# Properties of Cementitious Materials with Reclaimed Cement

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## Abstract

This paper introduces an eco-friendly approach to developing cementitious materials using reclaimed cement obtained from demolished structures or disaster debris as a partial replacement for virgin cement, with a focus on the properties of the resulting cement paste. This innovative practice aims to reduce the demand for new cement in the building and construction industry, thereby contributing to a more sustainable and carbon-neutral built environment. Specimens with varying proportions of reclaimed cement, ranging from 0 to 20%, were prepared and analyzed for both fresh and hardened properties. The findings reveal that cement paste containing up to 20% reclaimed cement shows comparable performance to control specimens made solely with ordinary Portland cement (OPC), indicating their potential suitability for various built environment applications.

**Keywords:** reclaimed cement; compressive strength; heat of hydration; sustainability; cement

## 1 Introduction

The rapid development of the construction industry increases the demand for different types of concrete. Concrete is composed of a few primary materials, with cement serving as the crucial binder that holds these components together. Cement, when mixed with water, forms a paste that binds the other materials together and hardens over time, which contributes to the physical properties of hardened concrete.

Cement is produced by following multiple energy-intensive processes which include extreme heating of its materials [1]. This heating process releases a significant amount of carbon dioxide ($CO_2$) into the atmosphere, thus posing detrimental effects to the environment. More than 500,000 tons of harmful emissions per year come from the cement industry, making it the third largest source of air pollution [2]. A typical concrete mix has only 10-15% cement by mass, yet 90% of its greenhouse gas emissions come from cement [3]. The study of alternative cementitious materials has been emerging. Since the use of concrete cannot be eliminated to minimize environmental impacts.

Multiple studies have investigated alternatives or additives to cement [4]– [7]. Supplementary cementitious materials (SCMs) have been widely used in concrete as partial replacements to cement because most SCMs are by-products of industrial processes making them more cost-effective, and because of their significant contribution to the physical properties of concrete [8]. Commonly used SCMs include fly ash, slag, and silica fume [9]. However, the growing demand for SCMs such as fly ash and slag is expected to outstrip supply by 50%, while the availability of slag cement is diminishing due to reduced blast furnace operations [10].

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