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Installation of New No. 7 Finishing Stand at Yawata Hot Strip Mill

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Abstract:

Nippon Steel installed a new No. 7 finishing stand at the Yawata hot strip mill to improve productivity of mainly special steels. At the same time, measures were implemented to stabilize rolling on the existing finishing stands. Since the completion of the revamping work in November 1993, the Yawata hot strip mill has operated smoothly and has accomplished not only the originally planned productivity increases but also achieved hot coil quality improvements. This paper describes the results to date.

1. Introduction

Nippon Steel's Yawata hot strip mill (see **Fig. 1**) began commercial operation in April 1982. It produces hot-rolled coils of not only carbon steels, but also special steels, such as stainless steels, electrical steels and high-carbon steels. Since the production of hot-rolled coils of special steels has many hot rolling process constraints as compared with hot-rolled coils of carbon steels, the productivity of special steels (production per unit time) tended to be lower than that of carbon steels. Nippon Steel started work on the installation of a new No. 7 finishing stand, after much study, as one measure for improving the productivity of hot-rolled coils of special steels. After a construction period of 27 months starting in 1991, the final work was completed in November 1993. During four work stop ages, lasting seven to 14 days, measures were instituted to stabilize rolling operations on the existing finishing stands. The installation of the new F7 stand, the measures taken to stabilize rolling on the existing finishing stands, and the operation improvements achieved are reported below.

2. Installation of New No. 7 Finishing Stand

As a six-high mill to perform schedule-free rolling,the new finishing stand F7 was designed to ensure the interchangeability of accessory parts, such as rolls and chocks, with the existing finishing stands. The following design considerations were taken into account to reinforce the functions of the existing equipment:

(1)Increase in response of the mill speed control system, which is basic to quality accuracy improvement, and also of the

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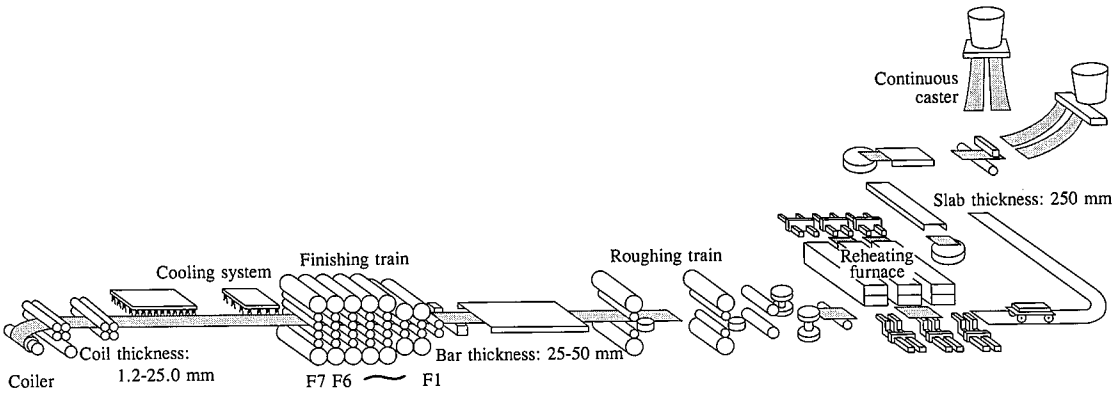

Fig. 1 Layout of Yawata hot strip mill

looper, screwdown and work roll bender control systems

(2)Improvement in equipment reliability to lessen maintenance required on work rolls and intermediate roll shift equipment

(3)Provision and setup of function to change between large-diameter and small-diameter work rolls to meet demands for higher thickness accuracy

The main equipment specifications of the new F7 stand designed according to the above ideas are compared with those of the existing F6 stand in **Table 1**. The housings of the two stands are comparatively shown in **Fig. 2**. The servo valve was located close to the hydraulic screwdown cylinder to improve hydraulic screwdown response, and the hydraulic screwdown cylinder was installed in the upper part of the mill to facilitate maintenance. As a result of these changes, the screwdown response characteristic (90° phase delay) of the new F7 stand improved twofold as compared with that of the existing F6 stand. The work roll bender control servo valve was also located close to the work roll bender cylinder to achieve a twofold improvement in the response characteristic (90° phase delay). An AC motor was adopted as the mill drive motor to also improve the response of the speed control system. To allow the use of small-diameter work rolls, a spring-loaded shift mechanism is used for each spindle of reduced diameter. Measures were also implemented to assure the desired strength of the drive system and to move the natural frequency away from the normal frequency in the operating range. Use of smaller thickness members, for example, lowered looper inertia as compared with that for the F6 stand's looper. Since the frequency of work roll changes of the final stand was expected to rise, the operating speed of each part comprising the roll changing device was increased to change the work rolls in 3.5 minutes. The work roll shift mechanism was driven by a direct-coupled hydraulic cylinder to improve roll holding accuracy. This drive method aimed at better roll wear equalization and stabilized rolling. The general view of the finishing train, including the new

