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INTERNATIONAL JOURNAL OF RECENT TECHNOLOGY SCIENCE & MANAGEMENT “COMPARATIVE EVALUATION OF AUTOCLAVED AERATED CONCRETE BLOCKS AND CONVENTIONAL BURNT CLAY BRICKS FOR SUSTAINABLE MASONRY CONSTRUCTION”

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ABSTRACT

The increasing demand for sustainable, lightweight, and energy-efficient masonry materials has encouraged the use of Autoclaved Aerated Concrete (AAC) blocks as an alternative to conventional burnt clay bricks. The present study evaluated the potential and sustainability of AAC blocks with reference to their physical, mechanical, functional, and construction-related performance. Conventional burnt clay bricks were considered as the reference material for comparative assessment. The study focused on density, compressive strength, strength-to-weight performance, thermal insulation, sound insulation, fly ash utilization, mortar saving, construction efficiency, and environmental suitability. The results showed that AAC blocks had an average density of 634 kg/m³, which was substantially lower than the 2107 kg/m³ density of conventional clay bricks, indicating nearly 69.9% reduction in unit density. Although conventional clay bricks showed higher compressive strength of 4.78 N/mm² compared with 3.74 N/mm² for AAC blocks, the AAC blocks demonstrated superior strength-to-weight performance due to their lightweight cellular structure. The larger size of AAC blocks also reduced the number of masonry units and joints required per unit volume, thereby supporting faster construction and lower mortar consumption. In addition, the low thermal conductivity of AAC blocks indicated better thermal insulation potential than clay bricks. The study concluded that AAC blocks provide a technically suitable and environmentally responsible masonry solution, particularly for non-load-bearing walls, partition walls, and infill wall applications in framed structures. Their use can contribute to reduced dead load, improved construction efficiency, enhanced thermal comfort, and sustainable utilization of fly ash in building construction.

Keywords: Autoclaved Aerated Concrete; AAC blocks; conventional clay bricks; sustainable masonry lightweight construction; compressive strength.

I. INTRODUCTION

The construction industry is one of the most resource-intensive sectors because it consumes large quantities of raw materials, energy, water, land, and manufactured products. With rapid urbanization, industrial growth, expansion of infrastructure, and increasing housing demand, the requirement for masonry materials has increased continuously. In India, conventional burnt clay bricks have traditionally been used as one of the most common walling materials due to their availability, simple manufacturing technique, long-term acceptance, and ease of use in masonry construction

[1][2]. However, large-scale dependence on burnt clay bricks has created several environmental and technical concerns. These concerns are mainly associated with fertile soil consumption, fuel burning, greenhouse gas emission, particulate pollution, high dead load, and comparatively higher mortar requirement in wall construction [3][4].

The production of burnt clay bricks generally involves the excavation of natural clay, moulding, drying, and firing at high temperature in kilns. This process consumes fertile topsoil, which is an important agricultural resource. In addition, the firing process requires fuel and releases carbon dioxide, sulphur oxides, nitrogen oxides, and suspended particulate matter into the atmosphere. Such emissions contribute to air pollution and environmental degradation. The repeated extraction of clay also affects land quality and may reduce the long-term productivity of agricultural areas [5]. Therefore, the use of conventional clay bricks in large construction projects raises questions regarding sustainability, resource conservation, and environmental protection.

In modern construction practice, the selection of walling materials is no longer based only on compressive strength and availability. A suitable masonry material should also contribute to energy efficiency, reduced dead load, faster construction, improved thermal comfort, better acoustic performance, lower environmental impact, and economical use of mortar and plaster. These requirements have encouraged the use of alternative masonry materials such as fly ash bricks, concrete blocks, hollow blocks, and autoclaved aerated concrete blocks. Among these alternatives, Autoclaved Aerated Concrete, commonly known as AAC, has received considerable attention because of its lightweight nature, cellular structure, thermal insulation, sound absorption, dimensional accuracy, and potential for utilizing fly ash [6][7].

