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Study on Concrete Using Fly Ash, Rise Husk Ash and Egg Shell Powder

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***Abstract:** Approximately, yearly concrete production is about 10 billion cubic meters. Cement is a very important constituent of concrete, and approximately 4180 million tons of cement were produced in 2014 globally. Production of one ton of cement releases approximately one ton of CO2 which makes up 7% of all CO2 emissions produced globally. Hence, there is necessity to use supplementary cementitious materials (SCMs) as partial replacement of cement and sand in concrete. Utilization of SCMs reduces the consumption of Ordinary Portland cement, and thereby reduces the energy consumption and greenhouse gas emissions associated with cement production. This research centres around the growth of the strength attributes of concrete by optimal substitution of cement with joint ratio of Rice husk ash (RHA) and Egg shell powder (ESP) with optimum joint ratio of sand replacement as Fly ash(FA). Initially ESP and RHA replaced with cement in proportion of 2.5%,5%,7.5%,10% and 5%,10%,15%,20% respectively. FA replaced with sand in proportion of 10%,20%,30%, and 40%. Based on individual replacement results further ternary mix designs were carried out.*

Keywords: **Fly ash, Rice husk ash, Egg shell powder, sand supplementary materials, compressive strength, split tensile strength**

I. INTRODUCTION

It is a pressing need today for the concrete industry to produce concrete with lower environmental impact, these-called green concrete. This can be achieved in three ways. The first one is by reducing the quantity of cements one tonne of cement saved will save equal amount of CO2 to be discharged into atmosphere. Secondly by reducing the use of natural aggregates whose resources are limited and are exhausting very fast.

Fly ash is generally used as replacement of cement, as an admixture in concrete, and in manufacturing of cement. Concrete containing fly ash as partial replacement of cement poses problems of delayed early strength development. Concrete containing fly ash as partial replacement of fine aggregate will have no delayed early strength development, but rather will enhance its workability and strength. This higher workability and strength achieved gives scope for indirectly reducing the cement quantity in concrete.

India is a major rice producing country, and the husk generated during milling is mostly used as a fuel in the boilers for processing paddy, producing energy through direct combustion and / or by gasification. About 20 million tons of RHA is produced annually. This RHA is a great environment threat causing damage to the land and the surrounding area in which it is dumped.

India is in fifth position in the world annual egg production. About 1.61 million tons of egg shells are being waste annually by disposing it as a landfill, which attracts vermin due to attached membrane and causes problems to human health and environment.

Maisarah Ali et al (2015) introduced RHA as the micro filler in concrete mixtures. The replacement of RHA which is lighter as compared to the Ordinary Portland Cement results in decreasing density of cement fibre composite and less permeable concrete. 5% of RHA was used as cement replacement material for target strength of 50MPa. Microstructure properties of both mixes were analysed using FESEM. Higher silica contains in concrete cubes containing RHA led to the greater formation of calcium Silicate Hydrate (CSH) that contributed towards strength development to the concrete during curing. Water absorption of concrete with RHA replacement is lower than concrete without RHA. The compressive strength test of concrete with 5% RHA replacement is lower than without RHA replacement. However, the target compressive strength of is achieved. [2]

Divya Chopra et al (2014) replaced cement content with rice husk ash (RHA) as supplementary cementitious materials (SCM's) in SCC and observed fresh flow (slump flow, V Funnel, U-box, L-Flow), mechanical strength (compressive and split tensile) and durability properties (porosity and rapid chloride permeability test) at 7, 28 and 56 d. Concrete specimens were prepared with 0%, 10%, 15% and 20% RHA replacing cement content. Conplast SP430 was used conforming to IS: 9103 (1999) as a high range water reducing admixture. An increase of about 25% strength at 7 d, 33% at 28 d and 36% at 56 d was observed with RHA content of 15% RHA when compared to control mix. Maximum split tensile strength was 3.8 N mm^2 at 28 d and 4.0 N mm^2 at 56 d for 15%

RHA replacement. All the mixes were less porous as compared to the control mix at all ages and showed “low range” to “very low range” chloride penetration. [5]

Rafat Siddique (2003) conducted experimental investigation carried out to evaluate the mechanical properties of concrete mixtures in which fine aggregate (sand) was partially replaced with Class F fly ash. Fine aggregate (sand) was replaced with five percentages (10%, 20%,30%, 40%, and 50%) of Class F fly ash by weight. Tests were performed for properties of fresh concrete. Compressive strength, splitting tensile strength, flexural strength, and modulus of elasticity were determined at 7, 14, 28, 56, 91, and 365 days. Compressive strength, splitting tensile strength, flexural strength, and modulus of elasticity of fine aggregate (sand) replaced fly ash concrete continued to increase with age for all fly ash percentages. [10]

