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Experts at the Illinois Center for Transportation are furthering research into wide-base tires, strong enough to replace dual-tire setups on trucks

by Leslie Sweet, Illinois Center for Transportation, USA



Researchers at the Illinois Center for Transportation (ICT) are taking the lead in US and international research related to the wide-base tire, and are paving the way for optimal implementation of new tire technology. An innovative technology that benefits the environment through fuel efficiency, the wide-base tire is a replacement for the conventional dual-tire system on commercial trucks.

“By quantifying the wide-base tire’s impact on pavements, and easing related concerns, the ICT has provided the wide-base tire with even more potential to benefit the nation’s trucking industry and the environment,” says Imad L. Al-Qadi, ICT director and founder professor of engineering at the University of Illinois at Urbana-Champaign, USA.

A wide-base tire is simply a wider tire that replaces the standard dual-tire system. Conventionally, commercial semi-truck trailers use dual-tire systems to provide an adequate footprint for carrying heavy loads and distributing axle load over a large area of the road. However, the new generation of wide-base tires operates at the same air pressure as dual tires, and with its new and optimized structural design, is proving itself as a good economic option for the trucking industry for several reasons.

“Because a single, wide-base tire and wheel combination is lighter than two standard tires and wheels, the conserved weight may then be used to reduce fuel consumption or to increase cargo



Wide-base tires being tested on Smart Road

“By quantifying the wide-base tire’s impact on pavements, and easing related concerns, the ICT has provided the wide-base tire with even more potential to benefit trucking”

Imad L. Al-Qadi, University of Illinois

capacity for trucks by at least 757 liters of fuel per load,” explains Al-Qadi. Fuel savings are also realized through the reduction of a truck’s rolling resistance when a wide-base tire is used. Due to the recent increase in fuel prices and new emissions-reducing technologies, which have negatively affected fuel consumption efficiency, fleet fuel economy is a major factor dictating the cost-effectiveness

of trucking operations with tire rolling resistance, accounting for approximately 35% of the energy supplied by the engine.

The new generation of wide-base tires reduces tire rolling resistance by as much as 12%, resulting in a considerable reduction in fuel consumption. If a long-haul truck accumulates 150,000 miles per year, the new generation of wide-base tires could save over 3,760 liters of fuel per year per truck. By burning less fuel, the new generation of wide-base tires also helps to reduce polluting carbon dioxide emissions by more than four metric tons annually – an estimated environmental cost saving of US\$500 annually per truck.

In addition, the wide-base tire is able to absorb more of the dynamic bouncing of the truck, transmitting less of the dynamic load to the pavement. The use of one tire rather than two increases a truck’s stability as the clearance between the wheels’ centers increases. The trucking industry can realize additional savings through tire repair and recycling, and because less rubber is used to produce one wide-base tire than two tires for dual-tire assemblies, there are fewer tires to recycle.

In terms of safety, results of extensive testing suggest that vehicle control is continuously maintained during rapid air loss in a wide-base tire. The wide-base tire also provides more ride comfort, with field testing indicating a 12% improvement in the calculated ride number over dual-tire assembly. Finally, the wide-base tire results in 0.5dB less noise than the dual-tire assembly, which is particularly important when interstates are located close to populated or residential areas.

As a result of full-scale testing and advanced modeling, Al-Qadi and his students have found that the newest generation of wide-base tires result in a similar level of road impact as the conventional dual-tire system, but with a varying pattern of damage for different pavement structures. For example, the new wide-base tire caused less damage near the road surface, but greater damage at a deeper road depth than the conventional dual-tire system. Therefore, they found that the combined pavement damage is less for interstate highway systems, but greater for local roads when the wide-base tire system is used. These new findings will provide state pavement agencies with a basis for implementing appropriate load regulations and road pricing of trucking operations when regulating wide-base tires.

