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## SUSTAINABLE BUILT ENVIRONMENT

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## SUSTAINABLE BUILT ENVIRONMENT

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# DEMOLITION WASTE CEMENT FIBER CONCRETE

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## ABSTRACT

*In Malaysia, the awareness of recycling products is still weak in the people's mentality, especially in the construction industry. The wastage of the demolition process is usually dumped into the landfill when the demolition material doesn't hold much value to be reused. This continuous effect will eventually fill the waste demolition site with demolition waste, particularly concrete materials. The consequence of this issue will be several problems with surrounding like pest problem, environmental damage, bad views and health issue to surrounding resident. This study aims to develop an innovation to reuse demolition waste into building material. The objective is to identify the current issue of demolition waste material, to propose an innovative idea of demolition waste cement fibre concrete and to suggest the marketability of demolition waste cement fibre concrete. The study will continue to find a way to use the demolition waste material and to transform it into useful material that can be used again in construction industries as main product or the substitute and the study will use several methods to obtain the objective for this study, such as desk study, experimenting and lab test. The data from the finding using the mentioned method will be recorded and assessed to fit the criteria of commercialization of the product in the future market. The future of this innovation can be developed more into better material use for environmental benefits that fits the criteria of industries revolution 4.0.*

**Keyword:** Wastage, Demolition Material, Fiber Concrete, Polypropylene Fibre, Recycle Cement.

## INTRODUCTION

Demolition is the tearing-down of buildings which involves taking a building apart whilepreserving the valuable elements for reuse. The building is brought down either manually or mechanically depending upon the method used for demolition of buildings(Rathi & Khandve, 2014). Demolition wastes are heterogeneous mixtures of building materials such as aggregate, concrete, wood, paper, metal, insulation, and glass thatare usually contaminated with paints,

fasteners, adhesives, wall coverings, insulation, and dirt. Demolition process is one of the main contributors to concrete and powdery cement wastage. (El-Haggar, 2016). Construction industry in Malaysia still opens their arms to the idea for improvements to the present construction and demolition (C&D) waste management practices to ensure the good environment stability and prevent condition issues. As the concrete rubbles is one of the materials of demolition waste in Malaysia, the industry needs to find a place to dispose of the demolition waste of concrete material that mostly in rubbles and brittle state other than landfill or rubbish disposal area and after the disposal, the concrete will be there untouched if not used for other purpose (Eusuf et al., 2012). The effect of this problem will lead to environmental problems. If ignored, the rubbles from demolition disposal will put a bad view on the people and may createa new habitat for pests that can have a negative effect on the residents' arounds. Otherthan that, the demolition concrete rubbles waste can bring health issues when the disposal concrete is exposed to water and air in the surrounding area (Ferronato & Torretta, 2019).

## LITERATURE REVIEW

### Demolition Waste

According to Clark County Code (CCC), there are two categories of construction anddemolition (C&D) wastes, which are thought to be the primary wastes generated by the construction and demolition industries. The first type of waste is construction waste, which is described by the same code as "materials that are generated as a direct result of building construction activity; such waste includes, but is not limited to,concrete, rubble, fibreglass, asphalt, bricks, plaster, wood, metal, caulking, paper and cardboard, roofing wastes, tarpaper, plastic, plaster and wallboard and other similar materials". Along with those supplies, different paints, sealants, adhesives, and fasteners are also used in construction (El-Haggar, 2007). Paint, fasteners, adhesives,wall coverings, dirt, and insulation are frequently present on destroyed buildingmaterials like concrete, wood, paper, metal, insulation, and glass. These types of waste are also generated during the complete or selective removal or demolishing of existing structures brought on by man-made processes or natural disasters such as earthquakes, floods, hurricanes, etc. (Vaishnavi Devi et al., 2021). Construction and demolition (C&D) waste makes up 20% to 30% of the total waste in landfills, accordingto a case study on the subject conducted in Kuala Lumpur. Construction waste is produced at a rate twice that of demolition waste. In 2016, indirect data were gatheredfrom 38 locations. The information was gathered from delivery orders for truckloads ofconstruction waste as in Table 1. It was calculated how much waste Kuala Lumpur produces on average. The estimation of waste generation for other states on the Malaysian Peninsula was calculated using the data. The complete data collection for residential projects in Kuala Lumpur in 2016 (1 year). According to Kupusamy et al. (2019), indirect methods were used to collect the data.

