Towards Self-monitoring, Actively-reporting, Railway Track (SMART)

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Outline of presentation

• Track performance indicators
• Current monitoring methods
• Data processing
  Automatic datum finding
  Estimating the track stiffness
• Application
  to isolated defects
  to long lengths of track
• Future methods: optical fibres
Track performance indicators
Track performance indicators

- Track geometry: deviation in line or level over a length of track

Vehicle based measurement used for network scale maintenance scheduling

- Deflection under load

![Diagram of deflection under load]

- Track support system modulus (“track stiffness”): expressed per unit length of rail, includes effects of subgrade, ballast, pads etc

Lineside measurement used for detailed investigation
Monitoring methods
Measuring track from train

Photo: 125 Group
Lineside monitoring methods
MEMS Accelerometers

- Low cost and robust, suitable for long term monitoring (leave in place)
Data processing
Interpretation of geophone data

1. Geophone produces a voltage proportional to velocity of the sensor

2. Knowing the response characteristics of the geophone the velocity can be computed

3. Integration of velocity data gives calculated displacement

4. Dominant axle and bogie frequencies can be obtained
Typical geophone data showing artefacts of processing

Source: Milne et al, JRRT (2018)
Automated estimation of track zero position (datum finding) by considering the cumulative distribution function (CDF)

Automated processing of railway track deflection signals obtained from velocity and acceleration measurements.
Theoretical normalised displacement and distribution functions for a single load on a beam with an elastic foundation

Source: Milne et al, JRRT (2018)
Measured and theoretical displacements and distribution functions for a Javelin train

Source: Milne et al, JRRT (2018)
Estimating the support system stiffness from the ratio of harmonic peaks, without knowledge of the train load


https://doi.org/10.1139/cgj-2015-0268
Numerical FFT for measured velocity data from (a) an 11 car Pendolino (b) a 5 car Supervoyager (c) a 6 car Turbostar at S2 (d) a 4 car Electrostar
Displacement magnitude ratio vs track support system modulus for different train types
Applications
Application to the repair of isolated defects
Sleeper transition and UTX defect site

- Transition from mono-block to duo-block sleepers
- Shallow UTX in vicinity of the defect
- Site was unsuccessfully tamped

- Repaired using under sleeper pads, targeted hand packing
- Monitored using MEMS accelerometers
Sleeper transition and UTX defect site

After tamping

After repair

Mid Defect - Cess

Mid Defect - 6ft

Defect End - Cess
Application to long lengths of track


• Level, stiffness and deflection survey

• Vehicle track interaction modelling
Stiffness and deflection survey
Sleeper level survey
Field data: deflections

- **a)** Javelin
- **b)** Eurostar
- **c)** Velaro
Field data: inferred track support system moduli

Javelin

Eurostar

Velaro
Future monitoring
Optical fibre measurements
Optical fibre measurements: high strains indicate track faults.
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Thankyou for listening

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Journal papers (1)


Journal papers (2)


Journal papers (3)


