CURRENT PRACTICE IN BALLAST MAINTENANCE & RENEWAL

Andy Franklin
Professional Head of Civil Engineering
Carillion Rail

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Agenda

- What does ballast do?
- What constitutes good ballast?
- How does ballast material fail?
- How does the ballast system fail?
- Implications of ballast failure?
- Current ballast maintenance methods
- Current ballast renewal methods
- Sustainability challenge

What does ballast do?

Key part of the track ‘system’. It:

- supports the sleepers or bearers both vertically and laterally
- spreads the loading from the sleepers or bearers onto the formation
- provides a drainage path for precipitation

Additionally it:

- facilitates adjustment of the track geometry

What constitutes good ballast?

Good ballast must be:

- the correct size and shape
- hard – resistant to crushing and abrasion
- resistant to water – wet attrition value
- angular – will interlock to form a stable matrix to support the track but allow free drainage

Detailed in Network Rail specification NR/SP/TRK/006

How does the ballast material fail?

Ballast particles fail by:

- Crushing
  - overloading
  - mechanical maintenance (Machine and manual tamping)
- Abrasion
  - tamping
  - dynamic track movement under traffic
- Attrition
  - Exacerbated by the presence of water

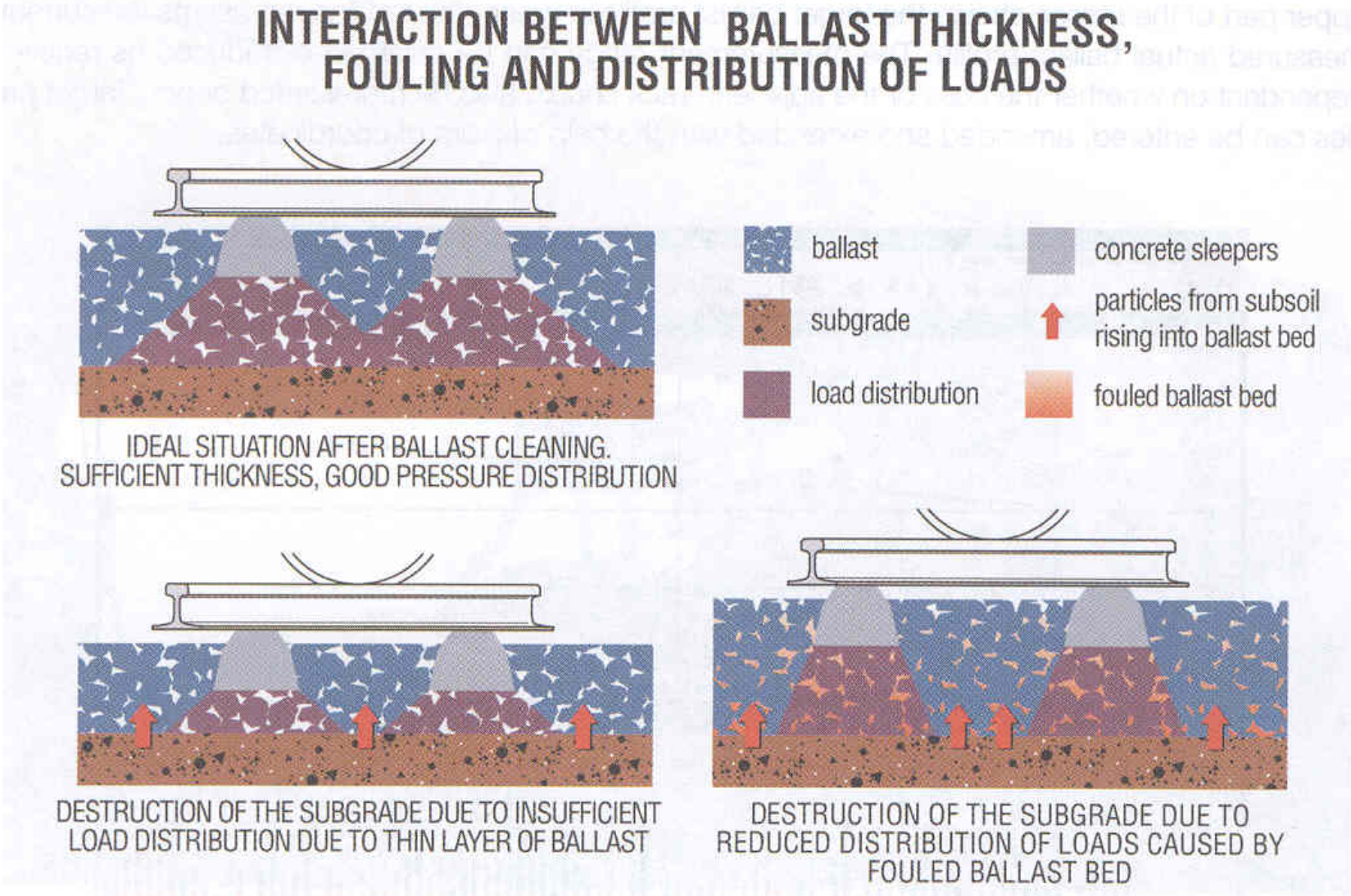
How does the ballast system fail?

