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Tests Review of research on properties of concrete under load and sulfate attack

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Abstract: The deterioration of concrete performance is the result of the combination of various factors in the engineering environment. The dry-wet cycle accelerates the sulfate attack of concrete, which is more serious than the concrete in the long-term immersion environment. The load has a significant influence on the concrete. This paper sorts out the relevant literatures of previous scholars on the study of concrete performance, finds out its inadequacies, and proposes new research prospects.

Keywords: Sulfate attack; dry and wet cycle; load and sulfate attack.

1. Introduction

The application of concrete structuring is extensive and universal, and it has always been a concern. The performance of concrete structures in destructive environments with harmful media erosion can be severely affected, the rate of degradation will increase, and functional advantages will be difficult to manifest and the premature decommissioning will occur. Concrete structures are subjected to a certain load during the process of use, which can cause serious material damage to concrete. The erosion of sulfate has a great influence on the deterioration of concrete, and it is extensive and universal. If the concrete structure is affected by the dry-wet cycle in the environment, the comprehensive deterioration effect is better. There have been many studies on the performance of concrete, and there are many studies on the performance changes under load and sulfate attack. There are few studies on the analysis of the performance of concrete by multi-angle analysis, XRD diffraction analysis and changes in mechanical properties and dynamic elastic modulus. Therefore, it is important to study the deterioration mechanism and performance degradation of concrete after the coupling of load and sulfate erosion. It is important to comprehensively analyze the performance of long-term concrete under load and sulfate attack environment by using various detection methods.

2. Effect of sulfate attack on concrete performance

In the humid environment with sea, sulfate erosion as a common environmental factor has a great negative impact on the basic mechanical properties of concrete structures. Michalis [1] (1892) found needle-like crystals called ettringite in concrete after being subjected to sulfate attack. Biczok [2] found that the difference in the concentration of Na2SO4 solution makes the products after erosion very different. The lower and upper limits of the product are determined by the SO_4^{2-}concentration of 1000mg/L and 8000mg/L. When the concentration is lower than the lower limit, the product is calcium strontium. Stone, above the upper limit concentration level, the product is mainly gypsum, and between the lower and upper concentration levels, the product is a mixture of the two. The existing mechanism of sulfate eroded concrete is roughly classified into carbon sulphite type, sulphate crystal type, ettringite type, gypsum type and hydrated calcium silicate decomposition type [3], in which sulphate crystal type erosion belongs to Physical, other parts are chemical. In the concrete strength, the change law of the sulfate attack is generally first increased and then decreased [4].

Nehdi and Suleiman [5] studied the performance of concrete after physical and chemical double erosion, and found that the erosion in the part of chemical immersion is chemical, and partial erosion exposed to harsh environment is physical. The damage after six months of physical erosion only stays on the outer surface of the concrete, but the performance of the concrete will gradually decrease in the long-term physical erosion. The chemical composition of the concrete, the bonding properties and the unique pore structure all increase the durability of the concrete against physical erosion to some extent. Zhao Shunbo et al. [6] studied the change of sulfate ion concentration caused by differential sodium sulphate solution on concrete immersion. The research shows that the concentration of Na2SO4 solution is in the same direction as the SO42- concentration of the surface concrete of the test piece; the longer the corrosion time, the more SO42- can invade the inside, the greater the concentration of SO42- in the same layer depth, the depth of invasion. The degree of increase is significantly reduced.

3. Effect of sulfate attack on concrete performance under dry and wet cycles

Lee [7] studied the change of the expansion of concrete under different environments, and the results showed that the expansion of concrete in the wet and dry cycle, freeze-thaw cycle and long-term immersion changes in turn. Kosmatka[8] found that concrete hardened in a dry environment will expand due to the absorption of moisture in the moist air, and the realization will be very subtle. The tensile force will be generated in the shrinking behavior after the concrete is dried. The increase of the tensile force will

produce more than the concrete resistance. The destructive force of the tensile strength, the more the cumulative force of the destructive force, the more the internal crack increases, and the increase of the penetration force will cause the damage of the concrete. Sahmaran et al. [9] found that the erosion in a single sulfate environment was less than the degree of erosion under the combined effect of sulfate and dry-wet cycles.

Yang Quanbing et al.[10] studied the effect of sulfate crystallization on coagulation performance under dry and wet cycles. It was found that sulphate crystallization has great destructive effect on concrete structure, leading to its flaking. The frequency of the wet and dry cycle and the concentration of the sulfate change in the same direction as the expansion force of the concrete. According to Gao Rundong [11], the loss of concrete under dry and wet cycles mainly comes from the swelling erosion of ettringite in humid environment and the crystallization pressure of water and salt in drying. Wang Hailong [12] studied the microscopic changes of eroded concrete by experimental SEM images, and found that the damage of concrete under the dry and wet cycle of sodium sulfate is the result of the interaction between erosion products and sulphate crystal expansion.

