CENTRE FOR RESEARCH AND INNOVATION
Politeknik Sultan Salahuddin Abdul Aziz Shah
Persiaran Usahawan,
Seksyen U1,
40150 Shah Alam,
Selangor.

ISSN 2462-2524

Sekapur Sirih

Assalamualaikum w.b.t dan Salam Sejahtera.

Alhamdulillah, syukur ke hadrat Allah S.W.T. kerana dengan limpah kurniaNya sebuah Diges Akademik PSA bagi tahun 2020 telah berjaya dihasilkan. Syabas dan tahniah saya ucapkan kepada Jawatan Kuasa Penerbitan yang diselaraskan oleh Pusat Penyelidikan dan Inovasi Politeknik Sultan Salahuddin Abdul Aziz Shah.

Penerbitan Diges ini adalah satu usaha murni bagi mendokong aspirasi negara dalam memperkayakan koleksi bahan ilmiah di Institusi Pengajian Tinggi terutamanya dalam bidang TVET. Usaha ini juga membuktikan bahawa kita sentiasa responsif dan relevan dalam bidang penulisan, penyelidikan dan inovasi selaras dengan hasrat Pelan Pembangunan Pendidikan Tinggi Negara. Penulisan ini juga adalah diharapkan akan menjadi wadah bagi perkongsian ilmu, pemikiran dan kepakaran di kalangan warga PSA, pihak industri dan komuniti setempat.

Bagi menggalak dan menyemarakkan usaha penulisan ilmiah ini, pihak PSA telah memperkenalkan Anugerah Bitara kepada semua warga mulai tahun 2019. Kini, satu unit khas bagi menerbitkan karya-karya penulisan telah ditubuhkan. Adalah diharapkan agar usaha penulisan dan penerbitan di institusi ini akan terus berkembang sehingga ianya menjadi satu budaya dalam menambahkan khazanah ilmu negara. Akhirnya, saya mendoakan agar Diges ini akan dapat dimanfaatkan oleh semua pihak demi kelestarian ilmu dalam sistem pendidikan negara.

Sekian, terima kasih.

Dr. Hj. Mohd Zahari Bin Ismail
Pengarah
Politeknik Premier Sultan Salahuddin Abdul Aziz Shah

Prakata

Assalamualaikum W.B.T. dan Salam Sejahtera

Segala pujian dan kesyukuran ke hadrat Allah S.W.T kerana dengan izin dan limpahan rahmatNya maka Pusat Penyelidikan dan Inovasi (CRI), Politeknik Sultan Salahuddin Abdul Aziz Shah (PSA) telah berjaya menerbitkan Diges Akademik PSA bagi tahun 2020 .

Setinggi tinggi penghargaan dan tahniah diucapkan kepada semua pihak yang terlibat terutamanya kepada Sidang Redaksi Diges 2020, penyelaras CRI Jabatan dan para pensyarah yang telah memberi komitmen dan usaha yang tidak berbelah bahagi dalam menjayakan penerbitan Diges ini.

Penerbitan ini merupakan satu inisiatif oleh Pusat Penyelidikan dan Inovasi (CRI) bagi pengumpulan dan perkongsian idea serta penyelidikan yang berjaya dihasilkan dan digarab untuk tatapan dan manfaat umum. Sumbangan yang sangat berharga ini di harap dapat dijadikan sebagai satu rujukan bagi menyemai minat untuk berfikiran kritis, kreatif dan inovatif dalam menghasilkan penebitan berilmiah.

Justeru itu, diharapkan usaha penerbitan Diges 2020 ini dapat memberi inspirasi kepada pensyarah dan pelajar untuk menghasilkan penulisan berkualiti dan berimpak tinggi. Semoga usaha murni ini akan berterusan sehingga menjadi satu budaya di kalangan pensyarah dan pelajar di PSA.

Sekian, terima kasih.

Dr. Hjh Wan Rosemehah Binti Wan Omar

Ketua Pusat Penyelidikan dan Inovasi

Politeknik Premier Sultan Salahuddin Abdul Aziz Shah

ISI KANDUNGAN

THE STUDY OF CLAY PEBBLES AS PARTIAL REPLACEMENT OF NATURAL AGGREGATE IN CONCRETE

Ainul Haezah Noruzman and Hazruwani Binti A Halim
Politeknik Sultan Salahuddin Abdul Aziz Shah, Persiaran Usahawan Seksyen U1, 40150 Shah Alam, Selangor Darul Ehsan
Corresponding author: ainulhaezah@yahoo.com

Abstract

The study examined the concrete behaviour made with different percentages of lightweight aggregates and compared to normal concrete. The study aimed to investigate the effect of clay pebbles as partial replacement of natural aggregate with percentages of 0%, 10%, 20%, 30%, 40%, and 50%, respectively. The tests involved performance of parameters such as compressive strength and density of concrete. The evaluation of the compressive strength and density was measured at curing age of 28 days. The results indicated that the compressive strength decreased with increasing amount of clay pebble percentage in concrete mixture. The clay pebble concrete showed reduction in density with the increasing amount of clay pebble percentage. The use of 10% of clay pebbles in concrete met the requirement guideline of ACI standard. It was concluded that the application of clay pebbles can be utilized for the application of structural concrete. Hence, this application can probably minimise the exploitation of natural resources especially coarse aggregate for environmental sustainability.

Keywords: *lightweight concrete, clay pebbles, aggregate, compressive strength, density*

1.0 Introduction

Concrete is a composite material which consists of cement, coarse aggregate, fine aggregate, and water. To achieve the desired strength of concrete, the mix often uses additives and reinforcements to enhance the performances in terms of strength and durability. Concrete transforms from a fresh state to hardened state as well as durable stone-like material with various uses, including as foundations, brick, wall, pavements, bridge, highways, parking structures, dams, and reservoir, all over the country.

In Malaysia, it was estimated that 60% (RM138 billion) of the RM 230 billion for development expenditure was budgeted for physical development to be undertaken by the construction sector for enhancing the national economy (Ismail et. al., 2013). The rapid growth in this sector, in conjunction with economic growth, consequently, indirectly requires considerably high amount of production and consumption of construction minerals such as

natural aggregate and sand. In this regard, high demand for concrete in construction, especially the consumption of natural resources such as gravel and granite, has reduced the natural stone deposits, and at the same time, has caused the irreparable damage to the environment. As a result, it is shifting towards production method using sustainable materials to secure and maintain the preservation of long-term availability of construction mineral supplies (Alengaram et al., 2013; Ismail et al., 2013). One such attempt to reduce the exploitation of natural aggregate is by the application of lightweight aggregate in concrete.

Lightweight concrete (LWC) is a type of concrete which includes an expanding agent that increases the volume of the mixture while giving additional qualities such as lowering the dead weight. The product is lighter than conventional concrete(Sonia, and Subashini, 2017). There are three classifications of lightweight concrete depending on the unit weight or density, normally ranged from 320 to 1920 kg/m^3 (Chaipanich and Chindaprasirt, 2015) According to ACI 213 (2001), it can be classified in terms of strength which are low strength concrete (0.7-2.0 MPa), moderate strength concrete (7-14 MPa), and structural concrete (17-63 MPa). The density of these concretes is in the range of 300-800 kg/m^3, 800-1350 kg/m^3, and 1350-1920 kg/m^3, respectively. These applications have been used since the early 1900s in the United States, and LWC has been used in multi-storey buildings, long span bridges, off-shore platforms, and large structures (Mindess et al., 2003). The advantages of using LWC in construction are due to its low density, low thermal conductivity, low shrinkage and high heat resistance, in addition to reduction in dead load, lower cost, and faster building rate (Wongkeo et al., 2012).

Researchers have attempted to produce lightweight concrete by replacing natural aggregate with natural materials such as volcanic pumice, expanded glass, clay, shale, and expanded leca (Divya, et al., 2017; Kurpinska and Kułak, 2019; Singh, 2016). As a result, replacements with aggregates made of industrial by-products such as fly ash, bottom ash, oil palm shell, palm oil clinker, and promising results were obtained (Malkawi et al., 2020; Nazreen et al., 2018; Wongkeo et al., 2012). The final properties of the LWC depend on the type and mechanical properties of LWA used in the concrete mixture. However, there is little information in the application of light expanded clay known as clay pebbles for agricultural purposes to replace coarse aggregate in concrete. This study aims to investigate the effect of mechanical properties of concrete using clay pebbles as partial replacement of natural aggregate in the mix, and to compare it to conventional concrete. Hence, by utilising this material, it could potentially be used as lightweight aggregate as building material in achieving the characteristic performances of lightweight concrete for construction.

2.0 Experimental Program

2.1 Cement

Ordinary Portland Cement (OPC) complying with BS EN 197-1: 2011 was used in all concrete mixes. The chemical composition of the cement is as shown in Table 1.

Table 1: Chemical composition of cement

Composition	Percentage
SiO_2	2.10
Al_2O_3	0.497
Fe_2O_3	2.48
CaO	49.50
SO_3	0.496
MgO	0.201

2.2 Aggregate

Natural river-washed quartz sand complying with BS 882: 1992 was used as fine aggregate respectively. The size of river sand passing sieve of 2.36 mm was used, and its fineness modulus was 4.21. On the other hand, the coarse aggregate used was crushed granite with maximum nominal size of 12 mm. Care was taken to ensure the coarse aggregates used were free from deleterious particles of dry mud, leaves and other deleterious materials.

2.3 Clay Pebbles

Clay pebbles were used as partial replacement of natural aggregate in concrete mixture. The clay pebbles have a variety of colours from light to dark brown as shown in Figure 1. The clay pebbles used were manufactured by heating clay to around 1200 ˚C in a rotary kiln. The yield gasses expanded the clay by thousands of small bubbles during heating producing a honeycomb structure. The clay pebbles were approximately round- or potato-shaped due to circular movement in the kiln and were available in different sizes and densities. The size used in the study was about 2-10 mm in diameter of clay pebbles, normally used for agriculture or horticulture purposes.

Figure 1: Clay pebbles

2.4 Admixture

To enhance the mixing process, plasticizer was added to improve the workability of concrete. Plasticizer is a liquid form of cement admixture and allows the water cement ratio to be reduced. The plasticizer used was from the brand Pentens Q-Set.

2.5 Mix proportion

The mix proportion of LWC used in the study was 1: 1.5: 3 and 0.45 water cement ratio was employed for all concrete types. The compositions of clay pebbles used as replacement for natural aggregate were 0%, 10%, 20%, 30%, 40%, and 50% in concrete. All mix proportions are shown in Table 2.

Table 2: Mix proportion of concrete

Specimen	Cement (Kg)	Sand (Kg)	Gravel (Kg)	Clay Cement pebbles (Kg)	Plasticizer (g)	Water (Kg)
CPC0%	5.7	8.6	16.9	-	57	2.57
CPC10%	5.7	8.6	15.21	1.69	57	2.57
CPC20%	5.7	8.6	13.52	3.38	57	2.57
CPC30%	5.7	8.6	11.83	5.57	57	2.57
CPC40%	5.7	8.6	10.14	6.76	57	2.57
CPC50%	5.7	8.6	8.45	8.45	57	2.57

2.6 Compressive Strength Test

The concrete sample used mould sized 150 mm x 150 mm x 150 mm and casted for about 36 cubes for compressive strength. The test was carried out according to BS EN 12390-3: 2009. The samples were tested at 28 days. The average of three values was taken as the strength value for all batches.

3.0 Results and Discussion

3.1 Effect of clay pebbles in concrete strength properties

The compressive strength results of light weight concrete containing clay pebbles at various percentages and tested at curing ages of 28 days are depicted in Figure 2. Replacement of natural aggregate with clay pebbles reduced the compressive strength for all mixtures. This can be related to the lower strength of clay pebble aggregate compared to the natural aggregate in concrete. Clay pebble content also affected the rate of strength development of concrete mixture as shown in Figure 3. Higher percentage replacement of clay pebbles with 50% of addition in concrete showed lower strength compared to clay pebbles at 10% of addition in the concrete mixture. However, when compared to control specimen, the increment in the compressive strength loss at 28 days was higher. The reduction in strength may be attributed to the cement binder-aggregate bonding failure. The particles of clay pebbles which were round due to the effects of its manufacturing could possibly contribute towards lower strength as well as the presence of void within the clay pebbles and natural aggregate which allowed fast crack propagation and hastened failure under applied load. The incorporation of clay pebbles as partial replacement of natural aggregate in concrete showed similar results to other research findings (Rashad, 2018). The results of compressive strength of 10% of clay pebbles probably met the specification of ACI for the application for structural concrete with the range of strength within 14-63 MPa as shown in Table 3.

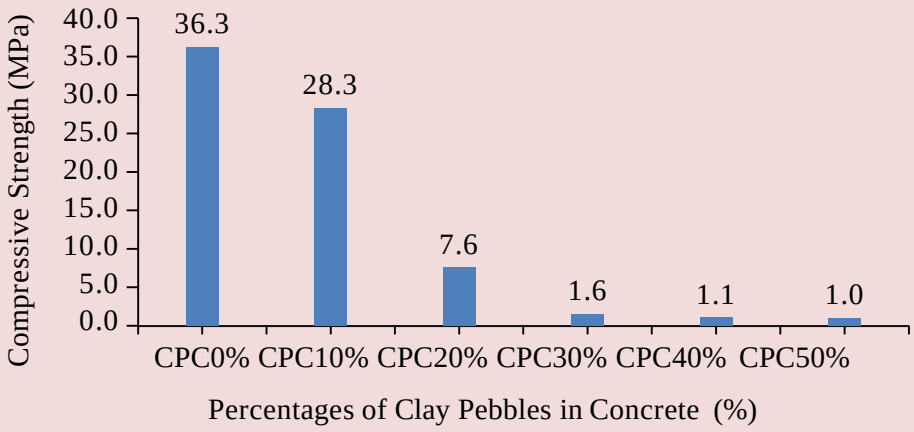


Figure 2: Results of compressive strength of clay pebble concrete at 28 days

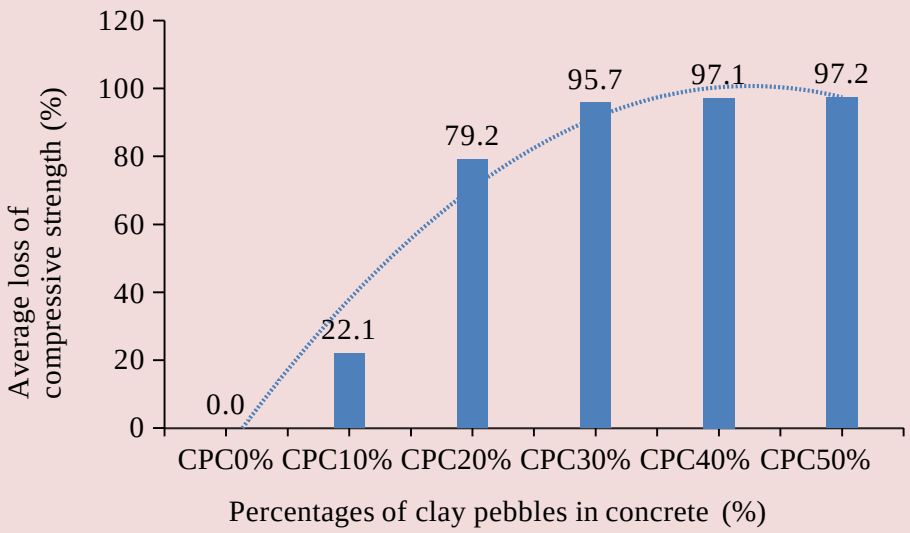


Figure 3: Average loss of compressive strength at the age of 28 days of different mixtures

3.2 Effect of clay pebbles in density of concrete properties

The density of the clay pebble concrete specimen and control is presented in Figure 4. The density of concrete was determined by measuring the volume of concrete over mass of concrete. The figure shows that higher percentages of clay pebbles cause the density of the concrete to be lighter than the normal weight concrete. The reduction in density could be associated to its low specific gravity, and the incorporation of clay pebbles in the concrete can produce a porous structure which can contribute to this reduction (Rashad, 2018). Based on the characteristics of clay pebbles as well as mix design, the concrete production could be classified as non-structural and structural concrete. Table 3 shows the specification of lightweight concrete in terms of strength and density according to ACI (2003), and clay pebble density has a major effect on the concrete density. The incorporation of 10% of clay pebbles in the concrete mixture met the requirement of ACI standard guideline.

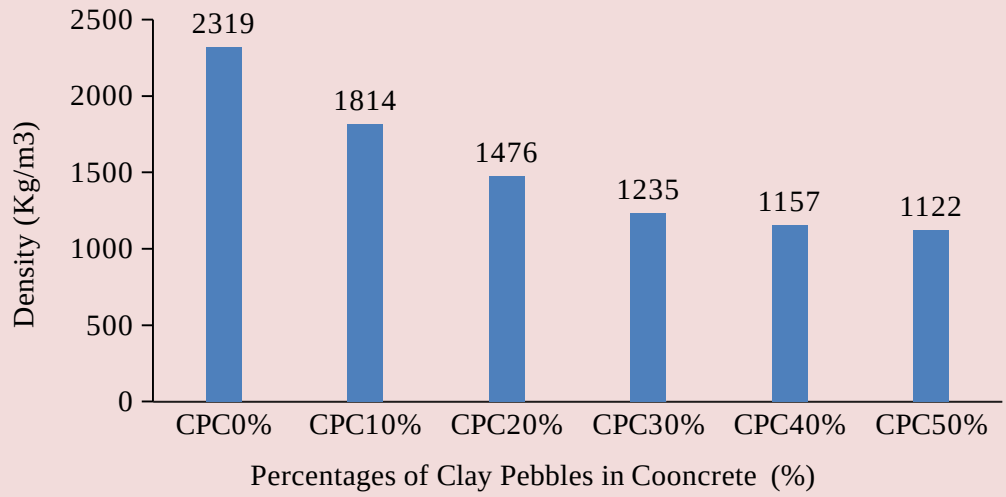


Figure 4: Results of density of clay pebble concrete at 28 days

Table 3: Specification of lightweight concrete in term of strength (Mpa) and density (Kg/m^3) according to ACI (2003)

Specimens	Specification of strength and density		
	Low	Moderate	High
	0.7-2.0 (Mpa) 300-800 (Kg/m^3)	7 - 14(Mpa) 800-1350 (Kg/m^3)	17 - 63 (Mpa) 1350-1920 (Kg/m^3)
CPC0%	-	-	36.3 Mpa 2319 Kg/m^3
CPC10%	-	-	28.3 Mpa 1814 Kg/m^3

4.0 Conclusion

The conclusions that can be drawn from the present study are as follows:

- Clay pebbles are compatible to be used as lightweight aggregate in concrete mixture. Clay pebble concrete can be classified as lightweight concrete.
- The replacement of natural aggregate with clay pebbles could cause a reduction in compressive strength.
- The density and strength properties of clay pebble concrete are comparable to the normal weight concrete. Thus, clay pebbles can be used for structural purposes.
- The incorporation of clay pebbles in the concrete declines its density. The density declines as the clay pebbles increase.

Acknowledgment

The authors gratefully acknowledge the technical staff at Politeknik Sultan Salahuddin Abdul Aziz Shah for the guideline, services, and facilities.

References

ACI 213. (2001). *Guide for structural lightweight aggregate concrete*. American Concrete Institute, Committee 213 Report, Paris.

Alengaram, U. J., Muhit, B. A. Al, and Jumaat, M. Z. Bin. (2013). Utilization of oil palm kernel shell as lightweight aggregate in concrete - A review. *Construction and Building Materials*, *38*, 161–172. https://doi.org/10.1016/j.conbuildmat.2012.08.026

Chaipanich, A., and Chindaprasirt, P. (2015). *The properties and durability of autoclaved aerated concrete masonry blocks*. *Eco-efficient Masonry Bricks and Blocks: Design, Properties and Durability*. Elsevier Ltd. https://doi.org/10.1016/B978-1-78242-305-8.00009-7

Divya Bhavana, T., Kumar, R. K., Nikhil, S., and Sairamchander, P. (2017). Study of light weight concrete. *International Journal of Civil Engineering and Technology*, *8*(4), 1223–1230.

Ismail, S., Hoe, K. W., and Ramli, M. (2013). Sustainable Aggregates: The Potential and Challenge for Natural Resources Conservation. *Procedia - Social and Behavioral Sciences*, *101*(November), 100–109. https://doi.org/10.1016/j.sbspro.2013.07.183

Kurpinska, M., and Kułak, L. (2019). Predicting performance of lightweight concrete with granulated expanded Glass and Ash aggregate by means of using Artificial Neural Networks. *Materials*, *12*(12). https://doi.org/10.3390/ma12122002

Malkawi, A. B., Habib, M., Alzubi, Y., and Aladwan, J. (2020). Engineering properties of lightweight geopolymer concrete using Palm Oil Clinker aggregate. *International Journal of GEOMATE*, *18*(65), 132–139. https://doi.org/10.21660/2020.65.89948

Mindess, S., Young, J. F., and Darwin, D. (2003). *Concrete*. USA: Pearson Education.

Nazreen, M. S., Mohamed, R. N., Ab Kadir, M. A., Azillah, N., Ahmad Shukri, N., Mansor, S., and Zamri, F. (2018). Characterization of lightweight concrete made of palm oil clinker aggregates. *MATEC Web of Conferences*, *250*. https://doi.org/10.1051/matecconf/201825003002

Rashad, A. M. (2018). Lightweight expanded clay aggregate as a building material – An overview. *Construction and Building Materials*, *170*, 757–775. https://doi.org/10.1016/j.conbuildmat.2018.03.009

Singh, N. T. (2016). Effective uses of Light Weight Concrete. *Journal of Civil Engineering and Environmental Technology*, *3*(March), 208–211.

Sonia, T., and Subashini, R. (2017). Experimental Investigation on Mechanical Properties of Lightweight Concrete using LECA and Steel Scraps. *SSRG International Journal of Civil Engineering*, *5*(11), 594–598.

Wongkeo, W., Thongsanitgarn, P., Pimraksa, K., and Chaipanich, A. (2012). Compressive strength, flexural strength and thermal conductivity of autoclaved concrete block made using bottom ash as cement replacement materials. *Materials and Design*, *35*, 434–439. https://doi.org/10.1016/j.matdes.2011.08.046

DIGITAL LOGIC TRAINER: INNOVATION IN TEACHING AND LEARNING OF DIGITAL ELECTRONIC AT ELECTRICAL DEPARTMENT PSA

Marlina Ramli, Nor Rofizah Abdul Mutalib and Julaiha Omar
Politeknik Sultan Salahuddin Abdul Aziz Shah, Persiaran Usahawan Seksyen U1,
40150 Shah Alam, Selangor Darul Ehsan
Corresponding author: marlina_ramli@psa.edu.my

Abstract

Digital electronics systems are become widely spread and applicable in most of application including education. A digital logic trainer for the student's laboratory experiment was designed and realized to simplify the problems of the learner in the study courses like basic electronics and digital logic systems. The primary goal of this trainer is to perform the basic Boolean function such as AND, OR, NOR, NAND. The other objective is to avoid losing and damage of components during experiment. The whole project involves various methods such as collecting information on data, design the concept and process to develop the product itself. This trainer is designed to work appropriate with practical works for Digital Electronic subject

Keywords: Digital Trainer, Gate, Boolean

1.0 Introduction

Electronic industry has played a significant role in the global market due to its wide applications in variety of sectors. Rapid advancement in the electronic technology demands knowledge and understanding of the electronic that hence embed and emphasis in the education system was stated by Mohammad et al. (2019). In relation to this, the university has included the Digital Electronics (DE) as a core subject in electrical engineering course. A. O. Ajao et al. (2014) expressed digital system is involved in all aspects of modern technology, such as data processing, industrial control, and instrumentation for many fields of science and engineering.

A digital logic trainer is a command equipment in electronics and digital learning aid which was designed to educate students in the study of logic design skills, practice, testing and modify the digital circuits of the simple network. L. A. Ajao et al. (2017) describe digital logic is the processing of only two output states or conditions of ON (1) and OFF (0) with varies number of inputs which can be 2, 3, 4 and so on The basic and derive logic gates are

AND, OR, NAND, NOR, EXOR and EXNOR. Basic electronic and the digital logic system, are essential courses offered by the students of higher learning in the areas, like computer science and engineering, electrical and electronics engineering and other related fields which was identified as major in their curriculum development is explained by Sothong, and Chayratsami (2010).

The innovation of Digital Logic Trainer is a very simple teaching equipment to guide students through their first steps in digital electronics field. It consists of a breadboard plate mounted on a printed circuit platform where power supply are distributed, in order to use them in practical experiments. The basic Boolean function, which is AND, OR, NOR, NAND are performed. Logic Gates Logic gates are the fundamental building blocks of digital systems. These devices are able to make decisions, in the sense that they produce one output level when some combinations of input levels are present and a different output when other combinations are applied; hence given the name Logic Gates. The two levels produced by digital circuitry are referred as HIGH and LOW, TRUE and FALSE, ON and OFF, or simply 1 and 0. There are only three basic gates: AND, OR and NOT. The other gates are merely combinations of these basic gates. Logic gates can be interconnected to perform a variety of logical operations. This interconnection of gates to achieve prescribed outcomes is called logic design.

2.0 Methodology

The digital trainer kit is a self-contained set of electronic circuits that can be interlinked by students to create working circuits. Component parts cannot be removed or lost in the lab and interlinking is performed by short coloured cables fitted with small insulated alligator clips. Digital logic is the processing of only two states or conditions; ON and OFF. There are certain electronic chips (called gates) that convert simple on and off conditions to create a third on or off condition. The basic gates are AND, OR, NAND, NOR and NOT. These digital gates are explained and combinations of these simple gates in various configurations permits more complex logic or counting and maths to be computed.

This trainer is aimed at producing digital trainer design that meet the feature such as easy to understand, easy to handle when doing a practical work and able to understand each gate used. Furthermore, the damage and the broken of IC can be prevented. This digital trainer has been designed with the idea of providing basic facilities essential for conducting simple experiments in the laboratory. By this trainer, student can get familiarized with the various

type of digital ICs. The system is suitable for conducting experiments on TTL IC. All connections and controls are clearly marked and conveniently located. It is very useful in digital electronics laboratories for performing digital experiments. It is also useful to build and test circuits as well as making projects related to digital electronics or understanding in the subject.

A flexible, user friendly, and self-contained low-cost digital logic trainer was designed and achieved with the use of numbers of integrated circuit (IC) electronic components in the module. The followings are the components wired together to realize the system. A digital complementary metal-oxide semiconductor integrated circuits (CMOSICs), toggle switch, LED dual colour, Resistor, 7-segment LED display, connector cord, printed circuit board and others. The overall circuit design is shown in Figure 1.

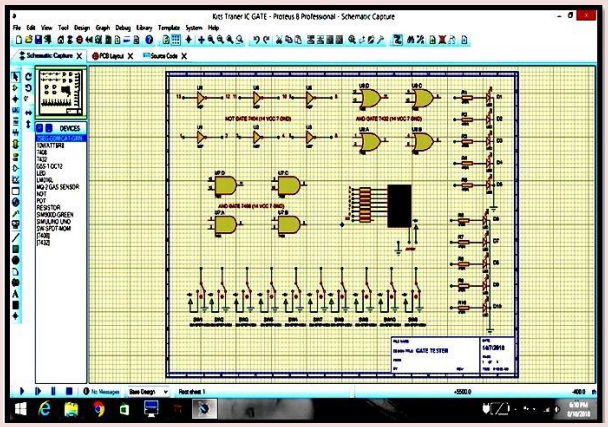


Figure 1: Circuit design

The Digital logic trainer requires + 5V power supply at V_{cc} so the internal circuit can work. To ensure that the received power does not exceed 5V then there is an inner internal controller. If the power goes into excess of 5V will cause the internal circuit to be damaged. As a safety measure, one diode is attached to the V_d pin. The power supply circuit is shown in Figure 2.

