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Integrating Air Vents and Polystyrene in Light Weight Brick to Maintain HVAC

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Abstract:

Objectives: The main objective of this project is to implement Integrating Air Vents and Polystyrene in Light Weight Brick to Maintain HVAC

Methods: The brick firing process temperature, PSF types and mix content, densities, water absorption, compressive strength are all examined and analyzed in this analysis. Although the use of polystyrene is implemented in the building sector to maintain the thermal efficiencies in the buildings. But still it is rarely used due to the lack of scientific knowledge on the behaviour of polystyrene in maintaining of the thermal efficiency. This analysis considers giving an overview of the requirements and importance of maintaining the temperatures in the buildings.

Findings: More over the importance of an application of Thermal Insulating Brick (TIB) in building sector is emphasized and shown in this paper. Comparison of conventional light weight brick is done with polystyrene in light weight brick. Hence from results it can conclude that polystyrene in light weight brick gives effective outcome in terms of performance, test capability and life time. Performance will be improved, test capability will be increased and life time will be increased.

Novelty: As a result, the present analysis aims to decrease the density of the bricks and enhance their thermal insulation properties. Polystyrene foam has become one of the substances that are used to create pores in the raw materials for bricks.

Keywords: Polystyrene, Thermal Insulating Brick (TIB), Thermal efficiency, HVAC (Heating, ventilation, and air conditioning), Light weight brick**.**

1. Introduction

Clay bricks and blocks with improved thermal insulation properties can be made by employing combustible additives in the appropriate quantities and particle sizes. Polystyrene foam is one of the materials used for this. During the burning process, each particle dissipates, leaving behind a cavity that could be improving the brick's thermal insulation capabilities. To reduce thermal conductivity and brick density, polystyrene foam is used as a performing material in the brick body, which reduces the building's mass and increases its earthquake resistance. This is connected with the blocks abatement of compressive strength [1]. The main problem is how to minimize the strength loss caused by the ceramic body's increased porosity while maintaining the bricks adequate load-bearing capacity.

By using controlled processes, it is possible to enhance the volume of the eliminates if some plastics are added to the raw materials. The weight of the bricks is decreased by expanding the volume of the empty spaces. In the finished product, this leads in particular features, such as greater thermal resistance. A further advantage of lightweight bricks is that they are less expensive to transport. Under the trademark "Porotone," polystyrene foam is used to create large pores in order to create lightweight bricks. At temperatures between 100 and 700 °C, expanded polystyrene decomposes thermally without producing any ash. The process releases benzene and styrene gases, which are released with the flue gases [2].

Studies on thermal insulation are becoming increasingly common because of the global significance of energy conservation and the rising costs of heating buildings. According to one analysis, buildings consume around 40% of the world's energy demands, or about 60% of all the energy used in buildings, for space heating and cooling [3]. As a result, studies on thermal insulation are being conducted. Choosing the right building material and its components is a good way to save energy. Therefore, enveloping buildings with materials that provide thermal insulation is one of the best ways to reducing energy consumption.

Numerous studies have been conducted to determine the appropriate thermal insulation material type and thickness uses in buildings. This topic has been the subject of numerous studies, the thickness of an insulator is considered to be affected by type, among other things, shape, construction materials, insulation, and costs of the building. In addition, a few studies have attempted to determine the optimum thickness of thermal insulation for various climates conditions.

Interest in light weight structure in modern construction work like high rise buildings which is being preferred to reduce the weights on the structure and from environmental and economical point of view, it is most required to design the buildings with thermal insulating properties,than the traditional practices which are being followed in building constructions [4].By the thermal conductivity thermal behaviour of any material is characterized, overall transfer of heat should be as that it should maintain the comfort temperature, although the thermal conductivity

coefficient and the overall coefficient of heat transfer depend on the properties of the material as well as the temperature source, different environments have different impacts on the thermal behaviour of the materials.

In the segment of lightweight bricks with polystyrene which is lightest composite and also it weights several times less than the similar elements.By using this kind of bricks in the buildings we can assure the insulation in the building as well as the dead loads on the structural members can be reduced considerably from either of these cases consumption of cost (or) energy is considerably reduced by using TIB. This can minimize the consumption of energy during the process of cooling the space and also this can reduce the operating time of the appliances which are used to maintain the thermal insulation and the other aspect of reducing the dead loads which are acting on the structure of the cost and the operating expenses are also minimized due to the fast construction of the walls.

Due to the finite supply of fossil fuels and the high energy cost, there is a requirement to design the building which are energy efficient, the performance of the energy consumption will depends up on the materials and systems that are been used. No two buildings are identical, so the energy consumption will vary from building to building. Buildings should have a significant amount of energy for space cooling, while thermally insulated structures use less energy improved [5].

