POLITEKNIK SULTAN SALAHUDDIN

ABDUL AZIZ SHAH

STUDY OF E-WASTE AS REPLACEMENT MATERIAL OF COARSE AGGREGATE

NUR NAJWA BINTI KHAIRULANUAR

(08DKA20F1002)

JABATAN KEJURUTERAAN AWAM

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

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STUDY OF E-WASTE AS REPLACEMENT MATERIAL OF COARSE AGGREGATE

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ACKNOWLEDGEMENT

I would like to express my gratitude to everyone who was involved, either directly or indirectly, in helping me complete this task. Firstly, I appreciate all the help, advice, and information given by the lecturer, Puan Farihah Binti Mansor. Without their support, I may not be able to face and solve the difficulties that I encounter during the process until I complete this assignment.

In addition, I want to send a big thank you to my beloved parents because they sacrificed to accept responsibility for giving me money and their opinion to make sure I finished my job. Without, their aid, I am sure that I will face many obstacles to completing my assignment, as I do not have my own money yet.

Last but not least, I would like to express thousands of thanks to my group member Muhammad Thalha bin Hamdan, who gave his hand and his opinion as well as the information that I did not know. I know that without cooperation and tolerance between the group members, I could not finish this coursework perfectly. I am thankful to God because He sent help through him. Finally, I'd like to thank everyone who assisted and guided us through this coursework.

STUDY OF E-WASTE AS REPLACEMENT MATERIAL OF COARSE AGGREGATE

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Abstract

The increasing advancement of technology leads to an increase in electrical and electronic waste known as E-Waste. According to the Department of Environment, the amount of e-waste that was discarded in 2020 is estimated at 1 053 302 tonnes. E-Waste can be categorized into two types, namely E-Waste Industry and Household E-Waste. E-Waste materials include unused or damaged phones, washing machines, televisions, and all appliances that use electrical components. Therefore, this study is to determine the strength of the concrete mix of e-waste as a replacement material as coarse aggregate in the M15 grade concrete mix. In this study, we use a mixture of 1:2:4 as a concrete production material. E-Waste is used as a partial substitute for coarse aggregate where it will be mixed with 3%, 5% and 10%. The tests carried out are compression tests and water seepage rate tests. From the findings of the study, the more e-waste is used, the more the strength of e-waste concrete is increased but it's not reached the minimum strength of M15 concrete grade. In addition, it provides a high rate of water absorption compared to nominal concrete. The 10% E-Waste data, shows the highest compressive strength rate (14.2 N/mm) and the highest water absorption rate (7.67g) among the three percentages of the mixture. Ultimately, e-waste concrete can only be used as a finish and as a non-structural-building material. In conclusion, this study will show how E-Waste disposal can help improve the quality of environmental pollution by mixing in concrete.

Keywords: *E-Waste, Compression Strength, Environment Sustainability, Concrete Material*

Abstrak

Kemajuan teknologi yang semakin meningkat membawa kepada peningkatan sisa elektrik dan elektronik yang dikenali sebagai E-Waste. Menurut Jabatan Alam Sekitar, jumlah e-sisa yang dibuang pada tahun 2020 dianggarkan sebanyak 1 053 302 tan. E-Waste boleh dikategorikan kepada dua jenis iaitu Industri E-Waste dan E-Waste Isi Rumah. Bahan E-Waste termasuk telefon yang tidak digunakan atau rosak, mesin basuh, televisyen, dan semua peralatan yang menggunakan komponen elektrik. Oleh itu, kajian ini adalah untuk menentukan kekuatan bancuhan konkrit e-waste sebagai bahan gantian sebagai agregat kasar dalam bancuhan konkrit gred M15. Dalam kajian ini, kami menggunakan campuran 1:2:4 sebagai bahan pengeluaran konkrit. E-Waste digunakan sebagai pengganti separa bagi agregat kasar di mana ia akan dicampur dengan 3%, 5% dan 10%. Ujian yang dijalankan ialah ujian mampatan dan ujian kadar resapan air. Daripada dapatan kajian, semakin banyak e-waste digunakan, semakin tinggi kekuatan konkrit e-waste tetapi ia tidak mencapai kekuatan minimum gred konkrit M15. Di samping itu, ia memberikan kadar penyerapan air yang tinggi berbanding konkrit nominal. Data 10% E-Waste, menunjukkan kadar kekuatan mampatan tertinggi (14.2 N/mm) dan kadar serapan air tertinggi (7.67g) antara tiga peratusan campuran. Akhirnya, konkrit e-waste hanya boleh digunakan sebagai kemasan dan sebagai bahan binaan bukan struktur. Kesimpulannya, kajian ini akan menunjukkan bagaimana pelupusan E-Waste dapat membantu meningkatkan kualiti pencemaran alam sekitar dengan mencampurkan dalam konkrit.

Kata kunci: E-Waste, Kekuatan Mampatan, Kelestarian Alam Sekitar, Bahan Konkrit

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CHAPTER ONE
INTRODUCTION

1.1 INTRODUCTION

Our aims were to protect the environment, recycle waste, and preserve natural resources. Recycled e-waste is one of the new waste products used in the concrete industry. The reuse of e-waste in the concrete industry is seen to be the most practical application to solve the issue of disposing of a significant amount of reclaimed e-waste material. By doing this, pollution from e-waste material may be avoided. Engineers are seeking for fresh, suitable solutions to continue the construction because coarse aggregates are so expensive. In conjunction with replacement, the partial storage of e-waste in concrete can help to reduce environmental issues. One study found that up to 15% of the coarse aggregate can be replaced with e-waste material.

1.2 PROJECT BACKGROUND

This project contains the e-waste as a partial replacement for coarse aggregate which is 3%, 5% and 10% will reduce the usage of coarse aggregate in concrete grade M15. The purpose this study is to compare the level of strength and water absorption rate of concrete that has been partially produced by e-waste materials with previous studies then give suggestions and improvements to further improve the quality of concrete to be used in the construction of structures in civil engineering. In addition, to reducing the use of natural materials in the manufacture of concrete such as fine aggregate, coarse aggregate, water and cement. By replacing some of the e-waste materials with natural material, the environment, living things and human health are also guaranteed.

1.3. PROBLEM STATEMENT

1.3.1 PROBLEM OF CONCRETE

The problem of concrete that may we facing it is the using of natural resources use in mixture of concrete are too high. In concrete 1:2:4 mixture, we use 2 part of sand which is 1m3 sand = 35l so 2m3 sand = 70l. Next, E-Waste concrete give more strength compared to conventional concrete (Rathore & Rawat, 2019). In tension, concrete is brittle and weak. Plain concrete suffers from two flaws: low tensile strength and low strain at fracture (Srinivasa Rao Srinivasa Rao et al., 2010). A cost of sand is too high such as 9.90 dollar/ton as America compared to Malaysia. At Malaysia a range price of RM 37.00/ton. Concrete can be visually inspected to identify any troubled or degraded areas. Construction mistakes, disintegration, scaling, cracking, efflorescence, erosion, spalling, and popouts are just a few of the issues that can arise with concrete. In the construction industry, it is common to hear about issues with concrete failure that are not always visible. These are simply symptoms of a real problem. With internal chemical reactions that may take place and the costs that are needed to repair the concealed failure. There are many failures that always happen to the concrete, which are mechanical, chemical, fire, stray currents and corrosion. A mechanical failure is defined as any physical impact that causes concrete to crack such as vibration, collision, overloading or any movement. Chemical contamination inside concrete can weaken the cement matrix. In addition, if concrete is exposed to the highest temperatures problem such as expansion and deterioration can happen.