The ballast system degrades due to:

- creation of fines
- ingress of fines from above (Spillage from trains, windborne material)
- ingress of vegetable matter
- ingress of material from the formation

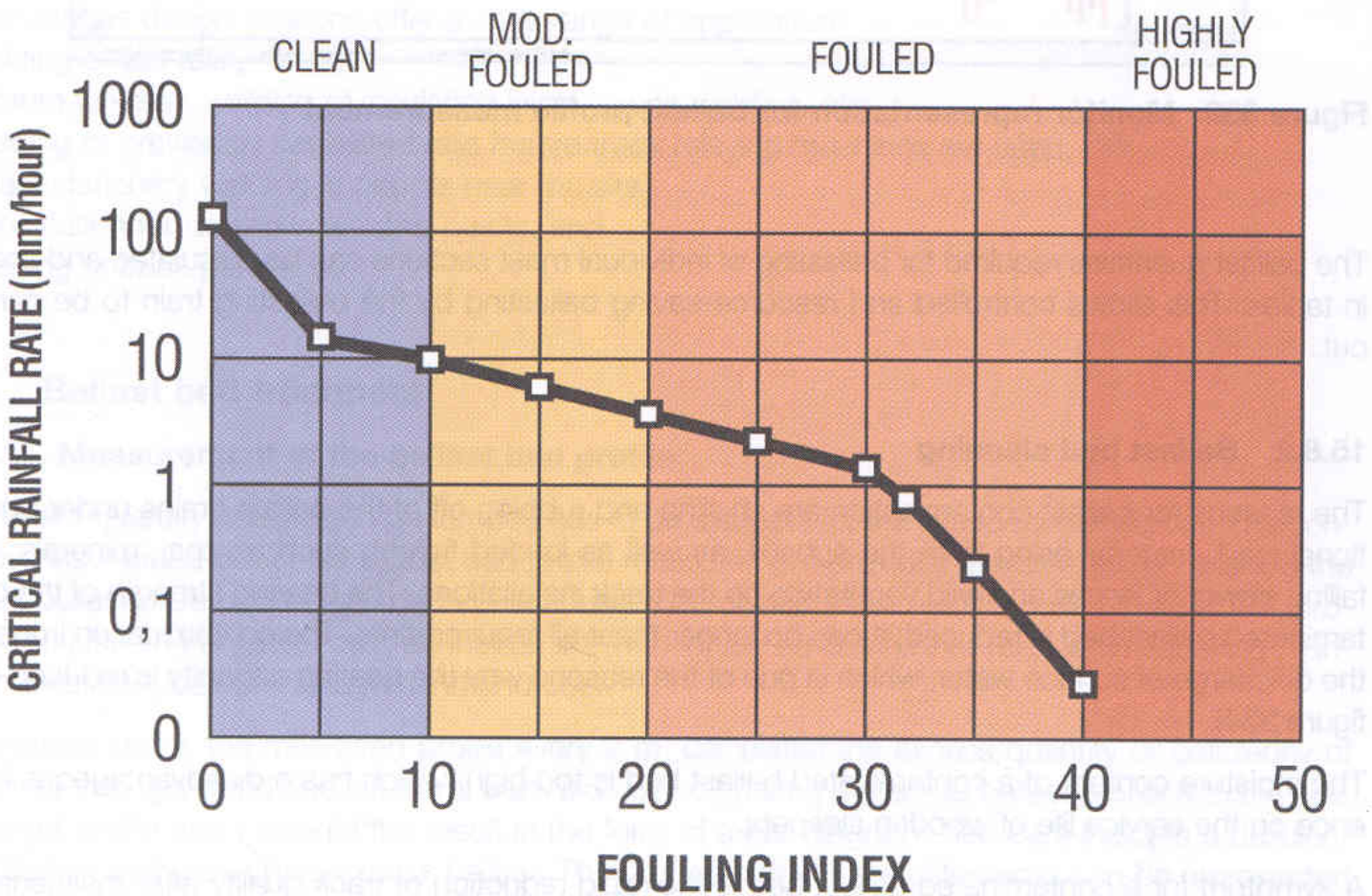
There is a strong correlation between ballast problems and problems in maintaining good track geometry (track quality)

How does the ballast system fail?



