Micro-analysis of Marine Sand From Zhoushan Seas

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Abstract: The main salt components and ion content of seawater were qualitatively and quantitatively analyzed. The results show that the seawater in this region has low ion content and low salt content, and direct application is relatively beneficial to engineering. Meantime, the property test was carried out to investigate the basic physical behavior of the goal sea sand. The results show that Zhoushan sea sand has low chloride ion content, uniform particle size and low mud content.

1. Research Background:
Under the background of China’s transformation of a maritime power into a maritime power, research on marine engineering structural materials has become a frontier topic in international material science research. At the same time, with the sustainable development of the marine economy, the tourism industry is booming, the number of migrants is increasing, and the infrastructure construction is increasing, which leads to the continuous increase in the demand for sand and gravel fresh water. The contradiction between supply and demand will increasingly highlight the composition of sea sand and river sand. There is a big difference in the microscopic structure, which leads to its macro performance not meeting the requirements for use. Therefore, multi-scale research methods are applied to the constituent materials of marine cement-based materials to find the bridge relationship between macroscopic and microscopic composition, so as to analyze the influence of microscopic and chemical combination of such materials on macroscopic phenomena, for seawater and sea sand. Provide scientific reference for the practical engineering application and improvement of marine phase cement materials.

2. Seawater Test
2.1 Sampling And Composition Testing
The sample was taken from the Lincheng District of Zhoushan, about 1 km away from the island. The annex has no sewage from the river. Because of the large amount of seawater in the area, the precipitation phenomenon after retrieving must be evenly tested before it can be tested.

2.2 Composition Test
The composition of seawater is relatively complex, containing a large amount of inorganic salts and free ions. The laboratory internal test method is used to calibrate the chemical components with high
content and great influence on concrete performance. (eg. ions: chloride, sulfate, bromide, sodium, potassium, magnesium, calcium, carbonate and salts)

2.3 Test Results And Analysis
There are differences in the salinity of seawater in various areas of the ocean, and the overall trend is from nearshore to ocean. Because the river has played a role in dilution, the performance of rivers and rivers into the sea is more obvious. The offshore waters of China's coastal areas are generally weakly alkaline, and there is a large difference in ion concentration. The overall percentage does not change much [1]. Specification ASTM D1141-98 gives the basis for artificially configured seawater, see Table 1

Table 1 Composition of Seawater Chemical Composition

| Ingredient   | NaCl | MgCl₂ | Na₂SO₄ | CaCl₂ | KCl | NaHCO₃ | KBr | H₃BO₃ |
|--------------|------|-------|--------|-------|-----|--------|-----|-------|
| Concentration mg·L⁻¹ | 24530 | 5200  | 4090   | 1160  | 695 | 201    | 101 | 27    |

| Ingredient   | SrCl₂ | NaF | Ba(NO₃)₂ | Mn(NO₂)₂ | Cu(NO₃)₂ | Zn(NO₃)₂ | Pb(NO₃)₂ | AgNO₃ |
|--------------|-------|-----|----------|----------|----------|----------|----------|-------|
| Concentration mg·L⁻¹ | 25    | 3   | 0.0994   | 0.034    | 0.0308   | 0.0096   | 0.0066   | 0.00049 |

Fig 1 Seawater Ion And Salt Content Distribution in Zhoushan
The ionic content and salt content of Zhoushan seawater are relatively low, and direct application and engineering construction are most beneficial. It can be seen from Fig. 1 that the salt with the highest content in seawater has a NaCl content of 18 g/kg and a Cl⁻ content of 13.718 g/kg, but has a large decrease compared with the artificial seawater configuration and other ion contents. Ye Dongzhong [3] pointed out that the hydration reaction and strength of cement will increase with the increase of sodium chloride. When the content of sodium chloride reaches 2%, the content reaches the maximum and the setting time will also be shortened. Liu Jian [6] et al. believed that Cl⁻ participated in the early reaction of cement to form a small volume of chloride salt. When the salt content reached

![Ion species graph](image_url)
12%, the maximum compressive strength of the paste consistency was the highest. It can be seen from the above that the Cl$^{-}$ content has a certain promoting effect on the performance improvement of different configurations of concrete in an appropriate range.

Secondly, the content of MgCl reaches 3.6g$\cdot$kg$^{-1}$. When MgCl is produced in excess, the formation of Mg(OH)$_2$ and CaCl$_2$·12H$_2$O will cause the concrete to swell and block the hydration reaction. Scholars such as Gong Yufeng[5] believe that Mg$^{2+}$ participates in the reaction and reacts with SiO$_2$ to form Mg·SiO$_2$·H$_2$O in the middle stage of hydration reaction to make C-S-H gelation worse. Zhoushan seawater has the lowest magnesium ion content relative to other regions, which is relatively favorable for concrete preparation.

The presence of a certain amount of SO$_4^{2-}$ in the sample reacts with C$_3$A in the cement to form more crystalline ettringite. The expansion of ettringite inevitably leads to uniformity of the concrete and reduces the strength of the concrete. However, studies have shown that the water-cement ratio has a significant effect on the growth of ettringite. Under the same conditions, the larger the water-cement ratio, the looser the cement stone structure, and the more space the ettringite is formed. The water-cement ratio is small, the cement stone structure is relatively tight, the pores are small, the amount of ettringite formed is small, and the crystal is anisotropically grown and needle-like.

3 Sea sand Test

3.1 Property Test

The sea sand of the sample was taken from the sand of Nansha in the Putuo District of Zhoushan and the “Beach” of Dongsha. The sample was tested for eds, xrd, sem, particle size and conventional performance (refer to GB/T14684-2010 “Building Sand”).

The sand was subjected to a grain size test using a Malvern laser particle size analyzer, and the apparent density, bulk density, mud content, and shellfish content of the sand were tested in accordance with "Building Sand" GB/T 14684-2011.

3.2 Analysis of Test Results

![Fig 2 Distributions of The Marine Sand Sizes From The Sieving Analysis](image)
The sieving test data was analyzed. The total fineness modulus of the sea sand sample used in this study was Fm=1.21, which was ultrafine sand. According to the Malvern laser particle size analyzer test, the specific surface area of Dongsha sample is 23.41m²/kg, and the specific surface area of Nansha sample is 30.12m²/kg. According to the cumulative volume distribution curve, the Dongsha sample has slightly larger particle size than the Nansha sample, but two sea sand samples. The distribution of grain size in the mesoscale range of 200μm~1mm is basically the same. In addition to the bulk density of less than 1400Kg / m², the stone powder content is higher than others.

4. Conclusion
In the relatively national scale of Zhoushan seawater, the lowest ion and salt content has the least impact on concrete performance and the lowest desalination cost. The exact content of the ionic salt can be precisely improved in the actual application of the project. Through the basic performance test of the sea sand sample, other properties are satisfied in addition to the void ratio. Combined with microscopic image analysis, the Zhoushan sea sand has the characteristics of rough surface, large void ratio, uniform distribution, elliptical shape and elongated strip shape.

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