Series 1 Structures

Why so **Large**?

Rob Daffern

March 2024

Furrer+Frey
Overhead contact lines

ANNIVERSARY 100 YEARS 1923–2023

Agenda

- Quick recap
- Remit and priorities
- Distractions
- Case study: Monoboom
- Case study: TTC
- Case Study: SSA
- Allocation
- State of mind / Perception / Reality
- 2024 usage
- Lessons
- Questions

Rob Daffern

MEng MIMechE MPWI

- 23 years in Rail
- Balfour Beatty
- Network Rail Mtce
- Network Rail projects
- Furrer+Frey

Assumptions:

Audience know basics of OLE “competent”

Audience are broadly familiar with Series 1 / GWEP

This is my **Personal** experience and opinion

Many educated estimates (not hard figures).

Don’t share what I say here unless you are “competent” to understand it properly!

GWEP Priority ~2012

- New fleet of trains. Mostly EMU (some Bi Modes)
- Paddington to Swansea in service by 2017
- High Output Plant construction

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- Paddington to Swansea in service by 2017
- High Output Plant construction
- Cost
- Other things that seem important now with hindsight

GWEP Overheads

- ~1,200 office staff (£5m a week = £2k minute)
- Priority = Speed

(Steel was approx. £700 a tonne*)

- £ ~ 3 tonnes a minute of steel in design/management

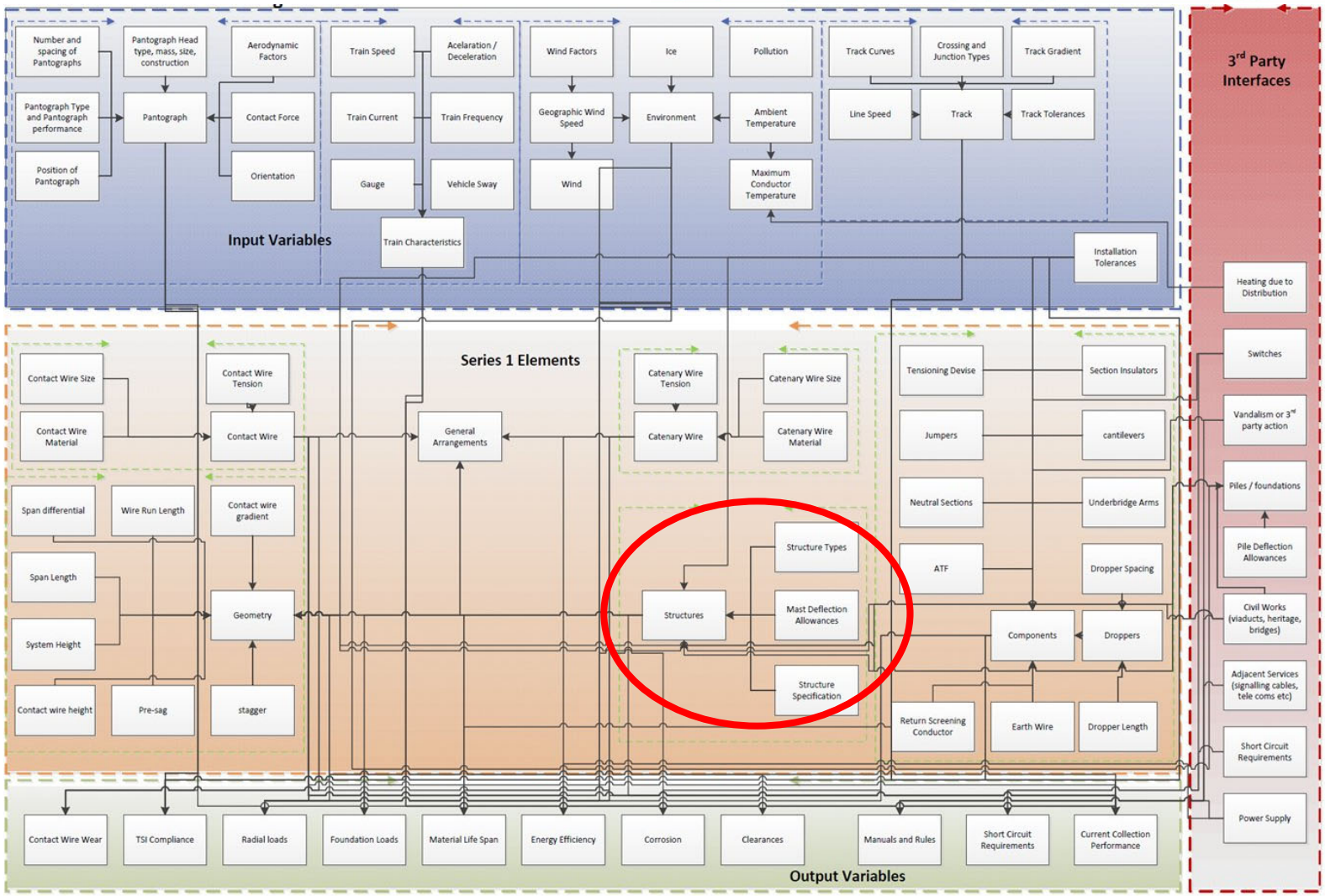
- *ONS Jan 2024.

Series 1: Remit ~ 2012

- 140mph multi pantograph
- ATF and EW
- Step change reliability improvement
- TSI compliance / Interoperable
- Improved safety
- Reduced maintenance / 120yr structure life
- “High output” construction
- “High output” design
- Mechanically independent wire runs (no tail wires)
- Safety by design: Mechanised on site. Assembled off site
- Modularisation of procurement / assemblies (*one size fits all*)

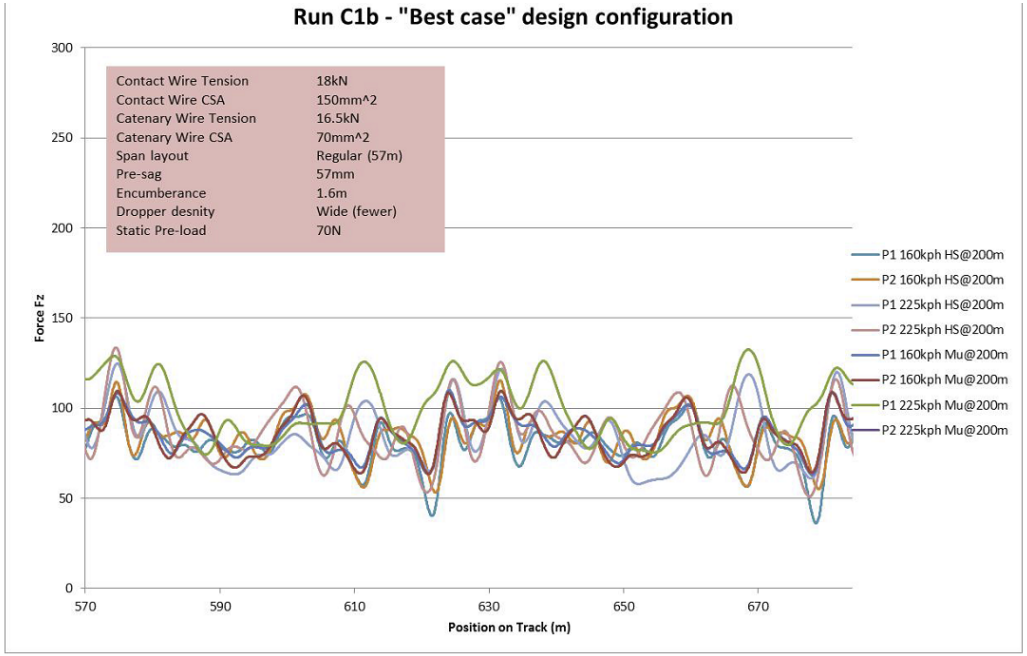
Distractions

+ System Design WIP
+ Allocation Design WIP



Distractions = Early Unknowns

“Get the piles in the ground”



