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Material Properties of White Cement Mortar Using Pyroclastic Flow Deposits

Ken Watanabe, Mamoru Fujii and Jun Mauricio Arai
Dept. of Architecture and Building Engineering, School of Engineering, Tokai University
Hiratsuka, Kanagawa, Japan

ABSTRACT

In concrete industries, studies on alternative materials to aggregates for concrete have extensively been carried out, aiming to resolve the problem of environmental destruction caused by extraction of natural aggregates or the problem of depletion of natural aggregates resources. In the present study, we have investigated the mix proportion, strength characteristics and long-term durability for mortars made of white cement and shirasu as fine aggregate material, targeting at interior and exterior panels as secondary products of concrete.

KEY WORDS: White cement; Shirasu; mortar; Mix proportion; Compressive strength.

INTRODUCTION

Nowadays it is indispensable to take the global environmental issues into consideration at industrial activities. In concrete industries as well, studies on recycled aggregate concretes have extensively been carried out, aiming to resolve the problem of environmental destruction caused by extraction of natural aggregates or the problem of depletion of natural aggregates resources.

In view of these situations, it should be an important subject to investigate alternative materials to aggregates for concrete. Takewaka and coworkers have made a series of investigation on the applicability of shirasu, the pyroclastic flow deposits obtainable in a large quantity from South Kyushu (hereafter referred to as shirasu), to an alterative to concrete aggregates. They have reported the mix proportion and the strength characteristics of shirasu concrete (Takewaka et al., 1987; Kawamata et al., 1988, for instance) and examples of application to the concrete foundation for piers (Takewaka, 2004). Kaku and others have proposed a formula for strength estimation of concrete from their study on concrete with shirasu as fine aggregate and lapilli as coarse aggregate (Kaku et al., 1989).

From these results, the alternative use of shirasu to fine aggregate for concrete appears promising and other various applications will also be possible than that to concrete for building components.

In the present study, we have investigated the mix proportion, strength characteristics and long-term durability for mortars made of white cement and shirasu as fine aggregate material, targeting at interior and exterior panels as secondary products of concrete.

EXPERIMENTAL PROCEDURE

The summary of the present experiment is given in Table 1. The items examined are the fresh property, 28 day strength, strength development, and shrinkage property. In the present experiment we adopted the standard curing as a basis to grasp fundamental properties, although other curing methods are also possible. The target flow value was determined by a trial mixing.

For the fine aggregates presented in Table 1, (8) denotes shirasu under 8 mm (sieved finer than 8 mm, surface-dry density: 2.08 g/cm^3, water absorption: 7.7 %, fineness modulus: 1.49), (2) denotes shirasu under 2 mm (sieved finer than 2 mm, surface-dry density: 2.17 g/cm^3, water absorption: 4.6 %, fineness modulus: 1.21), and (NT) denotes natural fine aggregate of a mixture of crushed sand (surface-dry density: 2.64 g/cm^3, water absorption: 1.46 %, fineness modulus: 3.03) and pit sand (surface-dry density: 2.56 g/cm^3, water absorption: 1.78 %, fineness modulus: 1.79) with a ratio of 7:3 by weight. (8)' denotes shirasu under 8 mm, from which shirasu under 0.15 mm was removed. All the shirasu used was from Kirishima.

For cements, (WH) denotes white cement (density: 3.05 g/cm^3, 28 day compressive strength: 64.0 N/mm^2) and (N) ordinary Portland cement (density: 3.16 g/cm^3, 28 day compressive strength: 61.07 N/mm^2). As to admixtures, (P) denotes plain mortar, and (AE) denotes mortar with air-entraining and high-range water-reducing admixture (superplasticizer) in a mass ratio of 1% to cement. Figures in parentheses in the target flow value column are those for base mortar (shirasu under 8 mm, plain mortar with water to white cement ratio: 50 %).

Circles in the table indicate that the corresponding tests were carried out. In the strength test, closed circles, ●, are for specimens with a dimension of 40 x 40 x 160 mm, and open circles, ○, are for specimens with a dimension of 40 x 40 x 160 mm and 100φ x 200 mm.