Investigation on Sustainable Concrete using Manufactured Sand & Rice Husk Ash

A. Jyothiprasanna[1] K. G. Rahul Varma[2]
[1]P.G Student [2]Assistant Professor
[1,2]Department of Civil Engineering
[1,2]AnnamacharyaInstitute of Technology & Sciences, Tirupati, India

Abstract— As we know that concrete is the second largest consumed material by humans in the entire world after water. If its consumption is done at the same rate, it may get exhausted in the coming future. So we have to find alternatives to replace concrete. Or else as we know that concrete is a mixture of cement, sand and gravel. We can preserve concrete by finding replacement material for cement, sand or gravel which can give same or more strength to concrete. In past, already many replacements were done by many people for cement, sand and gravel to make better concrete. The present proposal involves replacement of river sand with manufactured sand by 25%, 50%, 75%, 100% and cement with rice husk ash by 10% to get good strength concrete. Use of manufactured sand and Rice husk ash in concrete as replacement for sand and cement respectively is very rare and as both the materials are easily available and are of low cost. It would become the best replacement if it gives good strength concrete.

Key words: Manufactured Sand, Rice Husk Ash; Compressive Strength; Ultrasonic Pulse Velocity; Rebound Number, Water Absorption, Acid Resistance

I. INTRODUCTION

Concrete is the most used construction material due to its structural stability and strength. Materials used for making concrete come from the earth's crust. Thus, it depletes its resources every year creating ecological strains. On the other hand, human activities on the Earth produce solid waste in considerable quantities of over 2500/MT per year, including industrial wastes, agricultural wastes and wastes from rural and urban societies. Recent technological development has shown that these materials are valuable as inorganic and organic resources and can produce various useful products. Amongst the solid wastes, the most prominent ones are fly ash, blast furnace slag, rice husk, silica fume and demolished construction materials. From the middle of 20th century, there had been an increase in the consumption of mineral admixtures by the cement and concrete industries.

The increasing demand for cement in concrete is met by partial cement replacement. Substantial energy and cost savings can result when industrial by-products are used as a partial replacement for the energy intense Portland cement. The use of by-products is an environmental friendly method of disposal of large quantities of materials that would otherwise pollute land, water and air. Most of the increase in cement demand will be met by the use of supplementary cementing materials. Sand is the one of main constituents of concrete making which is about 35% of volume of concrete used in construction industry. Natural sand is mainly excavated from river beds and always contain high percentage of in organic materials, chlorides, sulphates, silt and clay that adversely affect the strength, durability of concrete & reinforcing steel there by reducing the life of structure, when concrete is used for buildings in aggressive environments, marine structures, nuclear structures, tunnels, precast units, etc. Digging sand, from river bed in excess quantity is hazardous to environment. The deep pits dug in the river bed, affects the ground water level. Erosion of nearby land is also due to excessive sand lifting. In order to fulfill the requirement of fine aggregate, some alternative material must be found.

Now-a-days good sand is not readily available and these resources are also exhausting very rapidly. Because of its limited supply, the cost of Natural River sand has sky rocketed and its consistent supply cannot be guaranteed. It is also being transported from a long distance, so it is a necessary to find some substitute to natural river sand. The artificial sand produced by proper machines can be a better substitute to river sand. The sand must be of proper gradation (it should have particles from 150 microns to 4.75 mm in proper proportion) and such sand will have few voids and will be more economical as cement quantity required will be less. Demand for manufactured fine aggregates for making concrete is increasing day by day as river sand cannot meet the demands in construction. River sand is not graded properly and has excessive silt and organic impurities and these can affect the durability in concrete whereas manufactured sand has no silt or organic impurities.

II. EXPERIMENTAL WORK

The main objective of this work was to study the suitability of Rice husk ash and manufactured sand as replacement materials of cement and river sand respectively. Preparation of M20 mix as per IS 10262:2009. Prepare the concrete mix by using RHA and M-Sand.

A. Objective

1) Effect of RHA and M-Sand on compressive strength of concrete.
2) Effect on material properties of concrete.
3) Effect on Surface hardness of concrete.
4) Effect of water absorption on concrete.

III. MATERIALS

In this project, RHA and M-Sand were used as replacement materials of cement and river sand. The physical and chemical properties of cement and RHA are tabulated in Table 1.

