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The microstructure of lightweight aggregates made of pulverised fuel ash

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BSTRACT Lightweight aggregates can replace the natural aggregates in concrete, which will roduce lightweight concrete. Lightweight aggregates are well known for their porous and cellular ructure. Porosity of the aggregate has significant influence on the properties of the aggregates. This aper presents a study on to pore structure of aggregates made from sintered pulverised fuel ash. The orosity of the aggregates is related to the absorption characteristics of the aggregate. Scanning Electron licroscope (SEM) has been used to study the morphology of the aggregates. The pulverised fuel ash sed to manufacture the lightweights aggregates was obtained from a local power station in Kapar, elangor.

ightweight aggregates, Pulverised Fuel Ash, Microstructure, Porosity)

INTRODUCTION

ılverised fuel ash (PFA) has a long history of e as construction material. It can be used as a ;ht base material when compacted and as a ızzolan as it hardens when mixed with lime and ater. The use of PFA in the production of ;htweight aggregate is well established for ample, Lytag aggregates. It has been used in a mber of large-scale projects such as the nstruction of North Sea oil production atforms [1].

ie utilization of PFA is realized by low :hnology applications such as in construction fills and embankments, back fill, pavement se and sub base course landfill cover. Medium :hnology applications of PFA include oduction of blended cement, precast products, ncrete pipes, production of bricks and htweight aggregates. High technology plications of PFA include materials recovery, er for polymer matrix composites and metal ıtrix composites.

The amount of PFA produced by electric power generation is increasing in Malaysia annually. According to the 8th Malaysia Plan, by the year 2005, Malaysia will use about 11.2 million tonnes of coal per annum [2]. This will produce more than 2 million tonnes of PFA annually but only a small amount will be utilized for construction purposes.

RAW MATERIALS

Samples of PFA from local power plants were examined for their mineralogical, chemical and physical properties. The result of the chemical composition analysis showed that the samples could be classified as Class F (PFA) according to ASTM C 618. Scanning Electron Microscope (SEM) has been used to study the morphology of the PFA particles.

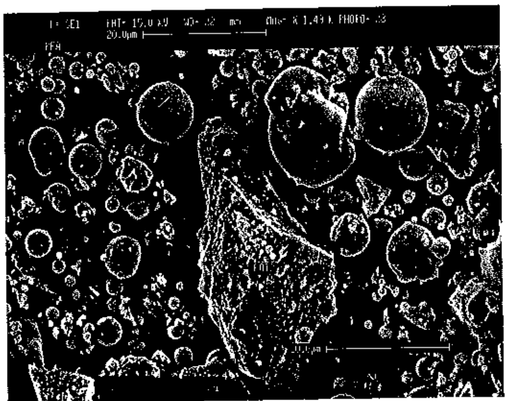

Figure 1. SEM micrograph for the Pulverised Fuel Ash (1.49kx)

Cambridge Stereoscan 200 was used to study the morphology of the PFA particles. Examination under the scanning electron microscope showed that the samples had the usual pulverised fuel ash morphology and were composed of mostly small, spherical particles. Figure 1 shows SEM micrograph of the cenospheses particle. It can be noticed that the PFA sample consists of almost regular spherical (cenospheres) particles ranging 4 um to 14 um in diameter. Figure 2 shows micrograph of cenospheres particle.

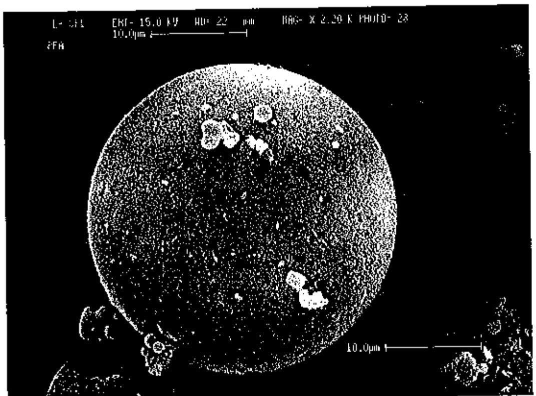

Figure 2. SEM micrograph for the cenospheres particle (2.20kx)

The manufacture of lightweight aggregate

The PFA, clay and other suitable materials are blended together. The blending of the raw materials is critical and it is only by careful control of the water contents of the mixture that it is possible to produce the strong spherical pellets. Then the mixture is pelletised with 10-15% water and the green pellets are fired in muffle furnace at temperatures of about 1100 ^{0}C to 1200 ^{0}C. The resultant material is open textured with voids that are interconnected and permeable to water.

RESULTS AND DISCUSSION

The results presented here are based on the examination of the microstructure of the lightweight aggregates. The outer layer of the lightweight aggregates is red brown in colour. The outer layer of the lightweight aggregates appears to be fused mass with little sign of voids, produced probably by momentary exposure to intense heat at the point. Figure 3 shows the edge region to be made up of a honeycomb type structure.

