

Application of Energy Saving and Green Environmental Protection Building Materials in Building Engineering

Yixin Peng*

Hainan Vocational University of Science and Technology, Haikou 570203, Hainan, China

*Author to whom correspondence should be addressed.

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Abstract: Construction engineering plays a vital role in urban development, especially as the pace of modern progress continues to accelerate. The widespread use of energy-saving and green environmental protection building materials in this field not only brings convenience to daily life but also promotes the scientific, sustainable, and stable development of construction projects. These materials significantly extend the service life of buildings while supporting environmental protection efforts. This paper explores the practical application value of energy-saving and environmentally friendly building materials in construction engineering, outlines the key application principles, and analyzes their specific types and usage requirements. The aim is to provide a valuable reference for future research and practical implementation.

Keywords: Energy saving and green environmental protection; Building materials; Building engineering; Application path

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1. Introduction

In the global push towards sustainable development, the construction industry, being a major area for resource consumption and carbon emissions, is experiencing unparalleled pressure to undergo transformation. Energy-efficient and eco-friendly building materials have emerged as a crucial driving force behind the sustainable advancement of this sector^[1]. With their attributes of low energy consumption, minimal pollution, and recyclability, these materials can significantly mitigate environmental harm throughout a building's lifecycle while also enhancing its performance and comfort. From cutting energy usage during production to lowering operational costs in use, green materials are revolutionizing all facets of construction endeavors. Whether addressing climate change or fulfilling the public's demand for high-quality living spaces, the extensive adoption of energy-saving, green, and environmentally friendly building materials in construction carries profound implications, ushering in a new era of green growth within the industry^[2].

2. The application value of energy-saving green environmental protection building materials in construction projects

2.1. Green environmental protection and pollution-free

As a new type of material, energy-saving green building materials differ significantly from conventional building materials. These differences are mainly reflected in the fact that harmful substances are not added during their production and processing. Additionally, they possess notable characteristics such as environmental friendliness and energy efficiency. At the same time, its recyclable characteristics, such as the recycling and reprocessing of scrap steel and waste concrete, save natural resources and reduce production costs. In addition, some green environmental protection materials also have antibacterial, air purification, and other functions, which is conducive to improving indoor environmental quality and protecting human health. Therefore, the use of energy-saving green environmental protection building materials in construction projects can avoid causing pollution to the surrounding environment ^[3].

2.2. Energy consumption is relatively small

In general, the construction process involves building materials that tend to consume a significant amount of energy. This is because their production processes are still evolving, leading to inevitable environmental and ecological pollution during the extraction, processing, and utilization of raw materials. From an environmental protection perspective, these materials produce fewer pollutants during production, and some are biodegradable, which helps minimize contamination of soil and water resources. Energy-saving, green, and environmentally friendly building materials can be efficiently recycled, thus preventing excessive resource depletion. Additionally, these materials typically have lower costs, making them better suited to meet the demands of today's ecologically focused society ^[4].

2.3. Functional diversity

In contemporary building construction, energy-efficient, green, and environmentally friendly materials exhibit functional versatility. Typically, these materials are composed of multiple components and are formed through a specific manufacturing process. The significant composite properties of such materials allow for the full utilization of the advantages of various substances while minimizing the drawbacks of conventional building materials in construction projects ^[5].

3. Principles followed by energy-saving, green, and environmentally friendly building materials in construction projects

3.1. The principle of no harm and energy conservation

In construction projects, the selection of green environmental protection materials is guided by the principles of harm prevention and energy efficiency. These materials must ensure they pose no threat to human health, avoid emitting harmful volatile substances like formaldehyde or benzene, maintain indoor air quality at its source, and provide occupants with a safe and comfortable environment. Additionally, enhancing energy savings remains crucial. For instance, utilizing high-performance insulation materials such as polystyrene boards or rock wool boards can significantly minimize building heat transfer. This reduces the energy required for winter heating and summer cooling, thereby improving energy efficiency. Such practices assist buildings in achieving energy conservation and emission reduction targets, decrease reliance on conventional energy sources, and align with the

modern concept of low-carbon development ^[6].

3.2. Conform to the principle of ecological development

Adhering to the principle of ecological development demands that green building materials exhibit eco-friendliness throughout their entire life cycle, from production to disposal. During the manufacturing phase, emphasis should be placed on selecting renewable and recyclable raw materials, such as recycled aggregates derived from waste concrete. This approach can help decrease the over-extraction of natural sand and gravel while safeguarding natural resources. Additionally, the manufacturing process should incorporate low-energy and low-pollution technologies to minimize carbon emissions and waste generation. Once these materials are no longer in use, they should either be reusable or biodegradable, allowing for easy reclamation or natural decomposition. This ensures minimal environmental impact, preserves ecological balance and stability, and fosters a harmonious relationship between architecture and nature ^[7].

