



Research Article

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## The research of ring pressure of the pile foundation on the influence of the durability of concrete

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### ABSTRACT

The test make steel cylinder concrete, PVC protection tube cylinder concrete, spray coatings Outside the cylinder concrete and no protective measures on ordinary cylinder concrete in three different strength grade: C25, C35 and C50, putting in the freeze-thaw cycle in three kinds of environment of 5% sulfate solution, 5% sulfate + 3% chlorine salt solution and distilled water. Analysis of the Research of Ring pressure of the Pile foundation on the influence of the durability of concrete by measuring the concrete of Pile foundation corrosion mass loss before and after freezing and thawing. Experiments show that: the concrete with protective measures almost has no mass losses with the level of pile foundation concrete in the same corrosive environment, that is to say, the durability is good. While the unprotected concrete has mass losses after the freeze-thaw action hitches in three kinds of solution, and the largest mass loss is in the mixed solution, the durability is the worst.

**Keywords:** Pile foundation, Extrusion method, Freezing and thawing, Durability.

### INTRODUCTION

For a long time, designers and builders aim at the problem of pile foundation considering mainly intensity far as the durability of the structure strength. Over the past 20 years, the survey data of these countries who have more coastal engineering and more advanced technology like the United States, Britain, the Netherlands and Japan indicates that buildings of pile foundation in the splash zone, mostly use less than 20 years, have to cost a huge sum of money to repair because of the serious of reinforcement corrosion and concrete crack. In recent years, although the scientific research workers have made great efforts in our country, but for some new pile wharf, including the large prestressed concrete pipe pile wharf building in the early 90s, according to the survey, under a variety of comprehensive factors the concrete component surface have micro cracks and mild rusty spot. Because of the bad environment Building after five years in Southern port. And 7 ~ 15 years or so, artifacts appear reinforcement rust expansion, concrete cracking and peeling.



Figure 1 concrete pile damage

The factors influencing the durability of reinforced concrete pile foundation is very much [1], the main internal factors to ensure the durability of the structure is the material performance, and the main external factors is the

damage of chloride ion. The durability of the Pile foundation concrete depends on the degree of protective measures of reinforced concrete. In this paper, The author analyzed the Research of Ring pressure of the Pile foundation on the influence of the durability of concrete by Simulation of the actual engineering environment and measuring the concrete of Pile foundation corrosion mass loss before and after freezing and thawing in three kinds of solution.

## DESIGN

Ring pressure protective measures include high elastic modulus ring pressure (metal liners) and Low stiffness of ring crush liners (hoop prestressed slab, PVC liners). The mechanism of action is to make the tensile stress change into compressive stress when concrete expansion occurs to effectively inhibiting the deformation and fracture of inflating damage. Pile foundation erosion not only can effectively reduce harmful material into concrete and the concrete can have ferrule effect when destroyed by inflating.

The test make steel cylinder concrete, PVC protection tube cylinder concrete, spray coatings Outside the cylinder concrete and no protective measures on ordinary cylinder concrete in three different strength grade: C25, C35 and C50, putting in the freeze-thaw cycle in three kinds of environment of 5% sulfate solution, 5% sulfate + 3% chlorine salt solution and distilled water. Analysis of the Research of Ring pressure of the Pile foundation on the influence of the durability of concrete by measuring the concrete of Pile foundation corrosion mass loss before and after freezing and thawing.

## LABORATORY EQUIPMENT

This experiment adopts the method of quick frozen. Concrete freeze-thaw cycle experiment was carried out according to 《Ordinary concrete long-term performance and durability test method standard》 [2] (GB/T50082-2009) and 《Hydraulic concrete test procedures》 (DL/T5150-2001). The experimental equipment is as follows:

- ① sprayer: Gusmer H - 20/35 sprayer;
- ② Freezing and thawing box: TDR - type 2 concrete automatic fast freeze-thaw test equipment;
- ③ cone test is homemade, long is 400 mm, cross section inner diameter is 100 mm. Materials is PVC tube, inner diameter 100 mm, 110 mm diameter, Q235 steel pipe, steel test 150 mm \* 150 mm \* 150 mm;
- ④ Mixer: HT - 50 type concrete mixer.

