

USA

1575, Highway 411 N.
Suite 401
Cartersville, GA 30121
P: 888-564-7904 F: 905-564-2450



CANADA

6767 Invader Crescent
Mississauga, ON L5T 2B7
P: 888-564-7904 F: 905-564-2450

Website: www.titussteel.com **E-Mail:** sales@titussteel.com

TITUS MANGANESE

The Ultimate
Work-Hardening
Steel

GENERAL INFORMATION

TITUS MANGANESE is a "Work Hardening" steel commonly referred to as "AUSTENITIC 11-14% MANGANESE". It is non-magnetic.

WORK HARDENING refers to the fact that the steel becomes harder and harder the more it is impacted or compressed.

The steel has an original hardness of only 220 BRINELL. With continued impact and/or compression it will harden up to 550 BRINELL.

It should be noted that only the outer skin surface hardens. The outer layer remains highly ductile and tough. As the surface wears it continually renews itself becoming harder and harder.

APPLICATIONS

TITUS MANGANESE is an outstanding steel for severe wear conditions, caused by impact abrasion.

Some examples:

- Quarries, Construction – Earth Moving:
crusher jaw, grizzly, screen, stone chute, chain guide plate, spreader plate, shovel bucket...
- Mines, Coal Mines:
bucket blade of loader (underground mining), parts of chain conveyor, sprocket-wheel, various armouring elements ...
- Cement Plants:
chain extractor ...
- Iron Industry, Foundry:
guide and shift plates, scrap container liners, shot-blast units, pedestal liners, wear liners ...
- Concrete/Brick Factories:
core and diving mould walls, grinding mill scraper, mixer paddle, shake-out table ...
- Scrap/Recover Plants:
wheel disk, striker and hammer mill ...
- Automotive Industries:
Shot-blasting equipment ...

Other Advantages:

- Low coefficient of friction in metal-to-metal applications
- Non-magnetic properties in electrical transformer assemblies and for industrial lifting magnets.

FABRICATION

Composition and Structure are in accordance with the following standards:

- ASTM A-128 Gr B2 (Original Hadfield Specification)

High Homogeneity

- Fully austenitic
- Free of Carbide

Steel Making

- The steel is manufactured in an electric furnace. The steel making process uses a heat ladle refining system ... double ladle and double slag.
- All refining is performed under vacuum.
- The steel is bottom poured into ingots under gas protection.
- NOTE: TITUS MANGANESE is unique in that it adheres to the original Hadfield specification. This involves a separate heat treatment after rolling, which results in "Ease of Forming", versus other Manganese steel.

Rolling is performed with very modern equipment, including:

- Automatic gauge control system
- High pressure water jets descaling
- Computer controlled rolling program

GENERAL PROPERTIES

CHEMICAL COMPOSITION

	C (%)	Mn (%)	Si (%)	S (%)	P (%)
ASTM A128 Gr B2	1.05//1.2	11.5/14	< 1.0		≤ 0.070
TITUS MANGANESE	1.05//1.2	12/13.5	0.25/0.50	≤ 0.010	≤ 0.030
	1.13	13	0.40	0.003	< 0.020

MECHANICAL PROPERTIES

Y.S	UTS	Elongation	Charpy V	Hardness (HB)
≥350 MPa ≥51 KSI	≥800 MPa ≥116 KSI	El _(5d) % ≥30	KCVL ≥ 80 J/cm ² at + 20 C KCVL ≥ 60 ft/lbs at 68 F	180/245

Typical values obtained are:

Y.S	UTS	Elongation	Charpy V	Hardness (HB)
≈ 380 MPa ≈ 55 KSI	≈ 940 MPa ≈ 136 KSI	EI _(5d) % ≈ 40	KCVL ≈ 140 J/cm ² at + 20 °C KCVL ≈ 100 ft/lbs at 68 °F	≈ 220

PHYSICAL PROPERTIES

	Physical Properties (Metric)		Physical Properties (U.S.)	
	Unit	Result	Unit	Result
Thermal Conductivity	W/m. °C cal/cm.s. °C	12.6 0.03	BTU/hr.ft. °F	7.3
Thermal Coefficient Expansion 0 to 600 °C (32 to 1112 °F)	10 ⁻⁶ . °C ⁻¹	21.5	10 ⁻⁶ . °F ⁻¹	11.9
Specific Heat	J/kg. °C	502	cal/g. °C	0.12
	cal/g. °C	0.12	BTU/lb. °F	0.12
Specific Gravity (Density)	kg/m ³	7880	LB/Cu.In	0.2831
	g/cm ³	7.88	/	7.88
Electrical Resistivity	μΩ.cm	70 to 80	μΩ.cm	70 to 80
Magnetic permeability : about 1.002				

NOTE: Physical characteristics at +20°C (+68°F) accept the thermal coefficient of expansion.

