ANALYSIS OF DIFFERENCES IN THE BEHAVIOUR OF TRADITIONAL AND SELF-COMPACTING STEEL FIBRE REINFORCED CONCRETE

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Abstract

Many studies have been conducted in past decades in order to promote the application of steel fibre reinforced concrete (SFRC), either traditional or self-compacting. However, just a few of them focus on explaining the differences in the behaviour and the properties of these two types of concrete. The objective of this paper is to analyse such differences in terms of flexural behaviour, fibre content and orientation. For that, an extensive experimental programme was conducted. In total 3 mixes of self-compacting and 3 mixes with traditional concrete were produced with the nominal fibre contents of 30kg/m³, 45kg/m³ and 60kg/m³. In each case, specimens were cast and characterized with the Bending Test (code EN 14651) and the Inductive test. The results show how fibre orientation justifies the differences in the mechanical behaviour of the materials and the scatter of the results.

Keywords: SFRC, SFRSCC, bending test, inductive test, fibre orientation

1. Brief description of the work

SFRC has notable advances such as remove rebars totally or partially from concrete, increase the energy absorption capacity and toughness of the material as well increase tensile and flexural strength of concrete. Initially, researchers paid more attention to study the different elements of traditional steel fibre reinforced concrete (SFRC). However, with the reduction of skilled workers it was more and more difficult to produce good structural elements to meet the requirements of clients. In order to resolve this thorny issue, self-compacting concrete (SCC) appeared in 1988 invented by K. Ozawa.[3]. By adding steel fibres into SCC can not only have the merits of SCC but also could combine the advantages of SFRC. Research on steel fibre reinforced self-compacting concrete (SFRSCC) has been highlighted since it was put into use in real structural elements.[4][5]
In order to guarantee the quality of SFRC, generally, the characterization of post-cracking residual tensile strength is performed through three point or four point bending test. On the other hand, the fibre content is estimated according to the UNE-EN 14721:2006. For that, specimens must be either crushed or fresh concrete should be washed in order to separate the fibres that are then weighted.

In the present paper, firstly, study on SFRC and SFRSCC by three point bending test to characterize and compare the post-cracking behaviour will be presented. Then non-destructive test “inductive test” would be carried out on cubic samples, which are extracted from prismatic specimens, to assess the fibre content and orientation within the specimens. Finally, further analysis of post-cracking behaviour according to bending and inductive test will give an objective evaluation for using SFRC, either traditional or self-compacting.

In experimental study, batches of concrete with the fibre content of 30 kg/m$^3$, 45 kg/m$^3$, and 60 kg/m$^3$ were cast both for SFRC and SFRSCC. Compression test and three point bending test, in accordance with EN 12390 and EN 14651, respectively. Afterwards, inductive test was performed in cubic samples which are extracted from prismatic specimens.

The inductive test results illustrate that fibres tend to align parallel to the bottom of the mould since; the wall effect as well as the flow direction of concrete also lead to the results. [7][8]

Combining the results of bending test and inductive test, it may be easy to know that the residual strength of concrete is proportional to the inductive test results. This conclusion would be useful in the application of evaluating the post-crack behaviour of SFRC.

2. Conclusions

The following conclusion may be drawn from this research programme:

- The LOP and residual tensile strength are proportional to the fibre content for SFRC and SFRSCC.
- With the same fibre content, the residual tensile strength for SFRSCC is higher than SFRC.
- The load-CMOD curves and inductive test results indicate that a more uniform distribution of steel fibres appear in SFRSCC if compared with SFRC.
- The inductive test is capable of detecting differences in the fibre content.
- By using inductive test result can predict the post-cracking behaviour of SFRC.

3. Acknowledgment

This paper has been accomplished under the framework of the project “FIBHAC: Self-compacting Fibers and Concrete. Development of a new concept of precast segments for tunnels”, project subscribed to the programme INNPACTO 2011(IPT-2011-1613-420000). In this sense, the authors want to thank the Ministry of Science and Innovation for the economic support provided for its execution. Authors also would like to show the appreciation to master students Ana Guillamon and Felix Rennie for their help for part of experimental programme and data analysis. The first author would like to acknowledge the scholarship received from China Scholarship Council.