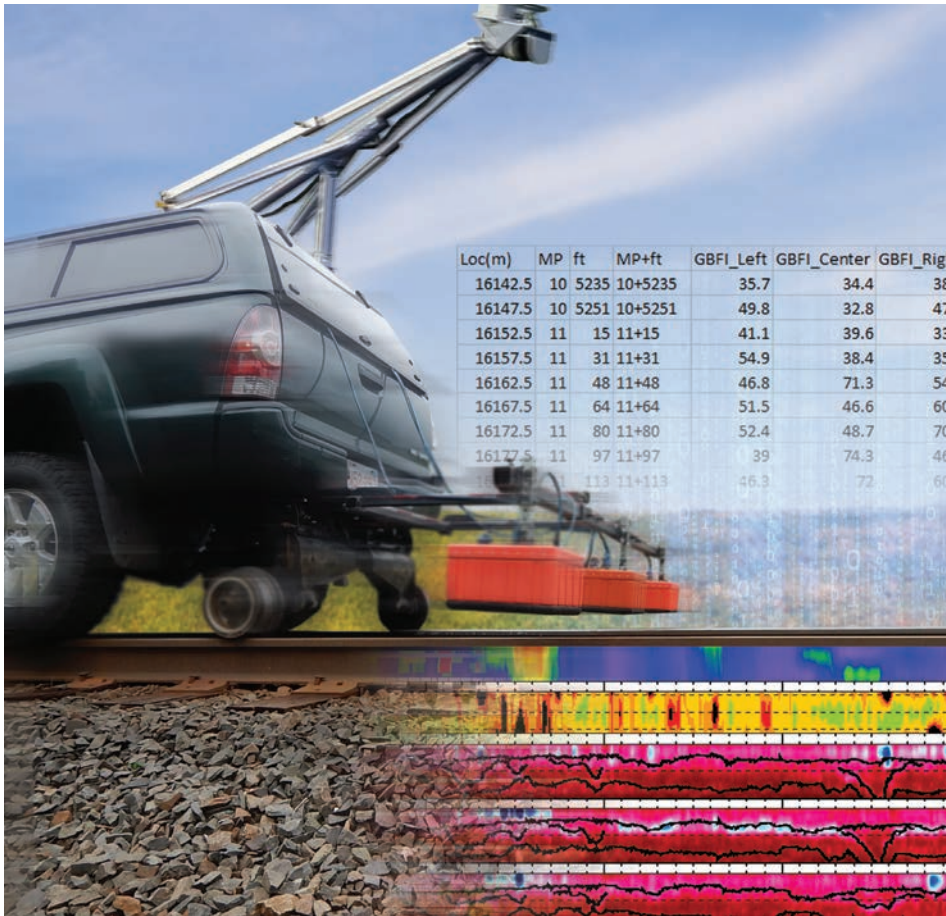


Substructure
Maintenance
Management



Direct your maintenance efforts precisely to where they are needed most



Loram's services, customized to your requirements, include advanced **Ground Penetrating Radar (GPR)**, **Track Geometry analysis** and **LiDAR mapping** to help identify exactly where and when to perform maintenance or renewal work. By taking a data-driven approach, your maintenance strategy is objectively prioritized to the critical areas of need and targeted to solve root cause issues, optimizing available budgets and extending track component life.

Maintenance benefits.

- Prolong the useful life of ballast
- Provide overall smoother track for a given class of track
- Reduce risk of rail defects
- Increase track availability, minimizing maintenance windows and slow orders
- Quantify the ballast state-of-good-repair backlog
- Identify and correct the cause of underlying problems rather than continue to treat symptoms
- Address poorly-performing substructure on a systematic network level, creating economy of scale

Economic benefits.

