# POLITEKNIK SULTAN SALAHUDDIN ABDUL AZIZ SHAH

# UNFIRED CLAY BRICK USING ASH BALES

## JABATAN KEJURUTERAAN AWAM


1) KHISHOREEY A/P K. SATHIA MOORTHY

2) NUR ZUZI BATRISYIA BT MOHD ROZI

1) 08DKA20F2014

2) 08DKA20F2017


**SESI 1:2022/2023**

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Laporan ini dikemukakan kepada Jabatan Kejuruteraan Awam sebagai memenuhi sebahagian syarat penganugerahan Diploma Kejuruteraan Awam

## JABATAN KEJURUTERAAN AWAM

## SESI 1:2022/2023

# AKUAN KEASLIAN DAN HAK MILIK

# TAJUK PROJEK

1. Kami, KHISHOREEY A/P K. SATHIA MOORTHY (020116-10-1486) dan NUR ZUZI BATRISYIA BT MOHD ROZI (020920-10-0476) adalah pelajar Diploma Kejuruteraan Awam, Politeknik Sultan Salahuddin Abdul Aziz Shah, yang beralamat di Persiaran Usahawan, Seksyen U1, 40150 Shah Alam, Selangor.

2. Saya mengakui bahawa 'Projek tersebut diatas' dan harta intelek yang ada didalamnya adalah hasil karya/ rekacipta asli saya tanpa mengambil atau meniru mana-mana harta intelek daripada pihak-pihak lain.

3. Saya bersetuju melepaskan pemilikan harta intelek 'Projek tersebut' kepada 'Politeknik tersebut' bagi memenuhi keperluan untuk menganugerahan Diploma Kejuruteraan Awam kepada kami.

Diperbuat dan dengan sebenar-benarnya diakui oleh yang tersebut; )

1. KHISHOREEY A/P K. SATHIA MOORTHY )
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1. 020116-10-1486 2. 020920-10-0476)

Di hadapan saya, ( 820205-03-5498) sebagai penyelia projek pada tarikh: 11/8/2022 )

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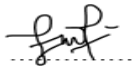
2. 

1. KHISHOREEY A/P K. SATHIA MOORTHY
2. NUR ZUZI BATRISYIA BT MOHD ROZI

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# PENGHARGAAN

Bismillahirrahmanirrahim,

Alhamdulillah, Bersyukur ke hadrat Ilahi yang maha pengasih lagi maha penyayang, dengan izin-Nya memberi peluang kepada kami untuk menyiapkan Projek Tahun Akhir ini. Projek ini hanya dapat dicapai kerana bantuan dan sokongan ramai orang. Saya ingin mengambil kesempatan ini untuk mengucapkan terima kasih kepada semua orang atas bantuan mereka.

Puan Zurina bt Safee, yang menyelia pengajian dan penyelidikan kami, adalah orang pertama yang kami ingin ucapkan terima kasih atas segala bantuan dan sokongan beliau. Kami berterima kasih atas masa dan usaha beliau dalam membantu kami untuk menyiapkan projek ini, terutamanya semasa fasa penyelidikan dan penulisan laporan. Sepanjang projek ini, kesabaran dan sokongan beliau amat dihargai.

Di samping itu, , penyelaras projek tahun akhir, dan semua pensyarah dipuji atas segala usaha memberikan penerangan dan syarahan mengenai projek tersebut.

Akhir kata, kepada ibu bapa, saudara mara dan rakan-rakan terdekat, kami ingin merakamkan ucapan terima kasih di atas sokongan yang tidak berbelah bahagi sepanjang kajian ini dijalankan. Tanpa sokongan dan dorongan berterusan mereka, projek kami tidak akan berjaya.

# ABSTRAK

Bata tanah liat adalah bata yang diperbuat daripada tanah liat yang dihancurkan dan dicampur dengan air untuk melembutkan dan memudahkan proses pembentukan. Dalam proses pembuatan bata, ia dilakukan tanpa bahan campuran dan dijemur di bawah sinar matahari selama beberapa hari, untuk proses pengerasan dan tidak hancur jika direndam dalam air. Bata biasanya dibakar pada suhu tinggi yang boleh menyebabkan peningkatan gas karbon dioksida yang boleh merosakkan alam sekitar. Alternatifnya ialah menghasilkan bata yang berkualiti bagi memenuhi syarat yang telah ditentukan. Dalam kajian ini, abu jerami merupakan bahan campuran yang ditambah kepada sampel bata dengan peratusan berbeza iaitu 0%, 5% dan 10%. Dengan abu jerami ini, adalah mungkin untuk mencari komposisi optimum dan menentukan ciri-ciri batu bata melalui ujian kekuatan mampatan dan proses pengeringan semula jadi. Nisbah yang digunakan untuk batu bata ini ialah 6:2:2 iaitu tanah liat, pasir, dan simen. Hasil kajian mendapati sampel bata dengan peratusan abu jerami sebanyak 10% memberikan hasil yang terbaik berbanding bacaan sampel bata lain dengan nilai kekuatan mampatan 0.79kN. Manakala untuk ujian pengeringan, sampel bata tanah liat ini mengambil masa 21 hari atau 3 minggu untuk kering sepenuhnya.

