TABLE XVII.—Curve formulæ.*

	Given.	Sought.	Formulæ.
1	D	R	$R = \frac{50}{\sin \frac{1}{2} D}$
2	R	D	$\sin \frac{1}{2} D = \frac{50}{R}$
3	Δ, D	L	$L = 100 \frac{\Delta}{D}$
4	D, L	Δ	$\Delta = \frac{DL}{100}$
5	Δ, L	D	$D = 100 \frac{\Delta}{L}$
6	R, Δ	T	$T = R \tan \frac{1}{2} \Delta$
7	"	C	$C = 2R \sin \frac{1}{2} \Delta$
8	"	M	$M = R \operatorname{vers} \frac{1}{2} \Delta$
9	"	E	$E = R \operatorname{exsec} \frac{1}{2} \Delta$
10	T, Δ	R	$R = T \cot \frac{1}{2} \Delta$
11	"	E	$E = T \tan \frac{1}{4} \Delta$
12	"	C	$C = 2T \cos \frac{1}{2} \Delta$
13	"	M	$M = T \cot \frac{1}{2} \Delta \cdot \operatorname{vers} \frac{1}{2} \Delta$
14	E, Δ	R	$R = \frac{E}{\operatorname{exsec} \frac{1}{2} \Delta}$
15	"	T	$T = E \cot \frac{1}{4} \Delta$
16	"	C	$C = 2E \frac{\sin \frac{1}{2} \Delta}{\operatorname{exsec} \frac{1}{2} \Delta}$
17	"	M	$M = E \cos \frac{1}{2} \Delta$
18	C, Δ	R	$R = \frac{C}{2 \sin \frac{1}{2} \Delta}$
19	"	M	$M = \frac{1}{2} C \tan \frac{1}{4} \Delta$
20	"	T	$T = \frac{C}{2 \cos \frac{1}{2} \Delta}$
21	"	E	$E = \frac{1}{2} C \frac{\operatorname{exsec} \frac{1}{2} \Delta}{\sin \frac{1}{2} \Delta}$
22	M, Δ	R	$R = \frac{M}{\operatorname{vers} \frac{1}{2} \Delta}$
23	"	C	$C = 2M \cot \frac{1}{4} \Delta$
24	"	T	$T = M \frac{\tan \frac{1}{2} \Delta}{\operatorname{vers} \frac{1}{2} \Delta}$
25	"	E	$E = \frac{M}{\cos \frac{1}{2} \Delta}$

*See par. 16 for meaning of letters.

TABLE XVII.—Curve formulæ—*Continued.*

	Given.	Sought.	Formulæ.
26	R, T	△	$\tan \frac{1}{2} \triangle = \frac{T}{R}$
27	"	"	$\sin \frac{1}{2} \triangle = \frac{T}{\sqrt{T^2 + R^2}}$
28	R, C	△	$\sin \frac{1}{2} \triangle = \frac{C}{2R}$
29	"	"	$\cos \frac{1}{2} \triangle = \frac{1}{R} \sqrt{\left(R + \frac{C}{2}\right)\left(R - \frac{C}{2}\right)}$
30	R, M	△	$\text{vers} \frac{1}{2} \triangle = \frac{M}{R}$
31	"	"	$\cos \frac{1}{2} \triangle = \frac{R - M}{R}$
32	R, E	△	$\text{exsec} \frac{1}{2} \triangle = \frac{E}{R}$
33	"	"	$\cos \frac{1}{2} \triangle = \frac{R}{R + E}$
34	T, C	△	$\cos \frac{1}{2} \triangle = \frac{C}{2T}$
35	"	"	$\tan \frac{1}{4} \triangle = \sqrt{\frac{2T - C}{2T + C}}$
36	T, E	△	$\tan \frac{1}{4} \triangle = \frac{E}{T}$
37	"	"	$\cos \frac{1}{2} \triangle = \frac{T^2 - E^2}{T^2 + E^2}$
38	C, M	△	$\tan \frac{1}{4} \triangle = \frac{2M}{C}$
39	"	"	$\cos \frac{1}{2} \triangle = \frac{C^2 - 4M^2}{C^2 + 4M^2}$
40	M, E	△	$\cos \frac{1}{2} \triangle = \frac{M}{E}$
41	"	"	$\tan \frac{1}{4} \triangle = \sqrt{\frac{E - M}{E + M}}$
42	R, T	C	$C = \frac{2TR}{\sqrt{T^2 + R^2}}$
43	"	M	$M = R - \frac{R^2}{\sqrt{T^2 + R^2}}$
44	"	E	$E = \sqrt{T^2 + R^2} - R$
45	R, C	T	$T = \frac{CR}{2\sqrt{\left(R + \frac{C}{2}\right)\left(R - \frac{C}{2}\right)}}$
46	"	M	$M = R - \sqrt{(R + \frac{1}{2}C)(R - \frac{1}{2}C)}$
47	"	E	$E = \frac{R^2}{\sqrt{(R + \frac{1}{2}C)(R - \frac{1}{2}C)}} - R$

TABLE XVII.—Curve formulæ—*Continued.*

	Given.	Sought.	Formulæ.
48	R, M	T	$T = \frac{R\sqrt{M\,(2R - M)}}{R - M}$
49	"	C	$C = 2\sqrt{M\,(2R - M)}$
50	"	E	$E = \frac{RM}{R - M}$
51	R, E	T	$T = \sqrt{E\,(2R + E)}$
52	"	C	$C = \frac{2R\sqrt{E\,(2R + E)}}{R + E}$
53	"	M	$M = \frac{RE}{R + E}$
54	T, C	R	$R = \frac{CT}{\sqrt{(2T + C)\,(2T - C)}}$
55	"	M	$M = \frac{1}{2}C\sqrt{\frac{2T - C}{2T + C}}$
56	"	E	$E = T\sqrt{\frac{2T - C}{2T + C}}$
57	T, E	R	$R = \frac{(T + E)\,(T - E)}{2E}$
58	"	C	$C = \frac{2T\,(T^2 - E^2)}{T^2 + E^2}$
59	"	M	$M = \frac{E\,(T^2 - E^2)}{T^2 + E^2}$
60	C, M	R	$R = \frac{M^2 + (\frac{1}{2}C)^2}{2M}$
61	"	T	$T = \frac{C\,(C^2 + 4M^2)}{2\,(C^2 - 4M^2)}$
62	"	E	$E = M\,\frac{C^2 + 4M^2}{C^2 - 4M^2}$
63	M, E	R	$R = \frac{EM}{E - M}$
64	"	T	$T = E\sqrt{\frac{E + M}{E - M}}$
65	"	C	$C = 2M\sqrt{\frac{E + M}{E - M}}$
66	T, M	R	$R^3 - R^2\,\frac{M^2 + T^2}{2M} + RT^2 - \frac{1}{2}MT^2 = 0$
67	"	E	$E^3 + E^2M - ET^2 + MT^2 = 0$
68	"	C	$C^3 + 2TC^2 + 4M^2C - 8M^2T = 0$
69	C, E	R	$R^3 + R^2\,\frac{4E^2 - C^2}{8E} - R\,\frac{C^2}{4} - \frac{C^2E}{8} = 0$
70	"	T	$2T^3 - T^2C - 2TE^2 - CE^2 = 0$
71	"	M	$M^3 + M^2E + M\,\frac{C^2}{4} - \frac{C^2E}{4} = 0$

TABLE XVIII.—Natural versed sines and external secants.