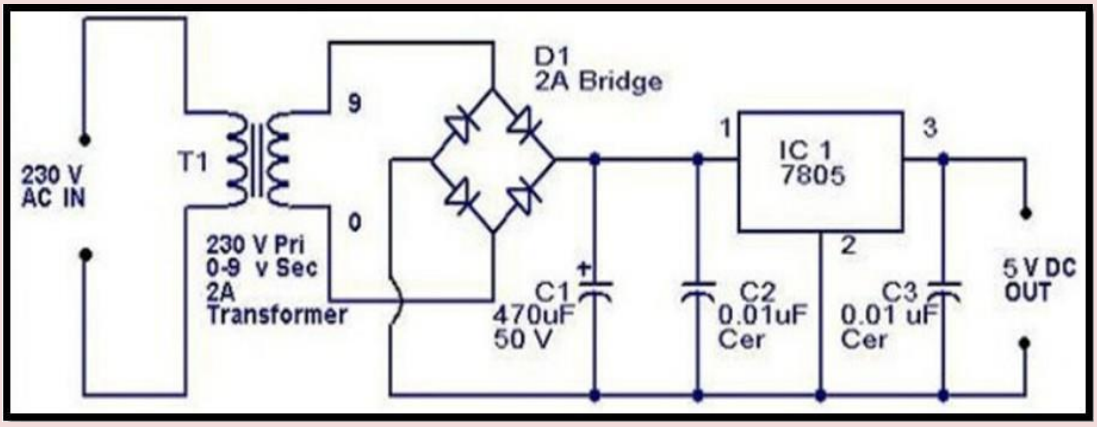


Figure 2: Power supply circuit

IC or integrated circuit as shown in Figure 3 is one of the active electrical components which is a combination of thousands of electrical components such as transistors, resistors, diodes and even capacitors. The components of this IC are also stored in different types of components in a more compact form. In IC, components such as transistors, resistors, diodes, and capacitors are also integrated into a single network unity in smaller finishes. Each IC has different numbers on its cover, and for example the lab uses many of the IC is NAND 7400 NOR 7402 AND 7408 OR 7432 NOT 7404 EX-OR 7486. The majority of the IC is made using silicon semiconductor materials. As has been said earlier, the function of the IC component varies greatly depending on its compiler component. ICs are classified into logic families according to their internal digital design, two main classes of these families that will be used in this lab are TTL and CMOS.

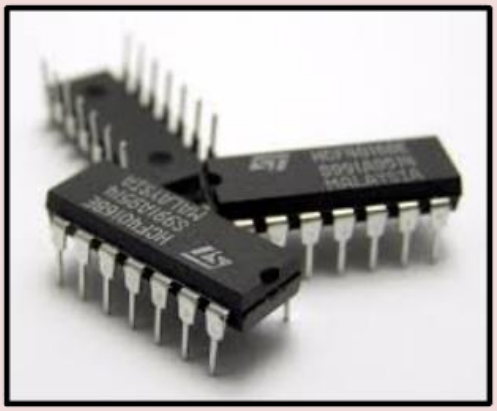


Figure 3: Integrated circuit

To identify suitable gate to be selected, the output for all possible input combinations should be studied. This logic trainer uses 5V DC power supply and ground connection to control IC. This switch logic is used to provide the output and drive the circuit to be designed and built.

This data switch also provides zero (ground) voltage to logic 0, and either + 5V or other voltage settings for logic 1. It is important to note that for logical input we must use either 5V or 0V. We cannot allow a float input if we want 0V float input is considered logical 1

An electrical switch is any device used to interrupt the flow of electrons in a circuit. Switches are essentially binary devices: they are either completely on ("closed") or completely off ("open"). Toggle switch as shown in Figure 4, connect or decide the current by moving the toggle or the mechanically available lever. Problem measurement, this switch is relatively small and often used in electronics circuit.

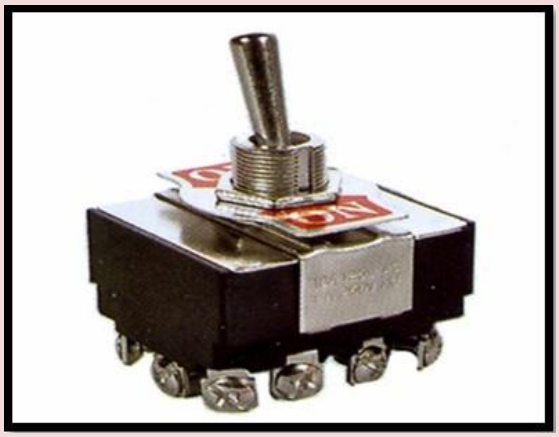


Figure 4: Toggle switch

3.0 Comparison with existing trainer

Comparing with existing trainer available at Politeknik Sultan Salahuddin Abdul Aziz Shah as shown in Figure 5 and summarize in Table 1, the innovated Digital Logic Trainer is easy to understand because it is not too complicated, and all the components have been provided in this trainer. It will avoid losing and damage of components. It just needs to connect the input and output at each gate. In addition, students can refer directly to data sheets provided and hence will shorten time to complete the task.

Existing trainer

Innovated trainer

Figure 5: Comparison between existing trainer and innovated trainer

Table 1: Comparison between existing trainer (Digital Lab) and innovated trainer (Digital Logic Trainer)

	Existing trainer (Digital Lab)	Innovated trainer (Digital Logic Trainer)
Operation	hard to understand	easy to understand
Data sheets	do not have data sheets and need to search for themselves	data sheet has been provided on every IC
Practical duration time	long time	short time
Additional wire	must use many jumper wire	can reduce the jumper wire

The problem normally happened is lost and damage of the IC components because the components are given separately in each of lab session. As the size of components are small, it easy to loose and damage. The student will face difficulties to perform practical lab because the use of IC component is necessary. IC commonly used are 7400 (Gate NAND IC), 7402 (Gate NOR IC), 7432 (Gate OR IC), 7408 (Gate AND IC), 7404 (Gate NOT IC). Therefore, in order to prevent loss and damage to IC components, the innovation of new digital logic trainer is designed to facilitate lecturers and students. The upgraded digital trainer kits can save cost for the purchase of new components. Additionally, the IC components already have been attached to the digital trainer kit. The students will be able to know the exact gate that is used the display board will show the type of IC component.

4.0 Conclusion

A digital logic trainer for the student's laboratory experiment was developed and packaged in a single module to minimize the cost, and easy to operate by every student. Digital Logic Trainer is effective and meets design features that are set up and require a low cost of maintenance. Most of the integrated circuit (IC) chips and other components used in this designed were relatively available in the market and found cheaper. The innovated trainer can facilitate the students easily during their practical lab in practical understanding, logic circuit verification and to improve their competency. It will also expose students to the basic electronic theory, digital system and logic principles. Overall the innovated trainer will help students easy and quick to understand about this digital electronic subject.

References

Ajao, A. O., Kadiri, K. O., and Bamigboye, O. O. (2014). Local Fabrication of Digital Logic Trainer for Laboratory Demonstration. *International Journal of Innovation in Science and Mathematics*, *2*(1), 43–46.

Ajao, L. A., Agajo, J., Ajao, A. O., and Oke, J. T. (2017). Development of a Low-Cost Digital Logic Training Module for Students Laboratory Experiments. *Journal of Engineering and Technology (JET)*, *8*(1).

Mohammad, Z., Amar, F. Z., and Syahrul, H. (2019). E-Logic Trainer Kit : Development of an Electronic Educational Simulator and Quiz Kit for Logic Gate Combinational Circuit by Using Arduino as Application. *International Journal of Online and Biomedical Engineering*, *15*(14), 67–77.

Sothong, S., and Chayratsami, P. (2010). Design of combinational logic training system using FPGA. In *Proceedings - Frontiers in Education Conference, FIE* (pp. 1–4). https://doi.org/10.1109/FIE.2010.5673663

Sun Lab Tek Equipment. (n.d.). Digital Logic Trainer. (available online https://www.labtekindia.com/digital-logic-trainer.html [accessed on 15/01/2020])

TREE TAGGING AT CIVIL ENGINEERING DEPARTMENT, POLITEKNIK SULTAN SALAHUDDIN ABDUL AZIZ SHAH

Hazlan Abdullah, Zullhyzrifee Ishraf Zulkifly and Muhammad Kamal Ariffin Hj. Badrun
Department of Civil Engineering
Politeknik Sultan Salahuddin Abdul Aziz Shah, Persiaran Usahawan Seksyen U1,
40150 Shah Alam, Selangor Darul Ehsan
Corresponding author: hazlan@psa.edu.my

Abstract

This project is to provide the tag tree to tree landscape at the Department of Civil Engineering (JKA), to provide information to students about the families of trees, and their common and scientific names. A variety of search methods were used to gather information about the trees of the JKA, Politeknik Sultan Salahuddin Abdul Aziz Shah (PSA). This information is available on the internet, in books and other reading materials such as magazines. The process of creating the tree tags used the high impact polystyrene as a main material. To appreciate the benefits of trees, people need to know about trees, even just the common name of it. This project is to deliver and create attractive tree tags for students, lecturers and anyone passing through the JKA area learn about the tree names. This method is better than the process of nailing or binding to tag the trees. It will prevent the trees from damage and defects. This method is very suitable for small trees, particularly trees that can invigorate the landscape. Besides, this approach can provide a new landscape area to areas that are more beneficial to the students and the surrounding community. The abandoned trees need to be preserved to be able to provide information such as family and common name of the tree through the tree tag. The materials used must have strong endurance and resistance to weather. The tags should also have a script that can be easily understood and has a colour that contrasts with the board so that the writing can be easily read.
Keywords: *landscape, local name, scientific name, tree tagging*

1.0 Introduction

Malaysia is truly blessed by Mother Nature and this has never failed to fascinate scientists and adventurers, who have journeyed into its dense, tropical forest in search of its natural wealth and beauty. The Malaysian rainforest is like another country, where a seemingly impenetrable fortress of formidable trees defines the border and safeguards the right and interests of its inhabitants (MTC, 2002). Forest world-wide, especially tropical rainforests in Malaysia play numerous crucial ecological roles. These forests are very important to sustain the livelihood of man, such as food sources, habitat and water supply.

These are other ecological roles too, such as mitigating climate change. In Peninsular Malaysia, the forests are classified based on several factors, such as substrate, structure and floristic composition, as well as altitude. There are three main forest covers, which are represented by mangrove forests, peat swamp forests and dry inland forests (Norazlinda et al, 2016).

A tree is a perennial woody plant growing to a considerable height and size, with a self-supporting main stem and usually developing branches at some distance from the ground. A tree usually has a more or less spreading crown support some distance off the ground by a main stem, so that the crown is typically sparse or absent near ground level. It is reasonable to include multi-stems if the main stems are trunk like relative to the rest of the plant, as in mature trees of coppice origin and open grown trees whose lower branches have subsided to the ground all round (Plilip, 2014). Trees have particular features within the plant kingdom. Among vascular plants, their longitudinal and radial growth continues for a very long time and they eventually become very large. Heartwood formation, which occurs on the inner part of the trunk, is another special phenomenon found only in trees (Tadashi & Mohd Hamami, 2008). Trees create a landscape that is attractive to recreation and residential areas, an environment where people want to live and work. Mature trees in botanical parks are a vital element of our landscape and bring many benefits such as provide shade, beauty and other benefits to the visitors (Firdaus et al, 2016).

In environmental contributions, mature trees will reduce more noise pollution by absorbing sounds, reduce the temperature at parking lots, reducing runoff and providing cleaner water. In social contributions, mature trees in recreation areas are estimated to improve outdoor leisure and recreation experiences in parks. In additions, views of nature in recreation parks will reduce the personal stress (Firdaus et al, 2016). Street trees have been an integral part of the urban landscape. Besides important environment services such as air and water purification, wind and noise filtering or microclimate stabilization, natural areas provide social and psychological services, which are of crucial significance for the liveability of modern cities and the well-being of urban residents. The greening of urban Malaysia has focused primarily on beautification and has mainly been the province of horticulturists, landscapers, nursery workers, town planners and architecture with negligible input from foresters (Sreetheran et al, 2011).

Landscape is the environment experienced by individuals. It carries a wide meaning comprising of the structure of geology and soil, flora and fauna, patterns of human activities such as plantations, forestry, housing and industry. It is also the interaction between natural resources and human needs, which include efforts towards appreciating beauty and aesthetic values, architecture and the overall ecology and history of an area (National Landscape Department).

To appreciate the benefits of trees, people should know about trees even though just the name of the tree. This initiative is further extended to the Department of Civil Engineering (JKA) at Politeknik Sultan Salahuddin Abdul Aziz Shah (PSA), which provides students of a Diploma in Wood Based Technology Programme (TBK) with a dendrology course that learns about trees. Generally, many people know the names of the trees based on only common names. However, they do not know the scientific name and family. In the PSA, there are many different species of trees and landscaping has no name tag on each tree. Members of PSA usually only know the common name of the tree and there are only a few students and lecturers who learn more scientific names and taxonomic families and species for trees. The project provides information about trees to students, lecturers and anyone passing through the JKA area. This study was conducted to provide information about the common name, scientific name and tree families. The names of trees species and family tree are written on plastic plates to facilitate tree people see when passing through the study area. Given its popularity, the presentation of this study aims to provide information to students and lecturers or staff at the JKA in terms of common names, scientific names, and families of the trees.

2.0 Methodology

2.1 Method to Make the Tag Tree

Seventy tags tree for each landscaping trees. Tags for every different species of trees provide information such as the scientific and common name, and the family of the tree. The selection of the landscape tree species is in accordance with that record with the JKA. The project is carried out in the JKA. There are two types of samples. The first sample is a tree species. The chosen species are the ones planted by the PSA, and not by past projects. The second sample is a plastic tag tree.

2.2 Sample Species

There are about 20 tree species in the JKA and about 70 trees are placed with plastic tree tagging. The subjects for this project are the trees planted at the JKA area at PSA. 20 species were chosen as a sample from this department. This quota sampling technique was utilized to identify tree species. Quota sample is used when the sample is selected regularly.

2.3 Tree Species

The sample is selected from the population tree in the JKA in a way that each item has the same chance of being selected as a sample. To obtain the data sample, first, the researcher needs the required data about the tree, such as a loss of the tree population. There are about 20 types of species used in this study. The number of species was selected quotably from the tree population of the JKA in PSA. Each species has only ten tags. If there is only one tree for a species, then there is only one tag. The sample was then counted from 70 trees for each species from the JKA. Therefore, the tree tagging was provided to a total of 70 trees from about 20 species.

2.4 Plastic Tree Tagging

The main material of the tag tree is a high impact polystyrene plate. The reason this type of plastic is more beautiful, compact, and cheap. Besides, with high impact, polystyrene products are more durable. It is nonmagnetic and does not easily ignite. It is also resistant to weather. This as evidence that high impact polystyrene can be used to make a tree tag. The choice of materials should be appropriate to the product. For outdoor products, selection materials should be appropriately selected to ensure the product quality standards to maintain the longer term. The products look more attractive and not easily damaged due to weather, insect attack and rustiness.

2.5 Procedure of Tree Tagging Process

For this project, there are two types of procedures. The first procedure is the search and identification of landscape tree species in terms of numbers, scientific name, common name and a family tree. The second procedure is the production of plastic tree tag.

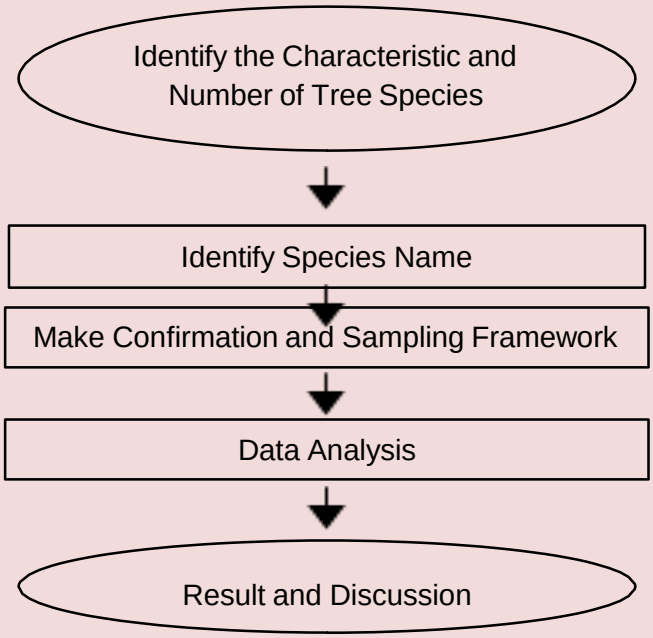


Figure 1: The flow chart search and identification of landscape tree species

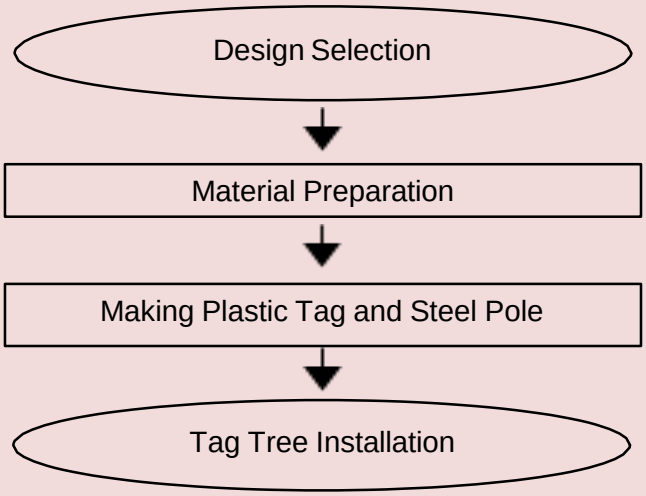


Figure 2: The flow chart producing plastic tree tagging

3.0 Result and Discussion

There are three parts of the results to discuss. The first part is the overall total number of tree species and the number of plastic tags, which is placed on each tree. The second part is the name of the landscape tree species in terms of the scientific name, common name and family tree. The last part is the result of the plastic tree tag products.

3.1 Number of Tree

There are about 120 landscape trees in the JKA that been planted by the PSA. There are about 70 trees tagging on the tree landscape. a, about 58% of landscape trees have tree tagging.

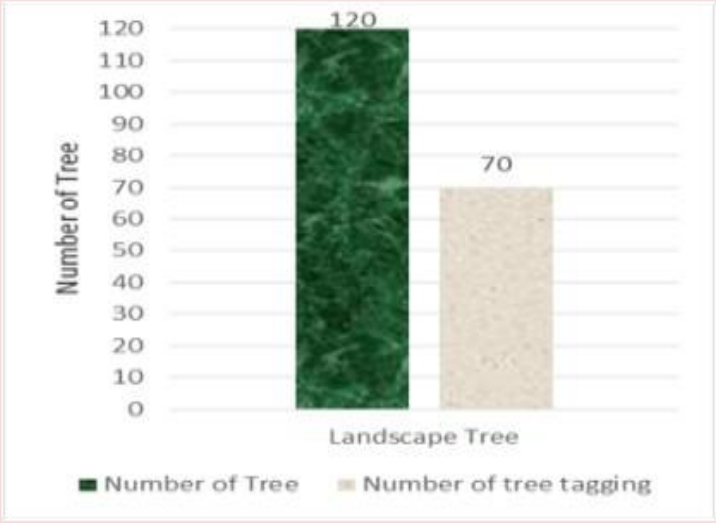


Figure 3: Number of tree and number of tree tagging

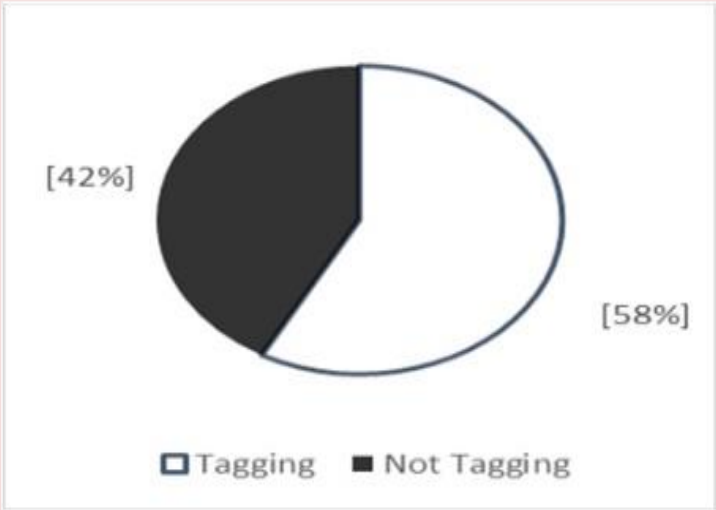


Figure 4: Plastic tree tagging for tree landscape at Civil Engineering Department

Table 1: The number of tree landscape provide tree tagging

Common Name of Tree Species	Number of Tree Tagging	Common Name of Tree Species	Number of Tree Tagging
Pinang Kuning	3	Medang Teja	10
Bunga Tanjung	4	Palas Payung	1
Jenjuang	3	Semarak Api	3
Bunga Raya	1	Siantan	4
Serdang Cina	5	Tekoma	1
Garden Croton	1	Tembusu	7
Manila Palm	2	Kelat Paya	5
Malayan Banyan	3	Pinang Merah	8

From Table 1, Medang Teja had the maximum tree tagging. Tekoma, Garden Croton, Palas Payung had the minimum tree tagging. Only 58% of the trees have plastic tree tag by each species. This number is reduced if the number of trees is decrease.

3.2 Name Landscape Tree Species

There are 20 species tree landscape at Civil Engineering Department. Maximum number of tree tagging is 10. This is the quota for each species. Finding the information of tree in terms of scientific name, common name and family of tree is possible to carry out this project. The information available in book, internet and also from interview the people.

Table 2: The list of scientific name, common name and family of tree

Scientific Name	Common Name	Family of Tree
Dypsis Lutescens	Pinang Kuning	*Arecaceae*
Livistoinia Chinensis	Bunga Tanjung	*Sapotaceae*
Cordyline Fruticosa	Jenjuang	*Asparagaceae*
Hibiscus Rosa-Sinensis	Bunga Raya	*Malvaceae*
Livistoinia Chinensis	Serdang Cina	*Arecaceae*
Codiaeum Variegatum Cultivars	Garden Croton	*Euphorbiaceae*
Veitchia Merrillii	Manila Palm	*Arecaceae*
Cinnamomum Iners	Medang Teja	*Lauraceae*
Licuala Grandis	Palas Payung	*Arecaceae*
Delonix Regia	Semarak Api	*Fabaceae*

Ixora Coccinea Hybrida	Siantan	*Rubiaceae*
Tabebuia Rosea	Tekoma	*Bignoniaceae*
Fagraea Fragrans	Tembusu	*Loganiaceae*
Syzygium Campanulatum	Kelat Paya	*Myrtaceae*
Ficus Microcarpa	Malayan Banyan	*Moraceae*
Areca Catechu	Pinang Merah	*Arecaceae*

3.3 Tree Tagging

Plastic tree tagging was placed in front of the tree. Seventy trees are chosen according to the scope.

Figure 5: Medang teja before put plastic tree tagging

Figure 6: Medang teja after put plastic tree tagging

Tree tag is a piece of information such as scientific name, common name, and family of the tree are there on each plate and placed on the tree. The presence of such information on the tag conveys knowledge to the public who were passing through the area. The plastic selection of high-impact types of propylene was used as the tagging is suitable for high durability. Besides, this type of plastic is readily available at a low cost. Tagging the most appropriate way is to use a pole and fix it into the ground. The method of fixing the pole into the ground is better because it will not damage the tree. The use of iron as a pole is more suitable than using wood because of its durability and cheaper cost.

4.0 Conclusion

Based on the study, information about the landscape trees can be improved in terms of family trees, common and scientific names. This information can be gathered from any resources anywhere and can be presented in various forms. High impact polystyrene as the main material for tagging was used as the primary material for outdoor use in a long-term time.

References

Firdaus, C.S., Ramly, H. and Ely Raizee, J. (2016). The mature trees in recreation areas and its role in enhancing quality of life. *Procedia-Social and Behavioral Science*, 234, 289-298.

MTC (2002). Green Malaysia: Rainforest encounters. Kuala Lumpur: Malaysian Timber Council.

National Landscape Department. National landscape policy: Malaysia beautiful garden nation. National Landscape Department. Ministry of Housing and Local Government.

Norazlinda, M., Nizam, M.S., Latiff, A., Ahmad Fitri, Z. and Sani, M. (2016). Tree species composition, diversity and biomass of Bukit Panchor State Park, Pulau Pinang, Malaysia. In *AIP Conference Proceedings*.

Plilip, J. W. (2014). The meaning of 'tree'. *Newsletter of the Arboricultural Association*, 166, 32-33.

Sreetheran, M., Adnan, M. and Khairil Azuar, A.K. (2011). Street tree inventory and tree risk assessment of selected major roads in Kuala Lumpur, Malaysia. *Arboriculture & Urban Foresty*, 37(5), 226-235.

Tadashi, N., & Mohd Hamami, S. (2008). The formation of wood in tropical forest trees: A challenge from the perspective of functional wood anatomy. Serdang, Selangor: Universiti Putra Malaysia.

A REAL-TIME MONITORING OF THE HEART RATE AND BODY TEMPERATURE FOR REMOTE DOCTOR

Baharuddin Mustapha and Siti Hajar Abdul Hamid
Department of Electrical Engineering
Politeknik Sultan Salahuddin Abdul Aziz Shah, Persiaran Usahawan Seksyen U1,
40150 Shah Alam, Selangor Darul Ehsan
Corresponding author: baharuddinmustapha@gmail.com

Abstract

This paper described monitoring heart rate and body temperature using wireless technology. The monitoring device is specially designed for old folks that are having a critical disease and have a difficulty to go to the hospital. Regular checking of health condition is required for those having critical disease. Almost all health monitoring devices for heart rate and body temperatures are available in the market with the traditional way which is manual used, but the cost is quite expensive and it is not much effective. The aim of this project is to elderly people who are not able to go to the hospital can be monitored by a doctor from far distances. The problem can be solved by using android technology and GSM to receive data from the patient. Therefore, heart rate and temperature sensors are used for patient monitoring. Sensors give correct output and it rules out the use of traditional medical instruments such as thermometer and blood pressure equipment reading. For continuously sending messages from the patient's location to medical advisory, the GSM modem is used. This module provides relief to medical advisory for patient monitoring and patients for freedom of movement.

Keywords*: *monitoring, heart rate sensor, temperature sensor, microcontroller

1.0 Introduction

Heart rate is the frequency of the heart cycle where it depends on the demand for oxygen in a body. Human body temperature is a measurement of average body heat where comparison and reaction are made between the inner body part of the body and surrounding areas. The temperature differs depending on one's daily routines and activities (M. Punitha et al, 2015). Heart rate and body temperatures are two important parameters to maintain a vital life. These parameters can give some important indicators of the body's health condition. Monitoring of the patient data is important because enables doctor of physician having access directly to the patient through a mobile phone.

Monitoring of patient constantly is difficult because doctors are unable to monitor particular patient for total working hours. In a hospital, either the nurse or the doctor has to move physically from one person to another for the health check-up of patients, due to which it is not possible to monitor their conditions continuously (A.V. Kale, 2015). The surveillance of the heart rate and body temperature using wireless technology by remote is a new device or development technology tools for monitoring the heart rate and body temperature of the patient. It will send the information to the doctors about the patient's heart rate and body temperature if the reading is abnormal. With the existence of the new monitoring technology, they can monitor the heart rate and body temperature of the patient even they are not in the hospital.

The remote heart rate and temperature monitoring system gives information on heart rate and body temperature simultaneously and sends results to the mobile phone. Thus, in this system development, the condition of the body can be monitored from remote places. Arduino Uno is embedded at central and remote respectively to control the system (P. P. Singh, 2014). The parameters of temperature sensor and heartbeat are displayed on the Liquid Crystal Display (LCD) displays which are act as an output. The GSM-based technology is used to transmit and receive data wirelessly among central and remote so that the patients can be monitored continually from their homes.

2.0 Literature Review

There are many health monitoring devices available in the market for measuring the important parameters of a patient condition status. All of these tools aim to give correct readings with minimal error. The researcher has come up with the new technology of monitoring heart rate and body temperature to enable the patient can be monitored by a doctor even they are not going to the hospital. The researchers theorized was explained their work in the section below. Wireless technologies have made this monitoring more effective to use. M. B. Prasad has developed a Gsm based health care monitoring system. The system is builds upon the integration of wireless communications into medical applications to revolutionize personal healthcare. The objective of this project is to build a wireless heart eat monitoring system using GSM Technology, which could potentially be an integral part of a suite of personal healthcare appliances for a large-scale remote patient monitoring system. As its name implies this is a Health monitoring the system, with a feature of sending SMS to doctor and patients relative in event of an emergency, hence the system can be used at hospitals as well as at home.

In another study, a group of researchers has developed a remote patient monitoring system (S. Sebastian et al, 2012). This research provides the image-based system which acquires the ECG signal via digital camera, this information is performed on the tool like MATLAB and data sending through the internet network and stored in the database. Then the original image is then availed to the doctor via Android mobiles. The purpose of this system is the vital signs and parameters from the ICU monitoring system and makes this data to be available to the doctor who may not be in the hospital and the country. In case of any abnormality, the doctor is alerted by sending a notification from the server to his mobile. The drawback of this paper is that due to the slow internet connection the data will not be sent to the doctor which is located remotely. M. D'Souza et al, (2018) have developed a wireless patient health monitoring system by using ZigBee. The fixed monitoring system can be used only when the patient is on the bed and this system is huge and only available in the hospitals in ICU development of a microcontroller-based system for a wireless heartbeat and temperature monitoring using ZigBee. The system is developed for home use by patients that are not in a critical condition but need to be constant or periodically monitored by clinician or family. In any critical condition the SMS is sent to the doctor or any family member. So that can easily save many lives by providing them quick service.

