NCHRP Project 12-71

Design Specifications and Commentary for Horizontally Curved Concrete Box-Girder Highway Bridges

Appendix E

Detailed Global Analysis Results

This Appendix contains the graphical results generated from the finite element global bridge analysis. The three bridge loading scenarios are “self weight”, “live load total” and “post tension total”. The plots are arranged in the following order:

1 Bridge Model Scattergrams – Spine vs. Grillage

2 Bridge Model Ratio Plots – Spine vs. Grillage

3 Bridge Model Ratio Plots - Straight to Curve (spine and grillage)

4 Effect of Diaphragms – Grillage Analysis

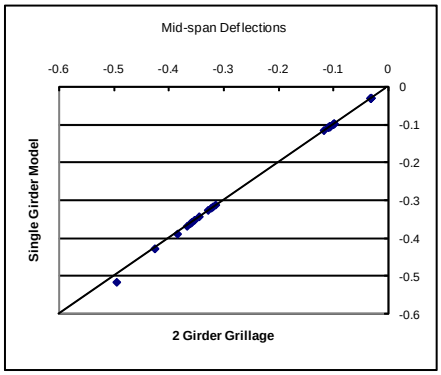
5 Effect of Diaphragms – Ratio Plots

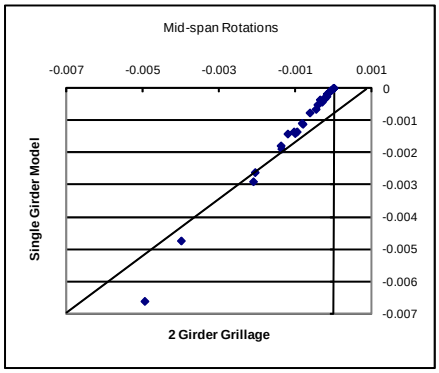
6 Effect of Hinges – Grillage Analysis

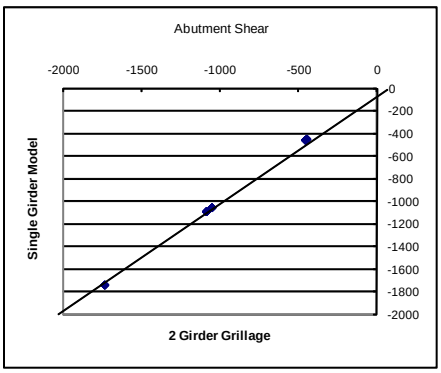
7 Effect of Hinges – Ratio Plots

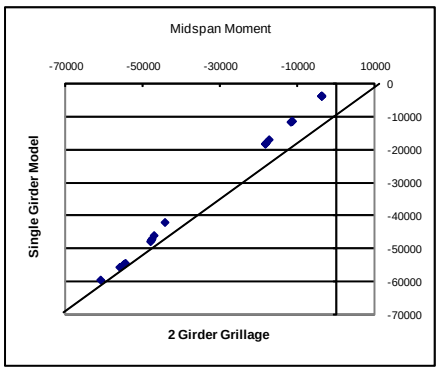
8 Effect of Skews

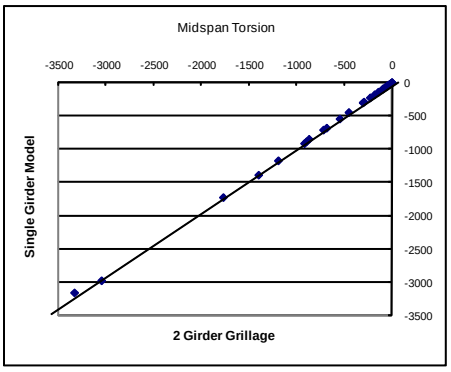
9 Figure E.1.1: Single Cell, Pre-Cast, 6’x18’ Column: Self Weight

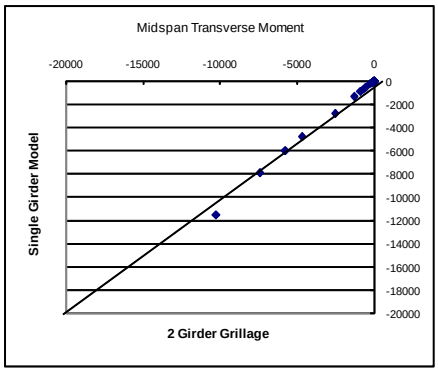


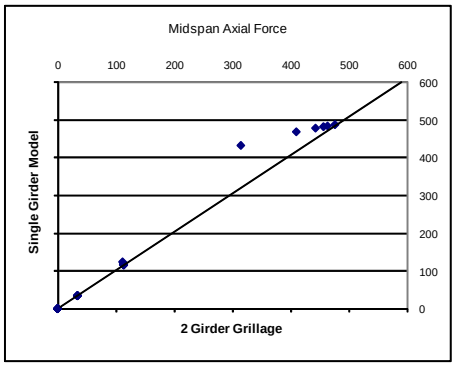












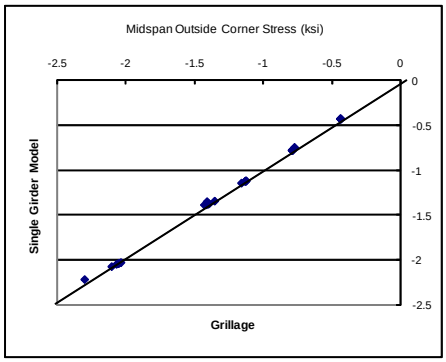
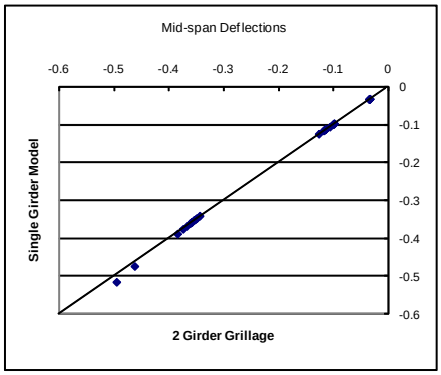
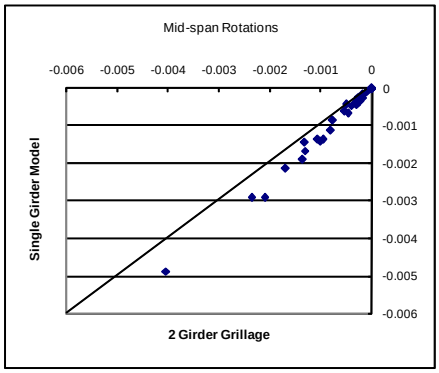
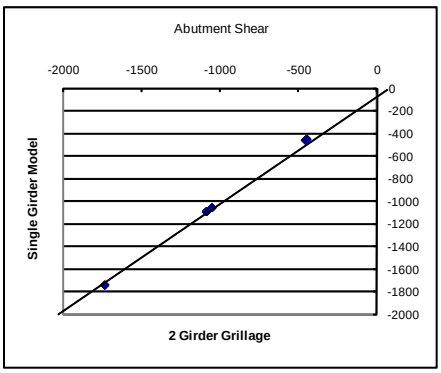
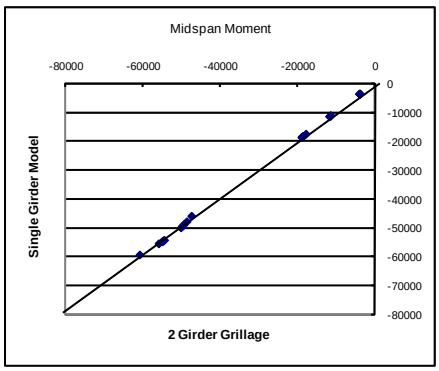


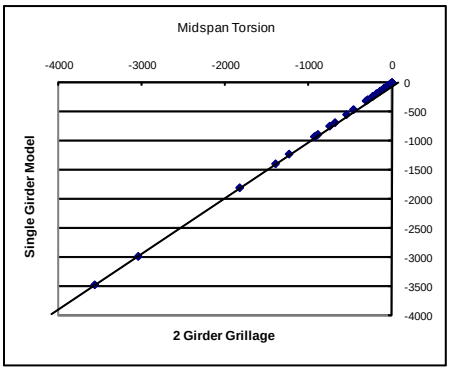
Figure E.1.2: Single Cell, Pre-Cast, 6'x6' Column: Self Weight

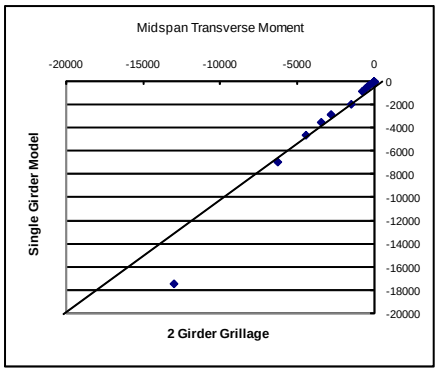


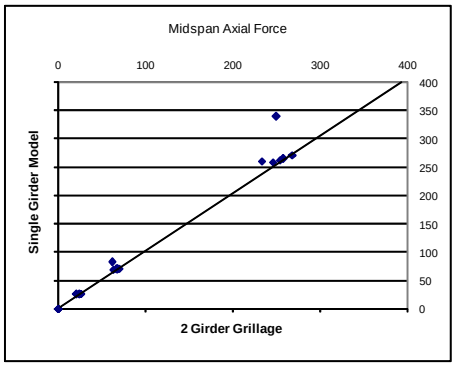












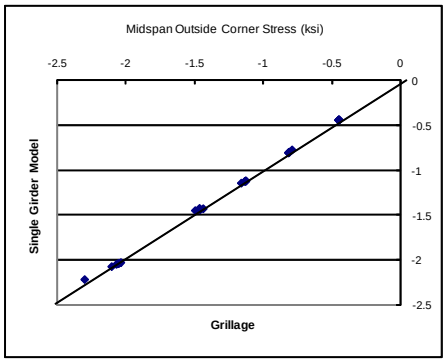
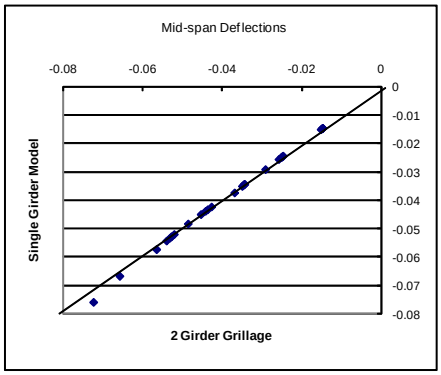
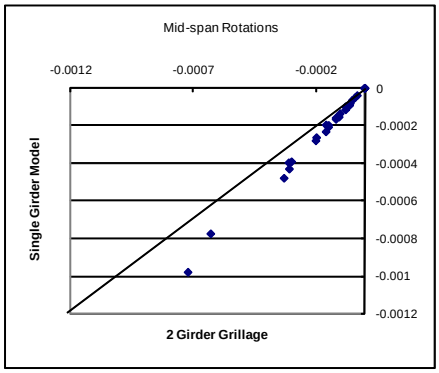
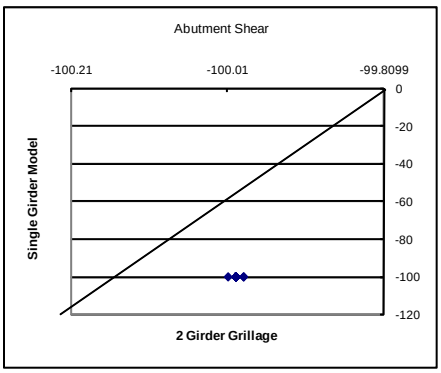
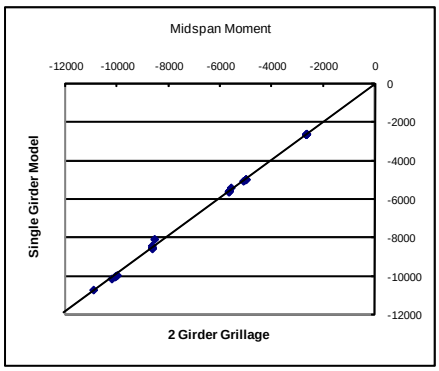


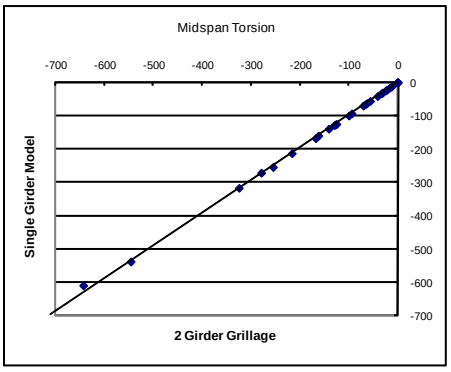
Figure E.1.3: Single Cell, Precast, 6'x18' Column: Live Load Total

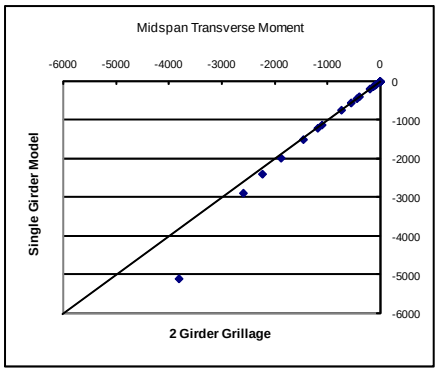


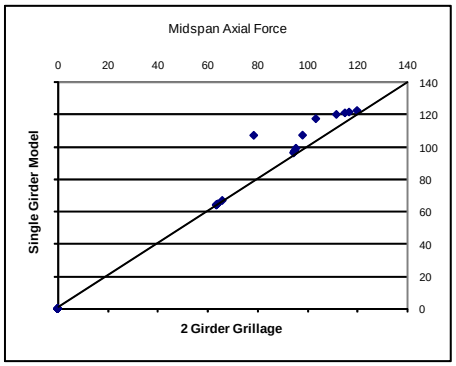












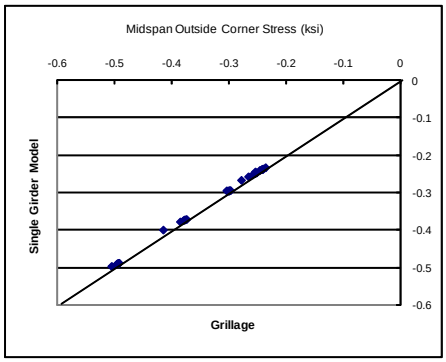
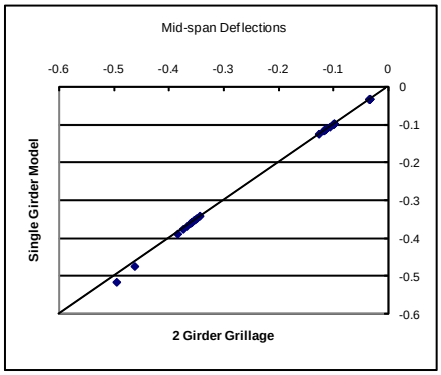
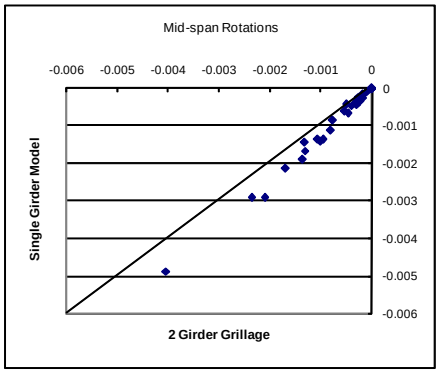
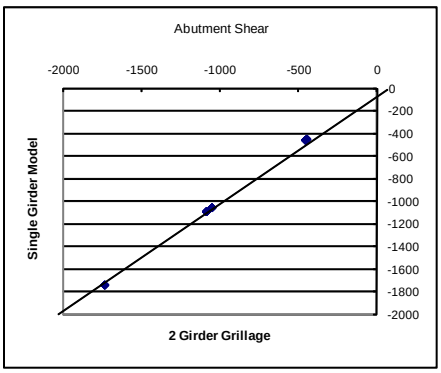
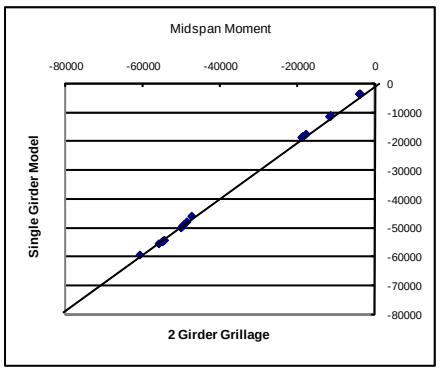


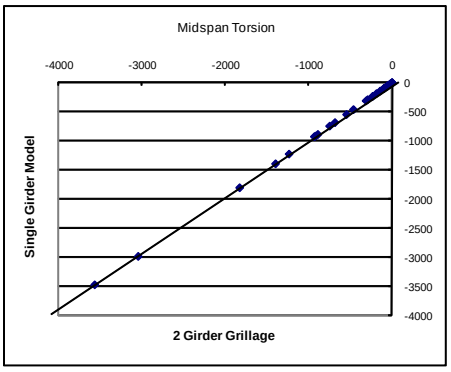
Figure E.1.4: Single Cell, Pre-Cast, 6x6 Column: Live Load Total

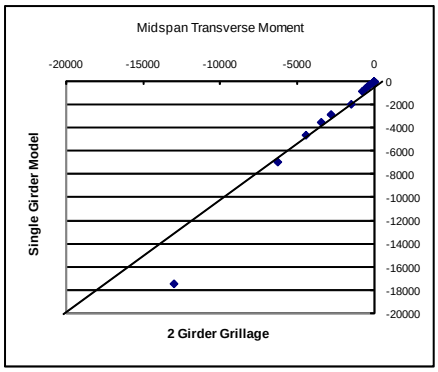


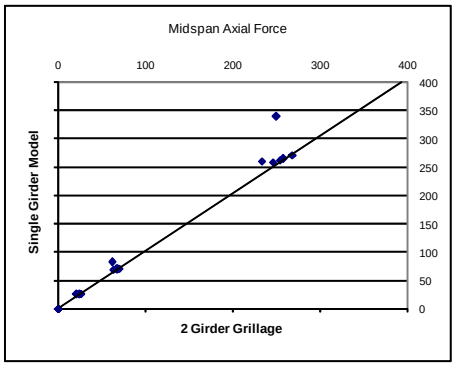












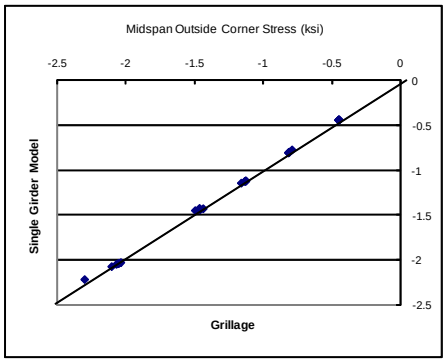
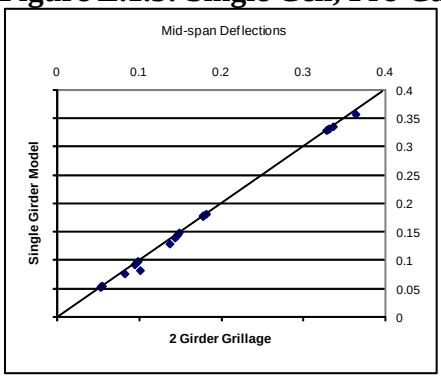
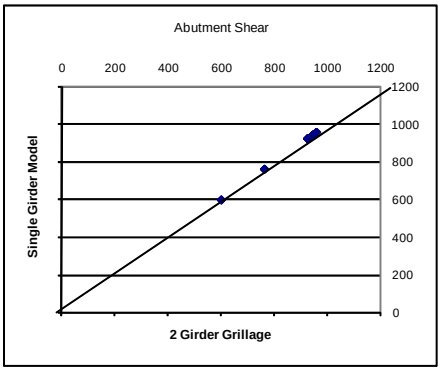
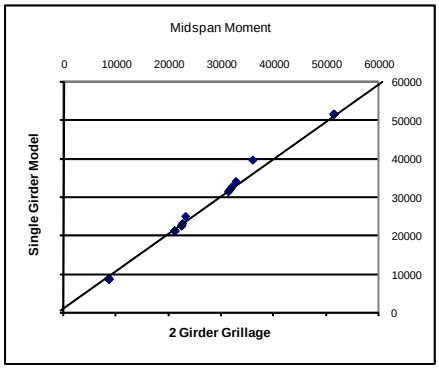
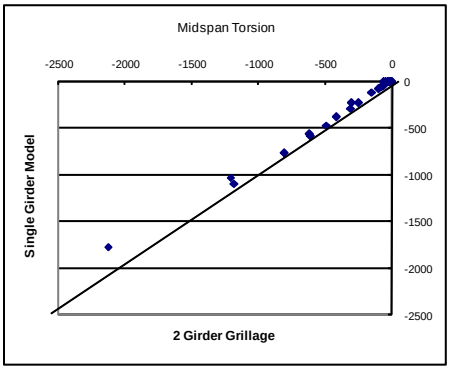


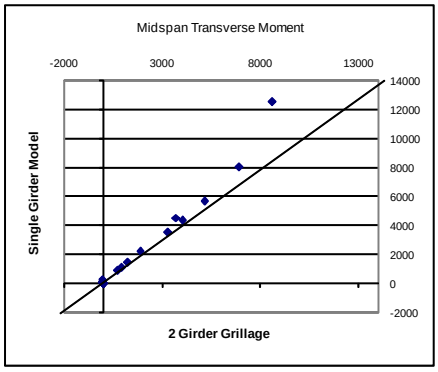
Figure E.1.5: Single Cell, Pre-Cast, 6'x18' Column: Post Tension Total

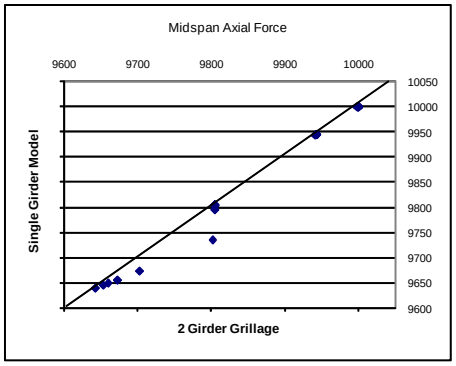












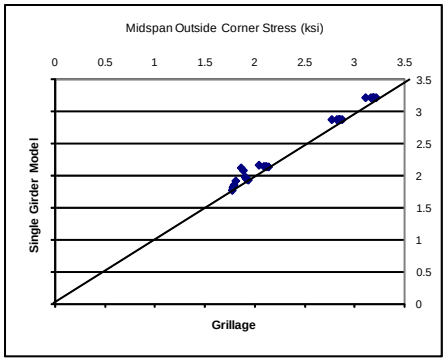
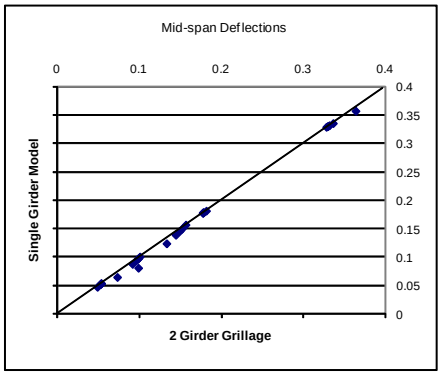
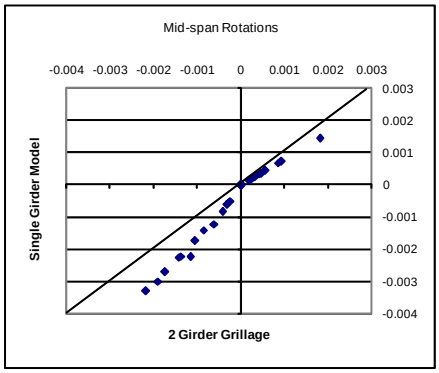
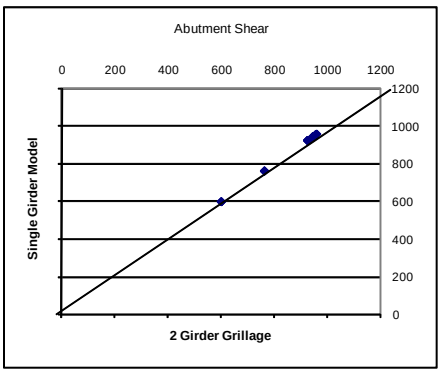
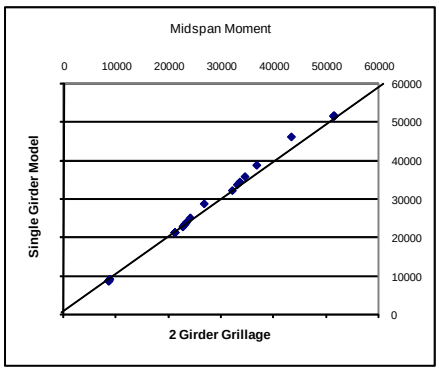


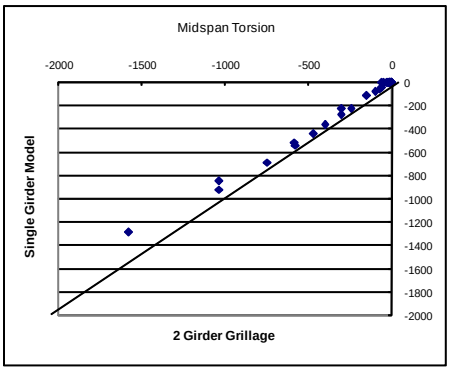
Figure E.1.6: Single Cell, Pre-Cast, 6x6 Column: Post Tension Total

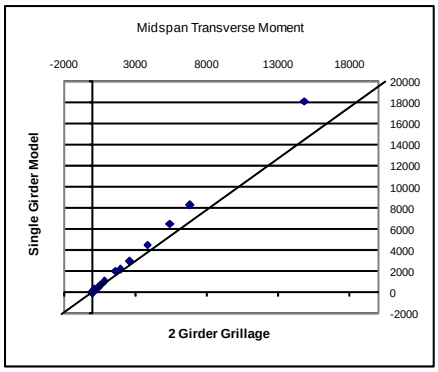


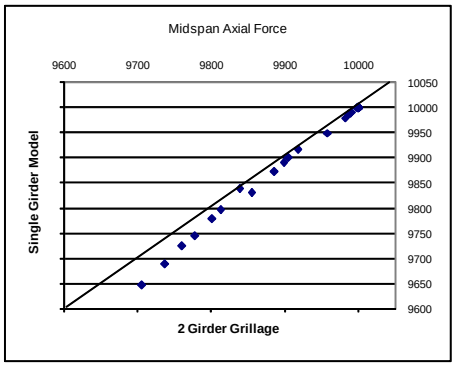












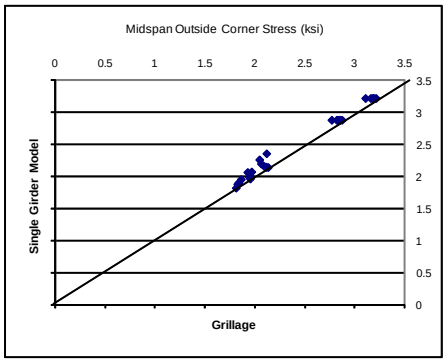
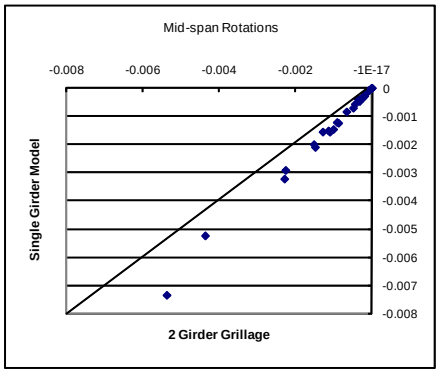
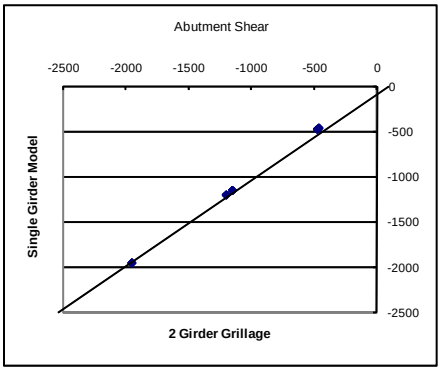
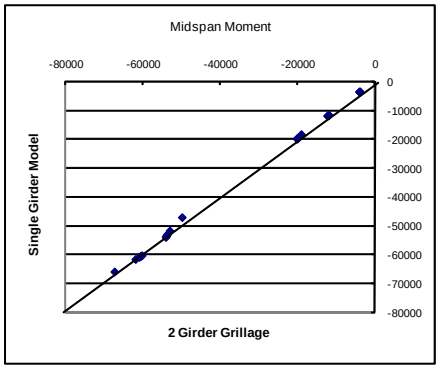
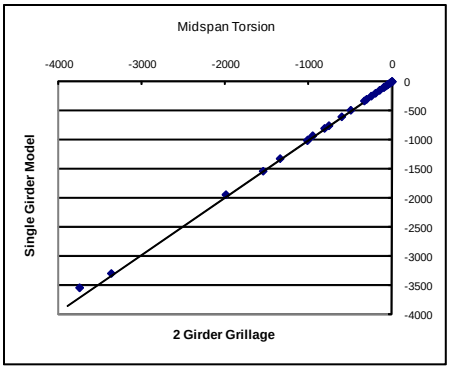


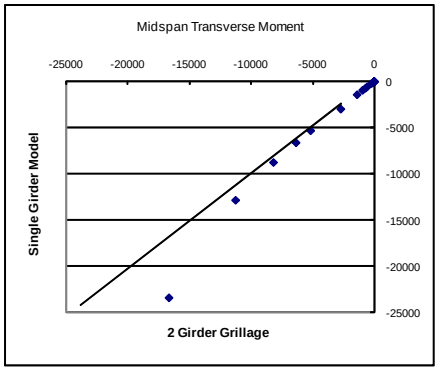
Figure E.1.7: Single Cell, Cast In Place, 6’x18’ Column: Self Weight

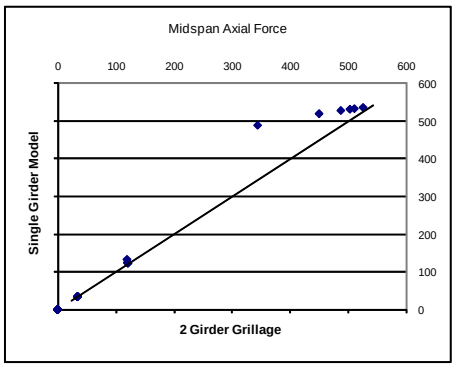












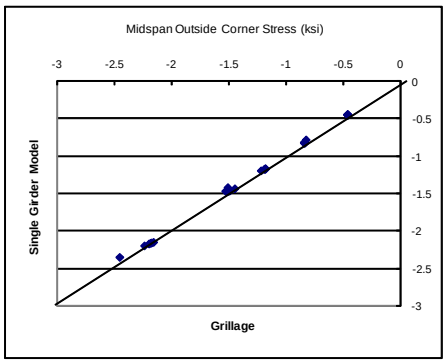
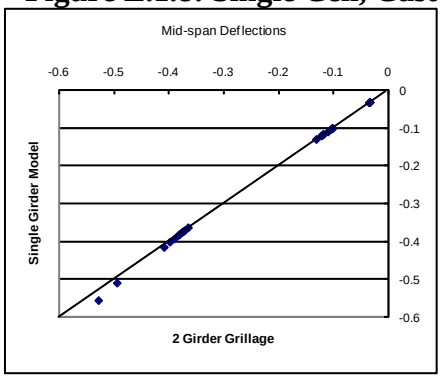
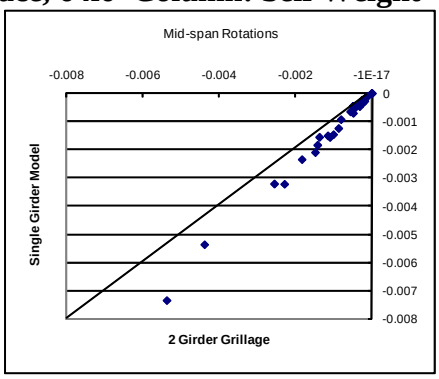
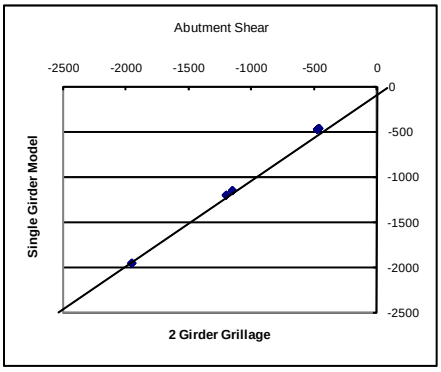
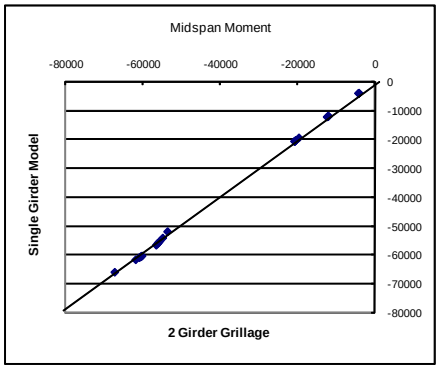


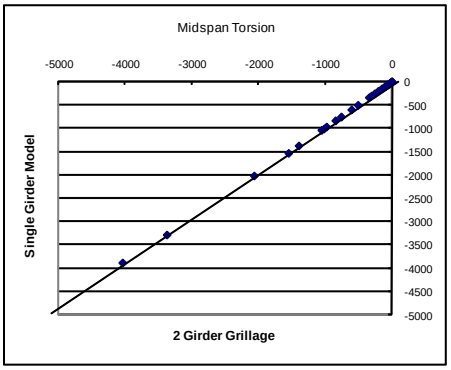
Figure E.1.8: Single Cell, Cast In Place, 6'x6' Column: Self Weight

