



KKU ENGINEERING JOURNAL

KKU ENGINEERING JOURNAL

Vol.43 No.4 October – December 2016

ISSN 0125-8273

TABLE OF CONTENTS

ORIGINAL RESEARCH

Influence of clay content on permeability of compacted lateritic soil <i>SakulsaksriChaiyasat</i>	1
Production and characterization of porous insulating fired clay bricks with corn cobs admixture <i>SiwatLawanwadeekul, KittisakSamootherak, WichetYimlamai, JakkitHunyala, MattikaBunma</i>	4
Combined rogowski coil for the detection of partial discharge <i>PongchitSaetang, AmnartSuksri</i>	10
An adaptive personalized learning system <i>AekavuteSujarae, NatchayaKijmongkolchai, ChutipornAnutariya</i>	14
Comparative performance of multiobjective evolutionary algorithms for solving multiobjective optimal reactive power dispatch problems <i>KasemNuaekaew, NantiwatPholdee, PraminArtrit, SujinBureerat</i>	18
Effects of different ohmic contact widths and distances on the absolute sensitivity of two-dimensional hall sensor <i>YongyutKaewjumras, Athirot Mano, AmpornPoyai, WisutTitiroongruang</i>	23
Image matching with multi medium Delaunay triangulation <i>NatthapolKaewpontong, SomchaiLimsiroratana</i>	26
New amplitude controllable current-mode quadrature oscillator using DO-CDTAs <i>CharinsakSaetiaw, PhatsagulThitimahatthanagusol, SaksitSummart</i>	29
Study of induced voltage 115 kV in Lao P.D.R parallel transmission lines caused by electric field induction <i>KetsanaRatanalangsy, JittipathTriyangkulsri, NgodnaphaChansavang, ApiratSiritaratiwat</i>	32
English proficiency requirements for engineering graduates at private organizations in Thailand <i>PanitasSureeyatanapas, ApichartBoonma, SukangkanaThalangkan</i>	35
Utilization of cassava trunk waste mixed with cement to particle board wall for thermal resistance in building <i>PakamasChoosit, PhanudejKudngaongarm, KittipongSuweero</i>	40
The time derivative of flux-linkage dependence on flux-linkage with partitioned-stator doubly-salient permanent-magnet generator structure <i>WaratSriwannarat, Anan Kruesubthavorn, Paul Nutter, KittipongTonmitr, ApiratSiritaratiwat</i>	44
Performance study of solar panels with cooling systems at low ambient temperature <i>IttipolHindee, GridsadaLampongchat, NuchidaSuwapaet</i>	47
Automatic measurement of electro-mechanical parameters of low-frequency loudspeakers <i>ChukietSodsri</i>	52
Recycled Concrete Aggregate (RCA) Thai reverse logistics supply chain management for ready mix plants <i>Hermann Gruenwald</i>	57
Frequency domain identification of volterra model for separating ultraharmonic using the technique of half-frequency of the input signal <i>ChindaSamakee, SunyaPasuk</i>	60

ORIGINAL RESEARCH (CONT.)