Guo Zhongqun [13] carried out a combination test of dry and wet cycles with chloride salt, dry and wet cycle and sulphate, and three different environmental factors of dry and wet cycle with chloride salt and sulphate, and studied the change of mechanical properties, indicating dry and wet cycle. It will destroy its internal pore structure and accelerate the erosion of concrete salt solution. Cody [14] studied the change of the expansion of concrete in Na2SO4 solution in three different environments. The study found that the concrete has the largest amount of expansion under dry and wet cycles. Rivard et al. [15] analyzed the changes in the alkali concentration of concrete pores caused by the dry-wet cycle. The results showed that the alkali concentration of the pores decreased by 34-61% after the dry-wet cycle.

4. Effect of load and sulfate attack on concrete performance

The effect of sulfate alone combined with loading and sulphate on the diffusion of sulfate ions inside the concrete is different. Schneider [16] studied the variation of the properties of concrete under the load of sulphate under load, and found that the performance of concrete under sulfate attack has a great influence on the level of compressive stress. The effect of different compressive stress range is very Big difference. 0.275 is the lower limit of compressive stress and 0.65 is the upper limit of compressive stress. When the compressive stress is at the level above the upper limit point of 0.65, the greater the compressive stress, the higher the damage rate of sulfate to concrete. When the stress level is below the lower limit of 0.275, the damage of

sulfate to concrete will follow. The compressive stress increases and decreases, which plays a partial protection role. The greater the compressive stress, the more the damage effect of the compressive stress on the concrete is, the greater the compressive stress is between the lower limit of the boundary point of 0.275 and the upper limit of the boundary point of 0.65.

WG Piasta et al. [17] found that compressive stress is coupled with sulphate. In fact, compressive stress appears to reduce the expansion effect caused by sulphate to some extent and improve the corrosion resistance of concrete. Xing F [18] shows that The load will increase the impact of the degree of concrete damage caused by sulfate attack and the effect of expansion. Yu [19] analyzed the coupling effect of sulfate attack and dynamic heat load. The research shows that the durability of concrete is affected by the concentration and stress level of the salt solution. The dynamic heat load makes the cracking earlier than the original case, making The rate of diffusion of sulfate ions is higher. Gao [20] and Yang [21] studied the coupling effect of sulfate solution erosion and long-term load. Studies have shown that long-term load can accelerate the attack of sulfate. Chen [22] studied that in the case of sulfate attack, the change of stress level is the same as the change direction of concrete by sulfate attack. Compared with short-term load, the compressive stress and tension of long-term load have great influence on concrete damage. obvious. Mu Ru [23] and other studies found that the performance of concrete in 5% Na_2SO_4 solution will increase the corrosion rate of concrete with the increase of load. The longer the load exists, the more obvious the impact will be. The degree of damage inside the concrete will increase due to the presence of long-term loads in the presence of medium, and the rate of deterioration of concrete performance will increase. Lin Yumei [24] studied the corrosion of seawater on concrete under load, and analyzed that the compressive stress caused damage to the mechanical properties of concrete, accelerated the corrosion degree of concrete, and the degree of corrosion of compressive stress was deformed. The performance has a greater impact on the intensity. V.Zivica[25] studied the corrosion of cement mortar in sulphate solution under compressive load. The results show that the corrosion effect of sulphate solution on cement mortar under load is obvious and has great influence. At the same time, the effect of water on concrete performance is not obvious, and the impact is small. Within 60% of the compressive load, the strength of the concrete increases and the porosity decreases, which is due to the fact that the compressive stress inhibits the expansion and the extent of the crack. Teng Haiwen et al. [26] found that the synergistic effect of sulfate erosion and bending stress is found. The bending compressive stress accelerates the rate of sulfate attack on concrete erosion. The higher the level of compressive stress, the higher the failure rate. fast.

5. Existing problems and research prospects

In the existing research, the research results of concrete durability have gradually improved, and the research on the influence factors, test methods and performance testing methods of concrete under the action of single environmental factors is also effective. Most of the existing studies only consider the effects of single acting load, sulfate attack, etc., and the use of single concrete performance testing methods. The single-factor concrete durability standard test and testing method are difficult to fully reflect. The working condition of concrete in the actual environment. After understanding the current research status, how to use the current test equipment and test methods to conduct concrete performance test under different environmental conditions is of great significance under the existing test conditions.

In the current research, the domestic and international characterization methods for concrete durability are mainly macroscopic indicators such as apparent flaking amount, dynamic elastic modulus and compressive strength loss, and high-spectral analyzers are used to analyze the microscopic changes of concrete and the integration with macroscopic properties. There are few evaluation studies, especially the study of the variation law of concrete under the environment of load and sulfate attack. Therefore, considering the coupling of load and sulfate erosion, the comprehensive evaluation and analysis of the durability of concrete from the perspective of macroscopic and microscopic changes has important research significance.

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