From ‘Track Compendium’ by Bernhard Lichtberger

How does the ballast system fail?



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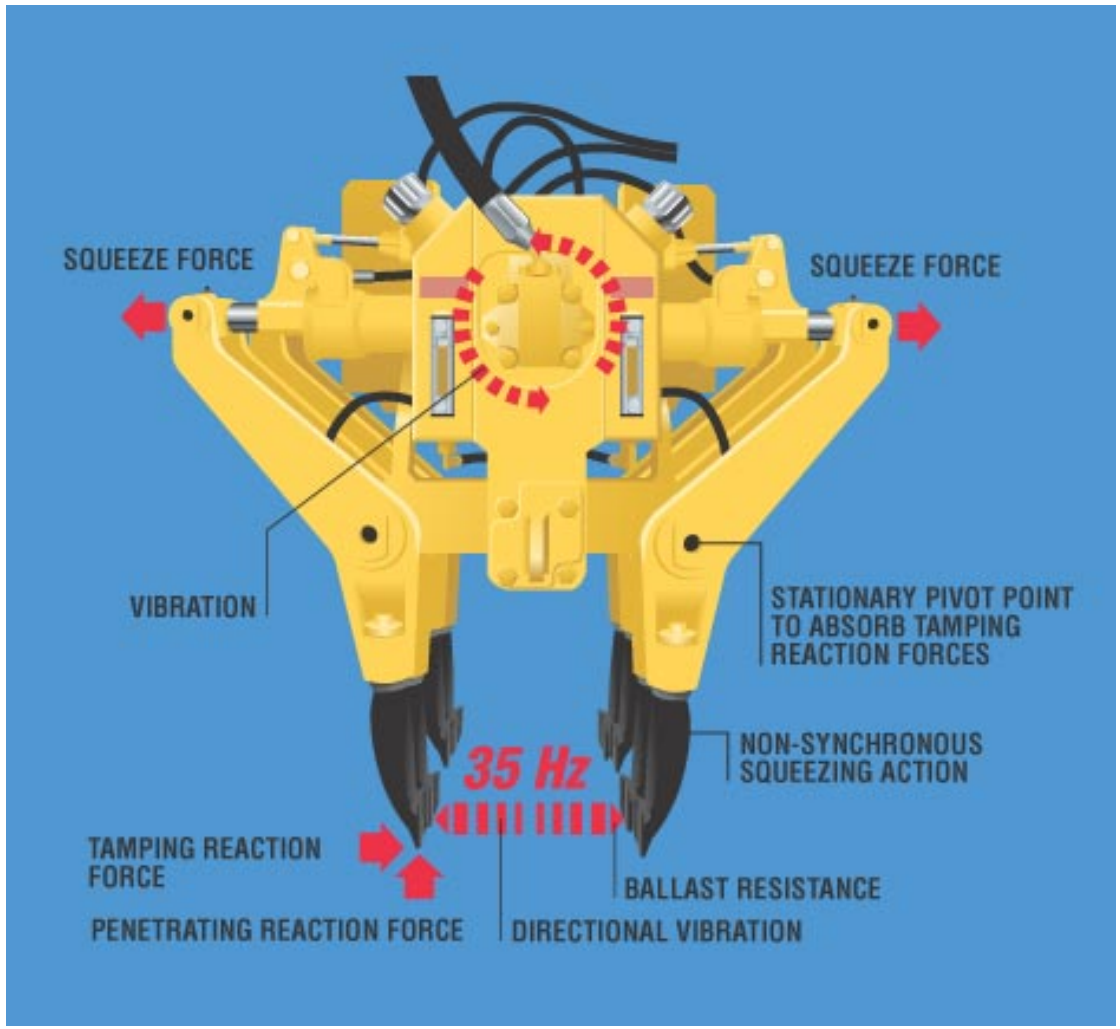
Creation of fines - Mechanised Tamping

Every time the tines go in it (each tamping cycle) creates 4kg of fines!

As track quality deteriorated more tamping won't necessarily help!

Creation of fine - Mechanised Tamping



Wet beds – fines from ballast degradation

Water ponds in wet weather (despite)

Platform wall doesn't help

Slurry rising up through the ballast

Colour and texture (gritty) indicates that the problem is probably ballast attrition and sleeper abrasion

Wet beds – spillage from trains

Serious coal spillage!

