HIGH PERFORMANCE CONCRETE WITH RICE HUSK ASH

A PROJECT REPORT

Submitted by

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CERTIFICATE

Certified that the thesis "**HIGH PERFORMANCE CONCRETE WITH RICE HUSK ASH**" which is submitted by **MR. JASPREET SINGH Regd no. 41200399**, in fulfilment of the requirement for the award of the degree of Master of Technology in the **Department of Civil Engineering,** Lovely Professional University, Phagwara, Punjab, is a record of the candidate's own independent and original research work carried out under supervision and guidance of **Dr. Prem Pal Bansal**. The matter embodied in this thesis has not been submitted in part or full to any other University or Institute for the award of any degree.

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It is certified that the above statement made by the student concerned is correct to best of my knowledge and belief.

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ABSTRACT

Strong Material is a key factor in measuring strength of a Structure. The fact that India is a developing nation having Mega structure and line up in the strongest nations of the world. For strong structure strength of material used should be high enough.

What if the concrete used is having a high strength and we are also able to save the material and make it eco Friendly. That's the better idea to make the structure ecofriendly and also the use of material is less.

The main objective of the project is to expedite the improvement of infrastructure with the help of High Performance Concrete. The project has one of the major advantage that we can use the waste material produced during farming and use that thing in the improvement of strength of material and use it in the contruction part of mega structures.

This Project addresses the potential use of Rice Husk Ash (RHA) as a cementitious material in concrete mixes. RHA is produced from the burning of rice husk which is a by- product of rice milling. The ash content is about 18-22% by weight of the rice husks. Research has shown that concrete made with RHA as a partial cement substitute to levels of 5%, 10%, 15% and 20% by weight of cement has superior performance characteristics compared to normal concrete. Also, the use of RHA would result in a reduction of the cost of concrete construction, and the reduction of the environmental greenhouse effects.

Due to growing environmental concerns and the requirement to conserve energy and resources, efforts have been made to burn the husk at a controlled temperature and atmosphere, and to utilize the ash so produced as a supplementary cementing material.

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LIST OF SYMBOLS AND ABBREVIATIONS

Symbol/Abbreviation	**Name**
RHA	Rice Husk Ash
CTM	Compression Testing Machine
MM	Millimeter
N	Newton
Kg	Kilogram
MPa	Mega Pascal’s
HPC	High Performance Concrete
Ml	Milliliter
M1	0% RHA Replacement
M2	5% RHA Replacement
M3	10% RHA Replacement
M4	15% RHA Replacement
M5	20% RHA Replacement
M6	25% RHA Replacement

CHAPTER 1

INTRODUCTION

1.1 PREFACE

Global production of rice is approximately 580 million tons a year and this is rising, as the world population and the consumption of rice increases day by day. Table 1 shows the most rice-growing countries in the world and the potential husk and ash production. The milling of rice produces rice husk, which is a waste material. Rice husk is generated on average at a 20% rate by weight of the rice that is processed. Most of the husk is burned or dumped as waste.

The burning of the husks produces ash at an average of 18% by weight of the husks. Prior to 1970, RHA was usually produced by uncontrolled combustion, and the ash so produced was generally crystalline and had poor pozzolanic properties.

Due to growing environmental concerns and the requirement to conserve energy and resources, efforts have been made to burn the husk at a controlled temperature and atmosphere, and to utilize the ash so produced as a supplementary cementing material.

Workability, strength, and durability are the three basic properties of concrete. Amount of useful internal work necessary to overcome the internal friction to produce full compaction is termed as Workability. Size, shape, surface texture and grading of aggregates, water-cement ratio, use of admixtures and mix proportion are important factors affecting the workability of Concrete.

Country	Rice, Paddy Production in 2002 (t)	Percentage of Total Paddy Production (%)	Husk Produced (20% of total) (t)	Potential Ash Production (18% of husk) (t)
China	177,589,000	30.7	35,517,800	6,393,204
India	123,000,000	21.2	24,600,000	4,428,000
Indonesia	48,654,048	8.4	9,730,810	1,751,546
Bangladesh	39,000,000	6.7	7,800,000	1,404,000
Viet Nam	31,319,000	5.4	6,263,800	1,127,484
Thailand	27,000,000	4.7	5,400,000	972,000
Myanmar	21,200,000	3.7	4,240,000	763,200
Philippines	12,684,800	2.2	2,536,960	456,653
Japan	11,264,000	1.9	2,252,800	405,504
Brazil	10,489,400	1.8	2,097,880	377,618
USA	9,616,750	1.7	1,923,350	346,203
Korea	7,429,000	1.3	1,485,800	267,444
Rest of the World	29,091,358	5.0	5,818,272	1,047,289
Total (World)	579,476,722	100	115,895,344	20,861,162

Table 1: Rice Paddy, and Potential Husk and Ash Production in the 20 Highest Producing Countries 2002

The objective of this thesis is mainly to provide the information on the utilization of Rice Husk Ash as a substituting cementing material for producing high-performance concrete. This project presents data on the basis of physical and chemical properties of Rice Husk Ash and discusses the properties of concrete incorporating the ash as a substituting cementing material. In addition to the effects of the percentage of RHA as cement replacement and water-cementitious materials ratio on the properties investigated.

Rice husk, an agricultural waste, constitutes about one-fifth of the 300 million metric tons of rice produced annually in the world. Due to growing environmental concerns and the requirement to conserve energy and resources, efforts have been made to burn the husk at a controlled temperature and atmosphere, and to utilize the ash so produced as a supplementary cementing material.

The optimized RHA, by controlled burn and/or grinding, has been used as a pozzolanic material in cement and concrete. Using it provides several advantages, such as improved strength and durability properties, and environmental benefits related to the disposal of waste materials and to reduced carbon dioxide emissions.

Figure 1: Rice Husk

Figure 2: Rice Husk Ash

Durability is mainly influenced by environmental exposure condition, freezing - thawing, contact to the aggressive chemicals, type and quality of constituent materials, water-cement ratio, workability, shape and size of member, degree of compaction, efficiency of curing, effectiveness of cover concrete, porosity and permeability. During service life of structures, penetration of water and aggressive chemicals, carbonation, chloride ingress, leaching, sulphate attack, alkali-silica reaction and freezing-thawing are resulting deterioration. Loading and weathering inter link voids and micro-cracks present in transition zone and network of same micro cracks gets connected to cracks on concrete surface which provides primary mechanism of the fluid transport to interior of concrete. Subsequent increase of penetrability leads to easy ingress of water, oxygen, carbon dioxide and acidic ions etc into concrete resulting cracking, spalling, loss at mass, strength and stiffness.

1.2 SALIENT FEATURES

- Concrete with RHA shows more resistant to extreme conditions in comparison to plain cement concrete.
- It is more economical than plain cement concrete.
- It increases the workability of concrete.
- Due to addition of RHA concrete becomes more cohesive and more plastic.
- Bulk density of RHA content decreases with increase in RHA content.
- Use of RHA as an alternative to cement reduces corrosion and increases durability of concrete strength.
- RHA increases the impermeability characteristics of concrete.
- RHA reduces the impact on environment and capital cost of structure.
- RHA is also used for building load bearing blocks brick tiles at low cost.
- Replacement of cement with RHA leads to increase in compressive strength.
- Ideal mix is obtained at 20% replacement of RHA.

Rice husk can be burnt into ash that fulfils the physical characteristics and chemical composition of mineral admixtures.

Pozzolanic activity of rice husk ash (RHA) depends on:

- Silica content
- Silica crystallization phase
- Size and surface area of ash particles.

In addition, ash must contain only a small amount of carbon.RHA that has amorphous silica content and large surface area can be produced by combustion of rice husk at controlled temperature. Suitable incinerator/furnace as well as grinding method is required for burning and grinding rice husk in order to obtain good quality ash. Although the studies on pozzolanic activity of RHA, its use as a supplementary cementitious material, and its environmental and economical benefits are available in many literatures, very few of them deal with rice husk combustion and grinding methods.

The optimized RHA, by controlled burn and/or grinding, has been used as a pozzolanic material in cement and concrete. Using it provides several advantages, such as improved strength and durability properties, and environmental benefits related to the disposal of waste materials and to reduced carbon dioxide emissions.

1.3 PHYSICAL PROPERTIES

- Some other physical properties of Rice Husk Ash is that it feels soft when it touches the hand.
- It left the grey colour in Hand and touched.
- The particle size is really very small with irregular shape.

