SRI LANKA STANDARD 1006 PART 1 : 2016

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SPECIFICATION FOR

STEELS FOR STRUCTURAL AND GENERAL ENGINEERING PURPOSES

PART 1 : STRUCTURAL STEELS

(FIRST REVISION)

SRI LANKA STANDARDS INSTITUTION

Sri Lanka Standard

SPECIFICATION FOR STEELS FOR STRUCTURAL AND GENERAL ENGINEERING PURPOSES
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SLS 1006 Part 1 : 2016

Gr. 11

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Sri Lanka Standards are subject to periodical revision in order to accommodate the progress made by industry. Suggestions for improvement will be recorded and brought to the notice of the Committees to which the revisions are entrusted.

This standard does not purport to include all the necessary provisions of a contract.

Sri Lanka Standard
SPECIFICATION FOR STEELS FOR STRUCTURAL AND GENERAL ENGINEERING PURPOSES
Part 1 : Structural Steels
(First Revision)

FOREWORD

This standard was approved by the Sectoral Committee on Materials, Mechanical Systems and Manufacturing Engineering and was authorized for adoption and publication as a Sri Lanka Standard by the Council of the Sri Lanka Standards Institution on 2016-11-24.

A long felt need of a more comprehensive standard including the clause 'Certification of Compliance' made it necessary to revise this standard to bring it in line with the current international standards published by the International Organization for Standardization(ISO).

This standard is issued in three parts as follows:

Part 1 Structural steels
Part 2 General engineering steels
Part 3 High yield strength structural steels for bars and sections.

This is the first revision of **SLS 1006 : Part 1: 1993**.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or an analysis, shall be rounded off in accordance with **SLS 102**. The number of significant places retained in the rounded off value shall be the same as that of the specified value in this standard.

In the preparation of this standard, the assistance derived from the **ISO 630** Structural Steel, a publication of International Organization for Standardization is gratefully acknowledged.

1 SCOPE

This standard specifies the requirements chemical composition, manufacture, finish, mechanical properties, dimensions, sectional properties, marking, testing and sampling for steels for general structural use. This standard applies to steel plates, hot rolled sections and bars, which are used in as-delivered condition and normally intended for welded or bolted structures.

This standard covers eight steel grades, S235, S275, S355, S450, SG205, SG250, SG 285, SG 345 and four qualities (A, B, C and D). Not all grades are available in all qualities, and some qualities have Charpy V-notch requirements.

This standard does not include the following products, some of which are covered by other standards.

- Sheet and strip,
- Tubular products.

NOTE:
Dimensions and tolerances for rolling and cutting are given in the respective product standards.

2 REFERENCES

ISO 212	Flattening test
ISO/TS 4949	Steel names based on letter symbols
SLS 978 : Part 1	Tensile testing of Metallic Materials Method of test at ambient temperature
CS 13	Bend testing of steel products other than sheet, strip, wire and tube.
SLS 102	Presentation of numerical values
SLS 391	V-notched beam impact test for steel
SLS 874	Steel products Part 1 Classification and definitions Part 2 Identification markings

3 DEFINITIONS

For the purposes of this standard the following definitions shall apply:

3.1 killed steel : Steel that has been fully deoxidized before casting as distinct from rimmed steel.

3.2 semi-killed steel : Steel that has been partially deoxidized before casting, but carbon monoxide leaves blowhole type porosity distributed throughout the ingot.

3.3 rimmed steel : Low carbon steel in which deoxidation has been controlled to produce an ingot having a rim or skin almost free from carbon and impurities, within which is a core where the impurities are concentrated as a result of gas evolution or rimming action.

3.4 flat products : product having approximately rectangular cross sections, the width being much greater than the thickness.

3.5 long products : Long products have a constant cross section that is usually defined by a standard that establishes the normal size ranges and the tolerances on shape and dimensions. The surface is generally smooth, but in certain cases, e.g. reinforcing bars, may have a regularly raised or indented pattern.

NOTE *For further references see SLS 874 Steel Products Part 1, Classification and definitions.*

4 SYMBOLS

The symbols used in this standard shall have the meanings assigned to them as given below:

t Thickness or diameter of test piece
R_m Tensile strength
R_{ch} Upper yield stress
S_o Area of cross section of the test piece
A Percentage elongation after fracture
L_o Gauge length of test piece

5 DESIGNATION

Steels shall be designated by the strength grade and carbon composition.

5.1 Grades

This standard covers eight steel grades S235, S275, S355, S450, SG205, SG250, SG 285, SG 345.

5.2 Qualites

Quality A, B, C and D.

6 REQUIREMENTS

6.1 Chemical composition

6.1.1 *Heat analysis*

6.1.1.1 *Heat analysis for S235, S275, S355 and S450 grades*

The composition limit on analysis carried out on samples taken during casting for S235, S275, S355 and S450 shall be as given in Table **1** and the maximum carbon equivalent values(CEV) based on heat analysis shall be as given in Table **2**.

