INDEX TO SECTION III

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Section III

DESIGN CHARTS, DESIGN DATA AND FORMULAE FOR AIRCRAFT TUBING

The design data of this section are based on the requirements of the ANC-5 Handbook, October 1940 revision

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1. STANDARD SYMBOLS

The following standard symbols are used in this section. These symbols correspond to those used in the ANC-5 Handbook.

- **A** — area of cross section, square inches
- **a** — subscript "allowable"
- **B** — slenderness ratio factor
- **b** — subscript "bending"
- **C** — circumference
- **c** — fixity coefficient for columns; distance from neutral axis to extreme fiber; subscript "compression"
- **cr** — subscript "critical"
- **D** — diameter of tube
- **D/t** — ratio of diameter to thickness of tube
- **E** — modulus of elasticity in tension
- **F** — allowable stress
- **f** — internal (or calculated) stress
- F_b — allowable bending stress, modulus of rupture in bending
- f_b — internal (or calculated) primary bending stress
- F_c — allowable compressive stress
- f_c — internal (or calculated) compressive stress
- F_{cc} — allowable crushing or crippling stress (upper limit of column stress for local failure)
- F_{co} — column yield stress (upper limit of column stress for primary failure)
- F_{cu} — ultimate compressive stress
- F_{st} — modulus of rupture in torsion
- F_{su} — ultimate shear stress
- F_t — allowable tensile stress
- f_t — internal (or calculated) tensile stress
- F_{tu} — ultimate tensile stress
- F_{ty} — tensile yield stress
- **M** — bending moment
- **P** — axial load
- **PSI or psi** — pounds per square inch
- **Q** — statical moment of a portion of a cross sectional area about the neutral axis of the beam
- **G** — modulus of elasticity in shear (modulus of rigidity)
- **I** — moment of inertia of cross sectional area in inch units
- **r** — radius in inches
- **S** — shear load
- **T** — torsional moment, inch units
- **t** — thickness of wall of tube
- ϕ — angle of twist of a tube
- **Z** — section modulus in inch units
- ρ — radius of gyration in inch units
- δ — deformation

2. TABLE OF PROPERTIES OF STEEL AIRCRAFT TUBING

All units in these tables of properties of seamless tubular sections—rounds, streamline, square and elliptical—are inches and pounds except the one column "Wt. per Ft."

The tensile strengths are computed by the formula $\frac{F_{tu}}{A}$.

The bending strengths are computed on the basis of the allowable stress obtained from Figure 4–20, page 4–35 of ANC–5, "Strengths of Aircraft Elements." No data are available at this time on the allowable bending stress of 1025 steel.

The torsional strengths are computed on the basis of the allowable shear stress obtained from Figure 4–21 and Figure 4–22 of pages 4–36 and 4–37 of ANC–5, "Strengths of Aircraft Elements."

No data are available at present on the bending and torsional strengths of streamline, square and elliptical tubes. Progress is being made in obtaining these data.

The tables and charts of this section were prepared under the supervision of Professor R. O. Wickersham, University of Maryland, principally by the following seniors in Mechanical Engineering, Aeronautical Section: W. M. Darling, F. J. Blazek, R. W. Laughead, E. C. Saltzman, E. C. Hawkins, assisted by Miss Ruth Sauer, Department Secretary.

Rounds — PROPERTIES OF AIRCRAFT STEEL TUBING — Table I

For explanation of symbols see Sec. III—1

O.D. Inches	Wall Decl. Inches	Wall Gage No.	Area	Wt. per ft.	I	Z	ρ	Tensile Strength, lbs. 1025 F_{tu}=55000 F_{ty}=36000	Tensile Strength, lbs. X4130 F_{tu}=95000 F_{ty}=75000	Tensile Strength, lbs. X4130 F_{tu}=100000 F_{ty}=85000	Bending Strength, lbs. in. X4130 F_{tu}=95000 F_{ty}=75000	Bending Strength, lbs. in. X4130 F_{tu}=100000 F_{ty}=85000	Torsional Strength, lbs. in. 1025 F_{tu}=55000 F_{ty}=36000	Torsional Strength, lbs. in. X4130 F_{tu}=95000 F_{ty}=75000	Torsional Strength, lbs. in. X4130 F_{tu}=100000 F_{ty}=85000
3/16	.022	24	.0114	.0389	.00004	.0004	.0590	627	1080	1140	51.2	54.2	29	50.1	52.8
	.028	22	.0140	.0477	.00005	.0005	.0573	770	1330	1400	64.5	68.3	37	65.0	68.4
	.035	20	.0168	.0570	.00005	.0005	.0553	925	1600	1680	65.0	68.8	39	67.0	70.4
1/4	.022	24	.0158	.0536	.0001	.0008	.0809	869	1500	1580	99.3	105.5	56	95.8	100.8
	.028	22	.0195	.0664	.0001	.0009	.0791	1070	1850	1950	115.0	121.5	65	111.0	117.0
	.035	20	.0236	.0804	.0001	.0011	.0770	1300	2240	2360	142.0	150.0	82	141.0	148.6
5/16	.022	24	.0201	.0683	.0002	.0013	.1030	1105	1910	2010	154.7	164.0	87	151.0	158.8
	.028	22	.0250	.0851	.0002	.0016	.1010	1375	2380	2500	200.0	211.0	111	192.6	202.4
	.035	20	.0305	.1037	.0002	.0019	.0988	1680	2900	3050	243.0	256.5	137	236.4	248.8
3/8	.022	24	.0244	.0829	.0003	.0020	.1250	1340	2320	2440	230.0	244.0	130	224.0	236.0
	.028	22	.0305	.1038	.0004	.0024	.1230	1680	2900	3050	290.5	307.0	163	280.8	296.0
	.035	20	.0374	.1271	.0005	.0029	.1208	2060	3550	3740	362.5	386.0	203	352.0	370.0
	.049	18	.0502	.1706	.0006	.0036	.1165	2760	4770	5020	465.0	490.0	287	459.0	483.0
7/16	.022	24	.0287	.0976	.0006	.0028	.1471	1580	2730	2870	310.5	326.0	176	305.4	321.6
	.028	22	.0360	.1225	.0007	.0034	.1451	1980	3420	3600	398.0	418.0	228	388.0	408.0
	.035	20	.0443	.1505	.0009	.0041	.1428	2435	4210	4430	504.5	533.0	281	485.0	510.0
	.049	18	.0598	.2033	.0011	.0052	.1384	3290	5680	5980	665.5	702.0	375	638.0	671.0
1/2	.022	24	.0330	.1123	.0010	.0040	.1691	1815	3140	3300	428.0	452.0	246	426.0	448.0
	.028	22	.0415	.1411	.0012	.0048	.1672	2280	3940	4150	547.0	571.0	309	630.0	562.0
	.035	20	.0511	.1738	.0014	.0056	.1649	2810	4850	5110	666.0	705.0	376	650.0	683.0
	.049	18	.0694	.2360	.0018	.0072	.1604	3815	6590	6940	907.0	960.0	508	878.0	924.0
	.058	17	.0805	.2738	.0020	.0080	.1576	4430	7650	8050	1023.0	1080.0	580	1004.0	1056.0
9/16	.022	24	.0374	.1270	.0014	.0050	.1913	2055	3550	3740	520.0	550.0	299	516.0	543.0
	.028	22	.0470	.1596	.0017	.0060	.1892	2585	4460	4700	660.0	696.0	378	652.0	688.0
	.035	20	.0580	.1972	.0020	.0071	.1869	3190	5510	5800	824.0	866.0	466	806.0	848.0
	.049	18	.0790	.2687	.0026	.0092	.1824	4350	7500	7900	1140.0	1210.0	638	1102.0	1160.0
	.058	17	.0919	.3125	.0030	.0107	.1796	5050	8730	9190	1360.0	1433.0	766	1316.0	1384.0
5/8	.022	24	.0417	.1417	.0019	.0061	.2133	2295	3960	4170	622.0	653.0	356	616.0	647.0
	.028	22	.0525	.1785	.0023	.0074	.2113	2890	4990	5250	800.0	836.0	456	788.0	830.0
	.035	20	.0649	.2205	.0028	.0090	.2090	3570	6160	6490	1017.0	1070.0	574	992.0	1044.0
	.049	18	.0887	.3014	.0037	.0118	.2044	4880	8430	8870	1540.0	1530.0	806	1390.0	1462.0
	.058	17	.1033	.3512	.0042	.0134	.2015	5690	9820	10330	1675.0	1770.0	938	1620.0	1708.0
11/16	.022	24	.0460	.1564	.0025	.0073	.2354	2530	4370	4600	730.0	765.0	414	714.0	752.0
	.028	22	.0580	.1972	.0032	.0093	.2334	3190	5510	5800	977.0	1032.0	562	968.0	1018.0
	.035	20	.0717	.2439	.0038	.0111	.2310	3940	6810	7170	1232.0	1293.0	702	1214.0	1278.0
	.049	18	.0983	.3341	.0050	.0145	.2264	5400	9340	9830	1740.0	1832.0	976	1680.0	1770.0
	.058	17	.1147	.3899	.0057	.0166	.2235	6300	10900	11470	2060.0	2175.0	1148	1984.0	2088.0
3/4	.022	24	.0503	.1711	.0033	.0088	.2575	2765	4780	5030	854.0	906.0	484	836.0	880.0
	.028	22	.0635	.2159	.0041	.0109	.2555	3495	6040	6350	1122.0	1189.0	644	1112.0	1170.0
	.035	20	.0786	.2673	.0050	.0133	.2531	4320	7470	7860	1450.0	1522.0	828	1426.0	1502.0
	.049	18	.1079	.3688	.0067	.0179	.2484	5940	10250	10790	2075.0	2210.0	1186	2044.0	2154.0
	.058	17	.1261	.4287	.0076	.0203	.2455	6940	12000	12610	2480.0	2620.0	1386	2390.0	2518.0
	.065	16	.1399	.4755	.0083	.0221	.2433	7690	13300	13990	2740.0	2905.0	1532	2644.0	2784.0
7/8	.022	24	.0590	.2004	.0054	.0123	.3017	3240	5600	5900	1156.0	1224.0	646	1116.0	1174.0
	.028	22	.0745	.2533	.0067	.0153	.2996	4100	7080	7450	1530.0	1607.0	866	1498.0	1578.0
	.035	20	.0924	.3140	.0082	.0187	.2972	5080	8770	9240	1963.0	2065.0	1122	1938.0	2040.0
	.049	18	.1272	.4323	.0109	.0249	.2925	7000	12100	12720	2840.0	2965.0	1590	2770.0	2880.0
	.058	17	.1489	.5061	.0125	.0286	.2896	8190	14150	14890	3375.0	3550.0	1900	3276.0	3450.0
	.065	16	.1654	.5623	.0137	.0313	.2873	9100	15700	16540	3790.0	3990.0	2116	3650.0	3850.0
	.083	14	.2065	.7021	.0164	.0375	.2814	11350	19600	20650	4730.0	4990.0	2640	4560.0	4800.0
1	.028	22	.0855	.2907	.0101	.0202	.3438	4700	8120	8550	1960.0	2050.0	1100	1894.0	1996.0
	.035	20	.1061	.3607	.0124	.0248	.3414	5840	10100	10610	2530.0	2655.0	1440	2486.0	2620.0
	.049	18	.1464	.4977	.0166	.0332	.3367	8050	13900	14640	3650.0	3835.0	2084	3596.0	3786.0
	.058	17	.1716	.5835	.0191	.0382	.3337	9440	16300	17160	4350.0	4590.0	2480	4280.0	4510.0
	.065	16	.1909	.6491	.0210	.0420	.3314	10500	18150	19090	4910.0	5200.0	2800	4790.0	5040.0
	.083	14	.2391	.8129	.0253	.0506	.3255	13150	22700	23910	6230.0	6630.0	3440	5940.0	6360.0
	.095	13	.2701	.9182	.0280	.0560	.3217	14850	25650	27010	7050.0	7450.0	3940	6820.0	7160.0

For explanation of symbols see Sec. III—1

O.D. Inches	Wall		Area	Wt. per ft.	I	Z	ρ	Tensile Strength, lbs.			Bending Strength, lbs. in.		Torsional Strength, lbs. in.		
	Decl. Inches	Gage No.						1025 F_{tu}=55000 F_{ty}=36000	X4130 F_{tu}=95000 F_{ty}=75000	X4130 F_{tu}=100000 F_{ty}= 85000	X4130 F_{tu}=95000 F_{ty}=75000	X4130 F_{tu}=100000 F_{ty}= 85000	1025 F_{tu}=55000 F_{ty}=36000	X4130 F_{tu}=95000 F_{ty}=75000	X4130 F_{tu}=100000 F_{ty}= 85000
1⅛	.028	22	.0965	.3280	.0145	.0258	.3880	5310	9170	9650	2425.0	2555.0	1348	2322.0	2452.0
	.035	20	.1199	.4074	.0178	.0316	.3856	6600	11400	11990	3130.0	3300.0	1776	3070.0	3224.0
	.049	18	.1656	.5631	.0240	.0427	.3808	9100	15750	16560	4570.0	4830.0	2614	4516.0	4750.0
	.058	17	.1944	.6609	.0277	.0492	.3778	10700	18500	19440	5460.0	5760.0	3120	5400.0	5680.0
	.065	16	.2165	.7359	.0305	.0542	.3755	11900	20600	21650	6190.0	6500.0	3510	6070.0	6400.0
	.083	14	.2717	.9237	.0371	.0660	.3696	14950	25800	27170	7920.0	8420.0	4460	7700.0	8120.0
	.095	13	.3074	1.045	.0411	.0731	.3657	16900	29200	30740	9070.0	9570.0	5060	8740.0	9200.0
1¼	.028	22	.1075	.3654	.0201	.0322	.4322	5910	10400	10750	2960.0	3125.0	1618	2794.0	3940.0
	.035	20	.1336	.4542	.0247	.0395	.4297	7350	12700	13360	3790.0	4030.0	2148	3700.0	3900.0
	.049	18	.1849	.6285	.0334	.0534	.4250	10150	17550	18490	5550.0	5870.0	3196	5510.0	5800.0
	.058	17	.2172	.7384	.0387	.0619	.4219	11950	20650	21720	6690.0	7070.0	3852	6640.0	7000.0
	.065	16	.2420	.8226	.0426	.0682	.4196	13300	23000	24200	7570.0	7980.0	4350	7500.0	7900.0
	.083	14	.3042	1.034	.0521	.0834	.4136	16700	28900	30420	9840.0	10330.0	5540	9560.0	10080.0
	.095	13	.3447	1.172	.0578	.0926	.4097	18950	32800	34470	11300.0	11850.0	6300	10880.0	11440.0
	.120	11	.4260	1.448	.0688	.1101	.4018	23400	40500	42600	13880.0	14650.0	7740	13400.0	14100.0
1⅜	.028	22	.1185	.4028	.0269	.0391	.4763	6520	11250	11850	3480.0	3695.0	1892	3270.0	3588.0
	.035	20	.1473	.5009	.0331	.0481	.4739	8110	14000	14730	4530.0	4810.0	2532	4380.0	4610.0
	.049	18	.2041	.6939	.0449	.0653	.4691	11200	19400	20410	6660.0	7050.0	3810	6580.0	6950.0
	.058	17	.2400	.8158	.0521	.0758	.4661	13200	22800	24000	8040.0	8500.0	4600	7960.0	8380.0
	.065	16	.2675	.9094	.0575	.0836	.4637	14700	25400	26750	9110.0	9580.0	5220	9000.0	9480.0
	.083	14	.3369	1.145	.0706	.1027	.4577	18550	32000	33690	11800.0	12430.0	6700	11560.0	12180.0
	.095	13	.3820	1.299	.0787	.1145	.4538	21000	36300	38200	13630.0	14300.0	7650	13220.0	13920.0
	.120	11	.4731	1.608	.0940	.1367	.4457	26000	45000	47310	16950.0	17970.0	9480	16400.0	17220.0
1½	.028	22	.1295	.4402	.0351	.0468	.5205	7120	12300	12950	4070.0	4350.0	2160	3670.0	3950.0
	.035	20	.1611	.5476	.0432	.0576	.5181	8870	15300	16110	5350.0	5610.0	2926	5060.0	5320.0
	.049	18	.2234	.7593	.0589	.0785	.5133	12300	21200	22340	7850.0	8280.0	4480	7720.0	8140.0
	.058	17	.2627	.8932	.0684	.0912	.5103	14450	25000	26270	9500.0	9980.0	5420	9340.0	9860.0
	.065	16	.2930	.9962	.0756	.1008	.5079	16100	27800	29300	10780.0	11290.0	6170	10660.0	11220.0
	.083	14	.3695	1.256	.0931	.1241	.5019	20320	35100	36950	14030.0	14800.0	7960	13760.0	14480.0
	.095	13	.4193	1.426	.1039	.1385	.4979	23050	38850	41930	16070.0	16980.0	9140	15800.0	16620.0
	.120	11	.5202	1.769	.1248	.1664	.4898	28600	49500	52020	20300.0	21650.0	11400	19680.0	20700.0
1⅝	.028	22	.1405	.4776	.0448	.0551	.5647	7730	13350	14050	4740.0	5010.0	2470	4260.0	4480.0
	.035	20	.1748	.5943	.0553	.0681	.5623	9610	16600	17480	6200.0	6540.0	3364	5800.0	6120.0
	.049	18	.2426	.8248	.0754	.0928	.5575	13350	23050	24260	9100.0	9600.0	5180	8920.0	9400.0
	.058	17	.2855	.9707	.0878	.1081	.5544	15700	27100	28550	11020.0	11690.0	6300	10900.0	11460.0
	.065	16	.3186	1.083	.0970	.1194	.5520	17500	30150	31860	12540.0	13200.0	7160	12380.0	13020.0
	.083	14	.4021	1.367	.1198	.1474	.5459	22100	38250	40210	16380.0	17250.0	9320	16100.0	16960.0
	.095	13	.4566	1.552	.1341	.1650	.5420	25100	43400	45660	18800.0	19970.0	10720	18500.0	19500.0
	.120	11	.5674	1.929	.1617	.1990	.5338	31200	53900	56740	24050.0	25450.0	13460	23240.0	24500.0
1¾	.035	20	.1886	.6411	.0694	.0793	.6065	10400	17900	18860	7050.0	7450.0	3794	6550.0	6900.0
	.049	18	.2618	.8902	.0948	.1083	.6017	14400	24850	26180	10500.0	11050.0	5900	10180.0	10720.0
	.058	17	.3083	1.048	.1105	.1263	.5986	16950	29300	30830	12630.0	13330.0	7240	12480.0	13120.0
	.065	16	.3441	1.478	.1514	.1398	.5962	18950	32700	34410	14400.0	15170.0	8220	14200.0	14980.0
	.083	14	.4347	1.478	.1514	.1730	.5901	23900	41300	43470	18870.0	19900.0	10840	18700.0	19660.0
	.095	13	.4939	1.679	.1697	.1939	.5861	27150	46900	49390	21900.0	22850.0	12400	21340.0	22540.0
	.120	11	.6145	2.089	.2052	.2345	.5779	33800	58400	61450	27900.0	29300.0	15680	26760.0	28500.0
	.156	5/32	.7823	2.660	.2508	.2866	.5662	43100	74400	78230	35850.0	37850.0	20000	34500.0	36340.0
1⅞	.035	20	.2023	.6873	.0857	.0914	.6507	11150	19200	20230	7950.0	8500.0	4240	7330.0	7720.0
	.049	18	.2811	.9556	.1172	.1250	.6458	15450	26700	28110	11880.0	12500.0	4660	11480.0	12080.0
	.058	17	.3311	1.126	.1368	.1459	.6427	18200	31450	33110	14430.0	15170.0	8200	14160.0	14980.0
	.065	16	.3696	1.257	.1516	.1617	.6404	20300	35100	36960	16500.0	17300.0	9380	16180.0	17060.0
	.083	14	.4673	1.589	.1880	.2005	.6343	25700	44450	46730	21450.0	22600.0	12300	21240.0	22400.0
	.095	13	.5312	1.806	.2110	.2251	.6302	29200	50500	53120	25000.0	26200.0	14240	24600.0	25880.0
	.120	11	.6616	2.249	.2559	.2730	.6220	36400	62900	66160	31950.0	33600.0	18020	31120.0	32760.0
	.156	5/32	.8437	2.868	.3141	.3350	.6102	46400	80100	84370	41200.0	43900.0	23100	39800.0	42000.0
2	.035	20	.2161	.7345	.1043	.1043	.6949	11900	20500	21610	8980.0	9500.0	4700	8100.0	8540.0
	.049	18	.3003	1.021	.1430	.1430	.6900	16500	28500	30030	13450.0	14150.0	7400	12780.0	13480.0
	.058	17	.3539	1.203	.1670	.1670	.6869	19500	33600	35390	16200.0	17100.0	9180	15880.0	16700.0
	.065	16	.3951	1.343	.1851	.1851	.6845	21750	37550	39510	18510.0	19530.0	10540	18220.0	19180.0

PROPERTIES OF AIRCRAFT STEEL TUBING

For explanation of symbols see Sec. III—1

O.D. Inches	Wall: Decl. Inches	Wall: Gage No.	Area	Wt. per ft.	I	Z	ρ	Tensile Strength, lbs.: 1025 $F_{tu}=55000$ $F_{ty}=36000$	Tensile Strength, lbs.: X4130 $F_{tu}=95000$ $F_{ty}=75000$	Tensile Strength, lbs.: X4130 $F_{tu}=100000$ $F_{ty}=85000$	Bending Strength, lbs. in.: X4130 $F_{tu}=95000$ $F_{ty}=75000$	Bending Strength, lbs. in.: X4130 $F_{tu}=100000$ $F_{ty}=85000$	Torsional Strength, lbs. in.: 1025 $F_{tu}=55000$ $F_{ty}=36000$	Torsional Strength, lbs. in.: X4130 $F_{tu}=95000$ $F_{ty}=75000$	Torsional Strength, lbs. in.: X4130 $F_{tu}=100000$ $F_{ty}=85000$
2	.083	14	.4999	1.699	.2300	.2300	.6784	27500	47500	49990	24400.0	25650.0	13900	24000.0	25320.0
	.095	13	.5685	1.933	.2586	.2585	.6744	31250	54000	56850	28200.0	29750.0	16120	27860.0	29300.0
	.120	11	.7087	2.409	.3144	.3143	.6660	39000	67400	70870	36100.0	38200.0	20500	35440.0	36260.0
	.156	5/32	.9050	3.077	.3873	.3873	.6542	49700	86000	90500	47200.0	50100.0	26400	45600.0	48000.0
2⅛	.049	18	.3196	1.086	.1723	.1622	.7342	17600	30350	31960	14930.0	15800.0	8260	14220.0	14980.0
	.058	17	.3766	1.280	.2013	.1895	.7311	20700	35800	37660	18200.0	19130.0	10240	17650.0	18580.0
	.065	16	.4207	1.430	.2234	.2103	.7287	23150	39950	42070	20600.0	21850.0	11820	20320.0	21400.0
	.083	14	.5325	1.810	.2780	.2616	.7226	29300	50600	53250	27200.0	28750.0	15580	26940.0	28360.0
	.095	13	.6059	2.060	.3128	.2944	.7185	33400	57600	60590	31800.0	33300.0	18140	31340.0	33000.0
	.120	11	.7559	2.570	.3812	.3588	.7102	41600	71900	75590	40900.0	42900.0	23200	39900.0	42100.0
	.156	5/32	.9664	3.285	.4712	.4435	.6983	53200	91800	96640	53300.0	56500.0	29960	51700.0	54500.0
2¼	.049	18	.3388	1.152	.2053	.1825	.7784	18650	32150	33880	16600.0	17500.0	9060	15620.0	16420.0
	.058	17	.3994	1.358	.2401	.2134	.7753	22000	37950	39940	20250.0	21340.0	11280	19500.0	20480.0
	.065	16	.4462	1.517	.2665	.2369	.7729	24550	42400	44620	23000.0	24300.0	13040	22500.0	23700.0
	.083	14	.5650	1.921	.3322	.2953	.7667	31100	53700	56500	30400.0	32000.0	17360	29920.0	31540.0
	.095	13	.6432	2.186	.3741	.3325	.7627	35400	61000	64320	35250.0	37250.0	20200	34800.0	36700.0
	.120	11	.8030	2.730	.4568	.4060	.7543	44200	76300	80300	45500.0	47900.0	25900	44800.0	47100.0
	.156	5/32	1.0278	3.494	.5663	.5034	.7423	56500	97500	102780	59900.0	63400.0	33760	58200.0	61200.0
	.188	3/16	1.2149	4.130	.6514	.5790	.7322	66900	115500	121490	71200.0	75600.0	39960	69000.0	72600.0
2⅜	.049	18	.3581	1.217	.2423	.2040	.8225	19700	34000	35810	18350.0	19380.0	9880	17080.0	17960.0
	.058	17	.4222	1.435	.2835	.2387	.8195	23200	40100	42220	22450.0	23650.0	12380	21380.0	22500.0
	.065	16	.4717	1.604	.3149	.2652	.8171	25950	44900	47170	25450.0	26900.0	14320	24640.0	26000.0
	.083	14	.5976	2.032	.3930	.3309	.8109	32900	56800	59760	33800.0	35400.0	19600	33200.0	35600.0
	.095	13	.6805	2.313	.4429	.3730	.8068	37450	64600	68050	39200.0	41200.0	22400	38600.0	40600.0
	.120	11	.8501	2.890	.5419	.4563	.7984	46800	80800	85010	50700.0	53200.0	28800	49200.0	52400.0
	.156	5/32	1.0891	3.703	.6735	.5672	.7864	59900	103500	108910	67000.0	70400.0	37660	65000.0	68400.0
	.188	3/16	1.2885	4.381	.7764	.6538	.7762	70800	122500	128850	80400.0	85000.0	44700	77100.0	81200.0
2½	.049	18	.3773	1.283	.2834	.2267	.8667	20750	35850	37730	19900.0	21300.0	10760	18600.0	19580.0
	.058	17	.4450	1.513	.3319	.2655	.8636	24500	42300	44500	24400.0	25900.0	13500	23300.0	24540.0
	.065	16	.4972	1.690	.3688	.2950	.8612	27400	47300	49720	28000.0	29500.0	15660	27020.0	28440.0
	.083	14	.6302	2.143	.4608	.3686	.8550	34700	59900	63020	36860.0	39100.0	21100	36400.0	38320.0
	.095	13	.7178	2.440	.5198	.4158	.8510	39500	68200	71780	43300.0	44500.0	24720	42700.0	44900.0
	.120	11	.8972	3.050	.6369	.5095	.8425	49400	85300	89720	56000.0	58500.0	31860	55000.0	57900.0
	.156	5/32	1.1505	3.911	.7935	.6348	.8305	63300	109000	115050	73600.0	77800.0	41700	72100.0	76200.0
	.188	3/16	1.3622	4.631	.9165	.7332	.8202	75000	129500	136220	88700.0	93800.0	49700	86000.0	90400.0
2¾	.049	18	.4158	1.414	.3793	.2759	.9551	22900	39600	41580	23700.0	25400.0	12520	21600.0	22800.0
	.058	17	.4905	1.668	.4445	.3233	.9520	27000	46600	49050	29100.0	30850.0	15900	27400.0	28800.0
	.065	16	.5483	1.864	.4944	.3596	.9496	30150	52100	54830	33450.0	35200.0	18500	31800.0	33600.0
	.083	14	.6954	2.364	.6189	.4501	.9434	38300	66100	69540	44100.0	46700.0	25000	43300.0	45600.0
	.095	13	.7924	2.694	.6991	.5084	.9393	43600	75300	79240	51300.0	54400.0	29460	50800.0	53500.0
	.120	11	.9915	3.371	.8590	.6247	.9308	54500	94300	99150	66800.0	70600.0	38400	66500.0	69700.0
	.156	5/32	1.2732	4.328	1.0746	.7815	.9187	70000	121000	127320	89900.0	93800.0	50900	87200.0	91800.0
	.188	3/16	1.5094	5.131	1.2456	.9059	.9084	83000	143000	150940	107900.0	113700.0	60600	104600.0	110200.0
3	.049	18	.4543	1.544	.4946	.3297	1.0435	24950	43100	45430	27700.0	29500.0	14380	24800.0	26140.0
	.058	17	.5361	1.822	.5802	.3868	1.0404	29550	51000	53610	34000.0	36200.0	18280	31500.0	33200.0
	.065	16	.5993	2.037	.6457	.4305	1.0379	32950	56900	59930	39200.0	41300.0	21340	37000.0	38760.0
	.083	14	.7606	2.586	.8097	.5398	1.0317	41900	72300	76060	51900.0	54900.0	29260	50500.0	53200.0
	.095	13	.8670	2.947	.9156	.6104	1.0276	47700	82400	86700	60500.0	63800.0	34400	59600.0	62700.0
	.120	11	1.0857	3.691	1.1276	.7517	1.0191	59700	103000	108570	79000.0	83100.0	45100	77900.0	82000.0
	.156	5/32	1.3959	4.746	1.4153	.9435	1.0069	76700	132500	139590	105700.0	110800.0	60000	103800.0	109200.0
	.188	3/16	1.6567	5.632	1.6454	1.0969	.9966	91100	157500	165670	127200.0	134300.0	72200	124600.0	131200.0
	.210	7/32	1.9113	6.498	1.8595	1.2397	.9864	105000	181500	191130	149000.0	158000.0	83800	144600.0	152200.0
3¼	.049	18	.4928	1.675	.6313	.3885	1.1319	27100	46800	49280	32200.0	34100.0	16160	28000.0	29440.0
	.058	17	.5816	1.977	.7410	.4560	1.1287	32000	53300	58160	39200.0	42000.0	20600	35800.0	37600.0
	.065	16	.6504	2.211	.8251	.5078	1.1263	35800	61800	65040	45200.0	47800.0	24200	41900.0	44200.0
	.083	14	.8258	2.807	1.0360	.6375	1.1201	45500	78500	82580	59900.0	63750.0	33660	58200.0	61200.0
	.095	13	.9416	3.201	1.1727	.7217	1.1160	51800	89500	94160	70000.0	74400.0	39800	68800.0	72400.0
	.120	11	1.1800	4.011	1.4471	.8905	1.1074	64900	112000	118000	91800.0	96600.0	52400	90400.0	95200.0
	.156	5/32	1.5186	5.163	1.8216	1.1210	1.0952	83500	144000	151860	123300.0	129000.0	70100	120000.0	127700.0
	.188	3/16	1.8040	6.133	2.1228	1.3063	1.0848	99300	171500	180400	149000.0	156900.0	84600	146000.0	154000.0
	.219	7/32	2.0831	7.082	2.4051	1.4801	1.0745	114500	198000	208310	174800.0	185000.0	98800	170200.0	179000.0

Rounds PROPERTIES OF AIRCRAFT STEEL TUBING Table I

For explanation of symbols see Sec. III—1

O.D. Inches	Wall: Decl. Inches	Wall: Gage No.	Area	Wt. per ft.	I	Z	ρ	Tensile Strength, lbs.: 1025 $F_{tu}=55000$ $F_{ty}=36000$	Tensile Strength, lbs.: X4130 $F_{tu}=95000$ $F_{ty}=75000$	Tensile Strength, lbs.: X4130 $F_{tu}=100000$ $F_{ty}=85000$	Bending Strength, lbs. in.: X4130 $F_{tu}=95000$ $F_{ty}=75000$	Bending Strength, lbs. in.: X4130 $F_{tu}=100000$ $F_{ty}=85000$	Torsional Strength, lbs. in.: 1025 $F_{tu}=55000$ $F_{ty}=36000$	Torsional Strength, lbs. in.: X4130 $F_{tu}=95000$ $F_{ty}=75000$	Torsional Strength, lbs. in.: X4130 $F_{tu}=100000$ $F_{ty}=85000$
3½	.065	16	.7014	2.385	1.0349	.5914	1.2147	38600	66600	70140	51500.0	54700.0	27440	47200.0	49800.0
	.083	14	.8910	3.029	1.3012	.7435	1.2085	49000	84600	89100	69100.0	72800.0	38200	66100.0	69500.0
	.095	13	1.0162	3.455	1.4739	.8422	1.2043	55900	96500	101620	80900.0	85100.0	45500	78400.0	82600.0
	.120	11	1.2742	4.332	1.8220	1.0411	1.1958	70100	121000	127420	105200.0	111000.0	60200	104000.0	109400.0
	.156	5/32	1.6414	5.580	2.2990	1.3137	1.1835	90300	156000	164140	142000.0	149200.0	81000	140000.0	147200.0
	.188	3/16	1.9512	6.633	2.6848	1.5342	1.1730	107500	185500	195120	172000.0	181000.0	98000	169000.0	178200.0
	.219	7/32	2.2550	7.666	3.0483	1.7418	1.1627	124000	214000	225500	202000.0	213500.0	114800	198000.0	208400.0
	.250	1/4	2.5525	8.678	3.3901	1.9372	1.1524	140500	242000	255250	232500.0	245000.0	130200	224600.0	236600.0
3¾	.065	16	.7525	2.558	1.2777	.6814	1.3031	41400	71500	75250	58600.0	62000.0	30660	52800.0	55800.0
	.083	14	.9562	3.251	1.6080	.8576	1.2968	52600	90800	95620	78000.0	82700.0	42700	73800.0	77600.0
	.095	13	1.0908	3.708	1.8228	.9722	1.2927	60000	103500	109080	91400.0	96700.0	51100	88400.0	93000.0
	.120	11	1.3685	4.652	2.2565	1.2035	1.2841	75200	130000	136850	120350.0	126500.0	68200	117800.0	124000.0
	.156	5/32	1.7641	5.997	2.8533	1.5218	1.2718	97100	167500	176410	161300.0	169900.0	92000	159200.0	167400.0
	.188	3/16	2.0985	7.134	3.3383	1.7804	1.2613	115500	199000	209850	197500.0	206500.0	112200	193800.0	204000.0
	.219	7/32	2.4268	8.250	3.7971	2.0251	1.2509	137000	230500	242680	231000.0	243000.0	131200	226800.0	239000.0
	.250	1/4	2.7489	9.345	4.2307	2.2564	1.2406	151500	261000	274850	266000.0	280000.0	149800	258400.0	272000.0
4	.065	16	.8035	2.732	1.5557	.7779	1.3914	44200	76300	80350	65400.0	69700.0	33800	58200.00	61300.0
	.083	14	1.0214	3.472	1.9597	.9799	1.3852	56100	97000	102140	88100.0	93100.0	47600	82200.0	86600 0
	.095	13	1.1655	3.962	2.2228	1.1114	1.3810	64100	110500	116550	103300.0	108900.0	57180	98600.0	104000.0
	.120	11	1.4627	4.973	2.7552	1.3776	1.3724	80500	139000	146270	135000.0	142500.0	75510	132200.0	139000.0
	.156	5/32	1.8867	6.414	3.4903	1.7452	1.3601	104000	179000	188670	181500.0	192000.0	104000	179800.0	190000.0
	.188	3/16	2.2457	7.635	4.0902	2.0451	1.3495	123500	213000	224570	223000.0	236500.0	127600	220000.0	231600.0
	.219	7/32	2.5985	8.834	4.6598	2.3299	1.3391	143000	246500	259850	263500.0	276000.0	149200	257600.0	271400.0
	.250	1/4	2.9452	10.01	5.2002	2.6001	1.3288	162000	280000	294520	302000.0	319000.0	171200	295600.0	311400.0
	.313	5/16	3.6202	12.31	6.1975	3.0988	1.3084	199000	344000	362020	378000.0	401000.0	211400	365000.0	384000.0
4¼	.065	16	.8546	2.905	1.8714	.8897	1.4798	47000	81100	85460	55400.0	77900.0	36800	63600.0	77900.0
	.083	14	1.0866	3.694	2.3593	1.1103	1.4736	59700	103000	108660	97800.0	102500.0	52400	90600.0	95600.0
	.095	13	1.2400	4.216	2.6775	1.2600	1.4694	68200	118000	124000	116000.0	121500.0	63000	109000.0	114600.0
	.120	11	1.5570	5.293	3.3224	1.5635	1.4608	85600	148000	155700	151600.0	159500.0	85400	147200.0	155200.0
	.156	5/32	2.0095	6.832	4.2158	1.9839	1.4484	110000	190000	200950	204000.0	214000.0	116800	201000.0	211800.0
	.188	3/16	2.3930	8.135	4.9473	2.3281	1.4378	131500	227000	239300	249500.0	263500.0	143200	247200.0	260400.0
	.219	7/32	2.7703	9.418	5.6442	2.6561	1.4274	152500	263000	277030	294500.0	310500.0	168400	290600.0	306400.0
	.250	1/4	3.1416	10.68	6.3077	2.9683	1.4170	173000	298000	314160	351500.0	358000.0	192600	332400.0	350000.0
	.313	5/16	3.8656	13.14	7.5387	3.5476	1.3965	212500	367000	386560	426000.0	453000.0	240000	414000.0	436000.0
4½	.065	16	.9056	3.079	2.2271	.9898	1.5682	49900	86000	90560	81100.0	87000.0	40200	69200.0	73100.0
	.083	14	1.1517	3.915	2.8098	1.2488	1.5619	63400	109000	115170	108500.0	115300.0	57800	99600.0	108400.0
	.095	13	1.3147	4.469	3.1902	1.4179	1.5578	72400	125000	131470	127600.0	135300.0	68700	120000.0	126400.0
	.120	11	1.6512	5.613	3.9627	1.7612	1.5491	90900	157000	165120	167400.0	177000.0	94400	163200.0	171600.0
	.156	5/32	2.1322	7.249	5.0354	2.2380	1.5367	117000	202500	213220	226000.0	239500.0	130000	224600.0	236400.0
	.188	3/16	2.5403	8.636	5.9166	2.6296	1.5261	140000	241500	254030	279000.0	293000.0	159400	275400.0	290000.0
	.219	7/32	2.9421	10.01	6.7585	3.0038	1.5156	162000	279500	294210	330500.0	346500.0	188600	325000.0	342000.0
	.250	1/4	3.3379	11.35	7.5625	3.3611	1.5052	183500	317000	333790	380000.0	397000.0	216000	373400.0	392000.0
	.313	5/16	4.1111	13.98	9.0612	4.0272	1.4846	226000	390000	411100	479000.0	505000.0	270000	465000.0	490000.0
	.375	3/8	4.8597	16.52	10.4217	4.6319	1.4644	268000	462000	485970	570000.0	608000.0	319600	551000.0	581000.0
4¾	.065	16	.9567	3.252	2.6253	1.1054	1.6566	52600	91000	95670	89500.0	95700.0	43100	74400.0	78300.0
	.083	14	1.2169	4.137	3.3143	1.3955	1.6503	66900	115500	121590	120000.0	127500.0	66200	108200.0	114200.0
	.095	13	1.3893	4.723	3.7645	1.5851	1.6462	76400	132000	138930	141000.0	149000.0	75800	131000.0	138000.0
	.120	11	1.7455	5.934	4.6803	1.9707	1.6375	96000	166000	174550	185200.0	196000.0	103600	178500.0	188400.0
	.156	5/32	2.2550	7.666	5.9550	2.5074	1.6251	124000	214000	225500	250740.0	266000.0	143400	247600.0	260600.0
	.188	3/16	2.6875	9.137	7.0049	2.9494	1.6145	148000	255500	268750	310000.0	326000.0	177000	305600.0	321600.0
	.219	7/32	3.1139	10.59	8.0107	3.3729	1.6039	171000	295500	311390	364000.0	384000.0	209000	360800.0	379200.0
	.250	1/4	3.5343	12.02	8.9738	3.7784	1.5934	194000	336000	353430	423000.0	446000.0	240400	416000.0	437000.0
	.313	5/16	4.3565	14.81	10.7764	4.5374	1.5728	239500	415000	435650	530000.0	563000.0	301200	518000.0	547000.0
	.375	3/8	5.1542	17.52	12.4224	5.2305	1.5525	284000	490000	515420	638000.0	677000.0	357000	616000.0	648000.0
5	.083	14	1.2821	4.359	3.8758	1.5503	1.7387	70500	122000	128210	130200.0	139600.0	68000	117600.0	123800.0
	.095	13	1.4639	4.977	4.4042	1.7617	1.7345	80500	139000	146390	155000.0	164000.0	81600	142800.0	150200.0
	.120	11	1.8397	6.254	5.4798	2.1919	1.7259	101000	175000	183970	206000.0	214500.0	113000	195000.0	205400.0
	.156	5/32	2.3777	8.083	6.9803	2.7921	1.7134	131000	226000	237770	276000.0	290000.0	151200	271200.0	285400.0
	.188	3/16	2.8348	9.637	8.2192	3.2877	1.7028	156000	269000	283480	339000.0	358500.0	194800	336000.0	354000.0
	.219	7/32	3.2858	11.17	9.4089	3.7636	1.6922	181000	312000	328580	403000.0	425000.0	232000	401000.0	420000.0
	.250	1/4	3.7306	12.68	10.5507	4.2203	1.6817	205000	354000	373060	465000.0	490000.0	266000	456000.0	481000.0
	.313	5/16	4.6019	15.64	12.6958	5.0783	1.6610	253000	437000	460190	589000.0	622000.0	334000	577000.0	607000.0
	.375	3/8	5.4487	18.52	14.6647	5.8659	1.6406	300000	518000	544870	710000.0	751000.0	399000	688000.0	724000.0

