

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

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INTERNATIONAL

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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

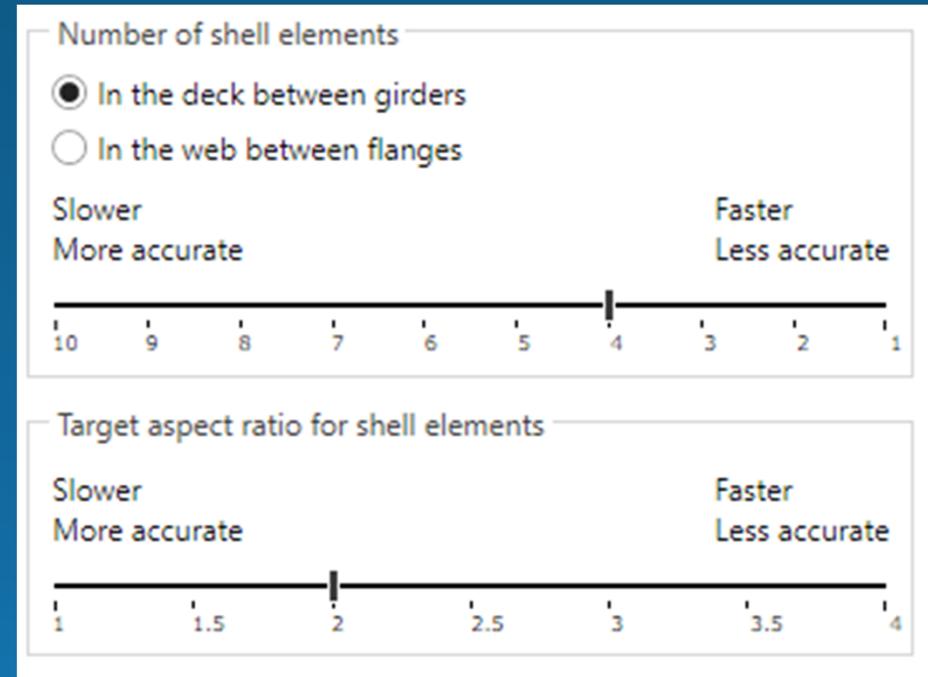
# Factors that Influence 3D Analysis Speed

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- ▶ 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



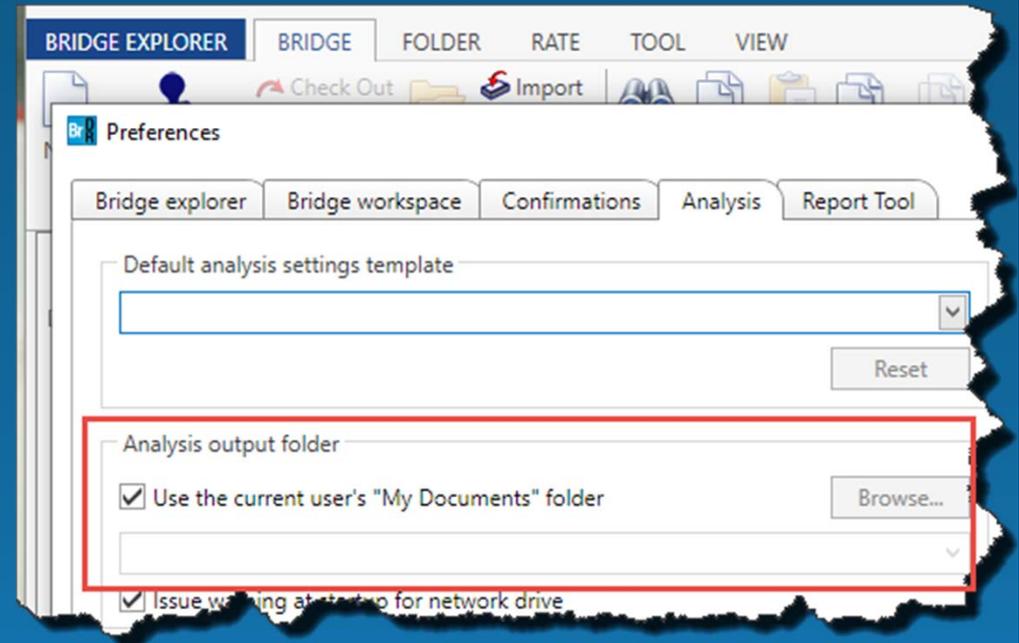
# Live Loading Increments

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

Longitudinal loading	
Vehicle increment:	<input type="text" value="1.000"/> ft
Transverse loading	
Vehicle increment in lane:	<input type="text" value="2.000"/> ft
Lane increment:	<input type="text" value="4.000"/> ft

