Conference proceedings (Volumes 1 and 2) of the

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Which "Horse" For Your "Course"?

By: Brian Bock, Group General Manager Technical Services, Queensland Rail

Summary: This paper describes the wheel/rail interface and associated problems. It concentrates on the issue of profile management and the differing strategies. The question is asked as to whether these different strategies can be valid and if so under what conditions. A brief history of the experiences of three Australian rail systems is given. The paper provides some directions considered worthy of future work from a railway operators point of view.

The complete technical paper can be found in the International Heavy Haul Association's 1999 STS Conference on Wheel / Rail Interface held June 14-17, 1999 in Moscow, Russia.

Wheel/Rail Interaction, Train Safety and Cost of Traffic

By: Victor M. Bogdanov, Deputy Director, All-Russian Railway Research Institute, Russia

Summary: In this paper, the main directions of research work performed on Russian Railways on a problem at trackrolling stock interaction, are described. Establishing permissible train speed, track and bogie maintenance norms, rolling stock certification tests, wheel flange wear and side wear of the rail head are examined.

The complete technical paper can be found in the International Heavy Haul Association's 1999 STS Conference on Wheel / Rail Interface held June 14-17, 1999 in Moscow, Russia.

Rail/Wheel Interaction from A Track And Vehicle Design Perspective

By: Harry M. Tournay, Pr Eng. BSc Eng. (Mech.) (Rand) FSAIME Assistant General Manager, Spoornet (Engineering)

Summary: In this paper the influence of suspension design on the tracking characteristics of railway vehicles is discussed together with the resulting interaction between rail and wheel. Contact mechanics and the forces acting between the rail and a railway wheelset are reviewed. The influence of suspension design on these forces is described. A design philosophy is presented for rail and wheel profiles in order to optitnise rail/wheel interaction and vehicle tracking characteristics. A rail and wheel management maintenance approach is then proposed together with anticipated future development directions.

The complete technical paper can be found in the International Heavy Haul Association's 1999 STS Conference on Wheel / Rail Interface held June 14-17, 1999 in Moscow, Russia.

Modelling of Rolling Stock - Track Interaction: Analytical Approach

By: Alexandr Y. Kogan, Prof. All-Russian Railway Research Institute

Summary: In the article the theoretical statements of the random vibration investigations in the "track-train" system are outlined. Analytical methods of the investigations of combined statistical vibrations of a track and rolling stocks as a united mechanical system are described.

The complete technical paper can be found in the International Heavy Haul Association's 1999 STS Conference on Wheel / Rail Interface held June 14-17, 1999 in Moscow, Russia.

Assessment of Wheel/Rail Interaction and Vehicle Dynamics at BHP Iron Ore

By: S Marich (formerly of BHP Research, Australia, now with Rail Services Australia)

P Bartle, BHP Research, Australia,

R Bowey, BHP Research, Australia,

A Cowin, BHP Iron Ore, Australia,

G Offereins, BHP Iron Ore, Australia, and

M Moynan, BHP Iron Ore, Australia

Summary: An extensive field study has been conducted recently at BHP Iron Ore (BHP-10) with the primary objective of assessing different wheel/rail profile combinations, and in particular: Conformal contact and 2 point contact.

The assessment has been based on the influence which these two very different approaches to establishing particular wheel/rail interaction characteristics have on rail and wheel wear in curved track, rolling contact fatigue defect development on rails primarily in curved track, and hunting behaviour of bogies in tangent track. Bogie/vehicle hunting has also examined in terms of wheel hollowing and wheel/rail contact friction modifiers. The results obtained have clearly shown that at BHP-10: Conformal wheel/rail contact is preferred in curved track, primarily because

of the reduced rail gauge face and wheel flange wear; and 2 point wheel/rail contact is preferred in tangent track, primarily because of the improved vehicle hunting behaviour.

The complete technical paper can be found in the International Heavy Haul Association's 1999 STS Conference on Wheel / Rail Interface held June 14-17, 1999 in Moscow, Russia.

Locomotive Radial Steering Bogie Experience in Heavy Haul Service

By: Cart A. Swenson, Electro-Motive Division, General Motors Corporation

Summary: Since Electro-Motive Division (EMD) of General Motors introduced the 3-axle radial steering bogie in 1993, over 2500 heavy haul freight locomotives have been put in service with this new design. The application of these radial bogies is on diesel locomotives with AC (altematina current) and DC (direct current) traction, with power ranging from 4000 to 6000 traction horsepower. In addition to the heavy haul applications in North America with axle loads of over 30 metric tons, EMD has applied this new bogie technology to international locomotive designs with axle loads of 21 metric tons. Radial bogie designs are also being developed for other track gauges as well. The heavy haul AC traction locomotives are typically dispatched today at wheel-rail adhesion levels of 35% to 38% in normal operation and develop adhesion levels up to 48% for starting trains. In spite of these dramatic increases in adhesion, the wheel wear is reduced with -the radial steering bogies. Extended wheel life results from significant reductions in wheel flange wear. Accordingly, even in operations where wheels are typically re-profiled for tread wear, the profound effect of lower flange wear minimizes the amount of metal removed in wheel re-profiling and extends wheel life.

The complete technical paper can be found in the International Heavy Haul Association's 1999 STS Conference on Wheel / Rail Interface held June 14-17, 1999 in Moscow, Russia.

Effect of the Wheel Profile on Dynamics of Rail Vehicle and Wear of the Wheel/Rail Contact Pair

By: V. F. Ushkalov, Institute of Technical Mechanics of the National Academy of Sciences of Ukraine

Summary: A modified mathematical model is developed to study the wheel/rail interaction and evaluate the effect of different factors on the wheel wear and the rail vehicle dynamics. The Community of Independent States (CIS) wheel profiles and the most known foreign profiles are examined. A great effect of the car wheel profile on the wheel/rail contact pair wear is shown. Development of the car wheel profile new standard for 1520 track gauge is concluded to be expedient. Two new profiles for car wheels are developed using computer - aided modelling and theoretical prediction of their efficiency is done. 160 wheels with the proposed profiles were tested in route trains transporting iron ore from Ukraine to Poland and Slovakia. After 76 ths km run their wear appeared to be approximately twice as less than the wear of the standard wheels operating under the same conditions.

The complete technical paper can be found in the International Heavy Haul Association's 1999 STS Conference on Wheel / Rail Interface held June 14-17, 1999 in Moscow, Russia.

Development of the Wheel Profiles of Cars and Locomotives

for the Existing Railways for Reduction of Wear of Wheel Flanges and Lateral Surfaces of Rail.

By: V. Kondrashov, All-Russian Railway Research Institute, Russia,

I. Maksimov, All-Russian Railway Research Institute, Russia, and

V. Galperin, All-Russian Railway Research Institute, Russia

Summary: This work presents some results of research at the All-Russian Railway Research Institute (VNIIZhT) on evaluation of influence of the state of wheel profiles on dynamics of railway carriages and wear characteristics of wheels. The research work was carried out in two stages: collection of informnation about the state of wheel profiles and rails under operation; working out of algorithms and programs used to investigate influence of wheels and rails profiles on dynamics of carriages and wear characteristics of contact surface.

The results of measurements of freight car wheels and rail profiles are formulated in the work. The results are presented as averaged wheel and rail profiles depending on the degree of their wear. Methods for making calculations, results of calculations for determination of the zones of wheel and rail profiles and geometrical characteristics of track gauge, mostly influencing on dynamics of carriages are stated in the theoretical part of the paper. Evaluation was made of influence of the chosen wheel profiles and of the profiles of wheels under operation on dynamics of carriages and wear characteristics of wheels. Based on the results of evaluations profiles for operational test were chosen.

The complete technical paper can be found in the International Heavy Haul Association's 1999 STS Conference on Wheel / Rail Interface held June 14-17, 1999 in Moscow, Russia.

Influence of the Design and State of Wagon's Running Gear and Track on the Wear of Wheels and Rails

By: E. P. BLOKHIN, A. D. LASHKO, and A. N. PSHINKO, Dnepropetrovsk State Technical University of Railway Transport (DIIT) State Administration of Ukrainian Railways

Summary: The results of theoretical investigations and on-track tests have been presented. The work of friction forces in the wheel flange / rail contact area with respect to travelling distance has been accepted as a wear criterion.

The influence on various factors for several running modes in curves of various radii with various velocities has been investigated. Among those factors were: the bogie design; wagon types, wheel profiles (a total of 9 profiles have been considered, including ones from the CIS, Great Britain, Germany, the S1002 profile in combination with R65 and UIC-60 rails); friction between the wheel flange and the rail; friction in the centre-pivot, friction in wedges; deviations of the most important running gear parameters from the values, allowed after depot repair; state of the curved section of track in plan.

The results of the tests have confirmed the validity of both the model and the conclusions about the influence of the design and state of the nmnmg gear of wagons and track on the wear of wheels and rails.

The complete technical paper can be found in the International Heavy Haul Association’s 1999 STS Conference on Wheel / Rail Interface held June 14-17, 1999 in Moscow, Russia.

Problems in the Wayside Measurement of Train - Track Interaction

By: Grigory Izbinsky, Denis D'Aoust, Wayside Inspection Devices, Inc., Quebec, Canada

Yuri Romen, Mikhail Levinson, Complex Testing Department,

Yuri Zikov, Ural Division, Railway Research Institute, Moscow, Russia

Sergey Zakharov, Ilya Zharov, Alexandr Kogan, Material Testing Department All-Russian Railway Research Institute, Moscow, Russia

Summary: This paper presents the results of test train measurements made using three different measurement methods. The results obtained using each measurement method are analyzed as to their repeatability and ability to differentiate test wagon interaction with the track. The interaction is characterized by measuring the lateral forces acting on the railhead, the angle of attack of each wheel set and the tracking position in relation to the track centerline.

The complete technical paper can be found in the International Heavy Haul Association's 1999 STS Conference on Wheel / Rail Interface held June 14-17, 1999 in Moscow, Russia.

Test and Study on Chinese Freight Wagon Derailment on Straight Track

By: QIAN LIXIN, Director of International Heavy Haul Association and Professor, China Academy of Railway Sciences

Summary: On the main track of Beijing-Shanghai Railway, systematic freight wagon derailment test has been conducted to find out the cause of wagon derailment taken place on straight track. 32 trains have been tested in three types of classification. During the test,

derailment coefficient, rate of wheel load reduction and other dozens of parameters have been collected from wayside and on-board. Wheel/rail contact status has been recorded by photographic method. The test shows that safety level of derailment coefficient for freight wagon on straight track can not base on the Formula Nadal only, but should take the lasting time of the maximum derailment coefficient into consideration. The test also shows that derailment is related with wheel/rail friction coefficient, technical status of wagons, loading status of wagons, position of wagons in a train, whether the train is under traction or idle operation and magnitude of braking compressive force. And curve section and elevating one side of rails of the straight track can both restrain snake movement of wagons to lower the possibility of derailment.