Effect of steaming condition varying in time and temperature on the quality of dark parboiled rice with germination	64
<i>ThatchapolChungcharoen, SomkiatPrachayawarakorn</i>	
Numerical investigation of the influences of nozzle convergence angle on the water ejector efficiency	67
<i>SutidaPhitakwinai, SirichaiThepa, WanichNilnont</i>	
Preparation of graphite oxide using modified Tours method by using raw graphite powder from jewelry industry waste	70
<i>KhittipopUtila, DoungkamonPhihusut</i>	
Classification of diabetic retinopathy using artificial neural network	74
<i>WeeragulPratumgul, Worawat Sa-ngiamwibool</i>	
Characteristics of the stable isotopes ($\delta^{18}O$ and δ^2D) composition in precipitation from Bangkok, Kamphaeng-Phet and Suphanburi, Thailand	78
<i>BoonsomPorntepkasemsan, WuthikraiKulsawat, PhatchadaNochit</i>	
Distribution of ^{210}Po in some marine biota of a Samut-Sakhon region: evaluation of dose to consumers	81
<i>WuthikraiKulsawat, BoonsomPorntepkasemsan</i>	
Vanillin production from lignin degradation using hydrothermal method over Fe_2O_3/Al_2O_3 catalysts	84
<i>WuttichaiPhithakkuncharoen, SirawitSangnak, ArthitNeramittagapong, SutasineeNeramittagapong</i>	
Effect of engine speeds and duty cycle percentages of fuel injection on actual fuel injection rate	87
<i>JirawatBoonjun, NitiKammuang-lue</i>	
Using generalized linear models and time series models to forecast gasohol consumption in Thailand	92
<i>SujittaSuraphee, WeerapatSessomboon, RojaneeHomchalee</i>	
The factors affecting on consumption of some petroleum product in Thailand using general linear model and generalized linear model	96
<i>AmpikaKonkaew, SujittaSuraphee, RojaneeHomchalee</i>	
Determination of linke turbidity factor from the precipitable water vapor and visibility data	100
<i>SayanPhokate</i>	
A solution approach for solving the location routing problem of the central rubber market	103
<i>SomsakKaewploy, SombatSindhuchao</i>	
Ranking of important knowledge areas and measurement of competency levels of construction project managers in Cambodia	108
<i>NoppadonJokkaw</i>	
Using GM(1,1) with sample standard deviation to forecast downtrend rainfall for small sample in KhonKaen, Thailand	111
<i>MatheePongkitwitoon, WatcharinKlongdee</i>	
Multi-hop network localization in unit disk graph model under noisy measurement using tree-search algorithm with graph-properties-assist traversing selection	114
<i>PhisanKaewprapha, NattakanPuttarak, ThaewaTansarn</i>	
Seasonal biodiversity of adult insects in relation to environmental factors at the irrigation system based on light trap collection	118
<i>Taeng On Prommi</i>	

ORIGINAL RESEARCH (CONT.)

The distribution and some ecological characteristics, and essential oil of <i>Cunninghamia konishii</i> Hayata in Pu Hoat nature reserve, Nghe An province, Vietnam	121
<i>Nguyen Thi Thanh Nga, Nguyen Anh Dung, Nguyen Thanh Chung, Tran Huy Thai, Nguyen Danh Hung</i>	
Detecting generalized salt and pepper noise image based on standard deviation	125
<i>Ratthasart Thawong, Supap Sakha, Watcharin Klongdee</i>	
Robust goal programming approach to an intermodal routing decision problem	130
<i>Wichitsawat Suksawat Na Ayudhya</i>	
Co-sensitized ruthenium(II) for dye-sensitized solar cells (DSSCs)	133
<i>Preeyapat Prompan, Kittiya Wongkhan, Rukkiat Jitchati</i>	
A simple colorimetric method for the determination of aromatic amines	137
<i>Benjawan Nhokaew, Rukkiat Jitchati</i>	
Study of mirror uses on electricity generation of solar cel	141
<i>Parinya Turapra, Arkom Kaewrawang, Kittipong Tonmitra</i>	
A new strategy to improve quality of ready mixed concrete using rice husk ash	144
<i>Panupong Pongpitakkul, Sakprayut Sinthupinyo, Tawatchai Charinpanitkul</i>	
Investigation of average optical density and degree of liquids saturation in sand by image analysis method	147
<i>Sitthiphat Eua-Apiwatch, Siam Yimsiri</i>	
Energy saving of cooling tower replacement by a mathematical model	152
<i>Wutthisak Thanuanram, Narongrit Auppapong</i>	
Experimental water to air thermoelectric cooling application in automobile	155
<i>Nattadon Pannucharoenwong, Somnuk Theerakulpisut, Athiwit Rakngam, Chatchai Benjapiyaporn, Julaporn Benjapiyaporn, Polkit Promteerawong</i>	
Design and development of a local microelectrode puller for electrophysiology research in Thailand	158
<i>Sutheera Sangsiri, Uthane Supatti</i>	
Flow rate analysis experiment on thermoelectric cooling	162
<i>Nattadon Pannucharoenwong, Athiwit Rakngam, Somnuk Theerakulpisut, Chatchai Benjapiyaporn, Julaporn Benjapiyaporn, Polkit Promteerawong</i>	
The efficiency of anaerobic baffled reactor (ABR) for wastewater prepared from chicken manure	165
<i>Prapruet Thinpru, Panomchai Weerayutsil, Kulyakorn Khuanmar</i>	
Tail-biting LDPC convolutional codes over power line communication system	167
<i>K. Chairathum, P. Suthisopapan, K. Ounda, T. Sriphoonga, V. Imtawil</i>	
High output water cooled thermoelectric refrigerator	170
<i>Nattadon Pannucharoenwong, Athiwit Rakngam, Somnuk Theerakulpisut, Chatchai Benjapiyaporn, Julaporn Benjapiyaporn, Polkit Promteerawong</i>	
Development of cement boards from coconut shell ash for energy and environment conservation	173
<i>Pramot Weeranukul, Kittipong Suweero</i>	
Classifying rubber breed based on rough set feature selection	176
<i>Phanarut Srichetta</i>	
50 Ton tubular ice factory production optimization	180
<i>Nattadon Pannucharoenwong, Chatchai Benjapiyaporn, Somnuk Theerakulpisut, Sittikorn Saeng-Uthai, Julaporn Benjapiyaporn, Polkit Promteerawong</i>	

