Western Bridge Engineers' Seminar

September 4–6, 2013

Hyatt Regency Hotel | Bellevue, Washington

ADVANCES IN DESIGN, CONSTRUCTION, INSPECTION & PRESERVATION OF BRIDGES

800-942-4978
cm.wsu.edu/wbes2013

Seminar managed by:

WASHINGTON STATE UNIVERSITY
CONFERENCE MANAGEMENT

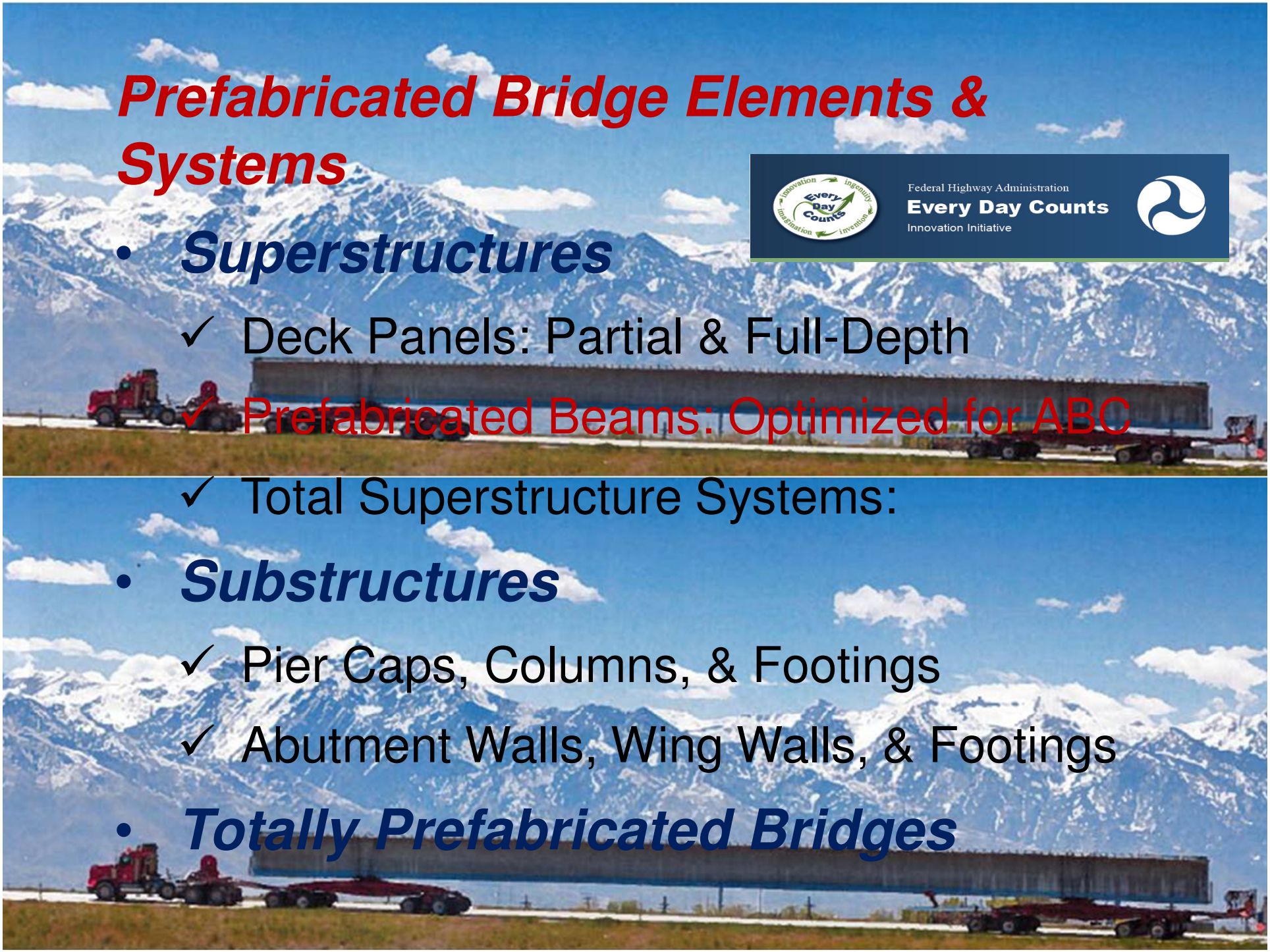
Prefabricated Decked Girders for Accelerated Bridge Construction in Washington State

Scott Sargent

Bijan Khaleghi

Bridge and Structures Office
Washington State
Department of Transportation

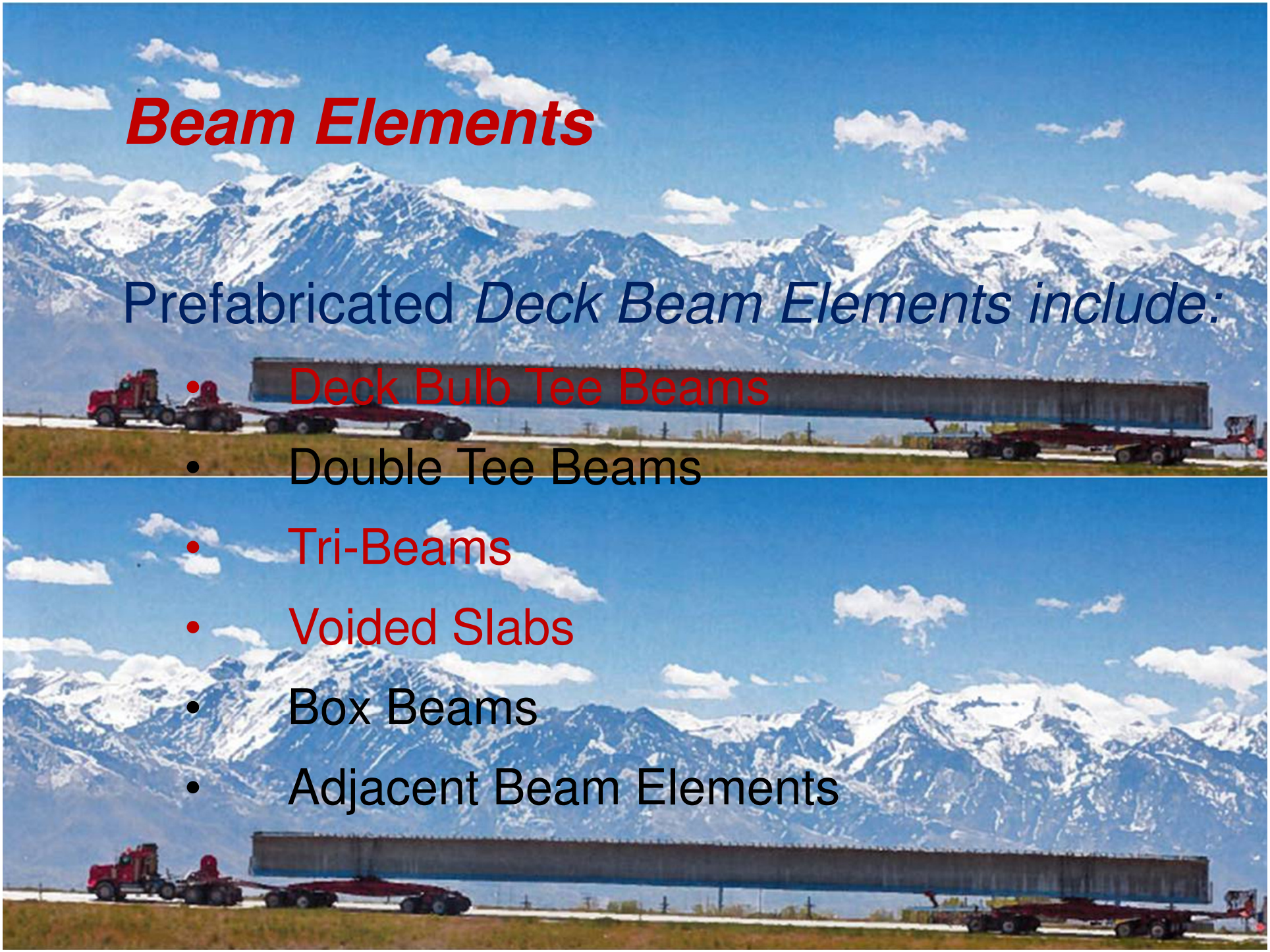

innovation
ingenuity
Every Day Counts
imagination
invention
Federal Highway Administration
Every Day Counts
Innovation Initiative
Summit -1: P2P Exchange - PBES
Prefabricated Bridge Elements & Systems
Accelerated Bridge Construction
November 13-16, 2012
Seattle, Washington
Summit -2: Every Day Count – GRS-IBS
November 29-30, 2012
Portland, Oregon



Prefabricated Bridge Elements & Systems

Federal Highway Administration
Every Day Counts
Innovation Initiative

- ***Superstructures***
  - ✓ Deck Panels: Partial & Full-Depth
  - ✓ Prefabricated Beams: Optimized for ABC
  - ✓ Total Superstructure Systems:
- ***Substructures***
  - ✓ Pier Caps, Columns, & Footings
  - ✓ Abutment Walls, Wing Walls, & Footings
- ***Totally Prefabricated Bridges***



