

# High Strength Steel (HSS) tubes for structural and engineering applications



Tenaris produces a large dimensional range of seamless tubes in high strength steel for engineering and structural applications where the critical factor is controlling weight and/or a high resistance to stress requirement.



# High Strength Steel (HSS) tubes for structural and engineering applications

## Description and product application field

Tenaris has developed the following steel grades, supplied in quenched and tempered condition:

- TS590
- TS690 LS/HS
- TS770 LS/HS
- TS890

The main characteristics of these products, compared to traditional steel grades, are elevated yield strength and very good toughness at low temperature, with a chemical composition that guarantees an optimum weldability. High strength seamless steel tubes used for structural and engineering purposes are produced according to Tenaris Specification PSP 00148. In all cases latest edition of this specification shall be used. These tubes are used in steel construction for civil and engineering purposes where the relationship between mass and space occupied is specially critical.



## Applicable Standards

The specification PSP 00148 is based on EN 10210-1/2 and SEW 090 t.2 standards. For the purpose of this specification “based on” means that these standards are only taken as reference but full compliance with those documents is not envisaged.

### EN 10210-1/2

Hot finished structural hollow sections of non-alloy and fine grain steels – Part 1: Technical delivery conditions – Part 2: Tolerances, dimensions and sectional properties.

### SEW 090 t.2

Liquid quenched and tempered high-resistance fine grained steels – General technical delivery conditions for tubes and hollow sections.

### EN ISO 6892 – 1

Metallic materials – Tensile testing – Part 1: Method of test at room temperature.

### EN ISO 148 – 1

Metallic materials – Charpy pendulum impact test – Part 1: Test method.

EN ISO 10893-2 - Automated Eddy current testing of seamless and welded (except submerged arc-welded) steel tubes for the detection of imperfections.

EN ISO 10893-3 - Automated full peripheral flux leakage testing of seamless and welded (except submerged arc-welded) ferromagnetic steel tubes for the detection of longitudinal and/or transversal imperfections.

EN ISO 10893-10 - Automated full peripheral ultrasonic testing of seamless and welded (except submerged arc-welded) steel tubes for the detection of longitudinal and/or transversal imperfections.

EN 10204-1 - Metallic products – Types of inspection documents.

## Order definition

- Tenaris Specification PSP00148
- Steel grade
- Dimensions: external diameter, wall thickness & length in mm - quantity and relative tolerances

### Options

- CEV other calculations (PCM/CET)
- Additional specific inspections
- Other identification type
- Other color coding at one end
- Other certification type
- Different straightness value
- Different length

## Steel grades

Chemical analysis steel grades with low carbon and sulfur content, with the addition of micro alloying and tempering elements, which can vary in percentage according to the steel grade.

CHEMICAL ANALYSIS %										
GRADE	C	Mn	Si	P	S	Ni	Cu	V	Cr	Mo
TS590	≤ 0.16	≤ 1.60	0.15 - 0.50	≤ 0.020	≤ 0.007	≤ 0.3	≤ 0.20	≤ 0.10	≤ 0.40	≤ 0.40
TS690LS/HS	≤ 0.16	≤ 1.60	0.15 - 0.50	≤ 0.020	≤ 0.007	≤ 0.3	≤ 0.20	≤ 0.10	≤ 0.70	≤ 0.40
TS770LS/HS	≤ 0.18	≤ 1.70	0.20 - 0.50	≤ 0.020	≤ 0.007	≤ 0.3	≤ 0.20	≤ 0.10	≤ 0.50	≤ 0.50
TS890	≤ 0.20	≤ 1.50	0.20 - 0.50	≤ 0.020	≤ 0.007	≤ 0.3	≤ 0.20	≤ 0.10	≤ 0.80	≤ 0.70

Other elements like Nb, and Ti may be added in order to increase hardenability and improve mechanical properties up to a total combined of 0.10% max. Boron shall not be intentionally added. Non-specified residual elements shall not exceed 0.05% each.

