AASHTOWare Bridge Design & Rating (BrDR)
3D FEM Analysis Troubleshooting

AASHTOWare RADBUG Meeting
July 30-31, 2019
South Lake Tahoe, CA

Michael Baker INTERNATIONAL | *We Make a Difference*

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BrDR 3D FEM Analysis Troubleshooting

- Hardware recommendations
- Factors that influence analysis speed
- Tips for successful analysis
- Troubleshooting
  - Non-zero moments at end supports
  - Different number of nodes per girder

Hardware Recommendations

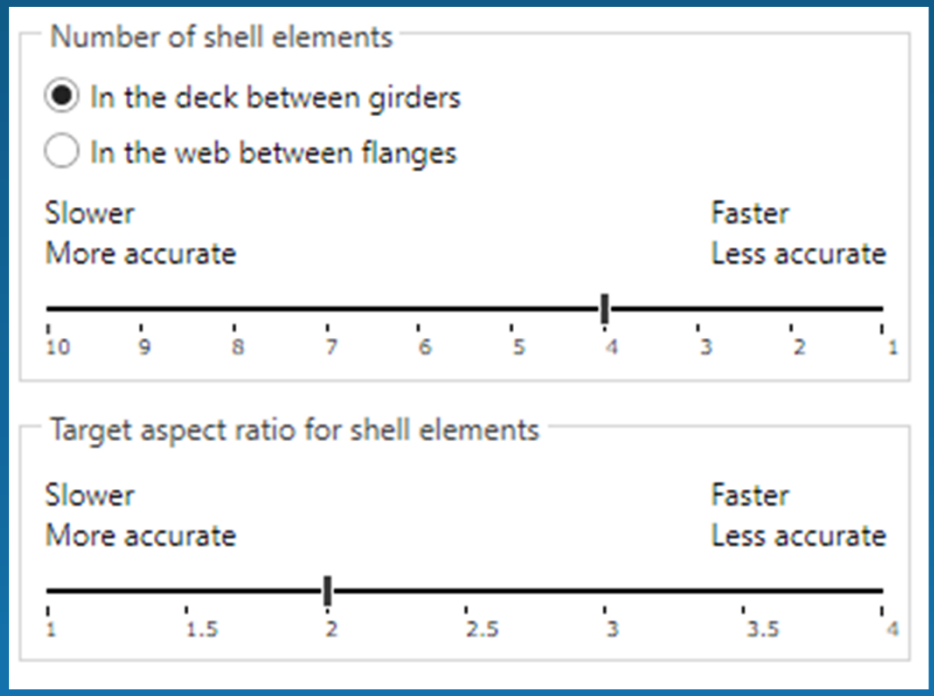
- Machine: Intel Core i7 processor or equivalent
- Memory: 32 GB or more
- Hard Disk: Solid State Drive

Factors that Influence 3D Analysis Speed

- Number of degrees of freedom
- Number of live load vehicles
- Live loading increments
- Analysis output selections

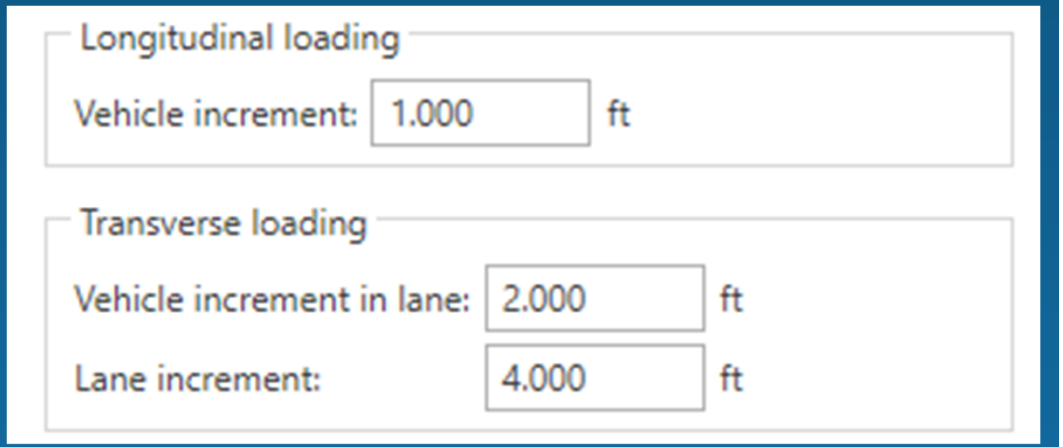
Number of Degrees of Freedom

- Number of shell elements in the deck between girders or in the web between flanges
- Target aspect ratio for shell elements
- Found on Superstructure Definition: Analysis tab



Live Loading Increments

- Vehicle increment for longitudinal loading
- Vehicle increment in lane and lane increment for transverse loading
- Found on Superstructure Definition: Analysis tab