+ **Linespeed**

Tension / Wire size / System height / Overspeed = **LOADS**

+ **GL/RT1210**

Wire heights/ Level crossings = **HEIGHTS**

+ **Windspeed** (Pre Civ 072 073, Pre Pan 97)

Mast sizes / Baseplate loads / Span lengths / Foundation loads / No PAN yet = **LOADS**

+ **Resilience** & Reliability

Tension, mast deflection, Wire size, system height, dropper spacing, pre sag, span length = **LOADS**

+ **TSI compliance**

Wire heights / TMLA / tolerances / Tension / Over speed / Pan configurations = **LOADS** and **HEIGHTS**

Distractions = Early Unknowns

+ **Electrical safety**: ATF (Pre Pan 83)

Clearance 600mm / ATF vicinity permits / danglers vs fixed posts = **LOADS** and **HEIGHTS**

+ **Crash Safety**

Spaceframe / lattice, then oval, round, square/rectangle, H/I. = **LOADS**

+ **HOP train**

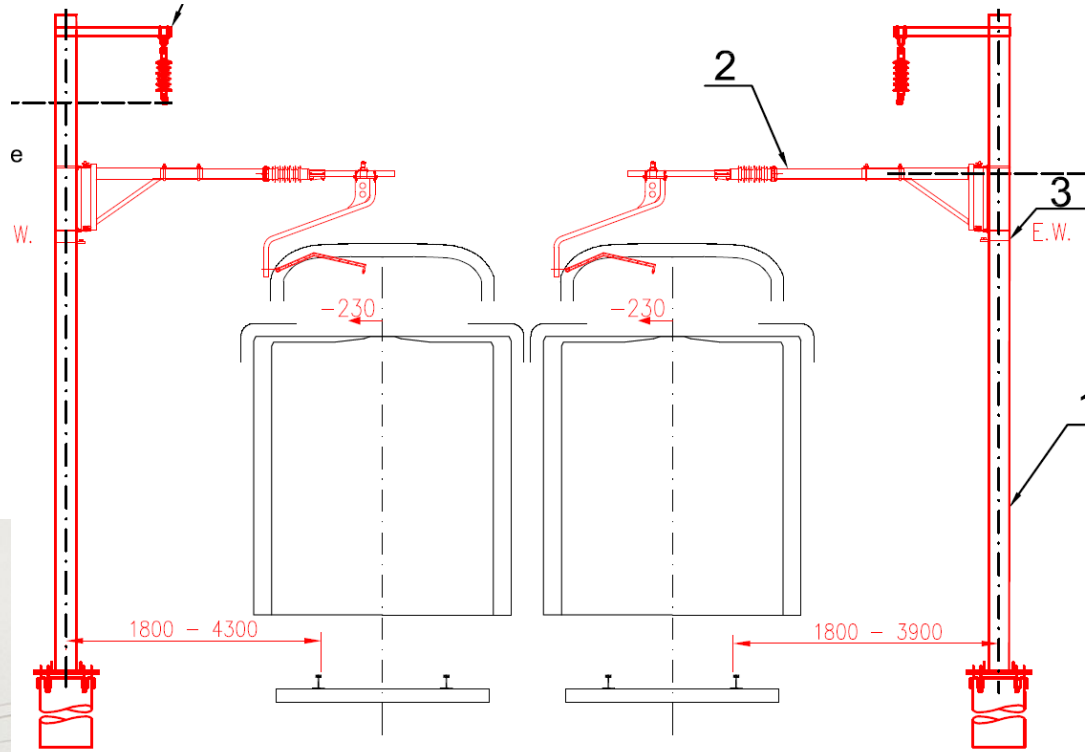
ORR involvement, safe work zones, stillages, which track is it on….. = Lengths = **Heights**

+ OLEMI vs **Eurocodes** 2010

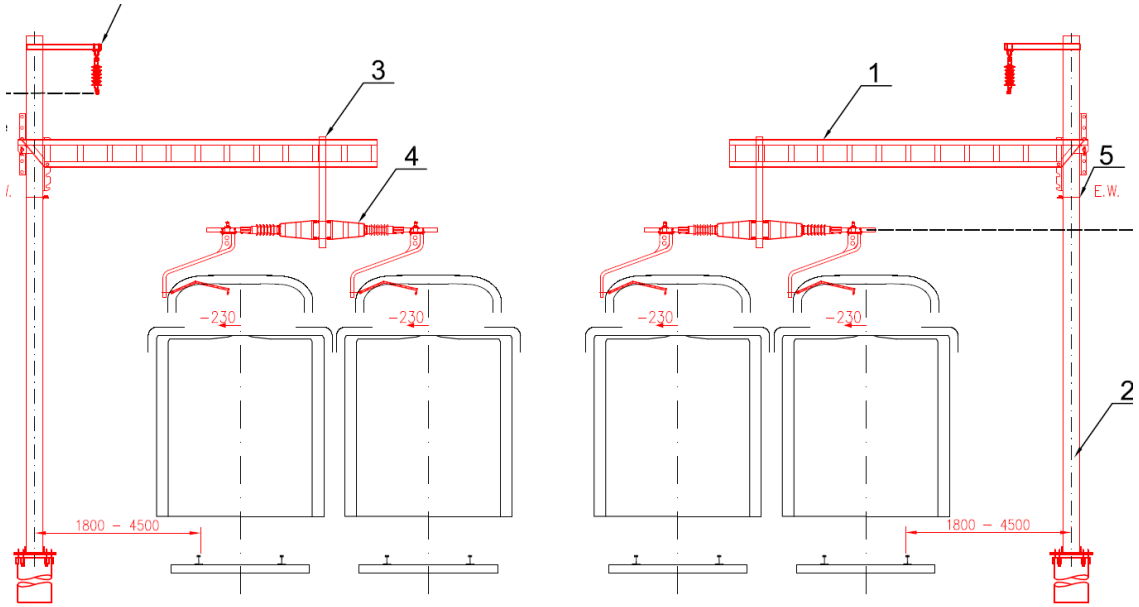
FOS / Assumptions / arguments = **LOADS**