Streamline PROPERTIES OF AIRCRAFT STEEL TUBING — Table II

For explanation of symbols see Sec. III—1

Equiv. Round O.D.	Wall		Axes		Area	Wt. per ft.	I Major	Z Major	ρ Major	I Minor	Z Minor	ρ Minor	y	Tensile Strength	
	Dec'l	Gage	Major	Minor										95000	100000
¾	.035	20	1.0114	.4286	.0786	.2673	.0017	.0079	.1486	.0073	.0140	.3046	.520	7460	7860
	.049	18	"	"	.1079	.3668	.0022	.0103	.1435	.0097	.0187	.2998	.519	10230	10790
⅞	.035	20	1.1800	.5000	.0924	.3140	.0028	.0112	.1753	.0118	.0195	.3572	.606	8760	9240
	.049	18	"	"	.1272	.4323	.0037	.0148	.1703	.0158	.0261	.3525	.606	12100	12720
	.058	17	"	"	.1489	.5061	.0042	.0168	.1671	.0182	.0301	.3495	.605	14120	14890
1	.035	20	1.3485	.5714	.1061	.3607	.0043	.0151	.2020	.0178	.0257	.4100	.693	10100	10610
	.049	18	"	"	.1464	.4977	.0057	.0200	.1972	.0239	.0345	.4044	.693	13890	14640
	.058	17	"	"	.1716	.5835	.0065	.0228	.1939	.0278	.0402	.4023	.692	16300	17160
1⅛	.035	20	1.5170	.6428	.1199	.4074	.0063	.0196	.2292	.0257	.0329	.4626	.780	11390	11990
	.049	18	"	"	.1656	.5631	.0083	.0258	.2240	.0347	.0445	.4573	.780	15700	16560
	.058	17	"	"	.1944	.6609	.0094	.0292	.2205	.0402	.0516	.4549	.779	18430	19440
	.065	16	"	"	.2165	.7359	.0103	.0320	.2182	.0443	.0569	.4525	.779	20600	21650
1¼	.035	20	1.6857	.7143	.1336	.4542	.0088	.0246	.2559	.0355	.0409	.5154	.867	12670	13360
	.049	18	"	"	.1849	.6285	.0116	.0325	.2509	.0482	.0557	.5107	.866	17500	18490
	.058	17	"	"	.2172	.7384	.0133	.0372	.2477	.0560	.0647	.5077	.866	20600	21720
	.065	16	"	"	.2420	.8226	.0145	.0406	.2451	.0618	.0714	.5053	.865	23000	24200
1⅜	.035	20	1.8543	.7857	.1473	.5009	.0118	.0300	.2828	.0476	.0549	.5683	.954	14000	14730
	.049	18	"	"	.2041	.6939	.0157	.0400	.2777	.0648	.0680	.5635	.953	19400	20410
	.058	17	"	"	.2400	.8158	.0181	.0461	.2745	.0754	.0791	.5604	.953	22800	24000
	.065	16	"	"	.2675	.9094	.0198	.0504	.2719	.0833	.0875	.5581	.952	25400	26750
1½	.035	20	2.0228	.8571	.1611	.5476	.0154	.0359	.3096	.0621	.0597	.6209	1.040	15300	16110
	.049	18	"	"	.2234	.7593	.0207	.0483	.3045	.0848	.0815	.6162	1.040	21200	22340
	.058	17	"	"	.2627	.8932	.0239	.0555	.3014	.0988	.0951	.6131	1.039	24900	26270
	.065	16	"	"	.2934	.9962	.0262	.0611	.2989	.1093	.1052	.6108	1.039	27800	29340
	.083	14	"	"	.3695	1.256	.0316	.0737	.2923	.1351	.1302	.6047	1.038	35000	36950
1⅝	.035	20	2.1913	.9285	.1748	.5943	.0198	.0426	.3365	.0793	.0704	.6736	1.127	16600	17480
	.049	18	"	"	.2426	.8248	.0266	.0573	.3314	.1085	.0964	.6689	1.126	23100	24260
	.058	17	"	"	.2855	.9707	.0308	.0448	.3282	.1266	.1124	.6659	1.126	27100	28550
	.065	16	"	"	.3186	1.083	.0338	.0728	.3256	.1402	.1245	.6634	1.126	30200	31860
	.083	14	"	"	.4021	1.367	.0410	.0883	.3192	.1738	.1545	.6574	1.125	38200	40210
	.095	13	"	"	.4566	1.552	.0453	.0976	.3149	.1949	.1732	.6541	1.125	43400	45660
1¾	.035	20	2.3600	1.0000	.1886	.6411	.0249	.0498	.3633	.0995	.0820	.7263	1.214	17900	18860
	.049	18	"	"	.2618	.8902	.0336	.0672	.3583	.1363	.1123	.7216	1.214	24800	26180
	.058	17	"	"	.3083	1.048	.0389	.0778	.3551	.1592	.1312	.7186	1.213	29300	30830
	.065	16	"	"	.3441	1.170	.0428	.0856	.3525	.1765	.1455	.7163	1.213	32700	34410
	.083	14	"	"	.4347	1.478	.0521	.1042	.3461	.2192	.1809	.7101	1.212	41200	43470
	.095	13	"	"	.4939	1.679	.0577	.1154	.3418	.2463	.2034	.7061	1.211	46800	49390
1⅞	.035	20	2.5285	1.0714	.2023	.6878	.0308	.0575	.3902	.1227	.0943	.7789	1.301	19300	20230
	.049	18	"	"	.2811	.9556	.0417	.0779	.3851	.1685	.1296	.7743	1.300	26700	28110
	.058	17	"	"	.3311	1.126	.0482	.0900	.3815	.1969	.1515	.7712	1.300	31400	33110
	.065	16	"	"	.3696	1.257	.0532	.0993	.3794	.2186	.1683	.7690	1.299	35000	36960
	.083	14	"	"	.4673	1.589	.0650	.1214	.3729	.2719	.2093	.7624	1.299	44300	46730
	.095	13	"	"	.5312	1.806	.0722	.1348	.3687	.3598	.2770	.7523	1.299	50600	53120
2	.035	20	2.6970	1.1428	.2161	.7345	.0376	.0658	.4170	.1494	.1076	.8313	1.388	20550	21610
	.049	18	"	"	.3003	1.021	.0510	.0893	.4120	.2053	.1480	.8269	1.387	28600	30030
	.058	17	"	"	.3539	1.203	.0591	.1034	.4088	.2402	.1732	.8238	1.387	23500	35390
	.065	16	"	"	.3951	1.343	.0652	.1141	.4062	.2668	.1925	.8217	1.386	37500	39510
	.083	14	"	"	.4999	1.699	.0799	.1398	.3998	.3325	.2399	.8156	1.386	47400	49990
	.095	13	"	"	.5685	1.933	.0889	.1556	.3954	.3744	.2703	.8115	1.385	54000	56850
2¼	.049	18	3.0343	1.2857	.3388	1.152	.0735	.1144	.4657	.2946	.1887	.9325	1.561	32200	33880
	.058	17	"	"	.3994	1.358	.0854	.1329	.4625	.3450	.2212	.9294	1.560	37900	39940
	.065	16	"	"	.4462	1.517	.0944	.1469	.4600	.3835	.2458	.9271	1.560	42500	44620
	.083	14	"	"	.5650	1.921	.1161	.1807	.4533	.4794	.3075	.9223	1.559	53600	56500
	.095	13	"	"	.6432	2.186	.1298	.2020	.4492	.5409	.3470	.9170	1.559	61000	64320
	.120	11	"	"	.8030	2.730	.1556	.2421	.4402	.6629	.4255	.9086	1.558	76200	80300

Streamline PROPERTIES OF AIRCRAFT STEEL TUBING

For explanation of symbols see Sec. III—1

Equiv. Round O.D.	Wall Dec'l	Wall Gage	Axes Major	Axes Minor	Area	Wt. per ft.	I Major	Z Major	ρ Major	I Minor	Z Minor	ρ Minor	y	Tensile Strength 95000	Tensile Strength 100000
2½	.049	18	3.3713	1.4285	.3773	1.283	.1018	.1425	.5194	.4063	.2343	1.0377	1.734	35800	37730
	.058	17	"	"	.4450	1.513	.1186	.1660	.5163	.4764	.2747	1.0346	1.734	42300	44500
	.065	16	"	"	.4972	1.690	.1312	.1837	.5137	.5300	.3057	1.0325	1.734	47300	49720
	.083	14	"	"	.6302	2.143	.1621	.2269	.5071	.6640	.3832	1.0265	1.733	59900	63020
	.095	13	"	"	.7178	2.440	.1815	.2541	.5028	.7504	.4333	1.0224	1.732	68100	71780
	.120	11	"	"	.8972	3.050	.2188	.3063	.4938	.9226	.5329	1.0141	1.731	85100	89720
2¾	.049	18	3.7085	1.5714	.4158	1.414	.1366	.1739	.5732	.5434	.2848	1.1432	1.908	39500	41580
	.058	17	"	"	.4905	1.668	.1593	.2028	.5699	.6372	.3340	1.1398	1.908	46600	49050
	.065	16	"	"	.5483	1.864	.1765	.2247	.5674	.7099	.3723	1.1379	1.907	62100	54830
	.083	14	"	"	.6954	2.364	.2188	.2785	.5609	.8907	.4673	1.1318	1.906	66100	69540
	.095	13	"	"	.7924	2.694	.2455	.3125	.5566	1.0081	.5289	1.1279	1.906	75300	79240
	.120	11	"	"	.9915	3.371	.2973	.3785	.5476	1.2427	.6523	1.1196	1.905	94900	99150
3	.058	17	4.0455	1.7142	.5361	1.822	.2085	.2433	.6236	.8318	.3997	1.2456	2.081	51000	53610
	.065	16	"	"	.5993	2.037	.2312	.2698	.6211	.9265	.4452	1.2434	2.081	56800	59930
	.083	14	"	"	.7606	2.586	.2872	.3352	.6145	1.1645	.5599	1.2373	2.080	72400	76060
	.095	13	"	"	.8670	2.947	.3229	.3768	.6103	1.3184	.6338	1.2332	2.080	82300	86700
	.120	11	"	"	1.0857	3.691	.3925	.4580	.6013	1.6289	.7839	1.2249	2.078	103000	108570
	.156	5/32	"	"	1.3959	4.746	.4824	.5630	.5879	2.0497	.9869	1.2118	2.077	132500	139590
3¼	.058	17	4.3828	1.8571	.5816	1.977	.2668	.2873	.6773	1.0617	.4708	1.3511	2.255	55350	58160
	.065	16	"	"	.6504	2.211	.2961	.3189	.6747	1.1830	.5248	1.3487	2.254	61900	65040
	.083	14	"	"	.8258	2.807	.3689	.3973	.6684	1.4886	.6604	1.3426	2.254	78500	82580
	.095	13	"	"	.9416	3.201	.4150	.4470	.6639	1.6873	.7489	1.3386	2.253	89500	94160
	.120	11	"	"	1.1800	4.011	.5062	.5452	.6549	2.0887	.9275	1.3304	2.252	112000	118000
	.156	5/32	"	"	1.5186	5.163	.6251	.6732	.6416	2.6353	1.1707	1.3173	2.251	144000	151860
3½	.065	16	4.7200	2.0000	.7014	2.385	.3723	.3723	.7286	1.4831	.6108	1.4541	2.428	66700	70140
	.083	14	"	"	.8910	3.029	.4645	.4645	.7220	1.8686	.7699	1.4481	2.427	84600	89100
	.095	13	"	"	1.0162	3.455	.5234	.5234	.7177	2.1194	.8733	1.4442	2.427	96550	101620
	.120	11	"	"	1.2742	4.332	.6400	.6400	.7087	2.6269	1.0828	1.4358	2.426	121300	127420
	.156	5/32	"	"	1.6414	5.580	.7934	.7934	.6952	3.3221	1.3705	1.4227	2.424	156200	164140
3¾	.065	16	5.0570	2.1428	.7525	2.558	.4604	.4297	.7822	1.8299	.7033	1.5594	2.602	71500	75250
	.083	14	"	"	.9562	3.251	.5754	.5371	.7757	2.3073	.8871	1.5534	2.691	91000	95620
	.095	13	"	"	1.0908	3.708	.6490	.5777	.7713	2.6195	1.0075	1.5497	2.600	103900	109080
	.120	11	"	"	1.3685	4.652	.7955	.7425	.7624	3.2505	1.2502	1.5412	2.600	130000	136850
	.156	5/32	"	"	1.7641	5.997	.9894	.9235	.7489	4.1192	1.5855	1.5281	2.598	167800	176410
4	.065	16	5.3940	2.2856	.8035	2.732	.5614	.4912	.8359	2.2270	.8025	1.6648	2.775	76300	80350
	.083	14	"	"	1.0214	3.472	.7024	.6146	.8293	2.8161	1.0148	1.6604	2.775	97200	102140
	.095	13	"	"	1.1655	3.962	.7933	.6941	.8250	3.1917	1.1506	1.6549	2.774	110800	116550
	.120	11	"	"	1.4627	4.973	.9739	.8522	.8160	3.9661	1.4303	1.6467	2.773	139000	146270
	.156	5/32	"	"	1.8867	6.414	1.2153	1.0634	.8026	5.0332	1.8164	1.6333	2.771	179000	188670
	.188	3/16	"	"	2.2457	7.635	1.4109	1.2345	.7926	5.9364	2.1431	1.6259	2.770	213500	224570
4¼	.065	16	5.7313	2.4285	.8546	2.905	.6761	.5568	.8895	2.6784	.9082	1.7704	2.949	81100	85460
	.083	14	"	"	1.0866	3.694	.8473	.6978	.8830	3.3817	1.1471	1.7641	2.948	103000	108660
	.095	13	"	"	1.2400	4.216	.9574	.7885	.8787	3.8426	1.3035	1.7604	2.948	118000	124000
	.120	11	"	"	1.5570	5.293	1.1779	.9701	.8698	4.7789	1.6216	1.7519	2.947	148000	155700
	.156	5/32	"	"	2.0095	6.832	1.4729	1.2131	.8573	6.0748	2.0628	1.7387	2.945	191000	200950
	.188	3/16	"	"	2.3930	8.135	1.7144	1.4120	.8464	7.1732	2.4365	1.7314	2.944	227500	239300
4½	.083	14	6.0683	2.5713	1.1517	3.915	1.0105	.7860	.9367	4.0256	1.2894	1.8696	3.122	109500	115170
	.095	13	"	"	1.3147	4.469	1.1429	.8889	.9324	4.5759	1.4662	1.8656	3.121	125000	131470
	.120	11	"	"	1.6512	5.613	1.4082	1.0953	.9235	5.6952	1.8254	1.8572	3.120	157000	165120
	.156	5/32	"	"	2.1322	7.249	1.7650	1.3728	.9098	7.2508	2.3247	1.8441	3.119	202500	213220
	.188	3/16	"	"	2.5403	8.636	2.0580	1.6007	.9001	8.5740	2.7498	1.8372	3.118	241500	254030
	.219	7/32	"	"	2.9421	10.01	2.3221	1.8061	.8884	9.8001	3.1451	1.8251	3.116	280000	294210
4¾	.083	14	6.4055	2.7142	1.2169	4.137	1.1938	.8797	.9910	4.7471	1.4403	1.9751	3.296	115600	121690
	.095	13	"	"	1.3893	4.723	1.3509	.9955	.9861	5.3978	1.6382	1.9711	3.295	132000	138930
	.120	11	"	"	1.7455	5.934	1.6668	1.2283	.9772	6.7256	2.0418	1.9629	3.294	166000	174550
	.156	5/32	"	"	2.2550	7.666	2.0932	1.5425	.9634	8.5673	2.6017	1.9492	3.293	214000	225500
	.188	3/16	"	"	2.6875	9.137	2.4455	1.8021	.9539	10.1398	3.0811	1.9424	3.291	255500	268750
	.219	7/32	"	"	3.1139	10.59	2.7633	2.0363	.9420	11.6100	3.5289	1.9309	3.290	296000	311390

PROPERTIES OF AIRCRAFT STEEL TUBING

For explanation of symbols see Sec. III—I

Equiv. Round O.D.	Wall Dec'l	Wall Gage	Axes Major	Axes Minor	Area	Wt. per ft.	I Major	Z Major	ρ Major	I Minor	Z Minor	ρ Minor	Tensile Strength 95000	Tensile Strength 100000
¾	.035	20	.9728	.4864	.0786	.2673	.0023	.0094	.1709	.0069	.0143	.2971	7460	7860
⅞	.035	20	1.1348	.5674	.0924	.3140	.0037	.0132	.2013	.0112	.0198	.3485	8760	9240
	.049	18	"	"	.1272	.4323	.0049	.0173	.1965	.0150	.0265	.3437	12100	12720
1	.035	20	1.2972	.6486	.1061	.3607	.0057	.0176	.2314	.0170	.0262	.4003	10100	10610
	.049	18	"	"	.1464	.4977	.0075	.0233	.2271	.0229	.0353	.3954	13900	14640
1⅛	.035	20	1.4592	.7296	.1199	.4074	.0083	.0226	.2623	.0245	.0335	.4518	11380	11990
	.049	18	"	"	.1656	.5631	.0110	.0301	.2576	.0331	.0453	.4469	15700	16560
1¼	.035	20	1.6212	.8106	.1336	.4542	.0115	.0287	.2930	.0339	.0418	.5034	12660	13360
	.049	18	"	"	.1849	.6285	.0153	.0378	.2880	.0459	.0567	.4986	17510	18490
	.058	17	"	"	.2172	.7384	.0176	.0435	.2849	.0533	.0657	.4952	20300	21720
1⅜	.035	20	1.7824	.8912	.1473	.5009	.0154	.0345	.3231	.0453	.0508	.5546	14000	14730
	.049	18	"	"	.2041	.6939	.0207	.0464	.3182	.0616	.0692	.5496	19400	20410
	.058	17	"	"	.2400	.8158	.0238	.0535	.3151	.0716	.0804	.5463	22800	24000
1½	.035	20	1.9456	.9728	.1611	.5476	.0202	.0415	.3539	.0587	.0604	.6038	15300	16110
	.049	18	"	"	.2234	.7593	.0272	.0559	.3489	.0809	.0831	.6016	21200	22340
	.058	17	"	"	.2627	.8932	.0314	.0646	.3459	.0941	.0967	.5983	25000	26270
	.065	16	"	"	.2930	.9962	.0346	.0711	.3435	.1041	.1070	.5960	27800	29300
1⅝	.049	18	2.1076	1.0538	.2426	.8248	.0349	.0663	.3795	.1035	.0982	.6531	23100	24260
	.058	17	"	"	.2855	.9707	.0404	.0767	.3763	.1206	.1145	.6492	27000	28550
	.065	16	"	"	.3186	1.083	.0445	.0845	.3739	.1336	.1267	.6467	30300	31860
1¾	.049	18	2.2700	1.1350	.2618	.8902	.0440	.0776	.4101	.1301	.1146	.7050	24800	26180
	.058	17	"	"	.3083	1.048	.0510	.0900	.4069	.1518	.1338	.7017	29300	30830
	.065	16	"	"	.3441	1.170	.0563	.0992	.4045	.1682	.1482	.6992	32800	34410
1⅞	.049	18	2.4320	1.2160	.2811	.9556	.0546	.0897	.4405	.1608	.1323	.7564	26750	28110
	.058	17	"	"	.3311	1.126	.0633	.1042	.4374	.1878	.1545	.7532	31400	33110
	.065	16	"	"	.3696	1.257	.0699	.1150	.4347	.2083	.1713	.7507	35100	36960
	.083	14	"	"	.4673	1.589	.0859	.1413	.4287	.2589	.2129	.7443	44400	46730
2	.049	18	2.5940	1.2970	.3003	1.021	.0666	.1027	.4710	.1961	.1512	.8080	28600	30030
	.058	17	"	"	.3539	1.203	.0775	.1194	.4681	.2292	.1767	.8047	33600	35390
	.065	16	"	"	.3951	1.343	.0856	.1320	.4658	.2543	.1961	.8023	37500	39510
	.083	14	"	"	.4999	1.699	.1054	.1625	.4591	.3166	.2441	.7958	47400	49990
	.095	13	"	"	.5685	1.933	.1177	.1815	.4551	.3563	.2747	.7917	53900	56850
2¼	.058	17	2.9184	1.4592	.3994	1.358	.1117	.1531	.5289	.3293	.2257	.9080	37800	39940
	.065	16	"	"	.4462	1.517	.1237	.1695	.5266	.3658	.2507	.9055	42300	44620
	.083	14	"	"	.5650	1.921	.1529	.2095	.5202	.4568	.3130	.8991	53600	56500
	.095	13	"	"	.6432	2.186	.1713	.2348	.5160	.5150	.3529	.8948	61100	64320
2½	.058	17	3.2428	1.6214	.4450	1.513	.1549	.1911	.5900	.4550	.2806	1.0112	42300	44500
	.065	16	"	"	.4972	1.690	.1716	.2117	.5875	.5060	.3121	1.0088	47200	49720
	.083	14	"	"	.6302	2.143	.2129	.2626	.5812	.6332	.3905	1.0024	59900	63020
	.095	13	"	"	.7178	2.440	.2390	.2948	.5771	.7150	.4410	.9981	68200	71780
	.120	11	"	"	.8972	3.050	.2900	.3577	.5685	.8781	.5416	.9893	85300	89720
2¾	.065	16	3.5668	1.7834	.5483	1.864	.2306	.2586	.6488	.6778	.3800	1.1118	52100	54830
	.083	14	"	"	.6954	2.364	.2868	.3216	.6422	.8498	.4765	1.1054	66100	69540
	.095	13	"	"	.7924	2.694	.3225	.3617	.6380	.9607	.5387	1.1001	75100	79240
	.120	11	"	"	.9915	3.371	.3927	.4404	.6294	1.1829	.6633	1.0923	94200	99150
	.156	$\frac{5}{32}$	"	"	1.2732	4.328	.4841	.5430	.6167	1.4820	.8310	1.0789	121000	127320
3	.065	16	3.8912	1.9456	.5993	2.037	.3019	.3103	.7097	.8848	.4548	1.2151	56800	59930
	.083	14	"	"	.7606	2.586	.3763	.3868	.7034	1.1111	.5711	1.2086	72200	76060
	.095	13	"	"	.8670	2.947	.4238	.4357	.6992	1.2576	.6464	1.2044	82500	86700
	.120	11	"	"	1.0857	3.691	.5176	.5321	.6905	1.5517	.7976	1.1955	103000	108570
	.156	$\frac{5}{32}$	"	"	1.3959	4.746	.6409	.6589	.6776	1.9501	1.0024	1.1820	132200	139590
	.188	$\frac{3}{16}$	"	"	1.6567	5.632	.7396	.7603	.6682	2.2803	1.1721	1.1732	157000	165670
3¼	.065	16	4.2152	2.1076	.6504	2.211	.3862	.3664	.7705	1.1301	.5362	1.3180	61900	65040
	.083	14	"	"	.8258	2.807	.4823	.4576	.7642	1.4208	.6742	1.3117	78400	82580
	.095	13	"	"	.9416	3.201	.5438	.5161	.7600	1.6095	.7637	1.3074	89400	94160
	.120	11	"	"	1.1800	4.011	.6660	.6320	.7513	1.9896	.9441	1.2985	112000	118000
	.156	$\frac{5}{32}$	"	"	1.5186	5.163	.8279	.7856	.7383	2.5071	1.1896	1.2849	143900	151860
	.188	$\frac{3}{16}$	"	"	1.8040	6.133	.9586	.9096	.7221	2.9385	1.3943	1.2763	171000	180400
3½	.065	16	4.5396	2.2698	.7014	2.385	.4851	.4274	.8316	1.4172	.6244	1.4215	66600	70140
	.083	14	"	"	.8910	3.029	.6068	.5347	.8253	1.7839	.7859	1.4150	84600	89100
	.095	13	"	"	1.0162	3.455	.6850	.6036	.8217	2.0223	.8909	1.4107	96000	101620
	.120	11	"	"	1.2742	4.332	.8408	.7408	.8123	2.5037	1.1031	1.4017	121000	127420
	.156	$\frac{5}{32}$	"	"	1.6414	5.580	1.0486	.9239	.7993	3.1620	1.3931	1.3880	156000	164140
	.188	$\frac{3}{16}$	"	"	1.9512	6.663	1.2177	1.0729	.7900	3.7136	1.6361	1.3796	185200	195120

For explanation of symbols see Sec. III—I

Size	Wall		Area	Wt. per ft.	I	Z	ρ	Tensile	Strength
Dist. Across Flats	Dec'l	Gage						95000	100000
3/8	.022	24	.0294	.0998	.0006	.0031	.1415	2795	2940
	.028	22	.0368	.1252	.0007	.0038	.1396	3500	3680
	.035	20	.0453	.1589	.0009	.0045	.1372	43100	4530
	.049	18	.0612	.2081	.0011	.0057	.1318	5820	6120
1/2	.022	24	.0396	.1348	.0016	.0065	.2023	3760	3960
	.028	22	.0499	.1697	.0020	.0079	.1991	4740	4990
	.035	20	.0616	.2096	.0024	.0094	.1956	5850	6160
	.049	18	.0841	.2861	.0030	.0120	.1892	8000	8410
	.058	17	.0980	.3330	.0033	.0134	.1853	9300	9800
	.065	16	.1084	.3684	.0035	.0141	.1804	10300	10840
5/8	.022	24	.0483	.1641	.0033	.0104	.2600	4640	4830
	.028	22	.0630	.2143	.0040	.0129	.2526	5990	6300
	.035	20	.0780	.2652	.0048	.0155	.2489	7400	7800
	.049	18	.1071	.3640	.0063	.0201	.2420	10200	10710
	.058	17	.1251	.4253	.0071	.0227	.2379	11900	12510
	.065	16	.1388	.4717	.0077	.0245	.2348	13200	13880
3/4	.028	22	.0761	.2588	.0064	.0168	.2890	7240	7610
	.035	20	.0944	.3209	.0078	.0206	.2866	8950	9440
	.049	18	.1300	.4419	.0103	.0274	.2816	12350	13000
	.058	17	.1522	.5175	.0118	.0313	.2784	14500	15220
	.065	16	.1692	.5751	.0129	.0342	.2760	16100	16920
	.083	14	.2113	.7184	.0154	.0408	.2700	20100	21130
7/8	.028	22	.0892	.3033	.0103	.0236	.3390	8470	8920
	.035	20	.1108	.3766	.0125	.0288	.3364	10510	11080
	.049	18	.1528	.5193	.0168	.0386	.3320	14500	15280
	.058	17	.1794	.6098	.0193	.0445	.3283	17100	17940
	.065	16	.1996	.6785	.0212	.0487	.3528	19000	19960
	.083	14	.2502	.8504	.0255	.0588	.3194	23800	25020
1	.028	22	.1023	.3479	.0154	.0309	.3883	9720	10230
	.035	20	.1271	.4322	.0190	.0380	.3867	12100	12710
	.049	18	.1758	.5978	.0256	.0511	.3813	16700	17580
	.058	17	.2065	.7020	.0295	.0591	.3782	19600	20650
	.065	16	.2300	.7819	.0324	.0649	.3756	21900	23000
	.083	14	.2890	.9824	.0394	.0788	.3693	27500	28900
	.095	13	.3272	1.112	.0436	.0873	.3652	31100	32720
1 1/8	.035	20	.1435	.4878	.0275	.0489	.4340	13650	14350
	.049	18	.1988	.6757	.0369	.0657	.4311	18900	19880
	.058	17	.2336	.7942	.0427	.0759	.4265	22200	23360
	.065	16	.2604	.8852	.0471	.0838	.4241	24800	26040
	.083	14	.3278	1.114	.0576	.1024	.4191	31100	32780
	.095	13	.3716	1.263	.0640	.1138	.4151	35700	37160
	.120	11	.4600	1.564	.0760	.1351	.4064	43700	46000
1 1/4	.035	20	.1599	.5435	.0378	.0604	.4891	15200	15990
	.049	18	.2217	.7536	.0513	.0821	.4831	21100	22170
	.058	17	.2608	.8865	.0595	.0952	.4778	24800	26080
	.065	16	.2908	.9886	.0657	.1051	.4753	27600	29080
	.083	14	.3666	1.246	.0806	.1290	.4960	34800	36660
	.095	13	.4161	1.414	.0899	.1438	.4647	39600	41610
	.120	11	.5161	1.755	.1074	.1718	.4561	49000	51610
1 3/8	.035	20	.1763	.5992	.0506	.0736	.5360	16800	17630
	.049	18	.2446	.8316	.0689	.1003	.5309	23200	24460
	.058	17	.2879	.9787	.0801	.1166	.5276	27400	28790
	.065	16	.3212	1.092	.0886	.1288	.5251	30500	32120
	.083	14	.4055	1.378	.1091	.1587	.5187	38600	40550
	.095	13	.4605	1.566	.1219	.1773	.5145	43800	46050
	.120	11	.5723	1.946	.1464	.2130	.5058	54400	57230

For explanation of symbols see Sec. III—1

Side	Wall		Area	Wt. per ft.	I	Z	ρ	Tensile	Strength
	Dec'l	Gage						95000	100000
1½	.035	20	.1926	.6549	.0661	.0881	.5859	18300	19260
	.049	18	.2675	.9095	.0902	.1203	.5807	25400	26750
	.058	17	.3150	1.071	.1051	.1401	.5776	29900	31500
	.065	16	.3516	1.195	.1162	.1550	.5750	33400	35160
	.083	14	.4443	1.510	.1436	.1915	.5686	42200	44430
	.095	13	.5050	1.717	.1608	.2144	.5643	48000	50500
	.120	11	.6284	2.136	.1940	.2586	.5556	59600	62840
1¾	.049	18	.3134	1.065	.1451	.1658	.6804	29800	31340
	.058	17	.3693	1.255	.1691	.1932	.6766	35100	36930
	.065	16	.4124	1.402	.1877	.2146	.6747	39200	41240
	.083	14	.5220	1.774	.2331	.2663	.6682	49600	52200
	.095	13	.5938	2.019	.2618	.2992	.6640	56400	59380
	.120	11	.7307	2.484	.3175	.3628	.6592	69500	73070
2	.049	18	.3592	1.221	.2180	.2180	.7790	34100	35920
	.058	17	.4236	1.440	.2557	.2557	.7769	40250	42360
	.065	16	.4732	1.609	.2838	.2838	.7744	45000	47320
	.083	14	.5996	2.038	.3536	.3536	.7679	56900	59960
	.095	13	.6827	2.321	.3981	.3981	.7636	64900	68270
	.120	11	.8530	2.900	.4859	.4856	.7548	81000	85300
	.156	5/32	1.0912	3.710	.6010	.6010	.7422	104000	109120
2¼	.049	18	.4051	1.377	.3080	.2738	.8721	38550	40510
	.058	17	.4778	1.624	.3607	.3207	.8689	45400	47780
	.065	16	.5341	1.816	.4000	.3556	.8654	50700	53410
	.083	14	.6773	2.302	.5007	.4451	.8598	64400	67730
	.095	13	.7716	2.623	.5640	.5013	.8549	73400	77160
	.120	11	.9652	3.281	.6918	.6149	.8466	91600	96520
	.156	5/32	1.2372	4.206	.8765	.7791	.8418	117500	123720
2½	.058	17	.5321	1.809	.5074	.4035	.9757	50600	53210
	.065	16	.5949	2.022	.5643	.4488	.9739	56400	59490
	.083	14	.7549	2.566	.7071	.5625	.9678	71600	75490
	.095	13	.8605	2.925	.7981	.6530	.9631	81800	86050
	.120	11	1.0775	3.663	.9809	.7806	.9541	102500	107750
	.156	5/32	1.3831	4.702	1.2256	.9760	.9413	131500	138310
	.188	3/16	1.6479	5.602	1.4257	1.3183	.9301	156500	164790
2¾	.058	17	.5864	1.993	.6792	.4940	1.0763	55700	58640
	.065	16	.6557	2.229	.7559	.5497	1.0737	62400	65570
	.083	14	.8326	2.830	.9481	.6896	1.0671	79000	83260
	.095	13	.9494	3.227	1.0724	.7799	1.0628	90100	94940
	.120	11	1.1898	4.045	1.3213	.8653	1.0541	113000	118980
	.156,	5/32	1.5291	5.198	1.6569	1.1121	1.0410	145000	152910
	.188	3/16	1.8238	6.200	1.9334	1.3264	1.0296	173500	182380
3	.065	16	.7166	2.436	.9860	.6573	1.1730	68100	71660
	.083	14	.9102	3.094	1.2394	.8263	1.1669	87500	91020
	.095	13	1.0383	3.530	1.4032	.9355	1.1625	98500	103830
	.120	11	1.3021	4.426	1.7325	1.1550	1.1544	124000	130210
	.156	5/32	1.6750	5.694	2.1793	1.4529	1.1406	159200	167500
	.188	3/16	1.9997	6.798	2.5503	1.7002	1.1381	190000	199970
	.219	7/32	2.3081	7.847	2.8873	1.9249	1.1184	219000	230810

TABLE V

MECHANICAL PROPERTIES OF MATERIALS				1025 Steel	
CONDITION				Before Welding	After Welding (Properties in Affected Zone)
Specification			Army*	Tube 57–108–1*	Tube 57–180–1*
			Navy*	Tube 49–T–1*	Tube 49–T–1*
TENSION	F_{tu}	Ultimate Stress,	psi	55,000	45,000
	F_{ty}	Yield Stress,	psi	36,000	
	F_{tp}	Proportional Limit,	psi	25,000	
	E	Modulus of Elasticity,	psi	28,000,000	
COMPRESSION	F_{cu}	Ultimate (block) Stress,	psi	55,000	
	F_{cy}	Yield Stress,	psi	36,000	
	F_{cp}	Proportional Limit,	psi	25,000	
	F_{co}	Column Yield Stress,	psi	36,000	
	E_c	Modulus of Elasticity,	psi	28,000,000	
SHEAR	F_{su}	Ultimate Stress,	psi	35,000	
	F_{st}	Torsional Modulus of Rupture,	psi	50,000	
	F_{sp}	Proportional Limit (torsion),	psi	20,000	
	G	Modulus of Rigidity (torsion),	psi	10,000,000	
BEARING	F_{br}	Ultimate Stress,	psi	90,000	
FATIGUE	F_{be}	Bending Endurance Limit, (300,000,000 cycles of completely reversed stress)	psi	25,000	
	w	Specific weight, 0.2833 lb./cu. in. 490 lb./cu. ft.			
		Nominal Chemical Composition 0.25% C, .65 Mn, .045% P (max.), .050% S (max)			

REMARKS:

1. Where joints with tapered welds at angles of 30 degrees or less to the center line, or fish-mouth welds formed by cuts of 60 degrees or less are used, the allowable tensile stress near the welding can be assumed to be 50,000 psi.

2. In welded structures where seven or more members converge, the allowable stress shall be determined by dividing the normal allowable stress by a materials factor of 1.5, unless the joint is reenforced in a manner for which specific authority has been obtained from the licensing or procuring agency. A tube that is continuous through a joint should be assumed as two members.

**Note*—The new Aeronautical Board Specification for 1025 Carbon Steel tubing is AN–WW–T–846. It is now in use but there is no change in physical properties affecting the values in this table.

TABLE VI

MECHANICAL PROPERTIES AND MATERIALS				Alloy Steels -X4130		
Condition				Normalized Plate Tube and Bar—.188" Thick and Under (X-4130)	Near Welding[2] when Welded after Heat Treatment (X-4130) Special	Normalized[1] Tubes—.188" Thick and Under (X-4130) Special
Specification			Army*	57-180-2D for Tubing		
			Navy*	Rd. Tubing 44T18 Str. Tubing 44T17		
TENSION	F_{tu}	Ultimate Stress,	psi	95,000	84,000	100,000
	F_{ty}	Yield Stress,	psi	75,000		85,000
	F_{tp}	Proportional Limit,	psi			
	E	Modulus of Elasticity,	psi	29,000,000	29,000,000	29,000,000
		Elongation in 2 in., %				12
COMPRESSION	F_{cu}	Ultimate (block) Stress,	psi	95,000	76,000	100,000
	F_{cy}	Yield Stress,	psi	75,000		85,000
	F_{cp}	Proportional Limit,	psi			
	F_{co}	Column Yield Stress,	psi	79,500		90,100
	E_c	Modulus of Elasticity,	psi	29,000,000	29,000,000	29,000,000
SHEAR	F_{su}	Ultimate Stress,	psi	55,000	52,500	58,000
	F_{st}	Torsional Modulus of Rupture	psi	80,000	73,500	84,000
	F_{sp}	Proportional Limit (torsion)	psi	40,000		
	G	Modulus of Rigidity (torsion)	psi	11,000,000	11,000,000	11,000,000
BEARING	F_{br}	Ultimate Stress,	psi	140,000	130,000	147,000
FATIGUE	F_{be}	Bending Endurance Limit, (300,000,000 cycles of completely reversed stress)	psi	45,000		
	w,	Specific Weight,	0.2833	lb./cu. in.	490 lb./cu. ft.	

REMARKS:

1. The properties in this line are for use in connection with *civil* aircraft only. Their use is permissible provided that the tensile properties stated are guaranteed by the manufacturer of the tubing. These properties apply only to tubing "as received."
2. In welded structures where seven or more members converge, the allowable stress shall be determined by dividing the normal allowable stress by a materials factor of 1.5, unless the joint is reenforced in a manner for which specific authority has been obtained from the licensing or procuring agency. A tube that is continuous through a joint should be assumed as two members.

**Note*—The new Aeronautical Board Specification for X4130 tubing will be issued in March 1941 as AN-WW-T-850, and in all probability will be used for aircraft requirements by all government agencies. It does not in any way affect the physical values in this table.

3. COMMONLY USED FORMULAS

It is assumed that engineers using this handbook are thoroughly familiar with the basic principles of the strength of materials such as found in any textbook on the subject. The following formulas of strength of materials are listed for reference purposes. The sign conventions generally accepted in their use are that quantities associated with tensile action (load, stress, strain, etc.) are considered as negative. When compressive action is of primary interest, however, it is sometimes convenient to consider the associated quantities to be positive.

Simple Unit Stresses

3:1 $f_t = \frac{P}{A}$ (tension)

3:2 $f_c = \frac{P}{A}$ (compression)

3:3 $f_b = \frac{My}{I} = \frac{M}{Z}$

3:4 $f_s = \frac{S}{A}$ (average direct shear stress)

3:5 $f_s = \frac{SQ}{Ib}$ (longitudinal or transverse shear stress)

3:6 $f_s = \frac{Tr}{I_p}$ (shear stress in round tubes due to torsion)

3:7 $f_s = \frac{T}{2At}$ (shear stress due to torsion in thin-walled structures of closed section. Note that A is the area enclosed by the median line of the section)

Combined Stresses

3:8 $f_n = f_c + f_b$ (compression and bending)

3:9 $f_{s_{max}} = \sqrt{f_s^2 + \left(\frac{f_n}{2}\right)^2}$ (compression, bending, and torsion)

3:10 $f_{n_{max}} = \frac{f_n}{2} + f_{s_{max}}$

Deflections (axial)

3:11 $e = \frac{\delta}{L}$ (unit deformation or strain)

3:12 $E = \frac{f}{e}$ (This equation applies when E is to be found from tests in which f and e are measured)

3:13 $\delta = eL = \frac{f}{E} L = \frac{PL}{AE}$ (This equation applies when the deflection is to be calculated using a known value of E)

3:14 $\phi = \frac{TL}{GJ}$ (Used when torque T is constant over length L)

Basic Column Formulas

3:15 $F_{c_e} = \frac{c\pi^2 E}{(L/\rho)^2}$ (Euler formula for long columns)

$= \frac{\pi^2 E}{(L'/\rho)^2}$ where $L' = \frac{L}{\sqrt{c}}$

3:16 $F_c = F_{co}\left[1 - K\left(\frac{L'/\rho}{\pi\sqrt{E/F_{co}}}\right)^n\right]$ (General parabolic formula)

3:17 $F_c = F_{co}\left[1 - \frac{F_{co}(L'/\rho)^2}{4\pi^2 E}\right]$ (2.0 parabola—Johnson formula)

3:18 $F_c = F_{co}\left[1 - .3027\left(\frac{L'/\rho}{\pi\sqrt{E/F_{co}}}\right)^{1.5}\right]$ (1.5 parabola)

3:19 $F_c = F_{co}\left[1 - .385\left(\frac{(L'/\rho)}{\pi\sqrt{E/F_{co}}}\right)\right]$ (1.0 parabola—straight line formula)

Basic Column Formulas (non-dimensional)

3:20 $R_a = \frac{F_c}{F_{co}}$ (Allowable stress ratio)

3:21 $B = \frac{L'/\rho}{\pi\sqrt{E/F_{co}}}$ (slenderness ratio factor)

3:22 $R_a = \left(\frac{1}{B}\right)^2$ (Euler formula)

3:23 $R_a = 1 - KB^n$ (general parabolic formula)

3:24 $R_a = 1 - .25B^2$ (2.0 parabola—Johnson formula)

3:25 $R_a = 1 - .3027B^{1.5}$ (1.5 parabola)

3:26 $R_a = 1 - .285B$ (1.0 parabola—straight line formula)

4. COLUMNS AND COLUMN CURVES

A theoretical treatment of columns can be found in standard textbooks on the strength of materials. The problems confronting the designer include, however, many points which are not well defined by theory and which frequently cause some confusion. These will be considered in this section.

Primary Instability Failure

General: A column may fail through primary instability by bending laterally or by twisting about some axis parallel to its own axis. This latter type of primary failure is particularly common to columns having unsymmetrical open sections. The twisting failure of a closed section column such as a tube is precluded by its inherently high torsional rigidity.

Long Columns: The Euler formula for long columns which fail by lateral bending is given by Eq. 3:15. No explanation of this classical formula need be offered, as its derivation can be found in many standard textbooks on the strength of materials. The value to be used for the restraint coefficient, c, depends on the degree of end fixation. Definite rules as to the maximum value which may be assumed are given in the specific airworthiness requirements of the Government services. The true significance of the restraint coefficient is best understood by considering the end restraint as modifying the effective column length, as indicated in Eq. 3:15. For a pin-ended column having zero end restraint c = 1.0 and L′ = L. A fixity coefficient of 2 corresponds to a reduction of the effective length to $1/\sqrt{2}$ or .707 times the total length.

Short Columns: If the length of a column is reduced below a certain critical value, primary bending failure will occur at loads below those predicted by the Euler formula. This is due to a reduction in the effective value of E which is caused by changes in the slope of the stress-strain diagram and by unavoidable eccentricities. In this region the test results show more scatter than in the Euler range and it is customary to adopt an empirical or semi-empirical formula for predicting the allowable column stress. When a definite eccentricity exists, the critical column loads are reduced due to the combined effects of axial load and bending. Special formulas for such cases can be found in standard textbooks and handbooks.

Although many types of formulas have been devised to cover the short-column range, it has been customary, in aircraft work, to use the Johnson formula for round steel tubes and the straight line formula for round aluminum alloy tubes. Recent tests at the National Bureau of Standards have shown, however, that the Johnson formula does not have the correct shape for round tubes of normalized X–4130 steel.

A modified parabola having an exponent 1.5 (Eq. 3:18) gives a satisfactory representation of the Bureau of Standards test data on round tubes of this material and it has therefore been adopted for this handbook. The Johnson formula (Eq. 3:17) will be used for round 1025 steel tubes and round heat-treated alloy steel tubes.

It will be noted that the above column formulas are of the general form given by Eq. 3:16. For example, the straight line formula is a special case of Eq. 3:16 in which the exponent n is equal to 1.0. In a similar manner the Johnson formula is obtained by setting n equal to 2.0. The above equations strictly apply only to round tube sections as they were derived from tests on such sections. In many cases, however, they will be found to be satisfactory for selections of other shapes when local instability is not critical.

Column Yield Stress (F_{co}): The upper limit of the allowable column stress for primary failure is called the *column yield stress* and will be designated F_{co}. It can be determined by extending the "short-column" curve to a point corresponding to zero length, neglecting any tendency of the curve to rise rapidly or "pick-up" for very short lengths. The short-column curve used in determining F_{co} should be obtained from tests on specimens having geometrical proportions such that local failure is precluded except for very low values of L'/ρ.

