The 2016 World Congress on
The 2016 Structures Congress (Structures16)
Jeju Island, Korea, August 28-September 1, 2016

Effect of sludge filler on mechanical properties of epoxy mortar

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ABSTRACT

This paper presents the effect of waste soil sludge filler on the mechanical properties of epoxy mortar designed for concrete repair. Mortar samples were prepared and tested for compressive and flexural strength. The results were analyzed with currently existing performance requirements for repair mortars. The minimum quantity of epoxy required to meet the compressive and flexural strength requirements was found to be 10 wt% with sludge filler of 10 and 20 wt% while a maximum increase of 73.22% and 79.89% in compressive and flexural strength, respectively, was observed for mortar with epoxy at 15 wt% and sludge filler at 20 wt%.

1. INTRODUCTION

Degradation of concrete occurs due to various reasons such as environmental loads, faulty material, constructions and design errors (Briffett 1995). Maintenance material with good strength and compatible properties with those concrete substrates should be chosen to repair such failures to avoid future deterioration of the concrete structure (Emmons 1993; Vaysburd 2006).

For the past two decades, epoxy mortar has been utilized as a repair material (Mays 1992; ACI-Committee 2007). However, the epoxy resin used as a binder was most responsible for the high cost of the epoxy mortar (Mays 2002). Hence, an optimized quantity of epoxy resin should be proportioned for an economical repair scheme. This can be achieved by selecting the fine aggregate used to prepare the epoxy mortar, but most sand available on the market lack fine particles passing sieve size of 150 micrometer because their presence is not preferred for most concrete application (Smoak 1998). Hence, in this study, a fine soil sludge, a waste product of aggregate washing process, was investigated as filler for the epoxy mortar (Chang, Lee et al. 2010).

In this paper, the effect of sludge on the compressive and flexural strength of epoxy mortar is presented. The preliminary results are analyzed with currently existing standards for repair mortar.

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Note: Paper to be submitted to "Computers and Concrete, An International Journal" for the purpose of Special Issue.

2. EXPERIMENT

2.1 materials

Epoxy and sand were purchased from a local store. The properties of epoxy resin and its hardener used in this study are presented in Table 1. Sludge was collected from an aggregate production plant located in Gyeonggi-do, Korea. Before use, the sludge was dried at 110°c for 24 hours and grinded by a steel roller and then sieved.

The particle size distribution of the sand and the sludge was determined using LA-950 laser scattering particle size analyzer manufactured by Horiba, Japan. Figure 1 and Figure 2 show the particle size distribution of the sand and sludge used in this study.

Table 1 Properties of Epoxy resin and hardener

Type	Epoxy resin	Epoxy hardener
Mixing proportion	3	1
Specific gravity	1.14±0.1	1.02±0.1
Viscosity (mPa.s)	550±50	
Pot life (Min)	30±10 at 23°C	
Hardening time (Hrs)	24-36 at 23°C	

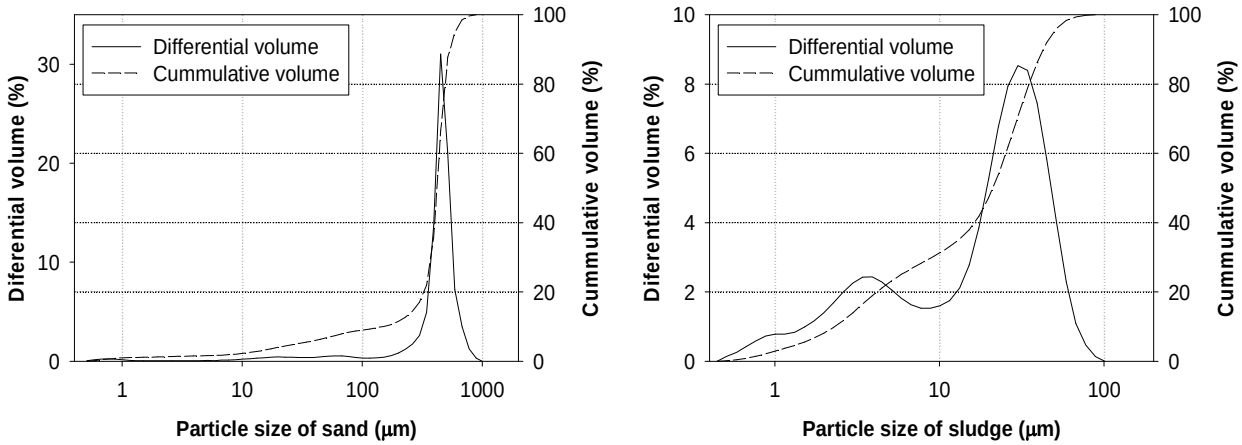

Figure 1 Particle size distribution of sand and sludge

The chemical composition of sludge was determined by X-ray Fluorescence analysis using XGT-5000 manufactured by Horiba, Japan. The result shows the chemical composition of sludge are SiO_2 (56.98%), Al_2O_3 (24.61%), Fe_2O_3 (13.76%), K_2O (2.26%), CaO (1.20%), TiO_2 (0.859) and MnO_2 (0.33%).

2.2 Mix Proportion

Four control mortar groups were prepared with epoxy at 10, 15, 20 and 25 wt% mixed with sand at 90, 85, 80, 75 wt%, respectively. Sludge filler was added as a sand substitute at 10, 20, 30 and 40 wt% of the samples found in each group.