Doctoral Dissertation
Doctoral Program in Civil and Environmental Engineering (31th Cycle)

Advances in reliability methods for reinforced concrete structures

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Summary

The reliability analysis of reinforced concrete structures requires methodologies able to fulfill the safety requirements expected by the society. These requirements, as defined by international codes, are represented by limits on the likelihood that structural collapse may occur in a given reference period. These limits are dependent from the typology, the destination of use and the lifetime for which a structure should carry out its serviceability.

In this context, approaches and methodologies aimed to the design and the assessment of reinforced concrete structures in compliance to "target" reliability levels are provided. In this way, engineers and designers can handle efficient tools, which, however, are affected by uncertainties of both *aleatory* and *epistemic* nature. The dissertation for obtaining the title of Ph.D. in Civil and Environmental Engineering is part of the described above context.

In the first part, the general framework for the probabilistic calibration of empirical or semi-empirical resistance models has been proposed. This methodology has been applied to the probabilistic calibration of the semi-empirical resistance model reported by the *fib Model Code 2010* for the evaluation of laps and anchorages tensile strength in reinforced concrete structures.

In the second part, the topic related to the use of non-linear finite element analysis for design and assessment purposes has been analyzed. In the details,

international codes allow to use advanced tools for non-linear analysis within the design and assessment processes.

In order to account for the different sources of uncertainty, several safety formats for non-linear analysis of reinforced concrete structures has been proposed by the literature and codes. After a detailed comparison of the mentioned above safety formats, two advances are proposed: the reliability-based calibration of partial safety factor related to resistance model uncertainties using plane stress non-linear finite element analysis; a methodology to account for the influence of failure mode variation within the predictions obtained by different safety formats.

Finally, a code format framework based on the levels of approximation approach for structural design and assessment of reinforced concrete structures by means of non-linear finite elements analysis is proposed and discussed.