Turhan Bilir et al (2015) studied the influence of fly ash as fine aggregate in mortar properties Flow ability, unit weight, ultrasound pulse velocity, compressive and flexural strengths, modulus of elasticity, stress–strain behaviour and free drying and restrained shrinkage tests were conducted on mortars produced. It was observed that the usage of fly ash as fine aggregate presents a new approach to consume high amount of fly ash without causing significant changes on properties of mortars when it was used at the ratio of 60–70%. FA usage significantly reduces unit weight which was desirable in point of reducing cross sections of structural elements and dead load. Reducing dead load was very important to lightening the earthquake damage and saving life. Weight loss is 36.6% when FA is used at the ratio of 100%. [6]

Homnuttiwong (2012) investigated compressive strength, water permeability and abrasion resistance of high volume fine fly ash and fine ground palm oil fuel ash concrete. They replaced up to 70% Portland cement type I by fine fly ash (FFA) and fine ground palm oil fuel ash (GPA). They reported that FFA was more reactive than GPA. Their results also confirmed that compressive strength, water permeability and abrasion resistance were comparable with normal concrete due to increase in pozzolanic activity of FFA. [17]

Dr Sowmya N et al. (2015) conducted an experimental study on properties of Egg Shell Concrete with Partial Replacement of Cement by Fly Ash. Two wastes are used 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 up to 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%).out of this 7.5% of egg shell powder replacement gives highest compressive strength and Split Tensile Strength. Fly ash percentage are varied from 0% to 30% with 7.5% off egg shell powder. The combination of ESP + FA showed the reduction in compressive strength compared to egg shell concrete mixes beyond 5% replacement of fly ash to optimum egg shell content concrete. [23]

II. EXPERIMENTAL INVESTIGATION

A. *Materials and Method*

1) *Materials Used:* Ordinary Portland cement (OPC) 43 grade of specific gravity of 3.15 in compliance with Indian standard code IS 8122 -1995 (21) was employed. Graded river sand passing through 4.75 mm sieve with fineness modulus of 2.67 and specific gravity of 2.6 was utilized as fine aggregate. The coarse aggregate was regionally accessible compacted granite aggregate, passing through 12.5 mm sieve and maintained on 4.75 mm sieve with fineness modulus of 6.64 compliant to IS 383-1970. Fly ash for this study was taken from torrent Thermal Power Plant located in Gandhinagar Gujarat shown in which is sold by Ethios Enviro Solutions (P) Ltd, Ahmedabad, Gujarat. From the source class F type fly ash was collected of size 75 µm. It is advisable that to all parameter of fly ash conforming to replacement of IS 3812 -2013(part 2) limits for class F fly ash use in concrete. Rice husk residue was collected from a rice mill at Godhra, Gujarat, India which is sold by Kaveri Traders, Ahmedabad, Gujarat shown in Figure 4.2. Initially rice husk was converted into ash by open burning method at a temperature ranging from 3000C to 4500C. The amount of un-burnt carbon was found in (end product) ash at a temperature below 6500C. The fired rice husk ash was black in colour obviously due to excess amount of carbon content. The fired husk residue ash was further burnt to a temperature of 6500 C over a period of 2 h before it is used as a cement replacement material. Egg shells were collected from Ghaziabad based egg exporter Nature-Egg LLP, Ghaziabad, Uttar Pradesh. Egg shell was washed thoroughly (to remove organic properties) and dried in sun light 5 to 7 days and made in to a powdery substance to obtained an average particle size of 45 µm.

The lignosulphonates based super plasticizer of brand REDWOP product ID “PLASTCONE AP211” water reducing concrete admixture was used which was light brown in color. It was satisfied as per IS 9103- 1999. Superplasticizer dose used 0.5% by cement weight.

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Fig.1 Egg shell powder

Fig.2 fly ash

Fig.3 rice husk ash

2) Chemical Properties:

Table 1. chemical properties of FA, RHA and ESP

Particle size allocation of OPC, Fly ash, RHA and Egg shell powder was decided. Physical properties such as specific gravity, bulk density, and fineness of OPC (IS 8122-1985), Fly ash (IS 1727- 1967), RHA (IS1727-1995) and Egg shell powder were calculated.