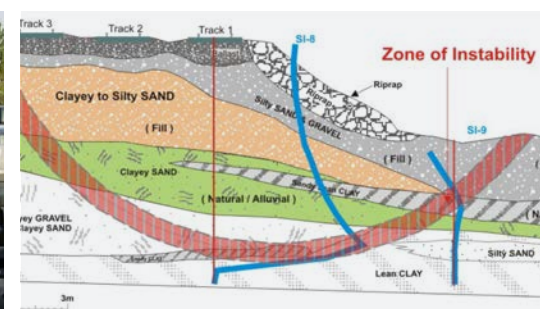
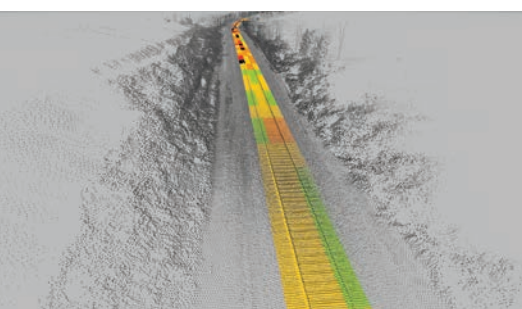
- Reduce maintenance and capital costs, focusing resources to when and where they are most effective
- Reduce deterioration of superstructure components
- Provide predictive maintenance intervals and fewer unplanned service interruptions

Loram Substructure Maintenance Management delivers maintenance optimization and savings.

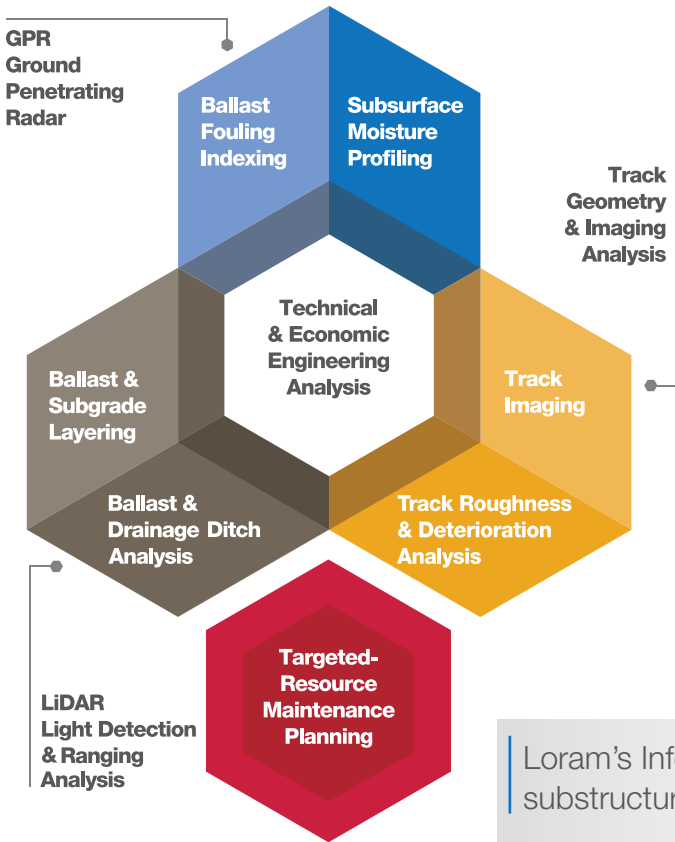
Actionable Intelligence gives you the confidence in knowing the condition of your entire track structure in order to make informed decisions that optimize maintenance programs and capital investment. Loram's Substructure Maintenance Management services diagnose and solve problems that affect the condition and performance of railway tracks by seamlessly combining expertise in track roadbed materials,

data analytics and maintenance techniques.

Poorly-performing ballast and drainage have profound influence on the long-term costs associated with maintaining track reliability, as well as the life-cycle costs of ties, rails and fastening systems. Identifying and addressing the root cause of recurring issues and poor track performance reduces maintenance-related interference and creates more predictable maintenance intervals.



Uncover hidden substructure health issues before they become costly cascading problems



By implementing a data-driven approach that segregates and prioritizes the track network based on performance, it's conservatively estimated that at least 10% of the annual roadbed and structures maintenance and renewal budgets can be effectively reallocated to more immediate requirements.



Loram's Information Integration software visualizes your substructure health and maintenance hotspots

Information integration.

LiDAR data mapping provides a scan of the right-of-way to determine shoulder conditions, drainage ditch location and depth and cut/fill conditions. This track topography is used in conjunction with the GPR and track geometry analysis to identify targeted track substructure issues and their underlying origins.

LiDAR information can also be used to identify the width and height of the shoulder to determine the volume of excess or needed ballast.

Integrating the topography from LiDAR with the GPR fouling index and moisture profile data provides documented clarity on the internal drainage capacity of the track, and the adequacy of the ditch to convey water from the right-of-way.

