Utilization of Rice Husk Ashand Waste Paper Sludge Ash as Partial Replacement of Cement in Concrete: A Review

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Abstract— Data Mining is the Process to extract knowledge from the data or data stream, Mining high utility itemsets focus on the itemset with high profit only, as data or itemset may be static or in a stream mine this type if data has become a significant research topic. In this research paper we have presented different methods available for mining high utility dataset , to develop algorithm for this requires logic to mine the high utility itemsets from data streams, We have compared following algorithms, One pass Algorithm, Two Phase Algorithm, Mining top k-Utility Frequent itemset, and Sliding window based algorithms like MHUI-BIT(Mining High Utility Itemset Based on BIT Vector), MHUI-TID(Mining High Utility Itemset based on TID-List) for lexicographical tree based summary data structure. And the FHM algorithm which we will used for our proposed work “Fast High Utility Miner) Using estimated utility Co-occurrence Pruning.

Key words: Rice Husk Ashand, MHUI-TID

I. Introduction

Concrete is one of the most widely used construction products in the world. It is mixture of cement, fine aggregate, course aggregate and water. Concrete construction does not require highly skilled labour. The durability of concrete depends upon proportioning, mixing and compacting of the ingredients. The cost of construction materials is increasing day by day because of high demand, scarcity of raw materials, and high price of energy. The advantages by incorporating these supplementary cementing materials include energy consumption saving (in cement production), low cost, engineering properties improvement, and environmental conservation through reduction of waste deposit. When these materials blended with cement and in the presence of water, they can react with Calcium Hydroxide ($Ca(OH)_2$) which forms in hydrated Portland cement to produce additional Calcium Silicate Hydrate (C-S-H). With the addition of the these pozzolanic materials, many aspects of concrete properties can be favorably influenced, some by physical effects associated with small particles which have generally a finer particle size distribution than ordinary Portland cement and others by pozzolanic and cementitious reactions resulting in certain desirable physical effects.

A. *Rice Husk Ash*

Rice husk ash (RHA) is a by-product from the burning of rice husk. Rice husk is extremely prevalent in East and South-East Asia because of the rice production in this area. The rich land and tropical climate make for perfect conditions to cultivate rice and is taken advantage by these Asian countries. The husk of the rice is removed in the farming process before it is sold and consumed. It has been found beneficial to burn this rice husk in kilns to make various things.

1) Properties of RHA

The utilization of rice husk for use as a cementations material in cement and concrete depends on the pozzolanic property of its ash. The pozzolanic reactivity of the ash is closely related to the form of silica present and the carbon content.

B. *Waste Paper Sludge Ash*

These days there is an increasing emphasis on a cleaner environment and maintaining the balance of the eco-system of the biosphere. It is generally believed that environmental protection with zero risk and economic growth do not go hand in hand, but at the same time it is also true that sustainable growth with environmental quality is not an unattainable goal. The problem is multi-dimensional and multifaceted and calls for integrated efforts by the industry, Govt. policy makers, environmental managers and development agencies to look into generation, disposal and utilization aspects.India produces over 300 million tonnes of industrial wastes per annum by chemical and agricultural process. These materials create problems of disposal, health hazards and aesthetic.

C. *Objective*

The main objectives of the present work are:

- To study the behavior of concrete for various proportion of RHA, WPSA and combination of both (RHA+WPSA) with the strength parameters and workability parameters.
- To examine the feasibility of using unprocessed rice husk ash and waste paper sludge ash to reduce the amount of cement.

D. *Problem Identification*

The methods for disposing of the straw and stubble residue remaining in the fields after harvest are either burning or baling. Although some limited uses of rice straw such as animal feed or paper making are maintained. But the remaining husks are transported back to field for disposal, usually by open field burning. As a result most farmers tend to burn the straw in open fields, boosting air pollution and serious human health problems due to the emission of carbon monoxide. Sludge consumes a large percentage of local landfill space for each and every year.

E. *Methodology*

- Tested the material properties as per Indian standards code (IS 383 – 1996) procedures.
- Mix design for concrete proportion has been developed as per IS 10262 – 1982.

- Casted and cured the concrete specimens as per Indian standards procedures.
- The characteristic strength of hardened concrete specimen was tested as per IS 456 – 2000.
- Finding the optimum strength of optimum replacement of hypo sludge as cement.

II. LITERATURE REVIEW

In this chapter, the work carried out by various investigators on the use of RHA, WPSA as partial replacement of cement for producing concrete and mortar are reviewed and presented.

