International Journal of Research in Engineering, Science and Management
Volume-3, Issue-2, February-2020
www.ijresm.com | ISSN (Online): 2581-5792

Study of Partial Replacement of Eggshell Powder in Ferrocement

Akshay B. Meshram[1], V. A. Patil[2], Somanagouda Takkalaki[3]
[1]*P.G. Student, Dept. of Civil Engineering, B. R. Harne College of Engineering and Technology, Mumbai, India*
[2]*Professor & Principal, Dept. of Civil Engineering, B. R. Harne College of Engg. and Tech., Mumbai, India*
[3]*Assistant Professor, Dept. of Civil Engineering, B. R. Harne College of Engg. and Technology, Mumbai, India*

***Abstract*: The release of carbon dioxide gas during manufacturing of cement causes the environment pollution and global warming. This is all due to combustion of fossil fuel. On other hand there is also waste from food industries and hatchers mainly calcium rich egg shell. The content of egg shell is mainly of calcium with nearly same composition as limestone which is also main constituent cementing materials. Egg shell waste can be used as fertilizers in urea, and is also deposited as landfills. Eggshell waste in landfills in excess creates problems associated with human health and environment when it comes in contact with human immune system. The egg shell in powder form, which is rich in calcium content, can be used as replacement of cement as it consists of calcium which make it as a cementing material. This present study describes the feasibility of ESP based ferrocement. The present study carries the mechanical properties such as compression test, flexural strength test, and split tensile strength test and also durability properties like water absorption test and sorptivity test and results are compared with normal self-compacting ferrocement.**

***Keywords*: ESP (Eggshell powder), OPC (Ordinary Portland Cement), RHA (Rice Husk Ash), SCEM (Self Compacting Egg Shell Mortar).**

1. Introduction

Concrete and mortar are tremendously used by developing countries to develop their infrastructure and India is one of such country in which government is utilizing most of its resources to develop the infrastructure of the Country. At present, for various reasons, the construction industry is not sustainable. Firstly, cement is the major component for the production of concrete and mortar, for the manufacturing of cement lot of energy is required. Secondly, it consumes huge amount of natural resources due to which no introductory material will be left for the future generation hence we have to utilize some waste material which can be easily used in the production of the cement mortar without changing the properties of the mortar. Lastly at the present time we need structures which are durable and can carry large amount of load without undergo successive deflection and cracking. To achieve this, we need concrete with high mechanical properties like compressive strength, flexural strength and split tensile strength. To enhance the mechanical and durability properties we have to use other supplementary cementing materials.

A. Eggshell

Eggshell is basically a waste material which is produced from the egg breaking plants, bakeries, and restaurant and also from other sources which effect the environment and creates environmental problems like pollution. The chemical composition of eggshell shows that it can be used in the concrete by converting it in the powdered form. The composition of the eggshell is such that it contains calcium oxide (CaO) in a large extent which resembles with the composition of the cement as cement is also very rich in the calcium oxide. According to a study done by the NECC (National Egg Coordination Committee) eggshell waste generation in India is 190,000 tonnes per annum. Eggshell waste in landfills attracts vermin due to attached membrane and causes problems associated with human health and environment. Hence we have to find out other the alternatives through which, we can easily dispose off eggshell waste without affecting the environment and human health.

Table 1
Chemical Composition of ESP

Parameters	ESP Results
Sp. Gravity	2.32
CaO	51.57 %
SiO_2	0.35 %
Al_2O_3	0.40 %
Fe_2O_3	0.03 %
LOI	45.1 %

B. Ferro cement

Ferro cement is a type of thin walled reinforced concrete construction, where usually a hydraulic cement mortar is reinforced with layers of continuous and relatively small diameter wire meshes. The mesh may be made of metallic or other suitable material. It is an ideal material of construction, as it gives maximum strength output with the minimum energy input. Due to large amount of fine wire reinforcement, which is continuous and spread in both directions, it has much higher area of contact with cement mortar of very high strength.
Application of Ferro cement:

- Residential and public buildings
- Agriculture Structures
- Transportation Structures

Advantages of Ferrocement:

- Basic raw materials are available
- Fabricated into any desired shape
- Low skilled labour
- Ease of construction
- Low construction material cost.

