

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 7, Issue 2, February 2018

Study and Analysis on Use of Rice Husk Ash in Rigid Pavements

Mohd Muzaffer Ahmed¹, Mohammed Ibrahim², P.Sandeep Chandra³

B.Tech Student, Department of Civil Engineering, MRITS College, Maisammaguda, Dulapally, Secunderabad, Dist.
Medchal, India¹

Assistant Professor, Department of Civil Engineering, MRITS College, Maisammaguda, Dulapally, Secunderabad,
Dist. Medchal, India^{2,3}

ABSTRACT: In the present investigation, a feasibility study is made to use Rice Husk Ash as an admixture to an already replaced Cement with fly ash (Portland Pozzolana Cement) in Concrete, and an attempt has been made to investigate the strength parameters of concrete (Compressive and Flexural). For control concrete, IS method of mix design is adopted and considering this a basis, mix design for replacement method has been made. Five different replacement levels namely 5%, 7.5%, 10%, 12.5% and 15% are chosen for the study concern to replacement method. Large range of curing periods starting from 3days, 7days, 28days and 56days are considered in the present study.

KEYWORDS: Concrete, Rice Husk Ash, Cement.

I. INTRODUCTION

Concrete is a widely used construction material for various types of structures due to its structural stability and strength. All the materials required producing such huge quantities of 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 and 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.

This paper will introduce and explore the usage Rice Husk Ash (RHA) as a replacement along with cement. Fly ash has been thoroughly studied and used for several decades, yet current usage is far below its potential. The benefits of rice husk ash (also known as rice hull ash) have been documented since the 1980's, yet it remains barely available in the INDIA. The addition of recovered ultra-fines (such as mineral flours) to concrete has gotten relatively little attention, especially in the INDIA.

For the first time in INDIA in this project already replaced fly ash based cement has been used along with Rice Husk Ash. The research summarized here provides the structural engineer with some practical insights into the use of carbon-neutral mineral admixtures and their performance benefits.

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 7, Issue 2, February 2018

II. LITERATURE REVIEW ON RICE HUSK ASH

H.B.Mahmud, B.S.Chia and N.B.A.A. Hamid discussed about the workability and compressive strength of Rice husk ash concrete. They discussed that it is easy to produce high strength grade 80 concrete incorporating RHA. After completing all the experiments, they concluded that Concrete containing RHA either as an additional admixture or as a replacement of cement can produce strength of 80 N/mm² at 28 days.

Mauro M. Tashima, Carlos A. R Da Silva, Jorge L. Akasaki, and Michele Beniti Barbosa describes about the water absorption and compressive strength of Concrete using RHA. Adding 10% RHA to the concrete, a reduction of 38.7% in water absorption was observed for 28 days curing. The compressive strength of concrete was increased about 12% by 10% replacement of RHA for 28 days curing concrete.

M. Nehdi, J. Duquette, A. El Damatty discussed about the compressive strength and surface scaling and chloride penetrability of Concrete using RHA. Compressive strengths achieved by concrete mixtures incorporating the new RHA exceeded those of concretes containing similar proportions of SF. The resistance to surface scaling of RHA concrete was better than that of concrete containing similar proportions of SF. While the chloride penetrability was substantially decreased by RHA.

Gemma Rodriguez de Sensale discussed about the study on the development of compressive strength up to 91 days of concretes with rice-husk ash (RHA). Two different replacement percentages of cement by RHA, 10% and 20%, and three different water/cement ratios (0.50, 0.40 and 0.32), were used. The results are compared with those of the concrete without RHA, with splitting tensile strength and air permeability. It is concluded that residual RHA provides a positive effect on the compressive strength at early ages, but the long term behavior of the concretes with RHA produced by controlled incineration was more significant.

