



Abstract of the Thesis



Name : Joshi Parth Harkishan

Enrollment No. : 189999912027

Faculty : Engineering

Discipline/Branch : Civil Engineering

Title of the Thesis : Development of Self-Compacting Concrete Using Ceramic Waste

Abstract

The widespread utilization of cement in construction significantly contributes to its escalating production, thereby exacerbating raw material depletion and environmental pollution. Notably, the production of one metric ton of cement results in the emission of a proportionate quantity of carbon dioxide, a greenhouse gas implicated in global warming. One potential mitigation strategy involves the reduction of cement consumption or production. Given cement's critical role in the construction sector, the identification of suitable alternative materials is of paramount importance. Consequently, researchers are actively investigating the incorporation of supplementary cementitious materials, encompassing natural pozzolans, as well as waste and by-products derived from diverse industrial processes. Self-Compacting Concrete is a special type of concrete, characterized by its exceptional flowability and ability to achieve a high-quality surface finish without segregation, typically achieved through an increased cement content. The use of self-compacting concrete (SCC) in routine construction projects in India remains relatively limited, largely due to insufficient awareness and a lack of widely available technical data among practitioners. As with any new material or construction technology, broad acceptance generally depends on clear evidence that it can match or outperform conventional concrete in practice. In recent years, however, substantial research efforts within the country have focused on developing and optimizing SCC so that it can be reliably used in Indian conditions. Numerous full-scale casting and testing programs have documented its technical and economic benefits, providing growing proof that SCC is a viable and often advantageous alternative to traditional vibrated concrete. Research indicates that incorporating filler materials with cement as a powder component can also improve the rheological properties of SCC mixtures, reducing the necessity for higher cement contents, thereby lowering costs and minimizing heat of hydration. The utilization of alternative industrial waste materials in construction has garnered significant research attention over the years, with the aim of assessing their suitability for self-compacting concrete applications and their potential as filler materials. This research undertakes an experimental investigation to determine the potential of various ceramic waste as supplementary cementitious material in SCC.

In the present experimental investigation, the main concentration was focused on identifying a particular source of ceramic waste to be used as a replacement to cement in SCC. For this, four different types of ceramic waste were collected. This included - (1) ceramic sludge generated during tile manufacturing process, (2) waste collected from broken tiles, (3) waste collected from broken sanitary ware, and (4) waste collected from broken earthen ware. Each of these wastes was broken down to smaller pieces and then



grounded to fine Ceramic Waste Powder (CWP). Firstly, the pozzolanic potential of these CWP were assessed using direct methods - Frattini test and Lime reactivity test and also by indirect methods - Strength Activity Index (SAI) test. CWP with better pozzolanic reactivity was used in further experimental investigation. The concrete mix was prepared keeping binder (cement + CWP) content constant at 450 kg/m³. The cement was replaced by CWP at 5%, 10%, 15%, 20%, 25% and 30% by weight of cement for three different series of water to binder ratio: 0.4, 0.45 and 0.5. A total of 21 mixes were casted. The fresh properties of these mixes (flowability, pass ability, viscosity and segregation resistance) were assessed as per the European guidelines EFNARC 2005. The mechanical properties (compressive strength of cubes, split tensile strength of cylinders, flexural strength of beams, ultrasonic pulse velocity) were assessed as per Indian Standards and durability properties (rapid chloride penetration test, sorptivity test, and resistance to Sulphur attack, acid attack and sea-water immersion) were assessed as per available literature and compared with controlled SCC with no CWP. It was concluded that CWP can be used to successfully produce SCC mixtures with improved fresh and hardened properties. It improved the mixtures' resistance to segregation and their capacity to pass through obstructions. The incorporation of CWP up to a concentration of 10% in SCC mixtures led to more densely compacted structures, exhibiting more or similar strength, low permeability and overall better durability as compared to controlled SCC. Furthermore, the successful results of this study suggest that the use of CWP in SCC can be implemented, expanding the range of available fillers for SCC, conserving landfill space, and mitigating CO₂ emissions associated with cement production.

This Ph.D. thesis would be useful for developing sustainable concrete - by replacing up to 10% of cement with CWP in SCC. This research diverts non-biodegradable ceramic waste from landfills and lowers carbon emissions from cement manufacturing. It provides a cost-effective, durable concrete mix with superior chemical resistance and low permeability for longer-lasting infrastructure. Ultimately, the study delivers key technical data to advance sustainable, circular construction practices in building sectors.

List of Publications:

1. Joshi, P. H., & Parekh, D. N. (2023). Valorization of ceramic waste powder as cementitious blend in self-compacting concrete – A review. *Materials Today: Proceedings*, 77(3), 1007-1015. <https://doi.org/10.1016/j.matpr.2023.01.068> (SCOPUS indexed)
2. Joshi, P., & Parekh, D. (2022). Assessment of Utilization of Ceramic Waste As a Substitute To Concrete Constituents – a Review. *Revista Ingeniería de Construcción*, 37(1), 69–78. <https://doi.org/10.7764/ric.00019.21> (WoS indexed)
3. Joshi, P. H., & Parekh, D. N. (2026). Experimental Investigation on the Influence of High Water-to-Binder Ratio on the Properties of Self-Compacting Concrete Incorporating Ceramic Waste Powder as a Cement Replacement. *International Journal of Aquatic Research and Environmental Studies*, 6(S5), 1465–1475. <https://injoere.com/index.php/injoere/article/view/1579/1021> (SCOPUS indexed)
4. Joshi, P. H., & Parekh, D. N. (2026). Prediction of Fresh and Mechanical Properties of Self-Compacting Concrete Using Gaussian Process Regression. *International Journal of Innovative Science and Research Technology*, 11(7), 1898. <https://doi.org/10.38124/ijisrt/26jul1169> (UGC)