IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE)
e-ISSN: 2278-1684,p-ISSN: 2320-334X, Volume 11, Issue 2 Ver. II (Mar- Apr. 2014), PP 61-68
www.iosrjournals.org

"To Study The Partial Replacement Of Cement By FA & RHA And Natural Sand By Quarry Sand In Concrete"

Rinki .K. Khot[1], R. S. Deotale[2], Abhijeet .R. Narde[3]

[1]M.Tec student (structural), Civil Engineering Department, Yeshwantrao chavan college of Engineering, Nagpur, INDIA,

[2]Associate Prof. Civil Engineering Department, Yeshwantrao chavan college of Engineering, Nagpur, INDIA,

[3]Research Scholar and lecturer, Civil engineering Department, Rajiv Gandhi Engineering Collage, Nagpur, INDIA

Abstract: *Large scale exploitation of natural sand creates environmental impact on society. River sand is most commonly used fine aggregate in concrete but due to acute shortage in many areas, availability, cost & environmental impact are the major concern. To overcome from this crisis, partial replacement of sand with quarry sand can be an economic alternative. Quarry sand has been used in different construction purposes but replacement technology has emerged as an innovative development to civil engineering material. Design mix of M20 grade concrete with replacement of 0%, 15%, 30%, 45%,60% of quarry sand have been considered for laboratory test i.e slump test, compressive strength, split tensile strength, flexural strength, permeable voids and acid attack. (Cubes, cylinders, beams sample).*

The detailed study is on the effect of partial replacement of cement with Rice Husk Ash and Fly Ash on concrete. In this project different combination of Fly Ash and Rice Husk Ash as a partial replacement of cement and river sand by quarry sand is carried out. The composition of 7.5% Rice Husk Ash + 22.5% Fly Ash with 60% of quarry sand gives maximum strength results.

Keywords: *Admixture, Cement, Fly Ash(FA), Quarry sand(QS), Rice Husk Ash(RHA).*

I. Introduction

Concrete is the most widely used construction material in civil engineering industry because of its high structural strength, stability and malleability. Recent technological developments have shown that these materials can be used as valuable inorganic and organic resources to produce various useful value-added products. The concrete industry is constantly looking for supplementary cementitious material with the objective of reducing the solid waste disposal problem. Rice husk ash (RHA), Fly Ash (FA) and quarry sand (QS) are among the solid wastes generated by industry. Substantial energy and cost savings can result when industrial by-products are used as partial replacements for the energy- intensive Portland cement. High quality sand is in short supply in India; thus an increasing demand for cement and concrete can be met by partially replacing cement with RHA and FA same as sand with QS respectively. This investigation is done to study the feasibility of using locally available RHA, FA and QS as partial replacements for cement and sand in concrete. In this project materials are added fly ash, rice husk, and quarry sand with using admixture to obtain concrete of desired property. In this project, first phase is to replace natural sand by quarry sand at different proportion of 15% interval upto 60% and in second phase we have taken the combination of FA and RHA with the above combination of natural sand and quarry sand i.e done in phase first. we have started proportion form as 30% FA and 0% RHA mix together in concrete by replacement of cement with the increase of RHA by 5% and simultaneously decrease of FA by 5% ,last proportion taken 22.5%FA and 7.5% RHA. The tests on hardened concrete are destructive test while the destructive test includes compressive test on concrete cube for size (150 x 150 x 150) mm, Flexural strength on concrete beam (500 x 100 x100) and split tensile strength on concrete cylinder (150 mm ø x 300mm) and permeable voids (200 x 100 x100) mm as per IS: 516 – 1959, IS: 5816 – 1999 and ASTM C642-97 respectively. The work presented in this project reports is an investigation on the behaviour of concrete produced from blending cement with FA and RHA and sand with Quarry Sand (QS).

The objectives and scope of present study are:

1. To find the optimum percentage of Quarry Sand in concrete by partial replacement of Natural Sand.
2. To use pozzolanic material such as FA and RHA in concrete by partial replacement of cement.
3. To use both the pozzolanic material i.e FA and RHA with the combination of Natural Sand and Quarry Sand.
4. To find permeable voids, compressive strength, flexural strength, and split tensile strength.
5. To provide economical construction material.
6. To test the acid resistance.
7. Provide safeguard to the environment by utilizing waste properly.

