

WSDOT/TxDOT Bridge Practices and Innovations

Richard Pickings, P.E.,
BridgeSight Inc.



BridgeSight

Software™

WSDOT



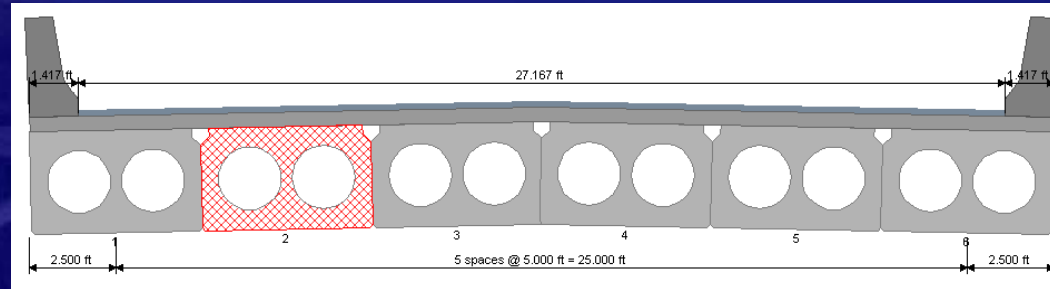
Washington State
Department of Transportation

- Precast/Pretensioned I-Girder
- Design Practices
 - Envelope of Simple and Continuous Behavior
 - Moderately High Seismic Zones
 - Standard Intermediate Diaphragm Layout Rules
 - Design for Shipping and Handling
 - Compute LRFR Rating Factors for All LRFD Designs

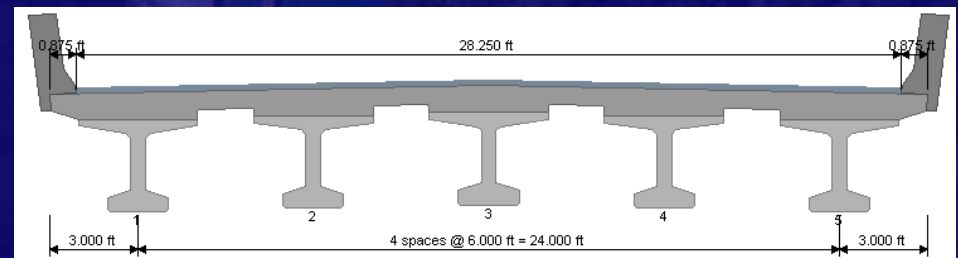
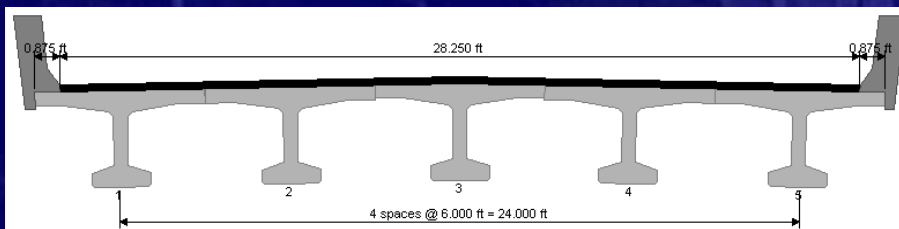
Span Capabilities

