MECHANICAL PROPERTIES OF LIGHT WEIGHT BRICKS USING PERLITE AND LIME MATERIAL

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Abstract— The aim of this study is investigation of brick reproducibility using expanded perlite aggregate as the main raw material. Engineering parameters such as weight per unit of volume, mechanical strength of produced control brick with a dimension of 190 x 90 x 90 mm were determined and optimized. The chemical composition of perlite are 70-75 % silicon oxide (SiO_2), 12-15 % Aluminium Oxide (Al_2O_3), 3-4 % Sodium oxide (Na_2O), 3-5 % Potassium oxide (K_2O), 0.5-2 % Iron oxide(Fe_2O_3), 0.2-0.7 % Magnesium oxide (MgO), 0.5-1.5 % Calcium oxide (CaO), 3-5 % loss on ignition (chemical / combined water). Its thermal, lightness, and acoustic insulation properties make perlite an excellent material to be used as lightweight aggregate in brick manufacturing.Binding materials such as cement, gypsum, lime, bitumen and clay were used for manufacturing perlite brick.These bricks were tested for compressive strength, water absorption, efflorescence, Density and sound test as per Indian Standards. Brick in standard sizes manufactured at different perlite–lime Ratios and unit weight, compressive strength, volume reduction and heat conductivity values were obtained. Then the mixture with the best combination of the properties was determined and cost optiminization was described.

Keywords—Expanded Perlite,Lime Powder,Water;Specific gravity;Compression test.

1.INTRODUCTION

1.1 GENERAL

Perlite is used in various areas such as construction materials, agriculture, medical and chemical industry. Moreover, expanded perlite aggregate (EPA) has been used within the constructional elements such as brick, plaster, pipe, wall and floor block; however has not been industrially utilized in concrete yet. EPA is a heat and sound insulator, and lightweight material which ensures economic benefits in constructions.

Such well burnt bricks do not breakdown when immersed in water. The temperatures in these kilns go 700 – 1100 degree celcious. In this chapter we will deal with the manufacturing of clay bricks and methods of testing them for use in building construction. The chemical composition of Perlite are: 70–75% Silicon Oxide: SiO_2,12–15% Aluminum Oxide:Al_2O_3, 3–4%

Sodium oxide: Na_2O, 3–5% Potassium Oxide: K_2O, 0.5-2% Iron oxide: Fe_2O_3, 0.2–0.7% Magnesium oxide: MgO, 0.5–1.5% Calcium oxide CaO 3–5% loss on ignition (chemical / combined water). Perlite is used in industries, agriculture, horticultural aggregate, vermiculite, refractory material, ladle topping, building construction products, fillers, filter aid and used in hot tops and risers. This paper summarizes the study of chemical and physical properties of Perlite and its application in India.

1.2 PERLITE:

Perlite is a type of volcanic rock with pearly lustre. It expands and becomes porous when heated. Colour of crude perlite is light grey to glossy black whereas, thecolour of expanded perlite ranges from snowy white to greyish white. Distinguishing feature apart from other volcanic glasses is that perlite when heated to about 850-900 °C expands 4 to 20 times its original volume. This expansion is due to the presence of 2 to 5% combined water in crude perlite which when heated vaporises to form countless tiny bubbles. Expanded perlite is not only amazingly light weight, but also has exceptional physical properties. Unexpanded (raw) perlite has a bulk density around 1100 kg/m3 (1.1 g/cm3), while typical expanded perlite has a bulk density of about 30-150 kg/m3.Perlite is used in industry in both the forms- Crude Perlite and Expanded Perlite. Most perlite is expanded to produce ultra light perlite by heating. Crude perlite is prepared by crushing and screening to various size fractions.

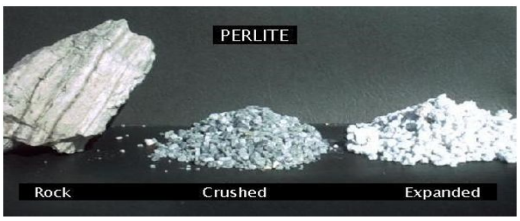


Figure.1.1

1.2.1 EXPANDED PERLITE:

Expanded perlite aggregate EPA has been used in constructional elements such as brick, plaster, pipe, wall, and floor block, however, has not been industrially used in concrete yet. Perlite is a glassy form of rhyolitic or dacitic magma. It contains 2–5% water. Upon rapid heating, perlite transforms into a cellular material of low bulk density. As the chemical water held within the perlite boils at temperatures of 900–1,100°C, the resultant steam forms bubbles within the softened rock to produce a frothy like structure. The formation of these bubbles allows perlite to expand up to 4–20 times of its original volume.

