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TECHNICAL PAPER

Reinforcing masonry products through cellulosic fiber and agro waste material: characterization and microstructure

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Abstract

Contemporary cementitious materials as a substitute for building materials get a unique place in the field of construction industry due to its various applications. These materials would definitely reduce the carbon footprint and build an eco-friendly environment. In this regard, cellulosic and agro waste materials were used as a contemporary material in nano-sized particles to the cementitious compound. The purpose of the study is to inherent the reinforcing characteristics to the cementitious compound in addition to binding property and thereby a minimal percentage of reinforced material can be reduced in a structural concrete. In this direction, an attempt has been made to inherent the cementitious material by constant 3% of nano-silica and varied percentage of nano-filler viz., 1%, 2%, 3%, and 4% to the weight of cement. The characteristics of the mortar were analyzed through workability, mechanical, durability and thermal conductivity. At advanced curing ages, the contemporary materials provided desired characteristics in various aspects. Use of nano-sized particles exhibit a beneficiary effect of reduced voids, increased density, decreased pore volume and enhanced pozzolanic activity at an extended percentage of NF-03. These combined effects improved the properties of cementitious compound than that of ordinary PPC. The outcome of the present study would reduce the depletion of natural resources and induce additional reinforcing properties to the virgin (masonry) material.

Keywords Contemporary cementitious material · Cellulosic fiber · Agro industrial waste · Steam explosion · Reinforcing · Nano-silica · Nano-filler

Introduction

Concrete is one of the most commonly used building material in worldwide [1]. Moreover, the primary constituent is cement whose utilization is massive and also it has environmental hazards resulting in greenhouse effect [2]. Cement manufacturing industry is the third largest source in emitting the carbon-di-oxide [3]. As reported by World Business Council for sustainable development, India is the second largest cement manufacturer and at the end of 2050 about 850 million tons of carbon-di-oxide will be emitted. Recent studies also reported that for 1 kg of cement about 0.95 kg of carbon-di-oxide will be emitted [4]. Based on the above factors inclusive of environmental concern, depletion of natural resources etc., an environmental regulation has framed and forced the researchers to search for a new source material which are compatible, easy available and pollution free to the environment [5].

In this regard, cellulosic material and agro industrial waste materials offered a contemporary source in the field of research line. Agro industrial waste such as rice husk ash, rice straw ash, sugarcane bagasse ash provides a contemporary over traditional materials which has various advantages include feasibility, economic, minimize the issue concerning disposal, conservation of natural resources etc., [6, 7]. In addition, it also possesses pozzolanic properties [8, 9]. Rice husk ash is one of the by-products of agro industrial waste materials. Rice husk ash contains nearly 80% of silica thereby possessing pozzolanic properties. According to ASTM C618, it is categorized as class N pozzolanic material [10]. About 518 million tonne of paddy produced in worldwide. During milling, husk was removed from the rice as it contains less nutritional value. It also estimated that 1 kg of rice contains 0.2 kg of husk [11]. Further, rice husk

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