A new Polyether mixture air-entraining agent

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Abstract. Air-entraining agents have been regarded as essential for the workability of concrete since the 1930s, the uniform, stable tiny bubbles in concrete can improve the workability of concrete, reduce segregation and bleeding in fresh concrete, improve freeze-thaw durability and increase pump-ability of fresh concrete. In this work, we synthesize a new polyether air-entraining agent AE-x. By contrast with a variety of air-entraining agents, AE-x has a relatively good air entraining properties, AE-x also has good compatibility with Polycarboxylate Superplasticizers and other concrete admixtures, The hardened concrete with the addition of the AE-x exhibits a satisfactory pore size distribution system which is of higher porosity with small-size and lower porosity with large-size than other air-entraining agents.

1 Introduction

A large number of chemical substances can be used as air-entraining agents of concrete. Many of these are refined by-products from various industrial processes, [1-2]The most commonly used chemicals are abietic soap or sodium abietate, Vinsol resin, salts of fatty acids, salts of sulphonated hydrocarbon, K12, alkyl-benzyl sulphonates, triterpenoid saponin, etc. Both these air-entraining agents have many shortcomings, such as bad water-solubility, big dosage for abietic soap and Vinsol resin, bad air-bubble systems, high air content loss, high strength loss per air content for alkyl-benzyl sulphonates or other sulphonates;[3-4] These obvious shortcomings, especially high strength loss, badly influence the application of air-entraining agent, because the compressive strength is an important parameter in many Chinese standards. Therefore, it is necessary to synthesize an effective air-entraining admixture (AEA), either can introduce appropriate uniform, stable tiny bubbles ,or with low strength loss .

In this work, we synthesize a new polyether air-entraining agent surfactant combining Polyoxyethylene coconut amide with sodium alcohol ether sulphate, we call it AE-x for short .By contrast with a variety of air-entraining agents, AE-x has a relatively good air entraining properties and good compatibility with Polycarboxylate Superplasticizers and other concrete admixtures, The hardened concrete with the addition of the AE-x exhibits a satisfactory pore size distribution system which is of higher porosity with small-size and lower porosity with large-size than other air-entraining agents.

2 Experimental sections

2.1 Raw materials

The cement used is P.O 42.5 with specific area of 340 m^2/kg from Huaxin cement factory in china. river quartz sand with the fineness modulus of 2.57 and crushed aggregate with the size of 5±25 mm were used.

Air-entraining agents in our experiment including triterpenoid saponin from Xinyuan Chemical Co.,Ltd. Jinan、K12 and Ts-5 from Japan. The polycarboxylate superplasticizers ZJ-SS-15 is from our lab. Sodium Alcohol Ether Sulphate and Polyoxyethylene coconut amide are purchased from

Sinopharm Chemical Reagent Co., Ltd.

2.2 Characterization and evaluation of samples

Air entraining performance are determined by the height of foaming and defoaming time according to Chinese standard JGJ 56-84.

The air content of fresh concrete are determined by LC-615A (Sanyo,Japan) according to the Chinese ConstructionMaterials Standard JC/T601-1995.

The porosity and the pore size distribution of the sample are measured with ASAP2010M instrument (Micrometrics, USA).The porosity and the macropore size distribution are analyzed by Superimage software (provided by Shanghai Zhongchen Digital Technical Company,China)

The tests of the fluidity and the compressive strength of the concrete are conducted according to the Chinese National Standard GB/T 2419-1994 and GB/T 17671-1999

