MIDAS Workflows for Sustainable Design

Going Beyond Standard Designs

23rd October 2025

Agenda

1 Introduction & Background

2 Project #1 –
Reservoir Road Underbridge

3 Project #2 –
Tottenham & Hampstead Line Underbridges

4 Conclusions

Project #1 – Reservoir Road UB

Bridge reconstruction project between 2016 (Form 001) and 2020 (Form 003).

Located in Whaley Bridge, Peak District.

Project #1 – Reservoir Road UB

Original structure from 1907.

Single deck supporting UP and DOWN lines.

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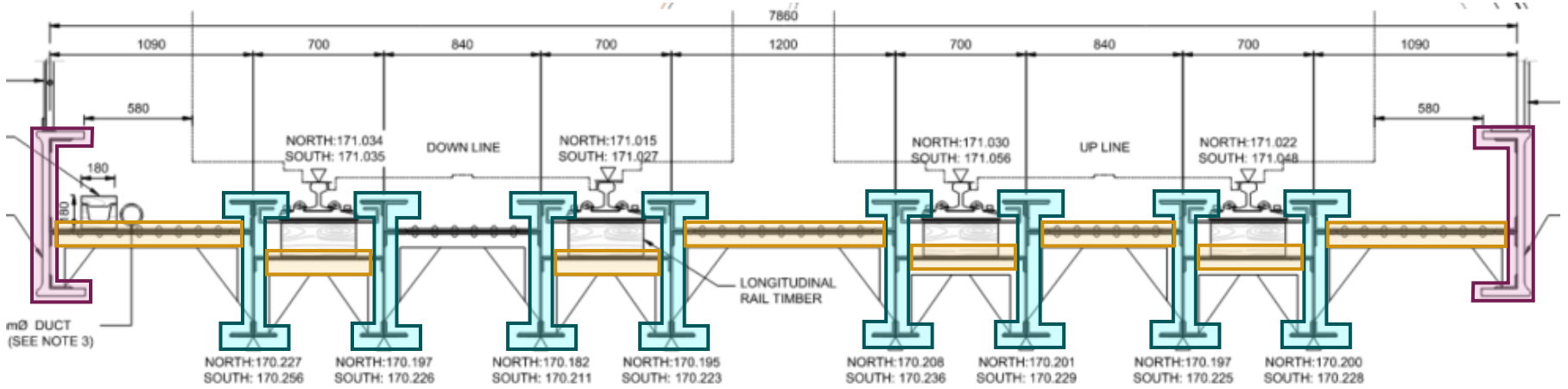
Single deck supporting UP and DOWN lines.

Wrought iron **outer girders** and trough girder pairs supporting track timbers.

Steel riveted deck plates between girders.

Limited walkway width creating hazard.

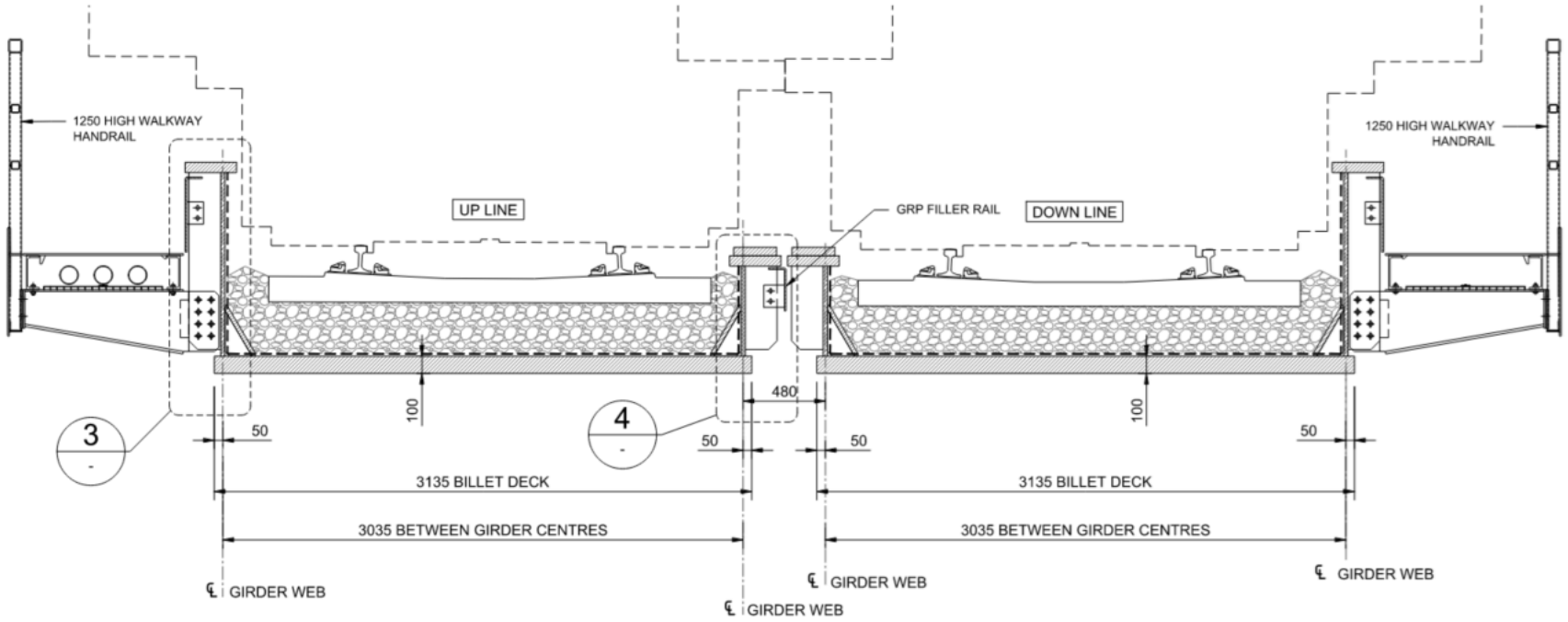


Project #1 – Reservoir Road UB

Single deck replaced with 2no billet decks.

External walkways made crossing safer.

Billet decks reduce construction depth but increase weight.



D 000014 SECTION
SCALE: 1:25

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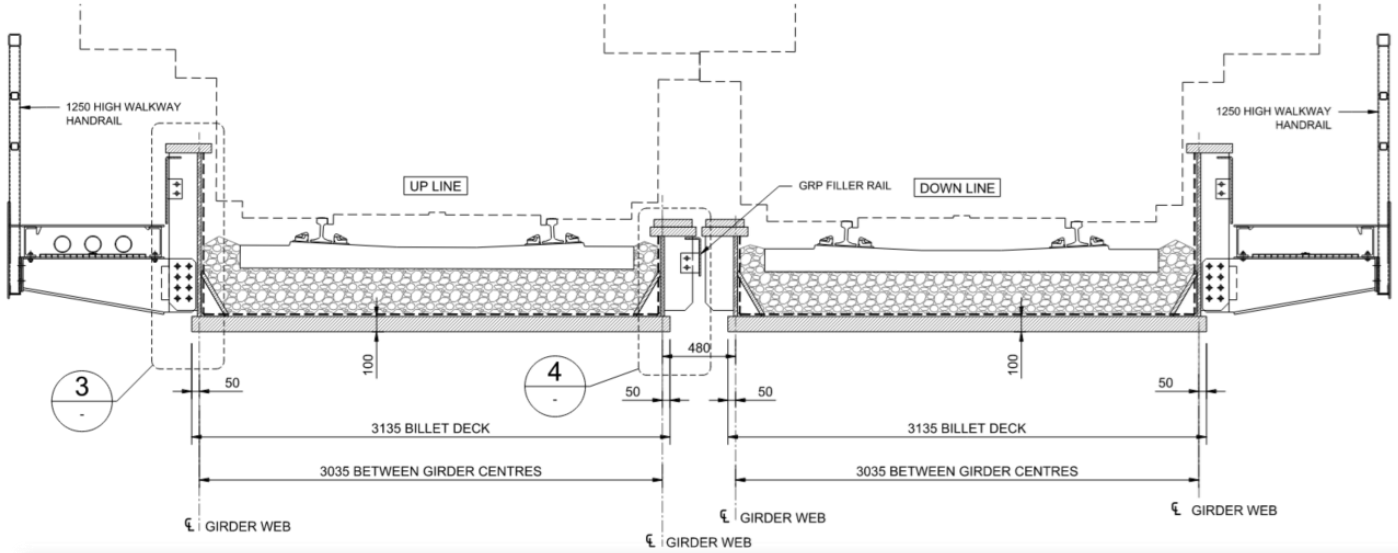
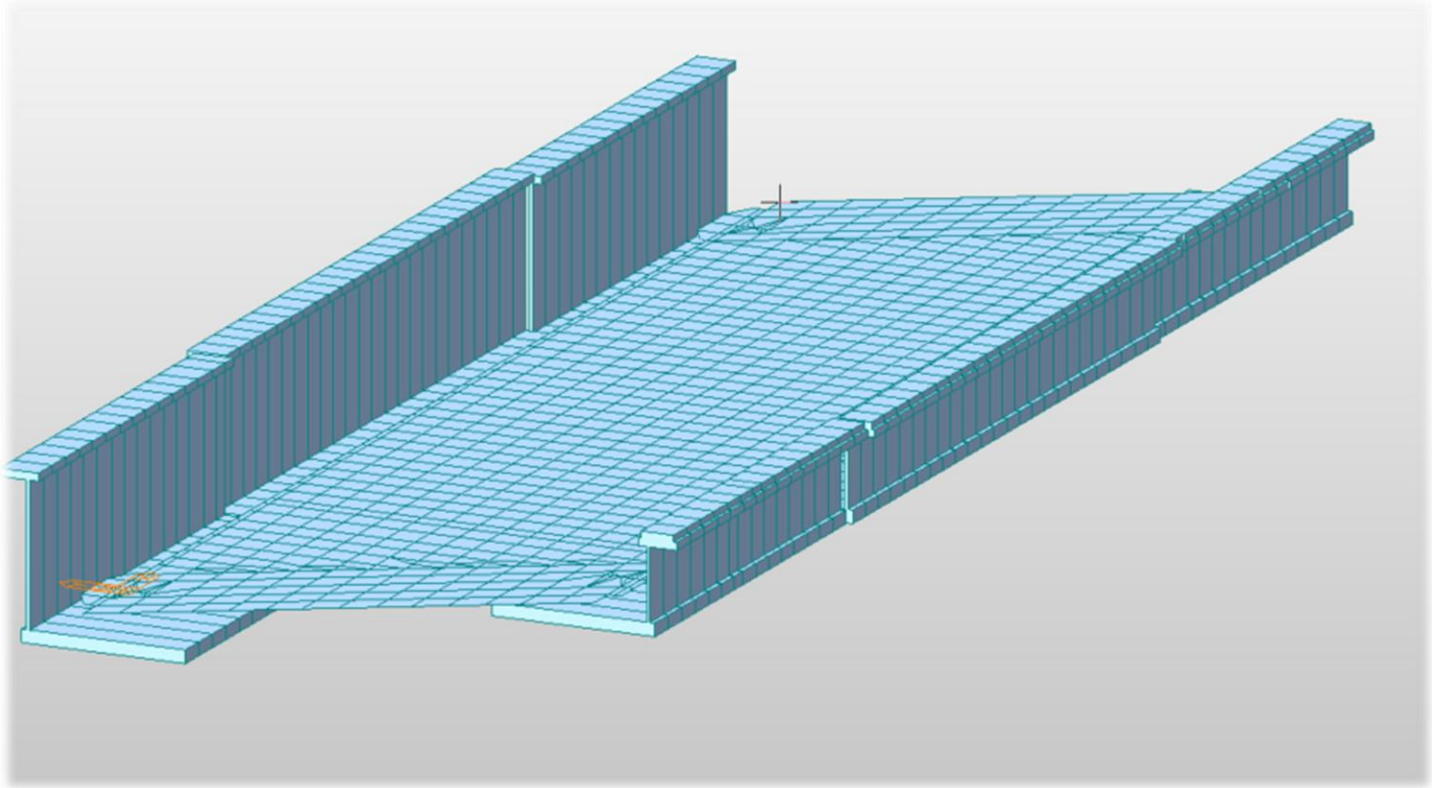
Design Optimisation