Rice covers 1% of the earth's surface and is a primary source of food for billions of people. Globally, approximately 600 million tonnes of rice paddy is produced each year. On average 20% of the rice paddy is a husk, giving an annual total production of 120million tonnes. In the majority of rice producing countries, much of the husk produced from the processing of rice is either burnt or dumped as waste. Rice husks are one of the largest readily available but most under-utilized biomass resources, being an ideal fuel for electricity generation. The calorific value varies with rice variety, moisture but a typical value for husks with 8-10% moisture content. The treatment of rice husk as a 'resource' for energy production is a departure from the perception that husks present disposal problems. The concept of generating energy from rice husk has great potential, particularly in those countries that are primarily dependent on imported oil for their energy needs. For these countries, the use of locally available biomass, including rice husks is of crucial importance. Rice husk is unusually high in ash compared to other biomass fuels – close to 20%. The ash is 92 to 95% silica (SiO₂), highly porous and lightweight, with a very high external surface area. Its absorbent and insulating properties are useful to many industrial applications, and the ash has been the subject of many research studies. If a long term sustainable market and price for rice husk ash (RHA) can be established, then the viability of rice husk power or co-generation plants are substantially improved.

Therefore, In this paper, an attempt has been made against lower grade concretes as it is helpful for normal constructions using Rice Husk Ash (RHA) as a replacement of cement.

III. EXPERIMENTAL PROCEDURE

A. Materials Used

(i). Cement

Cement used in the experimental work is PORTLAND POZZOLONA CEMENT conforming to IS: 1489 (Part1)-1991. The physical properties of the cement obtained on conducting appropriate tests as per IS: 269/4831 and the requirements as per IS 1489-1991 are given in Table 1.

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 7, Issue 2, February 2018

Table 1: Physical properties of procured PPC

Particulars	Test Results	Requirements of IS:1489-1991
Specific Gravity	3.15	
Fineness (m ² /kg)	369	300 min.
Normal Consistency	32%	
Setting Time(min) Initial Final	175 265	30 600
Compressive strength (Mpa) 3 days 7 days 28 days	27 38 56.5	16 min. 22 min. 33 min.
Drying Shrinkage %	0.06%	0.15 max.

(ii). Rice Husk Ash

Rice Husk Ash used in the present experimental study was obtained from N. K. Enterprises, Gangavathi, Karnataka. Specifications, Physical Properties and Chemical Composition of this RHA as given by the Supplier are given in Table 2.

Table 2. Physical Properties of RHA

Physical state	Solid non-Hazardous
Appearance	Very fine powder
Particle size	25 microns - mean
Colour	Grey
Odour	Odourless
Specific Gravity	2.3

(iii). Aggregates

1. Fine Aggregate

Fine aggregate was purchased which satisfied the required properties of fine aggregate required for experimental work and the sand conforms to zone III as per the specifications of IS 383: 1970.

- Specific gravity = 2.7
- Fineness modulus = 2.71

2. Coarse Aggregate:

Crushed granite of 20 mm maximum size has been used as coarse aggregate. The sieve analysis of combined aggregates confirms to the specifications of IS 383: 1970 for graded aggregates.

- Specific gravity = 2.64
- Fineness Modulus = 6.816

(iv). Water

Water is an important ingredient of concrete as it actively participates in the chemical reaction with cement. Since it helps to form the strength giving cement gel, the quantity and quality of water is required to be looked in to very

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 7, Issue 2, February 2018

carefully. Mixing water should not contain undesirable organic substances or inorganic constituents in excessive proportions.

In this project clean potable water was obtained from the site where i work, for mixing and curing of concrete.

B. Mix Design For M20 Grade Concrete:

Design Stipulations:

1. Characteristic Compressive Strength required at the end of 28 days: 20 N/mm².
2. The maximum size of Aggregate: 20mm (Angular).
3. Type of Exposure: Moderate.
4. The degree of Workability: 0.90 (compacting factor).
5. Degree of Quality Control: Good

Test Data for Materials:

1. Specific Gravity of Cement: 3.15
2. Specific Gravity of Coarse Aggregate: 2.64
3. Specific Gravity of Fine Aggregate: 2.70
4. Assumed slump to be achieved: 50-100 mm

Sieve Analysis:

1. Coarse Aggregate: Confirming to Table 2 of IS: 383
2. Fine Aggregate: Confirming to Zone II of Table 4 of IS: 383

Target Mean Strength Of Concrete:

For a tolerance factor of 1.65 and using table 1, the obtained target mean strength for the given grade of concrete = 20 + 4.6 x 1.65 = 27.6 N/mm².

