44th Annual Conference and Business Meeting on Tire Science and Technology

Rolling Towards Sustainability: Tires for A Greener Future

Speakers and Abstracts

September 23rd – 25th, 2025

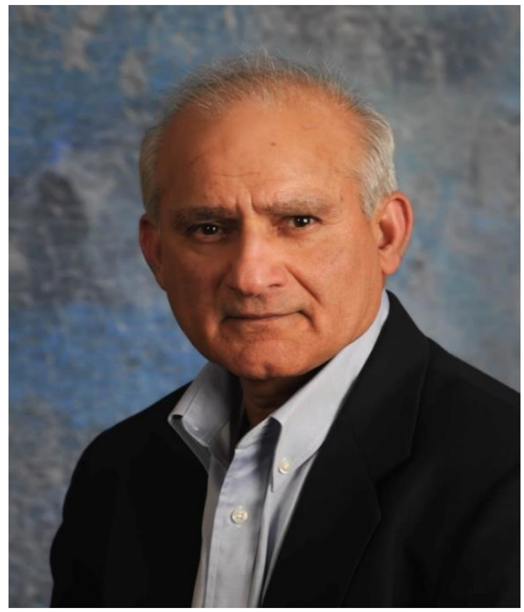
Invited Speakers

KEYNOTE ADDRESS

Surendra K Chawla

Former Lead Consultant, Polymer Industry Cluster, Greater Akron Chamber of Commerce, Akron, Ohio
Senior Director, Global Innovation (Retired), The Goodyear Tire & Rubber Company

Title of Talk:
Sustainability in the Tire Industry: Driving Toward a Greener Future



Surendra Chawla joined The Goodyear Tire & Rubber Company in 1978 as a Senior Research Engineer. He had many roles during his career at Goodyear, including head of Goodyear Corporate Research from 2003 to 2008.

In 2009, Dr. Chawla was assigned to lead Goodyear's Global Innovation initiative. In this role, he championed a culture of open innovation, exploring, assessing and integrating external technologies for sustainable products and process leadership, and creating new business opportunities in the Connected, Autonomous, Shared and Electrical (CASE) vehicle mobility solution space. Dr. Chawla directed creation of a global R&D network of world-class universities, research institutes, national laboratories, IT and engineering services networks, suppliers, customers and start-ups (representing the US, Europe, China, India, Singapore, Vietnam, and Brazil), and successfully integrated dozens of innovations into Goodyear products, materials and manufacturing technology platforms.

Dr. Chawla was one of the founders of Goodyear Institute of Technology (GIT) – "forum for tire related technologies". Hundreds of Goodyear associates around the world have benefitted from this program. Dr Chawla retired from Goodyear in 2018 as Senior Director of Global Innovation.

In 2021, Dr. Chawla joined Greater Akron Chamber of Commerce leading the Polymer Industry Cluster's initiative to enhance collaboration among businesses and regional universities for sustainable economic growth. This effort led to the Greater Akron region being Designated as a Sustainable Polymers Tech Hub by the U.S. Economic Development Administration (EDA); a of $51 million award from EDA, and a $31 million Innovation Hub award from the State of Ohio. These funds are designated to advance R&D efforts for sustainability including sustainable sources of advanced materials, workforce development and training, and to promote entrepreneurial culture for start-ups.
Dr. Chawla has a Bachelor's degree in Mechanical Engineering from India, and Master's and PhD degrees from the Illinois Institute of Technology (IIT), Chicago, USA.

PLENARY LECTURE

<u>Title of Talk:</u>

Tire Wear Emissions and Air Quality: Current Insights and Pathways Toward a Sustainable Future

Driven by Michelin's "All Sustainable" approach, we believe that balancing human, economic, and environmental impacts is essential to long-term success. At Michelin, we care about our impact on the Planet, People and Profit with the same intensity. This is what we call now our 3P strategy. Michelin is committed to leveraging talent and innovation capabilities to better understand and reduce tire wear emissions during the rolling phase. In this lecture, we will share our advancements in understanding Tire and Road Wear Particles (TRWP) and explore the complexities of recent findings related to abrasion and air quality. We will present key results from our research and provide an overview of the latest scientific literature. Finally, we will discuss emerging trends in the tire industry and outline strategies for promoting a more sustainable future.

Frederic Biesse

Senior Fellow
Physics and Modeling
Michelin

Frederic Biesse has been working for Michelin for 26 years. After earning a Master of Engineering degree from Central-Supélec, he worked for several years in the numerical analysis domain. He then joined the tire performance analysis team, initially focusing on noise performance then expanding his expertise to wear and later rolling resistance. M. Biesse became the manager of the tire performance analysis team focused on wear and rolling resistance. He is currently a Fellow (expert) in tire physics and performance modeling at the Michelin R&D center in Clermont-Ferrand, France.

Damien Lim
Senior Principal Research
Physics and Modeling
Michelin

Damien Lim is a Tire Wear Performance Research Engineer at Michelin Americas R&D Center. In this role, he specializes in fundamental studies of tire wear mechanisms and the development of predictive tools and testing methodologies designed to optimize tire performance.

Damien holds a Master of Engineering degree from Arts-et-Métier ParisTech and a Master of Mechanical Engineering from the Georgia Institute of Technology, both completed in 2007. He has 14 years of experience at Michelin where he has held various positions across multiple teams, including test engineering and NVH (Noise, Vibration, and Harshness) performance, before establishing himself in the tire wear performance team.

BANQUET SPEAKER

Scott Sass

Director of Technology
Alterra

Title of Talk:

Polymer Circularity: Steering Clear of Potholes

Scott Sass has worked in process development and optimization for over 20 years. Starting with General Electric (10 years), his passion was ignited by the opportunities associated with refractory materials (W, Mo, Re) processing supporting the lighting and healthcare divisions. In 2014 Scott joined Akron based Alterra to lead the scale up and commercialization of a technology that provides an end-of-life solution to discarded plastics. In his time with Alterra the technology and company has grown to be the largest producer of circular oil produced from end-of-life plastics in the world. At Alterra Scott has the opportunity to work with a team with an unflinching spirit for accepting tough challenges and developing solutions with a lasting impact for future generations.

Scott received his B.S. in Materials Science and Engineering from The Ohio State University and lives with his wife and 2 children in Medina, Ohio. In his free time Scott enjoys coaching his son's baseball team and spending time with his family.

Oral Presentations

1.1

Impact of Rubber Oxidation on Tire Retreading and Proposed Criterion for Acceptance

Mahmoud Assaad

Endurica LLC, Findlay, Ohio, USA

Abstract

Tire retreading is a proven, efficient sustainability practice that reduces environmental impact while offering economic benefits. By choosing retreads, industries and consumers contribute to waste reduction, lower emissions, and resource conservation, making it a key component of a greener future. However, over time, oxygen diffusion weakens the rubber as it loses elasticity and becomes brittle and less flexible. If the original casing has significant oxidation, it creates a weak interface with the new rubber and the tread might separate prematurely. Knowing the amount of oxygen concentration at the interface helps assess the extent of the material degradation and the integrity of the casing. Common practices for post manufacturing retreaders rely on visual inspection to detect cracks, durometer to measure hardness, or shearography to detect damage. However, the rubber industries (TRA, ETRTO), provide guidelines on casing integrity and acceptance criteria based on rubber testing (ASTM D297-93). This paper proposes a threshold of the rubber oxygen content above which the rubber degradation by oxidation is considered to be excessive and the retreading should be reconsidered regardless of the tire age. This critical oxygen content was proposed by (Tokita, Lake-Lindley, Gent-Hirakawa, ASTM D3859). A numerical model of oxygen diffusion is developed to map the state of oxygen across the casing surface, and the time to reach this critical concentration is calculated. Two tire types (PCR, TBR) are analyzed using 1-D and 2-D numerical models. The predicted performance and longevity are compared under normal and severe service conditions.

Presenting Author Biography

Senior Technical Advisor, (Endurica)
Senior R&D Associate, Goodyear (Retired)
Adjunct Assistant Professor, University of Akron
• Ph.D. - Engineering Science & Mechanics (Major) and Applied Mathematics (minor) Iowa State University (ISU), Ames, Iowa – 1983
• M.S. - Structural Engineering; (ISU) – 1979
• M.S. - Polymer Science from the University of Akron, Ohio. – 1990
•Diplome d'Ingenieur Civil-Section Travaux Public, Universite' de Saint-Joseph, Ecole Superieure d'Ingenieur, Beirut, Lebanon – 1976
• Co-author of the Composite segment of The Pneumatic Tire book.
• Taught short courses on Plastics and Elastomers in Engineering Design in Pisa-Italy,
• Recipient of the special Achievement Award from NASA for his meritorious accomplishments, dedicated work, and special efforts.
• Winner of the "2008 Create the future design contest" in the machinery/equipment category
• Received an "Honorable mention award for excellence of presentation & significance of content" from the TS 2007 Tire society for paper "Thin Film Heat Flux Sensor for Measuring Film Coefficient of Rubber Components of a Rolling Tire.

