Analysis and optimization of CVC backup roll contour of a 1800mm continuous hot rolling mill

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Abstract. The backup rolls are used with work rolls and their service period is much longer than work rolls. The backup roll affects the control ability of the mill for profile and flatness of products and roll contact pressure. If the backup roll contour is not appropriate, there will be a non-uniform roll contact pressure and the peak value of roll contact pressure may be large. According to the actual situation of a 1800mm CVC mill, combined with the typical wear condition of backup roll, A 3D finite element model of roll system was established. The roll contact pressure is analyzed with the model, and the improvement method of backup roll contour is proposed. With the improved backup roll contour, the non-uniform level of roll contact pressure drops by 18.2% and the peak value of roll contact pressure descends by 19.1%. All these can reduce the consumption of backup roll and the risk of backup roll spalling effectively.

Introduction

The hot rolling mill works under the condition of high temperature and heavy load, both backup roll and work roll will have non-uniform wear[1,2]. For the CVC roll contour, due to its asymmetric roll curve, the wear of backup roll is more serious[3]. In order to improve the roll contact pressure for CVC mills, more and more backup rollers used CVC roll contour to match the work rolls. The service period of backup roll is always one to four weeks that much longer than work roll. If the backup roll contour is not appropriate, there will be a non-uniform roll contact pressure and the peak value of roll contact pressure may be large. These will lead to instability of rolling, even lead to backup roll spalling. [4] Reasonable backu roll contour can improve the roll contact pressure, reduce the non-uniform wear and avoid the backup roll spalling.Hao et.al.[5] improved the backup roll contour from conventional roll contour to CVR roll contour to uniform the roll contact pressure.Li et.al.[3]adopted MBR roll contour instead of conventional roll contour and the backup roll wear uniformed after improvement. In this paper, the roll contact pressure improved by choosing the optimal range of the equivalent crown of the CVC roll contour for backup roll.

Analysis of the backup roll contour of the 1800mm CVC continuous hot rolling mill

For the 1800mm hot rolling production line, the CVC roll contour are used for the work rolls and backup rolls of all stands. The backup rolls have chamfers in edge. This paper analyzed the backup roll of F4 which wear the most seriously in all stands. The equivalent crown range of F4 backup roll contour is [1.15mm,-0.15mm], the backup roll contour of F4 is shown as Fig.1(a). The typical wear condition of F4 backup roll is shown as Fig.1(b). The wear curve in the middle of the backup roller is "S" type similar as the CVC roll contour and there is a peak at the edge of the wear curve, just as Fig.1(b)shown. These will lead to instability of rolling and be a danger of spalling.

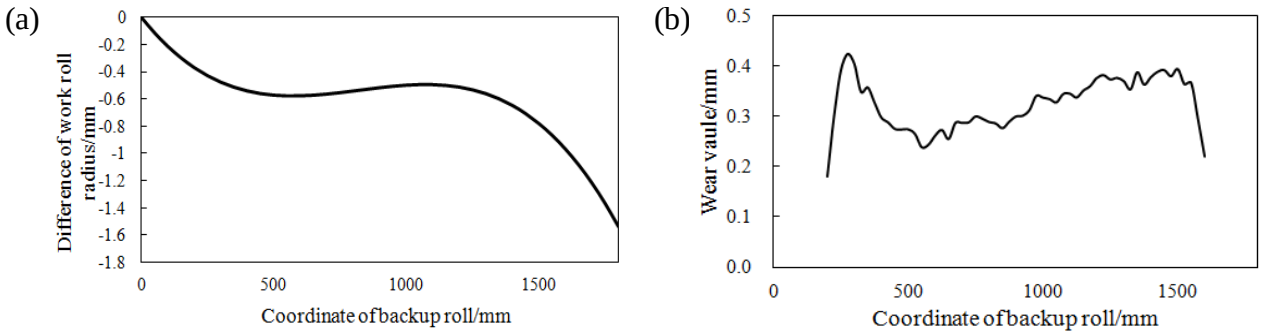

Fig.1 (a) the backup roll contour of F4; (b) The wear value of F4 backup roll

During the rolling, the backup roll only contact with the work roll and the wear of backup roll is mainly related to the roll contact pressure. So the roll contact pressure should be analyzed. A 3D finite element model of roll stacks for 1800mm hot rolling mill was built using ANSYS software package[6,7], just as Fig.2 shown.

