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Characteristics solidified cement waste using heavy concrete and light concrete paste generated from KRR-2 and UCP

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1. Introduction

As the number of obsolete research reactors and nuclear facilities increases, dismantling nuclear facilities has become an influential issue. During the decommissioning of nuclear plants and facilities, large quantities of slightly contaminated concrete wastes are generated. In Korea, the decontamination and decommissioning of the retired TRIGA MARK II and III research reactors and a uranium conversion plant at KAERI has been under way. By dismantling KRR-2, more than 260 tons of radioactive concrete wastes were generated among the total 2,000 tons of concrete wastes and more than 60 tons of concrete wastes contaminated with uranium compounds have been generated.

Typically, the contaminated layer is only 1~10mm thick because cement materials are porous media, the penetration of radionuclides may occur up to several centimenters from the surface of a material. Concrete is a structural material which generally consists of a binder (cement), water, and aggregate. The binder is typically a portland cement which comprises the four principal clinker phases tricalcium silicate (Ca_3SiO_5) and constitutes 50-70%, decalcium silicate (Ca_2SiO_4), tricalcium aluminate ($Ca_3Al_2O_6$), and calcium aluminoferrite ($Ca_4Al_2Fe_2O_{10}$). Cement powder (anhydrous cement) created from the co-grinding of clinkers and gypsum is mixed with waster and hydrate phase are formed. The interaction between highly charged C-S-H particles in the presence of divalent calcium counter ions is strongly attractive because of ion-ion correlations and a negligible entropic repulsion. In the temperature range 100-300°C, these evolutions are mainly attributed to the loss of the bound water from the C-S-H gel. Similar consequences have been reported for mortars and concretes enhanced sometimes by the appearance of micro-cracks related to the strain incompatibilities between the aggregates and the cement paste [1-4]. Concrete aggregates are combined mutually strongly by hydrated cement paste. Radionuclides may be found in cement-base materials. The cement fine powder should be stabilized for disposal criteria in a final disposal repository.

The aim of this study was to establish the optimized solidification conditions for the treatment of concrete paste contaminated with radioniclides. The solidification tests had been performed using the pastes which were contaminated with the radionuclide generated from TRIGA MARK II and uranium conversion plant.

2. Method and Result

For the experimental test, radioactively contaminated concrete pastes are used generated from dismantling the retired TRIGA MARK II and III research reactors and uranium conversion plant. Figure 1 shows the experimental procedure. Concrete parts are crushed for a size reduction. Crushed concrete waste was sieved below 1mm using 8-in. diameter brass wire cloth sieves and an electric vibratory shaker for 5min in batches. Cement paste was heated at 700℃ in muffle furnace. The cement paste powder was solidified with chemical material. Compressive tests were conducted to solidified waste.

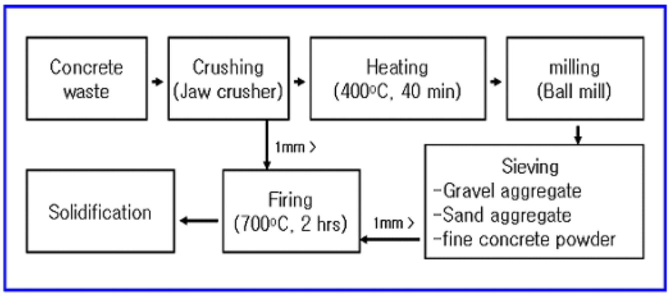

Fig.1. Experimental procedure

In general, the compressive strength is calculated by making maximum load recorded on measuring device divided by cross-sectional area of sample. Compressive strength which is very important in quantifying structural stability of solidified waste is highly dependent on the method of specimen making and testing.

Figures 1, 2 show compressive strength for substitution rate of dehydrated light and heavy paste. The most importation reactions of cement with waste are those which lead to binding, i.e. a chemical reaction. The nature of the binding forces in a cement matrix is species, so it is difficult to produce a general description. At 20 wt % of substitution rate of dehydrated concrete fine powder, the compressive strength of solidified waste was achieved about 5.4MPa and volume reduction was minimized.

Figures 3, 4 show Comparison of compressive strength dehydrated with hydrated light paste and heavy paste at curing period 7 days. As shown figures, compressive strength of dehydrated paste was excellent compared with hydrated paste. The compressive strength more than meets disposal criteria designed to prevent subsidence in a disposals facility.