1.2

Environmental Quantification of Tire Rubber Emissions Using Multi-Dimensional Chemical Fingerprinting

Nick Molden

Emissions Analytics, Redondo Beach, CA, USA

Abstract

Over 2.3 billion tires are produced globally per year, with an ever-increasing complexity of chemical additives to optimize safety and performance. Greater understanding of the chemicals and polymer degradation products allows the environmental impact of tires to be better understood. This presentation shows an untargeted mass spectrometry methods to analyze tire rubber for environmentally important chemicals to develop a comprehensive tire chemical source profile – from over 500 tires from light, medium and heavy-duty tires from the US and Europe. The tire antioxidant 6PPD is the only chemical detected in every tire, and the presentation will show how a single chemical tracer for tire wear is insufficient.

Presenting Author Biography

Nick founded Emissions Analytics in 2011 to understand the holistic environmental impact of vehicles on air, soil and water. He is author of Critical Mass, a book that proposes radical simplification of car ratings and taxation.

Nick is chairman of European standardisation CEN Workshop 90 on collecting real driving tailpipe emissions data, and Workshop 103 on measuring vehicle interior air quality. He is an Honorary Senior Research Fellow at Imperial College London.

1.3

Devulcanizing End-of-Life Tire Rubber – Towards Rubber Sustainability and Rubber Product Circular Economy

Ben Chouchaoui

Windsor Industrial Development Laboratory, Inc., Windsor, Ontario, Canada

Abstract

Canada registers about 30 million passenger vehicles. Each such vehicle replaces all its four tires every three to four years. This averages to a tire a year, which means Canada scraps about 30 million tires each single year. Still, this problem is worsening with electric vehicles, as they are heavier, more vehicles on roads, cheaper tires that last less, etc. Add to that, tires from non-registered vehicles, off-the-road equipment, trucks, buses, construction machinery, etc.

Strategies to cater to retiring tires in North America in general include incineration (45%), crumb rubber generation (34%), and landfilling (19%), all showing several shortcomings. Add to that illegal dumping, unfortunately, in particular in poor jurisdictions and remote areas. Rubber cooks (vulcanizes, with a fraction of a vulcanization agent, heat and pressure) to turn into tires, like dough turning into bread (with yeast and heat). This makes rubber hard to recycle. Over the last two years, Windsor Industrial Development Laboratory developed technology to reverse vulcanization (un-cook rubber, like going from leftover bread to dough). The first product under the laboratory EcoCa™ program, just developed and proved, and gearing to mass-produce and sell is passenger vehicle parking blocks.

Windsor's laboratory is engaging in projects throughout Canada, namely residential, commercial, institutional, and industrial parking lots. Moreover, it is developing several green products from scrap tires for various industrial sectors. The benefits are numerous (tackling a health and environmental challenge, creating recycled feedstock that address rubber sustainability, engineering green products towards product circular economy, saving on depleting natural resources (hydrocarbons from which synthetic rubber is made), reducing energy consumption, eliminating greenhouse emissions, creating jobs, improving infrastructures, developing more knowhow, etc.). Windsor's laboratory intends to lead rubber sustainability and rubber product circular economy with the development of large products using recovered, devulcanized, and compounded rubbers from post-industrial and post-consumer wastes.

Presenting Author Biography

Ben Chouchaoui is a graduate of École Polytechnique de Montréal and the University of Waterloo in Canada. His expertise is in materials and computer-based simulations. He worked for German, Canadian, and American Automotive Tier-One suppliers for six years (upon completing his PhD, in 1994), in R&D, on composites sealing systems (rubbers and plastics). He started WIDL or the Windsor Industrial Development Laboratory, in 2000, offering cost-effective services in material and process and product simulation and testing, to aid in product design and manufacturing. He started in 2006 the WIDL' Seminars, to bring people of various technical backgrounds up-to-speed in 1- Materials and 2- Product development through simulation and 3- Testing with acceleration using Time-Temperature Superposition (TTS), and the 4- Correlation of numerical predictions to the "real world". He looks now to close the loop in product development by recycling polymers with which to make new engineered materials and products.

1.4

Replacement Tires for EV vehicles: Consumer Perceptions and Test Findings

Jacob George

Consumer Reports

Abstract

Consumer Reports conducted a comprehensive evaluation of replacement tires tailored for electric vehicles (EVs), focusing on models from Bridgestone, Hankook, Michelin, Pirelli, and Yokohama. The study addresses the unique demands EVs place on tires, such as increased weight and instant torque, which can lead to accelerated tire wear. Key performance metrics assessed include braking efficiency, handling, ride comfort, noise levels, and rolling resistance. In addition to the testing, the evaluation incorporated insights from Consumer Reports' EV Charging Community which explored when EV owners replaced their tires and how they selected replacement tires.
The findings indicate that while EV-specific tires are designed to handle these challenges, certain conventional all-season tires also perform admirably, offering potential cost savings without significant compromises in performance. The report underscores the importance of selecting tires that balance durability, efficiency, and comfort to optimize the driving experience of EV owners.

2.1

A Comprehensive Approach to Tire Model Scaling for Intelligent Tire Algorithms Development

Anish Gorantiwar, Peter Lee, Kanwar Singh, Qian Li

The Goodyear Tire and Rubber Company, Akron, Ohio, USA

Abstract

A key feature of intelligent tires is their ability to provide the traction envelope in real-world conditions in real time. This capability relies on sensing solutions and algorithms that detect environmental and other conditions related to tire performance. In this work, we explore the role of semi-empirical tire models in algorithm development. Traditionally, these tire models are calibrated using laboratory or test track data obtained from new tires. However, to support real-time traction envelope estimation or prediction, it is necessary to extend these models to account for varying operating environments and tire wear states.

This study presents a comprehensive approach to tire model scaling using both physical and virtual testing environments for intelligent tire algorithms detecting tire grip levels. A semi empirical tire model has been generated from physical flat trac Force and Moment (F&M) testing and has been used as the baseline for tuning coefficients based on different road surfaces. Variations in tire model longitudinal parameters were conducted to assess the effects of both global and micro-coefficients. An optimization framework has been developed to scale the tire model to match the mu-slip curves generated from skid-trailer data, with tests conducted on the same tire across three different surfaces. Following this, the tire models were tested in an offline simulation environment to analyze both tire-level and vehicle-level metrics. Testing was also conducted physically on an instrumented 5-door hatchback vehicle platform, focusing on the same surfaces as the skid trailer tests. Comparative studies between offline simulation metrics and on-vehicle metrics demonstrated a strong correlation in both rank-ordering and absolute magnitudes of performance metrics.

The obtained results from the vehicle simulations can be used to calibrate the traction related tire algorithms virtually, thereby enabling more efficient algorithm development. This approach also shows promises for extending to vehicle lateral dynamics as well.

Presenting Author Biography

Anish Gorantiwar is a Vehicle Dynamics engineer at The Goodyear Tire and Rubber Company primarily focusing on tire modeling, vehicle dynamics and Driver-in-the-Loop (DiL) simulation capability development. Anish graduated with his PhD in Mechanical Engineering from Virginia Tech in 2023 with a focus on vehicle dynamics and tire mechanics.

2.2

A New Tire Model Parameter Identification for Truck Tires by Integrating Bench and Road Testing with Advanced Data Filtering and Simulation Validation

Zechao Li, Wang Xin, Yintao Wei, Zhengwei Li

Tsinghua University, Beijing, Beijing, China

Abstract

The parameterization of an FTire model for a truck tire is substantiated by a substantial number of experimental tests. Nevertheless, due to limitations in experimental costs and the capability of testing equipment to fulfill the necessary requirements, acquiring an FTrie model for a truck tire proves to be a challenging endeavor. Therefore, the paper presents a methodology that synergizes bench testing and road testing to accomplish these experimental trials. Road testing is vulnerable to a myriad of uncontrollable interferences, resulting in data of inferior quality compared to that acquired through bench testing. This disparity in data quality can significantly and adversely impact the accuracy of parameter identification. To tackle this problem, this paper proposes an innovative filtering methodology that is specifically designed to process road test data, with the ultimate objective of enhancing the precision of parameter identification. This paper conducts an in-depth exploration of the correlation between the pivotal FTire parameters and the experimental trials. Drawing insights from this analytical endeavor, a novel methodology is put forward for identifying the essential FTire parameters through the application of the least squares technique. Finally, this paper employs the Adams Testrig simulation module to validate the accuracy of the identified model.

