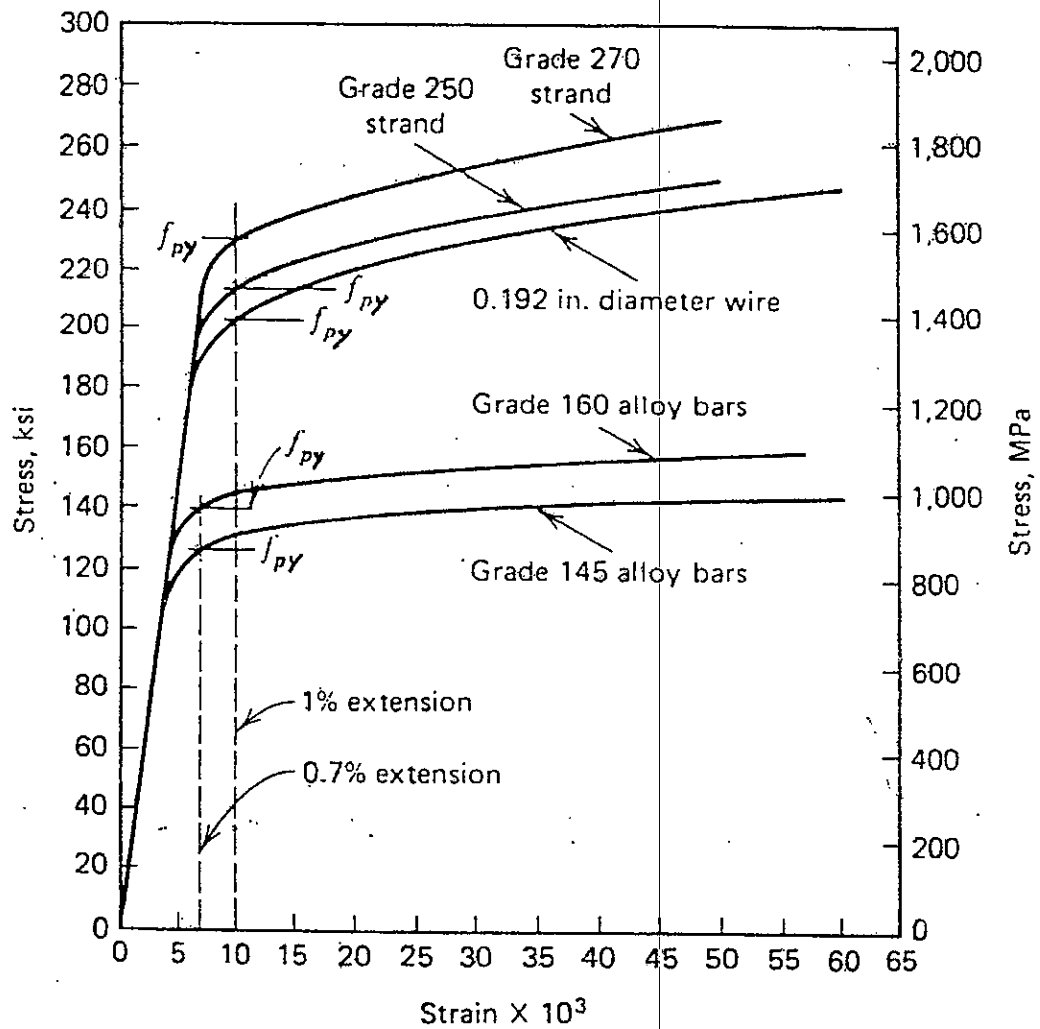




$E_p \approx 29,000 \text{ ksi} = 200 \text{ kN/mm}^2$ for wires
 $E_p \approx 27,000 \text{ ksi} = 186 \text{ kN/mm}^2$ for strand
 $E_p \approx 27,000 \text{ ksi} = 186 \text{ kN/mm}^2$ for bars

