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Analysis of Mechanical and Bactericidal Properties of Cement Mortars with Waste Glass Aggregate and Nanomaterials

Piotr Wiśniewski*

Department of Civil Engineering and Architecture, West Pomeranian University of Technology, Al. Piastow 50, Szczecin 71-311, Poland

Introduction

The construction industry is increasingly focused on sustainability, driven by the need to reduce waste and improve the performance of building materials. One promising approach involves the use of waste materials as aggregates in cement mortars. Waste glass aggregate, a byproduct of glass recycling, is gaining attention due to its potential to enhance the properties of cementitious materials while simultaneously reducing landfill waste. Incorporating waste glass not only promotes sustainability but also has implications for the mechanical performance of mortars, such as compressive strength, workability and durability.

In addition to waste glass, the use of nanomaterials in cement mortars offers a new dimension of enhancement. Nanomaterials, including nano-silica, nano-titania and carbon nanotubes, can significantly improve the mechanical properties and impart additional functionalities to cementitious materials. Their unique characteristics at the nanoscale enable better dispersion within the cement matrix, enhancing interfacial bonding and contributing to the overall strength and durability of the mortars. the rise of antibiotic-resistant bacteria in various environments, including construction sites and public spaces, has necessitated the exploration of bactericidal properties in building materials. The incorporation of bactericidal agents, particularly in cement mortars, can inhibit the growth of harmful microorganisms, contributing to healthier indoor environments. This study aims to analyze the mechanical and bactericidal properties of cement mortars containing waste glass aggregate and nanomaterials, providing a comprehensive evaluation of their potential applications in sustainable construction practices [1].

Description

Waste glass aggregate is derived from recycled glass products, such as bottles, jars and other containers. The recycling of glass not only conserves natural resources but also reduces energy consumption and greenhouse gas emissions associated with the production of new glass. When incorporated into cement mortars, waste glass aggregate can enhance various mechanical properties, such as compressive and flexural strength, depending on the proportion and processing of the aggregate. The glass aggregate typically undergoes a size reduction process, resulting in fine and coarse particles that can be blended with traditional aggregates. The smooth surface texture of glass can affect the workability of the mortars, influencing factors such as water retention and flowability. Studies have shown that appropriate replacement levels of natural aggregates with waste glass can yield mortars with comparable or superior mechanical properties, making them suitable for various applications. Moreover, the incorporation of waste glass can improve the durability of cement mortars by enhancing resistance to chemical attacks and mitigating shrinkage. The amorphous structure of glass contributes to a denser microstructure in the cement matrix, leading to lower permeability and increased resistance to water ingress, which is crucial for long-term performance [2].

Nanomaterials, defined as materials with at least one dimension in the nanoscale range (1-100 nm), have unique properties that can enhance the performance of cementitious materials. Commonly used nanomaterials include nano-silica, nano-titania and carbon nanotubes. Nano-silica, for instance, can enhance the hydration process of cement by providing additional nucleation sites, leading to improved strength and durability. The incorporation of nanomaterials into cement mortars can also improve the bonding at the Interfacial Transition Zone (ITZ) between the aggregates and the cement paste. This enhanced bonding can significantly increase the mechanical properties of the mortars, such as compressive strength and tensile strength. Furthermore, the use of nanomaterials can contribute to the reduction of porosity, enhancing the overall durability and resistance to environmental factors. In addition to mechanical enhancements, certain nanomaterials possess inherent bactericidal properties. For example, nano-titania has been shown to exhibit antimicrobial activity under ultraviolet light, making it suitable for applications where hygiene is a priority. The dual functionality of nanomaterials improving mechanical properties while providing antimicrobial effects makes them highly attractive for use in cement mortars. The mechanical properties of cement mortars containing waste glass aggregate and nanomaterials are typically assessed through standardized tests. Compressive strength, flexural strength and tensile strength are the primary parameters evaluated. These tests provide insights into the load-bearing capacity and durability of the mortars [3].