Sr.No.	**Particulars**	**Properties**
01	Colour	Grey
02	Shape Texture	Irregular
03	Mineralogy	Non Crystalline
04	Particle Size	<45 micron
05	Odour	Odourless
06	Specific Gravity	2.3

Table 2: Physical Properties of RHA

1.4 CHEMICAL PROPERTIES

Sr. No.	Particulars	Proportion
01	Silicon dioxide	86.94%
02	Aluminum oxide	0.2%
03	Iron oxide	0.1%
04	Calcium Oxide	0.3-2.2%
05	Magnesium Oxide	0.2-0.6%
06	Sodium Oxide	0.1-0.8%
07	Potassium Oxide	2.15-2.30%
08	Ignition Loss	3.15-4.4%

Table 3: Chemical Properties of RHA

- A residual RHA obtained from open field burning.
- The material was carefully homogenized and prepared in two Conditions:

➢ Natural RHA (NRHA): the ash was only dried, homogenized, and packed to enhance the transport to the laboratory.

➢ Grinded RHA (GRHA): after drying and homogenization process the RHA was ground in a laboratory ball mill by one hour for Optimization.

1.5 Why RHA?

- Because RHA is considered as a good pozzolanic material by many researchers.
- First research was done by Mehta and Pirth in 2000 to study the RHA effect on reducing temperature in high strength concrete.
- Mehta and Pirth also finds out that RHA also increases the properties of concrete like compressive strength.

- RHA is easily available as India's staple diet is rice so RHA is easily available and can be replaced thus decreasing cost and greenhouse gases emission.

1.6 High performance concrete (HPC)

High performance concrete (HPC) exceeds the properties and constructability of normal concrete. Normal and special materials are used to make these specially designed concrete that must meet a combination of performance requirements. Special Blend, implementation, and curing practices may be needed to produce and manage high-performance concrete. High performance concrete was mainly use in tunnels, bridges, high-rise buildings and its strength, durability, and high modulus of elasticity. It was also used in the repair of shotcrete, poles, parking garages, and agricultural applications.

High performance concrete characteristics are developed applications and specific environments; some properties are

- High abrasion resistance
- High durability and long life in severe environments
- Low permeability and diffusion
- High strength
- High early strength
- Resistance to chemical attack
- High resistance to frost and deicer scaling damage
- Toughness and impact resistance
- Volume stability
- Ease of placement
- Compaction without segregation
- Inhibition of bacterial and mold growth

High performance concrete are made with care selected ingredients of high quality and optimized mix drawings; these are grouped, mixed, placed, compacted and hardened to the highest industry standards. Typically, such concretes have a low ratio of water to cementing materials from 0.20 to 0.45. Plasticizers are typically used to make these fluid concretes and achievable.

1.7 Supplementary Cementing Materials

Fly ash, silica fume, or slag are often required in the production of high strength concrete; the strength gain obtained with these Supplementary Cementing Materials cannot be achieved by using only additional cement. These supplementary cementitious materials are generally added at levels of 5% to 20% by mass or more doses of cementing material. Some specifications will allow to use up to 10% silica fume, unless evidence is available indicating that the concrete product with a rate larger dose will have a satisfactory strength, durability and volume stability. The water-cementing materials ratio must be adjusted so that equal workability becomes the basis of the comparison between the test mixtures. For each set of documents, there will be a cement content of cementitious materials with optimal strength booster that does not continue to increase with greater amounts and the mixture becomes too sticky to handle properly. Blended cements containing fly ash, silica fume, slag or calcined clay can be used to make high-strength concrete with or without the addition of supplementary cementitious materials.

1.8 Research on RHA

The primary aim of experimental work is to study the properties of Rice Husk Ash. Preparation of mix design. Replacement of cement with RHA as different proportions with cement.

- **Objective**
  a) Effect of Rice Husk Ash on workability.
  b) Effect on Compressive strength of concrete.
  c) Effect on flexural strength of concrete.
  d) Effect on split tensile strength of concrete.
  e) Comparison of result of different tests with varying proportion of RHA.

1.9 RESEARCH SIGNIFICANCE

A step after aluminum and steel, Portland cement is the most energy-intensive material. Due to growing environmental concerns and the need to use less energy-intensive products, efforts are being made to find cement replacement materials. The use of RHA offers one such possibility. This paper presents the characteristics of RHA and the effect on the properties of concrete, and provides information on the development of high-performance concrete using Rice Husk Ash as an alternative supplementary cementing material.

CHAPTER 2

2.1 LITERATURE REVIEW

The cement has been the major building material in today's construction because of its binding and high compressive strength properties. Beside this, it also causes release of greenhouse gas carbon dioxide which causes global warming and other environmental issues.

Researches were done to decrease the carbon footprint and use of waste material to be used in construction. The rice husk ash is a waste material which have shown promising results if replaced with cement in production of concrete.

Previous researches done by researcher's shows that it enhances the corrosion resistance capability of produced concrete with RHA and increase in compressive strength.

The research done in past by –

- **D.V. Reddy, Ph.D, P.E.(**Professor and Director of the Center for Marine Structures & Geotechnique)

P.E, Department of Civil Engineering, Florida Atlantic University mainly on 10 % and 20 % replacement have done research with replacement of 5%, 10%, 15%, 20% and determined the compressive, flexure strength and split tensile strength of the hardened concrete.

D.V. Reddy, Ph. D, P.E. and Marcelina Alvarez, B.S detailed, the use of RHA will not only concrete production of better quality and low cost, but also reduce carbon dioxide (CO2) emissions from cement production. The partial replacement of cement by RHA will result in lower energy consumption associated with cement production. The potential market for rice husk energy systems and equipment has been studied by Velupillai et al. (1997). The reference also addresses economic development, urbanization, living standards, stricter environmental regulations, and consolidation in the rice milling industry is the reduction of certain traditional uses balls, and creating new opportunities for the use of the envelope. He discusses the potential use of rice husk Ash (RHA) as a cementitious material in concrete mixes. RHA is produced by burning rice husk which is a by-product of rice milling. The ash content is about 18 to 22% by weight of rice hulls. Research has shown that concrete containing RHA in partial replacement of cement concentrations of 10% to 20% by weight of cement has superior performance characteristics compared to normal concrete. In addition, the use of ORS would result in a reduction in the cost of concrete construction, and the reduction of the greenhouse effect on the environment.

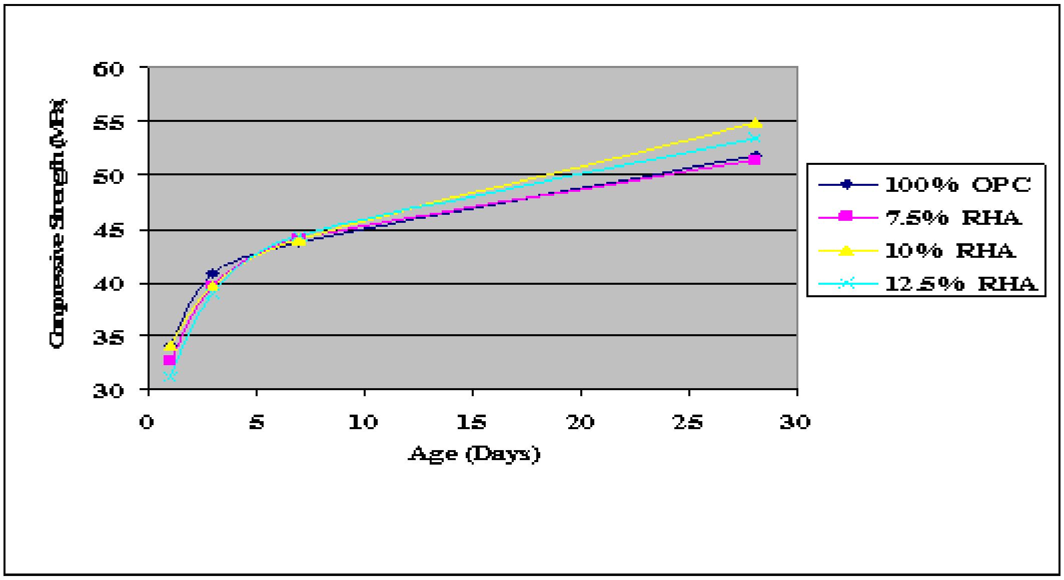

Figure 3: Compressive strength at different RHA% and w/cm= 0.40- Reproduced from Bouz oubaa and Fournier, 2001.

