

A Review Study of Egg Shell Powder and Black Gram Pulse with Jaggery as a Lime Replacing Material in Portland Cement

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Abstract

The importance of cement in modern society cannot be overestimated. There is no escaping from the impact of cement, that it makes our everyday life. Effective deployment of bio-waste has been given importance in our society for environmental and economic concerns. Reclamation of eggshell from hatcheries, home, bakeries and industries is an efficient and cost-productive way to reduce waste disposal and prevent serious environmental issues. Eggshells waste constitutes essential organic and inorganic materials that can be composted with other materials for enhancing the pre-existing property. The major concern in any civil sector is efficient construction with minimal cost investment. Cement is one of the pivotal components for construction. Affordable and strong, resilient cement is the need of the hour and is the key to future sustainable development. The main aim of this study is to search an alternative of Limestone in cement for sustainable development in future. In this research paper, Eggshell powder, Black gram pulses with jaggery were used as a partial substitute for cement to decrease the usage of limestone in cement production.

Keywords: Cement, Portland cement, Concrete, Eggshell Powder, Sustainable development.

Cement: Cement, in general, is an adhesive substance of all kinds, but, in a narrower sense, the binding materials used in building and civil engineering construction. Cement is finely ground powders that, when mixed with water, set to a hard mass. Setting and hardening result from hydration, which is a chemical combination of the cement compounds with water that yields submicroscopic crystals or a gel-like material with a high surface area. Because of their hydrating properties, constructional cements, which will even set and harden under water, are often called hydraulic cements.

Portland Cement: Cement manufactured from chalk and clay which hardens under water and when hard resembles Portland stone in colour.

Concrete: Concrete is formed when Portland cement creates a paste with water that binds with sand and rock to harden. Concrete is

characterized by the type of aggregate or cement used, by the specific qualities it manifests, or by the methods used to produce it. In ordinary structural concrete, the character of the concrete is largely determined by a water-to-cement ratio. The lower the water content, all else being equal, the stronger the concrete. The mixture must have just enough water to ensure that each aggregate particle is completely surrounded by the cement paste, that the spaces between the aggregate are filled, and that the concrete is liquid enough to be poured and spread effectively. Another durability factor is the amount of cement in relation to the aggregate (expressed as a three-part ratio—cement to fine aggregate to coarse aggregate). Where especially strong concrete is needed, there will be relatively less aggregate.

Eggshell Powder: Eggshell powder is a natural source of calcium and other elements (e.g. strontium and fluorine).

Sustainable development: Economic development that is conducted without depletion of natural resources.

OBJECTIVE

The main objective of the study was to determine whether eggshell powder and pulses can be a substitute to a percentage of limestone powder in cement for sustainable development. Complete mountains are vanishing from different states of India due to limestone mining.

MATERIALS

Egg shell powder, Black Gram Pulse, Jaggery, Lime, Silica, Aluminium sulphate,

Calcium Sulphate, Iron Oxide, Magnesia, Sulphur, Alkalies

INTRODUCTION

The eggshell waste produced from poultry and other places is very high in number. We cannot completely substitute lime stone with Eggshell Powder. But we can decrease the amount of limestone used generally and add eggshell powder, black gram with jaggery can create cement which will help in sustainable development. About 9% of the country's total limestone reserves are distributed in the Meghalaya state. If we see the scientific studies, the loss of forest cover, pollution of water, soil and air, depletion of natural flora and fauna, reduction in biodiversity, erosion of soil, instability of soil and rock masses, changes in landscape and degradation of agriculture land are some of the conspicuous environmental implications of limestone mining. Conservation of natural resources and recycling of waste materials is vital. This replacement will decrease the costing in manufacturing and would not deplete the planet.

History of Cement and Concrete

The origin of cement goes back to ancient Greece and Rome. The materials used were lime and a volcanic ash that slowly reacted with it in the presence of water to form a hard mass 2,000 years ago. The term cement, derives from the Latin word caementum, which meant stone chippings such as were used in Roman mortar—not the binding material itself.