0°–10				10°–20°					P. P.					
° ′	Vers.	d.	Exsec.	d.	° ′	Vers.	d.	Exsec.	d.		110	100	90	80	70
0 0	·00000	0	·00000	0	10 0	·01519	51	·01542	52						
10	·00000	1	·00000	1	10	·01570	52	·01595	53	1	11	10	9	8	7
20	·00001	2	·00001	2	20	·01622	53	·01648	54	2	22	20	18	16	14
30	·00004	3	·00004	3	30	·01674	54	·01703	55	3	33	30	27	24	21
40	·00007	3	·00007	3	40	·01728	54	·01758	56	4	44	40	36	32	28
50	·00010	4	·00010	4	50	·01782	55	·01814	57	5	55	50	45	40	35
1 0	·00015	5	·00015	5	11 0	·01837	55	·01871	58	6	66	60	54	48	42
10	·00020	6	·00020	6	10	·01893	57	·01929	59	7	77	70	63	56	49
20	·00027	7	·00027	7	20	·01950	57	·01988	60	8	88	80	72	64	56
30	·00034	8	·00034	8	30	·02007	58	·02048	61	9	99	90	81	72	63
40	·00042	8	·00042	8	40	·02066	59	·02109	62						
50	·00051	10	·00051	10	50	·02125	60	·02171	62		60	50	40	30	20
2 0	·00061	10	·00061	10	12 0	·02135	61	·02234	63	1	6	5	4	3	2
10	·00071	11	·00071	11	10	·02246	62	·02297	65	2	12	10	8	6	4
20	·00083	12	·00083	12	20	·02308	62	·02362	65	3	18	15	12	9	6
30	·00095	13	·00095	13	30	·02370	63	·02426	66	4	24	20	16	12	8
40	·00108	13	·00108	14	40	·02434	64	·02494	67	5	30	25	20	15	10
50	·00122	15	·00122	14	50	·02498	65	·02562	68	6	36	30	24	18	12
3 0	·00137	15	·00137	16	13 0	·02563	66	·02630	69	7	42	35	28	21	14
10	·00152	16	·00153	16	10	·02629	66	·02700	70	8	48	40	32	24	16
20	·00169	17	·00169	17	20	·02695	67	·02770	71	9	54	45	36	27	18
30	·00186	18	·00187	18	30	·02763	68	·02841	72						
40	·00204	19	·00205	19	40	·02831	69	·02914	73		10	9	9	8	8
50	·00223	20	·00224	20	50	·02900	70	·02987	74	1	1	0.9	0.9	0.8	0.8
4 0	·00243	21	·00244	21	14 0	·02970	70	·03061	75	2	2	1.9	1.8	1.7	1.6
10	·00264	21	·00265	21	10	·03041	72	·03136	76	3	3	2.8	2.7	2.5	2.4
20	·00286	22	·00286	23	20	·03113	72	·03213	77	4	4	3.8	3.6	3.3	3.2
30	·00309	23	·00309	23	30	·03185	72	·03290	78	5	5	4.7	4.5	4.2	4.0
40	·00333	24	·00332	24	40	·03258	74	·03368	79	6	6	5.7	5.4	5.1	4.8
50	·00355	25	·00357	25	50	·03332	75	·03447	80	7	7	6.6	6.3	5.9	5.6
5 0	·00380	26	·00382	26	15 0	·03407	75	·03527	81	8	8	7.6	7.2	6.8	6.4
10	·00406	26	·00408	27	10	·03483	76	·03609	82	9	9	8.5	8.1	7.6	7.2
20	·00433	27	·00435	27	20	·03559	77	·03691	83						
30	·00460	27	·00462	28	30	·03637	78	·03774	84		7	7	6	6	5
40	·00488	29	·00491	29	40	·03715	79	·03858	85	1	0.7	0.7	0.6	0.6	0.5
50	·00518	30	·00520	30	50	·03794	80	·03943	86	2	1.5	1.4	1.3	1.2	1.1
6 0	·00548	30	·00551	31	16 0	·03874	80	·04030	87	3	2.2	2.1	1.9	1.8	1.6
10	·00578	32	·00582	32	10	·03954	81	·04117	88	4	3.0	2.8	2.6	2.4	2.2
20	·00610	32	·00614	33	20	·04036	82	·04205	89	5	3.7	3.5	3.2	3.0	2.7
30	·00643	33	·00647	34	30	·04118	83	·04295	90	6	4.5	4.2	3.9	3.6	3.3
40	·00676	33	·00681	34	40	·04201	84	·04385	91	7	5.2	4.9	4.5	4.2	3.8
50	·00710	35	·00715	35	50	·04285	84	·04476	92	8	6.0	5.6	5.2	4.8	4.4
7 0	·00745	36	·00751	36	17 0	·04369	85	·04569	93	9	6.7	6.3	5.8	5.4	4.9
10	·00781	36	·00787	37	10	·04455	86	·04662	95						
20	·00818	37	·00824	38	20	·04541	87	·04757	95		5	4	4	3	3
30	·00855	38	·00863	39	30	·04628	87	·04853	96	1	0.5	0.4	0.4	0.3	0.3
40	·00894	39	·00902	40	40	·04716	89	·04949	98	2	1.0	0.9	0.8	0.7	0.6
50	·00933	40	·00942	41	50	·04805	89	·05047	98	3	1.5	1.3	1.2	1.0	0.9
8 0	·00973	41	·00983	41	18 0	·04894	90	·05146	100	4	2.0	1.7	1.6	1.4	1.2
10	·01014	41	·01024	42	10	·04984	91	·05246	101	5	2.5	2.2	2.0	1.7	1.5
20	·01056	42	·01067	43	20	·05075	92	·05347	102	6	3.0	2.7	2.4	2.1	1.8
30	·01098	43	·01110	44	30	·05167	93	·05449	103	7	3.5	3.1	2.8	2.4	2.1
40	·01142	44	·01155	45	40	·05260	93	·05552	104	8	4.0	3.6	3.2	2.8	2.4
50	·01186	45	·01200	46	50	·05354	94	·05656	105	9	4.5	4.0	3.6	3.1	2.7
9 0	·01231	46	·01246	47	19 0	·05448	95	·05762	106						
10	·01277	47	·01293	48	10	·05543	96	·05868	107		3	2	2	1	1
20	·01324	47	·01341	49	20	·05639	97	·05976	109	1	0.2	0.2	0.1	0.1	0.0
30	·01371	48	·01390	50	30	·05736	97	·06085	109	2	0.5	0.4	0.3	0.2	0.1
40	·01420	49	·01440	50	40	·05835	98	·06194	111	3	0.7	0.6	0.4	0.3	0.1
50	·01469	50	·01491	51	50	·05931	99	·06305	112	4	1.0	0.8	0.6	0.4	0.2
10 0	·01519	51	·01542	52	20 0	·06030		·06418		5	1.2	1.0	0.7	0.5	0.2
° ′	Vers.	d.	Exsec.	d.	° ′	Vers.	d.	Exsec.	d.	6	1.5	1.2	0.9	0.6	0.3
										7	1.7	1.4	1.0	0.7	0.3
										8	2.0	1.6	1.2	0.8	0.4
										9	2.2	1.8	1.3	0.9	0.4
											P. P.				

TABLE XVIII.—Natural versed sines and external secants—*Continued.*

20°–30°						30°–40°										
° ′	Vers.	d.	Exsec.	d.	° ′	Vers.	d.	Exsec.	d.	P. P.						
20 0	.0603	10	.0642	11	30 0	.1339	15	.1547	15		31	30	29	28		
10	.0613	10	.0653	11	10	.1354	14	.1566	19	1	3.1	3.0	2.9	2.8		
20	.0623	10	.0664	11	20	.1369	14	.1586	20	2	6.2	6.0	5.8	5.6		
30	.0633	10	.0676	12	30	.1383	15	.1606	20	3	9.3	9.0	8.7	8.4		
40	.0643	10	.0688	11	40	.1398	15	.1626	20	4	12.4	12.0	11.6	11.2		
50	.0654	10	.0699	12	50	.1413	15	.1646	20	5	15.5	15.0	14.5	14.0		
21 0	.0664	10	.0711	12	31 0	.1428	15	.1666	20	6	18.6	18.0	17.4	16.8		
10	.0674	10	.0723	12	10	.1443	15	.1687	20	7	21.7	21.0	20.3	19.6		
20	.0685	10	.0735	12	20	.1458	15	.1707	21	8	24.8	24.0	23.2	22.4		
30	.0696	11	.0748	12	30	.1473	15	.1728	21	9	27.9	27.0	26.1	25.2		
40	.0706	10	.0761	12	40	.1489	15	.1749	21							
50	.0717	11	.0772	13	50	.1504	15	.1770	21		27	26	25	24		
22 0	.0728	10	.0785	12	32 0	.1519	15	.1792	21	1	2.7	2.6	2.5	2.4		
10	.0739	11	.0798	13	10	.1535	15	.1813	21	2	5.4	5.2	5.0	4.8		
20	.0750	11	.0811	13	20	.1550	15	.1835	22	3	8.1	7.8	7.5	7.2		
30	.0761	11	.0824	13	30	.1566	16	.1857	22	4	10.8	10.4	10.0	9.6		
40	.0772	11	.0837	13	40	.1582	15	.1879	22	5	13.5	13.0	12.5	12.0		
50	.0783	11	.0850	13	50	.1597	16	.1901	22	6	16.2	15.6	15.0	14.4		
23 0	.0795	11	.0863	13	33 0	.1613	16	.1923	23	7	18.9	18.2	17.5	16.8		
10	.0806	11	.0877	13	10	.1629	16	.1946	23	8	21.6	20.8	20.0	19.2		
20	.0818	12	.0890	14	20	.1645	16	.1969	23	9	24.3	23.4	22.5	21.6		
30	.0829	11	.0904	14	30	.1661	16	.1992	23							
40	.0841	12	.0918	14	40	.1677	16	.2015	23		23	22	21	20		
50	.0853	12	.0932	14	50	.1693	16	.2038	23	1	2.3	2.2	2.1	2.0		
24 0	.0864	11	.0946	14	34 0	.1709	16	.2062	24	2	4.6	4.4	4.2	4.0		
10	.0876	12	.0960	14	10	.1726	16	.2086	24	3	6.9	6.6	6.3	6.0		
20	.0888	12	.0975	15	20	.1742	16	.2110	24	4	9.2	8.8	8.4	8.0		
30	.0900	12	.0989	14	30	.1758	16	.2134	24	5	11.5	11.0	10.5	10.0		
40	.0912	12	.1004	15	40	.1775	17	.2158	24	6	13.8	13.2	12.6	12.0		
50	.0924	12	.1019	15	50	.1792	17	.2183	24	7	16.1	15.4	14.7	14.0		
25 0	.0937	12	.1034	15	35 0	.1809	16	.2207	25	8	18.4	17.6	16.8	16.0		
10	.0949	13	.1049	15	10	.1825	17	.2232	25	9	20.7	19.8	18.9	18.0		
20	.0961	12	.1064	15	20	.1842	17	.2258	25							
30	.0974	13	.1079	15	30	.1859	17	.2283	25		19	18	17	16		
40	.0986	12	.1094	15	40	.1876	17	.2309	25	1	1.9	1.8	1.7	1.6		
50	.0999	13	.1110	16	50	.1893	17	.2334	26	2	3.8	3.6	3.4	3.2		
26 0	.1012	13	.1126	16	36 0	.1910	17	.2360	26	3	5.7	5.4	5.1	4.8		
10	.1025	13	.1142	16	10	.1927	17	.2387	26	4	7.6	7.2	6.8	6.4		
20	.1037	13	.1158	16	20	.1944	17	.2413	27	5	9.5	9.0	8.5	8.0		
30	.1050	13	.1174	16	30	.1961	17	.2440	27	6	11.4	10.8	10.2	9.6		
40	.1063	13	.1190	16	40	.1979	17	.2467	27	7	13.3	12.6	11.9	11.2		
50	.1077	13	.1206	17	50	.1996	17	.2494	27	8	15.2	14.4	13.6	12.8		
27 0	.1090	13	.1223	16	37 0	.2013	17	.2521	27	9	17.1	16.2	15.3	14.4		
10	.1103	13	.1240	17	10	.2031	18	.2549	27							
20	.1116	13	.1257	17	20	.2049	17	.2576	28		15	14	13	12		
30	.1130	14	.1274	17	30	.2066	17	.2604	28	1	1.5	1.4	1.3	1.2		
40	.1143	13	.1291	17	40	.2084	18	.2633	28	2	3.0	2.8	2.6	2.4		
50	.1157	14	.1308	17	50	.2102	18	.2661	28	3	4.5	4.2	3.9	3.6		
28 0	.1170	13	.1325	18	38 0	.2120	18	.2690	29	4	6.0	5.6	5.2	4.8		
10	.1184	14	.1343	17	10	.2138	18	.2719	29	5	7.5	7.0	6.5	6.0		
20	.1198	14	.1361	18	20	.2156	18	.2748	29	6	9.0	8.4	7.8	7.2		
30	.1212	14	.1379	18	30	.2174	18	.2778	29	7	10.5	9.8	9.1	8.4		
40	.1226	14	.1397	18	40	.2192	18	.2807	30	8	12.0	11.2	10.4	9.6		
50	.1239	13	.1415	18	50	.2210	18	.2837	30	9	13.5	12.6	11.7	10.8		
29 0	.1254	14	.1433	18	39 0	.2228	18	.2867	30							
10	.1268	14	.1452	19	10	.2247	19	.2898	30		11	10	0			
20	.1282	14	.1470	18	20	.2265	18	.2928	31	1	1.1	1.0	0.0			
30	.1296	14	.1489	19	30	.2284	19	.2959	31	2	2.2	2.0	0.1			
40	.1311	15	.1508	19	40	.2302	18	.2991	31	3	3.3	3.0	0.1			
50	.1325	14	.1527	19	50	.2321	19	.3022	31	4	4.4	4.0	0.2			
30 0	.1339	14	.1547	20	40 0	.2339	18	.3054	31	5	5.5	5.0	0.2			
										6	6.6	6.0	0.3			
										7	7.7	7.0	0.3			
										8	8.8	8.0	0.4			
										9	9.9	9.0	0.4			