Cess too high impeding drainage (note old arisings)

Long term problem leading to formation failure in places

Also corrosion problems for rail and fastenings

Wind borne material

A problem with building a railway on the beach!

Ballast completely choked with sand

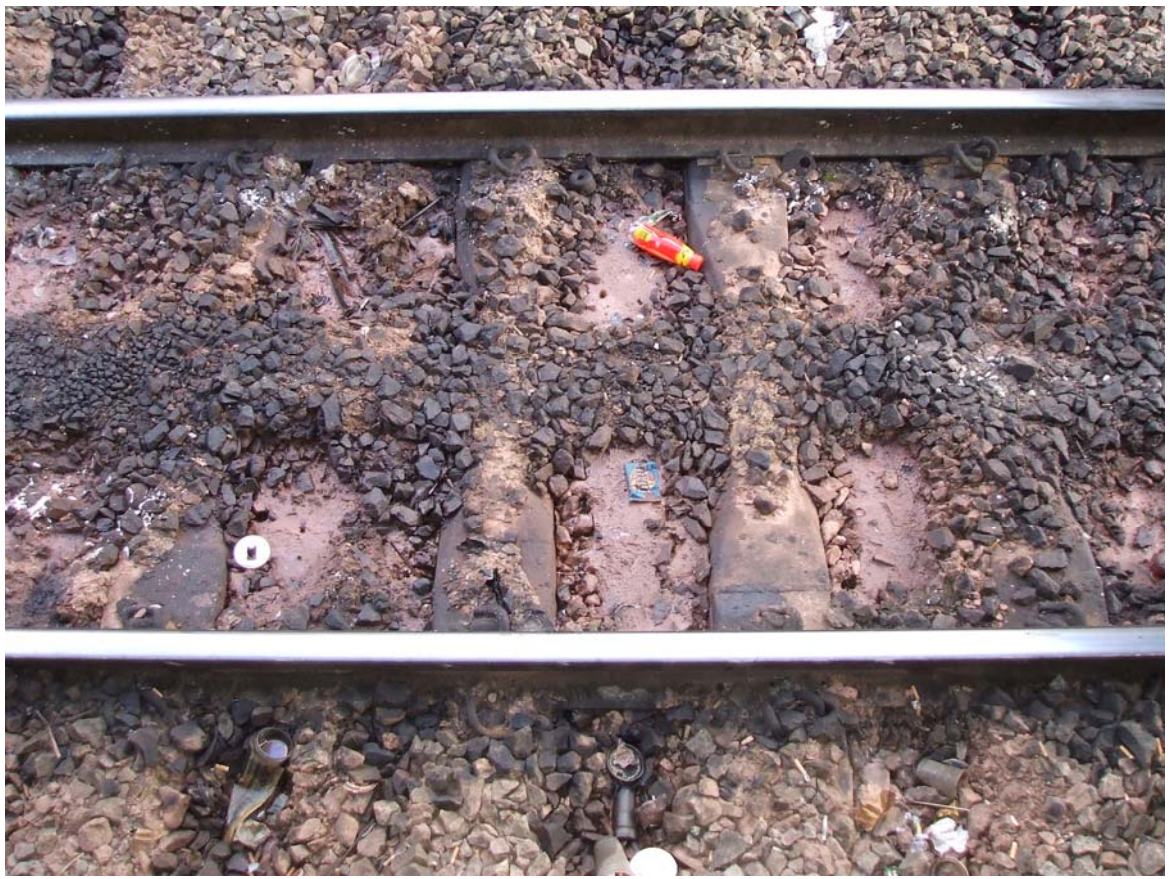
Fortunately drainage is good

Wet beds – formation failure

Water ponds in wet weather (despite a drain)

