

Abrasion-Resistant Steel Plates of JFE Steel[†]

1. Overview

Over the years since the production launch the “Ever Hard” (EH) abrasion-resistant steel plates from JFE Steel in the 1960’s, EH plates have been used for wide-ranging applications in industries such as mining, civil engineering, and construction machinery. Ever Hard plates have also been steadily improved to satisfy more exacting customer demands for abrasion resistance, low-temperature toughness, weldability, and deep-hardened thick plates. JFE Steel’s efforts to deliver these improvements have culminated in the following products¹⁾:

- (1) Standard and alloy type series in 1985
- (2) Special grade JFE-EH-SP in 1993
- (3) LE Type series in 2003 (The Japan Institute of Metals Award 2003)

With rising global demand, the production of EH plates has reached an annual tonnage of about 70 000.

This report introduces the specifications and charac-

teristics of the Ever Hard steel plates from JFE Steel.

2. Specifications and Characteristics

2.1 Specifications for EH Plates

Table 1 shows JFE Steel standards for abrasion-resistant steel plates (EH) categorized into three groups (standard, alloy, and LE types) and one special grade (EH-SP). The diverse grades available accommodate the needs and demands of various users.

The three-digit notation for the grades in Arabic numerals is the classification for minimum Brinell hardness. A classification of ‘360’ means that the hardness of plate surface is over 360 (average 400); ‘400’ means over 400 (average 450); ‘500’ means not less than 477 (average 500).

The letter ‘A’ next to the Arabic numerals denotes the alloy type, and ‘LE’ stands for leading edge.

The properties of each type are as follows¹⁾:

Table 1 JFE steel standards for abrasion resistant steel plates

Type	Grade	Thickness (mm)	Chemical composition (%) C_{eq}^{*1}	Hardness (●: Average of surface) (Brinell, Load : 29.4 kN (3 000 kgf))						Charpy impact test (Longitudinal)		Characteristics & Merit	
				HB	360	400	440	477	500	556	Temp. (°C)		Energy (J)
Standard	JFE-EH360	6–50	—	361 min.							—	—	Standard type
	JFE-EH400	6–50		401 min.									
	JFE-EH500	6–50		477 min.									
Alloy	JFE-EH360A	6–100	—	361 min.							0 (13<t≤50)	21 min.	Thickness available up to 100 mm
	JFE-EH500A	6–100		477 min.							0 (13<t≤25)	21 min.	
LE	JFE-EH360LE	6–19	0.40 max.	361–440							–40	27 min.	Excellent low temperature toughness
		19.1–32	0.43 max.										
	JFE-EH500LE	6–19	0.55 max.	477–556								21 min.	
		19.1–32	0.58 max.										
SP	JFE-EH-SP	6–65	—	401 min.							—	—	Super abrasion resistance

^{*1} $C_{eq} = C + Mn/6 + (Cu + Ni)/15 + (Cr + Mo + V)/5$

[†] Originally published in *JFE GIHO* No. 18 (Nov. 2008), p. 72–74

- (1) The standard type has three grades, JFE-EH360, JFE-EH400, and JFE-EH500, ranging in thickness from 6 to 50.8 mm. A minimum surface hardness is guaranteed.
- (2) The alloy type has two grades, JFE-EH360A and JFE-EH500A, ranging in thickness from 6 to 100 mm. The thicker plates have a higher guaranteed minimum surface hardness than the standard type.
- (3) The LE type guarantees low-temperature toughness at -40°C and a low carbon equivalent to maintain the surface hardness. The LE type is available in two grades, JFE-EH360LE and JFE-EH500LE, ranging in thickness from 6 to 32 mm. Both have excellent weldability and cold-formability.
- (4) JFE-EH-SP has the same hardness as JFE-EH400, but even better abrasion resistance. Its thickness ranges from 6 to 65 mm.

2.2 Characteristics of EH Plates

2.2.1 Abrasion resistance

Figure 1 shows the relationship between hardness and the abrasion resistance ratio. The abrasion resistance was evaluated according to ASTM G65 (ASTM: American Society for Testing and Materials). SiO_2 was used for abrasive. The abrasion resistance was calculated as the ratio of the weight loss of TS 400 N/mm² steel to the weight loss of abrasion-resistance steel.

Abrasion resistance generally increases with hardness. The abrasion resistance ratio of the EH360, EH400 and EH500 grades are about three, four and five times that of TS 400 N/mm² steel, respectively. JFE-EH-SP has a very high abrasion resistance in spite its relatively lower hardness¹⁾. This property can be attributed to the

hard precipitates in JFE-EH-SP. Engineers must note, however, that the abrasion resistance of a steel will vary with the abrasion environment. If you are planning to use abrasion-resistant steel for a particular application, please consult with JFE Steel beforehand.

2.2.2 Low-temperature toughness and weldability

Figure 2 compares the absorbed energy of the Standard and LE types. The LE type has lower carbon equivalent than the standard type and double the absorbed energy. The LE type is suitable for the use in cold areas, where its superior resistance to impacts can be expected to extend its lifetime.

