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Optimum Use of Microsilica in Reducing Corrosion Reinforcing Steel of Marine Concrete Structures
(Case study of Imam Khomeini quay P1)

A.R. Tangtakabi, M. H. Ramesht*, A. Golsoorat Pahlaviani, T. Pourrostam

Department of Civil Engineering, Islamic Azad University, Central Tehran Branch, Tehran, Iran

ABSTRACT: Marine structures are considered as infrastructural structures due to their special geographical location and their important share in the country's economy. The most important damage to marine concrete structures in the tidal zone is due to the corrosion of reinforcements in concrete. These conditions reduce the useful life of concrete structures. One of the effective methods to prevent corrosion of reinforcement and reduce the penetration of chloride ions in concrete structures in marine environments is to improve the quality and mechanical properties of concrete using microsilica, although various studies have been conducted on this subject. However, this paper intends to investigate the optimal use of microsilica in reducing reinforcement corrosion in marine concrete structures on the properties of hardened concrete in 18 months and at different times. In the Sample laboratory, with a ratio of water to cement, 34% ,40% and superplasticizer range from 3% to 6%, and the microsilica with the percentages 7,10,13, made, and after the exposed conditions on aggressive, etc. testing corrosion rate, has been measured. The results show that. The effect of concrete mix containing 10% silica fume with a ratio of water to cement 34%, the durability of the reinforcement against corrosion and service life of marine structures increases.

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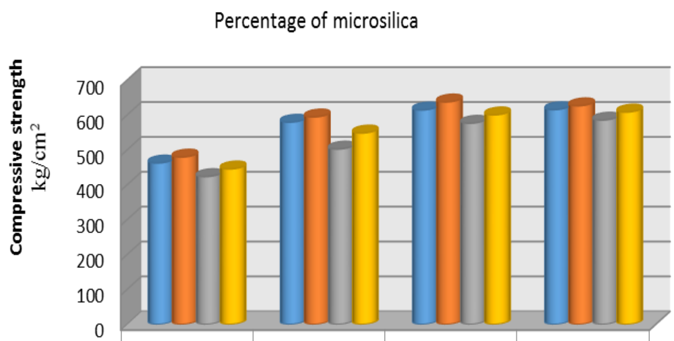
1- Introduction

Degradation of marine concrete structures due to corrosion of reinforcement, under the influence of chloride ions, is one of the main causes of the destruction of reinforced concrete structures. The conditions governing marine structures on the shores of the Persian Gulf, both in terms of salts in seawater and in terms of the prevailing climatic conditions, have made this environment one of the most aggressive marine environments in terms of corrosion. Early breakdowns of concrete structures in the Persian Gulf region due to reinforcement corrosion have already imposed high repair costs on the countries of the region, which is a serious and important economic problem. For this reason, the growing acceptance of the causes of corrosion of reinforced concrete buried in concrete, ways to prevent it, factors that cause high strength and durability of concrete is a sign of the importance of the issue. Reinforced concrete structures in the sea are exposed to chemical and electrochemical damage. The most important causes of corrosion are two phenomena of air carbonation and chloride infiltration. Due to reinforcement corrosion and cracking of the concrete, the useful life of marine concrete structures is significantly reduced. This type of damage is more common in the tidal zone, because in the tidal zone, due to wetter and drier the penetration of chloride into the concrete is intensified and as a result, the intensity of corrosion increases.[2 ,1]

2- Methodology

In this research, Portland cement type 2, Tehran cement factory with a grade of 400 kg/m^3 has been used. The aggregate used in making the samples is made according to ASTM-C33 standard .[3] The aggregate used in the construction of these samples is shown in accordance with the granulation of Table 5 and Figures 3 to 5, which complies with the ASTM regulations for the aggregation of consumables in concrete. The prepared sand is river-type with a specific weight of 2560 kg/m^3 and the crushed sand is prepared with a specific weight of 2650 kg/m^3. Consumable aggregate prepared from Omid crusher sand mines has been prepared near Shushtar city at a distance of about 195 km from Mahshahr city. Since the use of microsilica in concrete increases water consumption, a superplasticizer was used to create high fluidity in the concrete

*Corresponding author's email: Mhramesht@yahoo.com



	Control sample	7%	10%	13%
w/c=0.34,sp=0.5	463	580	615	616
w/c=0.34,sp=0.6	480	595	638	627
w/c=0.4,sp=0.3	424	503	577	586
w/c=0.40,sp=0.4	446	549	601	609

Fig. 1. Effect of microsilica on compressive strength of 28 days of concrete

mix and not to use more water, which will affect the porosity and strength issues. This reduction in water content will increase the strength and durability of the concrete4]]. In this research, MECRET TB 101F is used. This superplasticizer is delayed and its combined base is naphthalene and melamine and corrosion resistant, which is suitable for marine structures and corrosive environments.

3- Results and Discussion

To test the compressive strength of concrete, 15 × 15 × 15 cm^3 cubic specimens were prepared and the results of the compressive strength test are shown in Table 6 and Figure 9. As can be seen, for all three concrete samples containing 7, 10 and 13% microsilica, the compressive strength was 28 days higher than the control sample. The percentage of lubricant is 6%, which is about 32% higher than the control sample [58-]. Considering that the aim of this study is the optimal use of microsilica in reducing the corrosion of reinforcement in marine concrete structures, concrete samples were kept in the laboratory and in the conditions of the Persian Gulf environment for 18 months. Corrosion tests were performed on the samples every 4.5 months. Was performed, and laboratory results were compared. The corrosion intensity in terms of concrete age (corrosion duration) for samples containing 7, 10 and 13% microsilica (cement weight) and sample without microsilica (control sample). The corrosion intensity of samples containing microsilica in the range of 7 to 13% over a period of approximately 18 months is much lower than the corrosion intensity of sample without microsilica. Cements are placed; firstly, they fill very small glazed spaces, and secondly, because they are chemically active, they combine with calcium hydroxide [$Ca(OH)_2$] from the dewatering of cement and convert it into hydrated calcium silicate. This reduces the voids in the reduced cement glaze of calcium hydroxide to a more solid body similar to other cement paste silicates, the texture of the cement paste becomes more uniform and the properties of concrete are improved, causing corrosion resistance and a significant improvement in permeability. Concrete becomes aggressive in environments. Comparing Figures 12 and 13 and the corrosion intensity of laboratory samples according to the age of concrete for 34% w /c, 4% w/c and 3% of different microsilica, shows that the corrosion intensity in concrete samples with water to cement ratio of 34% (34 % w/c) is less than the water to cement ratio of 40% (w/c = 4%), and this is due to the reduced permeability of concrete in a fixed superplasticizer with a lower w /c ratio.

4- Conclusion

Considering that one of the main causes of premature failure in reinforced concrete structures is corrosion of rebars due to chloride penetration in concrete and the most important factor in increasing the rate of this degradation is concrete permeability, the use of pozzolanic materials such as microsilica has a positive effect on It has corrosion, increases electrical resistance and decreases concrete permeability. The aim of this study is the optimal use of microsilica in reducing reinforcement corrosion in marine concrete structures, which is as follows with a replacement ratio of 3% microsilica and the use of superplasticizer and reducing the ratio of water to cement.

A) The use of concrete containing microsilica in the range of 7 to 13% by weight of cement has a significant effect on reducing corrosion compared to concrete without microsilica. Therefore, the use of microsilica affects the onset and propagation time of progress in steel corrosion.

B) Due to the reduction of concrete permeability, the water to cement ratio of 34% for three different percentages of microsilica was more appropriate than the water to cement ratio of 40%.

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