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REVIEW ON FATIGUE BEHAVIOR OF HIGH-STRENGTH CONCRETE AFTER HIGH TEMPERATURE

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ABSTRACT

The fatigue of high-strength concrete after high temperature has begun to attract attention. But so far the researches work about the fatigue of high-strength concrete after high temperature have not been reported. This article based on a large number of literature. The research work about the fatigue of high-strength concrete after high temperature are reviewed, analysed and expected, which can provide some reference for the experimental study of fatigue damage analysis.

1. INTRODUCTION

In practice, HSC structures not only need to withstand static load, but also have to bear cyclic loadssuch as vehicle, wind, wave or others, and sometimes even suffer a fire or other high temperature history, which will cause fatigue damage. At present, the research on the fatigue properties of HSCafter high temperature has become a central issue for scholars.So far, there are many researches on high-strength concrete, but most researches [1-3] mainly focuson the basic properties of HSC, such as strength and durability. The studies on the fatigue damage ofconcrete after high temperature are few and only focus on axial compression fatigue of plain concreteafter high temperature [4]. While, fatigue properties of HSC after high temperature have not beenreported. In this paper, the research on the fatigue properties of HSC after high temperature is reviewed, analyzed and evaluated. It can provide reference for fatigue test and damage analysis ofHSC after high temperature.

2. RESEARCH STATUS OF FATIGUE BEHAVIOUR OF HSC

Wu Peigang et al [5] studied the axial compression fatigue behavior of HSC under constant-amplitudeand variable-amplitude repeated loads. Based on the tests, fatigue strength and fatigue deformation ofHSC under constant-amplitude repeated loading were analyzed, the empirical formula of longitudinaltotal strain and residual strain of fatigue strength were given, and a formula for judging the fatiguefailure by residual strain was put forward. Lu Xiaobin et al [3] pointed out that HSC with lateralconfining pressure $\sigma 3$ growth, the axial peak strain $\varepsilon 1c$ and transverse peak strain $\varepsilon 3c$ alsosignificantly increased, and in the triaxial compression of different loading path seemed to limitstrength σ1c and curve of the status quo was minimal. Tian Yaogang et al [6] studied theintroduction of the damper of concrete under the vibration load of bending fatigue performance.

Compared with the same level of strength of HSC, the anti-fatigue performance of HSC with dampingfunction was obviously improved. With the increase of vibration fatigue load, the service life of HSCwith damping function was obviously reduced. On the basis of experiment, the vibration fatigue lifeprediction equation of HSC with damping function under different failure probabilities was established.

He Zhenjun et al [7] conducted a high-strength high-performance concrete at different stress ratio ofmulti-axis tension and compression tests, which showed that the compressive strength anddeformation of multi-axial tension and compression depend on the stress state and stress ratio, and themulti-axial tensile strength σ1f and σ3f were smaller than the uniaxial tensile and compressivestrength ft and fc at all stress ratios. And the peak strain ε3p of the main pressure was the largest inuniaxial compression.A dynamic triaxial compression test of HSC was carried out by JKGran et al [8]. It pointed thatstress-strain relationships, stress and strain measurements in triaxle compression, which provided dataand a reference for the complete nonlinear relationship between stress and strain tensors. ErtekinAztecan et al [9] performed the Drucker-Prager yield criterion for triaxle compression tests of ordinaryand HSC. The Drucker-Prager parameter value increased with the increase of the ordinary concretestrength, and the Drucker-Prager parameter equation and the correctness of the equation were provedby the data collected.

3. RESEARCH STATUS OF MECHANICAL PROPERTIES OF HSC AFTER HIGH TEMPERATURE

Li Lijuan et al [10] conducted a high-temperature test on HSC (100 MPa), which studied itsappearance, compressive strength, flexural strength and splitting tensile strength after 500℃ and800℃.HSC after high temperature could occurs bursting phenomenon, with the fire temperatureincreasing, compressive strength, flexural strength and tensile strength splitting gradually becomesmaller, microstructure gradually worse, Mainly as follows: the loss of crystal water, cement hydratedecomposition occurs when the fire temperature reaches 800℃, the crystal water all lost, cementhydrate all the decomposition, the structure becomes loose. He Zhenjun [11-12] conducted C50 andC6O of HSC under multi-axial stress state strength and deformation performance test after hightemperature. And the corresponding failure modes and mechanisms, multiaxial strength, peak strain,stress-strain curves of the specimens under different stress states and different stress ratios afterdifferent high temperatures were analyzed, and the corresponding strength and deformationconclusions were given. The failure criterion formula of HSC under multi-axial stress condition wasestablished. Zhao Dongfu et al [13] studied the microstructural changes of HSC after differenttemperature and different constant temperature time from different angles by means of ultrasonic,scanning electron microscopy, X-ray diffraction and so on. The physical and chemical changes and theresulting microstructure changes were analyzed, studies had shown that with the heating temperatureand constant temperature time, the compressive strength of concrete showed a trend of decreasing.Long T et al [14] studied the fire performance of HSC and compiled the fire test data. It indicatedthat HSC and plain concrete showed great difference in the temperature range of 20℃ to 400℃. Fu-

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Ping Cheng et al [15] studied the stress-strain curves of high-strength concrete at 20℃, 100℃, 200℃,400℃, 600℃ and 800℃, and pointed out that the compressive strength of HSC increased withtemperature. The compressive strength at 800℃ was about one quarter of its initial strength. MasoodGhandehari et al [16] tested compressive strength, splitting tensile strength and correspondingultrasonic pulse velocity of high-strength concrete after 100℃, 200℃, 300℃ and 600℃. It was foundthat with the increase of temperature, HSC was higher than the compressive strength loss rate and theresidual strength measured at the ultrasonic pulse velocity was slightly lower than the value directlyexposed to more than 200°C.

4. CONCLUSIONS

By summarizing and analysing the research on the fatigue properties of HSC after high temperature in recent years. It is found that there are many researches focused on the mechanical properties but littleresearch focused on the fatigue properties. What's more, many researchers considered the fatigue,complex environment and other factors separately, which made those studies don't meet the objectiveengineering practice well and can't correctly determine the damage process and extent of HSC. Because of different research purposes and angles, the studies on the fatigue of HSC after hightemperature didn't connect the temperature history well with macro-mechanical properties, and cannotreveal its evolution mechanism under high temperature and complex load. The relationships betweentemperature, length of time and macro-mechanical properties of HSC have not been established yet.The research needs to be studied further and more systemic, which will be the main direction to studythe fatigue performance of HSC.

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