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Synergy
SYNERGY
ENGINEERING SOLUTION

Synergizing Ideas, Delivering Excellence

PRODUCT RANGE

www.synergytubes.com

Pipes & Tubes

STAINLESS STEEL: ASTM A-213, A-269, A-312, A-358, A-249, A-240, A-479, TP304, 304L, 304H, 316, 316L, 316H, 316TI, 317, 317L, 312, 347, 309, 310, 310S, 409, 410 etc. in all required size & specifications.

CARBON STEEL: ASTM A-106 GR. A&B, A-333, GR. I & 6, A-53 GR. A&B, ASTM A-210 GR. A-1, BS 3059, PART I&II, SA 179, IS 1233, PART I IS 3589 GR 3301 410, etc. in shapes & sizes.

ALLOY STEEL :

SA/A 213 T11, T12, T22, T5, T9, T91

SA /A-335-P11,P22,P5,P9,P91

SA 691 ½ CR, 1CR, ¼CR, 2¼CR, 5CR, 9CR, 91CR.

15CDV6 & AISI 4130 Tubes.



Sheets & Plates

CARBON & ALLOY STEEL:

Normalized, Normalized & Tempered, Water Quenched

ASTM A-516 Gr60 & 70, ASTM A-387 Gr.11, 12, 22, 5, 9, 91

Corten A & Corten B.

400BHN & 500BHN Abrasion Resistant Plates

High Yield Steel S690 QL & S700MC

High Manganese Steel Plates.

Stainless, Duplex, Super Duplex Steels.

Nickel Alloys.

Aluminium Alloys, Copper & Cupro Nickel Sheets.

Buttweld Fittings

PIPE FITTINGS: BW/SW/SRD/Forged & Compression type with ferrules such as ELBOW, TEES, REDUCERS, STUBENDS, FLANGES, UNIONS, CAPS, NIPPLES, COUPLING, ELBOWLETS, WELDOLETS, NUTS, BOLTS, STUDS, WASHERS, VALVES & GASKETS etc. A182, A-194, A-234, WPB, A - 350 LF, A - 403 WP, A-120, WPL as per dimension ANSI B- 36.10, B36.90, B16.5, B - 16.9, B- 16.11 & B- 16.18 etc.



Flanges

FLANGES: C S. S S. A S. Forged Flanges

Size: ½" to 24" SORF BLRF, WNRF from ready stock

Grade: ASTM A-105 & ASTM A-182 F304, F316

FERRULE FITTINGS: In Single ferrule, double ferrule in the shape of CONNECTER UNION, RED UNION, UNION TEE, UNION ELBOW, BULK HEAD UNION CROSS ETC.

PLATES



STAINLESS STEEL PLATES CHEMICAL COMPOSITIONS (%)

Type	C*	Mn*	P*	S*	Si*	Cr	Ni	Others
304	0.08	2.00	0.045	0.030	0.75	18.0-20.0	8.0-10.5	NO.25
304L	0.03	2.00	0.045	0.030	0.75	18.0-20.0	8.0-12.0	NO.25
309S	0.08	2.00	0.045	0.030	0.75	22.0-24.0	12.0-15.0	
310S	0.08	2.00	0.045	0.030	1.50	24.0-26.0	19.0-22.0	
314	0.15	1.5	0.045	0.030	1.5-2.5	23-27	19-23	
316	0.08	2.00	0.045	0.030	0.75	16.0-18.0	10.0-14.0	Mo 2.0-3.0, NO.10
316L	0.03	2.00	0.045	0.030	0.75	16.0-18.0	10.0-14.0	Mo 2.0-3.0, -0.10
316Ti	0.08	2.00	0.045	0.030	0.75	16.0-18.0	10.0-14.0	NO.10Ti5(C+N)Min0.70Max
317L	0.03	2.00	0.045	0.030	0.75	18.0-20.0	11.0-15.0	Mo 3.0-4.0, NO-10
321	0.08	2.00	0.045	0.030	0.75	17.0-19.0	9.0-12.0	Ti5 (C+N)Min, 0.70 Max
330	0.08	2.00	0.030	0.030	0.75-1.5	17.0-20.0	34.0-37.0	GUI
347	0.08	2.00	0.045	0.030	0.75	17.0-19.0	9.0-13.0	Cb 10XC Min, 1.0 Max
409	0.03	1.00	0.030	0.040	1.00	10.5-11.75	0.5Max	Ti 6(C) Min-0.75 Max
410	0.15	1.00	0.030	0.030	1.00	11.5-13.5	0.75	
420	0.15Min	1.00	0.030	0.040	1.00	12.0-14.0		
430	0.12	1.00	0.030	0.040	1.00	16.0-18.0		
431	0.2	1.00	0.04	0.030	1.00	15.0-17.0	1.25-2.50	EN 57
440C	0.95-1.0	1.00	0.04	0.03	1.00	16.0-18.0		
446	0.2	1.5	0.04	0.03	1.00	23.0-27.0	0.60Max	
17-4PH	0.07	1.0	0.04	0.03	1.0	15-17.50	3.0-5.0	CU 3.0-5.0
904L	0.02	2.00	0.030	0.045	1.00	19.0-23.0	23.0-28.0	MO 4.0-5.0, CUL,0-2.0

* = Max.

