TRU East Alliance

Colton Junction Tangential Wiring Works & MVP OLE Examples

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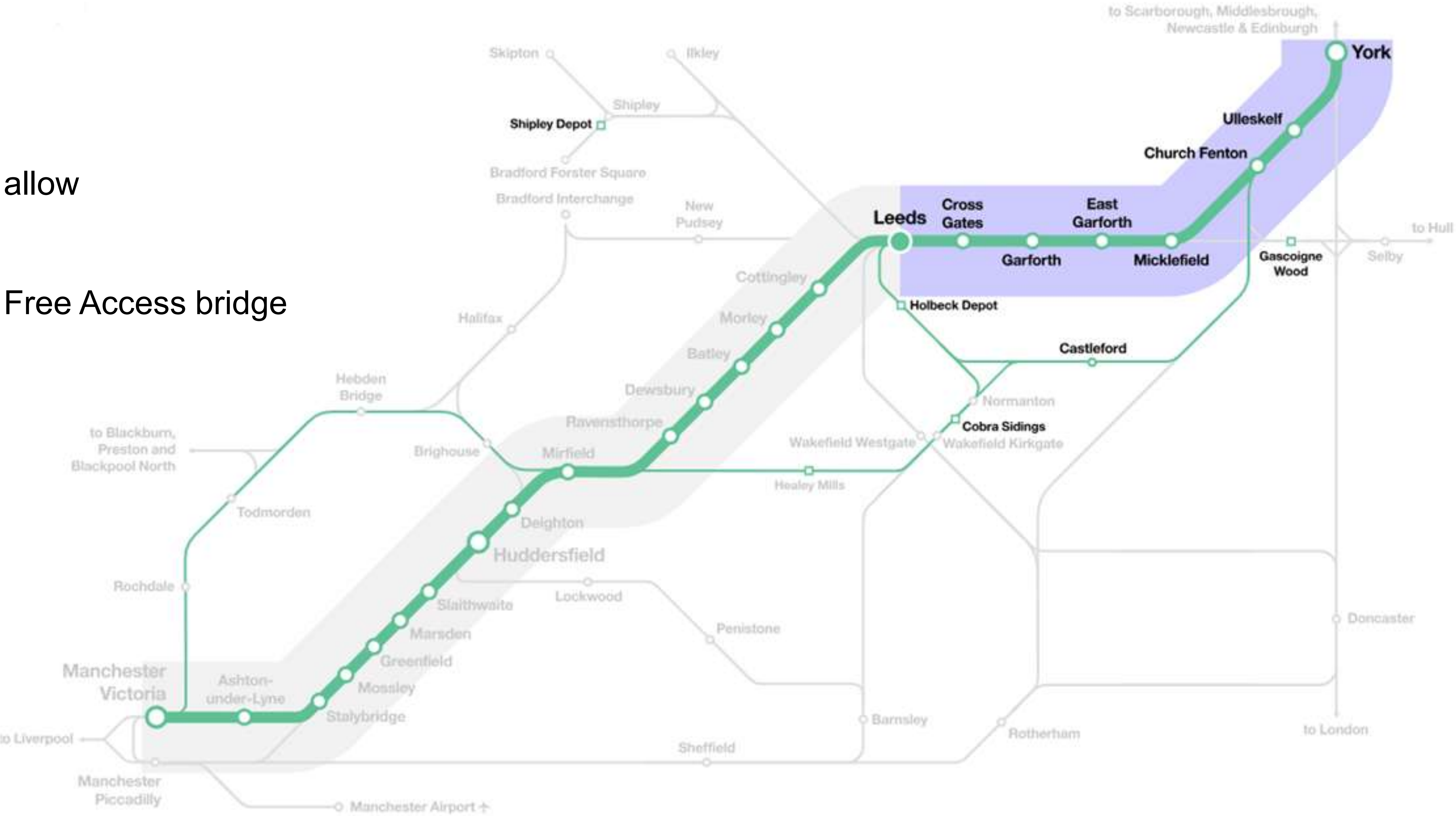
TRANSPENNINE ROUTE UPGRADE

ON TRACK TO BETTER

TRU East Alliance Delivery Scope

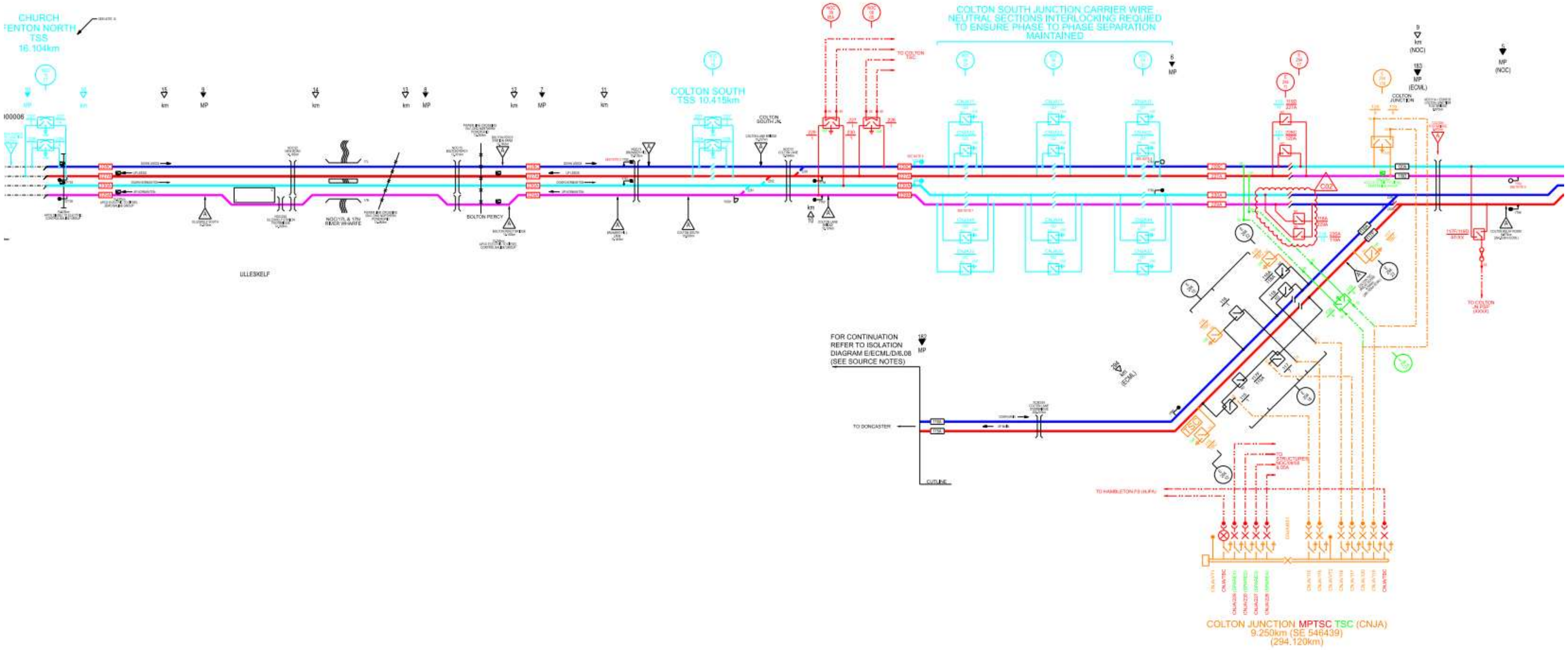
- 25kV A.C. Overhead Line Electrification for the full route between Colton Junction and Leeds
- Line Speed Improvements up to 125mph
- Closure of 5No. Level Crossings
- Overbridge and Underbridge reconstructions
- Resignalling of the route to improve capacity and to allow for line speed increases
- Platform improvement works along with a new Step Free Access bridge
- Culvert and drainage interventions
- New electrified train care depot at Shipley



TRU Project E1 Electrification Overview

- Project E1 introduces approximately 32km of new UKMS125 OLE between Colton Junction (ECML) & Church Fenton Station, along with associated traction bonding and track works to support an LSI to 125mph on the Up & Down Leeds Lines

- The OLE is fed from Colton Junction TSC, via Hambleton SFC, using 4No. new circuit breakers & infeed cables to OLE line side disconnectors.

