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Experimental Investigation on Concrete using Egg Shell Powder, Metakaolin and Rice Husk Ash

Keramat khan[1], Dr K U Muthu[2]
[1]PG Student, [2]Professor and HOD, Dept of Civil Engineering, BRCE, Bangalore, Karnataka, India

Abstract: Nowadays environmental problems are more and more significant. The industrial area produces lots of waste materials and CO2, respectably. One of the most effective ways to solve these problems is the utilization of these waste materials. One choice of the usage of the waste materials is in the construction industry. The most common and widely used building material is concrete. The most significant and indispensable part of concrete is cement. The production process of cements from its raw material produces a lot CO2. The most effective way to decrease the CO2 emission of cement industry is the substitution of a proportion of cement with supplementary cementing materials. Ternary blended concrete is developed by partial replacement of cement with metakaolin, Egg shell powder and rice husk ash in M20 concrete mix design . In this research the experimental investigations carried out in two phase, First the Experimental work was carried out to investigate the effect of egg shell powder by partial replacing cement and keeping same water cement ratio, The concrete mixes had 0%, 2.5%, 5%, 7.5%, 10%, 12.5% of ESP (Egg Shell Powder), replacing cement partially and compressive, split and flexural tests are conducted . After getting the optimum percentage of Egg shell Powder, the next Experimental work was carried out to investigate the effect of Meta kaolin, Rice husk Ash and Egg shell powder by partial replacing cement and keeping same water cement ratio to ordinary concrete & Metakaolin, RHA and ESP. The concrete mixes had 0%, 5%, 10%, 15%, 20% of Meta kaolin ,RHA with 5% ESP, replacing cement partially. From this research the results are much better as compare to conventional concrete.
Keywords: Egg shell powder (ESP), Rice husk powder (RHA), Metakaoline, Split Tensile, compressive and Flexural Strength.

I. INTRODUCTION

It is observed that different study reports have been brought to light as regards the evaluation of individual effectiveness of Meta kaolin, Rice husk ash and Egg shell blended concrete. Nevertheless, there is a scarcity in respect of the study reports which focused on the joint implementation of Meta kaolin and rice husk ash. The main reason for the current exploration is to accurately assess Meta kaolin, Rice husk ash (RHA) and Egg shell powder (ESP) chemically, physically and miner logically differentiated, to explore the feasibility of their employment as a cement-substituting material in the concrete industry.

Meta kaolin obtain from local suppliers. Metakaolin is manufactured Pozzolanic mineral admixture which significantly enhances many performance characteristics of cement based mortars, concrete and related products. The use of Pozzolanic materials in the manufacture of concrete has a long, successful history. Most pozzolans used in the world today are by products from other industries, such as coal flash, blast furnace slag, rice husk and silica fumes. Metakaoline is a dehydroxylated form of the clay mineral kaolinite. Rocks which have more akaolinite are known as china clay or kaolin, area used traditionally in the manufacture of porcelain The particle size of Metakaoline is smaller than cement particles, but not as fine as silica fume.

The supplementary pozzolanic agent from agriculture by-products like rice husk ash (RHA) are emerging as hot topics of incessant research. Rice husk ash has high silica substance in the shape of non-crystalline. Hence, it is a pozzolanic material which can be employed as additional cementitious objects. Rice husk is an agricultural remainder derived from the external cover of rice grains during milling procedure. It comprises 20% of the 500 million tons of paddy generated in the world.

Eggshell consists of several mutually growing layers of $CaCO_3$, the innermost layer-maxillary 3 layer grows on the outermost egg membrane and creates the base on which palisade layer constitutes the thickest part of the eggshell. The top layer is a vertical layer covered by the organic cuticle. The eggshell has calcium, magnesium carbonate (lime) and protein. In many countries, it is the accepted practice for eggshell that first it is drying and then it is using as a source of calcium in animal feeds. For this study I collected broken egg shells from college canteen and outside restaurants. First the shells boiled in water to clean from other materials and dried it in air for four days approximately at a temperature range of 25-30^{0}C. Then I crushed it by hand, grinded and sieved through 90µm.materials passed through 90µm sieve was used for cement replacement.

The present report deals with the effects of mineral admixtures, by partial replacement of cement, in terms of improved performance on compressive, flexural and tensile strengths. First the Experimental work was carried out to investigate the effect of egg shell powder by partial replacing cement and keeping same water cement ratio, The concrete mixes had 0%, 2.5%, 5%, 7.5%, 10%, 12.5% of ESP (Egg Shell Powder), replacing cement partially and compressive, split and flexural tests are conducted . After getting the optimum percentage of Egg shell Powder, the next Experimental work was carried out to investigate the effect of Meta kaolin, Rice husk Ash and Egg shell powder by partial replacing cement and keeping same water cement ratio to ordinary concrete & Metakaolin, RHA and ESP. In this program we are going to construct cubes samples of size 150mmx150mmx 150mm for different percentages of Meta kaolin ,RHA and Egg shell with partial replacement of cement will casted and tested. The concrete mixes had 0%, 5%, 10%, 15%, 20% of Meta kaolin ,RHA with 5% ESP, replacing cement partially, so as to determine the best proportion which would give maximum compressive strength. Beam specimens will casted and tested for their flexural strength. The dimensions of each beam will 500mm x 100mmx 100mm. The beams were tested on universal testing machine to verify their flexural strength after 7days, 28 days of curing with single point load. The results will compare with the beams of varying flexural strength of Plain Cement Concrete, Plain Cement Concrete with Meta kaolin, RHA and ESP. Cylinder specimens will casted and tested for their split Tensile strength. The dimensions of each cylinder will 300mm diameter and 150mm length. The specimens were tested on universal testing machine to verify their split tensile strength after 7days, 28 days of curing. The results will compare with the specimens of varying split tensile strength of Plain Cement Concrete, Plain Cement Concrete with Meta kaolin, RHA and ESP.