Portland cement is a successor to a hydraulic lime that was first developed by John Smeaton in 1756 when he was called in to

erect the Eddystone Lighthouse off the coast of Plymouth, Devon, England. The invention of portland cement usually is attributed to Joseph Aspdin of Leeds, Yorkshire, England, who in 1824 took out a patent for a material that was produced from a synthetic mixture of limestone and clay. By the early 21st century, China and India had become the world leaders in cement production, followed by the United States, Brazil, Turkey, and Iran. Among the ancient Assyrians and Babylonians, the bonding substance most often used was clay. The Egyptians developed a substance more closely resembling modern concrete by using lime and gypsum as binders.

LITERATURE REVIEW

Many implementations were proposed and implemented previously they are done with Egg shell powder, Pulses husk, Rice husk and iron slag.

Amarnath Yerramala, studied the properties of concrete with eggshell powder as cement replacement. This paper delivered the study into utilization of poultry waste in concrete through the advancement of concrete fusing eggshell powder (ESP). Diverse ESP concretes were created by supplanting 5-15% of ESP for cement. The outcomes showed that ESP can effectively be utilized as incomplete substitution of concrete in concrete creation. The information introduced cover quality improvement and transport properties. Regarding the outcomes, at 5% ESP substitution the strength were higher than control concrete and show that 5% ESP is an

ideal substance for greatest strength. Also, the execution of ESP cements was practically identical up to 10% ESP substitution as far as transport properties with control concrete. The outcomes additionally demonstrate that option of fly ash remains alongside ESP is helpful for moved forward execution of concretes.

Jayasankar.R et al did the experimental study on Concrete using Fly Ash, Rice Husk Ash and Egg Shell Powder. In this study, Ordinary Portland cement on forming to IS: 8112, 43 grade, Dalmia brand was used. Screened river sand with fineness modulus equal to 2.6 conforming to grading zone III of IS: 3831970 was used. Well graded blue granite stone aggregate passing through 12mm and retained in 4.75mm sieve with fineness modulus of 7.48 was used. Fly ash procured from Neyveli Lignite Corporation, Neyveli, Tamil nadu India was sieved before used. Egg shells procured from local centers was grinded, sieved before used. Rice Husk Ash procured from local agricultural lands and flower mills was incinerated, cleaned and sieved before used. Based on the results of these works it can be concluded that RHA, Fly ash and ESP mixed cubes has equal strength with that of conventional concrete cubes in certain categories. M20 and M25 cubes takes equal load compared to conventional concrete and M30 grade concrete's load carrying capacity is slightly decreased.

Raw Materials - Composition

Portland cement consists essentially of compounds of lime (calcium oxide, CaO) mixed with silica (silicon dioxide, SiO₂) and alumina (aluminum oxide, Al₂O₃). The lime

can be obtained from a calcareous (lime-containing) raw material, and the other oxides can be derived from an argillaceous (clayey) material. New proposed materials like egg shells powder can be taken by collecting waste egg shells and black gram pulse from a local farm or general stores. Wasted extra jaggery can be taken from any local jaggery making hoyspot like Yamunanagar, Haryana. Additional raw materials such as silica sand, iron oxide (Fe_2O_3), and bauxite—containing hydrated aluminum, $\text{Al}(\text{OH})_3$ —may be used in smaller quantities to get the desired composition.

ROLE OF EGGSHELL POWER, BLACK GRAM, JAGGERY

After analyzing, studying and researching the constructions in Assam by The Ahom Dynasty who ruled for 600 years, I found out the used materials like jaggery, rice, black gram, xon (a kind of plant fiber), snail slime, stone lime, fishes, oil, resin of sal tree etc. Eggshell powder increased strength of concrete. More over it increases the initial setting time and works as a binding material. When studied even Black gram was used as a binder in mortar and plaster in ancient times in India. Black gram worked as a deforming agent and has substantially improved the hydrophobic property of cement mortar and concrete. It provides bet strength after a year. Jaggery acted as a thin layer over the cement particles and it slows down the hydration process. This kept the constructed wall very cool even in hot summer of India. The research goes back a few decades and substitute a few amounts of limestone

powder with different parts of eggshell powder, pulses and jaggery to soften the impact of pollution through limestone mining and construction.

