Abstract

During the post war period, a significant lack of infrastructures appeared. Facing to this growing demand, civil engineers had to conceive promptly, without considering durability. Today, those infrastructures constitute a heritage that has to be kept operational. Stackholders have observed noticeable signs of degradation resulting from interactions between the environment and constitutive materials. Durability tends to decrease till the serviceability becomes affected and, in some cases, till the structural safety is concerned. One of the major causes leading to such a noticeable loss of performance has been identified as being the corrosion phenomena induced either by carbonatation or by chloride ions ingress. The created corrosion products being expansive, tensile stresses are generated and usually lead to the cover concrete cracking. From a practical point of view, when first observable signs of degradation are noticed on site, it is generally too late and service actions have to be performed. This results in important expenses that could have been avoided if a satisfying prediction had been made. This thesis aims at proposing some answers to that problem. Two main objectives have been defined. The first one consists in formulating reliable constitutive models for better understanding of the mechanical behavior of existing structures. The second objective aims at developing a probabilistic approach for updating the mechanical model according to the experimental information available on site. A general constitutive framework has been proposed coupling elasticity, isotropic damage and internal sliding. Its thermodynamical admissibility has been checked. This general framework has been declined in two specific constitutive models: the first one for modeling the steel/concrete interface including corrosion and, the second one, for modeling concrete. Both models have been validated on several discriminent structural cases. They can be used for monotonic and cyclic loadings. Besides, they account for non linear hysteretic effects, quasi unilateral effect, permanent strains etc. Sometimes, very accurate information is not required and the use of simplified models is sufficient. Hence, simplified versions of the proposed constitutive models have been proposed within the framework of the multifibber beams theory. Especially, in the case of the steel/concrete interface, although a Timoshenko based kinematic is assumed, a non-perfect interface between steel and concrete can be considered locally. The material parameter identification is not always straightforward. Therefore, the use of robust updating methods can improve the accuracy of mechanical models. A complete probabilistic approach based on Bayesian Networks has been proposed. It allows not only considering the uncertainties related to mechanical parameters but also reducing the gap between experimental measurements and numerical predictions. This study shows that coupling reliable constitutive models to robust updating methods provide satisfying predictions that can help stackholders to better plan service actions and better manage budgets constraints.