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Usage of Sugarcane Bagasse as Concrete Retarder

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ABSTRACT

Concrete is the most common material used in building construction nowadays. The production process of concrete also includes additional ingredients other than aggregates, cement and water. This additional ingredient was known as concrete admixture. One of the most frequent concrete admixtures used is retarder. Retarding admixture is one of the famous admixture used because it can retard the hydration process of the concrete thus, prolong the setting time especially in hot weather concreting. This condition will offer extra time for transportation and also for concrete placement. Other than that, for multiple batch of concrete placement, the extension of setting time will avoid cold joints from happening. However, the high demand of admixture causes the price in the market increased. Therefore, the use of sugarcane bagasse as a natural admixture for concrete is suggested. The concrete produced by adding sugarcane bagasse was tested in terms of setting time by using the standard penetration test for concrete. For hardened concrete, the concrete was also tested in terms of mechanical properties which include compressive strength test, tensile strength test and flexural strength test. The results show that the concrete added with sugarcane bagasse has longer setting time up to four hours instead of only two hours for normal concrete. The strength of hardened concrete also increased when added with sugarcane bagasse. Therefore, as the conclusion, sugarcane bagasse can be used as a natural concrete retarder based on the results obtained.

Keywords: Sugarcane bagasse, natural admixture, concrete retarder

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1. INTRODUCTION

Retarding admixture or retarders are used to slow the rate of setting time of the concrete mix. Retarders mainly made of the basis of sugar (sugar-based). The retarders oppose the hot weather which decrease and accelerate the concrete setting time. The hot weather causes the increase in rate of hardening that causes difficulty in placing and finishing process. Retarders help keeping the concrete more workable during placing and delay the initial setting time of concrete. Besides that, retarders also increase the compressive strength of the concrete by lowering the water-cement ratio. In concrete industry, retarders are widely used for long transportation and handling period to prevent concrete for set in within allowable time. Moreover, the increase setting time will give more time to the workers to complete the texturing process. Normally chemical retarder will be used. It is expensive and chemical based. This situation has led to the extensive study on concrete resulting in natural admixture to be used as concrete retarder in most structural application without affecting its quality.

2. OBJECTIVES

The objectives of this paper are:

1. To identify the potential application of sugarcane bagasse in concrete application; and
2. To study the effect of sugarcane bagasse mixed with fresh concrete as retarder.

3. METHODOLOGY

Methods and procedure that were used to complete this research will be explained. Basically, the experimental aim of this research is to determine the functionality of sugarcane bagasse as a concrete admixture or in more specific as concrete retarder. The test for determining the effectiveness of sugarcane bagasse as concrete retarder include penetration test that was arranged to compare the time taken between normal concrete and concrete with sugarcane bagasse to set. Besides that, as from the literature review it is stated that the retarder will also give slight improvement on the final strength of the concrete besides its main function. Therefore, the mechanical strength test that includes compressive strength, flexural strength and tensile strength were also done. Figure 1 shows the sequence of works from the preparation stage until the conclusion stage. All the works was done at the Structure Laboratory in Universiti Pertahanan Nasional Malaysia, Kuala Lumpur.