Selection Of Water Cement Ratio:

From the fig: 1 the free water cement ratio for the obtained target mean strength is 0.50. This is equal to the value prescribed for Moderate conditions in IS 456.

Selection Of Water And Sand Content:

From table 4, for 20 mm nominal maximum size aggregate and sand confirming to grading zone II, water content per cubic meter of concrete = 186 kg and sand content as a percentage of total aggregate by absolute volume = 35 percent. Required water content = 186 + 186x3/100 = 186 + 5.58 = 191.61 /m³.

Determination Of Cement Content :

Water cement ratio = 0.50

Water = 191.61 /m³

Cement = 191.61/0.50 = 383 kg/m³

This content is adequate for mild exposure condition, according to appendix A of IS 456

Determination Of Coarse Aggregate And Fine Aggregate:

From table 3, for the specified maximum size of aggregate of 20mm, the amount of entrapped air in the wet concrete is 2 percent.

$$0.98 = (191.61 + 383/3.15 + 1/0.33 \times f_a/2.7) \times 1/1000$$

$$0.98 = (186 + 372/3.15 + 1/0.77 \times c_a/2.64) \times 1/1000$$

$$F_a = 594 \text{ kg/m}^3$$

$$C_a = 1356 \text{ kg/m}^3$$

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 7, Issue 2, February 2018

The Mix Proportion Then Becomes:

Water	Cement	Fine Aggregate	Coarse Aggregate
191.61 / m ³	383 kg	594 kg	1356 kg
0.50	1	1.55	3.54

IV. TESTS CONDUCTED

i) Test for Compressive Strength of Concrete Specimen: (As per IS: 516-1959)

A. Apparatus:

Testing Machine

The testing machine may be of any reliable type, of sufficient capacity for the tests and capable of applying the load at the specified rate. The permissible error shall be not greater than + 2 percent of the maximum load. The testing machine shall be equipped with two steel bearing platens with hardened faces. One of the platens shall be fitted with a ball seating in the form of a portion of a sphere, the centre of which coincides with the centre of the plain rigid bearing block. The bearing faces of the both platens shall be at least as large as, and preferably larger than the nominal size of the specimen to which the load is applied. The bearing surface of the platens, when new, shall not depart from a plane by more than 0.01 mm at any point, and they shall be maintained with a permissible variation limit of 0.02 mm. The movable portion of the spherically seated compression platen shall be held on the spherical seat, but the design shall be such that the bearing face can rotate freely and tilted through small angles in any direction.

B. Procedure:

Specimens stored in water shall be tested immediately on removal from the water and while they are still in the wet condition. Surface water and grit shall be wiped off the specimens and any projecting fins removed. Specimens when received dry shall be kept in water for 24 hours before they are taken for testing. The dimensions of the specimens to the nearest 0.2 mm and their weight shall be noted before testing approximately 140 kg/sq cm/min until the resistance of the specimen to the increasing load breaks down and no greater load can be sustained. The maximum load applied to the specimen shall be recorded and the appearance of the concrete and any unusual features in the type of failure shall be noted.

C. Calculation:

The measured compressive strength of the specimen shall be calculated by dividing the maximum load applied to the specimen during the test by the cross-sectional area, calculated from the mean dimensions of the section and shall be expressed to the nearest kg per sq cm. Average of three values shall be taken as the representative of the batch provided the individual variation is not more than + 15 percent of the average. Otherwise repeat tests shall be made.

ii) Test for Flexural Strength of Concrete Specimen:

A. Apparatus:

The testing machine may be of any reliable type of sufficient capacity for the tests and capable of applying the load at the rate specified. The permissible errors shall be not greater than + 0.5 percent of the applied load where a high degree of accuracy is required and not greater than + 1.5 percent of the applied load for commercial type of use. The bed of the testing machine shall be provided with two steel rollers, 38 mm in diameter, on which the specimen is to be supported, and these rollers shall be so mounted that the distance from centre to centre is 60 cm for 15.0 cm specimens or 40 cm for 10.0 cm specimens. The load shall be applied through two similar rollers mounted at the third points of the supporting span that is spaced at 20 or 13.3 cm centre to centre. The load shall be divided equally between the two loading rollers and all rollers without subjecting the specimen to any torsional stresses or restraints.

