BABV

PENUTUP

5.1 Kesimpulan

Dari hasil penelitian ini dapat ditarik suatu kesimpulan bahwa:

1. Dari pengujian tarik dengan semakin lama waktu pengelasan pada proses *spot welding* maka dihasilkan kekuatan tarik yang semakin besar dan nilai optimum di dapat pada variasi waktu 14 detik dengan variasi yang terbaik juga didapat pada waktu pengelasan ini dalam kuat arus 8800 *Ampere* (A) dan ditunjukkan pada luasan daerah kekuatan tarik. Namun setelah waktu pengelasan ini tepatnya di 16 detik, gumpalan nugget tidak membesar lagi bahkan membuat pengumpulan/lekukan (*indentation*) dan distorsi/perubahan panas yang mempengaruhi tampilan dari sambungan tersebut. Berdasarkan hasil pengujian tarik ternyata kerusakan terjadi pada bagian perbatasan *nugget* dengan *base metal*.
2. Dari hasil penelitian ini didapatkan hasil pengelasan optimal khususnya baja SPCC sesuai JIS G-3141 untuk tebal plat 1 mm maka kombinasi arus yang terbaik adalah 8800 *Ampere* (A) dengan waktu pengelasan 14 (s), karena pada waktu ini mempunyai kekuatan tarik rata-rata 2,536 kN. Pada kombinasi ini kekuatan tarik sambungan las titik yang paling besar dan nilai kekerasannya juga relatif besar.

3. Kemudian bila dibandingkan dengan pengujian uji tarik menggunakan spesimen baja SPCC tanpa dilas maka gaya yang diperlukan sampai spesimen putus adalah 5,460 kN. Sedangkan tegangan yang diperlukan sampai spesimen putus adalah 273 N/mm^2. Ini membuktikan bahwa spesimen yang diuji sesuai dengan standar JIS G-3141 yaitu dengan tegangan tarik (*Tensile Streingth*) minimal 270 N/mm^2.
4. Dari hasil uji kekerasan, pada daerah logam dasar (*BM*) nilai kekerasannya sama 159 HV karena tidak terpengaruh panas. Pada daerah terpengaruh panas (*HAZ*) nilai kekerasan tertinggi adalah 693 HV pada arus 8800 *Ampere* (A) dengan waktu las 16 (s), sedangkan pada daerah logam lasan (*WM*) nilai kekerasan yang tertinggi adalah 864 HV pada arus 8800 *Ampere* (A) dengan waktu las 16 (s).

5.2 Saran

Setelah pengolahan dan pembahasan hasil penelitian, maka penulis mencoba memberikan beberapa saran, diantaranya:

1. Perlu dilakukan penelitian lanjutan yang menganalisis kuat arus yang berbeda, karena pada perbedaan variasi kuat arus berpengaruh terhadap hasil kekuatan lasan.
2. Perlu dilakukan penelitian lanjutan terhadap tebal plat, yang mana banyak industri yang menggunakan plat yang berbeda-beda sesuai penggunaannya.

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LAMPIRAN

JIS G3141

Tensile strength, elongation and non-aging property

Symbol of quality	Tensile strength N/mm2	Elongation %						Tensile test piece
	Discrimination according to nominal thickness mm							
	0.25 or over	0.25 or over to and excl. 0.40	0.40 or over to and excl. 0.60	0.60 or over to and excl. 1.0	1.0 or over to and excl. 1.6	1.6 or over to and excl. 2.5	2.5 or over	
SPCC	(270 min)	(32 min)	(34 min)	(36 min)	(37 min)	(38 min)	(39 min)	No. 5 in rolling direction
SPCD	270 min	34 min	36 min	38 min	39 min	40 min	41 min	
SPCE	270 min	36 min	38 min	40 min	41 min	42 min	43 min	

JIS G3141

Hardness

Temper grade	Symbol of temper grade	Hardness	
		HRB	HV
1/8 hard	8	50 to 71	95 to 130
1/4 hard	4	65 to 80	115 to 150
1/2 hard	2	74 to 89	135 to 185
Full hard	1	85 min	170 min

JIS G3141

Chemical composition, %

Symbol of grade	C	Mn	P	S
SPCC	0.12 max	0.50 max	0.040 max	0.045 max
SPCD	0.10 max	0.45 max	0.035 max	0.035 max
SPCE	0.08 max	0.40 max	0.030 max	0.030 max

Designation: A 370 – 97a

Standard Test Methods and Definitions for Mechanical Testing of Steel Products[1]

This standard is issued under the fixed designation A 370; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense.

