Foreword

The formulation of this National Standard was initiated by the Agricultural Machinery Testing and Evaluation Center (AMTEC) under the project entitled "Enhancing the Implementation of AFMA Through Improved Agricultural Engineering Standards" which was funded by the Bureau of Agricultural Research (BAR) of the Department of Agriculture (DA).

This standard has been technically prepared in accordance with PNS 01-4:1998 (ISO/IEC Directives Part 3:1997) – Rules for the Structure and Drafting of International Standards. It provides specifications of metal bars, pipes, and tubes for agricultural machinery and structures.

The word “shall” is used to indicate requirements strictly to be followed in order to conform to the standard and from which no deviation is permitted.

The word “should” is used to indicate that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others, or that certain course of action is preferred but not necessarily required.

In the preparation of this standard, the following references were considered:

Blodgett, Omer,W. 1966. Design of welded structures. The James F. Lincoln Arc Welding Foundation. Cleveland, Ohio, USA.

ISO R657/1:1968, Dimensions of hot-rolled steel sections – Part 1: Equal-leg angles (Metric series) – Dimensions and sectional properties

ISO R657/2:1968, Dimensions of hot-rolled steel sections – Part 2: Unequal-leg angles (Metric series) – Dimensions and sectional properties

ISO R657/11:1968, Dimensions of hot-rolled steel sections – Part 11: Sloping flange channel section (Metric series) – Dimensions and sectional properties

ISO 1035/1:1980, Hot-rolled steel bars – Part 1: Dimensions of round bars

ISO 1035/2:1980, Hot-rolled steel bars – Part 2: Dimensions of square bars

ISO 1035/3:1980, Hot-rolled steel bars – Part3: Dimensions of flat bars

JIS G 3466:1994, Stainless steel pipes for machine and structural purposes

PNS 26:2002, Steel – Black and hot-dipped zinc-coated (galvanized) longitudinally welded steel pipes (for ordinary use) – Specification

PNS 49:2002, Steel bars for concrete reinforcement

Engineering Materials –Metal bars, pipes, and tubes – Specifications

1 Scope

This standard establishes specifications and provides technical information for metal bars, pipes, and tubes for agricultural machinery and structures.

2 References

The following normative references contain provisions which, through reference in this text, constitute provisions of this standard:

JIS G 3101:1997, Hot-rolled steel for general structures

JIS G 3114:1998, Hot-rolled atmospheric corrosion resisting steels for welded structures

JIS G 3444:1994, Carbon steel tubes for general structural purposes

JIS G 3446:1994, Carbon steel square tubes for general structural purposes

JIS G 3452:1998, Carbon steel pipe for ordinary piping

JIS G 3459:1998, Stainless steel pipes

3 Application

Metal bars, pipes and tubes are used for components, structural framing and mechanical elements for agricultural machinery and structures.

4 Definitions

4.1
bar
long evenly shaped piece of solid metal

4.2
deformed bar
steel bar with lugs or protrusions called deformations

4.3
nominal diameter of deformed bar
diameter equivalent to the diameter
r of a plain round bar having the same mass per meter

4.4
pipe
long hollow cylinder of specified thickness whose nominal size is approximated by the inside diameter

4.5
tube
long hollow product of round or any other cross-section whose size is specified by the outside dimensions

5 Bars

5.1 Classification

Bars shall be classified according to their cross-section (Figure 1). Round bars are further classified as smooth and deformed bars.

