Data sheet: A5.3

ROQ-tuf® AM700

Hot Rolled, Roller Quenched and Tempered Structural and Pressure Vessel Steel Plate

General description

ArcelorMittal South Africa produces quenched and tempered steels under the trade names ROQ-last® for WEARPLATE and ROQ-tuf® for structural and pressure vessel applications. ROQ-tuf® AM700 is a high strength quenched and tempered, fine-grained steel. The mechanical properties are achieved by austenitising and water quenching, followed by tempering. The steel has been developed to provide an excellent combination of strength, toughness and weldability. ROQ-tuf® AM700 is a fully killed steel, which is calcium treated to ensure low levels of sulphur. Furthermore, inclusion shape control techniques are used to ensure excellent through thickness notch toughness.

Plates are supplied quenched and tempered with a microstructure consisting of tempered martensite.

This product complies with the requirements of material specification BS EN10 137 - 2 Gr S690QL.

Typical applications for ROQ-tuf® AM700 include:

- pressure vessels
- earth moving equipment
- dump trucks
- trailers
- mobile cranes
- drilling rigs
- high speed fans
- buildings
- other high strength structural applications

ROQ-tuf® AM700 may be flame or plasma cut using conventional equipment. No preheat is necessary.

Chemical composition

Table 1a. Chemical composition specification (ladle analysis, percent)

Thickness (mm)	C	Mn	P	S	Si	Cu	Ni	Cr	Mo	B	P_{cm}[1]
6-25	0,20 max	1,20 max	0,020 max	0,010 max	0,35 max	0,10 max	0,10 max	1,00 max	0,35 max	0,001-0,005	0,38 max

Table 1b. Typical chemical composition (ladle analysis, percent)

Thickness (mm)	C	Mn	P	S	Si	Cu	Ni	Cr	Mo	B	CE[2]	P_{cm}[1]
6-25	0,17	1,00	0,010	0,003	0,30	0,03	0,03	0,78	0,24	0,0027	0,50	0,30

For further information, contact:
ArcelorMittal South Africa, PO Box 2, Vanderbijlpark 1900. Toll free number 0800 005043,.

Notes:

1. $P_{cm} = C + \frac{Si}{30} + \frac{(Mn + Cu + Cr)}{20} + \frac{Ni}{60} + \frac{Mo}{15} + \frac{V}{10} + 5B$
2. $CE = C + \frac{Mn}{6} + \frac{(Cr + Mo + V)}{5} + \frac{(Cu + Ni)}{15}$

Mechanical properties

Table 2. Mechanical properties

	Thickness t (mm)
	6 ≤ t ≤ 25
Yield strength (MPa)	700 minimum
Tensile strength (MPa)	780 - 900
Elongation in 50mm (%)	18 minimum
Charpy impact energy at - 50°C (J) [1]	50 (Longitudinal)

Note:

1. These Joule values are guaranteed minimum average values for a set of three 10mm x 10mm test specimens. The minimum value for any single Charpy specimen is not less than 70% of the guaranteed minimum average value.

Dimensions

ROQ-tuf® AM700 is available in thicknesses from 6mm to 25mm. Refer to the data sheet: Plate Mill Products: Available Dimensions (file reference A1.3) and SPE 111 for available width-thickness combinations.

Dimensional tolerances

ROQ-tuf® plates are supplied to the tolerances specified in data sheet 1.4 Plate Mill Product Tolerances.

Ultrasonic testing

As part of ArcelorMittal Steel South Africa's internal quality assurance system, all plates are ultrasonically tested to EN 10160 S_0. Ultrasonic testing to stricter criteria is available on enquiry.

Weldability

ROQ-tuf® AM700 is readily weldable by metal arc methods, provided that a low hydrogen practice is applied. Specific attention should be given to ensure:

- sufficient weldment strength
- sufficient weldment notch toughness
- freedom from weld cracking problems.