Type	U.S. Customary			Metric		
	Nominal diameter (in.)	Nominal area (in. ²)	Nominal weight (lb/ft)	Nominal diameter (mm)	Nominal area (mm ²)	Nominal mass (kg/m)
Seven-wire strand (Grade 250)	$\frac{1}{4}$ (0.250)	0.036	0.12	6.350	23.2	0.179
	$\frac{5}{16}$ (0.313)	0.058	0.20	7.950	37.4	0.298
	$\frac{3}{8}$ (0.375)	0.080	0.27	9.525	51.6	0.402
	$\frac{7}{16}$ (0.438)	0.108	0.37	11.125	69.7	0.551
	$\frac{1}{2}$ (0.500)	0.144	0.49	12.700	92.9	0.729
	(0.600)	0.216	0.74	15.240	139.4	1.101
Seven-wire strand (Grade 270)	$\frac{3}{8}$ (0.375)	0.085	0.29	9.525	54.8	0.432
	$\frac{7}{16}$ (0.438)	0.115	0.40	11.125	74.2	0.595
	$\frac{1}{2}$ (0.500)	0.153	0.53	12.700	98.7	0.789
	(0.600)	0.215	0.74	15.240	138.7	1.101
Prestressing wire	0.192	0.029	0.098	4.877	18.7	0.146
	0.196	0.030	0.10	4.978	19.4	0.149
	0.250	0.040	0.17	6.350	31.6	0.253
	0.276	0.060	0.20	7.010	38.7	0.298
Prestressing bars (smooth)	$\frac{3}{4}$ (0.750)	0.44	1.50	19.050	283.9	2.232
	$\frac{7}{8}$ (0.875)	0.60	2.04	22.225	387.1	3.036
	1(1.000)	0.78	2.67	25.400	503.2	3.973
	$1\frac{1}{8}$ (1.125)	0.99	3.38	28.575	638.7	5.030
	$1\frac{1}{4}$ (1.250)	1.23	4.17	31.750	793.5	6.206
	$1\frac{3}{8}$ (1.375)	1.48	5.05	34.925	954.8	7.515
Prestressing bars (deformed)	$\frac{5}{8}$ (0.625)	0.28	0.98	15.875	180.6	1.458
	$\frac{3}{4}$ (0.750)	0.42	1.49	19.050	271.0	2.217
	1(1.000)	0.85	3.01	25.400	548.4	4.480
	$1\frac{1}{4}$ (1.250)	1.25	4.39	31.750	806.5	6.535
	$1\frac{3}{8}$ (1.375)	1.56	5.56	34.925	1006.5	8.274

^aSI equivalents of all design equations will be found in "Building Code Requirements for Reinforced Concrete," (ACI 318M-83), American Concrete Institute, Detroit, 1983.

Reinforcing Bars

Bar size	U.S. Customary			Metric		
	Nominal diameter (in.)	Nominal area (in. ²)	Nominal weight (lb/ft)	Nominal diameter (mm)	Nominal area (mm ²)	Nominal mass (kg/m)
3	0.375	0.11	0.376	9.525	71	0.560
4	0.500	0.20	0.668	12.700	129	0.994
5	0.625	0.31	1.043	15.875	200	1.552
6	0.750	0.44	1.502	19.050	284	2.235
7	0.875	0.60	2.044	22.225	387	3.042
8	1.000	0.79	2.670	25.400	510	3.973
9	1.128	1.00	3.400	28.651	645	5.060
10	1.270	1.27	4.303	32.258	819	6.404
11	1.410	1.56	5.313	35.814	1,006	7.907
14	1.693	2.25	7.657	43.002	1,452	11.385
18	2.257	4.00	13.600	57.328	2,581	20.240

