PROPERTIES OF FOAMED CONCRETE WITH PROCESSED SPENT BLEACHING EARTH AS PARTIAL CEMENT REPLACEMENT

ROKIAH BINTI OTHMAN

DOCTOR OF PHILOSOPHY
(CIVIL ENGINEERING)

UNIVERSITI MALAYSIA PAHANG

SUPERVISOR'S DECLARATION

I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the degree of Doctor of Philosophy (Civil Engineering).

_____

(Supervisor's Signature)

Full Name : PM. DR. KHAIRUNISA MUTHUSAMY

Position : ASSOCIATE PROFESSOR

Date : 24 August 2020

STUDENT'S DECLARATION

I hereby declare that the work in this thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Malaysia Pahang or any other institutions.

_____

(Student's Signature)

Full Name : ROKIAH BINTI OTHMAN

ID Number : PAC11004

Date : 24 August 2020

PROPERTIES OF FOAMED CONCRETE WITH PROCESSED SPENT BLEACHING EARTH AS PARTIAL CEMENT REPLACEMENT

ROKIAH BINTI OTHMAN

Thesis submitted in fulfilment of the requirements
for the award of the degree of
Doctor of Philosophy (Civil Engineering)

Faculty of Civil Engineering Technology
UNIVERSITI MALAYSIA PAHANG

AUGUST 2020

ACKNOWLEDGMENTS

In the name of God, the Merciful praise is to God and prayers and peace on our beloved Muhammad the Messenger of Allah (may Allah bless him and grant him peace) and his honourable companions and those who followed for him. All praise to Allah for His grace this study has been conducted successfully. I would like to express my sincere appreciation and thankfulness to my supervisor PM. Dr. Khairunisa Muthusamy for her full guidance from the beginning until the end of this research, encouragement and opinions. I would also like to express my special thanks to Mr. Bee Chan from Eco Innovation Sdn.Bhd. for his assistance and supply of PSBE during the study and all the technical staff at UMP concrete laboratory, CENLAB and FIST for their assistance during preparation of materials and testing. Finally, my regards and blessings go to my beloved family. Words cannot express my gratitude to my parents for all the sacrifices made on my behalf. Special thanks to my husband and daughter for their everlasting moral support and endless love to make me have the courage to reach my goal. I would also like to thank all my final year project students, my best friends Mohd Arif, Youven, Nadia and FKASA colleagues for supporting me and encouraging me to pursue my goal. Thank you all and God bless.

ABSTRAK

Pengeluaran Portland simen membawa kepada sejumlah besar karbon dioksida (CO_2) yang dikeluarkan dari penambatan batu kapur. Berkaitan dengan ini, industri pembinaan berpeluang untuk mengurangkan pelepasan CO_2 dengan menggabungkan bahan buangan atau produk sampingan industri sebagai penggantian simen akan menghasilkan konkrit yang lebih mesra alam. Tanah pelunturan yang digunakan untuk proses penyulingan semasa proses penapisan minyak kelapa sawit membentuk satu enap cemar pepejal yang dipanggil SBE. Sisa buangan ini dibuang di tapak pelupusan tanpa rawatan. SBE dijana dalam kuantiti yang besar dan menjadi semakin sukar untuk mengabaikan pelupusan SBE apabila pengeluaran minyak sawit meningkat. Oleh itu, penyelidikan ini menyelidik kesan SBE yang telah diproses (PSBE) sebagai pengganti separa simen pada sifat-sifat seperti kebolehkerjaan, kekuatan mekanikal dan ketahanlasakan untuk konkrit berbuih (FC). Pemprosesan konkrit berbuih PFC adalah campuran simen dengan buih dan PSBE sebagai pengganti separa simen. Penggunaan PSBE akan mengurangkan penggunaan simen, mengurangkan sisa buangan dibuang di tapak pelupusan dan dapat mengurangkan masalah pencemaran alam sekitar. Objektif pertama kajian ini adalah untuk menentukan peratusan optima PSBE sebagai pengganti separa simen. Eksperimen yang melibatkan enam jenis campuran dengan penggantian separa simen sebanyak 0%, 10%, 20%, 30%, 40% dan 50% PSBE telah dijalankan. Campuran yang mengandungi 30% PSBE spesimen mempamerkan kekuatan mampatan 56% lebih tinggi, 40% lebih tinggi kekuatan lenturan dan modulus keanjalan 58% lebih tinggi berbanding dengan spesimen kawalan konkrit berbuih (FC). Objektif kedua kajian ini adalah untuk mengkaji kesan pengawetan yang berbeza seperti pengawetan air, pengawetan udara, pengawetan air permulaan untuk tujuh hari dan seterusnya pengawetan udara, pengawetan cuaca semula jadi dan pengawetan air permulaan untuk tujuh hari dan seterusnya cuaca semula jadi pada sifat-sifat kekuatan konkrit berbuih. Konkrit berbuih yang mengandungi PSBE dan spesimen yang diawet dalam air awal selama tujuh hari dan seterusnya cuaca semula jadi mempamerkan hasil yang sangat baik, sementara spesimen yang diawet dalam pengawetan udara memberikan hasil terendah berbanding yang lain. Objektif ketiga kajian ini adalah untuk mengkaji sifat-sifat ketahanan konkrit berbuih yang mengandungi PSBE. Spesimen 30%PSBE mempamerkan ketahanan yang lebih baik dengan penyerapan air yang 52% lebih rendah, keliangan yang lebih rendah 45% dan kedalaman karbonasi yang lebih rendah 60% berbanding dengan spesimen kawalan konkrit berbuih (FC). PFC menunjukkan 77% lebih rendah daripada FC terhadap penembusan ion klorida dengan kebolehtelapan rendah sederhana. Pada akhir tempoh rendaman dalam asid hidroklorik, spesimen 30% PSBE mempamerkan ketahanlasakan yang lebih tinggi daripada spesimen kawalan FC dengan kehilangan jisim sebanyak 0.25% dan kehilangan kekuatan mekanikal 5.42% dalam larutan 5% asid selepas 1800 jam. Begitu juga selepas rendaman dalam natrium sulfat, spesimen 30% PSBE mempamerkan ketahanlasakan yang lebih baik daripada spesimen kawalan FC dengan perubahan jisim sebanyak 1.32%, perubahan dalam pengembangan sebanyak 0.98% dan kehilangan kekuatan mekanikal sebanyak 7.5% dalam 5% natrium sulfat selepas 52 minggu. Kajian mikrostruktur telah menunjukkan struktur dalaman PFC menjadi lebih padat daripada spesimen kawalan FC dengan imej kapas yang padat yang berbentuk kecil (CSH) dan beberapa plat heksagon (CH) yang membawa kepada peningkatan kekuatan dan ketahanlasakan. Berdasarkan analisis regresi, hasilnya menunjukkan korelasi yang kuat antara pemboleh ubah bebas yang dipilih dan pemboleh ubah bersandar kerana nilai R^2 lebih dekat dengan satu. Kesimpulannya, konkrit berbuih yang mengandungi 30% PSBE sebagai pengganti separa simen memenuhi syarat untuk kekuatan bebas galas struktur yang telah mempamerkan kekuatan dan ketahanlasakan yang lebih baik daripada konkrit berbuih biasa mempunyai potensi untuk digunakan dalam aplikasi pembinaan.

