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EXTENDED ABSTRACT

Evaluation of Moisture Sensitivity of Asphalt Mixtures Incorporating Carbon NanoTube

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1. Introduction

In the present paper, the effects of a carbon nanotube on the moisture sensitivity of asphalt mixtures were investigated. Moisture sensitivity of asphalt mixtures is related to a phenomenon named stripping. The breaking of the bond between aggregate and asphalt binder is known as stripping (Xiao et al, 2010). Stripping reduces the strength of the material over the years which will manifest itself as rutting, corrugation, shoving, raveling, cracking, etc (Kodaii et al, 2012). Previous researches have introduced some additives for improving the moisture sensitivity of asphalt mixtures. Hydrated lime, Portland cement, polymeric material, and some other liquid anti stripping additives reduce the rate of moisture damage in asphalt mixtures. Recently, the use of nano materials in modifying different materials has become widespread (Alsaffar et al, 2014). In this study, a nano material named carbon nanotube with the quantity of 1, 2 and 3% was used for modification of asphalt binder. Moisture sensitivity of modified samples was investigated using indirect tensile strength test. In addition, the strength of modified samples was evaluated through marshal test.

2. Methodology

2.1. Experimental study

A 60/70 asphalt binder based on penetration grade was selected for this study. Since, aggregate type has a significant effect on the moisture sensitivity of asphalt mixtures, two different aggregates including siliceous and lime aggregate were used for fabricating of mixtures. In addition, 0, 1, 2 and 3% of the carbon nanotube were used for modification of asphalt binder. Fig. 1 shows an image of carbon nanotube in 100nm. The fabricated samples were tested using indirect tensile strength (ITS) and marshal tests. ITS test was conducted on dry and wet samples. In the next stage, tensile strength ratio (TSR) was determined, as well.

3. Results and discussion

3.1. Effect of carbon nanotube on indirect tensile strength

In order to investigate the moisture sensitivity of asphalt mixtures containing carbon nanotube, 48 samples were tested using indirect tensile strength test. Table 1 shows the effect of this additive on the ITS of both wet and dry samples as well as TSR. From the table, ITS of dry samples fabricated using siliceous and lime aggregate increases when additive content increases. Similar performance can be seen for wet samples. In addition, TSR value improves when additive content increases. It means that this additive enhances the moisture sensitivity of mixtures. Higher TSR value is preferable than its lower value.

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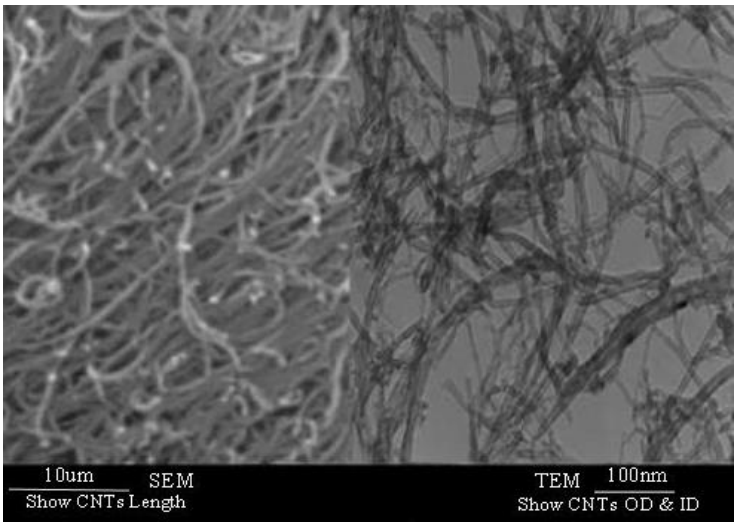

Fig. 1. SEM Image of Carbon Nanotube (100nm)

3.2. Effect of carbon nanotube on marshal samples

Marshal strength of mixtures containing carbon nanotube was investigated using marshal apparatuses. Table 1 shows the effect of this additive on marshal strength. From the table, marshal strength of samples containing additive is higher than of mixtures without additive. Marshal strength increases when additive content increases.

Table 1. Results of indirect tensile strength and marshal test

Additive content	Siliceous aggregate				Lime aggregate			
	ITS (dry)	ITS (wet)	TSR (%)	Marshal Strength	ITS (dry)	ITS (wet)	TSR (%)	Marshal Strength
0%	645.7	479.7	74.29	1210.67	631.7	483.7	76.57	1181.66
1%	713.7	590.7	81.62	1254.67	702.3	600.7	85.57	1236.67
2%	725.7	666.0	88.49	1306.33	736.7	665.7	90.36	1283.33
3%	794.3	748.3	94.21	1340.00	774.7	725.0	93.59	1334.33

4. Conclusions

This study showed that moisture sensitivity of asphalt mixtures modified by carbon nanotube depends on additive content and aggregate type. Carbon nanotube improves the moisture sensitivity of mixtures. Mixtures containing higher amount of carbon nanotube additive shows better stripping performance than that of containing lower amount of this additive. Carbon nanotube increases the indirect tensile strength of mixtures as well as marshal strength. Aggregate type shows a significant effect on the TSR values. Generally, mixtures fabricated with lime aggregate has higher TSR value when compared those mixtures fabricated siliceous aggregate.

5. References

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