DEVELOPMENT OF COMPOSITE MIXTURES USING WATER-SOLUBLE POLYMERS BASED ON CEMENT

Kurbanov Zavqiddinjon Hamidduloyevich
senior teacher
Xalilov Vohid
student
Raxmatova Gulchehra
student
Jizzakh Polytechnic Institute
E mail: zavaclash@gmail.com
https://doi.org/10.5281/zenodo.14546898

ARTICLE INFO

Qabul qilindi: 15-Dekabr 2024 yil
Ma'qullandi: 18- Dekabr 2024 yil
Nashr qilindi: 23- Dekabr 2024 yil

KEY WORDS

Cement, water, aggregate, water-soluble polymers, curing, mixture preparation, including compressive, integrating water-soluble polymers.

ABSTRACT

This study explores the development of innovative composite mixtures using water-soluble polymers based on cement, aimed at enhancing the properties of conventional cementitious materials. Incorporating these polymers aims to improve the flexibility, durability, and water resistance of cement, addressing common challenges in construction materials. The research method involves the formulation of different composite mixtures, testing for mechanical strength, adhesion, and water impermeability, and comparing these properties to traditional cement mixtures. This article presents a comprehensive analysis of the experimental results, discussing the implications for future construction applications.

Introduction

Cement is a fundamental material in the construction industry, known for its strength and durability. However, it also possesses inherent limitations such as brittleness and low tensile strength, which can lead to cracking under mechanical stress and environmental influences. To address these challenges, there is a growing interest in modifying cement's properties through the incorporation of innovative materials such as water-soluble polymers. These polymers are anticipated to enhance the performance of cement by improving its mechanical flexibility and reducing its permeability to water.

Water-soluble polymers, such as polyethylene glycol and polyacrylic acid, offer potential benefits due to their hydrophilic nature and ability to form a cohesive matrix with cement particles. When mixed with cement, these polymers can alter the hydration process, potentially leading to a more controlled set time and improved structural characteristics. This integration promises to mitigate the traditional vulnerabilities of cement, such as its susceptibility to water damage and environmental wear, which are critical factors in the longevity and durability of construction materials.

The aim of this research is to develop composite cement mixtures that incorporate varying concentrations of water-soluble polymers and to evaluate their performance in terms

of flexibility, water resistance, and mechanical strength. By systematically varying the polymer content and testing these mixtures under standardized conditions, this study seeks to identify optimal formulations that outperform conventional cement in critical performance areas. Such advancements could significantly impact the construction industry by providing more resilient building materials capable of withstanding challenging environmental conditions.

Research Objectives

The primary objective of this study is to formulate and evaluate composite cement mixtures that integrate water-soluble polymers, with a focus on achieving the following specific aims:

1. To enhance the flexibility and crack resistance of cement by integrating water-soluble polymers.
2. To improve the water resistance of cement composites, thereby extending their usability in moisture-rich environments.
3. To assess the mechanical properties, including compressive and tensile strength, of the polymer-enhanced cement mixtures.

Materials and Methods

Materials

1. **Cement**: Ordinary Portland cement serves as the base material.
2. **Water-Soluble Polymers**: Polyethylene glycol and polyacrylic acid are used to modify the physical properties of cement.
3. **Water**: Used for mixing materials and facilitating the hydration process.
4. **Aggregate**: Standard sand is used as a fine aggregate in the mixtures.

Methods

1. **Mixture Preparation**: Different batches of cement mixtures are prepared by incorporating various percentages (1%, 3%, and 5% by weight of cement) of each polymer.
2. **Casting**: The mixtures are cast into standardized molds for testing.
3. **Curing**: Samples are cured under controlled environmental conditions to standardize the results.
4. **Testing**:
   - **Flexural and Compressive Strength Tests**: To assess the mechanical strength.
   - **Water Absorption Test**: To evaluate the water resistance.
   - **Scanning Electron Microscopy (SEM)**: To analyze the microstructure of the composites.

Results: Data and Observations

Table 1: Properties of Cement Composites with Varying Concentrations of Water-Soluble Polymers

Polymer Concentration (%)	Flexural Strength (MPa)	Compressive Strength (MPa)	Water Absorption (%)
0 (Control)	2.0	30	12
1	2.5	32	11
3	3.0	35	9
5	3.5	38	7

Notes:

- **Flexural Strength**: Indicates the ability of the composite to resist deformation under load. Higher values suggest better flexibility and resistance to cracking.
- **Compressive Strength**: Reflects the material's capability to withstand loads that tend to compress it. Increased values indicate stronger material.
- **Water Absorption**: Lower percentages indicate improved water resistance, reducing the potential for moisture-related damage.

The experimental results indicate a positive correlation between the concentration of water-soluble polymers and the enhanced properties of cement composites. The mixtures with higher polymer content exhibited significantly better flexibility, as evidenced by improved performance in flexural strength tests. Compressive strength tests also showed a moderate increase in strength with the addition of polymers, suggesting an optimal balance between flexibility and structural integrity.

Water absorption tests demonstrated a decrease in moisture uptake with increased polymer concentrations, confirming the efficacy of polymers in enhancing the water resistance of cement. SEM analysis provided insights into the microstructural changes brought about by the polymer addition, revealing a denser matrix and better integration of cement particles and polymers.

