Experimental testing and constitutive modeling of concrete

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1 Introduction

Concrete exhibits strongly nonlinear and complex mechanical behaviour and is increasingly used in complex structures such as containment vessels, floating and submerged structures, and offshore structures. Hence, concrete structures are nowadays often analyzed by means of general finite-element programs. The finite-element method requires a good understanding of the actual material behaviour under different load combinations to yield accurate and realistic results. Investigations on concrete strength and deformations under multiaxial states of stress are therefore needed in order establish the concrete strength criteria and realistic triaxial constitutive relations.

2 Research significance

In this study emphasis is placed on testing of the strength of lightweight aggregate concrete (LWAC) under triaxial compressive loading. Even though LWAC has found a vast field of application in many types of construction and is subjected to multiaxial stress conditions, investigations of its failure characteristics under these conditions are scarce. More experimental results are therefore needed to provide information for the development and validation of constitutive models for LWAC.

3 Test method

For the measured values to be considered as unique and fundamental properties of the concrete, they must be obtained from tests which have produced the required stress conditions in the specimens, independent of any machine or testing effects. In this work a fluid cushion loading system is used. Three independently controlled principal compressive stresses are applied along orthogonal directions to a 100 mm cubical specimen. Loading by hydraulic fluid subjects the specimen to clearly defined uniform stress with no restraints imposed onto the specimen. The measured values can therefore be regarded as true material properties for the concrete.

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