Y.-m. Chun et al (July 11-13, 2005) Fibrous residuals generated from pulp and paper mills were included in concrete. By using proper amounts of fibrous residuals, water, and HRWRA, concrete mixtures containing the residuals were produced comparable to reference concrete mixtures (no residuals) in slump and compressive strength. In general, HRWRA was used in proportion to the amount of wood fibers in concrete. In general, the length change (drying shrinkage) of concrete mixtures containing the residuals was equivalent to that of the reference concrete mixtures.

Kartini.K (Nov.2011) studied the effect of partial replacement of OPC cement by RHA from 10% to 30% for M30, M40 and M50 and tested the cubes at 28, 60, 90 and 120 days after curing in water. For the durability performance he conducted the water permeability, water absorption and rapid chloride ion penetration (RCPT).

Satish Kumar et al (Sept-Oct,2012) experimental study was carried out to find the suitability of the alternate construction materials such as, rice husk ash, sawdust, recycled aggregate and brickbats as a partial replacement for cement and conventional aggregates.

Jayanti Rajput et al (May-June2013)

The paper presents the details, if approximately 10% of cement is replaced by equal amount of RHA, there is not any significant depreciation in the compressive strength.

Rushabh A. Shah et al (April 2013) Hypo sludge is investigated for its use as a partial replacement for cement in cement mortar (1:3). The utilization of Hypo Sludge as cement replacement material in mortar or as additive in cement introduces many benefits from economical, technical and environmental points of view.

Jayeshkumar et al (Sept 2013) Studied the eco-efficient utilization of Hypo sludge as partial replacement of cement in concrete for development of low cost rigid pavement of rural road infrastructure. The Hypo sludge was replaced within the range of 10-40%by weight of cement. In the present study, 5 different mixes of Hypo Sludge are tested for parameters like: compressive strength, flexural strength and cost.

III. MATERIALS AND METHODS

This chapter presents the general information about the materials and methods which is used in the thesis work.

A. Cement

Cement is a material, generally in powder from, that can be made into a paste usually by addition of water and, when poured, will set into a solid mass. Numerous organic compounds used for adhering, or fastening materials, are called cements. Cement is binder material with adhesive and cohesive properties. Cement, when mixed with coarse aggregate, fine aggregate and water it made concrete. The OPC is classified into three grades, namely 33 Grade, 43 Grade, 53 Grade depending upon the strength of 28 days.

Name of Compound	Formula	Abbreviated Formula	% Content
Tricalcium Silicate	$3CaO.SiO_2$	C_3S	40-55
Diacalcium Silicate	$2CaO.SiO_2$	C_2S	15-30
Tricalcium aluminate	$3CaOAl2O_3$	C_3A	8-11
Tetracalcium aluminoferrite	$4CaOAl_2O3Fe2O_3$	C_4AF	13-17

Table 1: Typical composition of OPC

When Portland cement is mixed with water, its constituent compounds undergo a series of chemical reactions that are responsible for the eventual hardening of concrete. Reactions with water are designated hydration, and the new solids formed on hydration are collectively referred to as hydration products.

B. Aggregates

Generally, aggregates occupy 70% to 80% of the volume of concrete and have an important influence on its properties. They are granular materials, derived for the most part from natural rock (crushed stone, or natural gravels) and sands. These are those aggregates which passes through IS sieve 4.75 mm. Fine aggregate/ sand is an accumulation of grains of mineral matter derived from the disintegration of rocks.

1) Coarse Aggregates

The aggregate which is retained over IS Sieve 4.75 mm is termed as coarse aggregate. The coarse aggregates may be of following types:-

- Crushed graves or stone obtained by crushing of gravel or hard stone.
- Uncrushed gravel or stone resulting from the natural disintegration of rocks.
- Partially crushed gravel obtained as product of blending of above two types.

C. Water

Drinking water is good for making concrete. Water serves following purposes Water is used to prepare a plastic mixture of the various ingredients and to impart workability to concrete. Water is also needed for the hydration of the cementing materials to set and harden during the period of curing.

D. Rice Husk Ash (RHA)

Rice milling generates a by-product known as husk. Rice husk ash is an attractive pozzolan. Due to its low cost and high activity it has a promising perspective in sustainable construction. The main component of the rice husk ash is silica, which is the element that governs the reactivity of the ash. The Rice Husk Ash is obtained by burning the Rice

Husk, obtained from local mills, in heaps of 50 to 60kg in open air.

