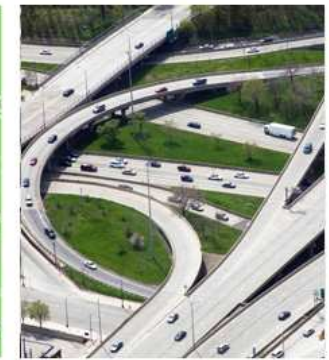


## 2009 ROADS AND BRIDGES CONFERENCE



# Modeling with Bentley Rail

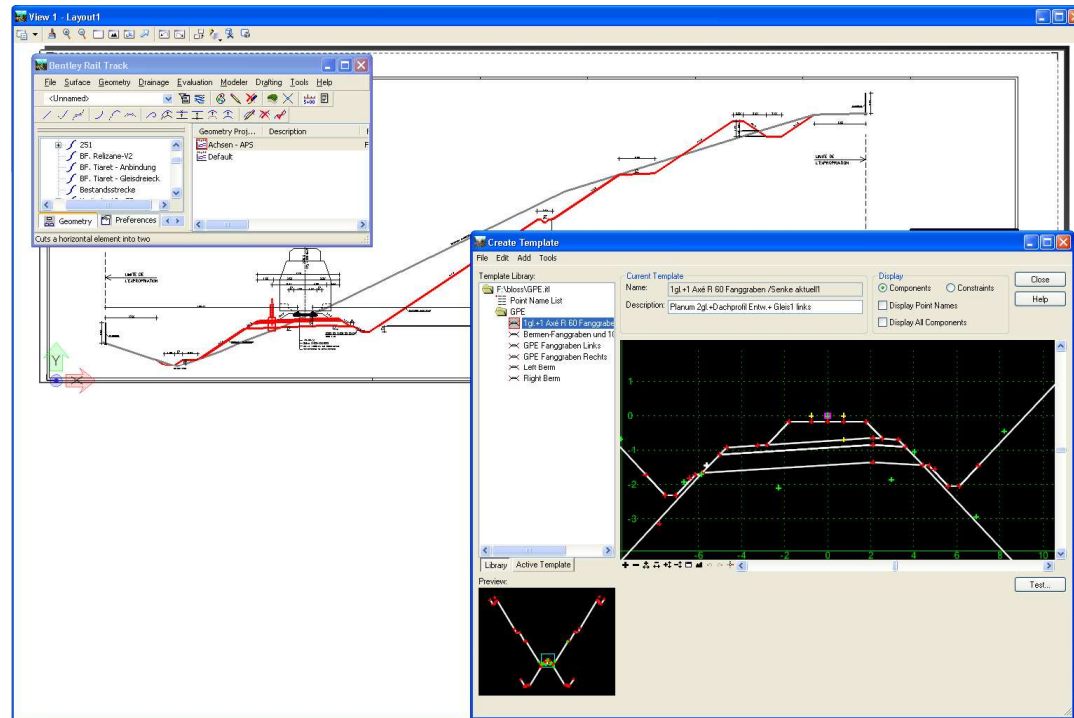
Robert Nice  
Solutions Architect - Bentley Systems UK

# Roadway Designer for Track

Utilizing Roadway Design for modeling track and earthwork.

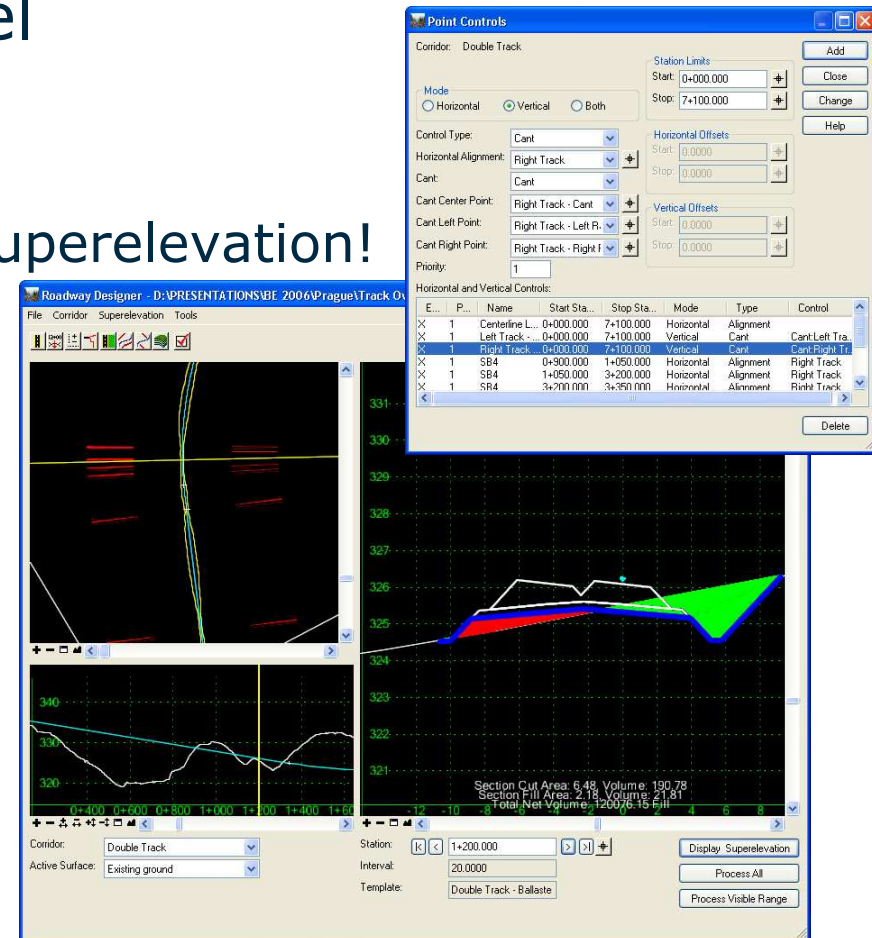
# Earthwork Modeling & Templates

- Components
  - Closed shapes that represent “man-made” materials
  - Ballast
  - Subballast
  - Sleepers / ties
  - Other materials
- End conditions
  - Ditches
  - Cut / fill slopes
    - *Similar to roads!*