W and D Size		U.S. Customary			Metric		
		Nominal diameter (in.)	Nominal area (in. ²)	Nominal weight (lb/ft)	Nominal diameter (mm)	Nominal area (mm ²)	Nominal mass (kg/m)
Smooth	Deformed						
W31	D31	0.628	0.310	1.054	15.951	200.0	1.569
W30	D30	0.618	0.300	1.020	15.697	193.6	1.518
W28	D28	0.597	0.280	0.952	15.164	180.7	1.417
W26	D26	0.575	0.260	0.934	14.605	167.7	1.390
W24	D24	0.553	0.240	0.816	14.046	154.8	1.214
W22	D22	0.529	0.220	0.748	13.437	141.9	1.113
W20	D20	0.504	0.200	0.680	12.802	129.0	1.012
W18	D18	0.478	0.180	0.612	12.141	116.1	0.911
W16	D16	0.451	0.160	0.544	11.455	103.2	0.810
W14	D14	0.422	0.140	0.476	10.719	90.3	0.708
W12	D12	0.390	0.120	0.408	9.906	77.4	0.607
W11	D11	0.374	0.110	0.374	9.500	71.0	0.557
W10.5		0.366	0.105	0.357	9.296	67.7	0.531
W10	D10	0.356	0.100	0.340	9.042	64.5	0.506
W9.5		0.348	0.095	0.323	8.839	61.3	0.481
W9	D9	0.338	0.090	0.306	8.585	58.1	0.455
W8.5		0.329	0.085	0.289	8.357	54.8	0.430
W8	D8	0.319	0.080	0.272	8.103	51.6	0.405
W7.5		0.309	0.075	0.255	7.849	48.4	0.380
W7	D7	0.298	0.070	0.238	7.569	45.2	0.354
W6.5		0.288	0.065	0.221	7.315	41.9	0.329
W6	D6	0.276	0.060	0.204	7.010	38.7	0.304
W5.5		0.264	0.055	0.187	6.706	35.5	0.278
W5	D5	0.252	0.050	0.170	6.401	32.3	0.253
W4.5		0.240	0.045	0.153	6.096	29.0	0.228
W4	D4	0.225	0.040	0.136	5.715	25.8	0.202
W3.5		0.211	0.035	0.119	5.359	22.6	0.177
W3		0.195	0.030	0.102	4.953	19.4	0.152
W2.9		0.192	0.029	0.098	4.877	18.7	0.146
W2.5		0.178	0.025	0.085	4.521	16.1	0.127
W2		0.159	0.020	0.068	4.039	12.9	0.101
W1.4		0.135	0.014	0.049	3.429	9.0	0.073

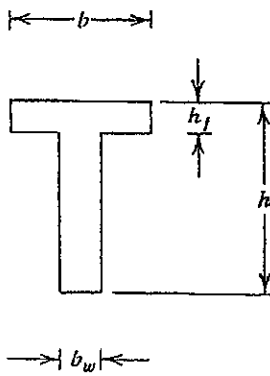


Table A.9 Section Properties of T-Beams

b_w/b	h_f/h	A_c	I_c	c_1	c_2	r^2
0.1	0.1	$0.190bh$	$0.0179bh^3$	$0.286h$	$0.714h$	$0.0945h^2$
0.1	0.2	0.280	0.0192	0.244	0.756	0.0688
0.1	0.3	0.370	0.0193	0.245	0.755	0.0520
0.2	0.1	0.280	0.0283	0.371	0.629	0.1010
0.2	0.2	0.360	0.0315	0.322	0.678	0.0875
0.2	0.3	0.440	0.0319	0.309	0.691	0.0725
0.3	0.1	0.370	0.0365	0.415	0.585	0.0985
0.3	0.2	0.440	0.0408	0.374	0.626	0.0928
0.3	0.3	0.510	0.0417	0.355	0.645	0.0819
0.4	0.1	0.460	0.0440	0.441	0.559	0.0954
0.4	0.2	0.520	0.0486	0.408	0.592	0.0935
0.4	0.3	0.580	0.0499	0.391	0.609	0.0860