Medical monitoring terminal called GSM-GPRS Based Intelligent Wireless Mobile Health Monitoring System for Cardiac Patients was designed by M. Varma et al, (2013). Transmission of the vital signs measured using the smartphone can be a lifesaver in critical situations. System for people who stay alone at home or suffering from heart disease. Developing hardware that will sense the heart rate of blood pressure and body temperature. Using GSM modem all information lively transmitted to a smartphone, from smartphone all information transmitted to the server using GPRS. M. Aminian et al, (2013) has proposed a Hospital Health Care Monitoring System using Wireless Sensors Network. There is a continuous observation of the patient's physiological parameters such as blood pressure of the patient as well as heart rate. This system is mainly useful for pregnant women to measure the various parameters like blood pressure, heartbeat and fatal movement to control the health issue. This system has to monitor more than one patient at a time and easily able to sense the blood pressure (BP) and heart rate of the patients. In this system, there is a sensor node attached to the body of a patient to measure signals from the wireless sensors and sends these signals to the database. This system can detect the abnormal conditions of the patient, raise an

alarm to the patient and sends an SMS/Email to the doctor for treatment. The main advantage of this system is to increase the freedom for enhancing a patient's quality of life. The demerit of this system is that in this the patients need to get admitted to the hospital for continuous monitoring of the patient's physiological parameters. This WSN gets complicated if the number of patients is admitted in the hospital beyond the specified limit.

D. Rajan et al, (2013) have developed Health Monitoring Laboratories by Interfacing Physiological Sensors to Mobile Android Devices. This project describes, Android Java-DSP (AJDSP) as a mobile application that interfaces with sensors and enables simulation. This also helped in the visualization of signal processing. In this system firstly there is the creation of an interface between both external sensors and on-board device sensors for monitoring the physiological parameter of a human being. This paper also explored the trend of mobile sensing and adapted it towards improving digital signal processing (DSP), by building interfaces to medical sensors and external sensors. In this paper, there is the use of SHIMMER. It is a small wireless low-power sensor platform that can record and transmit physiological (Health-related like ECG) and kinematic data in real-time. The drawback of this system is that it only monitors the patient which is admitted to the hospital. In this work, low power sensors are used. Smart Elderly Home Monitoring System with an Android Phone has been introduced by T.H. Kenny et al, (2013). A few factors had considered taking into account certain facts, which are heart attack and stroke as they are the major cause of hospitalization of the elder people. There are more chances of survival if the older people get the treatment within an hour. An android smartphone with an accelerometer is used to detect a fall of the carrier, and this android device is known as a healthcare device. The android phone is then connected to the monitoring system by using the TCP/IP protocol through WiFi. Because of this system, elderly and chronically ill patients can stay independently in their own homes and secure in the knowledge that they are being monitored. The drawback of this system is that it only considers elder people as there are more chances of a sudden (emergency) outbreak in them like heart attack and stroke.

Other research carried out by B. Jeon et al, (2013) have developed a Design and Implementation of Wearable ECG System. The project describes the design and implementation part of wearable ECG with the smartphone for the real-time monitoring of health. In this system, a smart shirt is developed with ECG sensors and can be worn by any type of patient for monitoring his or her health in real-time and get the required treatment or prescription. These systems are mainly developed considering elder people in mind as they live alone in their homes. Therefore, this system monitors elderly people for self-diagnosis

purposes. The result of this system was the system could monitor and diagnose patients' heart conditions in real-time, when they wear a sports-shirt with an ECG sensor in it. In addition to this, the system also provides graphical information with history management tools and an automatic emergency call system to the patient to get the required treatment in time. The drawback of the system is that it only concentrates on elder people and it includes a shirt (ECG sensor) for wearing which costs a lot.

3.0 System Design

3.1 Hardware Configuration and Designation

The main component of the proposed project includes heart rate and temperature sensors, microcontroller, GSM modules, LCD and buzzer. Figure 1 shows the block diagram of the proposed project. The hardware implementation flow can be seen through this block diagram.

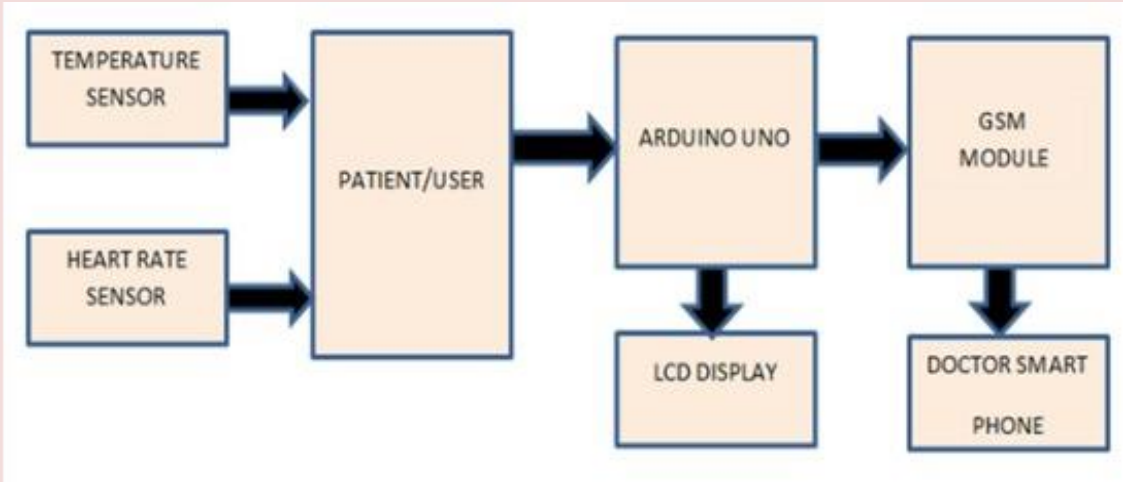


Figure 1: The block diagram of real-time monitoring of the heart rate and body temperature for a remote doctor

The circuit diagram of the design device is shown in Figure 2.

3.1.1 Heart rate sensor

Heart rate sensor gives a digital output of heart rate when a finger is placed on it. The beat LED on the sensor is flashes with each heartbeat, when the heartbeat detector is working. The output of the sensor is then connected to the PIC controller directly to measure the Beats per Minute (BPM) rate. It works on the principle of light modulation by blood flow through fingers at each pulse. The specifications of this sensor are: -

- Operating voltage is +5V DC regulated.
- Operating current is 100 mA.
- Output data levels are 5V TTL level.
- LED is use to Heart beat detection and Output High Pulse.
- Light source are 660nm Super Red LED

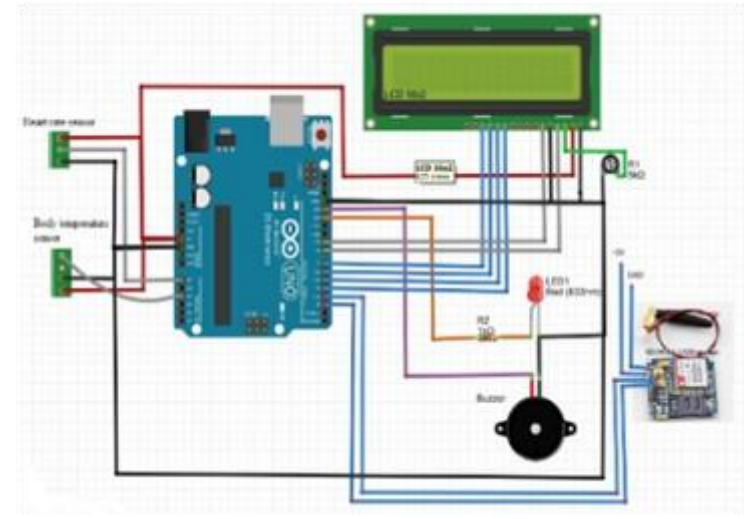


Figure 2: The circuit diagram of real-time monitoring of the heart rate and body temperature for a remote doctor

The principle operation of this sensor is illustrated in Figure 3.

3.1.2 Temperature sensor

LM35 is used as a temperature sensor which gives output voltage linearly proportional to Celsius temperature. The temperature sensor senses the temperature from the body and sends the data to the microprocessor. The processor converts the data in digital form and displays it on the LCD screen. It has higher accuracy and a wider range from its counterparts. LM35 used as a temperature sensor which gives output voltage linearly proportional to Celsius temperature (S. Satyanarawan et al, 2013). The specifications of LM35 are;

- Calibrated Directly in °Celsius (Centigrade).
- Linear + 10 mV/°C Scale Factor.
- 0.5°C Ensured Accuracy (at +25°C).
- Rated for Full −55°C to +150°C Range.

Figure 3 illustrates the front view of the LM35 temperature sensor.

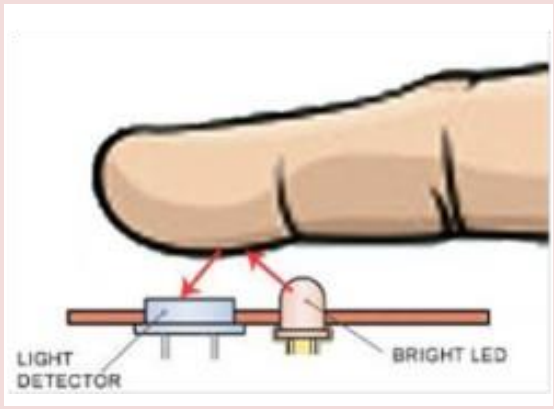


Figure 3: The illustration of the working principle of the heart rate sensor

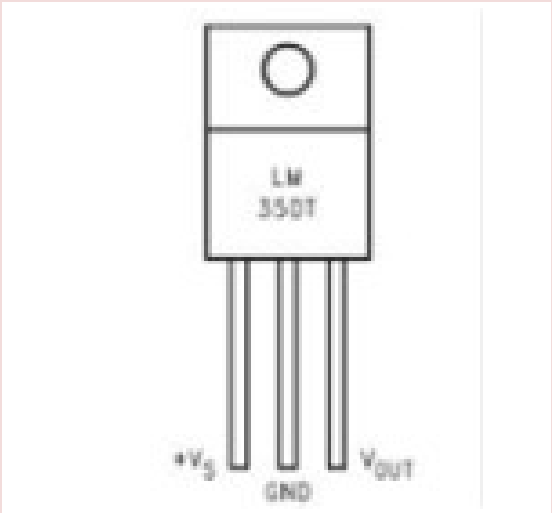


Figure 3: The front view image of the temperature sensor

3.1.3 Microcontroller

A microcontroller unit (MCU) is a single-chip micro-computer that commonly contains all the components such as the external power supply, power pin, ground pin, In-circuit serial programmer, serial in and out, digital I/O ports, USB plug, analog in and reset button as shown in Figure 4. Each patient node is based on an Arduino Uno, which is an open-source microcontroller platform for electronic prototyping that provides a flexible interface between hardware and software (W.M. Jubadi et al, 2019). The Arduino Uno platform is used to acquire, process, and transmit the signals. Additionally, a GSM module is incorporated into each Arduino to provide communication; this capability is necessary for communication with other patient nodes, the nurse server, and the smartphone.

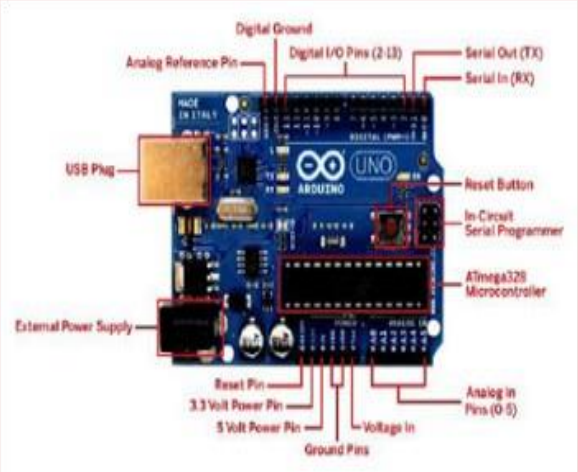


Figure 4: The top view of a full feature of Arduino Uno

3.1.4 GSM modules

GSM (Global System for Mobile communications) is the most popular standard for mobile phones in the world. Figure 5 shows the GSM modules used for this project. The GSM Association estimates that 80% of the global mobile market uses the standard. GSM is used by over 3billion people across more than 212 countries and territories. Its ubiquity makes international roaming very common between mobile phone operators, enabling subscribers to use their phones in many parts of the world. GSM differs from its predecessors in that both signaling and speech channels are digital, and thus is considered a second-generation (2G) mobile phone system. GSM needs an adapter to give a power source to its module.

Figure 5: The GSM modules

3.1.5 LCD

The LCD is used to display the digital parameters on the hardware circuit device. A 16x2 LCD means it can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in 5x7 pixel matrix [10]. This LCD has two registers, namely, Command and Data. The command register stores the command instructions given to the LCD. A command is an instruction given to LCD to do a predefined task like initializing it, clearing its screen, setting the cursor position, controlling display etc. The data register stores the data to be displayed on the LCD. LCD could produce very bright images due to high peak intensity and no need much power to operate. Easy installation and compatible with most programming languages brings the LCD to become the most display solution for commercial electronic projects. Cheaper in price makes the LCD the best choices for engineers in their research projects.

3.1.6 Buzzer

A buzzer or beeper is an audio signalling device, which may be mechanical, electromechanical, or piezoelectric and finds extensive use in electronics circuits and designs especially to trigger an alarm or as a system alert device. In the event of any abnormalities, if the patient or person presses any emergency switch, a buzzer is used to alert the people around and to seek help from them.

3.2 Software Initialization and Installation

The implementation of the software for the proposed device is illustrated in the flowchart as in Figure 6. The programming of this project has been delivered using a package of Arduino Uno software. The accuracy of the measurement dependably on the interfacing between hardware and software. The integration for both parts is technically and thoroughly checked to ensure the reliability of a reading. GSM wireless monitoring system takes a position as a receiver and transmits the data from the patient to the smartphone.

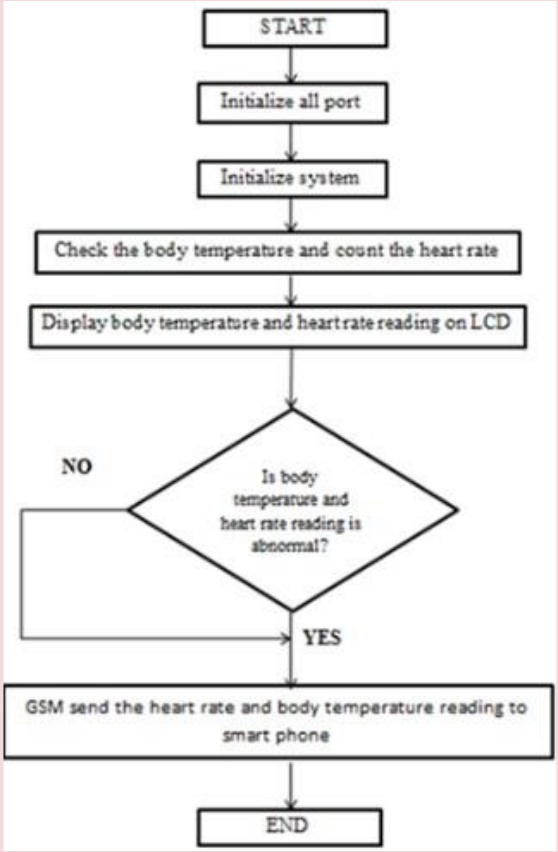


Figure 6: The flowchart of the software configuration

4.0 Result and Discussion

Experiments were conducted prior to various components being integrated into the system's hardware and software. The results following the integration of both hardware and software. The temperate sensor was attached to the patient body to get the value of the temperature while the heart rate sensor will attach at fingers to get the reading of BPM. Based on the experiments, this monitoring system was given a good reading to the two parameters that had been stated. The average measurements for the heart rate in a different range of ages as shown in Table 1. The percentage differences between the commercial device and designed device are less than 5% for all kind ranges of ages and in acceptable ranges. The heart rate results for the ages of 18 to 25 show the respondents in good health with referred to the standards resting heart rate**.** Body temperature measurements for both commercial device and the developed device has minimal percentage difference between 0 to 10% as shown in Figure 7.

Table 1: Heart rate measurements between the commercial device and developed device for a different range of ages

Age	Heart rate at rest		Percentage difference (%)
	Commercial device	Designed device	
18-25	60.6	61	0.7
26-35	67	65.8	1.8
36-45	73.4	73.8	0.5
46-55	81	84.2	3.8
56-65	100.2	100.8	0.6
66-75	87.4	88.4	1.1

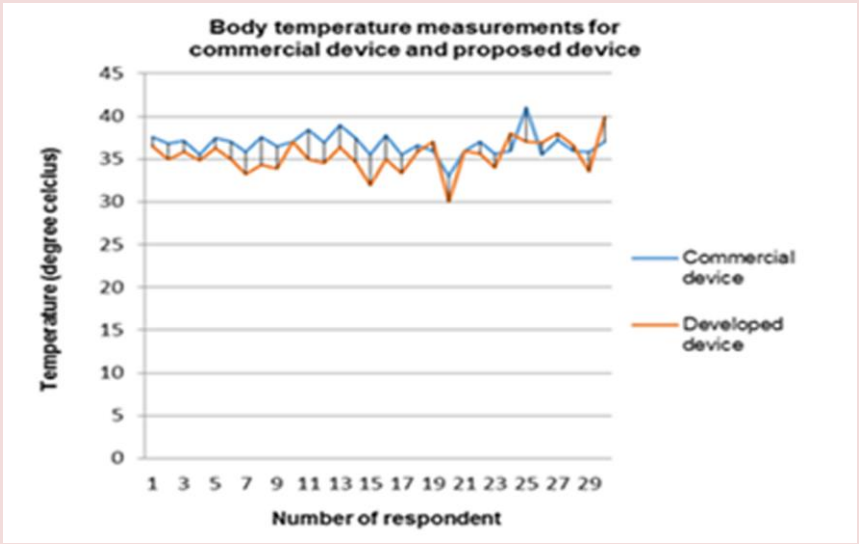
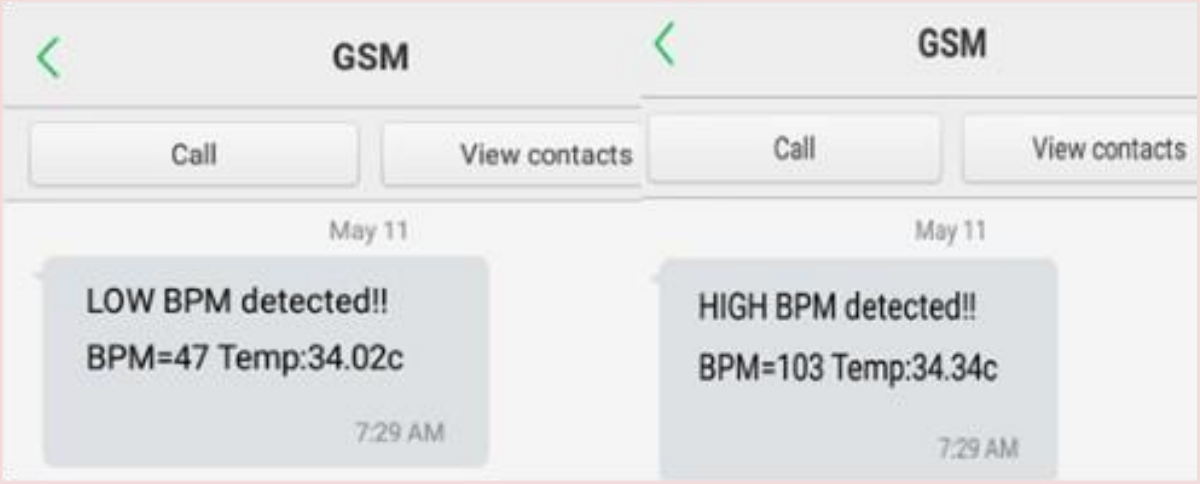


Figure 7: The comparison of the body temperature measurement results between the commercial device and developed device

Figure 8 and 9 shows the prototype and screenshot of the alerting messages through SMS on the smartphone when the abnormal reading occurs for the developed device.

Figure 8: The top view of the prototype for the developed device



(a) (b)

Figure 9: The alerted messages received on a smartphone (a) Low BPM is detected (b) High BPM is detected

According to the American Heart Associates, there are 3 ranges of the heart rate readings that labelled is LOW, HIGH and NORMAL. The BPM is considered LOW when the measurement reading is 60 and below while the NORMAL BPM reading is between 60 to 100 bpm. If the BPM measurement show 100 and above, it will be categorized as HIGH BPM. An alerting message will be activated automatically when the measurement readings are in LOW BPM and HIGH BPM.

5.0 Conclusion

A prototype of real-time monitoring of the heart rate and body temperature for a remote doctor has been developed and tested successfully. At glance, the device has beneficially the medical personnel of monitoring patient heart rate and temperature wirelessly. Moreover, the doctor and guardians can keep track of the condition of the heart rate and body temperature even the patient at home. The results obtained are reliable and the percentage difference is small as compared to the commercial device. The system is able to alert the medical advisory, caregivers and any assigned family through SMS when the abnormal reading occurs. The developed device is applicable for use in hospitals, homes, and ambulances.

References

M.B. Prasad (2018). GSM based Health Care Monitoring System. *International Journal of Innovative Technology and Exploring Engineering (IJITEE)*, 8, 253–255.

S. Sebastian, N. R. Jacob, Y. Manmadhan, V. R. Anand & M. J. Jayashree (2012). *International Journal of Distributed and Parallel Systems (IJDPS)*, 3, 99-110.

M. D'Souza, R. Z. Dias, A. N. Pednekar, N. P. Bhat & P.R. Kolambkar (2018). Wireless Patient Health Monitoring System. *International Journal of Science Technology & Engineering*, 4, 33-37.

M. Varma, Y. C. Rao & J. S.S. Ramaraju (2013). GSM-GPRS Based Intelligent Wireless Mobile Health Monitoring System for Cardiac Patients, *International Journal of Engineering Research & Technology (IJERT)*, 2, 1103–1108.

M. Aminian & H. R. Naji (2013). A Hospital Healthcare Monitoring System Using Wireless Sensor Networks, *Journal of Health & Medical Informatics*, 4, 1–6.

D. Rajan, A. Spanias, S. Ranganath, M. K. Banavar & P. Spanias (2013). Health Monitoring Laboratories by Interfacing Physiological Sensors to Mobile Android Devices. *In Proceedings of the 2013 IEEE Frontiers in Education Conference*, pp 1–7.

T. H. C. Kenny, J. V. Lee & Y. D. Chuah (2013). Smart Elderly Home Monitoring System with an Android Phone. *International Journal of Smart Home*, 7, 17-32.

B. Jeon, J. Lee & J. Choi (2013). Design and Implementation of a Wearable ECG System, *International Journal of Smart Home*, 7, 61-70.

S. Satyanarayan, Y. R. Satyanarayan & D. H. Desai (2013). Intelligent Wireless Emergency Alert System for Patient Monitoring using AT89S52 Microcontroller. *International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering*, 2, 1224-1230.

A STUDY ON SHEAR STRENGTH OF MARINE SOIL BY USING WASTE PAPER SLUDGE AS AN ADDITIVE MATERIAL

Farihah Mansor and Daliela Ishamuddin
Department of Civil Engineering
Politeknik Sultan Salahuddin Abdul Aziz Shah, Persiaran Usahawan Seksyen U1,
40150 Shah Alam, Selangor Darul Ehsan
Corresponding author: farihah@psa.edu.my

Abstract

Construction on marine soil area is a great challenge in the field of geotechnical engineering and has encountered many problems such as slope instability, bearing capacity failure, and excessive settlement. Marine soil is a soil that has a natural moisture content higher than its liquid limit. High compressibility and low shear strength are the reasons for most of the problems encountered. Waste paper sludge is one of the wastes generated from the process of paper production and generally has no economic value. The addition of waste paper sludge as a stabilizer enhances the strength and stiffness modulus of raw soil. The objectives of this technical report are to investigate the physical and engineering properties of plain marine soil and marine soil with different percentages of waste paper sludge and to evaluate the optimum percentage of waste paper sludge that gives the maximum strength. Laboratory soil testing was done to identify the soil characteristics and shear strength parameters. Five tests were performed, which are moisture content, sieve analysis, Atterberg Limits test, compaction test, and triaxial test. The 5% of waste paper sludge was the optimum percentage to stabilize the marine soil at a maximum deviator stress of 636.3 kPa at effective stress of 200 kPa. The addition of 5% waste paper sludge also improved the total shear strength with an increment of 103% in friction angle, ϕ from 13° to 26.5° compared to marine soil only. The cohesion value also improved from 70 to 100 kPa. Hence, treatment with waste paper sludge to improve marine soil is a suitable method. Utilization of waste paper sludge can reduce the construction cost as well as promoting an environmentally friendly method of soil stabilization and solving disposal problems.

Keywords*: *marine soil, waste paper sludge, shear strength, triaxial test

1.0 Introduction

Generally, Malaysia has three types of soil, which are residual soils of granite, residual soils of sedimentary rock, and coastal alluvial soils. Marine soil is one of the main soils and is found in the West and East Coast of Peninsular Malaysia. With the rapid development in Malaysia, it is impossible to avoid construction on this type of soil. This soil originates from flooding during ancient times. It is a soft, sensitive soil that is always associated with high settlement and high instability, poor soil properties that are not suitable for engineering requirements, uncertain performance, low unconfined compressive strength of between 25 and 50 kPa, and flat or featureless surface (Ali and Alsamaraee, 2013). Marine soil has been described by Rao et al. (2011) as a soil that has a natural moisture content of higher than its liquid limit. According to Bushra and Robinson (2009), high compressibility and low shear strength are the reasons for most of the problems encountered when projects are constructed on marine soil deposits. In addition, Rao and Mathew (1996) defined marine soil deposits as loose sediments that are formed with high void ratio and are highly sensitive to stress system and water content.

All over the world, problems of marine soil have appeared as cracking and break-up of pavements, railway and highway embankments, roadways, building foundations, irrigation systems, water lines, and canal and reservoir linings. The losses caused due to the damaged structures prove the need for more reliable investigation of such soils and necessitate methods to eliminate or reduce the effect of settlements. Therefore, marine soil should be treated, and its properties need to be improved before it is suitable to become the foundation for construction projects or a subgrade for pavements of roads and highways. Therefore, this research was conducted to analyse the possibility of using waste paper sludge as an additive material to increase the shear strength of marine soil.

Waste paper sludge contains kaolinite which on heating at high temperature becomes metakaolin (Teja et al., 2016). This metakaolinite helps to reduce swell as much as possible and improves the soil properties.

2.0 Methodology

The location of the soil sampling was Kampung Sungai Buaya, Banting, Selangor. The site is underlain by marine and continental deposits which are clay, silt, sand, and peat with minor gravel. Samples were taken by using hand augers from a vertical boring at a maximum depth of 1 m. The test was carried out in accordance to BS 1377:1990. Five tests were performed, which are moisture content, sieve analysis, Atterberg Limits test, compaction test, and triaxial test to identify the physical and engineering properties of soil.

Waste paper sludge (WPS) was taken from Pascorp Paper Industries Berhad at Bentong, Pahang. Twelve specimens of disturbed sample of marine soil were prepared for triaxial test, which are three samples each for 0%, 2%, 5%, and 8% WPS.

3.0 Results and Discussion

3.1 Particle Size Distribution

According to Rahman et al. (2013), marine soil in Malaysia consists of 19% sand, 57% silt, and 24% clay. Moreover, Ahmad and Harahap (2016) stated that marine soil in Peninsular Malaysia consists of 7% sand, 46% silt, and 47% clay. Table 1 shows that the particle size distribution values of marine soil from Banting, Selangor are slightly close to those from the research done by Rahman et al. (2013). It has greater amount of silt and sand compared to clay. Even though sampling was made from a location with marine and continental deposits that consist of clay, silt, sand, peat, and minor gravel, the soil was classified as sandy SILT.

Table 1: Particle size distribution of marine soil at Banting, Selangor.

Particle size distribution (%)	
Gravel	0
Sand	25
Silt	53
Clay	22
Classification	Sandy SILT

3.2 Atterberg Limits Test

Table 2 shows that the value of plastic limit increased with increasing WPS percentage. Meanwhile, the values of liquid limit and plasticity index decreased with increasing WPS percentage. This result is significantly comparable with the research by Teja et al. (2016), where the liquid limit and plasticity index of swelling soil were reduced to 34.3% and 11.82% respectively when treated with WPS compared with untreated soil.

Table 2: Atterberg limits test

Properties	0% WPS	2% WPS	5% WPS	8% WPS
Plastic limit (%)	30	32	33	35
Liquid limit (%)	55	52	51	49
Plasticity index (%)	25	20	18	14
Soil classification	Silt with high plasticity	Silt with high plasticity	Silt with high plasticity	Silt with intermediate plasticity

3.3 Compaction Test

The results of compaction test are shown in Figure 1. When the percentage of WPS increased, the maximum dry density (MDD) decreased whilst the optimum moisture content (OMC) increased.

