Analysis of the influence of corroded reinforcing steel bars in the bond behavior of recycled aggregate concrete (HR)

Concrete manufacturing has a great impact on the environment, as for its production is required a wide range of natural resources. For this reason the recycling of waste concrete from construction is considered as a measure to reduce the environmental impact related to concrete manufacture. Concrete waste recycling allows a more sustainable construction development, environment preservation and green products generation.

Recycled aggregates for concrete manufacture have been used in concrete with little structural responsibility, mass concretes and coatings. However, this analysis aims to determine the validity of these recycled aggregates so it can be used as structural concrete.

To enhance the use of recycled aggregate concrete for structural concrete this work focuses on the bond capacity between the concrete and the reinforcing steel bars depending on the amount of recycled aggregate used for concrete manufacture. Additionally it was believed interesting to analyze the influence of corroded reinforcing steel bars in the bond behavior of recycled aggregate concrete, since corrosion is one of the most important pathologies suffered by reinforced concrete.

To perform the analysis of the influence of recycled aggregates in the bond capacity of reinforced concrete four doses were designed with different percentages of replacement of natural aggregate by recycled coarse aggregate, HC without recycled aggregate, HR20 with a 20% of recycled aggregates, HR50 and HR100 with 50% and 100% of recycled aggregates. With these dosages are made pull – out test with uncorroded bars and pull – out test with three different degrees of corrosion in the reinforcing steel bars. To get the different degrees of corrosion we submit the different specimens to accelerate corrosion trying to reproduce natural corrosion.

Phase 1 was designed to study the bond behaviour from the four types of concretes with steel reinforcement bars of 12 mm was characterized. 100 mm cubic concrete specimens with embedded steel bars were produced in order to carry out the pull-out test. The steel bars completely crossed the cube section of 100 mm. A piece of plastic tube was used to debond 50 mm of steel bar from the concrete leaving the other 50 mm to bond with the concrete (see Figure 2a). In total were cast 16 cubic specimens, four for each concrete type.

Experimental **phase 2** was performed in order to determine the influence of steel corrosion on the bond strength of HR concretes and HC concrete. In this case 10 mm steel bars were used. In order to control corrosion procedure the steel bars were partially embedded in concrete and did not fully cross the entire length of the cubic concrete specimen. Three different corrosion levels were achieved as a result of an applied electrical current on the steel bars in all of the four types of concretes specimens, after which the pull-out test was carried out on each specimen. Concrete initiation cracking and crack length were also measured during the test in order to evaluate the influence of the different percentages of substitute recycled concrete aggregates employed, as well as its higher porosity on the bond capacity due to the steel bars corrosion.

After doing all the test we can conclude that:

The bond behaviour is strongly dependent on compressive strength values. The recycled aggregate concretes which had a similar compressive strength to that of conventional concrete obtained similar or better bond strength.

Recycled aggregate concretes produced employing up to 50% of coarse recycled aggregates achieved similar slip and bond strength to those of conventional concrete. However the recycled aggregate concrete produced with 100% of RCA suffered an important stiffness drop.

On reaching the same corrosion level it was noted that the initial cracking (visually detectable) of recycled aggregate concretes occurred later than conventional concrete. Furthermore there is no determined relationship between the amount of cracks produced with RA replacement and the corrosion level, nor is there a relationship between the amount of cracks and maximum bond strength.

The employment of a higher amount of RCA leads to better bond strength performance at very low corrosion levels. A higher corrosion level caused similar behaviour on RAC and CC concretes.