## TEST NUMBER AND GROUPING

**Table 1 specimen grade, size, protective measures and code table**

| Concrete grade (MPa) | specimen size (mm) | Protection type  | Mixed environment | Sulfate environment | Water environment |
|----------------------|--------------------|------------------|-------------------|---------------------|-------------------|
| C25                  | Φ100×400           | Steel Casing     | GHD25             | GLD25               | GQD25             |
|                      |                    | PVC Protective   | PHD25             | PLD25               | PQD25             |
|                      |                    | No Protection    | WHD25             | WLD25               | WQD25             |
|                      |                    | Spraying Coating | THD25             | TLD25               | TQD25             |
| C35                  | Φ100×400           | Steel Casing     | GHD35             | GLD35               | GQD35             |
|                      |                    | PVC Protective   | PHD35             | PLD35               | PQD35             |
|                      |                    | No Protection    | WHD35             | WLD35               | WQD35             |
|                      |                    | Spraying Coating | THD35             | TLD35               | TQD35             |
| C50                  | Φ100×400           | Steel Casing     | GHD50             | GLD50               | GQD50             |
|                      |                    | PVC Protective   | PHD50             | PLD50               | PQD50             |
|                      |                    | No Protection    | WHD50             | WLD50               | WQD50             |
|                      |                    | Spraying Coating | THD50             | TLD50               | TQD50             |

## RAW MATERIALS, AND SPECIMENS OF PRODUCTION

### RAW MATERIAL AND MIXING RATIO

The mixing proportion design shown in the following table.

**Table 2 concrete single material consumption (kg)**

| Concrete grade | cement (kg) | sand (kg) | stone (kg) | water (kg) | mineral powder (kg) | fly ash (kg) | Water reducing agent (kg) | water-cement ratio |
|----------------|-------------|-----------|------------|------------|---------------------|--------------|---------------------------|--------------------|
| C25            | 182         | 642       | 1247       | 170        | 66                  | 83           | 4.30                      | 0.51               |
| C35            | 209         | 731       | 1144       | 152        | 76                  | 95           | 4.94                      | 0.40               |
| C50            | 267         | 621       | 1153       | 150        | 97                  | 121          | 6.30                      | 0.31               |

### SPECIMEN MAKING

A. choose inner diameter is 100 MMPVC tube; Inner diameter 100 mm, 110 mm diameter, Q235 steel tube. Use PVC pipe and steel pipe cutting machine cut into small pieces of 400 mm, outside the base of each small pieces of brush oil, add 150 mm \* 150 mm \* 150 mm steel test, filling it With mixture, Make sure that is no mixture into the tube, After being dried, it is finished. A total of 27 steel pipe mold and 54 PVC pipe die;

B. Weighing according to the proportion of material, mixing and loading test, vibrating forming, number each level species, ripping after 24 hours, maintenance in standard curing room 28 days.

C. Take out specimen, reserve the steel with pipe protection outsourcing, it is concrete with steel pipe outsourcing. Remove PVC pipes in part of PVC tube as unprotected and besmearing brush paint, Using Gusmer H - 20/35 sprayer spray paint outside the concert with number T , which is needed spray coating cylinder concrete.



Figure 2 Die setting



Figure 3 vibrating and molding

### SOLUTION PREPARATION

Prepare two kinds of solutions according to the percentage by volume: 5% sodium sulfate solution, 3% sodium chloride and 5% sodium sulfate mixed solution.

test results and analysis

The mass changes of the same level and protective measures of concrete in different solution is in the following figure