When the column yield stress is reached, the walls of the column will tend to buckle unless restrained by extreme shortness, or by the application of lateral restraining forces. In some cases, however, if the specimen has not been allowed to buckle, the stress may be increased considerably above this value. Due to the danger of buckling when the column yield stress is approached, the latter should be considered as the limiting stress for all columns.

The column yield stress is mainly determined by the nature of the compressive stress-strain diagram of the material. When the material has a definite yield point in compression, this value may be assumed for the column yield stress. Few aircraft materials, however, have a sharply defined yield point. In such cases it is usually possible to determine the column yield stress as a function of either the tensile or compressive yield stress. For example, F_{co} for normalized X–4130 round tubes is approximately equal to 1.06 times the tensile yield stress.

5. NON-DIMENSIONAL COLUMN CURVES FOR PRIMARY FAILURE

General: On account of the many factors involved it is often difficult to predict the effects of possible material variations on the strength of columns as obtained by tests. When the column failure is definitely of the *primary bending type* it is advisable to plot the test results with non-dimensional coefficients. The following coefficients will be adopted for this purpose.

3:27 R_a = allowable stress ratio
$= F_c/F_{co}$
where F_c = allowable column stress
F_{co} = column yield stress

3:28 B = slenderness ratio factor
$$B = \frac{L'/\rho}{\pi\sqrt{E/F_{co}}}$$
$L' = L/\sqrt{c}$ (See eq. 3:15)

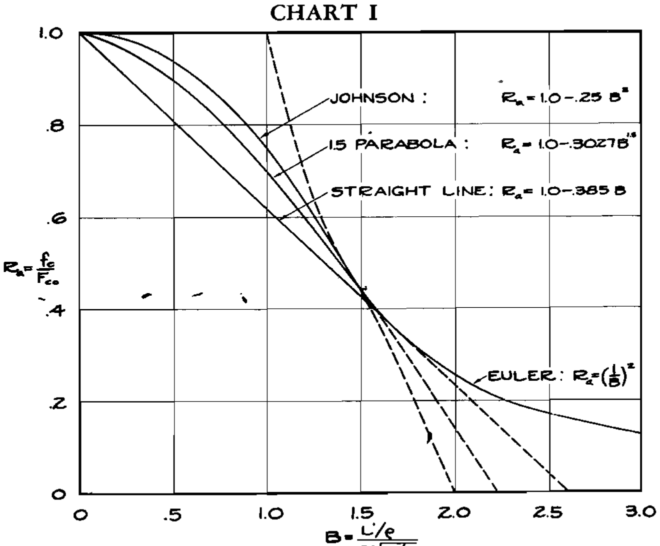
The slenderness ratio factor can be considered as the ratio between the effective slenderness ratio (L'/ρ) and the (L'/ρ) at which the Euler stress for a pin-ended column would equal F_{co}. Thus, when $B = 2$, the Euler stress F_{ce} would equal ¼ F_{co}, or R_a would be .25 (since the Euler stress varies inversely as the square of L'/ρ).

Typical Column Curves: Typical column curves plotted in terms of these non-dimensional coefficients are illustrated in Chart I. It will be noted that the Johnson parabolic curve is tangent to the Euler curve at a value of $R_a = .5$; that is, the Euler formula will not apply when it gives stresses higher than half the column yield stress. It is also convenient to know that the stresses given by the 1.5 parabolic formula and the straight line formula are equal to those given by the Euler formula at values of R_a equal to .4286 and .333 respectively.

Charts of Strength of Steel Tubes: The formulas used in computing these charts are given in Table 7. The symbols used are defined in Part 1 of this section.

Effects of Welding: The primary failure stress of a column having welded ends is determined from the formulas of Table 7 without regard for the effects of welding. These stresses, however, should not exceed a "cut-off" stress which accounts for the effects of welding on the local failure of the column. In the case of X–4130 tubing having tensile yield stresses of 75,000 and 85,000 psi, the welding cut-offs are at stresses of 67,500 and 76,600 psi, respectively.

CHART I



Various Column Curves in Non-Dimensional Form

TABLE 7
COLUMN FORMULAS FOR STEEL TUBES

Tubes	Material Steel	Fty—psi	Fco—psi	Short Column Formulas(a)	Critical(b) L'/ρ	Long Column Formulas
Round and Square	1025	36,000	36,000	$36{,}000 - 1.172\left(\frac{L'}{\rho}\right)^2$	124	$276 \times 10^6 / \left(\frac{L'}{\rho}\right)^2$
	X-4130	75,000	79,500	$79{,}500 - 51.9\left(\frac{L'}{\rho}\right)^{1.5}$	91.5	$286 \times 10^6 / \left(\frac{L'}{\rho}\right)^2$
	X-4130	85,000	90,100	$90{,}100 - 64.4\left(\frac{L'}{\rho}\right)^{1.5}$	86.0	$286 \times 10^6 / \left(\frac{L'}{\rho}\right)^2$
Streamline and Elliptical	X-4130	75,000	79,500	See footnote (c) $79{,}500 - K\left(\frac{L'}{\rho}\right)^{1.5}$	See footnote (c)	$286 \times 10^6 / \left(\frac{L'}{\rho}\right)^2$
	X-4130	85,000	90,100	See footnote (c) $90{,}100 - K\left(\frac{L'}{\rho}\right)^{1.5}$	See footnote (c)	$286 \times 10^6 / \left(\frac{L'}{\rho}\right)^2$

Note (a) $\frac{L'}{\rho} = \frac{L}{\rho\sqrt{c}}$

Note (b) Critical $\frac{L'}{\rho}$ is that above which columns are "long" and below which they are "short."

Note (c) The values of K and critical $\frac{L'}{\rho}$ are functions of $\frac{R}{t}$ of the tube. See charts Nos. 2, 3, 4 and 5 for these values.

6. FAILURE UNDER COMBINED LOADING

For combined loading conditions in which failure is caused by buckling or instability, no general theory exists which will apply in all cases. It is convenient, however, to represent such conditions by the use of "stress ratios," which can be considered as non-dimensional coefficients denoting the fraction of the allowable stress or strength which is utilized or which can be developed under special conditions. For simple stresses the stress ratio can be expressed as:

$$3{:}29 \quad R = \frac{f}{F}$$

where f = applied stress
F = allowable stress

Note that the "margin of safety" as usually expressed, is given by the equation:

$$3{:}30 \quad \text{M.S.} = \frac{1}{R} - 1.0$$

Considering the case of combined loadings, the general conditions for failure can be expressed by equations of the following type:

$$3{:}31 \quad R_1^x + R_2^y + R_3^z + - - - - - = 1.0$$

In this equation R_1, R_2 and R_3 may denote, for instance, the stress ratios for compression, bending, and shear, and the exponents x, y and z define the general relationship of the quantities. This equation may be interpreted as indicating that failure will occur only when the sum of the stress ratios is equal to or greater than one. An advantage of this method is that the formula yields correct results when only one loading condition is present. Consequently it tends to give good results when any one loading condition predominates. It also permits test data to be plotted in non-dimensional form, which is a decided advantage.

In many cases it is convenient to deal directly with "load ratios" rather than stress ratios. The load ratio is simply the ratio of the applied load to the allowable load and is equal to the corresponding stress ratio.

Considering only two loading conditions, such as bending and torsion, Eq. 3:31 can be plotted as a single interaction curve of R_b against R_s. Likewise, in the case of combined bending and compression, R_c can be plotted against R_b. When all three conditions exist, the equation represents an interaction surface, which can be plotted as a family of curves. Typical curves corresponding to various exponents are shown in Chart 6. The general significance of Eq. 3:31 and the chart just mentioned is that the addition of a second loading condition will lower the percentage of the allowable stress which may be utilized in the original loading condition. If the exponents approach infinity, the curve of Chart 6 will approach the lines $R_1 = 1.0$ and $R_2 = 1.0$, indicating that the two loading conditions have no effect on each other.

When only two stress ratios are involved and when the two different applied stresses remain in constant proportion, the margin of safety of the member may be determined from Chart 6 by the following method:

(1) Locate the point on the chart representing the applied values of R_1 and R_2 computed from the applied stresses. [Illustrated as point (1)].

(2) Draw a straight line through this point and the origin (shown as a diagonal dotted line in the figure).

(3) Extend this line to intersect the proper stress-ratio curve (corresponding to the condition under consideration) at point (2).

(4) Read the allowable values R_{1a} and R_{2a} as the ordinate and abscissa, respectively, of point (2).

(5) The factor of utilization or strength ratio is obtained as the ratio of the applied to the allowable value of either stress ratio as follows:

$$2{:}32 \quad U = \frac{R_1}{R_{1a}} = \frac{R_2}{R_{2a}}$$

(6) The true margin of safety then can be computed from the following equation:

$$2{:}33 \quad \text{M.S.} = \frac{1}{U} - 1$$

Note that when the following stress ratio expressions are used, the margins of safety can be computed as indicated.

For $R_1 + R_2 = 1$

$$\text{M.S.} = \frac{1}{R_1 + R_2} - 1$$

For $R_1^2 + R_2^2 = 1$

$$\text{M.S.} = \frac{1}{\sqrt{R_1^2 + R_2^2}} - 1$$

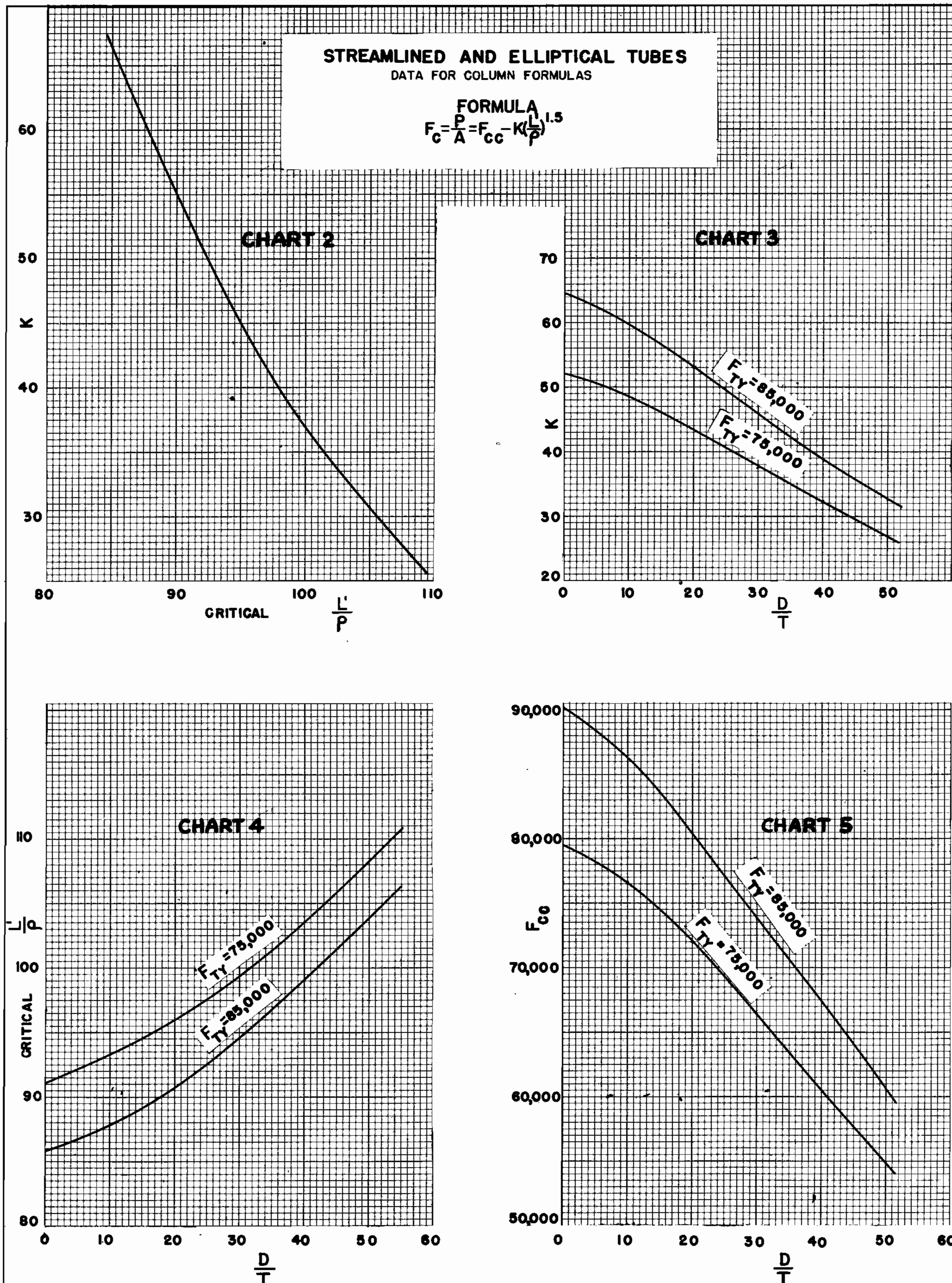
Other M.S. formulas can, of course, be determined for the more complicated stress ratio expressions.

STREAMLINED AND ELLIPTICAL TUBES

DATA FOR COLUMN FORMULAS

FORMULA

$$F_c = \frac{P}{A} = F_{cc} - K\left(\frac{L'}{\rho}\right)^{1.5}$$



7. EXAMPLES OF USE OF COLUMN CHARTS

The column charts give the allowable column loads of tubes as a function of their lengths and end fixity, c = 1 or c = 2. For a required load to be carried and a given length, it is a simple matter to select the lightest tube capable of meeting the requirements.

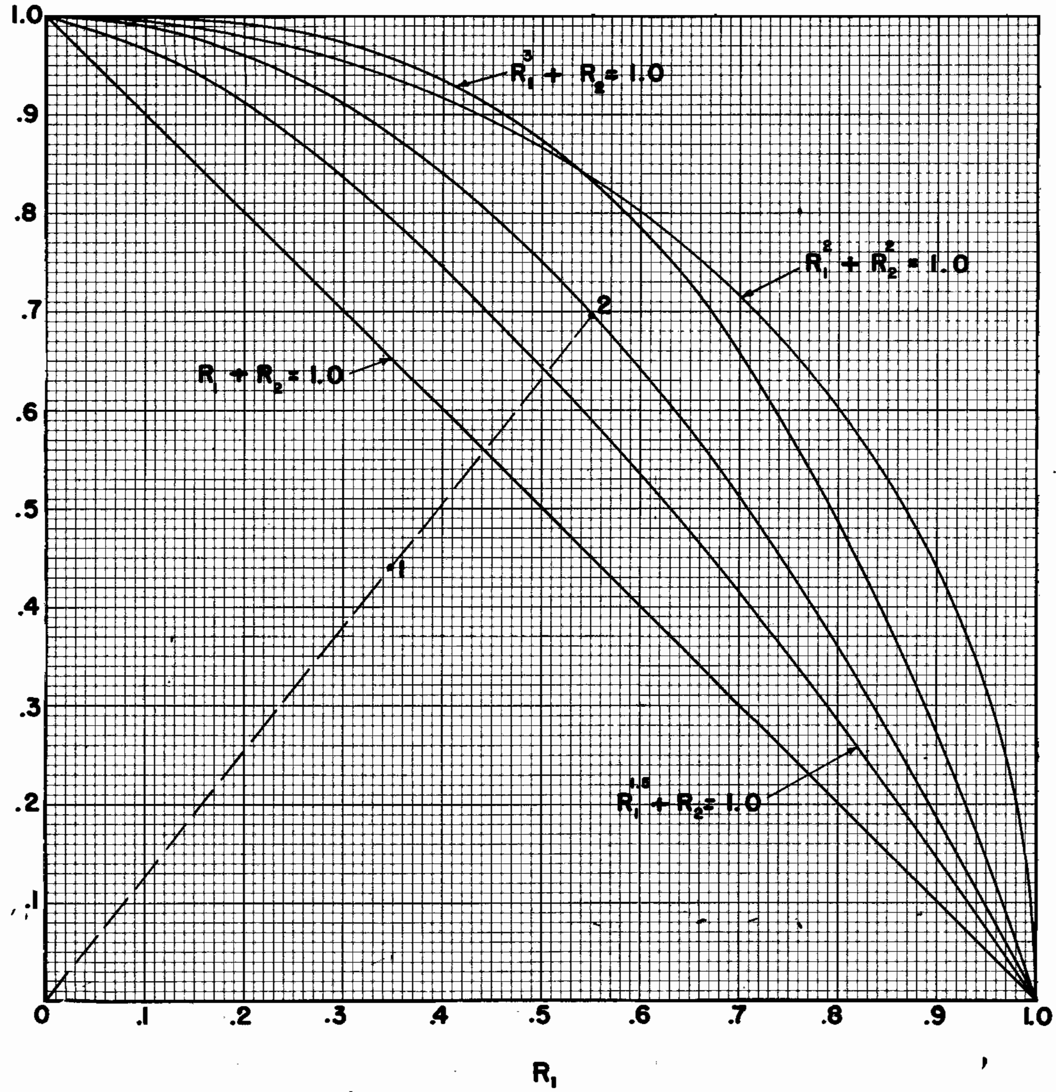
For example, if a round tube, 50 inches long, welded at the ends (c = 2) is required to carry a load of 28,000 pounds, select the lightest tube available. Assume the material to be special X-4130, F_{tu} = 100,000, F_{ty} = 85,000. Tubes on the following two adjacent charts will satisfy the requirements:

ROUNDS, 85,000, D = 1⅝″ to 1⅞″, and
ROUNDS, 85,000, D = 2″ to 2½″.

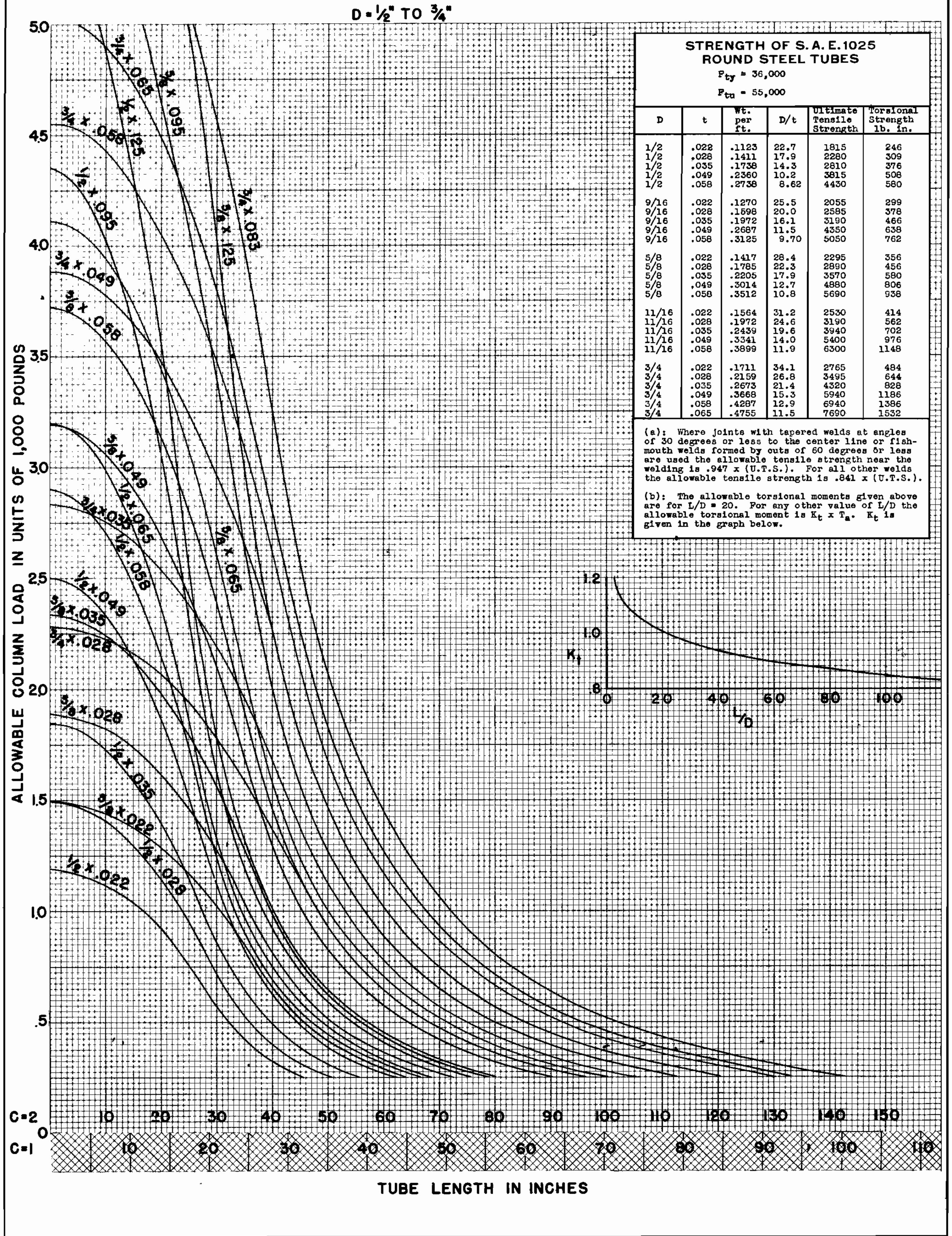
From the first we find that of the two probable tubes 1⅞″ x 0.083″ and 1¾″ x 0.095″ the first is the lighter. From the second we find that the 2¼″ x 0.058″ is the lightest. We note in the charts in the upper right-hand corners that the weight of the 1⅞″ x 0.083″ tube is 1.589 pounds per foot and the weight of the 2¼″ x 0.058″ tube is 1.358 pounds per foot. Thus if the lightness is the criterion the 2¼″ x 0.058″ tube would be selected. For convenience of the engineer, the tensile strength, the bending strength, and the torsional strength of the tubes are repeated on the charts.

It should be particularly noted that in selecting a tube for lightness adjacent charts should be consulted for possible lighter tubes.

CHART 6



TYPICAL INTERACTION CURVES
FOR COMBINED LOADING CONDITIONS



STRENGTH OF S.A.E.1025 ROUND STEEL TUBES

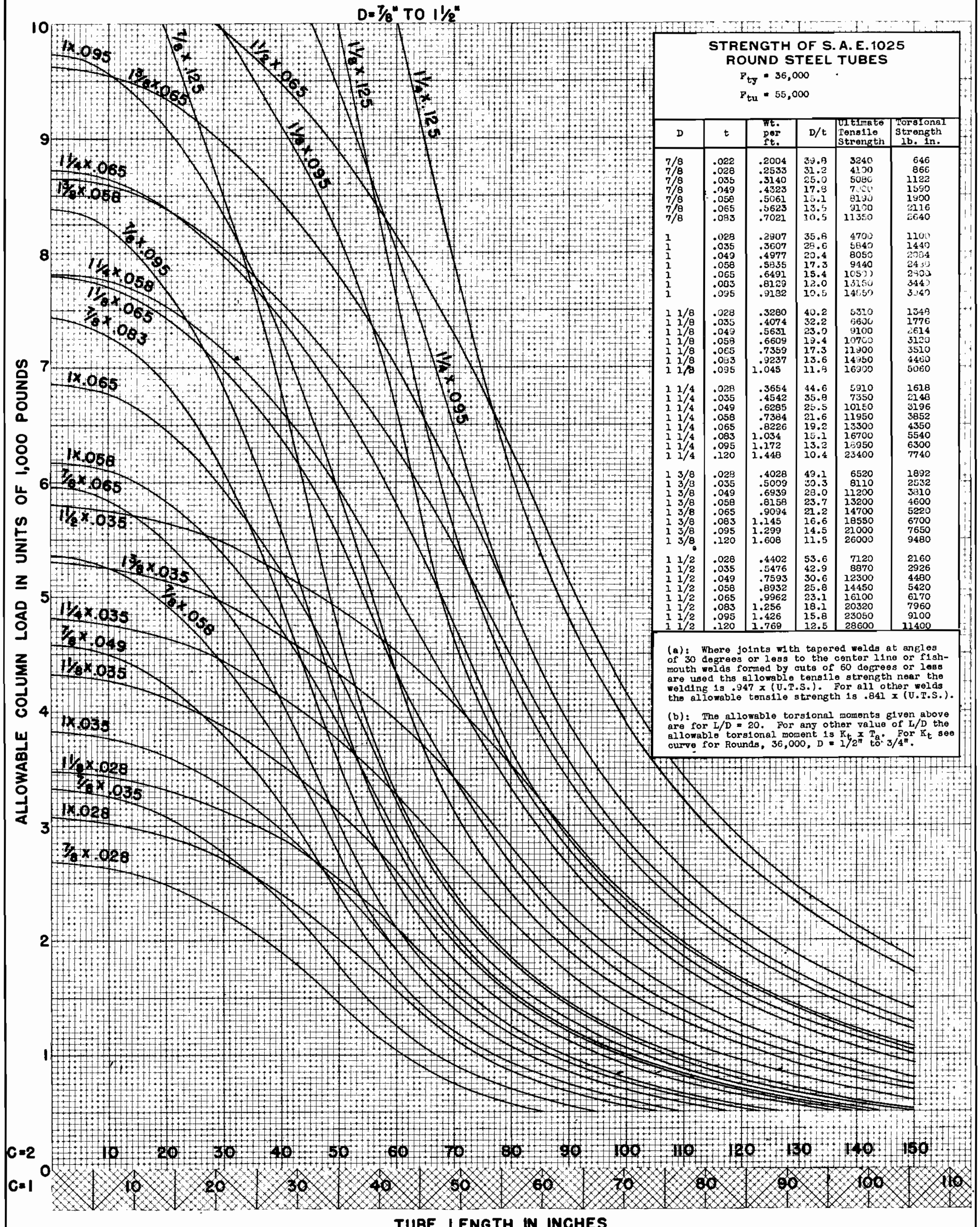
F_{ty} = 36,000

F_{tu} = 55,000

D	t	Wt. per ft.	D/t	Ultimate Tensile Strength	Torsional Strength lb. in.
1/2	.022	.1123	22.7	1815	246
1/2	.028	.1411	17.9	2280	309
1/2	.035	.1738	14.3	2810	376
1/2	.049	.2360	10.2	3815	508
1/2	.058	.2738	8.62	4430	580
9/16	.022	.1270	25.5	2055	299
9/16	.028	.1598	20.0	2585	378
9/16	.035	.1972	16.1	3190	466
9/16	.049	.2687	11.5	4350	638
9/16	.058	.3125	9.70	5050	762
5/8	.022	.1417	28.4	2295	356
5/8	.028	.1785	22.3	2890	456
5/8	.035	.2205	17.9	3570	580
5/8	.049	.3014	12.7	4880	806
5/8	.058	.3512	10.8	5690	938
11/16	.022	.1564	31.2	2530	414
11/16	.028	.1972	24.6	3190	562
11/16	.035	.2439	19.6	3940	702
11/16	.049	.3341	14.0	5400	976
11/16	.058	.3899	11.9	6300	1148
3/4	.022	.1711	34.1	2765	484
3/4	.028	.2159	26.8	3495	644
3/4	.035	.2673	21.4	4320	828
3/4	.049	.3668	15.3	5940	1186
3/4	.058	.4287	12.9	6940	1386
3/4	.065	.4755	11.5	7690	1532

(a): Where joints with tapered welds at angles of 30 degrees or less to the center line or fish-mouth welds formed by cuts of 60 degrees or less are used the allowable tensile strength near the welding is .947 x (U.T.S.). For all other welds the allowable tensile strength is .841 x (U.T.S.).

(b): The allowable torsional moments given above are for L/D = 20. For any other value of L/D the allowable torsional moment is $K_t \times T_a$. K_t is given in the graph below.



STRENGTH OF S.A.E. 1025 ROUND STEEL TUBES

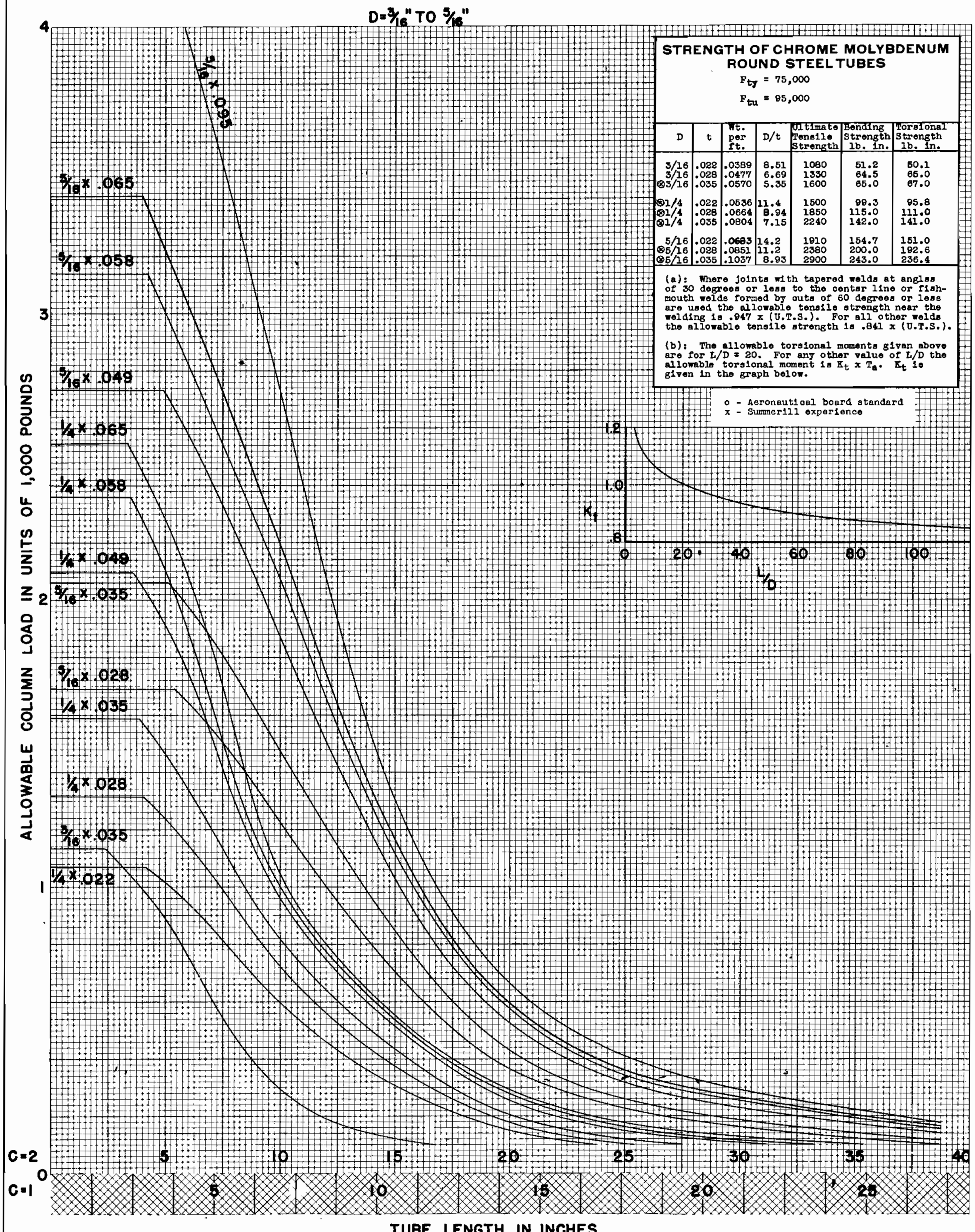
$F_{ty} = 36,000$

$F_{tu} = 55,000$

D	t	Wt. per ft.	D/t	Ultimate Tensile Strength	Torsional Strength lb. in.
7/8	.022	.2004	39.8	3240	646
7/8	.028	.2533	31.2	4100	866
7/8	.035	.3140	25.0	5080	1122
7/8	.049	.4323	17.8	7000	1590
7/8	.058	.5061	15.1	8190	1900
7/8	.065	.5623	13.5	9100	2116
7/8	.083	.7021	10.5	11350	2640
1	.028	.2907	35.8	4700	1100
1	.035	.3607	28.6	5840	1440
1	.049	.4977	20.4	8050	2084
1	.058	.5835	17.3	9440	2430
1	.065	.6491	15.4	10500	2800
1	.083	.8129	12.0	13150	3440
1	.095	.9182	10.5	14650	3040
1 1/8	.028	.3280	40.2	5310	1348
1 1/8	.035	.4074	32.2	6600	1776
1 1/8	.049	.5631	23.0	9100	2614
1 1/8	.058	.6609	19.4	10700	3120
1 1/8	.065	.7359	17.3	11900	3510
1 1/8	.083	.9237	13.6	14950	4460
1 1/8	.095	1.045	11.8	16900	5060
1 1/4	.028	.3654	44.6	5910	1618
1 1/4	.035	.4542	35.8	7350	2148
1 1/4	.049	.6285	25.5	10150	3196
1 1/4	.058	.7384	21.6	11950	3852
1 1/4	.065	.8226	19.2	13300	4350
1 1/4	.083	1.034	15.1	16700	5540
1 1/4	.095	1.172	13.2	18950	6300
1 1/4	.120	1.448	10.4	23400	7740
1 3/8	.028	.4028	49.1	6520	1892
1 3/8	.035	.5009	39.3	8110	2532
1 3/8	.049	.6939	28.0	11200	3810
1 3/8	.058	.8158	23.7	13200	4600
1 3/8	.065	.9094	21.2	14700	5220
1 3/8	.083	1.145	16.6	18550	6700
1 3/8	.095	1.299	14.5	21000	7650
1 3/8	.120	1.608	11.5	26000	9480
1 1/2	.028	.4402	53.6	7120	2160
1 1/2	.035	.5476	42.9	8870	2926
1 1/2	.049	.7593	30.6	12300	4480
1 1/2	.058	.8932	25.8	14450	5420
1 1/2	.065	.9962	23.1	16100	6170
1 1/2	.083	1.256	18.1	20320	7960
1 1/2	.095	1.426	15.8	23050	9100
1 1/2	.120	1.769	12.5	28600	11400

(a): Where joints with tapered welds at angles of 30 degrees or less to the center line or fish-mouth welds formed by cuts of 60 degrees or less are used ths allowable tensile strength near the welding is .947 x (U.T.S.). For all other welds the allowable tensile strength is .841 x (U.T.S.).

(b): The allowable torsional moments given above are for L/D = 20. For any other value of L/D the allowable torsional moment is $K_t \times T_a$. For K_t see curve for Rounds, 36,000, D = 1/2" to 3/4".



STRENGTH OF CHROME MOLYBDENUM ROUND STEEL TUBES

F_{ty} = 75,000

F_{tu} = 95,000

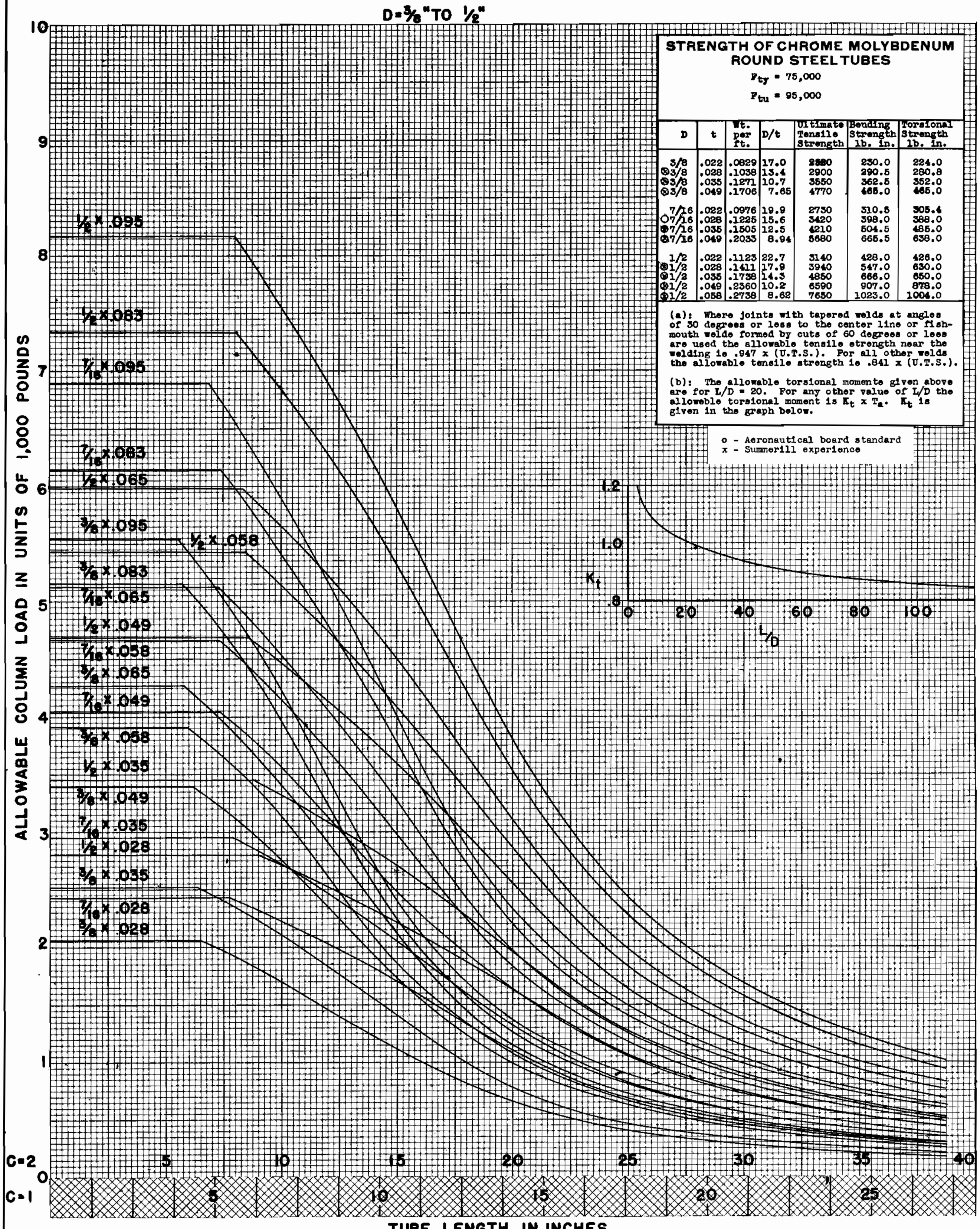
D	t	Wt. per ft.	D/t	Ultimate Tensile Strength	Bending Strength lb. in.	Torsional Strength lb. in.
3/16	.022	.0389	8.51	1080	51.2	50.1
3/16	.028	.0477	6.69	1330	64.5	65.0
⊗3/16	.035	.0570	5.35	1600	65.0	67.0
⊗1/4	.022	.0536	11.4	1500	99.3	95.8
⊗1/4	.028	.0664	8.94	1850	115.0	111.0
⊗1/4	.035	.0804	7.15	2240	142.0	141.0
5/16	.022	.0683	14.2	1910	154.7	151.0
⊗5/16	.028	.0851	11.2	2380	200.0	192.6
⊗5/16	.035	.1037	8.93	2900	243.0	236.4

(a): Where joints with tapered welds at angles of 30 degrees or less to the center line or fish-mouth welds formed by cuts of 60 degrees or less are used the allowable tensile strength near the welding is .947 x (U.T.S.). For all other welds the allowable tensile strength is .841 x (U.T.S.).

(b): The allowable torsional moments given above are for L/D = 20. For any other value of L/D the allowable torsional moment is $K_t \times T_a$. K_t is given in the graph below.

o - Aeronautical board standard
x - Summerill experience

For Rounds — 85,000 Yield See III — 42



STRENGTH OF CHROME MOLYBDENUM ROUND STEEL TUBES

F_{ty} = 75,000

F_{tu} = 95,000

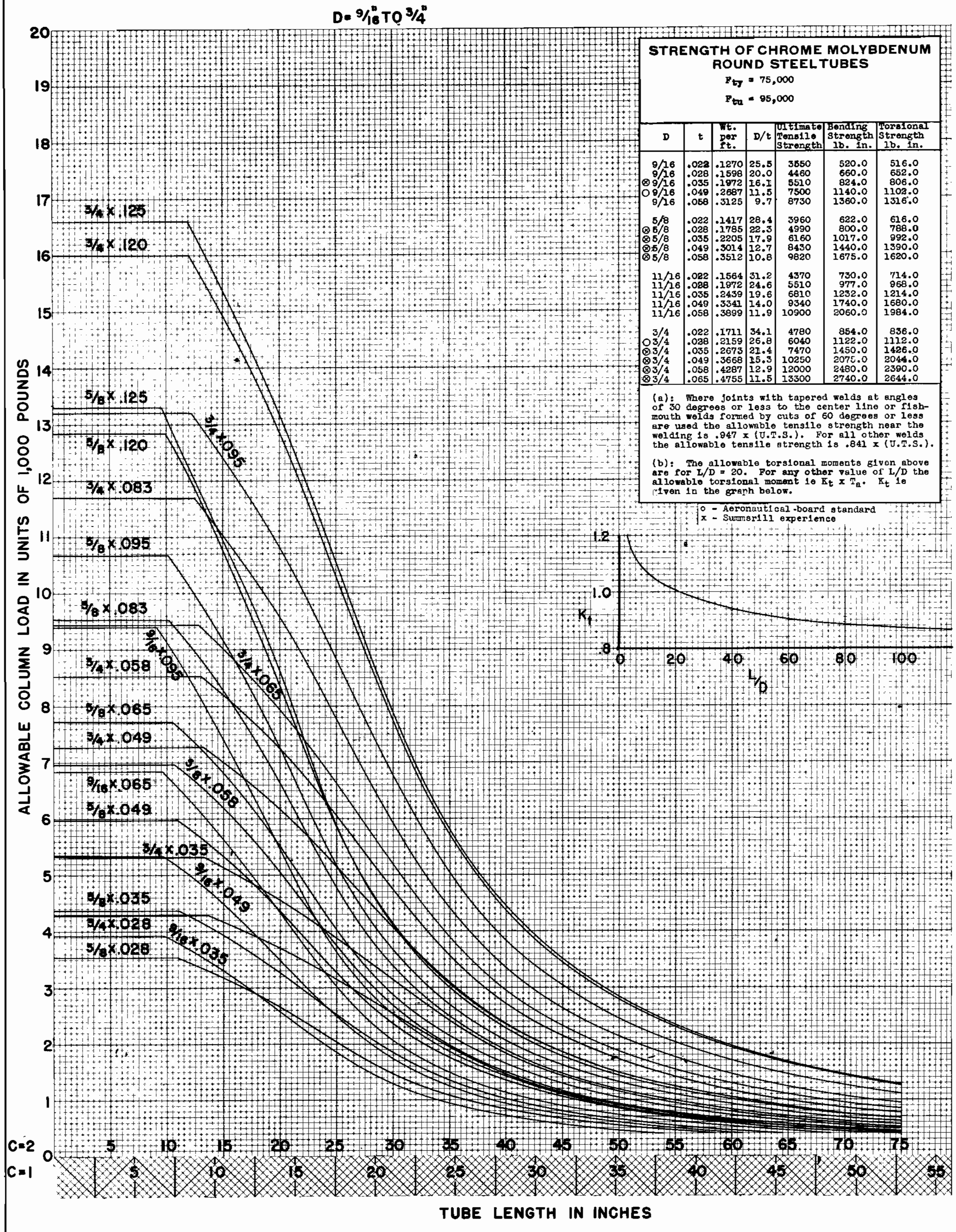
D	t	Wt. per ft.	D/t	Ultimate Tensile Strength	Bending Strength lb. in.	Torsional Strength lb. in.
3/8	.022	.0829	17.0	[illegible]	230.0	224.0
⊗3/8	.028	.1038	13.4	2900	290.5	280.8
⊗3/8	.035	.1271	10.7	3550	362.5	352.0
⊗3/8	.049	.1706	7.65	4770	465.0	465.0
7/16	.022	.0976	19.9	2730	310.5	305.4
○7/16	.028	.1225	15.6	3420	398.0	388.0
⊗7/16	.035	.1505	12.5	4210	504.5	485.0
⊗7/16	.049	.2033	8.94	5680	665.5	638.0
1/2	.022	.1123	22.7	3140	428.0	426.0
⊗1/2	.028	.1411	17.9	3940	547.0	630.0
⊗1/2	.035	.1738	14.3	4850	666.0	650.0
⊗1/2	.049	.2360	10.2	6590	907.0	878.0
⊗1/2	.058	.2738	8.62	7650	1023.0	1004.0

(a): Where joints with tapered welds at angles of 30 degrees or less to the center line or fish-mouth welds formed by cuts of 60 degrees or less are used the allowable tensile strength near the welding is .947 x (U.T.S.). For all other welds the allowable tensile strength is .841 x (U.T.S.).