Presenting Author Biography

Zechao Li earned his Ph.D. degree from Beijing Institute of Technology, China, in 2022. Currently, he is engaged in research on intelligent suspension systems and tires at the School of Vehicle and Mobility, Tsinghua University. His primary research interests encompass tire modal analysis and NVH (Noise, Vibration, and Harshness) characteristics.

2.3

Study on New Method of Tire Virtual Submission

Dekuan Liu, Dang Lu, Yandong Zhang

Jilin University, Changchun, Jilin Province, China

Abstract

With the innovation of the new energy vehicles, automobile manufacturers are paying more and more attention to the tire virtual submission technology which replaces the physical prototype with the virtual prototype, in order to reduce the cost and shorten the development period. To solve this problem, this study proposes a new tire virtual submission method. UniTire / FE model is used for pure side-slip, pure longitudinal slip pure camber condition and based on UniTire / FE simulation results, UniTire / Prediction model is used to obtain virtual test data of combined slip condition, which significantly improves the efficiency of tire tire virtual submission. This paper will first introduce the UniTire / FE model, which reasonably reduces the number of meshes by simplifying the rubber material and focusing on the modeling of the skeleton material. At the same time, the contact boundary constraints and tire-road friction are improved by simplifying the contact assembly of the tire rim, focusing on the modeling of the tire-road contact and the ground imprint area, so as to establish an efficient and high-precision finite element model.Then this study will show the ability of the UniTire / Prediction model to predict the composite conditions of pure camber condition, pure side-slip condition and pure longitudinal slip condition to predict the combined conditions of camber side-slip, side-slip longitudinal slip and camber side-slip longitudinal slip, so as to improve the efficiency of tire virtual submission and ensure the accuracy of prediction. Finally, by comparing the test period and data of the method proposed in this study with the traditional tire virtual submission method, the efficiency and accuracy of the output results of this method are verified. The application of this method can effectively shorten the vehicle development cycle and has important engineering value.

Presenting Author Biography

He is a doctoral student engaged in tyre dynamics research at the State Key Laboratory of Automotive Simulation and Control, Jilin University, Changchun City, Jilin Province, China. His research field is tire dynamics.

2.4

Comparison of UniTire and MF Tire Models in Characterizing Friction Ellipses

Longfei Zhou, Dang Lu

College of Automotive Engineering, Jilin University, Changchun, Jilin, China

Abstract

In the new era of intelligent vehicles, with the deep integration of electrification and intelligence technologies and the innovation in intelligent chassis technologies, the demand for high-precision tire models has become increasingly urgent. Modern vehicles are gradually transitioning from passive response to active perception, and the control of tire forces is expanding from linear regions to nonlinear regions. Therefore, characterizing the large-slip friction characteristics of tire models has become a research hotspot. In this study, pure side-slip, pure longitudinal slip, and composite slip characteristics of tires were first tested under different loads. Through parameter identification, the parameters of the UniTire and MF models were obtained. Subsequently, through model simulations, the shapes of friction ellipses derived from the UniTire and MF models were demonstrated. The key parameters affecting friction ellipse characteristics in different tire models were analyzed, and a detailed discussion on the distinct modelling mechanisms of the two models was conducted. The research revealed that the theoretical framework of the semi-empirical UniTire model is based on the derivation of the friction ellipse, while the experience-based MF model lacks an inherent expression of the friction ellipse and requires extensive experimental data to achieve reasonable friction ellipse characteristics.

Presenting Author Biography

Longfei Zhou is a doctoral candidate engaged in tyre dynamics research at the State Key Laboratory of Automotive Simulation and Control, Jilin University, Changchun City, Jilin Province, China.

2.5

A Novel Tire Radius and Slip Ratio Model for Advanced Vehicle Simulation Grounded in Real-World Physics

Carlos Nerini[1,2], Nicolas Carabetta[1], Federico Zacchigna[2]

[1]WOM Testing Technologies, Turin, Torino, Italy

[2]Universidad de Buenos Aires FIUBA, Buenos Aires, Bs As, Argentina

Abstract

The slip ratio is fundamental in tire dynamics, influencing traction, braking, and vehicle safety in both pure longitudinal and combined vehicle dynamics. Traditionally, it is computed using the effective rolling radius, defined under steady-state free-rolling conditions. However, this approach does not fully capture tire grip behavior under complex 3D load states and nonzero wheel orientations, limiting accuracy in vehicle dynamics simulations and real-world applications.

This research introduces a novel reference radius that accounts for tire deformation and contact patch dynamics. By integrating high-precision tire data from real driving conditions with AI-driven physical modeling, the proposed solution provides a more accurate and physically meaningful slip ratio. Theoretical analysis and simulations highlight the limitations of conventional approaches and demonstrate the improved predictive capability of this new method.

This study leverages patented state-of-the-art technology to measure tire dynamics in real-world conditions, complemented by advanced data engineering techniques. The resulting methodology enhances tire characterization and modeling, establishing new workflows in tire and vehicle dynamics engineering.

The outcomes of this work drive advancements in traction and braking control, as well as autonomous vehicle performance, contributing to safer, more efficient, and higher-performing mobility solutions.

Presenting Author Biography

Carlos Nerini is the Managing Director and Co-Founder of WOM Testing Technologies, a start-up dedicated to innovation in the mobility industry. Based in Torino, he also supports global customers as a senior expert in tire and vehicle dynamics.

He began his career at PSA Groupe as a tire engineer, later joining the vehicle dynamics team as a chassis simulation engineer. He ended his collaboration with the OEM in the role of performance engineer, being responsible for vehicle dynamics, road testing, and tuning of tires and chassis components.

Additionally, he serves as a professor of vehicle dynamics at Buenos Aires University.

3.1

Belt and Sidewall Part Stiffness Estimation Method using Finite Element Tire Model

Gibin Gil[1], Kwon Bum Pyun[1], Rak Jin Seong[1], Yaswanth Siramdasu[2]

[1]Hankook Tire & Technology, Daejeon, Republic of Korea

[2]Hankook Tire & Technology America Technical Center, Uniontown, Ohio, USA

Abstract

Tire development process involves design parameter tuning of various components since good performance can be achieved when the proper stiffness balance in the tire is established. Tire is a complex structure with internal pressure and contains layers of composite materials. Therefore, changing certain design parameters may affect the stiffness of other areas of the tire due to the interaction between the components. It makes it difficult for tire design engineers to predict the effect of specification tuning on the stiffness balance of the tire.

In this research, a method to estimate the belt and sidewall part stiffness of a tire is proposed. The belt deflection of a tire due to the lateral displacement is simulated using finite element analysis. Then, by matching the belt and sidewall deflections output to the beam on the elastic foundation model, belt and sidewall stiffness are estimated. It utilizes simple static finite element simulation results and the required computational resource is minimal. The obtained parameters can be used to map the tire design specification onto the stiffness characteristics space, which can provide useful information during the tire development process.

This work presents the stiffness parameter changes due to the tire design modification based on the simulation results of a set of finite element tire models. The results show the sensitivity of design parameter change on the belt and sidewall part stiffness. In addition, it presents the relationship between the proposed stiffness parameters and the parameters of commercial physical tire models such as CDTire and FTire. The results provide insight about the efficient parameterization process for CDTire and FTire when the tire finite element models are available.

Presenting Author Biography

Gibin Gil received the Ph.D. degree in 2013 from the University of Arizona with the research on multibody dynamics and numerical methods. He has been working at the advanced research department of Hankook Tire and Technology since 2004. He is currently the leader of the virtual tire development project group. His research fields are vehicle dynamics, virtual tire modeling, and numerical methods. Gibin Gil is a member of SAE International and the Korean Society of Automotive Engineers.

