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A Comparative Study on Egg Shell Concrete with Partial Replacement of Cement by Fly Ash

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Abstract: The carbon dioxide produced by cement industries causes environmental pollution and global warming. In 1000Kg of cement manufacturing processes approximately 900Kg of CO_2 is emitted. In order to reduce the impact of cement production on atmosphere, waste by products is used as admixture in this study, so that environmental pollution and natural resources consumption is reduced. 75million tones of fly ash which are rich in silica are disposed to landfill as a waste annually in India. Egg shell powders which are rich in calcium are thrown away as a waste. In the present study, these 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 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%)
Keywords: Fly Ash (FA), Egg Shell Powder (ESP), Compressive Strength, Split Tensile Strength and Flexural Strength.

I. INTRODUCTION

Concrete is a composite material which has relatively high compressive strength, but significantly lower tensile strength. At present, for a variety of reasons, the concrete construction industry is not sustainable. Firstly, it consumes huge quantities of virgin materials which can remain for next generations. Secondly, the principal binder in concrete is Portland cement, the production of which is a major contributor to greenhouse gas emissions that are implicated in global warming and climate change. Thirdly, many concrete structures suffer from lack of durability which may waste the natural resources. A major component of concrete is cement and it is one of the three primary producers of carbon dioxide, a major greenhouse gas. 900kg of CO_2 are emitted for every ton of concrete. As of 2001, the production of Portland cement contributed 7% to global CO_2 emission, largely due to the sintering of limestone and clay at 1500°C. The CO_2 emission of concrete is directly proportional to the cement content used in the concrete mix. Cement manufacture contributes greenhouse gases both directly through the production of carbon dioxide when calcium carbonate is thermally decomposed, producing lime and carbon dioxide and also through the use of energy, particularly from the combustion of fossil fuels. There is a growing interest in reducing carbon emission related to cement production from both academic and industrial sectors. Recycling of waste components contributes to energy savings in cement production, to conservation of natural resources and to protection of the environment. Hence, currently, the entire construction industry is in search of a suitable and effective waste product that would considerably minimize the use of cement and ultimately reduce the construction cost. Fly ash produced from coal combustion was simply entrained in flue gases and dispersed into atmosphere. This created environmental problems and health concerns. Instead of dispersing it into atmosphere or sending it to land fill it can be effectively used in concrete production as supplementary material to cement. In India, the total production of fly ash is nearly as much as that of cement. But our utilization of fly ash is only about 5% of the production. Fly ash is finely divided residue resulting from the combustion of powdered coal and transported by flue gases and collected by electrostatic precipitator. There are two types of fly ash, one if class F fly ash and another one is class C. Class F fly ash contains less than 5% lime and class C fly ash contains more than 10% of lime. The main component o fly ash is silicon dioxide and aluminum oxide [8].

Through pozzolanic activity, fly ash combines with free lime to produce the same cementitious compounds formed by the hydration of Portland cement. Due to this series of chemical reaction, rate of strength gain for fly ash concrete is relatively slower at early ages of curing [2].

India is in fifth position in the world annual egg production. About 1.61 million tones 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.

It is scientifically known that the eggshell is mainly composed of compounds of calcium. Calcium carbonate, ($caco_3$), is the major composition of the eggshell, accounting for 93.70% of the total composition of the eggshell. Similarly, calcium carbonate ($caco_3$), is the primary raw material in the production of cement. The produced OPC is composed of four main Calcium compounds in the forms of dicalcium silicates, (C_2S), tricalcium silicate, (C_3S), tricalcium aluminate, (C_3A), and tetra-calcium aluminoferite, (C_4AF). It is, therefore, indicated that cement and eggshells have the same primary composition in calcium compounds [1].

Calcium rich egg shell is a poultry waste with chemical composition nearly same as that of limestone. Use of eggshell waste instead of natural lime to replace cement in concrete can have benefits like minimizing use of cement, conserving natural lime and utilizing waste material. Eggshell waste can be used as fertilizer, animal feed ingredients and other such uses [7].

An approach had been made in this study to reduce usage of cement by replacing cement partially by fly ash (FA) and egg shell powder (ESP), which are by products of electrostatic precipitators in thermal power stations and egg that would otherwise end up in landfills.

A. Background and Related Work

Mtallib and Rabiu (2009) carried out the investigation on properties of ESA as a admixture in concrete. They conducted consistency test on ESP. It was observed that higher the contents of ESA in the cement, the faster the setting of cement. The decreased setting time of OPC was due to addition of ESA portrays ESA as an accelerator.

