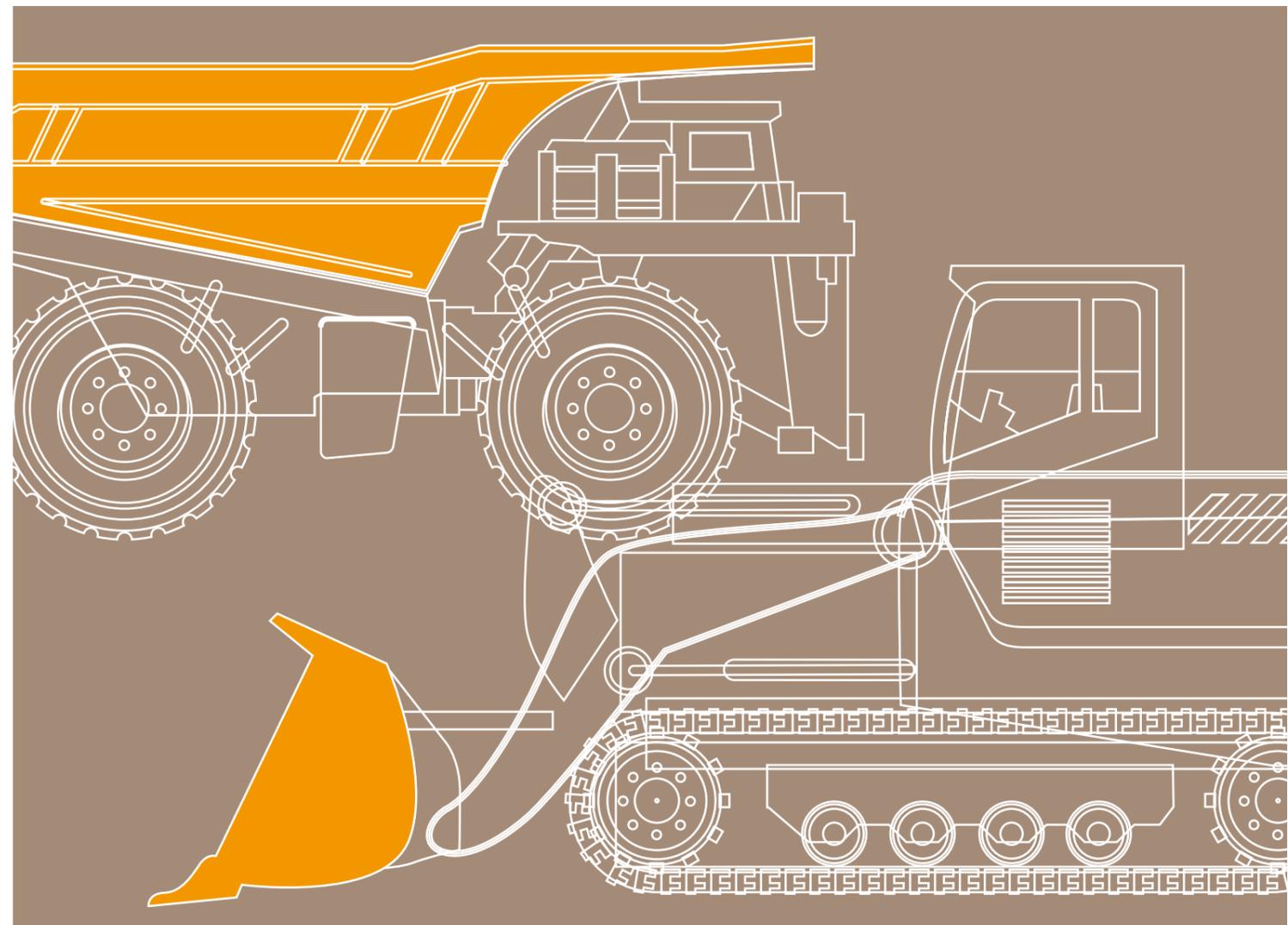


ABREX™

Abrasion resistant steel plate

NIPPON STEEL & SUMITOMO METAL

<http://www.nssmc.com/>



**NIPPON STEEL &
SUMITOMO METAL**

Nippon Steel & Sumitomo Metal Corporation

2-6-1 Marunouchi, Chiyoda-ku, Tokyo 100-8071 Japan
Tel: +81-3-6867-4111

ABREX™

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**NIPPON STEEL &
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Foreword

The WEL-TEN AR Series and the WEL-HARD Series from the former Nippon Steel and the SUMIHARD Series from the former Sumitomo Metal are all widely used abrasion resistant steel plates which meet the needs for higher strength steel for applications in construction and other types of industrial machinery.

