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Non linear static analyses of RC frame structures: influence of corrosion on seismic response

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ABSTRACT

When dealing with RC structures, an accurate assessment of the structural safety and serviceability state should account for the time-dependent variation of the structural response with the deterioration level, especially under seismic excitations. Actually, the increasing damage may produce significant changes in the safety coefficients, with respect to both ultimate and service limit states. The variation of the mechanical characteristics of concrete over time is a consequence of the chemical, physical and environmental attacks that the structure may suffer. As an example, damaging processes may be induced by diffusive attack of aggressive agents like sulphate and chloride ions, as well as by carbonation process, which can lead to concrete deterioration and reinforcement corrosion. Experimental tests performed on RC members have shown that, with increasing levels of reinforcing steel corrosion, not only the reduction of the load carrying capacity may occur, but also the change of the failure mechanism from the ductile to the brittle type. Consequently, an effective non linear model able to describe the progressive degradation and its consequences over time is strongly required. To this aim, highly sophisticated models have been developed in the last decades within the framework of the finite element method, in order to account for the coupled mechanical-environmental damage, both in the static and the dynamic field (e.g. [1], [2] and [3]).

However, due to the computational complexity of detailed formulations, concentrated plasticity models are often applied in practical applications, especially when seismic analyses of real structures have to be performed. Within this framework in order to define appropriate moment-rotation laws of plastic hinge, two different approaches may be adopted. The first one, developed at a “micro” level, accounts for the material ductility and adopts accurate finite element models with proper damage laws varying with the corrosion level. In such a way, it is possible to perform detailed analyses of the critical zones of the structure, i.e. where plastic hinges may form. The second one is developed at a sectional (“macro”) level and is based on the definition of specific moment-curvature relationships as a function of the corrosion degree of the rebars.

In this paper, the preliminary results of a study concerning the influence of rebars corrosion on the seismic response of RC structures are shown. In particular, the second of the two approaches previously described has been adopted in this initial phase of the

research. Non linear static analyses (pushover) have been performed on some study cases, in sound conditions as well as at the end of the service life (50 years), assuming the hypothesis of a moderate corrosive attack, for example due to a uniformly distributed carbonation.

The most relevant effects of corrosion phenomena have been introduced by adopting analytical and experimental relationships available in literature. It is worth noting that for moderate levels of corrosive attack, as assumed in the present study, limited loss of bond between steel and concrete has been detected (e.g. [4]). Therefore, the hypothesis of the conservation of plane sections may be considered still valid ([5]) allowing to neglect the effect of reinforcement corrosion on bond interaction.

The results of the analyses have been discussed in terms of capacity curves and collapse mechanisms, in order to estimate the residual load bearing capacity (e.g. at the end of the service life for which the structure has been designed) and the change of the failure mechanism from the ductile to the brittle one. Figure 1 shows the comparison between the capacity curves of a RC frame under different corrosion patterns: the tendency to the reduction of the load bearing capacity as the corrosion level increases and the relevant loss of ductility can be observed, especially when the corrosive attack is concentrated at the basis of the columns.

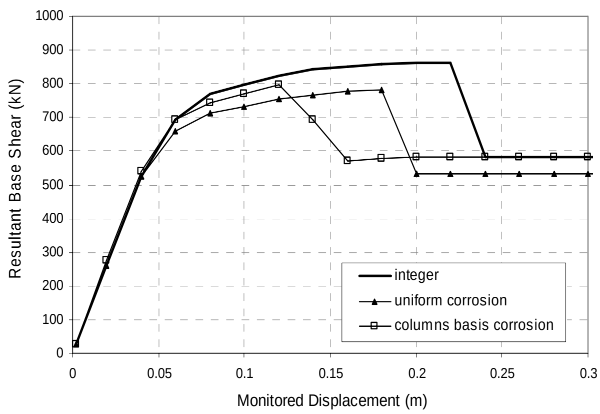

Figure 1: Capacity curves: influence of the corrosion pattern

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