1.3.2 PROBLEM OF E-WASTE

E-waste problem is in Malaysia will generates 24.5 million of e-waste regarding to electric equipment now day keep increasing. Factor of increasing e-waste are household and industry are E-waste estimates from the DOE for television sets, personal computers, and rechargeable batteries increased dramatically from 463,866 metric tonnes in 2011 to 832,692 metric tonnes in 2020. This data is increasing 44% and this data will keep going because of the high use of electric equipment use nowdays. As we know, e-waste has toxic substances that are dangerous because they are exposed to the surrounding environment. If the waste disposal of this material cannot be controlled, it can have a negative effect on human life, air, water, soil, and living things. This can contribute to various problems due to e-waste in the future. Improper disposal methods can also cause the waste of these toxic substances to endanger human life. The pollution that occurs from e-waste cannot be seen with the naked eye, but the content of the material can have a bad effect on human health. For example, to the brain, liver, heart, and kidneys, and damage to the human skeletal system. This is because the content of the e-waste material contains mercury, which is harmful to humans and other living things.

1.4 OBJECTIVES

The objectives of this research are to develop the ability of concrete when concrete is mixture with e-waste using 3%, 5%, and 10% with the ratio of 1:2:4 using grade of concrete M15 Therefore, these are some objectives that to identified the result at the end of research:

I. To produce a concrete with e-waste as partially replacement of coarse aggregate
II. To determine the strength of concrete when e-waste a partially replace by e-waste
III. To determine the absorption of water when e-waste partially replace in the concrete

1.5 SCOPE STUDY

Fine aggregate will be replaced by e-waste using ration of 1:2:4 where 1 part. Next, E-Waste will be collected at Department of Environment with proposal paper will be carried out to the Director of DOE Selangor. The E-Waste that using in this study is mobile smartphone. The e-waste concrete will be replaced by 0%, 3%, 5%, and 10% with 3 sample of each ratio and result will be taken for 7 days, and 28 days of curing. Concrete will be casting using cube size which is 150mm x 150mm x 150mm for compressive strength. Lastly, the test will be carried out are compressive strength, and water absorption test. The test is intended to determine how e-waste can maintain concrete's strength and how its replacement can change the amount of air in the mix of concrete.

1.6 DEFINITION

1.6.1 DEFINITION OF CONCRETE

Concrete is a combination of cement and aggregates such as sand, water, fine and coarse aggregates. The mixing rate of concrete is very important in the production of quality concrete. Quality concrete can have a positive impact in a construction project. Concrete is a substance with a fairly diverse composition. The aggregate determines the maximum characteristics and workability of concrete. The mechanical properties of concrete are influenced by aggregate properties such as aggregate shape, size, source, crushing type, normal or light or heavy weight aggregate, angularity index, modulus of elasticity, surface texture, specific gravity, bulk density, adsorption and moisture content, cleanliness, soundness of aggregate, bulking of aggregate, thermal properties, and aggregate grading, among others (Varsha Rathore and Aruna Rawat,2019). Concrete is one of the world's oldest and most widely used construction materials, owing to its low cost, wide availability, long durability, and ability to withstand adverse weather conditions. Concrete is a brittle substance with strong compressive but poor tensile strength (Hasan M.Y. Tantawi ,2015). The new generational mix design method should be developed based on the performance criteria. The concrete strength obtained from the design concrete mix and optimum cement content should not be considered the only parameter for the stability of the concrete mix. (Shoib Bashir Wani, Tahir Hussain Muntazari and Nusrat Rafique, 2021).

1.6.2 DEFINITION OF E-WASTE

E-waste is waste or electrical and electronic goods that do not want to be used or that have been damaged. Unattended e-waste can affect human health. E-waste refers to electrical or electronic items that have been abandoned, surpluses, obsoleted, or broken. Rapid technological progress and inexpensive beginning costs have resulted in a rapid adoption rate. Globally, there is an increasing abundance of electronic trash. several tonnes of e-waste must be disposed of every year (P Asha,2015). Hazardous and inert waste materials from the electronics and electrical sectors are separated into two groups. E-waste, or inert waste, refers to outmoded, discarded, or malfunctioning electrical or electronics devices. E-waste products are extremely difficult to dispose of. (Varsha Rathore and Aruna Rawat,2019). Depending on their density and condition, certain materials found in some electrical equipment can be harmful. In California, for instance, non-operational cathode ray tubes (CRT) from televisions and monitors are currently regarded as dangerous. (Cal Recycle, 2022)

1.7 CONCLUSION

At the end of this research, the concrete is testing using compression test and water absorption test to determine the strength and water infiltration rate of concrete. This research also identifies how to reuse the usage of e-waste that keep increasing nowadays.

CHAPTER TWO
LITERATURE REVIEW

2.1 INTRODUCTION

The usage of e-waste more increasing days by days. To keep the circular economy among stakeholder, the reuse, reduce and recycle (3R) must be implemented to make a sustainability of environment and to develop the Sustainable Development Goals 2030 (SDG 2030). This research is doing to study on the strength of concrete when e-waste will be replaced as fine aggregate. Hence, the source to get sand are more difficult due to amount of sand use in construction are highly demand. Also, the price of sand is high due to demand of company and some of them must compete to get the sand. So, this study will be focus on the how the effective of concrete when it will be replaced with e-waste as fine aggregate.

2.2 THE CONCRETE AND E-WASTE

2.2.1 CONCRETE

Varsha Rathore and Aruna Rawat define the concrete is the object where all the substance are mix together based on material composition. This is where the coarse and fine material are the filler with the additional of cement paste. The ability of concrete and the useful of concrete are depending on the size of aggregate. (Rathore & Rawat, 2019). Concrete are backbone and very important has to be manufactured in large quantity due to demand of infrastructure development. (Raut et al.2018). Inflated concrete exercise may detritus matter scarcity. As a result, suitable constituents must be reinstated in sufficient quantities to meet the equitable of concrete surviving in the field (Alagusankareswari et al., 2016). Concrete has a good strength in terms of compressive, stiffness and durability. But in tension, concrete is brittle and weak. Plain concrete suffers from two flaws which is low tensile strength and low strain at fracture (Srinivasa Rao Srinivasa Rao et al., 2010.). In terms of economy side, Inflation is one of the most serious issues that every country faces. It has become critical to reduce construction costs while maintaining structural strength and durability.

The physical property of concrete is fire resistance. This is because, when a building experiences a fire, it can accommodate the fire so that it does not spread to other parts. In addition, the concrete hardens quickly when water is added to the mixture. This matter is important in a construction project because the uncertainty of the weather will disrupt the construction process. The presence of water in Portland cement will result in the occurrence of two main chemical reaction processes, which are the hydrolysis process and the hydration process.

2.2.2 E-WASTE

Sunil Ahirwar says that electronic waste become more increasingly because of the market product on electric equipment keep growth rapidly. People nowadays would rather buy a new appliance than go through the trouble of having an old one repaired (Sunil Ahirwar et al.2016). Non-metal parts in PCBs (printed circuit boards) from e-waste can be recovered and used as an ingredient in concrete (Sagar R. Raut et al. 2018). Hazardous and inert waste materials are the two types of waste materials generated by the electronics and electrical industries. It is extremely difficult to dispose of E-waste materials. Waste materials from other industries, such as fly ash, are used in concrete production (Rathore & Rawat, 2019).

E-waste also known as electronic waste. It is any electronic product or product containing electronic components that has reached the end of it is usable life cycle. E-waste can divide into two main types which are from industrial sector and household e-waste. By MarketWatch in 2018, consumers replaced their mobiles every 15 months. Nowadays, people would prefer to purchase a new appliance rather than deal with the hassle of having an old one repaired. (Sunil Ahirwar et al.2016). Example of e-waste which is mobile phones, tablets, laptops and others. This is can cause the proliferation of digital devices is becoming a problem to the world in future. This is because e-waste contains dangerous chemicals such as cadmium, lead, lead oxide, antimony, nickel and mercury. Therefore, can harm the health of humans include can pollute the surrounding environment which is the rivers, lakes, and seas and can release toxic gases into the atmosphere that can bad ecosystems.