Here NSSMC is proud to introduce the new ABREX* Series, with 4 standard options of abrasion resistant steel plate in addition to 3 extra tough options. We appreciate your support and look forward to receiving your orders for these products.

*ABREX stands for ABrasion Resistance EXcellent.

Advantages of Using ABREX™

The use of abrasion resistant ABREX steel plate markedly reduces the weight of structural members exposed to severe abrasive conditions. Compared with regular steel, ABREX steel plate reduces structural weight and delivers economic merits.

Adoption of high performance abrasion resistant ABREX will prolong the service life of machinery and components.

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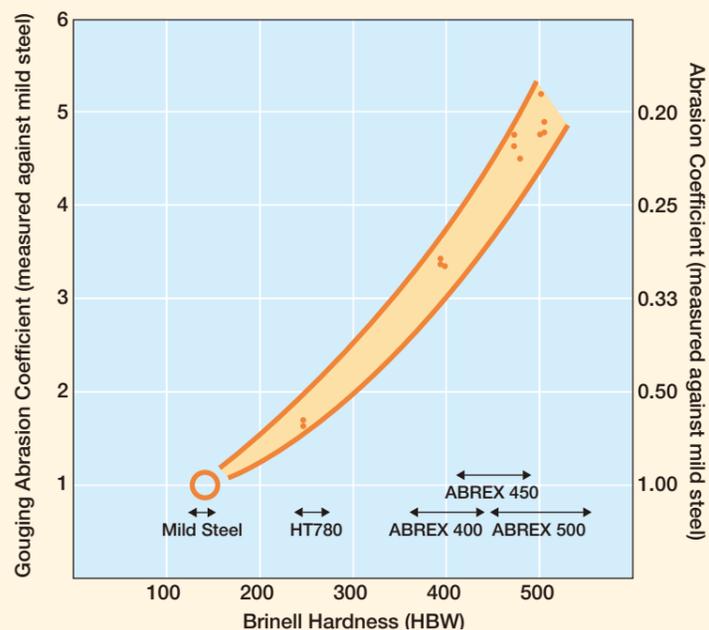
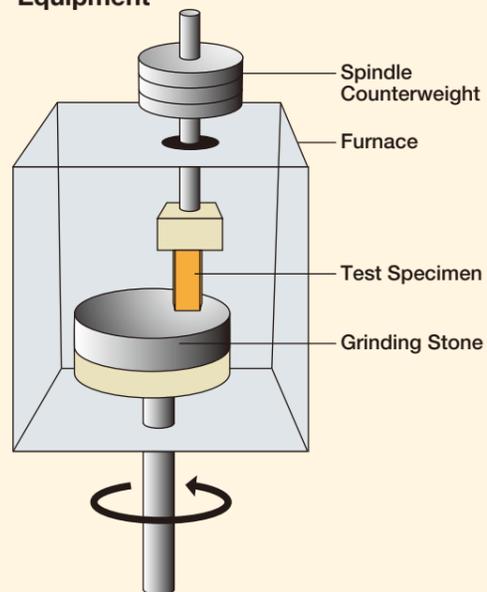
Abrasion Resistance

The loss in the mass of steel due to abrasion decreases as the surface hardness of steel increases. Accordingly, it is necessary for steel, for which abrasion resistance is required, to have higher surface hardness. NSSMC's abrasion resistant ABREX steel plate is designed by placing priority on resistance to abrasion caused by earth and sand. It offers excellent scratching abrasion resistance 2 to 5 times that specified for mild steel.

