International Workshop on the Use of Wide-Base Tires

Federal Highway Administration
Turner-Fairbank Highway Research Center
October 25-26, 2007

MINUTES

Gary Henderson, the Director of the Federal Highway Administration (FHWA) Office of Infrastructure Research and Development, gave the welcoming remarks and introductions. He spoke briefly about some of the work underway at the Turner-Fairbank Highway Research Center (TFHRC), including the involvement of our office in the investigation of the recent failure of the I-35 Bridge in Minneapolis, Minnesota. He emphasized the importance of collaborative efforts such as this workshop to advance our ability to effectively provide solutions to our transportation infrastructure issues.

Eric Weaver, FHWA Research Highway Engineer with the Pavement Design and Performance Modeling Team, reviewed the purpose, objectives and desired outcomes of the workshop, which are:

Purpose

Provide a venue for the exchange of ideas on the use and performance of wide-base tires on heavy trucks, both domestically and internationally. This includes the current state of knowledge on the pavement response to these tires. This will allow us to provide better direction for the current and future research in this field. The workshop interest will focus on the effect of wide-base tires on pavement performance, pavement design, environment, safety, freight, and highway policy.

Objectives

1. Identify the state of the practice of wide-base tires both domestically and internationally, both in terms of tire configuration and market share and demand.
2. Identify relevant recent and current national and international research efforts on wide-base tires.
3. Identify the research needs as to the effectiveness and impact of using wide-base tires.

Desired Outcomes

1. Provide direction of future research related to wide-base tires to improve our understanding of their impact on pavement and the environment and the implications for their increased use on infrastructure, the trucking industry, and the environment.
2. Establish collaboration between meeting attendees to initiate the research.
3. Communicate the results of this workshop through distribution of the minutes, presentations and supporting reference documents on the Asphalt Research Consortium (ARC) website and portable media.

PRESENTATIONS

John Melson, Director of Michelin America's Research & Development, gave a presentation on the history of tire technology and development. His presentation included the technical challenges of optimizing materials, geometries, and fabrication techniques to achieve desired loading capacity, wear resistance, traction, stability, increased safety and reduced rolling resistance. Their latest developments with wide-base tires allow for reduced aspect ratio and increased width, improved stress distribution and stability, while reducing rolling resistance.

He also showed films documenting Michelin research on wide-base tire safety. The films present truck and trailer responses to tire sudden failure for both dual and wide-base tires. It was shown that with proper driving techniques, no loss of control was observed.

Presentation: "Progress in Tires," filename "Tire Presentation FHWA Wide Base Dual Seminar.ppt,"

Brian Routhier, of the American Trucking Association (ATA) gave a presentation on their fleet experiences with wide-base tires. In general, the top 3 issues of the trucking industry are drivers, fuel, and tires. The latter two may change places in terms of priority depending on the price of fuel. Through a survey of some of their largest fleet members they were able to obtain feedback on experience and perceptions with the use of wide-base tires. Though the feedback was primarily positive, some negative responses were given and in some cases feedback was inconsistent from one respondent to another. Inconsistency or misinterpretation of regulations governing wide-base tires use was cited as a serious hindrance to more widespread application.
Brian's presentation includes the following topics:

- Tread wear rate
- Tire replacement frequency
- Re-tread performance
- Brake cooling
- Ride; handling, maneuverability, and stability
- Traction

Presentation: "Wide Base Tires – Fleet Experience," filename "ATA-Wide Base Tires Fleet.ppt," Reference Documents: ATA whitepaper entitled "New Generation Wide Base Single Tires," filename "Wide Base Summary-v9-ATA-whitepaper.pdf."

Cheryl Bynum, of the United States Environmental Protection Agency (US EPA) SmartWay Transport Partnership presented some recent EPA research and their position on fuel saving technologies. Their preliminary results indicate a potential fuel saving of 3-4% through the use of wide-base tires. In her presentation Cheryl explained that the primary goals of the SmartWay Transport Partnership (STP) are reduced fuel consumption and related emissions through minimization of energy losses due to

improved freight practices and technologies. These include reduced idle time, lower rolling resistance and wind drag, lower speed, and other fuel-saving strategies.