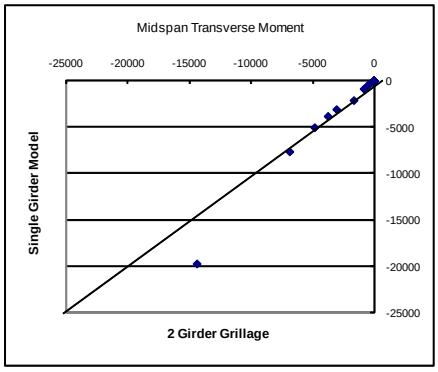


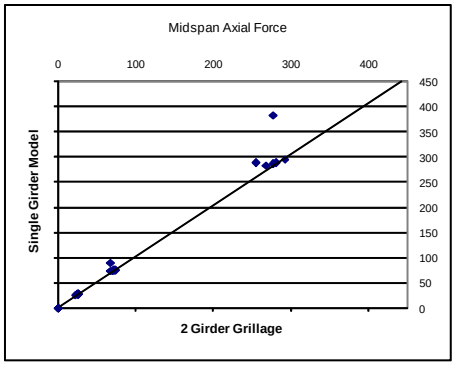












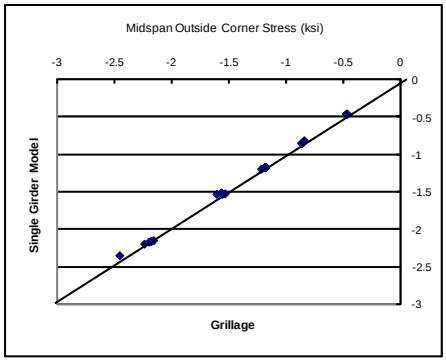
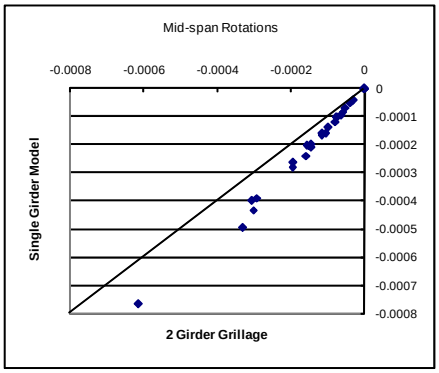
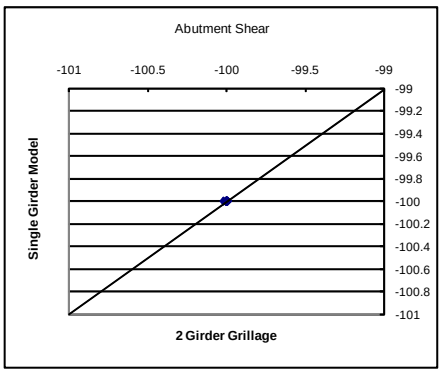
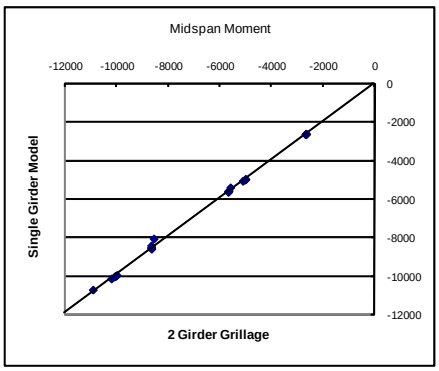
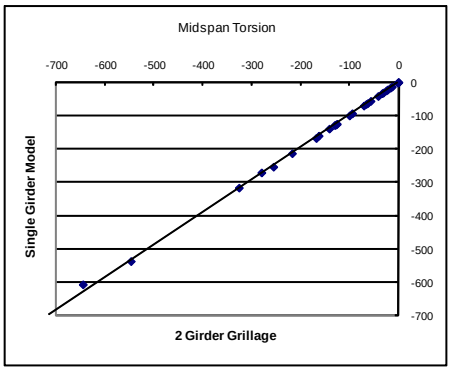


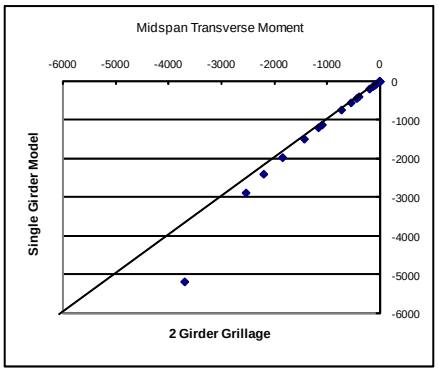
Figure E.1.9: Single Cell, Cast In Place, 6'x18' Column: Live Load Total



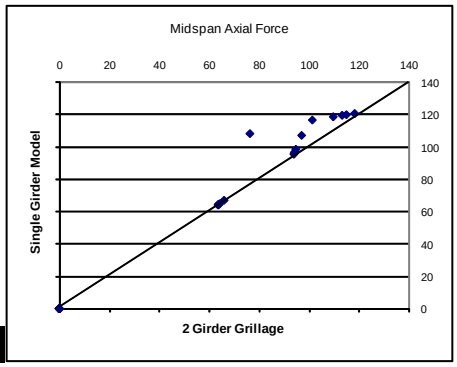








[redacted]



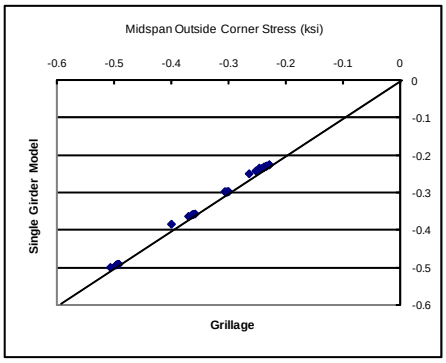
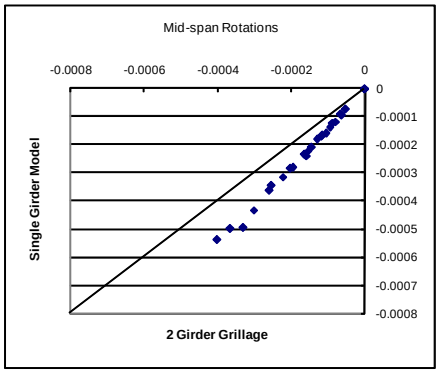
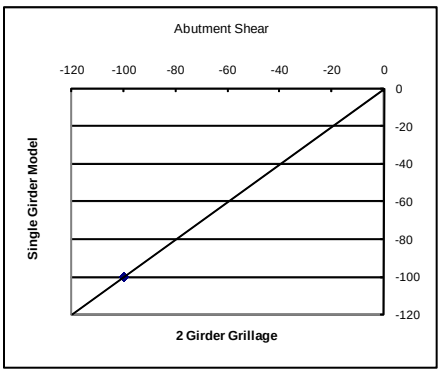
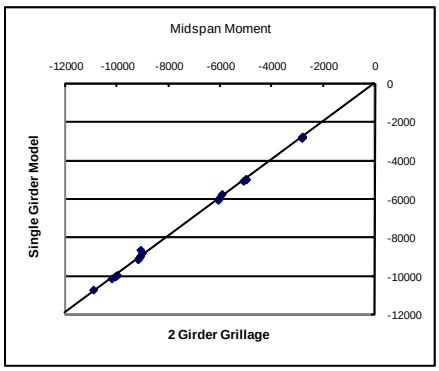
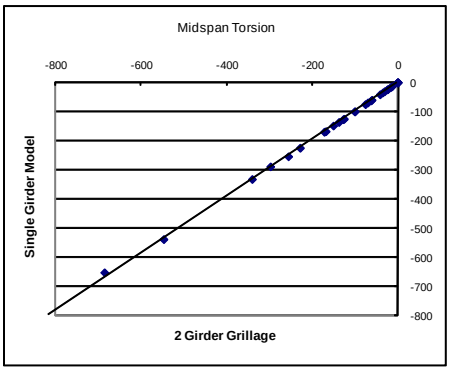


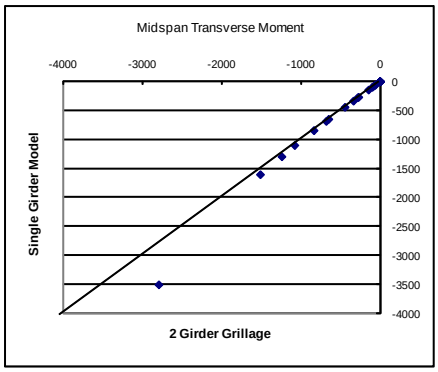
Figure E.1.10: Single Cell, Cast In Place, 6'x6' Column: Live Load Total

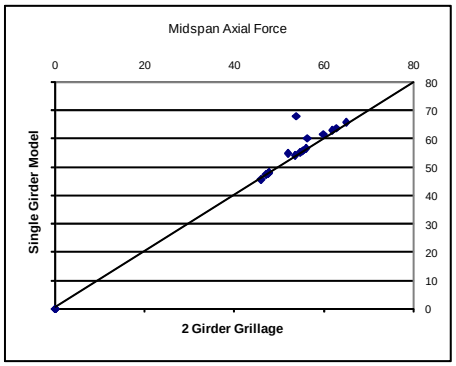












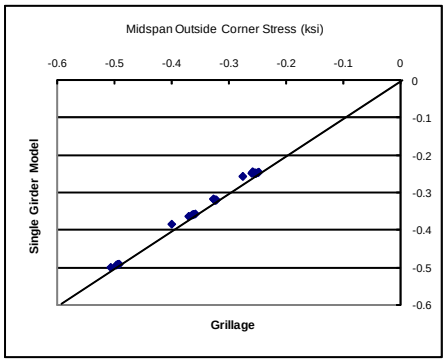
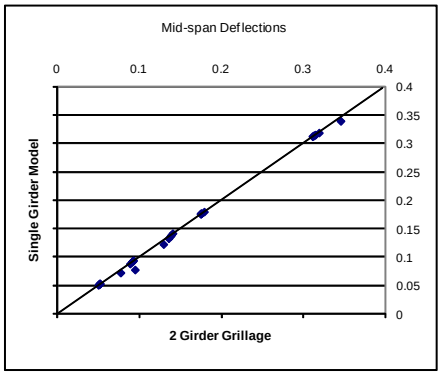
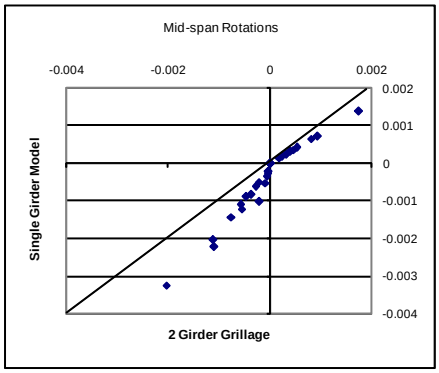
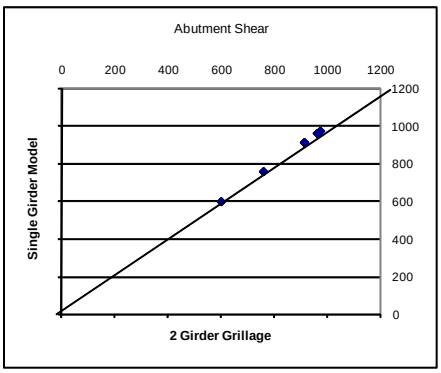
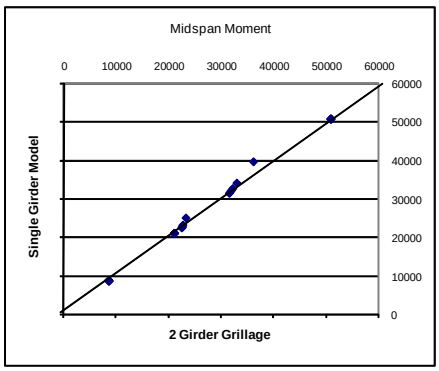


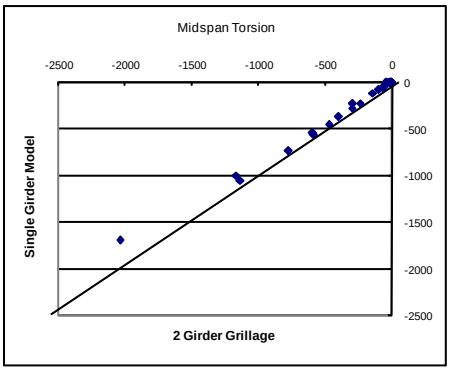
Figure E.1.11: Single Cell, Cast In Place, 6'x18' Column: Post Tension Total

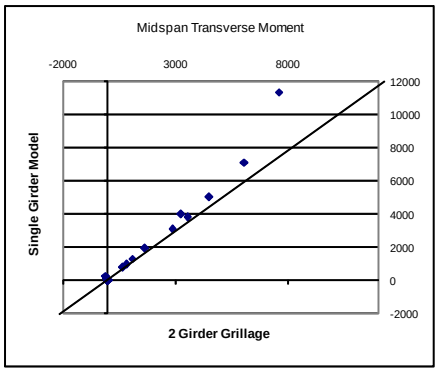


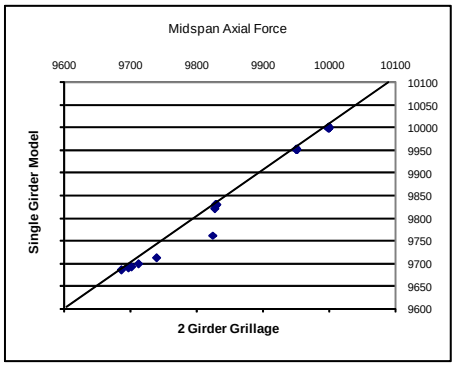












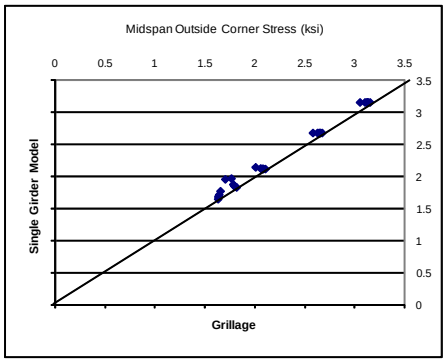
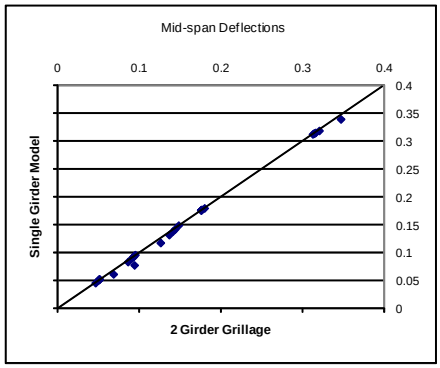
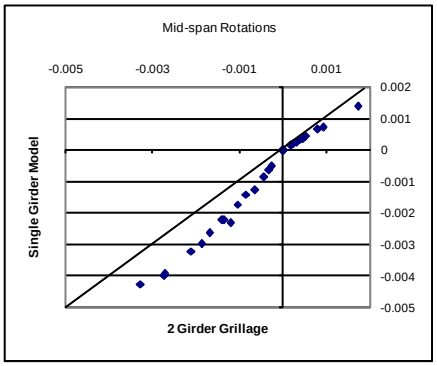
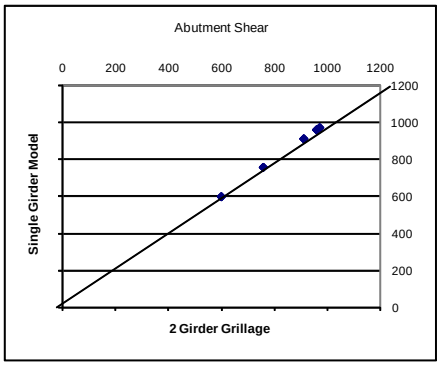
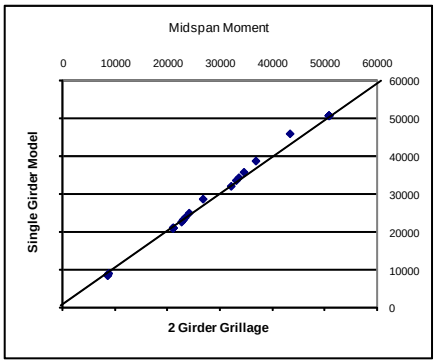


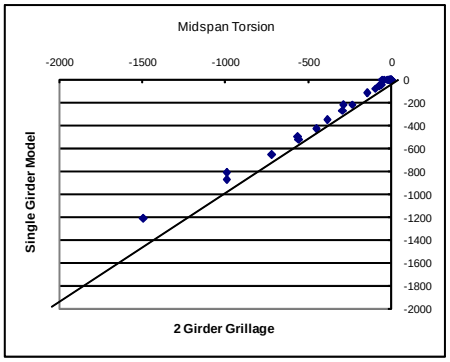
Figure E.1.12: Single Cell, Cast In Place, 6'x6' Column: Post Tension Total

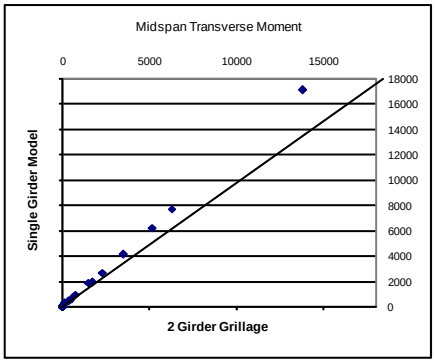


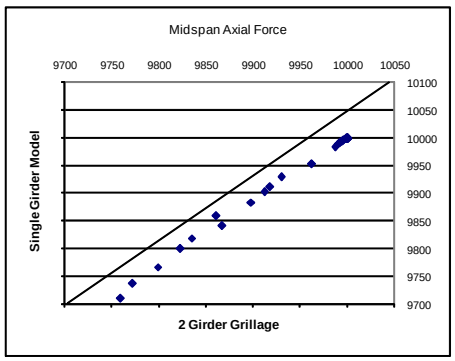












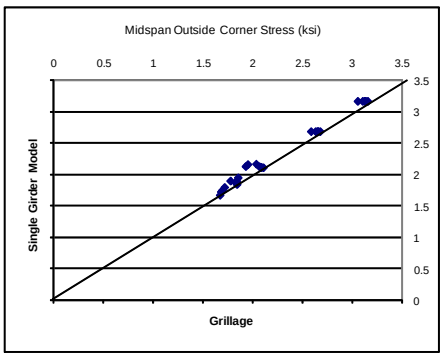
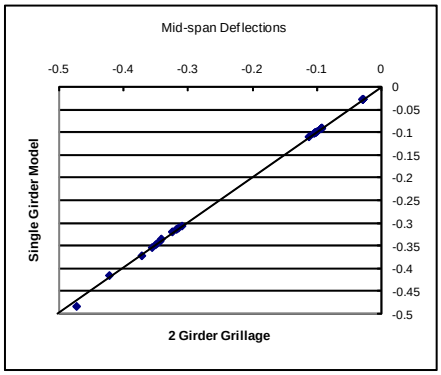
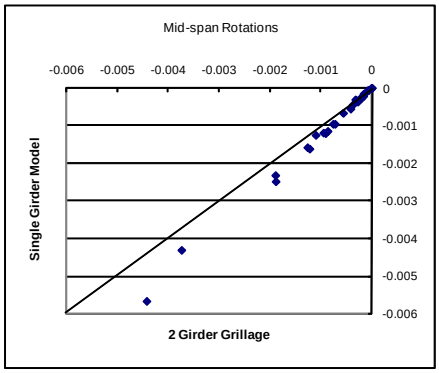
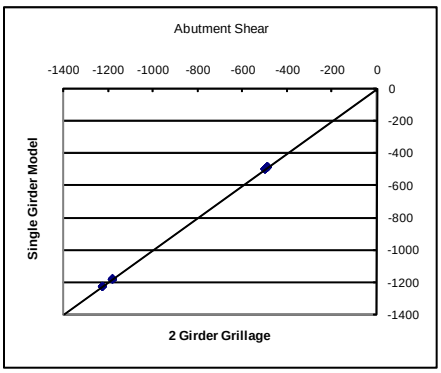
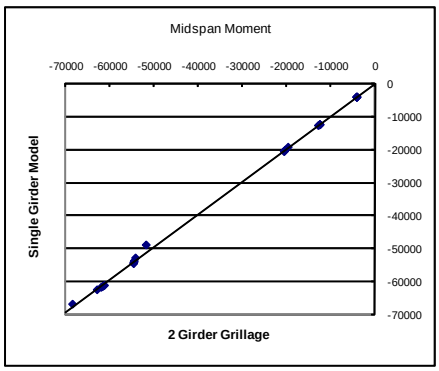


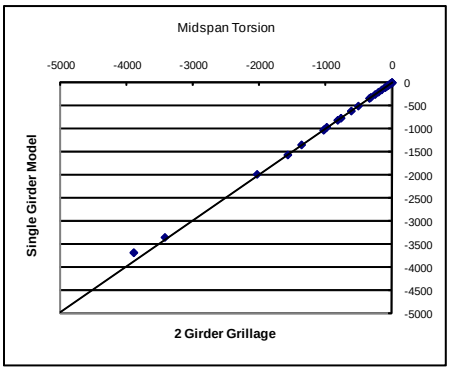
Figure E.1.13: Two Cell, Cast In Place, 6'x18' Column: Self Weight

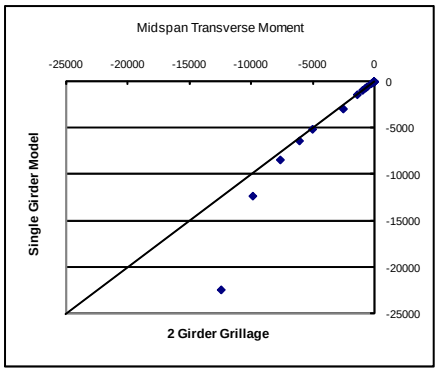


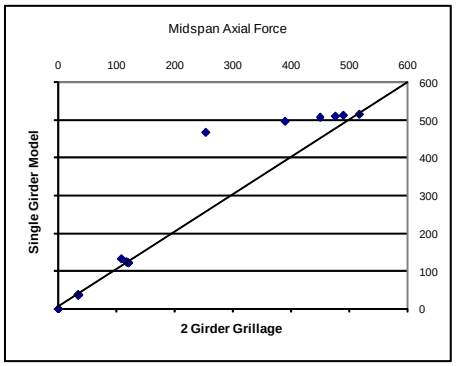












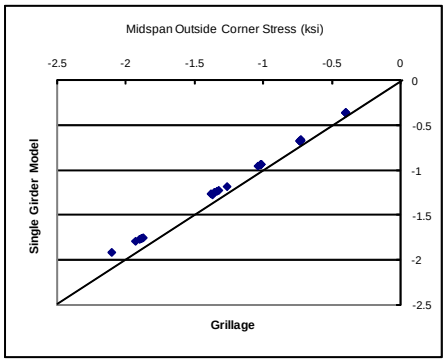
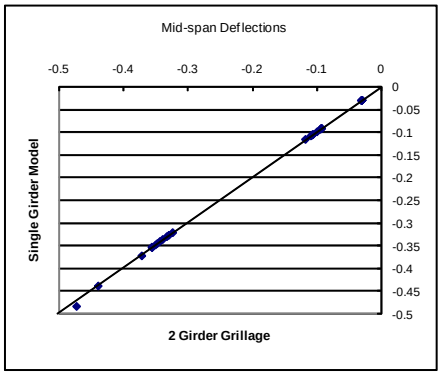
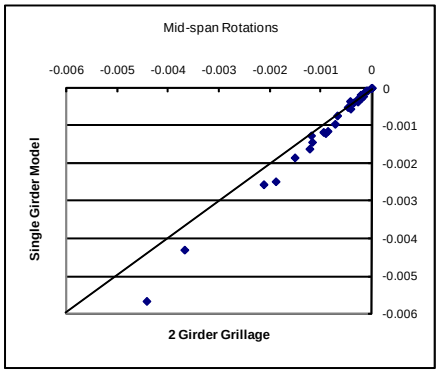
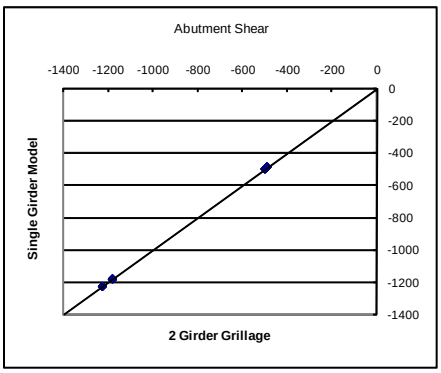
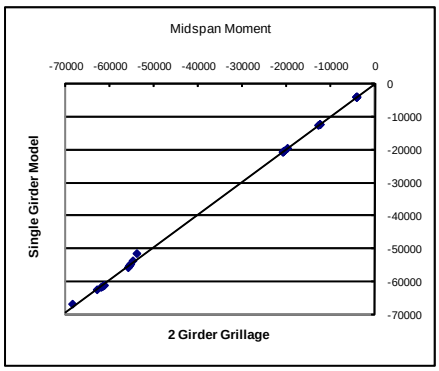


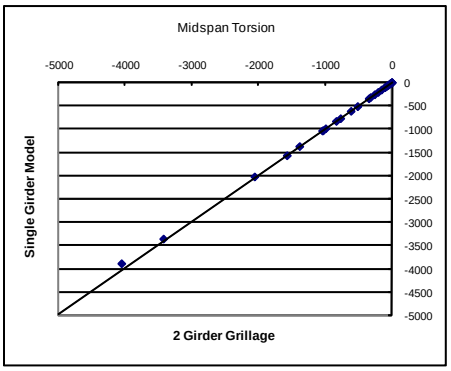
Figure E.1.14: Two Cell, Cast In Place, 7'x7'Column: Self Weight

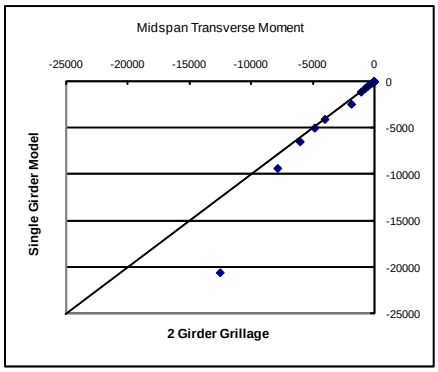


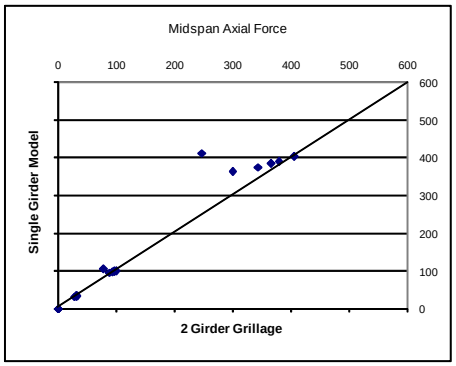












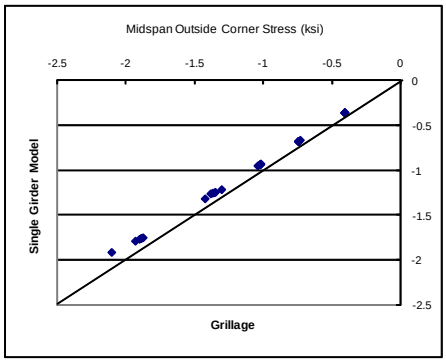
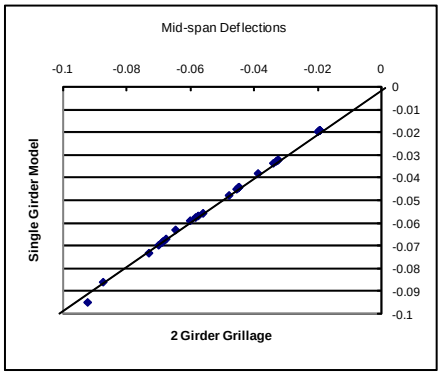
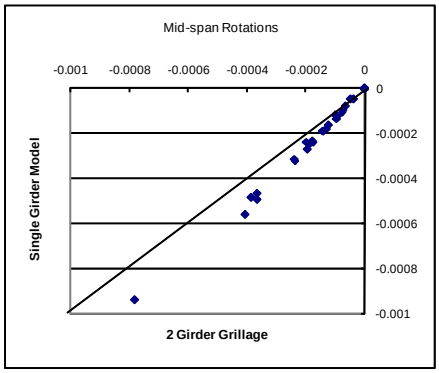
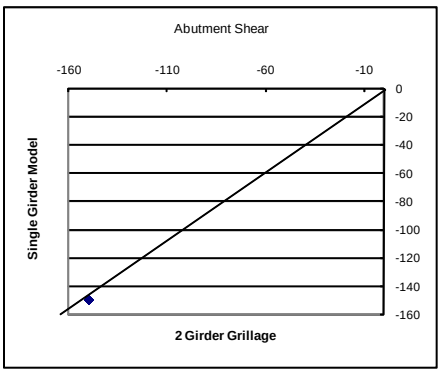
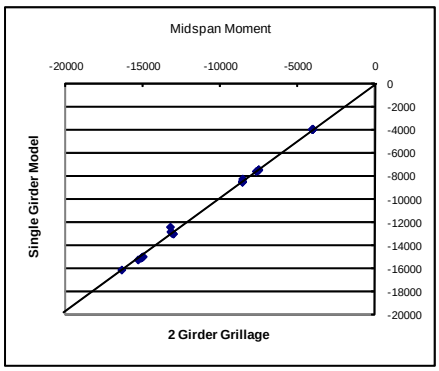


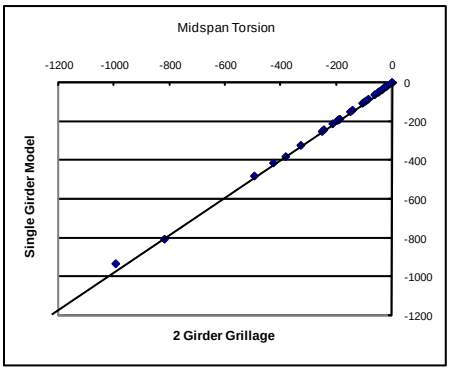
Figure E.1.15: Two Cell, Cast In Place, 6'x18' Column: Live Load Total

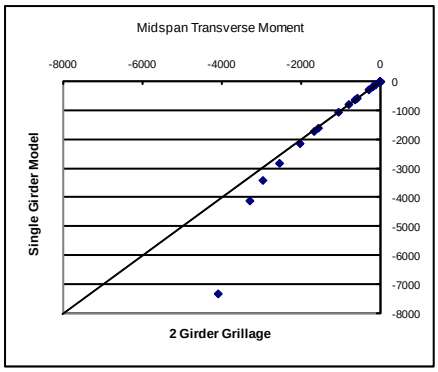


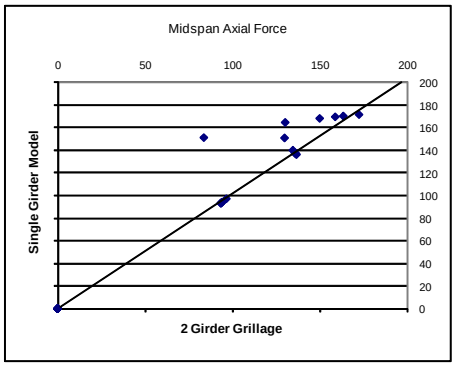












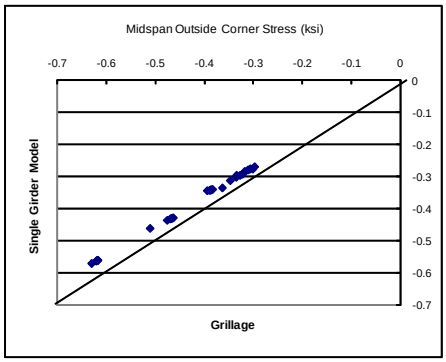
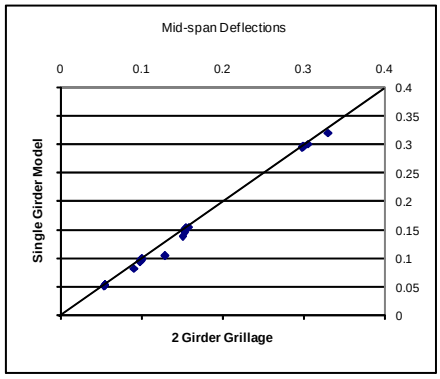
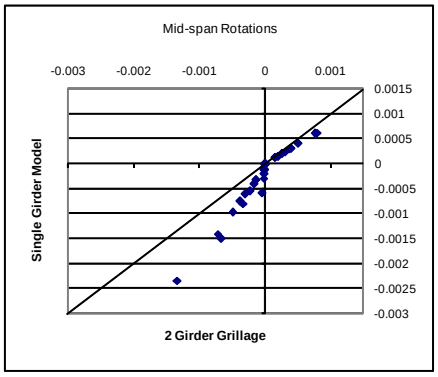
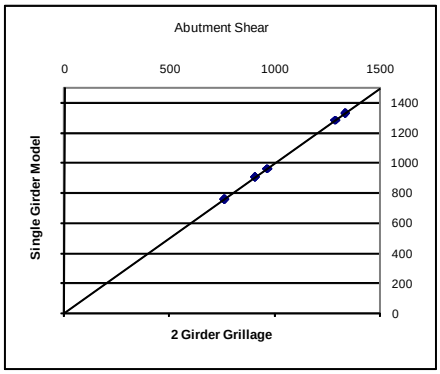
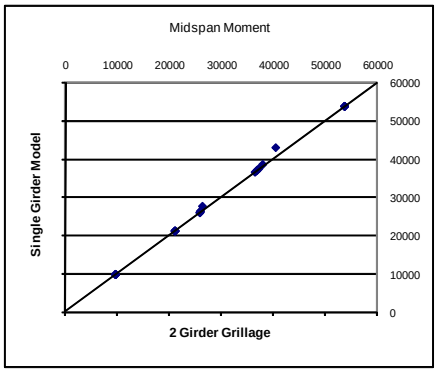


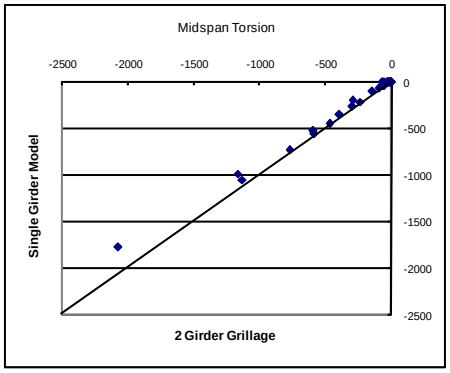
Figure E.1.16: Two Cell, Cast In Place, 7'x7'Column: Live Load Total

