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Development of Cement Paste with Composite of Corn Husk Ash

Mohd Ghazali, Sarah Nadiah[1*], Mohd Hassan, Mohd Shahril & Md Latiff, Aniza

[1]Polytechnic Muadzam, Shah, Lebuh Raya Tun Abdul Razak, 26700 Muadzam Shah, Pahang, MALAYSIA

*Corresponding author email: sarahnadiah@mohe.gov.my

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Abstract: This paper is a study on impact test behavior of composite between cement paste and corn husk ash. In order to help the environment for future, the idea of mixing biodegradable material in original composition is something that could be an idea for designing sustainable product. Because of that, it is better to make use corn husk into something useful by mixing the corn husk ash with cement paste rather than by just using only cement with water and sand to create concrete. The objectives of this study are to identify the effect of curing days and amount of corn husk in composite mixture and examine the strength of impact force on the composite mixture. A combination of mixing cement with varied percentage of corn husk (0%, 25%, 50% and 75% by weight) and sand (1:2 ratio) and fix amount of water (0.6 ratio) will be carried out in order to determine the impact strength in this mixture. This study uses 7, 14, 28 and 56 curing days in order to determine the most optimum parameter since curing days gives effect to mechanical properties. Based on this study, result mixing corn husk ash create same impact strength or even better than the actual cement mixture with combination as in parameter.

Keywords: Natural waste, corn husk, cement

1. Introduction

Cement is material that consist of calcined lime or limestone and clay that are powdery composition. By mixing with water, it will form to be mortar or cement paste. Cement is widely use in all over the world where today each country are strive to become a develop country and the development causing to create building or housing. This development will mostly use cement as its main material. The excessive use of cement and sand to create concrete would cause to detrimental environmental effect in future life. In order to make the natural waste to become more useful product, the idea of mixing natural waste material in original composition is something that could be an idea for designing sustainable product.

Corn is one of the largest crops in Malaysia in which by year 2010, the need for corn supply has reached to 47000 tan and kept on increasing to 55000 tons in 2013 (Perangkaan, 2013). The increasing of corn crop in Malaysia simultaneously raised to the production of corn husk waste. As this waste need attention, it is better to make use of the corn husk into something useful by mixing the corn husk with cement paste rather than utilizing full use of only cement with water and sand to create concrete. However, the properties of this composite need to be studied and examined so that comparison on its strength behaviour of the cement and water mixture and corn husk could be tested to achieve its maximum efficiency. The mechanical properties can be determined by conducting destructive test on the composite with different rate of composition in order to find the best mixture of cement paste and corn husk mixture.

The important of this is to contribute to the environment and building construction by using natural waste into something useful. It could contribute to the future research development in the idea of combining material with natural waste. Corn husk is a natural waste that are currently will disposed by farmers or buyers without realizing that corn husk can be used other situation for example mixing in other material to create better composite. The significant of this study is to support nowadays situation to have green environment and make use of natural waste (corn husk) that might be a new finding or solution to reduce the use of cement in construction. Study the impact test on cement would leads on finding the best mixture of material that is able to withstand unexpected extreme load or blast load. Having result in

*Corresponding author: sarahnadiah@mohe.gov.my
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impact strength will be useful in the civil application.

2. Literature Review

2.1 Clay as Basic Material

Clay as the main material in creating cements which act as a binder in construction of building. Clay a raw material that are vital in today industry and mostly use in the traditional ceramic (Aramide, 2012). However, in order to create cement, clay and limestone or calcined lime are process together in using chemical. Cement Industry Federation (2015) a website that are about manufacture cement stated that the main raw material in producing cement are clay, limestone, shale, sand and iron ore which also highlight the use of clay in creating cement. It claimed that clay as raw material not just used to make ceramic but also an important part in creating cement. From the raw material, it will undergoes a process whereby combination of raw material is essential to ensure the target chemistry for clinker is achieved (Cement Industry Federation, 2015). The site also explains that these clinkers are the target so that cement clinker with a mineralogical structure that is highly reactive with water can be created which will act as binder in concrete. The research carried out by Aramide (2012) and Temimi et al. (1998) found that clay are widely used in construction area that are generally blended together in order to achieve standard composition and optimum properties for any application that includes cement.

2.2 Cement

Cement is widely used in construction material. This increasing demand for housing has been a major problem facing governments in most developing countries around the globe (Yalley & Asiedu, 2013). The rapid growth in infrastructure development has caused to high demand of cement that is currently happened in most developing countries. The exponential development of infrastructures, especially in rising regions further increases the demand for concrete materials such that the worldwide construction and usage of concrete will soon exceed the 10 billion tons per year mark (Mobasher, 2011). Cement that mostly used is known as Portland cement in which act as binder for the sand and other aggregate in creating solid form of mass. The function of the Portland cement is to react with water to form a firm product known as cement paste, which abide by to the particles of sand and stone together to form a hard solid mass of the fitting shape (Hihara et al., 2013). Having cement paste to bind the aggregate together also determine it strength that can withstand in the environment condition. In order to have better mixture of concrete it depends on the suitable amount of cement uses in which it helps in creating stronger bind between course. The amount of cement paste needed is only that which is sufficient to coat all the aggregate particles (typically 10%–20% of the concrete by weight), it is the component that is most susceptible to environmental degradation of the concrete and, therefore, can undermine the durability of the structure.

