



LUNCH & LEARN

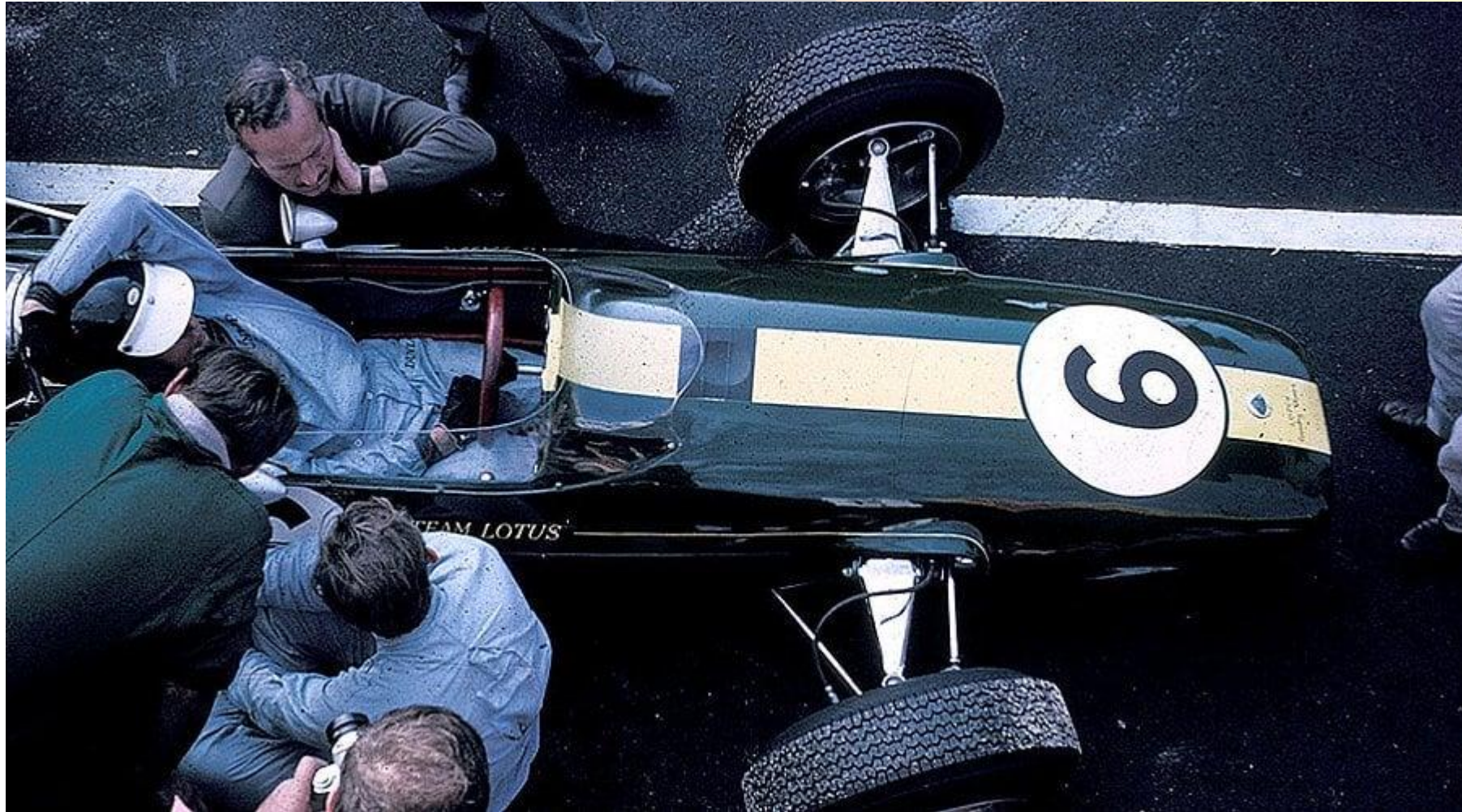
The Integrated Composite Sleeper The “Hedgehog”

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MIET





What would happen If Formula 1 designed a sleeper?



"Simplify, then add lightness" Colin Chapman



Network Rails Vision for CP7

Our vision:

A simpler, better, greener railway.

Simpler

We'll play our part in unifying the railway to make it easier for people to choose rail, improving customer service, growing passenger numbers and freight.
We'll root out waste and duplication and stop doing things that don't add value.

Better

We'll continue putting passengers first and shifting more goods by rail; encourage local accountability and be more commercially minded. We'll create a new type of rail leader, invest in the skills and safety of our colleagues, and **help rebuild the railway**, offering good service everywhere and **transforming it whenever the opportunity arises by working closely with our partners.**

Greener

And by making rail simpler and better, we'll attract more people to the cleanest, greenest form of mass transport.
While reducing our own carbon footprint to minimise the impact on nature.

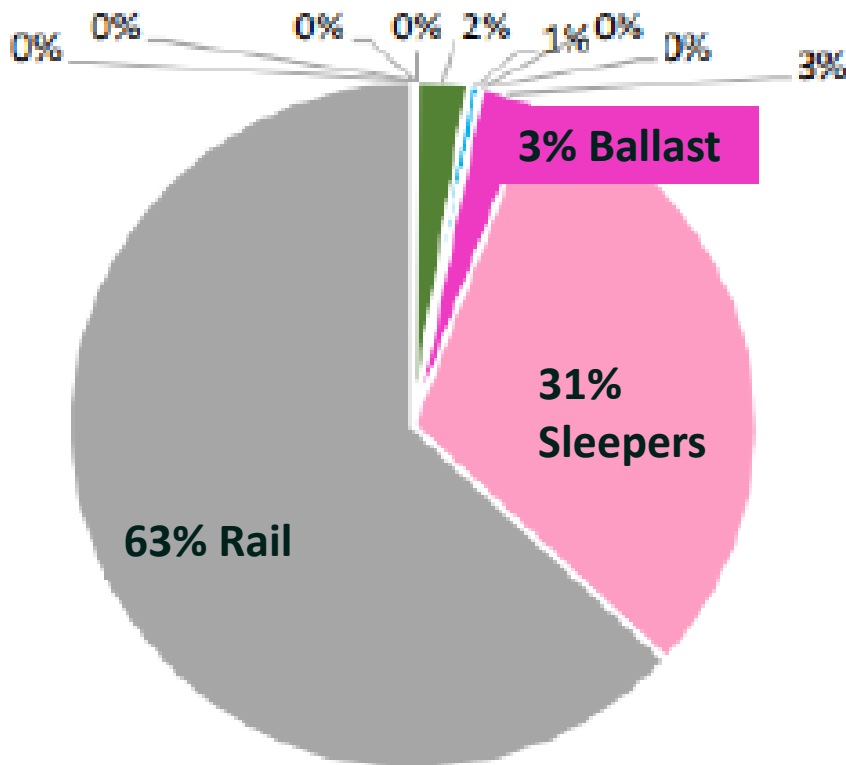
Can a Sleeper be Simpler, Better and Greener and help deliver Network Rails Vision?



Carbon Emissions Associated with Track Renewals

SRSA Total Carbon Emissions (% Total)

- GoGreen Waste Carbon Emissions
- Electricity (mains) Carbon Emissions
- Natural gas (mains) Carbon Emissions
- Bottled gas (LPG) Carbon Emissions
- Red diesel Carbon Emissions
- Petrol Carbon Emissions
- Burning/heating oil Carbon Emissions
- Water Use Carbon Emissions
- Ballast Carbon Emissions
- Sleepers Carbon Emissions
- Rail Carbon Emissions



Current / Proposed Solutions

- Rail: Green Rail Electric Arc Furnace
- Sleepers:
 - Composite Sleepers / Bearers for Timber
 - CEM2 & 3 Concrete Sleepers
 - THIOCRETE® Sulphur Sleepers
- Ballast: Blended / Recycled Ballast



Problem: Can a Composite Sleeper be made Greener, Better and Simpler?



Baseplated Plastic Recycled Composite $\approx 36\text{kgco}^2\text{e}$



Pan 11 Baseplate $\approx 15\text{kgco}^2\text{e}$



- 83% of embedded carbon is in the baseplates alone
- Current composite Cat 2 to 6 track
 - Seen primarily as a direct replacement for wood.
- Baseplates, E & P Clips do not lend themselves to mechanical renewals.
- Pandrol Fastclip system is Network Rail preferred fastening for track renewals.