Particulars	cement	RHA
Chemical composition		
% Silica(SiO_2)	20.65	86.94

% Alumina(Al_2O_3)	5.67	0.2
% Iron Oxide(Fe_2O_3)	0.51	0.1
% Lime(CaO)	61.81	2.2
% Magnesia(MgO)	2.6	0.5
Physical properties		
Specific gravity	3.15	2.3
Fineness (m^2/Kg)	311.5	285.7

43 grade ordinary Portland cement was used to conforming to IS 12269:1987. Manufactured sand was as fine aggregate and crushed granite stones of size 20 mm and 12 mm were used as coarse aggregate. The bulk specific gravity in oven dry condition, water absorption of the coarse aggregate 20 mm and 12mm and fineness modulus of CA were 2.65, 0.5% and 7.69 respectively. The bulk specific gravity in oven dry condition, water absorption of the sand and fineness modulus were 2.58, 1% and 2.61 respectively.

IV. Mix Design

The design of M20 grade concrete is done by using IS 10262 – 2009 code method and is as follows:

Materials	Quantity	Ratio
Cement	350	1
Fine aggregate	693	1.98
Coarse aggregate	1161	3.3
Water	182	0.52

Table 2: Mix ration of concrete

S.no	Mix name	% of RHA	% of M-Sand
1	M0	0	0
2	M1	10	25
3	M2	10	50
4	M3	10	75
5	M4	10	100

V. Results & Discussion

A. *Compressive strength test*

The compressive strength was conducted on cubical specimens after 7, 14 and 28 days curing period. The test results were tabulated in table 4 and plotted in figure 1. The compressive strength (N/mm^2) = Failure load/cross sectional area.

S.no	Mix name	Compressive strength(N/mm^2)		
		7 days	14 days	28 days
1	M0	14.89	18.76	22.62
2	M1	17.33	20.22	23.73
3	M2	16.67	17.73	21.57
4	M3	16.31	17.46	17.89
5	M4	12.44	12.67	12.93

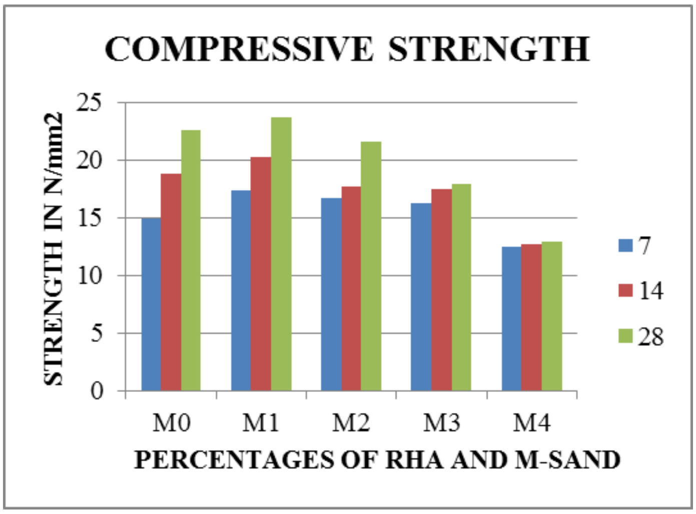

Fig. 1: Compressive strength versus age

It has been observed that, after replacement of cement with 10% of rice husk ash and river sand with manufactured sand in normal concrete there is about 5% increase in compressive strength as compare to normal concrete. Afterwards the compressive strength starts decreasing. Therefore the maximum compressive strength can be obtained by replacing cement with 10% RHA and river sand with 25% M-Sand.

B. *Ultrasonic pulse velocity test*

Ultrasonic pulse velocity test was conducted on concrete cubes at periods of 7, 14 and 28 days. The test results were tabulated in table 5 and plotted in figure 2. Pulse velocity = (path length/travel time).