Slurry rising up through the ballast

Colour and texture (smooth) indicates that this is not ballast attrition



Ingress of vegetable matter

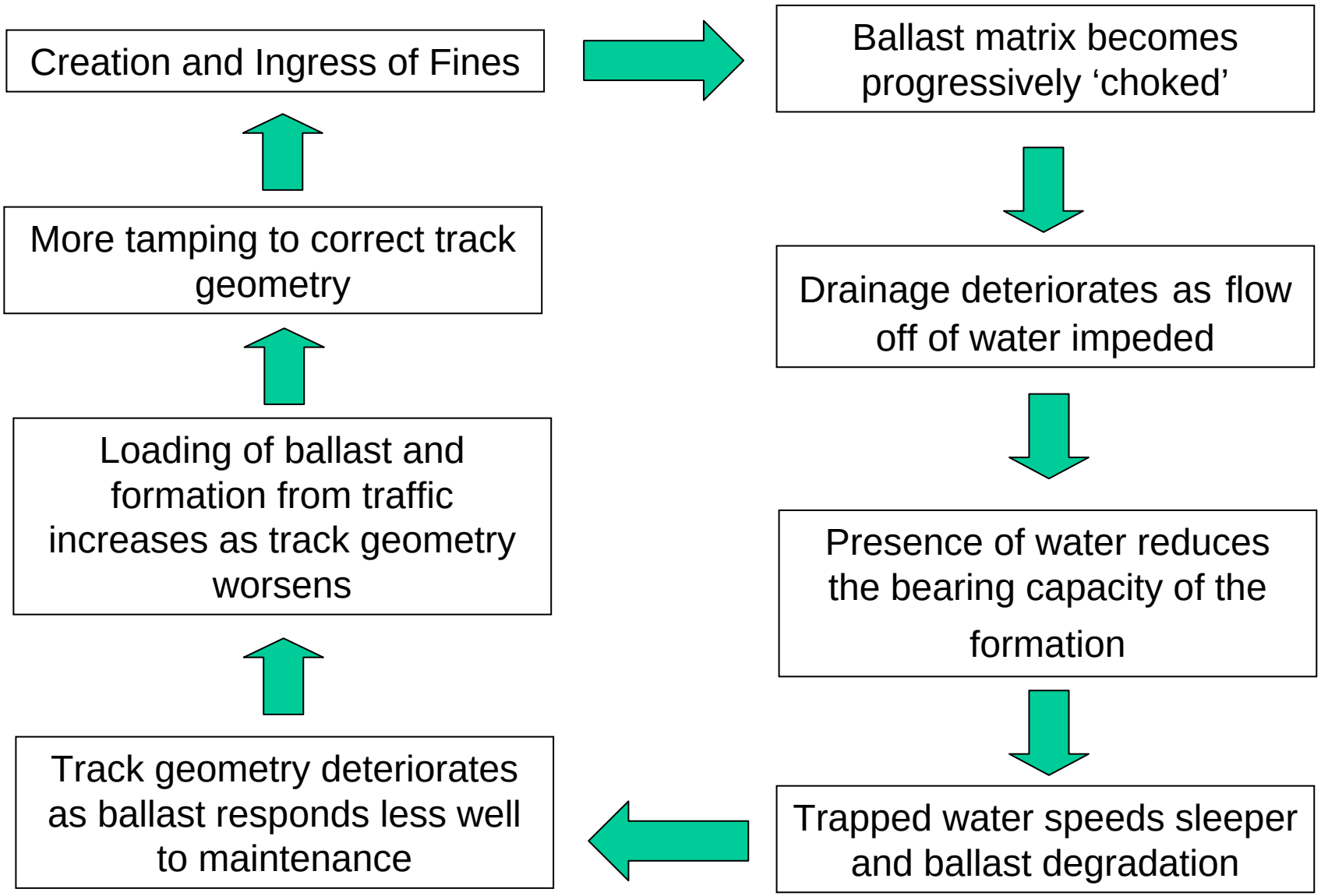
Walkway has blocked drainage

Sand from loco sanders adds to choking of ballast

As plants die back roots are left in the ground

When you have got grass things are pretty bad!

The cycle of decline?



Implications of ballast failure

- Deteriorating track quality – poor ride quality
- Discreet track geometry faults (e.g. twist & cyclic top) – risk of derailment
- Loss of lateral stability - increased risk of track buckling
- ‘Ponding’ of water - damage to the formation
- Formation of wet beds - damage to the sleepers and bearers

Objectives of ballast maintenance and renewal

The objectives are clear!

