International Journal of Enhanced Research in Science, Technology & Engineering
ISSN: 2319-7463, Vol. 9 Issue 6, June-2020, Impact Factor: 6.754

Egg Shell as an ingredient of concrete – A Literature Review

Yasmeena Javed[1], Dr. Mool Chand Choudary[2], Dr. Vanita Aggarwal[3]

[1] Research Scholar, Dept. of Civil Engineering MM Engineering College Mullana, India
[2]Assistant Professor, Dept. of Civil Engineering MM Engineering College Mullana, India
[3]Professor and Head, Dept. of Civil Engineering MM Engineering College Mullana, India

ABSTRACT

This paper presents the literature available from the previous experimentations carried out by different researchers from time to time on the utilization of egg shell powder waste in civil engineering applications. The generation of egg shell powder in India is about 1900000 tonnes per annum [23]. Most of the egg shell powder [ESW] is disposed off in landfills which create problems for human beings and environment. Egg shell waste in the form of powder can be used in making concrete either by replacing OPC to some extent as egg shell powder is rich in calcium and its chemical composition is similar to that of limestone or as fine aggregate in concrete. As an aggregate in concrete, ESW help to save energy in manufacturing cement, reducing CO_2 emission, sustainability of aggregate and saving of land by reducing the waste quantity of egg shell waste, resulting to overall economy for future. For any developing country, recycling of any type of waste is an important issue. Thus, egg shell waste can be a substitute ingredient in concrete. The aim of this paper is to review the research paper on use of eggshell waste in concrete.

Keywords:- Fly ash, Egg shell waste, slump, compressive strength, flexural strength, split tensile strength, water absorption and sulphate attack test.

INTRODUCTION

For a developing nation, concrete has been accepted as a construction material for various types of infrastructures such as buildings, bridges, dams and roads etc. For production of concrete about 10-15% OPC cement is used which is a costlier ingredient. About 1.1 tonnes of limestone is used for production of 1 tones of OPC [23] at the same time 1 tones of Co_2 is emitted in atmosphere. The production of OPC depletes the natural resources and utilizes energy and creates atmospheric problems related to human being and environment. Keeping in view, these important issues, construction industry is researching for waste materials for green concrete. The waste materials generally used in concrete are fly ash, Rice husk ash, silica fume and egg shell powder. Which has been accepted in IS code. Egg shell waste has similar proportions like pozzolana and thus well suited for substitution in concrete in place of OPC. Keeping in review the importance of use of egg shell waste in concrete, it can be taken as in ingredients of concrete.

LITERATURE REVIEW

The property wise literature review of the previous researches conducted during the period (2019-2014)by different researches as under.

Fresh properties of concrete

Gajjar R A and Zala J [2018]; studied M25 grade concrete in which GGBS kept constant at 25% and ESP was replaced up to 30% in increment of 5% and found that slump value reduces as the percentage of ESP increases.

Afolayan J O [2017];studied effect of replacement of egg shell in concrete with partial replacement of ESP as 0%,5%,10%,15%,20%,25% and 30% in mix ratio of 1:2:4 with water cement ratio of 0.55.Due to presence of egg shell ash in concrete workability increases as compared to the conventional concrete.

Asman Afizah S N et al; [2017]; carried out comparative study on slump test of M30 grade concrete using RHA and ESP with percentages (2%:8%, 4%:6%, 6%:4%).It was concluded that by the replacement of ESP and RHA concrete is more workable. The optimum percentage of egg shell and rice husk 4% and 6 % respectively.

T.karum Kumar and N. Priyanka [2017]; studied slump test on M30 and M40 grade concrete using copper slag (0%-30%) and egg shell powder(0%-30%) by weight. It was found that the slump cone value increase with increase in copper slag and egg shell powder up to 25% of CS and ESP.

Dhanalakshmi M et al [2015]; studied egg shell (upto12.5%) in concrete with fly ash (0%-30%) as partial replacement in cement. It was found that with increase in percentage of ESP slump value decreases as compared to the control concrete but with addition of fly ash the slump value increases.