Sleeper Type	SCO Cost 2023	Life	Tonage	Track Cat	Lat Res	KgCO2e
Concrete G44	£104.32	30	30	1a to 4	Medium	60
Concrete EG47	£99.71	30	30	1 to 4	Medium	59
Steel	£112.44	20	15	3 to 6	Medium	150
Hardwood	£205.00	25	15	3 to 6	Low	182
Plastic Recycled Composite	£221.00	40	25	2 to 6	Low	36



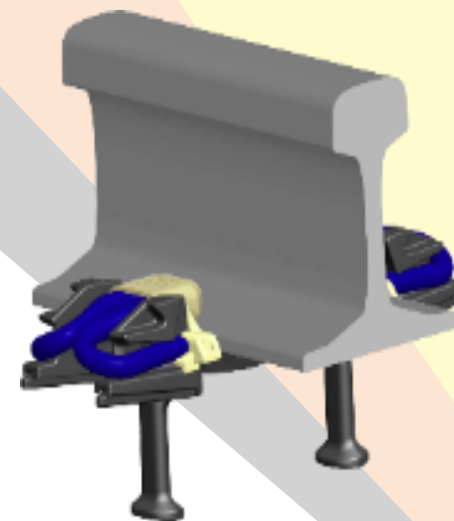
Pandrol Fastclip $\approx 1.5\text{kgco}^2\text{e}$



Solution: Design and produce a mechanised renewal compatible composite sleeper with an integrated Pandrol Fastclip shoulders for Cat1a Track

Project Goals: To Conduct a tender to Design, Produce, Approve and Install a Composite Sleeper with the following properties:

- Cat1a track compatible
 - G44 Concrete equivalent variant
 - EG47 Concrete equivalent (3rd and 4th Rail Compatible) variant
- Integrated Pandrol Fastclip Fastening System
- Lowest possible embedded carbon
- Climate change resilient
- At a lower cost than current composites

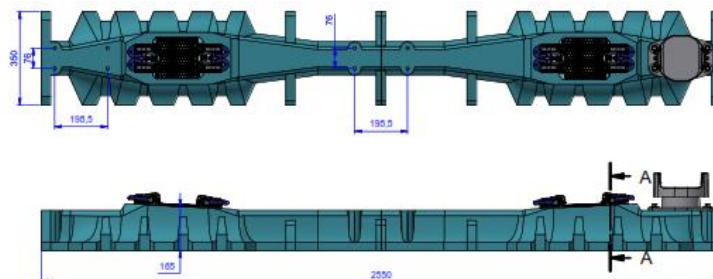
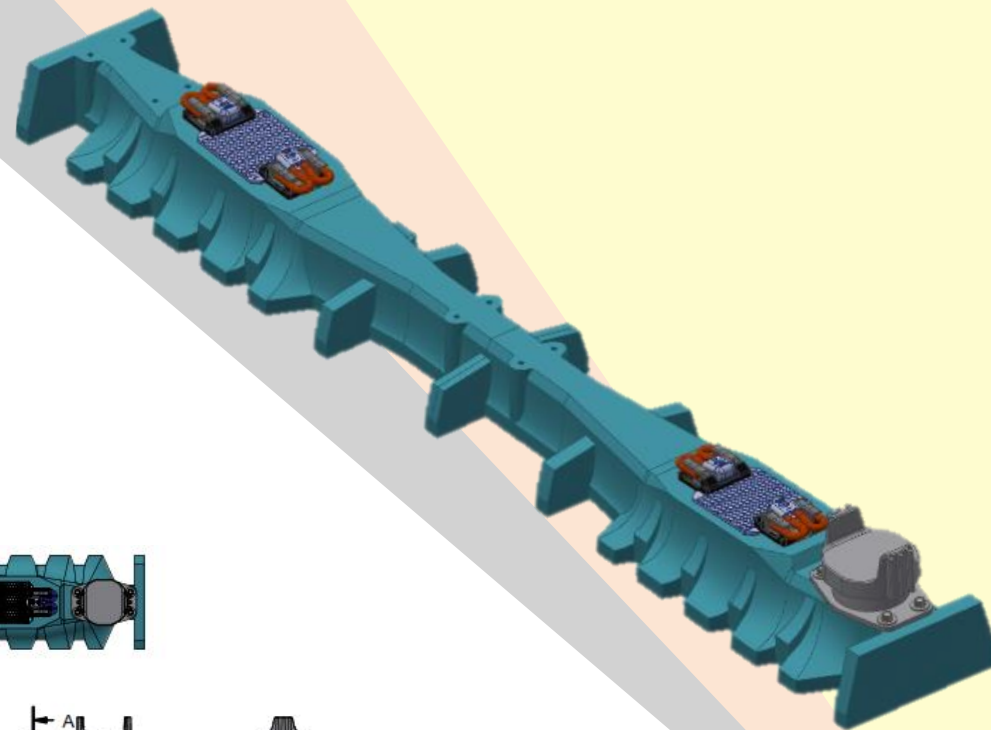


Pandrol Fastclip $\approx 1.5\text{kgco}^2\text{e}$



Result: The Network Rail in conjunction with Lankhorst Engineered Products Integrated Composite KLP SLEEPER 104 The “Hedgehog”

- **Greener:** Reduces the embedded carbon by up to 90%(Hardwood Sleepers) and 79%(Concrete Sleeper).
- **Greener:** Is made from 90% recycled materials and is fully recyclable.
- **Better:** Exceeds the performance of concrete sleepers.
- **Simpler:** Offers a single design that can replace full and shallow depth concrete sleepers with or with out 3rd and 4th rail insulators.





Lankhorst Network Rail Hedgehog Sleeper (3rd /4th Rail Compatible)

Size

- L 2550 x W 350 x H 160mm

Weight

- 78kg

Embedded CO2

- Estimated at 12kgCO2e

Fastening

- Pandrol FE/FC or Vossloh Screw

Lateral Resistance

- Greater than G44

Compatibility

- Existing Sleeper Bales
- New Track Construction Train (NTC)
- Network Rail Track Relaying System (TRS)
- Ballast Cleaners and undercutters

Use

- All track categories
- None Electrified, AC and DC Tracks

End plate for
lateral resistance
and existing plant
compatibility

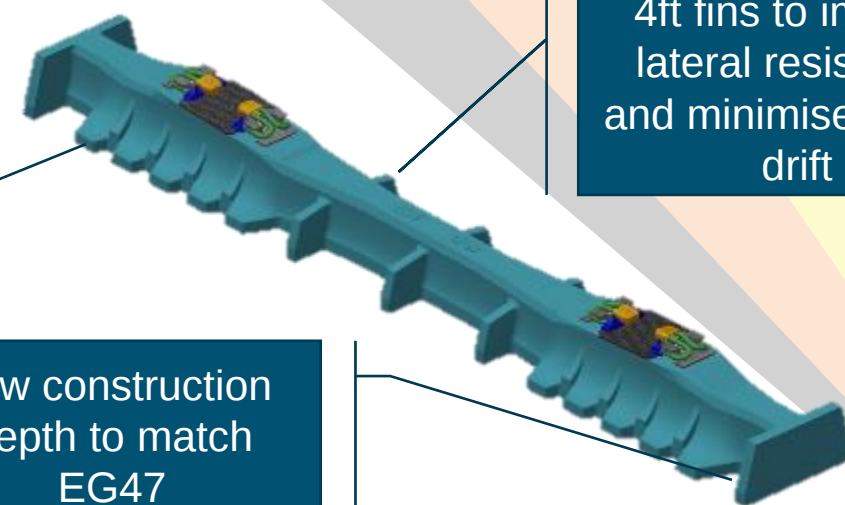
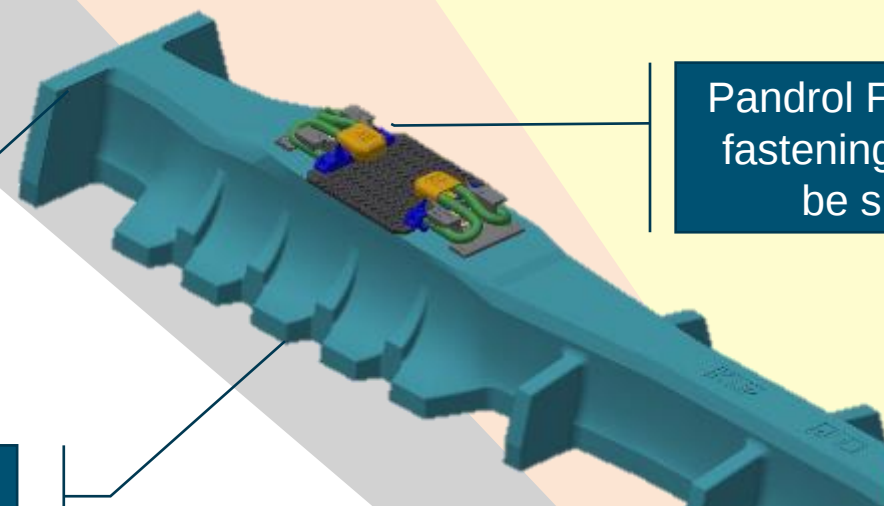
Hedgehog design to
improve lateral resistance
while providing optimised
bearing pressure

Moulded from
recycled materials
and fully
recyclable

Low construction
depth to match
EG47

Pandrol FC integrated
fastenings. FE could
be specified

4ft fins to improve
lateral resistance
and minimise ballast
drift





Tender and Initial Design

KLP® Hybrid Polymer Track Sleeper - 100 series

KLP® Hybrid Polymer Track Sleeper - type 101

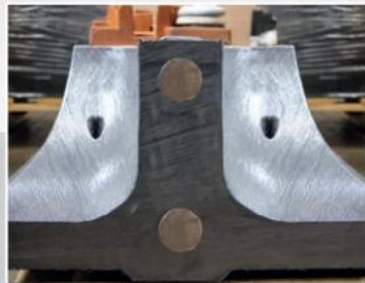
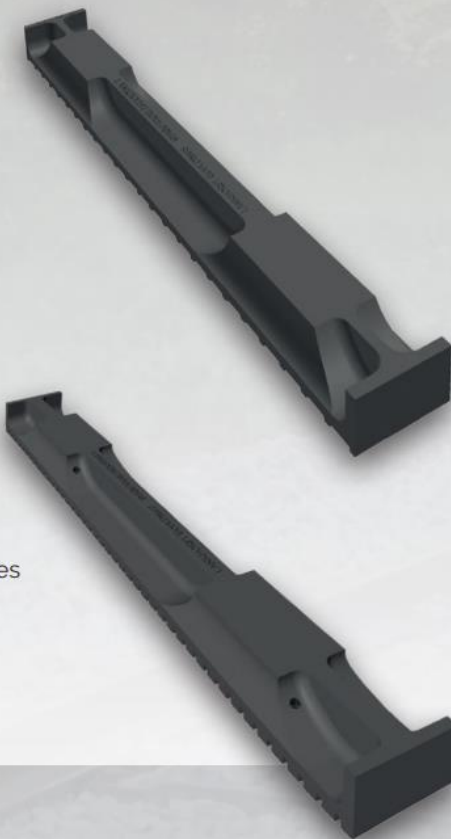
Size: (W)275 x (H)150 x (L)2400 mm

