

SafeRailSystem

Track bed inspection by high speed radar



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SafeRailSystem

Background

Much of the track renewal and maintenance work undertaken on rail networks all around the world is caused by the influence of poor ballast and formation conditions below the track and imprecise decision making of when, where and how to intervene with remedial engineering works. Engineers currently undertake ballast and formation investigation through:

- excavation of trial holes to examine the undertrack condition or
- using analysis of undertrack conditions specialist contractors employing core sampling or slow speed GPR (Ground Penetrating Radar) surveys

Both of these investigations have inherent weaknesses in that they are often inconclusive leading to poor or even wrong decision making; in addition they require track access to undertake.

These weaknesses can affect the following engineering decisions:

- Track maintenance activities are often repeated as maintainers attack the effect of the problem and not its undertrack cause. (i.e. the specification of the work is incorrect)
- The identification of renewal sites by route is sometimes incorrect as the relationship between track deterioration rates and undertrack conditions is difficult to identify using the current inspection and analysis systems. This can lead to incorrect track renewal budgetary provision being made for routes
- Track renewal operations are incorrectly targeted as current systems do not always provide the correct work specification (i.e. incorrect start and finishes or selection of work types)
- Track renewal quality does not match quality expectations due to wrong specification or poor workmanship
- Formation renewal treatment incorrectly specified and targeted

The solution to all the previous problems is the **SafeRailSystem**, that permits:

- A regular high speed (up to 100 Km/h) survey of the undertrack conditions on the rail network
- The identification of undertrack conditions down to a depth of 3 meter below the top of the rail (or at greater depths if required) including the identification of:
 - ✓ ballast thickness
 - ✓ presence of ballast pockets
 - ✓ amounts of fines in the ballast layers (ballast fouling, qualitative)
 - ✓ level of water tables

SafeRailSystem Features and Benefits



Major features

- ❑ **Continuous, high speed (100 Km/h)** mapping of ballast thickness
- ❑ Differentiation between **clean and fouled ballast**
- ❑ Detection of sections with **drainage problems**
- ❑ Locating areas with **Insufficient Bearing Capacity** (e.g. Ballast Pockets)
- ❑ Mapping **thickness of Subballast Layers**
- ❑ Mapping **Quality of Subballast Layers**
- ❑ Locating **irregularities** along the Track (e.g. Peat, Bedrock etc.)
- ❑ Locating **pipes and cables** (metallic and non-metallic) across the Track (only at low speed)



Major benefits

- ❑ Improved decision making for the client of where, when and how to intervene with maintenance and renewal operations based on a greater understanding of undertrack conditions and their influence on track geometry
- ❑ Reduced cost of current undertrack investigation procedures
- ❑ Improved specification of works with a reduction of reworking
- ❑ Improved reliability of investment calculations
- ❑ Improved quality of renewal
- ❑ An integrated and national approach to the management of undertrack conditions
- ❑ Reduced costs of maintenance and renewal operations

SafeRailSystem SYSTEM TECHNOLOGY

The **SafeRailSystem** is a train borne inspection system based on a multichannels and multifrequency radar technology. It can be mounted on any kind of rail vehicle having buffers. The architecture of this system enables:

- ❑ **velocity:** up to **100 km/h (upgrade to 160 km/h will be soon available)**
- ❑ track bed **survey depth: 3 meters**
- ❑ **multichannels system (up to 8 channels)** allowing surveying all over the track in one run
- ❑ **best data quality:** special technology permitting a better removal of background noise
- ❑ **accurate positioning:** thanks to a special contact-less positioning system
- ❑ **high capacity:** able to survey up to **700 km** in one run without stop
- ❑ **user-oriented results:** the processed survey output gives the information as needed by railway engineers and management authorities in an easily understandable format
- ❑ **integrated video-camera (option):** the system is interfaced with continuous video data for correlating radar data with visual info (option)



SafeRailSystem mounted on a Chinese train. This configuration enables **SafeRailSystem** to survey **3 profiles in one run: along the axis of the track and on the left and right side of the sleepers. Maximum speed: 100 Km/h.**



Radar antennas mounted on a Chinese train. This enables Ground Control to detect undertrack problems which can cause track geometry anomalies. It provides complete information about the track conditions in one run.

The measurements are controlled by one operator on board of the train. The antennas are connected to a compact system control unit box that can be easily positioned in the operator cabin.

All the acquisition operations are controlled by a single operator in the train cabin on a PC.



The **SafeRailSystem** control unit.

The data acquired on the railway are stored in the PC. Up to 700 Km can be stored in one train run. Stored data are then processed at the office by means of a dedicated suite of processing software, as explained in the following. The processing work can be parallelised on several operators for maximum efficiency.

SafeRailSystem	
ACQUISITION AND PROCESSING SOFTWARE	
ITEM	SPECIFICATIONS
SRS-Acq	Acquisition software package
SRS-DP (Data Processing)	Radar Data processing software
SRS-AR (Analysis and Reporting)	Analysis, Display and Reporting of the output results

SRS – Acq

Software instrument dedicated to georadar data collection for trackline investigation under Windows XP Professional.