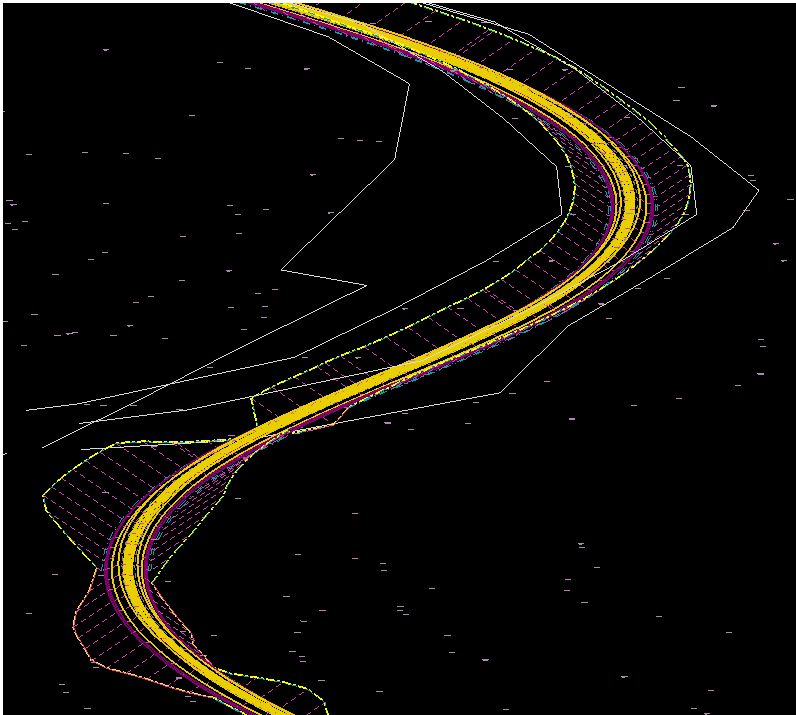
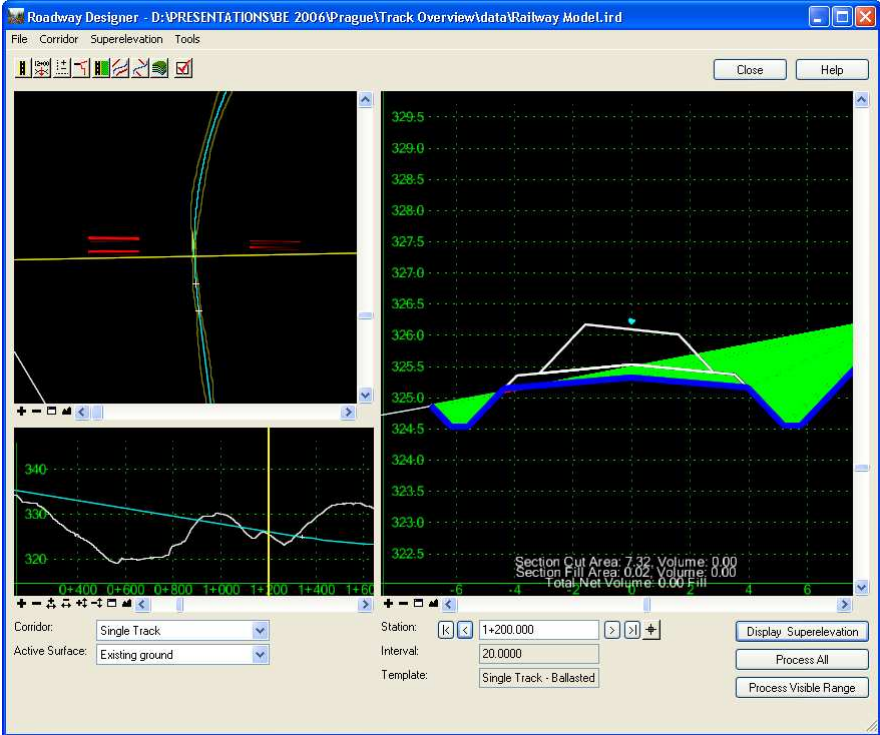


# Earthwork Modeling & Roadway Designer

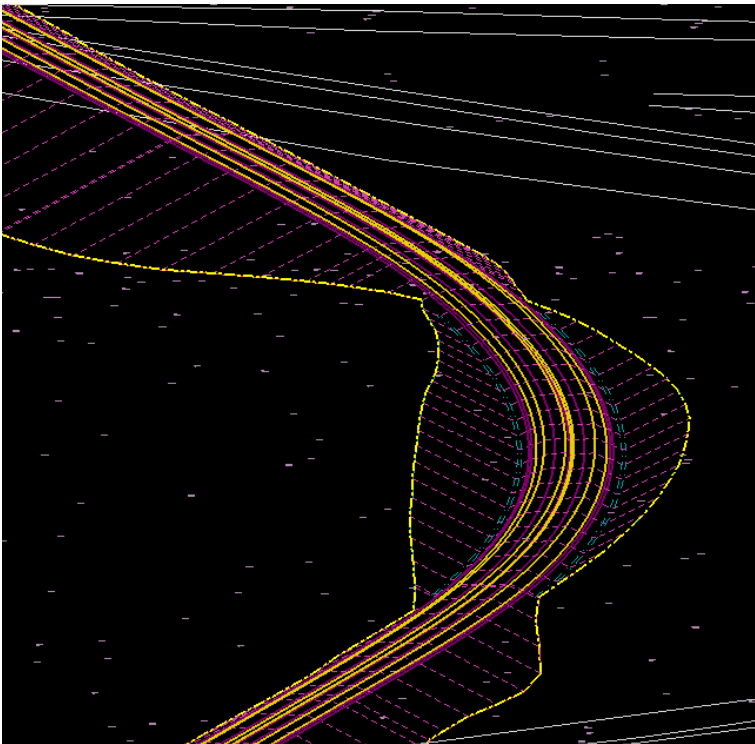
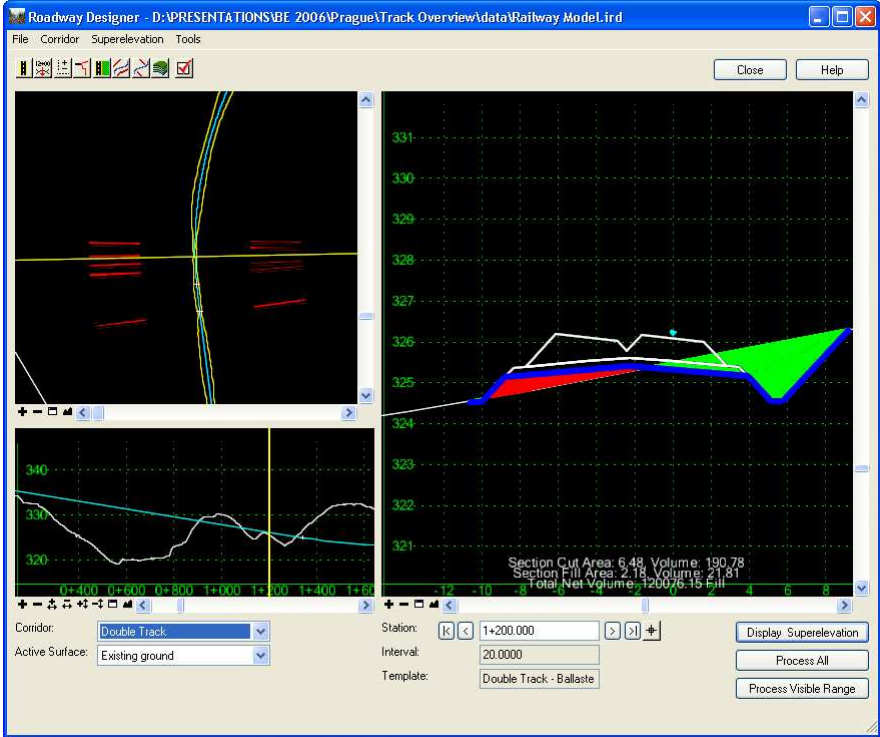
- Utilize alignment model
  - Horizontal
  - Vertical
  - Cant, which is railway superelevation!
  
- Define model specifics
  - Typical sections
  - Point controls
    - Cant
    - Shoulder widening
    - Minimum ballast depth
    - Etc.