2. Literature Survey

S. N. Shah, K. H. Mo, S. P. Yap, J. Yang, and T. C. Ling.et.al [6], several million tons of different types of wastes are generated every year globally and this is expected to increase in the future. Most of these wastes are dumped via land filling or incineration which creates environmental concerns. One of the possible methods of utilizing these wastes is by incorporating them as alternatives to common concrete constituents. In this regard, foamed concrete could provide an excellent medium for incorporating these wastes in a large volume primarily due to low strength requirement of foamed concrete. A significant number of researches is carried out to explore the idea of integrating waste materials in pre-foamed concrete. However, the limited knowledge available to recognize the utilization of this waste and the influence on foamed concrete limits the adoption of the concept and further development. Hence, this paper compiles and reviews the usage of various types of wastes such as industrial, agricultural, quarry, and construction industry wastes as a potential replacement for cement and fine aggregate in foamed concrete. Due to the unique composition and the resulting chemical and physical properties, as well as the nature of replacement (either as cement or fine aggregate replacement), each type of waste contributes differently to the performance of foamed concrete. Generally, a non-load bearing foamed concrete with low thermal conductivity, low density, and adequate compressive strength can be produced by incorporating the waste materials. This paper also describes the advantages of incorporating waste materials in foamed concrete compared to conventional concrete and proposes the further development of the concept for future application of a more sustainable and eco-friendly foamed concrete.

Veiseh S and Yousef.et.al [7] Bricks are widely used in building construction as the most common building materials in Iran. The heavy weight of bricks accounts for the great mass of construction and thus causes more vulnerability against earthquake forces. In the present work, it is, therefore, tried to reduce the density of the bricks, as well as improve thermal insulation

properties. Polystyrene foam is one of the substances that are added to the raw materials of bricks, as a pore-forming material. The effect of PSF type and its content in the mix, and also the effect of firing process temperature of the bricks on density, water absorption and compressive strength, are investigated and discussed in this paper.

H. Shin, H. K. Lee, H. -Y. Cha, S. W. Heo and H. Kim.et.al [8], Internet of things (IoT) has received much attention from many fields, and its applications are widespread in various domains. As many devices are connected to the Internet, the security issues arise and need to be addressed. In this paper, we review the challenges and the current status of IoT security technologies. Since most IoT devices operate on battery power or self-harvested energy sources, it is critical to reduce energy consumption for device operations. Therefore, we review some of light weight block cipher algorithms, which are one of the fundamental building blocks of countermeasures to cope with IoT security threats.

G. Pachideh and M. Gholhaki.et.al [9] The Autoclaved Aerated Concrete (AAC) is notorious for its insufficient strength and high water absorption leading to problems during the construction phase. To tackle such problems, the current paper examines the effect of silica fume, zeolite and granulated blast furnace on the behavioural characteristics of this concrete type. In doing so, the compressive, tensile strength and water absorption tests were conducted on 100×200 mm cylindrical and $100 \times 100 \times 100$ mm cubic specimens. Based on the results, the addition of the pozzolanic materials can effectively enhance the mechanical properties and diminish the water absorption of the autoclaved aerated concrete. Comparatively, the specimens containing silica fume, zeolite, and granulated blast-furnace slag led to increasing the compressive strength of the AAC up to 184, 200 and 172%. Moreover, the inclusion of the pozzolanic materials by 21% of the cement weight, could manage to improve the tensile strength by 25%. Most importantly, the water absorption of the specimens containing silica fume, zeolite, and granulated blast-furnace slag was reduced by 50, 45 and 35%, respectively.

A. Raj, D. Sathyan, and K. M. Mini.et.al [10] With the increase in global warming, the construction sector is trying to find an alternative to ordinary concrete due to its high dead weight and thermal conductivity. Researchers are going in different directions and presently the emerging trend is the use of foamed concrete, which is a lightweight concrete having more strength-to-weight ratio with density varing from 300 to 1800 kg/m^3. This reduces the dead load on the structure, cost of production and labour cost involved during the construction and transportation. Also, the large number of pores in the foam concrete reduces the thermal and sound absorption, thus making the structure appropriate for all climatic conditions. The paper reports an in-depth review of foamed concrete in terms of its components, fresh state and physical properties like consistency, stability, workability, drying shrinkage, air-void system and water absorption. It also includes a brief review of foam concrete prepared using various types of foams such as chemically expanded and air cured foams. Various mechanical properties like compressive strength, flexural strength and elastic modulus are also discussed. In addition, to have more understanding about the variable aspects that promote a better habitable atmosphere for all climatic conditions functional characteristics like thermal conductivity, fire resistance, acoustic properties and resistance to aggressive environment are also presented. Apart from this, the paper reports a brief outline of various applications of foam concrete.