TABLE XVIII.—**Natural versed sines and external secants**—*Continued.*

40°–50°					50°–60°					
° ′	Vers.	d.	Exsec.	d.	° ′	Vers.	d.	Exsec.	d.	P. P.
40 0	.2339	19	.3054	32	50 0	.3572	23	.5557	53	9 8 7 6 5 4
10	.2358	19	.3086	32	10	.3594	23	.5611	54	1 0.9 0.8 0.7 0.6 0.5 0.4
20	.2377	19	.3118	33	20	.3617	23	.5666	55	2 1.8 1.6 1.4 1.2 1.0 0.8
30	.2396	19	.3151	33	30	.3639	23	.5721	56	3 2.7 2.4 2.1 1.8 1.5 1.2
40	.2415	19	.3183	33	40	.3661	23	.5777	56	4 3.6 3.2 2.8 2.4 2.0 1.6
50	.2434	19	.3217	33	50	.3684	23	.5833	56	5 4.5 4.0 3.5 3.0 2.5 2.0
41 0	.2453	19	.3250	34	51 0	.3707	23	.5890	57	6 5.4 4.8 4.2 3.6 3.0 2.4
10	.2472	19	.3284	33	10	.3729	22	.5947	58	7 6.3 5.6 4.9 4.2 3.5 2.8
20	.2491	19	.3317	33	20	.3752	23	.6005	58	8 7.2 6.4 5.6 4.8 4.0 3.2
30	.2510	19	.3352	34	30	.3775	23	.6064	59	9 8.1 7.2 6.3 5.4 4.5 3.6
40	.2529	19	.3386	34	40	.3797	22	.6123	59	
50	.2549	19	.3421	35	50	.3820	23	.6182	59	3 2 1 0 9 8 7
42 0	.2568	19	.3456	35	52 0	.3843	23	.6242	60	1 0.3 0.2 0.1 0.0 0.9 0.8 0.7
10	.2588	19	.3491	36	10	.3866	23	.6303	61	2 0.6 0.4 0.2 1.9 1.7 1.6
20	.2607	19	.3527	36	20	.3889	23	.6365	61	3 0.9 0.6 0.3 2.8 2.5 2.3
30	.2627	20	.3563	36	30	.3913	23	.6427	62	4 1.2 0.8 0.4 3.7 3.4 3.0
40	.2647	19	.3599	37	40	.3935	23	.6489	63	5 1.5 1.0 0.5 4.7 4.2 3.8
50	.2666	20	.3636	37	50	.3958	23	.6553	63	6 1.8 1.2 0.6 5.6 5.1 4.5
43 0	.2686	20	.3673	37	53 0	.3982	23	.6616	64	7 2.1 1.4 0.7 6.6 5.9 5.2
10	.2706	20	.3710	37	10	.4005	23	.6681	65	8 2.4 1.6 0.8 7.6 6.8 6.0
20	.2726	20	.3748	38	20	.4028	23	.6746	65	9 2.7 1.8 0.9 8.5 7.6 6.7
30	.2746	20	.3786	38	30	.4052	23	.6811	66	
40	.2766	20	.3824	38	40	.4075	23	.6878	66	6 5 4 3 2 1
50	.2786	20	.3863	39	50	.4098	23	.6945	67	1 0.6 0.5 0.4 0.3 0.2 0.1
44 0	.2806	20	.3901	38	54 0	.4122	24	.7013	68	2 1.2 1.0 0.8 0.6 0.4 0.2
10	.2827	21	.3941	40	10	.4145	23	.7081	69	3 1.8 1.5 1.2 0.9 0.6 0.3
20	.2847	20	.3980	39	20	.4169	24	.7150	69	4 2.4 2.0 1.6 1.2 0.8 0.4
30	.2867	20	.4020	40	30	.4193	24	.7220	70	5 3.0 2.5 2.0 1.5 1.0 0.5
40	.2888	20	.4060	40	40	.4216	23	.7291	70	6 3.6 3.0 2.4 1.8 1.2 0.6
50	.2908	20	.4101	41	50	.4240	24	.7362	71	7 4.2 3.5 2.8 2.1 1.4 0.7
45 0	.2929	20	.4142	41	55 0	.4264	24	.7434	72	8 4.8 4.0 3.2 2.4 1.6 0.8
10	.2949	20	.4183	41	10	.4288	24	.7507	73	9 5.4 4.5 3.6 2.7 1.8 0.9
20	.2970	21	.4225	42	20	.4312	24	.7581	73	
30	.2991	20	.4267	42	30	.4336	24	.7655	74	25 25 24 24 23
40	.3011	21	.4309	43	40	.4360	24	.7730	75	1 2.5 2.5 2.4 2.4 2.3
50	.3032	21	.4352	43	50	.4384	24	.7806	76	2 5.1 5.0 4.9 4.8 4.7
46 0	.3053	21	.4395	43	56 0	.4408	24	.7883	77	3 7.6 7.5 7.3 7.2 7.0
10	.3074	21	.4439	44	10	.4432	24	.7960	78	4 10.2 10.0 9.8 9.6 9.4
20	.3095	21	.4483	44	20	.4456	24	.8039	78	5 12.7 12.5 12.2 12.0 11.7
30	.3116	21	.4527	44	30	.4480	24	.8118	79	6 15.3 15.0 14.7 14.4 14.1
40	.3137	21	.4572	45	40	.4505	24	.8198	80	7 17.8 17.5 17.1 16.8 16.4
50	.3159	21	.4617	45	50	.4529	24	.8279	81	8 20.4 20.0 19.6 19.2 18.8
47 0	.3180	21	.4663	45	57 0	.4553	24	.8361	82	9 22.9 22.5 22.0 21.6 21.1
10	.3201	21	.4708	45	10	.4578	25	.8443	82	
20	.3222	21	.4755	47	20	.4602	24	.8527	83	23 22 22 21 21
30	.3244	21	.4802	47	30	.4627	24	.8611	84	1 2.3 2.2 2.2 2.1 2.1
40	.3265	21	.4849	47	40	.4651	24	.8697	85	2 4.6 4.5 4.4 4.3 4.2
50	.3287	21	.4896	48	50	.4676	25	.8783	86	3 6.9 6.7 6.6 6.4 6.3
48 0	.3308	22	.4945	48	58 0	.4701	24	.8871	87	4 9.2 9.0 8.8 8.6 8.4
10	.3330	21	.4993	48	10	.4725	24	.8959	88	5 11.5 11.2 11.0 10.7 10.5
20	.3352	22	.5042	49	20	.4750	25	.9048	88	6 13.8 13.5 13.2 12.9 12.6
30	.3374	21	.5091	50	30	.4775	25	.9139	89	7 16.1 15.7 15.4 15.0 14.7
40	.3395	22	.5141	50	40	.4800	25	.9230	90	8 18.4 18.0 17.6 17.2 16.8
50	.3417	22	.5192	50	50	.4824	24	.9322	90	9 20.7 20.2 19.8 19.3 18.9
49 0	.3439	22	.5242	51	59 0	.4849	25	.9416	91	
10	.3461	22	.5294	51	10	.4874	25	.9510	91	20 20 19 19 18
20	.3483	22	.5345	52	20	.4899	25	.9606	92	1 2.0 2.0 1.9 1.9 1.8
30	.3505	22	.5397	53	30	.4924	25	.9703	93	2 4.1 4.0 3.9 3.8 3.7
40	.3527	22	.5450	53	40	.4949	25	.9801	94	3 6.1 6.0 5.8 5.7 5.5
50	.3550	22	.5503	53	50	.4975	25	.9900	94	4 8.2 8.0 7.8 7.6 7.4
50 0	.3572	22	.5557	53	60 0	.5000	25	1.0000	95	5 10.2 10.0 9.7 9.5 9.2
° ′	Vers.	d.	Exsec.	d.	° ′	Vers.	d.	Exsec.	d.	6 12.3 12.0 11.7 11.4 11.1
										7 14.3 14.0 13.6 13.3 12.9
										8 16.4 16.0 15.6 15.2 14.8
										9 18.4 18.0 17.5 17.1 16.6
										P. P.