A. Background and Related Work

Amaranth Yerramala: He has studied the use of poultry waste in concrete through the development of concrete incorporating eggshell powder (ESP). He developed Different ESP concretes by replacing 5-15% of ESP for cement. The results indicated that ESP can successfully be used as partial replacement of cement in concrete production. With respect to the results, at 5% ESP replacement the strengths were higher than control concrete and indicate that 5% ESP is an optimum content for maximum strength. In addition. The results further show that addition of fly ash along with ESP is beneficial for improved performance of concretes.

Dhanalakshmi M, Dr Sowmya N J, Dr Chandrashekar A: These people have used two wastes as a partial replacement of cement and various properties like workability, compressive strength, split tensile strength and flexural strength were determined. Egg shell powder are varied upto 12.5% (0%, 2.5%, 5%, 7.5%, 10% and 12.5%) and fly ash is added to optimum egg shell powder content cement concrete from 0% to 30% (0%, 5%, 10%, 15%, 20%, 25% and 30%), this study shows that shell concrete gives greater split tensile and flexural strength compared to concrete without egg shell powder, they obtain 5% optimum value for egg shell powder.

Doh Shu Ing and Chin Siew Choo: He carried out an investigation on egg shell powder as potential additive to concrete. In his investigation, five different percentages of egg shell powder with respect to cement was added into concrete mix of grade M25. Based on the investigation they came across the conclusion that water cement ratio of 0.4 produces medium workability, ESP as filler in concrete had improved the compressive strength of concrete and maximum strength was obtained at 10% replacement. Flexural strength of concrete was improved with addition of ESP to concrete compared to control concrete mix. ESP has addition to concrete had improved the resistance to failure under bending and water absorption was reduced at initial stage.

B. Objectives

The most important objectives of this study are

1) To study the relative strength development with age of (ESP) concrete, with control concrete.
2) To study the comparative strength development with age of (MK+RHA+ESP) concrete, with control concrete.
3) Use of industrialized waste in a positive way.
4) To conduct compression test on (MK+RHA+ESP) and ordinary concrete on standard IS specimen size (150x 150 x 150) mm.
5) To conduct Flexural test on (MK+RHA+ESP) and ordinary concrete on standard IS specimen size (100x100x500) mm.
6) To conduct split tensile test on (MK+RHA+ESP) and ordinary concrete on standard IS specimen size (150 mm x 300mm) mm.
7) To provide inexpensive construction material.
8) To protect the environment by utilizing waste properly.

II. MATERIAL

A. Cement

Ordinary Portland cement of 43 grade (Ramco) conforming to IS 8112-1989 is used. Table 1 shows the test results of basic properties of cement.

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Table 1: Basic Properties of Cement

Properties	Results
Specific gravity	3.15
Standard consistency	32%
Initial setting time	38min
Final setting time	480min
fineness	5.3%

Table 2. Chemical Analysis for Cement.

SiO_2	21.3
CaO	63.14
Fe_20_3	3.77
Al_20_3	5.41
MgO	1.2
Na_2O	0.56

B. *Fine Aggregate*

Natural river sand of size below 4.75mm conforming to zone III of IS 383-1970 was used as fine aggregate. Table 3 shows the test results of basic properties of fine aggregates.

Table 3: Basic Properties of Fine Aggregates

Properties	Results
Specific gravity	2.60
Water absorption	1.45%

C. *Coarse Aggregate*

Natural crushed stone with 20mm down size was used as coarse aggregate. Table 4 shows the test results of basic properties of coarse aggregates.

Table 4: Basic Properties of Coarse Aggregates

Properties	Results
Specific gravity	2.65
Water absorption	0.39%

D. *Egg Shell powder*

Eggshell consists of several mutually growing layers of $CaCO_3$, the innermost layer-maxillary 3 layer grows on the outermost egg membrane and creates the base on which palisade layer constitutes the thickest part of the eggshell. The top layer is a vertical layer covered by the organic cuticle. The eggshell has calcium, magnesium carbonate (lime) and protein. In many other countries, it is the accepted practice for eggshell that first it is drying and then it is using as a source of calcium in animal feeds. For this study I collected broken egg shells from college canteen and outside restaurants. First the shells boiled in water to clean from other materials and dried it in air for four days approximately at a temperature range of 25-30^{0}C. Then I crushed it by hand, grinded and sieved through 90µm.materials passed through 90µm sieve was used for cement replacement.

