# 고로 슬래그 및 POFA 함유 녹색 삼원 시멘트 페이스트의 역학적 특성 연구

# The mechanical characteristics of green ternary cement paste incorporating blast furnace slag and palm oil fuel ash

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Abstract

This study investigated the use of different amounts of BFS and POFA. In all mixture systems, 60% cement was replaced with POFA and BFS as a substitute for Ordinary Portland Cement. The results show that with the addition of POFA and BFS, although the early compressive strength will be reduced, the strength will be significantly improved at 28 days. In the ternary system, the 28-day strength is negatively correlated with increasing POFA content.

키 워 드 : POFA, 고로 슬래그, 역학 특성
Keywords : POFA ,blast furnace slag, mechanical properties

## 1. Introduction

Ordinary Portland Cement (OPC) is one of the most widely used building materials in the world. But it produces a lot of greenhouse gases in the process of production. In order to achieve sustainable development, many countries are working hard to reduce the carbon emissions generated in the production process of cement, and are actively looking for alternatives to OPC. Palm Oil Fuel Ash (POFA) is a by-product of biomass thermal power plants. The main chemical composition is silica, which belongs to the pozzolanic material.In addition, blast furnace slag (BFS) is an industrial waste produced during steelmaking and also has cementitious and pozzolanic properties. Many scholars have studied the ternary system composed of POFA, fly ash and metakaolin, but the study of the ternary system composed of POFA and BFS is still unclear. Therefore, this paper is aims to study the mechanical properties of ternary cement pastes blended by OPC, POFA and BFS.

## 2. Materials and Method

The POFA was collected from burning palm oil kernel shells and palm oil fibers in a palm oil mill located in Johor area of southern Malaysia and desiccating. Then POFA wasplaced in an oven at a temperature of 110 ± 5 ˚C for 24 h. After this process, grind the remaining particles with a 45-μm sieve. BFS was used with 2.93 g/cm3 specific gravity. Blaine specific surface area was 3750 $cm^2/g$. This study uses Portland cement produced by South Korea Cheonma concrete company (South Korea). The density of cement is 3.14 $g/cm^3$.The mix proportions of blended paste were presented in Table 1. In all mixture system, 60% cement was replaced with POFA and BFS. The compressive strength of pastes was tested at 2,3,7 and 28 days in accordance with KS L ISO 679.

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Table.1 Mixture proportions.

| | Cement | Water | POFA | GGBFS |
|---|---|---|---|---|
| OPC | 100 | 50 | 0 | 0 |
| 60S | 40 | 50 | 0 | 60 |
| 45S15P | 40 | 50 | 15 | 45 |
| 30S30P | 40 | 50 | 30 | 30 |
| 15S45P | 40 | 50 | 40 | 15 |
| 60P | 40 | 50 | 60 | 0 |

## 3. Results and Discussion

The compressive strength of all blended cement pastes at 2 , 3, 7, and 28 days is shown in Figure 1.To further compare the change of compressive strength, the relative compressive strength (normalized to the strength of OPC) of all cement pastes is also calculated and shown in Figure 2. From compressive strength results, the strength of all specimens gradually increased over time. Due to the addition of POFA and BFS will increase the water-cement ratio, the early strength will decrease. But at 28 days, the strength of 60S was 3% higher than OPC, beacause of the pore refinement by BFS was evident. Meanwhile, the 28-day compressive strength also decreased with the increase of POFA content, among which in the ternary system, 45S15P obtained the best result of 32Mpa. This is because POFA contains more CaO and therefore has a more pronounced and rapid hydraulic effect. , slurries containing cementitious materials generally take longer to obtain the full benefit from the pozzolanic reaction[1].

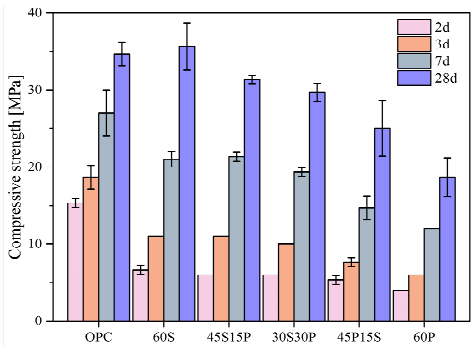


Figure 1. Compressive strength of cement pastes

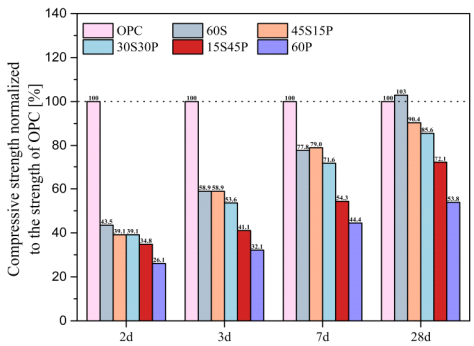


Figure 2. Relative compressive strength

## 4. Conclusion

This study measured the mechanical properties of the mixture in cement paste with different POFA and BFS contents. It is feasible to utilize 45% mass fraction of BFS and 15% mass fraction of POFA to substitute cement, which can alleviate the problem of environmental pollution caused by OPC in the production process, and obtain mechanical properties similar to OPC.

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## References

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