Editor-in-chief

Prof. Dr. Prinya Chindapasirt
Khon Kaen University, Thailand

Editor

Prof. Dr. Sujin Bureerat
Khon Kaen University, Thailand
Assoc. Prof. Dr. Somchai Chuan-udom
Khon Kaen University, Thailand

Editorial Board

Prof. Dr. Shahrum Abdullah
Universiti Kebangsaan Malaysia, Malaysia
Engr. Dr. Wan Rosmiza Zana Binti Wan Dagang
Universiti Teknologi Malaysia, Malaysia
Prof. Dr. Vute Sirivivatnanon
University of Technology Sydney, Australia
Prof. Dr. Jay Sanjayan
Swinburne University of Technology, Australia
Prof. Dr. Fernando Pacheco-Torgal
University of Minho, C-TAC Research Centre, Portugal
Prof. Dr. Mika Sillanpää
Lappeenranta University of Technology, Finland
Prof. Dr. Chitsan Lin
National Kaohsiung Marine University, Taiwan
Prof. Dr. Donald Slack
University of Arizona, United States
Prof. Dr. Masami Ueno
University of the Ryukyus, Japan
Prof. Dr. Noboru Sonehara
National Institute of Informatics, Japan
Prof. Dr. Yong-Taek Im
Korea Advanced Institute of Science and Technology, Korea
Prof. Dr. Chongrak Polprasert
Thammasat University, Thailand
Prof. Dr. Somchart Soponronnarit
King Mongkut's University of Technology Thonburi, Thailand
Prof. Dr. Suksun Horpibulsuk
Suranaree University of Technology, Thailand

Assistant Editors from Khon Kaen University, Thailand

Asst. Prof. Dr. Anupap Meesomboon
Asst. Prof. Dr. Khanitha Kamwilaisak
Asst. Prof. Dr. Papot Jaroenapibal
Dr. Nantiwat Pholdee

Administrative Assistant

Ms. Nantawan Chanwicha

Contact address: KKU Engineering Journal, 7th Floor, Pienvichitr Building, Faculty of Engineering, Khon Kaen University, Muang Khon Kaen, 40002 Thailand.