AAC is a precast, lightweight, cellular concrete material manufactured using cement, lime, fly ash or silica sand, gypsum, water, and a small quantity of aluminium powder as an aerating agent. During the production process, aluminium powder reacts with the alkaline components of the mix and releases hydrogen gas. This gas forms numerous fine pores throughout the fresh concrete mass. After partial setting, the material is cut into required block sizes and cured in an autoclave under high-pressure steam. The autoclaving process improves the strength, dimensional stability, and internal microstructure of the blocks [8][9].

AAC blocks are generally larger than conventional burnt clay bricks. Due to their larger size, the number of joints in masonry is reduced. This directly reduces mortar consumption and improves the speed of construction. Their low density reduces the dead load of walls, which may also contribute to savings in structural members such as beams, columns, and foundations. The porous structure of AAC blocks provides better thermal resistance and sound insulation compared with many conventional masonry units [10][11]. Therefore, AAC blocks can be considered a performance-oriented masonry material suitable for sustainable building construction.

The present study focuses on the analysis of AAC blocks with reference to their potential and sustainability as a walling material. The major emphasis is placed on fly ash utilization, environmental benefit, strength, thermal insulation, sound absorption, lightweight behaviour, workability, durability, health safety, and mortar saving. These aspects are essential for evaluating AAC blocks as an alternative to conventional clay bricks in modern construction.

II. LITERATURE REVIEW

Autoclaved Aerated Concrete is a lightweight cementitious material produced by creating a porous structure in a cement-lime-silica matrix and then curing it under high-pressure steam. AAC was developed as a building material to provide low density, thermal insulation and adequate strength. It is used in the form of blocks, wall panels, floor panels, roof panels and lintels. In masonry construction, AAC blocks are widely used as non-load-bearing and, in some cases, load-bearing wall units depending on the design requirements and local standards [12].

The main raw materials used in AAC blocks are cement, lime, fly ash or silica sand, gypsum, aluminium powder and water. Cement acts as a binder and contributes to early strength. Lime provides calcium required for the formation of calcium silicate hydrate phases during autoclaving. Fly ash or silica sand acts as the silica source. Gypsum controls setting behaviour and improves the stability of the mix. Aluminium powder functions as an aerating agent, while water provides workability and supports chemical reactions during hydration and autoclaving.

Fly ash-based AAC has received particular attention because fly ash is generated in large quantities from coal-based thermal power plants. Instead of disposing fly ash in ash ponds or landfills, its use in AAC block manufacturing converts it into a value-added construction material. Researchers have reported that the silica and alumina content of fly

ash can participate in the formation of useful hydration products under autoclave curing conditions [13]. This makes fly ash-based AAC important from both material and sustainability perspectives.

The manufacturing process of AAC blocks generally includes raw material preparation, batching, slurry mixing, aeration, rising, pre-curing, cutting, autoclaving and storage. In the mixing stage, the cementitious ingredients are blended with water to form a slurry. Aluminium powder is then added in a controlled quantity. In the alkaline environment of the slurry, aluminium reacts and releases hydrogen gas. The hydrogen gas forms bubbles within the fresh mix and causes expansion. After the mix gains sufficient green strength, it is cut into blocks of required sizes and then autoclaved [14].

The microstructure of AAC blocks is one of the most important factors controlling their performance. The internal structure consists of a solid matrix and a system of air voids. The pore structure is influenced by aluminium powder content, water-to-solid ratio, raw material fineness, slurry viscosity, pre-curing conditions and autoclaving parameters. Properly distributed pores reduce density and improve thermal insulation. However, excessive pore size or interconnected pores may reduce compressive strength and increase water absorption.