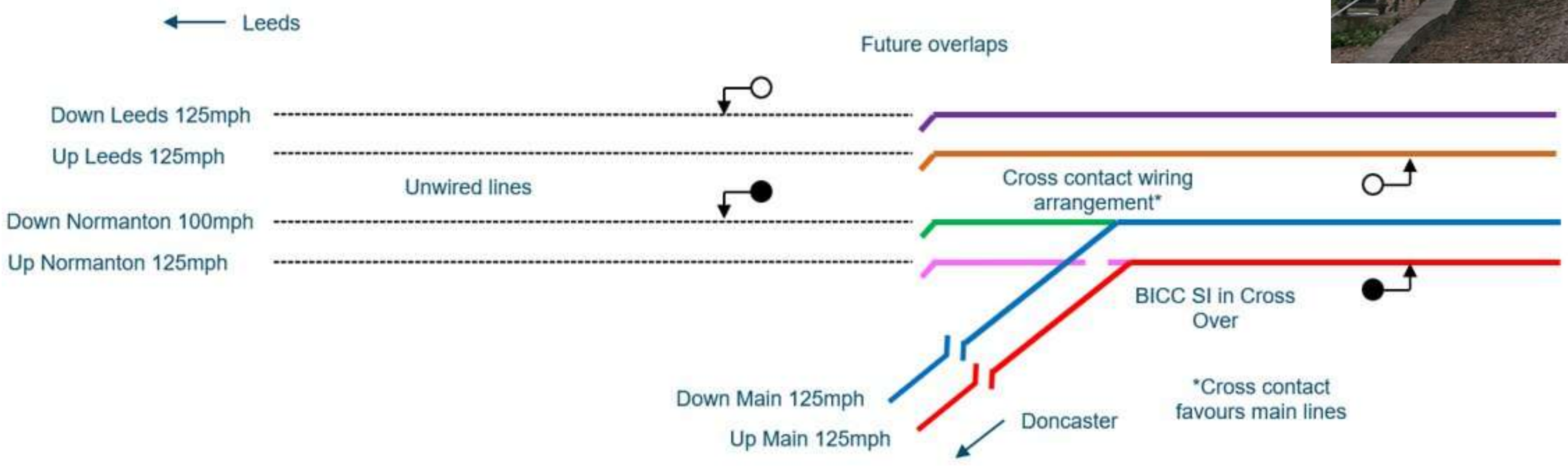


Colton Junction Existing Wiring Arrangement

- Original wiring at Colton Junction dates back to ECML electrification, added for overrun protection on Up & Down Leeds and Normanton Lines only.

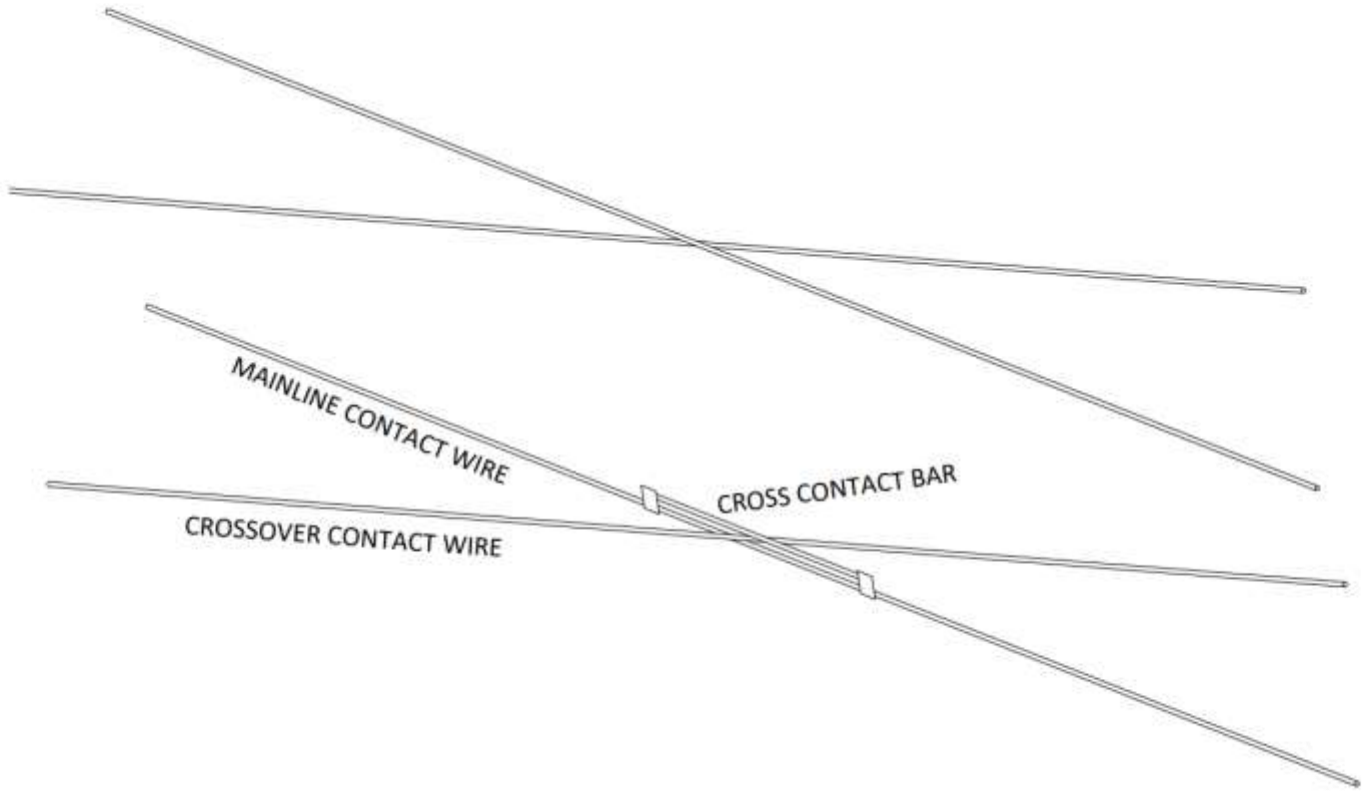
- A BICC ceramic bead section insulator was installed to separate power between the Up Main and Up Normanton crossover, has never seen a pantograph and is overrun only.

- Section insulators are “hard spots” in OLE and are only used in low-speed areas like crossovers, sidings, and stations — not suitable for 125mph mainline running.