While Santhanam describes the e-waste problem as growing daily due to production and consumption with today's technological advancements, the uncontrolled processing of electrical and electronic waste in developing nations may pose major health and pollution dangers. Lead, cadmium, beryllium and brominated flame retardants are examples of pollutants that may be present in electronic junk components like CRTs (cathode ray tubes). Electronic waste was projected to be around 400,000 metric tons in a 2007 study by the Manufacturer Association of Information Technology (MAIT) of India and GTZ if Germany. The majority of the waste was derived from computers, mobile phones and televions. (Santhanam Needhisan et al. 2020)

In Malaysia, "e-waste" is categorised as schedule waste in the First Table under Code 110 and is defined as "unusable e-waste." Mineral Resources and Environment Ministry, 2017. The Mohamamd Tapir Mapa claims that toxins like Pb, Sg, Hg, Cd, Ni, Polybrominated Diphenyl Ethers (PBDEs), and Polychlorinated Biphenyls can be found in e-waste (PCBs). Industrial and domestic use are the main sources of e-waste. There are currently no rules that apply to domestic e-waste; the Constitution primarily concerns industrial e-waste and disposal techniques. So, this explains why there is more household waste today. (Muhammad Tapir Mapa et. al 2018).

2.3 COMPRESSIVE STRENGTH

Concrete's compressive strength is defined as its ability to withstand loads before failing. The compressive strength test is the most important of the many tests performed on concrete because it provides information about the concrete's properties. (Pijush Samui et al. 2020). Sagar R. Raut from table 2.1 show their research on Experimental Study on Utilization of E-Waste in Cement concrete found that the addition mixture 15% with coarse aggregate replace by e-waste is the good ratio within 7 days, 14 days and 28 days after sample taken by that day (Sagar R. Raut et al. 2018). Varsha Rathore and Aruna Rawat on table 2.2 shows the study e-waste partially replace with coarse aggregate with ratio of 1: 1.82: 3.43 and 15% with different size. (Varsha Rathore et al. 2019). Otherwise, in K. Alagusankareswari study in e-waste replacement of fine aggregate shows that the more rate of percentage of e-waste mix with concrete, the strength come to decrease. (K. Alagusankareswari et al. 2016).

Meanwhile, other studies of concrete with additional of other substance shows the good results. According to the Chandramouli K said that all the grade of concrete M20, M30, M40, and M50 shows that percentage of concrete increase when glass fibre is added by 0.03% in all mixtures. (Chandramouli. K et al. 2010). In other research, Shadheer Ahameer said that the various type of natural fibres with the different of addition of content for grade M20 and M25 are increases the strength. (Shadheer et al. 2020).

The ability of a material or structure to support loads on its surface without cracking or deflecting is known as compressive strength. When a material is compressed, its size tends to decrease, and when it is stretched, its size elongates (Gopal Mishra, 2020). Compressive strength commonly needs to achieve 15MPa (2200 psi) to 30MPa (4400 psi) for construction in commercial and industrial structures.

Lakshmi and Nagan (2010) found that strength shows decreased when e-plastic content was more than 20%. Studies shows that e-waste can be used in concrete but not to strength on load structures. Therefore, concrete that contains e-waste material can be used in effectively as lightweight concrete. Lightweight concrete is a very versatile material for construction which is in a range of technical, economic and environment that can enhance and provide advantages to become a dominant material for construction in the new millennium. In other studies, by Arora and Dave (2013) experiments done shows that the increase in compressive strength by 5%. In this study, we can look through from the compressive strength that have been made in the laboratory.

Addition of ewaste (%)	**Day**		
	Result (N/mm^2)		
	7	14	28
0	9.72	18.2	28.65
5	9.86	18.45	30.2
10	10.2	18.8	31.6
15	11.6	19.2	31.7
20	9.81	18.0	26

Table 2.1: Compressive Strength

Addition of ewaste (%)	**Size (mm)** **Result (N/mm^2)**		
	< 10	10-15	20
0	25	25	25
5	23	31	33
10	20	33	34
15	18	33	34
20	16	25	26
25	16	22	23
30	15	16	17

Table 2.2 Compressive Strength based on particle size

2.4 FLEXURAL STRENGTH

The flexural test indirectly evaluates the tensile strength of concrete. It assesses the ability of an unreinforced concrete beam or slab to withstand bending failure. Based on Aruna studies, it shows in table 2.4 shows that 15% of e-waste as replacement of coarse aggregate with different size of coarse aggregate. (Varsha et al. 2019). S. Sandeep Kumar in his studies that shows in the table 2.5 shows that e-waste as fine aggregate are decrease when the more e-waste added in the mixture (Sandeep Kumar et al. 2016) .

In other research such as natural sugarcane bagasse slightly increased flexural strength by 3%. It stated that when raw jute is applied to concrete with 1 percent cement weight, the flexural strength of the concrete cube improves, and with the addition of 4.5 percent adjusted jute, the flexural strength grows. Fibre was used in the concrete blend at percentages of 3%, 5%, and 7% (by cement weight). The primary effect of using concrete is to increase the bend modulus, as a participant makes the concrete work more effective. (Shadheer Ameer et al. 2020). Other research in study of glass fibres shows that positive result when the percentage of glass fibre increase in concrete mixture compared to nominal cube. (Srinivasa Rao. P et al. 2010). Figure 5 shows the result.

Addition of ewaste (%)	**Size (mm) Result (N/mm^2)**		
	< 10	10-15	20
0	3.5	3.5	3.5
5	3.2	3.8	4
10	3.1	3.9	4
15	3	3.9	4.1
20	2.8	3.6	3.7
25	2.8	3.3	3.4
30	2.7	2.8	2.9

Table 2.3: flexural strength on E-Waste replacement Coarse Aggregate.

Concrete Type	**Flexural Strength, N/mm^2**
Control Mix	5.60
E10	4.67
E20	3.33
E30	3.20

Table 2.4: The flexural strength of the concrete

2.5 WATER ABSORPTION

(Feldman and Sereda, 1968) proposed adsorption are the process by which molecules of substances bind to the surface of concrete either through physical bonds or as a result of chemical bonds. To determine the amount of water absorbed under particular circumstances, water absorption is required. The type of plastic used, the additives utilised, the temperature and the duration of exposure are all factors that affect water absorption. The data indicate how the materials operate when it is wet or humid. For water absorption test rates of 0%, 3%, 5% and 10% are 2.3, 2, 5.73 and 7.67 respectively.

The data obtained show that the rate of water absorption is increasing according to the adding e-waste material. This factor may be due to air condition which can caused the highest water absorption to concrete. According to Maritime Code BS6349 specifies that water absorption should not exceed 3% or 2%. In addition, the curing condition can also cause the concrete surface to lose hydration. Therefore, the curing method can also affect this result. The porosity can be decreased by properly curing, which can also lower the rate of moisture loss and provide a constant source of the moisture needed for hydration (Alamri, 1988).