3.2

Cord Dynamic Properties for FEA Modal and Steady State Dynamics of Tires

Md Nafis Soumik[1], Shameem Shahrear Sifat[1], Akshay Kumar Pakala[1], Anudeep Reddy Vedire[2], Michelle Hoo Fatt[1]

[1]The University of Akron, Akron, Ohio, USA

[2]Central College, IA, Pella, Iowa, USA

Abstract

Tire cords not only give shape and structural stability of a tire, but they influence the overall tire performance especially when it pertains to vehicle NVH. Yet research to characterize and model their dynamic behavior in a tire is lacking. In most cases cords are modeled with either linear or hyperelastic materials in FEA steady state dynamic simulations of tires. In this project, we present a method to accurately characterize and model tire cord properties for FEA modal and steady state dynamic analyses of tires. We show through DMA testing that the storage and loss moduli of a Polyester 1500/2 cord are dependent on both frequency and mean tensile strains about which they are calculated from. The storage modulus increases with increasing frequency and strain, while the loss modulus increases with increasing frequency but does not vary substantially with strain. We use time-temperature superposition to find Master Curves of the storage and loss moduli at frequencies over 1 kHz and mean strains up to 3%.

Our solution methodology is validated by performing steady-state vibration experiments on two-ply rubber-cord laminates and using ABAQUS steady-state dynamics with our cord viscoelastic response modeled with frequency- and strain-dependent storage and loss moduli. These tests include transverse vibration of a pre-loaded dual cantilever and in-plane vibrations of a pre-tensioned membrane. We perform separate DMA tests on the rubber in the laminate to determine its viscoelastic properties and provide this for ABAQUS input. In contrast to the polyester cord, the storage modulus of the rubber increases with increasing frequency and decreases with increasing mean tensile strains. Like the polyester cord, the rubber loss modulus increases with increasing frequency and does vary substantially with strain. A good correlation was found between ABAQUS simulations and experimental results.

Presenting Author Biography

Md Nafis Soumik is a graduate researcher assistant and Ph.D. student in Mechanical Engineering at The University of Akron. His research is supported by the Center for Tire Research (CenTiRe), an NSF IUCRC. This work focuses on developing accurate tire cord properties for NVH simulations of tires. Before coming to The University of Akron, Nafis completed a BS degree in Naval Architecture and Marine Engineering from Bangladesh University of Engineering and Technology (BUET), and he worked as a Web Content Developer for a year, gaining valuable experience in technical communication.

3.3

Modeling of Tread Molding by the Material Point Method

Julian Meyer[1], Fursan Hamad[2], Rafal Nojek[2], Michael Kaliske[1]

[1]Institute for Structural Analysis, Technische Universität Dresden, Dresden, Germany

[2]Mechanics & Simulation Development, Continental Reifen Deutschland GmbH, Hannover, Germany

Abstract

In tire production, the molding of the tread is one of the most intricate and opaque processes. However, it also plays a significant role in tire performance. During this step, the uncured tire tread is subjected to extreme conditions and undergoes massive deformations, posing considerable challenges to simulation frameworks that could aid in the design process. For example, traditional mesh-based simulations face extreme distortion of the elements, resulting in inaccurate and unstable behavior. This study lays the foundation for a framework based on the Material Point Method (MPM) to address these challenges. The tire tread is discretized using particles called material points. To compute their interactions, the material points are projected onto a static background grid to solve the underlying differential equations, facilitating a fast and robust computation. The focus of this contribution in on the modeling of the mold and its interaction with the green tire, taking the unique properties of the MPM into consideration. Approaches based on the penalty method and the direct elimination method are presented and applied to molding examples to investigate their efficacy.

Presenting Author Biography

Julian Meyer is a PhD student at the Institute for Structural Analysis at TU Dresden, specializing in the Material Point Method and its application to tires. He studied civil engineering at TU Dresden from 2018 to 2023.

3.4

Mitigating Tire Air Cavity Resonance Using Acoustic Metasurfaces and Porous Liners: A Comparative Numerical Study

ABM Mominul Haque, Hyeonu Heo

The University of Akron, Akron, Ohio, USA

Abstract

Tire Air Cavity Resonance (TACR) significantly contributes to interior vehicle noise and remains a persistent challenge in low-noise tire design. Conventional approaches typically utilize porous materials, such as polyurethane foam, applied to the inner tire wall to dampen cavity resonance frequencies and attenuate the air cavity mode through thermal and viscous dissipation. While porous materials have shown promising results, their performance is limited by space constraints, environmental durability, and poor tunability for specific resonance frequencies. In this study, we propose an innovative approach incorporating acoustic metasurfaces mounted on the tire rim as an alternative or complementary solution for TACR mitigation. Inspired by recent advancements in porous-lined tire technologies, our approach exploits the reflective, phase-shifting and resonant properties of metasurfaces to achieve superior control over the cavity's acoustic field, especially at targeted low frequencies under 500 Hz. This poster presents an ongoing numerical study comparing the acoustic performance of porous liners and metasurface-based treatments, as well as exploring their combined application within the tire cavity. We first characterize the fundamental resonance behavior using a baseline model of a tire–rim assembly with an enclosed air cavity. The study then simulates the application of: (i) a porous liner with validated material parameters from previous research, (ii) a metasurface liner of various geometries composed of locally resonant subwavelength structures mounted on the rim, and (iii) a hybrid configuration combining both treatments. Our analysis compares cavity resonance frequency, sound pressure level reduction, and required thickness to assess the effectiveness, tunability, and space efficiency of metasurfaces—both alone and in combination with traditional porous materials.

Presenting Author Biography

ABM Mominul Haque earned his Bachelor of Science in Mechanical Engineering in 2015 from the Islamic University of Technology (IUT), Bangladesh. He began his professional career as a Lecturer at Sonargaon University, Bangladesh, where he served for almost two years. Later, he joined Rupantarita Prakritik Gas Company Limited (RPGCL), a state-owned company in Bangladesh, where he worked for over six years in various technical and managerial capacities. In Fall 2025, he commenced his Ph.D. in Mechanical Engineering at the University of Akron, USA. His research interests include vibration and noise reduction of structures, acoustic metamaterials, and the mechanical behavior of advanced materials.

3.5

Transient Oscillations Reduction to Reach Steady State Severe Traction/braking Rolling of a Tire with Pattern in an Explicit Lagrangian FEM Simulation

Lorenzo Massimi[1], Nicola Pesa[1], Michael Kaliske[2]

[1]Bridgestone, Rome, Italy

[2]Institute for Structural Analysis, Technische Universität Dresden, Dresden, Germany

Abstract

The presentation will focus on a workflow to quickly reach a stable steady state severe traction/braking solution of a tire with pattern rolling in an explicit Lagrangian environment. Starting point is an a-priori estimation of the free rolling rotational velocity based on the tire radius, with a simulation of the tire rolling without road contact in a static/dynamic steady state environment.

The solution is transferred to the explicit environment and free rolling condition is reached through a Lagrangian simulation of the tire landing on the road moving at the desired speed. Using linear connectors applied on the road with relative velocity dampers, it is possible to quickly reach a severe steady-state traction/braking condition, starting from the free rolling solution.

Main novelty is in transferring the dynamic effects from the tire (always controlled in kinematic) to the road (controlled in a combination of dynamic and kinematic), modelled as a rigid body with its own dynamics. With a proper calibration of road mass and road damping properties, it is possible to quickly dampen transitory oscillation.

Presenting Author Biography

Lorenzo Massimi has entered Bridgestone in 2019 and the core of his activities has been virtual vehicle dynamics and advanced FEM tire simulations in the field of performance prediction (noise, wear, wet etc.), with a special focus on simulated contact mechanics.

Lorenzo has an academic background in the theory of FEM structural simulations (new elements formulation and definition, Eulerian-Lagrangian tire FEM simulations etc).

4.1

Influence of Tread Block Stiffness on Tire Traction

Hans Ragnar Appel[1], Michael Hindemith[1], Rebecca Berthold[1], Matthias Wangenheim[1], Klaus Wiese[2], Burkhard Wies[2]

[1]Leibniz University Hannover, Garbsen, Germany

[2]Continental Reifen Deutschland GmbH, Hannover, Germany

Abstract

Due to continuous wear, tire tread blocks change their geometrical shape over the tire’s life, generally resulting in height reduction. The obvious consequences are increased structural stiffness of the tread and less compliance to adapt to the road asperities, potentially affecting the tire's ability to transmit traction and braking forces effectively.

In this work, we use viscoelastic finite element (FE) simulations to evaluate the dry traction potential of siped and non-siped tread blocks varying tread depth, slip and load conditions. In addition to assessing the overall tread block traction, we present a novel statistical approach for interpreting FE results enabling us to distinguish between contributions of different friction mechanisms, such as interlocking or hysteresis. All simulations are validated by experiments utilizing our RePTiL (Realistic Pattern Testing in Lab) test rig, which is able to perform realistic rolling motion of individual tread block samples on real asphalt surfaces under varying slip conditions.

