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Studies on Concrete using Fly Ash, Rice Husk Ash and Egg Shell Powder

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ABSTRACT

Through out the world, concrete is being widely used for the construction of most of the buildings, bridges etc. Hence, it has been properly labeled as the backbone to the infrastructure development of a nation. Currently, our country is taking major initiatives to improve and develop its infrastructure by constructing express highways, power projects and industrial structures to emerge as a major economic power and it has been estimated that the infrastructure segment in our country is expected to see investments to the tune of Rs.4356 billion by the year 2009. To meet out this rapid infrastructure development a huge quantity of concrete is required. Unfortunately, India is not self sufficient in the production of cement, the main ingredient of concrete and the demand for exceeds the supply and makes the construction activities very costlier. Hence, currently, the entire construction industry is in search of a suitable and effective the waste product that would considerably minimize the use of cement and ultimately reduce the construction cost. Few of such products have already been identified like Rice Husk Ash (RHA), Fly Ash, Silica Fumes, Egg shell etc. Amongst these RHA and Egg shells are known to have good prospects in minimizing the usage of cement.

Keywords: Concrete, characterization, eggshell power (ESP), Rice Husk Ash (RHA), Fly Ash (FA).

1. Introduction

Fly ash is comprised of the non-combustible mineral portion of coal consumed in a coal fueled power plant. Fly ash particles are glassy, spherical shaped “ball bearings” – typically finer than cement particles – that are collected from the combustion air-steam exiting the power plant. Rice husk ash globally, approximately 600 million tonnes of rice paddy is produced every year. On an average 20% of the rice paddy is husk, giving an annual total production of 120 million tonnes. In the majority of rice producing countries much of the husk produced from the processing of rice is either burnt or dumped as a waste. The treatment of rice husk as a resource for energy production is a departure from the perception that husks present disposal problems. The concept of generating energy from rice husk has great potential, particularly in those countries that are primarily dependent on imported oil for their energy needs. Rice husks are one of the largest readily available but most under-utilized biomass resources, being an ideal fuel for electricity generation. In recent years, special attention has been devoted to industrial

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sectors that are sources of pollution of the environment the industry produces large volumes of solid wastes, which can end up in rivers, lakes, and coastal waters. The disposal of these wastes is a very important problem, which can cause risk to public health, contamination of water resources and polluting the environment. A large number of food plants are constantly accumulating substantial quantities of eggshell waste. This natural solid waste, although non-hazardous, is directly disposed in the environment. As a consequence, a huge problem of pollution is generated. In addition, it can attract rats and worms due the organic protein matrix, resulting in a problem of public health. The studies have been already made in this area by using egg shell power Wall tile is a ceramic material primarily composed of clays, carbonates, and quartz. The aim of the current study was to characterize an eggshell waste sample, determining chemical compositions and physical characteristics. The potential use of this waste as a cementing material for concrete was also examined.

1.Theoretical Background of the Study

Earlier works on the combination concrete conducted by scholars have led us to the point that the egg shell powder can be used as a supplement for industrial lime. In their article "Effect of Eggshell powder on the Stabilizing Potential of Lime on an Expansive Clay Soil" by O. O. Amu, A. B. Fajobi and B.O. Oke Department of Civil Engineering, Obafemi Awolowo University, Ile-ife, Nigeria have come to the conclusion that the 4% ESP + 3% lime as the optimal percentage of lime-Egg shell Powder Combination. There were also studies on using Egg Shell Powder in wall tile materials. Egg Shell Powder is rich in $CaCo_3$. Based on the researches conducted by M. N. Freire, J. N. F. Holanda in their article "Characterization of avian eggshell waste aiming its use in a ceramic wall tile paste". Opine that the eggshell rich in $CaCo_3$ can be used as an alternative raw material in the production of wall tile material. World over 500 millions tons of rice is harvested. Of which 20% is rice husk which is a threat to the environment. To reduce the pollution various tests are conducted to find out whether these matters can be converted into some useful material. Feng Qing-fe et al in their article "Concrete with Highly Active Rice Husk Ash" have studied the strength, pore volume and pore distribution of the concrete using Rice Husk Ash.

These Studies prompts to think and investigate the possibility of using Egg Shell Powder, Rice Husk Ash and Fly Ash as partial replacement in the conventional Concrete.