(b): The allowable torsional moments given above are for L/D = 20. For any other value of L/D the allowable torsional moment is $K_t \times T_a$. K_t is given in the graph below.

o - Aeronautical board standard
x - Summerill experience

For Rounds — 85,000 Yield. See III — 42



STRENGTH OF CHROME MOLYBDENUM ROUND STEEL TUBES

$F_{ty} = 75{,}000$

$F_{tu} = 95{,}000$

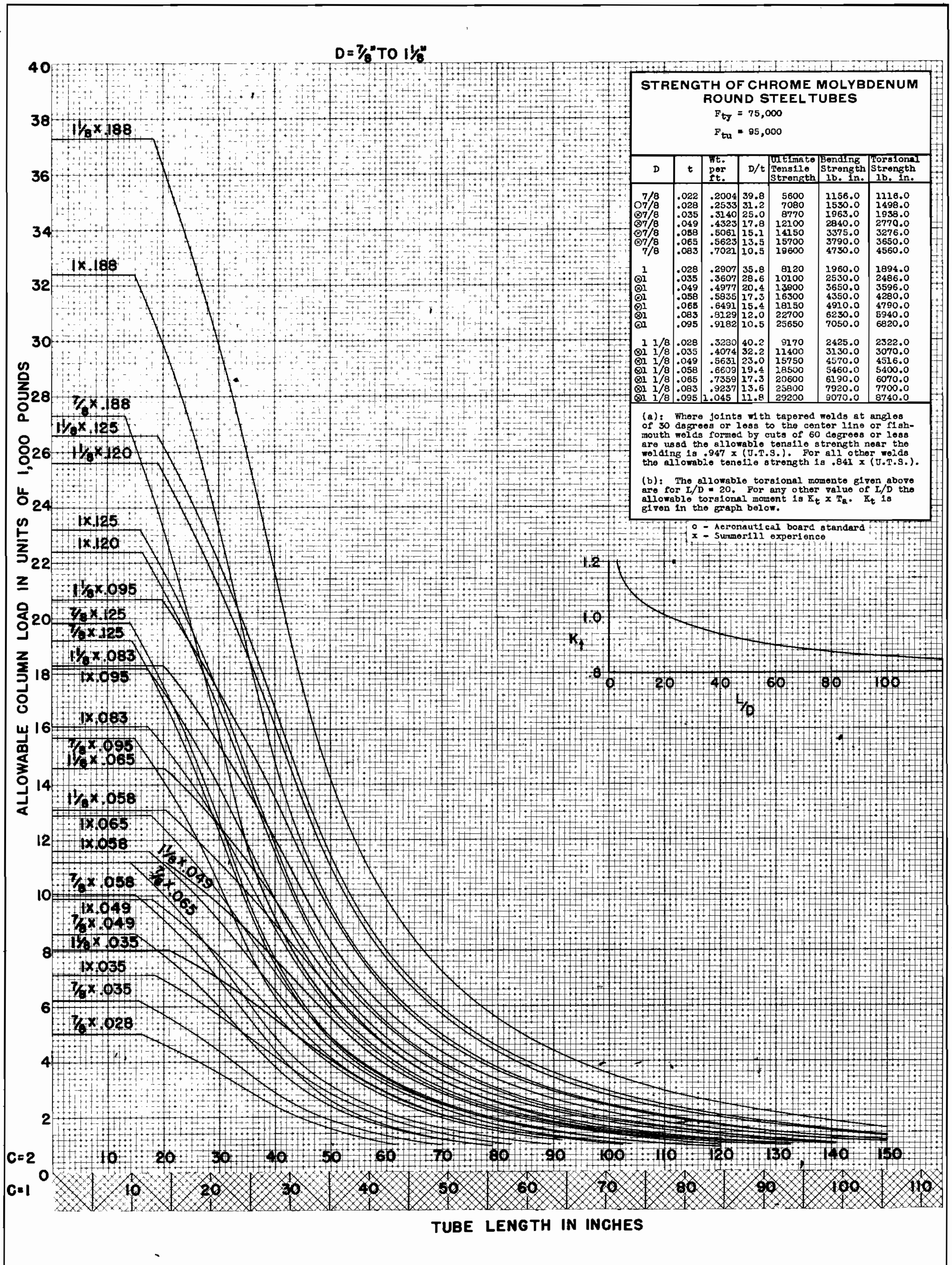
D	t	Wt. per ft.	D/t	Ultimate Tensile Strength	Bending Strength lb. in.	Torsional Strength lb. in.
9/16	.022	.1270	25.5	3550	520.0	516.0
9/16	.028	.1598	20.0	4460	660.0	652.0
⊗ 9/16	.035	.1972	16.1	5510	824.0	806.0
○ 9/16	.049	.2687	11.5	7500	1140.0	1102.0
9/16	.058	.3125	9.7	8730	1360.0	1316.0
5/8	.022	.1417	28.4	3960	622.0	616.0
⊗ 5/8	.028	.1785	22.3	4990	800.0	788.0
⊗ 5/8	.035	.2205	17.9	6160	1017.0	992.0
⊗ 5/8	.049	.3014	12.7	8430	1440.0	1390.0
⊗ 5/8	.058	.3512	10.8	9820	1675.0	1620.0
11/16	.022	.1564	31.2	4370	730.0	714.0
11/16	.028	.1972	24.6	5510	977.0	968.0
11/16	.035	.2439	19.6	6810	1232.0	1214.0
11/16	.049	.3341	14.0	9340	1740.0	1680.0
11/16	.058	.3899	11.9	10900	2060.0	1984.0
3/4	.022	.1711	34.1	4780	854.0	836.0
○ 3/4	.028	.2159	26.8	6040	1122.0	1112.0
⊗ 3/4	.035	.2673	21.4	7470	1450.0	1426.0
⊗ 3/4	.049	.3668	15.3	10250	2075.0	2044.0
⊗ 3/4	.058	.4287	12.9	12000	2480.0	2390.0
⊗ 3/4	.065	.4755	11.5	13300	2740.0	2644.0

(a): Where joints with tapered welds at angles of 30 degrees or less to the center line or fish-mouth welds formed by cuts of 60 degrees or less are used the allowable tensile strength near the welding is .947 x (U.T.S.). For all other welds the allowable tensile strength is .841 x (U.T.S.).

(b): The allowable torsional moments given above are for L/D = 20. For any other value of L/D the allowable torsional moment is $K_t \times T_a$. K_t is given in the graph below.

o - Aeronautical-board standard
x - Summerill experience

For Rounds — 85,000 Yield . See III — 42



STRENGTH OF CHROME MOLYBDENUM ROUND STEEL TUBES

F_{ty} = 75,000

F_{tu} = 95,000

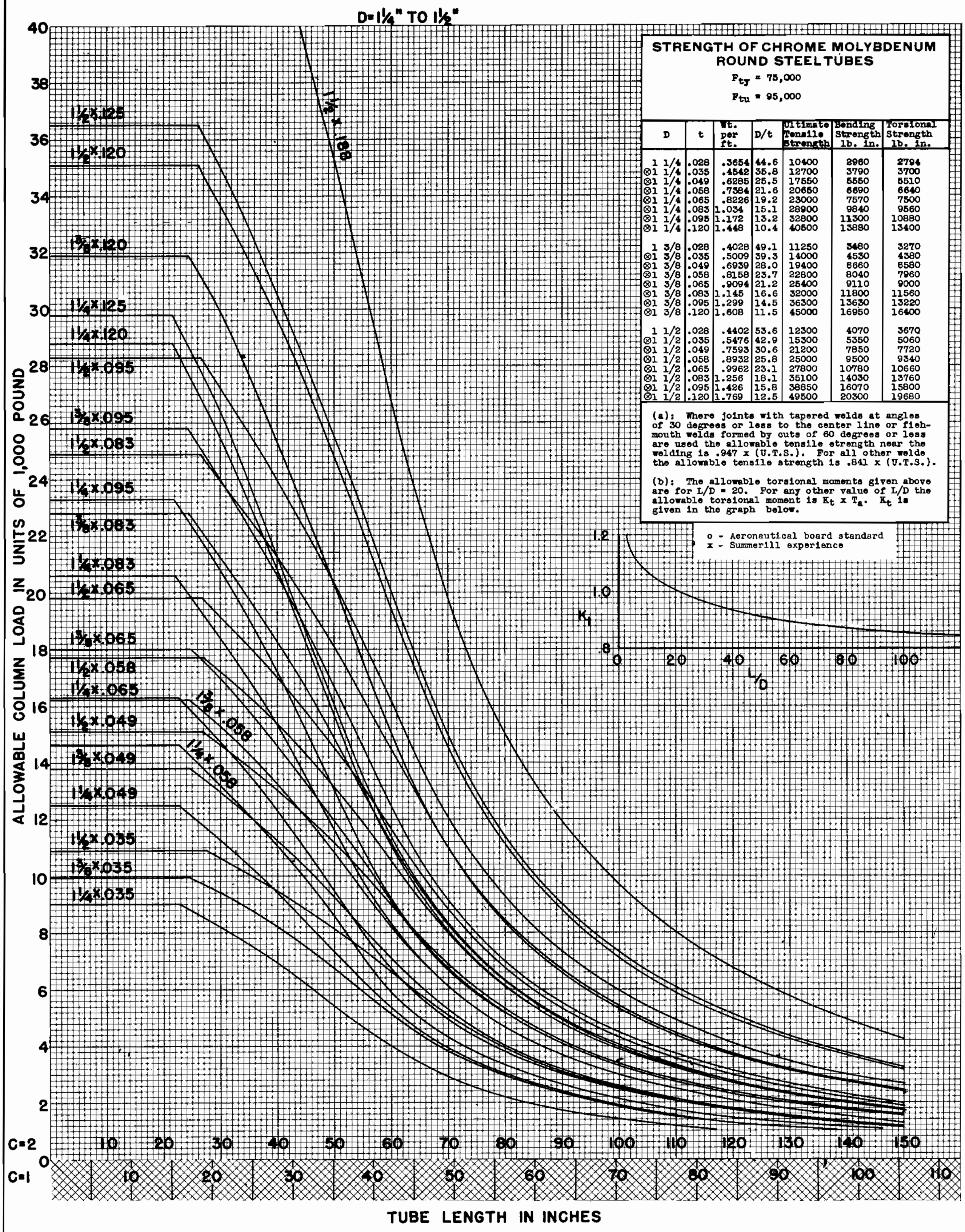
D	t	Wt. per ft.	D/t	Ultimate Tensile Strength	Bending Strength lb. in.	Torsional Strength lb. in.
7/8	.022	.2004	39.8	5600	1156.0	1116.0
o7/8	.028	.2533	31.2	7080	1530.0	1498.0
⊗7/8	.035	.3140	25.0	8770	1963.0	1938.0
⊗7/8	.049	.4323	17.8	12100	2840.0	2770.0
⊗7/8	.058	.5061	15.1	14150	3375.0	3276.0
⊗7/8	.065	.5623	13.5	15700	3790.0	3650.0
7/8	.083	.7021	10.5	19600	4730.0	4560.0
1	.028	.2907	35.8	8120	1960.0	1894.0
⊗1	.035	.3607	28.6	10100	2530.0	2486.0
⊗1	.049	.4977	20.4	13900	3650.0	3596.0
⊗1	.058	.5835	17.3	16300	4350.0	4280.0
⊗1	.065	.6491	15.4	18150	4910.0	4790.0
⊗1	.083	.8129	12.0	22700	6230.0	5940.0
⊗1	.095	.9182	10.5	25650	7050.0	6820.0
1 1/8	.028	.3280	40.2	9170	2425.0	2322.0
⊗1 1/8	.035	.4074	32.2	11400	3130.0	3070.0
⊗1 1/8	.049	.5631	23.0	15750	4570.0	4516.0
⊗1 1/8	.058	.6609	19.4	18500	5460.0	5400.0
⊗1 1/8	.065	.7359	17.3	20600	6190.0	6070.0
⊗1 1/8	.083	.9237	13.6	25800	7920.0	7700.0
⊗1 1/8	.095	1.045	11.8	29200	9070.0	8740.0

(a): Where joints with tapered welds at angles of 30 degrees or less to the center line or fish-mouth welds formed by cuts of 60 degrees or less are used the allowable tensile strength near the welding is .947 x (U.T.S.). For all other welds the allowable tensile strength is .841 x (U.T.S.).

(b): The allowable torsional moments given above are for L/D = 20. For any other value of L/D the allowable torsional moment is $K_t \times T_a$. K_t is given in the graph below.

o - Aeronautical board standard
x - Summerill experience

For Rounds — 85,000 Yield See III — 42



STRENGTH OF CHROME MOLYBDENUM ROUND STEEL TUBES

F_{ty} = 75,000

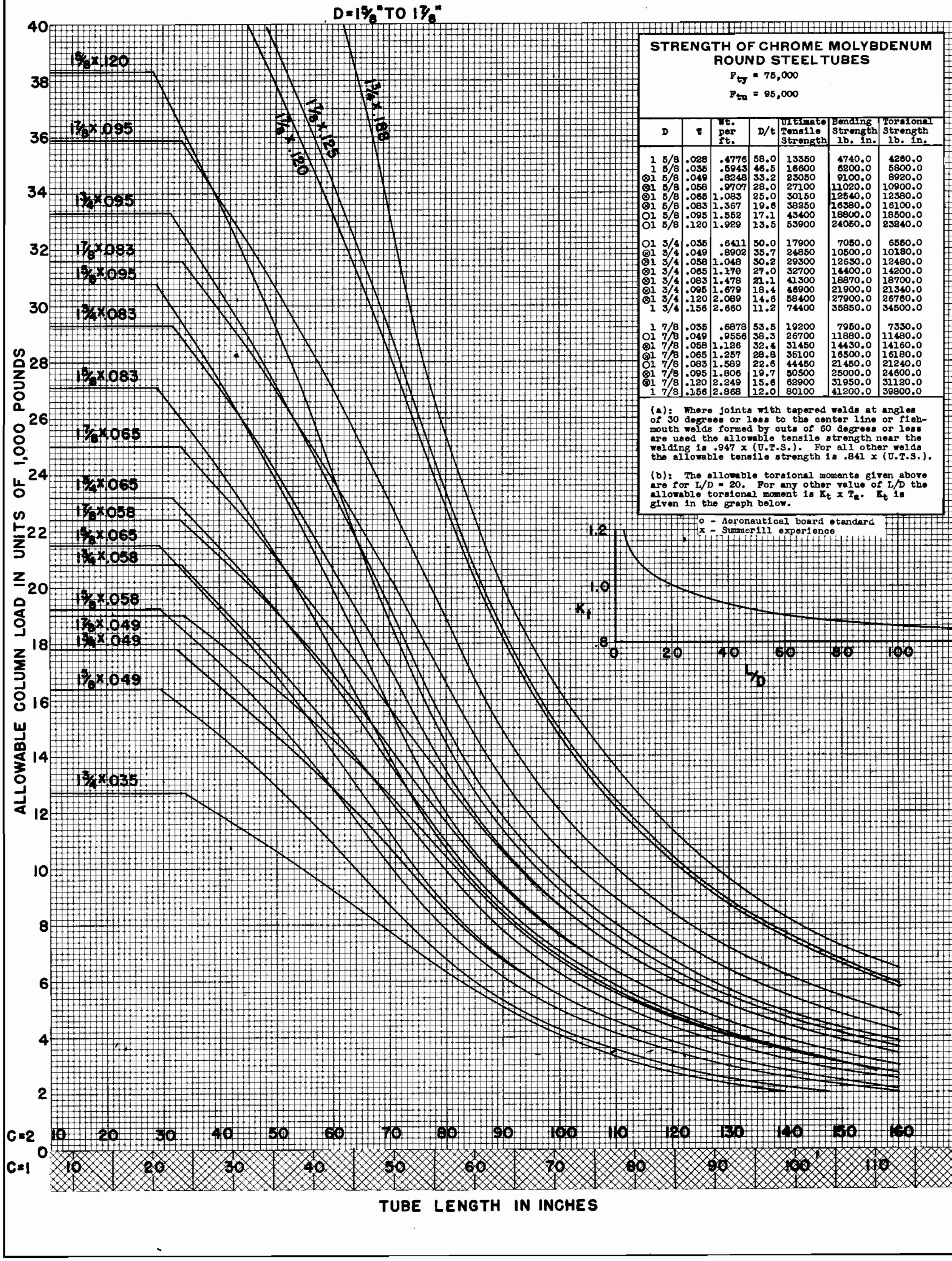
F_{tu} = 95,000

D	t	Wt. per ft.	D/t	Ultimate Tensile Strength	Bending Strength lb. in.	Torsional Strength lb. in.
1 1/4	.028	.3654	44.6	10400	2960	2794
⊗1 1/4	.035	.4542	35.8	12700	3790	3700
⊗1 1/4	.049	.6285	25.5	17550	5550	5510
⊗1 1/4	.058	.7384	21.6	20650	6690	6640
⊗1 1/4	.065	.8226	19.2	23000	7570	7500
⊗1 1/4	.083	1.034	15.1	28900	9840	9560
⊗1 1/4	.095	1.172	13.2	32800	11300	10880
⊗1 1/4	.120	1.448	10.4	40500	13880	13400
1 3/8	.028	.4028	49.1	11250	3480	3270
⊗1 3/8	.035	.5009	39.3	14000	4530	4380
⊗1 3/8	.049	.6939	28.0	19400	6660	6580
⊗1 3/8	.058	.8158	23.7	22800	8040	7960
⊗1 3/8	.065	.9094	21.2	25400	9110	9000
⊗1 3/8	.083	1.145	16.6	32000	11800	11560
⊗1 3/8	.095	1.299	14.5	36300	13630	13220
⊗1 3/8	.120	1.608	11.5	45000	16950	16400
1 1/2	.028	.4402	53.6	12300	4070	3670
⊗1 1/2	.035	.5476	42.9	15300	5350	5060
⊗1 1/2	.049	.7593	30.6	21200	7850	7720
⊗1 1/2	.058	.8932	25.8	25000	9500	9340
⊗1 1/2	.065	.9962	23.1	27800	10780	10660
⊗1 1/2	.083	1.256	18.1	35100	14030	13760
⊗1 1/2	.095	1.426	15.8	38850	16070	15800
⊗1 1/2	.120	1.769	12.5	49500	20300	19680

(a): Where joints with tapered welds at angles of 30 degrees or less to the center line or fish-mouth welds formed by cuts of 60 degrees or less are used the allowable tensile strength near the welding is .947 x (U.T.S.). For all other welds the allowable tensile strength is .841 x (U.T.S.).

(b): The allowable torsional moments given above are for L/D = 20. For any other value of L/D the allowable torsional moment is K_t x T_a. K_t is given in the graph below.

For Rounds — 85,000 Yield - See III — 42



STRENGTH OF CHROME MOLYBDENUM ROUND STEEL TUBES

F_{ty} = 75,000

F_{tu} = 95,000

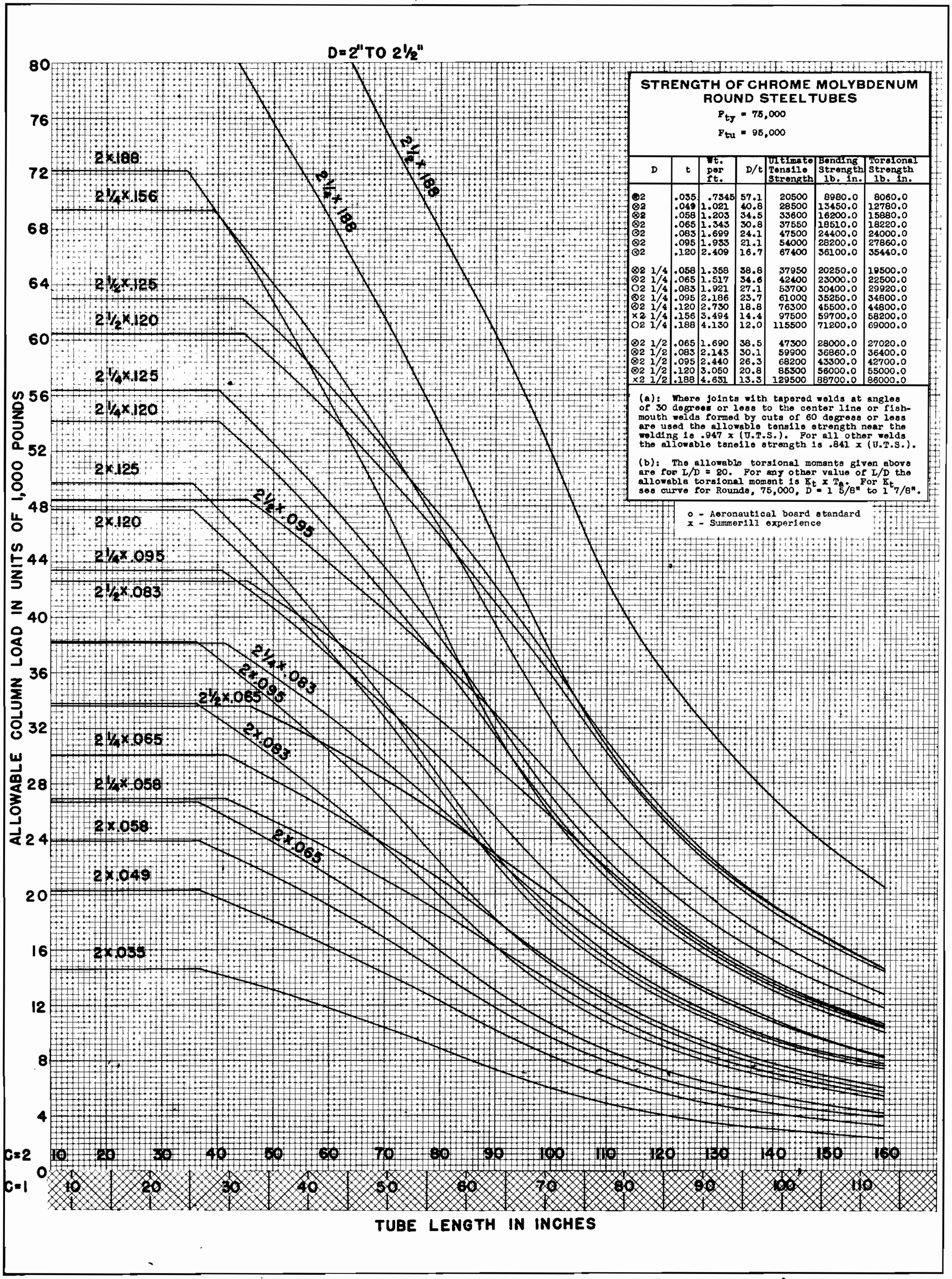
D	t	Wt. per ft.	D/t	Ultimate Tensile Strength	Bending Strength lb. in.	Torsional Strength lb. in.
1 5/8	.028	.4776	58.0	13350	4740.0	4260.0
1 5/8	.035	.5943	46.5	16600	6200.0	5800.0
⊗1 5/8	.049	.8248	33.2	23050	9100.0	8920.0
⊗1 5/8	.058	.9707	28.0	27100	11020.0	10900.0
⊗1 5/8	.065	1.083	25.0	30150	12540.0	12380.0
⊗1 5/8	.083	1.367	19.6	38250	16380.0	16100.0
O1 5/8	.095	1.552	17.1	43400	18800.0	18500.0
O1 5/8	.120	1.929	13.5	53900	24050.0	23840.0
O1 3/4	.035	.6411	50.0	17900	7050.0	6550.0
⊗1 3/4	.049	.8902	35.7	24850	10500.0	10180.0
⊗1 3/4	.058	1.048	30.2	29300	12630.0	12480.0
⊗1 3/4	.065	1.170	27.0	32700	14400.0	14200.0
⊗1 3/4	.083	1.478	21.1	41300	18870.0	18700.0
⊗1 3/4	.095	1.679	18.4	46900	21900.0	21340.0
⊗1 3/4	.120	2.089	14.6	58400	27900.0	26760.0
1 3/4	.156	2.660	11.2	74400	35850.0	34500.0
1 7/8	.035	.6878	53.5	19200	7950.0	7330.0
O1 7/8	.049	.9556	38.3	26700	11880.0	11480.0
⊗1 7/8	.058	1.126	32.4	31450	14430.0	14160.0
⊗1 7/8	.065	1.257	28.8	35100	16500.0	16180.0
O1 7/8	.083	1.589	22.6	44450	21450.0	21240.0
⊗1 7/8	.095	1.806	19.7	50500	25000.0	24600.0
⊗1 7/8	.120	2.249	15.6	62900	31950.0	31120.0
1 7/8	.156	2.868	12.0	80100	41200.0	39800.0

(a): Where joints with tapered welds at angles of 30 degrees or less to the center line or fish-mouth welds formed by cuts of 60 degrees or less are used the allowable tensile strength near the welding is .947 x (U.T.S.). For all other welds the allowable tensile strength is .841 x (U.T.S.).

(b): The allowable torsional moments given above are for L/D = 20. For any other value of L/D the allowable torsional moment is K_t x T_a. K_t is given in the graph below.

o - Aeronautical board standard
x - Summerill experience

For Rounds — 85,000 Yield . See III — 42



STRENGTH OF CHROME MOLYBDENUM ROUND STEEL TUBES

F_{ty} = 75,000

F_{tu} = 95,000

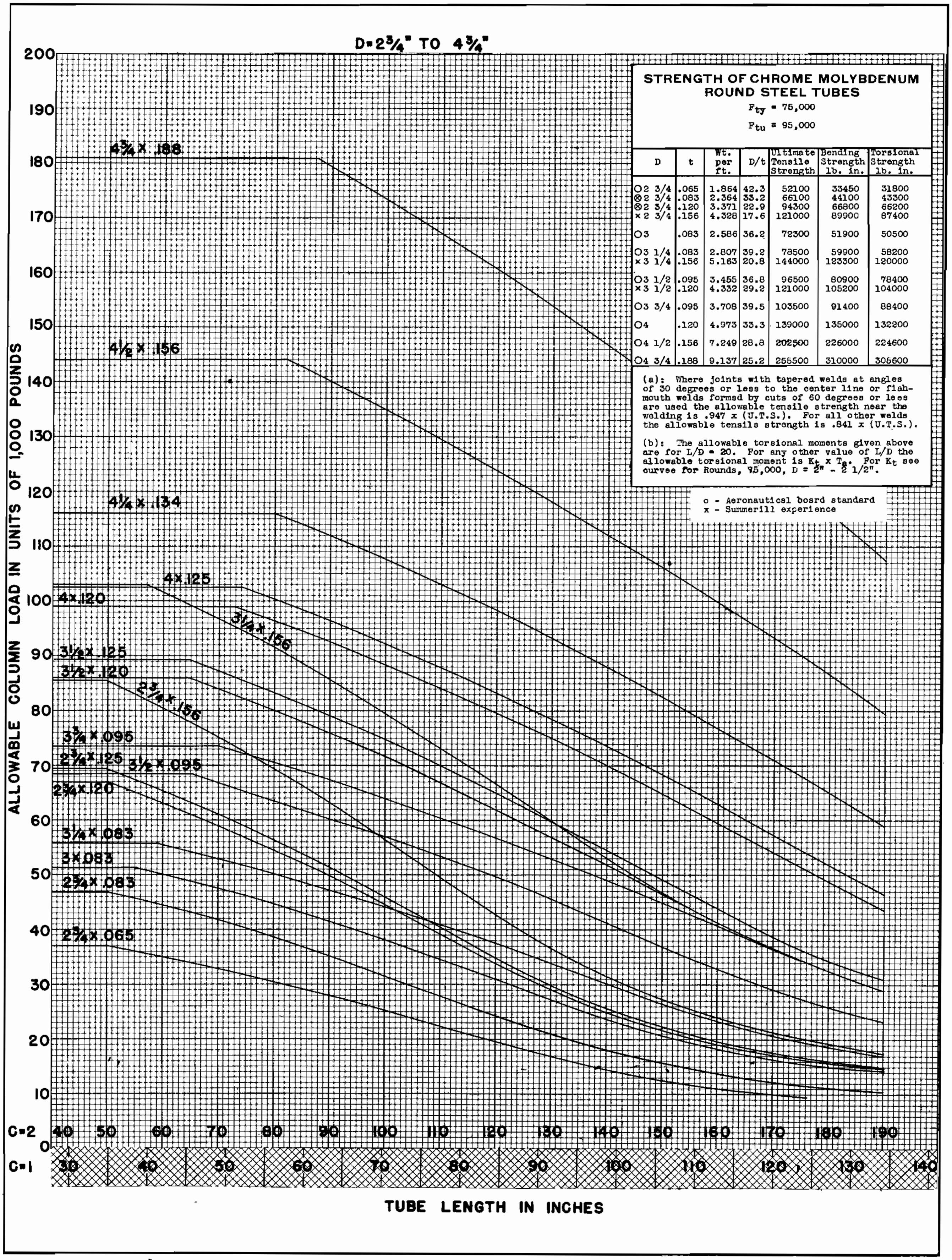
D	t	Wt. per ft.	D/t	Ultimate Tensile Strength	Bending Strength lb. in.	Torsional Strength lb. in.
⊗2	.035	.7345	57.1	20500	8980.0	8060.0
⊗2	.049	1.021	40.8	28500	13450.0	12780.0
⊗2	.058	1.203	34.5	33600	16200.0	15880.0
⊗2	.065	1.343	30.8	37550	18510.0	18220.0
⊗2	.083	1.699	24.1	47500	24400.0	24000.0
⊗2	.095	1.933	21.1	54000	28200.0	27860.0
⊗2	.120	2.409	16.7	67400	36100.0	35440.0
⊗2 1/4	.058	1.358	38.8	37950	20250.0	19500.0
⊗2 1/4	.065	1.517	34.6	42400	23000.0	22500.0
O2 1/4	.083	1.921	27.1	53700	30400.0	29920.0
⊗2 1/4	.095	2.186	23.7	61000	35250.0	34800.0
⊗2 1/4	.120	2.730	18.8	76300	45500.0	44800.0
×2 1/4	.156	3.494	14.4	97500	59700.0	58200.0
O2 1/4	.188	4.130	12.0	115500	71200.0	69000.0
⊗2 1/2	.065	1.690	38.5	47300	28000.0	27020.0
⊗2 1/2	.083	2.143	30.1	59900	36860.0	36400.0
⊗2 1/2	.095	2.440	26.3	68200	43300.0	42700.0
⊗2 1/2	.120	3.050	20.8	85300	56000.0	55000.0
×2 1/2	.188	4.631	13.3	129500	88700.0	86000.0

(a): Where joints with tapered welds at angles of 30 degrees or less to the center line or fish-mouth welds formed by cuts of 60 degrees or less are used the allowable tensile strength near the welding is .947 x (U.T.S.). For all other welds the allowable tensile strength is .841 x (U.T.S.).

(b): The allowable torsional moments given above are for L/D = 20. For any other value of L/D the allowable torsional moment is $K_t \times T_a$. For K_t see curve for Rounds, 75,000, D = 1 5/8" to 1 7/8".

o - Aeronautical board standard
x - Summerill experience

For Rounds — 85,000 Yield - See III — 42



STRENGTH OF CHROME MOLYBDENUM ROUND STEEL TUBES

F_{ty} = 75,000

F_{tu} = 95,000

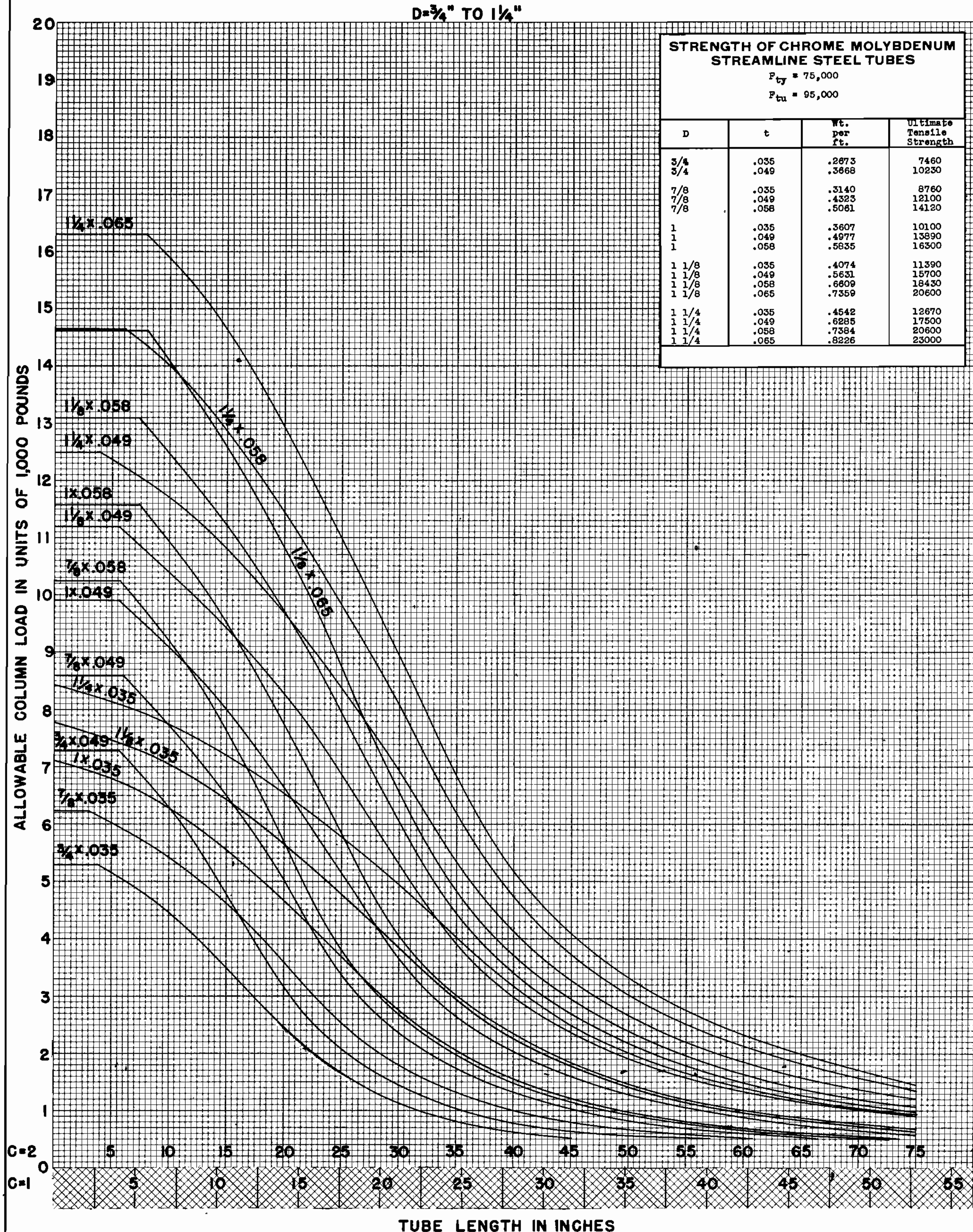
D	t	Wt. per ft.	D/t	Ultimate Tensile Strength	Bending Strength lb. in.	Torsional Strength lb. in.
O2 3/4	.065	1.864	42.3	52100	33450	31800
⊗2 3/4	.083	2.364	33.2	66100	44100	43300
⊗2 3/4	.120	3.371	22.9	94300	66800	66200
×2 3/4	.156	4.328	17.6	121000	89900	87400
O3	.083	2.586	36.2	72300	51900	50500
O3 1/4	.083	2.807	39.2	78500	59900	58200
×3 1/4	.156	5.163	20.8	144000	123300	120000
O3 1/2	.095	3.455	36.8	96500	80900	78400
×3 1/2	.120	4.332	29.2	121000	105200	104000
O3 3/4	.095	3.708	39.5	103500	91400	88400
O4	.120	4.973	33.3	139000	135000	132200
O4 1/2	.156	7.249	28.8	202500	226000	224600
O4 3/4	.188	9.137	25.2	255500	310000	305600

(a): Where joints with tapered welds at angles of 30 degrees or less to the center line or fish-mouth welds formed by cuts of 60 degrees or less are used the allowable tensile strength near the welding is .947 x (U.T.S.). For all other welds the allowable tensile strength is .841 x (U.T.S.).

