

540–780 MPa Grade Hot-rolled Steel with Excellent Formability†

1. Introduction

In recent years, weight reduction by application of high strength steel sheets has become an urgent issue from the viewpoint of improving automobile fuel economy. High strength steel sheets are widely used in a variety of body structural parts. Although the main stream in automobile chassis and truck frame parts is currently 440 and 540 MPa grade steel sheets, full-scale efforts to reduce weight by applying high strength steel sheets have begun recently¹⁾.

Chassis are important safety parts. High punchability, stretch-fangeability, fatigue properties, etc. are particularly demanded in this application, but it is difficult to realize these properties and high strength simultaneously. Moreover, in many cases, toughness is also required in application for thick parts. A chemical conversion property and weldability are also essential.

As a result of research and development to improve formability and fatigue properties, mainly from the viewpoint of microstructure control, JFE Steel succeeded in developing a series of 540, 590, and 780 MPa grade high strength hot-rolled steel sheets with high formability, which provide formability exceeding the conventional steel sheet with excellent stretch-fangeability B (JFS: The Japan Iron and Steel Federation Standard). This report introduces the developed steel sheets, focusing on their outstanding performance and examples of application.

2. Performance of Developed Steel Sheets

2.1 Basic Properties

Figure 1 shows the balance of elongation and the hole-expansion property of the developed 540, 590 and 780 MPa grade steel sheets, together with those of the conventional steel sheets. As a distinctive feature, the developed sheets possess a hole expanding property and elongation far exceeding the property balance of the conventional JSH540B, JSH590B, and JSH780R of the same strength grades, respectively. Examples of the typical mechanical properties of the developed steel sheets

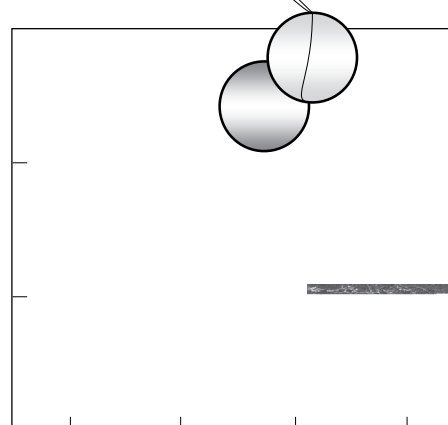


Table 1 Mechanical properties

YP: Yield point TS: Tensile strength
El: Elongation : Hole expansion ratio

are shown in **Table 1**. Because the developed 540 and 590 MPa grades both guarantee a lower limit value of elongation exceeding those of JSH540B and JSH590B by 2%, and a hole expanding ratio ($\geq 100\%$) exceeding those of JSH540B and JSH590B by 20% and 25%, respectively, higher strength and weight reduction can be expected in parts to which JSH440B ($\geq 100\%$) was conventionally applied. In the 780 MPa grade in Table 1, the thin material (3.2 mm) is a pickled sheet and the thick material (6.0 mm) is a non-pickled sheet. In addition to an elongation value equal or superior to that of JSH780R, a hole expanding ratio of 60% or more is guaranteed in thin material applications. The inset in Fig. 1 shows the typical microstructure of the developed 780 MPa grade, which has a microstructural morphology consisting mainly of bainite.

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D ZLGH UDQJH RI SXQFKLQJ FOHDUDQFHV WKH GHYHORSHG
 03D JUDGH VWHHO VKHHW GLVSOD\ V H[FHOHQW SXQFKDELO
 LW\ ZLW\ 780 MPa-grade VIDFW\ 780 MPa-grade SXQFKHG VXUIDFH TXDOLW\

Figure 2 VKRZV DQ H[DPSON RI WKH IDWLJXH SURSHUWLHV
 RI WKH GHYHORSHG VWHHO VKHHWV 7KH ¿JXUH VKRZV
 WKH UHVXOWV RI D IDWLJXH WHVW RI D IDWLJXH WHVW VSHFLPHQ
 ZLWK D SXQFKHG KROH IRU D[LDO WHQVLRQ WHQVLOH WHQVLOH
 PRGH 7KH IDWLJXH SURSHUWLHV RI WKH SXQFKHG KROH SDUW
 DUH FRQVLGHUH G WR EH UHODWH G WR WKH TXDOLW\ RI WKH SXQFKHG
 VXUIDFH

