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Non-destructive tests for monitoring the degradation of reinforced concrete structures: preliminary results of Icarus project

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The monitoring of degraded reinforced concrete structures represents one of the most important topics for scientific research. Considering that the global non-destructive testing (NDT) market is constantly growing, the possibility of adopting new methods and approaches to identify possible causes of deterioration is fundamental for saving time and costs for repairs and maintenance in civil structures and infrastructures. Consequently, smart use of existing methods and/or the development of innovative strategies based on the integration of non-invasive methodologies play a crucial role in the field of engineering. In this context, CNR (IMAA and ISPC) and Unicusano have proposed the Italian Research Project of National Relevance (PRIN) – ICARUS, an innovative project based on the development of a multiscale and multisensory integrated approach for the assessment of deterioration in reinforced concrete structures.

The starting point of the research involves evaluating the capability of geophysical methodologies and other NDT methods to highlight deterioration phenomena affecting concrete and/or reinforcements (Capozzoli et al, 2021; Fornasari et al,2023). Data obtained non-invasively are supported and validated by destructive analyses to develop improved laws regarding adhesion, slip, and tensile stiffness.

The first phase of the research was conducted on three types of reinforced concrete specimens reinforced with ribbed bars, smooth bars, and strands. A set of specimens with limited dimensions (200x200x200mm) was created in a previous experimental test (Benenato et al. 2020), and some of them were subjected to an accelerated corrosion process. In this research phase, only six specimens were studied, three intact and three corroded, using ground-penetrating radar (GPR) and ultrasonic tests (UT). Pullout tests and microscopic measurements were carried out to validate the approach's usefulness.

The specimens were studied without degradation and at the end of the degradation process. Future research will be conducted through monitoring at intermediate levels of corrosion to identify the capability of NDT tests to assess possible deterioration phenomena in the early stages of rebar corrosion.

Despite the uncertainties attributable to the limited size of the samples and the heterogeneities of the concrete, preliminary results show the capability of GPR and ultrasonic tests to identify variations related to the corrosion phenomena occurring in reinforced concrete structures.