



Under the Tracks: Detecting Sinkholes with Fiber Optic DAS

Saudi Arabia

Project Overview

In many parts of Saudi Arabia, the subsurface is composed of soluble sedimentary rocks that naturally give rise to karst landscapes. These geological conditions create hidden vulnerabilities beneath the surface and represent one of the country’s most significant geohazards.

Sinkholes are not just localized anomalies, they can affect roads, pipelines, buildings, and critical transport infrastructure, including railways. Their sudden formation can lead to costly damage, operational disruptions, and safety risks, making early detection essential for maintaining reliable services.

A key freight rail line in Saudi Arabia was facing exactly this challenge. Along one of its track segments, sinkholes had begun to form, posing serious safety concerns and the potential for major service interruptions if left unaddressed.

Geocomp, a Sercel business together with its local partner, carried out a detailed geophysical investigation with geotechnical characterization to identify the root causes of ground instability. The study focused on both long-term engineering solutions and short- to long-term monitoring strategies to manage risk.

The project involved deploying a variety of instrumentation alongside the web-based monitoring system, iSite Central. This approach enabling early detection and proactive management of sinkhole-related events.



Background

- Freight rail line in Saudi Arabia located in an area prone to karst-related sinkhole formation
- Sinkholes posed safety risks and threatened service continuity along a critical route
- A 1.5 km track segment required continuous monitoring without disrupting operations



Solution & Benefits

- Continuous DAS monitoring along the full 1.5 km rail segment
- Early detection of ground vibrations and potential void formation
- Integration of Distributed Fiber Optic Sensing with satellite and seismic monitoring for comprehensive risk assessment
- All data management was performed through iSite Central, a managed cloud-based service enabling centralized monitoring of infrastructure

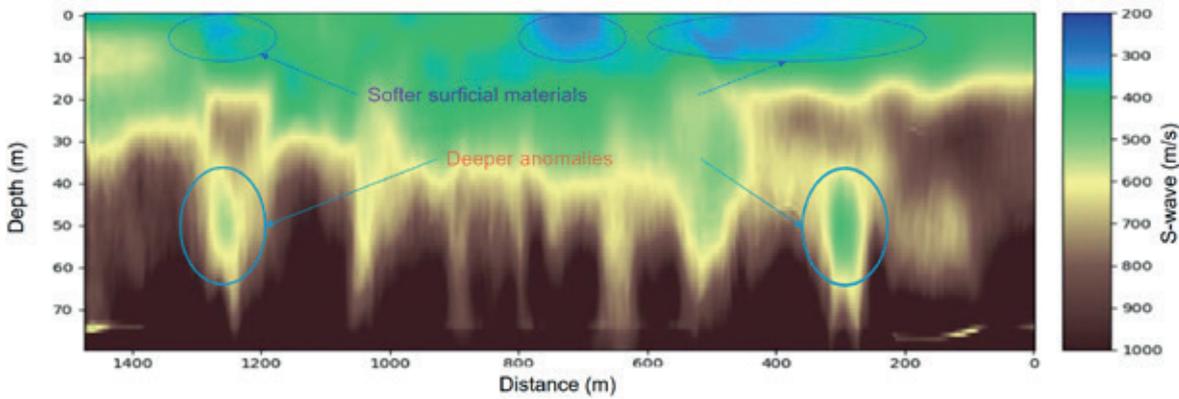


Figure 1: 2D shear wave velocity profile beneath the rail track, derived from DAS data. Colours show the ground stiffness: blue/green indicates softer, slower rock, while brown shows harder, faster formations.

An important component of the monitoring strategy was fiber optic sensing. The team deployed AP Sensing’s high resolution Distributed Acoustic Sensing (DAS) technology across the full 1.5 km rail. The fiber optic cable connected to the DAS system was installed along the rail subgrade to provide continuous, long-distance, and long-term measurements, enabling the detection of ground vibrations and potential void formation, complementing more conventional instrumentation. As a result, the rail line operator was able to maintain operations on a critical commercial routewhile effectively managing sinkhole risks.

Solution

DAS provided real-time, high-resolution seismic measurements, enabling early detection of ground movement, potential voids, and proactive sinkhole management. AP Sensing’s interrogator ensured reliable data capture in the harsh desert environment, offering unprecedented spatial coverage along the 1.5 km rail segment.

Geocomp and its local partner implemented a comprehensive monitoring and mitigation system combining DAS with complementary technologies:

- Wire-break Time Domain Reflectometry (TDR) sensors for localized structural monitoring
- Monthly InSAR satellite surveys to detect subtle ground deformations
- Passive seismic monitoring in the highest-risk zones for rapid response

Results & Benefits

- Early detection of ground instability and potential voids
- Continuous monitoring without disrupting rail operations

- Enhanced safety and reduced operational risk
- Data-driven guidance for long-term engineering and maintenance decisions
- Ability to maintain operations on a critical commercial rail line while managing sinkhole risks



Figure 2: Plan view of the installation



Figure 3: Sinkhole formation along road in Saudi Arabia