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Result Analysis on Innovation in Construction Material Management for Enhanced Project Performance

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Abstract: *The building sector has a big impact on the environment and the world's resource usage. As a result, novel materials are being used more and more in sustainable construction techniques to lessen their negative effects on the environment, increase energy efficiency, and improve the overall sustainability of infrastructure and buildings. This analysis looks at the most recent developments in cutting-edge materials for sustainable building and how they might completely change the building industry. The review starts off by listing the main issues that the construction sector is dealing with, such as waste production, carbon emissions, and resource depletion. It then looks at how novel materials can help with these issues, stressing how they can be more durable, use less energy, and have less lifespan costs than more conventional materials. A number of cutting-edge materials are covered, such as recycled aggregates, engineered wood products, and materials derived from biotechnology. The utilisation of engineered wood products, including cross-laminated timber, as sustainable substitutes for conventional building materials is on the rise because of its robustness, longevity, and capacity to sequester carbon.*

Keywords: Negative Effects, Environment, Increase Energy, Efficiency, Improve Sustainability, Infrastructure, Buildings

I. INTRODUCTION

Due to the numerous governing factors involved, the construction sector is one of the most sophisticated and demands a significant amount of planning and study. These elements are regarded as the difficulties in accomplishing prosperous building projects. The nation's vision, financial stability, people and cultural awareness, logistics and project location, transportation, resource availability, country stability and security, time constraints, and construction specifications and standards are a few examples of these elements. A method of designing, constructing, and operating buildings with the goal of minimising negative effects on the environment, conserving resources, and producing hygienic, energy-efficient structures and infrastructure is called sustainable construction, sometimes referred to as green building or eco-friendly construction (Iqbal et al., 2021, Umoh et al., 2024, Vijayan et al., 2023). It is motivated by the realisation that the building sector has substantial negative effects on the environment and society, including waste production, carbon emissions, and resource depletion. By incorporating sustainable practices throughout a building's whole lifecycle from design and construction to operation and demolition sustainable construction seeks to address these issues (Abatan, et al., 2024, Adekanmbi, et al., 2024, Hossain, et al., 2020, Ogugua, et al., 2024). Innovative material utilisation is one of the main tenets of sustainable construction. Innovative building materials provide long-term substitutes for conventional ones, frequently through increased durability, less energy usage, and cheaper lifespan costs. These supplies are necessary to achieve the objectives of lowering environmental effect and improving building performance, as well as to advance sustainable construction methods. It is impossible to exaggerate the significance of novel materials in environmentally friendly building. Traditional building materials with large energy consumption and carbon emissions during production, like brick, steel, and concrete, have a substantial negative impact on the environment.

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II. CONSTRUCTION MATERIALS

(i) Green-mix concrete- Green blend Concrete is a novel building material that is more robust, long-lasting, and ecologically benign. To create sustainable goods, these concrete elements are combined with appropriate industrial or agricultural waste and recycled materials.

(ii) Geometric microstructure- In order to protect structures against seismic disasters, some researchers have developed a way to alter how waves pass through materials without changing the structural composition of the material. Scientists have effectively created a microstructure pattern made of steel plates that can flex and produce acoustic waves. The diverted waves transfer massive energy from tsunamis to residential buildings via a metamaterial veil property.

(iii) Glass and plastic- Plastic and glass are included in this cutting-edge movement. These days, glass and plastic are used to create several inventive materials. Certain types of glass materials, like those that are fire, impact, explosion, and bullet resistant, are currently available in Polish markets. Certain completed goods exhibit superior mechanical strength more than three to six times that of ordinary glass as well as strong thermal resistance and resilience to temperature fluctuations. They are superior materials because they can withstand heavy loads in structural contexts like building facades and skylights, as well as shield noise in streets and highways. Research indicates that high molecular weight plastics are appropriate for use in construction because of their low flexibility, light weight, strong chemical resistance, and light transmittance.

III. PRODUCTION OF BRICKS

There has been a major technological breakthrough in the production of durable, reliable and high strength bricks.

(i) Use of Cigarette Butts in Production of Bricks- Dziadosz & KoŁczak said that bricks made from a cigarette butt are lighter, more effective, and more efficient due to innovations in building materials.