II. Material And Methods

The work in this paper presents the investigation on the behaviour of concrete produced from blending of cement with the combination of RHA and FA and natural sand by quarry sand. The physical and chemical properties of RHA, FA and OPC were first investigated. Mixture proportioning was performed to produce high workability concrete with target strength of 26.6 N/mm^2 (M20) for the control mixture. The effect of RHA on concrete properties was studied by means of the fresh properties of concrete and the mechanical properties i.e. Compressive strength, split tensile strength, flexural strength, deflection, and permeable voids test was studied as the time dependent property.

2.1. Cement

The Ordinary Portland cement (43 Grade) was used with a specific gravity of 3.15. Initial and final setting time of the cement was 55 min and 305 min, respectively. Its chemical composition is given in Table 1.

Table 1: Following are the Chemical properties of cement (OPC), Fly ash and Rice husk ash as per Geo technical laboratory

Tested	Cement	Fly ash	RHA
SiO_2	19.71	61.39	83.87
Al_2O_3	5.20	($SiO_2+Al_2O_3+ Fe_2O_3$) =94.36	(SiO2+Al_2O_3+ Fe_2O_3) =86.19
Fe_2O_3	3.73		
CaO	62.91	0.51	0.20
MgO	2.54	0.82	0.52
SO_3	2.72	0.31	0.11
K_2O	0.90	0.02	0.13
Na_2O	0.25	0.02	0.16
LOI	0.96	7.21	0.44

2.2. Quarry sand

Quarry Sand was obtained from Sidheshwar quarry, Pachgaon. Plant: 360, Surgaon, Nagpur. The cheapest and the easiest way of getting substitute for natural sand is by crushing natural stone to get artificial sand of desired size and grade which would be free from all impurities is known as Quarry Sand. In this study, Quarry sand conforming to grading Zone – II was used as fine aggregate instead of river sand and the specific gravity is 3.

2.3. Rice Husk Ash

Rice husk ash was obtained from Ellora Paper Plant located in Tumsar, Bhandara. In this plant stream is used for drying the wet paper with the help of burning the rice husk at 700^0c. Rice Husk Ash is one of the most silica rich raw materials containing about 80-95% silica after complete combustion. The Specific gravity of rice husk ash is 2.12 and bulk density is 0.781 g/cc RHA, produced after burning of Rice husk (RH) has high reactivity and pozzolanic property. Silica has been added in concrete to increase strength, flexibility and aging resistance. Studies have shown that RHA resulting from the burning of rice husks at control temperatures have physical and chemical properties that meet ASTM (American Society for Testing and Materials).Standard C 618-94a. Studies have shown that to obtain the required particle size, the RHA needs to be grown to size 45 μm – 10 μm.

2.4. Fly Ash

Fly ash used was obtained from Koradi Power Plant Nagpur. Fly ash is one of the residues generated in the combustion of coal. Fly ash is generally obtained from the chimneys of power generation bottom furnaces. Depending upon the source and makeup of the coal being burned, the components of the fly ash produced vary considerably, but all fly ash includes substantial amounts of silica (silicon dioxide, SiO_2) (both amorphous and crystalline) and lime (calcium oxide, (CaO). The specific gravity of fly ash is 2.2

2.5. Aggregate

Good quality river sand was used as a fine aggregate. The fineness modulus and specific gravity are 2.73and 2.5. Coarse aggregate passing through 20mm and retained 10mm sieve was used. Its specific gravity was 2.85.

2.6. Chemical Admixture

A commercial AC- Plast-BV-M4 black cat Chemical Limited. Chemical Limited type super plasticizer was used to maintain the workability of fresh concrete. The dosage of super plasticizer was kept constant in mass basis; it was 1%-2% of cement weight. This super plasticizer with less than 0.05% chloride content as per IS standard and compatible with all grades of cement.

III. Experimental Programme

Experimental programme comprises of test on cement, RHA, FA, cement concrete with partial replacement of cement with RHA and FA.

3.1 Rice Husk Ash

The physical test results on RHA are as follows:

1. Normal Consistency = 41%
2. Initial and Final Setting time = 185min and 305min
3. Soundness = 0.014
4. Specific Gravity = 2.12

3.2 Ordinary Portland Cement

OPC 43 grade cement is used for this whole experimental study. The physical test results on OPC are as follows.

1. Normal consistency = 32%
2. Initial Setting time = 55 min.
3. Final Setting Time = 305 min.
4. Specific Gravity = 3.15

3.3 Test on Concrete

An M20 mix is designed as per guidelines in IS 10262-2009 based on the preliminary studies conducted in the constituent materials. Tests on fresh concrete are obtained as follows.