**Kata kunci: Abu Jerami, bata tanah liat tanpa bakar, ujian kekuatan mampatan**

# ABSTRAK

Clay bricks are bricks made from crushed clay and mixed with water to soften and facilitate the formation process. In the process of making bricks, it is done without mixed materials and dried in the sun for several days, for the hardening process and does not disintegrate if soaked in water. Bricks are generally burned at high temperatures which can cause an increase in carbon dioxide gas that can damage the environment. An alternative is producing quality bricks to meet the conditions that have been determined. In this study, straw ash is a mixed material added to the brick sample with different percentages of 0%, 5% and 10%. With this straw ash, it is possible to find the optimal composition and determine the characteristics of bricks through compressive strength tests and the natural drying process. The ratio used for these bricks is 6:2:2 which is clay, sand, and cement. The results of the study found that a brick sample with a straw ash percentage of 10% gave the best results compared to the reading of other brick samples with a compressive strength value of 0.79kN. While for the drying test, this clay brick sample takes 21 days or 3 weeks to dry completely.

**Keywords: Straw Ash, unfired clay brick, compressive strength test.**

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# LIST OF SYMBOLS

| SYMBOL | TITLE |
| --- | --- |
| ٪ | Percentages |

# LIST OF SHORT FORM

| | |
|---|---|
| PSA | Politeknik Sultan Salahuddin Abdul Aziz Shah |
| kN | Kilonewtons |
| kg | Kilograms |
| IADP | Integrated Agricultural Development Project |
| BERNAS | Padiberas Nasional Ber had |
| Mm | Milliliters |
| UTM | Universal Testing Machine |
| g | Gram |
| $N/mm^2$ | Newton per unit milliliters square |
| ICSEB | Compressed Stabilized Earth Brick |

# BAB 1

# INTRODUCTION

## 1.1 INTRODUCTION

Brick is one of the main materials in building construction. The materials used for the manufacturing process are clay, sand and cement, and sand. Bricks are rectangular in shape, and they are made from hard and durable inorganic materials. The size and weight of the brick is designed so that it can be easily held by one hand by the person handling it. One of the ingredients for making red bricks is clay. It has been mentioned above that clay as a raw material for bricks has plastic properties and dry shrinkage. The plastic properties of clay play an important role in the initial process of making red bricks, that is, at the time of dough making and molding. The plastic nature of clay is also related to drying shrinkage when the bricks are dried. Therefore, the two properties of the clay influence the strength, shrinkage, and quality of red bricks produced by burning.

Straw is one of the worst environmental pollutants in Malaysia, contributing more than 3 million tons of agricultural waste every year. The amount of remaining straw tends to be an issue for open burning in Malaysia, despite the fact that great efforts have been made to use it for various industrial purposes. As a result, one of the successes of the commercial brick industry was the creation of straw bricks, which had several advantages over open-fired straw. As can be observed, when rice straw is burned, it produces 150 kg of ash and has an average silica content of 82% for every 1000 kg of rice straw burned. Ash from rice straw shares some of the chemical composition of common organic fibers (Rosmiza Mohd Zainol)

## 1.2 PROBLEM STATEMENT

A large amount of straw as agricultural waste exceeding 3 million tons per year which is the most environmentally friendly pollutant in Malaysia. Then brick making is affected by weather conditions because when it rains it will affect brick making and cause product activity to decrease. The idea to make brick came out from the journal

(Sri Pranata, 2021). The burning of bricks affects the high cost of production where the price of firewood and coal is getting more expensive and harder to find.

Paddy is one of the main sources of income for some residents Peninsular Malaysia in general. Various techniques and methods are used in increasing production productivity as well as quality assurance that has been outlined by authorities such as the Integrated Agricultural Development Project (IADP). Padiberas Nasional Berhad (BERNAS), as well as several other government agencies.

Straw bales are part of the rice plant and are better known as rice stalks. The remaining straw bales will be burned for the purpose of planting rice the following. According to Matsumura and colleagues (2005), in general. Straw bales are widely used in various fields where the percentage of use. The straw is broken down as follows, reused in the rice fields (burned) by 61.5 %, animal feed by 11.6 %, manure or compost by 10.1 %, the floor of the cattle shed by 6.5 %, combustion as a source energy as much as 4.6%, cover material for the theme field area as much as 4%, handicrafts by 1.3% and others by 0.3%.

Ash straw bales are produced when hay is burned at a certain temperature either inside open or closed furnace. The use of straw ash is still less comprehensive compared to rice husk ash. Chaff ash has been used in a variety of ways such as concrete (Nehdi and colleagues, 2003), white pottery (Prasad and friends, 200 I) and catalytic activity (Ahmed and Adam, 2007). Research highlights also feature many studies on rice husk ash (Lakshmi and colleagues, 2008; Kurama and Kurama, 2008; Siqueira and colleagues, 2008; Adam and colleagues, 2006; Della and colleagues, 2002; Feng and friends, 2004) compared to rice straw ash. Therefore, this study aims detailing the straw and ash from the types of rice found in Malaysia.