# 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

AASHTO engine reports

Miscellaneous reports:

- Girder properties
- Summary influence line loading
- Detailed influence line loading
- Capacity summary
- Capacity detailed computations
- FE model for DL analysis
- FE model for LL analysis
- LL influence lines FE model
- LL influence lines FE actions
- LL distrib. factor computations

# Tips for Successful Analysis

- Fine tune the model while running the DL only

Analysis Settings

Design review  Rating

Analysis type: 3D FEM

Lane / Impact loading type: As Requested

Rating method: LRFR

Analysis option: DL Only

Apply preference setting: DL Only

LL Only

DL and LL

DL, LL and Spec-Checking

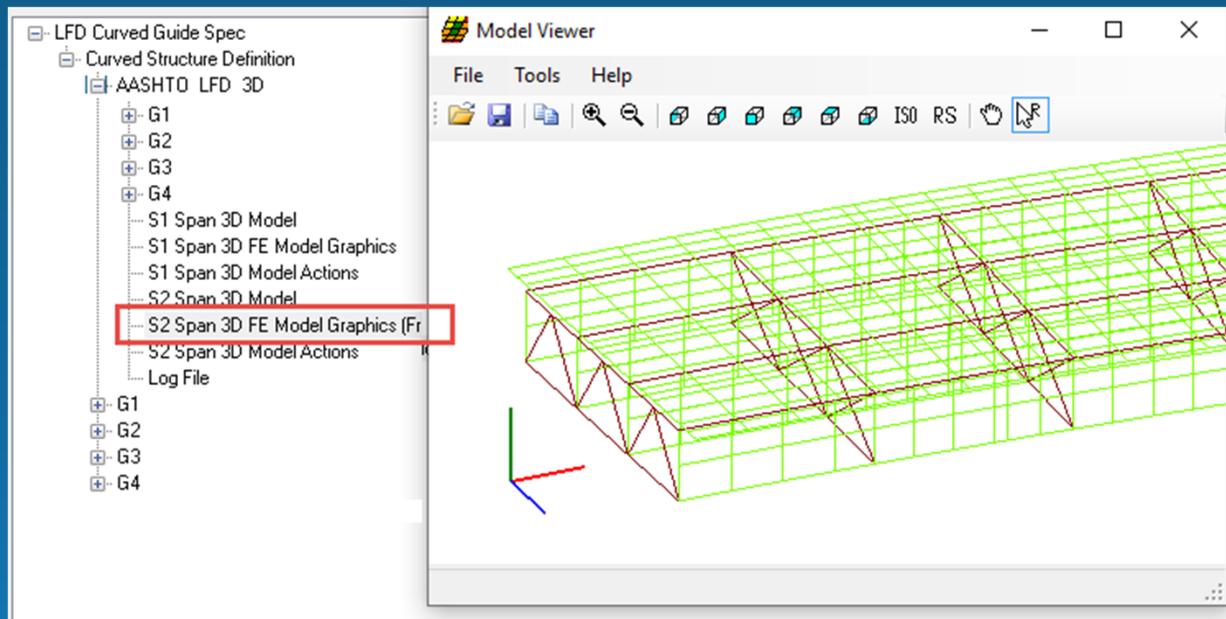
Spec-Checking Only

Traffic direction: Both directions

Refresh

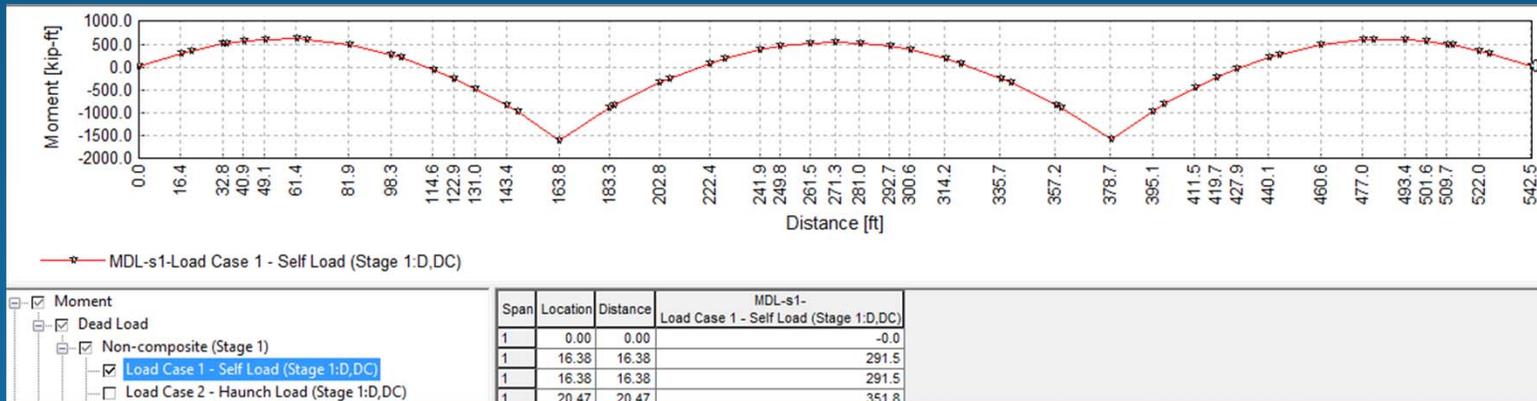
# Tips for Successful Analysis

## ► Review the DL model with Model Viewer



# Tips for Successful Analysis

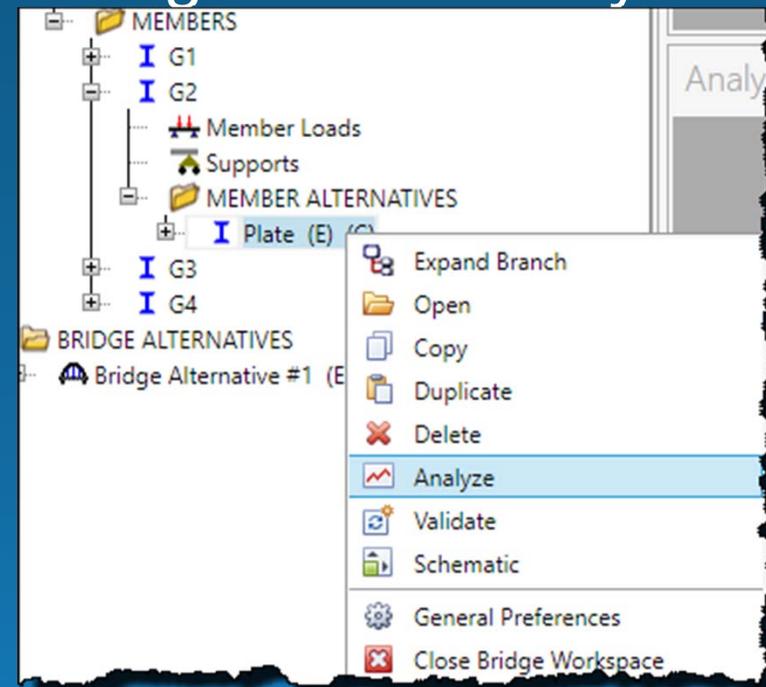
- ▶ Check the moments to see if they look 'normal'