Optimsation of Deck Thickness

Standard design practice – 125mm deck plate thickness.

Detailed Design, MIDAS modelling highlighted under-utilisation of deck plate.





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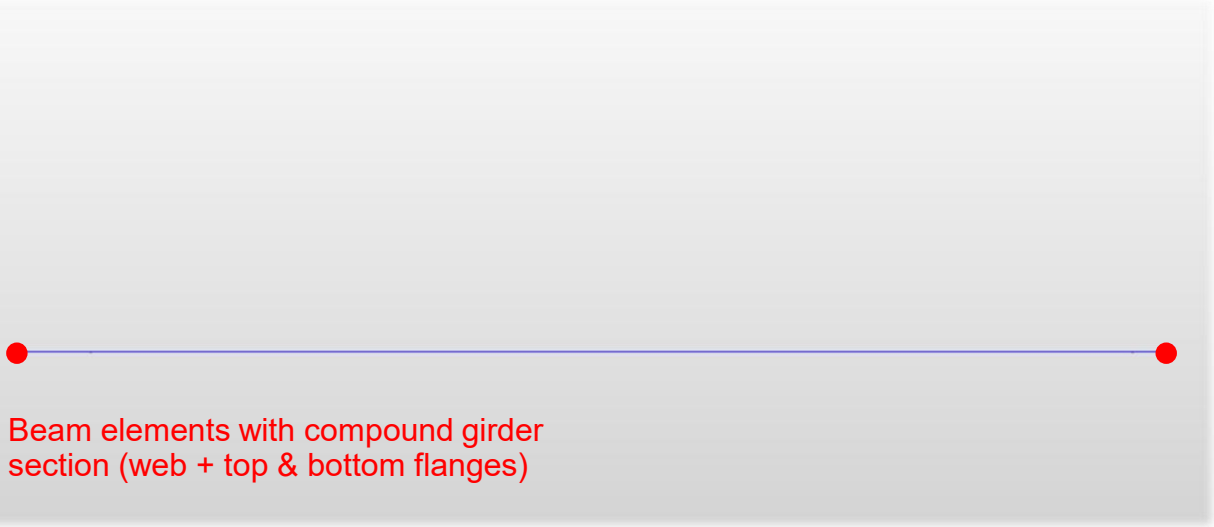

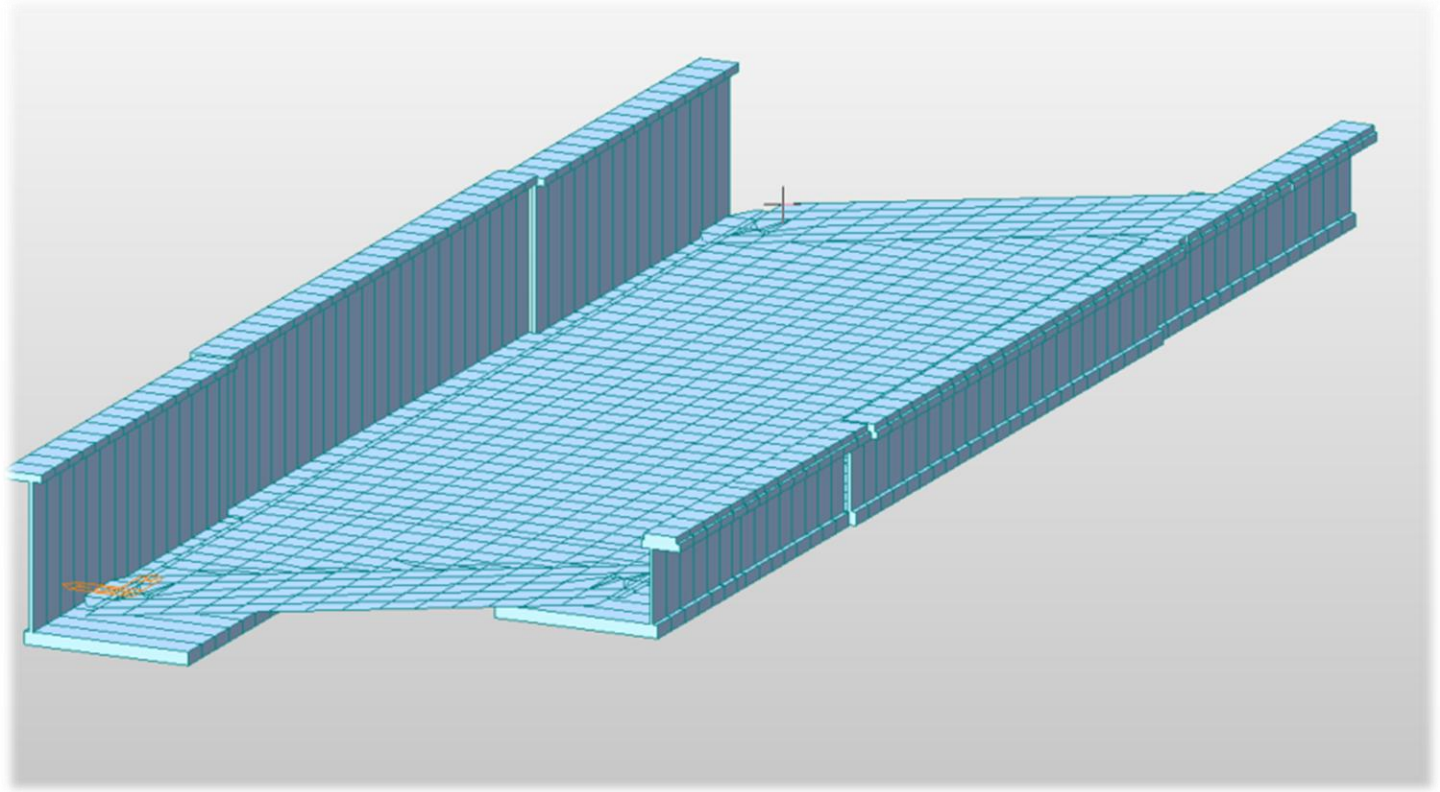

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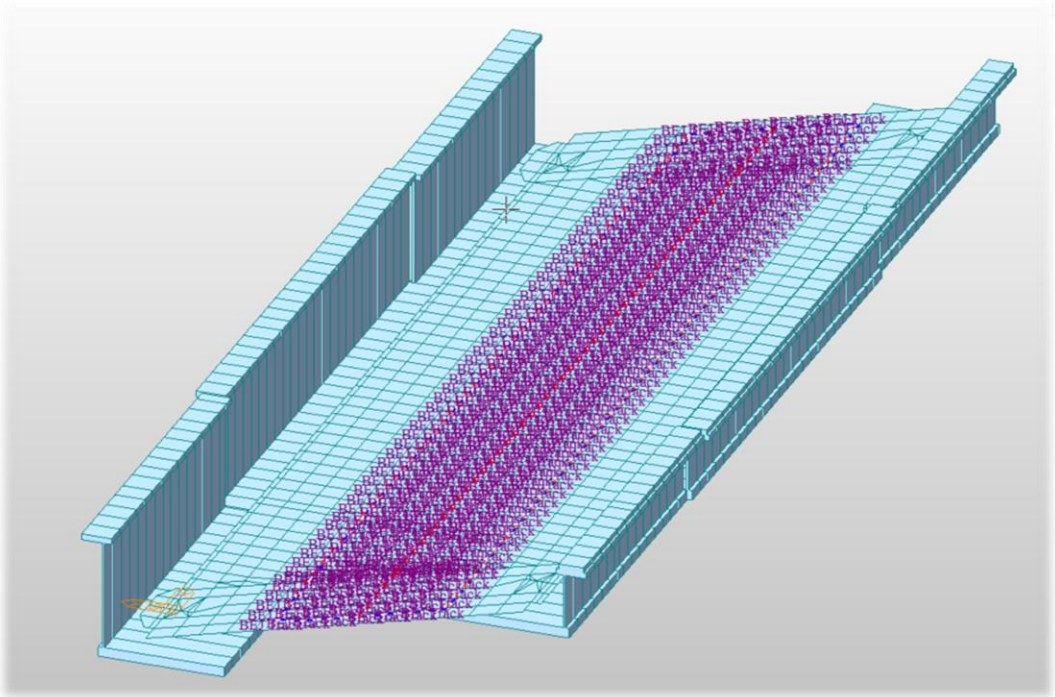
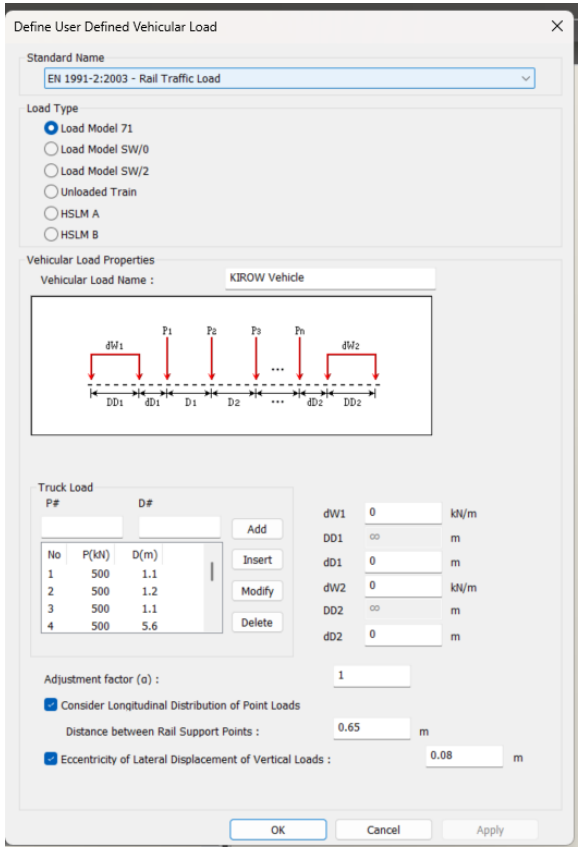
Loading:

- Self-weight + SIDL
- Live + Thermal + B&A cases
- Moving Load Analysis cases



Moving Load Analysis running over tracks (red)



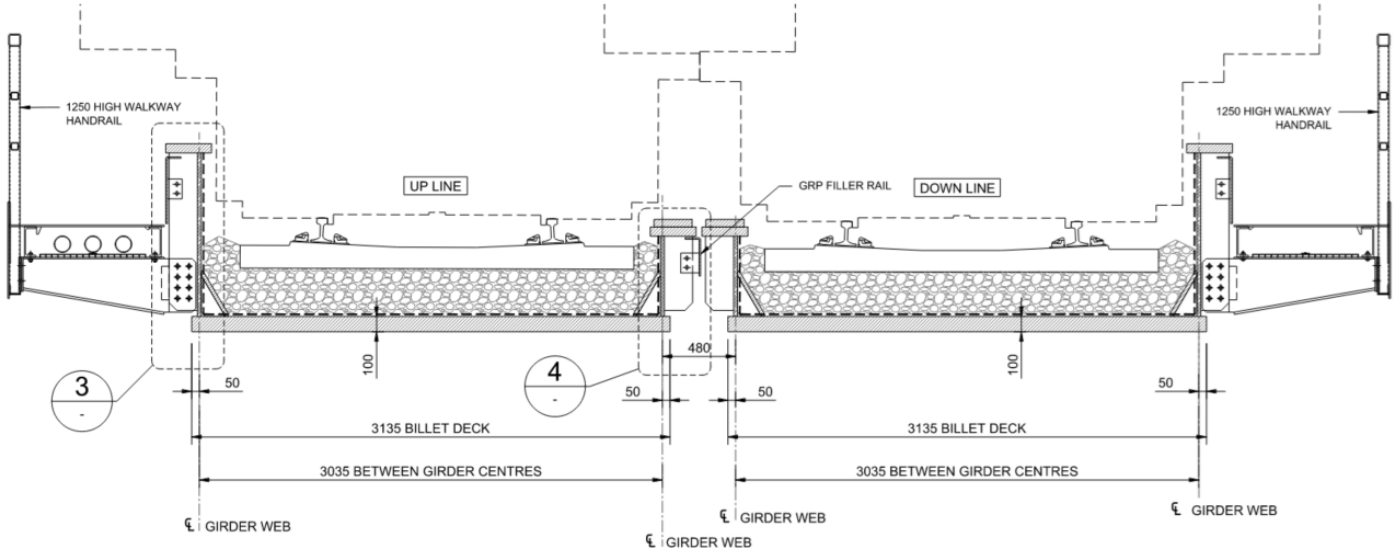
MIDAS Library contains standard Eurocode rail vehicle load models

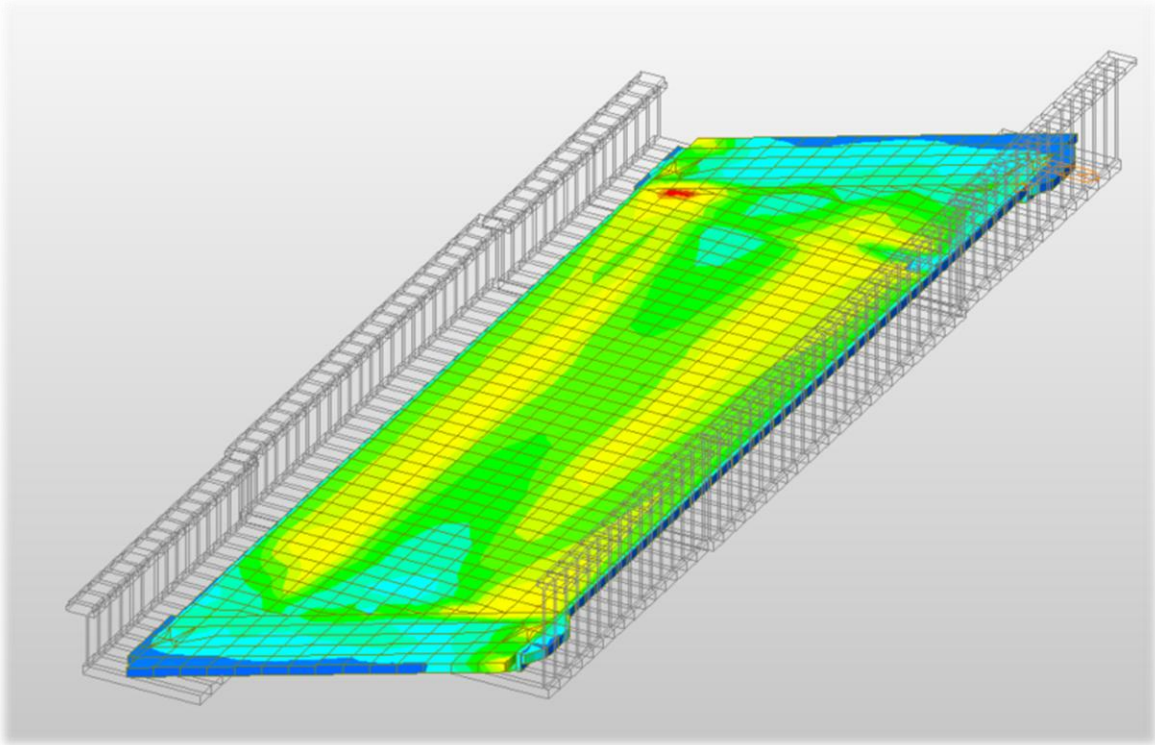
Optimsation of Deck Thickness

Final design thickness of 100mm for deck plate.

15% reduction in steel for each deck, removing 15.5 tonnes in total.

30 tonnes of embodied carbon.





Optimsation Outcomes

Cheaper structure for NR

Easier lift with reduced machinery for Contractor.

