Multi-physical field simulation of reinforced concrete corrosion process of a wharf structure

Qinghao Liu , Xiao Tang

China University of Petroleum (East China), Qingdao, Shandong，266580，

s22140022@s.upc.edu.cn

Abstract*:* There are a large number of Cl^-, Mg^{2+}, SO_4^{2-} ions in the marine environment, which have a strong corrosion effect on reinforced concrete structuresAccording to the field investigation of the wharf which has been in service for 47 years in Qingdao port, it is found that the phenomenon of steel corrosion and concrete protective layer peeling appears in the local structure of the wharf, which seriously threatens the structural safety of the wharf. In order to evaluate the corrosion state of the existing wharf structure, a multi-physical field simulation method was used to simulate the corrosion cracking process of the reinforced concrete structure, to study the influence of environmental parameters on the corrosion process, and to investigate the long-term corrosion process of the reinforced concrete structure and the multi-physical field coupling mechanism. According to the structural characteristics of the wharf, considering the geometric shape and material properties of the structure, the stress field, corrosion electric field and chemical field in the corrosion process are coupled, and the finite element model is established to realize the multi-physical field simulation of the corrosion process. The results show that the mass transfer process of chloride ion and dissolved oxygen is the main factor affecting the corrosion rate of steel bar. After the chloride ion concentration reaches the threshold value in the initial stage, the steel bar is depassivated and begins to rust. After entering the corrosion expansion stage, the uneven distribution of oxygen leads to the uneven corrosion of steel bar. The oxygen concentration at the corner of the wharf structure is low, and the corrosion rate of the steel bar is slow. However, the corrosion products lead to micro-cracks in the concrete, and the bearing capacity of the structure decreases. The oxygen concentration in the central area is high, and the corrosion rate of the steel bar is fast. The expansion of the corrosion products leads to the cracking and peeling of the concrete, which is consistent with the field situation. The corrosion rate of steel bars in the center position will further increase, while the corner structure will maintain relative integrity within 20 years. The coupling effect of structural mechanics-mass transfer process-corrosion electrochemical process will occur in the reinforced concrete structure of wharf under the accumulation of corrosion products to accelerate the degree of corrosion damage. Based on this model, a corrosion state evaluation method

is established, which provides a scientific basis for the corrosion detection and maintenance of the wharf structure.

Keywords Marine corrosion; reinforced concrete; multi-physics simulation; corrosion assessment