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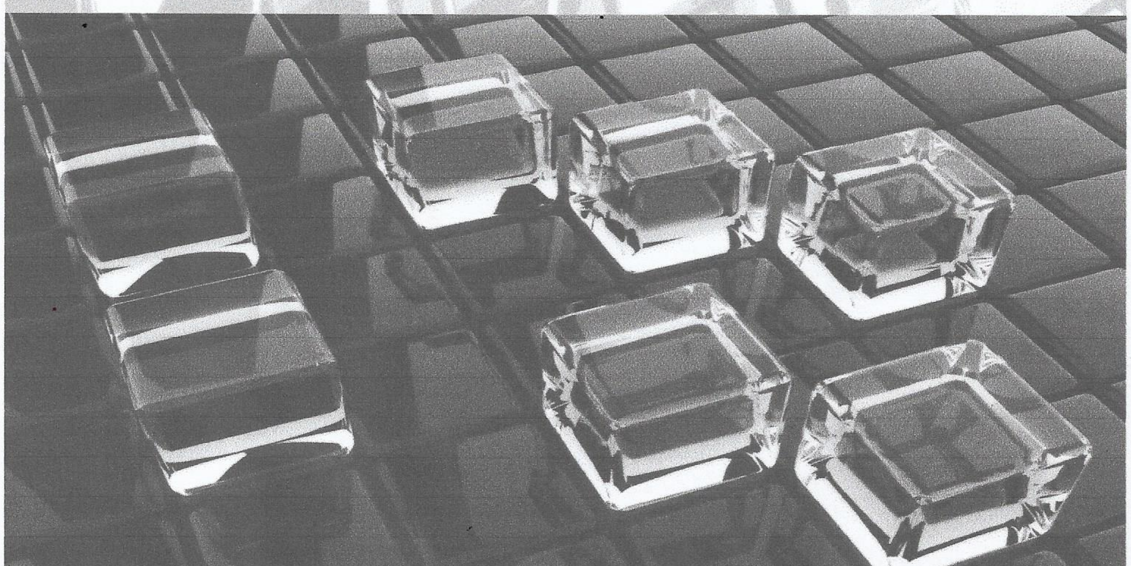

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EFFECT OF IRON ORE TAILINGS ON THE DRYING SHRINKAGE OF CONCRETE

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Abstract: The current pace of study about utilization of industrial waste material in making of concrete and its various applications in concrete production calls for a major paradigm towards achieving sustainability of the industry. Aggregate content in concrete is the most important factor affecting drying shrinkage. Previous researches have placed much attention on coarse aggregate content as it affects drying shrinkage while very few have reported about the influence of fine aggregate content in relation to the drying shrinkage. This study mainly focused on the effects of Iron ore tailings (a waste product generated from the production process of iron ore) on the drying shrinkage of concrete. Natural sand was partially replaced with Iron ore tailings to produce normal strength concrete. Five different types of iron ore tailings and the control sample generated six types of concrete samples that were used for the experiments. The physical properties, oxide composition and microstructure of fine aggregate materials, the mechanical properties of concrete and the drying shrinkage were studied. On the average 42% of ZIOTs passed 300μm sieve and this contributed to reduction in pore surface area of the concrete sample produced from it. This concrete sample also recorded moderate performance of drying shrinkage, with 90 days value of 462 x 10^{-6} and predicted ultimate shrinkage value of 605 x 10^{-6}. The general outcomes of research indicates that the inclusion of Iron ore tailings as fine aggregate in concrete improved the mechanical properties and slightly reduced the drying shrinkage of concrete.

Keywords: *Drying shrinkage, Hardened concrete, Iron ore tailings, concrete strengths, Elastic modulus.*

1.0 Introduction

Iron ore tailings is an industrial waste material derived during the production process of iron ore. The use of this material has not been fully established in construction of concrete structures, it is therefore necessary to evaluate more of it is potential when use as fine aggregate in concrete production. Drying shrinkage is caused by the withdrawal of water from concrete stored in unsaturated air, usually part of this movement is permanent (Neville, 2011). Due to the development of hydration process in concrete, it will change from a fluid to a plastic state, and finally to a solid hardened state. One of the most important properties of hardened concrete is the dimension solidity (Zongjin, 2011). The Portland cement concrete is considered the most versatile and economical structural material available. It is cheap and strong, and it can be placed in nearly any shape. However one of the greatest drawbacks of the concrete is that it shrinks as it dries. The quantity of aggregates in a concrete has a major impact on the drying shrinkage. Aggregates (fine and coarse) accounts for 70-80 by weight percent of concrete (Gencel et al., 2013).

There are several factors that affects the phenomenon of shrinkage in concrete structures. Due to volume instabilities such as drying shrinkage, concrete will crack at any stage of its service life (Mohd Sam et al., 2015). In large structural elements, tensile stresses are caused by differential shrinkage between the surface and the interior concrete. The larger shrinkage at the surface causes cracks to develop. These cracks may later, penetrate more deeply into the concrete. The extent of drying shrinkage is influenced mainly by the amount and type of aggregate and the water content of the concrete mix. The greater the quantity and quality of aggregate in a mix, the lower is the extent of shrinkage (Mehta and Monteiro, 2006): Aggregate with higher stiffness and of bigger size are more effective in reducing the contraction of concrete.

The general consensus of view relating to the phenomenon of drying shrinkage reveals that the magnitude of drying shrinkage is also a function of the fineness of gel. The finer the gel the more the shrinkage expected from the material. Cement paste shrinks more than mortar while mortar shrinks more than concrete. The concrete that contains smaller size aggregate is also expected to shrink more than concrete made with bigger size aggregate. However, due to the hygral behavior of concrete, it is very necessary to determine experimentally, the effects of any form of material on the properties of concrete, to be certain of its influence. This necessity becomes of paramount importance, when we are dealing with a new material. Tarr and Farny, (2008) mentioned that, the specific impact of any set of materials on the shrinkage of concrete should be determined by laboratory testing.

Several attempts and methods have been used in the past to reduce drying shrinkage of concrete. Some of this includes using the maximum practicable amount of aggregate in the mix, reduction of water-to-cement ratio and adjustment of water content when placing concrete during casting. Expansive cement is another important consideration, the paste of this cement at settling increases in volume at a greater degree compared to the ordinary Portland cement paste, thereby contributing to reduction in shrinkage. The use of expansive cement is valuable in concrete structures in which reduction in cracking is of importance. Such structures includes bridge decks, pavement slabs, swimming pool and all forms of liquid storage tanks. In general, the cement is used to produce shrinkage-compensating concrete and self-stressing concrete (Neville, 2011).