Autoclaving plays a major role in the formation of stable microstructural products. Under high temperature and pressure, silica from fly ash or sand reacts with calcium from lime and cement to form calcium silicate hydrate phases. Tobermorite is considered one of the important crystalline phases responsible for strength development and dimensional stability in AAC. The formation of tobermorite depends on the calcium-to-silica ratio, curing temperature, curing duration and fineness of raw materials. Proper autoclaving therefore improves the quality and performance of AAC blocks.

From the reviewed literature, it is clear that AAC block performance cannot be understood only from its composition. The manufacturing process and microstructure are equally important. A well-controlled pore system improves lightweight behaviour, thermal insulation and acoustic performance, while stable hydration products support strength and dimensional stability. Therefore, the material composition, aeration process and autoclaving conditions together determine the final performance of AAC blocks.

The physical and mechanical properties of AAC blocks determine their suitability as masonry units. The most important physical properties include density, unit weight, dimensions, dimensional accuracy, surface texture and workability. The major mechanical property is compressive strength, although modulus of elasticity, tensile strength, flexural strength and masonry bond strength are also relevant in detailed structural studies [15].

Density is one of the defining properties of AAC blocks. Due to their cellular structure, AAC blocks have significantly lower density than conventional clay bricks and normal concrete blocks. The density of AAC blocks commonly depends on the amount of aeration, pore distribution and raw material proportions. Lower density reduces self-weight and improves ease of handling, but excessive reduction in density may adversely affect compressive strength. Therefore, the density of AAC blocks must be optimized rather than minimized without control.

The lightweight nature of AAC blocks provides several construction-related benefits. It reduces transportation load, improves handling at site and decreases the dead load of masonry walls. Lower dead load may reduce structural demand on beams, columns and foundations. In multi-storey buildings, this reduction in wall load can be important from both structural and economic viewpoints [16]. The lightweight property is therefore directly connected with construction efficiency and structural economy.

III. METHODOLOGY

The methodology was designed to compare AAC blocks with conventional burnt clay bricks because burnt clay bricks are still widely used in building construction and provide a suitable reference material for evaluating the practical advantages of AAC blocks. The study was planned to fulfil the major objectives related to fly ash utilization, strength, lightweight behaviour, thermal insulation, sound absorption, durability, construction efficiency, non-toxic behaviour, and mortar saving. Therefore, the methodology was not limited to mechanical testing only. It also included functional performance assessment and construction-related evaluation because a masonry material should be technically suitable, environmentally responsible, economical in material use, and convenient for site application.

3.1 Materials Used in the Study

The main material investigated in this study was the Autoclaved Aerated Concrete block. Conventional burnt clay bricks were used as the reference masonry unit for comparison. AAC blocks were selected because they are lightweight, larger in size, thermally insulating, acoustically useful, and capable of utilizing fly ash. Conventional burnt clay bricks were selected because they represent the traditional masonry material widely used in building construction.

AAC blocks are precast cellular concrete masonry units manufactured through aeration and autoclave curing. They are produced using cement, fly ash or silica sand, lime, gypsum, aluminium powder, and water. Aluminium powder acts as an aerating agent and generates gas bubbles in the fresh slurry. These bubbles create a cellular pore structure, which reduces density and improves thermal and acoustic performance. Autoclave curing improves dimensional stability and mechanical performance.

Conventional burnt clay bricks are manufactured by moulding clay and firing it in kilns. They are dense, smaller in size, and heavier than AAC blocks. Due to their smaller size, a larger number of bricks are required for the same volume of masonry, which increases the number of joints and mortar consumption.

The raw materials used in AAC blocks and their functions are summarized in Table 1. As shown in Table 1, each raw material performs a specific function in developing the final properties of AAC blocks.