STAINLESS STEEL PLATES - MECHANICAL PROPERTIES

Mechanical Properties of wrought Stainless Steel
(All properties minimum specified as per code)

Type	UNS Designation	Condition	Tensile Strength Mpa	0.2% Proof Strength Map	Elongation % in 50mm	Hardness Brinell	ASTM Specification
301	S30100	Annealed	515	205	40	201	A167
302	S30200	Annealed	515	205	40	201	A167
304	S30400	Annealed	515	205	40	201	A240
304L	S30403	Annealed	485	170	40	202	A240
309S	S30908	Annealed	515	205	40	217	A167
310S	S31008	Annealed	515	205	40	217	A167
316	S31600	Annealed	515	205	40	217	A240
316L	S31603	Annealed	485	205	40	217	A240
316Ti	S31635	Annealed	515	205	30	217	A167
317L	S31703	Annealed	515	205	40	217	A240
321	S32100	Annealed	515	205	40	217	A240
330	No8330	Annealed	480	210	30	75	B536
347	S34700	Annealed	515	205	40	201	A240
409	S40900	Annealed	380	205	22	179	A176
410	S41000	Annealed	450	205	20	217	A176
420	S42000	Annealed	860*	-	-	-	A580
430	S43000	Annealed	450	205	22	183	A176
431	S43100	Annealed	965*	-	-	-	A580
440C	S44004	Annealed	760	450	14	223	A276
446	S44600	Annealed	515	275	20	217	A176
17-4PH	S17400	H1025	1070	1000	12	331	-
904L	-	Annealed	490	220	35	90	-

Duplex & Super Duplex STEEL PLATES - CHEMICAL COMPOSITION

UNS Designation ^B	Type ^E	Carbon ^D	Manganese	Phos Phorus	Sulphur	Silicon	Chromium	Nickel	Molybdenum	Nitrogen	Copper	Other Elements ^{E,F}
S31200	...	0.030	2.00	0.045	0.030	1.00	24.0-26.0	5.5-6.5	1.20-2.00	0.14-0.20	...	...
S31260	...	0.030	1.00	0.030	0.030	0.75	24.0-26.0	5.5-7.5	2.5-3.50	0.10-0.300	0.20-0.80	W 0.10-0.50
S31803	...	0.030	2.00	0.030	0.020	1.00	21.0-23.0	4.5-6.5	2.5-3.5	0.08-0.20	...	...
S32001	...	0.030	4.0-6.0	0.040	0.030	1.00	19.5-21.5	1.00-3.00	0.60	0.05-0.17	1.00	...
S32205	2205 ^G	0.030	2.00	0.030	0.020	1.00	22.0-23.0	04.5-6.5	3.0-3.5	0.14-0.20	...	...
S32304	2304 ^G	0.030	2.50	0.040	0.030	1.00	21.5-24.5	3.0-5.5	0.05-0.60	0.05-0.60	0.05-0.60	...
S32520	...	0.030	1.50	0.035	0.020	0.80	24.0-26.0	5.5-8.0	3.0-4.0	0.20-0.35	0.50-2.00	...
S32550	255 ^G	0.040	1.50	0.040	0.030	1.00	24.0-27.0	4.5-6.5	2.9-3.9	0.10-0.25	1.50-2.50	...
S32750	2507 ^G	0.030	1.20	0.035	0.020	0.80	24.0-26.0	6.0-8.0	3.0-5.0	0.24-0.32	0.50	...
S32760	...	0.030	1.00	0.030	0.010	1.00	24.0-26.0	6.0-8.0	3.0-4.0	0.20-0.30	0.50-1.00	W 0.50-1.00
S32900	329	0.080	1.00	0.040	0.030	0.75	23.0-28.0	2.0-5.00	1.00-2.00	...	...	...
S32950	...	0.030	2.00	0.035	0.010	0.60	26.0-29.0	3.5-5.2	1.00-2.50	0.15-0.35	...	...

Stainless Steel Duplex & Super Duplex Plates

Mechanical Test Requirements

UNS Designation ^B	Type ^A	Tensile Strength, min		Yield Strength, ^B min		Elongation in 2 in. or 50 mm, min, %	Hardness, max ^C		Cold Bend
		Ksi	MPa	Ksi	MPa		Brinell	Rockwell B	
S31200	...	100	690	65	450	25.0	293	31	not required
S31260	...	100	690	70	485	20.0	290	...	...
S31803	...	90	620	65	450	25.0	293	31 ^J	not required
S32001	...	90	620	65	450	25.0	...	25 ^G	not required
S32205	2205 ^F	90	620	65	450	25.0	293	31 ^J	not required
S32304	2304 ^F	87	600	58	400	25.0	290	32 ^J	not required
S32520	...	112	760	80	550	25.0	310	...	not required
S32550	255 ^F	110	760	80	550	15.0	302	32 ^J	not required
S32750	2507 ^F	116	795	80	550	15.0	310	32 ^J	not required
S32760	...	108	750	80	550	25.0	270	...	not required
S32900	329	90	620	70	485	15.0	269	28	not required
S32950 ^H	...	100	690	70	485	15.0	293	32	not required