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 7, Issue 2, February 2018

B. Procedure:

Test specimens stored in water at a temperature of 240 to 300 °C for 48 hours before testing shall be tested immediately on removal from the water whilst they are still in a wet condition. The dimensions of each specimen shall be noted before testing. No preparation of the surface is required.

C. Calculation:

The flexural strength of the specimen shall be expressed as the modulus of rupture f_b , which, if 'a' equals the distance between the line of fracture and the nearer support, measured on the centre line of the tensile side of the specimen, in cm, shall be calculated to the nearest 0.5 kg/sq cm as follows:

$$f_b = \frac{p \times l}{b \times d^2}$$

when 'a' is greater than 20.0 cm for 15.0 cm specimen, or greater than 13.3 cm for a 10.0 specimen, or

$$f_b = \frac{3 p \times a}{b \times d^2}$$

when 'a' is less than 20.0 cm but greater than 17.0 cm for 15.0 cm specimen or less than 13.3 cm but greater than 11.0 cm for a 10.0 specimen

Where

b = measured width in cm of the specimen,

d = measured depth in cm of the specimen at the point of failure

l = length in cm of the span on which the specimen was supported, and

p = maximum load in kg applied to the specimen

If 'a' is less than 17.0 cm for a 15.0 cm specimen, or less than 11.0 cm for a 10.0 specimen, the results of the test shall be discarded.

V. RESULTS AND DISCUSSIONS

This Compressive and Flexural strength development of Control concrete and Rice husk ash concrete at different curing periods are listed below. The present investigation is based on the IS method for Control concrete.

A. Compressive Strength: To study the strength development of Rice husk ash (RHA) concrete in comparison to Control concrete, compressive strength tests were conducted at the ages of 3, 7, 28 and 56 days. The tests results are reported in the table for control concrete are in the table for RHA concrete respectively.

i) Compressive Strength of Control Concrete:

The strength achieved at different ages namely 3, 7, 28 and 56 days for Control concrete are given in the table 3.

Grade of Concrete	3 days	7 days	28 days	56 days
M20	14.51	20.58	30.3	36.36

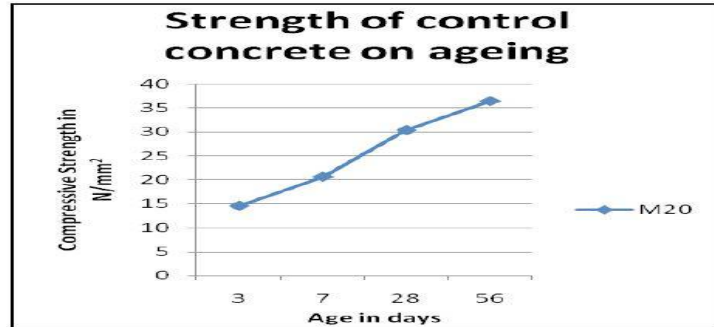
From the Graph 1, it is clear that as the age advances, the strength of Control concrete increases. The rate of increase of strength is higher at curing period up to 28 days. However the strength gain continues at a slower rate after 28 days.

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 7, Issue 2, February 2018



Graph 1. Compressive strength of control concrete

Grade of Concrete	3 days	7 days	28 days	56 days
M20	0.47	0.67	1	1.2

ii) Compressive Strength of Rice Husk Ash (RHA) Concrete:

Table 5 represents the variation of compressive strength with age for M20 grade RHA concrete, in each figure, variation of compressive strength with age is depicted separately for each replacement level of RHA considered namely 5%, 7.5%, 10%, 12.5% and 15%. Along with the variations shown for each replacement, for comparison similar variations is also shown for control concrete i.e., for 0% replacement.

In each of these variations, it can be clearly seen that, as the age advances, the compressive strength also increases. Graphical representation is also shown below.