Chemical Properties	FA (%)	RHA (%)	ESP (%)	IS 3812 – 2013(part 2) Requirement
Silicon dioxide, SiO_2	55.3	93.8	0.09	35 min
Aluminum oxide, Al_2O_3	25.70	0.74	0.44	–
Ferric oxide, Fe_2O_3	5.3	0.30	0.34	–
$SiO_2+Al_2O_3+Fe_2O_3$	85.9	94.89	-	70.0 min
Calcium oxide, CaO	5.6	0.89	47.49	–
Magnesium oxide, MgO	2.1	0.32	0.32	5.0 max
Titanium oxide, TiO_2	1.3	-	-	–
Potassium oxide, K_2O	0.6	0.12	-	–
Sodium oxide, Na_2O	0.4	0.28	0.17	1.5 max
Sulfur trioxide, SO_3	1.4	-	-	5.0 max
LOI (1000 C)	1.9	3.37	3.74	7.0 max

Specific surface area of OPC, FA and ESP were calculated as per IS 4031 (part 2)-1995 by means of Blain's air permeability tool. Definite surface area of RHA was calculated by using BET's technique by nitrogen adsorption. The physical properties of OPC, FA,

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RHA and ESP are contrasted in Table 1 Chemical examination for oxide composition of OPC (IS 4032-1985), Fly ash (IS3812-1981), RHA and Egg shell powder was calculated.

3) *Mix Proportions and Casting of Concrete Specimens:* All mixes were prepared with different proportions with rice husk ash and egg shell powder replaced by cement and fly ash replaced by sand in conventional M30 Grade concrete. Mix design is carried out as per IS 10262:2009. In the initial stage, chemical composition, physical traits, and categorization of FA, RHA and ESP were executed. In the second stage, concrete mixes with different proportion of individual supplementary material was carried out. Each control mix were prepared with constant water to cement ratio of 0.44. compressive strength and tensile strength test were carried out for each mix and analysing the results. In the third stage, based on results of individual replacement further mix designs were conducted. Replacement of 5% ESP by weight with cement was taken as constant for further mix designs. Compressive strength tensile strength and acid attack tests were carried out for each mix and analyse results.
4) *Compressive Strength of Concrete:* Compressive strength of cement concrete cube of all blends were calculated in accordance with provisions of IS 9013-1997 after 7 and 28 days of immersed water curing, and these cubes were experimented on digital compression testing machine according to I.S. 516-1959.
5) *Split Tensile Strength of Concrete:* Vide IS 5816-1999 and IS 516-1959 Splitting tensile strength(cylinder) and flexural strength(beam) was executed on ESP concrete of blend designation of RA0 to RA5 after 7 and 28 days of curing. The test consists of applying a compressive live load along the opposite generators of a concrete cylinder placed with its axis horizontal between the compressive plates. Due to the compression loading a fairly uniform tensile stress is developed over nearly 2/3 of the loaded diameter as obtained from as elastic analysis. The magnitude of this tensile stress fct (acting in a direction perpendicular to the line of action of applied loading) is given by formula in IS:5816-1999.

Fig.4 compression testing

Fig.5 split tensile strength testing

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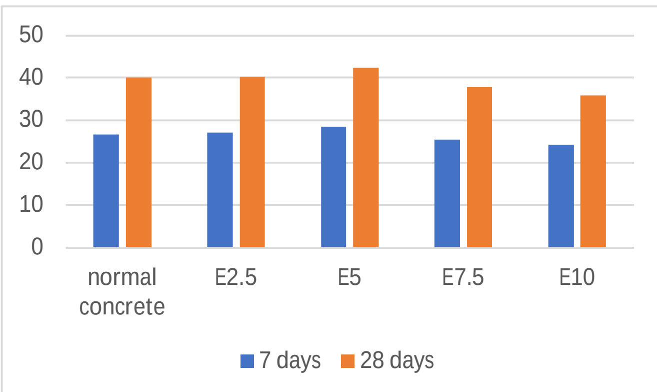
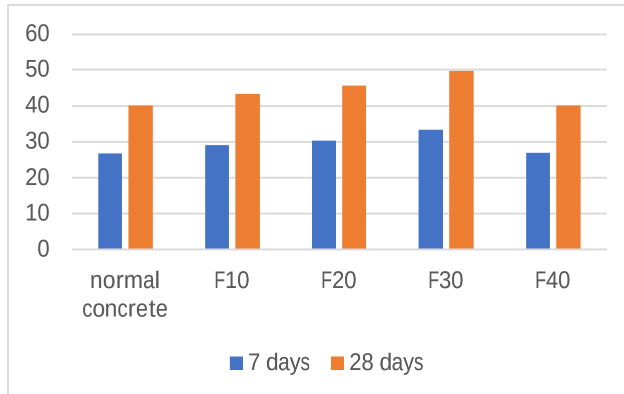
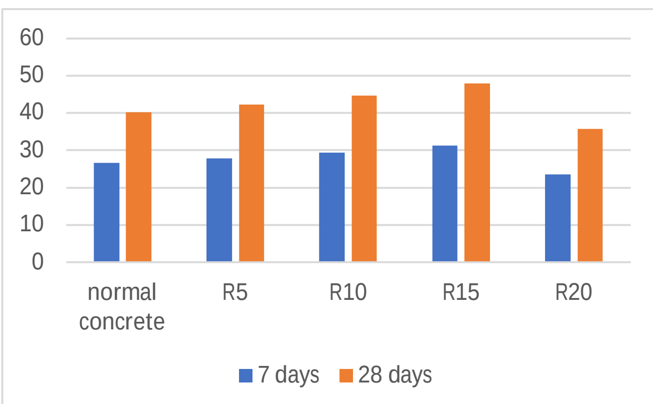
III. RESULTS