Thermal conductivity has been defined as "the rate of flow of heat per unit area per unit temperature gradient when heat flow is under steady state conditions" Tennent 1997. The thermal conductivity of porous materials depends on various parameters, such as the thermal properties of the constituent phases and the microstructure parameters, which include the volume fractions of the constituent phases, geometrical distribution of the phases, the size and size distribution of the particles, and the geometry of the individual papers.

Figure.1.2

1.2.1.1 PHYSICAL PROPERTIES OF EXPANDED PERLITE

Property of EPA	Determined limits
Color	White
Specific gravity	0.28
Unit weight kg/m^3	30–190
Porosity %	90
Specific heat kCal/kg °C	0.20–0.23
Melting point °C	1,300
Thermal conductivity W/mK	0.039–0.046
Thermal expansion mm/m °C	0.004–0.011

1.2.1.2 CHEMICAL PROPERTIES OF EXPANDED PERLITE

Component	Content in %
SiO_2	70.68
Al2O3	13.04
Na_2O	3.54
K_2O	4.34
Fe2O3	1.04
CaO + MgO	3.78
Other	3.38

1.2.2 ADVANTAGES OF EXPANDED PERLITE:

Industrial applications for Perlite are the most diverse, ranging from high performance fillers for plastics to cement for petroleum, water and geothermal wells. Other applications include its use as a filter media for pharmaceuticals, food products, chemicals and water for municipal systems and swimming pools. Additional applications include its use as an abrasive in soaps, cleaners, and polishes; and a variety of foundry applications utilizing Perlite insulating properties and high heat resistance. This same heat resistant property is taken advantage of when Perlite is used in the manufacture of refractory bricks, mortars, and pipe insulation. Over half of all the Perlite expanded in the United States annually is used to make ―formed products.‖ These products include ceiling tiles, pipe insulation, roofing board and fire-rated door cores, and are manufactured with a variety of binders. Perlite can safely be used over a wide range of temperatures. Being lightweight, non-combustible, and insulating, Perlite has been found to be useful in a wide variety of industrial applications, e.g., refractory brick, high temperature insulation, molten metal topping, cryogenic insulation, filtration, and lightweight fillers. Perlite and vermiculite are both used to improve moisture retention and aeration in soil. They are used in a similar manner, but they are not interchangeable. Perlite and vermiculite are quite different in composition and in how they improve your soil. Determining which is better for use in your garden depends on your plants and their needs.There are many uses for perlite. These uses can be broken down into three general categories: construction applications, horticultural applications, and industrial applications.

1.3 LIME POWDER:

Locally available Lime powder were used in this work. limestone is a general term for rocks that contain 80% or more of calcium or magnesium carbonates, including marble, chalk, and marl. lime has an adhesive property with bricks and stones, it is often used as binding material in masonry works.

Lime is a calcium-containing inorganic material in which carbonates, oxides, and hydroxides predominate. In the strict sense of the term, lime is calcium oxide or calcium hydroxide. It is also the name of the natural mineral (native lime) CaO which occurs as a product of coal seam fires and in altered limestonexenoliths in volcanic ejecta.[1] The word "lime" originates with its earliest use as building mortar and has the sense of "sticking or adhering".
The rocks and minerals from which these materials are derived, typically limestone or chalk, are composed primarily of calcium carbonate. They may be cut, crushed or pulverized and chemically altered. "Burning" (calcination) converts them into the highly caustic material "quicklime" (calcium oxide, CaO) and, through subsequent addition of water, into the less caustic (but still strongly alkaline) "slaked lime" or "hydrated lime" (calcium hydroxide, $Ca(OH)_2$), the process of which is called "slaking of lime". Lime kilns are the kilns used for lime burning and slaking.

When the term is encountered in an agricultural context, it usually refers to agricultural lime, which is crushed limestone, not a product of a lime kiln. Otherwise it most commonly means slaked lime, as the more dangerous form is usually described more specifically as quicklime or "burnt lime".

