes:-

[1] IS12269:1987 Specification For 53 Grade Ordinary Port Land Cement
[2] IS 2386-3 (1963)_ Methods of test for aggregates for concrete, Part 3
[3] IS 12269 : 2013 Ordinary Portland Cement, 53 Grade — Specification
[4] IS : 516 - 1959 Methods Of Tests For Strength Of Concrete
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AUTHORS PROFILE

Dr.V.Mallikarjuna Reddy,has received Ph.D JNTU Hyderabad, Telangana.He has over 31Years of teaching & 1 year of industrial experience.He is actively involved in Research work for the last 8 years. He worked in TGLG Polytechnic ADONI for 16 years and for 4years in ERITREA(NE AFRICA). He worked for JNTUH College of Engineering as Visiting Faculty for PTPG Structural Engineering for 5years. Presently he working as Professor& HoD of Civil Engineering Department in Gokaraju Rangarau Institute of Engineering and Technology.

B.Bhaskar,has completed Engineering from JNTUH College of Engineering, Manthani, Telangana, in the batch of 2012-2016 with first class degree. Presently pursuing masters in Structural Engineering Gokaraju Rangaraju Institute of Engineering and Technology (Hyderabad) attentively interested to conduct mechanical behaviour of self-compacting concrete by using M-sand & Rice Husk Ash.