Mehta , P.K., explain the durability of cement mortar in the presence of rice husk Ash (RHA). The strength and durability of mortar with different replacement levels (10%, 20% and 30%) of ordinary Portland cement (OPC) by the RHA is studied here. RHA was manufactured from an uncontrolled combustion process. The test samples were prepared with 2.73 FM river sand. The samples were stored in a controlled environment to test time. The results show that the addition of RHA has shown better results for 20% replacement level OPC 90 days. In the durability test all samples passed for 20 cycles except 25% replacement level of 30%.

When the rice husk ash is converted by uncontrolled combustion of generally from 3,000 to 4,500 C, the ignition has not been completed and the considerable amount of unburned carbon found in the resulting ash. The reactivity of the amorphous silica is directly proportional to the surface area of the ash. Some research papers discovers that not only the temperature, but time is also a factor of burning rice husks to produce effective. In the case of uncontrolled burning combustion especially heap, the burning time is totally dependent on the ambient environment say temperature, humidity and wind speed. Now limited research has been conducted again with the rice husk ash collected from uncontrolled combustion process.

Ramakrishnan S, Velrajkumar G, Ranjith S, explain the behavior of concrete for pavement replacing different percentages of ashes hush up by weight of cement for concrete quality control mixture M40. To study the effect of the rice hull ash (RHA) on the performance of various concrete parameters to produce an economic concrete for rigid pavements.

An attempt was made to use the bending strength of concrete reaches in the design of the rigid floor which is greater than the resistance to bending about the necessary IRC: 58-2002. Test conducted to study the effect of rice husk ash (RHA) on the performance of different concrete parameters to produce an economic concrete for rigid pavements. The partial replacement of cement with RHA provides the equivalent flexural strength of concrete which is more important for concrete pavements.

They conclude their paper:-

The compressive strength decreases with the increases in percentage of rice husk ash (RHA).For 10% replacement, the reduction is very less when compare to 20%, and 30% replacement.

2. The flexural strength of the cement-RHA concrete very less reduction in 5% & 10% of replacement.

3. The porosity test shown the void ratio is reduced up to 10% replacement, and voids increases in future increment of RHA.

4. The split tensile strength, impact strength also decreases with the increases in percentage of rice husk ash (RHA).

P.Padma Rao, A.Pradhan Kumar, B.Bhaskar Singh, explains, a feasibility study is made using rice husk Ash as an adjunct to cement already replaced by fly ash (pozzolan Portland cement) in concrete, and an attempt was made to study the strength parameters concrete (compressive and bending strength). For the control of concrete, is the mixture design method is adopted and given that basis, the design for the replacement method was made mix. Five different replacement levels, namely 5%, 7.5%, 10%, 12.5% and 15% were selected for the study concerning the replacement method.

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

Table 4: Highest Compressive strength obtained at different ages

Percentage Replacement	Increase or decrease in strength
0-5 %	-11.95
0-7.5 %	-8.93
1-10 %	-14.25
0-12.5 %	-35.60
0-15 %	-63.40

Table 5: Increase of decrease in strength of concrete at 3 days w.r.t % replacement of RHA

Percentage Replacement	Increase or decrease in strength
0-5 %	-6.63
0-7.5 %	-4.46
1-10 %	-8.54
0-12.5 %	-10.76
0-15 %	-26.88

Table 6: Increase or decrease in strength of concrete at 7 days w.r.t % replacement of RHA

Based on the limited study conducted on the behavior of the strength of Rice husk ash, the following conclusions are drawn:

At all levels of cement replacement rice husk ash; there is gradual increase of the compressive strength 3 days and 7 days.

However, there is significant increase in compressive strength of 7 to 28 days followed by a gradual increase of 28 days to 56 days.

At retirement age, with increasing replacement percentage rice husk ash both, the flexural strength of the rice husk ash the concrete is deemed to decrease gradually to 7.5% of replacement.

However, there is a significant decrease in the flexural strength of concrete rice husk ash.

OBILADE, I.O. summarizes the research on the properties of rice husk Ash (RHA) when used as a partial replacement of ordinary Portland cement (OPC) in concrete. OPC was replaced by RHA by weight to 0%, 10% and 20%. 0% replacement served as a control. Compaction factor test was performed on fresh concrete while the compressive strength test was performed on 150mm hardened concrete cubes after 7, 14 and 28 days of curing in water. The results revealed that the compaction factor decreases as OPC percentage replacement with RHA increased. The compressive strength of hardened concrete also decreased with increasing substitution of OPC with the RHA. It is recommended that further studies be conducted to gather more facts about the relevance of partial replacement of OPC with the RHA in concrete

Rice Husk Ash (RHA), which is an agricultural by-product has been reported to be a good pozzolan by many researchers. Mehta and Pirth (2000) studied the use of ORS to reduce the temperature in high strength concrete mass and obtained results showing that the RHA is very effective in reducing the temperature of the concrete mass compared to OPC concrete. Malhotra and Mehta (2004) reported later that RHA pattern with finer particle size OPC improves concrete properties, including higher amounts substitution results in lower water absorption values and the addition of RHA causes an increase in the compressive strength.

Rice Husk Ash Replacement	Compressive strength (N/mm2)		
(%)	7 days	14 days	28 days
0	17.51	21.60	29.15
5	16.88	17.44	27.68
10	12.01	12.83	20.88
15	11.24	12.55	18.70
20	10.86	11.51	1859
25	7.95	8.98	13.29

Table 7: Compressive Strength of Concrete Cubes with various percentages of RHA

The results of the compressive strength of concrete cubes show that compressive strengths reduced RHA increased the percentage. However, the compressive strength increased the number of days for each percentage increased hardening RHA replacement.

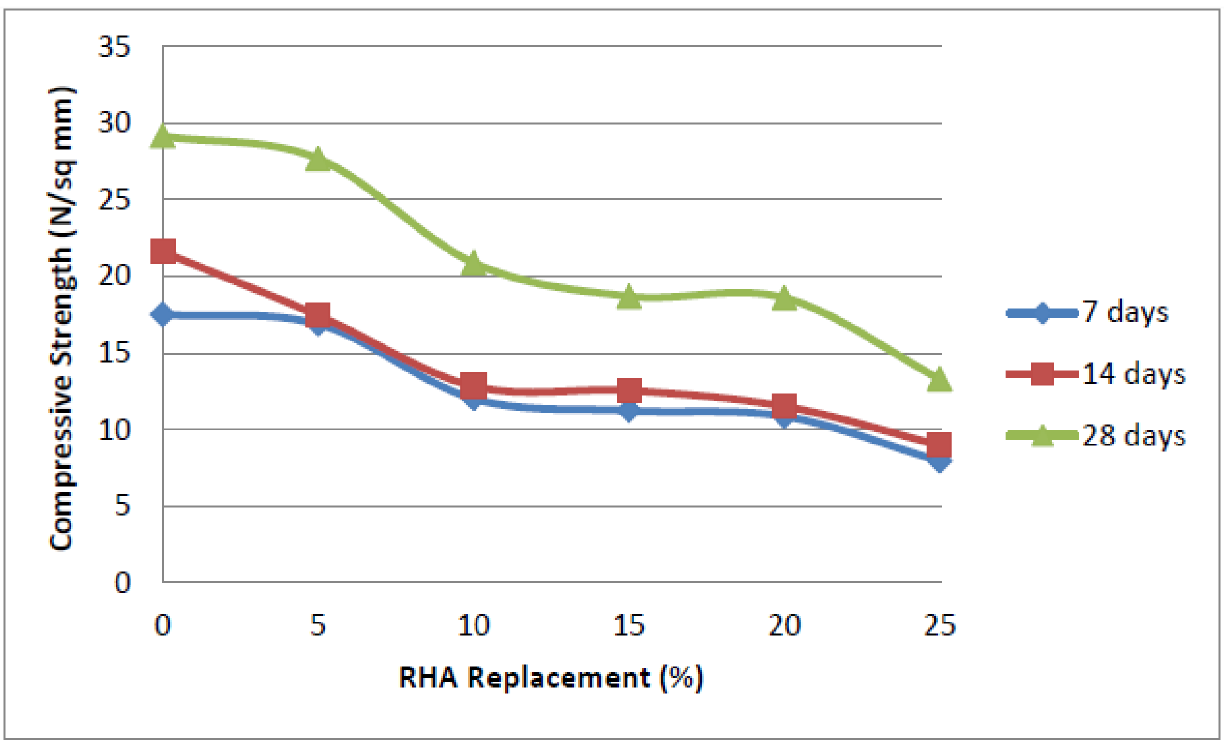

Figure 4: Effect of RHA content on compressive strength of concrete at different curing age

E.B.Oyetola, and M. Abdullahi, The compressive strength of concrete blocks some commercial sand Minna, Nigeria was investigated. Rice Husk Ash (RHA) was prepared using coal a wood fire. Preliminary analysis of the constituent materials of the Ordinary Portland cement (OPC) / Rice Husk Ash (RHA) hollow concrete sand blocks have been conducted to confirm their ability to manufacture the block.