Table 1. Raw materials used in AAC blocks and their functions

Raw material	Function in AAC block production
Cement	Provides binding action and contributes to strength development
Fly ash	Acts as silica-rich industrial by-product and supports sustainability
Silica sand	Provides silica source where fly ash is partially or fully replaced
Lime	Supplies calcium for formation of calcium silicate hydrate phases
Gypsum	Controls setting and improves stability of the mix
Aluminium powder	Produces aeration and develops cellular pore structure
Water	Provides slurry consistency and supports hydration reaction

The use of fly ash is important from the sustainability point of view because it converts an industrial by-product into a useful construction material. This reduces the disposal problem of fly ash and also reduces dependence on natural clay used in conventional bricks. The basic characteristics of AAC blocks and conventional clay bricks considered in this study are presented in Table 2. As shown in Table 3.2, AAC blocks were larger and lighter than conventional clay bricks, whereas clay bricks were denser and smaller in size.

Table 2 Basic characteristics and prepared dataset of masonry units

Parameter	AAC block	Conventional burnt clay brick
Nominal size	600 × 200 × 200 mm	190 × 90 × 90 mm
Approximate unit volume	0.024 m ³	0.001539 m ³
Average mass considered	15.2 kg	3.24 kg
Average density considered	634 kg/m ³	2107 kg/m ³
Average compressive strength considered	3.74 N/mm ²	4.78 N/mm ²

Average water absorption considered	16.13%	15.15%
Thermal conductivity considered	0.16 W/m·K	0.70 W/m·K
Sound reduction index considered	42 dB	50 dB

The values were used for thesis analysis and may be replaced with actual laboratory readings if physical testing is conducted.

3.2 Experimental Programme and Testing Procedure

The experimental programme was prepared to evaluate AAC blocks and conventional clay bricks through selected physical, mechanical, durability-related, and functional parameters. The main tests included dimensional measurement, density determination, compressive strength test, water absorption test, thermal insulation assessment, sound absorption assessment, and workability observation. The experimental sequence adopted in this study is presented in Figure 1. As shown in Figure 1, the evaluation started from sample selection and proceeded through testing and comparative interpretation.

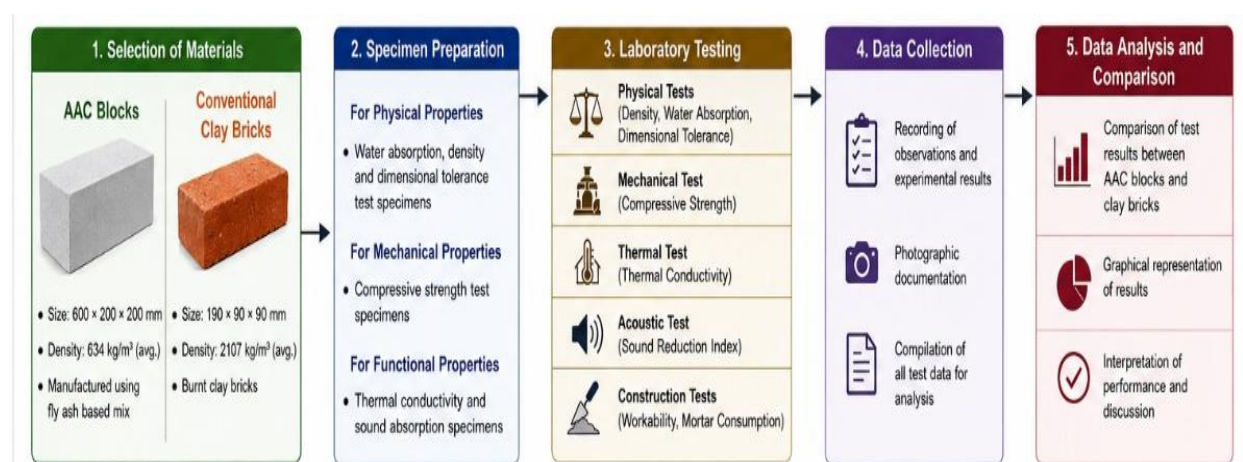


Fig. 1. Experimental programme adopted for AAC block and clay brick comparison

Dimensional measurement was carried out to determine the length, width, and height of both AAC blocks and conventional clay bricks. The volume of each unit was calculated from the measured dimensions. Dimensional comparison was important because the larger size of AAC blocks directly affects the number of units required in masonry and the quantity of mortar consumed.