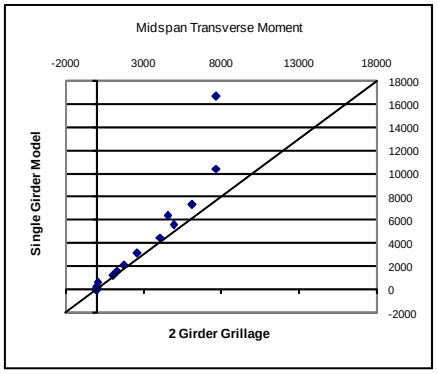


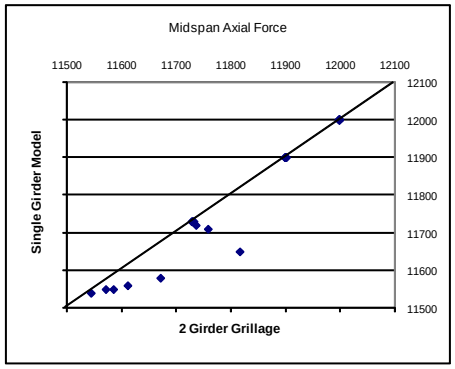












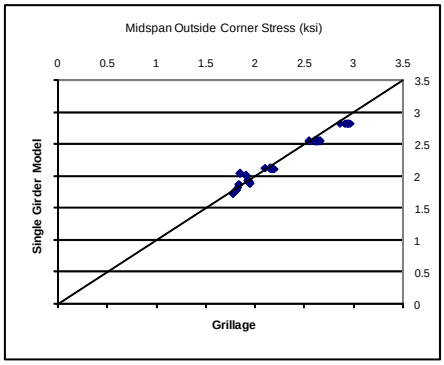
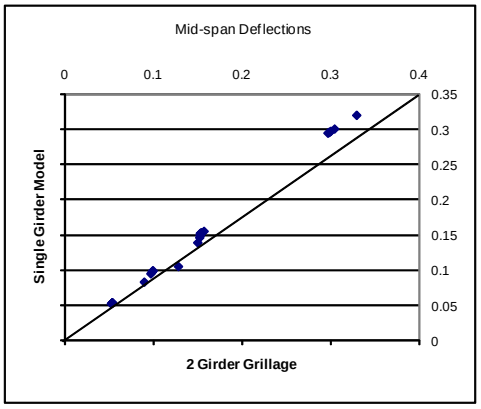
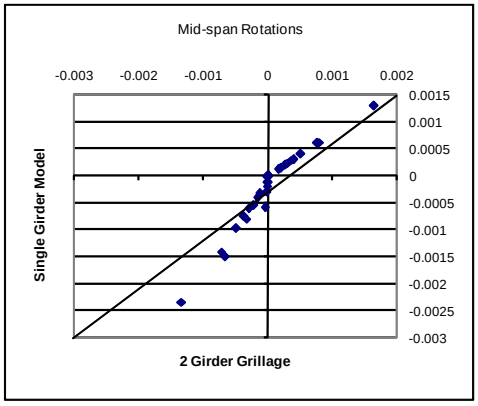
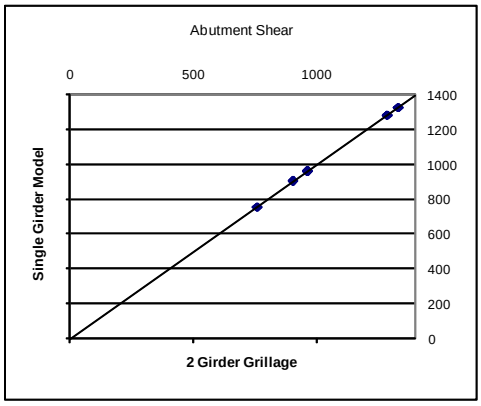
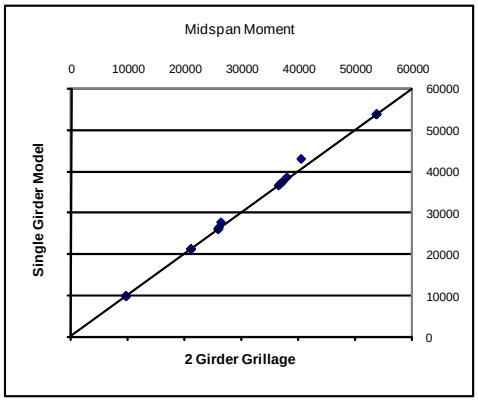


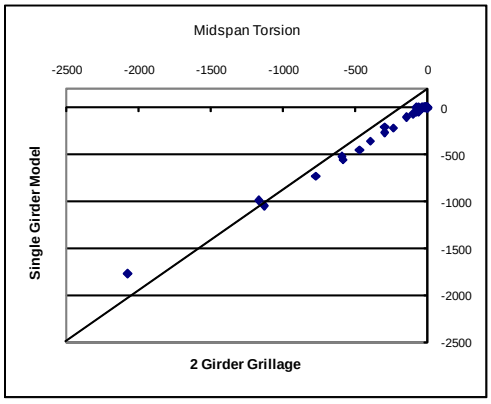
Figure E.1.17: Two Cell, Cast In Place, 6'x18' Column: Post Tension Total

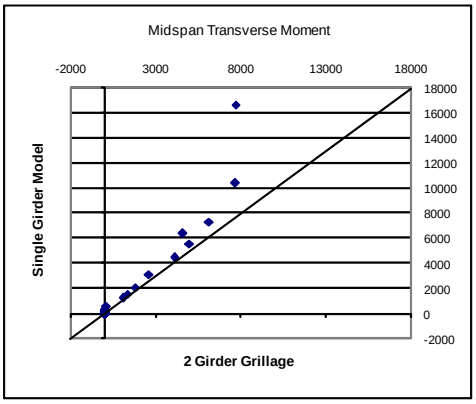


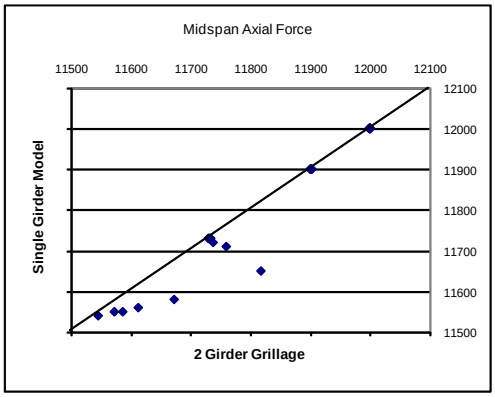












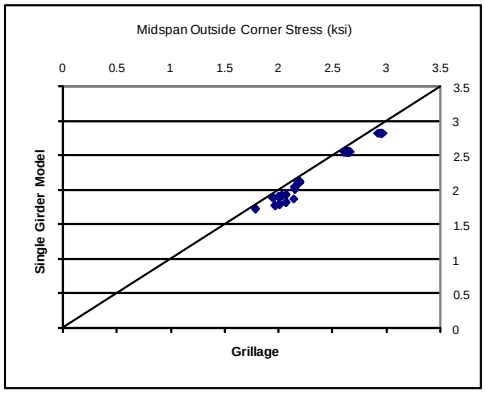
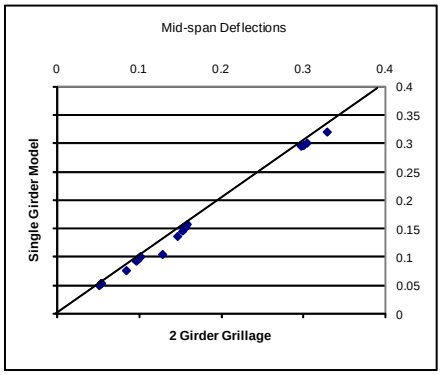
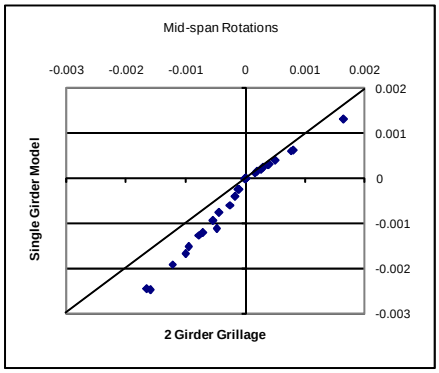
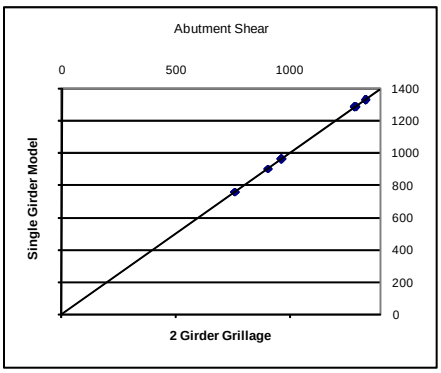
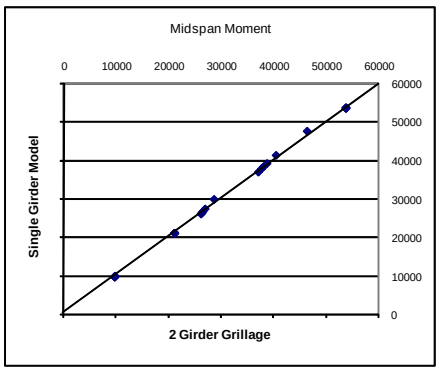


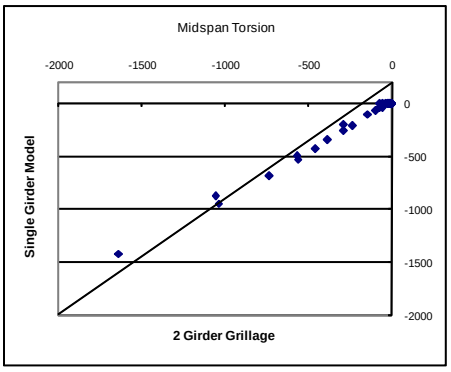
Figure E.1.18: Two Cell, Cast In Place, 7'x7'Column: Post Tension Total

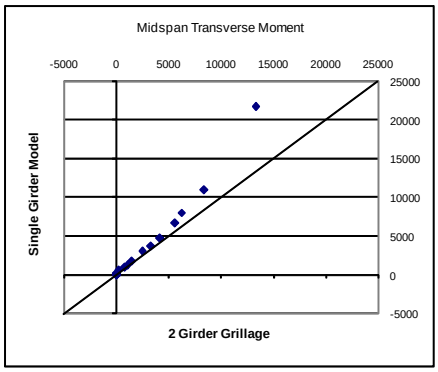


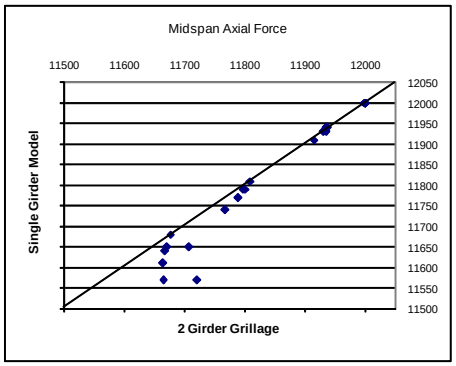












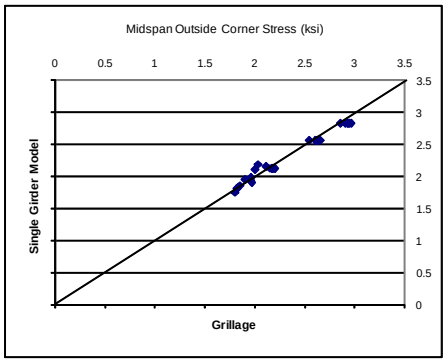
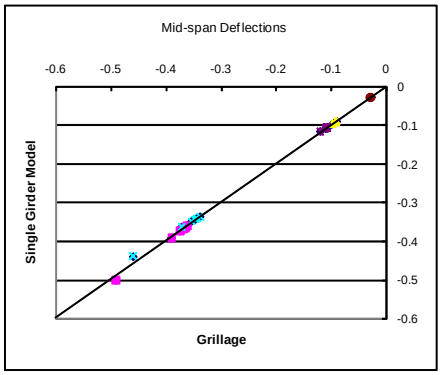
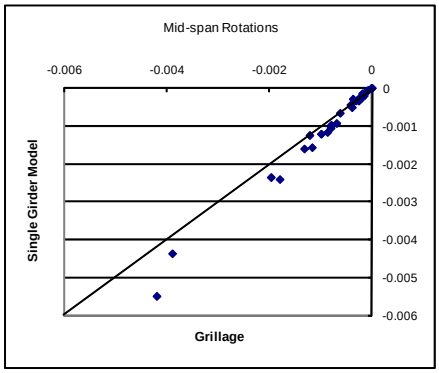
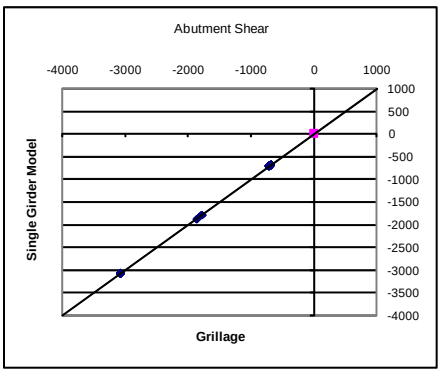
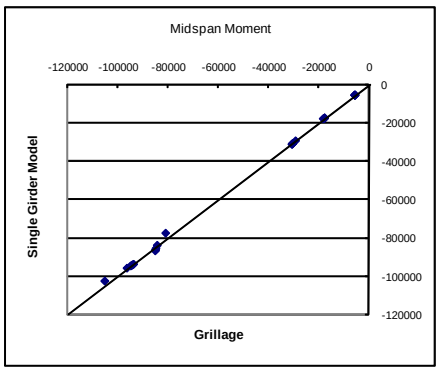


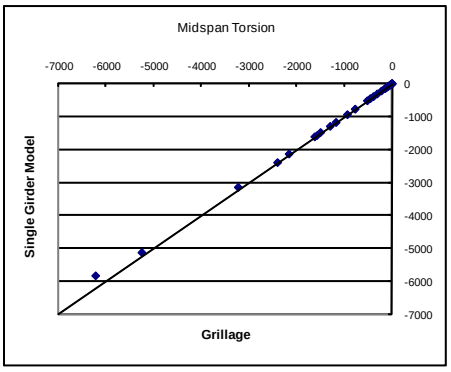
Figure E.1.19: Five Cell, Cast In Place, 6'x18' Column: Self Weight

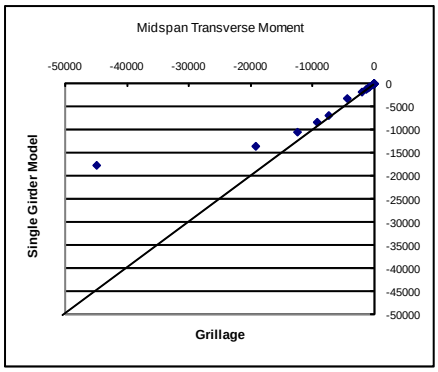


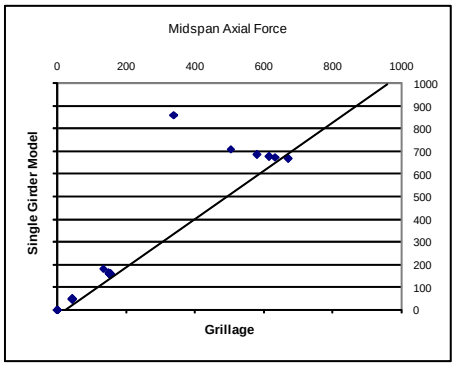












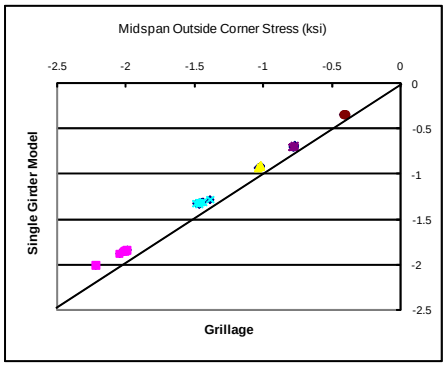
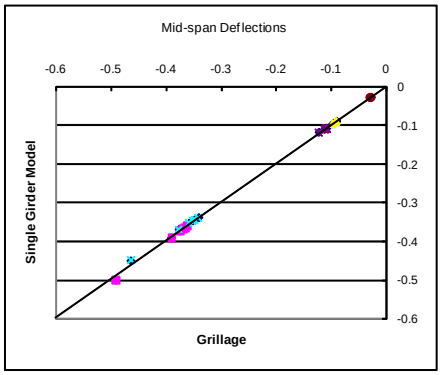
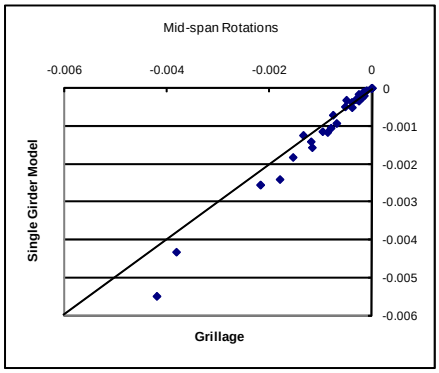
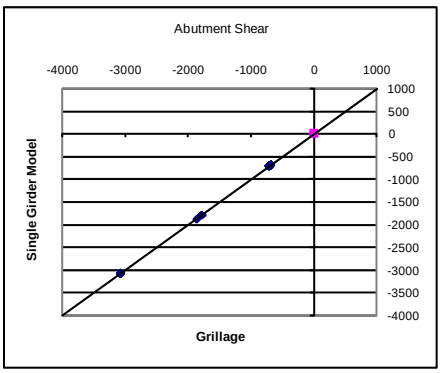
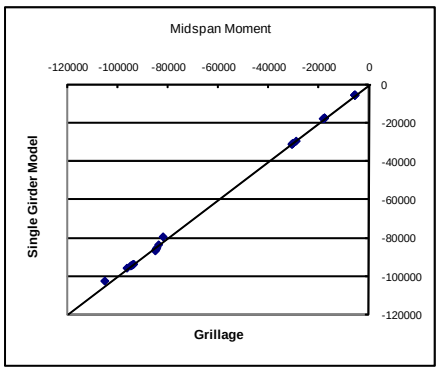


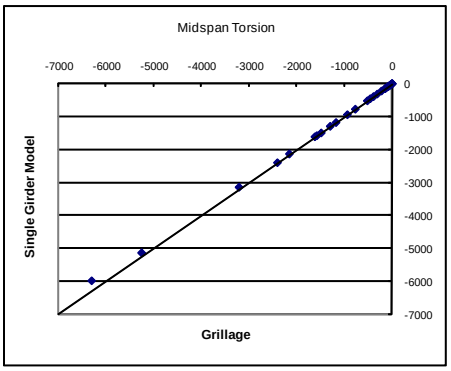
Figure E.1.20: Five Cell, Cast In Place, 8'x8' Column: Self Weight

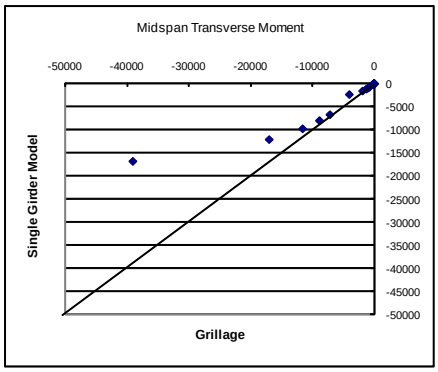


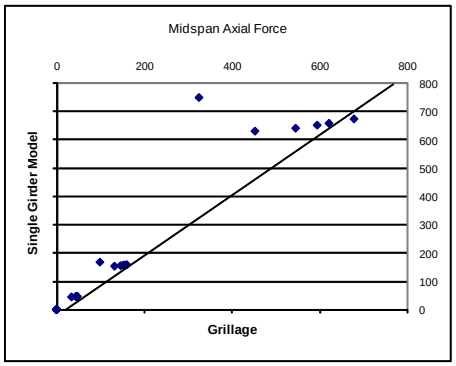












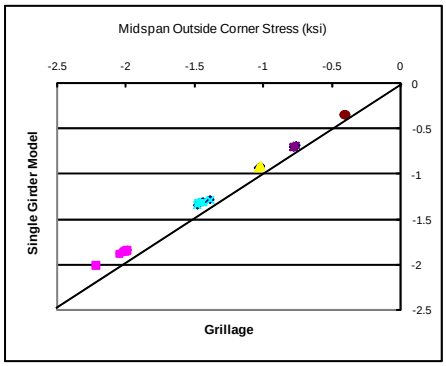
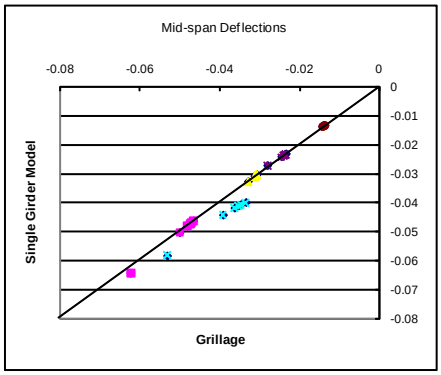
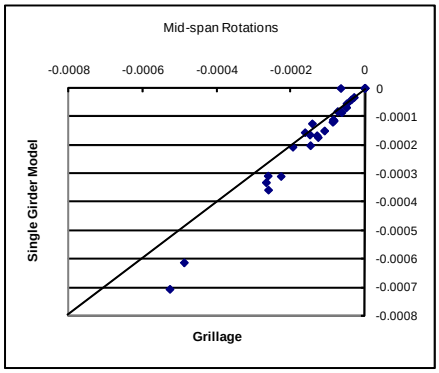
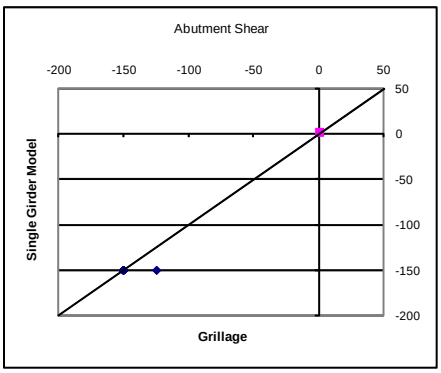
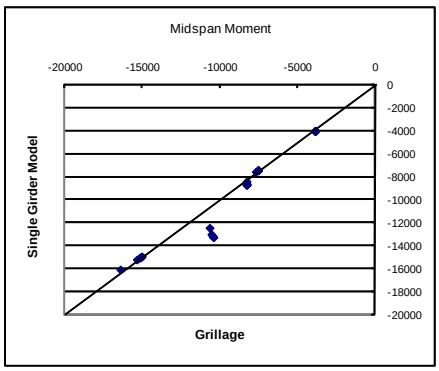


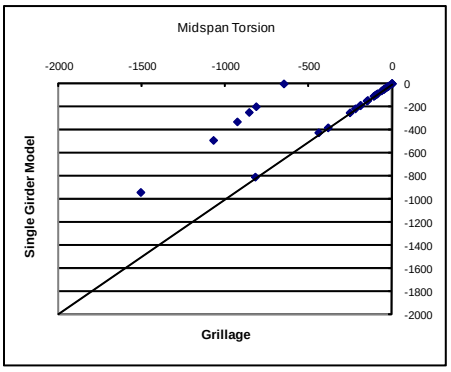
Figure E.1.21: Five Cell, Cast In Place, 6'x18' Column: Live Load Total

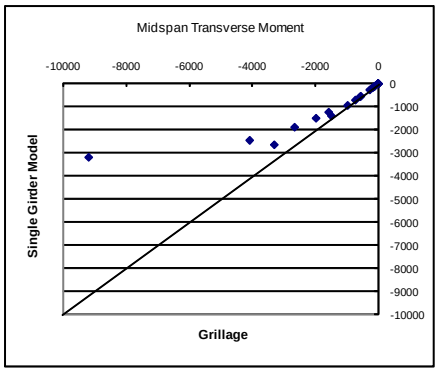


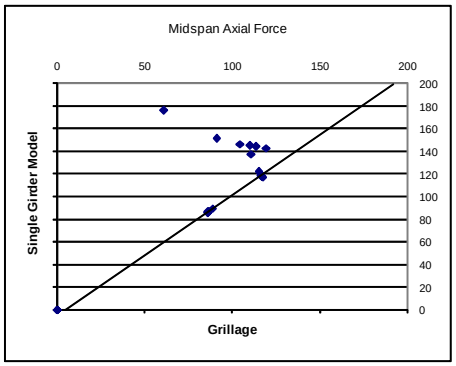












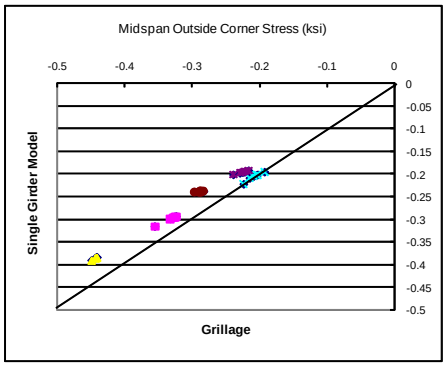
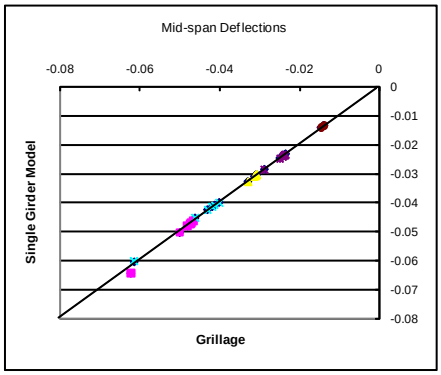
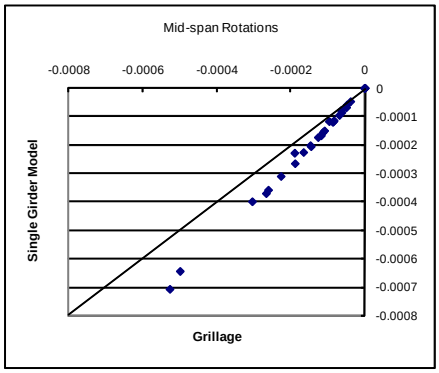
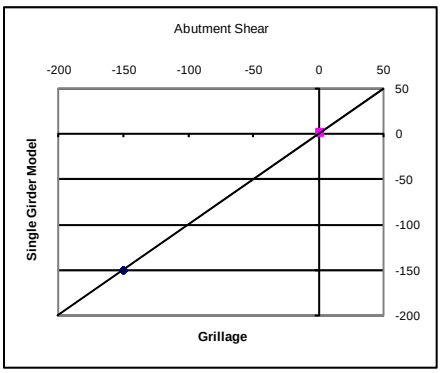
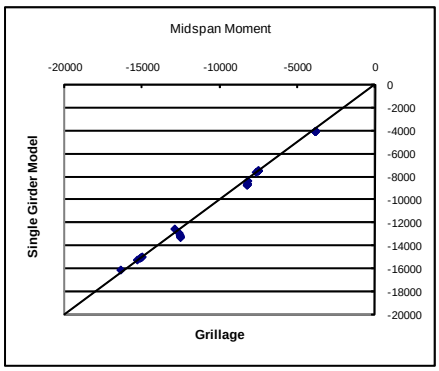


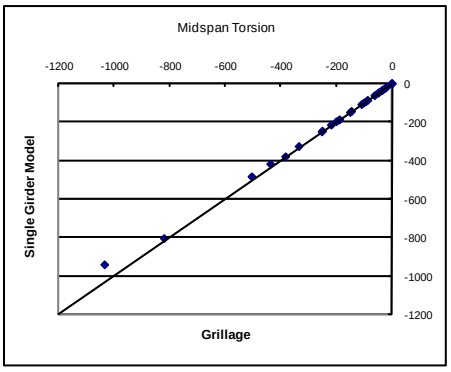
Figure E.1.22: Five Cell, Cast In Place, 8'x8' Column: Live Load Total

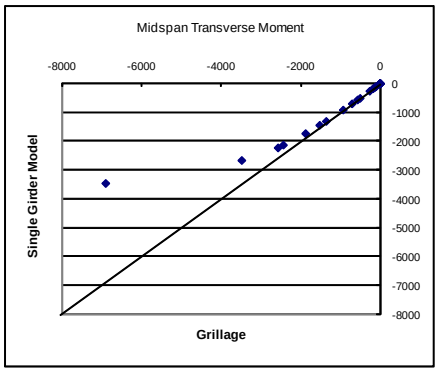


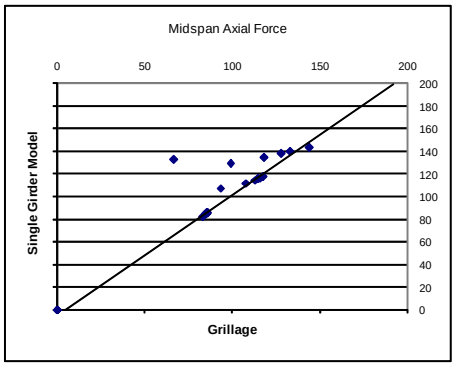












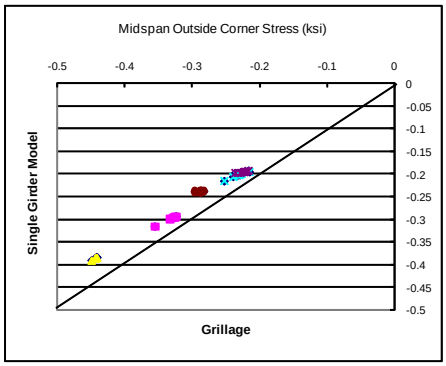
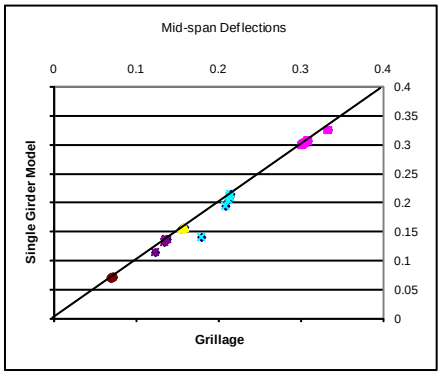
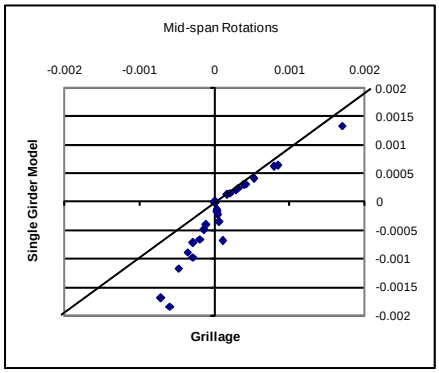
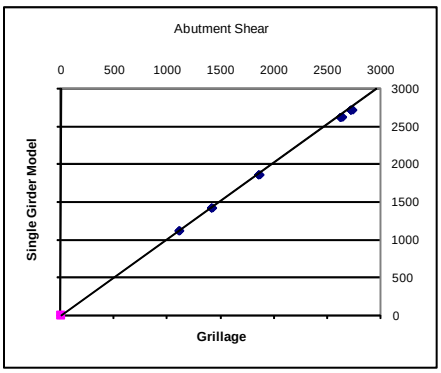
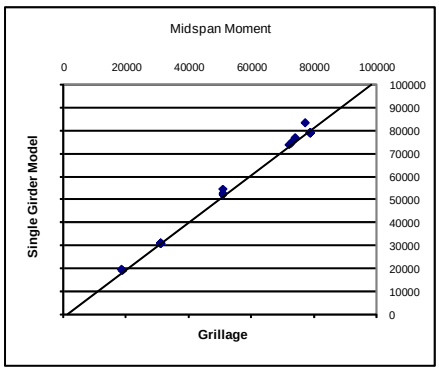


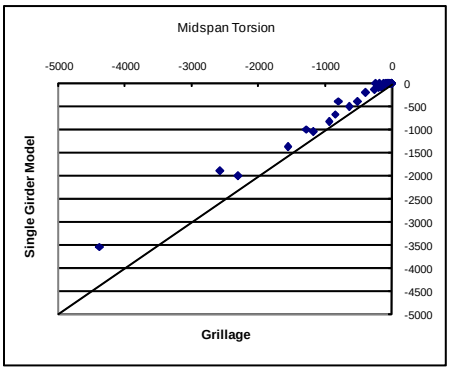
Figure E.1.23: Five Cell, Cast In Place, 6'x18' Column: Post Tension Total

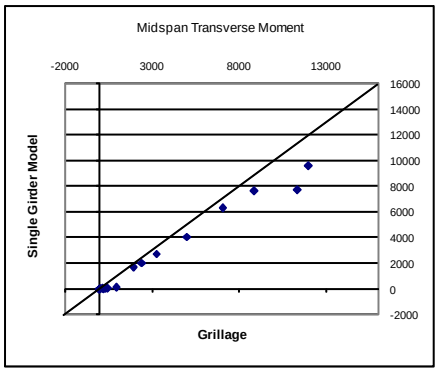


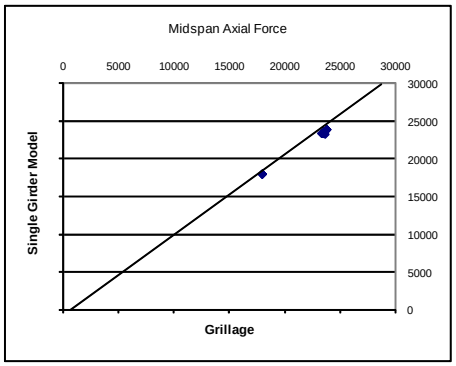












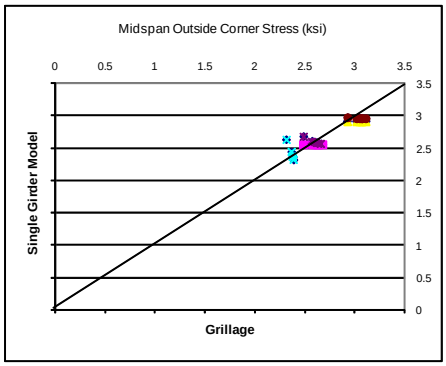
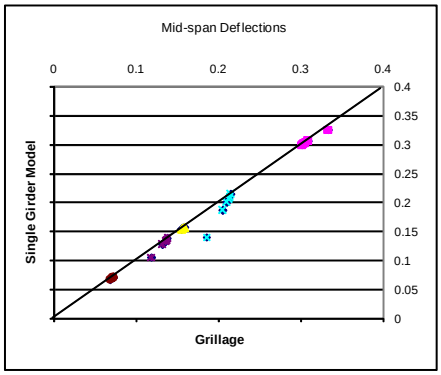
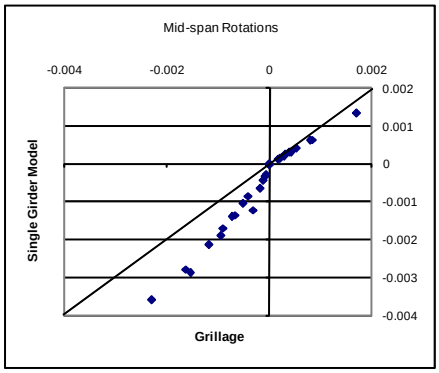
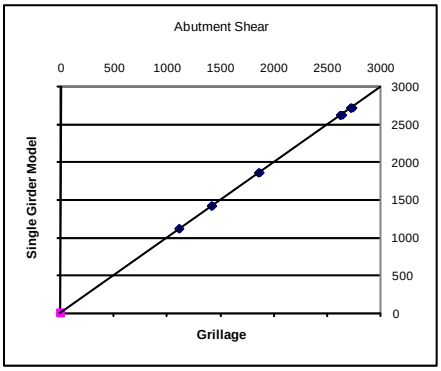
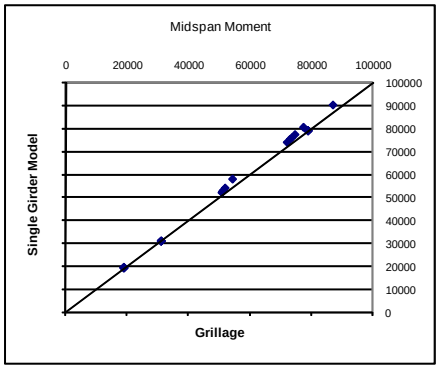


