IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.301
Volume 3, Issue 1, June 2023

Examining the Potential of Egg Shell Powder as A Cement Replacement in Concrete Experiments

Mr. Pratik Shajirao Dhamale[1], **Mr. Ajinkya Tatyasaheb Dhamale**[2],
Mrs. Harshada Popat Kale[3], **Mrs. Snehal Bhausaheb Godase**[4], **Prof. S. A. Patage**[5]
PG students, Department of Civil Engineering[1,2,3,4]
Associate Professor, Department of CivilEngineering[5]
A. B. M. S. Parishads Anantrao Pawar College of Engineering & Research, Parvati, Pune, India

Abstract: *In current days, a common trend exists to decrease usage of normal sources and recycle waste materials. Concrete plays the key position and a huge quantity of concrete in production. Eggshell waste is massive in global and eggshell is made up with calcium so it is allowed to concrete as partial substitute of Portland cement. The purpose of this work is to observe the performance of waste eggshell powder (ESP) as partial alternative of Portland cement in concrete to improve the strength in addition to reuse of waste eggshell powder. Eggshell powder is used in numerous mixtures which can be replaced at 5% intervals from 0% to 20% through weight of cement in concrete. After curing period of 28 days, it is checked for its compressive strength, split tensile strength, flexural strength test and durability test are taken. These are in comparison with a normal mixture which is 0% of ESP and determine the best combination of replacing the material.*

Keywords: Eggshell powder, Concrete and Cement

I. INTRODUCTION

1.1 General:

Energy plays a crucial role in growth of developing countries like India. In the context of low availability of non-renewable energy resources coupled with the requirements of large quantities of energy for Building materials like cement, the importance of using industrial waste cannot be under estimated. During manufacturing of one tonne of Ordinary Portland Cement we need about 1.1 tonnes of earth resources like limestone, etc. Further during manufacturing of 1 tonne of Ordinary Portland Cement an equal amount of carbon-di-oxide are released into the atmosphere. The carbon-di-oxide emissions act as a silent killer in the environment as various forms. In this Backdrop, the search for cheaper substitute to OPC is a needful one.

1.2. Materials used

1.2.1 Cement

Cement is the important required material for the construction of concrete. Cement is a well-known construction material and has engaged a vital place in construction work. There is a change of cement obtained in market and each type is used under convinced illness due to its singular properties such as Color and arrangement of cement. Although cement creates only about ten percentage of the volume of the various concrete mix, it is the active portion of the compulsory medium and the only systematically controlled component of concrete.

1.2.2 Course Aggregate

Without aggregate, large castings of neat cement paste would essentially self-destruct upon drying. Coarse aggregates are particles greater than 4.75 mm, but generally range between 9.5 mm to 37.5 mm in diameter. They can either be from primary, secondary or recycled.

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.301
Volume 3, Issue 1, June 2023

Fig 1. Coarse Aggregate

1.2.3 Fine Aggregate

The finer aggregate have a better positive effect on the properties of fresh concrete and hardened in high-performance concrete. Thus, fine aggregate are playing an important role in the concrete mixture.

1.2.4 Egg Shell Powder

Eggshell consists of several mutually growing layers of CaCO3, 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 primarily contains calcium, magnesium carbonate (lime) and protein. In many other countries, it is the accepted practice for eggshell to be dried and use as a source of calcium in animal feeds. The quality of lime in eggshell waste is influenced greatly by the extent of exposure to sunlight, raw water and harsh weather conditions. It is the fine grained powder with suitable proportion which is sieved to the required size before use with concrete/mortar.

Eggshell known as a smooth surface that is desirable compared rough eggshells fracture more easily. Most good quality eggshells from commercial layers contain approximately 2.2 grams of calcium in the form of calcium carbonate. About 95% of the dry eggshell is calcium.

Fig.2 Eggshell powder

Eggshell Powder Making Procedure

Fig 3 Processing of eggshell powder

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.301
Volume 3, Issue 1, June 2023

Collect broken eggshell from the local sources. The shells cleaned in normal water and air dried for five days approximately at a temperature range of 25 - 30oC. The shells then hand crushed, grinded and sieved as shown in fig

Processing of eggshell waste

- Washing,
- Air drying,
- Grinding,
- Sieving

1.3 Advantages of Eggshell

- Considerable reduction in alkali-silica and sulfate expansions.
- Meets the most stringent environmental regulations nationwide.
- Ideal for painting in occupied spaces.
- Excellent durability and washable finish.
- Resist mold and mildew on the paint film.
- Saves money; less material required. Meets strict performance and aesthetic requirements.