## Weldability

The steel grades indicated in the specification are weldable with traditional welding procedures, given observance of the generally accepted technical rules. It is important to define a welding procedure that takes into account the following conditions:

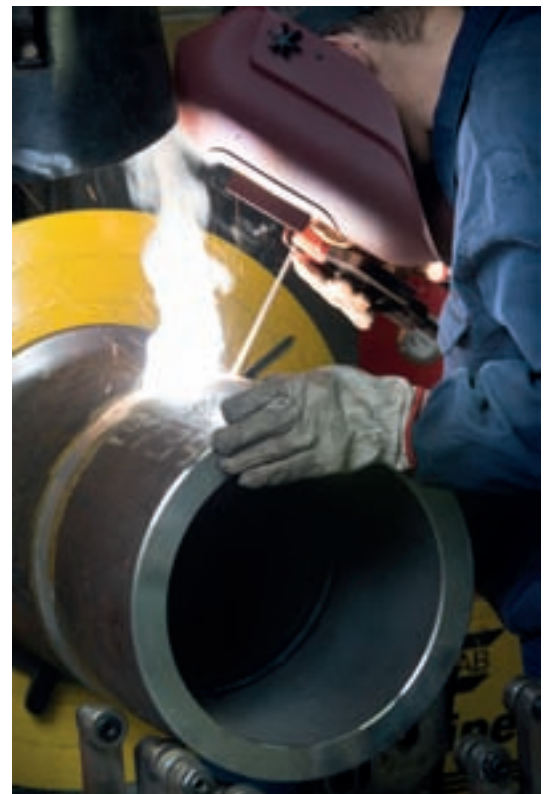
- Thickness of the base material
- Specific heat input (specially for HAZ)
- Design requirements
- Welding method used
- Welded material characteristics

Particular precautions should be taken towards crack susceptibility, which is more likely to happen with high thickness and high resistance. This phenomenon is connected mainly to the following factors:

- Chemical analysis (by means of CEV)
- The amount of diffusible hydrogen in the welded material
- HAZ micro-structure
- Tensile stress concentrations at the welded joint

Tenaris supplies customers' needs with specific technical documents ("**Welding Recommendation**") and deliveries of free-samples to perform welding tests.

The Welding Recommendations are produced in collaboration with IIS Progress S.r.l. company of the Italian Institute of Welding Group, Founder Member and Authorized Training Body of International Institute of Welding (IIW) and European Welding Federation (EWF).



## Carbon Equivalent Value (CEV)

The maximum Carbon Equivalent Value (CEV) is determined, based on the cast analysis, by the following formula:

$$CEV = C + \frac{Mn}{6} + \frac{Cr+Mo+V}{5} + \frac{Ni+Cu}{15}$$

The CEV shall comply with values stated in the table.

MAXIMUM CEV VALUES		
GRADE	WT (mm)	CEV (%) (max)
TS590	Wt All	0.53
TS690	Wt ≤ 12,5 mm	0.53
	Wt >12,5 mm	0.55
TS770	Wt ≤ 12,5 mm	0.55
	Wt >12,5 mm	0.61
TS890	Wt ≤ 12,5 mm	0.62
	Wt >12,5 mm	0.70

Options

a) Other calculation methods like PCM/CET may be agreed.

## Mechanical Properties

In order to meet tensile requirements, the tensile test shall be carried out at room temperature in longitudinal direction in accordance with EN ISO 6892-1.

Yield strength shall be reported as Rp 0.2% proof stress (0.2% permanent offset).

MECHANICAL PROPERTIES										
Grade ↓	WT (mm) →	Minimum Yield Strength (MPa)				Tensile Strength (MPa)			Min. Elong. Long%	Min. Elong. Transv%
		≤ 12	> 12 ≤ 20	> 20 ≤ 40	> 40 ≤ 50*	≤ 20	> 20 ≤ 40	> 40 ≤ 50*		
TS590		590		550	500	700-870	650-820	590-760	16	14
TS690LS		690		650	615	770-950	720-890	670-840	16	14
TS690HS		690		690	650	770-950	770-910	730-900	16	14
TS770LS		770	750	700	670	820-990	750-920	720-890	15	13
TS770HS		770		740	700	820-990	800-970	740-910	15	13
TS890		890		850	820	960-1130	920-1090	870-1040	14	12

(\*) Note that for 40 < wt ≤ 50 mm chemistry should be different from what reported in "CHEMICAL ANALYSIS" table at page 4

## Impact Toughness

Impact tests shall be carried out in accordance with EN ISO 148-1 for 10 x 10 mm full size specimens in the longitudinal direction @ temperatures -40°C and -50°C<sup>(\*\*)</sup>.

