EGGSHELL FOR BRICK: A SUSTAINABLE AND ECO-FRIENDLY BUILDING MATERIAL

Sneha C Nayak, UG Student, JSS Science and Technology University, SJCE in Mysuru & INDIA, **snehanayak77483@gmail.com**

Parinitha T Niranjan, Assistant Professor, JSS Science and Technology University, SJCE in Mysuru & INDIA, **parinitha@sjce.ac.in**

Dr. B. M. Krishna, Associate professor, JSS Science and Technology University, SJCE in Mysuru & INDIA, **bmkrishna_71@sjce.ac.in**

Chethan S, UG Student, JSS Science and Technology University, SJCE in Mysuru & INDIA, **chethancheetah128@gmail.com**

Mahadeva Swamy T M, UG Student, JSS Science and Technology University, SJCE in Mysuru & INDIA, **maaduswamy2002@gmail.com**

Abstract **Concrete brick, a ubiquitous construction material, finds use in diverse applications from structural walls to decorative pavers. It has a significant environmental impact due to their high embodied energy and carbon footprint. Eggshells are a byproduct of food production that are discarded from households and businesses, which has a negative environmental impact on the area around us. The eggshell is an important structure for two reasons. Firstly, it forms an embryonic chamber for the developing chick, providing mechanical protection and a controlled gas exchange medium. Secondly it is a container for the market egg, providing protection of the contents and a unique package for a valuable food. This project explores the potential of using eggshells as a partial replacement for cement in concrete bricks, aiming to develop a more sustainable and eco-friendly construction material.**

This project investigates the feasibility of using eggshells as a partial cement replacement in concrete bricks. Eggshells are collected, cleaned, dried, and ground into a fine powder. Different proportions of eggshell powder are then mixed with cement, sand, and water to create concrete mixtures. The resulting bricks are tested for mechanical properties like compressive strength. In the current study, egg shell powder is used in place of cement at weights of 7%, 14%, and 21% to examine the compressive strength of concrete cubes. Egg shell powder cubes' compressive strength has been tested after 7, 14, and 28 days. The average compressive strength of a concrete cube containing 14% egg shell powder, according to the data, is 35.2 N/mm^2.such that the optimum mixing proportion is to replace 14% of the cement by weight with egg shell powder. Thus, that the cost is reduced by 3.9% in comparison to a traditional concrete cube. Compared to the convectional concrete cube, the obtained compressive strength is lower. Ultimately, it is determined that using egg shell powder to make lightweight concrete cubes is not an acceptable substitute for conventional cement.

Keywords*: *Concrete brick, Egg Shell, Compressive Strength.

I. INTRODUCTION

The hard-shelled egg's protective outer layer is called the eggshell. It acts as an essential barrier, shielding the developing embryo within from external harm, germs, and other harmful factors. Eggshells are an easily available and frequently discarded waste product that can be used to create valuable building materials called eggshell bricks. If eggshells are not disposed of appropriately in the environment, they might become an agricultural waste and pollute the environment. In addition to lowering waste and promoting a circular economy, this creative idea provides a green and sustainable substitute for conventional bricks. Sustainable Materials are materials that are obtained, produced, and used sustainably take social and economic aspects into account in addition to minimizing adverse

 DOI : 10.35291/2454-9150.2024.0374

effects on the environment. Utilized in a variety of sectors, including manufacturing, consumer goods, and building, these materials are frequently recyclable, renewable, or biodegradable. By using sustainable materials, one can lessen pollution, prevent the depletion of natural resources, and advance social and environmental sustainability over the long run. Cement, sand, and gravel are combined to make concrete bricks. They come in an assortment of sizes and forms and are robust and long-lasting.

METHODOLOGY and PREPARATIONS

Eggshell waste collection involves systematically gathering discarded eggshells from sources such as local businesses, particularly restaurants. This process includes setting up dedicated collection bins, educating participants on acceptable eggshell conditions, establishing regular pickup schedules, and ensuring proper transportation. The collected eggshells can be repurposed for various sustainable purposes, including use as garden fertilizer, compost additives, seed starters, and pest deterrents. Forming partnerships with local farms or composting facilities can enhance the recycling process. Community engagement and compliance with waste regulations are crucial, and periodic evaluations help refine and improve the collection program over time.

Washing eggshells involves ensuring they are free from egg residue and membrane by rinsing under running water, soaking in warm water, gently scrubbing if necessary, and air-drying to prevent odors or mold. Once clean and dry, the eggshells can be stored until use. Drying eggshells using a hot air oven involves placing the thoroughly cleaned and rinsed eggshells on a baking sheet and drying them at a low temperature to remove moisture, making them suitable for further applications. Milling involves grinding the dried eggshells using a mortar and pestle or a grinder to produce a fine powder, which can be used as a calcium-rich supplement for plants, in composting, or for crafting projects. Sieving the ground eggshell powder with a 90 µ (micron) sieve ensures a consistent and fine particle size, separating larger particles from finer ones to achieve a uniform texture. The sieved material can then be used for preparing eggshell cubes.

