

## **ABSTRACT**

for PhD dissertation in program 8D07203 – «Mining Engineering»

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on the topic

### **«STUDY OF HARMONY PRESERVATION IN SUBSOIL DEVELOPMENT THROUGH WASTE PROCESSING »**

**The aim of the work** is to study the possibility of using waste from the mining and metallurgical complex and the fuel and energy complex to obtain popular building materials.

To achieve this goal, the following **objectives** were addressed:

- analyze mining and geological conditions of the Akzhal deposit, which determine stability of open-pit side;
- study physical and mechanical properties of rocks and beneficiation waste for their use in construction;
- study composition of strengthening solution for strengthening quarry wall;
- assess environmental impact of ash and slag waste;
- evaluate physical and mechanical properties of ash and slag waste from TPP-2 and TPP-3 of AIES;
- implement research results in production and educational processes.

#### **Research methods.**

The research methodology is based on both theoretical and empirical methods, based on generalization, comparative analysis, experimentation, as well as the principles of a systems approach, planning, and processing of experimental data. The study was conducted using systems-structural approach to mining and waste processing, which considers relationship between the composition, structure, and properties of technogenic mineral formations. This approach enables a comprehensive analysis of mining waste disposal and recycling processes, optimizes processing technologies, and improves the effectiveness of engineering solutions for stabilizing rock masses and reclaiming territories.

Experimental studies were conducted on laboratory samples using modern analytical methods, including electron microscopy and chemical studies, differential thermal analysis, IR spectrometry, X-ray phase analysis, and others. This integrated approach provides more accurate and reliable data, allowing for the evaluation of the properties and quality of materials with a high degree of certainty.

#### **Scientific novelty of the work:**

- new method for producing shotcrete mortar from technogenic waste from processing plant to strengthen cracked quarry slopes has been substantiated. This method is characterized by increased strength and durability of the mortar, while simultaneously reducing its cost. (Copyright Certificate RK № 58065 dated May 15<sup>th</sup> 2025).

- optimal composition of ash-slag binder and aerated concrete based on ash with a density of 700 kg/m<sup>3</sup> to 900 kg/m<sup>3</sup> from thermal power plant waste has been substantiated, which makes it possible to increase strength of cement-ash binder and ash-slag concrete while simultaneously simplifying technology, reducing number of components and increasing degree of mechanochemical activation (Patent RK № 8579 dated October 27<sup>th</sup>, 2023, and Patent RK № 8580 dated October 27<sup>th</sup>, 2023);

**Scientific thesis:**

- Stability of quarry slopes can be achieved by using shotcrete mortar made from technogenic products of enrichment plant, ensuring safe development of deposit and disposal of enrichment tailings;

- Composition of the ash and slag binder and aerated concrete with an ash density of 700 kg/m<sup>3</sup> to 900 kg/m<sup>3</sup> allows for disposal of ash dumps and reduces their negative impact on environment.

**Practical significance of the work:**

Research results have been implemented in production at the Akzhal lead-zinc deposit by Nova Zinc LLC and Politech Construction LLC. Patents of the Republic of Kazakhstan were obtained for the utility models «Method for Obtaining Ash-Containing Binder» and «Composition of Non-Autoclaved Ash-Aerated Concrete and Method for Obtaining It» as well as Certificate for «Assessment of the Suitability of Beneficiation Waste for the Creation of Solutions for Strengthening Fractured Slopes», which may further supplement existing regulatory documents.

The dissertation has been approved for implementation in the educational process at K.I. Satpayev Kazakh National Technical University for undergraduate and graduate courses in the Mining program. The main scientific and practical results are as follows:

1. Assessment was made of the ash and slag waste from TPP-2 and TPP-3 of the AIES as a source of environmental pollution and as a source of secondary resources.

2. Optimal composition of ash and slag binder and aerated concrete based on ash with a density of 700 kg/m<sup>3</sup> to 900 kg/m<sup>3</sup> from TPP waste was substantiated. Technical novelty of the method for producing ash-containing binder is confirmed by a patent of the Republic of Kazakhstan.

3. By studying physical and technical properties of ash from the Ekibastuz State District Power Plant-2, ash-gas concrete with average densities of 700, 800, and 900 kg/m<sup>3</sup> was obtained, technical novelty of which is confirmed by a patent of the Republic of Kazakhstan. Satbayev University has now launched a plant to produce splitter construction materials with the addition of ash.

4. Analysis of the mining, geological, and technogenic conditions of the Akzhal deposit confirmed the need to improve the stability of quarry walls, due to long-term operation and high loads on quarry slopes.

5. Shotcrete mixture composition was developed that allows for both strengthening fractured rocks and efficiently utilizing processing plant waste. The technical innovation of the resulting mixture is confirmed by a copyright certificate from the Republic of Kazakhstan.

6. Implementation of the research results represents a significant contribution to sustainable development of the construction industry. The production of new cement-sand building materials, as exemplified by Politech Construction LLC, promotes the efficient use of secondary resources and reduces the man-made impact on the environment.

**Dissertation research** was carried out in accordance with the Grant Financing Project No. AP14871694 «Development of a technology for processing ash and slag waste of a thermal power plant to obtain popular building materials» for 2022-2024 and the 4th task «Creation of a joint venture for the production of new and promising building materials based on waste from mining and metallurgical complexes and mineral raw materials of Kazakhstan» of the Program-targeted financing for 2023-2025 BR21882292 – «Integrated development of a sustainable construction industry: innovative technologies, production optimization, efficient use of resources and creation of a technology park», carried out by KazNITU named after K.I. Satpayev with the participation of the author.

