**TPF-5(197) The Impact of Wide-Base Tires on Pavement Damage - A National Study**

**Technical Advisory Committee Phase I Meeting**

**TFHRC, McLean, VA**

**October 26, 2011**

**Attendance**

A meeting of the FHWA National study for “The Impact of Wide-Base Tires on Pavement Damage” was held at FHWA Turner-Fairbanks Highway Research Center, on October 26, 2011. Those present for the meeting were:

Imad Al-Qadi (University of Illinois)

Eric Weaver (FHWA-TFHRC)

Tom Scarpas (Delft University)

John Harvey (University of California, Davis)

Jamie Green (FDOT)

Nadarajah Sivaneswaran Siva (FHWA-TFHRC)

Brian Diefenderfer (VA DOT)

Shongtao Dai (MnDOT)

Larry Buttler (TxDOT)

Tom Yu (FHWA)

Dan Hill (Montana DOT)

Keith Brewer (Rubber Manufacturer Association)

Steven Butcher (Rubber Manufacturer Association)

David Lippert (IL DOT)

Stan Lew (Michelin)

Morris De Beer (CSIR Built Environment, South Africa)\*

Jaime Hernandez (University of Illinois)

Lori Carpenter (University of Illinois)

Katherine Petros (FHWA-TFHRC)

Juanita Manley (FHWA)

\*Connected via Adobe Connect Pro

**Introduction**

Eric Weaver gave an overview of the meeting logistics and purpose. Imad Al-Qadi then opened the meeting with self-introductions.

**Presentation and Panel Discussions**

***Literature Review***

Imad Al-Qadi gave a PowerPoint presentation and overview of the Phase I report and literature review outcomes. Imad discussed the relevant literature on the potential relative impact of wide base tires on road infrastructure (accelerated pavement testing and numerical modeling and analytical methods), impact on dynamic tire loading, impact on trucking operations (fuel economy, hauling capacity, tire cost and repair, safety, ride and comfort), and impact on environment (gas emissions, tire recycling, and noise). Imad stated that all the studies that the research team looked at concluded that the wide-base tire is favored by the EPA, as they result inusing less fuel, and manufacturer testing shows that the tires are just a safe as the dual configuration. Imad stated that the research team will focus and quantify the damage of the wide-base tire compared to the dual-tire. Shongtao Dai asked what the difference is in the old generation wide-base tire and the new generation wide-base tire. Imad stated that there are significant design differences in the new tire vs. the old. Imad stated that the differences include the tire material and structure as well as the geometry design including the contact area.

***Modeling Approaches***

The finite element method includes viscoelastic asphalt material, dynamic analysis, three-dimensional contact stresses, continuous moving loading, layer interaction, and nonlinear granular material (for thin pavement). Imad discussed the three-dimensional contact stresses and showed that the importance of considering the non-uniformity of the three contact stresses. Dan Hill asked Imad to explain the transverse and longitudinal contact stresses, at which direction are they stretching the pavement outwards. Imad explained on the flip chart the distribution of one thread contact stresses along its length and widthstated that he will send Dan some slides in regards to this. Imad explained the contact stresses from the 455 and 425 tires.

***Tire Selection and Stress Measurements***

Imad then discussed the stress-in-motions system (SIM), selection of tires, contact stress measurements, tire modeling, and load deflection curves. Morris will provide the load deflection curve data. Imad stated that the research team conferred with the RMA and the dual-tire assembly 275/80R22.5 and for the 445/50R22.5 wide-base was chosen because they are available from all participating tire manufacturers. The research team will be making comparisons between the same tire types, but various tire manufacturer models will be considered analytically based on contact stresses data they provide.. The research team is requesting contact stresses from the manufacturers. The contact stresses for wide-base tire 455/55R22.5 can be provided by Michelin for modeling purposes. Michelin will provide the whole tire set-up for all four locations (UC-Davis, FDOT, South Africa, and UIUC). Imad then discussed the matrix for the contract stress measurements that includes tire type, inflation pressure, and tire loading (kips). Eric recommended to the panel, in terms of maintaining budget constraints and coming out with a robust model the test loading matrix limitation may not the best place to save the effort. He recommended considering the third objective of the study as an area to possibly cut back on. The panel will discuss and give the research team direction as the study proceeds.

***Summary of Data Resources Available***

Imad discussed the description of pavement structures, instrumentation, and APT available. The data came from the Virginia Smart Road, UIUC-ATREL thin-pavement sections, UIUC-ATREL full-depth sections, Ohio SPS-8 sections, UC-Davis permanent deformation profiles, and Florida DOT APT rutting tests. John stated that in the report they will show a checklist of what the requirements are for modeling compared to what attributes these datasets have. This will provide insight into what additional data must be obtained from this study.

Eric stated that FHWA has a graduate research fellow from Virginia Tech that has been working there for a year and a half and has been working on analyzing rosette strain gauge data from the OH DOT SPS-8 sites. Eric stated that her report is due at the end of this year and will be made available to this project, along with the data.

