

Design Memorandum

TO: All Design Section Staff
FROM: Bijan Khaleghi
DATE: December 18, 2014
SUBJECT: New WSDOT standard pretensioned wide flange Deck Bulb Tee girders

This design memorandum introduces the newly developed wide flange deck girder and wide flange thin deck girder types. These new girders have the same cross sectional dimensions as standard WSDOT wide flange girders, except that the flange width has been increased to between 5 feet and 8 feet. The top flange has also been thickened in the case of the wide flange deck girders in order to support traffic and superimposed dead loads without the need for a cast-in-place reinforced concrete deck. These new girder types will allow more efficient bridge superstructures to be constructed without the need for deck formwork.

These new girders are more efficient than the current WSDOT Deck Bulb Tee girders, and could be used in new projects suited for Deck Bulb Tee girders, and when accelerated bridge construction is desired.

Wide flange thin deck girders are designated as WFxxTDG with girder depth varying from 36 to 100 inches. This series requires a 5" minimum cast-in-place reinforced concrete deck. The WFxxTDG series girders are shown in Figure 1. The cross section properties are shown in Table 1 and span capabilities are shown in Tables 2 and 3.

Wide flange deck girders are designated as WFxxDG with girder depth varying from 39 to 103 inches. This series requires a concrete or HMA overlay. The WFxxDG series girders are shown in Figure 2. The cross section properties are shown in Table 4 and span capabilities are shown in Tables 5 and 6.

The new WSDOT standard prestressed concrete wide flange thin deck girders span up to 225 ft (250 ft LW Girders) based on the cross section dimensions and shipping weight limitations. The new WSDOT standard prestressed concrete wide flange deck girders span up to 195 ft (230 ft LW Girders).

The flange connections between adjacent WFxxDG girders shall be per BDM STD Drawings 5.6-A6. The use of CIP ultra-high performance concrete (UHPC) with lapping bars at the connection could be considered on a case-by-case basis. Light weight aggregate concrete could also be considered on a case-by-case basis. Use of UHPC and light weight aggregate concrete requires approval of the WSDOT Bridge Design Engineer.