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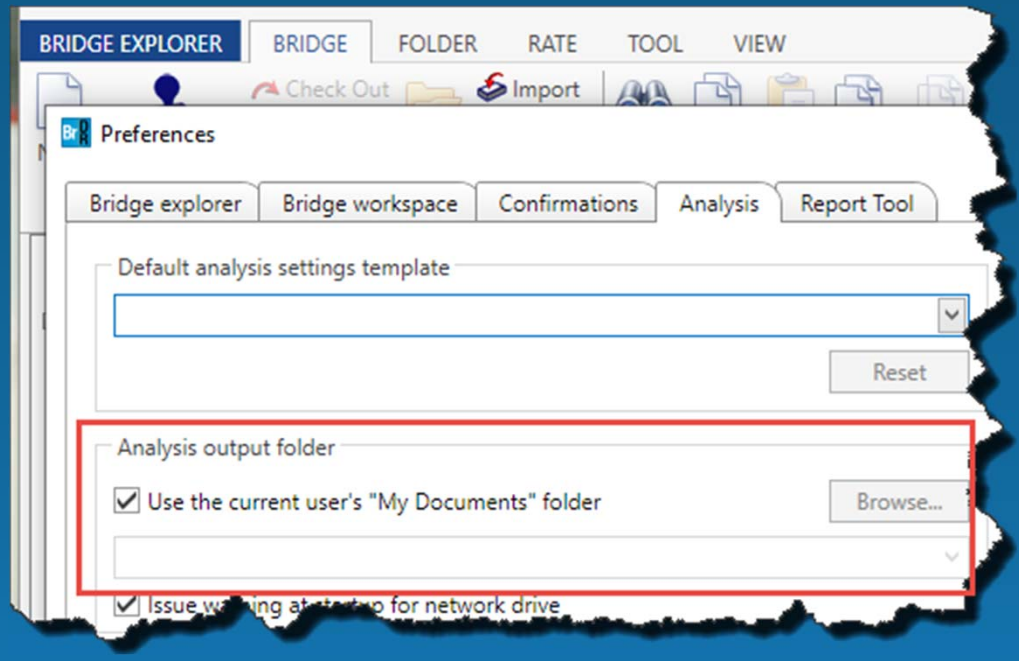
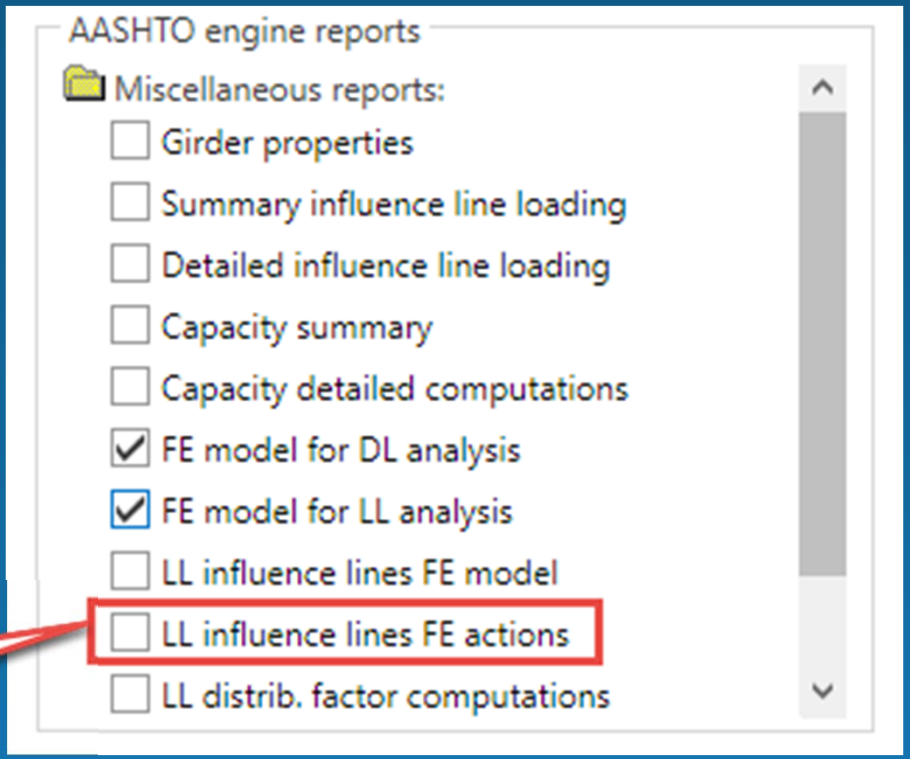
Analysis Output Selections

- Choose a local folder as the Analysis Output Folder. Writing analysis output to a network folder will degrade the performance of the analysis.



Analysis Output Selections

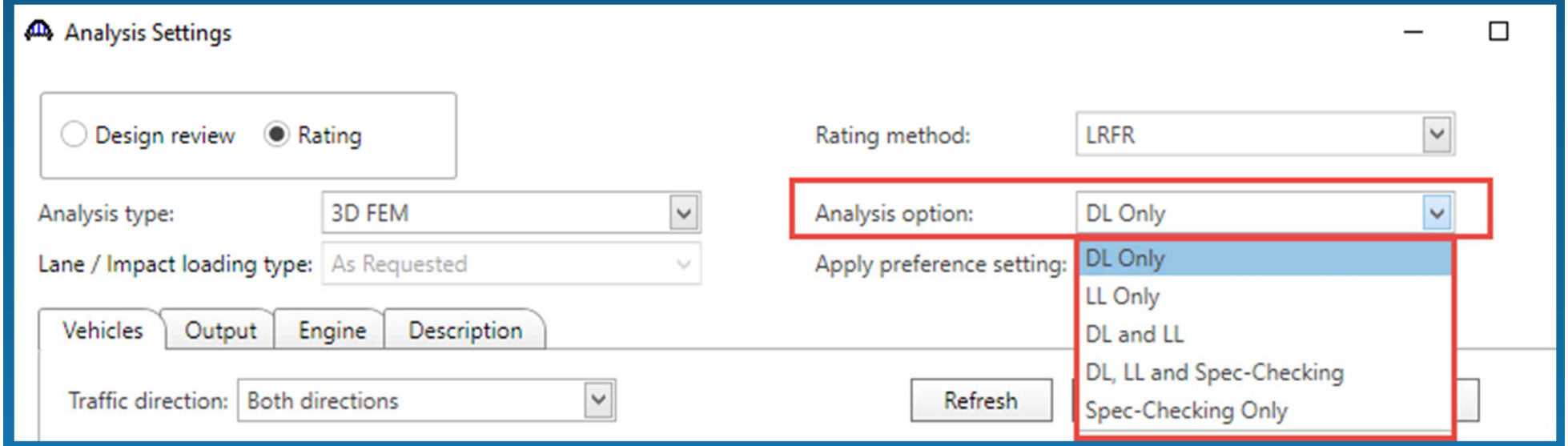
- Select only the necessary analysis output for the analysis. Disk operations are expensive from the analysis performance perspective.