For determining the CEV the following formulae shall be used.

$$CEV = C + Mn/6 + (Cr + Mo + V)/5 + (Ni + Cu)/15$$

NOTE: *If agreed upon at the time of enquiry and other formulae for the CEV and for weld-crack sensitivity composition (P_{cm}) can be used:*

$$P_{cm} = C + Si/30 + Mn/20 + Cu/20 + Ni/60 + Cr/20 + Mo/15 + V/10 + 5B$$

Table 1 – Chemical composition (heat analysis)[a] for S235, S275, S355 and S450 grades

Grade	Quality	Method of deoxi-dation[b]	C % max. for nominal product thickness in mm			Si % max.	Mn % max.	P % max.[d]	S % max.[d, e]	N % max.[f]	Cu % max.[g]	Other % max.[h]
			≤ 16	>16 ≤40	>40 [c]							
S235	B	FN	0.17	0.20	0.20	--	1.40	0.035	0.035	0.012	0.55	--
	C	FN	0.17	0.17	0.17	--	1.40	0.030	0.030	0.012	0.55	--
	D	FF	0.17	0.17	0.17	--	1.40	0.025	0.025	--	0.55	--
S275	B	FN	0.21	0.22	0.22	--	1.50	0.035	0.035	0.012	0.55	--
	C	FN	0.18	0.18	0.18 [i]	--	1.50	0.030	0.030	0.012	0.55	--
	D	FF	0.18	0.18	0.18 [i]	--	1.50	0.025	0.025	--	0.55	--
S355	B	FN	0.24	0.24	0.24	0.55	1.60	0.035	0.035	0.012	0.55	--
	C	FN	0.20	0.20 [j]	0.22	0.55	1.60	0.030	0.030	0.012	0.55	--
	D	FF	0.20	0.20 [j]	0.22	0.55	1.60	0.025	0.025	--	0.55	--
S450[k]	C	FF	0.20	0.20 [j]	0.22	0.55	1.70	0.030	0.030	0.025	0.55	1

a. See 6.1.1.1

b. FN = rimming steels not permitted; FF = fully killed steel.

c. For section with nominal thickness > 100 mm, the C content is by agreement.

d. For long products, the P & S content may be 0.005% higher.

e. For long products, the max. S content may be increased for improved machinability by 0.015 % by agreement if the steel is treated to modify the sulfide morphology, and if the chemical composition shown min. 0.002 .% Ca.

f. The maximum value for nitrogen dose not apply if the chemical composition shows a minimum total Al content of 0.020 % or., alternatively, minimum 0.015 % acid-soluble AI or if sufficient other N-binding elements shall be mentioned in the inspection document.

g. Cu content above 0.40% can cause hot shortness during hot forming.

h. If other element are added, they shall be mentioned on the inspection document.

i. For nominal thickness > 150 mm, C= 0.20 % max

j. For nominal thickness > 30 mm, C= 0.22 % max

k. Applicable for long products only.

l. The steel may show a Nb content of max 0.05 %, a V content of max 0.13% and a Ti content or max. 0.05%.

Table 2 – Maximum carbon equivalent – based on heat analysis [a]

Grade	Quality	Method of deoxidation [b]	Maximum CEV in % nominal product thickness in mm				
			≤30	>30 to ≤40	>40 to ≤150	>150 to ≤250	>250 to ≤400
S235	B	FN	0.35	0.35	0.35	0.40	--
	C	FN	0.35	0.35	0.35	0.40	--
	D	FF	0.35	0.35	0.35	0.40	0.40
S275	B	FN	0.40	0.40	0.40	0.44	--
	C	FN	0.40	0.40	0.40	0.44	--
	D	FF	0.40	0.40	0.40	0.44	0.44
S355	B	FN	0.45	0.47	0.47	0.49[c]	--
	C	FN	0.45	0.47	0.47	0.49[c]	--
	D	FF	0.45	0.47	0.47	0.49[c]	0.40
S450 [d]	C	FF	0.47	0.49	0.49	--	--

a. For any increase of elements which influence the CEV, the following applies:

1. For all S 235, S275, and S355 qualities, the following additional chemical requirement may be agreed at the time of the order: Copper content between 0.25 % and 0.40 % on heat analysis and between 0.20% and 0.45% on product analysis. In this case the maximum carbon-equivalent value of this table shall be increased by 0.02%.

2. When products of grades S275 and S355 are supplied with a control on Si (e.g for hot-dip zinc coating) so that there could be a need to increase the content of other elements, such as C and Mn, to achieve the required tensile properties, the maximum carbon equivalent value of this table shall be increased as follows:

-- For Si ≤ 0.030%, increase CEV by 0.02%

-- For Si ≤0.25 % increase CEV by 0.01%

b. FN= rimming steel not permitted; FF = fully killed steel

c. For long products, a maximum CEV of 0.54 applies,

d. Applicable for long products only.

