

CIVIL AND ENVIRONMENTAL ENGINEERING

DISEG - Ageing and degradation in the performances of concrete structures

Funded By	Dipartimento DISEG
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Context of the research activity	The target of the project is modelling the influence of ageing and degradation on the mechanical performances of concrete structures, regardless of the origin of damage (e.g. physical or chemical attack, corrosion, fatigue, pitting, fire,..).
Objectives	Ageing plays a key role in the management of the infrastructural heritage, with a wide range of consequences spanning from the safety of users to the economic costs, from the reparation techniques to the inconveniences and delays due to works. Knowing the current state of a manufact turns out to be a key desideratum for Authorities. In this Research Project, the problem of ageing and degradation of infrastructures will be studied through a hierarchical methodology, i.e., considering the scale of the material, of the structural element and of different infrastructure (e.g., bridge, large roof, etc). The target of the project is modelling the influence of ageing and degradation on the mechanical performances of materials and, thus, of the whole manufact, regardless of the origin of damage (e.g. physical or chemical attack, corrosion, fatigue, pitting, fire,..). Currently, Guidelines and Codes do not include specific indication for the modelling rules of ageing and degradation on existing civil structures. The approach normally aims at reaching a certain "level of knowledge" of the real mechanical performances of an infrastructure by means of destructive or non-destructive tests on materials and elements. Predictive degradation laws are still at the research level, showing poor relations with experiments at the real scale and practically no outputs for reliable engineering calculations and robust structural assessment. Recent collapses of bridges testify the need for a more consistent approach to the assessment of existing infrastructures. The aim of this project is to develop physically-based reliable models for ageing and degradation of ordinary or prestressed reinforced concrete and steel manufacts, including bridges, viaducts and large roofs. Furthermore, a precise objective will be pursued through the creation of structural Digital-Twins (DTs) of the observed object, able to interact with mechanical models and processed data to represent the actual state of the structural system and to determine on real-time the modification of the whole system and its

components, due to ageing, environmental condition, maintenance, repairing and retrofitting. The DTs will be based on Building Information Models (BIMs) exchanging information with computational models evaluating the current structural performance capacity. Classical model-driven approaches will be compared with modern data-driven methodologies; for this purpose, specific tools will be developed and embedded in the DT workspace. For three relevant case studies a web-based open-access platform will be realized to demonstrate the project achievements, showing the potentiality of the developed methodology for the construction management. In this framework, a special tool will be realized to perform the Life Cycle Assessment (LCA) of the observed structure and its modification due to ageing and repairing, evidencing also through the Global Warming Potential (GWP) indicator, the best practice.

Skills and competencies for the development of the activity

Basic knowledges of Structural Mechanics, Reinforced Concrete Structures and analysis of existing concrete structures.