Figure 1- Cigarette Butt Bricks

(ii) Pollution absorbing bricks- Thermal insulation made of pollution-absorbing bricks was included in the building's regular ventilation system. It is composed of interior insulation and an external façade system made of bricks. The matter particles suspended in the detachable hopper at the base wall are divided by the filtering system within the brick. In addition to improving air quality, bricks also lessen breathing issues caused by the air.

(iii) Three Dimensional Printing (3DP) in Civil Engineering- One method of connecting or solidifying elements to form a three-dimensional item using a combination of materials (such as liquid molecules or powdered grains) under computer control is 3D printing. Rapid prototyping and additive manufacturing are two applications for 3D printing. With the use of 3D model data, objects with nearly any geometry or form can be created. In a construction site, the printer creates in-situ earthenware blocks with an auxiliary capacity design. It takes 15 to 20 minutes to mass make these bricks. Stacked hardened bricks can be used to create pillars, vaults, or walls. Studies on the use of 3D in civil engineering construction have been conducted.

(iv) Cooling system in bricks- Hydrogel and Clay together produce a material with a cooling advantage on the interior of the building. Hydro-ceramics can reduce the temperature indoors by 6 ^{o} C. Its cooling effect is due to the presence of hydrogel absorbing large amounts of water. The absorbed water decreases temperature when heat is present.

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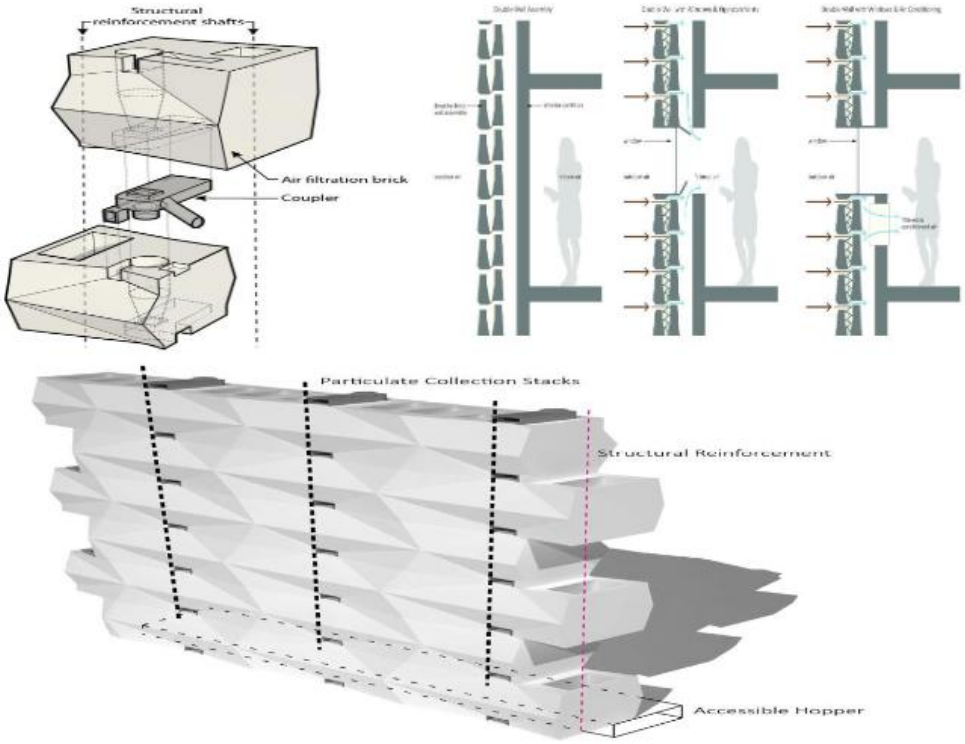

Figure 2- Pollution absorbing bricks

IV. RESULTS ANALYSIS

The findings demonstrate the recent growth in the field of construction innovation research. The quantity of journal articles on construction innovation that have been published has significantly increased within the past two years. This would have been aided by the two special editions of journals on building innovation, but the rise will also be a sign of recently concluded publicly supported research projects aimed at enhancing the performance of the construction sectors in terms of innovation. Cronbach's alpha coefficient was employed in this study to evaluate the reliability of the questions. SPSS was used to assess the Likert scale questions' dependability. The Cronbach's alpha co-efficient test results are shown in Table 1, and they were deemed satisfactory based on Maree's suggested reliability test requirements (2007).

