

Effect of Substitution of Crushed Waste Glass as Partial Replacement for Natural Fine and Coarse Aggregate in Concrete

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Abstract: Reusing of waste glass in concrete production is among the attractive option of achieving waste reduction and preserving the natural resources from further depletion thereby protecting the environment and achieving sustainability. This present study examines the possible reuse of waste glass crushed into fine and coarse aggregate sizes as partial substitute for natural fine and coarse aggregate in concrete. The variables in this study is both the fine and coarse aggregate while the cement and water-cement ratio were held constant. The crushed glass was varied from 0 – 100% in steps of 25% by weight to replace the both the natural fine and coarse aggregate in the same concrete mix. Concrete mixes were prepared using a mix proportion of 1:2:4 (cement: fine aggregate: coarse aggregate) at water-cement ratio of 0.5 targeting a design strength of 20 MPa. Tests were carried out on total number of 90 concrete cube specimens of size 150 x 150 x150 mm and 90concrete cylinder specimens of dimension 100 mm diameter by 200 mm height after 3, 7, 14, 28, 42 and 90 days of curing. Test results indicated that the compressive and split tensile strength of the hardened concrete decreases with increasing waste glass content compared with the control. However, concrete mix made with 25% waste glass content compared significantly well with the control and can be suitably adopted for production of light weight concrete.

Introduction

Most developing nations of the world are faced with enormous problems of managing their solid wastes [1]. Solid waste disposal is mostly practiced through dumping of waste on open sites (dump sites) and burning without any form of control or restrictions [2, 3]. These practices affect the environment by polluting the water, air and land with great repercussion on the health of society [4]. Consequently, focus is shifting towards creating a sustainable process that could result in reduction of solid waste generation by recycling and reusing of waste materials [2, 5]. According to [6], reusing of waste in the construction industry is among the most attractive options to utilize waste because a significant quantity of these waste materials can be consumed by the concrete industry without asking for very high conditions of quality. Research is ongoing on new innovative ways of producing sustainable and environmentally friendly concrete from waste materials apart from the traditional natural resources which are considered not environmentally sustainable in the near future. It is estimated that, yearly, concrete production consumes about 1.5 billion tonnes of cement, 9 billion tonnes of aggregate and 1 billion tonnes of water for mixing [7]. This has huge impact on the environment due to depletion of natural resources, intensive energy consumption and greenhouse gases emission [8]. Moreover, with the demand for concrete expected to increase by the year 2050 to about 18 billion tonnes owing to increasing construction activities, it can be inferred that concrete would hold great significance in the nearest future. Again, there are increasing concerns that environmental considerations must be paramount in the choice of construction materials [9]. In recent times, efforts have been invested by researchers to work on the properties of waste glass as a substitute for aggregate in concrete. Glass is an amorphous and non-biodegradable material and a major problem to landfill operation. Studies have investigated the effect on strength