Scope

1.1 These test methods[2] cover procedures and definitions the mechanical testing of wrought and cast steel products. e various mechanical tests herein described are used to termine properties required in the product specifications. riations in testing methods are to be avoided and standard thods of testing are to be followed to obtain reproducible d comparable results. In those cases where the testing uirements for certain products are unique or at variance with se general procedures, the product specification testing uirements shall control.

1.2 The following mechanical tests are described:

	Sections
sion	5 to 13
d	14
dness	15
rinell	16
ockwell	17
ortable	18
act	19 to 28
words	29

1.3 Annexes covering details peculiar to certain products appended to these test methods as follows:

	Annex
Products	1
ular Products	2
teners	3
nd Wire Products	4
nificance of Notched-Bar Impact Testing	5
verting Percentage Elongation of Round Specimens to quivalents for Flat Specimens	6
ting Multi-Wire Strand	7
nding of Test Data	8
hods for Testing Steel Reinforcing Bars	9
cedure for Use and Control of Heat-Cycle Simulation	10

1.4 The values stated in inch-pound units are to be regarded the standard.

1.5 When this document is referenced in a metric product cification, the yield and tensile values may be determined in h-pound (ksi) units then converted into SI (MPa) units. The elongation determined in inch-pound gage lengths of 2 or 8 in. may be reported in SI unit gage lengths of 50 or 200 mm, respectively, as applicable. Conversely, when this document is referenced in an inch-pound product specification, the yield and tensile values may be determined in SI units then converted into inch-pound units. The elongation determined in SI unit gage lengths of 50 or 200 mm may be reported in inch-pound gage lengths of 2 or 8 in., respectively, as applicable.

1.6 Attention is directed to Practices A 880 and E 1595 when there may be a need for information on criteria for evaluation of testing laboratories.

1.7 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

A 703/A 703M Specification for Steel Castings, General Requirements, for Pressure-Containing Parts[3]

A 781/A 781M Specification for Castings, Steel and Alloy, Common Requirements, for General Industrial Use[3]

A 833 Practice for Indentation Hardness of Metallic Materials by Comparison Hardness Testers[4]

A 880 Practice for Criteria for Use in Evaluation of Testing Laboratories and Organizations for Examination and Inspection of Steel, Stainless Steel, and Related Alloys[5]

E 4 Practices for Force Verification of Testing Machines[6]

E 6 Terminology Relating to Methods of Mechanical Testing[6]

E 8 Test Methods for Tension Testing of Metallic Materials[6]

E 8M Test Methods for Tension Testing of Metallic Materials [Metric][6]

E 10 Test Method for Brinell Hardness of Metallic Materials[6]

E 18 Test Methods for Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials[6]

These test methods and definitions are under the jurisdiction of ASTM mmittee A-1 on Steel, Stainless Steel and Related Alloys and are the direct ponsibility of Subcommittee A01.13 on Mechanical and Chemical Testing and cessing Methods of Steel Products and Processes.

Current edition approved Jan. 10 and March 10, 1997. Published November 7. Originally published as A 370 – 53 T. Last previous edition A 370 – 96.

For *ASME Boiler and Pressure Vessel Code* applications see related Specifion SA-370 in Section II of that Code.

[3] *Annual Book of ASTM Standards*, Vol 01.02.
[4] *Annual Book of ASTM Standards*, Vol 01.05.
[5] *Annual Book of ASTM Standards*, Vol 01.03.
[6] *Annual Book of ASTM Standards*, Vol 03.01.