# Easily create *new* single track model...



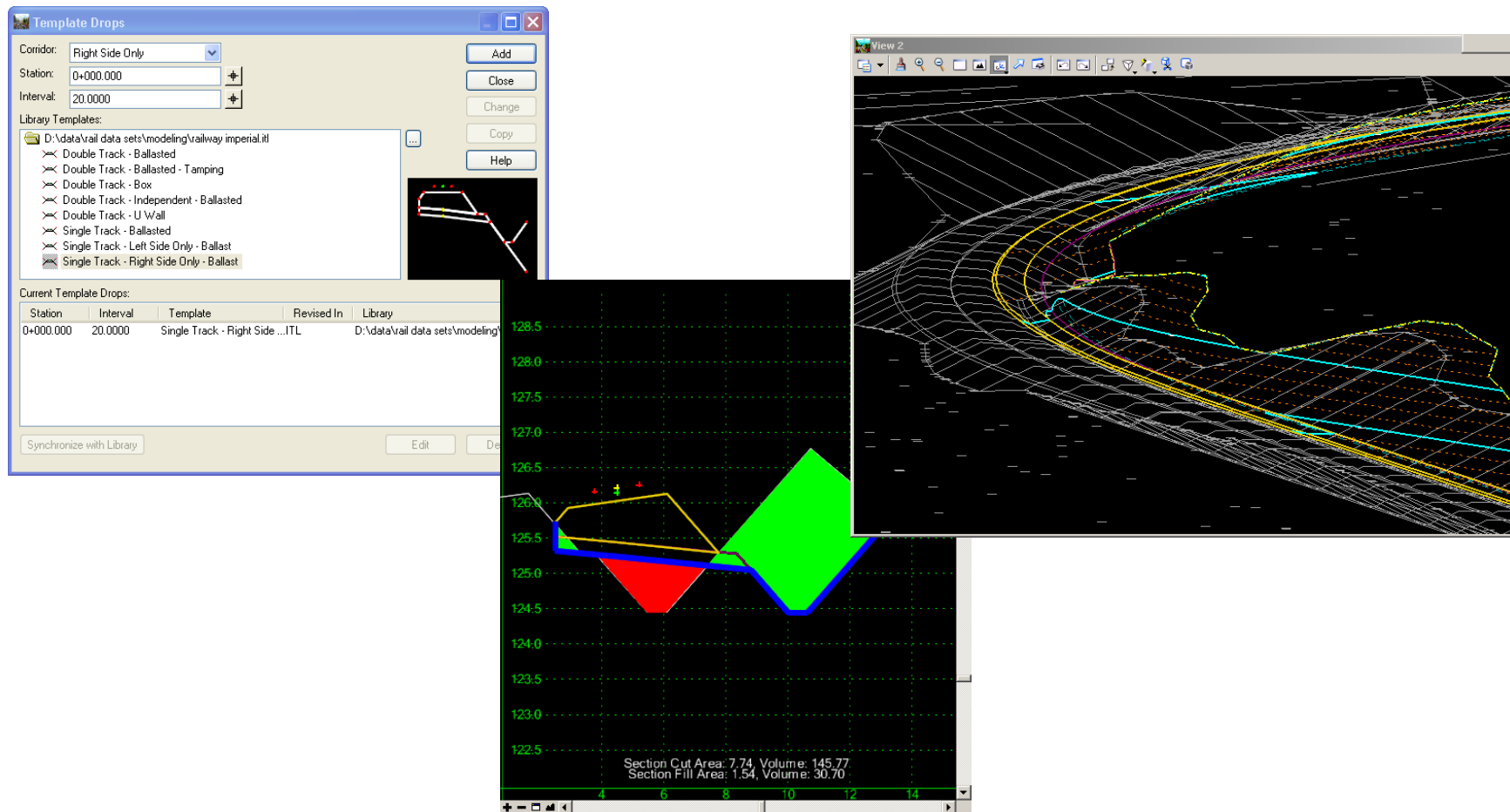
# Or a New double track model...



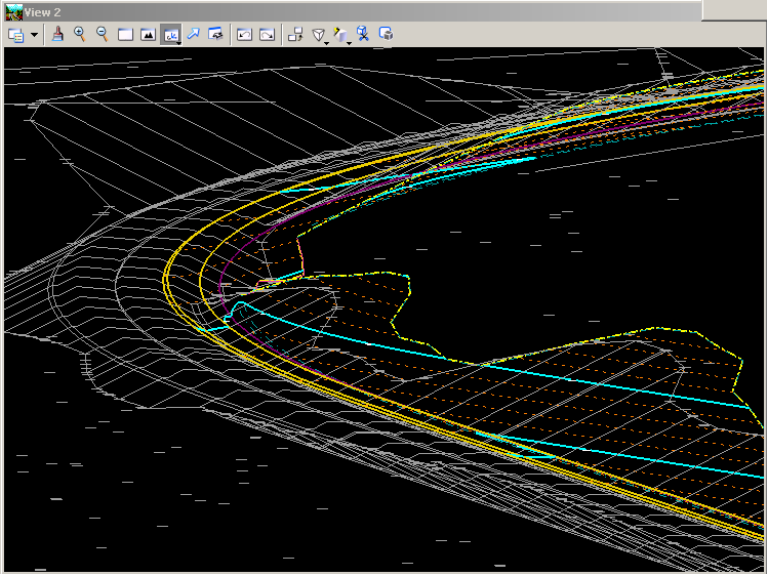


# Or Even Adding Track to a Corridor!

- Parallel *existing* horizontal, vertical and cant



# Easily create track models...



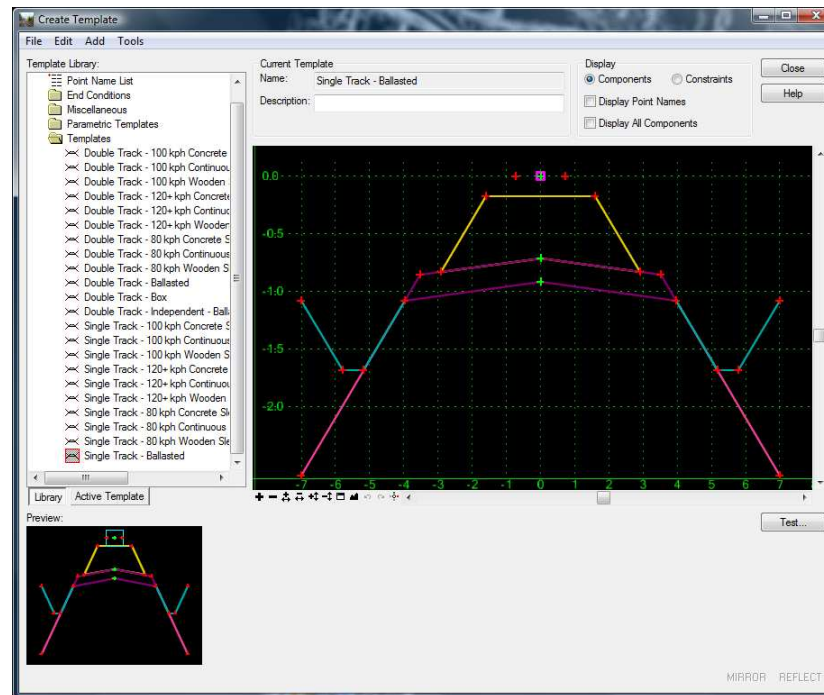


# So lets look at some examples

How to model track with Roadway Designer

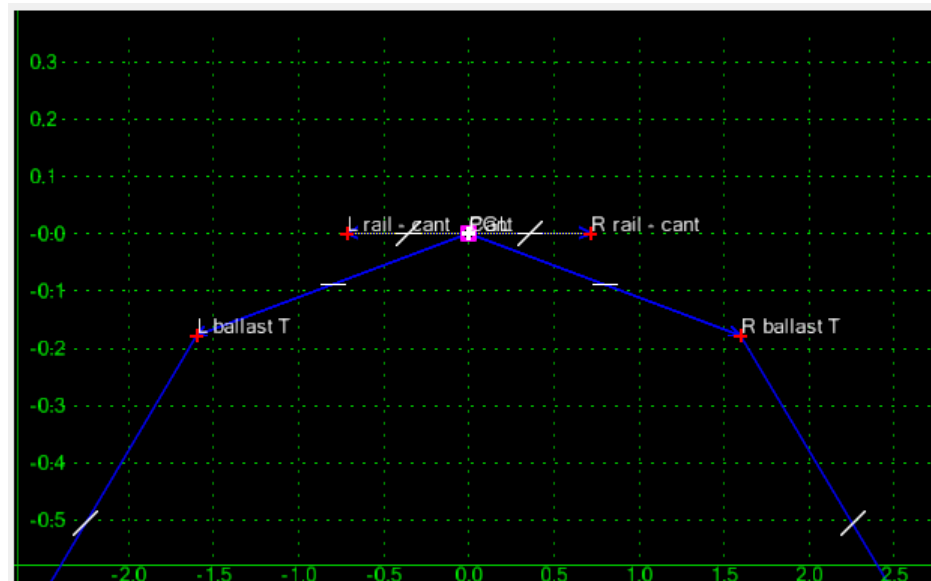
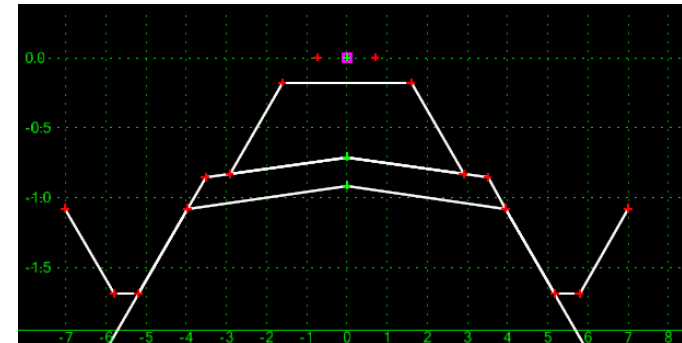
# Single Track