WORKABILITY

Normal processing can be performed on TITUS MANGANESE plates. However, due to its particular properties (aptitude to work-hardening, high coefficient of expansion, low thermal conductivity), specific precautions have to be taken, especially in machining and welding.

THERMAL CUTTING

Thermal cutting with plasma or laser is recommended. When possible, we advise selection of the process which produces cuts of the greatest precision.

MACHINING

Standard machining can be performed as long as inter-pass depth is deeper than the work hardness zone of the preceding pass. Therefore sufficiently powerful equipment, without excessive play is required.

DRILLING

- Drilling should be executed with a supercarburized Cobalt high speed steel bit, type HSSCO (e.g. AISI grade M42)
 - reinforced shape,
 - long twist,
 - point angle at 130°,
 - low cut speed 2 to 3m/min (80 to 120"/min),
 - high feed, for example: 0.08mm/rev to 0.15mm/rev (0.003"/rev. up to 0.0006"/rev.) for diameter bits from 10 to 20mm (0.40 to 0.80").
- Dry drilling leads to good results. The depth of the hole to be drilled, should not exceed 3 times the bit diameter.
- Drilling should be performed continuously, without any stop.
- Other possible solutions: drilling with bits at 3 lips with carbide-tipped or drilling with bits for concrete when small series or hot drilling are considered.

MILLING

- Supercarburized Cobalt milling tools, type HSSCO, are recommended, (e.g. AISI grade M42). Tools with carbide tip (e.g. ISO type P25) can also be used.
- The recommended parameters are:
 - cut-speed: 50m/min (160ft/min)
 - feed: 0.2mm/tooth for example (0.008"/tooth)

PUNCHING

- Punching can be achieved with sufficiently powerful equipment. The process should be as regular as possible.

FORMING

Forming with TITUS MANGANESE can be performed at room temperature. Pre-heating beyond 500°F is not recommended. Hardened edges resulting from previous mechanical shearing should be ground before forming. Also a light beveling of edges should be made.

The minimum temperature for hot forming must be greater than 850°C (1560°F). The pieces must be water quenched immediately. If the temperature is lower than 850°C (1560°F), it is necessary to re-heat at a temperature higher than 980°C (1800°F) before quenching.

WELDING

TITUS MANGANESE should be welded with some precautions due to its unique properties. Because of its high coefficient of expansion and low thermal conductivity, the steel is sensitive to thermal distortions and local excessive heating. Also long stages at temperatures higher than 300°C (572°F) induce carbide precipitation which decreases toughness and non-magnetism property.

All standard welding procedures can be used.

GENERAL RECOMMENDATIONS

Welding is performed with low heat-input – $E < 20\text{kJ/cm}$, interpass temperature limited to about 100°C (210°F) – with water cooling between each pass if necessary. Distortions should be hammered between passes if necessary.

NOTE: Never pre-heat.

WELD METAL

- Heterogeneous welds (main practice)
For manual arc welding:
 - TITUS MANGANESE – XL weld rod
 - weld deposit design 18 Cr 8 Ni 6 Mn per AWS A 5.4.E 307
 - weld deposit design 20 Cr 10 Ni 3 Mo per AWS A 5.4.E 308 Mo
- Homogeneous welds (work-hardenable deposits)
For manual arc welding:
 - typical deposits 13Mn 3 Ni Mo-Class 1 5.13 E Fe Mn per AWS
For semi-automatic welding, with or without protective gas, use flux-cored wire of similar composition.
- Examples of products:
 1. Coated electrode for manual welding:
 - TITUS MANGANESE – XL
 2. Flux-cored wire for semi-automatic welding:
 - TITUS MANGANESE - XL
 3. DO NOT use low hydrogen rod
 - Should use stainless steel (300 series) or Manganese
 - Best to check with weld supplier

PREPARATION

- **DO NOT PRE-HEAT** manganese steel.
- Remove rust, grease and other foreign matter. Organic matter can breakdown in the heat of the arc and cause porosity.