+ 2015-16 **Value engineering**

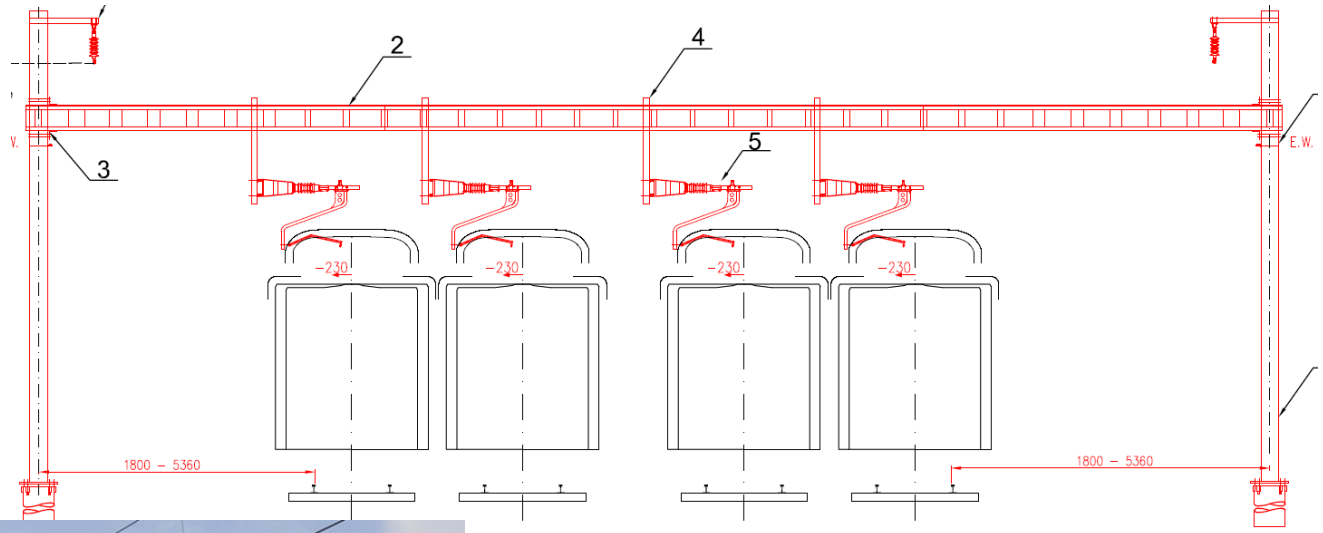
Series 1 Structures Range: STC



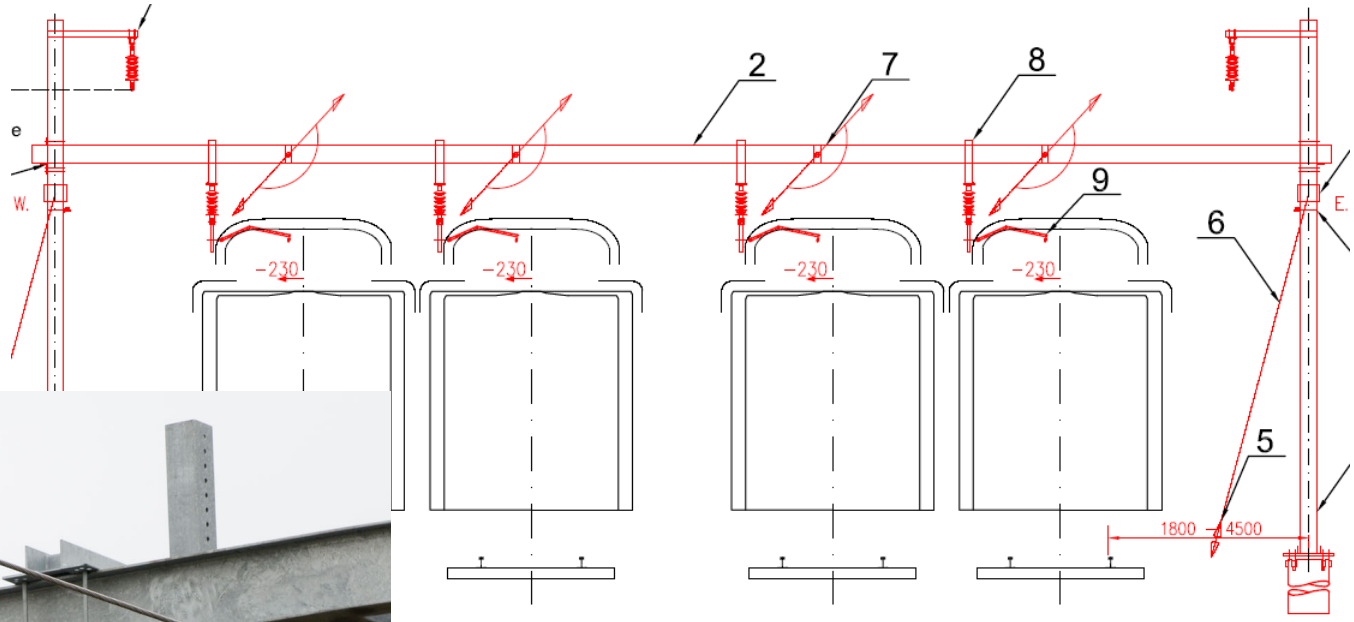
TTC



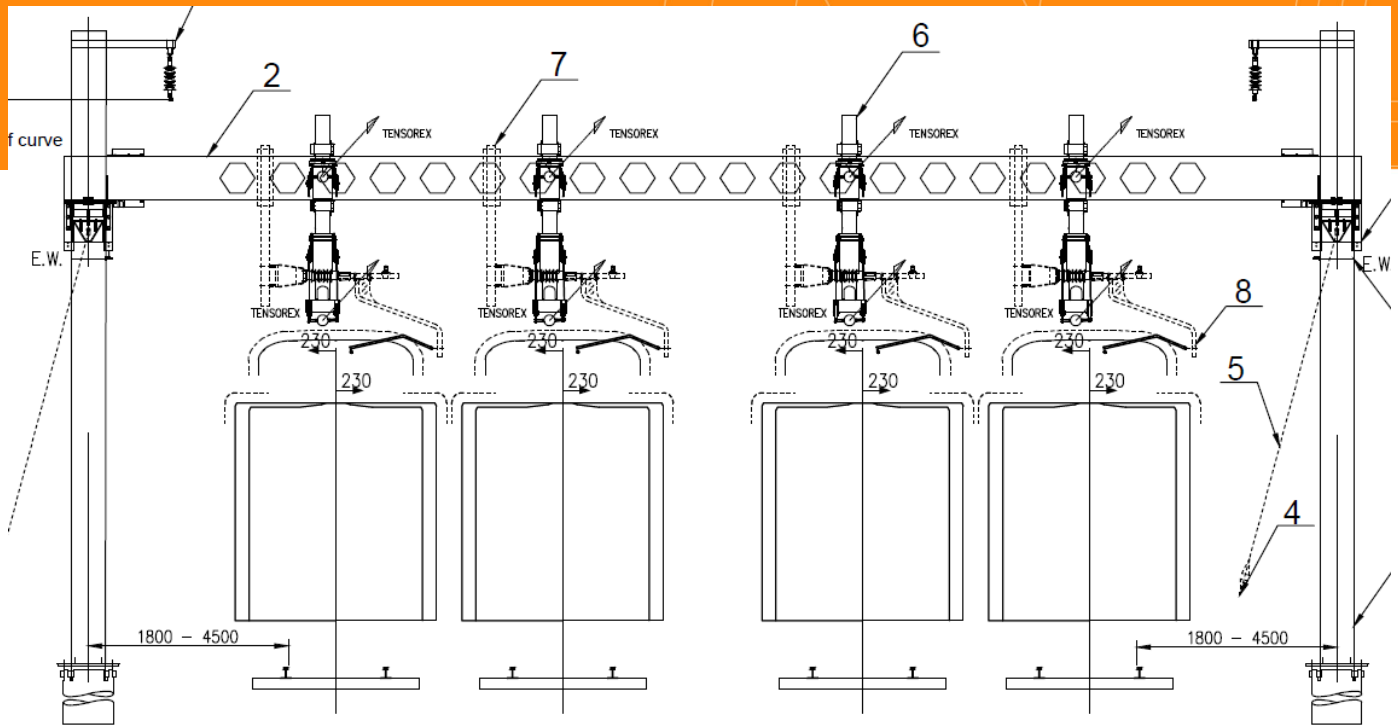
Q Boom



MPA (F Boom)