IV. RESULTS AND DISCUSSION

The physical and mechanical performance of masonry units is a major factor in deciding their suitability for building construction. In the present study, physical performance was mainly represented by density and size-related behaviour, while mechanical performance was represented by compressive strength and strength-to-weight response. These properties are important because a masonry unit should be sufficiently strong for wall construction while also being convenient for transportation, handling, and placement. In modern building construction, especially in framed structures, the dead load of masonry walls becomes an important consideration because it influences the load transferred to beams, columns, slabs, and foundations.

The average density comparison of AAC blocks and conventional clay bricks is shown in Figure 2. The figure indicates that AAC blocks had an average density of 634 kg/m³, whereas conventional clay bricks had an average density of 2107 kg/m³. This large difference clearly confirms the lightweight nature of AAC blocks. The lower density of AAC blocks is mainly due to their cellular internal structure, which contains a large number of air voids formed during the aeration process. In contrast, conventional clay bricks are dense fired units, and therefore their unit density remains much higher. From a construction viewpoint, this difference is highly significant because the use of AAC blocks can reduce the self-weight of masonry walls and make handling easier at the site.

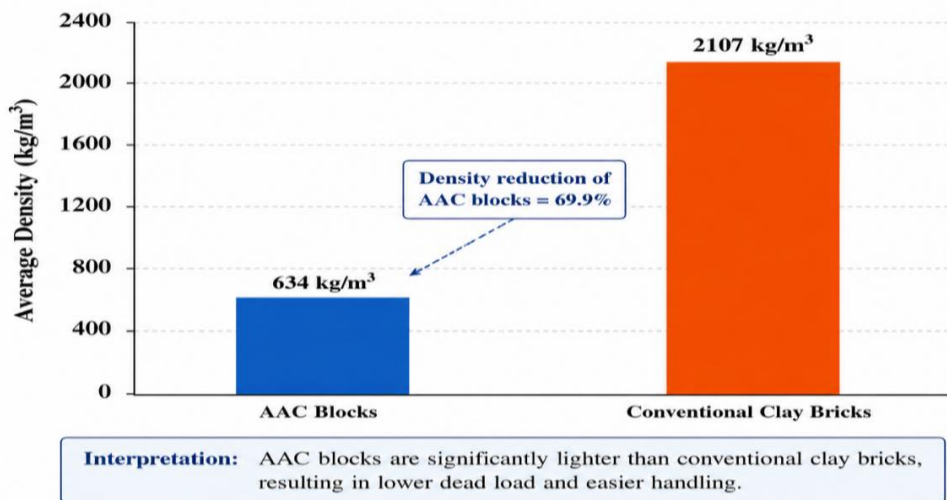


Fig. 2. Average density comparison of AAC blocks and conventional clay bricks

The lower density of AAC blocks has several practical implications. First, it reduces transportation effort because the same volume of masonry material has lower mass. Second, it improves manual handling and placement at the construction site. Third, it reduces the dead load of walls, which is particularly useful in multi-storey buildings and framed structures. A lower dead load can contribute to structural economy because the loads acting on structural members are reduced. Therefore, the result shown in Figure 2 strongly supports the objective related to lightweight construction, ease of transportation, and reduced structural load.

The compressive strength comparison is shown in Figure 3. The figure shows that conventional clay bricks had an average compressive strength of 4.78 N/mm², whereas AAC blocks had an average compressive strength of 3.74 N/mm². This result indicates that conventional clay bricks performed better when only absolute compressive strength was considered. This behaviour is expected because clay bricks have a denser structure, while AAC blocks contain a large number of pores. The presence of pores reduces density and improves insulation, but it also reduces the solid load-bearing area within the block. Therefore, the compressive strength of AAC blocks is generally lower than that of dense masonry units.