The average temperature was reached 483 °C. A preliminary analysis was conducted on the materials of the UCI/RHA sand hollow concrete blocks to determine their relevance to manufacture the block tests conducted include:

Chemical analysis of the rice husk ash, the analysis of the size of sand particles, density test on RHA and sand, bulk density test on RHA and sand, silt content test on the sand, riding test, setting time test, free test the moisture content and slump test. Mix design was carried out the absolute volume method to choose the most appropriate materials (cement, RHA, sand and water) which will produce blocks having the desired properties. Compressive strength and density OPC / ORS Sand concrete blocks were also determined.

RHA replacement of OPC (%)	0	10	20	30	40	50
Initial setting time (min)	95	189	191	305	374	429
Final setting time (min)	150	323	510	685	756	811

Table 8. Setting Times Test

The initial and final setting time increases with the increase of rice husk ash content. The reaction between cement and water is exothermic leading to the release of heat and evaporation moisture and therefore to strengthen the dough. As the rice hull ash replaces the cement, reaction rate decreases, and the quantity of heat also reduces led to the end of stiffening of the dough. As the hydration process requires water, a larger amount of water was also necessary for the process to continue.

The compressive strength variations with age hardening are shown in Table. The compressive strength generally increases with age to heal. The reaction between the cement particles or cement with water / RRS with water is known as hydration. Hydration proceeds with the presence of the evaporable water. Water is continuously supplied during curing and hydration process is continued. This allowed an increase in the compressive strength value. In the absence of evaporable water, there can be no gain in strength. However was reported that the compressive strength of concrete for mixing with the partial replacement of ball acha ash is not directly related to maturity. It was found that 7 and 14-day period of hydration of 10% and 20% AHA / OPC concrete strength is greater than that of conventional concrete. The difference may be due to the different material composition in the samples.

Age at curing % replacement level	Compressive strength (N/mm2)						Remarks
	1 Day	3 Days	7 Days	14 Days	21 Days	28 Days	
100 % OPC, 0% RHA	0.51	0.91	1.60	2.78	3.63	4.60	The compressive strength generally increases with age at curing and decreases as the RHA content increases.
90 % OPC, 10% RHA	0.40	0.70	1.31	2.43	3.35	4.09	
80 % OPC, 20% RHA	0.25	0.55	1.14	2.02	2.91	3.65	
70 % OPC, 30% RHA	0.15	0.36	0.74	1.35	1.79	2.07	
60 % OPC, 40% RHA	0.00	0.15	0.38	0.65	0.91	1.05	
50 % OPC, 50% RHA	0.00	0.06	0.30	0.40	0.42	0.59	

Table 9. Compressive Strength of Blocks

Dr. A.M. Pande1 and S.G.Makarande detailed, Rice Husk Ash used in this work was done in the laboratory by burning the ball using a furnace Ferro cement, incineration with temperatures not exceeding 7000 c. The ash was milled using mill Los Angeles 180, 270 and 360 minutes, XRD analysis was conducted to determine the shape of silica powder produced RHA samples. RHA samples were analyzed by electron microscope to show multilayer porous surface and micro RHA. Other materials used in the concrete mix were Portland cement, coarse aggregate 20 mm maximum size, and sand mining 5mm maximum size as fine aggregate. The fineness modulus of coarse aggregate and fine aggregate were 2.43 and 4.61 respectively.

Effect of adding RHA on the properties of concrete:-

The fresh concrete properties of all mixtures are given. The fall was in the order of (210-230 mm), bleeding was negligible for the control mixture. For concretes incorporating RHA, no bleeding or segregation was detected. The fresh density was within (2253-2347 kg / m3), the lowest density values were for mixing this is due to the low density of RHA that lead to a reduction in the mass per unit volume. Concrete incorporating finer RHA resulted in heavy concrete matrix.

The SP had to be content with increased finesse and RHA percentage, due to the high surface area of RHA thus increase the demand for water to maintain fluidity, Sp content increased to 2.00% for the mixture.

He gave following results in his experiments:

4.1 % Strength achieved for M20 grade concrete with 12.5%, 25% & 37.5% RHA:

The resistance to the average is considered more for 90 days and then less for 28 days and 7 days using 75 micron RHA. The average strength obtained is 12.5% CER compared to other proportions. One of recorded samples to reach 123.81% resistance to 90 days of curing compared to CCP. When RHA 150 microns is used, again reached the average strength is more for 90 days and there is less for 28 days and 7 days. The resistance% was obtained in the range of 85% to 90% for 7 days, compared to the CCP. Then, is considerably reduced 28 and 90 days of curing. At the very least, the minimum force was achieved in 25% of RHA using 75 microns. After 90 full days of healing was 67.37%. For 150 microns reached the minimum force was 37.5% of RHA. After 90 full days of healing was 34.78%. It can also be observed that when RHA fine was used (75 microns), the strength of% achieved was higher compared to the size of the ORS 150 microns.

From the above discussion, it is observed that when RHA 75 microns is used, the percentage of resistance achieved for 90 days is greater than that of PCC, while it is reduced in case of 28 days and 7 days. The average force obtained proves to be more for 7 days and 28 days, then it is reduced for 90 days with 75 micron RHA. The average force obtained is 25% CER compared to other proportions. One of the samples stored for maximum resistance 55.08% for 90 days of curing compared to CCP. When RHA 150 microns is used, again reached the average strength is more for 7 days and 28 days, then there is less for 90 days. The average strength obtained is 12.5% CER compared to other proportions. One of the samples stored for maximum strength 57.2% for 90 days of curing compared to CCP. At the very least, the minimum strength attained was 37.5% RHA using 75 microns. After 90 full days of healing was 26.96%. For 150 microns reached the minimum force was 25% RHA. After 90 full days of healing was 34.75%. It can also be observed that when RHA fine was used (75 microns), the force reaches% was slightly lower this year compared to the size of the ORS 150 microns

Mauro M. Tashima, Carlos A. R. da Silva investigates possibilities of adding Rice Husk Ash to the concrete. Rice husk was burnt approximately 48 hours under uncontrolled combustion process. The burning temperature was within the range 600 to 8500C. Depending on the chemical characteristics, the RHA has high levels of silicon dioxide, about 93%, and the density was 2.16 cm2 / g. 3 shows diffractograms X-ray to the sample of RHA. The results showed a clear peak corresponding to crystalline silica. The reason for this behavior is the long process of combustion time and the high temperature burning. According to Figure 4, the average distribution of particle size was 13.34µm. Thus the ORS is finer than the cement and should be called to work not only a role pozzolan, but also a microfiller effect.

Composition of concrete mixture:

He used the concrete mix proportions. Two doses of CSF, 5% (mixture E) and 10% (mixture F) in the cement replacement, and a mixture control (mixture D) were used. The slump test was fixed in 120 ± 20 mm, therefore, for the blends D and E, the amount of superplasticizer was 0.2% by mass of binder. To the mixture C, the ofsuperplasticizer assay was 0.3%

Cement	Sand	Coarse aggregate	W/C	Cement (kg/m3)		
				Mixture D	Mixture E	Mixture F
1	1.33	2.27	0.42	490.0	465.5	441.0

Table 10: Composition of concrete mixture

Compressive strength:

The compressive strength is shown in Table and Figure . The addition of RHA causes an increase in the compressive strength due to the ability of the pozolan, fixation of the calcium hidroxide, generated during the cement hydrate reactions. All degrees of replacement RHA increased the compressive strength. For a 5% ORS, 25% of the increase is verified by comparison with the mixture D.