S.no	Mix name	Pulse velocity(m/s)		
		7 days	14 days	28 days
1	M0	3623	3906	4121
2	M1	4121	4291	4445
3	M2	3759	3856	4011
4	M3	3623	3667	3958
5	M4	3417	3580	3807

Table 5: Ultrasonic pulse velocity test results

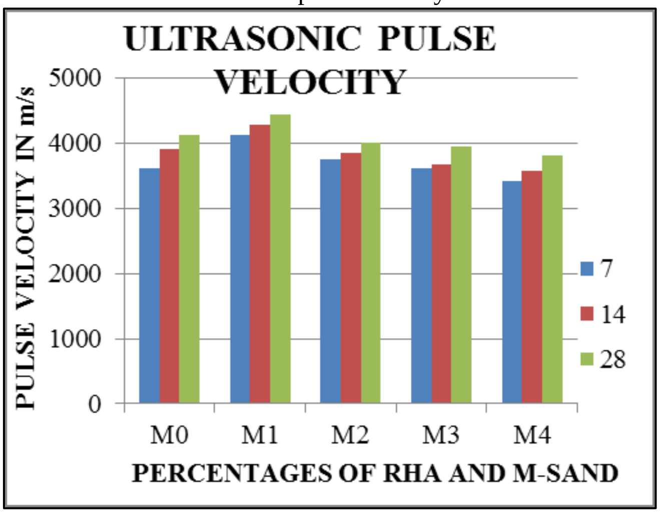

Figure 2: Ultrasonic pulse velocity versus age

It has been observed that after replacement of cement with 10% rice husk ash and river sand with 25% manufactured sand in normal concrete there is about 8%

increase in ultrasonic pulse velocity as compared to normal concrete. Afterwards it is starts decreasing. Therefore the maximum results can be obtained by replacing cement by 10% RHA and river sand with 25% M-Sand.

C. Rebound Hammer Test

The rebound hammer test was conducted on cubical specimens of 7, 14 and 28 days curing period. The test results were tabulated in table 6 and graph was plotted between compressive strength and rebound number in figure 3.

S.no	Mix	Rebound number		Compressive strength	
		7 days	28 days	7 days	28 days
1	M0	18.33	20.33	14.89	22.62
2	M1	19.55	21.67	17.33	23.73
3	M2	18.67	20.44	16.67	21.57
4	M3	18.33	19.44	16.31	17.89
5	M4	18	19	12.44	12.93

Table 6: Rebound hammer test results

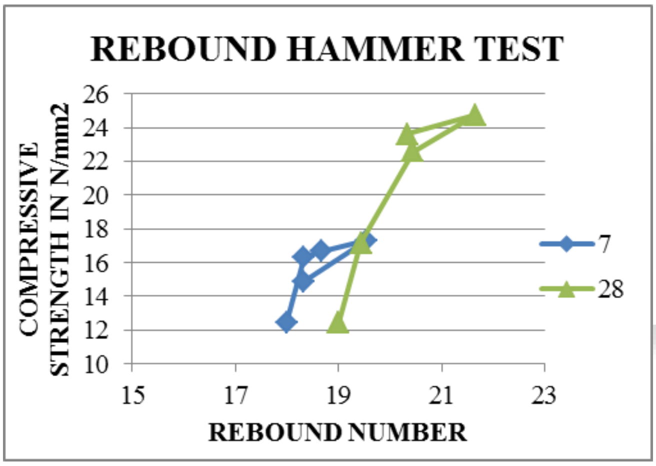

Figure 3: Compressive strength versus rebound number

From the test results observed that after replacement of cement with 10% RHA and river sand with 25% M-Sand in normal concrete there is 7% increase in rebound value as compared to normal concrete. Afterwards it is starts decreasing. Therefore the maximum results can be obtained by using 10% RHA and 25% M-Sand.

D. Water absorption test

Water absorption test was conducted on cylindrical specimens at 7, 14 and 28 days curing period. The test results were tabulated in table 7 and plotted in figure 4.

S.no	Mix name	% Water absorption		
		7 days	14 days	28 days
1	M0	5.83	4.97	4.21
2	M1	6.69	5.23	4.86
3	M2	7.04	6.52	6.51
4	M3	7.27	7.13	7.09
5	M4	7.42	7.89	8.01