Table 5: Basic Properties of ESP

Properties	Results
Specific gravity	1.94
Water absorption	5.95%

Table 6.Chemical Analysis for ESP

S. NO	OXIDE CONTENTS	PERCENTAGE (%)
1	CaO	60-67
2	SiO_2	17-25
3	Al_2O_3	3-8
4	Fe_2O_3	0.5-6.0
5	MgO	0.1-4.0
6	K_2O, Na_2O	0.4-1.3
7	SO_3	1.3-3.0


Fig: 1. Providing Egg shell powder


Fig: 2 Egg shell powder

E. Rice Husk Ash

Rice husk ash is obtained from local supplier. Rice husk has about 75 % organic hot-tempered material which burns up and the balance 25 % of the weight of this husk is converted into ash during the firing process, which is known as rice husk ash (RHA). For making rice husk ash rice husk is burning approximately 1148 hours under uncontrolled burning process. The burning temperature is within the range of 600 to11850 C^0. The ash obtained is ground in a ball mill near about for 30 minutes and color of rice husk ash is seen as grey. This RHA contains around 85%-90% amorphous silica. India is a major rice producing country, about 20 million tons of RHA is produced annually. This RHA is a great environment warning causing damage to the land and the surrounding area in which it is vacant. Lots of ways are being thought of for disposing it by making commercial use of this RHA. In the present investigation, Portland cement was replaced by rice husk ash at various percentages to study compressive and flexural strength.

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Volume 5 Issue VIII, August 2017- Available at www.ijraset.com

Table 7.Basic Properties of rice husk ash.

PROPERTIES	SPECIFICATION
Appearance	Grey Black
Bulk Density (gm/cc)	0.58
Moisture at 105ºC	1.87%
Loss On Ignition	< 6.0%
Residue on 350µ mesh	< 0.5%

Table 8: Chemical Analysis for Rice Husk Ash

SiO_2	92.89
Fe_2O_3	0.43
Al_2O_3	0.18
CaO	1.03
MgO	0.35
SO_3	0.1
$Al_2O_3 + Fe_2O_3$	0.61
Na_2O	3.56
K_2O	0.72

Fig:3 Rich husk Ash

F. Metakaoline

Meta kaolin obtains from local suppliers. Meta kaolin is a manufactured Pozzolanic mineral admixture which significantly enhances many performance characteristics of cement based mortars, concrete and related products. The use of Pozzolanic materials in the manufacture of concrete has a long, successful history. Most pozzolans used in the world today are by products from other industries, such as coal flash, blast furnace slag, rice husk and silica fumes . Metakaoline is a dehydroxylated form of the clay mineral kaolinite. Rocks which have more kaolinite are known as china clay or kaolin, are used traditionally in the manufacture of porcelain. The particle size of Metakaoline is smaller than cement particles, but not as fine as silica fume.

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Table:9.Basic Properties of meta kaolin.

Properties	**Value**
Density (gm/cm^3)	2.17
Bulk density (gm/cm^3)	1.26
Particle shape	Spherical
Colure	Grey
specific gravity	2.1

Table 10: Chemical Analysis for metakoalin

SiO_2	51-53 %	CaO	< 0.20%
Al_2O_3	42-44-%	MgO	< 0.10%
Fe_2O_3	< 2.20%	Na_2O	< 0.05%
TiO_2	< 3.0%	K_2O	< 0.40%
SO_4	< 0.5%	L.O.I.	< 0.50%

III. EXPERIMENTAL METHODS

A. Concrete Mix Design

According to IS: 456-2000, grade of concrete M20 is designated as ordinary or normal grade concrete. Mix proportions are achieved for ordinary concrete (M20) based on the guidelines of IS: 10262-2009 [9]. The target strength is 26.6 MPa as per Mix design.

B. Mix Proportion

First Cement is replaced by egg shell powder at 0%,2.5%,5%.7.5%,10%,12% after getting optimum value 5% ,the Cement is replaced by Metakaolin and rice husk ash at (5%,10,15%,20%) and addition of a constant 5% egg shell powder in every substitution.

Table 11: Ordinary Concrete mix proportion

Sr.no	**Material**	**Quantity**	**Proportion**
1	Cement	400 Kg/m^3	1
2	Sand	630 Kg/m^3	1.58
3	Coarse aggregate	1141.4 Kg/m^3	2.85
4	Water	**200 liter**	0.5

Table 12: Mix proportion of (Cement+ESP) per cubic meter

Sr.No	Mix designation	Cement (KG)	ESP %	ESP (KG)	F.A (KG)	C.A (KG)	W/C
1	M0	400	-	-	630	1141.4	0.5
2	M2.5	390	2.5	10	630	1141.4	0.5
3	M5	380.5	5	20.5	630	1141.4	0.5
4	M7.5	370	7.5	30	630	1141.4	0.5
5	M10	360	10	40	630	1141.4	0.5
6	M12.5	350	12.5	50	630	1141.4	0.5

Table 13: Mix proportion of (Cement + Metakaolin+RHS+5%ESP)

Sr. No	Mix Designation	Cement		RHS		METAKOALIN		Additives (ESP)		%of cement replacement
		Kg/m^3	%	Kg/m^3	%	Kg/m^3	%	Kg/m^3	%	
1	$E_0M_0R_0$	400	100	-	-	-	-	-	-	0
2	$E_5M_5R_5$	360	90	20	5	20	5	20	5	10
3	$E_5M_{10}R_{10}$	320	80	40	10	40	10	20	5	20
4	$E_5M_{15}R_{15}$	280	70	60	15	60	15	20	5	30
5	$E_5M_{20}R_{20}$	240	60	80	20	80	20	20	5	40

C. Specimen Preparation

1) Cubical moulds of size 150*150*150 mm
2) Cylindrical moulds of size 300mm height and 150 mm diameter.
3) Beams of size (100*100*500mm.

