Engineering Failure Analysis 18 (2011) 1784–1790

Contents lists available at ScienceDirect

Engineering Failure Analysis

journal homepage: www.elsevier.com/locate/engfailanal

Experimental study on dynamic damage evolution of concrete under multi-axial stresses

J.Y. Chen *, Z.X. Zhang, H.W. Dong, J. Zhu

Ningbo University, Ningbo 315211, PR China

ARTICLE INFO

Article history:
Received 10 October 2010
Received in revised form 14 April 2011
Accepted 15 April 2011
Available online 27 April 2011

Keywords:
Concrete
SHPB
Dynamic damage evolution
Mutil-axial stress

ABSTRACT

The effect of stress state on the dynamic compressive strength and the dynamic damage evolution process of concretes are investigated by use of a Spilt Hopkinson Pressure Bar (SHPB) and the ultrasonic technique. The columned concrete specimen is encircled by a steel sleeve. The multi-axial loading includes the axial and the radial loadings. The axial loading is supplied by the incidence bar, and the radial ones are produced by the steel sleeve. Analysis of the dynamic damage evolution of the samples is based on the measurement of the changes of ultrasonic wave velocities before and after the impact tests. The waveforms in the test bars, the stress strain curves, the confining pressure of the specimen, the dynamic compressive strength and other information about the samples are obtained during the SHPB experiments. The results of the tests show that the loading rate and stress states of the specimen apparently influence the damage evolution process in concretes. The dynamic damage evolutions are accelerated with the increase of the strain rate and are delayed significantly under the confined pressure.

1. Introduction

Concrete is a synthetic material that contains many holes, cracks and other original defects (or named as damage). Under the mechanical loading [1–3], the temperature loading [4,5] or the chemical environmental factors [6,7], the evolutions of the damage in concretes will be accelerated. The researches on the mechanical properties and the damage evolutions of concretes under dynamic loading have got significant progress [8–14]. Many scholars have conducted fruitful explorations, but most of the research work is limited to the one-dimensional stress [10,11] or the one-dimensional strain [12,13] cases.

The researches of the damage nucleations and evolutions in concrete materials provide more understandings about the failure mechanism of concrete. This paper discusses the dynamic response of C40 concretes under high loading rate and multi-axis stress state. The impact tests were conducted on samples under one-dimensional stress state and under the passive confining pressure state. The stress–strain curves are given with the influences of the stress state and the loading rate. Experiments show that the development of the damage evolution is increased with the loading rate, significantly slow down with increasing of confining pressure.

2. Specimens and experimental apparatus

2.1. Specimens

The specimen is a disc concrete with diameter 70 mm, thickness 35 mm (no-confining pressure state). The confined sample consists of a concrete disc with diameter 74.6 mm, thickness 37 mm and a steel sleeve. The specimens are shown in

* Corresponding author. Tel.: +86 574 87600496; fax: +86 574 87608358.
E-mail address: chenjiangying@nbu.edu.cn (J.Y. Chen).

1350-6307/$ - see front matter © 2011 Elsevier Ltd. All rights reserved.
doi:10.1016/j.engfailanal.2011.04.006