Presenting Author Biography

- Bachelor’s degree in Mechanical Engineering at Leibniz Universität Hannover (2013-2020)

- Master’s degree in Mechanical Engineering at Leibniz Universität Hannover (2020-2024)

- Scientific employee at the Institute of Dynamics and Vibration Research at Leibniz Universität Hannover since 2024 (Ph.D. student)

- Research focus on simulations of elastomer friction and contact mechanics

4.2

Research on the Prediction of Longitudinal Slip Characteristics Based on Side Slip Characteristics of Tires

Wenqing Bai, Dang Lu

Jilin University, Changchun City, Jilin Province, China

Abstract

Dynamic modelling of Truck and Bus Radial (TBR) tires is fundamental to the development of stability control systems and intelligent driving technologies for commercial vehicles. The prediction of mechanical characteristics under side slip-longitudinal slip conditions directly affects the control accuracy of systems such as ABS and ESC. However, conducting full-condition tests on TBR tires has always been a technical challenge due to constraints in testing conditions. To reduce test costs and obtain comprehensive condition data, it is necessary to conduct research on predicting longitudinal slip characteristics based on side slip characteristics for TBR tires. In this study, methods related to the prediction of longitudinal slip characteristics were analysed, including the Combinator method, Lund model method, state stiffness method, and a dynamic friction separation method incorporating a reference tire. Using finite element simulation as a research tool combined with theoretical models, the relationship between sideslip and longitudinal slip stiffness was investigated in detail. A TBR tire side slip-longitudinal slip stiffness ratio model was established, enabling the prediction of longitudinal slip characteristics based on side slip data. Additionally, the coupling mechanism of lateral-longitudinal friction coefficients was explored, and a novel method for predicting friction coefficients of TBR tires was proposed, achieving the prediction of longitudinal slip friction coefficients through tire lateral friction coefficients. Furthermore, focusing on the mechanical properties of TBR tires under pure longitudinal slip conditions, a UniTire model capable of predicting longitudinal friction coefficients and longitudinal slip stiffness was developed. The predictive performance of the established UniTire model was validated by comparing it with test data from a specific TBR tire, demonstrating the effectiveness of the proposed prediction methods.

Presenting Author Biography

Wenqing Bai is a graduate student engaged in tire dynamics research at The State Key Laboratory of Automotive Simulation and Control, Jilin University, Changchun City, Jilin Province, China.

4.3

Power Spectral Density (PSD) and Friction Models: The Approximations That Still Limit Us in Realistically Predicting the Rubber-Asphalt Friction Coefficient

Stefano Avolio[1], Andrea Ronchi[2], Michael Hindemith[3], Matthias Wangenheim[3], Francesco Timpone[1], Andrea Genovese[1]

[1]University of Naples Federico II, Napoli, Italy

[2]Pirelli Tyre S.p.A., Milano, Italy

[3]Leibniz Universität Hannover, Hannover, Germany

Abstract

Currently, friction models such as those developed by Persson or by Heinrich and Klüppel describe the friction behavior between a viscoelastic material and asphalt primarily as a result of hysteretic energy loss caused by the material's deformation due to surface roughness. Consequently, accurately characterizing the asphalt surface is essential for robust and reliable friction predictions.

The most commonly used metric in friction models to describe road surfaces is the power spectral density (PSD). Although the use of PSD has significant advantages, especially on self-affine surfaces, it provides limited insight into the local height distribution of roughness and may misinterpret sharp height variations as high-frequency roughness components. In addition, PSD is highly sensitive to the experimental method used to obtain the digital twin of the surface, whether through replication or direct measurement. All these factors can lead to inaccurate predictions that deviate significantly from the actual behavior of the compound on asphalt.

In this study, we examine the limitations of existing models, particularly their reliance on PSD as the sole surface estimator, while other surface descriptors such as the height distributions function may vary without affecting the PSD. We also compare experimental results obtained with a linear friction tester to predictions from numerical model, demonstrating that PSD alone, as used in the model, is insufficient to fully capture the interactions at the compound-asphalt interface.

Presenting Author Biography

Dr. Andrea Genovese is an assistant professor in Applied Mechanics at the University of Naples Federico II; founder and CEO of its spinoff VESevo. He works as academic advisor for several companies and racing teams. His research interests include design and development of mechatronic systems, smart systems, tribology, non-destructive materials characterization, energy harvesting, vehicle dynamics and vibration control. He is author of more than 50 papers in international journals and refereed conferences. He serves on the Editorial Board of several international scientific journals and conferences.

4.4

Novel Multi Length-Scale Modeling of Interfacial Convection and Its Effect on Flash Temperature

Sivaraman Ilanji Sethuramalingam, Saied Taheri

Center for Tire Research (CenTiRe)-Virginia Tech, Blacksburg, Virginia, USA

Abstract

The temperature of a tire tread block sliding on a wet road affects the grip available at the contact patch. Heat is generated due to interaction between the sliding rubber and the asperities at the interface. This heat is transferred to tread block through conduction at the area of actual contact of the interface. Convection occurs due to fluid flow in non-contact areas at the interface, thus transferring heat away from the tread block.

The temperature of the tread block is determined by the above-mentioned heat transfer processes at the interface, which are governed by complex physical phenomena such as multi length-scale roughness, viscoelasticity, fluid flow at the contact patch, etc. This work aims to quantify the effect of these heat transfer processes, and the resulting tread block temperature on the grip available, using an analytical multi length-scale model incorporating the above-mentioned physics. This will include, heat generation and convection to the fluid at the interface due to microfluidic flows and percolation.

Fluid flow through micro-asperity channels will be modeled using Burggemann's Effective medium theory. The temperature of the block, and heat transfer processes will be modeled using a novel formulation. The available grip will be calculated using the temperature of the tread block, and other aforementioned physical parameters. The model will also be validated using round rubber samples in a Dynamic Friction Tester which was designed and developed at the Center for Tire Research (CenTiRe), Virginia Tech.

Presenting Author Biography

Sivaraman is graduate student at Virginia Tech and has been a Graduate Research Assistant at the Center for Tire Research (CenTiRe) over the last 3 years. He is currently pursuing his PhD in Mechanical Engineering with a specialization in vehicle dynamics and tire modeling. He has been working on analytical modeling of wet tire-road interaction and has presented his work at multiple conferences and has won awards for them. He has worked in multiple student teams at Virginia Tech and his undergrad university, and has also completed multiple internships on vehicle and tire modeling.

5.1

Tire-Road Friction Estimation Based on a Deep Learning Using Microphone for Chassis Control Performance

Jiyeon Hong[1], Sehwan Ku[1], Youngsam Yoon[1], Sungwook Hwang[2], Sangkwon Lee[3]

[1]Hyundai Motor Company, Seoul, Republic of Korea

[2]Nexen Tire Company, Seoul, Republic of Korea

[3]Inha University, Seoul, Republic of Korea

Abstract

Advanced driver assistance systems (ADASs) and driving automation system technologies have significantly increased the demand for research on vehicle-state recognition. However, despite its critical importance in ensuring accurate vehicle-state recognition, research on road-surface classification remains underdeveloped. Accurate road-surface classification and recognition would enable control systems to enhance decision-making robustness by cross-validating data from various sensors. Therefore, road-surface classification is an essential component of autonomous driving technologies. This paper proposes the use of tire–pavement interaction noise (TPIN) as a data source for road-surface classification. Traditional approaches predominantly rely on accelerometers and visual sensors. However, accelerometer signals have inherent limitations because they capture only surface profile properties and are often distorted by the resonant characteristics of the vehicle structure. Similarly, image-based signals are susceptible to external factors such as lighting conditions, obstacles, and motion blur, which can compromise their reliability. In contrast, TPIN signals offer a more comprehensive representation of both the surface profile and texture characteristics of the road. Additionally, TPIN signals are less susceptible to environmental interferences that affect image-based methods. The TPIN signals are transformed into two-dimensional images using time–frequency analysis. These transformed images are subsequently utilized in conjunction with a convolutional neural network (CNN) architecture to evaluate the feasibility of a robust road-surface classification system. The system was implemented using MATLAB Simulink. Furthermore, this study explored the application of CNN-based artificial intelligence techniques to predict the tire–road friction coefficients across various road surfaces, providing a deeper understanding of the underlying principles governing tire–road interactions.

