

Functional Specification for a trackbed GPR survey.

1. Objectives:

- (i) To conduct a GPR survey of about 46,000 kms of railway track over IR by using 1 set of GPR system attached with under-frame of 01 nos nominated TRC (Track Recording Cars) within a time period of 14 months assuming an average productivity of 1500-3000km per month.
- (ii) To develop ballast fouling indices based on IR ballast specifications, considering standard sieve sizes used on IR for ballast gradation etc. and quality of ballast and different variety of contaminants such as coal dust, mud, crushed ballast, stone dust, Iron ore etc.
- (iii) Processing of collected data, to provide a calibrated and proven measurement of the thickness of clean ballast and average ballast fouling measurement averaged over 350mm from bottom of sleeper.
- (iv) Based on average productivities stated in 1(i), processing of the data as per para 1(iii) should be completed and reports of the same submitted within 30 days for the data recorded by the end of month. These data should be submitted as per jurisdiction chart of Assistant Divisional Engineer (ADEN)
- (v) All processed data must be in format so that it could be registered to RDSO linear reference system linked to a route tape and standard track blocks of 200mts.
- (vi) Based on the processed GPR results the system should provide customer definable rules & thresholds such as ballast fouling index, which can be used to provide ballast maintenance recommendations (ballast cleaning, shoulder ballast cleaning) across the surveyed network.
- (vii) The supplier of GPR services would provide the first set of rules & thresholds to be used to provide ballast maintenance recommendations for Indian railway (considering conditions on IR as described in Para 1(ii)) based on the use of thresholds provided by agency which shall be derived from the experience gained by service provider in other railway systems and their maintenance schedule. These would be reviewed by RDSO.
- (viii) All data collected should be archived, using a suitable external storage device solution or cloud based storage with exclusive access by IR starting from start of GPR data collection up to a period of at least 2 years following the completion of the data collection. All rights of access to appropriate external storage device where the data of Indian Railway will be stored, be remained reserved with Indian Railway.
- (ix) A viewing tool must be supplied on completion of the data processing to enable linear referenced processed reports along with recommendations to be viewed by RDSO.
- (x) Training to be provided to 4 RDSO/IR officials on similar system (wherever similar system is working), covering all important aspects of ballast fouling indices, calibration, sampling process and benchmarking of GPR survey report for maintenance instructions/guidelines with correlation with actual field conditions. Training shall also include methodology of monitoring the quality of signal output of antenna to timely address any issues regarding performance of the system.

(xi) Post processing of data and reporting to include

(a) For a targeted 350 mm from sleeper bottom, ballast fouling details and clean ballast depth as stipulated in point no 1(iv).

(b) For a targeted 1500 mm from sleeper bottom, ballast pockets, signs of formation failure, development of water pockets, locations with ingress of water etc. as required.

2. System description:

(i) Each of the 1 no GPR systems will be mounted on underframe of 01 nos nominated Track Recording Car (TRC). The TRC coach sketch & details are enclosed. The system should be mounted securely beneath the train to prevent damage and minimize the prospect of theft of any of the components. The details of mounting arrangements and necessary modifications required in existing parts to be submitted by service provider is to be specified by the firm.

(ii) Due care shall be taken to ensure that the antenna fitments fall within the IR Schedule of Dimension as specified by RDSO.

(iii) Each of the systems which is to be attached in 1 TRCs must comprise of antennas arranged in 2 arrays. Each array shall comprise of minimum 3 numbers of antenna. First array should have high frequency short wavelength (preferably 2 GHz) so that wavelength addresses to the concern of ballast fouling, clean ballast layer and water retention indications for 350 mm from sleeper bottom and the second array shall have wavelength and frequency (preferably 400 MHz) such that the issues regarding ballast pockets, signs of formation failure, development of water pockets, locations with ingress of water etc are addressed for depth up to 1500mm from sleeper bottom.

(iv) The antennas described in 2(iii) must be arranged in such a way that the reports give complete indicative health of shoulder ballast and central ballast.

(v) Normally the speed of scanning shall not be less than 80 kmph, however at the time of tender the service provider shall be asked to submit the maximum speed at which the GPR recording could be done which could be utilised in future. The scan interval shall not be more than 5 cm.

(vi) Sufficient arrangements must be in place to minimize electromagnetic interference and interference from dust/water ingress protection. The system should be able to work in all climatic conditions of IR.

3. GPR antenna requirements:

(i) Antennas will be mounted in protective housings which will prevent water ingress and provide protection against foreign object strikes like ballast hitting.

