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Features of Long-Term Operation of Portland Cement And Alkaline Binders and Methods for Extending Their Service Life

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Abstract

Portland cement and alkaline binders remain decisive in modern construction due to their versatility and mechanical operation. However, their long-term durability changes with chemical and environmental influences. This study investigates key degradation mechanisms including carbonation, sulfate exposure, and thermal instability while exploring advanced methods to extend their service life. Methods such as additive cement materials, improved mixture design and chemical additives are discussed, which provide practical solutions to increase the stability and long-term durability of building materials. The results will help develop a durable infrastructure for future requirements.

Key words: Portland Cement, alkaline binders, long-term durability, service life extension, carbonization resistance, impact on sulfate, additional cement materials, stability, innovative building materials

Introduction

Portlandtsement is one of the main hom material of construction around the world, with an annual production volume of more than 4.5 billion tons. Its advantage comes from excellent mechanical properties and versatility. However, the production process accounts for about 8-10 percent of global CO_2 harmful gases, which negatively affects the environment. In addition, Portlandcement is susceptible to chemical attacks such as carbonation, sulfate exposure, and chloride penetration, limiting its durability in aggressive environments.

On the other hand, alkaline binders, including hydroxide - activated materials and Geopolymers-provide a promising alternative with low emission. These materials have shown to reduce carbon by up to 80% compared to conventional cement, which increases resistance to chemical and thermal effects. Despite these advantages, problems such as standardization of materials, economic efficiency and comprehensiveness prevent widespread acceptance.

This research is aimed at assessing the long-term service characteristics of Portlandtsement and alkaline binders. By analyzing breakdown mechanisms and proposing innovative techniques such as additive cement materials and chemical additives, this work proposes strategies to extend service life and apply sustainable construction practices.

Relevance of the topic. The fact that Portland Cement is important in the production of reinforced concrete structures makes it an integral part of the development of infrastructure, housing and industrial construction. Nevertheless, its vulnerability to degradation mechanisms, including carbonation, sulfate effects, and chloride penetration, requires frequent maintenance and increases its costs in the exploitation process.

Conversely, alkaline binders, in particular Geopolymers and alkali-activated materials, exhibit greater resistance to aggressive environments. Studies show that geopolymers can maintain a strength of 80% even after prolonged exposure to acidic environments, making them an alternative solution for application in difficult conditions such as industrial areas.

As Global infrastructure requirements are increasing, it is critical to address these performance deficiencies. Solutions that improve resilience and reduce harmful emissions can benefit the economy and the environment at the same time.

Research objectives. This study considers the following main disadvantages:

1. Analysis of long-term durability of Portland cement and alkaline binders in an aggressive environment.

2. Perturbation mechanisms that include carbonation, sulfate effects, and thermal instability.

3. To increase durability and extend service life, identifying advanced methods such as chemical additives and mixture optimization.

Materials and Methods

The reasons that create the values of Portland cement properties include: Carbonation: carbon dioxide reacts with calcium hydroxide, causing the formation of calcium carbonate and loss of consistency. Sulfate effect: sulfates react with cement hydrates, reducing strength to 40% when exposed for a long time. Chloride penetration: chloride ions penetrate the concrete, causing corrosion of the fittings and reducing the integrity of the structure.

To mitigate these effects, this study assesses the addition of nano-Silicon, volatile ash, etc.to compact the microstructure and improve resistance to chemical attacks.

Resistance of alkaline binders

Alkaline binders, such as Geopolymers, reduce porosity and contribute to high durability. SEM analysis shows 25-50% low permeability compared to Portlandcement, with stable phases observed in Xrd tests under acidic and thermal conditions.

Experimental processes.

Samples are prepared using: Portlandtsement mixtures: include SCMS (e.g. flying ash) and nano-additives. Alkaline binders: made using sodium silicate and sodium hydroxide activators.

The test includes: Resistance to carbonation: depth measured under the action of accelerated CO_2. Sulfate resistance: strength loss analyzed after immersion in sulfate solutions. Chloride penetration: Ion diffusion rate and corrosion potential are evaluated. Thermal stability: samples subjected to controlled high temperature cycles. Microtusilm analysis: the use of SEM and XRD techniques. Mechanical tests: compression, bending and stretching tests.

Results and Discussion

Portlandtsement: An average loss of strength under the influence of sulfate for 12 months is 30%. After 90 days of exposure to CO_2, the carbonation depth increased by 5 mm. The entry rate of chloride is twice as high as that of hydroxide binders.

Alkaline Binders: It retained 85-90% of the compressive strength under sulfate conditions. The depth of carbonation after accelerated testing is only 2 mm. Showed low porosity and improved chemical durability. Comparative analysis Portlandcement samples showed large spatial variations in SEM and XRD Analyses, confirming microstructure instability. In contrast, hydroxide binders retained denser and more stable microstructures. Nano-additives have improved portlandcement durability by 20-30%, highlighting their potential as strength enhancers.