Principally:

- restore the drainage
- remove the fines (including damaged ballast)

Additionally:

- repair any damage to the formation
- improve the overall system (for example add blanketting or geogrids)

Current Maintenance of Ballast

- Ballast cleaning once done manually
- Grading of wet beds
  - Manual
  - Mechanical
- Shoulder cleaning
- Weeds praying (residual)
- Regulating & Brushing
- Drainage maintenance

Manual reballasting

Good results can be achieved by digging out with one of these……

and boxing in again with one of these……

Shoulder Cleaning

- Frequently problems are caused by the inability of water to reach the cess or the track drainage, shoulder cleaning restores the drainage path
- Not a lot done in the UK (not enough in my opinion)
- Purpose built machines are available (similar to ballast cleaners in concept)
- Can readily be done with road/rail excavators

Weed Spraying

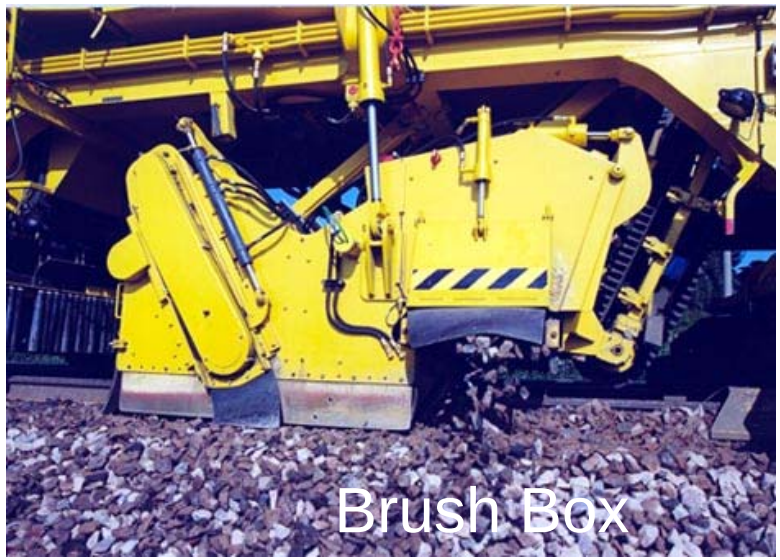
- Amount done dropped sharply at privitiastion (it is never ‘urgent’)
- Changes in allowable herbicides has caused some issues as modern herbicides are not residual and killing weeds once they have grown is not as effective as stopping them growing
- Regular spraying is vital to good track inspection and ballast maintenance

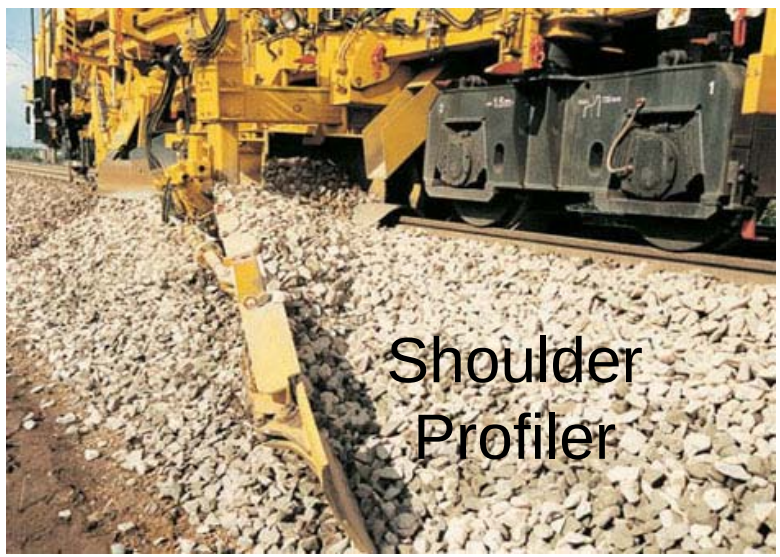
Ballast Regulating

- Can be done manually but uneconomic for other than short lengths
- Largely ceased after privatiastion but now making a comeback
- Restores correct profile of ballast following settlement or after other work (e.g. tamping)
- Very important for stability of Continuous Welded Track

Ballast Regulating

- Clears material off the sleepers and fastenings (important for inspection and the inspector!)
- Can sweep up and move ballast from places of excess to shortage
- Avoids ballast ‘pick-up’ on high speed lines
- High outputs can be achieved





Drainage Maintenance

- Problems with the ballast and formation are almost inevitably caused by water retention
- Good drainage is essential for good track and all drainage maintenance is money well spent
- Whilst cleaning of existing drains is increasing areas that need to be tackled are:
  - good drainage inspection and records
  - repair of existing drains
  - ingress of tree roots
  - replacement of filter materials
  - provision of new drainage runs
- There is a common perception that drains will last forever

Current Renewal of ballast

Track-in techniques

- Ballast cleaning
- Excavation with mechanical plant
- Vacuum Reballasting

Track-out techniques

- Excavation with mechanical plant

Track-in Techniques

Vacuum Reballasting

- New to the UK but in use on the Continent (notably Scandinavia) for many years
- Can tackle any material
- Water is not a problem (though disposing of the resultant slurry can be!)
- Excavation using the manipulator arm and spoil remove by vacuum
- High outputs can be achieved
- Can be used for many tasks (e.g. drainage, cable excavation, reballasting, wet bedding etc.)

