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Production and optimization of eco-efficient self compacting concrete SCC with limestone and PET

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HIGHLIGHTS

- Production and optimisation of an economic medium to high strength Eco-efficient SCC.
- RSM and multi-objectives optimisation used to maximise flow and compressive strength.
- Models for both flow and compressive strength have been developed and verified.

GRAPHICAL ABSTRACT

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ABSTRACT

This study aims to produce and optimize Eco-efficient self-compacting concrete (SCC) mixes using multi-waste substitutions. The main input parameters of mixes were total binder, fine aggregate and water contents whereas slump flow and compressive strength were the two main operational responses of produced concrete. Limestone powder (LP) and waste Polyethylene Terephthalate (PET) were used in concrete as parts of cement and fine aggregate respectively with high range water reducing admixture (SP) as part of water. Response Surface Methodology (RSM) and multi-objectives optimization using Minitab 17 statistical software were employed for this purpose.

Twenty SCC mixes were designed and checked experimentally using Central Composite Design (CCD) concept in RSM. Mathematical models were established and evaluated using analysis of variance test (ANOVA) according to the experimental results. This is in order to define the effectiveness degree of design parameters on the properties required and to adjust the derived mathematical models. Multi-objectives optimization process was adopted to determine the optimum values of the input parameters. The optimization revealed that the optimum values of the input factors, LP, PET and SP were 20.1%, 2.4% and 1.16% by weight respectively. These theoretical values were checked experimentally and the achieved responses were quiet similar or higher than the best proposed mix.

It was deduced that the developed models can be used to ensure a speedy mix design process by achieving maximum tested properties of eco-efficient SCC.

1. 1-Introduction

Spiritus sylvestre/wild spirit is the name given to carbon dioxide CO_2 in the seventeenth century. This gas is recognized as one of the first gases that differs from others in air and is described as a product of fermentation and combustion. Scientists observed its formation as an invisible substance due to the combustion of coal in a closed container [1]. CO_2 is an important component in the climate system, and it plays a key role in environmental pollution and global warming. For the global cement industry, the emission of CO_2 is estimated to be about 5–8% from the total amount of CO_2 in the atmosphere. During the manufacture of cement, there are two main sources of its emission: The first source is linked to the natural release of CO_2 associated with the de-carbonation of

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