Don't select! Report contains output of influence surface FE actions for unit load application

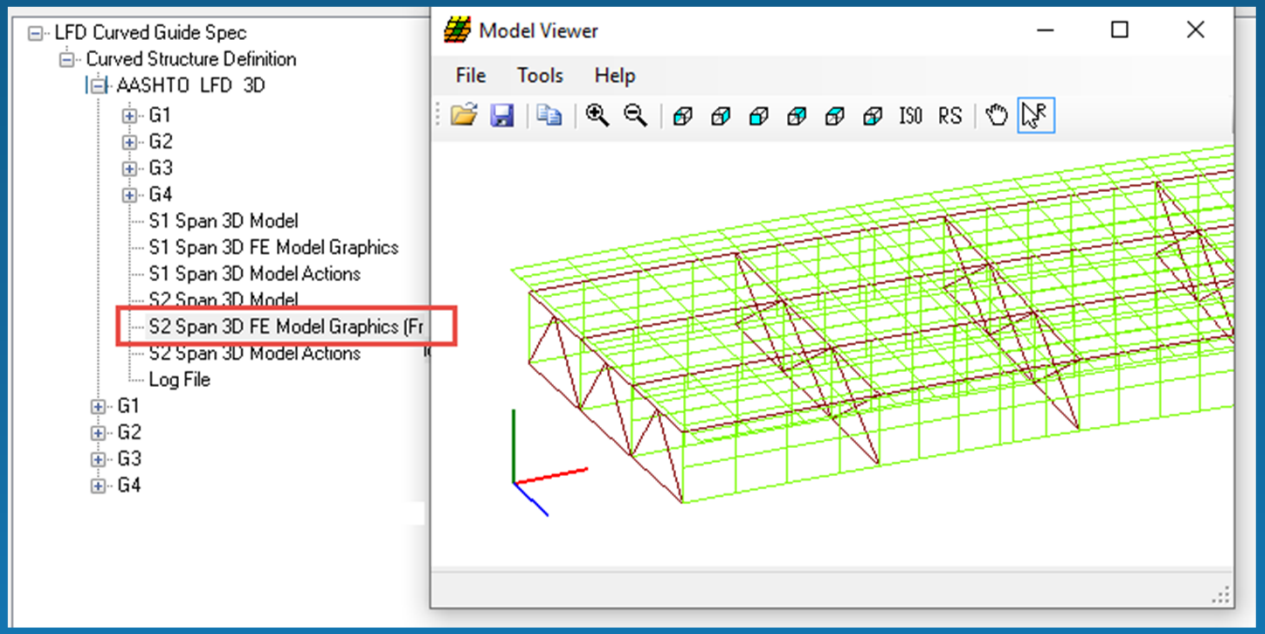
Tips for Successful Analysis

- Fine tune the model while running the DL only



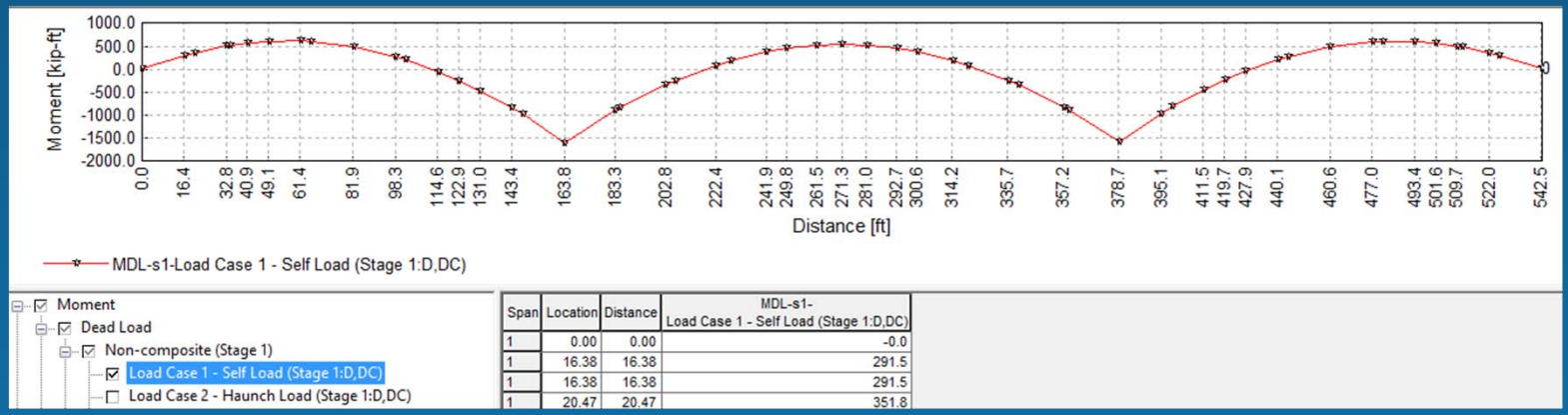
Tips for Successful Analysis

- Review the DL model with Model Viewer



Tips for Successful Analysis

- Check the moments to see if they look ‘normal’

