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Effect of superplasticizer in anti-washout admixture on paste

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Abstract. Anti-washout admixture used for anti-washout underwater concrete is composed of flocculant (e.g., paste stabilizer), superplasticizer, setting retarder, strengthening agent, etc. Good compatibility among those constitutes is necessary to release the vast material potential of anti-washout admixture. In the study, effects of polycarboxylate superplasticizer on fresh cement paste mixed paste stabilizer of various ionic type were experimentally investigated. Based on the experimental results, the optimizations on the ionic type and molecular weight of paste stabilizer, regarding the compatibility with polycarboxylate superplasticizer, were hence obtained. Additionally, suitable content ranges of polycarboxylate superplasticizer, molecular weight and content of paste stabilizer have been determined through systematic tests, such as saturation point test, fluidity test, and anti-washout test.

1. Introduction

With the gradually scarce underground natural resources, aquatic environment resources such as river and ocean resources are being founded ceaselessly. Nowadays, humans are even more in-depth exploiting river and ocean resources, which also promotes the development of hydraulic engineering and marine engineering technologies. Technologies of anti-washout underwater concrete turn it into reality to pour concrete underwater, which avoids cofferdam, foundation seepage control, foundation pit drainage and other related engineering measures and consequently saves a large amount of manpower and material resources [1, 2], These technologies are frequently applied to marine environment structures than to river structures [3]. Due to the limited strength of anti-washout underwater concrete affected by washout loss and water infiltration, steel bar corrosion embedded in the concrete may occur during casting and setting period [4, 5], so how to make sure that the residual stresses meet the engineering requirements is critical technology to the concrete [6, 7].

2. Materials and methods

2.1 Materials and mix design

The cement type is chosen as P·Ⅱ52.5 grade Portland cement; polycarboxylate superplasticizer, solid-containing content is 25%, and water reducing rate is 30 % when the content is 1.0% of cement by weight; the setting retarder is sodium tripolyphosphate (Na5P3O10), regent; stabilizers include anionic stabilizers named SSA40, SSA60, SSA 80 consequently, which average molecular weight are 4, 6, and 8 million; Cationic stabilizers named SSC40, SSC60, which average molecular are 10 million, and nonionic stabilizer named SSN100, which average molecular weight is 10 million.

2.2 Methods

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Fluidity and fluidity loss test, determination of anti-washout of paste and shear stress and viscosity test were carried out according to reference [8].

3. Results and discussion

3.1 Saturation Point Test

Prepare cement paste with the W/B ratio of 0.45 and the setting retarder of 4.0 wt.‰. Different mass combinations of superplasticizer are mixed into mixing water before poured into mixer. The fluidity as show in figure 1., the superplasticizer reaches to saturation point when the content achieves 0.4%. As shown in figure 2., the saturation points of superplasticizer is between 1.0% and 1.5% for different contents of paste stabilizer SSN100, which suggests that the paste stabilizer content does not have obvious influence on the saturation point.

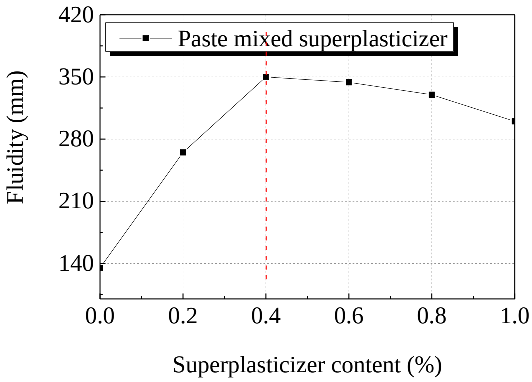

Figure 1. Initial fluidity of control paste mixed different content of superplasticizer

