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# Performance of Concrete Containing Palm Oil Shell as Coarse Aggregate Replacement

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**Abstract**

The use of sustainable materials in the construction industry is becoming a trend these days. This study investigates an environmentally friendly and affordable alternative for the lightweight concrete industries, exploring the usage of palm oil shells (POS) as an aggregate replacement. POS is a by-product of the palm oil industry. This study aims to investigate the performance of POS in concrete mixes in terms of workability, compressive strength, and density. The POS is of size 12 mm. The concrete samples are prepared using POS to partially replace coarse aggregate at 0%, 5.0%, 15%, and 25%. The water-cement ratio of 0.5 is selected because it provided the most suitable workability for concrete with partial replacement of the coarse aggregate with POS. The results of compressive strength show that the strength of concrete decreased with increasing POS concrete. However, the strength indicates that a concrete mix with 15% partial replacement of POS has a compressive strength of 26.01 MPa on the 28th day, which is much greater than 0% POS (i.e. the controlled sample), which has a lower value of 24.56 MPa.

Keyword: Concrete, palm oil shell, compressive strength test, density

## INTRODUCTION

Concrete is the most widely used building material in the world today. The high cost of concrete products such as cement, fine aggregate, and coarse aggregate has led to the need to look for alternative building materials [1]. The overall importance of using concrete in construction projects and works should not be overemphasized. In most cases, these indigenous products are disposed of as waste, polluting the environment. Many of them can be used as lightweight aggregate (LWA) for the production of lightweight concrete with the advantage of reducing the dead weight of concrete frames compared to conventional concrete with high dead loads, they can also be used for institutional stabilization, flexibility, and economy [2]. As a result,

the need for more durable and recycled materials has increased. Agricultural waste materials such as palm oil shells can serve as good substitutes or blends for some of these conventional building materials [3]. In this research, part of coarse aggregates is replaced with palm oil shells (POS).

## METHODOLOGY

The concrete design was prepared. After that, the materials are prepared in the laboratory for the mixing process. The material that used in this study are; Portland cement, coarse aggregate, fine aggregate (sand), water, superplasticizer (SP), and palm oil shells (POS).
The slump test is a simple and low-cost test that is prepared in the laboratory to determine workability and consistency. This test is performed following the procedures and methods outlined in the ASTM C143 in the United States.

The compressive strengths of the cube samples are determined at 7, 14, 21, and 28 days of curing age respectively.

## RESULT AND DISCUSSION

### Workability

The results of the research are obtained via slump test for the workability of fresh concrete, the compressive strength for the hardened concrete, and density calculation.

Comparing the slump results of concrete with different percentages of palm oil shells replacement (Figure 1), the highest value are the controlled samples. The 5% of palm oil shell content is the highest among all that contained the shells. Thus when comparing the workability of the concrete containing 5%, 15%, and 25% palm oil shells to the controlled sample, it is clear that the workability of the palm oil shell containing concrete has reduced considerably. Aside from that, the graph in Figure 1 revealed that 25% palm oil shell content had the lowest slump value when compared to 5% and 15% palm oil shell content.