Compressive strength tests are conducted using cylindrical or cubical specimens subjected to axial loading until failure. The results indicate the material's ability to withstand axial loads, which is crucial for structural applications. Flexural strength tests, often performed on prismatic specimens, evaluate the material's resistance to bending, while tensile strength tests assess the material's ability to resist tension forces. Factors influencing mechanical properties include the type and amount of waste glass aggregate, the nature and concentration of nanomaterials and the water-to-cement ratio. Optimal combinations can lead to significant improvements in strength and performance, making it essential to explore various formulations and processing techniques. The assessment of bactericidal properties in cement mortars involves evaluating the materials' ability to inhibit bacterial growth. Commonly used methods include the agar diffusion method and the viable cell count method. These methods allow researchers to quantify the reduction in bacterial colonies after exposure to the mortar samples [4].

Certain nanomaterials, such as silver nanoparticles and nano-titania, have been incorporated into cement mortars for their antimicrobial properties. Silver nanoparticles, known for their broad-spectrum antibacterial activity, can effectively reduce the growth of harmful bacteria, while nano-titania exhibits photocatalytic properties that enhance antibacterial performance under UV light exposure. The effectiveness of these materials in reducing bacterial growth is measured by comparing the bacterial colony counts on the surfaces of treated and untreated mortars. This assessment is particularly important for applications in healthcare, food processing and public spaces where hygiene is paramount. The use of waste glass aggregate and nanomaterials in cement mortars aligns with sustainable construction practices. By incorporating recycled materials, the demand for natural resources is reduced and waste generation is minimized. Furthermore, the enhanced properties of these mortars can lead to more durable structures, ultimately reducing the

***Address for Correspondence:** Piotr Wiśniewski, Department of Civil Engineering and Architecture, West Pomeranian University of Technology, Al. Piastow 50, Szczecin 71-311, Poland; E-mail: wpiotr@hotmail.com*

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environmental impact over the lifecycle of the materials.

Additionally, the reduction in carbon emissions associated with the production of conventional aggregates and the energy-intensive processes involved in cement manufacturing underscores the importance of exploring alternative materials. The incorporation of waste glass and nanomaterials not only contributes to sustainability but also supports the transition towards greener construction practices. Future research in this area should focus on several key aspects. Firstly, the long-term performance of cement mortars containing waste glass aggregate and nanomaterials under various environmental conditions needs to be thoroughly investigated. Understanding how these materials behave over time will provide valuable insights into their durability and suitability for real-world applications.

Further studies should explore the optimization of formulations to maximize mechanical and bactericidal properties. This includes varying the ratios of waste glass aggregate and nanomaterials, as well as investigating the synergistic effects of different combinations of nanomaterials. Lastly, the scalability of production methods for incorporating waste glass and nanomaterials into cement mortars should be assessed. Developing cost-effective and efficient methods for large-scale application will be essential for widespread adoption in the construction industry [5].

Conclusion

The analysis of mechanical and bactericidal properties of cement mortars incorporating waste glass aggregate and nanomaterials presents a promising pathway for enhancing the performance of building materials while promoting sustainability. The use of waste glass not only contributes to reducing landfill waste but also improves the mechanical properties and durability of mortars. Simultaneously, the incorporation of nanomaterials offers significant enhancements in strength and functionality, including the potential for antimicrobial effects that address hygiene concerns in various applications. As research progresses, the combination of waste glass and nanomaterials in cement mortars has the potential to revolutionize construction practices, providing materials that are not only environmentally friendly but also highly functional. Future investigations will be crucial in optimizing these formulations and ensuring their practical applicability in real-world scenarios. By embracing innovative approaches, the construction industry can move towards more sustainable and resilient building practices, ultimately benefiting both the environment and public health.

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Conflict of Interest

None.

References

1. Ismail, Zainab Z. and Enas A. Al-Hashmi. "Recycling of waste glass as a partial replacement for fine aggregate in concrete." *Waste Manag* 29(2009): 655-659.
2. De Muynck, Willem, Nele De Belie and Willy Verstraete. "Antimicrobial mortar surfaces for the improvement of hygienic conditions." *J Appl Microbiol* 108 (2010): 62-72.
3. Nguyen, Y. and Vanessa Sperandio. "Enterohemorrhagic *E. coli* (EHEC) pathogenesis." *Front Cell Infect Microbial* 2 (2012): 90.
4. Peleg, Anton Y. and David C. Hooper. "Hospital-acquired infections due to gram-negative bacteria." *N Engl J Med* (2010): 1804-1813.
5. Zhao, Haitao, Qi Xiao, Donghui Huang and Shiping Zhang. "Influence of pore structure on compressive strength of cement mortar." *Sci World J* 2014 (2014): 247058.

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