Shield metal arc welding and gas shielded welding are generally available for EH plates. **Figure 3** shows y-groove cold cracking test results for each grade. Delayed cracking must be prevented in EH plates, as well as high-strength steel. To accomplish this, it is important to keep the welding material dry and remove all oil and rust from the plate surfaces. Delayed cracking is much easier to prevent in the LE type than in the Standard Type, though the same preheating temperature

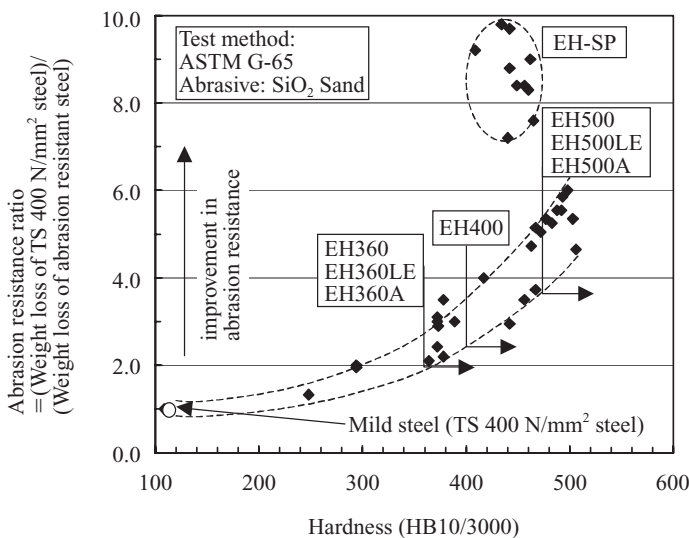


Fig. 1 Relation between hardness and abrasion resistance ratio

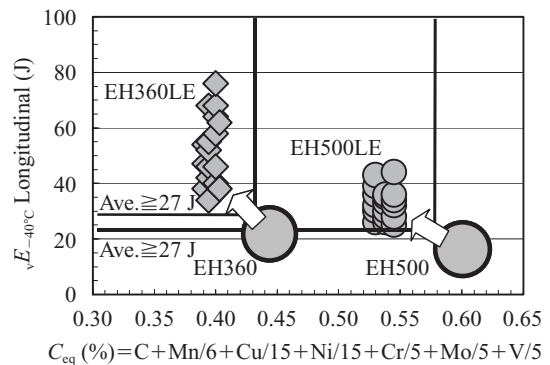


Fig. 2 Comparison of absorbed energy of Standard and LE type

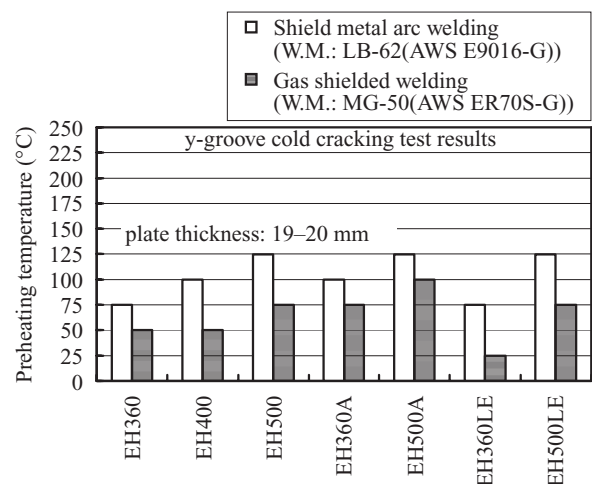


Fig. 3 Recommendation on preheating temperature

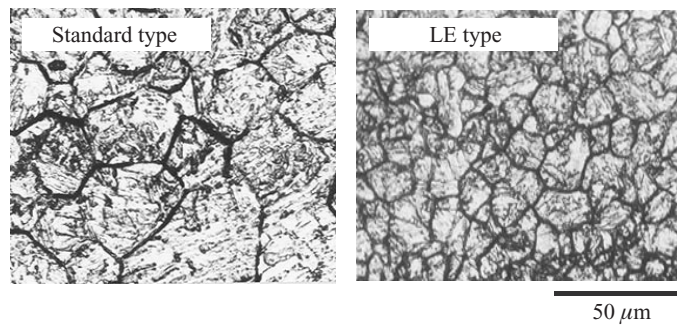


Photo 1 Comparison of microstructures of Standard and LE type

is required for both. The reason for this can be described as follows.

As shown in **Photo 1**, a fine grain size is achieved for the LE type by combining a micro-alloying method with a special heat treatment. This microstructure improves low-temperature toughness and prevents delayed cracking and cold-formability²⁾. These and other outstanding properties have been generating steadily higher demand for the LE type in recent years.

3. Conclusion

This report has introduced the specifications and characteristics of the abrasion-resistant steel plates (EH)

manufactured by JFE Steel. The company will continue to develop new products to fully meet the needs and expectations of customers around the world.

References

- 1) JFE Steel catalogue. Cat. no. C1J-007-02, et al.
- 2) Y. Murota, et al. JFE Giho. 2004, no. 5, p. 51–55.

For further information, please contact :

Plate Business Planning Dept.,
JFE Steel

Phone : (81) 3-3597-3371 Fax : (81) 3-3597-3533

Website : <http://www.jfe-steel.co.jp/en/products/plate/index.html>