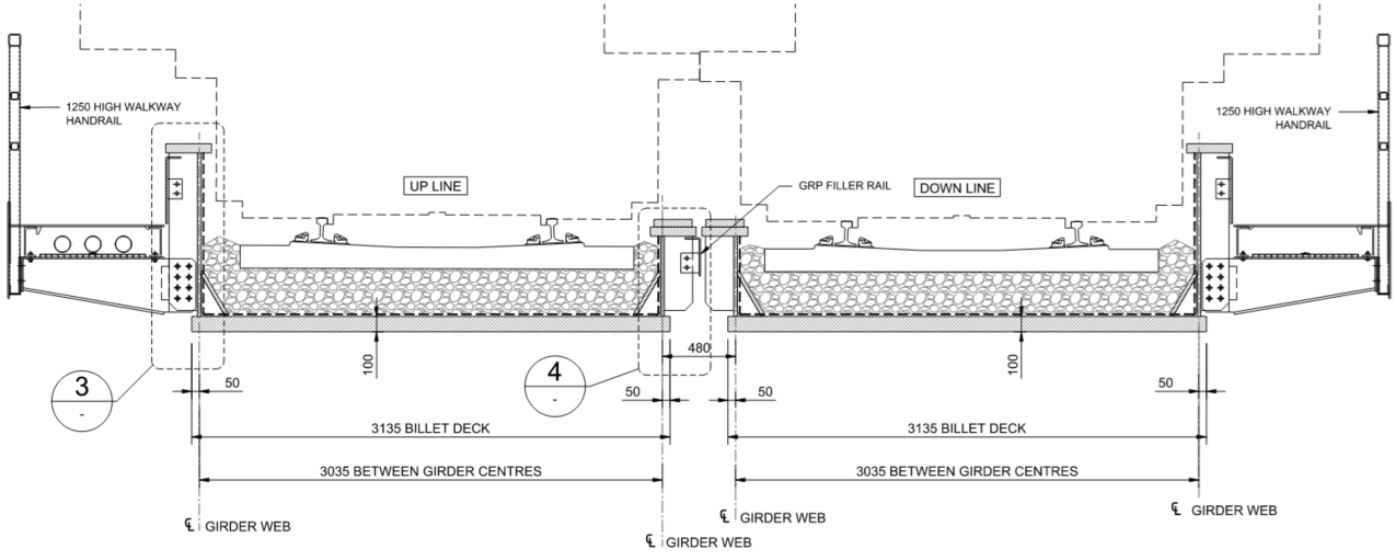
HOWEVER

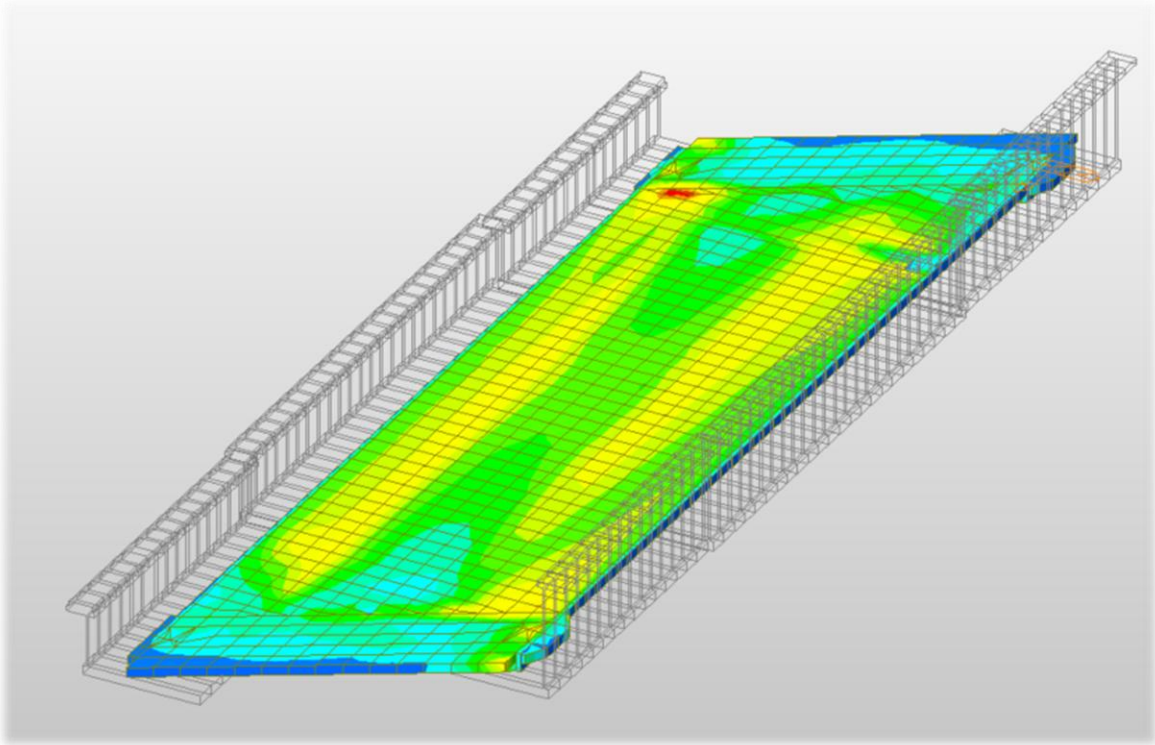
Lucky that:

Design team had budget & time left.

NR were happy to depart from established practice

Contractor could accommodate change in fabrication.





Digital Upgrade

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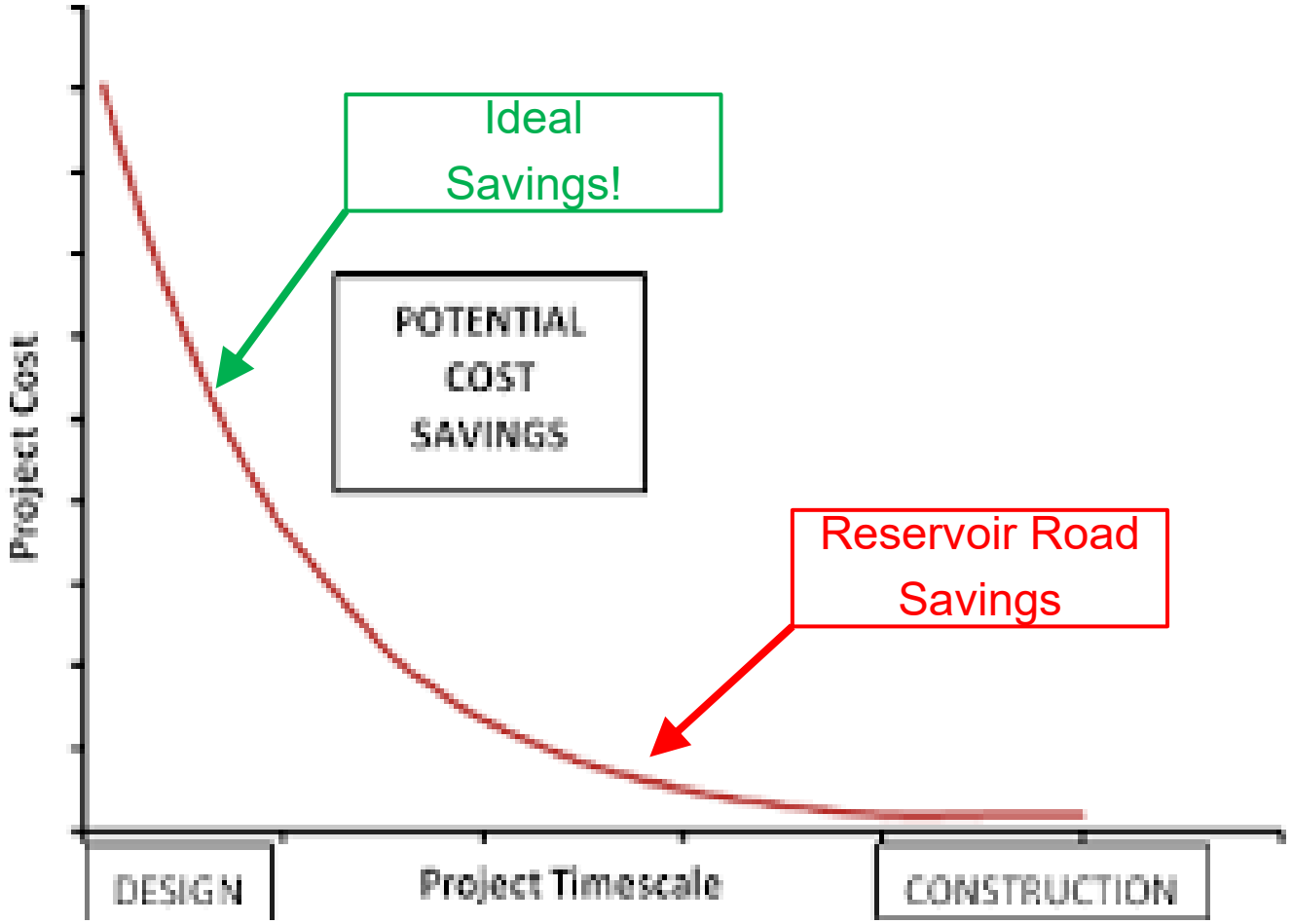
Chance for savings drops drastically as project progresses.

Earlier change is better, but harder to achieve.

MIDAS and connected programmes offer a way to thread the needle.

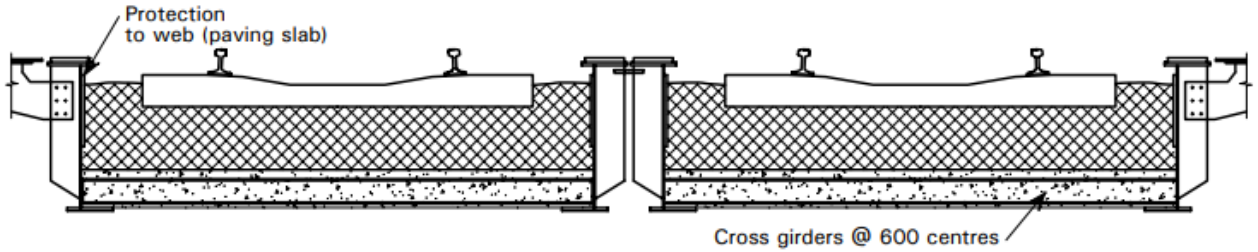


Beyond NR Standard Designs

Range of different standard over- and underbridges for different applications.

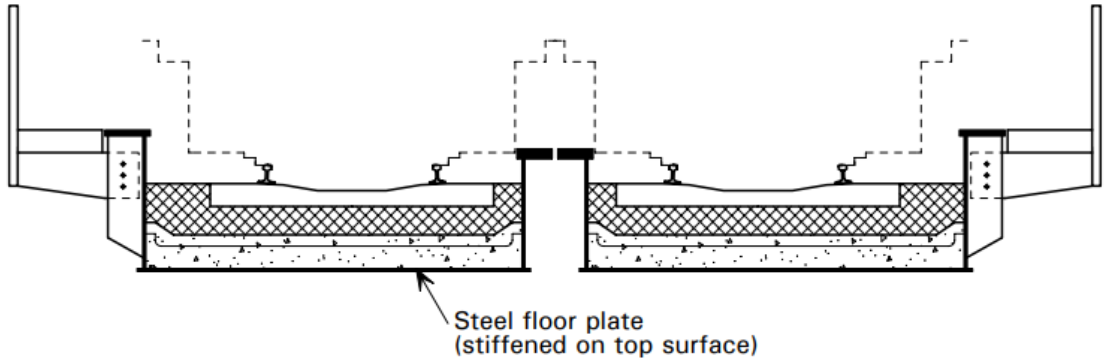
Pre-defined sections and details for design scenarios:

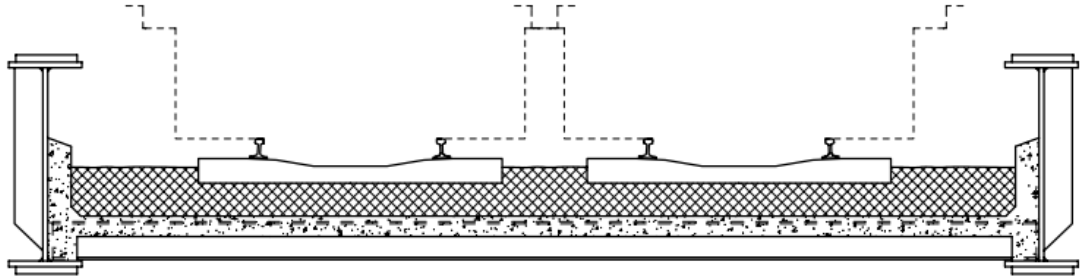
- Skew
- Span
- Construction Depth



NR Z-Type

NR U-Type





NR E-Type

Beyond NR Standard Designs

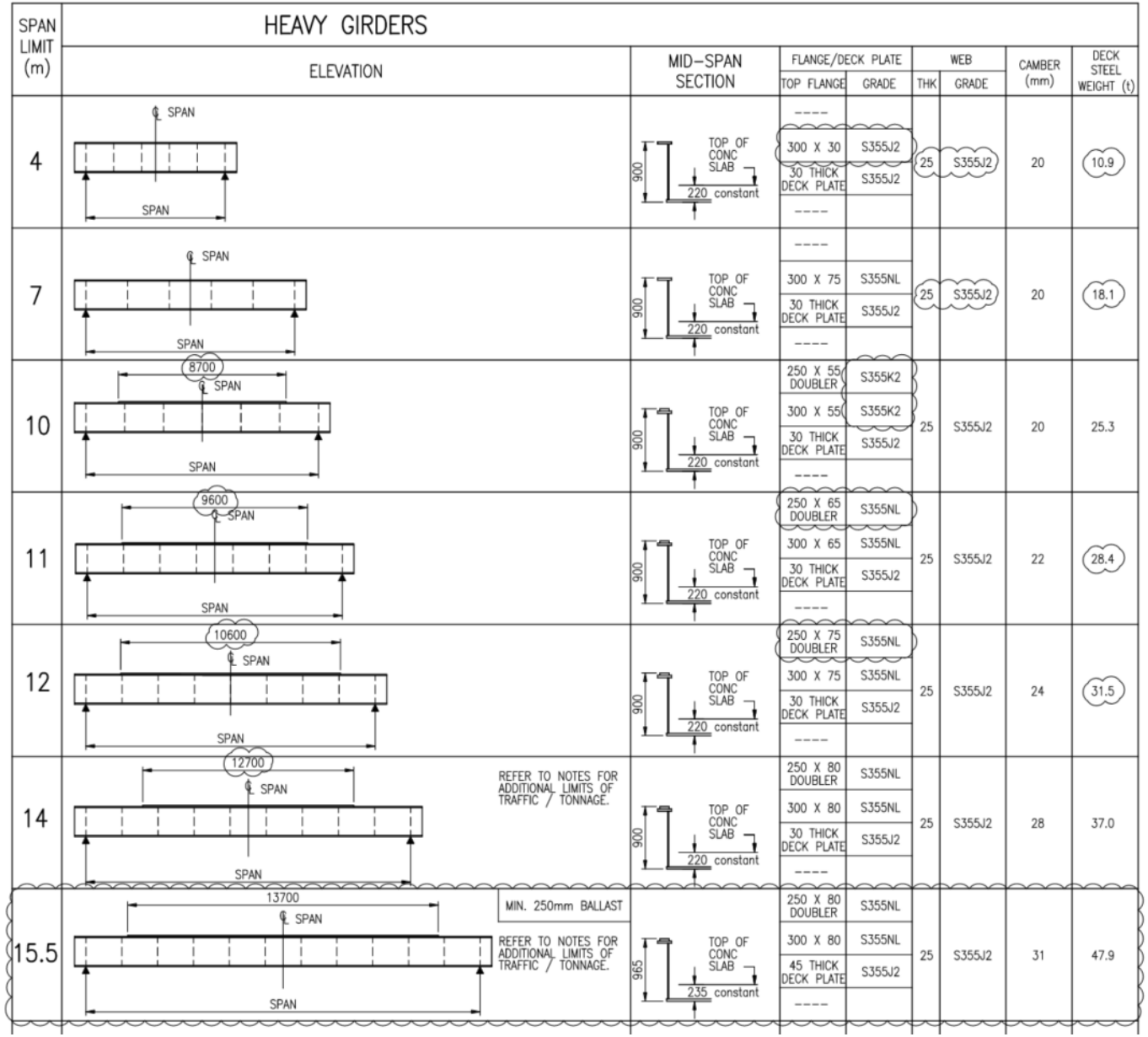
Range of different standard over- and underbridges for different applications.

Pre-defined sections and details for design scenarios:

- Skew
- Span
- Construction Depth

No calculation or analysis required if within standard range.

Standardisation makes over-design unavoidable. How do we identify that?



HEAVY GIRDERS

SPAN LIMIT (m)	ELEVATION	MID–SPAN SECTION	FLANGE/DECK PLATE TOP FLANGE	FLANGE/DECK PLATE GRADE	WEB THK	WEB GRADE	CAMBER (mm)	DECK STEEL WEIGHT (t)
4	℄ SPAN, SPAN	TOP OF CONC SLAB, 900, 220 constant	300 X 30 30 THICK DECK PLATE	S355J2 S355J2	25	S355J2	20	10.9
7	℄ SPAN, SPAN	TOP OF CONC SLAB, 900, 220 constant	300 X 75 30 THICK DECK PLATE	S355NL S355J2	25	S355J2	20	18.1
10	8700, ℄ SPAN, SPAN	TOP OF CONC SLAB, 900, 220 constant	250 X 55 DOUBLER 300 X 55 30 THICK DECK PLATE	S355K2 S355K2 S355J2	25	S355J2	20	25.3
11	9600, ℄ SPAN, SPAN	TOP OF CONC SLAB, 900, 220 constant	250 X 65 DOUBLER 300 X 65 30 THICK DECK PLATE	S355NL S355NL S355J2	25	S355J2	22	28.4
12	10600, ℄ SPAN, SPAN	TOP OF CONC SLAB, 900, 220 constant	250 X 75 DOUBLER 300 X 75 30 THICK DECK PLATE	S355NL S355NL S355J2	25	S355J2	24	31.5
14	12700, ℄ SPAN, SPAN REFER TO NOTES FOR ADDITIONAL LIMITS OF TRAFFIC / TONNAGE.	TOP OF CONC SLAB, 900, 220 constant	250 X 80 DOUBLER 300 X 80 30 THICK DECK PLATE	S355NL S355NL S355J2	25	S355J2	28	37.0
15.5	13700, ℄ SPAN, SPAN MIN. 250mm BALLAST REFER TO NOTES FOR ADDITIONAL LIMITS OF TRAFFIC / TONNAGE.	TOP OF CONC SLAB, 965, 235 constant	250 X 80 DOUBLER 300 X 80 45 THICK DECK PLATE	S355NL S355NL S355J2	25	S355J2	31	47.9

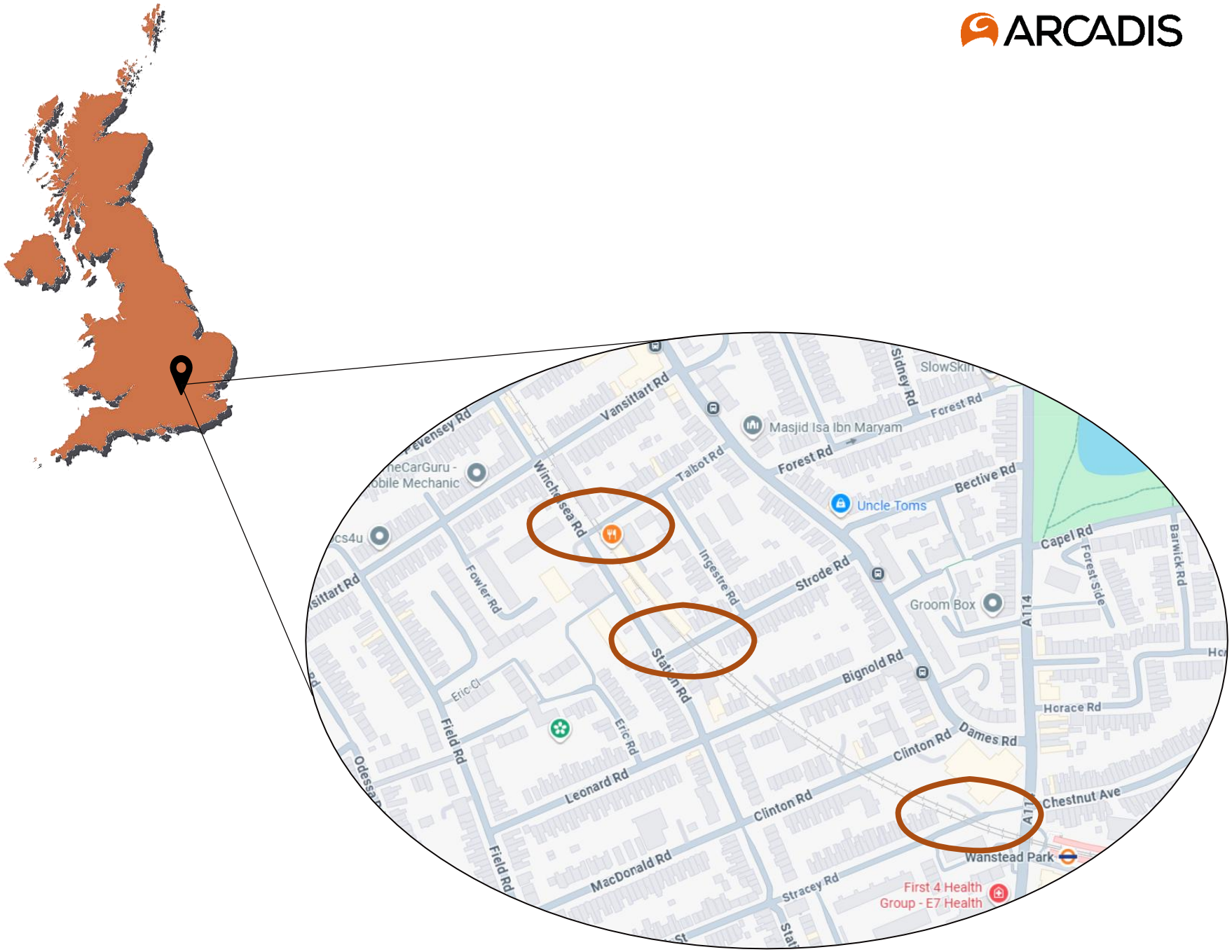
TAH2 Underbridges

3 Underbridge reconstructions – Tottenham and Hampstead Line

Located in NE London. Sequence of 3 single deck bridges on London Overground line being replaced.