2.6 MATERIAL ON E-WASTE

According to the Adnan Omar, e-Waste is a broad term that encompasses all white goods, consumer and business electronics, and information technology hardware that has reached the end of its useful life. (Adnan Omar et al. 2010). The w-waste such as discarded cell phones, cameras, CD Players, TVs, Radios, Drillers, fax machines, and all the electric equipment that does not use are classified as e-waste. PVC in wire coatings and cables, (2-ethylhexyl) phthalate (DEHP), diisononylphthalate (DINP), butyl benzyl phthalate (BBP), DIDP (diisodecyl phthalate), and dibutyl phthalate are examples of phthalates (DBP). Flame retardants include Polybrominated diphenylethers (PBDEs) are flame retardant additives widely used in plastic casings of electronic equipment's and as foams. (Sivakumaran S. 2013). In other studies, Fionna George said that e-waste can be categorized into two which in industries waste and household waste.

2.7 EFFECT OF CONCRETE WHEN MIXTURE WITH E-WASTE

According to the Krishna Prasanna, a trial study was conducted to justify the use of electronic waste in concrete as an incomplete substitution of fine total as well as coarse total in concrete with a percentage replacement ranging from 0% to 20%, i.e. (5%, 10%, 15%, and 20%) and conventional specimens were also prepared for M30 grade Concrete without the use of E-waste aggregates. At the end of the result, he discovered that using E-waste aggregates results in the formation of concrete with a lower weight than conventional concrete (P.Krishna Prasanna, et. al. 2017).

The other of researcher, Ashwini investigated the use of E-waste plastic particles as coarse aggregate in concrete with percentage replacements ranging from 0% to 10%, 20% to 30%, and 30% on the strength criteria of M20 concrete with a w/c ratio of 0.5. At the end of the result, they concluded that the addition of plastic to concrete fails in terms of strength. Plastic, on the other hand, can be used to replace some of the aggregates in a concrete mixture in order to reduce the unit weight of the concrete. This is beneficial in the production of lightweight concrete, such as concrete panels used in facades (Ashwini Manjunath B T et al. 2016).

E-waste is a feasible substitute for coarse aggregate in concrete that is intended for non-structural applications, according to K. Hamsavathi's research using Cathode Ray Tube Panel Plastics as coarse aggregate. Therefore, their experiments also demonstrate that the addition of 15% e-waste results in outstanding compressive strength and flexural strength, however the increase may result in a decreasing load. Their research also demonstrates how recycled e-waste plastics can result in concrete having a reduced density.

2.4 SUMMARY

Based on the literature review had be done, this project will include the Circular Economy to make sustainable environment better and safe the surrounding. This is because the study is based on recycle material that will be generate every year due to the increasing electronic waste This chapter has also covered how e-waste might affect concrete's strength material. This study will concentrate on the effects of water and the concrete's strength when e-waste is used to replace some of the coarse aggregate in a 1:2:4 concrete mix. This study is based on recycling materials that will be produced annually as a consequence of the increase in electronic waste.

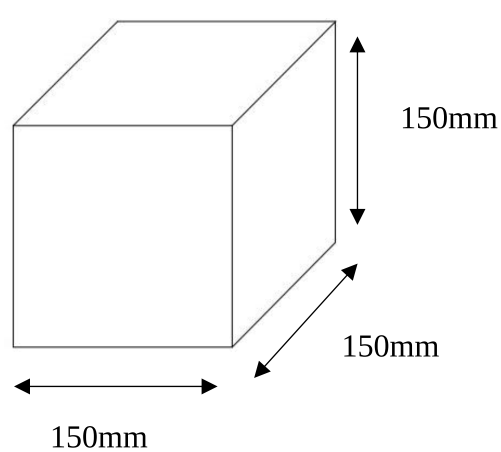
CHAPTER THREE
METHODOLOGY

3.1 INTRODUCTION

Given the current level of development, many structures will be developed in order to reach the status of developed country. Due to its many advantages over other types of conventional concrete, the availability of e-waste concrete allows us to enter the modern era. In order to test the workability and strength of e-waste concrete, a variety of combinations, including water, coarse aggregate, and e-waste to substitute fine aggregate, will be used in this study. On the 7th, 14th, and 21 days, tests will be run against this. As a result, this methodology will demonstrate the combination of materials, experiments, designs, and outcomes required to create e-waste concrete.

3.2 RESEARCH DESIGN

This e-waste concrete will be designed to standard concrete size which is M15 grade 150mm x 150mm x 150mm for compressive strength and the same cube will be tested for water absorption test. In this study, we will have three specimens which consists of e-waste of 3%, 5%, 10% as replace material of coarse aggregate. This cube will be put in the mould with the size pf 150 mmx 150mm x 150mm.



3.3 MATERIAL

3.3.1 E-WASTE

When an electronic product is discarded after reaching the end of its useful life, it produces "e-waste" or electronic garbage. E-waste production is greatly exacerbated by the society's emphasis on consumption and the accelerated advancement of technology. Depending on where it comes from, e-waste is divided into two categories: industrial e-waste and residential e-waste. E-waste will be added to concrete in amounts of up to 3%, 5%, and 10% to test for strength. This e-waste source will be available from the Thanam Industry Sdn. Bhd. Also, we are collected this e-waste from ERTH Company. For this study, we use communications and information technology devices that one of the categories of e-waste materials such as cell phone and smart phone. The material inside the smartphone is a Transistor, Capacitor, Motherboard, Chip Set, LCD Screen, Fibre Plastic, Phone Speaker, Phone Camera and a lot of wire.

Figure 3.3.1a Handphone E-Waste

Figure 3.3.1b E-Waste mixture with concrete

Figure 3.3.3c E-waste collected at ERTH

3.3.2 COARSE AGGREGATES

Coarse aggregates are irregular and granular materials used to make concrete, such as sand, gravel, or crushed stone. Coarse is usually found naturally and can be obtained by blasting quarries or crushing them by hand or with crushers. In this study the particle size of course aggregates that will use is 20mm following the standard size of concrete. The best aggregate is the angular shape because can create the strong bond or interlock with other material for cement paste. Coarse aggregates are the particles that retain in a 4.75 mm sieve. According to the Santhanam Needhidasan, the coarse aggregate is analysis by doing sieve analysis according to the IS 383:1970 and IS 10262:1982- Method of the test (Santhanam et al. 2020). We will collect by doing the sieve analysis to determine the properties of coarse aggregate to mix with the concrete. The distribution of aggregate particles by size within a sample is determined using a sieve analysis or gradation test. This data can then be analysed to evaluate whether or not the design and production requirements are fulfilled. The coarse aggregate is taken backside of Brickwork Workshop at Polytechnic Sultan Salahuddin Abdul Aziz Shah. After that, the coarse aggregate is weighing according to the experiment analysis.

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Figure 3.3.2a Coarse Aggregate

Figure 3.3.2b Coarse Aggregate at back of Brick Workshop

3.3.3 FINE AGGREGATE

Fine aggregates are any natural sand particles extracted from the ground by the mining process. Fine aggregates are made up of natural sand or crushed stone particles that are 14 inches in diameter or smaller. In this study, we replace the source material of fine aggregate with e-waste. we will see the results of concrete strength with the addition of e-waste materials. Aggregate shall be composed of naturally occurring (crushed or uncrushed) stones, gravel, and sand, or a combination of these materials. They must be hard, strong, dense, and long-lasting, free of veins and adherent coating, and free of harmful amounts of disintegrated pieces, alkali, vegetable matter, or other harmful substances. Flaky and elongated pieces should be avoided whenever possible. Aggregate that passes the 4.75-mm IS Sieve and contains no coarser material is permitted as fine aggregate (Santhanam et al 2020).

Figure 3.3.3a Fine Aggregate

3.3.4 CEMENT

A cement is a binder, a substance used for construction that sets, hardens, and adheres to other materials to bind them together. Cement is seldom used on its own, but rather to bind sand and gravel together. This cement is taken from concrete laboratory under supervise this supervisor project and person-in-charge for lab. The usage of this cement use is 4000g based on. According to the S. Bharani the physical properties of cement by the standard value as per IS 12, 269, Setting time initial minimum are 30 and setting time final are maximum 600. According to J.J Brookes, Portland Cement is the name given to a type of cement that mixes lime and argillaceous materials or materials that have silica, alumina and iron and burns them at a scorched temperature and then grinds the scorched stone (J.J. Broke et al 1987).