Pressure Vessel & Boiler Quality Steel Plates

IS - 2002 - 62 STEEL PLATES FOR BOILERS

Designation			Chemical Composition			Tensile test			Elongation	
	C max	mn	si max	P max	S max	Tensile Strength Kf/mm ²	Yield Strength Kf/mm ² min		Test	% min piece
IS 2002-1	0.18	0.5 1.2	0.15-0.35	0.035	0.040	36.7-49	24	23	5.65/Sc	24
IS 2002-2	0.20	0.5 1.2	0.15-0.35	0.035	0.40	41.7-54	27	26	5.65/Sc	22
IS 2002-3	0.22	0.5 1.2	0.15-0.35	0.035	0.040	46.8-59	29.5	29	5.65/Sc	21

ASTM A 537 - 35 PRESSURE VESSEL PLATES, HEAT TREATED, CARBON MANGANESES-SILICON STEEL

Designation	%Chemical Composition										Heat Treatment	Tensile Strength				
	C Max		Min. thickness in mm		P max	S max	Cu max	Ni max	Cr max	Mo max		Thickness in mm	Tensile Strength Ksi (MPa)	Yield Strength Ksi (MPa) min	GL= 8 in or 200 mm	
			t<1-1/2(38)	t>-1-1/2												
A 537 -1	0.24	0.15-0.50	0.70-1.35	1.0-1.60	0.035	0.040	0.035	0.25	0.25	0.08	Normalised	t<2-1 (64) 2-1/2<t<4 (100)	70-90 (485-620) 65-85 (450-585)	50 (345) 45 (310)	18	22
A 537 -2	0.24	0.15-0.50	0.70-1.35	1.0-1.60	0.035	0.040	0.035	0.25	0.25	0.08	Quenched & Tempered	T<2-1/2(64) 2-1/2<t<4(100)	80-100 (550-690) 75-95 (515-655)	60 (415) 55 (380)	-	22

ASME SA / ASTM A516 PRESSURE VESSEL PLATES, CARBON STEEL, FOR INTERMEDIATE AND LOWER TEMP. SERVICE

Designation	Chemical Composition, %						Tensile Test			
	Thickness in (mm)	C max	Si	Mn max	P max	S max	Tensile Strength Ksi (MPa)	Yield Strength Ksi (MPa), min or 200 mm	Elongation,% min	
									GI=8 in. *2 or 50 mm	GI=2 in
A 516-55	T<1/2 (13)	0.18	0.15~0.30	0.60~0.90	0.035	0.04	55-75 (380-515)	30(205)	23	27
	1<t<2(50)	0.20	0.15-0.30	0.60~1.20	0.035	0.04				
	2<t<4(100)	0.22								
	4<t<8 (200) t>8	0.24 0.26								
A 516-60	T<1/2 (13)	0.21	0.15~0.30	0.60~0.90	0.035	0.04	60-80 (415-550)	32(220)	21	25
	1<t<2 (50)	0.23	0.15-0.30	0.85~1.20	0.035	0.04				
	2<t<4 (100)	0.25								
	4<t<8 (200) t<8	0.27 0.27								
A 516-65	t<1/2(13)	0.24	0.15-0.30	0.85~1.20	0.035	0.04	65-85 (450-585)	35(240)	19	23
	1<t<2 (50)	0.26								
	2<t<4 (100)	0.28								
	4<t<8(200) t<8	0.29 0.29								
A 516-70	t<1/2 (13)	0.27	0.15-0.30	0.85~1.20	0.035	0.04	70-90 (485-620)	38(260)	17	21
	1<t<2 (50)	0.28								
	2<t<4< (100)	0.30								
	4<t8 (200) t>8	0.31 0.31								

NACE HIC Steel

Synergy Engg Solution provides a complete range of plate tested for its resistance to hydrogen induced cracking (HIC) in wet H₂S (sour service) environments. The plate is manufactured by Industeel (part of the Arcelor Mittal Group) & by ISD HUTA, Poland and is guaranteed by them to have the following minimum properties:

Crack Length Ratio (CLR) less than 5 %
Crack Thickness Ratio (CTR) less than 1.5%
Crack Sensitivity Ratio (CSR) less than 0.5%

The plate is tested to NACE TM 0284-03 Solution A and certified to EN 10204 3.2 (Lloyds). It is compatible with many of the world's most stringent proprietary specifications including Petrobras N1706, Saudi Aramco 01-SAMSS-016, EEMUA 179, Axens IN-43, Shell MESC 74/125, and Shell DEP 31.22.10.32.

We are able to offer plates to ASME / ASTM SA / A 516 Grades 60/65/70.
Plates are supplied from our stock / warehousing facilities at Taloja & Kalamboli, Navi Mumbai.

Specifications :

ASME /ASTM SA/A516-60/65/70

Technical Specifications :

Chemical Analysis

Max Ceq 0.41% ≤ 50mm, 0.43% > 50mm

Max S 0.001%, P 0.008%, Nb 0.015%, V 0.005%, O 0.002%

All material is made with an Electric Arc Furnace, fully killed, vacuum degassed, with fine grain.

