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STUDY OF RELATIONSHIP BETWEEN ALKALI-AGGREGATE REACTION AND ELECTRICAL RESISTIVITY

Chuichi Tashiro and Katsuo Yamada

Dept. of Material and Mineral Engineering, Faculty of Engineering, Yamaguchi University, Ube 755 Japan

1. INTRODUCTION

One of the major problems in studies on the alkali-aggregate reaction is sluggish reaction, even under accelerate condition. An accelerated test used to determine the alkali-aggregate or alkali-silica reaction were investigated by numerous researchers(1-4). Chatterji and Jensen (2) showed a simple chemical test for detection of alkali silica reactivity of aggregate.

This paper deals with the detection of alkali silica reactivity at early hydration stage. The measurements of electrical resistivity and expansion of mortar bar carried out. The electrical resistivity was closely related to the expansion of the mortar. It is suggested that the electrical resistivity of the mortar is utilized as a sensor for detection of the alkali-aggregate reaction.

2. EXPERIMENTAL PROCEDURE

The mortars were produced by mixing ordinary portland cement and quartz sand(Toyoura standard sand) or Pyrex glass sand at a ratio of 1:2 using water/cement=0.8.wt.%. Na_2SO_4 were added to the cement to cause the alkali-silica reaction. Table 1 shows chemical composition of the materials used.

Table 1. Chemical composition of materials.

	ig.loss	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	SO_3	R_2O_3	B_2O_3
Ordinary Portland cement	0.8	21.3	5.4	3.0	64.3	1.2	2.1	0.56	
Quartz sand		92.6	3.6	0.7	0.5	0.1			
Pyrex glass sand		80.7	3.6		0.7	0.6		4.14	10.5

The electrodes are made of 0.15 mm thick cut stainless steel plates, and adjusted by acrylic plates to hold 10 mm interelectrode distance. Fig.1 shows the electrodes. Then the electrodes were embedded in the placed cement mortar to measure the electrical resistivity. The measurement was performed in moist air curing at 23°C. For the electric resistance measurment, a LCR meter was used, with the frequency set at 1.02 kHz. The measuring intervals were as follows; every 10 min. for the 0-3 hours after cement mortar placing, every 15 min. for the 3-5 hours, and every 1 hour for the

5-12 hours.

The mortar bar with 20 X 20 X 220 mm was stored in moist air. At intervals, lengths of the bar was measured at 3, 7, 14 and 24 days, respectively.

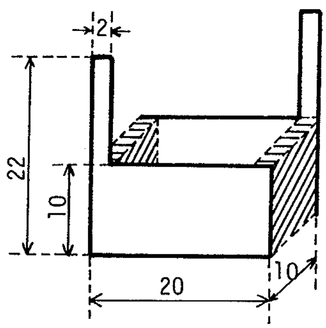

Fig.1 Schematic diagram of electrodes.

3. RESULTS AND DISCUSSION

3.1 Expansion

Fig.2 shows the expansion of the mortar bars. The expansion of the mortar made from the Pyrex glass sand and the alkali containing cement was remarkable. But the mortar made from the quartz sand and the alkali containing cement did not expanded. And also the mortar made from Pyrex glass sand and the normal cement too did not expanded. These observations indicated that the expansion of the alkali-silica reaction due to double factors of alkali composition in the cement and mineralogical characters of the sand.

3.2 Electrical resistivity

Fig.3 shows the electrical resistivity of the cement mortars. The electrical resistivity of the mortar made from the quartz sand and the cement increased moderately from 150 to 500 Ω cm during 7 days, and after that, degree of increases was small. And the resistivity of the mortar made from the pyrex glass sand and the cement increased moderately from 150 to 700 Ωcm during 7 days. The pattern with increases of the resistivity was similar to that, though the value was slightly larger. The electrical resistivity of the mortars made from the quartz sand and the alkali containing cement increased moderately from 50 to 200 Ωcm during 7 days, after that, degree of increases was smaller. On the other hand, the resistivity of the mortar made from the Pyrex glass sand and the alkali containing cement increased rapidly from 60 to 400 Ωcm during 7 days, and to 5000 Ωcm at 28 days.

3.3 Relation between expansion and electrical resistivity

The electrical resistivity is closely related to the expansion of the mortars bars. The relationship showed in Fig.4. The expanded mortar which was made from the Pyrex glass sand and the alkali containing cement showed two signals with electrical resistivity for alkali-silica reaction. Namely, after molding,the electrical resistivity showed about 60 Ω cm, in process of hardening, the electrical resistivity increased rapidly until about 5000 Ωcm. The increases of the electrical resistivity was directly proportional to expansion of the mortar. Na_2SO_4 added effected a drop of resistivity, and expansion as a result of alkali-silica reaction effected a rise of electrical resistivity.