ABSTRACT

The production of Portland cement leads to a significant amount of carbon dioxide (CO_2) emitted from the calcination of limestone. Related to this, the construction industry stands to reduce CO_2 emission by incorporating waste or industrial by-products as cement replacements that lead to making the concrete more environmentally green. The bleaching earth that used for decolouring during the palm oils refining process form a solid sludge called spent bleaching earth (SBE).The waste usually dumped in a landfill without any treatment. The SBE is generated in large quantity and it is becoming increasingly difficult to ignore the disposal of SBE when production of palm oil increased. Therefore, this research investigates the effect of Processed Spent Bleaching Earth (PSBE) as a partial cement replacement on the fresh properties, mechanical properties and durability properties of foamed concrete (FC). Processed Spent Bleaching Earth Foamed Concrete (PFC) is a mixture of cement paste with pre-foamed foam by using PSBE as partial cement replacement. The usage of PSBE will decrease the cement consumption, lesser the waste thrown at the landfill and reduce the environmental pollution issue. The first objective of the study is to determine the optimum percentage of PSBE as a partial cement replacement. The experiments involved six different types of mixtures with partial replacement of cement by 0%,10%,20%,30%,40% and 50% of PSBE were conducted. Mix containing 30% PSBE specimen exhibited 56% higher compressive strength, 40% higher flexural strength and 58% higher modulus of elasticity as compared to control FC. The second objective of the study is to investigate the effect of different curing regimes such as water curing, air curing, initial water for 7days and follow by air curing, natural weather and initial water for 7days and follow by natural weather on the mechanical properties of FC containing PSBE. The specimen cured in initial water for 7days and follow by natural weather exhibited excellent results, while specimen cured in air curing provides lowest results compared to others. The third objective of the study is to investigate the durability properties of FC containing PSBE. It is interesting to note that 30% PSBE specimen exhibited better durability with 52% lower water absorption, 45% lower porosity and 60% lower carbonation depth as compared to control FC. The 77% lower charge passes than FC shown the great resistance to chloride ion penetration with low moderate permeability. At the end of the immersion period in hydrochloric acid, the 30%PSBE specimen exhibit better durability than control specimen FC with 0.25% loss in mass and 5.42% loss in strength in 5% acid solution for 1800 hour. Similarly, after immersion in sodium sulphate, the 30%PSBE specimen exhibit better durability than control specimen FC with 1.32% change in mass, 0.98% change in expansion and 7.5% loss in strength in the 5% sodium sulphate after 52 weeks. The microstructure study has confirmed that inclusion of PSBE in FC is known to improve the internal structure of PFC to be denser than control FC specimen with the visible image of crowded tiny of cotton shaped (CSH) and few hexagonal plates (CH) contributing to enhanced strength and durability. Based on the regression analysis, the results show strong correlation between the selected independent variable and dependent variable due to the R^2 value closer to one. Conclusively, the foamed concrete containing 30% PSBE as partial cement replacement fullfill the requirement for strength of structural bearing load which exhibits enhanced strength and durability than plain foamed concrete has the potential to be used in construction application.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF SYMBOLS

%	Percentage
°C	Degree Celcius
μm	Micrometre
ρ	Density
σ	Stress
θ	Degree
T	Temperature
k	Thermal conductivity
±	Plus minus sign
σ	Compressive strength
P	Maximum Load
A	Cross sectional area
N	newton
f	Flexural strength
F	Maximum Load of prism
ε	Strain
Q	Heat Conduction

LIST OF ABBREVIATIONS

ASTM	American Society for Testing and Materials
Al_2O_3	Aluminium Oxide
BS	British Standard
BS EN	Bristish European Standard
Ca	Calcium
Si	Silicon
Al	Aluminium
Mg	Magnesium
K	Potassium
Fe	Ferum
$CaCO_3$	Calcium Carbonate
CH	Calcium Hydroxide
CO_2	Carbon Dioxide
C_3A	Tricalcium Aluminate
C_3S	Tricalcium Silicate
CSH	Calcium Silicate Hydrate
FC	Foamed Concrete
GHG	Greenhouse Gases
H_2O	Water
kg/m^3	Kilogram per meter cube
L	Litre
m^3	Meter cube
MPa	Mega Pascal
mm	Millimeter
OPC	Ordinary Portland Cement
SiO_2	Silicon Dioxide
SBE	Spent Bleaching Earth
PFC	Foamed Concrete with PSBE
PSBE	Processed Spent Bleaching Earth
w/c	Water cement ratio
LOI	Loss on Ignition

SEM	Scanning Electron Microscopy
FA	Fly ash
GGBS	Groung granulated furnace slag
SF	Silica fume
RHA	Rice husk ash
POFA	Palm oil ash
XRD	X-ray diffraction
ACI	American Concrete Institute
BET	Brunauer Emmet Teller
EDS	Energy dispersive x-ray spectroscopy
TG	Thermogravitimetric
DTA	Differential thermal analysis
FMD	Foamed concrete mix design
DOE	Design of experiment
MIRHA	Mirowave incinerated rice husk ash
E	Modulus of elasticity
HCI	Hydrochloric acid
W/mk	Thermal
AC	Air curing
WI	Water immersion
NW	Natural weather
7AC	7 days water immersion and then followed by air curing
7NW	7 days water immersion and then followed by natural weather Curing
RCPT	Rapid Chloride Permeability Test

REFERENCES

Abd Elrahman, M., El Madawy, M., Chung, S.-Y., Sikora, P., & Stephan, D. (2019). Preparation and Characterization of Ultra-Lightweight Foamed Concrete Incorporating Lightweight Aggregates. *Applied Sciences*, *9*(7), 1447.

Abd, A. M., & Abd, S. M. (2017). Case Studies in Construction Materials Modelling the Strength of Lightweight Foamed Concrete Using Support Vector Machine (SVM). *Case Studies in Construction Materials*, *6*, 8–15.

Ahmad, I. A., Pertiwi, N., & Taufieq, N. A. S. (2018). Reliability of Rice Husk Ash as Substitution of Portland Composite Cement Producing Green Concrete. *Ecology, Environment and Conservation*, *24*(April), S56–S63.

Ahmad, M. H., & Noor, N. M. (2010). Chemical Attack of Malaysian Pozzolans Concrete. *Journal of Science and Technology*, *1*(1), 11–24.

Ahmad, S., Barbhuiya, S. a., Elahi, a., & Iqbal, J. (2011). Effect of Pakistani Bentonite on Properties of Mortar and Concrete. *Clay Minerals*, *46*(1), 85–92.

Alengaram, U., Al Muhit, B. A., bin Jumaat, M. Z., & Jing, M. L. Y. (2013). A Comparison of the Thermal Conductivity of Oil Palm Shell Foamed Concrete With Conventional Materials. *Materials and Desig*n, *51*, 522–529.

Al-Chaar, G. K., Alkadi, M., & Asteris, P. G. (2013). Natural Pozzolan as a Partial Substitute for Cement in Concrete, *The Open Construction and Building Technology Journal*, *7*(1), 33–42.

Al-Chaar, G. K., Alkadi, M., Yaksic, D. A., & Kallemeyn, L. A. (2011). *The use of natural pozzolan in concrete as an additive or substitute for cement* (No. ERDC/CERL-TR-11-46).

Aldridge, D. (2000). Foamed Concrete. *Concrete*, *34*(4), 20-2.

Aldridge, D. (2005). Introduction to Foamed Concrete (What,Why,How?). In M. D. N. & A. M. Ravindra K. Dhir (Ed.), *Use of Foamed Concrete in Construction* (1 edition, pp. 1–14). Thomas Telford Publishing.

Ali, S., Arsalan, R., Khan, S., & Yiu, T. (2012). Utilization of Pakistani Bentonite as Partial Replacement of Cement in Concrete. *Construction and Building Materials*, *3*0, 237–242.

Allahverdi, A., & Skvara, F. (2000). Acidic Corrosion of Hydrated Cement Based Materials - Part 1. *Ceramics − Silikáty*, *3*(44), 114–120.

Altwair, N. ., Megat Johari, M. ., & Saiyid Hashim, S. . (2011). Strength Activity Index and Microstructural Characteristics of Treated Palm Oil Fuel Ash. *International Journal of Civil and Environmental Engineering*, *11*(5), 100–107.

Al-Zahrani, A. A., & Daous, M. A. (2000). Recycling of Spent Bleaching Clay and Oil Recovery. *Trans IChemE*, *78*(Part B, May), 224–228.

American Concrete Institute ACI 523.3R14, April, 2014, Guide for Cellular Concretes above 50lb/ft^3.

Amran, Y. H. M., Farzadnia, N., & Abang Ali, A. A. (2015). Properties and Applications of Foamed Concrete; A Review. *Construction and Building Materials*, *101*, 990–1005.

Asadi, I., Shafigh, P., Abu Hassan, Z. F. Bin, & Mahyuddin, N. B. (2018). Thermal Conductivity of Concrete – A review. *Journal of Building Engineering*, *20*(April), 81–93.