Vacuum Reballasting

Track-in Techniques

Excavators with Modified Buckets

- Generally used on smaller jobs (e.g. large groups of wet beds)
- Often seen as maintenance rather than renewal
- It is slow

Using excavators with modified buckets

Track-in Techniques

Ballast Cleaning

- Was very common in the UK but fell out of favour at privitisation
- Making a big comeback (e.g. Network Rail HOBCs)
- Needs right conditions for optimum results:
  - Right moisture content
  - Non-cohesive material (e.g. clay)
  - Not too hard
- Return rate under favourable conditions (over 50%)
- Many sites left until it is really too late to clean
- Ballast cleaners can be used to do ‘excavation’ without screening
- With modern machines very high outputs are possible
- Ballast ‘washing’ and ‘sharpening’ now being introduced on Continental machines

Ballast Cleaning

Return from screen box

Cutter Bar

Ballast Cleaning

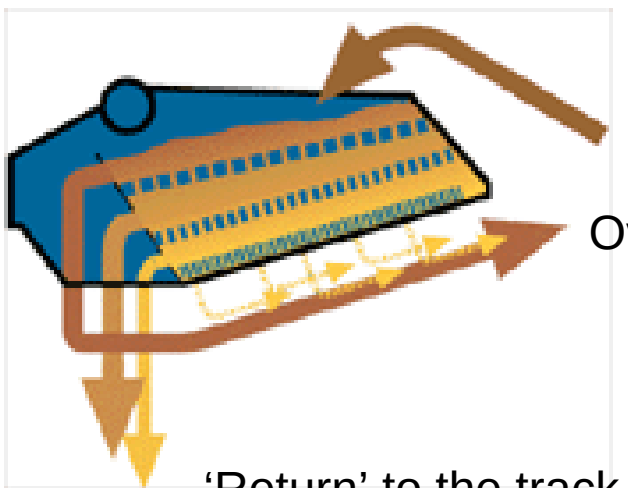
‘Screen Box’ with 3 screens

Screen sizes

80/60

50

30



Material in from cutter bar

Oversize material and fines to waste

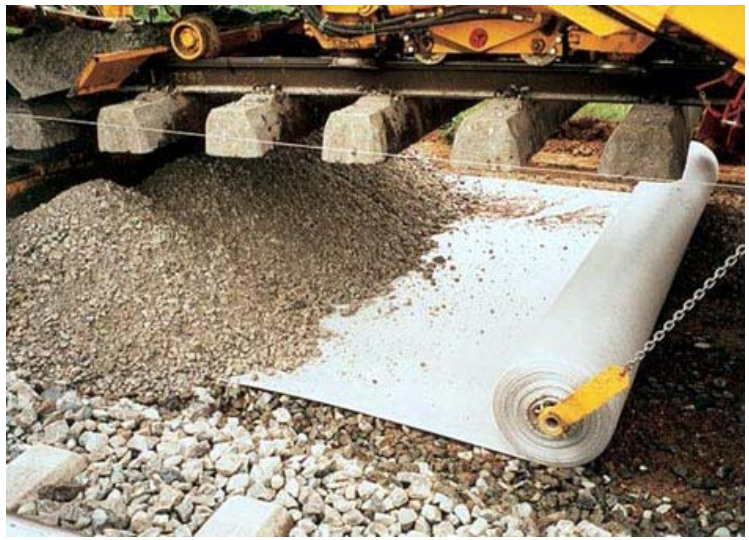
‘Return’ to the track behind the cutter bar