As from before, cement one of the clay composition in which the characteristic are more to ceramic that is a brittle and a solid material. Cement is made from raw material that contains mixture of calcium, silica, aluminium and iron (Cement Industry Federation, 2015). Cement that uses in construction are mix with sand which called as concrete. The mixing of cement, sand and water are very important where a study by Olubajo et al. (2014) stated that the water-cement ratio is one of the most important parameters that affect the performance (mechanical properties) of mortar.

The cement is a material that came from limestone and clay and this material had been processed and heated at a 1450oc which end up creating C=CaO, S=SiO2, A=Al2O3, and F=Fe2O3 (Hihara et al., 2013). This process that causing to create this type of chemical composition leads to create cementitious properties. The surplus water is considered to be a separate phase in the hardened cement paste and plays a main role in both the structure and properties of the paste in which the interlayer water in the C–S–H is thought to be held together and to hold the layers of the C–S–H together by hydrogen bonds (Hihara et al., 2013). By mixing with water it would cause the cement to harden and bind the concrete together. Cement mixed with water cement elements reacts to form their hydrates which C3S is responsible for the hardening of the concrete and, together with the C2S, produces calcium-silicate hydrate (C–S–H) and that responsible for the binding and strengthening of the cement paste considered as a colloidal solid with its particles bound together with water and increasing in polymerization over time (Hihara et al., 2013). This hardening process gives effect on the strength of the concrete since it depends on strenght of cement bonding with the sand and other types of supplementary cementitious material.

In current situation, the idea of creating a sustainable material are still progressing to improve the future living and most are trying to develop product that are recyclable and environment friendly. With that, the situation for cement material also needs to consider the sustainable concept in to meet the current trend in developing and innovating product for better future. As current situation is to build taller structures with improved seismic resistance and an indefinite service life that require materials with better performance than the conventional materials. This leads for manufacturer to consider the society's need to sustain it, the need for new and innovative materials for the repair and rehabilitation of civil infrastructures (Mobasher, 2011). The idea to create sustainable cement or concrete for construction are still in experiment in which several properties to be apply to the invention that produce better result. The current trends and speculations of research and development efforts as they apply to the sustainable design philosophy of construction materials leads to consider in the durability, quality, economical alternatives, cross-

disciplinary efforts, appropriate analysis, design, and technology transfer tools (Mobasher, 2011). This statement support the idea that creating sustainable concrete is should be developed in which it is important for the future life and the current trend producing better material.

2.3 Corn Husk

Corn husk is the outer part of the corn cob that usually farmer or people throw it away to make it decompose by itself. The corn husk which is the thin cellulose-rich leafy sheath that covers the corn cobs contains high cellulose content and has been exploited for different applications including the development of cellulose-rich fibers paper making, as solid substrate for citric acid production and for wrapping dough stated by Yalley and Asiedu (2013) and Ahenkora (2012). Corn husk can be used to create paper and provided a good data in terms of fiber length (Ahmad Rassdi, 2013). In order to make corn into a more useful material rather than burning turn it to soil, researcher today utilize it as a material to make composite with the idea of sustainable environment. In some place corn husk are used in composition of soil brick. The stabilization of soil blocks with corn husk ash can also curtail the pollution of the environment, reduce the cost of building whiles most importantly, enhancing the durability of soil blocks (Yalley & Asiedu, 2013). Meanwhile, the ash has been categorized as Pozzolanic material with about 60 – 65% SiO_2 and about 29% Al_2O_3 and 3.5% iron oxides, stated Medega et al. (2014) and Akinloye et al. (2014). Pozzolan is a silicieous material that has cementitious reaction with lime that contain in cement properties (Al-Chaar et al., 2013). Therefore, corn husk can be a useful natural waste as a supplementary to the cementatious material in cement or concrete.

2.4 Curing Days

Based on the literature review, curing days does give effect on the compressive strength of the concrete. Having different curing days can shows weather the concrete can with stand compressive force. According to previous researcher, the research uses different curing days to determine the compressive force. The concrete de-moulded after 24 hour and cured, while compressive strength was performed after 7 days, 14 days, 21 days and 28 days (Olugbenga, 2014). A study uses 7, 14, 28 and 56 days to test it compressive strength and tensile splitting strength (Umoh et al., 2013). A research combining corn cob ash (CCA) and pawpaw leaf ash (PPLA) uses 3, 7, 14, 21, 28, 50, and 90 days of curing in finding the effect to compressive strength (Ettu et al., 2013). Base on this three research, to identify the optimum compressive strength in concrete, curing days need to be tested. Having a standard step in curing cement paste would lead to determine the strength of the cement mixture and the result would help to compare strength in between different cured specimen. The curing step are depend on the environment of the experiment either cured in lab or in field. The ASTM C192 and C31 shows curing step either in lab or in field.