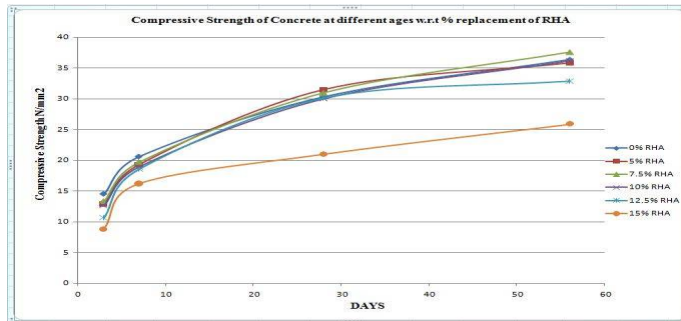
Age in days	0% RHA	5% RHA	7.5% RHA	10% RHA	12.5% RHA	15% RHA
3 days	14.51	12.96	13.32	12.7	10.7	8.88
7 days	20.58	19.3	19.7	18.96	18.58	16.22
28 days	30.3	31.5	31	30	30.14	21
56 days	36.36	35.84	37.62	36.15	32.88	25.88

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 7, Issue 2, February 2018



Graph 2: Compressive strength of concrete with different % replacement at different ages

B. Flexural Strength:

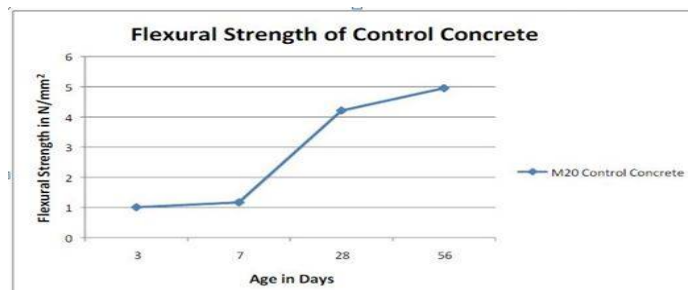
It is seen that strength of concrete in compression and tension (both tension and flexural tension) are closely related, but the relationship is not of the type of direct proportionality. The ratio of the two strengths depends on general level of strength of concrete. In other words, for higher compressive strength, concrete shows higher tensile strength, but the rate of increase of tensile strength is of decreasing order.

i) Flexural Strength of Control Concrete:

The strength achieved at different ages namely 3, 7, 28 and 56 days for Control concrete are given in the table 6

Grade of Concrete	3 days	7 days	28 days	56 days
M20	1.01	1.17	4.21	4.95

From the Graph 3, it is clear that as the age advances, the strength of Control concrete increases. The rate of increase of strength is higher at curing period between 7 to 28 days. However the strength gain continues at a slower rate after 28 days.



Graph 3. Flexural Strength of Control Concrete

ii) Flexural Strength of Rice Husk Ash (RHA) Concrete:

Variation of flexural strength with respect to age and percentage of RHA and effect of RHA percentage on Flexural strength of M20 grade concrete is depicted in the table 7. The rate of development of flexural strength is higher at 7 days to 28 days. At the later age between 28 days to 56 days only a marginal increase is observed. At 28 days, there is very less variation in flexural strength of RHA concrete at the replacement levels.

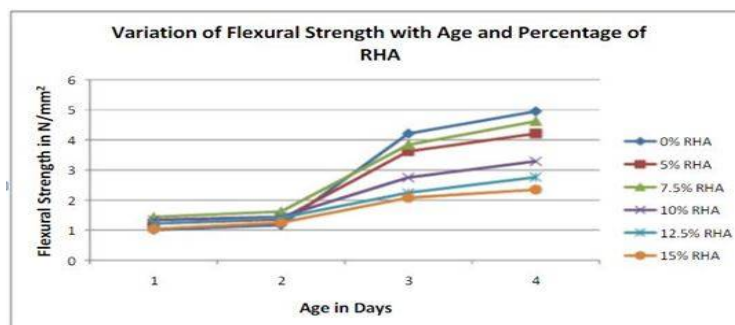
International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 7, Issue 2, February 2018

% RHA	3 days	7 days	28 days	56 days
0%	1.01	1.17	4.21	4.95
5%	1.22	1.36	3.62	4.21
7.5%	1.44	1.62	3.84	4.62
10%	1.34	1.41	2.75	3.29
12.5%	1.22	1.44	2.24	2.76
15%	1.04	1.25	2.08	2.35



