4th RMUTIC 2013 organized by Rajamangala University of Technology Phra Nakhon, Bangkok-Thailand

JOURNAL OF APPLIED SCIENCES RESEARCH

JOURNAL home page: http://www.aensiweb.com/jasr.html 2013 Special, 9(12) pages: 6160-6164

Published Online :15 January 2014 **Research Article**

The Innovation of Use of Waste Ash From Agricultural by-Product In Concrete Work

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Received: 12 November 2013; **Revised:** 14 December, 2013; **Accepted:** 20 December 2013.

ABSTRACT

This research presents the use of the waste ash from agricultural by-product in concrete work. Portland cement type I (CT) was partially replaced with ground bagasse ash (BA) and ground rice husk-bark ash (RB) at the dosage levels of 0%, 20% and 40% by weight of binder. Compressive strength and chloride penetration of concrete were determined. Test results indicated that the resistance to chloride penetration of concrete improves substantially with partial replacement of CT with a blend of waste ash and the improvement increases with an increase in the replacement level.

Key words: Bagasse ash; Concrete; Chloride; Compressive strength; Rice husk-bark ash

INTRODUCTION

Waste materials such as bagasse ash, rice husk ash, palm oil fuel, bottom ash and fly ash are the disadvantages of the generation procedure owning to the cost of disposal and poor environment. These materials can be modified as pozzolanic materials to be useful to the concrete work [4,5,9,11].

Rice husk-bark ash is a residue obtained from the burning of rice husk-bark as fuel source in the small power generation plants of Thailand. For this process, one portion of eucalyptus bark and two portions of rice husk are the normal composition and it is burnt at 800-900°C [11,10]. There are few researches about the rice husk-bark ash characteristics and its mechanical properties relating to the concrete work.

For sugar mill in Thailand, the bagasse ash is a large amount is disposed of by landfill and is still the problem for the power plants. The bagasse ash with high silica content could also be used as pozzolanic material in concrete work [5,9].

The purpose of this research is to utilize the rice husk-bark ash and bagasse ash as pozzolanic material for partly replacing Portland cement in order to produce concrete as well as to reduce negative environmental effects and landfill volume, which is required for eliminating the waste ash from agricultural by-product.

Materials and Materials

2.1 Materials:

Portland cement type I (CT), bagasse ash (from a sugar mill in Singhaburi Province, Thailand) and rice husk-bark ash (from the generation of the plants at Thai Power Supply Company Ltd., in Chachoengsao Province, Thailand) and Superplasticizer (SP) were the materials used for this study. Local crushed limestone was used as coarse aggregate. Graded river sand was used as fine aggregate. Rice husk-bark ash (RB) and bagasse ash (BA) were ground by a ball mill until 3% weight retained on a sieve No. 325# (45 µm). The physical properties of materials are given in Table 1. In this work, compressive strength and chloride penetration of concretes were determined.

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Table 1: Specific gravity and fineness of materials after improvement.

Physical properties	CT	RB	BA
Median particle size (μm), d_{50}	25	20	16
Retained on a sieve No. 325 (%)	N/A	2	2
Specific Gravity	3.14	2.26	2.28
Blaine Fineness (cm^2/gm)	3,650	12,000	13,500

2.2 Mix proportions of concrete and curing:

The concrete mix proportions are given in Table 2. Portland cement type I (CT) was partially replaced with rice husk-bark ash (RB) and bagasse ash (BA) at the dosages of 0%, 20% and 40%. CT was partially replaced with RB and BA in order to produce concrete with compressive strength at 28 days higher than 50 MPa. All concrete mixtures had constant water to binder ratio (W/B) of 0.30. A superplasticizer (SP) was used for maintaining workability with slump of concrete. The slump test was carried out as per ASTM C143 (2005a).

The cast specimens were covered with polyurethane sheet and damped cloth and placed in 23 ± 2°C chamber for 24 h. After 24 h, they were demoulded and were cured in water at 23 ± 2°C until the test age of 28 and 90 days.

Table 2: Concrete mixture proportions.