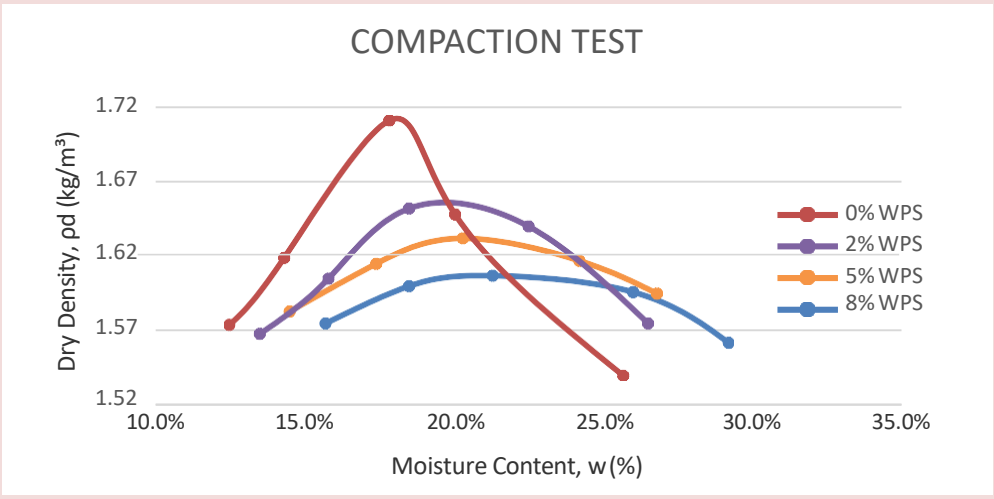


Figure 1: Dry density versus moisture content

The OMC value for all the three percentages of soil with WPS increased more than the OMC of soil with 0% WPS, and the MDD of soil with WPS is less than the MDD of soil with 0% WPS. The OMC of soil increased with the increase of WPS whilst the MDD decreased proportionally with WPS addition. The addition of 2% WPS resulted in the highest MDD compared with other percentages. The summary of compaction test is shown in Table 3.

Table 3: Compaction characteristics of soil with WPS

% of WPS	Optimum Moisture Content (%)	Dry Density, ρd (g/cm³)
0%	17.84	1.71
2%	18.5	1.65
5%	20.3	1.63
8%	21.3	1.61

3.4 Triaxial Test

These tests were carried out to investigate the stress-strain of soil with the addition of 2%, 5%, and 8% WPS for effective stress of 50, 100, and 200 kPa. The summary of effective friction angle and cohesion variance with WPS ratio is presented in Table 4.

Table 4: Summary of friction angle, ϕ and cohesion, c variance with % of WPS

Samples	Friction angle, ϕ (°)	Cohesion, c (kPa)
0% WPS	13	70
2% WPS	25	98
5% WPS	26.5	99
8% WPS	22.5	48

The effective friction angle of marine clay stabilized with WPS increased continuously (13° to 26.5°) with the addition of WPS from 0% to 5%. However, after the addition of 8% WPS, the friction angle decreased from 26.5° to 22.5°. The marine clay with 5% WPS addition showed the highest total shear strength since it had the highest increment value of undrained cohesion (c) from 70 to 99 kPa. This increase is due to the cohesion between particles, which is interparticle friction of WPS and marine soil and electrostatic attraction between ions (Khalid et al., 2015).

4.0 Conclusion

- The value of plastic limit increased with the increase of WPS percentage. Meanwhile, the values of liquid limit and plasticity index decreased with the increase of WPS percentage. Soil samples with 0%, 2%, and 5% WPS are classified as silt with high plasticity and the classification of soil sample with 8% WPS is silt with intermediate plasticity.
- The addition of WPS to the soil samples resulted in an increase in the optimum moisture content (OMC) and a decrease in the maximum dry density (MDD) of soil.
- WPS with 5% ratio is the optimum percentage to stabilize marine soil at the maximum deviator stress 636.3 kPa at effective stress of 200 kPa. The addition of 5% WPS improved the total shear strength with an increment of 103.85% in friction angle, ϕ from 13° to 26.5° compared to marine soil only. The cohesion value also improved by 41.43% from 70 to 99 kPa.
- Treatment with waste paper sludge is suitable as an improvement method to be applied in geotechnical engineering works, particularly for marine soil. To obtain

better, persistent, and consistent results, more ratios should be tested to determine the accurate optimum value of WPS in order to achieve maximum shear strength of marine soil. To understand more about the relationship between the shear strength and the engineering properties of marine clay, more testing should be done especially on the physical, mechanical, and geological properties of soil.

- Utilization of WPS can reduce the construction cost, promote an environmentally friendly method of soil additive, and improve the properties soil, while also solving disposal problems.

REFERENCES

Ahmad, N. R., and Harahap, I. S. H. (2016). The compression behaviour of marine clays in Malaysia. In *Proceedings of the International Conference on Offshore Mechanics and Arctic Engineering - OMAE* (Vol. 1, pp. 1–6). https://doi.org/10.1115/OMAE2016-54795

Ali, F., and Al-Samaraee, E. A. S. (2013). Field behavior and numerical simulation of coastal bund on soft marine clay loaded to failure. *Electronic Journal of Geotechnical Engineering*, *18 S*(January), 4027–4042.

Bushra, I., and Robinson, R. G. (2009). Consolidation behaviour of a cement stabilised marine soil. In *Proceedings of International Geotechnical Conference* (pp. 431–434).

Khalid, N., Mukri, M., and Kamarudin, F. (2015). SOFT Soil Subgrade Stabilization Using Waste Paper Sludge Ash (WPSA) Mixtures. In *Proceedings of the International Civil and Infrastructure Engineering Conference 2014* (pp. 439–446). https://doi.org/10.1007/978-981- 287-290-6

Rahman, Z. A., Yaacob, W. Z. W., Rahim, S. A., Lihan, T., Idris, W. M. R., and Mohd Sani, W. N. F. (2013). Geotechnical characterisation of marine clay as potential liner material. *Sains Malaysiana*, *42*(8), 1081–1089.

Rao, D. K., Rao, G. V. R. P., and Babu, K. J. (2011). Field studies on the marine clay foundation soil beds treated with lime, GBFS and reinforcement technique. *International Journal of Engineering Science and Technology*, *3*(4), 3105–3112.

Rao, S. N., and Mathew, P. k. (1996). Permeability studies in marine clays stabilized with lime column. *International Society Offshore and Polar Engineers*, *6*(3), 1–6.

Teja, V. S., Sindhuja, K., and Krishna, G. S. (2016). Improvement of Properties of Highly Swelling Soil by using Waste Paper Sludge. *International Journal of Engineering Development and Research*, *4*(2), 417–419.

CONVOLUTIONAL NEURAL NETWORK FOR BRAIN TUMOUR SEGMENTATION

Nor Kharul Aina Mat Din
Department of Electrical Engineering
Politeknik Sultan Salahuddin Abdul Aziz Shah, Persiaran Usahawan Seksyen U1,
40150 Shah Alam, Selangor Darul Ehsan
Corresponding author: nkaina82@gmail.com

Abstract

Convolutional neural network (CNN) has gain attention in deep learning due to its capability to automate some process including brain tumour segmentation. Automatic segmentation is better option compared to manual segmentation due to the large amount of MR images produced during imaging, and it also varies depends on the clinicians' expertise. In this study we assess a cascaded neural network architecture on a well-known multisequence MRI dataset, consisting of around 500 patients in total. This network is trained separately on BraTS 2015 and BraTS 2017 datasets. In self-validation, the 2015 model produced dice scores of 0.9098 and 0.8308 for the whole tumour and tumour core respectively, whereas the 2017 model produced dice scores of 0.9128 and 0.9150 for the whole tumour and tumour core respectively. On the other hand, in cross validation, the 2015 model produced dice scores of 0.8762 and 0.7722 for the whole tumour and tumour core respectively, whereas the 2017 model produced dice scores of 0.8824 and 0.7454 for the whole tumour and tumour core respectively.

***Keywords*:** *convolutional neural network, cascaded neural network, brain tumour segmentation, multimodal MRI*

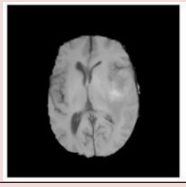
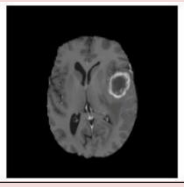
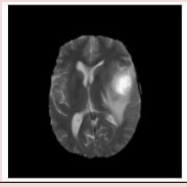
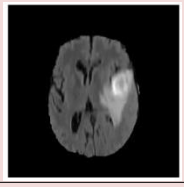
1.0 Introduction

Magnetic resonance imaging (MRI) remain as the best imaging modality used for brain tumour diagnosis. The four regular MR imaging sequence used for diagnostic imaging are T1, T1 contrast enhanced (i.e. T1 with gadolinium contrast enhancement), T2, and Fluid Attenuated Inversion Recovery (FLAIR) (Peni Agustin Tjahyaningtijas, 2018). Table 1 differentiate the image formed by each sequence.

Brain tumours can be identified as cells that grow abnormally in the brain. Two categories of brain tumour are cancerous (malignant) and non-cancerous (benign) tumours. This classification is based on the tumour's degree of aggression. We may also differentiate them into primary brain tumours originating from brain cells and metastatic tumours originally derived from another region or organ that has been affected.

Brain tumour segmentation is the process of identifying and labelling tumour tissue voxels in the image, and can involve segmentation into multiple subregions such as the tumour core and necrotic and edema areas, as illustrated in Figure 1 (Işın, Direkoğlu and Şah, 2016). As taken from BraTS dataset, all images were skull stripped. However, during a common MRI acquisition protocol, a large amount of MRI images will be produced, with multiple sequences, hence manual segmentation of the tumour is very tedious, and the accuracy also depends on the clinicians' expertise. Therefore, automated segmentation is essential.

Table 1: Glioma images produced by different MRI sequences

Imaging Sequence	T1	T1 contrast enhanced	T2	FLAIR
Main Purpose	Distinguish healthy tissue from the tumour	Identify tumour border by adding gadolinium (Gd) contrast agent	Highlights the edema region	Shows signal of water to set apart the edema area from the cerebrospinal fluid (CSF)
Example glioma image				

Deep learning methods have dominated medical image processing recently, and it is the newest approach to be used in automatic segmentation. Abd-Ellah *et al.* (2019), conclude that deep learning neural networks perform more accurately compared to traditional automated approaches. The advantage of this convolution neural networks (CNN) is that the network will automatically learn the features necessary for the segmentation task. There have thus been numerous applications of CNN for brain tumour segmentation such as (Hussain, Anwar and Majid, 2018) and also other diseases such as lung disease (Anthimopoulos *et al.*, 2016). In other traditional machine learning approaches, feature extraction has to be explicitly determined and chosen beforehand, which leads to less accurate results.

This manuscript is arranged as follows: Section 2 presents the method used in this study, while Section 3 presents the results and discusses them. Section 4 finally concludes this study with some recommendations for future work.

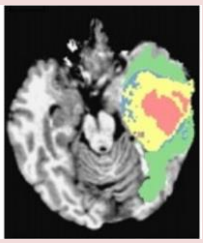


Figure 1: Example of brain tumour segmentation into the multiple subregions: green: edema, blue: enhanced core, yellow: core, red: necrotic core (image source: (Abd-Ellah *et al.*, 2019))

2.0 Methodology

This study is based on previous work (Wang *et al.*, 2017), which used cascaded convolutional networks to segment the whole tumour region as well as sub tumours regions which are the tumour core and the enhancing tumour core (i.e. non necrotic region). This network was implemented using NiftyNet (Gibson *et al.*, 2018), which is an open source platform based on Tensorflow. The overall architecture of this network is shown in Fig 2. The three networks hierarchically segment the whole tumor (WNet), tumor core (TNet) and enhancing tumor core (ENet) sequentially. More details can be found in (Wang *et al.*, 2017).

For evaluation, we used two networks which were separately trained on the BraTS 2015 (Menze *et al.*, 2015) and BraTS 2017 (Bakas *et al.*, 2017) datasets. The networks were tested in two ways, using their own training datasets (i.e. self-validation) and using the other dataset (i.e. cross validation, the BraTS 2015 tested with the BraTS 2017 dataset, and vice versa).

3.0 Result and Discussion

The results for self-validation and cross validation of each model is shown in Table 2 below. The dice score is used to quantify the similarity of the segmentation results with the ground truth. The results are averaged over all patients in each dataset.

Table 2: Results for model self-validation and cross validation

Model used	Average Dice scores		Dataset used
	Whole tumour	Tumour core	
BraTS 2015	0.9098	0.8308	BraTS 2015
	0.8762	0.7722	BraTS 2017
BraTS 2017	0.8824	0.7454	BraTS 2015
	0.9128	0.9150	BraTS 2017

In self-validation, the accuracy of each network is higher as it is tested on the same data used to train each network. We see that the accuracy is lower is cross validation as expected, however, they are relatively still high, and show that the networks have good generality, as each dataset consists of data from over 100 patients with different stages of gliomas (low and high grade).

4.0 Conclusions

Image segmentation of brain tumours is still an area of active research because of its significance in image-based diagnosis and remains challenging due to the variability in patients. Segmenting in 3D is an especially challenging and difficult task. In this work we managed to validate a cascaded CNN based method for 3D tumour segmentation with considerably large datasets of more than a hundred patients each. These results show that the models have good generalisation across different datasets places confidence for their use in new data.

References

Abd-Ellah, M. K. *et al.* (2019) 'A review on brain tumor diagnosis from MRI images: Practical implications, key achievements, and lessons learned', *Magnetic Resonance Imaging*. Elsevier Inc, 61, pp. 300–318. doi: 10.1016/j.mri.2019.05.028.

Anthimopoulos, M. *et al.* (2016) 'Lung Pattern Classification for Interstitial Lung Diseases Using a Deep Convolutional Neural Network', *IEEE Transactions on Medical Imaging*. Institute of Electrical and Electronics Engineers Inc., 35(5), pp. 1207–1216. doi: 10.1109/TMI.2016.2535865.

Bakas, S. *et al.* (2017) 'Advancing The Cancer Genome Atlas glioma MRI collections with expert segmentation labels and radiomic features', *Scientific Data*. The Author(s), 4(March), p. 170117. doi: 10.1038/sdata.2017.117.

Gibson, E. *et al.* (2018) 'NiftyNet: a deep-learning platform for medical imaging', *Computer Methods and Programs in Biomedicine*, 158, pp. 113–122. doi: 10.1016/j.cmpb.2018.01.025.

Hussain, S., Anwar, S. M. and Majid, M. (2018) 'Segmentation of glioma tumors in brain using deep convolutional neural network', *Neurocomputing*, 282(282), pp. 248–261. doi: 10.1016/j.neucom.2017.12.032.

Işın, A., Direkoğlu, C. and Şah, M. (2016) 'Review of MRI-based Brain Tumor Image Segmentation Using Deep Learning Methods', *Procedia Computer Science*, 102(August), pp. 317–324. doi: 10.1016/j.procs.2016.09.407.

Menze, B. H. *et al.* (2015) 'The Multimodal Brain Tumor Image Segmentation Benchmark (BRATS).', *IEEE transactions on medical imaging*, 34(10), pp. 1993–2024. doi: 10.1109/TMI.2014.2377694.

Peni Agustin Tjahyaningtijas, H. (2018) 'Brain Tumor Image Segmentation in MRI Image', *IOP Conference Series: Materials Science and Engineering*, 336(1). doi: 10.1088/1757-899X/336/1/012012.

Wang, G. *et al.* (2017) 'Automatic Brain Tumor Segmentation Using Cascaded Anisotropic Convolutional Neural Networks', in *Brainlesion: Glioma, Multiple Sclerosis, Stroke and Traumatic Brain Injuries*. Springer, Cham, pp. 178–190. doi: 10.1007/978-3-319-75238-9_16.

DEVELOPMENT OF LIGHTWEIGHT PAVING BLOCK USING PLASTIC BOTTLES AND SW-PU200

Salizawati Kamaruzzaman
Department of Civil Engineering
Politeknik Sultan Salahuddin Abdul Aziz Shah, Persiaran Usahawan Seksyen U1,
40150 Shah Alam, Selangor Darul Ehsan
Corresponding author: salizawati89@gmail.com

Abstract

Paving block is versatile, aesthetically attractive, functional, and cost effective and requires little or no maintenance if correctly manufactured and laid. But there are few problems that occur whenever it comes to paving block. The main problem statement that research define is the paving block nowadays is too heavy due to their high density. Furthermore, paving blocks nowadays have durability which are not strong for long periods of use and causes of cracking. In order to modify conventional paving block, plastic bottles and PU200 is the main materials to reduce the weight of the concrete block paving. The main purpose of the use of plastic bottles is to reduce the current pollution of the environment. Testing has been carried out to determine the density of lightweight paving block with the conventional paving block. The result of the test for lightweight paving block should be less than conventional paving block. To determine the skid resistance the value of the road pavement surface dry and wet, we are using skid resistance test on the paving block. Normal density for paving block nowadays is between 2240 to 2400 kg/m³. This research to produce an innovative lightweight paving block with density between 1440 to 1840 kg/m³ but still maintaining its strength. Furthermore, bottles that been added into paving block are very important for the effectiveness in this project, also from the paving block that produced can less the labour to install the paving block at the site work and reduce the time of installation. The size for the lightweight paving block that we created is 140mm x 80mm x 330mm. This lightweight paving is focused on pedestrian, home areas and pool areas.

Keywords**:** *lightweight paving block, less labour work, plastic bottles, PU-200 chemicals, pedestrian, installation time*

1.0 Introduction

During our past Corporate Social Responsibility (CSR) programme, the paving blocks that were installed in polytechnics were heavy and difficult to operate as well as having low strength where the brick was easily cracked. Thereby generating ideas for today's innovative paving block to lightweight block.

Plastic bottles and SW-PU200 (Polyurethane 200) is the main materials to reduce the weight of the concrete block paving. The main purpose of the use of plastic bottles is to reduce the current pollution of the environment.

The main problem statement that define is the paving block nowadays is too heavy due to their high density. Furthermore, paving blocks nowadays have durability which are not strong for long periods of use and causes of cracking.

The environment is filled with toxic plastic waste, posing a serious health risk to every living thing on our planet. Plastic waste including plastic bottles is the most accumulated on waste landfills in the country with a rate of 70 per cent compared with other waste materials (Peter Nansian, 2011)

Plastic bottles take hundreds of years to biodegrade in landfills. Every year people are dumped into water way and landfills causing pollution and health problem. The amount of waste or solid waste disposed to landfill is of 2,122 tons per day and an average of 20 percentage is plastic waste (Peter Nansian, 2011).

Generally, research on the construction of paving brick using lightweight block as a main goal of a project should have an objective that must be achieved to enable this research done successfully. The objectives of this study were to produce lightweight paving block using plastic bottles. Besides, it is also to determine the density of lightweight paving block using plastic bottles. Also, to compare compressive strength between lightweight paving block and control sample.

2.0 Methodology

In order to achieve the stated objectives, this study was carried out in few stages. In the initial stage, all the materials and equipment needed are gathered and checked for availability. Then the creating 330 mm x 140 mm x 80 mm paving block (MS1380:1995). The flow chart of methodology of this project is indicated in Figure 2.1.

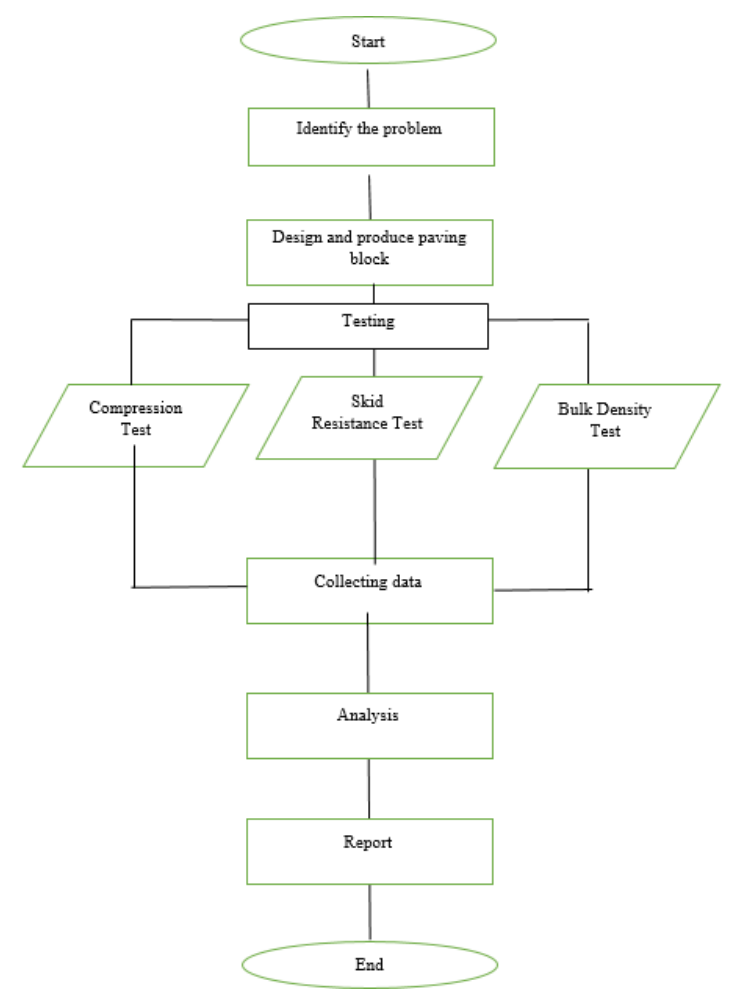


Figure 2.1: Flowchart of methodology

2.1 Material Properties

The material used in this study were plastic bottle and foam (SW-PU200). The description of each of the material is described in the following sections.

2.2 Plastic bottles

The plastic bottles in this study were PET/PETE (Polyethylene Terephthalate), HDPE (High Density Polyethylene), LDPE (Low Density Polyethylene) and Other (Including Polycarbonate, Nylon & Acrylic). The types and description of plastic bottles are listed in Table 2.1.

Table 2.1: Types of plastic bottles and description

Types of plastic bottles	Description
 PET/PET (POLYETHYLENE TEREPHTHALATE)	Commonly use in mineral water and drinking water and cannot be used, refilled or heated
 HDPE (HIGHT DENSITY POLYETHYLENE)	This bottle is thicker than PET, it is safe to refill and reuse also commonly use as shampoo, bottle, detergent bottle and etc
 LDPE (LOW DENSITY POLYETHYLENE)	LDPE bottle has its toughness, flexibility and relative transparency that make it good for packaging applications requiring heat- sealing. This bottle is used to make many thin, flexible products like plastic bags for dry-cleaning and fresh produce.
 OTHERS (INCLUDING POLYCARBONATE, NYLON & ACRYLIC)	This bottle commonly uses as baby bottles, sport bottle and 5-gallon of water and this bottle sometime can be recyclable and sometimes cannot.

2.3 SW-PU200

SW-PU200 is one liquid type radius firing urethane having strong hydrophobic type through injecting and putting leakage part of concrete and reacting with water, it is the product forming water firing stage of closed cell structure closing off from Influx water. As free-flux type having no stimulating offensive smell, it is a product that having quick response, no shrinking change and excellent permeable. Physical Properties of SW-PU200:

i. Viscosity – 450 – 600mPa.s
ii. Specific Gravity – 1.12 - 1.2
iii. Foaming Time – 300s – 400 s

2.4 Creating the paving block

The procedure as follows:

i. Find a wooden board.
ii. Cart the board using a wooden saw according to the size (330mmx140mmx80mm).
iii. Nail the board to make it into square shape.
iv. Found and dry empty bottles and chemical SW-PU200.
v. Put a little SW-PU200 in the bottle and fill it with water.
vi. Shake the bottle until the water and SW-PU200 mixed
vii. After a few minutes, the mixtures in the bottle will be hard.
viii. Place the bottle brick vertically in the wire mesh.
ix. Tied the bottle brick inside wire mesh.
x. Put it inside the formwork and fill it with concrete.

2.5 Compression Test

One of the important properties of concrete is its strength is compression. Compression test will be applied on four lightweight paving blocks, two blocks for control variable and two blocks of existing lightweight paving blocks. Compression test is very significant to determine the compressive strength for products which receive vertical loading. The compressive strength of the lightweight paving blocks samples was determined after the samples have been cast and cured for 7 and 28 days. The weight of the lightweight paving blocks samples was taken before conducting the compressive strength test. Samples were crushed with the cast faces touch with the testing machine at 7 and 28 days using the Compression Testing Machine. The results of the Compression test of the lightweight paving block are shown in Table 3.1. Compressive Strength = Maximum Load (N)/Load Area (mm^2) (Kassim and Rohim, 2017).

2.6 Skid Resistance Test

Skid resistance is important for road safety. With skid resistance it allows for better 'grip' between users and road surface. Most road surfaces have adequate skid resistance in the dry as compared during wet condition. The results of the Skid Resistance Test of the lightweight paving block are shown in Table 3.1.

2.7 Bulk Density Test

The soil bulk density (BD), also known as dry bulk density, is the weight of dry soil (Msolids) divided by the total soil volume (Vsoil). The total soil volume is the combined volume of solids and pores which may contain air (Vair) or water (Vwater), or both. The bulk density is calculated as mass per unit volume;

$$\text{Bulk Density} = \text{Mass (M)} / \text{Volume (V)}$$

Where; M is the weight of the specimen after dried in a ventilated oven at a temperature of 105 -115°C, while V is the volume (length x width x height) of the block.

The results of the Bulk Density Test of the lightweight paving block are shown in Figure 3.1.

3.0 Results and Discussion

The data gained are skid resistance test, compression test and density test based on the research objective.

3.1 Compressive Strength of Lightweight Paving Block

Table 3.1: Result and data of compression test

Type of bottles	Compressive strength (N/mm^2)	Average compressive strength (N/mm^2)
PET	10.40	10.40
LDPE	9.00	9.00
HDPE	5.00	5.00
OTHER	3.70	3.70

From the data obtained, this research to compare the strength of PET bottle 10.4 N/mm^2 with the HDPE bottle 5.0 N/mm^2. Followed by LDPE with 9.0 N/mm^2 and for other is 3.7 N/mm^2. It proves the PET bottle is the strongest compare to HDPE, LDPE and OTHER.

3.2 Density of Lightweight Paving Block

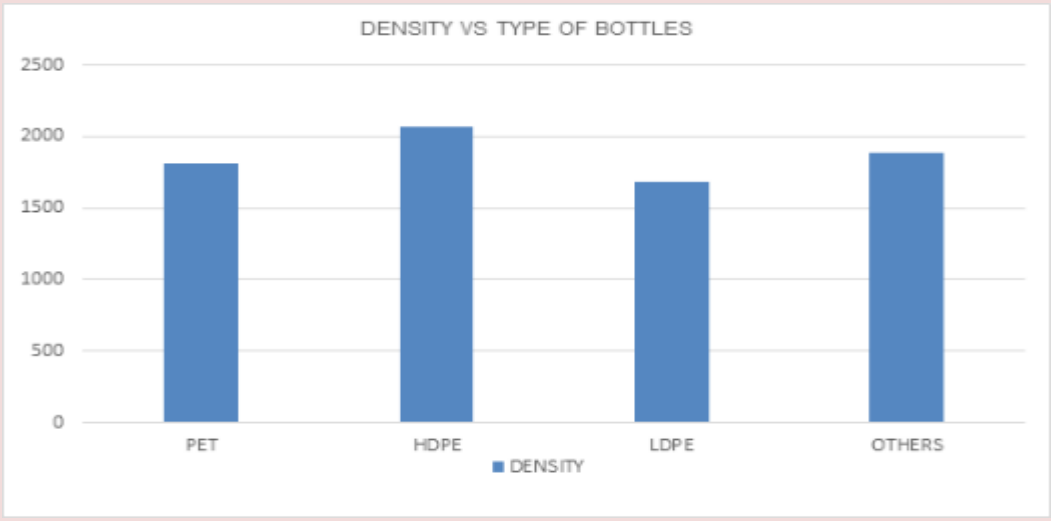


Figure 3.1: Data and Result of Bulk Density Test

From graph shows that the reading of LDPE is the lowest followed by PET, OTHER and HDPE. The LDPE weight is density = 1688.31 $\frac{kg}{m^3}$ meanwhile density of PET is 1812.77 $\frac{kg}{m^3}$, OTHERS density is = 1885.82$\frac{kg}{m^3}$ and HDPE density is 2072.51 $\frac{kg}{m^3}$. This proof that LDPE paving block is much lighter compared to PET, OTHER and HDPE.

3.3 Skid Resistance of Lightweight Paving Block

Table 3.2: Data and result of skid

Types of surface	Temperature	Skid Resistance Coefficient					Average of C value	A corrected value of C_t
		C value						
		1	2	3	4	5		
Dry Surface	30	25	27	25	28	30	27	29.25
Wet Surface	29	26	29	30	25	24	26.7	28.7

From the data obtained, this research to compare the skid resistance of dry surface 29.25 and wet surface 28.7.