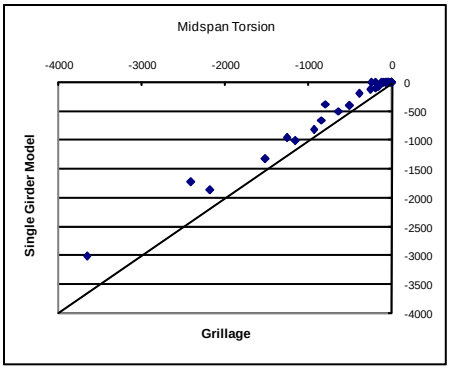
Figure E.1.24: Five Cell, Cast In Place, 8'x8' Column: Post Tension Total

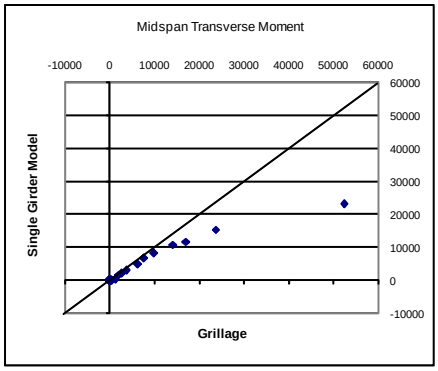


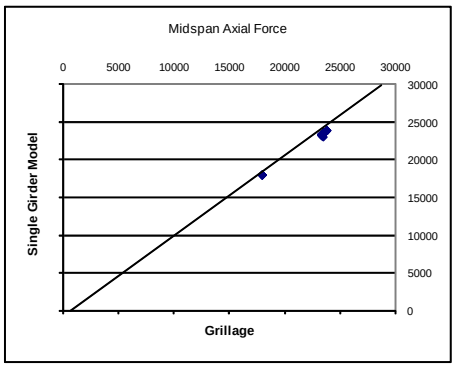












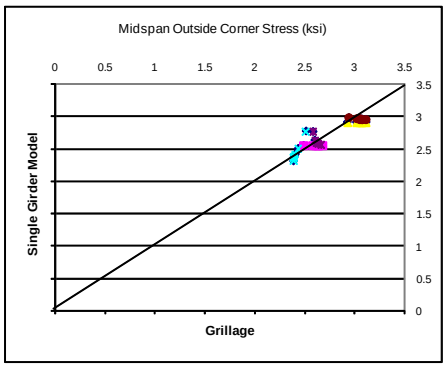
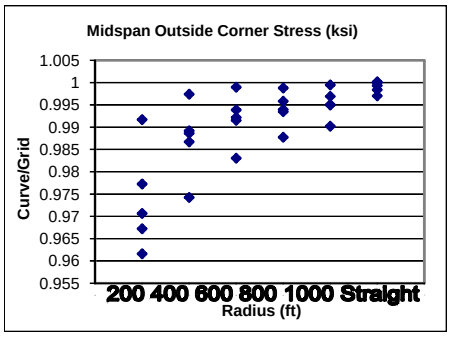
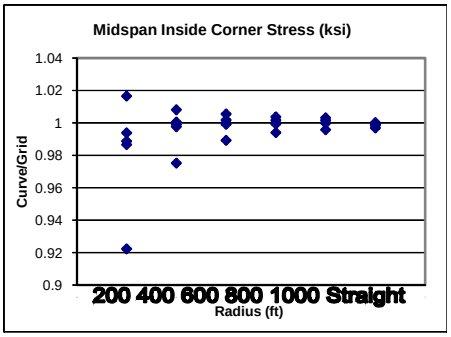
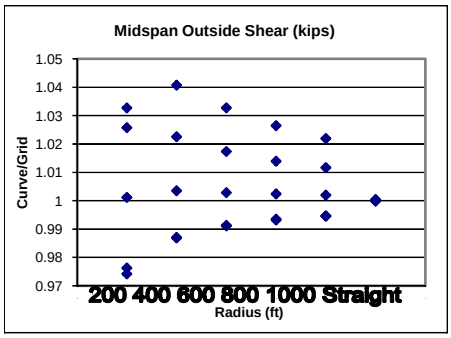


Figure E.2.1: Single Cell, Precast, 6'x18' Column: Self Weight







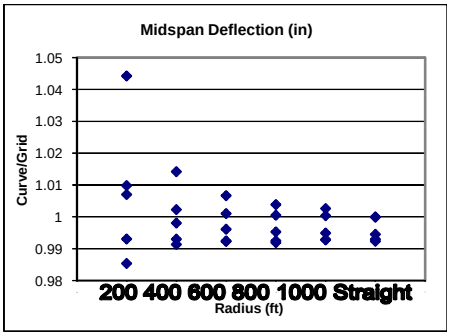
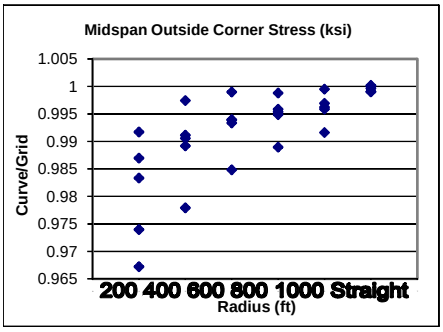
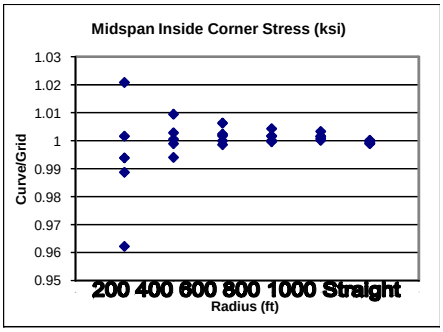
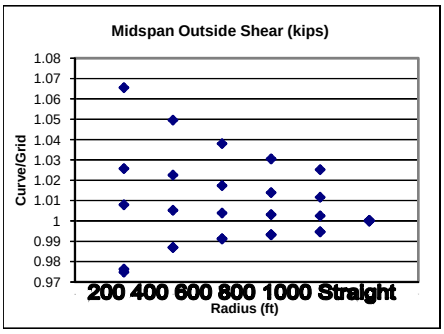


Figure E.2.2: Single Cell, Pre-Cast, 6'x6' Column: Self Weight







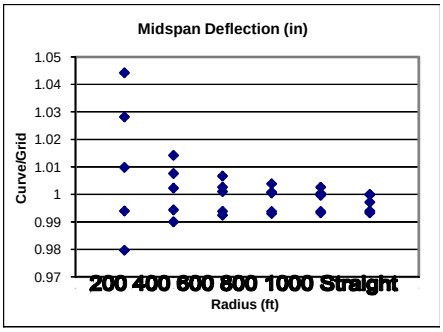
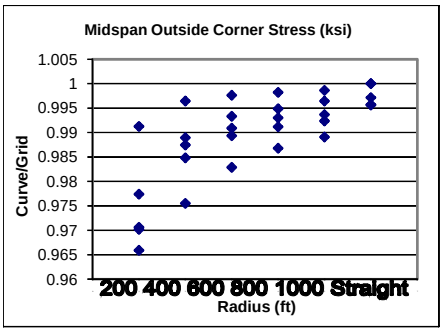
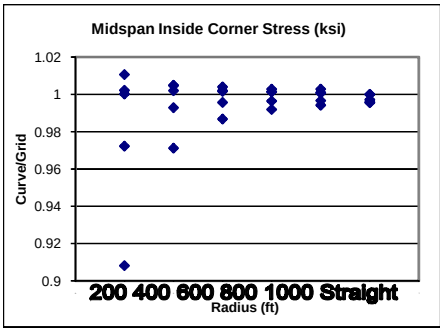
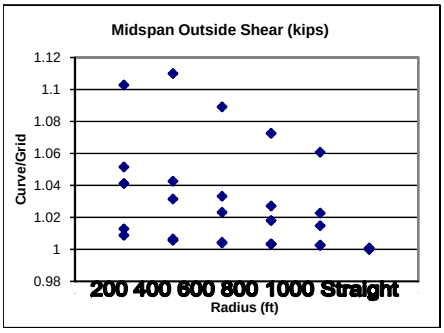


Figure E.2.3: Single Cell, Precast, 6'x18' Column: Live Load Total







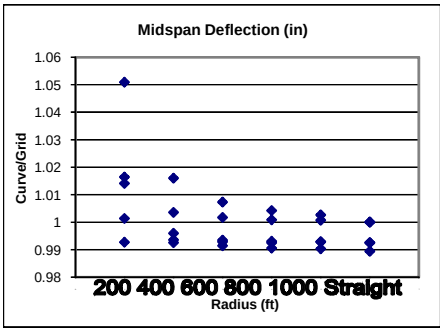
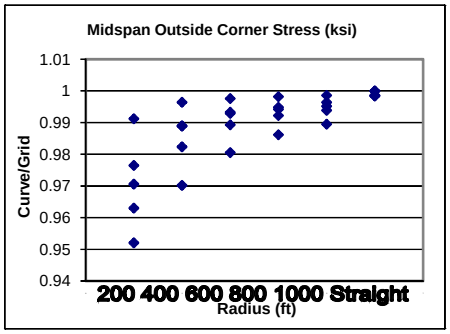
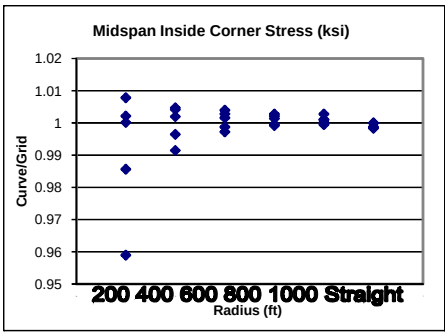
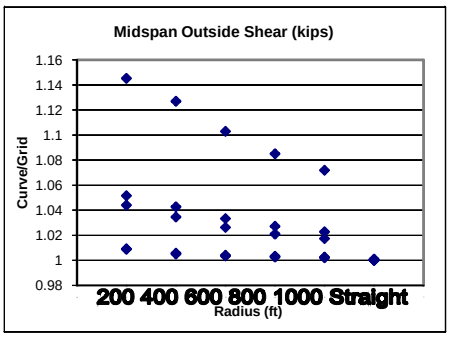


Figure E.2.4: Single Cell, Pre-Cast, 6x6 Column: Live Load Total







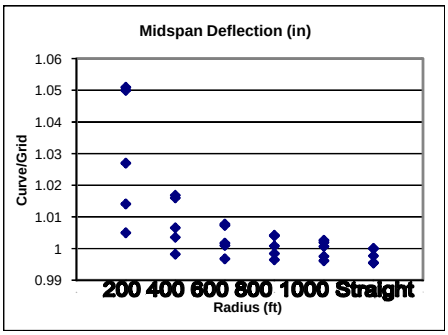


Figure E.2.5: Single Cell, Pre-Cast, 6'x18' Column: Post Tension Total

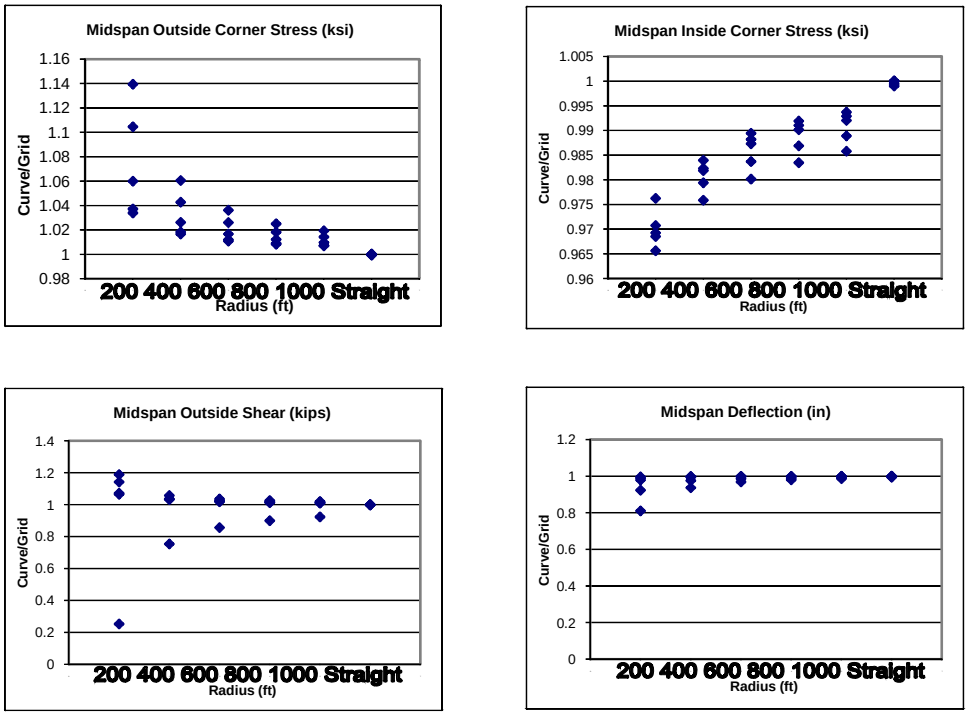


Figure E.2.6: Single Cell, Pre-Cast, 6x6 Column: Post Tension Total

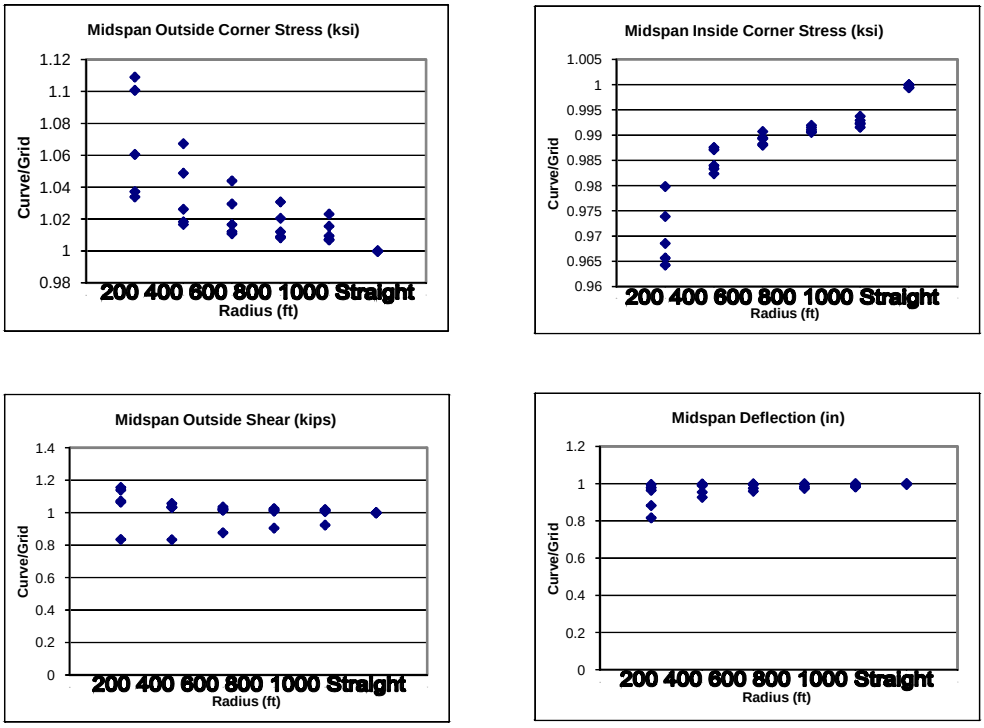
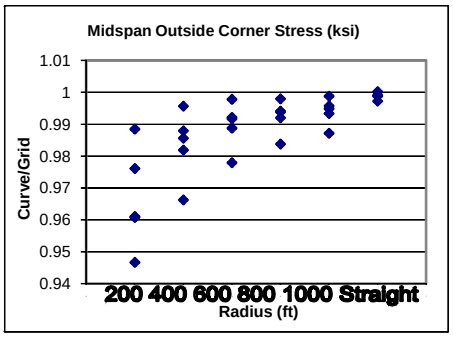
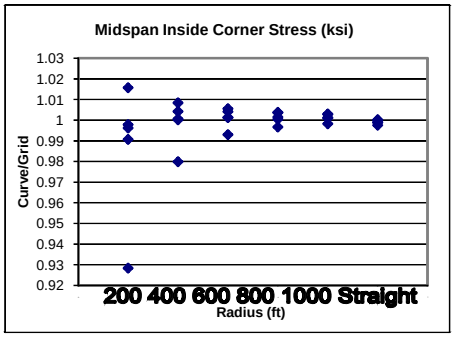
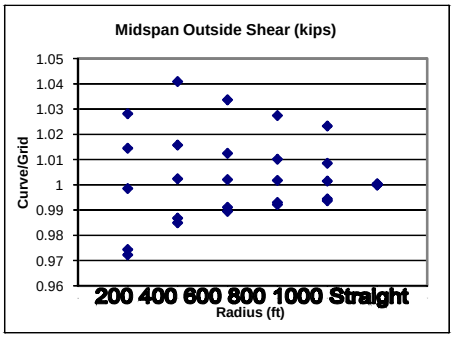


Figure E.2.7: Single Cell, Cast In Place, 6x18 Column: Self Weight







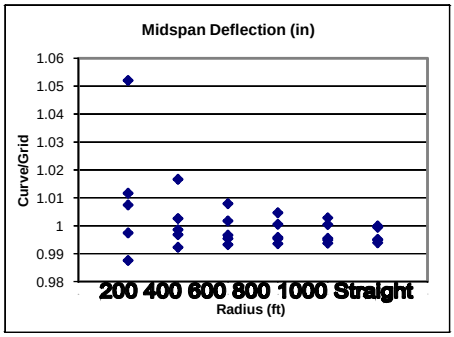
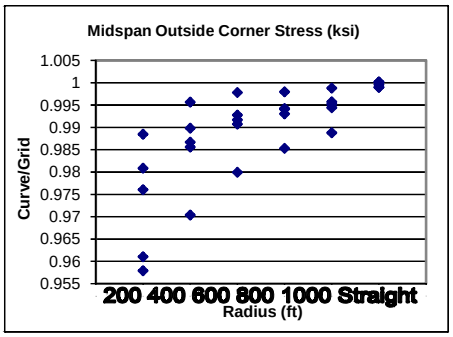
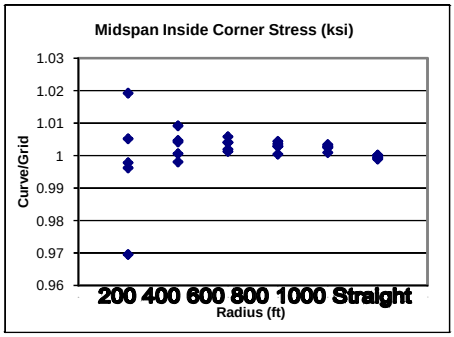
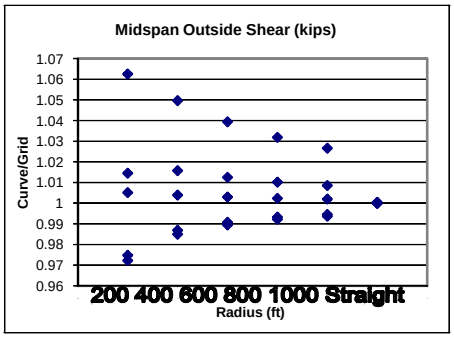


Figure E.2.8: Single Cell, Cast In Place, 6'x6' Column: Self Weight







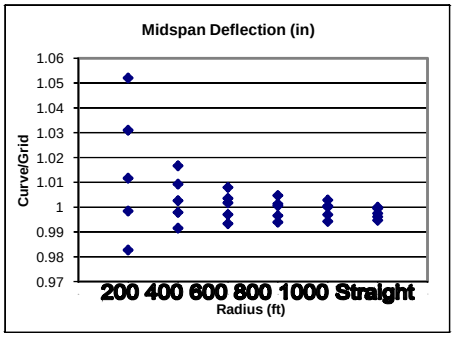


Figure E.2.9: Single Cell, Cast In Place, 6’x18’ Column: Live Load Total

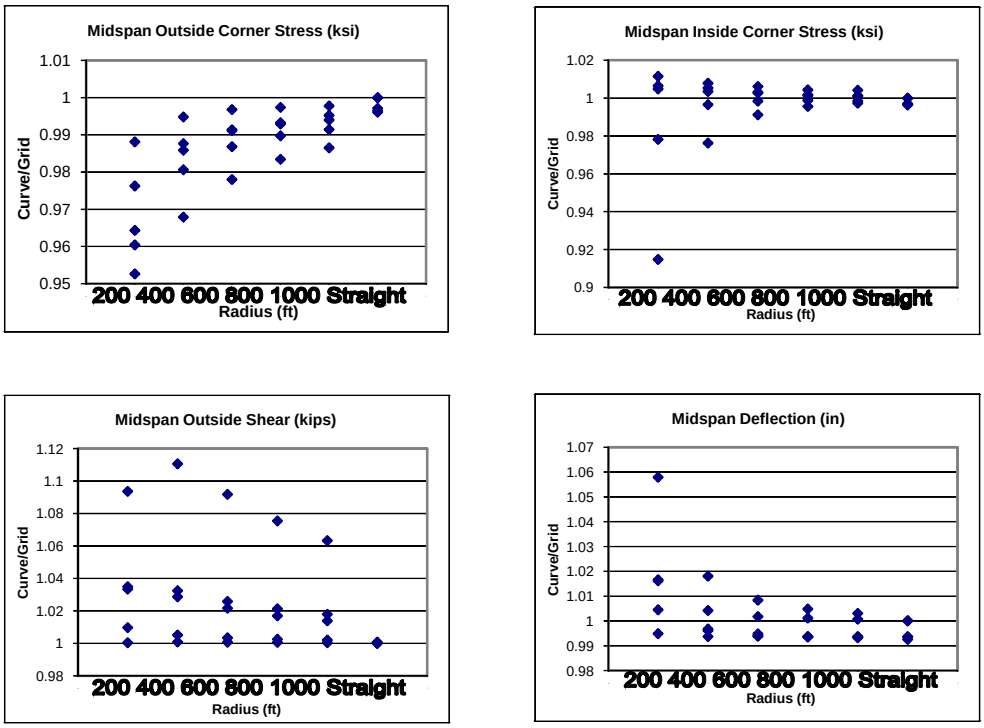


Figure E.2.10: Single Cell, Cast In Place, 6'x6' Column: Live Load Total

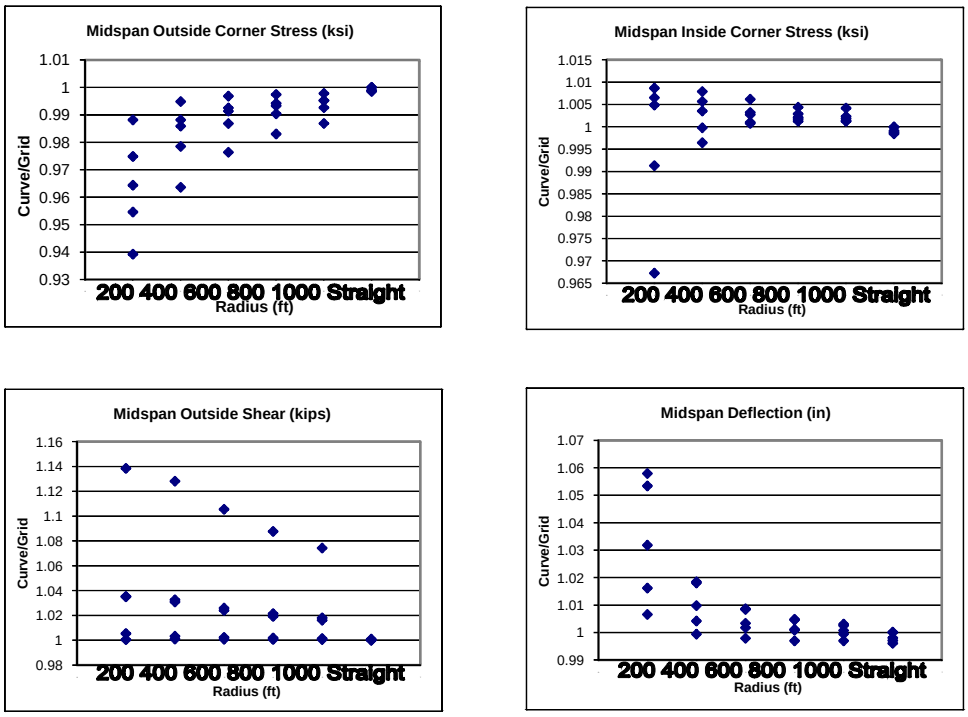
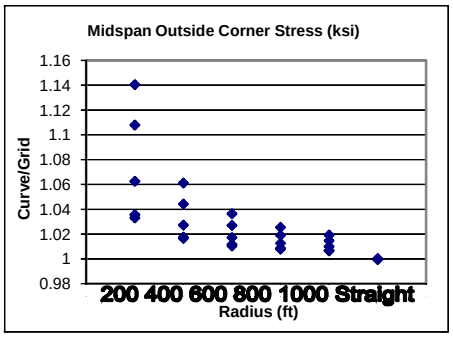
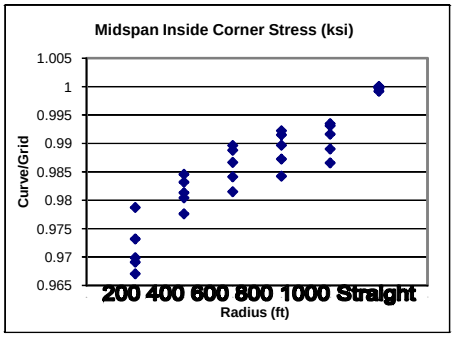
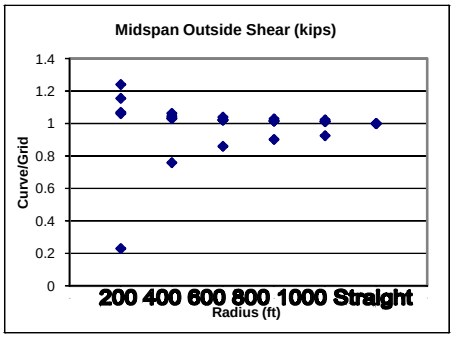


Figure E.2.11: Single Cell, Cast In Place, 6'x18' Column: Post Tension Total







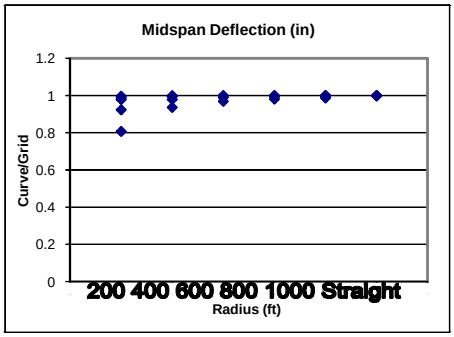
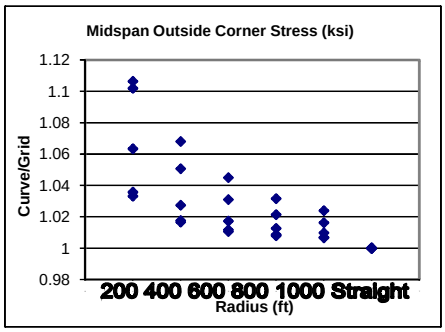
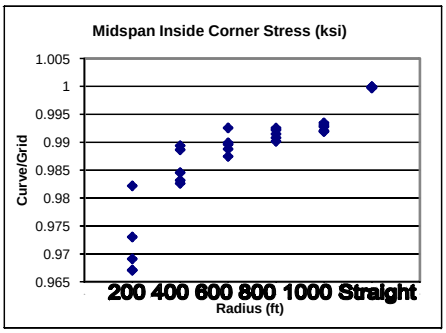
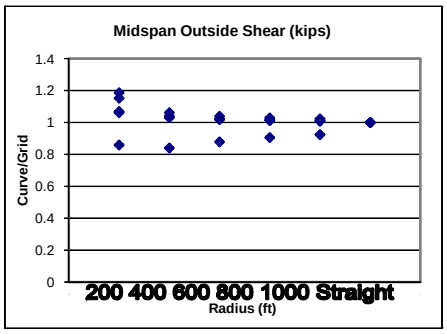


Figure E.2.12: Single Cell, Cast In Place, 6'x6' Column: Post Tension Total







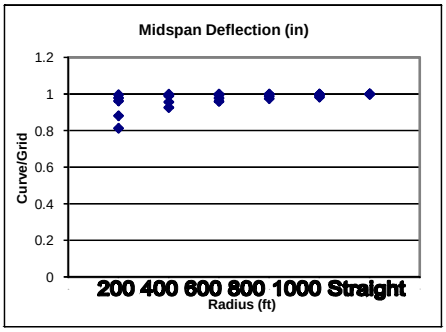
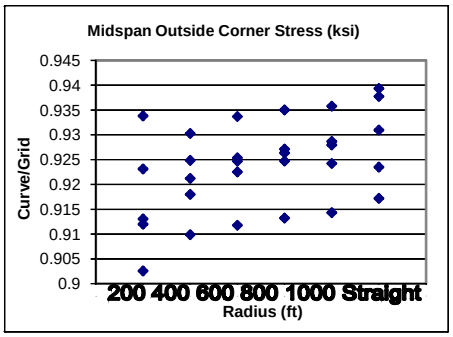
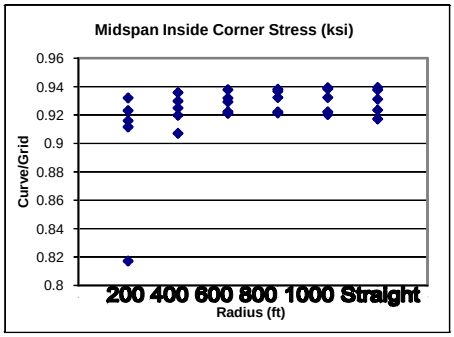
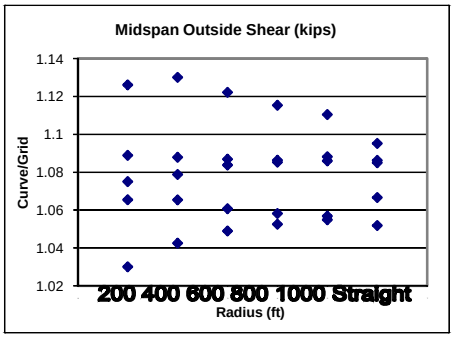


Figure E.2.13: Two Cell, Cast In Place, 6'x18' Column: Self Weight







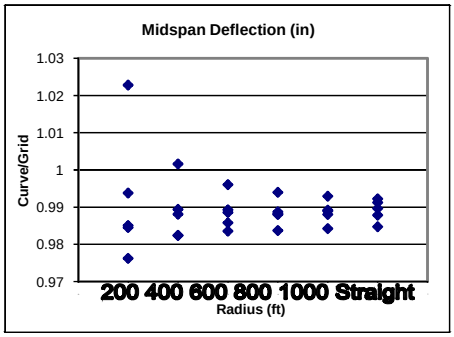
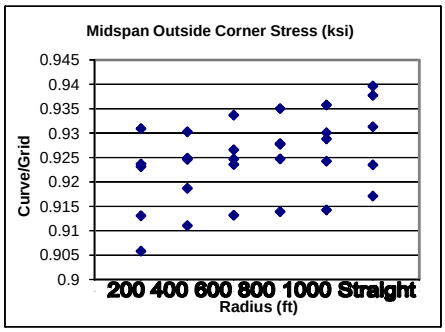
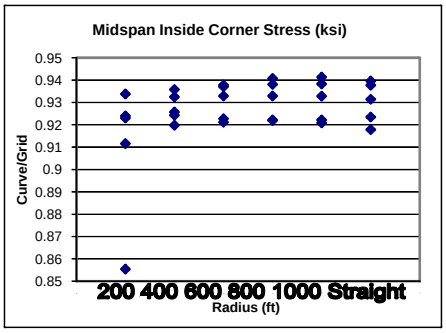
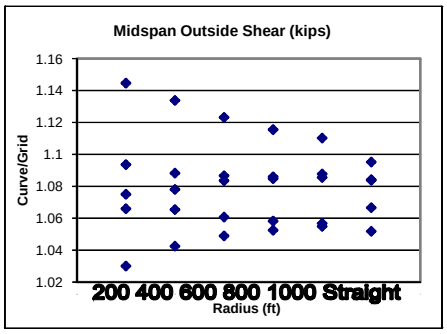