(b): The allowable torsional moments given above are for L/D = 20. For any other value of L/D the allowable torsional moment is K_t x T_a. For K_t see curves for Rounds, 75,000, D = 2" - 2 1/2".

o - Aeronautical board standard
x - Summerill experience

For Rounds — 85,000 Yield See III — 42



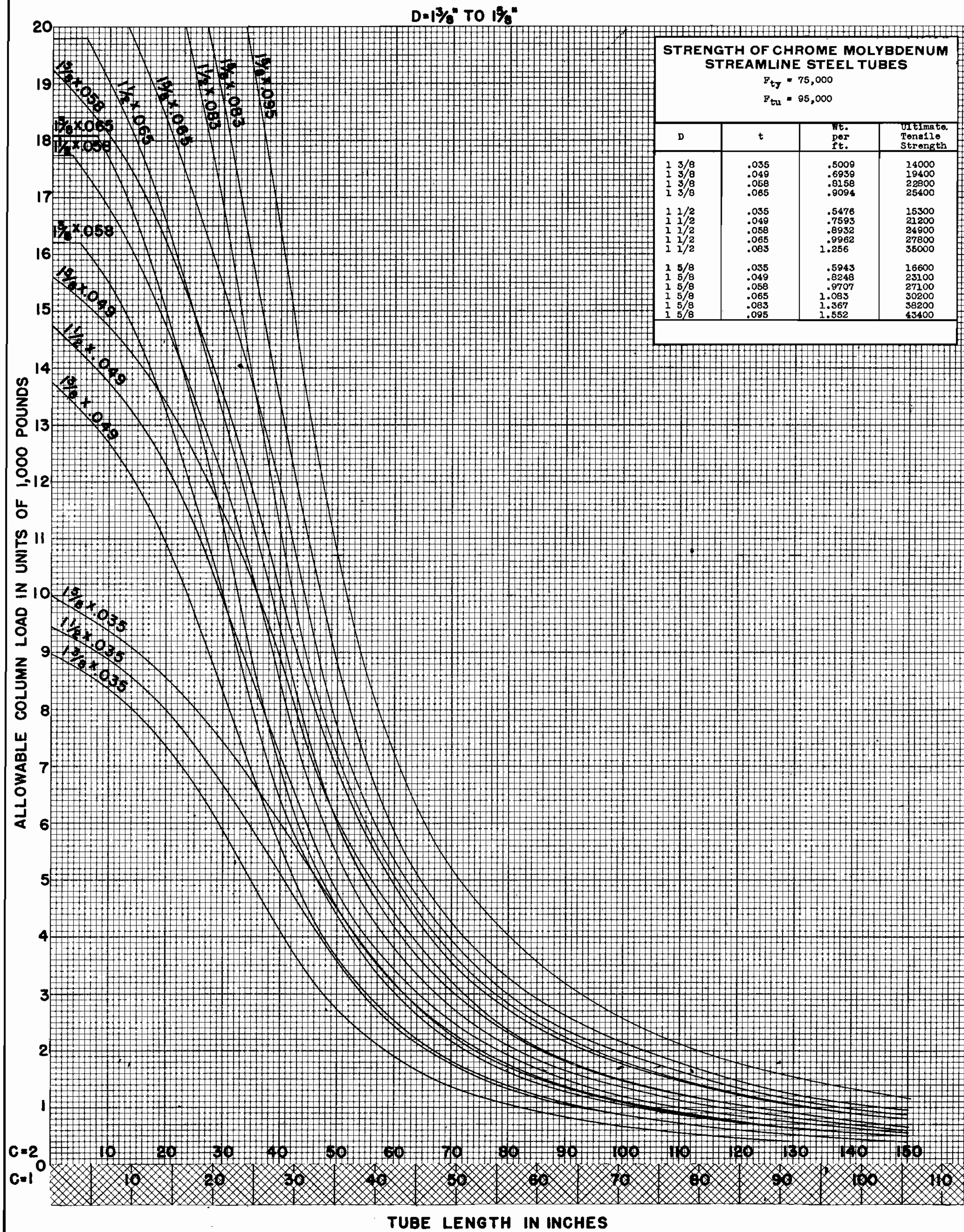
STRENGTH OF CHROME MOLYBDENUM STREAMLINE STEEL TUBES

F_{ty} = 75,000

F_{tu} = 95,000

D	t	Wt. per ft.	Ultimate Tensile Strength
3/4	.035	.2673	7460
3/4	.049	.3668	10230
7/8	.035	.3140	8760
7/8	.049	.4323	12100
7/8	.058	.5061	14120
1	.035	.3607	10100
1	.049	.4977	13890
1	.058	.5835	16300
1 1/8	.035	.4074	11390
1 1/8	.049	.5631	15700
1 1/8	.058	.6609	18430
1 1/8	.065	.7359	20600
1 1/4	.035	.4542	12670
1 1/4	.049	.6285	17500
1 1/4	.058	.7384	20600
1 1/4	.065	.8226	23000

For Streamline — 85,000 Yield See III — 50



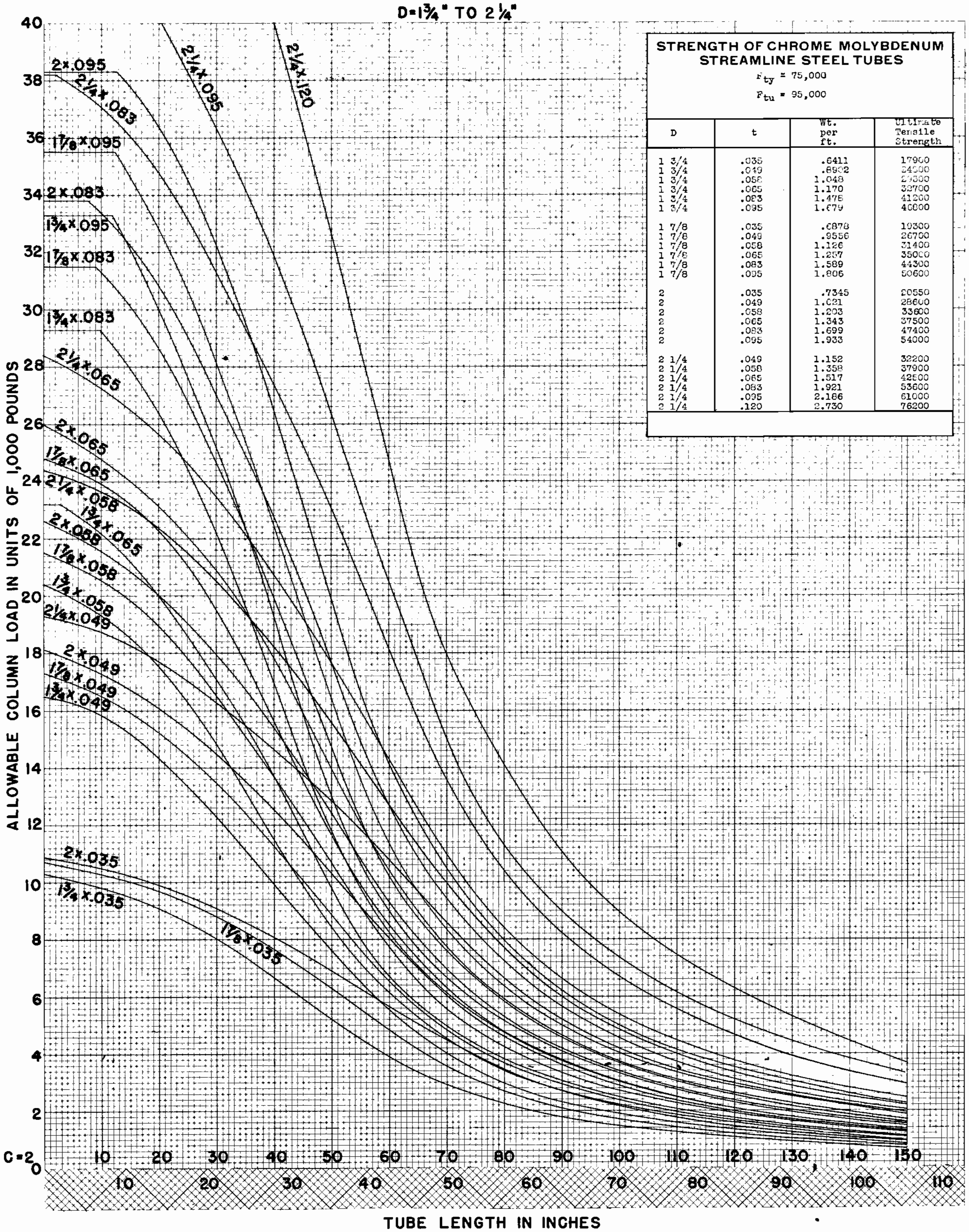
STRENGTH OF CHROME MOLYBDENUM STREAMLINE STEEL TUBES

F_{ty} = 75,000

F_{tu} = 95,000

D	t	Wt. per ft.	Ultimate Tensile Strength
1 3/8	.035	.5009	14000
1 3/8	.049	.6939	19400
1 3/8	.058	.8158	22800
1 3/8	.065	.9094	25400
1 1/2	.035	.5476	15300
1 1/2	.049	.7593	21200
1 1/2	.058	.8932	24900
1 1/2	.065	.9962	27800
1 1/2	.083	1.256	35000
1 5/8	.035	.5943	16600
1 5/8	.049	.8248	23100
1 5/8	.058	.9707	27100
1 5/8	.065	1.083	30200
1 5/8	.083	1.367	38200
1 5/8	.095	1.552	43400

For Streamline — 85,000 Yield. See III — 50



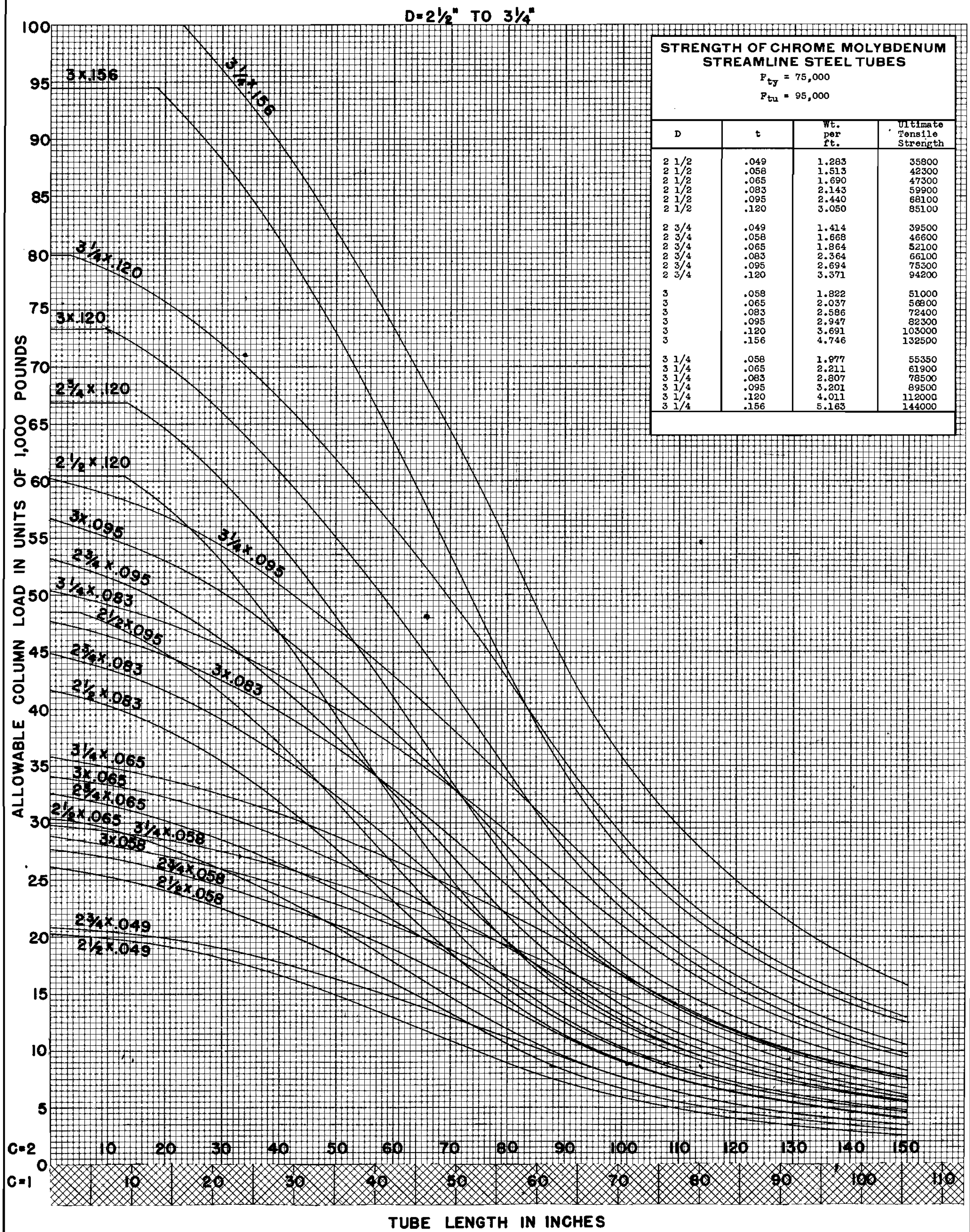
STRENGTH OF CHROME MOLYBDENUM STREAMLINE STEEL TUBES

F_{ty} = 75,000

F_{tu} = 95,000

D	t	Wt. per ft.	Ultimate Tensile Strength
1 3/4	.035	.6411	17900
1 3/4	.049	.8902	24500
1 3/4	.058	1.048	29300
1 3/4	.065	1.170	32700
1 3/4	.083	1.476	41200
1 3/4	.095	1.679	40800
1 7/8	.035	.6878	19300
1 7/8	.049	.9556	26700
1 7/8	.058	1.126	31400
1 7/8	.065	1.257	35000
1 7/8	.083	1.589	44300
1 7/8	.095	1.806	50600
2	.035	.7345	20550
2	.049	1.021	28600
2	.058	1.203	33600
2	.065	1.343	37500
2	.083	1.699	47400
2	.095	1.933	54000
2 1/4	.049	1.152	32200
2 1/4	.058	1.358	37900
2 1/4	.065	1.517	42500
2 1/4	.083	1.921	53600
2 1/4	.095	2.186	61000
2 1/4	.120	2.730	76200

For Streamline — 85,000 Yield See III — 50



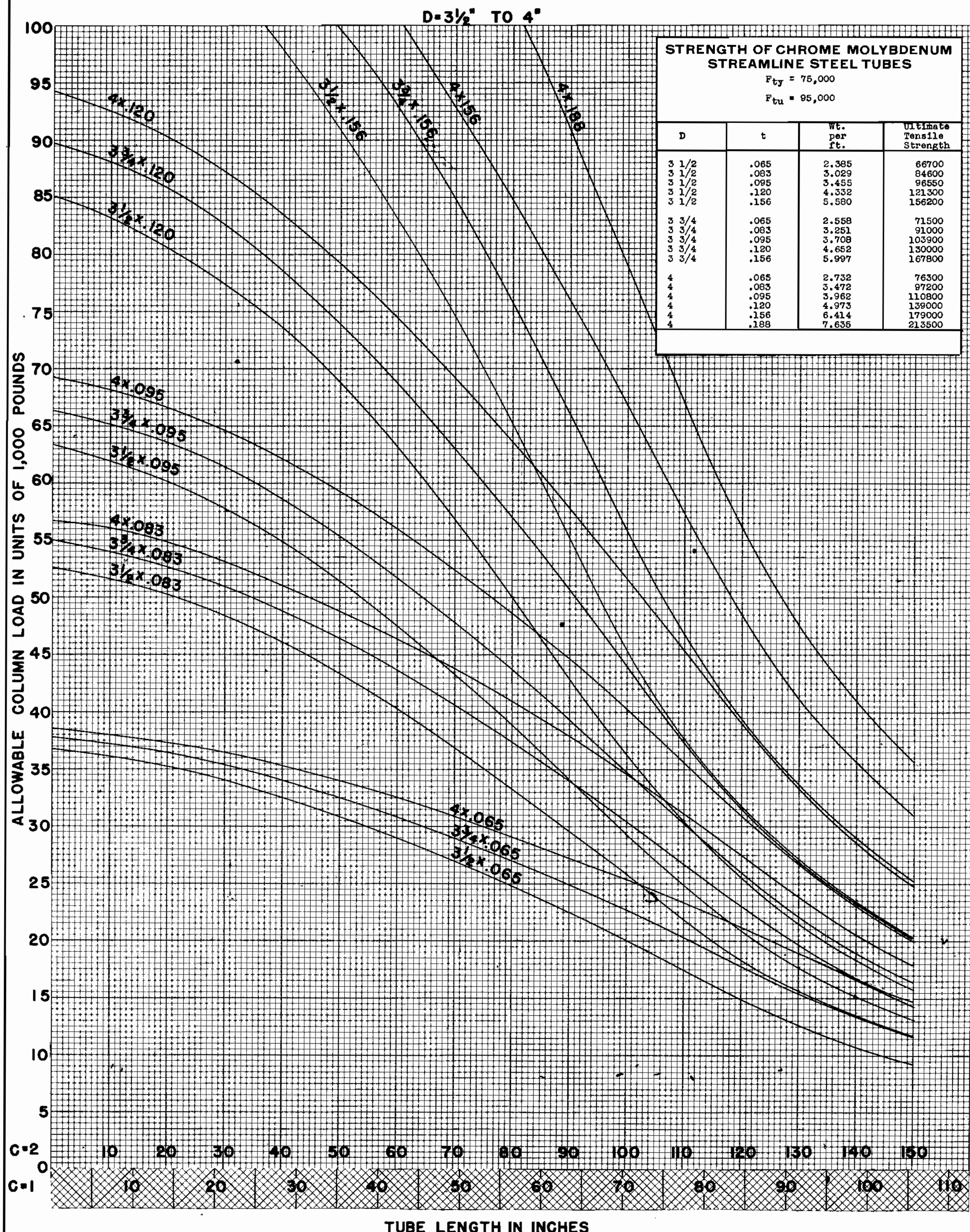
STRENGTH OF CHROME MOLYBDENUM STREAMLINE STEEL TUBES

F_{ty} = 75,000

F_{tu} = 95,000

D	t	Wt. per ft.	Ultimate Tensile Strength
2 1/2	.049	1.283	35800
2 1/2	.058	1.513	42300
2 1/2	.065	1.690	47300
2 1/2	.083	2.143	59900
2 1/2	.095	2.440	68100
2 1/2	.120	3.050	85100
2 3/4	.049	1.414	39500
2 3/4	.058	1.668	46600
2 3/4	.065	1.864	52100
2 3/4	.083	2.364	66100
2 3/4	.095	2.694	75300
2 3/4	.120	3.371	94200
3	.058	1.822	51000
3	.065	2.037	56800
3	.083	2.586	72400
3	.095	2.947	82300
3	.120	3.691	103000
3	.156	4.746	132500
3 1/4	.058	1.977	55350
3 1/4	.065	2.211	61900
3 1/4	.083	2.807	78500
3 1/4	.095	3.201	89500
3 1/4	.120	4.011	112000
3 1/4	.156	5.163	144000

For Streamline — 85,000 Yield - See III — 50



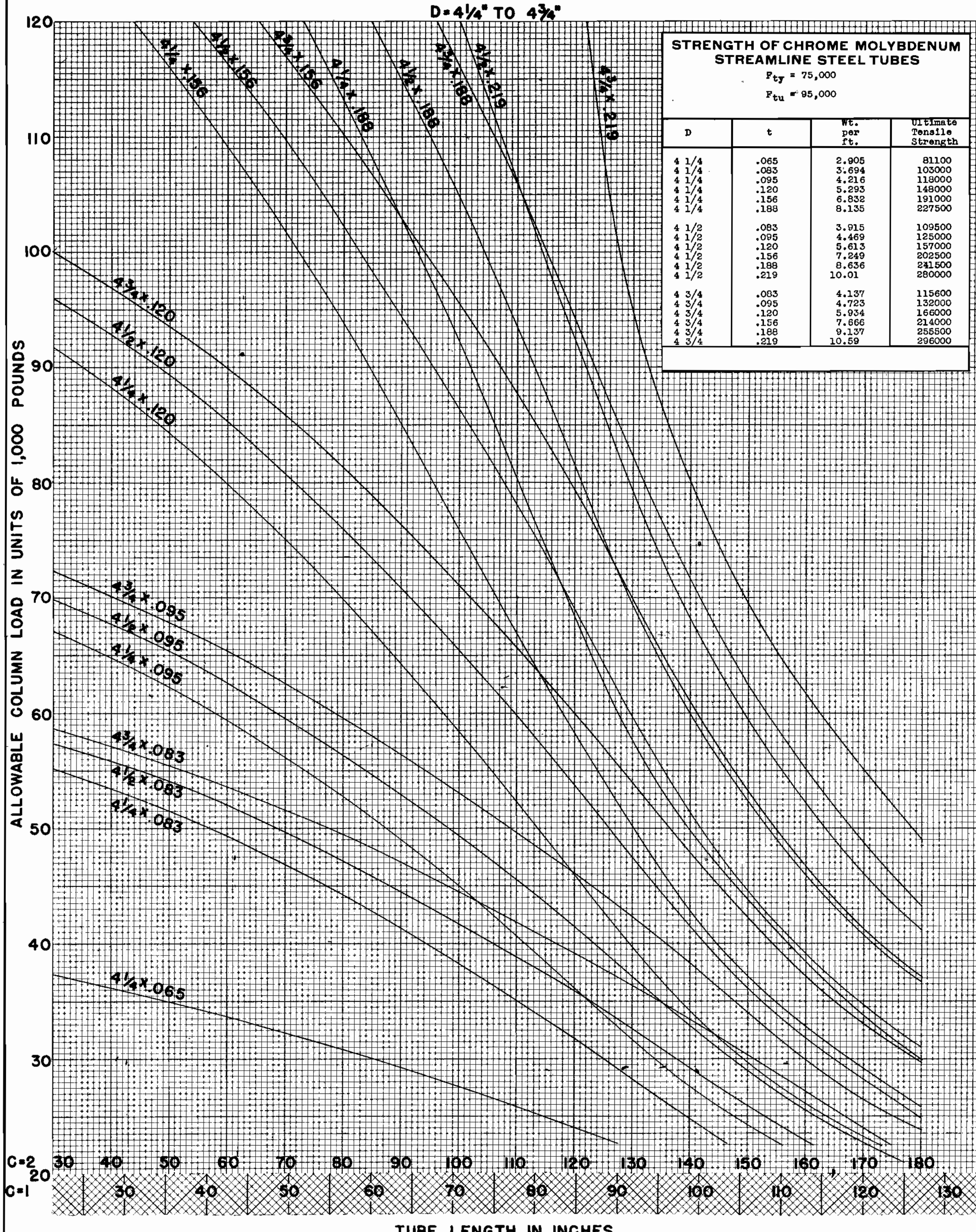
STRENGTH OF CHROME MOLYBDENUM STREAMLINE STEEL TUBES

F_{ty} = 75,000

F_{tu} = 95,000

D	t	Wt. per ft.	Ultimate Tensile Strength
3 1/2	.065	2.385	66700
3 1/2	.083	3.029	84600
3 1/2	.095	3.455	96550
3 1/2	.120	4.332	121300
3 1/2	.156	5.580	156200
3 3/4	.065	2.558	71500
3 3/4	.083	3.251	91000
3 3/4	.095	3.708	103900
3 3/4	.120	4.652	130000
3 3/4	.156	5.997	167800
4	.065	2.732	76300
4	.083	3.472	97200
4	.095	3.962	110800
4	.120	4.973	139000
4	.156	6.414	179000
4	.188	7.635	213500

For Streamline — 85,000 Yield See III — 50



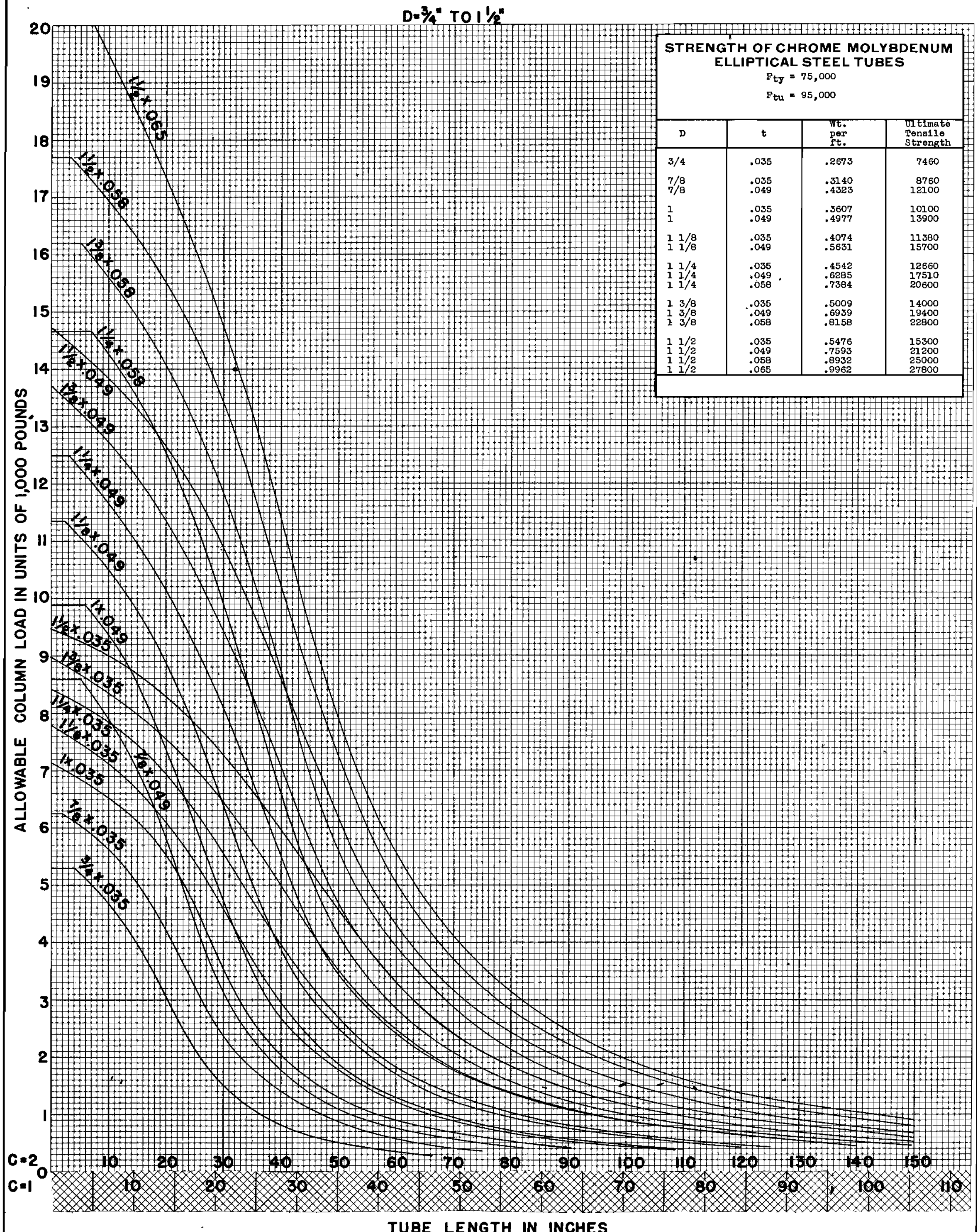
STRENGTH OF CHROME MOLYBDENUM STREAMLINE STEEL TUBES

F_{ty} = 75,000

F_{tu} = 95,000

D	t	Wt. per ft.	Ultimate Tensile Strength
4 1/4	.065	2.905	81100
4 1/4	.083	3.694	103000
4 1/4	.095	4.216	118000
4 1/4	.120	5.293	148000
4 1/4	.156	6.832	191000
4 1/4	.188	8.135	227500
4 1/2	.083	3.915	109500
4 1/2	.095	4.469	125000
4 1/2	.120	5.613	157000
4 1/2	.156	7.249	202500
4 1/2	.188	8.636	241500
4 1/2	.219	10.01	280000
4 3/4	.083	4.137	115600
4 3/4	.095	4.723	132000
4 3/4	.120	5.934	166000
4 3/4	.156	7.666	214000
4 3/4	.188	9.137	255500
4 3/4	.219	10.59	296000

For Streamline — 85,000 Yield See III — 50



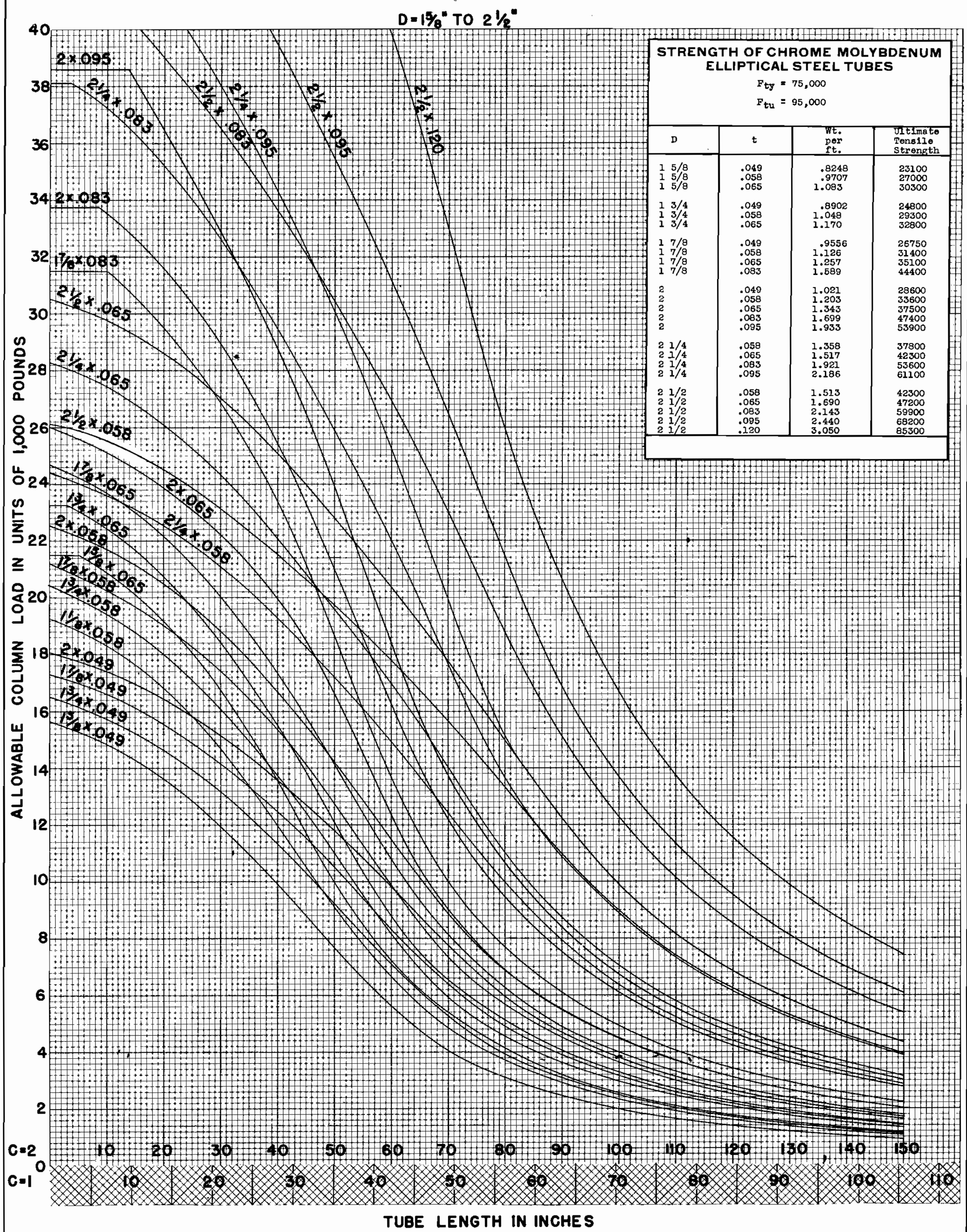
STRENGTH OF CHROME MOLYBDENUM ELLIPTICAL STEEL TUBES

F_{ty} = 75,000

F_{tu} = 95,000

D	t	Wt. per ft.	Ultimate Tensile Strength
3/4	.035	.2673	7460
7/8	.035	.3140	8760
7/8	.049	.4323	12100
1	.035	.3607	10100
1	.049	.4977	13900
1 1/8	.035	.4074	11380
1 1/8	.049	.5631	15700
1 1/4	.035	.4542	12660
1 1/4	.049	.6285	17510
1 1/4	.058	.7384	20600
1 3/8	.035	.5009	14000
1 3/8	.049	.6939	19400
1 3/8	.058	.8158	22800
1 1/2	.035	.5476	15300
1 1/2	.049	.7593	21200
1 1/2	.058	.8932	25000
1 1/2	.065	.9962	27800

For Ovals — 85,000 Yield See III — 56



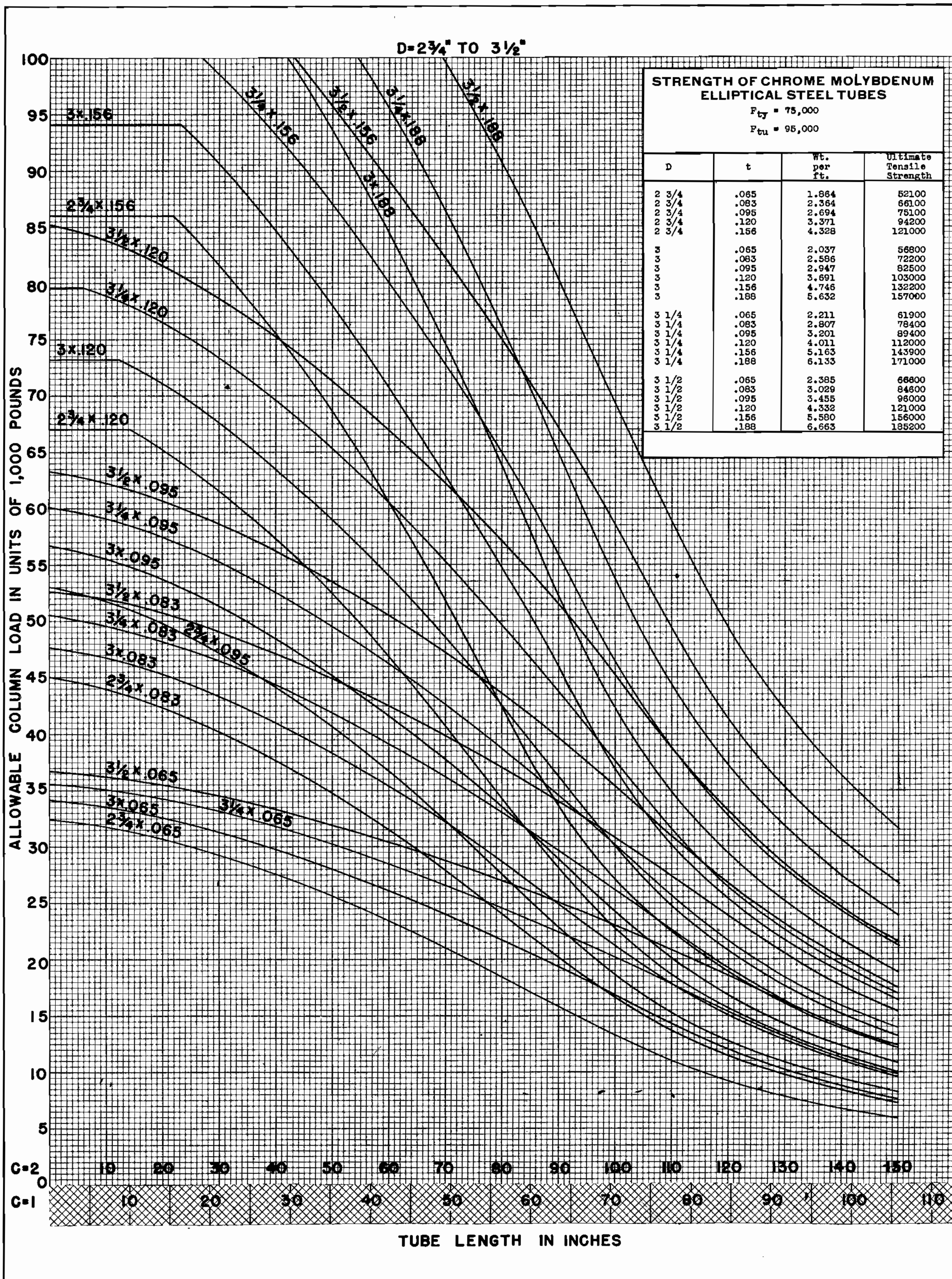
STRENGTH OF CHROME MOLYBDENUM ELLIPTICAL STEEL TUBES

F_{ty} = 75,000

F_{tu} = 95,000

D	t	Wt. per ft.	Ultimate Tensile Strength
1 5/8	.049	.8248	23100
1 5/8	.058	.9707	27000
1 5/8	.065	1.083	30300
1 3/4	.049	.8902	24800
1 3/4	.058	1.048	29300
1 3/4	.065	1.170	32800
1 7/8	.049	.9556	26750
1 7/8	.058	1.126	31400
1 7/8	.065	1.257	35100
1 7/8	.083	1.589	44400
2	.049	1.021	28600
2	.058	1.203	33600
2	.065	1.343	37500
2	.083	1.699	47400
2	.095	1.933	53900
2 1/4	.058	1.358	37800
2 1/4	.065	1.517	42300
2 1/4	.083	1.921	53600
2 1/4	.095	2.186	61100
2 1/2	.058	1.513	42300
2 1/2	.065	1.690	47200
2 1/2	.083	2.143	59900
2 1/2	.095	2.440	68200
2 1/2	.120	3.050	85300

For Ovals — 85,000 Yield See III — 56



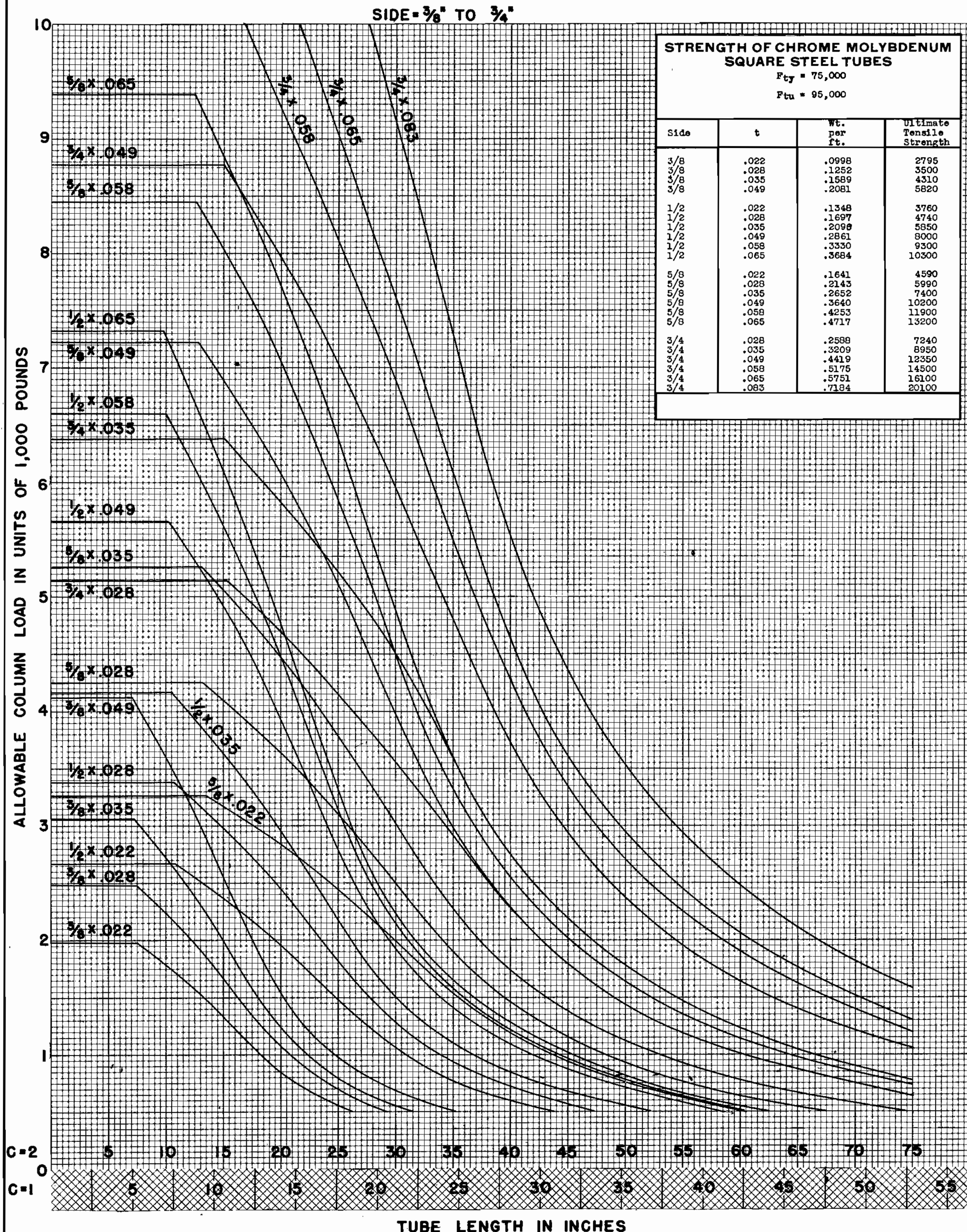
STRENGTH OF CHROME MOLYBDENUM ELLIPTICAL STEEL TUBES

F_{ty} = 75,000

F_{tu} = 95,000

D	t	Wt. per ft.	Ultimate Tensile Strength
2 3/4	.065	1.864	52100
2 3/4	.083	2.364	66100
2 3/4	.095	2.694	75100
2 3/4	.120	3.371	94200
2 3/4	.156	4.328	121000
3	.065	2.037	56800
3	.083	2.586	72200
3	.095	2.947	82500
3	.120	3.691	103000
3	.156	4.746	132200
3	.188	5.632	157000
3 1/4	.065	2.211	61900
3 1/4	.083	2.807	78400
3 1/4	.095	3.201	89400
3 1/4	.120	4.011	112000
3 1/4	.156	5.163	143900
3 1/4	.188	6.133	171000
3 1/2	.065	2.385	66800
3 1/2	.083	3.029	84600
3 1/2	.095	3.455	96000
3 1/2	.120	4.332	121000
3 1/2	.156	5.580	156000
3 1/2	.188	6.663	185200

For Ovals — 85,000 Yield See III — 56



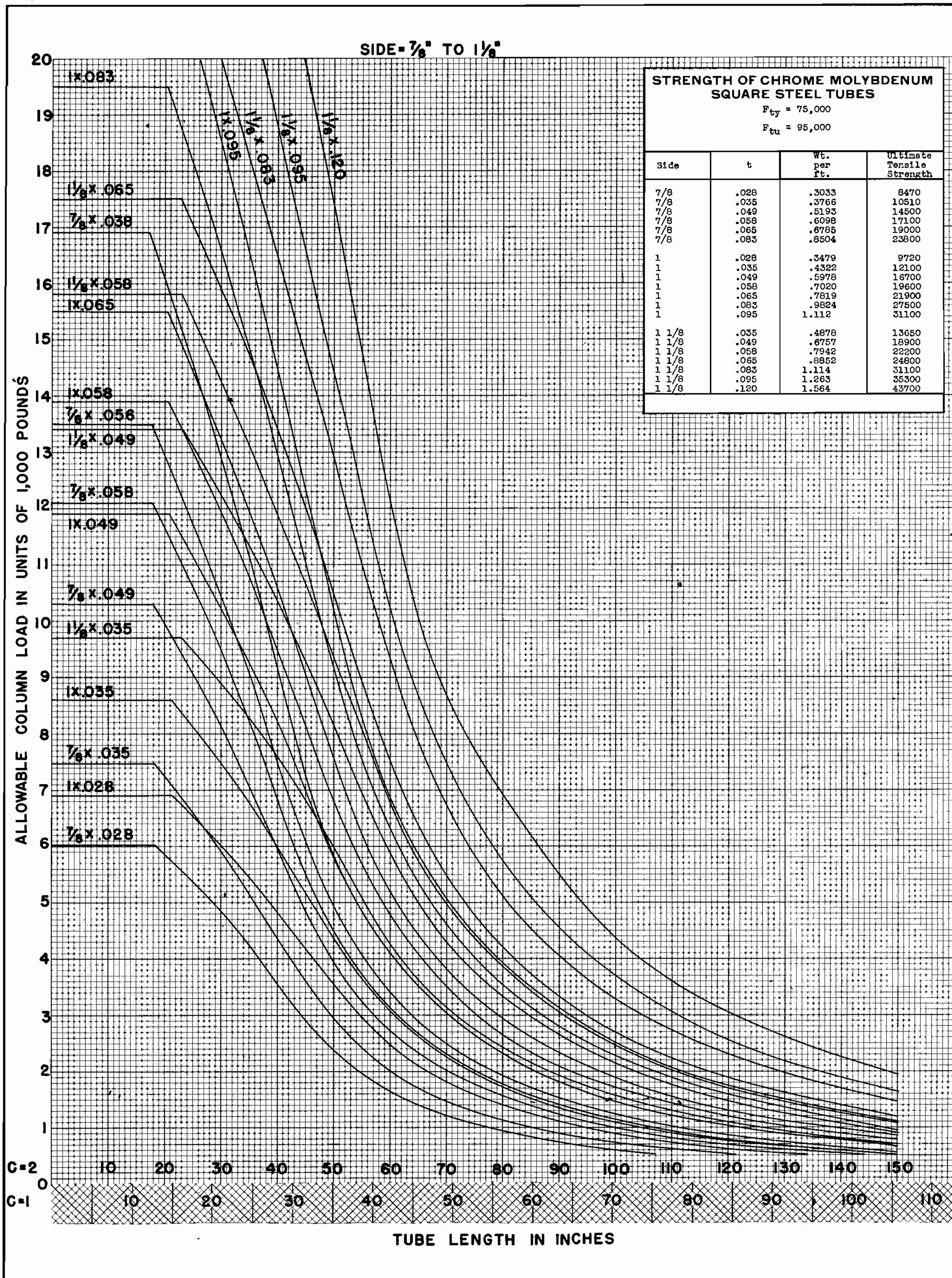
STRENGTH OF CHROME MOLYBDENUM SQUARE STEEL TUBES

F_{ty} = 75,000

F_{tu} = 95,000

Side	t	Wt. per ft.	Ultimate Tensile Strength
3/8	.022	.0998	2795
3/8	.028	.1252	3500
3/8	.035	.1589	4310
3/8	.049	.2081	5820
1/2	.022	.1348	3760
1/2	.028	.1697	4740
1/2	.035	.2098	5850
1/2	.049	.2861	8000
1/2	.058	.3330	9300
1/2	.065	.3684	10300
5/8	.022	.1641	4590
5/8	.028	.2143	5990
5/8	.035	.2652	7400
5/8	.049	.3640	10200
5/8	.058	.4253	11900
5/8	.065	.4717	13200
3/4	.028	.2588	7240
3/4	.035	.3209	8950
3/4	.049	.4419	12350
3/4	.058	.5175	14500
3/4	.065	.5751	16100
3/4	.083	.7184	20100