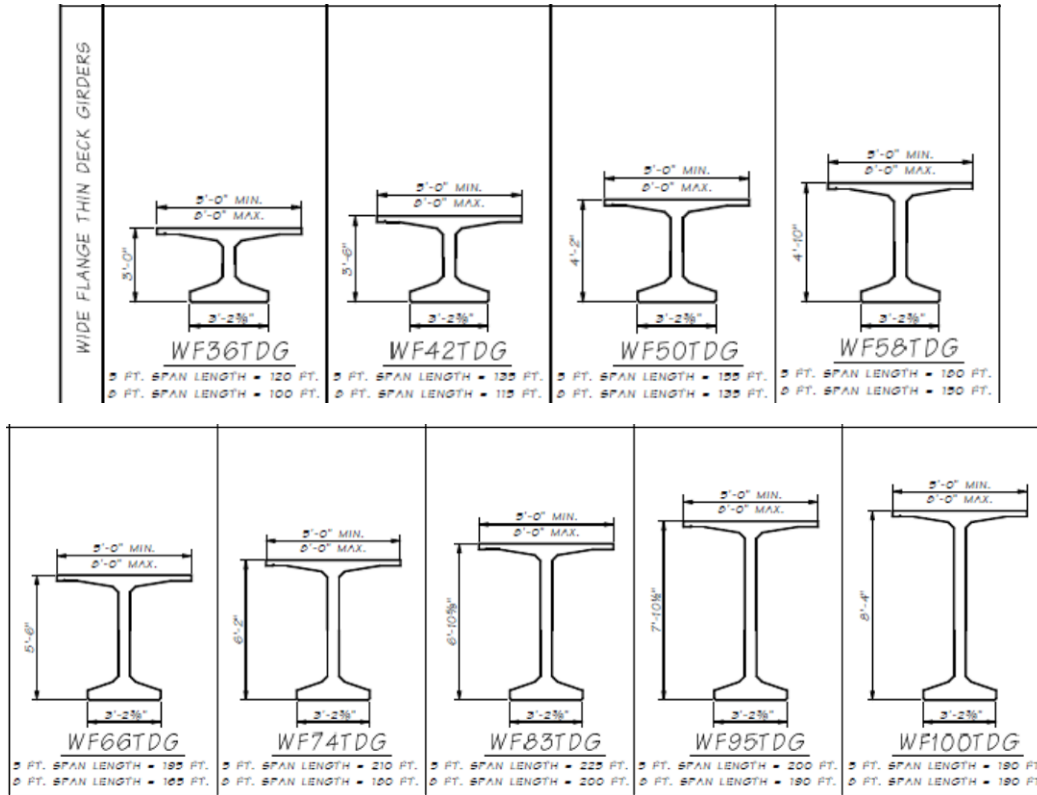


Figure 1: WFxxTDG Wide Flange Thin Deck Girders requiring 5" Minimum Cast-In-Place Concrete Deck.

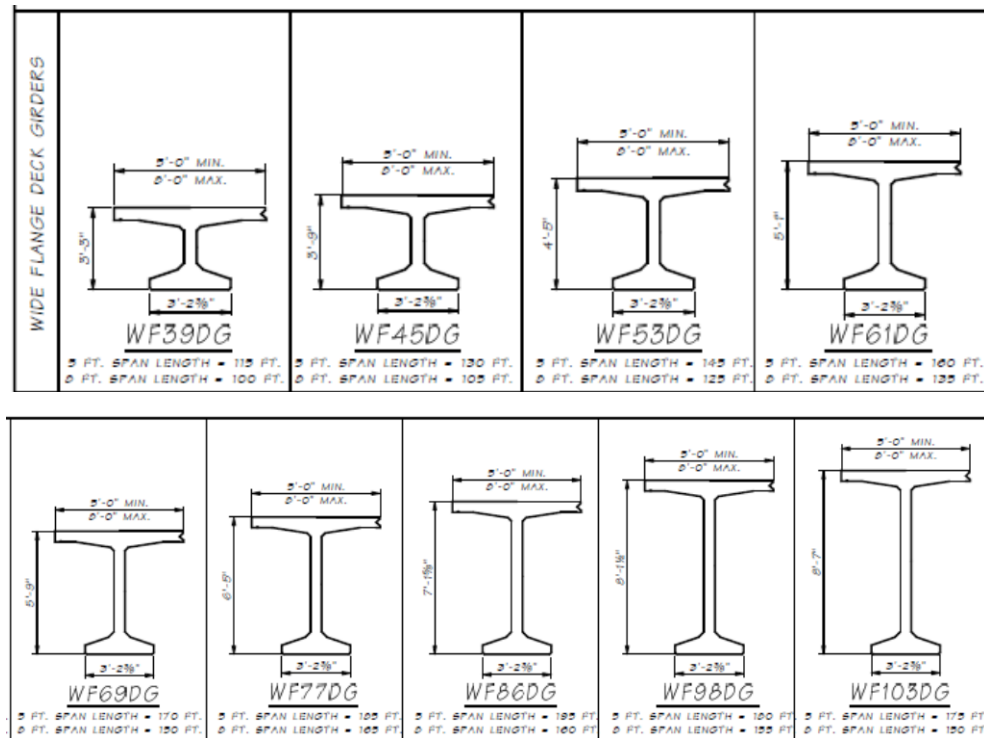


Figure 2: WFxxDG Wide Flange Deck Girders Requiring Concrete or HMA Overlay

Table 1: Section Properties of WFxxTDG Wide Flange Thin Deck Girders with 5" CIP Topping