Figure E.2.14: Two Cell, Cast In Place, 7'x7'Column: Self Weight







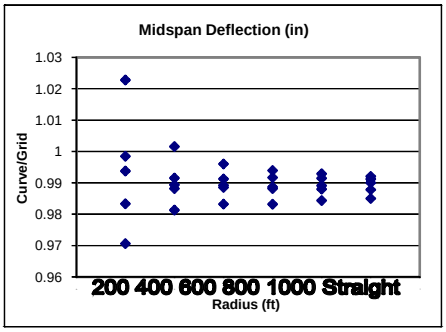


Figure E.2.15: Two Cell, Cast In Place, 6'x18' Column: Live Load Total

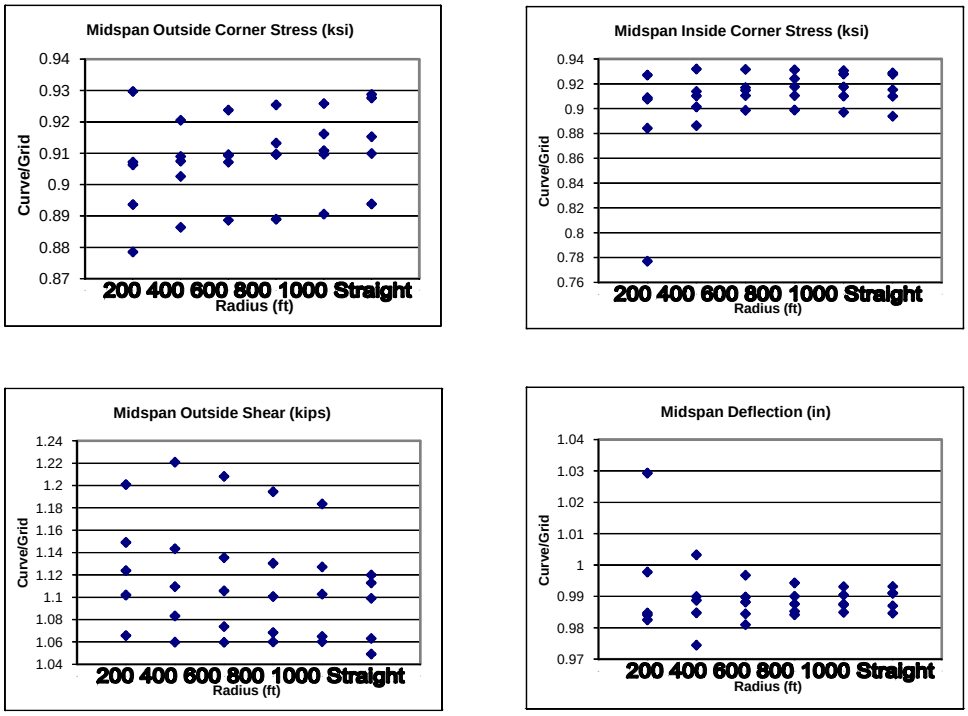


Figure E.2.16: Two Cell, Cast In Place, 7'x7'Column: Live Load Total

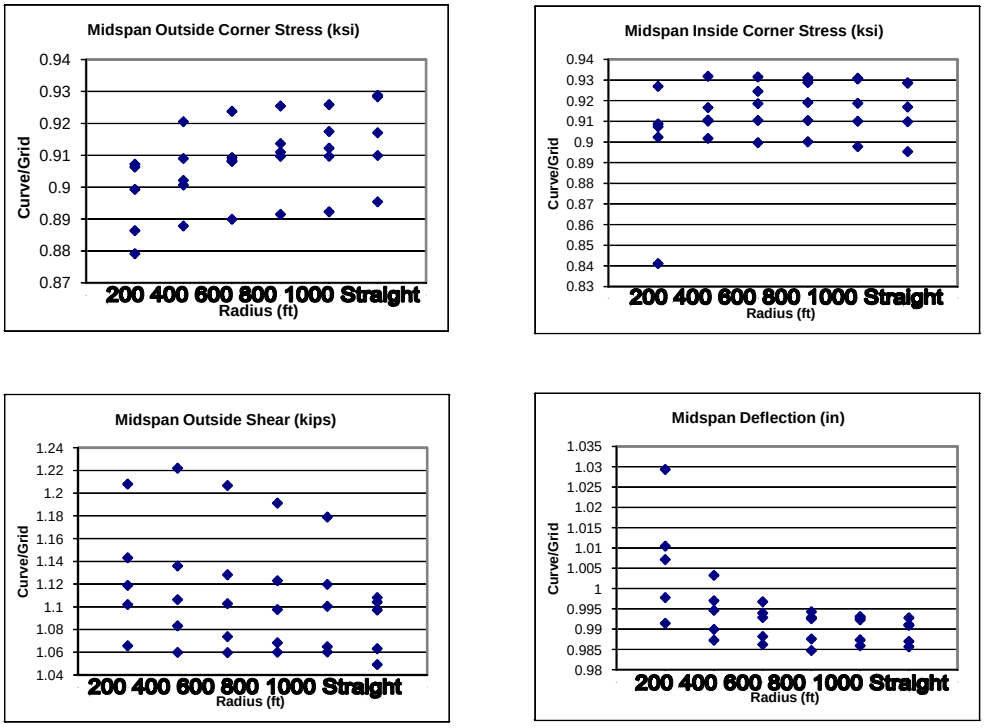


Figure E.2.17: Two Cell, Cast In Place, 6'x18' Column: Post Tension Total

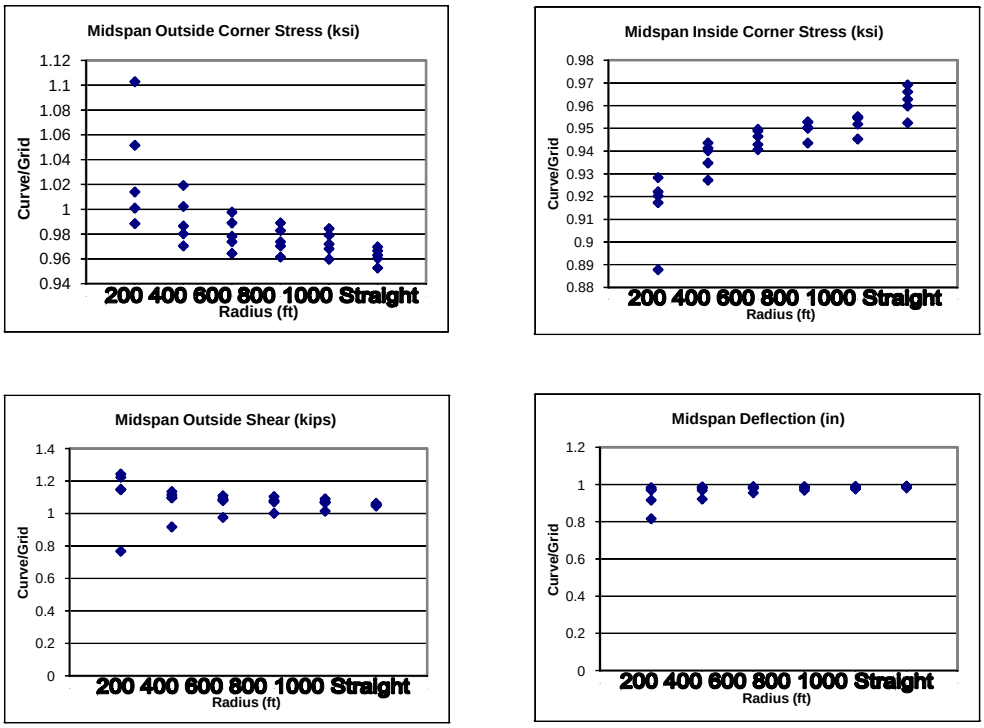


Figure E.2.18: Two Cell, Cast In Place, 7'x7'Column: Post Tension Total

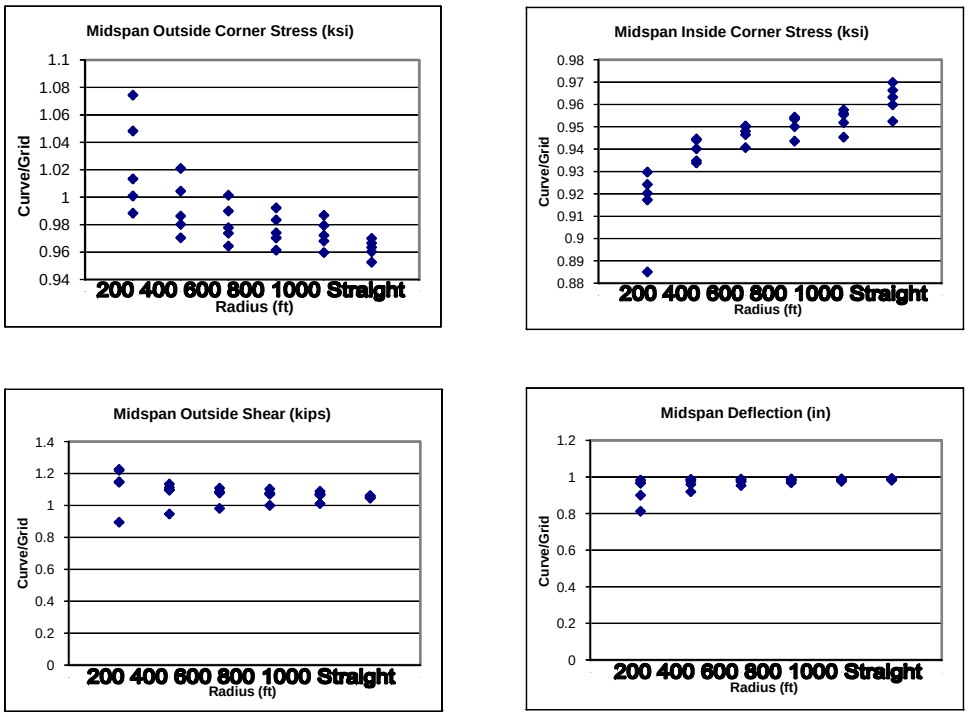


Figure E.2.19: Five Cell, Cast In Place, 6'x18' Column: Self Weight

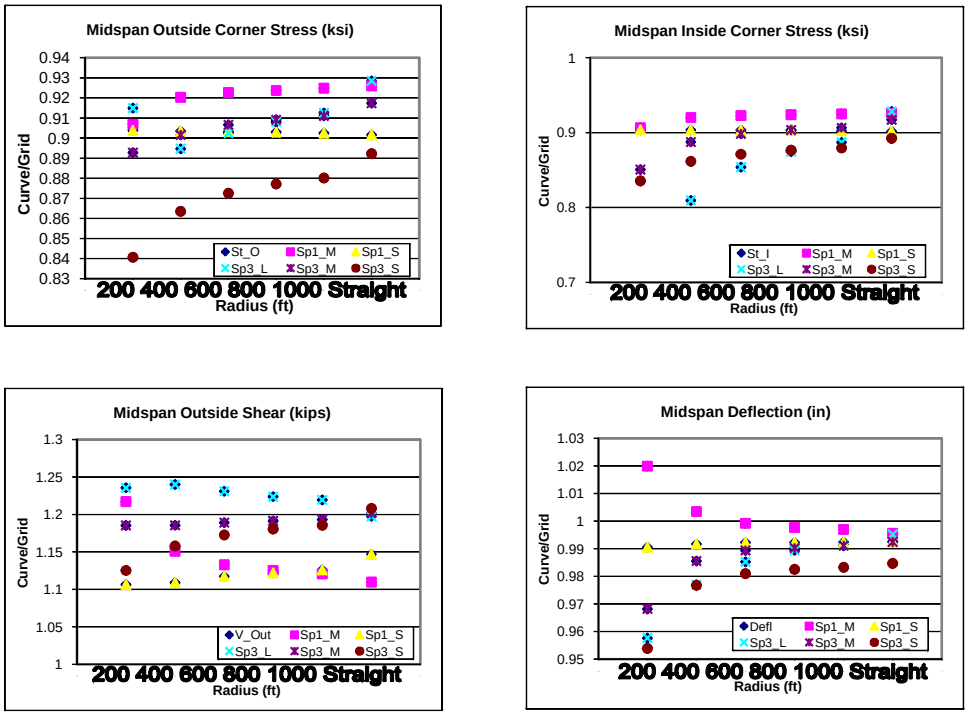


Figure E.2.20: Five Cell, Cast In Place, 6'x6' Column: Self Weight

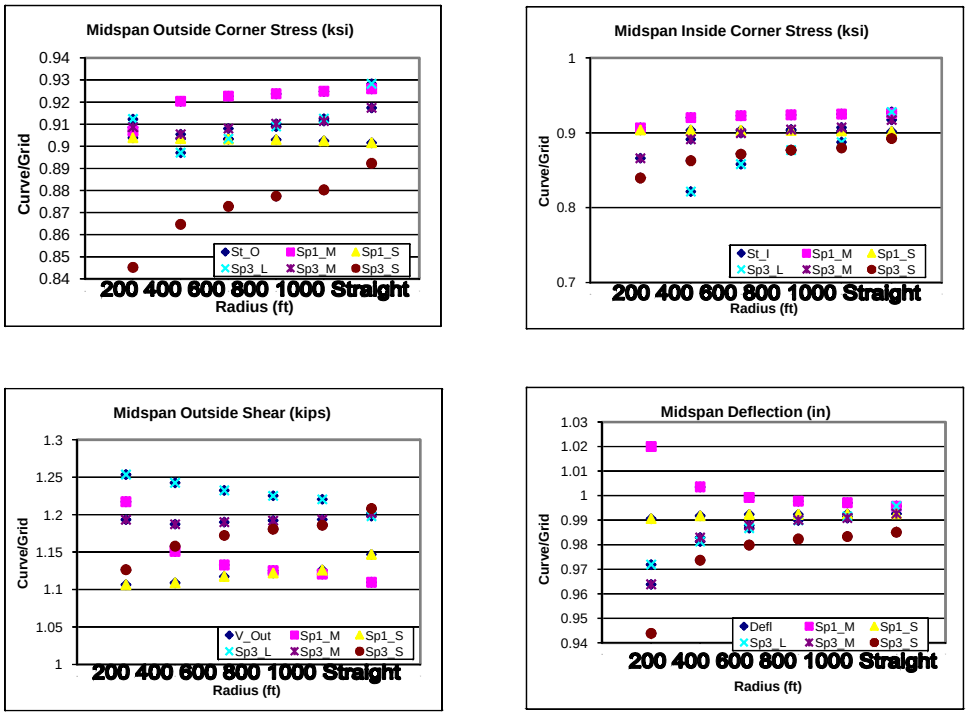


Figure E.2.21: Five Cell, Cast In Place, 6'x18' Column: Live Load Total

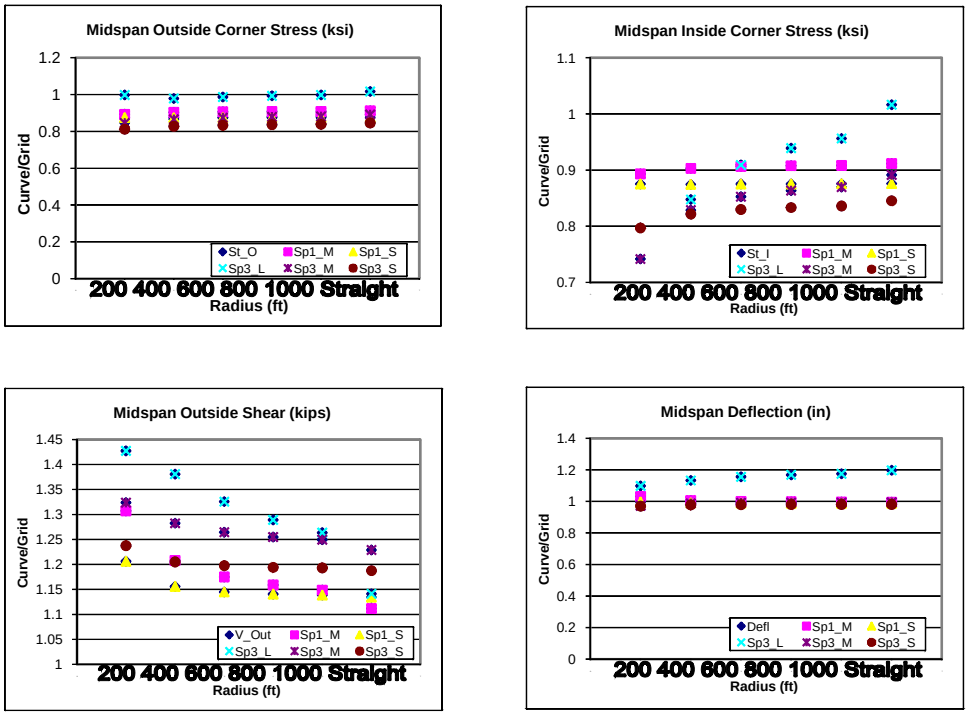


Figure E.2.22: Five Cell, Cast In Place, 8'x8' Column: Live Load Total

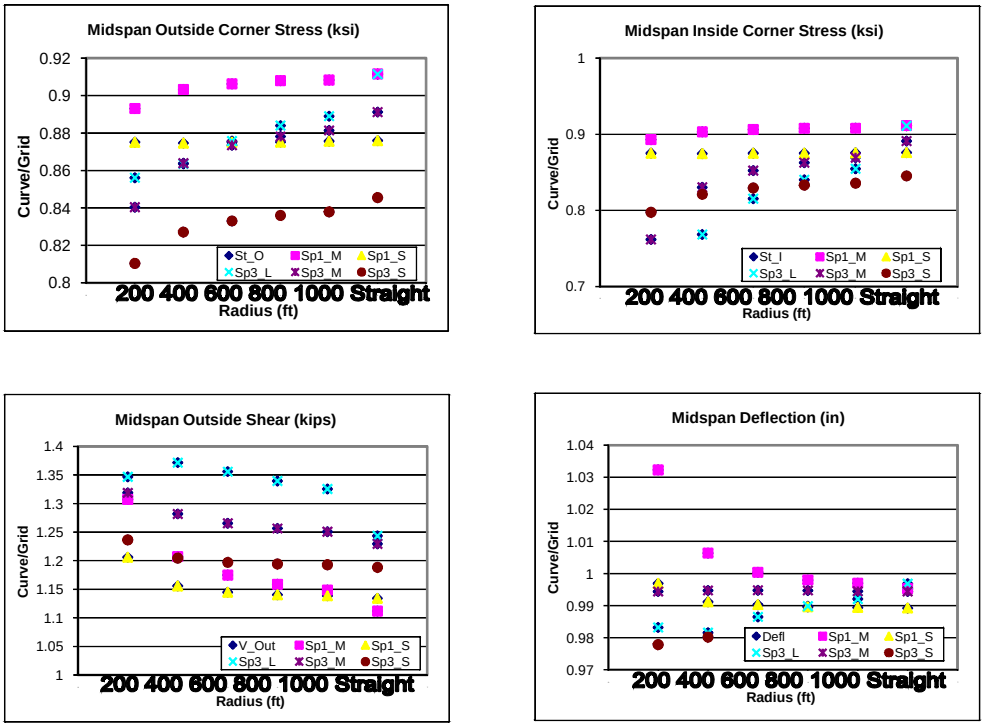


Figure E.2.23: Five Cell, Cast In Place, 6'x18' Column: Post Tension Total

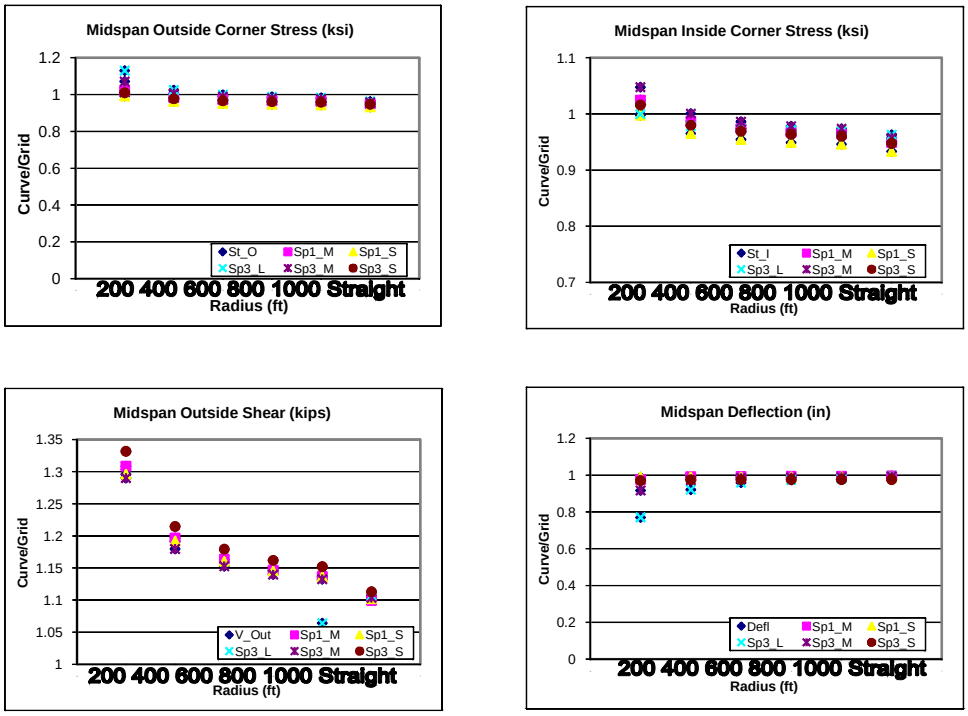


Figure E.2.24: Five Cell, Cast In Place, 8'x8' Column: Post Tension Total

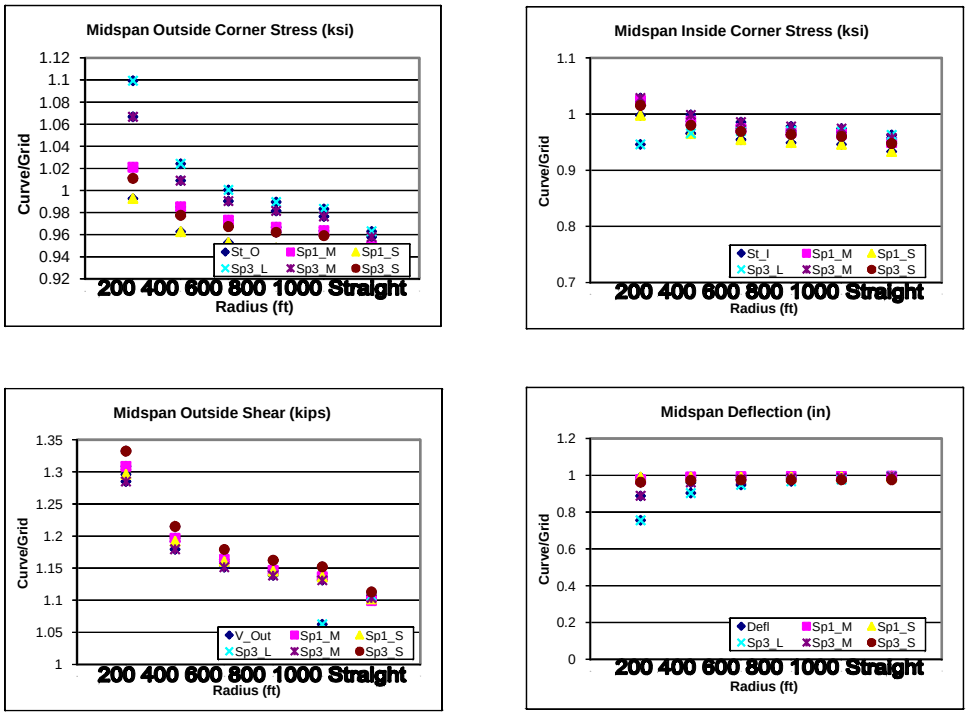
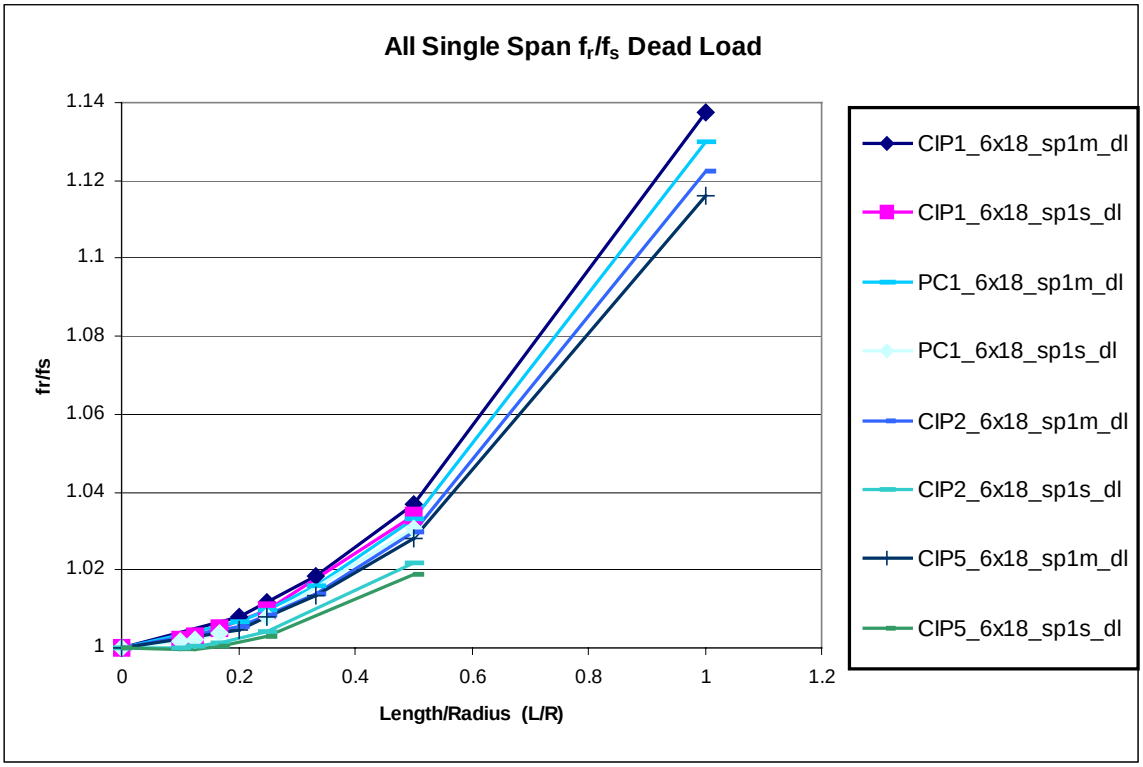


Figure E.3.1: Ratio of Dead Load Stresses in Curved Bridge Relative to Straight Bridge



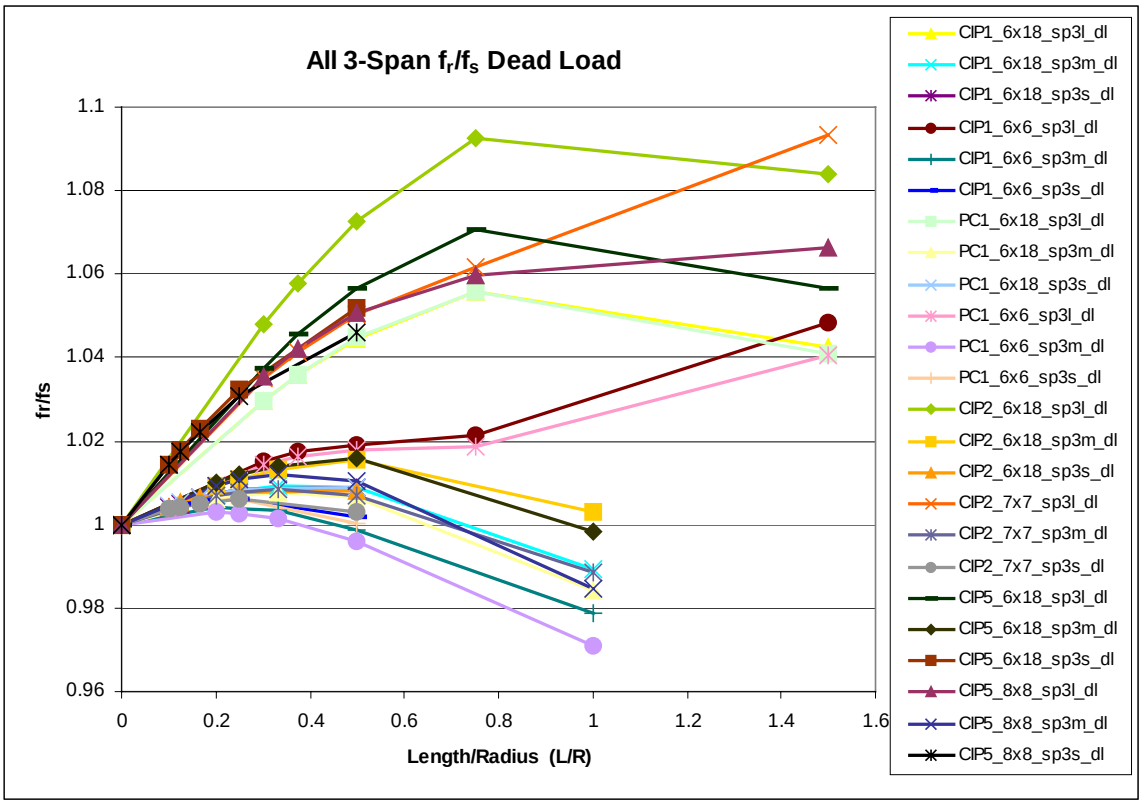
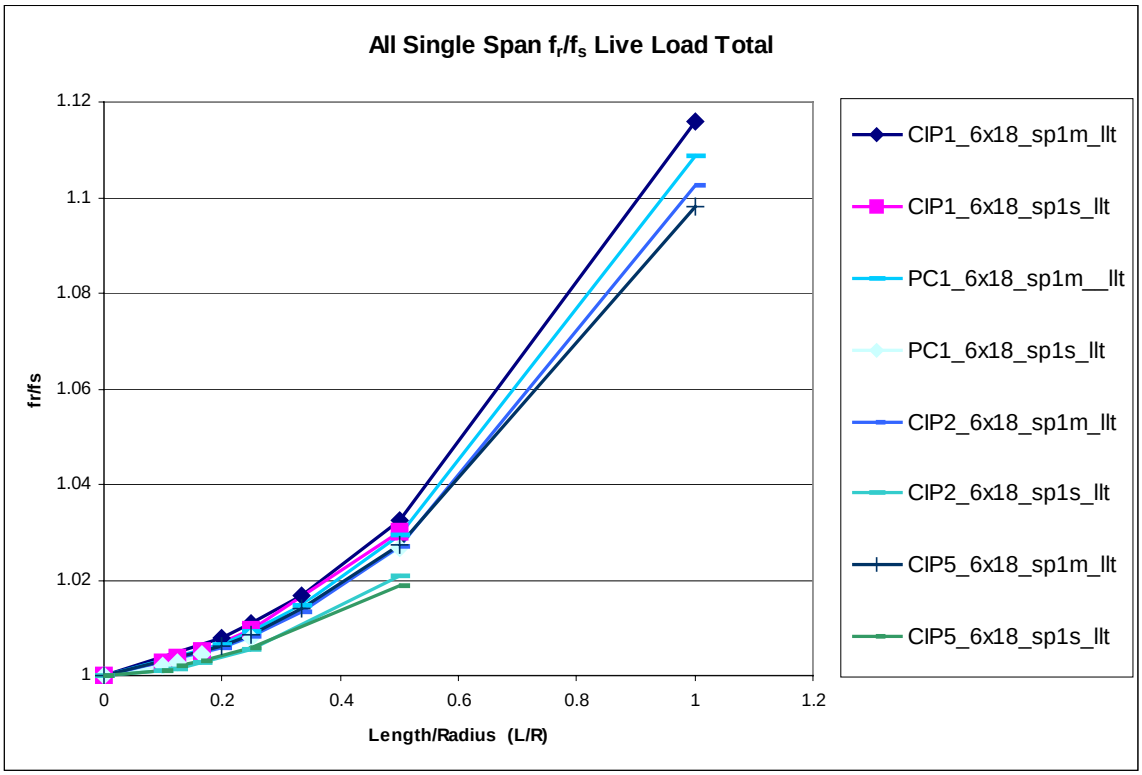


Figure E.3.2: Ratio of Live Load Stresses in Curved Bridge Relative to Straight Bridge