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Figure 3.3.4a Cement in packaging

Figure 3.3.4b Cement outside the packaging

3.3.5 WATER

The water-to-cementitious-materials ratio in concrete is critical for determining its strength and durability. Because the cement pastes affix promptly and adequately to the wet surface of the aggregates as opposed to a dry surface, water is required to soak the surface of the aggregates to develop adhesive qualities. Water ratio is very important in concrete production. This is because water quality affects the strength and texture of the concrete in construction work. Moreover, the quality of water is very important because impurities in it can interfere with the cement hardening process and can result in adverse effects on the strength of concrete or can cause pooling on the concrete surface (J.J Brooks, 1978). In addition to using water in the concrete mix, it is also needed in the preparation of mortar, curing work and others. The ratio of water in the concrete is commonly $1m^3$ of concrete is 150 litres.

Figure 3.3.5a Water in the cylinder measurement

3.4 RESEARCH METHOD

3.4.1 MIX PROPORTION

Table 3.4. shows the specifications of the mix value of concrete with the addition of e-waste material of 3%, 5%, and 10%. So far, the mix is according to:

Material	0%	3%	5%	10%
Cement	1000 g	1000 g	1000 g	1000 g
E-waste	0	120 g	200 g	300 g
Fine Aggregate	2000 g	2000 g	2000 g	20000 g
Coarse Aggregate	4000 g	3880 g	3800 g	3600 g

Water Cement Ratio: 0.55

For Grade M15 it using ratio 1:2:4 for one cube. So:

1 Cement = 1 kg of Cement

2 Fine aggregate = 2 kg of Fine Aggregate

4 Coarse Aggregate = 4 kg of Coarse Aggregate

H20 = 0.55 l

3.4.2 GRINDING

By Corrosionpedia says hard materials can be ground down to size or tools can be sharpened using this procedure, which is usually done in stages. After crushing, grinding is done to generate finished goods with the specified fineness. The final fineness, for instance, relies according to how finely the desired mineral is dispersed when the mineral ore is crushed to a given and then ground to a powder. Depending on the procedure being used, grinding can be done either wet or dry. However, for dry grinding, the materials may first need to be dried in cylindrical, rotary dryers.

This study will use e-waste component material to replace the partially source as a coarse aggregate. Thus, the method that needs to be done is by crushing and grinding the e-waste material into smaller particles that pass the size of 10mm, 20mm, 40mm in sieve shaker also need to be in angular shape and flaky shape and this e-waste will be determine in flakiness and elongation test equipment do determine the size of e-waste.

3.5 TESTING METHOD

3.5.1 COMPRESSIVE TEST MACHINE (CTM)

The maximum compressive load a material can withstand before fracturing is determined via a mechanical test. Compressive strength machine is the machine that ability to test a structure when load tending to elongate. This machine will be use after seven days or 28 days of curing, these specimens are evaluated on a compression testing equipment. Specimens should be loaded gradually at a rate of 140 kg/cm2 per minute until they fail. The compressive strength of concrete is calculated by dividing the load at failure by the area of the specimen. This machine test will be do at RTL Laboratory Sdn. Bhd. With existing technology, this compression machine can determine the strength, density, and load rate that can be accommodated at one time. A compression testing machine is a type of universal testing machine (UTM) that is specially designed to determine the strength and deformation behaviour of a material under compressive (pressing) load.

A compression tester is typically made up of a load cell, crossheads, compression test tools, electronics, and a drive system. Testing software is used to define machine and safety settings as well as store test parameters specified by testing standards such as ASTM and ISO. It is critical to consider the material to be tested as well as the standard(s) that must be followed when selecting compression test equipment.