Properties and Characteristics

Gouging Abrasion Test Results

Abrasion Test Equipment



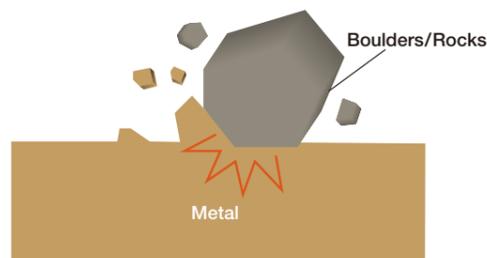
Test Conditions

The test specimen is pressed against the grinding stone and the grinding stone is rotated. The resulting abrasion is measured.

- Rotating speed : 30rpm
- Test duration : 20min
- Load : 29.4kg/cm²
- Ambient temperature : 200°C
- Grinding Stone : Special grindstone for use at high temperatures

Gouging Abrasion

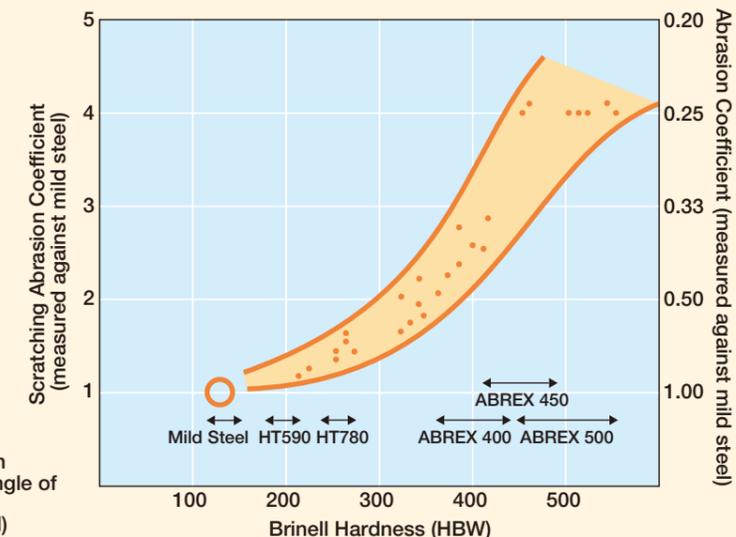
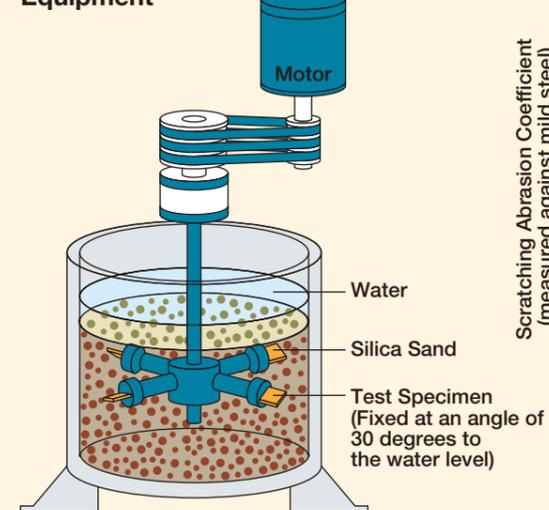
Boulders and rocks cause abrasion when they gouge and scrape a metallic surface. Due to repeated heavy loads and impacts, relatively large portions of the metallic surface can suffer damage, leading to the formation of grooves and dents. This can occur to shovels, etc. when tasked with excavating a rock face.



Properties and Characteristics

Scratching Abrasion Test Results (Moisture Type Testing)

Abrasion Test Equipment



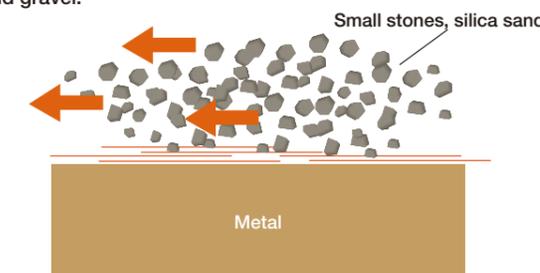
Test Conditions

Silica sand is suspended in water and the test specimen spun through this water. The resulting abrasion is measured.

- Container : 580mm in diameter
- Sand : The silica sand is in suspension in the water to a maximum level some 150mm above the test specimen.
- Water : Water is added until it reaches a level some 10mm above the level of the sand.
- Test specimen : 50mm x 50mm; 5mm thick
- Rotating speed : 3.7m/s

Scratching Abrasion

Comparatively small stones and silica sand caused abrasion when they come into contact with a metallic surface. As the load and force of impact is slight, any bumps and scrapes are relatively small. This can occur to the steel used in the load-bearing bay of a dump truck, etc. when filled with earth and gravel.