Beam Elements

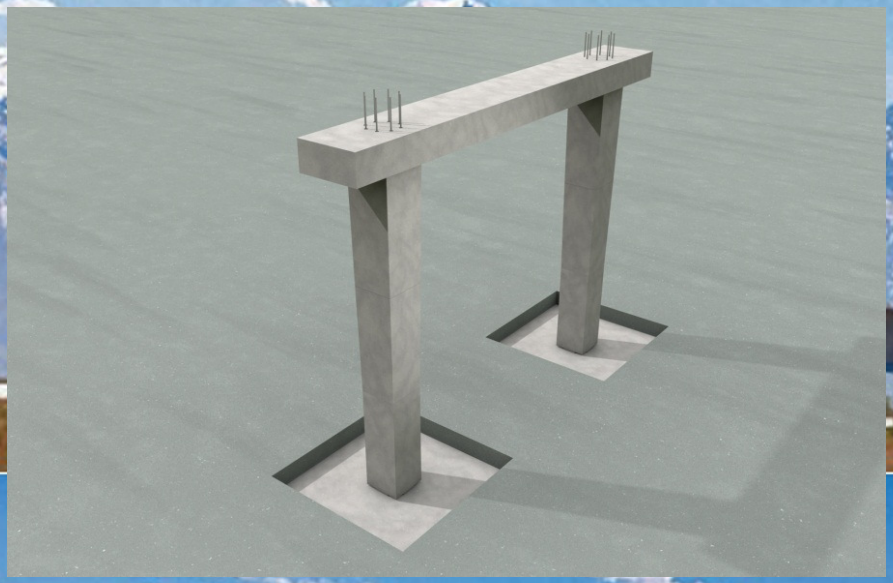
Prefabricated *Deck Beam Elements include:*

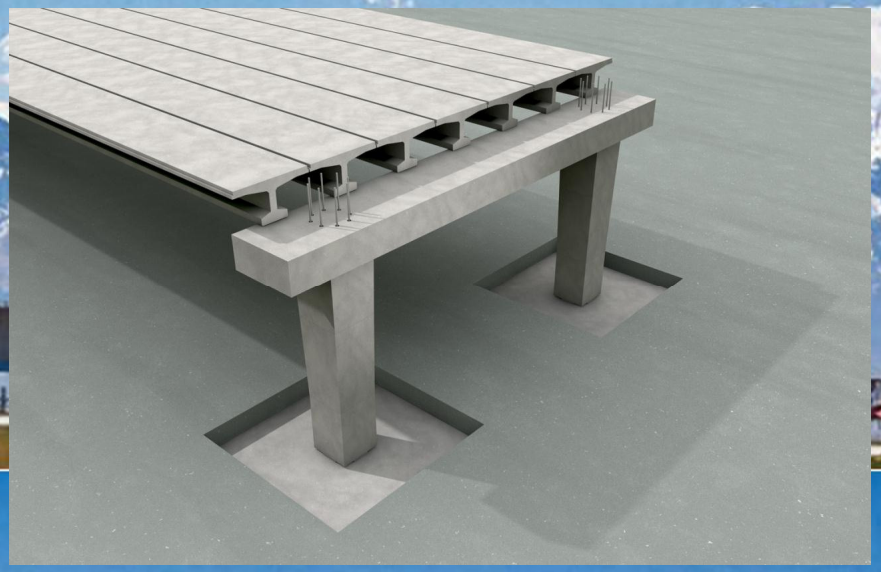
- Deck Bulb Tee Beams
- Double Tee Beams
- Tri-Beams
- Voided Slabs
- Box Beams
- Adjacent Beam Elements

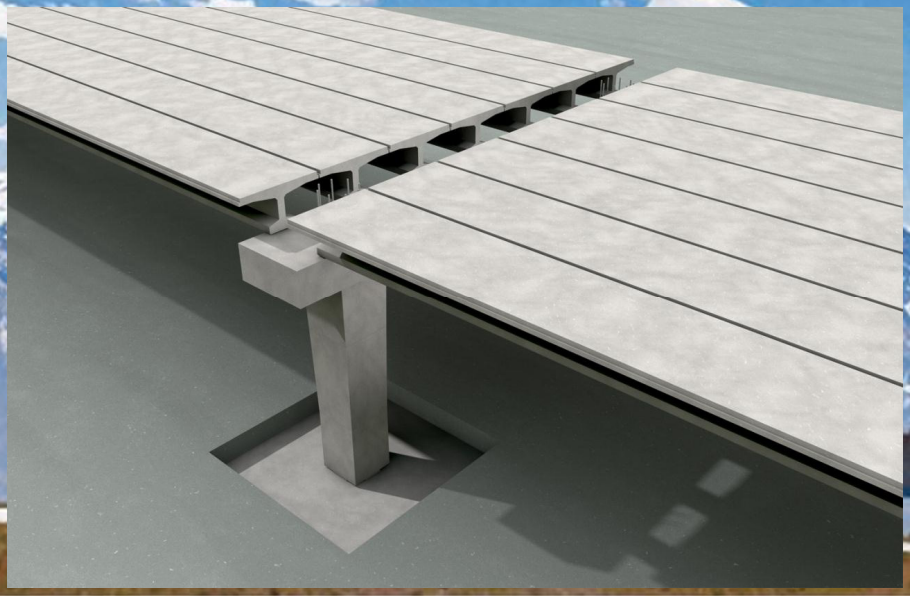
Skagit River Bridge - Permanent Span

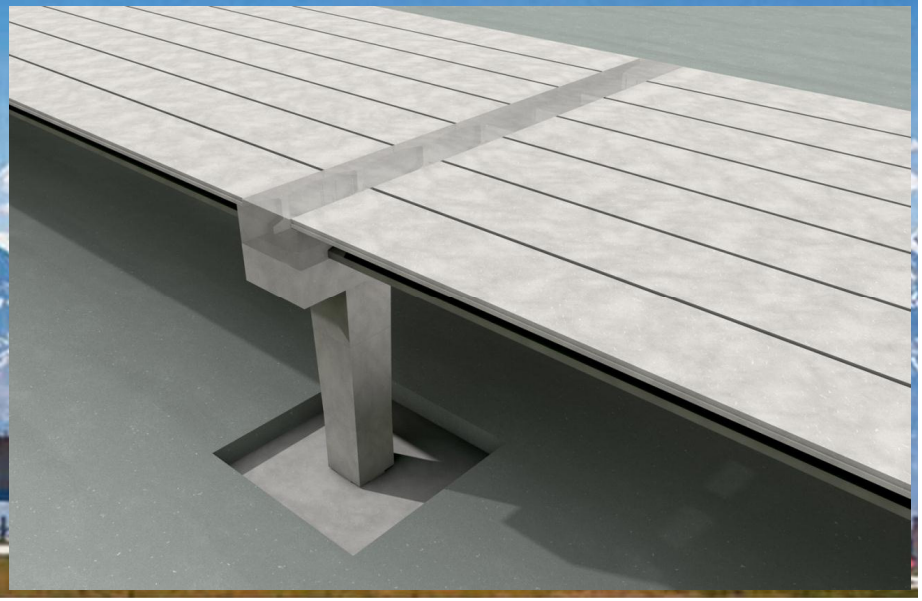
Prefabricated Bridge Elements & Systems

- ***HFL Project: Webinar: August 22, 2013***



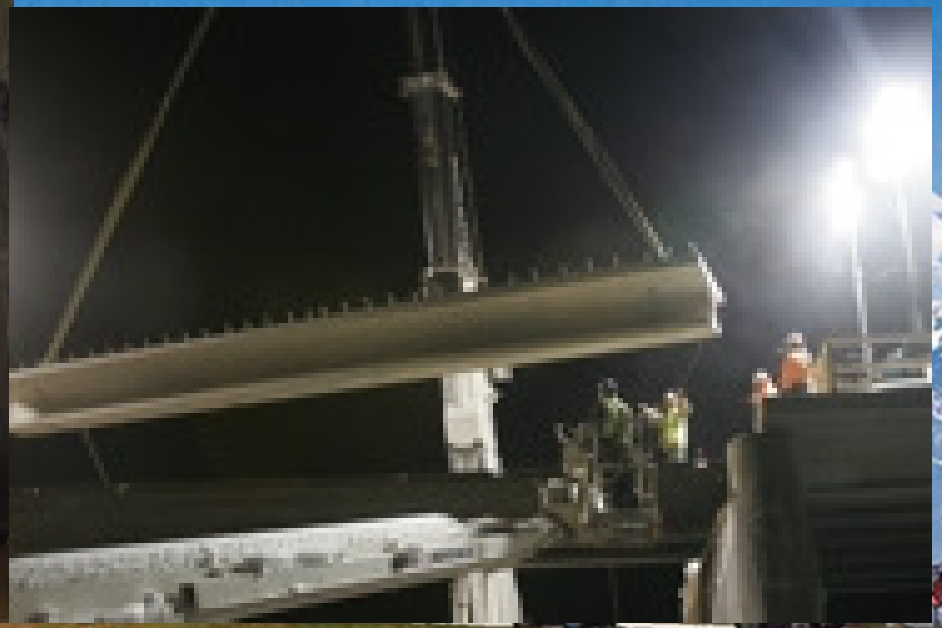






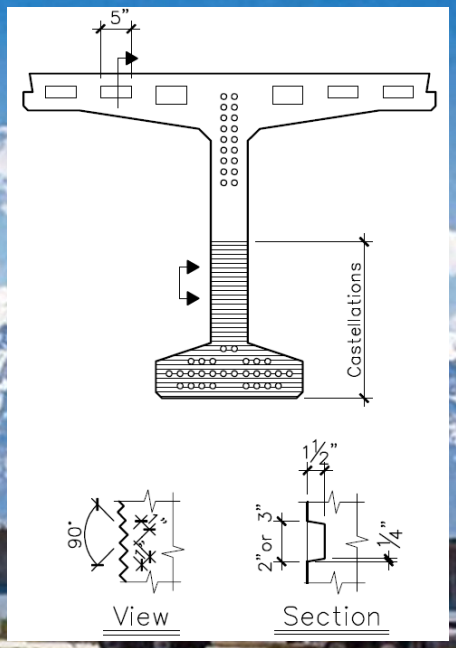
I-90 - Easton Bridge Span Replacement

At 4 a.m. an over-height load, 17 ½ feet high, hit the overpass, 17 feet over the highway, raked and ruined the underside of the overpass on eastbound I-90 at Easton.