Presenting Author Biography

Jiyeon Hong graduated from Soongsil University. He has four years of experience at Hyundai Motor Company Research & Development.

5.2

Electromagnetic and Thermal Analysis of Permanent Magnet Linear Synchronous Motor (PMLSM) and Magnetorheological (MR) Damper-Based Active Suspension System

Nayan Kumar Chowdhury, Jiajun Zhang, Wei YinTao

Tsinghua University, Beijing, Beijing, China

Abstract

Active suspension systems are crucial for enhancing ride quality and passenger comfort in vehicles because they have the capacity to adjust their stiffness and damping characteristics dynamically. Significant studies into the structural design of active suspension systems have been conducted recently by corporations and academic institutions. Currently, hydraulic and electromagnetic systems make up the majority of active suspension types. Notably, hydraulic active suspensions exhibit a comparatively slower response time, whereas electromagnetic active suspensions typically lack the capability to modify the damping force's characteristics actively. Therefore, we proposed an active suspension system that consists of a permanent magnet linear synchronous motor (PMLSM) and a Magnetorheological (MR) fluid damper. In our system, linear motors could provide fast and accurate force response. MR fluid damper is employed to provide fast and widely adjustable damping force, improving the ride comfort and handling stability of the vehicle. In order to examine the performance of our proposed system, the thrust curve and response time were calculated. Moreover, electromagnetic simulation and thermal simulation were carried out to test the performance of the suspension system, which proved that the impact caused by magnetic leakage could be ignored and that the heat generation of the coil would not affect the regular operation of our suspension system. Additionally, the proposed system demonstrates a reduction in tire dynamic forces, further optimizing vehicle stability and road contact. In summary, our proposed active suspension system is a powerful and robust system that can enhance driving comfort and handling stability compared to other active suspension systems.

Presenting Author Biography

Jiajun Zhang majored in theoretical and applied mechanics and vehicle engineering. He is currently working toward his bachelor's degree at Xingjian College, Tsinghua University, Beijing, China. Moreover, he will start his Phd in the fall of 2025 at the School of Vehicle and Mobility, Tsinghua University, Beijing,China. His research interests include active suspension control, linear motor design, and magnetorheological fluid.

5.3

Tire Dynamic Load Optimization via RBF-SARSA-Controlled Magnetorheological Suspension

Xiaoyu Wen, Yintao Wei

Tsinghua University, Beijing, China

Abstract

This article focuses on optimizing tire dynamic load variation through a suspension control strategy based on reinforcement learning (RL), aiming to improve the vehicle performance of handling and stability. A quarter-car magnetorheological (MR) semi-active suspension model was developed to serve as the training and simulation environment for the RL algorithm. To ensure efficient deployment and real-time implementation on embedded hardware platforms, an approximate RL control method integrating a Radial Basis Function Network (RBFN)-based Sarsa algorithm is developed. Specifically, the convergence efficiency and training stability of the policy are improved by integrating Dutch eligibility traces and a Softmax-based action selection machanism. Additionally, a tailored reward function is formulated to balance the objectives of minimizing tire dynamic load variations and controlling sprung mass vibrations. The policy is implemented onto embedded systems through automatic code generation facilitated by using MATLAB/Simulink's Embedded Coder, and its effectiveness is varified through real-vehicle testing. Experimental results indicate that the proposed algorithm substantially reduces tire dynamic load fluctuations, thereby significantly improving vehicle handling and stability performance while concurrently maintaining ride comfort.

Presenting Author Biography

Xiaoyu Wen received her B.Sc. degree from Nanjing University of Science and Technology, China, in 2018. She has gained professional experience at Honda and Li Auto. She is currently a Master's student at Tsinghua University, conducting research on vehicle dynamics, magnetorheological semi-active suspension systems, and reinforcement learning-based control strategies for real-time automotive applications.

6.1

Lettering, Grooves and Vents – Design Validation for Stress-Concentrating Tire Features

William Mars[1], Ethan Steiner[1], Thomas Ebbott[1], Greg Vernon[2], Matthew Sederberg[2]

[1]Endurica LLC, Findlay, Ohio, USA
[2]Coreform LLC, Orem, Utah, USA

Abstract

Tire engineers must avoid the development of cracks on tires during regulatory durability testing in order to qualify tires for the marketplace. Given that typical tread and sidewall features have the potential to concentrate stresses and to develop cracks, and considering the high cost of machining a new mold, a simulation-based workflow for analyzing stress-concentrating tire surface features has been developed and exercised. The workflow has been applied for samples of lettering, grooves, and vents. Each of these features involves small radii / high curvature surfaces which must operate under a multiaxial loading cycle imposed by tire loading and rotation. The workflow combines the Coreform Cubit meshing software, Abaqus finite element solver and the Endurica CL fatigue solver. The presentation investigates the discretization and computational requirements, and provides examples of acceptable and unacceptable feature geometry.

Presenting Author Biography

Dr. Will Mars founded Endurica LLC in 2008 to give product developers a simple and accurate workflow for analyzing the durability of elastomer products. The firm’s products and services are used by leading firms around the world to manage durability. Dr. Mars has received several awards for his scientific contributions and innovations. He has more than 60 peer-reviewed publications, holds four patents in the area of elastomer durability and is the past editor of two scientific journals.

6.2

Sensor-Driven Thermo-Mechanical Modeling for Mining Tire Temperature and Durability Assessment

Hao Wang[1], Jianyue Liu[2], Longhai Mu[1],Haijian Yin [2]

[1]E-rubber Technology (Tianjin) Co.,Ltd., Tianjin, China
[2]Techking Tires Ltd, Qingdao, China

Abstract

OTR tires in mining areas typically operate under low-speed, high-load, and complex road conditions. The severe operating conditions impose high demands on the tires' load-carrying capacity and thermal resistance, while also providing an ideal application scenario for simulation and intelligent technologies.

This study takes a wide-body dump truck tire as an example to explore the effective application methods of intelligent sensor technology and thermo-mechanical coupled FEA in the analysis of OTR tires. First, a novel tire TPMS capable of monitoring tire loads was used to collect the loading history of the tire in real working environments. The collected load information was then statistically classified to obtain virtual load history spectrum segments for tire simulation. Subsequently, finite element simulation tools were employed to analyze the stress and deformation of the tire under different load conditions. Computational fluid dynamics methods were used to analyze the internal and external cavity heat exchange conditions of the tire under various operating conditions, including convective heat transfer and thermal radiation.

Besides, a nonlinear viscoelastic hysteretic hysteresis model was established to characterize the heat generation of tire rubber materials, followed by the prediction of the transient thermal conduction and the temperature evolution across tire components under various operating conditions.

Furthermore, the damage accumulation of the tire rubber elements over their service life was calculated using the Endurica CL+DT fatigue analysis tools. The efficacy of the entire data collection, modeling, and simulation techniques was validated under bench test conditions through embedded RF technology by comparing the simulated temperature with the recorded temperature inside various tire parts. This integrated framework demonstrates potential for predictive safety assessment and lifecycle management of large-scale mining off-road tires, offering a systematic approach to optimize load-bearing performance and thermal stability under extreme operational demands.

Presenting Author Biography

Hao Wang holds a Master’s degree in Automotive Engineering from the School of Vehicle and Mobility at Tsinghua University, where his research focused on finite element simulation and fatigue analysis of rubber components and tires. His academic contributions were recognized with the 2015 Honorable Mention Award from The Tire Society. Currently serving as the General Manager of E-rubber Technology (Tianjin) Co., Ltd., he leads initiatives to integrate intelligent measurement technologies and multiphysics simulation methods into tire product development and performance optimization. By leveraging embedded sensing data and thermomechanical coupling modeling techniques, his team aims to enhance the load-bearing capacity, thermal management efficiency, and lifecycle reliability of mining off-road tires. His work bridges advanced computational methodologies with industrial applications, driving innovation in intelligent and high-performance tire solutions for extreme operational environments.