- Characteristics
  - Single track
  - Ballast surface rotates with superelevation
  - Sub-grade widens to accommodate high side superelevation, but cross-slopes remain constant



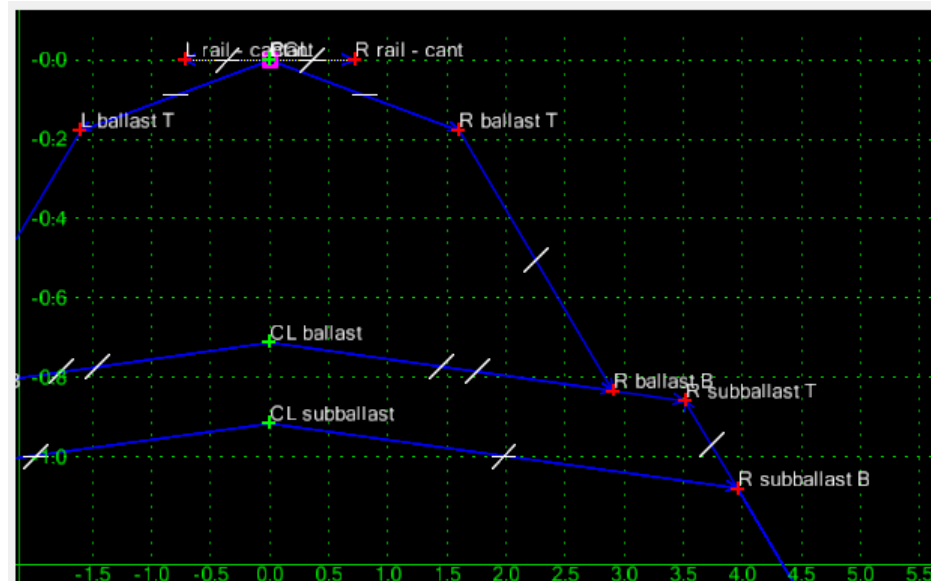
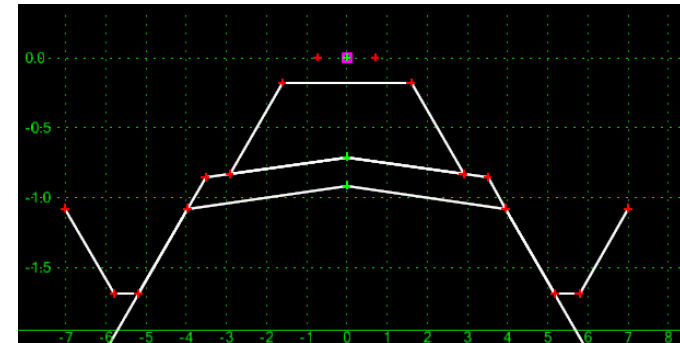
# Ballast Rotation

- Ballast Rotation with Superelevation
  - PGL
    - Vertical alignment constraint
  - Cant
    - *L rail - cant*
    - *R rail - cant*
    - Horizontal & slope constraint



# Sub-grade Widening

- Sub-grade shoulder widening (*high side super*)
  - *R subballast B*
    - Horizontal constraint
  - *R subballast T*
    - Two slope constraints
  - *R ballast B*
    - Two slope constraints



# Point Controls

- Within **Roadway Designer** add the **Point Controls** for
  - Cant
    - Center, left rail and right rail

Point Controls

Corridor: Single

Control Description:

Mode  
 Horizontal  Vertical  Both

Control Type: Cant

Horizontal Alignment: Right Track

Cant: Cant

Cant Center Point: Cant

Cant Left Point: L rail - cant

Cant Right Point: R rail - cant

Priority: 1

Station Limits  
 Start: 0+000.00  
 Stop: 7+100.00

Horizontal Offsets  
 Start: 0.0000  
 Stop: 0.0000

Vertical Offsets  
 Start: 0.0000  
 Stop: 0.0000

Horizontal and Vertical Controls:

E...	P...	Name	Start St...	Stop St...	Mode	Type	Control	Description
X	1	Cant	0+000.00	7+100.00	Vertical	Cant	Cant:L rail ...	

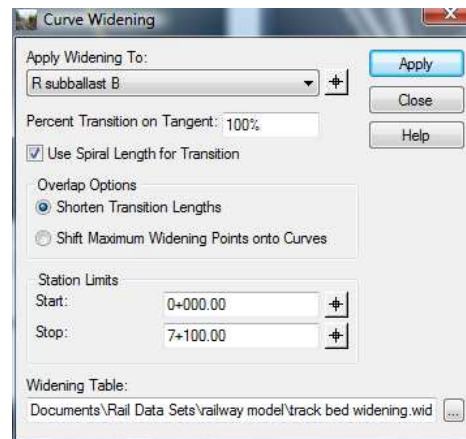
Buttons: Add, Close, Change, Help, Delete

# Curve Widening

- Curve widening will be applied to
  - *R subballast B*
  - *L subballast B*
- *Based upon a widening table*
  - And widening the outside shoulder!

```

;radius  inside_widening  inside_length  outside_widening  outside_length
      0      0              0              0.4              0
10000    0              0              0.4              0
  
```





## Final Point Controls

- After applying cant point controls and curve widening point controls, we will have the following:

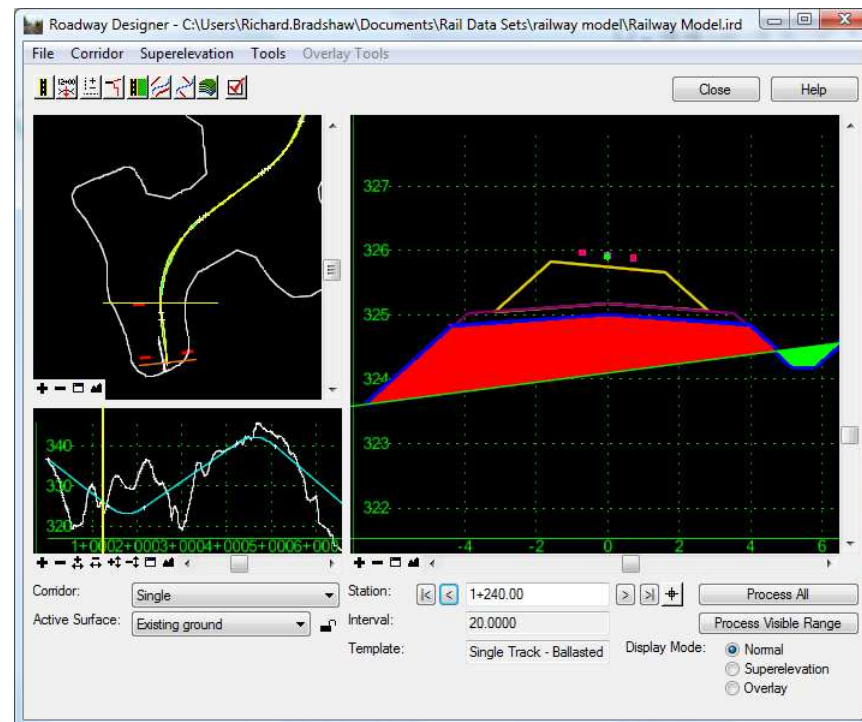
Point Controls dialog box configuration:

- Corridor: Single
- Control Description: [Empty]
- Point: L subballast B
- Mode:  Horizontal  Vertical  Both
- Control Type: Alignment
- Horizontal Alignment: Right Track
- Use as Secondary Alignment
- Priority: 1
- Station Limits: Start: 1+050.00, Stop: 3+200.00
- Horizontal Offsets: Start: -4.3624, Stop: -4.3624
- Vertical Offsets: Start: 0.0000, Stop: 0.0000

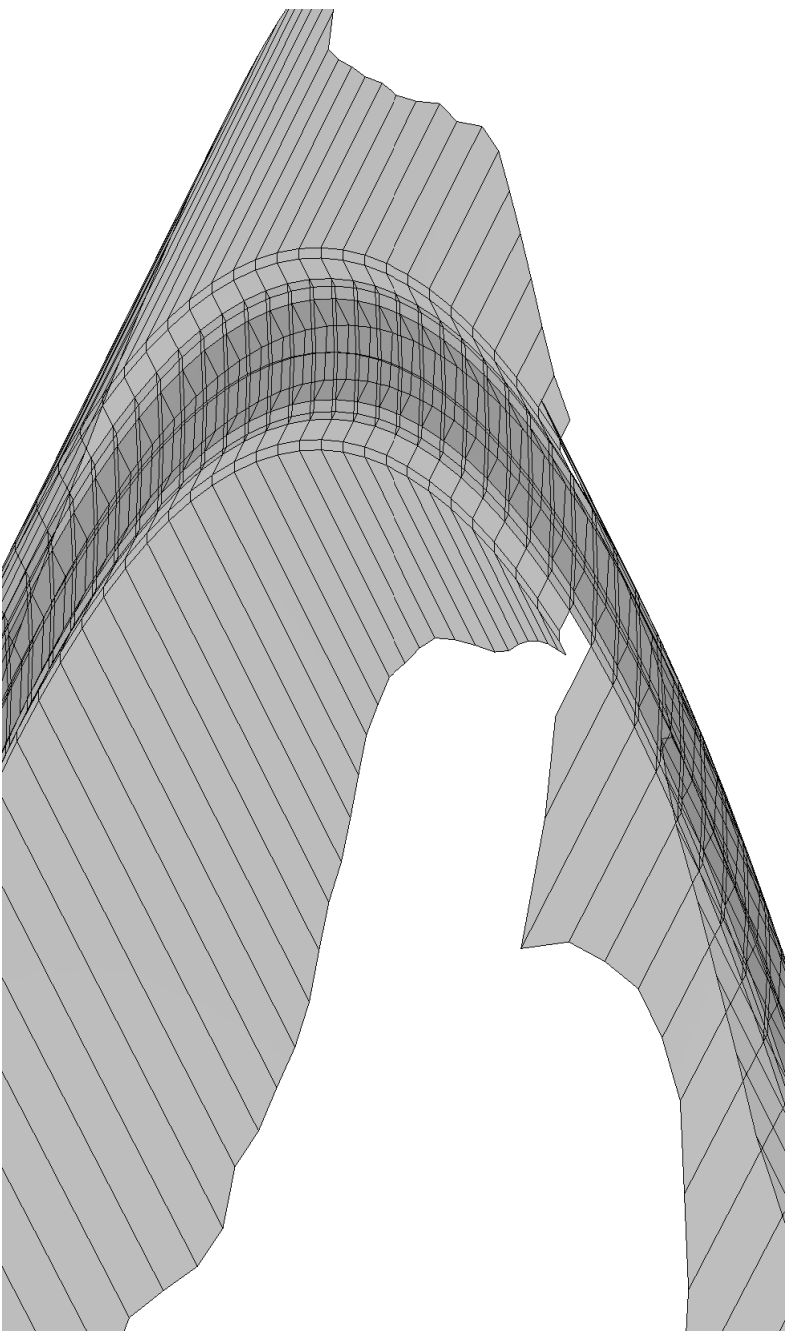
E...	P...	Name	Start St...	Stop St...	Mode	Type	Control	Description
X	1	Cant	0+000.00	7+100.00	Vertical	Cant	Cant:L rail ...	
X	1	L subballa...	0+900.00	1+050.00	Horizontal	Alignment	Right Trac...	
X	1	L subballa...	1+050.00	3+200.00	Horizontal	Alignment	Right Trac...	
X	1	L subballa...	3+200.00	3+350.00	Horizontal	Alignment	Right Trac...	
X	1	R subballa...	4+800.00	4+950.00	Horizontal	Alignment	Right Trac...	

## Within Roadway Designer...

- So a single template can model
  - Ballast rotation
    - Including the transition from tangent to circular arc
    - Left or right hand curves
  - Shoulder widening for “high side super”

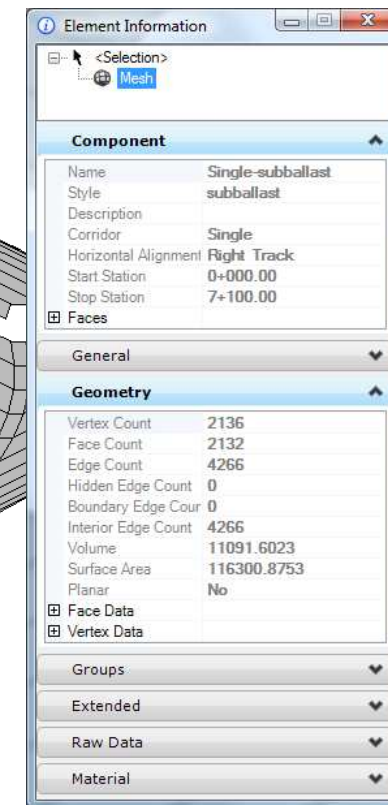
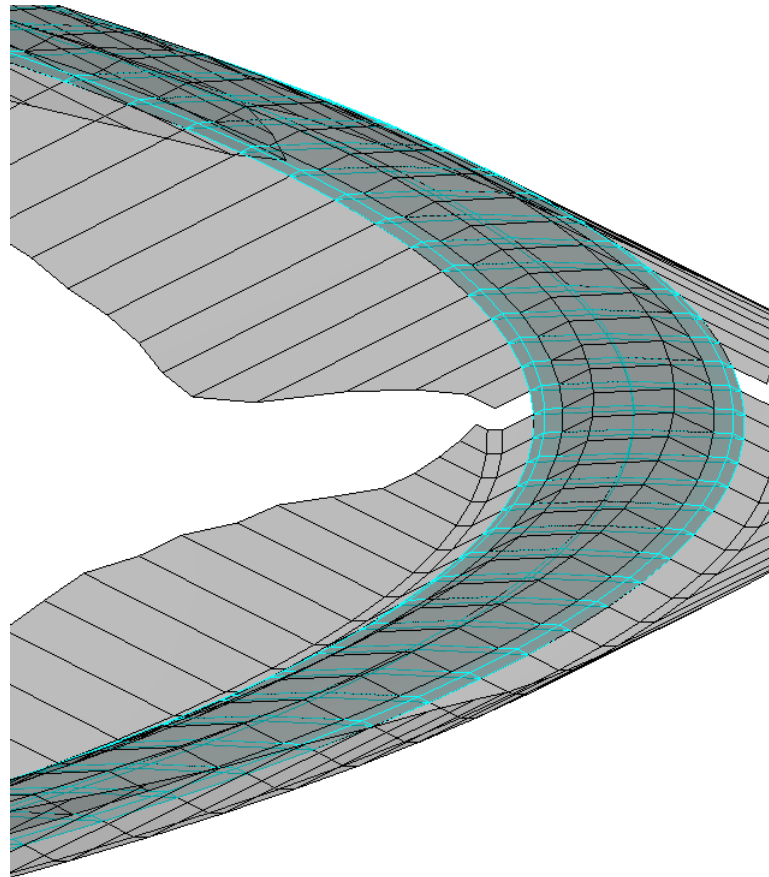
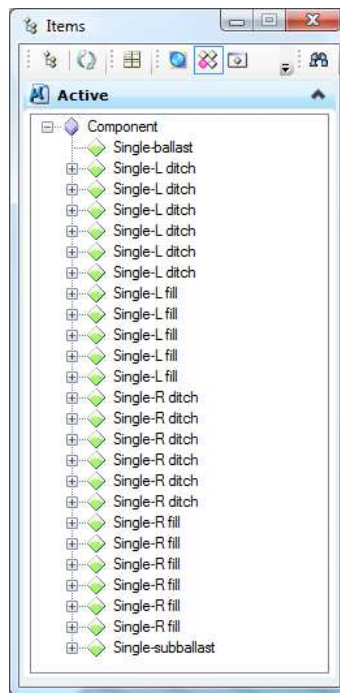


# A 3D Model...



## And ECXAttributes

- A means to share data without a specific application!