Initial project proposal to replace with 3 pairs of U-Type standard designs. 6 decks to deliver in total.

On curved section of track so range of spans and skews across 3 structures.



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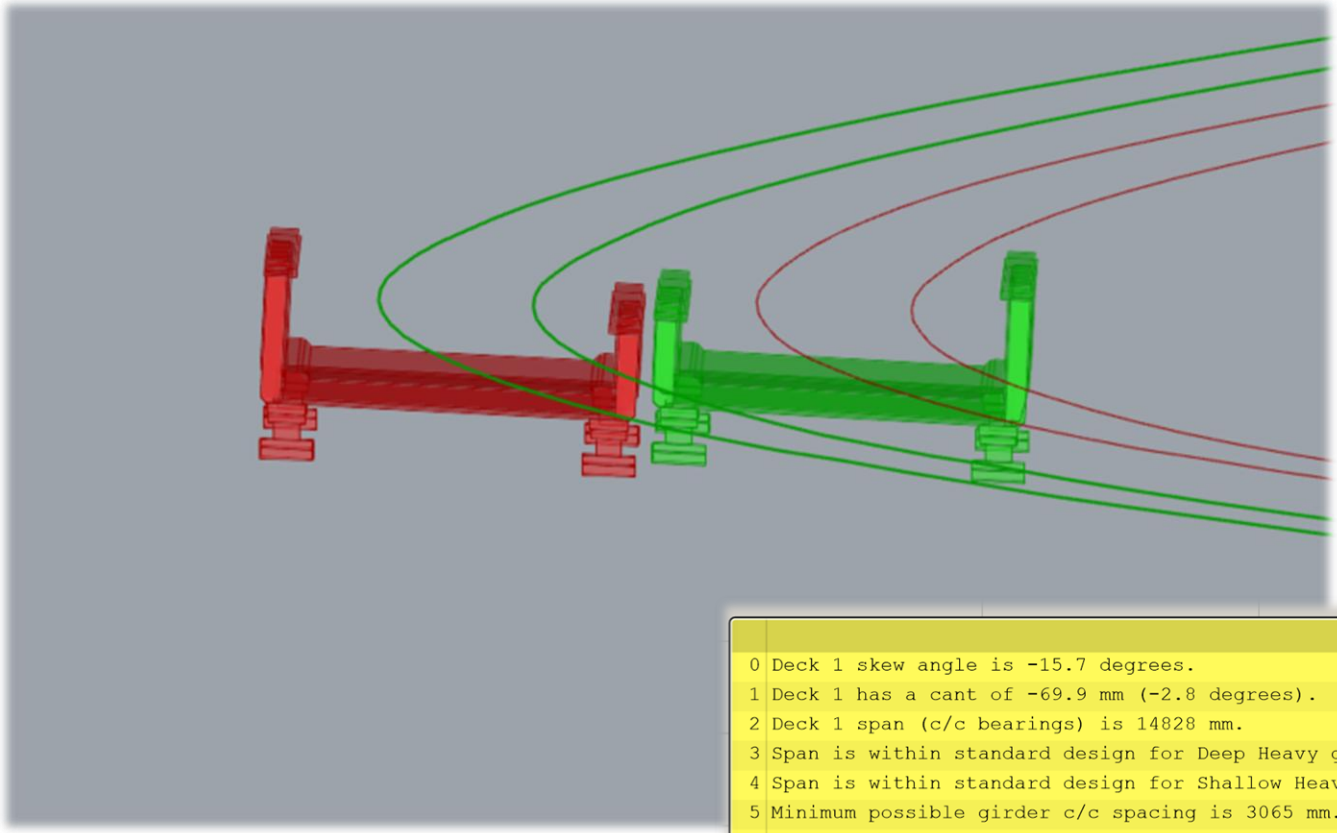
Setting Out Process

ES3 setting out tool.

Use of visual programming software to analyse site layout.

What is visual programming?



	{0}
0	Deck 1 skew angle is -15.7 degrees.
1	Deck 1 has a cant of -69.9 mm (-2.8 degrees).
2	Deck 1 span (c/c bearings) is 14828 mm.
3	Span is within standard design for Deep Heavy girders (girder 1).
4	Span is within standard design for Shallow Heavy girders (girder 2).
5	Minimum possible girder c/c spacing is 3065 mm.
6	Girder c/c spacing is within 3300mm standard design limit.
7	
8	Deck 2 skew angle is -15.7 degrees.
9	Deck 1 has a cant of -64.2 mm (-2.6 degrees).
10	Deck 2 span (c/c bearings) is 14839 mm.
11	Span is within standard design for Shallow Heavy girders (girder 3).
12	Span is within standard design for Deep Heavy girders (girder 4).
13	Minimum possible deck width is 3085 mm.
14	Girder c/c spacing is within 3300mm standard design limit.

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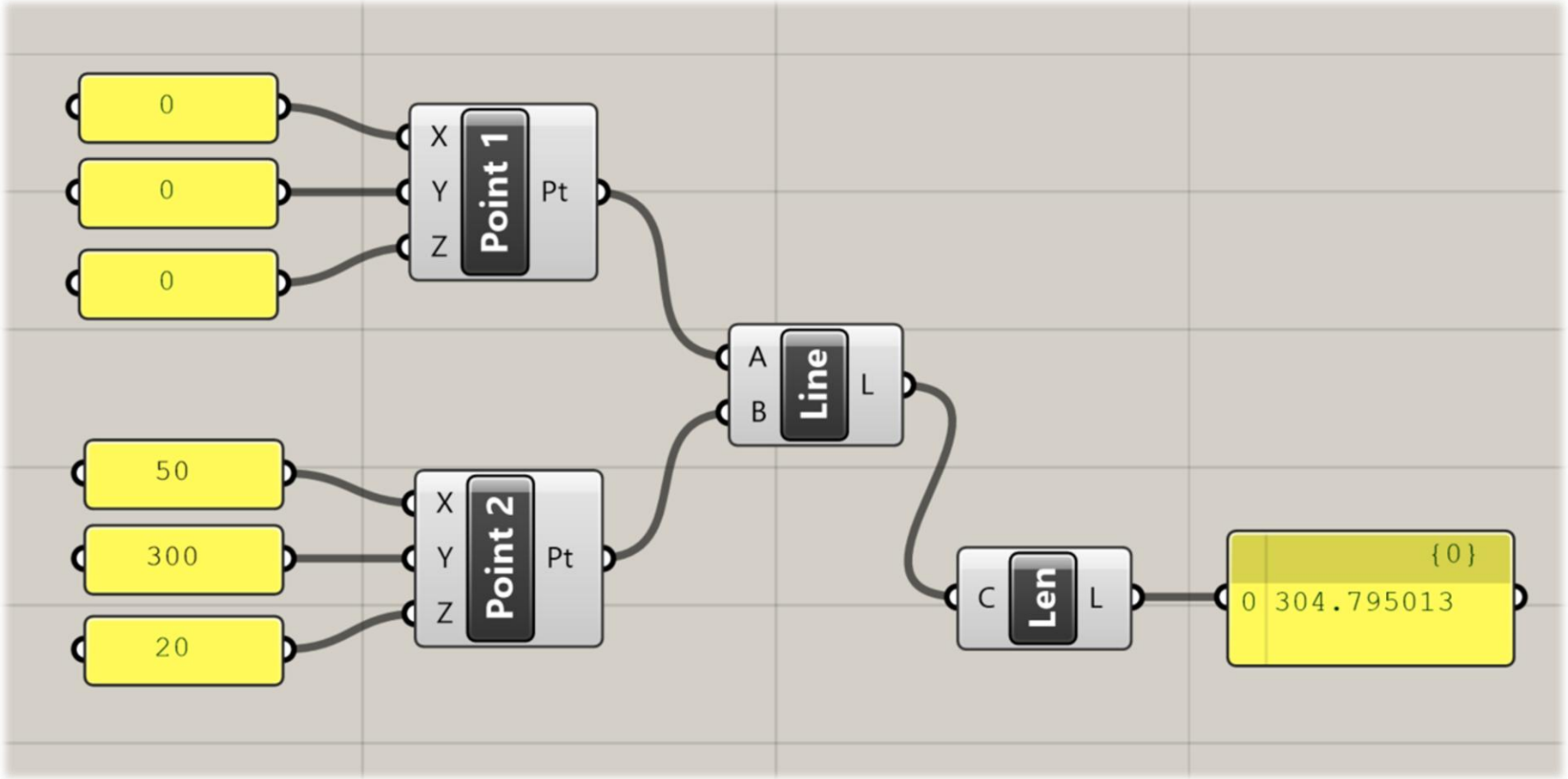


Example Grasshopper script

Setting Out Process

ES3 setting out tool.