Short/Medium Spans

- Solid or Voided Slab
 - To ~98 ft

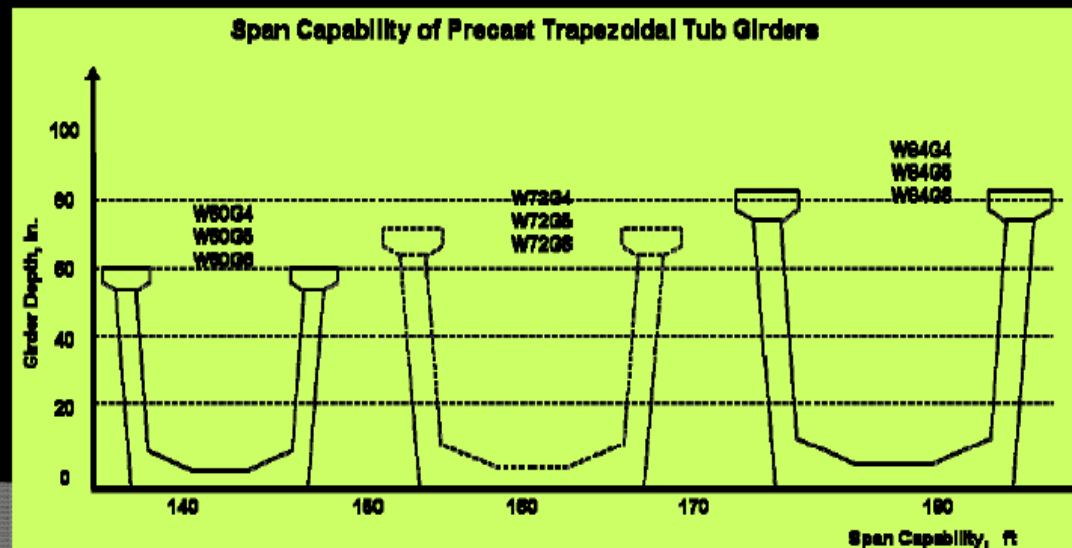
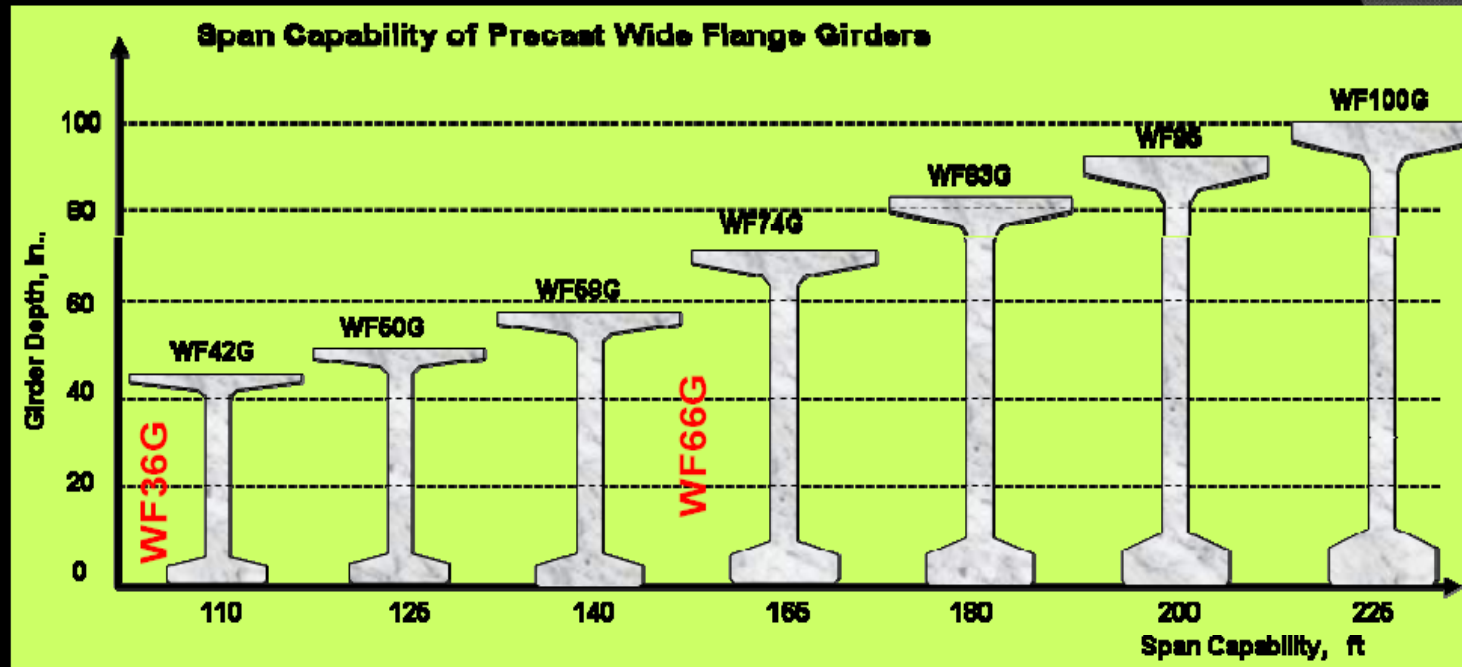