## 1.3 OBJECTIVE

The objective to produce bricks without burning is:-

i. To produce bricks without burning with Straw

ii. To test the relationship of the strength of bricks without firing

iii. To study the time taken in the brick to dry

## 1.4 SCOPE OF STUDY

The scope of this project for unfired clay brick using ash straw has been specialized for getting accurate, precise, and accurate results and achieve the objectives of the study set. Unfired brick making requires ash to bind the clay particles. Straw bales are a mineral resource that is very easy to find in Selangor. Straw bales have a low nutritional value and have a high ash content, which is around 23%. Ashes contain silica with a very high rate which is around 90 - 95%, with high level of porosity, lightness and a wide external surface are very suitable for the material mixture in brick making. The type of brick used is clay brick. The type and grade of clay masonry is defined as ASTM C62.

This project consists of materials such as cement, sand, clay, and straw bale ash. The ratio is 2:6:2. Straw bale ash as an additional material. The percentage of straw ash that will be used is 5% and 10%. Unfired clay bricks can offer a cost-effective form of construction and can have a very low environmental impact.

To the strength of the brick, compression test will be used. Compressive strength test on bricks is carried out to determine the load carrying capacity of bricks under compression with the help of compression testing machine.

## 1.5 IMPORTANT OF STUDY

In Malaysia the burning of rice straw releases a large amount of air pollutants which cause serious environmental problems. Recycle shredded rice straw and burn it for ash to produce lightweight clay bricks. Rice straw bricks with a mixture of suggested materials such as clay, straw bale ash and cement. It can make the weight of the brick 25% lighter than the traditional one. Indirect fire exposure tests were performed

according to the ASTM 119-00A standard to compare the fire exposure behavior of bricks to market clay bricks. An economic investigation showed that the bricks under study could save costs by 25% less than standard cement bricks. This states that the proposed brick can provide an economical, lightweight brick with competitive thermal insulation properties, while maintaining adequate mechanical properties, and fire resistance.

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# BAB2

# LITERATURE REVIEW

## 2.1 INTRODUCTION

Unfired clay brickwork uses units manufactured to accurate tolerances using a commercial extrusion or pressing system to provide a consistent, high-quality product. This enables rapid, cost effective, 100mm thick walls with low environmental impact to be constructed. In most cases, modern unfired clay bricks are produced in commercial fired brick manufacturing plants using similar materials to fired bricks, but without putting the bricks through the firing process. This significantly reduces the energy used in manufacture and previous research has indicated unfired bricks have 14% of the embodied energy of fired bricks and 25% of the embodied energy of concrete blocks. Nowadays, some fired brick plants have moved to making only modern earth masonry and associated products.

## 2.2 PREVIOUS RESEARCH

Bricks are artificial stone made of clay with or without mixed materials, dried in the sun for a few days then burned at high temperatures to harden and not crumble if immersed in water. Brick in general burned in waiting for combustion with high temperatures so that it can lead to increased carbon dioxide gas that can damage the environment it is necessary to find an alternative in producing good quality bricks to meet the conditions that have been determined. This research uses 3 variations of treatment of test specimens that is burned, dried and oven as much as 9 pieces with 3 repetitions of specimen in each variation. The dimensions of the specimens used are 230 mm x 110 mm x 50mm with a mixture of material in the form of a volume mass ratio of 60% soil:15% lime: 10% Ash husk: 5% sand: 10% Cement for test specimen is dried and diesel. (JAIR MEI IRWANSYAH,2018)

Determining the characteristics of the unburnt brick are compressive strength and water absorption level. The unburnt brick was made by clay which is added by cement, rice husk ash and Banawa lime. The bricks were made in 5 mixture variations that the composition of rice husk ash and lime are different for each mixture. The percentage of

rice husk ash and lime is as much as 30% of the total mass of the mixture, the rest of the mixture consists of 60% clay and 10% cement with mass ratio. Compressive strength of the bricks was obtained by dividing the maximum load with the area of the surface of the bricks. Water absorption level was obtained by dividing the difference between the wet mass and dry mass, with dry mass of the bricks. Tests conducted at 28 days. The result of this research showed that the highest compressive strength of bricks without firing. (Darmawati Darwis,2016)

Bricks are a basic wall material in building construction. In general, bricks have a base material of clay. A lot of research has been done to find innovations that also increase the strength of bricks. This research aims to increase the strength capacity of bricks by adding additives to produce an innovation of bricks that are unburnt and not easy to disintegrate. This research examines bricks with 3 (three) husk ash compositions. The percentage of husk ash, among others, in composition I is 30% and composition II is 24% and composition III is 45%. (Nasrul,2017)

## 2.3 CLAY BRICK

Construction of residential, commercial, and industrial constructions frequently uses clay brick as a building material. The procedure for making bricks has been improved, but it has basically remained the same since the Middle East is said to have produced the first bricks 10,000 years ago. In fact, brick-making practices in undeveloped regions of the world are identical to those used thousands of years ago. Although there are regional variances, the size of bricks is usually constant. This may be since larger bricks will offer better insulation in colder places. Clay is combined with water and an aggregate, such as sand, to prevent shrinkage and add bulk for making clay bricks. Worked into a rather thick consistency, the mud is then pressed into moulds and heated in a kiln to 1,832 degrees Fahrenheit (1,000 degrees Celsius). Modern brick factories can produce millions of bricks annually thanks to a variety of techniques and procedures that have been created for the fire process. Recycling is another source of brick. When brick buildings are torn down, the whole bricks are regularly gathered and put to new uses. Clay brick has also been used for paving in addition to construction, but in the age of the automobile, it has shown to be unable to support the weight. Brick streets all throughout the world have either been paved over or replaced. However, brick

pavers are frequently used in residential settings for elements like patios and pathways. Like this, many cities are experimenting with clay brick paving to provide an appealing feature to pedestrian areas.

