AP SENSING. SERCEL

Below Ballast Scan (BBS) in Action

A Case Study Compilation

Project Overview

Nowadays Fiber Optic Sensing (FOS) is increasingly used for track condition monitoring. Besides the known above ground monitoring, it can also be used to evaluate certain underground geological processes affecting the infrastructure. For instance, formation of sinkholes, or unstable layers, which can be destructive and may lead to catastrophic events on the railway network. The depth of investigation provided by conventional ballast and subgrade monitoring approaches, such as Ground Penetrating Radar (GPR), are often insufficient.

The collaboration between AP Sensing with its sensitive DAS technology, and Sercel with its enhanced solution for geophysical near surface evaluation provides insights of the underground geology along rail tracks. The world's first BBS solution revolutionizes train track condition monitoring and can analyse ground conditions up to 50 m below the ballast.

The BBS solution analyses vast amounts of DAS data to generate a 2D shear wave velocity profile under the track, indicating the condition and properties of the subsurface. Shear waves propagate faster through harder material and slower through weak layers, such as cavities or sinkholes; thusly, abnormal shear wave behaviour is a direct indicator of danger zones, that shall be evaluated.

Two case studies demonstrate the capabilities of BBS:

Case 1

Several tracks from Deutsche Bahn (DB) were monitored by AP Sensing proving the technology with existing fiber optic cable along the rail track. E.g., the system was used to monitor a 36 km track near Berlin to develop reliable algorithms using artificial intelligence (AI) for train tracking and Third Party Intrusion (TPI). (AP Sensing's Deutsche Bahn Cable Theft Monitoring Case Study).

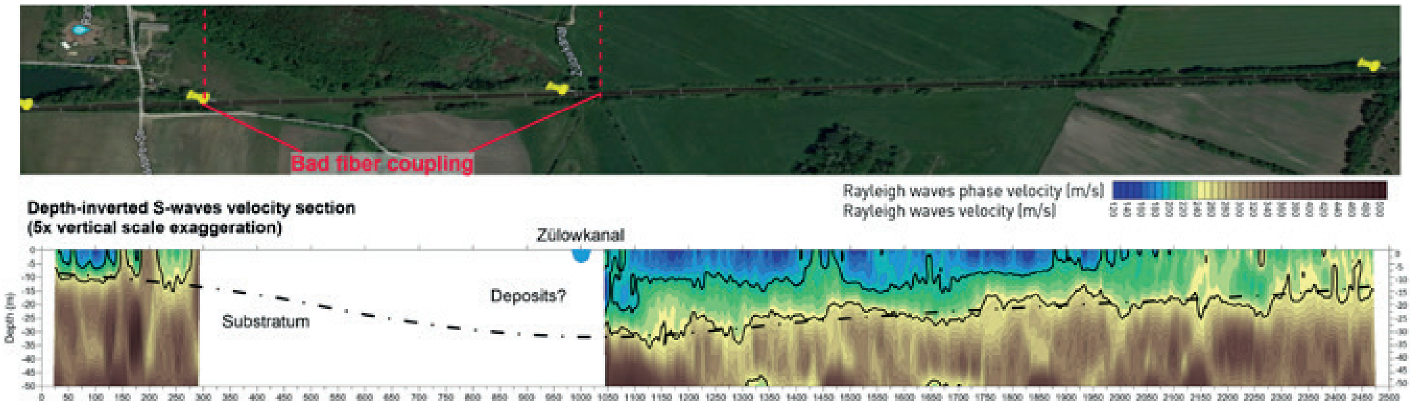
A BBS study was carried out as part of a collaboration between AP Sensing and Sercel to prove the value of

Background

- Various customers experience difficulties identifying the root cause of rail track integrity problems
- Insufficient underground geology assessment using existing monitoring techniques

Solution & Benefits

- Distributed Acoustic Sensing (DAS) system uses pre-existing track-side infrastructure
- Quick and cost-effective identification of critical zones over extended distances
- Rapid response with 24/7 access to real-time data
- Validation of novel BBS solution using conventional geophysical sensors



Map view of the track showing the location of DAS survey line (upper panel) and the 2D shear wave velocity profile based on DAS data (lower panel).

the roadbed scanning solution. A 2.5 km section with different surface features and visible differences in geology (presence of lake, fields, rock outcrops nearby) was selected.

In this trial the analysis of shear wave velocity shows a general conventional trend of velocity increase with depth (from dark blue colour at the surface, indicating soft rocks, to brown, indicating hardening). No danger zones were detected.

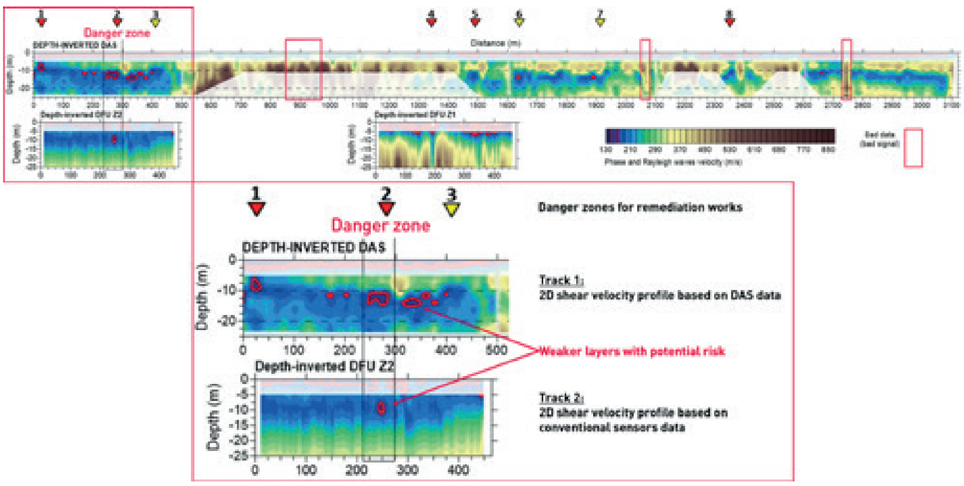
Case 2

A cargo train of one of the key railroad operators in Eastern Europe derailed because of ground subsidence. Traditional track integrity techniques could not provide proper subsurface evaluation with reasonable depth of investigation to identify the locations of sinkholes. Traditional blind drilling and subsequent cementing of sinkholes along a track more than 22 km long also could not guarantee a result. Therefore, to detect and cure hazard zones, Sercel performed nodal geophysical survey within 2 zones, each 500 m long.

In order to perform near surface characterization under the remaining problematic zone of the track it was decided to apply the BBS solution using a DAS system connected to existing buried fiber optic cables. DAS data interpretation provided exciting results giving a baseline understanding of underground geology.

Benefits

The BBS monitoring solution provides critical data on subsurface conditions needed for safe railway operations. The ability to analyse data at short notice after acquisition is extremely valuable for proactive danger zone identification over large areas and rapid decision making to predict and plan remediation operations. Moreover, the use of already existing fiber optic infrastructure, together with extremely long-range evaluation units, makes this joint solution of AP Sensing and Sercel very cost-effective with the potential of further time lapse monitoring to ensure that the situation does not degrade over seasons.



Seismic surface wave analysis along the track in Eastern Europe. The upper panel shows the entire ~3000m track length. The lower zoomed-in panel shows the first 500 m of the track with explanations.

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