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# Strength and Durability Performance of Mortars Incorporating Calcined Clay as Pozzolan in Comparison with silica fume

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## ABSTRACT

The use of low-grade calcined clays is the only potential material available in large quantities to meet the requirements of eco-efficient supplementary cementitious materials by decreasing the clinker content in blended types of cement or cement content in concrete. In the present paper, six mortar mixtures with a constant w/b ratio were used to investigate the mechanical and durability properties of mixtures substituted with low-grade calcined clays with/without limestone compared to PC and silica fume mixtures. The results show that using calcined clays with low or intermediate purity (i.e., kaolinite content) leads to enhanced durability besides the comparable strength development characteristics compared to PC mortar. In this regard, the addition of 30% calcined clay with/without limestone led to a marked decrease (about 80 and 40%) in chloride ion diffusion coefficient (Da) and an increase in surface chloride content (Cs) compared to the reference mixture. In addition, the utilization of calcined clay with a kaolinite content of 56.7% led to a reduction of 52% in Da and an increase of 140% in electrical resistivity compared to silica fume binder. The primary reason for the better performance is attributed to the refined pore structure and dense microstructure of the cement paste with the calcined clay pozzolan compared to PC and silica fume.

**Keywords:** **Calcined clay; durability; Kaolinite; Limestone; chloride diffusion.**



## 1. INTRODUCTION

The use of supplementary cementitious materials (SCMs) has a high potential to enhance strength characteristics, improve durability issues, reduce carbon emissions, and intact resource utilization in cement and concrete production, especially for developing countries. However, it should be noted that the dilution effect could negatively influence the mechanical properties, particularly at early ages. Additionally, it was reported that the cement industry is responsible for approximately 5–8% of the world's CO2 emissions [1, 2]. A forward-looking solution and strategy for decreasing CO2 emissions during the cement manufacturing stage are reducing the clinker-to-cement ratio by substitution a percentage of supplementary cementitious material as clinker. However, the most replacement value for pozzolans is about 35% and proved to be insufficient to drastically reduce the worldwide carbon emissions from cement production [3]. Today, in cement manufacturing, more than 80% of the supplementary cementitious materials for replacement of cement clinker are: limestone, fly ash, or slag [4]. It was also reported that the substitution of slag and fly ash, regardless of their quality, has particular problems [4]. Regarding limestone, it has been reported that adding more than 10% limestone to