

# High Strength Steel tubes for structural and engineering applications





Tenaris produces seamless tubes across a wide dimensional range in high-strength steels for engineering and structural applications, where weight control and high resistance to stress are critical requirements.



# High Strength Steel tubes

## DESCRIPTION AND PRODUCT APPLICATION FIELD

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

- TS590
- TS690
- TS770
- TS890
- TS960

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 34063.

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 34063 is based on EN 10210-3 standards.

## STEEL GRADES

The typical design chemical composition presents low carbon and sulfur values and the addition of other elements to achieve high tensile strength with a good toughness at low temperature.

## HEAT CHEMICAL ANALYSIS (% by mass) <sup>(1)</sup>

Grade	C	Si	Mn	P	S	Cr	Mo	Ni	Cu	Nb <sup>(2)</sup>	Ti <sup>(2)</sup>	V <sup>(2)</sup>	W	Zr <sup>(2)</sup>	N	B
TS590	≤ 0.16	0.20 - 0.40	≤ 1.50	≤ 0.020	≤ 0.007	≤ 0.40	≤ 0.40	≤ 0.25	≤ 0.20	≤ 0.060	≤ 0.050	≤ 0.10	≤ 1.50	≤ 0.15	≤ 0.020	≤ 0.0005
TS690	≤ 0.18	0.20 - 0.40	≤ 1.50	≤ 0.020	≤ 0.007	≤ 0.60	≤ 0.60	≤ 0.25	≤ 0.20	≤ 0.060	≤ 0.050	≤ 0.10	≤ 1.50	≤ 0.15	≤ 0.020	≤ 0.0005
TS770	≤ 0.18	0.20 - 0.40	≤ 1.50	≤ 0.020	≤ 0.007	≤ 0.70	≤ 0.65	≤ 0.25	≤ 0.20	≤ 0.060	≤ 0.060	≤ 0.10	≤ 1.50	≤ 0.15	≤ 0.020	≤ 0.0005
TS890	≤ 0.20	0.20 - 0.40	≤ 1.50	≤ 0.020	≤ 0.007	≤ 0.80	≤ 0.70	≤ 0.25	≤ 0.20	≤ 0.060	≤ 0.060	≤ 0.10	≤ 1.50	≤ 0.15	≤ 0.020	≤ 0.0005
TS960	≤ 0.20	0.20 - 0.40	≤ 1.50	≤ 0.020	≤ 0.007	≤ 1.00	≤ 0.75	≤ 0.25	≤ 0.20	≤ 0.060	≤ 0.060	≤ 0.10	≤ 1.50	≤ 0.15	≤ 0.020	≤ 0.0005

(1) Note that for WT>40 mm the chemistry could be different from what reported in the table

(2) At least 0.015% of a grain-refining element shall be present. Aluminium may be used for this purpose.

A minimum of 0.015% soluble Al is required, considered met if total Al ≥ 0.018%; in case of dispute, soluble Al shall be determined.



#### WELDABILITY

The steel grades indicated in the specification are weldable with traditional welding techniques.

It is important to define a welding procedure that takes into account the following conditions:

- Thickness of the base material;
- Specific heat input;
- 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 mainly connected to the following factors:

- Chemical composition (expressed by the Carbon Equivalent Value, CEV);
- The amount of diffusible hydrogen in the welded material;
- HAZ microstructure;
- Tensile stress concentrations at the welded joint.

Tenaris supports customer needs by providing specific technical documents (“**Welding Recommendations**”) and supplying 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).



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#### 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.

#### MECHANICAL PROPERTIES

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).

#### MAXIMUM CARBON EQUIVALENT

Grade	Maximum CEV
TS590	0.65
TS690	0.65
TS770	0.65
TS890	0.72
TS960	0.82

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

Grade	Minimum Yield Strength (MPa)				Tensile Strength (MPa)				Min. Elong. % (Long)
	WT (mm)								
	≤ 16	> 16 ≤ 20	> 20 ≤ 40	> 40 ≤ 50	≤ 16	> 16 ≤ 20	> 20 ≤ 40	> 40 ≤ 50	
TS590	590	590	550	500	700-870	700-870	650-820	590-760	16
TS690	690	690	690	650	770-940	750-930	750-930	730-900	16
TS770	770	740	740	700	850-1020	800-950	800-950	740-910	15
TS890	890	850	850	-	940-1110	920-1090	920-1090	-	14
TS960	960	960	-	-	980-1170	980-1170	-	-	12

Upon customer request, transversal tensile test can be carried out (if possible, to obtain samples). Results will be reported for information only.

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

### IMPACT TEST PROPERTIES IN LONGITUDINAL DIRECTION

Test temp. (°C) <sup>(1)</sup>	Grade	WT (mm)	Min. Ave. Energy (J) in longitud. direction
-40	TS590	All	45
		≤30	45
	TS690	>30	30
		≤50	30
	TS770	≤30	40
		>30	30
	TS890	≤50	30
		>30	30
	TS960	≤30	40
		>30	30
	TS960	≤20	40
		>20	30

(1) Test may be performed at different temperatures, upon agreement.