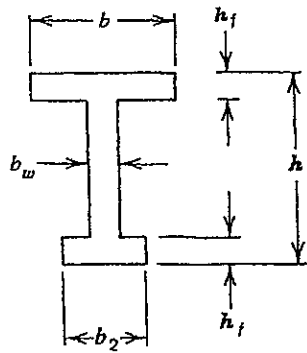


Table A.10 Section Properties of Unsymmetrical I-Beams

b_w/b	h_f/h	A_c	I_c	c_1	c_2	r^2
$b_2/b = 0.30$						
0.1	0.1	$0.210bh$	$0.0260bh^3$	$0.350h$	$0.650h$	$0.1236h^2$
0.1	0.2	0.320	0.0345	0.325	0.675	0.1080
0.1	0.3	0.430	0.0387	0.328	0.672	0.0900
0.2	0.1	0.290	0.0316	0.390	0.610	0.1090
0.2	0.2	0.380	0.0378	0.353	0.647	0.0994
0.2	0.3	0.470	0.0402	0.345	0.655	0.0856
$b_2/b = 0.50$						
0.1	0.1	$0.230bh$	$0.0326bh^3$	$0.403h$	$0.597h$	$0.1420h^2$
0.1	0.2	0.360	0.0464	0.389	0.611	0.1288
0.1	0.3	0.490	0.0535	0.394	0.606	0.1090
0.2	0.1	0.310	0.0373	0.428	0.572	0.1204
0.2	0.2	0.420	0.0488	0.405	0.595	0.1160
0.2	0.3	0.530	0.0540	0.401	0.599	0.1020
0.3	0.1	0.390	0.0430	0.443	0.557	0.1103
0.3	0.2	0.480	0.0510	0.418	0.582	0.1065
0.3	0.3	0.570	0.0553	0.408	0.592	0.0970
$b_2/b = 0.70$						
0.1	0.1	$0.250bh$	$0.0381bh^3$	$0.446h$	$0.554h$	$0.1525h^2$
0.1	0.2	0.400	0.0560	0.440	0.560	0.1391
0.1	0.3	0.550	0.0651	0.443	0.557	0.1182
0.2	0.1	0.330	0.0425	0.460	0.540	0.1290
0.2	0.2	0.460	0.0578	0.448	0.552	0.1258
0.2	0.3	0.590	0.0657	0.447	0.553	0.1113
0.3	0.1	0.410	0.0467	0.466	0.534	0.1140
0.3	0.2	0.520	0.0598	0.454	0.546	0.1150
0.3	0.3	0.630	0.0663	0.450	0.550	0.1051

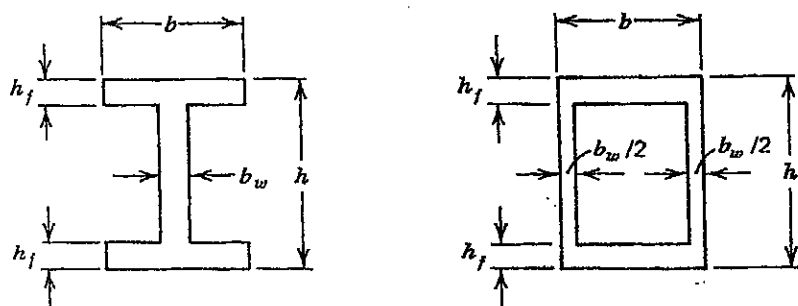


Table A.8 Section Properties of Symmetrical I-and Box Beams

b_w/b	h_f/h	A_c	I_c	c_1	c_2	r^2
0.1	0.1	$0.280bh$	$0.0449bh^3$	$0.500h$	$0.500h$	$0.160h^2$
0.1	0.2	0.460	0.0671	0.500	0.500	0.146
0.1	0.3	0.640	0.0785	0.500	0.500	0.123
0.2	0.1	0.360	0.0492	0.500	0.500	0.137
0.2	0.2	0.520	0.0689	0.500	0.500	0.132
0.2	0.3	0.680	0.0791	0.500	0.500	0.117
0.3	0.1	0.440	0.0535	0.500	0.500	0.121
0.3	0.2	0.580	0.0707	0.500	0.500	0.122
0.3	0.3	0.720	0.0796	0.500	0.500	0.111
0.4	0.1	0.520	0.0577	0.500	0.500	0.111
0.4	0.2	0.640	0.0725	0.500	0.500	0.113
0.4	0.3	0.760	0.0801	0.500	0.500	0.105

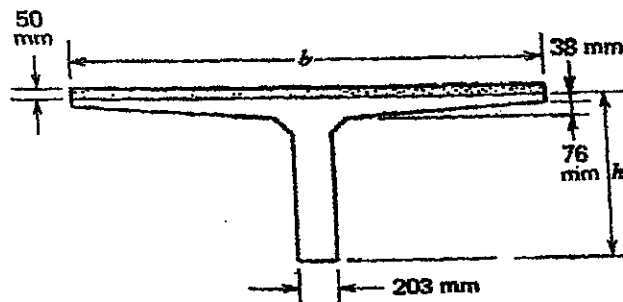


Fig. 6-21(a). Typical single-tee section (Lin Tee).

Table of Properties

b , mm	h , mm	A , $\times 10^4$ mm ²	I , $\times 10^8$ mm ⁴	y_t , mm	y_b , mm	V/S , mm	
2438	914	36.8	286.9	254	660	55	without 50 mm topping with 50 mm topping
3048	1219	50.5	703.3	289	930	59	
2438	914+50		367.4		739		

PCI Design Handbook gives tables of safe superimposed loads for these sections.