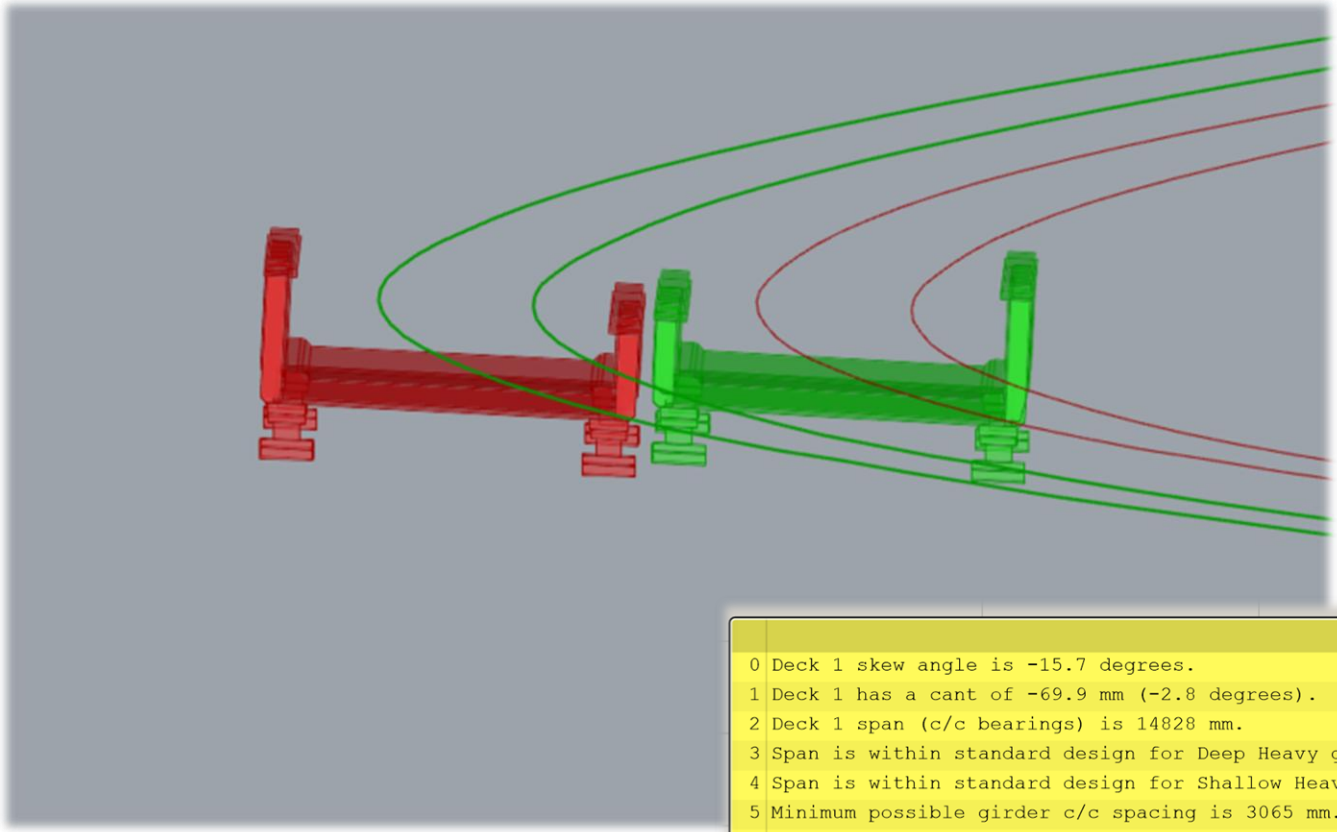
Use of visual programming software to analyse site layout.

What is visual programming?

Grasshopper uses site geometry to spaceproof a bridge deck that will fit:

a) Within existing space – highlights clashes.

b) Within range of standard design parameters.



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Setting Out Process

Tells us which structural types can and can't be used at a particular site.

Rapid iteration of new abutment position, minimising land-take and project impact.

Design team were able to switch proposal to E-type for worst-case structure – no lost work.

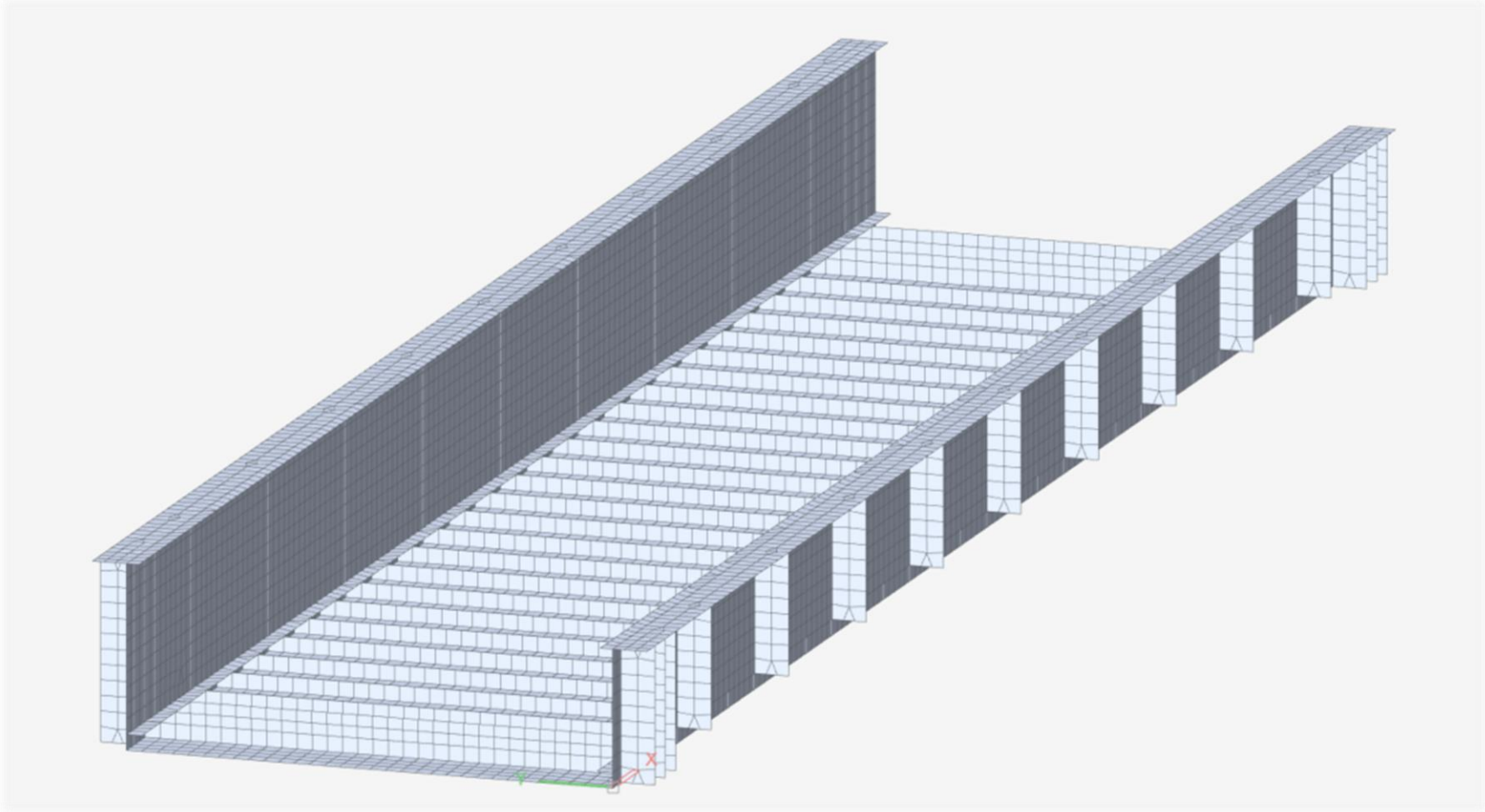
Integration with MIDAS

Outputs from setting out tool then feed into MIDAS analysis model, using MIDAS plugin to Grasshopper.

Plugin uses same logic to produce equivalent FE model of bridge for analysis.

Calculation within MIDAS plugin for composite sections, equivalent stiffness etc.

Plugin follows same rules each time. Change the inputs = Change the mesh automatically!



MIDAS mesh, section properties + materials created from Grasshopper plugin

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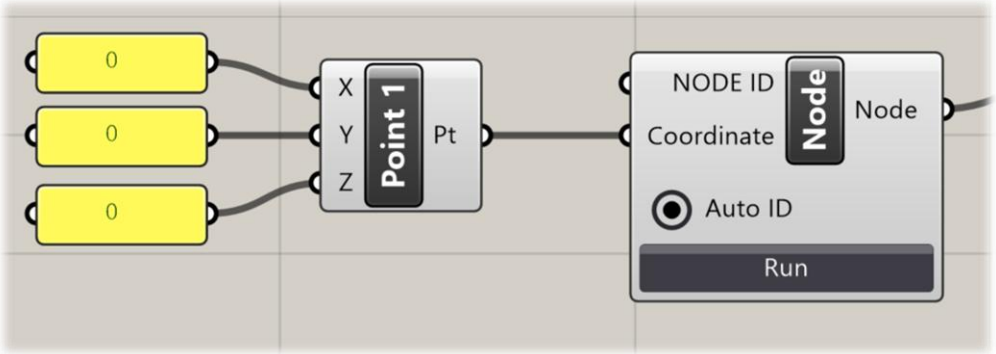
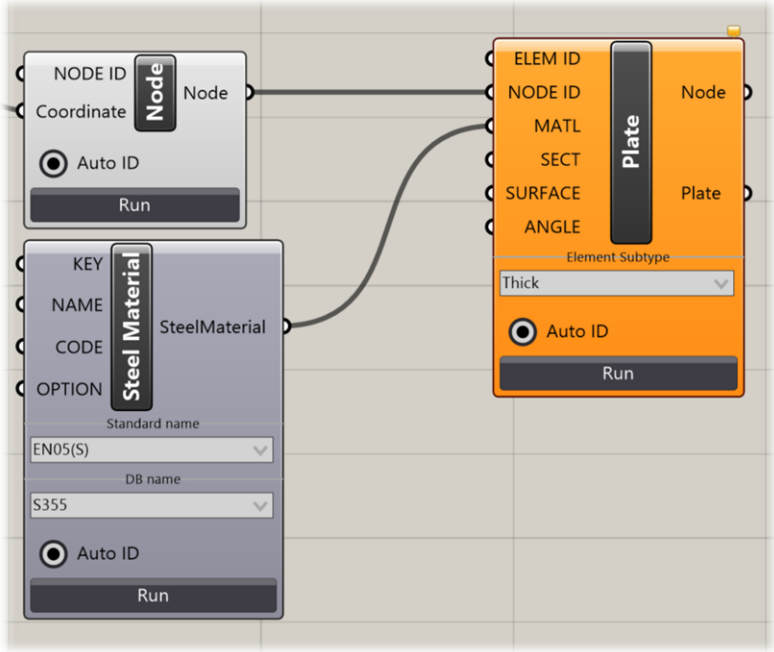
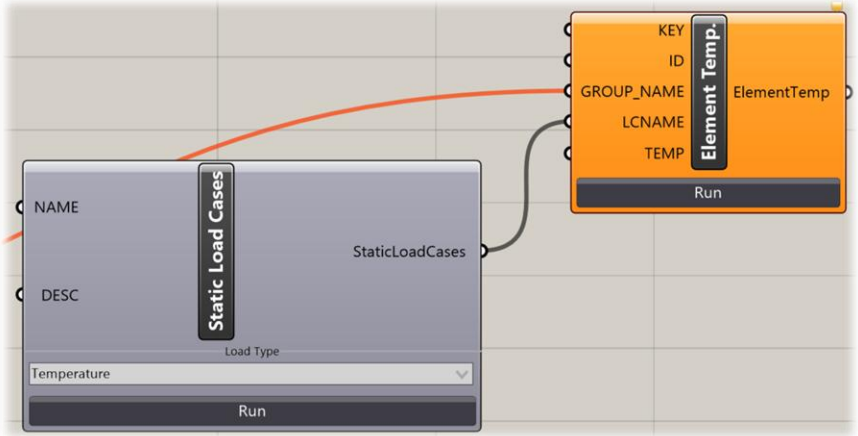