- Ideally suitable for light rail purposes with axle loads up to 15 tons
- Fully embedded in ballast-bed due to optimized design
- High lateral and vertical resistance due to the profiled shape
- Design can be customized to include 3rd rail applications

KLP® Hybrid Polymer Track Sleeper HS - type 102

Size: (W)250 x (H)160 x (L)2600 mm

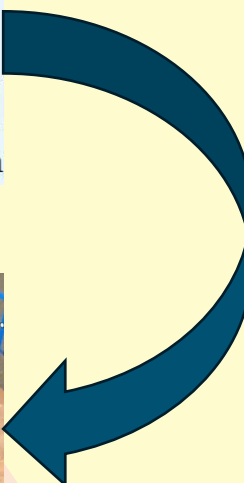
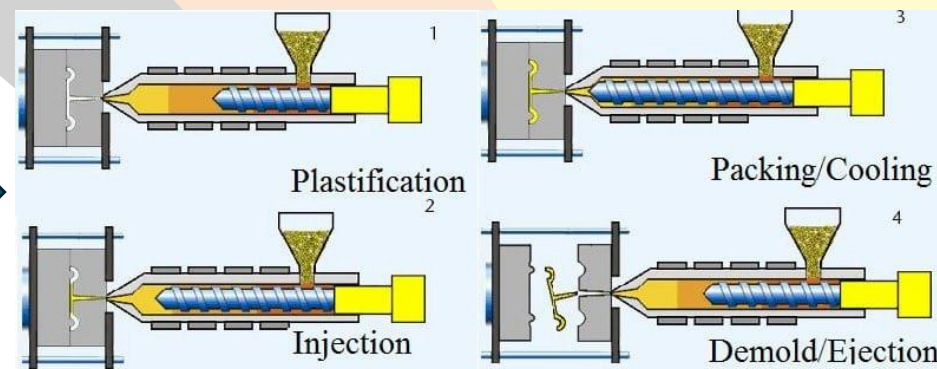
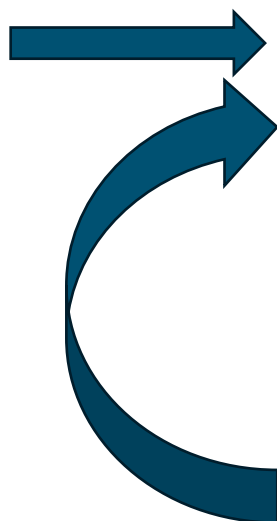
- Ideally suitable for main, side and industrial track with axle loads up to 25 tons
- Fully embedded in ballast-bed due to optimized design
- High lateral and vertical resistance due to the profiled shape
- Design can be customized to include 3rd rail applications & for different rail gauges



- PIN Notice Issues Late 2022
- Tender Jan to April 2023
- Contract Awarded to Lankhorst Engineered Products April 2023
- Lankhorst KLP Hybrid Polymer Sleeper HS type 102 used as basis for development.



From Bottle Top to a “Hedgehog” and back again!

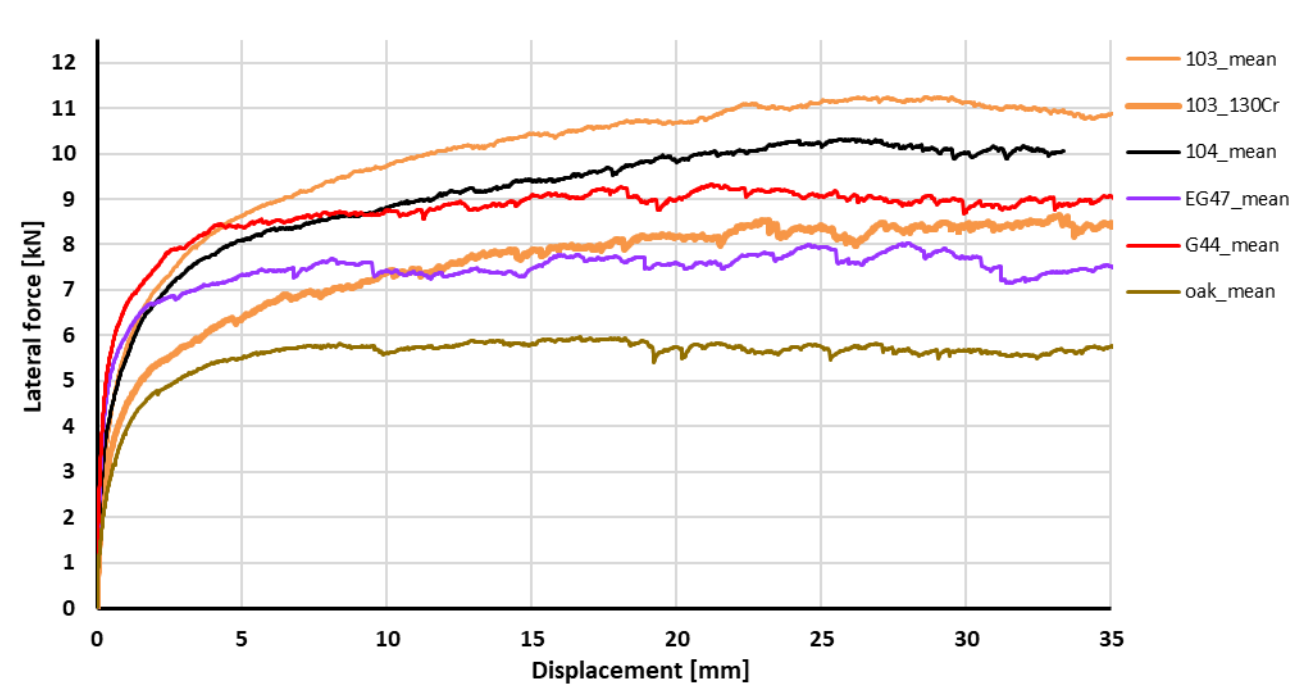


The HDPE (High-Density Polyethylene) plastic is used to make a wide range of consumer products such as milk containers, motor oil containers, shampoo containers, soap bottles, detergents, and bleach bottles. It can be used for a variety of applications because of its versatility and durability.

Additionally, a material such as HDPE is more environmentally friendly because it can be recycled and reused.



Design: Lateral Resistance

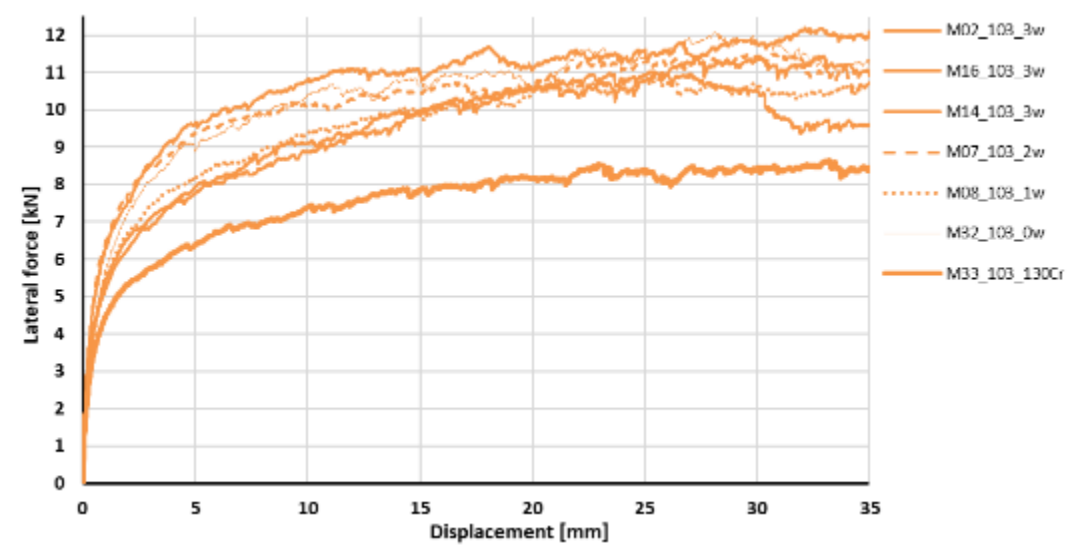
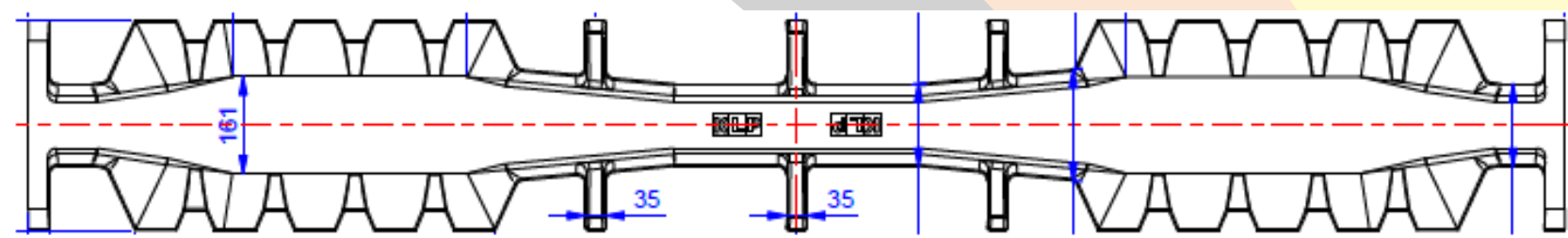


Graph shows that the of the Hedgehog sleepers outperform the concrete and timber sleepers on lateral resistance.





