INFLUENCE OF ASR SUPPRESSIVE LITHIUM ADMIXTURES ON CEMENT PASTE SETTING AND HARDENING

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ABSTRACT

The influence of addition of the lithium admixtures - Li_2CO_3, $LiOH{\cdot}H_2O$ and $LiNO_3$, on the setting and hardening of the cement pastes and on the heat evolution in pastes are presented.

Key words: Lithium salts, Setting, Hardening, Hydration heat

1 INTRODUCTION

Before 1940, aggregates were generally assumed to be essentially inert and chemically unreactive component of concrete. Stanton [1] was one of the earliest recherchers who identified the deleterious effects which could result from a chemical reaction between hydroxyl ions in the pore solution of the concrete and the poorly ordered forms of silica present in some aggregates. This reaction was referred as "alkali-aggregate reaction" (AAR). This reaction may result in serious damage to the concrete, owing to an abnormal expansion with the accompanying cracking and loss of strength [2]. The magnitude of the problem can be seen from informations published in the proceedings of eleven International Conferences on alkali-aggregate reaction.

Due to many problems with AAR in concrete structures there has been an increased activity to develop chemical and other admixtures to counteract the alkali-aggregate expansivity in concretes.

McCoy and Caldwell [3] were the first who investigated the effect of various chemicals on the expansion in mortars containing a high alkali cement and a reactive aggregates. It was concluded from extensive earlier work that some lithium salts are capable of reducing the expansion significantly. Some positive results were published also in CR [4]. Although substantial work has been carried out on the effect of the lithium chemicals on the expansion reactions, relatively less attention has been directed to their effect on other properties of cement and concrete. It is necessary to bear in mind that lithium treatments can cause side effects in the pattern of cement hydration that need to be evaluated for particular cement and for the form and dosage level of the lithium treatment contemplated. Partial results of some lithium salts influence on setting and hardening of cement paste are presented in the following text.

2 MATERIALS AND TEST METHODS

2.1 Materials

Commercially available portland cement CEM I 42.5R from the Cement Plant Radotín, Českomoravský cement a.s. Beroun was used in the test. In the cement paste Li_2CO_3, $LiOH{\cdot}H_2O$ and $LiNO_3$ were implemented in different proportions of 0.5; 1.0; 2.0; 3.0 and 5.0 % relate to cement weight. For the cement mix destilled water was used.

2.2 Test methods

The initial and final setting times of cement pastes were determined in accordance with ČSN EN 196-3 with the aid of the Vicat apparatus. Heat of hydration of pastes with lithium admixtures added was determined with a semiadiabatic calorimeter.

3 RESULTS AND DISCUSSION

Results of measurements of the initial and final setting times are presented in the Table 1 and Figures 1, 2, and 3. As can be seen Li_2CO_3 quite pronouncedly accelerates setting of cement mixtures. $LiOH{\cdot}H_2O$ has accelerating effect too but not so intensive as Li_2CO_3 has. In the case of $LiNO_3$ there is no expressive accelerating effect.

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Table 1: Influence of lithium salts on setting time (according to ČSN EN 196-3)

Quantity [%]	Lithium compounds					
	Li_2CO_3		$LiOH \cdot H_2O$		$LiNO_3$	
	Setting times					
	Initial [h, m]	Final [h, m]	Initial [h, m]	Final [h, m]	Initial [h, m]	Final [h, m]
0	2h 35m			3h 35m		
0.5	0h 15m	0h 35m	2h 25m	3h 15m	2h 15m	3h 15m
1.0	0h 10m	0h 20m	2h 00m	2h 45m	2h 15m	3h 10m
2.0	0h 8m	0h 15m	1h 35m	2h 15m	2h 10m	3h 05m
3.0	0h 6m	0h 11m	0h 50m	1h 05m	2h 10m	3h 00m
5.0	0h 7m	0h 18m	0h 15m	0h 25m	2h 25m	3h 15m

