



Discussion

A discussion of the paper “Top-bar effect of steel bars in self-consolidating concrete (SCC)” by M. Reza Esfahani, M. Lachemi, M. Reza Kianoush

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1. Introduction

The paper presented the results of an investigation dealing with the local bond strength between self-consolidating concrete and steel reinforcing bars. The authors made an interesting study of the uniformity of bond strength between concrete and horizontally positioned bars along vertically cast concrete elements (top-bar effect). However, two aspects were not considered in the discussion (or, at least, were not mentioned) which could influence the conclusions reached by the authors. These were: the lack of inferential test for the comparison of the concretes (Section 2) and the small concrete cover of the reinforcing bars (Section 3).

2. Inferential test for the comparison of concretes

The statement by the authors in relation to the greater relative bond strength of normal concrete (NC) was based exclusively on its mean value, without taking into account existing variations between different specimens of the same concrete. It should be emphasised that this variation is important: the coefficient of variation of the results obtained at the top of the specimens of NVC is 30.7% for a concrete cover of 40 mm.

The appropriate inferential test for the statistical treatment of the data from the trials carried out by Esfahani et al. is an analysis of variance (ANOVA) with three crossed factors (concrete, concrete cover and location). The results of this analysis show clear evidence of significant differences between concrete covers (p -value = 0.004) and between locations (p -value = 0.0009). However, this is not the case of the concrete factor, or of any interaction between factors. The p -value obtained by the analysis for the concrete factor is 0.3755, which thus indicates a high probability that the difference between the means observed by the authors is merely a random effect.

3. Concrete cover of the reinforcing bars

In general, researchers agree on indicating a somewhat stiffer bond behaviour in SCCs [1–5]. Because of this greater stiffness, radial stresses that are developed around reinforcement bars are higher and therefore the tensile strength of the concrete is reached sooner. Therefore, in the absence of transverse reinforcement, and

when the concrete cover of the reinforcing bars is small, early failure of the steel–concrete bond can occur due to the splitting of the concrete cover, resulting in lower ultimate bond strength, the stiffer the bond behaviour is. In fact, in the tests carried out by Esfahani et al., all the specimens had failure due to splitting of concrete and no pull-out failure of bars was observed.

According to this, if for example the bond behaviour of the top bars in SCC were to be stiffer than in the NC, the splitting of the concrete cover could occur earlier in the SCC, as would the bond failure. However, with greater confinement of the reinforcement (existence of transverse reinforcement or great concrete cover) the result would not necessarily be the same. Depending on the test conditions, (concrete cover thickness, transverse reinforcement, etc.) the tendencies that have been found might not be the same. It is therefore not appropriate to suppose, as a general rule, an increase of the location factor of ACI Code for the particular case of elements made with SCC. In fact, in the tests carried out by Chan et al. [6], Khayat et al. [7] and Castel et al. [8], in which the concrete cover-to-bar diameter ratio is much greater, the results obtained are opposed to those obtained by Esfahani et al.

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