They intend to accomplish this through collaboration with industry and other partners to establish fuel saving tools and practices that would result in a mutual benefit of fuel consumption, emissions and cost reduction. More research is needed to establish a standard test for truck fuel efficiency. Once this is available, those fleets meeting certain fuel efficiency criteria may obtain the SmartWay tag, which has a positive effect on their public image.

Presentation:
"Improving Heavy Truck Fuel Consumption," filename "EPA Bynum SW Tire Conf FHWA 10 25 2007.ppt."

Reference Documents:

- "Evaluating Real-World Fuel Economy on Heavy Duty Vehicles using a Portable Emissions Measurement System."
- "Effect of Single Wide Tires and Trailer Aerodynamics on Fuel Economy and NOx Emissions of Class 8 Line-Haul Tractor-Trailers" – filename "SAE-05CV045-23August05.pdf"
- "A Glance at Clean Freight Strategies – Single Wide-Based Tires," filename "EPA-STP-wide-base.pdf"

Imad Al-Qadi, of the University of Illinois at Urbana-Champaign gave two presentations In the first presentation, he provided a review of wide-base tires research study findings over the years and explained the differences between the 425 and the new generation of wide-base tires as well as the confusion in using the research outcome of the 425 tire to explain the performance of the new generation of wide-base tires. Some key points of his presentation include the following:

- Provided information on the tires used in the US and Europe.
- Wide-base tires have been used in Europe since the 1980s.
- Overview of the research outcome on the earlier generation of wide-base tires.
- Early research in all cases indicated that more pavement damage was produced by traditional wide base tires; 385mm and 425mm in width.
- Later wide-base tire designs have wider footprints and lower aspect ratios that produce a more uniform contact pressure distribution.
- Provided overview of the current research of the new generation of wide-base tires on pavements in North America and Europe.
- Showed the difference in tire pressure and imprint between various tire types.
- Discussed the impact of wide-base tires on fuel, emission, handling, stability, comfort, repair cost, recycling, noise, braking, hydroplaning, rolling resistance, etc..
- Research into modeling and accelerated pavement loading is needed to determine how the new designs affect pavement performance.
- He shared the progress of work over the past seven years on testing of the new generation of wide-base tires at the Virginia Smart Road and the APT at University of Illinois and the pavement response to loading using load-response instruments.

- He showed that the steering axle caused more damage to pavement than tandem axles and the difference in tire pressure between tires in dual-tire system can be detrimental to pavement.
- He illustrated the modeling approaches of pavement response to tire loading and its evolution from using elastic theory to HMA viscoelastic properties in finite element analysis.
- He discussed a comparison technique between tire effects on pavements considering several failure criteria.
- He provided a summery of the pros and cons of wide-base tires with respect to several parameters.
- He concluded that advanced modeling is the only approach to quantify pavement damage due to various tire configurations including the use of continuous moving load, layer interface friction, and dynamic analysis.

In the second presentation, Imad focused on advanced modeling and research direction. He discussed the following:

- The fine-tuning of the finite element modeling.
- Use of dynamic analysis procedure.
- Modeling of Smart Road and other pavement sections at various HMA thicknesses.
- Showed the 3D stress distribution for each rib of wide-base and dual tires.
- 3D finite element modeling indicates that high shear stresses developed approximately 50 mm (2 in.) below the pavement surface may be the source of crack initiation.
- For thick pavements, cracks initiate near the surface.
- He presented preliminary analysis of calculated potential damage due to dual tire and wide-base tires.
- He discussed the research needs in this field and suggested directions.
- A pool fund on wide-base tires was initiated and the tasks of the proposed research were presented.

Presentations:

1. "Impact of Wide-Base Tires on Pavement and Trucking Operation," filename "wide-base 1 Al-Qadi Wash 10-07.pdf."
2. "Impact of Wide-Base Tires on Pavement and Trucking Operation – Advanced Analysis," filename "wide-base 2 Al-Qadi Wash 10-07.pdf."

Reference Documents:

Yoo, P. J. and I. L. Al-Qadi, "Effect of Transient Dynamic Loading on Flexible Pavements," Journal of the Transportation Research Record, No. 1990, Transportation Research Board of the National Academies, Washington, DC, 2007, pp. 129-140.