The complete technical paper can be found in the International Heavy Haul Association's 1999 STS Conference on Wheel / Rail Interface held June 14-17, 1999 in Moscow, Russia.

Some Peculiarities of Wheel/Rail Interaction in Passing through Small-Radius Curves

By: V. G. Grigorenko, Far Eastern State Transport University, Russia,

V. I. Doronin, Far Eastern State Transport University, Russia

Summary: The dynamics of entering small radius curves by the three-axle locomotive bogies is investigated. Graphs of pressure force changes of the running-on wheel flange on the rail in different traction regimes and railroad track parameters are presented. Increase of flange pressure on the rail and its wear rate in passing through small-radius curves is shown to be associated with the bogie's forced shifting of the bogie from chord position into skewed one. The process of bogie skewness is defined, in principle, by the transverse tangential forces at the contact points of the wheel rolling surface and rail heads. To prevent bogie skewness, it is suggested that a special device be mounted between the locomotive body and the bogie.

The complete technical paper can be found in the International Heavy Haul Association's 1999 STS Conference on Wheel / Rail Interface held June 14-17, 1999 in Moscow, Russia.

Mathematical modeling of carriage nonlinear dynamics

By: T. Zyrianova, Ural State Academy of Railway Transport, Laboratory of Mathematical Modeling and Computer Technologies,

Yu. Yalishev, Ural State Academy of Railway Transport, Laboratory of Mathematical Modeling and Computer Technologies

Summary: This paper describes the models of dynamic interaction of a rail-wheel pair which can be used for analysis of emergencies. The models presented in the paper allow to reveal the mechanisms of increased intensity of lateral wear of rail and find means of its reduction. The program of 3-d visualisations of a dynamic wheel-rail contact is given.

The complete technical paper can be found in the International Heavy Haul Association's 1999 STS Conference on Wheel / Rail Interface held June 14-17, 1999 in Moscow, Russia.

Wheel/Rail Angle of Attack Measuring Instrument and its Application in the Research of Rail Wear

By: Shugu Zeng, Railway Engineering Research Institute, China Academy of Railway Sciences,

Hong Wang, Railway Engineering Research Institute, China Academy of Railway Sciences

Summary: This paper introduces the working principle and the block diagram of the wheel/rail angle of attack (α) measuring instrument. The instrument, using infrared light transmitting-receiving element and the circuits of oscillation, amplification, frequency selection, demodulation and reshaping, has such advantages as high accuracy, good anti-interference performance, shock proof, high energy conversion rate, light weight, and portability. It provides the functions of data acquisition, processing, printing and plotting, etc. Practices have proven its performance to be stable and reliable. The index of wheel/rail wear derived from the product of the angle of attack α multiplied by the lateral force Q is an effective parameter in the prediction of rail wear.

Keywords: angle of attack, measuring instrument, rail wear

The complete technical paper can be found in the International Heavy Haul Association's 1999 STS Conference on Wheel / Rail Interface held June 14-17, 1999 in Moscow, Russia.

Turnout Geometry Optimization with Dynamic Simulation of Trucks and Track

By: J. Rainer Oswald, VAE Aktiengesellschaft, Austria,

Peter E. Klauser, The Arc Group, Colorado, USA

Summary: Traditional turnout design methods assume that vehicle response is determined by kinematics, rather than dynamics. VAE Aktiengesellschaft has initiated a research and development program to examine new design methods. These consider turnout design as a vehicle/track interaction problem. The chosen method is to use a vehicle dynamics simulation program to develop the geometry with the lowest values for forces and acceleration.

The complete technical paper can be found in the International Heavy Haul Association's 1999 STS Conference on Wheel / Rail Interface held June 14-17, 1999 in Moscow, Russia.

Wheel/Rail Materials and Interaction: North American Heavy Haul Practices

By: D. H. Stone, Transportation Technology Center, Inc., Colorado, USA,

K. Sawley, Transportation Technology Center, Inc., Colorado, USA,

D. Kelly, Transportation Technology Center, Inc., Colorado, USA,

W. Shust, Transportation Technology Center, Inc., Colorado, USA

Summary: This paper summarizes current North American heavy-haul freight specifications and maintenance practices for wheels and rails. It lists the most common causes of wheel and rail removal, and describes work completed and in progress to extend the life of these major assets. Finally, it considers how the interactions between wheels and rails affect component life and service performance. Special attention is given to the use of rail grinding to extend rail life (with reference to the Illinois Central Railroad grinding strategy), and the development of new criteria to reduce wheel-climb derailment risk.

The complete technical paper can be found in the International Heavy Haul Association's 1999 STS Conference on Wheel / Rail Interface held June 14-17, 1999 in Moscow, Russia.

Wheel/Rail Quality and Damage: Russian Railways Practices and Perspectives

By: E. A. Shur, All-Russian Railway Research Institute, Moscow, Russia

V. N. Tsurenko, All-Russian Railway Research Institute, Moscow, Russia

Summary: Major quality indices of rails and wheels such as structure, chemical content, residual stress, geometry have been studied. These indices determine the constructive strength parameters: contact fatigue resistance, plastic flow resistance, brittle fracture resistance, side and vertical wear. Statistics, showing the change in damage to rails and wheels on Russian railroads in the past 20-30 years, have been analysed. These studies indicated that at present the major defects are, on the one hand, the side wear of rails and vertical wear of wheel flanges, and, on the other hand, - contact fatigue damage. A separate group of defects includes shelling on the wheel tread and rail surface, connected with thermomechanical damages. The major internal factors of rail and wheel steels have been found, which define contact fatigue resistance and the wear of rails and wheels. Prospective fines of production technology development and improvement of the methods of rail and wheel control have been worked out.

The complete technical paper can be found in the International Heavy Haul Association's 1999 STS Conference on Wheel / Rail Interface held June 14-17, 1999 in Moscow, Russia.

Perspectives on Metallurgy and Contact Mechanisms

By: Joseph Kalousek, National Research Council Canada,

Eric Magel, National Research Council Canada,

Stuart Grassie, Consulting Engineer, Glasgow, UK

Summary: The major reasons for deterioration and premature replacement of rail on heavy haul track are reviewed with particular regard to the mechanical and metallurgical factors influencing various damage mechanisms. Damage to the rail is principally a result of wear; rolling contact fatigue; other types of fatigue defects; corrugation; plastic flow and head crushing; martensitic layers, particularly from wheelbums; and batter ofjoints and welds. Some consideration is also given to wheel damage processes. Conclusions are drawn regarding means of reducing rail (and wheel) damage on existing systems. Future developments, primarily in the field of metallurgy, are also discussed. The proposed treatments address both mechanical and metallurgical factors to contain the damage. Considerable substantiation is provided for the proposals from an extensive review of published work.

The complete technical paper can be found in the International Heavy Haul Association's 1999 STS Conference on Wheel / Rail Interface held June 14-17, 1999 in Moscow, Russia.

Advances in Wheel/Rail Contact Mechanics

By: Zhiyun Shen, National Traction Power Laboratory, Southwest Jiaotong University, China,

Weihua Zhang, National Traction Power Laboratory, Southwest Jiaotong University, China,

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Jing Zeng, National Traction Power Laboratory, Southwest Jiaotong University, China,

Limin Zhang National Traction Power Laboratory, Southwest Jiaotong University, China

Summary: In this paper, new advances in the field of wheel/rail rolling contact mechanics and their applications are overviewed. Emphasis lies upon the research carried out in the National Traction Power Laboratory in recent years. The full-scale validation of Kalker's wheel/rail creep law is described and the effects of surface roughness and contamination were determined by experiments based on theoretical analyses. Special attention is laid upon the mechanism of wheel/rail adhesion and derailment safety. A brief overview of rail corrugation has been also given to indicate the related research required in the future. To combine theory with practice is the basic work principle of the National Traction Power Laboratory and is reflected in this paper.

The complete technical paper can be found in the International Heavy Haul Association's 1999 STS Conference on Wheel / Rail Interface held June 14-17, 1999 in Moscow, Russia.

Lubrication of Rails and Wheels on Russian Railways

By: L. Barteneva, All-Russian Railway Research Institute,

V. Tyutin, All-Russian Railway Research Institute,

V. Kartsev, All-Russian Railway Research Institute,

D. Veniaminov, All-Russian Railway Research Institute,

V. Nikitin, All-Russian Railway Research Institute

Summary: The results of introduction of lubrication of the contact "wheel-rail" on Russian railways for struggle with increased wheel flanges wear of rolling stock and side wear of rails are formulated.

Considerable growth of intensity of traffic on Russian railways in the middle of 80's resulted in aggravation of the problem of intensive wear in the contact "wheel-

rail". In reality, specific wear of wheels and rails (for a measuring device) was increased twice as much annually and as a result it was required that the specialists provide a basis for solution of the problem.

Simultaneously with investigations of the aggravation of the problem of wear, since 1989 there began introduction of lubrication of the "wheel-rair' contact on Russian railways at once on three directions.

As a result of adoption of a complex set of measures to reduce wheel and rail wear, the acuteness of the problem was reduced in 1996 and in 1997 wear indices came closer to the normative values which provided for the opportunity to increase service life of wheels and rails by 2-3 times.

The complete technical paper can be found in the International Heavy Haul Association's 1999 STS Conference on Wheel / Rail Interface held June 14-17, 1999 in Moscow, Russia.

Creep Force-Creepage and Frictional Work Behavior in Non-Hertzian Counterformal Rail/Wheel Contacts

By: Robert F. Harder, Ph.D., Associate Professor of Engineering, Department of Mathematics, Computer Science and Engineering, George Fox University, Newberg, Oregon

Summary: This study presents a quantitative evaluation of the mechanical behavior of counterformal non-Hertzian rail/wheel contacts that have been treated as both non-Hertzian and ellipticized geometries. Within the context of a new AARI-B/136RE wheel/rail combination, seven cases of non-Hertzian contact were examined. The degree of patch nonellipticity was quantified by introducing a dimensionless non-Hertzian strength parameter (NHS). Computations were performed using Kalker's programs CONTACT and USETAB. Results indicate that the influence of spin creepage on the asymmetric geometry of contacts having large values of NHS, can introduce significant levels of error into both the longitudinal creep forces and frictional work predicted by an ellipticized patch model. This work

also shows that good agreement exists between lateral non-Hertzian creep force predictions and results from the ellipticized contact model, where the level of agreement was found to be independent of both NHS and spin creepage.

