EXPERIMENTAL TEST ON FLEXURAL PERFORMANCE OF PRESTRESSED CONCRETE BEAMS DAMAGED BY CORROSION

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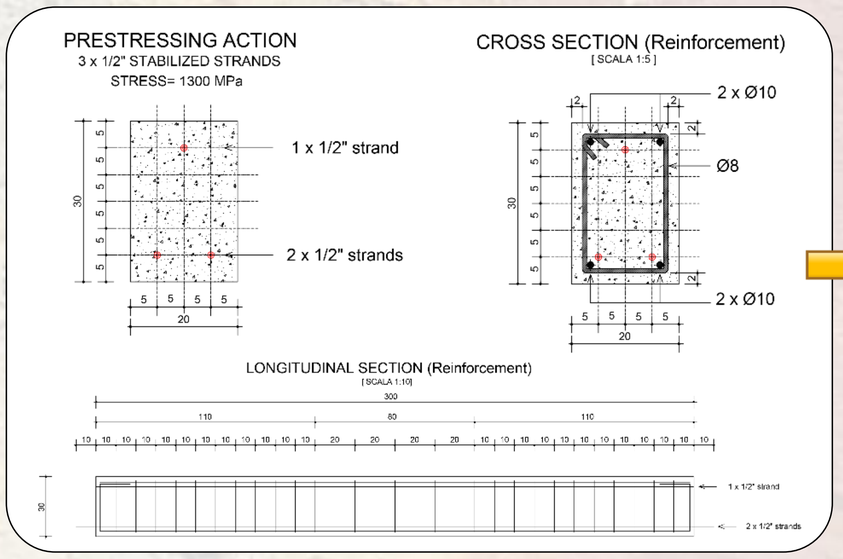
Prestressed reinforced concrete beams are widely used in industrial and commercial buildings, which are commonly exposed to aggressive environments and damaged by corrosion. This precast construction technique has been also used for the last 50 years in the majority of viaducts and bridges built in many countries like Italy. According to previous literature results, corrosion of prestressed concrete structures causes size reduction of strands, degradation of mechanical properties of steel, cracking of the surrounding concrete and bond decay at steel-to-concrete interface. The mixing of these effects strongly reduces the bearing-capacity of prestressed reinforced concrete members, changing the failure mechanism as well. In the framework of the OPTION research project between Niccolò Cusano University and Oslo Metropolitan University, an experimental campaign investigates the behaviour of corroded prestressed beams. Four prestressed beams (cross section size 200 × 300; total length 3000 mm; clear span 2700 mm) were first subjected to artificial corrosion, to obtain different damage levels, and then were tested in four-point bending. The goal is to estimate the corrosion level making a deteriorated prestressed reinforced concrete beam less ductile keeping the strength unchanged. In the present study, the first experimental results and some details about the laboratory procedure are presented.

