A CONCEPTUAL MODEL TO DESIGN RECYCLED AGGREGATE CONCRETE FOR STRUCTURAL APPLICATIONS

Marco Pepe

Dottorato di Ricerca in Ingegneria delle Strutture e del Recupero Edilizio ed Urbano

XIII Ciclo N.S. (2012-2014)

ABSTRACT

This Thesis proposes a conceptual formulation for controlling the resulting mechanical properties of Recycled Aggregate Concretes (RACs) via generalised mix-design rules intended at covering the specific features of Recycled Concrete Aggregates (RCAs).

As a matter of fact, the RCAs are characterised by a higher porosity and water absorption capacity than ordinary aggregates and, hence, general mix-design rules for ordinary structural concrete cannot be applied to RACs as such. Therefore, as a further step that goes beyond the currently available experimental and empirical investigations, the research presented in the present thesis proposes a rational mix design method for predicting the compressive strength evolution of RACs by considering both the mixture composition and the key properties of RCAs (i.e.; the amount of the attached mortar and indirectly the water absorption capacity). The formulations proposed in this thesis are based upon the results of several investigations carried out for characterising both RCAs and RACs. In fact, several tests were performed on different kinds of recycled aggregates, taking into account their origin, the processing procedure adopted for crushing the concrete demolition debris and their resulting size grading. The analysis of the results obtained in these tests led to proposing a comprehensive conceptual formulation that links the main engineering properties of aggregates to the porosity, particle density and attached mortar content of RCAs. Moreover, several concrete batches were produced for investigating the influence that three key parameters (viz. aggregate replacement ratio, nominal water-to-cement ratio and initial moisture condition of aggregates) have on the relevant properties for structural concrete. The behaviour of structural concrete is then analysed at a “fundamental” level, with the aim of scrutinising the physical properties and the mechanical behaviour of RACs, by taking into account the actual mixtures composition. Particularly, it is based on observing the hydration process developing inside RACs during the setting and hardening phase, and how these are influenced by the presence of RCAs.

The activities described in this work were carried out at the laboratories of the University of Salerno (IT), the Federal University of Rio de Janeiro (BR), as part of the “EnCoRe” Project (FP7-PEOPLE-2011-IRSES n. 295283; www.encorefp7.unisa.it) funded by the European Union within the Seventh Framework Programme, and Delft University of Technology (NL).