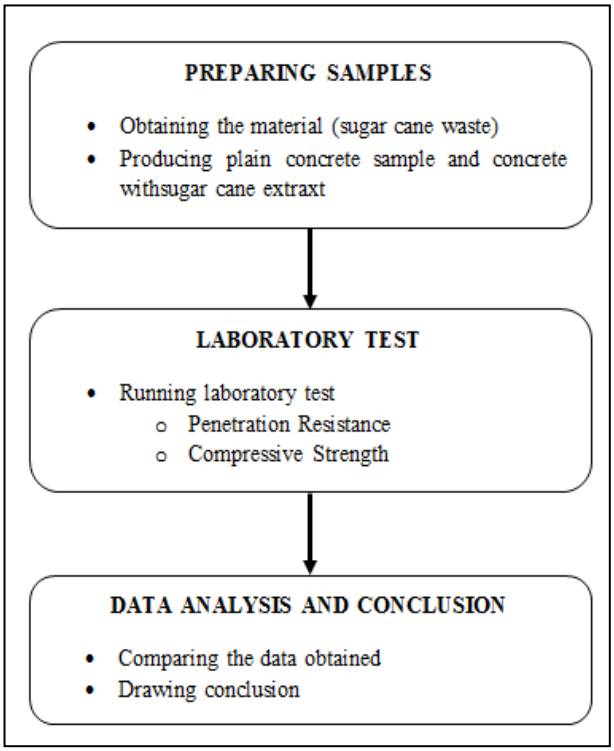

Figure 1: Research Flow

4. LITERATURE REVIEW

According to Balaguru and Shah (1992), sugarcane bagasse is the material left after the extraction of the sugarcane's juice. Generally the main composition of sugarcane is the sucrose consists in its stalks. According to Walfrod (1996), carbohydrates also present in sugarcane, the most common consists of the monosaccharides glucose and fructose and the disaccharide, sucrose. It is used as a sweetener in the food industry. According to Batta and Singh (1996), sucrose, glucose, and fructose are the only free sugars detected in leaf (source) and stem (sink) tissues of sugarcane. Table 1 shows the groups of compounds exist in sugarcane.

Table 1: Content of Sugarcane (Walford, 1996)

Groups	Compounds	%Bx
Sugars	Sucrose	81-87
	Reducing sugars	3-6
	Oligosaccharides	0.06-0.6
	Polysaccharides (including gums and dextrans)	0.2-0.8
Salts	Inorganic salts	1.5-3.7
Organic non-sugars	Organic acids	0.7-1.3
	Amino acids	0.5-2.5
	Dextrans	0.1-0.6
	Starch	0.11-0.5
	Gums	0.02-0.05
	Waxes, fats, phospholipids	0.05-0.15
	Colourants	0.1
Insolubles	Sand, bagasse, etc	0.15-1

The sugars found in sugarcane bagasse can make it act as a natural retarder as the main content of the chemical retarder is sucrose. According to Lea (1988), sugar belongs to the type of retarders that can hold up setting and hardening indefinitely. Retarding effects of a retarder depends upon a number of factors including dosage of the admixture, time of addition to the mix and curing condition (Bazid and Ullah, 2004). Use of sugar content in the concrete must be follow the correct proportion because a little amount of sugar in concrete mixture will cause the sugar to act as a retarder and too much quantity of sugar in concrete will cause the sugar act as accelerator. Many researches have been made to produce strength of concrete, to minimize cost of concrete and to find another material to add into the concrete to get an optimum strength of concrete. According to Kawade et al. (2013), sugarcane bagasse in concrete had significantly higher compressive strength compare to that of the concrete without sugarcane bagasse. According to Public Work Department of Malaysia (2005), for all concrete whether mixed on or off site, each batch shall be placed and compacted within two (2) hours of adding the cement to the dry aggregates. Some of the advantages are that sugarcane bagasse are biodegradable, economic, environmental friendly, and available in abundance and also offer several properties which are comparable with those of synthetic fibers. Some examples of natural fiber are sugarcane fiber, sisal, cotton, hemp, bamboo, wood, jute, banana and coir. The use of sugarcane bagasse can save a lot of energy and cost in the construction development as it is available for free because sugarcane bagasse is waste material compare to chemical retarder, easy to obtain and sustainable material. In order to achieve the optimum strength of concrete there

are some factor that have to implement. The example of sugarcane bagasse as in Figure 2 and 3.

Figure 2: The Original Condition of the Bagasse

Figure 3: Blended Sugarcane Bagasse

5. EXPERIMENTAL INVESTIGATION

To conduct this test, 4 types of concrete regarding the difference amount of sugarcane bagasse is produced which is one for the control sample and another three for the concrete mixed with sugarcane bagasse. For each types of concrete, 2 samples were prepared to obtain the average result. The test was done and samples were tested until failed.

