Track Monitoring Data Systems for Evaluation of Earthworks Instability

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26th October 2017
Title – Track Monitoring Data Systems for Evaluation of Earthworks Instability

1. Introduction
Purpose of the paper
Why important
What included and what not included
Digital age limits track walkouts but still need to visit sites r

2. Data Capture
Track recording train
Routeview
LADS Output
Omnicom
JBA Earthworks reports/Inclinometer data
BGS Database
Slope monitoring instrumentation
Google/BING Mapping
RINM Cross sections
OLE height/stagger

3. Track Behaviour
What does good track look like
Maintenance intervention types
Ballast properties and behaviour
Embankment fill properties and behaviour (Ash Fill/Clay fill etc)
Track zone of influence

4. Twist Faults/Cant deficiencies
(a) Track Related issues
- wet beds
- cyclic top on one rail

(b) Earthworks related issues
- Tree Desiccation cyclic top on one rail
- Slope instability
- Burrowing

5. Alignment Faults
(a) Track Related issues
- wet beds

(b) Earthworks related issues
- Slope instability

6. Maintenance Interventions/Trend analysis
(a) Track Related issues
- wet beds

(b) Earthworks related issues
- Slope instability
- Desiccation (trend analysis)

7. Dip Angle
(a) Track Related issues
- Jointed track on poor foundation

(b) Earthworks related issues
- Slope instability
- Bridge run-on/off

8. Rolling SD (Rolling eights/static eighths)
(a) Track Related issues
- Ballast attrition

(b) Earthworks related issues
- Slope instability

9. Ground Probing Radar
(a) Track Related issues
- Contaminated ballast

(b) Earthworks related issues
- Slope instability
- Pockets of water

10. Future Innovations
Satellite monitoring
Vibration Detection Units
Argo

11. Conclusions/Summary
Lessons learnt
Further work

ISSUES DISCUSSED IN PRESENTATION

Introductions
Anglia Earthworks
Track Recording Data (LADS)

Earthworks and Drainage Issues
Deep seated slope instability
Desiccation
Structures Run-on/off
Wet Beds

Other Track Issues
Maintenance effectiveness
Poor ballast condition
Some Background Information
Geology/Embankments/Rainfall/Drainage

- Large post-construction collapse settlement following rainfall infiltration.
  - Readily available locomotive ash and track ballast reinstated embankments.
  - Ash Ballast sometimes over side slopes as well for protection to clays.
  - Typically 1:1.5

- Space to walk and stand in safety.

- Vegetation cover.
Range of Typical Anglia Earthworks Failures

- Deep seated London Clay embankment instability
  - Chelmsford 2009

- London Clay cutting slope failures
  - Walthamstow Central 2009

- Perched Water table instability
  - (Tills over Clays) Brantham Hall 2014

- Glacial Till/Crag Washouts
  - Wymondham 2017

- Ash degradation /instability
  - Nags Head Lane 2016

- Storm Surge track and embankment washouts
  - Haddiscoe 2014

- Chalk Slope instability
  - Coalpit Cutting 2013

- Peat Wastage /Subsidence
  - Thrandeston Bog 2008

- Badger burrowing subsidence
  - Fordham 2016

- Rabbit burrowing subsidence
  - Pesthouse Lane 2015

- Clay Desiccation Track instability
  - Great Bentley 2009

- Ash Fires
  - Jacques Hall 1985
West Horndon to Dunton - FSS2 19m 35ch to 20m 55ch

Typical of issues on many embankments in Anglia

Slope Slip Surface Instability
Soil Creep
Vermin Burrowing
Tree Root Desiccation
Ash Degradation
Thick Ballast
Structures Run-on/Run-off
Poor Toe Drainage
Locally Prolific Hydrophilic Horsetail
Wet Beds
Inadequate Cess Walkways
Historic Patchwork of Treatments
What Is LADS

Linear Asset Decision Support (LADS) is a decision support tool designed to improve how you carry out Track, Earthworks and OLE maintenance inclusive of renewals. It is an integrated dashboard view of track asset information and is a key enabler in better understanding:

- Rates of asset degradation
- Different track fault types
- Determining the effectiveness of renewals and maintenance interventions,
- Predicting work volumes and output
- Targeted systems intervention

It allow greater validation of the proposed interventions and is part of a wider Asset Management toolkit.
## Data Presented by LADS