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

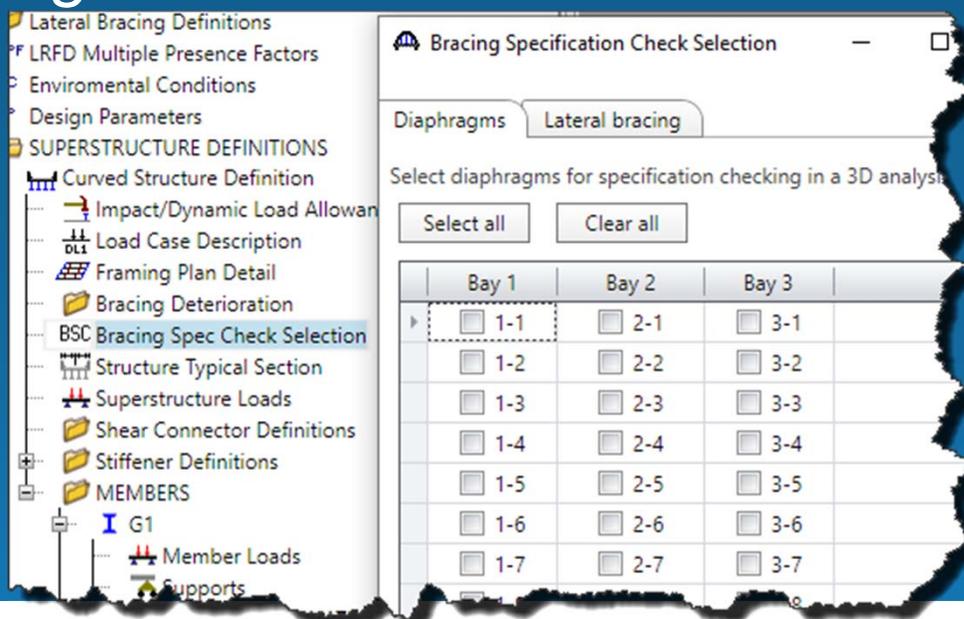
## Tips for Successful Analysis

- ▶ 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

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## ► Evaluate “Pinned” support conditions

Supports

Support number	Support type	Local translation constraints		
		X	Y	Z
1	Pinned	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
2	Roller	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>

Bearing Alignment

Support number	Girder bearing alignment type	Chord angle (degrees)
1	Tangent	
2	Tangent	
3	Tangent	
4	Tangent	

Supports

Support number	Support type	Local translation constraints	
		X	Y
1	Roller	<input type="checkbox"/>	<input checked="" type="checkbox"/>
2	Roller	<input type="checkbox"/>	<input checked="" type="checkbox"/>
3	Roller	<input type="checkbox"/>	<input checked="" type="checkbox"/>
4	Roller	<input type="checkbox"/>	<input checked="" type="checkbox"/>

# Troubleshoot Different Number of Nodes

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Analysis

Analysis - Curved Bridge

- ✖ Analysis Event
  - ✖ Curved Bridge
    - ✖ GIRDER-SYSTEM MEMBERS
      - ✖ G1 [G1]
      - ✖ G2 [G2]
      - ✖ G3 [G3]
      - ✖ G4 [G4]

Flanges will be modeled with beam elements and webs will be modeled with shell elements. Diaphragms, if defined by the user, are also included in the model as beam elements.

**Error - All members do not have the same number of nodes! Model cannot be generated!**  
**Error - Unable to generate girder system finite element model.**  
**Error - 3D controller - unable to do 3D analysis!**

✖ Errors | ⚠ Warnings

Type	Description
------	-------------

# Troubleshoot Different Number of Nodes

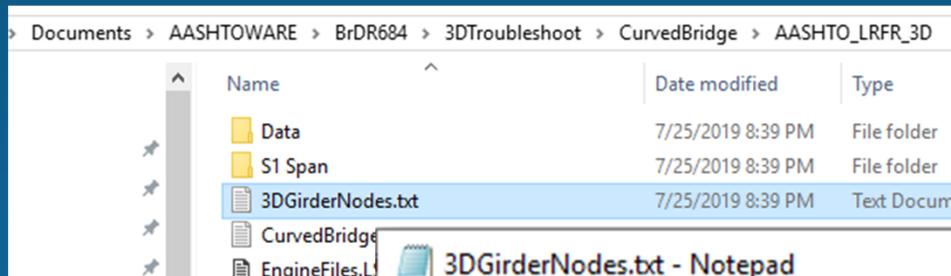
- ▶ “3DGirderNodes.txt”
  - ▶ Comma delimited file contains node locations and reason why node was generated
  - ▶ Developed for debugging, now shared with users
- ▶ 6.8.3: File generated when unable to generate mesh
- ▶ 6.8.4/7.0.0: File always generated