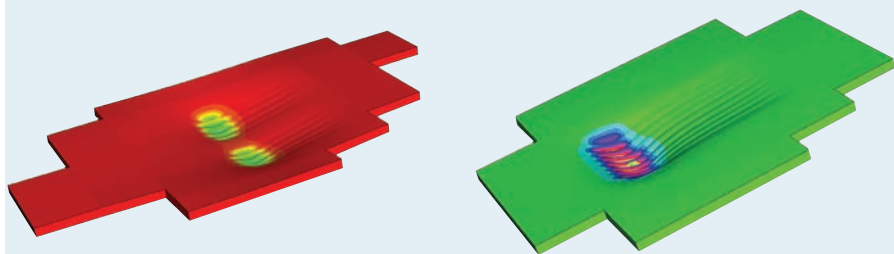
Al-Qadi’s research also demonstrates that a considerable portion of the road

The evolution of wide-base tires

Since their introduction in the early 1900s, wide-base tires have changed a great deal. Early versions were found to cause much more pavement damage than the dual-tire system. A design introduced in 2000 was found to result in improved load distribution and better handling. These tires were tested at the heavily instrumented all-weather state-of-the-art Virginia Smart Road – designed by Al-Qadi and his students – to quantify the response of different pavement designs to various tire configurations. This research assisted the development of a new wide-base tire introduced in 2003.

Through ICT, Al-Qadi and his students used 3D tire/pavement measured stresses to model the pavement loading with moving tires at various loads, tire pressures, and speeds. They then identified critical locations where pavement damage typically starts, which were different from those assumed.

The modeling outcome was validated by using instrumented flexible pavement test sections. The test sections were then loaded with the full-scale Accelerated Transportation Loading Assembly, which can imitate real-life traffic loading using various tire types and systems under different loading conditions while applying several decades’ worth of traffic within a few months. The pavement test sections simulate interstate highways and principal roads, as well as secondary pavement sections.



Illinois illuminated

The Illinois Center for Transportation (ICT) is a partnership between the Illinois Department of Transportation (IDOT) and the University of Illinois at Urbana-Champaign. Located at the Advanced Transportation Research and Engineering Laboratory (ATREL) in Rantoul, Illinois, the center sponsors research in transportation issues, such as safety, roads, bridges, congestion, environment, and materials.

ICT builds on the renowned experts in transportation and related fields at the University of Illinois, IDOT, and other universities and agencies by providing the appropriate tools and support required for objective advanced and innovative transportation research.

Since its inception in fall 2005, ICT has grown rapidly and is becoming the largest engineering center at the University of Illinois. More than 90 projects are currently being managed at ICT. The wide-base tire is just one example of how the ICT takes a proactive role in protecting the global environment by developing technologies that conserve resources.



The US\$2 million Accelerated Transportation Loading System can apply 10,000 repetitions per day

damage relates to traffic loading caused by the steering axle, which applies higher loads per unit area. Using a wide-base tire on the steering axle would reduce damage to the road, and improve handling.

Due to the environmental, economic, and safety advantages of the newest generation of wide-base tires, Al-Qadi predicts that their use in the USA will increase rapidly. Several European countries have been successfully using a different design of wide-base tire for the past two decades because of an axle-load

limit difference, and amendments were made to Canada's Vehicle Weights and Dimensions regulations regarding the use of new-generation wide-base single tires in summer 2008.

Al-Qadi has given several presentations on the wide-base tire in several provinces in Canada. Although its use is permitted in most US states, the USA has taken longer to accept it due to the weight limits that resulted from the attempt to introduce improperly designed wide-base tires in the 1980s.

"The good news is that the use of the new generation of wide-base tires has been growing and many stakeholders are interested in the technology, including the trucking industry, the Environmental Protection Agency, FHWA, and road researchers," says Al-Qadi. "The ICT will continue to lead research efforts in this field, collaborating with other world-renowned researchers on tire-road interaction, and disseminating the outcome of its research in North America and the world." **tire**



Wide-bases tire can aid rolling resistance and stability, while being pavement-friendly