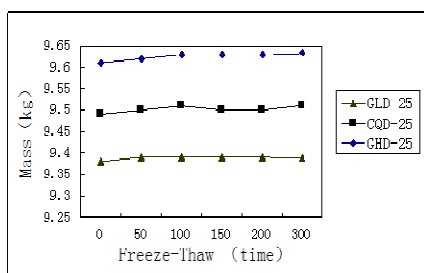


Figure 4 Mass change of C25 in the protection of Steel Casing

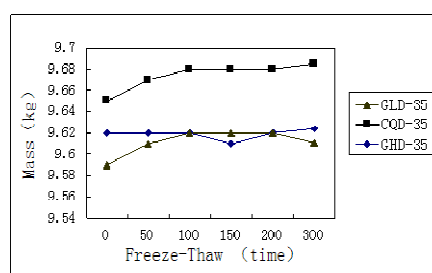


Figure 5 Mass change of C25 in the protection of Steel Casing

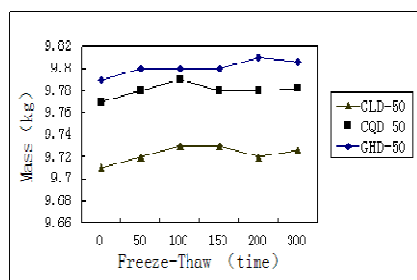


Figure 6 Mass change of C50 in the protection of Steel Casing

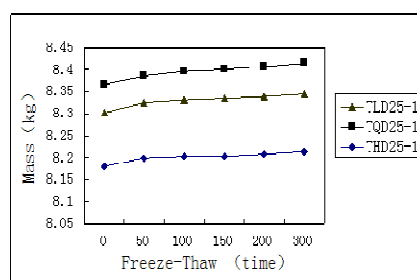
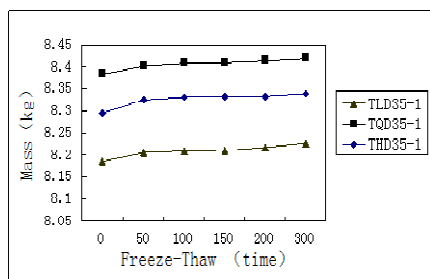
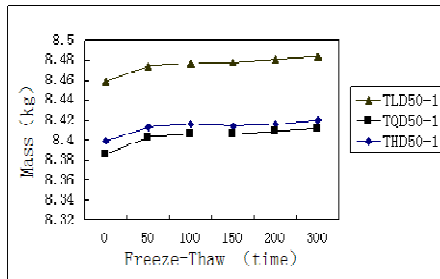


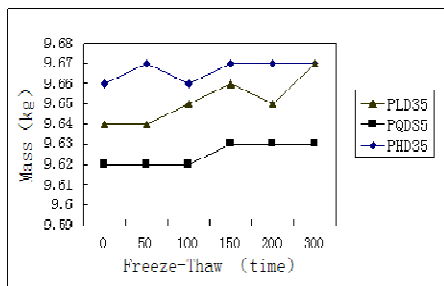
Figure 7 Mass change of C25 in the protection of Spraying Coating



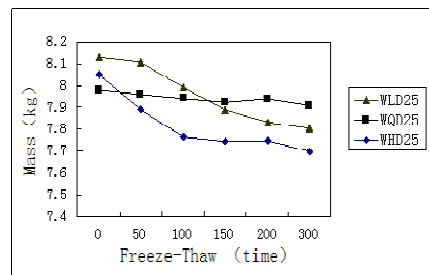
**Figure 8** Mass change of C35 in the protection of Steel Casing



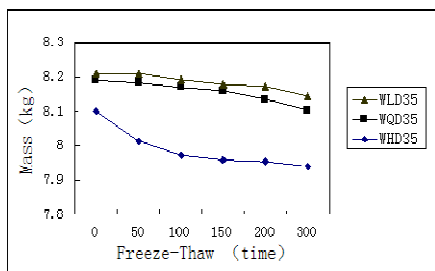
**Figure 9** Mass change of C50 in the protection of Spraying Coating



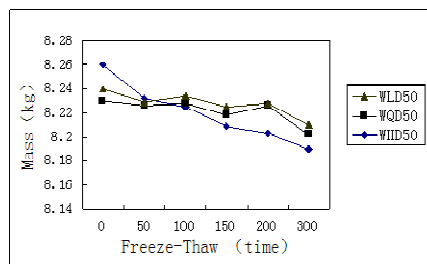
**Figure 10** Mass change of C35 in the protection of PCV



**Figure 9** Mass change of C25 in no protection



**Figure 12** Mass change of C35 in no protection



**Figure 13** Mass change of C50 in no protection

**ANALYSIS THE RESULT**

i. The mass of concrete with outsourcing steel tube is increased after freeze-thaw action hitches in three kinds of simulation environment ,The upward trend of curve is the same. Steel tube outsourcing concrete specimens appear the most obvious growth change after freezing and thawing 100 times, Approximate peak, then stabilized, growth is not big,The biggest mass to increase is of the original 0.36% ,Some mass is decline after 300 times of freezing and thawing .