- Decked Bulb Tee and Bulb Tee
 - To ~145 ft





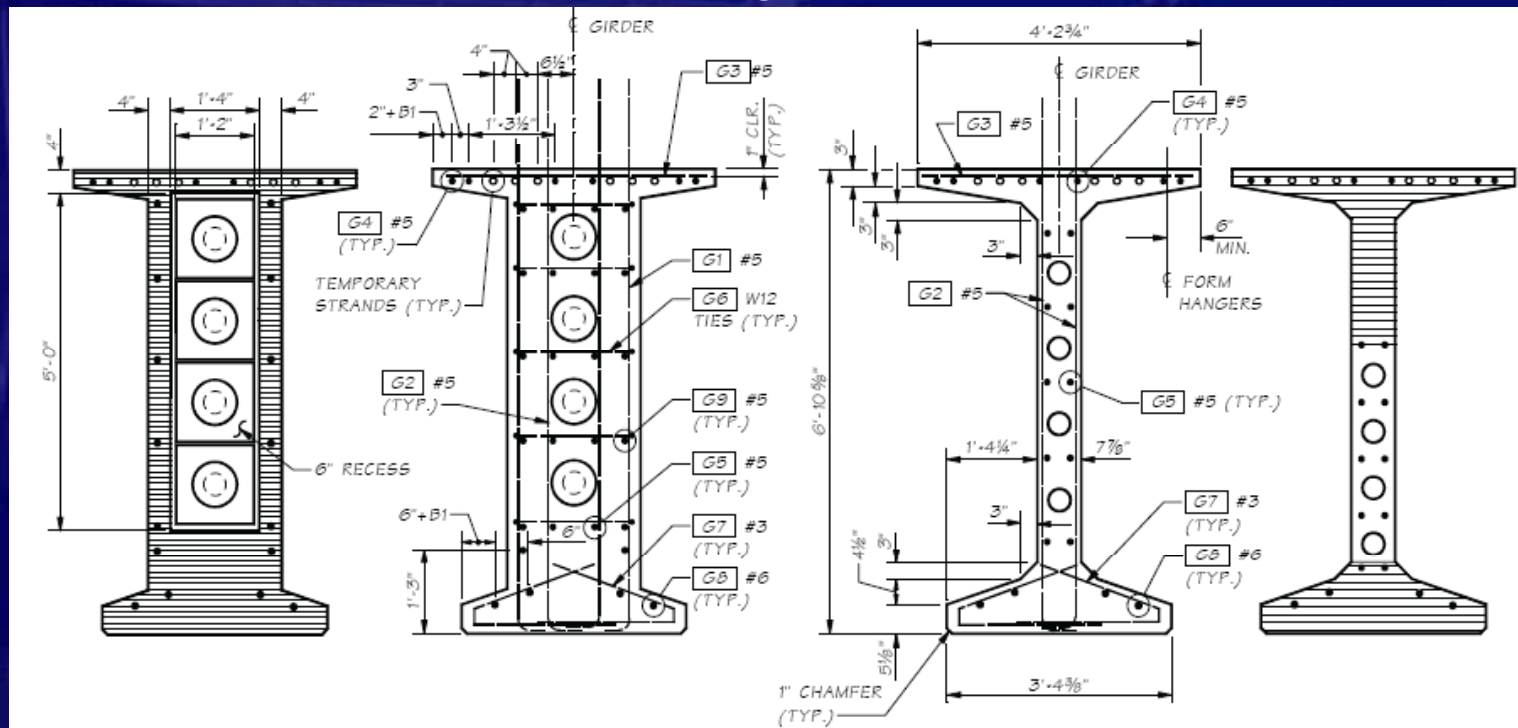
Standard Precast Pretensioned Girders



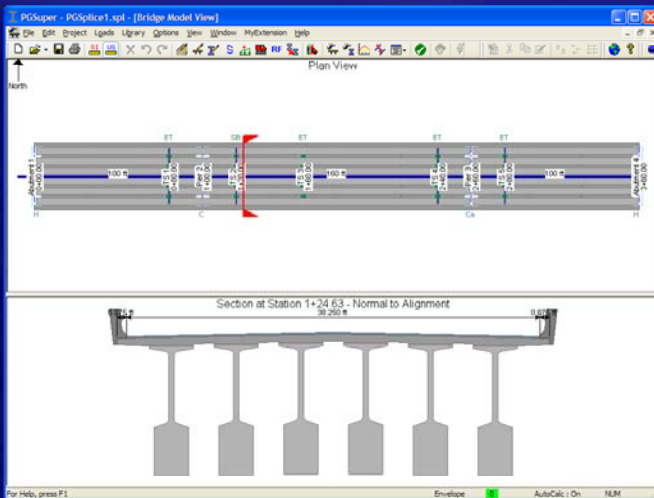
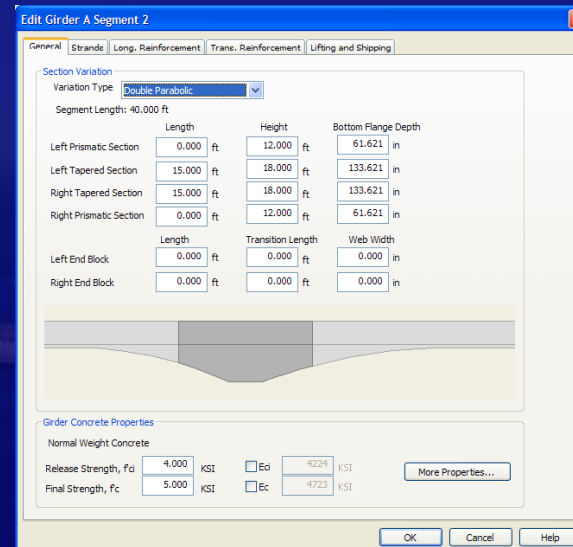
Spliced/Post-Tensioned I-Girders

- WF##PTG Series
 - Splice for Handling/Hauling
 - Simple/Cont Span Design
 - PT Before/After Slab Casting

- 7-7/8" Web Thickness
- 24" Tapered End Block



Post-Tensioning For Continuity

Edit Girder A Segment 2

General | Strands | Long. Reinforcement | Trans. Reinforcement | Lifting and Shipping

Section Variation
Variation Type: Double Parabolic