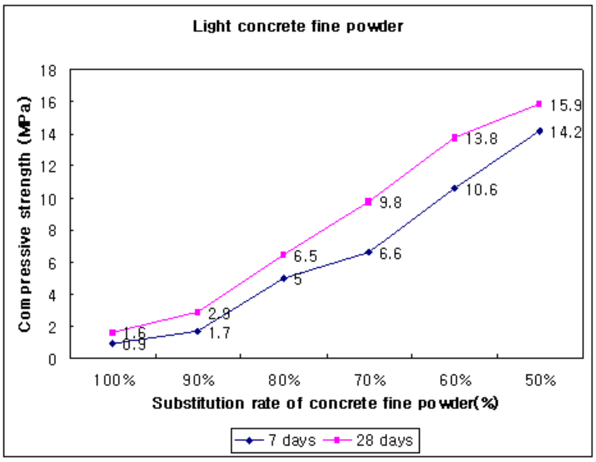

Fig. 1. Compressive strength of dehydrated light paste

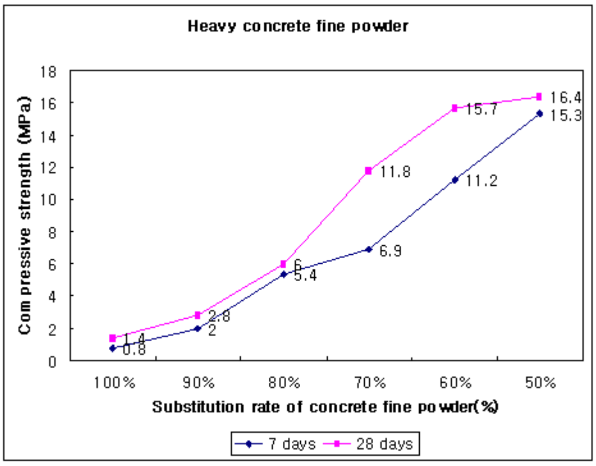

Fig. 2. Compressive strength of dehydrated heavy paste

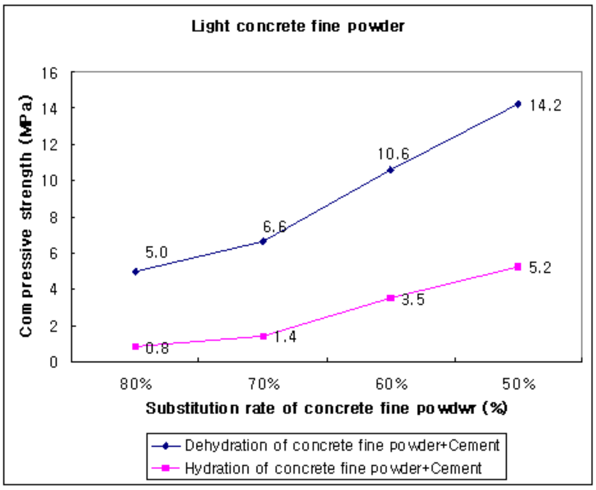

Fig. 3 Comparison of compressive strength dehydrated with hydrated light paste

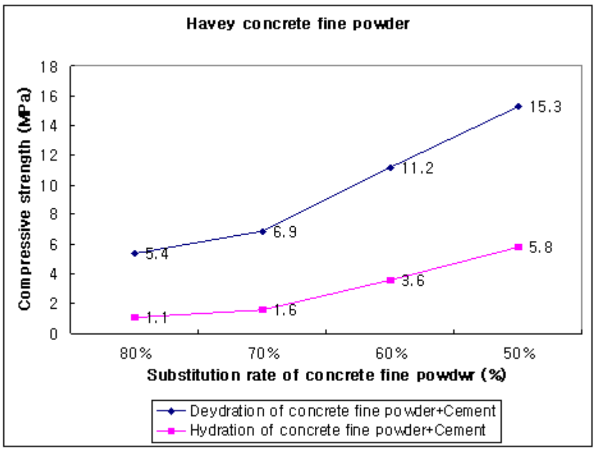

Fig. 4 Comparison of compressive strength dehydrated with hydrated heavy

3. Conclusions

We have investigates for the compressive strength of solidified waste form and hydration recovery property using heavy weight porous fine cement powder taken from the retired research reactor and light fine cement powder from uranium conversion plant. The optimum dehydration condition for cement fine powder was about at 700 ℃ for 2 hours. At 20 wt % of substitution rate of dehydrated concrete fine powder, the compressive strength of solidified waste was achieved about 5.4MPa and volume reduction was minimized in theses condition.

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