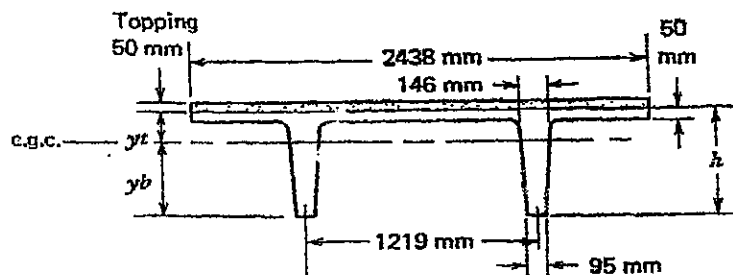


Fig. 6-21(b). Typical double-tee section.

Table of Properties

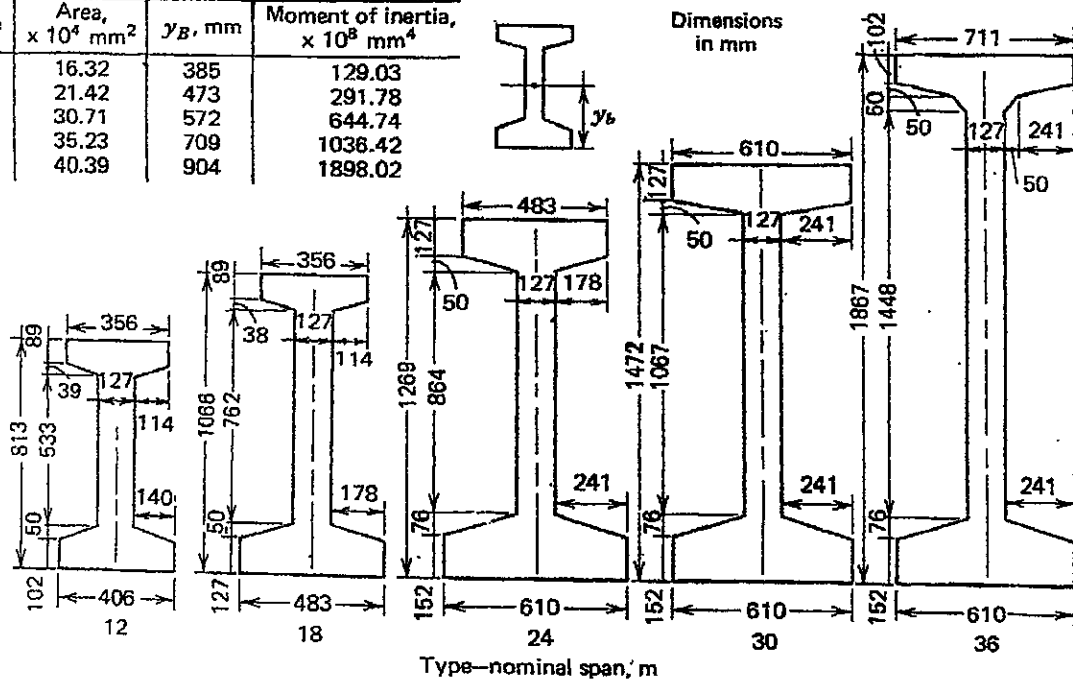
	h , mm	A , $\times 10^4$ mm ²	I , $\times 10^8$ mm ⁴	y_t , mm	y_b , mm	V/S , mm
Without topping	356	19.7	18.8	89	267	32
	457	22.2	38.7	120	337	34
	610	25.9	87.3	174	436	36
With topping 50 mm thick	356+50		29.9		315	
	457+50		57.4		394	
	610+50		124.3		506	

Other sections listed in PCI Design Handbook 305 mm, 406 mm, 508 mm, and 813 mm deep with tables of safe superimposed load.