Segment Length: 40,000 ft

	Length	Height	Bottom Flange Depth
Left Prismatic Section	0.000 ft	12.000 ft	61.621 in
Left Tapered Section	15.000 ft	18.000 ft	133.621 in
Right Tapered Section	15.000 ft	18.000 ft	133.621 in
Right Prismatic Section	0.000 ft	12.000 ft	61.621 in

	Length	Transition Length	Web Width
Left End Block	0.000 ft	0.000 ft	0.000 in
Right End Block	0.000 ft	0.000 ft	0.000 in

Girder Concrete Properties

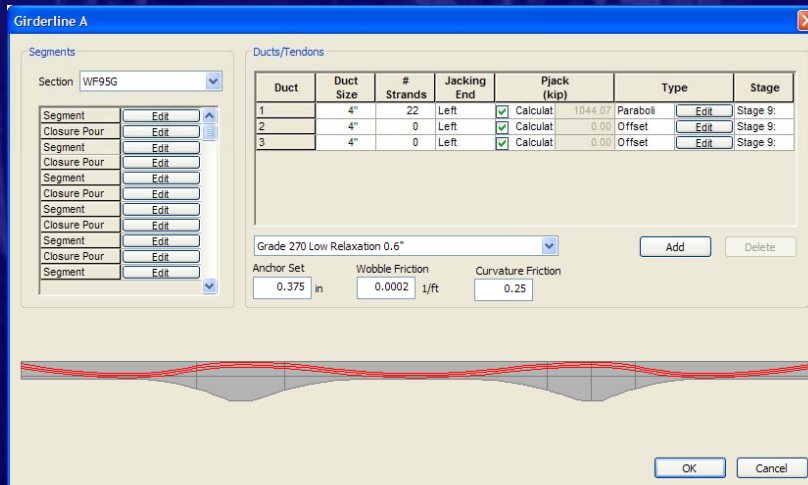
Normal Weight Concrete

Release Strength, f_d : 4,000 KSI Ed 4,224 KSI

Final Strength, f_c : 5,000 KSI Ec 4,723 KSI

More Properties...