Asadzadeh, S., & Khoshbayan, S. (2018). Multi-objective Optimization of Influential Factors on Production Process of Foamed Concrete Using Box-Behnken Approach. *Construction and Building Materials*, *170*, 101–110.

ASTM C1012 / C1012M-18b, Standard Test Method for Length Change of Hydraulic-Cement Mortars Exposed to a Sulfate Solution, ASTM International, West Conshohocken, PA, 2018

ASTM C109 / C109M-16a, Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens), ASTM International, West Conshohocken, PA, 2016

ASTM C1161-18, Standard Test Method for Flexural Strength of Advanced Ceramics at Ambient Temperature, ASTM International, West Conshohocken, PA, 2018

ASTM C1202-19, Standard Test Method for Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration, ASTM International, West Conshohocken, PA, 2019

ASTM C129-17, Standard Specification for Nonloadbearing Concrete Masonry Units, ASTM International, West Conshohocken, PA, 2017

ASTM C1437-15, Standard Test Method for Flow of Hydraulic Cement Mortar, ASTM International, West Conshohocken, PA, 2015

ASTM C150 / C150M-19a, Standard Specification for Portland Cement, ASTM International, West Conshohocken, PA, 2019

ASTM C330 / C330M-17a, Standard Specification for Lightweight Aggregates for Structural Concrete, ASTM International, West Conshohocken, PA, 2017

ASTM C332-17, Standard Specification for Lightweight Aggregates for Insulating Concrete, ASTM International, West Conshohocken, PA, 2017,

ASTM C469 / C469M-14, Standard Test Method for Static Modulus of Elasticity and Poisson's Ratio of Concrete in Compression, ASTM International, West Conshohocken, PA, 2014

ASTM C513 / C513M-11e1, Standard Test Method for Obtaining and Testing Specimens of Hardened Lightweight Insulating Concrete for Compressive Strength, ASTM International, West Conshohocken, PA, 2011

ASTM C618-19, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete, ASTM International, West Conshohocken, PA, 2019

ASTM C642-13, Standard Test Method for Density, Absorption, and Voids in Hardened Concrete, ASTM International, West Conshohocken, PA, 2013

ASTM C78 / C78M-18, Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading), ASTM International, West Conshohocken, PA, 2018

ASTM C796 / C796M-19, Standard Test Method for Foaming Agents for Use in Producing Cellular Concrete Using Preformed Foam, ASTM International, West Conshohocken, PA, 2019

ASTM C869 / C869M-11(2016), Standard Specification for Foaming Agents Used in Making Preformed Foam for Cellular Concrete, ASTM International, West Conshohocken, PA, 2016

ASTM C90-16a, Standard Specification for Loadbearing Concrete Masonry Units, ASTM International, West Conshohocken, PA, 2016

ASTM C94 / C94M-19a, Standard Specification for Ready-Mixed Concrete, ASTM International, West Conshohocken, PA, 2019

Atashgah, K. M., Hashempour, H., & Rezaei, M. K. (2014). An Investigation into the Role of Nano-Silica in Improving Strength of Lightweight Concrete. *European Online Journal of Natural and Social Sciences, 3*(4), 1058–1067. Retrieved from www.european-science.com

Awang, H., Al-Mulali, M. Z., Khalil, H. A., & Aljoumaily, Z. S. (2014). Utilisation of Oil Palm Ash in Foamed Concrete. In *MATEC Web of Conferences* (Vol. 15, p. 01033). EDP Sciences.

Awang,H. & Aljoumaily, Z. S. (2017). Influence of Granulated Blast Furnace Slag on Mechanical Properties of Foam Concrete. *Cogent Engineering*, *4*(1), 1–14.

Awang,H., Mydin, A. O., & Roslan, A. F. (2012a). Effect of Additives on Mechanical and Thermal Properties of Lightweight Foamed Concrete. *Advances in Applied Science Research, 3(*5), 3326–3338.

Awang, H., Mydin, A. O., & Roslan, A. F. (2012b). Microstructural Investigation of Lightweight Foamed Concrete Incorporating Various Additives, *International Journal of Academic Research*, *4*(2), 196–200.

Bakhtyar, B., Kacemi, T., & Nawaz, M. A. (2017). A Review on Carbon Emissions in Malaysian Cement Industry. *International Journal of Energy Economics and Policy*, *7*(3), 282-286.

Barbara, M., Tg, Á., & Ftir, D. T. G. Á. (2017). Investigation of Hydration Products of Fly ash – Slag Pastes. *Journal of Thermal Analysis and Calorimetry*, *130*(1), 351-363.

Barbhuiya, S., & Kumala, D. (2017). Behaviour of a Sustainable Concrete in Acidic Environment. *Sustainability (Switzerland)*, *9*(9).

Bayuaji, R. (2015). The influence of Microwave Incinerated Rice Husk Ash on Foamed Concrete Workability and Compressive Strength Using Taguchi Method. *Jurnal Teknologi*, *75*(1), 265–274.

Benhelal, E., Zahedi, G., Shamsaei, E., & Bahadori, A. (2013). Global Strategies and Potentials to Curb CO2 Emissions in Cement Industry. *Journal of Cleaner Production*, *51*, 142–161.

Beshara, A., & Cheeseman, C. R. (2014). Reuse of Spent Bleaching Earth by Polymerisation of Residual Organics. *Waste Management*, *34*(10), 1770–1774.

Bessenouci, M. Z., Bibi Triki, N. E., Khelladi, S., Draoui, B., & Abene, A. (2011). The Apparent Thermal Conductivity of Pozzolana Concrete. *Physics Procedia*, *21*(August 2015), 59–66.

Bing, C., Zhen, W., & Ning, L. (2012). Experimental Research on Properties of High-Strength Foamed Concrete. *Journal of Materials in Civil Engineering*, *24*(1), 113–118.

Bombatkar, S., Bajad, V., Murkut, V., Khedekar, D., & Jadhao, S. (2017). Review of Foamed Concrete. *International Journal of Research in Advent Technology (IJRAT)*, *Convergence*(April)275-278.

Brady K C and Greene M J (1997). Foamed concrete: A Review of Materials, Methods of Production and Applications. TRL Project Report PR/CE/149/97.

Brady, K. C., Watts, G. R. A., & Jones, M. R. (2001). Specifications for Foamed Concrete–The Use of Foamed Concrete as Backfill. *QS CE Geotechnics and Ground Engineering Highways Agency, TRL Limited, London*.

Brandt, A. M. (2009). Cement Based Composites Materials,Mechanical Properties and Performance. (A. M. Brandt, Ed.) (2nd edition). Taylor & Francis.

Brintha G, S. & Sakthieswaran N. (2018). Acid Attack on Concrete Containing Industrial Wastes. *Journal of Advances in Chemistry*, *12*(10), 4398–4401.

BS EN 12664(2001) Thermal Performance of Building Materials and Products– Determination of Thermal Resistance by Means of Guarded Hot Plate and Heat Flow Meter Methods–dry and Moist Products of Medium and Low Thermal Resistance.

BS EN 12620(2002) Aggregates for Concrete.

BS EN 206-1(2000) Concrete Specification, Performance, Production and Conformity

BS EN 197-1(2000) Cement Part 1: Composition, Specifications and Conformity Criteria for Common Cements. Eur Comm Stand;. p. 1–29

Cheah, K. Y., & Siew, W. (2004). Regeneration of Spent Bleaching Clay. *MPOB, Information Series*, (230).

Chen, B., & Liu, N. (2013). A Novel Lightweight Concrete-fabrication and Its Thermal and Mechanical Properties. *Construction and Building Materials*, *44*, 691–698.

Cheng, L. F., Fu, Y. N., & Zhou, T. Q. (2012). Strength Model Analysis of the Foam Concrete. *In Advanced Materials Research* (Vol. 450, pp. 610-613). Trans Tech Publications.

Chi, J. M., Huang, R., & Yang, C. C. (2002). Effects of Carbonation on Mechanical Properties and Durability of Concrete Using Accelerated Testing Method. *Journal of Marine Science and Technology*, *10*(1), 14–20.

