



Cold Drawn Steel Tubes with Regular and Multi Wall Thickness Profiles

1 Scope

This specification covers the requirements for heat-treatable or non-heat-treatable cold drawn carbon steel tubes with regular and multi wall thickness (TMT) and profiles used in the manufacture of structural parts requiring low, middle and high strength. The usage of this standard is indicated for applications, which require low weight and high performance. Typical applications include door impact beams, cross car beam, bumper impact beams, reinforcements for impact structures, bull bars and general tubular parts, and specific cases of reduction or elimination of stamping tools by employment of split techniques of symmetrical TMT profiles according to 3.1.4.3.

1.1 Material Description. The particular application shall determine the cold drawn operations to produce the finished steel tube and profile.

1.1.1 Resistance Welded Mechanical Tubing. Primary tubes and profiles supplied to this specification are roll formed from steel strip to the desired shape and dimension, tungsten inert gas (TIG), plasma or electric resistance welded into a tube, and then cold drawn process to achieve the desired profile and variable thickness, the heat treated may be made to reach the strength mechanical properties.

1.1.2 TMT Cold Drawn Tubes. Tubes manufactured by seamless process or rolled steel strip according to 1.1.1 are submitted in cold drawn process to construct a desired profile with variable wall thickness. The cold drawn process causes a work hardening and a mechanical strength improving, for higher strength grades, a heat treatment may be performed later to achieve the final mechanical property requirements. The specified grades are low strength with multi wall thickness (LSTMT) type ferrite + pearlite (FP), medium strength with multi wall thickness (MSTMT) and high strength with multi wall thickness (HSTMT) for the three types of multi phases (MP) such as ferrite and pearlite, bainite and/or martensite. The TMT tube final external profile may be circular, square or any other form specified by Product Engineering. The microstructure of the finished tubes may consist of ferrite and pearlite after cold drawn operation and martensite or bainite for heat-treatable tubes.

1.1.3 Material Identification. The GMW base metal specification number defines the material designation, steel product type, grade, and finish type. The sheet steel product type for manufactured primary tubes are cold rolled (CR) or hot rolled (HR) products. The steel grades will correspond to the chemical and mechanical requirements as shown in Tables 1 through 2. The finish type, an alpha character, will be designated with the finish unexposed (U). The descriptive items are used together to form the coding system. Examples of the coding system for engineering part drawings, electronic math data files, and/or manufacturing engineering documents are shown in Section 8.

GM WORLDWIDE	NORTH AMERICA	EUROPE	LATIN AMERICA	ASIA PACIFIC
GMW-16615-M-ST-T-LS TMT 787T/775Y FP				
GMW-16615-M-ST-T- MS TMT 1050T/950Y MP				
GMW-16615-M-ST-T- HS TMT 1475T/1250Y MP				

1.2 Symbols. Not applicable.

1.3 Applicability. Typical applications are uncoated or pre-coated thin gauge tubular structural parts or other design products derivate from tubes requiring yield and tensile strengths exceeding 775 MPa and 787 MPa respectively.

2 References

Note: Only the latest approved standards are applicable unless otherwise specified.

2.1 External Standards/Specifications.

ASTM A511	ASTM E45	ISO 898-1	JIS Z2201
ASTM A513	ASTM E1077	ISO 6892	SAE J419
ASTM A751	DIN 50602	JFS A 1001	

2.2 GM Standards/Specifications.

GMW3011	GMW14019	GMW14704	GMW16170
GMW3059	GMW14270	GMW14729	GMW16549
GMW3335	GMW14700	GMW14829	

2.3 Additional References.

- GM Product Quality Standards
- Statement of Requirements (SOR)

3 Requirements

The following section defines specific requirements for material on delivery, processing, performance and other stages during life cycle. Deviations required for individual GM business units are listed in Deviations at the end of this document.

Parts supplied according to this specification must undergo successful trials that fully meet end-product requirements. In the event of any changes to the heat treatment and/or manufacturing process to which the part was successfully validated, the appropriate engineering group must be notified and the part must be re-validated with the new process.