# 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

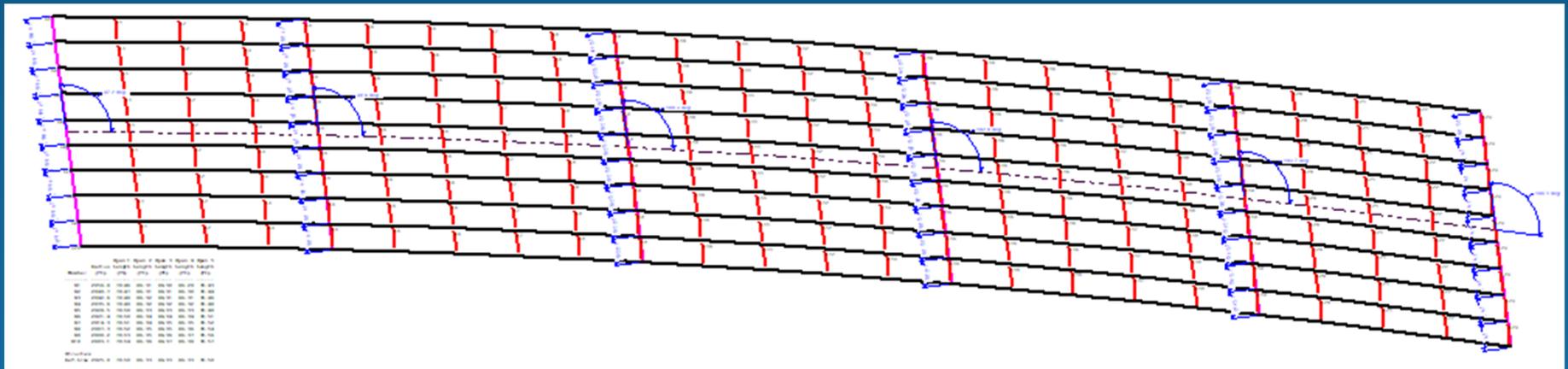
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```
3DGirderNodes.txt - Notepad
File Edit Format View Help
Bridge: 3D Mesh Example
Structure Definition: Curved Bridge
G1
TotalCount 1, Span Count 1, Distance: 0, 0%, Support, Tenth, bitmask 51
TotalCount 2, Span Count 2, Distance: 7.04642530658245, 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
```

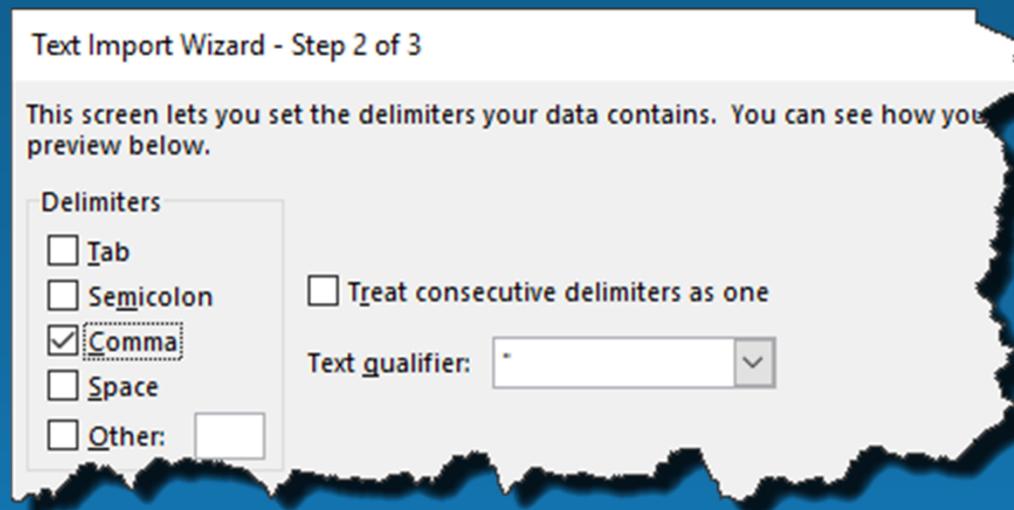
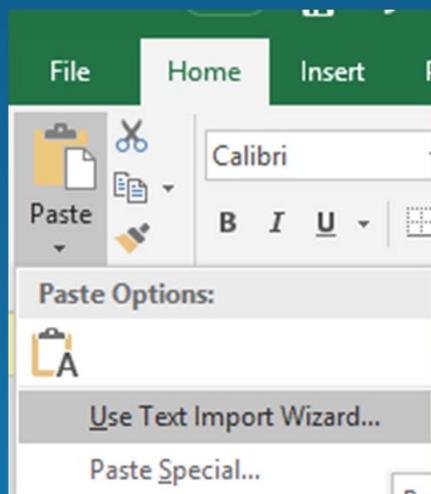
# Troubleshoot Different Number of Nodes

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# 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		
<b>TotalCount 117</b>	Span Count 25	Distance: 100%	Support	Diaph	Tenth	bitmask 179	<b>TotalCount 117</b>	Span Count 24	Dista
							<b>TotalCount 118</b>	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: 325.100	94.73%	Change	bitmas
Span Count 28	Distance: 325.159697	94.84%	bitmask 0		TotalCount 91	Span Count 28	Distance: 325.192	94.84%	bitmask 0	