Mixture	7 days	28 days
D	45.9	48.1
E	52.9	60.4
F	45.8	54.2

Table 11: Compressive strength (Mpa)

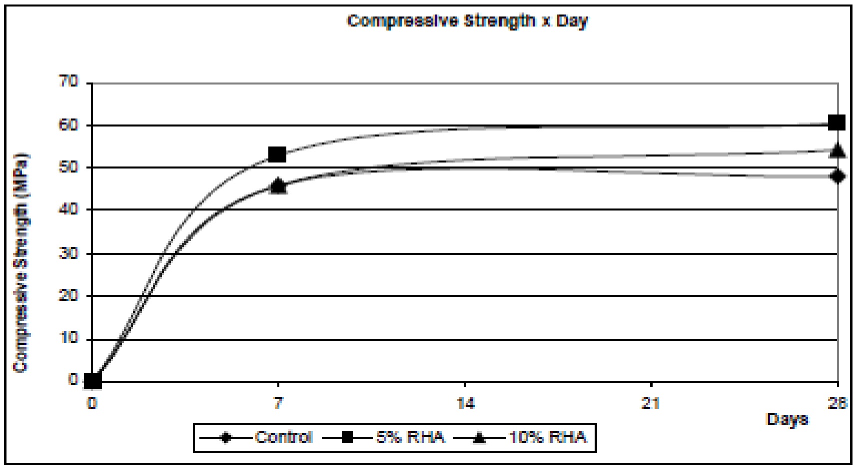

Figure 5: Result of compressive strength

Split Tensile strength:

The splitting tensile strength results are presented in Table and Figure. All Research degrees of replacement ORS, achieve similar results to the splitting tensile strength. The results can be realized that there is no interference of adding RHA in splitting tensile strength.

Mixture	7 days	28 days
D	4.85	5.37
E	4.94	5.79
F	4.82	5.78

Table 12: Split tensile strength

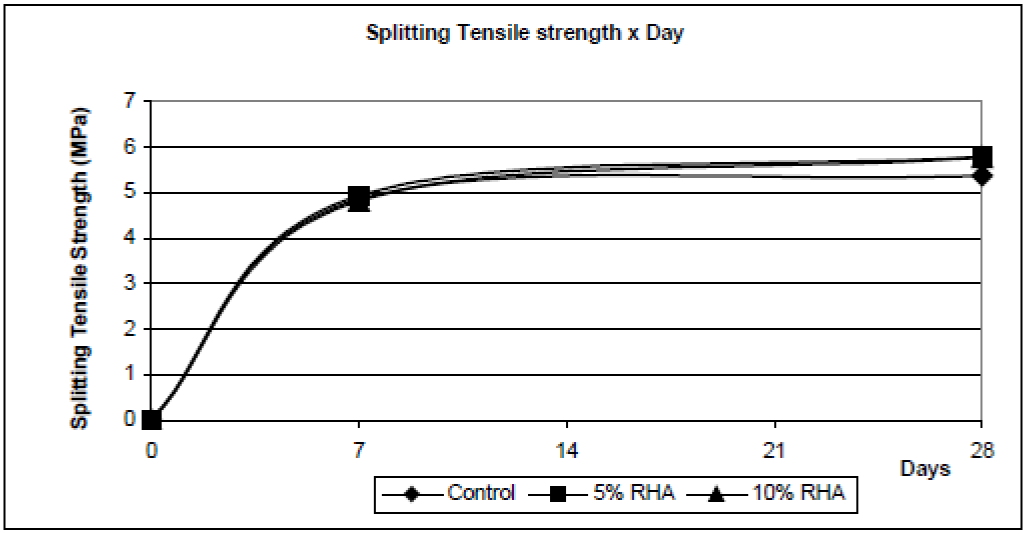

Figure 6: Result of split tensile strength

M. Anwar, T. Miyagawa and M. Gaweesh investigate "EFFECT OF USING A CONSIDERABLE PROPORTION OF RICE HUSK ASH AS A CEMENT REPLACEMENT ON CONCRETE PROPERTIES"

Compressive strength result:

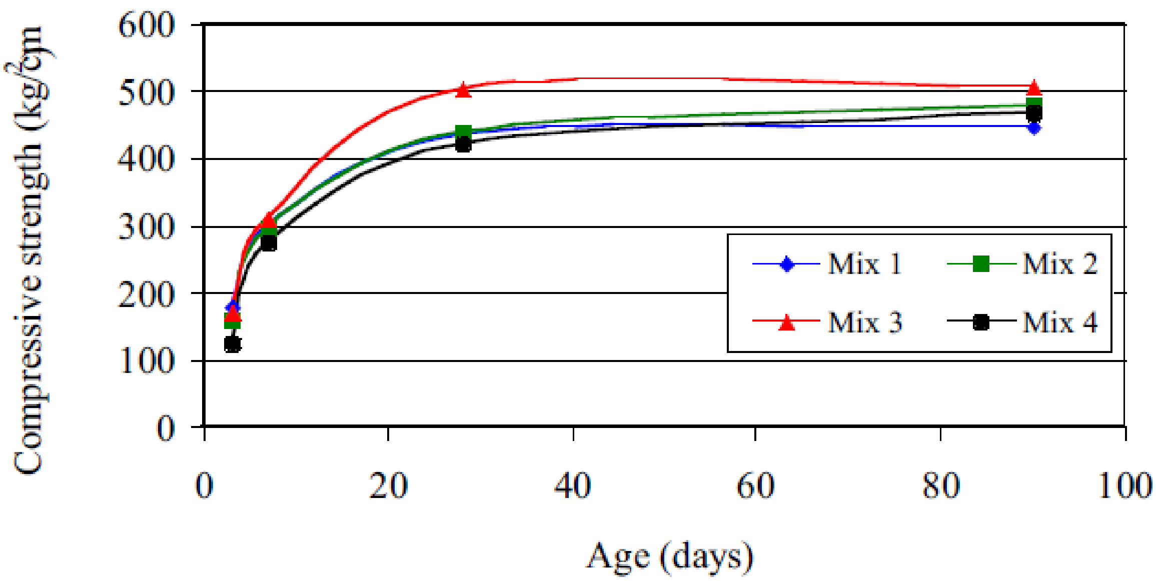

Figure 7: Result of compressive strength

Tensile and Flexural strength:

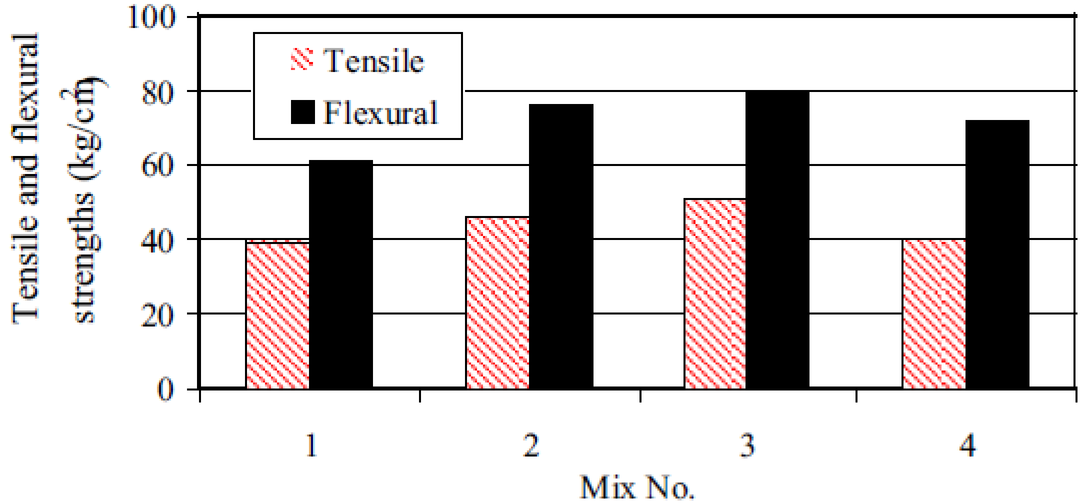

Figure 8: Result of tensile and flexural strength

CHAPTER 3

MATERIAL PROPERTIES AND MIX DESIGN

3.1 **Water**

Generally, water that is suitable for drinking is satisfactory for use in concrete. Water from lakes and streams that contain marine life also usually is suitable. When water is obtained from sources mentioned above, no sampling is necessary. When it is supposed that water may contain sewage, mine water, or wastes from industrial plants or canneries, it should not be used in concrete unless tests indicate that it is satisfactory. In the present experimental programme, potable tap water is used for casting.

3.2 METHODOLOGY

- The main objective of this work is to study the suitability of the rice husk ash as a pozzolanic material for cement replacement in concrete. However it is expected that the use of rice husk ash in concrete improve the strength properties of concrete.

- Also it is an attempt made to develop the concrete using rice husk ash as a source material for partial replacement of cement, which satisfies the various structural properties of concrete like compressive strength and Flexural strength.

