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# Development of a New Plan View Pattern Control System in Plate Rolling

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Synopsis :
In plate rolling, slab is rolled not only in longitudinal but also in transverse directions so as to get required dimensions of plate. Plate rolled in this way, however, develops unequal plastic deformation, making crop losses increased in top and bottom portions of both sides. The authors have developed a new method to measure the plastic deformation behavior during rolling by the composite picture method and formulated equation to estimate plate plan view pa

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*The authors have developed a new method to measure the plastic deformation behavior during rolling by the composite picture method and formulated equation to estimate plate plan view pattern. A new plate rolling method called MAS rolling has been established, making it possible to prevent the unequal plastic deformation and manufacture almost*

around 90 degrees and rolled in the longitudinal direction to a required plate thickness.

Non-homogeneous plastic deformation becomes

## 2.1 Basic Research by a Model Mill

In order to investigate the behavior of the plan view pattern of a rolled slab, a model mill was used to roll the contrary, in spool shape, in which both ends

rolling at the actual mill

protrude as compared with the central portion.

(2) Broadside rolling at the broadside rolling ratio (rolling width/slab width) of 2.0 is shown in

## 2.2 Quantitative Analysis by the Composite Picture Method

the plan view pattern change for each rolling pass and

plastic deformation and rolling conditions.

### 2.2.2 Changes of plan view pattern in sizing

Based on the result of the plasticine experiment,

**Table 1** Specification of test materials to study the plan view pattern of each pass during rolling

(2) Portion B pattern (convex crop pattern at the leading and tail ends) Amout of $f_2(y)$ of plan view pattern changes of portion B is calculated by equation **(2)**.

$$f_2(y) = c_0 + c_1 y + c_2 y^2 \quad \cdots\cdots\cdots\cdots (2)$$

$c_0 \sim c_2$ are constants determined by $r$ here.

$f_3(x)$: Amount of plan view pattern of portion B′

$b_0$ and $b_1$: Constants determined by the broadside rolling ratio.

$$f_4(y) = d_0 + d_1 y + d_2 y^2 \quad \cdots\cdots\cdots\cdots (4)$$

$f(y)$: Amount of plan view pattern of

while the longitudinal rolling ratio is large, the effects [redacted]

rolling. Crops in the leading and tail ends in the longitudinal direction take the convex shape, while side crops are in spool shape. Conversely, if the broad- [redacted]

sponds to the position in the longitudinal direction, [redacted]

created by longitudinal rolling.

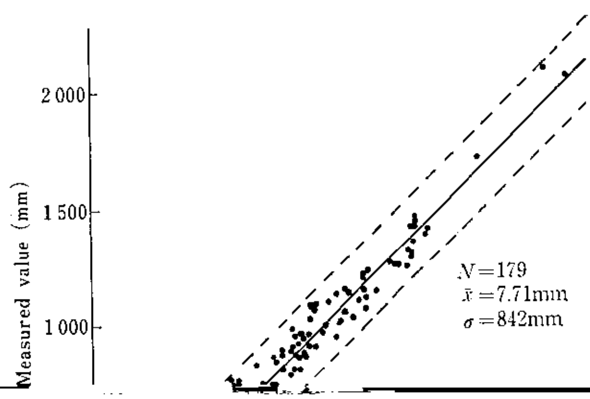
$$T_C = K(U_B - V_B) + L \quad \cdots\cdots\cdots\cdots (7)$$

[redacted]

can be represented by equation (10) on the basis of equations (2) and (4).

$$G(Y) = G(R_B \cdot y) = \alpha \frac{1}{h_m} \sum_{i=1}^{m-1} h_i f_2(y)_i + \alpha f_4(R_B \cdot y) + \mu \frac{1}{h_n} \sum_{j=1}^{n} h_j f_2(R_B \cdot y)_j \cdots\cdots (10)$$

$y$: Distance in transverse direction
$R_B$: Broadside rolling ratio
$h_m, h_n$: Thickness



methods are only for reducing inferior shapes on an

[redacted]

On the basis of the plan view pattern prediction model discussed in the previous section, we have established a new method of plan view pattern control (The MAS Rolling Method) which can deal with each slab accurately.