Doh Shu Ing and Chin Siew Choo (2014) carried out an investigation on egg shell powder as potential additive to concrete. In this investigation, five different percentages of egg shell powder with respect to cement was added into concrete mix of grade M_{25}. 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 a addition to concrete had improved the resistance to failure under bending and water absorption was reduced at initial stage.

Jayasankar et al. (2010) conducted a experimental study on properties of concrete by substituting rice husk ash, fly ash and egg shell powder to cement in concrete. M_{20}, M_{25} and M_{30} mix design was used with 5%, 10%, 15% and 20% variation of egg shell powder, rice husk ash and fly ash to cement and also in the combination of ESP +fly ash, ESP + RHA, fly ash + RHA, fly ash + RHA + ESP. It was observed that M_{20} and M_{25} cubes was taking equal load compared to conventional concrete but M_{30} grade concrete's load carrying capacity was slightly decreased. Therefore they concluded that RHA, ESP and Flyash mixed cubes when added with grades above M_{25} may results in the decreased strength level.

Marthong and Agrawal (2012) carried out a comparative study on effects of concrete properties by partially replacing ordinary Portland cement of varying grades by fly ash. It was also observed that at the age of 90 days the rate of strength gain for 33, 43 and 53 grades concrete was increased and had been maximum up to 20% fly ash replacement. They concluded that influence of fly ash on shrinkage was negligible. Increase in normal consistency with increase in fly ash content was observed. Setting time and soundness was decreased with the increase in grade of cement.

Sathanantham et al (2014) carried out a study on properties of M_{25} concrete by replacing fine aggregate partially by rice husk ash and egg shell powder. The maximum strength was observed at 20% for compressive, split tensile and flexural strength.

B. Objectives

The main objectives of this study are

1) To determine optimum percentage of ESP in concrete.

2) To ascertain the proper percentage required for the manufacturing of concrete with optimum ESP and FA variation to improve its hardened properties.

3) To study the compressive, split tensile and flexural behaviour of egg shell concrete and optimum content ESP + fly ash concrete and to compare the same with conventional concrete.

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.

Table 1: Basic Properties of Cement

Properties	Results
Specific gravity	3.1
Standard consistency	31%
Initial setting time	38min
Final setting time	480min
Fineness	5.3%

B. *Fine Aggregate*

Natural river sand of size below 4.75mm conforming to zone II of IS 383-1970 was used as fine aggregate. Table 2 shows the test results of basic properties of fine aggregates.

Table 2: Basic Properties of Fine Aggregates

Properties	Results
Specific gravity	2.62
Water absorption	1.45%

C. *Coarse Aggregate*

Natural crushed stone with 20mm down size was used as coarse aggregate. Table 3 shows the test results of basic properties of coarse aggregates.

Table 3: Basic Properties of Coarse Aggregates

Properties	Results
Specific gravity	2.65
Water absorption	0.39%

D. *Fly Ash*

Class F fly ash was used in this study and it was collected from Udupi Power Corporation Limited, Padubidri, Udupi District, Karnataka. Table 4 shows the test results of basic properties of fly ash.

Table 4: Basic Properties of Fly Ash

Properties	Fly Ash
Specific gravity	2.5
Fineness	2.28%

E. *Egg Shell Powder*

Egg shell which was a waste material was collected from KVG Engineering Hostel mess and are sun dried. Stored egg shell was powdered in flour mill. Table 5 shows the test results of basic properties of egg shell powder.

Table 5: Basic Properties of Egg Shell Powder

Properties	Results
Specific gravity	1.95
Fineness	5.9%

F. *Water*

In this investigation, for both mixing and curing ordinary portable water was used.

G. *Superplasticizer(SP)*

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Conplast SP430 was used as a superplasticizer. It is a chloride free, super plasticizing admixture. It was supplied as a brown solution which instantly disperses in water.

III. EXPERIMENTAL METHODS

A. *Concrete Mix Design*

Mix proportion used in this study was 1:1.61:2.65 (M40) conforming to IS 10262-2009 with water-cement ratio of 0.4 and superplasticizer of 0.75%.

B. *Batching and Mixing of Materials*

Weight batching and machine mixing were adopted in this study for concrete production. The percentage replacement of OPC 43 grade by FA and ESP and their material weight are shown in Table 6.