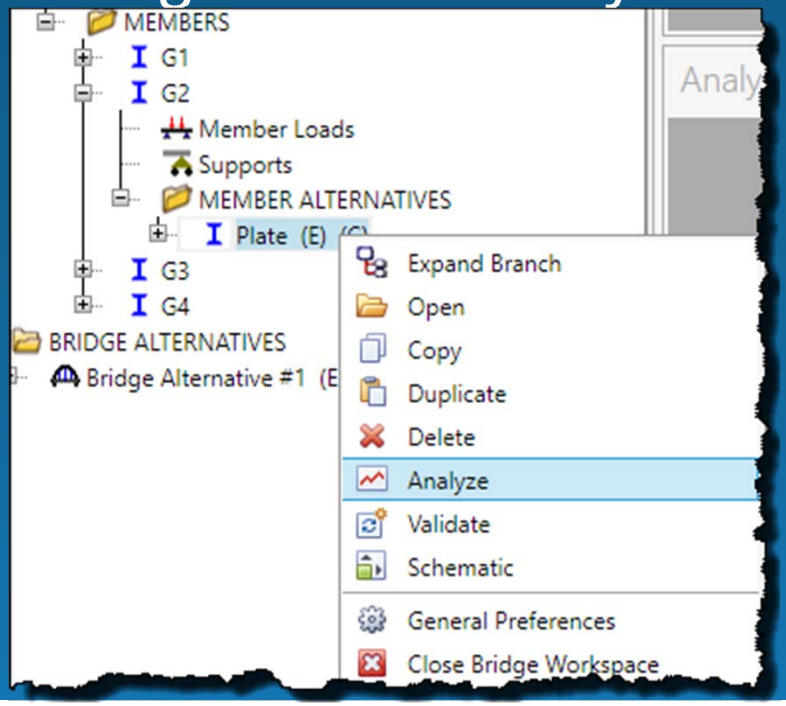


Span	Location	Distance	MDL-s1- Load Case 1 - Self Load (Stage 1:D,DC)
1	0.00	0.00	-0.0
1	16.38	16.38	291.5
1	16.38	16.38	291.5
1	20.47	20.47	351.8

- Run coarser meshes initially and only then fine tune the model

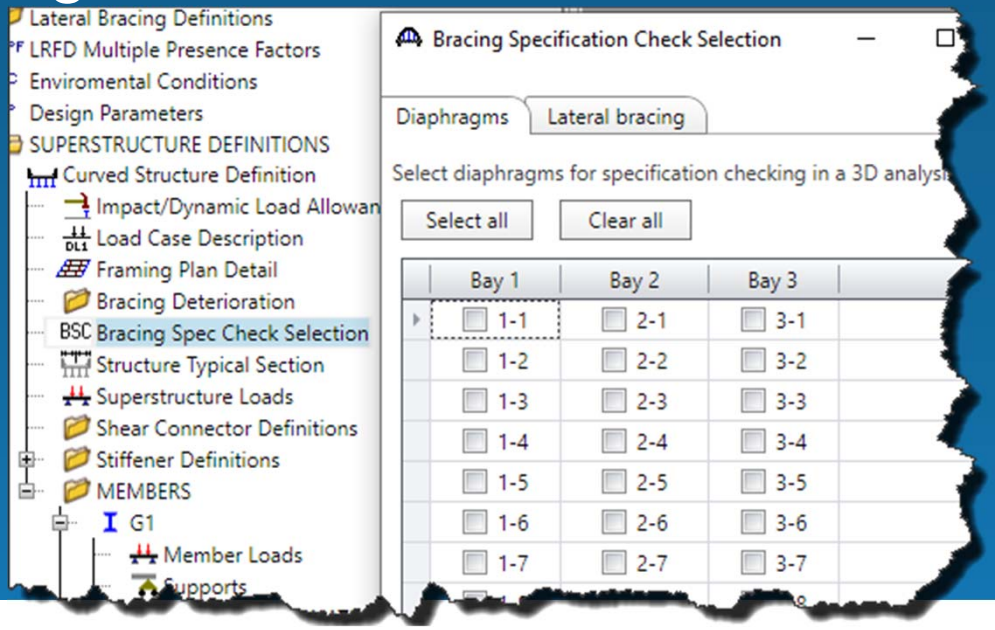
Tips for Successful Analysis

- Do initial live load analysis for a single vehicle only
- Do first spec check of 1 girder only
  - Launch 3D analysis from the member alternative
  - Only “Existing” alternatives have influence surfaces loaded and are spec checked