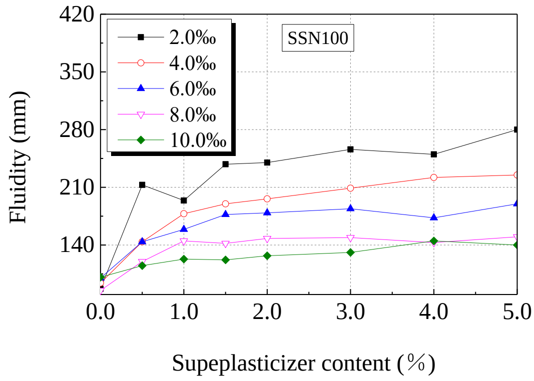

Figure 2. Initial fluidity of paste mixed paste stabilizer SSN100

The change regulations of fluidity are similar to that of different ionic type of paste stabilizer (see figure 3, 4). The increase of molecular weight has little effect on saturation point of superplasticizer. This indicates that the saturation point is within the value of 1.0% and 1.5%, although different molecular weight, lager molecular weights lead to lager tackifying effect.

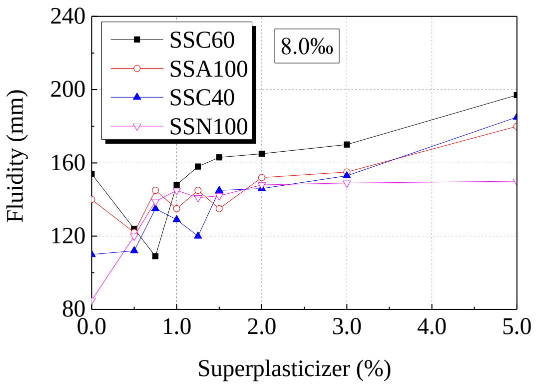

Figure 3. Saturation point of superplasticizer in paste mixed different ionic type of paste stabilizer with ten million molecular weight

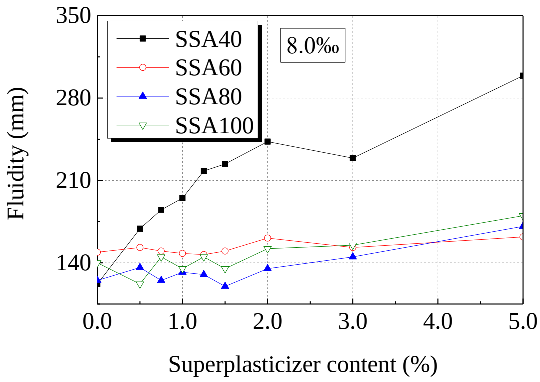

Figure 4. Saturation point of superplasticizer in paste mixed different molecular weight of paste stabilizer SSA

3.2 Fluidity Loss Test

Figure (5). expresses the fluidity loss of paste mixed 0.0‰~10.0% of paste stabilizer SSN100. The higher content of paste stabilizer SSN100, the smoother development of fluidity, and consequently the lower of fluidity loss.

