

Jagoba Lekue

Error Estimation in
Wheel-Rail Normal Contact
Area Measurements Using
Pressure Sensitive Film

Error Estimation in Wheel-Rail
Normal Contact Area Measurements
Using Pressure Sensitive Film

Fehlerabschätzung bei der Bestimmung von
Kontaktflächen im Rad-Schiene-Normalkontakt
mittels Druckmessfolie

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Preface

This work originated as a result of my research at the Institute of Rail Vehicles and Transport Systems of the RWTH Aachen University.

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Linz, April 2022
Jagoba Lekue

Summary

This monograph presents a series of research activities with the goal of determining whether pressure measurement films are a suitable tool for a quantitative assessment of the wheel-rail contact area. Firstly, the effect of influential factors such as geometry, applied load and surface roughness on the resulting imprint was thoroughly examined by means of analytically approachable case studies. This allowed a precise determination of the systematic error that alters experimental outcomes. After that, finite element representations of the measurement procedure were explored in order to characterize the measurement deviation based on mechanical principles. By virtue of the excellent reproducibility of the measurement procedure, as well as the meaningful insight obtained from finite element simulations, an empirically calibrated film model that matches experimental outcomes was developed. This was alternately interposed between wheel and rail models to estimate the measurement error originated under typical operation conditions. The results underline the marked dependence of the measurement error on surface roughness but foresee a robust and reliable use of pressure measurement films for validation of wheel-rail contact models as long as both numerical and experimental solutions represent the same reality of interest.

Zusammenfassung

Die vorliegende Monographie beschreibt eine Reihe von Forschungsaktivitäten, in denen die Eignung von Druckmessfolien zur quantitativen Auswertung der Rad-Schiene-Kontaktfläche bestimmt wurde. Zunächst wurde die Auswirkung von Einflussfaktoren wie Geometrie, Last und Oberflächenrauheit auf den resultierenden Abdruck anhand von analytisch lösbaren Fallbeispielen eingehend untersucht. Dies ermöglichte eine präzise Quantifizierung des systematischen Fehlers, der zu einer Verfälschung der experimentellen Resultate führt. Anschließend wurden Finite-Elemente-Modelle des Messverfahrens herangezogen, um die Messabweichung aus mechanischer Perspektive zu charakterisieren. Aufgrund der hervorragenden Reproduzierbarkeit des Messverfahrens sowie der aufschlussreichen Erkenntnisse aus Finite-Elemente-Simulationen, konnte ein empirisch kalibriertes Folienmodell entwickelt werden, welches experimentelle Ergebnisse nachbildet. Dieses wurde dann abwechselnd zwischen Rad- und Schienenmodellen eingefügt mit dem Ziel, den Messfehler, der unter typischen Betriebsbedingungen entsteht, abzuschätzen. Die Oberflächenrauheit konnte dabei als wesentlicher Einflussfaktor auf den Messfehler identifiziert werden. Außerdem kann aus den vorgenommenen Untersuchungen abgeleitet werden, dass Druckmessfolien zuverlässig und robust zur Validierung von Rad-Schiene-Kontaktmodellen eingesetzt werden können, vorausgesetzt, dass kohärente numerische und experimentelle Lösungen vorliegen.

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