TABLE XVIII.—**Natural versed sines and external secants**—*Continued.*

60°–70°					70°–80°					
° ′	Vers.	d.	Exsec.	d.	° ′	Vers.	d.	Exsec.	d.	P. P.
60 0	.5000	25	1·0000	101	70 0	.6580	27	1·9238	235	9 8 7 6 5
10	.5025	25	1·0101	102	10	.6607	27	1·9473	240	1 0·9 0·8 0·7 0·6 0·5
20	.5050	25	1·0204	103	20	.6634	27	1·9713	244	2 1·8 1·6 1·4 1·2 1·0
30	.5076	25	1·0307	105	30	.6662	27	1·9957	248	3 2·7 2·4 2·1 1·8 1·5
40	.5101	25	1·0413	106	40	.6689	27	2·0205	253	4 3·6 3·2 2·8 2·4 2·0
50	.5126	25	1·0519	107	50	.6717	27	2·0458	257	5 4·5 4·0 3·5 3·0 2·5
61 0	.5152	25	1·0626	109	71 0	.6744	27	2·0715	262	6 5·4 4·8 4·2 3·6 3·0
10	.5177	25	1·0735	110	10	.6772	27	2·0977	266	7 6·3 5·6 4·9 4·2 3·5
20	.5203	25	1·0846	111	20	.6799	27	2·1244	271	8 7·2 6·4 5·6 4·8 4·0
30	.5228	25	1·0957	113	30	.6827	27	2·1515	276	9 8·1 7·2 6·3 5·4 4·5
40	.5254	26	1·1070	114	40	.6854	27	2·1792	281	
50	.5279	26	1·1184	116	50	.6882	28	2·2073	287	4 3 2 1 0
62 0	.5305	25	1·1300	117	72 0	.6910	27	2·2360	292	1 0·4 0·3 0·2 0·1 0·0
10	.5331	25	1·1418	118	10	.6937	27	2·2653	298	2 0·8 0·6 0·4 0·2 1·9
20	.5356	26	1·1536	120	20	.6965	28	2·2951	304	3 1·2 0·9 0·6 0·3 2·8
30	.5382	26	1·1657	121	30	.6993	27	2·3255	310	4 1·6 1·2 0·8 0·4 3·8
40	.5408	26	1·1778	123	40	.7020	28	2·3565	316	5 2·0 1·5 1·0 0·5 4·7
50	.5434	26	1·1902	125	50	.7048	28	2·3881	322	6 2·4 1·8 1·2 0·6 5·7
63 0	.5460	26	1·2027	126	73 0	.7076	27	2·4203	328	7 2·8 2·1 1·4 0·7 6·6
10	.5486	26	1·2153	128	10	.7104	28	2·4531	335	8 3·2 2·4 1·6 0·8 7·6
20	.5512	26	1·2281	130	20	.7132	28	2·4867	342	9 3·6 2·7 1·8 0·9 8·5
30	.5538	26	1·2411	131	30	.7160	27	2·5209	349	
40	.5564	26	1·2543	133	40	.7187	28	2·5558	356	8 7 6 5 4
50	.5590	26	1·2676	135	50	.7215	28	2·5915	364	1 0·8 0·7 0·6 0·5 0·4
64 0	.5616	26	1·2811	137	74 0	.7243	28	2·6279	372	2 1·7 1·5 1·3 1·1 0·9
10	.5642	26	1·2948	138	10	.7271	28	2·6651	380	3 2·5 2·2 1·9 1·6 1·3
20	.5668	26	1·3087	140	20	.7299	28	2·7031	388	4 3·4 3·0 2·6 2·2 1·8
30	.5695	26	1·3228	142	30	.7327	28	2·7420	396	5 4·2 3·7 3·2 2·7 2·2
40	.5721	26	1·3371	143	40	.7355	28	2·7818	406	6 5·1 4·5 3·9 3·3 2·7
50	.5747	26	1·3515	145	50	.7383	28	2·8225	414	7 5·9 5·2 4·5 3·8 3·1
65 0	.5774	26	1·3662	146	75 0	.7412	28	2·8637	424	8 6·8 6·0 5·2 4·4 3·6
10	.5800	26	1·3810	148	10	.7440	28	2·9061	434	9 7·6 6·7 5·8 4·9 4·0
20	.5826	26	1·3961	151	20	.7468	28	2·9495	444	
30	.5853	26	1·4114	152	30	.7496	28	2·9939	454	3 2 1
40	.5879	26	1·4269	154	40	.7524	28	3·0894	465	1 0·3 0·2 0·1
50	.5906	26	1·4426	157	50	.7552	28	3·0859	476	2 0·7 0·5 0·3
66 0	.5932	26	1·4586	159	76 0	.7581	28	3·1335	488	3 1·0 0·7 0·4
10	.5959	27	1·4747	161	10	.7609	28	3·1824	500	4 1·4 1·0 0·6
20	.5986	26	1·4912	164	20	.7637	28	3·2324	512	5 1·7 1·2 0·7
30	.6012	26	1·5078	166	30	.7665	28	3·2836	525	6 2·1 1·5 0·9
40	.6039	27	1·5247	169	40	.7694	28	3·3362	539	7 2·4 1·7 1·0
50	.6066	27	1·5419	171	50	.7722	28	3·3901	553	8 2·8 2·0 1·2
67 0	.6092	27	1·5593	174	77 0	.7750	28	3·4454	567	9 3·1 2·2 1·3
10	.6119	27	1·5770	177	10	.7779	28	3·5021	582	29 28 27
20	.6146	27	1·5949	179	20	.7807	28	3·5604	598	1 2·9 2·8 2·8 2·7
30	.6173	27	1·6131	182	30	.7835	28	3·6202	614	2 5·8 5·7 5·6 5·5
40	.6200	27	1·6316	184	40	.7864	28	3·6816	631	3 8·7 8·5 8·4 8·2
50	.6227	27	1·6504	188	50	.7892	28	3·7448	649	4 11·6 11·4 11·2 11·0
68 0	.6254	27	1·6694	190	78 0	.7921	28	3·8097	667	5 14·5 14·2 14·0 13·7
10	.6281	27	1·6888	194	10	.7949	28	3·8765	686	6 17·4 17·1 16·8 16·5
20	.6308	27	1·7085	196	20	.7978	28	3·9451	707	7 20·3 19·9 19·6 19·2
30	.6335	27	1·7285	200	30	.8006	28	4·0158	728	8 23·2 22·8 22·4 22·0
40	.6362	27	1·7488	202	40	.8035	28	4·0886	748	9 26·1 25·6 25·2 24·7
50	.6389	27	1·7694	206	50	.8063	28	4·1636	772	
69 0	.6416	27	1·7904	210	79 0	.8092	28	4·2408	796	27 26 26 25
10	.6443	27	1·8117	213	10	.8120	28	4·3205	821	1 2·7 2·6 2·6 2·5
20	.6470	27	1·8334	215	20	.8149	28	4·4026	847	2 5·4 5·3 5·2 5·1
30	.6498	27	1·8554	220	30	.8177	28	4·4874	875	3 8·1 7·9 7·8 7·6
40	.6525	27	1·8778	224	40	.8206	29	4·5749	904	4 10·8 10·6 10·4 10·2
50	.6552	27	1·9006	228	50	.8235	28	4·6653	934	5 13·5 13·2 13·0 12·7
70 0	.6580	27	1·9238	231	80 0	.8263	28	4·7587		6 16·2 15·9 15·6 15·3
° ′	Vers.	d.	Exsec.	d.	° ′	Vers.	d.	Exsec.	d.	7 18·9 18·5 18·2 17·8
										8 21·6 21·2 20·8 20·4
										9 24·3 23·8 23·4 22·9
										P. P.

TABLE XVIII.—**Natural versed sines and external secants**—*Continued.*

80°–85d					85°–90°					
° ′	Vers.	d.	Exsec.	d.	° ′	Vers.	d.	Exsec.	d.	P. P.
80 0	·8263	28	4·7587	966	85 0	·9128	29	10·4737	·3946	
10	·8292	29	4·8554	999	10	·9157	29	10·8683	·4229	
20	·8321	28	4·9553	1035	20	·9186	29	11·2912	·4542	
30	·8349	28	5·0588	1072	30	·9215	29	11·7455	·4892	
40	·8378	29	5·1660	1111	40	·9244	29	12·2347	·5284	29 29
50	·8407	28	5·2772	1152	50	·9273	29	12·7631	·5725	1 2·9 2·9
81 0	·8435	29	5·3924	1196	86 0	·9302	29	13·3356	·6223	2 5·9 5·8
10	·8464	28	5·5121	1242	10	·9331	29	13·9579	·6789	3 8·8 8·7
20	·8493	29	5·6363	1291	20	·9360	29	14·6368	·7436	4 11·8 11·6
30	·8522	28	5·7654	1343	30	·9389	29	15·3804	·8180	5 14·7 14·5
40	·8550	29	5·8998	1398	40	·9418	29	16·1984	·9041	6 17·7 17·4
50	·8579	29	6·0396	1456	50	·9447	29	17·1026	1·0047	7 20·6 20·3
82 0	·8608	28	6·1853	1519	87 0	·9476	29	18·1073	1·1230	8 23·6 23·2
10	·8637	29	6·3372	1585	10	·9505	29	19·2303	1·2684	9 26·5 26·1
20	·8666	28	6·4957	1656	20	·9534	29	20·4987	1·4319	
30	·8694	29	6·6613	1731	30	·9564	29	21·9256	1·6365	
40	·8723	29	6·8344	1812	40	·9593	29	23·5621	1·8884	
50	·8752	29	7·0156	1898	50	·9622	29	25·4505	2·2032	28
83 0	·8781	28	7·2055	1991	88 0	·9651	29	27·6537	2·6039	1 2·8
10	·8810	29	7·4046	2091	10	·9680	29	30·2576	3·1247	2 5·7
20	·8839	29	7·6138	2198	20	·9709	29	33·3823	3·8195	3 8·5
30	·8868	29	7·8336	2315	30	·9738	29	37·2018	4·7741	4 11·4
40	·8897	29	8·0651	2440	40	·9767	29	41·9759	6·1383	5 14·2
50	·8926	28	8·3091	2576	50	·9796	29	48·1140	8·1846	6 17·1
84 0	·8954	29	8·5667	2723	89 0	·9825	29	56·2987		7 19·9
10	·8983	29	8·8391	2884	10	·9854	29	67·7573		8 22·8
20	·9012	29	9·1275	3059	20	·9883	29	84·9456		9 25·6
30	·9041	29	9·4334	3250	30	·9912	29	113·5930		
40	·9070	29	9·7585	3460	40	·9942	29	170·8883		
50	·9099	29	10·1045	3691	50	·9971	29	342·7752		
85 0	·9128		10·4737		90 0	1·0000		∞		
° ′	Vers.	d.	Exsec.	d.	° ′	Vers.	d.	Exsec.	d.	P. P.