Monoboom


f curve
E.W.
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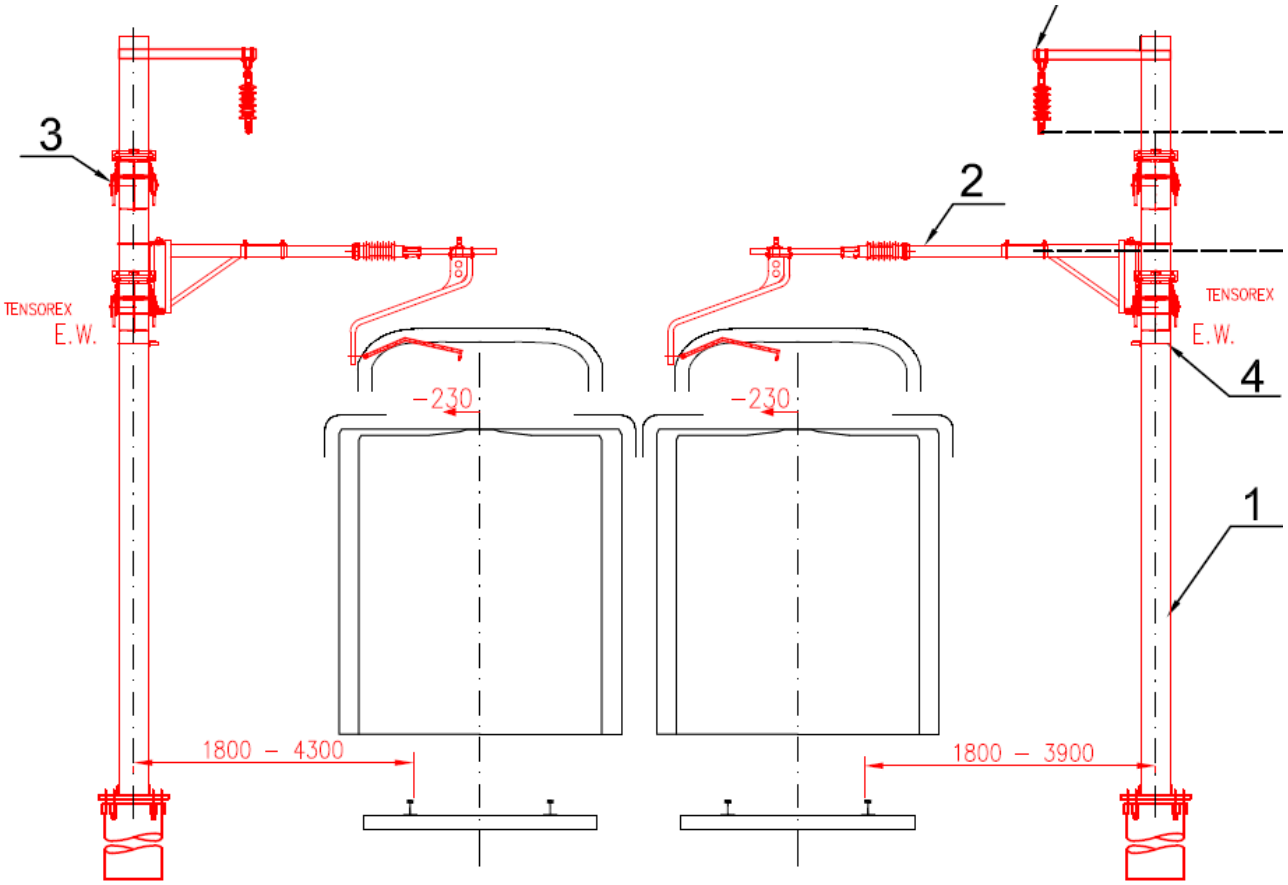
8
5
4
E.W
1800 – 4500
1800 – 4500

Series 1 SSA



Case Study 1: Monoboom Anchor Portal

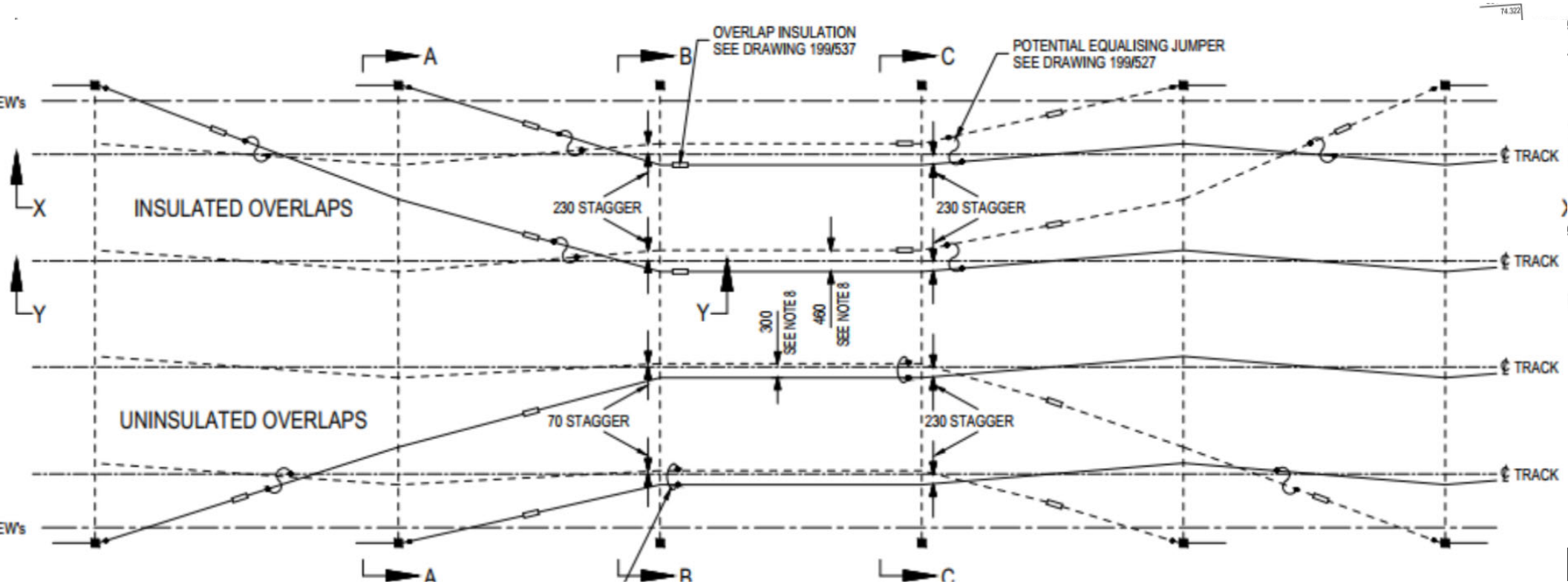
+ Remit: Mechanical Independence. (No Tail wires)

Examples:

+ Mk3b ECML
+ Heathrow Portal: Too many problems
+ Most of Europe
+ Series 1

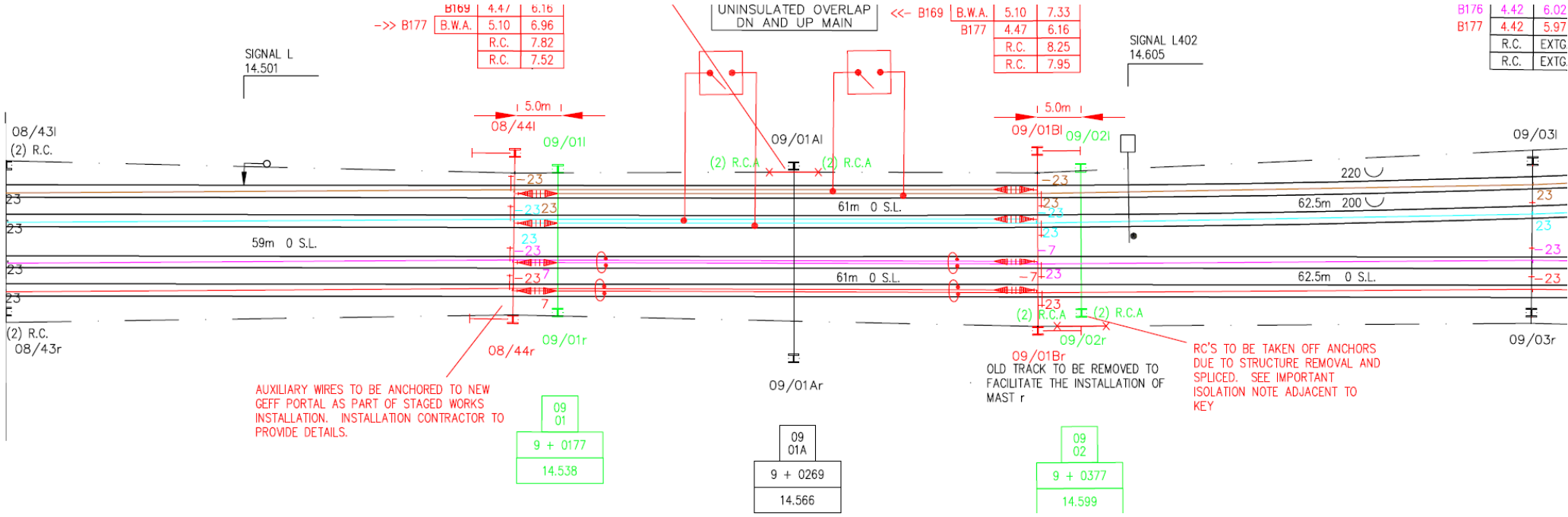
MK3b ECML / MML

- No Mechanical Independence. 5 span overlap eg 300metres long.
- Lots of insulators, lots of threading / flaking wires at construction
- ~~High Output~~
- 1 failure takes out 4 tracks
- Anchors out in cess



Most of Europe (GEFF)

+ Single (or three) span Overlap



Most of Europe (GEFF)

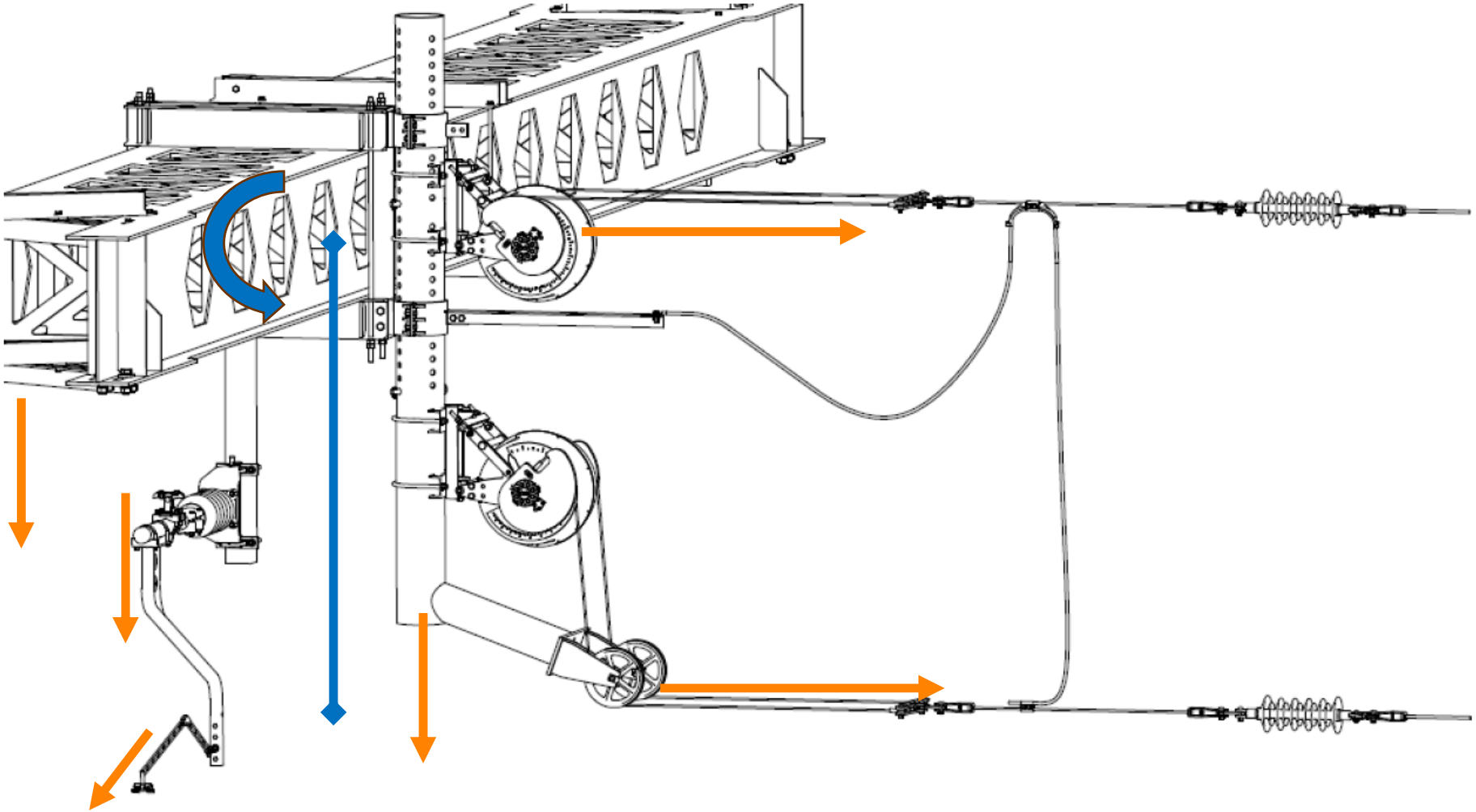
- Mechanical Independence
- Needs catenary flaking through: NOT high output
- Anchor above 4’
- Slow to structures to install
- Designed for concrete foundations
- “Ladder” ties/struts
- Loaded mainly in bending

Monoboom(Pat) Anchor

- Mechanically independent
- No Flaking: HOP
- Anchor above 4': HOP
- Designed for CHS piles
- Single span overlaps: HOP
- Allows each wire run to be approx. 120m longer (saves 5-10% overlaps)
- Looks big and heavy
- Is big and heavy