Precautions for Use

The amount of abrasion will change depending on the usage environment.

Weldability

Abrasion resistant steel is extremely strong and as a result it has a high sensitivity to cracking at low temperatures. What this means in terms of welding is that it underlines the importance of selecting the most appropriate welding materials as well as managing the pre-heating process correctly. Moreover, the constraints on couplers as well as other weld criteria such as welding heat input and weld bead length, etc. in addition to weld time, environmental conditions and the management of weld materials all require special attention.

A Guide to Pre-Heating Temperatures

Steel Material		Plate Thickness (mm)					
		4.5 - 7	~ 11	~ 25	~ 36	~ 50	~ 100
ABREX 400	Fillet Welding (Small Constraints)	*(0°C)	*(25°C)	*(25°C)	50°C	75°C	100°C
	Butt-Joint Welding (Medium Constraints)	*(0°C)	50°C	75°C	100°C	125°C	150°C
ABREX 450	Fillet Welding (Small Constraints)	*(25°C)	*(25°C)	50°C	100°C	100°C	
	Butt-Joint Welding (Medium Constraints)	50°C	50°C	75°C	125°C	150°C	
ABREX 500	Fillet Welding (Small Constraints)	50°C	50°C	75°C	100°C	125°C	
	Butt-Joint Welding (Medium Constraints)	100°C	100°C	125°C	150°C	175°C	

*: Room Temperature

In order to avoid low temperature cracking, the steel plate needs to undergo the required preheating. This can be approximated depending on various factors such as the carbon equivalent, the hydrogen content of the weld metal, the yield strength of the weld metal, the heat input and plate thickness to name but a few*1. The preheating temperatures shown in the table are calculations for temperatures used in gas-shield welding of soft joints, with a heat input of 1.7kJ/mm and assuming a weld metal hydrogen content dispersal of 3ml/100g*1.

However, appropriate preheating temperatures are also affected by external factors such as outdoor temperature, path numbers, groove form as well as the preheating method, etc. so please use these figures as a guide.

*1: pp347-357 No. 3 Volume 13, Collection of Papers from the Japan Welding Society (1995); N.Yurioka and T.Kasuya Also: P163 Steel Materials and Welding, Welding Digest 10 (1999), Sanpo Publishing Inc.

Properties and Characteristics

CTS Cracking Test Results (JIS Z3154: Lap Joint Weld Cracking Test)

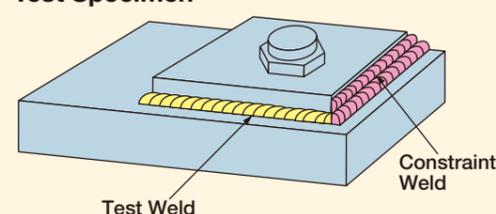
Designation	Plate Thickness (mm)	Cracking: Y/N	
		SMAW	GMAW
ABREX 400	25		
ABREX 450	25		
ABREX 500	25		

: No cracking

Test Method

Item	SMAW	GMAW
Temperature	Room Temperature	Room Temperature
Heat Input kJ/mm	1.73	0.85
Weld Material	LF52	SCH60
Hydrogen Content cc/100g	3.48	1.62

Test Specimen



Precautions for Use

Take care when preheating – heating a steel plate over the recommended preheating temperature will cause the plate to lose its hardness. Please ensure that the steel plate is not heated over 200 degrees Celsius.