Graph 4. Flexural Strength of Concrete with different % of RHA at different ages

VI. CONCLUSION

1. Based on the study carried out on the strength behavior of Rice Husk ash, the following conclusions are drawn:
2. At all the cement replacement levels of Rice husk ash; there is a gradual increase in compressive strength from 3 days to 7 days. However, there is a significant increase in compressive strength from 7 days to 28 days followed by a gradual increase from 28 days to 56 days.
3. At the initial ages, with the increase in the percentage replacement of Rice husk ash, the flexural strength of Rice husk ash concrete is found to increase gradually till 7.5% replacement.
4. By using this Rice husk ash in concrete as a replacement the emission of greenhouse gases can be decreased to a greater extent.
5. The technical and economic advantages of incorporating Rice Husk Ash in concrete should be exploited by the construction industries and rice industries more for the rice-growing nations of Asia.

VII. FUTURE SCOPE

1. Other levels of replacement with Rice husk ash can be researched.
2. 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 the marine environment etc. with Rice husk ash and Silica fume need investigation.
3. The study may further be extended to know the behavior of concrete whether it is suitable for pumping purpose or not, where pumping of concrete is being done to large heights.
4. For use of Rice husk ash concrete as a structural material, it is necessary to investigate the behavior of reinforced Rice husk ash concrete under flexure, shear, torsion, and compression.

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 7, Issue 2, February 2018

REFERENCES

1. H.B.Mahmud, B.S.Chia and N.B.A.A. Hamid, "Rice Husk Ash-An Alternative material in producing High Strength Concrete," International Conference on Engineering Materials, June 8-11, 1997, Ottawa, Canada, pp.275-284.
2. Mauro M. Tashima, Carlos A. R Da Silva, Jorge L. Akasaki, and Michele Beniti Barbosa, "The Possibility of adding the Rice Husk Ash (RHA) to the Concrete," Conference, FEIS/UNESP, Brazil 2001.
3. M. Nehdi, J. Duquette, A. El Damatty, "Performance of Rice Husk Ash produced using a new technology as a Mineral Admixture in Concrete," Cement and Concrete Research 33 (2003) 1203-1210.
4. Gemma Rodriguez de Sensale, "Strength Development of Concrete with Rice-Husk Ash," Cement & Concrete Composites 28 (2006) 158-160.
5. A.A. Boateng and D.A. Skeete, "Incineration of Rice Hull for use as a Cementitious Material: The Guyana Experience," Cement and Concrete Research, Vol.20, 1990, pp.795-802.
6. Arpana, "Rice Husk Ash-Admixture to concrete," 2nd National conference on Advances in concrete Technology, February 26-27, 2004, pp.93-98.
7. Chai Jaturapitakkul and Boonmark Roongreung "Cementing Material from Calcium Carbide Residue-Rice Husk Ash," Journal of materials in civil Engineering ASCE, September-October 2003, pp. 470-475.
8. Deepa G. Nair, K.S Jagadish, Alex Fraaij, "Reactive Pozzolanas from Rice Husk Ash: An alternative to cement for rural housing," Cement and Concrete Research 36(2006)1062-1071.
9. G.V.Rama Rao and M.V.Seshagiri Rao, "High-performance Concrete with Rice Husk Ash as Mineral Admixture," ICI Journal, April-June 2003, pp.17-22.
10. Min-Hong Zhang and V. Mohan Malhotra, "High-Performance Concrete Incorporating Rice Husk Ash as a Supplementary Cementing Material," ACI Materials Journal, November-December 1996, pp.629-636.
11. Ms.Nazia Pathan, "Use of Rice Husk Ash in making High-Performance Concrete," National Seminar on Innovation Technologies in Construction of Concrete Structures 7th & 8th Feb.2003, Dept. of Civil Engineering, KITS, Ramtek, Maharashtra State.
12. N.R.D.Murthy, P.Rathish Kumar, Seshu D.R and M.V. Seshagiri Rao, "Effects of Rice Husk Ash on the Strength and Durability of Concrete," ICI Journal July-September 2002, pp.37-38.