Colton Junction – Problem Area - Crossed Contact Wiring

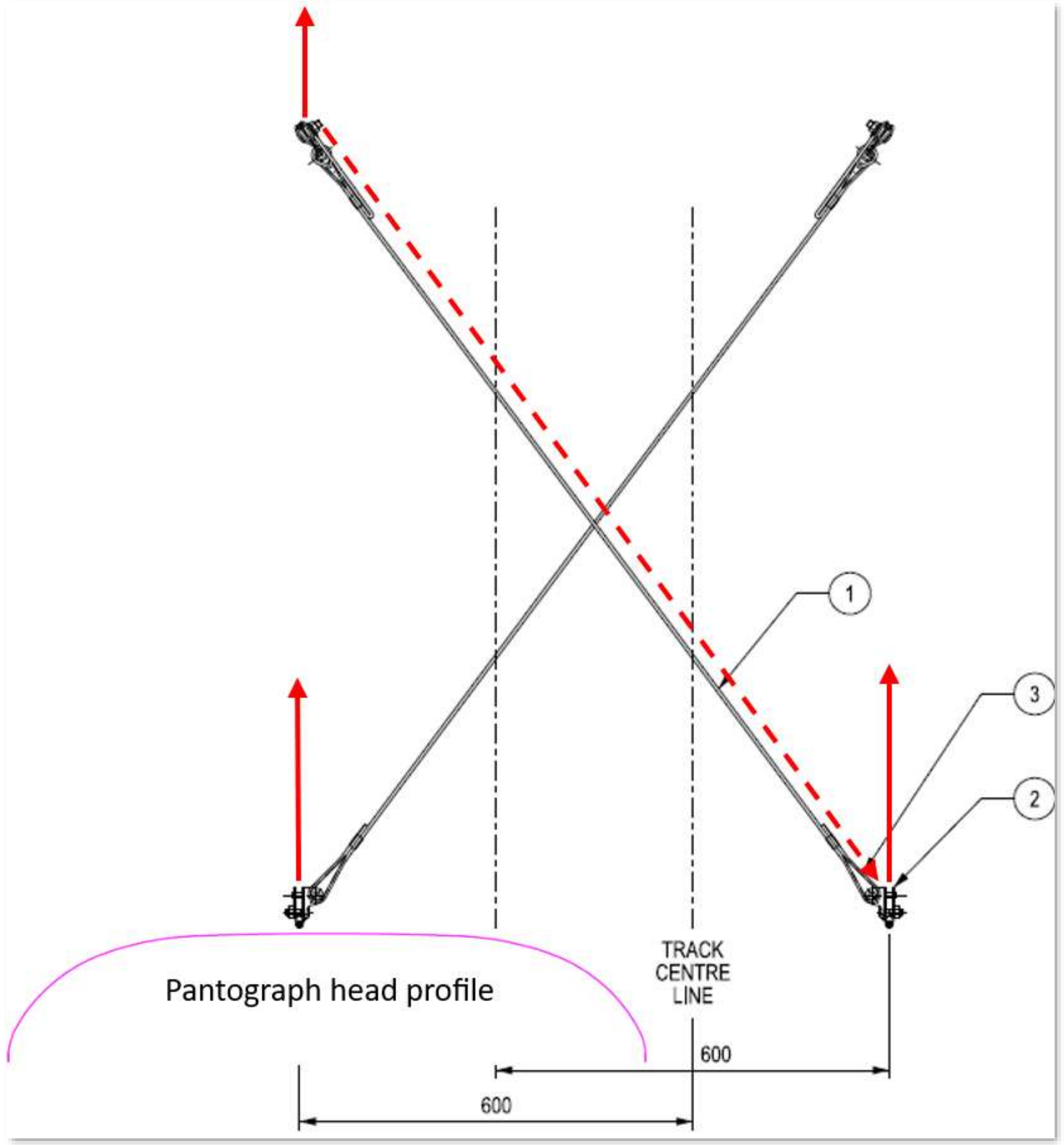
- Colton Junction uses Crossed Contact wiring at crossover points.
- This mechanically links main and crossover wires to lift together under a pantograph, reducing hook-over risk.
- The main line wire sits 20mm lower than crossover wire i.e. the higher speed route takes precedence, the lower speed route pantograph will strike the lower wire.
- However, at Colton Junction, all lines are high speed and therefore cannot be biased to a single route.
- Crossed contact bars are a known hard spot and have a failure mode of becoming detached which can cause dewirements.



Images Credit – Gary Keenor (Overhead Line Electrification for Railway 5th Edition)

Colton Junction – Solution - Tangential Wiring

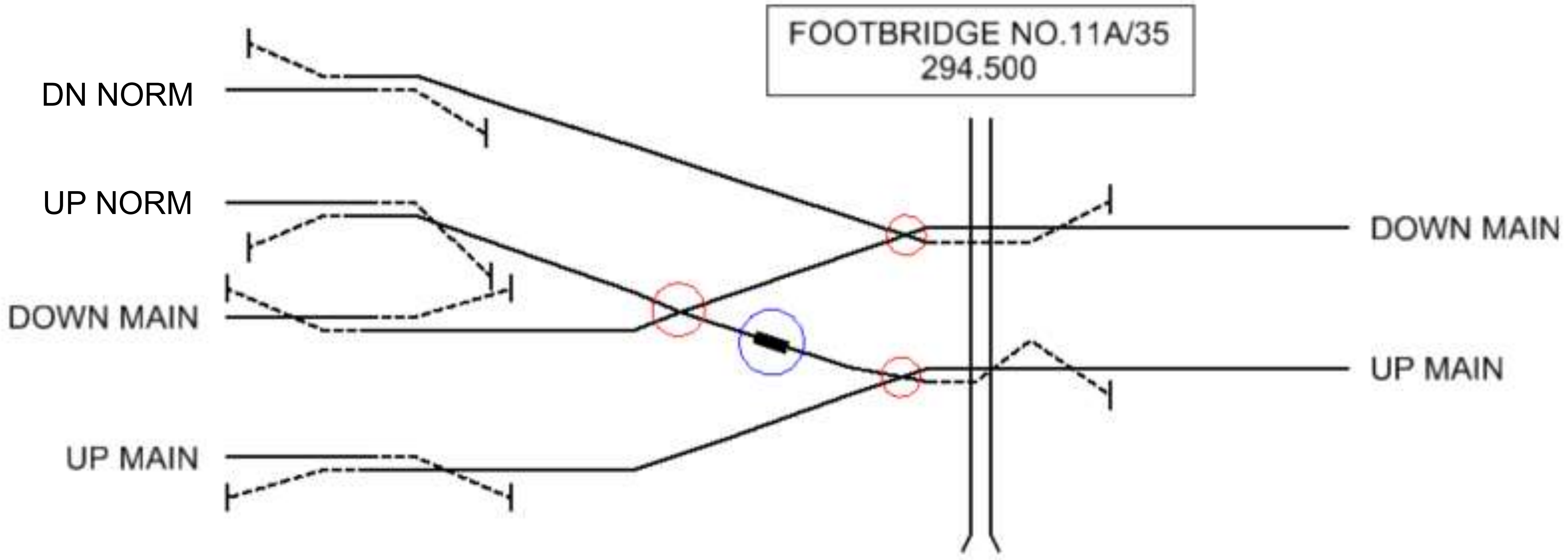
- Modern crossover wiring using “tangential” (parallel) alignment — wires do not cross.
- No cross-contact bar needed; hook-over risk is managed by “cross droppers.”
- Cross droppers are a standard UK Master Series arrangement for turnouts and crossovers.
- Higher speed mainline wire remains 20mm lower than crossover wire.
- As the pantograph lifts one wire, cross droppers raise the other — preventing hook-over and pantograph horn contact.



Wiring Diagrams

Existing crossed arrangement:

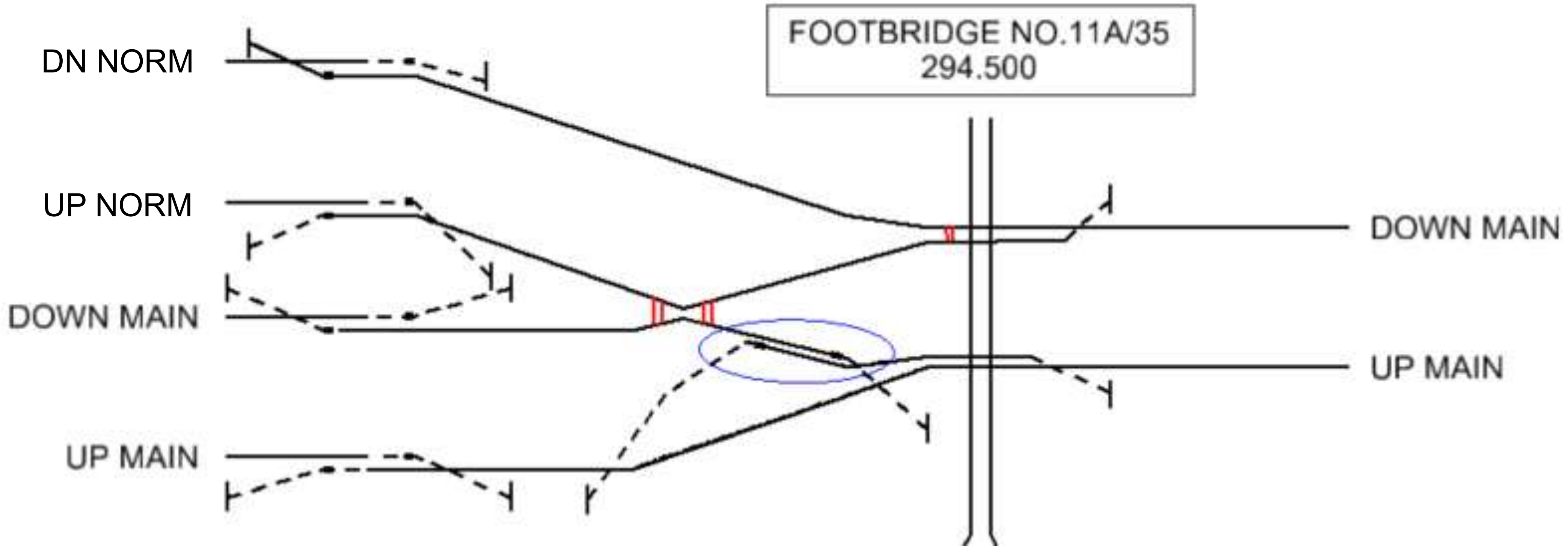
- Cross contact bars circled in red
- Section insulator circled in blue – Must be removed non-rated for 125mph running



