Experimental Investigation of Pinching Phenomena in Cold Rolling of Thin Steel Sheets

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Abstract. During rolling of metal sheets defects may occur, such as local waviness, surface ruptures, and sometimes strip breaks. These phenomena, commonly referred to as 'pinching', have been observed in combination with snaking problems (strip sideward movements) or tailing out, but even in the case of continuous rolling. Severe pinches compromise the strips quality and damages to the work rolls can also be caused. This clearly affects the production, resulting in low product quality, process delays and, consequently, in extra costs. The Fig. 1 represents part of a pinched strip where defects develop before the catastrophic complete rupture of the sheet. Even though pinching is a widely experienced issue, during both hot and cold rolling, it is not clear what mechanism is behind it. Pinches occur due to disruptions in the rolling process, therefore pinching sensitive operative regimes need to be identified such that mill operations can be performed in a way that keeps the process stable. Currently, pinching cannot be predicted by rolling simulation models due to the lack of knowledge about the circumstances leading to pinches. Therefore, rolling experiments have been performed at the pilot mill in Tata Steel (IJmuiden) in order to understand under which settings pinches are more likely to occur. This work contains important findings related to certain process conditions which result in pinching defects. It is shown that pinching phenomena take place when perturbations are introduced during the steady-state rolling process. This experimental approach allows to detect some process settings which play a role in the occurrence of these defects. Analysis of pinched material is performed, specifically to highlight the microstructure developed in the defect zone. This leads to fundamental considerations about the mechanism which results in pinching phenomena, providing a deeper insight into the problem.

Fig. 1 Pinching phenomena in a cold rolled steel sheet.

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