

Condition indices, condition evaluation and data-driven decision making for highway filter drains

Highway filter drains (HFDs) are aggregate filled trenches fitted with a porous carrier pipe laid at the base, used in the United Kingdom to drain significant lengths of the highway network acting as a combined drainage system. The highly porous granular backfill used, which is typically exposed at the surface of the trench, gradually deteriorates as foreign particles penetrate the trench and minimise the available void space in the drain. HFDs therefore require maintenance so they are fit for purpose. Following the paradigm shift of infrastructure management, and aiming to establish the context for a proactive HFD management approach, a set of condition assessment metrics is being developed along with the tools and methods to facilitate the requirement for reliable and accurate condition information to be collected. The aim of these developments is to improve decision making with regards to managing the maintenance of HFDs.

Under current business models, planned HFD maintenance often tends to be passive or reactive, based on empirical evidence in a given network with little formal long-term planning of investments or life-cycle cost assessment. This is largely due to the lack of a structured framework to enable road operators to collect and process condition data for this particular asset and the fact that dealing with drainage systems in the highways sector has not in the past been integrated in holistic Asset Management (AM) plans.

There is a consensus within the sector that any AM system is developed by aligning high level organisational goals to daily activities that prescribe what individuals are doing – how, when and where. This approach is defined by and revolves around asset data and knowledge generation. Condition data, a key input in any management system, enables the evaluation of the current physical state of an asset, allows the generation of performance indicators (from metrics to levels of service), enables the identification of current maintenance backlogs, and can be used to project deterioration and establish asset maintenance and rehabilitation (MR&R) strategies.

This research conducted by the Centre for Innovative and Collaborative Construction Engineering at Loughborough University, in collaboration with Connect Roads and Pavement Testing Services (PTS), focuses on the aforementioned drainage system and proposes the adoption of condition metrics that have been developed to represent deteriorated HFD performance, based on the extent of fouling or blocking of the drainage media.

The existing fuzzy projections of HFD service life (anticipated to be limited to 10 years according to design standards) are placed under evaluation and the proposed quantitative condition assessment approach addresses the gap between evaluating which drains are in a particular physical condition and how long-term investment plans can be generated for a given network.

To establish a quantitative level of anticipated performance, fouling metrics are mapped to drainage capacity trials. Relevant experimental work is being carried out to measure – as a proxy for degradation – the permittivity properties of HFD granular backfill material (Non-Destructive Evaluation using the ground penetrating radar (GPR) - see Figure 1) in various fouled

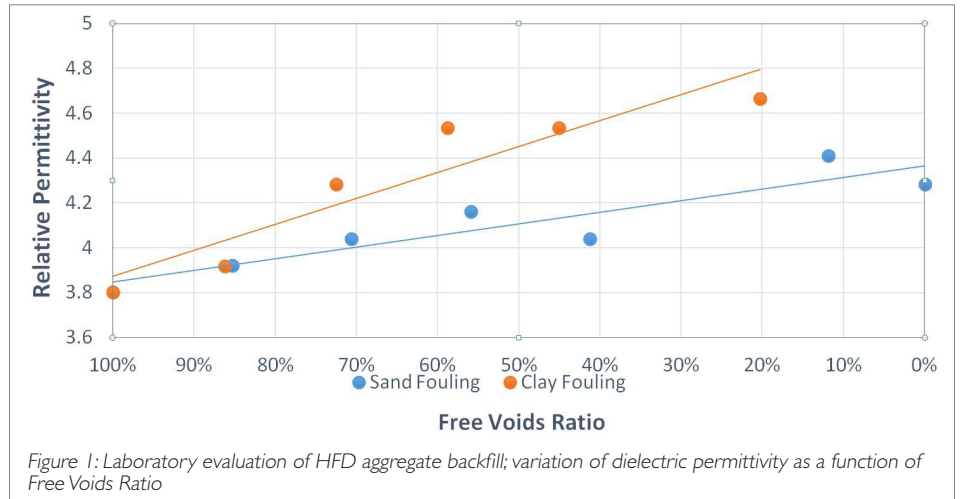


Figure 1: Laboratory evaluation of HFD aggregate backfill; variation of dielectric permittivity as a function of Free Voids Ratio

states, and moisture contents to represent in-service deteriorated sections. The permittivity dispersion study exhibits how the GPR can be applied in practice to extract and quantify the deterioration characteristics of the HFD aggregate backfill.

The proposed metrics, coupled to the GPR tool can provide the fundamental building blocks required to develop and adopt a Condition Assessment System (CAS) tailored to the specific service conditions of HFD. Evaluation techniques also using higher frequency antennae and the analysis from available void space of the material are being developed in collaboration with PTS. An example of such work is presented in Figure 2: two air-coupled antennae are

used to extract condition data from in-service HFD sections (this is similar to the approach used to evaluate railway trackbed). The data collection and analysis is carried out to define the framework required to conduct network-level non-destructive condition surveys of the physical condition of HFDs in the UK highways network.

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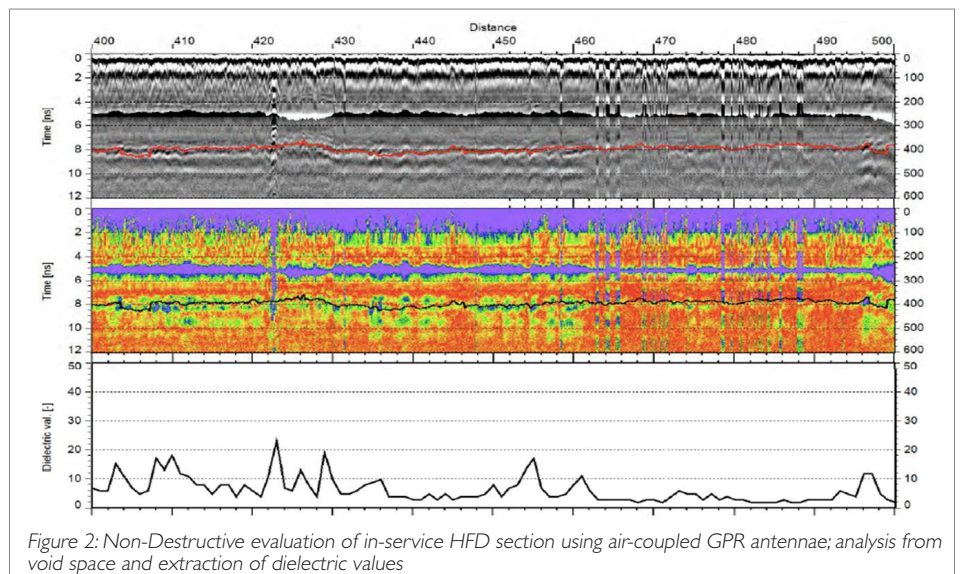


Figure 2: Non-Destructive evaluation of in-service HFD section using air-coupled GPR antennae; analysis from void space and extraction of dielectric values