 DOI: 10.19601/j.cnki.issn1943 - 9903.2024.06.006

Progress in Resource Utilization of River Sediment in the Field of Building Materials

Chenhao LIANG[1]*, Qiangbin CHENG[2], Xiaohong XIONG[1], Ruqi YI[3], Chen WANG[1]

1. College of Urban Construction, Jiangxi University of Technology, Nanchang 330022, China; 2. Organization Department of the Party Committee of Jiangxi University of Technology, Nanchang 330022, China; 3. College of Culture and Media, Jiangxi University of Technology, Nanchang 330022, China

Abstract At present, there is a great demand for building materials in the market, and the market prospect of building materials is relatively considerable. Through studying the composition of river sediment and its resource utilization in the field of building materials, this paper expounds the current domestic scholars' research on river sediment in building materials, and summarizes the current problems and challenges, so as to provide a reference for the sustainable development of river sediment in the field of building materials.

Key words River sediment, Building materials, Resource utilization

1 Introduction

With the continuous advancement of urbanization and the continuous development of infrastructure construction, green and high-performance building materials will be more and more favored, which provides a broad space for the development of the industry and will further promote the upgrading and innovation of the construction industry to meet people's demand for high-quality buildings, but at the same time, it will also cause clay consumption to a certain extent in the production of building materials. Chen Li[1] measured the chemical composition and burning loss rate of the collected sediment samples by X-ray fluorescence. The results showed that the chemical composition of the sediment was similar to that of clay, so the treated sediment was used instead of clay to produce building materials. This can not only reduce the mining of clay, reduce energy consumption, avoid the waste of potential resources, but also avoid secondary pollution to the environment caused by the placement of sediment, protect the ecology, and help to achieve the goal of "carbon peak and carbon neutrality". For this reason, many scholars at home and abroad have carried out research on the application of river sediment as building materials to ensure its safety and reliability.

2 Composition and utilization of river sediment

The research of Zhang Xiaojing[2] *et al.* shows that river sediment is mainly composed of sediments, minerals, organic substances, microorganisms and water, and its composition can replace traditional raw materials in building materials under certain conditions. But it is undeniable that this requires comprehensive consideration of many factors. First of all, the physical, chemical and mechanical characteristics of the sediment need to be comprehensively analyzed; secondly, a series of treatment operations are required to remove harmful substances or improve their performance. Although there is the possibility of replacing clay in the sediment, it also faces some challenges, such as great changes in the composition and properties of the sediment, and fluctuations in quality. In addition, there may be pollutants or technical limitations that lead to substandard building materials. Therefore, when applying river sediment to building materials, it needs to be carefully evaluated and properly tested and validated to ensure its feasibility and safety.

3 Resource utilization of river sediment in the field of building materials

At present, the research on sediment as building materials is quite extensive in China. On the one hand, researchers focus on the analysis of physical characteristics of sediment, such as particle size, moisture content, and its chemical composition, to assess its applicability in building materials; on the other hand, the mixing ratio of sediment and other materials, processing technology and other aspects are deeply explored. In addition, some scholars also pay attention to the environmental protection and cost-effectiveness of sediment in the production process of building materials. Through the composition analysis and performance test of sediment, their applicability and potential value are determined. After continuous process optimization and material ratio research, many scholars have achieved remarkable results and successfully transformed sediment into high-quality building materials. This not only reduces the construction cost, but also brings economic benefits to related industries. At the same time, it has also achieved important results in environmental protection, reducing the waste of sediment and environmental pollution. In addition, building materials made of sediment also show excellent performance. After testing, these materials have certain strength and durability,

Received: March 19, 2024 Accepted: June 5, 2024

Supported by Undergraduate Training Program for Innovation and Entrepreneurship of Jiangxi Provincial Department of Education (S202310846004 & S202310846007).

which can meet building needs.

3.1 Brick making The utilization of sediment as building materials mainly refers to mixing sediment with mineral materials or other additives, and through setting different technological conditions, building bricks that meet the standards are made[3]. The composition materials for brick making are rich and diverse, usually including clay, shale, coal gangue, sand and so on. Among them, clay is the main traditional raw material and has good plasticity, but it has the characteristics of non-regeneration. Therefore, the method of making bricks from sediment by using sand, minerals and organic substances in sediment can not only reduce river pollution, but also realize the use value of sediment in achieving the effect of replacing clay. In Jia Weidong's related research, it has been shown that making bricks from sediment within the environmental allowable value has great economic and environmental effects[4].

