Effect of addition time of heat stimulated admixture on fresh and hardened properties of mortar

Tokai University Student Member ○Zabihollah Tahery
Tokai University Regular Member Shigeyuki Date

1. INTRODUCTION

Presently, a new generation of superplasticizers (SPs) based on polycarboxylate polymers with long, comb-type side chains is demanded to permit for even more reduction of water content, up to 40% [1]. Elements such as the type and dosage of the SPs, the nature and amount of cement and aggregates, the temperature and mixing procedure, as well as the addition time of the admixtures cause different fluidizing effects for the resulting cementitious materials [2, 3].

In this research two types of superplasticizers used, type one is a polycarboxylic acid-based ether (here in after "SP1 "), and type two is a high-performance water reducing agent, type of air entraining (AE) polycarboxylic acid-based ether (here in after "SP2"). This research aimed to study the impacts of delayed addition of heat stimulated SPs on fluidity, fresh density, air content and compressive strength of cement mortar. The results demonstrates, as the addition time of SP increased the air content and fluidity of mortar increased sharply at the beginning, but the fresh density decreased. The compressive strength of mortar contained SP2, shown almost a decrease with increasing the delayed addition time in non-heated and heated conditions of SP2, but mortar contain heat stimulated SP1 shown a remarkable increase in compressive strength in 5 minutes delayed addition.

2. OUTLINE

This study is intended to carry out investigation on the effects of delayed addition of heat stimulated admixtures on fresh and hardened properties of cement mortar. The water, heat stimulated or non-heated SPs added to the premix of sand and cement in three different conditions. The air content, fresh density, fluidity and compressive strength of mortar was studied.

2.1 Materials used, mix proportions and addition conditions of SP

The materials used for this study are shown in Table 1. The water-cement ratio of mortar was 30%, and sand-cement ratio 2.0. The SP addition conditions are shown in Table 2. The dosage of SP are arranged to obtaining the targeted flow (approximately 120mm flow at 0 tamp and 200mm at 15 tamp).The admixtures were heated in 60℃temperature for 30 minute (Tolerance of temperatures was controlled as ± 1℃).

Table 1. Material used

Materials		Propeties
Cement	N	Ordinary portland cement, density:3.16g/cm^3, specific surface area 3340 c m^2/ g
Fine aggregate	S	Crushed sand from Kanagawa density*:2.63g/cm^3
Admixture	SP1	Superplasticizer (Polycarboxylic acid-based ether)
	SP2	High-performance waterreducing agent(type of AE):(Polycarboxylic acid-based ether)
* : in saturated surface-dry condition		

2.2 Mortar mixing method

The Whole procedure was performed in accordance with JIS R 5201"Physical testing methods for cement" Heated admixture were mixed with premix of sand-cement and mixing water, after taking out from a thermostatic chamber. The same procedure was applied in non-heated admixture. The ambient temperature of mixing was 20± 3 ℃.

Table 2. Admixture addition conditions

Mixing condition	Admixture addition method	Admixture delayed addition time(min)
Case 1	Mixed with water	0
Case 2	Added separately	5
Case 3	Added separately	10

3. RESLUTS

3.1 Impact of delayed addition of SP on the fluidity

Influence of delayed addition of SPs on fluidity of mortar are shown in Fig.4 and Fig.5. The results revealed as the addition time of the SP increases to the 5 minutes, the fluidity of mortar tends to increase sharply at the beginning with both heated and non-heated SPs. When the addition time of SP increased to 10 minutes the graph of fluidity increases with a mild slop. Heated SP shows more fluidity than non-heated SP in immediate addition and 5 minutes delayed addition. By other researchers, it was stated [4], that a slightly delayed addition would produce a more workable concrete or cement paste than an immediate addition.

3.2 Impact of delayed addition of SP on density and air content

Effect of delayed addition of SP on density and air content of mortar are shown in Fig.1 and Fig.2 respectively.

Keywords: heat stimulation, superplasticizer, fluidity, high range water reducer, fresh properties, hardened properties.
Contact address: Tokai Univ. 4-1-1 Kitakaname, Kanagawa Japan. TEL.0463-58-1211 FAX.0463-50-204

