Chloride ion permeability of concrete under the conditions of different dry-wet circulation research present situation analysis

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Abstract

For different dry-wet circulation system of permeability of chloride ions in concrete research present situation has made the detailed review, point out.The erosion of chloride ion of concrete has always been the hot spot of the research on concrete durability, the dry-wet circulation under the condition of many scholars at home and abroad for the chloride ion permeability in concrete has carried out many studies, and made a lot of research results. But has yet to find a more reasonable and unified dry-wet circulation system, use the circulation system of differ in thousands ways, scholars both at home and abroad are according to consider the factors influencing test and experiment purpose of set of test system and lead to poor comparability test results.

Keywords

Durability;dry-wet circulation system; chloride ion; penetrating quality.

1. Introduction

According to the "Code for Design of Durability of Concrete Structures" promulgated by the Ministry of Housing and Urban-Rural Development of the People's Republic of China in 2008[1], concrete durability means that the structure does not require additional costs under various environmental conditions within the specified service life. The ability to be reinforced to maintain its safety, normal use and acceptable appearance[2]. The durability of concrete structures has always been a research hotspot at home and abroad. The deterioration of concrete durability caused by chloride ion erosion is one of the most common durability problems of concrete [3]. The reinforced concrete structure in the dry and wet alternate zone of seawater is more likely to cause corrosion of steel than the onshore or underwater structure, which greatly accelerates the intrusion of chloride ions into concrete and the process of damage of concrete. The structural damage problem is more prominent.

With the vigorous construction of real estate projects and public infrastructure projects in China, concrete is becoming the most used building material in engineering and the most important structural material. The reinforced concrete structure has become the most widely used structural form in the world. The China Academy of Building Research's investigation of the durability of buildings in China shows that the damage of industrial buildings is serious, and the service life of the structure is generally not guaranteed for 50 years. Most of them must be overhauled or repaired and reinforced in the period of 20-30 years[4]. By the end of the 20th century, nearly 2.34 billion m2 of buildings in China had entered the ageing stage, and they were in early retirement. The annual cost of the concrete structure was more than 200 billion yuan [5]. Therefore, strengthening the durability study of concrete structures, improving the design quality and extending the service life of the structure is a very important practical topic and task before us.

2. Research Status of Permeability of Chloride Ion in Concrete by Different Dry and Wet Cycle Systems in China

Xu G [6] conducted a test on the transport characteristics of chloride ions in confined concrete under dry and wet alternating environment. The concrete design strength was C25, the water-cement ratio was 0.5, the dry-wet time ratio was 2:1, and the test piece size was 150 mm× 150mm×150mm, the

test results show that the transmission depth of chloride ions in the specimens at 120d, 240d and 360d (about 11mm, 15mm, 18mm respectively), with the extension of the test period, the transport depth of chloride ions increases gradually. The stress level has a significant effect on the chloride ion content of the concrete surface. The higher the concrete stress level in the same test period, the lower the surface chloride ion content, the more linear relationship between the two, and the increase of the test period, the stress level on the surface chlorine The influence of ion content is increased, and the decrease of surface chloride ion content increases. In addition, with the increase of dry-wet cycle, the surface chloride ion content increases gradually and tends to be stable without stress.

Zhang L.M[7] carried out the influence of the number of dry and wet cycles on the diffusion coefficient of chloride ion. The concrete design strength is C50, the water-to-binder ratio is 0.35, and the test piece is 500mm×100mm×75mm prism. Dry and wet cycle conditions: constant temperature 60℃ The oven is baked for 8h, cooled at room temperature for 2h, and immersed for 50h as a dry-wet cycle. The test results show that the concrete has a depth of chloride ion transport in the specimen at 120d, 240d, 360d (about 6mm, 11mm, 24mm respectively), concrete. The free Cl- concentration decreases with the increase of diffusion depth, and increases with the increase of the number of dry and wet cycles. The diffusion coefficient of concrete decreases with the increase of the number of dry and wet cycles.

Jiang S.H[8] conducted a dry-wet cycle test on the chloride ion permeability of concrete. The concrete strength was designed as C30 and C50 with fly ash as mineral admixture. The water-to-binder ratio was 0.45 and 0.35, respectively, using 100mm×100mm. ×100mm cube test piece, curing system of dry and wet cycle: natural soaking for 12h at 20℃, remove the moisture from the soaked surface, and dry it for 12h, which is a dry and wet cycle. The test results show that the dry and wet cycle is applied to concrete. The effect of internal chloride ion content is very significant. As the number of dry and wet cycles increases, the chloride ion concentration inside the concrete increases gradually. The chloride ion diffusion depth in C30 and C50 concrete is 7.4mm and 7.2mm, respectively. The ion diffusion depth is lower than that of C30 concrete. With the increase of the number of dry and wet cycles, the diffusion depth of chloride ion in C30 and C50 concrete increases slightly, but the increase is very small, only 0.4mm-0.5mm.

Fan Y.H[9] inferred the effect of dry and wet circulation on the diffusion behavior of concrete in high concentration brine. The design strength of ordinary concrete is C30, the prism of concrete is 100mm × 100mm × 400mm, and the water-cement ratio is 0.6. “Corrosion + dry-wet cycle” experiment, firstly immersing the test piece in brine for 68h, then drying for 4h (using hot air blowing at 50℃ for 10min, then drying naturally) for 1 cycle, studied the diffusion law of chloride ion. The effect of dry-wet cycle on the chloride ion diffusion behavior of concrete was discussed. The experimental results show that the free chloride ion concentration decreases with the diffusion depth, and it shows a linear downward trend before 7.5mm-8.5mm. After the diffusion depth is 10mm, the trend Under the action of dry and wet cycles, the diffusion rate of chloride ions is significantly higher than that of purely immersed specimens, but it can reduce the apparent chloride ion diffusion coefficient by 50%.