Doh Shu Ing [2014]; studied egg shell powder as potential filler in concrete. ESP was used in percentages as 0%, 5%, 10%, 15% and 20%. It was found that optimum percentage of ESP used as filler in concrete is 20% as it shows the slump of 75mm while as 0% shows slump of 70mm.thus ESP can be used in concrete as filler as it do not absorb excess water.

Yerramala A [2014]; studied properties of ESP (5-15)% in concrete as replacement of cement .Slump test was carried out and it was observed that concrete WITH ESP shows low slump value of 5-12mm as compared to conventional concrete.

Hardened properties of concrete
Compressive strength

S Sathvik et al; [2019]; carried out comparative study on M30 grade concrete with partial replacement of egg shell powder in percentages 5%,10%,15%,20% and coconut fiber in concrete. It was found that up to the 10% replacement of egg shell powder the compressive strength increases and beyond 10% it decreases at 7,14 and 28 days of curing. It was concluded that 2.77 percent of egg shell powder with 0.6 % of coconut fiber can giver higher tensile and compressive strength than normal concrete.

Bhuvaneswari M [2018]; studied mechanical properties of concrete by using egg shell with partial replacement of fine aggregates. Egg shell powder used in various percentages viz 0%,5%,10%,15%,20%and 25% .Compressive strength was determined at 7,14 and 28 days with above mentioned percentages. Compressive strength increases up to 20% but at 25% there is decrease in compressive strength.

Gajjar R A and Zala J; [2018]; studied of concrete by utilizing ESP up to 30% with 5% interval and GGBS at 25%. Test were conducted at 7,14 and 28 days with cubes of size 150x150x150 and was concluded that with replacement of 15 % of egg shell and 25 % of GGBS the compressive strength increases and was observed that there is 35% increase in strength than conventional concrete.

Ramathilagam.B.H et al; [2018]: carried out an experimental study on M30 grade of concrete where in cement was partially replaced by egg shell powder at 5% interval from 0%to 25%. It was found that the compressive strength increases with 10% replacement of egg shell but with further increases of egg shell powder strength decreases. Strength increment was 13.4% higher than that of the control concrete.

Sehgal S and Kaur A [2018]; studied M25 grade of concrete where in cement was replaced by various percentages of egg shell powder as 2.5%,5%,7.5%and 10% with silica fumes @ 15%. It was found that the compressive strength increases during initial replacements but after further addition it decreases. Compressive strength of concrete increases with EGP replacement of 2.5% with silica fumes. But on increases further percentage of silica fumes strength decreases. There is an increase of nearly 25% of strengths compared to the nominal mix. Thus the optimum quantity is 2.5% for replacement of cement by egg shell powder with silica fumes.

Anish G and Pavani A [2017]; carried out experimental study on concrete by investigating the effects of ESP and fly ash. ESP was taken in different percentages 0%, 7%, 14%, 21%, 28% by weight where in tests were conducted at 7 and 28 days on cubes of concrete. The cubes of 150X150X150 were tested for compressive strength at 7 and 28 days of curing. It was observed that compressive strength at 7 and 28 days of curing age was higher than that of conventional concrete for 21

percent of fly ash and ESP but with replacement of fly ash and ESP greater than 28% it was found that weight of cubes decreases up to 7% per cube.

Bandhavya G.B et al; [2017]: carried out an experimental study on partial replacement of cement with egg shell powder in concrete. The percentage of egg shell powder used were 0%, 5%, 10% and 15% of weight of cement. At 3 days the compressive strength of conventional concrete observed was less than that of concrete with egg shell powder. With further increase in percentage of egg shell powder there is decrease in compressive strength.

Babu A et al; [2017]; carried out experimental study on M 20 grade concrete by replacing cement with ESP @ 5%,10%,15%,20%,25% and reported that replacement of cement by 5% with ESP provide higher strength than the control concrete after that strength decreases

Kumar A [2017]; carried out study on concrete by partial replacement of cement with egg shell powder .Cement was partially replaced with egg shell powder with percentage of 5%,10% and 15% by weight of cement. It was noted that the compressive strength of concrete increases up to 10% at curing ages of 7,28days but there in decrease with replacement of 15%.