6.1.1.2 Product analysis for S235, S275, S355 and S450 grades

The product analysis may be requested by the purchaser; in which case this shall be specified on the order. The permissible deviations on analysis relative to the values for heat analysis in Table **1** shall be those given in Table **3** .

Table 3 – Chemical composition of product analysis, according to the specification in Table 1 [a]

Grade	Quality	Method of deoxi -dation [b]	C % max. for nominal product thickness in mm			Si % max.	Mn % max.	P % max.[d]	S % max.[de]	N % max.[f]	Cu % max.[g]	Other % max.[h]
			≤ 16	>16 ≤40	>40[c]							
S235	B	FN	0.19	0.22	0.23	--	1.50	0.045	0.045	0.014	0.60	--
	C	FN	0.19	0.19	0.19	--	1.50	0.040	0.040	0.014	0.60	--
	D	FF	0.19	0.19	0.19	--	1.50	0.035	0.035	--	0.60	--
S275	B	FN	0.24	0.24	0.25	--	1.60	0.045	0.045	0.014	0.60	--
	C	FN	0.21	0.21	0.21[i]	--	1.60	0.040	0.040	0.014	0.60	--
	D	FF	0.21	0.21	0.21[i]	--	1.60	0.035	0.035	--	0.60	--
S355	B	FN	0.27	0.27	0.27	0.60	1.70	0.045	0.045	0.014	0.60	--
	C	FN	0.23	0.23[j]	0.24	0.60	1.70	0.040	0.040	0.014	0.60	--
	D	FF	0.23	0.23[j]	0.24	0.60	1.70	0.035	0.035	--	0.60	--
S450[k]	C	FF	0.23	0.23[j]	0.24	0.60	1.80	0.040	0.040	0.027	0.60	1

a. See 6.1.1.2

b. FN = rimming steels not permitted; FF = fully killed steel.

c. For section with nominal thickness > 100 mm, the C content is by agreement.

d. For section and bars, the P and S content may be 0.005% higher.

e. For section and bars, the max. S content may be increased for improved machinability by 0.015 % by agreement, if the steel is treated to modify the sulphide morphology, and if the chemical composition shown min. 0.002 .% Ca.

f. The max value for nitrogen does not apply if the chemical composition shows a minimum total AI content of 0.015 % or., alternatively, minimum 0.013 % acid-soluble AI or if sufficient other N-binding elements are present. In this case, the N – binding elements shall be mentioned in the inspection document.

g. Cu content above 0.45% can cause hot shortness during hot forming.

h. If other elements are added, they shall be mentioned on the inspection document.

i. For nominal thickness > 150 mm, C= 0.22 % max

j. For nominal thickness > 30 mm, C= 0.24 % max

k. Applicable for long products only.

l. The steel may show a Nb content of max 0.06 %, a V content of max 0.15% and a Ti content of max. 0.06%.

Table 4 – Mechanical properties for *S205, S275, S355 and S450 [c] grades*

Grade	Quality	Upper yield stress, R_{ch} N/mm^2									Tensile Strength, R_m N/mm^2				A Min ($L_0 = 5.65\sqrt{S_0}$)							180° 2) 3) bend mandrel diameter	Impact test (V-notch)	
		t ≤ 16	16 < t ≤ 40	40 < t ≤ 63	63 < t ≤ 80	80<t ≤ 100	100<t≤ 150	150<t≤ 200	200<t≤ 250	250<t≤ 400	3≤t≤100	100<t≤150	150<t≤250	250<t≤400	t≤ 40 1)	40<t≤ 63 1)	63<t≤ 100 1)	100<t≤ 150 1)	150<t≤ 200 1)	200<t≤ 250 1)	250<t≤ 400 1)		Test Temp-erature °C	Energy Min. 4) J
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)
S 205	B 5)	235	225	--	--	--	--	--	--	--	360-510	--	--	--	26	--	--	--	--	--	--	2t	--	--
	B	235	225	215	215	215	195	195	175	--	360-510	350-500	340-490	--	26	25	24	22	21	21	21	2t	+20	27
	C	235	225	215	215	215	195	195	175	--	360-510	350-500	340-490	--	26	25	24	22	21	21	21	2t	0	27
	D	235	225	215	215	215	195	195	175	165	360-510	350-500	350-500	330-480	26	25	24	22	21	21	21	2t	-20	27
S 275	B	275	265	255	245	235	225	215	205	--	410-560	400-540	380-540	--	22	21	20	18	17	18	18	3t	+20	27
	C	275	265	255	245	235	225	215	205	--	410-560	400-540	380-540	--	22	21	20	18	17	18	18	3t	0	27
	D	275	265	255	245	235	225	215	205	195	410-560	400-540	380-540	380-540	22	21	20	18	17	18	18	3t	-20	27
S 355	B	355	345	335	325	315	295	285	275	--	470-630	450-600	450-600	--	22	21	20	18	17	18	18	3t	+20	27
	C	355	345	335	325	315	295	285	275	--	470-630	450-600	450-600	--	22	21	20	18	17	17	17	3t	0	27
	D	355	345	335	325	315	295	285	275	265	470-630	450-600	450-600	450-600	22	21	20	18	17	17	17	3t	-20	27
S450[c]	C	450	430	410	390	380	380	--	--	--	550-720	530-700	--	--	17	17	17	17	--	--	--	3t	0	27

