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Plastic Deformation of Cold-rolled Thin Sheets by Empirical results

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Abstract

Material flow in roll bite occurred during symmetric or asymmetric rolling of thin sheet was investigated by model rolling experiment in this study. The sheet samples with fine grids drawn by laser processing on longitudinal-thickness cross-section at the middle of the sheet width were used for the experiment to visualize material flow. By measuring the changes of roughness in the cross section after rolling, it was confirmed that the rolling was conducted practically in plane strain conditions in the cross section. Also the changes of vertical ruled lines before and after rolling reflect material flow throughout the roll bite. It clearly shows the characteristic that the inclination angle of the ruled line due to rolling increases monotonically as the different speed ratio increases. To compare the material flow of model rolling experiment, two dimensional steady-state rolling analysis using rigid plastic finite element (FE) method have been conducted. The profiles of the ruled line observed in the experiments have a good agreement with the calculated results. Also the calculated results of equivalent plastic strain reveal non-monotonical relations between the strain and the different speed ratio (i.e. maximal of the strain observed at certain different speed ratio). This qualitative discrepancy observed between the measured angles and the calculated strains in relation to the different speed ratio suggests that measurement of the angle of the ruled lines is not sufficient to characterize plastic strain.

Key words: Rolling, Material flow, Finite Element Method, Plastic strain

Introduction

It is important to clarify material flow in cold rolling for understanding the deformation of rolling, so studies by experiments or numerical calculations have been conducted. For example, material flow has been investigated by model mill rolling experiment by a method of providing a lattice-like scribe line [1], or by a method of inserting a pin in the thickness direction [2, 3]. But it is difficult to satisfy both plane strain constraint on material deformation and placement accuracy of tracer for displacement measurement, especially in application to thin sheet rolling. In this study, an experimental method to visualize the material flow in cold rolling with practical accuracy was proposed, by embedding profiled sheet component with fine grids. Also, the material flow due to