Girder Type	Flange Width	Depth in	Area in ²	Iz in ⁴	Yb in	Wt. w/ Normal Conc. k/ft	Wt. w/ Light Wt. Conc. k/ft
WF36TDG	5	36	724	133,860	18.3	0.83	0.63
	6		760	142,876	19.1	0.87	0.66
	7		796	151,079	19.8	0.91	0.69
	8		831	158,574	20.4	0.95	0.72
WF42TDG	5	42	761	196,472	21.2	0.87	0.66
	6		797	209,257	22.1	0.91	0.69
	7		833	221,047	22.9	0.96	0.72
	8		869	231,655	23.6	1.00	0.76
WF50TDG	5	50	810	301,351	25.1	0.93	0.70
	6		846	320,180	26.1	0.97	0.73
	7		882	337,484	27.0	1.01	0.77
	8		918	353,413	27.9	1.05	0.80
WF58TDG	5	58	859	432,124	29.1	0.99	0.75
	6		895	458,159	30.2	1.03	0.78
	7		931	482,182	31.2	1.07	0.81
	8		967	504,418	32.1	1.11	0.84
WF66TDG	5	66	905	590,360	33.0	1.04	0.79
	6		944	624,762	34.2	1.08	0.82
	7		980	656,637	35.3	1.12	0.85
	8		1016	686,254	36.3	1.17	0.88
WF74TDG	5	74	957	777,629	36.9	1.10	0.83
	6		993	821,556	38.2	1.14	0.86
	7		1029	862,410	39.4	1.18	0.89
	8		1065	900,502	40.5	1.22	0.92
WF83TDG	5	83	1012	1,024,963	41.4	1.16	0.88
	6		1048	1,080,991	42.7	1.20	0.91
	7		1084	1,133,297	44.0	1.24	0.94
	8		1120	1,182,242	45.2	1.28	0.92
WF95TDG	5	95	1085	1,418,851	47.3	1.24	0.94
	6		1121	1,493,290	48.8	1.29	0.97
	7		1157	1,563,099	50.2	1.33	1.00
	8		1193	1,528,697	51.5	1.37	1.04
WF100TDG	5	100	1116	1,605,724	49.8	1.28	0.97
	6		1152	1,688,602	51.3	1.32	1.00
	7		1188	1,766,458	52.7	1.36	1.03
	8		1224	1,839,735	54.1	1.40	1.06

Table 2: Span Capability of WFxxTDG Wide Flange Thin Deck Girders with 5" CIP Topping - Lightweight Concrete W/ Normal Weight Concrete Deck

Girder Type	Girder Spacing (ft)	CL Bearing to CL Bearing (ft)	"A" Dim. (in)	Deck Thickness (in)	Shipping Weight (kips)
WF36TDG	5	100	9.75	5.00	65
	6	115	10.25	5.00	78
	7	115	10.50	5.00	81
	8	110	10.75	5.00	81
WF42TDG	5	130	9.50	5.00	88
	6	140	10.25	5.00	99
	7	135	10.75	5.00	99
	8	125	11.00	5.00	96
WF50TDG	5	160	8.75	5.00	114
	6	160	9.75	5.00	119
	7	155	10.50	5.00	121
	8	145	11.00	5.00	118
WF58TDG	5	190	7.25	5.00	144
	6	185	8.75	5.00	146
	7	175	10.00	5.00	144
	8	165	10.50	5.00	140
WF66TDG	5	210	6.25	5.00	168
	6	215	7.75	5.00	179
	7	200	9.50	5.00	173
	8	190	10.50	5.00	170
WF74TDG	5	230	5.75	5.00	194
	6	225	7.00	5.00	197
	7	220	8.50	5.00	199
	8	210	9.75	5.00	197
WF83TDG	5	250	5.25	5.00	223
	6	245	6.25	5.00	225
	7	235	7.75	5.00	224
	8	225	9.25	5.00	221
WF95TDG	5	215	6.00	5.00	206*
	6	225	7.00	5.00	222*
	7	225	7.75	5.00	235*
	8	230	8.50	5.00	242*
WF100TDG	5	210	6.50	5.00	206*
	6	215	7.25	5.00	218*
	7	225	7.50	5.00	236*
	8	225	8.50	5.00	243

Table 3: Span Capability of WFxxTDG Wide Flange Thin Deck Girders with 5" CIP Topping - Normal Weight Concrete Girder and Deck

