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Compressive-Strength Evaluation of Recycled Aggregate Self-compacting Concrete Through Hammer Rebound Index

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Abstract. Hammer rebound index is an indirect measure that has traditionally been used to estimate the compressive strength of concrete through the use of statistical models. It is especially useful in the quality control performed during the construction of a concrete structure, as well as in rehabilitation works. The high content of fine aggregate and aggregate powder of Self-Compacting Concrete (SCC) reduces its surface hardness and causes that the models traditionally used to estimate the compressive strength through this indirect measure in conventional concrete are not valid. On the other hand, Recycled Concrete Aggregate (RCA) has a lower surface hardness than Natural Aggregate (NA) due to the presence of adhered mortar, which causes that its addition prevents of using the currently existing models. Therefore, this paper aims to prove the validity of this indirect measure for the in-situ estimation of compressive strength of recycled aggregate SCC. Furthermore, it is also analyzed how the relationship between this indirect measure and the compressive strength of SCC is affected by the modification of the fine RCA content or the nature of the aggregate powder, two aspects that remarkably condition the design and behavior of SCC. The final objective is to provide a useful tool/model that promotes the use of SCC with RCA in real structures.

Keywords: Hammer rebound index · Quality control · Recycled concrete aggregate · Self-compacting concrete · Statistical modelling

1 Introduction

Indirect control of concrete's compressive strength is a very useful feature during both the construction stage and the service life of any structure [1]. During the construction stage, it is necessary to verify that the concrete reaches the required compressive strength.

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estimating the compressive strength regardless of age. This situation is opposite to that used in conventional vibrated concrete [8].

$$CS_7 = \sqrt{6562 - \frac{149894}{HRI_7}} \tag{1}$$

$$CS_{28} = \sqrt{6462 - \frac{151866}{HRI_{28}}} \tag{2}$$

$$CS = \sqrt{6253 - \frac{142511}{HRI}} \tag{3}$$

4 Conclusions

In this paper, the validity of the hammer rebound index to predict the compressive strength of Self-Compacting Concrete (SCC) has been evaluated. In addition, the effect of some changes in the mix composition, concerning fine Recycled Concrete Aggregate (RCA) and aggregate powders, has been studied. These conclusions can be drawn:

(1) Using the hammer rebound index for compressive-strength estimation must be subjected to statistical adjustment. The variability of the measurements of this parameter, increased by changing the SCC composition, makes this type of study essential.
(2) Existing models for conventional concrete underestimate the compressive strength of SCC. This is due to the lower surface hardness of SCC because of its reduced coarse aggregate content, as well as its high amount of fine aggregate particles. The use of RCA and limestone filler also promotes this phenomenon.
(3) It is possible to develop models that allow accurate estimation of the compressive strength of SCC from the hammer rebound index regardless of the age of the SCC. For it, modification of the mix composition allows obtaining more general models.

Despite all this, further research is needed, as the number of tests performed was not enough to evaluate the uncertainty of the indirect measurements studied.

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