ii. The mass change of concrete with PVC outsourcing is similar to the steel tube after freeze-thaw action, the change is not big and slightly increased.

iii. The mass of the cylinder concrete with spray coating outside is on the increase after freeze-thaw action hitches in three kinds of simulation environment,The mass growth is apparent after freezing and thawing 50 times, but growth curve moves smoothly, continue to increase.

iv. The mass is reduced with no protection concrete after freeze-thaw action hitches in three kinds of solution ,The trend is consistent in the graph.But the trend is slower in sulfate solution and water than in sulfate, chloride salt solution .The mass change of the concrete of the level of C25 is most obvious,In mixed solution of C25 concrete , mass loss rate is 1.99% and 4.36% respectively after 50 times and 300 times of freezing and thawing,While in water and in sulfate solution, loss rate are 0.25%, 0.90% and 0.28%, 0.25% respectively,after 50 times and 300 times of freezing and thawing. On this basis, a preliminary thought of the degree of damage is in mixed solution > in sulfate solution > in clean water.

Generally think sulfate and chloride salt are mixed together, chlorine ion and hydration chlorate react calcium chloride calcium aluminate, thus reducing the damaging of expansion of ettringite,So the action of the chloride salt

will slow down the damage, But only under the action of two phase. The experimental results are under the effect of three phase and the results show that the worst damage is in the mixed solution. This is because the chlorine salt is inhibition the chemical expansion process of sulfate, This experiment is under the action of three phase in water saturated state, The frost heaving damage of concrete plays a main role, It depends on the saturated degree of concrete and its growth rate. Studies have shown that [3], Under the condition of normal temperature, The presence of sodium chloride is to greatly improve the concrete internal satisfied degree of water and its growth rate, That is, the initial degree of full water will increase before freezing. Also show that the initial degree of full water is higher in the mixed solution in the experiments than in sulfate solution and pure aqueous solution. In concentration, freezing and thawing cycle in the process of the existence of the mixed solution of chlorine salt will increase the water absorption rate of concrete, And in the field of liquid surface fluctuation with the environment, can produce effect similar to the effect of dry-wet circulation, The existence of chlorine salt can increase the effect of salt crystals. So, in a nutshell, the expansion of the chemical effect of chlorine salt is less than the increased role of frost, So, on the whole, the concrete damage is more serious in mixed solution.

□、Biggest loss occurred in the level of C25 unprotected concrete measures in the mixed solution after 300 times of freezing and thawing, Lost about 4.36% of the original quality, less than 5%, It is mainly due to the mixing of concrete for the double mixing concrete (fly ash and mineral powder).

vi、The mass is small increase under two kinds of protective measures of concrete after freeze-thaw action, Generally between 0.2% ~ 0.4%, with individual reached 0.7%, Reasons for the increase is due to the adopted preventive measures, So at the early stage of the maintenance and soak period, The solution enter into slow, at the stage of unsaturated water, After the start of freezing and thawing, Under the effect of multiphase, External solution enter into the micro cracks, voids of the concrete, and accelerate mass.

Because exposure on both ends of steel tube outsourcing concrete in the experiment, And all soaked in the solution, Solution enter into the concrete easily along the ends and the inner wall, So the mass of concrete peak approximation after freeze-thaw 100, At this point that internal concrete is in the saturation stage, Then the mass change gently, Even fall. While outside spray coating exposed at one end, Solution penetrate slower than steel tube outsourcing concrete with multiple function, So the mass change curve smooth and no obvious peak in the 300 freezing and thawing and In 300 freezing and thawing concrete failed to reach saturation. But in the practical engineering and the actual environment, steel tube outsourcing is above the liquid level, Concrete is not contact with solution, So in the actual number of freezing and thawing in analogy to the laboratory after reaching 300 times, The practical engineering is not saturated, So laboratory life prediction is less than the equivalent conditions of real life.