### b) Impact test in transversal direction:

### IMPACT TEST PROPERTIES IN TRANSVERSAL DIRECTION

Test temp. (°C) <sup>(1)</sup>	Grade	WT (mm)	Min. Ave. Energy (J) in transv. direction
-40	TS590	All	27
		≤30	27
	TS690	>30	27
		≤50	27
	TS770	≤30	27
		>30	27
	TS890	≤50	27
		>30	27
	TS960	≤30	27
		>30	27
	TS960	≤20	27
		>20	27

(1) Test may be performed at different temperatures, upon agreement.

Where it is impossible to use a standard impact test piece of 10x10mm, the largest possible of the following pieces shall be used: 10x7,5mm or 10x5mm. The required impact values are then reduced proportionally. If sub-size specimen has to be used, the largest possible one - close to tube wall thickness - shall be selected.

## NON-DESTRUCTIVE EXAMINATION

Each tube shall be inspected, at the manufacturer's option, using one of the following non-destructive testing techniques and the corresponding standards for the detection of longitudinal and transverse 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.

In all cases, the inspection shall be performed using a calibration standard with artificial notches having a depth not exceeding 5% (with a minimum of 0.50 mm) of the nominal wall thickness and a length of one inch, made from tubing of the same size and chemical composition.

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 10210-3 par. 10.3 and par. 7.4.

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

- c) Additional specific inspection (NDT).

## 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.

Other specific marking requirements may be performed upon agreement.

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## PACKAGING

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

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## 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

- d) Other certification type to be agreed.

# Dimensions & Tolerances

## DIMENSIONAL TOLERANCES

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

3) Tenaris may guarantee tighter length tolerances upon agreement.

4) Values will be checked with statistical process control.

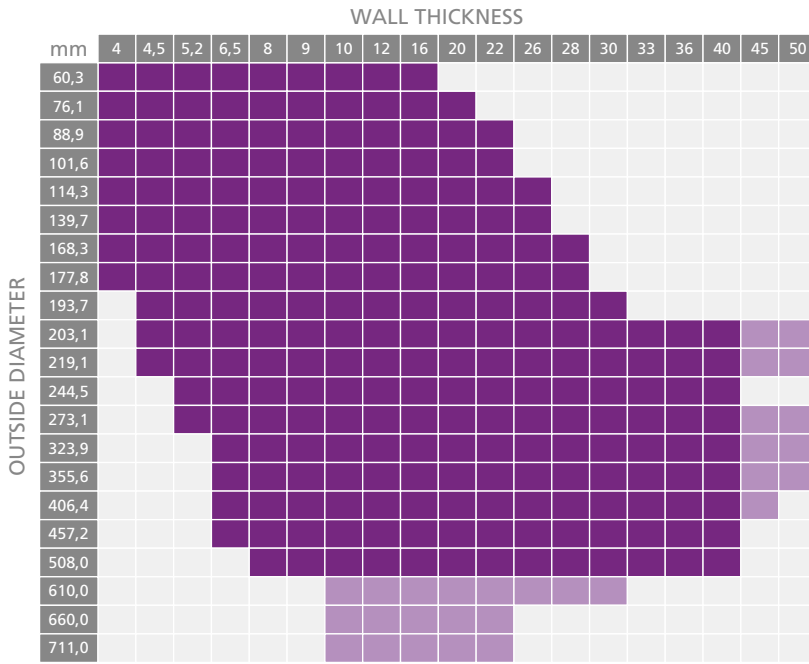
## ORDER DEFINITION

- Tenaris Specification PSP 34063
- Steel grade
- Dimensions: external diameter, wall thickness & length in mm - quantity and relative tolerances.

## Options

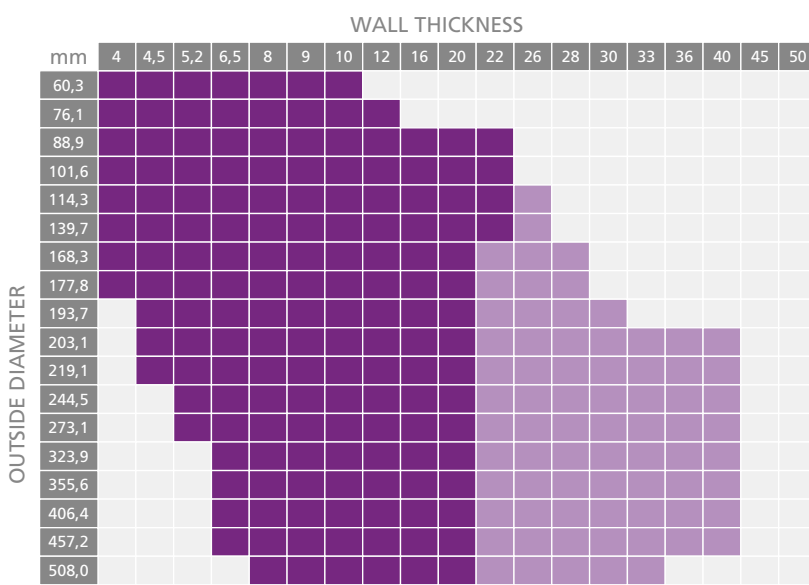
- a) Other calculation method like PCM/CET may be agreed
- b) Impact test in transversal direction
- c) Additional specific inspection (NDT)
- d) Other certification type to be agreed.

DIMENSIONAL RANGE TS 590/690



■ Dimension to be evaluated on request.

DIMENSIONAL RANGE TS 770/ 890



■ TS960 on demand only



For further information or contact us  
[www.tenaris.com](http://www.tenaris.com)

