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WORKSHOP ON RAIL CORRUGATIONS AND OUT-OF-ROUND WHEELS

1. INTRODUCTION

The following six papers were presented at a Workshop on Rail Corrugations and Out-of-Round Wheels which took place at the Technical University of Berlin on November 13, 1997. The workshop was organised by the Interdisciplinary Research Group in Rail Technology (Interdisziplinärer Forschungsverbund Bahntechnik) at the Technical University of Berlin and was chaired jointly by Prof. Ken Johnson (Cambridge), Prof. Klaus Knothe (Berlin) and Dr Stuart L. Grassie (Berlin and Glasgow). The aim of the workshop was to bring together people from science and practice in order to discuss new attempts which have been undertaken to understand the causes and consequences of rail corrugations and out-of-round wheels. Twelve papers in total were presented, of which seven have been chosen for publication in the Journal of Sound and Vibration. Four of these deal with rail corrugations and three with the problem of wheel polygonization.

Until recently it seemed that rail corrugation and out-of-round wheels were primarily problems of noise, reduction in passenger comfort, and an increase in track and possibly also vehicle maintenance. The recent (May 1998) Inter City Express (ICE) accident at Eschede in Germany made clear that out-of-round wheels may also be a problem of safety.

The first paper on rail corrugation, by Steffen Müller, is a new attempt in the tradition of Frederick and Sinclair [1], Valdivia [2] and Hempelmann [3] (linear approach) on the one hand as well as Ilias and Igeland [4] (non-linear investigations) on the other to explain the initiation of short pitch rail corrugation. Müller as well as the other authors before him combines short term dynamics of a wheelset rolling over a discretely supported rail with a long term wear feedback loop. Frederick, Valdivia and Hempelmann concentrated on the effects of structural dynamics. These result in mechanisms in which the corrugation is associated with a constant frequency, so that the wavelength varies in proportion to the predominant train speed. However, it is shown by Müller that even if the effects of structural mechanics are relatively subdued, there would be a tendency to produce corrugation in a wavelength range of 2–10 cm simply as a result of the contact mechanics.

Jakob B. Nielsen's paper contains a new mathematical approach for solving the problem of a cylinder rolling on sinusoidal rail irregularities. A similar problem has previously been considered by Piotrowski and Kalker [5, 6]. In contrast to Piotrowski's approach, Nielsen avoids having to discretize the contact patch. Non-elliptical contact pressure distributions are taken into account. The new method for solving problems of rolling contact mechanics is used to investigate the conditions under which sinusoidal irregularities on a

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surface (such as a rail) may increase, without any influence of structural mechanics. His conclusion is similar to that of Müller: sinusoidal irregularities increase preferentially in a particular wavelength range.

Heike Ilias's paper is an approach to the rail corrugation problem in which non-linearities of contact mechanics are taken into account as well as transient structural dynamics within the long-term wear process. The aim is to investigate the influence of railpad stiffness on corrugation growth. Starting with measured rail profiles it found that corrugations grow more quickly with stiffer railpads. In addition, a novel influence of the sleeper passing frequency is demonstrated.

The paper of Stuart Grassie and his colleagues presents an instrument for measuring the longitudinal rail profile. The results of such measurements can be used, as in the Heike Ilias paper, as an input to numerical models. The results are also used to propose and examine the validity of criteria to assess whether longitudinal irregularities have been removed satisfactorily by rail grinding.

The subsequent three papers deal with polygonization of wheels. Since 1993 there have been several research projects in Germany dealing with polygonal, or out-of-round wheels, after this problem became apparent on monobloc wheels on the first series of ICE vehicles. Four possible causes of polygonization have been proposed. In all of these, the polygonal wheel profile is considered to arise as the result of a feedback process, involving wear and structural dynamics, which is essentially similar to the models which have been established for corrugation generation.

In Morys' paper a method is presented to analyse the growth of out-of-roundness. In general, the method is quite similar to the investigations on initiation of rail corrugations which have been introduced by Frederick, Valdivia, Hempelmann and Müller. In contrast to these papers, however, the Morys approach is completely non-linear, so that, for example, it is possible to represent loss of contact which may occur as a result of extreme out-of-roundness. There are similarities between this work and that undertaken by Soua in France [7],

In the final paper, Peter Meinke shows that out-of-roundness may arise even in the absence of geometrical or material inhomogeneities, on wheel treads which have no initial irregularity. Methods which are well known from classical rotor dynamics are used to demonstrate that out-of-roundness may develop quickly if the wheelset is initially slightly imbalanced.

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