4.0 Conclusion

- The compression test showed that the strength paving block using PET bottle 10.4 N/ mm² with the HDPE bottle 5.0 N/mm². Followed by LDPE with 9.0 N/mm² and for other is 3.7 N/mm². It proves the PET bottle is the strongest compare to HDPE, LDPE and OTHER.
- The reading of LDPE is the lowest followed by PET, OTHER and HDPE. The LDPE weight is density = 1688.31 $\frac{kg}{m^3}$ meanwhile density of PET is 1812.77 $\frac{kg}{m^3}$, OTHER density is = 1885.82$\frac{kg}{m^3}$ and HDPE density is 2072.51 $\frac{kg}{m^3}$. This proof that LDPE paving block is much lighter compared to PET, OTHERS and HDPE.
- Through skid resistance test it was found that the dry surface 29.25 and wet surface 28.7 skid resistance.

Acknowledgement

The authors gratefully acknowledge the Department of Civil Engineering, Polytechnic Sultan Salahuddin Abdul Aziz Shah for the laboratory facilities provided.

References

American Concrete Institute Contractors. (2005). *The Contractor's Guide to Quality Concrete Construction* (Third Edit). American Concrete Institute, Farmington Hills, Mich.

Bungey, J. H., Millard, S. G., & Grantham, M. G. (2006). *Testing of Concrete in Structures* (4th Edition). Taylor & Francis Group.

Kassim, U., & Rohim, O. M. (2017). Sustainable green interlocking pavement block Akademia Baru. *Journal of Advanced Research in Applied Sustainable Green Interlocking Pavement Block*, (1), 1–7.

Peter Nansian. (2011). Everyone Needs to Play Role in Environmental. *The Star*.

"Plastics Industry Grasps for Straws," Everyone's Backyard, January/February 1990, Citizen's Clearinghouse for Hazardous Waste. (1990), 6. Retrieved from https://sites.google.com/site/greenvalleyactiongroup/home/relevant-and-recent-green-press/polystyrene

Thompson, R. C., Moore, C. J., Saal, F. S. V., & Swan, S. H. (2009). Plastics, the environment and human health: Current consensus and future trends. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *364*(1526), 2153–2166. https://doi.org/10.1098/rstb.2009.0053

Yesilata, B., Isıker, Y., & Turgut, P. (2009). Thermal insultation enhancement in Concrete by Adding Waste Pet and Rubber Waste. *Construction and Building Materials*, *23*(5), 1878–1882.

SHEAR STRENGTH STABILIZATION OF MARINE SOIL WITH EPS

Daliela Ishamuddin and Farihah Mansor
Department of Civil Engineering
Politeknik Sultan Salahuddin Abdul Aziz Shah, Persiaran Usahawan Seksyen U1,
40150 Shah Alam, Selangor Darul Ehsan
Corresponding author: dalielaishamuddin@gmail.com

Abstract

Marine soils are classified as soft soils mainly because of their high compressibility and low strength. The most common problems of road and embankment constructions with regard to marine soil are stability and long-term settlements. Expanded polystyrene (EPS) has been a new lightweight material used in soil stabilization to upgrade the soil compressive strength. The shear strength of modified marine soil with varying percentage of EPS are evaluated through a series of experimental investigations. Standard Proctor compaction tests and consolidated undrained triaxial tests are performed in this experimental program to assess the effects of the addition of EPS beads on the resistance parameters of marine soil. In particular, consolidated undrained tests are performed to see the change in the shear strength of marine soil upon EPS treatment using a consolidated undrained triaxial test before and after treatment of the soil samples. The engineering properties of marine soils are also determined. The results show an increment of 56% in the shear strength of the treated soil with 0.15% EPS compared to the untreated soil. However, increase of soil strength is not shown as the EPS increase.

Keywords: *Marine soil, EPS, shear strength, consolidated undrained test*

1.0 Introduction

Stable growth of economy since a decade ago has generated various developmental strata across the world. This growth, just as many other fields, demand for various grades of soils usage, including clay soil, as foundation for buildings, traffics, bridges and others. Marine soil is a type of soil found in the coastal regions of the world. In Malaysia, marine soil is found in the coastal area of peninsular Malaysia. Marine soil deposits in the peninsular Malaysia are of low permeability and has the capability of attenuating inorganic contaminants. Marine soil categorized as soft soil consists of a type of clays, montmorillonite, which can shrink and swell during natural changes in soil moisture. The swelling behaviour could cause building foundation on marine soil to be destroyed only in few years. Also, changes in climatic conditions on the construction site requires a lot of maintenance cost as the structure constructed on the marine clay (as subgrade) have less durability.

With some precautions, these potential hazards can be significantly reduced. This type of soils is usually associated with high settlement and instability, poor soil properties that are not suitable for engineering requirements and low unconfined compressive strength of less than 20 kPa (Mohammed et. al. 2017).

Fill materials have been used widely in civil engineering application around the world. Some of the fill materials being used in wide range is lightweight material. EPS can reduce loads imposed on adjacent and underlying structures and soils as a lightweight fill. EPS geofoam, EPS beads, tire waste products such as crumb rubber tire, shredded tire and tire chips are some of the various lightweight fill materials reported. Generally, EPS is not a soil fill replacement material but is intended to solve engineering challenges. The use of EPS reflects to benefit construction schedules and lowers the overall cost of construction because it is easy to handle during construction. Mohammed and Marto (2017) also recommended the use of recycled materials as additive that contribute to the strength increment and also environmentally friendly additives such as recycled tiles, marble dust, granite dust, shredded tyre rubber and plastics.

EPS applications span several different areas including packages for electronic equipment, household appliances such as thermal boxes, thermal and acoustic insulations, trays for food packaging etc. Based on Karimpour et. al. (2015), EPS beads are not expensive as EPS geofoam, they can meet the same settlement required with soil to reduce the volume of EPS mixed together, and are also recyclable from packaging materials, which are often treated as wastes. EPS with the composition of 98% air and 2% raw material (in mass) have given problem in disposal issue for many countries all over the world (Tamu et. al., 2014). Reutilization of this residue can serve to minimize environmental liabilities and for adding value to the material, thus eliminating the current problems regarding the disposal of residues in landfill sites.

2.0 Experimental Programs

2.1 Materials

The marine soil used in this study was taken from Banting in Kuala Langat district, located in the west of Malaysia. Table 1 and Figure 1 present the physical properties and the particle size distribution curve of this marine soil, respectively. The EPS beads used in this study is super light polymer foam, prepuffed from polystyrene resin.

Recycled EPS beads are used in this study. The beads are white, even, and spherical spherical, sized between 1-3 mm. EPS beads were added to the marine soil in different proportions ranging from 0, 0.15, 0.85% by weight. The EPS beads are white, rounded particles with diameters of 1 mm to 6 mm in size. EPS beads with diameter less than 3 mm are produced from expandable polystyrene resin and contain microscopic cells filled with a blowing agent (usually pentanes or butanes). The resin is exposed to steam under controlled pressure, which softens the cell walls. EPS beads are formed after the blowing agent expands and causes individual resin beads to increase in volume by up to 40 times.

Table 1: Properties of marine soil used in this study

USCS	Moisture content	Specific gravity	D_{10}	D_{30}	D_{60}
Sandy Silt	74.72%	2.48	-	0.010	0.059

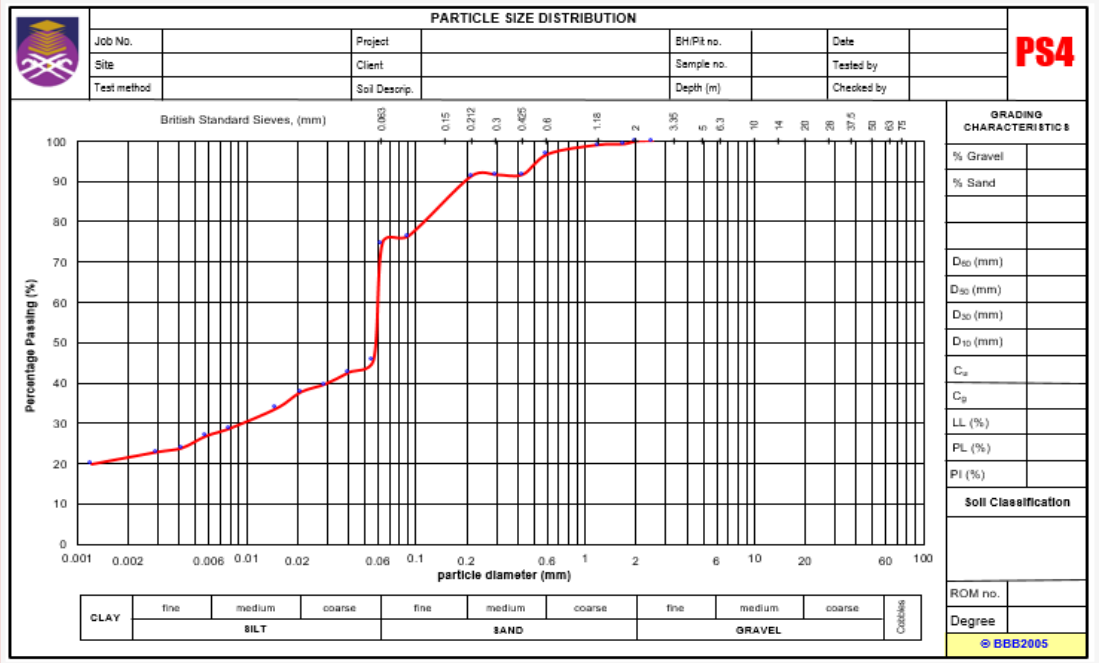


Figure 1: Particle size distribution curve of Banting soil

Marine soil is highly compressible and swellable soil which is usually found in a natural moisture content that is higher than its liquid limit. Finding in this research as shown in Table 2 stated the amount of LL, PL and PI for 0%, 0.15%, 0.5% and 0.85% EPS mixed respectively with marine soil. Considering the varying degree of expansively of finer faction, various mixes were prepared by adding different percentages of EPS beads as presented in Table 3.

Table 2: Atterberg limit test of treated marine soil

Samples	LL (%)	PL (%)	PI (%)	Plasticity Chart Classification
M0	55.0	30.0	25.0	Silt with High plasticity (MH)
M-EPS 0.15	53.2	39.3	23.1	Silt with High plasticity (MH)
M-EPS 0.5	51.4	41.7	22.3	Silt with High plasticity (MH)
M-EPS 0.85	49.2	43.6	20.4	Silt with Intermediate plasticity (MI)

Table 3: Mix proportions

EPS content	Soil sample
0%	M0
0.15%	M-EPS 0.15
0.5%	M-EPS 0.5
0.85%	M-EPS 0.85

2.2 Standard Proctor Test

Standard Proctor tests were undertaken to determine the optimum moisture content (OMC) and the Maximum dry density (MDD) of the mixture, as summarized in Table 4. It is observed that the addition of EPS reduces the amount of the dry density of soil mixture due to its physical structure that makes the composite lighter. Dry density of soil decreased from 1711 to 1547 kg/m^3. It is found that the optimum water content also decreases with range values from 17.84 to 15.83%, which is significantly affected by the increasing of EPS content. It is possible that increasing the volume of EPS beads in the mixing material would significantly decrease the values of the maximum density and the optimum moisture content of the material. This behaviour can be justified by the apparent low density and low moisture absorption of EPS beads. This behaviour is also observed by Abdelrahman et. al. (2013) and Mariana et. al. (2018). Figure 2 shows the test results and subsequent plot of moisture content versus dry density.

Table 4: Compaction test data of Banting soil

Soil sample	Maximum dry density (kg/cm)	Optimum moisture content (%)
M0	1711	17.84
M-EPS 0.15	1635	17.65
M-EPS 0.5	1593	16.34
M-EPS 0.85	1547	15.83

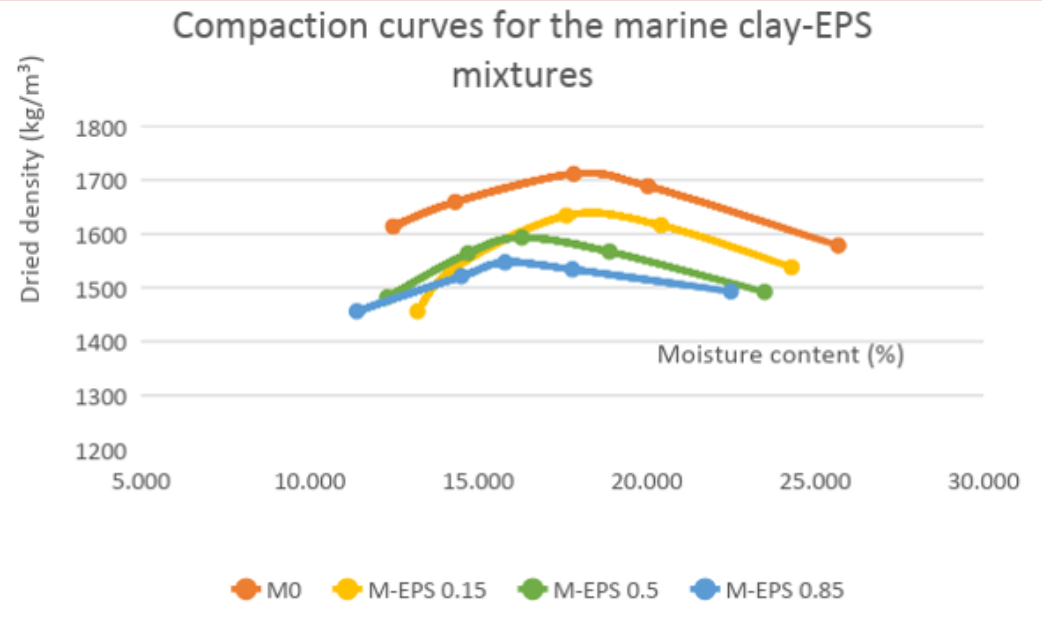
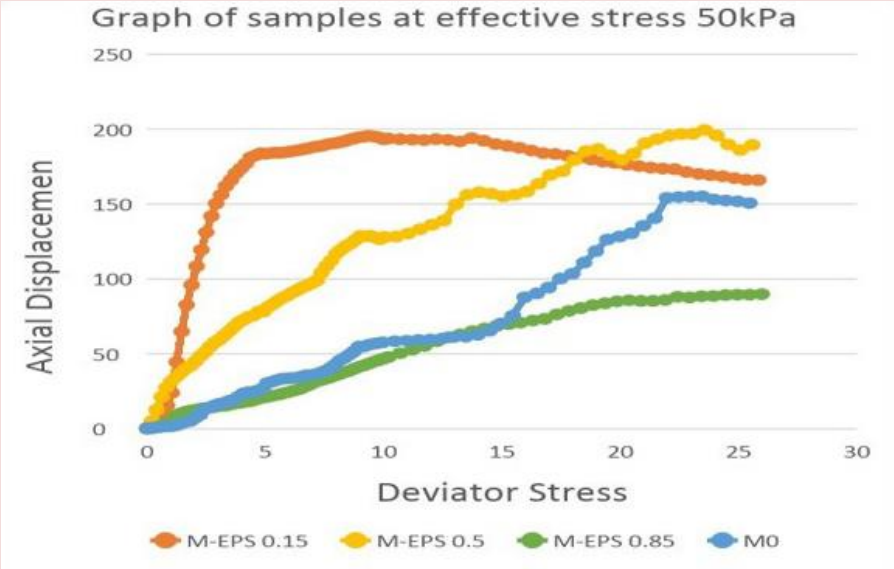


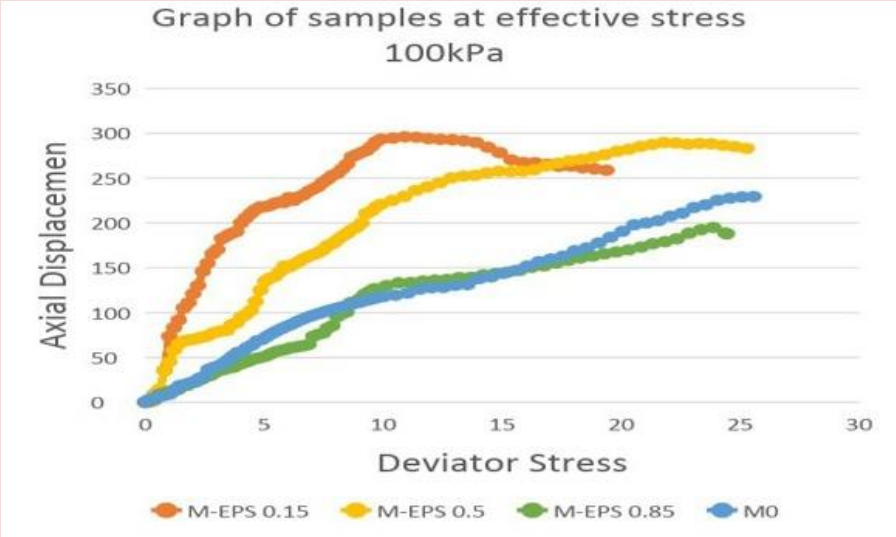
Figure 2: Compaction curves for different marine soil and EPS admixture

2.3 Consolidated Undrained Test

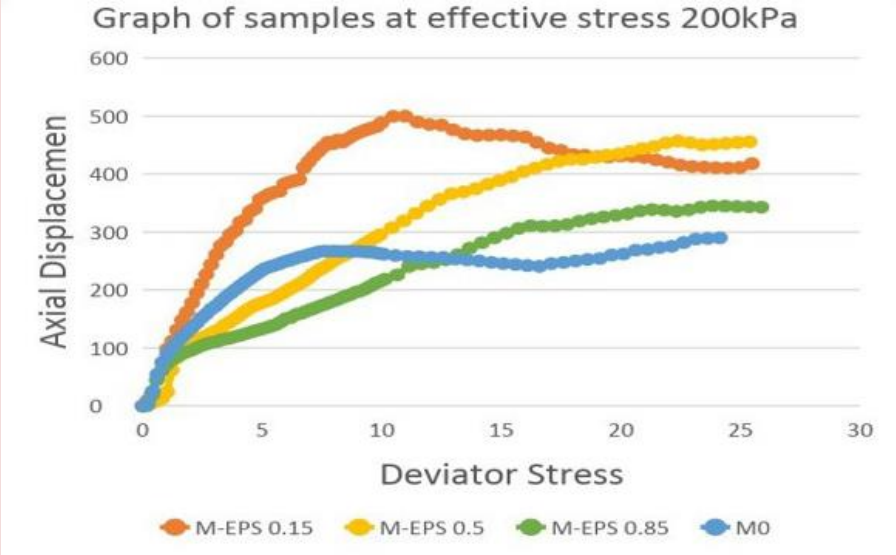
The consolidated undrained (CU) tests were conducted on cylindrical specimens with a diameter 38mm and height 76mm at the OMC and MDD condition. Specimens, with the mix proportions presented in Table 3 is carried out to obtain the shear strength of the soil mixed. Figure 3 presents the stress-strain curves of the modified soil sample with EPS at 0%, 0.15%, 0.5% and 0.85% respectively under varying effective stress. Obviously, sample at 0.15% EPS shows increment at 50, 100 and 200 kPa effective stress applied. Unfortunately, the other two (2) samples at 0.15 and 0.85% respectively decrease with increased amount of EPS.



(a)



(b)



(c)

Figure 3: Stress-strain curves of the specimen at (a) 50 kPa, (b) 100 kPa, (c) 200 kPa

The results from the consolidated undrained triaxial test is summarized in Table 5. As the results show, there is an increment of 56% for total shear strength in soil friction (ϕ) from 13° to 30° for M-EPS 0.15 compared with M0. The marine soil stabilized at 0.15% with EPS and gives the best result in terms of total strength due to the high value of internal locking of friction between the particles. Besides that, the marine soil stabilized at 0.5% and 0.85% EPS, respectively, but the stability decreases with further increase of EPS in the soil. Other than that, cohesion values are high for sample M0. However, these values decrease with increase in the amount of EPS in the marine soil. The addition of 0.15, 0.5 and 0.85% of EPS beads to the marine soil affected this soil's resistance parameters. This influence depends on the added content. For contents up to 0.15%, the cohesion intercept value decreases as the friction angle increases. The addition of 0.5% and 0.85% show decrease in the cohesion intercept for both parameters.

Table 5: Summary of friction angles' variation with % of EPS

Samples	Friction angle, ϕ (°)	Cohesion, *c (kPa)*
M0	13	65
M-EPS 0.15	30	42
M-EPS 0.5	28	38
M-EPS 0.85	25	10

According to Figure 4, improvement is observed in soil friction angle, Ø of soil mixed with EPS at certain percentage. The friction angle of the soil shows decrement with additional EPS at 0.5% and 0.85% while it increased only at 0.15% EPS. Failure envelopes of all specimen show decrement due to increment of EPS amount. This can be simply because the compressibility of EPS is much higher than the other constituents of the mixture.

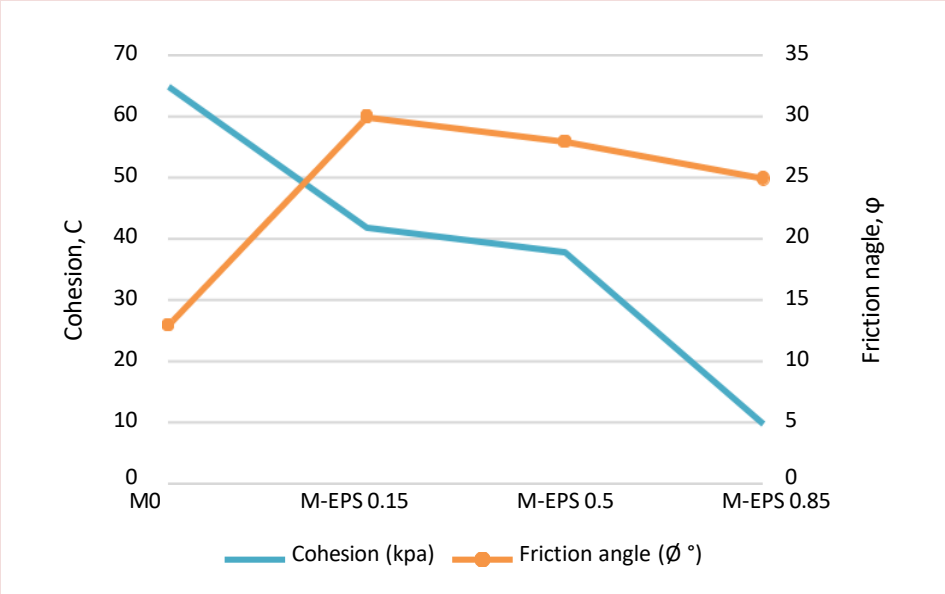


Figure 4: Relationship of Shear Strength Parameter with varying percentages of EPS samples

3.0 Conclusion

The effect of EPS content on the strength of marine clay can be obtained based on the shear strength parameters of treated sample with varying percentage. In this research shear strength analysis was determined by carrying out consolidated undrained test in laboratory using triaxial test machine on marine clay samples which were taken from Banting. The main findings of this study are as follows:

- The water content, liquid limit and specific gravity from the research are obtained in range of marine soil. After analysing all the results, the marine soils have varieties of soil particles that tend to give different values of soil properties, even though the samples were taken from the same location. The marine soil at the site location is identified as sandy silt with high plasticity based on USCS soil classification. The water content of the soil ranges between 75% - 86%. This has therefore showed the marine soils tend to experience settlement if a large amount of load is imposed on the soil. For that reason, a strong foundation must be designed to accommodate building on a marine soil area. EPS beads of 0.15%, 0.5% and 0.85% contents were respectively mixed with marine soil to identify the compressive strength at effective stresses of 50, 100 and 200 kPa. An increase of 0.15% of EPS results in an addition of the total strength at friction angle 30° and makes the mixture more ductile rather than brittle.
- Moreover, the total strength value of the mixture decreases by an increase of the EPS beads. EPS cannot absorb moisture content in soil, and this is proven to be possible

increased failure strain in soil sample. The maximum dry density and optimum moisture content decrease with increase of EPS amount in marine soil because the existence of EPS in the soil sample failed to give a good reaction between soil particles. Therefore, an additional binder could be added in the treated soil such as cement to increase the strength of soil. The result of compaction test has reflected the shear strength of soil when added with EPS. Shear strength parameter also show the same result as compaction test where the total stress of soil with friction angle and cohesion values decrease as EPS increase in soil sample. These scenario shows EPS beads as lightweight and recycle material in soil stabilization need further research to overcome the problem faced with previous researcher.

References

Abdelrahman G.E., Mohamed H.K., Ahmed H.M. 2013. "New Replacement Formations on Expansive Soils Using Recycled EPS Beads". Proceedings of the 18th International Conference on Soil Mechanics and Geotechnical Engineering, Paris.

Karimpour Fard, M., Jamshidi Chenari , R., Soheili , F, Shear Strength Characteristics of Sand Mixed with Eps Beads Using Large Direct Shear Apparatus Electronic Journal of Geotechnical Engineering · August 2015. Vol 20 (2015) Bund. 8

Mariana Vela Silveira, Alena Vitková Calheiros, Michéle Dal Toé Casagrande. 2018. "Applicability of the Expanded Polystyrene as a Soil Improvement Tool". J. Mater. Civ. Eng. 30 (6).

Mohammed Ali Mohammed Al-Bared, Aminaton Marto, 2017. "A Review on the Geotechnical and Engineering Characteristics of Marine Clay and the Modern Methods of Improvements. Malaysian Journal of Fundamental and Applied Sciences". Vol 13, No 4

Tamut, T., R. Prabhu, K. Venkataramana, and S. C. Yaragal. 2014. "Partial replacement of coarse aggregates by expanded polystyrene beads in concrete." Int. J. Res. Eng. Technol. 3 (2)

THE RELATIONSHIP BETWEEN EMPLOYEES' JOB SATISFACTION AND ATTITUDE TOWARDS ORGANISATIONAL CHANGE

Norfaizah Abas, Nurfadillah Ahmad Mahmmud and Azma Husnaiza Abdul Aziz
Department of Commerce
Politeknik Sultan Salahuddin Abdul Aziz Shah, Persiaran Usahawan Seksyen U1,
40150 Shah Alam, Selangor Darul Ehsan
Corresponding author: norfaizahabas@psa.edu.my

Abstract

Organisational change is a crucial process in organisations' strategic development. The higher education industry in Malaysia needs to consistently evolve to ensure relevance and competitiveness. Thus, employees' job satisfaction is a concern to organisations because it has been linked to higher acceptance of the organisational change. Hence, this study investigated the relationship between job satisfaction and employees' attitude towards organisational change. A total of 201 staff in Politeknik Sultan Salahuddin Abdul Aziz Shah were involved in this quantitative research. The findings displayed a significant positive relationship between job satisfaction and employees' attitude towards organisational change.
Keywords: *attitude towards change, job satisfaction*

1.0 Introduction

Change is an unavoidable process for many organisations. In order to remain competitive and relevant, organisations nowadays including higher education institutions have to be prepared to cope with rapid changes in the business environment (Lo, Ramayah, Min, & Songan, 2010). Gelaidan and Ahmad (2013) mentioned that an organisation needs to strive to adapt to rapid challenges, and change will not be successfully realised and effective if employees are not involved in the process.

This transformation plan emphasises on developing and strengthening the polytechnic system through the development of new programmes in niche areas, feedback from industries, collaborations with other local and international higher learning institutions, and producing knowledgeable and competent lecturers together with an excellent working culture (Department of Polytechnic Education, 2015). Thus, in ensuring that the Polytechnic Transformation Plan to become a reality, polytechnic staff is facing pressure to adapt in order to meet with the requirement (Ibrahim, Ghani & Salleh, 2012).

Employees' acceptance of change and readiness are basically dependent on their experiences in undergoing organisational change (Ludviga & Sennikova, 2016). Previous studies have shown that teachers nowadays have been dealing with various issues regarding their career such as work overload, inability to cope with changes following education policies, and technology advancement, and also emotional instability which will affect their job satisfaction (Ibrahim, Ghani & Salleh, 2012). This is concerning as previous researchers found that job satisfaction is essential to organisational performance (Mathieu & Farr, 1991; Ostroff, 1993). In the Malaysian context, several studies have been conducted on job satisfaction among teachers in schools and vocational colleges, but limited studies have examined in the polytechnics setting (Abdul Wahab, Fuad, Fuzlina, Ismail & Majid, 2014). Hence, this study investigated the level of employees' attitude towards organisational change and concurrently identify the relationship between job satisfaction and academic staff's job satisfaction among polytechnic employees.

2.0 Literature Review

2.1 Employees Attitude towards Organisational change

Hettiararchchi and Jayarathna (2014) highlighted that employee attitudes reflect their broad values and beliefs which lead to the improvement of individual assessments and preferences. This emphatically contributes to how they make decisions in their daily work routine which can have ripple effects on the overall productivity of an organisation.

