New Products & Technologies

TS 540—780 N/mm² Grade Hot-Rolled Steel Sheets with Good Formability and High Fatigue Strength, "RHA 540 DH—RHA 780 DH"*

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1 Introduction

A large quantity of hot-rolled high-strength steel sheets have been used in automotive chassis parts to reduce weight. When thinner sheets are adopted for further weight reduction, their press formability and fatigue strength must be improved.

This paper reports on the features of the TS 540–780 N/mm^2 grade hot-rolled high-strength steel sheet developed by Kawasaki Steel for improvement of the above characteristics, based on a new microstructural control method.

2 Features of Newly Developed Steel

2.1 Metallurgical Background

The newly developed steel has a dual-phase microstructure consisting of a ferrite phase precipitation-hardened by fine TiC and a martensite phase obtained by controlling the chemical composition and hot-rolling conditions. This microstructure affects the mechanical characteristics in the following three ways:

(1) As the advantageous features of the dual-phase microstructure have been retained, uniform elongation is improved and the yield ratio is reduced.

(2) The precipitation-hardened ferrite phase reduces the difference in hardness between the ferrite phase and the second phase of martensite; therefore, the concentration of working strain on the ferrite phase is suppressed, resulting in the improvement of local deformability.

(3) The precipitation-hardened ferrite phase restrains the initiation and propagation of fatigue cracks, leading to the improvement of fatigue strength.

The newly developed steel exhibits excellent formability and fatigue strength as a result of the above-mentioned microstructural control.

Table 1 Chemical composition of TS 780 N/mm^2 grade hot-rolled steel (mass%)

	C	Si	Mn	P	S	Al	Ti
RHA 780 DH	0.08	1.6	1.7	0.012	0.001	0.038	0.12

Table 2 Mechanical properties of the newly developed steels

Steel	Thickness (mm)	Yield strength (N/mm^2)	Tensile strength (N/mm^2)	Elongation (%)	Hole expansion ratio (%)
RHA 540 DH	2.6	420	560	32	110
RHA 590 DH	2.6	470	620	28	95
RHA 690 DH	2.6	545	720	24	65
RHA 780 DH	2.6	620	810	21	45

Tables 1 and **2** show an example of the composition and representative mechanical properties of the newly developed steel.

2.2 Formability

Figures 1 and **2** respectively show the relationship between the tensile strength and total elongation and between the tensile strength and expansion ratio of the newly developed steel, compared with conventional dual-phase steel (DP steel) and precipitation-hardening steel (HSLA steel).

The tensile strength–total elongation balance of the newly developed steel is better than that of the HSLA steel, though slightly worse than that of the DP steel. Therefore, the stretch formability and deep drawing

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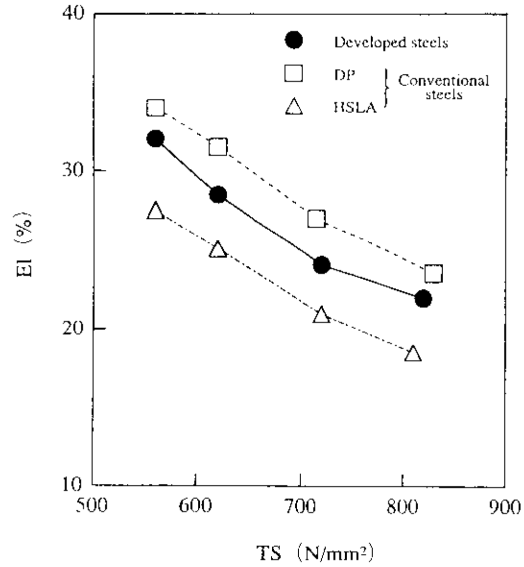

Fig. 1 Relationship between tensile strength and total elongation of the newly developed and conventional steels

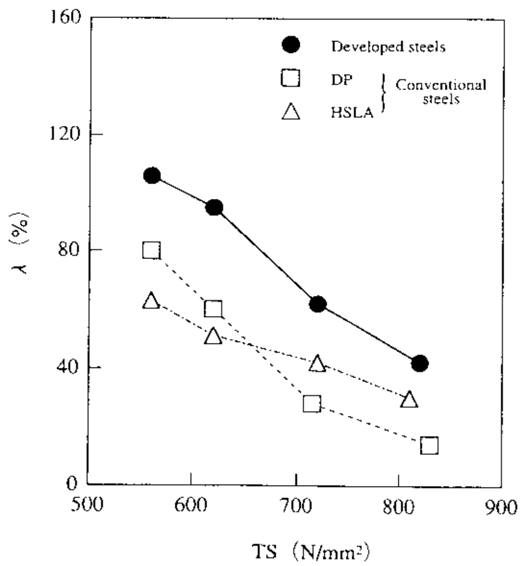

Fig. 2 Relationship between tensile strength and hole expansion ratio λ of the newly developed and conventional steels

formability of the newly developed steel are excellent in comparison with the HSLA steel. When the expansion ratio is compared at the same tensile strength level, the expansion ratio of the newly developed steel is higher than that of the HSLA steel and DP steel. Therefore, it can be concluded that the newly developed steel offers excellent stretch flanging formability.

2.3 Fatigue Strength

Figures 3 shows the relationship between the fatigue

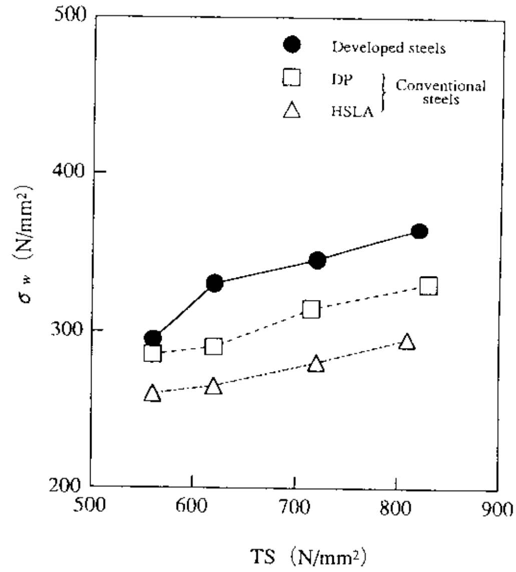

Fig. 3 Relationship between tensile strength and fatigue strength at 10^7 cycles, σ_w, of the newly developed and conventional steels

limit (10^7 cycle fatigue strength) observed in the completely reversed plane bending fatigue test and tensile strength, comparing the newly developed steel and conventional steel. On any strength level, the newly developed steel exhibits higher fatigue limits than conventional steel.

3 Concluding Remarks

The hot-rolled high-strength steel sheet introduced in this report has been developed to simultaneously improve formability and fatigue strength, satisfying the customers' strong needs for the development of such a product. The RHA 780 DH thus developed has already been used to make super high-strength wheel discs for automobiles,[1)] materializing a substantial reduction in weight of steel wheels of approximately 10%.

Since this hot-rolled high-strength steel sheet has good weldability, equivalent to that of HSLA steel, it is expected to be used for a wider range of applications not only in the automotive industry, but also in the construction, civil engineering, and machine tool industries.

References

1) I. Machida, M. Narita, R. Kureura, M. Morita, N. Aoyagi, and M. Sano: "Reduction in Weight of Steel Wheels by Development of 780MPa-Class Hot Rolled Steel Sheets", SAE paper No. 940536, Detroit (USA), (1994)

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