Nivedhitha M and Sivarija M[2017]; carried out an experimental study on the partial replacement of cement with egg shell powder and coconut shell powder with percentages of 2.5%,5% and 15%.The compressive strength of concrete increases up to the 5% replacement but decreases at 15% replacement.

Parkash A and Singh R[2017]; carried out experimental study on M20 grade concrete where in cement was replaced by egg shell powder with percentages of 6%,12%,18% and 24%.Cubes of concrete 150150150mm were tested at 7 and 28 days. It was found that compressive strength increases up to 12% replacement at 7 and 28 days but with further addition of egg shell powder the compressive strength decreases.

Patel JS et al; [2017]; studied the existing literature on the use of fly ash, RHA and ESP in concrete and commented that compressive strength of concrete gives good strength with RHA and ESP can be used as cement replacement up to 10% by weight of cement.

Bhaskaran H et al; [2016]; carried out an experimental study on strength properties of concrete with partial replacement of cement with egg shell powder in which the different percentages of egg shell powder were used viz 5%,10% and 15%.Compressive strength for specimen was obtained at 7 and 28 days which was higher than control concrete for 5% egg shell powder at 7 days of curing ages. Egg shell powder replacement greater than 10% had lower strength than control concrete.

Dhanalakshmi M et al; [2015]; carried out an experimental study on M40 concrete with fly ash and egg shell replacement in various percentages where fly ash is added from 0% to 30% at an interval of 5% and egg shell powder up to 12.5% at interval of 2.5% replacement. It was found that compressive strength of egg shell concrete at 7 days is same for conventional concrete but greater at 28 days.

Mastan S A and Kumar VRP[2015]; studied partial replacement of fine aggregate with egg shell powder in different percentages as 7%,14%,21%,28% 35% and class F fly ash (10%,20%,30%,40% and 50%) by weight. For 21% fly ash and egg shell powder compressive strength was higher than that of conventional concert at 7 and 28 days of curing ages. It was found that with replacement of 28% of fly ash and 21% of egg shell powder compressive strength decreases also there is decrease in weight of cubes up to 7% per cube.

Gowsika D et al; [2014]; studied M20 grade concrete at 28 days by replacing cement with egg shell powder with percentages of 5%,10%,15%,20%,25% 30% by weight of cement with admixtures saw dust ash, Fly ash and micro silica to enhance the strength of concrete. It was found that replacement of 20% of Microsilica and 5% of egg shell powder can be used without any reduction in compressive strength as compared to conventional concrete.

Flexural Strength

Bhuvaneswari M [2018]; studied mechanical properties of concrete by using egg shell with partial replacement of fine aggregates. Flexural strength increases for 0%, 5%,10%,15%and 20% of egg shell powder when compared to conventional concrete but slightly decreases at 25% of egg shell powder in concrete.

Ramathilagam.B.H et al; [2018]; carried out an experimental study on M30 grade of concrete where in cement was partially replaced by egg shell powder at 5% interval from 0%to 25%.it was found that the flexural strength of concrete increases up to 10% replacement of egg shell powder at 28days but after that the strength decreases.

Sehgal S and Kaur A[2018]; studied M25 grade of concrete where in cement was replaced by various percentages of egg shell powder as 2.5%,5%,7.5%and 10% with silica fumes @ 15%. It was found that flexural strength increases with esp replacement at 2.5% but it decreases with further replacement.

Anish G and Pavani A [2017]; carried out experimental investigation on concrete with replacement of ESP and fly ash at various percentages of ESP (0%, 7%, 14%, 21%, 28%). Beams to flexural strength were checked at 7 and 28 days and it was found that beyond 14% of ESP and fly ash flexural strength decreases as compared to the conventional concrete.

Nivedhitha M et al; [2017]; carried out an experimental study on the partial replacement of cement with egg shell powder and coconut shell powder with percentages of 2.5%,5% and 15%. The flexural strength increases up to the 15% replacement of cement by egg shell powder.