Organisational change is defined as an attempt or series of attempts to modify an organisation's structure, goals, technology, or work task (Carnall, 2003). It is also defined as the procedure of constantly reintroducing the organisations' direction, structure, and capabilities to serve the ever-changing needs of internal and external customers (Mora & Brightman, 2001). These types of changes occurring in the organisation have a tendency to be formal, planned, and goal-directed in nature. Moreover, the change in an organisation is influenced by internal and external factors (Balogun & Hope-Hailey, 2004; Carnall, 2003).

Correspondingly, attitudes toward organisational change are defined as an employee's overall positive or negative evaluative judgment of a change initiative implemented by their organisation (Elias, 2009). This is supported by Visagie (2010) who defined employee attitudes toward organisational change as certain uniformities of an individual's sentiments, views, or inclinations to act toward some aspects of his or her environment. Furthermore, Dunham, Grube, Gardner, Cummings, and Pierce (1989) argue that attitude towards change

in general consists of a person's cognitions about change, affective reactions to change, and behavioural tendency toward change which may formulate the response to change.

According to Gupta (2016), there are two outcomes of employees' attitudes toward change. The first outcome is that employees may have a negative attitude towards organisational change and are more likely to refuse to accept the change and the second outcome is that employees have a positive attitude towards organisational change and more likely to adapt with the changes. A positive attitude among employees can be explained when they are willing to work hard, make things happen, and achieve the targets that were set by the organisation (Rashid, Sambasivan, & Rahman, 2004). Therefore, employees' attitude during the change process in organisation plays a vital role in the successful implementation of new ideas in the organisation in the attainment of its goals and objectives. Thus, job satisfaction is an important element to be studied to assist organisations to recognise whether their employees are satisfied with their jobs in enhancing their positive attitude towards organisational change.

2.2 Job Satisfaction

According to Janssen (2001), job satisfaction is defined as the emotional reaction on the job and what employees assess based on their view, expectation, and standard. Alteration in one's job may influence workers' perceptions (Ang & Slaughter 2000). Davis (2004) found that each person might experience a different level of satisfaction or dissatisfaction since an individual may feel some aspects of the job are satisfying while other individuals find it distressing. Job satisfaction is a combination of positive or negative feelings that workers have toward their work based on what they expect towards it versus the real situation (Armstrong, 2003).

Furthermore, Khan, Kundi, Nawaz, and Yar (2014) found that rewards, pay, job promotion, job safety and security, working condition, relationship with co-workers, autonomy, relationship with supervisors, and nature of works have an impact on job performance. It also can be influenced by the type of job, age, gender, work experience, educational level, and supervisory support (Kapur, 2018).

2.2.1 Job Satisfaction and Employees Attitude toward Organisational change

Job satisfaction can be described as an inclusive valuation of employees' work and job-related experiences, which are influenced by one's beliefs, ideas, and opinions (Chan, Pan & Lee, 2004).

Studies found that job satisfaction is essential to enhance employees' motivation and encourages better performance (Raziq & Maulabakhsh, 2015). This is supported by Khan et al. (2014) who identified that rewards, pay, job promotion, job safety and security, working condition, relationship with co-workers, autonomy, relationship with supervisors and nature of works have a positive impact on job performance. Several studies have also reported that job satisfaction has a positive relationship with employees' commitment and loyalty (Chang, Chi & Chuang, 2010; Tidwell, 2005). This is also supported by Tarigan and Ariani (2015) who found that employees' job satisfaction levels significantly impact employees' tenure and productivity.

Similarly, Yousef (2000) investigated the direct and indirect effects of various facets of job satisfaction on attitudes toward organisational change. The results showed that working conditions, pay, supervision, and security have a positive relationship with attitudes toward change. The results also demonstrated that attitudes toward change increase in parallel with an increase in satisfaction with pay and promotion. Thus, based on previous studies, the proposed hypothesis for this study is:

H_1: There is a positive relationship between job satisfaction and employees' attitude towards change.

2.3 Theoretical Framework

2.3.1 Herzberg's Motivation-Hygiene Theory

Herzberg's Motivation-Hygiene Theory or dual-factor theory is one of the most known theories of job satisfaction (Yousef, 2000). The theory proposes that employees have mainly two types of needs which are hygiene and motivation. Hygiene factors are the needs that may be very satisfied by some certain conditions called hygiene factors (dissatisfies) such as supervision, interpersonal relations, physical working conditions, salary, benefits and others (Tietjen & Myers, 1998).

The theory suggests that job dissatisfaction is probable in the circumstances where hygiene factors do not exist in the working environment of an employee. In contrast, when hygiene needs are supplied, it does not necessarily result in full satisfaction as only the dissatisfaction level decreases (Furnham, Petrides, Jackson & Cotter, 2002).

Motivation factors arise from intrinsic factors such as recognition, achievement, or personal growth which are needed to motivate an employee to improve working performance. Herzberg stated that there are two categories of motives for the employees which are known as satisfiers and dissatisfies. He relates intrinsic factors with job satisfaction and extrinsic factors with dissatisfaction (Samad and Hassan, 2007).

Thus, this theory suggests that in order to improve job attitude and productivity, the management must recognise these two sets of factors in order to increase job satisfaction among employees in order to enhance organisational performance. Therefore, there is a need to study the relationship between job satisfaction and employees' attitude towards organisational change. The conceptual framework depicts the conceptual foundation to examine the relationship between job satisfaction and attitude towards organisational change.

2.4 Conceptual Framework

A thorough review of the literature reviewed led to the formation of the conceptual framework which is as illustrated in Figure 1:

Figure 1: Conceptual framework of job satisfaction

3.0 Research Methodology

3.1 Research Design

This quantitative study employed descriptive correlation to examine the relationship between job satisfaction and employees' attitude towards organisational change. Correlation was used to explain the relationship between the two tested variables which are job satisfaction and attitude towards organisational change. Besides, descriptive analysis was used to describe the characteristics of the data collected. Questionnaire was used to collect the data for this study.

3.2 Population and Sampling

The target population for this study was the staff of Politeknik Sultan Salahuddin Abdul Aziz Shah (PSA). A total of 201 respondents were selected based on the sampling table by Krejcie and Morgan (1970). Simple random sampling technique was employed in this study to ensure that each member of the population has an equal chance of being selected as the subject of the sample (Sekaran, 2006). From the list of the employees obtained, the researcher had generated a random sample of respondent selected in an Excel spreadsheet.

3.3 Research Instrument

A survey questionnaire was employed in this study. The questionnaire consisted of three sections: part A for demographic profile; part B consisted of items to measure employees' attitude towards organisational changes, and part C comprised items to measure the independent variable which is job satisfaction. Each item was measured using a 5-point Likert scale, specifically (1) Strongly Disagree, (2) Disagree, (3) Neutral, (4) Agree, (5) Strongly Agree. The construct of employees' attitude towards organisational change was adapted from Hallgrimson (2008) and Job Satisfaction: Application, Assessment, Causes, and Consequences. California: SAGE Publications, Inc. by Spector (1997).

A pilot study was conducted to ensure the questionnaire is suitable for the polytechnic's setting. A total of 30 respondents participated in the pilot study. The results of the reliability test are depicted in Table 1. Cronbach's alpha value of 0.879 demonstrates that the scale is statistically acceptable as the value is greater than 0.6.

Table 1: Cronbach's Alpha

No. of items	Cronbach's Alpha
15	0.879

3.4 Data Analysis

Statistical Packages for the Social Sciences (SPSS) version 25 was employed to analyse the data collected. Descriptive statistics were used to summarise the demographic profiles. The mean and standard deviation were calculated to sum up the findings of the data. Finally, Pearson correlation test was utilised to investigate the relationship between job satisfaction and attitude towards organisational change. A two-tailed test was also conducted to test the significance of the relationship.

4.0 Results and dissclasstion

4.1 Respondents' Profile

From 201 respondents involved, 10.4% or 21 were male staff while the remaining 89.6% or 180 respondents were female staffs. Table 2.1 and table 2.2 showed the respondents.

Table 2.1: Gender

Gender	No. of respondents	Percentage
Male	21	10.4%
Female	180	89.6%
Total	201	100%

Table 2.2: Departments

No	Departments	No. of respondents
1	Commerce	25
2	Electrical Engineering	42
3	Mechanical Engineering	23
4	Civil Engineering	33
5	General Studies	10
6	CISEC	7
7	Administration	35
8	Others	26
	Total	201

Descriptive analysis for the level of employees' attitude is based on the level of mean score range provided in Table 3 which was adopted from Kosnin and Lee (2008).

Table 3: Level of Mean Score Range

Range of Mean Score	Level
1.00-2.33	Low
2.34-3.67	Moderate
3.68-5.00	Higha

4.2 Level of Employees Attitude towards Organisational change

Table 4 shows the mean and standard deviation obtained for three components of employees' attitude towards organisational change. The highest score obtained was 3.68 which measured "I will work hard to make the changes successful". The lowest mean score was 3.54 which can be considered as moderate (Kosnin & Lee, 2008) Thus, employees have a moderate level of acceptance towards any changes to the programme or areas related to their work. These results concluded that the overall level of employees' attitude towards organisational change is moderate.

Table 4: Level of Employees Attitude towards Organisational change

Components	Mean	Std. Deviation	Level
I will accept any changes to the programme or area in which I work.	3.54	1.64	Moderate
I will work hard to make the changes successful	3.68	1.66	High
There is nothing I need to change about the way I do my job to be more efficient.	3.64	1.51	Moderate
Employees Attitude	3.62	1.13	Moderate

4.3 Relationship between Employees' Job Satisfaction and Attitude towards Organisational change

Pearson correlation coefficient test was employed in order to identify the relationship between the independent variable (job satisfaction) and dependent variable (employees' attitude towards organisational change). Based on the findings, the two variables are positively correlated and have a statistically significant linear relationship as $p < .001$. Furthermore, there is a strong association between job satisfaction and employees' attitude towards organisational change ($r = .519$). Thus, hypothesis H1 is supported. The result indicates that job satisfaction has a positive relationship with employees' attitude towards organisational change. This finding is consistent with previous studies by Raziq and Maulabakhsh (2015) and Aslan, Shaukat, Ahmed, Shah and Mahfar (2014).

Table 5: Correlation between Job satisfaction, commitment, job security and Attitude towards Organisational change

		Job Satisfaction
Attitude towards organisational change	Pearson Correlation	0.519**
	Sig. (2-tailed)	0.000
	N	201

Note: **. Correlation is significant at the 0.01 level (2 tailed).

5.0 Conclusion

In conclusion, the findings show that job satisfaction is beneficial towards employees' attitude towards organisational change. The results have demonstrated that job satisfaction has a strong relationship with employees' attitude towards organisational change. Further studies with larger samples are needed in order to validate the generalisability of this study. Future researchers are also encouraged to identify and investigate other factors that may contribute to employees' attitude towards organisational change.

References

Abdul Wahab, J., Fuad, M., Fuzlina, C., Ismail, H., & Majid, S. (2014). Headmasters' transformational leadership and their relationship with teachers' job satisfaction and teachers' commitments. *International Education Studies, 7*(13), 40-48.

Ang, S., & Slaughter, S. (2000). The missing context of information technology personnel: a review and future directions for research. *Framing the domains of IT management: Projecting the future through the past*, 305-327.

Aslan, A. S., Shaukat, M. Z., Ahmed, I., Shah, I. M., & Mahfar, M. (2014). Job Satisfactions of Academics in Malaysian Public Universities. *Procedia - Social and Behavioral Sciences, 114*, 154–158. https://doi.org/10.1016/j.sbspro.2013.12.676

Balogun, J., & Hope-Hailey, V. (2004). *Exploring Strategic Change*, 2nd edn. London: Prentice Hall.

Brzeziński, S., & Bąk, A. (2015). Management of Employees' Commitment in the Process of Organization Transformation. *Procedia Economics and Finance*, *27*(15), 109–115. https://doi.org/10.1016/S2212-5671(15)00979-X

Carnall, C. (2003). Managing Change in Organizations, 4th edn. Harlow: Prentice Hall.

Chan, J., Pan, Z. and Lee, F. (2004), 'Professional aspirations and job satisfaction: Chinese journalists at a time of change in the media', *Journalism & Mass Communication Quarterly*, 81, 2, 254–73.

Chang, H., Chi, N. and Chuang, A. (2010), 'Exploring the moderating roles of perceived person job fit and person-organisation fit on the relationship between training investment and knowledge workers' turnover intentions', *Applied Psychology*, 59, 4, 566–93

Davis, G. (2004). Job satisfaction survey among employees in small businesses. *Journal of small business and enterprise development*.

Department of Polytechnic Education. (2015). The Malaysian Polytechnic Education System (The Asia Pacific Accreditation and Certification Commission (APACC), 2015)

Dunham, R. B., Grube, J. A., Gardner, D. G., Cummings, L. L., & Pierce, J. L. (1989). The development of an attitude toward change instrument, *Paper presented at Academy of Management Annual Meeting*, August 11–16. Washington, DC.

Elias, S. (2009). Employee Commitment in times of Change: Assessing the Importance of Attitudes towards *Organizational Change. Journal of Management*, 35(1), 37–55. http://dx.doi.org/10.1177/0149206307308910

Furnham, A., Petrides, K. V., Jackson, C. J., & Cotter, T. (2002). Do personality factors predict job satisfaction?. *Personality and individual differences*, *33*(8), 1325-1342.

Gelaidan, H., & Ahmad, H. (2013). The Factors Effecting Employee Commitment to Change in Public Sector: Evidence from Yemen . *International Business Research, 6*(3). doi:10.55.39/ibr.v6n3p75

Gupta, A. R. P. (2016). A research paper on the Employees Attitude towards organizational Change, *15*(2), 44–47. https://doi.org/10.9790/0853-152124447

Hettiararchchi, H. A., &Jayarathna, S. M. (2014). The Effect of Employee Work Related Attitudes on Employee Job Performance: A Study of Tertiary and Vocational Education Sector in Sri Lanka. *Journal of Business and Management*, 16 (4), 74 – 83.

Hallgrimsson, T (2008). Organizational change and change readiness. Employees' attitudes during time of proposed merger.

Ibrahim, R. M., Ghani, M. A., & Salleh, A. M. M. (2013). Elevating organizational citizenship behavior among local government employees: The mediating role of job satisfaction. *Asian Social Science*, *9*(13), 92.

Janssen, O. (2001). Fairness perceptions as a moderator in the curvilinear relationships between job demands, and job performance and job satisfaction. *Academy of management journal*, *44*(5), 1039-1050.

Kapur, R. (2018). The Significance of Organizational Culture, Politics and Job Satisfaction among the Employees in Various Job Settings.

Khan, M. S., Khan, I., Kundi, G. M., Khan, S., Nawaz, A., Khan, F., & Yar, N. B. (2014). The impact of job satisfaction and organizational commitment on the intention to leave among the academicians. *International Journal of Academic Research in Business and Social Sciences*, *4*(2), 114.

Kosnin, A. M., & Lee, T. S. (2008). Pengaruh personaliti terhadap kepuasan kerja dan stres kerja guru. *Sains Humanika*, *48*(1).

Krejcie & Morgan (1970). Determining Sample Size for Research Activities. *Educational and Psychological Measurement*, pp. 607-610.

Ludviga, I., & Sennikova, I. (2016). Organisational Change : Generational Differences in Reaction and Commitment . Retrieved from http://www.bm.vgtu.It

Lo, M., Ramayah, T., Min, H.W. and Songan, P. (2010), "The relationship between leadership styles and organizational commitment in Malaysia: role of leader-member exchange", *Asia Pacific Business Review*, Vol. 16 Nos 1/2, pp. 79-103. doi: 10.1080/13602380903355676

Malaysia Higher Education Blueprint 2015-2025. (2015). Putrajaya, Selangor: Ministry of Education. Retrieved March 6, 2017, from www.moe.gov.my

Mathieu, J. E., & Farr, J. L. (1991). Further evidence for the discriminant validity of measures of organizational commitment, job involvement, and job satisfaction. *Journal of Applied Psychology*, *76*(1), 127.

Mora, J., & Brightman, B. K. (2001). 'Leading organizational change. Career Development International, 6(2), 111-118.

Rashid, Z. A., Sambasivan, M., & Rahman, A. A. (2004). The influence of organizational culture on attitudes toward organizational change. *Leadership & organization development Journal*.

Raziq, A., & Maulabakhsh, R. (2015). Impact of working environment on job satisfaction. *Procedia Economics and Finance*, *23*, 717-725.

Samad, S., & Hassan, Z. (2007). Assessing the effects of job satisfaction and psychological contract on organizational commitment among employees in Malaysian SMEs. In *The 4th SMEs IN A Global Economy Conference* (pp. 171-178).

Spector, P.E. 1997. Job Satisfaction: Application, Assessment, Causes, and Consequences. California: SAGE Publications, Inc.

Tarigan, V., & Ariani, D. W. (2015). Empirical study relations job satisfaction, organizational commitment, and turnover intention. *Advances in Management and Applied Economics*, *5*(2), 21.

Tidwell, M. V. (2005). A social identity model of prosocial behaviors within nonprofit organizations. *Nonprofit Management and Leadership*, *15*(4), 449-467.

Tietjen, M. A., & Myers, R. M. (1998). Motivation and job satisfaction. *Management decision*.

Sekaran, U. (2006). Research Methods for Business: A Skill Building Approach, 7th Edition. John Wiley & Sons.

Yousef, D. A. (2000). Organizational commitment: a mediator of the relationships of leadership behavior with job satisfaction and performance in a non-western country. *Journal of managerial Psychology*.

Visagie, C. (2010). *The Relationship between Employee Attitudes towards Planned Organizational Change and Organizational Commitment: An Investigation of a Selected Case within the South African Telecommunications Industry.* A Thesis Presented to the Cape Peninsula University of Technology, in Partial Fulfillment of the Requirements for the Master of Technology.

Z, MD Yunos, (2013) Examining the role of job satisfaction, job security, working environment and organisation commitment toward private lecturer in Klang Vally, master thesis.

Sieve O' Sound (S.O.S)

Isma Afiza Ismail and Muhapis A. Hakim
Department of Civil Engineering
Politeknik Sultan Salahuddin Abdul Aziz Shah, Persiaran Usahawan Seksyen U1,
40150 Shah Alam, Selangor Darul Ehsan
Corresponding author: isz_puppets81@hotmail.com.

Abstract

Sieve shaker is a widely used equipment in educational institutions, testing laboratories and construction sites. This equipment is used to separate coarse or fine-grained stones according to the size of the sieve according to BSI standards (British Standard Institution). In the construction world, the size of the aggregates used plays a major role in every concrete mix because it affects the durability and concrete strength. Thus, sieve shaker plays a very important role in determining the size of the aggregate to be used. However, this equipment produces sound pollution especially in test laboratories. Therefore, to produce Sieve O 'Sound (S.O.S) which is a sound-shield box for the sieve shaker to be used at the Polytechnic Sultan Salahuddin Abdul Aziz Shah labs. This product is able to reduce the noise pollution resulting from the sieve shaker. Among the materials used to produce S.O.S are acoustic foam, Styrofoam, and cotton. The materials used have the ability to absorb sound by using Sound Meter Level. Based on the result we obtain through the Sound Meter Level test, reduce from 17% to 22% percent of noise produced from sieve shaker, after using Sieve O' Sound shield box.

Keywords*: *Sieve O Sound, aggregate, sieve shaker, Sound Meter Level

1.0 Introduction

Sound pollution is defined as an undesirable sound. Sound pollution depends on the sound quantity, the sound quality and the acceptance attitude of the individual who hears it. However, the sound intensity exceeding 80dB is regarded as a noise pollution if it is based on sound test instrument evaluation. Sound pollution is a subjective matter because not all individuals regard the sound as they hear. Sounds can be divided into two classes namely music and noise. Music is a sound that consists of frequencies that are in contact with each other and we are able to detect uniformity in the sound. Noise sounds consisting of frequencies and intensities vary randomly and their uniformity cannot be traced.

There are four types of noise that have been classified, namely noise gland, fluctuation noise, impact noise and alternating noise. Noise gland has constant noise intensity. Intensity change between two sound wave peaks is less than 3dB. For fluctuating noise, fluctuation changes between two high and low waves are more than 3dB. Impact noise or impulse is a high noise and the duration is short. Sound pollution that occurs in a place can negatively affect the audience around it. In geotechnical labs, highway labs and concrete laboratories, sieve shaker will produce noisy sound when used. As a result, it will disturb the focus and behaviour of students and lecturers who are conducting activities and learning around the area. The tranquillity and comfort of the people should be emphasized so that the activities and quality of the work being carried out are not disturbed or affected.

Acoustic foam, Styrofoam, and cotton are the materials that will play a major role in the production of S.O.S. sound-shield box. This is because each selected material has its own ability to absorb sound waves resulting from sieve shaker. Hence, it is able to meet the objectives of the study.

2.0 Methodology

2.1 Acoustic Foam

Acoustic foam is a type of foam that has an open space cell which is specially designed to absorb sound waves and reduce the amplitude of sound waves. Typically, these foams are often used in music rooms or recording studios to increase the acoustic value of a room or space. It is a light foam made of polyurethane foam, polyether or polyester. It is square cut, tile-shaped and the surface is often pyramid or oval arch.

2.1.1 How Acoustic Foam Works Acoustic

Foam seeks to reduce or eliminate echoes and background noise by controlling the echoes generated by sounds that bounce from a surface like a wall. It works to absorb sound vibrations instead of reflecting it. This material is able to respond with normal and high frequency. To deal with lower frequencies, larger acoustic foam sheets should be used. It is made of various sizes, colours and thicknesses and is suitable for the wall, ceiling or floor. They work not only to absorb sounds, but also to enhance the quality of sound and speech in a room. Dealing with both mid and high frequencies at the same time, acoustic foam can also be counted as a type of cost-friendly heat reduction facility that is placed in corners of the room or wherever optimal sound mixes are needed as bass traps to minimize sound echoes. Reducing the amplitude of the waves, acoustic foams dissipate the sound energy as heat (Hoover, 2015).

2.2 Styrofoam

Styrofoam is a type of foam made from polystyrene. It is widely used worldwide. Styrofoam is often found in the form of cups and containers. It can also be found inside a wall panel or roof. The nature of this foam is thermal insulation and does not absorb water. The foam composition is 98% percent air, making it light and easy to float on the surface of the water.

2.2.1 How Styrofoam Works

This foam has proven that it is also capable of absorbing noise, not reflecting. Like acoustic foam, Styrofoam also has a lot of space for small cells, which can ease a wave of sound through it. However, this foam is not marketed as a major ingredient in the acoustic or noise industry. However, the effectiveness of this foam in absorbing sound cannot be denied because it is often used in wall panels. The presence of pores and voids plays a crucial part as they act as the medium of sound wave dissipation. The channel or pores containing air molecules will vibrate and lose energy due to the energy of the air molecules by the sound waves being converted to heat due to thermal and viscous losses at the walls of the interior pores and channels (Amares, Sujatmika, Hong, et al., 2017).

2.3 Wool

Porous materials are characterized by the fact that their surfaces allow sound waves to enter through many small holes or opening. Cotton is an example of porous material, made from fibrous cotton fibres. When cotton is exposed to sound waves, the surface air molecules and inside the cotton pores will vibrate, causing the sound waves to lose some of its original energy. The fibres in cotton will vibrate simultaneously under the influence of sound waves. Based on the article produced by Arenas and Crocker (2010) to examine the effectiveness of the use of cotton fabrics from sound absorbing manufacturers, the study conducted successfully recorded sound absorption coefficients cotton based on different thickness.

2.4 Mild Steel

Mild steel is a type of iron that contains a small percentage of carbon. It is also known as plain-carbon steel and low-carbon steel. This steel is one of the famous and common forms of steel because of its low price while it provides material properties that can be used for many applications. Mild steel contains approximately 0.05–0.25% carbon. Mild steel has low tensile strength, thus making the price affordable and easy to form.

2.5 Sound Level Meter

Sound Level Meter is an equipment used to assess noise or sound levels by measuring sound pressure as shown in Figure 1. Often referred to as a sound pressure level (SPL) meter, decibel (dB) meter, noise meter or noise dosimeter, a sound level meter uses a microphone to capture sound. The sound is then evaluated within the sound level meter and acoustic measurement values are shown on the display of the sound level meter. The most common unit of acoustic measurement for sound is the decibel (dB). With a portable sound level meter, industrial hygiene and workplace safety professionals can measure sound levels in multiple locations. In this test, the thickness used in sound level test as shown in Table 1.

Table 1: Thickness used in sound level test

TEST	Styrofoam	Wool	Acoustic Foam
1	1.25cm	0.5cm	4 cm

Figure 1: Sound Level Meter Equipment

3.0 Result and Discussions

3.1 Room Average Sound

Table 2: Room reading obtained at every distance.

Distance (m)	3m	6m	9m	12m
Room Sound (db)	45db	43db	47db	45db

Before the testing is conducted, the reading of room sounds is taken and recorded as in Table 2. This is to ensure the exact reading of noise produced by the sieve shaker. Four readings of room sound are taken based on the distance we have planned. Every distance has its own sound reading, this happened because the sound in a room travel depends on the wall surface, room size, and the things available in the room. All of these factors affect how the sound travels and is reflected in a room.

Table 3: Results of sound level meter

No. Testing	Test 1	Test 2	Test 3	Test 4
Distance (m)	3m	6m	9m	12m
Sieve Shaker + Room Sound (db)	91db	88.2db	85.7db	87.5db
Sieve Shaker Sound (db)	46db	45.2db	38.7db	42.5db
Sieve Shaker + Room + Sieve O' Sound Box (db)	75.9db	71.4db	66.8db	68.4db
Noise Reduced (db)	15.1db	16.8db	18.9db	19.2db
Percentage (%)	17%	19%	22%	22%

Overall results of the test as shown in Table 3. For the first test, record the noise produced by the sieve shaker by standing 3 meters away from it. Two data are obtained, the noise before and after the use of Sieve O' Sound. After subtracting the room sound at 3 meters distance, the exact noise of sieve shaker obtained during the first test is 46db. When the sieve shaker is placed inside the Sieve O' Sound, 15.1db of noise was managed to be reduced. Calculate the noise reduced by subtracting the room sound and the sieve shaker sound before and after the use of Sieve O' Sound.

During the second test, the noise from the sieve shaker decreased to 45.2db, and noise reduced after the use of Sieve O' Sound is 16.8db. The noise from the sieve shaker continues to drop, by reaching 38.7db during the third test, at 9 meters away from the sound level meter. At this distance, the noise reduced to 18.9db. Finally, during the fourth test, which is 12 meters away from the sieve shaker, the noise from the sieve shaker slightly increased to 42.5db. However, the reading of the noise reduced continues to drop, reaching 19.2db by the end of the test. Based on the data we obtained through this test, the effectiveness of this product was demonstrated by the reduction of noise before and after the use of the Sieve O' Sound Shield Box. The distance measured also affects the noise reduced as each point has a different room sound. The noise reduced increased proportionally to the distance taken.

For the first test, the sound shield box managed to reduce 17% of noise. The reduction of noise increased for the second test able to reduce 19% of noise. As the distance increases, the percent of noise reduced also increases. 22% of noise was reduced during the third and fourth test. Exposure to prolonged noise can cause serious hearing problems in the human ear.

4.0 Conclusions

Overall, these results have proven the workability and effectiveness of this product, thus marking the success of our project. During the test, some errors may have occurred. The data obtained may be inaccurate because the recorded sound may be affected by the noise coming outside of the concrete lab. The noise travelling around the room also affects the tests and data generated.

Acknowledgement

All praises to Allah S.W.T, Most Gracious and Most Merciful because of His grace, we have successfully carried out a project study. Finally, a big thanks to the lecturers that helps us at the Civil Engineering Department, Sultan Salahuddin Abdul Aziz Shah Polytechnic. The guidance and suggestions they have provided help us from all aspects of the project. Finally, we hope that this study will bring a positive impact on society and can be used by many parties. Thank you.

References

Amares, S., Sujatmika, E., Hong, T. W., Durairaj, R., and Hamid, H. S. H. B. (2017). A Review: Characteristics of Noise Absorption Material. *Journal of Physics: Conference Series*, *908*(1). https://doi.org/10.1088/1742-6596/908/1/012005

Arenas, J. P., and Crocker, M. J. (2010). Recent trends in porous sound-absorbing materials. *Sound and Vibration*, *44*(7), 12–17.

Hoover, R. (2015). Acoustic Foam – Sustainable or No? *Triple Pundit*. Retrieved from https://www.triplepundit.com/story/2015/acoustic-foams-sustainable-or-no/33601

NIOSH. (1998). *Occupational Noise Exposure. Revised Criteria 1998*. *U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES*. https://doi.org/10.1121/1.4778162

Noise Pollution. (2020). Retrieved from https://en.wikipedia.org/wiki/Noise_pollution

Norfatin, C., Asyikin, N., Nuramalina, and Nadia, N. (2014). *Sound Fighter Box. Final Year Project Report.* Politeknik Sultan Salahuddin Abdul Aziz Shah.