OK Cancel Help



Girdeline A

Segments

Section: WF95G

Segment	Edit
Segment	Edit
Closure Pour	Edit
Segment	Edit
Closure Pour	Edit
Segment	Edit
Closure Pour	Edit
Segment	Edit
Closure Pour	Edit
Segment	Edit
Closure Pour	Edit
Segment	Edit

Ducts/Tendons

Duct	Duct Size	# Strands	Jacking End	Calculat	Pjack (kip)	Type	Stage
1	4"	22	Left	<input checked="" type="checkbox"/>	1044.07	Paraboli	Stage 9:
2	4"	0	Left	<input checked="" type="checkbox"/>	0.00	Offset	Stage 9:
3	4"	0	Left	<input checked="" type="checkbox"/>	0.00	Offset	Stage 9:

Grade 270 Low Relaxation 0.6"

Anchor Set: 0.375 in

Wobble Friction: 0.0002 1/ft

Curvature Friction: 0.25

Add Delete

OK Cancel

• 250 ft Main Span



LRFR Load Rating

- Section 6, Part A of the AASHTO Manual for Bridge Evaluation, First Edition.



U.S. Department of Transportation
Federal Highway Administration

MEMORANDUM

Subject: **INFORMATION:** Bridge Load Ratings for the National Bridge Inventory

Date: October 30, 2006

From: *of Original Signed by*
M. Myint Lwin, P.E., S.E.
Director, Office of Bridge Technology

Reply to
Attn of: HIBT-30

To: Directors of Field Services
Division Administrators
Federal Lands Highway Division Engineers

Several State and FHWA Bridge Engineers have suggested that we clarify our policy regarding the appropriate methodology and loads to be used in reporting operating and inventory rating data (Items 63, 64, 65 and 66 of the 1995 Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges (Coding Guide), Report No. FHWA-PD-96-001) to the National Bridge Inventory (NBI). An overview of our past bridge load rating policies are provided in the attached appendix and our current policy and future direction is provided herein.

With the adoption of the AASHTO Load and Resistance Factor Design (LRFD) Specifications, our June 28, 2000, policy memorandum requiring all new bridges to be designed by the LRFD Specifications after October 1, 2007, and the ongoing effort to merge the Manual for Condition Evaluation of Bridges and the Guide Manual for Condition Evaluation and Load and Resistance Factor Rating of Highway Bridges (LRFR Manual), we believe that it is necessary to accommodate and support Load and Resistance Factor Rating (LRFR), while continuing to accept Load Factor Rating (LFR) for the large inventory of in-service bridges that have been designed by another method other than LRFD. The FHWA does not intend to mandate re-rating existing and valid bridge load ratings by LRFR.

Therefore, FHWA's policy for Items 63, 64, 65, and 66 of the Coding Guide is as follows (see [Table 1](#) for more information):

- For bridges and total replacement bridges designed by LRFD Specifications using HL-93 loading, prior to October 1, 2010, Items 63, 64, 65 and 66 are to be computed and reported to the NBI as either a Rating Factor (RF) or in metric tons. Rating factors shall be based on LRFR methods using HL-93 loading (see [Appendix A - Example 1](#)) or LFR methods using MS18 loading (see [Appendix A - Example 2](#)). Metric ton rating values shall be reported in terms of MS18 (32.4 metric tons) loading derived from a RF calculated using LRFR methods and HL-93 loading, or LFR methods using MS18 loading (see [Appendix A - Example 3](#)).
- For bridges and total replacement bridges designed by LRFD Specifications using HL-93, after October 1, 2010 Items 63, 64, 65 and 66 are to be computed and reported to the NBI as a RF based on LRFR methods using HL-93 loading (see [Appendix A - Example 1](#)).