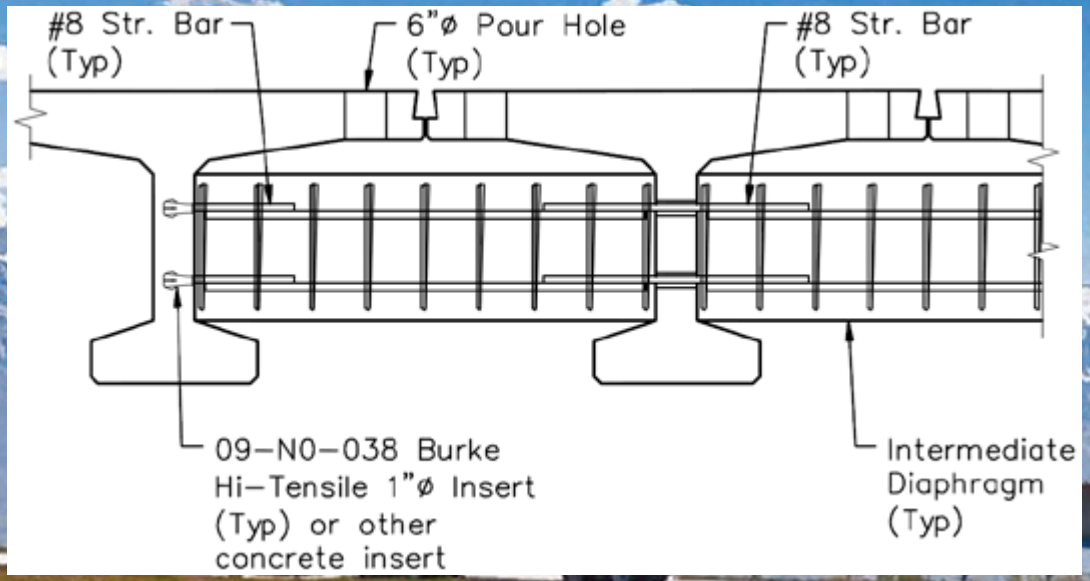


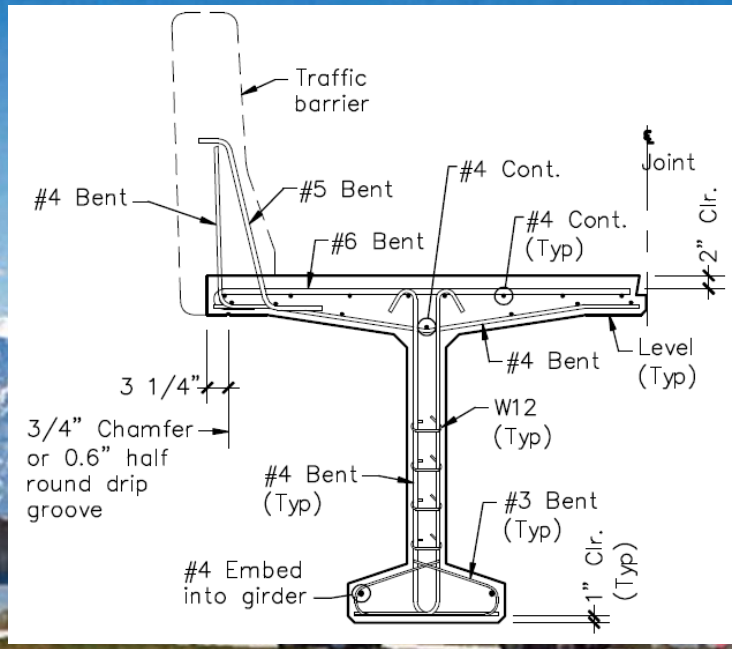
NCHRP Project 12-69

End diaphragm details.

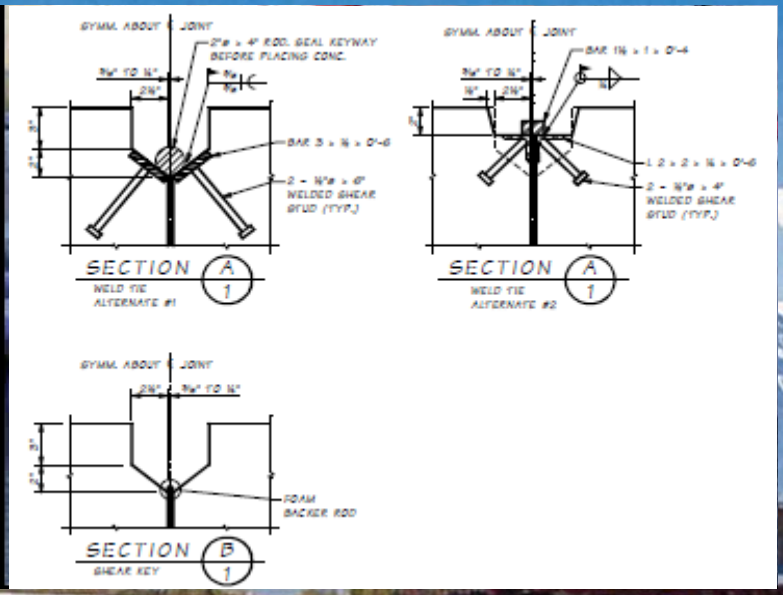


End diaphragm details.