When studying a weldment in a quenched and tempered plate, three zones can be differentiated, namely the weld metal zone, the re-quench zone and the re-temper zone.

a. The weld metal zone

The properties of the weld metal zone are largely governed by the composition of the filler metal, the dilution from adjacent parent material and the conditions under which solidification takes place.

b. Re-quench zone

This is the area adjacent to the weld metal where no melting in the base plate has occurred but where there is enough heat to austenitize the steel. Upon removal of the welding heat this zone cools rapidly to room temperature and the austenite transforms to martensite (second quench).

For further information, contact:
ArcelorMittal South Africa, PO Box 2, Vanderbijlpark 1900. Toll free number 0800 005043.

c. *Re-temper zone*

This is the area furthest removed from the weld zone. Here the welding heat is not sufficient to cause the base plate to become austenitic but is sufficient to subject the steel to a second short term tempering operation.

Welding parameters

Welding parameters must be selected in such a way that satisfactory overall properties of the welded joint are obtained by selecting the correct preheat and establishing the heat input requirements. This is done in order to obtain the proper balance between the re-quenching and re-tempering zones.

a. *Preheating*

Preheating is recommended in order to avoid an excessive re-quenching effect and subsequent brittleness of the heat-affected zone. Recommended preheating temperatures are shown in Table 3.

b. *Heat input rates*

The maximum heat input rate is determined by the allowable reduction in hardness in the re-temper zone of the weldment. The recommended heat input rates are shown in Table 3.
The formula for heat input is defined as:

$$\text{HI (kJ/mm)} = \frac{\text{current (amps) x voltage (volts)}}{\text{speed (mm/sec) x 1000}}$$

Table 3. Recommended preheating temperatures and weld heat input rates

Plate thickness *t* (mm)	Combined thickness *t* (mm)	Minimum preheat (°C)	Maximum heat input rates (kJ/mm)
6 - 10	20 30 40	35 35 35	1,2 - 1,5 1,2 - 1,5 1,2 - 1,5
10,1 - 20	40 60 80	50 50 80	1,2 - 2,0 1,5 - 2,5 1,5 - 3,0
20,1 - 30	60 90 120	50 80 100	2,0 - 3,0 2,5 - 3,5 2,5 - 4,0

c. *Consumables*

A low hydrogen process and consumables must be used. The process should result in a weld deposit hydrogen content below the critical value which will cause hydrogen cracking in the re-quench zone of the weldment.

Table 4. Suitable welding consumables

	Electrode classification AWS
Manual metal arc.	AWS E 11018
Metal inert or active gas	AWS ER 110 S-G
Flux cored arc welding	AWS E 110 T-1

For further information, contact:
ArcelorMittal South Africa, PO Box 2, Vanderbijlpark 1900. Toll free number 0800 005043.

Cold formability

ROQ-tuf® AM700 may be bent at ambient temperatures. Grinding of the flame cut or sheared edges in the bending area is recommended to avoid crack initiation.

The parameters recommended for bending are shown in Table 5.

Table 5. Minimum bending parameters for plate thickness t

	Transverse	Longitudinal
Bending diameter	≥ 6*t*	≥ 6*t*
Die width	≥ 7*t*	≥ 8*t*

Heat treatment and hot formability

Stress relieving and hot forming temperatures should be limited to a temperature at least 30ºC below the tempering temperature in order to maintain the mechanical properties of the steel. The temperature at which ROQ-tuf® AM700 is tempered is a function of the plate thickness, as shown in Table 6.

Table 6. Tempering and maximum post weld heat treatment (PWHT) temperatures

Thickness *t* (mm) [1]	Tempering temperature (ºC)	Maximum PWHT (ºC)
t ≤ 25	600	550

Certification

All plates are supplied with test and analysis certificates.

Supply condition

ROQ-tuf® AM700 is supplied in terms of Price List 111 and ArcelorMittal Steel South Africa's General Conditions of Sale.

For further information, contact:
ArcelorMittal South Africa, PO Box 2, Vanderbijlpark 1900. Toll free number 0800 005043.