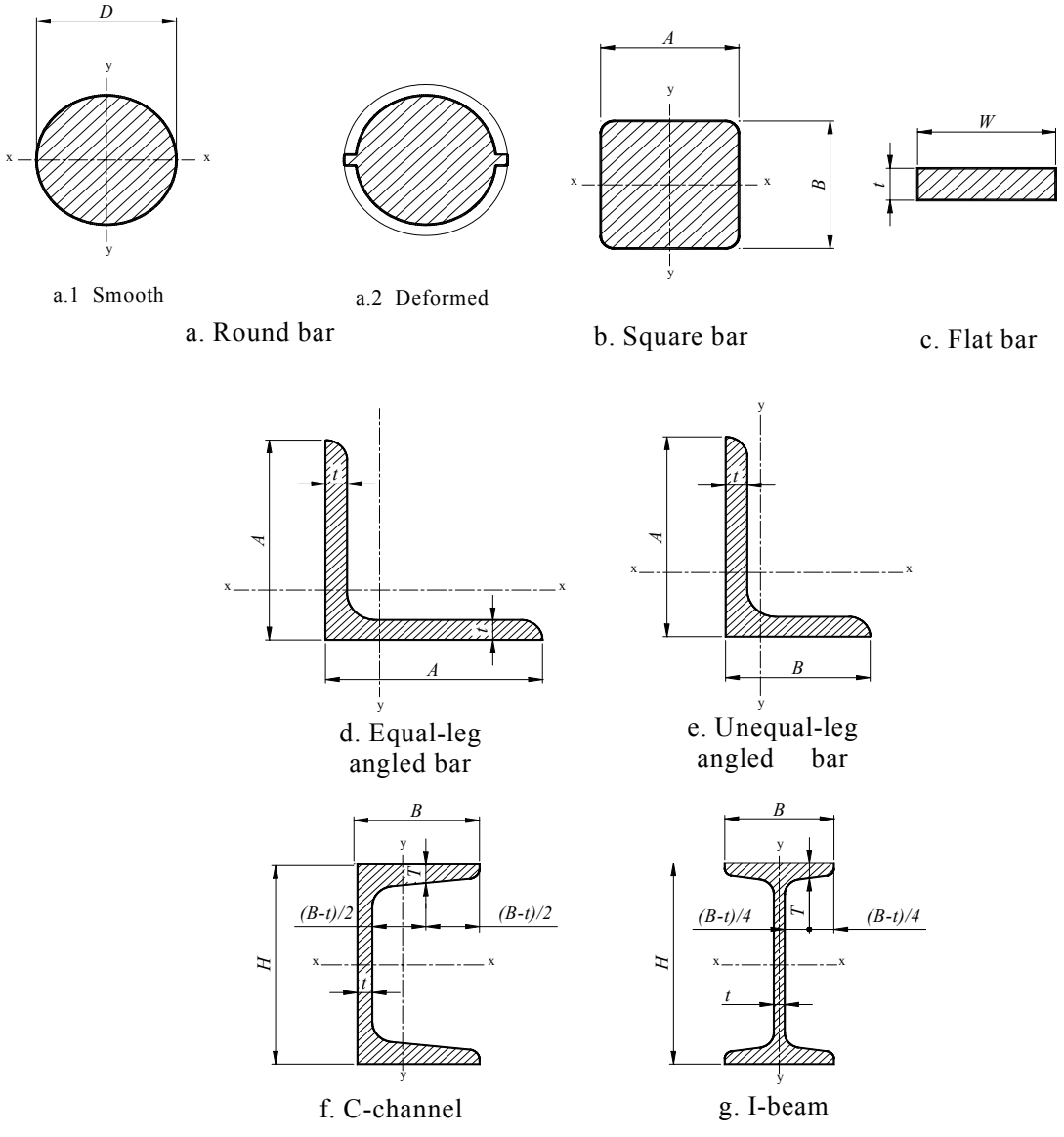


Figure 1 – Classification and nomenclature of bars

5.2 Nomenclature

Nomenclature and designation of dimensions of bars shall be as illustrated in Figure 1.

5.3 Dimensions

Dimensions and mass of different cross-section of bars shall comply with Tables 1-8.

Table 1 – Dimensions and sectional properties of round bars

Diameter, mm	Mass per unit length, kg/m	Moment of inertia cm^4	Section modulus cm^3	Diameter, mm	Mass per unit length, kg/m	Moment of inertia cm^4	Section modulus cm^3
8	0.395	0.02	0.05	50	15.4	163.63	12.27
10	0.617	0.26	0.10	55	18.7	239.56	16.33
12	0.888	0.54	0.17	60	22.2	339.29	21.21
14	1.21	1.01	0.27	65	26	467.33	26.96
16	1.58	1.72	0.40	70	30.2	628.58	33.67
18	2	2.75	0.57	75	34.7	828.35	41.42
20	2.47	4.19	0.79	80	39.5	1,072.33	50.27
22	2.98	6.13	1.05	90	49.9	1,717.67	71.57
25	3.85	10.23	1.53	100	61.7	2,618.00	98.18
28	4.83	16.09	2.16	110	74.6	3,833.01	130.67
30	5.55	21.21	2.65	120	88.8	5,428.68	169.65
32	6.31	27.45	3.22	140	121	10,057.31	269.39
35	7.55	39.29	4.21	160	158	17,157.32	402.12
40	9.85	67.02	6.28	180	200	27,482.72	572.56
45	12.5	107.35	8.95	200	247	41,888.00	785.40

Table 2 – Dimensions and mass of deformed steel bars

Nominal diameter mm	Nominal perimeter* mm	Nominal cross-sectional area** mm^2	Unit mass*** kg/m
10	31.4	78.54	0.617
12	37.7	113.10	0.888
16	50.3	201.06	1.578
20	62.8	314.16	2.466
25	78.5	490.88	3.853
28	88.0	615.75	4.834
32	100.5	804.25	6.313
36	113.1	1,017.88	7.990
40	125.7	1,256.64	9.865
50	157.1	1,963.50	15.413

* Nominal perimeter, mm = 3.1416 x nominal diameter in mm
** Nominal cross-sectional area, $mm^2 = 3.1416/4 \times (\text{nominal diameter})^2$
*** Unit mass, kg/m = 0.007854 g/mm^3 x nominal cross-sectional area in mm^2

Table 3 – Dimensions and sectional properties of square bars

Width, mm	Sectional area, cm^2	Mass per unit length, kg/m	Moment of inertia cm^4	Section modulus cm^3	Width, mm	Sectional area, cm^2	Mass per unit length, kg/m	Moment of inertia cm^4	Section modulus cm^3
8	0.64	0.502	0.03	0.09	30	9.00	7.06	6.75	4.50
10	1.00	0.785	0.08	0.17	35	12.2	9.58	12.51	7.15
12	1.44	1.13	0.17	0.29	40	16.0	12.6	21.33	10.67
14	1.96	1.54	0.32	0.46	50	25.0	19.6	52.08	20.83
16	2.56	2.01	0.55	0.68	60	36.0	28.3	108.00	36.00
18	3.24	2.54	0.87	0.97	70	49.0	38.5	200.08	57.17
20	4.00	3.14	1.33	1.33	80	64.0	50.2	341.33	85.33
22	4.82	3.80	1.95	1.77	100	100	78.5	833.33	166.67
25	6.25	4.91	3.26	2.60	120	144	113	1,728.00	288.00

Table 4 – Dimensions and mass of flat bars

Width, mm	Mass (kg/m) for thickness (mm) of										
	5	**6**	**8**	**10**	**12**	**15**	**20**	**25**	**30**	**40**	**50**
20	0.785	0.942	1.26	1.57	-	-	-	-	-	-	-
25	0.981	1.18	1.57	1.96	2.36	-	-	-	-	-	-
30	1.18	1.41	1.88	2.36	2.83	3.53	4.71	-	-	-	-
35	1.37	1.65	2.20	2.75	3.30	4.12	5.50	-	-	-	-
40	1.57	1.88	2.51	3.14	3.77	4.71	6.28	-	-	-	-
45	1.77	2.12	2.83	3.53	4.24	5.30	7.07	-	-	-	-
50	1.96	2.36	3.14	3.93	4.71	5.89	7.85	9.81	11.8	-	-
60	2.36	2.83	3.77	4.71	5.65	7.07	9.45	11.8	14.1	-	-
70	2.75	3.30	4.40	5.50	6.59	7.85	11.0	13.7	16.5	-	-
80	3.14	3.77	5.02	6.28	7.54	9.42	12.6	15.7	18.8	25.1	-
90	3.53	4.24	5.62	7.07	8.48	11.0	14.1	17.7	21.2	28.3	-
100	3.93	4.71	6.28	7.85	9.42	12.6	15.7	19.6	23.6	31.4	-
120	-	5.65	7.54	9.42	11.3	14.1	18.8	23.6	28.3	37.7	47.1
150	-	7.07	9.42	11.8	14.1	15.7	23.6	29.4	35.3	47.1	58.9