The complete technical paper can be found in the International Heavy Haul Association's 1999 STS Conference on Wheel / Rail Interface held June 14-17, 1999 in Moscow, Russia.

Simulation of Wheel/Rail Contact and Wear in Curved Track

By: I. G. Goryacheva, Institute for Problems in Mechanics, Russian Academy of Sciences,

M. N. Dobychin, Institute for Problems in Mechanics, Russian Academy of Sciences,

I. A. Soldatenkov, Institute for Problems in Mechanics, Russian Academy of Sciences,

V. M. Bogdanov, All-Russian Railway Research Institute

S. M. Zakharov, All-Russian Railway Research Institute

Summary: Wheel/rail contact in curved tracks is considered. The model is based on the solution of the contact mechanics problem taking into account the shape variation of contacting bodies due to wear. A two-point contact is investigated. The size and position of contact spots are determined depending on the angle of attack, rail cant and other geometrical parameters and loading conditions. The method of analysis of the rail/wheel shape evolution in wear process is suggested based on the wear equation, the averaging procedure and the contact characteristics obtained from the contact problem solution. The model can be used to predict the wear of rails and wheels in contact interaction, and to evaluate the influence of principal parameters on the process of wear.

The complete technical paper can be found in the International Heavy Haul Association's 1999 STS Conference on Wheel / Rail Interface held June 14-17, 1999 in Moscow, Russia.

Tribological Aspects of Rail/Wheel Interface

By: Sergey M. Zakharov, All-Russian Railway Research Institute, Moscow, Russia,

Ilya Zharov, All-Russian Railway Research Institute, Moscow, Russia,

Igor Komarovsky, All-Russian Railway Research Institute, Moscow, Russia

Summary: Factors determining wheel/rail tribological parameters are discussed. The requirements for the local physical models to achieve sufficient adequacy of tribodynamic models are formulated. Tribological factors are studied both with the help of mathematical and physical models. Several quasi-statical models are used to study the influence of the instantaneous axis of a wheel set rotation position and moments, resulting from forward displacement of wheel flange contact patch on the parameters responsible for wheel flange and rail head wear. The influence of the three-piece freight car bogie on the parameters of tribological behavior of wheel and rails moving in sharp curves is studied. Modeling of the wear process between wheel flange and side face of the rail head is studied and discussed. Four wear modes, referred as mild, severe, heavy and catastrophic have been identified in the laboratory tests. The wear modes which occur in worn wheel flanges and in side-worn rails have been found to correlate with those found on the rollers during laboratory tests. The boundaries of wear modes are found. Basing on the results of laboratory study, a wear law was derived and suggested to be used in dynamic models of wheel/rail interaction.

The complete technical paper can be found in the International Heavy Haul Association's 1999 STS Conference on Wheel / Rail Interface held June 14-17, 1999 in Moscow, Russia.

Prediction and Prevention of Rail Contact Fatigue

By: Daniel Boulanger, Sogerail,

Louis Gulardi, SNCF,

Andrt Galtier, IRSID,

Gilles Baudry, CREAS

Summary: For many years, rails had to be taken out of service mainly for reasons of internal fatigue and wear. Owing to the progress made in steel manufacturing and in the development of heat-treated grades, contact fatigue defects are now the principal cause of rail failure. Among these defects, head checking affects the outer rails of curves on high-speed lines and tracks with heavy axle loads. In order to understand the phenomenon and find appropriate solutions, a working group was set up composed of representatives of the iron and steel sector, the SNCF and research institutes. After observing, characterizing, modeling, simulating and performing various experiments concerning the phenomena concerned, this group now has at its disposal a number of tools designed to classify steel grades according to different operating conditions and to provide forecasts for rail monitoring and maintenance campaigns and laying down development guidelines. Track tests conceming steel grades and grinding are under way and have already yielded some promising results.

The complete technical paper can be found in the International Heavy Haul Association's 1999 STS Conference on Wheel / Rail Interface held June 14-17, 1999 in Moscow, Russia.

Analysis of Worn Rail Sections for Stress Concentration

By: Y. Q. Sun, Post Graduate Student, Centre for Railway Engineering, Central Queensland University,

M. Dhanasekar, Senior Lecturer in Structural Engineering, Central Queensland University,

B. Hagaman, Manager, Track Engineering, Civil Engineering, Queensland Rail

Summary: Rail is replaced when the percentage of head loss attains a specified Iimit. The decision for replacement of rail is therefore based on geometric parameters measured at site rather than the level of stress concentration the rail is subjected to under the wheel load. This paper addresses the effect of shape of the rail on the stress concentration with particular reference to wear. It is shown that the type and amount of wear affect the stress concentration in rail sections. It is also shown that by referring to the level of stress concentration it is possible to increase the level of geometric wear limits.

The complete technical paper can be found in the International Heavy Haul Association's 1999 STS Conference on Wheel / Rail Interface held June 14-17, 1999 in Moscow, Russia.

High Strength Rails with Optimised Residual Stresses

By: Jean Luc Perrin, Sogerail

Summary: With the aim to supplying rails with enhanced service life, Sogerail has perfected a set of process for the whole production line designed to improve fatigue strength, wear resistance and brittle fracture resistance. In particular, a new hardening process has been developed to produce rails with optimal residual stresses. This process eliminates straightening by roller

leveller allowing rails to be delivered with compressive stresses at the railhead and foot. The resulting rails have better characteristics as test circuit trials have shown.

The complete technical paper can be found in the International Heavy Haul Association's 1999 STS Conference on Wheel / Rail Interface held June 14-17, 1999 in Moscow, Russia.

Metallurgical Processes of Rail Steel Production and Properties of Railroad Rails

By: G. Fhilippov, RF SRC I.P.Bardin TsNIIChermet

V. Sinelnikov, RF SRC I.P.Bardin TsNIIChermet

Summary: The effect of different metallurgical processes on quality, mechanical properties and fracture resistance of railroad rails has been considered. It has been found that quality and service reliability of rails can be improved through the application of rational deoxidation and microalloying of molten metal with nitrogen-bearing materials, alloying and making of rail steel based on DRI.

The complete technical paper can be found in the International Heavy Haul Association's 1999 STS Conference on Wheel / Rail Interface held June 14-17, 1999 in Moscow, Russia.

Development of Bainitic Steel Rail with Excellent Surface Damage Resistance

By: Masaharu Ueda, Yawata R&D Lab., Nippon Steel Corp., Japan,

Koichi Uchino, Yawata R&D Lab., Nippon Steel Corp., Japan,

Hideaki Kageyama, Kyushu Techno Research Corp., Japan,

Kaneta Motohiro, Department of Mechanical Engineering, Kyushu Institute of Technology, Japan,

Akira Kobayashi, Yawata Works, Nippon Steel Corp., Japan

Summary: To improve the surface damage resistance of rails used for high-speed and for heavy-haul railways, the authors studied the application of bainitic steel for rails in place of the conventional pearlitic steel. As a result, it was confirmed that the bainitic steel is free from dark spot defects (squats), and the increase in hardness (strength) of bainitic steel is effective for the enhancement of flaking damage resistance. Based on these findings, the authors manufactured bainitic steel rails with improved surface damage resistance on a trial basis. The present paper describes the results of laboratory tests of tile bainitic steel and the properties of bainitic steel rail.

The complete technical paper can be found in the International Heavy Haul Association's 1999 STS Conference on Wheel / Rail Interface held June 14-17, 1999 in Moscow, Russia.

Working and Engineering Hardening of Wheel Contact Surfaces

By: V. M. Bogdanov, All Russian Railway Research Institute, Moscow, Russia,

D. P. Markov, All Russian Railway Research Institute, Moscow, Russia,

G. I. PEN'KOVA, All Russian Railway Research Institute, Moscow, Russia

Summary: The tribotechnical properties of surface layers of wheels and laboratory rollers hardened in service and in production were studied. Hardness of work self-hardened wheel tread is less 450 HV0.1 and slowly decreases with depth, approaching initial level 280-300 HV at 5-8 mm. Hardness of conical surface of flanges approaches 900 HV0.1 Depth of hardened layer here is less 0.5 mm. It was found that surface hardness of wheel steel (0.60-0.65% C) laboratory rollers is proportional to slippage in range from 0 to 2% and rises up to the maximum value 750-850 HV0.1, if slippage is more than 2%, creating frictional layer with the increased wear resistance. High quality thermal hardening of wheel flanges with hardness in the range from 600 to 800 HV minirnizes the wear rate of flanges and side wear of rails up to 3 times. Thermal hardening of wheel tread with martensite or tempering troostite with hardness more than 450 HV provokes high wear rate of tread (vertical wear).

The complete technical paper can be found in the International Heavy Haul Association's 1999 STS Conference on Wheel / Rail Interface held June 14-17, 1999 in Moscow, Russia.

Influence of Plasma Treatment on the Structure and Field-performance Stability of Railway Wheels

By: P. P. Ivanov, Associated Institute for High Temperatures , Russian Academy of Sciences,

E. KH. Isakaev, Associated Institute for High Temperatures , Russian Academy of Sciences,

A. S. Tyuftyaev, Associated Institute for High Temperatures , Russian Academy of Sciences,

G. A. Filippov, Associated Institute for High Temperatures , Russian Academy of Sciences

Summary: Tests for plasma nitriding railway wheels have been performed. The nitrided metal out performs the untreated metal in every way. Unusual structural components appear due to the saturation of steel with nitrogen in the process of plasma treatment. The smooth transitional zone ensures the strength of traction between the hardened zone and the bulk of metal.

The complete technical paper can be found in the International Heavy Haul Association's 1999 STS Conference on Wheel / Rail Interface held June 14-17, 1999 in Moscow, Russia.

Effects of Heavy Haul Traffic on Side Wear of High Rail on Curved Track and its Solutions

By: Hong Wang, Railway Engineering Research Institute, China Academy of Railway Sciences,

Wensheng Zhang, Railway Engineering Research Institute, China Academy of Railway Sciences,

Shugu Zeng, Railway Engineering Research Institute, China Academy of Railway Sciences

Summary: Based on the measured statistics on side wear of rails on over 50 curved tracks of heavy haul lines and a wheel/rail coupled model, this paper summarizes the regular patterns of side wear occurrence, development and distribution. The relationship of side wear of rail and track parameters, lubrication and optimizing wheel and rail profiles is studied. The measures to reduce rail side wear are proposed.