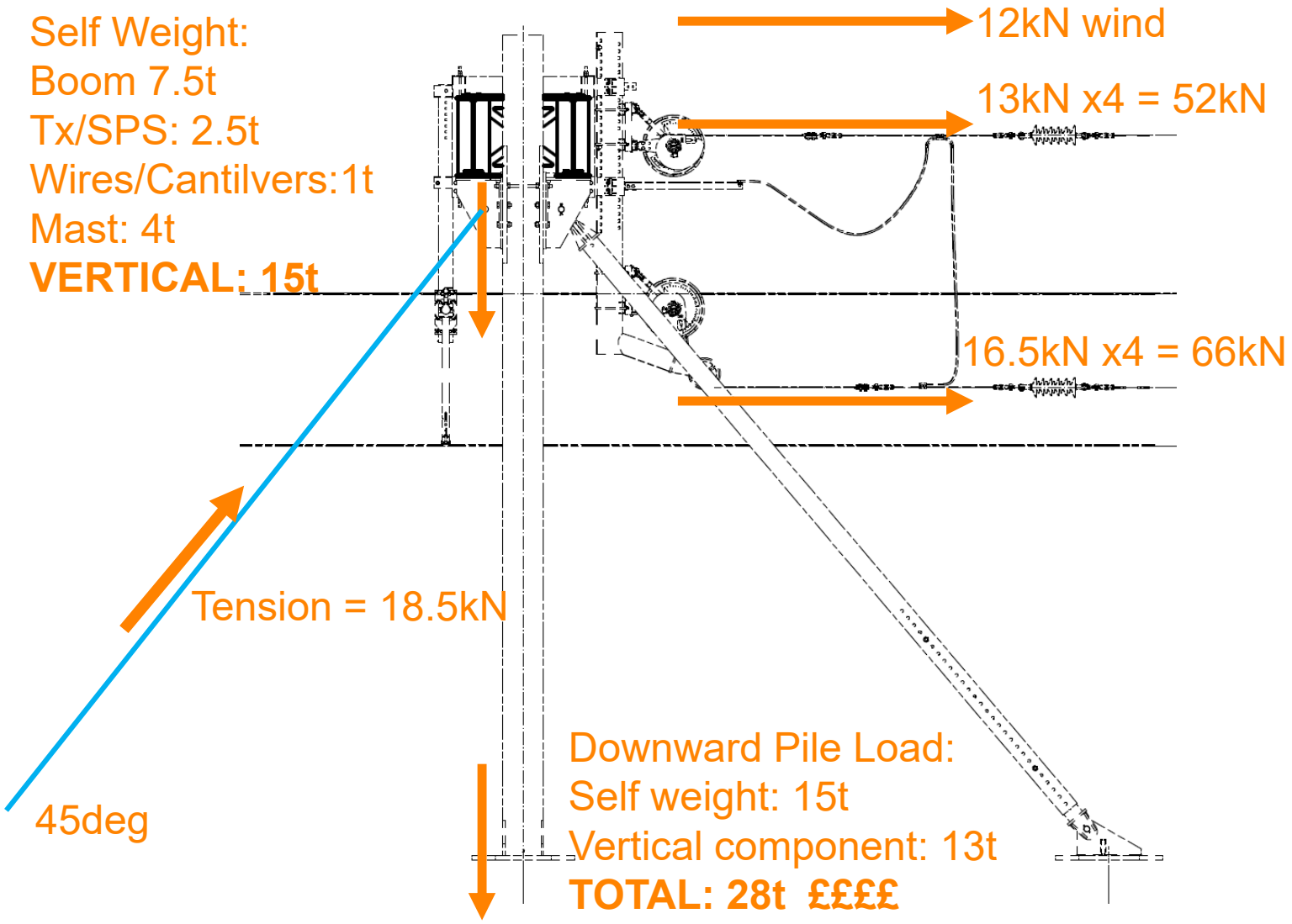
Monoboom Anchor Loading

+ Loaded in Bending AND Torsion



Example “CHEAP TIE”

Self Weight:
Boom 7.5t
Tx/SPS: 2.5t
Wires/Cantilvers:1t
Mast: 4t
VERTICAL: 15t



Along Track:
Cat: 5.2t
Con: 6.6t
Wind 1.2t
Along: 13t

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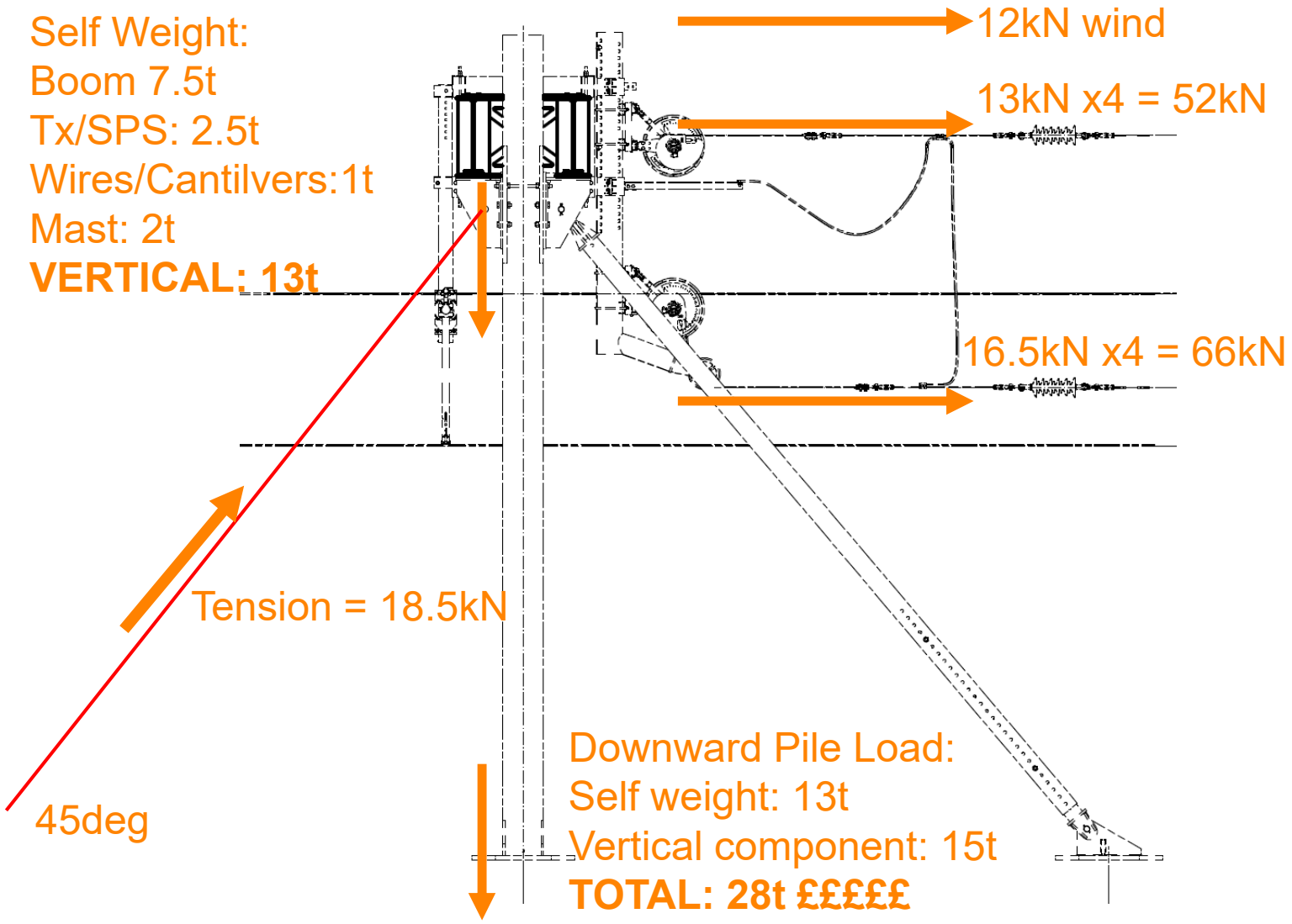
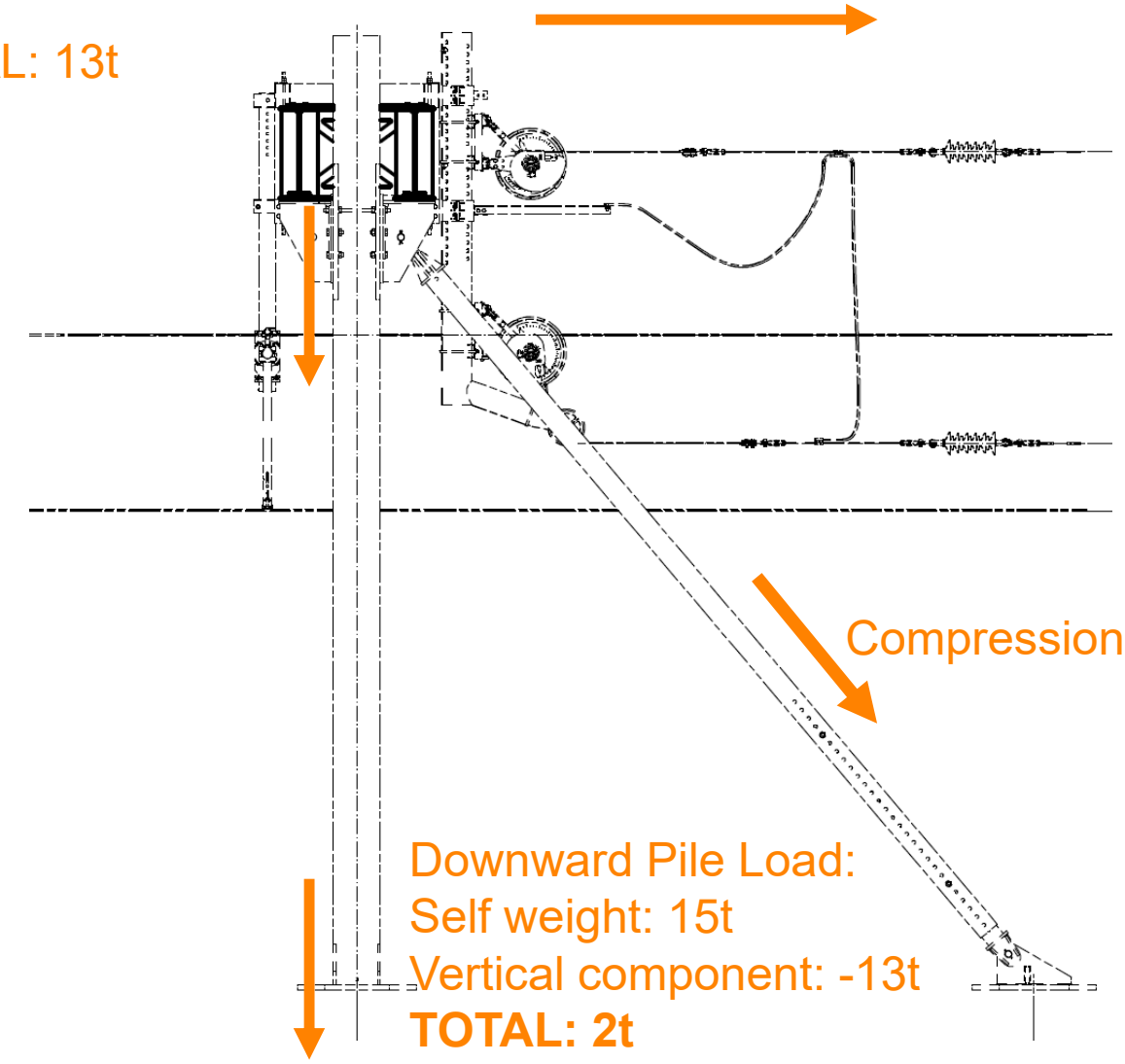