**Table 1: Total Data Collection for Kuala Lumpur regarding Construction Waste (Source: Kupusamy et al., 2019)**

| Month | Average (tons) |
|---|---|
| January | 699.7633 |
| February | 312.0925 |
| March | 378.054 |
| April | 194.34 |
| May | 326.044 |
| Jun | 352.5443 |
| July | 857.192 |
| August | 363.608 |
| September | 725.1662 |
| October | 405.8421 |
| November | 411.632 |
| September | 311.7453 |

## Recycle Concrete Powder

Numerous studies have been conducted on the mechanical characteristics andresilience of recycled aggregate concrete (RAC) (Guo et al., 2018). It has been suggested that recycling waste powders as supplementary cementitious materials (SCMs) is an efficient way to reduce the high carbon dioxide emissions and high energy consumption associated with cement production. For instance, recyclable SCMs have been made from municipal or industrial solid wastes like fly ash and wasteglass (Jiang et al., 2022). Recycled concrete powder (RCP) as in figure 1, made fromdemolished concrete, has also been investigated as an SCM in building materials.

**Figure 1: Recycled concrete powder (RCP)**

It is widely acknowledged that recycled coarse aggregates (RCAs) can replace naturalcoarse aggregates in concrete by up to 30% without affecting the concrete's overall performance (Coleman et al., 2005). Still, a sizable portion of concrete fines cannot berecycled or used again. More than 20–30 wt% of C&D wastes are recycled powder (RP) with a particle size below 150 m (Tang et al., 2020). For instance, Kim & Choi (2012) discovered that the fluidity and compressive strength of mortars decrease as the level of RCP replacement increases, and they found that replacing 45% of the cement with RCP results in decreases of 30% and 73%, respectively. In a statistical analysis of cement-based materials using RCP as a cement replacement, Kaliyavaradhan et al. (2020) discovered that the compressive strength typically decreases with the RCP content. However, regardless of the parent concrete strength, this reduction rate is comparable at a given RCP content.

## Polypropylene Fibre-Reinforced Concrete

Reinforced with Fibre Fibrous material makes up most of the composite materialthat is concrete, which strengthens its structural integrity. It includes mixtures of suitable fibres that are discrete, uniformly dispersed, and discontinuous in cement, mortar, or concrete. In order to prevent cracking caused by drying shrinkage and plastic shrinkage, fibres are typically used in concrete. Additionally, they lessen the permeability of concrete, which in turn lessens water bleeding (Constro, 2020).Concrete fibres come in a variety of sizes and shapes. The proportion of fibres, their percentage, diameter, and length are the main variables affecting the characteristics of fiber-reinforced concrete. This results in fibre reinforced concrete (FRC), a cementitious composite material with dispersed reinforcement in the form of fibres made of materials like steel, polymer, polypropylene, glass, carbon, and others. Self-compacting fibre reinforced concrete (SCFRC), high- and ultra-high performance fibrereinforced concrete (HPFRC and UHPFRC, respectively), hybrid fibre reinforced concrete (HFRC), and lightweight fibre reinforced concrete (LWFRC) are some of themore advanced types of concrete that have been produced in the last 30 years thanksto advancements in FRC development (Blazy et al., 2021). Concrete has evolved froma straightforward substance into an advanced solution that can be tailored to particularuses depending on the circumstances. These requirements cover both physical and mechanical characteristics, such as high compressive, tensile, and flexural strength, as well as economic and ecological considerations (Blazy & Blazy, 2021). Mechanicalcharacteristics include high compressive, tensile, and flexural strength. En 14889-2 and Sainz-Aja et al. (2022) define polypropylene fibres (PPF) as straight or deformedfragments of extruded, oriented, and cut polymer material as example in Figure 2. Microfibers and macrofibers are two different types of PPF that can be distinguished,according to EN 14889-2.

