Preface: Ever changing landscape

Chris Grayling unveils plans for fully privatised rail line

Single company to own track and run trains on Oxford-Cambridge route in first such operation since 1990s privatisation

Gwyn Topham and Matthew Weaver

Tuesday 6 December 2016 11.33 GMT

1,774
Agenda

• Success and problems
• Solutions for conventional rail
• High speed rail
• Far future
More passengers

Source: ORR
More traffic

- 100% growth in last 20 years
- 50% in 10 years
- EU average in 10 years -18%

Source: ORR
Less access
Network Rail Possession Times

% of core possessions

- <8hrs
- 8-12hrs
- 12-24hrs
- 24-48hrs
- 49-72hrs
- >72hrs

Courtesy Steve Featherstone NR
Less money
Rail industry costs and income 14-15 (simplified!)

Passengers
£9.6B income

Government
£3.5B input

Other
£0.4B income

Train Operators
£8.7B expenditure

Network Rail
£6.3B expenditure

£1.4B

Source: ORR
Success means problems

- More people
- Less time /access
- Cost pressures

What has been done to try to reduce the impact of these issues?
Two methods – from the track side

Rail lasts longer

Reduce track maintenance time
How do rails fail

Rolling Contact Fatigue

Wear

Foot fatigue

Welds
How do rails get damaged

Amount of damage

Wear

RCF

Other factors

Tight

Curvature

Shallow
Harder steels

R220
0.55% C

HP335
0.92% C

R260
0.72% C

R350HT
0.77% C
HP335 Trial Site at Hett Mill

- Standard rail developed severe RCF (25mm cracks) and lasted five years
- HP335 free from RCF after five years and predicted to last 28 years
Grinding

![Graph showing the relationship between crack depth and time during the grinding process. The x-axis represents time, while the y-axis represents crack depth. The graph illustrates how the crack depth decreases over time.]
Rail Grinding Equipment
Rail Grinding

Courtesy Cornwall Railway Society
Results of grinding
Rail Milling
Milling Results
Better measurement
Ultrasonic testing

70 degree probe coverage
37 degree probe coverage
0 degree probe coverage

Image courtesy Brian Whitney NR
Eddy Current
Trainborne Eddy Current

Direct measurement of RCF depth at line speed

Image courtesy Sperry Ltd
Better welding
Welding processes - Thermic

125 year old process but still the primary mechanism of welding in track
Uses the aluminothermic reaction to form a “portion” of hot metal to join both ends
Flash Butt Welding
Mobile Flash Butt Welding
Result

Number of rail breaks

Number of rail breaks


British Steel
Reduced track maintenance time
Old way
Getting better
Modern Day
Automation of renewals

Courtesy of Plasser-Theurer
Automation of maintenance
Speed up handbacks
Renewal miles good, with a higher level of automation, but still 15% lower than planned.
High Speed Rail
HS2 Route
Operational high speed track (>250kph)

UK 14th in the world

Source: UIC Sept 16
Operational and under construction

Total track operational and under construction km

Source: UIC Sept 16
Total operational, under construction and in planning

UK 26th in the world

Source: UIC Sept 16
Ballasted track

Image Courtesy Brian Counter PWI
Slab Track
## Which is better?

<table>
<thead>
<tr>
<th>Feature</th>
<th>Ballast</th>
<th>Slabtrack</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost</td>
<td>Low upfront</td>
<td>High upfront</td>
</tr>
<tr>
<td>Adjustability</td>
<td>Easy during life but alignment degrades</td>
<td>Hard after install but doesn’t move</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Resistance to ground movements?</td>
</tr>
<tr>
<td>Maintenance during life</td>
<td>Needs tamping</td>
<td>Minimal, to rail/clips only</td>
</tr>
<tr>
<td>Lifetime</td>
<td>~20 years</td>
<td>60-80 years</td>
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<tr>
<td>Replacement at end of life</td>
<td>&gt;400m per night</td>
<td>5 panels (25-50m) per night</td>
</tr>
<tr>
<td>Track Stiffness</td>
<td>Comparably soft</td>
<td>High stiffness</td>
</tr>
<tr>
<td>Noise/Vibration</td>
<td>Peak particle velocity issues</td>
<td>Ground borne vibration and noise reflection</td>
</tr>
<tr>
<td>Safety</td>
<td>Dust, slips/trips, flying ballast</td>
<td>Slippery when wet?!</td>
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</tbody>
</table>
Settlement

- Recommended to leave at least a year between excavation and track construction

Courtesy Wojciech Nawrat, RailOne
Switch and Crossings (S&C)
Typical UK switch
Typical High Speed Switch
Solution - Bainitics
Weldability
Potential future solutions

- WRIST European funded project
- Forged aluminothermic welding and orbital friction stir welding

Image courtesy WRIST project
The Far Future
Future

- Impact of autonomous cars
  - Already had autonomous trains for a long time
- Heavily used commuter and intercity routes versus branch lines
Very Light Rail Project

• 18 tonnes, diesel electric hybrid with regen brakes
• www.verylightrail.com
Pods on the railway/platooning

- Pods that run on existing track, can run singly or as a train
- http://railtaxis.weebly.com/
Rail Pods
Summary
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