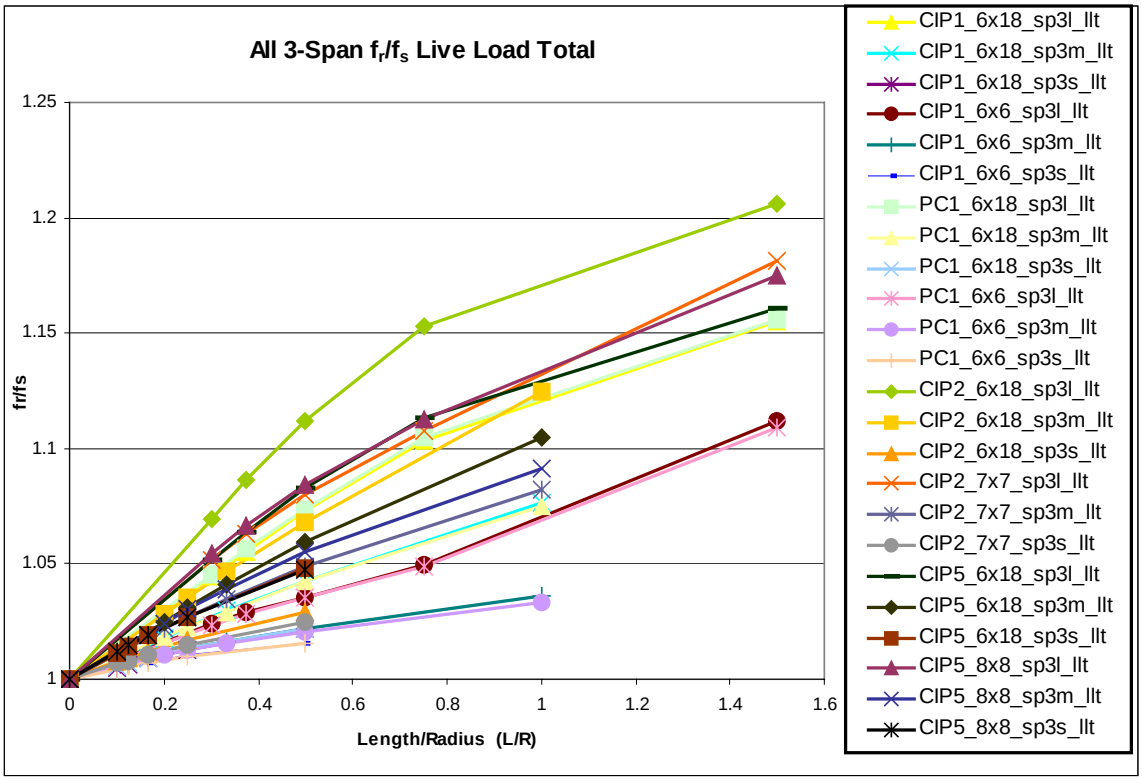
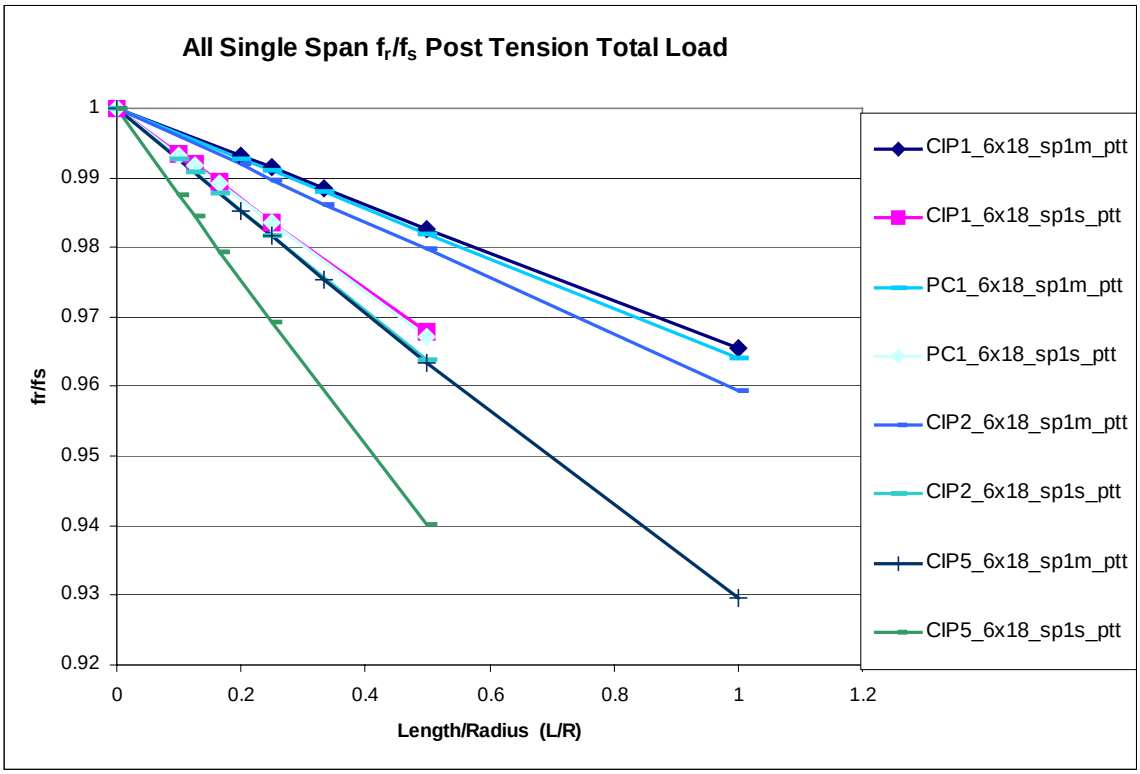


Figure E.3.3: Ratio of Post-Tensioning Stresses in Curved Bridge Relative to Straight Bridge



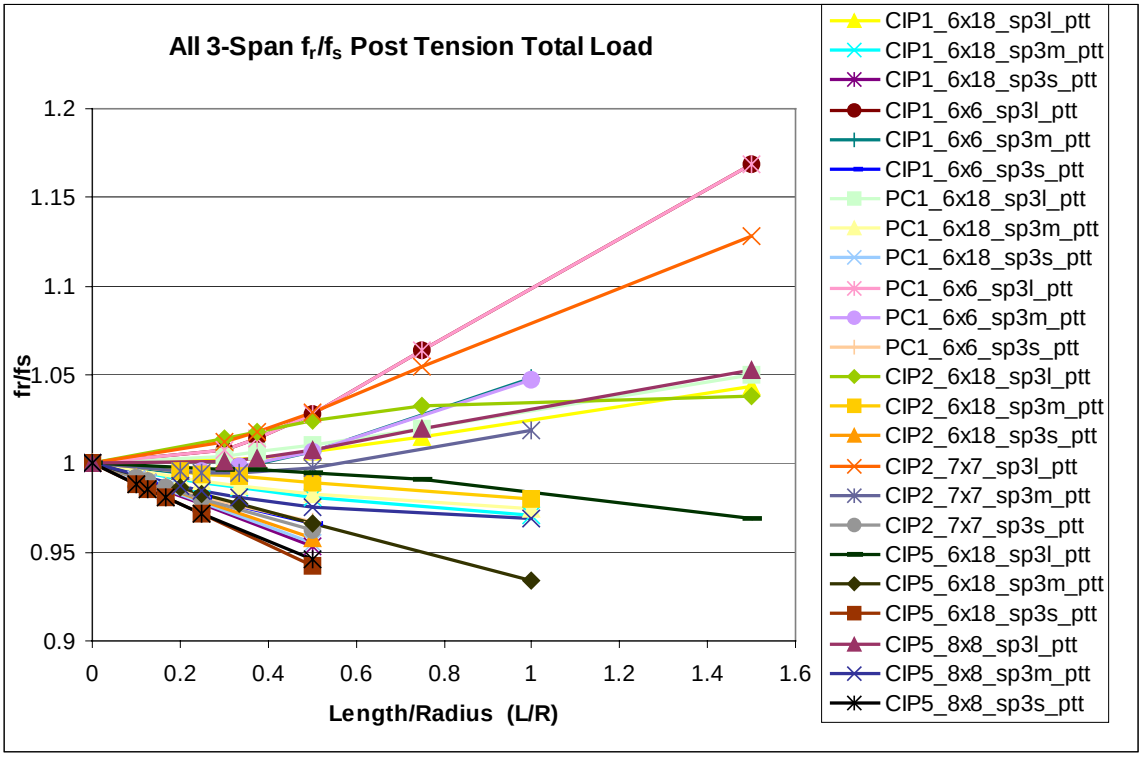
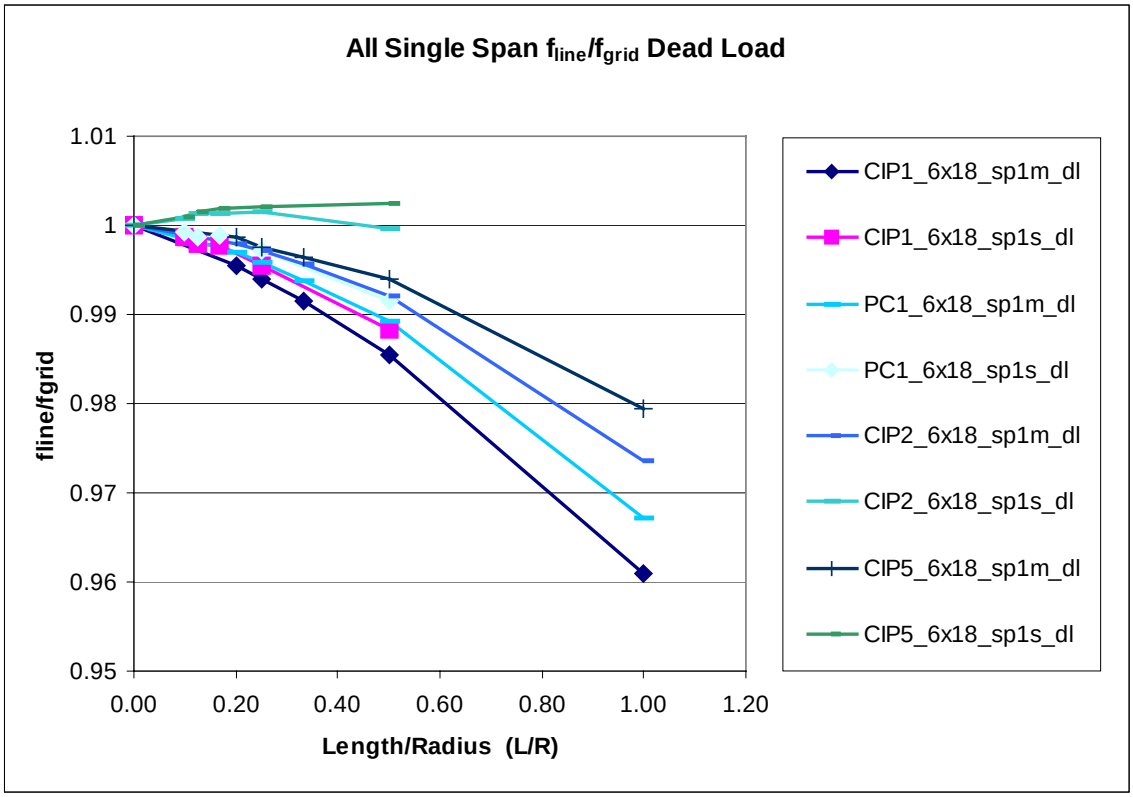


Figure E.3.4: Ratio of Dead Load Stresses in Curved Line Model Relative to Grillage Model



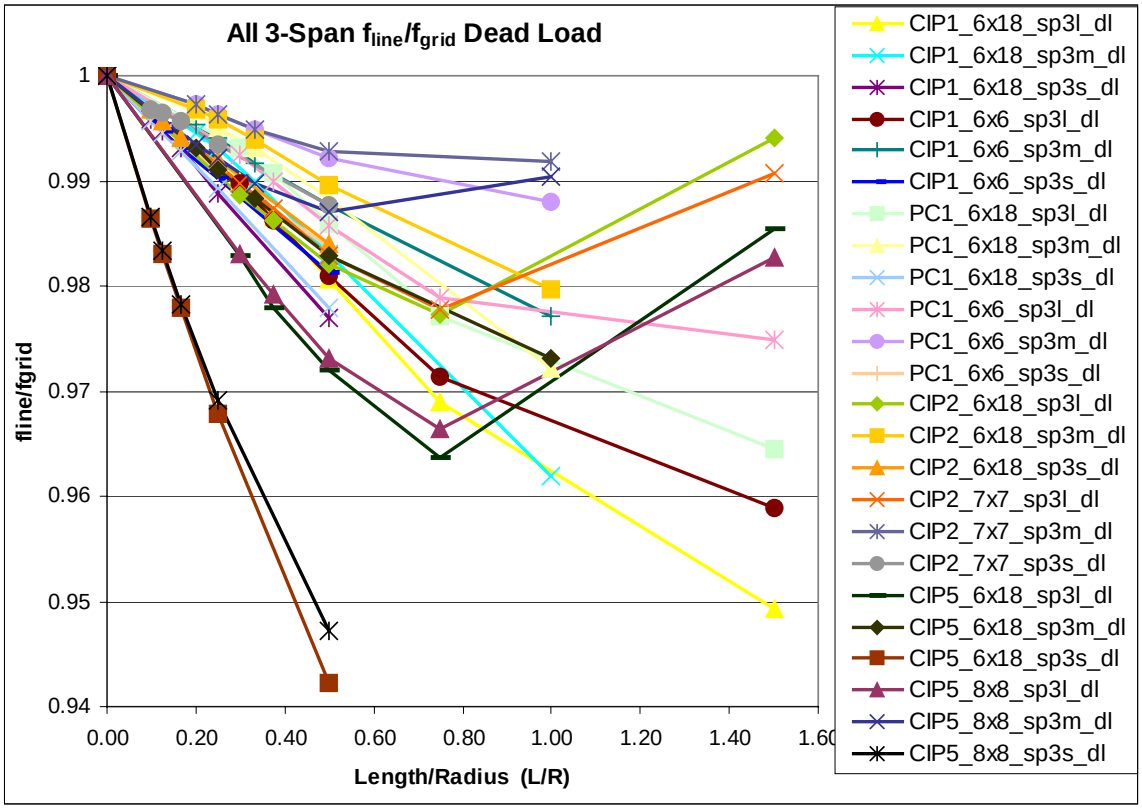
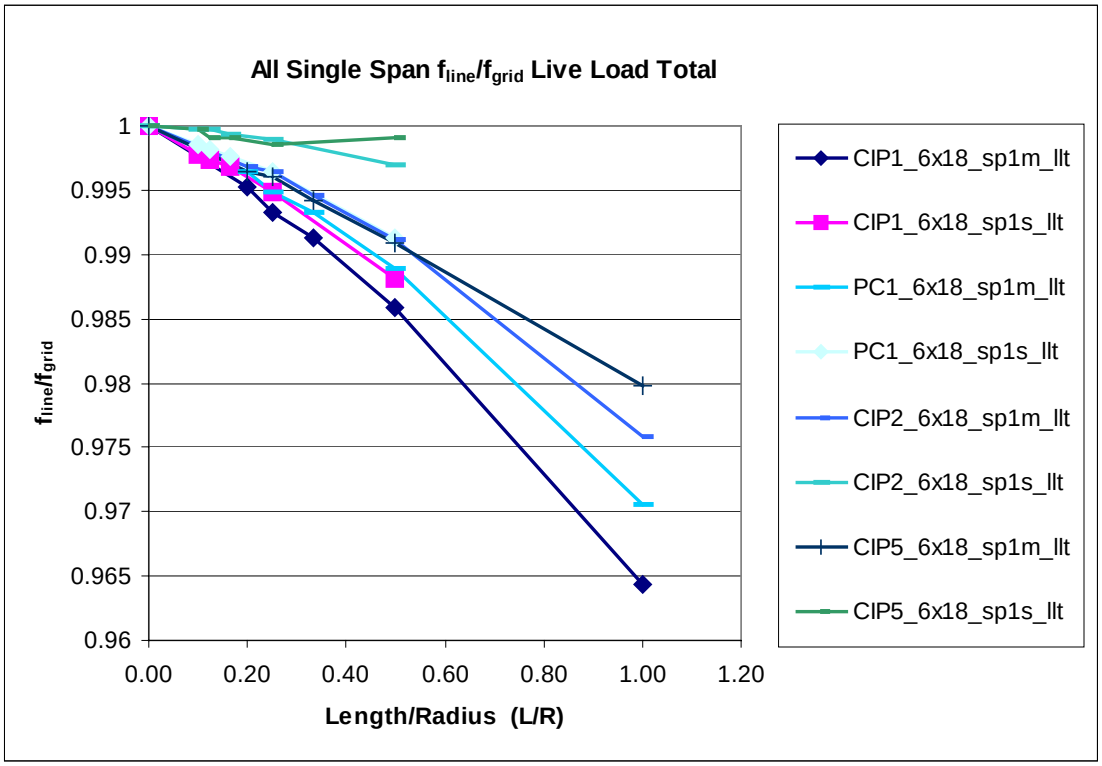


Figure E.3.5: Ratio of Live Load Stresses in Curved Line Model Relative to Grillage Model



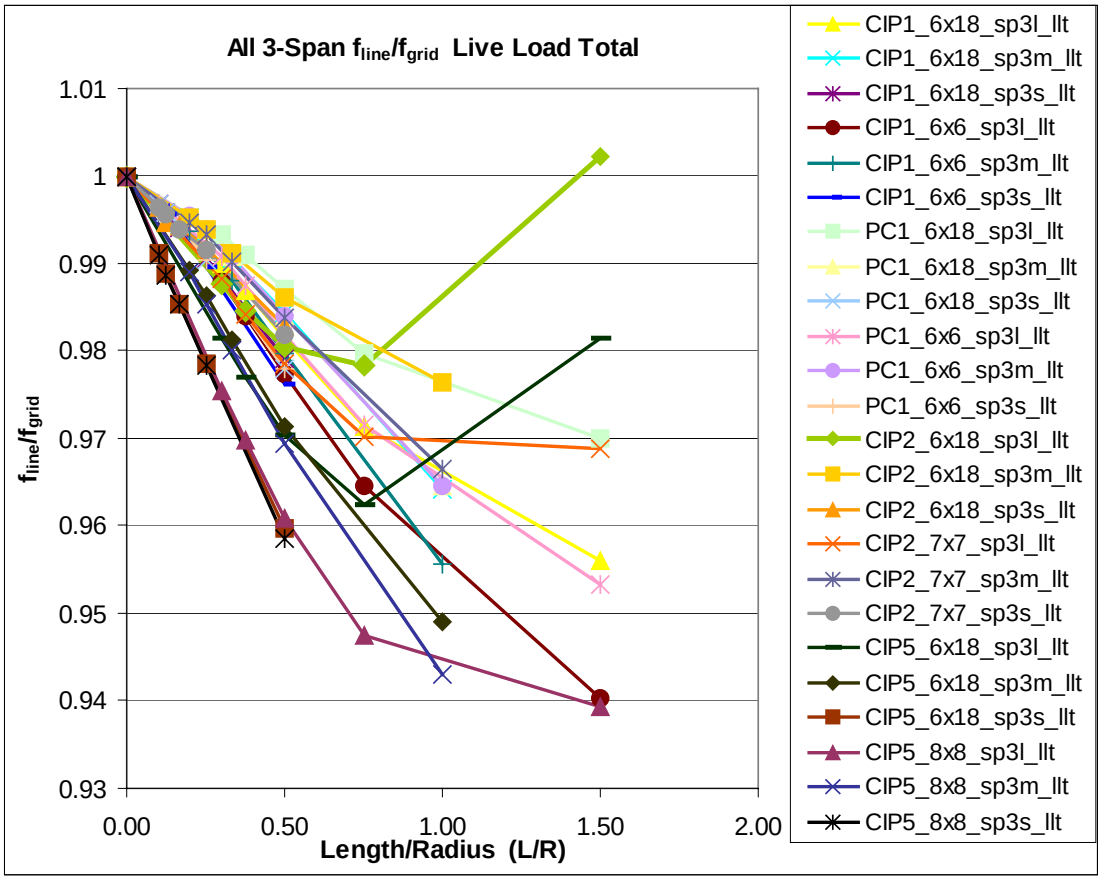
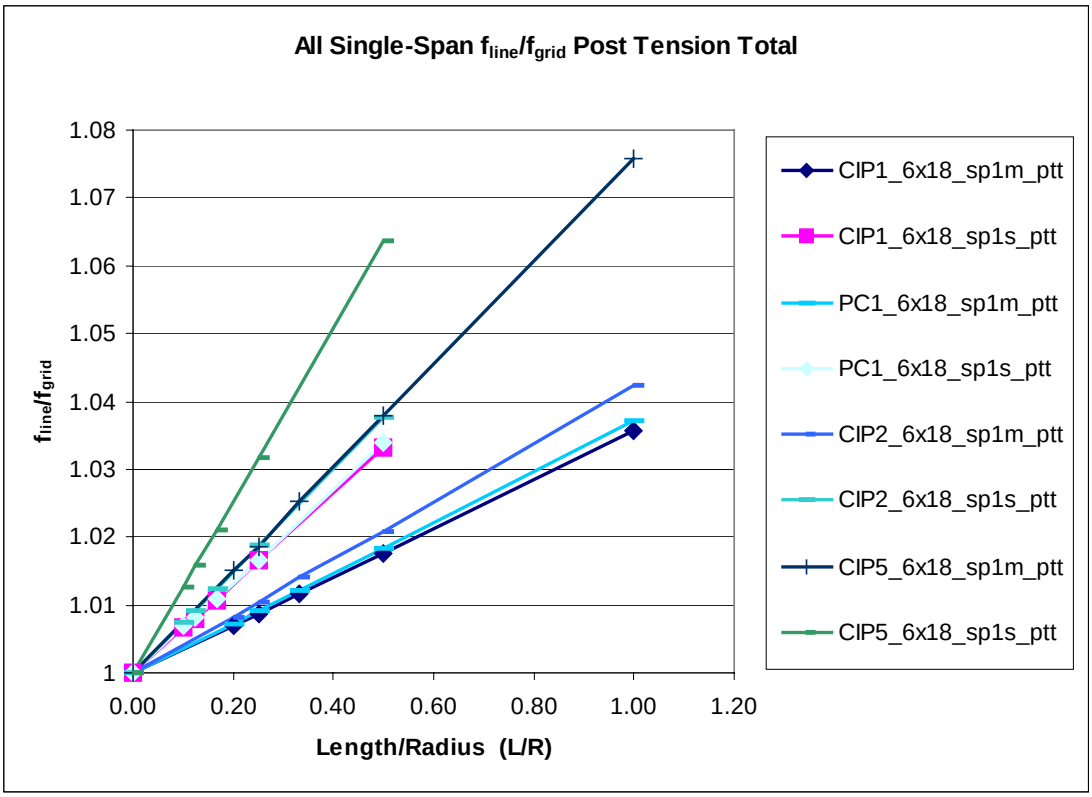


Figure E.3.6: Ratio of Post-Tensioning Stresses in Curved Line Model Relative to Grillage Model



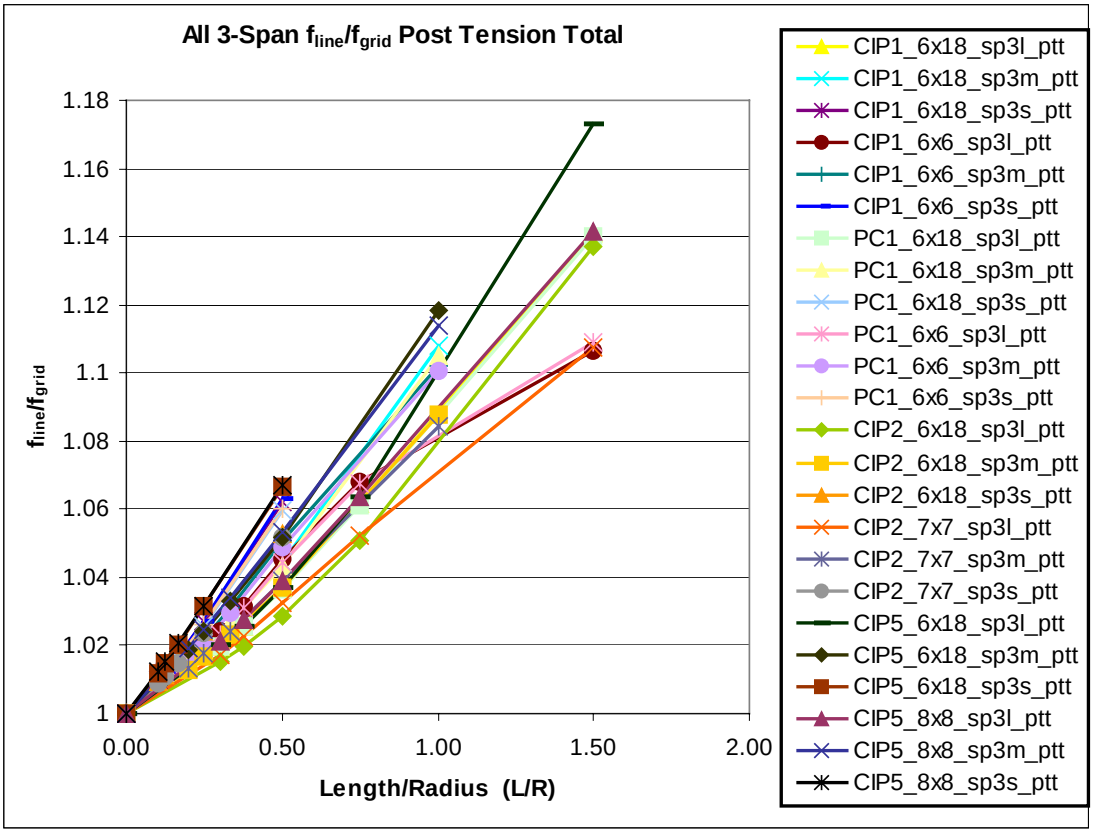
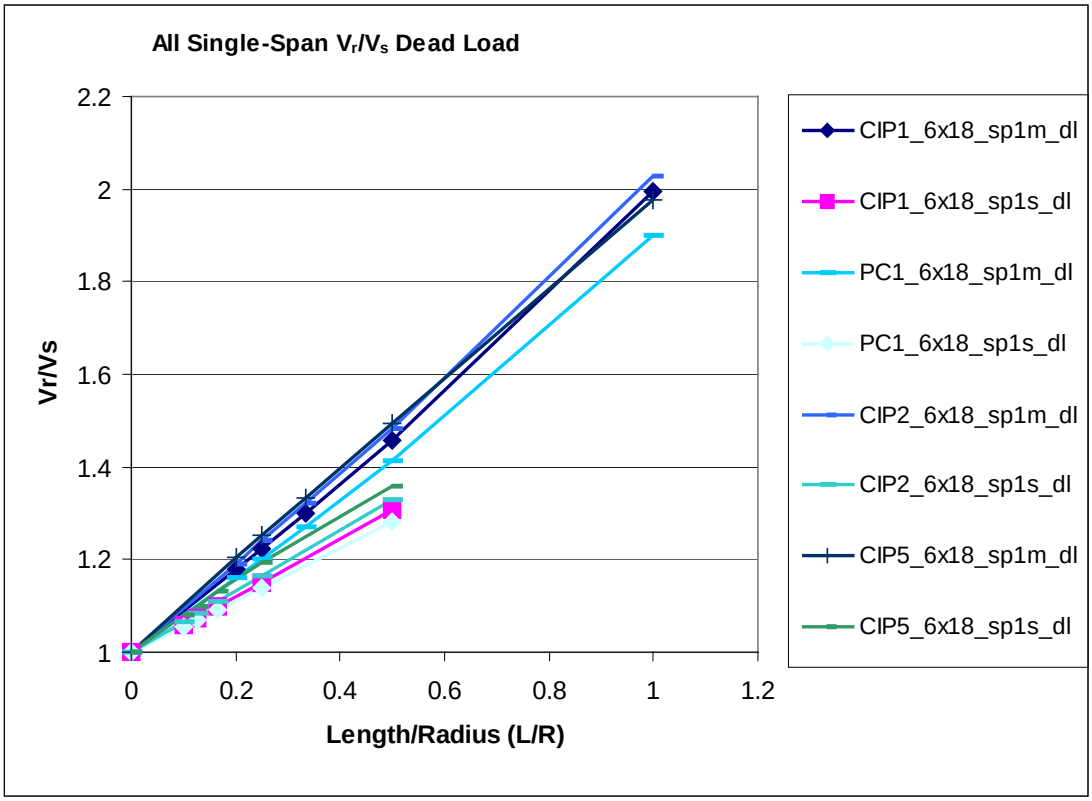


Figure E.3.7: Ratio of Dead Load Shear in Curved Bridge Relative to Straight Bridge



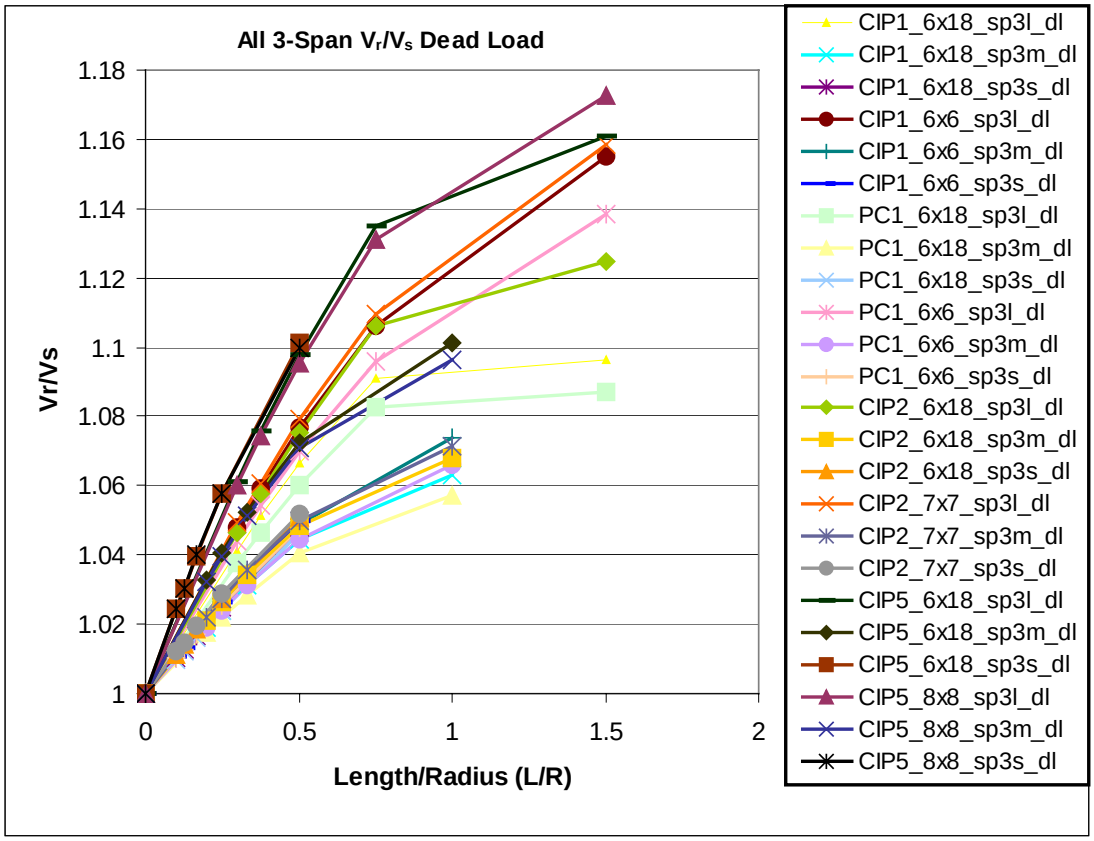
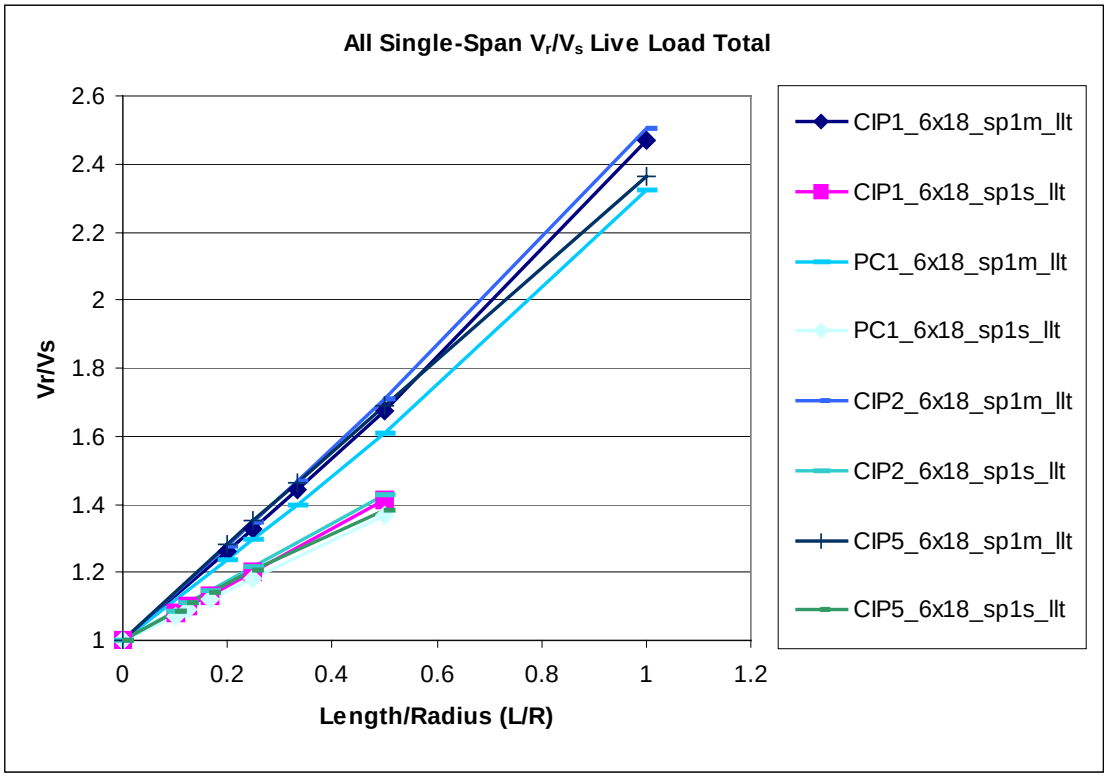


Figure E.3.8: Ratio of Live Load Shear in Curved Bridge Relative to Straight Bridge