The electrical resistivity of the cement mortar was sensitive to the character and property of the mortar. These movements of the electrical resistivity was easily observed from molding to 7 days. One of authors (5) showed that the electrical resistivity, ρ, of hardened cement paste

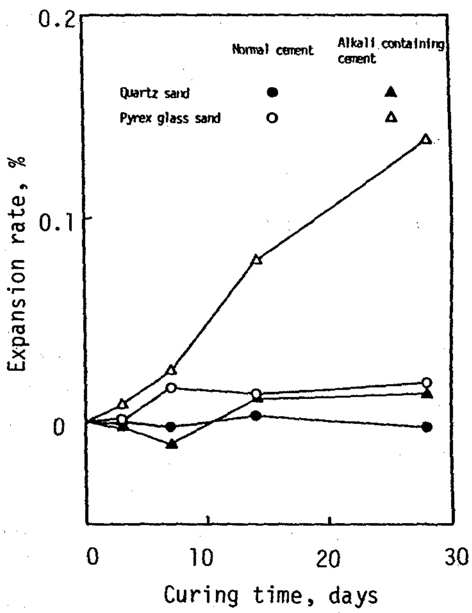

Fig.2. Expansion characteristics of mortars.

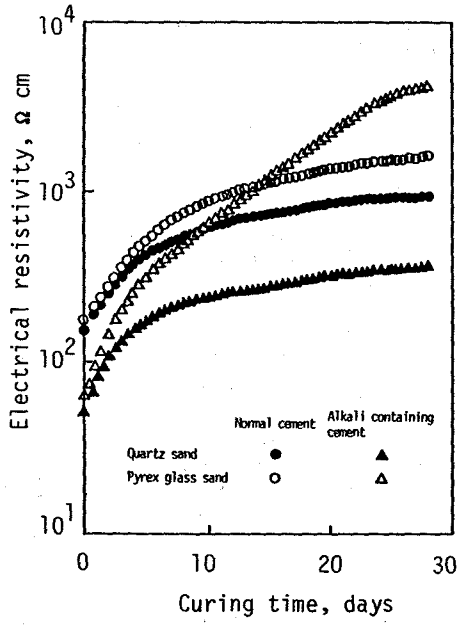

Fig.3. Variation of electrical resistivity of mortars.

was sensitive to the evaporable water content, w, and was expressed as

$$\rho = \rho_0 \exp\ (C/w)$$

where the constant C was an intrinsic quantity reflecting the microstructure of capillary pores in hadened cement paste. Therfore, C may be used for the alkali-aggregate reaction. It seems that the electrical resistivity is useful a sensor of the alkali-silica or alkali-aggregate reaction.

4. CONCLUSION

The electrical resistivity was closely related to the alkali-silica or alkali-aggregate reaction. The electrical resistivity of alkali containing cement mortar was about 60 Ωcm, and that of the normal cement was 150 Ω cm after molding. And the resistivity of the expanded mortar which was made from the Pyrex glass sand and the alkali containing cement increased rapidly with curing time, from 60 to 5000 Ωcm

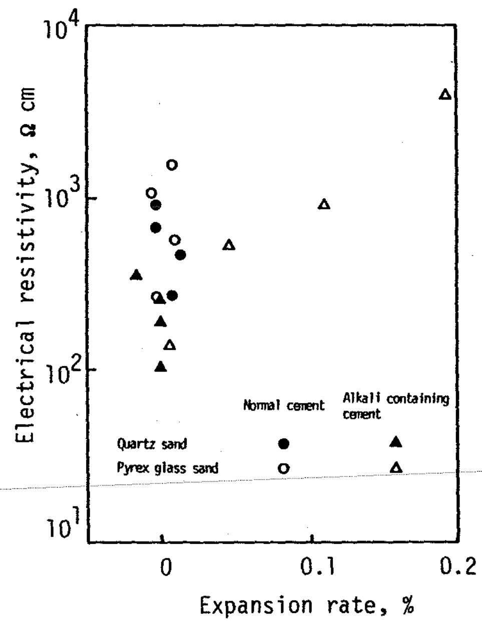

Fig.4. Comparison of expansion and electrical resistivity of mortars.

for 28 days. On the contrary, that of the normal cement mortar increased moderately. It was suggested that the electrical resistivity of the mortar is utlized as a sensor for detection of the alkali-aggregate reaction.

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