Beam Properties

Type	Area, $\times 10^4 \text{ mm}^2$	y_B , mm	Moment of inertia, $\times 10^8 \text{ mm}^4$
12	16.32	385	129.03
18	21.42	473	291.78
24	30.71	572	644.74
30	35.23	709	1036.42
36	40.39	904	1898.02

Washington State Standard Bridge Beams



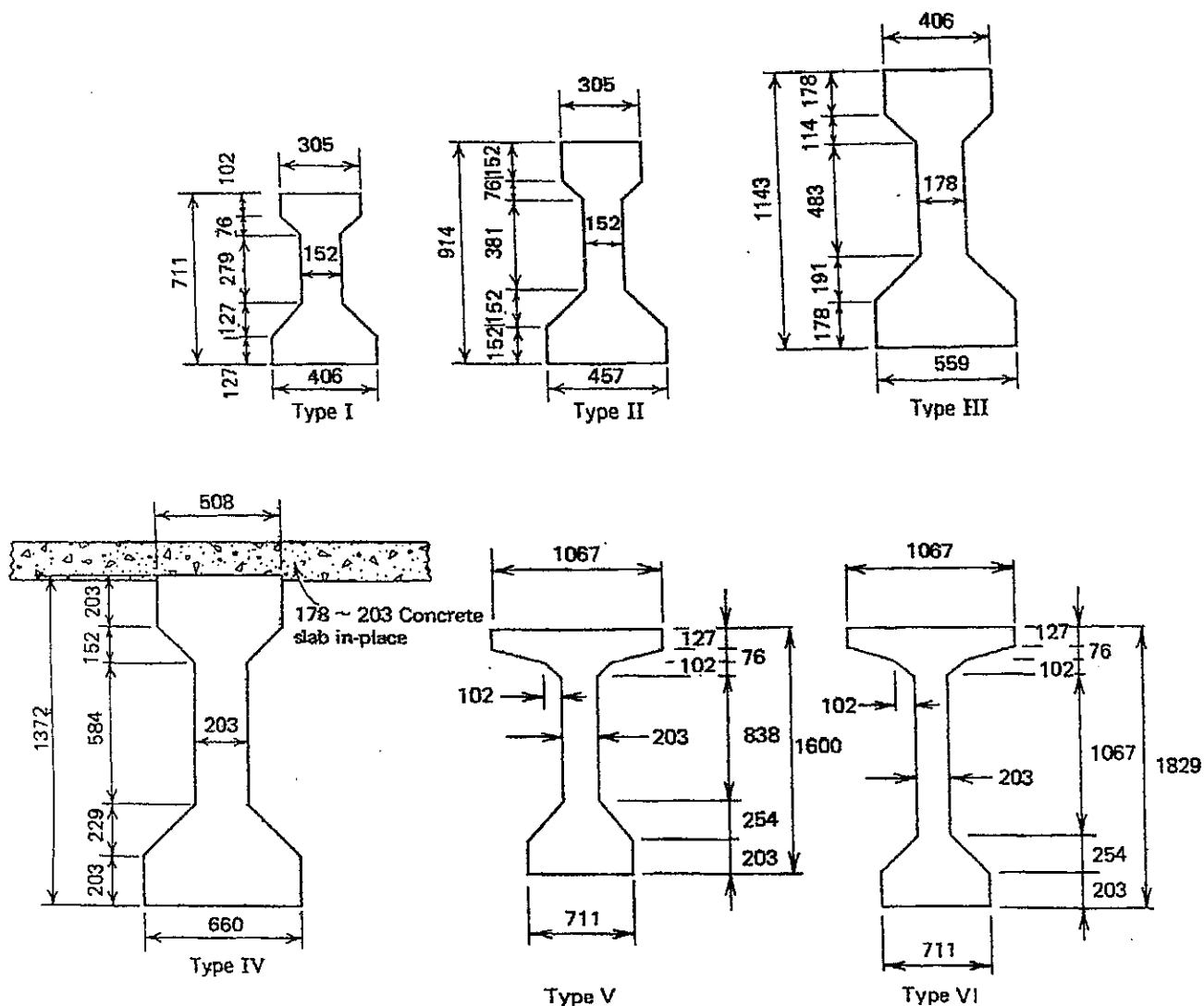


Fig. 6-21(d). Standard AASHTO-PCI prestressed concrete I-beams for highway bridges.²

Table of Properties
(Without in-place slab)