Keywords: side wear of rail, measures for reducing wear, wheel/rail interaction.

The complete technical paper can be found in the International Heavy Haul Association's 1999 STS Conference on Wheel / Rail Interface held June 14-17, 1999 in Moscow, Russia.

New Results of the Wheel/Rail Adhesion

By: Chen Houchang, Locomotive and Car Research Institute, China Academy of Railway Sciences,

Sun Qiong, Locomotive and Car Research Institute, China Academy of Railway Sciences,

Li Guoshun, Locomotive and Car Research Institute, China Academy of Railway Sciences,

Zang Qiji, Locomotive and Car Research Institute, China Academy of Railway Sciences,

Summary: A new method has been developed to deal with three-dimension rolling contact problem of wheel/rail, in which the friction coefficient is treated as a function of factors such as train velocity and so on. So that the effects of these factors on wheel/rail adhesion can be studied. The computer program of the method has been completed and a few new results, which are closer to practical observation than that of the previous theories, have been obtained. It can be considered as an extension of Kalker's rolling contact theory.

The complete technical paper can be found in the International Heavy Haul Association's 1999 STS Conference on Wheel / Rail Interface held June 14-17, 1999 in Moscow, Russia.

A Laboratory Study of the High - Speed Wheel/Rail Adhesion Characteristics in the Case of Large Slide/Roll Ratio

By: Sun Qiong, Locomotive and Cars Institute, China Academy of Railway Sciences,

Chen Houchang, Locomotive and Cars Institute, China Academy of Railway Sciences,

Li Guoshun, Locomotive and Cars Institute, China Academy of Railway Sciences,

Zang Qiji Locomotive and Cars Institute, China Academy of Railway Sciences,

Summary: A high-speed wheel/rail simulation facility has been developed to study the high-speed wheel/rail adhesion characteristics. A laboratory study of the high-speed wheel/rail adhesion characteristics in the case of large slide/roll ratio has been carried out by the simulation facility and some new results have been achieved. These new results show that the traction coefficient between the wheel and rail decreases with the slip ratio increasing in the case of large slide/roll ratio and then the traction force of the locomotive will decrease rapidly.

The complete technical paper can be found in the International Heavy Haul Association's 1999 STS Conference on Wheel / Rail Interface held June 14-17, 1999 in Moscow, Russia.

Maintenance Practices for Optimizing Wheel and Rail Life Cycles

By: A. S. Kretzmann, Manager (Perway) Spoornet (COALlink), South Africa

Summary: This paper discusses operational maintenance practices for controlling the condition of vehicles and track such that the design wheel/rail performance is achieved. A systems

approach is favoured which strives to simultaneously maximise the economic life of both the wheels and rails. Due consideration is given to business and safety requirements.

The complete technical paper can be found in the International Heavy Haul Association's 1999 STS Conference on Wheel / Rail Interface held June 14-17, 1999 in Moscow, Russia.

Engineering and Economic Implications of Hollow Worn Wheels on Wheel and Rail Asset Life and Fuel Consumption

By: Kevin J. Sawley, Transportation Technology Center, Inc., Colorado, USA,

Steven L. Clark, Transportation Technology Center, Inc., Colorado, USA

Summary: The objective of the project described in this paper is to determine an economic-based criterion for the removal of hollow worn wheels from service. Hollow worn wheels have deleterious effects on railroad costs and potentially, safety. They raise rolling resistance, increasing the fuel needed to haul cars. They increase rail wear, and the 'false flange' damages the rail surface and special track work. In addition, they can raise lateral forces in curved track, increasing track deterioration and raising potential derailment risk. Finally, hollow wheels impair a truck's ability to steer, increasing the risk of hunting (periodic lateral movement) in tangent track. A survey of North American wheel profiles indicates 6 percent of wheels are more than 3 mm hollow, and 2 percent are over 4 mm hollow.

An initial analysis of the removal from service of wheels with more than 3 mm hollow wear indicated positive economic benefits based on reduced fuel consumption and rail wear. However, additional assessment with improved modeling and sensitivity analysis indicates that achieving net benefits by removing hollow worn wheels may depend on factors other than fuel and rail wear. The maintenance costs of removing hollow wheels appear to outweigh the fuel and rail wear benefits. Hence, the other damaging affects of hollow wheels need to be considered when judging the merits of implementing a hollow worn wheel removal policy.

The complete technical paper can be found in the International Heavy Haul Association's 1999 STS Conference on Wheel / Rail Interface held June 14-17, 1999 in Moscow, Russia.

Technical and economical problems of locomotive wheel sets adhesion with rails

By: Lev A. Mouginchteine, All-Russian Raflway Research Institute, Moscow, Russia

Summary. The work is directed at evaluation of possibilities to increase loading of locomotives as per adhesion by taking into consideration the influence of unfavourable weather conditions on track sections with complicated profiles, damages of details and units of wheel-motor blocks, wear of locomotive wheel set treads, excessive power and fuel consumption in the movement of trains at the assigned speed.

The complete technical paper can be found in the International Heavy Haul Association's 1999 STS Conference on Wheel / Rail Interface held June 14-17, 1999 in Moscow, Russia.

Wheel/Rail Life Optimization with the Implementation of Increased Axle Loads on Carajas Railway, Brazil

By: Lauro José Varejas Fassarella, Companhia Ferroviaria de Nordeste, Brazil,

Luiz Elesbão De Oliveira Neto, MRS, Brazil

Adail Barros Filho, Companhia Vale do Rio Doce, Carajas Railway, Brazil,

Ricardo Sschmidt, Companhia Vale do Rio Doce, Carajas Railway, Brazil,

Ronaldo Costa, Companhia Vale do Rio Doce, Carajas Railway, Brazil,

José Raimundo Coelho, Companhia Vale do Rio Doce, Carajas Railway, Brazil,

Britto R. Rajkumar, Transportation Technology Center, Inc., USA,

Curtis L. Urban, Transportation Technology Center, Inc., USA

Summary: The Transportation Technology Center, Inc. (TTCI), a subsidiary of the Association of American Railroads provided Companhia Vale do Rio Doce (CVRD) with a comprehensive technical assessment of the engineering iinplications of introducing 32.5-metric ton axle loads on the Carajás Railway (1996-1999). The study focused on three specific areas: car equipment, permanent way, and train handling. During its first ten years of operation, the Carajás Railway had an inherent wheel shelling problem under 30.5-tonne axle loads. This was the initial focus of TTCI's study.

The results and conclusions of several investigations conducted on Carajás Railway formed the cornerstone of subsequent engineering analyses on the benefits and cost tradeoffs essential to a business decision on the economic consequences of moving to a heavier axle load. During many years of research in North America on the impact of heavier axle loads on train operations, vehicles, and track structure, TTCI has developed many sound technical approaches to optimize the investigations focused on 32.5- and 35-metric ton axle loads. TTCI has studied their effect on track degradation and the optimal material selections, maintenance practices, and operating techniques that will achieve improved safety, increase productivity and minimize ton-kilometer costs of transport.

The complete technical paper can be found in the International Heavy Haul Association’s 1999 STS Conference on Wheel / Rail Interface held June 14-17, 1999 in Moscow, Russia.

Systems Approach to Best Practices for Wheel/Rail Friction Control

By: Richard Reiff, Transportation Technology Center, Inc., USA,

Don Cregger, Norfolk Southern Railroad, USA

Summary: In this paper, optimum friction guidelines are presented for use by railroads to better manage lubrication application. These guidelines have been determined using computer models to forecast trends in train energy usage and curvmg forces, supplemented with field measurements to determine application system and lubricant performance. Recent innovations in measurement tools, in the form of hand operated and higher speed production tribometers, allow friction values of the rail to be measured. By establishing "best practices" for lubrication, target friction values can be measured and compared when changing application systems, operations, lubricants, or location of lubricators to better manage the rail/wheel system.

Rail/wheel lubrication can provide significant benefits to railway economics and efficiency. Track lubrication, traditionally applied by fixed wayside lubricators, has long been utilized by North American Railroads with the primary purpose of reducing rail wear on curves. Studies conducted by railroads and the Association of American Railroads in the early 1980's indicated significant savings in train energy could also be obtained through rail lubrication; thus increasing the development of lubricants and application equipment..

Proper lubrication has many benefits; however, excess lubrication, misplaced lubrication, improper lubrication, and uneven distribution has been shown to be a cause of poor train handling conditions. These poor conditions can lead to loss pf traction and reduced truck (bogie) steering, resulting in increased curving forces. Proper discipline in locating, inspecting, maintaining, and adjusting wayside and mobile application systems offers substantial benefit in obtaining optimum friction at the rail/wheel interface.

The complete technical paper can be found in the International Heavy Haul Association’s 1999 STS Conference on Wheel / Rail Interface held June 14-17, 1999 in Moscow, Russia.

Rail and Wheel Inspection Systems

By: D. H. Stone, Transportation Technology Center, Inc., Colorado, USA,

S. F. Kalay, Transportation Technology Center, Inc., Colorado, USA,

J. V. Kristan, Transportation Technology Center, Inc., Colorado, USA,

R. P. Reiff, Transportation Technology Center, Inc., Colorado, USA,

G. C. Garcia, Transportation Technology Center, Inc., Colorado, USA

Summary: North American systems for the detection of higher than normal states of stress, rail longitudinal forces and neutral temperatures, and the presence of cracks or component defects in wheels and rails enhance safe and economical railway operations. Early detection of such states and defects can be used to schedule preventive maintenance rather than performing unscheduled, and therefore more costly reactive repairs.

The complete technical paper can be found in the International Heavy Haul Association's 1999 STS Conference on Wheel / Rail Interface held June 14-17, 1999 in Moscow, Russia.

A Wayside Monitor of Vehicle Stability

By: R. Bowey, BHP Research Laboratories, Victoria, Australia,

G. Tew, BHP Research Laboratories, Victoria, Australia,

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M. Moynan, BHP Iron Ore, Port Hedland, Australia,

A. Cowin, BHP Iron Ore, Port Hedland, Australia

Summary: Vehicle hunting leads to increased and uneven wear on wheel, bogie and rail surfaces thereby increasing maintenance costs and in extreme cases can cause derailments. A prototype wayside monitoring system has been developed by BHP Research to measure the degree of lateral stability of ore cars on the BHP Iron Ore Railroad in Western Australia's Pilbara region. Early measurements have correlated well with visual observations and the system has been used successfully to identify hunting vehicles and to verify the effectiveness of maintenance procedures. By monitoring and quantifying the response of vehicles the system has the potential to assist in the evaluation of wheel and rail maintenance cycles, new wheel and rail profiles and several other maintenance and operational parameters. The paper outlines the development of the system and presents results-to-date relating to wheel wear, maintenance and fleet condition.