3. Research Methodology

3.1 Materials for concrete casting

Ordinary Portland cement Conforming to IS: 8112, 43 grade, Dalmia brand was used. Screened river sand with fineness modulus equal to 2.6 conforming to grading zone III of IS: 383-1970 was used. Well graded blue granite stone aggregate passing through 12mm and retained in 4.75mm sieve with fineness modulus of 7.48 was used. Fly ash procured from Neyveli Lignite Corporation, Neyveli, Tamil nadu India was sieved before used.

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Egg shells procured from local centers was grinded, sieved before used. Rice Husk Ash procured from local agricultural lands and flower mills was incinerated, cleaned and sieved before used.

3.2 Analysis and Interpretation

3.2.1 Chemical Analysis

Table 1: Rice Husk Ash

SiO_2	92.99
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

Table 2: Chemical Analysis for Fly Ash

Loss on ignition	4.5
$S_1 O_2$	56.65
$Al_2 O_3$	27.35
$Fe_2 O_3$	4.79
Ca O	2.19
MgO	0.57
Soluble $S_1 O_2$	3.95

Table 3: Chemical Analysis for Egg Shell Powder

CaO	50.7
SiO_2	0.09
Al_2O_3	0.03
MgO	0.01
Fe_2O_3	0.02
Na_2O	0.19
P_2O_5	0.24
SrO	0.13
NiO	0.001
SO_3	0.57
Cl	0.219

3.3 Compressive Strength Test

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The compressive strength of concrete is one of the most important properties of concrete. Concrete specimens of 150 x 150 x 150 mm cubes were cast with different proportions of concrete. After 24 hours the specimens are de moulded and subjected to curing, the cubes are then allowed to become dry for some hours, for each proportions triplicate specimens were cast. The cubes are tested in the compressive testing machine. The load was applied at the rate of 140KN/min.The ultimate load at which the cube fails was taken.

Table 4: Strength calculations with varying content

All strength in N/mm^2	M20	M25	M30	TOTAL
Control Concrete	9	9	9	27
Cement+flyash Cement+RHA* Cement+ESP**	36	36	36	108
Cement+flyash+RHA Cement+flyash+ESP Cement+RHA+ESP	36	36	36	108
Cement+flyash+RHA+ESP	12	12	12	36

*Rice Husk Ash **Egg Shell Powder

Table 5: Adopted Mix Proportion

	Cement	Fine Aggregate	Coarse Aggregate	Water
M20	1	1.5	3.43	0.5
M25	1	1.21	2.97	0.43
M30	1	1.05	2.64	0.39

4. Recommendation/Suggestion/Findings

The effect of FA, RHA, and ESP as cement replacement material on compressive strength of M20, M25, M30 Grade concretes was presented in Tables the compressive strength variation with respect to the percentage of replacement of cement by FA, RHA, and ESP and 14 days curing were shown in Figure

4.1 Compression Test Results (N/mm^2)

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Table 6: Cement + Flyash, Cement + RHA, Cement + ESP

	M20				M25				M30			
	5%	10%	15%	20%	5%	10%	15%	20%	5%	10%	15%	20%
ESP	29.79	27.26	24	21.48	33.72	31.11	28.50	24.89	35.02	32.15	28.50	25.63
FA	33.52	28.59	23	18.07	34.35	32.15	29.90	27.70	30.98	30.67	29.50	29.19
RHA	32.11	29.04	25	21.93	33.39	31.11	28.50	26.22	32.88	29.19	25.50	21.63

Table 7: Cement + Flyash + RHA, Cement + flyash + ESP, Cement + RHA + ESP

	M20				M25				M30			
	5%	10%	15%	20%	5%	10%	15%	20%	5%	10%	15%	20%
E+F	22.83	22.81	22.50	22.52	29.17	28.63	27.50	26.96	30.87	29.93	28.50	27.56
F+R	24.58	24.19	23.20	22.81	27.74	27.41	26.70	26.37	30.27	29.48	29.20	28.89
R+E	20.88	20.44	20	19.48	28.56	27.41	26	24.85	27.37	27.26	27.20	27.11

Table 8: Cement + flyash + RHA + ESP

	M20				M25				M30			
FA+ RHA + ESP	5%	10%	15%	20%	5%	10%	15%	20%	5%	10%	15%	20%
	21.29	21.18	21	20.89	25.89	25.63	25.30	25.04	29.68	28.89	27.90	27.11

