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Simulation of Non-Steady Rolling Phenomena in Cold Tandem Mills

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Synopsis :

Mathematical models have been developed which can accurately simulate time-series changes of strip thickness, tension, rolling load, etc. in cold tandem mills. These are composed of mathematical rolling and regulator models, and results of simulation agree well with those of actual rolling. As analysis of non-steady rolling phenomena can easily be carried out by those models without actual rolling, the field of their application is very wide. Then, they were used for various studies to obtain knowledge about systems such as automatic gauge control characterized by both accurate gauge at the high speed rolling stage and short off-gauge length at the threading stage, and flying gauge change characterized by short gauge-change time.

冷間タンデム・ミルにおける

Simulation of Non-Steady Rolling Phenomena in Cold Tandem Mills

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冷間タンデム・ミルの計算によるシミュレーション例¹⁻³⁾はいくつかあるが、シミュレーションに用いた圧延データおよび制御系に関する定数値

$$\beta \begin{cases} 0.7(1号スタンド) \\ 0.6(2-5号スタンド) \end{cases}$$

(7) 張力式

$$\frac{d h_{bi}}{d T} = \frac{E}{L_i} (V_{oi} - V_{oi-1}) \quad (18)$$

$$h_{bi} = h_{i,j-1} \quad (19)$$

τ_{Li} : スタンド間移送時間(s)

i : スタンド番号

2・2 制御系モデル

(8) ストリップの移送遅れ式

$$H_{i,j} = h_i \exp(-\tau_{Li} \cdot \delta) \quad (20)$$

(δ : 延滞モデルの遅延の遅延)

よる圧下位置制御系 (APR) とロール速度制御系 (ASR) を考えた。これらの制御系をシミュレーション用にモデル化したブロック図を Fig.1 に示す。なお、Fig.1に示すおおよそ、 δ は速度の指令値

P : 圧延荷重 (kg)

b : 板幅 (mm)

k_m : 平均変形抵抗 (kg/mm²)

Q_p : 圧下力関数

R : 傾斜角、 r : ロール半径 (mm)

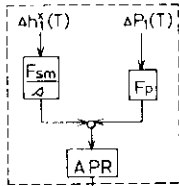
($\Delta S_p, VR_p$) に対して時間遅れを有する実際の圧下量およびロール速度を計算するものである。制御系の各係数は実回路を実測して決定し、モデルの制御応答性が実機のそれとよく合うことを確認し

$\Delta S(\text{mm})$

$VR(\text{mm/s})$

ΔS AGCシステムによる非定常圧延粗差

Screw down monitor AGC BISRA AGC



$\Delta h^s, \Delta h^s$: Thickness deviation by X-ray gauge

ΔP_1 : Rolling load deviation of No.1 stand

$V R_1^p$: Reference speed of roll

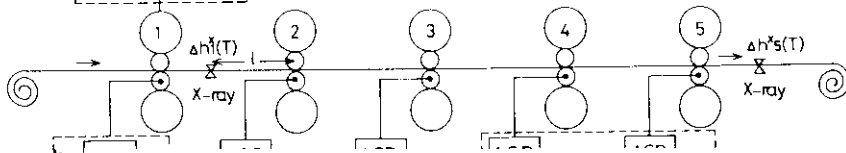
$F_{sm}, F_p, F_{vt}, F_{vm}$: Gain of AGC

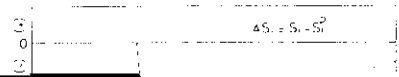
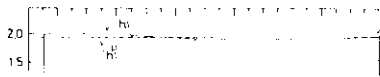
T : Time

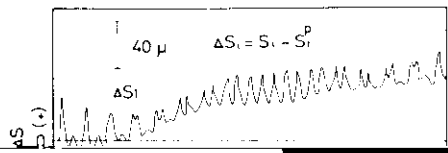
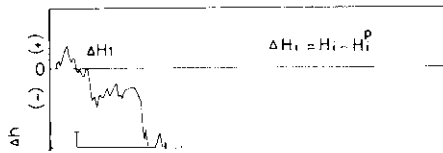
T_1 : Transfer delay time

