PARTIAL REPLACEMENT OF CEMENT IN CONCRETE BY RICE HUSK ASH WITH BENTONITE

P.Punitha[1], K.Ambiga[2]

[1,2]Assistant Professor, Department of Civil & Structural Engineering
Sri Chandrasekharendra Saraswathi Viswa Mahavidyalaya
Enathur, Kanchipuram - 631 561, Tamil Nadu, India.
E-mail: p.punitha@kanchiunv.ac.in, ambigacivil.scsvmv@gmail.com

ABSTRACT

In this paper, a detailed experimental investigation was carried out to investigate the effect of partial replacement of cement by Rice Husk Ash and constant amount of Bentonite (as admixture) in combined proportions ranging from 0 percent RHA to 100 percent cement mix together in concrete by replacement of cement with a gradual increase of RHA by 5 percent and a concurrent decrease of cement by adding the constant 10% of Bentonite (as admixture). The final proportion was 15 percent RHA and 85 percent cementwith 10 percent of Bentonite as admixture. The hardened concrete tests were destructive in nature, including a compressive test on a cube for size (150×150×150mm) 3, 7, 14 and 28 days of curing as per IS: 516-1959. The work provided in this paper reports on the impact on the behavior of concrete made from cement withvaried proportions of Bentonite and RHA on the mechanical properties of concrete such as compressive strength. All the materials such as cement fine Aggregate (M sand) coarse Aggregate, all the required test to be done.

Keywords: *Rice husk ash, Bentonite, Compressive strength, Partial replacement, admixture*

---

1. INTRODUCTION

There has been an increase in the number of studies published in recent years on the usage and exploitation of industrial, agricultural, and thermoelectric plant leftovers in the making of concrete. Bentonite, condensed silica fume, blast-furnace slag, and rice husk ash are all pozzolanic ingredients that have played an essential role in the creation of high-performance concrete. There has been a rise in the consumption of mineral admixtures by cement during the late twentieth century, and concrete is met by partial cement replacement. As is well known, concrete is a heterogeneous mixture of cement, water, and aggregates. Admixtures can be added to concrete to improve some of the attributes that are specifically sought. Concrete, in its most basic form, is a mixture of paste and aggregates. To achieve the necessary properties, various ingredients such as bentonite. and rice husk are added. The quality of the paste determines the character of the concrete. The key to producing strong, long-lasting concrete is precise proportioning, mixing, and compacting of the materials.

Green or sustainable structures use critical resources such as electricity, water, minerals, and land far more efficiently than code-compliant buildings. Global warming caused by the release of greenhouse gases into the atmosphere, such as carbon dioxide (CO_2), can be mitigated by substituting gas-emitting materials. Bentonite, rice husk ash (RHA), and other alternative materials have been developed as viable materials for the partial substitution of Portland cement in concrete manufacturing. Rice husk is not advised for human eating due to its low nutritional value and irregular abrasive surfaces that are not naturally destroyed, posing the risk of major health concerns. Many studies on the utilization of rice husk have been undertaken over many decades, and it has been proven that one tons of rice produces 200 kilograms of rice husk, which equates to 40 kg of ash. This accounts for 20% of the husk and 4% of the ash. When industrial by-products are employed as a partial replacement for the energy- intensive Portland cement, significant energy and cost savings can be realized. Among the several current leftovers and byproducts, the use of rice husk ash in the manufacturing of structural concrete is critical for India. India is the world's second largest rice paddy cultivating country. Both the technical benefits of structural concrete incorporating rice husk ash and the social benefits associated with a reduction in the amount of ash disposal problems in the environment have encouraged the growth of study into the potentialities of this material.

