Available online at www.sciencedirect.com
ScienceDirect

JOURNAL OF IRON AND STEEL RESEARCH, INTERNATIONAL. 2014, 21(9): 817-822

Study and Application of Camber Control Model of Intermediate Slab in Rough Rolling

Hai-yu WANG, Quan YANG, Xiao-chen WANG, Feng HE, Yu-feng CHEN
(National Engineering Research Center of Flat Rolling Equipment, University of Science and Technology Beijing, Beijing 100083, China)

Abstract: In order to solve the camber problem of intermediate slab in a domestic conventional hot rolling mill, a three-dimensional elastic-plastic dynamic model was built through finite element method to quantitatively calculate the influence of lateral flow factors in different entry thicknesses, reductions, reduction ratios differences on both sides and width factors. Thus, the extending difference at outlet of intermediate slab in length was transformed into thickness difference on both sides by the results, and then the tilting value of roll gap reduction to control the camber was calculated. Based on the above results, the camber control model of intermediate slab in rough rolling was established. The practical application on the rough rolling mill obtained a decent control effect, and it proved that this model had a high accuracy.

Key words: rough rolling; intermediate slab; camber; lateral flow factor; finite element method

During the production process in conventional hot strip rolling mills, camber of intermediate slab is one of the most significant defects when rolling on multi-pass in rough rolling. The primary reason of camber generating is the different reductions on both sides, caused by rolled piece factors (wedge of incoming material, uneven temperatures on both sides, and deviation) and rolling mill factors (mill longitudinal stiffness differences on both sides, too big clearance of mill housing and bearing chock)[1]. The different reductions on both sides make the thickness and extension different in length direction on both sides. The camber of intermediate slab can influence the finish rolling production deeply, cause the outlet section wedge easily that affects quality of product, and even lead to some accidents such as tail-flick and steel-heaping which seriously affects the normal production. Accordingly, the work that reduces or eliminates the camber of intermediate slab is significant.

Up to now, a lot of results have been published by domestic and foreign researchers on the camber of intermediate slab[2-5], but they only involve mill longitudinal stiffness, the wedge of incoming material and the disproportionation of temperature on both sides, etc. However, there are few researches on the relation between the thickness difference and the extending difference in length. The relation might be difficult to calculate accurately, due to the lateral flow of metal in deformation zone. Therefore, in this paper, the camber of intermediate slab was simulated by using finite element software ABAQUS/Explicit to analyze the relation between the thickness difference and the extending difference in length on both sides. Based on the calculation results, the automatic control model of camber was established to control the defect of camber.

1 Analysis of Intermediate Slab Camber

In rough rolling process, the thickness compression of intermediate slab may cause extension in length and width direction. Due to the arc-shape of roller, the longitudinal friction is less than the lateral friction, so the contact length will be much less than the contact width in deformation zone, and the

Foundation Item: Item Sponsored by National Key Technology Research and Development Program in 12th Five-year Plan of China (2011BAE23B00); Fundamental Research Funds for the Central Universities of China (FRF-SD-12-013B)
Biography: Hai-yu WANG, Doctor; **E-mail**: wanghaiyu813@163.com; **Received Date**: October 28, 2013

slab mainly extends in length direction[6]. It assumes that inlet intermediate slab is straight enough, the shape of camber at outlet section is ladder and the effect of crown on thickness is ignored. As shown in Fig. 1, L_1 is the length of outlet slab on long side; h_1 is the thickness of outlet slab on long side; B_1 is the width of outlet slab on long side; L_2 is the length of outlet slab on short side; h_2 is the thickness of outlet slab on short side; B_2 is the width of outlet slab on short side.