TABLE XIX.—**Elements of a circular curve of 1° curvature, 5,730 ft. radius.**

Δ	Tang., T.	Ext. dist., E.	Long chord, L. C.	Δ	Tang., T.	Ext. dist., E.	Long chord, L. C.
° ′				° ′			
1 00	50.00	0.218	100.00	9 00	450.93	17.717	899.09
10	58.34	0.297	116.67	10	459.32	18.381	915.70
20	66.67	0.388	133.33	20	467.71	19.058	932.31
30	75.01	0.491	150.00	30	476.10	19.746	948.92
40	83.34	0.606	166.66	40	484.49	20.447	965.53
50	91.68	0.733	183.33	50	492.88	21.161	982.14
2 00	100.01	0.873	199.99	10 00	501.28	21.886	998.74
10	108.35	1.024	216.66	10	509.68	22.624	1015.35
20	116.68	1.188	233.32	20	518.08	23.375	1031.95
30	125.02	1.364	249.98	30	526.48	24.138	1048.54
40	133.36	1.552	266.65	40	534.89	24.913	1065.14
50	141.70	1.752	283.31	50	543.29	25.700	1081.73
3 00	150.04	1.964	299.97	11 00	551.70	26.500	1098.3
10	158.38	2.188	316.63	10	560.11	27.313	1114.9
20	166.72	2.425	333.29	20	568.53	28.137	1131.5
30	175.06	2.674	349.95	30	576.95	28.974	1148.1
40	183.40	2.934	366.61	40	585.36	29.824	1164.7
50	191.74	3.207	383.27	50	593.79	30.686	1181.2
4 00	200.08	3.492	399.92	12 00	602.21	31.561	1197.8
10	208.43	3.790	416.58	10	610.64	32.447	1214.4
20	216.77	4.099	433.24	20	619.07	33.347	1231.0
30	225.12	4.421	449.89	30	627.50	34.259	1247.5
40	233.47	4.755	466.54	40	635.93	35.183	1264.1
50	241.81	5.100	483.20	50	644.37	36.120	1280.7
5 00	250.16	5.459	499.85	13 00	652.81	37.069	1297.2
10	258.51	5.829	516.50	10	661.25	38.031	1313.8
20	266.86	6.211	533.15	20	669.70	39.006	1330.3
30	275.21	6.606	549.80	30	678.15	39.993	1346.9
40	283.57	7.013	566.44	40	686.60	40.992	1363.4
50	291.92	7.432	583.09	50	695.06	42.004	1380.0
6 00	300.28	7.863	599.73	14 00	703.51	43.029	1396.5
10	308.64	8.307	616.38	10	711.97	44.066	1413.1
20	316.99	8.762	633.02	20	720.44	45.116	1429.6
30	325.35	9.230	649.66	30	728.90	46.178	1446.2
40	333.71	9.710	666.30	40	737.37	47.253	1462.7
50	342.08	10.202	682.94	50	745.85	48.341	1479.2
7 00	350.44	10.707	699.57	15 00	754.32	49.441	1495.7
10	358.81	11.224	716.21	10	762.80	50.554	1512.3
20	367.17	11.753	732.84	20	771.29	51.679	1528.8
30	375.54	12.294	749.47	30	779.77	52.818	1545.3
40	383.91	12.847	766.10	40	788.26	53.969	1561.8
50	392.28	13.413	782.73	50	796.75	55.132	1578.3
8 00	400.66	13.991	799.36	16 00	805.25	56.309	1594.8
10	409.03	14.582	815.99	10	813.75	57.498	1611.3
20	417.41	15.184	832.61	20	822.25	58.699	1627.8
30	425.79	15.799	849.23	30	830.76	59.914	1644.3
40	434.17	16.426	865.85	40	839.27	61.141	1660.8
50	442.55	17.066	882.47	50	847.78	62.381	1677.3

TABLE XIX.—Elements of a circular curve of 1° curvature, 5,730 ft. radius—*Continued.*

Δ	Tang., T.	Ext. dist., E.	Long chord, L. C.	Δ	Tang., T.	Ext. dist., E.	Long chord, L. C.
° ′				° ′			
17 00	856.30	63.634	1693.8	25 00	1270.2	139.11	2480.2
10	864.82	64.900	1710.3	10	1279.0	141.01	2496.5
20	873.35	66.178	1726.8	20	1287.7	142.93	2512.8
30	881.88	67.470	1743.2	30	1296.5	144.85	2529.0
40	890.41	68.774	1759.7	40	1305.3	146.79	2545.3
50	898.95	70.091	1776.2	50	1314.0	148.75	2561.5
18 00	907.49	71.421	1792.6	26 00	1322.8	150.71	2577.8
10	916.03	72.764	1809.1	10	1331.6	152.69	2594.0
20	924.58	74.119	1825.5	20	1340.4	154.69	2610.3
30	933.13	75.488	1842.0	30	1349.2	156.70	2626.5
40	941.69	76.869	1858.4	40	1358.0	158.72	2642.7
50	950.25	78.261	1874.9	50	1366.8	160.76	2658.9
19 00	958.81	79.671	1891.3	27 00	1375.6	162.81	2675.1
10	967.38	81.092	1907.8	10	1384.4	164.87	2691.3
20	975.96	82.525	1924.2	20	1393,2	166.95	2707.5
30	984.53	83.972	1940.6	30	1402.0	169.04	2723.7
40	993.12	85.431	1957.1	40	1410.9	171.15	2739.9
50	1001.70	86.904	1973.5	50	1419.7	173.27	2756.1
20 00	1010.29	88.389	1989.9	28 00	1428.6	175.41	2772.3
10	1018.89	89.888	2006.3	10	1437.4	177.55	2788.4
20	1027.49	91.399	2022.7	20	1446.3	179.72	2804.6
30	1036.09	92.924	2039.1	30	1455.I	181.89	2820.7
40	1044.70	94.462	2055.5	40	1464.0	184.08	2836.9
50	1053.31	96.013	2071.9	50	1472.9	186.29	2853.0
21 00	1061.9	97.58	2088.3	29 00	1481.8	188.51	2869.2
10	1070.6	99.15	2104.7	10	1490.7	190.74	2885.3
20	1079.2	100.75	2121.1	20	1499.6	192.99	2901.4
30	1087.8	102.35	2137.4	30	1508.5	195.25	2917.6
40	1096.4	103.97	2153.8	40	1517.4	197.53	2933.7
50	1105.1	105.60	2170.2	50	1526.3	199.82	2949.8
22 00	1113.7	107.24	2186.5	30 00	1535.3	202.12	2965.9
10	1122.4	108.90	2202.9	10	1544.2	204.44	2982.0
20	1131.0	110.57	2219.2	20	1553.1	206.77	2998.1
30	1139.7	112.25	2235.6	30	1562.1	209.12	3014.2
40	1148.4	113.95	2251.9	40	1571.0	211.48	3030.2
50	1157.0	115.66	2268.3	50	1580.0	213.86	3046.3
23 00	1165.7	117.38	2284.6	31 00	1589.0	216.25	3062.4
10	1174.4	119.12	2301.0	10	1598.0	218.66	3078.4
20	1183.1	120.87	2317.3	20	1606.9	221.08	3094.5
30	1191.8	122.63	2333.6	30	1615.9	223.51	3110.5
40	1200.5	124.41	2349.9	40	1624.9	225.96	3126.6
50	1209.2	126.20	2366.2	50	1633.9	228.42	3142.6
24 00	1217.9	128.00	2382.5	32 00	1643.0	230.90	3158.6
10	1226.6	129.82	2398.8	10	1652.0	233.39	3174.6
20	1235.3	131.65	2415.1	20	1661.0	235.90	3190.6
30	1244.0	133.50	2431.4	30	1670.0	238.43	3206.6
40	1252.8	135.36	2447.7	40	1679.1	240.96	3222.6
50	1261.5	137.23	2464.0	50	1688.1	243.52	3238.6

TABLE XIX.—**Elements of a circular curve** of 1° curvature, 5,730 ft. radius—*Continued.*

∠	Tang., T.	Ext. dist., E.	Long chord, L. C.	∠	Tang., T.	Ext. dist., E.	Long chord, L. C.
° ′				° ′			
33 00	1697.2	246.08	3254.6	41 00	2142.2	387.38	4013.1
10	1706.3	248.66	3270.6	10	2151.7	390.71	4028.7
20	1715.3	251.26	3286.6	20	2161.2	394.06	4044.3
30	1724.4	253.87	3302.5	30	2170.8	397.43	4059.9
40	1733.5	256.50	3318.5	40	2180.3	400.82	4075.5
50	1742.6	259.14	3334.4	50	2189.9	404.22	4091.1
34 00	1751.7	261.80	3350.4	42 00	2199.4	407.64	4106.6
10	1760.8	264.47	3366.3	10	2209.0	411.07	4122.2
20	1770.0	267.16	3382.2	20	2218.6	414.52	4137.7
30	1779.1	269.86	3398.2	30	2228.1	417.99	4153.3
40	1788.2	272.58	3414.1	40	2237.7	421.48	4168.8
50	1797.4	275.31	3430.0	50	2247.3	424.98	4184.3
35 00	1806.6	278.05	3445.9	43 00	2257.0	428.50	4199.8
10	1815.7	280.82	3461.8	10	2266.6	432.04	4215.3
20	1824.9	283.60	3477.7	20	2276.2	435.59	4230.8
30	1834.1	286.39	3493.5	30	2285.9	439.16	4246.3
40	1843.3	289.20	3509.4	40	2295.6	442.75	4261.8
50	1852.5	292.02	3525.3	50	2305.2	446.35	4277.3
36 00	1861.7	294.86	3541.1	44 00	2314.9	449.98	4292.7
10	1870.9	297.72	3557.0	10	2324.6	453.62	4308.2
20	1880.1	300.59	3572.8	20	2334.3	457.27	4323.6
30	1889.4	303.47	3588.6	30	2344.1	460.95	4339.0
40	1898.6	306.37	3604.5	40	2353.8	464.64	4354.5
50	1907.9	309.29	3620.3	50	2363.5	468.35	4369.9
37 00	1917.1	312.22	3636.1	45 00	2373.3	472.08	4385.3
10	1926.4	315.17	3651.9	10	2383.1	475.82	4400.7
20	1935.7	318.13	3667.7	20	2392.8	479.59	4416.1
30	1945.0	321.11	3683.5	30	2402.6	483.37	4431.4
40	1954.3	324.11	3699.3	40	2412.4	487.16	4446.8
50	1963.6	327.12	3715.0	50	2422.3	490.98	4462.2
38 00	1972.9	330.15	3730.8	46 00	2432.1	494.82	4477.5
10	1982.2	333.19	3746.5	10	2441.9	498.67	4492.8
20	1991.5	336.25	3762.3	20	2451.8	502.54	4508.2
30	2000.9	339.32	3778.0	30	2461.7	506.42	4523.5
40	2010.2	342.41	3793.8	40	2471.5	510.33	4538.8
50	2019.6	345.52	3809.5	50	2481.4	514.25	4554.1
39 00	2029.0	348.64	3825.2	47 00	2491.3	518.20	4569.4
10	2038.4	351.78	3840.9	10	2501.2	522.16	4584.7
20	2047.8	354.94	3856.6	20	2511.2	526.13	4599.9
30	2057.2	358.11	3872.3	30	2521.1	530.13	4615.2
40	2066.6	361.29	3888.0	40	2531.1	534.15	4630 4
50	2076.0	364.50	3903.6	50	2541.0	538.18	4645.7
40 00	2085.4	367.72	3919.3	48 00	2551.0	542.23	4660.9
10	2094.9	370.95	3935.0	10	2561.0	546.30	4676.1
20	2104.3	374.20	3950.6	20	2571.0	550.39	4691.3
30	2113.8	377.47	3966.3	30	2581.0	554.50	4706.5
40	2123.3	380.76	3981.9	40	2591.1	558.63	4721.7
50	2132.7	384.06	3997.5	50	2601.1	562.77	4736.9