Most tropical countries, particularly those in Asia, disposed of a considerable volume of agricultural waste, including India, Thailand, the Philippines, and Malaysia. If waste is not properly disposed of, it will cause social and environmental problems. Recycling discarded material is one approach to dealing with agricultural waste. The utilization of rice husk ash material to create a composite material suitable for construction. If not disposed of appropriately, rice husk ash is dangerous to the environment. Divya Chopra, Rafat Siddique, Kunal (2015) The effect of replacing cement content with rice husk ash (RHA) as supplementary cementitious materials (SCM's) in SCC and observing fresh flow (slump flow, V-Funnel, U-box, L-Flow), mechanical strength (compressive and split tensile), and durability properties (porosity and rapid chloride permeability test) at 7, 28, and 56 days is presented in this study.Ramakrishnan S, Velraj kumar G, Ranjith S R.S. Publication (January 2014) This paper explain the behavior of concrete for pavement replacing different percentages of ashes hush up by weight of cement for concrete quality control mixture M40. C. F. Christy, D. Tensing (2010) The study describes the findings of cement mortars with mix proportions of 1:3, 1:4.5, and 1:6 in which cement is partially substituted with Class-F bentonite at 0%, 10%, 20%, 25%, and 30% by weight of cement. The higher the compressive strength, even with partial replacement of bentonite with cement, the richer the mix. Godwin Akeke , Maurice Ephraim (2013) The purpose of this study was to look into the effects of using Rice Husk Ash (RHA) as a partial replacement for Ordinary Portland Cement (OPC) on the structural properties of concrete. Thi s report investigates the impact on the behavior of concrete generated by partial replacement of cement with a combination of Bentonite and RHA in various amounts.

2. MATERIALS AND METHOD

2.1 Materials Used In Eco-Friendly Concrete

Selection of materials are used in this project as shown in the Figure 1.

Bentonite

Sand

Cement

Coarse Aggregate

Rice Husk Ash

Table 1. Tests For Material Properties conducted:

Sl.No	Materials Test	Test Results
1	Setting Time Test On Cement	**Initial Setting Time – 30 minutes** **Final Setting Time – 10 hours**
2	Specific Gravity on Cement	**3.14**
3	Specific Gravity on Fine Aggregate	**2.67**
4	Specific Gravity On Coarse Aggregate	**2.69**
5	Water Absorption Test On Coarse Aggregate	**0.81%**
6	Water Absorption Test On Fine Aggregate	**0.148 %**
7	Sieve Analysis Test on Fine Aggregate	**2.958 %**
8	Sieve Analysis Test on Coarse Aggregate	**7.313 %**
9	Impact Test on Coarse Aggregates	**18.53%**

Fresh Concrete Test such as Slump cone test and Vee Bee Apparatus Test were conducted in the laboratory.

2.2 Data Interpretation

Grade of concrete, size of cube casting, the different proportion of the materials like bentonite and rice husk ash, etc. Which replaces the cement are interpreted are:

Grade of Concrete-M20.

Nominal Concrete-3 cubes of 1:1.5:3 ratio.

Cement Replaced by Rice Husk Ash in the Concrete with the Bentonite as admixture.

12 cubes with 100% cement and 0% RH.A. with the 1kg of Bentonite as admixture

12 cubes with 95% cement and 5% RH.A. 1kg of Bentonite as admixture

12 cubes with 90% cement and 10% RH.A. 1kg of Bentonite as admixture

12 cubes with 85% cement and 15% RH.A. 1kg of Bentonite as admixture

2.3 Mix Design

Mix Design Specifications

- M20 Grade Concrete
- Water cement ratio = 0.45
- Coarse aggregate of 12mm & 20 mm size (1600 Kg/m³)
- Fine aggregate (Dry sand 1600 Kg/m³)
- Cement - OPC (Grade 43) (unit weight – 1440 Kg/m³)

- Bentonite
- Rice husk ash

Table 2 Quantity of materials for 100% cement – 0% R.H.A composition

Quantity of cement required for 12 cubes	1.362x12	16.32 kg
Quantity of FA required for 12 cubes	2.27 x 12	27.24 kg
Quantity of CA required for 12 cubes	4.25 x 12	51 kg

Table 3 Quantity of materials for 95% cement – 5% R.H.A composition

Quantity of cement required for 12 cubes	1.292x12	15.50 kg
Quantity of R.H.A required for 12 cubes	0.068 x 12	0.816 kg
Quantity of FA required for 12 cubes	2.27 x 12	27.24 kg
Quantity of CA required for 12 cubes	4.25 x 12	51 kg
Quantity of bentonite as admixture for 12 cubes		1 kg

Quantity of cement required for 1 cubes = 1.36 x 95% = 1.292 kg

Quantity of R.H.A required for 1 cubes = 1.36 x 5% = 0.068 kg

Table 4 Quantity of materials for 90% cement – 10% R.H.A composition

Quantity of cement required for 12 cubes	1.224 x12	14.688 kg
Quantity of R.H.A required for 12 cubes	0.136 x 12	1.632 kg
Quantity of FA required for 12 cubes	2.27 x 12	27.24 kg
Quantity of CA required for 12 cubes	4.25 x 12	51 kg
Quantity of bentonite as admixture for 12 cubes		1 kg