MATERIAL ELEMENT	CONTENT (%)
Egg shell powder	22
Black Gram Pulse	13
Jaggery	3
Lime (CaO)	29
Silica (SiO_2)	17
Aluminum Sulphate (Al_2C_3)	5
Calcium Sulphate (CaSO_4)	3
Iron Oxide (Fe_2O_3)	3
Magnesia (MgO)	2
Sulphur	2
Alkalies (K_2O , Na_2O)	1

METHODOLOGY

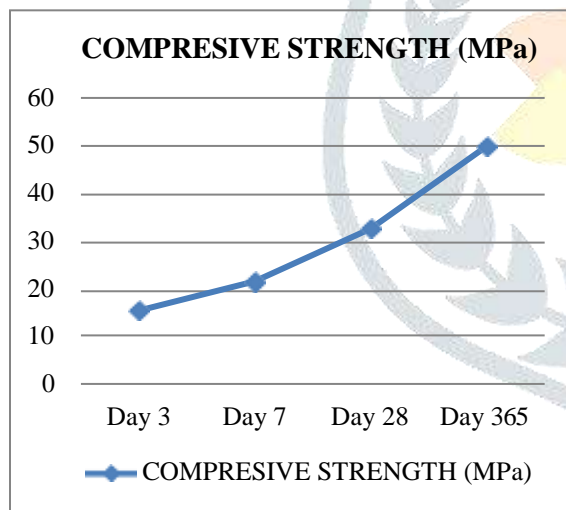
Leftover and wasted eggshells were collected from local vendors near to home. After collection shells were sterilized by boiling in filtered water for 25 minutes. Shells were air dried and grinded in a grinding machine with Black gram pulse and Jaggery. Now the mix of Egg shell powder, black gram pulse and Jaggery were taken with Limestone powder (grinded). After that the mix would go through wet, dry, and semi dry processes with the raw mix. The final product thus formed is cooled and grinded to better fineness. A concrete block of 150 mm with proposed materials for M-15 Portland pozzolana cement of 33 Grade was formed for testing and analyzing.

EXPERIMENTAL PROCEDURES & ANALYSIS

The basic objective of proposed design is to find the most economical proportions to achieve the desired end results (strength, durability). Eggshell Powder, Black gram pulse and Jaggery were added in the experiment with limestone in order to achieve similar strength keeping environment issues in mind.

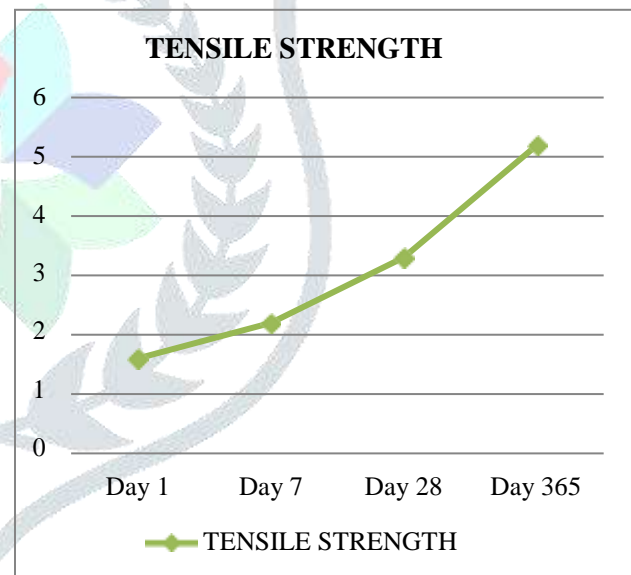
COMPRESIVE STRENGTH TEST

Compressive strength of concrete is the value of uniaxial compressive stresses reached when concrete fails completely. The compressive strength of concrete is given in terms of the characteristic compressive strength of 150 mm, tested at 3, 7, 28 days. The compressive strength was calculated for a year for proposed material on the basis of monthly results shown in the graph below.