Dhanalakshmi M et al; [2015]; carried out an experimental study on M40 concrete with fly ash and egg shell replacement in various percentages where fly ash is added from 0% to 30% at an interval of 5% and egg shell powder up to 12.5% at interval of 2.5% replacement. It was found that maximum flexural strength ids obtained at optimum percentage of egg shell that is 7.5% with addition of 5% of fly ash.

D.Gowsika et al; [2014]; studied M20 grade concrete at 28 days by replacing cement with egg shell powder with percentages of 5%,10%,15%,20%,25% 30% by weight of cement with admixtures saw dust ash, Fly ash and micro silica to enhance the strength of concrete. It was found that with the replacement of 5% of egg shell and 10% of Microsilica same flexural strength is obtained as that of conventional concrete.

SPLIT TENSILE STRENGTH

S Sathvik et al; [2019]; studied M 30 grade concrete with partial replacement of coconut fiber and ESP at 5%,10%,15% and 20%. It was observed that the split tensile strength at 7, 14 and 28 days increases up to certain percent of egg shell powder but it decreases with further addition of egg shell powder.

Sehgal S and kaur A [2018];studied split tensile strength for M25 grade concrete for which cement was replaced with egg shell powder by 2.5%,5%,7.5%and 10% and 15% of silica fumes. It was found that the split tensile strength increases with 15% of silica fumes but wit addition of egg shell powder it gets decreased at 7,14 and 28 days.

Anish G and Pavani A [2017]; carried out comparative study on split tensile strength of concrete with ESP at 0%,7%,14%,21%,28% by weight and fly ash. IT was concluded that the strength of cylinders at 7 and 28 days of curing was comparable up to 35% of sly ash and ESP replacement with normal concrete.

Bandhavya G.B et al; [2017]; carried out an experimental study on partial replacement of cement with egg shell powder in concrete. Split tensile strength is lower at 10% and 15% of egg shell powder in concrete compared to conventional concrete.

Babu A et al; [2017]: carried out study for M20 grade of concrete by replacement of (5-25) % of ESP and it was concluded that the split tensile strength increase up to 20% of ESP in concrete than that of normal concrete and the increase is about 5.16%.

Anand Parkash et al; [2017]; CARRIED OUT comparative study on partial replacement of cement with various percentages of egg shell powder viz. 6%, 12%, 18% and 24%.it was observed that the split tensile strength of concrete increases up to 6 % of egg shell powder at 7 and 28 days of curing but with further addition of egg shell powder split tensile strength decreases

Bhaskaran H et al; [2016]; carried out an experimental study on concrete with partial replacement of cement with egg shell powder in which different percentages of egg shell powder were used viz 5%,10% and 15%.Egg shell concrete gives greater split tensile when compared to concrete without egg shell powder.

Dhanalakshmi M et al; [2015]; carried out an experimental study on M40 concrete with fly ash and egg shell replacement in various percentages where fly ash is added from 0% to 30% at an interval of 5% and egg shell powder up to 12.5% at interval of 2.5% replacement. It was found that by adding various percentages of fly ash with optimum percentages of egg shell powder that is 7.5%split tensile decreases after addition of 5%of fly ash.

Mastan and Kumar VRP [2015]; carried out an experimental study on partial replacement of fine aggregate with addition of egg shell powder in various percentages as 7%,14%,21%,28% ,35% and class F fly ash (10%,20%,30%,40% and 50%) by weight. It was found that for M30 grade of concrete there in increase in split tensile strength at 3.5% of egg shell and fly ash but with increase in percentages it decreases at 7 and 28 days of curing.

Gowsika D et al; [2014]; studied M20 grade concrete at 28 days by replacing cement with egg shell powder with percentages of 5%,10%,15%,20%,25% 30% by weight of cement with admixtures saw dust ash, Fly ash and micro silica to enhance the strength of concrete. It was obtained that with the replacement of 10% of micro silica and 5% of egg shell powder concrete yields higher split tensile strength as compared to other compositions

Durability properties of concrete
Water Absorption

Gajjar R A and Zala J [2018]; studied the utilization of ESP and GGBS in M25 grade concrete for sulphate attack after 28 days using 5% sodium sulphate and 5 % magnesium sulphate. The specimen were immersed up to 90 days and found that weight increases in all the mixes and reduces as compared to its initial weight of the cube of size 150mm.

