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Advances in the assessment of mechanical properties of flexible pavements by GPR

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An extensive and time-efficient assessment of roads at the network level is crucial for road administrators and agencies to define priorities of intervention and decrease the likelihood of envisaged accidents.
Most of the damages in flexible pavements occur where stiffness of the asphalt and load-bearing layers is low. Therefore, an effective assessment of the strength and deformation properties of these layers can lead to identifying causes and locating the depth of damages. In addition, a prompt detection of early decay and loss of bearing capacity represents the real challenge to tackle for road administrators.
As a common practice in highway engineering, the Ground Penetrating Radar (GPR) and mechanical-based methods (e.g. Deflectometers, Curviameter, ...) are used separately for the assessment of the geometric (i.e. evaluation of the layer thicknesses) and the strength and deformation properties (i.e. evaluation of the deflection bowl) of road flexible pavements, respectively. The integration of the above information allows to evaluate reliable values of stiffness modulus of the pavement layers. In view of the aforementioned limitations and state-of-the-art practices in the assessment of the mechanical properties of flexible pavements, the development of a non-destructive testing methodology for real-time identification of early decay and loss of bearing capacity of roads at traffic speed would stand as a step forward compared with the traditional methods. Value added would be to provide an estimation of the pavement stiffness based on geometric, physical and mechanical attributes of the subsurface integrated into a unique model. This would emphasise strengths and narrow weaknesses of the above NDTs.
In particular, this work proposes an experimental-based model for the assessment of the stiffness of a road flexible pavement using high frequency GPR and Curviameter non-destructive testing (NDT) methods. To this effect, a 12 km-long stretch of a rural road located in the District of Madrid, Spain, was subjected to both GPR and Curviameter surveys. The georeferencing of the tests allowed for the matching between the physical and mechanical information from the two devices. A section worth 5% of the total length of the inspected stretch was randomly selected for calibration purposes. The proposed predictive model takes as input physical properties of the pavement calculated by GPR (i.e. thickness of the bitumen-bound layers and rate of attenuation of the signal) and returns as output the overall bearing capacity of the pavement expressed through a dedicated parameter.
As an outcome, a promising potential of GPR system and mechanical-based NDTs for predicting bearing strength of flexible pavements is pointed out, proving this methodology to be worthy for implementation is pavement management systems (PMSs).