Mechanical Properties :

Mechanical and HIC tests after simulated PWHT at 610°C (2 min/mm).

Ambient tensile properties as per standard.

Charpy impact test longitudinal and transverse direction

At -51°C for thickness ≤ 25mm (20J average /16J individual)

At -46°C for thickness >25mm (41J average /34J individual)

Applications :

- Condensers
- Dished ends
- Flanges
- Filters
- Heat exchangers
- Line pipe
- Pressure vessels
- Valves

HIC Steel Plate Size Range :

HIC Steel Plate Thicknesses: 6-105mm

HIC Steel Plate Widths: 2 metres, 2.5 metres, 3 metres

HIC Steel Plate Lengths: up to 12 metres





HOT ROLLED LOW, MEDIUM AND HIGH TENSILE STRUCTURAL STEEL AS PER IS 2062 : 2006

Table 1 Chemical Composition
(Clauses 5, 8.1 and 8.2)

Grade Designation	Quality	Ladle Analysis, Percent, Max					Carbon Equivalent (CE), Max	Method of Deoxidation
		C	Mn	S	P	Si		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
E165 (Fe290)	-	0.25	1.25	0.045	0.045	-	-	Semi-killed or killed
E250 (Fe410w)	A	0.23	1.5	0.045	0.045	0.4	0.42	Semi-killed or killed
E250 (Fe410w)	B	0.22	1.5	0.045	0.045	0.4	0.41	Killed
E250 (Fe410w)	C	0.2	1.5	0.04	0.04	0.4	0.39	Killed
E300 (Fe440)	-	0.2	1.3	0.045	0.045	0.45	0.4	Semi-killed or killed
E350 (Fe490)	-	0.2	1.5	0.045	0.045	0.45	0.42	Semi-killed or killed
E410 (Fe540)	-	0.2	1.6	0.045	0.045	0.45	0.44	Semi-killed or killed
E450 (Fe570)	D	0.22	1.6	0.045	0.045	0.45	0.46	Semi-killed or killed
E450 (Fe590)	E	0.22	1.8	0.045	0.045	0.45	0.48	Semi-killed or killed

Table 2 Mechanical Properties
(Clauses 5, 10.3 and 10.3.1)

Grade Designation	Quality	Tensile Strength R Min Mpa	Yield Stress, R Min Mpa			Percentage Elongation, A at Gauge Length, L, 5.65 ls, Min	Internal Bend Diameter Min		Charpy V-Notch Impact Energy Min J	
			<20	20-40	>40		≤25	>25	Room Temp	-20°C
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
E165 (Fe290)	-	290	165			23	2t	-	-	-
E250 (Fe410w)	A	410	250	240	230	23	3t	2t	-	-
E250 (Fe410w)	B	410	250	240	230	23	2t	3t	27 (see Note3)	
E250 (Fe410w)	C	410	250	240	230	23	2t	3t	27 (see Note3)	
E300 (Fe440)	-	440	300	290	280	22	2t	3t	50	30
E350 (Fe490)	-	490	350	330	320	22	2t	3t	50	25
E410 (Fe540)	-	540	410	390	380	20	2t	3t	50	25
E450 (Fe570)	D	570	450	430	420	20	2t	3t	45	20
E450 (Fe590)	E	590	450	430	420	20	2t	3t	45	20

NOTE: MATERIALS OF SIMILAR QUALITY IN FOREIGN STANDARDS ARE ALSO AVAILABLE.

For Eg.

- ASTM A 36 / SS 400 / S235JR / Q235
- ASTM A 572 Gr. 50 / S355JR & J2/ Q345

ABRASION RESISTANT PLATES

Abrasion Resistance Steel Plates

Quenched & Tempered Steel Plates

Alloy Steel Chrome Moly Plates

Corten Steel Plates

Hadfield Manganese Steel Plate



ABRASION RESISTANT PLATES

(AR Steel plate) with superior forming, welding and wear characteristic. This steel plate, with its high Brinell Hardness (BHN) rating, is particularly suited to the mining equipments, earth moving equipment, and aggregates processing, road target backstop and bullet trap application.

200 BRINEL WEAR RESISTANT STEELS

	CHEMICAL COMPOSITION						MECHANICAL PROPERTIES
GRADE	C% max	Mn% max	P% max	S% max	SI% max	CE max	
SAILHARD/ TISCRAL	0.23	1.6	0050	0.050	0.50	-	HARDNESS -2 00 BHN (MN)
Al 0.10m ax, Cr 065 ma x, Nb +V+Ti0.1 5 max							