Welding Materials

Recommended Welding Materials

1) In the event that welds are not required to have abrasion resistance (Common for all grades of steel)

Weld Method	Brand	Specification	Criteria (Plate thickness of 20mm)	Notes
Arc Welding with Covered Electrode	☒-16LH	JIS Z3211 E4916 AWSA5.1 E7016	Heat input equal to or less than 3.0kJ/mm	For all positions Low hydrogen type
Gas Shielded Arc Welding	☒YM-26	JIS Z3312 YGW11 AWSA5.18 ER70S-G	Heat input equal to or less than 2.0kJ/mm	For CO ₂ gas use
	☒YM-28S	JIS Z3312 YGW15 AWSA5.18 ER70S-G	Heat input equal to or less than 3.0kJ/mm	For Ar-CO ₂ gas use

2) In the event that welds are required to have abrasion resistance (Common for all grades of steel)

Weld Method	Brand	Specification	Example of Weld Metal Hardness Hv (98N)	Criteria (Plate thickness of 20mm)	Notes
Arc Welding with Covered Electrode	☒L-80	JIS Z3211 E7816-N5CM3U AWSA5.5 E11016-G	250	Heat input equal to or less than 3.0kJ/mm Preheated to at least 100°C	For all positions Low hydrogen type
	☒L-100EL	WES 4101 DK9016	320	Heat input equal to or less than 3.0kJ/mm Preheated to at least 100°C	For all positions Low hydrogen type
Gas Shielded Arc Welding	☒YM-80C	JIS Z3312 G78JA2UCN5M3T AWSA5.28 ER110S-G	260	Heat input equal to or less than 2.0kJ/mm Preheated to at least 50°C	For CO ₂ -gas use
	☒YM-80A	JIS Z3312 G78A4UMN5C1M3T AWSA5.28 ER110S-G	270	Heat input equal to or less than 3.0kJ/mm Preheated to at least 50°C	For Ar-CO ₂ gas use

*The weld material will have a required preheating temperature, as will the steel plate. The higher temperature should be applied in these cases.

When the steel plate cannot be preheated, or when the preheating process needs to be shortened, there is a method that involves the use of austenite type weld materials such as SUS309, etc. Moreover, compared with conventional solid wire, etc. the hydrogen content has really been reduced and this means that the preheating process can be shortened with the use of flux wire, etc. Please ask us for more details.

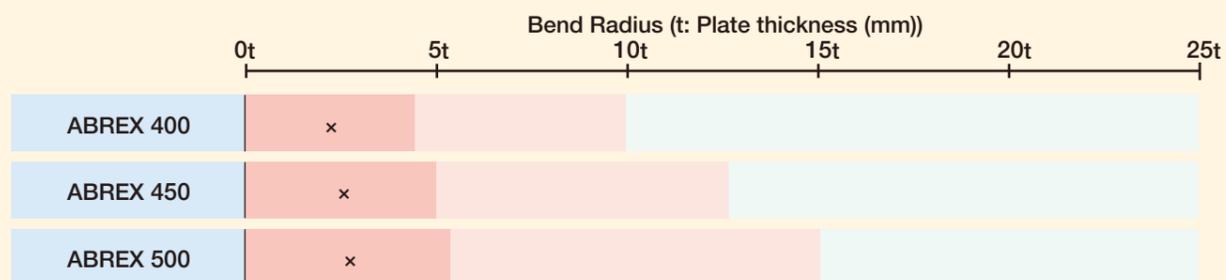
With regard to welds involving ABREX 600, please use austenite type weld materials such as SUS309, etc.

Please direct any inquires to:
Nippon Steel & Sumikin Welding Co., Ltd.
Shingu Bldg., 2-4-2 Toyo, Koto-ku, Tokyo 135-0016 JAPAN
Tel: +81-3-6388-9065
Fax: +81-3-6388-9088

Bending Formability

Compared to regular steel, abrasion resistant steel has a lower elongation value and as a result, it is important to take steps to prevent fabrication cracks. Please consider the bend radius, quality of gas cut surface and the bend direction when undertaking fabrication.

Guidelines for Maximum Bend Radii



The values shown above are a guideline for bending an edge piece in the longitudinal direction (rolling direction of plates) referred to as L. In the event of bending in the transverse direction (width direction of plates) referred to as T, please add in one more t value. Bend conditions (atmospheric temperature and moisture, facilities, edge processing, etc.) can lead to fluctuations in the maximum bend radius. These values are a guideline. In the event that the steel plate is undergoing bending for a specific purpose, please contact NSSMC immediately after placing your order. We do not recommend subjecting ABREX 600 to bending.