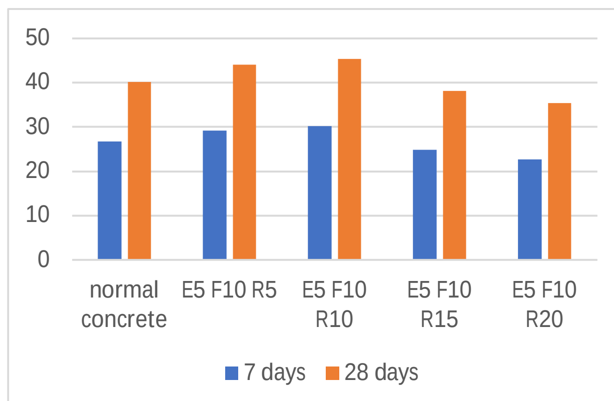
A. Compressive Strength of Concrete

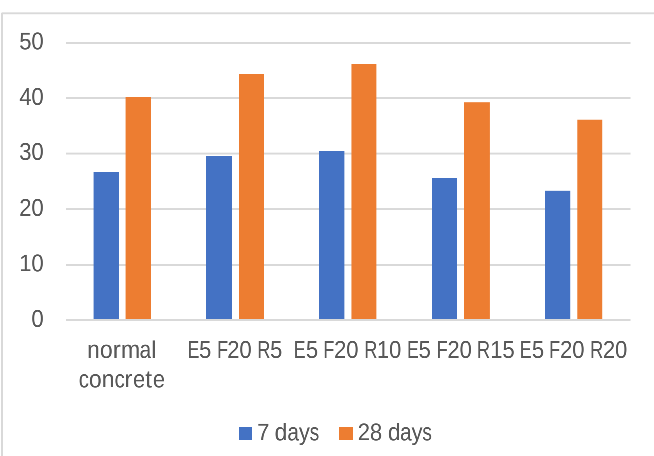
The outcomes of the compressive strength of ESP concrete for 7 and 28 days of curing time are shown in graph 1. It is crystal clear from the statistics that, the compressive strength enhances in blend description of E5 and thereafter come down with addition description of E7.5 and E10. The amorphous silica and the fine particle size of RHA and Fly ash are the underlying causes for the sterling pozzolanic function enhance in compressive strength. highest compressive strength was observed in blend mix F30 and R15. While in ternary mixes compressive strength enhances with blend E5F30R10 that is replacement of cement by 5% ESP 10% RHA while replacement of sand with fly ash 30% increases the compressive strength up to 30.4% with respect to normal concrete.

