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An On-line Measurement of Hot Strip Profile

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Synopsis :

Two sets of hot strip profile meter installed at Chiba Works; a No.1 for No.2 mill in March, 1979, a No.2 for No.1 mill in March, 1980; feature a combination of two high-precision X-ray thickness gages - the fixed type and the scanning type. The measuring system has been operating smoothly, contributing greatly to a high-precision measuring of strip crown and 'high spot'. The results of tests on this development are summarized as follows: (1) The profilemeter can detect 'high spots' of more than 4  $\mu\text{m}$  in height and 5mm in width in off-line tests and those of more than 5  $\mu\text{m}$  in height and 10mm in width during rolling. (2) It can measure the strip crown and wedges at an accuracy of within  $\pm 10 \mu\text{m}$ . (3) Regardless of strip profile changes during the scanning of the gage, the profilemeter output shows good correspondence to values measured by the  $\gamma$ -ray thickness gage in the subsequent line.

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# An On-line Measurement of Hot Strip Profile\*

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*Two sets of hot strip profilemeter installed at Chiba Works; a No. 1 for No. 2 mill in March, 1979, a No. 2 for No. 1 mill in March, 1980; feature a combination of two high-*

[The page contains several lines of text that are almost entirely obscured by heavy black redaction bars. Only a few fragments of text are visible, including the number '100' at the top left and some faint characters and symbols scattered throughout the page.]

ment output interval of the thickness gage. This equipment adopts a shift register of 16 steps and the correction of the measuring position is performed at an accuracy of 56.3 mm/step in No. 1 mill, and 61.9 mm/step in No. 2 mill.

- (3) The carriage speed of the scanning gage is altered in accordance with the following:
  - (a) Precision of profile detection
  - (b) Number of reciprocating scanning per strip

The carriage speed is set at 30–50 mm/s for the section of 100 mm from the strip edge and 50–150 mm/s for the center section to improve the precision of profile detection.

If the carriage speed is increased over 150 mm/s, it will eventually increase the noise level in the thickness measurement signals, which results in the deterioration of precision of profile detection.

Should the number of reciprocating scanning per strip in motion be increased, the traverse speed at the

## 2.2 Specifications of Profilemeter

**Table 1** shows the specifications of the X-ray thickness gage and **Table 2** the specifications of the control unit of the profilemeter.

The dimension of the X-ray beam on the pass line, when the slit is set, is 30 mm in the rolling direction of coil, and 6 mm in the width direction of the coil. The X-ray beam is narrowed in the width direction by slit in the scanning thickness gage. The slit is necessary for the following reasons:

- (1) The strip thickness varies greatly at the position 40–50 mm from the edge. The slit gage can perform a measurement of thickness with high precision in this section.
- (2) The slit gage accurately detect 'high spots' of very small dimensions in the width direction of the strip.

Table 1. Main classification of various assessment and audit activities

(1) Selection from 4 speeds according to strip

30 mm/s - 300 mm/s

25

system is equipped with a profilemeter control computer, the amount of traverse oscillation can be sampled at each time of thickness measurement while the gage is scanning over the entire strip width. In this way, upon completion of each measuring operation, each measuring position can be corrected, if necessary, by the amount of trav-

Fig. 4.

$$w = \Delta x_{d1} - \Delta x_{o2} \dots \dots \dots (5)$$

w: Wedge ( $\mu\text{m}$ )

### 2.5 Output of Thickness Deviation and Profile

- (1) Record output

obtained is within the range of the manufacturer's guarantee and no problems are found as to its

