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ScienceDirect

Procedia Engineering 171 (2017) 774 – 780

Procedia Engineering

www.elsevier.com/locate/procedia

Sustainable Civil Engineering Structures and Construction Materials, SCESCM 2016

The effect of seawater curing on the correlation between split tensile strength and modulus of rupture in high-strength concrete incorporating rice husk ash

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Abstract

This paper presents experimental and analytical methods conducted to study the effect of seawater curing on the correlation between split tensile strength and modulus of rupture (MOR) in high-strength concrete incorporating rice husk ash. Rice husk ash was added into the mix to partially replace cement content; replacement proportions were 0, 5, 10, 15, and 20%. To resemble the marine environment concrete samples were cured in seawater. The results show that the addition of rice husk ash increased the MOR and split tensile strength values, and also increased the resistance to seawater exposure. The correlation between split tensile strength and MOR had the empirical f_{st} = 125.3%×MOR for fresh water curing, and f_{st} = 115.8%×MOR for seawater curing.

Peer-review under responsibility of the organizing committee of SCESCM 2016.

*Keywords:*split tensile; MOR; rice husk ash; high strength concrete.

1. Introduction

The waterfront city is one of building concepts to be developed in Indonesia. Other countries, such as Singapore, Japan, the United Kingdom, and the USA have successfully applied this concept, and the Indonesian government is very supportive of waterfront city projects to improve economy and infrastructure development throughout the nation.

The aggressive characteristics of seawater mean that building materials that are resistant to seawater effects are required. Concrete is an appropriate selection for building materials in coastal areas, considering that it is non-

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Peer-review under responsibility of the organizing committee of SCESCM 2016.
doi:10.1016/j.proeng.2017.01.447

corrodible, formable, and workable material that has considerable benefits for coastal area constructions, particularly on a big scales. To gained a sustainable concrete, nowadays "green concrete concept" are mainly concerned, since it is environmentally friendly [1]. Marine areas are exposed to chemicals attack from chloride, magnesium salt, sulphate, and acid attack by bacteria [2]. Furthermore, the abrasive effects of seawater must also to be considered.

The challenge in construction is to make concrete an environmentally friendly building material while still completely supporting sustainable development. Sustainable development requires a sustainable construction industry, in particular sustainable concrete structural design and performance and viable building lifecycles [3].

Additive materials in concrete can improve concrete quality. Rice Husk Ash (RHA) is one of the additive material innovations that can improve concrete strength in certain dosages. RHA with high concentration of silicate could be used as pozzolanic material in concrete [4]. High strength concrete demands a low water cement ratio, thus the water cement ratio that can be used are 0.4, 0.32, 0.3, or 0.28 [5].

The aim of this study is to develop RHA as additive material in high-strength concrete that is exposed to seawater abrasion.

2. Experimental details

Fig. 1 shows the experimental details of this study, which includes preliminary testing, mix proportions, curing, and hardened concrete testing.

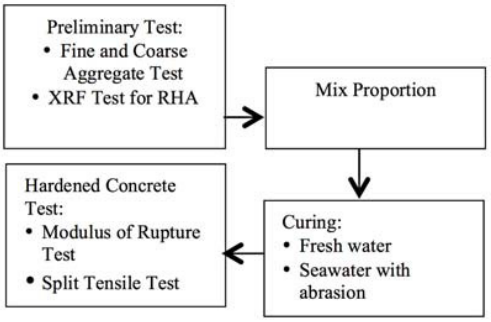

Fig. 1. Experimental details

RHA as an additive material for the concrete was obtained from Sragen, Central Java, Indonesia. X-Ray Fluorescence (XRF) analysis is a spectroscopic method commonly used for analysis of solids, in which secondary X-ray emissions are generated by excitation of a sample with X-rays.

Table 1 shows that the largest component of RHA is SiO_2; this resembles the same characteristics of the cement matrix. The reaction between cement, water, and RHA is shown below:

1. Chemical reaction between Original Portland Cement and water

$$OPC + H_2O \rightarrow CaO\ .SiO_2\ .\ H_2O + Ca(OH)_2$$

2. Chemical reaction between OPC, water, and RHA

$$OPC + SiO_2 + H_2O \rightarrow CaO\ .SiO_2\ .\ H_2O + Ca(OH)_2 + SiO_2$$

$$CaO\ .SiO_2\ .\ H_2O$$

The reaction between RHA and Hydro Carbon resulted in a decreased amount of CH, which decreased alkalinity and added cement paste endurance to the outer chemical reaction. The reaction also increased amount of Calsium