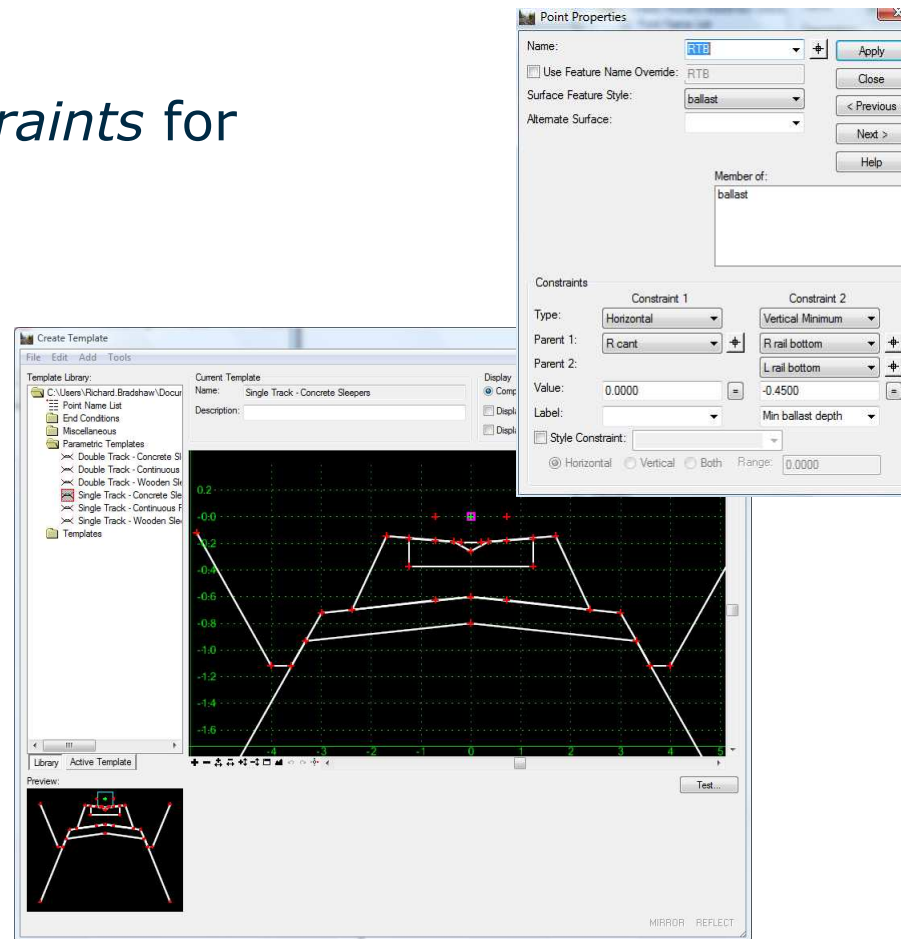


## Lets extend our solution

Building on top of the rail superelevation solution by adding more constraints into the template.

# Parametric & Other Constraints

- One point under each rail for minimum depth
- Constraints
  - *Parametric Constraints* for
    - Depth
    - Sub-grade widths
  - *Horizontal*
  - *Vertical Minimum*





# Parametric Constraints

- Parametric Constraints
  - *Min ballast depth*
    - Default to 450mm, but user can over-ride
  - *L subballast width & R subballast width*
    - Default to 3 m, but again it can be over-ridden

Parametric Constraints

Corridor: Single Station Limits: Start: 0+000.00 Stop: 7+100.00

Constraint Label: R subballast width Start Value: 3.0000 Stop Value: 3.0000

Override Values:

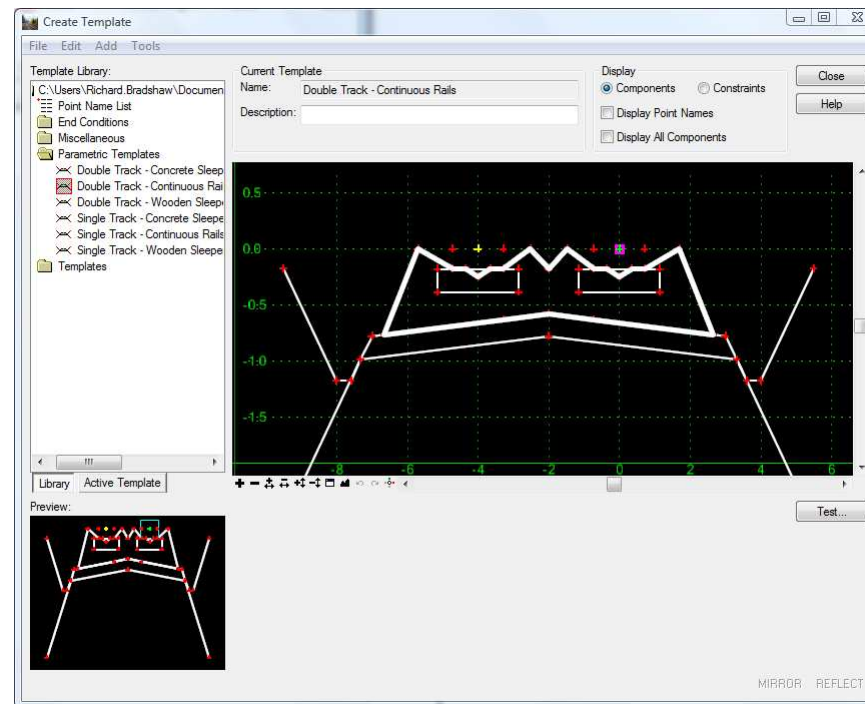
Enabled	Name	Start Value	Stop Value	Start Station	Stop Station
X	Min ballast dep...	-0.4500	-0.4500	0+000.00	7+100.00
X	L subballast wi...	-3.0000	-3.0000	0+000.00	7+100.00
X	R subballast wi...	3.0000	3.0000	0+000.00	7+100.00

## And lets extend it some more

Building upon our previous solutions to arrive at a more advanced solution

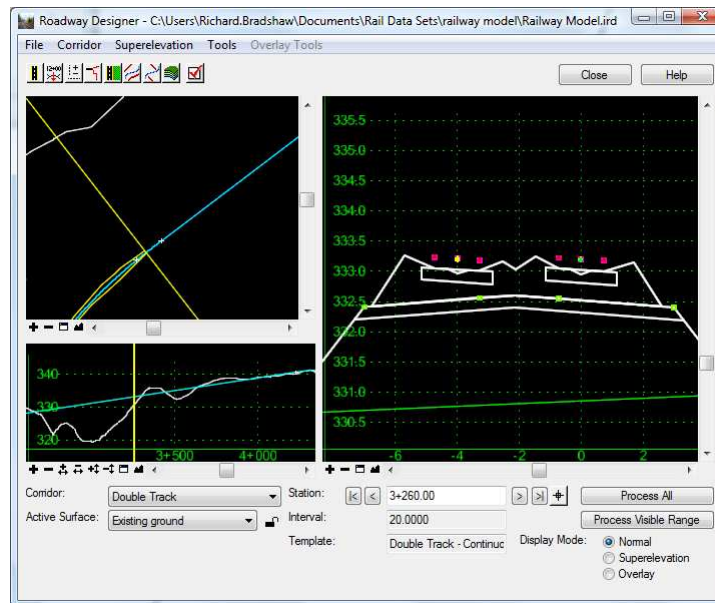
# Multiple Track Alignments

- Constraints
  - *Horizontal & slope constraints for superelevation*
  - *Minimum vertical depth under each rail to sub-grade*
    - Note “end of sleeper ballast build-up”