Beam Type	Area, $\times 10^4 \text{ mm}^2$	$I, \times 10^8 \text{ mm}^4$	$c_b, \text{ mm}$	Recommended Span Limits, m
I	17.81	95	320	9.1 ~ 13.7
II	23.81	212	402	12.2 ~ 18.3
III	36.13	522	515	16.8 ~ 24.4
IV	50.90	1085	628	21.3 ~ 30.5
V	65.35	2169	812	27.4 ~ 36.6
VI	70.00	3052	924	33.5 ~ 42.7

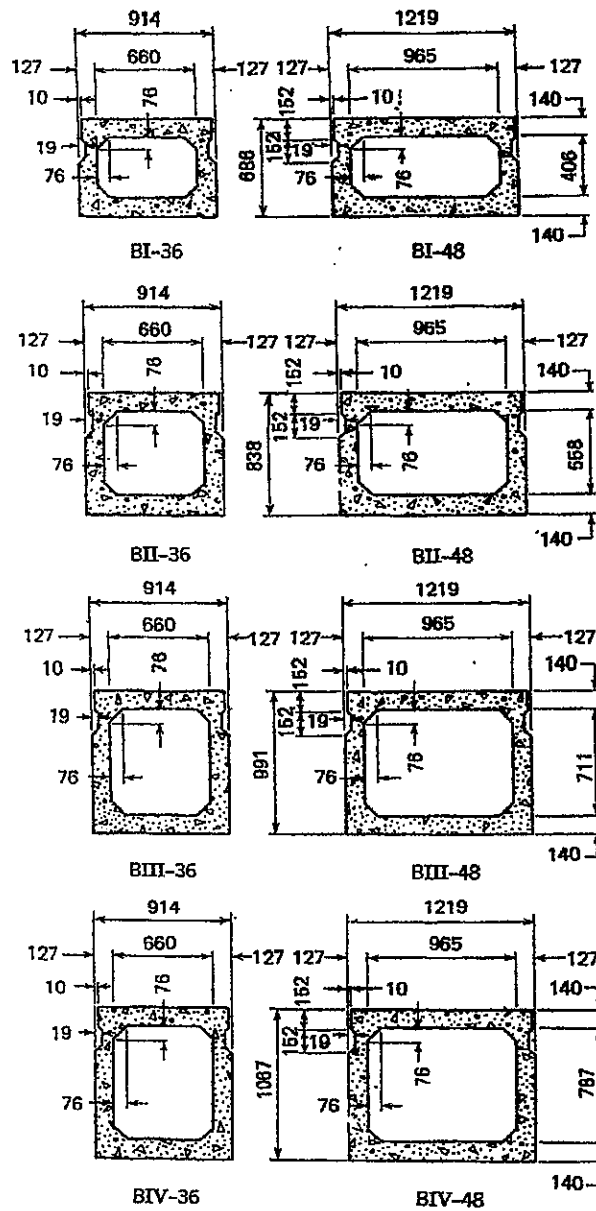


Fig. 6-21(e). Standard AASHTO-PCI prestressed concrete box beams for highway bridges.

Beam Type	Area, $\times 10^4 \text{ mm}^2$	$I, \times 10^8 \text{ mm}^4$	$c_b, \text{ mm}$	Recommended Span Limits, m	
				Draped Strand	Straight Strand
BI-36	36.2	209.5	339	22.56	18.90
BI-48	44.7	274.5	340	22.25	19.20
BII-36	40.0	354.4	414	26.21	22.25
BII-48	48.5	459.9	415	26.21	22.56
BIII-36	43.9	545.9	489	29.57	25.30
BIII-48	52.4	700.8	490	29.26	25.30
BIV-36	45.8	660.3	527	31.39	26.52
BIV-48	54.4	845.3	528	31.39	26.82

Friction Coefficients for Posttensioning Tendons^a

Type of Tendon	Wobble Coefficient <i>K</i> per Meter	Curvature Coefficient μ
Tendons in flexible metal sheathing		
Wire tendons	0.0033—0.0049	0.15—0.25
7-wire strand	0.0016—0.0066	0.15—0.25
High strength bars	0.0003—0.0020	0.08—0.30
Tendons in rigid metal duct		
7-wire strand	0.0007	0.15—0.25
Pregreased tendons		
Wire tendons and 7-wire strand	0.001—0.0066	0.05—0.15
Mastic-coated tendons		
Wire tendons and 7-wire strand	0.0033—0.0066	0.05—0.15

^aACI Code Commentary.