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HISTORY™ Steel Tube for High Strength Stabilizer

1. Introduction

Since global warming is a common worldwide problem, reduction of CO_2 emissions by improving automobile fuel consumption is desired. In order to reduce auto body weight to improve fuel consumption, hollowing of parts in which solid products made from bar steel were conventionally used is advancing, and application of ERW steel pipes, which have the advantages of comparatively low cost and excellent dimensional accuracy, is expanding. Because JFE Steel's HISTORY steel pipe can be manufactured with smaller diameters and thicker wall sizes than conventional ERW steel pipes and also has high workability, application as a hollowing item in place of steel bars is expanding, especially to stabilizers (**Photo 1**), which are used as automotive suspension parts. Accompanying the production of stabilizers with higher strength and thinner thicknesses to realize further weight reductions, steel pipes with higher fatigue characteristics than conventional products are required. This report introduces "HISTORY steel tube for high strength stabilizer," which was developed to meet these requirements.

2. HISTORY™ Steel Tube for High Strength Stabilizer

2.1 HISTORY™ Steel Pipe Manufacturing Process

Figure 1 shows the manufacturing process of the HISTORY steel pipe. Large-diameter ERW steel pipes are used as mother pipes, and small-diameter steel pipes are produced by diameter reduction rolling.

Photo 1 TS 1 300 MPa class stabilizer after heat treatment

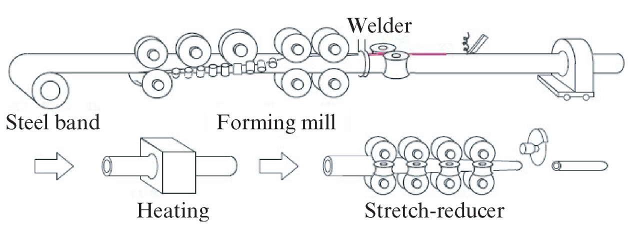

Fig. 1 Schematic illustration of HISTORY™ process

Table 1 Chemical composition of HISTORY™ steel tube for stabilizer

Steel grade	C	Si	Mn	Others
STKM/HITEN590	0.19	0.4	1.6	Nb,Ti,B
HISTORY22CB	0.23	0.2	0.5	Cr,Ti,B
JMERW/SAE15B26	0.26	0.2	1.2	Cr,Ti,B
JMERW/SAE15B37H	0.34	0.2	1.2	Cr,Ti,B

Table 1 shows the chemical composition of the high strength HISTORY steel pipe. Although the carbon content of the conventional HISTORY steel pipe was about 0.23% C, a technology which can stably produce steels with higher carbon contents of 0.26% C and 0.34% C has been established to realize higher strength.

2.2 Features

As the thickness of a steel pipe becomes thinner, the stress difference between the outer and inner surfaces becomes smaller when the pipe is used as a hollow stabilizer, and the inner surface becomes more likely to be the starting point of fatigue failure than the outer surface, which is strengthened by shot blasting. However, the surface quality of the inner surface is also important because crack sensitivity is higher in high strength materials.

The main surface qualities related to fatigue properties are (1) decarburization, which affects the hardening hardness, and (2) roughness, which affects stress concentration. Therefore, in order to achieve excellent fatigue characteristics, the following countermeasures were carried out to reduce the decarburization depth and surface roughness of the HISTORY steel pipe for high strength stabilizers.

2.2.1 Decarburization depth

The depth of surface decarburization was reduced by lowering the coiling temperature, as coiling is the process in which surface decarburization proceeds in the hot rolling process.

Figure 2 shows the effect of the coiling temperature on the surface carbon concentration and hardness distribution after quenching and tempering. Decarburization can be remarkably suppressed by lowering the coiling temperature.