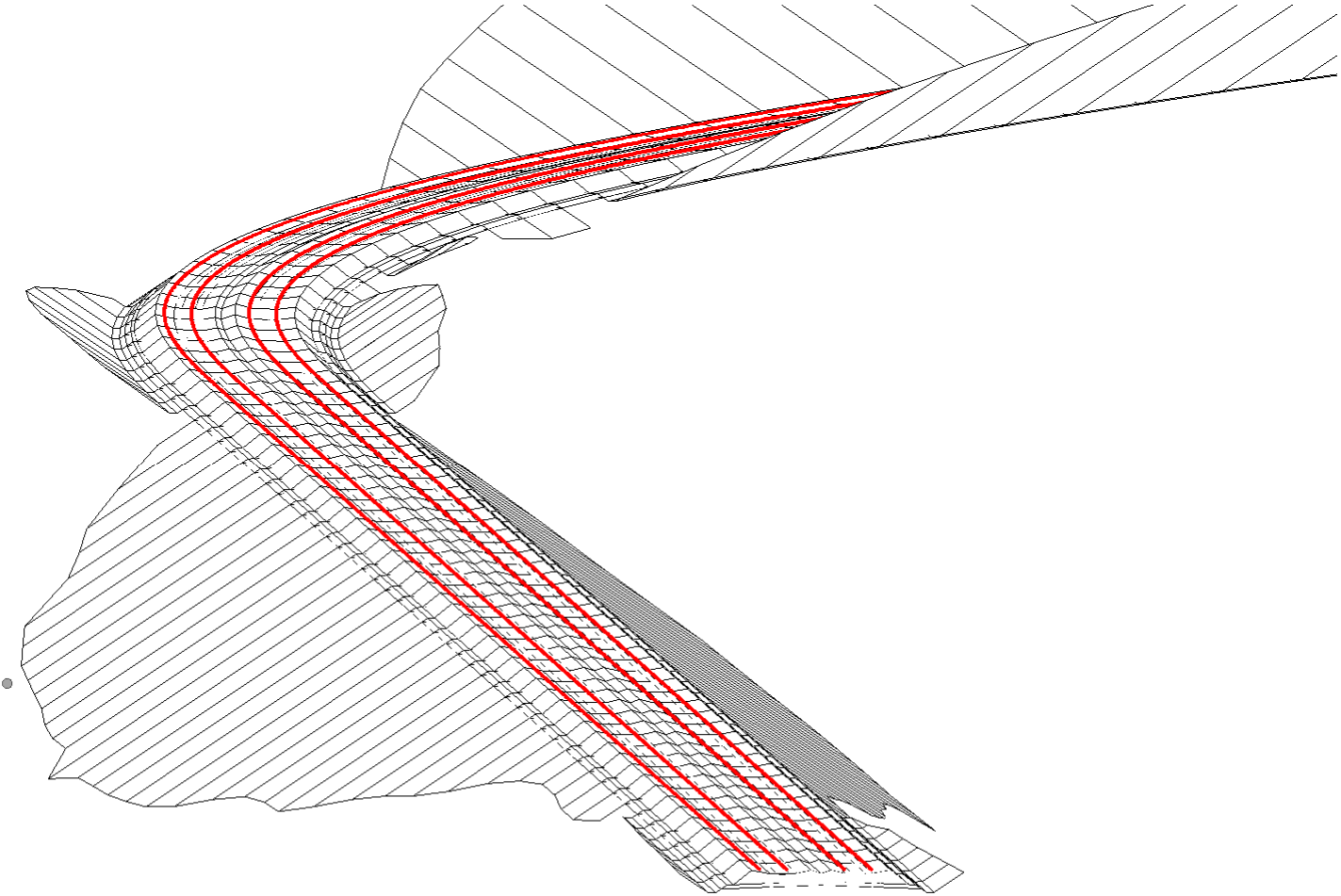
# Adding Multi-alignment Point Controls

- Points Controls
  - Right track *superelevation*
  - Left track *superelevation*
  - *Minimum vertical depth*
  - *Sub-grade widths*



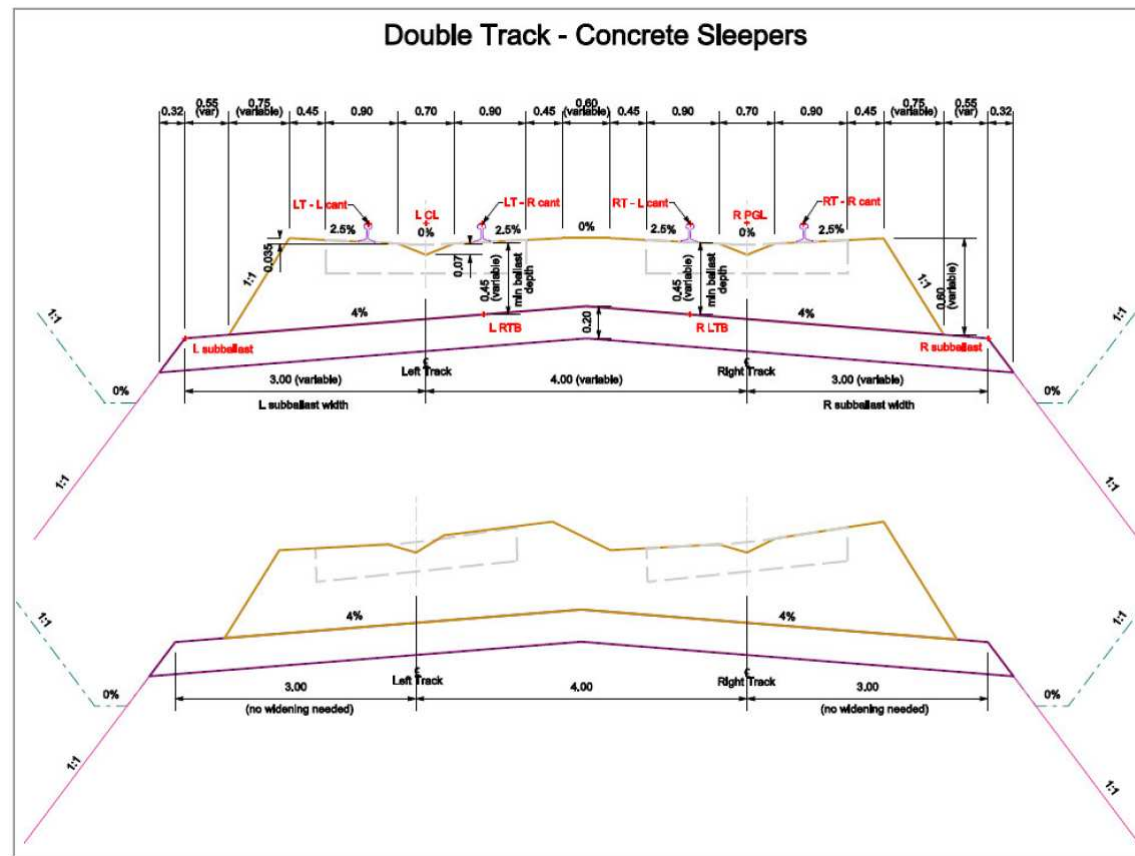
E...	P...	Name	Start St...	Stop St...	Mode	Type	Control	Description
X	1	RT - cant	0+000.00	7+100.00	Vertical	Cant	Cant.RT - ...	
X	1	LT - cant	0+000.00	7+100.00	Vertical	Cant	Cant.LT - ...	