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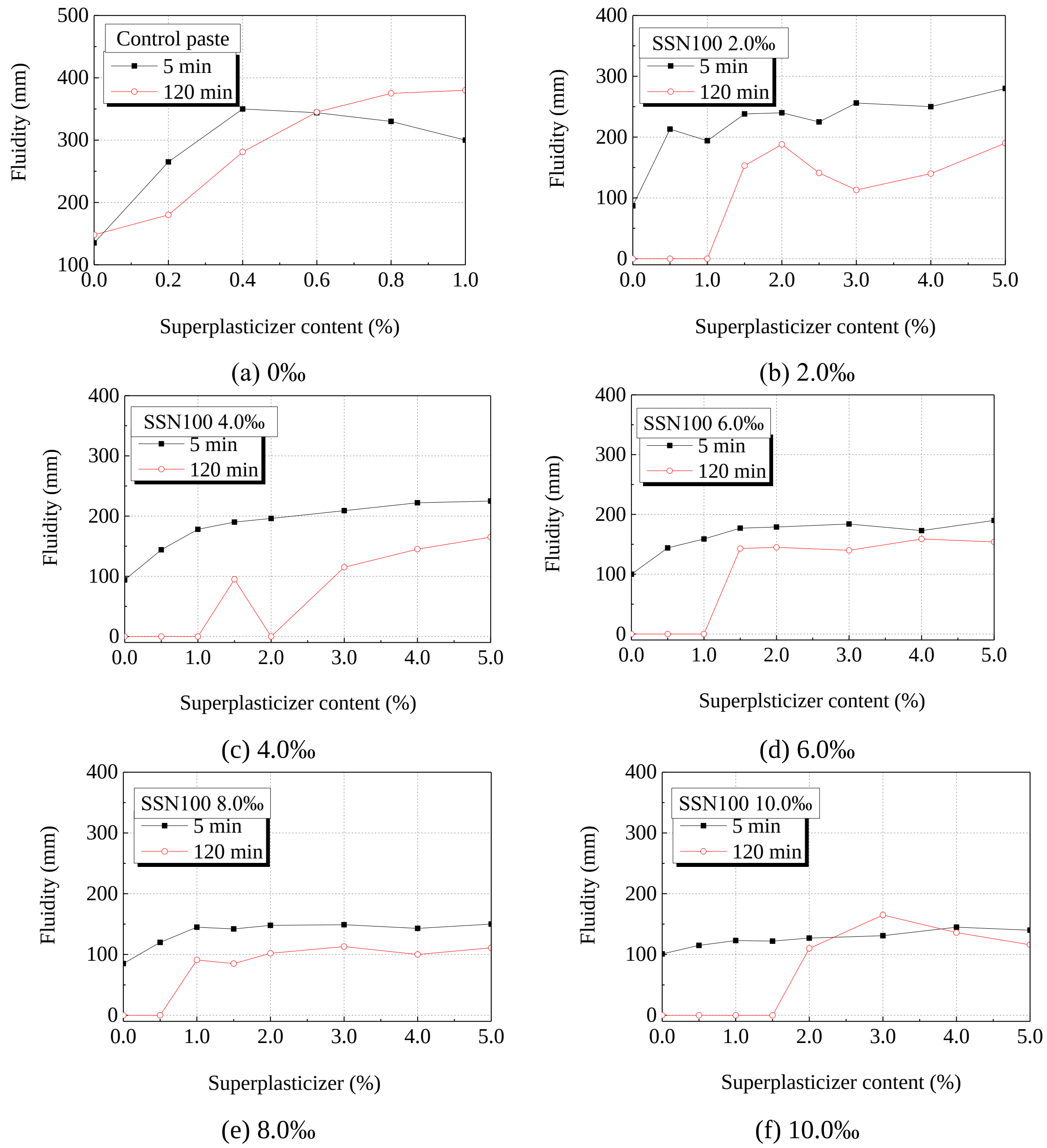

(a) 0‰ (b) 2.0‰

(c) 4.0‰ (d) 6.0‰

(e) 8.0‰ (f) 10.0‰

Figure 5. Fluidity of paste mix different content of paste stabilizer SSN100

3.3 Anti-Washout Test of Paste

Figure 6. is the water pH value that immerses the paste mixed 0.0%～5.0% content of superplasticizer and keeps the content of paste stabilizer SSN100 constant. Comparing to figure (6), the water pH value increases with the rise of superplasticizer content when it is lower than the saturation point (i.e., 1.0%～1.5%). The water pH value does not increase obviously when the content of superplasticizer exceeds the saturation point. To the same content of superplasticizer, the higher content of SSN100, the lower pH value of water. To sum up, SSN100 has good anti-washout property. Changing rules of water pH value are like that of fluidity.

As shown in figure 7, the turbidity does not increase obviously when the content of superplasticizer is less than 3.0%, but does increase obviously when the content of superplasticizer exceeds 3.0%. As shown in figure 8, in the same manner, the turbidity increases with the rise of superplasticizer content varying between 1.0% and 5.0%.