Deepika T et al; [2017] studied durability properties of concrete using20% of raw egg shell powder and 30 % of incineration egg shell powder in cement as replacement. It was obtained from various durability tests like water absorption test that the durability increases with the use of egg shell powder in concrete

Doh Si and Chin S C Ing [2014]; carried out experimental study on water absorption of concrete using ESP from 0% to 25% at intervals of 5%.It was determined that using egg shell powder in concrete as a filler can show reduction in water absorption up to 82.3% as that of normal concrete.

Yerramala A [2014]; studied concrete properties using ESP (5-15) % as replacement in cement. It was concluded that during initial 30min the absorption values were less than the limits which are associated with good concrete. For 15% of fly ash and 15% of egg shell powder maximum absorption is 1.87%.

Sulphate attack

Deepika T et al; [2017] studied durability properties of concrete using20% of raw egg shell powder and 30 % of incineration egg shell powder in cement as replacement. It was obtained from various durability test like sulphate resistance test, salt resistance test, acid resistance test, water absorption test that the durability increases with the use of egg shell powder in concrete

CONCLUSION

From the study of literature review, the following initial conclusion can be drawn

- The replacement of OPC by egg shell waste maintains the workability of concrete.
- By using of egg shell waste as partial replacement of OPC in concrete the compressive strength increase with age of curing and is more up to 10% of replacement levels of egg shell waste.
- Flexural strength increases with the age and in maximum at 10% level of egg shell waste.
- Split tensile strength increases with age and is maximum at 10% replacement of egg shell waste and the results have similar trends for compressive strength.

CONFLICT OF INTEREST

There is no conflict of interest.

