Aptness of nano alumina (Al_2O_3) with high range water reducer-incorporated concrete

Mudasir Peerzada
Department of Civil Engineering, National Institute of Technology, Srinagar, India
Khan Adnan, Basrah Bilal, Riyaz Janees and Bazila Qazi
Department of Civil Engineering, SSM College of Engineering and Technology, Srinagar, India, and
Naqash Ahmed Javed
Department of Civil Engineering, National Institute of Technology, Srinagar, India

Abstract

Purpose – The purpose of this paper is to study the effect of nano alumina (Al_2O_3) on the properties of fresh concrete, hardened concrete and microstructure of concrete incorporated with high range water reducer (HRWR). This initiative was taken to improve characteristic properties of concrete using nano alumina because nano alumina can be easily be manufactured from a scrap of industrial aluminum products, so its incorporation in concrete will not only reduce industrial aluminum waste but will also change the morphology of concrete at the microstructural level.

Design/methodology/approach – To accomplish the objectives of the research, four different concrete mixes with the constant water–cement ratio (W/C) and superplasticizer (SP) content 0.4 and 0.6% by weight of cement, respectively, were prepared, whereas nano alumina content was altered by 0.3% and 0.4% by weight of cement. Fresh property of concrete was analyzed by using slump cone test, whereas hardened properties of concrete were analyzed through compression test and flexural strength test. The interaction of nano alumina with concrete composite was evaluated using an X-ray diffraction test.

Findings – It was observed that 0.6% superplasticizer by weight of cement increased workability by 22% but with the addition of 0.3%, nano alumina by weight of cement workability decreased by 31%. Compressive strength increased by 4.88% with the addition of 0.6% superplasticizer but with the addition of 0.3% nano alumina by weight of cement compressive strength increased by 18.60%. Also, flexural strength increased by 1.21% with the addition of 0.6% superplasticizer by weight of cement but with the addition of 0.3% nano alumina by weight of cement flexural strength increased by 8.76%. With the addition of superplasticizer, alite and belite phases remained un-hydrated but with the addition of nano alumina alite phase was hydrated while belite phase was un-hydrated. The size of belite crystals in mixes having nano alumina was less than that of mix having 0.6% superplasticizer. Also with the addition of nano alumina, a calcium aluminum silicate phase was formed which was responsible for the increment of strength in mixes having nano alumina.

Originality/value – Incorporation nano alumina (Al_2O_3) in concrete will not only reduce industrial aluminum waste but will also reduce CO_2 emission. Nano alumina (Al_2O_3) also changes morphology of concrete at micro structural level.

Keywords Concrete, Poly carboxylate based ether (PCE), Nano alumina, Compressive strength, Flexural strength, XRD, Calcium aluminum silicate

Paper type Research paper

Abbreviations

W/C = water–cement ratio;
PCE = Poly carboxylate-based ether;
SP = super plasticizer;
HRWR = High range water reducer; and
XRD = X-ray diffraction.

1. Introduction

Ordinary Portland cement (OPC) is the primary source of binder in concrete which is manufactured by grinding clinkers along with a small quantity of calcium sulphate. To alter functions of OPC mineral admixtures and chemical admixtures are added to the concrete matrix. Mineral admixtures such as limestone, fly ash, pozzolans, silica fumes and granulated blast furnace slag are added to the concrete matrix to increase its strength or reduce its porosity while chemical admixture such as polycarboxylic acid (PCE), metakaolin or vinsol resins are added to the concrete matrix to achieve workability or alter setting time. Both of these mineral admixtures and chemical admixtures are added in small quantities to achieve novelty (Nazari and Riahi, 2019). Also, mineral admixtures are

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