3.1 Requirements on Delivery.

3.1.1 Chemical Requirements. Base metal composition based on product (TMT tube and profile) analysis determined per ASTM A751 shall conform to the requirements of Table 1 and/or shall be agreed upon between supplier and purchaser. Additional demands and restrictions may be imposed by local Materials Engineering organizations depending on the application.

Table 1: Chemical Composition Note 1, Note 2

Element \ Grades	LSTMT; MSTMT	HSTMT
Carbon	0.25 max.	0.28 max.
Manganese	1.6 max.	0.6 to 1.8
Aluminum	-	0.01 min.
Silicon	0.50 max.	0.15 to 0.80
Phosphorus	0.035 max.	0.035 max.
Sulfur	0.04 max.	0.03 max.
Chromium	0.25 max.	0.35 max.
Nitrogen	0.25 max.	0.15 max.
Boron	-	50 ppm max.
Titanium	-	0.15 max.
Copper	0.025 max.	0.45 max.
Molybdenum	-	0.08 max.
Niobium	0.20 max.	0.26 max.
Vanadium	0.25 max.	0.25 max.

Note 1: Chemical composition based on product (coil or sheet/blank, tube) analysis.

Note 2: max. = maximum, min. = minimum, ppm = parts per million

3.1.2 Mechanical Requirements.

3.1.2.1. Tension and Yield Strengths. Post-form not heat treated and heat treated products TMT cold drawn tube shall adhere to the requirements in Table 2. The 0.2% Offset Yield Strength, Tensile Strength and Percent Total Elongation shall be determined in the longitudinal direction per GMW3335 for samples. The test direction is not critical for heat treated TMT tube and profile. The usage of samples per ISO 6892 Type I (50 mm gage length ASTM type sample) or ISO 6892 Type II (80 mm gage length DIN type sample), or JIS Z2201 (No. 5) shall agree with Product Engineering.

For work hardened TMT tubes and profiles, as grade LS TMT, the work hardening may vary at different transversal points in a section; mainly in TMT tube and profile with small diameters or considerate variations of thicknesses. Then, for these cases, it is recommended the tension test performed direct in the tube, and the transversal profile area shall be specified on product drawing as test reference. For heat-treated TMT Tube and profile or in general parts of excessive size, the tests may be made in specimens if agreed with the Product Engineering.

Desired mechanical properties different from those specified in Table 2 and required for a specific application condition can only be used with the agreement of Product Engineering. For this case, the Product Drawing shall specify the material and test fields.

3.1.2.2. Bending Strength. For tubular parts used in safety components which require a desired bending strength to meet federal safety standards such as Federal Motor Vehicle Safety Standards (FMVSS) and Economic Commission for Europe (ECE) regulations. Specification of bending load per displacement shall be specified on product drawing for tube and profile with multi wall thickness. The bending load specification shall be determined by Finite Element Analysis (FEA) or experimentally during the product homologation phases, for this case, the constructed physical TMT tube and profile shall be tested in bending equipment, and its performance evaluated using a plot of load-displacement graph, where the bending specifications are obtained. The typical test instrumentation setup shall be carried out according to Figure 1, which shows the sketch of bending test equipment.

The drawing specification determines the minimum load from a certain bending displacement (d) up to final displacement, as follows:

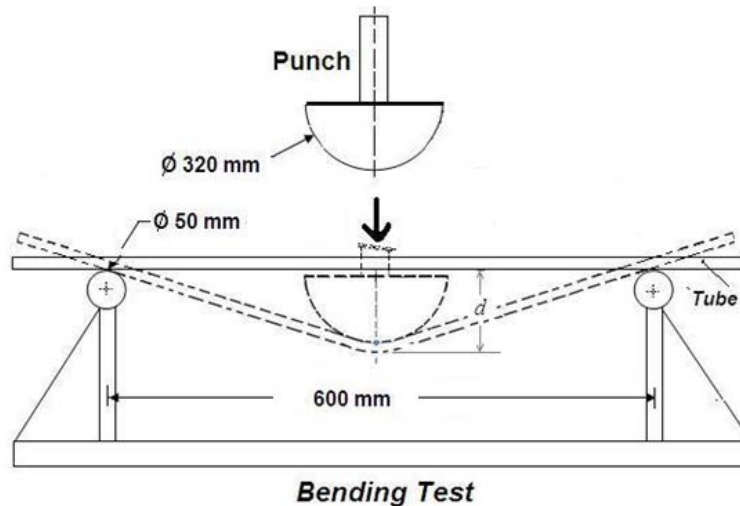
Typical illustrative example for usage as a drawing specification methodology (see also Appendix A):

Only as a reference, the following is an example of a bending specification:

- Load of 306 kg minimum from 50.8 mm to 101.6 mm of displacement.