Cho, H.-C., Ju, H., Oh, J.-Y., Lee, K. J., Hahm, K. W., & Kim, K. S. (2016). Estimation of Concrete Carbonation Depth Considering Multiple Influencing Factors on the Deterioration of Durability for Reinforced Concrete Structures. *Advances in Materials Science and Engineering*, *2016*, 1–18.

Çolak, A. (2003). Characteristics of Pastes From a Portland Cement Containing Different Amounts of Natural Pozzolan. *Cement and Concrete Research*, *33*(4), 585–593.

Cong, M., & Bing, C. (2015). Properties of a Foamed Concrete With Soil as Filler. *Construction and Building Materials*, *76*, 61–69.

Dayarathne, W. H. R. S., Galappaththi, G. S., Perera, K. E. S., & Nanayakkara, S. M. A. (2013). Evaluation of the Potential for Delayed Ettringite Formation in Concrete. *19th ERU Symposium, National Engineering Conference 2013, University of Moratuwa, Sri Lanka*, 59–66.

De Rose, L., & Morris, J. (1999). The Influence of Mix Design on the Properties of Microcellular Concrete. *Specialist techniques and materials for construction*, 185-197.

Dransfield J.M., 2000. Foamed Concrete: Introduction to the Product and its Properties, one-day awareness seminar on 'Foamed Concrete: Properties, Applications and Potential, University of Dundee, Scotland, pp. 1-11.

Drimalas, T., Clement, J. C., Folliard, K. J., Dhole, R., & Thomas, M. D. (2011). *Laboratory and Field Evaluations of External Sulfate Attack in Concrete* (No. FHWA/TX-11/0-4889-1) 7, 190.

Duan, P., Yan, C., & Zhou, W. (2016). Influence of Partial Replacement of Fly Ash by Metakaolin on Mechanical Properties and Microstructure of Fly Ash Geopolymer Paste Exposed to Sulfate Attack. *Ceramics International*, *42*(2), 3504–3517.

Edwin R. (2011). How Does Pozzolanic Reaction Make Concrete "Green"?. 2011 World of Coal Ash (WOCA) Conference, 1-14.

Eliche-Quesada, D., & Corpas-Iglesias, F. A. (2014). Utilisation of Spent Filtration Earth or Spent Bleaching Earth From The Oil Refinery Industry in Clay Products. *Ceramics International*, *40*(PB), 16677–16687.

EN, B. (2000). 197-1: 2000 Cement. *Composition, Specifications and Conformity Criteria for Common Cements*.

EN, B. (2006). 14630, 2006. Products and Systems for the Protection and Repair of Concrete Structures. Test Methods. Determination of Carbonation Depth in Hardened Concrete by the Phenolphthalein Method. *British Standard*.

Ezziane, K., Bougara, A., Kadri, A., Khelafi, H., & Kadri, E. (2007). Compressive Strength of Mortar Containing Natural Pozzolan Under Various Curing Temperature. *Cement and Concrete Composites*, *29*(8), 587–593.

Falade, F., Ikponmwosa, E., & Fapohunda, C. (2013). A Study on the Compressive and Tensile Strength of Foamed Concrete Containing Pulverized Bone as a Partial Replacement of Cement, *Pakistan Journal of Engineering and applied Science*,13, 82–93.

Falliano, D., De Domenico, D., Ricciardi, G., & Gugliandolo, E. (2018). Mechanical Characterization of Extrudable Foamed Concrete: An Experimental Study. *World Academy of Science, Engineering and Technology International Journal of Civil and Environmental Engineering*, *12*, 228-232.

Feng-qing, Z., Jun-qin, L., Qian, L., & Hao, L. (2011). Study of Foamed Concrete from Activated Ash / slag Blended Cement, *In Advanced Material Research*, *162*, 821–826.

Fernandez, R., Martirena, F., & Scrivener, K. L. (2011). The Origin of the Pozzolanic Activity of Calcined Clay Minerals: A Comparison Between Kaolinite, Illite and Montmorillonite. *Cement and Concrete Research*, *41*(1), 113–122.

Ferraris, C. F., Stutzman, P. E., & Snyder, K. A. (2006). Sulfate Resistance of Concrete: A New Approach. *R&D Serial*, *2486*.

Foletto, E. L., Alves, C. C. A., Sganzerla, L. R., & Porto, L. M. (2002). Regeneration and Utilization of Spent Bleaching Clay. *Latin American Applied Research*, *32*(2), 205-208.

Fouad, F. H. (2013). Chapter 47: Cellular Concrete. *In Significance of Tests and Properties of Concrete and Concrete-Making materials,ASTM International 2013*,561-569.

Franus, W., Panek, R., & Wdowin, M. (2015). SEM Investigation of Microstructures in Hydration Products of Portland Cement. In E. K. Polychroniadis, A. Y. Oral, & M. Ozer (Eds.), *2nd International Multidisciplinary Microscopy and Microanalysis Congress* (pp. 105–112). Cham: Springer International Publishing.

Gelim, K. A. M.(2011). *Mechanical and Physical Properties of Fly Ash Foamed Concrete* (Doctoral dissertation, Universiti Tun Hussein Onn Malaysia).

Ghorbani, S., Sharifi, S., Brito, J. De, Ghorbani, S., Ahmadi, M., & Tavakkolizadeh, M. (2019). Using Statistical Analysis and Laboratory Testing to Evaluate the Effect of Magnetized Water on the Stability of Foaming Agents and Foam Concrete. *Construction and Building Materials*, *207*, 28–40.

Giannakou, A. (2013). Thermally Insulating Foundations and Ground Slabs Using Highly-Foamed Concrete, *Journal of ASTM International*, *1*(6), 1–13.

Gökçe, H. S., Hatungimana, D., & Ramyar, K. (2019). Effect of Fly Ash and Silica Fume on Hardened Properties of Foam Concrete. *Construction and Building Materials*, *194*, 1–11.

Gowri, R., & Anand, K. B. (2018, February). Utilization of Fly Ash and Ultrafine GGBS for Higher Strength Foam Concrete. In *IOP Conference Series: Materials Science and Engineering* (Vol. 310, No. 1, p. 012070).

Gunawan, P., & Setiono. (2014). Foamed Lightweight Concrete Tech Using Galvalum Az 150 fiber. *Procedia Engineering*, *95*(Scescm), 433–441.

Gupta, P. K. (2017). Effect of Acidic Environment on Self Compacting concrete, *International Journal of Civil Engineering and Technology (IJCIET), 8*(2), 595-606.

Habeeb, G. A., & Mahmud, H. Bin. (2010). Study on Properties of Rice Husk Ash and Its Use as Cement Replacement Material 3 . Experimental Work 2 . Scope of Work, *13*(2), 185–190.

Habert, G., Choupay, N., Montel, J. M., Guillaume, D., & Escadeillas, G. (2008). Effects of the Secondary Minerals of the Natural Pozzolans on Their Pozzolanic Activity. *Cement and Concrete Research*, *38*(7), 963–975.

Hamidah, M. S., Azmi, I., Ruslan, M. R. A., Kartini, K., & Fadhil, N. M. (2005). Optimisation of Foamed Concrete Mix of Different Sand-cement Ratio and Curing Conditions. In *Use of Foamed Concrete in Construction: Proceedings of the International Conference held at the University of Dundee, Scotland, UK on 5 July 2005* (pp. 37-44). Thomas Telford Publishing.

Heikal, M., Eldidamony, H., El-Didamony, H., Heikal, M., Khalil, K. A., & El-Sanhory, A. (2017). Pozzolanic Activity of Silica Fume With Lime. *Journal of Basic and Environmental Sciences*, *4*(June), 236–246.

Hewayde, E., Ph, D., Nehdi, M., Allouche, E., & Nakhla, G. (2007). Effect of Mixture Design Parameters and Wetting-Drying Cycles on Resistance of Concrete to Sulfuric Acid Attack. *Corrosion*, (February), 155–163.

Hewlett P. (2004). Lea's Chemistry of Cement and concrete. Pozzolana and Pozzolanic Cements. Oxford: Elsevier Science & Technology Books; 2004. p. 471–635.