3 Results and discussion

3.1 Relationship between foam height of the four AEAs and its concentration in the aqueous solution

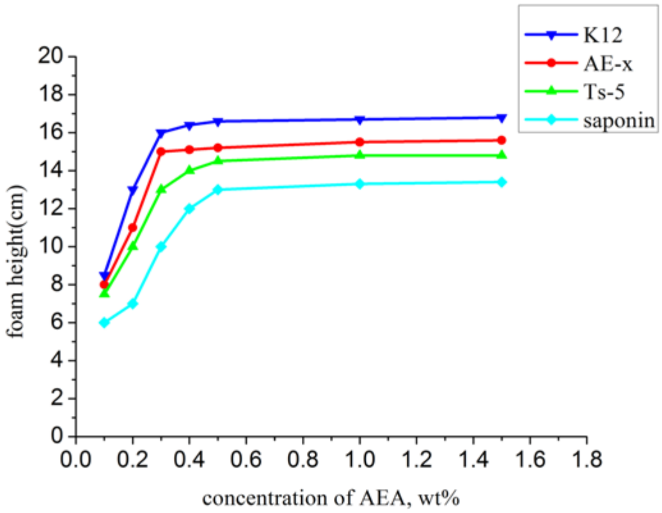

Fig. 1 Relationship between foam height of the AEA and its concentration

Table 1. foam stability

AEA	K12	AE-x	Ts-5	saponin
Foam stability(V10/V0)	0.62	0.91	0.89	0.76

The generated air-bubble volume or the foam capacity and the foam stability of a water solution of four AEAs are measured according to Chinese standard JGJ 56-84.The Relationship between foam height of the AEA and its concentration is shown in Fig.1. The stability is defined as the foam volume after 10 min divided by the initial volume when the AEA dosage is 0.02 wt%. The result is shown in Table 1. K12 has a good air-entraining ability but the worst bubble stability, triterpenoid saponin has a bad air-entraining ability leading by its' bad water-solubility.

3.2 Air content

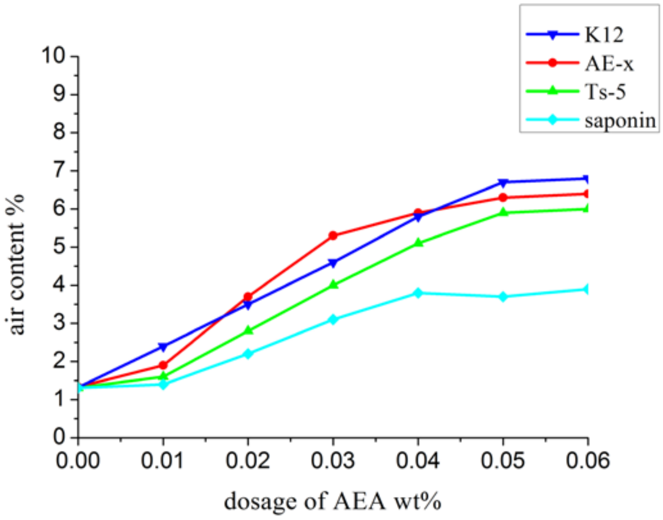

Fig. 2 Varies of air content with the dosage of AEA.

The result of variation of air content with the change of the AEA dosage is shown in Fig.2. It is indicated that the air content of fresh concrete increases with the amount of AEA in a linear fashion before 0.05 wt%.

3.3 Compressive strength

Table 2: compressive strength loss of four AEAs(0.03 wt%)

AEA	K12	AE-x	Ts-5	saponin
3d (MPa)	10	17	14	13
7d(MPa)	18	29	26	24
28d(MPa)	26	35	32	32

Generally, the compressive strength loss per air content (CLPA) is about 4±6%.[5] Results on effects of air content on the CLPA are displayed in Table 2. It indicates that at the same cement content and W/C, The effect of AE-x on CLPA is almost the same as that of Ts-5, but CLPA caused by K12 is obviously higher, which may be because the air-bubble system of K12 is worse than that for AE-x. Results in Table 2 prove appropriate air content does not affect the compressive strength. The compressive strength of concrete with AE-x is not reduced, but have some increase when the air content is below about 3.5%.

the compressive strength loss is determined not only by the porosity of the concrete but also by the pore size distributions.[6] In the case of the macropores size distributions, the porosity with the radius less than 0.025 mm amounts to about 68% with the addition of the AE-x, about 45% with the addition of the Ts-5, about 36% with the addition of the saponin and about 15% with the addition of K12. Also, bubbles with the radius less than 100 nm found in the concrete with the AE-x are about 74%, 54% are found in the concrete with the Ts-5, 33% are found in the concrete with the saponin and 21% are found in the concrete with the K12 respectively, all the AEAs dosage is 0.02 wt%. The hardened concrete with the addition of the AE-x exhibits a satisfactory pore size distribution system which is of higher porosity with small-size and lower porosity with large-size.

4 Conclusions

We synthesize a new polyether air-entraining agent called AE-x. By contrast with a variety of air-entraining agents, AE-x has a relatively good air entraining properties and good compatibility with Polycarboxylate Superplasticizers and other concrete admixtures, The hardened concrete with the addition of the AE-x exhibits a satisfactory pore size distribution system which is of higher porosity with small-size and lower porosity with large-size than other air-entraining agents.

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