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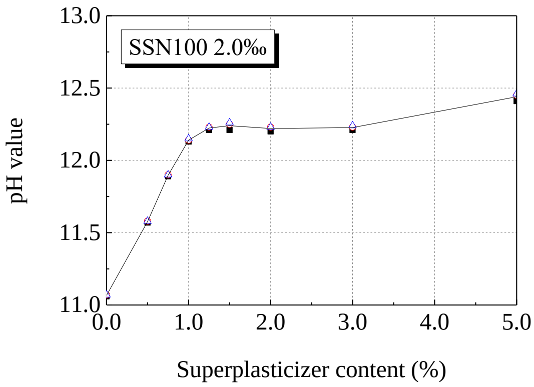
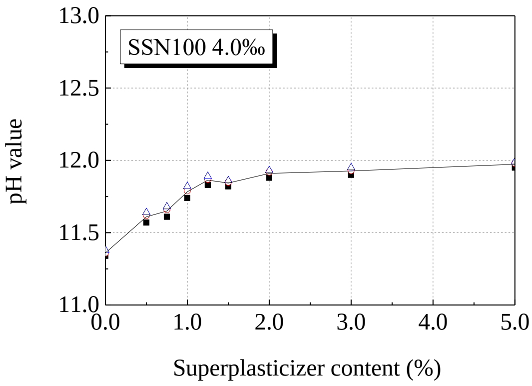
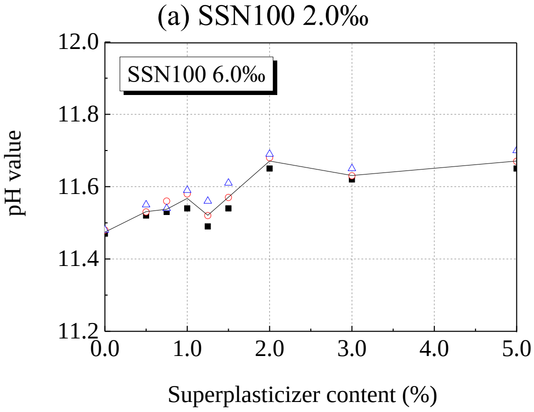


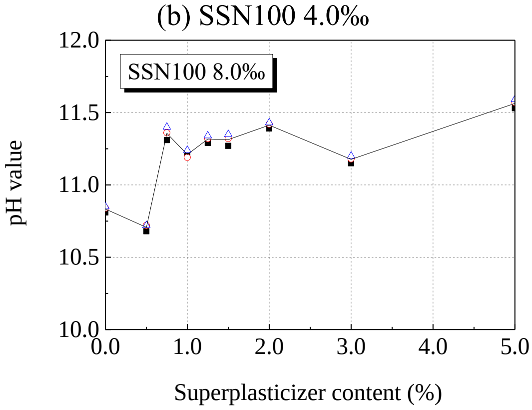
(a) SSN100 2.0‰



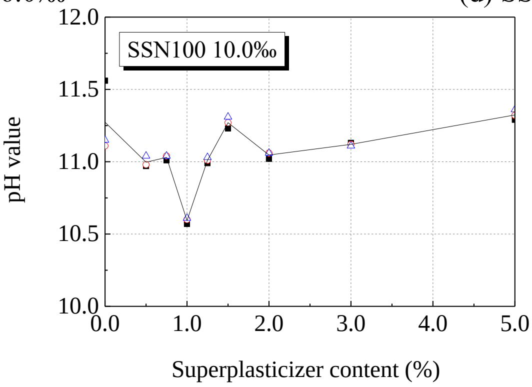
(b) SSN100 4.0‰



(c) SSN100 6.0‰

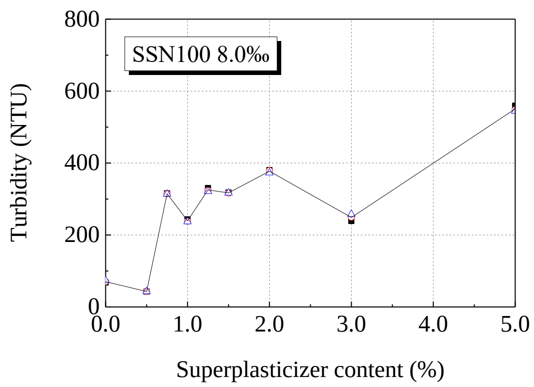


(d) SSN100 8.0‰



(e) SSN100 10.0‰

Figure 6. pH value of water immersed paste mixed different content of superplasticizer