Rahmat, A., and Abdul Hamid, A. H. (2015). Study of noise produced by construction activities in academic area. *Jurnal Teknologi*, *75*(5), 107–111. https://doi.org/10.11113/jt.v75.5079

Stansfeld, S. A., and Matheson, M. P. (2003). Noise pollution: Non-auditory effects on health. *British Medical Bulletin*, *68*, 243–257. https://doi.org/10.1093/bmb/ldg033

DEVELOPMENT OF FINGER GRIPPER USING FLEX SENSOR

Mariana Rosdi
Department of Electrical Engineering
Politeknik Sultan Salahuddin Abdul Aziz Shah, Persiaran Usahawan Seksyen U1,
40150 Shah Alam, Selangor Darul Ehsan
Corresponding author: myhanisathome@gmail.com

Abstract

This paper focuses on the development of the measurement finger gripper to help disable patients due to accident or decease. The system of artificial finger gripper requires flex sensor to measure smooth and accurate movement. In rehabilitation process there are a few stages that starting from the light exercise to heavy exercise orderly. When the patient needs to perform exercise, they must wait until they managed to get an appointment with a doctor and it will slow down the healing process of patients. The objective of this research is to develop the finger gripper by using flex sensor to determine the stage and patient needed for rehabilitation. Patient can do rehabilitation activities at home without seeing doctor frequently. This research also to help rehabilitate the hands, fingers, and wrist disorders and injuries by using physical methods.

Keywords*: *finger gripper, measurement, rehabilitation, flex sensor, exercise orderly

1.0 Introduction

Hand has a very delicate and complex structure. This allows muscles and joints in the hand a great range of mobility and precision. The different forces are also distributed in the hand in the best possible way. But the hand is also quite susceptible like tendons, nerve fibres, blood vessels and very thin bones, they are all positioned right under the skin and are only protected by a thin layer of muscle and fat. Only the palm is insulating by a strong pad of tendons for a powerful grip (Andrea et al.,2019). Our hands are put through quite a lot day in and day out and are often within range of dangerous tools. This makes hand problem and injuries due to wear and tear very common. In other words, when someone gets injured in sporting activities, suffers movement loss due to strokes or accidents, or is born with movement disabilities, physiotherapy can help to re-establish or optimise body movement. The problem is that when required a patient that always tired during therapy session. Some of device are lack of measurement indicator for testing the finger muscle bent of the patient and it will delay of rehab process due to inadequate number of available therapists. This project is intending to help Physiotherapy Department to develop the finger gripper using flex sensor for patient to measure their finger muscle bent level at home. It will be easier to monitor the patient for the

doctors by showing the data of bent level through the mobile without going to Physiotherapy Department. In science, the definition of “Gripper” is subsystems of handling mechanisms which provide temporary contact with the object to be grasped. Stroke is the principal cause of adult disabilities and leading causes of death worldwide (Andrea et al.,2019). In development of finger gripper, a sensor zed glove has been designed using flex sensors and Arduino to measure finger flexion movement in order to help doctor and rehabilitation specialist in therapy. The proposed system is able to detect finger flexion movement especially for numb patient (Mohd Rais Hakim et al., 2019).

2.0 Methodology

The block diagram shows how the finger gripper processes. Firstly, the battery will be detecting the microcontroller from the source to give the supply. The microcontroller turns on and send the signal to the A/D converter to change the signal from analogue signal to digital signal. After that, the signal enters the microprocessor. After that, it will enter the flex sensor to measure the strengthen level in finger. The microprocessor will produce a result following the programmed system that has programmed in Arduino software. The result will be display on the LCD Arduino Uno. The result also can be saved via SD Card module.

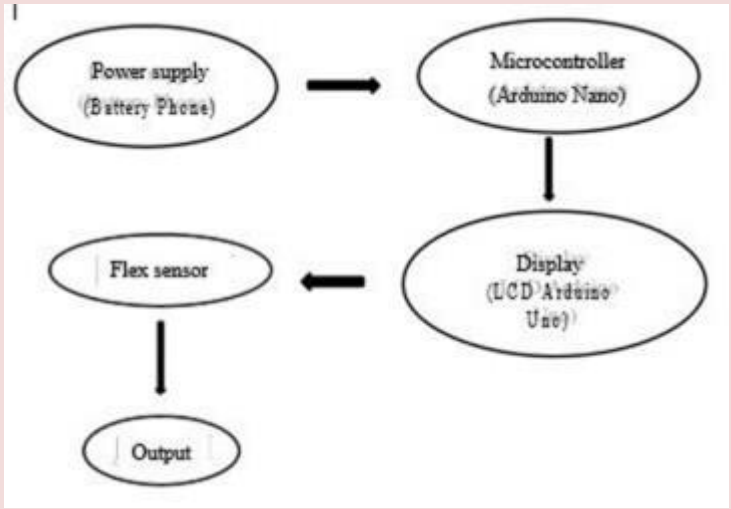


Figure 1: Finger gripper using flex sensor

A microcontroller is a small computer on a single integrated circuit containing a processor core, memory, and programmable input/output peripherals. The one that used in this project is Arduino Uno. Arduino is a single-board microcontroller designed to make the process of using electronics in multidisciplinary projects more accessible. The hardware consists of a simple open source hardware board designed around an 8-bit Atmel AVR microcontroller with complementary components to facilitate programming and incorporation into other circuits. An important aspect of the Arduino is the standard way that connectors are exposed, allowing the CPU board to be connected to a variety of the interchangeable add-on modules known as shields. The software consists of a standard programming language compiler and a boot loader that executes on the microcontroller.

This project is use flex sensor to measure the capabilities of human grip (Manavalan et al., (2019). The flex sensor is analogue resistor. It works as variable analogue voltage dividers. Flex sensor are made up from carbon resistive element within a thin flexible substrate. The sensor is producing a resistance output relative to the bend radius when the substrate is bent. With a typical flex sensor, a flex of 0 will give 10K resistance. A flex sensor is designed that can be bend easily in any way. The sensors function according to the change is resistance depending on the amount of bend introduce on the sensor. That's means, the flex sensor is a unique component which change its resistance according to the amount of bent. An inflexed sensor has nominal resistance of about 10KΏ. As the flex sensor bent the resistance gradually increases. When the sensor is bent at 90o its range will be between 10KΏ.-14KΏ.

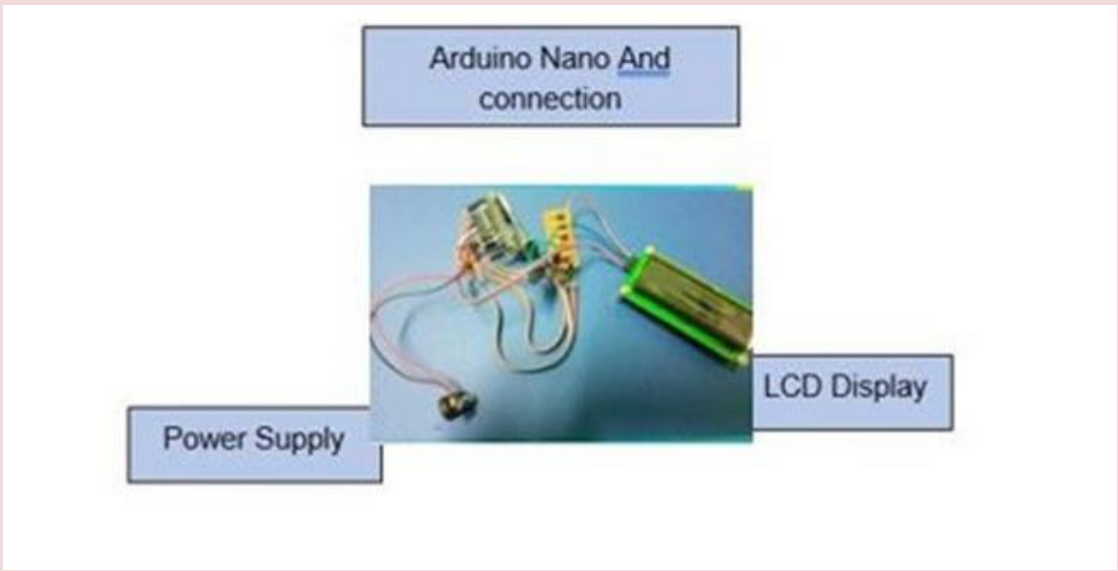


Figure 2: Assemble circuit connection

For the circuit operation, 9V of power supply (battery) is delivered to the power supply circuit. The current is delivered to the variable resistor and then it is sent to LCD to be turn on for display and Arduino Nano to run as a heart of the system. From Arduino Nano it will program the input by the flex sensor to calculate the bend of flex sensor value in percentage and send the result to SD Card to save the data. So, for the input line-up, from LCD the current goes to the resistor and the sensor with the different value to 10k ohm resistor. The resistor controls the current limit that goes through the flex sensor to avoid from the sensor component to burn. After the sensors have measured the bend of fingers, the measurement value will be sent to SD Card to save the data. For the input, Arduino Nano has been programmed and the result from the bend of the finger will be saved in percentage to make it easier to read. The result also shows the average value from 5 flex sensors for each finger and measure 3 outputs indicator.

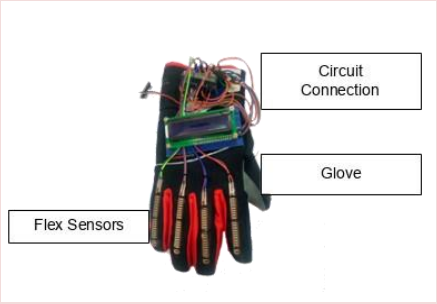


Figure 3: Final development of for finger gripper using flex sensor

3.0 Analysis and Results

To get the result of functioning of this project, 3 respondents from age 55 to 65 who are in trouble with gripping finger and in numb symptoms. The respondents are involved to test their strengthen level in finger. The reading is taken using the Indicator of finger gripper using flex sensor. After them strengthen level gained, this will analyse and discuss what affects the grip strength. Before perform the test on them, they have been asked to full fill the questionnaire that consist of questions about on their height, weight, daily activities and a little bit information about their lifestyle.

Strength is commonly defined as your body's ability to apply force and relates to various body parts and muscle groups. For example, grip strength is an upper-extremity function that measures the amount of force produced through the hand. While grip strength can be improved through proper training, there are numerous physiological factors that contribute to your grip strength (A. Wright et al, 2014).

Grip strength is related to your ability to firmly grip an object finger (A. Wright et al., 2014). The result shows that hand size is a physiological factor of grip strength. Someone with large hands and long fingers will generally have greater grip strength than someone with smaller hands or shorter.

Table 1: A physiological factor of grip strength

Palm size (cm)	Level of gripper (% newton)
15	1.2
16	1.4
17	1.5

Similar to hand size, bodyweight is directly correlated to grip strength. As a general rule, someone with a higher bodyweight has greater grip strength than someone who is skinny and lightweight (Melekoglu et al., 2019). From the result, however, small changes to the bodyweight won't significantly change grip strength. This was proved by the test graph below.

Table 2: Correlation between bodyweight to grip strength

Bodyweight (Kg)	Level of gripper (% newton)
55	1.2
68	1.4
75	1.5

The level of dexterity is another physiological factor of grip strength. For most people, the dominant hand or the hand preferred for the majority of daily activities is the hand with the most grip strength (César et al., 2017). In this research shows that, all the respondent is using righthand getting improve in bending from day 1 to day 3. The improvement of bent level is 58% compared to day 1 40%.

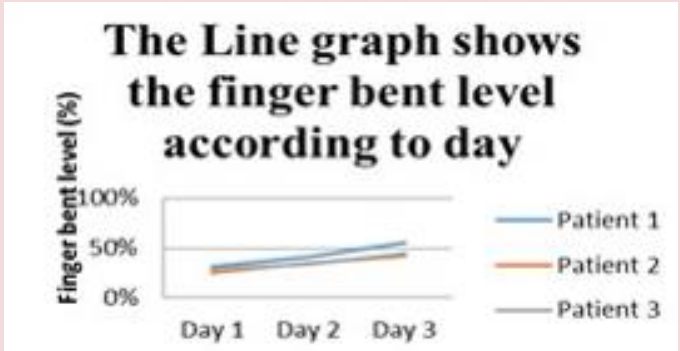


Figure 4: A summary of the finger bent level for 3 days by using right hand.

4.0 Conclusion

This research indicates a resolve problem for patient to measure their finger's bend. It gives an accurate rehab level for doctors to diagnose the status of bending level and take action for more rehabilitation technique. As the design solution develops, it will most likely find that the initial criteria need to be redefined or modified.

Acknowledgement

The authors gratefully acknowledge the Department of Electrical Engineering, Polytechnic Sultan Salahuddin Abdul Aziz Shah for the laboratory facilities provided.

References

Andrea R Zammit, PhD, Annie Robitaille, PhD, Andrea M Piccinin, PhD, Graciela Muniz-Terrera, PhD, Scott M Hofer, PhD (2019), Associations Between Aging-Related Changes in Grip Strength and Cognitive Function in Older Adults: A Systematic Review. The Journals of Gerontology: Series A, Volume 74, Issue 4, April 2019, Pages 519–527.

A. Wright and M. Stanisic, (2014) "Kinematic Mapping between the EXOS Handmaster Exoskeleton and the Utah-MIT Dextrous Hand," in Proc of the IEEE International Conference on Systems Engineering, 1990, pp. 809–811.

A. Wright and M. Stanisic, "Kinematic Mapping between the EXOS Handmaster Exoskeleton and the Utah-MIT Dextrous Hand," in Proc. of the IEEE International Conference on Systems Engineering, 1990, pp. 809–811.Data Glove With a Force Sensor Kostas N. Tarchanidis, Member, IEEE, and John N. Lygouras,Member,IEEE,IEEE TRANSACTIONSON INSTRUMENTATION AND MEASUREMENT, VOL. 52, NO. 3, JUNE 2003.

César Rafael M CostaI , Raoni C Dos-SantosI, Welington, V de PaulaI ,Wallace MV RibeiroI Anderson Luiz B SilveiraI, (2017). Acute static muscle stretching improves manual dexterity in young men. Print version ISSN 2318-8111On-line version ISSN 2358-0429 MedicalExpress (São Paulo, online) vol.4 no.3 São Paulo May/June 2017 Universidade Federal Rural do Rio de Janeiro, Physical Education and Sports, Seropédica, RJ, Brazil

L. Pao and T. Speeter, "Transformation of Human Hand Positions for Robotic Hand Control," in Proc. of the IEEE International Conference on Robotics and Automation, vol. 3, May 1989, pp. 1758–1763.

Manavalan, S.; Narayanan, M.; Pranav, J.; Ponmoorthy, R.; Basha, M. Sabeel (2019), Replication of Human Hand Using Flex Sensor, International Journal of Psychosocial Rehabilitation. 2019, Vol. 23 Issue 3, p446-455. 10p. 3 Color Photographs, 3 Diagrams

Melekoglu, Tuba; Isin, Ali; Türk, Aysen, (2019) Low Handgrip Strength Levels in Non-Athlete Adolescents Compared to Adolescent Athletes Journal of Education and Training Studies, v7 n2 p51-56 Feb 2019

Mohd Ali, A.M. and Ismail, M.Y. and Abdul Jamil, M.M. (2011) Development of artificial hand gripper for rehabilitation process. In: The 9th International Conference on Modelling in Medicine and Biology, 26 - 28 July 2011, Riga, Latvia.

Multi-fingered Telemanipulation (2002), Mapping of a Human Hand to a Three Finger Gripper. Angelika Peer, Stephan Einenkel, and Martin Buss 2002.

Mohd Rais Hakim Bin Ramlee; Hazlina Md Yusof, Shahrul Na'im Sidek ;(2019), Development of Gripping Assistive Device for Training System, International Islamic University Malaysia,Department of Mechatronics Engineering,Selangor,Malaysia, Published in: 2019 7th International Conference on Mechatronics Engineering (ICOM), DOI: 10.1109/ICOM47790.2019.8952065 Publisher: IEEE

Paetsch,W.; Kaneko,M.; Intelligent Robots and Stems'90.'Towards a New Frontier of Applications', Proceedings. IROS '90. IEEE International Workshop on 3-6 Julai 1990,pp, 853-858 vol 2.

S. Ekvall and D. Kragic, “Interactive Grasp Learning Based on Human Demonstration,” in Proc. of the IEEE International Conference on Robotics and Automation, vol. 4, April, May 2004, pp. 3519–3524

KAJIAN PENGGUNAAN 'PENAPIS AIR MUDAH ALIH MESRA ALAM DAN EKONOMI' UNTUK KEGUNAAN PENDUDUK ORANG ASLI DI KAWASAN POS BERSIH, TANJUNG MALIM, PERAK.

Norhayati Palil and Rohaidah Md. Nor
Jabatan Kejuruteraan Awam
Politeknik Sultan Salahuddin Abdul Aziz Shah, Persiaran Usahawan Seksyen U1, 40150 Shah Alam, Selangor Darul Ehsan
Penulis rujukan: pnorhayati.poli@1govuc.gov.my

Abstrak

Seiring dengan perkembangan teknologi dalam era globalisasi kini, pelbagai penapis air telah dikomersialkan sesuai dengan fungsi dan cara penggunaannya. Namun demikian, harga penapis air yang terdapat di pasaran adalah tinggi. Oleh yang demikian, kajian ini dilakukan untuk menghasilkan satu penapis air semulajadi bagi kegunaan penduduk orang asli di kawasan Pos Bersih, Tanjung Malim, Perak. Dalam kajian ini, bahan-bahan semulajadi seperti batu baur, pasir sungai, arang dan fabrik tanpa tenun (*non-woven fabric*) digunakan sebagai penapis. Ujian yang dijalankan adalah ujian kekeruhan kerana pada waktu hujan penduduk orang asli sukar mendapatkan bekalan air bersih untuk kegunaan harian mereka. Oleh sebab itu, penduduk di kawasan ini menggunakan air tadahan hujan sebagai bekalan air. Bekalan air bersih ini lazimnya digunakan untuk kegunaan harian seperti menyediakan makanan dan minuman, mencuci kereta, membasuh pinggan mangkuk, mencuci pakaian, dan sebagainya. Daripada ujian kekeruhan yang dilaksanakan, keputusan menunjukkan bacaan 29 NTU. Berdasarkan Piawai Kualiti Air Kebangsaan Malaysia (NWQS), bacaan ini mencapai tahap minimum NTU kelas ke-2. Oleh itu, kajian ini diyakini dapat memberi manfaat kepada penduduk orang asli kerana penapis air yang diperkenalkan adalah mudah dihasilkan dengan kos yang sangat rendah.

Kata kunci*: *Penapis air, ujian kekeruhan, pasir sungai, arang, batu baur

1.0 Pengenalan

Penapis air merupakan alat yang digunakan untuk menapis air. Alat ini berfungsi untuk menghilangkan bendasing daripada air secara halangan fizikal melalui liang-liang halus, proses kimia atau proses biologi. Penapis air juga membersihkan air pada tahap yang berbeza bergantung kepada tujuan seperti pengairan, air minuman, akuarium, kolam dan kolam renang. Kajian terdahulu dan kajian ini mendapati penggunaan bahan-bahan seperti arang,

pasir sungai, batu baur dan fabrik tanpa tenun (*non-woven fabric*) berperanan menapis bendasing bersaiz kecil yang tidak dapat ditapis oleh penapis sebelumnya. Pendekatan ini dapat menghasilkan air jernih daripada sampel air hujan. Faktor-faktor seperti kos yang murah dan cara penyediaan yang mudah diambil kira dalam penghasilan penapis ini. Oleh sebab itu, dengan mempertimbangkan kesukaran dan keperluan mendapatkan air bersih bagi penduduk kampung ini, satu penyelidikan dilakukan berdekatan Sungai Ulu Slim di perkampungan penduduk Pos Bersih. Penyelidikan ini mengkaji tadahan dan tapisan air hujan di Sungai Ulu Slim, Tanjung Malim, Perak. Lokasi ini merupakan salah satu tempat bagi penduduk kampung orang asli Pos Bersih mendapatkan air untuk kegunaan membersih dan mencuci. Penyelidikan ini mendedahkan bahawa Sungai Ulu Slim di perkampungan penduduk Pos Bersih tercemar apabila hujan. Pemerhatian juga telah mengungkapkan keprihatinan masyarakat orang asli dan penduduk yang tinggal di hilir tentang sifat Sungai Ulu Slim di kawasan perkampungan Pos Bersih yang tercemar dan keruh ketika hujan dan ketidakupayaannya untuk digunakan bagi tujuan domestik. Walaupun terdapat undang-undang dan institusi yang bertanggungjawab dalam pengurusan sumber air bagi masyarakat orang asli di kawasan tersebut, pencemaran masih berlaku. Maka timbul persoalan tentang punca pencemaran Sungai Ulu Slim di kawasan perkampungan Pos Bersih dan kesannya kepada kesihatan penduduk di situ.

Faisal Alanazi (2014) melakukan kajian terhadap bekalan air yang tercemar dengan toksin seperti logam berat, bakteria, virus, patogen dan puing-puing di kampung Sandikhola di Nepal. Menurutnya, penduduk di negara miskin ini cuba membuat pembaharuan dengan membina tangki air murahan yang mudah ditiru. Hasil kajian mendapati karbon dari batu kapur bertindak untuk penyingkiran klorin dan asid. Satu kajian lain dilakukan oleh Connor Smith (2016) terhadap potensi kaedah teknologi oleh penapisan pasir secara perlahan-lahan di peringkat masyarakat dan juga institusi. Hasil kajian mendapati penggunaan berulang penapis *biosand* membolehkan pembentukan lapisan-lapisan mikroorganisma yang membantu dalam mencerna patogen berbahaya sekaligus memudahkannya terperangkap dalam lapisan atas pasir. Wasif Imran (2013) pula melakukan kajian terhadap pembinaan penapis air menggunakan lapisan dua fabrik tanpa tenunan yang dihasilkan daripada gentian polipropilena. Kajian ini membandingkan kecekapan penapisan fabrik tanpa tenunan dengan penapis yang menggunakan fabrik tenunan polyester. Hasil kajian ini menyimpulkan bahawa kain bukan tenunan mempunyai kecekapan penapisan yang lebih baik daripada kain penapis tenunan pada kadar penapisan asid dan klorin yang lebih rendah.

2.0 Metodologi Kajian

2.1 Bahan-bahan asas

Bahan-bahan asas yang akan dimasukkan ke dalam penapis air mudah alih mesra alam disediakan seperti berikut:

i. Paip polivinil klorida (PVC) 250 mm dan penurun (reducer)
ii. Bahan-bahan organik
iii. Bahan-bahan penapis

Gambarajah 2.1:
Paip pvc yang digunakan

2.1.1 Paip Polivinil Klorida (PVC) dan penurun (*reducer*)

Jenis dan ukuran paip pvc 250 mm yang digunakan dalam penghasilan penapis air mudah alih mesra alam dan ekonomi seperti yang ditunjukkan a gambarajah 2.1.

Gambarajah 2.2: Uncang-uncang yang mengandungi bahan organik dan bahan penapis

2.1.2 Bahan-Bahan Organik

Bahan-bahan organik seperti arang dan bahan bahan penapis air seperti batu baur dan pasir dimasukkan ke dalam uncang mengikut nisbah 1:1:1 dan timbangan 1kg setiap satu uncang. Uncang-uncang yang telah sedia ditunjukkan dalam Gambarajah 2.2.

Gambarajah 2.3: Bahan-bahan penapis

2.1.3 Penyediaan Bahan-Bahan Penapis

Bahan-bahan yang akan digunakan di dalam penapis adalah seperti batu baur dan juga pasir sungai seperti yang ditunjukkan dalam Gambarajah 2.3. Bahan-bahan ini terlebih dahulu dibersihkan dan seterusnya dimasukkan ke dalam uncang mengikut timbangan 1kg setiap satu dan nisbah yang betul bagi memudahkan bahan-bahan tersebut dimasukkan ke dalam paip yang telah siap diukur dan dipotong. Perincian bag setiap bahan dijelaskan dalam sub-topik seterusnya.

2.1.3.1 Arang

Arang adalah pepejal hitam berliang yang terdiri daripada karbon amorf yang diperoleh sebagai sisa apabila kayu atau bahan organik lain dibakar tanpa udara. Kegunaannya adalah sebagai karbon aktif dalam penapisan air jernih. Selain itu, arang berfungsi sebagai bahan yang sangat berkesan untuk menghilangkan bau dan rasa air selain berfungsi sebagai penyerap.

2.1.3.2 Batu baur

Batu baur adalah pengagregatan longgar serpihan batu. Batu baur juga dapat diklasifikasikan mengikut julat saiz zarah dan termasuk kelas saiz dari granul hingga serpihan berukuran besar. Kegunaannya adalah untuk mengurangkan kekeruhan dan pepejal digantung secukupnya sebagai input kepada sistem penapisan. Selain itu, batu baur ini dapat mengurangkan penyumbatan yang disebabkan oleh alga dan mengurangkan bahan terampai dan koloid tanpa perlu menambah kulat.

2.1.3.3 Pasir sungai

Pasir sungai terdiri daripada batu-batu halus dan zarah mineral halus yang dikelaskan mengikut saiz, lebih halus daripada batu baur dan lebih kasar daripada lumpur. Pasir juga merujuk kepada kelas tekstur tanah atau tanah yang mengandungi lebih daripada 85 peratus zarah bersaiz besar. Fungsinya adalah untuk menapis kotoran halus.

2.1.3.4 Fabrik Tanpa Tenun (*Non-woven fabric*)

Fabrik tanpa tenun atau *non-woven fabric* adalah kain yang diperbuat daripada serat ruji (panjang tanpa putus) yang diikat bersama oleh ikatan kimia, haba mekanikal atau rawatan pelarut. Istilah ini juga digunakan dalam industri pembuatan tekstil untuk merujuk kepada fabrik yang dianggap tanpa tenunan untuk digunakan sebagai kain penapis kotoran atau zarah-zarah kecil.

2.2 Pemasangan Penapis Air Mudah Alih Mesra Alam

2.2.1 Pengukuran besi dilakukan sebelum sokongan paip dipasang.

Sebelum penyokong besi dipasang pada penapis air, pengukuran perlu dibuat mengikut spesifikasi dan ukuran yang telah ditentukan agar penapis air kukuh dan stabil.

Gambarajah 2.4: Penyediaan besi penyokong

2.2.2 Pemasangan bahan sokongan paip

Besi penyokong di pasang terlebih dahulu untuk menyokong paip PVC 250 mm.

Gambarajah 2.5: Penyediaan besi penyokong

2.2.3 Pemasangan penyokong paip yang telah siap dipasang

Penyokong paip yang telah siap dipasang perlu ditegakkan di tapak ujian untuk memasukkan paip pvc 250 mm.

Gambarajah 2.6: Pemasangan penyokong

2.2.4 Memasukkan bahan-bahan ke dalam penapis

Gambarajah 2.7 menunjukkan proses memasukkan bahan-bahan penapisan ke dalam penapis air mengikut turutan yang betul.

Gambarajah 2.7: Bahan-bahan dimasukkan ke dalam penapis sebelum dipasang ke penyokong

2.2.5 Pemasangan paip PVC lengkap berpenapis pada bahan sokongan paip.

Paip PVC 250 mm yang siap berpenapis dipasang pada besi penyokong yang telah diletakkan di tapak.

Gambarajah 2.8: Pemasangan paip PVC pada besi penyokong

3.0 Keputusan dan Perbincangan

Pengumpulan data dibuat dengan mengedarkan borang soal selidik responden mengikut bilangan sampel berdasarkan reka bentuk persampelan rawak berlapis. Kajian ini melibatkan 30 orang responden yang terdiri daripada penduduk orang asli di perkampungan Orang Asli Pos Bersih, Sungai Ulu Slim, Tanjung Malim.

3.1 Ujian kekeruhan yang dilakukan

Keputusan menunjukkan ujian kekeruhan telah mencapai standard " National Water Quality Standard Malaysia" iaitu 29 NTU yang dikategorikan sebagai kelas ke dua. Jadual 1 menunjukkan hasil ujian yang dijalankan.

Jadual 3.1: Keputusan Ujian Kekeruhan air

Jenis air	Parameter	Sebelum	Selepas	Kelas
Pos Earth River	Kekeruhan	300 NTU	20 NTU	2

Gambarajah 3.1 menunjukkan keberkesanan penapis air yang dihasilkan. Penduduk orang asli di kawasan perkampungan Pos Bersih di Tanjung Malim, Perak dapat menerima baik penapis air yang dihasilkan sekaligus memberi kebenaran kepada penyelidik untuk membuat kajian yang seterusnya. Penduduk juga berpuas hati dengan penghasilan penapis air mudah alih mesra alam dan ekonomi yang mudah dikendalikan ini kerana mereka juga dapat menggunakannya pada waktu hujan ketika air keruh untuk kegunaan harian seperti mencuci dan membasuh.