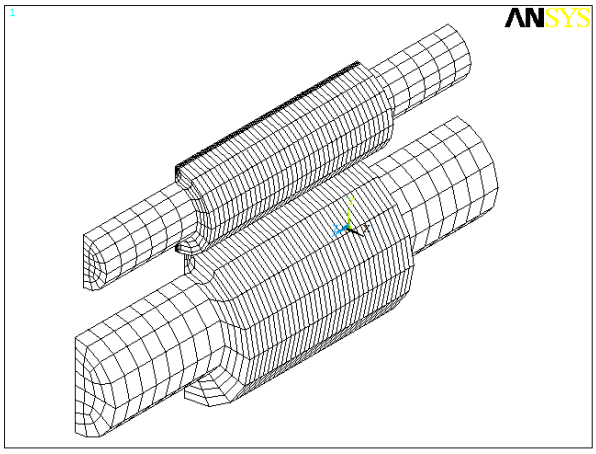

Fig. 2 the 3D finite element roll stack model for a 1800 mm 4-hi mill

The roll contact pressure can be calculated by the finite element model. The rolling parameters just use actual production data. The rolling force is 10kN/mm, the bending force is 300kN, the shifting is 0mm and the strip width is 1300mm. The distribution of calculated roll contact pressure is shown in Fig. 3. The distribution of calculated roll contact pressure is similar as the wear curve of backup roll just as Fig.3 shown. These show that the roll contact pressure directly affects the wear of the backup roll. So the wear of backup roll can be improved by improving the roll contact pressure.

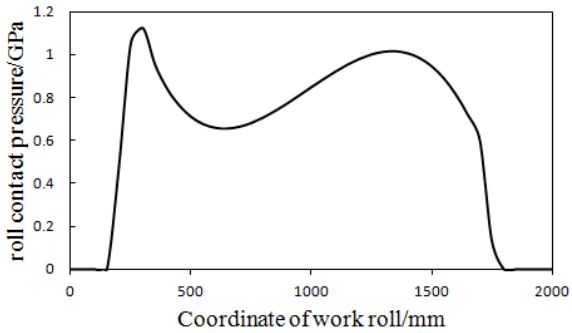

Fig.3 the distribution of calculated roll contact pressure

Improvement of CVC roll contour of backup roll

Before the improvement of backup roll contour, the direction of improvement (increase or decrease the equivalent crown range of CVC roll contour) should be determined first. Whether the equivalent crown range is large or small can be decided by the relationship between the distribution of roll contact pressure and the

CVC work roll contour. When the distribution of roll contact pressure is similar to the CVC work roll contour, the equivalent crown range of CVC backup roll contour is small. When the distribution of roll contact pressure is opposite to the CVC work roll contour, the equivalent crown range of CVC backup roll contour is large. The CVC work roll contour of F4 is shown as Fig.4.Compare with the distribution of roll contact pressure of Fig.3, the CVC work roll contour is opposite to the distribution of roll contact pressure. So the current equivalent crown range of CVC backup roll contour is large. It should be reduced.

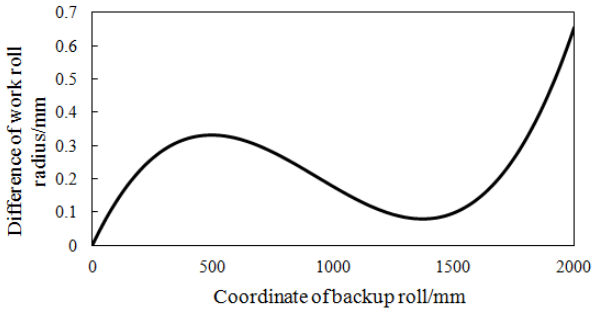

Fig.4 the CVC work roll contour of F4

The equivalent crown range reduce 0.1mm each time, and calculate the roll contact pressure by the finite element model, results are shown in Fig.5. The distribution of roll contact pressure is more uniform and the peak value is reduced with the decrease of the equivalent crown range. However, when the equivalent crown decreases too much, the peak shift from one side to the other side, the distribution of roll contact pressure is similar to the CVC work roll contour. These mean the equivalent crown range is too small.