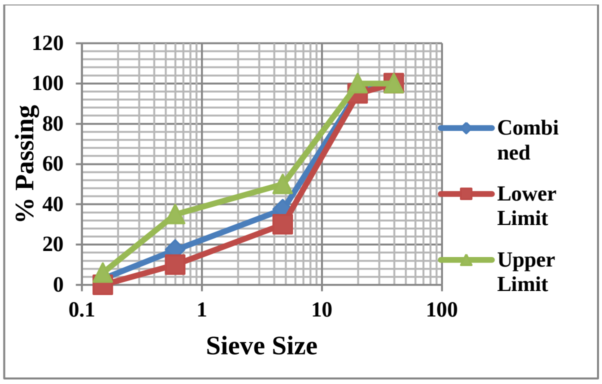
1. Slump Test= 65mm

3.4 Combine Grading

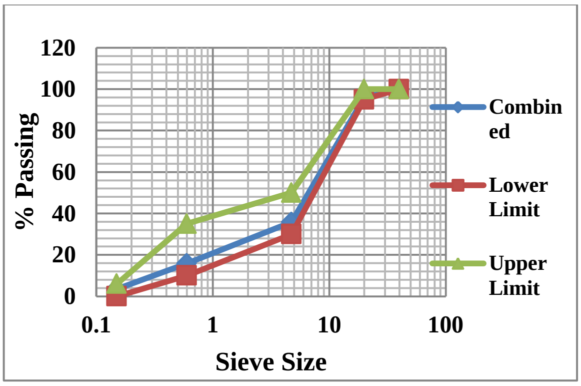
For each aggregate used in the mix design, include a gradation analysis that is representative of the aggregate. Aggregate are graded not only to maintain cohesiveness of mix, but also to meet the grading requirement of IS 383-1970. The gradation is done as per IS 383 in which according to our mix design 66.813% coarse aggregate which is kept constant and 33.816% fine aggregate are varied by different percent of quarry sand and natural sand. The following graph shows aggregate gradations and combined aggregate gradation.

Table 1. Combined gradation of All in Aggregates.

Sr. No.	Sieve Size (mm)	45% QS and 55% NS			60% QS and 40% NS		
		Combined	Lower Limit	Upper Limit	Combined	Lower Limit	Upper Limit
1.	40	100	100	100	100	100	100
2.	20	95.982	95	100	95.982	95	100
3.	4.75	37.45	30	50	35.78	30	50
4.	0.60	17.36	10	35	15.84	10	35
5.	0.150	2.953	0	6	3.55	0	6



Graph1: Combine grading of QS (45%) and NS (55%)



Graph2: Combine grading of QS (60%) and NS (40%)

3.5 Mixture Proportioning

The mixture proportioning was done according the Indian Standard Recommended Method IS 10262-2009.The target mean strength was 26.6 N/mm^2 for the OPC control mixture, the total binder content was 304.34 kg/m^3, fine aggregate is taken 476kg/m and coarse aggregate is taken 1242.62kg/m the water to binder ratio was kept constant as 0.46, the Superplasticizer content was varied to maintain a slump for all mixtures. The total mixing time was 10 minutes; the samples were then casted and left for 24 hrs before demoulding. They were then placed in the curing tank until the day of testing comes i.e 7, 28, 56 days in the ratio 1:2.2:4.5 by weight before water was added and was properly mixed together to achieve homogenous material. Water absorption capacity appropriately subtracted from the water/cement ratio used for mixing. Hence, cement was replaced in different percentages up to 30% with rice husk ash and fly ash and 150 × 150 × 150mm^3, Beam and Cylinder moulds were used for casting. Compaction of concrete in three layers with 25 strokes of 16 mm rod was carried out for each layer. The concrete was left in the mould and allowed to set for 24 hours before the cubes were de moulded and placed in curing tank. The concrete cubes were cured in the tank for 7, 28, 56 days.

3.6 Testing methods

Testing is done as per following IS code. The testing done for compressive strength of cubes were measured 7, 28, 56 days as per IS: 516 – 1959, the testing done for flexural strength of beam were measured 28 days as per IS: 516 - 1959 and the testing done for split tensile strength of cylinder were measured 28 days as per IS: 5816 – 1999 and the test done for permeable voids were measured 7,28 and 56 days as per ASTM C642.

