THE PRODUCTION OF LIGHTWEIGHT AGGREGATE FOR NEW CONSTRUCTION MATERIALS

Khairul Nizar Ismail & Kamarudin Hussin
Pusat Pengajian Kejuruteraan Alam Sekitar, Universiti Malaysia Perlis, P.O Box 77, d/a Pejabat Pos Besar, 01000 Kangar, Perlis, Malaysia
nizar@unimap.edu.my

Introduction

Pulverised fuel ash is one of the available industrial wastes, which can be developed as a new building material. Pulverised fuel ash is among the waste, which creates twin problems of disposal as well as environmental degradation due to its nature of causing air and water pollution in large scale. Lightweight aggregates produced from pulverised fuel ash, will be low-density aggregates, strong and it will reduce the dead weight and material handling costs for building constructions. In other words, it can be used as replacement for conventional (natural) aggregates in structural concrete.

Lightweight Aggregates

Pulverised fuel ash is the residue from the combustion of bituminous coal, generally as a result of the generation of electricity at a thermal power generation station. In Malaysia, about 600 MW (7%) of electricity is being supplied by the thermal power plant, which is located in Kapar, Selangor. Another thermal power plant, which is scheduled to be completed in 2003 in Lekir, Perak, would have 189 hectares of ash pond and could cater the ash for 25 years (Utusan Malaysia,1999). British Standard 3797 (Specification for lightweight aggregates for concrete) specifies that loose bulk densities of lightweight aggregates must not exceed 1200 kg/m^3 for 5 mm aggregates and below, and not exceeding 960 kg/m^3 for aggregates above 5 mm, all tested in an oven dry condition. The sulphate content is limited to 1 %, expressed as sulphur trioxide and loss on ignition is limited to 4% (Bs 3797, 1990). Preliminary findings have shown that adding more carbon to the aggregates composition can increase the porosity of lightweight aggregates(Verma et al, 1998). The porosity of the aggregates must also be controlled because it may affect the hardness of the aggregates.

Process

In this work, the unprocessed pulverised fuel ash was transferred into a mixer where it was combined with water and conveyed onto pan pelletisers. This would rotate, turning the pulverised fuel ash into spherical pellets. The ash contained up to 8% unburnt carbon, which was approximately the amount, required for sintering. If there is a fuel deficiency, this can be corrected by the addition of pulverised coal at the mixing stage. The blending of water and the ash is critical to the production of the pellets to produce maximum strength with minimum density. The "green" pellets were then fed onto a moving sinter strand or furnace The top surface of the pellet bed was ignited as it passes under oil fired ignition hood, which was maintained at a temperature of 1200 ^oC to 1300 ^oC (Mun, 1993). Ignition time, which varies with the carbon content of the ash, is usually about one minute. The pellets, which were fully sintered, were then graded and sorted into coarse, medium and fine aggregates.

Results and Discussion

The density and porosities of the aggregates were determined by means of measuring the weights of oven dry aggregates, vacuum water saturated aggregates and water immersed aggregates. The composition of raw materials was modified by 5 types of compositions as outlined in Table 1. The table provides a concise description of aggregates composition used in this work for each of the aggregates.

Table 1: Raw Materials Composition of Aggregates

	PFA (%)	QD (%)	RHA (%)	C (%)
AR 1	60	25	5	10
AR 2	60	20	10	10
AR 3	60	15	15	10
AR 4	60	10	20	10
AR 5	60	5	25	10

PFA: Pulverised fuel ash QD: Quarry dust
RHA: Rice husk ash C: Clay

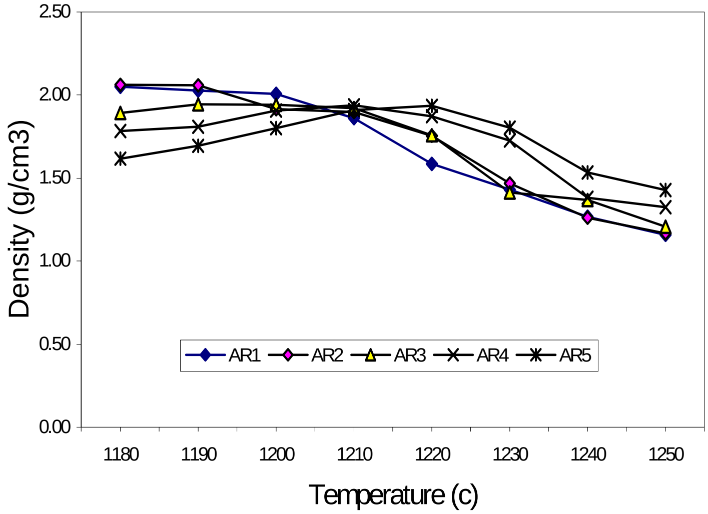

Figure 1 : Density versus temperature

Amongst the trials, composition AR 1 gives the most satisfactory results. The densities obtained for composition AR 1 vary from 1.1582 g/cm^3 to 2.0586 g/cm^3. The colour of the aggregates (AR 1) are brownish. From the observations and analysis, it can be concluded that pulverised fuel ash actually acts as a filler and quarry dust as the flux agent. Clay is more likely as bloating agent and rice husk ash as pores induction agent.

Conclusion

This paper shows one of the effective methods of utilising waste pulverized fuel ash from power generation plant in Malaysia, and the likely aggregate products that could be manufactured from them. The acceptance of lightweight aggregates for structural used in Malaysia has been slow, mainly because of the price of imported lightweight aggregates. However, the economy of lightweight aggregates for structural used is already apparent. For cast-in-situ structure, its smaller dead load makes foundations less expensive. For pre-cast structures, the smaller dead load also makes for economy, but the number of pieces in any structure will be considerably smaller, thereby reducing the labour input.

References

[1] Utusan Malaysia: "*Tenaga Pengerak Ke Alaf Baru*", Utusan Malaysia (M) Sdn. Bhd , 31 August 1999.

[2] Verma C.V, Handa C.K, Jain S.K & R.K Yadv. "*Techno Commercial Perspective Study For Sintered Fly Ash Lightweight Aggregates in India*", Construction and Building Materials 12, 1998

[3] British Standard 3797: "*Specification For Lightweight Aggregates For Masonry Units and Structural Concrete*", 1990

[4] Mun R.L: "*Lightweight Aggregates and Lightweight Concrete- Past, Present And Future*", Sydney , 1993.