Al-Qadi, I. L. and P. J. Yoo, "Effect of Surface Tangential Contact Stress on Flexible Pavement Response," The Journal of AAPT, Vol. 76, 2007, pp. 663-692.

Elseifi, M. A., I. L. Al-Qadi, and P. J. Yoo, "Viscoelastic Modeling and Field Validation of Flexible Pavements," Journal of Engineering Mechanics, ASCE, Vol. 132, No. 2, 2006, pp. 172-178.

Yoo, J. P., I. L. Al-Qadi, M. A. Elseifi, and I. Janajreh, "Flexible Pavement Responses to Different Loading Amplitudes Considering Layer Interface Conditions and Lateral Shear Forces," International Journal of Pavement Engineering, Vol. 7, No. 1, 2006, pp. 73-86.

Al-Qadi, I. L., M. A. Elseifi, P. J. Yoo, and I. Janajreh, "Pavement Damage due to Conventional and New Generation of Wide-Base Super Single Tires," The Journal of Tire Science and Technology, Vol. 33, No. 4, Oct 2005, pp. 210-226.

Elseifi, M. A., I. L. Al-Qadi, P. J. Yoo, and I. Janajreh, "Quantification of Pavement Damage Due to Dual and Wide-Base Tires," Journal of the Transportation Research Record, No. 1940, Transportation Research Board of the National Academies, Washington, DC, 2005, pp. 125-135.

Al-Qadi, I. L., M. A. Elseifi, and P. J. Yoo, "Characterization of Pavement Damage due to Different Tire Configurations," The Journal of AAPT, Vol. 74, 2005, pp. 921-962.

Al-Qadi, I. L., A. Loulizi, I. Janajreh, and T. E. Freeman, "Pavement Response to Dual Tires and New Wide-Base Tires at Same Tire Pressure," Journal of the Transportation Research Record, No. 1816, Transportation Research Board of the National Academies, 2002, pp. 125-136.

Al-Qadi, I. L, and M. A. Elseifi, "State-of-the-Practice of the New Generation of Wide-Base Tire and its Impact on Trucking Operations," Journal of the Transportation Research Record, No. 07-2432, Transportation Research Board of the National Academies, Washington, DC, 2007 (Accepted).

Al-Qadi, I. L., P. J. Yoo, M. A. Elseifi, and S. Nelson, "Creep Behavior of Hot-Mix Asphalt due to Heavy Vehicular Tire Loading," ASCE Journal of Engineering Mechanics (Accepted).

Yoo, P. J. and I. L. Al-Qadi, "The Truth and Myth of Fatigue Cracking Potential in Hot-Mix Asphalt: Numerical Analysis and Validation," the Journal of the AAPT (Accepted).

You P. J., and I. L. Al-Qadi, "Flexible Pavement Response to Different Loading Amplitudes," Airfield and Highway Pavements, ASCE, I. L. Al-Qadi, Ed., Atlanta, GA, Apr 2006, pp. 39-49.

Pyeong, J. Y., I. L. Al-Qadi, M. A. Elseifi, and I. Janajreh, "Effect of Moving Wheel Load Amplitude and Interface Condition on Flexible Pavement Responses," Paper No. 06-1634, 85th TRB Annual Meetings, Washington, DC, Jan 2006 (in CD).

Al-Qadi, I. L., M. Elseifi, and P. J. Yoo, "In-Situ Validation of Mechanistic Pavement Finite Element Modeling," Proceedings of the 2nd International Conference on Pavement Accelerated Facilities, B. Worel and K. Faults, Eds., Minneapolis, MN, Sep 26-29, 2004 (in CD).

Al-Qadi, I. L., M. A. Elseifi, Y. J. Yoo, and I. Janajreh, "Effect of Wide-Base and Dual Tires Configurations on Pavement Damage," Paper No. 04-4935, 83rd TRB Annual Meetings, Washington, DC, Jan 2004.

Guy Dore, of the Département de génie civil Université Laval in Québec presented research conducted to quantify the impact of wide-base tires use on pavement damage. The research was prompted by trucking industry requests to lift restrictions on wide-base

tires use. The presentation describes the experimental design, test section geometry and layout and the instrumentations.