Table 6: Mix Proportion Per Cubic Meter

Mixes Name	ESP (%)	FA (%)	Cement (Kg)	Fine Aggregate (Kg)	Coarse Aggregate (Kg)	Water (w/c 0.4) (liters)	0.75% SP (liters)
M	-	-	425	684.25	1126.25	170	3.1875
M1	2.5	-	414.375	684.25	1126.25	170	3.1875
M2	5.0	-	403.375	684.25	1126.25	170	3.1875
M3	7.5	-	393.125	684.25	1126.25	170	3.1875
M4	10	-	382.5	684.25	1126.25	170	3.1875
M5	12.5	-	371.875	684.25	1126.25	170	3.1875
M6	7.5	5	371.875	684.25	1126.25	170	3.1875
M7		10	350.625	684.25	1126.25	170	3.1875
M8		15	329.375	684.25	1126.25	170	3.1875
M9		20	308.125	684.25	1126.25	170	3.1875
M10		25	286.875	684.25	1126.25	170	3.1875
M11		30	265.625	684.25	1126.25	170	3.1875

C. *Casting of Specimens*

Cubes of size 100*100*100mm, cylinders of size 100mm dia and 200mm length and beams of size 100*100*500mm were casted. Mixing was done by adding coarse aggregates followed by water + superplasticizer, sand and cement. For each mix slump test was conducted to measure workability. Afterwards moulds were casted and compacted on table vibrator. Demoulding was done after 24 hours of casting and specimens are cured in water tank. Fig 1 shows the concrete placed in moulds.

Fig 1: Concrete placed in moulds

D. Slump Test

From the Table 7, it was observed that workability of concrete is decreased as the percentage of egg shell powder increased but reverse trend is observed with addition of fly ash to concrete with optimum ESP content.

Table 7: Test Results of Workability

Mixes	Results mm	Mixes	Results mm
M	100	M6	43
M1	95	M7	70
M2	85	M8	74
M3	75	M9	150
M4	35	M10	160
M5	0	M11	165

E. Testing of Specimen

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

Fig 2: Compressive strength Test

Fig 3: Split Tensile Strength Test

Fig 4: Flexural Strength Test

IV. RESULTS AND DISCUSSIONS

The Fig 5 and Fig 6 graphically represents the compressive strength of concrete with partial replacement of cement by egg shell powder at 7 and 28 days respectively. Maximum compressive strength is obtained at 7.5% replacement of ESP for both 7 and 28 days curing period. Compressive strength of egg shell powder concrete is similar to that of control concrete mix at 7 days and it is greater than control mix at 28 days strength. Optimum Split tensile strength and flexural strength are greater than control concrete mix (Fig 7 and Fig 8). The maximum split tensile and flexural strength at 28 days are obtained at 7.5% replacement of ESP to cement as similar to compressive strength. Upto 10% replacement, flexural strength is greater than control mix thereafter it has decreased.