Girder Type	Girder Spacing (ft)	CL Bearing to CL Bearing (ft)	"A" Dim. (in)	Deck Thickness (in)	Shipping Weight (kips)
WF36TDG	5	120	8.00	5.00	102
	6	110	8.25	5.00	98
	7	105	8.50	5.00	98
	8	100	8.75	5.00	98
WF42TDG	5	135	7.75	5.00	120
	6	130	8.25	5.00	121
	7	120	8.50	5.00	117
	8	115	8.75	5.00	117
WF50TDG	5	155	7.25	5.00	146
	6	150	8.00	5.00	148
	7	140	8.50	5.00	144
	8	135	8.75	5.00	145
WF58TDG	5	180	6.25	5.00	180
	6	165	7.50	5.00	172
	7	160	8.25	5.00	173
	8	150	8.50	5.00	169
WF66TDG	5	195	5.75	5.00	206
	6	185	7.00	5.00	203
	7	175	8.00	5.00	200
	8	165	8.50	5.00	196
WF74TDG	5	210	5.50	5.00	234
	6	200	6.50	5.00	231
	7	190	7.50	5.00	228
	8	180	8.25	5.00	224
WF83TDG	5	225	5.25	5.00	265
	6	220	5.75	5.00	268
	7	210	7.00	5.00	265
	8	200	8.00	5.00	261
WF95TDG	5	200	5.25	5.00	253*
	6	205	6.00	5.00	268
	7	200	7.00	5.00	270
	8	190	7.75	5.00	265
WF100TDG	5	190	5.50	5.00	247*
	6	200	6.25	5.00	270
	7	195	6.25	5.00	270
	8	190	7.00	5.00	263

Table 4: Section properties of WFxxDG Wide Flange Deck Girders with 1 1/2" Concrete Overlay

Girder Type	Flange Width	Depth in	Area in ²	Iz in ⁴	Yb in	Wt. w/ Normal Conc. k/ft	Wt. w/ Light Wt. Conc. k/ft
WF39DG	5	39	904	187,080	22.1	1.04	0.78
	6		976	220,122	23.2	1.12	0.85
	7		1048	211,401	24.0	1.20	0.91
	8		1120	221,258	24.8	1.28	0.97
WF45DG	5	45	941	268,767	25.5	1.08	0.82
	6		1013	287,201	26.7	1.16	0.90
	7		1085	303,216	27.7	1.24	0.94
	8		1157	317,265	28.6	1.33	1.00
WF53DG	5	53	990	403,778	29.9	1.14	0.86
	6		1062	431,007	31.3	1.22	0.92
	7		1134	454,805	32.5	1.30	0.99
	8		1206	475,786	33.5	1.38	1.05
WF61DG	5	61	1039	570,104	34.3	1.19	0.90
	6		1111	608,015	35.9	1.27	0.97
	7		1183	641,336	37.2	1.36	1.03
	8		1255	670,857	38.4	1.44	1.09
WF69DG	5	69	1088	769,358	38.7	1.25	0.95
	6		1160	819,889	40.4	1.33	1.01
	7		1232	864,536	41.9	1.41	1.07
	8		1304	904,275	43.2	1.50	1.13
WF77DG	5	77	1137	1,003,149	43.0	1.30	0.99
	6		1210	1,069,052	44.9	1.39	1.05
	7		1281	1,126,108	46.5	1.47	1.11
	8		1353	1,177,804	48.0	1.55	1.18
WF86DG	5	86	1192	1,309,439	47.9	1.37	1.04
	6		1264	1,393,403	49.9	1.45	1.10
	7		1336	1,468,338	51.6	1.53	1.16
	8		1408	1,535,630	53.3	1.61	1.22
WF98DG	5	98	1266	1,794,273	54.3	1.45	1.10
	6		1339	1,907,545	56.5	1.53	1.16
	7		1410	2,009,275	58.4	1.62	1.22
	8		1483	2,101,145	60.20	1.70	1.29
WF103DG	5	103	1297	2,022,390	56.9	1.49	1.13
	6		1369	2,149,212	59.2	1.57	1.19
	7		1411	2,263,384	61.2	1.65	1.25