Tel: +66 (0) 4336 2145-6 ext.603 **Fax:** +66(0) 4336 2142

Email: kku.enjournal@gmail.com

Table 2 Mixture by weight of cement boards from coconut shell ash

Ratio	Cement	Fine sand	Coconut shell ash	Tab water
1:0:12	1	0.4	0.12	0.33
1:0:13	1	0.4	0.13	0.33
1:0:14	1	0.4	0.14	0.33
1:0:15	1	0.4	0.15	0.33
1:0:16	1	0.4	0.16	0.33

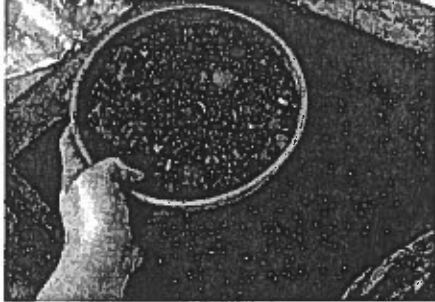


Figure 1 Sieving of coconut shell ash through sieve no.8 for size selection



Figure 2 Vibrate compression machine is used to cast the cement boards

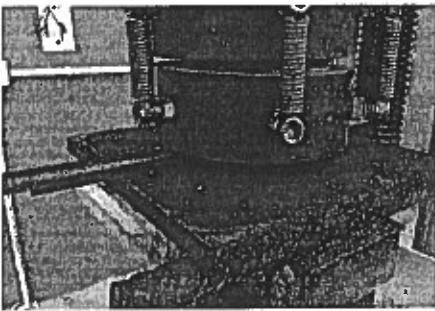


Figure 3 Test of bending strength and elasticity modulus of cement boards



Figure 4 Image of coconut shell ash by SEM at zoom 500 times

3. Results and discussions

The test results of cement board mixed with different coconut shell ash quantities include the general characteristic, density, thermal conductivity, swelling, bending strength, elastic modulus, and tensile strength perpendicular with surface that show as following.

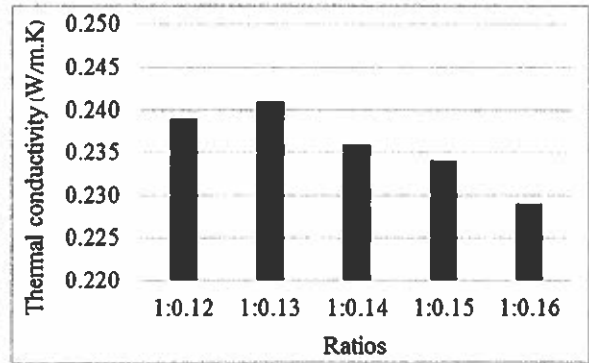


Figure 5 Thermal conductivity of cement boards mixed with coconut shell ash at 28 days

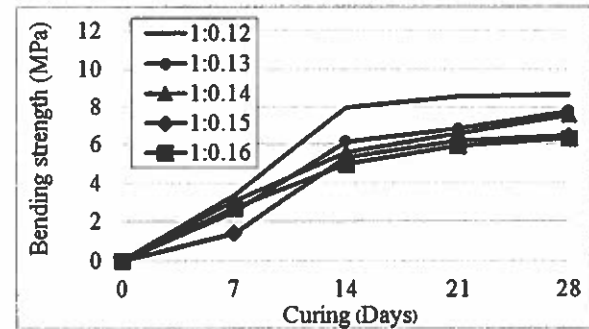


Figure 6 Bending strength of cement boards mixed with coconut shell ash

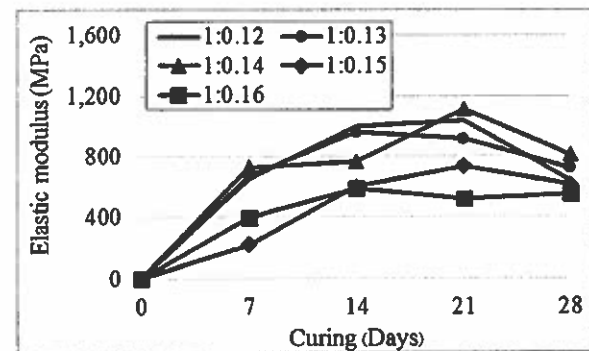


Figure 7 Elastic modulus of cement boards mixed with coconut shell ash



Development of cement boards from coconut shell ash for energy and environment conservation

Pramot Weeranukul*¹⁾ and Kittipong Suweero²⁾

¹⁾Department of Industrial Engineering, Faculty of Industrial Education,
Rajamangala University of Technology Phra Nakhon, Bangkok 10300, Thailand.