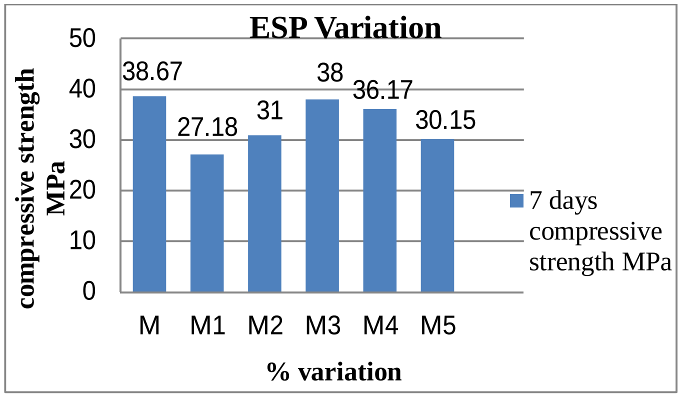

Fig 5: 7 Days Compressive Strength of ESP Variation

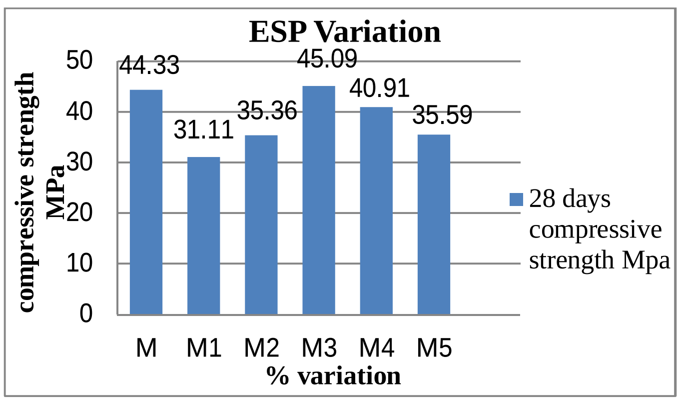

Fig 6: 28 Days Compressive Strength of ESP Variation

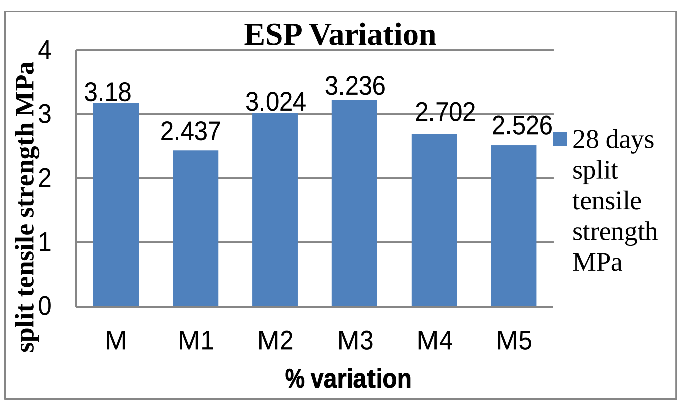

Fig 7: 28 Days Split Tensile Strength of ESP Variation

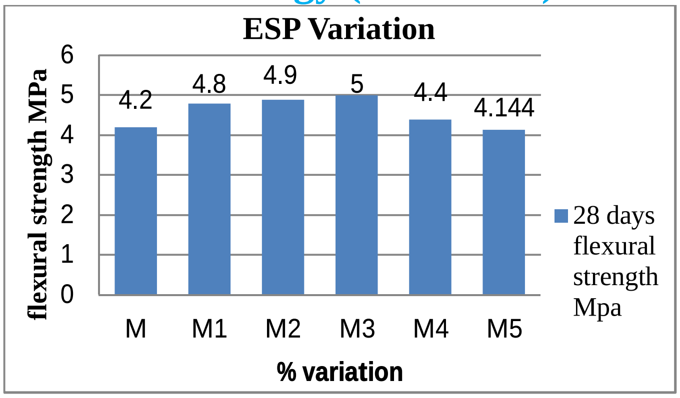

Fig 8: 28 Days Flexural Strength of ESP Variation

By considering 7.5% ESP as optimum dosage , FA was varied in concrete mix. From the Fig 9 and Fig 10, it can be observed that, the maximum compressive strength of optimum ESP + FA concrete is attained at M6 for both 7 and 28 days curing period thereafter decrease in strengths are observed. Optimum compressive strength at 7 days is lesser than control mix and at 28 days it is greater than control mix. Flexural strength is greater than control mix for all percentage variations (Fig 11). Split tensile strength is decreased beyond 5% addition of fly ash to optimum content ESP concrete (Fig 12). Maximum split tensile strength and flexural strength are obtained at M6 for 28 days curing period.