Heading	No of items	Cronbach's alpha	Rank
Effective material management practices	**14**	**0.84**	**Moderate**

Table 1- Reliability analysis

Figure 3 demonstrates that just 11.9% of survey respondents were between the ages of 50 and 59, whereas 54.2% of respondents were between the ages of 26 and 39 and 23.7% were between 40 and 49. 10.2% of the population was in the 18–25 age range at the same moment. The age range that predominated, which was 26 to 39, suggests that SME contractors employ the majority of recent graduates.

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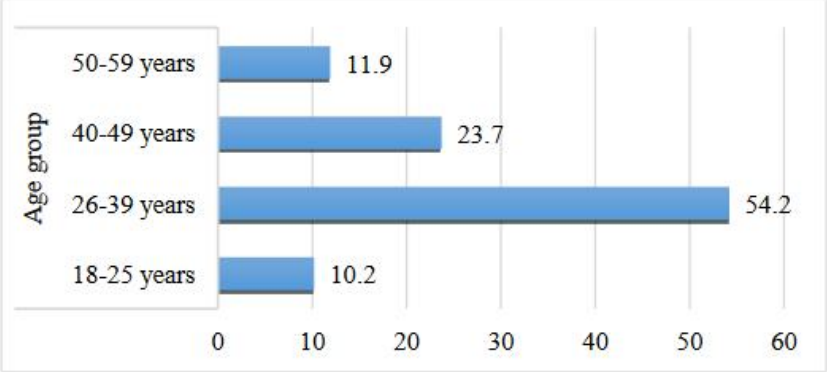

Figure 3- Age group of respondents

In terms of relevant industry experience, Figure 4 indicates that 37.3% of the respondents had between 1 to 5 years of experience, whereas the remaining 62.7% had more than 5 years of industry experience.

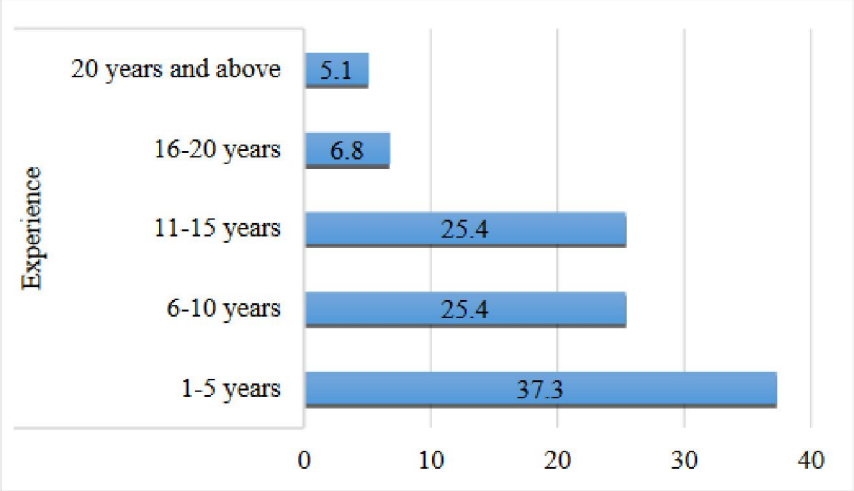

Figure 4- Experience of respondents

V. CONCLUSION

One of the developments in the field of building materials is the creation of Super Ductile Rebars, which are utilised in earthquake situations. There were documented success stories in the field of converting wastes into riches. In construction projects, the cost of the materials used could account for up to 40% of the total project cost. It is crucial to prioritise meeting certain criteria before implementing innovative construction materials. These include but are not limited to sustainability, durability, dependability, safety, economy, improved quality, enhanced mechanical and physical characteristics, flexibility in harsh environments, ease of assembly, and environmental friendliness. This study offers the most recent data on a number of cutting-edge building materials that are now on the market to the construction industry. This will provide even more value to the building material database.

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