2. Objectives and Methodology

A. Objectives

Objective of the work is to investigate the mechanical and durability properties of the cement mortar by partially replacing cement with the egg shell powder. In order to achieve the objectives, various trial mixes of cement mortar were conducted by varying the percentage the egg shell powder as a partial replacement of cement in cement mortar. The results of these tests were compared with that of the normal mortar mixture. Scope of the present study is to limit the use of cement by replacing it partially with the different percentages of the egg shell powder in cement mortar.

For Characterization of self-compacting ferrocement with partial replacement of cement by Eggshell powder, experimental work would be carried out to achieve following objective:

- To study the effect of cement mortar with ordinary Portland cement of grade 53 with partially inclusion of egg shell powder.
- To find the effect of ESP on compressive strength, split tensile strength, flexural strength, water absorption, and water sorption of cement mortar self-compacting ferrocement with partial replacement of cement by Eggshell powder.
- To study the workability properties of fresh self-compacting ferrocement.

B. Materials Used

- *Cement:* Ordinary Portland cement of 53 grade with a specific gravity of 3.14 is used.
- *Sand:* River sand is used with testing done by sieve analysis, the fine aggregates passing through 2.36 mm sieve is used.
- *Water*-cement ratio: Water-cement ratio was kept 0.4 in the entire research work.
- *Eggshell Powder:* The shells then hand crushed, grained in a grinding machine for obtaining a very fine powder then sieved through 90 µm Indian standard sieves.
- *Wire mesh:* The steel wire mesh of 4mm diameter is used in ferrocement.
- *Rice husk ash:* The RHA with fineness of 90 µm is used. As it contains large amount of SiO2 which makes it as cementitious material.

C. Test Performed

Mix design was maintained as 1:2 for entire research work as per ACI 549R-97 (1997). As per requirement, the replacement of ESP and RHA was done by 5%, 10%, 15% and the results were compared with conventional ferrocement i.e., 0% replacement of any materials. The mechanical properties of ferrocement like compressive strength, split tensile strength, flexural strength were carried out and durability properties like water absorption test and water sorptivity test were carried out. The results were taken after curing period of 7, 14, 28 days.

3. Testing's and Results

A. Test for Compressive Strength

The compressive strength of concrete is one of the most important properties of concrete in most of it structural application.

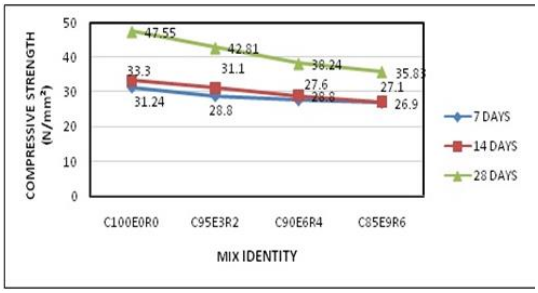

Fig. 1. Comparison between results of compressive strength (horizontal)

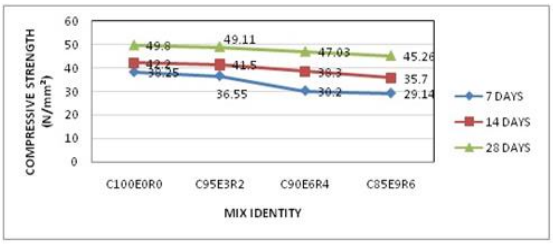

Fig. 2. Comparison between results of compressive strength (vertical)

By comparing the results of compressive strength of 28 days of horizontally aligned wire mesh or vertically aligned wire mesh, it is found out that vertically aligned cubes gives higher strength than that of horizontally aligned wire mesh.