NOTES:

c – For long products only

1 For transverse test pieces of plates and wide flats (see 3) of width 600 mm and over these values shall be reduced by two points.

2 This test shall only be carried out if specified in the order.

3 For transverse test pieces of plates and wide flats of width of 600 mm and over these values are increased by 0.5 t.

4 Average of three tests no individual result shall be less than 70 per cent of the specified.

5 This quality is only delivered in thicknesses less than 25 mm.

6 For thicknesses over 100 mm a tolerance of 20 N/mm^2 on the lower value of the range is permitted.

6.1.1.3 *Heat analysis for SG205, SG250, SG285 and SG345 grades*

The composition limit on analysis carried out on samples taken during casting for SG 205, SG 250, SG 285 and SG 345 grades shall be as given in Table **5** and the Mechanical properties at ambient temperature shall be as given in Table **7**.

For determining the CEV the following formulae shall be used.

$$CEV = C + Mn/6 + (Cr + Mo + V)/5 + (Ni + Cu)/15$$

Table 5 – Chemical composition (heat analysis)

Grade	Quality	C % max	Si % max	Mn % max	P % max	S % max	Cu % max	Ni % max	Cr % max	Mo % max	V % max	Nb % max	V+Nb % max	Ti % max
SG 205	A	a	0.55	a	0.04	0.05	a	a	a	a	a	a	a	a
	B	0.20	0.55	1.40	0.04	0.05	a	a	a	a	a	a	a	a
	C	0.17	0.05	1.40	0.04	0.05	a	a	a	a	a	a	a	a
	D	0.17	0.55	1.40	0.04	0.05	a	a	a	a	a	a	a	a
SG 250	A	a	0.55	a	0.04	0.05	a	a	a	a	a	a	a	a
	B	0.22	0.55	1.50	0.04	0.05	a	a	a	a	a	a	a	a
	C	0.20	0.55	1.50	0.04	0.05	a	a	a	a	a	a	a	a
	D	0.20	0.55	1.50	0.04	0.05	a	a	a	a	a	a	a	a
SG 285	A	a	0.55	a	0.04	0.05	a	a	a	a	a	a	a	a
	B	0.24	0.55	1.60	0.04	0.05	a	a	a	a	a	a	a	a
	C	0.22	0.55	1.60	0.04	0.05	a	a	a	a	a	a	a	a
	D	0.22	0.55	1.60	0.04	0.05	a	a	a	a	a	a	a	a
SG 345	A	a	0.55	a	0.04	0.05	0.60	0.45	0.35	0.15	0.15	0.05	0.15	0.04
	B	0.24	0.55	1.70	0.04	0.05	0.60	0.45	0.35	0.15	0.15	0.05	0.15	0.04
	C	0.22	0.55	1.70	0.04	0.05	0.60	0.45	0.35	0.15	0.15	0.05	0.15	0.04
	D	0.22	0.55	1.70	0.04	0.05	0.60	0.45	0.35	0.15	0.15	0.05	0.15	0.04

a There is no requirement , but the amount of these elements shall be determined for each heat and shall be reported in the inspection document as required by SLSI.

6.1.1.4 Prod*uct analysis for SG205, SG250, SG285 and SG345 grades*

The product analysis may be requested by the purchaser; in which case this shall be specified on the order. The permissible deviations on analysis relative to the values for heat analysis given in Table **5** shall be those given in Table **6**.

Table 6 – Permitted deviation of product analysis vs. heat analysis

Element	Range of specified elements %	Permissible deviation over maximum specified %
Carbon	≤ 0.15	0.03
	> 0.15 ≤ 0.24	0.04
Silicon	≤0.55	0.05
Manganese	≤1.70	0.10
Phosphorus	≤0.04	0.01
Sulfur	≤0.05	0.01
Vanadium	≤ 0.10	0.01
	> 0.10 ≤ 0.25	0.02
Niobium	≤ 0.05	0.01
Vanadium+ Niobium	≤ 0.15	0.01
Titanium	≤ 0.4	0.01
Copper	≤ 0.60	0.03
Nickel	≤ 0.45	0.03
Chromium	≤ 0.35	0.04
Molybdenum	≤ 0.15	0.01