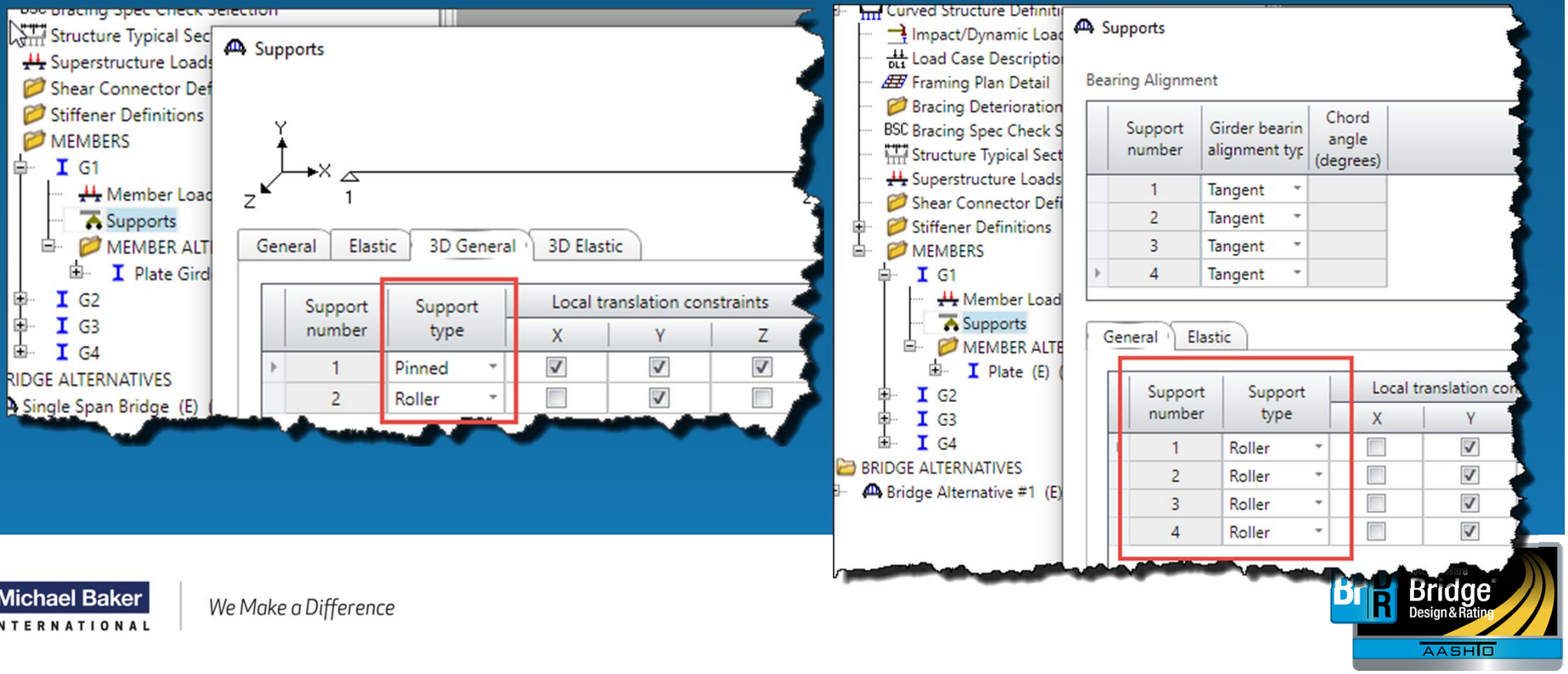
Tips for Successful Analysis

- Do not select diaphragms for spec checking until satisfied with girders



Troubleshoot Non-Zero Moments at End Supports

- Evaluate “Pinned” support conditions



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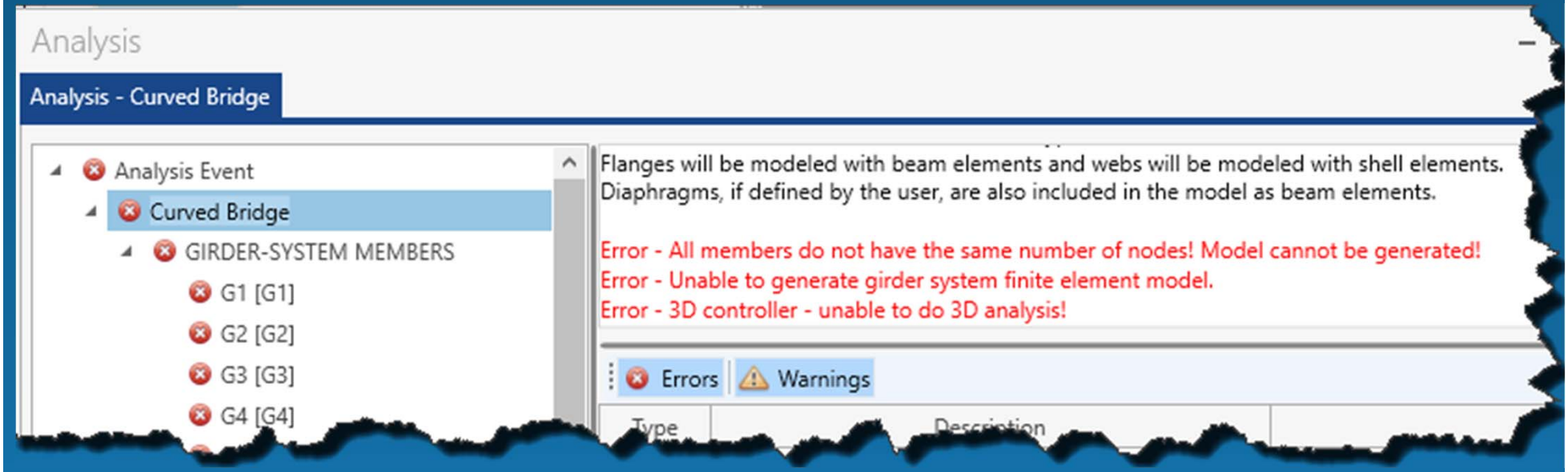
Troubleshoot Different Number of Nodes