Hilal, A. a., Thom, N. H., & Dawson, A. R. (2015a). On Void Structure and Strength of Foamed Concrete Made Without/With Additives. *Construction and Building Materials*, *85*, 157–164.

Hilal, A. a., Thom, N. H., & R. Dawson, A. (2015b). The Use of Additives to Enhance Properties of Pre- Formed Foamed Concrete. *International Journal of Engineering and Technology*, *7*(4), 286–293.

Holm, T. A., & Ries, J. P. (2006). Lightweight Concrete and Aggregates. In *Significance of Tests and Properties of Concrete and Concrete-Making Materials*. ASTM International.

Hossain, M. M., Karim, M. R., Hossain, M. K., Islam, M. N., & Zain, M. F. M. (2015). Durability of Mortar and Concrete Containing Alkali-activated Binder With Pozzolans: A Review. *Construction and Building Materials*, *93*, 95–109.

Hu, C., Li, H., Liu, Z., & Wang, Q. (2017). Influence of Curing Conditions on the Compressive Strength of Foamed Concrete. *DEStech Transactions on Environment, Energy and Earth Science*, (PEEE), 1–8.

Huang, Y. P., & Chang, J. I. (2010). Biodiesel Production From Residual Oils Recovered From Spent Bleaching Earth. *Renewable Energy*, *35*(1), 269–274.

Hussin, M. W., Abdullah, K., & Zakaria, F. (2008). Performances of Palm Oil Fuel Ash Cement Based Aerated Concrete in Acidic and Sulphate Environments. In *International Conference on Durability of Building Materials and Components (11DBMC), Istanbul Turkey* (pp. 11-14).

Ibrahim, R. K. H., Hamid, R., & Taha, M. R. (2012). Nanomaterials in Concrete, *2012*(June), 224–229.

Islam, M. M. U., Mo, K. H., Alengaram, U. J., & Jumaat, M. Z. (2015). Mechanical and Fresh Properties of Sustainable Oil Palm Shell Lightweight Concrete Incorporating Palm Oil Fuel Ash. *Journal of Cleaner Production*, *115*, 307–314.

James, T., Malachi, A., Gadzama, E. W., & Anametemfiok, V. (2011). Effect of Curing Methods on the Compressive Strength of Concrete, *30*(3), 14–20.

Jaya, R. P., Bakar, B. H. A., Johari, M. A. M., Ibrahim, M. H. W., Hainin, M. R., & Jayanti, D. S. (2014). Strength and Microstructure Analysis of Concrete Containing Rice Husk Ash Under Seawater Attack by Wetting and Drying cycles. *Advances in Cement Research*, *26*(3), 145-154.

Jones M.R., 2000. Foamed Concrete for Structural Use, One-day Awareness Seminar on 'Foamed Concrete: Properties, Applications and Potential', University of Dundee, Scotland pp. 54-79.

Jones, M. R., & McCarthy, A. (2006). Heat of Hydration in Foamed Concrete: Effect of Mix Constituents and Plastic Density. *Cement and Concrete Research*, *36*(6), 1032-1041.

Jones, M. R., & McCarthy, A. (2005). Utilising Unprocessed Low-lime Coal Fly Ash in Foamed Concrete. *Fuel*, *84*(11), 1398-1409.

Jones, M. R., & McCarthy, A. (2005b). Preliminary Views on The Potential of Foamed Concrete as a Structural Material. *Magazine of Concrete Research*, *57*(1), 21-31.

Just, A., & Middendorf, B. (2008). Microstructure of High-strength Foam Concrete. *Materials Characterization*, *60*(7), 741–748.

Kado, B., Mohammad, S., Lee, Y. H., Shek, P. N., Aida, M., & Kadir, A. (2018). Effect of Curing Method on Properties of Lightweight Foamed Concrete, *International Journal of Emgineering & Technology (IJET), 7*(2.29), 927–932.

Kareem, Q., & Hilal, N. (2015). An overview on the Influence of Pozzolanic Materials on Properties of Concrete, *International Journal of Enhanced Research in Science Technology & Engineering*, *4*(3), 81-92.

Karim, M. R., Hossain, M. M., Khan, M. N. N., Zain, M. F. M., Jamil, M., & Lai, F. C. (2014). On the Utilization of Pozzolanic Wastes as an Alternative Resource of Cement. *Materials*, *7*(12), 7809–7827.

Kavitha, D., & Mallikarjunrao, K. V. N. (2018). Design and Analysis of Foam Concrete,*International Journal of Engineering Trends and Application (IJETA), 5*(3), 113–128.

Kearsley, E. P., & Mostert, H. F. (2005). Designing Mix Composition of Foamed Concrete With High Fly Ash Contents. In *Use of Foamed Concrete in Construction: Proceedings of the International Conference held at the University of Dundee, Scotland, UK on 5 July 2005* (pp. 29-36). Thomas Telford Publishing.

Kearsley, E. ., & Wainwright, P. . (2002a). Ash Content for Optimum Strength of Foamed Concrete. *Cement and Concrete Research*, *32*(2), 241–246.

Kearsley, E. ., & Wainwright, P. . (2002b). The Effect of Porosity on the Strength of Foamed Concrete. *Cement and Concrete Research*, *32*(2), 233–239.

Kearsley, E. P. (1999).*The Effect of High Volumes of Ungraded Fly Ash on the Properties of Foamed Concrete* (Doctoral dissertation, University of Leeds).

Kearsley, E. P., & Wainwright, P. J. (2001a). Porosity and Permeability of Foamed Concrete. *Cement and Concrete Research*, *31*(5), 805-812.

Kearsley, E. P., & Wainwright, P. J. (2001b). The Effect of High Fly Ash Content on the Compressive Strength of Foamed Concrete. *Science*, *31*, 0–7.

Kearsley, E. P., & Wainwright, P. J. (2002c). Ash Content for Optimum Strength of Foamed Concrete. *Cement and Concrete Research*, *32*(2), 241-246.

Khitab, A., Arshad, M. T., Awan, F. M., & Khan, I. (2013). Development of an Acid Resistant Concrete: A Review. *International Journal of Sustainable Construction Engineering and Technology*, *4*(2), 33–38.

Kim, S. J., Yang, K. H., & Moon, G. D. (2015). Hydration Characteristics of Low-heat Cement Substituted by Fly Ash and Limestone Powder. *Materials*, *8*(9), 5847-5861.

Kiani, B., Gandomi, A. H., Sajedi, S., & Liang, R. Y. (2016). New Formulation of Compressive Strength of Preformed-foam Cellular Concrete: An Evolutionary Approach. *Journal of Materials in Civil Engineering*, *28*(10), 04016092.

Kolias, S., & Georgiou, C. (2005). The Effect of Paste Volume and of Water Content on the Strength and Water Absorption of Concrete. *Cement and Concrete Composites*, *27*(2), 211–216.

Kozłowski, M., & Kadela, M. (2018). Mechanical Characterization of Lightweight Foamed Concrete. *Advances in Materials Science and Engineering*, *2018*, 1–8.

Krämer, C., Kowald, T. L., & Trettin, R. H. F. (2015). Pozzolanic Hardened Three-phase-Foams. *Cement and Concrete Composites*, *62*, 44–51.

Kumar Karri, S., Rao, G. V. R., & Raju, P. M. (2016). Strength and Durability Studies on GGBS Concrete. *International Journal of Civil Engineering*, *2*(10), 34–41.

Kuzielová, E., Pach, L., & Palou, M. (2016). Effect of Activated Foaming Agent on the Foam Concrete Properties. *Construction and Building Materials*, *125*, 998-1004.

Lee, Y. L., Tan, C. S., Lim, S. K., Mohammad, S., & Lim, J. H. (2018). Strength Performance on Different Mix of Cement-Sand Ratio and Sand Condition for Lightweight Foamed Concrete. *E3S Web of Conferences*, *65*, 02006.

Leung, C. K. Y., & Lin, M. S. W. (2012). High Performance Cementitious Materials With Thermal Insulation Property, *11th International Conference on Concrete Engineering and Technology (CONCET 2012)* (June), 236–241.