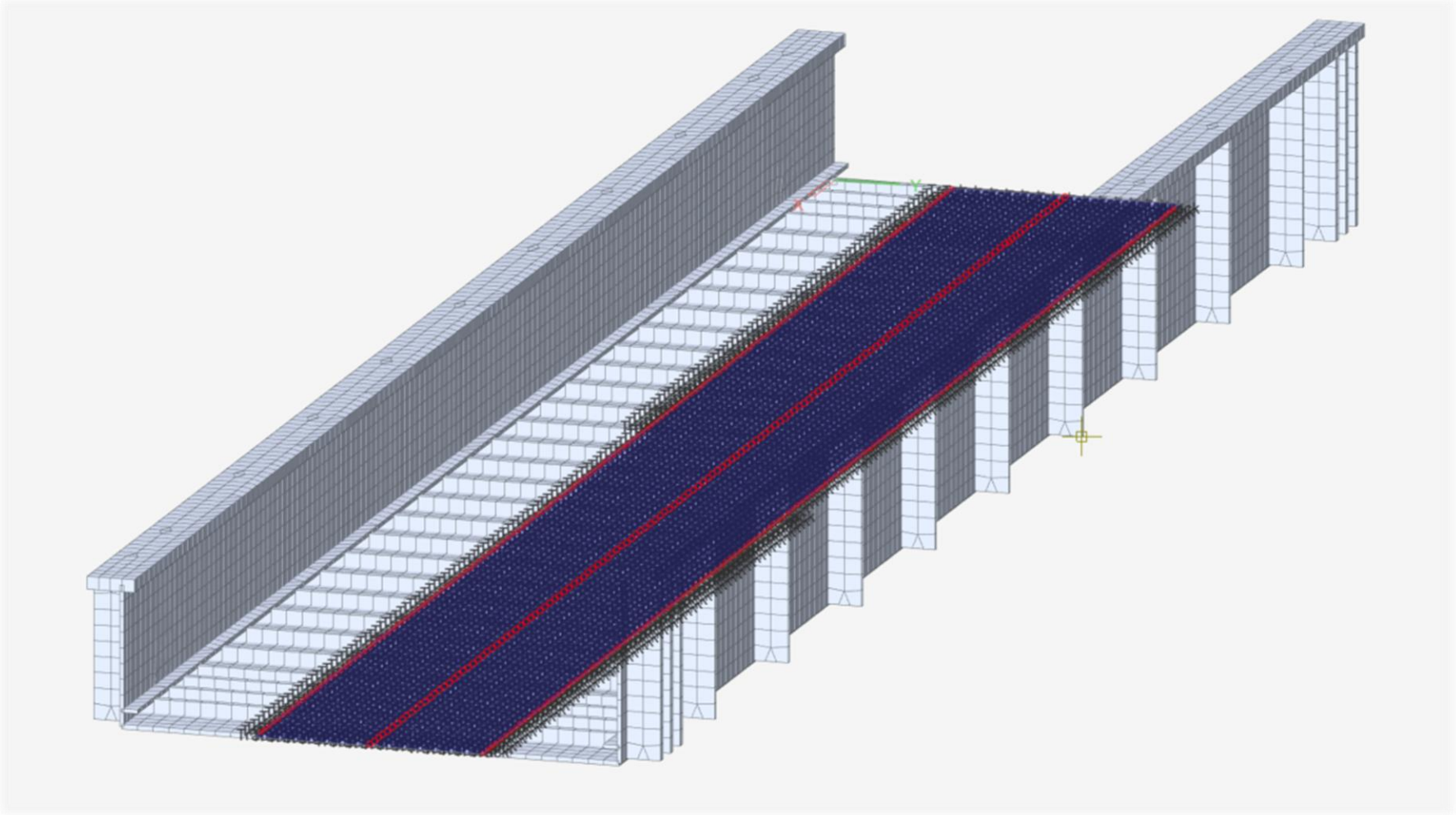




Integration with MIDAS

Load cases are automatically generated and combined within the script so a full analysis can be run.

MIDAS plugin reads geometry from 3D model so effects on loading like track position + cant + curvature are captured automatically.



Track position automatically set in model from Grasshopper inputs

Integration with MIDAS

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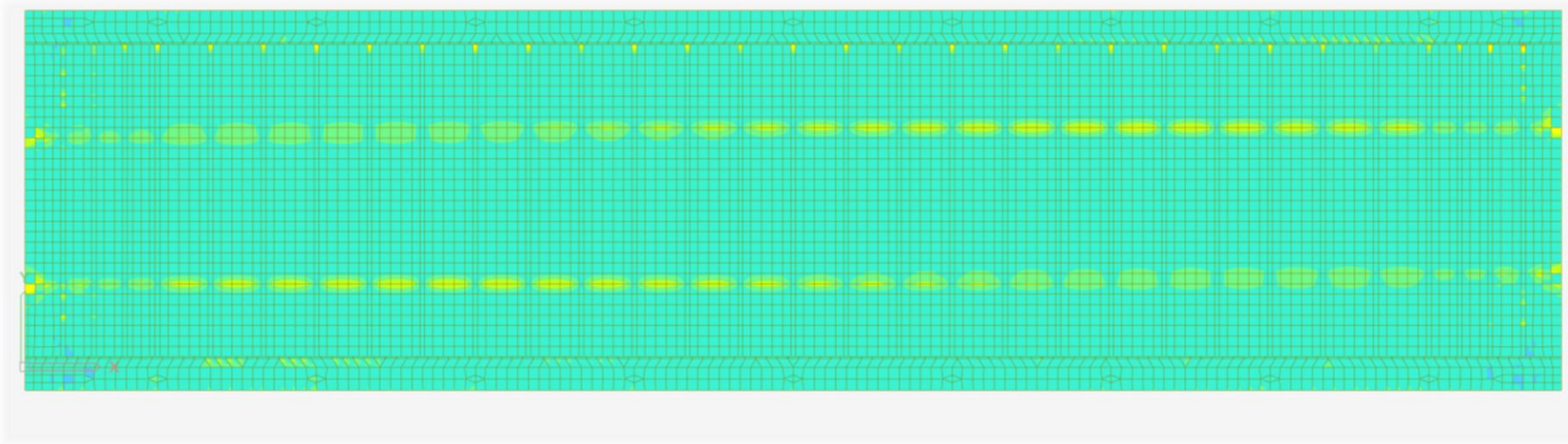
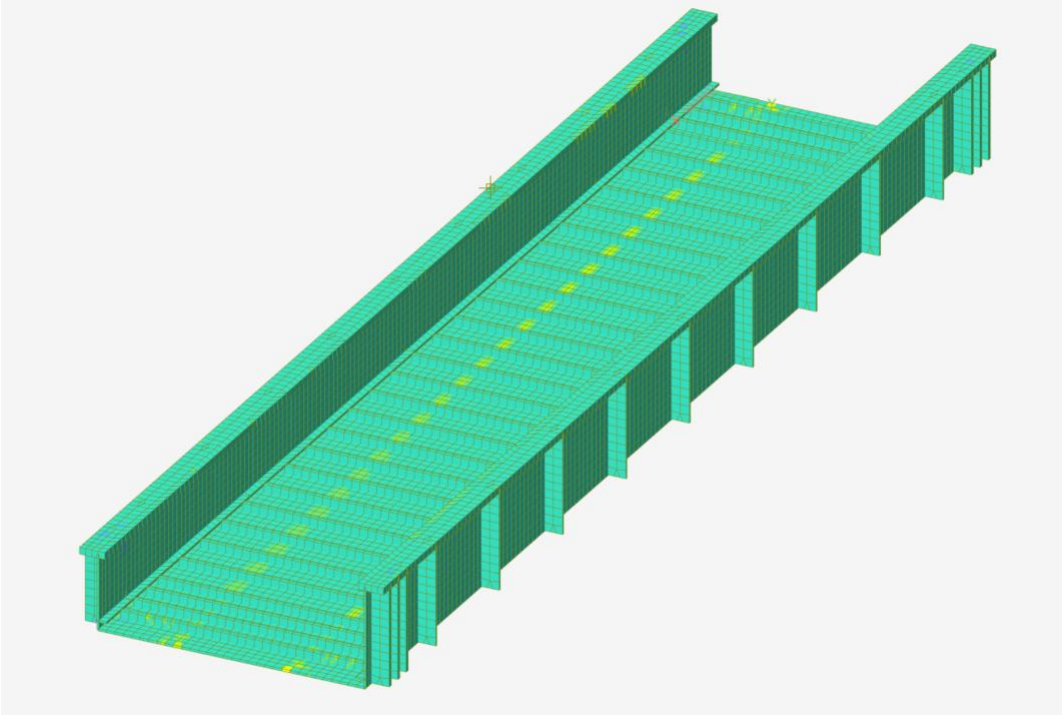
MIDAS plugin reads geometry from 3D model so effects on loading like track position + cant + curvature are captured automatically.

Design outputs rapidly available to check for under-utilisation and potential optimisation. All at earliest design stage.

Inputs can be manually fine-tuned to check whether changes still pass.





Conclusions

Why all this effort to not follow standard designs?

Balance of project time & best design.

MIDAS & integrated programmes give best of both worlds.

Opportunities are identified - with minimal effort – early enough to do something about them.

Client gets cost v benefit up front. No surprise later on.

Arcadis. Improving quality of life.

Thank You

Any Questions?

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