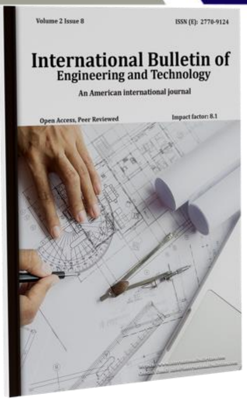

THE MAIN PROBLEMS THAT ARISE IN THE EXTRACTION OF RAW MATERIALS IN LIMESTONE QUARRIES

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Abstract. When assessing the strength of slag-alkaline binder based on crushing waste, rational proportions of components were revealed. It was found that the samples have a dense and homogeneous structure after hardening. The average compressive strength reaches 41.2 MPa. The results of testing samples from a dry building mixture including slag-alkaline binder with quartz sand are presented. The limits of compressive and bending strength of samples are determined. Diagrams of strength changes depending on the composition of the mixture and changes in the water-binder ratio are given.

Keywords: rocks, waste heap, quarry, limestone, binder, strength, compression, bending, dry mix.

INTRODUCTION

Mining operations on formation of waste dumps are an integral part of open-pit mining technology in quarries. Intensification and concentration of mining operations in quarries, increase in capacity, metal intensity and energy intensity of mining and transport equipment impose ever higher demands on ensuring work safety, creating conditions for safe and rhythmic implementation of all production processes in quarries, including waste dumping – the final link in the open-pit mining technological cycle. Establishing rational parameters of quarry waste dumps according to technological and engineering-geological conditions is a complex task, the solution of which requires comprehensive research. The process of their compaction, which is closely related to the parameters and procedure for carrying out waste dumping operations, as well as with waste dumping schemes, is of great importance for the stability of weakly cohesive rock masses of dumps and foundations. In this regard, consideration of these issues and development of technical solutions are a very urgent problem.

MATERIALS AND METHODS

It is advisable to carry out plugging operations using production waste based on slag-alkaline binder. It is advisable to use limestone screenings as an inert component. It is technologically advisable to use a dry mixture of slag-alkaline binder based on limestone crushing waste to perform the entire range of plugging operations. The composition of a dry building mixture based on a composite slag-alkaline binder has been developed and tests of samples made from the dry building mixture have been carried out.

RESULTS AND DISCUSSION

Slag-alkali cements differ from traditional binders in many respects in their chemical and mineralogical compositions, structure and nature of new formations. The main differences are as follows: prevalence of cryptocrystalline tobermorite structure of new formations, absence of free lime and highly basic calcium hydroaluminates in the latter, presence of constant highly alkaline environment in the body of hardened stone, resistance of new formations, their low solubility, stability of structure over time, increased density of

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hardened stone, abundance of gel-like masses, prevalence of gel-like pores and micropores, closed porosity, rounded shape of pores. These features of composition and structure are the reason for special properties of slag-alkali cements, due to which the latter can be used as special cements for obtaining solutions with special properties. Thus, slag-alkali cements have high mechanical strength, high adhesive properties in relation to fillers, which makes them suitable for obtaining special dry mortar mixes. The setting time of slag-alkali cements is somewhat shorter than that of Portland cement, can be regulated by the water-binder ratio, the content of the alkaline component, etc. They are also characterized by a high intensity of hardening at an early age, in connection with which they can be used to obtain fast-hardening solutions. The dense structure of solutions (fine-grained concrete), low solubility of new formations, closed porosity predetermine their high water impermeability, water resistance and frost resistance. These properties, as well as cavitation and abrasive resistance, static and hydrodynamic strength make slag-alkali solutions highly effective in the conditions of hydraulic engineering water management construction. High resistance in a number of corrosive environments, primarily under magnesian and sulfate aggression, in waters with low hydrocarbonate hardness makes the solutions corrosion-resistant. An increase in the content of the alkali component is also accompanied by a change in the amount of insoluble alkali bound by slag into hydration products. At the same time, the role of alkali as an active component of the binder increases. The optimal content of soda ash melt depends on the hardening conditions. For steamed concrete, it is 7 ... 10%. A large amount of melt causes stabilization of strength, which may be associated with the occurrence of stresses as a result of crystallization of sodium-containing compounds in the pores of the concrete structure already well formed during steaming, which is one of the reasons for the slow growth of strength during subsequent hardening. Under normal conditions, with an increase in the addition of melt up to 13%, an intensive growth of strength is observed. Slag hydration and stone structure formation slow down sharply. Possible crystallization of the alkaline component does not cause significant stress, but promotes compaction of the stone and increases its strength [2].

