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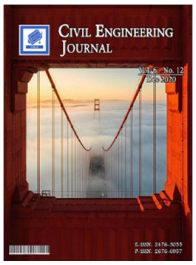

Development of Environment-Friendly Concrete through Partial Addition of Waste Glass Powder (WGP) as Cement Replacement

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Abstract

This paper presents the study carried out on the utilization of Waste Glass Powder (WGP) as supplementary cementitious material in concrete. The evaluation of the influence of WGP on the mechanical properties of concrete was carried out by casting and testing of concrete samples as per ASTM standards (cylinders and beam elements). The control samples were designed to represent field conditions with a target compressive strength of 20,000 kPa. The Portland cement in concrete was substituted with WGP in proportions of 0%-35% by weight, in increments of 5%. Two curing domains were adopted in the preparation of the test samples to evaluate the effect of pozzolanic material wherein the tested samples were cured for 28, 56, and 84 days. The study results indicated a reduction in compressive strength of concrete up to 10% with partial replacement of cement with 25% of WGP when standard curing of 28 days was adopted. Furthermore, with the same replacement proportion and prolonged curing for 84 days, the gap in strength reduction was reduced by 5%. However, a significant decrease in workability was noted between the control concrete samples and glass powder infused concrete. Furthermore, the Waste Glass Powder Concrete (WGPC) exhibited an improved flexural strength with the modulus of rupture for WGPC being 2% higher than control concrete at the age of 84 days. Based on the results of this study it was concluded that 25% replacement of cement with WGP provides an optimum replacement ratio.

Keywords: Supplementary Cementitious Materials; Waste Glass Powder; Pozzolanic; Prolong Curing; Recycling; Green Concrete.

1. Introduction

The construction industry has experienced a boom in wake of the development of concrete as a construction material. One of the major advantages of concrete as a construction material is the versatility with which it can be adapted to different construction scenarios. However, the manufacture of the conventional binding agent in concrete (cement) has a negative impact on the environment. It is estimated that cement production contributes approximately 7% of the overall carbon footprint [1, 2]. This has consequently led researchers to explore waste materials which can be used as partial replacement of cement. However, it is imperative that the waste material used as replacement of cement does not affect the mechanical properties of concrete beyond an acceptable level. Several studies have been carried out to this effect, where a number of materials such as bagasse ash, marble powder, silica fume, and fly ash, etc. have been used to replace a portion of cement in concrete [2-5]. These materials, in general, have demonstrated

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