TABLE XIX.—**Elements of a circular curve** of 1° curvature, 5,730 ft. radius—*Continued.*

Δ	Tang., T.	Ext. dist., E.	Long chord, L. C.	Δ	Tang., T.	Ext. dist., E.	Long chord, L. C.
° ′				° ′			
49 00	2611.2	566.94	4752.1	57 00	3110.9	790.08	5467.9
10	2621.2	571.12	4767.3	10	3121.7	795.24	5482,5
20	2631.3	575.32	4782.4	20	3132.6	800.42	5497.2
30	2641.4	579.54	4797.5	30	3143.4	805.62	5511.8
40	2651.5	583.78	4812.7	40	3154.2	810.85	5526.4
50	2661.6	588.04	4827.8	50	3165.1	816.10	5541.0
50 00	2671.8	592.32	4842.9	58 00	3176.0	821.37	5555.6
10	2681.9	596.62	4858.0	10	3186.9	826.66	5570.2
20	2692.1	600.93	4873.1	20	3197.8	831.98	5584.7
30	2702.3	605.27	4888.2	30	3208.8	837.31	5599.3
40	2712.5	609.62	4903.2	40	3219.7	842.67	5613.8
50	2722.7	614.00	4918.3	50	3230.7	848.06	5628.3
51 00	2732.9	618.39	4933.4	59 00	3241.7	853.46	5642.8
10	2743.1	622.81	4948.4	10	3252.7	858.89	5657.3
20	2753.4	627.24	4963.4	20	3263.7	864.34	5671.8
30	2763.7	631.69	4978.4	30	3274.8	869.82	5686.3
40	2773.9	636.16	4993.4	40	3285.8	875.32	5700.8
50	2784.2	640.66	5008.4	50	3296.9	880.84	5715 2
52 00	2794.5	645.17	5023.4	60 00	3308.0	886.38	5729.7
10	2804.9	649.70	5038.4	10	3319.1	891.95	5744.1
20	2815.2	654.25	5053.4	20	3330.3	897.54	5758.5
30	2825.6	658.83	5068.3	30	3341.4	903.15	5772.9
40	2835.9	663.42	5083.3	40	3352.6	908.79	5787.3
50	2846.3	668.03	5098.2	50	3363.8	914.45	5801.7
53 00	2856.7	672.66	5113.1	61 00	3375.0	920.14	5816.0
10	2867.1	677.32	5128.0	10	3386.3	925.85	5830.4
20	2877.5	681.99	5142.9	20	3397.5	931.58	5844.7
30	2888.0	686.68	5157.8	30	3408.8	937.34	5859.1
40	2898.4	691.40	5172.7	40	3420.1	943.12	5873.4
50	2908.9	696.13	5187.6	50	3431.4	948.92	5887.7
54 00	2919.4	700.89	5202.4	62 00	3442.7	954.75	5902.0
10	2929.9	705.66	5217.3	10	3454.1	960.60	5916.3
20	2940.4	710.46	5232.1	20	3465.4	966.48	5930.5
30	2951.0	715.28	5246.9	30	3476.8	972.39	5944.8
40	2961.5	720.11	5261.7	40	3488.2	978.31	5959.0
50	2972.1	724.97	5276.5	50	3499.7	984.27	5973.3
55 00	2982.7	729.85	5291.8	63 00	3511.1	990.24	5987.5
10	2993.3	734 76	5306.1	10	3522.6	996.24	6001.7
20	3003.9	739.68	5320.9	20	3534.1	1002.3	6015.9
30	3014.5	744.62	5335.6	30	3545.6	1008.3	6030.0
40	3025.2	749.59	5350.4	40	3557.2	1014.4	6044.2
50	3035.8	754.57	5365.1	50	3568.7	1020.5	6058.4
56 00	3046.5	759.58	5379.8	64 00	3580.3	1026.6	6072.5
10	3057.2	764.61	5394.5	10	3591.9	1032.8	6086.6
20	3067.9	769.66	5409.2	20	3603.5	1039.0	6100.7
30	3078.7	774.73	5423.9	30	3615.1	1045.2	6114.8
40	3089.4	779.83	5438.6	40	3626.8	1051.4	6128.9
50	3100.2	784.94	5453.3	50	3638.5	1057.7	6143.0

TABLE XIX.—Elements of a circular curve of 1° curvature, 5,730 ft. radius—*Continued.*

Δ	Tang., T.	Ext. dist., E.	Long chord, L. C.	Δ	Tang., T.	Ext. dist., E.	Long chord, L. C.
° ′				° ′			
65 00	3650.2	1063.9	6157.1	73 00	4239.7	1398.0	6816.3
10	3661.9	1070.2	6171.1	10	4252.6	1405.7	6829.6
20	3673.7	1076.6	6185.2	20	4265.6	1413.5	6843.0
30	3685.4	1082.9	6199.2	30	4278.5	1421.2	6856.4
40	3697.2	1089.3	6213.2	40	4291.5	1429.0	6869.7
50	3709.0	1095.7	6227.2	50	4304.6	1436.8	6883.1
66 00	3720.9	1102.2	6241.2	74 00	4317.6	1444.6	6896.4
10	3732.7	1108.6	6255.2	10	4330.7	1452.5	6909.7
20	3744.6	1115.1	6269.1	20	4343.8	1460.4	6923.0
30	3756.5	1121.7	6283.1	30	4356.9	1468.4	6936.2
40	3768.5	1128.2	6297.0	40	4370.1	1476.4	6949.5
50	3780.4	1134.8	6310.9	50	4383.3	1484.4	6962.8
67 00	3792.4	1141.4	6324.8	75 00	4396.5	1492.4	6976.0
10	3804.4	1148.0	6338.7	10	4409.8	1500.5	6989.2
20	3816.4	1154.7	6352.6	20	4423.1	1508.6	7002.4
30	3828.4	1161.3	6366.4	30	4436.4	1516.7	7015.6
40	3840.5	1168.1	6380.3	40	4449.7	1524.9	7028.8
50	3852.6	1174.8	6394.1	50	4463.1	1533.1	7041.9
68 00	3864.7	1181.6	6408.0	76 00	4476.5	1541.4	7055.0
10	3876.8	1188.4	6421.8	10	4489.9	1549.7	7068.2
20	3889.0	1195.2	6435.6	20	4503.4	1558.0	7081.3
30	3901.2	1202.0	6449.4	30	4 16.9	1566.3	7094.4
40	3913.4	1208.9	6463.1	40	4530.4	1574.7	7107.5
50	3925.6	1215.8	6476.9	50	4544.0	1583.1	7120.5
69 00	3937.9	1222.7	6490.6	77 00	4557.6	1591.6	7133.6
10	3950.2	1229.7	6504.4	10	4571.2	1600.1	7146.6
20	3962.5	1236.7	6518.1	20	4584.8	1608.6	7159.6
30	3974.8	1243.7	6531.8	30	4598.5	1617.1	7172.6
70	3987.2	1250.8	6545.5	40	461 .2	1625.7	7185.6
50	3999.5	1257.9	6559.1	50	4626.0	1634.4	7198.6
70 00	4011.9	1265.0	6572.8	78 00	4639.8	1643.0	7211.6
10	4024.4	1272.1	6586.4	10	4653.6	1651.7	7224.5
20	4036.8	1279.3	6600.1	20	4667.4	1660.5	7237.4
30	4049.3	1286.5	6613.7	30	4681.3	1669.2	7250.4
40	4061.8	1293.7	6627.3	40	4695.2	1678.1	7263.3
50	4074.4	1300.9	6640.9	50	4709.2	1686.9	7276.1
71 00	4086.9	1308.2	6654.4	79 00	4723.2	1695.8	7289.0
10	4099.5	1315.5	6668.0	10	4737.2	1704.7	7301.9
20	4112.1	1322.9	6681.6	20	4751.2	1713.7	7314.7
30	4124.8	1330.3	6695.1	30	4765.3	1722.7	7327.5
40	4137.4	1337.7	6708.6	40	4779.4	1731.7	7340.3
50	4150.1	1345.1	6722.1	50	4793.6	1740.8	7353.1
72 00	4162.8	1352.6	6735.6	80 00	4808.7	1749.9	7365.9
10	4175.6	1360.1	6749.1	10	4822.0	1759.0	7378.7
20	4188.4	1367.6	6762.5	20	4836.2	1768.2	7391.4
30	4201.2	1375.2	6776.0	30	4850.5	1777.4	7404.1
40	4214.0	1382.8	6789.4	40	4864.8	1786.7	7416.8
50	4226.8	1390.4	6802.8	50	4879.2	1796.0	7429.5

TABLE XIX.—Elements of a circular curve of 1° curvature, 5,730 ft. radius—*Concluded.*