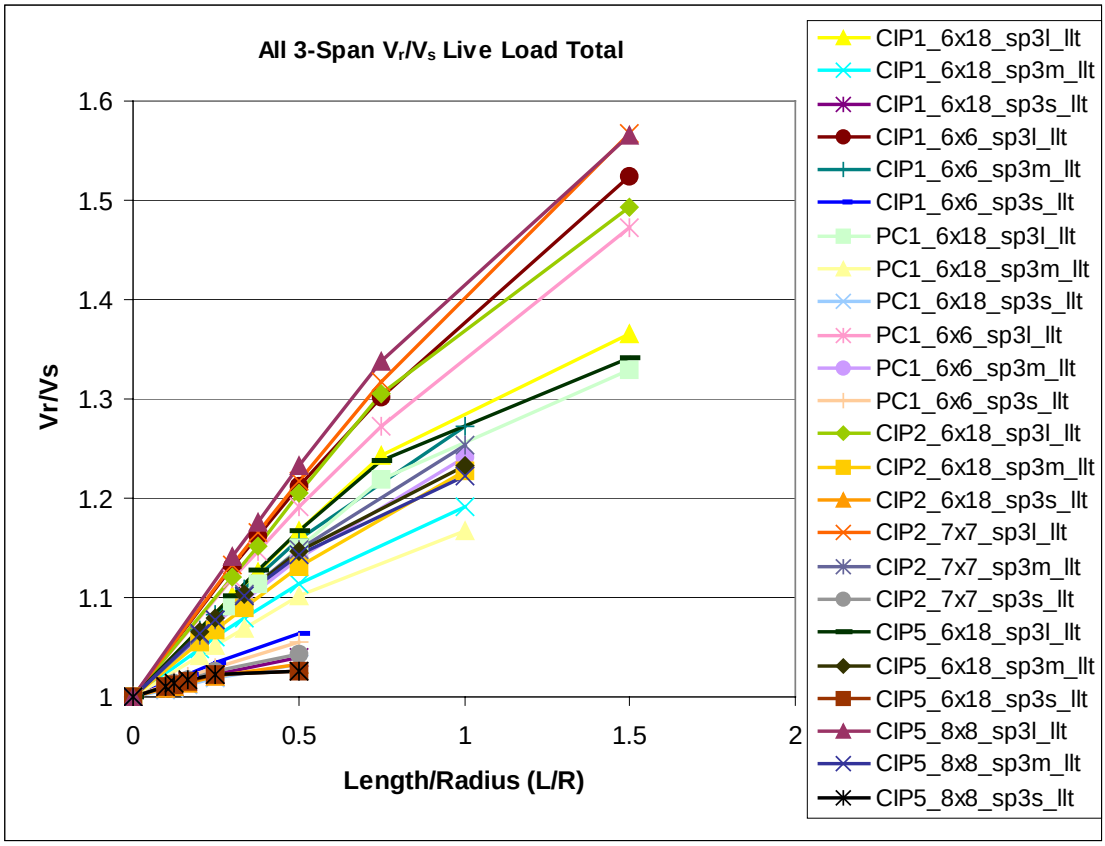
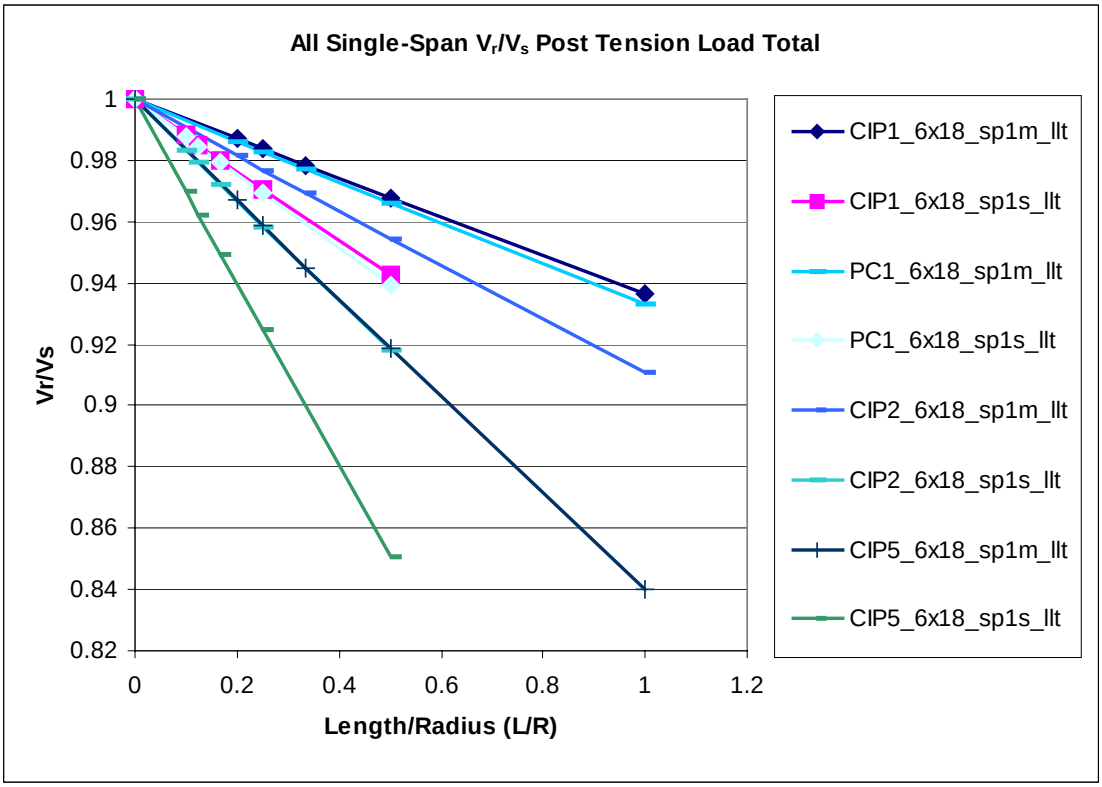


Figure E.3.9: Ratio of Post-Tensioning Shear in Curved Bridge Relative to Straight Bridge



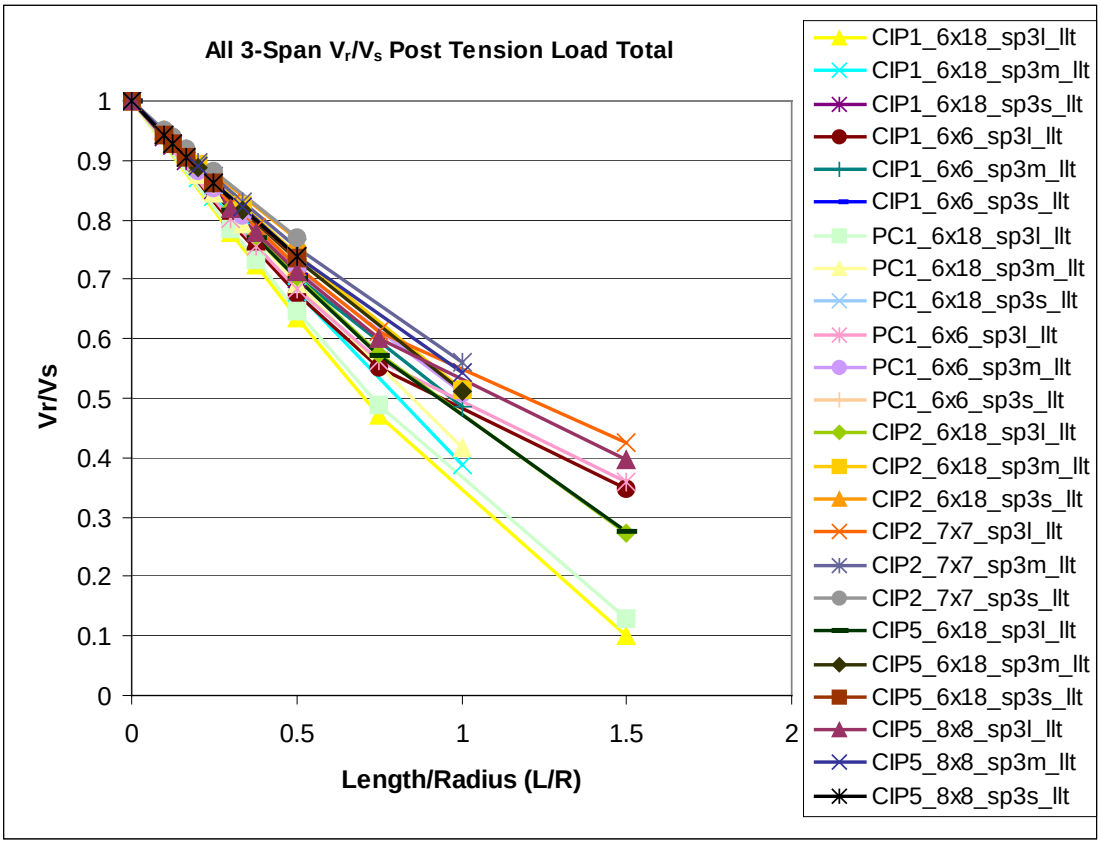
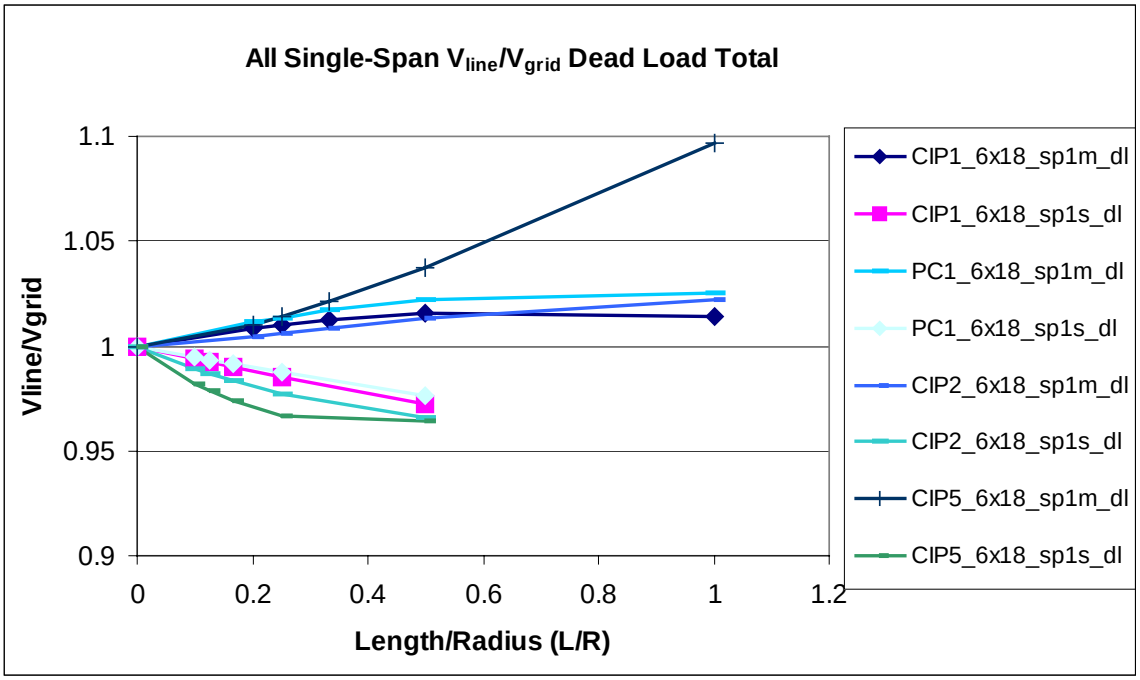


Figure E.3.10: Ratio of Dead Load Shear in Curved Line Model Relative to Grillage Model



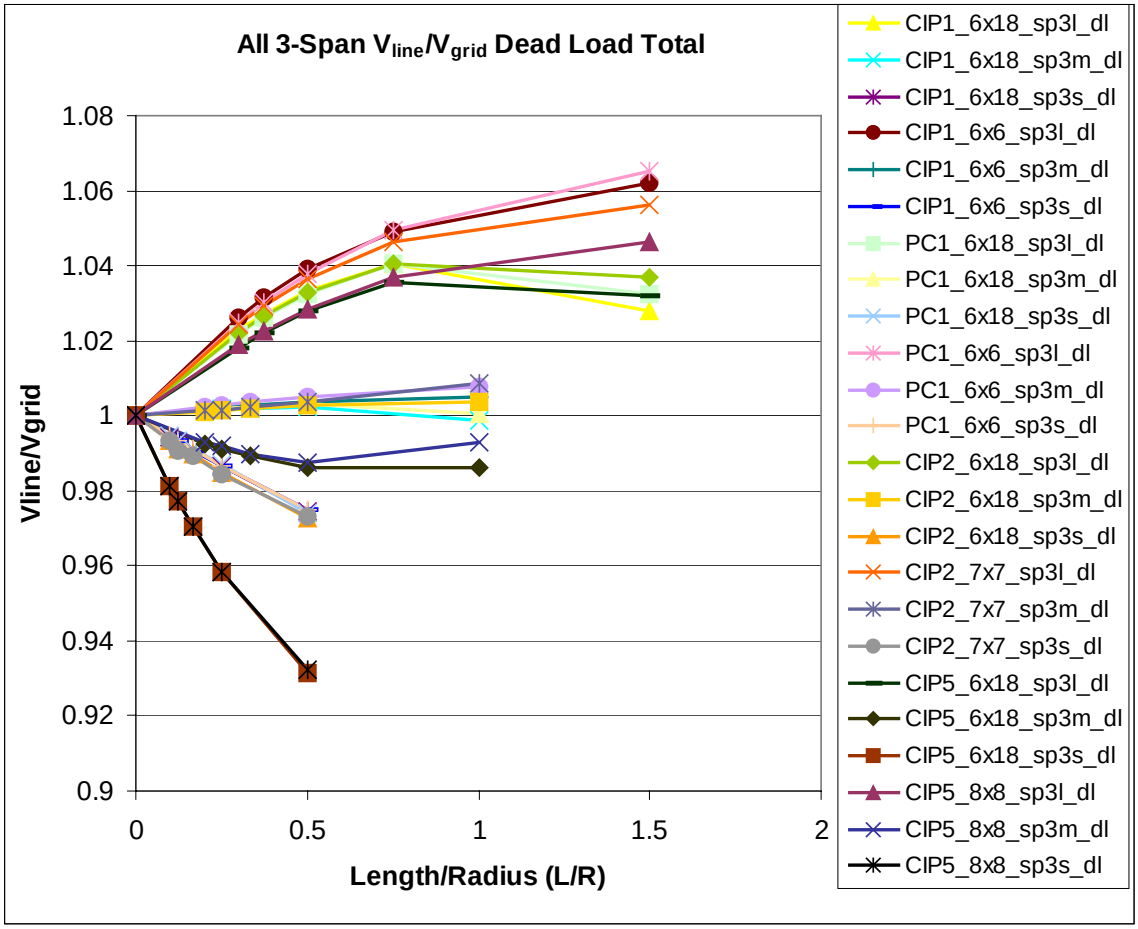
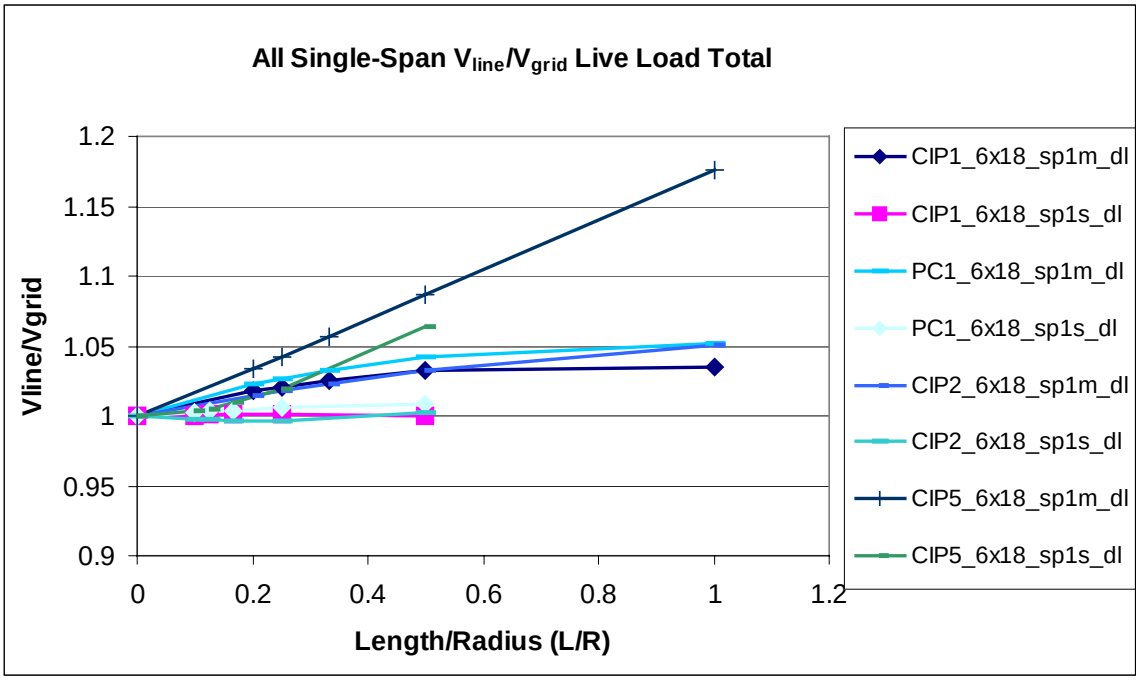


Figure E.3.11: Ratio of Live Load Shear in Curved Line Model Relative to Grillage Model



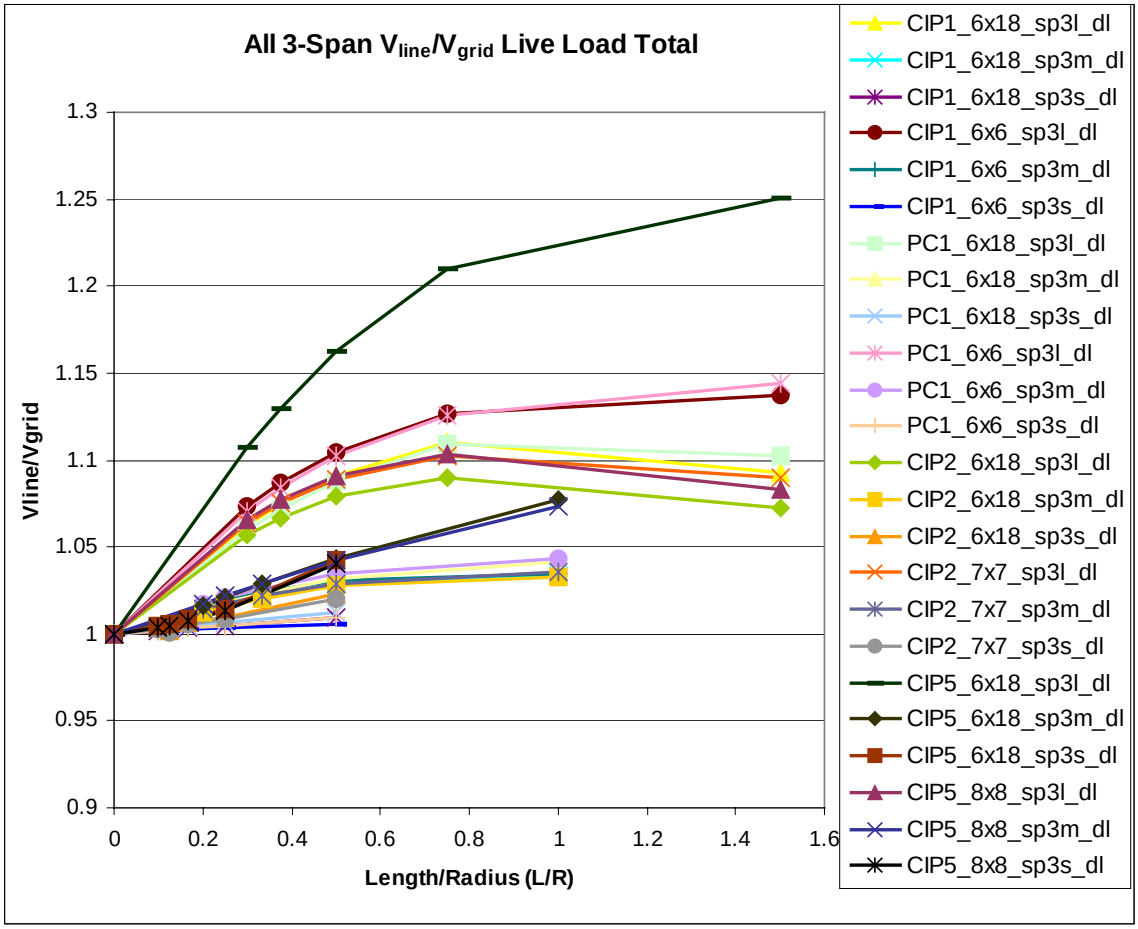
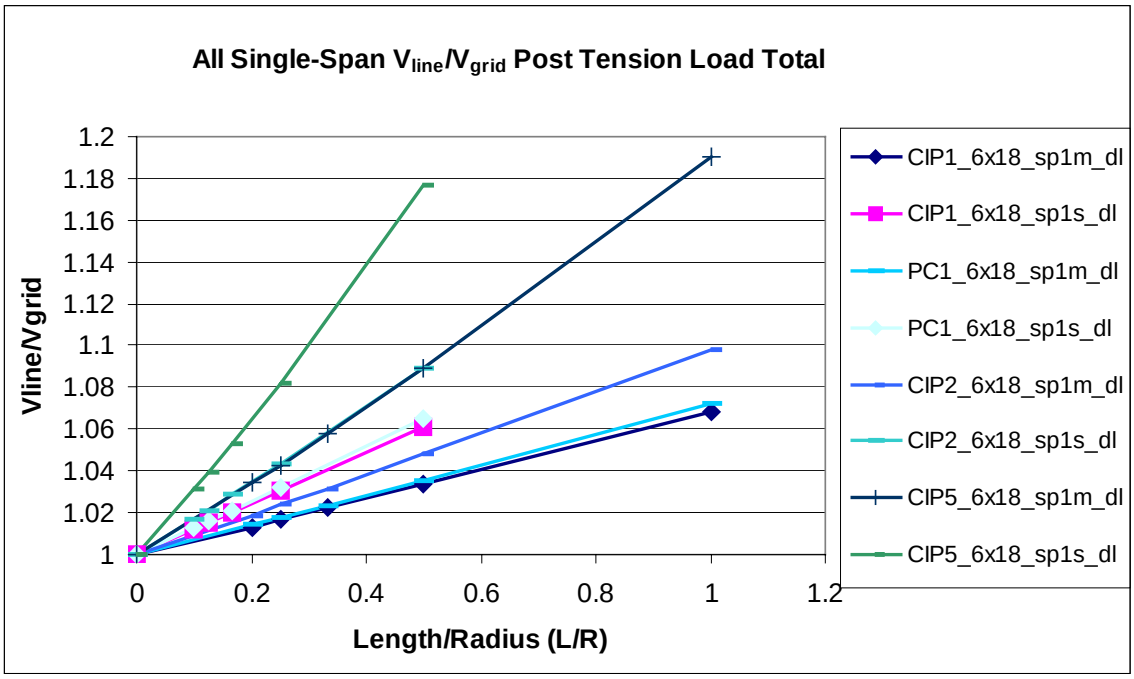


Figure E.3.12: Ratio of Post-Tensioning Shear in Curved Line Model Relative to Grillage Model



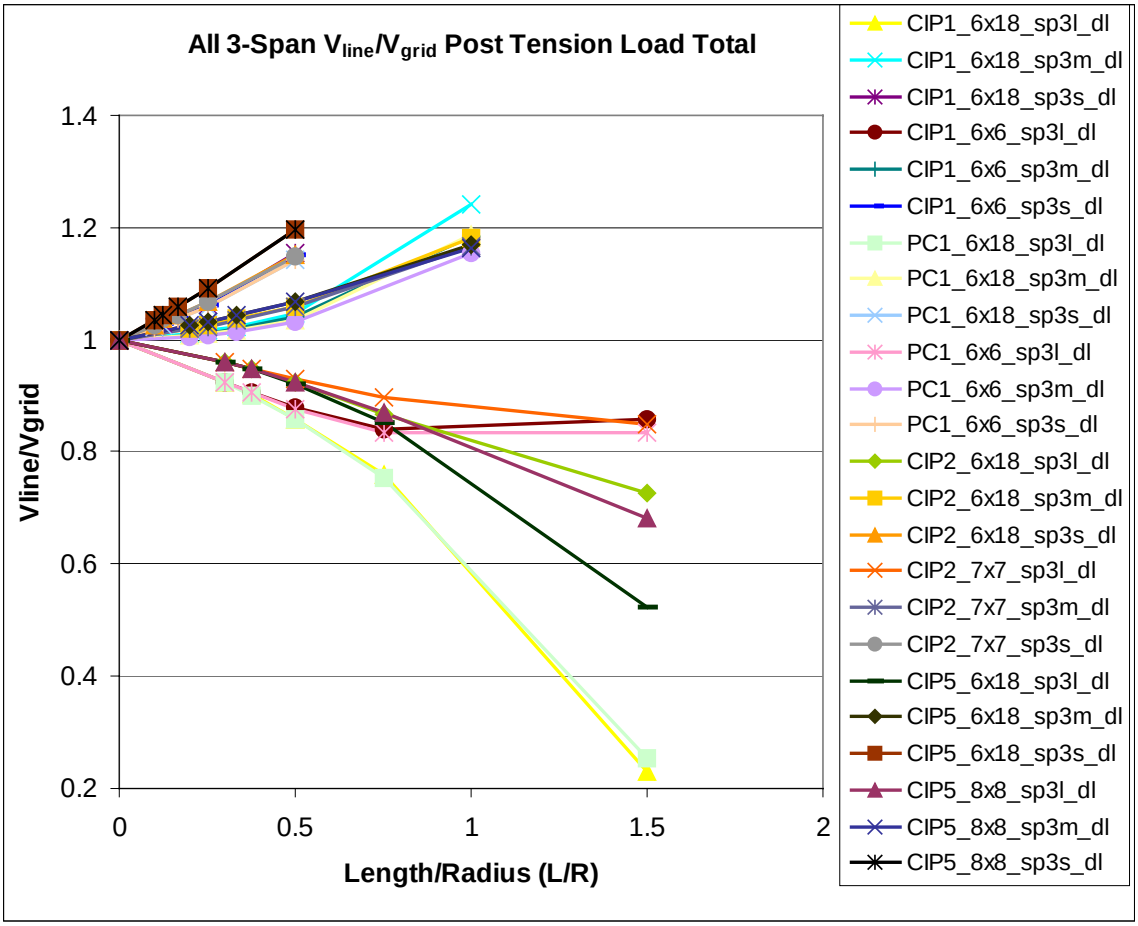
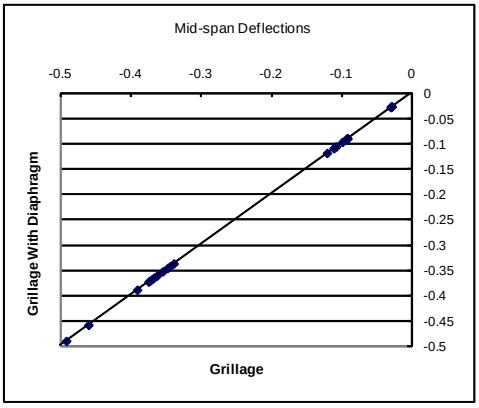
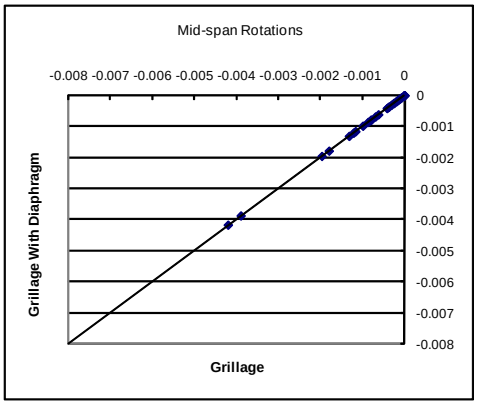
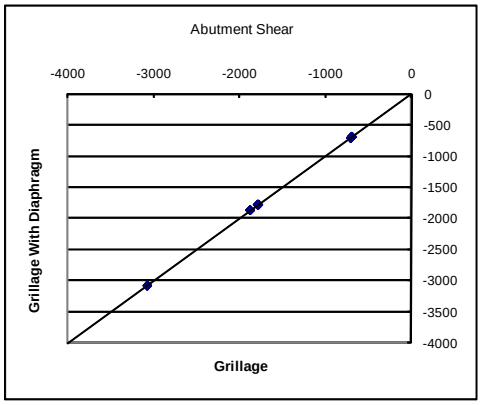
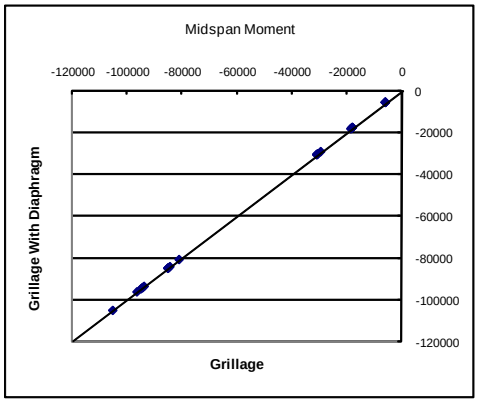


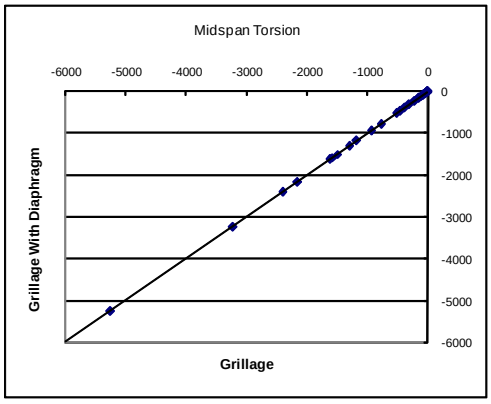
Figure E.4.1: Five Cell, Cast In Place, Diaphragm Analysis: Self Weight

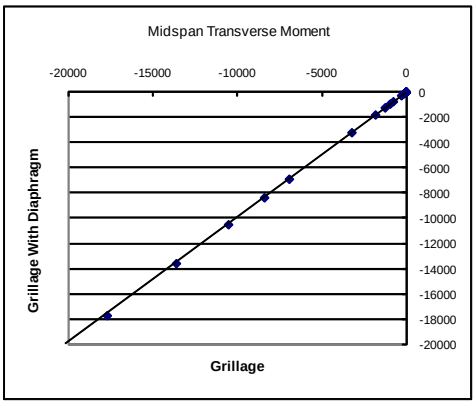


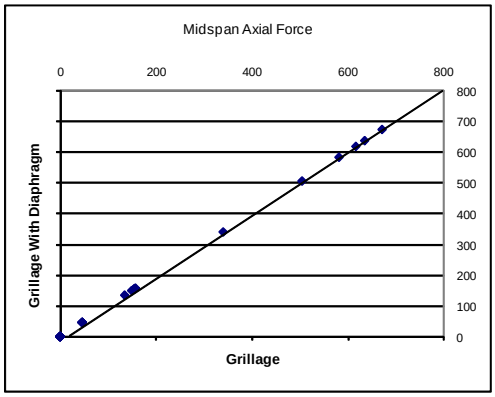












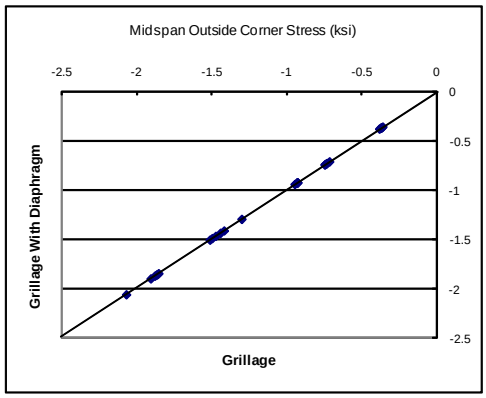
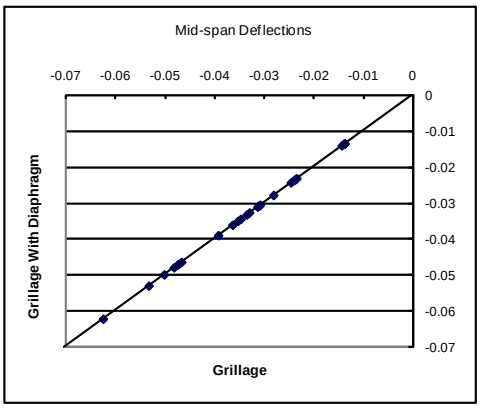
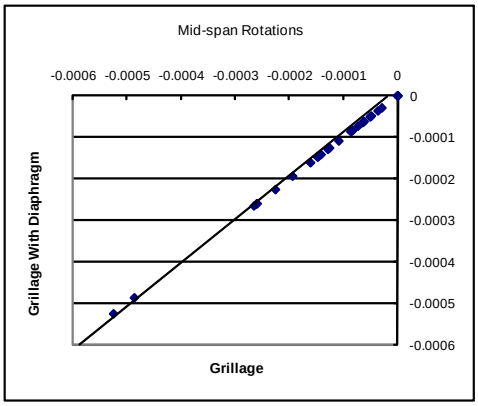
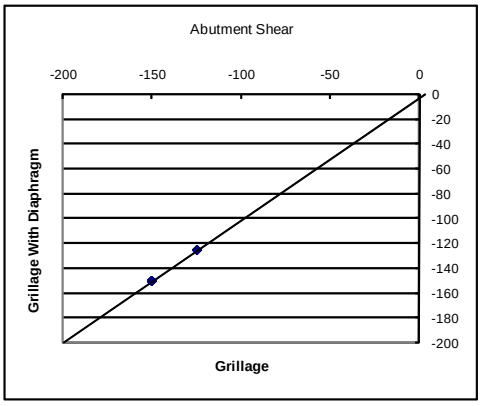
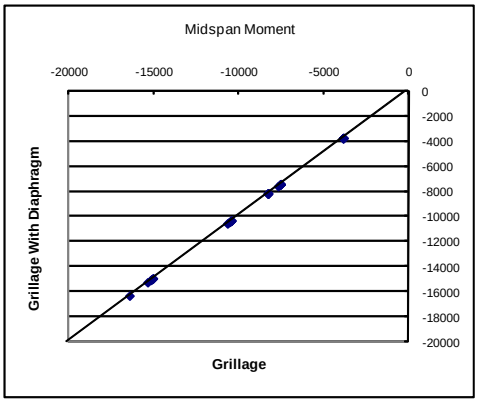


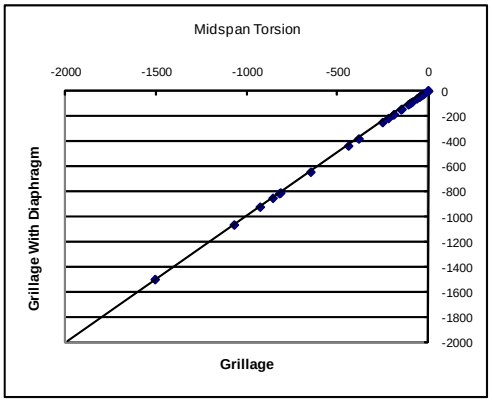
Figure E.4.2: Five Cell, Cast In Place, Diaphragm: Live Load Total