D. Mixing, Casting and Curing

The concrete were mixed in 80 liters capacity pan mixer. The mixing time kept to about 3 to 4 min. Mixing of the materials was in a sequence: (i) firstly coarse aggregate was placed into the pan mixer; (ii) portion of water quantity required for concrete mixes was poured into the mixture drum; (iii) cement and ESP, MA, RHA were gently placed into the drum, and (iv) sand was spread over the powders and started mixing. During mixing, the remaining mix design water quantity was poured into the mixer drum for thorough mixing of constituents. Specimens were then prepared and left for 24 hours. The specimens were demoulded after 24 hours and absorbed in normal water for curing until the test age.

E. Testing of Specimen

7 and 28 days compressive strength tests, 7 and 28 days split tensile strength tests and 7, 28 days flexural strength tests were carried out on compressive and flexural testing machine as shown in fig 2, 3 and 4 respectively.

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Volume 5 Issue VIII, August 2017- Available at www.ijraset.com

figure:4.compressive strength test of cubes.

figure:5.Split Tensile strength of cylinders

Figure:6. Flexural strength test of beam

IV. RESULTS AND DISCUSSIONS

A. Compressive Strength Test Results

From the below result tables and graphs it is seen the difference in compressive strength when compare ESP with ordinary and as well EMR concrete with ordinary concrete. It is observed that the result of compressive strength test is increased with the increase of Meta kaolin and rice husk proportion. The optimal strength is achieved at $E_5M_{10}R_{10}$(5% ESP,10% meta kaolin and 10% rice husk.

Table 14: compressive strength result of ESP concrete

mix	Compressive strength (N/mm^2)days	
	After 7 days	After 28 days
M_0	23.9	26.6
$M_{2.5}$	22.8	24.65
M_5	20.35	25.75
$M_{7.5}$	19.5	24.9
M_{10}	17	21.63
$M_{12.5}$	16	21.6

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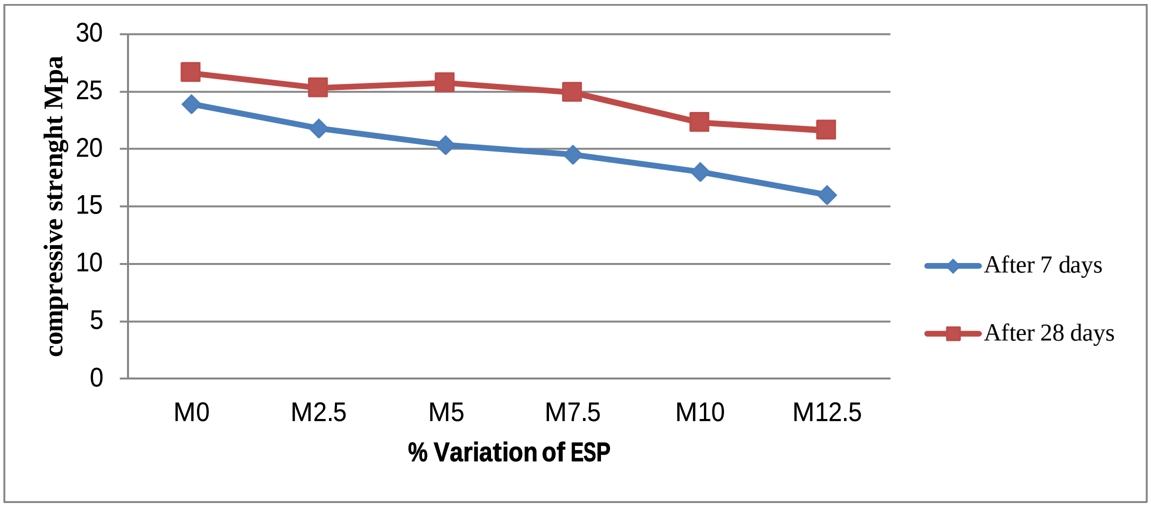
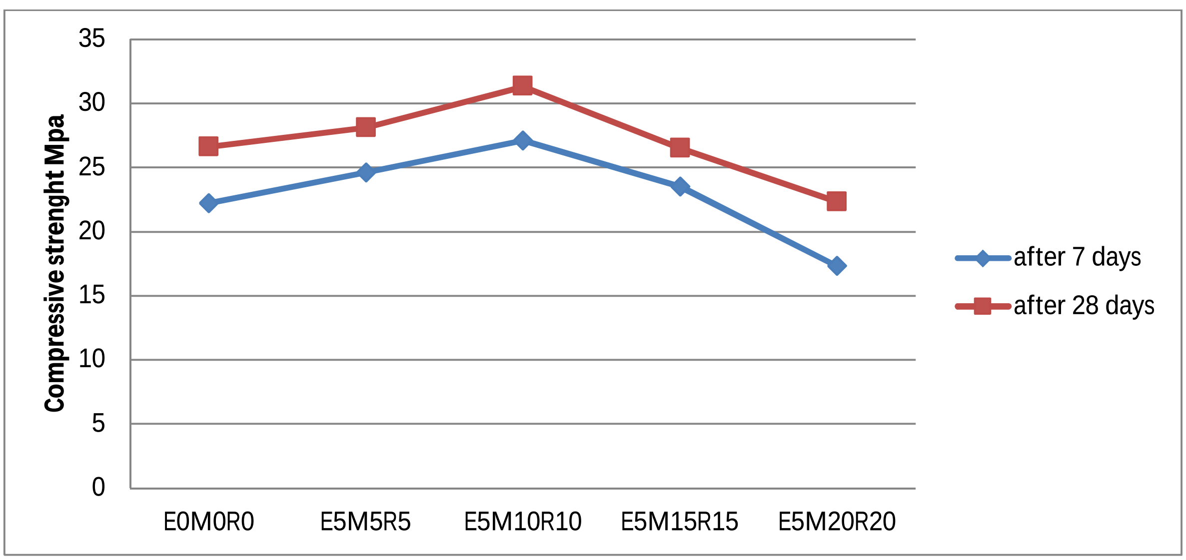
Table15: compressive strength result of (Cement+ESP+RHA+Metakoaline) concrete.