<table>
<thead>
<tr>
<th>Data Source</th>
<th>Asset Information</th>
<th>Refresh*</th>
<th>History/Retention</th>
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<tbody>
<tr>
<td>ACTRAFF:</td>
<td>Traffic (EMGTPA)</td>
<td>Periodically</td>
<td>12 months history</td>
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<tr>
<td>CARRS</td>
<td>Structures</td>
<td>One Off</td>
<td>Current record</td>
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<td>GEOGIS</td>
<td>Track Asset Register</td>
<td>Weekly</td>
<td>Current record</td>
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<tr>
<td>Radargrams &amp; Ballast Fouling Index</td>
<td>Ground Penetrating Radar (GPR)</td>
<td>Monthly</td>
<td>Current record</td>
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<tr>
<td>JBA</td>
<td>Earthworks</td>
<td>One Off</td>
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<tr>
<td>RDMS</td>
<td>Rail Defects, Rail Breaks, Rail Suspects, Rail RCF</td>
<td>Daily</td>
<td>Current record (3 yrs history)</td>
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<td>Network Model</td>
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<tr>
<td>TICLED</td>
<td>Tight Clearances</td>
<td>One Off</td>
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<tr>
<td>TRS:</td>
<td>Renewals</td>
<td>Weekly</td>
<td>Current record (3 yrs history)</td>
</tr>
</tbody>
</table>
What Good LADS Track Data Looks Like
What Bad LADS Track Data Looks Like
Ashdon Way Basildon – LADS data with Deeper 400Hz GPR
Ashdon Way Basildon – Deep Seated Progressive Embankment Failure
(FSS2 23m 60ch to 24m 10ch)
Tostock Embankment – Deep Seated Progressive Failure
(CCH 34m 65ch)

- Early identification of problem area extents
- Both GPR and twist faults show similar extents
- Identified progressive deterioration
- Targeting site investigation and embankment monitoring locations
Wrabness Embankment – Deep Seated Progressive Failure
(MAH 65m 60ch to 70ch)

Sleeper Ends Exposed - Twist Fault

Long Dip in track – Alignment Fault
Wrabness LADS track data 65M TO 66M – Up and Down Comparison
Blountswood Road SSV 34m 05ch to 65ch

Slope Slip Surface Instability
Soil Creep
Vermin Burrowing
Ash Degradation
Poor Toe Drainage
Leaning OLE Mast
Thick Ballast
Locally Prolific Hydrophilic Horsetail
Leaning trees
Inadequate Cess Walkways
Historic Patchwork of Treatments
Blountswood Road SSV 34m 05ch to 65ch Up and Down LADS Comparison
Blountswood Road SSV 34m 05ch to 65ch Down LADS data

GPR features at 25ch and 61ch

SSV 34ml 25.25ch to 34ml 25.75ch Down embankment shoulder drops and walkway restrained, but 3.5m cess, track good although recently tamped.
Cess walkway in poor condition between 34ml 59.5ch and 34ml 65.75ch Down, track good but recently tamped. From 34ml 60.25ch to 34ml 63.5ch cess and walkway drops with increased ballast thickness, there is also Horsetail in walkway.
There is a gabion toe berm between 34ml 60.75ch and 34ml 61.75ch
TWN 68m to 69m - LADS Up and Down (Single track)
Problem 68m 45ch
Ulemans Farm WIS 38 miles 1100yds - Embankment instability
Ulemans Farm WIS 38 miles 1015yds to 1120yds - Embankment instability
Typical Anglia Embankment/Structure Run-on/Run-off Differential Settlements
Manea Viaduct Approach Embankments
EMP 78m (east) to 79m (west) - LADS Down
Local Twist Faults on Peat Fens due to Trees

(ETN 72m 0880yds to 72m 1650yds Up)
LADS Summaries ETN 72m 0800yds to 72m 1650yds Up

- Layout
- Ellipse
- Workbank
- Twist
- Twist Exceedance
- AL70
- Maintenance Effectiveness

- Top Left (mm)
- Top Right (mm)
Maintenance effectiveness on Fens (EMP 74m 0550yds Up)

Stoneblowing more effective than Tamping
Clay Embankment Desiccation

BRE 412 “Desiccation in Clay Soils” - Desiccation in clay soils can result in shrinkage of the soil and subsidence of the ground; this may lead to damage to buildings. As the soil re-hydrates, it can swell, resulting in ground heave; this may also cause damage to buildings.

Harold Wood Slope inclinometer boreholes
Seasonal cyclic and progressive movements

 прогрессивное ухудшение, обычно 20 мм/год

Summer 2015 cycle peak
Summer 2016 cycle peak

Chattenden London Clay BRE Settlement rods
Seasonal cyclic and progressive movements showing effects of trees and grass

Trees vs Grass
Root penetration x5
Deformation x10
Desiccation related track deterioration

Good Track Geometry on London Clay Soils FSS2 and TLL
TAH2 8m 1270yds to 1340yds Down Wet Beds
TAH2 8m 1270yds to 1340yds Down Wet Beds

Repeat Twist Faults
Conclusions

1. Track monitoring data is a useful tool in the assessment of certain types of earthworks failure
2. Anglia Route are looking to undertake a wider Route review of such track monitoring data
3. Track monitoring data is a complimentary tool to supplement other existing earthworks assessment tools
4. Sharing case history data will hopefully assist in the more widespread use of such track monitoring data
5. Production of a more detailed user manual would further assist in the understanding of LADS
6. Network Rail are embarking centrally on a more detailed review of the benefits of using track monitoring data