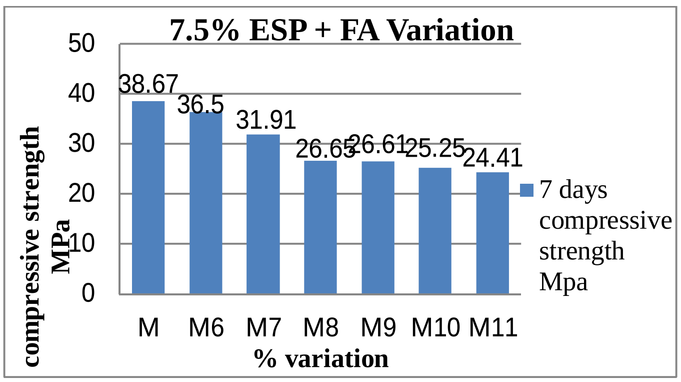

Fig 9: 7 Days Compressive Strength of 7.5% ESP + FA Variation

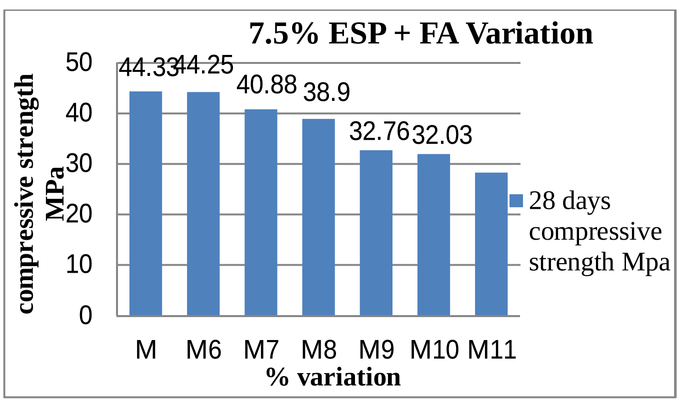

Fig 10: 28 Days Compressive Strength of 7.5% ESP + FA Variation

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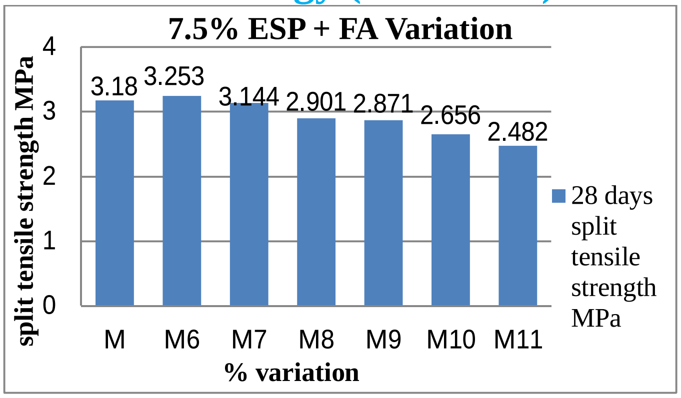

Fig 11: 28 Days Split Tensile Strength of 7.5% ESP + FA Variation

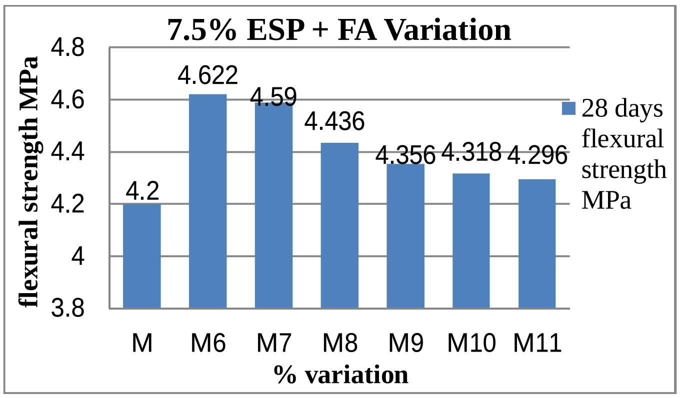

Fig 12: 28 Days Flexural Strength of 7.5% ESP + FA Variation

V. CONCLUSION

Based on the experimental investigation the following conclusion are drawn

A. Compressive strength of egg shell concrete at 7 days is almost similar to control concrete mix (M40) and greater than control mix strength at 28 days.

B. Egg shell concrete gives greater split tensile and flexural strength compared to concrete without egg shell powder.

C. 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.

D. As the percentage of FA increased beyond 5% in optimum egg shell concrete, the split tensile strength is found to be decreased compared to control concrete mix.

E. Optimum flexural strength is obtained at 5% replacement of fly ash to optimum content egg shell power concrete.

F. Combination of ESP and fly ash concrete shows greater Flexural strength for all percentage variation of fly ash with optimum content of ESP.

REFERENCES

[1] Mtallib M. O. A., Rabiu A., (2009), " Effect of Eggshells Ash on the Setting Time of Cement", Nigerian Journal of Technology, Volume 28, Issue 2, PP 29-38.

[2] Moinul Islam Md., Saiful Islam Md., (2010), "Strength Behaviour of Mortar Using Fly Ash as Partial Replacement of Cement", Concrete Research Letters, Issue 3, Volume 1, pp 98 - 106.

[3] 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, Volume 1, Issue 3, PP 362-372.

[4] Marthong C., Agrawal T. P., (2012), "Effect of Fly Ash Additive on Concrete Properties", International Journal of Advanced Engineering Research and Applications, ISSN 2248 - 9622, Issue 4, Volume 2, pp 1986 - 1991.

[5] Sathanantham T., Dinesh N., Ramesh Kumar R., Arunachalam., Chandra Sekar., Gowtham P., (2014), "Partially Replacement of Fine Aggregate by Rice Husk and Eggshell in Concrete", International Journal of Innovative research and studies, ISSN 2319-9725, Volume 3, Issue 1, PP 444-460.