Quantity of cement required for 1 cubes = 1.36 x 90% = 1.224kg

Quantity of R.H.A required for 1 cubes = 1.36 x 10% = 0.136 kg

Table 5 Quantity of materials for 85% cement – 15% R.H.A composition

Quantity of cement required for 12 cubes	1.156 x12	13.872 kg
Quantity of R.H.A required for 12 cubes	0.204 x 12	2.448 kg
Quantity of FA required for 12 cubes	2.27 x 12	27.24 kg
Quantity of CA required for 12 cubes	4.25 x 12	51 kg
Quantity of bentonite as admixture for 12 cubes		1 kg

Quantity of cement required for 1 cubes = 1.36 x 85% =1.156 kg

Quantity of R.H.A required for 1 cubes = 1.36 x 15% = 0.204 kg

Figure 2. Casting Concrete Cubes

4. Results and Discussion

4.1 Compressive Strength Reading

Specimens are casted in concrete cube of size (150mmx150xmm150mm) and cured the tested under compressive strength under compression testing Machine (CTM).

For compressive strength test, cube specimens of dimensions 150 x 150 x 150 mm were cast for M20 grade of concrete. The moulds were filled with different proportions of cement, Rice Husk Ash. Vibration was given to the moulds using table vibrator. The top surface of the specimen was leveled and finished. After 24 hours the specimens were de moulded and were transferred to curing tank where in they were allowed to cure for 3,7,14, and 28days. After 3,7, 14, and 28 days curing, these cubes were tested on digital compression testing machine as per I.S. 516-1959[14]. The failure load was noted. In each category, three cubes were tested and their average value is reported.

The compressive strength was calculated as follows:

Compressive strength (MPa) = Failure load / cross sectional area.

4.2 Compression Test Results

Result of M_{20} grade of opc concrete filled with various proportions of RICE HUSK ASH (R.H.A) and BENTONITE as admixture, split strength also for strength tedt are shown in table below.

Figure 3. Testing of concrete cubes

Table 6 Compression Test Results

S.NO	Mix Proportion			Compression strength after No of days of curing in N/mm^2			
	Cement by % of cement	R.H.A by % of cement	10% of bentonite as admixture	3 days	7 days	14 days	28 days
1	100	0	10%	8.3	15.5	17.23	24.56
2	95	5	10%	8.5	14.48	17.1	21.75
3	90	10	10%	8.3	13.03	17.72	21.05
4	85	15	10%	8.26	13.12	17.15	19.75

