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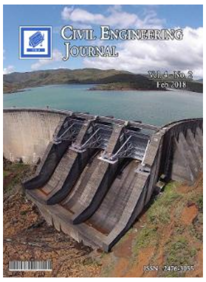
Civil Engineering Journal

Vol. 4, No. 2, February, 2018



Mechanistic Approach for Reducing the Thickness of Asphalt Layer Incorporating Steel Slag Aggregate

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Received 17 January 2018; Accepted 27 February 2018

Abstract

This study aimed to evaluate the possibility of reducing the thickness of asphalt layer as a novel solution for the high density of asphalt layer incorporated with steel slag aggregate, which increase the cost of transportation. Mechanistic-Empirical Pavement Design (MEPDG) approach was employed to evaluate the benefits of introducing polyvinyl alcohol fiber in terms of reducing the thickness of asphalt layer as well as the extension service life of asphalt layer. On the other hand, the correlation between creep strain slope (CSS) and secant creep stiffness modulus (SCSM) were assessed to provide a better evaluation and understanding concerning of the outputs of the dynamic creep test. The findings of this study showed that introducing polyvinyl alcohol fiber into the mixtures at the optimum content (0.5 kg/ton) have reduced the thickness of asphalt layer by approximately 10%. Additionally, polyvinyl alcohol fiber has increased the performance of the asphalt mixtures concerning of resilient modulus and dynamic creep. Furthermore, the correlation between CSS and SCSM was strong, which indicates that evaluation of permanent deformation using CSS and SCSM parameters provides better actual assessment than accumulation strain.

Keywords: Shear Stress; Asphalt; Steel Slag; Polyvinyl Alcohol; Fiber; Reduce Thickness; Creep Strain Slope; Secant Creep Stiffness.

1. Introduction

Asphalt mixture is a composite material containing coarse and fine aggregate, filler, and bitumen [1]. However, consumption of the natural aggregate has been increased due to the increasing projects in pavement applications [2]. As a result, there have been considerable efforts by researchers over the last two decades to reduce the increasing demand for the natural resources in the civil applications by using plants wastes as an alternative [3]. In this regard, steel slag is considered as a well-known by-product of steelmaking, which is used in the civil applications. Steel slag is produced by two manufacturing processes, which are basic oxygen furnace (BOF) and electric arc furnace (EAF) [4, 5]. Moreover, steel slag aggregate has been used for many decades due to its ability to enhance the performances of asphalt layer. Above that, the production of asphalt mixtures from slag instead from natural aggregate would decrease the amount of raw material extraction and enable further environmental benefit since less industrial by-products would be disposed in landfills [6].

Several studies have evaluated the utilization of steel slag aggregate in the asphalt mixtures as a partial or total replacement to the natural aggregate. Based on their finding, replacing the natural coarse aggregate by steel slag (EAF) exhibited better performances in contrast to control asphalt mixtures that containing 100% of the natural aggregate in connection with resilient modulus, dynamic creep, cracking resistance, fatigue resistance and moisture susceptibility. These enhancements were attributed to the properties of the steel slag aggregate (EAF) with reference to roughness, angularity, hardness, as well as it provides better interlocking and durability [6-13]. On the other hand, steel slag

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http://dx.doi.org/10.28991/cej-030995