Transactions of the Korean Nuclear Society Spring Meeting
Jeju, Korea, May 17-18, 2012

Microstructure Analysis to the LILW Concrete Structures by Environment Factor

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1. Introduction

LILW Concrete structures located on the seashore are affected by chloride attack, sulfuric acid, and carbonation [1][2]. In addition, as the life of structure is extended, it requires a precise evaluation of its durability. Therefore, this study was aimed at the validity of such techniques used to evaluate a concrete structure where a analysis techniques were applied to the changes in the concrete microstructure following a chloride attack degradation environments, and thereby exploring such changes in microstructure.

2. Mixing and Materials

The testing plan was set up in order to perform an analysis of the microstructure of the structure following a variety of degradation factors such as chloride attack, penetration of sulfuric acid, and carbonation, etc. as shown in Table 1 below. That is, it indicates the mortar mix excluding coarse aggregates in the mixing conditions applied to LILW concrete structures; the binder-water ratio was 0.45% while the replacement ratio of fly ash was 20%.

Table I: MIXTURE PROPORTIONS

W/B (%)	Replacement ratio of admixture (%)	Unit quantity			
		Cement	Fly ash	Fine aggre gate	Water
0.45	20	0.80	0.20	0.25	0.45

2.1. Materials

For this study, ordinary Portland cement Class-I (Korean origin) was adopted. For the fly ash, the product manufactured by K Company in Korea was adopted. A analysis was performed for the chemical components of ordinary Portland cement and fly ash using XRF.

For the fine aggregates used in this test, those produced in Oksan Cheongwon-gun, Chungbuk, South Korea were adopted.

For the water used in this test, pure secondary distilled water not containing any hazardous oils, acid, alkali, salts, etc. was adopted.

3. Experiment and result

3.1. Exposure to degradation conditions

After 28 days of curing, the entire sides of the mortar with the exception of one side as shown in Fig. 1 was coated with epoxy resin prior to such being exposed to a variety of degradation factors.

And, a 3% NaCl solution was manufactured and then exposed to a degradation environment at 20℃ in order to determine any breakdown of the mortar following the penetration of chloride over a short time.

3.2. Result of analysis for chloride attack

When chlorine ion penetrates into a concrete structure, the chlorine ion reacts to the cement paste in part [3]. That is, it comes to form Chloro-aluminate composite ($3CaO \cdot Al_2O_3 \cdot CaCl_2 \cdot 10H_2O$, Friedel's salt) after the result of chemical reaction. Fig. 1 shows the results of SEM of Friedel's salt and Na-rich component that are crystals resulting from the reaction of mortar that was precipitated in a 3wt% NaCl solution for 56 days to chlorine ion.

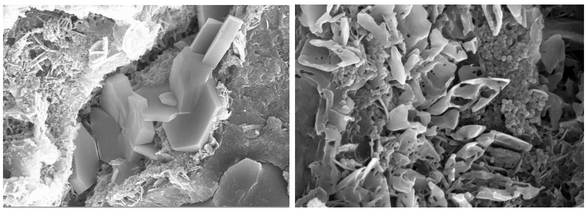

Fig. 1 Result of SEM Images

Fig. 2 and 3 shows the results of the EDS analysis of Friedel's salt and Na-rich component where the Friedel's salt was found to be composed of Ca, Al, Cl and O (Fig. 2). In addition, the elements of the Na-rich component could be identified through Fig. 3.

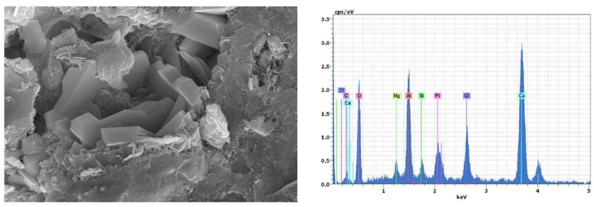

Fig. 2 Friedel`s salt and EDS result

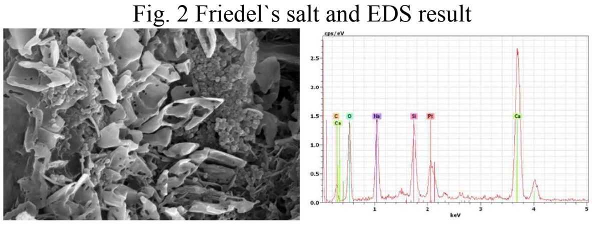

Fig. 3 Na-rich component & EDS result

XRD is useful equipment for assessing the existence of deterioration of the elements of concrete exposed to a variety of degradation environments. In the case of concrete exposed to a chloride attack environment, cement paste and chlorine ion react between each other and then come to form Friedel's (3CaO · Al2O3 · CaCl2 · 10H2O), which provides an important ground representing the deterioration in terms of the microstructure following the invasion of chlorine ion. Friedel's salt is characterized by the occurrence of a high peak at $11.2(2\theta)$ in the XRD analysis as shown in Fig. 4 and Fig. 5 shows the results of XRD analysis of the mortar specimen that was soaked in NaCl for 90 days after the reference curing process.

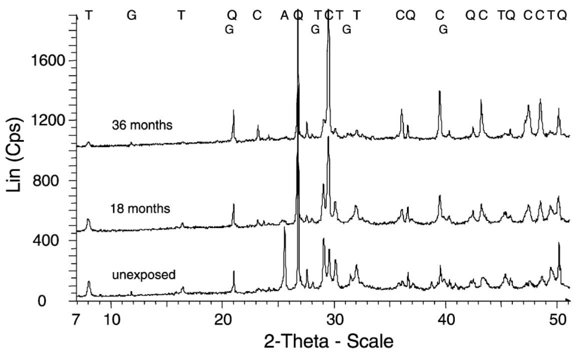

Fig. 4 XRD result of pure Friedel's salt

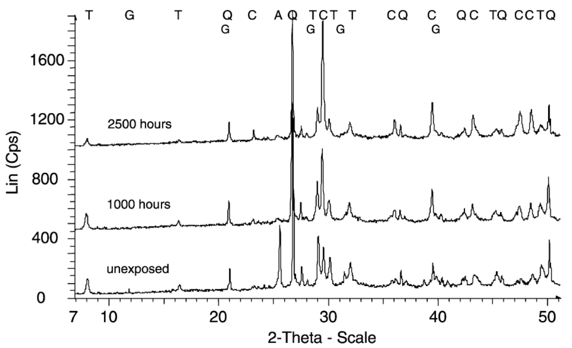

Fig. 5 XRD result of mortar specimen after 90 days

In order to identify the penetration of chloride, normally the existing method based on discoloration using AgNO3 solution is adopted [4]. However, a negative feature is that the resolution of this method is only in 1mm unit increments. Furthermore, although SEM and XRD provide beneficial information for judging whether the mortar elements have deteriorated or not due to the penetrated chlorine ion, there is such a restriction that chlorine ion may not directly measure the actual depth of penetration.

4. Conclusions

A variety of analysis techniques such as SEM, XRD, etc. were applied to the structural changes in concrete exposed to chlorine ion penetration which the existence of deterioration and penetrated depth, etc. could be more precisely judged as compared to the existing analysis.

Friedel's salt was produced through the reaction of chlorine ion and cement hardening body at the time chlorine ion penetration, a characteristic of which was investigated through SEM and XRD.

ACKNOWLEDGEMENT

This work was supported by the Radioactive Waste Management (2009T100100523) of Korea Institute of Energy Technology Evaluation and Planning (KETEP) grant funded by the Korea government Ministry of Knowledge Economy.

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