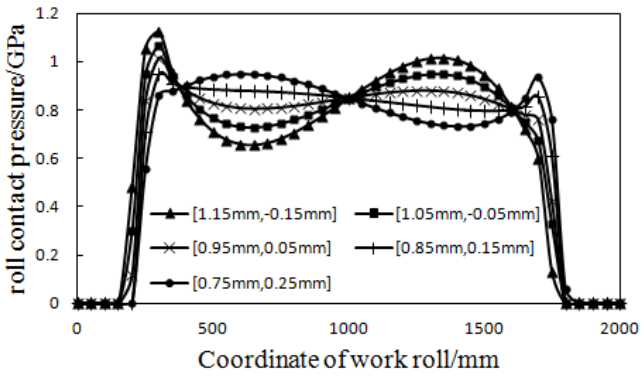

Fig.5 the roll contact pressures of different CVC backup roll contours

The improvement effect of backup roll contour can be reflected by the peak and non-uniform level of roll contact pressure[8]. In addition, the standard deviation between the calculated value and the average value of roll contact pressure should be considered too. It can reflect whether the distribution of roll contact pressure is reasonable. All these are shown in Table 1.

Table1 the parameters of roll contact presure for different backup roll contour

the equivalent crown range[mm]	the peak value of roll contact pressure[Gpa]	the non-uniform level of roll contact pressure	the standard deviation
[1.15,-0.15]	1.122	1.327	3.7583
[1.05,-0.05]	1.067	1.261	2.3916
[0.95,0.05]	1.016	1.198	1.0225
[0.85, 0.15]	0.949	1.115	0.9346
[0.75, 0.25]	0.951	1.121	2.0915

As Table 1 shown, when the equivalent crown range is smaller than [0.85mm,0.15mm], the roll contact pressure will deteriorate as the equivalent crown range decreased. So [0.85mm,0.15mm] is the reasonable

equivalent crown range. The backup roll contours before and after improvent are shown as Fig.6. With the improved backup roll contour, the non-uniform level of roll contact pressure drops by 18.2% , the peak value of roll contact pressure descends by 19.1% and the standard deviation descends by 75%.

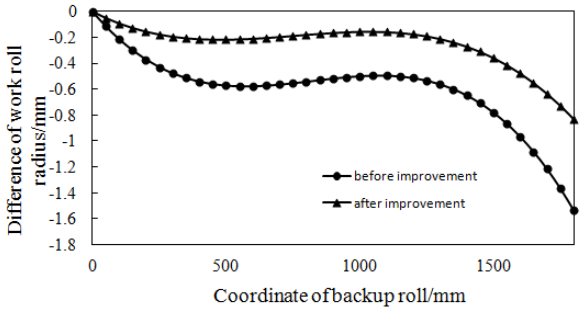

Fig.6 the backup roll contours before and after improvent

Conclusion

1. The typical wear condition of F4 backup roller for the 1800mm CVC mill was analyzed and a 3D finite element model of roll system was established. The roll contact pressure was calculated by the model. It was found that the distribution of calculated roll contact pressure was similar as the wear curve of backup roll by compared them. So the wear of backup roll can be improved by improving the roll contact pressure

2. It was found that the current equivalent crown range of CVC backup roll was too large by analyzed the relationship between the distribution of roll contact pressure and the CVC work roll contour.

3. Improved the CVC backup roll contour, and got reasonable contour by analyzed the contact pressures of different backup roll contours. With the improved backup roll contour, the non-uniform level of roll contact pressure drops by 18.2% and the peak value of roll contact pressure descends by 19.1%.

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