400 BRINEL WEAR RESISTANT STEELS

	Plate Thickness mm	CHEMICAL COMPOSITION IN % (Max)											CEV Typv.	CET Typv.	Hardness HB	Typical values		
		C	SI	P	S	Mn	Ni	Cr	Mo	B	Ai	Ti				Ys Mpa	UTS Mpa	E %
HARDOX 400	10 - 20	0,15	0,70	0,025	0,010	1,60	0,25	0,50	0,25	0,004	--	--	0,37	0,27	370-430	1000	1250	10
JFE EH360LE	6 - 32	0.17	0.55	0.020	0.010	1.60		0.40	0.35	0.004	-	0.020	0.40	0.43	361-440	1058	1308	23
ABREX 400	6 - 100	0.21	0.70	0.025	0.010	2.00	1.00	1.20	0.60	0.005					360-440	1075	1322	-
X AR 400		0.20	0.80	0.025	0.010	1.50	-	1.00	0.50	0.005					360-440	1050	1250	12
SR 400	12-20	0.16	0.70	0.025	0.010	1.60	0.25	0.50	0.25	0.0040		0.15	0.45		370-430	1000	1200	10
ABRAZO 400	8 - 19	0.20	0.50	0.025	0.010	1.60	0.70	0.25	0.20	0.004	0.06	0.04	0.43		360-400	1050	1200	14
Creusabro4 800		0.20		0,018	0,005	1,60	0,20	1.90	0.40			0,200			340-400	900	1200	12

500 BRINEL WEAR RESISTANT STEELS

	Plate Thickness mm	CHEMICAL COMPOSITION IN %(MA X)													Hardness HB	Typical Values		
		C	SI	P	S	Mn	Ni	Cr	Mo	B	Ai	Ti	CEV Typv.	CET Typv.		Ys Mpa	UTS Mpa	E %
HARDOX 500	4-13	0,27	0,70	0,025	0,010	1,60	0,25	1,00	0,25	0,004	--	--	0,49	0,34	470-530	-	-	-
ABREX 500	6 - 50	0.35	0.70	0.015	0.010	2.00	1.00	1.20	0.60	0.005					450-550	1373	1552	

QUENCHED & TEMPERED STEEL

QUENCHED & TEMPERED STEEL

NAXTRA-70/WELDOX-700E/DILIMAX690 E/S690QL.

High strength quenched & tempered steel with minimum yield strength of 690 mpa (100ksi)

Preferably used for welded structure. conveying plates, cranes, flood gates, bridges



HIGH STRENGTHED STEELS

	Thickness mm	CHEMICAL COMPOSITION IN %(MAX)											Typical Values		
		C	S	SI	P	Mn	Ni	Cr	Mo	B	Al	V	Ys Mpa	UTS Mpa	E %
DILLIMAX 690 E		0,18	0,010	0,50	0,020	1,60	1,80	1,50	0,60	0,004			690	770-940	14
NAXTRA M 700		0,20	0,010	0,08	0,020	1,60	-	1.5	0.6				700	770-940	14
RQT701	8 -30	0,20	0,010	0,50	0,025	1.60	0.70	0.25	0.20	0.004	0.006	0.008	690	790-930	18
WELDOX 700 E	4,0 - 50,1	0,20	0,010	0,60	0,020	1.60	2	0,70	0.70	0.005	0,015	0,09	700	780-930	14
HITEN 780L E	6-19 19.1-32	0.20	0.015	0.40	0.025	1.40	-	0.20	0.15	0.005	-	0.08	685	780-930	16
WELTEN 780 E	6-50	0.22	0.015	0.55	0.025	2.00	0.30	1.20	-	0.005	-	0.05	685	780-930	16
S690QL		0.18	0.01	0.50	0.02	1.60	1.15	1.00	0.60	0.005	-	0.1	690	790-940	14

SAILMA PLATES

IT'S A HIGH STRENGTH MICRO ALLOY STRUCTURAL STEEL SEMI-KILLED

Hardness AVAILABLE IN 300/300HI/350/350HI/410/410HI/450/450HI

Grade	C% max	Mn% max	P% max	S% max	Si% max	CE max	Yield Strength MPa min	ultimate Tensile Strength MPa min	Elongation %min GL 5.65 S	Internal diameter of bend
300	0.25	1.5	0.055	0.055			300	440-560	20	3T
300 Hi	0.20	1.5	0.040	0.040			300	440-560	21	3T
350	0.25	1.5	0.055	0.055			350	490-610	20	3T
350 Hi	0.20	1.5	0.040	0.040			350	490-610	21	3T
410	0.25	1.5	0.055	0.055			410	540-660	19	3T
410 Hi	0.20	1.5	0.040	0.040			410	540-660	20	3T
450	0.25	1.5	0.055	0.055			450	570-720	18	3T
450 Hi	0.20	1.5	0.040	0.040			450	570-720	19	3T
Nb = V + Ti = 0.30 max								Charpy Impact energy : 40J at 0°C for 300HI, 40J at 0°C, 30J at -20 °C for 350 HI, 35J at 0 °C, 25J at -20°C for 410 HI, 3J at 0 °C , 20J at -20 °C for 450 HI. Impact will be given for any one temperature. For 450 HI impact is for >10 mm. For <12 mm impact to be given only if speci ed.		

Alloy Steel Chrome Moly Plates to ASTM & EN STANDARDS.

