(323) Development of Mathematical Model for Plate Rolling

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I. Introduction

In the 2nd plate mill of Pohang Iron & Steel Co., the hot rolling process has been controlled by process computer to increase the productivity and to stabilize the quality of steels. An exact mathematical model for rolling load prediction was required to improve the efficiency of process computer control. This work is concerned with the development of accurate mathematical model for plate rolling.

II. Experimental method

a.Measurement of hot deformation resistance

Hot tensile test was used to measure the hot deformation resistance under the various experimental condition as shown in Table 1. High temperature carbon equivalent equation and mathematical model for hot deformation resistance of steel were developed under the basis of experimental and actual rolling data.

b.Prediction of plate temperature during hot rolling

Development of accurate temperature calculation model is very important because rolling load is largely dependent on the plate temperature. Mean temperature and through thickness temperature distribution of plate were calculated by lumped and F.D.M. method respectively.

Following items were considered.

i) heat conduction inside the work piece
ii)radiation loss to the surrounding medium
iii)heat conduction to the work roll
iv)heat gained by work done in deformation
v)heat loss due to water descaling jets.

III. Results

a.Hot deformation resistance of steel (K) was expressed as a function of ε, $\dot{\varepsilon}$, T and high temperature carbon equivalent(Ceq).

$$K=\dot{\varepsilon}^{0.15}\cdot\varepsilon^{(0.37-0.019\,Ceq)}\cdot\exp\{0.84-0.23Ceq+(2.6\times10^{3}+0.33\times10^{3}Ceq)/(T+273)\}$$

To calculate the rolling load,Sim's equation and hot deformation resistance of steel,suggested in this work,were used. Calculated rolling load showed good coincidence with the measured rolling load as in Fig.1.

b.Calculated surface temperature showed good coincidence as in Fig.2. Mean temperature (T_{mean}) of plate was expressed as a function of surface temperature (STEMP) and plate thickness (Thick)on the basis of F.D.M. calculation.

$$T_{mean}=-4015.53+Ln(Thick)\times71.16+Ln(STEMP)\times699.16$$

Table 1. Experimental conditions for the measurement of hot deformation resistance

Variables	Experimental range
No.of steel grade	23
temperature (°C)	750-1100
Strain	0-0.2
Strain rate (S^{-1})	0.01-0.05

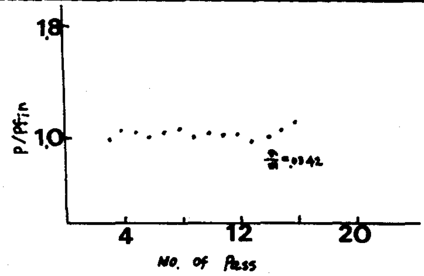

Fig.1. Ratio of measured(P) and calculated rolling load (P_{fin})

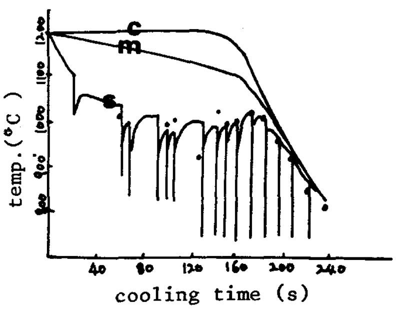

Fig.2.Comparison between calculated and measured temperature.
C:center temp., m:mean temp.,
S:surface temp., • : measured surface temp.