Gambarajah 3.1: Penyelidik bersama penapis air yang telah siap dipasang

3.1.1 Gambaran kekeruhan air sebelum dan selepas kajian dijalankan

Gambarajah 3.2 menunjukkan kekeruhan air di kawasan perkampungan Pos Bersih Tanjung Malim, Perak ketika hujan—sebelum dan selepas kajian—yang dilakukan dengan nisbah yang berlainan setiap satu. Hasil kajian yang didapati dengan menggunakan nisbah yang sama bagi setiap bahan adalah lebih baik dalam menghasilkan kejernihan air yang diinginkan.

Gambarajah 3.2: Kekeruhan air mengikut nisbah bahan penapis

Jadual 3.2: Skala instrumen soal selidik kajian berdasarkan aras keamatan

Skala	Aras Keamatan
1	Sangat Tidak Setuju
2	Tidak setuju
3	Kurang setuju
4	Setuju
5	Sangat Setuju

Jadual 3.3: Jadual Tahap Kecenderungan Skor Min (Landell, 1997)

Selang Skala Min	Interpretasi
1.00 – 2.33	Rendah
2.34 – 3.67	Sederhana
3.68 – 5.00	Tinggi

3.2.1 Teknik persampelan

3.2.1.1 Kaedah analisis

Data yang diperoleh daripada borang soal selidik yang dikembalikan digunakan untuk mengetahui maklum balas responden melalui analisis mengunakan perisian SPSS (*Statistic Package For Social Science).* Dapatan dipersembahkan dalam bentuk jadual dan kemudian ditafsirkan dengan merujuk Jadual Tahap Kecenderungan Skor Min (Landell, 1997) seperti Jadual 3.2 dan Jadual 3.3.

3.2.1.2 Dapatan kajian

Borang soal selidik mengandungi tiga bahagian (Bahagian A, B, dan C) untuk dijawab oleh responden. Dapatan daripada analisis kajian disimpulkan dengan merujuk kepada objektif dan pernyataan masalah kajian.

3.2.1.3 Analisis skor min

Analisis ini melibatkan Bahagian B soal selidik yang mengandungi beberapa persoalan untuk dinilai oleh responden sebelum dan selepas pemasangan penapis air mudah alih mesra alam dan ekonomi di perkampungan orang asli Pos Bersih, Tanjung Malim, Perak.

Jadual 3.4 menunjukkan soalan yang dikemukakan kepada responden berdasarkan borang soal selidik sebelum pemasangan penapis air. Skor min tertinggi (4.0) diperoleh daripada persoalan ‘Adakah air sungai yang mengalir di kampung anda mengalami kekeruhan ketika atau selepas waktu hujan? ‘. Sementara itu, skor min terendah iaitu 2.5 pula daripada persoalan “Adakah mutu kebersihan air mencapai tahap puas hati?’. Daripada jadual ini dapat dinyatakan bahawa penduduk orang asli di perkampungan orang asli Pos Bersih mendedahkan mereka mengalami masalah kekeruhan air pada waktu hujan dengan skor keseluruhan 1.64 iaitu pada tahap yang rendah.

Jadual 3.4: Soal selidik sebelum pemasangan penapis air

Bil	Soalan	Skor min	Tahap
1	Adakah kampung anda mengalami masalah mendapatkan air bersih ketika waktu hujan ?	2.8	Sederhana
2	Adakah mutu kebersihan air mencapai tahap puas hati ?	2.5	Sederhana
3	Adakah air sungai yang mengalir di kampung anda mengalami kekeruhan ketika atau selepas waktu hujan	4	Tinggi
4	Adakah hujan kerap turun di kampung anda ?	3.4	Sederhana
5	Adakah anda bersetuju jika penapis air didirikan di kampung anda?	3.5	Sederhana
Skor keseluruhan		**1.64**	**Rendah**

Jadual 3.5 menunjukkan soalan yang di kemukakan kepada responden berdasarkan borang soal selidik selepas pemasangan penapis air. Skor min tertinggi menunjukkan ‘Adakah produk ini membantu untuk mengurangkan kekeruhan air sungai ketika waktu hujan?’ dengan skor min 3.8 manakala skor min terendah iaitu 3.3 pula menunjukkan ‘Adakah produk ini memberi impak yang positif kepada kepada penduduk kampung dari segi kesenangan mendapatkan air bersih ketika hujan’ yang berada pada tahap sederhana.

Jadual 3.5: Soal selidik selepas pemasangan penapis air

Bil	Soalan	Skor min	Tahap
1	Adakah penapis air mudah alih mesra alam/ekonomi mudah digunakan?	3.7	Tinggi
2	Adakah tenaga kerja mahir diperlukan untuk menggunakan produk ini?	3.5	Sederhana
3	Adakah produk ini membantu untuk mengurangkan kekeruhan air sungai ketika hujan	3.8	Tinggi
4	Adakah produk ini memberi impak positif kepada penduduk kampung dari segi kesenangan mendapatkan air bersih ketika hujan	3.3	Sederhana
5	Adakah anda berpuas hati dengan produk yang dihasilkan dan diletakkan di kampung anda?	3.4	Sederhana
Skor keseluruhan		**3.65**	**Sederhana**

Daripada jadual ini dapat dinyatakan bahawa penduduk orang asli di perkampungan orang asli Pos Bersih telah membuktikan bahawa masalah yang mereka alami iaitu kekeruhan air pada waktu hujan dapat diatasi dengan pemasangan penapis air mudah alih mesra alam/ekonomi dengan skor min keseluruhan 3.65 yang berada pada tahap sederhana.

4.0 Kesimpulan

Kesimpulan daripada ujikaji yang dijalankan menunjukkan bahawa objektif dapat dicapai seperti yang dirancang. Daripada hasil analisis dan keputusan ujian, beberapa kesimpulan dapat dibuat. Antaranya:

- Ujian kekeruhan yang dijalankan mencapai standard yang telah ditetapkan oleh Piawai Kualiti Air Kebangsaan Malaysia (NWQS) dan mencapai tahap minimum yang ingin diuji untuk kejernihan air iaitu 29 NTU yang dikategorikan sebagai kelas ke-2.
- Kejernihan air yang dihasilkan oleh penapis air mudah alih mesra alam dan ekonomi ini sesuai untuk digunakan oleh penduduk orang asli di kawasan perkampungan Pos Bersih, Tanjung Malim, Perak di mana sesuai dengan nomad persekitaran hidup mereka dan untuk kegunaan harian mereka.
- Secara keseluruhannya, dapat disimpulkan bahawa penggunaan penapis air mudah alih mesra alam dan ekonomi ini dapat memberikan kebaikan untuk penduduk pedalaman seperti masyarakat orang asli yang tidak mampu untuk mendapatkan bekalan air bersih di tempat mereka terutama pada waktu hujan. Oleh itu, diharapkan dengan penghasilan penapis air ini, sedikit sebanyak dapat membantu mereka yang memerlukan kerana cara penyediaannya yang sangat mudah dan tidak memerlukan kos yang tinggi.

Rujukan

Clesceri, L. S., Greenberg, A. E., and Eaton, A. D. (1999). *Standard Methods for the examination of Water and Wastewater.* Amer Public Health Assn.

Drinan, J. E. (2001). *Waste and Wastewater Treatment: A Guide for the Nonenginnering Professional* (Ist Editio). CRC Press.

Kawamura, S. (2000). *Intergrated Design of Operation of Water Treatment Facilities* (Second Edi). John Wiley & Sons, Inc.

McGhee, T. J., and Steel, E. W. (1991). *Water Supply and Sewerage*. New York : McGraw-Hill.

Metcalf & Eddy. (1981). *Wastewater Engineering: Collection and Pumping of Wastewater*. (Goerge Tchobanoglous, Ed.). McGraw-Hill.

Metcalf, L., Eddy, H. P., and Techobanoglous, G. (1991). *Wastewater Engineering: Treatment Disposal Reuse*. (Third Edition, Ed.). New York : McGraw-Hill.

Pontius, F. W. (1990). *Water Quality and Treatment. A handbook of Community Water Supplies* (Fourth Edi). McGraw-Hill, Inc. https://doi.org/10.1002/9781118809167.ch7

Singh, J., and Singh, G. (2003). *Water Supply and Sanitary Engineering* (First Edit). Standard Publishers Distributors,New Delhi.

EFFECTS OF WASTE COCONUT SHELL AS PARTIAL REPLACEMENT OF SAND ON CEMENT MORTAR PROPERTIES

Ainul Haezah Noruzman
Department of Civil Engineering
Politeknik Sultan Salahuddin Abdul Aziz Shah, Persiaran Usahawan Seksyen U1,
40150 Shah Alam, Selangor Darul Ehsan
Corresponding author: ainulhaezah@yahoo.com

Abstract

Sand is well-known to be one the main ingredients of cementitious material. To date, many studies have explored the opportunities of research on new materials with strength and durability, which can potentially be used for construction, and at the same time, reduce the cost. In developing countries, the possibility of using agricultural wastes and industrial by-products from different industries is highly desirable and is found to have several practical advantages. This paper presents the investigations carried out on cube tests using coconut shell as partial replacement with addition of 0%, 5%, 10%, 15%, and 20% by weight of fine aggregate. The mortar mix ratio of 1:3 was used and all the samples were cured at 7 and 28 days. A total of 30 cubes sized 50 mm x 50 mm x 50 mm were cast and tested. The tests involved sieve analysis and compressive strength to measure their properties compared to the control sample. The results revealed the compressive strength of mortar reduced as the percentages of replacement increased. The replacement of sand less than 5% could be potentially used as building materials. Utilizing this material would help to minimize the generation of wastes associated from the production of coconut and less harmful impact toward the environment especially at landfill and dumping areas.

Keywords*: *coconut shell, compressive strength, fine aggregate, mortar, sieve

1.0 Introduction

The increasing demand for urbanization nowadays leads to the increasing production of building materials. Cement and concrete are the most widely used construction materials in the world today. Annual concrete production in the world reaches 12 billion tons, approximately 1.7 million tons of concrete per person (Kanellopoulos *et al.*, 2014). Meanwhile, cement, which is the main component in concrete, was globally produced in 2011 with the significant amount of 3.6 billion tons, and is forecasted to increase 5.8 billion tons in 2050 (Juenger and Siddique, 2015). However, building material industry, especially cement and concrete industry, induces significant impact on the environment.

The production of cement and concrete consumes very large amounts of fossil fuels and raw materials as well as energy (Dobiszewska, 2017). Apart from concrete, mortar also consumes a large amount of fine aggregate for masonry and plastering. This leads to an uncontrolled exploitation of river sand, which in turn leads to its scarcity (Gupta and Vyas, 2018).

The consumption of higher amount of energy and degradation of natural resources as the results of production of building materials adversely affect the earth landscape and generate multilevel of wastes. For instance, the production of cement bricks generates a large amount of energy, and releases substantial quantity of CO_2 as well as degradation of natural aggregate resources produced from quarrying operations. In recent years, rapid development has led to an increased demand for river sand as a source of construction materials. Sand is used as mortar, brick, glass, adhesives, and ceramics, and also plays an important role in water filtration, in chemicals, metal processing, and in plastic industry (Gavriletea, 2017). In Malaysia, the main source of sand is mostly from in-stream mining and excessive removal of sand, which may significantly distort the natural equilibrium of a stream channel as well as public facilities (Teo *et al.*, 2017). According to the study by Ashraf *et al.* (2011), at the Selangor river, it was revealed that in average, 11.73 million tons of sand and gravel were extracted from active channels, and 0.414 million tons were from floodplains. These resulted in riverbed lowering in the storage zone over the past two decades.

Extensive research has been conducted on the production of bricks from waste material for environmental protection and sustainable development purposes. Most researchers carried out the study manifest twofold; to provide a possible utilization of waste material in conjunction with the performances as building material, and to observe the potential of waste material that can be eliminated or minimised from waste generation itself. Therefore, a wide variety of waste materials has been studied including industrial and agricultural wastes (Demir *et al.*, 2005; Fatih and Ümit, 2005; Demir, 2006; Ahmari and Zhang, 2012; Liu *et al.*, 2012; Sutas *et al.*, 2012; Kadir *et al.*, 2016; Purwanto and Permana-Citra, 2019). Apart from that, a few studies have identified that the agricultural by-products of coconut shell can also be used as aggregate in cementitious material (Yerramala and Chu, 2012; Ahlawat and Kalurkar, 2014; Kadir *et al.*, 2016; Gautam and Gangwani, 2017; Andavan *et al.*, 2018).

The coconut palm (*Cacos nucifera L.*), described as ‘tree of life’ with multifarious uses, is grown in more than 93 countries. South East Asia is regarded as the origin of coconut (Kaur and Kaur, 2012).

It was estimated that the global coconut area in 2005 was about 12 million hectares, and total production was 11.9 million metric tons according to the Asia Pacific Coconut Community (APCC), including Malaysia that contributed about 88% of the acreage and 83.3% of the world output of copra (Sivapragasam, 2008). Coconut is the third most important industrial crops in terms of the total planted area in Malaysia. It was reported that local coconut oil was around 455,000 tons in 2009, which generated coconut husk and shell as biomass waste (Pariatamby, 2017). These cumulative figures of waste generation from coconut shell would potentially be environmentally risky to landfill areas.

Limited studies have been conducted in terms of the addition of coconut shell in cement mortar. However, further research is needed for better understanding of coconut shell as replacement of fine aggregate in mortar. Thus, this study aims to utilise coconut shell in mortar, and to measure the strength at 7 and 28 days. The results of this study will provide an alternative construction and building material with low production cost.

2.0 Experimental Program

2.1 Cement

Ordinary Portland Cement (OPC) complying with BS EN 197-1: 2011 was used in all mortar mixes. The chemical composition of the cement is as shown in Table 1.

Table 1: Chemical Composition of Cement

Composition	Percentage
SiO_2	2.10
Al_2O_3	0.497
Fe_2O_3	2.48
CaO	49.50
SO_3	0.496
MgO	0.201

2.2 Fine Aggregate

Natural river-washed quartz sand complying with BS 882: 1992 was used as fine aggregate respectively. The sand grading is shown in Table 2, and the fine modulus of sand is 1.92

Table 2: Grading of fine aggregate

Sieve Size (mm)	Mass of each Sieve (g)	Weight Retained (g)	Net Weight (g)	Retained weight	passing weight	Cumulative percentage passing (%)
4.76	480	480	0	0	530	100
2.36	440	450	10	10	520	98
1.18	430	490	60	70	460	87
0.6	370	480	110	180	350	66
0.3	330	480	150	330	200	38
0.15	310	410	100	430	100	19
Pan	290	390	100	530	0	0

2.3 Crushed Coconut Shell (CCS)

Coconut shells were collected from nearby grocery shops and a temple around Section 13, Shah Alam, Selangor. Figure 2 shows that the coconut shells were dried and cleaned from the husk and sunk. All samples were dried in hot weather for 1-2 months. After completely dry, the coconut shells were crushed using grinding machine. All crushed samples were kept in a closed container to avoid humidity. A sample of crushed coconut shells was sieved to determine the grading of the materials, as shown in Table 3.

Figure 2:
Waste and crushed coconut shells

Table 3: Grading of crushed coconut shell

Sieve Size	Mass of each sieve (g)	Weight Retained (g)	Net Weight (g)	Retained weight	Passing weight	Cumulative percentage passing (%)
5	480	520	40	40	400	91
2.36	440	540	100	140	300	68
1.18	430	590	160	300	140	32
0.6	370	440	70	370	70	16
0.3	330	360	30	400	40	9
0.15	310	340	30	430	10	2
Pan	290	300	10	440	0	0

2.4 Mix Proportions

In order to investigate the properties of crushed coconut shell mortar, 5 mixes were employed. The mix ratio used was 1:3, and free water to cementitious ratio was maintained constant at 0.5 for all mortar mixes. The compositions of crushed coconut shell used as substitute for fine aggregate were 0%, 5%, 10%, 15% and 20% in cement mortar as shown in Table 4.

Table 4: Mix proportion of cement mortar

Constituent	M0%	M5%	M10%	M15%	M20%
Cement (g)	520	520	520	520	520
Sand (g)	1040	988	936	884	832
Coconut Waste (g)	0	52	104	156	208
Water (g)	780	780	780	780	780

2.5 Compressive Strength Test

The trial mix used mortar cubes with size of 50 mm x 50 mm x 50 mm for compressive strength testing. The test was carried out according to BS EN 12390-3: 2009. The samples were tested at 7 and 28 days. The average of three values was taken as the strength values for all batches.

3.0 Result and Discussion

3.1 Particle Size Distribution

Grading curves for both fine aggregate and coconut shell are shown in Figure 3, respectively. The sand used in this study satisfied the grading requirements of fine aggregate according to BS 882:1992. The sand used was suitable for mortar production. From the graph, it was observed that particle size distribution for coconut shell also met the grading limit. Compared to sand, the grading curve for coconut shell was near the lower limit boundary. This was probably caused by crushing process, when the coconut shells were ground for a few hours, resulting in more particles to be larger before batching the samples.

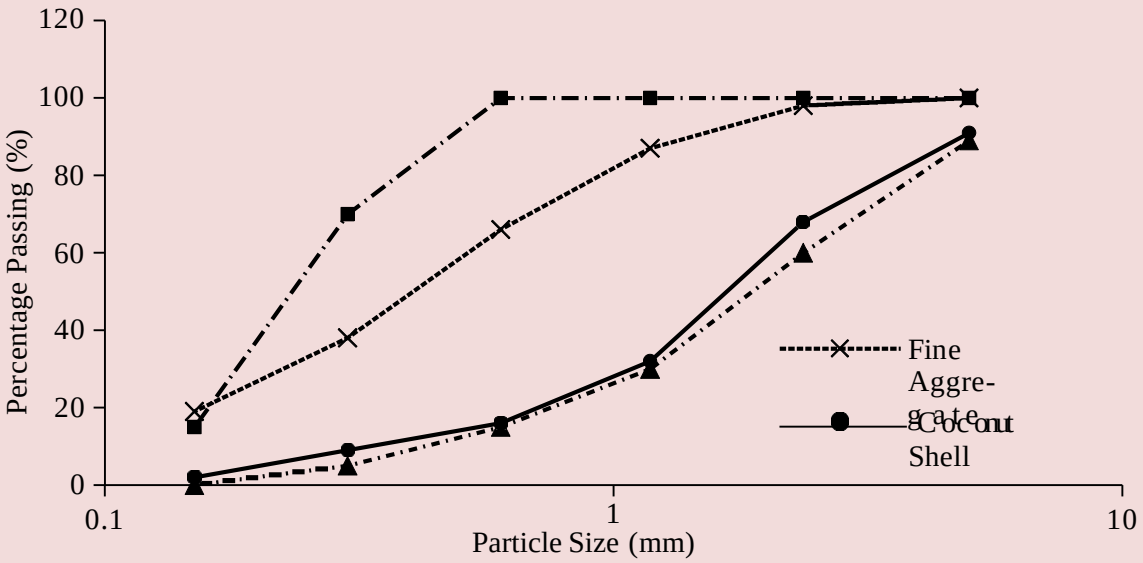


Figure 3: Comparison of grading curves between sand and coconut shell

3.2 Compressive Strength

Figure 4 illustrates the variation of compressive strength for 7 and 28 days with different percentage replacements of fine aggregate by crushed coconut shell. From the graph, it showed that the compressive strength of the mortar decreased gradually as the percentages of coconut shell increased in the mortar mixing. It was also found that the compressive strength of the mortar increased with the increase of the curing days. The normal mortar exhibited better strength compared to crushed coconut shell mortar mixes at 28 days. The rate of strength gaining experience between 7 and 28 days for normal mortar was 27.7 %. Meanwhile, the rates of strength for crushed coconut shell mortar were 5% (162.5%), 10% (213%), 15% (114.6%), and 20% (74.3%), respectively. At 7 days, as the percentages of crushed coconut shell substitution of fine aggregate increased, the compressive strength reduced. It could be due to the lack of sufficient bonding between the particles in mortar. The crushed coconut shell with larger particles decreased the surface area that affected the bonding (Yerramala and Chu, 2012; Tharwani *et al.*, 2017). However, at later age, the strength was achieved from all crushed coconut shell mixes but showed degradation in strength compared to normal mortar. Furthermore, the strength decreased with crushed coconut shell replacement. The trend of the results was in line with earlier studies. Finally, visual observations during mixing and compaction of all samples suggested that the mortar was homogenous. There was no segregation and bleeding, thus, the mixes were compactable.

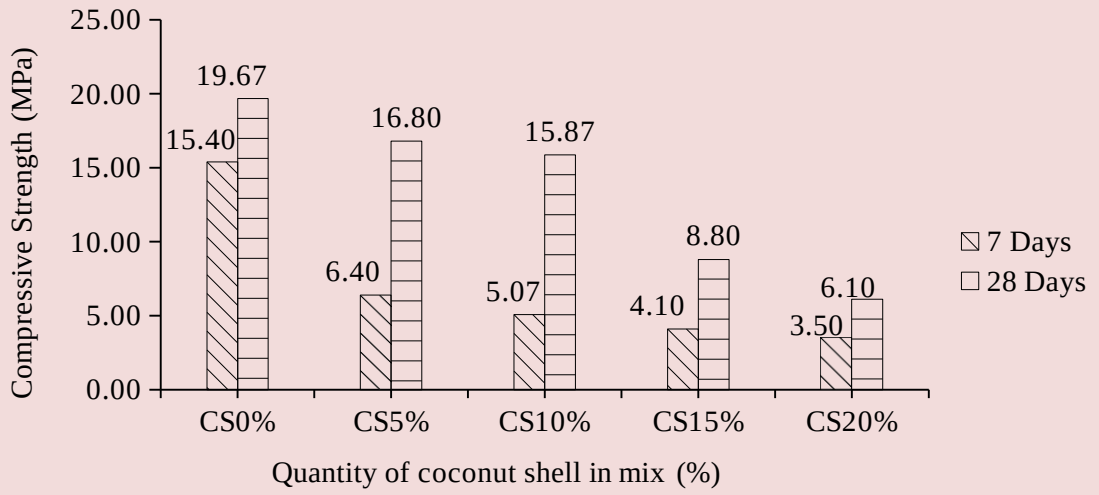


Figure 4: Compressive strength of percentages of crushed coconut shell in mortar

4.0 Conclusion

The conclusions that can be drawn from this study are as follows;

- The results show that coconut shell can be used as replacement of fine aggregate, but the performance of coconut shell mortar in strength is a little bit lower than normal mortar.
- The use of less than 5% of crushed coconut shell can be effective in terms of strength.
- As the coconut shell replacement percentages increase, the compressive strength decreases due to possible lack of effective bonding within the particle sizes in mortar.
- Grading of coconut shell meets the requirements of overall grading aggregate limit.

Acknowledgment

The authors gratefully acknowledge Politeknik Sultan Salahuddin Abdul Aziz Shah and technical staff at Universiti Teknologi Mara, UiTM Shah Alam, for the guideline, services and facilities.

References

Ahlawat, D. and Kalurkar, L. G. (2014). Coconut Shell as a Partial Replacement to Coarse Aggregate in Concrete. *Australian Journal of Basic and Applied Sciences*. 2014, 693–697.

Ahmari, S. and Zhang, L. (2012). Production of eco-friendly bricks from copper mine tailings through geopolymerization. *Construction and Building Materials*. 29, 323–331.

Andavan, S., Sreekar, N. R. and Vivek, P. (2018). Review on substitution of coconut shell as coarse mix in concrete combine by mistreatment of numerous grades. *International Journal of Pure and Applied Mathematics*. 119(17), 199–209.

Ashraf, M. A., Maah, M. J., Yusoff, I., Wajid, A. and Mahmood, K. (2011). Sand mining effects, causes and concerns: A case study from bestari jaya, Selangor, Peninsular Malaysia. *Scientific Research and Essays*. 6(6), 1216–1231

Demir, I. (2006). An investigation on the production of construction brick with processed waste tea. *Building and Environment*. 41(9), 1274–1278.

Demir, I., Baspinar, M. S. and Orhan, M. (2005). Utilization of kraft pulp production residues in clay brick production. *Building and Environment*. 40(11), 1533–1537.

Dobiszewska, M. (2017). Waste Materials Used in Making Mortar and Concrete. *Journal of Materials Education*. 39(6), 133–156.

Fatih, T. and Ümit, A. (2005). Utilization of Fly Ash in Manufacturing of Building Bricks. In *2005 World of Coal Ash (WOCA)*. 2005, 3–8.

Gautam, B. R. and Gangwani, L. R. (2017). Light Weight Aggregate Concrete by using Coconut Shell. *International Journal of Engineering Technology Science and Research*. 4(12), 225–236.

Gavriletea, M. D. (2017). Environmental impacts of sand exploitation. Analysis of sand market. *Sustainability (Switzerland)*. 9(7).

Gupta, L. K. and Vyas, A. K. (2018). Impact on mechanical properties of cement sand mortar containing waste granite powder. *Construction and Building Materials*. 191, 155–164.

Juenger, M. C. G. and Siddique, R. (2015). Recent advances in understanding the role of supplementary cementitious materials in concrete. *Cement and Concrete Research*. 78, 71–80.

Kadir, A. A., Zulkifly, S. N. M., Abdullah, M. M. A. B. and Sarani, N. A. (2016). The utilization of coconut fibre into fired clay brick. *Key Engineering Materials*. 673(January), 213–222.

Kanellopoulos, A., Nicolaides, D. and Petrou, M. F. (2014). Mechanical and durability properties of concretes containing recycled lime powder and recycled aggregates. *Construction and Building Materials*. 53, 253–259.

Kaur, M. and Kaur, M. (2012). A review on utilization of coconut shell as coarse aggregates in mass concrete. *International Journal of Applied Engineering Research*. 7(11 SUPPL.), 2063–2065.

Liu, H. J., Li, P. X., Cao, S. G. and Zhao, F. Q. (2012). Preparation of high-performance brick from construction and demolition waste. *Advanced Materials Research*. 391–392, 180–183.

Pariatamby, A. (2017). *Country Chapter State of the 3Rs in Asia and the Pacific-Malaysia*. [Online]. from http://www.uncrd.or.jp/content/documents/5691[Nov 2017] Malaysia.pdf.

Purwanto, P. and Permana-Citra, A. D. (2019). Recycling and processing of solid waste into products of the cosmetic packaging industry. *Journal of Physics: Conference Series*. 1295(1).

Sivapragasam, A. (2008). Coconut in Malaysia: Current developments and potential for re-vitalization. In *2nd International Plantation Industry Conference and Exhibition (IPICEX2008)*. 2008, 1–9.

Sutas, J., Mana, A. and Pitak, L. (2012). Effect of rice husk and rice husk ash to properties of bricks. *Procedia Engineering*. 32, 1061–1067.

Teo, F. Y., Chun Kiat, C., Ab Ghani, A. and Zakaria, N. A. (2017). River Sand Mining Capacity in Malaysia. In *Proceedings 37th IAHR WORLD CONGRESS*. 2017.

Tharwani, A., Sablani, A., Batra, G., Tiwari, S., Reel, D. and Gandhi, M. N. (2017). Study of Strength of Concrete by Using Coconut Shell. *IJISET-International Journal of Innovative Science, Engineering & Technology*. 4(5), 37–41.

Yerramala, A. and Chu, R. (2012). Properties of Concrete with Coconut Shells as Aggregate Replacement. *International Journal of Engineering Inventions*. 1(6), 2278–7461.

JAWATANKUASA PENERBITAN

DIGES AKADEMIK PSA BIL. 3/2020

PENASIHAT

DR. HJ. MOHD ZAHARI BIN ISMAIL

DR. HJH. NORHAYATI BINTI IBRAHIM

PN. ZALINA BINTI ISMAIL

TEKNIKAL

DR. HJH. WAN ROSEMEHAH BINTI WAN OMAR

DR. AINUL HAEZAH BINTI NORUZMAN

DR. HJH. WAN NOORAINI BINTI WAN KAMARUDDIN

HJH. AMIDAH BINTI MOHD UJANG

PN. NUR RAIHAN BINTI SALIM

PN. KARTINI SUMIYATI BINTI MOHD SALLEH

DR. HJ. MOHD NAJIB BIN HAMDAN

EN. MOHD NOR AQMAL BIN RAZALI

PANEL PEWASIT

DR. HJH. AZIAM BINTI MUSTAFA

DR. HJH. FADHILAH BINTI MOHD NOR

DR. BIBIE SARA BINTI SALLEH

DR. NOR ASIAH BINTI MUHAMMAD

DR. MARLINA BINTI RAMLI

PN. ATIKAH FATMA BINTI MD DAUD

PROMOSI DAN TUGAS KHAS

PN. UMI KHALTOM BINTI ABDULLAH

PN.SITI AZLIYA BINTI ISMAIL

PN. HJH. JULAIHA BINTI OMAR

EN. NOORAZLAN BIN MOHD SAMSUDDIN

DR. SITI KHALIJAH BINTI JAMAL

DR. MURUGADAS A/LRAMDAS@CHELAMUTHU

PN. ZAIMAH BINTI ABD. KARIM