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Health monitoring of railway ballast by air-launched GPR surveys

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A comprehensive assessment of the actual condition of the material composing railway track-beds is a crucial condition for an effective maintenance of the asset. In such a framework, GPR has demonstrated to be a viable alternative to the traditional techniques, well known to be invasive and time-consuming, for the inspection of track-beds.
This study reports on the experimental activities carried out on a test site area located in a railway depot in Rome, Italy. To the purpose of reproducing various different scenarios of health condition of track-bed material (i.e. ballast), a 30 m-long railway stretch was divided into 10 sub-stretches with length equal to 3 m. A specific combination of fragmentation and fouling of ballast particles and rate of humidity was arranged for each sub-stretch, in order to reproduce a comprehensive case history of potential decay conditions that it is likely to found in real life surveys.
The EM tests were conducted by means of a pulsed GPR system equipped with multiple air-launched horn antennas having central frequencies ranging between 1000 MHz and 2000 MHz. The antennas were kept suspended in the air at a height of 0.40 m, and were hand-towed along the railway stretch by means of a dedicated survey cart. All the devices were manufactured by IDS Georadar S.p.A. Main electromagnetic parameters of railway ballast were estimated for each scenario using time- and frequency-domain signal processing techniques. Interpretation of results has shown viability of the GPR method in detecting signs of decay at the network scale, thereby proving this technique to be worthy for implementation in asset management systems.