1.4 Aim

To find the effect of partial replacement of cement with eggshell powder in Concrete

1.5 Objectives

The objectives of this study are as follows

- To study the best mix proportion of the partial replacement of egg shell powder for cement in concrete by the value of strength per weight ratio of sample specimen.
- To study the feasibility of the partial replacement of above material in concrete by determining its compressive strength and split tensile strength. Based on the test results, to suggest most approximate level of adding egg shell powder.
- To study the strength parameters of the egg shell powder mixed specimens and to compare it with conventional specimens.
- To study the behaviour of beam with the percentage variation of eggshell as cement from 0% to 25% at 5% intervals. The Compressive and Flexural strength Properties have studied for each mixes.

1.6 Problem Statements

- In India, waste disposal is one of the factor contributing the environmental problem and increasing dramatically year by year. According to Antara News (2011), In India, the egg consumption of the Indian
- people which is still low. In Indian the per capita egg consumption of the people was recorded at one egg per week while in Indianthe per capita egg consumption was noted at three per day.

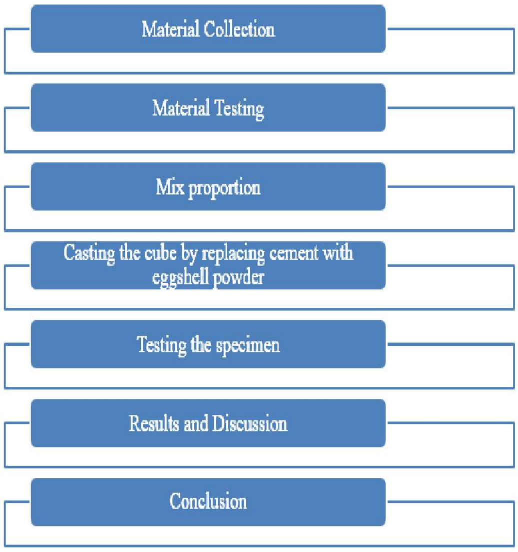
1.7 Scope of Study

An investigation, the effect on the performance of the eggshell powder as in admixturein concrete mixed. In eggshell concrete production, Portland composite cement, coarse aggregate, fine aggregate, water, and eggshell. The experiments will be used to investigate slump test, compressive strength, flexural test, water absorption test and water penetration test respectively. Thus, the amount of eggshell waste can be used as admixture in concrete production. Besides that, it also will decrease the construction cost. Some test and experiments are proposed to be performing to determine the performance concrete strength and eggshell ash. These eggshells must be grinded into fine powder. This test will be tested at 7 day, 14 day and 28 days to get the strength.

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.301
Volume 3, Issue 1, June 2023

II. METHODOLOGY

Flow chart 1: Pictorial representation



2.1 Materials

Constituent materials used in this investigation were procured from local sources. Ordinary Portland cement of C53 grade conforming to both the requirements of IS: 12269 and ASTM C 642-82 type I was used [7, 8]. Broken egg shells collected from the local sources. The shells cleaned in normal water and air dried for five days approximately at a temperature range of 25 - 30oC. The shells then hand crushed, grinded and sieved through Figure 4.1. Processing of eggshell waste (i) washing, (ii) air drying,
(iii) Grinding and (iv) sieving
90 µm. Material passed through 90 µm sieve was used for cement replacement and the retained material was discarded. Figure 1 shows processing of eggshell waste. Fly ash used in this investigation was procured from local suppliers. Chemical composition of the materials is presented in Table 1 along with specific gravities of the materials. Table 1 also shows chemical composition of lime stone [9]. From Table 1 it is clear that the chemical compositions of ESP and limestone are nearly same. Crushed blue granite of maximum size 20 mm was used as coarse aggregate. Well graded river sand finer than 2.36 mm was used as fine aggregate. The specific gravities of coarse and fine aggregates were 2.65 and 2.63 respectively.

2.2 Mixing, Compaction, Specimen Preparation And Curing

The concretes were mixed in a planetary mixer of 100l capacity. 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 mixer drum; (ii) portion of water quantity required for concrete mixes was poured into the mixture drum; (iii) cement and ESP were gently placed into the drum; and (iv) sand was spread over the powder 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 demolded after 24 hours and immersed in normal water for curing until the test age.