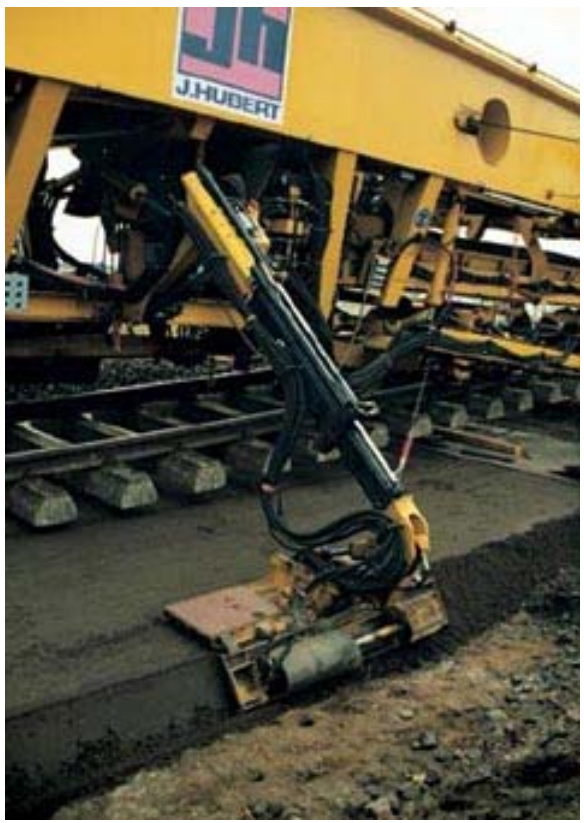
Track-in Techniques

Formation Rehabilitation

- The next step for ballast cleaners
- Replace the formation layers as well as the ballast
- Used extensively on the continent
- High outputs are achievable
- Issues with fitting them into the restrictive UK loading gauge

Formation Rehabilitation

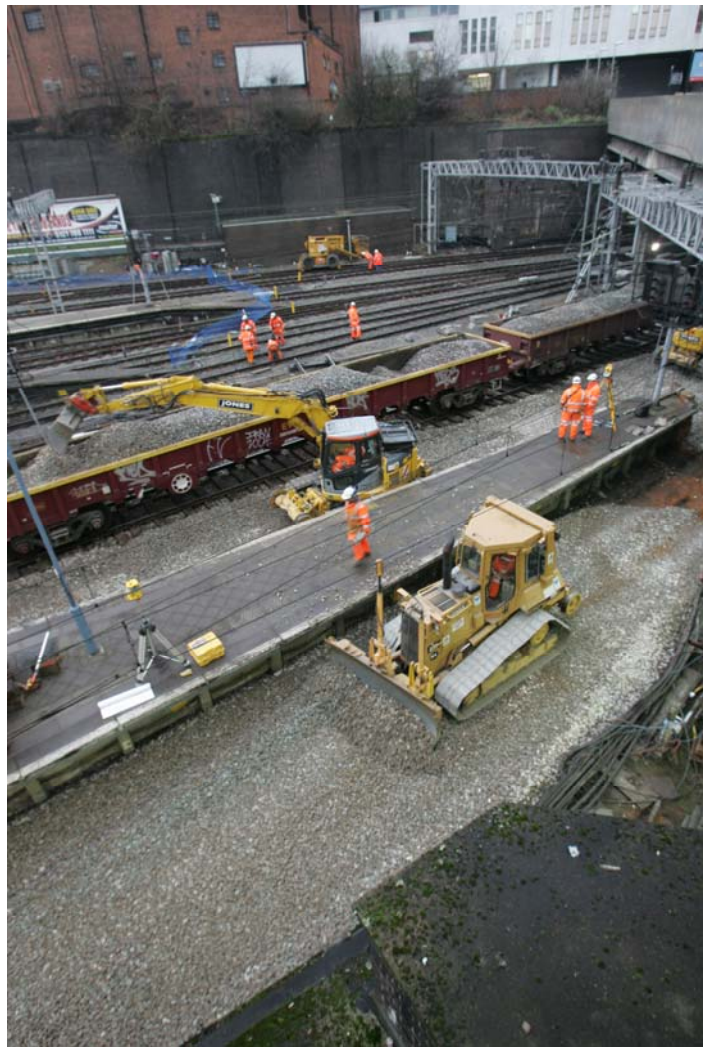




Track-out Techniques

Use of modified earthmoving plant:

- Most common technique in current use for track renewals
- Machine modified conversion to road/rail and addition of railway safety features
- Must take the track out so favored where the track is to be renewed as well
- Can tackle any material but very wet conditions can be a problem



Track-out Techniques

- Can readily add blanketing, geotextiles and geogrids
- Good control of level available using ground modelling techniques and laser control of machines
- Easy to compact the formation and ballast in layers
- Some continental countries are now using purpose built excavating machines and ‘ballast planers’

Sustainability Challenge

- Can we go on using vast quantities of new ballast?
  - 2.6 million tonnes in 2005/06
- 1.6 million tonnes disposed of
  - 90-92% reused but not in railway industry
- These figures represent a lot of train movements
- Reuse on site saves transport costs as well as stone
- Reuse on the railway allowed but only on low category lines (where there is little demand!)
- Techniques that prolong ballast life are clearly desirable
- Ballast cheap compared to cost of work

Thank you for you attention
Any questions?