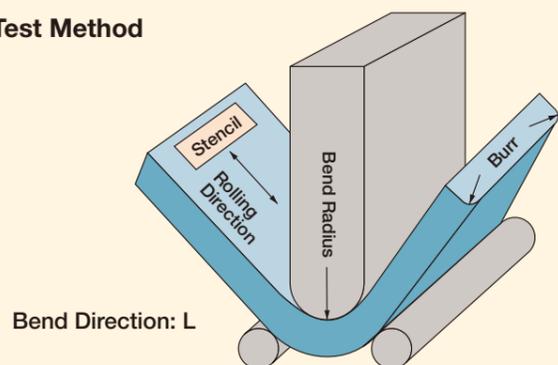
Properties and Characteristics

Wide Bend Test Results

Designation	Plate Thickness t (mm)	Test Specimen Width (mm)	Bend Direction	Bend Angle	Cracking: Y/N			
					1t	2t	3t	5t
ABREX 400	25	120	L	180°	x	x		
ABREX 450	25	120	L	180°	x	x		
ABREX 500	25	120	L	180°	x	x		

: No cracking, : Some small, localized cracking, x: Cracking

Test Method



Precautions for Use

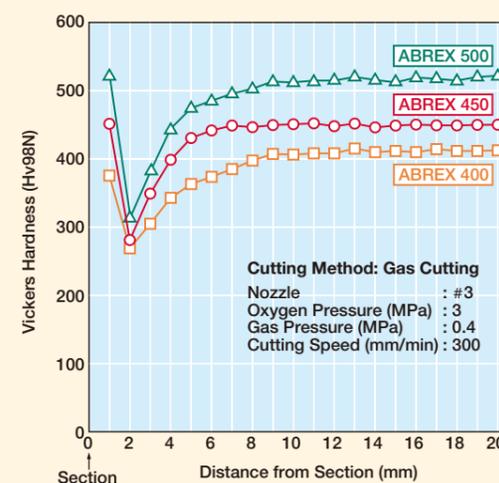
Because production of abrasion-resistant steel plate involves special heat treatment, the avoidance of hot working is recommended. Any notches or burrs on the sheared edge can lead to deterioration in the hardness of gas-cut sections, so it is recommended that any gas-cut sections be smoothed with a grinder, etc. In the event of bending abrasion-resistant steel to an extremely shallow bending radius, the corners should be beveled and care should be taken to ensure that the bend circumference be implemented in the L rolling direction. Please note that with abrasion-resistant steel plate, spring-back is greater than with conventional steel. In the event where the room temperature is less than 0 degrees Celsius, please avoid undertaking any bending procedures.

Thermal Cutting Performance

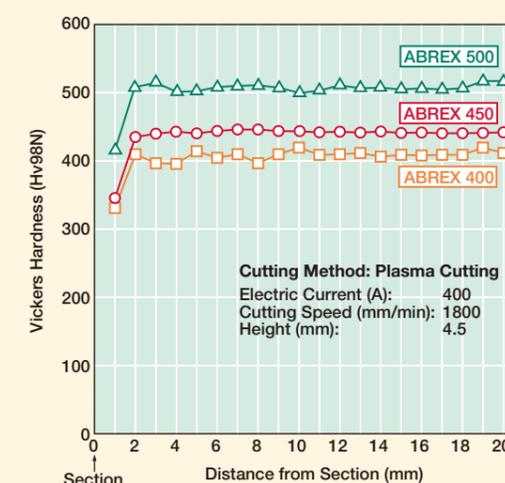
ABREX can be cut with gas, plasma and laser cutters, but the heat generated by these cutting techniques also affects the steel. Please select the best cutting solution to meet your needs once you have studied the affect of the cutting procedure and method.