2.3 Test Program

Main objective of the present investigation was to study performance of ESP concretes in terms of strength with normal water curing and with no chemical admixtures in the mixes. Performance of the concretes was assessed through: compressive strength, split tensile strength, water absorption and sorption. The specimens were tested for 1, 7 and 28 days. Three specimens were tested for each mix and for each curing age, the mean values were reported.

DOI: 10.48175/IJARSCT-11264

2.4 Compressive Strength Studies

Compressive loading tests on concretes were conducted on a compression testing machine of capacity 2000 kN. For the compressive strength test, a loading rate of 2.5 kN/s was applied as per IS: 516–1959 [10]. The test was conducted on 150mm cube specimens at 1, 7 and 28 days.

2.5 Split Tensile Strength

Split tensile strength test was conducted in accordance with ASTM C496 [11]. Cylinders of 100 x 200 mm size were used for this test. The test specimens were placed between the two platens with two pieces of 3 mm thick and approximately 25 mm wide plywood strips on the top and bottom of the specimens. The split tensile strength was conducted on the same machine on which the compressive strength test was performed

2.6 Permeable Voids And Water Absorption Studies

Absorption study was conducted to understand the relative porosity permeable void space of the concretes, in accordance with ASTM C 642-82 [12]. Absorption and permeable voids tests were conducted on two 150 mm cubes. Saturated surface dry specimens were kept in a hot air oven at 105oC until a constant weight attained. Permeable voids in concretes were evaluated using the following formula.

$$\text{Permeable voids} = (A-B)/V*100$$

Where, A is the weight of surface dried saturated sample after 28 days immersion period. B is the weight of oven dried sample in air. V is the volume of sample.

The specimens removed from the oven were allowed to cool to room temperature. These specimens were then completely immersed in water and weight gain was measured until a constant weight reached. The absorption at 30 min (initial surface absorption) and final absorption (at a point when the difference between two consecutive eights was almost negligible) were reported to

2.7 Sorption Test

The sorption test was conducted on the concretes in order to characterize the rate of moisture migration of water into the concrete pores. Cubes of size 150x150 mm were marked on all four sides at 10 mm intervals to measure the moisture migration. As explained in the water absorption test, the specimens were oven-dried. They were then allowed to cool down to the room temperature. After cooling, the cubes were placed in water on the wedge supports to make sure that only the bottom surface of the specimens in contact with the water. A cotton cloth was covered on the top of the wedge supports to

ensure that the specimens are in contact with the water throughout the test period. Moisture rise in the cubes was measured through weight gain of the specimens at regular intervals. Sorption of the concretes was then calculated using linear regression between the weight gain of the specimen per unit area of the concrete surface and square root of time for the suction periods

Fig 4 Egg Shell Powder

IJARSCT

ISSN (Online) 2581-9429

International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)

International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal

Impact Factor: 7.301

Volume 3, Issue 1, June 2023

Fig 5 Spilt Tensile Strength

Fig 6 Magnesium Sulfet

III. RESULTS AND DISCUSSION

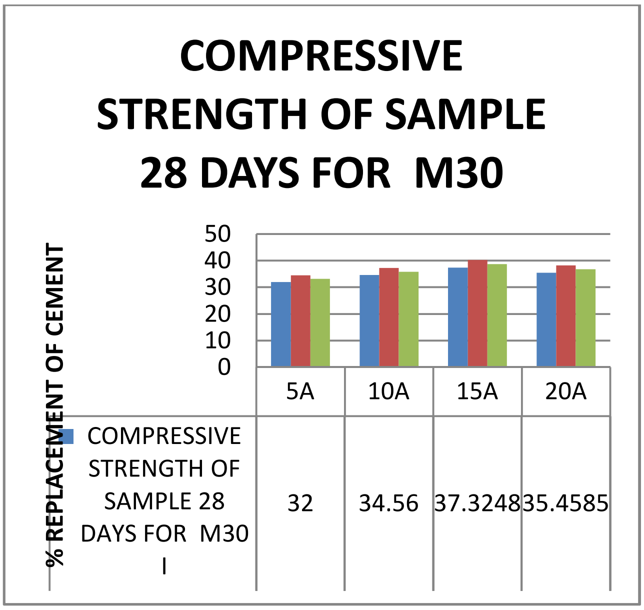
Following results are obtained when compressive tests are taken for 7 days, 14 days and 28 days