Note: h - hours, m - minutes

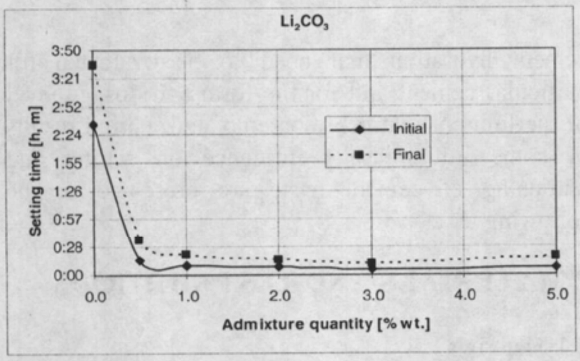


Fig. 1

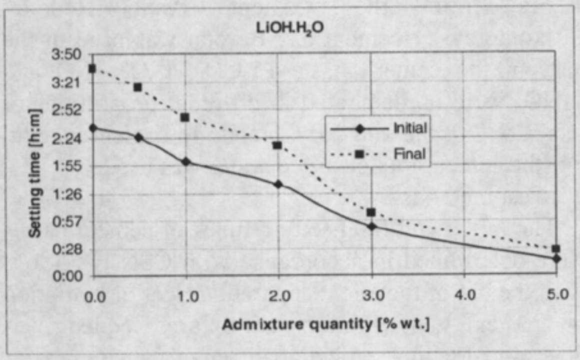


Fig. 2

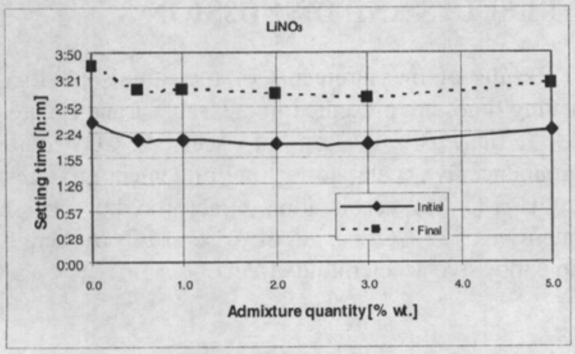
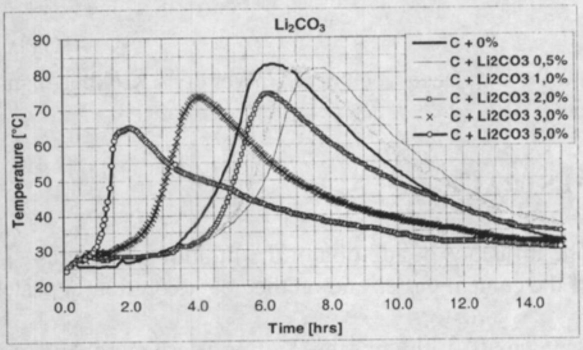


Fig. 3



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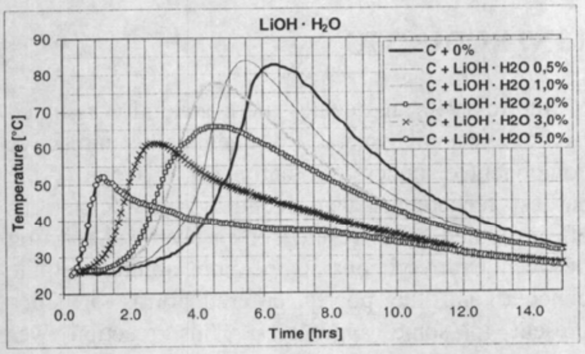

Fig. 5

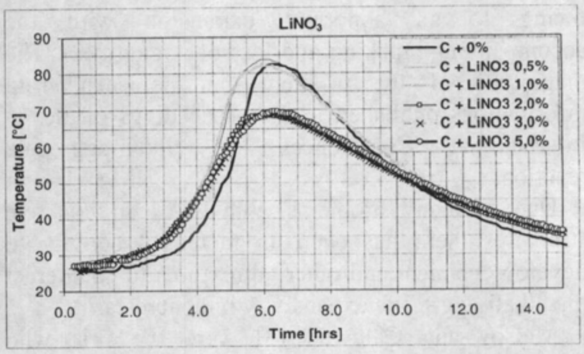

Fig. 6

Hydration of the cement is exothermic reaction which liberates a considerable amount of heat. The heat evolution depends on many factors inclusive chemical admixtures and data obtained, expressed as temperature changes of pastes are presented in Figures 4, 5 and 6. From the curves considerable differences between the action of different admixtures in different dosages can be seen. Li_2CO_3 and $LiOH{\cdot}H_2O$ generally accelerates hydration mainly at higher quantities added. However, the temperature in pastes is reduced with increasing salt dosages.

From the Fig. 6 can be seen quite different course of paste hydration with an addition of $LiNO_3$. Curves do not show pronounced accelerating effect of $LiNO_3$.

4 CONCLUDING REMARKS

From the results obtained follows that Li_2CO_3 and $LiOH \cdot H_2O$ accelerates hydration of the cement in proportions used. The influence of $LiNO_3$ on the hydration of portland cement used is quite different. $LiNO_3$ has only slight accelerating effect under the conditions used.

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