Span Count 29	Distance: 329.616270	100%	Support	Diaph Tenth	TotalCount 92	Span Count 29	Distance: 329.554	99.89%	Diaph	bitmas
Span Count 1	Distance: 329.695884	0.11%	bitmask 0		TotalCount 93	Span Count 30	Distance: 329.650	100%	Support	Tenth
Span Count 2	Distance: 334.077868	6.32%	Change	bitmask 33	TotalCount 94	Span Count 1	Distance: 329.729	0.11%	bitmask 0	
Span Count 3	Distance: 334.137548	6.41%	bitmask 0		TotalCount 95	Span Count 2	Distance: 334.100	6.31%	Change	bitmas

# Troubleshoot Different Number of Nodes

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Layout Diaphragms Lateral Bracing Ranges

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

259.018115' from Support 2

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)	
		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
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

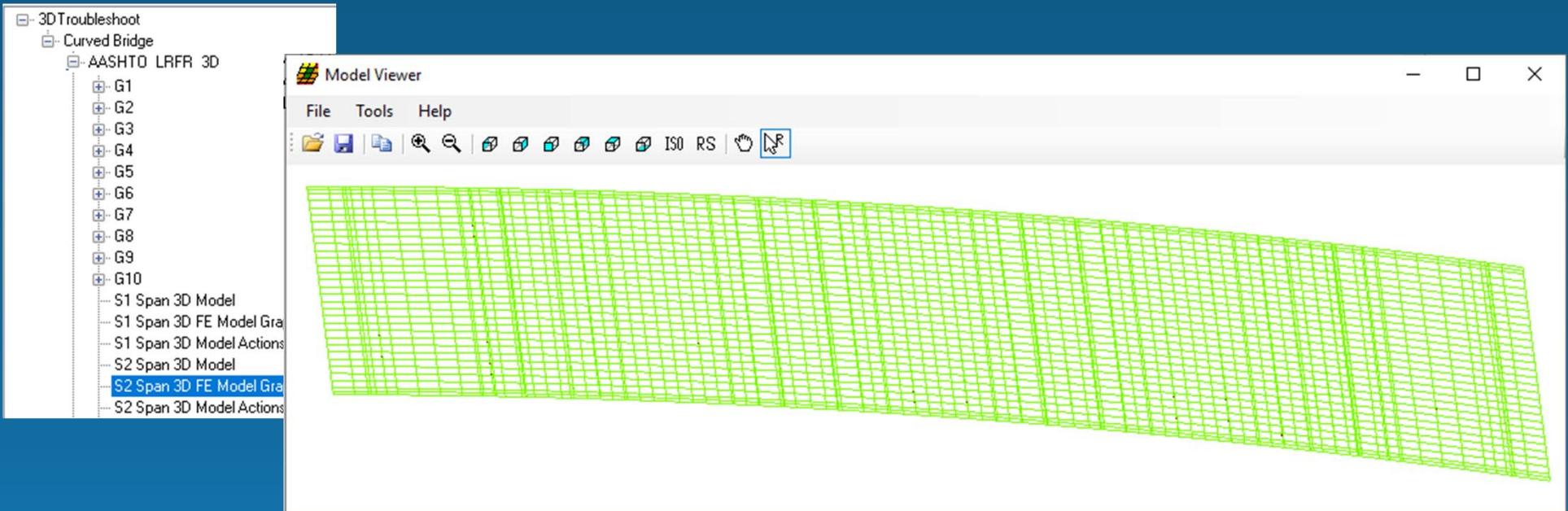
Copy Bay To...

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	Inter
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

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Thank You