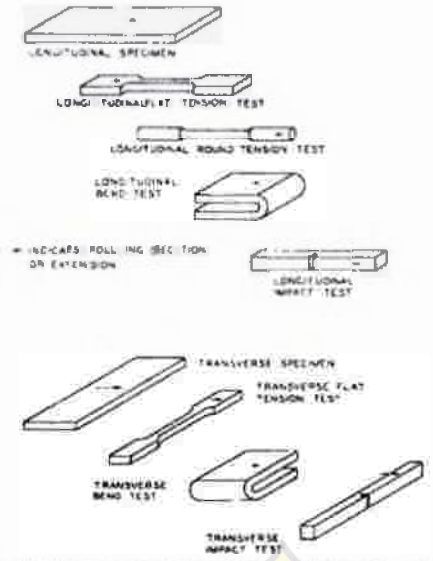
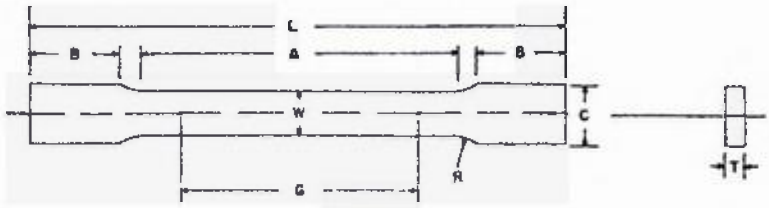


FIG. 1 The Relation of Test Coupons and Test Specimens to Rolling Direction or Extension (Applicable to General Wrought Products)



DIMENSIONS

	Standard Specimens				Subsize Specimen	
	Plate-Type, 1½-in. Wide		Sheet-Type, ½-in. Wide		¼-in. Wide	
	in.	mm	in.	mm	in.	mm
length (Notes 1 and 2)	8.00 ± 0.01	200 ± 025	2.000 ± 0.005	50.0 ± 0.10	1.000 ± 0.003	25.0 ± 0.08
(Notes 3, 5, and 6)	1½ + ⅛ − ¼	40+ 3 − 6	0.500 ± 0.010	12.5±0.25	0.250 ± 0.002	6.25 ± 0.05
ess (Note 7)			thickness of material			
s of fillet, min (Note 4)	½	13	½	13	¼	6
ll length, min (Notes 2 and 8)	18	450	8	200	4	100
of reduced section, min	9	225	2¼	60	1¼	32
of grip section, min (Note 9)	3	75	2	50	1¼	32
of grip section, approximate 4, 10, and 11)	2	50	¾	20	⅜	10

1—For the 1½-in. (40-mm) wide specimen, punch marks for measuring elongation after fracture shall be made on the flat or on the edge of the and within the reduced section. Either a set of nine or more punch marks 1 in. (25 mm) apart, or one or more pairs of punch marks 8 in. (200 rt may be used.

2—For the ½-in. (12.5-mm) wide specimen, gage marks for measuring the elongation after fracture shall be made on the ½-inch (12.5-mm) face edge of the specimen and within the reduced section. Either a set of three or more marks 1.0 in. (25 mm) apart or one or more pairs of marks mm) apart may be used.

3—For the three sizes of specimens, the ends of the reduced section shall not differ in width by more than 0.004, 0.002 or 0.001 in. (0.10, 0.05 mm), respectively. Also, there may be a gradual decrease in width from the ends to the center, but the width at either end shall not be more than 0.005 in., or 0.003 in. (0.40, 0.10 or 0.08 mm), respectively, larger than the width at the center.

4—For each specimen type, the radii of all fillets shall be equal to each other with a tolerance of 0.05 in. (1.25 mm), and the centers of curvature o fillets at a particular end shall be located across from each other (on a line perpendicular to the centerline) within a tolerance of 0.10 in. (2.5

5—For each of the three sizes of specimens, narrower widths (*W* and *C*) may be used when necessary. In such cases the width of the reduced hould be as large as the width of the material being tested permits; however, unless stated specifically, the requirements for elongation in a product ion shall not apply when these narrower specimens are used. If the width of the material is less than *W*, the sides may be parallel throughout h of the specimen.