Along Track:
Cat: 5.2t
Con: 6.6t
Wind 1.2t
Along: 13t

“OVER-ENGINEERED STRUT bigger than some masts”

VERTICAL: 13t

Along Track: 13t



Compression = 18.5kN

Downward Pile Load:
Self weight: 15t
Vertical component: -13t
TOTAL: 2t

Strut vs Tie

- Cheap tie =
  - Deep pile
  - Concrete infill
  - Refusal risk
  - Fewer piles per shift
  - Angry neighbours
  - “Sometimes impossible”: Covert to concrete
  - NOT HIGH OUTPUT

- “Over-engineered strut” =
  - Smaller piles
  - Lower risk
  - More piles per shift
  - Less noise
  - No concrete
  - HIGH OUTPUT

“One size fits all”: Procurement efficiency?

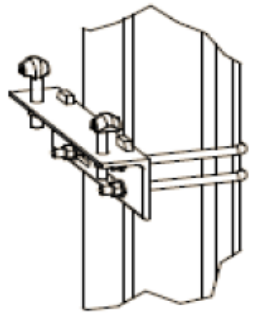
Case Study 2: TTC

Remit: Paddington to Swansea in service by 2017

High Output Plant construction

+ “Portals are better engineered” “more efficient” “cheaper” “easier”

+ Need all track access
+ Saturday nights or <2hrs mid week
+ Land+Leave® = Faster construction than olemi (increases boom loads)



TTC

TTC

TTC (**MAST**) Economics: OLEMI Vs Series 1 (No ATF)

OLEMI 381x102 DC 8m Mast

Series 1 SHS350x12.5 8m Mast

+ Load capacity: SAME		
+ Weight: 1175kg		1150kg
+ Cost: (**2017**) £2,800		£2100
+ Fabrication: 28hrs	(fillet welding)	8hrs (butt welding)

TTC Economics: **Mast**

- Estimate 3,000 TTCs
- Series 1: 3,400 working days fab (over 15 working years)
- OLEMI: 12,000 working days fab (over 52 working years)

UK Fabrication industry?

20teen

Labour expensive

Materials cheap

Project duration expensive

Remit:

- *Paddington to Swansea in service by 2017*
- *High Output Plant construction*

TTC (**Boom**) Economics: OLEMI Vs Series 1

+ Boom installation: 40mins
+ ~~High Output~~

2mins (Land+Leave®)

High Output

TTC

TTC Economics: Installation

- Estimate 3,000 TTCs
- Mid-week nights
- 5-6hour 2 track access.
- OLEMI max 3-6 / night = ~500 - 1,000 shifts
- Series 1 Proven 30 / night = ~100 shifts

Remember:

- *Paddington to Swansea in service by 2017*
- *High Output Plant construction*

Case Study 3 SSAs

+ Most people don't like SSAs
+ Saves 1 foundation EACH
+ OLEMI 356x368 needed
+ Series 1 SHS 350x16

+ One size fits all*
+ Level crossings

Aesthetics?

*RHS 500x300x16….

