



Application status of red mud and prospect of lightweight foam soil

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Abstract Red mud is a solid waste residue produced in the process of alumina production. The total amount of red mud is large due to technological reasons. And its elements are extremely complex, which can't be effectively used, leading to a large amount of land is occupied and the environment is polluted. This paper summarizes the research situation of red mud and light foam soil, analyzes the application prospect of red mud, and makes some suggestions to provide ideas for the research of red mud.

Keywords red mud; road base materials; light foam soil

1. Introduction

Red mud is a solid waste residue produced in the production process of alumina industry. Its appearance is red mud or powder because it is rich in iron oxide. There are three ways to produce alumina worldwide: bayer extraction, sintering production, bayer and sintering combined production. 95% are from the bayer method. The ratio of alumina production to the required red mud discharged is approximately 1:1.5. As of July 2020, the world's annual output of aluminum oxide was 132 million tons, of which China's annual alumina output was 69.18 million tons. The average utilization rate of red mud in the world is 15% at present, but the comprehensive utilization rate of red mud in China is only 4%, and most of the red mud produced is treated by onshore storage. A large amount of accumulation will occupy a large amount of farmland or construction land because red mud is strongly alkaline. On the other hand, the alkaline material in red mud penetrates into the ground with gravity, causing groundwater pollution. In addition, the fine dust formed by red mud floats with the wind, causing air pollution and affecting human health. Therefore, it is urgent to find an economic and environmentally friendly red mud recycling method.

2. Research Findings

2.1 Red mud is used as the road base material

The utilization of red mud in the construction of expressway or primary highway can greatly improve the utilization rate of red mud. The former Soviet road builders according to the first red mud applied to the pavement base in the 1980s [1], and built about 2000 m long test section. The test section paved a layer of 15cm red mud layer as a road base, half a year after the road performance test found the pavement in good condition, after the core get unlimited compressive strength in about 0.5~1Mpa. Qi [2] et al suggested the use of two ash stable red mud as subgrade filler. Red mud is used to pave a 4000m long, 15 meters wide test road to test indoor test results. The results show that the strength of the roadbed meets the requirements of the highway strength when red mud: fly ash: lime was 8:1:1. Liang [3] found that the performance of stable graded gravel mixed with



red mud is better than that of the same level when the mixing amount of red mud is 10%~16%. Li [4] studied the red mud as the kerb material of cement red mud concrete. It was found that the test 28d is 35.3MPa and 5.3MPa when the cement: sand: gravel was 1:0.34:2.72:0.77. The red mud was used in the cement red mud stabilized gravel base material was studied, and the test road was paved in a project site in Zhengzhou. It was found that the 7d side limited compressive strength was 1.84MPa when the cement: red mud: gravel was 4:20:80, indicating that the cement red mud gravel base has a good bearing capacity.

3. Research of foam lightweight soil

Many scholars have done a lot of research on the characteristics and application of foam lightweight soil in the world. Kearsley [5-7] studied the effect of fly ash content on the performance of foam lightweight soil. The study found that the unlimited compressive strength of foam light soil does not change with the amount of cement when the amount of fly ash is less than 67% of the amount of cement. The unlimited compressive strength of the foam light soil begins to become smaller when the amount of fly ash is higher than 67% of the cement amount. Tikalshy et al [8] studied the frost-thaw properties of foam light soil. It is found that the permeability depth is a key predictor of the development of frost-thaw soil, and the key factors affecting the frost-thaw resistance of foam light soil are the compressive strength, liquid permeability depth and permeability rate. Nambiar [9] studied the effect of packing type and sand particle size on the performance of foam concrete. The research shows that the consistency of the mixture mainly depends on the type of filler, the fluidity of foam concrete is mainly affected by the foam volume. Jones [10] used fly ash instead of sand to make foam lightweight soil and study its related properties. The research shows that by using fly ash to make the foam light soil has better performance than the foam light soil prepared with sand, including its fluidity, compressive strength and anti-sulfate erosion ability. Nambiar [11-13] studied the effect of stomatal properties on the compressive strength and density of foam light soil. It is found that the volume, size and spacing of pores have a great impact on the compressive strength and density of foam light soil. Panesar [14] studied the properties of porous concrete and the effects of synthetic foaming agents and protein foaming agents. It is found that the type of foaming agent significantly affects the thermal resistance and adsorption coefficient of the material, but has little impact on the mechanical properties of the material, and the performance of using compound foam lightweight soil is better than the material prepared by protein foaming agent. Hilal et al [15] studied its properties by incorporating silicon powder and fly ash into the foam light soil. The study shows that the addition of mineral admixture enhances the strength and ease of foam lightweight soil. Falliano et al [16] studied the influence of curing conditions, cement varieties, foaming agent and dry density parameters on the compressive strength of foam concrete. It is found that the increase of compressive strength of foam concrete is more or less linear trend with the increase of density. The increase of compressive strength is more obvious when the protein foaming agent is used for mix ratio design. Chen et al [17] studied the strength characteristics of foam lightweight soil with different parameters. The foam light soil test pieces of mineral powder, fly ash, slag and kaolin were studied, with unlimited compressive strength test and direct shear test at different times. The test shows that the compressive strength of foam light soil decreases with the increase of admixture ratio. Qiu et al [18] studied the performance of foam lightweight soil. It is found that water-solid ratio is the main factor affecting the performance of foam light soil.

4. Prospects

There are many kinds of foam concrete, but the commonly used is cement-based foam concrete, and the red mud used as light foam soil research is less. The performance of the new foam light soil is mainly studied by changing the mix ratio of foam light soil and the types of admixtures, including its unlimited compressive strength, freeze and thaw resistance, heat insulation performance, etc. The study of cement-based foam concrete is roughly divided into three categories. The first is the powder composition of foam concrete. The second is the



modification of foam foam agent. And the third is the lightweight aggregate. The present stage of light foam soil mix design can't like cement based light foam soil in accordance with the formula and fixed ideas with the expansion of lightweight foam soil research scope. Only guided by experience, through a series of experiments to determine the optimal amount of light foam soil material, and according to the actual production, explore the application of optimal foam light soil in road expansion, soft soil subgrade backfill, goaf filling and other practical engineering. It shows that the feasibility and economy of foam light soil in practical engineering application are better than that of ordinary soil filling materials after a large number of engineering examples, which further proves that foam light soil has a very wide application prospect in future construction.

5. Results

The application of red mud to light foam soil has high research value to study the optimal mix design, physical and mechanical characteristics, and through the law found laws, and constantly enrich the light foam soil system, so as to effectively solve the problem of low utilization rate of red mud.

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