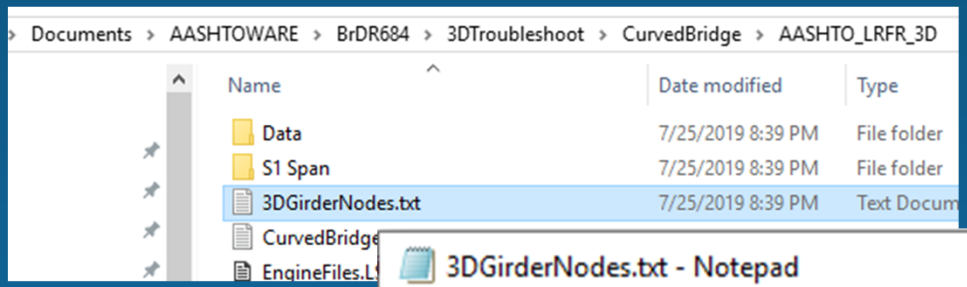
Troubleshoot Different Number of Nodes

- "3DGirderNodes.txt"
  - Comma delimited file contains node locations and reason why node was generated
  - Developed for debugging, now shared with users
- 6.8.3: File generated when unable to generate mesh
- 6.8.4/7.0.0: File always generated

Troubleshoot Different Number of Nodes

- Reasons why node was generated
  - Diaphragm, support, tenth point, cross section change point
  - “bitmask 0” : node was added to either get the same number of nodes in a span or added based on the number of shell elements selected on the Structure Definition: Analysis tab

Troubleshoot Different Number of Nodes

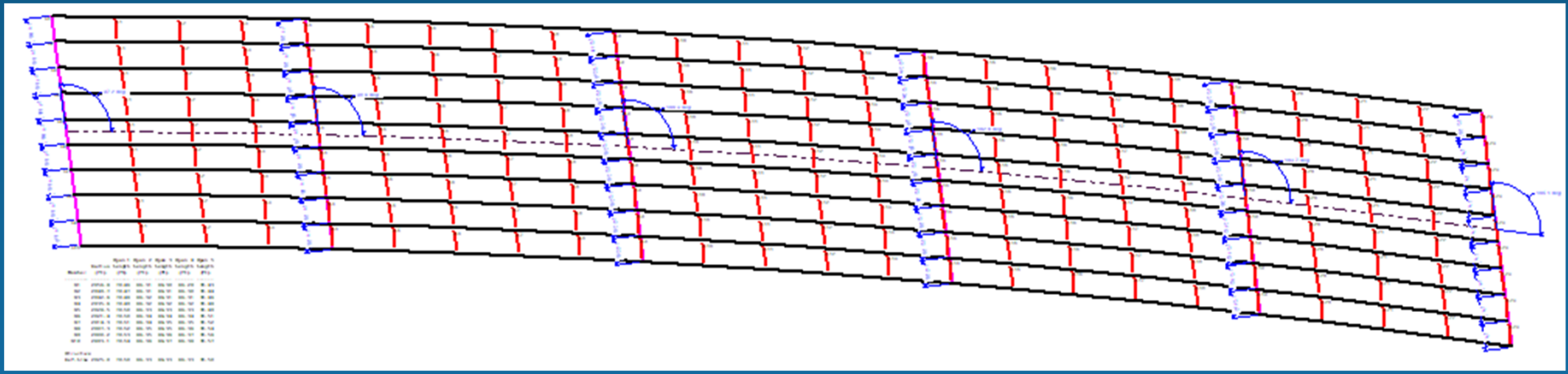


3DGirderNodes.txt - Notepad

File Edit Format View Help

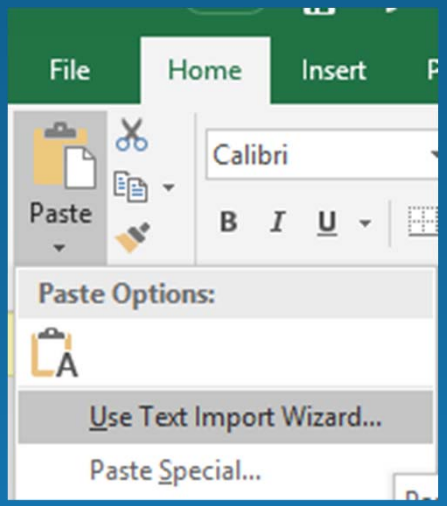
```
Bridge:  3D Mesh Example
Structure Definition:  Curved Bridge
G1
TotalCount 1, Span Count 1,  Distance: 0, 0%, Support, Tenth, bitmask 51
TotalCount 2, Span Count 2,  Distance: 7.04642530658245, 10%, Tenth, bitmask 48
TotalCount 3, Span Count 3,  Distance: 11.5, 16.3203319408739%, Change, bitmask 33
TotalCount 4, Span Count 4,  Distance: 12.488626546912, 17.7233504983664%, bitmask 0
TotalCount 5, Span Count 5,  Distance: 14.0928506131649, 20%, Tenth, bitmask 48
TotalCount 6, Span Count 6,  Distance: 17.625, 25.0126826485133%, Diaph, bitmask 128
TotalCount 7, Span Count 7,  Distance: 21.1392759197474, 30%, Tenth, bitmask 48
TotalCount 8, Span Count 8,  Distance: 28.1857012263298, 40%, Tenth, bitmask 48
TotalCount 9, Span Count 9,  Distance: 35.2321265329123, 50%, Diaph, Tenth, bitmask 176
```

