



# Performance Evaluation of Self-Curing Concrete Incorporating Palm Oil Fuel Ash

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## Abstract—

This study investigates the performance of self-curing concrete incorporating Polyethylene Glycol (PEG-400) as an internal curing agent and Palm Oil Fuel Ash (POFA) as a partial replacement for cement. The fresh, mechanical, and durability properties of the concrete were evaluated using standard tests. The results showed that PEG-400 improved internal moisture retention and hydration efficiency, while POFA enhanced long-term strength and durability through pozzolanic reaction. The combined use of PEG-400 and POFA produced sustainable and water-efficient concrete.

**Keywords—** Self-curing concrete, Palm Oil Fuel Ash, PEG-400, Sustainable concrete, Internal curing.

## I. INTRODUCTION

Concrete is one of the most extensively used construction materials worldwide due to its excellent compressive strength, durability, and adaptability in various structural applications. However, the rapid growth of the construction industry has led to increased consumption of cement and natural resources, resulting in significant environmental impacts such as carbon dioxide emissions and depletion of raw materials. Therefore, the development of sustainable and durable concrete has become an important area of research in modern construction practices. Proper curing is essential for achieving the desired strength and durability of concrete. Conventional

curing methods require continuous external water supply, which may not always be practical, particularly in regions facing water scarcity. Inadequate curing can result in poor hydration, shrinkage cracks, and reduced durability of concrete structures. Self-curing concrete, also known as internally cured concrete, has emerged as an effective solution to overcome these limitations. Self-curing agents such as Polyethylene Glycol (PEG) retain moisture within the concrete matrix, thereby promoting continuous hydration and improving the performance of concrete without the need for extensive external curing. Simultaneously, the utilization of supplementary cementitious materials derived from industrial and



agricultural wastes has gained considerable attention in sustainable concrete technology. Palm Oil Fuel Ash (POFA), an agro-industrial by-product generated from palm oil mills, possesses pozzolanic properties and can be effectively used as a partial replacement for cement. The incorporation of POFA in concrete reduces environmental pollution associated with waste disposal and decreases cement consumption. In addition, POFA contributes to improved microstructural properties through secondary hydration reactions, leading to enhanced long-term strength and durability. Recent studies have reported that self-curing concrete incorporating pozzolanic materials exhibits improved mechanical performance, reduced permeability, lower shrinkage, and enhanced resistance against aggressive environmental conditions. Nevertheless, limited research has been conducted on the combined effect of self-curing agents and POFA on the overall performance characteristics of concrete. Hence, further investigation is necessary to evaluate the effectiveness of this sustainable concrete system. The present study aims to evaluate the performance of self-curing concrete incorporating Palm Oil Fuel Ash. The investigation focuses on the mechanical and durability properties of concrete containing varying percentages of POFA along with a self-curing agent. Experimental studies including compressive strength, split tensile strength, flexural strength, water absorption, and acid resistance tests were carried out to assess the suitability of the developed concrete for sustainable and durable construction applications.

## II. LITERATURE REVIEW

Several researchers have studied the performance of self-curing concrete and the utilization of supplementary cementitious materials in concrete production. Jagannadha Kumar et al. reported that the use of Polyethylene Glycol (PEG) as a self-curing agent improved the hydration process and enhanced the strength characteristics of concrete. Neville stated that proper curing is essential for achieving desired strength and durability in concrete structures. Researchers also investigated the use of Palm Oil Fuel Ash (POFA) as a partial replacement for cement due to its pozzolanic properties. Studies revealed that POFA improves the microstructure of concrete by producing additional calcium silicate hydrate (C-S-H) gel, which enhances strength and durability performance. Experimental investigations conducted by various researchers showed that concrete containing POFA exhibited reduced permeability, lower water absorption, and better resistance against chemical attacks. Previous studies further indicated that the combined use of self-curing agents and pozzolanic materials can produce sustainable and durable concrete. However, limited research has been carried out on the combined effect of PEG-400 and POFA in self-curing concrete. Therefore, the present study focuses on evaluating the mechanical and durability performance of self-curing concrete incorporating Palm Oil Fuel Ash.

