Bayesian probabilistic assessment of in-situ concrete strength

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Summary

Core testing is considered the most accurate technique for the assessment of in-situ concrete strength. EN 13791:2007 gives guidance for estimating in-situ compressive strength in existing structures and states that core testing is the reference method. However, the number of cores that can be taken from a structure is usually limited, so it may be advantageous to supplement the core tests with some type of indirect test. The standard mentioned above establishes two alternatives for the calibration of indirect tests, both based on core tests results taken from the structure being assessed. One of them requires at least 18 core tests. But if it is available 18 core tests, it is only natural to ask if it is really necessary to supplement those core tests with an indirect test. This question motivates the study here presented. Specifically, this study deals with the determination of the number of cores above which the use of an indirect test, as a supplement to core tests, is no longer attractive.

Keywords: core tests; indirect tests; concrete strength; statistical uncertainty; Bayesian approach; calibration; NDT.

1. Introduction

Currently the most accurate method to assess the concrete strength of an existing structure is directly from core tests. However, the number of cores that can be taken from a structure is in general limited, not only because it introduces damage into the structure, but also because it is a time consuming and expensive technique. Thus, if it is required to estimate, for example, the characteristic value of the concrete strength from that small sample of cores, the statistical uncertainty will be large and reduce such an estimate.

This drawback can be overcome by supplementing the core tests with indirect tests, such as rebound hammer tests, ultrasonic pulse velocity tests, or other NDT. These tests are much more economic than core tests and furthermore do not introduce any damage into the structure. With these indirect tests it is possible to obtain a large number of results, virtually eliminating the statistical uncertainty.

Nevertheless, these tests need a previous calibration, which, according to EN 13791:2007 [1] must be carried out specifically for the structure being analyzed. In fact, the test results depends not only on the equipment itself, but also on the properties of the concrete, such as the concrete age, the type of aggregates, the condition in terms of durability, among others [2]. If indirect tests are used without a previous calibration carried out specifically for the structure under study, there is a real risk of introducing systematic errors.

According to EN 13791:2007 [1] the calibration must be carried out using cores taken from the structure. But, again, since the number of cores is limited, there will be (statistical) uncertainty in calibration. On the other hand, it is necessary to take into account the lack of precision of the indirect tests, because they measure a property not fully correlated with the concrete strength. Thus, by using indirect tests as a supplement to the direct test (core tests), even though the statistical

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