Properties and Characteristics

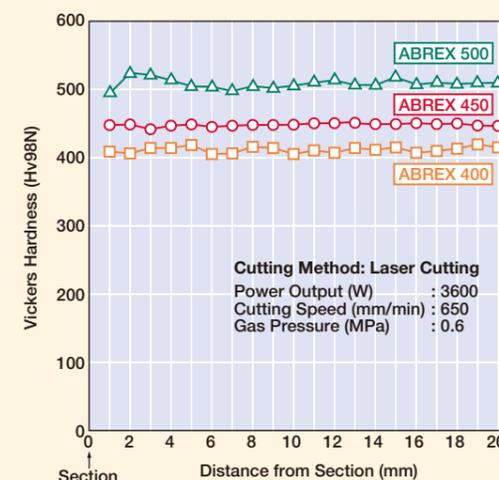
Hardness Distribution for Gas Cutting



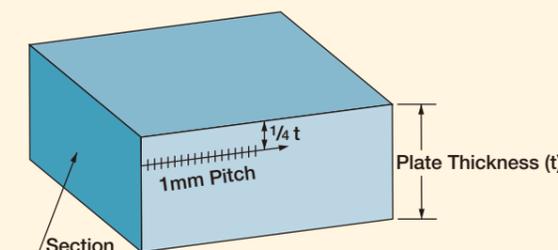
Hardness Distribution for Plasma Cutting



Hardness Distribution for Laser Cutting



Measuring Location



Thickness of Test Specimen

Designation	Thickness t (mm)
ABREX 400	25
ABREX 450	25
ABREX 500	25

Precautions for Use

In the event that room temperature is 5 degree Celsius or below, some preheating will be required. Please avoid the use of cold water during cutting. Please take special care when cutting small pieces or thin widths, as the hardness of the steel can deteriorate. Notches that result after cutting should be smoothed away with a grinder. As ABREX 600 steel plate can crack easily, we recommend preheating to 50 degrees Celsius and then cutting with an acetylene gas cutter.

Drilling Workability



As ABREX steel plate is extremely hard and this can make it difficult to form and process, we recommend any drilling take place in a machining center using an ultra-hard metal alloy drill. However, for smaller jobs and working with components, it is often the case that boor-bank drilling machines and high-speed steel drills are used, so here we will introduce our recommended approach to drilling ABREX steel plate using a high-speed steel drill.

(1) Points to Note when Drilling

When attaching the drill, please ensure that the external vibration of the tip of the drill does not exceed 0.03mm.

We recommend an aqueous drill lubricant with a high degree of transparency. Please ensure you have sufficient lubricant for the drilling process.

Ensure that the steel plate is secured to prevent vibrations, movement and any bending or warping during drilling.

(2) Recommended Conditions for Drilling

These are the recommended conditions for using a radial boor bank drilling machine with ABREX steel plate.

Type of Steel	Type of Drill	Drilling Speed (m/min)	5		10		15		20		25		30	
			Rotation Speed (min ⁻¹)	Feed Rate (mm/rev)	Rotation Speed (min ⁻¹)	Feed Rate (mm/rev)	Rotation Speed (min ⁻¹)	Feed Rate (mm/rev)	Rotation Speed (min ⁻¹)	Feed Rate (mm/rev)	Rotation Speed (min ⁻¹)	Feed Rate (mm/rev)	Rotation Speed (min ⁻¹)	Feed Rate (mm/rev)
ABREX 500	Powder High Speed Steel	5	320	0.05	160	0.10	110	0.15	80	0.15	65	0.15	55	0.15
		8	510	0.10	250	0.20	170	0.30	130	0.30	100	0.30	85	0.30
ABREX 400	Powder High Speed Steel	6	380	0.05	190	0.10	130	0.15	95	0.15	75	0.15	65	0.15
		10	640	0.10	320	0.20	210	0.30	160	0.30	130	0.30	110	0.30
	Cobalt High Speed Steel	5	320	0.05	160	0.10	110	0.15	80	0.15	65	0.15	55	0.15
		8	510	0.10	250	0.20	170	0.30	130	0.30	100	0.30	85	0.30

These values are a guide. Depending on how the steel plate is secured and the hardness of the machining tool, sometimes the appropriate settings will fall outside of this range, so before performing the actual drilling required, we recommend test drilling under the same conditions.

We do not recommend using a Cobalt High Speed Steel for drilling ABREX 500 steel plate.

Generally speaking, in terms of performance we recommend high settings for both the drilling speed (rotation speed) and the feed rate. However, this will have an impact on the working life of the drill. Conversely, if you wish to prioritize the working lifespan on the drill as well as the precision of the work, we recommend low settings for both the drilling speed (rotation speed) and the feed rate.

During drilling, the turnings from the drilling process can sometimes become very long and yet still be attached to the steel plate. When this occurs, trimming these turnings will reduce the burden on the drill.