4.3 Bar Chart view of strengths of cubes over the days:

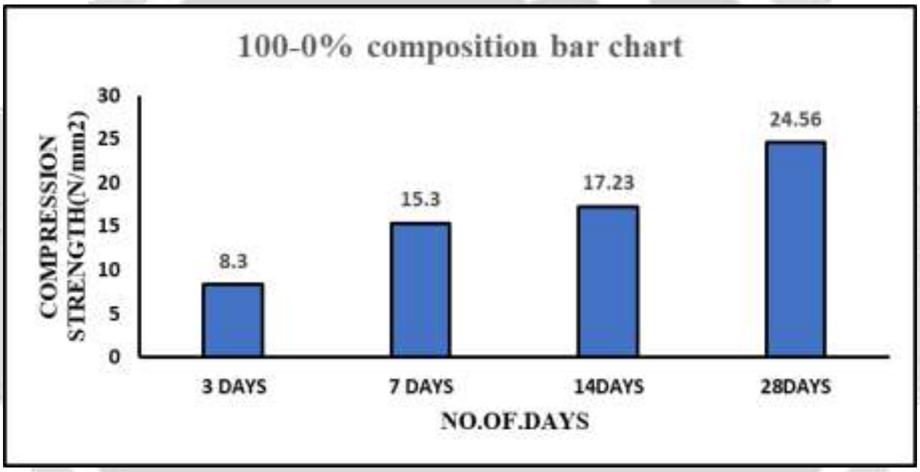

Figure 4. Compression strength for 100-0% composition cubes

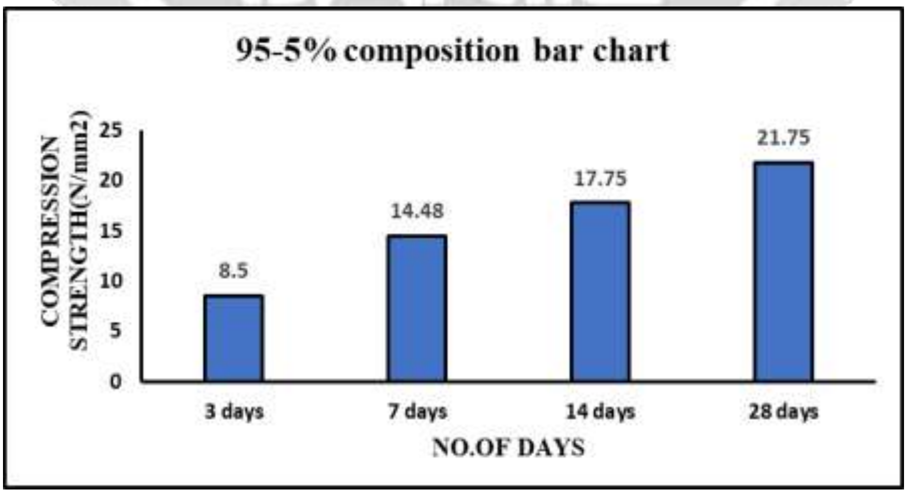

Figure 5 Compression strength for 95-5% composition cubes

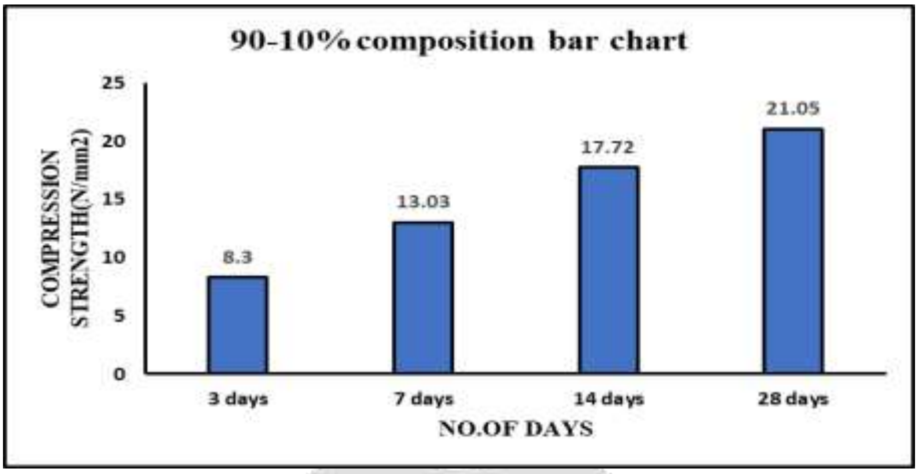

Figure 6 Compression strength for 90-10% composition cubes

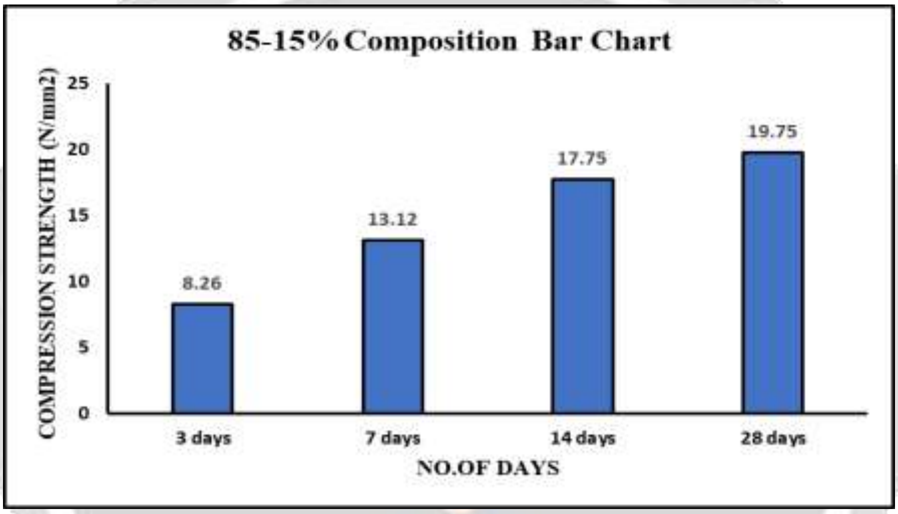

Figure 7 Compression strength for 85-15% composition cubes

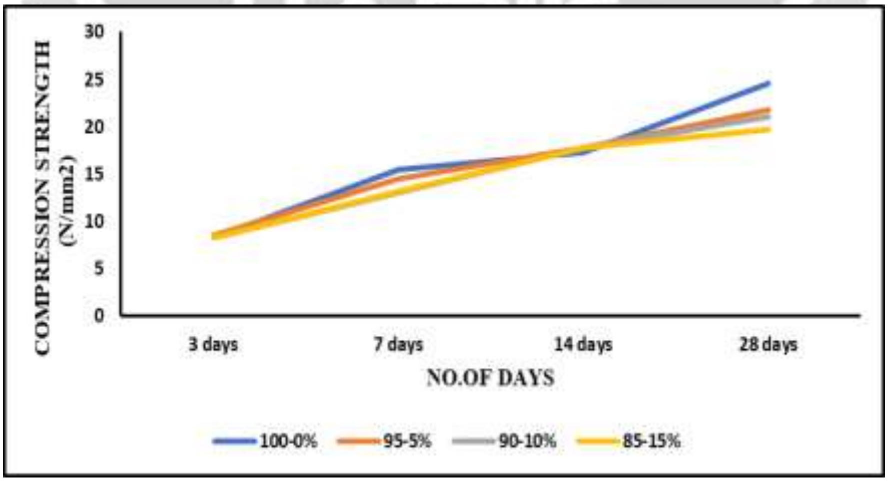

