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Effect of Particle Shape of Limestone Manufactured Sand and Natural Sand on Concrete

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Abstract

The particle shape parameters of natural sand and limestone manufactured sand were studied by the DIP method. The results showed that compared with the natural sand, the manufactured sand was more 19.0% in lengthwise ratio, less 11.5% in flatness ratio, more 0.3% in convexity ratio, more 0.2% in fulness ratio, less 19.3% in particle shape parameters, and less 14.8% in sphericity. Therefore, the natural sand was more close to sphere shape and more smooth, while the manufactured sand was more slim, flat and rough. When slump and the cement dosage are at the same time, manufactured sand concrete has larger water usage and less air content, but the compressive strength is greater than natural sand concrete.

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1. INTRODUCTION

Nomenclature

DIP digital image processing

Fine aggregate has important effects on the technical and economic performance of concrete, its dosage in concrete is only second to coarse aggregate. In recent years, under the pressure of environmental protection and the needs of the flood control, digging natural sand is restricted or even forbidden, and the rapid development construction market needs a large number of fine aggregate, so the manufactured sand is widely used in concrete engineering, and the performance of the manufactured sand and its concrete has become an important research subject. Grain shape and surface characteristics of aggregate is the important factor to determine water dosage of the concrete mix, the bigger the surface area, the bigger the effect is. Foreign scholars believe that 4.75-2.36mm particles have the biggest effect of the performance of concrete^[1]. Angularity of the particles can increase the compressive and flexural strength of concrete^[2], cementation of rough particles and cement paste is better, it's benefit of enhancing the strength, especially the flexural strength^[3]. Compared with natural sand concrete, manufactured sand concrete has larger unit water consumption, higher compressive strength, better permeability and frost resistance. Researchers generally consider that is mainly due to the grain shape and surface state of the manufactured sand. DIP has been used in this article to research the grain shape characteristics of the manufactured sand and natural sand, in order to reveal the difference between the two sands.

Fine aggregate particles are difficult to fully define and measure because of its irregular shape, therefore, effects of grain shape on the concrete properties is also difficult to precise evaluation^[4]. DIP technology is first using the camera to visualize the particles graphically, then using graphics processing software to analyse and compute the grain shape parameters. In the mid 1990s, scholars of University of Hong Kong applied this technology in coarse aggregate grain shape representation and description of the grading^{[5][6]}.

Stereoscopic microscope with DV320 digital imaging system made by Chongqing Aote Optics has been used to take 2D photos of manufactured and natural sand particles in this article. Length a , width b , area $S1$ and raised area $S2$ of those 2D photos have been measured by DIP technology. Weight of a certain number of the sand particles have been measured by electronic scale with accuracy of 0.0001g, and then calculate the average weight of each particle. Thus, the parameters of the aggregate grain shape and size parameters have been figured up, mainly including lengthwise ratio, flatness ratio, convexity ratio, fullness ratio, grain shape parameter and sphericity.

2. APPEARANCE CHARACTERISTICS OF LIMESTONE MANUFACTURED AND NATURAL SAND

In this paper, the manufactured sand used in this experiment are collected from Lechang gorge water conservancy project Jiangjunshan rock field, natural sand are collected from Yingde sand field. They are all medium sand, divide into five grades as 0.16-0.315mm, 0.315-0.63mm, 0.63-1.25mm, 1.25- 2.5mm and 2.5-5mm, their typical photos are shown as Figure1. The limestone manufactured sand grain has rough surface, sharp edges and corners, the natural sand grain has round appearance, but the surface is not smooth, there are some bumps, potholes and sharp edges in the surface. It's different from our usual impressions.



Fig.1. (a) Limestone manufactured sand;(b) Natural river sand.

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