Energy values for Charpy-V notch test for each grade are indicated below:

IMPACT TEST PROPERTIES IN LONGITUDINAL DIRECTION			
Grade	WT (mm)	Test temp. (°C)	Min. Ave. Energy (J)
TS590	All	-40	30
TS690LS	All	-40	45
TS690HS	All	-50	45
TS770LS	≤40	-40	45
	>40 ≤50		40
TS770HS	≤40	-50	45
	>40 ≤50		40
TS890	≤40	-40	45
	>40 ≤50		40

Additionally, upon request, impact tests could be carried out in the transversal direction:

IMPACT TEST PROPERTIES IN TRANSVERSAL DIRECTION			
Grade	WT (mm)	Test temp. (°C)	Min. Ave. Energy (J)
TS590	All	-40	20
TS690LS	All	-40	30
TS690HS	All	-50	30
TS770LS	≤40	-40	30
	>40 ≤50		27
TS770HS	≤40	-50	30
	>40 ≤50		27
TS890	≤40	-40	30
	>40 ≤50		27

(\*\*) Other test temperature may be performed upon agreement.  
When tube dimensions do not allow full size testing, sub-size specimens shall be used according to PSP00148.

## Non-destructive examination

Each tube shall be inspected, at manufacturer's option, by means of one of the following non-destructive techniques and corresponding standards for detection of longitudinal and transversal discontinuities:

- Flux Leakage examination according to EN ISO 10893-3
- Eddy Current according to EN ISO 10893-2
- Ultrasonic inspection according to EN ISO 10893-10

For all cases the inspection shall be performed using a calibration standard with artificial notches with depth of no more than 5 % (with a minimum of 0.50 mm) of the nominal wall thickness and one inch in length, made from the same chemistry and size of tubing.

In the case of encircling coil technique (EN ISO 10893-2) the calibration reference shall be through the wall radial hole with a maximum diameter of 1.4 mm.

If a particular technique among the above mentioned ones is required, it shall be stated during enquire and order.

Visual inspection shall be carried out according to Specification EN 10210-1 par. 9.3 and par. 6.8. The pipes will have a surface condition corresponding to the manufacturing method used, that is hot rolling followed by Q&T heat treatment. The pipes shall have a maximum residual magnetism of 30 Gauss.

Options

*b) Additional specific controls to be agreed*

## Surface protection

Tubes shall have external and internal bare surfaces. Upon request tubes can be supplied with the external varnished surface.

## Marking

All pipes shall be stenciled with: TENARIS XX (mill code), internal order number, heat number, dimensions, specification, grade, country of origin, plant inspector. Other specific marking requirements may be performed upon agreement.

Options

*c) Other identification to be agree*

*d) Color coding at one end to be agree*

## Packaging

Diameters greater than 168,3 mm: loose.

Diameters less than or equal to 168,3 mm: in bundles.

## Documentation

For each shipment a Material Test Certificate (MTC) type 3.1 according to EN10204-1 and Packing List (PL) shall be issued containing at least the following information:

- Customer reference
- Manufacturing Lot number
- Specification and Steel grade
- Chemical Analysis
- Mechanical test result
- Statement of NDT conformity
- Quantities and lengths shipped

Options

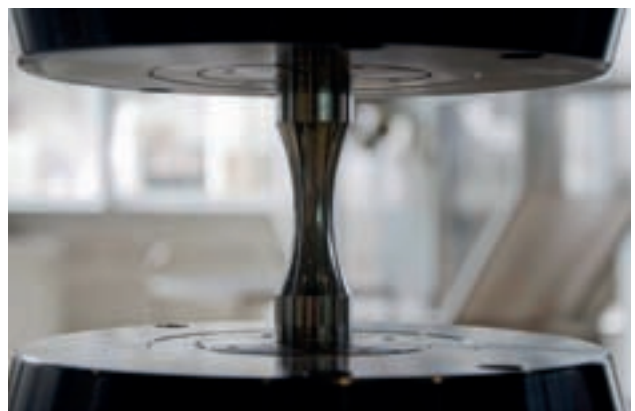
*e) Other certification to be agreed*

## Product Qualification

Upon agreement, tube qualification tests as WPS and WPQ (welding procedure specification and qualification), CTOD, etc. may be performed.