#### THE MASS CHANGE OF CONCRETE OF VARIOUS PROTECTIVE MEASURES IN THE SAME SOLUTION

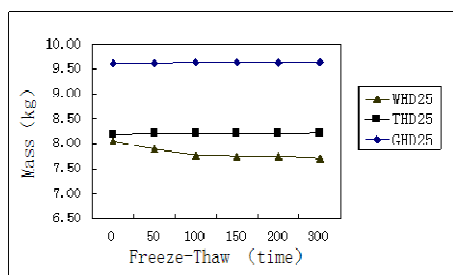


Figure 14

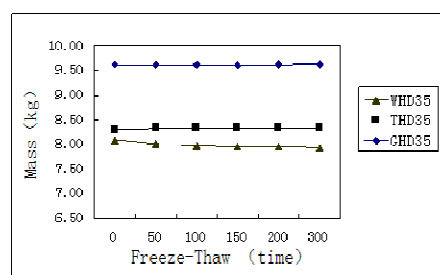


Figure 15

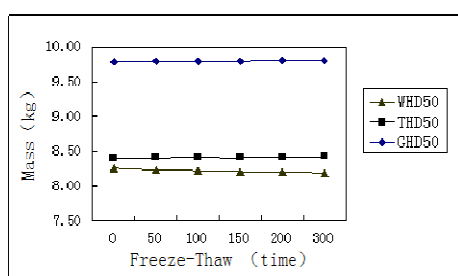


Figure 16

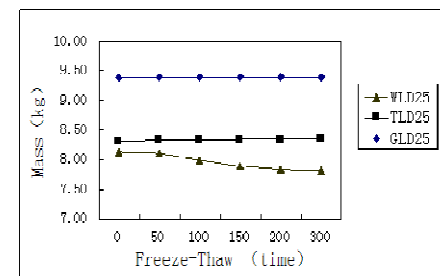


Figure 17

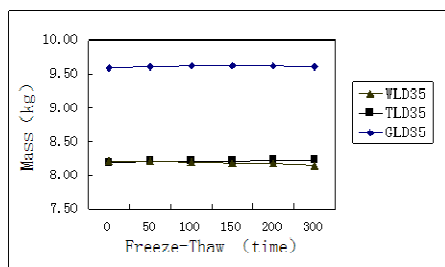


Figure 18

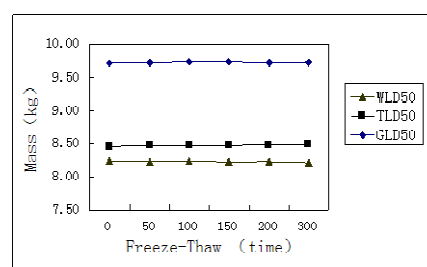


Figure 19

Among them: Figure 15 -17 is C25、 C35、 C50 concrete mass change with different protective measures in mixed solution;  
Figure 18-20 is C25、 C35、 C50 concrete mass change with different protective measures in sulfate solution;

### ANALYSIS THE RESULT

Steel tube outsourcing concrete and concrete outside of the spray coating who have protective measures mass changed little ,most have a slightly increased and mass have no obvious decline after 300 times after freezing and thawing though comparing with the same grade and environment protection. While the mass decline significantly without protective measures, And lower level of C25 concrete while using high-performance concrete mixing method, but the mass is also reduced 4.36% after 300 freezing and thawing in mixed solution, Nearly 5% of the damage criteria. This means unprotected concrete close to failure after 300 times of freezing and thawing, and the mass of steel tube outsourcing concrete and concrete outside of the spray coating has no obvious loss.

### SUPERFICIAL PHENOMENON

The following figure is the appearance comparison chart between internal concrete after remove steel pipe and no protective measures of concrete after 300 times of freezing and thawing:



Figure 21 The comparison of concrete between Steel Casing protection and no protection after 300 times freeze-thaw cycle

We can see from the picture intuitively, No matter what strength grade concrete without protective measures, the large-area surface after 300 times of freezing and thawing have appeared spalling phenomena lightly or heavily, But most steel tube outsourcing concrete is good, Individual specimen is peeling off.

### CONCLUSION

the concrete with protective measures almost has no mass losses with the level of pile foundation concrete in the same corrosive environment, that is to say, the durability is good. While the unprotected concrete has mass losses after the freeze-thaw action hitches in three kinds of solution, And the largest mass loss is in the mixed solution, the durability is the worst.

### REFERENCES

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