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Investigation of Compaction on Compressive Strength and Porosity of Pervious Concrete

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Abstract

Pervious concrete (PC) is a sustainable substitute for conventional concrete application yet limited due to lack of understanding on its performance characteristics. The mix design affects the performance, mainly due to its porous structure that is also not uniform in characteristics when mass produced. Although zero compaction is envisaged for casting of PC, it is important for mass production of PC with uniform properties. This study analyses the impact of compaction on two primary performance indicators of pervious concrete, porosity and compressive strength. Laboratory specimens of size 150 mm cubic were cast with varying aggregate-to-cement ratio (2.5–7.0), compaction (15–75 blows by standard proctor hammer) and compaction distributions (two types), where water-to-cement ratio was maintained at 0.3 and aggregates used were between 12 and 25 mm. Twelve specimens of each design were cast, and six specimens were tested for compressive strength and porosity and another six specimens were cored to obtain cylindrical cores of 100 mm diameter for porosity measurements and porosity distribution analysis using image analytical tools. Results revealed that actual porosity (measured through image analysis) represented the performance of pervious concrete, and that it is perfectly linearly correlated with effective porosity. The type of compaction distribution had significant impact on the relationship between porosity and compressive strength, while the impact was not statistically evident in porosity and compressive strength separately. The performance of the samples, however, showed correlation to the type of compaction employed when machine learning tools are employed.

Keywords Pervious concrete · Effective porosity · Compaction energy distribution · Compressive strength · Actual porosity

1 Introduction

The Industrial revolution contrived multiple detrimental effects on the environment due to anthropogenic activities intended to upgrade quality of life [1]. Although in past clay was used in constructions, following the inclusion of binders like gypsum and lime in constructions, cement has become a prominent construction material. This created a revolution in the construction. Thenceforth, most of the urban areas are paved with impermeable surface, predominantly from concrete applications [2, 3]. Due to reasons including lack of permeability of conventional concrete pavement, percolation of rainwater and recharge of groundwater resources are restricted. Since there is an absence of a persistent water supply to the soil, the microenvironment gets affected. Furthermore, there is no heat and moisture exchange between the soil and air thereby temperature and humidity of the urban microenvironment increase [4]. Subsequently, there is an urge to understand significance of the environment and concept of sustainable development [5–7].

In the construction field the concept of Green Buildings emerged, that employs several strategies, such as energy efficiency, water conservation, responsible use of materials and resources, and indoor air quality, to diminish the negative sustainability impacts of environment [8]. In green structures, usage of green materials is the most important criterion. Green materials will have less impact on the environment compared to that of conventional materials [9–11]. Pervious concrete is considered as green material for various reasons including, usage of more environmental friendly cements with less carbon footprints, elimination of fine aggregates, usage of waste material such as fly ash and bottom ash as fillers, reduced material utilization, enhanced permeability that promotes percolation of rainwater to recharge aquifers in urban spaces, reduced heat transfer makes it a

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