For Squares — 85,000 Yield See III — 59



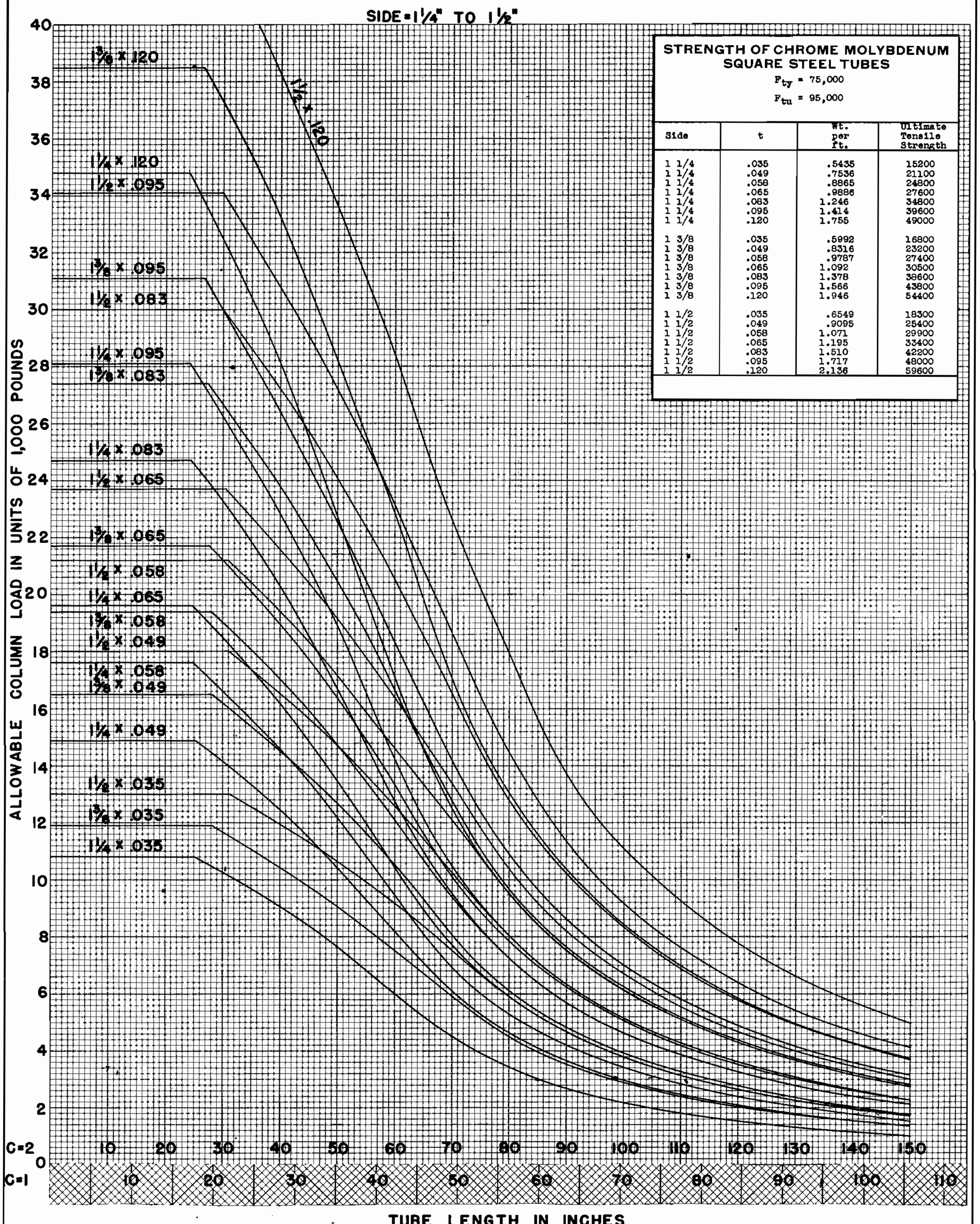
STRENGTH OF CHROME MOLYBDENUM SQUARE STEEL TUBES

F_{ty} = 75,000

F_{tu} = 95,000

Side	t	Wt. per ft.	Ultimate Tensile Strength
7/8	.028	.3033	8470
7/8	.035	.3766	10510
7/8	.049	.5193	14500
7/8	.058	.6098	17100
7/8	.065	.6785	19000
7/8	.083	.8504	23800
1	.028	.3479	9720
1	.035	.4322	12100
1	.049	.5978	16700
1	.058	.7020	19600
1	.065	.7819	21900
1	.083	.9824	27500
1	.095	1.112	31100
1 1/8	.035	.4878	13650
1 1/8	.049	.6757	18900
1 1/8	.058	.7942	22200
1 1/8	.065	.8852	24800
1 1/8	.083	1.114	31100
1 1/8	.095	1.263	35300
1 1/8	.120	1.564	43700

For Squares — 85,000 Yield See III — 59



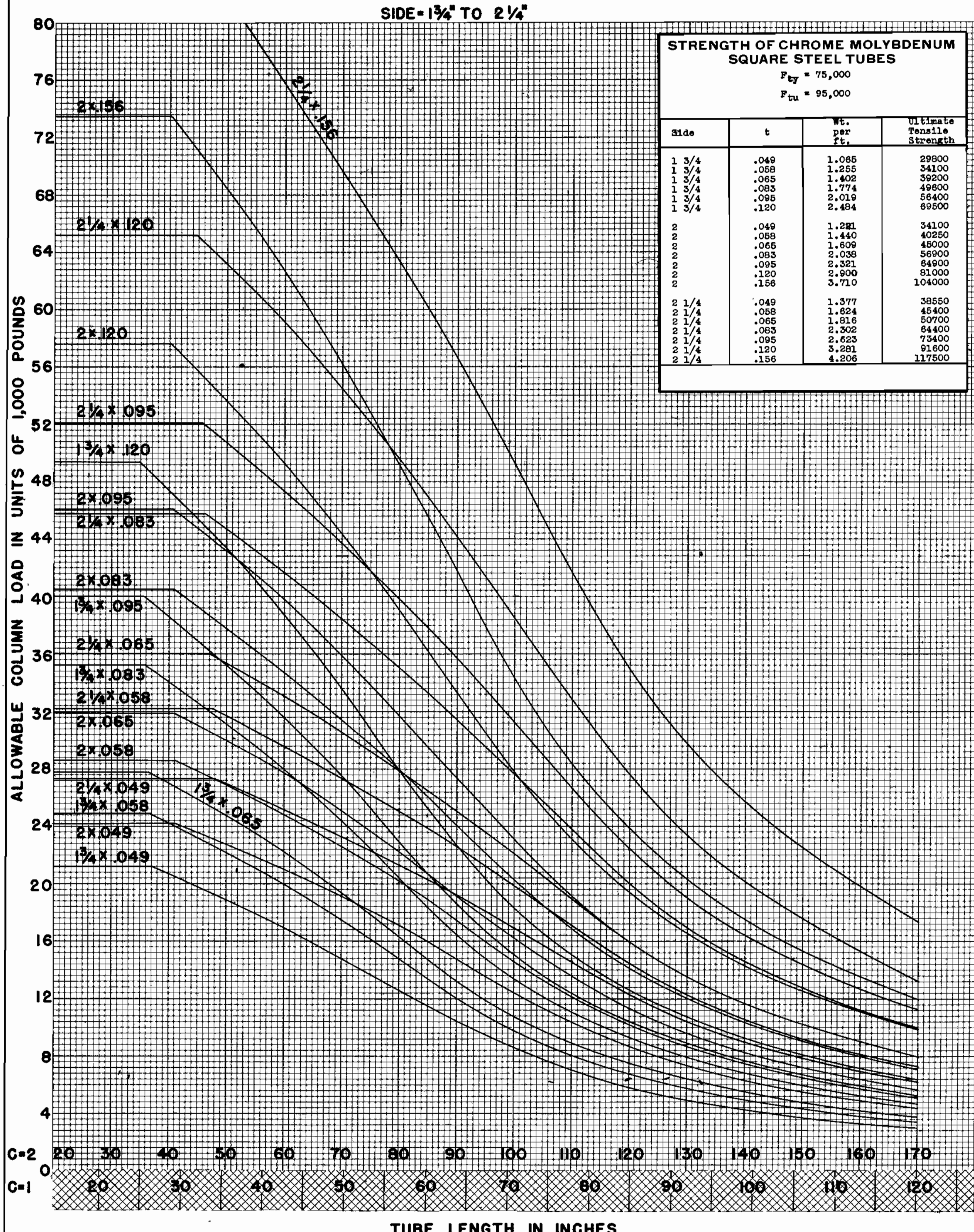
STRENGTH OF CHROME MOLYBDENUM SQUARE STEEL TUBES

F_{ty} = 75,000

F_{tu} = 95,000

Side	t	Wt. per ft.	Ultimate Tensile Strength
1 1/4	.035	.5435	15200
1 1/4	.049	.7536	21100
1 1/4	.058	.8865	24800
1 1/4	.065	.9886	27600
1 1/4	.083	1.246	34800
1 1/4	.095	1.414	39600
1 1/4	.120	1.755	49000
1 3/8	.035	.5992	16800
1 3/8	.049	.8316	23200
1 3/8	.058	.9787	27400
1 3/8	.065	1.092	30500
1 3/8	.083	1.378	38600
1 3/8	.095	1.566	43800
1 3/8	.120	1.946	54400
1 1/2	.035	.6549	18300
1 1/2	.049	.9095	25400
1 1/2	.058	1.071	29900
1 1/2	.065	1.195	33400
1 1/2	.083	1.510	42200
1 1/2	.095	1.717	48000
1 1/2	.120	2.136	59600

For Squares — 85,000 Yield See III — 59



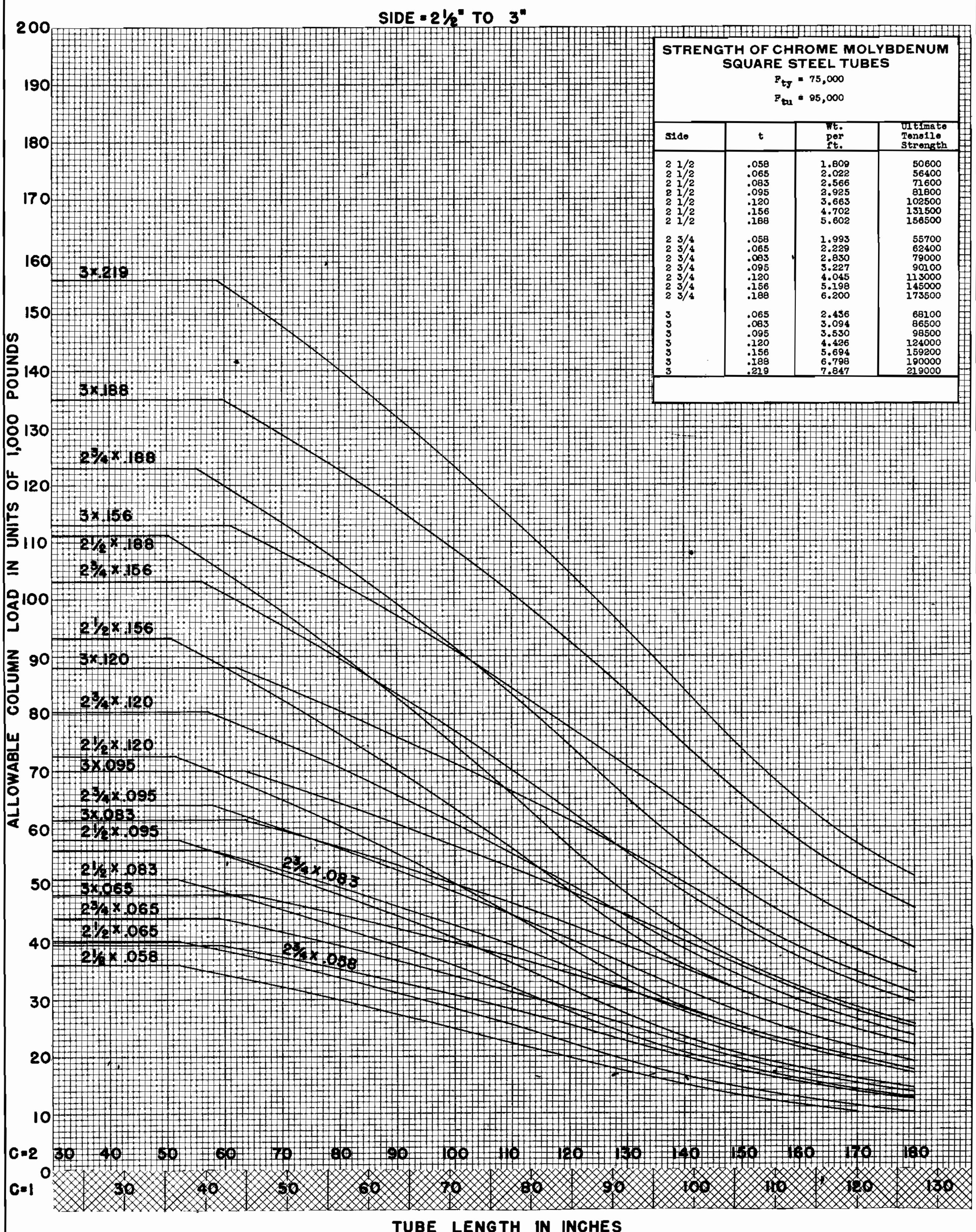
STRENGTH OF CHROME MOLYBDENUM SQUARE STEEL TUBES

F_{ty} = 75,000

F_{tu} = 95,000

Side	t	Wt. per ft.	Ultimate Tensile Strength
1 3/4	.049	1.065	29800
1 3/4	.058	1.255	34100
1 3/4	.065	1.402	39200
1 3/4	.083	1.774	49600
1 3/4	.095	2.019	56400
1 3/4	.120	2.484	69500
2	.049	1.221	34100
2	.058	1.440	40250
2	.065	1.609	45000
2	.083	2.038	56900
2	.095	2.321	64900
2	.120	2.900	81000
2	.156	3.710	104000
2 1/4	.049	1.377	38550
2 1/4	.058	1.624	45400
2 1/4	.065	1.816	50700
2 1/4	.083	2.302	64400
2 1/4	.095	2.623	73400
2 1/4	.120	3.281	91600
2 1/4	.156	4.206	117500

For Squares — 85,000 Yield See III — 59



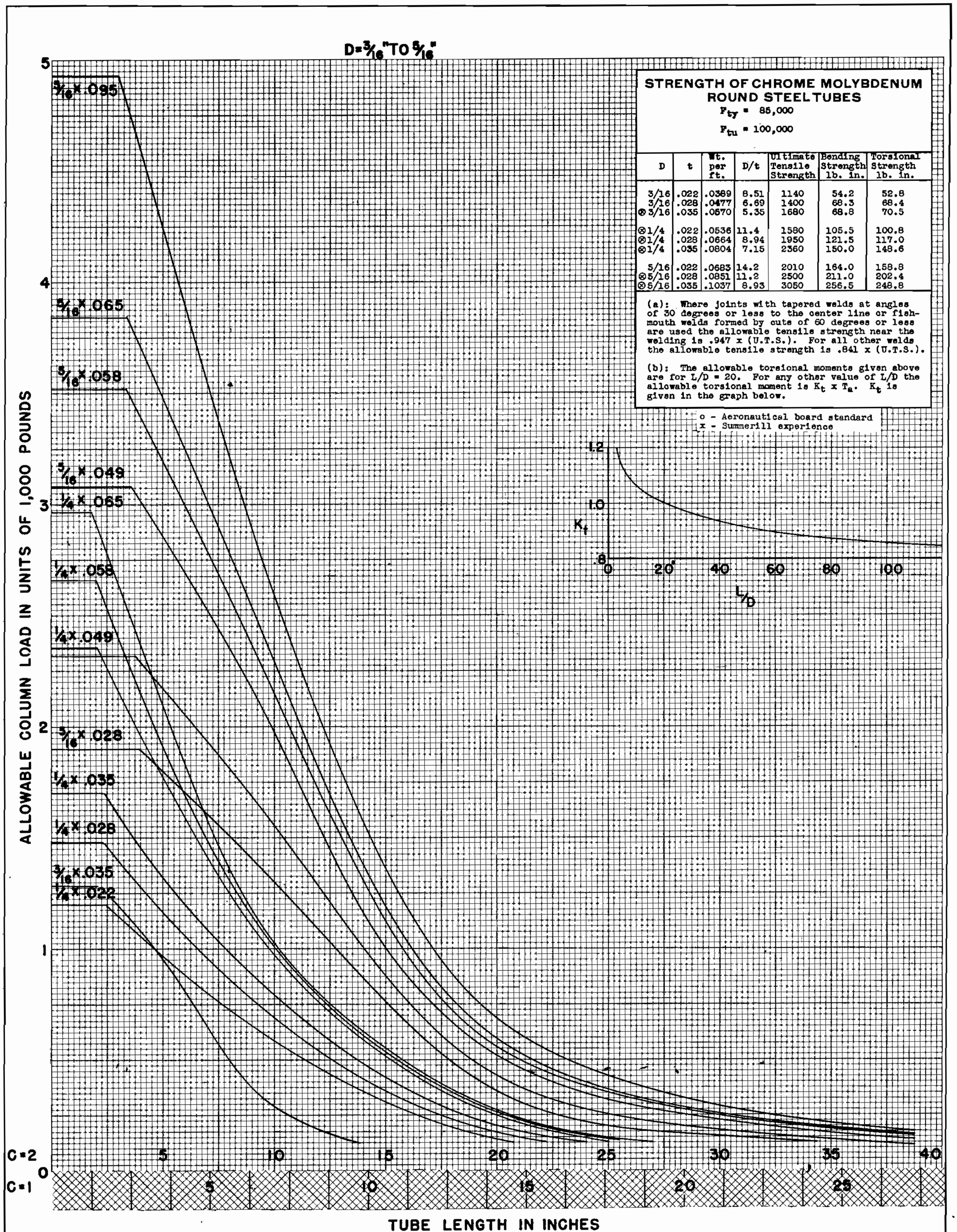
STRENGTH OF CHROME MOLYBDENUM SQUARE STEEL TUBES

$F_{ty} = 75,000$

$F_{tu} = 95,000$

Side	t	Wt. per ft.	Ultimate Tensile Strength
2 1/2	.058	1.809	50600
2 1/2	.065	2.022	56400
2 1/2	.083	2.566	71600
2 1/2	.095	2.925	81800
2 1/2	.120	3.663	102500
2 1/2	.156	4.702	131500
2 1/2	.188	5.602	156500
2 3/4	.058	1.993	55700
2 3/4	.065	2.229	62400
2 3/4	.083	2.830	79000
2 3/4	.095	3.227	90100
2 3/4	.120	4.045	113000
2 3/4	.156	5.198	145000
2 3/4	.188	6.200	173500
3	.065	2.436	68100
3	.083	3.094	86500
3	.095	3.530	98500
3	.120	4.426	124000
3	.156	5.694	159200
3	.188	6.798	190000
3	.219	7.847	219000

For Squares — 85,000 Yield See III — 59



STRENGTH OF CHROME MOLYBDENUM ROUND STEEL TUBES

F_{ty} = 85,000

F_{tu} = 100,000

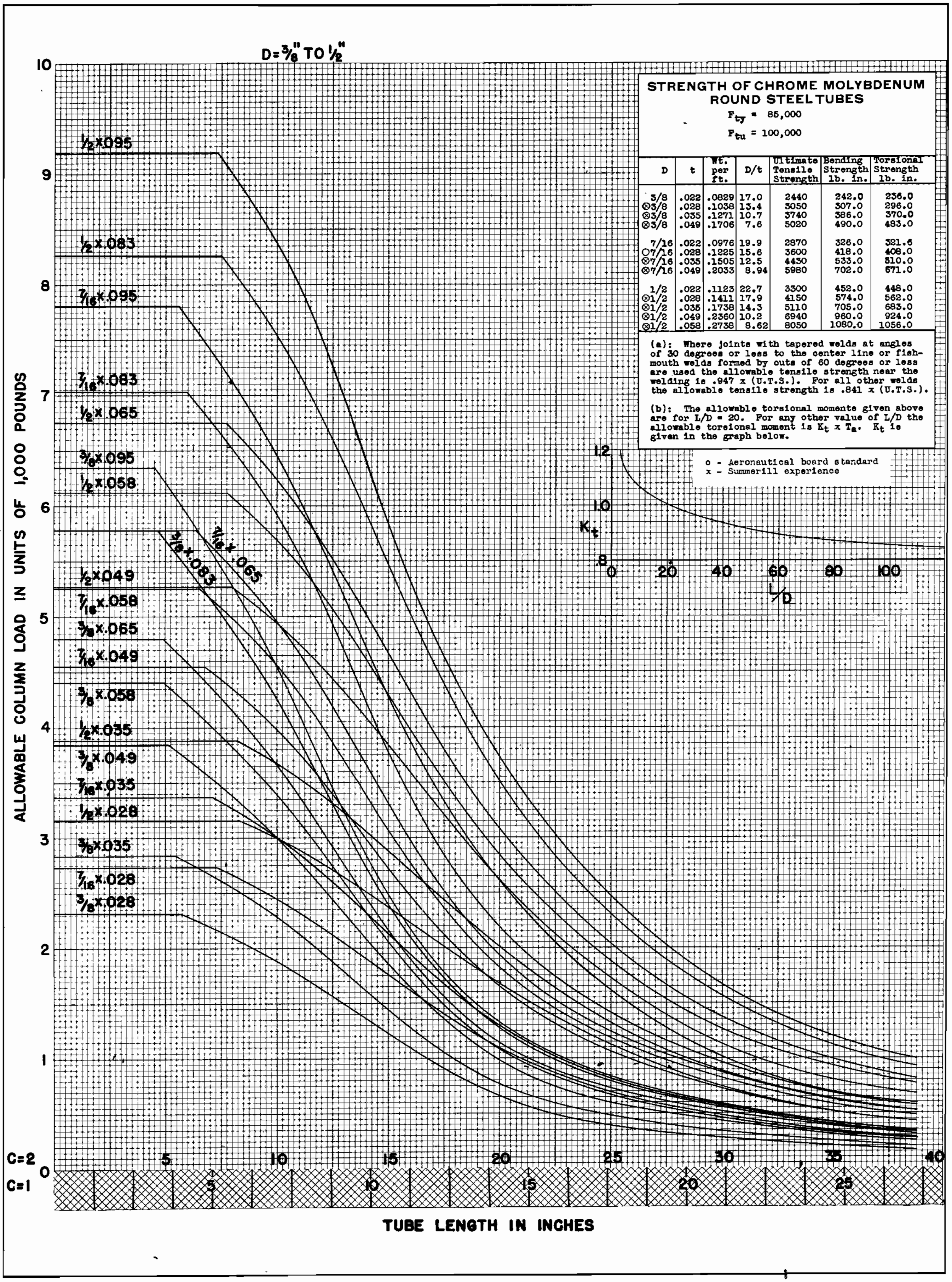
D	t	Wt. per ft.	D/t	Ultimate Tensile Strength	Bending Strength lb. in.	Torsional Strength lb. in.
3/16	.022	.0389	8.51	1140	54.2	52.8
3/16	.028	.0477	6.69	1400	68.3	68.4
⊗3/16	.035	.0570	5.35	1680	68.8	70.5
⊗1/4	.022	.0536	11.4	1580	105.5	100.8
⊗1/4	.028	.0664	8.94	1950	121.5	117.0
⊗1/4	.035	.0804	7.15	2360	150.0	148.6
5/16	.022	.0683	14.2	2010	164.0	158.8
⊗5/16	.028	.0851	11.2	2500	211.0	202.4
⊗5/16	.035	.1037	8.93	3050	256.5	248.8

(a): Where joints with tapered welds at angles of 30 degrees or less to the center line or fish-mouth welds formed by cuts of 60 degrees or less are used the allowable tensile strength near the welding is .947 x (U.T.S.). For all other welds the allowable tensile strength is .841 x (U.T.S.).

(b): The allowable torsional moments given above are for L/D = 20. For any other value of L/D the allowable torsional moment is $K_t \times T_a$. K_t is given in the graph below.

o - Aeronautical board standard
x - Summerill experience

For Rounds — 75,000 Yield · See III — 20



STRENGTH OF CHROME MOLYBDENUM ROUND STEEL TUBES

F_{ty} = 85,000

F_{tu} = 100,000

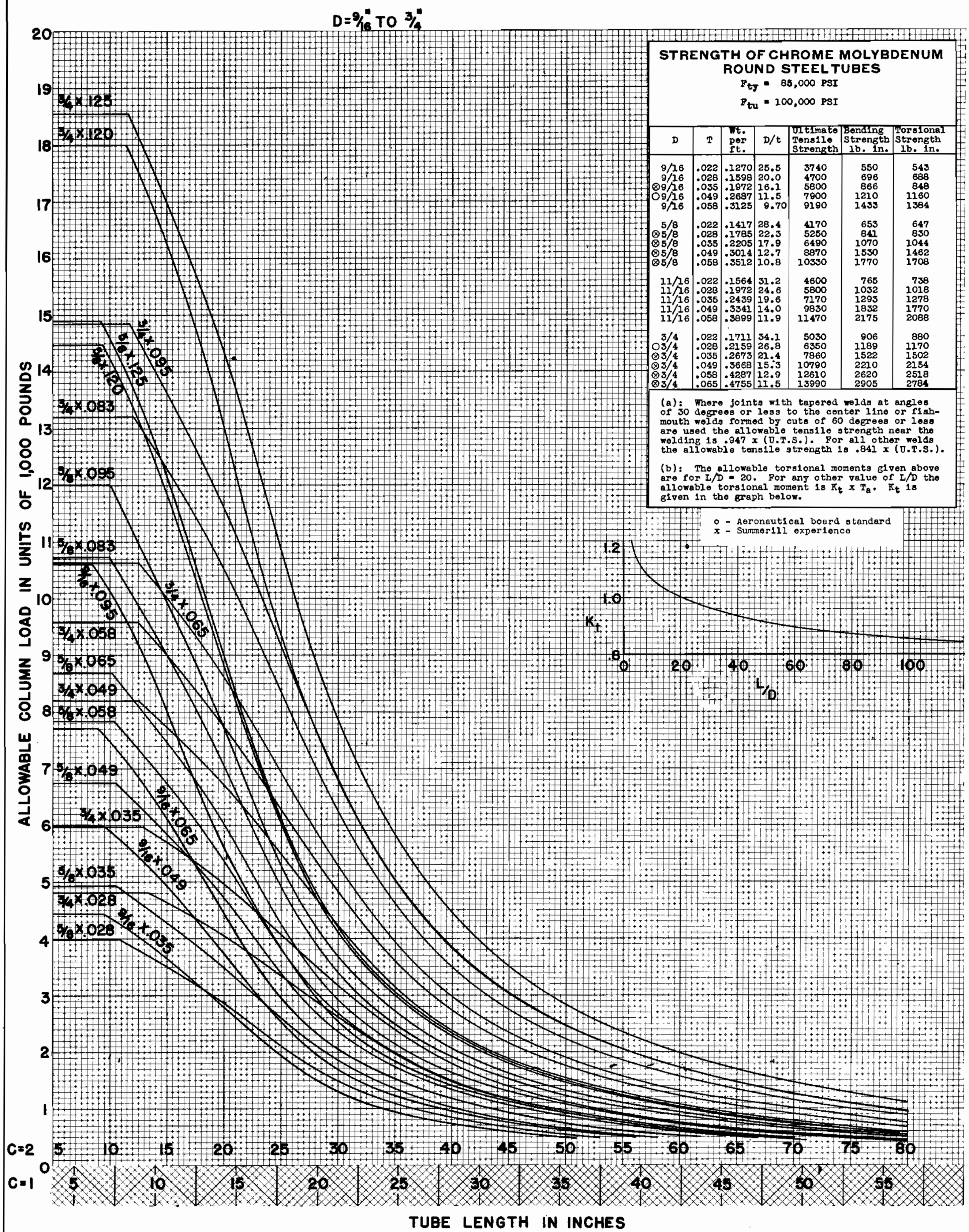
D	t	Wt. per ft.	D/t	Ultimate Tensile Strength	Bending Strength lb. in.	Torsional Strength lb. in.
3/8	.022	.0829	17.0	2440	242.0	236.0
⊗3/8	.028	.1038	13.4	3050	307.0	296.0
⊗3/8	.035	.1271	10.7	3740	386.0	370.0
⊗3/8	.049	.1706	7.6	5020	490.0	483.0
7/16	.022	.0976	19.9	2870	326.0	321.6
○7/16	.028	.1225	15.6	3600	418.0	408.0
⊗7/16	.035	.1505	12.5	4430	533.0	510.0
⊗7/16	.049	.2033	8.94	5980	702.0	671.0
1/2	.022	.1123	22.7	3300	452.0	448.0
⊗1/2	.028	.1411	17.9	4150	574.0	562.0
⊗1/2	.035	.1738	14.3	5110	705.0	683.0
⊗1/2	.049	.2360	10.2	6940	960.0	924.0
⊗1/2	.058	.2738	8.62	8050	1080.0	1056.0

(a): Where joints with tapered welds at angles of 30 degrees or less to the center line or fish-mouth welds formed by cuts of 60 degrees or less are used the allowable tensile strength near the welding is .947 x (U.T.S.). For all other welds the allowable tensile strength is .841 x (U.T.S.).

(b): The allowable torsional moments given above are for L/D = 20. For any other value of L/D the allowable torsional moment is $K_t \times T_a$. K_t is given in the graph below.

o - Aeronautical board standard
x - Summerill experience

For Rounds — 75,000 Yield See III — 20



STRENGTH OF CHROME MOLYBDENUM ROUND STEEL TUBES

F_{ty} = 85,000 PSI

F_{tu} = 100,000 PSI

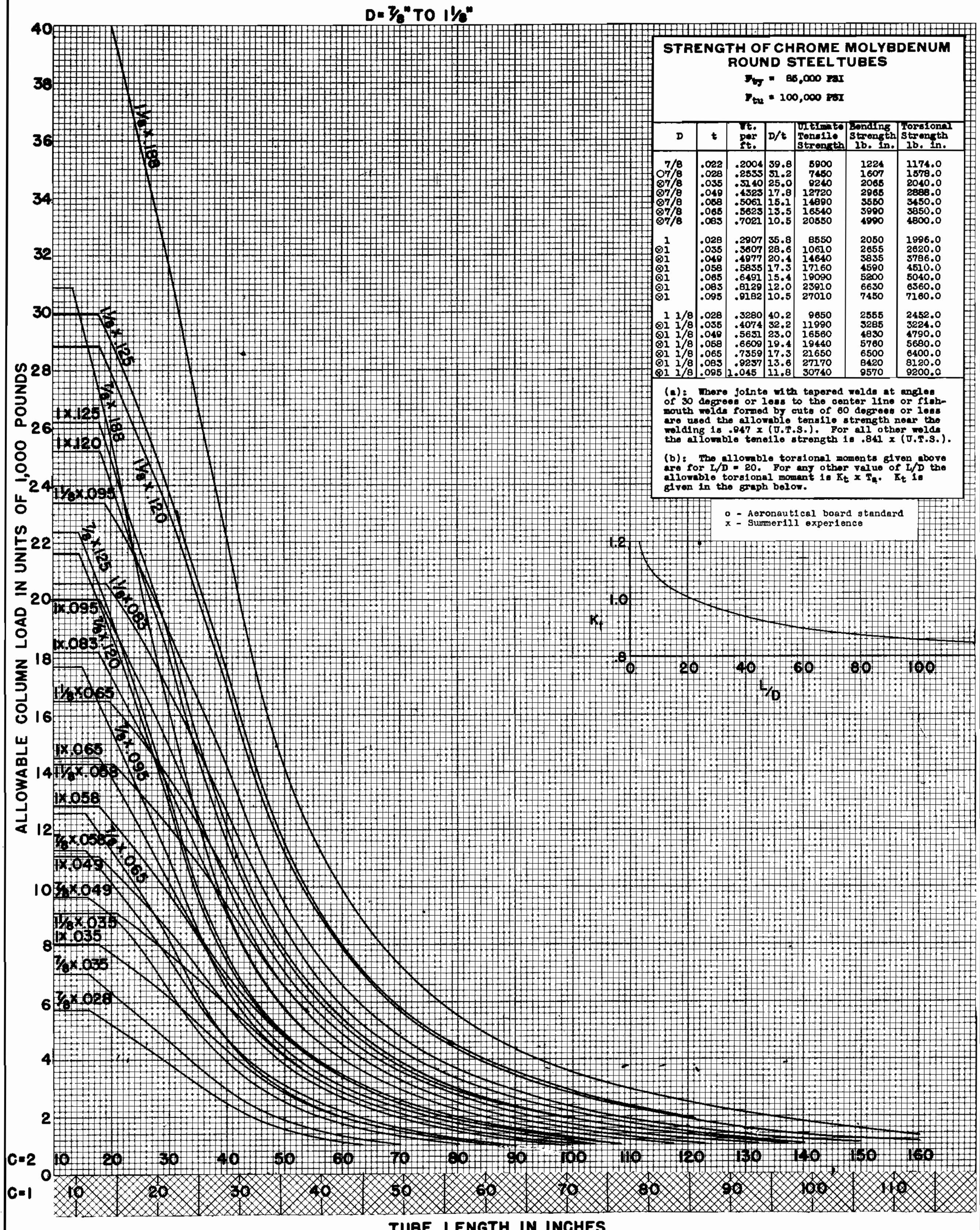
D	T	Wt. per ft.	D/t	Ultimate Tensile Strength	Bending Strength lb. in.	Torsional Strength lb. in.
9/16	.022	.1270	25.5	3740	550	543
9/16	.028	.1598	20.0	4700	696	688
⊗9/16	.035	.1972	16.1	5800	866	848
○9/16	.049	.2687	11.5	7900	1210	1160
9/16	.058	.3125	9.70	9190	1433	1384
5/8	.022	.1417	28.4	4170	653	647
⊗5/8	.028	.1785	22.3	5250	841	830
⊗5/8	.035	.2205	17.9	6490	1070	1044
⊗5/8	.049	.3014	12.7	8870	1530	1462
⊗5/8	.058	.3512	10.8	10330	1770	1708
11/16	.022	.1564	31.2	4600	765	738
11/16	.028	.1972	24.6	5800	1032	1018
11/16	.035	.2439	19.6	7170	1293	1278
11/16	.049	.3341	14.0	9830	1832	1770
11/16	.058	.3899	11.9	11470	2175	2088
3/4	.022	.1711	34.1	5030	906	880
○3/4	.028	.2159	26.8	6350	1189	1170
⊗3/4	.035	.2673	21.4	7860	1522	1502
⊗3/4	.049	.3668	15.3	10790	2210	2154
⊗3/4	.058	.4287	12.9	12610	2620	2518
⊗3/4	.065	.4755	11.5	13990	2905	2784

(a): Where joints with tapered welds at angles of 30 degrees or less to the center line or fish-mouth welds formed by cuts of 60 degrees or less are used the allowable tensile strength near the welding is .947 x (U.T.S.). For all other welds the allowable tensile strength is .841 x (U.T.S.).

(b): The allowable torsional moments given above are for L/D = 20. For any other value of L/D the allowable torsional moment is $K_t \times T_a$. K_t is given in the graph below.

o - Aeronautical board standard
x - Summerill experience

For Rounds — 75,000 Yield. See III — 20



STRENGTH OF CHROME MOLYBDENUM ROUND STEEL TUBES

F_{ty} = 85,000 PSI

F_{tu} = 100,000 PSI

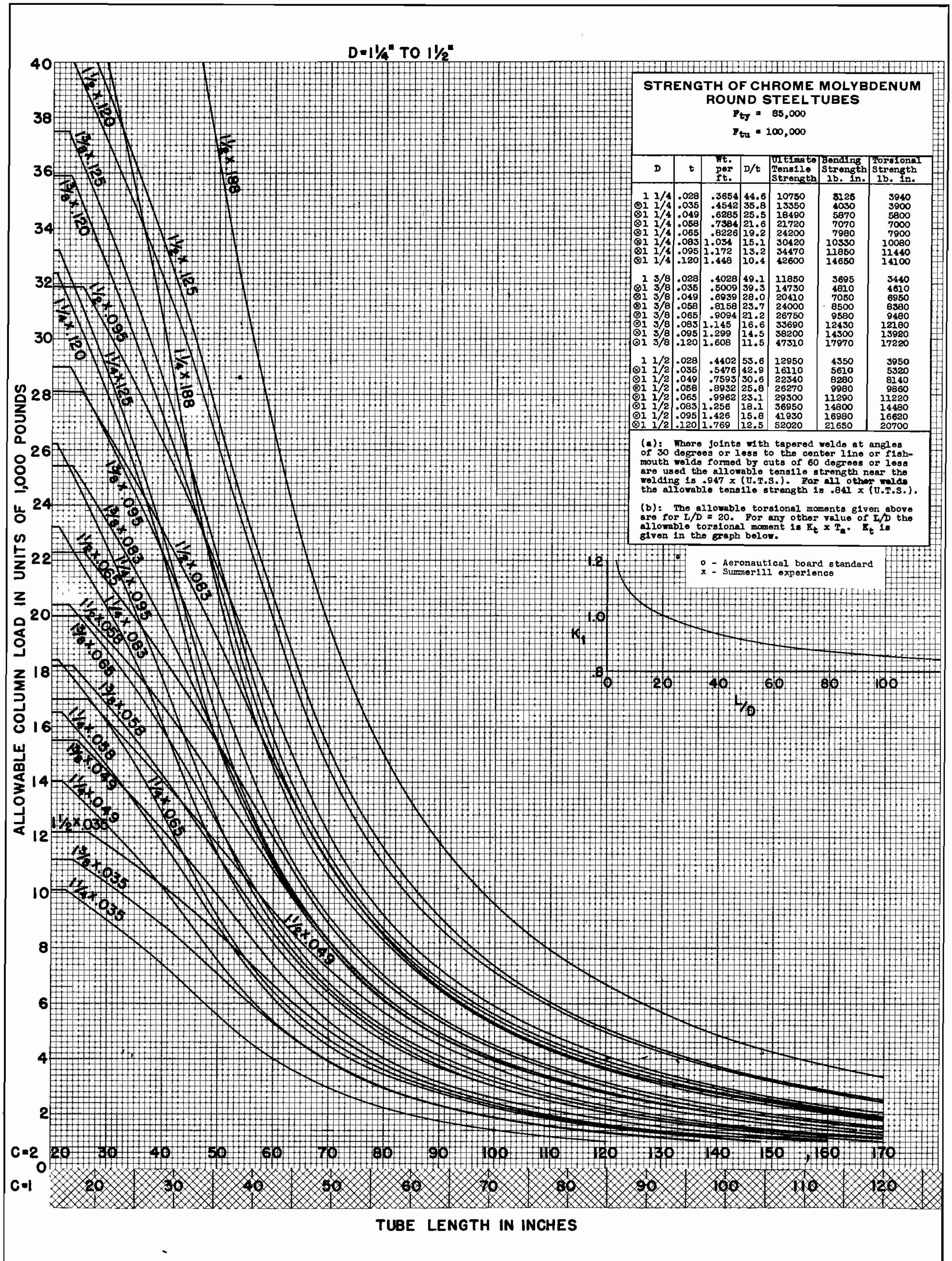
D	t	Wt. per ft.	D/t	Ultimate Tensile Strength	Bending Strength lb. in.	Torsional Strength lb. in.
7/8	.022	.2004	39.8	5900	1224	1174.0
○7/8	.028	.2533	31.2	7450	1607	1578.0
⊗7/8	.035	.3140	25.0	9240	2065	2040.0
⊗7/8	.049	.4323	17.8	12720	2965	2888.0
⊗7/8	.058	.5061	15.1	14890	3550	3450.0
⊗7/8	.065	.5623	13.5	16540	3990	3850.0
⊗7/8	.083	.7021	10.5	20550	4990	4800.0
1	.028	.2907	35.8	8550	2050	1996.0
⊗1	.035	.3607	28.6	10610	2655	2620.0
⊗1	.049	.4977	20.4	14640	3835	3786.0
⊗1	.058	.5835	17.3	17160	4590	4510.0
⊗1	.065	.6491	15.4	19090	5200	5040.0
⊗1	.083	.8129	12.0	23910	6630	6360.0
⊗1	.095	.9182	10.5	27010	7450	7160.0
1 1/8	.028	.3280	40.2	9650	2555	2452.0
⊗1 1/8	.035	.4074	32.2	11990	3285	3224.0
⊗1 1/8	.049	.5631	23.0	16560	4830	4790.0
⊗1 1/8	.058	.6609	19.4	19440	5760	5680.0
⊗1 1/8	.065	.7359	17.3	21650	6500	6400.0
⊗1 1/8	.083	.9237	13.6	27170	8420	8120.0
⊗1 1/8	.095	1.045	11.8	30740	9570	9200.0

(a): Where jointe with tapered welds at angles of 30 degrees or less to the center line or fish-mouth welds formed by cuts of 60 degrees or less are used the allowable tensile strength near the welding is .947 x (U.T.S.). For all other welds the allowable teneile strength is .841 x (U.T.S.).