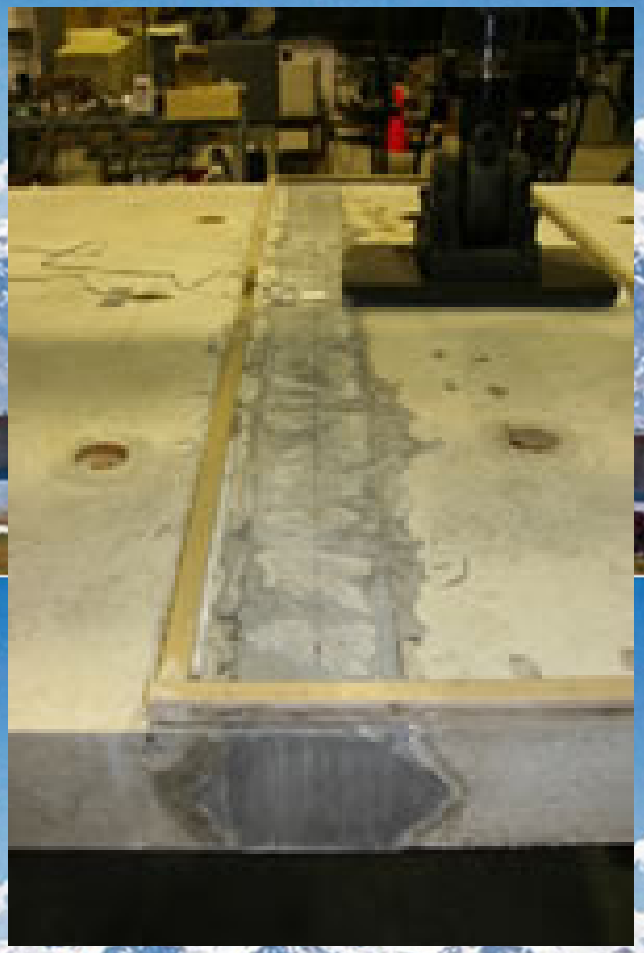




Connection of Deck Beam Elements



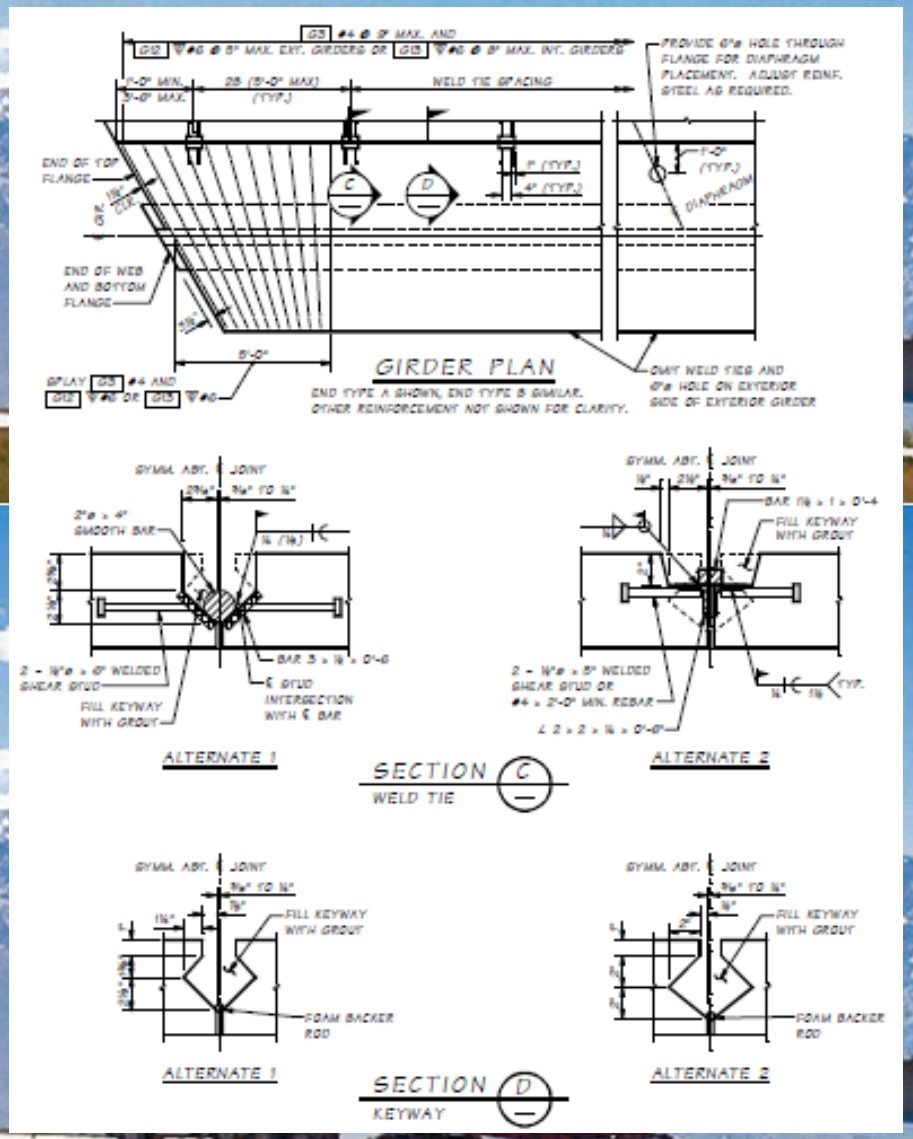
Examples of Deck Beam Elements

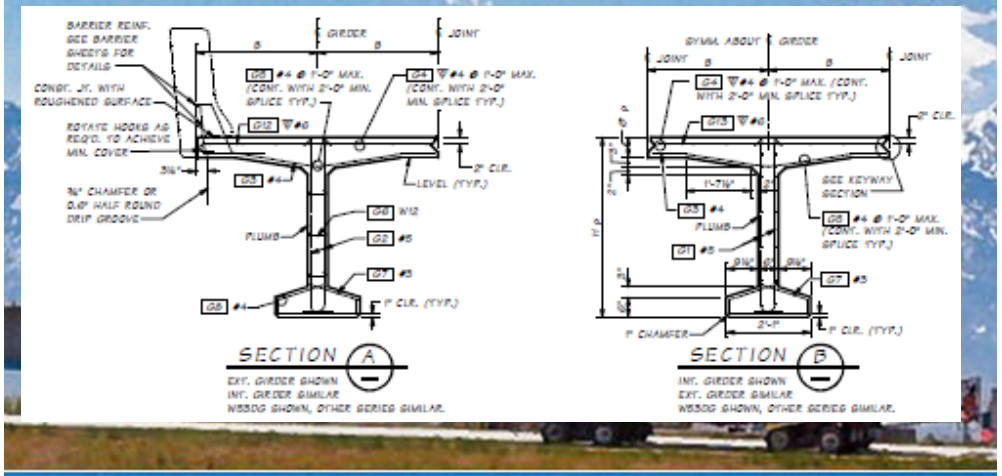


Ultra-High Performance Concrete (UHPC)

- Use as Joint Material Between Precast Deck Panels
- Used By NYSDOT With Decked Bulb-Tee Girders

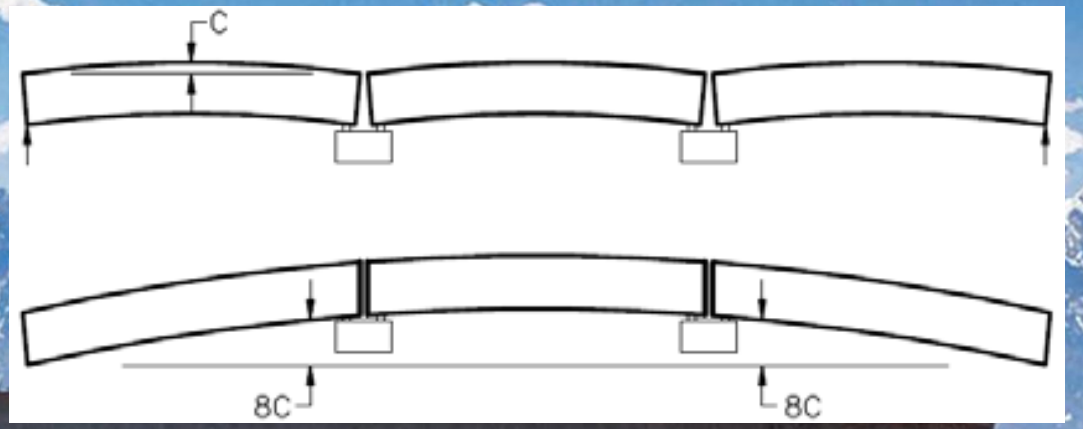
WSDOT Deck Bulb Tee Details



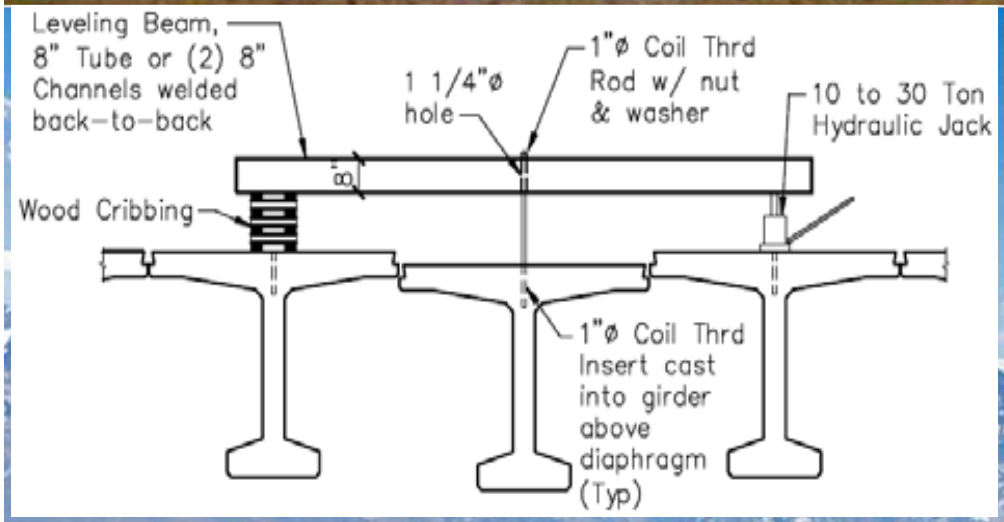


Camber Adjustment – DBT Girder Bridges

- Pre-cambering
- Flange Thickening
- CIP 5” Slab



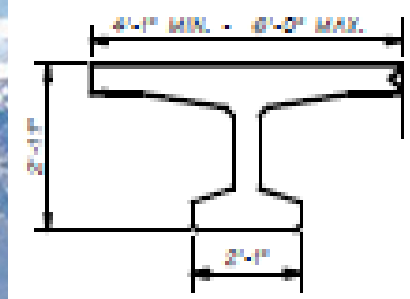
Camber adjustment for a three-span bridge.



Camber leveling diagram.

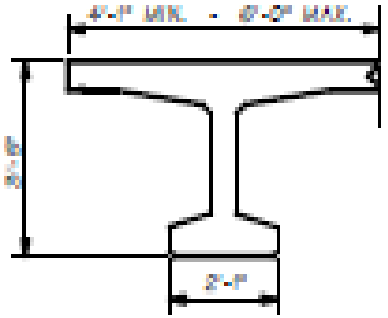
Substantially higher curvatures can be achieved using formwork

WSDOT Deck Bulb Tee Girders



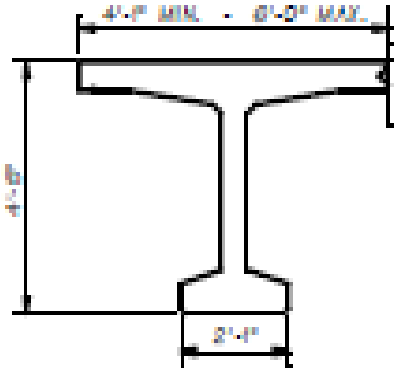
W35DG

SPAN LENGTH = 90 FT.



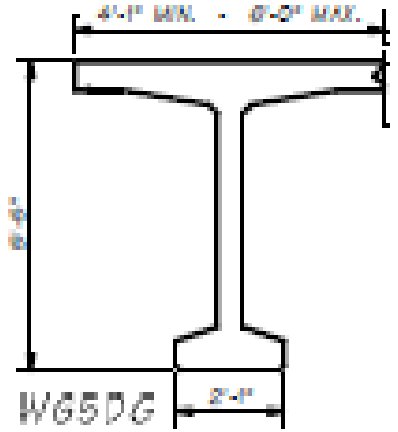
W41DG

SPAN LENGTH = 105 FT.



W53DG

SPAN LENGTH = 125 FT.



W65DG

SPAN LENGTH = 145 FT.

Girder Type	Girder Width (ft)	CL Bearing to CL Bearing (ft)	Excess Camber (in)
W35DG	4	95	4.38
	5	90	3.98
	6	85	3.82
W41DG	4	110	4.34
	5	105	4.50
	6	100	4.33
W53DG	4	135	4.29
	5	130	4.51
	6	120	4.51
W65DG	4	155	3.46
	5	145	3.71
	6	140	3.97

PNW
Pacific NorthWest
Precast/Prestressed

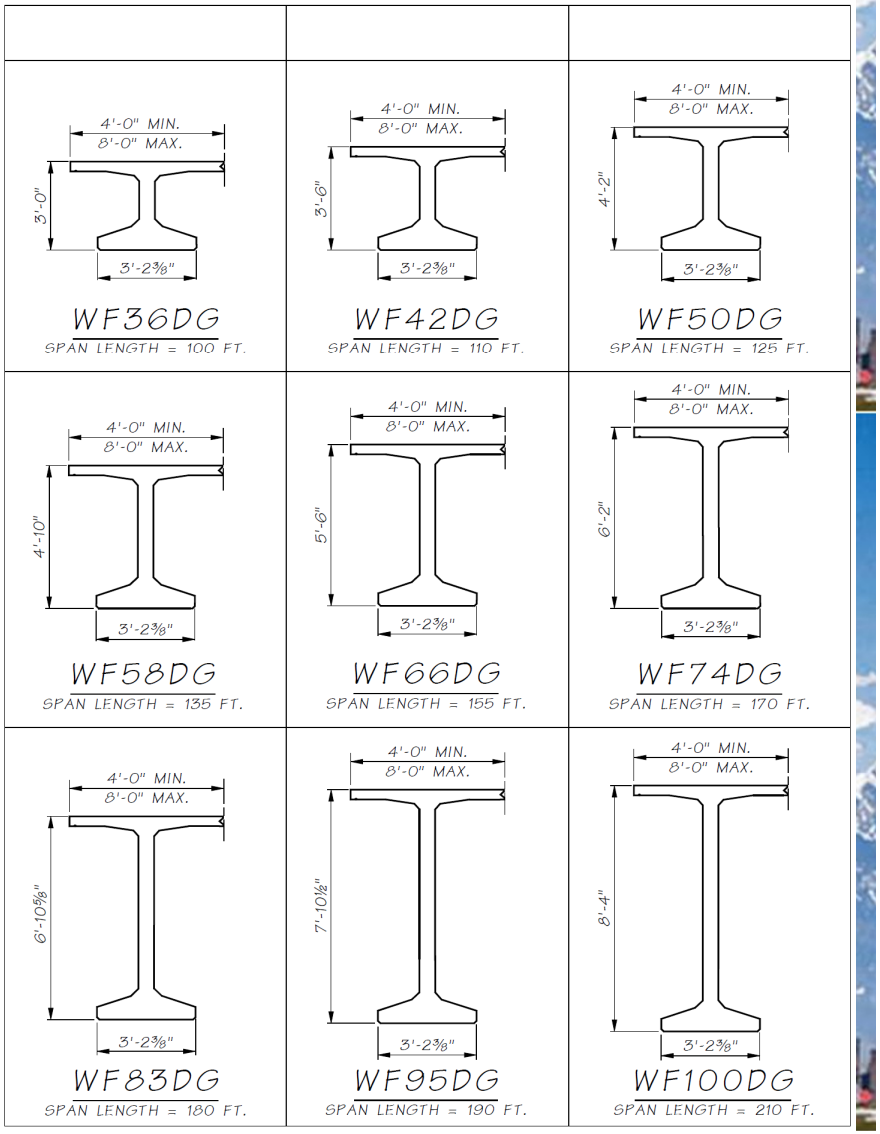
pci
PRECAST/PRESTRESSED
CONCRETE INSTITUTE