### 2.3.1 ADVANTAGES OF BRICK

Brick plays a very important role in the field of civil engineering construction. Bricks are used as an alternative to stones for construction purposes. Here are some advantage of brick.

**(i) Easily Maintained**

Clay bricks essentially look after themselves after they are installed. They continue to look as nice as the day they were laid down for many, many years! Clay bricks never deteriorate and always have a stunning, timeless appearance, unlike other building materials like render or paint that will need to be replaced numerous times over the years.

**(ii) Nature has offered construction materials**.

Nature's Own Material for Construction. One of the world's oldest building materials is clay brick. Around 4000 BC, the first brick was baked in the sun. Clay bricks are gorgeous, natural, long-lasting, and have a solid value.

**(iii) Natural and Eco Friendly**

Due to their composition of natural raw materials clay and water, clay bricks and pavers are particularly sustainable and natural building materials. Bricks and pavers have an incredibly long shelf life of well over 120 years and are completely free of pollutants and allergens, making them particularly compatible with people and the environment. They are also frequently recycled from projects that have been demolished, further enhancing their sustainability and environment.

**(iv) Peace and quiet**

Bricks made of clay are a sturdy, hefty, and dense product. This indicates that they are excellent at both providing insulation and noise reduction. Using clay bricks is a terrific technique to ensure a good night's sleep and reduce any noise from those dreaded "noisy neighbors" if you like a calm, serene home. Clay bricks are frequently used for inside walls to further insulate the home and reduce noise transmission inside, as well as for structural stability.

### 2.3.2 TYPE OF BRICK

#### I. Clay Brick Unfired

Unfired bricks are left to dry in controlled conditions, rather than fired, which significantly reduces the overall embodied energy of the resultant brick. When delivered to site, unfired clay is not as resistant to damage as fired clay, hence care should be taken with site storage, most importantly ensuring bricks are kept dry, including protection from rising moisture from the ground or very high humidity levels.

#### II. Facing Brick

broad variety of types, colours, and textures available

### 2.3.3 CLAY FACING BRICK

There are many types of brick from clay facing which are stock bricks, handmade Bricks, moulded handmade bricks, Water struck Bricks, Wire cut bricks.

- **Engineering Brick**

Maximum water absorption and a minimum compressive strength guarantee for engineering brick is more than 70N/mm for Class A and more than 50N/mm for Class B.

- Brick Special

A large selection of bricks in unique sizes or shapes are available from Kings court Country Manor Bricks to contrast or accent all facing bricks. These unique bricks may be cut and bonded or specially produced. For further details, please view our Brick Specials Page.

## 2.4 BRICK MATERIAL

Brick is a term that refers to small units used as building materials. These are often made with fired clay and secured in place with mortar, which is a mixture of water, cement, and sand. This acts as a bonding agent to achieve maximum durability. The nature of bricks is that they retain heat; they fight against corrosion and against fire. Brick is the best possible material for structures in limited spaces, buildings, as well as curved designs, with very little care, and which generally last a long time. At 4-inches wide and 8-inches long, the brick is made twice as wide. Because this is a small unit, there really aren't many limitations; you can easily build various structures using bricks. The brick Structure Archaeological research carried out during the restoration process of the Sewu Main Temple has found a brick structure. This structure is rectangular with a size of 530 cm x 524 cm with a height of 111 cm and consists of 19 layers of stone. Layers are arranged using very thin species. The size of an intact brick is around 42 cm long, 22 cm wide and has an average thickness of 5.84 cm.

## 2.5 STRAW BALES

Straw bales are frequently used to control overland flow from disturbed areas. Properly installed, they can be effective in removing sediment. Proper installation includes placing the bales in a shallow trench and securing them in place with stakes. In some cases, straw bales form a core of a rock fill check dam. The rock fill is placed over the straw bales, resulting in improved anchoring.

Straw bales are a sustainable, bio-based insulation material for construction derived from a co-product of cereal food crop production. Even though straw has been used in construction for millennia, the use of straw bales dates from only the late nineteenth century. While the use of straw is still largely niche, it has grown significantly around the world in recent years, supported by new research, construction innovations and building codes of practice. This chapter presents a state-of-the-art

review in the current understanding of straw bale materials and construction technologies. Techniques including load bearing, non-load bearing, and prefabricated penalized construction systems are covered. The structural and hygrothermal properties of straw, together with the fire resistance, structural properties, durability, and acoustic performance of wall assemblies are also presented. This second edition includes updates from the latest research and development work on straw bale construction.