Factors Affecting Durability. Material composition: high silicon and aluminum content in alkaline binders formed stable aluminosilicate gels resistant to chemical effects. Porosity: Portland cement showed a 25-30% higher overall porosity, which reduced durability. Environmental factors: high humidity and temperature changes accelerated the degradation of portlandcement, but had minimal effects on hydroxide binders.

Ways To Extend The Service Life. Inclusion of SCMS: Replacing 30-50% of portlandcement with slag reduced the loss of strength by 50% when exposed to sulfate. The addition of ash improved resistance to carbonation, reducing depth by 40%. Chemical additives: Nano-silica and Crystal additives improved microstructure, reducing chloride penetration by 30%.

Hydroxide activators optimization: Adjusting the sodium silicate-hydroxide ratios increased the hydroxide washing and compression strength by 15%.

Conclusion

Portlandtsement. It is susceptible to chemical degradation, but is significantly improved by SCMS and chemical additives. Alkaline binders: show high durability, reduced carbonation depth and low porosity, forming promising alternatives under aggressive conditions. Innovative strategies: adding SCMS, nano-additives, and optimized formulas effectively improves service life and stability

Importance for building materials and future research.

1. Validation: long-term field research to validate laboratory results.
2. Price Analysis: life cycle estimates for economic justification.
3. Innovative formulas: studying hybrid binders for improved efficiency.

By implementing these strategies, the construction industry can create a sustainable and robust infrastructure, reduce environmental impact, and increase the long-term efficiency of materials.

REFERENCES

Xakimov, S., & Dadaxanov, F. (2022). STATE OF HEAT CONDUCTIVITY OF WALLS OF RESIDENTIAL BUILDINGS. Science and innovation, 1(C7), 223-226.

Mukhtasar, M., Begyor, S., Aleksandr, K., Farrukh, D., Isroil, U., Sodiqjon, K., & Akbarjon, A. (2022). Analysis of the Effectiveness of the Development of the German Education System in Our Country. Journal of new century innovations, 18(1), 168-173.

Kazadayev, A., Sharopov, B., Hakimov, S., Umarov, I., Muxtoraliyeva, M., Dadaxanov, F., & Abdunazarov, A. (2022). MAMLAKATIMIZDA NEMIS TA'LIM TIZIMINI JORIY QILISHNING SAMARADORLIGI TAHLILI. Journal of new century innovations, 18(1), 124-129.

Sodiqjon, K., Begyor, S., Aleksandr, K., Farrukh, D., Mukhtasar, M., & Akbarjon, A. (2022). Prospective aspects of using solar energy. Journal of new century innovations, 18(1), 142-148.

Dadakhanov, F., Sharopov, B., Umarov, I., Mukhtoraliyeva, M., Hakimov, S., Abdunazarov, A., & Kazadayev, A. (2022). PROSPECTS OF INNOVATIVE MATERIALS PRODUCTION IN THE BUILDING MATERIALS INDUSTRY. Journal of new century innovations, 18(1), 162-167.

Абдуназаров, А., Хакимов, С., Умаров, И., Мухторалиева, М., Дедаханов, Ф., & Шаропов,

Б. (2022). МЕРОПРИЯТИЯ ПО ПОВЫШЕНИЮ ЭНЕРГОЭФФЕКТИВНОСТИ СОВРЕМЕННЫХ И РЕКОНСТРУИРУЕМЫХ ЗДАНИЙ. Journal of new century innovations, 18(1), 130-134.

Sharopov, B., Hakimov, S., Umarov, I., Muxtoraliyeva, M., Dadaxanov, F., & Abdunazarov, A. (2022). QUYOSH ENERGIYASIDAN FOYDALANIB TURAR JOY BINOLARI QURISHNING ISTIQBOLI TOMONLARI. Journal of new century innovations, 18(1), 135-141.

Hakimov, S., Sharopov, B., Umarov, I., Muxtoraliyeva, M., Dadaxanov, F., & Abdunazarov, A. (2022). URILISH MATERIALLARI SANOATIDA INNOVATSION MATERIALLAR ISHLAB CHIQARISHNING ISTIQBOLLI TOMONLARI. Journal of new century innovations, 18(1), 149-156.

Begyor, S., Isroil, U., Aleksandr, K., Farrukh, D., Mukhtasar, M., Sodiqjon, K., & Akbarjon, A. (2022). MEASURES TO IMPROVE THE ENERGY EFFICIENCY OF MODERN AND RECONSTRUCTED BUILDINGS. Journal of new century innovations, 18(1), 157-161.

Kholmirzayev, S., Akhmedov, I., Rizayev, B., Akhmedov, A., Dedakhanov, F., & Khakimov, S. (2022). RESEARCH OF THE PHYSICAL AND MECHANICAL PROPERTIES OF MODIFIED SEROBETON. Science and innovation, 1(A8), 1009-1013.

Kholmirzayev, S., Akhmedov, I., Khamidov, A., Umarov, I., Dedakhanov, F., & Hakimov, S. (2022). USE OF SULFUR CONCRETE IN REINFORCED CONCRETE STRUCTURES. Science and innovation, 1(A8), 985-990.