## Quality Assurance

Tenaris mills, in which these products are manufactured, are qualified according to the International Standard ISO-9001 -2000.



## R&D

In its global network of research and development centers Tenaris explores the boundaries of material science and mechanical design to develop products to help its customers meet their needs.

This global network collaborates with leading research centers and universities throughout the world in order to develop the products required by customers and optimize its industrial processes to assure the best performance and reliability in its products.

Tenaris offers a partnership to its customers that operating in different sectors : to the mechanical industry companies that use components made up with seamless steel tubes, to engineering companies that design and build civil and industrial constructions and that are constantly looking for ways to improve their efficiency and competitiveness in the undertaking of complex works.



Tenaris R&D Centre in Italy, Dalmine



DIMENSIONAL TOLERANCES	
Outside Diameter OD	+/-1% with a minimum of +/-0.5 mm
Wall Thickness WT	-10% <sup>(1), (2)</sup>
Straightness	0.2% of total length and 3 mm over any 1m length <sup>(3)</sup>
Length	-0/+100 mm for fixed length ≥6000 mm <sup>(4)</sup>
Mass (Kg/m)	-6%/+8% on individual delivered lengths <sup>(5)</sup>

- 1) The positive deviation is limited by the tolerance on mass.
- 2) Tenaris guarantees a WT tolerance in one section of -10%/+15%, average wall thickness shall be such as to comply with minimum and maximum weight per meter. Tighter WT tolerances may be evaluated upon request.
- 3) Better straightness values (i.e. 0.10% of total length) may be evaluated.
- 4) Tenaris may guarantee tighter length tolerances upon agreement.
- 5) Values will be checked with statistical process control.

Options

- f) Different straightness to that shown in the current specifications
- g) Different lengths to that shown in the current specifications

Dimension & Tolerances

Dimensional Range TS 590/690

DIMENSIONS		
WALL THICKNESS		
mm	4 4,5 5,2 6,5 8 9 10 12 16 20 22 26 28 30 33 36 40 45 50	
48,3		1.900
60,3		2.375
76,1		3.000
88,9		3.500
101,6		4.000
114,3		4.500
139,7		5.500
168,3		6.625
177,8		7.000
193,7		7.625
203		8.000
219,1		8.625
244,5		9.625
273		10.750
323,9		12.750
355,6		14.000
406,4		16.000
457		18.000
508		20.000
610		24.000
660		26.000
711		28.000
	0.157 0.177 0.205 0.256 0.315 0.354 0.394 0.472 0.630 0.787 0.866 1.024 1.102 1.181 1.299 1.417 1.575 1.772 1.968	inch.
	WALL THICKNESS	

Dimension to be evaluated on request.

Dimension & Tolerances

Dimensional Range TS 770/890

DIMENSIONS																	
		WALL THICKNESS															
mm		4	4,5	5,2	6,5	8	9	10	12	16	20	22	26	28	30		
OUTSIDE DIAMETER	48,3															1.900	
	60,3															2.375	
	76,1															3.000	
	88,9															3.500	
	101,6															4.000	
	114,3															4.500	
	139,7															5.500	
	168,3															6.625	
	177,8															7.000	
	193,7															7.625	
	203															8.000	
	219,1															8.625	
	244,5															9.625	
	273															10.750	
	323,9															12.750	
	355,6															14.000	
	406,4															16.000	
	457															18.000	
	508															20.000	
610															24.000		
660															26.000		
711															28.000		
		0.157	0.177	0.205	0.256	0.315	0.354	0.394	0.472	0.630	0.787	0.866	1.024	1.102	1.181	inch.	
		WALL THICKNESS															

Dimension to be evaluated on request.





For additional information, please visit:  
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