Dimensions and reinforcement arrangement of the tested beams



Particular of reinforcement arrangement of the tested beams

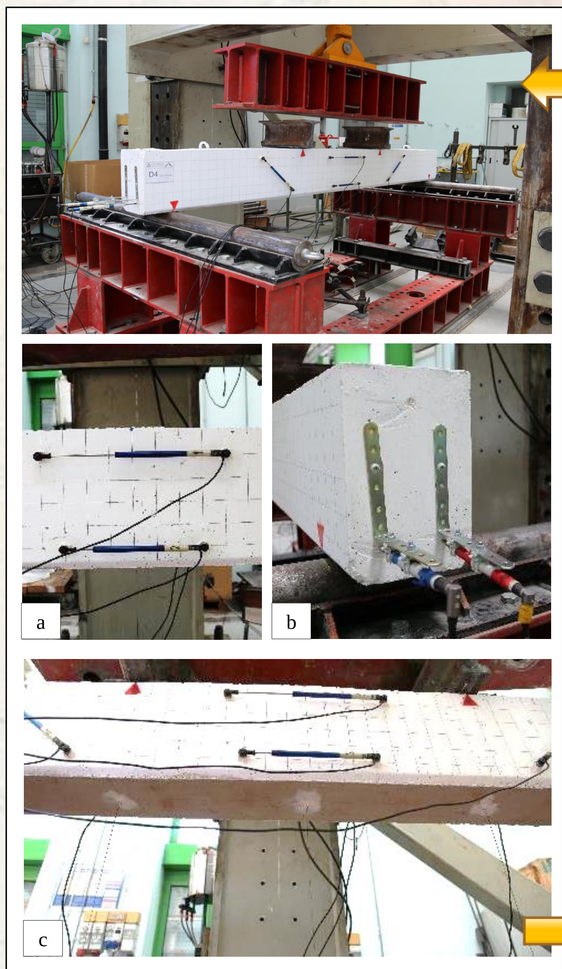
For the subsequent acceleration corrosion process of the strand, the stirrups and the mild reinforcements have been protected with a proper antirust.

Particular of the beam arrangement before artificial corrosion

The corrosion distribution on steel strands and mild reinforcement has been designed to represent the condition of actual natural corroded prestressed beams.
Since in existing PRC elements corrosion is more evident at the element ends, where the seepage is frequently located.

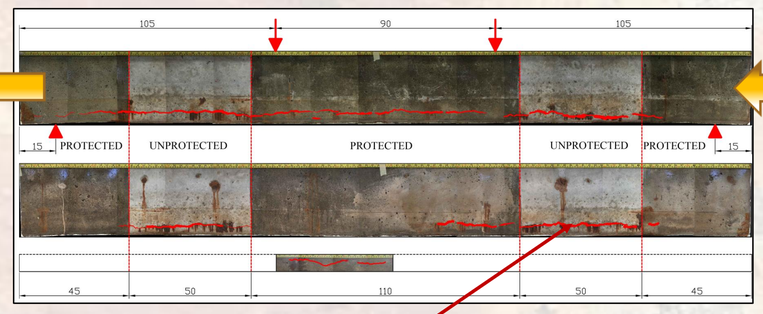
With the aim to mainly corrode the strand sections subjected to variable bending moment during the flexural test, the beams were finished with vinylester resin to limit the liquid penetration in the central area and in correspondence of the supports.

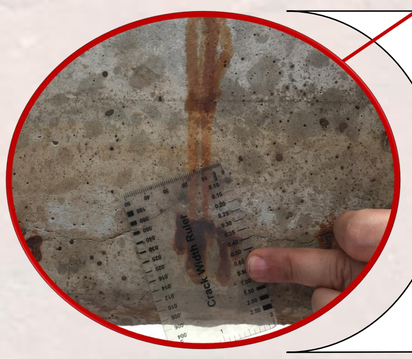
Flexural test setup



Each beam was instrumented with: (a) **linear potentiometers** to measure the sectional deformation of the beam; (b) linear inductive displacement transducers to measure the possible strands return during the test; (c) **wire potentiometers** to measure the beam deflection.

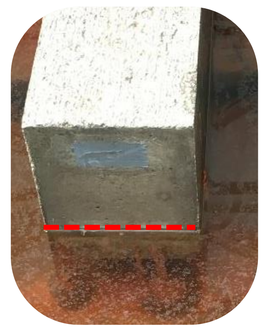
Crack width measuring process





After the degradation, longitudinal cracks have been detected along the whole length of the prestressed corroded beam.
The adopted corrosion procedure has favoured the formation of **wider cracks (0.10-0.50 mm)** on the unprotected shear spans and smaller in the midspan