Table 7 – Mechanical properties for *SG205, SG250, SG285 and SG345 grades*

Grade	Quality	Yield strength, MPa, min					Tensil strength MPa, min	Elongation [a] %, min.			Impact test (V-notch)		
		Thickness[b,] mm						$L_o = 5.65\sqrt{S_0}$	Gauge Length =50mm	Gauge Length =200mm	Test Temper-ature °C	Energy Min. [c] J	Maximum Thickness mm
		≤16	>16 to ≤40	>40 to ≤100	>100 to ≤200	>200							
SG 205	A	205	195	185	175	165	335-495	21	26	24	--	--	--
	B										+20	27	200*
	C										0	27	200*
	D										-20	27	200*
SG250	A	250	240	230	220	210	400-560	18	23	20	--	--	--
	B										+20	27	200*
	C										0	27	200*
	D										-20	27	200*
SG285	A	285	275	265	255	245	490-650	17	21	19	--	--	--
	B										+20	27	200*
	C										0	27	200*
	D										-20	27	200*
SG345	A	345	335	325	315	305	540-695	17	19	17	--	--	--
	B										+20	27	150
	C										0	27	150
	D										-20	27	150

a. *Only one of the three requirements is required. Unless specified on the order, the manufacturer may use either a proportional or fixed gauge length specimen. When the test value is reported, the specimen used shall be reported.*

b. The Producer should be contacted for possible thickness limits.

c. Average of three tests no individual result shall be less than 70 per cent of the specified.

* If agreed a thickness up to 250 mm may be applied.

6.2 Manufacture

Unless otherwise agreed at the time of order, the method of manufacture is left to the discretion of the manufacturer. The purchaser shall have the right to be informed of the method of manufacture on request at the time of delivery.

There are three fundamental conditions of supply which are available within the following broad limits.

a) Killed steel
b) Semi-killed steel
c) Rimmed steel

If any particular type of deoxidation is desired it shall be agreed between the manufacturer and the purchaser at the time of order.

6.3 Mechanical properties

The steels in the delivery condition shall comply with the mechanical properties specified in Table **4** and Table **7**.
For products over 63 mm in thickness, the mechanical properties shall be the subject of an agreement between the interested parties.

6.4 Finish

6.4.1 *Surface condition*

The products shall have a smooth surface corresponding to the rolling method used; there shall have no defects that are prejudicial to their subsequent processing or their intended end use.

6.4.2 *Removal of defects*

6.4.2.1 Repair by grinding

Minor surface defects may be removed by the producer by grinding, provided that the thickness is not reduced locally by more than 7 per cent (with a maximum of 3 mm) of the nominal value. Reductions greater than 4 per cent, but not exceeding 7 per cent, may be made only with the agreement of the purchaser.

6.4.2.2 Repair by welding

Unless otherwise specified, imperfections that are greater in depth than the limits specified in **6.4.2.1** may be removed and then weld metal deposited subject to the following limiting conditions:

a) The total area of the surface of any piece so repaired prior to welding shall not exceed 2 per cent of the total surface area of that piece.

b) The reduction of thickness of the material resulting from removal of imperfections prior to welding shall not exceed 20 per cent of the nominal thickness at the location of the imperfection nor shall the depth of the depression prior to welding exceed 30 mm.

c) The toes of angles, beams, channels and Z sections and the stems and toes of tees may be conditioned by grinding, chipping or air-arc gouging and welding. Prior to welding the depth of the depression measured from the toe inward, shall be limited to the thickness of the material at the base of the depression, with a maximum depth limit of 13 mm.

d) The edges of plates may be conditioned by the manufacturer to remove injurious imperfections by grinding, chipping or air-arc gouging and welding. Prior to welding the depth of the depression measured from the plate edge inward shall be limited to the thickness of the plate, with a maximum depth of 25 mm.

e) The reduction of sectional dimension of a round, square or hexagonal bar, or the reduction in thickness of a flat bar, resulting from the removal of an imperfection prior to welding shall not exceed 5 per cent of the nominal dimension or thickness at the location of the imperfection.

f) For the edges of flat bars, the depth of the defect prior to welding shall be measured from the edge inward and shall be limited to a maximum depth equal to the thickness of the flat bar or 13 mm whichever is less.

g) All welding shall be performed by competent welders using hydrogen-controlled welding electrodes appropriate for the grade being repaired. The electrodes shall be protected from moisture during storage and use.

h) The manufacturer shall establish and follow documented welding procedures which are appropriate for the material being welded.

6.4.2.3 Repair quality

The welds and adjacent heat affected zone shall be sound and free of cracks, the weld metal being thoroughly fused to all surfaces and edges without undercutting or overlap. Any visible cracks, porosity lack of fusion or undercut in any layer shall be removed prior to deposition of the succeeding layer. Weld metal shall project at least 2 mm above the rolled surfaces after welding, and the projecting metal shall be removed by chipping or grinding, or both, to make it flush with the rolled surface, and to produce a smooth finish.

