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# Recycle option for metallurgical by-product (Spent Foundry Sand) in green concrete for sustainable construction

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ABSTRACT

Reuse of waste materials as construction material is very much essential to achieve sustainable construction. Utilization of waste materials as construction material not only help in protection of environment but also result in monetary savings. Spent Foundry Sand (SFS) is the waste material generated by metal casting industry. This paper presents study on economic and environmental benefits of recycling of SFS in concrete as sand replacement. Strength and durability properties of green concrete made with SFS as sand replacement are also presented. Natural sand in concrete was replaced with SFS at 0, 5, 10, 15 and 20% replacement levels by weight. To assess the performance of green concrete made with SFS, compressive strength, splitting tensile strength, deicing salt resistance and chloride permeability tests were performed. At age of 28 days, green concrete mixtures containing SFS as sand replacement displayed up to 26% and 12.87% improvement in compressive strength and splitting tensile strength over that of control concrete, respectively. Similarly, concrete mixtures made with SFS exhibited 7.2–17.7% lower chloride ion penetration and 6.6–26.42% improvement in salt scaling resistance on use of SFS. The green concrete mixtures showed very slight scaling after 50 cycles of freezing and thawing in the presence of deicing salt compared to slight to moderate scaling shown by control concrete. The incorporation of up to 20% SFS as sand replacement results improvement in strength and durability properties of green concrete over those of control concrete. Green concrete made with SFS is economical and reduces negative impact on environment by reducing $CO_2$ emissions.



## 1. Introduction

Sustainable construction can be achieved with the help of green concrete by implementing the tools and strategies reported by Berry (2009) and Stanley (2010). For this purpose they suggested to use 1)., recycled material to reduce dependence on natural materials; 2) supplementary cementing materials to reduce consumption of cement thereby reducing $CO_2$ emissions; and 3) wash water in manufacturing of concrete with improved properties. Green concrete is the durable concrete produced with the aim to have the least impact on the environment by substituting 1) cement with waste materials such as fly ash, blast furnace slag and silica fumes; and 2) natural aggregates with recycled/waste materials or industrial by-products.

The manufacturing of cement, the main constituent of concrete contribute about 95% of the total greenhouse gas released per cubic yard of concrete produced (Obla, 2009). Worldwide, the cement manufacturing industry contributes nearly 7% of global greenhouse gas emissions. The emission of greenhouse gases to the atmosphere is responsible for global warming (www.ucsusa.org). As per Carbon Dioxide Information Analysis Center (CDIAC) statistical data, $CO_2$ emissions in India increased from 0.268 to 1.59 metric tons per capita in a period between year 1960 and 2013. $CO_2$ emissions are expected to increase in future with increase in construction activities, increase in living standards, etc. However, CDIAC data (2013) reveals that in India, per capita $CO_2$ emission is much lower compared to 16.39 metric tons per capita in USA.

Till date, research has been focused on the use of supplementary cementing materials to enhance the concrete properties and reduce $CO_2$ emissions. Though mining of natural aggregates contributes nearly 1% of the total $CO_2$ emissions, the mining of natural materials on large scale for use in the manufacturing of concrete every year

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