Δ		Tang., T.	Ext. dist., E.	Long chord, L. C.	Δ		Tang., T.	Ext. dist., E.	Long chord, L. C.
°	′				°	′			
81	00	4893.6	1805.3	7442.2	86	00	5343.0	2104.7	7815.2
	10	4908.0	1814.7	7454.9		10	5358.6	2115.3	7827.4
	20	4922.5	1824.1	7467.5		20	5374.2	2126.0	7839.6
	30	4937.0	1833.6	7480.2		30	5389.9	2136.7	7851.7
	40	4951.5	1843.1	7492.8		40	5405.6	2147.5	7863.8
	50	4966.1	1852.6	7505.4		50	5421.4	2158.4	7876.0
82	00	4980.7	1862.2	7518.0	87	00	5437.2	2169.2	7888.1
	10	4995.4	1871.8	7530.5		10	5453.1	2180.2	7900.1
	20	5010.0	1881.5	7543.1		20	5469.0	2191.1	7912.2
	30	5024.8	1891.2	7555.6		30	5484.9	2202.2	7924.3
	40	5039.5	1900.9	7568.2		40	5500.9	2213.2	7936.3
	50	5054.3	1910.7	7580.7		50	5517.0	2224.3	7948.3
83	00	5069.2	1920.5	7593.2	88	00	5533.1	2235.5	7960.3
	10	5084.0	1930.4	7605.6		10	5549.2	2246.7	7972.3
	20	5099.0	1940.3	7618.1		20	5565.4	2258.0	7984.2
	30	5113.9	1950.3	7630.5		30	5581.6	2269.3	7996.2
	40	5128.9	1960.2	7643.0		40	5597.8	2280.6	8008.1
	50	5143.9	1970.3	7655.4		50	5614.2	2292.0	8020.0
84	00	5159.0	1980.4	7667.8	89	00	5630.5	2303.5	8031.9
	10	5174.1	1990.5	7680.1		10	5646.9	2315.0	8043.8
	20	5189.3	2000.6	7692.5		20	5663.4	2326.6	8055.7
	30	5204.4	2010.8	7704.9		30	5679.9	2338.2	8067.5
	40	5219.7	2021.1	7717.2		40	5696.4	2349.8	8079.3
	50	5234.9	2031.4	7729.5		50	5713.0	2361.5	8091.2
85	00	5250.3	2041.7	7741.8	90	00	5729.7	2373.3	8103.0
	10	5265.6	2052.1	7754.1		10	5746.3	2385.1	8114.7
	20	5281.0	2062.5	7766.3		20	5763.1	2397.0	8126.5
	30	5296.4	2073.0	7778.6		30	5779.9	2408.9	8138.2
	40	5311.9	2083.5	7790.8		40	5796.7	2420.9	8150.0
	50	5327.4	2094.1	7803.0		50	5813.6	2432.9	8161.7

Note.—If $\Delta \times D$ is less than 600, the error in **tang. dist.** of the above table is less than 0.4 ft. If $\Delta \times D$ is less than 400, the error in tang. dist. is less than 0.25 ft. If $\Delta \times D$ is less than 200, the error in tang. dist. is less than 0.1 ft.

TABLE XX.—Middle ordinates for curving rails (feet).

Radius (feet).	Length of rail chords.											
	32	30	28	26	24	22	20	18	16	14	12	10
5,730	0.022	0.020	0.017	0.015	0.013	0.011	0.009	0.007	0.006	0.004	0.003	0.002
2,865	.045	.039	.034	.030	.025	.021	.017	.014	.011	.009	.006	.004
1,910	.067	.059	.051	.044	.038	.032	.026	.021	.017	.013	.009	.007
1,432	.089	.079	.068	.059	.050	.042	.035	.028	.022	.017	.013	.009
1,146	.112	.098	.086	.074	.063	.053	.044	.035	.028	.021	.016	.011
955	.134	.118	.103	.088	.075	.063	.052	.042	.034	.026	.019	.013
819	.156	.137	.120	.103	.088	.074	.061	.049	.039	.030	.022	.015
716	.179	.157	.137	.118	.100	.084	.070	.057	.045	.034	.025	.017
637	.201	.177	.154	.133	.113	.095	.078	.064	.050	.038	.028	.020
573	.223	.196	.171	.147	.126	.105	.087	.071	.056	.043	.031	.022
521	.245	.216	.188	.162	.138	.116	.096	.078	.061	.047	.035	.024
477	.268	.235	.205	.177	.151	.127	.105	.085	.067	.051	.038	.026
409	.312	.274	.238	.206	.175	.147	.122	.099	.078	.060	.044	.030
357	.356	.313	.273	.235	.200	.168	.139	.113	.089	.068	.050	.035
318	.400	.352	.307	.264	.225	.189	.156	.127	.100	.077	.056	.039
286	.445	.391	.340	.293	.250	.210	.174	.141	.111	.085	.063	.043
225	.57	.50	.44	.38	.32	.27	.22	.18	.14	.11	.08	.05
200	.64	.56	.49	.42	.36	.30	.25	.20	.16	.12	.09	.06
175	.73	.64	.56	.49	.41	.35	.29	.24	.18	.13	.10	.08
150	.86	.75	.65	.56	.48	.40	.33	.27	.21	.16	.12	.09
125	1.03	.90	.79	.68	.58	.49	.40	.32	.26	.20	.15	.10
100	1.31	1.13	.98	.85	.73	.61	.51	.41	.33	.25	.18	.13
80	1.62	1.42	1.28	1.06	.91	.76	.63	.51	.41	.32	.23	.16
60	2.17	1.91	1.74	1.42	1.21	1.09	.84	.68	.54	.41	.30	.21
50	2.63	2.31	2.00	1.73	1.46	1.23	1.01	.82	.73	.49	.36	.25
30	4.62	4.02	3.47	2.96	2.51	2.09	1.72	1.38	1.09	.83	.61	.42

TABLE XXI.—Bill of **material** for **standard pile bridges.**

Details.	16-ft. span.																			
	For 1 span.	For 2 spans.	For 3 spans.	For 4 spans.	For 5 spans.	For 6 spans.	For 7 spans.	For 8 spans.	For 9 spans.	For 10 spans.	For 11 spans.	For 12 spans.	For 13 spans.	For 14 spans.	For 15 spans.	For 16 spans.	For 17 spans.	For 18 spans.	For 19 spans.	For 20 spans.	For each addl. span.
Piles:																					
End bents	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	----
Int. bents	---	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	5
Caps, white pine, 14 by 14 ins., 14 ft. long	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	1
Sway braces, white pine, 4 by 10 ins*	---	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	2
Stringers, Douglas fir, 8 by 16 ins.:																					
16 ft. long	6	---	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	----
32 ft. long	---	6	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	3
Ties, white pine, S 1 S, 8 by 8 ins., 10 ft. long	15	29	43	57	71	85	99	113	127	141	155	169	183	197	211	225	239	253	267	281	14
Guard rails, white pine, S 1 S, 4 by 10 ins., 16 ft. long	2	5	7	9	11	14	16	18	20	22	25	27	29	31	33	36	38	40	42	45	2
Stringer bolts (square heads and nuts), ¾ in. diameter, 3 ins. threaded, 35 ins. long	4	8	20	28	36	44	52	60	68	76	84	92	100	108	116	124	132	140	148	156	8
Floor bolts (square heads and nuts), ¾ in. diameter, 3 ins. threaded, 44½ ins. long	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	2
Sway-brace bolts (square heads and nuts), ¾ in. diameter, 3½ ins. threaded:																					
21 ins. long	---	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	10
25 ins. long	---	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	1
Packing spools	8	16	40	56	72	88	104	120	136	152	168	184	200	216	232	248	264	280	296	312	16
Standard cast slot washers for ¾-in. bolts	16	50	100	142	184	226	268	310	352	394	436	478	520	562	604	646	688	730	772	814	42

TABLE XXI.—Bill of **material for standard pile bridges**—*Continued.*

Details.	16-ft. span.																				
	For 1 span.	For 2 spans.	For 3 spans.	For 4 spans.	For 5 spans.	For 6 spans.	For 7 spans.	For 8 spans.	For 9 spans.	For 10 spans.	For 11 spans.	For 12 spans.	For 13 spans.	For 14 spans.	For 15 spans.	For 16 spans.	For 17 spans.	For 18 spans.	For 19 spans.	For 20 spans.	For each addl. span.
Driftbolts, ¾ in. diameter, 22 ins. long	8	13	18	23	28	33	38	43	48	53	58	63	68	73	78	83	88	93	98	103	5
Spikes:																					
⅝ in. by 14 ins. long	13	22	31	40	49	58	67	76	85	94	103	112	121	130	139	148	157	166	175	184	9
½ in. by 10 ins. long	28	56	84	112	140	168	196	224	252	280	308	336	364	392	420	448	476	504	532	560	28
BULKHEADS.																					
Furring strips, 2 by 4 ins., 3 ft. 4 ins. long (cut from four 10-ft. lengths)	12	Alike for all bridges.																			
Planks, 3 by 10 ins.:																					
14 ft. long	2																				
16 ft. long	6																				
Spikes, 10 ins. long (planks to bents)	48																				
Nails, 4½ ins. long (strips to bents)	24																				

*				
Height of bridge ft.	10 to 12	13 to 15	16 to 18	19 to 20
Length of brace ft.	16	18	20	22

TABLE XXII.—Grades and grade angles.