WELDING

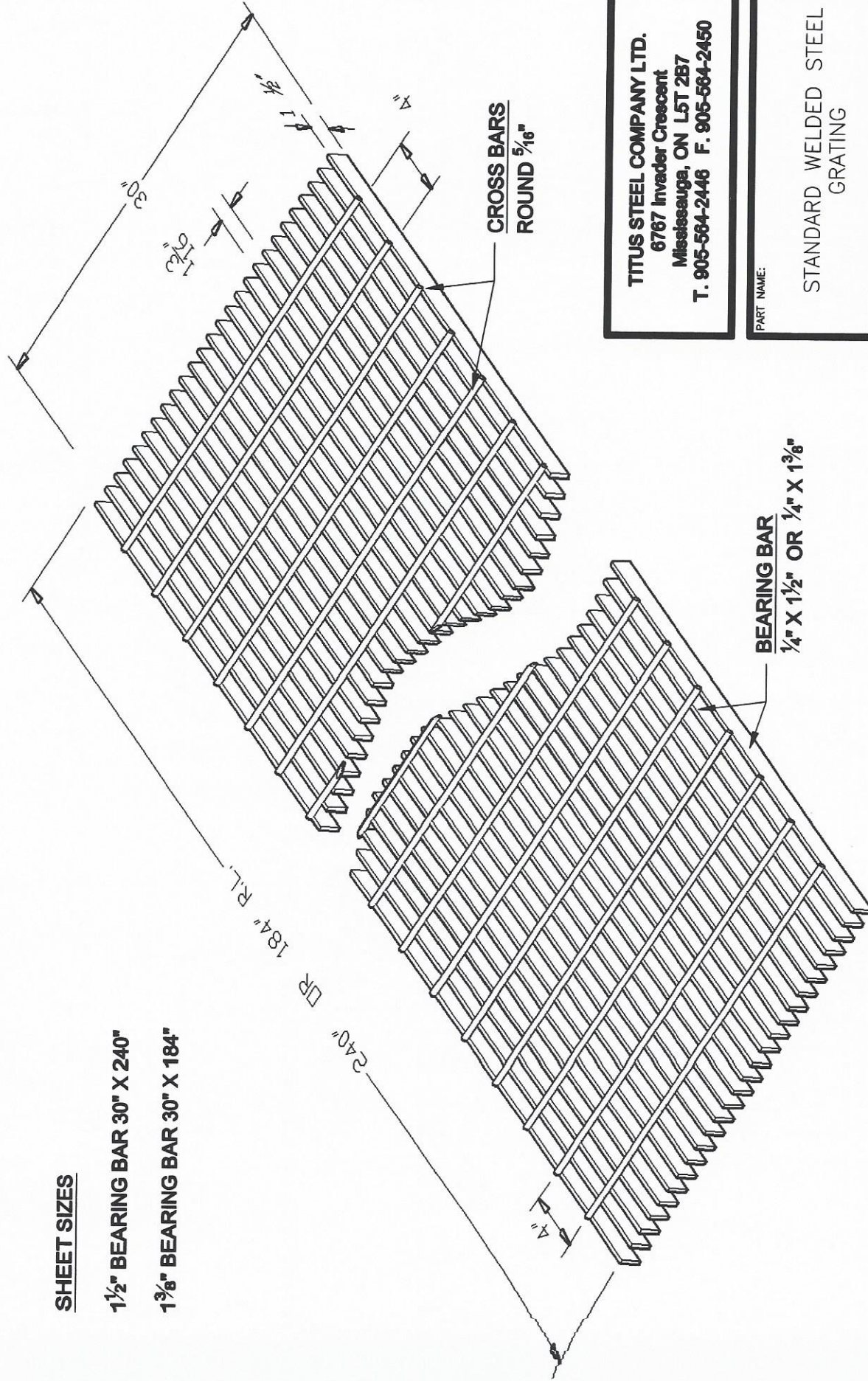
- Reduce energy input and heat built-up. Temperatures adjacent to the weld should never exceed 500°F one minute after the bead is deposited. (Use a weld-temp. stick to assist control of heat input). Factors that will reduce energy input:
 1. Maintain a short arc, (a long arc increases voltage);
 2. Minimize puddling, (puddling slows travel speed); &
 3. Skip weld where possible.
- **DO NOT POST-HEAT** manganese steel.

MANGANESE BAR GRATING 19-W-4

SHEET SIZES

1½" BEARING BAR 30" X 240"

1⅜" BEARING BAR 30" X 184"



TITUS STEEL COMPANY LTD.
6767 Invader Crescent
Mississauga, ON L5T 2B7
T. 905-564-2446 F. 905-564-2450

PART NAME:

STANDARD WELDED STEEL
GRATING

DATE	DEC.20/06	PROJECT NO.	JOB013
SCALE	NOT TO SCALE	CHECKED BY	M.U.
DRAWN BY	M D	DRAWING NO.	STEEL GRATE

Titus Manganese Steel

THE TOUGHEST WORK-HARDENING STEEL KNOWN

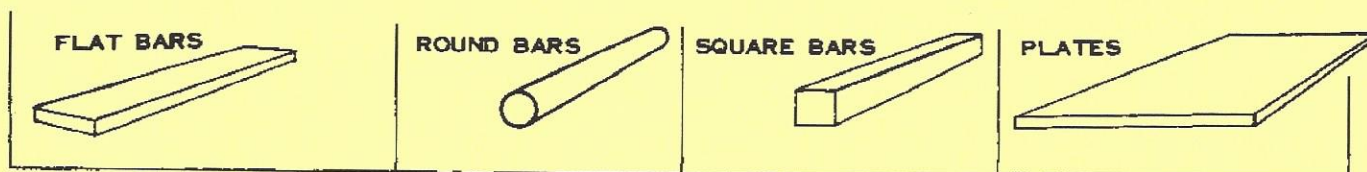
Titus manganese steel is used in applications where "impact" — "crushing" and "breaking" causes excessive wear.