Mix	flexural strength (N/mm^2)days	
	After 7 days	After 28 days
$E_0M_0R_0$	22.1	26.6
$E_5M_5R_5$	24.6	28.1
$E_5M_{10}R_{10}$	27.1	31.3
$E_5M_{15}R_{15}$	23.5	25.2
$E_5M_{20}R_{20}$	19.3	22.3



Graph.1 : Variation of compressive strength of ESP Concrete



Graph.2: Variation of Compressive strength of (5%ESP+Metakaoline+RHA).

B. Split Tensile Strength Test Result

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Volume 5 Issue VIII, August 2017- Available at www.ijraset.com

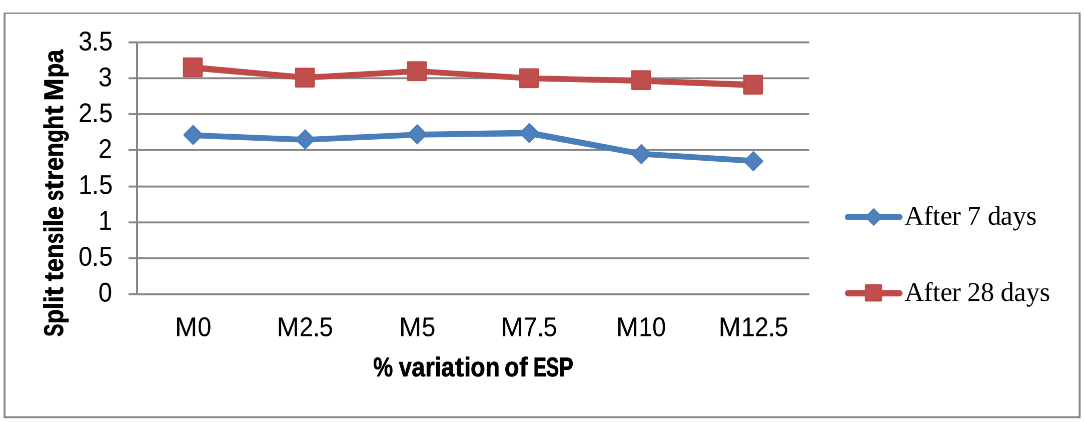
From the below result tables and graphs below it is seen the difference in split tensile strength when compare ESP concrete with ordinary and as well EMR concrete with ordinary concrete. It is observed that the result of split tensile strength test is increased with the increase of Meta kaolin and rice husk proportion. The optimal strength is achieved at E5M10R10(5% ESP,10% meta kaolin and 10% rice husk).

Table 16. Split tensile strength test result of ESP concrete.

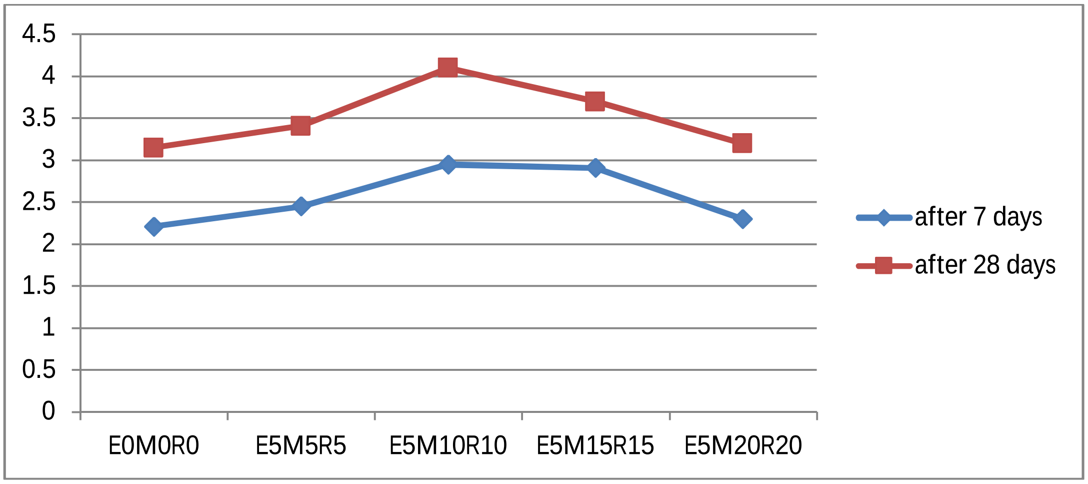
mix	Split tensile strength (N/mm^2)days	
	After 7 days	After 28 days
M_0	2.21	3.15
$M_{2.5}$	2.15	3.01
M_5	2.22	3.1
$M_{7.5}$	2.24	3
M_{10}	1.95	2.97
$M_{12.5}$	1.85	2.91