3.3. The principle of economy and aesthetics

The concepts of cost-effectiveness and visual appeal must not be overlooked. Green, environmentally friendly materials, while ensuring optimal performance, should also exhibit strong economic advantages. Although their initial costs might be somewhat higher, in the long term, due to energy-saving benefits and reduced maintenance expenses, they can lead to an overall decrease in costs, providing significant financial advantages for construction projects ^[8]. Additionally, these materials must align with architectural aesthetic requirements. Modern green materials are continually evolving in design innovation. For instance, eco-friendly paints offer diverse colors and textures, while energy-efficient doors and windows come in various styles. These elements not only enhance the visual attractiveness of buildings but also emphasize the distinct character of contemporary architecture. Thus, while promoting sustainable development, such structures also possess artistic allure, fulfilling people's aspirations for high-quality buildings.

4. The specific application of energy-saving green environmental protection building materials in construction projects

4.1. The application of energy-saving and green environmental protection building materials in the wall

The wall serves as a crucial component of a building, and the use of energy-efficient, green, and environmentally friendly materials in its construction plays a significant role in enhancing the overall performance of the structure.

4.1.1. New wall materials

For example, aerated concrete blocks are produced primarily from siliceous materials (such as sand or fly ash) and calcareous materials (like cement or lime) through a series of processes, including batching, mixing, casting, aeration, cutting, and autoclave curing. These blocks are known for their lightweight properties, with densities typically only one-third that of traditional clay bricks. This significantly reduces the overall weight of buildings and decreases foundation engineering costs ^[9]. Furthermore, they exhibit exceptional thermal insulation due to their low thermal conductivity, effectively minimizing heat transfer and reducing energy consumption in buildings. Additionally, aerated concrete blocks offer superior soundproofing capabilities, efficiently blocking external noise and enhancing indoor tranquility and comfort ^[10].

4.1.2. Composite wall material

Wall materials constructed from composite materials with varying characteristics are extensively utilized in construction projects. For instance, a commonly used material in external wall insulation systems is the composite wall made from polystyrene boards and cement mortar. Polystyrene boards exhibit superior thermal insulation capabilities due to their extremely low thermal conductivity, effectively maintaining heat retention and insulation. Meanwhile, cement mortar contributes excellent strength and durability, safeguarding the polystyrene board against environmental damage. This type of composite wall not only fulfills the thermal insulation needs of walls but also guarantees their structural integrity and stability. Additionally, it enhances the energy efficiency and longevity of buildings ^[11].

4.2. The application of energy-saving green environmental protection building materials in waterproof sealing

Ensuring that building structures remain unaffected by water and maintaining indoor dryness and comfort largely depend on the effectiveness of waterproof sealing. In this context, energy-efficient and eco-friendly waterproof sealing materials are crucial. They contribute significantly to preventing water infiltration while supporting sustainable construction practices.

4.2.1. Polymer waterproof coil material

Polymer-based waterproof membranes utilize synthetic rubber, synthetic resin, or a combination of both as primary materials. These are supplemented with suitable quantities of chemical additives and fillers, processed through various techniques to form rollable sheet materials. For instance, EPDM rubber waterproof membranes exhibit superior resistance to weathering, ozone, and chemical corrosion, along with excellent elasticity and tensile strength. They boast an extended lifespan and can maintain effective waterproofing capabilities even under severe environmental conditions. In contrast to traditional asphalt-based waterproof membranes, polymer alternatives offer easier installation via cold adhesive or self-adhesive methods, thereby minimizing environmental impact and energy usage during construction ^[12].

4.2.2. Sealant

In the various components of a building, such as doors, windows, and curtain walls, sealants are applied to fill gaps and provide functions like waterproofing, sealing, and sound insulation. Among these, silicone sealant is widely utilized as an environmentally friendly option. It demonstrates excellent resistance to weather conditions, water, and strong adhesive properties. This sealant adheres effectively to most construction materials, creating a robust sealing layer that efficiently prevents rain leakage and air infiltration. Additionally, its stable chemical composition ensures no environmental pollution, aligning well with green standards.

4.3. The application of energy-saving green environmental protection building materials in thermal insulation

Thermal insulation materials play a crucial role in decreasing building energy consumption and keeping the indoor temperature stable. Energy-efficient and environmentally friendly thermal insulation materials have become prevalent in construction projects.

4.3.1. Rock wool board

Rock wool board is an inorganic fiber material primarily produced from natural rocks such as basalt and diabase, through processes of high-temperature melting and fibrosis. This material exhibits exceptional thermal insulation capabilities due to its low thermal conductivity, effectively minimizing heat transfer. Additionally, rock wool board is non-combustible, offering superior fire resistance that enhances the fire safety of buildings. Its sound absorption and noise reduction properties are also noteworthy, significantly diminishing external noise interference within indoor environments. Furthermore, as an inorganic substance, rock wool board possesses stable chemical characteristics, resisting degradation over time and ensuring a long service life. The production process generates minimal environmental pollution, making it an eco-friendly option.

4.3.2. Foam glass

Foam glass is a porous glass material produced by utilizing recycled glass, foaming agents, modifying additives, and foaming accelerators, processed through grinding, mixing, shaping, and heat treatment. This material exhibits exceptionally low thermal conductivity and outstanding thermal insulation capabilities. Its closed-cell structure provides excellent waterproofing properties, effectively resisting moisture penetration. Foam glass is non-flammable, corrosion-resistant, nontoxic, and demonstrates strong chemical stability, making it an ideal eco-friendly thermal insulation material. In construction applications, foam glass can be employed for exterior wall insulation, roof insulation, and other components, significantly enhancing the energy efficiency of buildings.