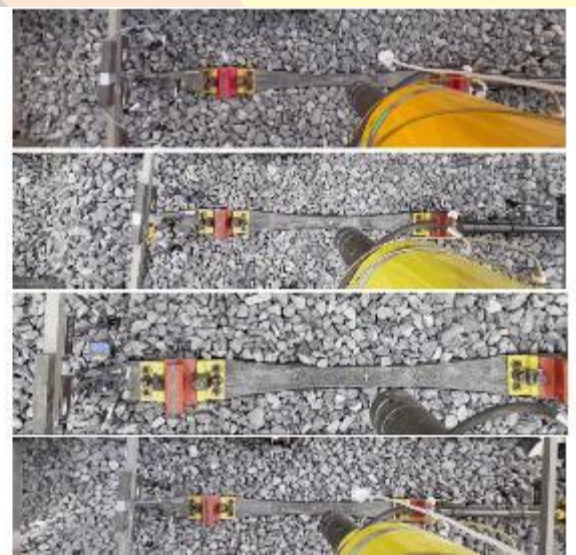
Design: Lateral Resistance Wings



Graph show that there is no significant influence of the number of wings on the sleeper. It can be the case that there is an influence, but that it is not visible due to the large variations in the individual test results.



- no wings
- 1 wing
- 2 wings
- 3 wings



However, observing the ballast particles in the sleeper centre does show that more ballast is mobilised due to the wings.