Proposed concept:

- Uncrossed tangential wiring
- Headspans replaced with portals
- Section insulator replaced with insulated overlap, circled in blue
- Insulated overlap performance and maintenance far superior to an SI

Industry best practice tells us this should be the correct solution



Dynamic Modelling

- No standard OLE basic design covers a 125mph double junction, as mainlines and crossovers are 125mph
- Concern regarding excessive pantograph forces – dewirement risk at a key ECML junction
- Design would be based on UKMS principles, however dynamic modelling could be undertaken to prove pantograph forces compliant
- University of Huddersfield a known resource

- Create scope - Multiple train/pantograph configurations required at different speeds, based upon:
    - ITSS (Indicative Train Service Specification)
    - TRU Rolling stock assumptions
    - TRU Rolling Stock Sectional Appendix
    - Summary of Rolling Stock/Infrastructure Compatibility (SoC)
    - Mainly Class 800's bi-mode / multiple configs & speeds
- Maximum pantograph force permitted = **350N** (as per EN 50119:2009)
- Assumed a relatively quick modelling verification exercise

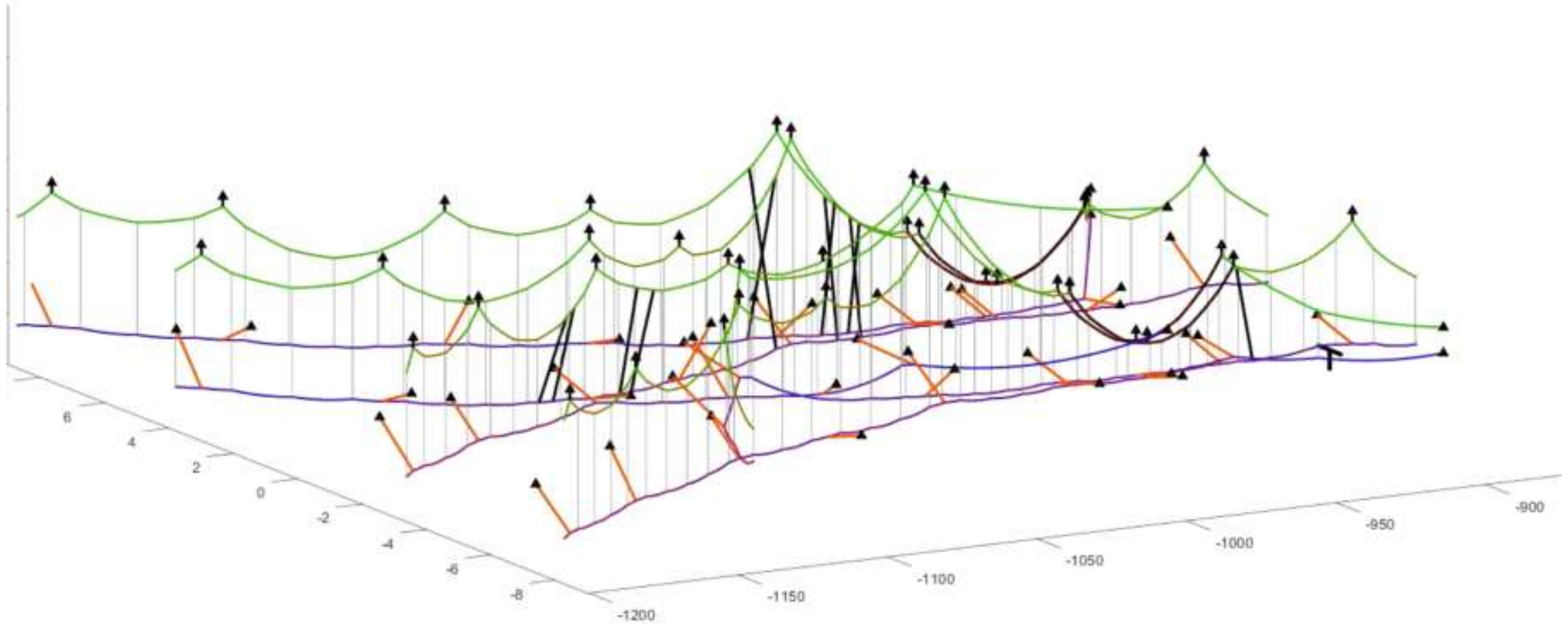
Initial Results

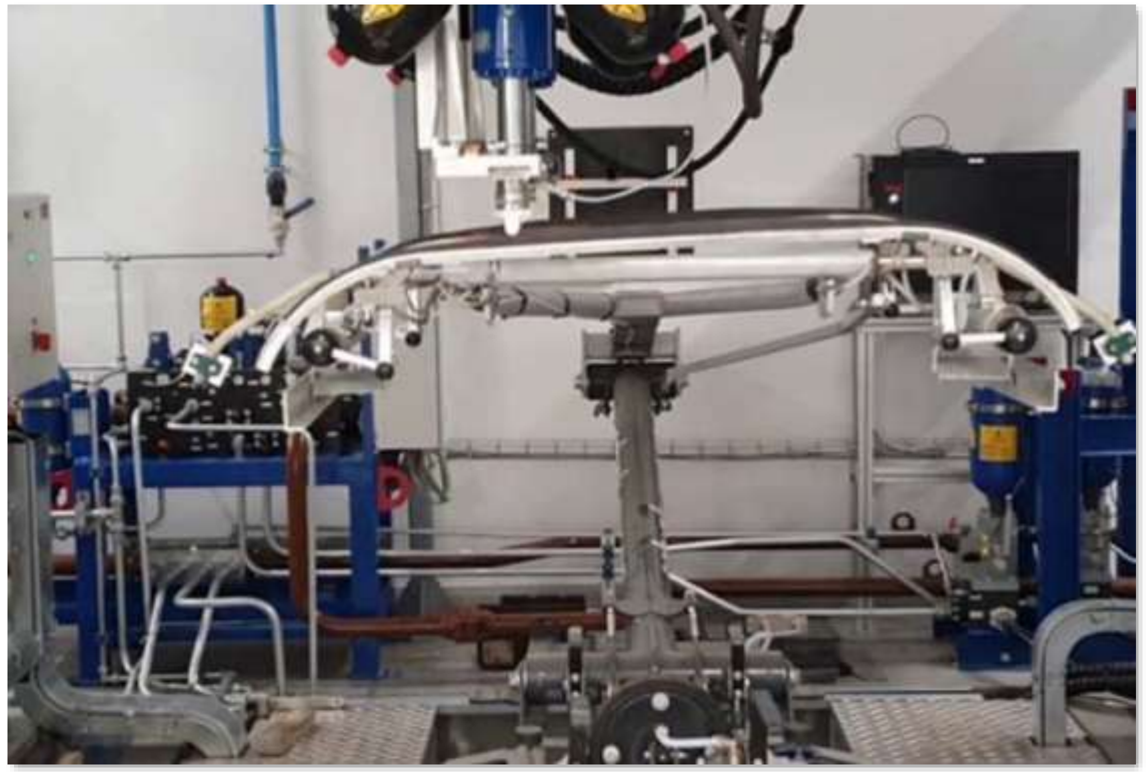
- Time consuming to model all pantograph variations, initially used twin HSX-250's at 216m spacing – representative of a 2 x 5 car Class 800 – two pantographs perform worse than a single