**Figure 2: Polypropylene fibers (PPF)**

They differ primarily in length, but more significantly in the job they do in the concrete.Because they can transfer loads acting on the structure and take the place of the conventional reinforcement in the form of steel bars, macro fibers are also known as structural fibres. As a result, the time required to produce the steel reinforcement is reduced, saving the investment costs. Their length typically ranges from 30 to 50 mm.However, because they are shorter than 30 mm, microfibers cannot perform the load-bearing function. Their primary function is to combat plastic shrinkage and prevent concrete cracks from forming. As a result, they make the element more durable and extend its life (Blazy & Blazy, 2021). When tiny cracks in the concrete appear, the shortfibres act as a bridge. Because they are present in greater quantities relative to the mixture's volume, they are more effective than macrofibers. As a result, the concrete becomes stronger during the first tensile phase. The longer fibres become active andstart to inhibit the growth of the cracks once the micro cracks connect and the microcracks result. As a result, the concrete's ductility is increased and it can withstand a heavy load despite continually growing deformations (Sainz-Aja et al., 2022). The polyethylene/polypropylene fibre combination had a favourable impact on the post- cracking behaviour of concrete in Silva et al (2013) research.

## METHODOLOGY

### Desk Study

A desk study is an initial analysis of the hydrogeology using all the information alreadyavailable, before more data is gathered from the field. Any hydrogeological assessment is likely to begin with the procedures described in this chapter because itis the first step in developing the conceptual model. By describing what is already known about a location and choosing which questions need to be answered, a desk study is a very helpful technique for designing a fieldwork programme. The desk studymust be completed because it is essential to organising what could be a protracted field study (Brassington, 2017). Under the same method, the literature review was used. The information gathered via research and examination of previous studies of literature reviews to accomplish the first objective. The literature review is conducted on the relevant topics of flash floods, the causes of flash flood and also the impact of flash flood. This may also include the first objective, which is critical review of currentissues and problems, as well as to assemble the prototype from improvised smart ecodrain cover as the innovation to counter or minimize the current issues. Journal articlesand other published materials related to the development of the innovation idea werecollected, filtered, and reviewed.

To achieve the first objective which is the current issue of the Demolition Waste Concrete, a study method, desk study by using literature review has been carried outto find the data regarding this problem from previous study under this topic. As part ofputting this study together, a huge number of reliable online sources were looked at and evaluated. Analysis of web publications has been chosen as the best way to learnabout a wide range of topics. Many articles have been written by people with differentideas and points of view. The articles have specific data and results that support the authors' claims. Several articles have been written to help make sure that the right amounts of concrete are used. The information gathered is used to find research problems, do research on existing recycled material, verify current issues, and find thebest material for this new idea. To further develop this idea, a method needed to obtainthe next objective of the study.

### Experimental

To develop this new idea, a method of lab experiment was executed to test the previous objective. As part of the process of ensuring the highest possible standard inconcrete construction, it is essential to conduct tests to evaluate the material's quality.Different concrete quality tests, such as compressive strength and water absorption, are used to ensure that the concrete produced is up to pace with a predetermined standard. It is possible to learn about the concrete's strength, and durability from the test results.

## Mix proportion.

Two different binder mixes were prepared, including a control mix consisting only of normal polypropylene fiber concrete without any additives, and another consisting of 5% Polypropylene fiber and 50% of demolition waste cement obtained from concretecube and concrete debris. This test is evaluated on four cube specimens with dimensions of 100mmx100mmx100mm of which two are polypropylene fibre concretemixes and other two are innovation products with demolition waste material for the purpose of comparison. Both mixtures were tested. The related tests measure the compressive strength of the concrete in its hardened state as well as the water absorption rate of cube concrete on 14 and 28 days after it has been cured. Table 2 shows mixed proportions for two molds, cube and cylinder.

**Table 2: Mix Proportion for Demolition Waste Cement Fibre Concrete**

| Material | Amount |
|---|---|
| Polypropylene fiber (kg/m³) | 0.5 |
| Water (kg/m3³) | 170 |
| Recycled Cement (kg/m³) | 550 |
| Aggregate (kg/m³) | 1200 |
| Sand (kg/m³) | 500 |

## Material and Equipment

### Recycled Cement

Recycled Cement is a cement that comes from the debris of old mortar and concrete. Generally, it will be used from demolition waste as the source of the unwanted material. The old concrete and mortar will be grinded and sifted into a few parts that are mostly used. Commonly, industries will sieve the demolition concrete debris to obtain the coarse aggregate from it and the left-over cements and powder would be disposed of. The disposed cements and powder may have a weakness and functional to the binding power for the concrete as it was alreadymixed with other materials such as paints and oil. Adding the adhesive material orretarded material may help prevent this issue. The amount used for this experimentis 550 kg/ m³.