6.3

Comprehensive Approach using Multiphysics Simulations to Predict Durability of Rubber Products

Mahmoud Assaad

Endurica, Findlay, Ohio, USA

Abstract

Rubber components often operate under conditions in which several physical phenomena such as dynamic loading, temperature and chemical exposure interact closely. There is a real need for a tool designed to help engineers and businesses predict and analyze the fatigue life of these rubber parts usually used in automotive, aerospace and industrial applications. In this paper, a novel and comprehensive approach is demonstrated to predict the durability of rubber components by considering the complex interactions between mechanical, thermal and oxidative reactions. Additionally, complete material testing protocols with input conditions corresponding to actual behavior are explained. Material properties such as stiffness, elasticity and resistance to crack growth are integrated as a function of temperature level and oxygen concentration to account for changes in behavior under different thermal and oxidative conditions. To fully demonstrate this crucial Multiphysics mechanism in materials design and engineering applications, two types of tires (PCR, TBR) were analyzed using FE models in Abaqus coupled with Endurica to provide accurate fatigue life predictions. Examples are presented to demonstrate the impact on the number of cycles to failure where rubber components are subjected to simple or harsh and complex conditions.

Presenting Author Biography

Mahmoud Assaad: senior technical advisor at Endurica in Findlay, Ohio, USA. He received his MSc in structural engineering from Iowa State University, Ames, Iowa, following it with a PhD from the same university with engineering mechanics as a major and applied mathematics as a minor. Assad started his industrial career with Goodyear as a senior research engineer in 1983. He gained his second MSc – in polymer science – from the University of Akron, Ohio in 1990. Assad is a senior R&D associate/retired in the global numerical methods, global simulation technology department at the Goodyear Technical Center, Akron, Ohio, USA. Author of the Composite segment of The Pneumatic Tire book and 27 publications. •Recipient of the special Achievement Award from NASA for “meritorious accomplishments, dedicated work, and special efforts”. •Winner of the "2008 Create the future design contest" in the machinery/equipment category. Holds 65 U.S., European patents trade secrets

6.4

Stiffness-hysteresis Tradeoff in the Dynamic Mechanical Behavior of Silica-reinforced Styrene-butadiene Rubber and Implications for Tire Tread Performance

Christopher Robertson[1], Danling Wang[2], Huiming Ren[2], Xingwang Dong[2]

[1]Polymer Technology Services LLC, Akron, OH, USA

[2]Zhongce Rubber Group Co., Ltd., Hangzhou, Zhejiang, China

Abstract

We show using temperature-dependent dynamic mechanical analysis (DMA) results that the peak height for loss tangent (tan(delta)) in the glass-to-rubber softening transition is inversely related to the dynamic storage modulus in the rubbery state, the latter influenced strongly by the type and concentration of reinforcing filler. New DMA results for a model passenger tire tread compound, based on styrene-butadiene rubber reinforced with different loadings of precipitated silica and silane coupling agent, illustrate this stiffness-hysteresis tradeoff. This general trend is also noted for published data for various tread compounds filled with precipitated silica or carbon black and with data for various elastomer nanocomposites from scientific literature. Viscoelastic models show the same inverse relationship, independent of any material-related interpretation. This viscoelastic tradeoff will be discussed, including the implications for tire tread performance.

Presenting Author Biography

Dr. Chris Robertson is principal consultant at Polymer Technology Services LLC in Akron, Ohio, a company that he founded in 2021 to provide technical consulting, training, and expert witness services for the rubber industry. Chris has 25 years of experience as a materials scientist and engineer in the tire and rubber industry. This experience includes 9 years working in R&D for tire companies (Bridgestone; Cooper Tire) and 4 years in a combined commercial and technical role at Endurica LLC. Chris teaches online graduate courses on elastomer science and technology as an adjunct professor in the Department of Plastics Engineering at the University of Massachusetts Lowell, and he is a visiting research scientist with the Rubber Technologies group of the Centre of Polymer Systems at Tomas Bata University in Zlín, Czech Republic. Chris has expertise and research interest in polymer viscoelasticity and rheology, rubber compound development, and elastomer fracture behavior.

7.1

Optimizing the Process of Indoor Tire Wear Testing

Guenter Leister[1], Markus Winter[2]

[1]twms-consulting, Schwaigern, Germany
[2]Kokusai Europe, Frankfurt, Germany

Abstract

As part of the Euro 7 legislation, the issue of tire abrasion has taken on a new significance. The European Union therefore wants to reduce tire abrasion by 30% by the year 2030.

Two methods have been developed to measure tire abrasion: the road method, which involves a convoy test with a reference tire and up to three test tires. The second is an indoor drum test on sandpaper, in which the test tires are subjected to a defined sequence of speed, wheel load, longitudinal and lateral forces. The ratio of the mass loss between the test subject and the test tire yields a wear index that ultimately serves as an approval criterion. The limit value is derived from a large-scale test according to the approved procedures.

The widespread use of sandpaper on tire test stands originally comes from the measurement of the lateral force and the restoring torque. Sandpaper has the property of wearing down quickly at first and then less and less. This makes it difficult to compare different tires, since the state of wear of the sandpaper is never really known. In most cases, a reference tire is always measured on a 2-position test stand so that at least one comparative statement can be made. However, this is not always useful because the dependence of wear on the surface texture of the sandpaper can vary from tire to tire.

This paper presents methods for avoiding reference tire measurements as much as possible while still achieving a high degree of reproducibility of the measurements. In addition, a method for optimally reducing test time is presented and evaluated.

Presenting Author Biography

Guenter Leister
1982- 1988 Master of Mechanical Engineering at University of Stuttgart
1988- 1992 Research Associate Institute B for Mechanics, University of Stuttgart. Ph.D. Theses: Simulation of multi-body systems with closed kinematic loops
1992 – 2020 Mercedes-Benz Cars, Last position: Director and Head for Wheels, Tires and Tire Pressure Monitoring
Since 2020 Owner of TPMS-consulting | tire wheel mobility solution
Since 2020 Honorary Professor at the University of Karlsruhe:
Author of the Book "Passenger Car Tires and Wheels", Springer ISBN: 978-3-319-50118-5,
Life Achievement Award of the "Tire Technology International", 2024.

7.2

Stretchable Sensors for Tire Tread Wear Monitoring

Shahba Tasmiya Mouna, Md. Jarir Hossain, Jae Won Choi

University of Akron, Akron, Ohio, USA

Abstract

Accurate monitoring of tire wear and road conditions is needed for enhancing vehicle safety, traction, and overall performance, yet it poses challenges due to limitations in sensor stretchability and integration. These sensors feature stretchable carbon nanotube electrodes integrated into a stretchable, pressure-sensitive layer made of an ionic liquid-polymer composite, enabling it to detect voltage changes in response to pressure variations. They are integrated into tire tread that is capable of tracking tire wear progression. Tire wear was simulated through incremental tread reduction maintaining consistent tire pressure, speed, and deformation. Results demonstrate distinct voltage outputs correlating with tread depth reduction enabling predictive assessment of tire lifespan. This approach establishes a transformative tool for intelligent tires, enhancing safety by identifying wear thresholds before failure and optimizing traction and stability across diverse driving environments.

Presenting Author Biography

Shahba Tasmiya Mouna is a Ph.D. student in Mechanical Engineering at the University of Akron with a background of Biomedical Engineering, working with Dr. Jae Won Choi. She is specializing in advanced additive manufacturing and sensing technologies. Apart from Tire Research she is also specializing in Biomechanical Research and Biosensing applications.

7.3

Towards a Digital Twin - Multi-physics Modeling of Wear Phenomena in Tires

Samir El Masri, Johannes Storm, Michael Kaliske

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Abstract

The main aim of a Digital Twin is to fully model one or more assets digitally, creating a virtual replica of the asset during all its design and operational lifetime. For physics-based Digital Twins, it is essential to capture not only mechanical deformations but also dissipative and degradation processes, such as temperature fluctuations, fatigue, and wear, that require a multi-physics simulation framework. This study, and in a step toward Digital Twins, aims to introduce wear into the simulation of tires in multi-physics manner. Traditional wear modeling approaches, which typically rely on post-processing methods like node-moving algorithms, often introduce inaccuracies in representing the exact amount of material loss. With that said, such limitations hinder the seamless integration of wear description into Digital Twin applications.

To address these challenges, a novel multi-physics approach that embeds wear calculations into the simulation in a fully coupled manner is proposed. By directly solving the mass balance equation alongside the momentum balance, the method guarantees an accurate and consistent representation of mass loss, eliminating the need for post-processing approaches and external adjustments. In this study, the coupled problem is adapted to steady-state rolling tire allowing for an efficient modeling of tire wear. Additionally, the critical numerical challenges, such as contact modeling and its impact on simulation accuracy and convergence are addressed. The approach is validated using a series of numerical examples focusing on steady state rolling tire simulations under various boundary conditions. These examples showcase the advantages of our method in terms of numerical stability, accuracy, and practical applicability. This work represents a promising advancement in integrating multi-physics phenomena into tire simulations, paving the way for a Digital Twin that replicates both mechanical and degradation processes.