### 2.5.1 USAGE OF STRAW BALES

A straw bale is very suitable as infill (non-load bearing) insulation for timber frame buildings with either an external render or timber rain screen finish. Straw enables vapor permeable walls, which are locally sourced and have low impact for construction. Nonetheless, it needs careful and accurate detailing in the construction stage to fully avoid the ingress and retention of moisture.

Another solution, which would eliminate the issues associated with straw bale construction, is strawboards. The commercial strawboard industry is relatively new and growing in the United States, the United Kingdom and China. Strawboards compete with reconstituted wood products, such as particle and fiberboards in markets for wall panels, ceiling panels, floor underlays, furniture, and cabinet construction. The variety of hybrid strawboards are suitable for use in many different applications, for instance, low density strawboards provide excellent thermal and acoustic insulation, whilst higher densities allow for structural applications. Waste agricultural raw materials to produce panels, such as wheat strawboard and rice strawboard, have the potential of being utilized as construction materials. To achieve the full commercialization of strawboards, several fundamental issues such as the strength and durability, the compatibility and interface of matrix and straw particles must be overcome.

### 2.5.2 STRENGTH OF STRAW BALES

Straw-bale walls have excellent breathability, allowing air to slowly permeate the building without moisture penetration. Additionally, straw bales bestow efficient thermal insulation against the heat in summer and the cold in winter, as well as providing natural sound insulation.

### i. Eco-friendly

Straw bale houses are incredibly eco-friendly. Straw bales are typically an agricultural by-product, one which would go to waste if not used for projects like house building. Plus, straw is highly renewable. It can be regrown each year instead of the decades it can take to grow trees for producing lumber. Harvesting the straw also requires very little energy and the bales cost less to transport than wood, concrete, or steel thanks to their lighter weight.

### ii. Cost-Efficient

If you want to build an efficient home, straw bales are a great choice. The high insulation factor means it costs less to heat or cool a house made of straw than certain alternatives. The material has a natural tromba effect, allowing it to store heat or coolness and release it to keep your home's temperature comfortable.

### iii. Convenient

Building a straw bale house isn't as complex as using traditional building methods. Usually, as long as one member of the construction team is highly knowledgeable, they can guide everyone else along. This is particularly convenient if you have limited access to skilled or experienced construction labor, as nearly anyone with the physical capability necessary can participate in construction.

### iv. Attractive Aesthetic

Straw bale houses have a variety of amazing aesthetic elements. The deep windows and niches are a common favorite, often providing enough depth to function as a seat or large shelf. Plus, the slightly uneven nature of straw bales gives the walls a finished yet rustic feel, which some people appreciate.

### v. Biodegradable

While a straw bale house can last for more than 100 years when constructed and maintained properly, the core material can be returned to the earth if rebuilding becomes necessary. With a bit of ploughing, the straw can be added to soil and will decompose quickly without harming the environment. In comparison, fiberglass – a common traditional home insulator – can be hard to dispose of properly and isn't biodegradable.

### 2.5.3 FACTORS OF STRAW BALES

On a small site, straw-bale walls may make up a significant portion of the floor space due to their thickness. The walls must be protected from moisture, much like in conventional construction, and straw bales may be plastered on both sides to give thermal mass. When straw-bale construction is carried out primarily by building professionals, the cost per square foot may be comparable to that of traditional building techniques. Stick construction can be more susceptible to termites and vermin than straw bale construction, but as with other methods of construction, it's crucial to seal off any cracks or holes. Since wood holds nails better than straw bales, nailing surfaces must be offered.

## 2.6 CLAY

Clay soil consists of small air pores and dense particle spacing that is zero void space. Therefore, clay is also soft at high humidity and quickly hardens when exposed to constant temperature. The specialty of clay is that it has a low shear strength and has a high compressibility rate. Figure 2.5.1 shows the ground clay. Therefore, this study was conducted to obtain differences in terms of compression rates and water absorption rates for clay types.

Even clay soil has some good qualities. Clay, because of its density, retains moisture well. It also tends to be more nutrient-rich than other soil types. The reason for this is that the particles that make up clay soil are negatively charged, which means they attract and hold positively charged particles, such as calcium, potassium, and magnesium.

Figure 2.5.1: Clay

## 2.7 CEMENT

Cement is adhesive substances of all kinds, but, in a narrower sense, the binding materials used in building and civil engineering construction. In figure 2.6.1 shows that cements of this kind are finely ground powders that, when mixed with water, set to a hard mass. Setting and hardening result from hydration, which is a chemical combination of cement compounds with water that yields submicroscopic crystals or a gel-like material with a high surface area. Because of their hydrating properties, constructional cements, which will even set and harden under water, are often called hydraulic cements. The most important of these is Portland cement.