**Author's personal contribution** includes active participation in formulating research goals and setting objectives, as well as in preparing scientific publications, report abstracts, and filing patent applications. Laboratory studies and testing were conducted by the author personally or with her direct participation. Furthermore, the author tested the developed technology under industrial production conditions. In joint publications, the author made significant contributions to experimental studies, data analysis, preparation and formatting of materials, their submission, and subsequent support.

#### **Publications and testing of work:**

The main thesis of dissertation work were published in 9 printed works:

1. Studying the properties of ash and slag waste for use in the manufacture of construction products. Mining of Mineral Deposit. №4, 2023. pp.102-109, ISSN -24145-3443 (Q2), <https://doi.org/10.33271/mining17.03.102> (Q2)
2. Study of agglomerite producibility from the Ekibastuz coal ashes. Eurasian mining. 2023. No.2. pp.85-88. ISSN 2072-0823 (Q2) DOI: 10.17580/EM.2023.02.18
3. Obtaining agglomerite from ash of Ekibastuz coal, selected from ash dump of CRPP-3 of Almaty city. News of the National Academy of Sciences of the Republic of Kazakhstan - Series of Geology and Technical Sciences, №2, 2023.-142-148 p. ISSN 2224-5278 (Q3), <https://doi.org/10.32014/2023.2518-170X.289>
4. Industrial waste recycling – one of the key directions of business development», News of the National Academy of Sciences of the Republic of Kazakhstan - Series of Geology and Technical Sciences, №2, 2023.-193-205 p. ISSN 2224-5278 (Q3), <https://doi.org/10.32014/2023.2518-170X.289>
5. Development of Mashanov's ideas on the harmony of the subsoil. M.: Mine surveying and subsoil use, № 1, 2022, 12-14 p., ISBN 2079-3332

6. Waste recycling is one of the key areas of development of the green economy. M.: Mine surveying and subsoil use, №6, 2022, 67-74 p., ISBN 2079-3332
7. Prospects for technogenic waste processing for production of construction materials. Mining Journal of Kazakhstan. №4, 2023.- 57-62 p., ISSN 2227-4766, <https://doi.org/10.48498/minmag.2023.2016.4.001>
8. Possibilities for technogenic waste for obtaining building materials», International scientific journal «Young scientist». - Kazan, №1, RSCI 2023. 24-27 p., ISSN 2072-0297
9. High lag for the «Green Kazakhstan project. Mining Journal of Kazakhstan. №1, 2025.-65-70 p., ISSN 2227-4766, MRNTI code 87.35.91:67.09.05

Scientific, experimental and practical results of work were reported and discussed at 6 international and domestic scientific and practical conferences:

1. Mashanov - Al-Farabi of the XX – century. Innovative technologies in geospatial digital engineering. Proceedings of the International scientific-practical conference dedicated to the 115th anniversary of the Corresponding Member of the Academy of Sciences of the Kazakh SSR A.Zh.Mashanov and the 100th anniversary of the Academician of the Academy of Sciences of the Kazakh SSR Zh.S. Erzhanov, 18 March, 2022, 260-265 p., ISBN 978-601-323-277-5
2. Large-tonnage technogenic waste - secondary raw materials. Proceedings of the International Scientific and Technical Conference «Development of the mining and metallurgical complex of Kazakhstan for the implementation of the State Investment Project», dedicated to the 110th anniversary of the birth of the outstanding scientist, brilliant teacher, major organizer of production, educator and public figure Academician O.A Baikonurov, November 25, 2022 -153 -157 p., ISBN 978-601-323-334-5
3. Waste management is one of the key areas of development of the “green” economy in Kazakhstan, 5th Conference of the International Scientific School of Academician of the Russian Academy of Sciences K.N. Trubetskoy «Problems and Prospects of Integrated Development and Conservation of the Earth’s Subsoil», November 14-18, 2022, - 181- 184 p., ISBN 978-5-6047953-2-3
4. Processing of ash and slag waste from thermal power plants to obtain building materials. Congress Proceedings of the 18th International Congress for Mine Surveying in Xuzhou, China. October 26-29, 2023.pp.248-252.
5. Use of enrichment waste for obtaining building materials. Proceedings of the International Mine Surveying Forum «Geospatial Digital Engineering in Geodesy, Mine Surveying and Geomechanics», 2023. Karaganda: KarTU.- 42-46 p.
6. Mining and metallurgical complex waste is a promising source for construction industry. Proceedings of the International Forum «Digital

technologies in geodesy and surveying», April 26-27, 2024, -pp. 46 -51, ISBN 978-601-323-463-2

3 monographs have been published:

1. Harmony of subsoils. Development of Mashanov ideas. Almaty, KazNRTU, 2022. – 225 p. ISBN 978-601-323-267-6
2. Prospects for the use of fly ash to produce building materials, Almaty, KazNITU, 2023. – 182 p. 2ISBN 978-601-323-401-4
3. Rational use of ash and slag waste in the production of advanced building materials, Almaty, KazNITU, 2024. – 175 p. ISBN 978-601-323-568-4

The main research results were obtained in the «Research Laboratory of Construction and Building Materials» of Technopark Stroytech and in the «Geomechanics and Geotechnology» Laboratory of the Mining Department of Satbayev University.