3. Materials Used

3.1. Materials

GGBS, EPS, water, Ordinary Portland Cement (OPC) are the components utilized in this analysis. The physical properties of the materials were evaluated.

3.2 Cement:

Ordinary Portland cement, as defined by Indian Standard Specification IS: 8112 is the type of cement used in this study as a binder as shown in Figure 1. The cement has a 1254 kg/m3 particle density.

Fig. 1: Ordinary Portland cement

3.3 GGBS:

GGBS (Ground Granulated Blast-furnace Slag) is a cementitious material whose main use is in concrete and is a by-product from the blast-furnaces used to make iron. Fig. 2 shows the GGBS.

Fig. 2: GGBS

3.4 Expanded polystyrene beads:

Figure 3 shows the sizes of the expanded polystyrene beads used in this analysis, which range from 1.18 to 2.36 mm. The EPS has a specific gravity of 0.01 and a bulk density of 30 kg/m^3, in addition to a particle density of 17.92 kg/m^3.

Fig. 3: EPS from the factory

3.5 Water:

Cement requires water as a crucial material. These two materials will react to produce cementing properties as a binder. The water that is utilised purity is required and free of any impurities because any dirt or impurity can change the chemical reaction between cement and water. For mixing, portable tap water is used. Weight is used to calculate the cement to water ratio, which is 0.5.

4. Results & Discussion

The below table (1) shows the parameters comparison for conventional light weight bricks integrated air vents polystyrene in light weight brick. In this performance, test capability and life time are given in detail manner.

Table. 1: Comparison of Parameters

S.NO	PARAMETER	CONVENTIONAL LIGHTWEIGHT BRICKS	INTEGRATING AIR VENTS AND POLYSTYRENE IN LIGHT WEIGHT BRICK
1	Performance	76%	93%
2	Test capability	81%	97%
3	Life Time	62%	96%

Comparison of performance and test capability is shown in below figure (4) for conventional light weight bricks, integrated air vents and polystyrene in light weight brick. Compared with conventional light weight bricks and integrated air vents, polystyrene in light weight brick improve performance and test capability.

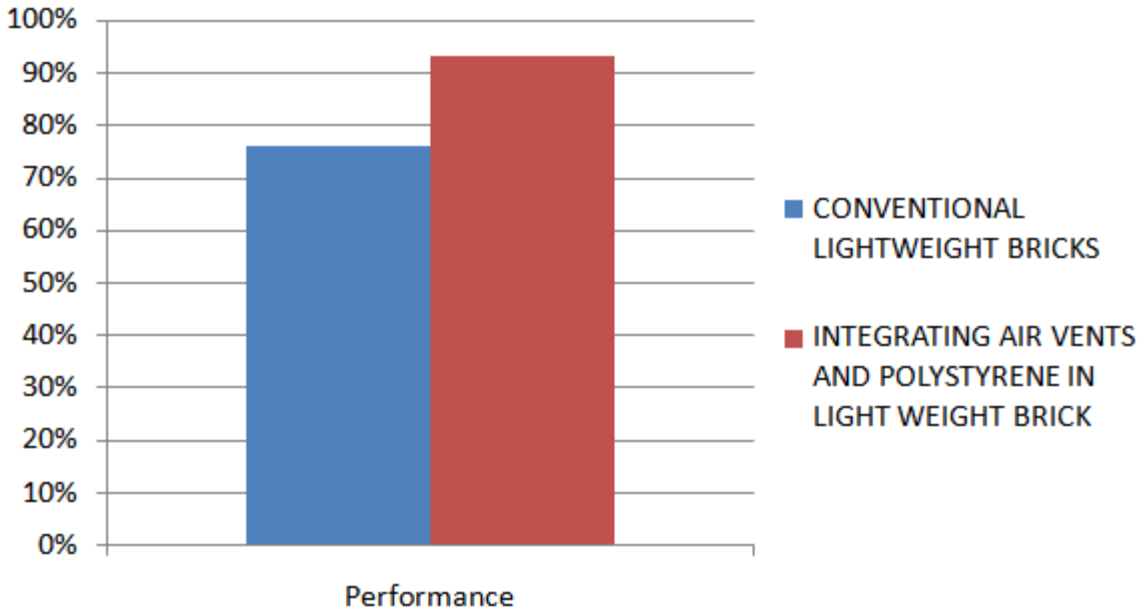

Fig. 4: Comparison of Performance

Comparison of test capability is shown in below figure (6) for conventional light weight bricks, integrated air vents and polystyrene in light weight brick. Compared with conventional light weight bricks and integrated air vents, polystyrene in light weight brick improve test capability.