sectional area of the material. Tensile strengths have dimensions of force per unit area. When stresses less than the tensile strength are removed, a material returns either completely or partially to its original shape and size. As the stress reaches the value of the tensile strength, however, a material, if ductile, that has already begun to flow plastically rapidly forms a constricted region called a neck, where it then fractures.

The Tensile Strength, Split Tensile Strength, Direct Tensile Strength of concrete is given in terms of the characteristic tensile strength of 150 mm, tested at 3, 7, 28 days. The tensile, split tensile and direct tensile strength was calculated for a year for proposed material on the basis of monthly results shown in the graph below respectively.



TENSILE STRENGTH TEST

Tensile strength is the maximum load that a material can support without fracture when being stretched, divided by the original cross-

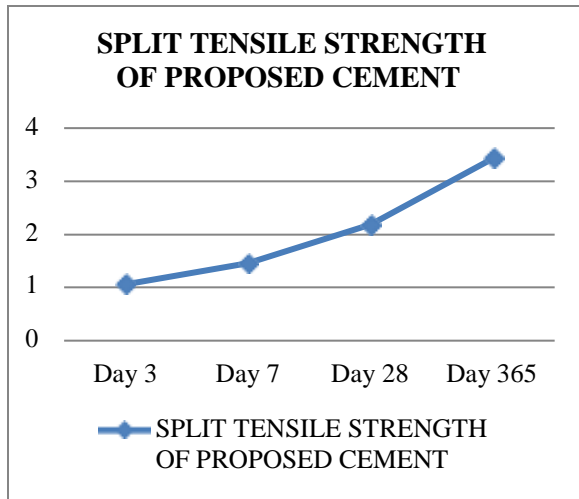
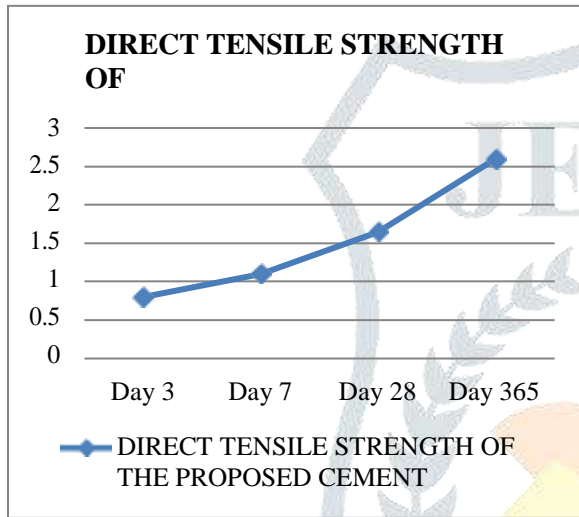


Fig: 1 (Cubic structure with force applied from top & static bottom)

Fig: 2 (Static cubic deformed model after applying load on border)



The figures 1 shows cubic model with 150mm dimensions. The arrows represent the load on the cubic model and shows deformation in figure two above. Different loads of 500, 1000, 5000, 10000 Newton per meter square was applied on the cubic model from top phase and kept the bottom static. The corners show the stress.