### Water

Water is used in the production of concrete and mortar as mixing water and aids inthe cement binding process, allowing for the creation of the required concrete or mortar consistency. Curing, or hardening, concrete or mortar also necessitates it. As a rule, you can utilize any water that is safe for human consumption. However,provided the quality of the concrete is not affected, non-potable water sources canbe used instead (NRMCA, 2022). The ratio of water to cementitious elements in the concrete mix is determined by the amount of water in contact with the cement, which in turn impacts the rate of concrete deterioration. Absorbent water is not factored into the total volume of mixing water. In most technical processes, qualitychecks on cement and aggregates are performed at regular intervals, but water isnot (Kokoszka, 2019). The qualities of fresh concrete, such as its setting time andworkability, as well as the strength and durability of hardened concrete, are profoundly influenced by the quality of the mixing water used in concrete. The watervolume used in this test is 170 kg/ m³.

### Polypropylene fibre (PPF)

Polypropylene fibre (PPF) is a kind of linear polymer synthetic fibre obtained from propylene polymerization. It has some advantages such as light weight, high strength, high toughness, and corrosion resistance. Generally used in concrete forits great feat and easier to obtain and produce compared to other fibres. For this experiment, only use 0.5kg/m³ of Polypropylene fibre.

### Sand

Sand is a naturally occurring granular material made up of small pieces of rock andminerals. Sand is usually made up of quartz, but this is not always the case. The size of the sand grains ranges from 4 mm to 2 mm. Most of the time, 70 to 80% ofall the concrete is made up of aggregate. Basically, it is surprising that the quality of the aggregate is seen as a crucial part of making concrete. Even though the strength of concrete doesn't make concrete strong, the quality of the aggregate willhave a big impact on the durability and strength of the concrete structure if the aggregate limit is allowed to be exceeded. The sand used in this study needs to beput through a sieve test to get the right size and separate any impurities. The amount used is 500 kg/m³ of sand.

### Aggregate

Aggregate is made up of rocks and minerals like gravel, sand, and crushed stone.The size of the particles determines whether the material is coarse or fine. The concrete that is made can be used as is or crushed, depending on what it will be used for. Aggregates help make the concrete mix denser, which can cut down on the amount of cement and water needed. They also add to the mechanical strengthof concrete, which makes it an essential material for building and maintaining structures that are strong and stable. Coarse aggregate, such as natural crushed gravel from the area, was used. The gravel's particles ranged in size from 4/75 to 9 mm and weighed 1200 kg/m³ for the experiment.

### Mixer

To produce concrete, a concrete mixer is required. The concrete mixer is used to combine the dry ingredients which are cement, sand, or gravel with water as theirwet materials. The most common type of mixer consists of a revolving cylinder used to combine cement, water, and sand. Convenient for use on smaller construction sites or in areas inaccessible to conventional ready-mix trucks, mobile concrete mixers are a popular alternative to stationary concrete batching plants. Portable concrete mixers allow construction personnel more time to work with theconcrete before it hardens because they are so simple to move and set up. Therehas been a reduction in the weight of portable concrete mixers, allowing for one- handed transport across the construction site. They can be towed by a vehicle and pushed around by hand using an electric motor-driven rotation, due to their wheelsand towing tongues.

### Molds

Molds consisting of plastic or steel cubes are used to pour concrete. Concrete cubemold 100mm x 100mm x 100mm and prism mold is a mold made of strong steel with reinforced structure. The lower machine tie bar and machine base support thebottom of the mold. The top tie bar of the machine braces the top. As a result, taking specimens is easy. Cube mold technology produced at various phases in a rotary system is determined by the component rotating vertically around an axis. Molds are also available in various other geometric shapes such as prisms.

### Trowel

Trowels were employed in the creation of this specimen, as shown in Plate 3.8. Atrowel is a hand tool that is frequently used for applying, smoothing, or transferringsmall amounts of fluid or particle material.