6.4.2.4 Inspection of repair

The manufacturer shall maintain an inspection programme to inspect the work to ensure that:

a) imperfections have been completely removed (inspection by means of visual, ultrasonic, magnetic, radiographic or dye penetrant methods, etc.);

b) the limitations specified above have not been exceeded;

c) established welding procedures have been followed;

d) any weld deposit is of acceptable quality as defined above.

6.4.2.5 Heat treatment after repair by welding

If the welding repair has been carried out on a product already normalized, another normalizing treatment is always necessary. Retesting after re-normalizing is not required. For flat products, if the repair by welding has been carried out on a product in the "as rolled" condition, a stress-relieving or normalizing treatment is desirable.

7 MARKING

The product features shall be legibly and indelibly marked as follows:

a) Manufacture's name or trade mark;

b) Steel grade or Quality class;

d) Batch number/ Heat number;

e) Type of product and main dimension; and

f) Quantity/ Weight.

NOTES:
1 Method and position of marking will depend on the type of product. (See SLS 874 Part 2 Identification markings).

2 Attention is drawn to certification facilities offered by SLSI. (See the inside back cover of this standard).

8 METHOD OF TEST

8.1 Selection of test pieces

8.1.1 *Plates and wide flats having a width equal to or greater than 600 mm.*

8.1.1.1 The test sample shall be taken mid-way between the centre line in the direction of rolling and edge of the rolled product.

8.1.1.2 The longitudinal axes of tensile and bend test pieces shall be perpendicular to the direction of rolling.

8.1.1.3 The longitudinal axes of impact test pieces shall be parallel to the direction of rolling.

8.1.2 *Sections and wide flats having a width of less than 600 mm.*

The longitudinal axes of the test pieces shall be parallel to the direction of rolling. However, if agreed, a transverse test piece may be used for widths between 450 and 600 mm.

For sections, the test samples shall be taken such that the axis of the test piece is 1/3 from the outer edge of the half-flange (for I, H and U section) or of the flange (for other sections, or in the case of small sections, as near as possible to this position (See Appendix **B**, Figures **1 – 7**), in the case of tapered flange sections the test samples may be taken at the outer ¼ position of the web.

8.1.3 *Rounds, squares, flat bars, hexagons and other similar products.*

The longitudinal axes of test pieces shall be parallel to the direction of rolling.

For small sizes, the test piece shall consist of a length of the product.

In other cases, the test samples shall be so taken that the axis of the test piece, so far as is possible, is located:

- for squares and flat bars, at 1/3 of the half-diagonal; (from the outer face) or of the half-width see Figure **9** and **10** of Appendix **B**.

- for rounds and hexagons, at 1/3 from the outside of the half-diameter or the half-diagonal see Figure **8** and **11** of Appendix **B**.

8.1.4 *Hollow sections* (see Figure **12** of Appendix **B**)

For round sections, the test piece shall consist of a section of the product.

For round sections, the test piece shall be taken longitudinally at any point in the section.

For square or rectangular sections, the test piece shall be taken longitudinally mid-way between the corners.

For longitudinally welded hollow sections, the longitudinal test piece shall be taken outside the weld zone.

8.2 Types of test

8.2.1 *Tensile test*

The tensile strength yield strength, and percentage elongation shall be determined from the appropriate test pieces in accordance with the procedure given in **SLS 978 Part 1.**

Normally the test piece used shall have a proportional prismatic or cylindrical shape and have an original gauge length (L_0) is given by the formula

$$L_0 = 5.65 \sqrt{So}$$

A prismatic test piece of rectangular cross-section shall have a maximum width on the gauge length portion of 40 mm, its thickness being that of the product; however, if the thickness of the product exceeds 30 mm, it may be reduced to 30 mm by planing or milling on one face only.

A cylindrical test piece may be used for product of more than 40 mm in thickness; it shall have a diameter of between 10 and 30 mm, the original gauge length being determined by the above formula. The axis of the test piece shall be positioned at ¼ of the thickness of the product.

A non-proportional test piece with a fixed original gauge length may also be used, in this case.

a) if the gauge length is 200 mm

- the value of the elongation for flat products is A % > 16

- the value of the elongation for long products is A % > 18; in the case of products with thicknesses greater than 8 mm, and A% >16 in the case of products with thicknesses up to and including 8 mm.

b) For other gauge lengths, reference shall be made to conversion tables. (See **ISO 2566-1)**

In case of dispute, however, only the results obtained on a proportional test piece shall be taken into consideration.

The yield stress specified in Table **4** and Table **7** is the upper yield strength, $R_{ch.}$

If the yield phenomenon is not visible., either the 0.2% proof stress ($R_{t\,0.2}$) or the 0.5% proof stress ($R_{t\,0.5}$) may be used. The specification of the material is complied with in this respect if either value satisfies to the specified values of yield stress.