Figure 3.5.1a Compression Test Machine

3.6 METHODOLOGY FLOW CHART

Chart 3.1 shows a flow chart throughout this study was implemented phase 1

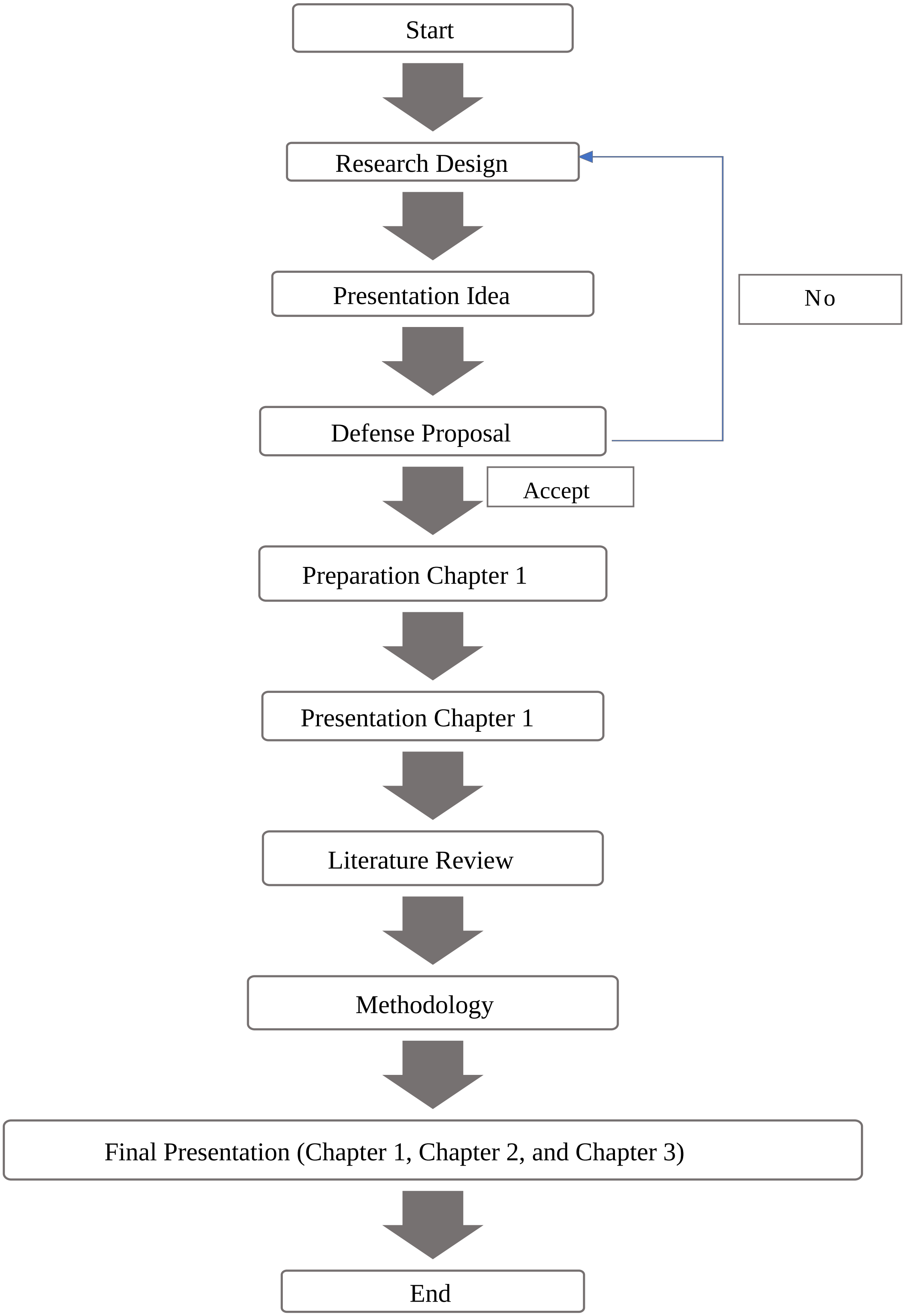
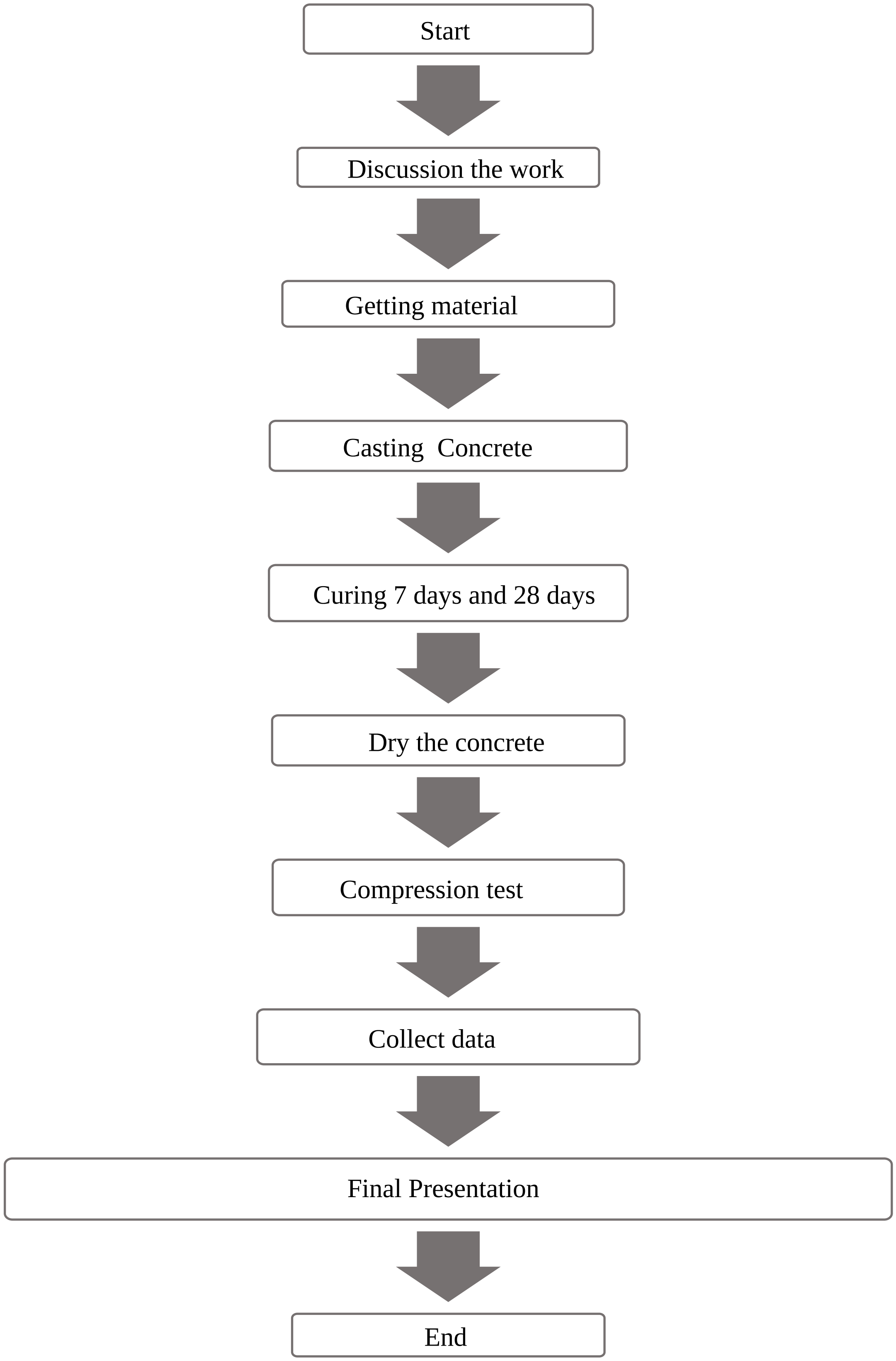


Chart 3.2 show flow chart through this study was implement



3.8 CONCLUSION

Based on all the material that used in this project, all are the material are easily to get. To determine the strength, the test that involved are compression test and to determine the bending moment, the test are flexural strength. Moreover, to complete this project, it use 14 weeks during the academic session 1 2022/2023.

CHAPTER 4
RESULT AND DISCUSSION

4.1 INTRODUCTION

This chapter will be focusing on the data and result that have been completed after concrete curing 7 days and 28 days. This data has been collected after doing the compression test and water absorption test. This analysis will be performed by table and graphs to show the differentiation of result when e-waste is mixed with concrete using ratio 1:2:4. The percentage of coarse aggregate use in this study are 3%, 5%, and 10%. The objectives of this study are to determine the strength of concrete when e-waste is replaced as partial replacement of coarse aggregate. This study also is to determine the water absorption test after the concrete are casting after one day sinking. The total of this concrete casting is 24 cube which is show in chapter 3 methodology. In this study, a concrete grade M15 are pointed according to the IS 10262:2009 method. The specimen of cube test is 150mm x 150mm x150mm. The test is conducted at Reliable Testing Laboratory Sdn. Bhd (RTL Laboratory). The testing is using Compression Test Machine (CTM). The overall of temperature are along this testing are 29^{o}.

4.2 RESULT FOR 7 DAYS COMPRESSION TEST

Addition of e-waste (%)	Result (N/mm^{2})			Average (N/mm^{2})
	Reading			
	1	2	3	
0	16.11	16.15	16.11	16.12
3	12.29	10.29	12.00	11.53
5	11.45	11.37	11.94	11.57
10	11.21	11.92	11.66	11.60