Ft. per station.	Ft. per mile.	Inclination.	Ft. per station.	Ft. per mile.	Inclination.	Ft. per station.	Ft. per mile.	Inclination.
		° ′ ″			° ′ ″			° ′ ″
0.02	1.056	0 00 41	0.52	27.456	0 17 53	1.02	53.856	0 35 04
.04	2.112	1 23	.54	28.512	18 34	1.04	54.912	35 45
.06	3.168	2 04	.56	29.568	19 15	1.06	55.968	36 26
.08	4.224	2 45	.58	30.624	19 56	1.08	57.024	37 08
.10	5.280	3 26	.60	31.680	20 38	1.10	58.080	37 49
.12	6.336	4 08	.62	32.736	21 19	1.12	59.136	38 30
.14	7.392	4 49	.64	33.792	22 00	1.14	60.192	39 11
.16	8.448	5 30	.66	34.848	22 41	1.16	61.248	39 53
.18	9.504	6 11	.68	35.904	23 23	1.18	62.304	40 34
.20	10.560	6 53	.70	36.960	24 04	1.20	63.360	41 15
.22	11.616	7 34	.72	38.016	24 45	1.22	64.416	41 56
.24	12.672	8 15	.74	39.072	25 26	1.24	65.472	42 38
.26	13.728	8 56	.76	40.128	26 08	1.26	66.528	43 19
.28	14.784	9 38	.78	41.184	26 49	1.28	67.584	44 00
.30	15.840	10 19	.80	42.240	27 30	1.30	68.640	44 41
.32	16.896	11 00	.82	43.296	28 11	1.32	69.696	45 23
.34	17.952	11 41	.84	44.352	28 53	1.34	70.752	46 04
.36	19.008	12 23	.86	45.408	29 34	1.36	71.808	46 45
.38	20.064	13 04	.88	46.464	30 15	1.38	72.864	47 26
.40	21.120	13 45	.90	47.520	30 57	1.40	73.920	48 08
.42	22.176	14 26	.92	48.576	31 38	1.42	74.976	48 49
.44	23.232	15 08	.94	49.632	32 19	1.44	76.032	49 30
.46	24.288	15 49	.96	50.688	33 00	1.46	77.088	50 11
.48	25.344	16 30	.98	51.744	33 41	1.48	78.144	50 52
.50	26.400	17 11	1.00	52.800	34 23	1.50	79.200	51 34
1.52	80.256	52 15	2.10	110.880	1 12 11	5.20	274.560	2 58 36
1.54	81.312	52 56	2.20	116.160	1 15 37	5.40	285.120	3 05 27
1.56	82.368	53 37	2.30	121.440	1 19 03	5.60	295.680	3 12 19
1.58	83.424	54 19	2.40	126.720	1 22 29	5.80	306.240	3 19 10
1.60	84.480	55 00	2.50	132.000	1 25 56	6.00	316.800	3 26 01
1.62	85.536	55 41	2.60	137.280	1 29 22	6.20	327.360	3 32 52
1.64	86.592	56 22	2.70	142.560	1 32 48	6.40	337.920	3 39 43
1.66	87.648	57 04	2.80	147.840	1 36 14	6.60	348.480	3 46 34
1.68	88.704	57 45	2.90	153.120	1 39 40	6.80	359.040	3 53 24
1.70	89.760	58 26	3.00	158.400	1 43 06	7.00	369.600	4 00 15
1.72	90.816	59 07	3.10	163.680	1 46 32	7.20	380.160	4 07 06
1.74	91.872	59 49	3.20	168.960	1 49 58	7.40	390.720	4 13 56
1.76	92.928	1 00 30	3.30	174.240	1 53 24	7.60	401.280	4 20 46
1.78	93.984	1 01 11	3.40	179.520	1 56 50	7.80	411.840	4 27 36
1.80	95.040	1 01 52	3.50	184.800	2 00 16	8.00	422.400	4 34 26
1.82	96.096	1 02 34	3.60	190.080	2 03 42	8.20	432.960	4 41 16
1.84	97.152	1 03 15	3.70	195.360	2 07 08	8.40	443.520	4 48 06
1.86	98.208	1 03 56	3.80	200.640	2 10 34	8.60	454.080	4 54 55
1.88	99.264	1 04 37	3.90	205.920	2 14 00	8.80	464.640	5 01 44
1.90	100.320	1 05 19	4.00	211.200	2 17 26	9.00	475.200	5 08 34
1.92	101.376	1 06 00	4.20	221.760	2 24 18	9.20	485.760	5 15 23
1.94	102.432	1 06 41	4.40	232.320	2 31 10	9.40	496.320	5 22 12
1.96	103.488	1 07 22	4.60	242.880	2 38 01	9.60	506.880	5 29 01
1.98	104.544	1 08 04	4.80	253.440	2 44 53	9.80	517.440	5 35 50
2.00	105.600	1 08 45	5.00	264.000	2 51 45	10.00	528.000	5 42 38

TABLE XXIII.—Inches in decimals of a foot.

1/16	3/32	1/8	3/16	1/4	5/16	3/8	1/2	5/8	3/4	7/8
.0052	.0078	.0104	.0156	.0208	.0260	.0313	.0417	.0521	.0625	.0729
1	2	3	4	5	6	7	8	9	10	11
.0833	.1667	.2500	.3333	.4167	.5000	.5833	.6667	.7500	.8333	.9167

TABLE XXIV.—Radii and deflections.

Deg. of curve.	Radius.	Tan. Def. 100 ft.	Chd. Def. 100 ft.	Def. for 1 ft.	Deg. of curve.	Radius.	Tan Def. 100 ft.	Chd. Def. 100 ft.	Def. for 1 ft.
° ′	*Ft.*	*Ft.*	*Ft.*	*Minutes.*	° ′	*Ft.*	*Ft.*	*Ft.*	*Minutes.*
0 10	34377	.145	.291	0.05	7	819.0	6.105	12.21	2.10
20	17189	.291	.582	0.10	20	781.8	6.395	12.79	2.20
30	11459	.436	.873	0.15	30	764.5	6.540	13.08	2.25
40	8594.4	.582	1.164	0.20	40	747.9	6.685	13.37	2.30
50	6875.5	.727	1.454	0.25	8	716.8	6.976	13.95	2.40
1	5729.6	.873	1.745	0.30	20	688.2	7.266	14.53	2.50
10	4911.2	1.018	2.036	0.35	30	674.7	7.411	14.82	2.55
20	4297.3	1.164	2.327	0.40	40	661.7	7.556	15.11	2.60
30	3819.8	1.309	2.618	0.45	9	637.3	7.846	15.69	2.70
40	3437.9	1.454	2.909	0.50	20	614.6	8.136	16.27	2.80
50	3125.4	1.600	3.200	0.55	30	603.8	8.281	16.56	2.85
2	2864.9	1.745	3.490	0.60	40	593.4	8.426	16.85	2.90
10	2644.6	1.891	3.781	0.65	10	573.7	8.716	17.43	3.00
20	2455.7	2.036	4.072	0.70	30	546.4	9.150	18.30	3.15
30	2292.0	2.181	4.363	0.75	11	521.7	9.585	19.16	3.30
40	2148.8	2.327	4.654	0.80	30	499.1	10.02	20.04	3.45
50	2022.4	2.472	4.945	0.85	12	478.3	10.45	20.91	3.60
3	1910.1	2.618	5.235	0.90	30	459.3	10.89	21.77	3.75
10	1809.6	2.763	5.526	0.95	13	441.7	11.32	22.64	3.90
20	1719.1	2.908	5.817	1.00	30	425.4	11.75	23.51	4.05
30	1637.3	3.054	6.108	1.05	14	410.3	12.18	24.37	4.20
40	1562.9	3.199	6.398	1.10	30	396.2	12.62	25.24	4.35
50	1495.0	3.345	6.689	1.15	15	383.1	13.05	26.11	4.50
4	1432.7	3.490	6.980	1.20	30	370.8	13.49	26.97	4.65
10	1375.4	3.635	7.271	1.25	16	359.3	13.92	27.84	4.80
20	1322.5	3.718	7.561	1.30	30	348.5	14.35	28.70	4.95
30	1273.6	3.926	7.852	1.35	17	338.3	14.78	29.56	5.10
40	1228.1	4.071	8.143	1.40	18	319.6	15.64	31.29	5.40
50	1185.8	4.217	8.433	1.45	19	302.9	16.51	33.01	5.70
5	1146.3	4.362	8.724	1.50	20	287.9	17.37	34.73	6.00
10	1109.3	4.507	9.014	1.55	21	274.4	18.22	36.44	6.30
20	1074.7	4.653	9.305	1.60	22	262.0	19.08	38.16	6.60
30	1042.1	4.798	9.596	1.65	23	250.8	19.94	39.87	6.90
40	1011.5	4.943	9.886	1.70	24	240.5	20.79	41.58	7.20
50	982.6	5.088	10.18	1.75	25	231.0	21.64	43.28	7.50
6	955.4	5.234	10.47	1.80	26	222.3	22.50	44.99	7.80
10	929.6	5.379	10.76	1.85	27	214.2	23.35	46.69	8.10
20	905.1	5.524	11.05	1.90	28	206.7	24.19	48.38	8.40
30	881.9	5.669	11.34	1.95	29	199.7	25.04	50.07	8.70
40	859.9	5.814	11.63	2.00	30	193.2	25.88	51.76	9.00

TABLE XXV.—DATA CONCERNING standard gage cars.

Class.	Length.	Width.	Height.	Approx. weight (empty in tons).	Capacity.	
					Cu. ft.	Tons.
	′ ″	′ ″	′ ″			
Box cars	33 6	8 3	7 0	14 to 20	1,934.6	20 to 30
	[1] 36 0	8 6	8 0	16 to 22	2,448.0	30 to 40
	[1] 40 0	8 6	8 0	18 to 25	2,720.0	40 to 50
Furniture cars	[1] 40 0	9 0	10 0	18 to 24	3,600.0	25 to 40
	44 5	8 4	8 6	20 to 24	3,146.1	30 to 40
	[1] 50 0	8 8	10 0	22 to 24	4,333.5	30 to 40
Refrigerator cars	[2] 29 0	8 1	7 1	20 to 25	1,660.4	20 to 30
	[1] 30 0	8 4	7 4	20 to 25	1,833.3	20 to 30
	[2 3] 34 0	8 3	7 5	20 to 28	2,080.5	25 to 45
Stock cars, single deck	34 0	8 8	7 0	15 to 18	2,062.7	20 to 25
	[1] 36 0	8 8	7 0	15 to 18	2,184.1	25 to 30
	40 0	8 8	8 0	18 to 21	2,773.4	35 to 40
Stock cars, double deck	34 0	8 8	7 6	15 to 18	2,210.1	20 to 25
	[1] 36 0	8 8	7 2	15 to 18	2,236.2	25 to 30
Flat cars	[1] 36 0	8 6	.....	12 to 15	.....	20 to 40
	[1] 40 0	8 8	.....	15 to 20	.....	30 to 50
	44 0	8 8	.....	15 to 20	.....	30 to 50
Gondola cars	32 0	8 3	3 7	13 to 15	945.9	20 to 30
	34 0	8 4	3 8	15 to 18	1,038.9	30 to 40
	[1] 38 0	9 2	3 9	18 to 20	1,306.3	40 to 50
	40 0	8 9	4 8	19 to 24	1,633.5	40 to 50
Caboose	30′ to 36′ long			15 to 18	.....	.....
Baggage, express, and mail	60′ to 70′ long			25 to 45	.....	.....
Coach	60′ to 75′ long			28 to 48	.....	.....
Dining cars	60′ to 70′ long			40 to 60	.....	.....
Sleeping cars	60′ to 70′ long			36 to 55	.....	.....

[1] Seem to be most usual sizes.
[2] Length between ice tanks, outside length about 8′ greater.
[3] Refrigerator cars carry from 4 to 5 tons of ice.