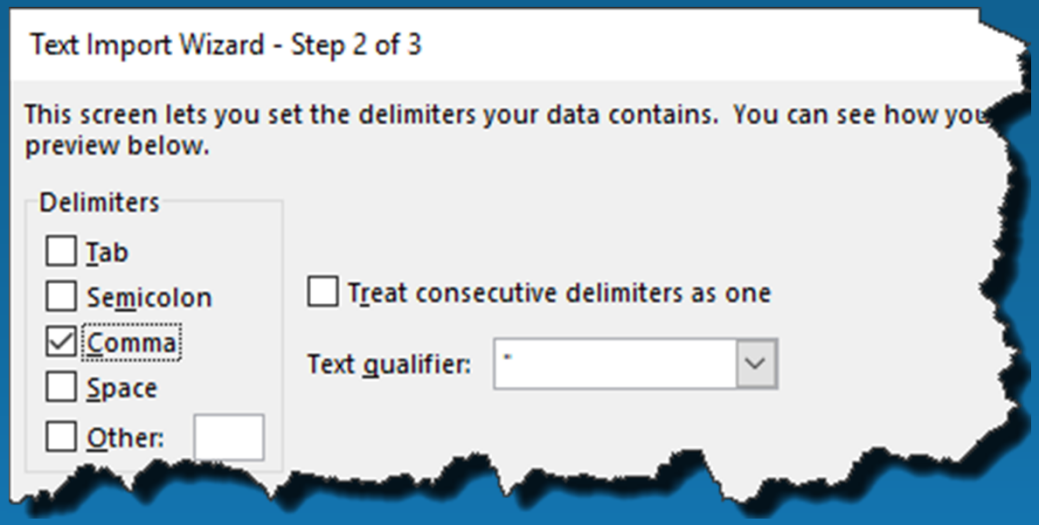
Troubleshoot Different Number of Nodes



Troubleshoot Different Number of Nodes

- Step 1: Use Paste/Use Text Import Wizard to copy each girder's data into its own column in Excel





Troubleshoot Different Number of Nodes

- Step 2: Examine total number of nodes per girder looking for differences

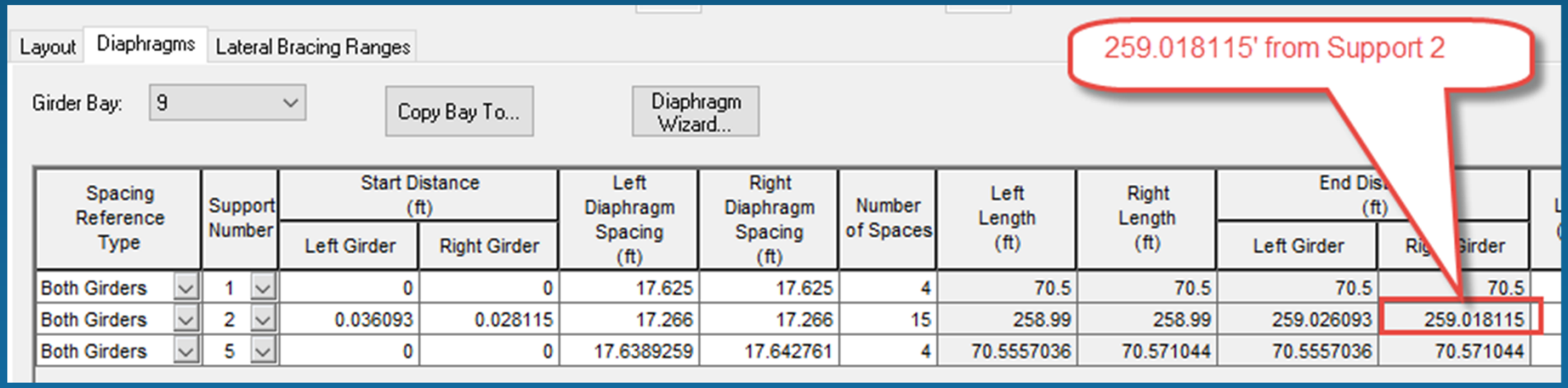
G9								G10			
TotalCount 115	Span Count 23	Distance:	83.77%	bitmask 0				TotalCount 115	Span Count 22	Dista	
TotalCount 116	Span Count 24	Distance:	90%	Tenth	bitmask 48			TotalCount 116	Span Count 23	Dista	
TotalCount 117	Span Count 25	Distance:	100%	Support	Diaph	Tenth	bitmask 179	TotalCount 117	Span Count 24	Dista	
								TotalCount 118	Span Count 25	Dista	

