KAWASAKI STEEL TECHNICAL REPORT
No.17 (October 1987)

Analysis and Control Systems for Shaft Vibration in Steel Rolling Processes

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Synopsis :
In recent years, the authors have been endeavoring to revamp steel rolling processes by realizing continuous and synchronized production between two processes in order to achieve higher quality of products. In cold and hot tandem mills or continuous annealing process lines, which required high response and high accuracy to the motor control system, the authors encountered troubles with shaft vibrations caused by interaction between mechanical and electrical control systems, and developed a new power drive technique which was effective in solving the problems. And authors were able to understand the influence of all the digital thyrister motor drive system and the cross current type cycloconverter drive system on the shaft vibration problem through computer simulation analyses and experiment

Analysis and Control Systems for Shaft Vibration in Steel Rolling Processes*



Synopsis:

In recent years, the authors have been endeavoring to revamp steel rolling processes by realizing continuous and

of high strength material for mechanical structures has led to a decrease in shaft cross section, and a decrease in the mechanical torsion natural frequency N_f of equipment. The torque amplifying factor TAF at the resonant point has also been adversely affected.

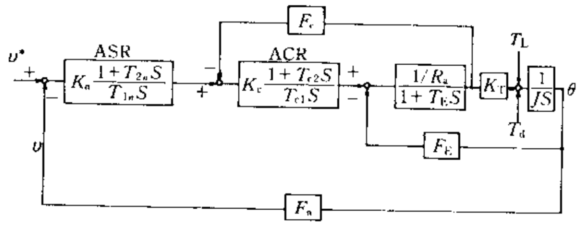
(2) Flexural Bending Vibration in Mechanical Drive System

When flexure, eccentricity or imbalance exists in the shaft system, the system vibrates at integermultiples of the rotary frequency of the roll- and motor-shafts. If, because of higher operating speeds, N_f lies within the actual-use rotary frequency, thorough examination is indicated.

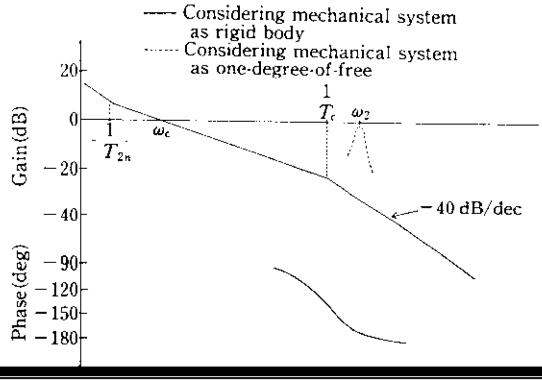
(3) Vibration of Mechanical Structures and Foundation

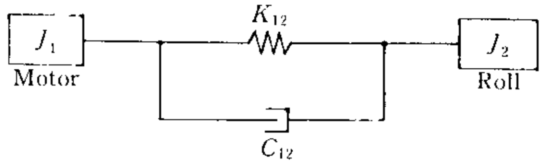
(4) Vibration of Strip Being Rolled

Clogging, slipping, changes in deformation charac-



v^*: Speed reference (rpm)
v: Speed feedback
$\dot{\theta}$: Angular velocity (rpm)
T_d: Torque disturbance (kgf·m)
T_L: Load torque (kgf·m)
R_a: Armature circuit resistance (Ω)
F_E: Voltage coefficient (V/rpm)
F_n: Speed feedback gain (mpm/rpm)
F_c: Current feedback gain
S: Laplacian
K_T: Torque coefficient

