

Square Coils with High Dimensional Accuracy by 4-Roll Mill[†]

1. Introduction

Some steel parts used in the electrical, automobile or machine industry are made of steel bars with square closed section, which are usually supplied by bright steelmakers. The process flow is very complicated; it consists of some drawing and annealing processes.

JFE Steel has developed a 4-roll mill in cooperation with Sumitomo Heavy Industries, Ltd. since 1994. With this roll, JFE Steel can produce a square coil with high dimensional accuracy compared with the traditional 2-roll mill. Our customers, using our square coil, can produce steel bars with square closed section by one-time drawing without annealing.

2. Square Coil with High Dimensional Accuracy

2.1 Rolling Method

Square coils are produced by the 4-roll mill as bar-in coils. The available sizes are from 12.7 to 27 mm square.

The round bars are rolled by a 4-flat-roll to form a square coil as shown in Fig. 1.

The most difficult part of this process is how to con-

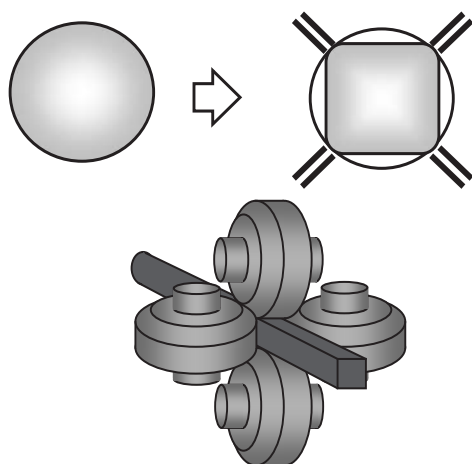


Fig. 1 Rolling method of square coils by 4 roll mill

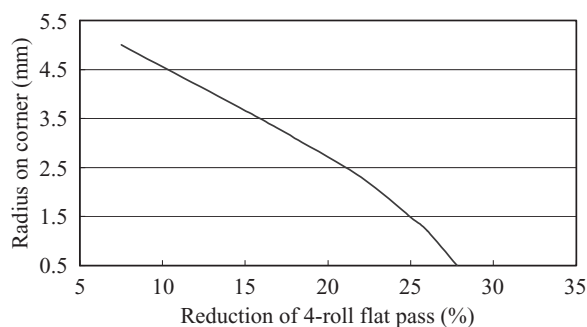


Fig. 2 Relation between reduction and radius on corner

trol the radius of the corners. As shown in Fig. 2, this is related to the reduction ratio of the 4-roll mill. We control the radius of the corners by selecting the most suitable reduction ratio. Commercially, we can supply square coils of 2.0-mm corner radius.

2.2 Actual Dimensions

Table 1 compares the actual dimensions of square coils produced by the traditional 2-roll mill and our 4-roll mill. The 4-roll mill shows better results than the traditional method. Table 2 shows the range of regular sizes of square section bars, and we can produce other special sizes if required by customers. We can also produce coils with rectangular closed section as shown in

Table 1 Comparison of rolling results for square section coils

4 Roll		$S: \pm 0.1 \text{ mm}$ $D: \pm 0.2 \text{ mm}$ $\theta \approx 90^\circ$
2 Roll		$S_1: \pm 0.2 \text{ mm}$ $D_1: \pm 0.2 \text{ mm}$ $D_2: \pm 0.5 \text{ mm}$ $R_1 \neq R_2$ $\theta \neq 90^\circ$

*R: Radius on corner

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Table 2 Size range of square section bars

(mm)

Square section bars	Size repertory												
	12.7	14	15.5	16	18	19	19.3	20	21	22	24	25	27

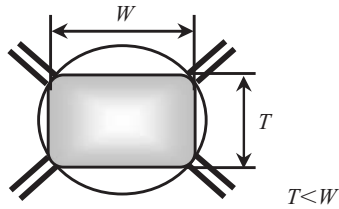


Fig. 3 Method of rolling rectangular section










Conventional	New Process
Round section bar 	Square section bar 
Shot blasting 	Shot blasting 
Drawing (rough) 	 Finish drawing
Annealing 	
Pickling 	
Finish drawing 	

Fig.4 Process comparison of square section bars

Fig. 3. In this case, the radius of corners is bigger than that of coils with square section.

3. Development of Customer Process

Figure 4 shows the process flow of one of our customers. They used to draw the conventional round coils twice (rough and finish) then apply the annealing process. With our square coils, they can achieve the final product by drawing only once.

4. Summary

JFE Steel’s West Japan Works produces wire rods and bars, and has developed an original 4-roll mill which can produce square coils with high dimensional accuracy. With these coils, our customers can improve their process flow and reduce production cost.

JFE Steel will continue to develop new products to meet customers’ needs.

Reference

- 1) Sakurai, Tomoyasu; Sakamoto, Toshio; Takeda, Ryo. Development of High Dimensional Accuracy Smaller Diameter Wire Rods and Square Coils Manufactured by 4-Roll Mill. Kawasaki Steel Technical Report. 2002, no. 47, p. 42–47.

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