Figure 2.6.1: Cement

## 2.8 SAND

Sand is a mixture of small grains of rock and granular materials which is mainly defined by size, being finer than gravel and coarser than silt. In figure 2.7.1 shows the size from 0.06 mm to 2 mm. Particles which are larger than 0.0078125 mm but smaller than 0.0625 mm are termed silt. Sand is made by erosion or broken pebbles and weathering of rocks, which is carried by seas or rivers. And freezing and thawing during the winter break rock up the sand will be made. Sometimes Sand on beaches can also be made by small broken-up pieces of coral, bone, and shell, which are broken up by predators and then battered by the sea, and even tiny pieces of glass from bottles discarded in the sea and other mineral materials or the bones of fishes or other oceanic animals. Sand can also be considered as a textural class of soil or soil type. A sandy soil containing more than 85 percent sand-sized particles by mass.

Figure 2.7.1: Sand

## 2.9 ASH BALES

The straw bale over other recycled building materials is that straw doesn't require any processing. Recycled plastics and tires must go through complicated, expensive transformations before they are ready to be used, but straw can arrive fresh from the farm and be ready to go.

Straw bales have been used in building for centuries, though in the past straw was used not for its environmental effects, but because it was cheap and available. As soon as bricks became easy to manufacture in mass quantities, straw fell by the wayside. Over the last decade, architects have come to see straw as a potentially revolutionary

way to lower the carbon footprint of new buildings, but until recently, the size and bulk of the bales has limited what can be built with them. Straw was only suitable for use in unconventional buildings which were designed around its limitations. In figure 2.8.1 show use as a pozzolan in the construction industry, as a filler, additive, abrasive agent, oil adsorbent, sweeping component, and as a suspension agent for porcelain enamels.

Figure 2.8.1: Ash straw

## 2.10 CHAPTER SUMMARY

Through literature review, we can obtain and access a lot more information about our study. In addition, articles written by researchers previously allowed us to study our project much more deeply. Besides, it also allows us to see our whole project about using sludge to make bricks. In conclusion, based on what we got from the research earlier, we found that it is possible to make bricks by using sludge from wastewater treatment plants. Waste sludge is a potential alternative to convert useful products into building materials that can reduce problems disposal.

# BAB 3

# METHODOLOGY

## 3.1 INTRODUCTION

This shows the methodological flow chart of this study. Before the laboratory experiment is carried out, the work implementation program is planned to achieve the objectives of the study. Summary of the whole experiment. This research is important so that the research carried out has the most suitable and effective method in answering the research problem. Therefore, the study method that was designed involves the study design, study subjects or samples, study procedures, data collection procedures and data analysis procedures.

## 3.2 METHODOLOGY FLOWCHART

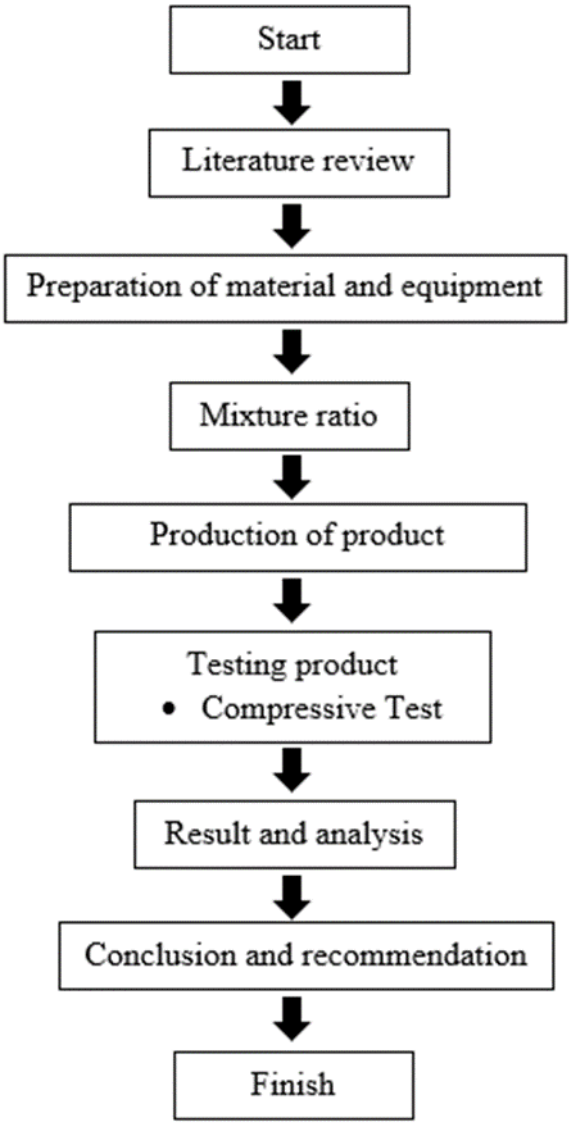


**Figure 3.2:** Methodology flowchart

## 3.3 PROJECT DESIGN

There are many advantages that make brick one of the most sought-after building materials. In addition to the standard size and simple shape, this artificial stone has strength, durability, and beauty, which is why it has been used for a very long time and almost everywhere. Also worth noting is the technology that makes the clay brick a set of processes that make it possible to obtain material with all the characteristics required by the customer. The design aims to describe the project to be implemented and provide

more detailed information to produce a quality brick. According to the standard, the brick size that is often used in the industry is 215mm×65mm×102.5mm.