Table 4.1: Compression test for 7 days curing

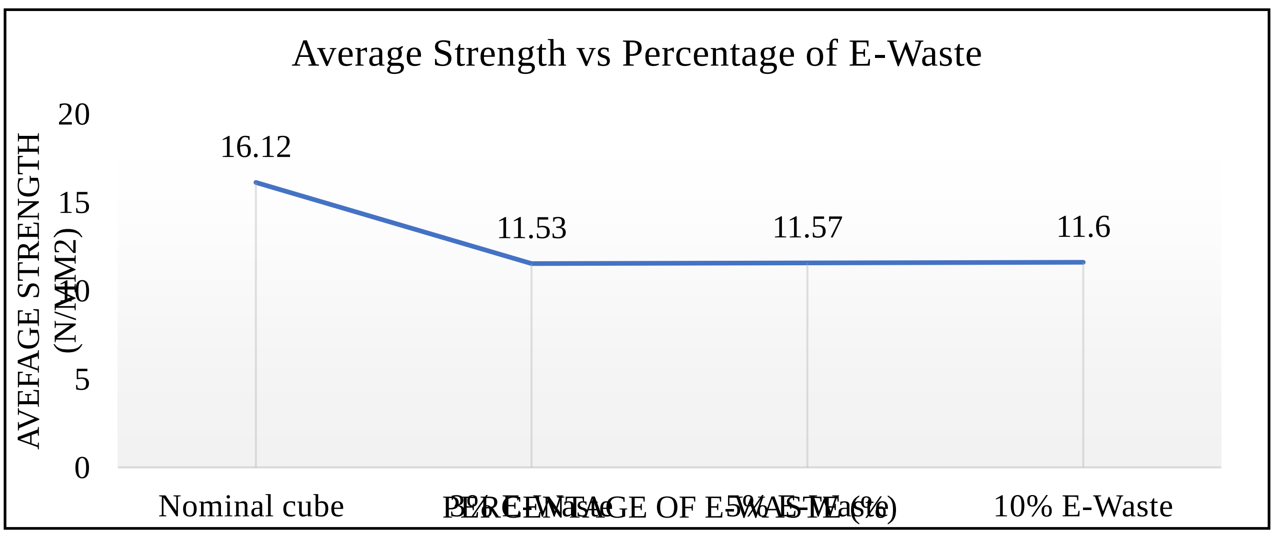


Chart 4.1: Compression Test for 7 days curing

The compression test are to determine the strength, ultimate load, and density of concrete when load are applied on the specimen. There are three cube on each concrete to determine the average of concrete reading. Compression test Table 4.1 show the data for 7 days curing for compression test according to the e-waste that have been partial replacement of concrete mixture. For 0% of e-waste or nominal cube, it shows that the average result are 16.12 N/mm^2. For 3% of e-waste, the average result are 11.53 N/mm. the 5% of e-waste, the average result are 11.57 N/mm. Lastly, the 10% of e-waste are 11.60 N/mm. The data shows the increasing strength of concrete when the percentage of e-waste are added in the mixture. From the table, it can observed the maximum compressive strength for 7 days concrete are 10% replacement of e-waste as coarse aggregate. Based on chart 4.1, the chart show that the strength of concrete are increasing statically and range of differentiation between concrete e-waste are 0.2-0.3 N/mm^2. In conclusion, the e-waste concrete with grade M15 can be used a non-structural building such as fence.

4.3 RESULT FOR 28 DAYS COMPRESSION TEST

Addition of e-waste (%)	Result (N/mm$^{2)}$			Average (N/mm^2)
	Reading			
		2	3	
0	16.11	16.15	17.32	17.32
3	12.25	12.07	12.53	12.83
5	13.62	12.20	12.41	12.74
10	14.40	13.91	14.28	14.20

Table 4.2: Compressive Strength for 28 days curing.

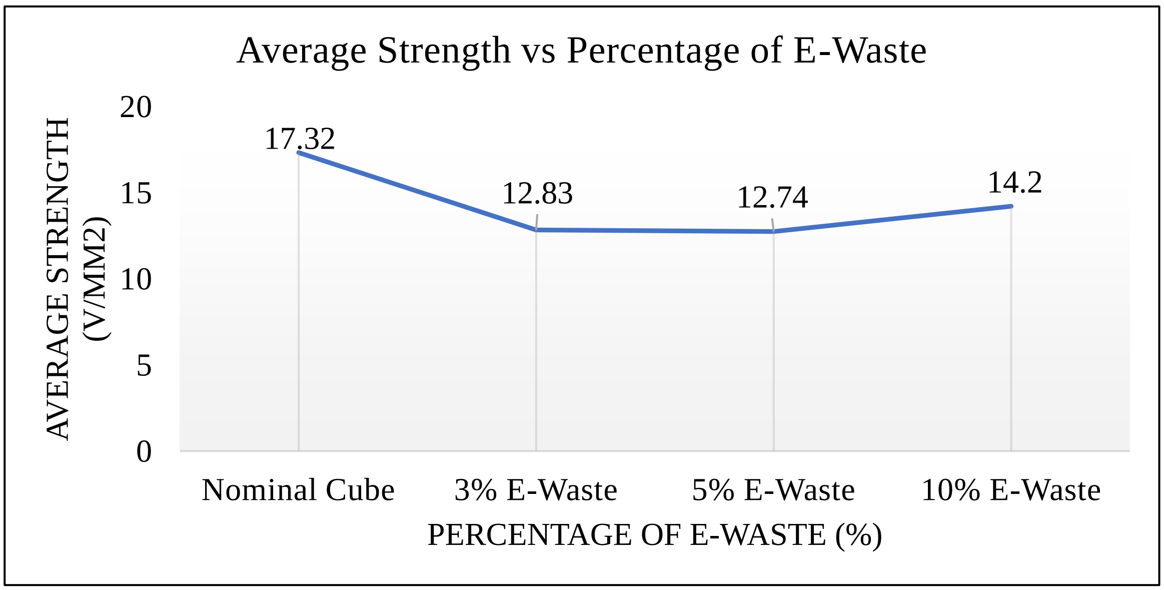


Chart 4.2: Compressive Strength for 28 days

Table 4.2 shows the compressive strength of 28 days concrete curing. The following result as show in the table. For 0% of e-waste, the strength are 17.32 N/mm. Next, when 3% of e-waste are added, the average strength of concrete are 12.83 N/mm. it show the increasing compare to 7 days curing. But it still not reach the standard nominal strength of grade M15. Meanwhile, the 5% of e-waste are replace, the average strength are 12.74 N/mm. It show the increases compare to the 7 days curing result but it show the decreases of strength compare to 3% of e-waste. Lastly, when

10% of e-waste are replace in concrete mixture, the result are 14.20 N/mm. Compare to 7 days curing result, it shows the increases strength but it also not reach the minimum requirement of M15 grade concrete. Based on chart 4.2 show the increasing of strength of 1.98 N/mm^2 but its not reach the minimum of grade M15 concrete. Based on the analysis strength of the 28 days curing concrete, it shows that the concrete are suitable for non-structural building such as fence or as a finishes in construction work.

4.4 RESULT AND DATA FOR WATER ABSORPTION TEST

Addition of e-waste (%)	Mass (g)		Difference between dry and wet concrete (g)
	dry	wet	
0	7287.07	7290	2.3
3	6635.07	6637	2
5	7070.73	7075	5.73
10	6655.67	6662	7.67

Table 4.3: Data for water absorption test

It is required to conduct water absorption tests on the concrete and collect the results after a one-day soak in a water tank. The dry concrete weighs 7287.07g and the dry weighs 7290 g for the 0% of e-waste. There is a 2.3g weight difference between dry and wet. 3% of concrete weighs 6635.07 g of dry concrete and 6637 g of wet concrete. There is a 2 g difference between the two varieties of concrete. Concrete weighs 7070.73 g dry and 7075 g wet for the 5% of e-waste, a difference of 5.73 g. The difference between the weights of dry and wet concrete for 10% of electronic trash is 7.67 grammes. The data shows that increasing percent in water absorption test toward this concrete according by adding the addition of e-waste. The lowest result for water absorption test is 3% and the highest result is 10%. From the data, we can see with adding the 3% of e-waste shows the good result for the concrete and by adding more e-waste is not suitable for this test to the concrete.

