Use of Ash of Agricultural Waste as Partial Replacement of Cement in Concrete (Rice Husk Ash, Saw Dust Ash, Wheat Straw Ash)

Samant Thakur, Sanjay Saraswat, Devansh Jain

Abstract— **Recent trend of technology is towards waste utilization and cost reduction in construction industries. In today's construction industry concrete is major and versatile building material and in concrete, cement is the most expensive material and to reduce its cost Agricultural waste is introduced in concrete. Rice Husk Ash (RHA), Wheat Straw Ash (WSA) and Saw Dust Ash (Ash) is introduced as a partial replacement of concrete. Rice Husk Ash (RHA), Wheat Straw Ash (WSA) and Saw Dust Ash (Ash) is replaced by cement upto 30% in concrete and their comparative is study is done on basis of their compressive strength and workability.**

Index Terms—**Concrete, Rice Husk Ash, Wheat Straw Ash, Saw Dust Ash, Cement**

I. INTRODUCTION

Concrete is a most widely used building material which is a mixture of cement, sand, coarse aggregate and water. It can be used for construction of multistory buildings, dams, road pavement, tanks, offshore structures, canal lining. The procedure of selecting suitable ingredients of concrete and determining their relative amount with the aim of bringing forth a concrete of the required strength, durability and workability as economically as possible is termed the concrete mix design. The compressive strength of hardened concrete is generally taken to be an index of its other properties depends upon many factors e.g. Quality and quantity of cement, water and aggregates batching and mixing, placing compaction and curing. The cost of concrete made up of the cost of materials, plant and labour the variation in the cost of material arise from the fact that the cement is several times costly than the aggregates thus the aim is to produce a mix as possible from the technical point of view the rich mixes may lead to high shrinkage and cracking in the structural concrete and to evolution of high heat of hydration is mass concrete which may cause cracking [4]. The actual cost of concrete is related to cost of materials required for producing a minimum mean strength called characteristic strength that is specified by designer of the structures[4].

Rice Husk is one of the most widely available agricultural wastes in many rice growing nations around the world, Globally, approximately 600 million tons of rice pad are made each year, On average, 20% rice paddy is husk giving a total output of 120 million tons [1]. The utilization of RHA as a pozzolanic material in cement and concrete provides several advantages, such as improved strength and strength properties, reduced materials cost due to cement savings, and environmental benefits related to the disposition of waste materials [2].

Sawdust is an organic waste resulting from the mechanical milling or processing of lumber (wood) into diverse configurations and sizes. The debris is normally employed as domestic fuel. The resulting ash known as saw-dust ash (SDA) is a form of pozzolana. Dry sawdust concrete weighs only 30% as a good deal as normal weight concrete and its insulating properties approximate those of wood. With proper cement to sawdust ratios, it is non inflammable. Every bit a basic construction material, sawdust concrete does indeed have its uses. Sawdust is in abundance in North Eastern India (Meghalaya) and other regions of the globe. Experimental work to assess the behavior of concrete properties both in plastic and hardened states with the inclusion of various waste products such as fly ash, coconut ash, Rice hush ash are available in the technical literature. Sawdust has been used in concrete for at least 30 years, but not widely. Although seriously limited by its low compressive strength, sawdust concrete can be induced to execute easily in certain floor and wall applications [3].

What is the chief agricultural product produced in Turkey and worldwide. It is calculated that world cereal output is close to 880 million tons, of which 550 million tons is wheat straw. The quantity of wheat straw production is 2.0– 2.8 tons/ha. The approximate quantity of wheat straw is 19–27 million tons in Turkey, according to the State Institute of Statistics. Straw is a yearly plant that belongs to monovalve class in Gramineae family. Body (straw) is either simple or a group that is 35–100 cm in length, straight and completely plain or covered with bristles on the beans. It grows on volcanic areas, hill slopes, steppes, and bare lands at various climates. The wheat plant has five main morphological parts: nods, internods, leaves, grains, and grain axis. The straws consist of C, H, O, N, Si, Fe, Al, Ca, Mg, Na, K, P, Cu, Mn, and Zn in various proportions. Straw has varying amounts of water, protein, oil, extractive material fiber, pentosan, cellulose, lignin, and ash. Leaves, guides, and nods contain high amount of silica. Proportions of the mor- phological parts vary depending on the wheat type, ecologi- cal conditions, and harvest height from ground [5].