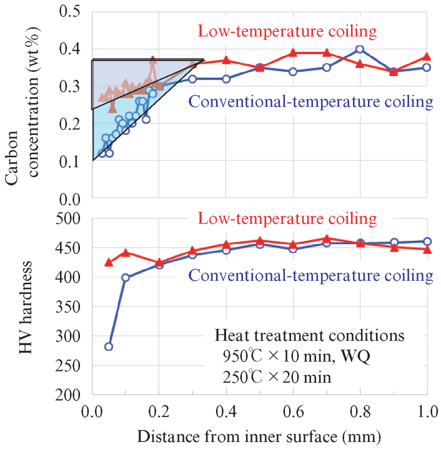

Fig. 2 Surface carbon concentration and hardness distribution after quenching and tempering

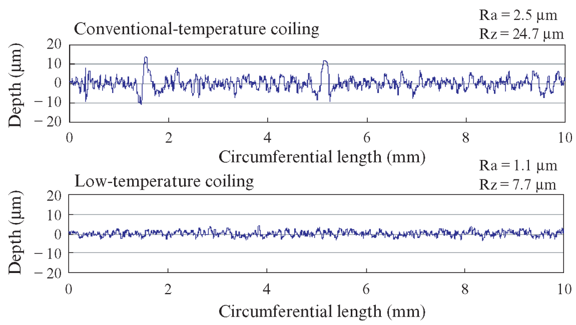

Fig. 3 Roughness of pipe inner surface circumferential direction

Table 2 Maximum roughness of tube inner surface

Manufacturing conditions	Ry_{90}
Conventional	32
Low temperature coiling	24
Low temperature coiling and heavy reduction skin pass rolling	17

Ry_{90}: Maximum hight of the inner surface of distribution function 90%

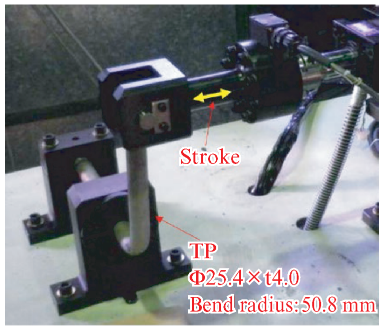

Photo 2 L-bending tester

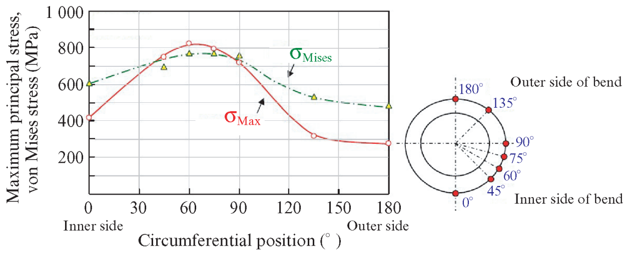

Fig. 4 Comparison of stress generated in L-bending test and stress generated in stabilizer by FEA

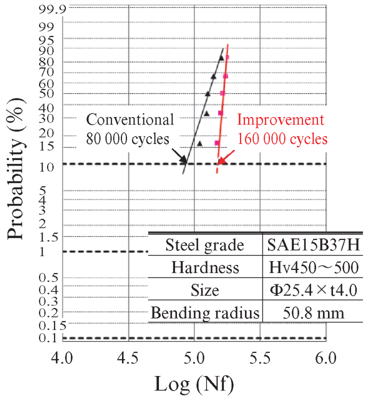

Fig. 5 Fatigue characteristic

2.2.2 Surface roughness

Lowering the coiling temperature is also effective for reducing surface roughness. This is considered to be related to grain refinement. **Figure 3** shows the measurement results of the circumferential roughness of the inner surface of the pipe after tube forming.

Table 2 shows the results of an estimation of the maximum height Ry at 90% probability in which the roughness values were arranged under the assumption of an exponential distribution function in order to confirm the effect of lowering the coiling temperature. In addition to lowering the coiling temperature, skin pass rolling under high pressure, which is effective for further lowering roughness, was also carried out. These countermeasures reduced roughness to about half of the conventional level.

2.3 Fatigue Characteristics

Generally, stabilizers break at the bending part, where the forces of bending and torsion work. Therefore, not only simple bending and torsion but also L-bending fatigue tests were carried out in combination with those tests using the testing machine shown in **Photo 2**. It has been confirmed that the stress distribution in this test corresponds to the calculated stress distribution in a FEA simulating the bending part of the stabilizer, as shown in **Fig. 4**.

Figure 5 shows the results of a durability test by L-bending before and after the countermeasures for inner surface quality. The fatigue life of the improved product was superior to that of the conventional product, confirming the effectiveness of the countermeasures.

3. Conclusion

JFE Steel will promote the development of new steel pipes for automobile parts in order to respond to demand for further improvement of fuel consumption in the future.

References

1) Toyooka, T.; Itadani, M.; Yorifuji, A. Kawasaki Steel Technical Report. 2001, vol. 33, no. 4, p. 145–150.

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