²⁾Technology Licensing Office of Rajamangala University of Technology,
Rajamangala University of Technology Thanyaburi, Pathum Thani 12110, Thailand.

Received April 2016
Accepted June 2016

Abstract

This research aims to develop the cement board from coconut shell ash. The Portland cement type 1: fine sand: tap water ratio is equal to 1: 0.4: 0.33 by weight. The 5 ratios of Portland cement type 1: coconut shell ash include 1: 0.12, 1: 0.13, 1: 0.14, 1: 0.15 and 1: 0.16 by weight. The cement board production uses the pressure casting in normal temperature (30 – 35 degree of Celsius) and controls the 0.75 g/cm³ of density, then test the properties of cement-bonded fiberboard follow TIS 878-2537 standard (cement bonded particle board: high density). From the results, 1: 0.12 is the most suitable ratio of cement board from coconut shell ash. This developed cement boards can reduce the quantity of coconut shell ash waste and have the good thermal insulation.

Keywords: Cement board, Coconut shell ash, Thermal insulation, Environment

1. Introduction

Cement boards or cement bonded particle boards are a construction material for construction the prefabricated houses which used as the walls instead of bricks [1]. From the high volume of Thai coconut export, it leaves the wastes of coconut, especially the coconut shell (more than 222,000 tons per year). These wastes usually dispose by burning to generate the electricity. However, this disposal cannot eradicate all of coconut shell but it remains many coconut shell ash [2]. When analyzing the characteristics of coconut shell ash, there combine the chunk and powder of coconut shell which are light weight and high hardness. Therefore, it is possible to put coconut shell ash as the aggregates of cement boards. The objectives of this study are to develop and test the cement boards mixed with coconut shell ash. And these results can lead the utilization of coconut shell ash and preserve the environment from waste disposals.

2. Materials and methods

2.1 Sieve the coconut shell ash through sieve no.8 (2.38 mm) for size selection (see Figure 1) which the coconut shell ash has 1.97 of specific gravity and the chemical composition as show in Table 1.

2.2 Design the 5 ratios of cement boards mixed with coconut shell ashes by weight as Table 2.

2.3 Weight and mix the mixture by measure and concrete mixer.

2.4 Cast the mixture to cement board size 30x30x1.5 cm by using the vibrate compression machine (Figure 2) and flip stand. The cement board casting was controlled by density (must higher than 0.75 g/cm³) [3].

2.5 Cure the cement board mixed with coconut shell ash in the air for 7, 14, 21, and 28 days that follow the testing standards.

2.6 Test the properties of cement board mixed with coconut shell ash with the TIS.878-2537 [4] and ASTM C177 [5]. There are consists of general characteristic, density, thermal conductivity, swelling, bending strength and elastic modulus (Figure 3), and tensile strength perpendicular with surface.

2.7 Analyze and conclude the results of cement boards mixed with coconut shell ash test.

Table 1 The chemical composition of coconut shell ash from XRF analysis

Element	%
SiO ₂	47.30
MgO	16.05
Al ₂ O ₃	15.34
Fe ₂ O ₃	12.38
CaO	0.57
K ₂ O	0.53
Na ₂ O	0.49
ZnO	0.29
MnO	0.20

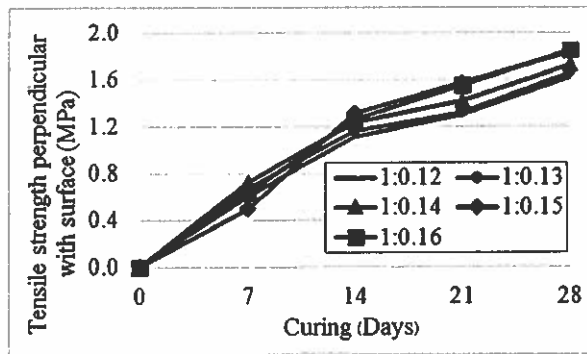


Figure 8 Tensile strength perpendicular with surface of cement boards mixed with coconut shell ash