Load Rating

Design Load Rating

Limit State	Type	Inventory			Operating		
		RF	γ_{LL}	Location from Left Support	RF	γ_{LL}	Location from Left Support
Strength I	Flexure	1.49	1.750	Span 1 Girder B, (0.5L _s) 60.000 ft	1.93	1.350	Span 1 Girder B, (0.5L _s) 60.000 ft
	Shear	1.58	1.750	Span 1 Girder B, 23.700 ft	2.46	1.350	Span 1 Girder B, (FoS, 0.0L _s) 0.000 ft
Service III	Stress	0.97	0.800	Span 1 Girder B, (0.5L _s) 60.000 ft			

TxDOT



- ~ \$50/sq ft. Avg. Unit Cost For I-Girder Bridge
- 2004 – Over 1,000,000 lin. ft of I-Girders
- Design Practices
 - Simple Span Design
 - Low Seismic Zone
 - No Intermediate Diaphragms
 - “Standard” Designs Via Parametric Plan Sheets

FY 2009 Average % Breakdown of Overall Project Costs for Bridges

<i>System</i>	<i>Structure %</i>	<i>Mobilization %</i>	<i>Removal %</i>	<i>Approach, etc. %</i>
Off-System Bridges	59.5%	7.4%	2.3%	30.7%
Off-System Culverts	49.0%	7.6%	3.4%	40.0%
On-System Bridges	47.6%	10.6%	3.0%	38.3%
On-System Culverts	49.9%	9.2%	3.9%	37.1%



*FY 2009 Average Unit Cost**

<i>System</i>	<i>Structure Type</i>	<i>Number Bridges</i>	<i>Deck Area (sq.ft.)</i>	<i>Adjusted Structure Cost**</i>	<i>Average Unit Cost (\$/sq.ft.)</i>
<i>Off Culvert</i>					
	Culverts	32	36,570	\$ 3,574,054	\$ 97.73
<i>Off Span</i>					
	Concrete Girder "Pan" (CG-PN)	2	5,304	\$ 260,638	\$ 49.14
	Girder Prestressed "Box" Beam (GP-BX)	11	29,078	\$ 3,681,523	\$ 126.61
	Girder Prestressed Decked Slab Beam (GPDSB)	1	1,961	\$ 174,576	\$ 89.02
	Girder Prestressed "I" Beam	26	183,079	\$ 9,964,855	\$ 54.43
	Girder Prestressed "I" Beam "Texas Shape" (GPITX)	1	1,820	\$ 112,436	\$ 61.78
	Prestressed Concrete Slab Beam (PCSB)	68	186,130	\$ 14,322,225	\$ 76.95
	Concrete Slab (SLAB)	8	50,088	\$ 2,931,359	\$ 58.52
	Structural Steel Truss (STRTR)	1	2,028	\$ 256,693	\$ 126.57
	Girder Steel "I" Beam (GS-I)	2	2,753	\$ 427,740	\$ 155.37
<i>Off Span Totals</i>					
	Off Totals	120	462,241	\$ 32,132,045	\$ 69.51
<i>On Culvert</i>					
	Culverts	42	259,815	\$ 17,173,705	\$ 66.10
<i>On Span</i>					
	Girder Prestressed "Box" Beam (GP-BX)	15	92,831	\$ 7,768,311	\$ 83.68
	Girder Prestressed "I" Beam (GP-I)	138	3,203,136	\$ 156,434,885	\$ 48.84
	Girder Prestressed "I" Beam "Texas Shape" (GPITX)	18	522,839	\$ 25,172,736	\$ 48.15
	Girder Prestressed "U" Beam (GP-U)	6	229,100	\$ 15,995,769	\$ 69.82
	Prestressed Concrete Slab Beam (PCSB)	32	260,921	\$ 16,501,775	\$ 63.24
	Concrete Slab (SLAB)	4	39,122	\$ 2,212,262	\$ 56.55
	Girder Steel "I" Beam (GS-I)	5	79,740	\$ 8,502,834	\$ 106.63
	Girder Steel Trapezoidal (GS-TR)	3	93,795	\$ 13,388,855	\$ 142.75
<i>On Span Totals</i>					
	On Totals	221	4,521,484	\$ 245,977,427	\$ 54.40