## Sample Preparation

Two sets of cube and cylinder tests were created to determine the difference in compressive strength and tensile strength between Demolition Waste Cement Fiber Concrete and Conventional Fiber Concrete. The formula for compressive strength forany material is the load applied at the point of failure divided by the cross-sectional area of the loaded surface. Two types of cubes and cylinders with different specimenswere used for this study. First, scrub the mold with a brush, then wash it thoroughly before rinsing it thoroughly. Remove as much moisture as possible from the mold before pouring the concrete. To release the concrete from the mold, use a paintbrushto apply releasing oil to the concrete mold used for this cube test that had been doneat Bengkel Kerjasama FSPU & FSSR in Uitm Seri Iskandar, Perak branch. Then, by using an electronic scale, accurately weigh the cement in accordance with the proportions of the mix design. Using a laboratory vibratory sieve shaker, separate thesand's particles into different sizes by passing it through a sieve. Then, weigh the sandon the electronic weighing scale in accordance with the mix design, and weigh the aggregate using the electronic weighing scale. The aggregate comes from the pile in Bengkel Gunasama FSSR & FSPU, the aggregate has been sieved according to desired size. Next, weigh the polypropylene fibre on the electronic weighing scale according to the mix design and using the electronic weighing scale, measure the weight of the water in accordance with the mix design. Mix all the listed material intoa mixer starting from sand, recycle cement, water, polypropylene fiber and lastly aggregate into the mixer. Mix thoroughly until it’s all uniformed. Both mixes were thenplaced in a steel cube mold to undergo the cube test.

Next is the compacting process. Vibration is a crucial step in many concrete construction operations. Hundreds or even thousands of air bubbles can form in concrete during the pouring process, greatly reducing the concrete's structural integrity. Shaking newly poured concrete with a concrete shaker helps get rid of any air bubbles. In the Bengkel Gunasama FSSR & FSPU, participants used a vibrating machine to shake a cube mold containing Demolition Waste Cement Fiber Concrete and Polypropylene fibre concrete. After compressing each type of concrete into separate steel cube molds, labels indicating “DWCFC” (Demolition Waste Cement Fiber Concrete), and "PFC" (Polypropylene Fiber Concrete) were affixed to the side ofeach form. To let the concrete cure overnight, it will be stored in the Bengkel Gunasama FSSR & FSPU before being accessed the following day. Hardenedconcrete is scraped out of the mold. Concrete cube removal from a steel mold. Next, the concrete cubes are preserved in a water tank for a few days before testing on bothconcrete specimens. For this project, both concretes will be cured in 21 days.

## Compressive and Tensile Test

Contrary to other stress tests, like tensile stress, which are conducted by testing on simple cylinder-shaped concrete, concrete testing on cube-shaped concrete allows forthe measurement of the concrete's ability to endure compressive stress in a structure.The compressive test for the building project, which is being conducted at Bengkel Gunasama FSSR & FSPU, UiTM Seri Iskandar, is being estimated to reach a goal strength of psi concrete strength at 7 days as opposed to psi concrete strength at 28 days. Make sure the specimen is completely dried out. Then, insert the sample into the apparatus and place it in a position where it's centres on the base plate as in figure3.


**Figure 3: Place the concrete cube into a compressive test.**

Keep records of the maximum load and any unusual failure type features. All simpleconcrete has been produced using the same process. Figure 4 shows the DWCFCcube after the test, which are both clearly fractured.

**Figure 4: The concrete cube cracks after reaching its maximum load.**

Repeat the same thing to the cylinder concrete of DWCFC and PFC to obtain the result. The concrete will crack after reaching its maximum load that it can handle as inFigure 5 below. To achieve the third objective, a method of study needed for the suggestion of innovation product marketability.