Akhmedov, I., Khamidov, A., Kholmirzayev, S., Umarov, I., Dedakhanov, F., & Hakimov, S. (2022). ASSESSMENT OF THE EFFECT OF SEDIBLES FROM SOKHSOY RIVER TO KOKAND HYDROELECTRIC STATION. Science and innovation, 1(A8), 1086-1092.

Kholmirzayev, S., Akhmedov, I., Khamidov, A., Akhmedov, A., Dedakhanov, F., & Muydinova, N. (2022). CALCULATION OF REINFORCED CONCRETE STRUCTURES OF BUILDINGS BASED ON THE THEORY OF RELIABILITY. Science and innovation, 1(A8), 1027-1032.

Kholmirzayev, S., Akhmedov, I., Khamidov, A., Umarov, I., Dedakhanov, F., & Kazadayev, A. (2022). ANALYSIS OF METHODS FOR PROCESSING SERA RAW MATERIALS AND MAKING SEROBETON. Science and innovation, 1(A8), 1004-1008.

Xamidov, A., Kholmirzayev, S., Rizayev, B., Umarov, I., Dadaxanov, F., & Muhtoraliyeva, M. (2022). THE EFFECTIVENESS OF THE USE OF MONOLITHIC REINFORCED CONCRETE IN THE CONSTRUCTION OF RESIDENTIAL BUILDINGS. Science and innovation, 1(A8), 991-996.

Umarov, I., Dadaxanov, F., Bolishev, E., & Boltamurotov, J. (2022). QURILISH MATERIALLARINI ISHLAB CHIQARISHDA INNOVATSION TEXNOLOGIYALARNING O 'RNI. Science and innovation, 1(C6), 153-159.

Bahodir, R., Islombek, A., Adhamjon, H., Sattor, K., Isroiljon, U., & Sodiqjon, H. (2022).

INFLUENCE OF AGGRESSIVE MEDIA ON THE DURABILITY OF LIGHTWEIGHT CONCRETE. Journal of new century innovations, 19(6), 318-327.

Хакимов, С., & Фаррух, Д. (2023). ТЕОРЕТИЧЕСКИЕ ОСНОВЫ СЕЙСМОСТОЙКОСТИ ЗДАНИЙ И СООРУЖЕНИЙ. ТЕСНика, (2 (11)), 10-13.

Umarov, I., Dadaxanov, F., Bo'lishev, E., & Boltamurotov, J. (2022). The role of innovative technologies in the production of building materials. Science and Innovation, 1(6), 153-159.

Bakhodir, R., Akhmedov, I., Shavkat, Y., Umarov, I., Kazadayev, A., & Dedaxanov, F. (2022). DURABILITY OF LIGHTWEIGHT CONCRETE IN AGGRESSIVE ENVIRONMENTS. Spectrum Journal of Innovation, Reforms and Development, 10, 431-438.

Bakhodir, R., Akhmedov, I., Shavkat, Y., Umarov, I., Kazadayev, A., & Dedaxanov, F. (2022). HEAVY CONCRETE AND ITS STRENGTH AND PROPERTIES IN A DRY HOT CLIMATE. Spectrum Journal of Innovation, Reforms and Development, 10, 457-466.

Bakhodir, R., Akhmedov, I., Shavkat, Y., Umarov, I., Kazadayev, A., & Dedaxanov, F. (2022). HOT CLIMATE ON THE PHYSICAL AND MECHANICAL PROPERTIES OF CONCRETE. Spectrum Journal of Innovation, Reforms and Development, 10, 448-456.

Bakhodir, R., Akhmedov, I., Shavkat, Y., Umarov, I., Kazadayev, A., & Farruh, D. (2022). INFLUENCE OF DRY HOT CLIMATE ON THE DEFORMABILITY OF COLUMNS MADE OF HEAVY CONCRETE. Spectrum Journal of Innovation, Reforms and Development, 10, 405-413.

Rizayev, B., Akhmedov, I., Yusupov, S., Umarov, I., Kazadayev, A., & Dadakhanov, F. (2022). NEW INNOVATIVE IDEAS IN THE FIELD OF PRODUCTION OF REINFORCED CONCRETE STRUCTURES. Spectrum Journal of Innovation, Reforms and Development, 10, 467-475.

Rizayev, B., Akhmedov, I., Yusupov, S., Umarov, I., Kazadayev, A., & Dadakhanov, F. (2022). SHRINKAGE DEFORMATIONS BETONA IN A DRY HOT CLIMATE. Spectrum Journal of Innovation, Reforms and Development, 10, 495-504.

Rizayev, B., Akhmedov, I., Yusupov, S., Umarov, I., Kazadayev, A., & Dadakhanov, F. (2022). DEFORMATION SHRINKAGE AND CREEP OF CONCRETE IN NATURAL CONDITIONS OF DRY HOT CLIMATE. Spectrum Journal of Innovation, Reforms and Development, 10, 476-486