Track evaluated

Ballast Fouling (plan view)
Black/Red = high fouling
Green = low fouling

Moisture Profiles (Left, Center, Right)
Relative moisture in the track.
Y-axis is depth from TOT
Black lines indicate layers determined from GPR
Blue = Higher moisture
Red = Lower moisture

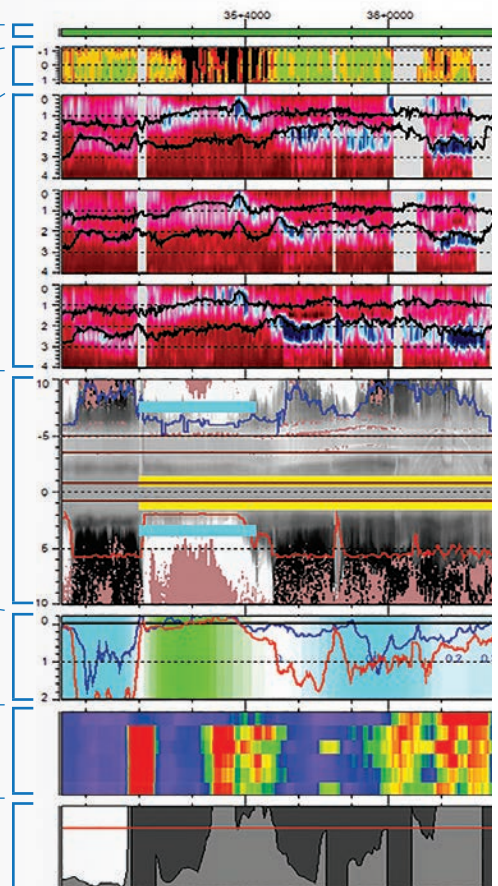
Right-of-Way Topography & Conditions
Linearized ground surface elevation, Y-axis is width of ROW in meters.
Dark blue & red lines indicate the low point invert within ditch area

Drainage (proposed) = Cyan line
Ballast Cleaning (proposed) = Yellow line

Drainage Ditch Depth
Y-axis is depth below TOT
Red indicates depth on right of ROW
Blue indicates depth on left of ROW

Geometry Roughness Heat Plots (RP62)
Running Roughness shown in 200' window.
Y-axis is decimal years.

Scoring
Scoring Block = Black background
Score = Grey area plot
Threshold = Red Line



Advanced technologies. Industry-leading expertise.

Loram GPR Solutions

Loram offers a range of GPR solutions, from our complete data collection and analysis services to deployable GPR systems available for rail car mounting.

Loram's standard hi-rail based survey system uses three 400 MHz antennas that are specially designed for the high-speed, non-invasive measurement of ballast and track formation. The antennas are deployed at the track centerline and at both ends of the ties.

In addition to the hi-rail based method of GPR data collection, Loram offers an on-board solution, where its GPR surveying equipment is installed onto one of the railroad's geometry cars to survey the track as the car travels.

Both the hi-rail based and on-board based systems are able to work in electrified track territory and in urban environments typically hindered by background electromagnetic noise.



Loram's 400 MHz GPR antenna is able to collect data to a maximum depth of 9 feet. For deeper penetration, Loram deploys lower-frequency antennas such as a 270 MHz antenna as needed, which has a maximum penetration depth of approximately 16 feet.



Loram's on-board GPR deployment uses special electromagnetic shielding to produce an "echo-absorbing enclosure" to allow the antennas to be placed underneath rail-bound vehicles. Information can be collected with minimal on-board assistance at a speeds of up to 125 mph with data collection every 8 inches.

Create a plan that fits your requirements.

Loram offers customizable levels of service, data collection and analysis—from essential ballast fouling information to sophisticated levels of monitoring, understanding and predictive vision. We offer intensive data collection technologies, robust analysis and detailed plans to provide the greatest return on your maintenance investments. Contact us today to learn more.

The industry leader in track substructure health insight.

Loram's Geotechnical & Substructure Management (GSM) division is formed on the expertise of HyGround Engineering and Roadscanners Oy of Finland, who have jointly engaged in projects in North America and worldwide since 2006.

These industry leaders in track substructure diagnostics and information management are now a part of Loram — building upon its 65- year plus legacy of world-class contract service work and substructure maintenance. With the acquisition of HyGround's expertise in railway geotechnics and Roadscanners' analytical expertise and software, Loram is uniquely qualified to provide industry-leading geotechnical insight and remediation services to railroads worldwide.



Geotechnical Services

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