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Experimental studies on mechanical properties of corroded steel bars after elevated temperature

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Abstract

The mechanical properties of steel bar deteriorates after erosion and elevated temperature. In the study 16 mm diameter bars were corroded by an electrochemical accelerated corrosion technique, and then heated at temperatures 300, 500 and 700℃. The bars were cooled naturally in furnace to ambient temperature and were tested in tension. The nominal yield strength, nominal ultimate strength and elongation were observed. The observations showed that nominal yield strength, nominal ultimate strength and elongation was changed significantly on the coupling effects of corrosion and temperature.

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Keywords: Reinforcing bars; corrosion; elevated temperature; mechanical properties; external current half immersion method

1. Introduction

Steel corrosion and fire have great damage to construction structure, which causes a large number of casualties and economic losses. Chloride ions in environmental media and the raw materials of concrete penetrate around the steel bar and destroy the Passive Film, which cause corrosion of steel bars and reduce the effective cross section of

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the steel bars. These damages will lead to the change of the Macro performance and Microstructure of the steel. Steel bar strength weakening and expansion cracking after corrosion cause the decrease of bond property between steel bar and concrete, which leads to the decrease in load-carrying capacity of structure. Mechanical properties of corroded steel bars after high temperature will show different attenuation laws with the elevated temperature experienced.

Xu Gang [1] studied the mechanical properties of corroded steel bars in concrete under the environment of chloride salt. The influence of different corrosion degree on the nominal yield strength, nominal ultimate strength, equivalent yield strength, equivalent ultimate strength, elongation and yield step Strength of reinforcement was discussed in the paper. Yu Xiaofen [2] studied the effect of Cl- concentration on the corrosion behavior of HPB300 steel in simulated concrete pore fluid. Shen Dejian [3] carried out experimental research and simulation analysis on the performance of corroded steel bar in concrete with seawater wave splashing, and discussed the relationship between yield strength, ultimate strength, ultimate elongation and failure mode with corrosion rate. Zhang Yan-nian [4] carried out the test on the mechanical properties of the rebar in concrete under immersion corroded by the impressed current, and analyzed the variation law of yield strength, ultimate strength and mass loss rate of steel bars after rusting. Li Fenglan [5] analyzed the variation law of mechanical properties of rebar with different corrosion degree, and established a computational model for the nominal yield strength of corroded rebar. Yuan Yingshu [6] studied the structural degradation model of corroded reinforced concrete beam, established the stress-strain relation of corroded steel bar and the degenerate model of bond stress-slip relationship between corroded steel bar and concrete. Wu Qing [7] carried out experimental research on the deterioration of mechanical properties of corroded steel bars, analyzed and compared the changes of the mechanical properties of rebar under different corrosion degree. Zhang Wei Ping [8]studied the stress-strain relationship of corroded steel bar , and he established the mathematical model of stress - strain relation of corroded steel bars under different environmental conditions .Wu Hongcui [9] tested the mechanical properties of HRB500 high strength steel bars after high temperature, and studied the variation law of stress-strain relation curve, yield strength, ultimate strength, elastic modulus, elongation ratio and section shrinkage of high strength steel HRB500 after high temperature. Yu Zhiwu [10] carried out the experimental study on the mechanical properties of the new Ⅲ grade steel bars after high temperature, and suggested the formula for calculating the yield strength, ultimate strength, elastic modulus, elongation and tensile stress-strain full curve of new Ⅲ-grade steel bars after high temperature. Wang Quanfeng [11] studied the mechanical properties of HRBF500 fine grain steel bars after high temperature, and suggested a formula for calculating the yield strength, tensile strength, elastic modulus and elongation after high temperature after fine grain. Wang Kongfan [12] studied the mechanical properties of steel bars at elevated temperatures and after high temperature cooling and to understand the changes in mechanical properties of steel bars. Wang Yuzhuo [13] studied the mechanical properties of cold-rolled ribbed bars after high temperature, and fitted the regression mathematical model formula with temperature change for the mechanical properties of cold-rolled ribbed bars after high temperature.

In this paper, the accelerated corrosion and high temperature test of 48 HRB335 hot rolled steel bars with 16mm diameter were studied, and the mechanical properties including elongation, nominal yield strength and nominal limit strength of steel bars considering coupling effect of corrosion degree and high temperature were investigated.

2. Test Overview

2.1 Specimen production

To study the mechanical properties regarding corrosion degree and high temperature, ten concrete slabs (dimensions 400mm × 350mm × 100mm) were prepared for the accelerated corrosion test. Six deformed bars were embedded in the middle of each concrete slab as shown in Fig. 1 and 2. The type of bars used are HRB335 hot rolled ribbed bars of diameter 16 mm.