- It is also expected that the final outcome of the project will have an overall beneficial effect on the utility of rice husk ash Concrete in the field of civil engineering construction work.

- Following parameters influences behavior of the rice husk ash concrete, so these parameters are kept constant for the experimental work:

a) Percentage replacement of cement by rice husk ash

b) Fineness of rice husk ash

c) Chemical composition of rice husk ash

d) Water to cementitious material ratio (w/b ratio)

3.3 METHODOLOGY ADOPTED FOR MIX DESIGN

Mix design is a process of selecting suitable ingredients for concrete and determining their proportions which would produce economical concrete. The proportioning of the ingredients of concrete is an important segment of concrete technology as it ensures quality and economy. For obtaining the concrete of desired performance characteristics, the component materials should be selected likewise. Then by considering these components, appropriate mix design is prepared.

3.3.1 Design of Concrete Mix

The compressive strength is said to be the index of quality of concrete. Therefore the design mix should be prepared keeping in view compressive strength of concrete with adequate workability so that the fresh concrete can be properly mixed, placed and compacted. The proportions for the mix were calculated adopting the requirements of water as specified in IS: 10262-2009. The following three steps must be followed for proportioning of concrete mixes.

(i) Selection of suitable ingredients-cement, supplementary cementing materials, aggregates, and water and chemical admixtures (if required).

(ii) Determination of the relative quantities of components to have economical concrete, that has desired rheological properties i.e. strength and durability.

(iii) Careful quality control of every phase of the concrete making process.

In the present study Mix Design (Design value at the age of 28 days) grade concrete is done according to BIS: 10262-2009

PROPERTIES OF CEMENT, FINE AGGREGATE AND COARSE AGGREGATE

Sr. No.	**Properties**	**Result**	**IS Code**
01	Fineness	2.125	IS 8112-1989
02	Specific Gravity	3.09	
03	Initial Setting Time	30 Min	

Table 13: Cement Properties

04	Final Setting Time	9.7 Hrs.	
05	Soundness	2mm	

Sr No.	**Property**	**Result**
01	Specific Gravity	2.732
02	Water Absorption	1%
ZONE as per IS 383-1970 III		

Table 14: Fine Aggregate Properties

Sr No.	**Size of Coarse Aggregate**	**Property**	**Result**
01	20 mm	Specific Gravity	2.71
		Water Absorption	.55%
02	10 mm	Specific Gravity	2.68
		Water Absorption	.50%

Table 15: Coarse Aggregate Properties

3.3.2 PREPARATION OF MIX DESIGN

- In this project we are using the M40 grade of Concrete mix design for testing purpose.
- Mix Design Proportions are given in the Table below:

MIX	**CEMENT**	**SAND**	**COARSE AGGREGATE**	**WATER**
RATIO	1	1.632	2.353	0.40

QUANTITY	442 Kg/m3	734.9 Kg/m3	1048.53Kg/m3	176.5 Kg/m3

Table 15- Mix Design of M40 Grade

Figure 9- M40 Mix Design

3.4.1 CASTING OF SPECIMENS

All the specimens were casted referring to the mix proportions mentioned in table. For these mix proportions, required quantities were weighed. Under this article, casting of specimens for different properties. Specimens for Compressive Strength 150x150x150 mm sized cube specimens were prepared for compressive strength. The materials required were weighed according to the mix proportion. Cement, fly ash, fine aggregates and coarse aggregates were dry mixed first to have a uniform colour.

After that 50% of the total water required was added to the mix to have thorough mixing for 3-4 minutes. Then 40% of the water was added with addition to the mix. Remaining 10% of water was sprinkled on the above mix and it was thoroughly mixed in the mixer. The oiled samples were then filled with the mix prepared and then filled moulds were put on the vibrating table for their proper mixing. Immediately after casting cubes, the specimens were covered with gunny bags to prevent water evaporation. Six identical cubes were casted. Out of six, three were tested after 7 days and rest after 28 days of curing.

3.4.2 Specimens for Split Tensile Strength

150x150x150 mm sized cube specimens were prepared for split tensile strength. The materials required were weighed according to the mix proportion. Cement, fly ash, fine aggregates and coarse aggregates were dry mixed first to have a uniform colour. After that 50% of the total water required was added to the mix to have thorough mixing for 3-4 minutes. Then 40% of the water was added with addition to the mix. Remaining 10% of water was sprinkled on the above mix and it was thoroughly mixed in the mixer. The oiled samples were then filled with the mix prepared and then filled moulds were put on the vibrating table for their proper mixing. Immediately after casting cubes, the specimens were covered with gunny bags to prevent water evaporation. Six identical cubes were casted. Out of six, three were tested after 7 days and rest after 28 days of curing.

3.4.3 Specimens for Young's Modulus

Diameter 150mm and 300mm length sized cylinder were casted for young's modulus. The materials required were weighed according to the mix proportion. Cement, fly ash, fine aggregates and coarse aggregates were dry mixed first to have a uniform colour. After that 50% of the total water required was added to the mix to have thorough mixing for 3-4 minutes. Then 40% of the water was added with addition to the mix. Remaining 10% of water was sprinkled on the above mix and it was thoroughly mixed in the mixer. The oiled samples were then filled with the mix prepared and then filled moulds were put on the vibrating table for their proper mixing. Immediately after casting cylinders, the specimens were covered with gunny bags to prevent water evaporation. Six identical cylinders were casted. Out of six, three were tested after 7 days and rest after 28 days of curing.

3.5 TESTING OF SPECIMENS

After casting, specimens were tested after 7 and 28 days of curing. Under this article, the procedure followed for testing of specimens is mentioned for evaluating various properties like compressive strength, splitting tensile strength, young's modulus of elasticity and rapid chloride permeability of concrete.

3.5.1 Mechanical Properties

3.5.1.1 Compressive Strength

Specimens were demoulded after 24 hours of casting. Then they were poured in curing tank for the predefined time. At the age of testing, specimens were taken out of the tank and allowed surface drying for 10-15 minutes. Specimens were tested in Compression Testing Machine (CTM) at the load rate of 5 kN/sec specified as per IS: 516-1959. CTM has the capacity of 5000kN. The failure load was then evaluated.

Figure 10: Universal testing Machine (UTM)

3.5.1.2 Split Tensile Strength

Specimens were demoulded after 24 hours of casting. Then they were poured in curing tank for the predefined time. At the age of testing, specimens were taken out of the tank and allowed surface drying for 10-15 minutes. Specimens were tested in Universal testing machine (UTM) at the load rate of 70 kN/min. UTM has the load capacity of 1000kN. The failure load was then evaluated. The formula used is

$$\text{Split tensile strength} = \frac{0.5187XP}{S^2}$$

P = Failure load, in N

S = Side of cube, in mm

3.6 DETERMINATION OF FLEXURE STRENGTH TEST ON CONCRETE BEAMS

For this test the beams of dimension 100mmX100mmX500mm were casted. Flexural st0rength, also known as modulus of rupture, bend strength, or fracture strength, [dubious – discuss] a mechanical parameter for brittle material, is defined as a material's ability to resist deformation under load. The transverse bending test is most frequently employed, in which a rod specimen having either a circular or rectangular cross-section is bent until fracture using a three point flexural test technique. The flexural strength represents the highest stress experienced within the material at its moment of rupture. The beam tests are found to be dependable to measure flexural strength. The value of the modulus of rupture depends on the dimensions of the beam and manner of loading. In this investigation, to find the flexural strength by using third point loading. In symmetrical two points loading the critical crack may appear at any section not strong enough to resist the stress with in the middle third, where the banding moment is maximum. Flexural modulus of rupture is about 10 to 20 percent of compressive strength depending on the type, size and volume of coarse aggregate used.

3.6.1 Calculations:

$Fb = PL / bd^2$

Where b= width in cm of specimen

d= depth in cm of specimen at point of failure

L= length in cm of specimen on which specimen was supported

3.7 DETERMINATION OF SPLIT TENSILE STRENGTH TEST

As we know that the concrete is weak in tension. Tensile strength is one of the basic and important properties of the concrete. The concrete is not usually expected to resist the direct tension because of its low tensile strength and brittle nature. However, the determination of tensile strength of concrete is necessary to determine the load at which the concrete members may crack. The cracking is a form of tension failure. The usefulness of the splitting cube test for assessing the tensile strength of concrete in the laboratory is widely accepted and the usefulness of the above test for control purposes in the field is under investigation. The standard has been prepared with a view to unifying the testing procedure for this type of test for tensile strength of concrete. The load at which splitting of specimen takes place shall then be recorded.

