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OPTIMAL WATER COOLING CONTROL FOR PLATE ROLLING

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Abstract. *In hot rolling process, rolled plate is cooled by spraying water so that plate temperature distribution is uniformed and reaches to the desired one. Through this process, quality of finished plate can be improved to high level. However, in water cooling process, measuring points of plate temperature are limited because of existence of the water mist. Further, a plate is suffered from complex phenomena such as heat transfer variation in high temperature between plate surface and cooling water. Therefore, there exist a lot of difficulties in controlling plate temperature distribution by a simple feedback control method. The objective of our research is to construct mathematical descriptions for a water cooling control. In this paper, LQ control system for plate temperature control in water cooling process is proposed based on the mathematical model of plate temperature, which adjusts cooling rate given to plate. The model was derived using finite element modeling method of heat transfer in lateral direction. Cooling speed of plate temperature during water cooling can be regulated adjusting weighting matrices in LQ control scheme. The practicability of the proposed method was checked through numerical experiments.*
Keywords: Water cooling, Plate rolling, Heat transfer model, Finite difference method, Finite element method, State equation, LQ control

1. **Introduction.** Plate quality is highly dependent on plate temperature distribution in hot rolling process. Achieving high quality of plate, hot rolling process requires that plate is cooled so that plate temperature distribution is uniform. At the same time, cooling speed of plate is required to be kept at a certain value. Usually, plate temperature distribution is cooled to the desired one by water cooling. In water cooling process, plate temperature distribution is estimated by the difference between the measured temperature and the desired one. Based on the estimated temperature distribution, plate cooling process is controlled by adjusting spraying water on the surface of plate opening and closing of valves in water-cooling apparatus. However, there are no means of precise realization of plate temperature distribution control during cooling. As for the reasons, measuring points of plate temperature are limited because of the water mist. Further, in water cooling process, a plate shows complex phenomena such as heat transfer variation between plate surface and cooling water. Therefore, there exist a lot of difficulties in controlling plate cooling properly.

In this research, we purse the construction of water cooling control system to attain a desired plate temperature distribution based on the mathematical description of plate temperature.

First, plate temperature model is constructed, which represents plate temperature characteristics during water cooling. Based on the heat transfer model, the mathematical