6—The specimen may be modified by making the sides parallel throughout the length of the specimen, the width and tolerances being the same pecified above. When necessary a narrower specimen may be used, in which case the width should be as great as the width of the material being mits. If the width is 1½ in. (38 mm) or less, the sides may be parallel throughout the length of the specimen.

7—The dimension *T* is the thickness of the test specimen as provided for in the applicable material specifications. Minimum nominal thickness (40-mm) wide specimens shall be 5/16 in. (5 mm), except as permitted by the product specification. Maximum nominal thickness of ½-in.) and ¼-in. (6-mm) wide specimens shall be ¾in. (19 mm) and ¼ in. (6 mm), respectively.

8—To aid in obtaining axial loading during testing of ¼-in. (6-mm) wide specimens, the over-all length should be as the material will permit.

9—It is desirable, if possible, to make the length of the grip section large enough to allow the specimen to extend into the grips a distance equal rds or more of the length of the grips. If the thickness of ½-in. (13-mm) wide specimens is over ⅜ in. (10 mm), longer grips and correspondingly ip sections of the specimen may be necessary to prevent failure in the grip section.

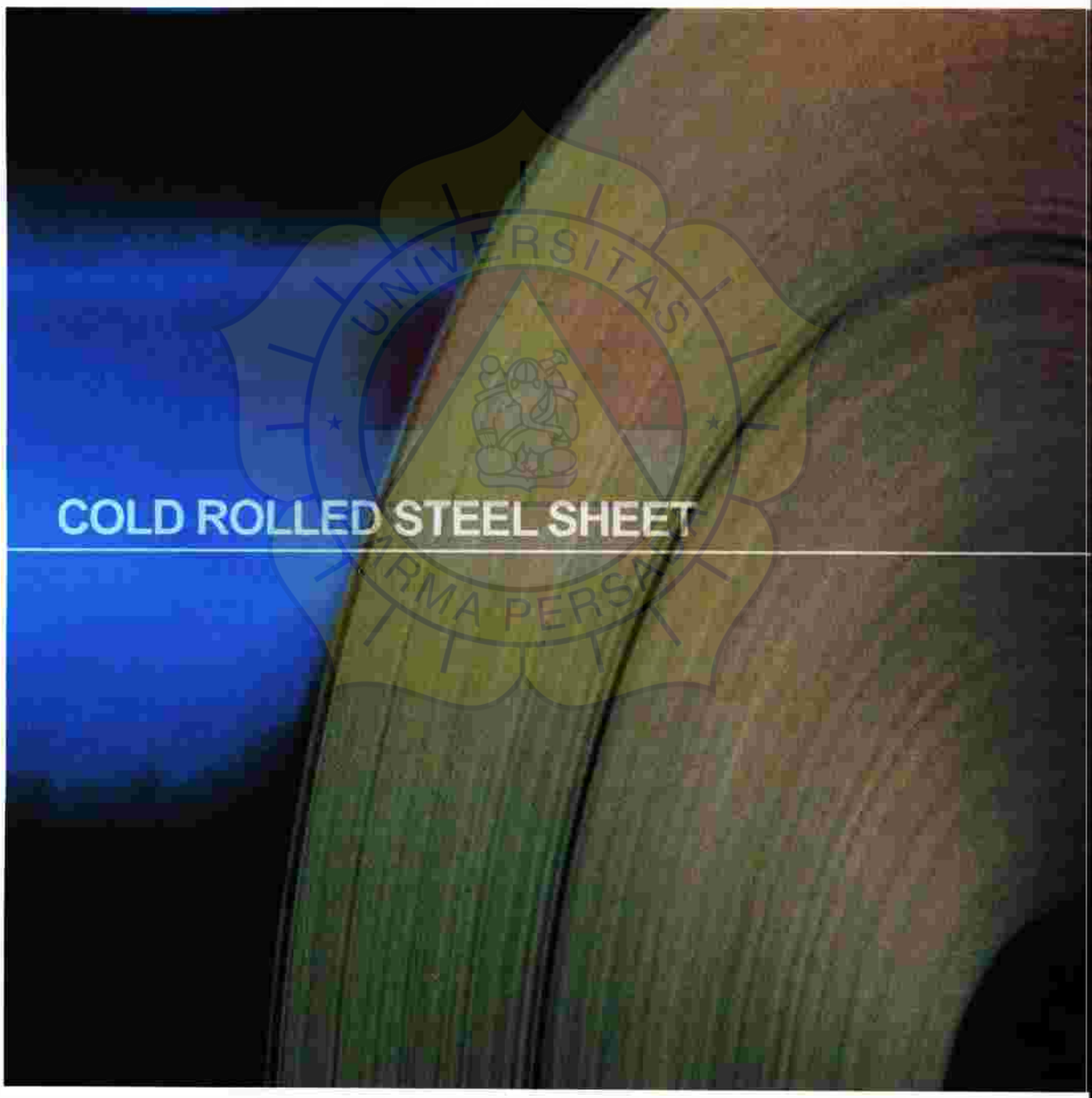
10—For standard sheet-type specimens and subsize specimens the ends of the specimen shall be symmetrical with the center line of the reduced ithin 0.01 and 0.005 in. (0.25 and 0.13 mm), respectively. However, for steel if the ends of the ½-in. (12.5-mm) wide specimen are symmetrical 05 in. (1.0 mm) a specimen may be considered satisfactory for all but referee testing.