Dust from quarry sites is a major source of air pollution, although the severity will depend on factors like the local microclimate conditions, the concentration of dust particles in the ambient air, the size of the dust particles and their chemistry, for example limestone quarries produce highly alkaline (and reactive) dusts, whereas coal mines produce acidic dust.

The air pollution is not only a nuisance (in terms of deposition on surfaces) and possible effects on health, in particular for those with respiratory problems but dust can also have physical effects on the surrounding plants, such as blocking and damaging their internal structures and abrasion of leaves and cuticles, as well as chemical effects which may affect long-term survival.

In addition to the dust-related air pollution, quarrying also contributes to carbon emissions through the use of heavy machinery, transportation of materials, and energy-intensive stone processing. These activities release greenhouse gases, contributing to climate change [3].

Unfortunately, quarrying involves several activities that generate significant amounts of noise. It starts with the preparatory activities, such as establishing road or rail access, compound and even mineral processing facilities. Next is the process of exposing the mineral to be extracted and this is usually done by removing the top soil and other soft layers using a scraper, or hydraulic excavators and dump trucks. The excavation of the mineral itself will involve considerable noise, particularly is blasting methods are used. Following this, the use of powered machinery to transport the materials as well as possibly processing plants to crush and grade the minerals, all contribute even more noise to the environment.

One of the biggest negative impacts of quarrying on the environment is the damage to biodiversity. Biodiversity essentially refers to the range of living species, including fish, insects, invertebrates, reptiles, birds, mammals, plants, fungi and even micro-organisms. Biodiversity conservation is important as all species are interlinked, even if this is not immediately visible or even known, and our survival depends on this fine balance that exists within nature.

Quarrying carries the potential of destroying habitats and the species they support. Even if the habitats are not directly removed by excavation, they can be indirectly affected and damaged by environmental impacts – such as changes to ground water or surface water that causes some habitats to dry out or others to become flooded. Even noise pollution can have a significant impact on some species and affect their successful reproduction. Nevertheless, with careful planning and management, it is possible to minimise the effect on biodiversity and in fact, quarries can also provide a good opportunity to create new habitats or to restore existing ones [5].

As the results of the conducted studies have shown, during the interaction of kaolinite with sodium carbonate, the bulk of the new formations is represented by small crystals in the form of tightly interwoven spherulites, close in structure to sodalite. The data of differential thermal analysis and IR spectrographic studies made it possible to establish the zeolitic nature of the resulting substance and the presence in it of CO2□ in the form of an interframework anion, as a result of which it can be classified as carbonate-sodalite. Hydrate-nepheline II was also recorded in the composition of the new formations, which over time turns into hydrate-nepheline I. The products of the interaction of kaolinite with potassium carbonate are mainly similar in shape and structure to kaliophilite containing zeolitic water. Along with the kaliophilite phase, a finely crystalline substance is formed, close in structure to potassium analcite. It has been established that the interaction of montmorillonite, hydromica and palygorskite with sodium carbonate results in the formation of new formations, represented in all cases mainly by a stable phase of alkaline hydroaluminosilicate composition, similar to natural analcime.

The thermodynamic calculations of the reactions of clay minerals with sodium and potassium carbonates have made it possible to establish the energetic possibility of their occurrence not only during autoclave treatment, but also during steaming, as well as under natural hardening conditions with the formation of stable products such as analcime and kaliophilite.

It has been established that compositions with a high content of waste from the dump (65...70%) are not suitable as a composite slag-alkaline binder, since samples made on their basis have low strength properties and a heterogeneous structure. In general, the developed composite slag-alkali binder includes readily available and inexpensive materials, one of which is limestone screenings, which are currently man-made waste requiring either rational use or disposal.

CONCLUSION

The cost estimate of the slag-alkaline binder shows that it is 62.2% lower than that of Portland cement. Thus, the methodological principles for determining the compositions and properties of a special-purpose dry construction mixture based on a slag-alkaline composite binder have been substantiated, which show that the main rock-forming clay minerals contained in fillers such as sandy loams and loams interact with sodium and potassium carbonates during the formation of building concrete structures. As a result, zeolite-like alkaline hydroaluminosilicates arise, possessing binding properties and capable of serving as structure-forming elements in materials based on widespread local raw materials from limestone crushing waste. When assessing the strength of the slag-alkaline binder based on crushing waste, rational proportions of three components were identified: limestone screenings - 40%. Water 28% by total weight. The samples have a dense and homogeneous structure after hardening. The average compressive strength reaches 41.2 MPa.

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