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Prolonged Effects of Concrete Containing Fly Ash from Wood Biomass

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Abstract

In the wood biomass is frequently utilised as a fuel to produce heat and power, producing a sizable amount of ash in the process. In order to properly dispose of ash, especially in its finest fraction, specialised engineering solutions are needed because ash particles contain heavy metals and can readily damage land, groundwater, or air. In this work, concrete with a 15% and 30% cement replacement, respectively, was made using wood fly ash with high pozzolanic oxide content and one with a high CaO content. Due to the low stiffness of the wood ash particles, the introduction of wood ash into concrete decreased the 28-day compressive strength by up to 37%; however, the 2-year compressive strength revealed very little pozzolanic reactivity.

Keywords: Wood biomass fly ash • Compressive strength • Capillary absorption • Drying shrinkage

Introduction

As the ash concentration rose, so did the concrete's capillary absorption, but there was hardly any change in the material's gas permeability. After a year, concrete drying shrinkage was reduced by up to 65% by wood fly ash with a high CaO component. In a mix with 30% high CaO fly ash, swelling occurred during the first few days of hydration. This swelling was attributed to volume expansion brought on by the development of portlandite and brucite, but it did not lead to cracking or a reduction in long-term compressive strength.

The use of wood biomass for energy generation has expanded as a result of the trend in the European Union to minimise greenhouse gas emissions from coal use. In the EU-28 countries, biomass burning is expected to have created 11 million tonnes of ash in 2018, the bulk of which was wood biomass. To prevent ash from wood biomass from contaminating the air, land, or groundwater, it is essential that it is managed effectively. However, the majority of the produced ash is currently landfilled due to logistical challenges, various ash characteristics, or a lack of laws. Returning natural wood combustion ash to the forest from which it came may be the best option because it includes vital plant nutrients concentrated in the coarse ashfractions [1].

Description

It has been proven that a variety of construction items may be made using fly ash as a raw material. Today, one of the most widely used cement substitutes is fly ash from coal combustion, and its use as a component of concrete is standardised. Many new supplemental cementitious materials, in addition to coal fly ash, are being studied in an effort to increase the sustainability of cement-based products by reducing cement use or enhancing durability. Major potential consumers of wood fly ash have also been noted in the cement and concrete industries. WFA differs from coal fly ash in terms of its characteristics. Depending on the wood species and the wood pieces, WFA's chemical makeup changes.

Furthermore, various combustion processes have a significant impact on the physical and chemical characteristics of WFA particles. Despite not being as reactive as cement, WFA from fluidized bed and grate combustors can exhibit hydraulic and/or pozzolanic qualities. The effects of employing WFA as a cement substitute material have been thoroughly investigated. Due to the existence of unburned carbon particles with a lower stiffness than cement particles, WFA lowers mechanical qualities and raises water demands when used as a cement substitute material. However, by using WFA in place of cement, you can boost strength and workability because it has better particle packing or can be activated by grinding [2].

More study is needed on the use of WFA in the concrete sector, in part because the majority of studies on the impact of WFA on the characteristics of cement composites have only investigated cement pastes and mortars, with only a small number of tests scaled up to the concrete level. In this work, two kinds of WFA with various physical and chemical properties are used as partial cement substitutes in concrete. Over the course of a year, the impact of the WFA additive on concrete's compressive strength, permeability, and drying shrinkage was investigated [3,4].

Two power stations in Croatia produced wood fly ash (WFA), which was collected. Both units employ the same grate combustor incineration technology and are biomass cogeneration power plants that produce both heat and electricity. Northern Croatian power plant 1, which produces WFA1, has a 2.75 MW electrical energy capacity and a 15 MW heat energy capacity. In addition to using thinning wastes including twigs and tips, branches, bark, needles/leaves, and wood industry waste as fuel, Plant 1 also burns wood chips from beech, oak, fir, and spruce. This has a 4.1 MW heat capacity and a 1 MW electric capacity and generates WFA2. The WFAs employed in this study's chemical makeup. According to ISO/TS standards, X-ray fluorescence was used to determine the composition of the elements, loss [5].

Conclusion

This study presents the findings of long-term experiments on concrete built using two types and two quantities of WFA as a substitute for some of the cement. The effects of WFA characteristics and composition on concrete's

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compressive strength, permeability, and shrinkage were investigated over the course of a year. The experiments result in the findings listed below. However, in the case of WFA2, the swelling deformation was also pronounced at a young age, which was most likely caused by a significant amount of free MgO and free CaO; the TG analysis revealed that the swelling deformation was caused by a significant amount of free MgO and free CaO; when the drying shrinkage of the mixes was tested over a year, a significant decrease in shrinkage was observed in the mixes containing 30% WFA compared to the reference mix.

Acknowledgement

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Conflict of Interest

None.

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