ASME SA 387 / ASTM A 387	Chemical Composition, % Grade and UNS Number														
	Carbon:	Manganese:	Phosphorus, max:	Sulfur, max:	Silicon:	Chromium:	Molybdenum:	Nickel, max:	Vanadium:	Columbium:	Boron:	Nitrogen:	Aluminum, max:	Titanium, max:	
	Heat analysis Product analysis	Heat analysis Product analysis	Heat analysis Product analysis	Heat analysis Product analysis	Heat analysis Product analysis	Heat analysis Product analysis	Heat analysis Product analysis	Heat analysis Product analysis	Heat analysis Product analysis	Heat analysis Product analysis	Heat analysis Product analysis	Heat analysis Product analysis	Heat analysis Product analysis	Heat analysis Product analysis	Heat analysis
Grade 2	0.50-0.21	0.55-0.80	0.035	0.035	0.15-0.40	0.50-0.80	0.45-0.60	--	--	--	--	--	--	--	--
S50460	0.04-0.21	0.50-0.88	0.035	0.035	0.13-0.45	0.46-0.85	0.40-0.65	--	--	--	--	--	--	--	--
Grade 11	0.05-0.17	0.40-0.65	0.035	0.035	0.50-0.80	1.00-1.50	0.45-0.65	--	--	--	--	--	--	--	--
K11757	0.04-0.17	0.35-0.73	0.035	0.035	0.44-0.86	0.94-1.56	0.40-0.70	--	--	--	--	--	--	--	--
Grade 12	0.05-0.17	0.40-0.65	0.035	0.035	0.15-0.40	0.80-1.15	0.45-0.60	--	--	--	--	--	--	--	--
K11789	0.04-0.17	0.35-0.73	0.035	0.035	0.13-0.45	0.74-1.21	0.40-0.65	--	--	--	--	--	--	--	--
Grade 22	0.50-0.15 ^A	0.30-0.60	0.035	0.035	0.50 max	2.00-2.50	0.90-1.10	--	--	--	--	--	--	--	--
K21590	0.04-0.15 ^A	0.25-0.66	0.035	0.035	0.50 max	1.88-2.62	0.85-1.15	--	--	--	--	--	--	--	--
Grade 5	0.15 max	0.30-0.60	0.035	0.03	0.50 max	4.00-6.00	0.45-0.65	--	--	--	--	--	--	--	--
S50200	0.15max	0.25-0.66	0.035	0.03	0.50 max	3.90-6.10	0.40-0.70	--	--	--	--	--	--	--	--
Grade 9	0.15 max	0.30-0.60	0.03	0.03	1.00 max	8.00-10.00	0.90-1.10	--	0.04 max	--	--	--	--	--	--
K90941	0.15max	0.25-0.66	0.03	0.03	1.05 max	7.90-10.10	0.85-1.15	--	0.05 max	--	--	--	--	--	--
Grade 91	0.08-0.12	0.30-0.60	0.02	0.010	0.20-0.50	8.00-9.50	0.85-1.05	0.4	0.18-0.25	0.06-0.10	--	0.030-0.070	0.02	0.01	0.01
K91560	0.06-0.15	0.25-0.66	0.025	0.012	0.18-0.56	7.90-9.60	0.80-1.10	0.43	0.16-0.27	0.05-0.11	--	0.025-0.080	0.02	0.01	0.01

^A The carbon content for plates over 5 in. (125 mm) in thickness is 0.17 max on product analysis.

TABLE 2 Tensile Requirements for Class 1 Plates

	Grades 2 and 12	Grade 11	Grades 22, 21, 5, 9, 21L, 22L
Tensile strength, ksi (Mpa)	55 to 80 (380 to 550)	60 to 85 (415 to 585)	60 to 85 (415 to 585)
Yield strength, min, ksi (Mpa)	33 (230)	35 (230)	30 (205)
Elongation in 8 in. (200 mm), Min, %A	18	19	---
Elongation in 2 in. (50 mm), Min, %A	22	22	18
Reduction of area, min, %	---	---	45 ^B 40 ^C

TABLE 3 Tensile Requirements for Class 2 Plates^A

	Grades 2	Grade 11	Grades 12	Grades 22, 21, 5,	Grades 91
Tensile strength, ksi (Mpa)	70 to 90 (485 to 620)	75 to 100 (515 to 690)	65 to 85 (450 to 585)	75 to 100 (515 to 690)	85 to 110 (585 to 760)
Yield strength, min, ksi (Mpa)/(0.2% offset)	45 (310)	45 (310)	40 (275)	40 (310)	60 (415)
Elongation in 8 in. (200 mm), Min, %B	18	18	19	--	--
Elongation in 2 in. (50 mm), Min, %B	22	22	22	18	18
Reduction of area, min, %	--	--	--	45 ^C	--40 ^D

Supplementary Requirements

Supplementary requirements shall not apply unless specified in order. A list of standardized supplementary requirements for use at the option of the purchaser is included in specification A 20/A 20M. Several of those considered suitable for use with this specification are listed below by title. Other tests may be performed by agreement between the supplier and the purchaser.

- S1. Vacuum treatment
- S2. Product analysis
- S3. Simulated post-weld treatment of mechanical test coupons
- S4.1 Additional tension test
- S5. Charpy V-Notch impact test
- S6. Drop weight test (for material 0,625 in. (16 mm) and over in thickness)

- S8. Ultra sonic examination in accordance with specification A 435/A 435 M.
- S9. Magnetic Particle examination
- S11. Ultrasonic Examination in accordance with specification A 577/ A 577M
- S12. Ultrasonic examination in accordance with specification A 578/A 578M and
- S17. Vacuum Carbon-Deoxidized steel

Additional Supplementary requirements

In addition, the following supplementary requirements are suitable for this application. S62 and S63 are applicable for Grades 22 and 21 only

S53.