11—For standard plate-type specimens the ends of the specimen shall be symmetrical with the center line of the reduced section within 0.25 in.) except for referee testing in which case the ends of the specimen shall be symmetrical with the center line of the reduced section within 0.10 m).

FIG. 3 Rectangular Tension Test Specimens

JFE

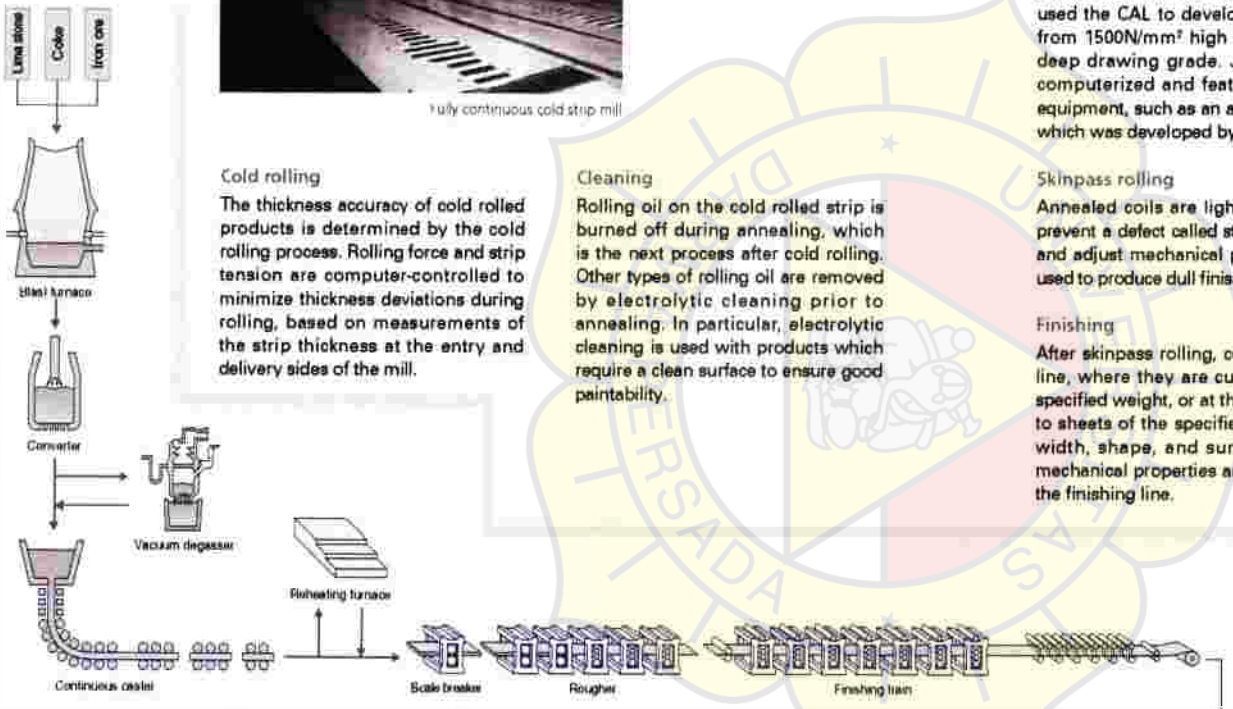
COLD ROLLED STEEL SHEET



JFE Steel Corporation

Manufacturing process

Fully continuous cold strip mill



Cold rolling

The thickness accuracy of cold rolled products is determined by the cold rolling process. Rolling force and strip tension are computer-controlled to minimize thickness deviations during rolling, based on measurements of the strip thickness at the entry and delivery sides of the mill.

Cleaning

Rolling oil on the cold rolled strip is burned off during annealing, which is the next process after cold rolling. Other types of rolling oil are removed by electrolytic cleaning prior to annealing. In particular, electrolytic cleaning is used with products which require a clean surface to ensure good paintability.

Annealing

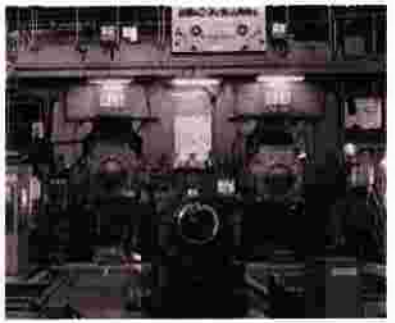
The formability of products is determined by annealing. Because cold rolling significantly increases material hardness, making forming difficult, annealing is performed to improve ductility by inducing a recrystallized structure in the steel. As the annealing process, coils are piled and covered by the box and annealed and this is called the batch annealing. The other is the continuous annealing process, in which coils are continuously treated. JFE uses two annealing technologies, depending on product requirements.

JFE is among the world's leaders in process technology for the continuous annealing line (CAL), and has also used the CAL to develop a wide range of new products, from 1500N/mm² high strength steel to non-aging extra deep drawing grade. JFE's advanced CALs are highly computerized and feature automatic quality assurance equipment, such as an automatic surface inspection device which was developed by JFE.