3.7 Acid Resistant Test

In this study, two concrete cubes with replacement of cement by 22.5% of FA , 7.5% RHA & 60% QS and control mix are weighed after 28-days of curing and immersed in diluted 1% of sulphuric acid solution for 30-days. Then the cubes are taken out and weighed. The percentage loss in weight and percentage reduction in compressive strength are calculated and compared with that of control mix. (CM)

3.8 Chloride Attack Test

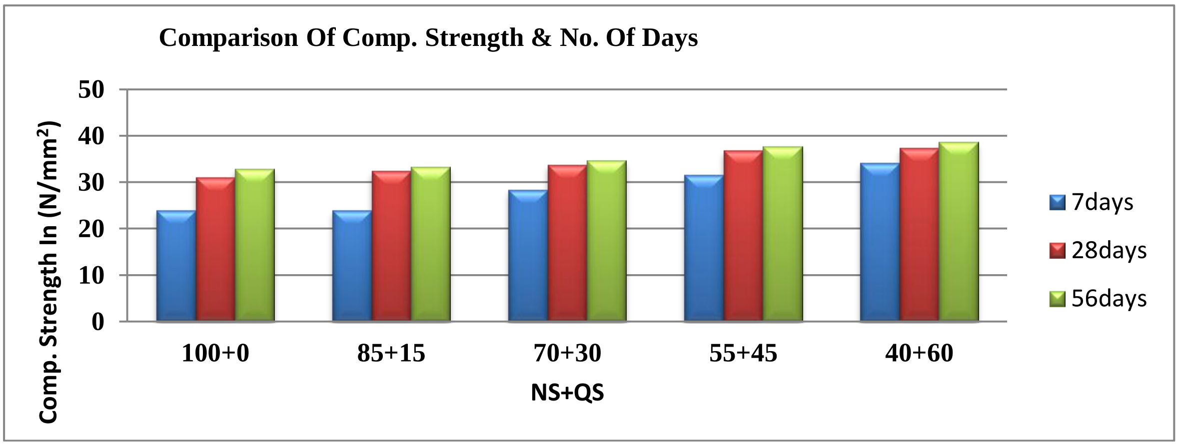
Chloride attack is one of the important aspects to be considered while dealing with the durability of concrete because it primarily causes corrosion of reinforcement. Concrete cubes with cement replaced by 22.5% FA, 7.5% RHA and natural sand replaced by 60% QS and control mixes are immersed in a solution of 3% hydrogen chloride by weight of water for 30-days. Then the cubes are taken out and weighed and the percentage reduction in compressive strength is calculated.

3.9 Permeable Voids Test

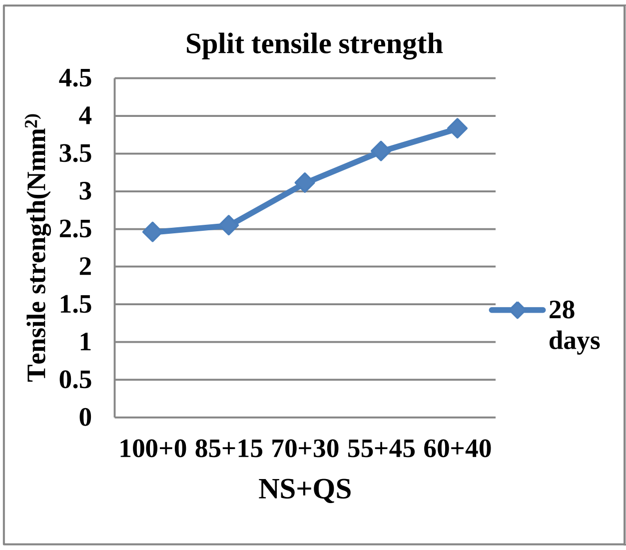
This test method covers the determination of density, percent absorption, and percent voids in hardened concrete. This test method is useful in developing the data required for conversions between mass and volume for concrete. It can be used to determine conformance with specification for concrete and to show differences.

Table 2 Compressive strength, Flexural strength, Split tensile strength.

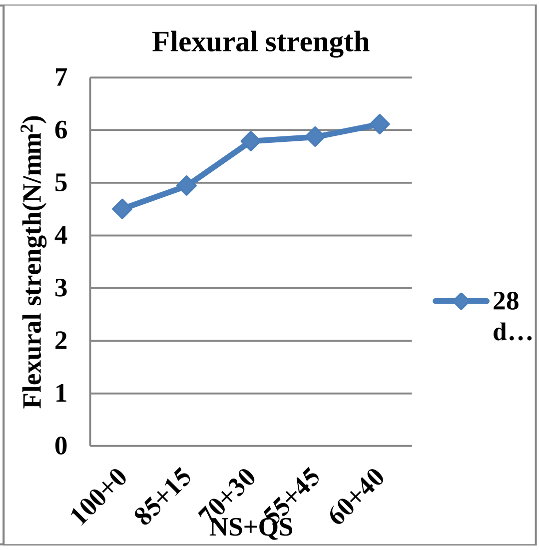
Sr. No.	Mix		Strength after curing in days in N/mm^2				
	Mix Proportion		7 Days	28 Days	56 Days	Flexural strength	Split tensile strength
	NS by %	QS by %					
A	Control mix		23.98	31.11	32.88	4.5	2.456
A1	85	15	23.98	32.44	33.33	4.94	2.546
A2	70	30	28.44	32.88	34.66	5.79	3.11
A3	55	45	31.55	36.88	37.77	5.87	3.53
A4	40	60	34.22	37.33	38.66	6.11	3.83