5.1 Compressive Strength

The compressive strength of grade 30 concrete added with sugarcane bagasse increases from 28.97 to 48.83 at 1% bagasse. Addition of 3% bagasse shows a little decline in compressive strength of concrete however, this situation still can be considered because the strength is still higher than the control sample.

5.2 Flexural Test

In flexural test, loading at 0.2kN/s is applied to the sample until failed. The strength of concrete that was added with sugarcane bagasse has increases although for a small value. This shows that the sugarcane bagasse gives enhancement to the flexural strength of concrete indirectly.

5.3 Tensile Split Test

The test was carried out using the load rate of 0.94kN/s until the samples failed.

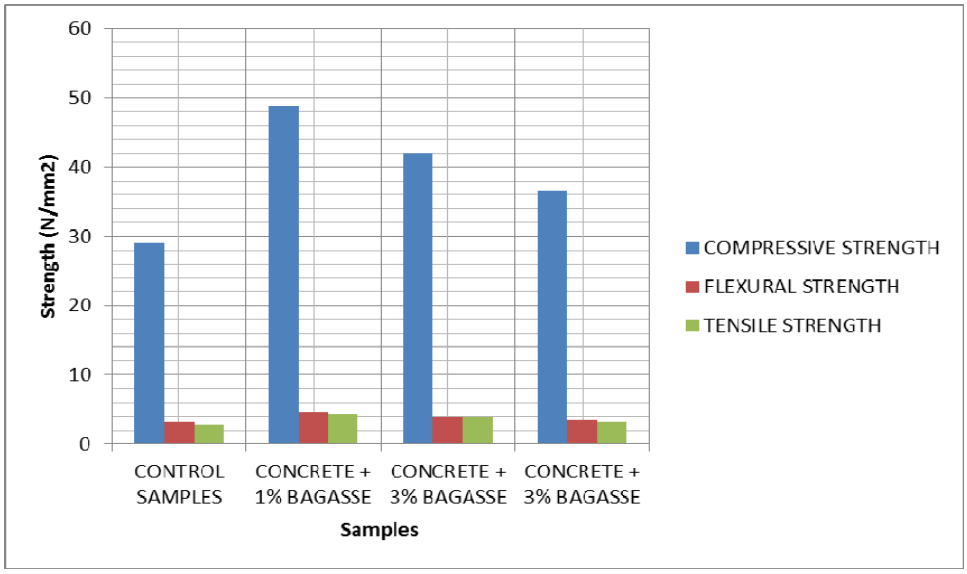

Figure 4: Overall Strength Test Results

From Figure 4, it clearly shows that the existence of sugarcane bagasse in concrete mix gives the effects on the strength of concrete. All the mechanical properties test on concrete shows positive results where the bagasse was successful to give improvement to the strength of concrete. This proves that the sugarcane bagasse shows similarity to the commercial concrete retarder that does not gives negative effects on the strength of concrete. These results show the

similarity between the bagasse and the commercial concrete retarder in terms of not giving negative effects on the strength of hardened concrete.

5.4 Penetration Test

Penetration test was carried out by preparing 4 samples that include one control sample and three samples added with different amount of sugarcane bagasse. As discussed in previous chapter, this test was done to identify the ability of the sugarcane bagasse to act as a retarder in concrete. The test was conducted using the Vicat Apparatus by referring to ASTM C403/C403M- 8 Standard Test Method for Time of Setting of Concrete Mixture by Penetration Resistance. Figure 5 shows the result of penetration test which is time versus penetration that produced by taking the average penetration depth to get a better view on the pattern of the penetration.