## III. METHODOLOGY



Fig. 1 Methodology of self-curing concrete

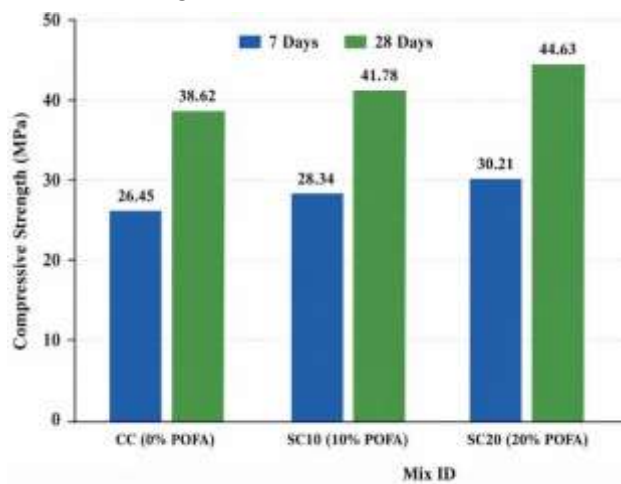
## IV. RESULTS AND DISCUSSION

### 4.1 Compressive Strength Test

The compressive strength test was conducted to determine the load carrying capacity of self-



curing concrete incorporating Palm Oil Fuel Ash (POFA). The test was carried out in accordance with IS 516:2018 specifications. Cube specimens of size 150 mm × 150 mm × 150 mm were cast for different concrete mixes and tested after 7 and 28 days of curing. After the completion of the curing period, the specimens were removed from the curing condition and cleaned properly to remove surface moisture. The cube specimens were placed centrally in the Compression Testing Machine (CTM) and load was applied gradually at a uniform rate until failure occurred. The maximum load carried by the specimen before failure was recorded. The compressive strength of concrete was calculated using the following relationship and value in figure 2.



$$f_c = \frac{P}{A}$$

Fig 2 Compressive strength at 7 and 28 days

#### 4.2 Split Tensile Strength Test

The split tensile strength test was conducted to determine the tensile strength characteristics of self-curing concrete incorporating Palm Oil Fuel Ash (POFA). The test was carried out in accordance with IS 5816:1999 specifications. Cylindrical specimens of size 150 mm diameter and 300 mm height were cast and tested after 28 days of curing. After the curing period, the specimens were removed and surface moisture was cleaned properly. The cylindrical specimen was placed horizontally between the loading plates of the Compression Testing Machine

(CTM). Load was applied gradually and uniformly along the length of the specimen until failure occurred due to splitting action. The maximum load at failure was recorded. The split tensile strength of concrete was calculated using the following equation and value in figure 3.

$$f_t = \frac{2P}{\pi DL}$$

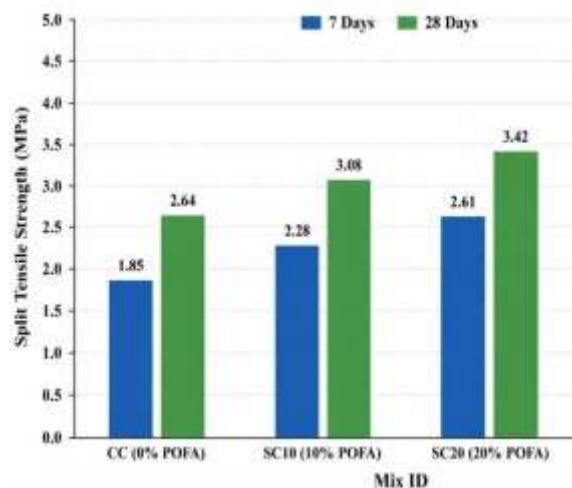


Fig 3 Split tensile at 7 and 28 days

#### V. CONCLUSION

The present study evaluated the performance of self-curing concrete incorporating Palm Oil Fuel Ash (POFA) using PEG-400 as a self-curing agent. The experimental investigation revealed that the incorporation of PEG-400 effectively provided internal curing by retaining moisture within the concrete matrix and promoting continuous hydration. Partial replacement of cement with POFA improved both the mechanical and durability properties of concrete up to an optimum replacement level. Among the various mixes, the SC20 mix containing 20% POFA exhibited superior performance in terms of compressive strength, split tensile strength, and flexural strength due to enhanced pozzolanic activity and improved microstructural development. In addition, self-curing concrete incorporating POFA showed reduced water absorption and better resistance against acid attack compared to conventional concrete. The utilization of POFA also contributed to sustainable construction by reducing cement



consumption and effectively utilizing agro-industrial waste material. Therefore, the combination of self-curing technology and Palm Oil Fuel Ash can be considered a sustainable, durable, and eco-friendly alternative for modern concrete construction applications.

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