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Effect of granite industry waste addition on durability properties of fly ash blended self-compacting concrete

Abhishek Jain [a,*], Sumit Choudhary [b], Rajesh Gupta [c], Sandeep Chaudhary [d,*], Lilesh Gautam [c]

[a] Department of Civil Engineering, Swami Keshvanand Institute of Technology, Management & Gramothan, Jaipur, Rajasthan, India
[b] Department of Civil Engineering, Aditya Engineering College, Surampalem, Andhra Pradesh 533437, India
[c] Department of Civil Engineering, Malaviya National Institute of Technology, Jaipur, Rajasthan, India
[d] Department of Civil Engineering, Indian Institute of Technology Indore, Simrol, Indore 453552, India

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ABSTRACT

The continuous production of granite powder (GP) waste causes a deadly impact on environment and human life. This present study thus examines the impact of granite powder (GP) as substitute to natural fine aggregate (up to 60%) on compressive strength and durability properties of eco-friendly fly ash blended self-compacting concrete (SCC). Results revealed that strength enhanced on incorporation of up to 40% GP in concrete mixture than fly ash blended control mixture. Resistance against chloride, carbonation and corrosion improved for incorporation of up to 50% GP in concrete mixture than fly ash blended control mixture. Moreover, all the blended SCC mixtures, except SCC mixture containing 50% and 60% GP, showed higher compressive strength than ordinary Portland cement (OPC) based control SCC mixture at higher days of curing. Besides, all the blended SCC mixtures, except mixture containing 60% GP, showed better resistance against chloride, carbonation, drying shrinkage and corrosion than OPC based control SCC mixture. It was hence concluded that GP up to 50% as an alternative of fine aggregate could be positively incorporated in the production of eco-friendly fly ash blended SCC for the improvement of aforesaid durability properties (with little higher precaution against drying shrinkage).

1. Introduction

The durability of concrete matrix is demarcated as the capability of concrete to withstand aggressive environment and protect it from the attack of unwanted substances. The penetration of unwanted or harmful substances into the concrete matrix deteriorates the service life of concrete structures. Common factors, such as drying shrinkage, carbonation, chloride attack, and corrosion, severely influence the durability of reinforced concrete structures [1]. It is stated that the engineering characteristics of the concrete matrix primarily depend on the attributes of concrete ingredients and their mixture proportions [2]. By the proper selection of concrete ingredients, the performance of the concrete matrix against the aggressive environment can be improved [3,4]. Besides, Hossain and Lachemi [5] reported that durability performance criteria of reinforced concrete structures could be achieved to some extent using self-compacting concrete (SCC) instead of normally vibrated concrete (NVC).

SCC is highly flowable concrete that can be effectively placed in tightly reinforced sections and complex shapes without the need for external vibration [6]. The popularity/application of SCC has increased worldwide to boost quality and serviceability of concrete structures since its development in the late-1980 s in Japan [7,8]. However, implementation of SCC at construction sites is still scarcer in many countries because of its higher cost. The prerequisite of higher cement and chemical admixture for attaining adequate workability characteristics makes the SCC costlier than NVC. Further, the higher cement content causes higher shrinkage and heat of hydration problems, which in turn leads the severe cracking and also damages the structural integrity by the attack of harmful substances into the concrete matrix [2]. Besides, the significant utilization of cement content in SCC is continuously leading the CO_2 emission. In past decades, several attempts [9–12] have been made for yielding sustainable SCC by swapping cement with secondary cementing materials, such as fly ash and metakaolin. Swapping of cement with these cementing materials not only enhances the performance of concrete but also reduces the cost of SCC and minimizes the landfilling and unwanted exploitation of natural resources. Therefore, incorporating these cementing materials in the manufacture of concrete products has become acceptable nowadays.

* Corresponding authors.
E-mail addresses: abhishekjn11@gmail.com (A. Jain), schaudhary@iiti.ac.in (S. Chaudhary).

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