UNIVERSITI TEKNOLOGI MARA

TECHNICAL VIABILITY STUDY OF STEEL SLAG AS NON - CONVENTIONAL MATERIAL IN CONCRETE

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ABSTRACT

Although recycling of waste material has started since the last few decades, recycling as a means of sustainable use of Non-Conventional material did not actually start until fairly recently. Recycling of industrial waste and by-product material which is an environmentally sensitive problem faced by waste manager throughout the world is no exception. Specifically steelmaking operations are concerned by this problem because of the generation of a huge quantity of by - products such as Electric Arc Furnace Slag (EAFS). Basically, there are two reasons to the rationale underlying the usage of slag as a source of aggregate; the need to conserve natural resources and the need to manage waste amicably. However, to make the feasible acceptance of slag as aggregate in concrete, its strength, deformation and durability must also be assured. This research attempts to provide that assurance by conducting a comprehensive investigation on the strength, deformation and durability performance. This study is divided into four (4) main phases: (i) chemical and physical properties of slag and its suitability as aggregate for concrete production (ii) design of mix proportions of SSA using replacement level of 0%, 10%, 50% and 100%. Six (6) series of concrete specimen were cast. The series refer to the difference of w/c ratios between the ranges 0.47 – 0.7. The specimens were tested from 3 days until 365 days (iii) the engineering properties considered include compressive, tensile and flexural strength, modulus of elasticity and drying shrinkage. These properties are important in evaluating the performances of the SSA concrete compared to the corresponding NA concrete (iv) in order to access the durability performance of SSA concrete, resistance to carbonation, sulphate attack and gas permeability were conducted. Gradation of the aggregates shows that the slag aggregates is suitable for concrete and complied to existing BS EN 12620:2002. Tests on the aggregate have shown that the resistance to mechanical action such as the impact and crushing value for slag aggregate is lower but higher in specific gravity and water absorption capacity than the natural aggregates. From the strength point of view with various w/c, the slag aggregate concrete compared well with the natural aggregate concrete. The mechanical properties steel slag aggregate concrete increased with the proportion of coarse aggregate. The results indicated that the higher concrete strength was obtained for the mixtures possessed a percentage of 100% SSA as a replacement of the coarse aggregate for all various w/c used. The static modulus of elasticity of the SSA concrete is found to be higher than NA concrete which is the higher the w/c ratio, the lower the static modulus of elasticity. With respect to deformation, SSA concrete produces lower drying shrinkage, at low w/c ratio. The drying shrinkage of the concrete mixtures incorporating with 10 and 100% SSA were approximately 33% and 51% less than of NA concrete respectively. The SSA concrete exhibited good durability performance compared to NA concrete. Using regression analysis, the correlation between the compressive and other mechanical properties and durability performance of control NA and SSA concrete have also been established.

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CHAPTER ONE
INTRODUCTION

1.1 General

All over the world, concrete has become the most widely used material on earth after water. Many aspects of our daily life depend directly or indirectly on concrete. The rapidly changing world is facing many threats and serious challenges. The glory of modern industrialisation has been in doubt with ample facts of environmental deterioration problem. With modern lifestyle, alongside the advancement of technology has led to an increase in the amount and type of waste being generated, leading to a waste disposal crisis (Malek Batayneh *et al.*, 2007).

Sustainable construction mainly aims at the reduction of negative environmental impact resulted by construction industry which is the largest consumer of natural resources. Over a period of time, waste management has become one of the most complex and challenging problems in the world which is affecting the environment. The rapid growth of industrialisation has also given birth to numerous kinds of waste by-products which environmentally create problem of storage (Mohammed Nadeem *et al.*, 2012).

Chief Executive of Alam Flora, Mohd Siraj on Sunday Star (2006), mentioned that new methods and technologies are needed to reduce waste-generation because many cities around the world are beginning to develop and implement sustainable projects. This includes using waste as raw material for building homes.

The largest constituent of concrete is aggregate, which typically occupies a major volume in concrete. The occupying coarse aggregate volume can vary from 70% to 80% of the absolute volume for normal weight of natural aggregates. Up to now, we have been using natural coarse aggregate with huge volume such as crushed stone, granite and limestone in concrete production. As a result, the natural coarse aggregate resources have become exhausted. Due to the high cost of natural aggregate and the rising emphasis on sustainable construction, there is a need for the construction industry to search for alternative material (Mien *et al.*, 2014).