Graph 3: Comparison of Comp. Strength & No. Of Days



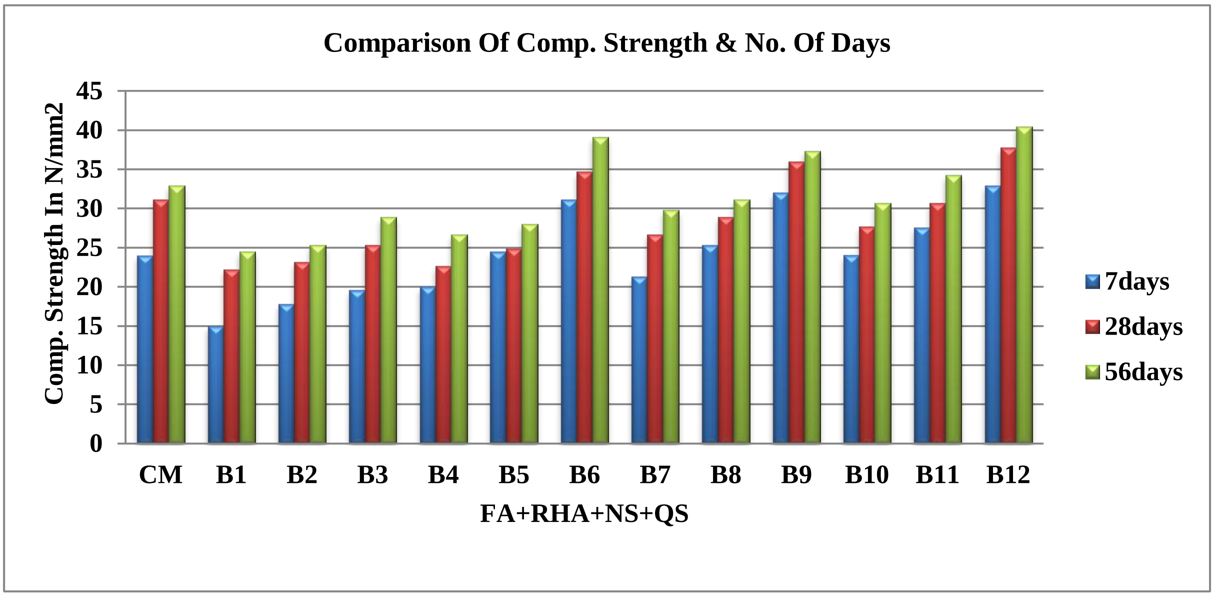
Graph 4: 28Days Tensile Strength



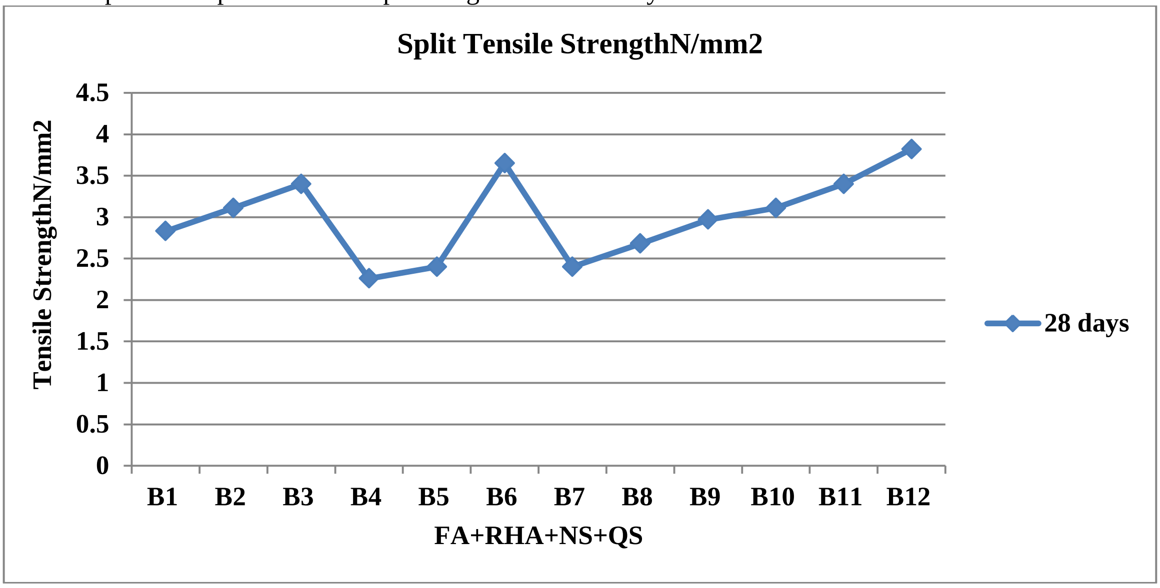
Graph 5: 28 Days Flexural Strength

Table 3: Compressive strength, Flexural strength, Split tensile strength

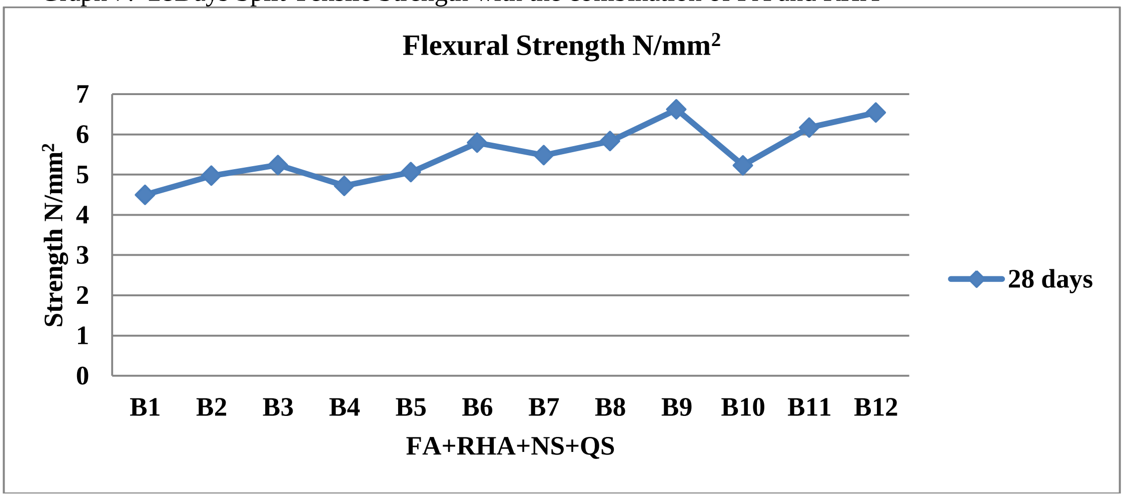
Sr. No.	Mix				Strength after curing in days in N/mm^2				
	Mix Proportion				7 Days	28 Days	56 Days	Flexural strength	Split tensile strength
	FA by%	RHA by %	NS by %	QS by %					
A	Control mix				23.98	31.11	32.88	4.5	2.456
B1.	30	0	85	15	15	22.22	24.44	4.5	2.83
B2.	25	5	85	15	17.77	23.11	25.33	4.97	3.11
B3.	22.5	7.5	85	15	19.55	25.33	28.88	5.24	3.4
B4.	30	0	70	30	20	22.66	26.66	4.72	2.26
B5.	25	5	70	30	24.44	24.88	28	5.06	2.4
B6.	22.5	7.5	70	30	31.11	34.66	39.11	5.79	2.65
B7.	30	0	55	45	21.33	26.66	29.77	5.48	2.4
B8.	25	5	55	45	25.33	28.88	31.11	5.83	2.68
B9.	22.5	7.5	55	45	32	36	37.33	6.62	2.97
B10.	30	0	40	60	24	27.66	30.66	5.23	3.11
B11.	25	5	40	60	27.55	30.66	34.22	6.17	3.4
B12.	22.5	7.5	40	60	32.88	37.77	40.44	6.54	3.82



