The application of Ground-Penetrating Radar to transportation engineering: recent advances and new perspectives (GI Division Outstanding ECS Award Lecture)

Geophysical Research Abstracts
Vol. 19, EGU2017-2742-1, 2017
EGU General Assembly 2017

The Application of Ground-Penetrating Radar to Transportation Engineering: Recent Advances and New Perspectives (GI Division Outstanding ECS Award Lecture)

Fabio Tosti (1), Andrea Benedetto (2), Lara Pajewski (3), and Amir M. Alani (1)

(1) School of Computing and Engineering, University of West London (UWL), St Mary's Road, Ealing, London W5 5RF, UK (Fabio.Tosti@uwl.ac.uk), (2) Department of Engineering, Roma Tre University, Via Vito Volterra 62, 00146, Rome, Italy, (3) Department of Information Engineering, Electronics and Telecommunications, Via Eudossiana 18, 00184 Rome, Italy

Ground-penetrating radar (GPR) is one of the most acknowledged and established non-destructive testing (NDT) techniques within the context of the health monitoring and assessment of transportation infrastructures. GPR is being increasingly used for the effective management of infrastructural assets as it weakens the case for using other destructive monitoring methods, such as digging holes, and allows for rapid and reliable detection of many causes of the subsurface damage. Thereby, its usage favours the optimisation of the economical expenditure for the effective maintenance of great infrastructures as well as it improves the public safety by preventing or not raising the risk of accidents.

GPR has been used in highway, railway and airfield engineering as well as for the monitoring of critical infrastructures, such as bridges and tunnels. It has found established use in the assessment of the geometric properties of the subsurface, such as in the case of the evaluation of the pavement layer thicknesses, or the size of the rebars in concrete-made structural components. Major physical-based investigations have been focused on the evaluation of the moisture ingress in flexible road pavements and in concrete structures, as well as on the detection of the rebars corrosion caused by the ingress of chloride. The majority of these parameters are evaluated using methods of signal analysis and data processing based on the signal in the time domain.

The sophistication of the hardware and software of the GPR systems over the last few years as well as the recent advances achieved in the research have contributed to raise the high potential of this non-destructive technique and paved the way towards new application areas in transportation engineering. In particular, GPR is nowadays finding major application when used with complementary non-destructive testing techniques, although it has still proved to provide reliable results in various self-standing applications.

This work aims at presenting the recent advances and the new perspectives in the application of GPR to transportation engineering. This study reports on new experimental-based and theoretical models for the assessment of the physical (i.e. clay and water content in subgrade soils, railway ballast fouling) and the mechanical (i.e. the Young's modulus of elasticity) properties that are critical in maintaining the structural stability and the bearing capacity of the major transport infrastructures, such as highways, railways and airfields.

With regard to the physical parameters, the electromagnetic behaviour related to the clay content in the load-bearing layers of flexible pavements as well as in subgrade soils has been analysed and modelled in both dry and wet conditions. Furthermore, it is discussed a new simulation-based methodology for the detection of the fouling content in railway ballast. Concerning the mechanical parameters, experimental based methods are presented for the assessment of the strength and deformation properties of the soils and the top-bounded layers of flexible pavements.

Furthermore, unique case studies in terms of the methodology proposed, the survey planning and the site procedures in rather complex operations, are discussed in the case of bridges and tunnels inspections.

Acknowledgements

The Authors are grateful to the GI Division President Dr. Francesco Soldovieri and the relevant Award Committee in the context of the "GI Division Outstanding Early Career Scientists Award" of the European Geosciences Union. We also acknowledge the COST Action TU1208 "Civil Engineering Applications of Ground Penetrating Radar" for providing networking and discussion opportunities throughout its activity and operation as well as facilitating prospect for publishing research outputs.