Methodological approaches to the condition assessment of reinforced concrete architectural heritage

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Methodological approaches to the condition assessment of reinforced concrete architectural heritage

By

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Abstract

The condition assessment of reinforced concrete architectural heritage represent a question of maximum priority that requires more and more attention from architects and engineers. A significant portion of this heritage is nearing the end of its useful life and, therefore, issues related to its conservation should be addressed. Numerous theoretical and experimental researches has been developed in this field in the last years, in order to provide new methodological approach for the conservation of 20th century concrete heritage buildings. This effort resulted in important documents, including deontological standards, guidelines, and regulations.

The specific challenges posed in preserving historic concrete structures are varied and complex. In fact, the strategies to be implemented must take into account the pioneering nature of both construction techniques and structural forms used at that time. The continuous experimentation that has characterized the construction of these buildings causes a difficult understanding of their structural behavior.

The condition assessment, based on Structural Health Monitoring (SHM) and calibrated FE Models, play a fundamental role in the conservation field of 20th century historic concrete structures, especially in identifying structural damages and degradation states. Appropriate strategies and criteria are needed to meet the preservation and conservation challenges of this heritage. In particular, to pursue the conservation principles, optimal strategies based on a correct maintenance, structural health monitoring and non-destructive techniques are preferable.

Experimental activities are part of the operations aimed at determining the state of conservation of the building and predicting its response to accidental actions. To this aim, structural models calibrated based on the experimental results represent a useful tool. In the case of heritage structures, non-invasive techniques are of paramount of interest, especially natural vibration-based monitoring.

However, the condition assessment of reinforced concrete architectural heritage raises several unresolved issues. Moreover, a part of this heritage (including buildings, bridge and other civil engineering structures) has been built with the prestressed concrete technique. In this context, post-tensioned concrete structures are very sensitive to natural deterioration and excessive environmental attacks, which can lead to insufficient safety levels. Unfortunately, the partial rupture or corrosion of pre-stressing tendons may be difficult to detect.

The overall aim of this PhD research is to propose methodological approaches, based on experimentally calibrated models, for the static and seismic condition assessments of reinforced concrete heritage structures. The research focuses on how the information coming from experiments can be integrated into a numerical model, which simulate the behavior of the structure and represent a useful tool for a refined condition assessment. In this context, particular attention is paid to the uncertainties in geometry, material characteristics, details, constraints, and the interaction with the surrounding environment that can significantly increase the complexity of the identification and model calibration of the structures.

Under these premises, an historical prestressed concrete structure has been proposed as a case study. In particular, Pavilion V of Turin Exhibition Center, built by Riccardo Morandi in the late 50s, has been selected for its post-tensioned system characterized by a complex spatial design.