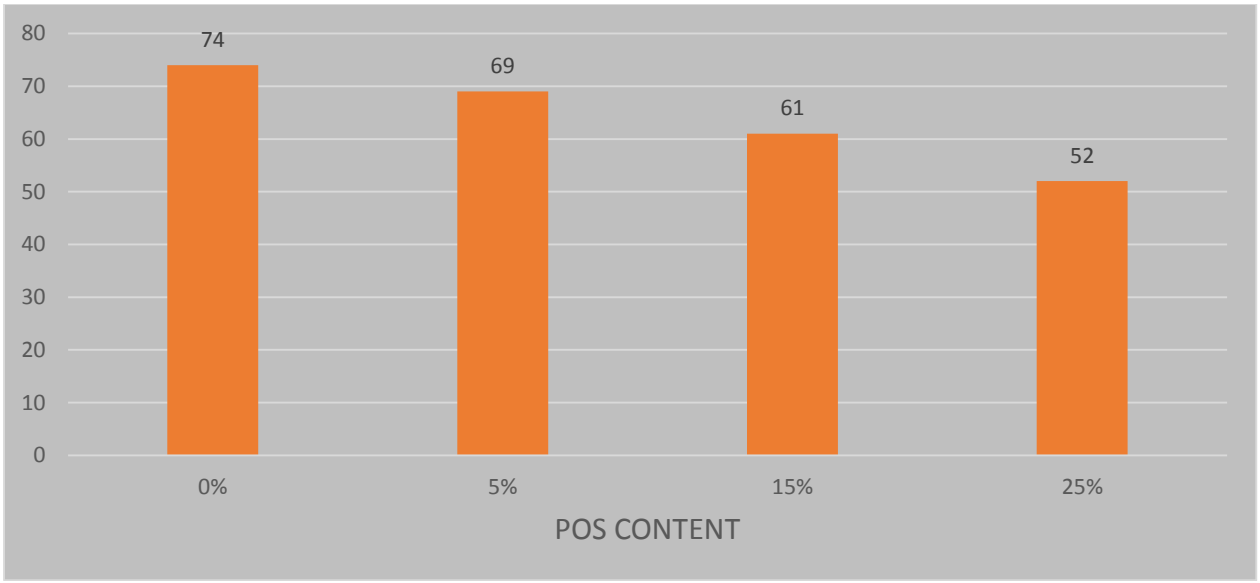


Figure 1 Workability of concrete with Partial Replacement of Palm Oil Shell

## Compressive Strength

The results show (Figure 2) that the differences in strength between all batches compared to the controlled batch. For all concrete mix that containing the partial replacement of Palm Oil Shell (POS), the highest strength obtained is on the 28th day that is for 15% of replacement POS at 26.01 MPa which is higher than 0% (the control) with a recorded value of 24.56 MPa. Therefore, the addition of POS a partial coarse aggregate replacement at a level of 15% increased compressive strength compared to the controlled sample and other percentage levels.