Zhang L.M[10] completed the influence of dry-wet cycle and fly ash content on the chloride ion binding capacity of concrete. The design strength of ordinary concrete is C60, the water-cement ratio is 0.35, the test piece size is 500mm×100mm×75mm prism, dry and wet. Cyclic test conditions: oven baked at 60 ℃ for 6 h, natural environment for 18 h, salt lake brine for 48 h, one cycle ends, data is measured every 50 cycles, and the influence of chemical corrosion on the chloride ion binding capacity of concrete is explored. The results show that the total chloride ion and free chloride ion concentration increase with the increase of the number of dry and wet cycles. The chloride ion binding capacity R of the concrete has a positive power function with the number of dry and wet cycles. The correlation coefficient is above 0.9062, with dry and wet The number of cycles increases and increases. It grows faster before 150 times and slows down after 150 times.

3. Research Status of Permeability of Chloride Ion in Concrete by Different Dry and Wet Cycle Systems in Foreign Countries

Delft University of Technology, Eindhoven University of Technology[11-12] conducted a test of the effects of dry and wet cycles on the chloride ion diffusion model, modeling and prediction of chloride ion intrusion, using Fick's second law, combined with ambient temperature And the fluctuation of humidity, chloride ion binding, diffusion and convection, and the influence of carbonization, simulating the model of chloride ion diffusion under dry and wet cycle conditions, the results show that the simulation results are consistent with the measurement results.

The University of Toronto[13] studied the effect of chloride circulation on the concrete protective layer. The concrete design strength was C30, the water-cement ratio was 0.4, and the test piece size was 350 mm × 250 mm × 75 mm. Two dry and wet circulation systems were designed: 1.0 Soaked in mol/l sodium chloride solution for 6h, the closed space of 50% relative humidity was allowed to stand for 18h or 66h as a cycle. The test results showed that the test piece with drying time of 18h had the deepest erosion depth of about 14.0mm and the drying time was For the 66h test piece, the erosion depth increased slightly and the depth was about 15.1mm. The longer the drying time, the higher the chloride ion content. There is a good square root relationship between the depth of erosion of chloride ions and the number of cycles.

The Lisbon Polytechnic University[14] studied the case of chloride ion-permeable concrete in the marine environment, using three different concrete mixes, two cast-in-place (water-cement ratios of 0.5 and 0.3 respectively), and one for shotcrete (gray) The ratio is 0.35), the designed test piece size is 1000mm×500mm×120mm, simulating the marine environment, the average annual dry and wet circulation system is: 9h in relative humidity 78% environment, 15h in relative humidity 64% environment, the test results show: chloride ion The diffusion coefficient varies with the quality of the concrete and the exposure conditions, showing a significant time dependence. The time dependence is due to the hydration of cement particles and the chemical reaction of seawater to reduce the pore structure; chloride ion content As time goes from high to low and then high, the high chloride ion content is mainly concentrated in the winter.

The University of Paraná and the University of Sao Paulo [15] studied the influence of the wet and dry cycle on the reinforced concrete structure of the marine environment, and designed a variety of reinforced concrete structures with different strength grades. The test results show that the higher the concrete, the lower the damage of chloride ions. Concrete that is not in the dry-wet cycle area, as long as the chloride ion content limit threshold in the environment is less than 0.40%, the concrete structure will have little effect; the concrete in the dry-wet cycle area, the dry-wet cycle greatly enhances the chloride ion erosion ability. .

Ljubljana University[16] analyzed the performance of chloride ion infiltrated fly ash concrete under the action of dry and wet cycles. The cylindrical test piece was used to test the depth change of chloride ion infiltration into concrete. The results showed that chloride ion was in fly ash. Concrete penetration depth is small, which indicates that fly ash has a potentially beneficial effect on the service life of reinforced concrete structures. Not only the porosity of fly ash plays a key role in the penetration of chloride ions into concrete, but also the composition of fly ash, especially calcium.

4. Analysis of research status in China and abroad

Through the elaboration and analysis of the above research status, the following conclusions can be drawn.

1) The performance of chloride ion permeation concrete under the action of dry and wet cycles has been extensively studied in the field of concrete durability at home and abroad, and a lot of research results have been obtained. However, the circulation systems used by scholars at home and abroad vary widely, and are based on experiments considered by themselves. The influencing factors and the experimental system set by the experiment purpose make the test results comparable.

2) Because the structural strength grades of different buildings are different, resulting in different cement content and cement grade in concrete, the performance study of chloride ion permeable concrete is discrete. However, the research on the performance of chloride ion permeable concrete is relatively simple at home and abroad. The big belly is mainly studied with a certain strength, and there is no systematic research on concrete with different strength or different mixing ratio.

5. Issues and trends that should be further studied

From the analysis of the above-mentioned research status at home and abroad, it is known that there are still some problems in the performance of chloride ion permeable concrete in the field of concrete durability. Further research is needed.

1) At present, the research on the performance of chloride ion permeable concrete at home and abroad is relatively simple. It is necessary to study the concrete with different strength and different mixing ratio, and finally obtain the range of performance indexes of chloride ion permeable concrete suitable for different strengths and different mixing ratios. Different buildings are well protected against chloride attack.

2) It is necessary to formulate corresponding wet and dry cycle system specifications to promote the further development and application of various researches involving dry and wet cycles.

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