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Effect of Compaction Method on the Mechanical and Anisotropic Properties of Asphalt Mixtures

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Abstract : Asphaltic mixture is a heterogeneous material composed of three main components: aggregates; bitumen and air voids. The professional experience and scientific literature categorize asphaltic mixture as a viscoelastic material, whose behavior is determined by temperature and loading rate. Properties characterization of the asphaltic mixture used under the service conditions is done by compacting and testing cylindric asphalt samples in the laboratory. These samples must resemble in a high degree internal structure of the mixture achieved in service, and the mechanical characteristics of the compacted asphalt layer in the pavement. The laboratory samples are usually compacted in temperatures between 140 and 160 degrees Celsius. In this temperature range, the asphalt has a low degree of strength. The laboratory samples are compacted using the dynamic or vibrational compaction methods. In the compaction process, the aggregates tend to align themselves in certain directions that lead to anisotropic behavior of the asphaltic mixture. This issue has been studied in the Strategic Highway Research Program (SHRP) research, that recommended using the gyratory compactor based on the assumption that this method is the best in mimicking the compaction in the service. In Israel, the Netivei Israel company is considering adopting the Gyratory Method as a replacement for the Marshall method used today. Therefore, the compatibility of the Gyratory Method for the use with Israeli asphaltic mixtures should be investigated. In this research, we aimed to examine the impact of the compaction method used on the mechanical characteristics of the asphaltic mixtures and to evaluate the degree of anisotropy in relation to the compaction method. In order to carry out this research, samples have been compacted in the vibratory and gyratory compactors. These samples were cylindrically cored both vertically (compaction wise) and horizontally (perpendicular to compaction direction). These models were tested under dynamic modulus and permanent deformation tests. The comparable results of the tests proved that: (1) specimens compacted by the vibratory compactor had higher dynamic modulus values than the specimens compacted by the gyratory compactor (2) both vibratory and gyratory compacted specimens had anisotropic behavior, especially in high temperatures. Also, the degree of anisotropy is higher in specimens compacted by the gyratory method. (3) Specimens compacted by the vibratory method that were cored vertically had the highest resistance to rutting. On the other hand, specimens compacted by the vibratory method that were cored horizontally had the lowest resistance to rutting. Additionally (4) these differences between the different types of specimens rise mainly due to the different internal arrangement of aggregates resulting from the compaction method. (5) Based on the initial prediction of the performance of the flexible pavement containing an asphalt layer having characteristics based on the results achieved in this research. It can be concluded that there is a significant impact of the compaction method and the degree of anisotropy on the strains that develop in the pavement, and the resistance of the pavement to fatigue and rutting defects.

Keywords : anisotropy, asphalt compaction, dynamic modulus, gyratory compactor, mechanical properties, permanent deformation, vibratory compactor
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