3.2 Preparation of ceramsite In the production of building materials, river sediment can replace natural clay materials to produce ceramsite[5], and ceramsite is a multi-component granular material. Its main components include the following parts: First of all, the core of the ceramsite is usually processed from natural or industrial raw materials such as soil, shale, and fly ash, which provide the basic structure of the ceramsite. Secondly, during the production process, a certain proportion of mineral components, such as feldspar and quartz, will be added to improve the hardness and durability of the ceramsite. In addition, in order to improve the performance of ceramsite, some auxiliary materials may be added, such as expansion agent and foaming agent, so that it has lighter weight and better heat preservation and insulation performance. Finally, after high-temperature firing, these raw materials and additives interact to form ceramsite with specific properties. Zhang Hongli[6] studied the high-temperature firing process of ceramsite using river sediment. The results showed that qualified ceramsite can be fired after properly adjusting the proportion of sediment, and the cost of producing ceramsite was lower than that of producing other building materials. Raw materials such as river sediment and their mixtures were also used as materials for preparing ceramsite. The results of thermogravimetric analysis showed that the overall chemical composition content of the mixed raw materials met the requirements of ceramsite for firing. Compared with the sediment of other adsorbents, the price of ceramsite is low, the adsorption effect is good, and it is conducive to the attachment of microorganisms[7], so the application of ceramsite with clay as the main component is promoted. This can not only solve the problem of polluted sediment disposal, but also realize the resource utilization of heavily polluted sediment, which is of great significance to improving river water quality.

3.3 Cement Cement is an important building material, its composition mainly includes clinker, gypsum and mixed materials. Clinker is usually made of limestone, clay or other materials calcined at high temperature and is the core component of cement. The role of gypsum is to adjust the setting time and hardening speed of cement, while mixed materials, such as fly ash and slag, can improve the performance of cement. Specifically, limestone provides the main source of calcium, clay or other raw materials provide components such as silicon and aluminum, and iron correction materials are used to adjust the chemical composition. These components are carefully processed during the production process, including processes such as grinding and mixing, resulting in cement with various properties to meet the needs of different projects.

3.4 Foam concrete Foam concrete is composed of cementitious materials, fillers, foaming agents and water-reducing agents, *etc.* It is a lightweight porous concrete prepared by physical or chemical foaming. Its excellent performance as a new product has been proved. Through cementitious materials, foaming agents and water-reducing agents, the sediment is transformed into environmentally friendly foam concrete[8]. This can not only give full play to the characteristics of small holes in the sediment itself, but also make the foam concrete have good heat insulation performance. On the basis of realizing the resource utilization of the sediment, new building materials with excellent quality and large social demand can be obtained.

3.5 Filling materials The filling material is made up of a variety of materials. The common ones include earthwork, such as mud, sand and gravel, which are commonly used basic materials in filling projects. Cohesive soil has certain consolidation ability, while sandy soil has better water permeability. In addition, industrial waste such as fly ash and slag, as well as building waste, can also be used as filling materials after appropriate treatment. However, using sediment as a filling material has many benefits[9]. On the one hand, it realizes the reuse of resources, turns sediment that may have been regarded as waste into treasure, and reduces the demand for traditional filling materials, which is in line with sustainable development concept; on the other hand, using sediment as a filling material can reduce project costs, and can effectively save project expenses compared with purchasing other expensive filling materials. In addition, the rational use of sediment can also reduce the potential impact of sediment piling on the environment, which can be said to serve multiple purposes. At the same time, the reasonable use of geosynthetics and improved materials to enhance and improve the stability of the fill can meet the needs of the filling project and ensure the stability, security and sustainable development of the project.

4 Conclusion

The use of traditional raw materials in the construction field will pollute the environment to a certain extent, which does not meet the requirements of environmental protection and sustainable development. The utilization of building materials of sediment is a potential way of resource utilization, and it is also very necessary for the state to provide policy support in the process of its development. The utilization of sediment as building materials has many benefits, but it also faces some challenges in the process of imple-

mentation. Through policy support, the development of sediment utilization as building materials can be promoted. In the future, sediment utilization as building materials may develop in the following directions: first, higher-performance sediment building materials are developed to improve their strength, durability and safety; second, the production process is further optimized, to reduce costs, and improve economic benefits; third, the integration with environmental protection technology is strengthened to realize the seamless connection between sediment treatment and building materials production; fourth, the application field is expanded, and not merely limited to traditional building materials, it can also be applied to decorative materials, *etc.*; fifth, the formulation of relevant standards and norms is promoted to ensure product quality and safety.

References

[1] CHEN L. Experimental research on making bricks from Wenruitang River sediment resources[D]. Shanghai: East China Normal University, 2013. (in Chinese).

[2] ZHANG XJ, WEI DH, ZHANG HL, *et al.* Microbial composition in urban river sediment and its potential to transform nitrogen and sulfur pollutants[J]. Environmental Pollution and Prevention, 2022, 44(4): 425 – 430. (in Chinese).

[3] YANG XY, WEI RP, YANG LY. Research on ceramsite preparation and phosphorus removal potential of polluted sediment[J]. Journal of Ecology and Rural Environment, 2019, 35(3): 368 – 376. (in Chinese).

[4] JIA WD, YIN JJ. Analysis of heavy metals in river sediment and research on brick making[J]. Environmental Science and Technology, 2017, 30(2): 23 – 26. (in Chinese).

