Behaviour of Asphalt Mixtures with Recycled Polyethylene Terephthalate and High Density Polyethylene Pellet as Fine Aggregate Replacement

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The main objective of this study is to evaluate the behaviour of asphalt mixtures with recycled Polyethylene Terephthalate (PET) and High Density Polyethylene (HDPE) as fine aggregate replacement. The modified asphalts were determined by engineering properties of asphalt such as stiffness, permanent deformation and fatigue behaviour using Asphalt Testing System. The percentage of recycled PET and HDPE replace fine aggregate in asphalt mixture start up 25% percent. The recycled plastic subsitute aggregate of sieve size aggregate from 1.18 to 3.36mm content as follow with hot mix asphalt wearing course 14 (ACW14) in Standard Specification of Public Work Department of Malaysia. The bitumen content of asphalt mixture was 5.5% of weight of asphalt mixture. The Repeated Load Axial Test (RLAT), Indirect Tensile Stiffness Modulus Test (ITSM) and Indirect Tensile Fatigue Test (ITFT) were used to determine the permanent deformation, stiffness and fatigue properties of asphalt, respectively. In stiffness aspect, the result shows that all PET modified asphalt is less stiff than unmodified asphalt. All HDPE modified asphalts are stiffer rather than unmodified asphalt except 25% HDPE modified asphalt. In term of permanent deformation via RLAT, all modified asphalt slightly resists axial strain compare to unmodified asphalt. In ITFT view, the unmodified asphalt is more resistant to fatigue rather than HDPE modified asphalt except 10% of HDPE modified asphalt. The 5% and 15% PET modified asphalt are more resistant to fatigue compare to unmodified asphalt. In conclusion, the 10% HDPE modified asphalt could consider comply with all engineering properties requirement.

Keywords- recycle High Density Polyethylene; recycled Polyethylene Terephthalat; fatigue; permanent deformation; stiffness

I. INTRODUCTION

Nowadays, plastics are used as substitute for other materials to improve the performance of product and/or reduce cost of manufacture. For instance, the plastic bottles are used widely by water manufacturers to place their drink product in supermarket. This material is very cheap and at same time it is strong enough to accommodate water load. However the problem of plastic bottles raise after the costumers does not know to use plastic bottles after they drink. As the easiest and quickest solution, the consumers will most likely throw it away.

Plastic consumption in Malaysia has grown in recent years. This situation, increasing plastic consumption as well as consumption of other waste materials has led to pressure on landfill sites to accommodate this waste. According to the Waste and Resources Action Programme (WRAP) survey, majority plastics collected for recycling from the household waste stream are plastic bottles. While there are many polymer types, the most of bottles are made from either Polyethylene Terephthalate (PET) or High-Density Polyethylene (HDPE) material and approximated the ratio is 55-60% PET to 40-45% HDPE [1]. The environment and traffic volume are the factor of pavement life service. The environment like high temperature and heavy rain could accelerate permanent deformation and damage subgrade structure due to water penetration into subgrade.

The experimental research on the application of waste plastic bottles PET as additive has been applied with stone mastic asphalt (SMA). The 80/100 penetration grade bitumen, crushed granite, Portland cement (as mineral filler) and the waste PET were used in their project. The percentage of the added PET in this research was from 0 to 10% by weight of bitumen. The result show that the stiffness modulus of PET modified asphalts was higher than unmodified asphalt as high as 16% by using 6% PET. The wheel tracking test results illustrate that the PET modified asphalt has much higher rutting or permanent deformation resistance compare to unmodified asphalt. The lowest rut depth occurred at 4% PET modified asphalt which reduced the rut depth by 29% compared to the unmodified asphalt. The appreciate amount of PET was evaluated to be from 4% to 6% by weight of optimum bitumen content. [2].

The investigation of the waste material containing powdered HDPE in the hot mix asphalt as a bitumen modifier was studied in Turkey. The 19mm continuously graded asphalt mixture was developed from HDPE modified bitumen and crush limestone. The weight of powdered HDPE was