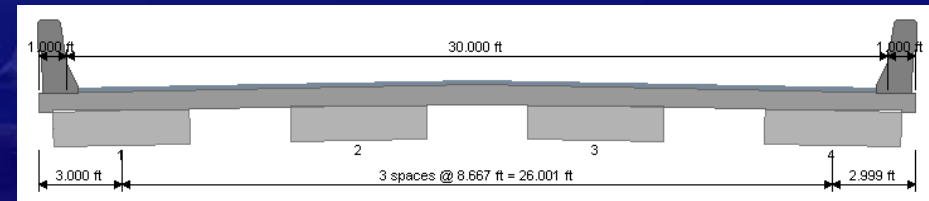
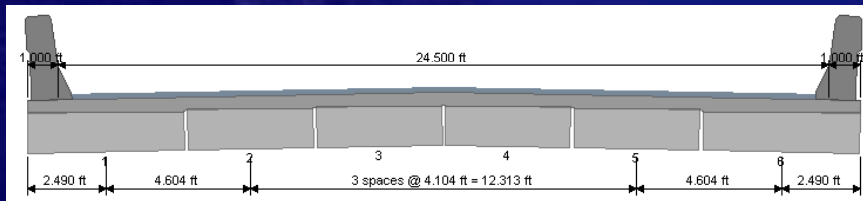
Span Capabilities

Short/Medium Spans



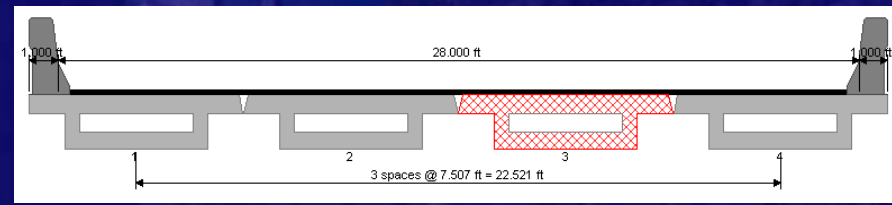
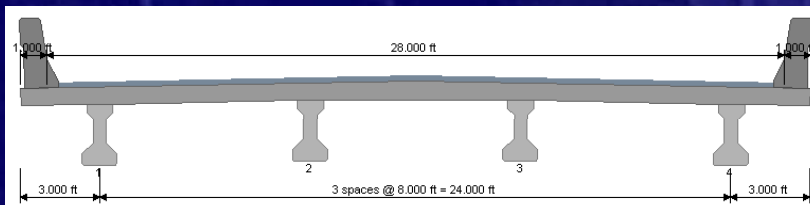
Solid Slab