# And the 3D model



# If you need some help

- ..\samples\rail modeling
  - .itl and associated .pdf (linked to the .itl)



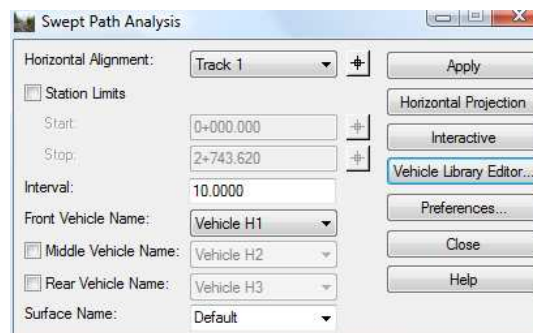


# Swept Path Modeling

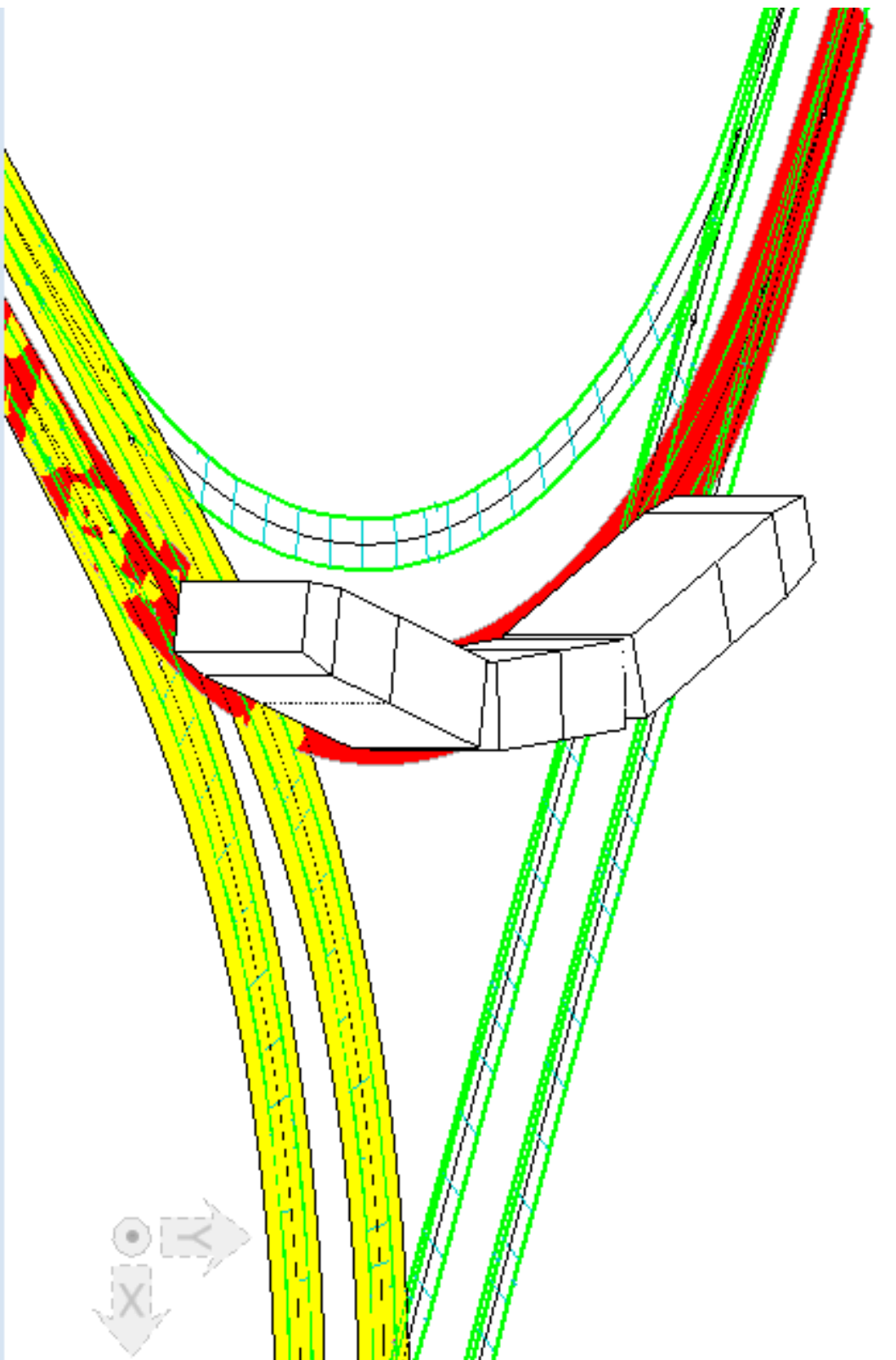
New functionality for the modeling of vehicle swept paths

# Swept Path Modeling

- New functionality for the creation of swept path / vehicle envelopes
  - Results can be
    - Horizontal project only
    - Interactive or
    - 3D mesh
  - Up to 3 vehicles in tandem
  - Uses horizontal, vertical and cant geometries

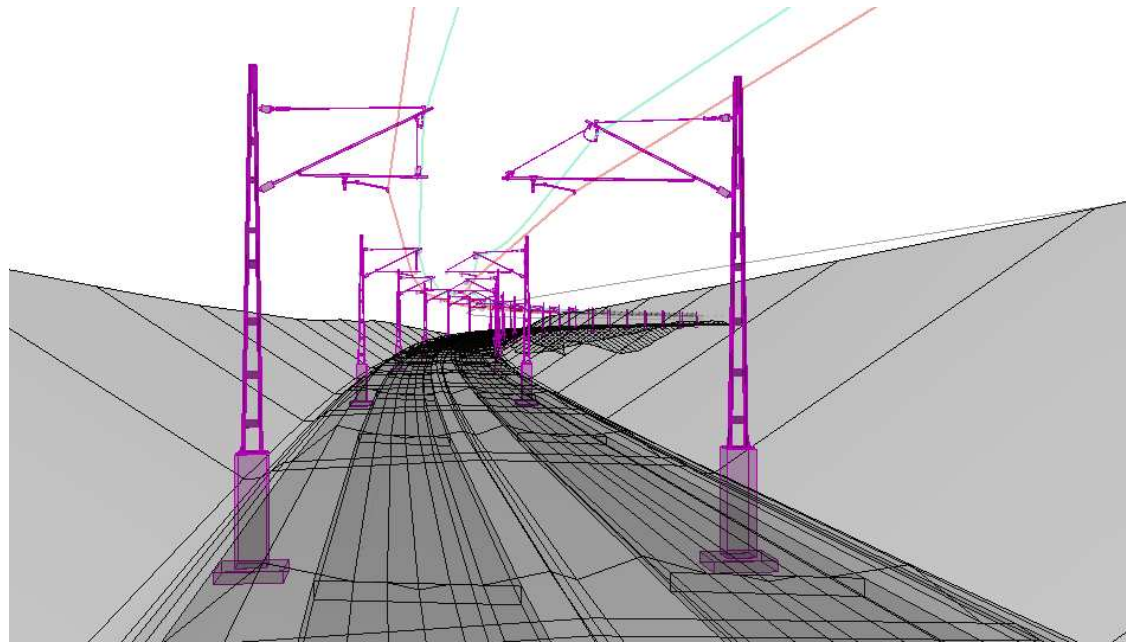


# Interactive



## And Combining Track & Overhead Line

- Creating the track model (geometry + surface) with **Bentley Rail Track**
- Creating the overhead line model, which is associated to the track geometry, with **Bentley Overhead Line**



# Questions?