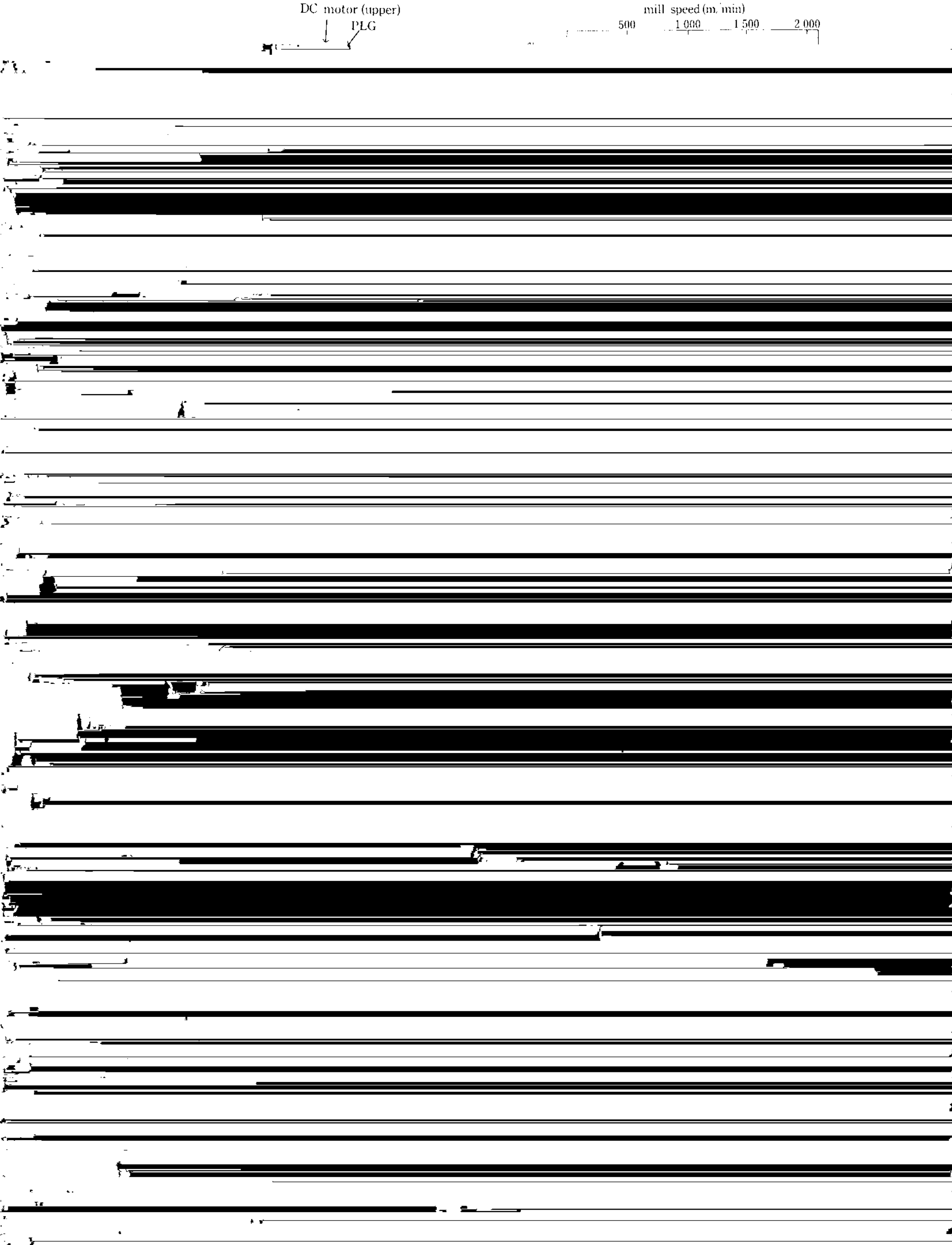




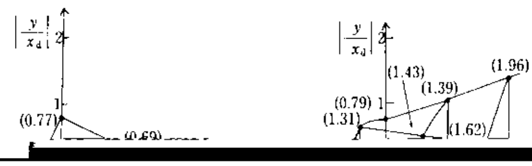
K_{12}: Equivalent torsional spring constant
C_{12}: Equivalent damping coefficient

Fig. 5 Mechanical resonance system

[redacted]

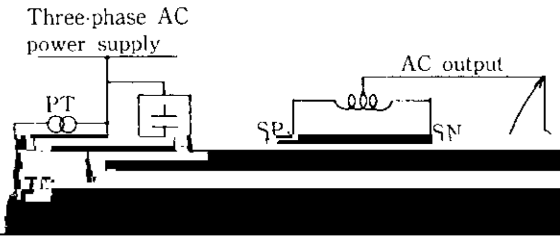

DC motor (upper)
PLG
mill speed (m/min)
500
1 000
1 500
2 000

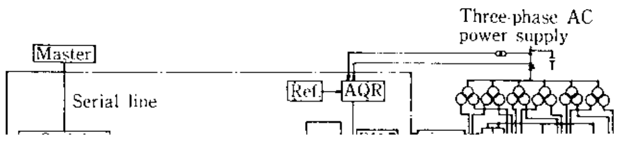
4.1.2 Simulation analysis comparison of analog control and digital control of thyristor Leonard control

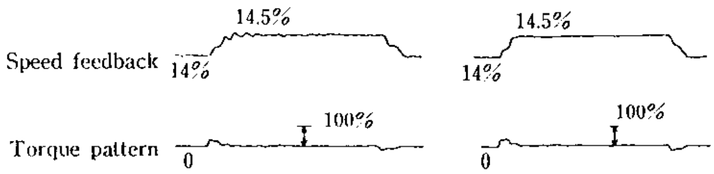


4.2 Effect of Speed Feedback Filter of Digital-type Thyristor Leonard Control System on Speed Response and Its Shaft Vibration Suppression Effect

4.2.1 Characteristics of speed feedback filter


Three-phase AC
power supply
PT
AC output
SP
SN


Master
Serial line
Ref
AQR
Three-phase AC
power supply



(a) Without MFC (b) With MFC

Fig. 19 Step response of speed

the MFC system are shown in Fig. 19. Speed feedback

signal fluctuations are greatly reduced with the MFC system.

6 Conclusions

The following conclusions were reached in respect of

speed detection feedback system is effective in

ensuring speed responsiveness and suppressing shaft vibrations.

(5) Shaft vibration suppression control by the model following control (MFC) system is effective. This method of control has been realized only through progress in theory and the development of micro-