- Very high forces simulated – up to **1,350N** on the Up Main Up Normanton route – through the diamond – Bridge Gradients / Small System Heights / Oscillations created by multiple discreate features through diamond

- Others routes **+600N**

- Forces unacceptable, revised design required





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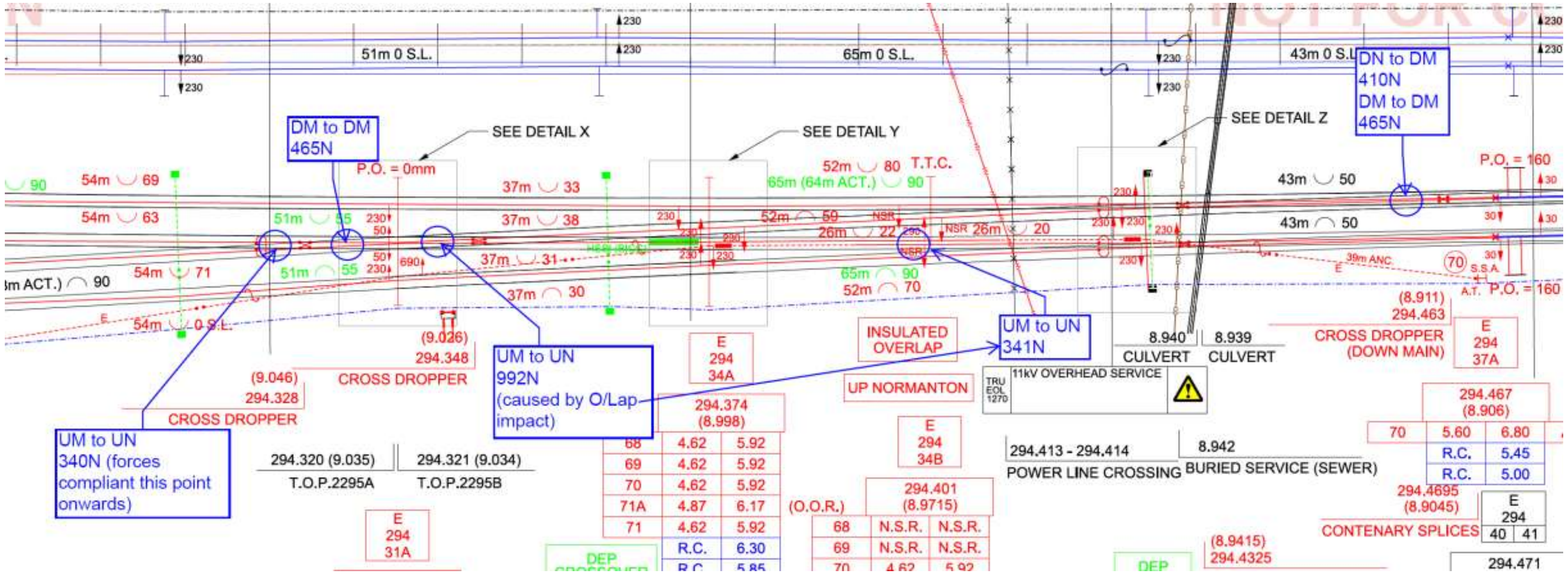
Design Iterations – A Collaborative Effort

- The University could suggest possible solutions but did not fully appreciate design or construction limitations – small steps required for traceability
- Working closely with TRU Design / Construction / Assurance
  - Bespoke cross dropper positions and arrangements
  - Revised support and registration equipment
- Forces still too high – **992N**
- Switch diamond still the problem area

Highest representative modelling outputs (following elimination of non-valid pantograph types, speeds and spacing

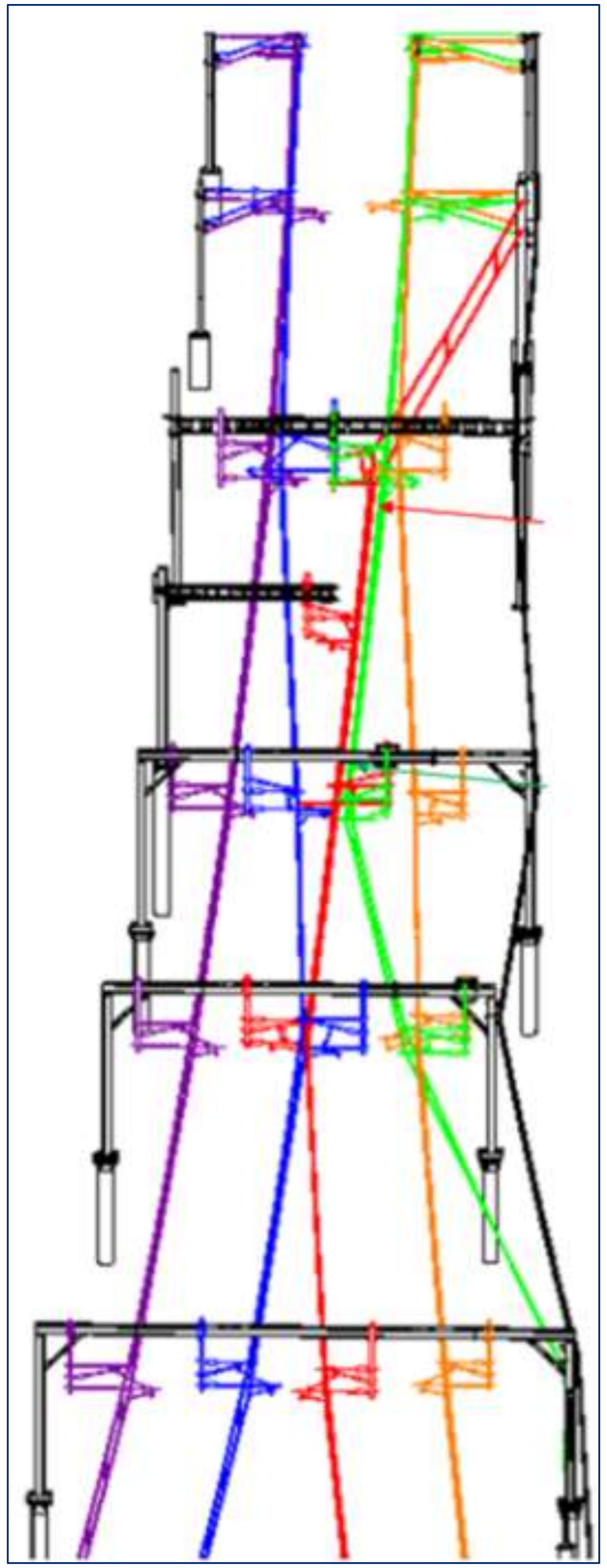
Route	Max. Contact Force(1) (N)	Max. Contact Loss(2) %
Down Main to Down Main (DM-DM)	465	0.6
Down Normanton to Down Main (DN-DM)	410	0.7
Up Main to Up Normanton (UM-UN)	992	2.3



Final Arrangement

- Knowledge gained from the previous round of iterations - over 2 years of work
- Lowering wire heights so no gradients through the junction
- Final fine tuning of cross dropper positions and quantities – making cross droppers more effective - (additional cross droppers)
- Additional overlap structure to reduce wire oscillations – reducing the impact on the rear pantograph
- Refinement of pantograph head profile used in the model
- Hogged (lifted) 1 x contact wire at the switch diamond – (20mm lift lowered forces)
- All simulated pan configs now under **200N**