Liew, A. C. M. (2005). New Innovative Lightweight Foam Concrete Technology. In A. M. Ravindra K Dhir, Moray D Newlands (Ed.), *Use of Foamed Concrete in Construction* (1st editio, pp. 45–50). Thomas Telford Publishing.

Lim, S. K., Tan, C. S., Lim, O. Y., & Lee, Y. L. (2013). Fresh and Hardened Properties of Lightweight Foamed Concrete With Palm Oil Fuel Ash as Filler. *Construction and Building Materials*, *46*, 39–47.

Lin, Feng, & Meyer C. (2009). Hydration Kinetics Modeling of Portland Cement Considering the Effects of Curing Temperature and Applied Pressure. *Cement and Concrete Research*, *39*(4), 255-265.

Liu, K., Deng, M., Mo, L., & Tang, J. (2015). Deterioration mechanism of Portland Cement Paste Subjected to Sodium Sulfate Attack. *Advances in Cement Research*, *27*(8), 477–486.

Liu, Z., Zhao, K., Hu, C., & Tang, Y. (2016). Effect of Water-cement Ratio on Pore Structure and Strength of Foam Concrete. *Advances in Materials Science and Engineering*, *2016*.

Lotfy, A., Hossain, K. M., & Lachemi, M. (2016). Mix Design and Properties of Lightweight Self-consolidating Concretes Developed With Furnace slag, Expanded Clay and Expanded Shale Aggregates. *Journal of Sustainable Cement-Based Materials*, *5*(5), 297-323.

Loh, S. K., Cheong, K. Y., & Salimon, J. (2017). Surface-active Physicochemical Characteristics of Spent Bleaching Earth on Soil-plant Interaction and Water-nutrient Uptake: A Review. *Applied Clay Science*, *140*, 59–65.

Loh, S. K., James, S., Ngatiman, M., Cheong, K. Y., Choo, Y. M., & Lim, W. S. (2013). Enhancement of Palm Oil Refinery Waste - Spent Bleaching Earth (SBE) into Bio Organic Fertilizer and Their Effects on Crop Biomass Growth. *Industrial Crops and Products*, *49*, 775–781.

Loh, S. K., Cheong, K. Y., Choo, Y. M., & Salimon, J. (2015). Formulation and Optimisation of Spent Bleaching Earth-based Bio Organic Fertiliser. *Journal of Oil Palm Research*, *27*(1), 57-66.

Loon, L. Y., Mujahid, A., Zaidi, A., Boon, K. H., & Sulaiman, S. (2010). Carbonation and Water Permeability of Foamed Concrete. *International Journal of Sustainable Construction Engineering and Technology*, *1*(1), 33-46 .

Lothenbach, B., Scrivener, K., & Hooton, R. D. (2011). Supplementary Cementitious Materials. *Cement and Concrete Research*, *41*(12), 1244–1256.

Łukowski, P., & Salih, A. (2015). Durability of Mortars Containing Ground Granulated Blast-furnace Slag in Acid and Sulphate Environment. *Procedia Engineering*, *108*, 47–54.

M R Jones, A McCharty, University of Dundee, U. (2005). Behaviour and Assessment of Foamed Concrete for Fill and Highway Applications. In A. M. Ravindra K Dhir, Moray D Newlands (Ed.), *Use of Foamed Concrete in Construction* (1st editio, pp. 61–88). Thomas Telford Publishing.

Ma, L. G., & Song, H. W. (2011). Analysis of Energy-saving Architecture With Self Thermal Insulation Structure of Fiber Reinforced Foamed Concrete. In *Applied Mechanics and Materials* (Vol. 71, pp. 444-446). Trans Tech Publications.

Maldonado-Valderrama, J., Martín-Molina, A., Martín-Rodriguez, A., Cabrerizo-Vílchez, M. A., Gálvez-Ruiz, M. J., & Langevin, D. (2007). Surface Properties and Foam Stability of Protein/surfactant Mixtures: Theory and Experiment. *The Journal of Physical Chemistry C*, *111*(6), 2715-2723.

Małolepszy, J., & Grabowska, E. (2015). Sulphate Attack Resistance of Cement With Zeolite Additive. *Procedia Engineering*, *108*(November), 170–176.

McCarthy, A., & Jones, M. R. (2005). Preliminary Views on the Potential of Foamed Concrete as a Structural Material. *Magazine of Concrete Research*, *57*(1), 21–31.

Meyer, C. (2009). Cement & Concrete Composites The Greening of the Concrete Industry. *Cement and Concrete Composites*, *31*(8), 601–605.

Meziti, C., & Boukerroui, A. (2011). Regeneration of a Solid Waste From an Edible Oil Refinery. *Ceramics International*, *37*(6), 1953–1957.

Miled, K., & Limam, O. (2016). Effective Thermal Conductivity of Foam Concretes: Homogenization Schemes vs Experimental Data and FEM Simulations. *Mechanics Research Communications*, *76*, 96–100.

Mirza, J., Riaz, M., Naseer, a., Rehman, F., Khan, a. N., & Ali, Q. (2009). Pakistani Bentonite in Mortars and Concrete as Low Cost Construction Material. *Applied Clay Science*, *45*(4), 220–226.

Mohamad, N., Samad, A. A. A., Lakhiar, M. T., Othuman Mydin, M. A., Jusoh, S., A., S., & Efendi, S. A. (2019). Effects of Incorporating Banana Skin Powder (BSP) and Palm Oil Fuel Ash (POFA) on Mechanical Properties of Lightweight Foamed Concrete. *International Journal of Integrated Engineering*, *10*(9), 69–76.

Dawood, E. T., Abbas, W. A., & Mohammad, Y. Z. (2016). Proportioning of Foamed Concrete Reinforced with Carbon Fibers. *Engineering and Technology Journal*, *34*(15 Part (A) Engineering), 2864-2876.

Mugahed Amran, Y. H., Abang Ali, A. A., Rashid, R. S. M., Hejazi, F., & Safiee, N. A. (2016). Structural Behavior of Axially Loaded Precast Foamed Concrete Sandwich Panels. *Construction and Building Materials*, *107*, 307–320.

Munir, A., Abdullah, Huzaim, Sofyan, Irfandi, & Safwan. (2015). Utilization of Palm Oil Fuel Ash (POFA) in Producing Lightweight Foamed Concrete for Non-structural Building Material. *Procedia Engineering*, *125*, 739–746.

Nagendra, V. (2018). Ground Granulated Blast Furnace Slag (GGBS): Effect of Particle Size and Dosage on Compressive Strength with Microstructural Analysis of Concrete. *International Journal for Research in Applied Science and Engineering Technology*, *6*(5), 2467–2474.

Nambiar, E. K., & Ramamurthy, K. (2006a). Influence of Filler Type on the Properties of Foam Concrete. *Cement and Concrete Composites*, *28*(5), 475-480.

Nambiar, E. K., & Ramamurthy, K. (2006b). Models Relating Mixture Composition to the Density and Strength of Foam Concrete Using Response Surface Methodology. *Cement and Concrete Composites*, *28*(9), 752-760.

Nambiar, E. K. K., & Ramamurthy, K. (2007a). Air-void Characterisation of Foam Concrete. *Cement and Concrete Research*, *37*(2), 221–230.

Nambiar, E. K. K., & Ramamurthy, K. (2007b). Sorption Characteristics of Foam Concrete. *Cement and Concrete Research*, *37*(9), 1341–1347.

Nambiar, E. K. K., Ramamurthy, K., & Constantiner, D. (2008). Discussion of the Paper "Models Relating Mixture Composition to the Density and Strength of Foam Concrete Using Response Surface Methodology ", *30*, 153–154.

Nambiar, E. K., & Ramamurthy, K. (2008). Models for Strength Prediction of Foam Concrete. *Materials and Structures*, *41*(2), 247.

Namsone, E., Šahmenko, G., & Korjakins, A. (2017). Durability Properties of High Performance Foamed Concrete. *Procedia Engineering*, *172*, 760–767.

Narayanan, N., & Ramamurthy, K. (2000). Structure and Properties of Aerated Concrete : a Review. *Cement and Concrete Composites*, *22*(5), 321–329.