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Samant Thakur, [1]M.E. Scholar, Samrat Ashok Technological Institute, Vidisha, M.P., India

Sanjay Saraswat, Assistant Professor, Samrat Ashok Technological Institute, Vidisha, M.P., India

Devansh Jain, Assistant Professor, UIT-RGPV, Bhopal , M.P., India

II. METHODOLOGY

A. Material Used

1. **Cement:** Ordinary Portland Cement of Grade 53 is used, which conforming IS 12269. 53 grade cement of ultra tech with a remarkably high CS3 (tricalcium providing long-lasting) durability of concrete constructions. Produces highly durable and sound concrete due to really low percentage of alkalis chlorides, magnesium oxide;
2. **Fine Aggregate**: Natural river sand conforming to Zone II as per IS 383 (1987) was employed. The fineness modulus of sand used is 2.64 with a specific gravity of 2.59.
3. **Coarse aggregate**: Crushed granite coarse aggregate conforming to IS: 383 (1987) was used. Coarse aggregate of size 20 mm down having the specific gravity of 2.77 and fineness modulus of 7.21 was used.
4. **Rice Husk Ash:** Rice hulls (or rice husks) are the hard protecting coverings of grains of rice. In addition to protecting rice during the growing season Rice husk is removed from the Bhagrava Krishi Farm, Vidisha where rice is removed from the farm and then with the help of thrasher rice and rice husk are separated, and then this rice husk burns. The combustion operation of rice husk continues approximately 48 hours. After 48 hours rice husk ash remains untouched for 12 hours due to the cooling process. Then rice husk ash goes through a mechanical operation of grating to make rice husk fine, because finer husk gives better resolution when it is replaced by cement in concrete.
5. **Wheat Straw Ash:** Wheat straw is an agricultural by-product, the dry stalks of wheat plants, after the grain and chaff have been removed. Wheat Straw makes up almost half of the yield of cereal crop. It holds many usages, including fuel, livestock bedding and fodder, thatching and basket-making. It is usually pulled together and stored in a straw bale, which is a pile of straw tightly bound with string or wire. Bales may be square, rectangular, or unit of ammunition, depending on the type of baler used. Wheat straw is taken from Mr. Ravindra Dangi farm and then they are gone burning process which continues for 1 hour and cooling process takes home in approximately 1 hour. Later on the cooling process wheat straw ash goes through the mechanical operation of grating to make wheat straw ash more finer which accelerate test results when it is replaced by cement in concrete.
6. **Saw Dust Ash:** Sawdust or wood dust is a by-product of cutting, grinding, drilling, sanding, or otherwise pulverizing wood with a saw or other tool; it is composed of fine particles of wood. Sawdust or wood waste is taken Yadav furniture and sons, Vidisha where furniture of different type are constructed on a large shell. Sawdust is collected and then burning process of saw dust continues for 18 hours and cooling operation of saw dust continues for 10 hours and saw dust ash are ready to apply.
7. **Water:** Water used in paver blocks is conforming the specification of IS 456 : 2000. Water applied for mixing is free from injurious amount of oils, acids, bases, salts, sugar, organic materials or other sums that may be deleterious to concrete.

B. **Mix Proportion:** Mix design of the concrete is done strictly as per the stipulation of the IS 10262 : 2009. According to IS code specification mix of M40 grade is designed, 10 different types of mix are prepared with different part of RHA, SDA and WSA. CC mix is prepared with 0% of cement replacement or we can also pronounce it is controlled concrete. The epithet of the mix and their description is presented below in table 1.

S.No.	Mix Name	Mix Description
1	RHA10	10% cement is replaced by RHA
2	RHA20	20% cement is replaced by RHA
3	RHA30	30% cement is replaced by RHA
4	SDA10	10% cement is replaced by SDA
5	SDA20	20% cement is replaced by SDA
6	SDA30	30% cement is replaced by SDA
7	WSA10	10% cement is replaced by WSA
8	WSA20	10% cement is replaced by WSA
9	WSA30	10% cement is replaced by WSA
10	CC	Controlled Concrete

Table 1: Description of Different mix of Concrete

Casting And Curing: Concrete cube of 15cm*15cm*15cm is casted according to IS 516 : 1959.For each mix there is 3 + 3 cubes(3 for 7 days of curing and another 3 for 28 days of curing) was casted and average of three was noted as a final result of the compressive strength. Curing is done strictly as per the specification of IS 156 : 1959, curing is done at the room temperature in curing tank filled with normal clean water up to 28days.