**Figure 5: The concrete cylinder crack after reaching its maximum load.**

## Marketability of Demolition Waste Cement Fibre Concrete.

To achieve the final objective which is the suggestion of marketability of an innovationproduct, a desk study such as literature review and web info was taken to know the full cycle demands of the innovation product. An innovative product's marketability is essential because it provides a means of advertising and promoting it within the construction industry, as well as facilitating its actualization and use (Shields, 2022). If there are no requirements for the concrete aggregate to be recycled, the demolition waste concrete is typically crushed into concrete rubble and sent to a landfill. Its use is strongly advised as an alternative to regular cement in the creation of concrete or any fibre-reinforced concrete. It is one of the environmentally friendly and sustainabletechnologies that can be produced with recycled materials while using fewer natural resources to make concrete. By reducing the amount of concrete demolition waste dumped in landfills, which is obviously detrimental to the environment due to its production and use, this innovation at least has the potential to have some positive environmental effects.

The data gains for marketability comes from secondly point and desk study regardingdemands of the fibre reinforced concrete and cements. The website such as CIDB andMalaysia Board of Statistics shows the incoming demands for both materials. The price of raw materials and coal is rising, shipping costs are rising, and the value of theUS dollar relative to the ringgit is also contributing to price increases in Malaysia's cement market, which has seen consumption rise. Going forward, more demand growth is anticipated as businesses deal with narrower profit margins. (CN, 2023). It is getting harder and harder for businesses that import raw materials or cement to maintain healthy profit margins. For Cement Industries (Sabah) Sdn Bhd (CIS), for instance, rising shipping costs and the strengthening US dollar are resulting in higher input and product sale prices. Similar to other parts of Malaysia, Sarawak experiencessignificantly higher cement prices than other regions due to the shortage of cement and related factors. "To date, the average unit price of cement in Sarawak is 15% higher compared with Peninsular Malaysia and also 4% higher than in Sabah," said astatement issued by the Sarawak Economic Development Corp (SEDC) and Bintulu Development Authority (BDA), who are reportedly looking to set up a joint-venture (JV)company to import 0.5-1Mt cement annually from Thailand (CN, 2023). Cement Production in Malaysia decreased to 1630 thousands of Tonnes in May from 1660 thousands of Tonnes in April of 2023 (*Department of Statistics Malaysia*, 2023).

## FINDING AND ANALYSIS

### Performance of Demolition Waste Cement Fiber Concrete

This section's discussion will be centred on the effectiveness of fibre concrete made with demolition waste cement and the results of tests that included compression and tensile strength tests. For innovation, a product made with polypropylene fibre, where 0.1 kg/m3 of the material was used for the cube test. Therefore, the performance of the Compressive Strength Test and Tensile Strength Test on Fibre Concrete using Demolition Waste Cement is used to discuss all results.

### Performance Between Fiber Concrete Using Demolition Waste Cement and Normal Polypropylene Fibre Concrete

#### Weight Comparison between Normal Product and Innovation Product

The weight comparison between conventional concrete and innovative concrete is shown in Table 4.1 below for testing on a 100x100x100 mm cube of each type of product. Normal polypropylene fibre concrete weighs 2.28 kg, whereas innovative concrete weighs 2.29 kg. This indicates that because innovative concrete has small difference compared to normal Polypropylene Fibre Concrete in weight.

#### Compressive strength test result

The compressive strength for Demolition Waste Cement Fibre Concrete and Normal Polypropylene Fibre Concrete is shown in Table 4. In the context of DWCFC, it showsthat on days 7 and 28, when 550 kg/m³ recycled cement is added to Polypropylene fibre concrete, the compressive strength is almost the same. This show that demolitionwaste cement or recycled concrete powder can have the same profile and attribute fornormal cement.

**Table 3 Compressive strength of Demolition Waste Cement Fiber Concrete and Normal Polypropylene Concrete**

| Type of concrete | 7 days (N/mm²) | 28 days (N/mm²) |
|---|---|---|
| PFC | 19.97 | 28.8 |
| DWCFC | 20.62 | 27.2 |

#### Tensile strength result

Similar to the compressive strength findings, the results between Demolition Waste Cement Fiber Concrete and Normal Polypropylene Fibre Concrete are not far off as inTable 4. The tensile strength of the DWCFC and PFC show normal PFC has a highertensile strength compared to DWCFC around 0.08 N/mm². This show that DWCFC isstill a great substitute.

