

Structural Concrete Using Oil Palm Shell (OPS) as Lightweight Aggregate

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Abstract

This paper presents part of the experimental results of an on-going research project to produce structural lightweight concrete using solid waste, oil palm shell (OPS), as a coarse aggregate. Reported in the paper are the compressive strength, bond strength, modulus of elasticity, and flexural behaviour of OPS concrete. It was found that although OPS concrete has a low modulus of elasticity, full-scale beam tests revealed that deflection under the design service loads is acceptable as the span-deflection ratios ranged between 252 and 263, which are within the allowable limit provided by BS 8110. Laboratory investigations show encouraging results and it can be summarised that OPS has good potential as a coarse aggregate for the production of structural lightweight concrete, especially for low-cost housing construction and also for use in earthquake prone areas.

Key words: Low-cost housing, Solid waste, Lightweight concrete, Stress-strain curve, Prototype beam test.

Introduction

The growing concern of resource depletion and global pollution has challenged many engineers to seek and develop new materials relying on renewable resources. These include the use of by-products and waste materials in building construction. Many of these by-products are used as aggregate for the production of lightweight concrete. Although there has been much research conducted on the structural performance of lightweight aggregate concrete, these are mostly confined to naturally occurring aggregates, manufactured aggregates, and aggregates from industrial by-products.

Being the world's largest producer and exporter of palm oil, Malaysia is well known for its palm oil industry; however, one significant problem in the processing of palm oil is the large amounts of waste produced and this is one of the main contributors to the nation's pollution problem. At the mills, when the fresh fruit bunches (FFB) are processed

and oil extraction takes place, solid residues and liquid wastes are generated. These by-products include empty fruit bunches, fibre, shell, and effluent. Currently, research efforts have been directed towards the potential use of oil palm shell (OPS) as aggregate for the production of lightweight concrete. In this respect, Universiti Malaysia Sabah (UMS) built a small footbridge [Figure 1(a)] of about 2 m in span in May 2001 and a low-cost house [Figure 1(b)] with a floor area of about 59 m² in 2003, both using OPS concrete. Both structures were constructed on the campus, which is located near the coastal area. This area has an annual rainfall of about 2500 mm, air temperature in the range of 22.9 to 32.2 °C, and relative humidity of 71.6% to 91.0%.

In Malaysia, there is an annual production of over 4 million tonnes of waste OPS. Figure 2 shows a photo of waste OPS being left at a mill area. Exploiting this waste material not only maximises the use of oil palm, but also helps preserve natural resources and maintain ecological balance. Currently, there