E. Waste Paper Sludge Ash

Paper mill sludge is a major economic and environmental problem for the paper and board industry. The material is a by-product of the deinking and re-pulping of paper. The million tonnes quantity of paper mill sludge produced in the world. The main recycling and disposal routes for paper sludge are land-spreading as agricultural fertilizer, producing paper sludge ash, or disposal to landfill, WPSA containing more than 20% lime (CaO) and possesses cementitous properties and pozzolanic properties that resulting in the self-cementing characteristics.

IV. Experimental Work and Methodology

A. General

This chapter describes the properties of material used for making concrete mixis determined in laboratory as per relevant codes of practice. Different materials used in tests were OPC, coarse aggregates, fine aggregates, rice husk ash and waste paper sludge ash.

B. Ordinary Portland Cement

Ordinary Portland Cement (OPC) of 53 Grade (Ambuja cement) was used throughout the course of the investigation.

Sr. No.	Characteristics	Values Obtained Experimentally	Values Specified By IS 12269:1987
1.	Specific Gravity	3.10	3.10-3.15
2.	Standard Consistency	31%	30-35
3.	Initial Setting Time	115 minutes	30min(minimum)
4.	Final Setting Time	283 minutes	600min(maximum)
5.	Compressive Strength(N/mm^2) 7 days 28 days	38.49 N/mm^2 52.31 N/mm^2	37 N/mm^2 53 N/mm^2

Table 2: Properties of OPC 53 Grade

C. Aggregates

1) Fine Aggregates

Aggregates constitute the bulk of a concrete mixture and give dimensional stability to concrete. The aggregates provide about 75% of the body of the concrete and hence its influence is extremely important.

Weight of sample taken =1000 gm					
Sr. No	IS-Sieve (mm)	Mass Retained (gm)	Cumulative mass Retained	Cumulative %age mass Retained	Cumulative %mass passing through
1	4.74	1	1	0.1	99.9
2	2.36	22	23	2.3	97.7
3	1.18	77	100	10	90
5	600µ	153	253	25.3	74.7
6	300µ	264	517	51.7	48.3
7	150 µ	425	942	94.2	5.8
8	Below150µ	58	1000	100	0
	Total			Σ283.6	

Table 3(A): Sieve Analysis of Fine Aggregate

FM of fine aggregate = 283.6/100=2.836

Characteristics	Value
Specific gravity	2.63
Bulk density	5%
Fineness modulus	2.83

Table 4(B): Physical Properties of fine aggregates

2) Coarse Aggregates

Locally available coarse aggregate having the maximum size of 20 mm was used in this work. The aggregates were tested as per IS: 383-1970. The results are shown in Table 4.2.1(A) and Table4.2.2(B).

Weight of sample taken =2000 gm					
Sr. No	IS-Sieve (mm)	Mass Retained (gm)	Cumulative mass Retained	Cumulative %age mass Retained	Cumulative % mass passing through
1	40	0	0	0	100
2	20	145	145	7.25	92.75
3	10	1829	1974	98.7	1.3
5	4.74	124	1998	99.9	0.1
6	2.36	0	1998	99.9	0.1
7	1.18	0	1998	99.9	0.1
8	600µ	0	1998	99.9	0.1
9	300µ	0	1998	99.9	0.1
10	150 µ	0	1998	99.9	0.1
11	Below150µ	2	2000	100	0
	Total			Σ805.35	

Table 5(A): Sieve Analysis of Coarse Aggregate (20 mm)

FM of Coarse aggregate = 805.35/100=8.0535

Characteristics	Value
Type	Crushed
Colour	Grey
Shape	Angular
Nominal Size	20 mm
Specific Gravity	2.62
Total Water Absorption	0.89
Fineness Modulus	8.05

Table 6(B): Properties of Coarse Aggregates

D. RHA

In this work, Rice Husk was taken from R. K. Enterprises, Bhangrotu, (Mandi), Himachal Pradesh, India. Rice husk firstly wash with portable water then dried in the sun. After then rice husk burnt in the open atmosphere so as to convert it into ash.

Appearance	Fine powder
Particle Size	Sieved through 90 micron sieve
Specific gravity	2.21
Color	Light grey

Table 7: Physical properties of Rice Husk Ash

E. Waste Paper Sludge Ash

Waste paper sludge was taken from Haripur Paper Company Baddi. Waste paper was burnt in the open atmosphere so as to convert it into ash.

Appearance	Fine powder
Particle Size	Sieved through 90 micron sieve
Color	Dark grey
Specific gravity	2.09

Table 8: Physical properties of Waste Paper Ash

F. Mix Design

The concrete mix design was done by using IS 10262 for M-20 grade of concrete.