The complete technical paper can be found in the International Heavy Haul Association's 1999 STS Conference on Wheel / Rail Interface held June 14-17, 1999 in Moscow, Russia.

Inrail Comprehensive Wheel Set Inspection for the 21st Century

By: Zack F. Mian, BSEE, MSIE, President, International Electronic Machines Corporation

Hans J. Naumann, DIPL.-ING., DIPL.-KFM. (MSBA), Chairman, Simmons Machine Tool Group

Summary: This paper describes the latest development of wheel set inspection techniques by equipment installed in the rail track.

In order to provide safe rail transport, extraordinary measures to inspect and maintain railroad wheels must be taken. This responsibility is especially important for the Heavy Haul Railways and for the high speed passenger and transit rail service. Railroad wheel inspection techniques have lagged far behind the demands of the industry. Existing hand-held gauges are inefficient, inaccurate and unreliable leading to expensive, and in some cases, unsafe operations. New techniques are required to ensure continued safe, efficient and cost effective operations.

International Electronic Machines Corporation (IEM) has developed a state-of-the-art comprehensive Wheel Inspection System (WIS). The WIS provides wheel profile and dimensional measurements, such as **rim thickness, flange height, flange thickness, flange angle, reference groove and wheel diameter.** Furthermore, **wheel cracks and shelling conditions, out-of-roundness and flat spots**are detected. The WIS easily ties in with existing wayside equipment. IEM has further developed a wayside vehicle identification system.

The benefits of WIS include the following:

More thorough and uniform wheel inspections - leading to safer operations

Better profile maintenance - contributing to superior ride quality

Elimination of the time-consuming manual measuring process - reducing labor costs

Improved scheduling of wheel maintenance activities - leading to reductions in equipment down time.

While the improvements by WIS contribute in many respects as outlined above, the major contribution is the elirnination or reduction of deraihnents caused by faulty wheel profiles or wheel cracks not discovered on time in the past.

The complete technical paper can be found in the International Heavy Haul Association's 1999 STS Conference on Wheel / Rail Interface held June 14-17, 1999 in Moscow, Russia.

Technologies And Applications Of Wheel/Rail Geometry

Measurement For High-Speed Railway Vehicles

By: Angelo Zingarelli, Fiat Ferroviaria Savigliano, Italy,

Cesare Santanera, DMA Torino, Italy,

Daniela Parena, Fiat Ferroviaria Savigliano, Italy

Summary: Tight specifications about ride quality, safety and cost of the railway transport compel the high speed bogies designer to bring to carefully analyse the wheel-rail phenomena. Particularly, the knowledge of the wheel-rail contact geometric parameters is very important since they strongly affect the vehicle dynamics. To measure these parameters, fast and high accuracy instruments are required: the new rail profile measurement system presented herein fulfils these tough requirements. This paper first recalls the basics of the problem. Some important requirements for the rail profile measurement are then shown. The last part briefly describes the instrument and presents some available results, applied to real problems of railway vehicle running technique. Track gauge, contact point position, wheel-rail clearance, equivalent conicity are very important figures to know to improve bogie's stability and curving and to check track condition in a whole train-track system view. In the paper the authors show some results about investigation on high speed trains stability on Direttissima Line; different section are compared and contact geometry differences are explained. Also presented are measurements on SNCF lines where a tight correlation between contact geometry and bogie lateral accelerations has been pointed out.The fmal concept about this experience was the homologation of the train-track system as opposed to the homologation of the train alone.

The complete technical paper can be found in the International Heavy Haul Association's 1999 STS Conference on Wheel / Rail Interface held June 14-17, 1999 in Moscow, Russia.

Monitoring of the Condition of Track and Running Gears on Heavy-Haul Railway Segments

By: Victor M. Bogdanov, PhD, All-Russia Raflway Research Institute, Moscow,

Mikhail A. Levinzon, PhD, All-Russia Raflway Research Institute, Moscow,

Maxim B. Chinkarev, Eng, All-Russia Raflway Research Institute, Moscow

Summary: The main disadvantages of the currently used routine of the allowed speed definition are shown. The track monitoring system is introduced, which takes into account the specific features of the particular track segment. The system architecture and basic technologies used in the development are described. The contribution of the system to the trackwork scheduling and execution is shown.

The complete technical paper can be found in the International Heavy Haul Association's 1999 STS Conference on Wheel / Rail Interface held June 14-17, 1999 in Moscow, Russia.

Structure and maintenance optimization of curve track segments with the aim of a wheel flange and rail wear-out reduction

By: Victor 0. Pevzner, Professor, All-Russia Raflway Research Institute, Moscow

Summary: The structural parameters of the curve track segments should meet the requirements of the most high-speed passenger trains movement, as well as the slowest freight trains movement. This caused the necessity to standardize the passenger and freight trains speed ratio

in respect to the curve radiuses and the accepted range of uncompensated acceleration rational values.

The complete technical paper can be found in the International Heavy Haul Association's 1999 STS Conference on Wheel / Rail Interface held June 14-17, 1999 in Moscow, Russia.

The Relation Between Improved Track Quality and Wheel - Rail Interaction

By: Rainer Wenty, Engineer, Plasser & Theurer, Vienna, Austria

Summary: At the Heavy Haul Conference in Beijing, 1993, Riebberger [1] showed the relation between track quality and dynamic axle forces, based on the track calculation model of German Railways.. At the next conference in Capetown, 1997, R Chopra and A Krishan of Indian Railways [2] presented a field study based on this. The conclusion of both papers was to keep track forces low by high quality track standard. Low track forces also mean to have low dynamic reaction forces on the wheels and thereby on the rolling stock. Therefor track condition plays is a key figure in rail - wheel interaction and maintaining high track standards bears potential for reduction of fleet maintenance expenditures. In the Heavy Haul industry, new and improved track maintenance methods have contributed already to better quality but still it is important to identify sectors where further improvements are possible.

The complete technical paper can be found in the International Heavy Haul Association's 1999 STS Conference on Wheel / Rail Interface held June 14-17, 1999 in Moscow, Russia.

Rail Inspection - Now and for the Future

By: Dr. Robin Clark, Director of Engineering, Sperry Raff Service, Danbury, CT

Summary: Since 1928 Sperry cars have been testing the railroads of North America. The technology has been developed over the intervening years to a point where today the main system comprises a PC based Strip Chart Recorder (SCR) using ultrasonic and induction information.

As traffic densities increase and track testing time gets reduced, the march forward on the technology front is focusing on several issues. These are improved inspection techniques, faster inspection, better use of the data acquired and adding intelligence to the testing system to reduce the reliance on the operator.

Combined these will produce a more reliable test package that will better satisfy the railroad needs for speed and flexibility, but at the same time maintain the high quality of the test. Complimentary physical techniques will continue to provide the most thorough inspection of the rail. A challenge for the future will be how best to fuse and use this information. Allowing the test system a larger role in the decision making process will have a major role to play as well.

This paper will describe where we are today in terms of rail testing technology and the steps we are taking to make improvements for the future.

The complete technical paper can be found in the International Heavy Haul Association's 1999 STS Conference on Wheel / Rail Interface held June 14-17, 1999 in Moscow, Russia.

Joint Research by Railway and Contractor on Headcheek Prevention

By: Dr. Wolfgang Schöch, Application Manager, Speno International

Summary: Speno International is essentially a contracting company engaged mainly in rail grinding. Research work is undertaken only occasionally, for instance in order to find new applications for grinding or for optimisation of existing ones. As co-operation between customer and contractor takes place virtually everyday in grinding practise, such research work maybe beneficial for both parties. Investing their knowledge, expertise and experience results in extending their know how.

Surface fatigue is a well known phenomenon principally for heavy haul railways. German railways (DB AG) and Speno Intemational have undertaken research work in order to understand better that phenomenon. Test sections have been ground to different shapes of profiles to simulate all the currently existing tolerances of the existing target profile for grinding. The development of surface fatigue afterwards has been monitored, allowing the determination of the target profile and the permissible tolerances. The results obtained on a conventional line may help to improve further the effect of rail maintenance by grinding on heavy haul lines particularly with regard to the definition of permissible deviations from a given target profile.

The complete technical paper can be found in the International Heavy Haul Association's 1999 STS Conference on Wheel / Rail Interface held June 14-17, 1999 in Moscow, Russia.

Rectification of Rail Profiles on the Sishen-Saldanha Iron-Ore Export Line with the Rail Planing Machine

By: Hermann T. Hone, Executive Director, Plasser Railway Machinery (South Africa)

Summary: Over the period 1988 to 1992 track maintenance input on the Sishen to Saldanha iron ore line was not increased to compensate for the increase in traffic during that period. According to Kretzinan [1] this resulted in a drastic deterioration in wheel/rail wear, manifested particularly in severe hunting damage to rails (sinusoidal side wear) and unacceptably worn locomotive and wagon wheels. By March 1994 a combined Rolling Stock/Perway strategy was implemented to avoid a crisis in the short term and to ensure the long term integrity of the track and vehicles. This strategy included action plans to prevent further hunting damage, to correct existing hunting damage and to prolong wheel life expectancy. The objective of this paper is to highlight the role played by the Plasser & Theurer SBM140 Rail Planing Machine in the successes achieved as a result of the implementation of the combined Rolling Stock/Perway strategy over the period September 1994 to October 1998.

The complete technical paper can be found in the International Heavy Haul Association's 1999 STS Conference on Wheel / Rail Interface held June 14-17, 1999 in Moscow, Russia.

Turnout Grinding - Increasing The Life Of Heavy Haul Turnouts By Maintenance Profiling

By: G. Beh, Principal Drafting Coordinator, Civil Engineering, Queensland Rail,

B. Hagaman, Manager Track Engineering, Civil Engineering, Queensland Rail

G. Mason, Civil Engineer, Civil Engineering, Queensland Rail

Summary: Queensland Rail is a narrow gauge railway (1067 mm) hauling over 100 million gross tonnes of coal per annum to export ports.

The network has nearly 200 main-line heavy haul turnouts carrying 25 tonne axle-load, 80 km/h coal traffic. These turnouts are predominantly 60 kg 1 in 16 with swing-nose (SNX) and rail bound manganese crossings (RBM). In an effort to extend their service life, a program of turnout grinding was investigated and consequently developed.