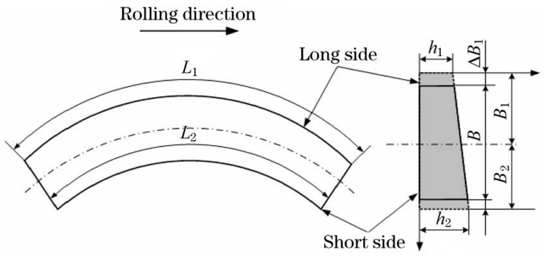

Fig. 1 Schematic diagram of intermediate slab camber

According to the principle of invariant volume in press working theory, the following formula can be obtained when ignoring the lateral flow:

$$L_{10}\times h_1 = L\times H = L_{20}\times h_2 \tag{1}$$

where, L_{10} and L_{20} are the lengths on long side and short side of outlet intermediate slab when ignoring the lateral flow, respectively; L is the entry length; H is the entry thickness.

When considering the lateral flow, the following equation can be obtained:

$$\begin{cases} (L_1+\bar{L})\times(h_1+\bar{h})\times B_1/4 = L\times H\times \\ \quad B/2 = (L_2+\bar{L})\times(h_2+\bar{h})\times B_2/4 \\ B_1 = B/2+\Delta B_1 \\ B_2 = B/2+\Delta B_2 \end{cases} \tag{2}$$

where, ΔB_1 and ΔB_2 are the values of lateral flow in width on long side and short side, respectively; B is the entry width; $\bar{L}$ is the average length of outlet slab; $\bar{h}$ is the average thickness of outlet slab.

The lateral flow of strip with large entry thickness and reduction on both sides cannot be ignored. Consequently, the lateral flow factors are defined as follows:

$$\begin{cases} s_1 = 2\times\Delta B_1/B \\ s_2 = 2\times\Delta B_2/B \end{cases} \tag{3}$$

where, s_1 and s_2 are the lateral flow factors in width on long side and short side, respectively.

Combining Eqs. (2) and (3), the thicknesses and length ratios of intermediate slab on both sides can be shown as follows:

$$\begin{cases} \dfrac{(h_1+\bar{h})/4H}{\bar{L}/(L_1+\bar{L})} = \dfrac{B}{2B_1} = \dfrac{1}{1+s_1} \quad (s_1\geqslant 0) \\ \dfrac{(h_2+\bar{h})/4H}{\bar{L}/(L_2+\bar{L})} = \dfrac{B}{2B_2} = \dfrac{1}{1+s_2} \quad (s_2\geqslant 0) \end{cases} \tag{4}$$

When $s_1=0$, $s_2=0$, Eq. (4) equals Eq. (1). s_1 and s_2 affected by the lateral flow factors are gained by simulating the results.

From Eq. (4), the thickness difference of intermediate slab on both sides, Δh[7], can be shown as:

$$\Delta h = h_2-h_1 = 4\times H\times[(L_1+L_2)/(L_1+3L_2)/(1+s_2)-(L_1+L_2)/(3L_1+L_2)/(1+s_1)] \tag{5}$$

where, L_1 and L_2 are respectively fitted to a parabola by center-line deviation[8,9] of intermediate slab which is detected by width gauge, and then the parabolas on both sides are respectively scattered to some points. So, the coordinate of points on both sides which correspond to points on center-line can be obtained according to the width of intermediate slab, the coordinate and the normal of each point on center-line. Then, the lengths on both sides can be obtained by summing the ordinate of adjacent points.

2 Simulation of Lateral Flow Factors

2.1 Establishing of finite element model

As an example of 2160 rough rolling mill in a domestic factory, a dynamic analytic model of intermediate slab was established in rough rolling process by using ABAQUS/Explicit software[10,11]. The work rolls were defined as analysis rigid bodies, and the intermediate slab as elastic-plastic body. The type of elements is C3D8R and the total number is 191750. In order to ensure the accuracy of the results and improve solving efficiency, the grids were refined on sides to reduce the number of elements. Fig. 2 shows the 3D dynamic FE model, and the parameters are given in Table 1.

Fig. 2 3D dynamic FE model

Download English Version:

https://daneshyari.com/en/article/1628535

Download Persian Version:

https://daneshyari.com/article/1628535

Daneshyari.com