Manganese steel is tough because: as it receives crushing impact blows, the surface work-hardens from 200 Brinell hardness up 600 B.H.N. Beneath this surface the hardness graduates down to the original hardness of ordinary steel. Thus in service it develops a hard wear resistant skin with a tough, strong core.

Manganese steel is an austenitic steel and as such is practically non-magnetic. This property also makes it useful in many applications as bottom plates for lifting magnets - separator drum shells for magnetic materials - wear shoes on electric brakes etc.

The composition of Manganese Steel, Original Hadfield Specification is:

Mn: 11.00%—14.00%, C: 1.00—1.40%, Si: .10—.30%— with residual elements kept to carefully controlled tolerances.



SIZE	Est. Wt. Per Ft.	SIZE	Est. Wt. Per Ft.	SIZE	Est. Wt. Per Ft.	SIZE	Est. Wt. Per Ft.
1/4" x 1"	.85 lbs.	1/4"	.17 lbs.	3/8"	.48 lbs.	1/8"	5.10 lbs.
" x 1 1/2"	1.28 "	3/8"	.38 "	1/2"	.85 "	3/16"	7.65 "
" x 2"	1.70 "	1/2"	.67 "	5/8"	1.33 "	1/4"	10.20 "
" x 4"	3.40 "	5/8"	1.04 "	3/4"	1.91 "	3/8"	15.30 "
3/8" x 1"	1.28 "	3/4"	1.50 "	7/8"	2.61 "	1/2"	20.40 "
" x 2"	2.55 "	7/8"	2.04 "	1"	3.40 "	5/8"	25.50 "
" x 3"	3.83 "	1"	2.67 "	1 1/8"	4.30 "	3/4"	30.60 "
" x 4"	5.10 "	1 1/8"	3.38 "	1 1/4"	5.31 "	1"	40.80 "
1/2" x 1"	1.70 "	1 1/4"	4.17 "	1 1/2"	7.65 "	1 1/8"	45.90 "
" x 1 1/2"	2.55 "	1 3/8"	5.05 "	2"	13.60 "	1 1/4"	51.00 "
" x 2"	3.40 "	1 1/2"	6.01 "			1 1/2"	61.20 "
" x 3"	5.10 "	1 3/4"	8.18 "			2"	81.60 "
" x 4"	6.80 "	2"	10.68 "				
" x 6"	10.20 "	2 1/4"	13.52 "				
3/4" x 2"	5.10 "	2 1/2"	16.69 "				
" x 3"	7.65 "	2 3/4"	20.19 "				
" x 4"	10.20 "	3"	24.03 "				
" x 6"	15.30 "	3 1/4"	28.21 "				
" x 8"	20.40 "	3 1/2"	32.71 "				
1" x 2"	6.80 "						
1" x 3"	10.20 "	4"	42.73 "				
1" x 4"	13.60 "	5"	66.76 "				
1" x 6"	20.40 "						
1" x 8"	27.20 "						
2" x 2 1/2"	17.00 "						
2" x 3"	20.40 "						
2" x 4"	27.20 "						
2" x 5"	34.00 "						
2" x 6"	40.80 "						

BARS - Random 10-12 ft.
PLATE - 4'x8', 5'x10', 6'x12'
and more.

WELDING IS DONE USING
MANGANESE WELD ROD.
ADDITIONAL CUTTING WELDING
& FORMING INFORMATION ON
REQUEST

OTHER TITUS PRODUCTS & SERVICES

- MANGANESE WELD ROD
- MANGANESE CAST TUBING
- MANGANESE WIRE MESH SCREENING
- STEEL TRACTOR GROUSER BAR
- PIPE & H-BEAM PILE POINTS
- SUB ARC FLUX RECLAIMING
- WEAR STEEL SPECIALISTS.



TITUS STEEL COMPANY LIMITED
and
TITUS FLUX RECLAIMING DIV.

6767 Invader Cres.,
Mississauga, Ontario.
Canada L5T 2B7
tel: (905) 564-2446
fax: (905) 564-2450