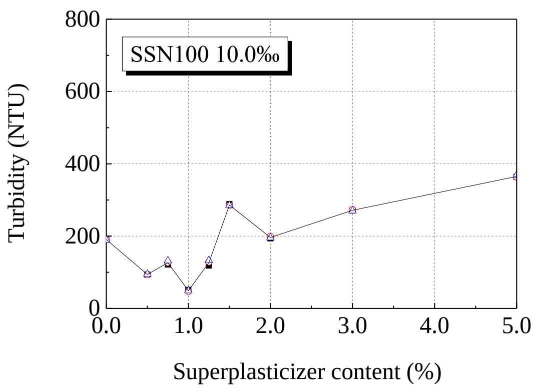


Figure 7. Turbidity of water after immersed paste mixed 8.0‰ of paste stabilizer SSN100

Figure 8. Turbidity of water after immersed paste mixed 10.0‰ of paste stabilizer SSN100

Figure (9). is the suspension particle content of water after immersed paste mixed different content of superplasticizer. The suspension particle content linear increase with the rise of superplasticizer content when less than 6.0‰, which means that the paste stabilizer has not played the act of anti-washout effect within the content, and that suspension particle content does not increase obviously at 8.0‰ and 10.0‰.

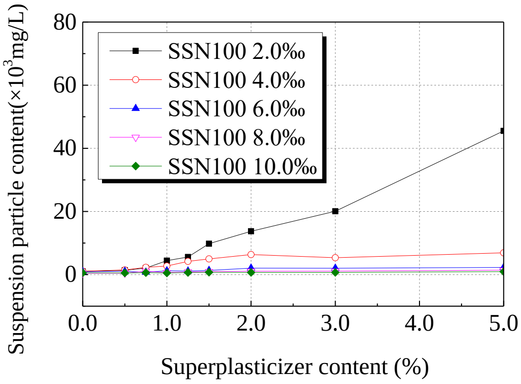


Figure (9). Suspension particle content of water after immersed paste mixed superplasticizer

Conclusion

Regarding the paste mixed anionic, cationic, and nonionic paste stabilizer, the saturation point of polycarboxylate superplasticizer is between 1.0% and 1.5%. The ionic type has little effect on polycarboxylate superplasticizer.

To the paste mixed different molecular weight and content of anionic, cationic of paste stabilizer, the fluidity of paste completely loses within 30 min. But to the paste mixed nonionic paste stabilizer, the paste of the same kind shows good fluidity within the test content scope of superplasticizer. This indicates bad compatibility between anionic, cationic stabilizer with polycarboxylate superplasticizer, but good compatibility between nonionic stabilizer with polycarboxylate superplasticizer.

For the content of polycarboxylate superplasticizer lower than saturation point, anti-washout properties of paste mixed nonionic paste stabilizer decrease with the rise of superplasticizer. To the content of polycarboxylate superplasticizer over the saturation point, anti-washout properties no longer decrease obviously, but the shear stress and viscosity decrease slightly with the rising content of polycarboxylate superplasticizer.

Acknowledgement

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Reference

[1] C.S. Jiang, L.N. Lu, S.B. Guan 2004 Journal of Wuhan University, vol 19 p 66
[2] G. X. Chen, Z. Q. Du, R Yang 2012 Concrete p 117.
[3] H. Y. Moon, K. J Shin 2007 Construction and Building Materials vol 21 p 98
[4] J. J. Assaad, C. A. Issa 2013 Material and structure vol. 46 p 1613
[5] H. Y. Moon, K. J. Shin 2006 Cement and Concrete Research vol 36 p 521
[6] Hughes BP 1961 Civil Eng Public Rev vol 56 p 633
[7] Sonebi M, Khayat KH 1999 ACI Mater J vol 96 p 519
[8] Juan Liu 2015 Hunan University p 16