Alternative solution to the gamma bench for the dielectric characterization of materials

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In the field of civil engineering, and more particularly in the road building, it is necessary to control some physical parameters with standard methods. These controls ensure the implementation is performed according to the technical specifications. They also allow to optimize the structure dimensions with the best safety/cost ratio and an optimal lifetime. Compactness related to density and therefore indicative of mechanical strength necessary to support traffic solicitations is a key parameter to control. Currently, density control in the laboratory is done using bench with nuclear sources on pavement cores, based on the emission and reception of gamma rays. Its replacement has now become a major issue since this method generates increasingly high costs and constraints (use, storage, transport and exposure to ionizing radiation). The objective of this work is to find an alternative non-nuclear solution to control the pavement compactness with an accuracy equivalent to the gamma-bench method. The proposed solution is an electromagnetic bench (EM), allowing cores tomography to measure permittivity. The density will then be evaluated by means of mixing rules. The EM bench consists of a vector network analyzer (Agilent E8362B) and two Ultra-Wide Band antennas [1.4-15 GHz] which are developed in this project in order to have the best performances (accuracy, dimensions...).

The antennas are placed facing each other, separated by a distance D. A cylindrical sample (core) extracted from stratified road medium of diameter d to be tested is placed in the middle of the system and both antennas move with a given step (ranging from a few mm to 1 cm) along the sample to measure by stratification the core EM properties. The entire EM bench is motorized and driven by software developed in the laboratory. At each step, a measurement of $S_{21}$-parameter is recorded. Then signals are processed in the time domain to evaluate the relative permittivity.

The first results of modeling and measurements on laboratory asphalt samples show that the system makes it possible to evaluate the relative permittivity of different stratified materials. Accuracy, resolution and perspectives will be discussed.

key words : density, asphalt concrete, radar, electromagnetic bench

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