8.2.2 *Bend test*

Bend test shall be carried out in accordance with **CS 13.**

The test piece shall be of rectangular section and have a width greater than or equal to 30 mm, its thickness shall be that of the product, but it may, if the thickness of the product exceeds 30 mm, be reduced to 30 mm by planing on one face only. In this case, the bend shall be made so that the remaining rolled surfaces is on the outside of the bend.

In the case of circular hollow sections with outer dimensions less than 400 mm, the bend test may be replaced by a flattening test carried out in accordance with **ISO 202.**

For circular hollow sections, bending is in the direction of the curve of the test piece; for squares and rectangular hollow sections, bending is parallel to the axis of the section.

8.2.3 *Impact test*

8.2.3.1 The impact test shall normally be carried out on products having a thickness greater than or equal to 12 mm or diameter greater than or equal to 16 mm. The test piece shall be machined so that, for flat products, the face nearest to the rolled surface is not more than 1 mm from it. For products of thickness greater than 40 mm, the test piece shall be taken in

such away that its axis is positioned at ¼ thickness from the surface. The notch shall be perpendicular to the rolled surface.

If agreed at the time of enquiry and order, impact tests may be carried out on products having a thickness less than 12 mm, the dimensions of the test pieces shall be in accordance with the requirements of **SLS 391** i.e. 10 mm x 7.5 mm and 10 mm x 5 mm. The specified energy values are given in Table **4** and **7** for shall correspond to 10 mm x k.

8.2.3.2 The test shall be carried out using a V-notch test piece supported at both ends (see **SLS 391)**, the value to be taken into account being the average of the results obtained on three test pieces, but adjacent to each other from the same product, unless there are reasons for a retest(see **8.2.5**)

8.2.4 *Faulty tests and defective test pieces*

When a test does not give the required results because of an error in execution the test shall be cancelled. Error in execution means incorrect machining, incorrect mounting in the testing machine, malfunction of the machine or any other anomaly independent of the metal itself.

If a defective test piece gives satisfactory results, the batch shall be accepted but the corresponding item (from which the test sample was taken) shall be submitted to an individual examination for soundness.

8.2.5 *Retests*

If during inspection, the required values are not achieved, additional tests unless otherwise agreed, may be carried out as follows;

8.2.5.1 Tensile test and bend test (if specified)

a) If a test piece does not give the required values, the corresponding item is deemed not to comply with the specification, unless two other test pieces from the same item are tested and give satisfactory results. In this case, the item and the batch are considered to comply with the specification.

b) If one or both of the additional test pieces do not satisfy the requirements, the corresponding item is deemed not to comply with the specification.

8.2.5.2 Impact test

a) If the average of the three impact values is less than the specified value or if one individual value is below 70 per cent of the specified value, three supplementary test pieces shall be taken from the same item and shall be subjected to a test. The average value of the six results shall not be less than the specified value . Not more than two individual values shall be less than the specified value and only one individual value may be lower than 70 per cent of the specified value.

b) If an item presented for the first time is not considered to comply with the specification, the remainder of the material may be accepted provided that two other representative items are tested in accordance with the specification and give satisfactory results.

8.2.6 *Chemical analysis*

8.2.6.1 Test method to be used for chemical analysis shall be agreed between the parties concerned.

8.2.6.2 If a product analysis is specified on the order, the number of samples to be taken shall be agreed to between the interested parties.

The samples may be taken from the test pieces used to check the mechanical properties or from the full thickness of the product at the same place as the test pieces. In case of dispute, only the analysis of material from the full thickness of the product shall be taken into consideration.

9 CERTIFICATION OF COMPLIANCE

Criteria for conformity shall be as given in **Appendix A**.

Appendix A
Compliance of a Lot

The sampling scheme given in this Appendix should be applied where compliance of a lot to the requirements of this standard is to be assessed based on statistical sampling and inspection.

Where compliance with this standard is to be assured based on manufacture's control systems complied with type testing and check tests or any other procedure, appropriate scheme of sampling and inspection should be adopted.

A.1 Lot

In any consignment of steel products of same strength grade and same quality class belonging to one batch of manufacture or supply shall constitute a lot.

A.2 Scale of sampling

A.2.1 *Samples shall be tested from each lot for ascertaining the conformity of the product to the requirements of this specification.*

A.2.2 *The number of products to be selected from the lot shall be in accordance with column **(1)** and column **(2)** of Table **8.***

A.2.3 *Products shall be drawn at random. In order to ensure the randomness of selection, random numbers tables as given in **SLS 428** shall be used.*

Table 8 – Scale of sampling

Number of items in the lot (1)	Number of items to be selected from the lot (2)	Acceptance number (3)
Up to 500	5	0
501 – 35 000	20	1
35 001 – 150 000	32	2

A.3 Numbers of Tests

A.3.1 *Each product selected as in **A.2.2** shall be inspected for marking requirements.*

A.3.2 *Each item selected as in **A.2.2** shall be tested for the requirements given under **6.1.1.2** and **6.1.1.4.***

A.3.3 *Each item selected as in **A.2.2** shall be tested for the requirements given under **6.3.***

A.4 Criteria for conformity

A lot shall be declared as conforming to the requirements of this specification if the following conditions are satisfied.