Results were obtained by comparing pavement responses for spring and summer conditions relative to that produced by a 9 kip single axle load on dual tires (Benkleman Beam). They compared Dual 11R22.5 & 12R22.5 and Wide-base 385 & 455 tires. The results indicate that the wide-base tires appear to be more damaging in fatigue during the spring, based on higher longitudinal tensile strains at the bottom of the asphalt layer. For summer conditions the difference between the two may be a wash, depending on whether longitudinal or transverse strains are considered more critical. The response of an instrumented test pad produced less shear strain near the surface in all cases.

Future research plans will include thinner pavement layers.

Presentations:

- "Monitoring Mechanical Response Of In Service Pavements Using Retrofitted Fibre Optic Sensors," filename "ACPEM 07 (Dore).ppt."
- "Laval University's experience with the wide-base single tires," filename "LAVAL-Wide Base tire experience (Dore).ppt."

Reference Documents:

- "Strains at shallow depth in bound surfacing materials," filename "ICAP 06 (Pierre, article).doc."
- "Characterization of tire impact on the pavement behaviour," filename "SCGC04 (Pierre et Dore).doc."

Armelle Chabot, of the LCPC - Centre de Nantes – MSC in France presented research prompted by a desire coming from Europe to increase the total tonnage of freight carried without increasing the maximum weight per axle (11.5T max for Europe). Currently, 40 ton is the normal French and Europe maximum weight, so to reach 44 and even 50 or 60 ton without inducing further pavement damage, either more axles are needed or reduced stress from an axle carrying more weight. They are updating the French Pavement Design Procedure to examine the prospects of using more tandem axle with eventually the use of the new wide-base tires (455 – 495). The use of these new wide-base tires is not common in France at this time.

They have created two software applications, ViscoRoute and ViscoAnalyze. ViscoAnalyze first builds complex modulus master curves from lab data. Then, ViscoAnalyse uses these master curves to fit the visco-elastic law behavior (Huet and Huet Sayegh laws) of bitumen and asphalt material. The French version of this software can be downloaded free from the LCPC web site (http://www.lcpc.fr/fr/produits/viscoanalyse/index.dml). The English version will be soon available on the LCPC web site at the beginning of 2008. (http://www.lcpc.fr/en/produits/index.dml).
A large material database (ViscoMatData) with complex modulus values and other relevant properties is also under construction since March 2007.

ViscoRoute uses the visco-elastic Huet Sayegh law of asphalt material to predict moving vehicles effects on flexible pavement. The Huet Sayegh parameters are coming from ViscoAnalyse or later from ViscoMatdata. ViscoRoute 3D dynamic pavement modeling uses the double Fast Fourier Transform (FFT) to arrive at fast calculus solutions. Its results have being validated on accelerated pavement testing (APT) results. Compared with elastic results at the top of the pavement, it is shown that the visco-elasticity effects of the materials give different stress distributions. High tension and shear stresses behind the wheel can be found while compression stress values under the wheel are reduced.
ViscoRoute first version (for only one uniform rectangular load), ViscoRoute-v1, will be available free on the LCPC web site very soon. Multi-loadings effects can be simulated with the help of the superimpose principle as it has been done first to simulate tandem effects on flexible pavement (Chabot et al., 2006).
ViscoRoute-v2, second version, takes into account directly in the calculus multi-loading (both elliptical and rectangular) effects. LCPC is working on tacking into account the 3D actual tire pavement interface pressure patterns in the ViscoRoute-v2 software application.
From an APT point of view, old LCPC-APT results have not indicated so far a difference in pavement damage for rutting between wide-base and dual tires.

Presentation:
"Some Modeling Results on Flexible Pavement Obtained with the help of ViscoRoute Software," filename "Chabot-Widebase-Worshop-Mclean-AC.pdf."

Reference Documents:

– ""ViscoRoute: Viscoelastic Modeling for Asphalt Pavements," filename "ViscoRoute-bl258-259-089-en.pdf."

