PHYSICAL APPEARANCE OF COLD-BONDED LIGHTWEIGHT AGGREGATE PRODUCED FROM INCINERATION ASH

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ABSTRACT: This study focussed on the physical appearance of aggregate using manual pelletizing technique for the manufacturing and production of cold-bonded lightweight aggregate. Manual pelletizing method is seldomly employed to manufacture aggregate due to the availability of modern machine. However, using this machine, the size of manufactured aggregate cannot be selected and usually comes in various size. The objective of this study is to examine the physical appearance of aggregate including its colour and texture. Lightweight aggregate was produced with the combination of three main key materials which is cement, foam, and incineration ash with specific ratio. Using manual technique, the lightweight aggregate is shaped and mould to the desired size. For this study, size of 15 mm is selected as it is reflected more with the coarse aggregate normally used in concrete. Results show that lightweight aggregate produced using this technique has a more uniform surface and no obvious crack can be seen on the surface. It can further be used as new alternative aggregate in concrete production.

Keywords: *Physical Properties, Lightweight Aggregate, Pelletization, Incineration Ash, Concrete*

1. INTRODUCTION

Builders and engineers throughout the world are paying more attention to the application of lightweight aggregate as it can contribute to lower density of concrete. The interest of using lightweight concrete is at high if it can contribute to comparable compressive strength. If lightweight concrete with comparable high strength is realised, the section size of any structural member could be reduced due to lighter permanent action imposed to the member especially from upper structures. This may permit not only large space availability but also reduce the usage of reinforcement and cement quantity. Lightweight concrete can be sub-divided into two main categories, which is the lightweight aggregate (LWA) concrete and cellular concrete. In LWA concrete, the main materials used were basically LWA, cementitious material, fine aggregate and water. Some admixtures may be added into the mixture if certain property such as for ultra-high strength concrete where super plasticisers is required.

LWA can be obtained either from natural resources such as oil palm shell or from artificial aggregate where it has been produced from a factory [1], [2]. Various types of LWA can be produced such as expanded clay, sintered fly ash [3] or air-cooled blast furnace pelletized slag [4]. LWA can be manufactured either by cold-bonded pelletizing process or by sintering process which will cause higher energy consumption. In cold-bonded pelletizing process, the agglomeration of aggregate pellet was helped by water as an agglomeration agent [5]. This is a procedure where finer particles were merged with each other and become larger solid particles which resulted in lightweight due to presence of small pores.

2. METHODOLOGY

First and foremost, all materials needed in this study were prepared prior to mixing processes. The incineration ash used were fly ash (FA) and bottom ash (BA) and collected from incineration plant in Malaysia. The ash was partially replaced the cement content with the percentage replacements were set to be 40% and 50% by volume fraction method. The type of foaming agent is Polyoxyethylene Alkyether Sulfate and foams were prepared with the ratio of 1:33 where 1 is the portion of foaming agent meanwhile 33 is the portions of water.
In the making of LWA paste, dry ingredients which is cement and ash were poured into a laboratory mixer and mixed for 2 minutes. Then, foam was added into the dry materials and mixed again thoroughly for another 2 minutes. To ensure firm, workable, and sticky paste is produced, the mixer was kept moving for 3 minutes at ambient temperature. Later, aggregate paste was taken out from the mixer and using hand, manual pelletization process was conducted to produce circular-shaped aggregate balls with the size of 15 mm. Aggregate paste and freshly produced pellets are shown in Figure 1. There are four different sets of pellets samples being produced and categorized based on the types of ash and ash content, namely LWAFA40, LWAFA50, LWABA40 and LWABA50. All of the aggregate samples are left at room temperature for at least 24 hours after it continues with designated curing condition. This earlier hardening process is important to ensure all the components stick properly with each other before proceeding to next curing

regime. For aggregate cured in air curing, the samples were left at room temperature continuously until 28 days. Meanwhile, for water curing aggregate, it was transferred from room condition and soaked in the water, also until 28 days.

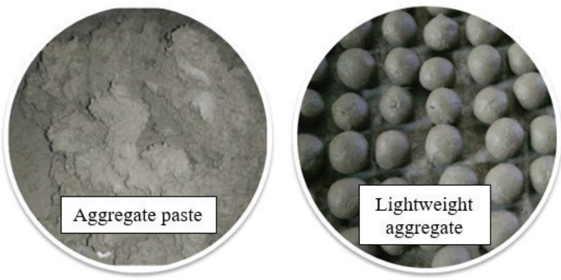
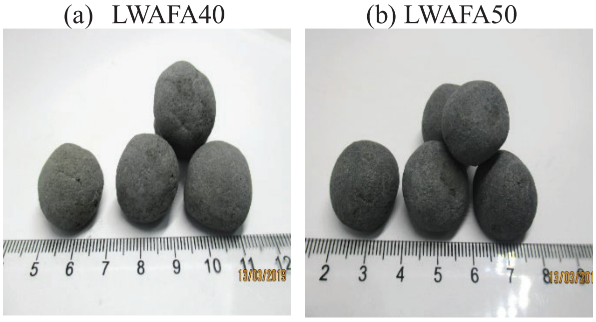


Figure 1 Pelletization Process

3. RESULTS AND DISCUSSION

The physical characteristics of FA and BA used in this study plays an important role on how the final product which is an aggregate is going to resemble. FA is classified as Class C ash. Class C fly ash is more effective in terms of development because it contains calcium alumino silicate glass which is highly reactive. The colour for FA is normally yellowish. As for cement, the original colour is dark grey. The results for surface texture can be seen from Figure 2. For LWAFA40 (Figure 2 (a)) and LWAFA50 (Figure 2 (b)), colour of aggregate samples did not change significantly from each other. Colour for LWAFA40 is more likely to be greyish as the content of cement is more dominant in this samples.

(a) LWAFA40 (b) LWAFA50



(c) LWABA40 (d) LWABA50

Figure 2 Lightweight Aggregate

In addition, the particles of FA can be seen slightly in LWAFA40 samples which indicated by the small yellow fragments which can be identified on the aggregate surface. However, the colour starts to change into more yellowish grey for samples FALA50 where more yellow fragments can be seen. This is due to the facts that half of the FALA50 was made from FA. Since all the LWA were pelletized using manual method, the surface of the aggregate is quite smooth and maintained its predetermined shape which is circular suggesting stronger interaction between cement and ash. In addition, no major surface crack can be identified due the mild compression to its surface during the pelletization process. Almost no pores can be seen. On the other hand, for LWA samples which contained BA, the colour intensity for each LWA samples is significantly increased from lighter grey to darker grey and almost nearly black. Original color of BA is black when its originally obtained from incineration plant. The addition of BA resulted into heavier aggregates and more strong aggregates. The colour variant for LWABA40 and LWABA50 is shown in Figure 2(c) and (d), respectively.

4. CONCLUSION

The production of LWA can be presumably as successful and have comparable qualities and characteristics when compared with normal weight aggregate. The cold-bonding process is proved to be a good method to produce LWA which requires no extensive heat treatment and can produced more uniform aggregate. Addition of foam inside the aggregate paste proof to be a contributor to the density reduction of the LWA and future use in other civil engineering application is fully recommended.

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