B. Test for split tensile strength

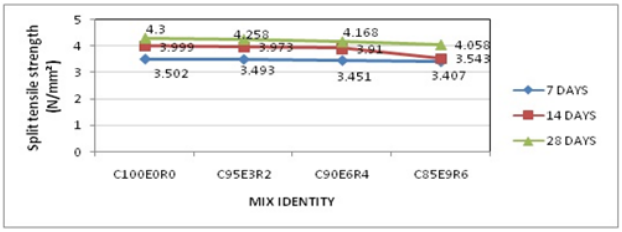

Fig. 3. Comparison between results of Split Tensile Strength

C. Test for flexural strength

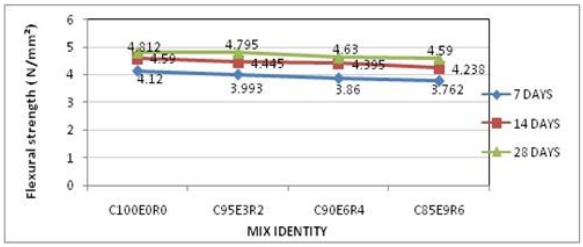

Fig. 4. Comparison between results of flexural Strength

D. Test for water absorption

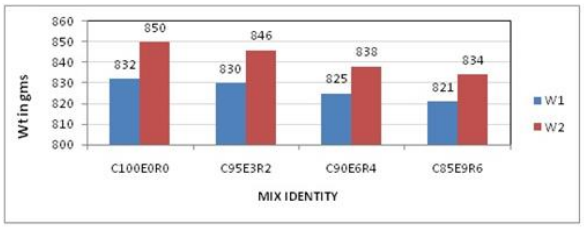

Fig. 5. Comparison between results of water absorption test

E. Test for water sorptivity

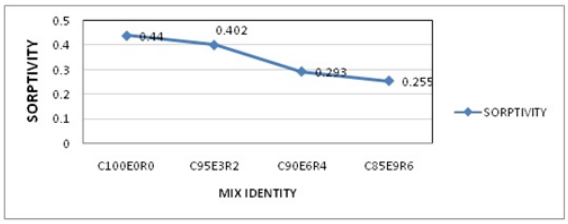

Fig. 6. Comparison between results of water sorptivity test

4. Conclusion

- It is concluded that the ferrocement cubes having a vertical aligned wire mesh shows higher strength as compared to horizontally aligned wire mesh ferrocement.
- Replacement of 3% Egg shell powder + 2% RHA in cement gives 5% reduction in Split Tensile strength than controlled self-compacting ferrocement at curing period of 28 days.
- Egg shell powder obtained from industrial wastes was added in various ratios with addition of RHA for cement replacement and it was found that replacement of cement by 3% Egg shell powder + 2 % RHA gives reduction of almost 2% in compressive strength properties of conventional self-compacting ferrocement in case of vertically aligned wire mesh in ferrocement.
- It was observed that after 28 days of curing period, the compressive strength was 48.3 N/mm² and after heating the compressive strength for the same specimen was reduced to 46.52 N/mm².

References

[1] Maxwell T. Hincke, Yves Nys, Joel Gautron, "The eggshell: structure, composition and mineralization" Frontiers in Bioscience 17, 1266-1280, January 1, 2012.
[2] Soumyan K, Aswathi Viswanath, "Experimental Study to Check the Effect of Egg Shell Powder and Rice Husk Ash on the Property of Concrete", International Journal of Engineering Research & Technology.
[3] D. Gowsika, S. Sarankokila., K. Sargunan, "Experimental Investigation of Egg Shell Powder as Partial Replacement with Cement in Concrete", International journal of engineering Trends and Technology, Volume 14, No. 2(2014).
[4] Bandhavya G, Sandeep K, "An Experimental Study On Partial Replacement of Cement with Egg Shell Powder in Concrete", International Research Journal of Engineering and Technology (IRJET), Volume 4 Issue 6 June 2017.
[5] Gaikwad M. J., Shah S. N., Patil S. V., Dhonde H. B, "Development of self- compacting mortar for prefab ferrocement", Proceeding National Conference On Ferrocement, Ferocement Society of India, 2015.
[6] P. Pliya, D. Cree., "Limestone derived eggshell Powder as a replacement in Portland cement mortar", Construction and Building Material, 95, 2015,
[7] Harsha Bhaskaran, Niya Eldhose, "Study on Egg Shell Concrete", International Journal of Engineering Research & Technology.
[8] Amarnath Yerramala, "Properties of concrete with eggshell powder as cement replacement", The Indian Concrete Journal October 2014, Pg. No. 94-102.
[9] P. Srichandana, Kamanuru Naga Deepika, "Experiment Study on Effects of Ferro cement", International Journal & Magazine of Engineering, Technology, Management and Research, Volume 2015, No. 3, pp. 379-382. March 2015.
[10] M.Amala, M. Neelamegam, "Experimental Study of Flexure and Impact on Ferrocement Slabs", IOSR Journal of Mechanical and Civil Engineering, pp. 62-66.
[11] Asadullah, Ansari Abu Usama, Vajed Shaikh, "An Experimental Study on Ferrocement", IOSR Journal of Engineering, pp. 50-55.
[12] Nagesh M. Kulkarni, D. G. Gaidhankar, "Analysis and Design of Ferrocement Panels an Experimental Study", International Journal of Inventive Engineering and Sciences (IJIES), Volume 1, Issue 5, April 2013.