From the results, 5 ratios of the cement board mixed with coconut shell ash had the good characteristics both of thickness and surface as the requirement of TIS.878-2537 standard [4]. When mixed the different ratios of coconut shell ash into the cement board, there were many effects to the properties including: the thermal conductivity, bending strength, elastic modulus, and tensile strength perpendicular with surface. The porosity of coconut shell ashes (Figure 4) in cement boards had affecting to decrease the thermal conductivity (Figure 5) and prevent the heat transfer [6]. The thermal conductivity of every ratios of cement board mixed with coconut shell ash can pass the TIS.878-2537 standard (no greater than 0.25 W/m.K) [4]. Moreover, the coconut shell ash also decreased the bending strength and elastic modulus of cement boards (see Figure 6 and 7) which lower than the TIS.878-2537 standard (must higher than 9 and 3,000 MPa, respectively) [4]. The values of elastic modulus were confused from the uncertain distribution of porous coconut shell ash that affected the strength behaviors, especially the values related with the deflection as elastic modulus. According to Figure 8, the tensile strength perpendicular with surface of cement boards were increased by coconut shell ash which all the cement boards mixed with coconut shell ash can pass the TIS.878-2537 standard (must higher than 0.5 MPa) [4]. The tensile strength of cement boards mixed with coconut shell ash were increased because the characteristic of some chunk in coconut shell ash had the tapered shape [7] as see in Figure 4. When compared the density of cement boards mixed with coconut shell ash and the standard of TIS.878-2537, there are 2,280 to 2,330 kg/m³ [4] of cement boards mixed with coconut shell ash which higher than the standard almost 2 times (the density must be 1,100 to 1,300 kg/m³). While the swelling of all cement boards were in range of the TIS.878-2537 with the values less than 2% (0.79 to 0.83% were the swelling values of the every sample) [4].

4. Conclusions

The development of cement board from coconut shell ash for energy conservation and environmental shown that coconut shell ash could cast by using the vibrate compression machine and flip stand. Result of testing properties when compared with TIS. 878-2537 found that the some properties of cement boards mixed with coconut shell ash still could not pass the standard. According to the porous surfaces and tapering shape of coconut shell ash, the increasing of this ash can improves the thermal insulation and tensile strength perpendicular with surface of the cement boards. The suitable ratio of cement board mixed with coconut shell ash

is 1:0.12 which had highest bending strength. Although the density, bending strength, and elastic modulus of cement board mixed with coconut shell ash could not pass the standard, there are possibility to produce as the cement board products because this standard is not perfect controlling for every markets. Moreover, the production of cement board mixed with coconut shell ash is more quickly (1 minutes of casting process) and low investment cost (use the machine as same as concrete block production) when compare to common cement board production (12 hours of casting process). Furthermore, this cement board product can lead the utilization of coconut shell ash and preserve the environment from waste disposals.

5. Acknowledgements

The authors are grateful to the Rajamangala University of Technology Phra Nakhon for financially supporting this study.

6. References

- [1] Department of Industrial Promotion. Cement plywood. Bangkok: Department of Industrial Promotion; 1996.
- [2] Center of Agriculture Information. Agriculture statistics of Thailand 2001/02. Bangkok: Agriculture Statistics of Thailand; 2002.
- [3] Pablo A. Wood cement boards from wood wastes and fast-growing plantation species for low cost housing. *The Philippine Lumberman* 1989;35:8-53.
- [4] Thai Industrial Standards Institute (TISI). Thai industrial standard: cement bonded particleboards: high density (TIS. 878 - 2537). Bangkok: Thai Industrial Standards Institute; 1994.
- [5] American Society for Testing and Materials (ASTM). Annual book of ASTM standards. Philadelphia: American Society for Testing and Materials; 2010.
- [6] Pakhunworakit T, Puttipairote P, Ounjittichai W, Thisawipat P. Thermal resistance efficiency of building insulation material from agricultural waste. *Journal of Architectural/Planning Research and Studies* 2006;4:3-13.
- [7] Bledzki AK, Gassan J. Composites reinforced with cellulose based fibers. *Progress in Polymer Science* 1999;24:221-274.