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Table 9: Split Tensile Strength at 28 Days in N/mm^2

Mix/ Mix Ratios	M20	M25	M30
Control.Conc	1.9	2.35	2.8
5%	1.25	1.6	1.63
10%	1.21	1.58	1.6
15%	1.17	1.57	1.57
20%	1.13	1.55	1.54

4.2 Comparison of various results obtained

4.2.1 Cement + Flyash, Cement + RHA, Cement +ESP

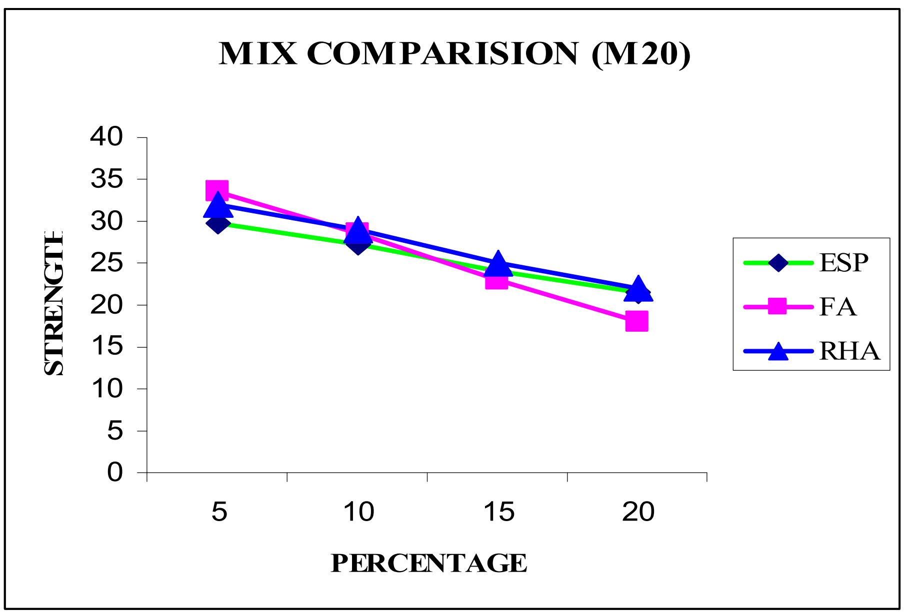

Figure 1: Comparison of 14 days compressive strength (M20)

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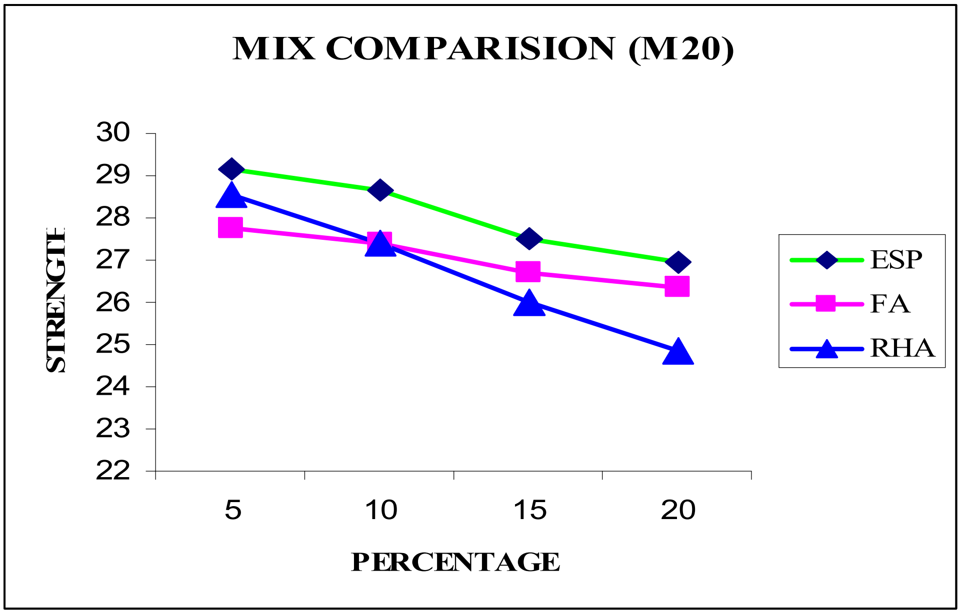

Figure 2: Comparison of 14 days compressive strength (M25)