### 3.3.1 SAMPLING

This clay brick sampling can be made with various series of compression pressures to produce this prototype. The mixing ratio is 2:2:6 (cement: sand: clay). This mixing ratio is done to produce a prototype size with dimensions of 120mm x 50mm x 40mm. The method of mixing raw materials is done manually. The percentage of water required to produce a good mixture is between 10% and 20% of the weight of the soil. Then this mixture will be held to form a ball of soil and dropped at a height of 1 meter. The shape of the soil ball drop is observed to obtain the optimum water content. The most optimal water content rate can be known through the fraction of soil balls among the 4 or 5 fractions produced. It was found that the most optimal water usage rate for clay is 20%.

### 3.3.2 DATA COLLECTION METHOD

This prototype is tested with a compressive strength test to find out how strong the bricks are according to percentages such as 0%, 5% and 10%. Figure 3.3.2.1 shows the Universal Testing Machine (UTM) used to obtain the compressive strength of this prototype. It is performed where each prototype sample is weighed and dried under the sun for 3 to 4 weeks. This test is based on EN771: Part 1: 2003. The weight of the sample after the drying process for 21 to 28 days. Each prototype physical test will be performed using 3 samples to obtain an average reading value for each compressive strength test.


**Figure 3.3.2.1:** Universal Testing Machine (UTM)

## 3.3.3 MATERIAL AND EQUIPMENT

### 3.3.3.1 MATERIAL

The materials used in this research are as follows.

I. Water
II. Clay soil
III. Straw ash
IV. Cement
V. Sand

### 3.3.3.2 TOOL

The tools used in this research include:

I. Hoe

II. Stirrer

III. Bucket

IV. Brick mold tools

V. Brick pressure tool (compression test)

### 3.3.4 DATA ANALISYS METHOD

**TABLE 3.3.4: DATA ANALYSIS METHODS**

| Sample 0% (straw ash) | Sample 5% (straw ash) | Sample 10% (straw ash) |
|---|---|---|
| Water | Water | Water |
| Cement | Cement | Cement |
| Sand | Sand | Sand |
| Clay | Clay | Clay |

Clay bricks are the most well-regarded thing in terms of architecture or durable structures in construction. In the building, this condition must be maintained so that the building stands perfect, but sometimes also needs attention when stone the bricks in the building experience seepage or dampness and it will be moldy resulting in no sale value for the building. The strength of clay brick will decrease, according to stone care research. A good clay brick can be achieved by doing several steps such as,

#### 3.3.4.1 COMPRESSION STRENGTH TEST

Compressive strength tests on clay bricks are carried out to determine the load carrying capacity of bricks under compression with the help of compression testing machine.

# BAB 4

# EXPECTED OUTCOME

## 4.1 INTRODUCTION

Test data on the strength of unfired bricks (straw ash) without firing. The purpose of using different series of compression pressures in the production of prototypes is to obtain the most optimal compression strength based on the series of applied pressures. Physically the prototype was tested through compression stress tests at the age of 7 and 10 days. The overall compressive strength results for the clay brick prototype. Compressive strength test data as shown in Table 4.1.1.

**Table 4.1.1:**Compression strength test data

| Percentage straw ash | Weight(g) | Maximum load(kN) | Compressive strength (N/mm²) | Average compressive strength (N/mm²) |
|---|---|---|---|---|
| 0% | 1665.0 | 20.6 | 1.00 | 0.73 |
| | 1607.7 | 16.1 | 0.79 | |
| | 1714.3 | 15.0 | 0.71 | |
| 5% | 1595.9 | 16.2 | 0.80 | 0.77 |
| | 1676.2 | 16.5 | 0.81 | |
| | 1670.6 | 14.6 | 0.70 | |

| | | | | |
|---|---|---|---|---|
| 10% | 1720.8 | 17.7 | 0.85 | 0.79 |
| | 1636.2 | 15.5 | 0.77 | |
| | 1672.2 | 15.3 | 0.75 | |

**Table 4.1.1** shows a compressive strength test performed to obtain the strength of the clay brick sample. The sample used is according to the percentage of 0%, 5% and 10%. This procedure is for the compressive strength test at a certain percentage of straw ash. The relationship between the compressive strength test and the percentage of straw ash. The compressive test of brick specimens with rice husk ash fiber gives an indication of more ductile specimens. In compressive testing, the fibrous specimen of rice husk ash gives a soft fracture.

In pure brick testing, the compressive load reached a peak of 5680 kilo newtons/m2 and decreased rapidly as the brick specimen was broken or destroyed. However, for ash bales fiber bricks, the load drop after fracture shows a relatively slower load drop rate.