No.	Mix	W/B	Mix proportions (kg/m^3)						Super P.	Slump (mm)
			Cement	RB	BA	Fine aggregate	Coarse Aggregate	Water		
1	CT	0.30	560	-	-	715	925	168	7	200-250
4	20BA	0.30	448	-	112	720	915	168	9	200-250
5	40BA	0.30	336	-	224	713	910	168	20	200-250
6	20RB	0.30	448	112	-	710	923	168	8	200-250
7	40RB	0.30	336	224	-	705	918	168	15	200-250

2.3 Compressive strength test:

The 100 mm diameter and 200 mm height cylindrical specimens were used for compressive strength testing. The compressive strength test was carried out as per ASTM C39 (2005b). They were tested at the ages of 28 and 90 days.

2.4 Rapid test on resistance to chloride penetration:

All concrete mixtures were tested for rapid chloride penetration test (RCPT) the next day in accordance with the method described in ASTM C39 (2005b) and ASTM C1202 (2005c).

Results and Discussions

3.1 SP requirement and compressive strength of concrete:

The results of the required SP of concrete are given in Table 2. The incorporation of waste ash (RB and BA) required more SP, compared to the CT concrete. This is due to their specific surfaces and the cellular structure of their particles. The test results are similar to the other researches [9,10].

The results of compressive strengths are presented in Fig. 1-3. The strengths at 28 and 90 days of CT concrete were 55 and 68 MPa, respectively. The compressive strengths of concrete developed continuously. The strengths of 20RB and 20BA concretes were greater than that of the CT concrete for all test ages since the small particle size of RB and BA particles filled the spaces in the matrix and enhanced the pozzolanic reaction [10] and offset the reduction in the amount of CT of 20% level of replacement. The compressive strength of the 20RB and 20BA concrete was higher than those of 40RB and 40BA concretes because the 20RB and 20BA mixes required less SP and resulted in a denser matrix compared with those of 40RB and 40BA concretes. Relationship between compressive strength and level (%) of replacement with RB and BA are given in Fig. 2 and 3 respectively.

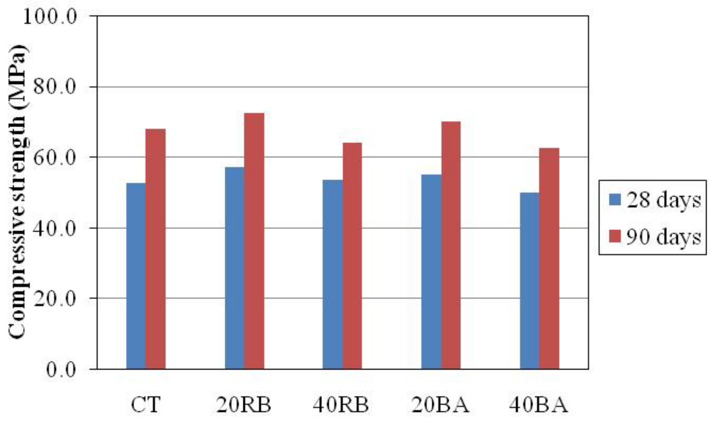

Fig 1. Compressive strength of concrete

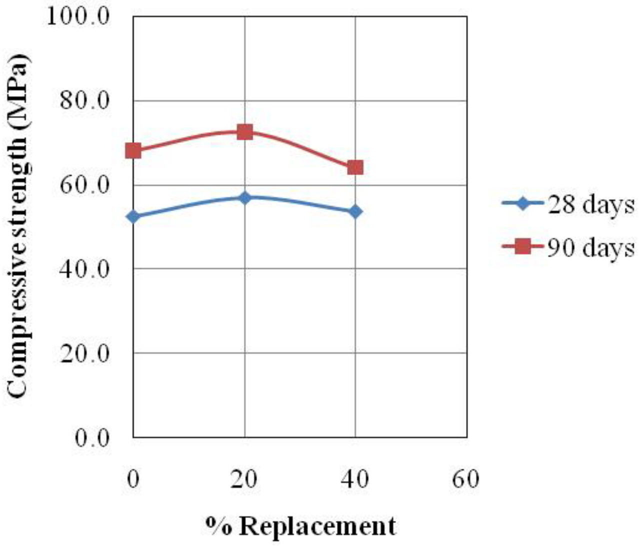

Fig. 2: Relationship between compressive strength and level of replacement with RB