Table: 17. Split Tensile strength test result of (Cement+ESP+RHA+Metakoaline) concrete.

Mix	flexural strength (N/mm^2)days	
	After 7 days	After 28 days
$E_0M_0R_0$	2.21	3.15
$E_5M_5R_5$	2.45	3.41
$E_5M_{10}R_{10}$	2.95	4.1
$E_5M_{15}R_{15}$	2.91	3.7
$E_5M_{20}R_{20}$	2.3	3.2



Graph.3: Variation split tensile strength of ESP Concrete.



Graph.4:Variation of Split Tensile strength of (5%ESP+Metakaoline+RHA)

C. *Flexural Strength Test Result*

From the below result tables and graph it is seen the difference in flexural strength when compare ESP concrete with ordinary and as well EMR concrete with ordinary concrete. The maximum flexural strength at 28 days is obtained at 5% replacement of cement with ESP and the optimal flexural strength of ESP concrete is more than ordinary concrete. Result of flexural strength test is increased with the increase of Meta kaolin and rice husk proportion. The optimal strength is achieved at E5M10R10 (5% ESP, 10% meta kaolin and 10% rice husk).

Table 18: Flexural strength test result of ESP concrete.

Mix	flexural strength (N/mm^2)days	
	After 7 days	After 28 days
M_0	5.125	8.12
$M_{2.5}$	5.20	8.15
M_5	5.5	8.7
$M_{7.5}$	5.4	8.6
M_{10}	5.15	8.1
$M_{12.5}$	4.9	7.5

Table 19: flexural strength test result of (Cement+ESP+RHA+Metakoaline) concrete

Mix	flexural strength (N/mm^2)days	
	After 7 days	After 28 days
$E_0M_0R_0$	5.125	8.12
$E_5M_5R_5$	5.35	8.55
$E_5M_{10}R_{10}$	5.8	9.2
$E_5M_{15}R_{15}$	5.9	8.2
$E_5M_{20}R_{20}$	5.2	7

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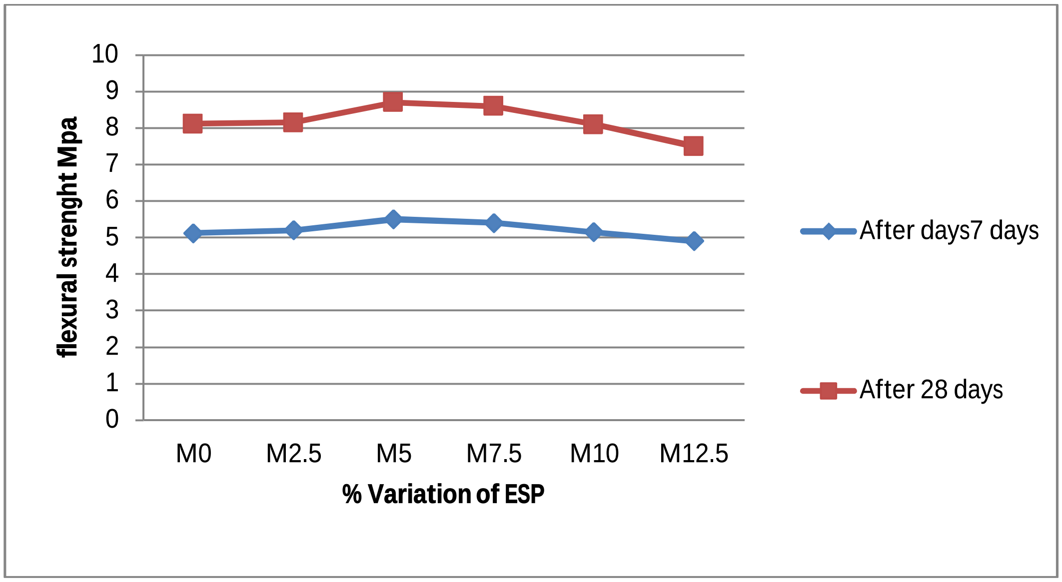
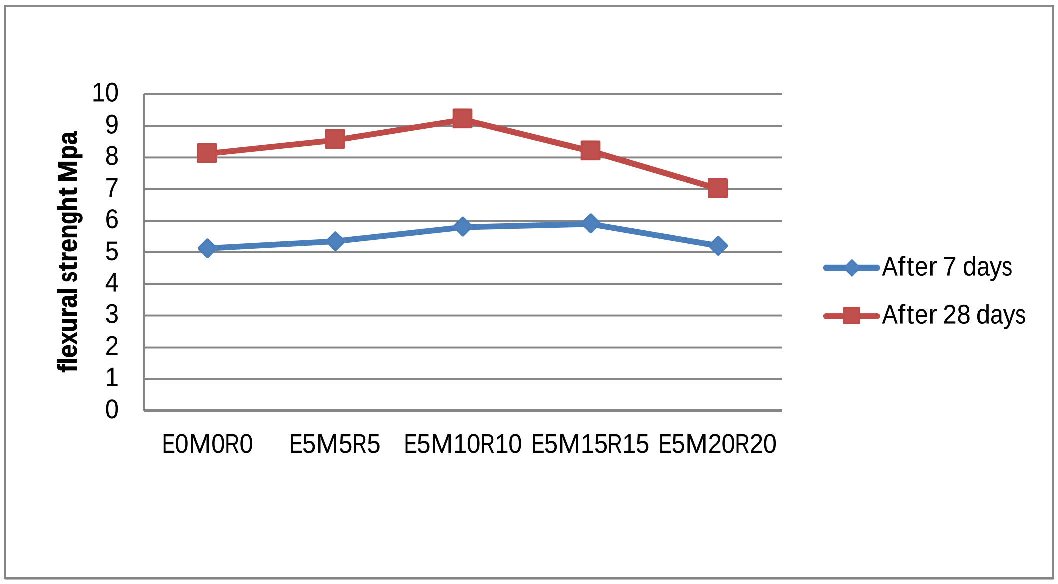