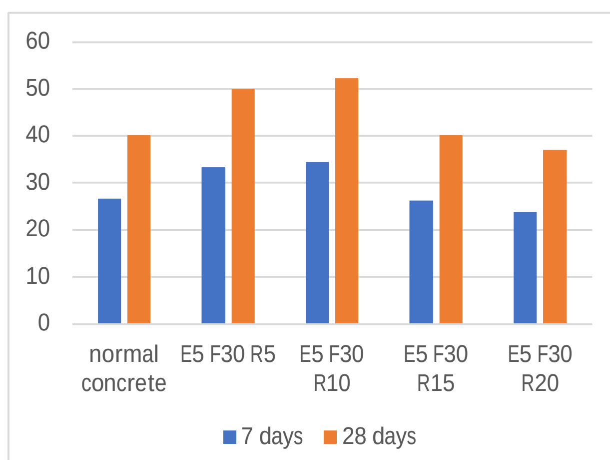












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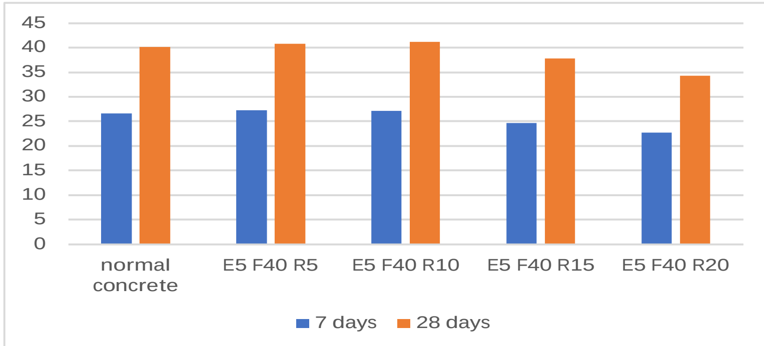
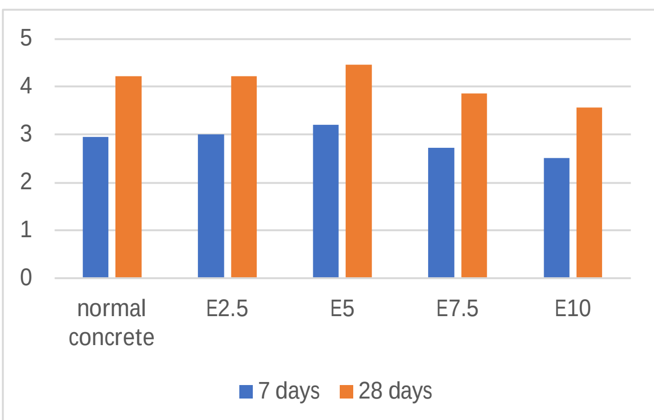
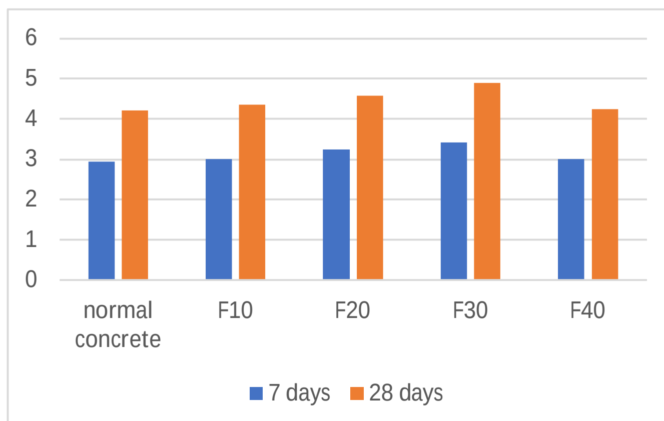


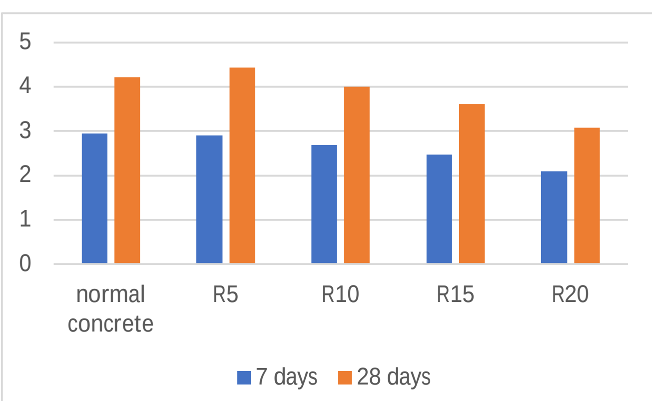
Graphs 1. Compression strength results of all mix designs