Design: Sleeper Width, Height, length and Lateral Resistance

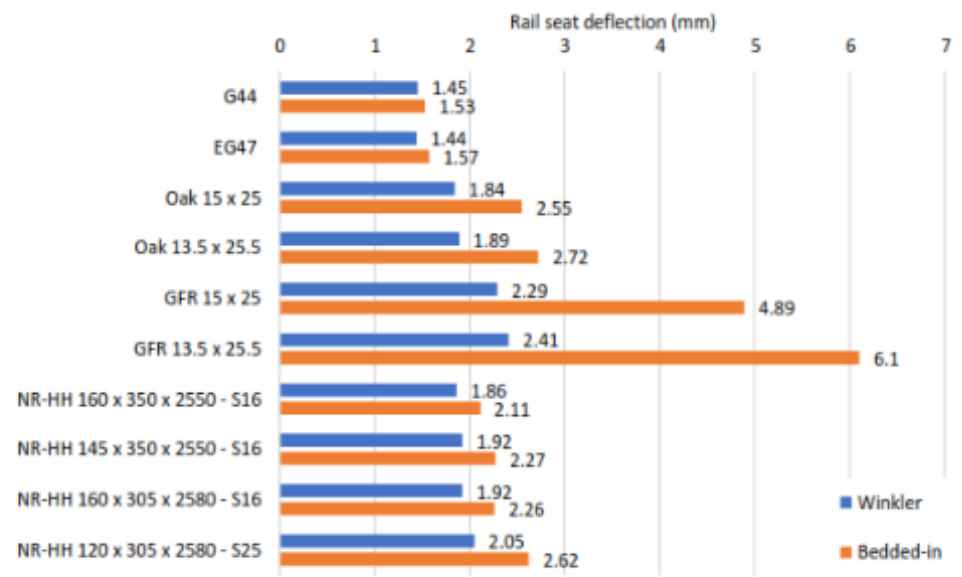


Figure 12: Rail seat deflections

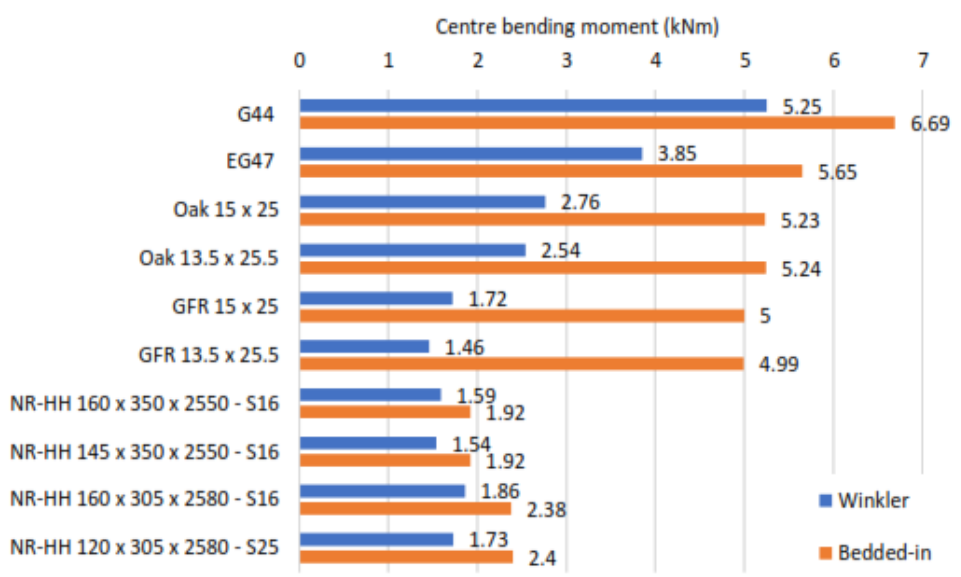


Figure 13: Centre bending moments

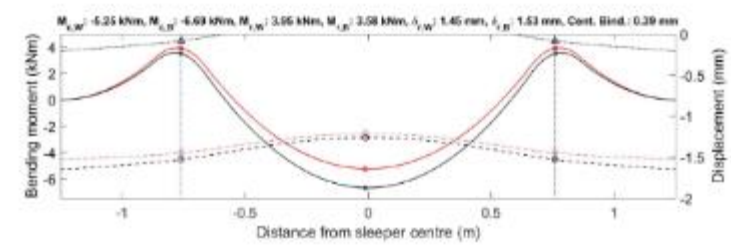


Figure 2: G44 concrete sleeper

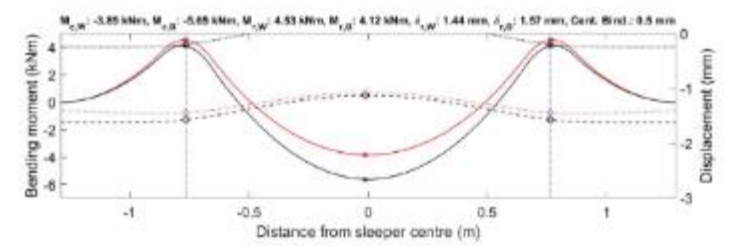


Figure 3: EG47 concrete sleeper

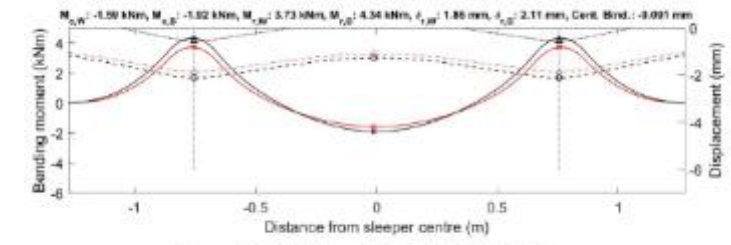


Figure 8: NR-HH sleeper 160 x 350 x 2550 - S16

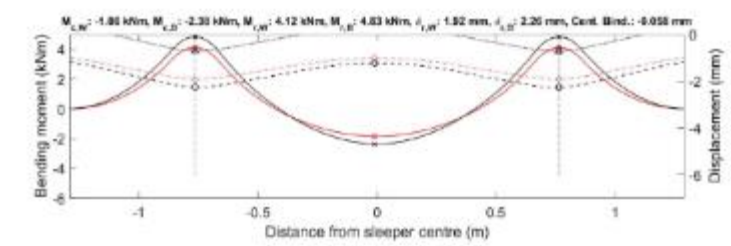


Figure 10: NR-HH sleeper 160 x 305 x 2580 - S16

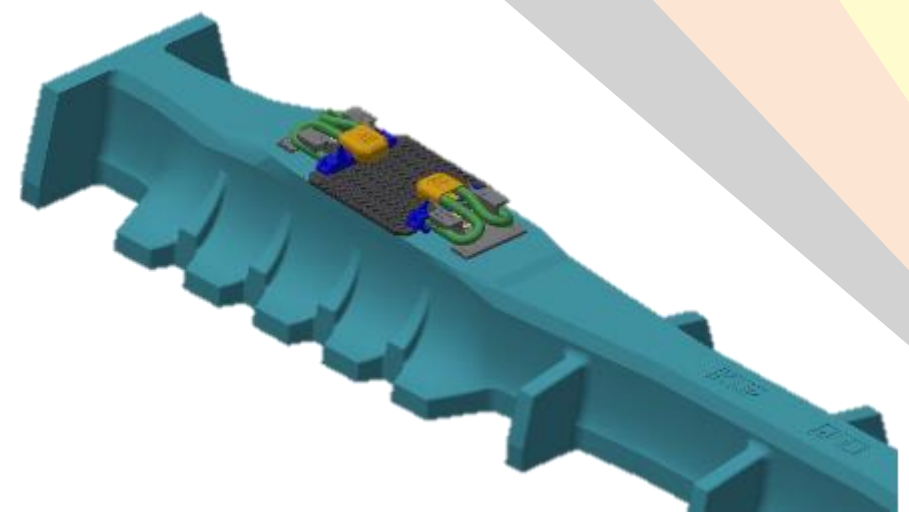
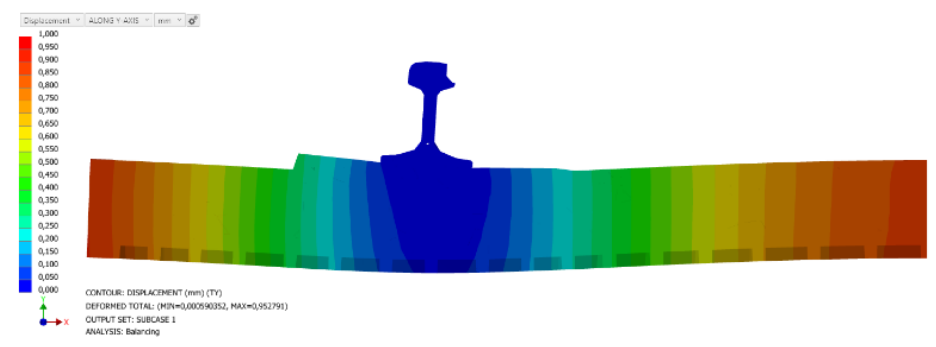
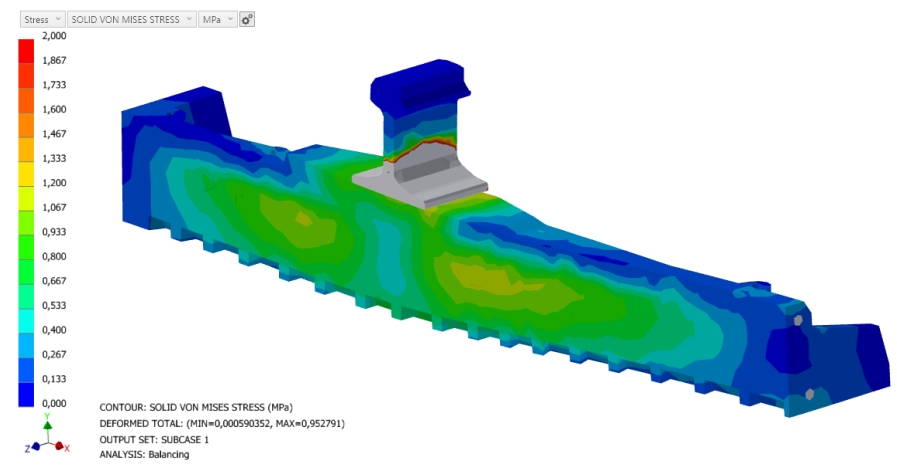


Design: Shape

A sleeper that is balanced, i.e. neither centre-bound nor end-bound, will give the smallest resilient deflection for its dimensions, and therefore the most efficient material use.

The design allows much of the sleeper to be entombed in ballast and so the sleeper mobilises more ballast increasing lateral resistance.

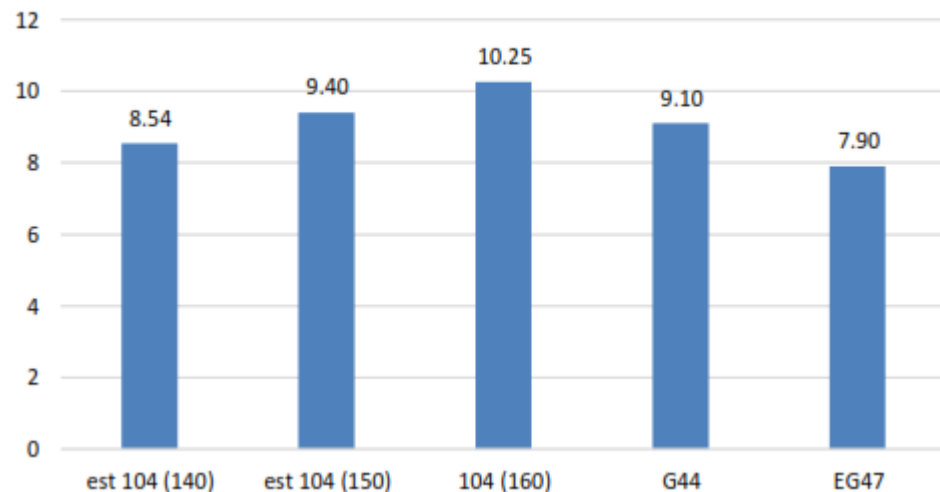
The centre of the sleeper is primary required to hold gauge.





Design: Sleeper Width, Height, length and Lateral Resistance

Lateral Resistance @ 25 mm movement

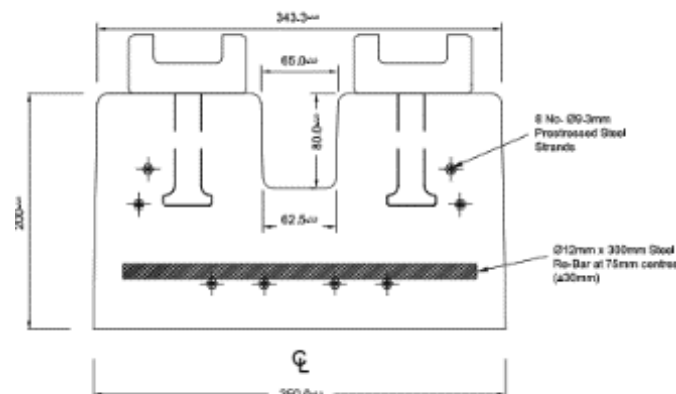
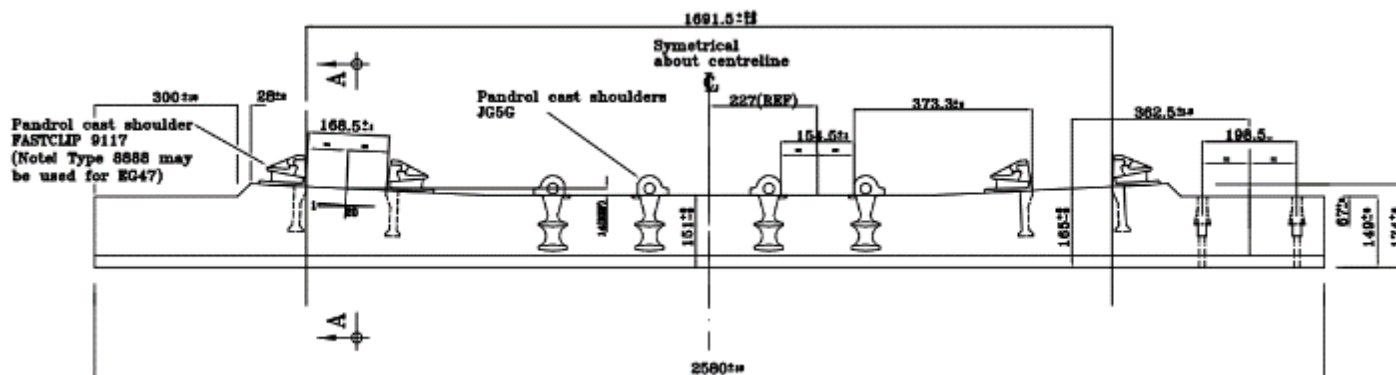


The height and length of the sleeper has been chosen to match the EG47. This allows for:

- Reduced construction height of 35mm compared to G44
- Construction height only 10mm greater than timber sleeper.
- 3rd / 4th Rail Conductor pots
- Optimum lateral resistances which is greater than G44

The Width of the Sleeper was chosen to be 350mm to match the G55 that is compatible with NR Tampers.