Continuous annealing line

Skinpass rolling

Annealed coils are lightly rolled by the skinpass mill to prevent a defect called stretcher strain, improve strip shape, and adjust mechanical properties. Skinpass rolling is also used to produce dull finish and bright finish products.



Skinpass mill

Finishing

After skinpass rolling, coils are processed at the recoiling line, where they are cut to produce product coils of the specified weight, or at the shearing line, where they are cut to sheets of the specified dimensions. Product thickness, width, shape, and surface quality are inspected, and mechanical properties are tested using specimens taken at the finishing line.

Product Standards, Characteristics and Application

JFE Steel is producing wide range of products which have excellent characteristics based on the public standards like Japanese Industrial Standard(JIS) to original JFE standard, at the East Japan Works (Chiba and Keihin plants) and the West Japan Works (Fukuyama and Kurashiki plants).

Public Standard Products

JFE Steel is producing products based on following public standards.

● Japanese Industrial Standard (JIS)

Classification		Designation	Characteristics and Application
G3141	Cold-reduced carbon steel sheets and strip	SPCC, SPCC-T SPCD, SPCE, SPCF	Best suited for automobiles, electrical appliances, etc. due to wider workable ranges from commercial to deep drawing qualities.
G 3135	Cold rolled high strength steel sheets with improved formability for automobile structure use	SPFC SPFC***Y SPFC***H	Mainly used for automobiles due to high strength and improved formability.
G 3125	Superior atmospheric corrosion resisting rolled steels	SPA-C	Best suited for rolling stock bodies or constructions due to superior atmospheric corrosion resistance.