[redacted]

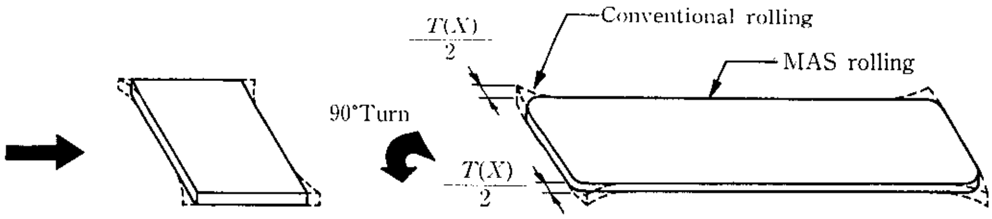
$X = \alpha x$

$\Delta h(x)$: Amount of plate thickness modification at distance $x$ in the longitudinal direction

$T(X)$: Side crops at distance $X$ in the

[redacted]

sizing rolling



modification according the "volume conservation law" was confirmed.

### 4.2 MAS Rolling Control System[5]

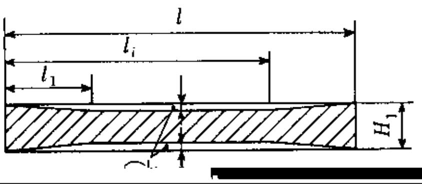
In applying the MAS rolling method for practical purposes, it is important to establish a highly accurate control system which will cause no discrepancy in thickness modification patterns and no excessive or deficient amount of thickness modification. In the thickness modification patterns shown in **Fig. 16**, it is necessary to control accurately modification amount $\Delta h(l_i)$, reduction completion point $l_1$ and reduction increase starting point $l_i$.

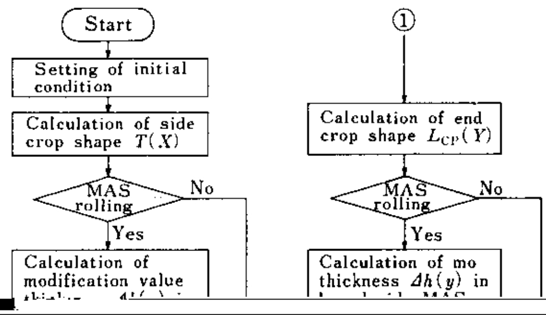
**Fig. 17** shows the control system of the MAS rolling method. By means of the process computer ⑧, it computes the appropriate modification pattern, obtains reduction modification amount $\Delta S(l_i)$ from thickness modification amount $\Delta h(l)$ and further obtains roll speed $R$ in consideration of the characteristics of the reduction position control system. Next, it [illegible]

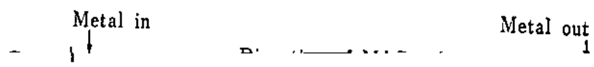
in **Fig. 16** by considering the forward slip and links such information to the micro-controller ⑨.

The micro-controller gives instructions concerning the aimed control speed to the roll speed control system, and simultaneously with the biting of the slab, it gives instructions concerning the thickness modification amount and control positions.