Troubleshoot Different Number of Nodes

- Step 3: For girders with difference, examine number of nodes per spans

G9						G10					
Span Count 27	Distance: 325.077868	94.75%	Change	bitmask 33		TotalCount 90	Span Count 27	Distance: 325.10(	94.73%	Change	bitmas
Span Count 28	Distance: 325.159697	94.84%	bitmask 0			TotalCount 91	Span Count 28	Distance: 325.19:	94.84%	bitmask 0	
Span Count 29	Distance: 329.61627(	100%	Support	Diaph	Tenth	TotalCount 92	Span Count 29	Distance: 329.55-	99.89%	Diaph	bitmas
Span Count 1	Distance: 329.695884	0.11%	bitmask 0			TotalCount 93	Span Count 30	Distance: 329.65(	100%	Support	Tenth
Span Count 2	Distance: 334.077868	6.32%	Change	bitmask 33		TotalCount 94	Span Count 1	Distance: 329.72:	0.11%	bitmask 0	
Span Count 3	Distance: 334.137548	6.41%	bitmask 0			TotalCount 95	Span Count 2	Distance: 334.10(	6.31%	Change	bitmas

Troubleshoot Different Number of Nodes



Spacing Reference Type	Support Number	Start Distance (ft)		Left Diaphragm Spacing (ft)	Right Diaphragm Spacing (ft)	Number of Spaces	Left Length (ft)	Right Length (ft)	End Dis. (ft)		L
		Left Girder	Right Girder						Left Girder	Rig Girder	
Both Girders	1	0	0	17.625	17.625	4	70.5	70.5	70.5	70.5	
Both Girders	2	0.036093	0.028115	17.266	17.266	15	258.99	258.99	259.026093	259.018115	
Both Girders	5	0	0	17.6389259	17.642761	4	70.5557036	70.571044	70.5557036	70.571044	

Diaphragm at 70.536605’ (support 2) + 259.018115’ = 329.55472’

Pier 4 is at 329.650012’

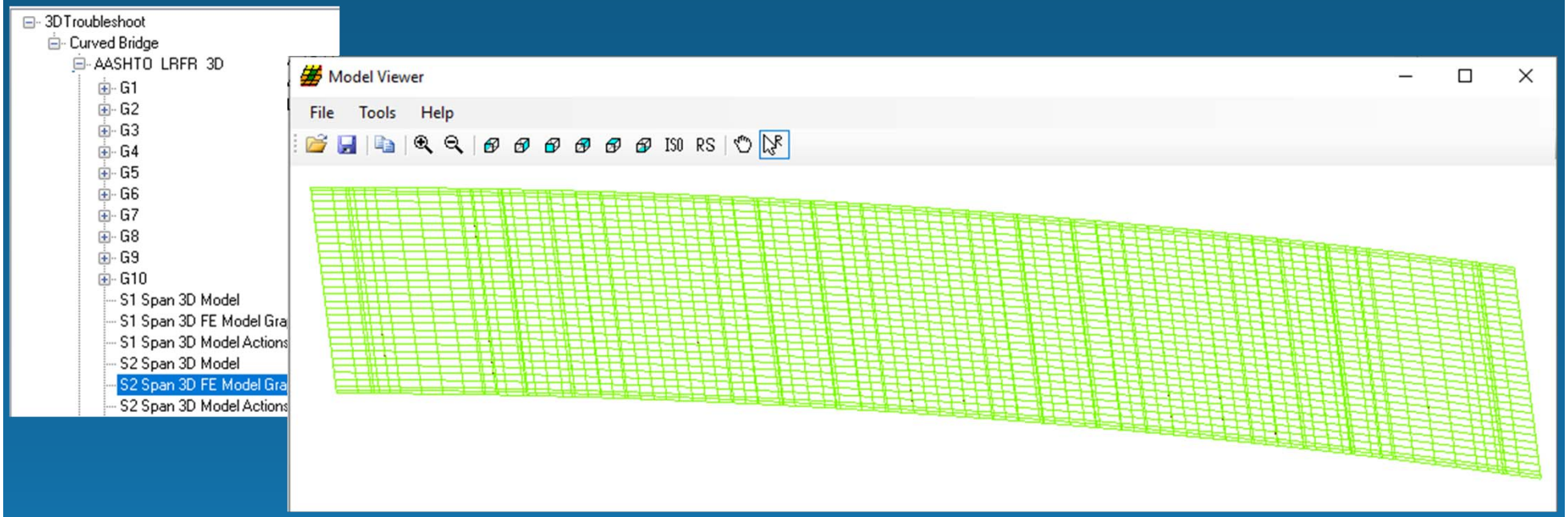
Troubleshoot Different Number of Nodes

- Change the number of diaphragm spacing from 15 to 14
- Add a new row at 0’ from Support 5(Pier 4) with 0’ spacing
- Move Span 5 data down a row

Girder Bay: 9 | Copy Bay To... | Diaphragm Wizard...

Spacing Reference Type	Support Number	Start Distance (ft)		Left Diaphragm Spacing (ft)	Right Diaphragm Spacing (ft)	Number of Spaces	Left Length (ft)	Right Length (ft)	End Distance (ft)		Load (kip)	
		Left Girder	Right Girder						Left Girder	Right Girder		
Both Girders	1	0	0	17.625	17.625	4	70.5	70.5	70.5	70.5	0.47	Inter
Both Girders	2	0.036093	0.028115	17.266	17.266	14	241.724	241.724	241.760093	241.752115	0.47	Inter
Both Girders	5	0	0	0	0	1	0	0	0	0	0.47	Inte
Both Girders	5	0	0	17.6389259	17.642761	4	70.5557036	70.571044	70.5557036	70.571044	0.47	Inter

Troubleshoot Different Number of Nodes



Thank You

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