V-73 EFFECT OF EXPANSIVE AGENT ON MIXTURES INCORPORATING HIGH VOLUME OF SLAG AND FLY ASH

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1.Object of this study

A large addition of mineral materials of slag and fly ash may give concrete a high flowability and deformability as well as a low hydration heat generation, but also induce a much longer time period for the process of setting and a relatively low strength at early age. Here in this research, the effect of expansive agent on such mixtures in reducing the initial volume change during the process of setting and in extracting the compressive strength at early ages were investigated.

2.Outline of Experiment

To investigate the effect of expansion agent on concrete with high content of mineral mixture, three sets of tests were done.

- Test1 Effect of expansion agent on bleeding and initial volume change of mortars in fresh state. "Method for Testing the Ratio Bleeding and Expansion of Pre-pacted Concrete's Mortar"(JSCE-1986)was adopted.
- Test2 Development of expansion strain of mortar at early age. Conduct sensors were used to measure the lowering of the top surface of specimen during the mixture processing setting and the expansion strain of specimen after remolding.
- Test3 Effect on increasing compressive strength of concrete in early age

Materials used: Portland cement(Specific gravity 3.15), fly ash (Specific gravity 2.19), and Slag (Specific gravity 2.91, specific surface area in blaine value 6000) mixed at the proportion of 25:45:30 by volume. Sand(Specific gravity 2.62), gravel(specific gravity 2.65, maximum size 15mm); Expansive agent(specific gravity 2.95, CSA type); viscosity agent, superplasticizer. The mix proportions of mortar and concrete are shown in table 1 and 2 respectively.

Table 1. Mix Proportion of Mortar

No.	S/(P+CSA)	W/(P+CSA) (%)	CSA/(P+CSA) (%)	Visc./(P+CSA) (%)
1	1.70	36	0.0	0.00
2	1.69	36	6.3	0.00
3	1.70	36	0.0	0.04
4	1.69	36	6.3	0.04

% of powder by weight

Table 2. Mix Proportion of Concrete

Mix No.	V_w/V_b	Binder(kg/m^3)				Aggr.(kg/m^3)		CSA#20	Air	Curing cond.
		W	C	Sg	Fa	S	G	kg/m_3	(%)	
1	.95	170	113	182	176	804	852	0	2.3	free expansion
2			111	156	176			30		
3	.90	168	177	136	184	783		0	2.5	restrain
4			172	132	179			15		
5			161	124	168			50		

Superplasticizer: 0.7% of powder by weight

3.Effect on reducing bleeding and initial volume change

Fig.1 and Fig.2 shows the effect of expansive agent on the bleeding and the initial volume change of mortars either with or without the present of viscosity agent. The bleeding ratio is defined as the volume ratio of bleeding water to the water initially contained. It is thought that the larger the addition of expansive agent the greater the reduction of bleeding ratio. Here the result of Test 1 illustrated that the bleeding ratio of the mortar with expansive agent added at the dosage of 6.3% was reduced to about one-third, and even up to about one-seventh with the addition of viscosity agent, of that of mortar without both of them. Correspondingly, the initial volume change within the first several hours after casting also had a great reduction as shown in Fig.2. Since in its chemical reaction, expansive agent combines water, turning out a product with an expanded volume two times of the original one, thus reduces the free water content and compensates shrinkage due to bleeding and hardening. On the other hand, the test of the time for mixture passing through P-furnral showed that the addition of expansive agent gave little influence on the flowability of fresh mixed mortars, while the addition of viscosity agent really did.

4. Expansion strain and compressive strength at early ages

The expansion strain was measured with the specimen remolded at 2days after casted. The result in Fig.4 shows the growth of expansion strain. It seems that the present of viscosity agent is benefit

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for the development of expansion strain, even cured in air with the humidity at 45-50%, a notable growth of expansion strain could be obtained. it is supposed that the further reduction of bleeding due to the present of viscosity agent provides more water available for the reaction of expansive agent, and it is doubtful that weather the addition of viscosity agent may result a micro-structure batter in preventing drying. Fig.4a and Fig.4b give the test results of compressive strength gained at the specified age under restrained and unrestrained condition respectively. Both of them show an increase in compressive strength at the content over 30 kg/m^3. In the case of unrestrained, the specimen were remolded at the 2 days after being placed, and then kept in water until the age for test. The addition of $30kg/m_3$ expansive agent gave a nearly 20% increment in compressive strength comparing to that of expansive agent free.

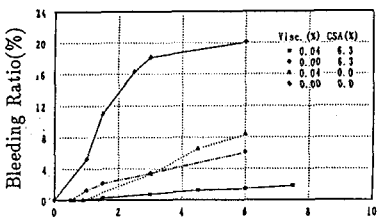

Fig.1 Bleeding of Mortar

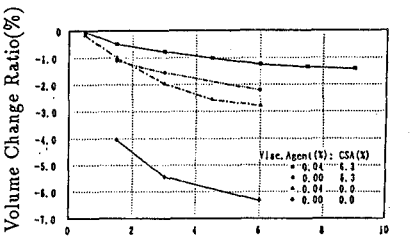

Fig.2 Initial Volume Change of Mortar

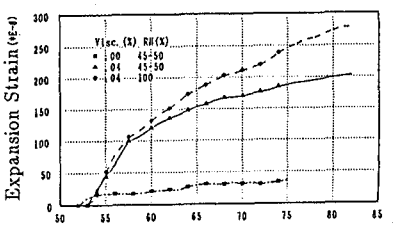

Fig.3 Effect of Viscosity agent and Curing Condition

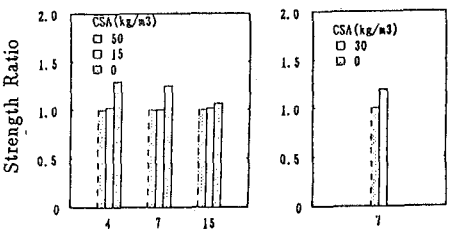

Fig.4a Fig.4b Improvement of Compressive Strength

5. Conclusion

For mixtures incorporating high volume of mineral materials of slag and fly ash, effect of expansive admixture on the characteristics of mixture's bleeding, initial volume change, growth of expansion strain and early age compressive strength were tested. The results are as following:

1. The addition of expansive admixture is benefit for reducing bleeding and initial volume change without injuring the flowability of mixture as viscosity agent may do.
2. The expansive admixture extracts compressive strength of such mixture at early age.
3. The present of viscosity agent improves the effect of expansive admixture especially in the development of expansion strain of mixture curing in air.

Acknowledgement

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Reference

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