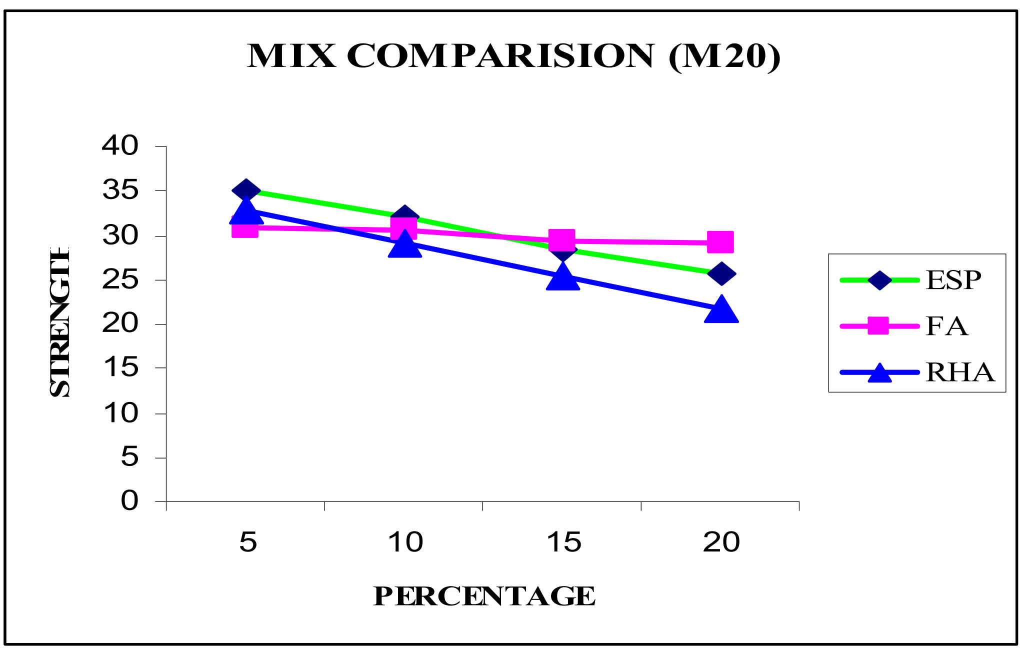

Figure 3: Comparison of 14 days compressive strength (M30)

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4.2.2 Cement + Flyash + RHA, Cement + Flyash + ESP, Cement + RHA + ESP

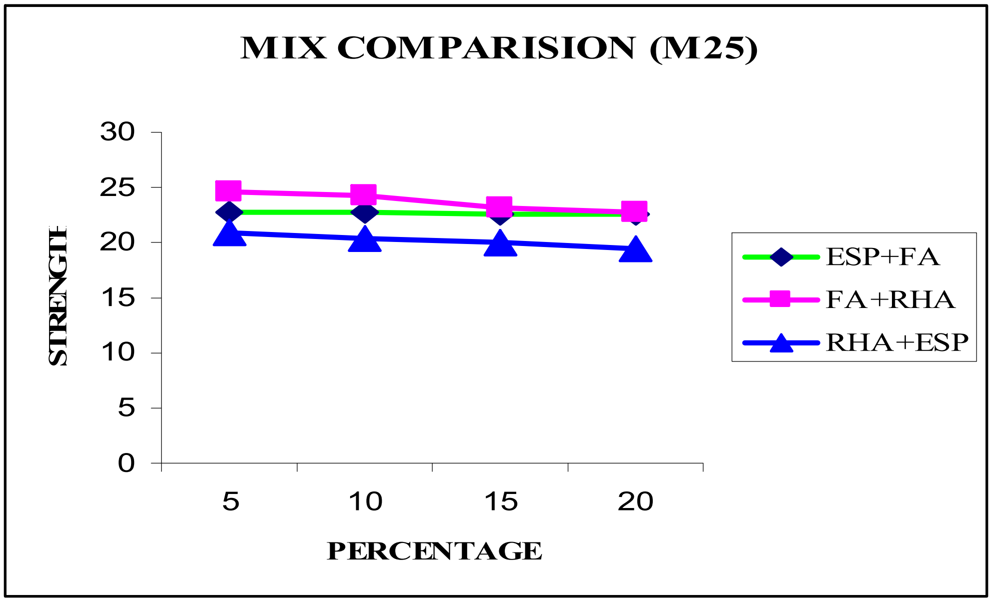

Figure 4: Comparison of 14 days compressive strength (M20)