-> Reference : Duhamel D., Chabot A., Tamagny P., Harfouche L., 2005. Viscoroute: Visco-elastic modeling for asphalt pavements - Viscoroute : Modélisation des chaussées bitumineuses. *Bulletin des Laboratoires des Ponts et chaussées (http://www.lcpc.fr/en/sources/blpc/index.php)*, (258-259), 89-103.

– "Visco-Elastic Modeling For Asphalt Pavements – Software ViscoRoute," filename "Chabot-et-al-ViscoRoute-ISAP2006.pdf."

-> reference : Chabot A., Tamagny P., Duhamel D., Poché D., 2006, "Visco-elastic modeling for asphalt pavements – software ViscoRoute". *10th International Conference on Asphalt Pavements*, August 12-17, Québec, Canada. ISBN 978-2-550-49009-8, **2**, 5-14.

– "A mathematical-based master-curve construction method applied to complex modulus of bituminous materials," filename "chailleux_EATA2006.pdf."

-> reference : Chailleux E., Ramond G., Such C., de la Roche C., 2006, A mathematical-based master-curve construction method applied to complex modulus of bituminous materials. *Roads Materials and Pavement Design*, **7** (EATA Special Issue), 75-92.

Morris de Beer, of CSIR Built Environment in South Africa presented efforts they have made in measuring the actual tire pavement interface pressure patterns in 3 dimensions.

Because South Africa must import all of its crude oil, asphalt is very expensive and the pavement surface layers are thin. It is believed that the stress distribution near the surface is what dominates pavement failures, as the underlying material is quite strong and remains relatively consistent across seasons due to the dry environment. South Africa is currently re-evaluating their mechanistic-empirical pavement design system and they use the Heavy Vehicle Simulator (HVS) to calibrate and validate their performance models.

Wide-base tires are not widely used in South Africa (~10-15%), partially because load limit laws, based on mass and number of tires per axle, restrict their use. However, research with the HVS and Stress-In-Motion (SIM) technology have shown that wide-base tires offer advantages to dual tires in terms of the uniformity of contact stress distribution.

After 20 years of monitoring truck traffic with the SIM, they have found that overall tire inflation pressures have increased 20% in the last 20 years and that the steering axle tires tend to have 10% higher inflation pressures than the rest. The monitoring also has shown inconsistencies in the inflation pressures and type of tires used in dual configurations, and that approximately 1/3 of the trucks were recorded as being over weight. This of course results in increased contact stresses applied to the pavement surface. These factors coupled together negate the positive intent of the weight limit laws and add merit into changing them to accommodate more widespread use of wide-base tires. Further research is needed on additional "new generation" wide-base tires to provide a solid foundation for load limit policy changes.

Presentation:
"Measurement of Tire Contact Stresses: The South African Experience," filename "International Workshop on Wide Base Tires- SIM De Beer.ppt."

Reference Documents:
- "Tyre-Pavement Interface Contact Stresses On Flexible Pavements – Quo Vadis ?", filename "CAPSA-2004- DE BEER M - PAPER 061-4.pdf."
- "Reconsideration of tyre-pavement input parameters for the structural design of flexible pavements," filename "ICAP-2006-FINAL PAPER- ABS0059.pdf."
- "Evaluation of non-uniform tyre contact stresses on thin asphalt Pavements," filename "ICAP-2002-DE BEER M - PAPER 1-8-3.pdf."
- "Towards The Application Of Stress-In-Motion (SIM) Results In Pavement Design And Infrastructure Protection," filename "8ISHVWD-DE BEER-PAPER 36.pdf."
- "Statistical Analysis Of Vehicle Loads Measured With Three Different Vehicle Weighing Devices," filename "INFRASTRUCTURE - SATC 2005 - ZQP MKHIZE - M DE BEER - 005 - FINAL PAPER.PDF."
- "Comparison Of Contact Stresses Of The Test Tires Used By The 1/3rd Scale Model Mobile Load Simulator (MMLS3) And The Full-Scale Test Tires Of The Heavy
- Vehicle Simulator (HVS) – A Summary," filename "SATC 2007- FINAL PAPER 121 - M DE BEER - SIM-MMLS3.pdf."