Neville, A.M (1996). Properties of Concrete. Longman group Limited, Essex.

Noordeen, S., Karthikeyan, K., & Parveen, M. a N. (2013). Contribution Of Rice Husk Ash To The Properties Of Cement Mortar And Concrete. *International Journal of Engineering Research & Technology (IJERT*, *2*(4), 388–397.

Olivia, M. (2011). *Durability Related Properties of Low Calcium Fly Ash Based Geopolymer Concrete* (Doctoral dissertation, Curtin University).

Osei, D. Y., & Jackson, E. N. (2012). Compressive Strength and Workability of Concrete Using Natural Pozzolana as Partial Replacement of Ordinary Portland Cement. *Advances in Applied Science Research*, *3*(6), 3658-3662.

Othuman, A., & Wang, Y. C. (2011). Elevated-temperature Thermal Properties of Lightweight Foamed Concrete. *Construction and Building Materials*, *25*(2), 705–716.

Paiva, H., Velosa, A., Cachim, P., & Ferreira, V. M. (2016). Effect of Pozzolans with Different Physical and Chemical Characteristics on Concrete Properties. *Materiales de Construcción*, *66*(322), 083.

Panesar, D. K. (2013). Cellular Concrete Properties and the Effect of Synthetic and Protein Foaming Agents. *Construction and Building Materials*, *44*, 575–584.

Papayianni, I., & Milud, I. A. (2005). Production of Foamed Concrete with High Calcium Fly Ash. In *Use of Foamed Concrete in Construction: Proceedings of the International Conference held at the University of Dundee, Scotland, UK on 5 July 2005* (pp. 23-27). Thomas Telford Publishing.

Park, E. Y., Kato, A., & Ming, H. (2004). Utilization of Waste Activated Bleaching Earth Containing Palm Oil in Riboflavin Production by Ashbya Gossypii. *Journal of the American Oil Chemists' Society*, *81*(1), 57-62.

Pedraza, A. R. M. (1999). Mixture Design Optimisation Of Cellular Concrete. In *Specialist Techniques and Materials for Concrete Construction: Proceedings of the International Conference Held at the University of Dundee, Scotland, UK on 8-10 September 1999* (p. 219). Thomas Telford.

Pekmezci, B. Y., & Akyüz, S. (2004). Optimum Usage of a Natural Pozzolan for the Maximum Compressive Strength of Concrete. *Cement and Concrete Research*, *34*(12), 2175–2179.

Pool, A. V. (2007). National Ready Mixed Concrete Association (NRMCA). *Revista Concrete In focus*.

Prasad, J., Jain, D. K., & Ahuja, a K. (2006). Factors Influencing The Sulphate Resistance of Cement Concrete and Mortar. *Asian Journal of Civil Engineering (Building and Housing)*, *7*(3), 259–268.

Protus, (2014). I*nvestigation of the Pyroprocessing and the Optimum Mix Ratio of Rice Husks, Broken Bricks and Spent Bleaching Earth to Make Pozzolanic Cement* (Doctoral Dissertation, KenyattaUniversity).

Puttappa, C. G., Rudresh, V., Azmi, I., Muthu, K. U., & Raghavendra, H. S. (2008). Mechanical Properties of Foamed concrete. In *Proceedings on CD of the International Conference on Construction and Building Technology (43)* (pp. 491-500).

Rahman, A. M. B. A. (2014). Strength Development of Foamed Concrete. *Material Science*, 1-7.

Ramamurthy, K., Nambiar, E. K. K., & Ranjani, G. I. S. (2009. A Classification of Studies on Properties of Foam Concrete. *Cement and Concrete Composites*, *31*(6), 388–396.

Ramezanianpour, A. A., & Moeini, M. A. (2018). Mechanical and Durability Properties of Alkali Activated Slag Coating Mortars Containing Nanosilica and Silica Fume Mechanical and Durability Properties of Alkali Activated Slag Coating Mortars Containing Nanosilica and Silica Fume. *Construction and Building Materials*, *163*(July), 611–621.

Ramos, T., Matos, A. M., Sousa-coutinho, J., Frias, R., & Frias, R. (2014). Strength and Durability of Mortar Using Cork Waste Ash as Cement Replacement, *17*(4), 893–907.

Rao, N. V., & Meena, T. (2017). A Review on Carbonation Study in Concrete. *IOP Conference Series: Materials Science and Engineering*, *263*(3).

Rashwan, M. M., Megahed, A. R., & Essa, M. S. (2015). Effect of Local Metakaolin on Properties of Concrete and Its Sulphuric Acid Resistance. *Journal of Engineering Sciences*, *43*(2), 183–199.

Ravindra K. Dhir, Moray. D. N. & Aikaterini McCarthy (2005). *Use of Foamed Concrete in Construction*. Thomas Telford Publishing.

Richard, A. O., & Ramli, M. (2013). Experimental Production of Sustainable Lightweight Foamed Concrete. *British Journal of Applied Science & Technology*, *3*(4), 994–1005.

Richard, A. O., & Ramli, M. B. (2011). A Qualitative Study of Green Building Indexes Rating of Lightweight Foam Concrete. *Journal of Sustainable Development*, *4*(5), 188–195.

Risdanareni, P., Sulton, M., & Nastiti, S. F. (2016). Lightweight Foamed Concrete for Prefabricated House. *AIP Conference Proceedings*, *1778*(October 2016).

Rum, R. H. M., Jaini, Z. M., Boon, K. H., Khairaddin, S. A. A., & Rahman, N. A. (2017). Foamed Concrete Containing Rice Husk Ash as Sand Replacement: An Experimental Study on Compressive Strength. *IOP Conference Series: Materials Science and Engineering*, *271*, 012012.

Sabir, B. B., Wild, S., & Bai, J. (2001). Metakaolin and Calcined Clays as Pozzolans for Concrete: A Review. *Cement and Concrete Composites*, *23*(6), 441-454.

Saleh, I. S. (2017). Effect of External and Internal Sulphate on Compressive Strength of Concrete. *International Journal of Applied Engineering Research*, *12*(20), 10324–10333.

Sancak, E., & Özkan, Ş. (2015). Sodium Sulphate Effect on Cement Produced with Building Stone Waste. *Journal of Materials*, *2015*, 1–12.

Sangiorgi, C., Tataranni, P., Simone, A., Vignali, V., Lantieri, C., & Dondi, G. (2014). Waste Bleaching Clays as Fillers in Hot Bituminous Mixtures. *Construction and Building Materials*, *73*, 320–325.

Sanjaya, C. S., Tamilselvan, T., & Wee, T. H. (2007). Permeability of Foamed Concrete. *32ndConference on Our World In Concrete & Structures*, 28-29.

Sarathy, R. V., & Dhinakaran, C. (2014). Strength and Durability Characteristics of GGBFS Based HPC. *Asian Journal of Applied Sciences*, *7*(4), 224-231.

Sengul, O., & Tasdemir, M. A. (2009). Compressive Strength and Rapid Chloride Permeability of Concretes with Ground Fly Ash and Slag. *Journal of Materials in Civil Engineering*, *21*(9), 494–501.

Shaikh, F. U. A. (2016). Mechanical and Durability Properties of Fly Ash Geopolymer Concrete Containing Recycled Coarse Aggregates. *International Journal of Sustainable Built Environment*, *5*(2), 277-287.

Shannag, M. J. (2011). Characteristics of Lightweight Concrete Containing Mineral Admixtures. *Construction and Building Materials*, *25*(2), 658–662.

Siva, G. I., & Ramamurthy, K. (2012). Cement & Concrete Composites Behaviour of foam concrete under sulphate environments. *Cement and Concrete Composites*, *34*(7), 825–834.

Siva, I., & Ramamurthy, R. K. (2010). Relative Assessment of Density and Stability of Foam Produced with Four Synthetic Surfactants, *Materials and Structures*, *43*(10), 1317–1325.

Sokołowska, J. J., & Woyciechowski, P. (2013). Effect of Acidic Environments on Cement Concrete Degradation. In *Proceedings of the 3rd International Conference on Sustainable Construction Materials & Technologies–SCMT3*.