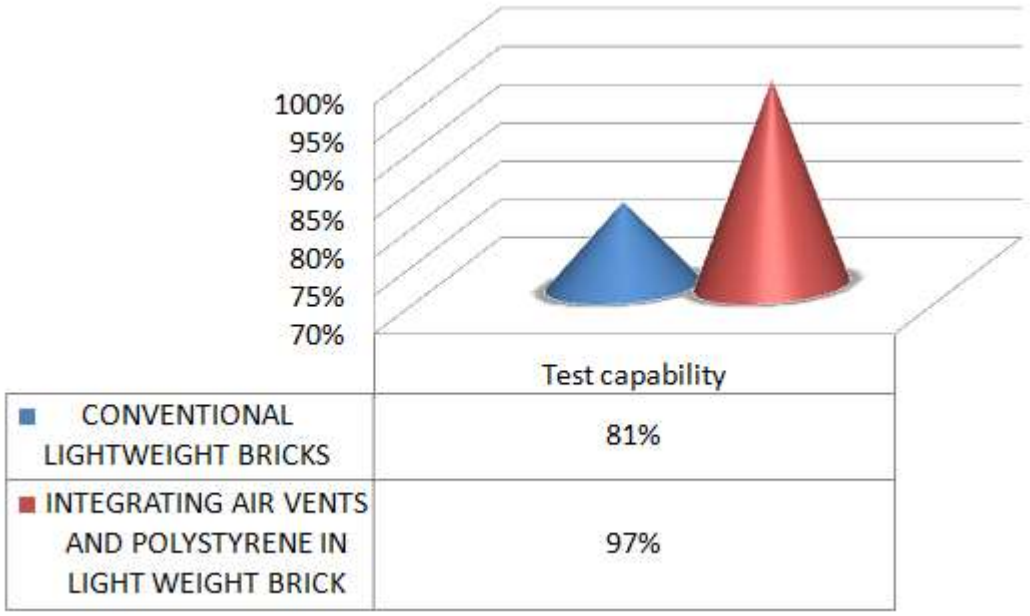

Fig. 5: Test Capability

Comparison of lifetime is shown in below figure (6) for conventional light weight bricks, integrated air vents and polystyrene in light weight brick. Compared with conventional light weight bricks and integrated air vents, polystyrene in light weight brick improve life time.

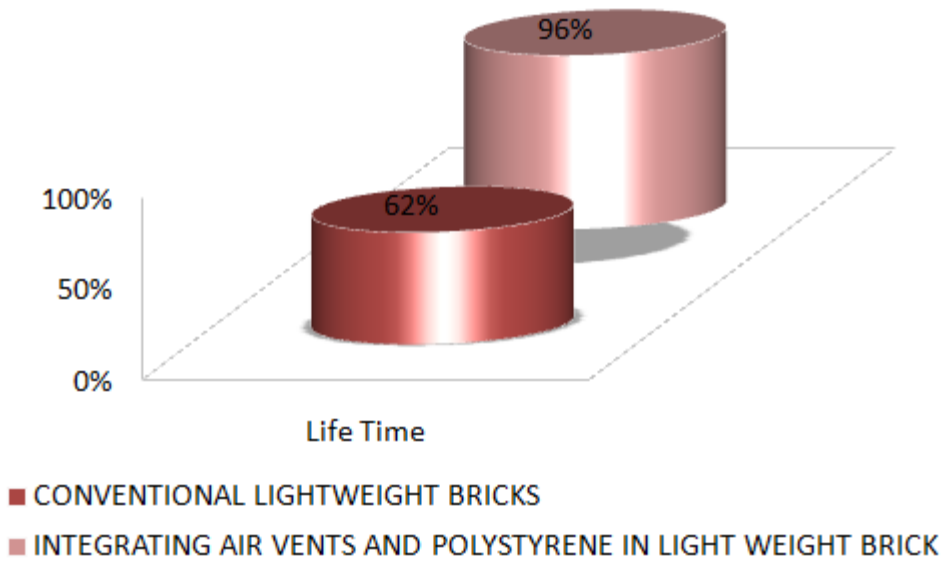

Fig. 6: Comparison of Life Time

5. Conclusion

In hot desert environments, the building envelope has a significant impact on heat transfer into buildings. Walls are important heat conductors for similar reasons due to their large surface areas and high thermal conductivities. To reduce the interior's susceptibility to heat stress, it has produced a wide range of lightweight bricks. It is possible to observe that life time, performance and test capability is increased in polystyrene in light weight bricks compared with conventional light weight bricks.

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