C. Test Performed

1. **Compressive Strength:** compressive strength is the capacity of a material or social system to withstand loads tending to reduce size. It can be measured by plotting applied force against deformation in a testing machine. Some material fracture at their compressive strength limit; others deforms irreversibly, so a given amount of distortion may be considered as the limit for compressive load. The compressive strength of concrete was determined using 150mm concrete cubes. The concrete was

made by replacing 10, 15, 20% of the coarse aggregate by recycling aggregate and Coconut shells. Also concrete cubes without RA and CS were cast in comparison. Compressive strength is often evaluated along a universal testing machine; these range from very small tabletop systems to ones with over 53 MN capacity. Measurements of compressive strength are affected by the specific test method and conditions of measurement. Compressive forces are usually identified in relation to a specific technical standard.

2. **Workability: Workability is one of the physical parameters of concrete, which involves the strength level and durability as well as the cost of labor and appearance of the finished product**. Concrete is said to be workable when it is easily placed and compacted homogeneously Slump cone test was conducted to determine the workability of concrete mix. Metal molds, in the shape of the frustum of a cone, open at both ends, and furnished with the handle, top internal diameter 4 in (102 mm), and bottom internal diameter 8 in (203 mm) with a height of 1 ft (305 mm). A 2 ft (610 mm) long bullet nosed metal rod, 5/8 in (16 mm) in diameter. The test is carried out employing a mold known as a slump cone or Abrams cone. The cone is placed on a strong non-absorptive surface. This cone is filled with fresh concrete in three stages, each time it is tamped using a pole of standard dimensions. At the end of the third form, concrete is struck off flush to the top of the mold. The mold is carefully lifted vertically upwards, so as not to shake up the concrete cone. Concrete subsides. This subsidence is termed as slump, and is appraised into the nearest 5 mm if the slump is <100 mm and measured to the nearest 10 mm if the slump is >100 mm.

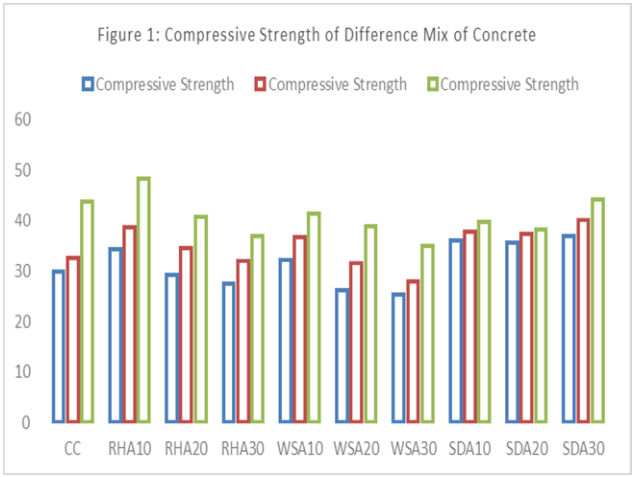
III. RESULT AND DISCUSSION

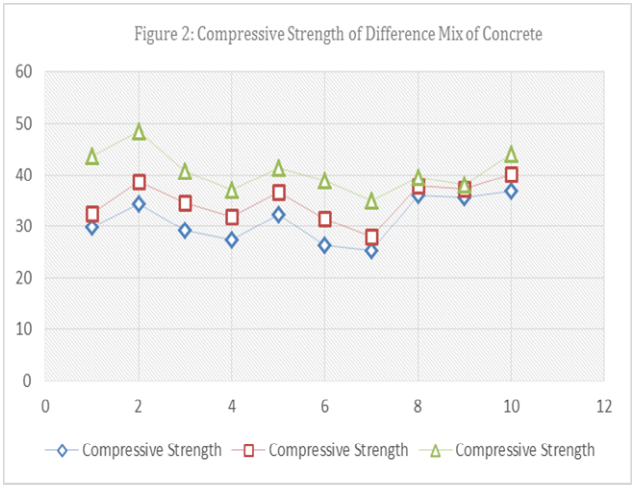
A. **Slump Cone Test:** To check workability of the concrete Slump cone test has been done on the various mixes of concrete and it has been found that ash of agricultural waste possess less workability when it mix in concrete, although the water cement ratio is strictly 0.4 so the slump cone test gives less reading and when we add waste material like WSA, RHA and SDA so workability goes down and slump cone test value varies 0-20mm.