Figure.1.3 Lime Powder

1.3.1 PHYSICAL PROPERTIES OF LIME POWDER:

PHYSICAL APPEARANCE	WHITE POWDER
SPECIFIC GRAVITY	2.2
pH(1%solution)	12.4
SOLUBILITY@20°C(68°F)	0.165 g/100ml water
BULK DENSITY	2210.5kg/m^3(138 lb/ft^3)

1.3.2 CHEMICAL PROPERTIES OF LIME POWDER:

CHEMICAL PROPERTIES	
Chemically, both limestone and marbles are siliceous calcium carbonate rocks.	
Lime (CaO)	38-42%
Silica (SiO2)	20-25%
Alumina (Al2O3)	2-4%
Other Oxides like Na, Mg	1.5 to 2.5%
Loss On Ignition (LOI)	30-32%

1.4 AIM

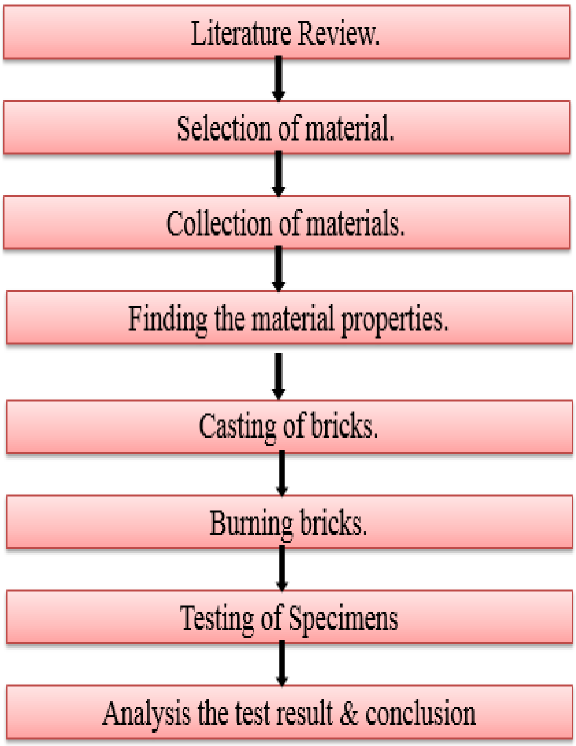
To Experimental study on light weight bricks using perlite and lime materials.

1.5 SCOPE :

- ❖To reduce the weight of the bricks.
- ❖Floating bricks.
- ❖To avoid the accidents of fire industries.

2.METHODOLOGY:

2.1 FLOWCHART:



The methodology of the project involves collection of literature and necessary documents required for the experimental work. After the sufficient documents are collected, the materials required for the experimental work is collected, and tested for its originality against the project specifications. When the materials satisfy the project specifications, the specimens (bricks) are to be casted and are to be burned under normal bricks conditions.

When the materials are burned, the bricks are tested for their compression strength, and the water absorption test.

3. MATERIAL COLLECTION AND TESTING

3.1 MATERIAL PROPERTIES:

3.1.1 Specific gravity test of Expanded perlite:

The empty specific gravity bottle designed and was taken as (w1).The bottle was filled with perlite and the weight is taken as (w2).The specific gravity bottle was filled with perlite and water weighed which was taken as (w3).Roll the bottle in the incline position until no further air bubble rise to the surface. Fill the bottle to the top with water and weight (w4).

Specific gravity of EPA = $\left(\frac{W2-W1}{(W2-W1)-(W3-W4)}\right)$

Figure:3.1.specific gravity test

3.1Specific gravity of Expanded Perlite

Description	Weight in g		
	Trial I	Trial II	Trial III
Weight of empty mould (W_1)	611	611	611
Weight of mould +EPA (W_2)	630	620	629
Weight of mould + EPA +water (W_3)	1450	1468	1465
Weight of mould + water (W_4)	1510	1510	1510

4.EXPERIMENTAL PROGRAM:

This Indian Standard was adopted by the Indian Standards Institution on 17 November 1968, after the draft finalized by the Flooring and Plastering Sectional Committee had been approved by the Civil Engineering Division Council. These bricks are made of raw materials, such as clay or shale of suitable composition with low lime and iron content, felspar, flint or sand, and vitrified at high temperatures in ceramic kilns. These bricks are-designed primarily for use in chemical and allied industries and are normally used with chemical resistant mortars.

This standard covers the requirements for bricks intended for use where minimum absorption is required and thermal shock and alkali resistance are not important service factors. In the formulation of this standard due weightage has been given to international co-ordination among the standards and practices prevailing in different countries in addition to relating it to the practices in the field in this country.

It is necessary to Check the quality of brick before using it in any construction activities. There are some field tests that we can conducting the field in order to check the quality of bricks. A Brick is generally subjected to the following tests to find for the Construction work. These tests are as follows.

Compression Test.

