ARTICLE IN PRESS

Materials Today: Proceedings xxx (xxxx) xxx

Contents lists available at ScienceDirect

Materials Today: Proceedings

journal homepage: www.elsevier.com/locate/matpr

Strength and durability studies on slag cement concrete made with copper slag as fine aggregates

Abhishek Maharishi [a,*], S.P. Singh [a], Lalit Kumar Gupta [b], Shehnazdeep [a]

[a] Department of Civil Engineering, Dr B R Ambedkar National Institute of Technology, Jalandhar 144011, India
[b] Department of Civil Engineering, Swami Keshvanand Institute of Technology, Management & Gramothan, Jaipur 302017, India

ARTICLE INFO

Article history:
Received 25 May 2020
Received in revised form 24 July 2020
Accepted 10 August 2020
Available online xxxx

Keywords:
Copper slag
Mechanical properties
Acid attack
Sulfate attack
Water absorption and voids

ABSTRACT

The current investigation is an attempt to perform the strength and durability studies on slag cement concrete prepared by using copper slag (CS) as a fractional/full replacement for natural fine aggregates (FNA). Tests were performed for compressive strength, split tensile strength, acid attack, sulfate attack, water absorption, and voids. The degree of replacement of natural fine aggregates with copper slag was put at 20%, 40%, 60%, 80%, and 100% by volume. A control mix containing 100% natural fine aggregates were also prepared for comparison. The strength and durability of slag cement concrete mixes having varying copper slag content were analyzed based on the results. A considerable rise in compressive strength of concrete having a 40% copper slag fraction when compared to control was also observed. However, compressive strength declined beyond 40% substitution as a result of excess free water and was lowest for 100% substitution. The tensile strength exhibited similar behavior to that of compressive strength. On acid and sulfate exposure, change in mass accompanied by a reduction in compressive strength was shown by all concrete mixes. The results showed a decrement in water absorption with an increment in copper slag fraction up to 40% of natural fine aggregates. On further increment in copper slag fraction, a rapid increase in absorption was observed due to an increase in void content in concrete. Water absorption showed a similar trend to that of percentage voids. Therefore, the use of copper slag up to 40% fraction of natural fine aggregates is recommended to derive a concrete with sound strength and durability characteristics.

1. Introduction

Global utilisation of about 25×10^9 tonne/year makes concrete one of the most widely used building materials [1]. Design versatility, easy availability and reasonable cost favor the dominance of concrete in the construction industry [2]. Its uses range from structural applications like buildings, bridges, roads, and dams to non-structural applications like kerbs, pipes, and drains. Concrete's significance as a construction material will always remain the same. But to cater to the needs of present-day construction standards, regular modifications are necessary [3]. Aggregates occupy almost 55%–80% of concrete volume [4]. While the natural coarse aggregates (size > 4.75 mm) can be obtained by crushing large size rocks, but in terms of fine aggregates (size < 4.75 mm), we are completely dependent on naturally occurring river sand. The continuously increasing consumption and reduced availability of fine sand, on the one hand, increases its cost. At the same time, it also leads to serious environmental concerns like loss of water holding strata and sliding of river banks due to fast withdrawal from river bed [5]. The various industrial activities, along with the production of primary products, results in the formation of various by-products that have little or no industrial application. These industrial by-products, which are generated in huge amounts around the world, introduce serious challenges related to their handling and disposal [6]. Granite powder [7], coal bottom ash [8], marble powder [9], fly ash [10], glass powder [11], copper slag [12] etc. are some of the induatrial by-products. One of the ways to come out of this helpless situation could be to treat industrial by-products as sustain-

* Corresponding author.

https://doi.org/10.1016/j.matpr.2020.08.232
2214-7853/© 2020 The Authors. Published by Elsevier Ltd.

Please cite this article as: A. Maharishi, S. P. Singh, L. K. Gupta et al., Strength and durability studies on slag cement concrete made with copper slag as fine aggregates, Materials Today: Proceedings, https://doi.org/10.1016/j.matpr.2020.08.232