Application of Recycle Material in Construction Industry a Method of Sustainable Development

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***Abstract*—The compressive strength of cement pastes is paly important role in concrete characteristics and structure stability. Many researchers have been involved in enhancing and introducing new composite material. In this research work, it is aimed to use natural minerals present in sawdust powder for improving compressive strength of Ordinary Portland Cement (OPC) pastes. The micro properties, crystalline structural and hydration of OPC paste have been investigated using X-ray diffraction (XRD) and Atomic Force Microscopy (AFM). The results indicated blending of 4% of sawdust powder in OPC paste is improved compressive strength of OPC paste considerably after 28 and 56 days. It has good agreement with previous research work is reported in [6]. The research can be continued by proposed other proportion of sawdust blended in OPC paste.**

***Index Terms*—composite material, natural mineral, hydration, XRD, AFM.**

I. Introduction

The agricultural solid waste is an economical option to design of green buildings. This recycling material is appropriate selection for developing composite, sustainable and reliable construction material. Among the various waste materials the sawdust due to mineral content, appears well admixtures to hydration behaviour of ordinary Portland cement (OPC).

To develop a new composites building material for none or semi-structural panelling the waste wood, waste paper and Tradical lime have been used. It has been observed contribution of self-strength of Wood-Crete was due to the influence of the size of sawdust particles used [1]. The size of sawdust particles depends on the kind of wood from which the sawdust is obtained and also on the size of the teeth of the saw [2]. In this research work the grounded particles size of < 45 μm as mineral admixtures on the hydration behaviour and mechanical properties of ordinary Portland cement (OPC) has been investigated. It is indicated [3] that the wood wastes may induce solid or chipped wood in its natural stage without chemical contamination, and or without and with halogenic materials as timber preservative. There are several research works [4]-[6] in self-compactability concrete containing sawdust ash (SDA) as powder material and naphthalene sulphonate (NS) and melamine sulphonate (MS). The results reported that SDA can be used as powder material with cement, and super-plasticizers to produce flowable concrete**.** The compressive strength development of SCC mortar shows a tremendous improvement over the control. At 90 days, the best strength was recorded at 10 wt% replacement and this is approximately 30% above the value of the control.

The wood chippings as fibers in concrete due to low cost proximity of the sources, and the potential pollution of wood wastes is interesting issue in developing new concrete and several other potential applications [7]. The specific objective of this research work is to identify effect of sawdust on enhancing OPC paste compressive strength after 28 and 56 days. The micro properties and hydration of OPC paste have been investigated in order to validation of presented work.

II. Methodology and Experiments

In this research work the effect of sawdust grounded particles size of < 45 μm as mineral admixtures on the hydration behaviour and mechanical properties of ordinary Portland cement (OPC) has been investigated.

A. Materials and Cement Paste Mix Design

The additive is sawdust, collected from wood industry of Pahang province of Malaysia to investigate for modifying compressive strength of OPC paste. The sawdust contents natural minerals. The produced additive for cement paste from recycle material is an economical idea and important step in sustainable development. The additive has been used as admixtures along with OPC paste (43 G) as a binding material. The produced OPC paste tested on 28 and 56 days. The sawdust reform mineralogical characteristics of OPC paste. The work is made up base on trial mixes. In this research work for identification of appropriate natural additive and establish optimization of materials mix ratio the additives are mixed based on weight.

B. Compressive Strength

To obtain the effect of 4% sawdust mixture on the compressive strength of OPC paste, cubical molds (5 cm

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× 5 cm × 5 cm) were prepared according water to cement and additive ratio indicated in Table I. After initial curing of 1 day, the specimens were kept at water 25 ± 5℃ for 28 and 56 days. The compressive strength has been measured as per ACI and the average value of three specimens has been selected for interpretation.

TABLE I. MIX DESIGNS OF THE SOLIDIFIED WASTES.

Identity	W/C ratio
OPC (100%)	0.37
OPC (96%) + sawdust (4%)	0.37

C. XRD and AFM

X-ray diffractometry (XRD) and Atomic Force Microscopy (AFM) have been used to investigate on hydration process of OPC paste - Sawdust, mixture after 28 and 56 days of curing. The samples were sieved and separated to a particle size of < 45 μm for performance of XRD analysis and AFM imagination, in order to reconnaissance on hydration and morphological characteristic of cement pastes.