Experimental Results:

Table 1 Compressive Strength Of Sample 28 Days For M30

COMPRESSIVE STRENGTH OF SAMPLE 28 DAYS FOR M30			
% REPLACEMENT OF CEMENT	I	II	III
5A	32	34.5	33.2
10A	34.56	37.26	35.856
15A	37.3248	40.2408	38.72448
20A	35.45856	38.22876	36.78826

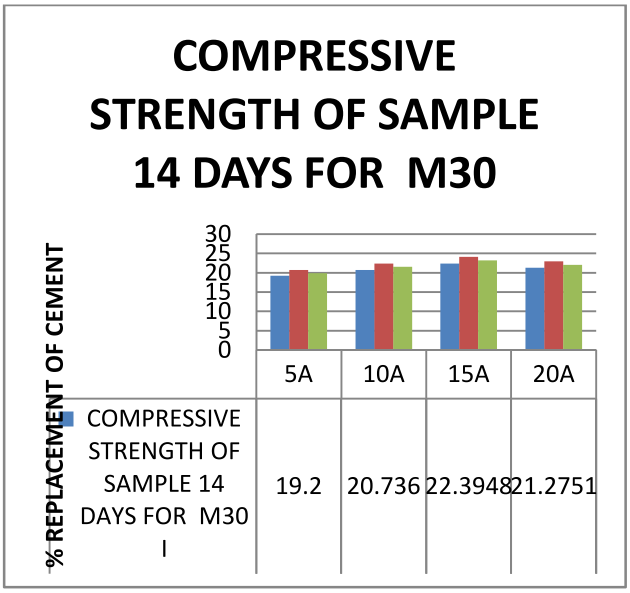
IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.301
Volume 3, Issue 1, June 2023



Graph 1 Compressive Strength of Sample 28 Days for M30

Table 2 Compressive Strength of Sample 14 Days for M30

COMPRESSIVE STRENGTH OF SAMPLE 14 DAYS FOR M30			
% REPLACEMENT OF CEMENT	I	II	III
5A	19.2	20.7	19.92
10A	20.736	22.356	21.5136
15A	22.39488	24.14448	23.23469
20A	21.27514	22.93726	22.07295

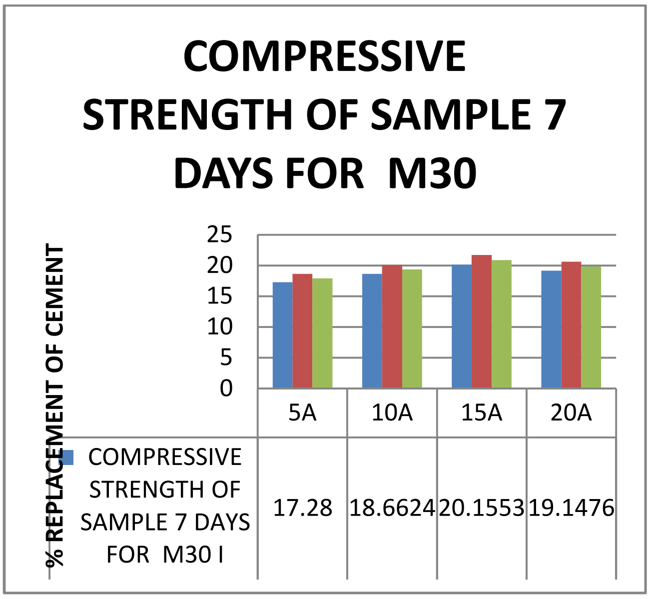


Graph 2 Compressive Strength Of Sample 14 Days For M30

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.301
Volume 3, Issue 1, June 2023

Table 3 Compressive Strength Of Sample 7 Days For M30

COMPRESSIVE STRENGTH OF SAMPLE 7 DAYS FOR M30			
% REPLACEMENT OF CEMENT	I	II	III
5A	17.28	18.63	17.928
10A	18.6624	20.1204	19.36224
15A	20.15539	21.73003	20.91122
20A	19.14762	20.64353	19.86566