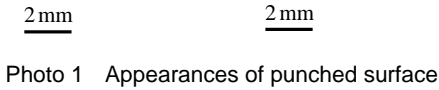


Photo 1 Appearances of punched surface

Fig. 3 Application of developed 780 MPa-grade steel to lower-arm

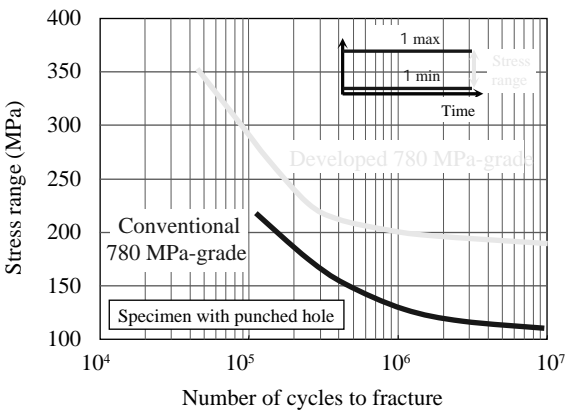


Fig. 2 Fatigue properties

Fig. 4 Application of developed 780 MPa-grade steel to truck frame

3. Examples of Recommended Applications

3.1 Chassis

7KH WUHQQ WRZDUG ZHLJKW UHG.
 VWUHQJWK VWHHO VKHHWV WR DXW
 WR EHFRPH D IXOO VFDOH SUDFWL
 VWUHWFK ÁDQJH IRUPLQJ DQG EXUU
 EHIRUH EXUULQJ IRUPLQJ LV DOVR
 VWHHO VKHHWV VHULHV LV LGHDO I
 \$\$\$OLFDFWLRQ RI WKH GHYHORSHG
 WR ORZHU DUP SDUWV LQVHVVLRQ
 9DULRXV EHQH¿WV FDQ DOVR EH I
 LPSURYHG \LHOG FRVW UHGXFWRQ
 RI HGJH WULPPLQJ DIWHU SUHV IR

3.2 Truck Frame Parts

7KH GHYHORSHG VWHHO ZLWK KDV H[FHOHQW
 SXQFKHG VXUIDFH TXDOLW\ DOVR GURSON WKH KLLJKZSRWLQJXV SURBSURY
 HUWLHV LQ FRPSDULVRQ ZLWK WKH FHOHQWV LQ DOVR FDUHQJ FDSDF
 \$PRQJ RWKHU SURSHUWLHV WKH GHYHORSHG VWHHOV JDOVRRW UR
 SURYLGHV DUF ZHOGDELOLW\ DQG GURSON SDUWV LQVHVVLRQ DQG GGL
 SHUIRUPDQFH HTXDO RU VXSHULRULWV DQG VRIURDWHLCHV\ LSWRQKDEL
 PDWHULDORV RI WKH VDPH VWUHQJWKV LQ TXDOLW\ WRXJKQHVV LV DOVR
 IRU WKLFN SDUWV \$\$\$OLFDFWLRQ F
 JUDGH VWHHO VKHHW WR WUXFN

shown in **Fig. 4**, is progressing.

4. Conclusion

JFE Steel developed a series of high strength hot-rolled steel sheets with excellent formability using the company's unique material design technology and high accuracy manufacturing technology. These steel sheets provide an excellent balance of stretch-fangeability and elongation, and have various other outstanding properties, such as punchability, fatigue properties, toughness, etc. Weldability and chemical conversion performance are also equal or superior to those of the existing materials. Application to automobile chassis has begun. The developed steel sheets are also suitable for truck frame

parts, construction equipment, and similar applications.

JFE Steel intends to create a mass production system for these steel sheets and promote further expansion of their applications in order to contribute to automobile weight reduction.

References

- 1) Tatsumi, Taro et al. Transactions of the Society of Automotive Engineers of Japan. 1998, no. 92-98, p. 1–4.
- 2) Tomita, Kunikazu et al. Tetsu-to-Hagane. vol. 87, no. 8, 2001, p. 37–43.

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