Graph 6: Comparison of Comp. Strength & No. Of Days



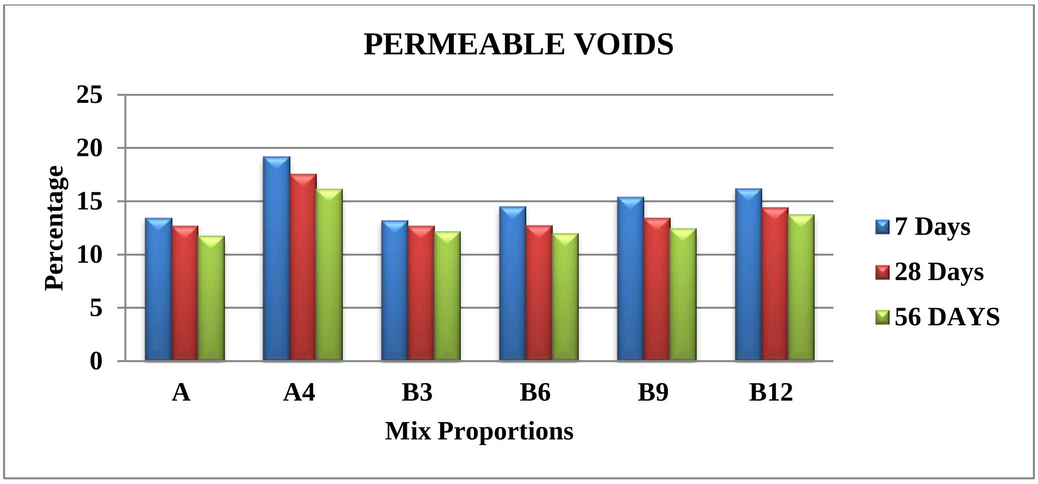
Graph 7: 28Days Split Tensile Strength with the combination of FA and RHA



Graph 8: 28Days Flexural Strength With The Combination Of FA And RHA

Table 4: Permeable Voids for critical sections

Sr. No.	Mix				Strength after curing in days in N/mm^2		
	Mix Proportion				7 Days	28 Days	56 Days
	FA by%	RHA by %	NS by %	QS by %			
A	0	0	100	0	13.44	12.7	11.77
A4	0	0	40	60	19.2	17.57	16.19
B3	22.5	7.5	85	15	13.2	12.7	12.2
B6	22.5	7.5	70	30	14.5	12.77	11.97
B9	22.5	7.5	55	45	15.4	13.46	12.45
B12	22.5	7.5	40	60	16.2	14.44	13.74



Graph 9: Comparison of permeable voids and No. of days

Table 5: Reduction in weight and compressive strength of concrete cubes immersed in 3% hydrogen chloride

Mix designation	Average weight of cube Before immersion, (gm)	Average weight of cube after immersion, (gm)	Reduction in weight, %	Average compressive strength before immersion, N/mm^2	Average compressive strength after immersion, N/mm^2	Reduction in compressive strength, %
CM (A)	8900	8850	0..56%	31.11	29.33	8.43%
22.5%FA+7.5%RHA	8800	8770	0.34%	37.77	36.44	3.52%

Table 6: Reduction in weight and compressive strength of concrete cubes immersed in 1% sulphuric acid solution

Mix designation	Average weight of cube Before immersion, (gm)	Average weight of cube after immersion, (gm)	Reduction in weight, %	Average compressive strength before immersion, N/mm^2	Average compressive strength after immersion, N/mm^2	Reduction in compressive strength, %
CM (A)	8900	8870	0.33%	31.11	27.22	12.5%
22.5%FA+7.5%RHA	8800	8780	0.22%	37.77	35.11	5.87%

IV. Conclusions

Based on the results presented above, the following conclusions can be drawn:

1. The percentage of water cement ratio is depends on quantity of RHA and QS used in concrete. Because RHA is a highly porous material.
2. Compressive strength increases with the increase in the percentage of Fly ash and Rice Husk Ash up to replacement (22.5%FA and 7.5% RHA) of Cement in Concrete for different mix proportions.
3. Compressive strength increase by addition of quarry sand in addition to FA and RHA.
4. The maximum 28 days split tensile strength was obtained with 22.5% fly ash 7.5% rice husk ash mix.
5. The maximum 28 days flexural strength was obtained again with 22.5% fly ash and 7.5% rice husk ash mix but with 45% QS replaced by NS.
6. Though the cost of rice husk ash is zero and thus we preferred RHA in concrete as compare to silica fumes and it is also economical also.
7. Due to the high absorbing quality of the RHA, the dosage of super plasticizer had to be increased along with RHA fineness to maintain the desired workability.
8. Since RHA increase the strength but decrease the workability of material so to increase the workability FA is added with the combination of RHA.
9. According to the mix the combine gradation 45% QS replaced by NS meets the grading limits as per IS 383-1970.
10. According to combine grading 45% QS gives good strength but it has also been resulted than on adding more percent of QS i.e 60% its also has given better results.
11. Permeable voids are decreasing with age of curing.