***APT Matrix and Material Testing Discussion***

Imad outlined the proposed pavement structures (including UIUC-ATREL, UC-Davis, and Florida DOT) and accelerated pavement testing, material characterization (complex dynamic modulus, semi-circular beam, cross-anisotropic characterization of granular materials [low volume], and volumetric properties of AC mixtures). John Harvey explained UC-Davis pavement structure. John stated that they did a lot of tracking of the surface profile with a laser. Eric suggested looking at rosettes (on a vertical plain), similar to what was done in OH, to obtain near surface shear strain responses.. John stated that they can try using the rosettes but will first see what the cost is to do this. Jamie Greene explained the Florida DOT’s proposal. Jamie stated that Florida DOT is interested in top down cracking as well so they might try using the rosettes. Eric stated that the panel needs to see how many sections are proposed at each institution, what are the range of the surface thicknesses that are being considered, what are the ranges of the base types and thicknesses, and what kind of instrumentation is going to be included as well as a material characterization chart. Brian Diefenderfer suggested that each state decide what range they would like to see. Eric stated they would like to see a range from low volume to high volume and the associated instrumentation that would be required to validate the models and anticipated distress.

***Pavement Damage***

For pavement damage evaluation the research team will look at fatigue cracking (bottom-up and top-down), asphalt concrete rutting, sub grade rutting, damage ratio, and combined damage ratio. The research also considers conducting artificial neural network (ANN), life cycle cost analysis (LCCA), life cycle assessment (LCA), and options for utilization of modeling results. Imad discussed the transfer functions that will be used to link pavement response and damage. The pavement response is obtained from FEM. The maximum shear strain will also be considered for near-surface cracking or top-down cracking. Eric stated that he was wondering about some of the NCHRP projects that are attempting to improve upon some of the performance models from NCHRP 1-37A. Imad stated that it has been discussed and the research team will make use of those reports as they become available. Imad then discussed the formulas that will be used (fatigue cracking, AC rutting, and sub grade rutting) and the ratios (damage and combined damage).

Imad then talked about the Artificial Neural Network (ANN). ANN is a prediction of damage ratio based on FEM. The input for ANN is loading factors, tire factors, pavement structure factors, and environmental factors. Imad discussed the possibility of doing Life Cycle Cost Analysis (LCCA) and Life Cycle Assessment (LCA). LCCA can identify real cost inputs, calculate low-volume damage due to current traffic (control), calculate pavement damage caused by expected traffic (WBT), and run real cost for both scenarios (dual-tire control and WBT). For LCA, John stated that the research team would be looking at upstream material production in the construction phase, which they have models for, but will need case studies. John stated that the balance will be if the tires are wearing the pavement out faster, it means that within the life cycle you’re going to do more frequent overlays which is going to produce more greenhouse gases and energy use. The trade off would be to do a sensitivity analysis that includes range of smoothness, rolling resistance, and surface characteristics, hauling distance, traffic levels and congestion, traffic closure during constructions, and fleet composition. The factorial analysis is mainly composed of traffic condition and pavement condition. Stan Lew stated that he has a report out of Quebec that looked at economical and societal analysis and the factor was 1/10. Stan will send this report to the research team. For LCA the construction schedule will be analyzed using CA4PRS, vehicle emission will be modeled using MOVES, and a process and framework to analyze environmental effects will be developed.

Imad then discussed the options for utilizing the modeling results, including option 1, full factorial of pavement systems, option 2, ANN on specific scenario, and option 3, postpone ANN for future work. Imad suggested developing something with the low-volume for ANN and run the interstate finite element analysis. This will give us the framework to use for the interstate at any time. Eric stated that he would like to see a breakdown of the work element implications. Imad stated that doing the ANN for low-volume roads is within the budget. The only change will be in the shifting of money to an expert (to be determined) whose focus is on ANN (possibly Erol Tutumluer at UIUC). Eric suggested reducing the parameters for a larger structure. Tom Scarpas suggested investigating how deep we can see the surface distributions (how far can we see the effects at the surface contact stresses) to help in reducing parameters. Tom stated to compare loads with the two tires and see what the surface stress distributions are and what the influence is.

Imad stated that to moving forward if the panel can decide on the matrix for the loading and contact stresses so South Africa can start on their measurements and the research team will start putting the models together. Imad and Stan will work together on the logistics for getting the materials to the four locations.

***Final Product, Marketing and Implementation Plan***

Eric would like to see a timeline of what are the steps that need to be taken to see the product implemented and address the following:

* is this something that will be used by states to consider policy decisions?
* what are the hindrances that might be involved in implementation?
* what does the product look like (something that can be installed on a computer or run from a website)?
* how are these envisioned to be addressed as the research progresses?

The meeting was adjourned at 4:30 p.m.

**Action Items:**

* Imad will send out the information on the difference between the old and new generation wide-base tires. December 3, 2011
* Stan will provide contact stress data. January 23, 2012
* Imad will send the slides and information he has on the longitudinal and transverse strain. November 30, 2011
* The research team will discuss to including strain gage rosettes and report back to Eric with any questions or comments December 5, 2011
* The research panel to decide what range they would like to see for base types and thicknesses and send that information to Eric. November 26, 2011
* Stan will send the Quebec report to the research team. November 21, 2011
* The research team will develop a project timeline from start of the project to implementation. November 26, 2011