Comparative Evaluation of Fatigue Behavior for Modified Asphalt Concrete Pavement

Abstract

Fatigue crack has been recognized as one of the main forms for structural damage in asphalt concrete pavement. It is caused by the accumulation and growth of cracks, under the action of repeated vehicular loading, aging and effect of the environment. It is one of the most important problems that reduce the quality of asphalt concrete pavement and increase costs of construction and maintenance.

The main objective of the study is to provide a comparative evaluation of pavement resistance to the phenomenon of fatigue cracking between modified asphalt concrete pavement and conventional asphalt concrete pavement under the influence of changing the percentage of asphalt content by (0.5% ±) of the optimum value, changing the testing temperature and under the influence of long-term aging and moisture damage. To achieve that, the preparation of asphaltic mixtures involves the use of (40-50) penetration grade asphalt cement from AL-Nasria Refinery, mineral aggregate (12.5 mm nominal maximum size gradation), lime stone used as filler and two types of additives, fly ash and silica fumes were implemented.

The experimental program consisted of preparation of 15 Marshall Specimens of 63.5 x101.5 mm using Marshall Method to determine the optimum of asphalt content value. Then 25 rectangular slabs were prepared using the roller compactor device with dimensions (400 mm x 300 mm x 50 mm). Beam specimens were obtained by cutting each slab to five beams into dimension (400 mm * 60 mm * 50 mm). 75 beam specimens were tested using Nottingham four point bending beam device under the influence of three levels of constant strain (750MƐ, 400MƐ, 250MƐ), and three asphalt content value (4.4%, 4.9%, 5.4%), and different testing temperatures (5 ° C, 20 ° C and 30 ° C), short and long-term aging and moisture damage process.

The results obtained from Nottingham test showed that decreasing the asphalt content leads to decreasing the fatigue life and stiffness. In addition, it was noted that decreasing the testing temperature led to decreasing the fatigue life of the pavement and increasing its stiffness. The process of long term aging showed its impact by increasing stiffness and reducing the fatigue life of the asphalt concrete pavement as compared with short term aging, while the process of moisture damage showed high reduction in the fatigue life of asphalt concrete pavement and stiffness.

When the asphalt content was 4.4%, the Fatigue life increased by (50% and 111%) and stiffness increased by (124% and 155%), also at 5.4% AC, the fatigue life by (69%) and

(145%), and an increase in stiffness by (77%) and (61%) for modified mix with silica fumes and fly ash respectively, as compared with the control mix.

For temperature effect noted at 5 °C, the fatigue life increasing by (50%) and (145%) and the stiffness by (34%) and (43%) When testing temperature increased to 30 °C, the fatigue life increased by (48%) and (78%), and the stiffness increased by (66%) and (78%), for modified mix with silica fume and fly ash, respectively as compared with control mix.

Under the effect of long term aging, the fatigue life and stiffness had increased by (96%) and (178%) and by (56.5%) and (48%) for modified asphalt concrete pavement with silica fumes and fly ash, respectively, as compared with control asphalt concrete pavement. While under the effect of moisture damage, the Fatigue life and stiffness increased by (219%) and (96%) and (120%) and (82%) for modified asphalt concrete pavement with silica fume and fly ash respectively.