When specified by the purchaser, the axis of the tensile and impact test specimens shall come from the mid-thickness of each plate tested, in lieu of midway between the center thickness and the top or bottom surface of the plate.

S60. Restricted Carbon

S60.1 The maximum of the steel, based on heat analysis, shall be restricted in accordance with the following equations:

S62. Temper Embrittlement Factor

S62.1 The Composition of the steel, based on heat analysis,

Shall be restricted in accordance with the following equations:

$$J = (Si + Mn) X (P + Sn) X 104 \leq 150 \quad (Si, Mn, P \text{ and } Sn \text{ in wt } \%)$$

$$Cu \leq 0.20\%$$

$$Ni \leq 0.30\%$$

S62.1.1 Lower values of J, Cu, and Ni can be specified by agreement between putween and the supplier.

S62.1.2 When so specified by the purchaser, the maximum value of J shall not exceed 100.

S62.1.3 The values of J shall be reported.

S62.1.4 If the plates are repaired by welding, the composition of the weld deposit shall be restricted in accordance with the following equations:

$$X = (10P + 5Sb + 4Sn + As) 100 \leq 15 \quad (P, Sb, Sn \text{ and } As \text{ in ppm})$$

$$Cu \leq 0.20\%$$

$$Ni \leq 0.30\%$$

S62.1.5 The values of X shall be reported.

S63. Impact Properties After Step Cooling

S63.1 The Charpy V- notch impact properties shall be determined as follows:

Chrome-Moly Plates as per EN specification 10028-2

Stahlsorte		Massenanteil in %														
Kurzname	Werkstoffnummer	C	Si	Mn	P max.	S max.	Al _{gesamt}	N	Cr	Cu ^b	Mo	Nb	Ni	Ti max.	V	Sonstige
16Mo3	1.5415	0,12 bis 0,20	≤ 0,35	0,40 bis 0,90	0,025	0,010	e	≤ 0,012	< 0,30	≤ 0,30	0,25 bis 0,35	--	≤ 0,30	--	--	--
13CrMo4-5	1.7335	0,08 bis 0,18	≤ 0,35	0,40 bis 1,00	0,025	0,010	e	≤ 0,012	0,70f bis 1,15	≤ 0,30	0,40 bis 0,60	--	--	--	--	--
10CrMo9-10	1.7380	0,08 bis 0,14g	≤ 0,50	0,40 bis 0,80	0,020	0,010	e	≤ 0,012	2,00 bis 2,50	≤ 0,30	0,90 bis 1,10	--	--	--	--	--

EN 10028-2 Mechanical

Matl. Grade	Werkstoff-nummer	Supply Condition	Thickness mm	bestimmte Elgenschaften			J min. Test Temperatur In °C von			
				Y.S Mpa min.	U T S Mpa	EL% min.	-20	0	+20	
16Mo3	1,5415	+N°	< 16	275	440 bis 590	22	t	t	31	
			16 < t < 40	270						
			40 < t < 60	260						
			60 < t < 100	240						
			100 < t < 150	220						
			150 < t < 250	210						
13CrMo4-5	1.7335	+NT	< 16	300	450 bis 600	19	t	t	31	
			16 < t < 60	290						
			60 < t < 100	270						
		+NT oder +QT	100 < t < 150	255	430 bis 580		t	t	27	
			150 < t < 250	245						
			+QT							420 bis 570
10CrMo9-10	1.7380	+NT	< 16	310	480 bis 630	18	t	t	31	
			16 < t < 40	300						
			40 < t < 60	290						
		+NT oder +QT	60 < t < 100	280	470 bis 620		17	t	t	27
			100 < t < 150	260						
			150 < t < 250	250						

Hadfield Manganese Steel Plate

Mn13 / Creusabro® M / Hadfeild® / CSEC Hi-Mn Brand is a high Manganese, fully austenitic, quench annealed, non magnetic, work-hardening steel with an exceptionally high level of wear resistance when subjected to work-hardening by shock or high impact pressure in service.

The main characteristics is a superior wear resistance: Severe wear on the surface has a work-hardening effect on the austenitic structure of this steel. This, when combined with the level of carbon in accordance with the international standards, leads to an increase in hardness from 200BHN (in as delivered plates) up to an in-service hardness of at least 600BHN.

This work-hardening capability renews itself through out in-service life. The underlayers not work-hardened maintain an excellent resistance to shock and a very high ductility.

Typical Applications:

- Quarries and Constructions: Earth moving crusher jaw, grizzly, screen, stone chutes, chain guide and shredder plates, shovel buckets.
- Mines: Bucket blade of loader, chain conveyor parts, sprocket wheel, various armouring elements.
- Iron Industry, Foundry: Guiding and shifting plates, scraps container, liner of shot blasting unit, pedestal liner, angled bolster cup, wear liner.
- Concrete and Brickworks: Core and dividing wall of parpen mould, grinding mill scraper, mixer paddle.
- Scraps – Recoveries: Wheel disk, striker and hammer mill.
- Automotive Industries: Shot blasting equipment.