III. RESULTS AND DISCUSSIONS

A large quantity of greenhouse gases can be emitted during the storage of sawdust and wood chippings [8]. Using of this recycle material in construction industry is appropriate method for sustainable development. The formation of crystalline phases, microstructure of sawdust and hydration of cement paste have been analysed by using AFM and X-ray diffraction (XRD). The Fig. 1-Fig. 2 and Table II are indicated the roughness of sawdust - OPC paste. The results show that the acceptable effect of sawdust in improving compressive strength of OPC paste. The compressive strength of OPC paste shows a tremendous improvement over the control. At 56 days, the strength was recorded at 4 wt % replacement and this is approximately 20% above the value of the control. According to results in Table III when the age of specimen is reaching to near 90 days the compressive strength is more stabilizing, it has good agreement with previous research work is reported in [6]. The report of XRD, in Fig. 2 show, cellulose effects positively on the cement paste on 28 and 56 days around 10 % while it is expected to improve further in coming days.

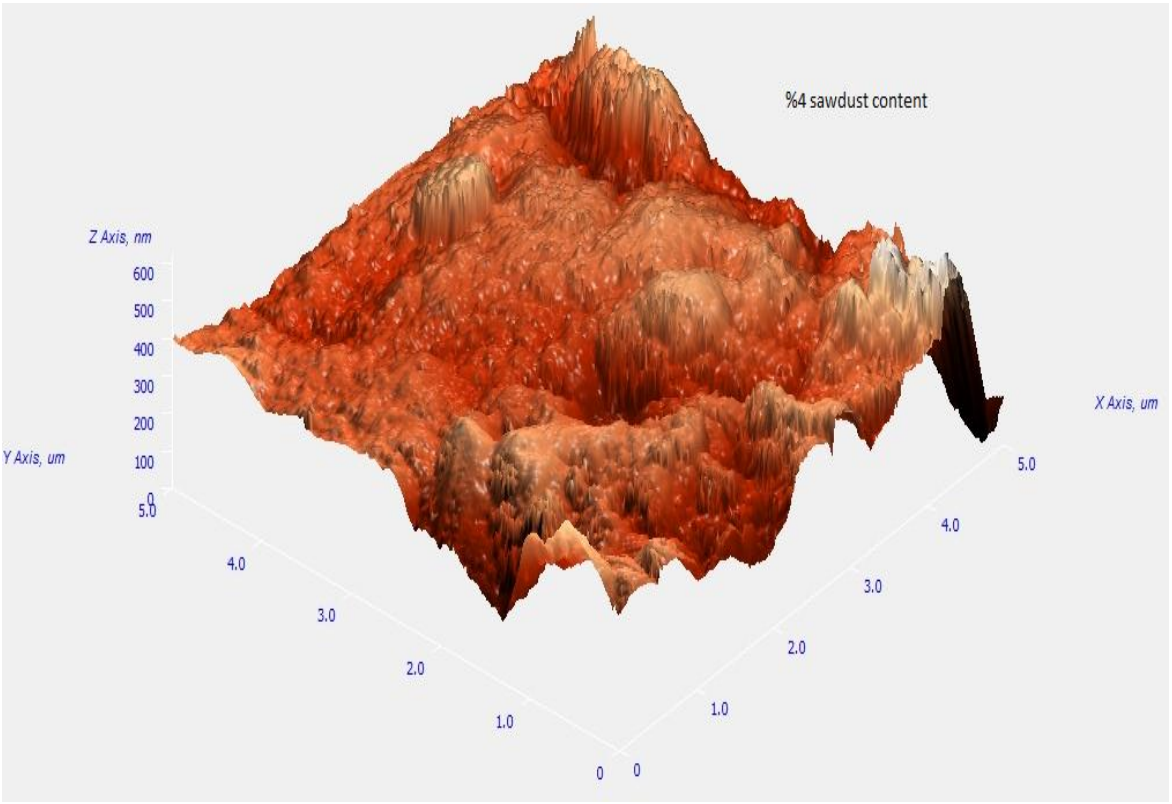

Figure 1. AFM image of 96% of cement paste and 4% sawdust mixture

TABLE II. CONCRETE-ADDITIVE MIXTURE RATIO

Sl. No	% of sawdust	Compressive strength after 28 days (MPa)	Compressive strength after 56 days (MPa)
1	-	30.10	34.13
2	4	33.61	40.99