Time to build and test

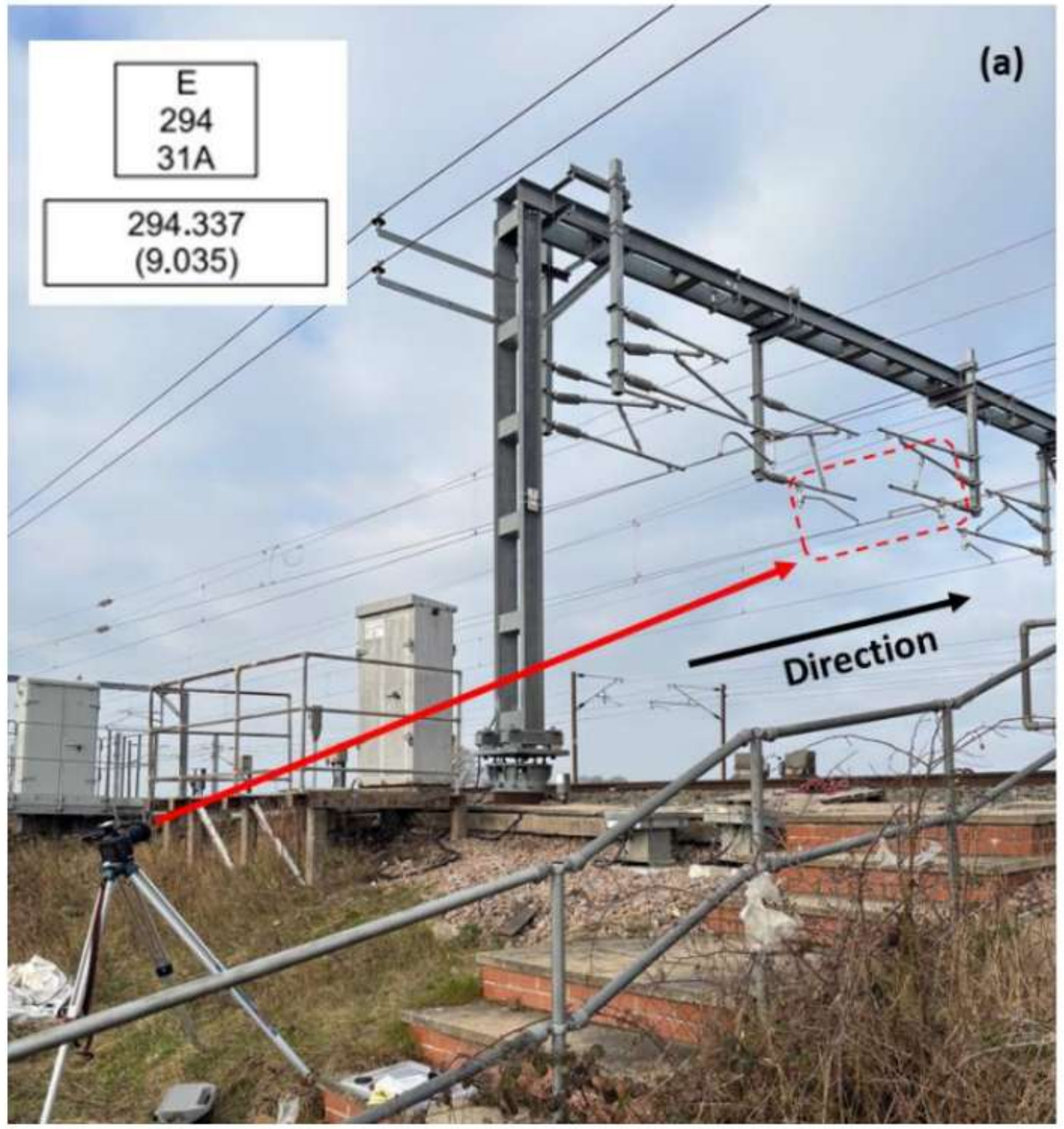


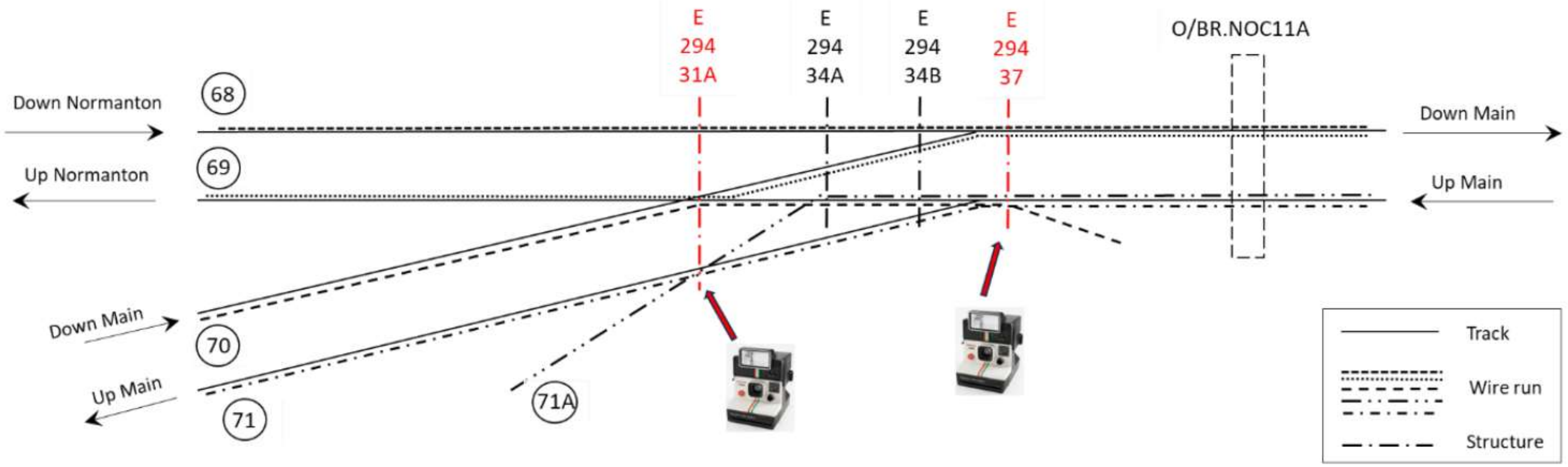
Colton Junction – Construction Works

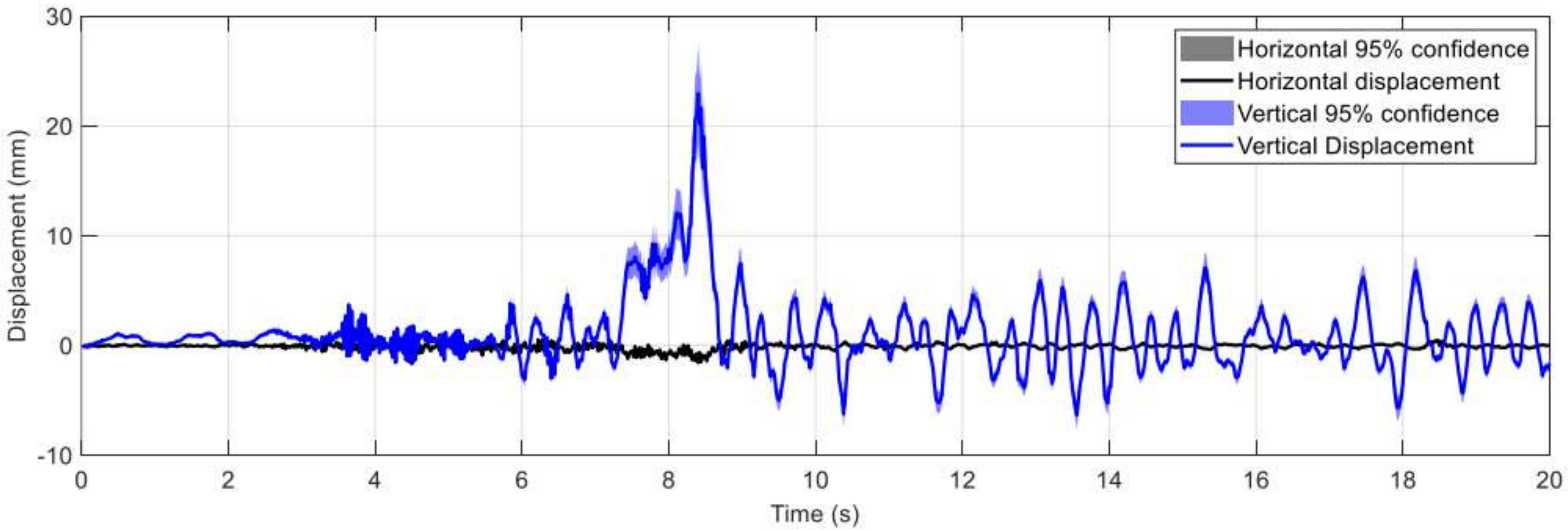
- Implemented over 2x 54hr Weekend Possessions – Wk35 (23) & Wk52 (25)
- Wk35 Wires lowered through the junction to remove any change in gradients, installation of new SPS and registration equipment
- Wk52 Un-crossing of the wiring through the crossover, cross splicing, removal of headspans, installation of new catenary wires to remove AWAC cantenary which is a known maintenance burden. Creation of a new insulated overlap to remove the need for the Section Insulator in the diamond area.
- Post construction – no AWAC or Contact Splices in the Junction Area – Reduced Maintenance!