Table 5 – Dimensions and sectional properties of equal-leg angled bars

A	x	t	Sectional area,	Mass,	$I_x = I_y$	$Z_x = Z_y$	A	x	t	Sectional area,	Mass,	$I_x = I_y$	$Z_x = Z_y$
mm	x	mm	cm^2	kg/m	cm^4	cm^3	mm	x	mm	cm^2	kg/m	cm^4	cm^3
20	x	3	1.12	0.88	0.39	0.28	70	x	7	9.40	7.38	42.3	8.41
		4	1.45	1.14	0.49	0.36			8	10.6	8.36	47.5	9.52
25	x	3	1.42	1.11	0.80	0.45			10	13.1	10.3	57.2	11.7
		4	1.85	1.45	1.01	0.58	80	x	6	9.35	7.34	55.8	9.57
		5	2.26	1.77	1.20	0.71			8	12.3	9.63	72.2	12.6
30	x	3	1.74	1.36	1.40	0.65			10	15.1	11.9	87.5	15.4
		4	2.27	1.78	1.80	0.85			12	17.9	14.0	102	18.2
		5	2.78	2.18	2.16	1.04	90	x	6	10.6	8.30	80.3	12.2
35	x	3	2.04	1.60	2.29	0.90			8	13.9	10.9	104	16.1
		4	2.67	2.09	2.95	1.18			10	17.1	13.4	127	19.8
		5	3.28	2.57	3.56	1.45			12	20.3	15.9	148	23.3
40	x	3	2.35	1.84	3.45	1.18	100	x	6.5	12.7	9.99	120	16.3
		4	3.08	2.42	4.47	1.55			8	15.5	12.2	145	19.9
		5	3.79	2.97	5.43	1.91			10	19.2	15.0	177	24.6
		6	4.48	3.52	6.31	2.26			12	22.7	17.8	207	29.1
45	x	3	2.66	2.09	4.93	1.49			15	27.9	21.9	249	35.6
		4	3.49	2.74	6.43	1.97	120	x	8	18.7	14.7	255	29.1
		5	4.30	3.38	7.84	2.43			10	23.2	18.2	313	36.0
		6	5.09	4.00	9.16	2.88			12	27.5	21.6	368	42.7
50	x	3	2.96	2.33	6.86	1.86			15	33.9	26.6	445	52.4
		4	3.89	3.06	8.97	2.46	150	x	10	29.3	23.0	624	56.9
		5	4.80	3.77	11.0	3.05			12	34.8	27.3	737	67.7
		6	5.69	4.47	12.8	3.61			15	43.0	33.8	898	83.5
		7	6.56	5.15	14.6	4.16			18	51.0	40.1	1,050	98.7
		8	7.41	5.82	16.3	4.68	180	x	15	52.1	40.9	1,590	122
60	x	4	4.71	3.70	15.8	3.58			18	61.9	48.6	1,870	145
		5	5.82	4.57	19.4	4.45			20	68.3	53.7	2,040	159
		6	6.91	5.42	22.8	5.29	200	x	16	61.8	48.5	2,340	162
		8	9.03	7.09	29.2	6.89			18	69.1	54.2	2,600	181
		10	11.1	8.69	34.9	8.41			20	76.3	59.9	2,850	199
70	x	5	6.84	5.37	31.3	6.11			24	90.6	71.1	3,300	235
		6	8.13	6.38	36.9	7.27							