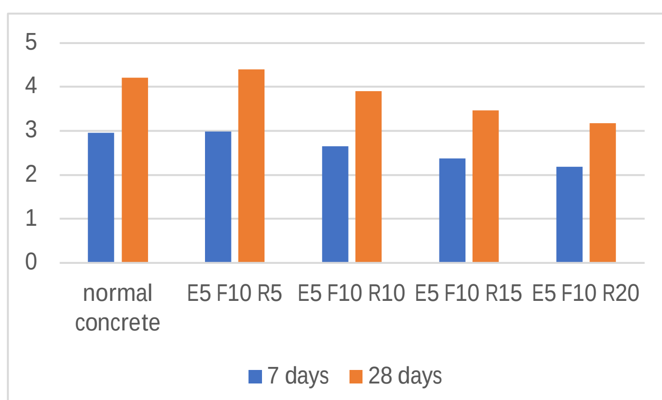
B. Split tensile Strength of Concrete

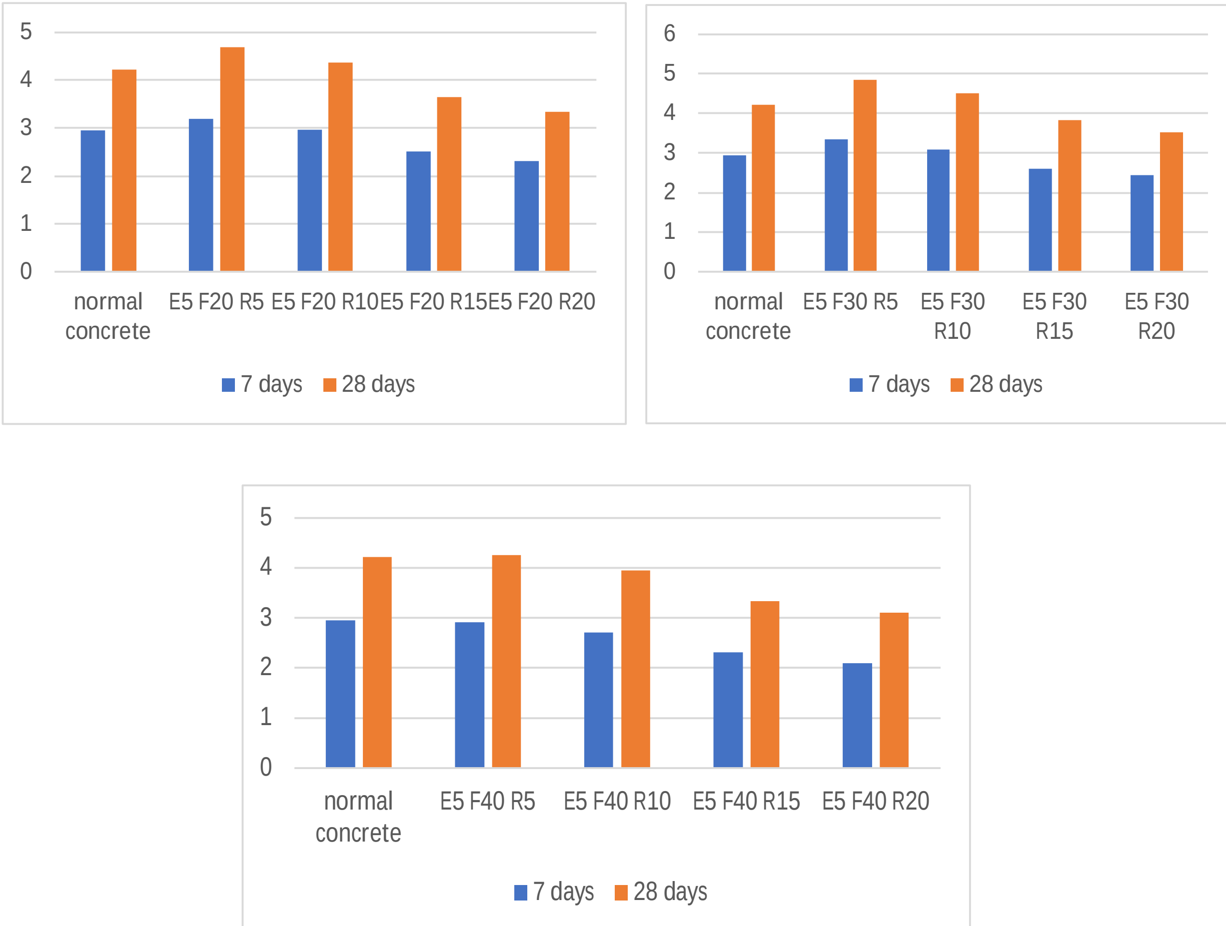
The outcomes of the split tensile strength of RHA concrete for 7 and 28 days of curing time are shown in graph 2. It is crystal clear from the statistics that, the split tensile strength decreases in blend description of R10 and thereafter come down with addition description of R15 and R20. The amorphous silica and the fine particle size of Fly ash are the underlying causes for the sterling pozzolanic function enhance in split tensile strength. highest compressive strength was observed in blend mix F30 and R15. While in ternary mixes compressive strength enhances with blend E5F30R5 that is replacement of cement by 5% ESP 5% RHA while replacement of sand with fly ash 30% increases the split tensile strength up to 15% with respect to normal concrete.











Graphs 1. Compression strength results of all mix designs

IV. CONCLUSION

From experiment following conclusions can be drawn:

A. It has been found that 5% replacement of Egg shell powder with cement increases the compressive strength up to 5.5% and split tensile strength up to 5.8%.

B. It is noticed that 30% replacement of Fly ash with sand increases the compressive strength up to 24% and split tensile strength up to 16%.

C. From the result, it has been found that replacement of fly ash with sand up to 40% also satisfies the criteria of target mean compressive strength

D. It has been found that 15% replacement of Rice husk ash with cement increases the compressive strength up to 19.4%.

E. A noticeable observation was made that replacement of cement by Rice husk ash above 5% reduces the split tensile strength of concrete up to 27% compare with normal concrete.

F. In ternary mixes E5F30R10 that is replacement of cement by 5% ESP 10% RHA while replacement of sand with fly ash 30% increases the compressive strength up to 30.4% with respect to normal concrete.