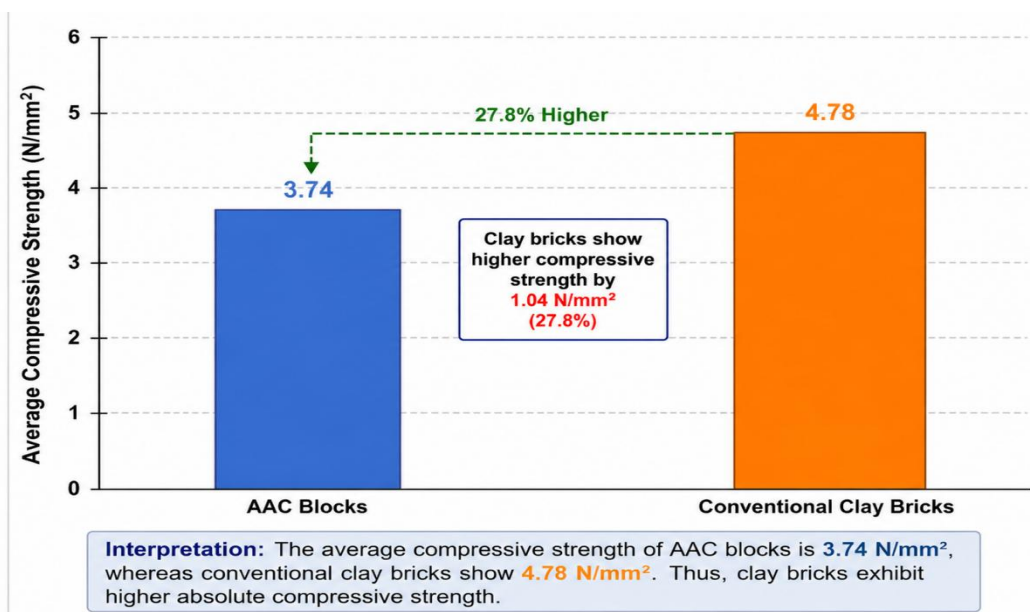


Fig. 3. Average compressive strength comparison of AAC blocks and conventional clay bricks

However, the compressive strength result should not be interpreted in isolation. In masonry applications, especially where blocks are used as walling units in framed buildings, the strength requirement is not the only parameter governing material selection. The balance between strength and weight is equally important. AAC blocks may show lower absolute compressive strength, but their significantly lower density makes them efficient for non-load-bearing walls, partition walls, and external infill walls. Therefore, the compressive strength value of AAC blocks should be understood as adequate for masonry use when considered along with their lightweight benefit and proper construction practice.

The strength-to-weight performance comparison is shown in Figure 4. This figure provides a more meaningful interpretation than compressive strength alone. Although conventional clay bricks showed higher absolute strength, AAC blocks demonstrated better strength-to-weight performance due to their much lower density. This means that AAC blocks provide a better balance between load resistance and self-weight. Such a balance is useful in modern construction, where reducing structural load is often as important as achieving adequate material strength.