**Table 4: Tensile strength of Demolition Waste Cement Fiber Concrete and Normal Polypropylene Concrete**

| Type of concrete | 7 days (N/mm²) | 28 days (N/mm²) |
|---|---|---|
| PFC | 2.68 | 4.43 |
| DWCFC | 2.60 | 4.36 |

## Marketability of Demolition Waste Cement Fiber Concrete in Malaysia's construction industry.

The results of the study for marketability shows the demands for cements are high while the production is decreasing. This is consistent with the statement from Malaysia's board of statistics, Cement Production in Malaysia decreased to 1630 thousands of Tonnes in May from 1660 thousands of Tonnes in April of 2023 (*Department of Statistics Malaysia*, 2023). The reinforced concrete also hit the same problem by the international government as the demand was high, but the productionwas still slow because of the world's decreasing cement production.

The data gains for marketability comes from secondly point and desk study regardingdemands of the fibre reinforced concrete and cements. The website such as CIDB andMalaysia Board of Statistics shows the incoming demands for both materials. The price of raw materials and coal is rising, shipping costs are rising, and the value of theUS dollar relative to the ringgit is also contributing to price increases in Malaysia's cement market, which has seen consumption rise. Going forward, more demand growth is anticipated as businesses deal with narrower profit margins. (CN, 2023). It is getting harder and harder for businesses that import raw materials or cement to maintain healthy profit margins. For Cement Industries (Sabah) Sdn Bhd (CIS), for instance, rising shipping costs and the strengthening US dollar are resulting in higher input and product sale prices. Similar to other parts of Malaysia, Sarawak experiencessignificantly higher cement prices than other regions due to the shortage of cement and related factors. "To date, the average unit price of cement in Sarawak is 15% higher compared with Peninsular Malaysia and also 4% higher than in Sabah," said astatement issued by the Sarawak Economic Development Corp (SEDC) and Bintulu Development Authority (BDA), who are reportedly looking to set up a joint-venture (JV)company to import 0.5-1Mt cement annually from Thailand (CN, 2023). Cement Production in Malaysia decreased to 1630 thousands of Tonnes in May from 1660 thousands of Tonnes in April of 2023 (*Department of Statistics Malaysia*, 2023).

The marketability of this innovation idea can focus on the construction industries as it's on the peak and demands for the materials. Focusing on single production, the company that producing recycled aggregate can fully benefits from the machines andbusiness from these innovations for extra materials to be marketed. From this point onwards, until Malaysia become a country that can fully be dependable on their own production and can fully utilised the wasted material, the demands for the market for this Demolition Waste Cements is marketable.

## RECOMMENDATION AND CONCLUSION

Even the products are from demolition concrete, Demolition Waste Cement can still provide a sustainable construction material in the industry. Perhaps in just a little quantity, the impact of this products will go unnoticeable but in bigger scale, the wastage of the concrete rubbles and demolition material can be reduced greatly. As an alternative to normal cement, the impact of the product can be listed as in table 5.

**Table 5: The Advantage of Demolition Waste Cement Fiber Concrete as Cement Alternative**

| Advantage | Demolition Waste Cement Fiber Concrete | Normal Fiber Concrete |
|---|---|---|
| Material usage | Using recycle cement for binding | Using normal cement |
| Environmental advantage | Reduce demolished concrete rubble wastage | Not reducing concrete wastage |
| Workability | Strong and good as alternative building material | Strong and good for building material |
| Cost | Reduced for using recycle product | Normal cost for Fiber Concrete |
| Sustainability | Can be used multiple time as long as it can be recycled. | Used once and waiting for recycle on demolish. |

From table 5, most of the advantage of Demolition Waste Cement Fiber Concrete is focusing on sustain and environmentally friendly. The product was made to give an alternative to normal cement in concrete making, as it still has the same attribute to normal fiber concrete in strength and durability. The product itself still open for upgradeto better material. In current study, the material used are recycle cement and polypropylene fiber as fiber element in concrete. In the future, the fiber can be changeinto more sustainable and environmentally friendly compared to polypropylene whichare made from plastic. The fiber can be more natural and easier to obtain such as paddy fiber or palm oil fiber. This open up for future study in improving this idea and increase this products chance in the future market.

In conclusion, Demolition Waste Cement Fiber Concrete might be the solution for thewastage of concrete rubbles in the landfill and become a substitute for normal concretefor its workability and efficiency as building material.

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