These dimensions offer the best uniform loading of the sleeper on the ballast bed and the greatest lateral Resistance

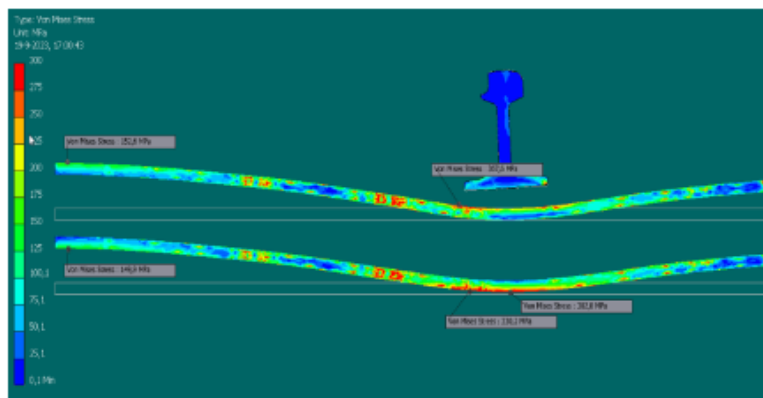




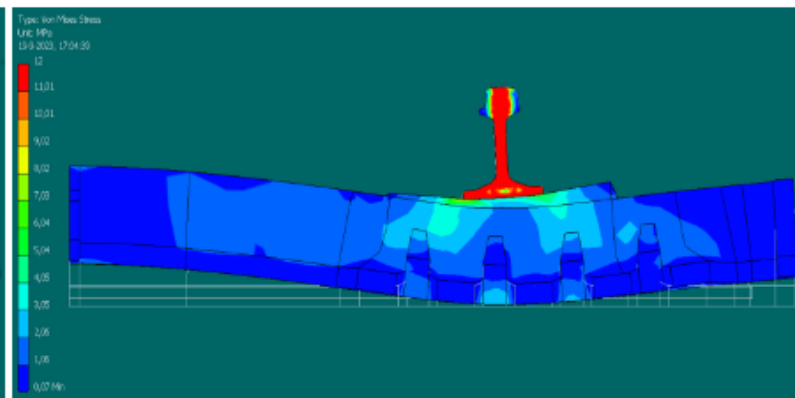
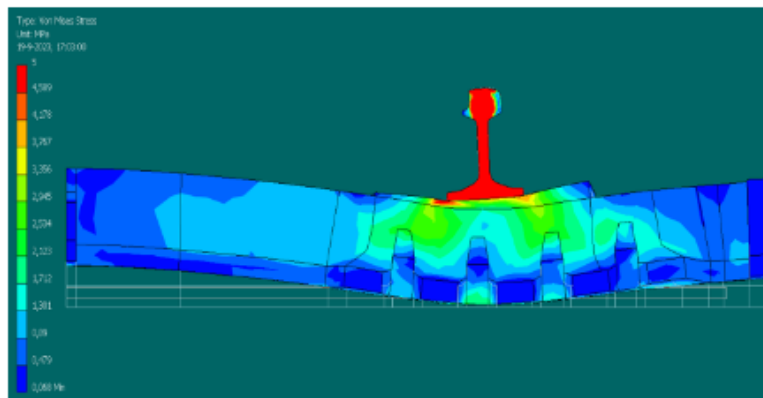
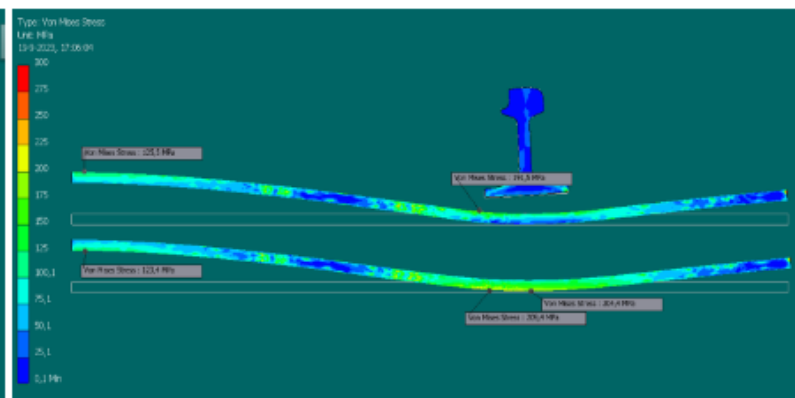
Design: Material

Choice of material KLP-HS, based on FEA and stability of cast-in fastener

KLP-PE



KLP-HS

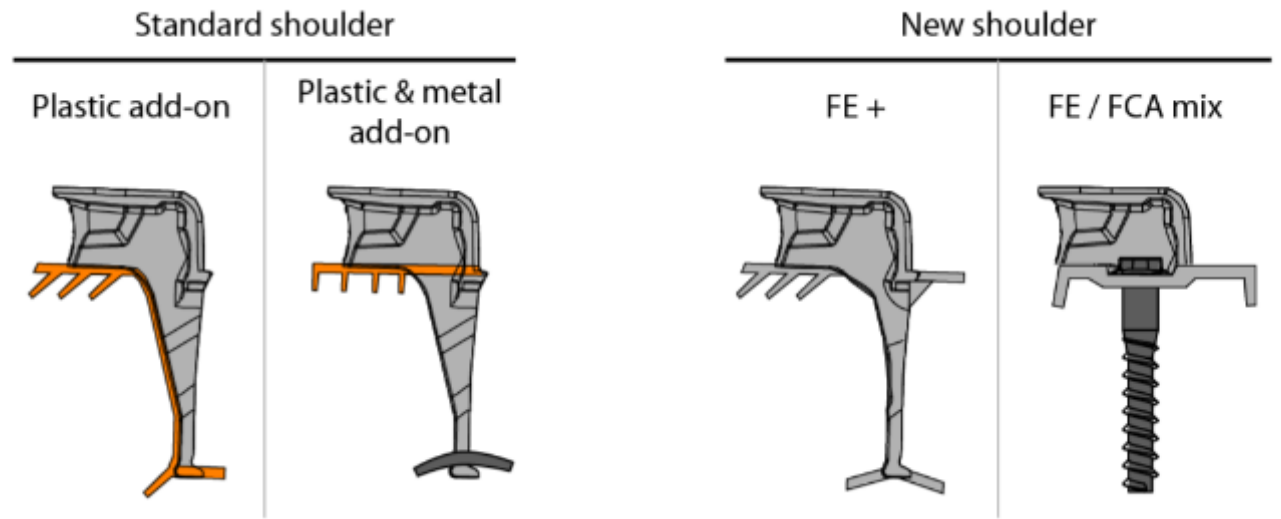


KLP[®]-HS:

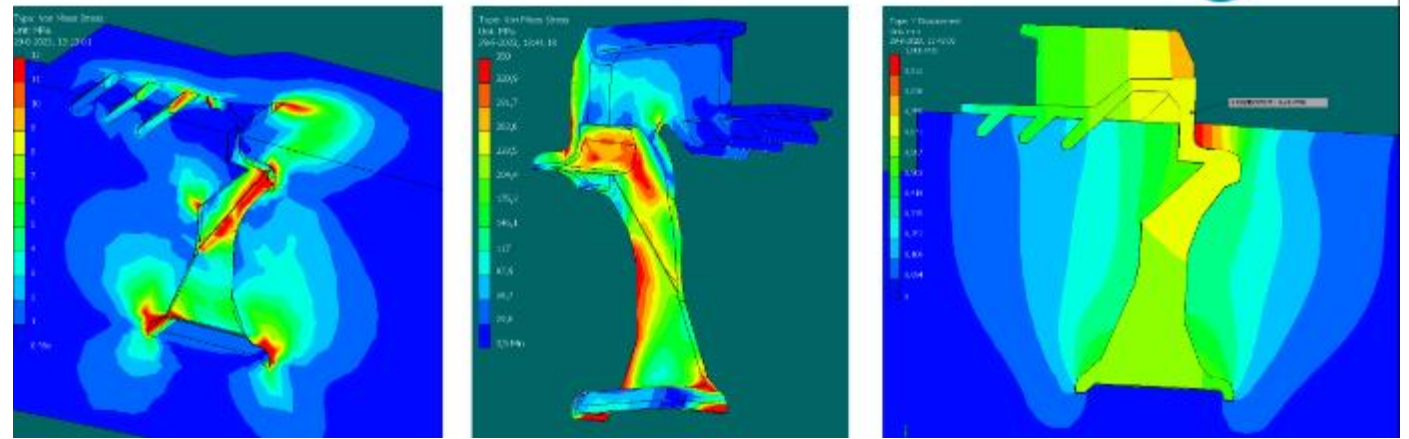
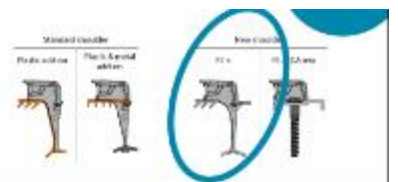
- is a 100% recycled, environmentally friendly polyethylene,
- does not rot,
- does not splinter,
- has excellent damping properties,
- can be machined like wood,
- is coloured with carbon black, which is an excellent UV blocker, ensuring the lifetime of the beam. Any degradation of the material will only take place in the outer 10th of a millimetre, thus not affecting product properties.



Design: Fastening FC, FCA or FE



NEW FE in HDPE, LC-B



A redesigned FE shoulder offers by far the best performance as shown by FMEA and minimises CO²

Network Rail currently uses FC across the Infrastructure

FC has 100% more embedded CO² than FE

FE would require some re-tooling

Solution to produce both a FC and FE variant.