## 4.2 COMPRESSION TEST GRAPH

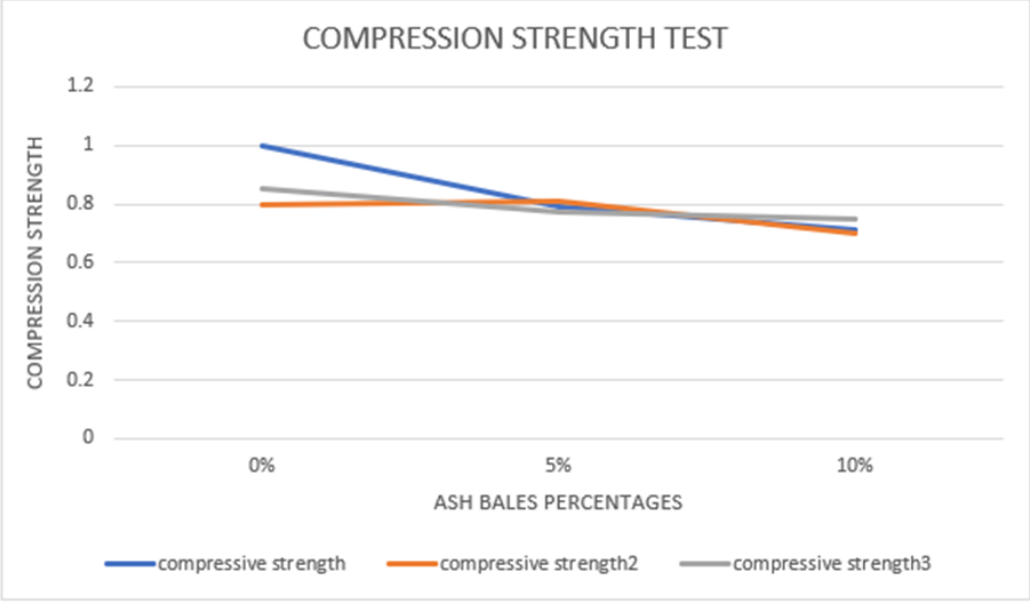


**FIGURE 4.2.1:** Compression test

Based on the results from the compressive strength test graph on figure 4.2.1 shows that the addition of bales ash at a certain percentage will decrease the compressive strength of bricks, but after passing the optimal limit of variation the addition of bales ash will increase the compressive strength of bricks. On the addition of bales ash in percentage 5% and 10% decrease in compressive strength. This is due to the arrangement of silicon dioxide found in clay and ash to achieve stability of the molecular arrangement, which means that the particles are closer together because the pores can be fully filled.

## 4.3 STANDARD COMPRESSION TEST UNFIRED BRICK

**TABLE 4.3.1** STANDARD COMPRESSION TEST UNFIRED BRICK

| MIX | Specimen No. | Max. load (Ton) | Max. Stress ($Kg/Cm^2$) |
|---|---|---|---|
| MIX A | 1 | 35 | 114.4 |
| | 2 | 36 | 116.7 |
| | 3 | 35 | 113.6 |
| MIX B | 1 | 30 | 97.8 |
| | 2 | 22 | 72.5 |
| | 3 | 15 | 49 |
| Commercial Sample | 1 | 54 | 177.9 |
| | 2 | 63 | 204.3 |
| | 3 | 55 | 177.6 |

**TABLE 4.3.1** shows the three mixes wide maximum compression loads applied variance. The result of compression strength value is different to our result at **TABLE 4.1.1**. Our results were low value due to the lack of quality control measured.

## 4.4 BRICK SHAPE AND MEASUREMENT

**Figure 4.4.1:** Prototype Brick

**Figure 4.4.1** shows the prototype produced with dimensions of 100mm × 50mm × 40mm like Interlocking Compressed Stabilized Earth Brick (ICSEB) which is 100mm x 125mm x 250mm in terms of strength, mixing ratio, and other properties of ICSEB. The main purpose of producing this prototype brick is to test in terms of compressive strength and water absorption rate which if the test is made against ICSEB which requires a lot of time and energy in its

production. This prototype can save the use of time and energy to get more accurate test values and fast.

## 4.5 RATIO FOR ASH BALES

**TABLE 4.5.1:** Ratio ash bales

| **Ash bales** | **0%** | **5%** | **10%** |
|---|---|---|---|
| **Hardness** | Not hard | Not hard | Hard |
| **Compressive or crushing test** | Easily break | Easily break | Strong |
| **Durability** | Break | Break | Will break |
| **Structure** | Standard shape | Standard shape | Standard shape |

**Table 4.5.1** shows the results of the analysis of the difference in the strength of bricks when subjected to a compression test using different percentage values of straw ash. The compressive strength of bricks using different percentage ratios of straw ash, such as 0%, 5% and 10%.

# BAB 5

# CONCLUSIONS

## 5.1 CONCLUSIONS

To avoid burning rice straw in the field, which degrades air quality and results in the creation of black clouds in Malaysia, burned rice straw was also employed in this project. To avoid this situation, we can make bricks which are more helpful than wasting the straw in this world. From the expected outcome results that have been analyzed and discussed, it can be concluded that the thickness of a brick affects the compressive strength value produced. The thicker the material, the stronger the pressure will also increase.

From the results of the analysis of this research, we can conclude that the compressive strength of the largest bricks obtained is 1.00N/mm². It is obtained as a percentage 0% straw ash that has been dried under the sun for 28 days or 1 month.

## 5.2 RECOMMENDATIONS

I. Studying the appropriate mixing ratio for clay prototypes to be stronger against compressive stress.

II. Introducing additives that can hold the aggregates so that they are thicker for clay-based prototypes so that they are not easily decomposed when exposed to environmental conditions.

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