Hand mixing of eggshell, sand, coarse aggregate, and cement involves manually combining these materials to create a concrete mixture. The process starts with cleaning and preparing the eggshells, which are then mixed with sand, coarse aggregate, and cement in appropriate proportions. This manual mixing ensures a uniform distribution of ingredients, resulting in a homogeneous concrete mix. Incorporating eggshells can contribute to unique properties or sustainability. Eggshell bricks are made by cleaning, drying, and milling the eggshells into a fine powder, which is then mixed with traditional brick-making materials like clay, sand, and cement. The mixture is molded into bricks and allowed to cure, potentially enhancing strength or insulation.

Curing the bricks involves standard periods of 7, 14, and 28 days. The initial 7-day curing period involves keeping the bricks in a controlled environment to develop early strength. The subsequent 7 days (total 14 days) ensure sufficient strength and durability through continued hydration of the cement. By the end of the 28-day period, the bricks achieve maximum strength and desired properties for structural integrity.

The compressive strength test measures the ability of the eggshell bricks to withstand axial loads by applying force until the brick fails, indicating its structural performance. The specific gravity of cement, a crucial property indicating its density relative to water, is measured using the pycnometer method to ensure quality and consistency.

II. RESULT AND DISCUSSION

COMPRESSIVE STRENGTH FOR STANDARD BRICK

Table 1 : Achieved compressive strength standard cubes

Mixing	Trial	N/mm2	N/mm2
For 7 days	Trial 1	25.0	25.6
	Trial 2	26.5	
	Trial 3	25.5	
For14 days	Trial 1	37.5	37.3
	Trial 2	36.0	
	Trial 3	38.5	
For 28 days	Trial 1	42.5	42.0
	Trial 2	41.5	
	Trial 3	42.0	

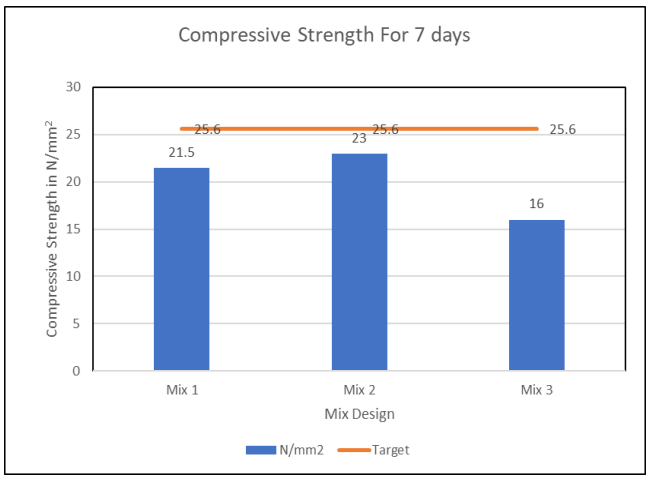
COMPRESSIVE STRENGTH FOR 7 DAYS

Table 4.2 shows that compressive strength of mix -1 cement cube of sample 1,sample 2 and sample 3 for 7 days ,7 % ESP , is found to be 22.5, 22.0 and 20 N/mm2 respectively and that of mix -2 cement cube sample 1,sample 2 and sample 3 for 7

days, 14 % ESP , is found to be 22, 23 and 24 N/mm2 respectively and that of mix 3 cement cube sample 1,sample 2 and sample 3 for 7 days , 21 % ESP , is found to be 15, 16 and 17 N/mm2 respectively.

Figure 4.1 shows that the average compressive strength of mix 2 is approximately higher than that of mix 1 and mix 3 after 7 days.