### 3.2 High Spot Detectability

Fig. 7 shows data obtained from a test performed



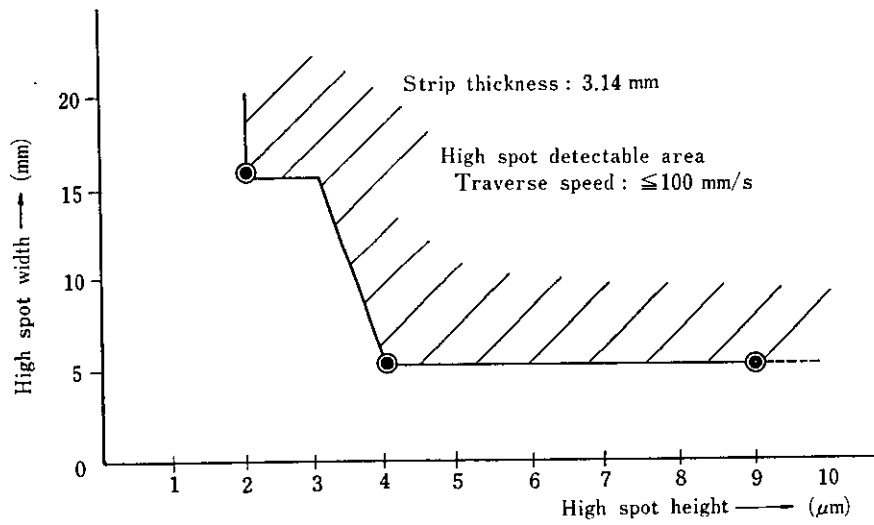


Fig. 8 Detectability of strip 'high spot' by the off-line test

amount of X-ray reception differs even on the high spot of the same height depending on the occupation ratio of the high spot width to the slit

improved. Fig. 9 shows the data obtained when both fixed and scanning gages are fixed at the line center. In this example, the thickness measured by the fixed

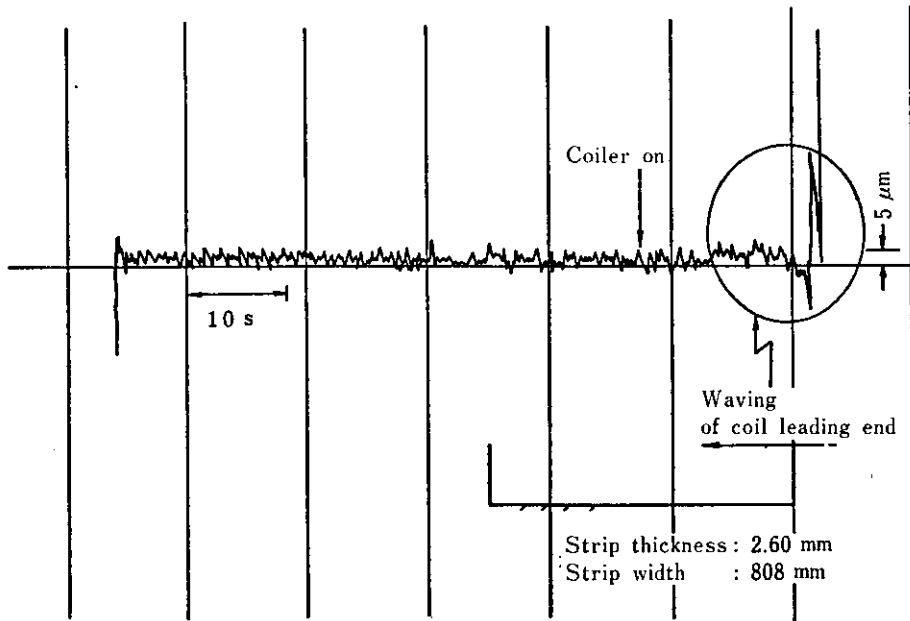
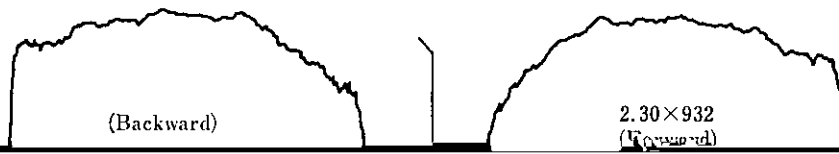
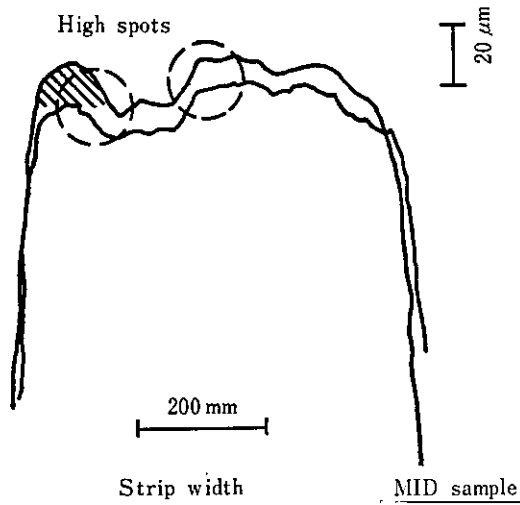