A.4.1 *Each item inspected as in **A.3.1** satisfies the marking requirements.*

A.4.2 *The number of items not conforming to the requirements when tested as in **A.3.2** and **A.3.3** is less than or equal to the corresponding acceptance number given in column **(3)** of Table **8** separately.*

Appendix B

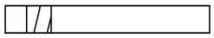

FIGURE 1 - Plate

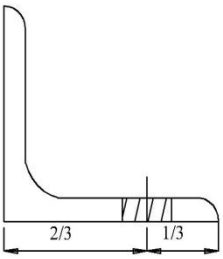

FIGURE 2 - L - section

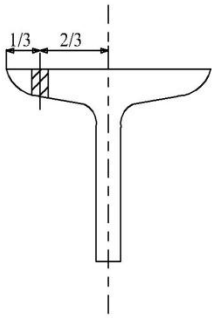

FIGURE 3 - T - section

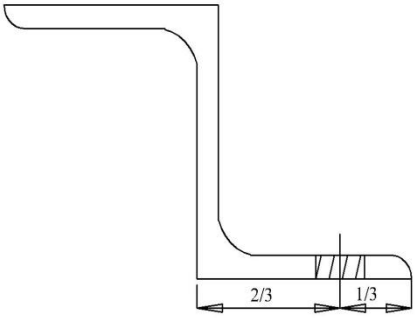

FIGURE 4 - Z-section

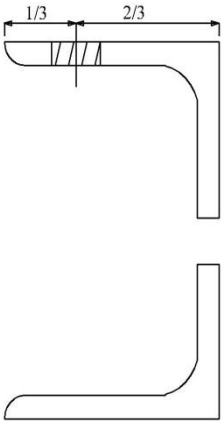

FIGURE 5 - U - section

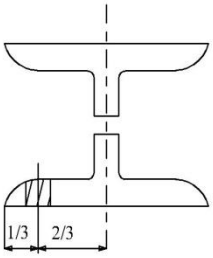

FIGURE 6 - I-section

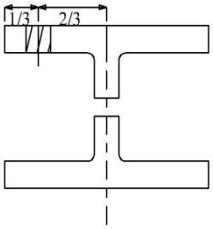

FIGURE 7 - H-section

POSITION OF SAMPLES

POSITION AND ORIENTATION OF SAMPLES

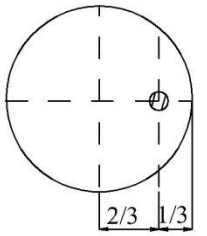

FIGURE 8 - Round bar

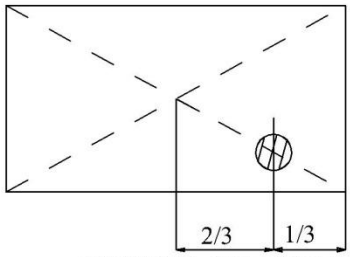

FIGURE 9 - Flat of feet bar

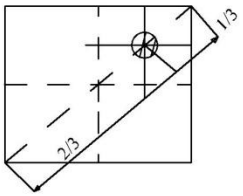

FIGURE 10 - Square bar

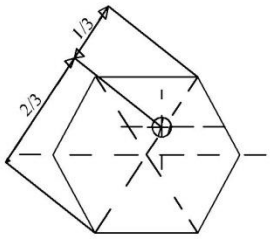

FIGURE 11 - Hexaganal bar

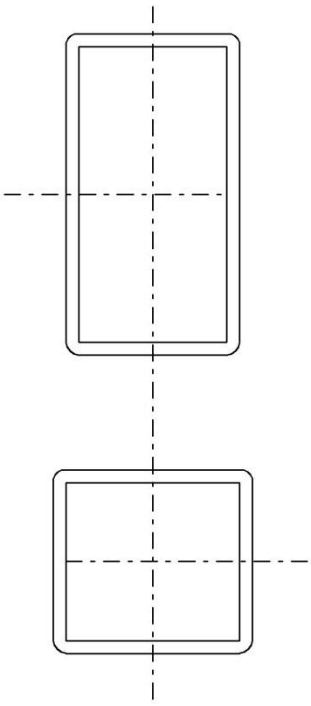

FIGURE 12 - HOLLOW SECTION

POSITION OF SAMPLES

POSITION AND ORIENTATION OF SAMPLES

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