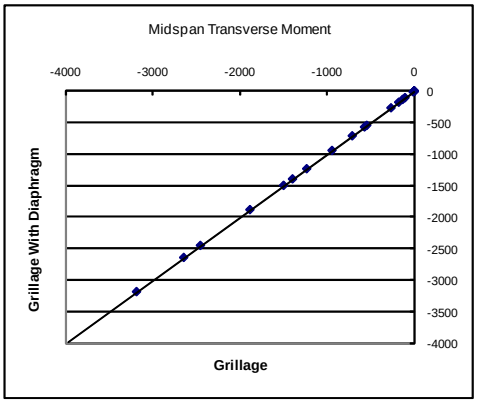


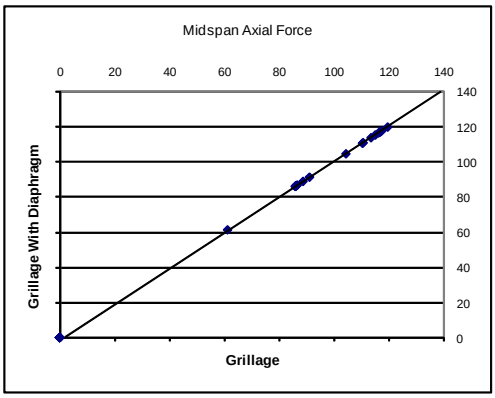












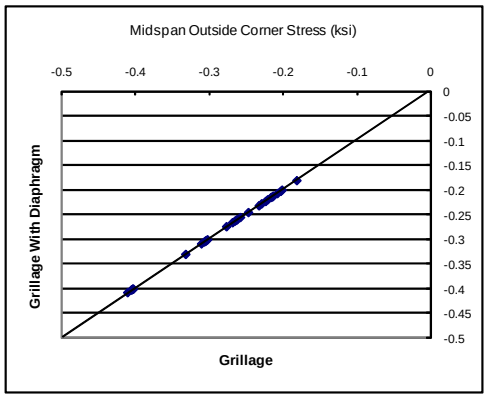
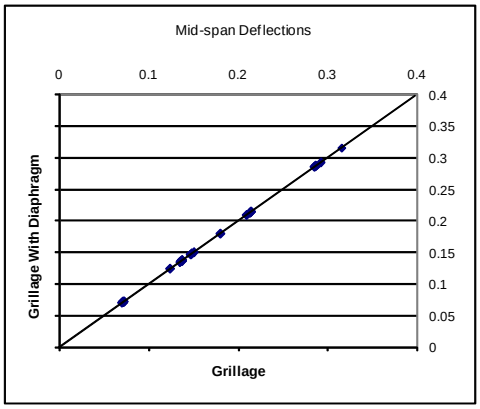
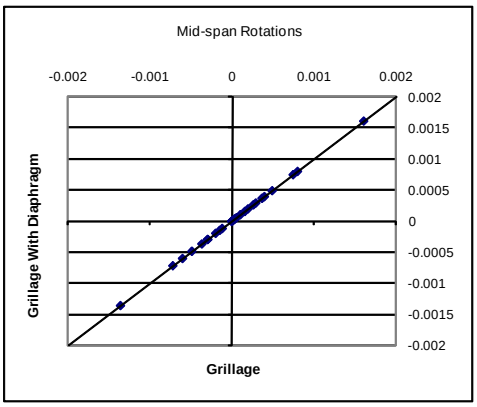
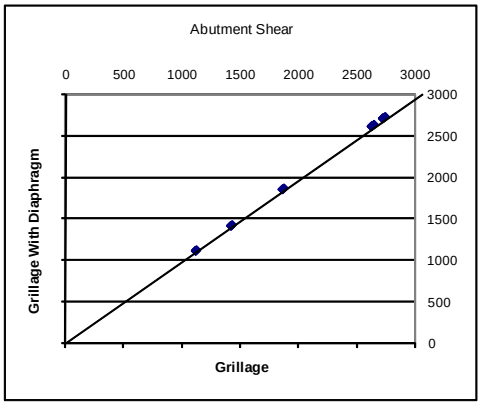
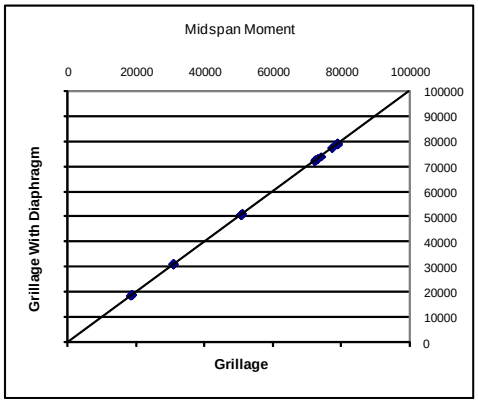


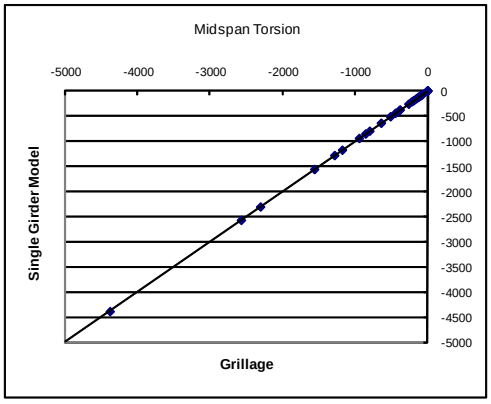
Figure E.4.3: Five Cell, Cast In Place, Diaphragm: Post Tension Total

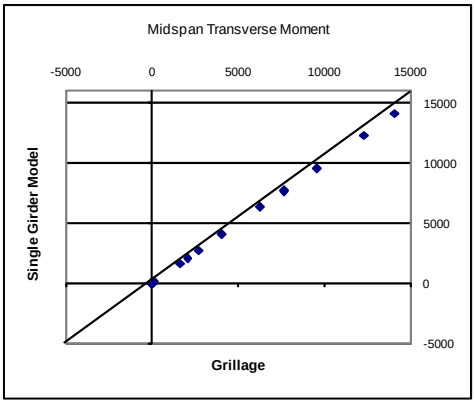


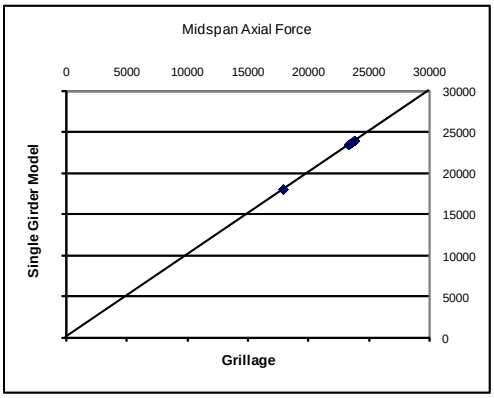












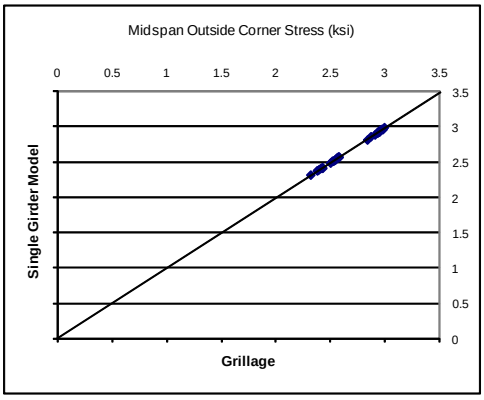


Figure E.5.1: Five Cell, Cast In Place, Diaphragm: Self Weight

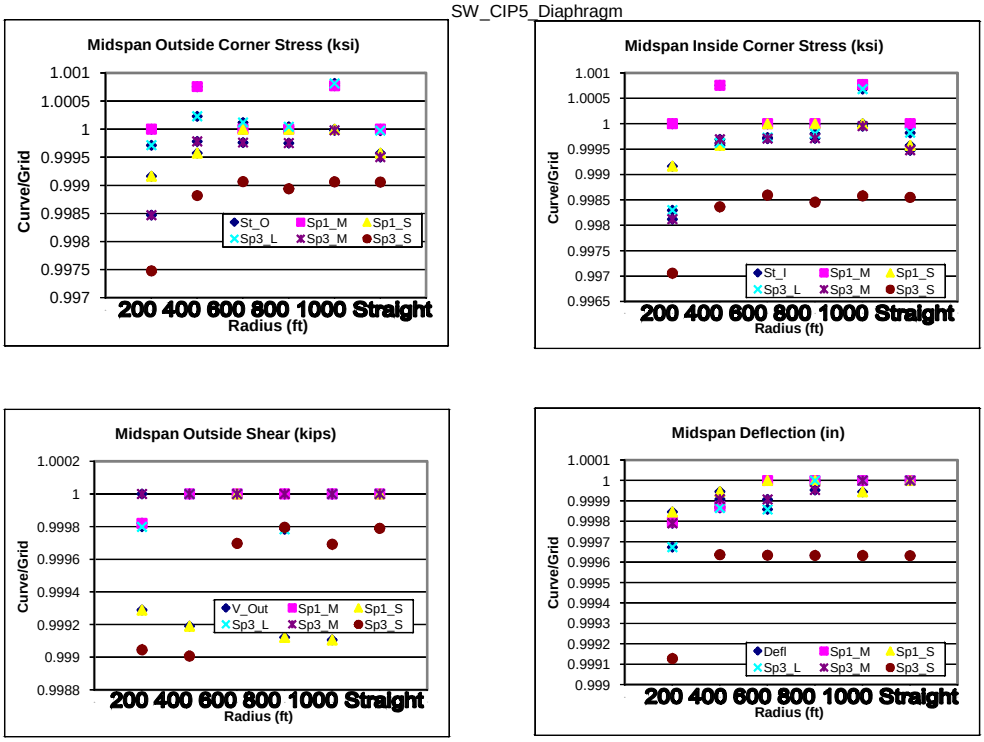


Figure E.5.2: Five Cell, Cast In Place, Diaphragm: Live Load Total

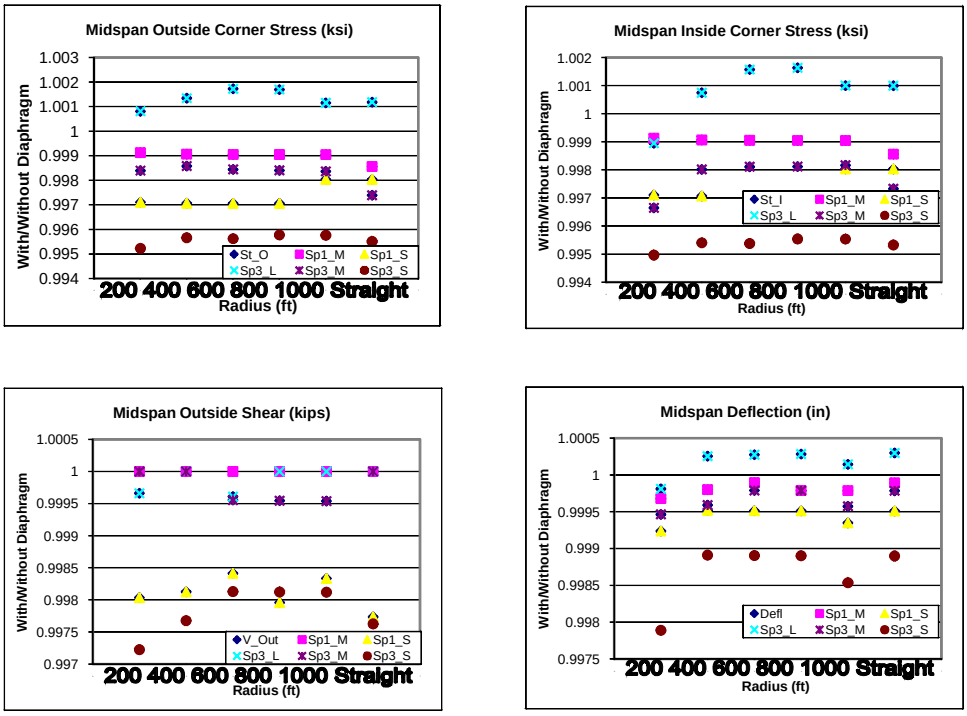
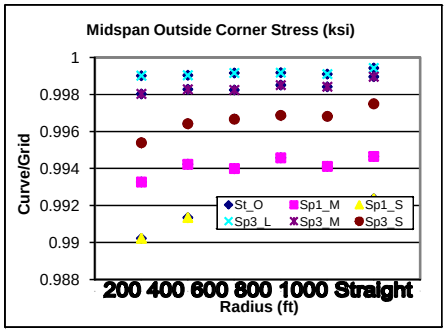
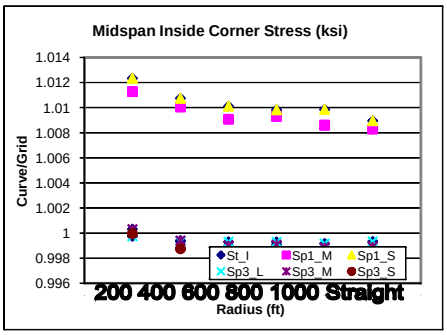
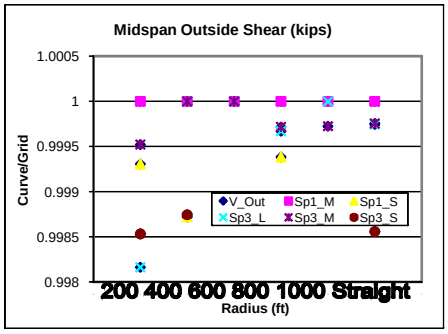


Figure E.5.3: Five Cell, Cast In Place, Diaphragm: Post Tension Total







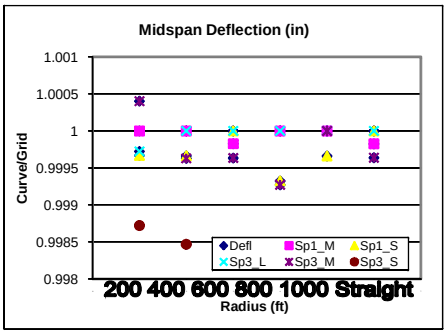
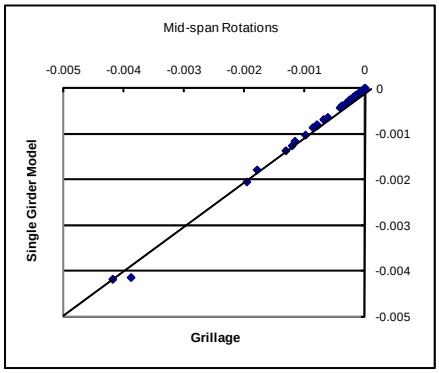
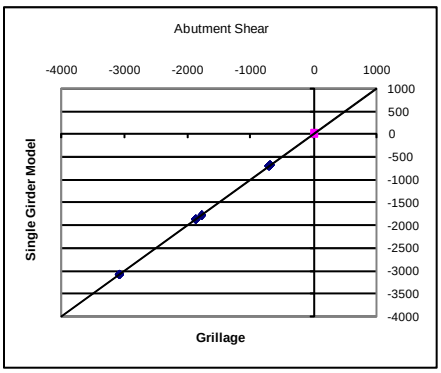
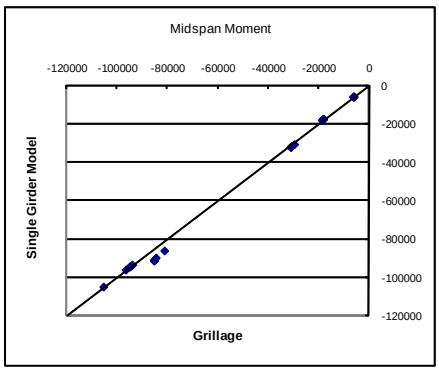
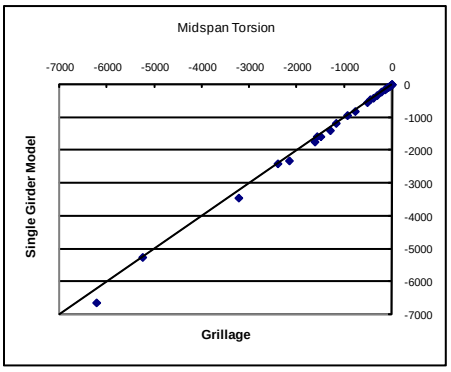


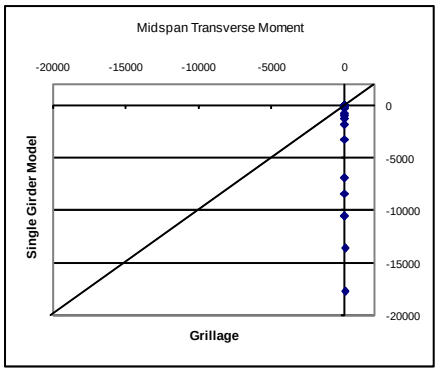
Figure E.6.1: Five Cell, Cast In Place, Grid Model Hinge: Self Weight

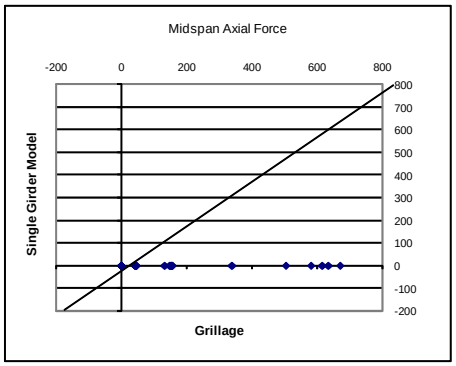












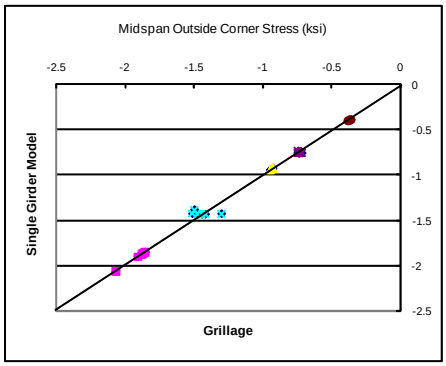


Figure E.6.2: Five Cell, Cast In Place, Grid Model Hinge: Live Load Total

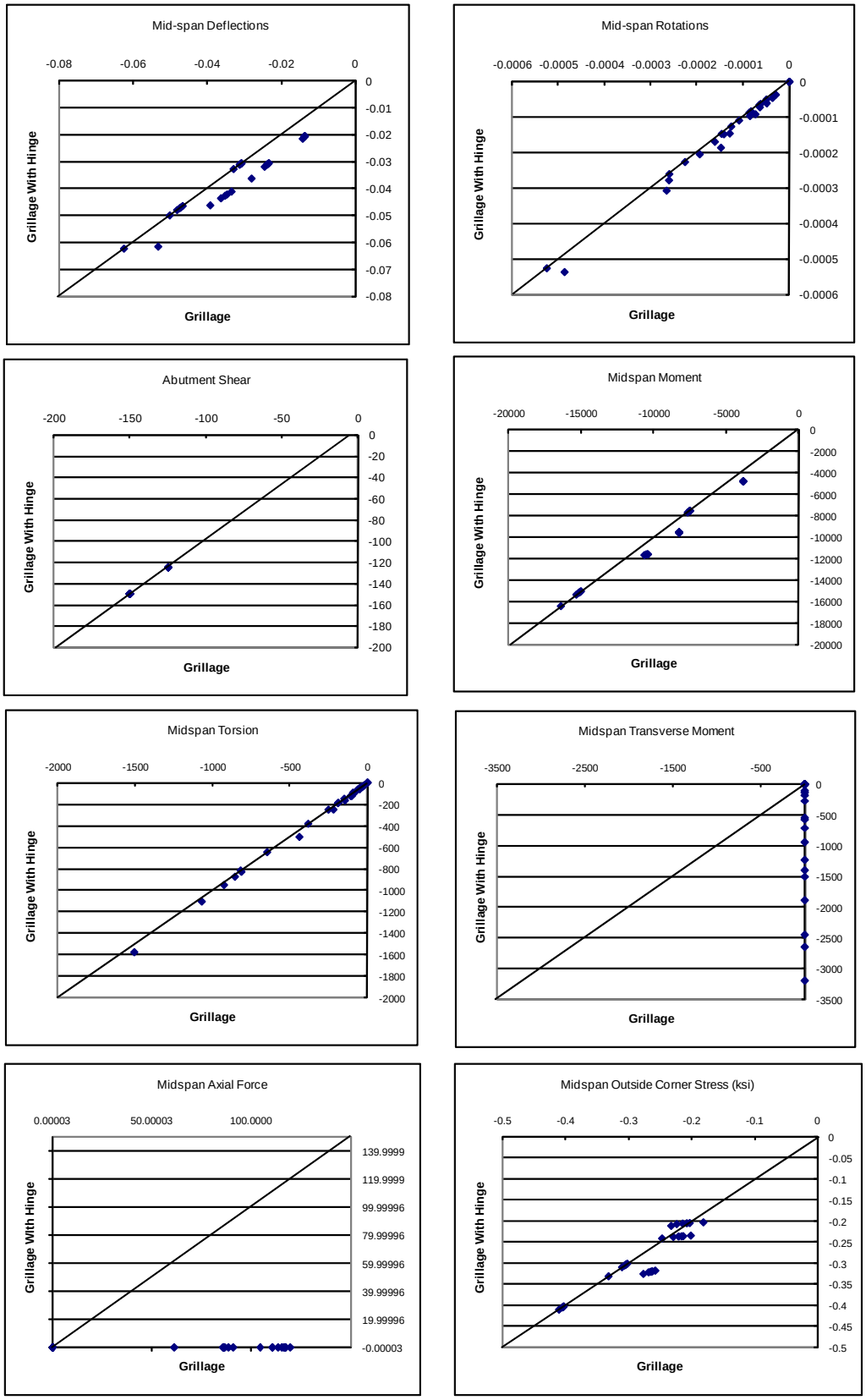
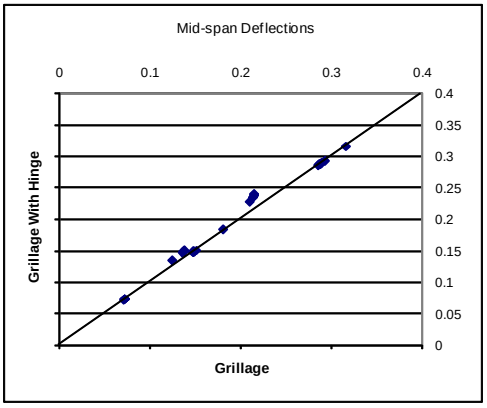
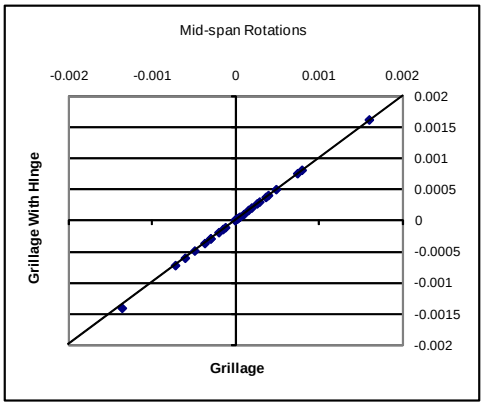
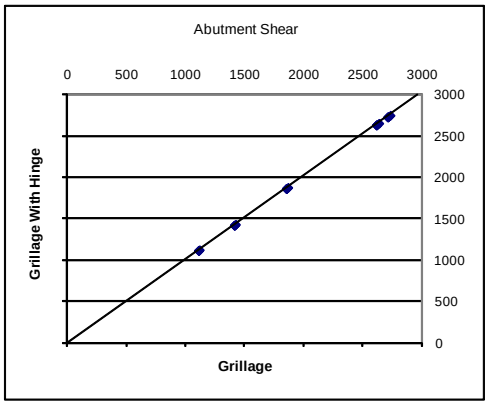
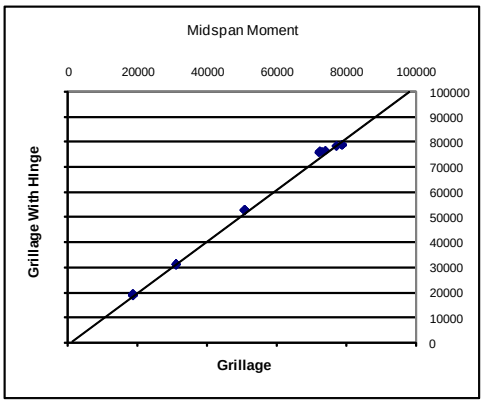


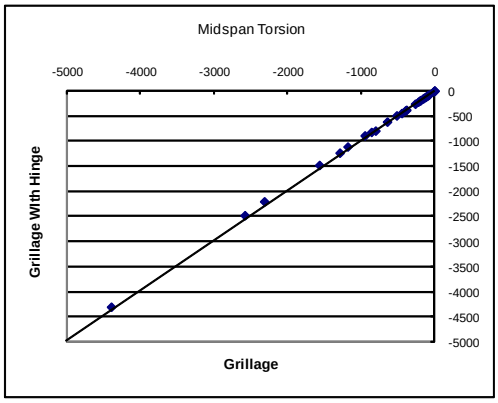
Figure E.6.3: Five Cell, Cast In Place, Grid Model Hinge: Post Tension Total

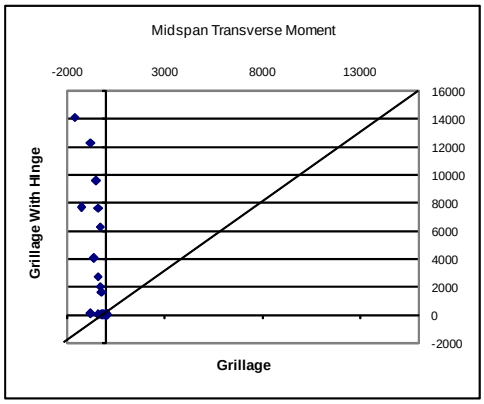


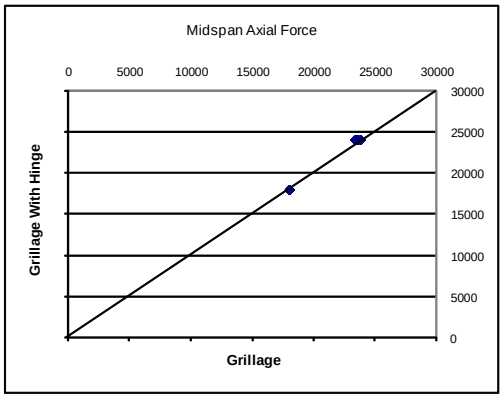












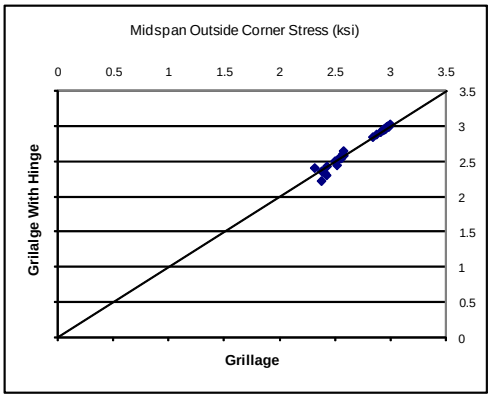


Figure E.7.1: Five Cell, Cast In Place, Grid Model Hinge: Self Weight

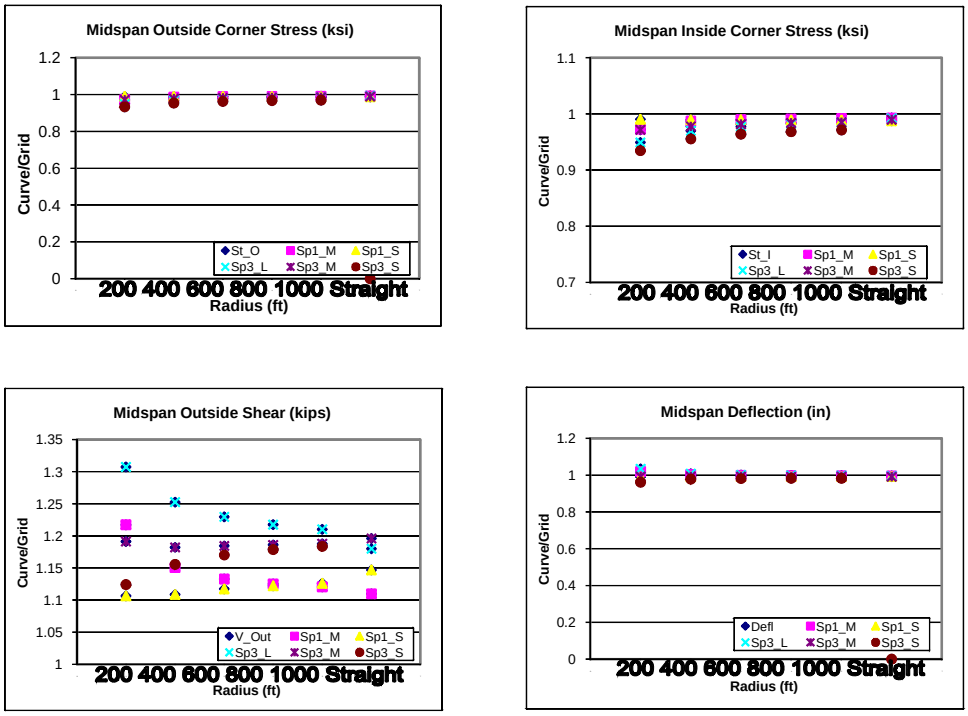


Figure E.7.2: Five Cell, Cast In Place, Grid Model Hinge: Live Load Total

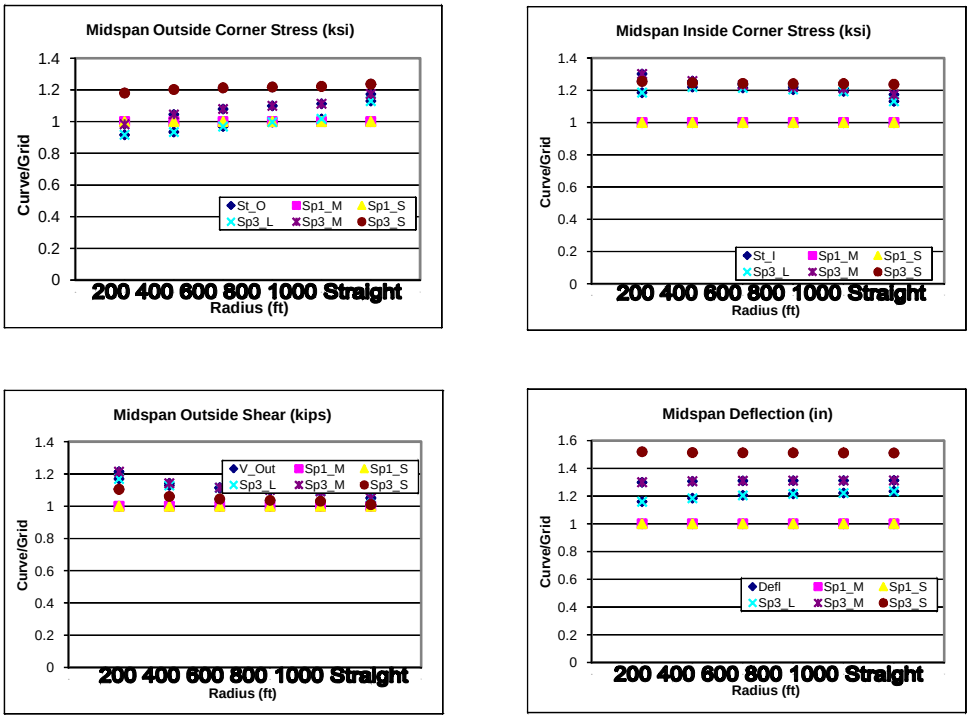
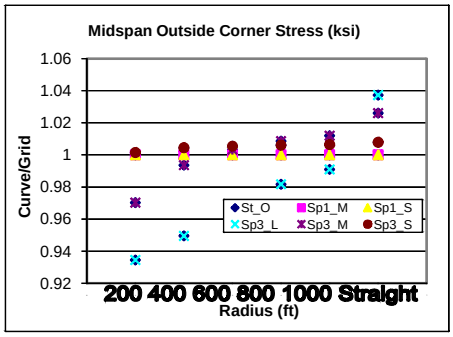
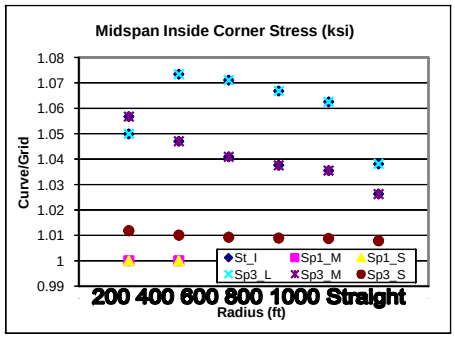
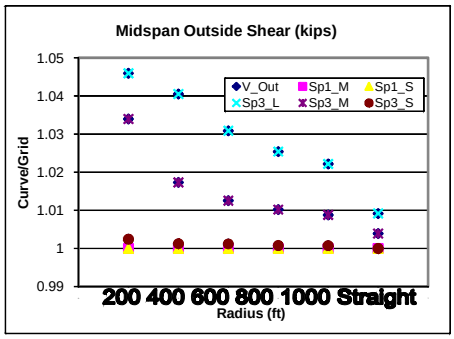


Figure E.7.3: Five Cell, Cast In Place, Grid Model Hinge: Post Tension Total







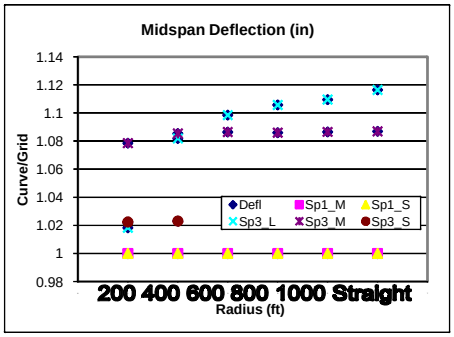


Table E1: Straight DL 200 ft/Single Span - Skew Shear Results				
	Obtuse (Element 1)		Acute (Element 21)	
	Value	Ratio	Value	Ratio
Radial	-389.35	1.00	-387.84	1.00
Skew-Left	-605.00	1.55	-190.65	0.49
Skew-Both	-392.94	1.01	-342.23	0.88

Table E2: Straight LL 200 ft/Single Span - Skew Shear Results				
	Obtuse (Element 1)		Acute	
	Value	Ratio	Value	Ratio
Radial	-47.80	1.00	-47.53	1.00
Skew-Left	-85.66	1.79	-10.05	0.21
Skew-Both	-48.20	1.01	-35.44	0.75

Table E3: DL - 400 ft Radius, 200 ft Single Span - Skew Shear Results				
	Obtuse (Element 1)		Acute	
	Value	Ratio	Value	Ratio
Radial	-577.89	1.00	-189.78	1.00
Skew-Left	-782.91	1.35	-58.28	0.31
Skew-Both	-614.14	1.06	-183.66	0.97

Table E4: LL - 400 ft Radius, 200 ft Single Span - Skew Shear Results				
	Obtuse (Element 1)		Acute	
	Value	Ratio	Value	Ratio
Radial	-81.62	1.00	-12.01	1.00
Skew-Left	-116.15	1.42	12.53	-1.04
Skew-Both	-85.08	1.04	-9.13	0.76

Table E5: DL - Straight, 200/300/200 ft Multi Span - Skew Shear Results				
	Obtuse (Element 1)		Acute	
	Value	Ratio	Value	Ratio
Radial	-297.35	1.00	-296.59	1.00
Skew-Left	-378.79	1.27	-197.35	0.67
Skew-Both	-378.02	1.27	-197.66	0.67

Table E6: DL-400 ft R, 200/300/200 ft Multi Span - Skew Shear Results				
	Obtuse (Element 1)		Acute	
	Value	Ratio	Value	Ratio
Radial	-370.00	1.00	-202.20	1.00
Skew-Left	-452.84	1.22	-135.81	0.67
Skew-Both	-453.89	1.23	-135.81	0.67