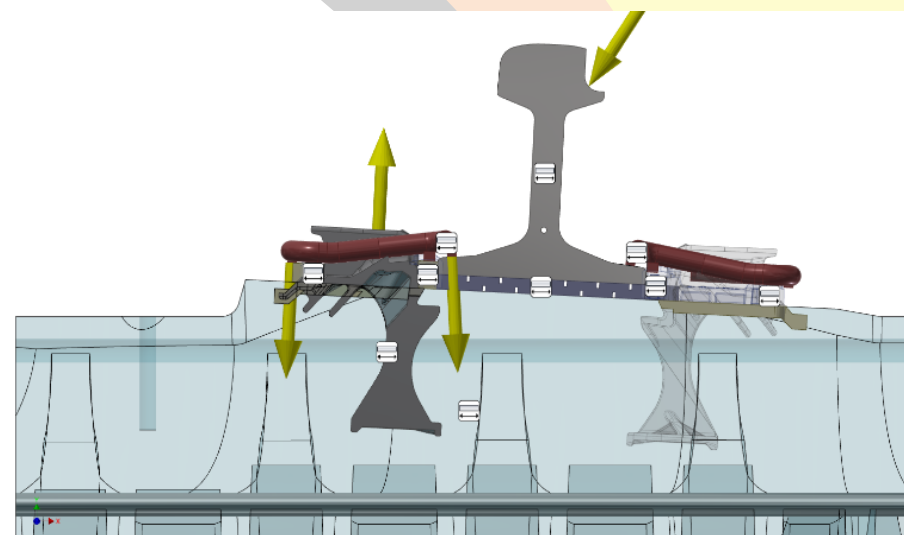
FC Development prioritised to simplify acceptance into service as deemed to be CSM non-significant as FC is in service.



Fastening Testing

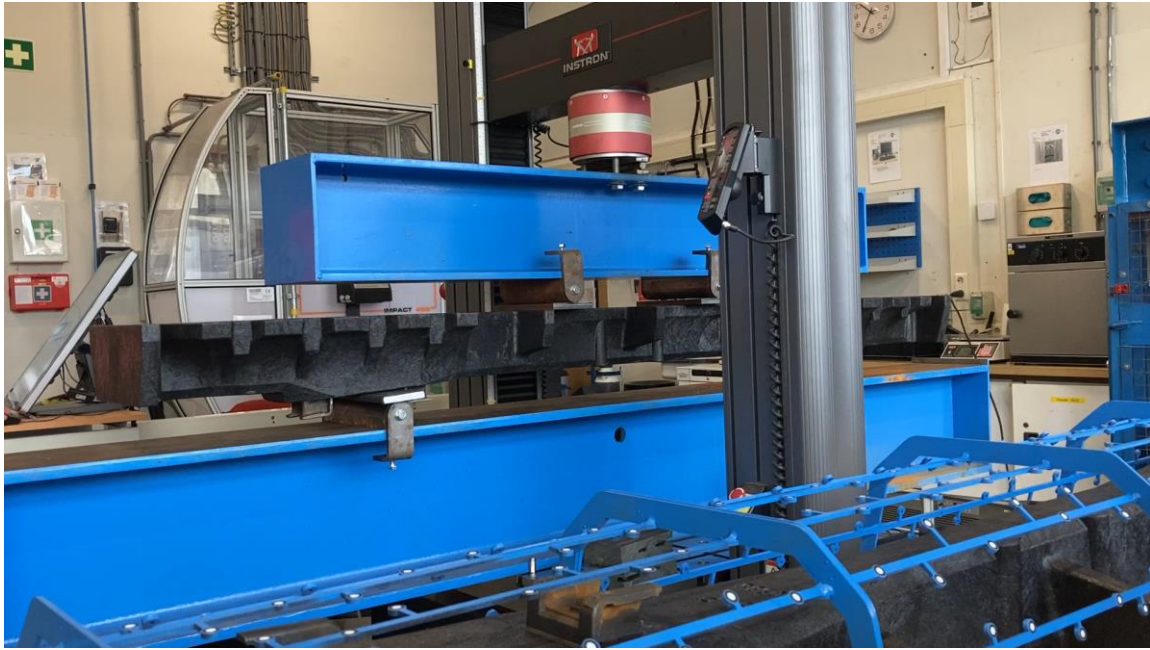


1. EN 13146-4:2012 -> Effect of repeated loading A load is placed at a specific angle & point on the assembled rail. For category C applications, a (maximum) force of 83kN with an angle of 33° is specified.
2. EN13146-10:2017 -> Proof load pull-out resistance A pull out load is placed perpendicular to the top surface. A force of 60kN is used to optimise.





Static Bend and System Testing





Material Test





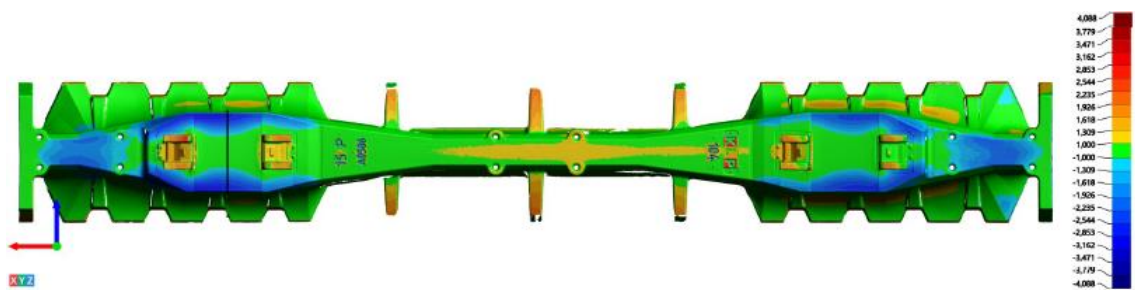
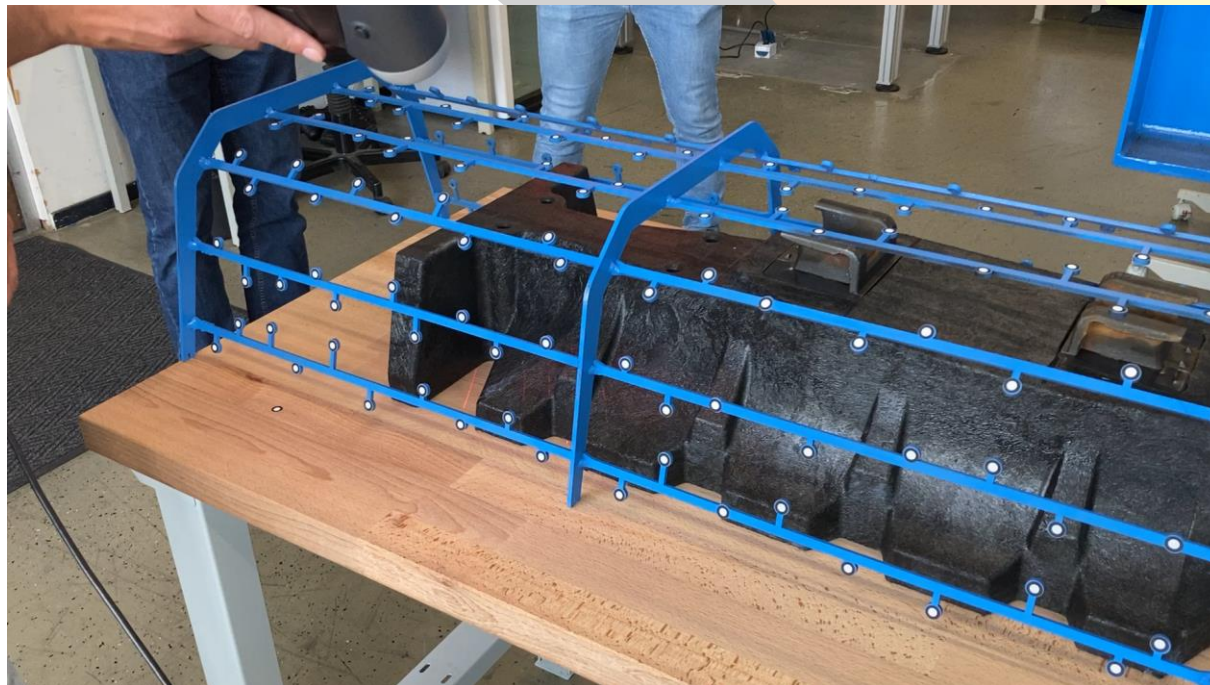
Mechanised Renewals

- Compatible with existing 4 & 7 sleeper bales
- Compatible with existing Fastclip clippers
- NTC and TRS compatible
- Possible to have a 14 sleeper bale