It is also used for its low coefficient of friction in metal-to-metal applications, its non-magnetic properties in electrical transformer assemblies and for industrial lifting magnets.

A high manganese, fully austenitic, quench annealed, non magnetic, work-hardening steel with an exceptionally high level of wear resistance when subjected to work-hardening by shock or high impact pressure in service.

The main characteristics is a superior wear resistance:

Severe wear on the surface has a work-hardening effect on the austenitic structure of this steel.

This, when combined with the level of carbon in accordance with the international standards, leads to an increase in hardness from 200BHN (in as delivered plate) up to an in-service hardness of at least 600BHN.

This work-hardening capability renews itself through out in-service life. The underlayers not work-hardened maintain an excellent resistance to shock and a very high ductility.

Chemical Analysis Typical values (% weight)

C	Si	Mn	S	P
1.13	0.40	13	0.003	<0.20



Mechanical Properties

	Hardness HB	Yield Strength Mpa	UTS Mpa	EI%	KCV 200C (600F)- J
Typical Values	200	380 (55 KSI)	940 (136 KSI)	40	≥ 112 J (≥ 83 ft.lbs)
Guaranted Values*	180/245	350 (51 KSI)	800 (116 KSI)	30	64 J (47 ft.lbs)

WEATHER RESISTANT STEELS (Corten Steel)

It is a steel resistant to bad weather. Because of its special chemical composition, it is self-protected creating a special coat which prevents rust from progressing both in urban and industrial environments.

This special rust coat provides it with an aspect suitable for decoration, facades or covers without coating.

Applications :

Widely used in bridge construction, any kind of structures, fences, urban furniture, sculptures, containers, etc.

Size Range :

Thicknesses : 1.2 mm - 50 mm

Widths : 1.25mm, 1.5m, 2.5m

Lengths : up to 12m



Chemical composition of steels with Improved atmospheric corrosion resistance													
Grade	C % max.	Si % max.	Mn %	P %	S % max.	N % max.	Cr %	Cu %	V %	Ni %	Z %	Al %	Mo %
According To EN Grades EN 10025-5 (European Standards)													
S235J0W	0.13	0.4	0.20-0.60	0.04	0.04	0.01	0.40-0.80	0.25-0.55	-	0.65	-	-	<16
S235J2W	0.13	0.4	0.20-0.60	0.04	0.03	-	0.40-0.80	0.25-0.55	-	0.65	-	-	> 3 < 100
S355J0W	0.12	0.75	1	0.06-0.15	0.04	0.01	0.30-1.25	0.25-0.55	-	0.65	-	-	> 3 < 40
S355J2WP	0.12	0.75	1	0.06-0.15	0.03	-	0.30-1.25	0.25-0.55	-	0.65	-	-	
S355J0W	0.16	0.5	0.50-1.50	0.04	0.04	0.01	0.40-0.80	0.25-0.55	-	0.65	0.15	-	
S355J2W	0.16	0.5	0.50-1.50	0.03	0.03	-	0.40-0.80	0.25-0.55	-	0.65	0.15	-	
S355K2W	0.16	0.5	0.50-1.50	0.03	0.03	-	0.40-0.80	0.25-0.55	-	0.65	0.15	-	
According To ASTM & ASME SEC-II PART A (American Standards)													
A 588 GR. A	0.19	0.3-0.65	0.80-1.25	0.04	0.05	-	0.40-0.65	0.25-0.40	0.02-0.10	-	-	-	345
A 588 GR. B	0.2	0.15-0.50	0.75-1.35	0.04	0.05	-	0.40-0.70	0.20-0.40	0.01-0.10	-	-	-	485
A 588 GR. C	0.15	0.15-0.40	0.80-1.35	0.04	0.05	-	0.30-0.50	0.20-0.50	0.01-0.10	-	-	-	485
A 588 GR. K	0.17	0.25-0.50	0.50-1.20	0.04	0.05	-	0.40-0.70	0.30-0.50	-	-	Cb-0.005-0.05	-	485
A 242 TYPE-1	0.15	-	1	0.15	0.05	-	-	0.20 min	-	-	-	-	480
A 242 TYPE-2	0.2	0.20-0.50	1.35	0.04	0.05	-	-	0.20 min	-	-	-	-	480
According To Indian Railways Specification. (Indian Standards)													
IRSM-41	0.1	0.30-0.50	0.25-0.45	0.75-0.14	0.03	-	0.35-0.49	0.30-0.60	0.05	0.28-0.49	-	-	360
According To Manufacturer Trademarks													
Cor-Ten A	0.12	0.25-0.75	0.20-0.50	0.07-0.15	0.03	-	0.50-1.25	0.25-0.55	-	0.65	-	>0.02%	355
Cor-Ten B	0.16	0.30-0.50	0.80-1.25	0.03	0.03	-	0.40-0.65	0.25-0.40	0.02-0.10	0.4	-	>0.02%	355

* Steel Properties mentioned are for reference only. For Exact properties please refer the Specification book of the country agencies.

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