Table 6 – Dimensions and sectional properties of unequal-leg angled bars

A	*x*	*B*	*x*	*t*	Sectional area,	Mass,	I_x	I_y	Z_x	Z_y
mm	*x*	mm	*x*	mm	cm^2	kg/m	cm^4	cm^4	cm^3	cm^3
30	x	20	x	3	1.43	1.12	1.25	0.44	0.62	0.29
				4	1.86	1.46	1.59	0.55	0.81	0.38
				5	2.27	1.78	1.90	0.66	0.98	0.46
40	x	20	x	3	1.73	1.36	2.80	0.47	1.09	0.30
				4	2.26	1.77	3.59	0.60	1.42	0.39
				5	2.77	2.17	4.32	0.71	1.73	0.48
40	x	25	x	4	2.46	1.93	3.89	1.16	1.47	0.62
				5	3.02	2.37	4.69	1.39	1.81	0.76
45	x	30	x	4	2.86	2.24	5.77	2.05	1.91	0.91
				5	3.52	2.76	6.98	2.47	2.35	1.11
60	x	30	x	5	4.29	3.37	15.6	2.60	4.04	1.12
				6	5.08	3.99	18.2	3.02	4.78	1.32
60	x	40	x	5	4.79	3.76	17.2	6.11	4.25	2.02
				6	5.68	4.46	20.1	7.12	5.03	2.38
				7	6.55	5.14	22.9	8.07	5.79	2.74
65	x	50	x	5	5.54	4.35	23.2	11.9	5.14	3.19
				6	6.58	5.16	27.2	14.0	6.10	3.77
				7	7.60	5.96	31.1	15.9	7.03	4.34
				8	8.60	6.75	34.8	17.7	7.93	4.89
75	x	50	x	5	6.05	4.75	34.4	12.3	6.74	321
				6	7.19	5.65	40.5	14.4	8.01	3.81
				7	8.31	6.53	46.4	16.5	9.24	4.39
				8	9.41	7.39	52.0	18.4	10.4	4.95
80	x	40	x	5	5.80	4.56	38.2	6.49	7.35	2.06
				6	6.89	5.41	44.9	7.59	8.73	2.44
				7	7.96	6.25	51.4	8.63	10.1	2.81
				8	9.01	7.07	57.6	9.61	11.4	3.16
80	x	60	x	6	8.11	6.37	51.4	24.8	9.29	5.49
				7	9.38	7.36	59.0	28.4	10.7	6.34
				8	10.6	8.34	66.3	31.8	12.2	7.16
100	x	50	x	6	8.73	6.85	89.7	15.3	13.8	3.85
				7	10.1	7.93	103	17.4	16.0	4.46
				8	11.4	8.99	116	19.5	18.1	5.04
				10	14.1	11.1	141	23.4	22.2	6.17
100	x	65	x	7	11.2	8.77	113	37.6	16.6	7.53
				8	12.7	9.94	127	42.2	18.9	8.54
				10	15.6	12.3	154	51.0	23.2	10.5
100	x	75	x	8	13.5	10.6	133	64.1	19.3	11.4
				10	16.6	13.0	162	77.6	23.8	14.0
				12	19.7	15.4	189	90.2	28.0	16.5
125	x	75	x	8	15.5	12.2	247	67.6	29.6	11.6
				10	19.1	15.0	302	82.1	36.5	14.3
				12	22.7	17.8	354	95.5	43.2	16.9
150	x	75	x	9	19.6	15.4	456	78.33	46.9	13.2
				10	21.6	17.0	501	85.8	51.8	14.6
				12	25.7	20.2	589	99.9	61.4	17.2
				15	31.6	24.8	713	120	75.3	21.0
150	x	90	x	10	23.2	18.2	533	146	53.3	21.0
				12	27.5	21.6	627	171	63.3	24.8
				15	33.9	26.6	761	205	77.7	30.4
200	x	100	x	10	29.2	23.0	1,220	210	93.2	26.3
				12	34.8	27.3	1,440	247	111.0	31.3
				15	43.0	33.7	1,758	299	137.0	38.4
200	x	150	x	10	34.2	26.9	1,396	680	99.6	59.2
				12	40.8	32.0	1,652	803	119.0	70.5
				15	50.5	39.6	2,022	979	147.0	86.9
				18	60.0	47.1	2,376	1,146	174.0	103

Table 7 – Dimensions of channel sections

H, mm	*B*, mm	*T*, mm	t, mm	Sectional area, cm^2	Mass, kg/m	I_x cm^4	I_y cm^4	Z_x cm^3	Z_y cm^3
80	45	7.5	5.5	10.5	8.23	102	18.0	25.6	5.85
100	50	8.0	5.9	13.1	10.3	200	27.2	40.0	7.77
120	55	8.5	6.3	16.0	12.5	350	39.5	58.4	10.1
140	60	9.0	6..7	19.2	15.0	570	55.3	81.4	12.8
160	65	10.0	7.2	23.2	18.2	900	79.0	113	16.8
180	70	10.5	7.7	27.2	21.3	1,320	105	147	20.6
200	75	11.5	8.2	.32.1	25.2	1,930	142	193	26.0
220	80	12.0	8.7	36.6	28.7	2,640	183	240	31.0
250	85	13.0	9.2	43.2	33.9	4,000	240	320	38.2
300	100	15.0	10.0	57.5	45.2	7,800	452	520	61.1
350	100	16.0	10.5	66.0	51.8	11,900	496	678	66.3
400	100	17.0	11.0	75.0	58.9	17,200	541	858	71.0

Table 8 – Dimensions of I-beams

H, mm	*B*, mm	*T*, mm	*t*, mm	Sectional area, cm^2	Mass, kg/m	I_x cm^4	I_y cm^4	Z_x cm^3	Z_y cm^3
80	40	6.0	4.0	7.69	6.03	77.7	5.65	2.82	0.857
100	50	6.8	4.5	10.9	8.57	175	12.3	4.93	1.06
120	60	7.6	5.0	14.7	11.5	342	23.5	7.84	1.27
140	70	8.4	5.5	18.8	14.8	603	41.2	11.8	1.48
160	80	9.2	6.0	23.6	18.5	993	66.7	16.7	1.68
180	90	10.0	6.5	28.9	22.7	1,540	103	22.8	1.89
200	100	10.8	7.0	34.6	27.2	2,300	151	30.2	2.09
220	110	11.6	7.5	40.8	32.1	3,290	216	39.2	2.30
240	120	12.0	7.8	46.3	36.4	4,450	286	47.7	2.49
250	125	12.2	7.9	49.0	38.4	5,130	328	52.4	2.56
270	125	12.7	8.2	52.6	41.3	6,340	343	54.9	2.55
300	30	13.2	8.5	58.4	45.8	8,620	402	61.8	2.62
350	140	14.6	9.1	71.1	58.8	14,200	556	79.5	2.80
400	150	15.5	9.7	83.5	65.5	21,600	725	96.7	2.95
450	160	16.5	10.3	96.9	76.1	31,400	940	117	3.11
500	170	18.7	11.0	116.0	91.2	46,600	1,290	151	3.33
550	180	20.4	12.0	136.0	107	65,700	1,680	186	3.51
600	210	22.1	13.0	167.0	131	97,500	2,850	271	4.13

5.4 Materials

Materials of hot-rolled steel bars shall be in accordance with JIS G 3101:1997. For hot-rolled atmospheric corrosion resisting steels, material specifications shall be in accordance with JIS G 3114:1998. Mechanical properties of deformed bars shall conform to Table 9.