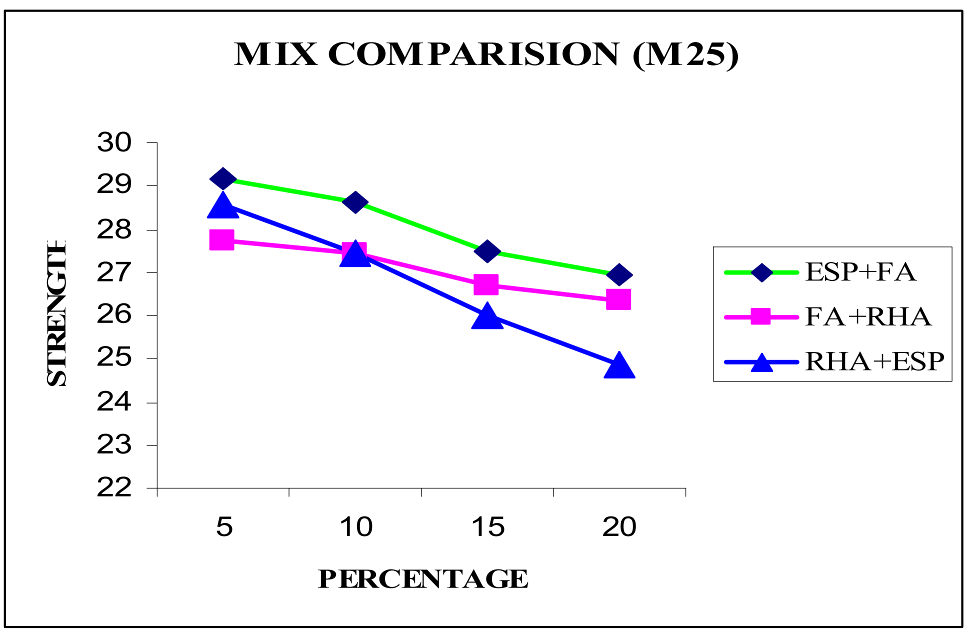

Figure 5: Comparison of 14 days compressive strength (M25)

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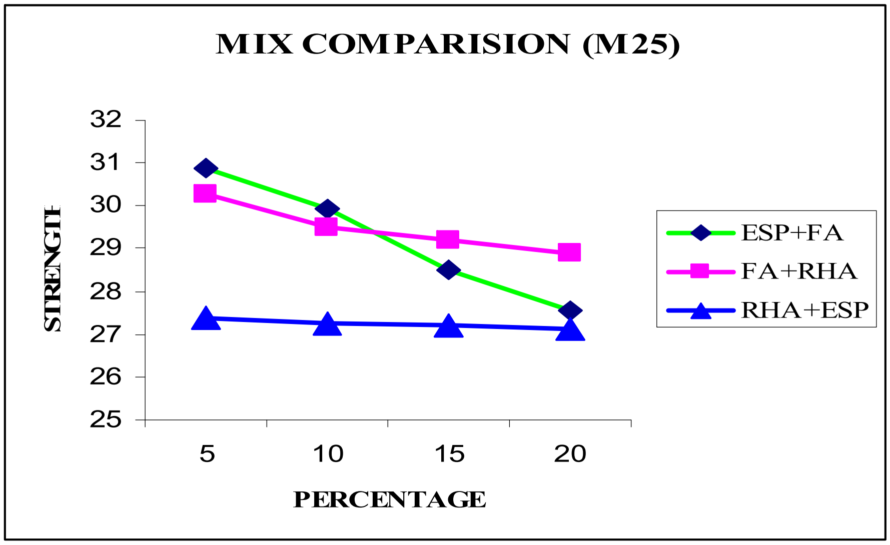

Figure 6: Comparison of 14 days compressive strength (M30)

