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Autore FESTUCCIA, ALESSANDRA

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Sommario The subject of this research is the study of the behavior of existing structures damaged by corrosion. The tragic earthquakes recently occurred, have clearly demonstrated the high vulnerability of existing buildings with reinforced concrete structures. In the methods provided for the evaluation of vulnerability of the structure, however, the building is generally considered "new" i.e. with its structure free of damages. Actually a structure does not maintain its initial mechanical and functional characteristics during the entire life. One of the most common problems related to the durability of existing reinforced concrete structures is linked to the corrosion of the reinforcements. In fact, the reinforcement corrosion is known to be the primary cause responsible for the decrease of the load capacity. The corrosion attack, in fact, reduces the geometrical and mechanical characteristics of the reinforcements and induces the formation and progression of cracks in concrete or cover delamination, sometimes heavily influencing also the bond mechanism between steel and concrete. In essence, the performance of reinforced concrete structures can be strongly reduced, also for the substantial reduction of the ductility. These issues highlight the need to study a method for the evaluation of structural damage induced by corrosion, to provide an estimate of

the residual strength capability and to establish the security level of the corroded structures. In this context, it has been studied the experimental data available in the literature, concerning the effects of corrosion on reinforced concrete structures, and one of the fundamental aspects emerged is the variation of the collapse mechanism of corroded beams. In particular, beams designed for obtaining a flexural failure have shown a shear collapse related to stirrups corrosion and cover delamination. While the flexural problem has been widely studied in the literature, the problems related to shear is still open. The context of the present research aims to investigate the behaviour of reinforced concrete structures damaged by corrosion of the stirrups. The aim of the research is therefore to evaluate the residual strength capacity of the reinforced concrete structures affected by corrosion of the transverse reinforcements, by constructing a theoretical model validated by experimental results. With this research it has been focused attention on the behaviour and performance aspects of reinforced concrete beams subjected to corrosion of transverse reinforcements. In this regard it has been conducted an experimental activity aimed to investigate the mechanism of collapse and the residual load bearing capacity of reinforced concrete beams affected by corrosion of the stirrups. Specifically, static tests on six specimens of the beam in real scale have been conducted, with the aim to evaluate their residual strength capacity. The tests involve conventional 4PBT (4 breaking point test) where the loading span is appropriately selected to induce shear failure. The beams have been designed and instrumented according to similar studies carried out in literature in order to get comparable results. The tests performed are the 4PBT in order to get uniform bending in the central part of the beam, equal to l/3, and uniform shear in the lateral parts, always equal to l/3 length. All the beams have the same geometry, concrete mixture and longitudinal reinforcement: they differ only in transverse reinforcement. The specimens have been designed to obtain a shear failure, and are divided according to different types depending on the different stirrup scheme. A type in the area where it is expected the shear failure does not have stirrups. Another has transverse reinforcement, not symmetrical to favorite the failure in a specific part of the beam, and finally, to investigate the behavior of reinforced concrete beams affected by corrosion of the stirrups, one of these types of beam is designed with stirrups "inverted U" shaped, i.e. without the leg of the stirrups at the bottom face of the beam, in order to simulate a destructive corrosive attack of the bottom leg of the stirrups, because indications of literature have highlighted the difficulty to proceed effectively with an effective selective and localized corrosion. In order to explain the shear-resistant mechanisms of the different types of reinforced concrete beams it has been evaluated the basic mode to transfer shear between transverse reinforcement and concrete. It was developed an analysis model for each type of reinforced concrete beam, to evaluate the shear strength according to different patterns based on methods provided in national codes (NTC 2008), european codes (EN 1992 -1 -1: 2005), and international codes (ACI 318 -2011), for the estimation of the shear strength in absence or presence of transverse reinforcement. It was developed a finite element model (FEM) that simulates the behavior of specimens of reinforced concrete beams with destructive corrosive attack of the bottom leg of the stirrups. The behavior of steel and concrete materials, and the study of the bond at the interface between steel and concrete are based on models of the CEB-FIP Model Code 1990

and of the FIB Model Code for Concrete Structures 2010. It was made a 2D model of the beam where the concrete was modelled as plate, and the cracking of the concrete was modelled with smeared crack approach. The top and bottom tensile reinforcements and the stirrups where it is not expected the shear failure were modelled as embedded reinforcement in the plate elements, which means that a perfect bond between the reinforcements and the surrounding concrete was assumed. The stirrups where it is expected the shear failure were all modelled with truss elements, including an appropriate bond-slip model in interface elements. All analysis are performed without taking account of the safety coefficients. For proper validation of the numerical model, a comparison between the experimental and numerical results has been carried out. Also a simple model has been implemented to investigate the ultimate load bearing capacity of an open stirrup. With a simple bilinear model, based on FIB 2010, bond and anchorage of the bars have been simulated. Analytical and experimental results have been compared.

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