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Preparation of non-sintered lightweight aggregates from dredged sediments and modification of their properties

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HIGHLIGHTS

- Dredged sediments are utilized to produce non-sintered lightweight aggregates.
- WLAs and WSLAs are manufactured by waterproofing and wrap-shell process.
- Superior performance of WSLAs is due to pozzolanic reaction of the shell layer.
- Silicon polymer membrane ensures WLAs equip with a hydrophobic surface.
- Hard concrete shell is important for non-sintered LWAs applied in harsh environment.

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ABSTRACT

A novel preparation technique of non-sintered lightweight aggregates (LWAs) from dredged sediments was conducted in this study. In order to deal with the problem of hydration and low strength of the ceramsites without calcination, waterproofing lightweight aggregates (WLAs) and wrap-shell lightweight aggregates (WSLAs) are manufactured through the process of waterproofing and wrap-shell, respectively, and untreated lightweight aggregates (ULAs) were utilized as core layer. The performance characteristics, such as basic physical properties, mechanical strengths, water resistance, harsh environment resistance, and microstructure, of ULAs, WLAs and WSLAs were investigated. Results show that ULAs have a uniform particle size distribution, but their compressive strength is rather low (0.27 MPa), and the value of water absorption was as high as 24.18%. WSLAs were equipped with a hard and stable concrete shell, which raised their compressive strength to 2.46 MPa, and the salt, frost and shearing resistance were improved. These results reveal that, if dredged sediment would be used as raw material for producing non-sintered LWAs in concrete pouring, a stable shell layer was extremely essential to avoid their obtained specimen from crushing or being hydrated.

1. Introduction

Dredging operations are necessary for irrigation and water transport to keep the normal maritime and river activities. The global sediments produced by this process were as many as hundred millions of tons annually [1]. Generally, dredged sediment is a type of very soft soils with notably low mechanical strength and extremely high moisture content. Apart from that, the sediments may be contaminated with heavy metals and organic pollutants [2,3]. In many countries, dredged sediment are frequently physically treated and dewatered before disposal, and the typical practice of disposal are landfill, application to farmland and forestry and sea dumping. The most common methods of dewatering is putting the dredged sediment in an area to dewatered naturally, but this process would take long time and caused secondary pollution [4]. Therefore, regeneration and beneficial reuse of dredged sediment have mainly been explored in long time. The search for cost-effective and eco-friendly disposal options has become most pressing matter because of tighter environmental regulations, declining public acceptance of other solutions in many countries [5].

Traditional lightweight aggregates (LWAs) were made from mineral resources, such as clay and shale, and fly ash in common. An increasing number of large-scale construction projects, such as Stolma bridge and Nordhordland bridge in Norway, Charter Oak

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