G_m4, G_m5 : Successive gain

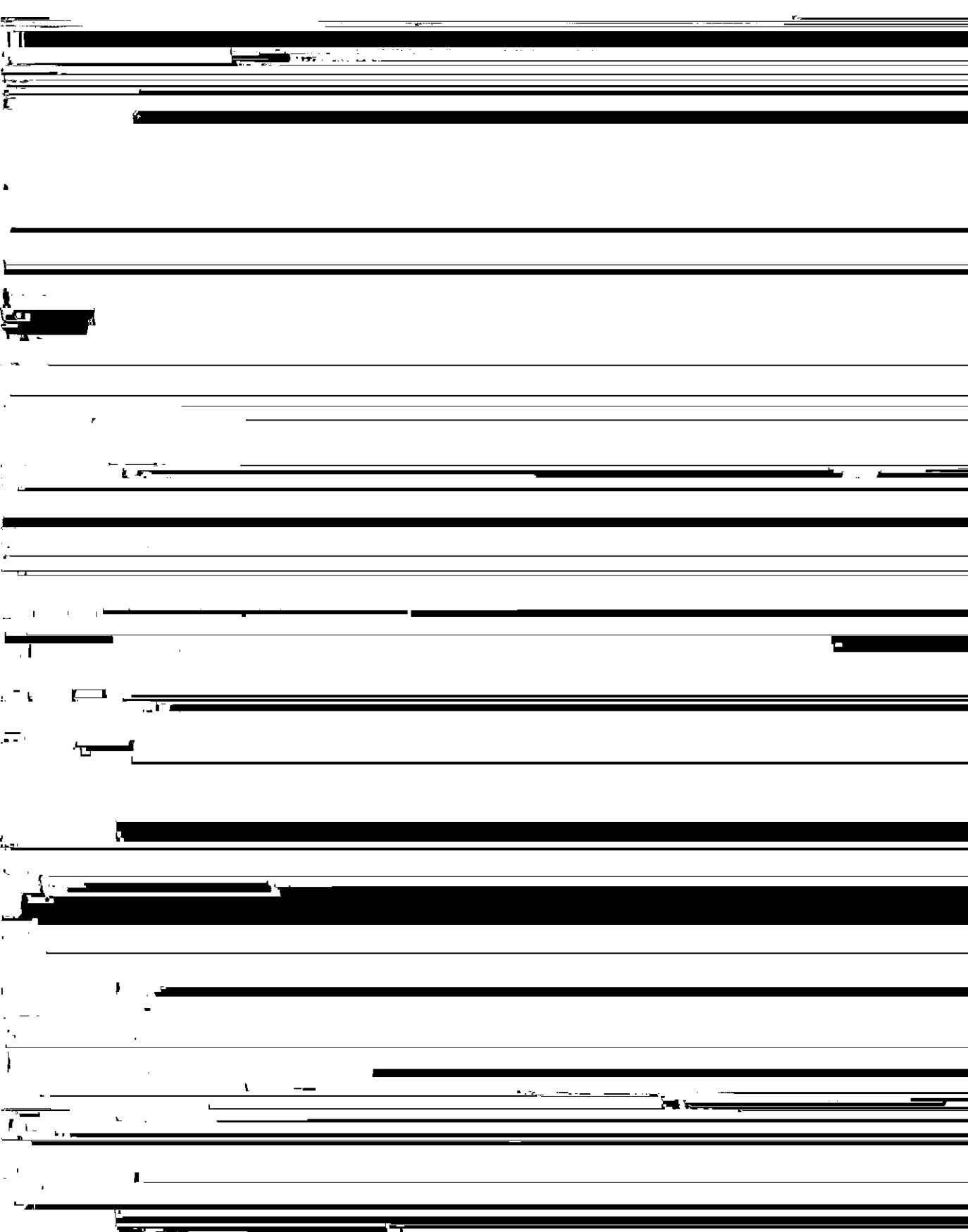
s : Laplace transformation operator







of the changing point passing through No.



ムが最適であることが明らかとなつた

はを得た。

5・2 走間板厚変更システムの検討^{9,10)}

5・1・5・5の検討項目はすべて実機にて確認して