Simulation of seismic response of embedded steel reinforcement in marine environment

Abstract

As it is widely known, most of the reinforced concrete structures located in coastal areas, suffer from the consequences of the corrosion factor. Chloride-induced corrosion, in synergy with other hazardous factors, such as seismic actions or air pollutant emissions, is harmful to the structures. The derived drop in durability, raises issues of security and reliability, concerning the structural integrity of the structures. Consequently, a great demand for handling such structures is created.
Although the durability of the reinforced concrete structures is a major issue, only recently has it captured the scientific community's interest and to date, the necessary documentation and quantification of the corrosive factor in the construction industry's valuation of elements of older constructions have not been carried out.

The extended study, analysis, and quantification of the corrosion consequences premise laboratory reproduction of the corrosion phenomenon, with the use of accelerated experimental techniques. In the present study, an analysis was conducted concerning the consequences of the corrosion phenomenon on steel reinforcement, with the use of accelerated experimental techniques such as applying electric current and secondly oligocyclic fatigue in order to simulate the behavior of corroded steel in earthquake conditions (dynamic loading).

The mechanical behavior of reinforcing steel under cyclic loading is of decisive importance in the mechanical response of reinforced concrete elements. Intense seismic actions as well as the loading history of reinforced concrete elements are known to consume significant energy reserves of the steel (similar to oligocyclic fatigue).

The hysteretic stress-strain model of the reinforced steel is degraded, additionally contributing to the degradation of the mechanical response of the reinforcement steel and its degree of corrosion. To date, the degradation of the mechanical behavior of steel under cyclic loading including the corrosive agent has not been sufficiently studied. In this light and based on experimental data of oligocyclic fatigue tests on pre-corroded reinforcing steel bars, in this study, a modeling of the lifetime of the steel in recycling (modelling of the hysteretic loops in oligocyclic fatigue) was carried out as a function of the degree of corrosion. The analytical prediction models obtained are in agreement with the experimental results and can be a reliable tool as the beginning of a more general discussion in the seismic analysis of reinforced concrete elements, taking into account the degree of steel corrosion.

For the laboratory study of the corrosive phenomenon, the accelerated electro corrosion method was adopted, by imposing a current density on the steel reinforcement of the samples along with mechanical stress & strain testing in the Material Testing System Machine.

Key Words: [Corrosion, Reinforcing Steel B500c, Hysteretic Material, Cyclic loading, Fatigue, Accelerated electro corrosion, durability]