New Products & Technologies

High Strength and High Elongation Tubular Products "HISTORY Steel Tube" with Good Bendability*

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1 Introduction

Weight reduction and rigid auto-bodies have been extensively examined in recent years in the automotive industry from the viewpoints of environmental protection and improvement of car-collision safety. The use of the tubes in auto-parts components has been increasing due to the characteristics of lightweight hollow section and high stiffness closed section. The demand for high strength tubes with excellent formability is continuously growing.

High strength and high elongation tubular products called HISTORY steel tubes manufactured based on fine grain metallurgy have been developed in order to meet this demand. They will be manufactured in the newly developed tube making process called HISTORY (high speed tube welding and optimum reducing technology).

The present report describes technical aspects of HISTORY steel tubes and their bending formability.

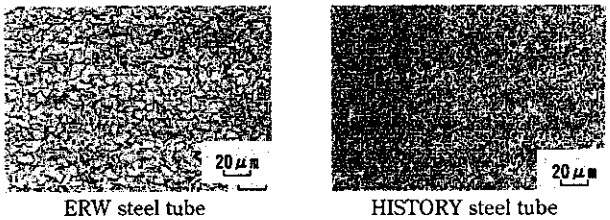
2 Manufacturing Process and Characteristics of High Strength and High Elongation HISTORY Steel Tubes

2.1 Manufactrurnig Process

Figure 1 shows an outline of the manufacturing process of the high strength and high elongation HISTORY steel tubes. Hot rolled sheet is formed into cylindrical shape in a CBR mill which can minimize the forming strain. Then, both edges of formed sheet are heated and melted by high frequency induction electric current to be welded at a squeeze roll. Then the welded cylindrical pipe is rolled by the stretch-reducing mill to become HISTORY steel tubes while it is subjected to high OD reduction at a moderate high temperature.

2.2 Feature of Metallurgical and Mechanical Properties

(1) Due to the large rolling strain at a moderate high temperature, the microstructure is composed of fine grain ferrite and dispersed fine cementite (secondary phase) as shown in **Photo 1**. Because of this microstructure, despite their high tensile strength, HISTORY steel tubes can have higher elongation (El) than ERW steel tubes, as shown in **Fig. 2**.



ERW steel tube HISTORY steel tube

Photo 1 Comparison of microstructure between ERW steel tube and HISTORY steel tube

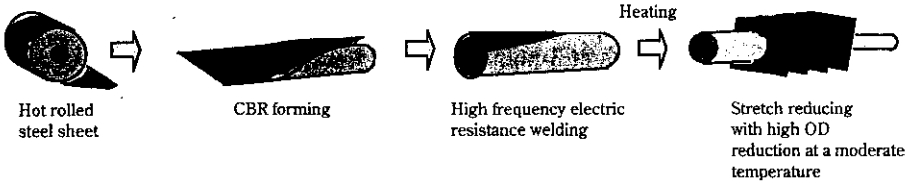


Fig. 1 Manufacturing process of high strength and high elongation HISTORY steel tube

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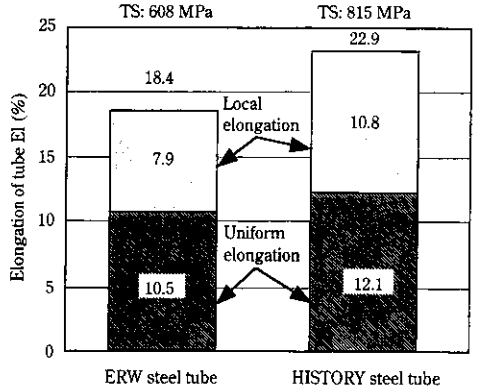

Fig. 2 Comparison of elongation between ERW steel tube and HISTORY steel tube by tensile test (No. 12 specimen of JIS Z 2201)

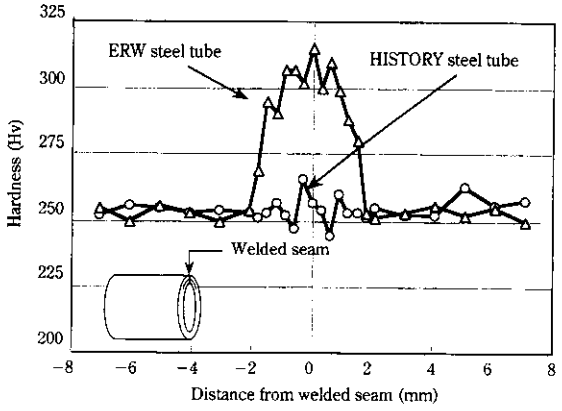

Fig. 3 Comparison of hardness distribution around welded seam between ERW and HISTORY steel tube with tensile strength of 780 MPa

(2) Due to stretch reducing with high OD reduction at a moderate high temperature after welding, hardness at a welded seam is almost equal to that adjacent to welded seam (**Fig. 3**), therefore no post heat treatment is required, as it is with conventional ERW steel tubes.

3 Bending Formability of High Tensile and High Elongation HISTORY Steel Tubes

Photo 2 shows the appearance of the 3-point bending test. **Photos 3**, **4** and **Table 1** show the results of 3-point bending tests on HISTORY and ERW steel tubes.