No visible tube collapse is allowed between specified ranges of displacements (d) during bending test. In Figure 1, note three component contact points: a dynamic punch and two static supports, the loading device consists of a rigid, steel cylinder or semi-cylinder 320 mm in diameter with the surface continuous and smooth. The TMT tube and profile must be supported on a rigid, horizontal fixture adequately restrained at the bending equipment to prevent lateral and/or rotational movement of the tube during the test.

The punch shall apply a load to the TMT tube and profile center in a perpendicular direction normal to the equipment vertical plane. Apply the load continuously such that the loading device travel rate is 20 mm/minute (0.79 in/minute) until the loading device travels 129 mm. At reaching the maximum displacement specified on the drawing, no visible crack or breakage is allowed. Unless otherwise specified herein, the test shall be performed at ambient conditions.



Note: When the bending test requirements are specified on a drawing and the tube length is smaller than 600 mm, the tube supplier shall produce samples with length of 750 mm minimum only for this purpose.

Note: For non-symmetrical transversal profiles, the bending test may be performed in any transversal position, unless specified on drawing.

Figure 1: Test Equipment Description

3.1.3 Physical Requirements.

3.1.3.1 Material Thickness and Tolerances. For LSTMT, MSTMT and HSTMT tubes and profiles require the control of moments of inertia defined in design as a dimensional control, so the detailed engineering part drawing or electronic math data file specify the tube profile and the variable wall thickness. After that, the moment of inertia referent to defined profile shall be specified on drawing, such as in X and Y directions, such as: I_x/I_y ; I_x ; I_y ; W_{cm} . The W_{cm} is the moment of resistance referent to mass center. The product drawing shall reference the X and Y axes for any TMT tube and profile for moment of inertia calculations.

When moments of inertia and W_{cm} are not specified on drawing in agreement with Product Engineering, the dimensional tolerances for electric resistance welded tubes shall follow ASTM A513 - Type 2 and ASTM A511 for seamless tubes.

3.1.3.2 Surface Requirements.

3.1.3.2.1 Pretreatment/Paintability. For painted applications the surface shall be capable of achieving a high quality zinc phosphate conversion coating according to GMW3011 (for crystal size and coating weight) and also capable of meeting the requirements of GMW16170 "Thin Film; Nanometers Thick (NT) Pretreatment".

The adhesion of the E-coat must fulfill the test requirements of the cross hatch test according to GMW14829 (requirement: rating 0, as-received and after 120 h humidity exposure per GMW14729) and the delamination test according to GMW14704 (Rating 0 or 1 after 48 h test duration) for paint adhesion.

For fully painted applications on exposed (E) surfaces, the material shall meet the requirements of the stone chip resistance test according to GMW14700, method A (or B) and method C, with a minimum stone impact resistance rating of 8.

3.1.3.2.2 Adhesive Compatibility. Surfaces of the pre-coated and uncoated flat products and/or finished parts furnished to this specification shall be capable of being adhered with the respective adhesives specified for the specific application.

Adhesive Compatibility shall be tested according GMW16549. Deviations from this requirement need to be agreed by Materials Engineering and Product Engineering.

3.1.3.3 Microstructure.

3.1.3.3.1 Inclusions. Two (2) optional methods for analysis are available. There should be an agreement with the local business unit which of the two following methods has to be performed:

Method A: ASTM E45 Method D, Plate III, by analysis at 100x inclusion content shall not exceed a rating of 2.0 for thin and 2.0 for heavy.

Method B: Opel 105 (DIN 50602) technique M: by analysis, inclusions shall not exceed size index 3; in case of diameters smaller than 20 mm, they shall not exceed size index 2.

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