Table 9 – Mechanical properties of deformed bars

Class	Grade	Yield strength MPa	Tensile strength MPa
Regular	230	230	390
	275	275	480
	415	415	620
Weldable	230W	230	390
	275w	275	480
	415W	415*	550**

* Maximum yield strength of weldable steel bar is 540 Mpa, however a value of 560 Mpa shall be allowed for a retest
** Actual tensile strength shall not be less than 1.25 times the actual yield strength.

5.5 Designation

Bars shall be designated by the following data in the sequence shown: Bar classification, dimensions, and material.

5.6 Markings

5.6.1 Smooth bar cross-section

Bars shall be clearly marked with the following items by an appropriate method on each bar or on each bundle of bars.

1) Designation
2) Manufacturer's name or its abbreviation

5.6.2 Deformed bars

5.6.2.1 The manufacturer's identifying mark, bar size and grade shall be clearly embossed in each bar. The system of marking shall be as given below and as shown in Figure 2.

a) The manufacturer's identifying mark – a logo or symbol registered or to be registered with the Philippine Patent Office and published in the Official Gazette.

b) Bar size – Arabic number reflecting the nominal diameter.

c) Grade – Dash (parallel to the rib) or the grade number itself

No dash	– grade 230
1 dash	– grade 275
2 dashes	– grade 415
No W	– non-weldable
W	– weldable

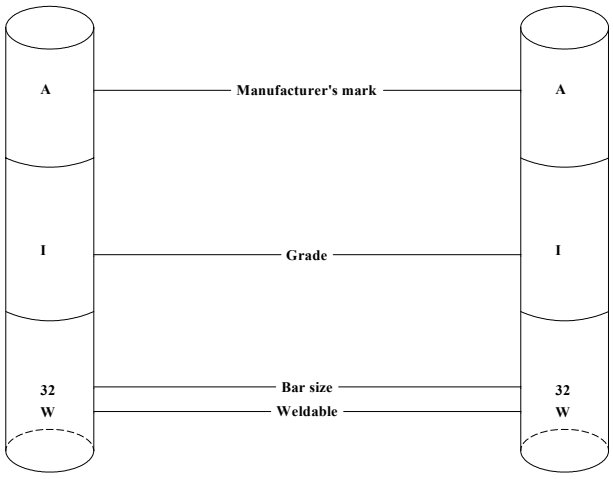


Figure 2 – Markings for deformed bars

5.6.2.2 Color codes painted on the surface of the ends of each bar may also be used in lieu of the grade and shall be as follows:

Grade 230 – white
Grade 275 – yellow
Grade 415 – green
Weldable grade – red (additional color code)
Quenched & tempered – silver

5.6.2.3 Other marks shall be indicated on the tag securely attached to each bundle of bars. Each bundle shall be properly tagged indicating the batch number, diameter, length, number of pieces and name of manufacturer.

6 Pipes

6.1 Classification

Pipes are classified as light and heavy.

6.2 Dimensions

Dimensions of pipes shall conform to Table 10.

Table 10 – Dimensions and sectional properties of pipes, mm

Nominal diameter	Outside diameter	Thickness			Moment of inertia			Section modulus		
		S10 (Light gauge)	S40 (Heavy gauge)	S80 (Extra heavy)	S10 (Light gauge)	S40 (Heavy gauge)	S80 (Extra heavy)	S10 (Light gauge)	S40 (Heavy gauge)	S80 (Extra heavy)
3	10	1.2	1.7	2.4	0.02	0.03	0.03	0.02	0.03	0.03
6	14	1.6	2.2	3	0.07	0.09	0.12	0.05	0.07	0.08
10	17	1.6	2.3	3.2	0.13	0.18	0.23	0.08	0.11	0.14
15	21	2	2.8	3.7	0.31	0.42	0.51	0.15	0.20	0.25
20	27	2.3	2.9	3.9	0.78	0.95	1.21	0.29	0.35	0.45
25	34	2.6	3.4	4.6	1.79	2.26	2.89	0.53	0.66	0.85
32	42	2.8	3.6	4.8	3.68	4.60	5.87	0.88	1.10	1.40
40	48	2.9	3.7	5.1	5.75	7.15	9.43	1.20	1.49	1.96
50	60	3.2	4	5.5	12.52	15.34	20.31	2.09	2.56	3.39
60	73	3.2	5.2	7	22.88	35.67	46.26	3.13	4.89	6.34
80	96	3.6	5.5	7.6	59.11	87.64	117.16	6.16	9.13	12.20
100	114	4	6	8.6	110.38	161.24	223.26	9.68	14.14	19.58
125	141	5	6.6	9.5	260.91	338.55	472.38	18.50	24.01	33.50
150	160	5	7.1	11	383.66	534.12	797.55	23.98	33.38	49.85
200	219	5.8	8.2	12.7	1,149.48	1,598.50	2,400.04	52.49	72.99	109.59
250	273	6.6	9.3	12.7	2,542.63	3,529.79	4,730.48	93.14	129.30	173.28
300	324	6.9	10.3	14.3	4,462.91	6,557.54	8,936.12	137.74	202.39	275.81

6.3 Materials

Materials of pipes shall conform to Table 11.

Table 11 – Materials of pipes

Material	Specification	Use
Carbon steel*	JIS G 3452:1988	General purpose steels for low stressed components
Stainless steel	JIS G 3459:1988	Used where corrosion resistance and toughness are the primary requirements
		Uses include pipe fittings,
* Steel pipes may be black (BI) or hot-dipped zinc-coated (GI)		

6.4 Designation

Pipes shall be designated by the following data in the sequence shown: Nominal size, classification, length, and material.

6.5 Markings

Pipes shall be clearly marked with the following items by an appropriate method on each pipe or on each bundle of pipes.