This software permit to manage all the functions of the multichannels control unit SRS

SRS-Acq SW controls:

- a sophisticated automatic signal calibration system
- a complete diagnostic instrument for a continuous check-up of the efficiency level of the machine
- the start point coordinates
- the management of the Doppler encoder for the position of the radar data

GPS connection and Video Camera, is also available as option, through a simple tool managing and saving in real time.

Data are stored in real time into the hard disk of the computer.

SRS – DP

Software module dedicated to the layers analysis for railway applications. This module includes advanced "pattern recognition" algorithms, which provide user with information related to the different layer related to the material composition. The code is able to identify the different layers with semi-automatic or manual railway related procedures. The user can visualise, simultaneously, up to 4 parallel radar maps and run this sections with an automatic scrolling. All the radar data can be selected in a rapid and efficient way. The user can introduce and analyze drilling information.

Main tasks:

- Continuous Mapping of Ballast Thickness
- Differentiation Between Clean and Fouled Ballast
- Detection of Sections with Drainage Problems
- Locating Areas with Insufficient Bearing Capacity (e.g. Ballast Pockets)
- Mapping Thickness and Quality of Subballast Layers
- Locating Irregularities along the Track (e.g. Peat, Bedrock etc.)

Main features are:

- automatic data processing of radar data
- manual or semi-automatic detection of layer interfaces
- synthetic output of layer information
- automatic legend
- printing of end results in selectable scale
- various editing functions on the radar maps
- export to excel

SRS - AR

Software module dedicated to the analysis, display and reporting of the results processed with SRS-DP package. This module permit to have a detailed overview of all the geotechnically relevant parameters, which enables railway engineers to manage the results and to use them as basis for their track renewal plans.

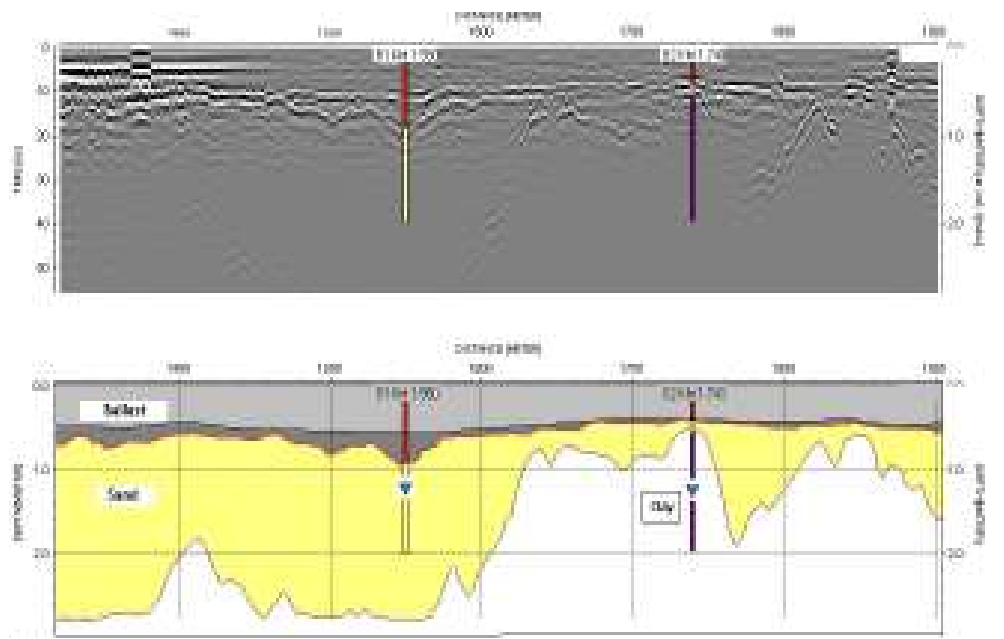
Main task

- Display of the longitudinal stratigraphic sections
- Display of drilling information
- Display of geotechnical relevant parameters:
 - Ballast Bed Moisture (qualitative)
 - Ballast Fouling (qualitative)
 - Evenness of Track Bed Basis
 - Moisture Distribution in Intermediate Layer (qualitative)
 - Formation Moisture Distribution (qualitative)
- Display of Track Bed Cross Section at each Position along the track
- Video and Pictures viewer (if data available)
- Display of position of constructions along the track (if data available)
- Display of position of various objects, if data available (masts, crossing pipes and cables, etc.)