Graph.5: Variation of Flexural strength of ESP Concrete.



Graph.6: Variation of Flexural strength of (5%ESP+Metakaoline+RHA)Concrete

V. CONCLUSION

Based on the experimental investigation the following conclusion are drawn

A. Egg shell concrete gives greater flexural strength compared to concrete without egg shell powder.

B. Egg shell concrete had less split tensile and compressive strength compared to concrete without egg shell powder.

C. Optimum flexural strength is obtained at 5% replacement of egg shell power concrete.

D. Rice husk ash (RHA) contains 87.68 – 91 % silica and Egg shell powder contains 93.70% calcium carbonate.

E. Based on the results of these works it can be concluded that RHA, Metakaolin and ESP mixes had greater strength compare to conventional concrete.

F. Compressive, Flexural and tensile strength improves with the increase the percentage of Rice Husk Ash, Metakaolin and egg shell powder of 7 and 28 days curing.

G. Better mechanical and physical properties of concrete can be obtained with the replacement of cement with rice husk ash, metakaolin and Egg shell powder in E5M10R10 mix.

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REFERENCES

[1] Ashif M. Qureshi, Shakeeb R. Khan, Yudhishthir.V. Sharma, Bhola M. Sontakke.**"**Experimental investigation to check the effect of Egg shell powder and Rice husk ash on property of concrete**"**. International Journal on Recent and Innovation Trends in Computing and Communication Volume: 3 Issue:2 ISSN: 2321-8169, February 2015 ,Page 067– 070.

[2] M. Sivakumar, N. Mahendran **"**strength and permeability properties of concrete using Fly Ash (FA), Rice Husk Ash (RHA) AND Egg shell powder (ESP)" . Journal of Theoretical and Applied Information Technology 20th August 2014. Vol. 66 No.2, Page 489-499.

[3] Dhanalakshmi M , Sowmya N J , Chandrashekar A **"**A Comparative Study on Egg Shell Concrete with Partial Replacement of Cement by Fly Ash". International Journal of Engineering Research & Technology (IJERT) ISSN: 2278-0181, Vol. 4 Issue 05, May-2015, Page 1532-1538.

[4] D.Gowsika, S.Sarankokila, K.Sargunan **"**Experimental Investigation of Egg Shell Powder as Partial Replacement with Cement" Concrete International Journal of Engineering Trends and Technology (IJETT) **–** Volume 14 Number 2 **–** Aug 2014, Page 65-68.

[5] Jayasankar.R, Mahindran.N, Ilangovan.R **"**Studies on Concrete using Fly Ash, Rice Husk Ash and Egg Shell Powder" .International journal of civil and structural Engineering Volume 1, No 3, 2010, Page 362-372.

[6] Ashok Kumar Yadav, Dhaval S. Shah, Dhaval N. Amlani, Saureen R. Naik, Tej J. Patel, Devang M. **"**Comparative Study of Rice Husk Ash, Metakaolin & standard concrete**"**. International Journal of Recent Advances in Engineering & Technology (IJRAET).ISSN: 2347 - 2812, Volume-4, Issue -3, 2016, Page 81-84.

[7] K.Madhu1, T.Divya Bhavana and Syed Eashan Adil. **"**Study on partial replacement of cement with Metakoalin and Rice husk ash" International Journal of advanced research (IJAR). Int. J. Adv. Res. 4(12), 300-305 ISSN: 2320-5407. December 2016, Page 300-305

[8] A. N. Swaminathen, Mohammad Abith, Liya Jolly , Mathiyalagan. R, Abhijith. K.S **"** Effect of partial replacement of cement with Metakaolin and Rice husk Ash on the strength and durability properties of high strength concrete**"**. International Journal of Advanced Research Trends in Engineering and Technology (IJARTET) Vol. 3, Special Issue 8, March 2016, Page 16-26

[9] Tan Yeong Yu, Doh Shu Ing* and Chin Siew Choo "The Effect of Different Curing Methods on the Compressive Strength of Eggshell Concrete" Indian Journal of Science and Technology", Vol 10(6), DOI: 10.17485/ijst/2017/v10i6/111210, February 2017, Page 1-4.