Washington State
Department of Transportation
Bridge and Structures Office

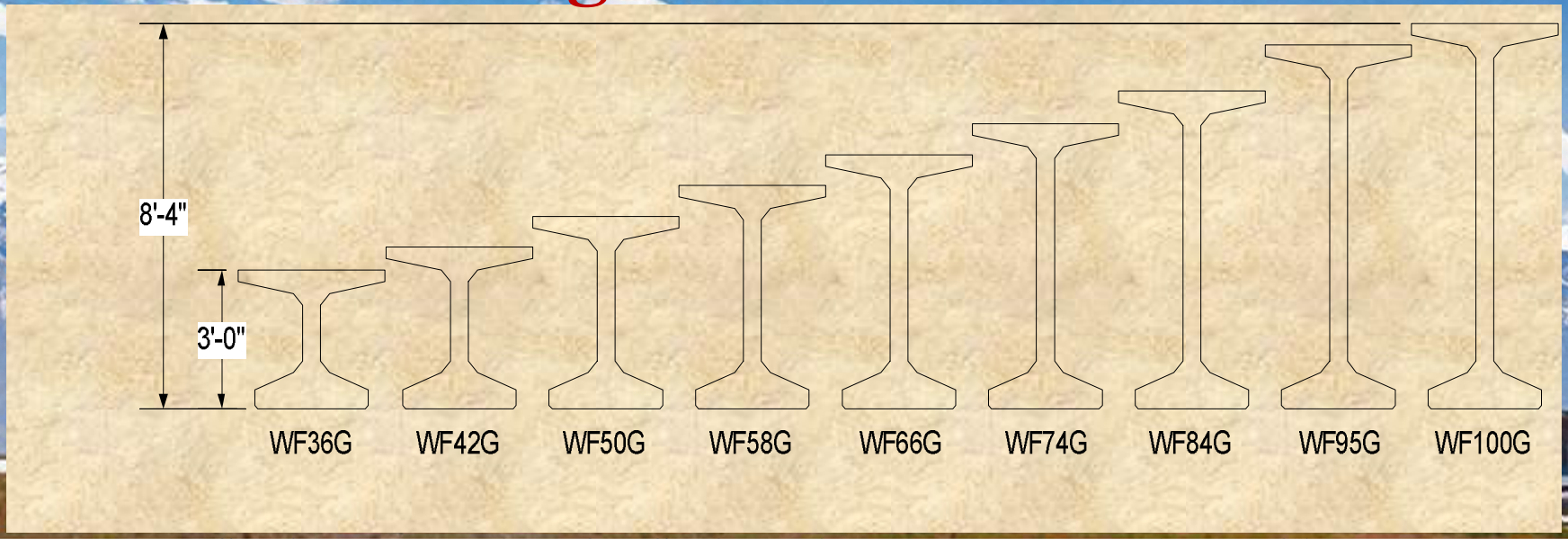
Wide Flange Deck Bulb Tee Girders

(Efficient DBT Girder)

PRECAST PRESTRESSED GIRDERS



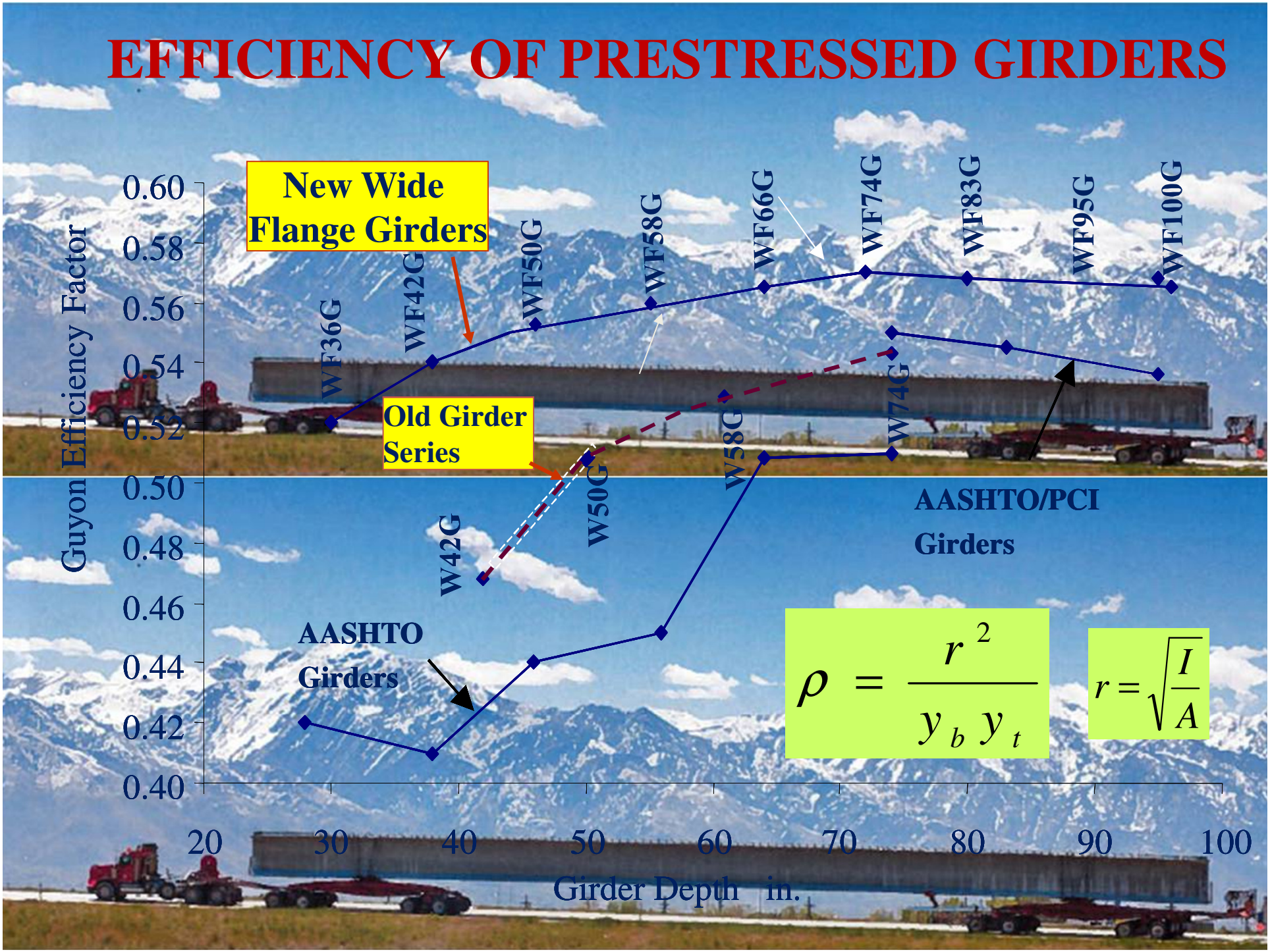
Wide Flange Pretensioned Girders



Section Properties of WSDOT Wide Flange Pretensioned Girders.

Girder	Height (in)	Area (in^2)	Y_b (in)	Y_t (in)	I (in^4)	S_b (in^3)	S_t (in^3)
WF36G	36	690.8	17.5	18.4	124,771	7115.0	6757.7
WF42G	42	727.5	20.4	21.6	183,642	9019.7	8486.3
WF50G	50	776.5	24.1	25.8	282,559	11699.6	10931.2
WF58G	58	825.5	28.0	30.0	406,265	14526.6	18636.5
WF66G	66	874.5	31.8	34.2	556,339	17493.0	16268.9
WF74G	74	823.5	35.7	38.3	734,356	20594.8	19152.5
WF83G	82.64	976.4	39.8	42.8	959,395	24088.0	22417.7
WF95G	94.50	1049.1	48.9	45.6	1,328,994	29147.8	27175.1
WF100G	100	1082.8	48.3	51.7	1,524,912	31588.9	29480.4