(b): The allowable torsional moments given above are for L/D = 20. For any other value of L/D the allowable torsional moment is K_t x T_a. K_t is given in the graph below.

o - Aeronautical board standard
x - Summerill experience

For Rounds — 75,000 Yield - See III — 20



STRENGTH OF CHROME MOLYBDENUM ROUND STEEL TUBES

F_{ty} = 85,000

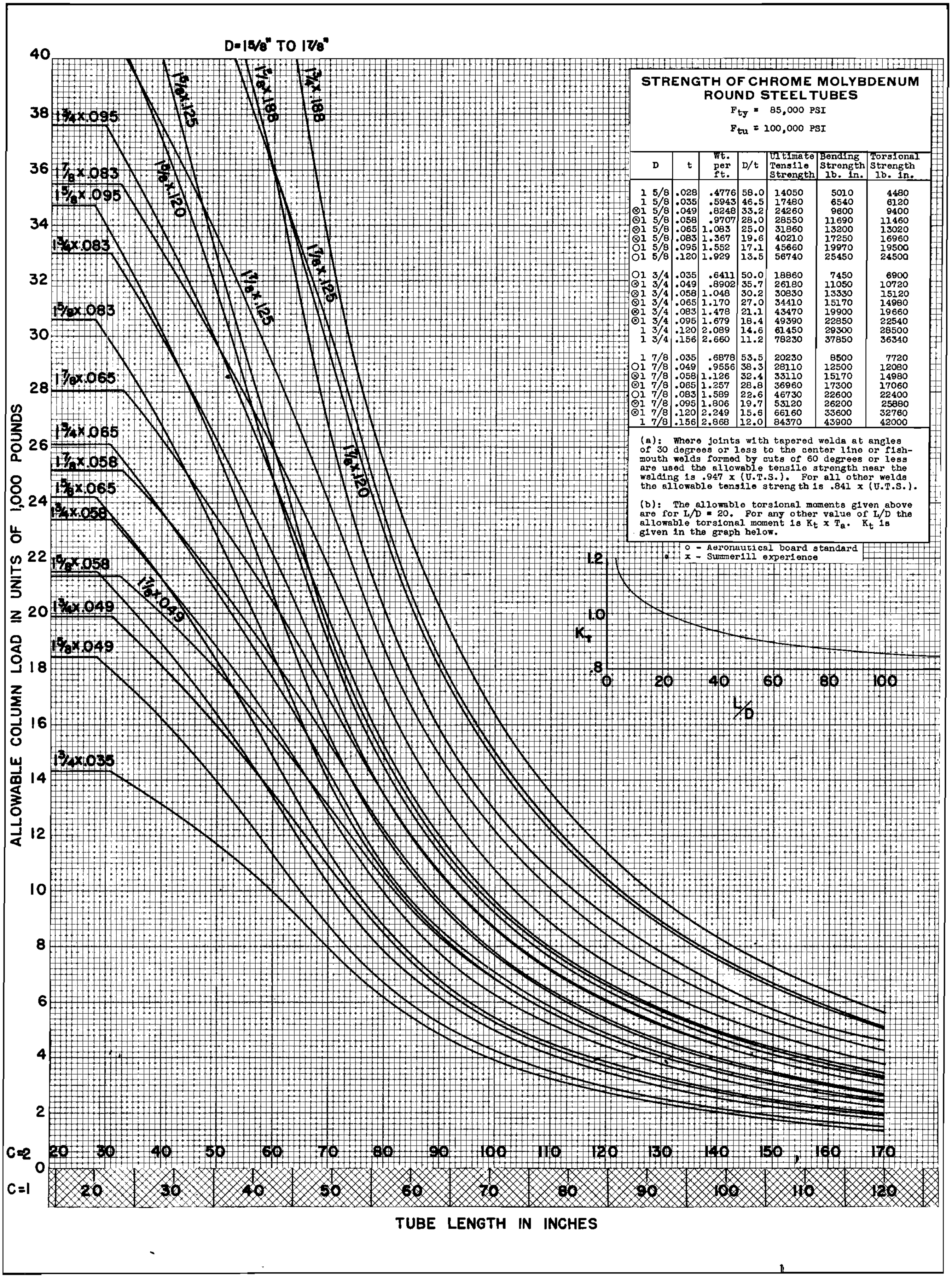
F_{tu} = 100,000

D	t	Wt. per ft.	D/t	Ultimate Tensile Strength	Bending Strength lb. in.	Torsional Strength lb. in.
1 1/4	.028	.3654	44.6	10750	3125	3940
⊗1 1/4	.035	.4542	35.8	13350	4030	3900
⊗1 1/4	.049	.6285	25.5	18490	5870	5800
⊗1 1/4	.058	.7384	21.6	21720	7070	7000
⊗1 1/4	.065	.8226	19.2	24200	7980	7900
⊗1 1/4	.083	1.034	15.1	30420	10330	10080
⊗1 1/4	.095	1.172	13.2	34470	11850	11440
⊗1 1/4	.120	1.448	10.4	42600	14650	14100
1 3/8	.028	.4028	49.1	11850	3695	3440
⊗1 3/8	.035	.5009	39.3	14730	4810	4610
⊗1 3/8	.049	.6939	28.0	20410	7050	6950
⊗1 3/8	.058	.8158	23.7	24000	8500	8380
⊗1 3/8	.065	.9094	21.2	26750	9580	9480
⊗1 3/8	.083	1.145	16.6	33690	12430	12180
⊗1 3/8	.095	1.299	14.5	38200	14300	13920
⊗1 3/8	.120	1.608	11.5	47310	17970	17220
1 1/2	.028	.4402	53.6	12950	4350	3950
⊗1 1/2	.035	.5476	42.9	16110	5610	5320
⊗1 1/2	.049	.7593	30.6	22340	8280	8140
⊗1 1/2	.058	.8932	25.8	26270	9980	9860
⊗1 1/2	.065	.9962	23.1	29300	11290	11220
⊗1 1/2	.083	1.256	18.1	36950	14800	14480
⊗1 1/2	.095	1.426	15.8	41930	16980	16620
⊗1 1/2	.120	1.769	12.5	52020	21650	20700

(a): Where joints with tapered welds at angles of 30 degrees or less to the center line or fish-mouth welds formed by cuts of 60 degrees or less are used the allowable tensile strength near the welding is .947 x (U.T.S.). For all other welds the allowable tensile strength is .841 x (U.T.S.).

(b): The allowable torsional moments given above are for L/D = 20. For any other value of L/D the allowable torsional moment is $K_t \times T_a$. K_t is given in the graph below.

For Rounds — 75,000 Yield See III — 20



STRENGTH OF CHROME MOLYBDENUM ROUND STEEL TUBES

F_{ty} = 85,000 PSI

F_{tu} = 100,000 PSI

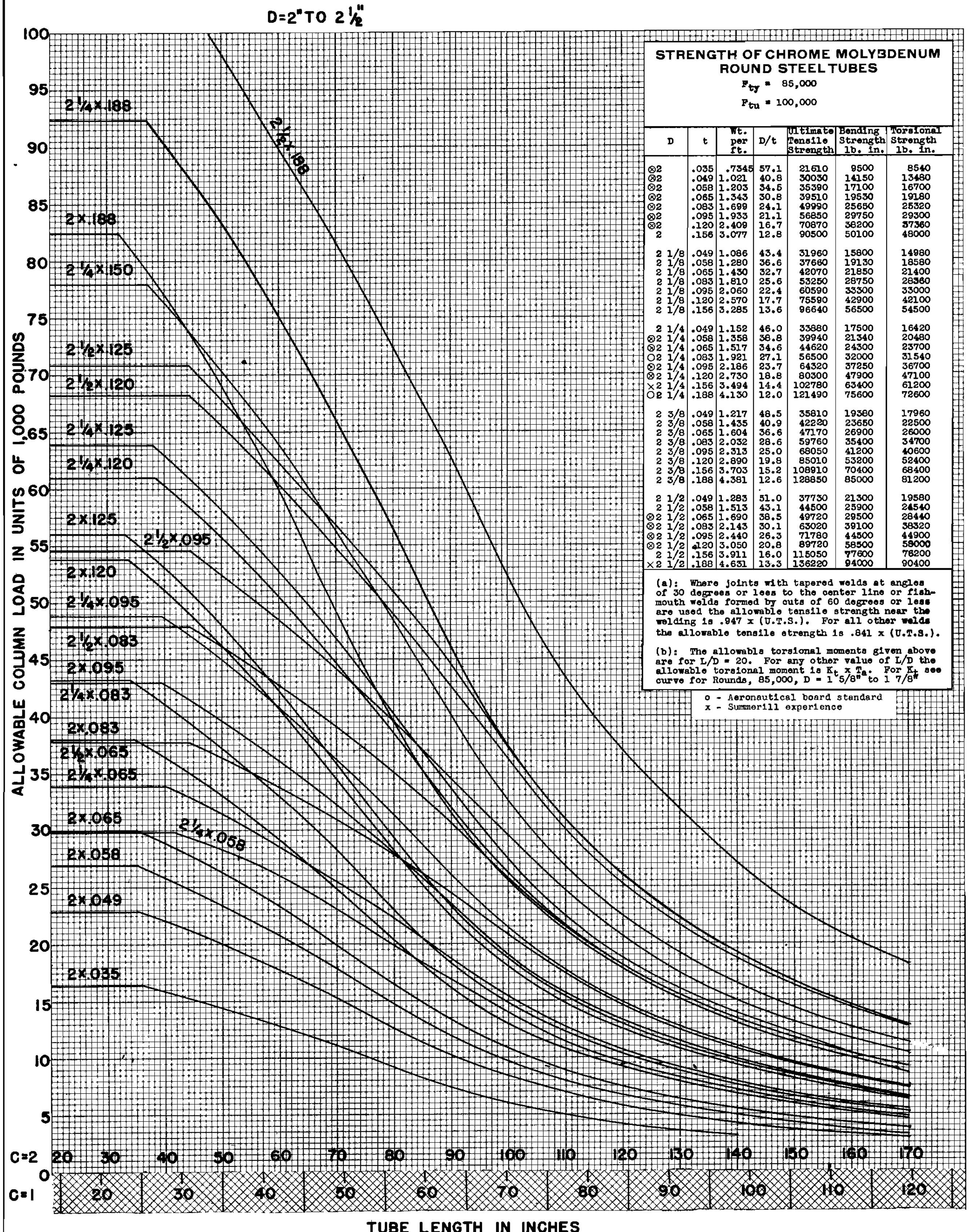
D	t	Wt. per ft.	D/t	Ultimate Tensile Strength	Bending Strength lb. in.	Torsional Strength lb. in.
1 5/8	.028	.4776	58.0	14050	5010	4480
1 5/8	.035	.5943	46.5	17480	6540	6120
⊗1 5/8	.049	.8248	33.2	24260	9600	9400
⊗1 5/8	.058	.9707	28.0	28550	11690	11460
⊗1 5/8	.065	1.083	25.0	31860	13200	13020
⊗1 5/8	.083	1.367	19.6	40210	17250	16960
○1 5/8	.095	1.552	17.1	45660	19970	19500
○1 5/8	.120	1.929	13.5	56740	25450	24500
○1 3/4	.035	.6411	50.0	18860	7450	6900
⊗1 3/4	.049	.8902	35.7	26180	11050	10720
⊗1 3/4	.058	1.048	30.2	30830	13330	15120
⊗1 3/4	.065	1.170	27.0	34410	15170	14980
⊗1 3/4	.083	1.478	21.1	43470	19900	19660
⊗1 3/4	.095	1.679	18.4	49390	22850	22540
1 3/4	.120	2.089	14.6	61450	29300	28500
1 3/4	.156	2.660	11.2	78230	37850	36340
1 7/8	.035	.6878	53.5	20230	8500	7720
○1 7/8	.049	.9556	38.3	28110	12500	12080
⊗1 7/8	.058	1.126	32.4	33110	15170	14980
⊗1 7/8	.065	1.257	28.8	36960	17300	17060
○1 7/8	.083	1.589	22.6	46730	22600	22400
⊗1 7/8	.095	1.806	19.7	53120	26200	25880
⊗1 7/8	.120	2.249	15.6	66160	33600	32760
1 7/8	.156	2.868	12.0	84370	43900	42000

(a): Where joints with tapered welds at angles of 30 degrees or less to the center line or fish-mouth welds formed by cuts of 60 degrees or less are used the allowable tensile strength near the welding is .947 x (U.T.S.). For all other welds the allowable tensile strength is .841 x (U.T.S.).

(b): The allowable torsional moments given above are for L/D = 20. For any other value of L/D the allowable torsional moment is $K_t \times T_a$. K_t is given in the graph below.

o - Aeronautical board standard
x - Summerill experience

For Rounds — 75,000 Yield See III — 20



STRENGTH OF CHROME MOLYBDENUM ROUND STEEL TUBES

F_{ty} = 85,000

F_{tu} = 100,000

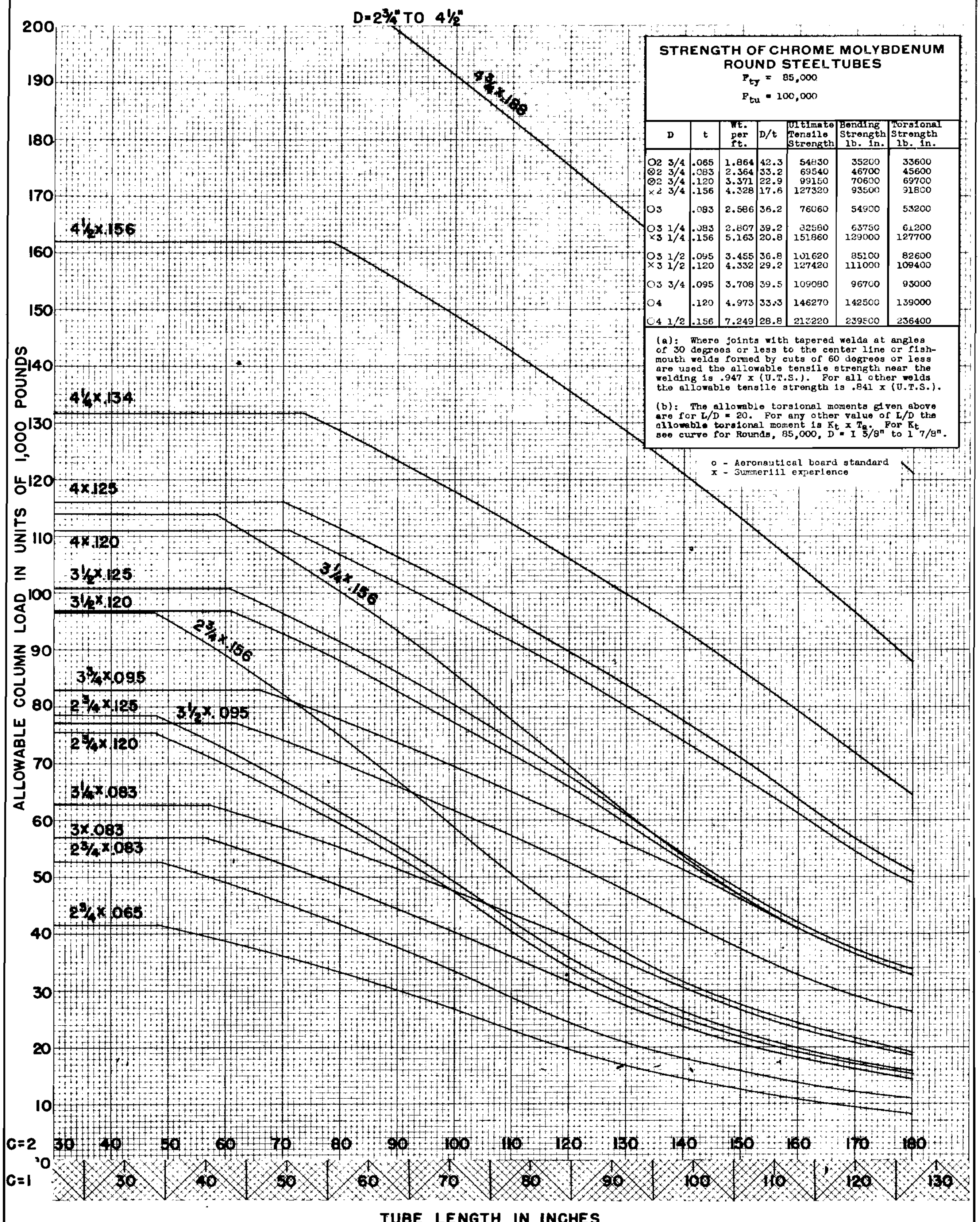
D	t	Wt. per ft.	D/t	Ultimate Tensile Strength	Bending Strength lb. in.	Torsional Strength lb. in.
⊗2	.035	.7345	57.1	21610	9500	8540
⊗2	.049	1.021	40.8	30030	14150	13480
⊗2	.058	1.203	34.5	35390	17100	16700
⊗2	.065	1.343	30.8	39510	19530	19180
⊗2	.083	1.699	24.1	49990	25650	25320
⊗2	.095	1.933	21.1	56850	29750	29300
⊗2	.120	2.409	16.7	70870	38200	37360
2	.156	3.077	12.8	90500	50100	48000
2 1/8	.049	1.086	43.4	31960	15800	14980
2 1/8	.058	1.280	36.6	37660	19130	18580
2 1/8	.065	1.430	32.7	42070	21850	21400
2 1/8	.083	1.810	25.6	53250	28750	28360
2 1/8	.095	2.060	22.4	60590	33300	33000
2 1/8	.120	2.570	17.7	75590	42900	42100
2 1/8	.156	3.285	13.6	96640	56500	54500
2 1/4	.049	1.152	46.0	33880	17500	16420
⊗2 1/4	.058	1.358	38.8	39940	21340	20480
⊗2 1/4	.065	1.517	34.6	44620	24300	23700
○2 1/4	.083	1.921	27.1	56500	32000	31540
⊗2 1/4	.095	2.186	23.7	64320	37250	36700
⊗2 1/4	.120	2.730	18.8	80300	47900	47100
×2 1/4	.156	3.494	14.4	102780	63400	61200
○2 1/4	.188	4.130	12.0	121490	75600	72600
2 3/8	.049	1.217	48.5	35810	19380	17960
2 3/8	.058	1.435	40.9	42220	23650	22500
2 3/8	.065	1.604	36.6	47170	26900	26000
2 3/8	.083	2.032	28.6	59760	35400	34700
2 3/8	.095	2.313	25.0	68050	41200	40600
2 3/8	.120	2.890	19.8	85010	53200	52400
2 3/8	.156	3.703	15.2	108910	70400	68400
2 3/8	.188	4.381	12.6	128850	85000	81200
2 1/2	.049	1.283	51.0	37730	21300	19580
2 1/2	.058	1.513	43.1	44500	25900	24540
⊗2 1/2	.065	1.690	38.5	49720	29500	28440
⊗2 1/2	.083	2.143	30.1	63020	39100	38320
⊗2 1/2	.095	2.440	26.3	71780	44500	44900
⊗2 1/2	.120	3.050	20.8	89720	58500	58000
2 1/2	.156	3.911	16.0	115050	77600	76200
×2 1/2	.188	4.631	13.3	136220	94000	90400

(a): Where joints with tapered welds at angles of 30 degrees or less to the center line or fish-mouth welds formed by cuts of 60 degrees or less are used the allowable tensile strength near the welding is .947 x (U.T.S.). For all other welds the allowable tensile strength is .841 x (U.T.S.).

(b): The allowable torsional moments given above are for L/D = 20. For any other value of L/D the allowable torsional moment is $K_t \times T_a$. For K_t see curve for Rounds, 85,000, D = 1 5/8" to 1 7/8"

o - Aeronautical board standard
x - Summerill experience

For Rounds — 75,000 Yield See III — 20



STRENGTH OF CHROME MOLYBDENUM ROUND STEELTUBES

F_{ty} = 85,000

F_{tu} = 100,000

D	t	Wt. per ft.	D/t	Ultimate Tensile Strength	Bending Strength lb. in.	Torsional Strength lb. in.
○2 3/4	.065	1.864	42.3	54830	35200	33600
⊗2 3/4	.083	2.364	33.2	69540	46700	45600
⊗2 3/4	.120	3.371	22.9	99150	70600	69700
×2 3/4	.156	4.328	17.6	127320	93500	91800
○3	.083	2.586	36.2	76060	54900	53200
○3 1/4	.083	2.807	39.2	82580	63750	61200
×3 1/4	.156	5.163	20.8	151860	129000	127700
○3 1/2	.095	3.455	36.8	101620	85100	82600
×3 1/2	.120	4.332	29.2	127420	111000	109400
○3 3/4	.095	3.708	39.5	109080	96700	93000
○4	.120	4.973	33.3	146270	142500	139000
○4 1/2	.156	7.249	28.8	213220	239500	236400

(a): Where joints with tapered welds at angles of 30 degrees or less to the center line or fish-mouth welds formed by cuts of 60 degrees or less are used the allowable tensile strength near the welding is .947 x (U.T.S.). For all other welds the allowable tensile strength is .841 x (U.T.S.).

(b): The allowable torsional moments given above are for L/D = 20. For any other value of L/D the allowable torsional moment is K_t x T_a. For K_t see curve for Rounds, 85,000, D = 1 5/8" to 1 7/8".

o - Aeronautical board standard
x - Summerill experience

For Rounds — 75,000 Yield See III — 20

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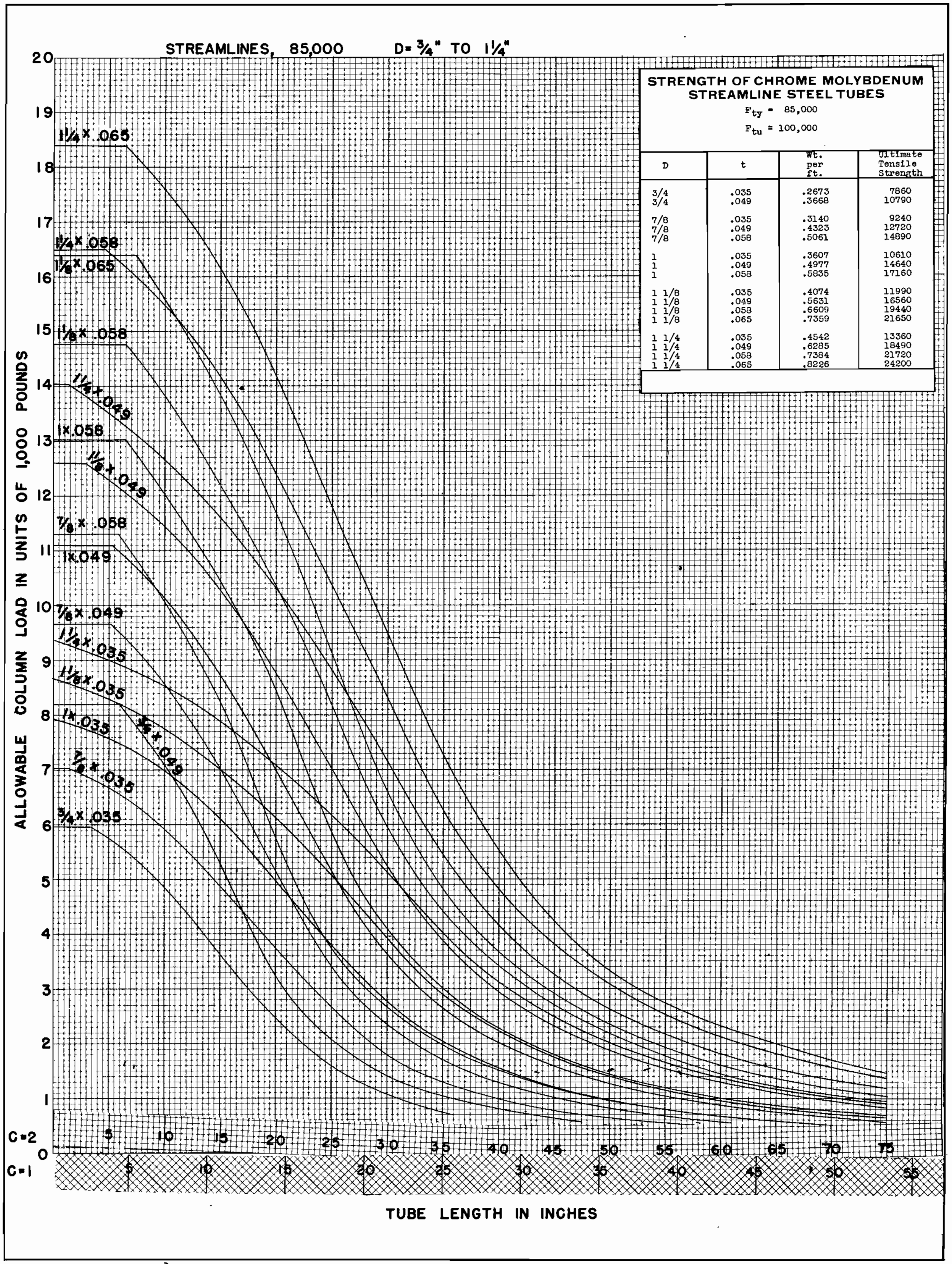


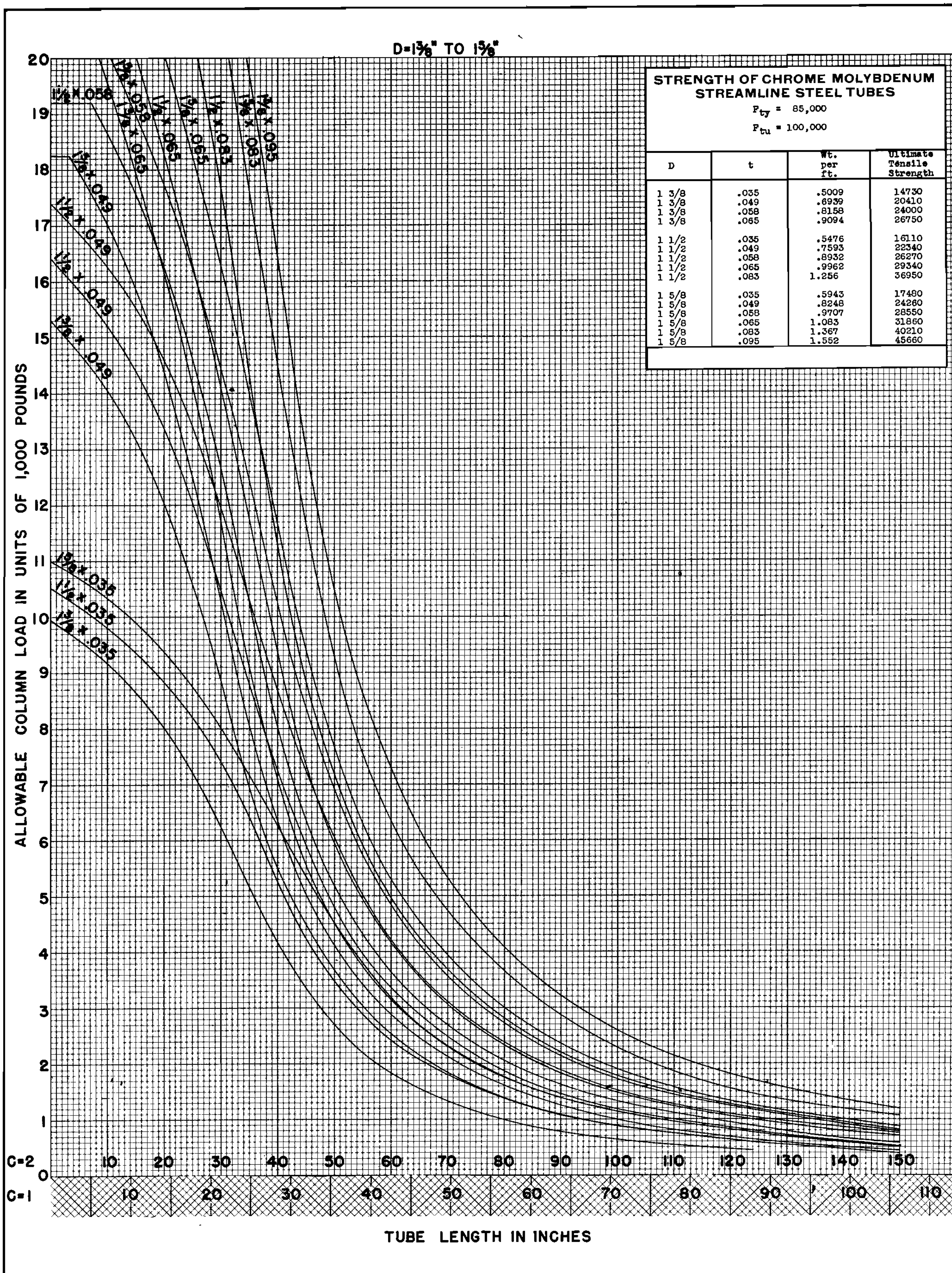
STRENGTH OF CHROME MOLYBDENUM STREAMLINE STEEL TUBES

F_{ty} = 85,000

F_{tu} = 100,000

D	t	Wt. per ft.	Ultimate Tensile Strength
3/4	.035	.2673	7860
3/4	.049	.3668	10790
7/8	.035	.3140	9240
7/8	.049	.4323	12720
7/8	.058	.5061	14890
1	.035	.3607	10610
1	.049	.4977	14640
1	.058	.5835	17160
1 1/8	.035	.4074	11990
1 1/8	.049	.5631	16560
1 1/8	.058	.6609	19440
1 1/8	.065	.7359	21650
1 1/4	.035	.4542	13360
1 1/4	.049	.6285	18490
1 1/4	.058	.7384	21720
1 1/4	.065	.8226	24200

For Streamline — 75,000 Yield See III — 28



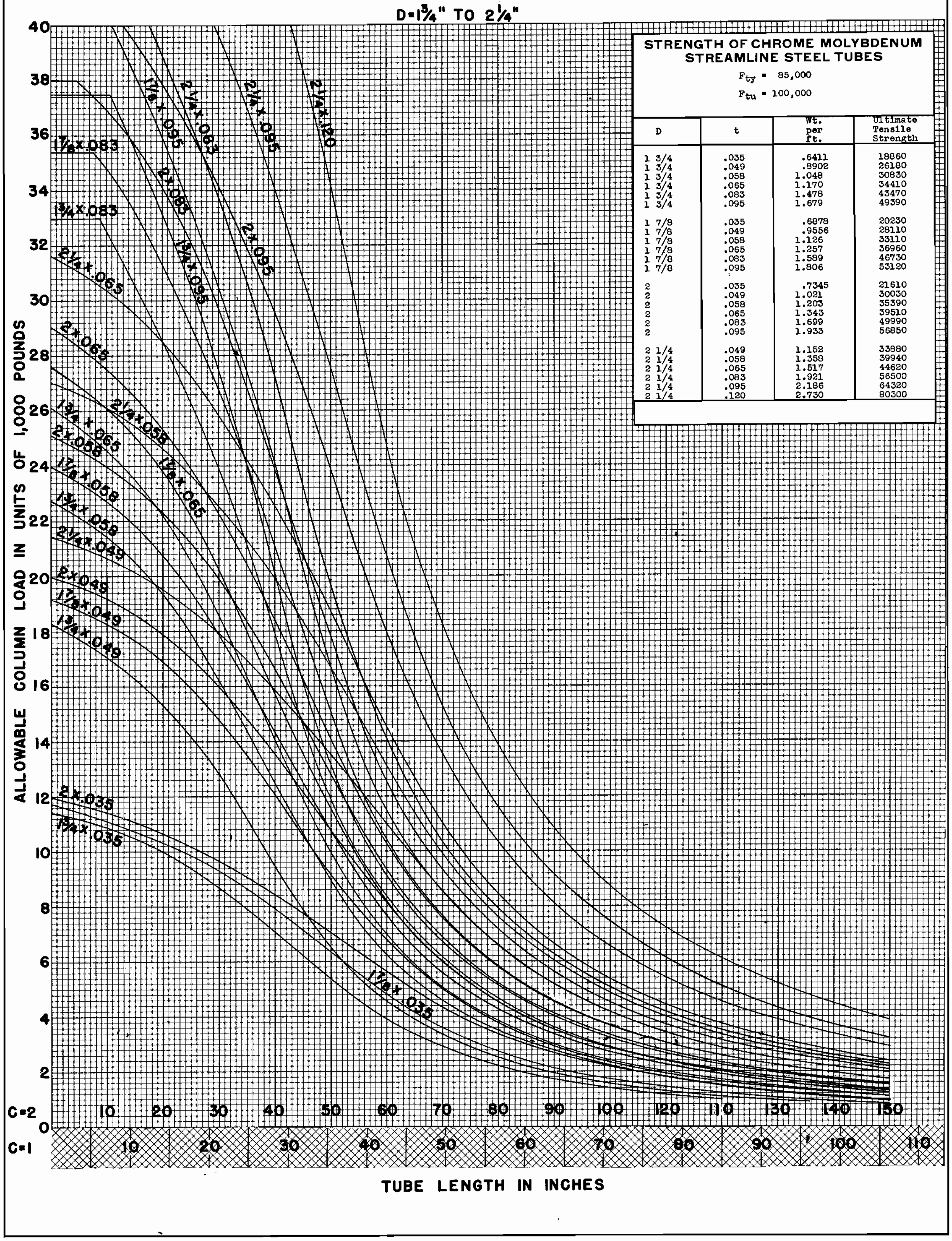
STRENGTH OF CHROME MOLYBDENUM STREAMLINE STEEL TUBES

F_{ty} = 85,000

F_{tu} = 100,000

D	t	Wt. per ft.	Ultimate Tensile Strength
1 3/8	.035	.5009	14730
1 3/8	.049	.6939	20410
1 3/8	.058	.8158	24000
1 3/8	.065	.9094	26750
1 1/2	.035	.5476	16110
1 1/2	.049	.7593	22340
1 1/2	.058	.8932	26270
1 1/2	.065	.9962	29340
1 1/2	.083	1.256	36950
1 5/8	.035	.5943	17480
1 5/8	.049	.8248	24260
1 5/8	.058	.9707	28550
1 5/8	.065	1.083	31860
1 5/8	.083	1.367	40210
1 5/8	.095	1.552	45660

For Streamline — 75,000 Yield See III — 28



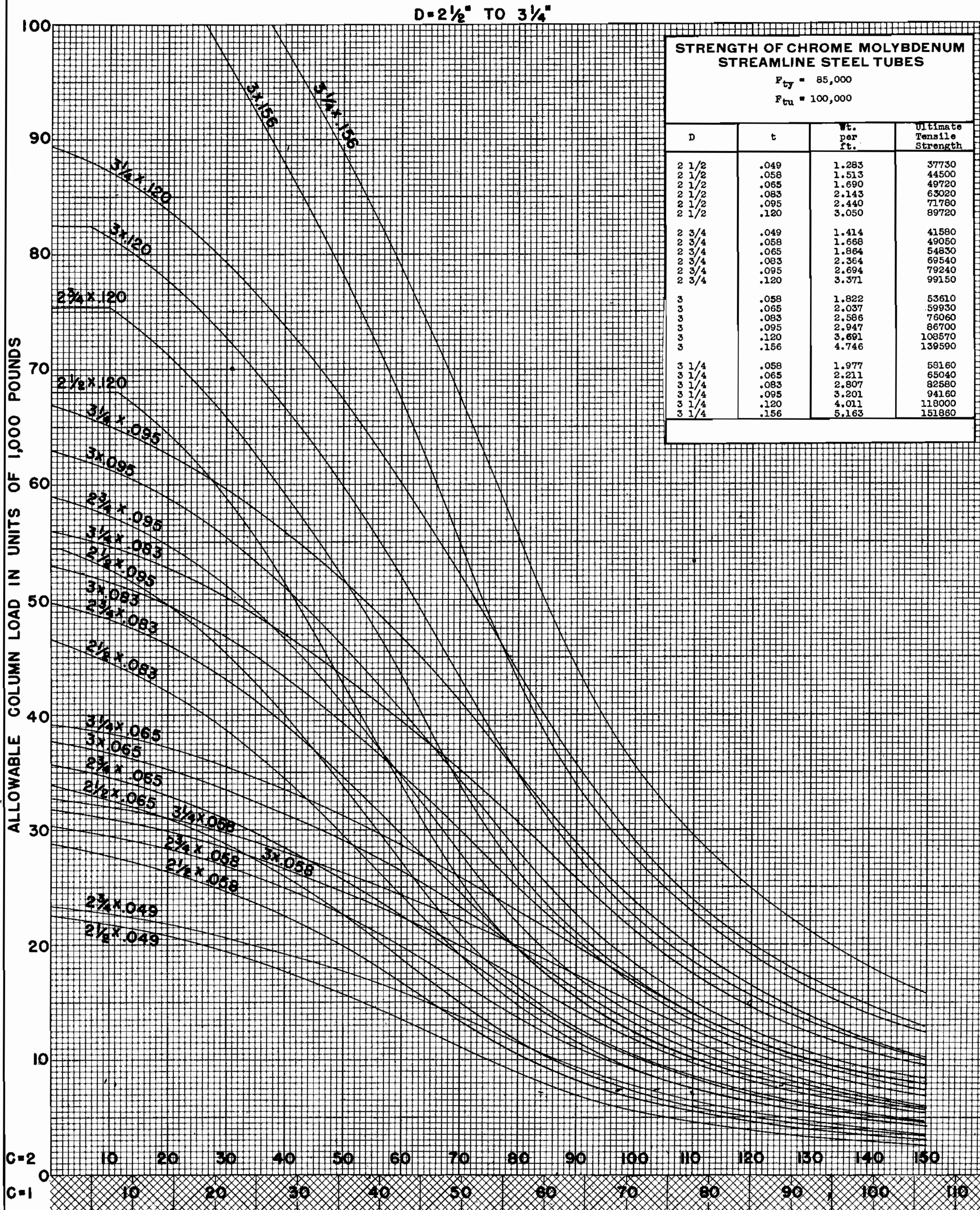
STRENGTH OF CHROME MOLYBDENUM STREAMLINE STEEL TUBES

F_{ty} = 85,000

F_{tu} = 100,000

D	t	Wt. per ft.	Ultimate Tensile Strength
1 3/4	.035	.6411	18860
1 3/4	.049	.8902	26180
1 3/4	.058	1.048	30830
1 3/4	.065	1.170	34410
1 3/4	.083	1.478	43470
1 3/4	.095	1.679	49390
1 7/8	.035	.6878	20230
1 7/8	.049	.9556	28110
1 7/8	.058	1.126	33110
1 7/8	.065	1.257	36960
1 7/8	.083	1.589	46730
1 7/8	.095	1.806	53120
2	.035	.7345	21610
2	.049	1.021	30030
2	.058	1.203	35390
2	.065	1.343	39510
2	.083	1.699	49990
2	.095	1.933	56850
2 1/4	.049	1.152	33880
2 1/4	.058	1.358	39940
2 1/4	.065	1.517	44620
2 1/4	.083	1.921	56500
2 1/4	.095	2.186	64320
2 1/4	.120	2.730	80300

For Streamline — 75,000 Yield See III — 28



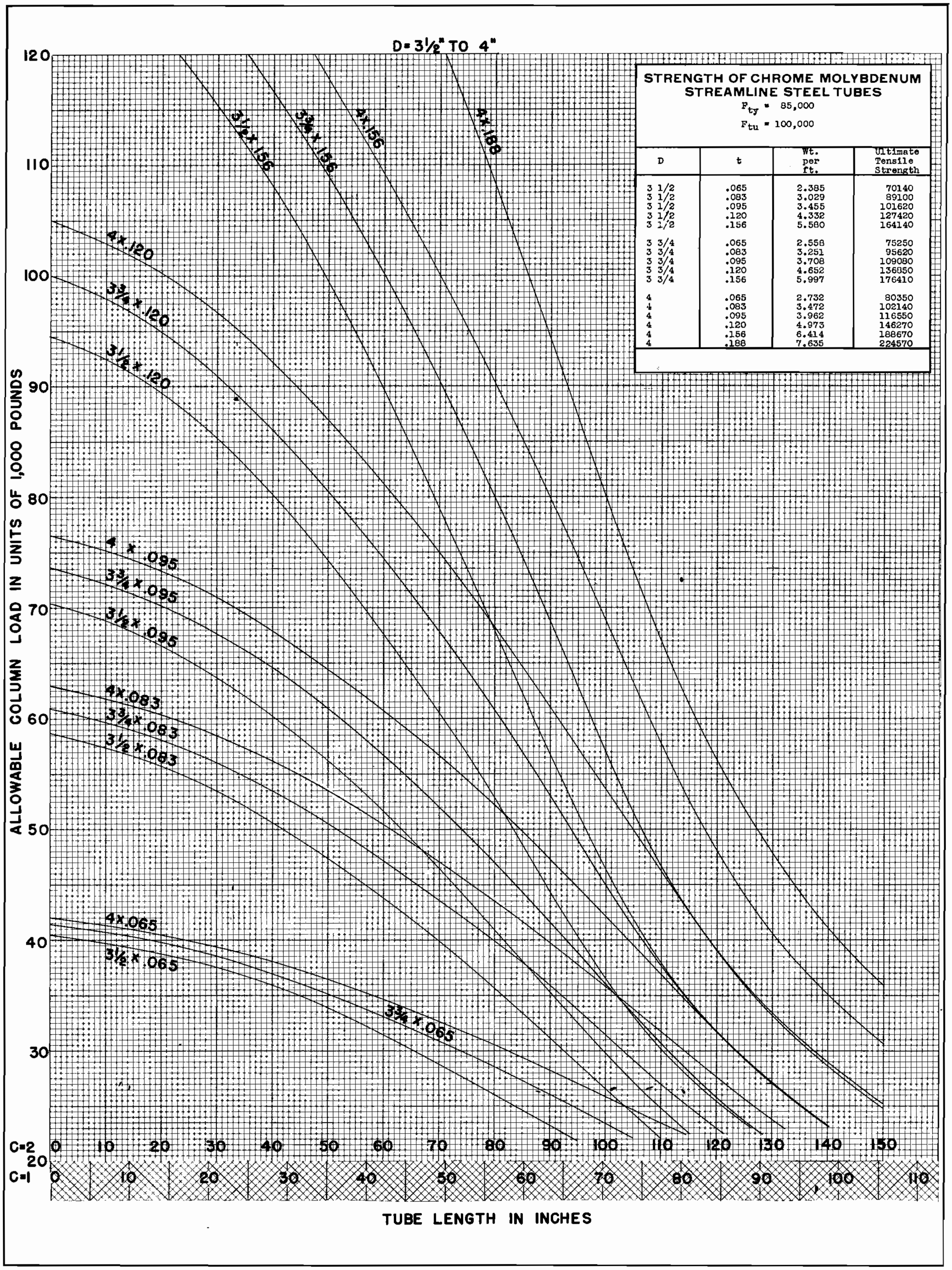
STRENGTH OF CHROME MOLYBDENUM STREAMLINE STEEL TUBES

F_{ty} = 85,000

F_{tu} = 100,000

D	t	Wt. per ft.	Ultimate Tensile Strength
2 1/2	.049	1.283	37730
2 1/2	.058	1.513	44500
2 1/2	.065	1.690	49720
2 1/2	.083	2.143	63020
2 1/2	.095	2.440	71780
2 1/2	.120	3.050	89720
2 3/4	.049	1.414	41580
2 3/4	.058	1.668	49050
2 3/4	.065	1.864	54830
2 3/4	.083	2.364	69540
2 3/4	.095	2.694	79240
2 3/4	.120	3.371	99150
3	.058	1.822	53610
3	.065	2.037	59930
3	.083	2.586	76060
3	.095	2.947	86700
3	.120	3.691	108570
3	.156	4.746	139590
3 1/4	.058	1.977	58160
3 1/4	.065	2.211	65040
3 1/4	.083	2.807	82580
3 1/4	.095	3.201	94160
3 1/4	.120	4.011	118000
3 1/4	.156	5.163	151860