- "Tire-Pavement Contact Stress Patterns From the Test Tires of the Gautrans Heavy Vehicle Simulator (HVS) MK IV+," filename "SATC-2005-PAPER-DE BEER 101699-1.pdf."

Peter Sebaaly, of the University of Nevada at Reno, presented his plans to develop an applied modeling application through work with the Asphalt Research Consortium (ARC). The application will integrate currently available models that were developed through past research at various institutions. These models include vehicle dynamics and stability, tire contact stress distributions, pavement characterization and visco-elastic dynamic pavement response. The intent is to produce a software application that can be readily used by a state pavement or materials engineers to analyze pavement design features needed for special traffic loading situations, such as intersections, ramps, hills or off-road or heavy haul routes. With an input library of truck suspension and tire characteristics, the model will be able to produce the response expected with a given number of load repetitions to allow for appropriate design adjustments. Differences in results from using wide-base and dual tires may be evaluated.

Presentation:
"Dynamic Response of Flexible Pavements," filename "unr.ppt."

Reference Documents:
- "Pavement Strain from Moving 3D Load Distribution," filename "3D-MOVE.pdf."
- "Determination of Pavement Damage from Super-Single and Singled-out Dual Truck Tires," filename "NCHRP1-36-Single Tires.pdf."
- -"Extent of Use and Performance Traits of Super-Single Tires," filename "NCHRP1-36-Single Tires-2.pdf" ."

Eric Weaver, of the FHWA, presented research on Hot Weather Shear controlled loading experiments at the SHRP/LTPP SPS-8 flexible pavement sections at the Ohio Test Road. This experiment was a part of a larger tire study within the Truck Pavement Interaction Research Program, led by Bill Kenis. These experiments used both dual and wide-base configurations of tires on instrumented pavement test sections in hot weather. The strain gage rosettes were fixed to the sides of square holes in the existing flexible pavement to capture shear strains. The variables included; 2 tire manufacturers, vehicle speed, lateral offset and tire inflation pressure. The data was never analyzed to determine the relative shear strains produced across the matrix of variables. This is the only known data set containing shear strain results produced from what was then the Michelin 495 "prototype" wide-base tire.

Presentation:
"Truck Pavement Interaction Research Program – Tire Study," filename "InternationalWidebaseWorkshop-Weaver.ppt."

DISCUSSION

Committee AFD40 will sponsor Workshop 0830 "Validation of Advanced Flexible Pavement Modeling with Accelerated Pavement Testing (APT) Data" Sunday January 13, 2008 at the annual meeting of the Transportation Research Board (TRB). The workshop was organized by the Consortium for Accelerated Pavement Testing (CAPT) and FHWA. The aim is to harmonize instrumentation and data from APT. Topics include:

- Impact of APT on pavement engineering LCPC
- State of the art on pavement instrumentation and accurate measurement – Per Ullidtz, John Harvey.
- Needs for accurate modeling – T. Scarpas
- Modeling of HMA – Eyad Masad
- State of the art in HMA testing and characterization – Andy Collop
- Model validation using APT measurement – Imad Al-Qadi
- Panel Discussion – Nelson Gibson

Research Needs:

The workshop participants expect increased use of wide-base tires and agreed that a national program is needed, with international collaboration, to quantify the comparative damage between dual and wide-base configurations for various pavement designs and traffic conditions. The experiments within the program should be designed to compliment the objectives of EPA, ATA, and the tire industry. The overall goal is to produce a foundation of research results solid enough to shape policy on wide-base tires use. The program would include the following elements:

Modeling

The program participants need to reach consensus on appropriate modeling technique(s), which depend on multiple factors, such as what can and what should be measured. The dominant stress states that contribute to failure mechanisms should be identified through modeling. This will show the critical locations of stress and strain accumulation for a given loading condition, pavement design, and failure mode.

Research by Dore, Al-Qadi and others has shown that near-surface induced stresses and strains dominate the causes of top-down cracking. These appear to be a combination of tensile and shear strains, which lead to crack initiation. Research done at the University of California at Berkeley, Nevada Automotive Testing Center, and South Africa has characterized tire contact stress distributions for a select set of tire types. There is a need of a database of tire characterization under a variation of load, speed, and inflation pressures to support modeling. An artificial neural network to predict stress distributions between test conditions was developed at Penn State. This technology may prove beneficial to bring the amount of testing to within practical magnitudes.