[10] Amarnath Yerramala "Properties of concrete with eggshell powder as cement replacement". Indian Concrete Journal · October 2014, page 93-102

[11] Mahendrakar Kiran Kumar1 and C.Rajamallu,International "A Brif Experiment study on Metakaoline admixed concrete with and without Rice husk Ash" Journal of Innovative Research in Advanced Engineering (IJIRAE) ISSN: 2349-2763 Issue 06, Volume 3 (June 2016),page 1-5

[12] Text Book - Shetty M. S., (2013), "Concrete Technology - Theory and Practical", S.Chand Publishing.

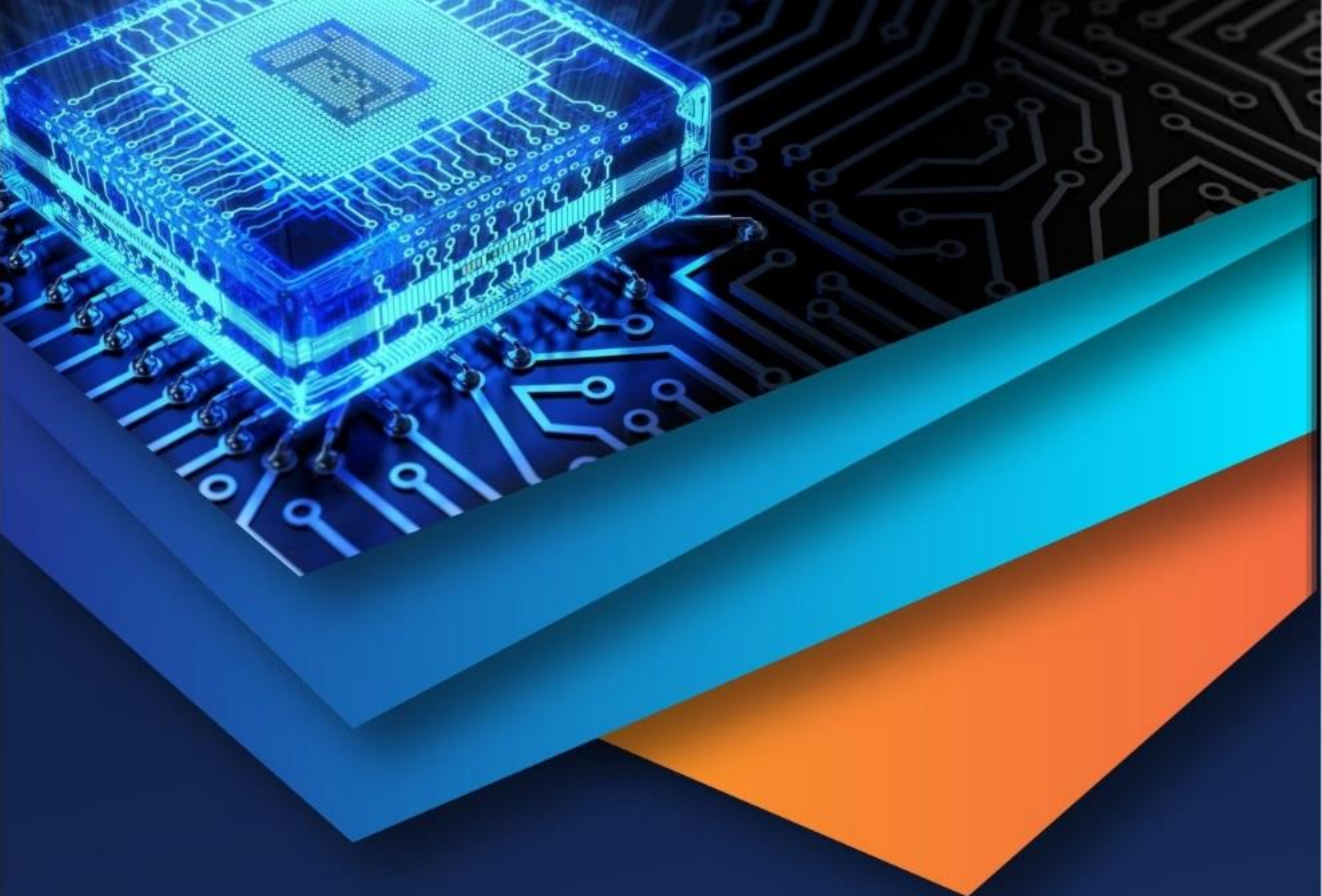
[13] IS 456-2000, Indian Standard, Plain and Reinforced Concrete - code of pratice.

[14] IS 383-1970, Indian Standard Specification for Coarse and Fine Aggregates from Natural Sources for Concrete.

[15] IS 10262-2009, Indian Standard Recommended Guidelines for Concrete Mix Design.

Author Details

Keramat Khan, Post graduate student, Department of Civil Engineering, VTU University,Karnataka,Bangalore



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