For Streamline — 75,000 Yield See III — 28



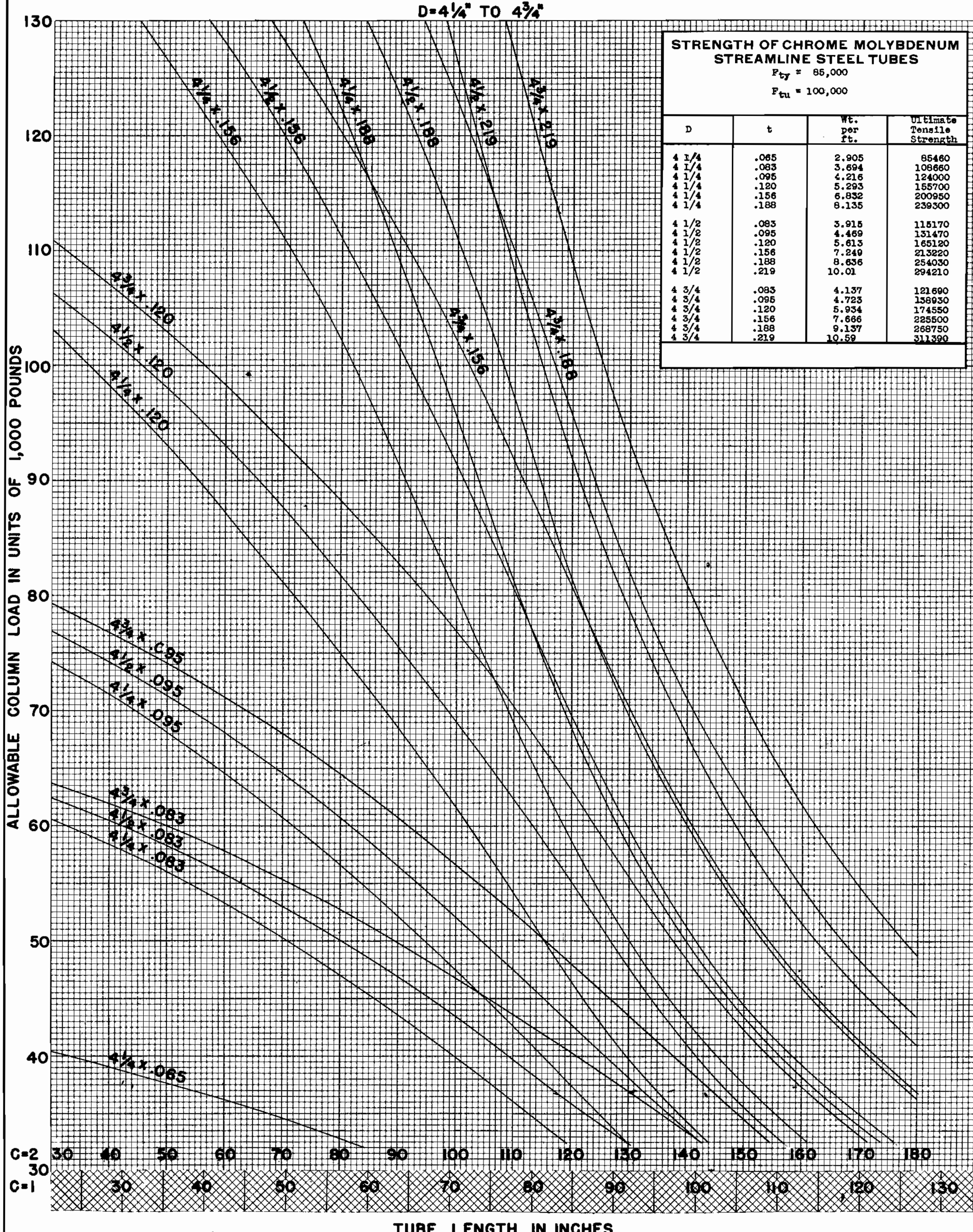
STRENGTH OF CHROME MOLYBDENUM STREAMLINE STEEL TUBES

F_{ty} = 85,000

F_{tu} = 100,000

D	t	Wt. per ft.	Ultimate Tensile Strength
3 1/2	.065	2.385	70140
3 1/2	.083	3.029	89100
3 1/2	.095	3.455	101620
3 1/2	.120	4.332	127420
3 1/2	.156	5.580	164140
3 3/4	.065	2.558	75250
3 3/4	.083	3.251	95620
3 3/4	.095	3.708	109080
3 3/4	.120	4.652	136850
3 3/4	.156	5.997	176410
4	.065	2.732	80350
4	.083	3.472	102140
4	.095	3.962	116550
4	.120	4.973	146270
4	.156	6.414	188670
4	.188	7.635	224570

For Streamline — 75,000 Yield See III — 28



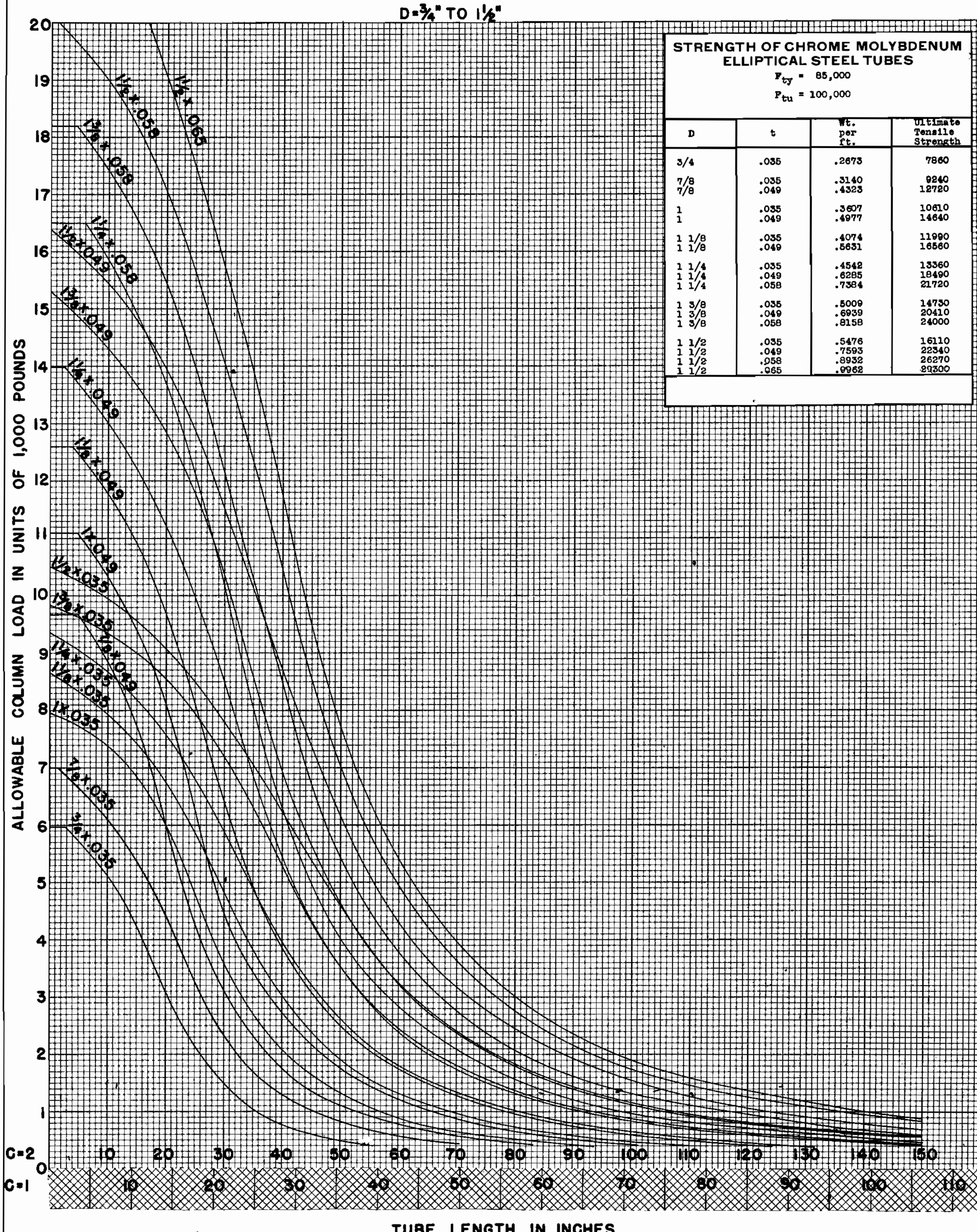
STRENGTH OF CHROME MOLYBDENUM STREAMLINE STEEL TUBES

F_{ty} = 85,000

F_{tu} = 100,000

D	t	Wt. per ft.	Ultimate Tensile Strength
4 1/4	.065	2.905	85460
4 1/4	.083	3.694	108660
4 1/4	.095	4.216	124000
4 1/4	.120	5.293	155700
4 1/4	.156	6.832	200950
4 1/4	.188	8.135	239300
4 1/2	.083	3.915	115170
4 1/2	.095	4.469	131470
4 1/2	.120	5.613	165120
4 1/2	.156	7.249	213220
4 1/2	.188	8.636	254030
4 1/2	.219	10.01	294210
4 3/4	.083	4.137	121690
4 3/4	.095	4.723	138930
4 3/4	.120	5.934	174550
4 3/4	.156	7.666	225500
4 3/4	.188	9.137	268750
4 3/4	.219	10.59	311390

For Streamline — 75,000 Yield See III — 28



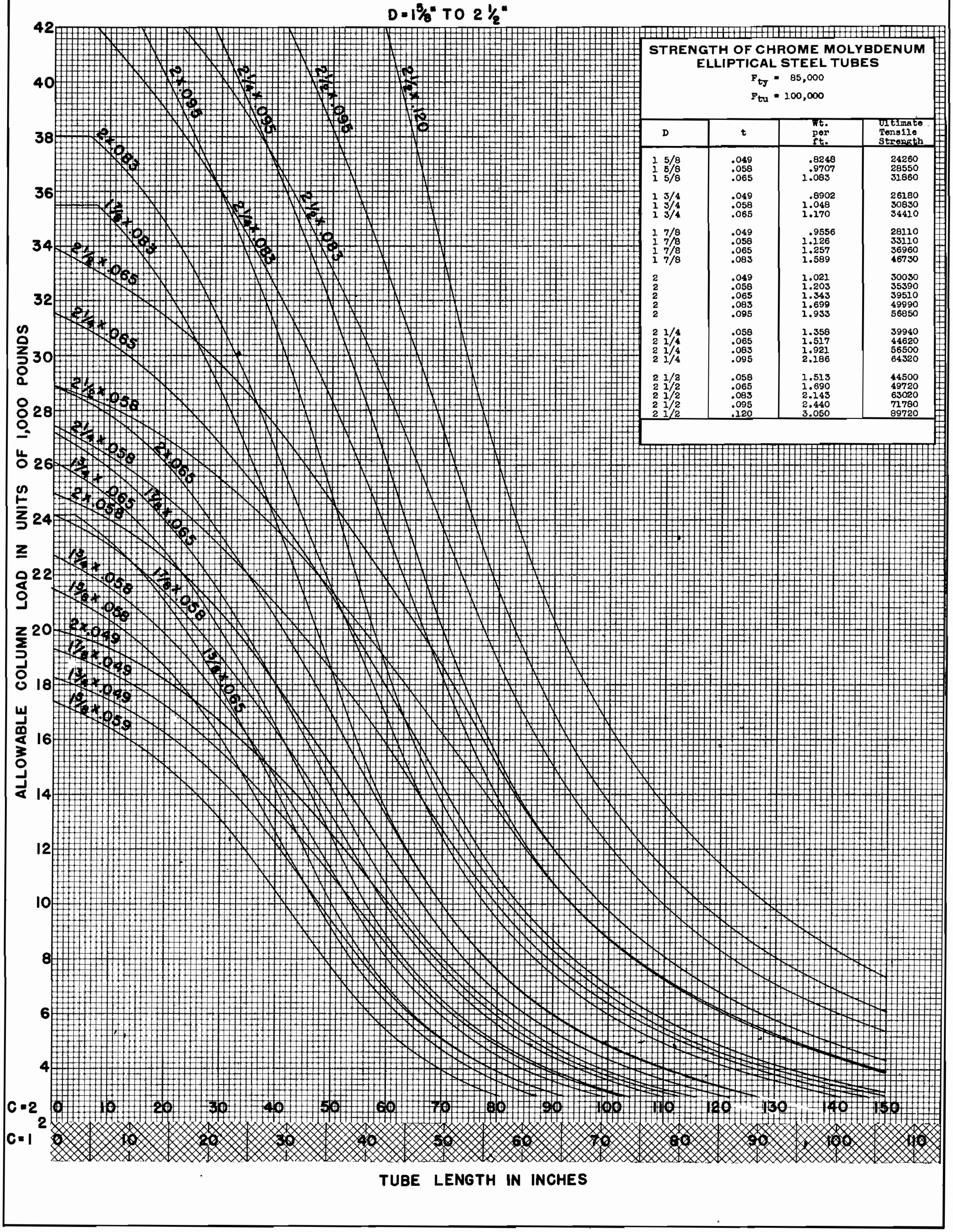
STRENGTH OF CHROME MOLYBDENUM ELLIPTICAL STEEL TUBES

F_{ty} = 85,000

F_{tu} = 100,000

D	t	Wt. per ft.	Ultimate Tensile Strength
3/4	.035	.2673	7860
7/8	.035	.3140	9240
7/8	.049	.4323	12720
1	.035	.3607	10610
1	.049	.4977	14640
1 1/8	.035	.4074	11990
1 1/8	.049	.5631	16560
1 1/4	.035	.4542	13360
1 1/4	.049	.6285	18490
1 1/4	.058	.7384	21720
1 3/8	.035	.5009	14730
1 3/8	.049	.6939	20410
1 3/8	.058	.8158	24000
1 1/2	.035	.5476	16110
1 1/2	.049	.7593	22340
1 1/2	.058	.8932	26270
1 1/2	.065	.9962	29300

For Ovals — 75,000 Yield See III — 34



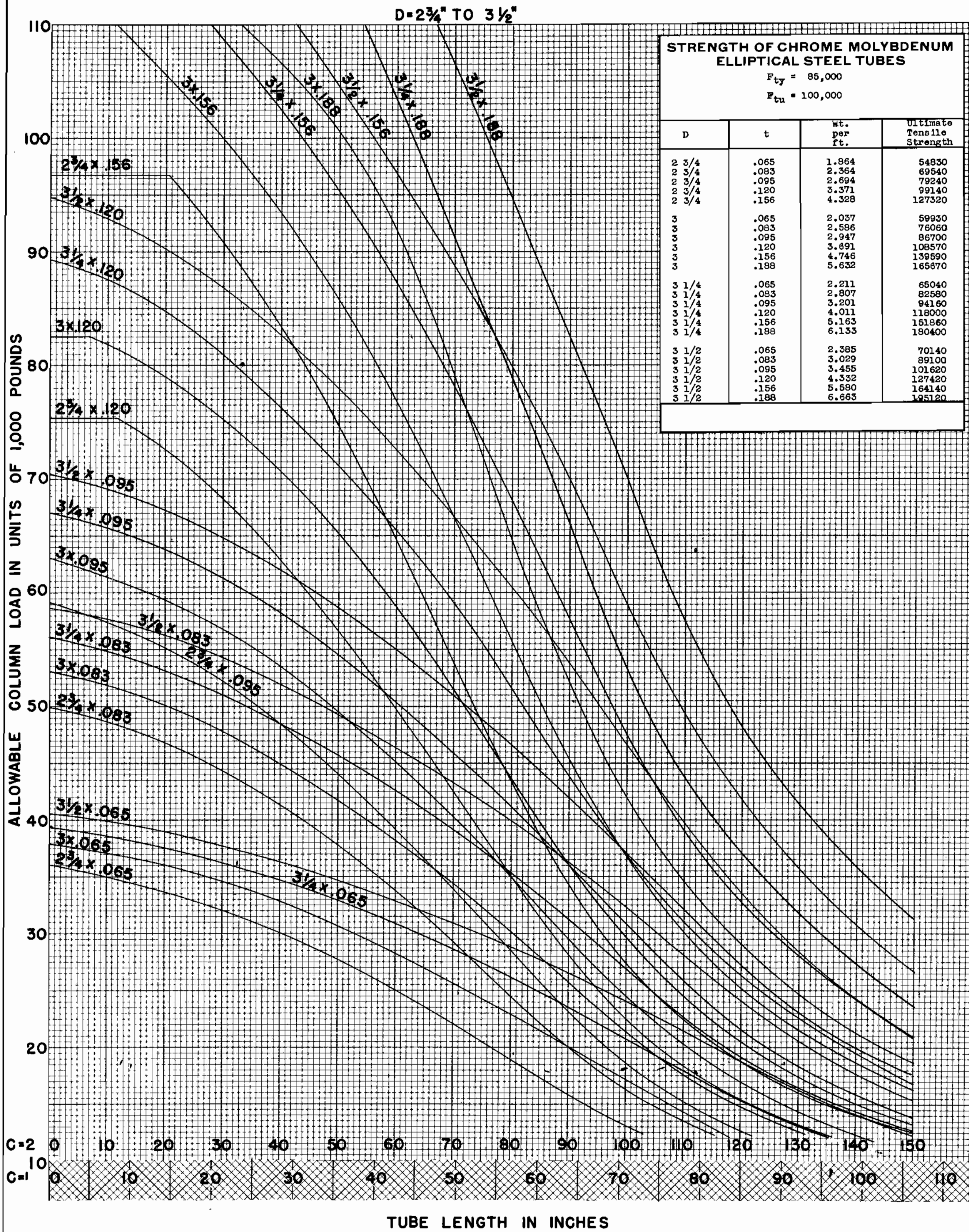
STRENGTH OF CHROME MOLYBDENUM ELLIPTICAL STEEL TUBES

$F_{ty} = 85,000$

$F_{tu} = 100,000$

D	t	Wt. per ft.	Ultimate Tensile Strength
1 5/8	.049	.8248	24260
1 5/8	.058	.9707	28550
1 5/8	.065	1.083	31860
1 3/4	.049	.8902	26180
1 3/4	.058	1.048	30830
1 3/4	.065	1.170	34410
1 7/8	.049	.9556	28110
1 7/8	.058	1.126	33110
1 7/8	.065	1.257	36960
1 7/8	.083	1.589	46730
2	.049	1.021	30030
2	.058	1.203	35390
2	.065	1.343	39510
2	.083	1.699	49990
2	.095	1.933	56850
2 1/4	.058	1.358	39940
2 1/4	.065	1.517	44620
2 1/4	.083	1.921	56500
2 1/4	.095	2.186	64320
2 1/2	.058	1.513	44500
2 1/2	.065	1.690	49720
2 1/2	.083	2.143	63020
2 1/2	.095	2.440	71780
2 1/2	.120	3.050	89720

For Ovals — 75,000 Yield See III — 34



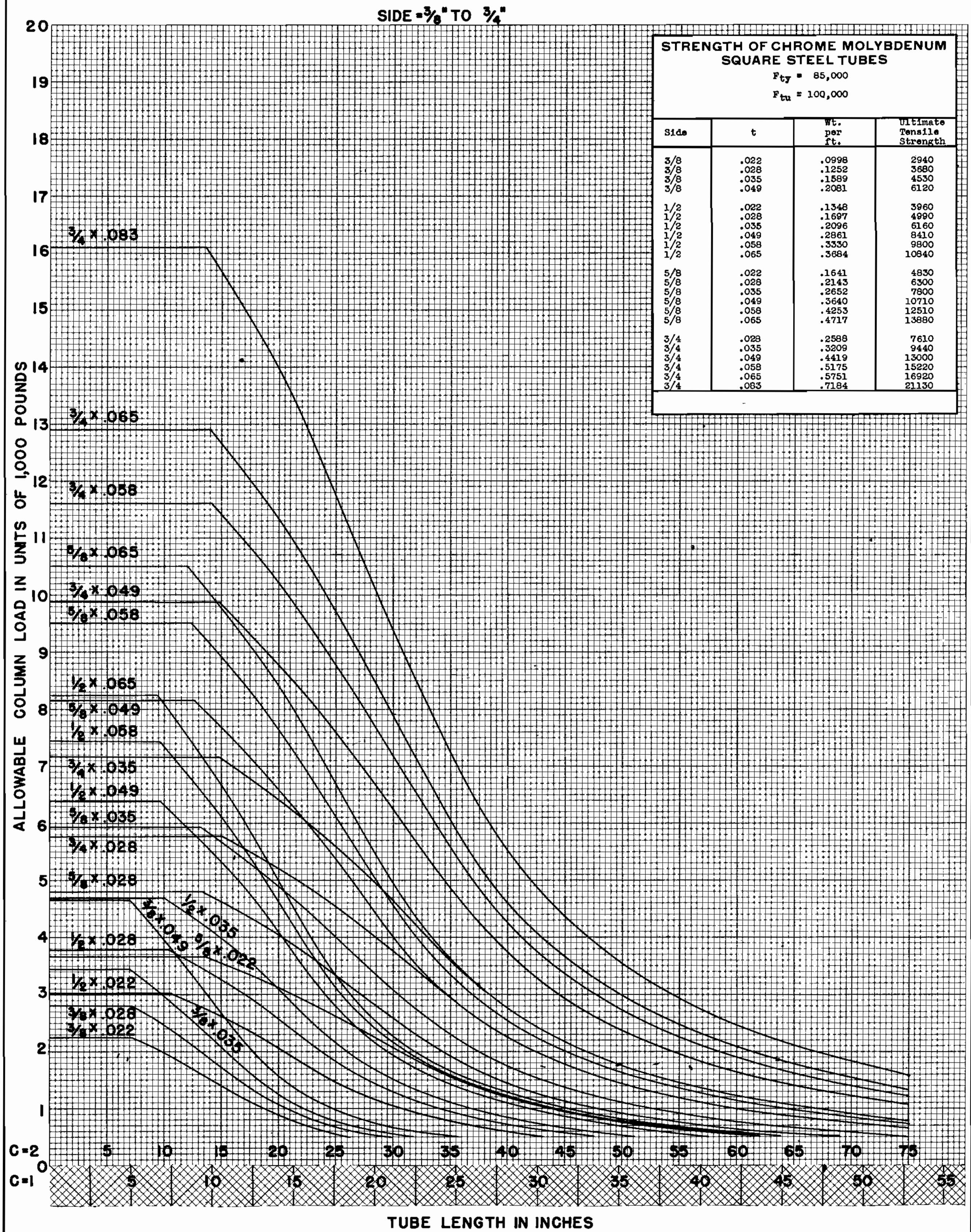
STRENGTH OF CHROME MOLYBDENUM ELLIPTICAL STEEL TUBES

F_{ty} = 85,000

F_{tu} = 100,000

D	t	Wt. per ft.	Ultimate Tensile Strength
2 3/4	.065	1.864	54830
2 3/4	.083	2.364	69540
2 3/4	.095	2.694	79240
2 3/4	.120	3.371	99140
2 3/4	.156	4.328	127320
3	.065	2.037	59930
3	.083	2.586	76060
3	.095	2.947	86700
3	.120	3.691	108570
3	.156	4.746	139590
3	.188	5.632	165670
3 1/4	.065	2.211	65040
3 1/4	.083	2.807	82580
3 1/4	.095	3.201	94160
3 1/4	.120	4.011	118000
3 1/4	.156	5.163	151860
3 1/4	.188	6.133	180400
3 1/2	.065	2.385	70140
3 1/2	.083	3.029	89100
3 1/2	.095	3.455	101620
3 1/2	.120	4.332	127420
3 1/2	.156	5.580	164140
3 1/2	.188	6.663	195120

For Ovals — 75,000 Yield See III — 34



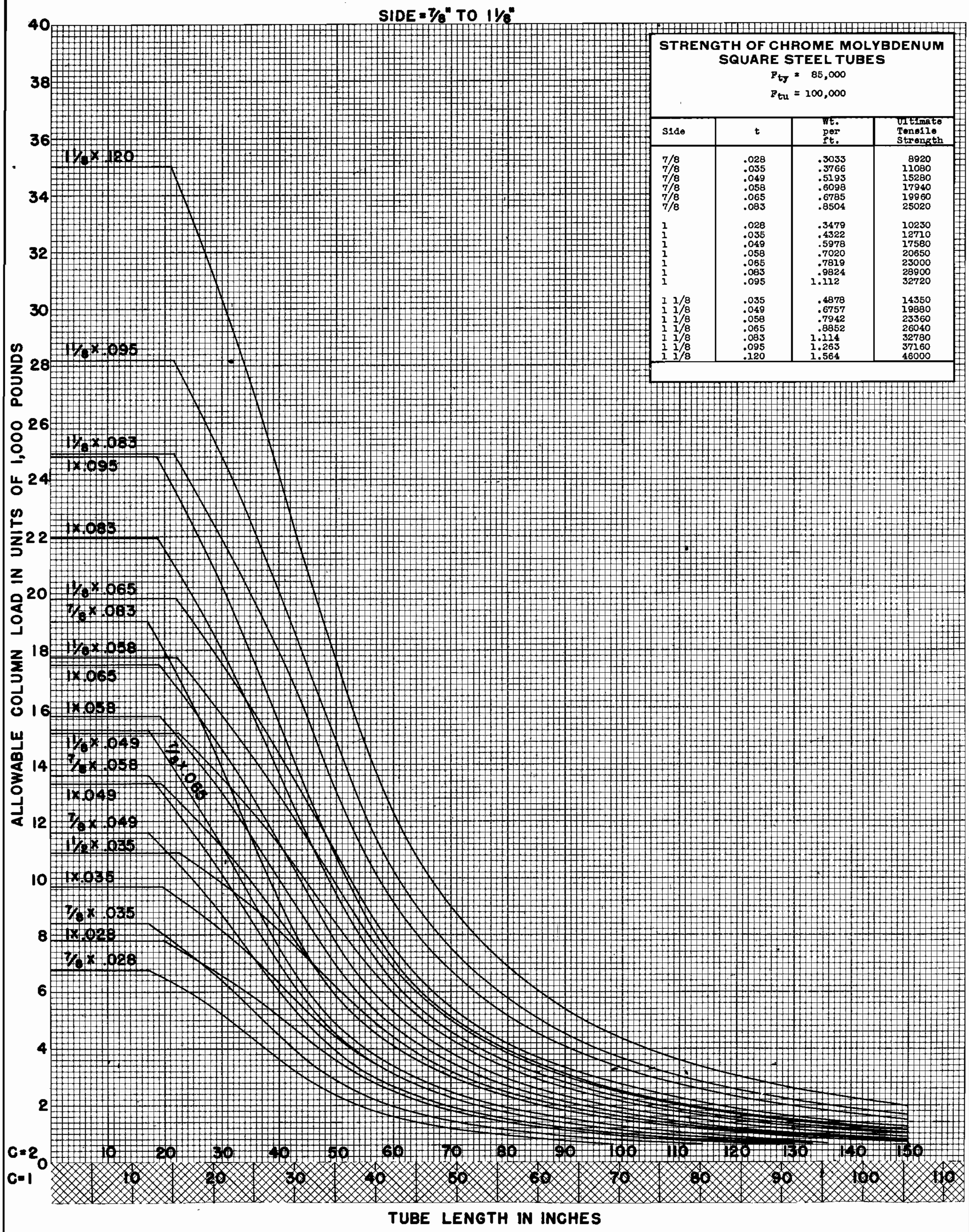
STRENGTH OF CHROME MOLYBDENUM SQUARE STEEL TUBES

F_{ty} = 85,000

F_{tu} = 100,000

Side	t	Wt. per ft.	Ultimate Tensile Strength
3/8	.022	.0998	2940
3/8	.028	.1252	3680
3/8	.035	.1589	4530
3/8	.049	.2081	6120
1/2	.022	.1348	3960
1/2	.028	.1697	4990
1/2	.035	.2096	6160
1/2	.049	.2861	8410
1/2	.058	.3330	9800
1/2	.065	.3684	10840
5/8	.022	.1641	4830
5/8	.028	.2143	6300
5/8	.035	.2652	7800
5/8	.049	.3640	10710
5/8	.058	.4253	12510
5/8	.065	.4717	13880
3/4	.028	.2588	7610
3/4	.035	.3209	9440
3/4	.049	.4419	13000
3/4	.058	.5175	15220
3/4	.065	.5751	16920
3/4	.083	.7184	21130

For Squares — 75,000 Yield - See III — 37



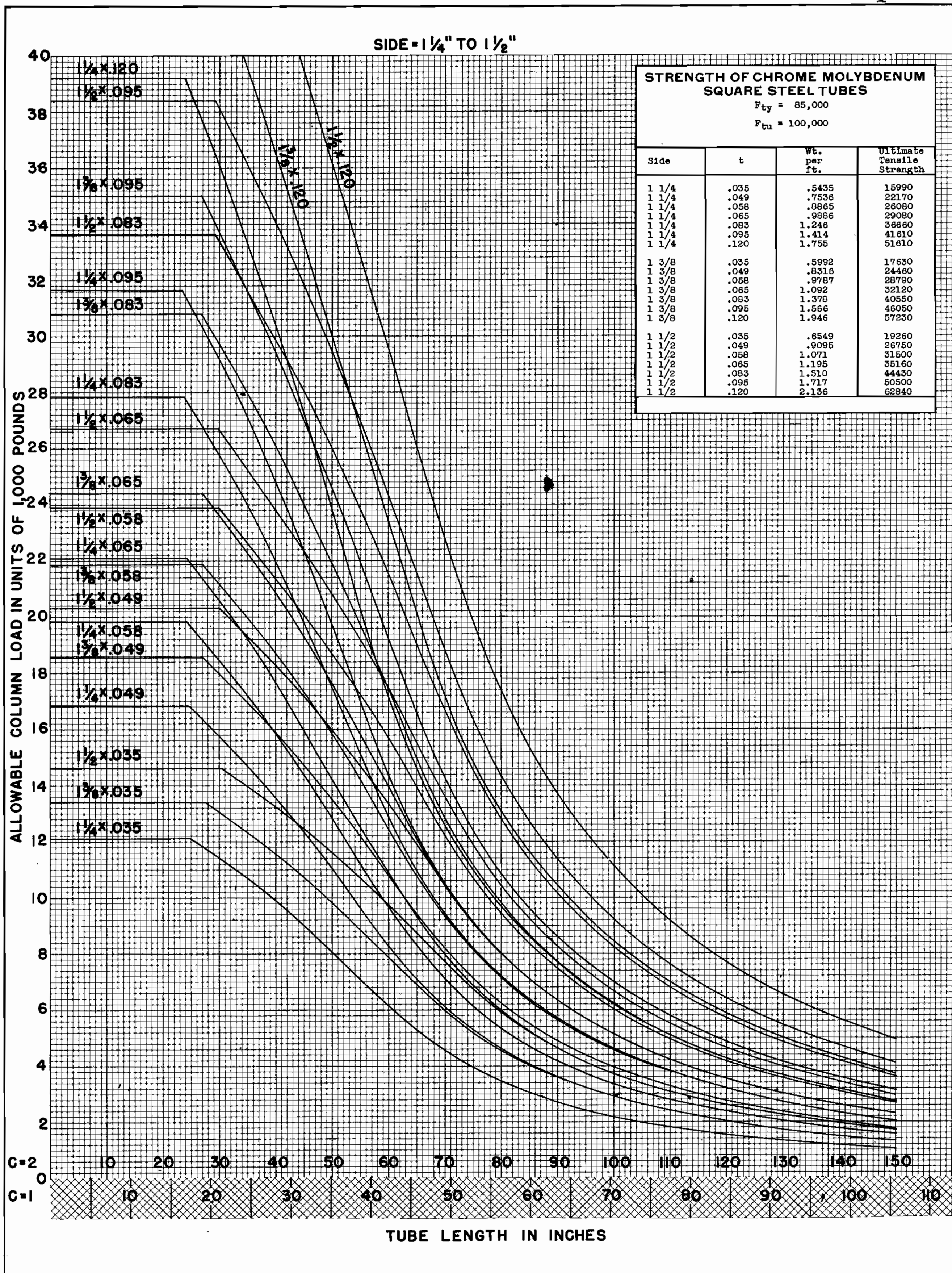
STRENGTH OF CHROME MOLYBDENUM SQUARE STEEL TUBES

F_{ty} = 85,000

F_{tu} = 100,000

Side	t	Wt. per ft.	Ultimate Tensile Strength
7/8	.028	.3033	8920
7/8	.035	.3766	11080
7/8	.049	.5193	15280
7/8	.058	.6098	17940
7/8	.065	.6785	19960
7/8	.083	.8504	25020
1	.028	.3479	10230
1	.035	.4322	12710
1	.049	.5978	17580
1	.058	.7020	20650
1	.065	.7819	23000
1	.083	.9824	28900
1	.095	1.112	32720
1 1/8	.035	.4878	14350
1 1/8	.049	.6757	19880
1 1/8	.058	.7942	23360
1 1/8	.065	.8852	26040
1 1/8	.083	1.114	32780
1 1/8	.095	1.263	37160
1 1/8	.120	1.564	46000

For Squares — 75,000 Yield See III — 37



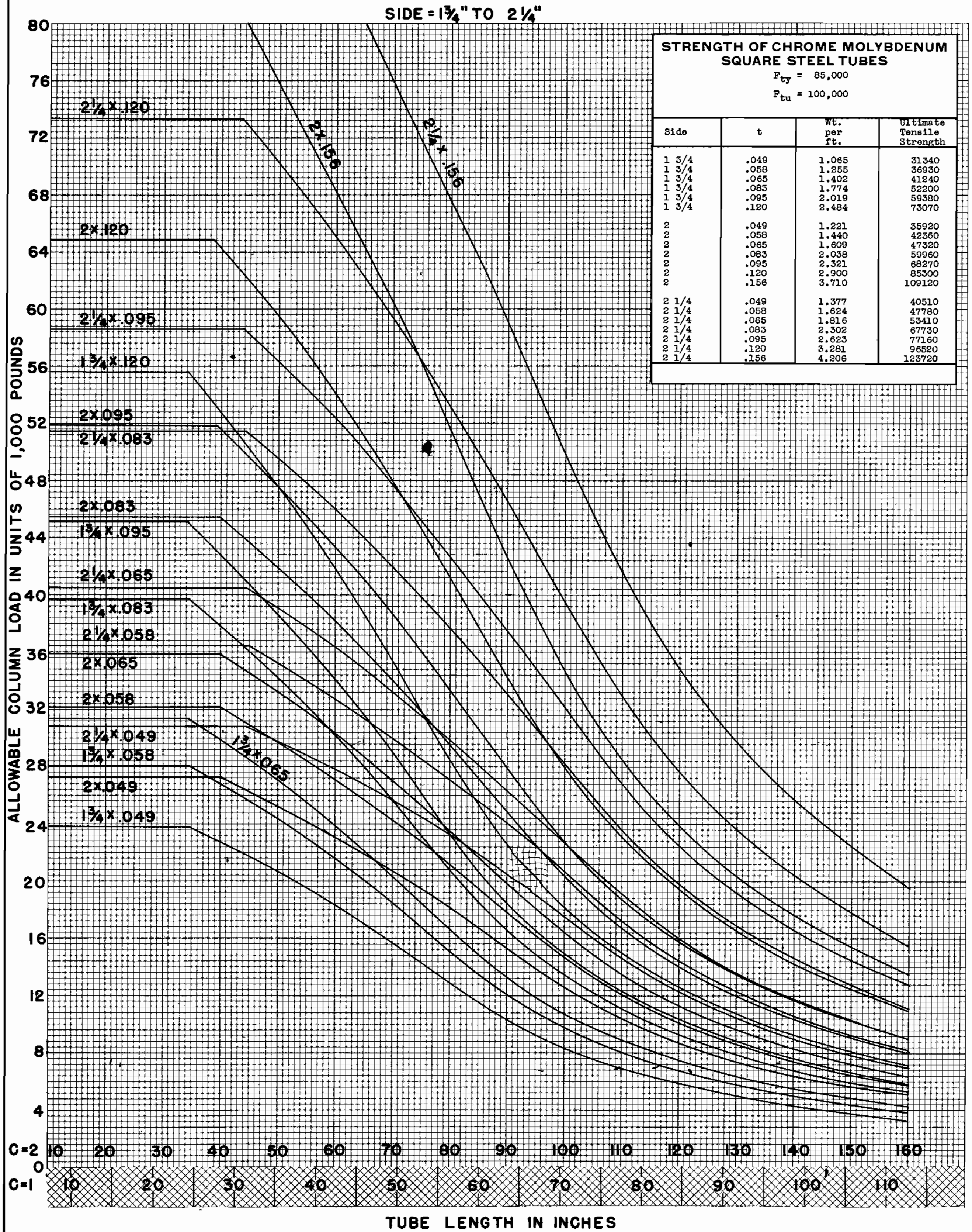
STRENGTH OF CHROME MOLYBDENUM SQUARE STEEL TUBES

F_{ty} = 85,000

F_{tu} = 100,000

Side	t	Wt. per ft.	Ultimate Tensile Strength
1 1/4	.035	.5435	15990
1 1/4	.049	.7536	22170
1 1/4	.058	.8865	26080
1 1/4	.065	.9886	29080
1 1/4	.083	1.246	36660
1 1/4	.095	1.414	41610
1 1/4	.120	1.755	51610
1 3/8	.035	.5992	17630
1 3/8	.049	.8316	24460
1 3/8	.058	.9787	28790
1 3/8	.065	1.092	32120
1 3/8	.083	1.378	40550
1 3/8	.095	1.566	46050
1 3/8	.120	1.946	57230
1 1/2	.035	.6549	19260
1 1/2	.049	.9095	26750
1 1/2	.058	1.071	31500
1 1/2	.065	1.195	35160
1 1/2	.083	1.510	44430
1 1/2	.095	1.717	50500
1 1/2	.120	2.136	62840

For Squares — 75,000 Yield See III — 37



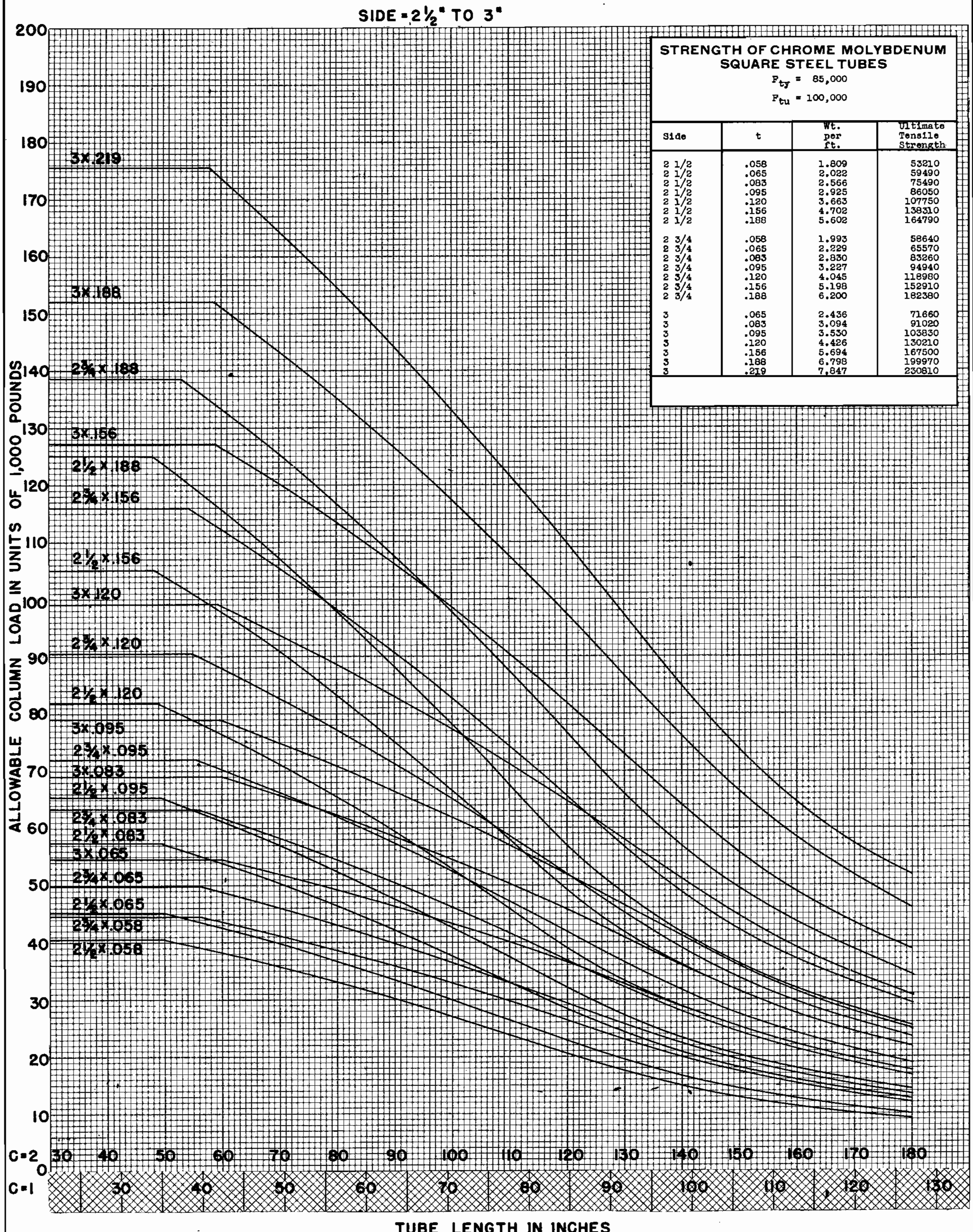
STRENGTH OF CHROME MOLYBDENUM SQUARE STEEL TUBES

F_{ty} = 85,000

F_{tu} = 100,000

Side	t	Wt. per ft.	Ultimate Tensile Strength
1 3/4	.049	1.065	31340
1 3/4	.058	1.255	36930
1 3/4	.065	1.402	41240
1 3/4	.083	1.774	52200
1 3/4	.095	2.019	59380
1 3/4	.120	2.484	73070
2	.049	1.221	35920
2	.058	1.440	42360
2	.065	1.609	47320
2	.083	2.038	59960
2	.095	2.321	68270
2	.120	2.900	85300
2	.156	3.710	109120
2 1/4	.049	1.377	40510
2 1/4	.058	1.624	47780
2 1/4	.065	1.816	53410
2 1/4	.083	2.302	67730
2 1/4	.095	2.623	77160
2 1/4	.120	3.281	96520
2 1/4	.156	4.206	123720

For Squares — 75,000 Yield See III — 37



STRENGTH OF CHROME MOLYBDENUM SQUARE STEEL TUBES

F_{ty} = 85,000

F_{tu} = 100,000

Side	t	Wt. per ft.	Ultimate Tensile Strength
2 1/2	.058	1.809	53210
2 1/2	.065	2.022	59490
2 1/2	.083	2.566	75490
2 1/2	.095	2.925	86050
2 1/2	.120	3.663	107750
2 1/2	.156	4.702	138310
2 1/2	.188	5.602	164790
2 3/4	.058	1.993	58640
2 3/4	.065	2.229	65570
2 3/4	.083	2.830	83260
2 3/4	.095	3.227	94940
2 3/4	.120	4.045	118980
2 3/4	.156	5.198	152910
2 3/4	.188	6.200	182380
3	.065	2.436	71660
3	.083	3.094	91020
3	.095	3.530	103830
3	.120	4.426	130210
3	.156	5.694	167500
3	.188	6.798	199970
3	.219	7.847	230810

For Squares — 75,000 Yield See III — 37