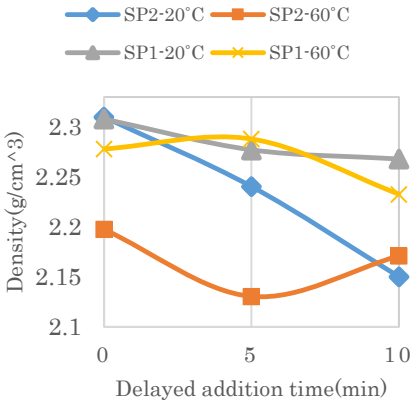

Fig. 1. Density of fresh mortar

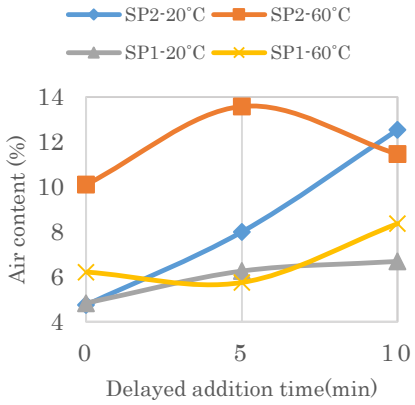

Fig. 2. Air content of mortar

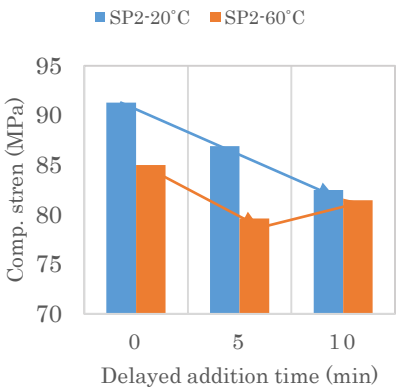

Fig. 3. 28 days Compressive strength

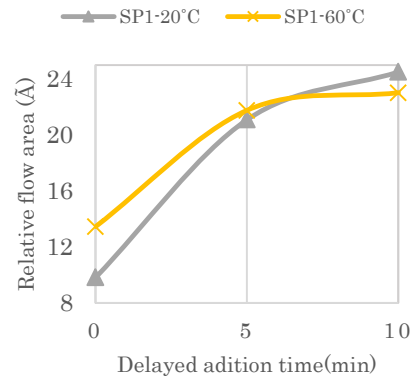

Fig. 4. Fluidity of mortar (SP1)

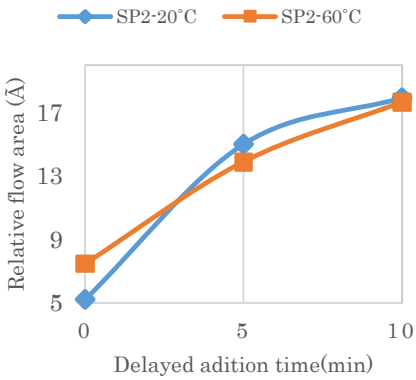

Fig. 5. Fluidity of mortar (SP1)

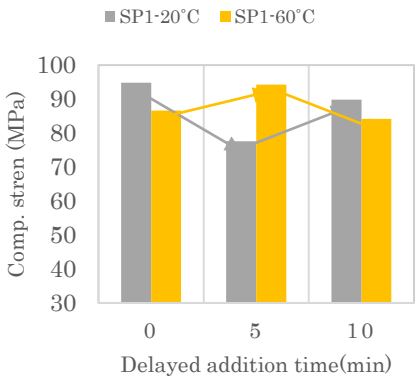

Fig. 6. 28 days Compressive strength

The fresh density of mortar was decreased by increasing the delayed addition time of the SP in both heated and non-heated conditions, but conversely air content increased. The SP2 which is an air entraining type SP, shown more decrease in density and increase in air content than SP1 especially in heated condition. SP2 exposed a slight increase in density with 5 minutes delayed addition to the mix.

3.3 Influence of delayed addition of SP on compressive strength of mortar

The compressive strength of mortar under delayed and immediate addition of SPs are shown in fig.3 and fig.6. The compressive strength of mortar is a direct function of fresh density, and have inverse relationship with air content of mortar in both heated and non-heated conditions of SP1 and SP2. This phenomenon is visible in comparison of fig.3 and fig.6 with fig.1. SP2 which is air entraining type (AE), shown more decrease in density by increasing the delayed addition time of SP and consequently a decrease in compressive strength especially in heated condition. The SP1 shown remarkable compressive strength in 5 minutes delayed addition when the SP was heated.

4. CONCLUSIONS

By 5 minutes addition time of the SP, the fluidity of mortar increase sharply, with both heated and non-heated SPs, by increasing time to 10 minutes the graph of fluidity increases mildly. Heated SP shows more fluidity than non-heated SP in immediate addition and 5 minutes delayed addition. The fresh density of mortar was decreased by increasing the delayed addition time of the SP in both heated and non-heated conditions, but air content increased. SP2 of type (AE), shown more decrease in compressive strength by increasing the delayed addition time of SP, especially in heated condition. The SP1 shown remarkable compressive strength in 5 minutes delayed addition when the SP was heated.

REFERENCES

1) Rixom MR, Mailvaganam NP: Chemical admixtures for concrete, 2nd ed, E & F. N. Spon, pp. 1±33, 1986.
2) Ramachandran VS, Feldman RF, Beaudoin JJ: Concrete science. London, pp. 151±3, 1981.
3) Chiocchio G, Paolini AE: Optimum time for addition superplasticizers to portland cement pastes, Cement and Concrete Research, 15(5), pp.901±8, 1985.
4) Collepardi M: Superplasticizers and air entraining agents state of the art and future needs, American Concrete Institute, ACI SP 144-20, , pp. 399±416,1994.