(ii) Antennas used by supplier should have proven track record to meet the stated objectives. Documents regarding performance of these documents is to be submitted.

(iii) Where the bidder/contractor's data processing algorithms utilize frequency or amplitude based analysis of the data, such as for ballast fouling, they shall provide a proven method of antenna performance monitoring and calibration. To ensure high data quality and repeatability between antennas they shall be monitored every week during data collection. Antennas exhibiting amplitude or frequency changes outside of agreed limits shall be replaced. Antenna performance results shall be made available to RDSO via a shareable webpage.

(v) GPR data shall be monitored in real time during data capture to automatically alert the operator when poor quality data is being collected.

4. GPR data acquisition system:

(i) The system shall be able to take distance measuring inputs from the TRC to locate exact position of TRC, to accurately trigger data capture at a minimum scan intervals described as before.

(ii) All GPR data shall be referenced by km post, elapsed distance and block number as per the TRC route tape.

(iii) The supplier shall be able demonstrate accurate co-location of GPR data with the TRC before the start of the survey.

(iv) The system will be capable of automatically monitoring GPR data quality and automatically creating production and error reports of GPR data quality for upload to a shareable webpage or download at the end of a recording shift.

(v) The data acquisition system shall be remotely accessible to monitor system performance and if required change system settings.

(vi) The system will be configurable to upload GPR data to a suitable cloud storage platform to limit manual handling of data.

5. Data processing:

(i) Data processing is to be done by a team of technical manpower & software analyst having experienced in railway track scanning with use of GPR system service provider utilising required system software.

(ii) Delivery of the results of processing the GPR data to deliver ballast quality results as per para 1(iii) for 46,000km of the network shall be on a continuous basis and not later than time as stipulated in point no 1(iv). These data should be submitted for every stretch as stated in 1(iv).

(iii) Detail report of identifiable ballast pockets/ ballast puncturing up to 1.5mts depth, signs of subgrade failure and water pockets causing drainage related issues in track ballast must be made available in an agreed time limit (time limit to be mentioned by agency with tender offer) after suspected locations are notified to agency and GPR Survey has already been done.

6. Ballast fouling calibration:

(i) A sampling and calibration program shall be decided based on previous experience of agency and IR conditions and shall be completed within a desirable time frame which shall not exceed 30 days after the system is available in India and all other preliminary studies have been done. It is expected that all the required preparations for calibration shall be done by the time the system arrives in India.

(ii) The sampling program in Para 6 (i) shall detail previous calibration exercises carried out for other railroads worldwide to relate GPR-derived ballast quality measurements to physical measurements of ballast quality and recommend a best practices approach to implement.

(iii) Sampling and calibration program with details of activities involved shall be submitted with tender offer. These details shall also include equipment etc. to be used for calibration.

(iv) If the calibration is to be done again to comply the accuracy mentioned in the tecno-commercial conditions the agency/service provider shall not receive any extra payment and this re-calibration shall be on agency's cost.

(v) Any data previously issued shall be reissued if the original calibration used is changed.

7. Reporting:

Reports shall include followings

(i) The detail formats of the reports have to be submitted by the agency along with the tender offer, changes if required shall be communicated to successful tenderer along with LOA and the changed formats shall be submitted within next 30 days for approval.

(ii) It is expected that reports shall be produced in at-a-glance sheets (excel sheets or csv files etc.) where it could be easily made out by colour codes etc degree of ballast fouling, depth of clean ballast etc. The length of track covered in each sheet shall be user dependable, the report must include chainages, elapsed distance, block number, ballast fouling categories for the left shoulder, centre and right shoulder and the thickness of clean ballast as categories for the left shoulder, centre and right shoulder. Category thresholds should be editable by the customer.

(iii) Track charts with km post and asset labels derived from the route tape showing ballast fouling and ballast depth categories for the left shoulder, centre and right shoulder. This should be producible with a selectable block size (5m, 25m, 50m, 100, 200m).

(iv) Maintenance planning recommendations for ballast cleaning (shoulder and centre) shall be given with the reports.

(v) A viewing tool to enable linear referenced processed reports, to be viewed by RDSO. The customer should be able to select any part of the network and view linked processed radargrams with a map overview.

(vi) On request for specified track sections, similar report as described in 7(i) for ballast pockets, layer roughness representing potential subgrade failure and wet beds.

(vii) If requested, detailed track-bed inspection reports on a per km basis to investigate the potential cause of track geometry faults.