B. **Compressive Strength Test:** Compressive Strength of Different mix is presented in table 1 and Figure 1 and 2. Although all material is usable because they gives better effects by replacing cement, but if we see RHA10, RHA20 and SDA 30 mix gives best result in compressive strength. Compressive strength of concrete cube is determined and it is found that all fabric at any part of mixing up to 30% gives satisfactory results where Rice husk Ash (RHA) gives 48.42, 40.86 and 37.05 for 10,20 and 30% replacement respectively, which is more than 85% of designed Fck. Where Wheat Straw Ash (WSA) does not give excellent resolution but it is satisfactory, it gives 41.42, 38.92 and 35.05 N/mm2 at 10,20 and 30% replacement respectively. And Saw Dust, ash (SWA) gives an average result as compare to above materials it posses 39.66, 38.21,44.21 N/mm^2 at 10,20 and 30% replacement respectively. Altogether these results are approximately 28 of curing. Compression strength testing is posted out after at 7th and 14th days of curing, it has been observed that 60% strength is gained by concrete curb at 7th day of curing and 80% strength is attained at 14 days of curing.

S. No.	Mix	Compressive Strength		
		7 Days	14 Days	28 Days
1	CC	29.91	32.61	43.71
2	RHA10	34.32	38.77	48.42
3	RHA20	29.34	34.56	40.86
4	RHA30	27.42	31.95	37.05
5	WSA10	32.32	36.77	41.42
6	WSA20	26.34	31.56	38.92
7	WSA30	25.42	27.95	35.05
8	SDA10	36.12	37.85	39.66
9	SDA20	35.64	37.36	38.21
10	SDA30	36.98	40.22	44.21

Table 1: Compressive Strength of Different mix of Concrete.





CONCLUSION

The effect of study shows that there are good prospects of using Rice husk Ash (RHA), Wheat Straw Ash (WSA), Saw Dust Ash (SWA) as a porcelain combination with ordinary Portland cement (OPC) in the Concrete cube. The M-40 grade concrete cube is cast and its compressive is determined. The combination of 10%, 20% and 30% cement replacement Mix is prepared by using all WSA, RHA and SWA for 0.4 water cement ratio. It shows that compressive increase with curing time. The compressive strength of concrete cube with fly ash gives tremendous results. Its FA10 and FA30 mix gives 52.9 and 52.77 N/mm2 compressive strength respectively which is amazing. Where Rice Husk Ash RHA10 mix gives excellent compressive strength, i.e. 54.2 N/mm^2. Wheat straw ash gives average results, they all mix are above 85% of limited intensity. Saw Dust Ash SDA30 mix posses good compressive strength, i.e. 49.6 N/mm^2. All mix gives more than 85% compressive strength so all waste mix can be used for concrete block. Equally if you want to select just one material then I will suggest RHA30 and SDA30 it gives good compressive strength and also save 30% also of the cementum. If any mix we want to select on the basis of compressive and there are some aspect on which we have to select mix and they are

1. Percentage replacement: we have taken maximum percentage replacement so that maximum cement can be saved and also prevent environment.
2. Compressive Strength: after percentage replacement we have look its compressive strength.

REFRENCES

[1] Ajay Kumar, Kalyani Mohanta, Devendra Kumar, Om praksh; "Properties and Industrial Application of Rice Husk: A Review "; International Journal of Emerging Technology and Advance Engineering; Volume 2,Issue 10, October 2012, pp 86-90; ISSN 2250-2459.

[2] V.Ramasamy; "Compressive Strength and Durability Properties of Rice Husk Ash Concrete"; KSCE Journal of Civil Engineering, Volume 16, Issue 1, pp. 93-102; www.springer.com/12205

[3] C.Marthong; "Sawdust ash (SDA) as Partial Replacement of Cement"; International Journal of Engineering Research and Applications; Volume 2, Issue 4, July – August 2012, pp. 1980-1985; ISSN 2248 – 9622.

[4] Devansh Jain, A K Saxena and Sanjay Saraswat; "A Review of Effect of Micro Silica in Concrete", Corona Journal of Science and Technology ISSN : 2319 – 6327 (Online), Vol. 3, No. I (2014), pp. 14-18 @Corona Publication http://www.coronapublication.com.

[5] Hasan Biricik, Fevziye Akoz, Ilhan Berktay, Ali N. Tulgar;"Study of Pozzolanic Properties of Wheat Straw Ash";Cement and Concrete Research,1999, pp. 637-643.

[6] Aman Jatale, Kartikey Tiwari, Sahil Khandelwal; "Effects On Compressive Strength When Cement Is Partially Replaced By Fly-Ash"; IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) e-ISSN: 2278-1684 Volume 5, Issue 4 (Jan. - Feb. 2013), pp. 34-43 www.iosrjournals.org.

[7]] IS 10262 : 2009 Bureau of Indian Standard, India.