Real time technical state control
by fiber optics based monitoring system
Real time indication of accidental condition

Implementation of intellectual technical state monitoring system allow to safely operate railway by the on-time alerting of the train driver about accidental condition of track along the road.

MONITORING SYSTEM IMPLEMENTATION BENEFITS

- Elimination of human factor affection
- Operating costs

- Track measurement car
- Technical state monitoring system
COMPARISON WITH EXISTING MONITORING SYSTEMS

Track parameters, monitored by track measurement car:
- Track gauge monitoring, level, subsidence etc.,
- Unevenness of plan and profile of track in length up to 200 meters
- Recording of track profile for straight and curved sections
- Track deviation control in plane and profile

NIC IRT fiber-optics based monitoring system

Alarm

Parameters, controlled by fully automated measurement car
- Apply control for main geometrical parameters of track (10 parameters)

Departure from station based on fiber-optics monitoring system alarm about tack critical state

Economy cut by decrease of monitoring cart usage.
1 – Strain and temperature sensitive fiber-optic cable
2 – Recorder unit, utilized for data processing and alarm statement transfer to personnel or main control system.

System generate optical signal in fiber-optic cable, and analyze reflected light spectrum to calculate track parameters.

Reflected light

Light-reflecting cable section

1 meter distance reflection over optical cable length

Reflected signal spectrum

- Brillouin component
- Brillouin component
- Rayleigh component
- Raman component
- Raman component

Spectrum wave length
System purpose:

- Real-time railway track technical state diagnostics
- Detection of track critical stains and deflections
- Train maximum allowed speed evaluation for current section
- Soil deflection detection by analysis of track strains
RAILWAY TRACK MONITORING SYSTEM

System structure and mounting:

1 – Recorder unit
2 - Armor fiber-optics cable (stain and temperature sensor).
3 – Track mounting cable attachments
4 – Analysis software

Fiber-optic sensor mounting on the track
RAILWAY TRACK MONITORING SYSTEM

System specification:

**Measurement distance** – up to 120 km for one optical channel

**Number of optical channels:** up to 32 for one recorder unit

**Stain measurement range:** -5000… +5000 microstrain

**Spatial resolution:** Stain measurement with 1 meter step along the cable

**Software options:**

- Real-time current stain state monitoring of track;

- Limiting values specification for alarm signalization. Transition of information via alarm signal about stain level, location and time of critical event.

- Strain over time change analysis; load spectrum analysis.

- Train maximum allowed speed evaluation for current section state
System purpose:

- Track soil foundation deflections control
- Seasonal soil temperature change control
System structure and installation:

1. Recorder unit
2. Armor fiber-optics cable (stain and temperature sensor) for single direction measurement
   2a - Armor fiber-optics cable (stain and temperature sensor)
   2b - measuring fabric for stain detection in two directions
3. Soil mounting cable attachments (anchors).
4. Analysis software

Measurement fabric installation
System specification:

**Measurement distance** – up to 120 km for 1 optical channel

**Number of optical channels:** up to 32 for one recorder unit

**Stain measurement range:** -5000… +5000 microstrain

**Temperature measurement:** -50… +150 °C

**Spatial resolution:** Stain measurement with 1 meter step along the cable

**Software options:**

- Real-time current stain state monitoring of track foundation.
- Limiting values specification for alarm signalization.
- Transition via alarm signal of information about stain level, location and time of critical event.
- Strain over time change analysis.
- Soil shear strain analysis, specification of maximum stain direction.
TUNNEL SAFETY MONITORING SYSTEM

System purpose:

- Fire safety control by temperature measurement
- Tunnel mechanical state monitoring by analysis of strains on construction critical points.
System purpose:

- Real time technical state monitoring of framework;
- Real time structural loads monitoring;
- Early critical state alarming.
Oil railway tank monitoring system

- Leakage detection by measuring the acoustic signals
- Timely detection and fire prevention by measuring temperature field

- Fiber-optic cable-sensor for measurement:
  - temperature,
  - acoustic signal
Fiber-optic based track & foundation monitoring system practical usage on transcontinental railway, USA.

- Semi-automatic mounting of fiber-optic cable on tracks
  - Cable attachment points
  - Cable mounting device
- Track damage location detection by monitoring system measurement
- Track foundation deflection detection by monitoring system measurement
Fiber-optics based monitoring practical usage for RCRS's East Rail, China.

Track technical state monitoring

Train speed and total weight analysis

Example of cable mounting to the track

Railroad track section with monitoring system (blue on map)
WORLD EXPERIENCE OF RAILWAY TRACK AND FOUNDATION MONITORING SYSTEM USAGE

Fiber-optic based foundation monitoring system practical usage on Beijing-Changli railroad.

System structure

Gravelling

Measurement fabric installation with sanding-up