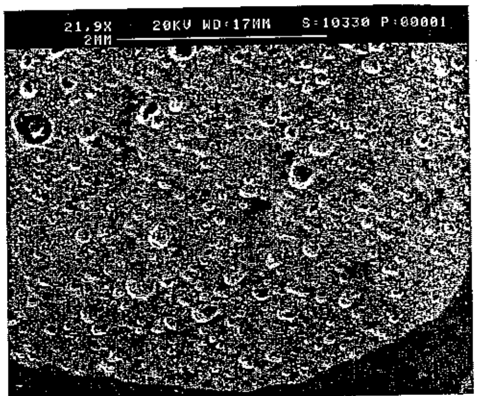

Figure 3. Cross section surface of lightweight aggregates

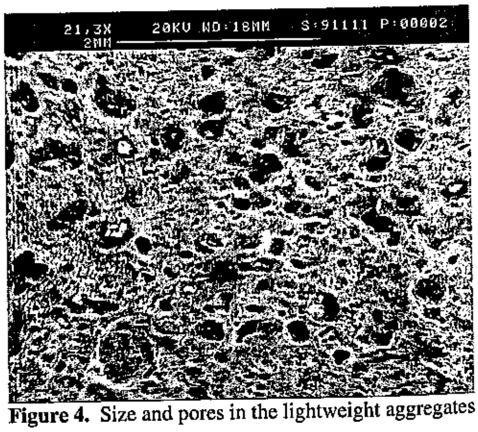

Figure 4. Size and pores in the lightweight aggregates

Figure 4 shows the distribution and sizes range of voids on cross section surface. The surfaces are irregular and the voids appear to be distributed fairly. These figure show that the pores are interconnected, and that overall structure of the pellets is porous. The voids appear to have been formed by gases escaping through a melted material. The pore size distribution is very important. Fine pore structure can result in poor sintering process, insufficient diffusion of air into and combustion products out of the pellets. On the other hand, green pellets with high porosity structure and large pores are too weak to survive in sintering process [4]. The structure of unreacted cenospheres is shown in Figures 5 and 6.

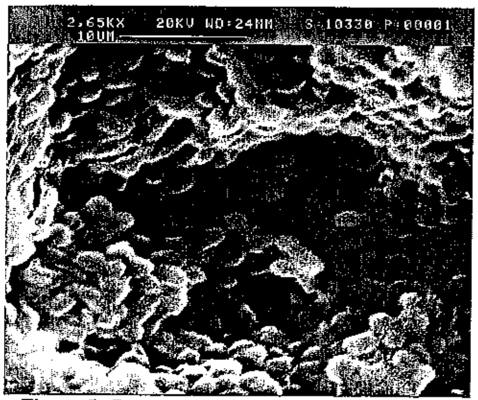

Figure 5. Pore structure of unreacted cenospheres

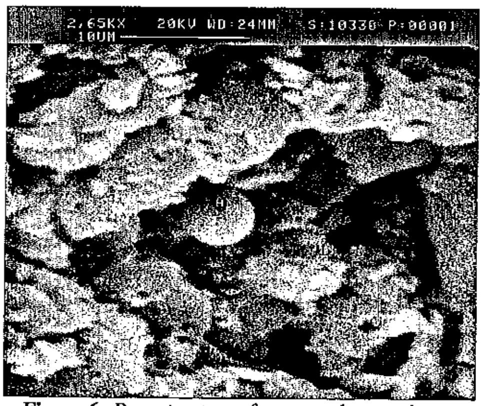

Figure 6. Pore structure of unreacted cenospheres

Figure 5 shows unreacted cenospheres of various sizes and these were found throughout the cross section of the specimen examined. The diameter of the cenospheres varies from 2 to 6 μm. The overall structure of lightweight aggregate (figure 3) appears to be composed of the honeycomb type of materials that is formed by the virtual melting of the various raw materials with the unreacted cenospheres fused into it [3].

CONCLUSION

There is a potential for producing lightweight aggregates from pulverised fuel ash in Malaysia. It can be utilised in producing a moderate strength concretes. The aggregates can be made pellets and sintered at suitable temperature.

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REFERENCES

1. Price, W, *Lightweight concrete for North Sea : the BP Harding (forth) Field gravity base tank*, Quarterly Journal of the federal de la Precontrainte 1995: **2**, 3-7
2. Ministry of Finance, *8th Malaysian Plan, Chapter 11 (2000),337*
3. Swamy, R.N. and Lambert, G.H. (1981), *'The Microstructure of Lytag Aggregate'*, The International Journal of Cement Composite and Lightweight Concrete, Volume **3**, No.4
4. Bijen, J.M.J. (1986), *'Manufacturing Process of Artificial Lightweight Aggregates From Fly Ash'*, The International Journal of Cement Composite and Lightweight Concrete, Volume **8**, No.3.