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A comprehensive approach for the assessment of in-situ pavement density using GPR technique

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Proper construction of the asphalt pavement is a prerequisite to developing a long lasting roadway that does not require extensive future maintenance. This goal is achieved by verifying that design specifications are met through the use of quality assurance (QA) practices. The in-situ density is regarded as one of the most important controls used to ensure that a pavement being placed is of high quality because it is a good indicator of future performance. In-situ density is frequently assessed utilizing one or more of the following three methods: cores, nuclear density gauge measurements or non-nuclear density gauge measurements.
Each of the above mentioned methods, however, have their distinct disadvantages. Cores, for example, are generally considered to be the most accurate means of measuring in-situ density, however, they are a time consuming and destructive test that introduces a defect into asphalt pavements. Because of the destructive nature associated with coring, contractors and agencies have alternatively used non-destructive nuclear and non-nuclear density gauges for quality control purposes. These instruments allow for a more rapid assessment of the in-situ density, allowing measurements to be taken even during the pavement's construction. The disadvantage of these gauges are that they provide density readings only at discrete locations of the asphalt pavement mat, while no consensus exists among pavement researchers on the proper correlation between the gauges and core density.
In recent years, numerous alternative methods have been introduced for the assessment of in-situ density, both during asphalt pavement construction and afterwards. These methods include, amongst others, intelligent compaction, thermal imaging and ground penetrating radar (GPR). Among these methods, GPR has been defined as both a technically feasible and promising method for the nondestructive, rapid, and continuous evaluation of in-situ asphalt pavement density based on electromagnetic mixing (EM) theory, through the utilization of proper models. These models enable the prediction of asphalt mixture density dependent on its bulk dielectric constant as measured by the GPR, the dielectric properties of the asphalt mix materials, as well as other material information. The goal of the present study is to attempt to verify the prediction performance of various density models. To accomplish this goal GPR surveys were carried out in the field during asphalt pavement construction to evaluate the density results due to different compaction modes. The GPR data was analyzed to calculate the appropriate asphalt mix dielectric properties needed for the activation of the considered density prediction models. Predicted densities were compared with densities of the field cores extracted from the as-built asphalt pavement prior to trafficking. It was found that the predicted density values were significantly lower when compared to the ground truth data. A further investigation of the effect of temperature on GPR readings showed that GPR seems to overestimate the in-situ density. However, this approach could be used effectively to evaluate the performance of different compaction methods and set up the compaction pattern that is needed to achieve the desired asphalt pavement density.