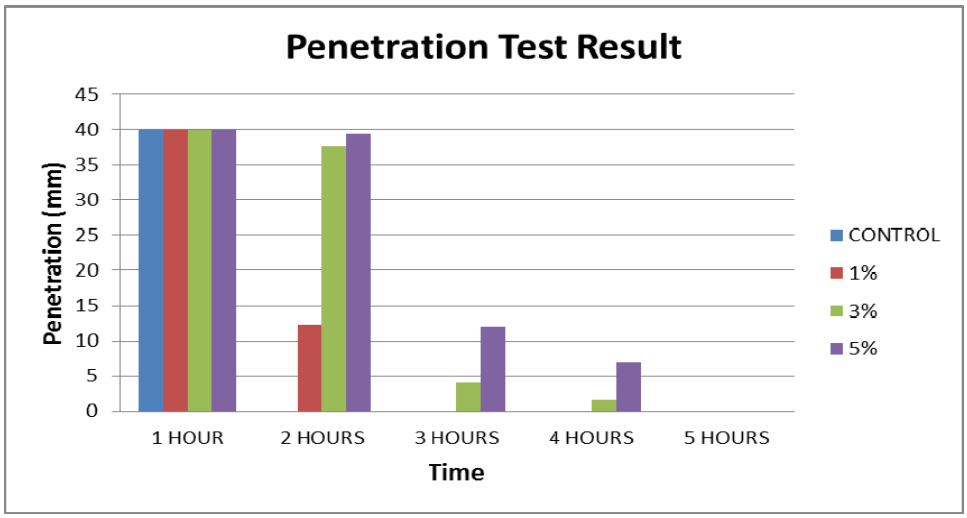

Figure 5: Penetration test according to concrete setting time

From the Figure 5, concrete added with sugarcane bagasse allowed the needle of the Vicat apparatus to penetrate the fresh concrete for a longer time frequency. At two hours, the control sample already cannot be penetrated while the concrete added with 1% of sugarcane bagasse can still be penetrated at average of 12.33mm at two hours. For 5% sugarcane bagasse, the sample cannot penetrate in five hours.

6. CONCLUSION

The aim of this research is to find out the ability of sugarcane bagasse to be used as a concrete admixture as retarder where if the project succeed, sugarcane bagasse can be used to replace commercial concrete retarder that require high cost. The results of the research describe the reaction between the sugarcane bagasse and the cement to make the setting time of the concrete becomes longer. Moreover, the mechanical properties test of concrete done gives the clear view on the effect of sugarcane bagasse on the strength of concrete. From the results obtained, all objectives that have been fixed at the beginning of the research have been achieved. After added with sugarcane bagasse, the setting time of concrete have been extended for several hours depending on the amount of sugarcane bagasse added.

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REFERENCES

Bazid, K. & Ullah, M. (2004). Effect of Retarding Admixture on the Setting Time of cement Paste in Hot Water. *Eng. Sci, 15*(1), 63-79.

Batta, S. K. & Singh, R. (1996). Sucrose Metabolism in Sugarcane Grown Under Varying Climate Conditions: Synthesis and Storage of Sucrose in Relation to the Activities of Sucrose Synthase. *Phytochemistry, 25*(11), 2431-2437.

Balaguru P. N. & Shah, S. P. (1992). Fiber Reinforcement Cement Composite. McGraw-Hill.

Eko M. R. & Riskowski G. L. (2001). A Procedure for Processing Mixtures of Soil, Cement and Sugarcane Bagasse. *Agricultural Engineering International CIGR Journal of Scientific Research and Development, 3*, 1-11.

Jayakumaran, G. (2005). The Effect of Over Dosages of Concrete Retarder. UTM, Malaysia.

Kawade U. R, Rathi V. R, and Girge V. D. (2013). Effect of used of Bagasse Ash on Strength of Concrete. *Engineering Science, 2*.

Lea F. M. (1988). The chemistry of cement and concrete (3rd ed.). Edward Arnold, London, UK.

Mindness, S. & Young, F. (1981). Concrete. Prentice Hall Inc. Englewood Cliffs, New Jersey.

Standard Specification for Building Works. (2005). Public Work Deparment of Malaysia.

Susilorini, R., Ganis, R. I., Nugraha, H. A., Syaefudin, I. & Ardi, S. B. (2008). The Using of Sugarcane Liquide as Green Retarder and Accelerator for Concrete Mixture. Symposium Nasional RAPI VII 2008, Indonesia.

Walfrod, S. N. (1996). Composition of Cane Juice. Sugar milling Research Institute, University of Natal, Durban.