High Output Allocation Design

+ OLEMI: Summary of calc sheets

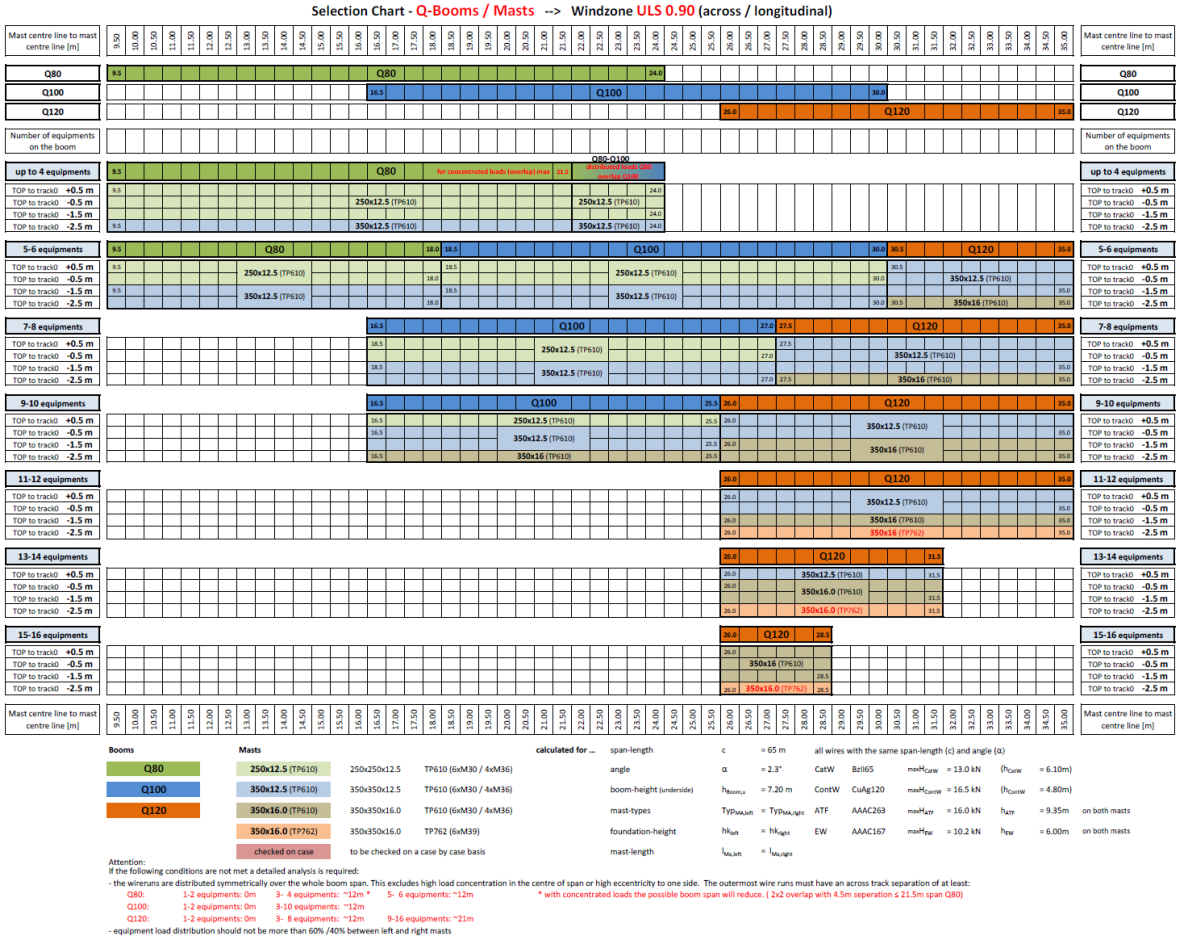
+ Series 1: Allocation Charts

Great:

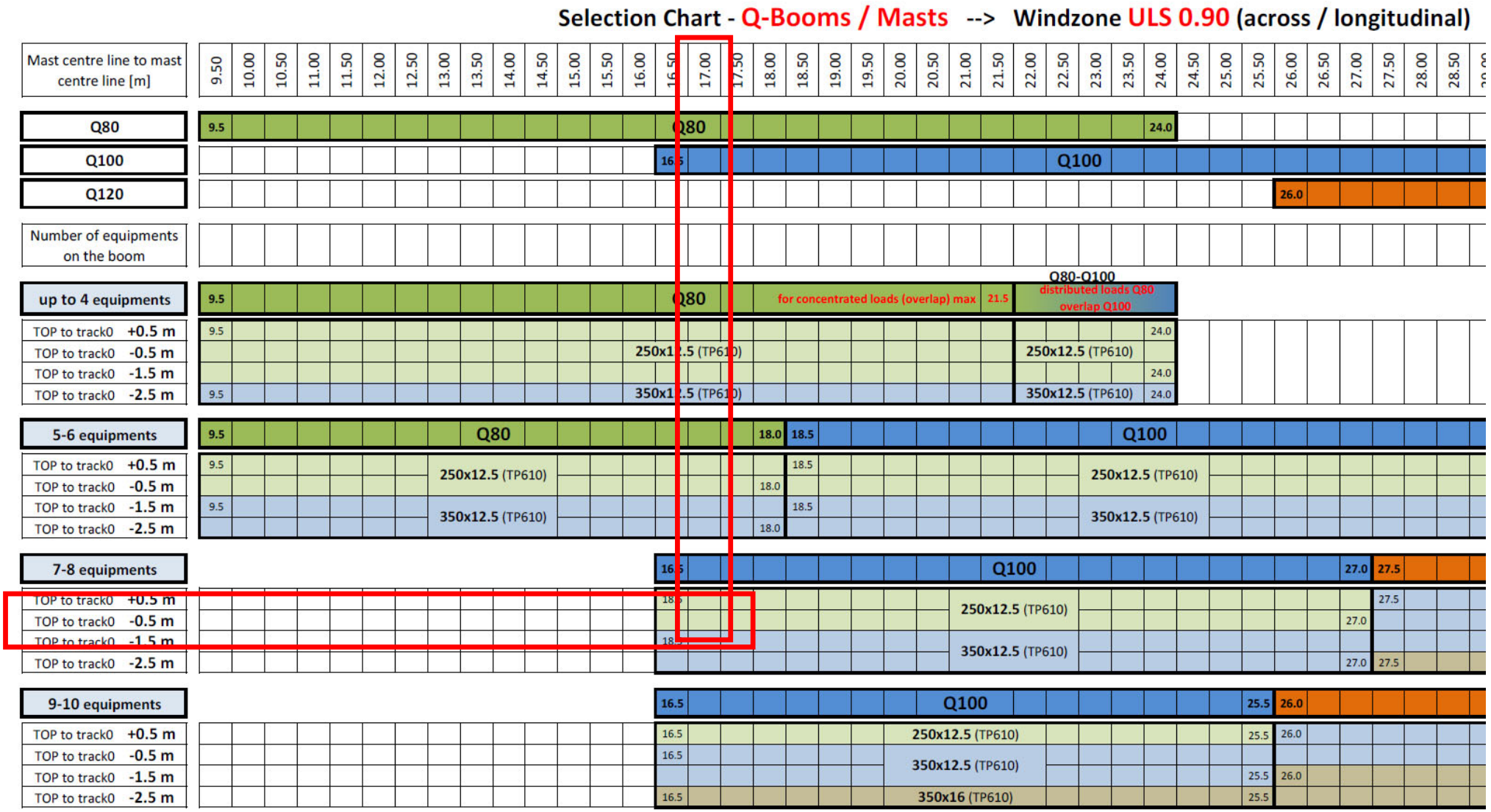
+ Negligible competence needed
+ Fast, low skilled allocation design
+ Very efficient way to design / allocate

But:

+ Everything is rounded UP
+ Not the most efficient way to use steel
+ Revised 2016 after **Value Engineering**



High Output Allocation



Procurement?

Remember:

- *Paddington to Swansea in service by 2017*
- *High Output Plant construction*

Procurement?

- Accidental over ordering….
- Re-use of “scrap”:

What's happening now?

- **MML**
  Monobooms 2 & 4 track, F Boom MPAs
- **Trans Pennine**
  TTCs Small & Large, Monobooms 2 & 4 track
- **SSV**
  TTCs, Monobooms, F Boom MPAs
- **Crossrail East & West**
  Monoboom anchors

- **Scotland**
  Monoboom anchors
- **TFW**
  Q Booms, TTC, F Boom
- **Anglia MK1 replacement**
  - TTCs, **Self supporting** F Boom MPAs (save 4x foundations), SSAs

What's happening now?

- Copies from competitors are in development
- F Boom, TTC, Monoboom: In UKMS
- F+F Licence Series 1 to NR and anyone in the UK can use them (for NR).
- Outside UK F+F own all design rights.

THINK! Perception vs Reality

I Can See
NOW, today
Height / width
Big anchor struts
Big anchor booms
Aesthetics
Commercial Sense

THINK! Perception vs Reality

I Can See	I Can't See
NOW, today	The past
Height / width	Wall thickness
Big anchor struts	Pile depths (Monoboom)
Big anchor booms	Piles not needed (SSA / F Boom)
Aesthetics	Manual Flaking Avoided
	Shorter possessions
Commercial Sense	Weight
	Costs / time saved
	Accidents avoided

Reflection

Remember:

+ *Paddington to Swansea in service by 2017*
+ *High Output Plant construction*

Lessons:

+ Simon Skinner SPL MML "*Series 1 is actually not that bad!*"
+ Series 1 Structures are bigger than we are used to!
+ Not unreasonably heavy
+ Not over engineered
+ Delivered their remit of high output / fast construction
+ The design saves a huge amount of **unseen** cost and time
+ Any additional steel is trivial vs benefits
+ The industry often forgets this…

Reflection

I wish….

I Hope… Share the benefits.

Anyone can blame big structures…..

Future Electrification:

Real Project costs is management, not steel:

+ Minimise Change
+ Minimise mid-project innovation
+ Value engineer BEFORE starting
+ Agree key parameters BEFORE starting

Series 1 structures are large, but free-up efficient (unseen) electrification.

Questions?

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