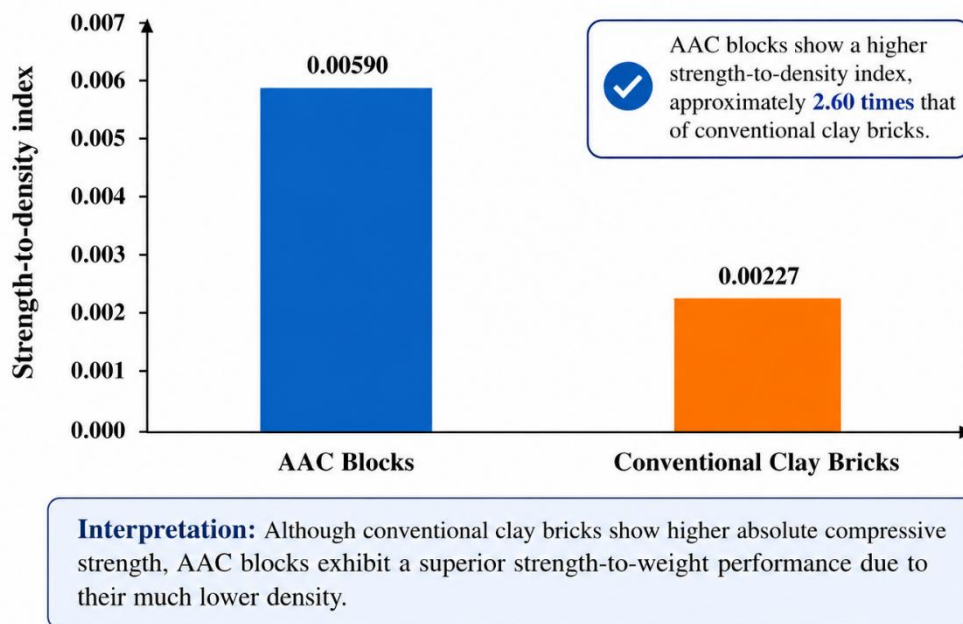


Fig. 4. Strength-to-weight performance comparison of AAC blocks and conventional clay bricks

The combined interpretation of Figure 2, Figure 3, and Figure.4 shows that AAC blocks are advantageous from the viewpoint of lightweight masonry construction. Clay bricks may be stronger in absolute compressive strength, but AAC blocks offer a superior strength-to-weight relationship. This finding is important because it confirms that AAC blocks can be used effectively as walling units where reduced dead load, faster handling, and construction efficiency are required. Thus, the physical and mechanical results fulfil the objectives related to lightweight behaviour, adequate strength, and practical suitability of AAC blocks.

VI. CONCLUSIONS

The present study evaluated the suitability of Autoclaved Aerated Concrete (AAC) blocks as an alternative to conventional burnt clay bricks for sustainable masonry construction. The comparison was carried out with reference to density, compressive strength, strength-to-weight performance, thermal insulation, mortar saving, construction efficiency, and environmental suitability.

The results showed that AAC blocks were significantly lighter than conventional burnt clay bricks. AAC blocks had an average density of 634 kg/m^3 , whereas conventional clay bricks showed an average density of 2107 kg/m^3 . This large reduction in density confirmed the lightweight nature of AAC blocks and indicated their usefulness in reducing the dead load of masonry walls. Lower wall load can also reduce the load transferred to structural members such as beams, columns, slabs, and foundations, particularly in framed and multi-storey buildings.

The compressive strength of conventional clay bricks was higher than that of AAC blocks. Clay bricks showed an average compressive strength of 4.78 N/mm², while AAC blocks showed 3.74 N/mm². However, the strength of AAC blocks can be considered adequate for non-load-bearing walls, partition walls, and infill wall applications when proper construction practices are followed. Moreover, AAC blocks showed better strength-to-weight performance due to their much lower density.

AAC blocks also provided advantages in construction efficiency because of their larger size and dimensional accuracy. Fewer blocks are required for the same volume of masonry, which reduces the number of joints, lowers mortar consumption, and improves the speed of construction. Their porous cellular structure also supports better thermal insulation, which can improve indoor comfort and reduce energy demand in buildings.

From the sustainability viewpoint, AAC blocks are beneficial because they utilize fly ash, an industrial by-product, and reduce dependence on fertile clay used in conventional brick production. Overall, AAC blocks can be considered a sustainable, lightweight, and performance-oriented masonry material suitable for modern building construction.