1) Designation
2) Manufacturer's name or its abbreviation

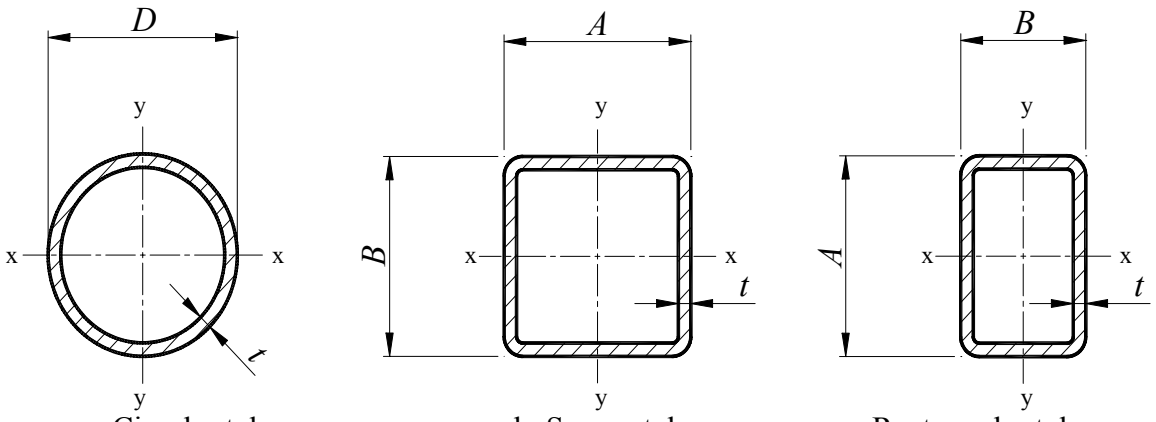
7 Tubes

7.1 Classification

Tubes shall be classified according to their shape (Figure 3).

7.2 Nomenclature

Nomenclature and designation of dimensions of tubes shall be as illustrated in Figure 3.



a. Circular tube b. Square tube c. Rectangular tube

Figure 3 – Classification and nomenclature of tubes

7.3 Dimensions

Dimensions of tubes shall conform to Table 12-14.

Table 12 – Dimensions of circular tubes

Nominal diameter *D* mm	Thickness *T* mm	Cross-sectional area cm^2	Moment of inertia *I* cm^4	Section modulus *Z* cm^3	Outside diameter *D* mm	Thickness *T* mm	Cross-sectional area cm^2	Moment of inertia *I* cm^4	Section modulus *Z* cm^3
22	2.0	1.238	0.61	0.56	114	3.2	11.17	172	30.2
27	2.0	1.583	1.26	0.93		3.5	12.18	187	32.7
	2.3	1.799	1.41	1.03		4.5	15.52	234	41.0
34	2.3	2.291	2.89	1.70	140	3.6	15.40	357	51.1
43	2.3	2.919	5.97	2.80		4.0	17.07	394	56.3
	2.5	3.157	6.40	3.00		4.5	19.13	438	62.7
49	2.3	3.345	8.99	3.70		6.0	25.22	566	80.9
	2.5	3.621	9.65	3.97	165	4.5	22.72	734	88.9
	2.8	4.029	10.6	4.36		5.0	25.16	808	97.8
	3.2	4.564	11.8	4.86		6.0	30.01	952	115
60	2.3	4.205	17.8	5.90		7.1	35.26	1,100	134
	3.2	5.760	23.7	7.84	191	4.5	26.32	1,140	120
	4.0	7.100	28.5	9.41		5.3	30.87	1,330	139
76	2.8	6.465	43.7	11.5		6.0	34.82	1,490	156
	3.2	7.349	49.2	12.9		7.0	40.40	1,710	179
	4.0	9.085	59.5	15.6		8.2	47.01	1,960	206
89	2.8	7.591	70.7	15.9	216	4.5	29.94	1,680	155
	3.2	8.636	79.8	17.9		5.8	38.36	2,130	197
102	3.2	9.892	120	23.6		6.0	39.64	2,190	203
	4.0	12.26	146	28.8		7.0	46.03	2,520	233
	5.0	11.9	177	34.9		8.0	41.1	2,840	263
						8.2	42.1	2,910	269

Table 13 – Dimensions of square tubes

A mm	*T* mm	Sectional Area cm^2	Moment of inertia, *I* cm^4	Section modulus *Z* cm^3	*A* mm	*T* mm	Sectional Area cm^2	Moment of inertia, *I* cm^4	Section modulus *Z* cm^3
40	1.6	2.392	5.79	2.90	100	6.0	21.63	311	62.3
	2.3	3.332	7.73	3.86		9.0	30.67	408	81.6
50	1.6	3.032	11.7	4.68		12.0	38.53	471	94.3
	2.3	4.252	15.9	6.34	125	3.2	15.33	376	60.1
	3.2	5.727	20.4	8.16		4.5	21.17	506	80.9
60	1.6	3.672	20.7	6.89		5.0	23.36	553	88.4
	2.3	5.172	28.3	9.44		6.0	27.63	641	103
	3.2	7.007	36.9	12.3		9.0	39.67	865	138
75	1.6	4.632	41.3	11.0		12.0	50.53	1,030	165
	2.3	6.552	57.1	15.2	150	4.5	25.67	896	120
	3.2	8.927	75.5	20.1		5.0	28.36	982	131
	4.5	12.17	98.6	26.3		6.0	22052	1,150	153
80	2.3	7.012	69.9	17.5		9.0	48.67	1,580	210
	3.2	9.567	92.7	23.2	175	4.5	30.17	1,450	166
	4.5	13.07	122	30.4		5.0	33.36	1,590	182
90	2.3	7.932	101	22.4		6.0	39.63	1,860	213
	3.2	10.85	135	29.9	200	4.5	34.67	2,190	219
100	2.3	8.852	140	27.9		6.0	45.63	2,830	283
	3.2	12.13	187	37.5		8.0	59.79	3,620	362
	4.0	14.95	226	45.3		9.0	66.67	3,990	399
	4.5	16.67	249	49.9		12.0	86.53	4,980	498