Stark, J. (2011). Recent Advances in the Field of Cement Hydration and Microstructure Analysis. *Cement and Concrete Research*, *41*(7), 666–678.

Sudha, P., Selvaraj, R., & Palanisamy, T. (2015). Intensification of Calcined Clay as a Pozzolanic Material in Cement Mortar. *International Journal of Applied Engineering Research*, *10*(15), 35640–35644.

Tarasov, A. S., Kearsley, E. P., Kolomatskiy, A. S., & Mostert, H. F. (2010). Heat Evolution Due to Cement Hydration in Foamed Concrete. *Magazine of Concrete Research*, *62*(12), 895-906.

Targan, Ş., Olgun, a., Erdogan, Y., & Sevinc, V. (2003). Influence of Natural Pozzolan, Colemanite Ore Waste, Bottom Ash, and Fly Ash on the Properties of Portland Cement. *Cement and Concrete Research*, *33*(8), 1175–1182.

Thakrele, M. H. (2014). Experimental Study on Foam Concrete. *International Journal of Civil, Structural, Environmental and Infrastructure Engineering Research and Development*, *4*(1), 145–158.

Thokchom, S., Ghosh, P., & Ghosh, S. (2009). Resistance of Fly Ash Based Geopolymer Mortars in Sulfuric Acid. *ARPN J. Eng. Appl. Sci*, *4*(1), 65-70.

Tian, W., & Han, N. (2017). Experiment Analysis of Concrete's Mechanical Property Deterioration Suffered Sulfate Attack and Drying-Wetting Cycles. *Advances in Materials Science and Engineering*, *2017*, 1–13.

Tikalsky, P. J., & Carrasquillo, R. L. (1989). *The Effect of Fly Ash on the Sulfate Resistance of Concrete* (No. FHWA/TX-90+ 481-5). University of Texas at Austin. Center for Transportation Research.

Tironi, A., Trezza, M. A., Scian, A. N., & Irassar, E. F. (2012). Kaolinitic Calcined Clays: Factors Affecting its Performance as Pozzolans. *Construction and Building Materials*, *28*(1), 276-281.

Tsai, W. ., Chen, H. ., Hsieh, M. ., Sun, H. ., & Chien, S. . (2002). Regeneration of Spent Bleaching Earth by Pyrolysis in a Rotary Furnace. *Journal of Analytical and Applied Pyrolysis*, *63*(1), 157–170.

Türkel, S., Felekoğlu, B., & Dulluç, S. (2007). Influence of Various Acids on the Physico-Mechanical Properties of Pozzolanic Cement Mortars. *Sadhana - Academy Proceedings in Engineering Sciences*, *32*(6), 683–691.

Vanier, D. J. (1995). Durability of High Performance Concrete. *Materials and Structures*, *28*(1), 56–61.

Vedalakshmi, R., Sundara Raj, A., & Palaniswamy, N. (2008). Identification of Various Chemical Phenomena in Concrete Using Thermal Analysis. *Indian Journal of Chemical Technology*, *15*(4), 388–396.

Vizcaíno Andrés, L. M., Antoni, M. G., Alujas Diaz, A., Martirena Hernández, J. F., & Scrivener, K. L. (2015). Effect of Fineness in Clinker-calcined Clays-limestone Cements. *Advances in Cement Research*, *27*(9), 546–556.

Walker, R., & Pavía, S. (2011). Physical Properties and Reactivity of Pozzolans, and Their Influence on the Properties of Lime-pozzolan Pastes. *Materials and Structures/Materiaux et Constructions*, *44*(6), 1139–1150.

Wang, K. S., Chiou, I. J., Chen, C. H., & Wang, D. (2005). Lightweight Properties and Pore Structure of Foamed Material Made From Sewage Sludge Ash. *Construction and Building Materials*, *19*(8), 627–633.

Wang, R., Gao, P., Tian, M., & Dai, Y. (2019). Experimental Study on Mechanical and Waterproof Performance of Lightweight Foamed Concrete Mixed with Crumb Rubber. *Construction and Building Materials*, *209*, 655–664.

Wang, S. H. (2011). Preparation of Foam Concrete from Graphite Tailing. *Advanced Materials Research*, *356–360*, 1994–1997.

Wang, Y. C. (2012). Thermal and Mechanical Properties of Lightweight Foamed Concrete at Elevated Temperatures, *Magazine of Concrete Research*, *64*(3),212-224

Wang, Y. W., & Tang, B. X. (2012). Experimental Study of the Foam Agent in Lightweight Aggregate Concrete. *Applied Mechanics and Materials*, *226–228*, 1776–1779.

Wee, T. H., Daneti, S. B., & Tamilselvan, T. (2011). Effect of w/c Ratio on Air-void System of Foamed Concrete and Their Influence on Mechanical Properties. *Magazine of Concrete Research*, *63*(8), 583-595.

Wee, T. H., Babu, D. S., Tamilselvan, T., & Lim, H. S. (2006). Air-void System of Foamed Concrete and its Effect on Mechanical Properties. *ACI Materials Journal*, *103*(1), 45.

Whittaker, M., & Black, L. (2016). Current Knowledge of External Sulfate Attack. *Advances in Cement Research*, *27*(9), 532-545

Wongkeo, W., & Chaipanich, A. (2010). Compressive Strength, Microstructure and Thermal Analysis of Autoclaved and Air Cured Structural Lightweight Concrete Made with Coal Bottom Ash and Silica Fume. *Materials Science and Engineering A*, *527*(16–17), 3676–3684.

Yang, K. H., Lee, K. H., Song, J. K., & Gong, M. H. (2014). Properties and Sustainability of Alkali-activated Slag Foamed Concrete. *Journal of Cleaner Production*, *68*, 226–233.

Yang, K.-H., & Song, J.-K. (2009). Workability Loss and Compressive Strength Development of Cementless Mortars Activated by Combination of Sodium Silicate and Sodium Hydroxide. *Journal of Materials in Civil Engineering*, *21*(3), 119–127.

Yetgin, Ş., & Çavdar, A. (2006). Study of Effects of Natural Pozzolan on Properties of Cement Mortars. *Journal of Materials in Civil Engineering*, *18*(6), 813-816.

Yoo, C. K., & Lin, S. W. (2004). Regeneration of Spent Bleaching Clay. *Malaysian Palm oil Board, Ministry of Plantation Industries and Communities, MPOB TT*, (230).

Yu, Luo, Gao, Wang, Li,Wei, & Wang (2011). Pore Structure and Microstructure of Foam Concrete. In *Advanced Materials Research* (Vol. 177, pp. 530-532). Trans Tech Publications.

Yu, X. G., Gao, Y. N., Lin, L., & Li, F. (2012). Influence of Foaming Agent on the Properties of High Density Foam Concrete. In *Advanced Materials Research* (Vol. 399, pp. 1214-1217). Trans Tech Publications.

Yu, X. G., Luo, S. S., Gao, Y. N., Xiao, H., Li, D. J., Xu, H. C., & Li, F. (2012). Microstructure, Mineral Phases and Strength of the Foam Concrete. In *Key Engineering Materials* (Vol. 492, pp. 484-488). Trans Tech Publications.

Zhao, W., Huang, J., Su, Q., & Liu, T. (2018). Models for Strength Prediction of High-Porosity Cast-in-situ Foamed Concrete. *Advances in Materials Science and Engineering*, *2018*(1),1-10.

Zhao, X., Lim, S.-K., Tan, C.-S., Li, B., Ling, T.-C., Huang, R., & Wang, Q. (2015). Properties of Foamed Mortar Prepared with Granulated Blast-Furnace Slag. *Materials*, *8*(2), 462–473.

Zulkarnain, F., & Ramli, M. (2011a). Durability of Performance Foamed Concrete Mix Design with Silica Fume for Housing Development. *Journal of Materials Science and Engineering*, *5*, 518–527.

Zulkarnain, F., & Ramli, M. (2011b). Rational Proportion for Mixture of Foamed Concrete Design. *Jurnal Teknologi*, *55*(May), 1–12.

Zych, T. (2014). Test Methods of Concrete Resistance to Chloride Ingress. *Civil Engineering Issue 6-B, Technical Transaction*, *21*, 117-139