4.4. The application of energy-saving green environmental protection building materials in the prevention of fire

Fire presents a significant risk to the safety of both structures and people, thus making the use of energy-efficient, eco-friendly building materials with good fire resistance essential in construction endeavors.

4.4.1. Fireproof paint

Fire-resistant paint is a specialized coating applied to building surfaces to inhibit fire propagation and prolong the substrate's resistance to burning during a fire. Among these, water-based fireproof coatings represent an eco-friendly option. They utilize water as a solvent, eliminating the need for organic solvents and preventing the release of volatile organic compounds during both production and application. This makes them safe for both the environment and human health. Water-based fireproof coatings exhibit excellent fire-retardant properties; when exposed to fire, they quickly expand to create an insulating barrier that prevents heat from transferring to the underlying material, thereby safeguarding the structural integrity of the building. Additionally, these coatings offer superior aesthetic qualities, allowing for customization in terms of color and gloss to meet architectural design requirements.

4.4.2. Non-combustible materials

For example, inorganic fiber-reinforced cement boards use cement as the base material and inorganic fibers (such as glass or carbon fibers) as reinforcing materials. These boards are manufactured through processes like molding and maintenance. Inorganic fiber-reinforced cement boards are non-flammable, meaning they will not catch fire or produce toxic gases when exposed to flames. This makes them effective in preventing the spread of fire. Additionally, they possess high strength and excellent weather resistance, making them suitable for applications such as building firewalls or fire-resistant ceilings, thereby enhancing the fire safety of structures^[13].

5. Requirements for the application of energy-saving green environmental protection building materials in building projects

5.1. Focus on environmental and ecological pollution issues

In the process of selecting and utilizing energy-efficient and eco-friendly construction materials, it is crucial to thoroughly evaluate their environmental and ecological consequences. Initially, the manufacturing procedures for these materials should aim to reduce the depletion of natural resources and minimize ecological harm. For instance, preference can be given to materials derived from industrial by-products or agricultural residues, promoting resource reutilization. Furthermore, during their application, these materials must not emit hazardous substances like formaldehyde or benzene, which could lead to volatile organic compound pollution and compromise both indoor and outdoor air quality, ultimately affecting human health. Additionally, proper consideration must be given to material disposal methods to guarantee that they can either be sustainably recycled or disposed of in an environmentally responsible manner upon reaching the end of their useful life, thereby mitigating any adverse environmental effects ^[14].

5.2. Pay attention to environmental protection and energy conservation

The construction sector must steadfastly advance towards the goals of environmental protection and energy conservation. This involves consistently encouraging the adoption and implementation of energy-efficient, green building materials in various projects. Firstly, greater emphasis should be placed on investing in the research and development of such eco-friendly materials. By fostering technological innovation among research institutions and enterprises, it is possible to enhance material performance and quality while simultaneously cutting production expenses, thereby increasing market competitiveness. Furthermore, architectural design firms and construction entities should proactively integrate these sustainable materials into their projects. They can refine both design strategies and construction techniques to fully leverage the benefits of energy-saving and environmentally friendly materials. Through boosting building energy efficiency, minimizing energy usage, and curbing greenhouse gas emissions, the industry can play a pivotal role in addressing global climate change.

5.3. Pay attention to the publicity and promotion of energy-saving and green building materials

To enhance the market recognition and usage rate of energy-efficient green building materials, it is crucial to intensify promotional efforts. Government departments can develop relevant policies and regulations that offer specific incentives and support for construction projects utilizing these materials, thereby encouraging the industry to adopt them more actively. Simultaneously, diverse media platforms—including television, newspapers, and the internet—can be leveraged to extensively promote the benefits and successful applications of energy-efficient green building materials, increasing public understanding and acceptance. Furthermore, organizing specialized training sessions and technical exchange events can help disseminate knowledge and application techniques to professionals in architectural design, construction, and supervision. This will not only elevate their expertise but also foster the broader integration of energy-saving and environmentally friendly materials in construction projects ^[15].

6. Conclusion

In conclusion, the integration of energy-efficient and green building materials in construction has yielded significant outcomes, transitioning steadily from theoretical promotion to practical implementation. This

approach not only enhances the ecological and environmental attributes of structures but also drives technological advancements and upgrades within associated industries. Nevertheless, achieving a thorough green transformation in the construction sector demands ongoing commitment from all stakeholders. Researchers must persist in boosting investment in research and development, refining material characteristics, cutting expenses, and broadening their applications. Simultaneously, governmental bodies should enhance policies and regulations, reinforce market oversight, and incentivize the adoption of green materials in more construction endeavors. Moreover, raising public awareness and acceptance of green buildings remains vital. As technology evolves, policies are reinforced, and societal consensus is established, energy-saving and green building materials will undoubtedly play a leading role in future construction initiatives, providing a robust foundation for creating an ecologically sustainable and livable environment.

Disclosure statement

The author declares no conflict of interest.

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