These recommendations are made with the proviso that an aqueous drill lubricant is being used. We recommend a good quality aqueous drill lubricant used at less than 20x dilution.

When using a non-aqueous drill lubricant or when an emulsion lubricant has been diluted over 20 times, please reduce the drilling speed by 20%.

(3) Examples of Drill Process Data (for reference purposes)

This table shows reference data for drilling using a radial boor bank drilling machine.

Type of Steel	Type of Drill	Drilling Depth (mm)	Machine Tool	Drill Lubricant	Drill Diameter (mm)	Drill Speed (min ⁻¹)	Rotation Speed (min ⁻¹)	Feed Rate (mm/rev)	Plated Through Hole	Length of Cut (mm)
ABREX 500	Powder High Speed Steel	25	Standing radial boor bank drilling machine	aqueous drill lubricant at 15x dilution	10	5.2	165	0.15	31	775
					20	4.7	75	0.25	53	1325
					30	4.7	50	0.25	20	500
ABREX 400	Powder High Speed Steel	25	Standing radial boor bank drilling machine	aqueous drill lubricant at 15x dilution	10	6.3	200	0.15	78	1950
					20	6.9	110	0.25	136	3400
					30	7.1	75	0.25	42	1050
	Cobalt High Speed Steel	25	Standing radial boor bank drilling machine	aqueous drill lubricant at 15x dilution	10	5.2	165	0.15	123	3075
					20	4.7	75	0.25	52	1300
					30	4.7	50	0.25	34	850

Close-up Photos of Drill Bits (All 3 have a diameter of 20mm)

ABREX 500 Powder High Speed Steel
4.7m/min 0.25mm/rev
Plated Through Hole: 53

ABREX 400 Powder High Speed Steel
4.7m/min 0.25mm/rev
Plated Through Hole: 136

ABREX 400 Cobalt High Speed Steel
4.7m/min 0.15mm/rev
Plated Through Hole: 52

Examples of the Product in Use



Bulldozer



Dump Truck

Crusher



Excavator

Reference

NSSMC Specifications; Comparison with Former Specifications

Former NSC Product Name	Former Sumitomo Metals Product Name	New NSSMC Name
	SUMIHARD-K340	
WEL-HARD400 WEL-TEN AR360E	SUMIHARD-K400	ABREX 400
WEL-TEN AR400E	SUMIHARD-K450	ABREX 450
WEL-HARD500 WEL-TEN AR500E	SUMIHARD-K500	ABREX 500
		ABREX 600
		ABREX 400LT
		ABREX 450LT
		ABREX 500LT

* With regard to products that have been discontinued or where the product name no longer exists, NSSMC can continue to manufacture said products in line with any existing agreement and specifications.

* With regard to special specification products not included in the above table, please contact us about these specific products.

Hardness Table

Vickers Hardness	Brinell Hardness 10mm sphere; 29400N Load	Rockwell Hardness		Shore Hardness	Tensile Strength (N/mm ²) (approximate values)
		Tungsten Carbide Sphere	B Scale 980N Load Sphere 1/16in Diameter		
600	564		55.2	74	
590	554		54.7		2055
580	545		54.1	72	2020
570	535		53.6		1985
560	525		53.0	71	1950
550	517		52.3		1905
540	507		51.7	69	1860
530	497		51.1		1825
520	488		50.5	67	1795
510	479		49.8		1750
500	471		49.1	66	1705
490	460		48.4		1660
480	452		47.7	64	1620
470	442		46.9		1570
460	433		46.1	62	1530
450	425		45.3		1495
440	415		44.5	59	1460
430	405		43.6		1410
420	397		42.7	57	1370
410	388		41.8		1330
400	379		40.8	55	1290
390	369		39.8		1240
380	360	(110.0)	38.8	52	1205
370	350		37.7		1170
360	341	(109.0)	36.5	50	1130
350	331		35.5		1095
340	322	(108.0)	34.4	47	1070
330	312		33.3		1035
320	303	(107.0)	32.2	45	1005
310	294		31.0		980
300	284	(105.5)	29.8	42	950
290	275	(104.5)	28.5	41	915
280	266	(103.5)	27.1	40	890
270	256	(102.0)	25.6	38	855
260	248	(101.0)	24.0	37	825