1) Design Stipulations for Proportioning

Grade designation	M20
Type of cement grade	OPC 53 grade confirming to IS12269:1987
Maximum nominal size of aggregates	20 mm
Minimum cement content kg/m^3	320 kg/m^3
Maximum water cement ratio	0.55
Workability	75 mm (slump)
Exposure condition	Mild
Degree of supervision	Good
Type of aggregate	Crushed angular aggregate
Maximum cement content	450 kg/m^3
Chemical admixture	Not

Table 9:

2) Test Data for Materials

Cement used	OPC 53 grade confirming to IS 12269:1987
Specific gravity of cement	3.10
Specific gravity of Coarse aggregate Fine aggregate	2.88 2.63
Sieve analysis Coarse aggregate Fine aggregate	Coarse aggregate : Conforming to Table 2 of IS: 383 Fine aggregate : Conforming to Zone III of IS: 383

Table 10:

3) Target Strength for Mix Proportioning

f'ck = fck + 1.65 s

Where,

f'ck = Target average compressive strength at 28 days,

fck = Characteristic compressive strength at 28 days,

s= Standard deviation

From Table 1 standard deviation, s = 4.6 N/mm^2

Therefore target strength = 20 + 1.65 x 4.6 = 27.59 N/mm^2

4) Selection of Water Cement Ratio

From Table 5 of IS:456-2000, maximum water cement ratio = 0.55 (Mild exposure)

Based on experience adopt water cement ratio as 0.50

0.5 < 0.55, hence ok

Maximum Size of Aggregate(mm)	Water Content including Surface Water, Per Cubic Meter of Concrete(kg)	Sand as percent of Total Aggregate by Absolute volume
20	186	35

Table 11: Selection of water and sand content From Table 4 of IS 10262:1982

Change in condition	Percent adjustment required	
	Water Content	Sand in total Aggregate
Increase or decrease in water- cement ratio that is 0.05	0	-2
Increase or decrease in value of compacting by 0.10	0	0
For Sand	0	-1.5

Table 12: Adjustments from Table 6 of IS 10262:1982

Therefore, required sand content as percentage of total aggregate by absolute volume =35-3.5=31.5%

Volume of aggregate= 100-31.5=68.5%

5) Calculation of Cement Content

Water cement ratio = 0.50

Cement content = 186/0.5 = 372 kg/m^3 >320 kg/m^3(given)

From Table 5 of IS: 456, minimum cement content for mild exposure condition = 300 kg/m^3

Hence OK

6) Determination of Coarse and Fine Aggregate contents

From Table 3 of IS 10262:1982,for the specified maximum size of aggregate of 20mm,the amount of entrapped air in the wet concrete is 2 percent. Taking this into account and applying

$V= (W+C/S_C+1/P \times fa/S_{fa}) \times 1/1000$

$Ca =1-P/P \times fa \times S_{ca}/S_{fa}$

Where,

V = absolute volume of fresh concrete, which is equal to gross volume(m^3) minus the volume of entrapped air.

W = mass of water (Kg) per m^3 of concrete

C =mass of cement (Kg) per m^3 of concrete

S_c = specific gravity of cement

P =ratio of FA to total aggregate by absolute volume

F_a, C_a = total masses of FA and CA (Kg) per m^3 of concrete respectively

S_{fa}, S_{ca} = specific gravity of saturated, surface dry fine aggregate and coarse aggregate respectively.

0.98= 186+372/3.10+1/.315 × fa/2.63) × 1/1000

980 = 306+1.20 f_a

f_a = 561.66 Kg/m^3

C_a=1216.74 Kg/m^3

The mix proportion then becomes:

Water:Cement:Fine Aggregate:Coarse Aggregate

186:372:561.66:1216.74

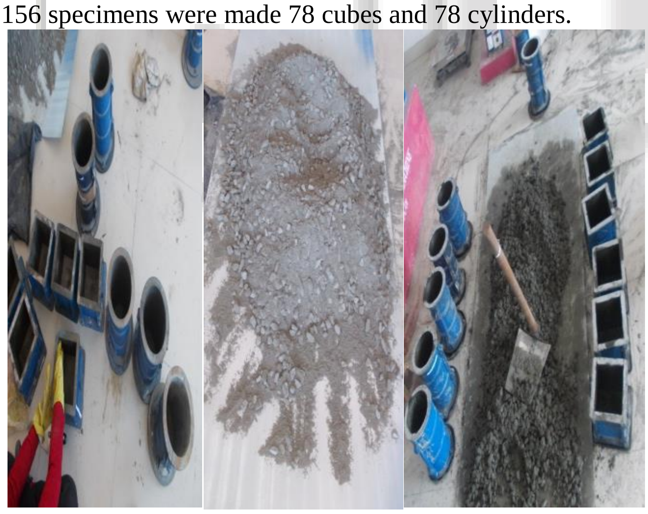
0.5:1:1.5:3.2

Mix	%	w/c ratio	Water (Kg/m^3)	Cement (Kg/m^3)	Fine Aggregate (kg/m^3)	Coarse Aggregate (Kg/m^3)	RHA (Kg/m^3)	WPSA (Kg/m^3)
Control	-	0.50	186	372	562	1217	-	-
Rice Husk Ash	5	0.50	186	353.4	562	1217	18.6	-
	10	0.50	186	334.8	562	1217	37.2	-
	15	0.50	186	316.2	562	1217	55.8	-
	20	0.50	186	297.6	562	1217	74.4	-
Waste Paper Sludge Ash	5	0.50	186	353.4	562	1217	-	18.6
	10	0.50	186	334.8	562	1217	-	37.2
	15	0.50	186	316.2	562	1217	-	55.8
	20	0.50	186	297.6	562	1217	-	74.4
Mixture of RHA and WPSA	5	0.50	186	353.4	562	1217	9.3	9.3
	10	0.50	186	334.8	562	1217	18.6	18.6
	15	0.50	186	316.2	562	1217	27.9	27.9
	20	0.50	186	297.6	562	1217	37.2	37.2

Table 13: The mixture proportions used in laboratory for experimentation are shown in table

G. Casting

Before casting, the entire moulds were cleaned and oiled properly. These were tightened properly before casting. The coarse aggregates, fine aggregates, cement and other ingredients (RHA & WPSA) were weighed first with accuracy. For each mix 12 samples were casted, 6 cubes (150 x 150 x 150mm) for compressive strength at 7and 28days and 6 cylinders for splitting tensile strength at 7and 28 days. Casting was done with varying percentage 5%, 10%, 15%& 20% respectively as a partial replacement of cement with rice husk ash and waste paper sludge ash. Total 156 specimens were made 78 cubes and 78 cylinders.



(A)Oiling of Cubes & Cylinder(B) Dry mixing (C) Filling of Moulds

Fig. 1: Casting

H. Compaction

The compaction was done by hand using tamping bar. The concrete was filled in the moulds in four layers and each layer was approximately one quarter of the height of mould. Each layer was tamped with 25 strokes of the round end of the tamping bar. The strokes should be distributed over the entire area of the mould. Finally the surface of concrete was leveled and finished and smoothened by metal trowel.

Fig. 2: Compaction

I. Curing of Concrete

Curing is the process of preventing the loss of moisture from the concrete whilst maintaining a satisfactory temperature regime. It is essential to use proper and adequate curing techniques to reduce the permeability of the concrete and enhance its durability by extending the hydration of the cement, particularly in its surface zone.

Fig. 3: Curing Tank

Usually, curing starts as soon as the concrete is sufficiently hard. Normally 14 or more days of curing for ordinary concrete is the requirement. However, the rate of hardening of concrete is very much reduced with the reduction of ambient temperature. The period of curing shall not be less than 10 days. The specimens are cured for 7 and 28 days and taken out from water at the time of testing.

V. FUTURE SCOPE

Study has shown that rice husk ash and waste paper sludge ash can be used in concrete. There are several areas in which further work can be extended:

1) Some tests relating to durability aspects such as water permeability, resistance to penetration of chloride ions, corrosion of steel reinforcement, resistance to sulphate attack durability in marine environment etc. with Rice husk ash and Waste Paper Sludge Ash need investigation.
2) The study may further be extended to know the behavior of concrete whether it is suitable for pumping purpose or not as present day technology is involved in RMC where pumping of concrete is being done to large heights.
3) For use of Rice husk ash and Waste Paper Sludge Ash concrete as a structural material, it is necessary to investigate the behavior of reinforced Rice husk ash and Waste Paper Sludge Ash concrete under flexure, shear, torsion and compression
4) Work can be done on the microscopic structure of Rice Husk Ash and Waste Paper Sludge Ash so that chemical properties can be known.
5) Further research is needed to establish the long-term durability of concrete containing mineral admixtures. The microstructure properties of concrete are needed to be further researched.
6) Research can be done to find out the characteristics strength of concrete using properly grinded and controlled temperature burnt RHA and WPSA.

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