In March 1997, an initial grinding trial was undertaken on a turnout which was of poor condition using the Queensland Rail owned 32 stone grinder. Later inspections on the condition of this turnout have indicated that the results of the trial were quite successful in extending the life of the turnout components. Two other relatively new turnouts were also ground with favourable results.

As the grinding trials showed that turnouts can be successfully profiled using the rail grinder an economic analysis of turnout grinding was carried out. Ths analysis showed , that with the extended service life expected by grinding the turnouts on a regular cycle, that turnout grinding was economically feasible.

The complete technical paper can be found in the International Heavy Haul Association's 1999 STS Conference on Wheel / Rail Interface held June 14-17, 1999 in Moscow, Russia.

Effects of Rail Grinding Practices on Wheel/Rail Performance Under 35.4-tonne Axle Loads

By: Semih Kalay, Transportation Technology Center, Inc., Colorado, USA,

Joseph Lopresti, Transportation Technology Center, Inc., Colorado, USA,

Magdy El-Sibaie, US Federal Railroad Administration, Washington D.C., USA

Summary: Transportation Technology Center, Inc. (TTCI) engineers have been performing tests to help determine the effects of grinding on the life of rail, as limited by wear and fatigue. Effects of grinding on the curving performance of the cars in the Heavy Axle Load (HAL) train are also being studied. The HAL train consists of 70 loaded coal hopper cars, each weighing approximately 142,880 kg. The cars are equipped with improved suspension bogies designed to improve curving performance of HAL vehicles. The tests are being performed through a joint effort between the Association of American Railroads (AAR) and the U.S. Federal Railroad Administration (FRA).

The grinding trial rails (all premium head hardened rail in curved track) have now accumulated over 525 million gross tons (MGT). Four different grinding practices are being evaluated, along with rail that is not ground. No internal fatigue defects have developed in any of the rails. The surface condition of the non-ground rail is comparable to that of the ground rail. There is significantly more wear, especially in the high rail, on the ground rail.

Three wayside load measuring stations have been installed on the track used to monitor the curving performance of the HAL train. Two of the stations are in a 291.1-metre curve, one where the rail is ground, and one where it is not. The test results show that the average lateral forces are higher in test sections where the rail is ground. NUCARS, a vehicle dynamics simulation program developed by Transportation Technology Center, Inc., was used to study how contact geometry resulting from various grinding practices affects vehicle curving. Results of these studies show that under commonly occurring operating conditions, wheel and rail profiles can combine to create contact geometry that adversely affect wheel set steering, leading to the generation of large lateral gage widening forces, increased wheel/rail wear, and increased train rolling resistance. The rail-grinding test is part of a larger overall program jointly funded by the FRA and the AAR that examines the effect of HAL cars on various track components to improve railroad safety and productivity.

The complete technical paper can be found in the International Heavy Haul Association's 1999 STS Conference on Wheel / Rail Interface held June 14-17, 1999 in Moscow, Russia.

Field-performance Analysis of Wheel Sets at the Moscow Railways

By: I. L. Paristyi, Moscow Railways,

A. A. Troitsky,Moscow Railways,

A. E. Yablonsky, Associated Institute for High Temperatures, Russian Academy of Sciences,

E. KH. Isakaev, Associated Institute for High Temperatures, Russian Academy of Sciences,

P. P. Ivanov, Associated Institute for High Temperatures, Russian Academy of Sciences

Summary: A computer-controlled plasma technology was developed for the treatment of rolling stock wheels, providing the thermal hardening of tread and flange working surfaces. As a result of the plasma treatment the surface hardness of the wheel grows from 255 up to 420-450 HB. Herewith the wear capability of the wheel metal grows 2-3 times and its resistance to the weariness-driven destruction grows 1.5 times due to the pecularities of the structural state of the steel, arising out of the thermal impact and of the nitriding of the steel during the plasma treatment. Installation of several plants based on this technology in engine houses allowed to carry out a full scale experiment in order to assess the running characteristics of treated wheel sets in comparison with plain ones. The comparative analysis is made in terms of wheel life between mounting and truing or dismounting, of flange and band wear-out, of wheel change per fixed ran of locomotive. The obvious advantage of plasma treated wheel sets is shown.

The complete technical paper can be found in the International Heavy Haul Association's 1999 STS Conference on Wheel / Rail Interface held June 14-17, 1999 in Moscow, Russia.

The Head Hardened Rail - is it economical?

By: Klaus Riessberger, Univ.-Prof. Dipl.-Ing.Dr.techn., Technical University Graz

Summary: Probes of rail and wheel material are rolled onto each other under load and 10 % creep. It was found that differences in wear-rates depend also on the direction of creep, with driving creep resulting in higher abrasion. Wheel abrasion does not grow with higher hardnesses of rails. Transformation of reduced rail-wear into longer track-life leads to excellent economic results.

The complete technical paper can be found in the International Heavy Haul Association's 1999 STS Conference on Wheel / Rail Interface held June 14-17, 1999 in Moscow, Russia.

Remote Condition Monitoring of Trackwork for Improved Economics of Maintenance

By: J. Rainer Oswald, VAE Aktiengesellschaft, Zeltweg, Austria

Summary: In the past Corrective Maintenance and Preventive Maintenance have been the two main strategies for maintenance. VAE Aktiengesellschaft has developed the remote condition monitoring system VAE ROADMASTER 2000. This system avoids the disadvantages of the traditional methods of maintenance and allows a "just in time" condition based maintenance method. So the maintenance can be planned exactly according the actual need and the economic is improved.

The complete technical paper can be found in the International Heavy Haul Association's 1999 STS Conference on Wheel / Rail Interface held June 14-17, 1999 in Moscow, Russia.

Contribution to Heavy Haul Train Safety by Reduction and Control of Train Forces

By: M. E. Clark, Keystone Industries, PA,

J. I. Pershwitz, Keystone Industries, PA

Summary: It is shown by computer simulation that elimination of slack in trains through application of the new slackless and slack control technology, can dramatically decrease longitudinal forces in the heavy haul trains and significantly contribute to stability against deraihnent in curves.

The complete technical paper can be found in the International Heavy Haul Association's 1999 STS Conference on Wheel / Rail Interface held June 14-17, 1999 in Moscow, Russia.

Impact of High Wheel Slipping on the Life Time of Rubber-Metal Elements and Wheel Sets on Electric Locomotives

By: Relja Jovanovic, Mechanical Engineering Department, Institute of Transportation CIP, Belgrade, Yugoslavia,

Aleksandar Radosavljevic, Mechanical Engineering Department, Institute of Transportation CIP, Belgrade, Yugoslavia

Summary: The important types of power vehicles on the Yugoslav Railways (JŽ) are the electric locomotives 441 series, license ASEA-Sweden and series 461 imported from Resice-Romania based on ASEA specifications. In the technical design of these vehicles, suspension of shaft reducing gear on bogie frame and damping of torsion vibrations in the oscillating chain: rotor - torque rod - joint - reducing gear teeth is possible via suspension lever with two rubber metal elements, which total 12 in an elastic coupling. All these elements same as wheel sets are correctly, conventionally (static-dynamics) calculated and manufactured. Contrary to the above, in operation on the JŽ network (and surely everywhere where these cracking an designs are applied) these rubber-metal elements are subject to accelerated fatigue axles suffer from torsion (they rarely break) which is dangerous and causes damages to JŽ. The paper queries the impact of high wheel slipping and stick-slip" effect onto the above, and the ways to remove these problems.

The complete technical paper can be found in the International Heavy Haul Association's 1999 STS Conference on Wheel / Rail Interface held June 14-17, 1999 in Moscow, Russia.

North American Heavy Haul Facts, Fiction and Conventional Wisdom

By: Roy A. Allen, President, Transportation Technology Center, Inc., Colorado USA,

James R. Lundgren, Assistant Vice President Transportation Technology Center, Inc., Colorado USA,

Semih F. Kalay, Chief Technical Officer Transportation Technology Center, Inc., Colorado USA,

Summary: As with other parts of the world, North American heavy haul operators continue to be challenged to optimize the wheel/rail interface under continually changing conditions. Over

the years, many views from our side of the globe have been presented: experimental, anecdotal and otherwise.

A capsule summary is presented here of the understanding we have gained through our applied research efforts in the North American environment. We recognize a key requirement of research is to accurately quantify the benefits and costs of proposed solutions to enable rational purchasing decisions. And within the context of this STS session of the IHHA, we recognize the obligation to ensure that the research conclusions are stated in terms that heavy haul operation managers can readily implement.

In particular, we believe the primary needs worldwide of heavy haul railroads in the area of wheel/rail interaction are:

- Consensus on wheel and rail profile maintenance practices
- A set of inspection, monitoring, and measurement protocols
- A set of threshold criteria and decision tools for safe and efficient operation of heavy haul railroads.

The complete technical paper can be found in the International Heavy Haul Association's 1999 STS Conference on Wheel / Rail Interface held June 14-17, 1999 in Moscow, Russia.

WHEEL/RAIL INTERACTION EUROPEAN COUNTRIES PROBLEMS AND EXPERIENCE

By: Jacques Raison, S.N.C.F., Traction and Rolling Stock Division, Department for Bogies, Brakes and Thermal Properties

Summary: The wheel-rail pairing is a key part of the railway. Since the earliest origins of this transport mode, extensive theoretical studies, bench tests and line tests have been carried out in

the search for a better understanding and a better control of wheel-rail contact and for optimised geometrical shapes, materials, manufacturing and inspection procedures. At the same time, feedback from the different operators has been instrumental in giving us the necessary knowledge to adapt a number of rules and regulations and improve both safety and performance still further (especially as regards speed and axle-load).

I will begin with a brief look at the UIC leaflets that deal with rails and wheels and which are the culmination of several decades of study and research work as well as experience in revenue service, and then move on to a presentation of wheel-rail interaction in a number of different areas, including safety, vehicle dynamics and noise. Lastly, before concluding, I will say a few words about the new projects launched at UIC level.

The complete technical paper can be found in the International Heavy Haul Association's 1999 STS Conference on Wheel / Rail Interface held June 14-17, 1999 in Moscow, Russia.

Improved Safety and Performance through a Better Understanding of Vehicle/Track Dynamics

By: Michael Roney, General Manager Engineering Services and Systems, Canadian Pacific Railway

Summary: This paper provides the railway operator with a review of the basic causes and concerns surrounding the man different aspects of dynamic interaction between freight vehicles and track. It is intended to contribute to the practitioner's understanding of the root cause of excessive track and vehicle reactions and deterioration. The paper highlights corrective action that can be taken to manage the derailment risk of excessive dynamic interaction and to reduce maintenance and operating costs through improved control of vehicle/track dynamics.