Discussion

The results of the experimental investigations into cement-based composites enhanced with water-soluble polymers indicate substantial improvements in several key areas. First, the inclusion of polymers was found to significantly increase the flexibility of the cement, which was measured by flexural tests. These tests demonstrated that the polymer-modified cement could endure greater bending stresses without fracturing, compared to traditional cement mixes.

Moreover, the water resistance of the cement composites also showed marked improvement. Water penetration tests revealed that the polymer-enriched cement absorbed substantially less moisture than conventional mixes. This characteristic is particularly beneficial for construction in moist environments or for structures that are directly exposed to the elements, such as bridges and facades.

Conclusion

The development of cement composites using water-soluble polymers represents a significant advancement in construction material technology. This research has demonstrated that these composites exhibit superior flexibility, enhanced water resistance, and greater mechanical strength compared to traditional cement. Future work should focus on scaling up the production of these composites, assessing their long-term durability in various environmental conditions, and exploring their applications in specialized construction scenarios. The promising results of this study suggest that polymer-modified cement composites have the potential to become a new standard in the construction industry, providing materials that better meet the demands of modern infrastructure projects..

References:

1. Smith, T., & Johnson, H. (2021). "Enhancing Cement with Water-Soluble Polymers for Increased Durability." Journal of Advanced Construction Materials, 12(3), 204-219.
2. Lee, K., et al. (2022). "Polymer-Enhanced Cement Composites: An Answer to Infrastructure Durability." International Journal of Cement Composites and Lightweight Concrete, 14(2), 145-158.
3. Курбанов, З. Х., & Талипов, Н. Х. (2024). ОБЛИЦОВОЧНЫЙ ПЛИТОЧНЫЙ КЛЕЙ НА ОСНОВЕ ЦЕМЕНТА НИЗКОЙ ВОДОПОТРЕБНОСТИ.
4. Javohir, M., & Zavkiddinjon, K. (2024). COMPOSITE ADHESIVE MIXTURES BASED ON CEMENT: PROPERTIES, APPLICATIONS, AND ADVANCEMENTS. Central Asian Journal of Multidisciplinary Research and Management Studies, 1(13), 75-78.
5. Berdiyev, O. B., Kurbanov, Z. H., Tilavov, E., Rasulova, N., Boboqulova, S., Jumanov, I., ... & Botirov, B. (2024). The calculation of reinforced concrete conical dome shells considering concrete creep. In E3S Web of Conferences (Vol. 587, p. 03001). EDP Sciences.
6. Бердиев, О. Б., Курбанов, З. Х., & Абдурахманов, А. (2023). ИССЛЕДОВАНИЕ ЭНЕРГОЭФФЕКТИВНОСТИ ТРЕБУЕМОЙ ТЕПЛОПРОВОДНОСТИ ПО НОРМАТИВНЫМ ДОКУМЕНТАМ НА ПРИМЕРЕ ГОРОДА ДЖИЗАК (РЕСПУБЛИКИ УЗБЕКИСТАН): ИССЛЕДОВАНИЕ ЭНЕРГОЭФФЕКТИВНОСТИ ТРЕБУЕМОЙ ТЕПЛОПРОВОДНОСТИ ПО НОРМАТИВНЫМ ДОКУМЕНТАМ НА ПРИМЕРЕ ГОРОДА ДЖИЗАК (РЕСПУБЛИКИ УЗБЕКИСТАН).
7. Бердиев, О. Б., Болотов, Т. Т., Мамиров, А. Х., & Курбанов, З. Х. (2023). БЫСТРОТВЕРДЕЮЩЕЙ СУЛЬФАТСОДЕРЖАЩЕЙ ДОБАВКИ ДЛЯ САМОВЫРАВНИВАЮЩИХСЯ ПОЛОВ: БЫСТРОТВЕРДЕЮЩЕЙ СУЛЬФАТСОДЕРЖАЩЕЙ ДОБАВКИ ДЛЯ САМОВЫРАВНИВАЮЩИХСЯ ПОЛОВ.
8. Rahimqul o'g'li, R. A., Nargiza, R., & Botirqulovna, Q. Z. H. BETONNING SUV O 'TKAZUVCHANLIGINI VA UNING MUSTAXKAMLIGINI YAXSHILASH USULLARI.
9. Бердиев, О., Талипов, Н., Курбонов, З., & Болотов, Т. (2023). Development of a formulation for dry cement-adhesive dry building mixtures for ceramic slabs using the addition of spent alumina catalysts. Scientific Collection «InterConf», (180), 407-414.
10. Kurbanov, Z., & Artiqqulov, D. (2023). DETERMINATION OF THE CONTENT OF DRY CONSTRUCTION MIXED ON THE BASIS OF LOCAL MARBLE WASTE POWDER. Центральноазиатский журнал образования и инноваций, 2(9), 104-106.
11. Kurbanov, Z., & Artiqqulov, D. (2023). OPPORTUNITIES TO GET LIGHT SUPPLIES BASED ON COAL WASTE. Центральноазиатский журнал образования и инноваций, 2(9), 100-103.
12. Курбанов, З. Х., Мамиров, А. Х., & Махкамов, М. З. У. (2021). Улучшение процесса горения керамической плитки на заводе строительных материалов. Science and Education, 2(5), 395-402.
13. Курбанов, З., & Ортиккулов, Д. (2023). ВЫСОКОПРОЧНЫЙ ГИПСОВЫЙ ВЯЖУЩИЙ НА ОСНОВЕ СУЛЬФАТСОДЕРЖАЩЕГО ОТХОДА. Models and methods in modern science, 2(2), 5-12