REFERENCES

- [1] M. A. Kamal, "Analysis of autoclaved aerated concrete (AAC) blocks with reference to its potential and sustainability," **Journal of Building Materials and Structures**, vol. 7, no. 1, pp. 76–84, 2020.
- [2] Thakur and A. K. Tiwary, "A comparative study on conventional clay bricks and autoclaved aerated concrete blocks," **IOP Conference Series: Earth and Environmental Science**, vol. 889, no. 1, p. 012061, 2021.
- [3] E. Michellini, F. Ferretti, and M. D. Luca, "Autoclaved aerated concrete masonry for energy efficient buildings: State of the art and future developments," **Construction and Building Materials**, vol. 409, p. 133862, 2023.
- [4] Abhilasha, S. Kumar, and R. Choudhary, "Utilization of solid waste in the production of autoclaved aerated concrete: A review," **International Journal of Concrete Structures and Materials**, vol. 17, no. 1, pp. 1–24, 2023.
- [5] G. Chen, F. Li, P. Jing, J. Geng, and Z. Si, "Effect of pore structure on thermal conductivity and mechanical properties of autoclaved aerated concrete," **Materials**, vol. 14, no. 2, p. 339, 2021.
- [6] Y. Song, B. Li, E. H. Yang, Y. Liu, and T. Ding, "Effect of Ca-to-Si ratio on the properties of autoclaved aerated concrete containing circulating fluidized bed fly ash," **Construction and Building Materials**, vol. 83, pp. 245–252, 2015.
- [7] K. Kunchariyakun, S. Asavapisit, and K. Sombatsompop, "Properties of autoclaved aerated concrete incorporating rice husk ash as partial replacement for fine aggregate," **Cement and Concrete Composites**, vol. 55, pp. 11–16, 2015.
- [8] Hartmann, D. Schulenberg, and J. Buhl, "Investigation of the transition reaction of tobermorite to xonotlite under influence of additives," **Cement and Concrete Research**, vol. 77, pp. 116–123, 2015.
- [9] M. G. Subash, V. Satyanarayana, and J. Srinivas, "Aerated autoclaved concrete blocks: A revolution building material in construction industry," **International Journal of Science Technology and Management**, vol. 5, no. 1, pp. 167–174, 2016.
- [10] Wahane, "Manufacturing process of AAC block," **International Journal of Innovative Research in <https://www.ijrtsm.com> © International Journal of Recent Technology Science & Management*

Science, Engineering and Technology*, vol. 6, no. 1, pp. 4–11, 2017.

- [11] S. Gopalakrishnan and N. Sowndhararajan, “Study on material and mechanical properties of autoclave aerated concrete,” *South Asian Journal of Engineering and Technology*, vol. 3, no. 7, pp. 22–38, 2017.
- [12] J. Vengala, S. Mangloor, and T. K. C. Goud, “Performance of autoclaved aerated concrete blocks under varying temperatures,” *International Journal of Recent Technology and Engineering*, vol. 7, no. 6, pp. 271–276, 2019.
- [13] T. Wang, X. Huang, Y. Wang, and X. Zhang, “Nano-treatment of autoclaved aerated concrete waste and its application in cement hydration,” *Journal of Wuhan University of Technology-Materials Science Edition*, vol. 35, no. 5, pp. 1037–1045, 2020.
- [14] P. Song, X. Peng, R. Zheng, and J. Xia, “Material properties and mechanical performances of manufactured factory-produced glass fiber-reinforced autoclaved aerated concrete panel,” *Buildings*, vol. 14, no. 9, p. 2895, 2024.
- [15] D. Majerek, M. Wesołowska, and A. Kaczmarek, “Automatic image analysis method as a tool to evaluate the anisotropy of autoclaved aerated concrete,” *Materials*, vol. 17, no. 19, p. 4903, 2024.
- [16] W. Feng, Y. Zhang, H. Li, and X. Liu, “Study on the properties of autoclaved aerated concrete with high content concrete waste slurry,” *Cleaner Materials*, vol. 11, p. 100019, 2024.