Fig. 9 Accuracy of position correction of two thickness gage





#### 4.3 Accuracy of Crown Detection (Example at No. 1 mill)

The sample sheet was cut in a manner as described in 4.2, and the measured value of the hand micrometer and profile record chart were compared. The results are shown in Fig. 12. This example shows the data where crown was obtained by the hand micrometer and from the profile record chart with the reference points of 20, 30, and 40 mm from the strip edge. Accuracy of  $\pm 10 \mu\text{m}$  is observed regardless of the distance from the strip edge for the crown with less than  $90 \mu\text{m}$ . It is confirmed that the reading accuracy from the chart is  $10 \mu\text{m}$  at minimum. The reasons for the larger deviation in the data for the crowns over  $100 \mu\text{m}$  obtained at the reference point of 20 mm are

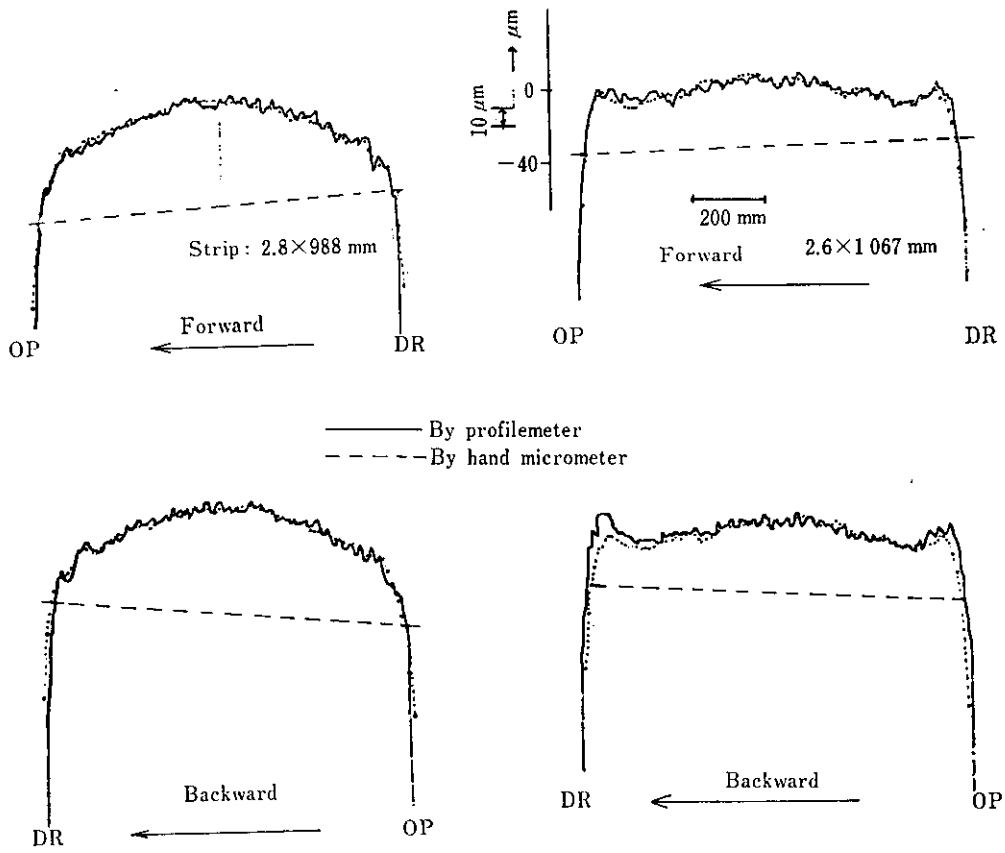


Fig. 13 Comparison between profiles measured by profilemeter and by hand micrometer

Profile measured by  $\gamma$ -ray

measured by the  $\gamma$ -ray thickness gage (the cross point of profile record of the  $\gamma$ -ray thickness gage and the diagonal line that declines toward the left) are plotted in Fig. 14. The record of profilemeter and the measured values of  $\gamma$ -ray thickness gage agree well when the crown and wedge vary during the scanning of profilemeter. From this, the authors concluded that the discordance is due to the cause listed in item (1) and

The change of rolls of the latter finishing stands (F3-F7) is carried out. The number of stands to be replaced is determined by the degree of abnormality and the number of steels yet to be rolled in the same rolling cycle.

- c. Edge build-up
  - (a) Alteration of the distribution of rolling reduction

in accordance with the specified technical standards.

The initial aim of the profilometer with regard to ~~attention accuracy~~ has been accomplished. The steel

**Reference**

- 1) T. Nishimura and T. Tsujii:  
Proceedings of International Conference, on Steel Rolling, 1  
(Sept., 1980) Tokyo, p. 659