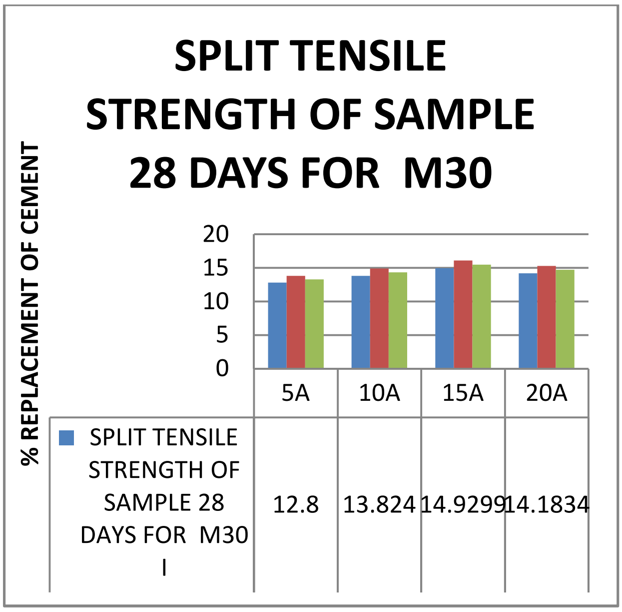
Graph 3 Compressive Strength Of Sample 7days For M30

3.1 Results of Split tensile Test-

Table 4 Split Tensile Strength Of Sample 28 Days For M30

% REPLACEMENT OF CEMENT	I	II	III
5A	12.8	13.8	13.28
10A	13.824	14.904	14.3424
15A	14.92992	16.09632	15.48979
20A	14.18342	15.2915	14.7153

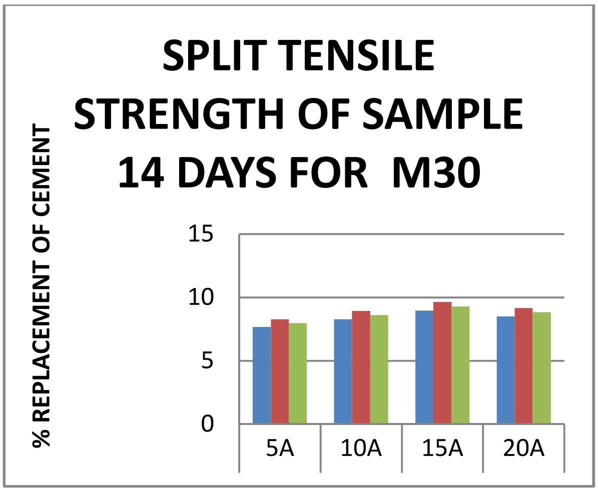
IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.301
Volume 3, Issue 1, June 2023



Graph 4 Split Tensile Strength Of Sample 28 Days For M30

Table 5 Split Tensile Strength Of Sample 14 Days For M30

SPLIT TENSILE STRENGTH OF SAMPLE 14 DAYS FOR M30			
% REPLACEMENT OF CEMENT	I	II	III
5A	7.68	8.28	7.968
10A	8.2944	8.9424	8.60544
15A	8.957952	9.657792	9.293875
20A	8.510054	9.174902	8.829181



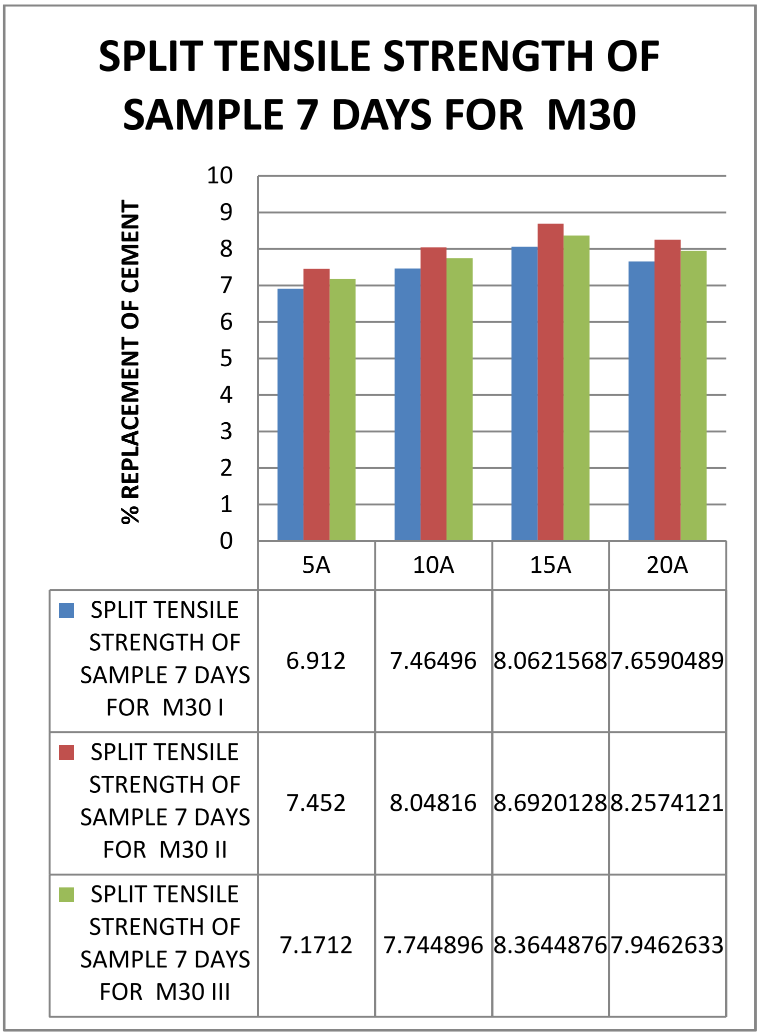
Graph 5 Split Tensile Strength Of Sample 14 Days For M30