● The Japan Iron and Steel Federation Standard (JFS)

Classification		Designation	Characteristics and Application
A 2001	Cold rolled steel sheets for automobile use	JSC	Specifying cold rolled steel products for automobile use (General use to high strength steel)

JFE Standards

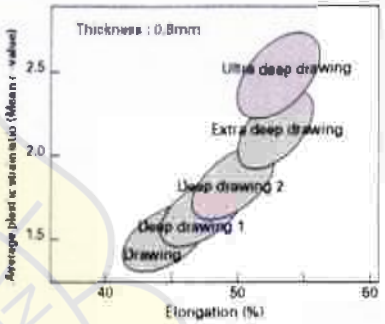
Cold rolled steel sheets for general use JFE-C

JFE produces six grades of cold rolled soft steel products, according to formability, ranging from commercial quality JFE-CC (equivalent to JIS-SPCC) to extra deep drawing quality JFE-CG, which is superior to JIS-SPCF, and ultra deep drawing quality JFE-CGX, which features an extremely high plastic strain ratio (mean r-value). JFE also produces two grades of bake-hardening (BH) cold rolled sheets, which display yield point increase when baked after painting.

Automobile part (front fender)

Automobile part (Side panel outer)

Relation between elongation and average plastic strain ratio (mean r-value) of cold rolled steel



Comparison of height of cups cylinder between extra deep drawing and ultra deep drawing quality

● Mechanical Properties

Classification	Designation	Yield Point min. (N/mm²) Thickness mm			Tensile Strength min. (N/mm²)	Tensile Test Elongation min. (%) Thickness mm								Mean r-value min. Thickness mm		BH Value min. (N/mm²)
		0.4≤ <0.8	0.8≤ <1.0	1.0≤ ≤3.2		0.4≤ <0.8	0.6≤ <0.8	0.8≤ <1.0	1.0≤ <1.2	1.2≤ <1.6	1.6≤ <2.0	2.0≤ <2.5	2.5≤ ≤3.2	0.5≤ ≤1.0	1.0< ≤1.6	
Commercial quality	JFE-CC	(145)	(135)	(125)	(270)	(37)	(38)	(39)	(40)	(41)	(42)	(43)	(44)	—	—	—
Drawing quality	JFE-CD	135	125	115	270	40	41	42	43	44	45	46	47	(1.2)	(1.1)	—
Deep drawing quality 1	JFE-CE	130	120	110	270	42	43	44	45	46	47	48	49	(1.4)	(1.3)	—
Deep drawing quality 2	JFE-CF	120	110	100	270	44	45	46	47	48	49	50	51	(1.6)	(1.5)	—
Extra deep drawing quality	JFE-CG	100		90	260	46	47	48	49	50	51	52	—	1.8	1.7	—
Ultra deep drawing quality	JFE-CGX	100		90	260	46	47	48	49	50	—	—	—	2.1	2.0	—
Bake hardenability quality	JFE-CEH	135	125	115	270	40	41	42	43	44	45			(1.4)	(1.3)	30
Deep drawing quality with bake hardenability	JFE-CGH	135	125	115	260	—	44	45	46	—				(1.6)	(1.4)	30

Reference 1. JIS No 5 test piece for tensile test taken in rolling direction
2. For thickness less than 0.8mm, the above tests are omitted if not specifically requested
3. Figures in parentheses are reference values

● Dimensional tolerance

Size tolerances conform JIS G 3141(Cold-reduced carbon steel sheets and strip). Refer to page 18.

● Available product size range

The available size range is shown on page 20.

Accessories and specifications:

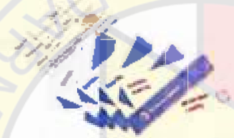
Flat probe shoe attachment MIC 270
Prism shoe attachment MIC 271

Carrying case
for MIC 10 and accessories

Instrument carrier and drop-up stand
MIC 1040

Application Software
UltraHARD

Serial data cable
for printer and PC



Memory cards
for the storage of measurement and
calibration data as well as report formats

Method of measurement:
Vickers penetration with indentation evaluation by the UCI method under load (diamond angle 136°)

UCI probes:
To be selected according to application:
Handheld probes:

10 N (1 kgf)	standard	MIC 201-A
	short	MIC 201-AS
	extended	MIC 201-AL
50 N (5 kgf)	standard	MIC 205-A
	short	MIC 205-AS
	extended	MIC 205-AL
98 N (10 kgf)	standard	MIC 2010-A
Motor probes:		
8.6 N (0.9 kgf)		MIC 211
3 N (0.3 kgf)		MIC 2103-A
1 N (0.1 kgf)		MIC 2101-A

Range:
20 - 1740 HV

Conversion:
HV, HB, HRC, HRB
N/mm² (only with the 10 kgf handheld probe) according to DIN 50150, ASTM E 140

Display:
4 digit LCD with switchable backlight

Weight:
approx. 300g

Dimensions:
160 x 70 x 45 mm,
6.3 x 2.8 x 1.8 inches (W x H x D)

Permissible ambient temperature:
In operation: -15°C to 55°C(5°F to 131°F)
In storage: -20°C to 60°C (-4°F to 140°F)

Power:
2 x 1.5V AA batteries

Operational duration:
approx. 15 hours without backlight

Interface (for version MIC 10 DL):
RS232C bidirectional

Data Logger (for version MIC 10 DL):
Internal memory for up to 1800 measurements, memory card for up to 590 measurements. Dependent on the number of measurements per set. Warning given with memory overflow.

Statistics:
Display of the average value
For version MIC 10 DL: printout with maximum, minimum, average value, absolute and relative range, absolute and relative standard deviation.

Probe accessories:
Handheld probe or motorized probe (is selected according to application)
Guiding devices and test supports
TGDL/PC-data cable (version MIC 10 DL)
Application software
Further information about our extensive probe and accessory program will be given on request.

GEInspectionTechnologies.com

We reserve the right to technical modifications without prior notice

Krautkramer MIC 10

Quick hardness testing made easy.
Versatile in application and data storage.

GE imagination at work

AGFA NDT | HOCKING | SEIFERT

Quick hardness testing wherever you wish.

As with all other hardness testers from our MICRODUR line, the MIC 10 operates according to the UCI method (Ultrasonic Contact Impedance). This method enables quick and easy measurement: position probe and read off the value. This operational ease is achieved because the Vickers diamond indent in the material's surface is electronically measured and instantly displayed as a hardness value without using the cumbersome optical evaluation of a microscope normally associated with Vickers hardness testing.

The small, handy MIC 10 makes life easy for you: a hardness tester that you can take anywhere - on scaffolds for testing large containers and pipes, or for testing components at any location. The small narrow probes even enable you to make measurements on positions difficult to access, such as tooth flanks or roots of gears.

You can measure in any direction, e.g. in the horizontal or overhead positions. The instrument carrier and prop-up stand permits two hand operation, for correct probe positioning and guidance.

Easy operation, high performance and unique data processing.

What this small instrument can do.
By pressing a key, you can display your reading as a single value or as the active arithmetical average value of a hardness measurement set. Editing of erroneous single values, without having to interrupt the measurement set, is just as simple. Adjustable alarm thresholds show you critical measurement values both visually and with audiable alarms. The calibration parameters for measurements on low and non-alloyed steel are preprogrammed into the MIC10, however, the instrument can be easily and quickly recalibrated to other materials.

Instrument operation can be customized for specific testing requirements: unnecessary functions can be inhibited, e.g. various hardness scales or the recalibration capability. This reduces key presses and simplifies operation.

Saving data - unlimited possibilities.
We have given a lot of thoughts to the subject of saving data and have come up with the MIC 10 DL in order to give you special support with repetitive testing and documentation.

Memory cards are available in addition to the internal memory of the instrument, these not only store measurement data but also material dependent instrument settings and report formats.
You are able to calibrate the instrument automatically for specific material using the information stored on the memory card. Reports can be created in an individual format and printed via the RS 232C interface of the MIC 10. Once again, the operation is simple: switch on data logger or insert a memory card and measure.

After measurement, the complete measurement set is automatically stored at the next available location and can be recalled at any time, displayed and printed.

Additionally, the user programs of the UltraHARD series offer you a range of possibilities for data transfer to a PC and further data processing like evaluation, statistics and documentation.