REFERENCES

[1] Babu A, Ramprasanth A A, Shanmugavadivu U A(2017), "Experiment Investigation on Partial Replacement of Eggshell Powder In Conventional Concrete" *International journal of ChemTech Research* ,ISSN:0974-4290,Vol.10 NO. 8,pp 453-457.
[2] Gajjar R A and Zala J (2018), "UTILIZATION OF EGG SHELL POWDER & GGBS IN CONCRETE" *IJARIIE*-ISSN (O)-2395-4396,Vol-4 Issue-3.
[3] Afolayan J O [2017], "Experimental Investigation of the Effect of Partial Replacement of Cement with Eggshell Ash on the Rheological Properties of Concrete" *International Journal of Engineering and Applied Sciences (IJEAS),*ISSN: 2394-3661, Volume-4, Issue-12.
[4] Asman Afizah S N Salinah Dullah , Janice Lynn Ayog, Adriana Amaludin1, Hassanel Amaludin, C. H. Lim , and Aslina Baharum [2017], **"**Mechanical Properties of Concrete Using Eggshell Ash and Rice Husk Ash As Partial Replacement Of Cement**"** *MATEC Web of Conferences* ***103***, 01002 (2017) DOI: 10.1051/matecconf/ 201710301002 *ISCEE 2016*
[5] T.karum Kumar and N. Priyanka [2017], **"**Experimental Study On Properties Of Strength And Durability Of Concrete By Partial Replacement Of Fine Aggregate With Copper Slag And Cement With Egg Shell Powder For M30 And M40 Grade Concrete" *International Journal Of Professional Engineering Studies* Volume Viii /Issue 4
[6] Dhanalakshmi M, Dr Sowmya N J, Dr Chandrashekar A(2015), "A Comparative Study on Egg Shell Concrete with Prtial Replacement of Cement by Fly Ash, *International Journal for Research In Applied Science & Engineering Technology (IJRASET),*ISSN: 2321-9653, Volume -3 Issue-2.
[7] DOH Shu Ing, CHIN Siew Choo(2014] Eggshell Powder: Potential Filler in Concrete *8th MUCET 2014 Melaka, Malaysia*.
[8] Y Amarnath Yarmala (2014), Properties of concrete with eggshell powder as cement replacement, *Indian concrete journal* 88(10):94-105.
[9] S Sathvik , A Edwin, Basnett Anmol, Sharma Prerna, Carmicheal (2019), "Experiment of Partial Replacement of Egg Shell Powder and Coconut Fiber in Concrete" *International Journal of Innovative Technology and Exploring Engineering (IJITEE)*, ISSN: 2278-3075, Volume-8, Issue- 6S4.
[10] Bhubaneswar M (2018), A study on Mechanical Properties of Concrete by using Egg Shells with Partial Replacement of Fine Aggregate, *International Journal of Scientific Research and Engineering Trends (IJSRET),* ISSN(online):2395-566X, Vol 04, Issue-02.
[11] Ramathilagam.B.H, Aravinth.K, Ananth.C, Arisivamani.L (2018), International Journal of Engineering Science and Computing (IJESC), Volume 8 Issue NO. 4.
[12] Seghal S and Kaur Amardeep(2018),"Study of Effect of Egg Shell Powder and Silica Fumes on Properties of Concrete" *International Journal of Advanced Research in Science, Engineering And Technology*, ISSN:2350-0328,Vol.5,Issue -11.
[13] Anish G and Pavani A (2017), "An Experimental Investigation on Effect of Fly Ash on Egg Shell Concrete" *International Journal of Trend in Scientific Research and Development*, Volume 1(4), ISSN: 2456-6470.
[14] G.B Bandhavya , K Sandeep, G.B Bindhushree (2016), An Experimental study on partial Replacement Of Cement With Egg Shell Powder in concrete, *International Research Journal of Engineering and Technology (IRJET)*, Volume: 04, Issue: 06 | June -2017, e-ISSN: 2395 -0056 , p-ISSN: 2395-0072.
[15] Kumar Atul (2017), Egg Shell Powder Partial Replaced With Cement Concrete, *International Journal of Science and Research (IJSR)* ISSN: 2319-7064,Voume 7 Issue 9.
[16] Nivedhitha M , Dr. Sivaraja M (2017), Experimental Study on Partial Replacement of Cement with Coconut Shell Powder and Egg Shell Powder, *International Journal of Innovative Research in Science, Engineering and Technology*, Vol. 6, Issue 5.
[17] Parkash Anand and Yadav Kumar Pardeep (2017), A Review Study Of Egg Shell Powder As a Cement Replacing Material In Concrete, *International Journal of Latest Research In Engineering and Computing (IJLREC),* Volume 05, Issue 04 , ISSN:2347-6540, Page No. 6-9.
[18] Patel J.S, Dr K.B. Parikh,Prof. A.R.Darji (2017), "Study on Concrete Using Fly Ash, Rice Husk Ash And Egg Shell Powder" *International Journal for Research In Applied Science & Engineering Technology (IJRASET)*,ISSN:2321-9653, Volume 5 Issue 2.
[19] Bhaskaran Harsha, John Linet, P. M Neethu and Sebastian Traisy (2016), A study on egg shell concrete , *International Journal of Engineering Research & Technology (IJERT)*,ISSN: 2278-0181, Vol 04, Issue 13.
[20] Mastan Akhil Shaik and Kumar Prasath V.R(2015), Experimental Study on Concrete by Partial Replacement of Fine Aggregates with Fly Ash and Egg Shell Powder, *International Journal & Magazine of Engineering Technology*, Management and Research, ISSN No: 2348-4845, Volume 2, Issue no. 2.
[21] Gowsika D, Sarankokila S, Sargunan k (2014), Experimental Investigation of Egg Shell Powder as Partial Replacement with Cement in Concrete, *International Journal of Engineering Trends and Technology (IJETT)* – Volume 14 Number 2 –
[22] T. Deepika N.Gobinath, M.Tigerprabakaran[2017] Durability Study On Concrete With
[23] Egg Shell Powder *International Journal of Advanced Science and Engineering Research* ISSN: 2455-9288, Volume: 2, Issue: 2, June 2017
[24] www.wikipedia.com.