EFFICIENCY OF PRESTRESSED GIRDERS

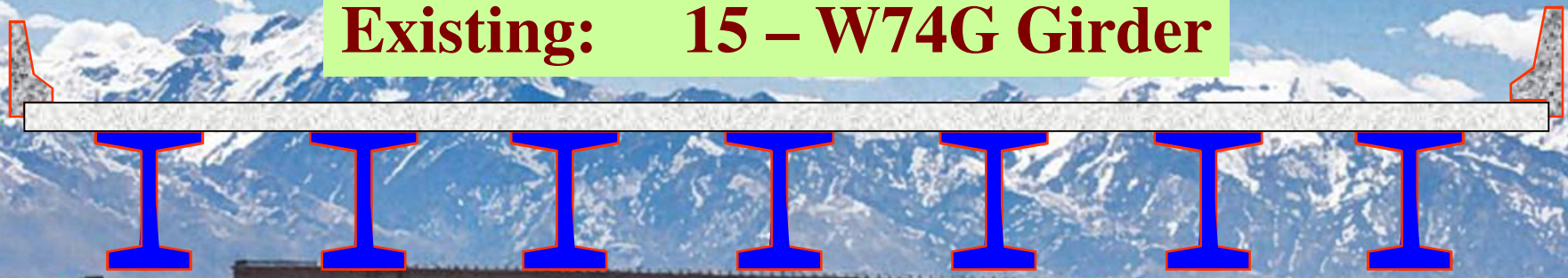


EFFICIENCY OF PRESTRESSED GIRDERS

Superstructure Replacement, Span = 145 ft

Span 8 ~
48 feet Above Tracks

Existing: 15 – W74G Girder

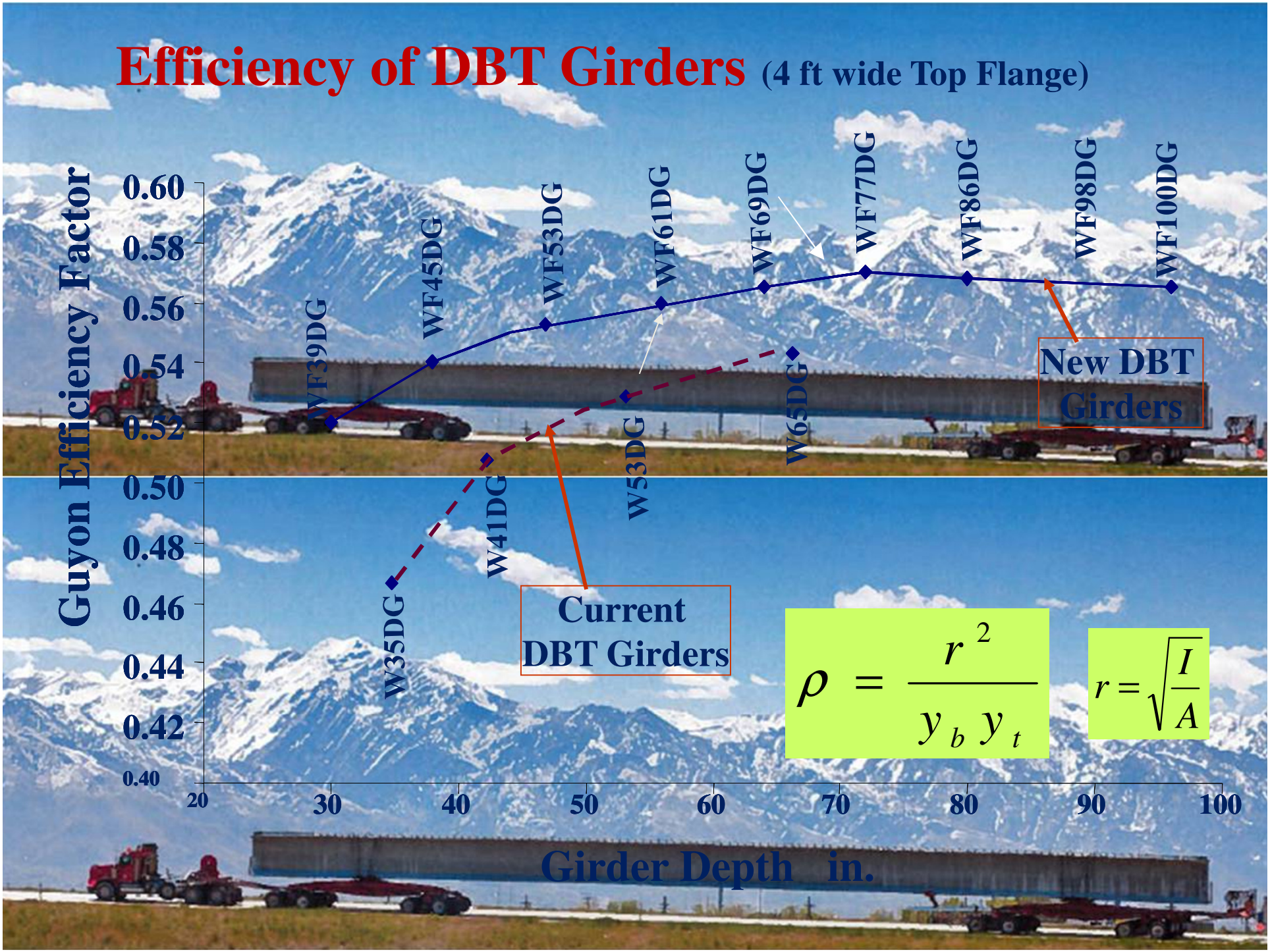


Replacement: 7 – WF74G Girder

Record-Length Precast Girders 2000-2011

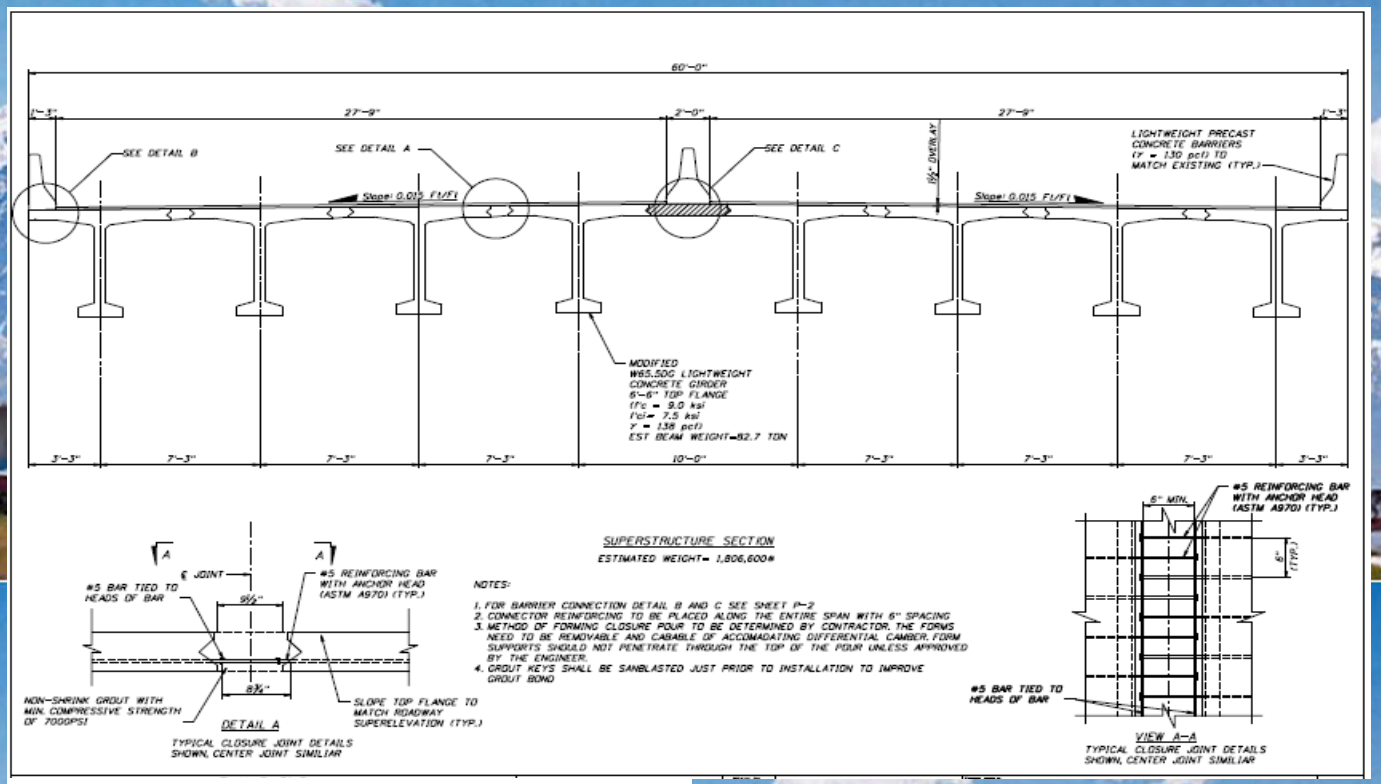
Bridge		Length	Year
1.	37th Street Calgary, CA	213 ft.	20XX
2.	S.R. 99/AWV Seattle, WA	205 ft.	2011
3.	Highway 864 Taber, Alberta, CA	203.5 ft.	2001
4.	I-15 & Beck St. Salt Lake City, UT	195 ft.	2010
5.	SR-532 Mark Clark Bridge WA	186 ft.	2009
6.	Padden Parkway Bridge WA	185 ft.	2002
7.	I-405/NE 8th to SR 520 WA	184 ft.	2010
8.	NE 12th over I-405Attalia WA	181 ft.	2006
9.	Tieton River Bridge, Yakima WA	180 ft.	2009
10.	SR9/Harvey Creek, Snohomish WA	178 ft.	2008

Efficiency of DBT Girders (4 ft wide Top Flange)

