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Effects of using carbon nano tubes on thermal and ductility properties of bitumen

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Abstract

New plans must be used to improve quality and to increase productivity and duribility of convetional pavements. In this investigation,it has been attempted to promote technical characteristics of bitumen using carbon nanotubes as an additive. Wet and dry process methods are most practical ways of mixing CNF in AC. It was decided that the best method to adopt for this investigation was the dry process.In this study thermal and ductility properties of modified bitumen by 0.1, 0.5, and 1% carbon nano tube content in bitumen were evaluated considering bitumen penetration, softening point, and ductility tests, then the results were compared to those of unmodified bitumen. It was found that adding carbon nano tubes effects on thermal properties of bitumen by increasing the softening point, and decreasing the bitumen penetration. It was also shown that bitumen ductility decreases by carbon nano tubes modification process.

Keywords: bitumen, carbon nano tube, ductility, bitumen penetration, softening point

1. INTRODUCTION

Nanotechnology is a relatively new field in science dealing with structures that are on the nano-scale. To illustrate how miniscule the nano-scale is, the following comparison could be made: if a human hair has a diameter of a football field, a nano-sized particle would have the diameter of a pencil. In 1985, Kroto and Smalley first discovered buckminsterfullerene and since then this technology has evolved rapidly [1]. Nano-sized particles have been used in numerous applications to improve various properties. However, due to many reasons including the cost of production and purification, nano-sized particles have seen very little use in the construction field. One of the promising additives in the construction field is the use of carbon nanotubes. In 1991, these materials were first characterized in depth by Iijima [2].

In general, carbon nanotubes are made of sheets of graphite that have rolled up to form a tubular structure. This is accomplished through various methods with a majority of them using electricity and an inert gas in an enclosed chamber [3]. There are two general types of carbon nanotubes: single-walled nanotubes (SWNTs) and multi-walled nanotubes (MWNTs). Because of the physics involved, MWNTs are easier and cheaper to produce [4]. However, they lack the strength found in SWNTs [4]. Nevertheless, SWNTs are found in bundles whereas MWNTs are found as individual molecules, allowing MWNTs to be dispersed efficiently in a material [4]. MWNTs are also stiffer than SWNTs and have a longer length, sometimes approaching the centimeter range [4]. The type and production of nanotubes will determine the diameter the materials which could range from 0.4nm (the smallest possible value) [5] up to several hundred nm [4]. This combination of long length and small diameter can lead to aspect ratios approaching 1,000,000:1. This gives rise to unique engineering characteristics such as some of these materials having a Young's Modulus of anywhere from 18 GPa to 68 GPa with a failure strain of 0.12 (12%) [6]. In addition, they can possess a tensile strength anywhere from 1.4 GPa to 2.9 GPa [6]. All of these properties make carbon nanotubes ideal candidates for improving the mechanical properties of various construction materials.