Key words: velhicle/track, track dynamics, vehicle dynamics, vehicle/track interaction

The complete technical paper can be found in the International Heavy Haul Association's 1999 STS Conference on Wheel / Rail Interface held June 14-17, 1999 in Moscow, Russia.

Influence of Rail head wear rate on formation and development of cracks in their head

By: L. Krysanov, VNIIZHT, All-Russian Railway Research Institute, Moscow, Russia,

A. Abdurashitov, VNIIZHT, All-Russian Railway Research Institute, Moscow, Russia

Summary: Data from the analysis of removal of rails due to internal transverse cracks in the head of rails on the East Siberian, Transbaikalian and Krasnoyarsk Railways for the period 1990-1996 is presented.

The dependences of single withdrawal of rails (N, pieces /100 km of main track) on the given defect for a curve of various radii from intensity of lateral wear of rails are presented. The interrelation between the rate of deterioration of rails and formation of cracks in their head is investigated. Thus the influence of rail lubrication intensity on lateral deterioration, and consequently on the process of initiation and development of cracks in the head of rails was studied.

The results of studies of the influence of speed on the development of the existing cracks in the head of rails in track are given. The dependences of the growth rate of a crack on its initial sizes, the quality of rail, and the conditions of operation are defined.

The complete technical paper can be found in the International Heavy Haul Association's 1999 STS Conference on Wheel / Rail Interface held June 14-17, 1999 in Moscow, Russia.

High Strength Bainitic Steel Rails for Heavy Haul Railways with Superior Damage Resistance

By: S. Mitao, Materials & Processing Research Center, NKK Corporation, Fukuyama, Japan,

H. Yokoyama, Materials & Processing Research Center, NKK Corporation, Fukuyama, Japan,

S. Yamamoto, Materials & Processing Research Center, NKK Corporation, Fukuyama, Japan,

Y. Kataoka, Rail & Section Dept., Fukuyama Works, NKK Corporation, Fukuyama, Japan,

T. Sugiyama, Plate, Section & Bar Technology Development Dept., NKK Corporation, Tokyo, Japan

Summary: Flaking and wear behavior in the bainitic and pearlitic rail steels with various tensile strengths were studied. Emphasis was placed on examining the formation behavior of the white etching layer (WEL) in bainitic and pearlitic steels, and its effect on flaking resistance. The advantages of the newly developed high-strength bainitic steel with superior flakinresistance, good wear resistance and excellent weldability are also discussed.

Key words : bainite, pearlite, rail, wear, rotating contact fatigue, flaking, damage resistance, white phase, martensite.

The complete technical paper can be found in the International Heavy Haul Association's 1999 STS Conference on Wheel / Rail Interface held June 14-17, 1999 in Moscow, Russia.

Thermophisical Fundaments of Tribological Interaction of Wheels and Rails

By: Yu. M. Luzhnov, Association of Tribology Engineers of Russia (ATE), Moscow, Russia,

A. V. Chichinadze, Association of Tribology Engineers of Russia (ATE), Moscow, Russia,

O. A. Govorkov, Association of Tribology Engineers of Russia (ATE), Moscow, Russia,

A. T. Romanova, Association of Tribology Engineers of Russia (ATE), Moscow, Russia

Summary: Heat dynamics of friction and physical-chemical concepts of solid interactions and economic indicators are discussed as applied to the wear in the wheel-rail system.

The complete technical paper can be found in the International Heavy Haul Association's 1999 STS Conference on Wheel / Rail Interface held June 14-17, 1999 in Moscow, Russia.

Appropriate Specification of Grinding Requirements for Heavy Haul Railways

By: Stuart L. Grassie, consulting engineer, Glasgow, UK

Summary: The longitudinal and transverse profile of a ground rail, and the metal removed by the grinding operation, are considered as the principal factors which it may be desirable to control on a ground rail. These closely control the physical problems which grinding alleviates. The outline of a grinding specification is suggested by considering both what is required in order to alleviate the problems and what is practical. Three components of a specification are discussed: the technical standards, the means of demonstrating that a specification has been met, and policing of the requirements. The paper discusses primarily the

first of these, but treats also the second in some detail since there numbers in a specification have little meaning if there is no consideration of how it shall be demonstrated that a ground rail complies or does not comply with a specification. It is suggested that the most useful specification is one which not only gives limits to quantities, but also specifies the fraction of track which must lie within these limits.

The complete technical paper can be found in the International Heavy Haul Association's 1999 STS Conference on Wheel / Rail Interface held June 14-17, 1999 in Moscow, Russia.

Experimental Study on the Effect of Preventive Grinding on RCF Defects of Shinkansen Rails

By: Makoto Ishida, Manager Track Dynamics Lab., Railway Technical Research Institute,

Noritsugi Abe, Senior Engineer Track Tech., Railway Technical Research Institute,

Takuya Moto, Researcher Track Dynamics Lab., Railway Technical Research Institute

Summary: Rail surface defects called shellings in Japan or squats in Britain, hereinafter referred to as surface shellings, are a kind of rolling contact fatigue (RCF) defects causing considerable maintenance cost including rail renewal not only on Shinkansen lines but also on narrow gauge lines in Japan. Preventive grinding of rail head surface is currently considere most reliable and effective as a measure to reduce the occurrence of surface shellings so that a lot of railway companies adopt it. However, since the effect of the preventive grinding is not understood clearly enough, it is of great concern to obtain the optimal grinding period and grinding amount (thickness from rail surface). The authors have been tackling to obtain an experimental solution for more than 10 years. In this paper the effect of preventive grinding for Shinkansen rails is discussed on the basis of experimental results using a large rolling disc machine.

The complete technical paper can be found in the International Heavy Haul Association's 1999 STS Conference on Wheel / Rail Interface held June 14-17, 1999 in Moscow, Russia.

Lubricating Materials and Tehnologies: Russian Railways Practices

By: V. V. Perekrestova, All-Russian Railway Research Institute (VNIIZhT), Moscow, Russia

A. V. Nesterov, All-Russian Railway Research Institute (VNIIZhT), Moscow, Russia

Summary: Specifications for lubricating materials for the protection of rails and flanges of wheel pairs of rolling stock from wear under modem operation conditions have been developed. Various types of lubricating materials for reducing wear in wheel - rail contact to suite the technologies of supplying lubricant into the zone of friction by autonomous mobile rail-lubricators, stationary wayside lubricators, locomotive flange-applicators are described.

The complete technical paper can be found in the International Heavy Haul Association's 1999 STS Conference on Wheel / Rail Interface held June 14-17, 1999 in Moscow, Russia.

Simulation of the Stress-deformed State of Wheels of a Rolling Stock from Operational Effects

By: S. N. Kiselev, Moscow State University of Railway Communication (MIIT),

A. S. Kiselev, Moscow State University of Railway Communication (MIIT),

A. V. Savruhin, Moscow State University of Railway Communication (MIIT)

I. L. Pascholok, Moscow State University of Railway Communication (MIIT)

Extended summary: Computer modeling of the processes taking place in hardfacing and subsequent service was carried out on the basis of solving a non-linear problem of non-stationary thermo-elasto-plasticity using the main assumptions of the theory of heat and mass exchange, plastic flow, elasticity and a finite element analysis. Results of numerical simulation identified potentially dangerous zones. Results of calculations for each of indicated zones covered the change of temperature as well as components and intensities of stress and strains.

Research on a stress-deformed state of wheels of railway cars and locomotives is an important and urgent problem, since the failure of a wheel can have heavy consequences. The research work is devoted to numerical modeling of the thermomechanic processes in wheels in service. A modeling program developed by us was created on the basis of modem numerical methods. A program complex has a pre-processor- and post-processor, enabling the automated construction of models and processing of results.

The external diameter of a wheel on a rolling surface is equal to 950 mm, the thickness of the wheel rim is 70 mm, the width of wheel rim is 140 mm. Variants of the geometry of worm wheels with thicknesses of the wheel rim from 25 up to 60 mm were also considered. The main part of the research was conducted on axially-symmetric models, which represent a radial section of a wheel. Three-dimensional accounts were used to study problems of verification. The wheel is made of wheel steel 2.

Stresses and deformations in wheels arise during manufacturing. They are connected with the technology of manufacturing of wheels which includes martempering of a surface layer for the purpose of hardening. As a result of complex thermomechanical processes and processes of conversion of structures in a wheel there are elastic and plastic deformnations and stresses. Even more intensively the process of formation of residual stresses proceeds by use of technological process of repair of worn wheels. Residual stress-deformed state deformations and stresses from operational loads are imposed. Thermomechanic processes, occurring at braking, introduce a

larger influence on stress-deformed state of a wheel, than other operational loads. At long braking cycles or emergency braking, the friction brake shoe at the rolling surface undergoes intensive non-uniform heating and redistributes residual technological stresses.

The results of modeling of the stress-deforned state were used for the determination of dangerous zones, assessment of the effect on the wheel life of thermal of cycles, determination of maximum temperatures of heating, speeds of cooling and structural optimization of modes of manufacturing, optimization of operational practice, and optimization of the geometry of the wheel.

The complete technical paper can be found in the International Heavy Haul Association's 1999 STS Conference on Wheel / Rail Interface held June 14-17, 1999 in Moscow, Russia.

Running wheels and Switch point Frogs lifetime optimization with Automated multi electrode welding

By: Vladimir V. Melikov, Tashkent Rail Road Engineers Institute

Summary: High stress and loads in a heavy weight railroad traffic shortens the service life of the wheels and the switch point frogs. The existing refurbishing methods - manual and a single electrode automatic build up by welding are not effective enough. This article introduces multi electrode welding under flux build up methods for the running wheels and the switch point frogs. Both methods are human error free and produce outstanding weld metal quality. The running wheel welding doubles its service life and as a result eliminates wheel and axle set replacement.

The switch point frog multi electrode welding reduces the number of scheduled repairs and extends the frog service life up to 3 times.

The complete technical paper can be found in the International Heavy Haul Association's 1999 STS Conference on Wheel / Rail Interface held June 14-17, 1999 in Moscow, Russia.

Diagnostic train for evaluation of deformability of railway track metal

By: Mikhail A. Levinzon, PhD, All-Russian Railway Research Institute, Moscow, Russia,

Vladimir L. Krilov, Eng, All-Russian Railway Research Institute, Moscow, Russia

Summary: The distinctions of the deformation properties of metal along the railway track should be considered as an additional disturbing action causing the growth of the rolling stock - track interaction forces. Therefore it is necessary to perform load tests of the track to reveal deviations in its rigidity. With this purpose the diagnostic train is created in the All-Russian Railway Research Institute.