	8		1513	2366711	63.10	1.73	1.31
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Table 5: Span Capability of WFxxDG Wide Flange Deck Girders with 1 1/2" Concrete Overlay. Lightweight Concrete W/ Normal Weight Concrete Deck

Girder Type	Girder Spacing (ft)	CL Bearing to CL Bearing (ft)	"A" Dim. (in)	Deck Thickness (in)	Shipping Weight (kips)
WF39DG	5	105	6.75	1 1/2	85
	6	115	7.50	1 1/2	100
	7	105	7.50	1 1/2	98
	8	100	7.25	1 1/2	100
WF45DG	5	130	7.25	1 1/2	108
	6	130	7.50	1 1/2	117
	7	120	7.75	1 1/2	116
	8	115	7.75	1 1/2	118
WF53DG	5	155	6.00	1 1/2	136
	6	150	7.50	1 1/2	141
	7	140	7.75	1 1/2	141
	8	130	7.75	1 1/2	139
WF61DG	5	180	6.25	1 1/2	165
	6	170	7.00	1 1/2	167
	7	155	7.75	1 1/2	162
	8	145	7.75	1 1/2	161
WF69DG	5	200	5.50	1 1/2	192
	6	190	6.50	1 1/2	194
	7	175	7.75	1 1/2	190
	8	160	7.75	1 1/2	184
WF77DG	5	220	5.00	1 1/2	220
	6	210	6.00	1 1/2	223
	7	190	7.50	1 1/2	214
	8	180	8.00	1 1/2	214
WF86DG	5	230	4.25	1 1/2	241
	6	220	5.75	1 1/2	245
	7	205	7.00	1 1/2	241
	8	190	7.75	1 1/2	234
WF98DG	5	210	4.75	1 1/2	234
	6	220	5.25	1 1/2	259
	7	215	6.75	1 1/2	267
	8	200	7.50	1 1/2	261
WF103DG	5	205	4.25	1 1/2	234
	6	215	5.50	1 1/2	259
	7	210	6.50	1 1/2	266
	8	200	7.25	1 1/2	266

Table 6: Span Capability of WFxxDG Wide Flange Deck Girders with 1 1/2" Concrete Overlay - Normal Weight Concrete Girder and Deck

Girder 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	5.50	1 1/2	222
	8	150	5.75	1 1/2	228
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	180	3.25	1 1/2	265
	6	170	4.00	1 1/2	265
	7	160	4.25	1 1/2	263
	8	155	4.50	1 1/2	268
WF103DG	5	175	4.00	1 1/2	264
	6	165	3.50	1 1/2	263
	7	160	4.25	1 1/2	269
	8	150	4.50	1 1/2	264

The PGsuper program, Bridge Design Manual and WSDOT standard drawings are being modified to include these new standard prestressed girders.

Background:

The wide flange deck and thin deck girders could be used for new projects. However, the suitability of girders for shipping and handling should be evaluated on a job-by-job basis.

The shipping weight limits shown above are for a single girder segment and do not include the weight of the hauler. These limits are conservative and are set low to ensure that all girders can be trucked to all jobsites. Girders of 270+ kips could be shipped to some specific projects.

The Design Parameters for span capability charts are:

- PGSuper Version 2.8.0
- Girder $f'_{ci} = 7.5$ ksi, $f'_c = 9.0$ ksi
- Shipping weight < 270 kip
- Slab $f'_c = 4.0$ ksi.
- No vertical or horizontal curve
- 2% roadway crown slope
- Standard WSDOT "F" shape barrier
- 6% roadway superelevation for shipping check
- Standard WSDOT Abutment End Type A
- Includes 2" future HMA overlay with density of 140 pcf

If you have any questions please contact Scott Sargent at 705-7753

SargenW@wsdot.wa.gov, Rick Brice at [705-7174](tel:705-7174) BriceR@wsdot.wa.gov, Brian Aldrich at 705-7224 AldricB@wsdot.wa.gov, or Bijan Khaleghi at 705-7181

Bijan.Khaleghi@wsdot.wa.gov.

cc: Mark Gaines, Bridge Construction – 47354

Craig Boone, Bridge and Structures – 47340