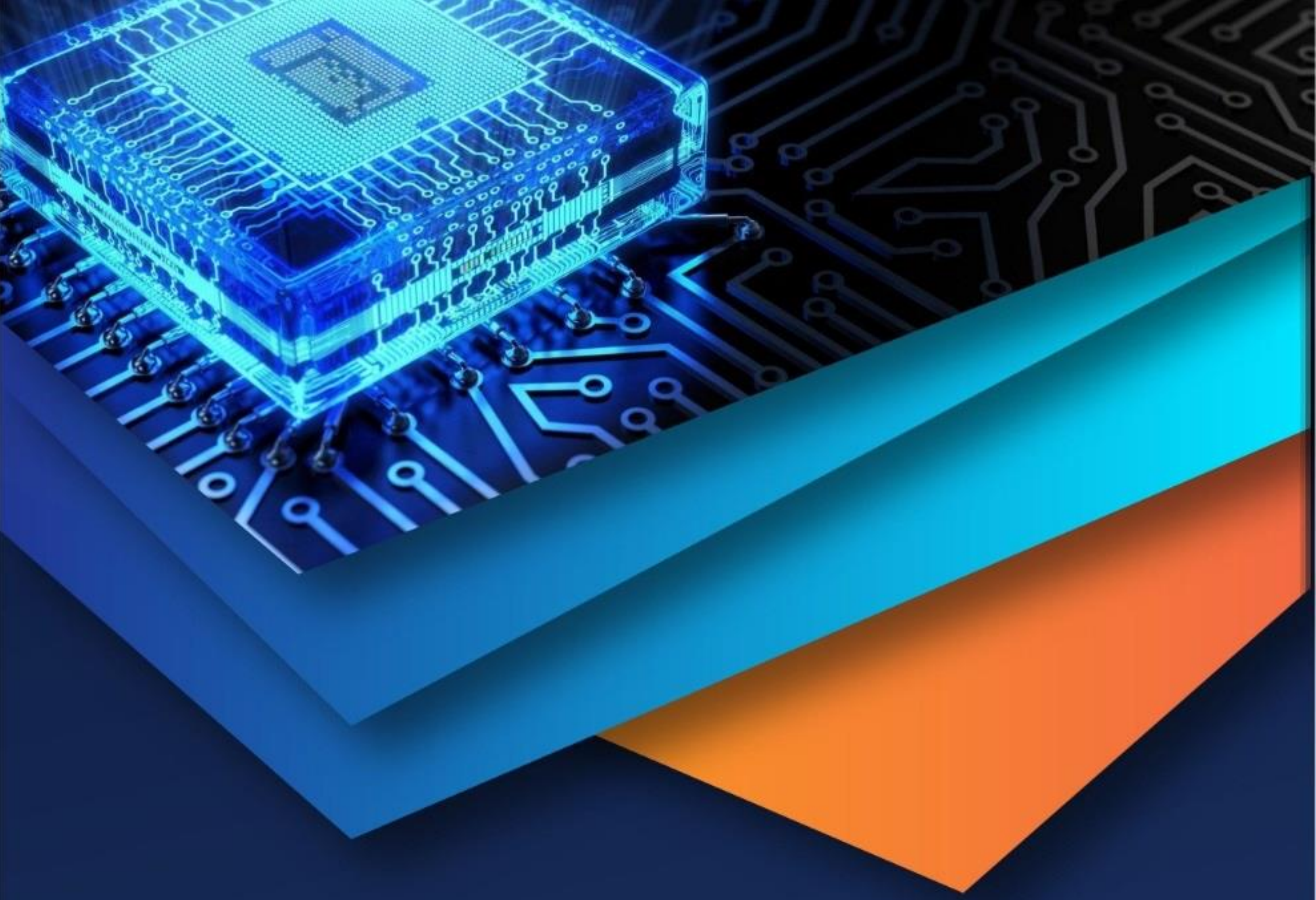
G. In ternary mixes E5F30R5 that is replacement of cement by 5% ESP 5% RHA while replacement of sand with fly ash 30% gives maximum tensile strength which increases 15% with respect to normal concrete.

H. It is determined that fly ash can be successively used as sand supplementary material for achieving green and durable concrete.

I. Experimental result showed that rice husk ash and egg shell powder can be successively used as cement supplementary material for achieving economical and durable concrete.