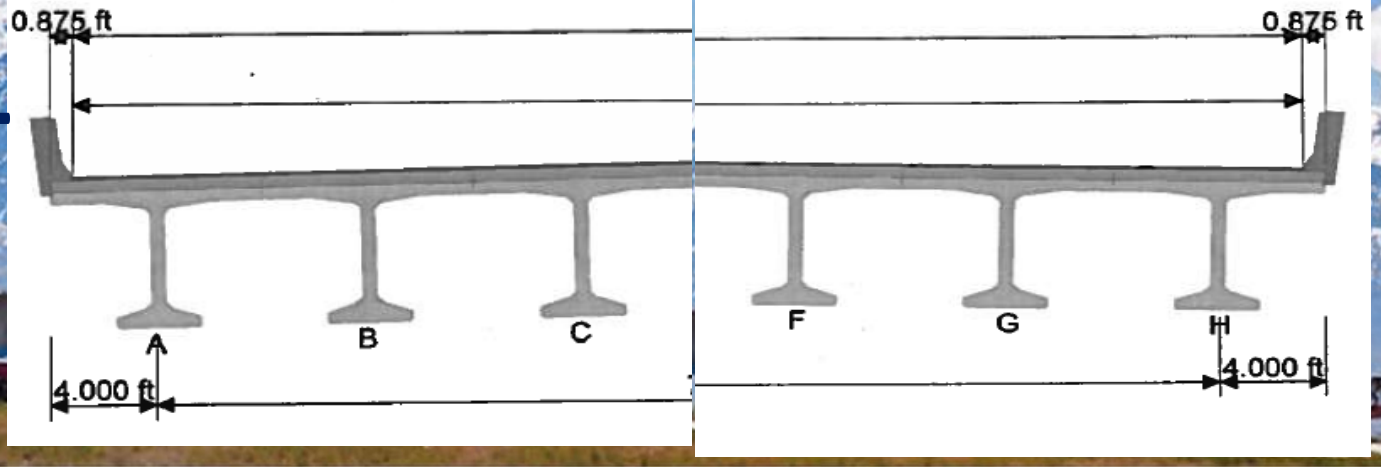


Skagit River Bridge Replacement

Current Design



New DBT Design



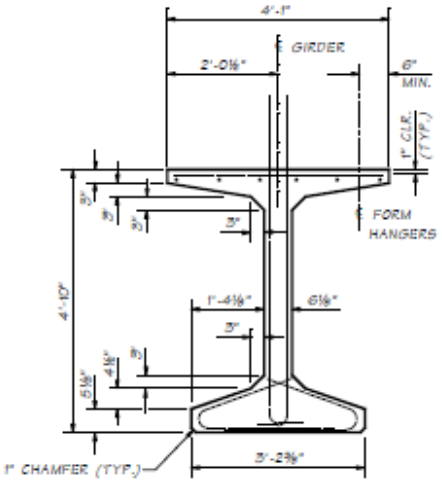
Skagit River Bridge Replacement

Skagit River Bridge Replacement

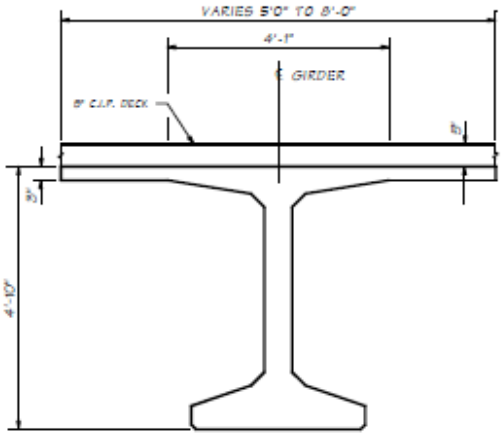
Light Weight Concrete Deck Bulb Tees

New WSDOT Deck Girders:

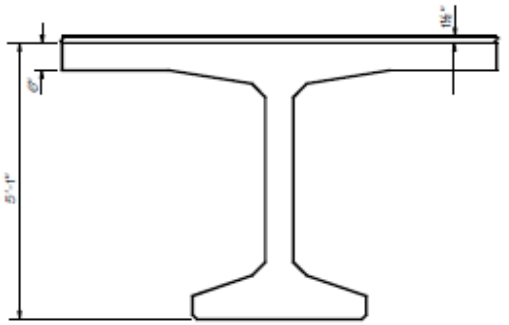
- Deck Bulb Tee Girder with 1 ½” CIP Overlay
- Bulb Tee Girders with 5" CIP Slab



WF58G



WF58BTG



WF61DBT

DESIGN CONSTRAINTS FOR DEVELOPMENT DBT GIRDERS

- Strength of Concrete:
  - f'ci = 7.5 ksi
  - f'c = 9.0 ksi
  - Slab f'c = 4.0 ksi.
- 1/2 D40 ≥ C
- Shipping weight < 270 kip
- 2% roadway crown slope
- Standard WSDOT "F" shape barrier
- 6% roadway super-elevation for shipping check
- Includes 2" future HMA overlay

Span Capability of Wide Flange Bulb Tee Girders with 5" CIP Topping - 1

Girder Type	Girder Spacing (ft)	CL Bearing to CL Bearing (ft)	"A" Dim. (in)	Deck Thickness (in)	Shipping Weight (kips)
WF36DG	5	105	8.75	5.00	89
	6	100	8.25	5.00	89
	7	95	8.50	5.00	89
	8	90	8.50	5.00	88
WF42DG	5	115	8.75	5.00	102
	6	115	8.75	5.00	107
	7	110	8.75	5.00	107
	8	110	8.50	5.00	112
WF50DG	5	130	8.75	5.00	123
	6	125	9.00	5.00	124
	7	125	8.75	5.00	129
	8	120	8.75	5.00	129
WF58DG	5	145	8.75	5.00	145
	6	140	9.00	5.00	148
	7	135	9.00	5.00	147
	8	130	9.00	5.00	147

Span Capability of Wide Flange Bulb Tee Girders with 5" CIP Topping - 2

Girder Type	Girder Spacing (ft)	CL Bearing to CL Bearing (ft)	"A" Dim. (in)	Deck Thickness (in)	Shipping Weight (kips)
WF66DG	5	155	8.75	5.00	164
	6	150	8.75	5.00	165
	7	145	8.75	5.00	166
	8	145	8.75	5.00	172
WF74DG	5	160	8.25	5.00	178
	6	155	8.25	5.00	179
	7	150	8.25	5.00	180
	8	150	8.25	5.00	186
WF83DG	5	175	8.00	5.00	207
	6	170	8.00	5.00	208
	7	165	8.25	5.00	209
	8	160	8.00	5.00	210
WF95DG	5	190	8.00	5.00	240
	6	185	8.25	5.00	241
	7	180	8.25	5.00	242
	8	175	8.00	5.00	243
WF100DG	5	195	8.00	5.00	253
	6	190	8.25	5.00	254
	7	185	8.25	5.00	255
	8	180	8.25	5.00	256

Section Prosperities of Wide Flange Deck Bulb Tee Girders with 5" CIP Topping

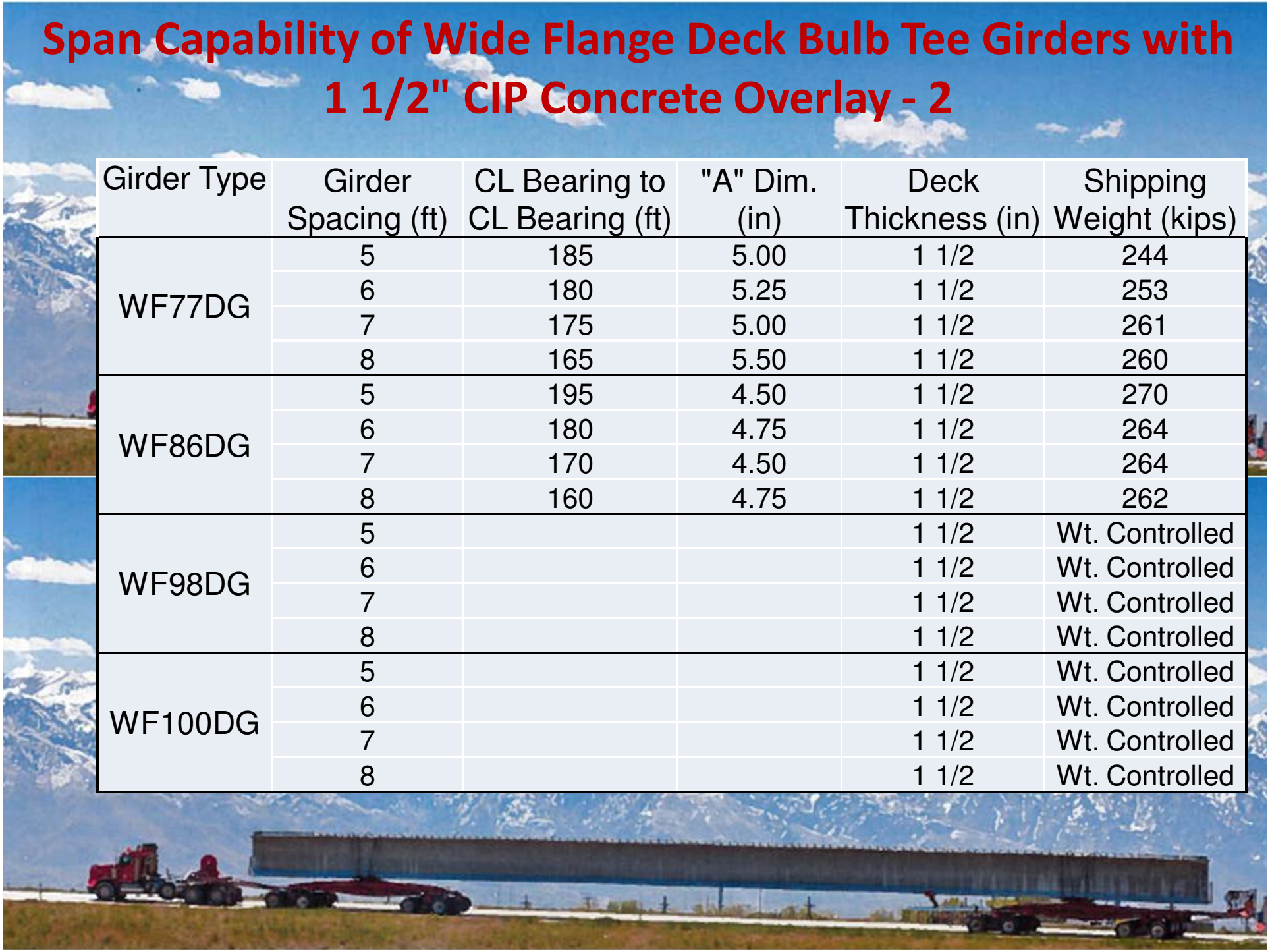
Girder Type	Flange Width	Depth in	Area in^2	Iz in^4	Yb in	Wt k/ft	Max Span
WF36BTG	5	36	724	133,916	18.3	0.83	105
	6		760	142,939	19.1	0.87	100
	7		793	151,184	19.8	0.91	95
	8		831	158,650	20.4	0.95	90
WF42BTG	5	42	761	196,559	21.2	0.87	115
	6		797	209,355	22.1	0.91	115
	7		833	221,047	22.9	0.96	110
	8		869	231,773	23.6	1.00	110
WF50BTG	5	50	810	301,497	25.1	0.93	130
	6		846	320,342	26.1	0.97	125
	7		882	337,652	27.0	1.01	125
	8		918	353,606	27.8	1.05	120
WF58BTG	5	58	859	432,350	29.1	0.99	145
	6		895	458,408	30.2	1.03	140
	7		931	482453.9	31.2	1.07	135
	8		967	504,712	32.1	1.11	130
WF66BTG	5	66	907	590,691	33.0	1.04	155
	6		944	625,124	34.2	1.08	150
	7		980	657,030	35.3	1.12	145
	8		1016	686,678	36.3	1.17	145
WF74BTG	5	74	958	778,094	36.9	1.10	160
	6		994	822,062	38.2	1.14	155
	7		1030	862,957	39.4	1.18	150
	8		1066	901,091	40.5	1.22	150
WF83BTG	5	83	1019	1,055,610	41.8	1.17	175
	6		1055	1,113,127	43.2	1.21	170
	7		1091	1,155,851	44.5	1.25	165
	8		1127	1,217,144	45.7	1.29	160
WF95BTG	5	95	1086	1,449,827	47.3	1.25	190
	6		1122	1,494,240	48.7	1.29	185
	7		1158	1,564,224	50.1	1.33	180
	8		1194	1,629,897	51.4	1.37	175
WF100BTG	5	100	1117	1,606,860	49.7	1.28	195
	6		1153	1,589,822	51.3	1.32	190
	7		1189	1,767,763	52.7	1.36	185
	8		1225	1,841,125	54.0	1.40	180