**Fig. 18** shows the flow chart of MAS rolling. Sizing MAS and broadside MAS are performed depending on the plan view pattern prediction model.






broadside rolling ratio of 1.5 was a boundary: the spool shape is produced below it and barrel shape

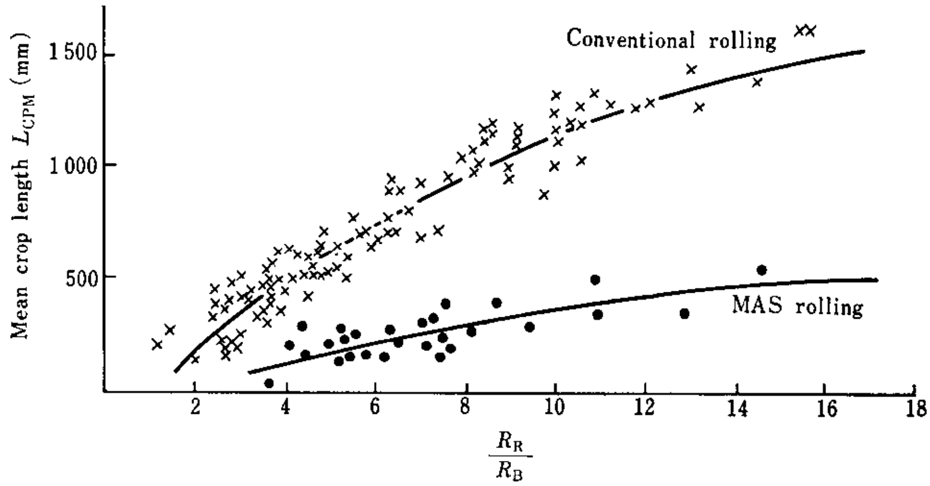



Fig. 21 Improvement of top- and bottom crop shape

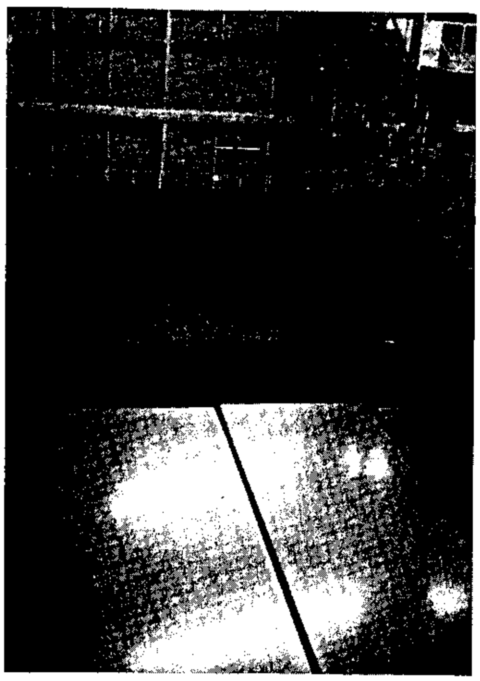
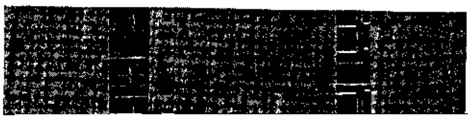


Photo. 4 Plate plan view pattern by MAS rolling



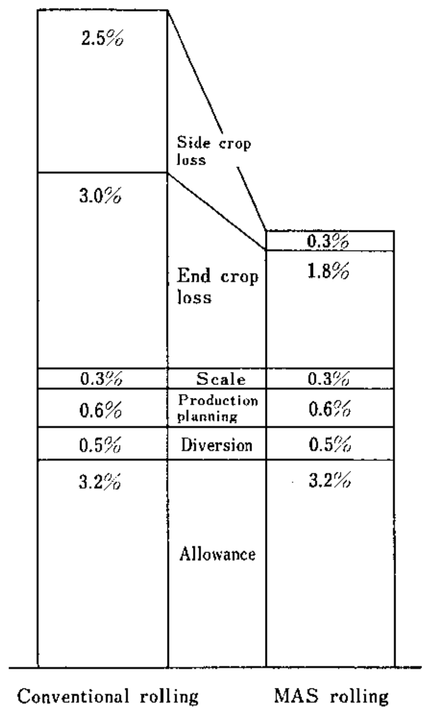



Fig. 22 Decreased loss through MAS rolling

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