The complete technical paper can be found in the International Heavy Haul Association's 1999 STS Conference on Wheel / Rail Interface held June 14-17, 1999 in Moscow, Russia.

An instrumented wheel set for study of interactions of railway vehicles and track

By: J. S. Romen, All-Russian Railway Research Institute, Moscow, Russia,

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V. A. Koval All-Russian Railway Research Institute, Moscow, Russia,

G. I. Ignatanko, Velikoluksky Locomotive-repair plant

Summary: For study of the interaction of wheel and rail an instrumented wheel set was developed. It measures not only lateral and vertical forces, but also for strains from a wheel flange to the rail-head, a difference from usual designs. Equipment and the processors of primary handling data are located on the axle of wheel set. The information from a rotated wheel pair is transmitted with the help of infra-red emitter by a without contact mode in a digital code in a coach body for registration and handling. The application of a wheel pair with a separate measurement of strains, acting on a wheel flange and wheel-tread, allows in more details under operating conditions to study processes of derailments, and also wear of wheel flanges and top rails. With its help the magnitudes of directing strains, causing wear of wheel flanges in maintenance, were studied. The work on the definition of influence of a track and vehicle condition on safety of driving and intensity wear processes of wheel-tread and wheel flanges is doing. **Note: In this paper the term "directing strain" or "directing force" means curving force in US practice.**

The complete technical paper can be found in the International Heavy Haul Association's 1999 STS Conference on Wheel / Rail Interface held June 14-17, 1999 in Moscow, Russia.

Critical Displacement of the Rail Head under Action of Wheels

By: Vladimir G. Krivonogov, All Russian Railway Research Institute (VNIIZhT), Moscow, Russia,

Vasiliy S. Lysyuk, All Russian Railway Research Institute (VNIIZhT), Moscow, Russia,

Sergey N. Sharapov, All Russian Railway Research Institute (VNIIZhT), Moscow, Russia

Summary: Large forces appear when trains brake on curved sections of the track. The vertical and the lateral forces produce displacement of the rail head. The results of the numeric calculations of elastic displacements and stresses of the rail type R65 are presented. The critical displacement of the rail head is defined as a displacement resulting in derailment. Displacements and stresses in the rail are calculated by the 3D Finite Element Method (FEM). Both tangent and curved sections of the rail track in a wide range of loads are considered.

Keywords: rail, force, critical displacement, derail, numeric calculation

The complete technical paper can be found in the International Heavy Haul Association's 1999 STS Conference on Wheel / Rail Interface held June 14-17, 1999 in Moscow, Russia.

Practical Ways to Estimate Reduction of Resistance to Train Motion when Applying Lubricant on Lateral Sides of Rails

V. I. Rakhmaninov, All-Russian Railway Research Institute, Moscow, Russia,

A. V. Andreyev, All-Russian Railway Research Institute, Moscow, Russia

Summary. Herewith considered are some methodological approaches and principal results of experimental research aimed at estimating the effect of grease applied on lateral side of a rail head to alterations of resistance to movement and level of expenditure of electric power for train traction.

This paper also shows that observance of technology of smearing does not result in significant change of adhesion for electric locomotives.

The complete technical paper can be found in the International Heavy Haul Association's 1999 STS Conference on Wheel / Rail Interface held June 14-17, 1999 in Moscow, Russia.

Improvement of the Operational Characteristics of Wrought Steel Wheels

By: I. L. Pasholok, All-Russian Railway Research Institute, Moscow, Russia,

A. V. Sukhov, All-Russian Railway Research Institute, Moscow, Russia

Summary: The analysis of the normative documents and literary data has shown, that alongside with the general tendency to increases in the strength characteristics of wheels and rails in responded at increase of traffic intensity there is the interaction between strength characteristics of wheel and rail. Significant (up to 40 % and more) increases in the strength characteristics of rails over the appropriate characteristics of wheels of freight cars result in decreases of serviceability both wheels and rails. Further increasing of rail hardness leads to a drop of serviceability both wheels and rails. In view of the inefficiency of superficial hardening of wheel's flange and lubrication of contact between wheel and rail for increase of service life of wheels of freight cars, we offer to remove big differences between strength characteristics of wheels and rail by hardening of wrought steel wheel rims on working depth (50 mm) up to a value of the hardness of rails. This can increase the service life of freight car wheels more than twice their normal value.

The complete technical paper can be found in the International Heavy Haul Association's 1999 STS Conference on Wheel / Rail Interface held June 14-17, 1999 in Moscow, Russia.

Locomotive Wheel-set Tread Wear Dependency Caused by Sliding in Relation to Rails

By: L. A. Mouginchteine, All-Russian Railway Research Institute, Moscow, Russia,

A. A. Khatskhelevitch, All-Russian Railway Research Institute, Moscow, Russia,

L. I. Monakhov, All-Russian Railway Research Institute, Moscow, Russia

Summary: Efficient locomotive operation handling is dependent on wheel tread wear over a rolling circle due to excess way gen erated by wheel-set sliding. This report reviews the results of statistical and experimental research enabling to receive this sort of dependency for a wide range of wheel-set sliding.

The complete technical paper can be found in the International Heavy Haul Association's 1999 STS Conference on Wheel / Rail Interface held June 14-17, 1999 in Moscow, Russia.

Car Three-Piece Truck With Double Spring Suspension

By: A. Dolmatov, All-Russian Railway Research Institute, Moscow, Russia,

V. Belousov, All-Russian Railway Research Institute, Moscow, Russia,

G. Egorov, All-Russian Railway Research Institute, Moscow, Russia,

V. Novoselov, All-Russian Railway Research Institute, Moscow, Russia,

O. Selikhova, All-Russian Railway Research Institute, Moscow, Russia

Summary. The car department of the All-Russian Railway Research Institute is engaged in all scientific questions relating to the construction and the maintenance of the car fleet. The existing truck was introduced into manufacture in 1956. Practical experience and research provide the basis for a new design.

The complete technical paper can be found in the International Heavy Haul Association's 1999 STS Conference on Wheel / Rail Interface held June 14-17, 1999 in Moscow, Russia.

Fatigue Analysis **of** Wheelset Elements

By: V. Galperin, All Russian Railway Research Institute (VNIIZhT), Moscow, Russia,

S. Flyumenbaum, All Russian Railway Research Institute (VNIIZhT), Moscow, Russia

Summary: To estimate the reliability of wheelset design according to fatigue resistance parameters basing on analyzing stress-and-strain state stochastic formulation of wheelset loading by vertical and lateral forces combined with stress factors from rolling surface irregularities was used. To calculate dynamic variation of stresses in wheelset critical areas and coefficient of strength safety factor reserve to fatigue destruction, elements method was used.

This makes it possible, by comparing calculated values with established one, define wheelset constructive parameters for new service conditions and to determine spoilage norms for deviations from wheelset constructive geometric dimensions and for characteristics of rolling surface irregularities.

The complete technical paper can be found in the International Heavy Haul Association's 1999 STS Conference on Wheel / Rail Interface held June 14-17, 1999 in Moscow, Russia.

Availability of an asymmetrical coach loading at full use of load-carrying capacity

By: Alexander M. Brzhezovskiy, All Russian Railway Research Institute (VNIIZhT), Moscow, Russia

Summary: With the purpose of definition of grounded standards of an asymmetrical loading of universal eight-wheel freight cars a full use of load-carrying capacity researches are conducted to determine the dynamic quality and car motion stability with the different versions of the center of gravity position both in longitudinal and transverse directions as allowed. With it, unlike in early researches, parameters of load were in accordance with maximum meaning - weight of the load 700-712 kN, general height of the center of gravity of loaded coach 2.15-2.18 in, the largest static axis and wheel loading 248 and 141 kN accordingly. On the base of experimental data fixed and introduced new standards of the asymmetrical coach loading in practice of Russian railways.

The complete technical paper can be found in the International Heavy Haul Association's 1999 STS Conference on Wheel / Rail Interface held June 14-17, 1999 in Moscow, Russia.

Automation of Processing of Wear Parameters and Forecasting of Work of Wheel Pairs of Electric Locomotives

By: N. P. Buinova, The Irkutsk Rail Transport Engineering Institute,

E. A. Petrjakova, The Irkutsk Rail Transport Engineering Institute,

A. P. Homenko, The Irkutsk Rail Transport Engineering Institute

Summary: The wear of wheels and rails in the process of interaction is an objective process. The rate of change of the degree of the wear depends on numerous factors. Increasing of the resource of the "wheel-rail" system, as a rule, requires serious material expenses. However, the required results may be obtained by choosing optimum parameters of the rim and the flange and the variant of turning of the wheel pairs.

For this purpose the authors have created a program which makes it possible to choose the most economically profitable variant of turning and arrangement of wheel pairs under the electric locomotive in every concrete case with consideration for the working conditions and the service available at the depot. The findings are based on processing of statistical data for electric locomotives working on the East-Siberian railway during four years of operation. The program was tested in the locomotive depot of the Irkutsk-Sortirovocbny station. This made it possible to evaluate the efficiency of organization of repairs of the wheel pairs, to provide for extending their service life and to give recommendations on the reduction of expenses of servicing of the wheel pairs of the electric locomotives.

The complete technical paper can be found in the International Heavy Haul Association's 1999 STS Conference on Wheel / Rail Interface held June 14-17, 1999 in Moscow, Russia.

Increase of rail grinding efficiency

By: L. Krysanov, All Russian Railway Research Institute (VNIIZhT), Moscow, Russia,

A. Abdurashitov, All Russian Railway Research Institute (VNIIZhT), Moscow, Russia

Summary: The data of the analysis of rail profile grinding by trains with active working stones for a ten year period on Octybriskaya and Gorkovskaya Railways is resulted. It is noted that the efficiency of rail profile grinding can be much higher as the basic attention at grinding had been given to liquidation or reduction of rail undulation but the questions of influence of the contour of the cross section of rail heads on their operational stability and durability were studied very little. Now study by All-Russian Railway Research Institute (VNIIZhT MPS) shows that the repair cross sections of rail heads for various operational conditions are developed depending on the plan of a line, given deterioration of the rail head surface and accumulated tonnage on rails. The repair cross sections were developed at the VNIIZhT experimental loop with the use of 10-cars grinding train "Speno International". As a result of studying the influence of the rapaired rail profile on the level of force interaction between track and rolling stock and also on process of origin and development of fatigue cracks in rail head was established.

The complete technical paper can be found in the International Heavy Haul Association's 1999 STS Conference on Wheel / Rail Interface held June 14-17, 1999 in Moscow, Russia.