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Non-sintered dredged sediments artificial cobblestones: Preparation, structure and properties

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HIGHLIGHTS

- Dredged sediments are utilized to produce a new artificial cobblestones in non-sintered method.
- Dregred sediments artificial cobblestones (DSACs) has a multilayer core–shell and three-dimensional network-like structure.
- When the particle size of DSAC is between 10 and 20 mm, the single strength of DSACs reaches the maximum of 1.25 MPa.

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ABSTRACT

A novel preparation process of non-sintered dredged sediments artificial cobblestones (DSACs) was conducted in this study. DSACs with a multilayer core–shell structure was manufactured by wrap-shell process. The performance characteristics, such as particle form factor, water absorption, particle size distribution, strength, density, frost resistance, and salt resistance of different particle sizes of DSACs were investigated. The results showed that DSACs was nearly spherical, and with a three-dimensional network-like structure. The single DSACs strength increased with the decrease of its particle size. When the particle size of DSACs was between 10 and 20 mm, the single strength of DSACs reached the maximum of 1.25 MPa. After 50 freeze–thaw cycles and 50 days of soaking in salt solution, the mass of DSACs showed no obvious mass loss. However, with the increase of the particle size, the strength of the DSACs got weakened. With the feasibility of preparation process, this technology paves the avenue to the resource utilization of dredged sediments and avoids excessive exploitation of mineral resources.

1. Introduction

The siltation of oceans, rivers and reservoir areas is a major issue in water resources management, which is mainly caused by the expansion of the port range and the reduction of its water storage capacity, resulting in the accumulation of sediments and pollutants in the channel. As a result, a lot of dredged sediments is produced [1–3]. Dredged sediments is rich in organic matter, nutrients like nitrogen and phosphorus, as well as heavy metals and other pollutants [4–6]. In order to avoid secondary pollution, it is necessary to study on harmless disposal and resource utilization of dredged sediments. Typical methods are using dredged sediments as materials for water conservancy [7], filling [8] and building [9]. Among them, the use of dredged sediments as building materials is one of the effective methods for the disposal of dredged sediments, which can not only reduce the consumption of raw materials for building material manufacturing, but also protect the environment.

As building materials, dredged sediments was used to prepare aggregates and concrete blocks. Such as Ozer-Erdogan [9] used marine dredged materials as a fine aggregate in ready-mixed concrete, it had been proved that dredging materials could be used to make high-quality concrete blocks whose compressive strength can reach up to 38.05 MPa. Daniela [10] mixed the marine dredging spoils and other waste materials to produce ceramics, the ceramics were air sintered in a muffle furnace. Although the ceramics had good mechanical properties, but it would release harmful heavy metal elements and consume a lot of coal during the calcination process, and the preparation process of ceramics caused serious pollution to the environment. In Zhao's study [11], dredged sediments were dried and ground and subsequently used in partial cement replacement in the manufacture of mortars and concrete. The incorporated sediments influenced the hydration

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