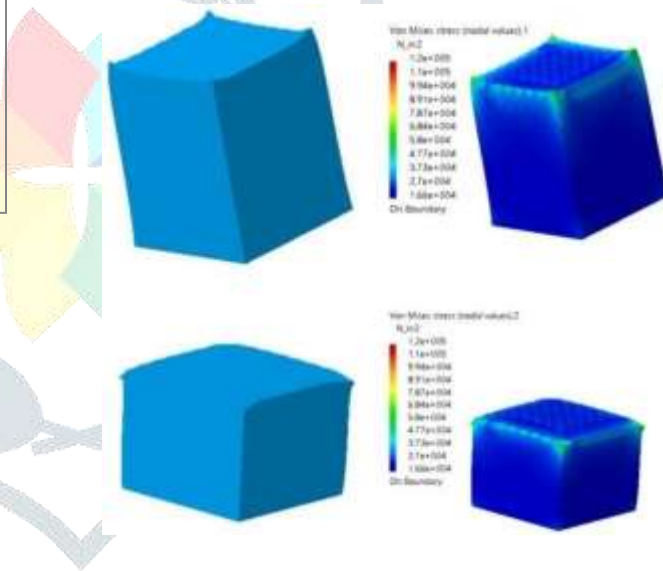


Fig: 3 (Cubic structure showing tensile strength on applying 500 Newton per meter square)

Fig: 4 (Cubic structure showing compressive strength on applying 500 Newton per meter square)

Material	<u>Custom Composition</u> (Egg shell powder, Black Gram Pulse, Jaggery, Lime(CaO))
Young's modulus	1.936e+009N_m2
Poisson's ratio	0.16
Density	1440kg_m3

Conclusions

1. The compressive strength of proposed cement increases by the addition of waste ceramic egg shell powder and black gram in cement.
2. The proposed percentage of Egg shell powder, black gram and jaggery is 22%, 13% and 3% in the the concrete.
3. The maximum Compressive strength test is achieved 33 on 28th day and 50 after a year of setting.
4. The Tensile strength of concrete increases by the addition of waste ceramic egg shell powder and black gram in cement.
5. The maximum Tensile strength test is achieved 3.3 on 28th day and 5.2 after a year of setting.
6. The Split Tensile strength of concrete increases by the addition of waste ceramic egg shell powder and black gram in cement.
7. The maximum Split Tensile strength test is achieved 2.178 on 28th day and 3.432 after a year of setting.
8. The Direct Tensile strength of concrete increases by the addition of waste ceramic egg shell powder and black gram in cement.
9. The maximum Direct Tensile strength test is achieved 1.65 on 28th day and 2.60 after a year of setting.
10. The Initial setting time of concrete increased with later on strength due to the addition of black gram.
11. Proposed cement variation can be used in higher temperature areas like Rajasthan, India.

References

1. Poornima K, N.B. Darshan, Manju Nath, Revanasiddappa K, Sanjay M, A Review Study of Egg Shell Powder as a Cement Replacing Material in Concrete
2. Ramathilagam.B.H et al, “An Experimental Investigation of Egg Shell Powder as a Partial Replacement of Cement in Paver block”, International Journal of Engineering Science and Computing, Volume 8 Issue No.4, April 2018
3. L. Romanoff and A. J. Romanoff, The avian egg. 1949.
4. O. Amu, A. . Fajobi, and B. . Oke, “Effect of Eggshell Powder on the Stabilizing Potential of Lime on an Expansive Clay Soil,” J. Appl. Sci., vol. 5, no. 8, pp. 1474– 1478, 2001.
5. S.Mani Raj, C.Karthick Raja, M.Karuthapandi, Ms V.Saranya, Experimental Study on Eco-Concrete

using Natural Admixtures, (SSRG- IJCE)
Special Issue ICRTETM March 2019,

6. IS 516: 1959; Methods of tests for Strength of concrete
7. IS 383: 1987 Bureau of Indian Standards, Specification for Fine and Coarse Aggregates from natural source for concrete
8. T. Nakano, N. Ikawa, and L. Ozimek, "Chemical composition of chicken eggshell and shell membranes,"
9. TEXT BOOK - Shetty M. S., (2013), "Concrete Technology - Theory and Practical", S.Chand Publishing