4.1.COMPRESSION TEST:

1. Unevenness observed in the bed faces of bricks is removed to provide two smooth and parallel faces by grinding. It is immersed in water at room temperature for 24 h.
2. The specimen is then removed and any surplus moisture is drained out at room

temperature. The frog and all voids in the bed face is filled with cement mortar (1 cement, clean coarse sand of grade 3 mm and down). It is stored under the damp jute bags for 24 h followed by immersion in clean water for 3 days.

3. The specimen is placed with flat faces horizontal, and mortar filled face facing upwards between two 3 ply plywood sheets each of 3 mm thickness and carefully centered between plates of testing machine.

4. Load is applied axially at a uniform rate of 14 N/mm^2 per minute till failure occurs. The maximum load at failure is noted down. The load at failure is considered the maximum load at which the specimen fails to produce any further increase in the indicator reading on the testing machine.

Figure4.1.Compression Test

$$\text{Compressive strength}(N/mm^2) = \frac{\text{Maximum load at failure in N}}{\text{Avg. area of the bed faces in } mm^2}$$

BRICK RATIO	TRIAL I	TRIAL II	TRIAL III	Avg Compressive Strength (N/mm^2)
CONVENTIONAL BRICK	8.30	7.70	7.8	7.93
B1 (70,30)	3.37	3.56	3.31	3.41
B2 (75,25)	3.52	3.42	3.30	3.41
B3 (80,20)	3.44	3.3	3.4	3.38
B4 (85,15)	2.79	2.71	2.91	2.80

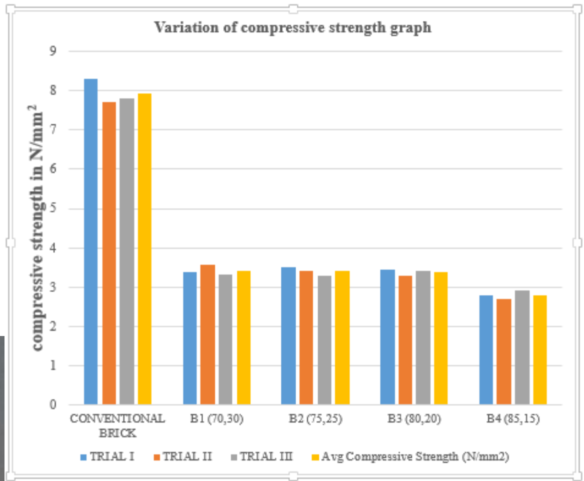


Figure.4.1.Graph for compression strength

5.CONCLUSION:

This work effectively converts perlite into useful building materials like building bricks and floor interlocks which can effectively reduce the self weight or dead load and further decreases the problem of fire industries accidents in the society. Rather than the expanded perlite going into the landfill or incinerators it can be used as construction materials at a much lower cost after undergoing certain specific processing. From the compression testing results we come to know that expanded perlite material when effectively mixed lime gives the 3.3 N/mm^2 compressive strength. This brick is floating into the water.

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6.REFERENCE:

- Atila Gurhan Celik , Tolga Depci ,⇑, Ahmet Mahmut Kılıc (2014) **“New lightweight colemanite-added perlite brick and comparison of its physicomechanical properties with other commercial lightweight materials”** Construction and Building Materials

- Atila Gürhan Çelik(2015)”**Investigation on characteristic properties of potassium borate and sodium borate blended perlite bricks”** Journal of cleaner production.

- ilker Bekir Topc-u, Burak Is-ıkdag(2007)“ **Manufacture of high heat conductivity resistant clay bricks containing perlite “** ScienceDirect(Building and Environment.

- S. Shankarananth and B. Jaivignesh (2016) **“Experimental Study on the use of Glass Powder, GGBS, & Perlite in Fly ash Brick”** International Journal of Advanced Research (2016), Volume 4, Issue 4,

- Ravi kumarVandana Patyal,Balwinder Lallotra and Deepankar kumar Ashish(2014)”**study of properties of light weight Fly ash brick”**International Journal of Engineering Research and Applications ISSN:2248-9622

- Dr.A.S.Kanagalakshmi,T.Prawinkiruthik,R. Settu,J.Sankar, K.Vishnu(2015)“**Experimental Investigation using Fly ash,Copper Slag,Gypsum,Marble Dust as Smart Building Material in Brick Manufacturing”**International Journal of civil Engineering Vol.1,Issue.1.

- İ. Demir and M. Orhan (2004)**“An Investigation on the Production of Construction Brick with Perlite Addition”** .