Table 1 Comparison of basic equipment specifications

	F7	F6 (existing)
Mill type	Six-high (large/small-diameter work roll change)	Six-high
Work roll diameter (mm)	Large-diameter work rolls: 625/525 [Small-diameter work rolls: 485/435]	625/525
Work roll shift	Direct-coupled hydraulic cylinder Shift: ±100 mm	Electric lever* Shift: ±75 mm
Hydraulic screwdown	Screwdown cylinder in upper part of mill Response speed: 20 Hz	Screwdown cylinder in lower part of mill Response speed: 10 Hz
Work roll bender	±80 ton/chock Response speed: 12 Hz	±65 ton/chock Response speed: 7 Hz
Mill motor	AC 4,500 kW Response speed: 40 rad/s	DC 9,000 kW Response speed: 20 rad/s
Drive type	Single drive	Twin drive
Spindle type	Spring loaded	Hydraulic pullback
Looper GD²	1,550kg-m²	1,684kg-m²
Work roll change time	3.5min	4.5min

Small-diameter work rolls enclosed in bracket are future provision.
*Already modified to direct-coupled hydraulic cylinder type

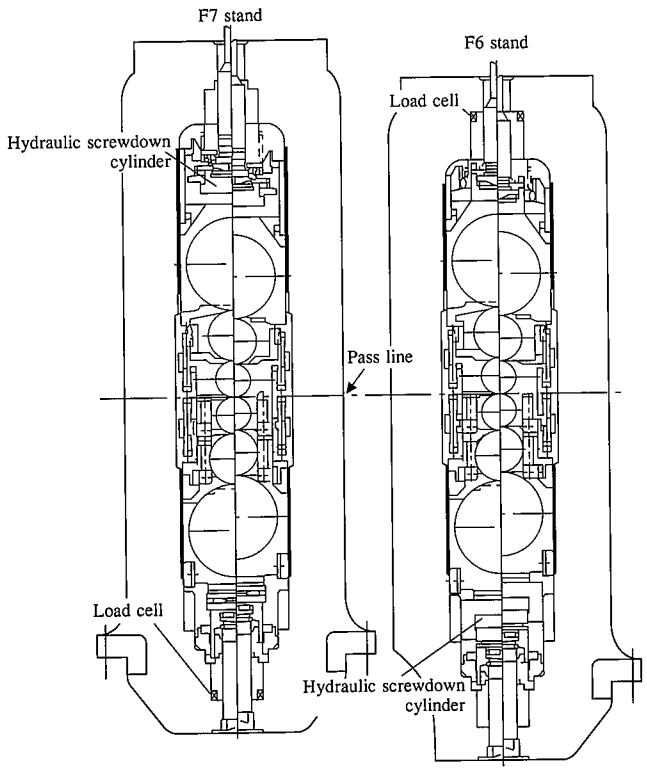

Fig. 2 Comparison of F7 and F6 stands

F7 stand, is shown in **Photo 1**, and the F7 stand apperars in **Photo 2**.

3. Measures Taken for Improving Rolling

The principal measures implemented at the same time as the new F7 stand installation for improving rolling on the existing finishing stands are listed in **Table 2**. These were to reduce clearances in the rolling direction and roll axis direction with the rolls installed in the stands. In place of the conventional shift device, the direct-coupled hydraulic cylinder drive mechanism shown in **Fig. 3** was installed in the work roll keeper and shift devices of all of the existing finishing stands to improve the accuracy of holding the work rolls in direct contact with the strip. This mechanism is of the same construction as that of the F7 stand. The hydraulic circuit was modified so that the clamps to be axially shifted when changing the work rolls and intermediate rolls could be pushed at a low pressure against the roll chock keeper. Another change was so that the clamp hooks could be applied with minimum clearance between the clamp and chock. As a result, the axial clearance was reduced to 1.8 mm or less on a design value basis.