[5] LI B, HUA SG, PEI DJ, *et al.* Research progress on river sediment disposal and resource utilization[J]. Resource Conservation and Environmental Protection, 2023(1): 131 – 134. (in Chinese).

[6] ZHANG HL. Research on high temperature firing ceramsite from river sediment[D]. Hangzhou: Zhejiang University of Technology, 2020. (in Chinese).

[7] SAN JD, CAI DS, OU WC, *et al.* Study on the preparation and properties of sediment ceramsite[J]. Metal Mine, 2022(11): 229 – 237. (in Chinese).

[8] YANG XY. Research on the utilization of light building materials and the solidification effect of heavy metals in river sediment[D]. Shanghai: Shanghai Jiaotong University, 2020. (in Chinese).

[9] WANG L. Current situation of river sediment resource utilization and risk assessment research progress[J]. Water Resources Development and Management, 2022, 8(10): 36 – 41. (in Chinese).

(From page 21)

14.78 mm, respectively. The increase rate of settlement in the early stage of monitoring was fast, and the settlement value gradually tended to be stable with the increase of monitoring time. During the monitoring period, the settlement value of the slope did not change suddenly, and the slope was stable. The monitoring results show that the values of rainfall, deep displacement and surface displacement of the slope were relatively stable during the monitoring period, and the slope was stable.

4 Conclusions

According to the condition of the open-pit coal mine slope, we designed and constructed the slope automatic monitoring system, determined the monitoring frequency of rainfall, deep displacement and surface displacement, and analyzed the slope monitoring data. The results show that the maximum daily cumulative rainfall in the monitoring period was 6 mm, and the overall rainfall was small, which had no significant impact on the slope. No significant sliding surface was formed during the monitoring period, and the overall condition of the slope was good. The horizontal displacement increased rapidly in the early stage of monitoring, and the horizontal displacement tended to be stable with the increase of monitoring time. The maximum horizontal displacement of the slope was 22.74 mm in the monitoring period. The growth rate of settlement in the early stage of monitoring was fast, and the settlement value gradually tended to be stable with the increase of monitoring time. The maximum settlement value of the slope in the monitoring period was 18.65 mm, and the slope was in a stable state. In summary, the application of slope automatic monitoring system in opencast coal mine can provide support for coal mine safety production.

References

[1] LI S. Application of 3D laser scanner in slope monitoring of open-pit coal mine[J]. Mining Equipment, 2023(11): 19 – 21. (in Chinese).

[2] SONG J. Analysis of displacement monitoring data of rock mass slope with fracture structure in Tianchi Energy South Open-pit Coal Mine[J]. Opencast Mining Technology, 2023, 38(5): 100 – 102. (in Chinese).

[3] LI WP, LIU QS, LIU XY, *et al.* Ground radar technology for slope monitoring in open-pit coal mines[J]. Opencast Mining Technology, 2023, 38(4): 49 – 52. (in Chinese).

[4] WANG LW. Application of GNSS slope monitoring technology in Baiyinhua No.2 Open-pit Mine[J]. Opencast Mining Technology, 2022(5): 32 – 35. (in Chinese).

[5] DU K. Application status of slope monitoring technology in open-pit coal mine[J]. Inner Mongolia Coal Economy, 2020(2): 142. (in Chinese).

[6] CHEN LL, GU YK, ZHAO JK. Ideas of slope monitoring early warning safety decision making[J]. Opencast Mining Technology, 2018, 33(1): 47 – 49,54. (in Chinese).

[7] WANG XR. Application of IBIS-M slope monitoring early warning system in Ha'erwusu Open-pit Coal Mine[J]. Opencast Mining Technology, 2018, 33(4): 71 – 74. (in Chinese).

[8] LI ZL, WANG XL, HAN M. Application of GPS monitoring technique in the slope monitoring of open-pit coal mine[J]. Opencast Mining Technology, 2016(10): 52 – 54, 59. (in Chinese).

[9] XIANG D, ZHANG YG, ZHANG L, *et al.* Application of CORS system in slope monitoring of Weijiamao Open-pit Coal Mine[J]. Opencast Mining Technology, 2016(2): 48 – 51. (in Chinese).

[10] SHI B, YANG GH. Application of slope monitoring warning system in Haerwusu open-pit coal mine[J]. Opencast Mining Technology, 2014(9): 82 – 84. (in Chinese).

[11] WEI ZG, XU YL, DING H, *et al.* Slope landslide mode and radar monitoring and early warning of dump slope in Huolinhe North Open-pit Coal Mine[J]. Modern Mining, 2022, 38(1): 71 – 74,78. (in Chinese).

[12] LUO A, WANG HL, LI KG. Monitoring and early warning of north slope in Xianfeng Open-pit Coal Mine[J]. China Water Transport, 2020, 20(2): 251 – 252. (in Chinese).