Table 14 – Dimensions of rectangular tubes

A mm	*B* mm	*T* mm	Sectional Area cm^2	Moment of inertia		Section modulus	
				I_x cm^4	I_y cm^4	Z_x cm^3	Z_y cm^3
50	20	1.6	2.072	6.08	1.42	2.43	1.42
		2.3	2.872	8.00	1.83	3.20	1.83
	30	1.6	2.392	7.96	3.60	3.18	2.40
		2.3	3.332	10.6	4.76	4.25	3.17
60	30	1.6	2.712	12.5	4.25	4.16	2.83
		2.3	3.792	16.8	5.65	5.61	3.76
		3.2	5.087	21.4	7.08	7.15	4.72
75	20	1.6	2.872	17.6	2.10	4.69	2.10
		2.3	4.022	23.7	2.73	6.31	2.73
	45	1.6	3.672	28.4	12.9	7.56	5.75
		2.3	5.172	38.9	17.6	10.4	7.82
		3.2	7.007	50.8	22.8	13.5	10.1
80	40	1.6	3.672	30.7	10.5	7.68	5.26
		2.3	5.172	42.1	14.3	10.5	7.14
		3.2	7.007	54.9	18.4	13.7	9.21
90	45	2.3	5.862	61.0	20.8	13.6	9.22
		3.2	7.967	80.2	27.0	17.8	12.0
100	20	1.6	3.672	38.1	2.78	7.61	2.78
		2.3	5.172	51.9	3.64	10.4	3.64
	40	1.6	4.312	53.5	12.9	10.7	6.44
		2.3	6.092	73.9	17.5	14.8	8.77
		4.2	10.60	120	27.6	24.0	10.6
	50	1.6	4.632	61.3	21.1	12.3	8.43
		2.3	6.552	84.8	29.0	17.0	11.6
		3.2	8.927	112	38.0	22.5	15.2
		4.5	12.17	147	48.9	29.3	19.5
125	40	1.6	5.112	94.4	15.8	15.1	7.91
		2.3	7.252	131	21.6	20.9	10.8
	75	2.3	8.852	192	87.5	30.6	23.3
		3.2	12.13	257	117	41.1	31.1
		4.0	14.95	311	141	49.7	37.5
		4.5	16.67	342	155	54.8	41.2
		6.0	21.63	428	192	68.5	51.1
150	75	3.2	13.73	402	137	53.66	36.6
	80	4.5	19.37	563	211	75.0	52.9
		5.0	21.36	614	230	81.9	57.5
		6.0	25.23	710	264	94.7	66.1
	100	3.2	15.33	488	262	65.1	52..5
		4.5	21.17	658	352	87.7	70.4
		6.0	27.63	835	444	111	88.8
		9.0	39.67	1130	595	151	119
200	100	4.5	25.67	1330	455	133	90.9
		6.0	33.63	1700	577	170	15
		9.0	48.67	2350	782	235	156
	150	4.5	30.17	1760	1,130	176	151
		6.0	39.63	2270	1,460	227	194
		9.0	57.67	3170	2,020	317	270

7.4 Materials

Materials of carbon steel round tubes shall be in accordance with JIS G 3444:1994. For carbon steel square and rectangular tubes, material specifications shall be in accordance with JIS G 3446:1994.

7.5 Designation

Tubes shall be designated by the following data in the sequence shown: classification, dimensions, and material.

7.6 Markings

Tubes shall be clearly marked with the following items by an appropriate method on each tube or on each bundle of tubes.

1) Designation
2) Manufacturer's name or its abbreviation

8 Selection of bar, pipe, and tube

The size of bar, pipes and tubes can be selected using either Figure 4 or 5. The moment of inertia given the following parameters: type of loading, amount of load, length of beam, and the allowable deflection can be obtained using Figure 4. Similarly, the section modulus given the following parameters: type of loading, amount of load, length of beam, maximum bending moment, and the allowable unit stress; the section modulus can be obtained using Figure 5. The moment of inertia or the section modulus shall then be used in determining the appropriate dimensions to be used.

