Trackbed asset management
Improvements in data driven decision making

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The trackbed asset
What is it and why is it important?

Research suggests a significant proportion of track problems can be sourced in the trackbed. Aside increased maintenance and renewal, failure can lead to derailments if not remedied.

7.5% due to trackbed - Lots of root causes of failure but how do we determine this?

Derailments caused by track in the US - 2007 to 2009 (Read, 2011)
Understanding the trackbed asset
Subgrade related failure mechanisms

Repeated dynamic loading → Fine grained soils → Excessive moisture content

Progressive shear failure

Attrition with mud pumping

Excessive plastic deformation

- Differential track geometry
- Excessive repeated track maintenance
- Potential safety issues
Understanding the trackbed asset
Ballast related failure mechanisms

Talen from Selig and Waters (1994) – North American Study

Infrastructure/traffic/environment dependent – understanding source and affects of each is key to optimising maintenance and renewal strategies
Drainage is a System

Drainage, earthworks, transitions…all have an impact and can be the source of problems. They need to be understood to identify root causes of trackbed failure…..lets look at an example
Understanding the trackbed asset
System related failure mechanisms

Earthworks failures should manifest at the track level in some form but is this understood?

We are currently investigating link between track quality metrics / history with earthworks failures / high risk sites.

Outputs have potential to use track data to spot developing earthworks faults and facilitate improved system related decision making (i.e. enable asset owners to better identify root causes before they become more serious – in this case the earthworks).
Understanding the trackbed asset

Other considerations

M&R history can also inform us - What has / hasn’t worked? – e.g. Incorrect treatments, Continued maintenance

In summary to manage the trackbed asset it is important we understand root causes of failure so right decisions can be made in terms of treatment / timing. We need to treat it as a system. The solution may not be in the trackbed

Rolling stock, drainage, track, earthworks, bridge, transition, site history needs to be understood so we don’t end up treating the symptom…..Lots of developments over 20 years to help this decision making process (PPE developed also!)
Trackbed renewal decision making

Pre 2000

Late 90s Railtrack investment focussed on assets likely to generate performance improvements in the short run, such as renewal of rail, rather than investments in long term performance and quality (e.g. ballast renewal)

Hatfield (Oct 2000), a metal fatigue induced derailment, caused 4 fatalities, injured 70 - Investigation exposed major stewardship failings of Railtrack *

Trackbed renewal decision making
Pre 2000

A myriad of causes however the Office Rail Regulator enforced several improvement measures around asset management....... **including requirements to maintain a comprehensive database of their assets and condition**

This was an important milestone in recognising importance of asset data and its use to make informed decisions

The importance of ballast, formation and subgrade deterioration on track performance also gained wider appreciation / recognition
Trackbed renewal decision making
Pre 2000

Decision making dominated by local engineer knowledge, shallow pits at set intervals and average track indices over 1/8 mile sections (not always!)

Limitations with historic practice
- Focused on shallow seated failures
- Localised problems lost in “averaged” track data

Multiple causes of track performance issues not investigated / bottomed out (Track components, Earthworks, Drainage, Structural interaction, Stiffness /critical velocity etc)
Trackbed renewal decision making 2000-2005

Trackbed renewal decision making 2000-2005

Filled in the gaps between known intrusive investigations and gave more data to delineate problems

GPR integrated into measurement fleet.

Ability to target problem hot spots

Starts to be used for other network asset management purposes (e.g condition / fouling)

Earthwork failure identification

Renewals quality assessment

Great step forward but not applicable to all asset owners….
Trackbed renewal decision making 2000-2005

- Automatic Ballast Sampling introduced mid 2000s
- Sampling to recover trackbed core overcoming disadvantages of trial pits
- Written into NR standard (+ standard logging key)
- Used with GPR gives huge advance in track renewals decision making ability
- Value in data for other AM purposes post renewal (30-40% of network coverage)
Trackbed renewal decision making 2000-2005

Stiffness also an important parameter to measure. Why?

- Soft / variable stiffness produces high bending stress (rail breaks)
- Rapid change in support (e.g. transitions) results in poor top
- Critical Velocity over very soft ground limits train speed

In 2003 FWD introduced to railways - drop weight method of evaluating layer stiffness and critical velocity
Trackbed renewal decision making 2005-2010

Total Route Evaluation concept born – bringing it all together

More scientific approach to investigating the trackbed and designing the problems out
Trackbed renewal decision making 2005-2010

Increased development of solutions by industry (examples)
- Antipumping geo-composites
- Wide Aperture geogrids

Geosand
The first Anti-Pumping Geocomposite

Geogrid Trials at Coppull Moor on the West Coast Main Line
Trackbed renewal decision making 2010+

“CP5 Policy focussed on improving understanding of asset degradation through better condition information…. progression of long term strategic R&D themes (e.g. trackbed substructure)”

Ref NR CP5 Business Plan

“Understanding condition of substructure is vital for maintaining good track geometry…..stiffness measurements will provide the best information for remediation of embankments and cuttings”

“Developments are required in the measuring technology area”

“Causes of variability of track stiffness need to be better understood”

“Track management processes need to be developed to identify track stiffness problem sites and take appropriate action”
Trackbed renewal decision making 2010+

Industry (e.g. through work of the TSWG) has made good progress in

(a) measurement and
(b) understanding of stiffness

Work to be done in analysis of data. Also only currently investigated at difficult problem sites.
Trackbed renewal decision making 2010+

- Leaps forward in linear asset data collection / management / visualisation / analytics (EAMs, LADS, TAMP).
- Enables decision makers to access / view all data streams
Trackbed renewal decision making
2010+

Further solution development to remediate deeper seated / problem sites

- Geowebs
- Asphalt Track
- Micropiling
Trackbed renewal decision making
What next?

**Rolling wheel stiffness measurement** a key enabler to improved renewals decision making.....Understanding of data and how to use it equally as important!

**Instrumented in service trains** gives increased frequency of measurement and more opportunities for improved analytics / decision support tool development

**Big data** Not all solutions require additional data collection in rail ....Data already collected and stored as part of regular inspection practices means there is a vast potential resource available for mining and information discovery, particularly if it can be shared...

**Machine learning** opportunities with increased availability of data and computer processing power
Trackbed renewal decision making

Overview

What do we do and when?

What is the site history (maintenance / renewal) and what are the future requirements (load, tommage, design life etc)?

What are our asset management drivers (cost, risk, performance)?

Where are the ballast fines from?

What is the condition and stiffness of the formation?

What is the condition and capacity of the drainage system?

What about underlying earthworks problems? Historic or current?

Any other issues with adjacent assets? Transitions / structures etc

Does Industry truly understand cost, risk and performance impacts of decisions?
Trackbed renewal decision making

Summary

The UK rail industry has come a long way in improving methods of trackbed investigation, analysing data and trackbed remedial options to optimise renewals decision making. There has been huge improvement in collating multiple sub-system data sets for the engineer to make informed decisions. Further improvements possible with network stiffness measurement.

As we move to a data driven world the benefits of analytics are immense…. However before we rush to collect additional data, there is already a huge amount of data available. Linking dataset trends across subsystems is key.

To truly make the right decisions, every one has to be aligned with the organisational asset management strategy. To do this day to day impacts of decisions need to be understood in cost, risk and performance terms.
Thanks for listening