Table 7: Water absorption test results

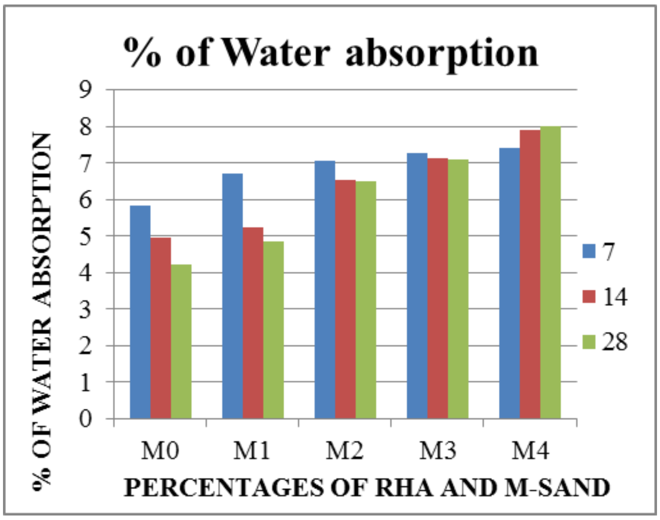

Fig. 4: % of water absorption of concrete mixes

From the test results, it can be concluded that as % of manufactured sand is increased then % of water absorption is also increased to large extent as compared to normal concrete mix where water absorption is less. Presence of rice husk ash and increase in M-Sand increases the % of water absorption when compared to normal concrete mix.

VI. CONCLUSIONS

Based on the results of this experimental investigation, the following conclusions can be drawn:

1) From the test results, it can be concluded that, replacement of cement by 10 % RHA and river sand by 25% manufactured sand gives the optimum results.
2) Compressive strength, Ultrasonic pulse velocity and rebound values are increased up to M1 mix (10% of RHA and 25% of M-Sand) and decreased afterwards. Water absorption values kept increasing from M0 to M4.
3) The compressive strength test result of mix M1 on 28th day showed 5% increase in strength when compared with normal mix M0.
4) Ultrasonic pulse velocity test result of mix M1 on 28th day showed 8% increase in velocity when compared with normal mix M0.
5) Rebound hammer test result of mix M1 on 28th day showed 7% increase in rebound value when compared with normal mix M0.
6) Percentage of Water absorption is more for mixed concrete compared to Normal concrete.
7) Effective utilization of RHA and M-Sand in concrete can save natural resources and hence can help to keep our environment safe.

REFERENCES

[1] Makarand Suresh Kulkarni, Paresh GovindMirgal, Prajyoth Prakash Bodhale, S.N. Tande. "Effect of rice husk ash on properties of concrete". Journal of civil engineering and environmental Technology, Vol. 1, pp: 26-29, 2014.

[2] Keerthana.B, Gobhiga.S. "Experimental study on concrete with partial replacement of cement with Rice

husk ash and Fine aggregate with granite dust". Engineering science and technology an international journal. Vol. 6, pp: 36-41, 2016.

[3] S.D.Nagrale, Dr.Hemant Hajare, R.Pankaj, Modak. "Utilization of rice husk ash". International journal of engineering research and application. pp: 001-005, 2012.

[4] M.Adams joe, A.Maria Rajesh, P.Brightson, M.Prem Anand. "Experimental investigation on the effect of manufactured sand in high performance concrete". American journal of engineering research. Vol. 2, pp: 46-51, 2013.

[5] HuajianLi ,Fali Huang. "Effect of granite dust on mechanical and some durability properties of manufactured sand concrete, Construction and Building materials", 109, pp: 41-46, 2016.

[6] XinxinDing ,Changyong Li. "Experimental study on long-term compressive strength of concrte with manufactured sand,Construction and Building materials", 108, pp: 67-73, 2016.

[7] A.JayaPrithika , S.K. Sekar. "Mechanical and fracture characteristics of eco-friendly concrete produced using manufactured sand,Construction and Building materials", 103 , pp: 1-7, 2016.

[8] Amir Modarres, ZeinabHosseini. "Mechanical properties of roller compacted concrete containing rice husk ash, Material & Design", 64, pp: 227-236, 2014.

[9] GritsadaSua-iam,NattMakul. "Utilization of high volumes of unprocessed lignite-coal fly ash and rice husk ash in self consolidating concrete, Journal of cleaner production", 78, pp:184-194, 2014.

[10] A.L.G. Gastaldini, M.P. da Silva. "Total shrinkage,chloride penetration, and compressive strength of concretes that contain colored rice husk ash, Construction and Building materials", 54, pp: 369-377, 2014.

[11] IS 10262-2009 recommended guidelines for concrete mix design.

[12] IS 10262-1982 IS recommended for guidelines for concrete mix design .

[13] IS 456 – 2000, "Plain and reinforced concrete – code of practice", Bureau of Indian Standards, New Dehi, India.

[14] ASTM C 597-02, Standard test methods for pulse velocity through concrete. ASTM International, West Conshohocken, USA, 2002.

[15] M.S shetty,concrete technology, Chand.S and co.ltd, India.