3.7.1 Calculations:

The split tensile strength of the specimen calculated from the following formula

Tsp = (2P/ (πdL))

Where P= maximum load in tonne

L= length of the specimen

d= diameter of width of the specimen

CHAPTER 4

Results And Discussions

4.1 RESULTS OF SLUMP TEST

MIX	RHA Replacement	Slump Value (mm)
M1	0%	77
M2	5%	72
M3	10%	66
M4	15%	60
M5	20%	50

Table 16: Result of Slumps

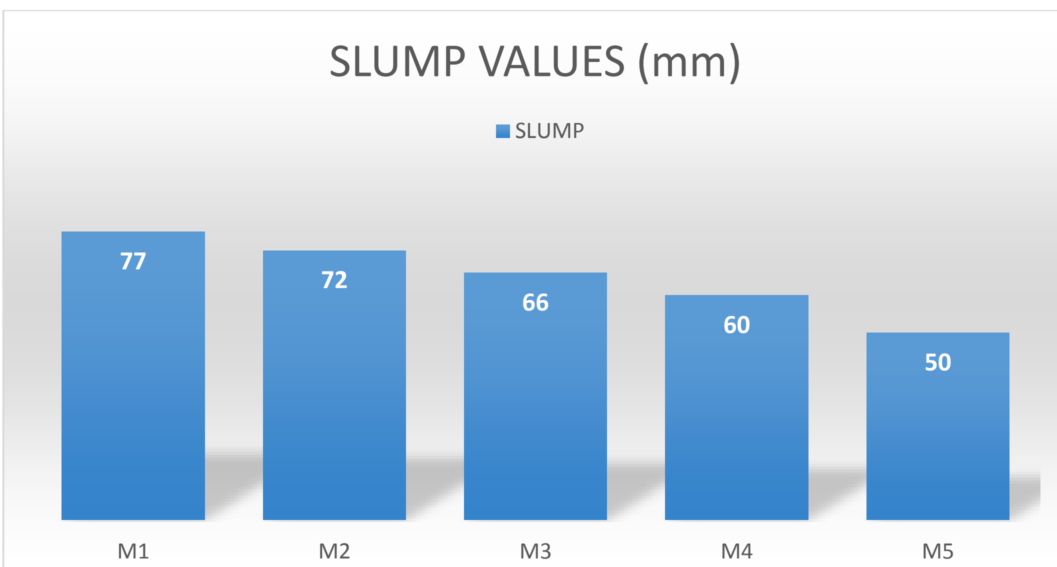

Figure 11 - Results of Slump Value

In this chapter the parameters studied on the control and concrete made with replacement of Rice husk Ash with cement. These parameters are Compressive strength, Flexural strength and Split Tensile Strength.

4.2 COMPRESSIVE STRENGTH

Six cubes sized 150mmx150mmx150mm were casted to be tested at 7 days and 28 days of curing for each mix except for concrete mix containing carbon nanotubes. Nine numbers of cubes for concrete were casted and tested after 28days of curing. Table 4.1 details the values of compressive strength for different batches.

4.2.1 RESULT OF COMPRESSIVE STRENGTH

MIX	**RHA Replacement**	**Compressive Strength (N/mm^2)**	
		7 Days	**28 Days**
M1	0%	33.5	47.6
M2	5%	36.7	49.1
M3	10%	34.6	46.2
M4	15%	31.9	40.1
M5	20%	27.4	35.3
M6	25%	21.1	27.4

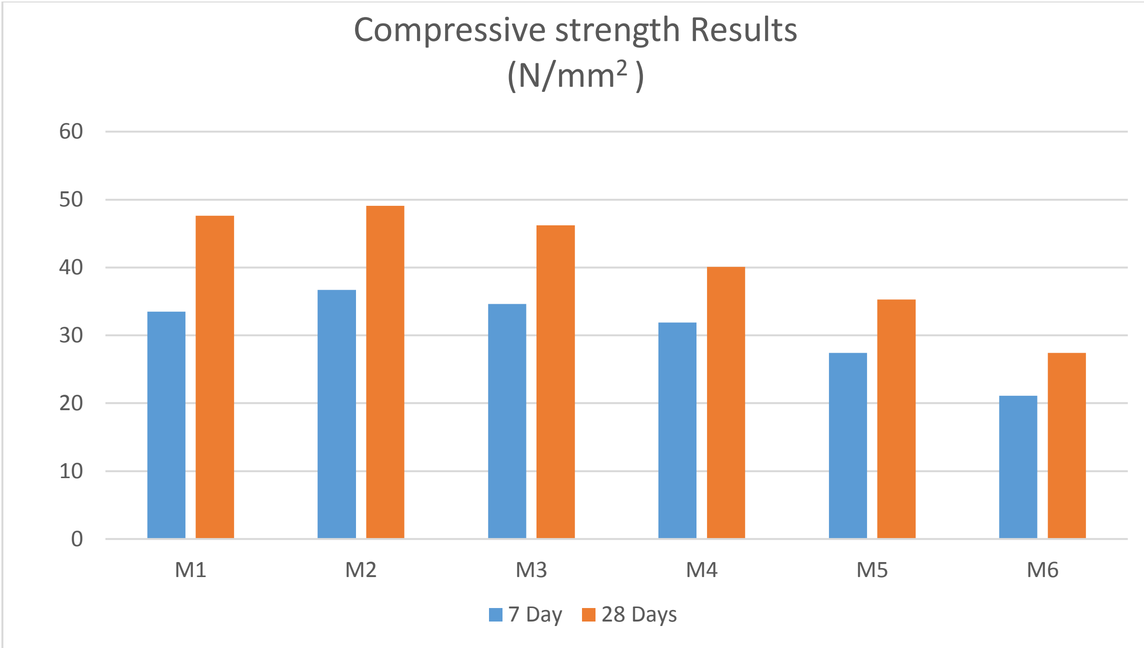

Figure 12 – Result of Compressive strength

4.3 SPLITTING TENSILE STRENGTH

Six cubes sized 150mmx150mmx150mm were casted to be tested at 7 days and 28 days of curing for each mix except for concrete mix containing carbon nanotubes. Nine numbers of cubes for concrete were casted and tested after 28 days.

4.3.1 RESULTS OF SPLIT TENSILE STRENGTH

SPLIT TENSILE STRENGTH (N/mm^2)		
Sample	7 Days	28 Days
M1	2.163	3.021
M2	2.360	3.178
M3	1.921	2.643
M4	1.814	2.517
M5	1.586	2.118
M6	1.443	2.041

Table 19 - Split Tensile Strength of Concrete

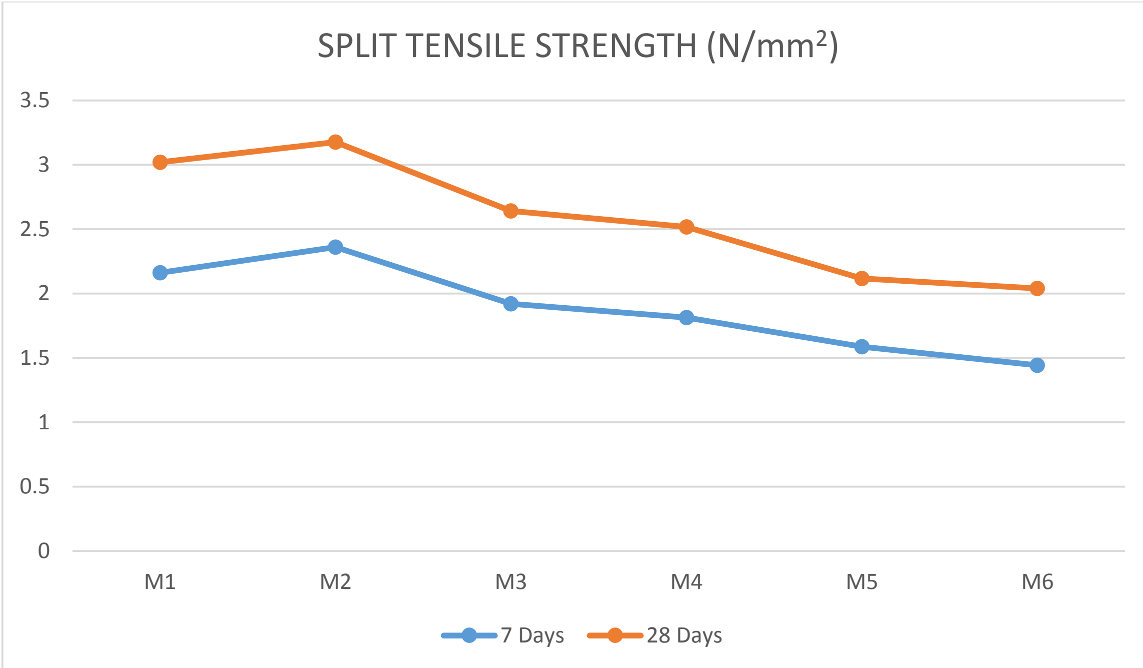

Figure 19 – Split tensile strength

4.4 COMPARING RESULTS

- As the project done is with RHA and without RHA so we need to compare the results of the two.
- Now below are the comparison of results of the project in form of Table and the graphical representation.