[6] Doh Shu Ing., Chin Siew Choo., (2014), "Eggshell Powder: Potential Filler in Concrete", Malaysian Technical Universities Conference on Engineering

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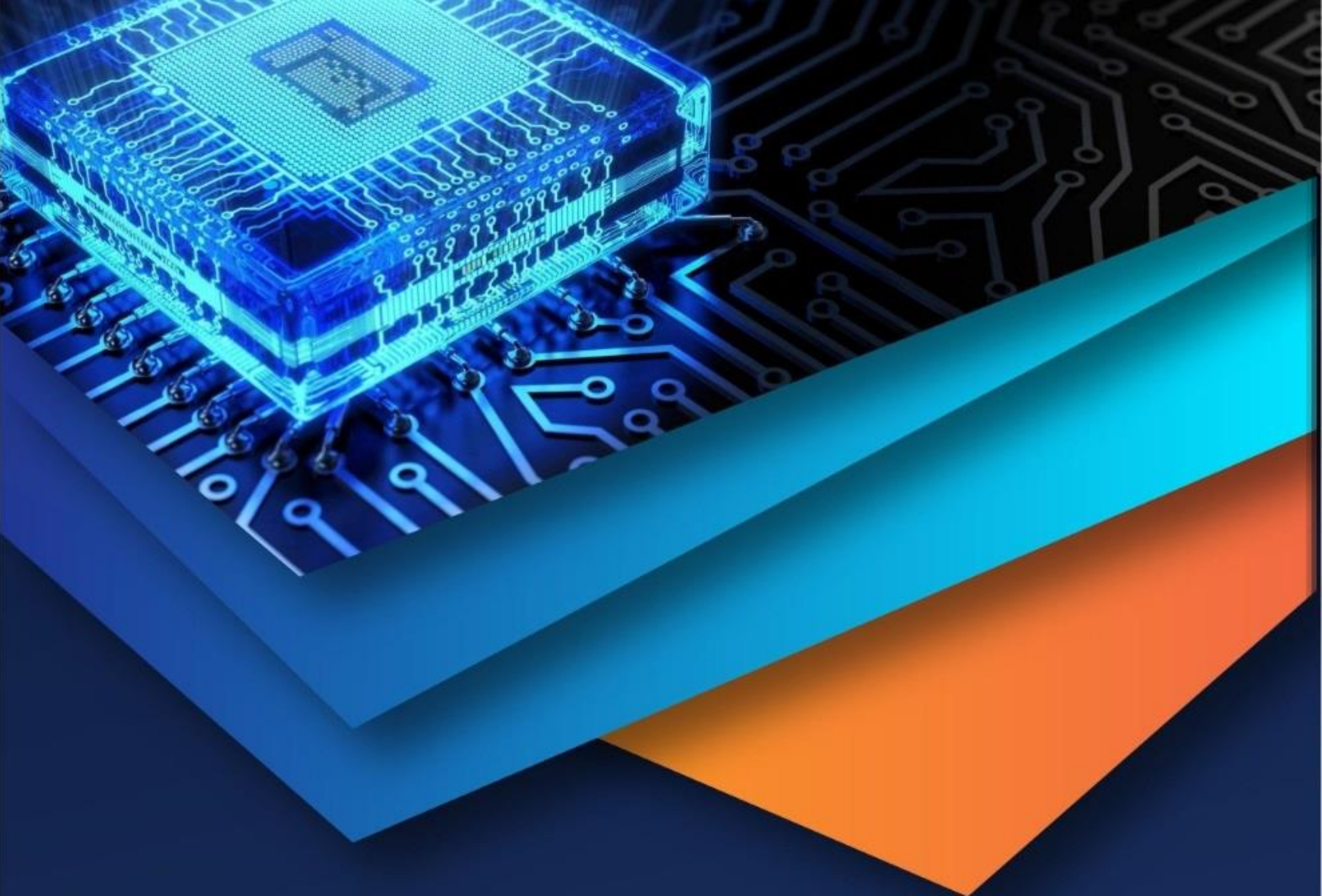
and Technology.
[7] Amarnath Yerramala., (2014), "Properties of Concrete with Eggshell Powder as Cement Replacement", The Indian Concrete Journal, PP 94-102.
[8] TEXT BOOK - Shetty M. S., (2013), "Concrete Technology - Theory and Practical", S.Chand Publishing.
[9] IS 456-2000, Indian Standard, Plain and Reinforced Concrete - code of pratice.
[10] IS 383-1970, Indian Standard Specification for Coarse and Fine Aggregates from Natural Sources for Concrete.
[11] IS 10262-2009, Indian Standard Recommended Guidelines for Concrete Mix Design.



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