Main features are:

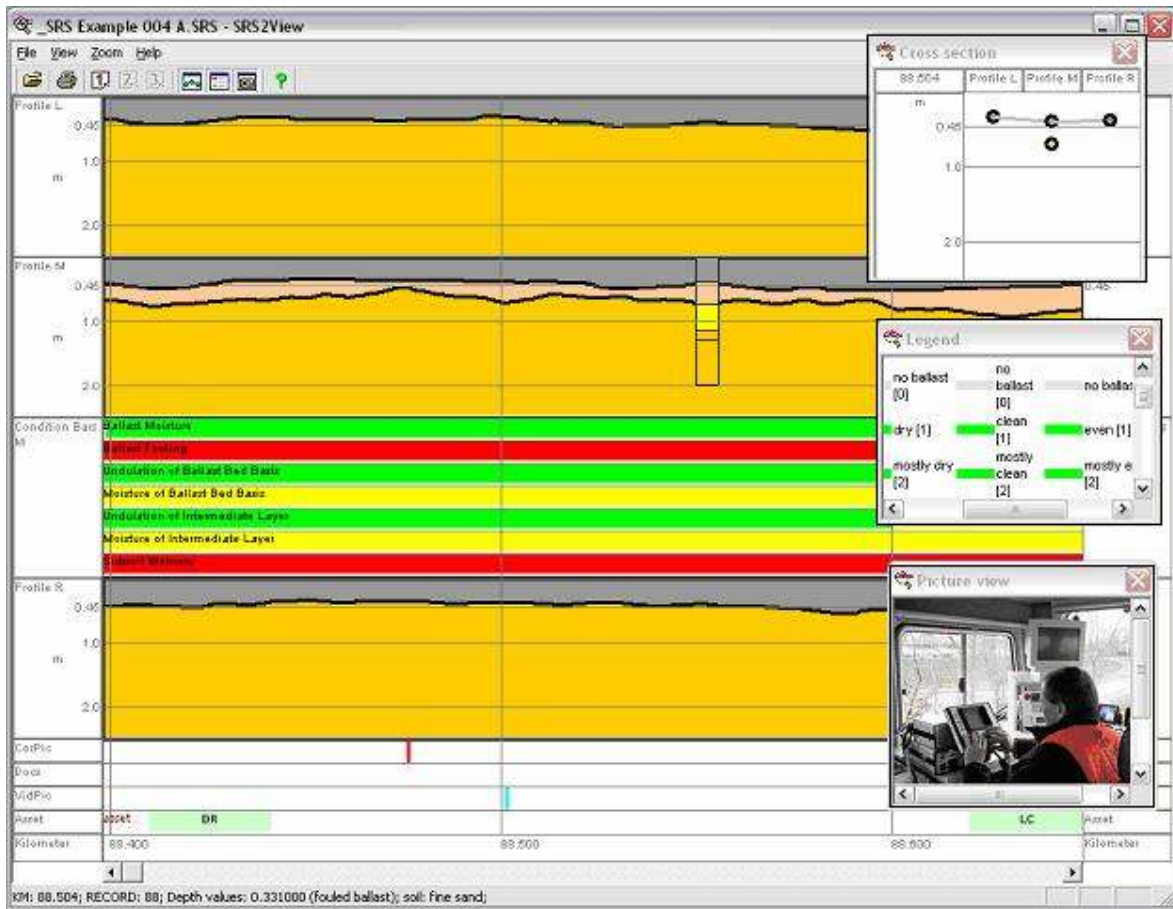
- Semi-automatic elaboration of results
- Automatic generation of cross section
- Automatic legend
- Printing of results in selectable scale
- Various editing functions
- Display of pictures and video with relative coordinates

A complete professional software package enables the user to obtain complete pictures of the geotechnical conditions of the track.



Pictures of the SRS-DP processing software (radar data)

A track section between km 1.300 and km 1.900 (horizontal axis). The vertical axes represent both depth in meter related to top of sleepers and travel time of the waves in nanoseconds. The ballast has been renewed to a depth of 0.5 m (pale grey layer). Below, there is fouled ballast (dark grey layer). Ballast settlements can be seen between km 1.460 and 1.570. This is an indication for insufficient bearing capacity of the sandy formation (yellow layer). Below the sandy formation there is clay. Between km 1.600 and km 1.900 the clay layer is almost adjacent to the ballast bed. In this section, a well working drainage is important. Otherwise water will remain inside the track, leading to eventual stability problems of the track. There are crossings at km 1.370 and km 1.870. Drillings have been carried out at km 1.550 and km 1.740. In both boreholes ground water has been found in a depth of 1.2 m.



Data Interpretation by SRS-AR: track bed condition bars

TRAINING EXPERIENCE

SafeRailSystem is an integrated product based on more than 20 years of experience with train borne infrastructure examination.

More than 20.000 Km of railways tracks have been surveyed with this system in various European countries such as Germany, France, Netherlands, UK, Russia, Turkey, etc..

All this requires to understand our customer's demands and to speak the customer's language.

List of Customer

Following the customer list of the **SafeRailSystem**:

- COLOMBIA: CARBONES DEL CERREJON
- RUSSIA: OCTOBER RAILWAY
- UNITED KINGDOM: ZETICA
- ROMANIA: ISPCF (ISTITUTO DE STUDI SE PROJECTARI DE CAI FERRATE)
- NETHERLANDS: EURAILSCOUT INSPECTION AND ANALYSIS B.V
- GERMANY: GROUND CONTROL GMBH
- BRASIL: IDS RADAR ltd
- SPAIN: IGT TECHNOLOGY