Colton Junction – Post Commissioning Monitoring

- Following the Wk52 Tangential Wiring Works a TSR of 90mph was implemented on the Dn Leeds Line for 1 week
- At possession hand back EMU services through the junction were monitored using Digital Image Correlation to determine the level of contact wire vertical displacement (uplift).
- Measured uplift was compared with simulated values from the UoH modelling which was within 5mm of predicted – TSR lifted and 125mph running implemented

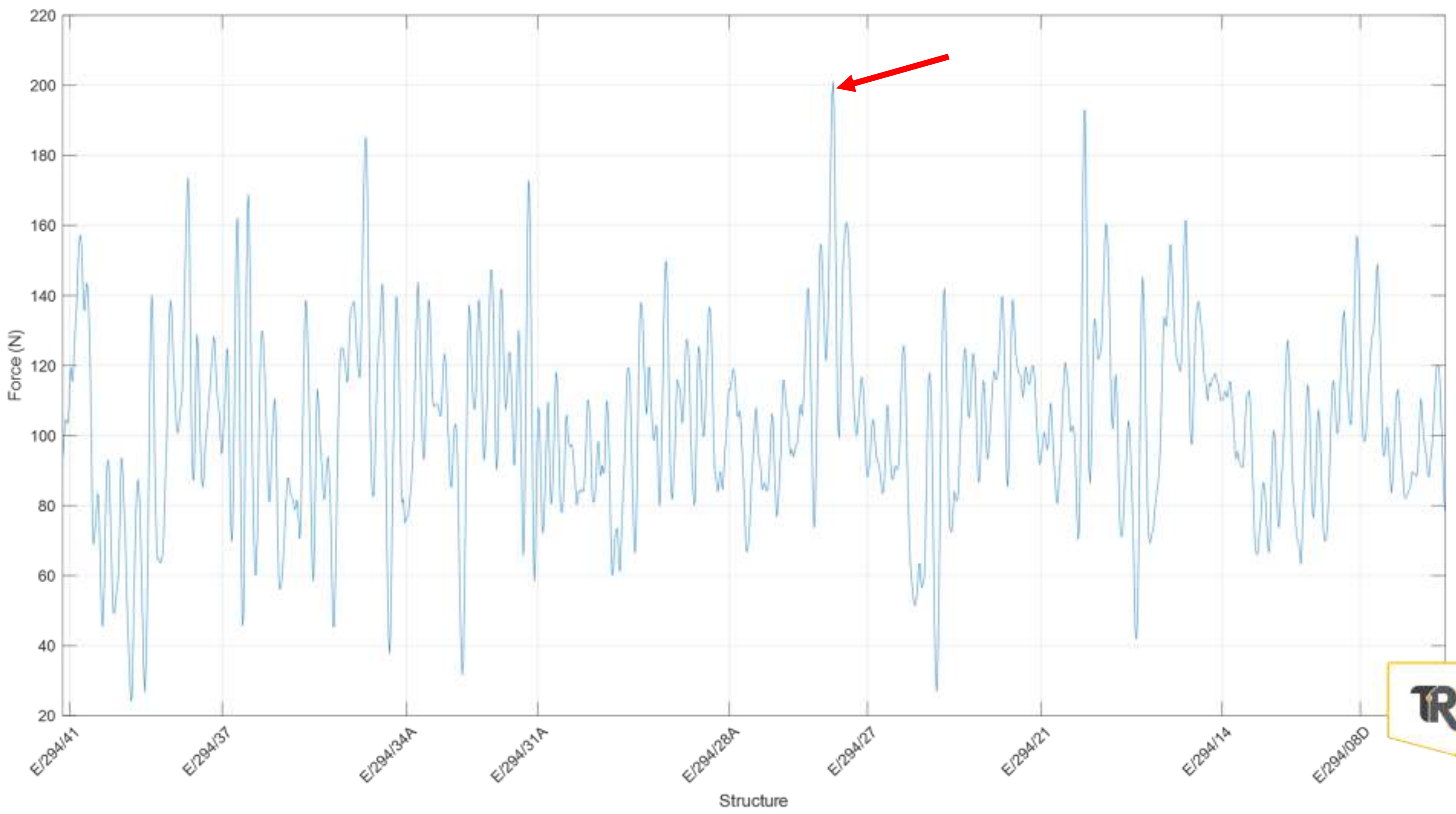






Colton Junction – Test Train Dynamic Assurance

- WK02 – Class 91 EMU with 2No. Class 43 DMUs & 3No. Mk 3 Coaches ran through the Junction at 125mph with an instrumented HS-X Pantograph
- Measured contact forces through the junction showed **Fmax 201N**



F_{max} = 201N
F_{min} = 24N
F_{mean} = 103N
σ = 26N
Speed = 125 mph

MVP Examples on TRU East

- 72m Span Lengths were utilised – TRU E1 is mainly straight track
- Lateral Pile Testing to reduce pile lengths in high rock areas using 'rock sockets'
- Use of foundation load cases to reduce design effort for OLE foundations reducing timescales from AiP to foundation installation to 4 months
- Review and analysis of 610mm pile steel boss and studs to allow an increase over the historical 181kNm limit – removing the need for pile caps & transfer plates.
- Use of VCC's at bridges in line with NR/L2/ELP/27716 – Business as Usual
- Regulation 14 in draft against ENE NTSN Clause 6.2.4.5, *"Assessment of dynamic behaviour and quality of current collect (integration into a subsystem)* Aim for no test trains or Assessment Body review of wire geometry

Figure 20: Huddlestone - Moment verses Displacement for TP1 (3 metre pile embedment)-