Quality Assurance



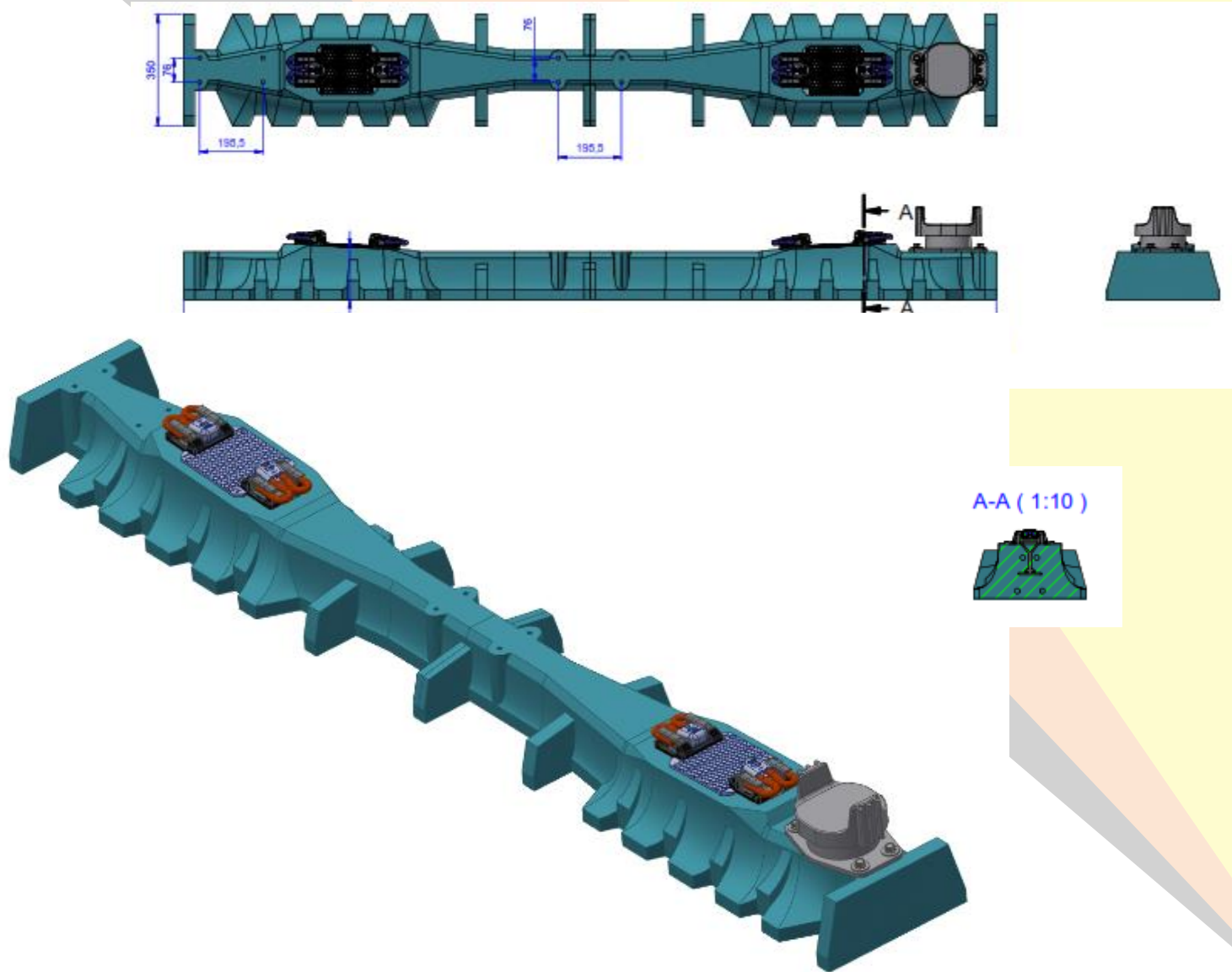
3d Scanning for all critical measurements and tolerances

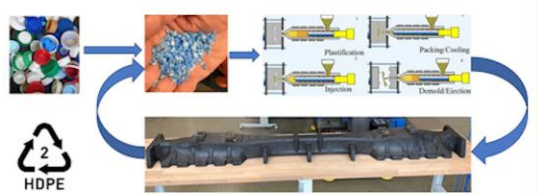
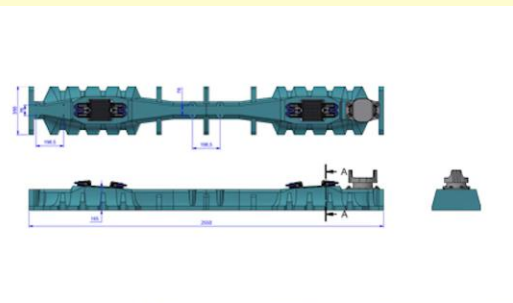
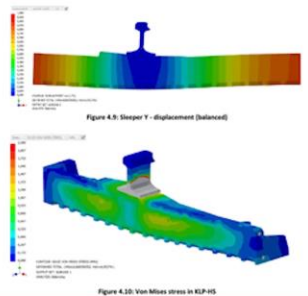


X Ray to check reed bar placement



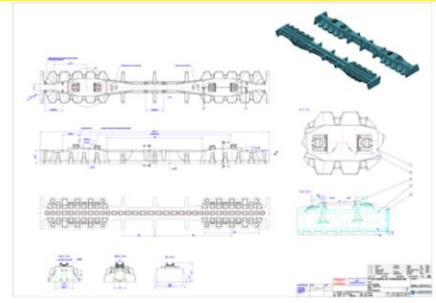
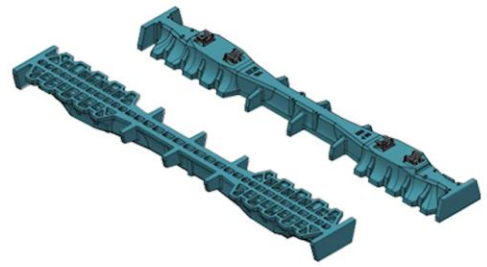
The Network Rail Integrated Composite Hedgehog Sleeper





NetworkRail

The Integrated Composite Sleeper: The “Hedgehog” Sleeper





Network Rails Vision for CP7

Our vision:

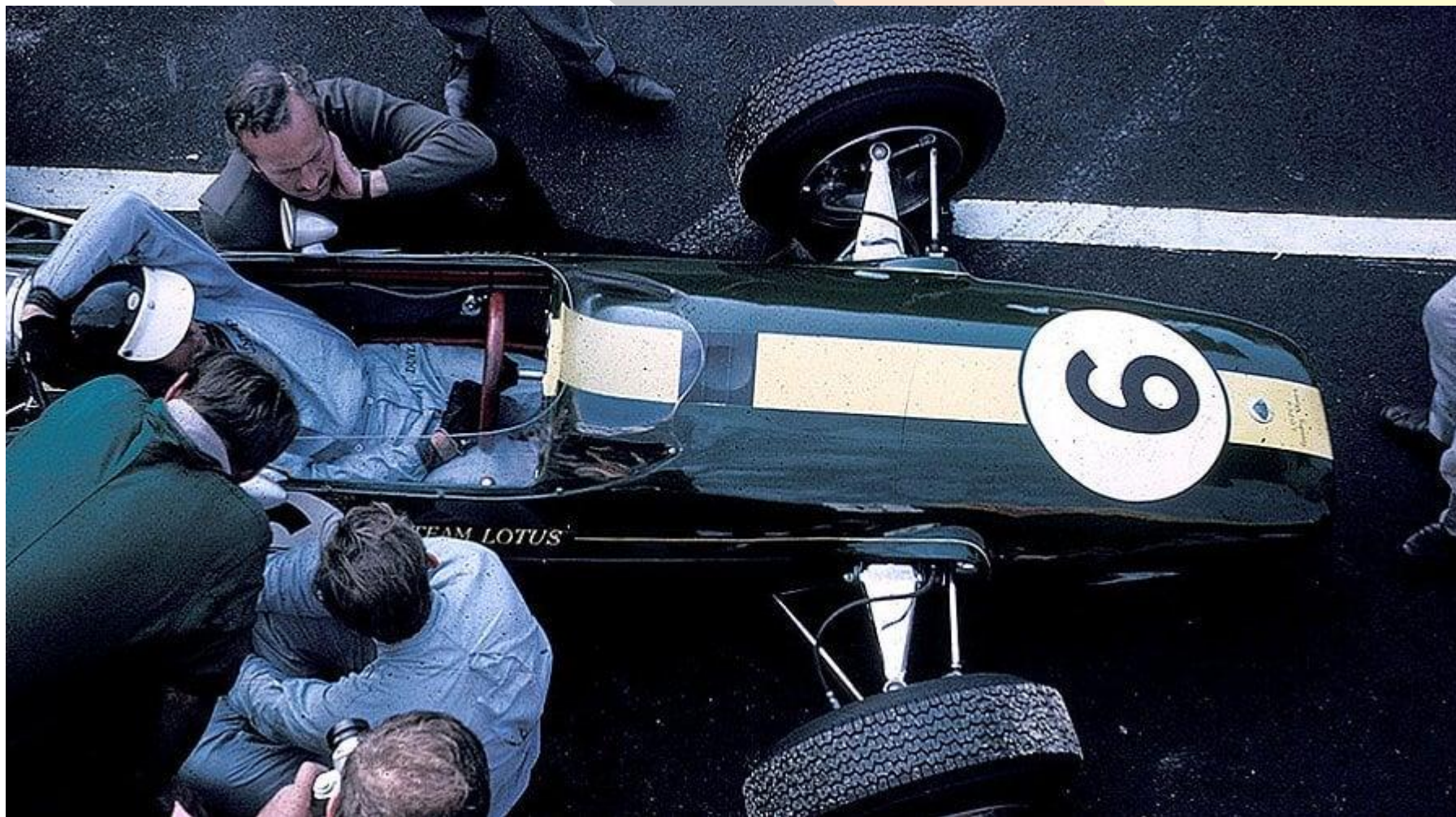
A simpler, better, greener railway.

Simpler	Better	Greener
• Single Sleeper Design • No Base Plates • No Screws • No additional fitment of baseplates required.	• Lighter • Better Lateral Resistance • CAT1a Track Compatible • Lower cost than base plated composite sleeper • Compatible with Mechanised Renewals • No need for Under Sleeper Pads • Better Ballance leading to longer ballast life and lower maintenance interventions.	• Made for Recycled Materials • Longer Service Life • Less fuel required for transportation • Lower embedded carbon. • Fully Recyclable

**Can a Sleeper be Simpler, Better and Greener and help deliver
Network Rails Vision?**



What would happen If Formula 1 designed a sleeper?



"Simplify, then add lightness" Colin Chapman

I Believe they would design a Hedgehog