 DOI : 10.35291/2454-9150.2024.0374

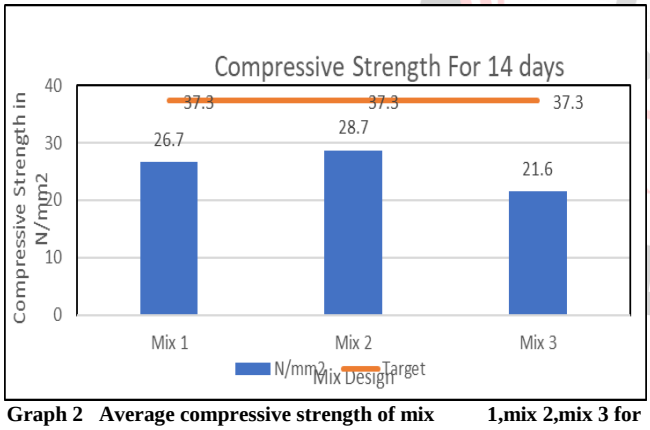


Graph 1 Average compressive strength of mix 1, mix 2, mix 3 for 7 days

COMPRESSIVE STRENGTH FOR 14 DAYS

Table 4.3 shows that compressive strength of mix -1 cement cube of sample 1,sample 2 and sample 3 for 7 days , 7 % ESP , is found to be 26.5, 27.5 and 26 N/mm^2 respectively and that of mix -2 cement cube sample 1,sample 2 and sample 3 for 7 days , 14 % ESP , is found to be 30, 28 and 28 N/mm^2 respectively and that of mix 3 cement cube sample 1,sample 2 and sample 3 for 7 days , 21 % ESP , is found to be 21.5, 21.5 and 22 N/mm^2 respectively.

Figure 4.2 shows that the average compressive strength of mix 2 is higher than that of mix 1 and mix 3 after 14 days.

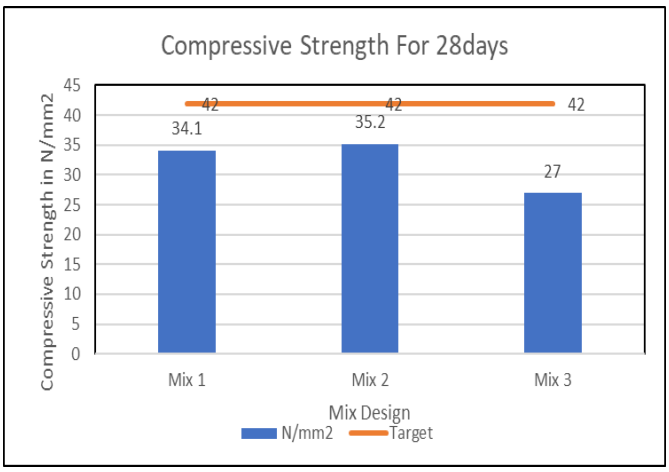


Graph 2 Average compressive strength of mix 1,mix 2,mix 3 for 14 days

COMPRESSIVE STRENGTH FOR 28 DAYS

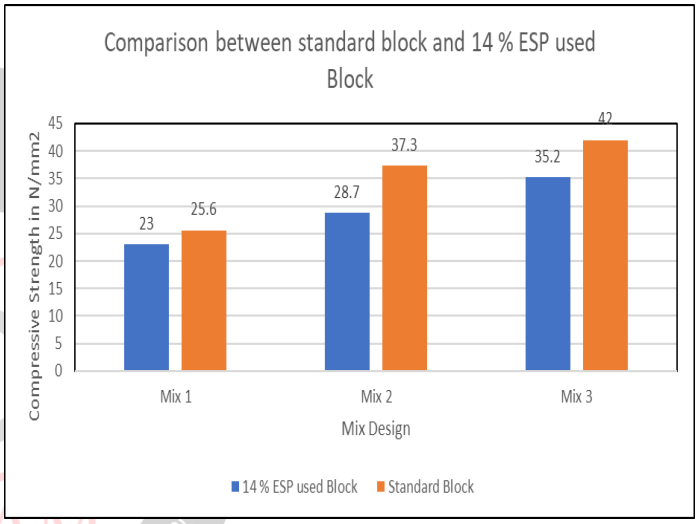
Table 4.4 shows that compressive strength of mix -1 cement cube of sample 1,sample 2 and sample 3 for 7 days , 7 % ESP , is found to be 32.5, 34.5 and 235.5 N/mm2 respectively and that of mix -2 cement cube sample 1,sample 2 and sample 3 for 7 days , 14 % ESP , is found to be 34, 35.5 and 36 N/mm2 respectively and that of mix 3 cement cube sample 1,sample 2 and sample 3 for 7 days , 21 % ESP , is found to be 28, 27 and 26 N/mm2 respectively.

Figure 4.3 shows that the average compressive strength of mix 2 is higher than that of mix 1 and mix 3 after 28 days.



Graph 3 Average compressive strength of mix 1,mix 2,mix 3 for 28 days

Compressive strength comparison between Eggshell powder used cube/block and standard block



Graph 4 Compressive strength of standard block and 14 % ESP used block for 28 days

III. CONCLUSION

In this particular study, cement cubes having size 100mm X 100mm X 100 mm were made by replacing cement with ESP by 7%, 14% and 21%.

Based on the result and discussion made in the chapter 4, the following conclusions are drawn

- Average compressive strength of mix -1 is found to be 34.1 N/mm2 , mix -2 is 35.2 N/mm2 and mix -3 is 27 N/mm2 for 28 days. It can be said that cubes of mix proportion having 14% ESP has more compressive strength than mix proportion 7% and 21% ESP respectively.
- Hence the optimum percentage of ESP replacement of cement in concrete is 14%.
- When 14% egg shell power is used in place of cement in concrete, the cost savings is 3.0% when compared to

 DOI : 10.35291/2454-9150.2024.0374

regular concrete. Hence, Utilizing ESP as replacements in cement cubes proves cost effective.