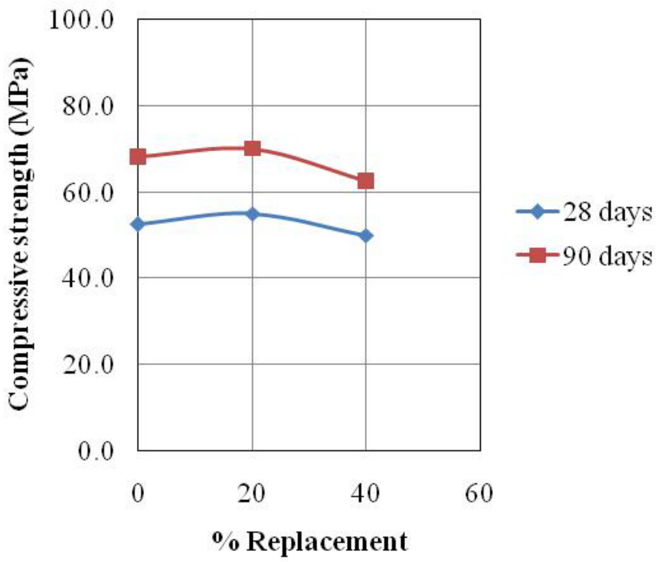

Fig. 3: Relationship between compressive strength and level of replacement with BA

3.2 Chloride penetration of concrete:

The results of the chloride resistance test of the concrete at 28 and 90 days are described in Fig. 4. The incorporation of rice husk-bark ash and bagasse ash increased the resistance to chloride penetration. The replacements of CT with waste ash reduced the charge passed (coulomb) indicating the increase in the resistance to chloride penetration. The test results are similar to the other researches [5,9,10]. This is due to the hydration and pozzolanic reaction of RB and BA.

In Fig. 4, the charge passed of RB and BA concretes were lower than those of CT concrete because both RB and BA consisted of high amount of SiO_2 [5,11,10]. This is due to the pozzolanic reaction between SiO_2 and $Ca(OH)_2$ resulted in calcium silicate hydrate (CSH) and contributed to the strength of concrete. In addition, a large amount of CSH product and the ability of ion chloride absorption are helpful to reduce the penetration [9,8,6,7]. This finding of this work is useful in order to convince the construction industry for the use of waste ash from agricultural by-product (rice husk-bark ash and bagasse ash) in making concrete. In addition, results indicate that the chloride resistance of concrete is effective when Portland cement is replaced with 40% of RB and BA (see Fig.4).

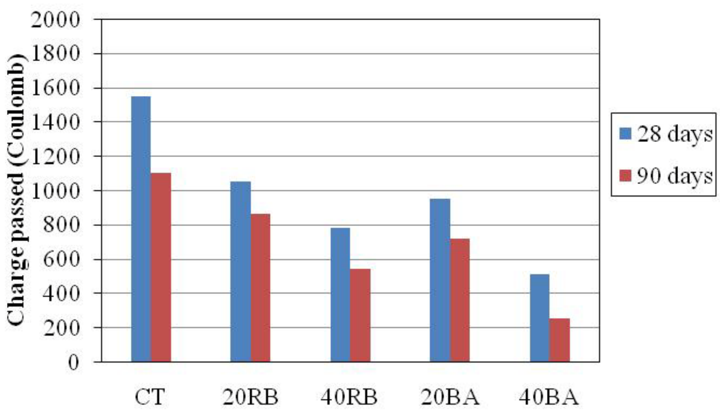

Fig. 4: Chloride penetration of concrete

Conclusions:

From the test, it can be concluded that bagasse ash (BA) and rice husk-bark ash (RB) (waste ash from agricultural by-product) can be used as cementitious materials to replace part of Portland cement in making concrete with relatively high strength and good resistance to chloride penetration. The chloride resistance of concrete is effective when Portland cement is replaced with 40% of RB and BA.

Acknowledgements

This work was supported by the Thailand Research Fund (TRF) under the TRF Research Grant for New Scholar No. MRG5580120; Office of the Higher Education Commission (OHEC); Rajamangala University of Technology Phra Nakhon (RMUTP); Office of the National Research Council of Thailand (NRCT)and the Thailand Research Fund under the TRF Senior Research Scholar.

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