Span Capability of Wide Flange Deck Bulb Tee Girders with 1 1/2" CIP Topping -1

Type	Girder Spacing (ft)	CL Bearing to CL Bearing (ft)	"A" Dim. (in)	Deck Thickness (in)	Shipping Weight (kips)
WF39DG	5	115	5.25	1 1/2	122
	6	110	5.50	1 1/2	126
	7	100	5.50	1 1/2	123
	8	100	5.75	1 1/2	131
WF45DG	5	130	5.25	1 1/2	143
	6	125	5.50	1 1/2	148
	7	115	5.75	1 1/2	146
	8	105	5.50	1 1/2	142
WF53DG	5	145	5.00	1 1/2	167
	6	140	5.25	1 1/2	173
	7	130	5.75	1 1/2	172
	8	125	5.75	1 1/2	176
WF61DG	5	160	5.00	1 1/2	193
	6	155	5.25	1 1/2	200
	7	145	5.50	1 1/2	200
	8	135	5.50	1 1/2	198
WF69DG	5	170	5.00	1 1/2	215
	6	165	5.00	1 1/2	223
	7	155	5.00	1 1/2	222
	8	150	5.00	1 1/2	228

Span Capability of Wide Flange Deck Bulb Tee Girders with 1 1/2" CIP Concrete Overlay - 2

Girder Type	Girder Spacing (ft)	CL Bearing to CL Bearing (ft)	"A" Dim. (in)	Deck Thickness (in)	Shipping Weight (kips)
WF77DG	5	185	5.00	1 1/2	244
	6	180	5.25	1 1/2	253
	7	175	5.00	1 1/2	261
	8	165	5.50	1 1/2	260
WF86DG	5	195	4.50	1 1/2	270
	6	180	4.75	1 1/2	264
	7	170	4.50	1 1/2	264
	8	160	4.75	1 1/2	262
WF98DG	5			1 1/2	Wt. Controlled
	6			1 1/2	Wt. Controlled
	7			1 1/2	Wt. Controlled
	8			1 1/2	Wt. Controlled
WF100DG	5			1 1/2	Wt. Controlled
	6			1 1/2	Wt. Controlled
	7			1 1/2	Wt. Controlled
	8			1 1/2	Wt. Controlled



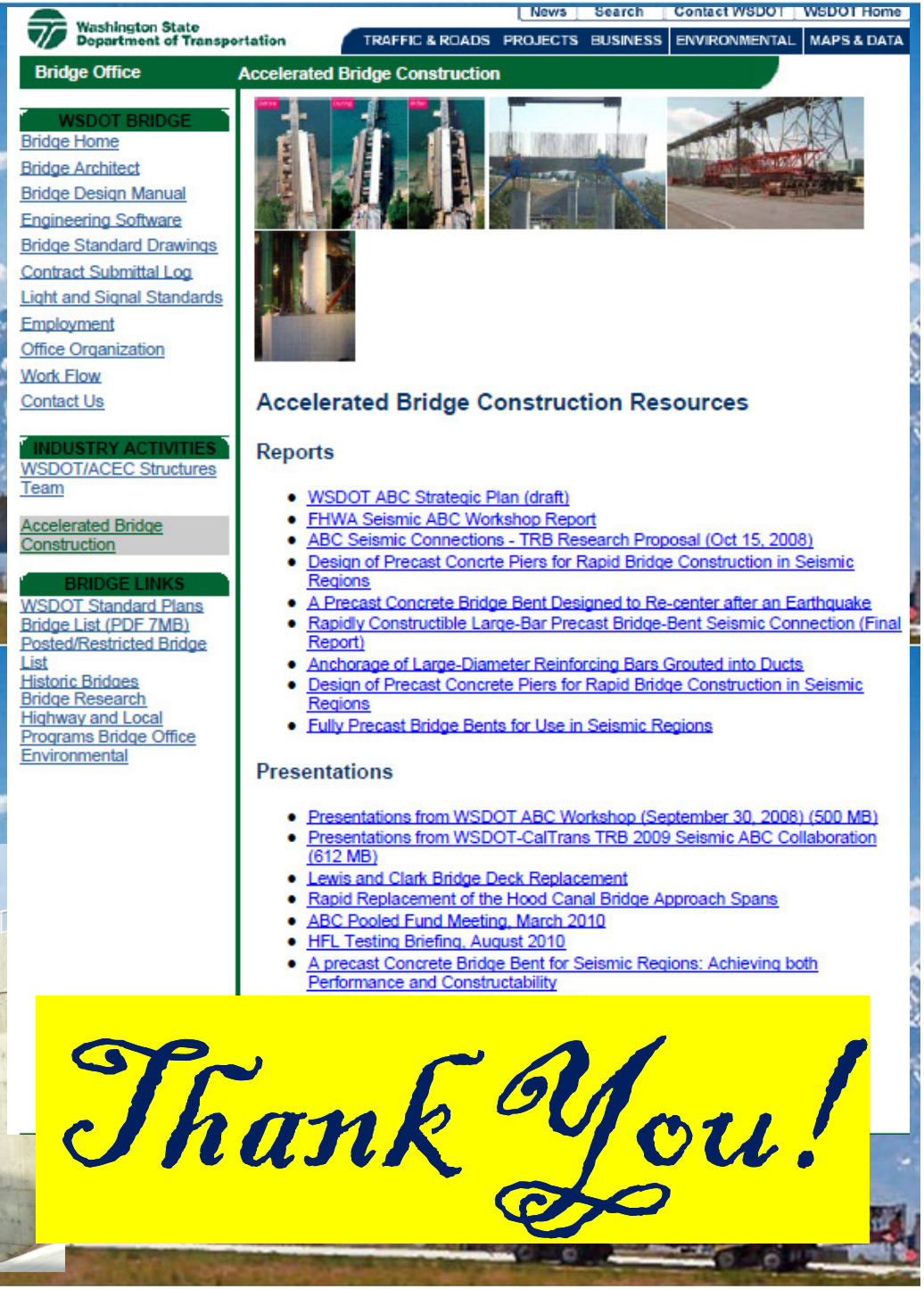
Section Prosperities of Wide Flange Bulb Tee Girders with 1 1/2" CIP Concrete Overlay

Girder Type	Flange Width	Depth in	Area in^2	Iz in^4	Yb in	Wt k/ft	Max Span
WF39BTG	5	39	904	187,176	22.1	1.04	122
	6		976	200,232	23.1	1.12	126
	7		1048	211,523	24.0	1.20	123
	8		1120	221,391	24.8	1.28	131
WF45BTG	5	45	941	268,913	25.5	1.08	143
	6		1013	287,368	26.7	1.16	148
	7		1085	3,034,042	27.7	1.24	146
	8		1157	317,468	28.6	1.33	142
WF53BTG	5	53	990	404,014	29.9	1.14	167
	6		1062	431,274	31.3	1.22	173
	7		1134	455,101	32.5	1.30	172
	8		1206	476,110	33.5	1.38	176
WF61BTG	5	61	1039	570,457	34.3	1.19	193
	6		1111	608,414	35.9	1.27	200
	7		1183	641778.2	37.2	1.36	200
	8		1255	671,340	38.4	1.44	198
WF69BTG	5	69	1088	769,862	38.7	1.25	215
	6		1160	820,456	40.4	1.33	223
	7		1232	865,163	41.9	1.41	222
	8		1304	904,959	43.2	1.50	228
WF79BTG	5	77	1138	1,003,839	43.0	1.30	244
	6		1210	1,068,052	44.9	1.39	253
	7		1282	1,126,962	46.5	1.47	261
	8		1354	1,178,734	48.0	1.55	260
WF86BTG	5	85	1193	1,310,387	47.9	1.37	270
	6		1265	1,394,461	49.9	1.45	264
	7		1337	1,469,503	51.6	1.53	264
	8		1409	1,536,896	53.2	1.61	262

Next:

- *Standard Drawings*
- *Bridge Design Manual*
- *Design Aids*

- Scott Sargent - BDM
  SargenS@wsdot.wa.gov
- Brian Aldrich – Concrete Specialist
  AldrichB@wsdot.wa.gov
- Rick Brice – Software/PGSuper
  BriceR@wsdot.wa.gov
- Bijan Khaleghi
  KhalegB@wsdot.wa.gov



Thank You!