Table 6 Split Tensile Strength Of Sample 7days For M30

SPLIT TENSILE STRENGTH OF SAMPLE 7 DAYS FOR M30			
% REPLACEMENT OF CEMENT	I	II	III

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.301
Volume 3, Issue 1, June 2023

5A	6.912	7.452	7.1712
10A	7.46496	8.04816	7.744896
15A	8.062157	8.692013	8.364488
20A	7.659049	8.257412	7.946263



Graph 6 Split Tensile Strength of Sample 7days for M30

IV. CONCLUSION

We conclude that with this experiment the 5% and 15% of egg shell powder with cement is attained Max., compressive strength. So, the egg shell powder is used as a partial replacement with cement in concrete.

Replacement of Egg shell powder and Magnesium sulphate as an admixture replacement in cement yields similar flexural strength as in common place concrete.

Replacement of Egg shell powder and small Magnesium sulphate as an admixture replacement in cement yields higher Split enduringness as compared to completely different compositions.

For 20% replacement is showing same results as of 15%, therefore 15% replacement is optimum percentage for replacement.

V. FUTURE STUDY

Following tests and results are proposed in Future study

- Durability test against attack.
- Validation of work against experimental model for stress-strain curve

REFERENCES

[1]. AmarnathYerramala, .Properties of concrete with eggshell powder as cement replacement., The Indian Concrete Journal October 2014.

[2]. D.Gowsika, .Experimental Investigation of Egg Shell Powder as Partial Replacement with Cement in Concrete., International Journal ofEngineering Trends and Technology (IJETT) . Volume 14 Number 2 . Aug 2014.

[3]. M.O.A. Mtallib and A. Rabiu, .Effects Of Eggshells Ash On The Setting Time Of Cement., Vol 3, 12 January 2011.

[4]. Isaac O. Igwe, Genevive C. Onuegbu,. Studies on Properties of Egg Shell and Fish Bone Powder Filled Polypropylene ., AmericanJournal of Polymer Science 2012, 2(4): 56-61.

[5]. Praveen Kumar R, .Experimental Study on Partial Replacement of Cement with Egg Shell Powder., International journal of innovationsin engineering and technology, Volume 5, ISSN: 2319-1058.

[6]. Dinesh.N, Ramesh Kumar.R, Arunachalam, Chandrasekhar, Gautam.P (2001), .Partial Replacement of Fine Aggregate by Rice husk ashand Eggshell Powder., International Journal of Innovative Science and research, Vol.3, Issue 1, pp.1-17.

[7]. Jayasankar.R, Mahindran.N, Ilangovan.R (2010), .Studies on Concrete Using Fly Ash, Rice Husk Ash and Egg Shell Powder.,International Journal of Civil and Structural Engineering, Vol. 1, Issue No 3, pp. 362-373.

[8]. J.Karthick, R.Jeyanthi, M.Petchiyammal (2012), .Experimental Study on Usage of Egg Shell as Partial Replacement for Sand inConcrete., International Journal of Advanced Research in Education Technology, Vol.1, Issue 1, pp. 7-11.