Figure 5.7 Comparison Of Compression Strength & No. of Days

4.3 Compressive Strength test

After 28 days of curing, (150 mm X 150mm) blocks were tested in the CTM machine.
The following tests yielded the following findings.

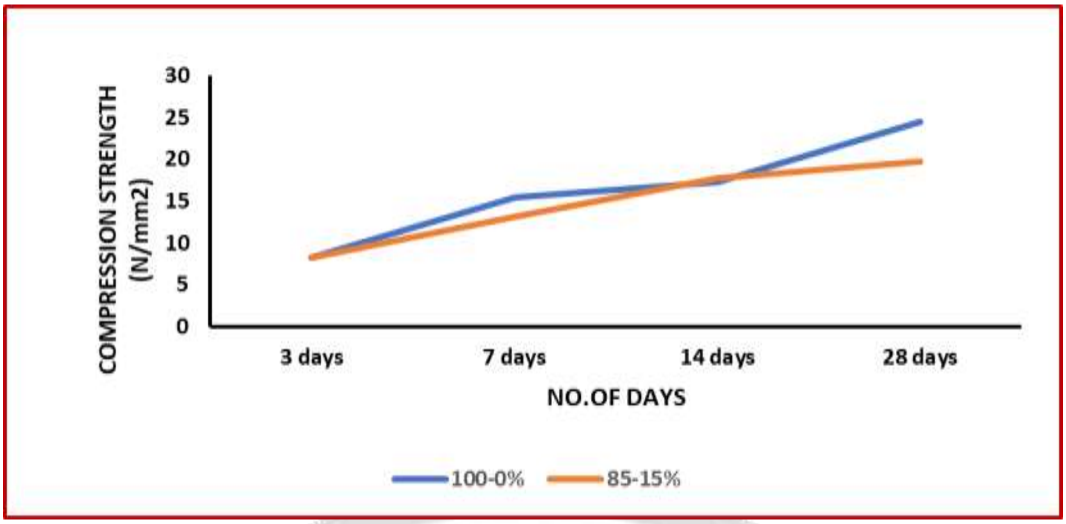

Figure 5.8 Comparison Of Compressive Strength Of Concrete

From the above graph we know that eco-friendly concrete performed better than a regular concrete in compression strength test. By adding Bentonite and Rice Husk Ash to concrete by partially replacing cement with these materials.