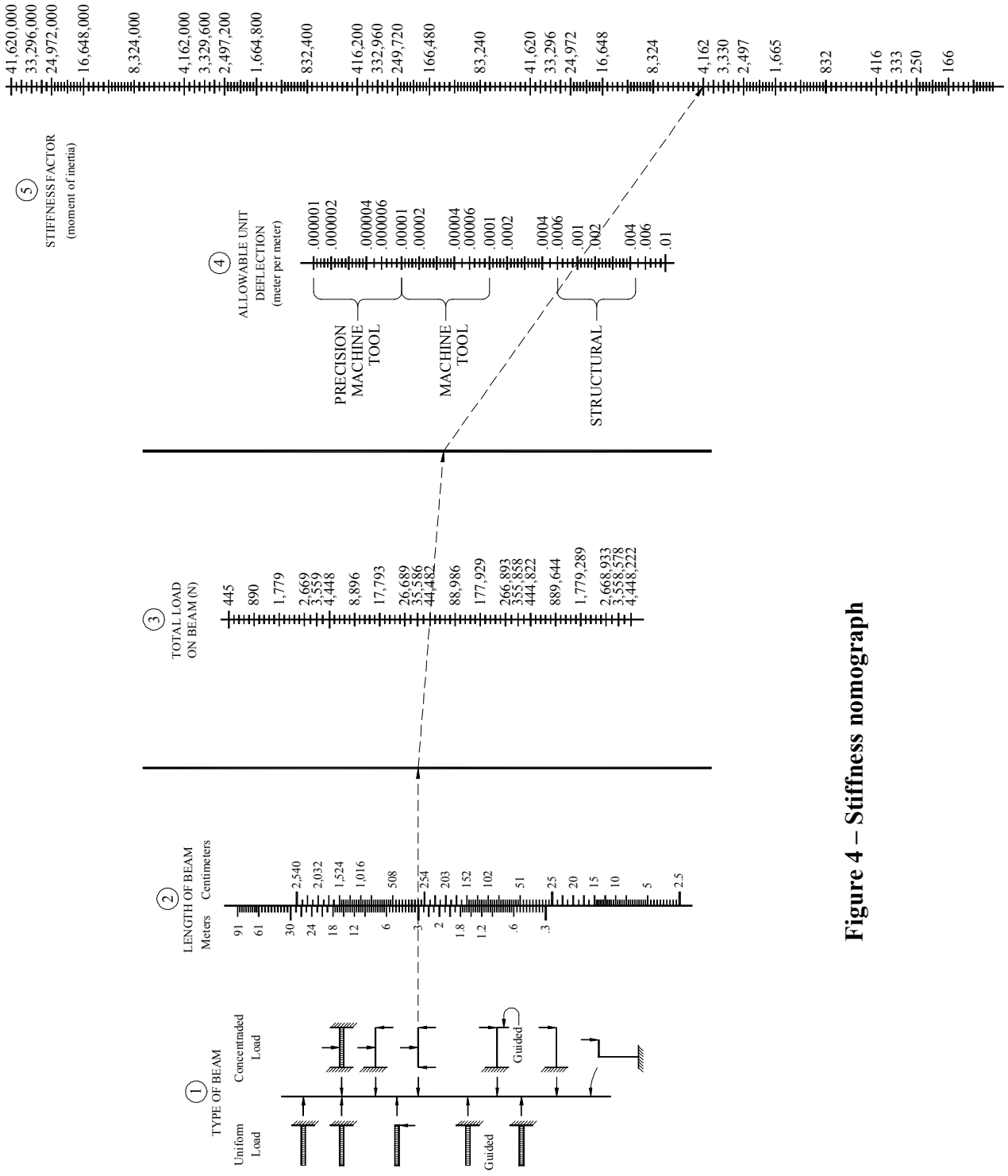


Figure 4 – Stiffness nomograph

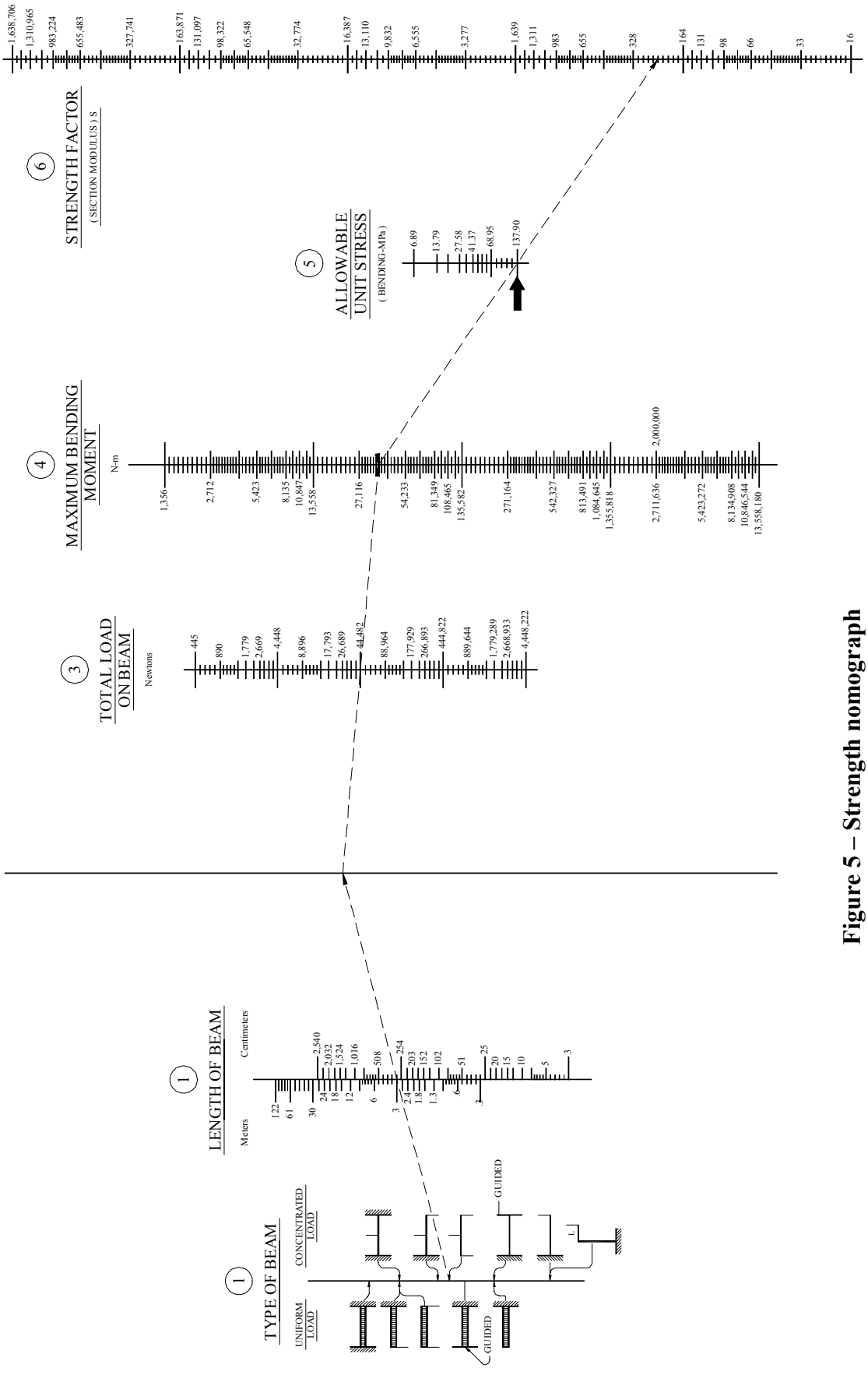


Figure 5 – Strength nomograph