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The Influence of Freeze-thaw Cycles on the Impact Compressive Behaviors of Large-sized Ceramsite Concrete

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Abstract. The horizontal bundled Hopkinson pressure bars apparatus were used to carry out the impact compressive test of the large-sized ceramsite concrete for the first time. The paper studied the law of crack development and dynamic elastic modulus and the impact compressive properties of ceramsite concrete sample influenced by freeze-thaw cycles. Experimental results showed that: the cracks or holes broadened and distributed more widely with the increase of freeze-thaw cycles; the density and the ultrasonic velocity and the dynamic elastic modulus of the sample decreased with the damage accumulation in freezing and thawing cycles; the dynamic compressive strength decreased with the increase of cycles of freeze-thaw and the volume fraction of the ceramsite; and the maximum compressive strength increased with the increase of strain rates.

Key words: Freeze-thaw cycles (FTC); Large- sized ceramsite concrete; Bundled Hopkinson pressure bars(BHPB); Impact compressive behaviors

1. Introduction

Concrete is one of the most widely used building materials in many civil buildings. As a new type of lightweight aggregate concrete with advantage of environmental friendly, the ceramsite concrete has been more and more widely used in the engineering field. Therefore, the research on the mechanical properties of it is gradually deepening, the influence factors included not only the concrete admixture (Ke, 2009, Maryam, 2012), the ratio of mixture (Li, 2014, Shi, 2013), the external environment (Shi, 2014) and others, but also the loading speed (Shi, 2013, Shi, 2014, Wang, 2013), i.e., response of mechanical behaviors from statics transferred to dynamic ones. Split Hopkinson pressure bar (SHPB) is one of the apparatus that most commonly used for material impact dynamic mechanical performance test. In order to meet the 2 basic assumptions of the SHPB technology, the small size specimen is carried out on the ordinary SHPB bar. Dong and Zhang (2011)studied the dynamic behaviors of normal concrete by

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means of vertical BHPB. They concluded that the BHPB would effectively avoided the lateral inertia effect caused by impacted test with large radius bar, which can meet the requirements of stress uniform assumptions and one-dimensional stress hypothesis of SHPB technology, and the requirement of the material uniformity assumption of large-sized concrete specimen. In this paper, the impact compressive test of the large-sized ceramsite concrete samples were carried out on self-made horizontal BHPB apparatus at first time. The impact compressive behaviors of ceramist concrete effected by FTC were studied.

2. Samples preparation

2.1 Materials

Ceramsite aggregate, ceramsite shale produced in Henan, China. The basic properties are as follows: particle apparent density is 878 kg/m^3, particle size is 10-15mm; water absorption (24h) is 7.72%; surface adsorption water rate is 3.99%. Cement, ordinary portland cement 325. Sand is River sand, diameter is 0.25-0.5mm. Water is ordinary water supply.

2.2 Samples

The concrete sample is a rectangular block of 150mm×150mm×100mm. Total 4 kinds of samples were produced (mortar and 3 concretes with different volume fraction of ceramsite (VFC)). The volume fraction of shale ceramsite and the weight of mixture of concrete samples are shown in table1.

After been vibrated, formed and standard cured, the sample was polished, and the parallelism of two impacted surfaces were required less than 0.05mm.

Table1 Mixture proportion of concrete samples

Sample types(VFC)	Identifier	Water	Cement	Sand	Ceramsite
Mortar concrete(0%)	A	0.43	1.00	1.20	0
Ceramsite concrete(15%)	B	0.43	1.00	1.20	0.18
Ceramsite concrete(30%)	C	0.43	1.00	1.20	0.43
Ceramsite concrete(45%)	D	0.43	1.00	1.20	0.81

3. Experimental study and results analysis

3.1 Test of freeze-thaw cycle and the law of crack development

The samples are tested by means of the rapid FTC machine with conditions as: temperature from -10 ℃ to 10 ℃, cycles from 10 to 50 and interval number is 5 times. Before the FTC test, the sample has been soaked in the water for 96 hours to ensure the sample in water saturated state (but due to the coverage of the surface of the ceramsite, the inner space of the ceramsite was not necessarily permeated into the water). The sample was also in full water saturation state during FTC testing. One cycle time is 3.5 hours. The surface perfect degree and the crack development of the sample