Though HISTORY steel tubes have higher tensile strength than ERW steel tubes, HISTORY steel tubes have higher resistance to bending collapse and buckling than ERW steel tubes. In addition, 3-point bending can form HISTORY steel tubes into U-shapes with very small bending radius despite their high tensile strength of 780 MPa grade. In addition, HISTORY steel tubes do not need the adjustment of welded seam positions during

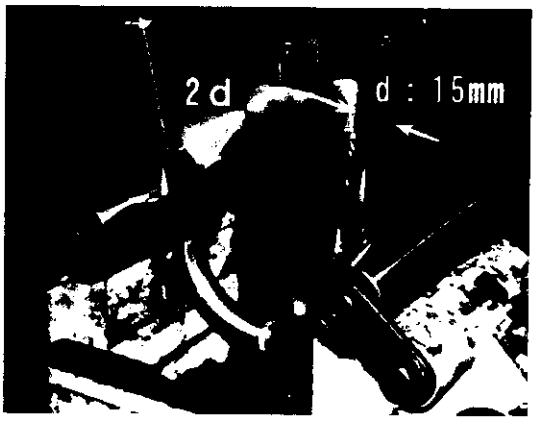

Photo 2 Appearance of 3-point bending test (Bending radius: 30 mm)

	Size (mm)	TS (MPa)	YS (MPa)	El (%)
HISTORY	$\phi 15 \times t1.8$	530	575	32
ERW	$\phi 15 \times t1.8$	480	509	18

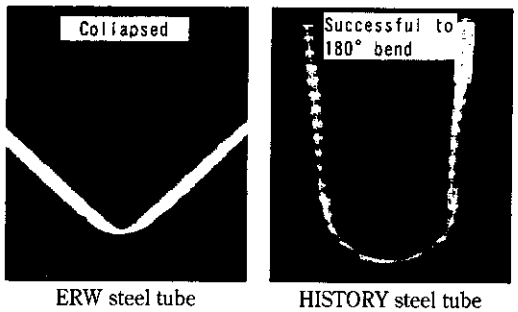

Photo 3 Comparison of bent tubes between ERW and HISTORY steel tubes after 3-point bending tests

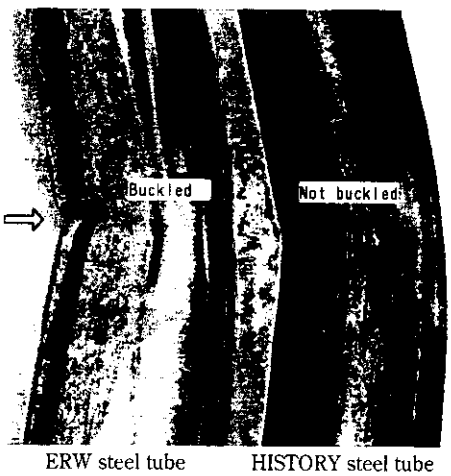

Photo 4 Appearance of bent tubes of ERW and HISTORY steel tube after draw bending without internal plug (bending conditions: R = 150 mm × 20°)

Table 1 Results of 3 point bending test for HISTORY steel tubes with tensile strength of 780 MPa: Tube size: $\phi 25.4 \times t3.0$ mm, Bending conditions: bending radius = 50.8 mm, bending angle = 180°

Tensile properties of test specimens (Specimen: JIS No. 11)				Shape after bending
YS (MPa)	TS (MPa)	El (%)	YR (%)	
815	845	34	96	Good
783	819	36	96	Good

bending operation due to the uniform distribution of hardness in the circumferential direction across the welded seam, contributing to improvement of working efficiency.

4 Size Availability

The production of HISTORY steel tubes will start in autumn 2000. The product size range is shown in **Fig. 4**.

5 Concluding Remarks

HISTORY steel tubes has been introduced, focusing on excellent bendability. But HISTORY steel tubes have the excellent formability not only for bending, but also for a wide range of other types of plastic processing. High tube productivity based on the stretch-reduce rolling with high OD reduction is another main feature of HISTORY steel tubes.

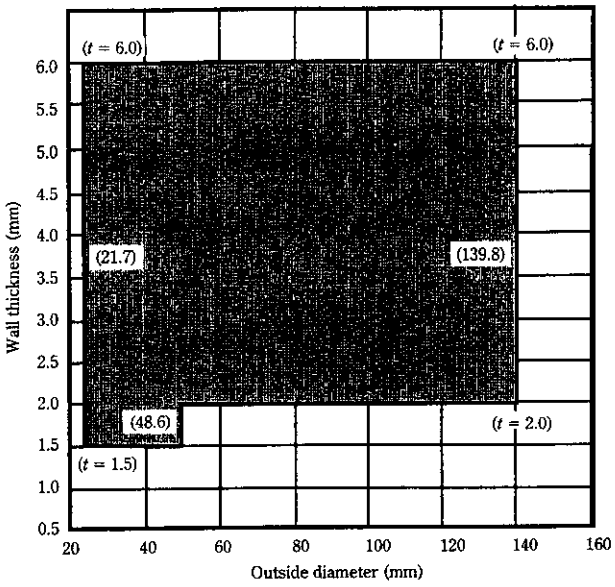

Fig. 4 Available size range of HISTORY steel tube

In addition to the growing demand for the higher strength steel tubes, the improvement of their formability will be required much more. HISTORY steel tubes are the tubular product that can cost-effectively meet this demand.

For Further Information, Please Contact to:

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