Considerations:

- Stress combinations that allow for the least damage – Optimize the tire/pavement contact stress to meet this condition.

- Advanced modeling capabilities – Multiaxial materials models are lacking.
- Miner's hypothesis applicability to nonlinear materials.
- Combined impact of axle groups.
- Consider strain energy of distortion. Strain distortion energy may be best applied to steady state.
- Effect of surface texture on the contact stress distribution; i.e. coarse vs. smooth.
- Effect of road condition on dynamic impact of wide-base tires.
- Stochastic capability to account for variability in tire condition and inflation pressures, as well as difference in response in measurement instrumentation.
- Relationship between truck configurations and bridge designs.

Testing and Data Collection and Analysis

To support the modeling efforts, there is a need for an appropriate APT experimental design. The 2008 TRB workshop mentioned before will be a starting point for future planning in this area. Any new research should be conducted on 445 mm and higher tire widths because most significant research has been conducted on 425 mm and lower tire width. According to Michelin, the 445 mm & 455 mm are sold at 4 or 5-fold in the US market over the 425 mm. The 425 was not intended for highway use. An appropriate dual tire should be selected for comparison in future research. 275/80 R22.5 dual is the most common Michelin dual tire for long hauls, but there are different tires for different operational characteristics, even within this size. In the case of Michelin, the 445 replaces the 80 series on 22.5 in. wheels and the 455 replaces the 90 series on 22.5 in. wheels.

There is a need for consensus on appropriate instrumentation to ensure that the data being collected is of sufficient consistency between testing programs to allow for results comparison. This will be dictated by a tradeoff between what should be measured in the pavement and what can be measured. Similarly, this is related to what should be measured in the laboratory to emulate the pavement measurements.

During the course of the pavement response and damage measurements, there should be some effort to quantify rolling resistance to aid EPA research on fuel consumption and emissions. They are working on an ISO process to measure rolling resistance. SAE rolling resistance methods allow for inconsistencies in the way it is conducted among manufacturers.

Additional Considerations

- More pavement-tire interface testing needs to be conducted; the South African SIM technology has been used for this purpose.
- Axle configurations should be evaluated for relative damage contributions as well.
- Post mortem cores should be taken at ALF to determine the cracking initiation location. Research is being conducted at TFHRC to explore the use of GPR technology to help identify the source of crack initiation.

Collaboration and Cooperation

To maximize the integrity of results and conclusions from the research efforts, the endorsement of the FHWA, EPA, ATA, and tire industry is needed. Therefore, consultation, feedback and approval of research work and objectives require their review and approval. The ATA can provide market demand information; the EPA can provide direction on how to incorporate rolling resistance measurement guidance and the tire industry can provide tires, modeling technology and guidance on how to conduct and deliver the research in an objective, non-bias manner.

The Illinois-initiated Pooled Fund Study (PFS) provides a mechanism for all concerned parties to fund and coordinate the progress of research through the formation of a technical advisory committee (TAC). The TAC will need to be informed of other ongoing research efforts to make the best decisions on research focus.

Coordination potential:

- TROWS Study with Pirelli conducted with LCPC.
- NCHRP 1-42A with Ray Roque.
- RILEM 210 - cracking, by stress state and failure mode. RILEM Conference, June 16-18 in Chicago, sponsored by FHWA and IL DOT, is focused on cracking.
- Western Research Institute P3 symposium.
- UTCs.
- UIUC research efforts in this field.
- ARC research efforts in this field.

Communication

The research plans and outcomes will receive the maximum buy-in from all involved through effective communication. The primary message for delivery is the actual benefits and limitations of wide-base tires use from an infrastructure, economical, environmental and industry perspective. The research needs to demonstrate these benefits and costs to the public in a manner that is easily understood. There is a need for a source to gain and communicate the information, such as a website.

Research Implications

- Incorporated of research finding into pavement design applications.
- Specifications for pavement construction contractors.
- Resistance from trucking industry to change.

Participants List for the International Workshop on Wide Base Tires

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