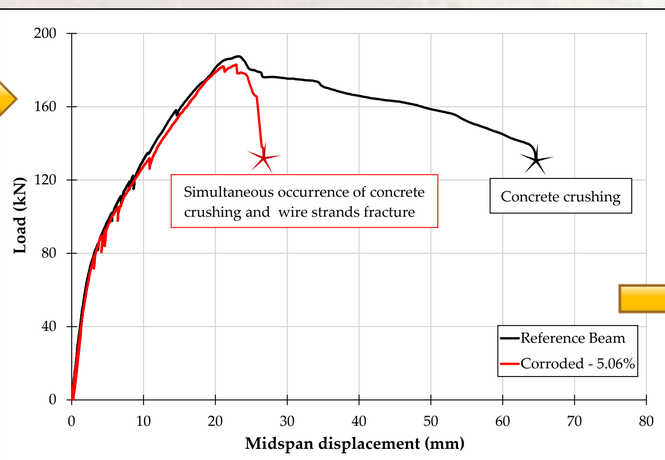
Accelerated corrosion process



The two beams have been artificially corroded by mean an electrolytic process: the lower strands acts as an anode, an external steel bar as a cathode, a 3% NaCl aqueous solution close the circuit. According to El Maaddawy, a current density of about **350 µA/cm²**, corresponding to a 0.4 A constant current, was applied on each inferior strand to speed up the artificial deterioration process without compromising the structural response.

The entire beam has been then partially immersed in the saline solution maintaining the lower surface about **50 mm** under the solution.

Main experimental results

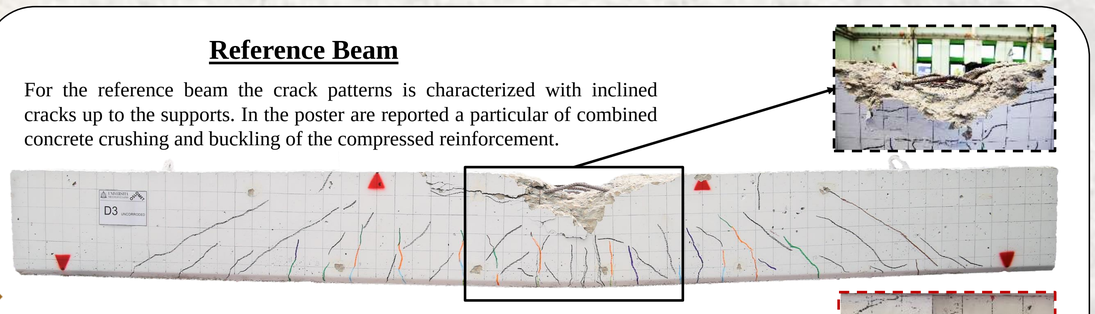


The obtained results in terms of load-displacement curve for the sound and corroded beams are reported. A softening branch can be detected for the sound beam that collapsed for the combined concrete crushing and buckling of the compressed reinforcement. For the corroded beam a brittle failure, without any ductility retention can be detected.

Crack pattern

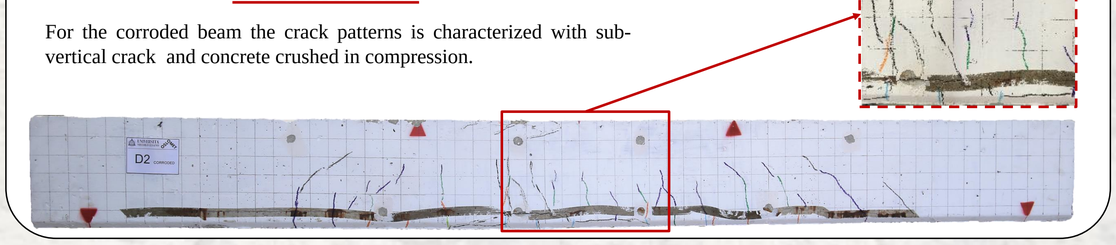
Reference Beam

For the reference beam the crack patterns is characterized with inclined cracks up to the supports. In the poster are reported a particular of combined concrete crushing and buckling of the compressed reinforcement.



Corroded Beam

For the corroded beam the crack patterns is characterized with sub-vertical crack and concrete crushed in compression.



References

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