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Behavior of damaged concrete cylinders passively confined

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Abstract

This study focused on the behavior of the damaged concrete cylinders passively confined by an envelope constituted by the stack of the polymers tubes bonded by a STR resin under the axial compression load until rupture. The aim is to study the influence of the thickness of the polymer tube and the degree of damage of the concrete on the confinement rate. The compressive load was applied only on the concrete and not on the tube. Three series were considered: concrete cylinders, confined undamaged concrete cylinder and confined damaged concrete cylinder. The concrete cylinder is passively confined by 1, 2 and 3 tubes respectively. All the tubes have the same thickness but different diameters, so that during the stacking of the tubes the clearance between them is rapidly absorbed by the resin to ensure good contact and adhesion between the tubes over the all the circumference of the concrete cylinder. The effect of the radial confinement is shown by the different stress-strain curves depicted for each series of concrete cylinder. Analysis of the results obtained from the various compression tests carried out on the various short concrete cylinders shows that the ultimate stresses at the peak and the corresponding deformations experience an improvement as a function of the thickness of the polymer tube, the lateral confinement pressure does not vary linearly with the thickness of the polymer tube but above all that the confinement effect is higher for the damaged concrete cylinders Comparatively to the undamaged concrete cylinder. In conclusion, passive confinement by polymer tubes is particularly recommended for damaged concrete cylinders and columns.

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1. Introduction

In concrete structures subjected to mechanical stress, the initiation and the development of cracks as well as the appearance of the deformations is considered as the starting point of any failure and rupture. The rigidity of the materials is thus reduced. A lot of techniques and process for the reinforcement of concrete have been proposed by designers for several decades to improve the performance of these concretes and extend the lifetime of structures [1, 2, 3, 4, and 5]. The contribution of the reinforcement and confinement in the improvement of concrete performance has been investigated. Many experimental and analytical studies on reinforced concrete column with different type of FRP and metallic tubes have been conducted in the past three decades.

The low tensile strength, impact resistance, crack and shear resistance of the concrete, a new materials and techniques are used to remedy some of this weaknesses. [6, 7, 8]. The concept of the confinement of the concrete is realized using composite materials 'FRP' based on glass, carbon and other fibers. This confinement mechanism increases the strength and especially under compression loading.

When the concrete is subjected to axial compression, the latter deforms laterally. This deformation produces a cracking which increases with the increase of the load and which finally leads to the rupture of the concrete. If the concrete is retained laterally to reduce this deformation, the strength of the concrete and its ductility will be increased. This phenomenon is commonly called confinement of the concrete [5]. The confinement of concrete which consists in preventing these deformations can be achieved either by an external envelope or by a small spacing between the stirrups. The various composites offer modulus of elasticity and various rigidities which can modify the axial and radial behavior of the confined concrete cylinders [9, 10, 11, 12].

Confinement generally increases two characteristics of the concrete: the compressive strength $fcc > fco$ and the deformation corresponding to the ultimate compressive stress $\varepsilon cc > \varepsilon co$ [13,14,15]. . Thus in seismic regions, reinforcement is provided to confine the concrete and consequently to increase the ductility of the columns and beams [16].

Two aspects of confinement appear; When the confinement level is low, the deformations generated are close to ordinary deformations, which is commonly called "softening strain" [17], and when confinement is high, We are in this case, in the presence of great deformations, we speak then of "strain-hardening". "PRF" composite materials have been used for concrete confinement only since the early 1980s, although the use of concrete filled concrete pipes (PVC) began in the late 1970. Kurt, C.E. [18] suggested the use of plastic pipes, filled with concrete. The specimens were examined under axial compression load. He found that the ultimate strength of short columns increased 3.3 times the flash pressure of the tubes accompanied also by a marked improvement in ductility. No conclusions were drawn for long columns.

Saafi et al. (1999) [9] conducted experimental and analytical studies to evaluate the performance of concrete columns confined with CFRP and GFRP tubes. They found that columns reinforced by carbon fiber or glass fiber fabrics show significant growth in strength and ductility compared to those of unconfined specimens. The rate of increase depends on the thickness, the mechanical properties of the composite tube and the resistance of the control concrete. The mode of failure of the composite specimens was generally marked by the rupture of the fiber tube with bursting along half the height of the specimen. In the case of carbon fiber tubes, the rupture was more sudden and was accompanied by simultaneous rupture of the composite tube and the crushing of the concrete core.

In order to thoroughly understand the compressive behavior of the passively confined by an envelope constituted by the stack of the polymers tubes bonded by a STR resin under the axial compression load until rupture, The axial compression tests have been carried out to study the influence of the thickness of the polymer tube and the degree of damage of the concrete on the confinement rate. A comprehensive conclusion of compression behavior of confined damaged concrete cylinders by a polymer tubes was summarized, which can be used to aid engineers in designing and reinforcing damaged concrete members to ensure a desirable performance of element.

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