4. Operational Improvements Achieved

The load per finishing stand was reduced by installing the new F7 stand, and the clearance between the rolls in each stand was lowered by a variety of measures. The resultant improvement

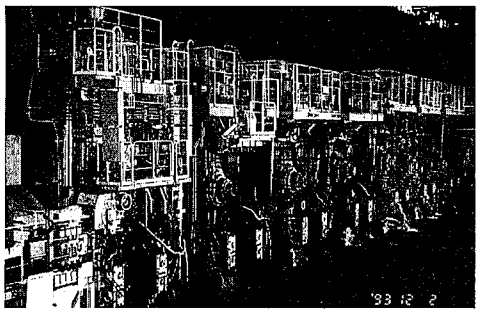

Photo 1 Finishing train, including F7 stand in foreground

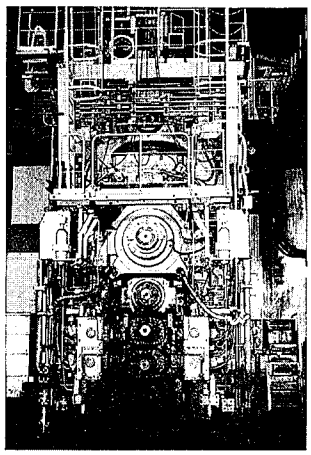

Photo 2 F7 stand

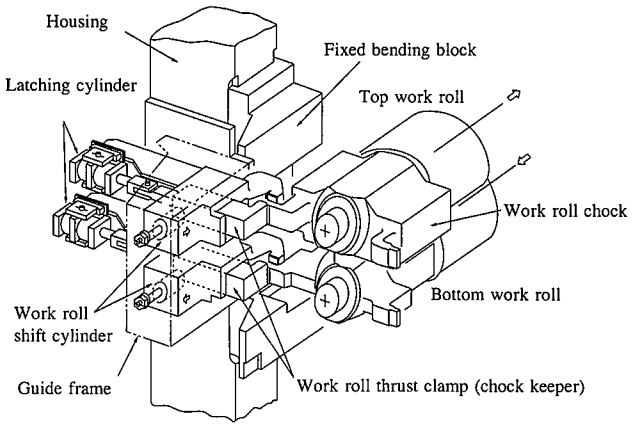

Fig. 3 Work roll shift equipment (direct-coupled hydraulic cylinder type)

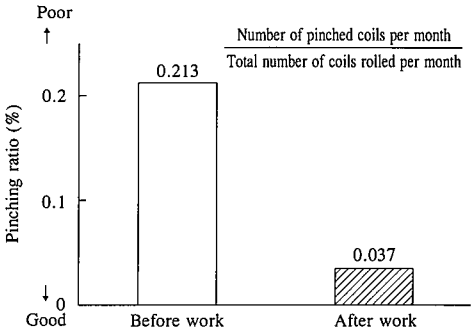

Fig. 4 Improvement in finish rolling stability

Table 2 Measures implemented for stabilizing rolling by type of roll

Type of roll	Measures in roll axial direction	Measures in rolling direction
Work roll	(1)Change in work roll shift mechanism: From electric lever type to direct-coupled hydraulic cylinder type (2)Installation of new gap-less clamp circuit by modification of hydraulic circuit (3)Change in shape of keeper liner (4)Reduction in clearance of roll bearings	(1)Installation of liners in housing contact surfaces
Intermediate roll	(1)Installation of new gap-less circuit by modification of hydraulic circuit (2)Installation of liner in chock clamp (3)Reduction in clearance of roll bearings	(1)Installation of liners in housing contact surfaces
Backup roll	(1)Insertion of minimum-clearance rolls by reinforcement of roll shift cylinders during roll change (2)Wear protection for keeper plates	(1)Installation of stainless steel liners in housing contact surfaces

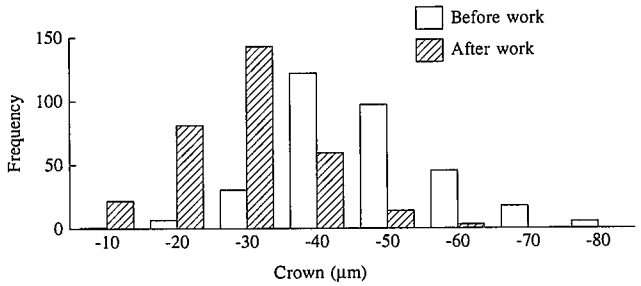

Fig. 5 Reduction in crown of 3-mm thick coils

in the roll holding accuracy markedly stabilized the rolling of difficult-to-roll thin and hard coils and increased the productivity of the hot strip mill. The "pinching ratio" used as an indicator of finish rolling stability is compared before and after the completion of the revamping work of the Yawata hot strip mill in **Fig. 4**. The securing of rolling conditions stabilized the quality levels for the better. The thickness difference between the transverse center and edges of the coil or crown in particular was uniformly reduced as shown in **Fig. 5**. At the same time, coil shape was also improved.

5. Conclusions

Nippon Steel implemented measures at the Yawata hot strip mill to improve the productivity of the finishing stands, including the installation of the new No. 7 finishing stand. Since the completion of the associated work in November 1993, the hot strip mill has operated smoothly and has not only achieved the productivity improvement as originally intended, but also raised hot-rolled coil quality. Now that the finishing stands are augmented, the personnel of the Yawata hot strip mill will strive to accomplish further productivity, cost, and quality improvements.

Reference

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