# Research of Concrete Durability in the Environment with Salt Solution

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Abstract: Using ordinary Portland cement and Portland blastfurnace-slag cement, the test specimens whose water cement ratio is in range from 0.45 to 0.60 have been made. After having been corroded by seawater in accelerated corrosion experiment, based on rule and cause of changes of strength and weight loss rate, experiment data has been provided for quantitative analysis of broken state. It has been showed that under the condition, durability of Portland blastfurnace-slag cement is better than that of ordinary Portland cement, when the corrosive coefficient of concrete member is 0.8, it is in conformity with limit value of 25% strength loss in American ASTM standard.

Key words: seawater; concrete; water cement radio; durability; accelerated corrosion experiment
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## 1 Preface

Seawater has great influence on concrete structures for its causticity. The contact area between seawater and concrete is different, and therefore erode estate is also different. The worst erosion happens in the place where water lines change periodically for the concrete in that area experience the diversification of damp-dry, freeze-thaw[1].

## 2 Experimental program

### 2.1 Corrosive liquor

During the experiment, man-made mixed liquor was used to simulate the seawater of TangGu harbor in TianJin. In order to execute the experiment efficiently, 5 times mixed liquor had been used to speed the erosion.

### 2.2 Material properties

Cement: NO.425 ordinary Portland and slag Portland.

Fine aggregate: middle-size sand. The fineness modulus was 2.70.

Coarse aggregate: pea gravel (5~10 mm in diameter).

### 2.3 The concrete mix

According to the different type of cement and the water to cementitious ratio, cube specimen was made (40 mm × 40 mm × 160 mm) and listed in table 1.

### 2.4 The experimental method

In the oceanic concrete structure, some areas of the structure where experience the diversification of damp and dry erode most. So the acceleration immerge-drying cycle method had been used to investigate the principle of erosion. The immerge-drying cycle means the formed concrete was settled for 24 hours under damp condition and maintained for 28 days. In order to eliminate the dispersibility of the results, specimens were dried for 16 h after been immersed into the caustic liquor and natural water respectively for 8 h. After making cycle that way stated above, the strength, fracture, weigh psing were measured.

Tab. 1 Mix of concrete

| No. | cement/kg | water/kg | sand/kg | gravel/kg |
|---|---|---|---|---|
| C1, C5 | 367 | 220 | 734 | 1101 |
| C2, C6 | 369 | 203 | 739 | 1107 |
| C3, C7 | 372 | 186 | 744 | 1116 |
| C4, C8 | 370 | 166 | 750 | 1125 |

Note: 1. C1~C4 ordinary Portland cement.
2. C5~C8 Portland blastfurnace-slag cement.

## 3 Experimental results and analysis

The Concrete specimen using ordinary Portland and slag Portland whose water to cementitious ratio were 0.45, 0.50, 0.55, 0.60 respectively had been tested for the sake of making comparison of erode status[2].

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According to the specification (GB749—65), the cube specimen (10mm×10mm×30mm) employing 1∶3.5 cement-sand ratios were made, after that the strength of 6m- specimens were compared to get the anti-erode coefficient. If the coefficient less than 0.8 mean erosion exist, on the contrary, if the coefficient is bigger than 0.8 mean no erosion. Base on the ASIM provisions, erosion will happen when weigh losing exceed 5%, length expand exceed 0.4%, and strength losing exceed 25%[3].

For the specimen (40mm×40mm×160mm), the losing strength of $f_t$ and $f_c$ exceed 25% and weigh losing is no more than 5% when anti-erode coefficient is less than 0.8. The losing strength of $f_t$, $f_c$ and weigh losing are no less than 25% when anti-erode coefficient is bigger than 0.8. The test results indicated that when the corrosive coefficient of concrete member was equal to 0.8, it was in conformity with limit value of 25% strength loss in American ASIM standard and weigh losing was no more than 5%.

The anti-erode coefficient of concrete ascend with the times of cycle and later descend. The results of 60 times cycle show that concrete anti-erode ability ranking is C4> C3> C2> C1 for ordinary cement, C8> C7> C6> C5 for Portland, and their water to cementitious ratio order is 0.45> 0.50> 0.55> 0.60. The anti-erode ability of cement comparison is C5> C1, C6> C2, C7> C3, C8> C4 when they have the same water to cementitious ratio. From the angel of anti-erode coefficient, the behavior of Portland blastfurnace-slag cement are better than that of ordinary Portland cement. In short, the durability of Portland blastfurnace-slag cement concrete precedes that of ordinary Portland cement concrete.

## 4　Conclusions

(1) The test results indicated that in the course of the concrete corrosion, firstly its interior structure was all gradually compacted by the corrosion production, and secondly its tightness gradually decreased because of the generation and expansion of the corrosion production, lastly its structure was destroyed.

(2) Compared Portland blastfurnace-slag cement with ordinary Portland cement, the osmosis for resisting chloride and durability of Portland blastfurnace-slag cement was stronger than that of ordinary Portland cement under the same water cement ratio, the ability for resisting seawater corrosion was better than that of ordinary Portland cement.

(3) The test results indicated that when the corrosive coefficient of concrete member was equal to 0.8, it was in conformity with limit value of 25% strength loss in American ASIM standard and weigh losing was no more than 5%.

(4) Whether ordinary Portland cement or Portland blastfurnace-slag cement, with the decrease of water cement ratio, the ability for resisting corrosion of concrete gradually increased. When the concrete was used in the sea or nearby, and combined with ice salt in the cold weather, we had better select water cement ratio which is not higher than 0.45.

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# 海水侵蚀环境下混凝土耐久性的研究


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摘　要：采用普通硅酸盐水泥和矿渣硅酸盐水泥，分别配制了水灰比在0.45～0.60范围内的混凝土试件，采用加速腐蚀试验研究了在海水侵蚀后，其强度、重量损失随时间变化的规律及原因，并为试件损伤状态定量化解析提供了试验数据。结果表明，在相同的试验条件下，矿渣硅酸盐水泥混凝土耐久性优于普通硅酸盐水泥混凝土；混凝土试件的抗蚀系数为0.8时与美国ASIM标准规定的强度损失25%的界限值吻合较好。



关键词：海水；混凝土；水灰比；耐久性；加速腐蚀试验

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