Presenting Author Biography

Samir El Masri earned a Bachelor of Science in Civil and Environmental Engineering from Rafik Hariri University in Lebanon (2014–2017) and then completed a Master of Science in Civil Engineering at the University of Southampton, UK (2017–2018). From 2018 to 2021, he worked as a consulting engineer at Advanced Construction Technology Services while concurrently pursuing an MSc in Advanced Concrete Technology from the University of Leeds. In 2021, he embarked on a third postgraduate program—an MSc in Advanced Computational and Civil Engineering Structural Studies at TU Dresden, which he completed in 2024. He is currently pursuing a PhD at the Institute for Structural Analysis, Dresden University of Technology.

8.1

Tire Performance Across Different Road Surfaces: A Data-Driven Framework for Predictive Tire Modeling

Henning Olsson, Marco Furlan, Matthew Strang, Ethan Ackerman

Calspan, Buffalo, NY, USA

Abstract

Understanding and predicting tire performance across different road surfaces is essential for both tire and vehicle development. While indoor testing provides precise and repeatable measurements, it does not directly replicate real-world road interactions. This research presents a novel two-phase approach that enhances the predictive capability of indoor testing by integrating highly repeatable and precisely controlled test surfaces with an advanced modeling framework. This method enables accurate performance predictions in both virtual and physical development workflows.

In the first phase, we developed a set of mathematically generated test surfaces that capture key textural attributes of real-world roads. These surfaces, fabricated using a novel manufacturing method, enable precise and repeatable measurements of tire performance across a spectrum of surface characteristics. By combining targeted tire measurements on these surfaces with detailed tread rubber assessments, we gain fundamental insights into how tire tread interacts with varying surface textures.

Building upon this data, the second phase introduces a predictive modeling framework that enables performance translation between surfaces. Using high-resolution 3D scans of real road textures, converted into power spectral density (PSD) representations, we establish a mapping between indoor test results and real-world road conditions. This multi-step mathematical approach predicts how a tire tested on a controlled indoor surface will behave on different proving grounds, enabling a streamlined transition from lab-based testing to real-world validation.

The method has been validated using full-vehicle testing across different road surfaces, demonstrating its effectiveness in capturing the influence of surface properties on tire performance. Future work will focus on integrating this approach into virtual development workflows, allowing tire and vehicle manufacturers to optimize performance predictions before physical prototypes exist, thus increasing efficiency and reducing development costs.

Presenting Author Biography

Since joining Calspan in 2015, Henning has been developing and implementing testing technologies to help Calspan's customers bring new and innovative tires and vehicles to market faster than before. With extensive experience in the use of CAE and simulations to understand and predict tire performance, Henning works side-by-side with global customers to make tire testing and modelling more accurate, repeatable and cost-effective. Prior to joining Calspan, Henning spent several years as a vehicle dynamics engineer in high-level motorsports. Henning received his B.S in Engineering from Dartmouth College and his M.S in Automotive Engineering from the Royal Institute of Technology in Sweden.

8.2

Research on Tire Mechanics Modeling under Multiple Inflation Pressures Based on Mechanism and Data Fusion

Hao Yuan, Dang Lu, Konghui Guo

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Abstract

Variations in tire inflation pressure significantly affect tire mechanical properties and vehicle dynamics. Developing a high-precision tire mechanical model applicable to complex operating conditions and multiple inflation pressures is crucial for vehicle dynamics simulation and control. Traditional semi-empirical models (such as Pacejka) consider the effects of tire pressure but exhibit limited prediction accuracy under complex slip conditions and lack an adequate representation of hysteresis effects.

To enhance modeling accuracy under multiple inflation pressures, this study proposes a data-driven approach that integrates mechanism-based modeling with deep learning. By conducting tire handling tests under different inflation pressures, three models are developed: the traditional Pacejka model, a data-driven deep learning model, and a hybrid mechanism-data fusion model. Their prediction accuracy and generalization ability are compared across various operating conditions.

Experimental results demonstrate that, compared to semi-empirical physical models and purely data-driven prediction methods, the mechanism-data fusion model exhibits higher prediction accuracy and better generalization under multi-pressure and complex operating conditions while effectively capturing tire hysteresis effects. This study provides an optimized approach that combines physical modeling and data-driven methods for tire force prediction, offering new insights into tire dynamics modeling and vehicle dynamic control.

Presenting Author Biography

Hao Yuan is a Ph.D. student at Jilin University, specializing in tire dynamics. Under the guidance of Professor Dang Lu , his research focuses on tire sensors, intelligent tires, and multi-inflation pressure tire modeling. Currently, he is dedicated to integrating mechanistic modeling with data-driven approaches for studying tire characteristics under varying inflation pressures. In this conference, he will present his latest findings on this topic.

8.3

Development of Tire Performance Prediction Model using CNN Deep-learning Model

Dongyoon Shin[1], Youngsam Yoon[1], Hyosik Kim[1], Hyeongju Kim[1], Jaegil Lee[1], Sangkwon Lee[2], Seonguk Hwang[3]

[1]Hyundai Motor Company, Seoul, Seoul, Republic of Korea

[2]Inha University, Incheon, Incheon, Republic of Korea

[3]Nexen Tire, Seoul, Seoul, Republic of Korea

Abstract

Predicting various performance characteristics of tires at the early stages of tire development is a challenging task, particularly when considering their integration with vehicles. Moreover, during the vehicle development process, there may be instances where certain tire performance metrics fall short of initial expectations. In such cases, it becomes necessary to make trade-offs with other performance attributes in order to implement improvements. Therefore, the ability to accurately predict tire performance at an early stage is important.

In this study, a convolutional neural network (CNN) was developed based on the non-supervised training method to predict tire performance for PRAT, Torque steer under acceleration, Snow, Hydroplaning, Wet Braking, Dry Mu, Cornering Stiffness, Pattern noise. Two learning algorithms, i.e., stochastic gradient descent (SGD) and RMSProp, were applied to the CNN model for comparison of their learning performance. In this case, an image of the pattern of the tire to be designed was used as the input of the CNN. Therefore, a technology for predicting tire performance was developed by developing an artificial intelligence review system based on input of a database of design elements for tire performance and output of tire performance evaluation results, and by developing a GUI-based review system.

Presenting Author Biography

Mr. Shin Dongyoon is a engineering researcher of Hyundai Motor Company. He received his bachelor from mechanical engineering from Hanyang university in Seoul, Korea and has 4 years of experience in automotive researcher. His work focuses on wheel & tire system engineering design of commercial vehicle. He can be reached at shindy@hyundai.com

8.4

AI-Powered Tyre Noise Prediction from Tread Profile Images: Accelerating Design-Stage Approvals

Lakshmi Sampathraghavan[1,2], V Krishna Teja Mantripragada[2], Neeraj Ramachandran[2], Krishnakumar Ramarathnam[1]

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Abstract

The prediction of tyre noise from tread profiles is a critical aspect of tyre design, particularly for electric vehicles (EVs), where pass-by noise (PBN) and in-cabin noise play significant roles in the overall vehicle acoustic experience. This paper focuses on predicting tyre tread profile noise directly from tire pattern images using convolutional neural networks (CNNs) and extends the methodology to forecast both PBN and in-cabin noise. This approach aims to streamline tyre noise optimization especially for lower noise applications like EVs, providing quicker and more reliable predictions during the design stage. The proposed framework is trained on a comprehensive dataset of indoor and outdoor tire noise measurements. By correlating tyre pattern design approaches with noise signatures, the proposed framework reduces reliance on physical prototypes, enabling early-stage noise predictions. This innovative approach not only accelerates the tyre development process but also supports the design of quieter and more efficient tyres, aligning with the growing demands of sustainable and comfortable mobility solutions.

Presenting Author Biography

Lakshmi is an accomplished automotive engineering professional, currently working with JK Tyres for more than 5 years, specializing in noise and NVH. Her key accomplishment includes the development of a pitch sequence optimization tool for reducing tire noise and improving tread pattern design. Holding an MS in Vehicle Dynamics and Parameter Estimation, Lakshmi is now pursuing her PhD at IIT Madras. Her research focuses on leveraging AI to advance tire noise prediction. Lakshmi's expertise bridges the gap between industry and academia, demonstrating exceptional technical acumen and a steadfast commitment to innovation in noise-optimized tire solutions.