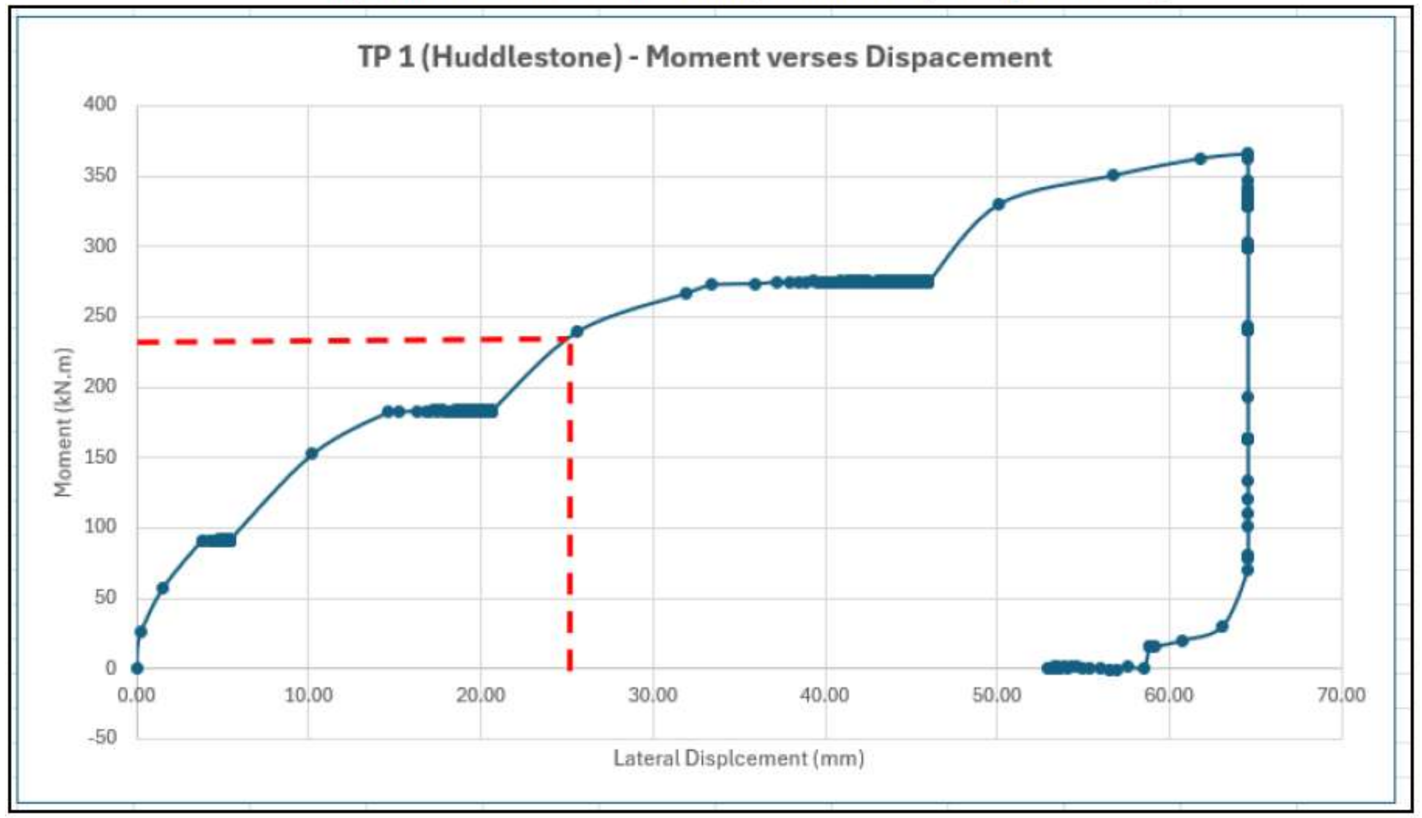
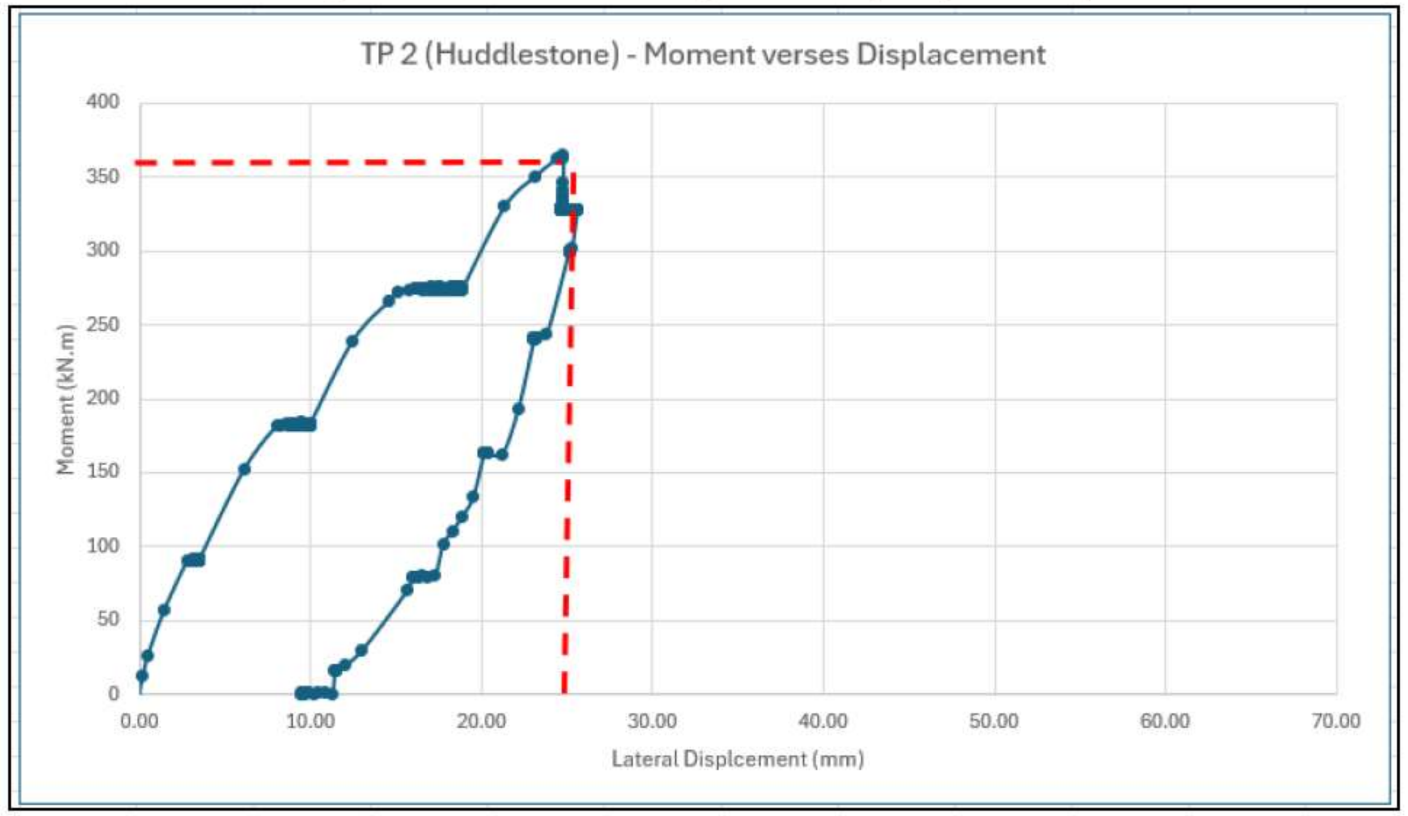
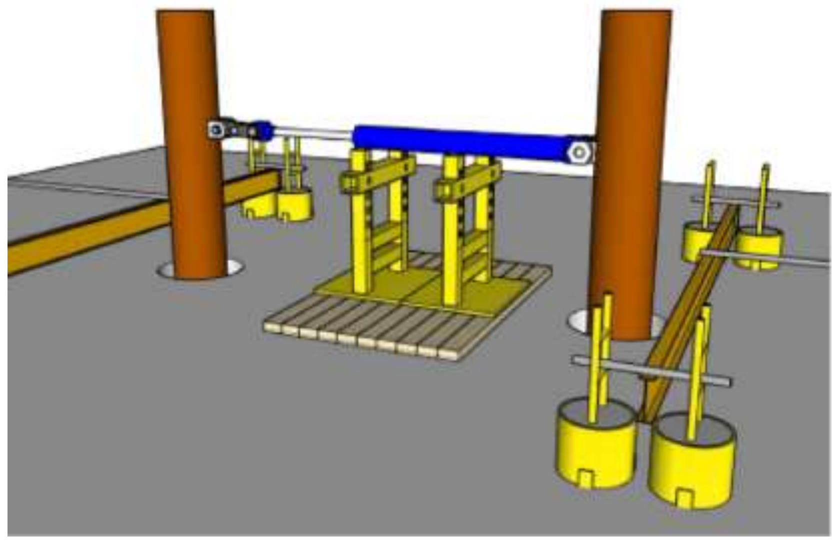


Figure 21: Huddlestone - Moment verses Displacement for TP2 (4 metre pile embedment)





Questions?