4.4.1 Compressive Strength Result Comparison

MIX	RHA REPLACEMENT	COMPRESSIVE STRENGTH (N/mm^2)		FLEXURE STRENGTH
		7 DAYS	28 DAYS	28 DAYS (N/mm^2)
M1	0%	33.5	47.6	3.037
M2	5%	36.7	49.1	3.350
M3	10%	34.6	46.2	3.151
M4	15%	31.9	40.1	2.516
M5	20%	27.4	35.3	2.185
M6	25%	21.1	27.4	1.975

Table 20- compressive strength and flexure strength

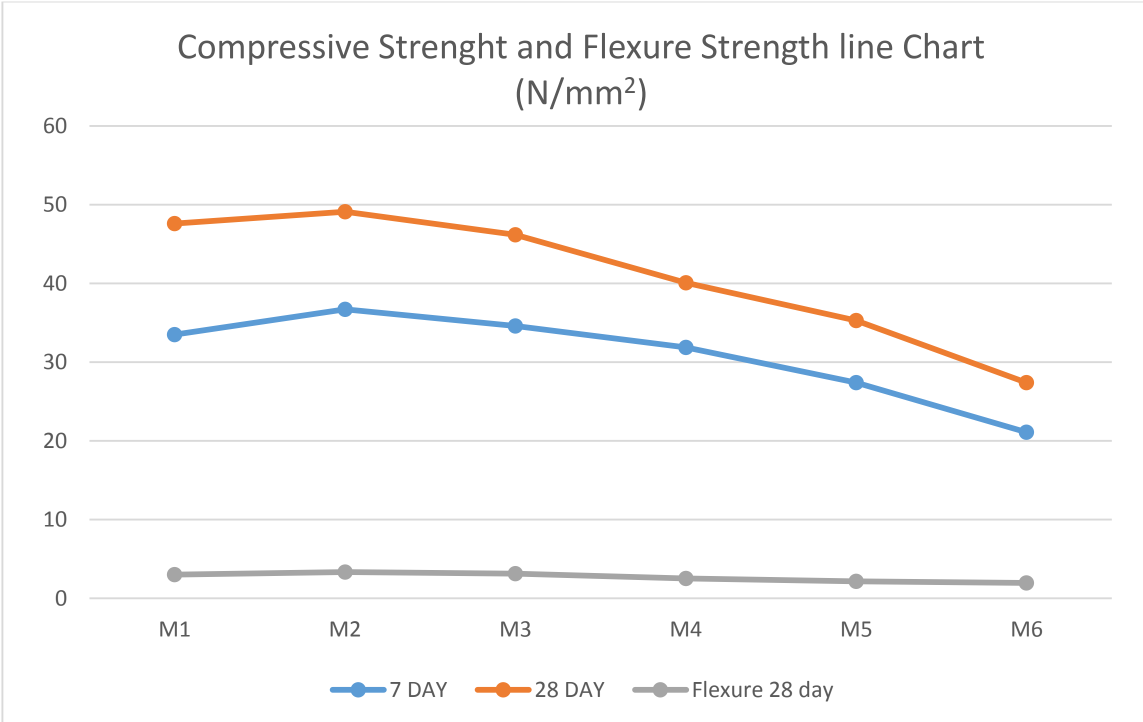

Figure 14 – Comparison of compressive and flexure strength

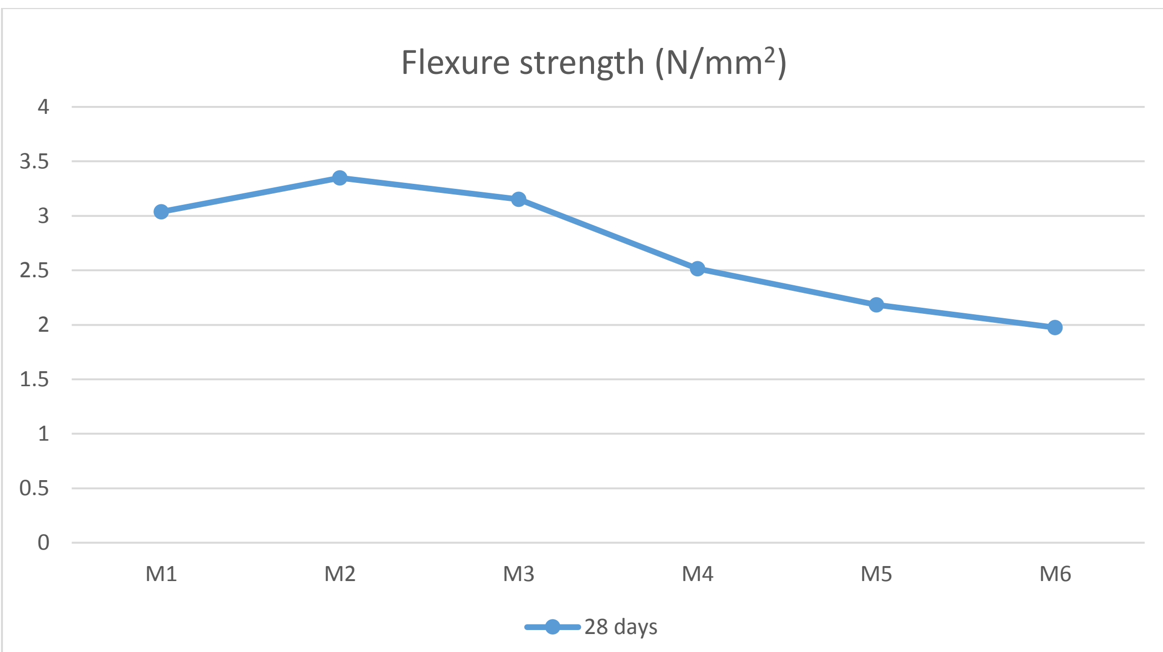

Figure 15- Flexure Strength of concrete

- From the above results we can demonstrate that the Compressive Strength of concrete can be increased if a correct Proportion of RHA is to be mixed properly.

- Flexure strength came out to be good at M2 grade in our testing and after further increase in RHA we notice a sudden decrease in flexure strength.
- From the above results we come to a conclusion that for M2 (5% RHA Replacement) we get maximum compressive, flexural and split tensile strength for the concrete.

CHAPTER 5

CONCLUSION

- After doing this project following conclusions are made :
  - ✓ Rice Husk Ash is a highly reactive pozzolanic material and can be used as a supplementary cementing material to produce high-performance concrete.
  - ✓ The compressive strength of the concrete containing up to 15 percent of the RHA was higher than that of the control Portland cement concrete. The strength of the concrete increased with decreasing $w/(c + \text{RHA})$.
  - ✓ Due to the high specific surface of the RHA, the concrete incorporating RHA required higher dosages of the super-plasticizer and the air-entraining admixture than the control Portland cement and silica fume concretes to achieve the same slump and air content.
  - ✓ The RHA concrete had slightly longer setting times than those of the control and the silica fume concretes. The bleeding of the concrete incorporating RHA was negligible.
  - ✓ The RHA concrete had higher compressive strengths at ages up to 180 days compared

with that of the control concrete, but lower values than those of the silica fume concrete.

- ✓ The flexural and splitting tensile strengths, modulus of elasticity, and drying shrinkage of the control concrete and the concrete incorporating RHA or silica fume were comparable

APPENDIX

1. IS: 516-1959 method of test for strength of concrete
2. IS 4031-2 (1999) for fineness test procedure
3. IS 4031-11 (1998) for specific gravity of cement
4. IS 383:1970 for sieve Analysis of Fine and Coarse Aggregate.

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