4.2.3 Comparison of Cement + Flyash + RHA + ESP

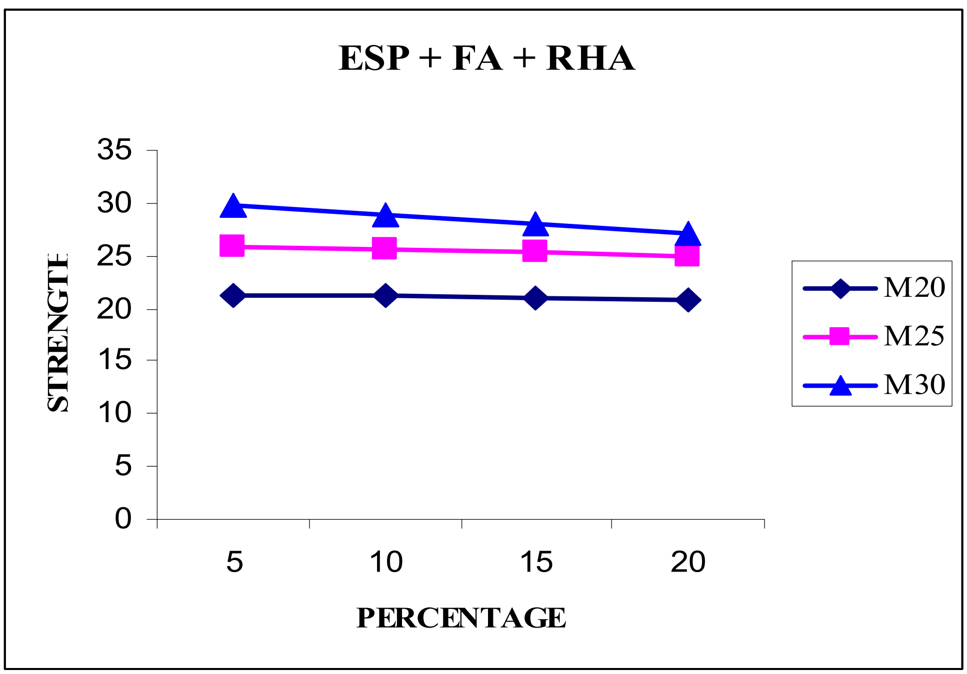

Figure 7: Comparison of 14 days compressive strength Special Mix

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4.2.4 Comparison of Cement+Flyash+RHA+ESP (split tensile Test)

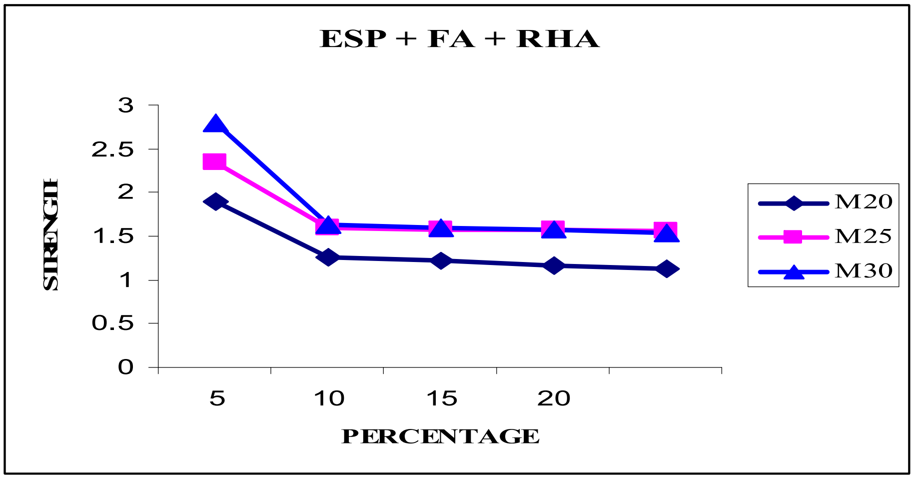

Figure 8: Comparison of 28 days split tensile strength

5. Findings

When 20% of special mixed concrete is tested in the M20 and M25 grade concrete there is no change in the strength level. Where as when the same mix is tested at the M30 grade there is slight decrease in the strength level in respect of compressive strength

6. Conclusion

Based on the results of these works it can be concluded that RHA, Fly ash and ESP mixed cubes has equal strength with that of conventional concrete cubes in certain categories. M20 and M25 cubes takes equal load compared to conventional concrete. And M30 grade concrete's load carrying capacity is slightly decreased. There fore it can be concluded that RHA, Fly ash and ESP mixed cubes when added with the grades above M25 may results in the decrease of the strength level. Hence a research study has been proposed to investigate the strength of grades M40, M50 and above grades using RHA, Fly ash and ESP to minimized the usage of cement in concrete and also identify the properties of above mentioned.

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