

Development of Numerical Model Based Deep Learning for the Roll Force Prediction of the Hot Rolling Process

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Extended Abstract

In hot strip rolling, a capability for precisely predicting roll force is crucial for sound process control. As far as the prediction accuracy is concerned, a rigorously formulated finite element (FE) process model is perhaps the best choice. However, a FE process model in general requires a large CPU time, rendering itself inadequate for on-line purpose. In this paper, we present a on-line prediction model applicable to precision process control in a finishing mill.

During the several decades, the models for the roll force during rolling are demonstrated for the precise prediction on the basis of the finite difference models [1-2] and the finite element (FE) models [3-5] than on the basis of the elementary models [6-8] which inherently involve many simplifying assumptions. However, a precise model such as a FE process model tends to require a large time for the calculation. In this paper, a numerical model based deep learning is presented for the prediction of the roll force during the hot rolling.

The hot rolling process consists of reheating furnace, roughing mill, induction heater and finishing mill. There exist several reheating furnaces to heat the slab for the rolling temperature, the roughing mill to reduce the thickness, the induction heater for additional heating and the finishing mill to produce the product of desired thickness. Before the rolling, the set-up of roll forces and gaps for the rolling stands was performed for the desired thickness of the strip. If the set values of the roll forces are not correct for the outlet thickness, the thickness deviation is high, furthermore the strip does not meet the customer's requirements. For the hot rolling process, sound prediction of the roll forces is vital for achieving the desired thickness for the customer's requirements. In addition, by achieving the desired thickness at each rolling stand, we can ensure rolling stability.

In this paper, mathematical model is presented for the prediction of the roll force before the rolling to set the roll gap. The model consists of a numerical model for the prediction of the roll force, a sub-models for the prediction of the mechanical properties of the strip by the deep learning, which is the deep neural networks. The sub-models to predict the mechanical properties during rolling is developed based on the results of finite element (FE) simulations. From the combination of these models, the roll force before the rolling to set the roll gap can be predicted to produce the desired thickness of the strip. The prediction accuracy of the proposed model is examined through comparison with actual data.

References

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