12. Durability test carried out in the investigation through acid attack test and chloride test with 1%sulphuric acid and 3% hydrogen chloride shows that at 22.5% FA+7.5%RHA replaced with cement and 60% QS replaced with natural sand in concrete is more durable than in terms of durability factors than the control mix.
13. It is observed that Rice Husk Ash and QS concrete will be durable as compared to control concrete.

Acknowledgement

The co-author wishes to express his sincere thanks to the Guide Prof. R. S. Deotale sir, & also to Lecturer A. R. Narde sir of civil Engineering department for his kind support & valuable guidance.

References

[1] Manguriu1, G.N., Karugu2, C.K., Oyawa3, W.O., Abuodha4, S.O. And Mulu5, P.U.1, 2, 3, 5 Department of Civil, Construction and Environmental Engineering Jomo Kenyatta University of Agriculture & Technology "Partial Replacement Of Natural River Sand With crushed Rock Sand In Concrete Production"

[2] R. S. Deotale, S. H. Sathawane, A.R. Narde Department of Civil Engineering, Yeshwantrao Chavan College of Engineering , Nagpur, MH, India 441110 " Effect of Partial Replacement of Cement by Fly Ash, Rice Husk Ash with Using Steel Fibres in Concrete"

[3] Satish D. Kene1, Pravin V. Domke2, Sandesh D. Deshmukh3, R.S.Deotale Department of Civil Engineering, Yeshwantrao Chavan College of Engineering , Nagpur, MH, India 441110 "Assessment OF Concrete Strength Using Fly Ash and Rice Husk Ash"

[4] Manguriu1, G.N., Karugu2, C.K., Oyawa3, W.O., Abuodha4, S.O. And Mulu5, P.U.1, 2, 3, 5 Department of Civil, Construction and Environmental Engineering Jomo Kenyatta University of Agriculture & Technology "Partial Replacement Of Natural River Sand With crushed Rock Sand In Concrete Production"

[5] D. S. Rajendra Prasad Professor, Department of Civil Engineering, S.I.T., Tumkur –572103S. Suresh Research Scholar, Department of Civil Engineering, S.I.T., Tumkur –572103, G. S. Shashidhar Research Scholar, Department of Civil Engineering, S.I.T., Tumkur –572103 " Effect of RHA and CRP as Replacement Materials and Effect of CO2 Curing of Concrete"

[6] Dao Van Dong- Doctor, Pham DuyHuu- Professor, Nguyen Ngoc Lan- Engineer developed "Effect of rice husk ash on properties of high strength concrete"

[7] G. A. Habeeb, M. M. Fayyadh Department of Civil Engineering, Faculty of Engineering, University of Malaya, Malaysia developed "Rice Husk Ash Concrete: the Effect of RHA Average Particle Size on Mechanical Properties and Drying Shrinkage".

[8] "Fly Ash (FA) as a Cementitious Material has been Studied Extensively and it is Observed that FA refines the Microstructure of Portland Cement Matrix and thereby Enhancing the Durability" N. P. Raja mane et-al, 2006

[9] IS 10262 -2009 "IS Method of Mix Design", Bureau of Indian Standards, New Delhi

[10] IS 516 -1959 "Methods of Tests for strength of concrete", Bureau of Indian Standards, New Delhi

[11] IS 456 -2000 "Code of Practice for Plain and Reinforced Concrete", Bureau of Indian Standards, New Delhi.

[12] Shetty M. S. "Concrete Technology" S. Chand & Co.Ltd, 1997.

[13] C.Marthong Lecturer, Civil Engineering Department, Shillong Polytechnic, Shillong, Meghalaya, India, 793008 " Effect of Rice Husk Ash (RHA) as Partial Replacement of Cement on Concrete Properties"

[14] Arunachalam.K1, Vigneshwari.M2 1- Professor and Head, Civil Engineering Department, Thiagarajar College of Engineering, Madurai -625015. 2- M.E-Structural Engineering, Thiagarajar College of Engineering, Madurai -625015. "Experimental investigation on ultra high strength concrete containing mineral admixtures under different curing conditions".

[15] Prinya Chindaprasirt and Sumrerng Rukzon "Pore Structure Changes of Blended Cement Pastes Containing Fly Ash, Rice Husk Ash, and Palm oil fuel ash caused by carbonation.".

[16] Fred Andrews-Phaedonos, VicRoads, Australia "Assessment Of Concrete Durability Using A Single Parameter With A High Level Of Precision – The Vpv Test".

[17] B. Miloud Laboratory Of Geomaterials & Development Civil Engineering Department, M'sila University, Algeria "Permeability And Porosity Characteristics Of Steel Fiber Reinforced Concrete".