

Politechnika Śląska

Wydział Inżynierii Materiałowej



Rozprawa doktorska

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**Sterowanie stanem naprężeń własnych w szynach kolejowych poprzez
modyfikację kalibrowania walców i rolek prostujących prostownic**

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SUMMARY OF DOCTORAL THESIS

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"The way of controlling the state of residual stresses in railway rails by modifying the roll pass design of rolls and straightening rollers"

The concept of the thesis assumes obtaining a lower level of residual stresses in the rail foot in relation to the currently required normative values by means of the use of a new, unique roll pass design of roll grooves and straightening rollers and related changes in technological parameters of rolling and straightening processes.

The theoretical part of the thesis covers the importance of residual stresses in rails and their impact on the operational properties of railway rails, in particular their resistance to cracking, development of rolling contact fatigue and overlapping residual stresses occurring in rails on thermal stresses and dynamic stresses from operation. A review was also made of worldwide standards in the field of requirements imposed on railway rails regarding the permissible level of residual stresses and the measurement methodology as well as a review of currently available destructive and non-destructive methods of testing residual stresses in rails. The last chapter of the theoretical part of the dissertation contains the analysis of the impact of rail technology in the field of rolling, cooling and straightening processes on the distribution of residual stresses in the finished product.

The research part presents the results of the accepted study programme including the determination of the impact of changes in the shape of the working surface of the rollers of vertical and horizontal straighteners on the state of residual stresses in the rail foot and the results of the impact of changing the shape of roll grooves in Z2, D1 and D2 stands in the rail foot area, which after straightening process lead to a reduction of the residual stresses. In the first stage of own research, numerical simulations of the straightening process were carried out using different variants of the straightening rollers and computer simulations of the rolling process using new roll pass design of roll grooves. Then, in industrial conditions, straightening experiments were carried out using innovative straightening rollers and rolling rails using a new roll pass design of finishing stand groove to give the concavity of the rail foot and straightening the rail using traditional and shaped straightening rollers. Laboratory tests of chemical composition, mechanical properties of rail steel and tests of the residual stresses distribution in various places on the rail perimeter by the method of strain gauges and hole drilling were carried out.

The summarizing part contains a statistical analysis of the results of empirical research and assesses the influence of carried out rolling and straightening experiments on the level of residual stresses not only in the rail foot but also in rail web and rail head and in selected 16 places on rail perimeter. The influence of individual experiments on the obtained straightness in the vertical and horizontal plane as well as the geometrical correctness of the finished product were also analysed. A method of calculating the averaged stresses as an indicator of the effectiveness of reducing the residual stresses in rails has been developed. Formulated final conclusions have the form verifying the accepted objective of the thesis and indicate the selected straightening variant for use in industrial conditions.

Key words: railway rail, residual stresses, roll pass design of straightening rollers, roll pass design of rolls, strain gauge method of measuring residual stresses, hole drilling method, rail rolling, rail straightening.