- To ~50 ft



AASHTO I-Girder or Decked Slab Beam

- 50-70 ft



- 40-60 ft

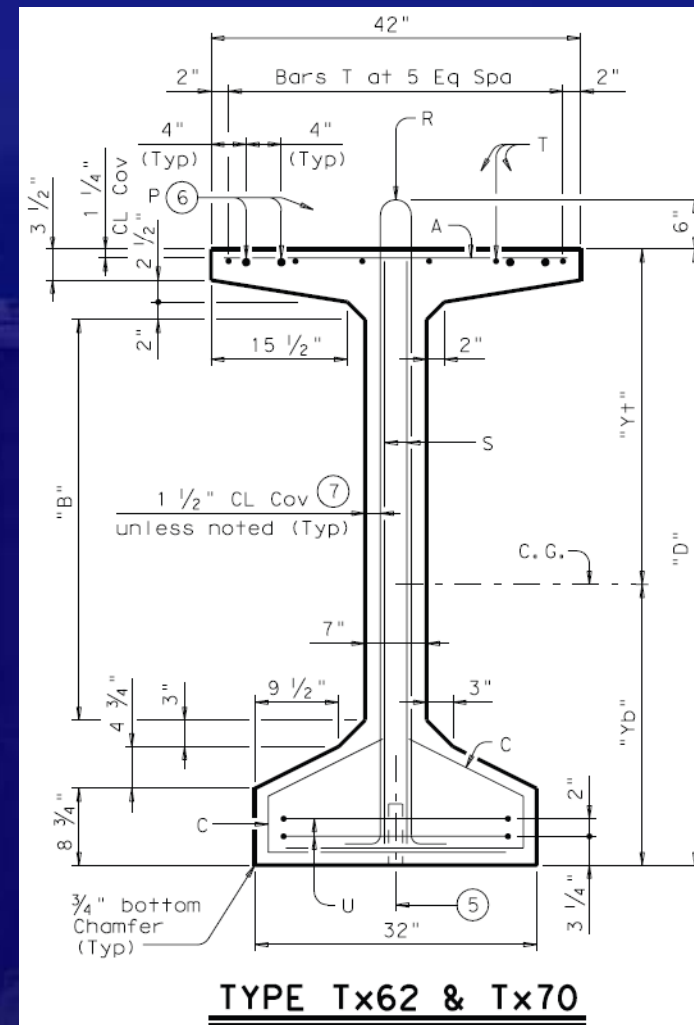


Span Capabilities

Longer Spans

TxDOT I Girder (Tx##)

- Tx28 to ~70 ft
- Tx85 to ~165 ft





I Girders, Recommended Span Lengths for LRFD

Beam Type	Beam Depth	¹ Approx Structure Depth	Use
TX28	28 in.	38 in.	Economical span limit is 70 ft. Spans should not exceed 80 ft.
TX34	34 in.	44 in.	Economical span limit is 80 ft. Spans should not exceed 95 ft.
TX40	40 in.	50 in.	Economical span limit is 95 ft. Spans should not exceed 105 ft.
TX46	46 in.	56 in.	Economical span limit is 105 ft. Spans should not exceed 120 ft.
TX54	54 in.	64 in.	Economical span limit is 125 ft. Spans should not exceed 140 ft.
TX62	62 in.	72 in.	Economical limit is 135ft. Spans should not exceed 150 ft.
TX70	70 in.	80 in.	Economical limit is 145 ft. Spans should not exceed 150 ft due to handling constraints.

¹Approx Structure depth is Beam Depth plus 8" minimum slab plus 2" estimated haunch.

TxDOT Optional Girder Analysis (TOGA)



- Value Engineering
 - Streamlined Evaluation of Fabricator Optional Designs
- Simplified UI can be Used by Technicians
- Utilizes PGSuper as Underlying “Engine”

A screenshot of the PGSuper software interface, titled "PGSuper - Tx70_test.toga - [Toga Plugin]". The interface is divided into several sections with input fields and labels. The "General Information" section includes fields for Bridge (Tx70 example), Bridge ID (id tx701), Job Number (job tx70), Engineer (rdp), Company (bridgesight), and Comments (my comment). The "Design Information" section includes Span No. (1), Beam No. (3), Beam Type (Tx70), Beam Spacing (8.000 ft), Span Length (118.000 ft), Slab Thickness (8.000 in), Relative Humidity (60 %), LLDf (Moment) (0.667), and LLDf (Shear) (0.814). The "Material Properties" section includes Ec. Slab (5000.000 KSI), Ec. Beam (5000.000 KSI), and f_c, Slab (4.000 KSI). The "Design Data" section includes *f_t, Design Compressive Stress, Top CL (3.320 KSI), *f_t, Design Tensile Stress, Bottom CL (-3.870 KSI), and Mu, Required Ultimate Moment (8827.37 kip-ft). The "Optional Uniform Design Loads" section includes w non-comp, dc (0.000 kip/ft), w comp, dc (0.127 kip/ft), and w comp, dw (0.187 kip/ft). The interface also shows a menu bar (File, View, Help) and a status bar at the bottom with the text "For Help, press F1" and a page number "2".

Thank You!!

Questions?

- Special Thanks:
 - Doug Mooradian, PCMAC
 - Jim Ma, CalTrans
 - Rick Brice, WSDOT
 - Gregg Freeby, TxDOT

BridgeSight

Software™