CONCLUSIONS

Compressive strength improves as the ratio of Bentonite and Rice Husk Ash increases up to replacement of cement in concrete for different mix proportions. The proportion of water cement ratio is determined by the amount of RHA utilized in the concrete. Because RHA is a porous substance. The workability of concrete was discovered to decline when RHA in concrete increased. The use of rice husk ash in concrete as a replacement can reduce greenhouse gas emissions to a larger level. As a result, there is a larger chance of obtaining a greater amount of carbon credits. The technological and economic benefits of using Rice Husk Ash in concrete should be capitalized on by the construction and rice sectors, particularly in Asia's rice-growing nations. This research is important in the global context of achieving sustainable development.

REFERENCES

1. M.Fang(2004),Experimental Study on Rice Husk Combustion in a Circulating Fluidized Bed-Fuel Preocessing Technology,Vol.85(No. 11);pp:1273-1282.
2. Adeyuwi,A.P.,Ola and B.F.(2005),Application of water works sludge as partial replacement for cement in concrete production,Science Focus Journal,10(1);pp:123-130.
3. T.G. Chuah(2005),Rice Husk as a potentially Low Cost BioSorbent for Heavy Metal and Dye Removal:An overview,Desalination,Vol.175(No.3);pp:315-316.
4. V.M. Srivastava,I.O. Mall and I.M. Mishra (2006),Characterization of Mesoporous Rice Husk Ash(RHA) and Adsorption Kinetics of Metal Ions from Aqueous Solutiononto RHA,Journal of Hazardous Materials,Vol.134(No.1);pp:257-267.
5. W.T. Tsai,M.K. Lee and Y.M. Chang(2007),Fast Prolysis of Rice Husk-Product Yield and Composition,Bioresource Technology,Vol.98(No.1);pp:22-28.
6. Habeeb,G.A.,Fayyadh,M.M.(2009),Saw dust ash concrete:the Effect of SDA Average Particle Size,Mechanical Properties and Drying Shrinkage.Australian Journal of Basic and Applied Sciences,3(3);pp:1616-1622.
7. Ghassan Abood Habeeb, Hilmi Bin Mahmud [2010]: Experimental Study on the Properties of Rice Husk Ash with A.A.A Portland Cement , ISSN: 2456- 6470, Volume-3 Issue-5, August 2019, pp.1771-1775.
8. C. F. Christy, D. Tensing[2010]: Partial replacement of cement with rice husk ash in concrete production: an exploratory cost-benefit analysis for low-income communities Pp:127-141

9. Prof.Kumar R. Sathish(2012),Experimental Study On The Properties Of Concrete Made With Alternate Construction Materials, International Journal of Modern Engineering and Research,Vol.2;pp:3006-3012.
10. TOMAS U. GANIRON JR(2013),Effects Of Rice Husk As Substitute For Fine Aggregate In Concrete Mixture; International Journal Of Advanced Science And Technology,Vol. 58;PP:29-40
11. Godwin Akeke , Maurice Ephraim (2012) Compressive Strength of Concrete with Rice Husk as Partial Replacement of Ordinary Portland Cement, Scholarly Journal of Engineering Research, Vol 1(2), pp 32-36.
12. Obilade,I.O.(2014),Experimental Study On Rice Husk As Fine Aggregates In Concrete; The International Journal of Engineering and Science(IJES),Vol.3;pp:09-14.
13. Singh Smita (Research Scholar) & Mr. Kumar Dilip (Asst. Prof.) (2014),Alternate and Low Cost Material-Rice Husk Ash(RHA),International Journal of Innovative Research in Advance Engineering,Vol.1;pp:214-218.
14. S.I. Khassaf,A.T. Jasim,F.K. Mahdi(2014),Investigation of the properties of concrete containing RHA to reduce seepage in canals;International Journal of Scientific and Technology Research,Vol.3;pp:348-354.
15. Sheth Ananya,Goel Anirudh,Pai Venkataram B.H.(2014),Properties of concrete on replacement of coarse aggregates and cementious materials with Styrofoam and Rice Husk Ash respectively;American Journal of Engineering and Research,Vol.3;pp:268-27.
16. Ramakrishnan S, Velrajkumar G, Ranjith S R.S. Publication (January 2014) "Behavior Of Cement R-H Ash Concrete For Pavement" Issue 4, Vol.1 (LE R 04)
17. Divya Chopra, Rafat Siddique, Kunal [2015]: "Strength, permeability and microstructure of self-compacting concrete containing rice husk ash"(LE R 03)
18. Vinod Goud, et al (oct 2016) Experimental study of partial Replacement of Cement with Fly as In Concrete and Its Effect.