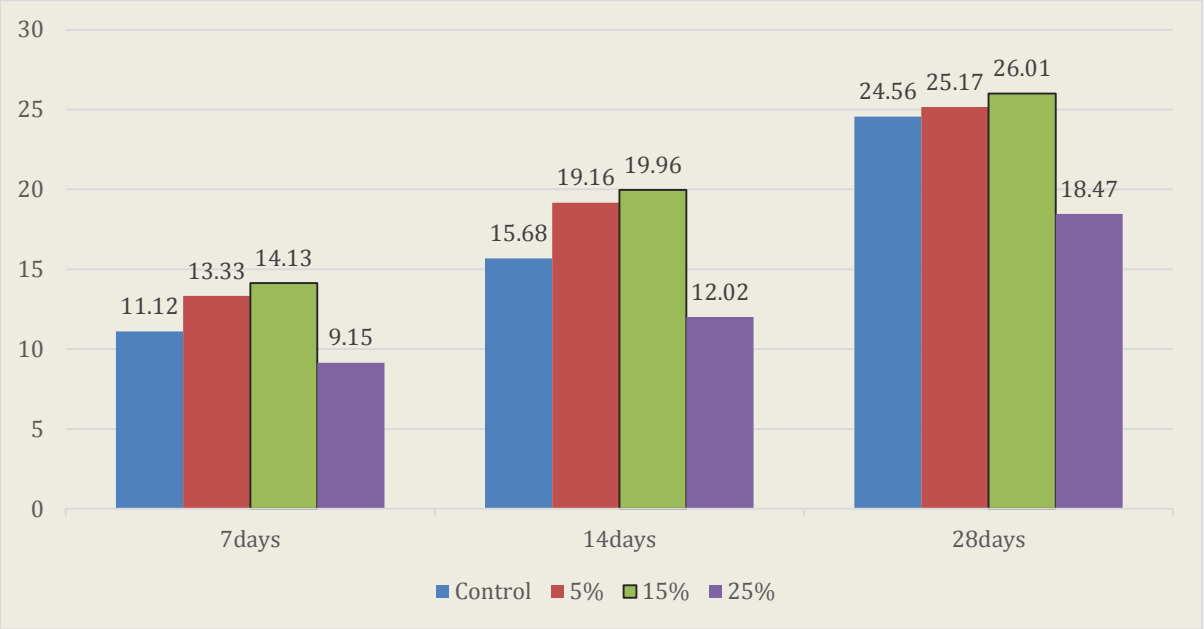


Figure 2 The Comparison of Compressive Strength of 5%, 15%, and 25% Palm Oil Shell (POS) at 7, 14, and 28 days curing age.

## Density

The decreased density (Figure 3) could be attributed to the direct result of the specific gravities of the materials. Although all the concrete samples with 5%, 15%, and 25% POS as aggregate weighed more than 2000 kg/ $m^3$, it is important to note that the densities of 30% POS concrete of the typical mixes are in the range of structural lightweight concrete with densities less than 2000 kg/ $m^3$.

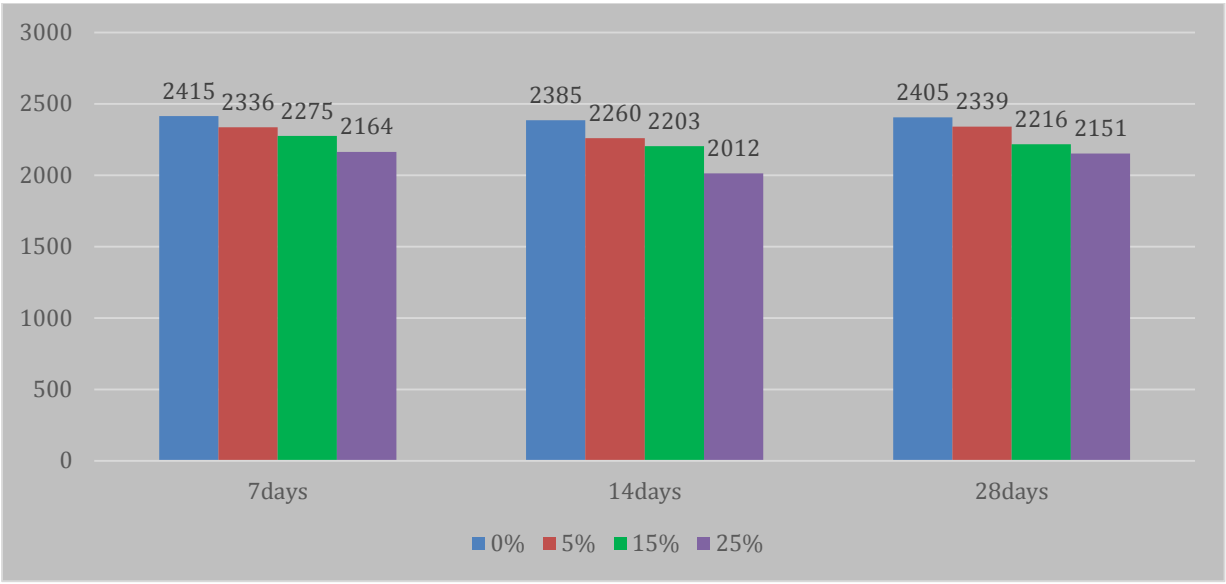


**Figure 3** The Density of 0%, 5%, 15%, and 25% Palm Oil Shell Replacement.

## CONCLUSION

With the addition of POS, the workability of the new concrete mix reduces. Water absorption in POS-containing concrete increases but remains within standard ranges. The addition of POS reduces concrete strength; however, the replacement of 15% POS obtains acceptable results because it falls within the range of requirements for structural LWC components. However, we can generalize that palm oil shell waste may be used as a coarse aggregate replacement in concrete, but it is not suggested for structural usage when the percentage is raised due to the poor compressive strength when compared to regular concrete containing natural rock aggregates.

## ACKNOWLEDGEMENT

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