3. Methodology

3.1 Corn Husk Ash

In order to create the corn husk ash, firstly corn husk will be clean and dried under the sun for 2-3 months. Later, on the dried corn husk will undergoes process by burning in furnace at temperature 950o c. Lastly the ash will go through cooling process in the furnace (Akinloye et al., 2014).

3.2 Impact Test

The specimen will be mount on the backstop, C, as in Fig. 1, and set at a height symmetrical with the central portion of the specimen, this shall be stood on edge on the base plate. The specimen may be tested with either the face or the back toward the hammer; in general, a lower failure value is obtained when the face is struck (ASTM C368, 2011). In another method by ACI, there are two types of systems are commonly used: a drop-weight-type system and a pendulum-type system (Charpy impact system). In comparing both systems, it can be observed that the electronic instrumentation is the same for both systems even though the mechanical configurations of the drop weight and the Charpy systems are different. (ACI Committee 544, 1999). The impact machine that will be using are provided in the Polytechnic Metallurgy Lab. The impact test machine is AIT 300-D Digital Pendulum Impact Testing Machine.

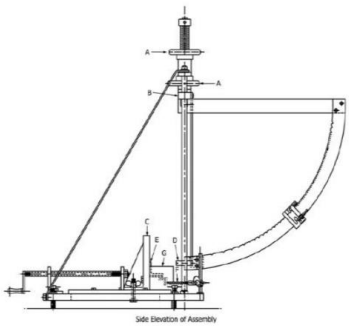

Fig. 1: Impact test apparatus (ASTM C368, 2011)

3.3 Design of Experiment (DOE)

The experiment shall be conducted according to parameter as in Table 1 that is: a) *Parameter 1:* Corn husk ash. The detail mixture composition as in Table 1. Amount of corn husk ash by weight with 0%, 25%, 50% and 75%; 2) *Parameter 2:* Curing days. Curing days for concrete 7, 14, 28 and 56 days; and 3) *Parameter 3:* Water & sand. Fix amount of water ratio of 0.6 from total weight of corn husk ash and cement.

Table 1: Parameters and the variation of level

Parameter	Level 1	Level 2	Level 3	Level 4
Corn husk ash (%)	0%	25%	50%	75%
Curing day (days)	7	14	28	56

4. Results

The result with the four mixture and different curing days are shown in Table 2. Mixture 1 is for the result on 0% corn husk ash and full cement, Mixture 2 is for 25% corn husk ash, Mixture 3 is for 50% corn husk ash and Mixture 4 is for 75% of corn husk ash. Each of the specimens was tested based on the curing day of 7, 14, 28, and 56.

Table 2: Result on impact test

Curing days	7	14	28	56
Mixture 1	153.6	163.3	169.2	161.8
Mixture 2	137.0	136.2	167.1	169.7
Mixture 3	116.4	124.3	124.7	121.7
Mixture 4	123.0	134.3	118.6	105.3

5. Discussion

As the curing days developed, the impact strength on the mixture started to increase. However, for Mixture 1 impact strength slightly decreased on the 56 curing days from 169.2 J to 161.8 J. Based on the hardness strength result, as the curing days for each of the specimen increased, the surface hardness of the mixture changes. As the curing days started to increased, the mixtures were more stabilized in which showed the brittleness in the specimen where the hardness decreased as well as impact strength. However, the inclination of the hardness and impact are due to one of the specimen in Mixture 4 having low impact strength as shows in Table 2, while the other two specimens maintain its strength. This is might be due to the mixture start to brittle because effect from cement hydration and leads to micro-crack. This cement hydration reaction encompassed volume changes depending on the environment, the climatic conditions, and curing method. The reaction can cause shrinkage which results in the growth of micro-cracks throughout the cement paste and it is impossible to anticipate the sizes, number, and location of these flaws in each location of each casting of concrete. This flaws tends to leads in reducing the concrete strength (Hihara et al., 2013). The impact strength on Mixture 2 showed different results in which the impact strength starts to increase as time goes by even on the 56 curing day has impact strength that is higher than Mixture 1. During the 14 days of curing, the specimen has not been stabilized properly which cause to decrease on the impact result. This could be because of hydration process that has not been completely formed.

6. Conclusion

This experiment it is to study by replacing cement to corn husk ash mixing into a cement paste. This would create same impact strength or even better than the actual cement mixture. The process making for cement which releasing hazardous gasses such as CO2, NH4 and NOX¬ are the one of the causes that leads to global warming. Based on the

result determine, by combining parameter of the corn husk amount (0%, 25%, 50%, and 75% by weight) and the curing days 7, 14, 28 and 56 days causing of increase impact strength. However, to much of corn husk ash causing to reduce the impact strength. This shows in result which 75% of corn husk ash has less impact strength compare to lower percentage of corn husk ash. This can be concluded that the best mixing composition is 25% with curing days more the 56 days.

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