REFERENCES

[1] Gemma Rodrı´guez de Sensale(2006), "Strength development of concrete with rice-husk ash", Cement & Concerte Composites,vol.28 pp.158–160
[2] Maisarah Ali, Mohd Syafiq Fadzil and Siti Asmahani Saad(2015), "Effect of Rice Husk Ash (RHA) on Physical Property and Mechanical Strength of Concrete", Advanced Materials Research, Vol. 1115, pp 150-155
[3] Rafat Siddique, Karambir Singh, Kunal, Malkit Singh, (2016) "Properties of bacterial rice husk ash concrete", Construction and Building Materials,vol.121,pp.112–119
[4] Satish H. Sathawane, Vikrant S. Vairagade and Kavita S Kene, (2013) "Combine Effect of Rice Husk Ash and Fly Ash on Concrete by 30% Cement Replacement" Chemical, Civil and Mechanical Engineering Track of 3rd Nirma University International Conference (Procedia Engineering vol.51,pp. 35 – 44)
[5] Divya Chopra, Rafat Siddique, Kunal, (2015) "Strength, permeability and microstructure of self-compacting concrete containing rice husk ash", Biosystems engineering ,vol.130,pp.72-80
[6] Turhan Bilir, Osman Gencel(2015), "Properties of mortars with fly ash as fine aggregate", Construction and Building Materials
[7] Ha Thanh Le, Horst-Michael Ludwig(2015),"Effect of rice husk ash and other mineral admixtures on properties of self-compacting high performance concrete", Material Design
[8] Hwang, K., Noguchi, T. and Tomosawa, F. (2004)," Prediction Model of Compressive Strength Development of Fly Ash Concrete". Cement and Concrete Research, vol.34, pp.2269-227
[9] Felipe Rivera, Patricia Martinez, Javier Castro, Mauricio Lopez (2014), "Massive Volume Fly-Ash Concrete: A More Sustainable Material with Fly Ash Replacing Cement and Aggregates", Cement and Concrete Composites
[10] Rafat Siddique(2003). "Effect of fine aggregate replacement with Class F fly ash on the mechanical properties of concrete". Cement Concrete Res; vol.33,pp.539–47
[11] Bakoshi T, Kohno K, Kawasaki S, Yamaji N. "Strength and durability of concrete using bottom ash as replacement for fine aggregate". SP- 179, ACI, 1998; pp.159–72.
[12] Shirish V. Deo, Arun D. Pofale(2015), "Parametric Study for Replacement of Sand by Fly Ash for Better Packing and Internal Curing", Open Journal of Civil Engineering,vol.5,pp.118-130
[13] Y. Bai, F. Darcy(2005), "Strength and drying shrinkage properties of concrete containing furnace bottom ash as fine aggregate", Construction and Building Materials,vol.19,pp.691–697
[14] Turhan Bilir, Osman Gencel(2015), "Properties of mortars with fly ash as fine aggregate", Construction and Building Materials
[15] K. T. Varughese & B. K. Chaturvedi (1996), "Fly Ash as Fine Aggregate in Polyester Based Polymer Concrete", Cement & Concrete Composites, vol.18, pp.105-108
[16] Chatterjee, A.K. (2011) Indian Fly Ashes: Their Characteristics and Potential for Mechanochemical Activation for Enhanced Usability. Journal of Materials in Civil Engineering, vol.23, pp.783-788.
[17] Homnuttiwong, S., Jaturapitakkul, C. and Chindaprasirt, P. (2012)," Permeability and Abrasion Resistance of Concrete Containing High Volume Fine Fly Ash and Palm Oil Fuel Ash", Computers and Concrete, vol.10, pp.349-360.
[18] Filho, J.H., Medeiros, M.H.F., Pereir, E., Helene, P. and Isaia, G.C. (2013)," High Volume Fly Ash Concrete with and without Hydrated Lime: Chloride Diffusion Coefficient from Accelerated Test", Journal of Materials in Civil Engineering, vol.25, pp.411-418
[19] Jayasankar R., Mahindran N., Hangovan R., (2010), "Studies on Concrete using Fly Ash, Rice Husk Ash and Egg Shell Powder", International Journal of Civil and Structural Engineering, ISSN 0976-4399, Vol.1, Issue 3, pp.362-372
[20] Hanifi Binici, Orhan Aksogan (2015), "Mechanical and radioactivity shielding performances of mortars made with cement, sand and egg shells", Construction and Building Materials
[21] Doh Shu Ing(2014), Eggshell Powder: Potential Filler in Concrete, 8th MUCET
[22] Papadakis, V.G(1999), "Effect of Fly Ash on Portland Cement Systems Part-I: Low Calcium Fly Ash". Cement and Concrete Research, vol.29, pp.1727-1736
[23] Dr Soma N J, Dr Chandrasekhar (2015)," A Comparative Study on Egg Shell Concrete with Partial Replacement of Cement by Fly Ash", International Journal for Research in Applied Science & Engineering Technology (IJRASET), Volume 3, Special Issue-I1,
[24] N. Ghafoori, Y. Cai, B. Ahmadi (1997)," use of dry bottom ash as a fine aggregate in roller compacted concrete", ACI Spec. Publ. (SP-171),pp.487– 507



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