4.5 SUMMARY OF RESULT COMPRESSIVE STRENGTH OF CONCRETE

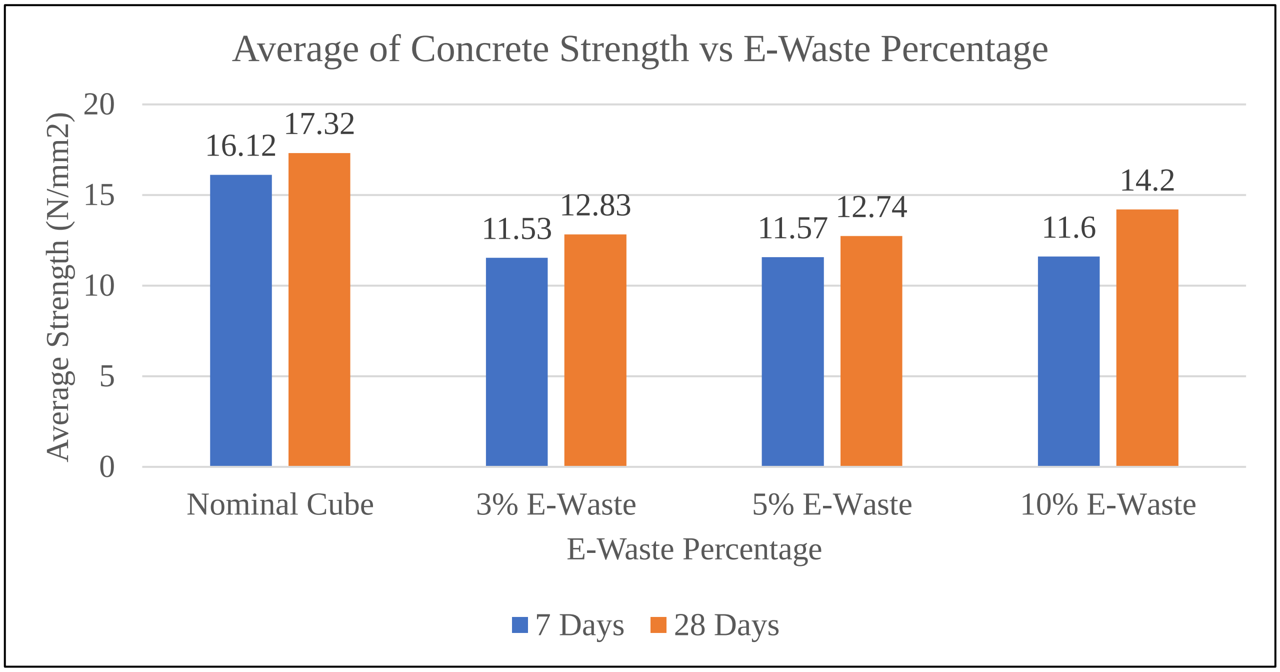


Figure 1 Chart 4.3: Compressive Strength result summary

Based on the chart 4.3, it shows the average of strength and e-waste percentage in replacement of the concrete mixture. For the 3% E-waste it show the different between 7 days and 28 days are 5.33% with the different of 1.3 N/mm^2. Next for 5% E-Waste, the increasing of concrete are 4.8% with the different are 1.17 N/mm^2. And lastly, the 10% of E-waste concrete are 10.08% increasing with different with the different of 2.6 N/mm^2. From the data, it show the increasing of concrete strength but its not exceeding 15 N/mm^2. After all, there have the discussion to determine the problem and the conclusion are show in chapter 5.

4.6 SUMMARY CHAPTER

In summary, the data has been collected after casting the concrete 7 days and 28 days. The testing of the compressive strength has been done at RTL Lab Sdn. Bhd and Concrete Laboratory, Politeknik Sultan Salahuddin Abdul Aziz Shah. This data are collected based on the objectives of this study which is to determine the strength of e-waste concrete after partially added in concrete mixture to replace coarse aggregate. Meanwhile, we also collected the water absorption test of this concrete do determine the absorption of water after partially added e-waste in the mixture. This water absorption test are required to do to determine the aired hole in concrete mixture. With all the data that have been collected, we are able to do discussion and conclusion of this study.

CHAPTER 5
CONCLUSION AND RECOMMENDATION

5.1 INTRODUCTION

This topic will review the study that was done and the information that was presented in chapter 4. This study focuses on the use of an e-waste composite as a partial replacement for concrete. However, there are compounds in e-waste that can bind the concrete's bond. Additionally, this chapter will discuss the project's outcome and if the material is appropriate for use in civil engineering, finishing, or building. This study produces concrete using concrete M15 with an about 1:2:4 mixture. Next, this study requires that the 150 mm x 150 mm x 150 mm e-waste concrete be compressed to see its compressive strength. This study is also intended to estimate the mass of water that has been absorbed in concrete by determining the rate of water infiltration into concrete. After chapter 4 analysis and debate, this section will discuss the suggestions and enhancements that must be made in order to manufacture mature concrete of grade M15.

5.2 CONCLUSION

In conclusion, grade M15 with a minimum strength rating of 15N/mm was successfully used to produce this study. Finding substitutes for coarse aggregate in the manufacturing of concrete was the original study main goal. Electrical and electronic waste is growing as technology advances. This poses a threat to the surrounding as well as raising radiation levels overall, particularly in the environment. Additionally, the goal of this concrete is to determine the compressive strength of concrete made from e-waste. 10% e-waste almost achieved a rate of 15 N/mm2 when the compressive strength of concrete was tested**.** The compression rate of the produced concrete will be impacted by flaws in the manufacturing process, such as erroneous water readings. The mix rate of the concrete produced is also impacted by faults in reading equipment and inaccuracies in weighing tools. The final goal of this study was to measure the rate of water infiltration into the concrete that was made. A.M. Neville claims that doing a water infiltration test is a straightforward way to evaluate the rate of water penetration (Neville et al 1987). Overall, all three goals were accomplished. However, because there are various issues both during and following the manufacture of concrete, adjustments are required. In addition to using increasingly complex technology and electrical and electronic equipment, this study was done to establish a stable, sustainable ecology and a good circular economy. The Sustainable Development Goals (SDG 2030), specifically Core 9: establishing stability and green technologies in infrastructure, innovation, and industry, were the motivation behind this study. According to the data that has been discovered, this concrete is appropriate as a non-structural construction material for fences and other non-load bearing structures. In conclusion, this study has been completed, the findings have been included in chapter 4, and the involved in the study final objective has been achieved.

5.3 RECOMMENDATION

This study was conducted with consideration for a number of variables, including the environment. It is hoped that the institution would be able to carry out and implement this e-waste study in the future. This aims to create pupils who are creative and keep up with the most recent technology advancements. It is advised that an e-waste study be conducted in grade M10 concrete for the following study. Additionally, it is advised to conduct a study on concrete E-Waste using the M15 idea and partially coarse to fine aggregate due to the rising cost of sand today.

5.4 SUMMARY

In conclude, this chapter discussed the highest rate of e-waste concrete that was reached, which is 14.2 N/mm, and the highest load that could be supported, which is 323.9 kN. This chapter has also demonstrated how the creation of e-waste concrete has helped to accomplish all three goals. In addition to explaining why this study on e-waste needs to be carried on a regular basis, this chapter also offers some recommendations that can be put into practise

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APPENDIX

STUDENT PROJECT GANTT CHART

GANTT CHART																
DCC 40181 & DCC 50252: FINAL YEAR PROJECT 1 AND FINAL YEAR PROJECT 2																
STUDY ON CONCRETE WITH E-WASTE AS REPLACEMENT MATERIAL IN CONCRETE MIXTURE																
CIVIL ENGINEERING DEPARTMENT																
SESSION	SESSION 2 2021/2022															
WEEK	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12	W13	W14	W15	W16
DISCUSSION SESSION																
DISCUSSION ON THE PROJECT TITLE	■	■	■													
CHOOSING THE PROJECT TITLE	■	■	■													
PREPARATION FOR DEFEND PROPOSAL		■	■	■												
DEFEND PROPOSAL					■											
DISCUSSION ON LITERATURE REVIEW					■	■	■									
PRESENTATION PROGRESS (TOPIC 1 INTRODUCTION)								■	■	■	■	■	■	■		
DISCUSSION ON PREPARATION OF METHODOLOGY													■	■		
PRESENTATION FINAL PROPOSAL														■		
SESSION	SESSION 1 2022/2023															
WEEK	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12	W13	W14	W15	W16
LABORATORY SESSION																
PREPARATION THE MATERIAL	■	■	■													
CONCRETE CASTING				■	■	■										
CONCRETE TESTING AND WATER ABSORPTION TEST					■	■	■									
PREPARATION FOR PROGRESS PRESENTATION								■								
PRESENTATION PROGRESS									■							
ANALYSIS OF CONCRETE RESULT										■	■					
FINAL PRESENTATION								■	■	■	■	■	■	■		