- Although it is meet theoretical compressive strength, results appeared to be unsatisfactory and failed to meet the requirements.
- Therefore, it is not advisable to utilize in large construction industry. it can be used in pavements,
- Thus, eggshell power can be used in construction materials in the future as a way of reducing carbon dioxide emission into the atmosphere.

ACKNOWLEDGMENT

We like to show sincere gratitude to all those who helped us in the completion of this project. During our project work, we faced some challenges due to the lack of insight knowledge and experience, but these people helped us to get over from all the difficulties and in final compilation of one idea to shaped sculpture

We would like to express our greatest gratitude to our project guides **Dr. B M Krishna**, Associate professor and **Mrs. Parinitha T Niranjan**, Assistant professor, Department of Environmental Engineering, SJCE JSSSTU, Mysuru, for their continuous help and monitoring during the projects. Their exemplary guidance and constant encourage at that even our most profound gratitude is not enough.

We sincerely thankful **Mahendra Kumar H. M**, Assistant Professor department of civil engineering, SJCE JSSSTU, Mysuru, and their students for their support, and expertise throughout the duration of this project. Their mentorship and insightful feedback have been instrumental in shaping the direction of our project and enhancing the quality of the final outcome.

We would also like to thank **Dr. Sadashiva Murthy B M**, Professor and head of Department of Environmental Engineering, JSS STU, Mysuru, for his Governance and Support.

We also thank lab instructor, **Ranganath**, department of civil engineering for guiding through the whole process.

All our team is thankful to all faculties and staff of the department of environmental engineering for their help and support towards this project and our team.

REFERENCES

[1] Amarnath Yerramala (2014) "Properties of concrete with eggshell powder as cement replacement", Indian Concrete Journal, Volume 4, Page 158-196.

[2] Blasius Ngayakamo, Azikiwe Peter Onwualu, (2022), "Recent advance in green processing technologies for valorisation of eggshell waste for sustainable construction material", Heliyon8, Volume 8,Pages 2405-8440.

[3] Doh Shu Ing, S.C. Chin (2017) "Eggshell as a partial cement replacement in concrete development", Magazine of Concrete Research, Volume 70, Issue 13, Page 662-670

[4] Fahad Alsharari, Kaffayatullah Khan, Muhammad Nasir Amin, Waqas Ahmad

[5] Usama Khan, Mohammed Mutnbak, Moustafa Houda , Ahmed M. Yosri, (2022), "Sustainable use of waste eggshell in cementitious materials an experimental and modelling based study", Case Studies in Construction Materials, Volume17, Pages 2214-5059.

[6] Jose Holanda, Andre Destefani, Mateus Carvalho Amaral (2013) "Soil–cement bricks incorporated with eggshell waste", Waste and Resource Management, Volume166, Issue WR3, Page 137-141.

[7] Kaffayatullah Khan, Waqas Ahmad Muhammad Nasir Amin, Ahmed Farouk Deifalla, (2023) "Investigating the feasibility of using waste eggshells in cement-based materials for sustainable construction" Journal of Material Research and Technology, Volume 23, Pages 4059-4074.

[8] Kamran Basit1, Nitish Kumar Sharma2, Brij Kishor3(2019) "A Review on partial replacement of cement by eggshell powder", International Journal of Engineering and Technology, Volume: 06, Pages1104-1107, Issue:02.

[9] Navaratnarajah sathiparan, (2021), "Utilization prospects of eggshell powder in sustainable construction material", Case Studies in Construction Materials, Volume 293 ,123465.

[10] Prakash Singh, Mukesh Kumar Das, Surender Bishnoi (2023) "Influence of eggshell powder in ordinary concrete for sustainable environment", Materials Today: Proceedings, Volume 2721, Page 98103.

[11] Sagar Paruthi, Afzal Husain Khan, Ashish Kumar, Fanish Kumar, Mohd Abul Hasan, Hassan M. Magbool, Mohammad Saood Manzar (2023) "Sustainable cement replacement using waste eggshells: A review on mechanical properties of eggshell concrete and strength prediction using artificial neural network", Case Studies in Construction Materials 8, Volume18, Page2214-5095.

[12] Saleh Ali Said Al Abri, Chiranjeevi Rahul Rollakanti, Kiran Kumara Poloju, Adams Joe (2022), "Experimental Study on Mechanical Properties of Concrete by partial replacement of Cement with Eggshell Powder for Sustainable Construction", Materials Today: Proceedings65, Volume 3, Issue 3, Page 1-2.

 DOI : 10.35291/2454-9150.2024.0374