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Empirical prediction of mechanical properties of flexible pavement through GPR

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To date, it is well known that the frequency of accidental events recorded on a road, is related to the deterioration rate of its pavement. In this sense, the monitoring of the pavement health over a road network is a crucial task for the administrations, to define a priority scale for maintenance works, and accordingly to lower the risk of accidents.
Several studies suggest the possibility to employ Ground-penetrating Radar (GPR) to overcome the limits of traditional bearing tests, which due to their low productivity and high costs, can only give a discrete knowledge about the strength of the pavement. This work presents a GPR-based empirical model for the prediction of the bearing capacity of a road pavement, expressed as Young's Modulus. The model exploits the GPR to extract information on the thickness of the base course and the clay content, by referring to the signal velocity and attenuation, respectively.
To test the effectiveness of the model, experimental activities have been accounted for. In particular, multi-frequency GPR tests have been performed along road sections of rural roads, composed of a flexible pavement, for a total of 45 Km. As ground-truth, light falling weight deflectometer (LFWD) and Curviameter have been employed. Both the electromagnetic and the mechanical datasets have been properly processed, in order to reduce misinterpretations and to raise the statistical significance of the procedure. Hence, the calibration of the parameters composing the model was run in a subsection, equal to 8% of the total length, randomly selected within the surveyed track. Finally, as validation, the model has been applied to the whole analysed dataset. As a result, the empirical model showed a good effectiveness in predicting the mechanical response of the pavement, with a normalised root mean squared deviation equal to 0.27. Finally, by averaging the measured and predicted mechanical data every 50 m and sorting the results into strength classes, a qualitative approach useful for a visual detection of low-resistance areas has been also proposed.
This study demonstrates the efficiency and reliability of GPR in mechanical assessment of flexible pavements. This empirical approach can represent a useful tool for administrations and companies managing road assets, for a non-destructive detection of the areas interested by early stage deterioration processes, and the definition of a priority-based scheduling of maintenance works.

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