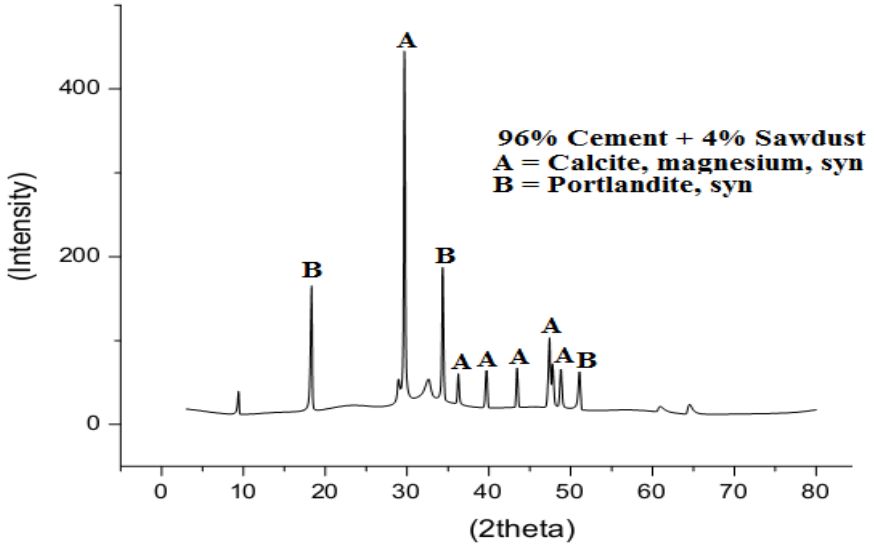

Figure 2. XRD pattern of 96% cement paste + 4% sawdust after 28 days.

TABLE III. AFM ROUGHNESS RESULTS FOR SAWDUST-CEMENT PASTE

Material composition	Sample name	Height parameters					Shape parameters		Other parameters		
		Sq, Root mean square roughness	Sa, Average roughness	St, Area peak-to-valley height	Sp, Maximum area peak height	Sv, Maximum area valley depth	Sku, Kurtosis	Ssk, Skewness	Sds, Area peak density	Sdq, Area root mean square slope	Sda, Area average absolute slope
C96.0% + S4%	4	59.194 nm	42.483 nm	620.928 nm	264.433 nm	356.494 nm	6.586	-0.547	76.350 1/um*um	0.648	0.535

C=Cement S= Sawdust

IV. CONCLUSIONS

Among the various waste materials the sawdust due to mineralogical characteristics appeared well admixtures to hydration behaviour of Ordinary Portland Cement (OPC) paste, it occur due to easy minerals interaction. This natural additive is suitable for the design and modification of OPC paste characteristics. The results help in commercialization industrial solid waste, sustainable development and environment pollution solution. The blending of 4% sawdust powder in OPC paste is enhanced compressive strength of OPC paste on 28 and 56 days. The research program is continued on how to improve the flexural and tensile strength of structural and non-structural concrete elements. The method more suits for thin cross section plain concrete.

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REFERENCES

[1] P. Aigbomian, M. Fan. (December 2012). Development of wood-crete building materials from sawdust and waste paper. *Construction and Building Materials*. [Online]. 40. pp. 361–366. Available: http://www.sciencedirect.com/science/article/pii/S095006181200829X

[2] A. K. Afuwape, "*Design and testing of sawdust compactors*," BSc thesis. Ile Ife (Nigeria): Department of Agriculture and Engineering, Obafemi Awolowo University; 1983.

[3] A. Evrard, editor. Hemp concretes, *A Synthesis of Physical Properties*, 2003.

[4] A. U. Elinwa, S. P. Ejeh, and A. M Mamuda. (April 2007). Assessing of the fresh concrete properties of self-compacting concrete containing sawdust ash. *Construction and Building Materials*. [Online]. vol. 22. pp. 1178–1182. Available: http://www.sciencedirect.com/science/article/pii/S0950061807000414

[5] EFNARC. *Specification and Guidelines for Self-Compacting Concrete*. London: EFNARC Publication, 2002. p. 1–32.

[6] A. U. Elinwa and Y. A. Mahmood. (May 2001). Ash from timber waste as cement replacement material. *Cem Concr Comp*. [Online]. 24. pp. 219–22. Available: http://www.sciencedirect.com/science/article/pii/S0958946501000397

[7] P. Coatanlem, R. Jauberthie, and F. Rendell.(March 2005). Lightweight wood chipping concrete durability. *Constr Build Mater*. [Online]. vol. 20, pp. 776–81. March 2005. Available: http://www.sciencedirect.com/science/article/pii/S0950061805000814

[8] M. Wihersaari, "Evaluation of greenhouse gas emission risks from storage of wood residue," *Biomass Bioenergy*, vol. 28, pp. 444–53, February 2005.

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