CENTER FOR TRANSPORTATION RESEARCH
THE UNIVERSITY OF TEXAS AT AUSTIN

Project Summary Report 1713-S1
Project 0-1713: Evaluation of the AASHTO 18-Kip Load Equivalency Concept
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PROJECT SUMMARY REPORT

SUMMARY OF FINDINGS FROM ANALYSIS OF THE IMPACT OF CHANGING TRAFFIC CHARACTERISTICS ON PAVEMENTS

What We Did ...

The main objective of this research project was to determine whether the Load Equivalence Factors (LEFs), which are based on tire pressure and type used by the AASHO Road Test, change significantly with higher tire pressure, new axle configurations, environmental conditions, and the use of supersingle tires.

The scope of the research included flexible and rigid pavements. The extension and validation of the AASHTO LEFs include dual tires with increased tire pressure, supersingles, tridem axles, and the environment found in Texas.

A methodology was developed to produce a performance-based fatigue model (PBFM). The PBFM was developed based on the reanalysis of the AASHO Road Test data using mechanistic analysis techniques. The PBFM was then used with the developed methodology to evaluate changing traffic characteristics, including higher tire pressure, new axle configurations, environmental conditions, and the use of supersingle tires.

Key steps of the research process are illustrated in Figure 1.

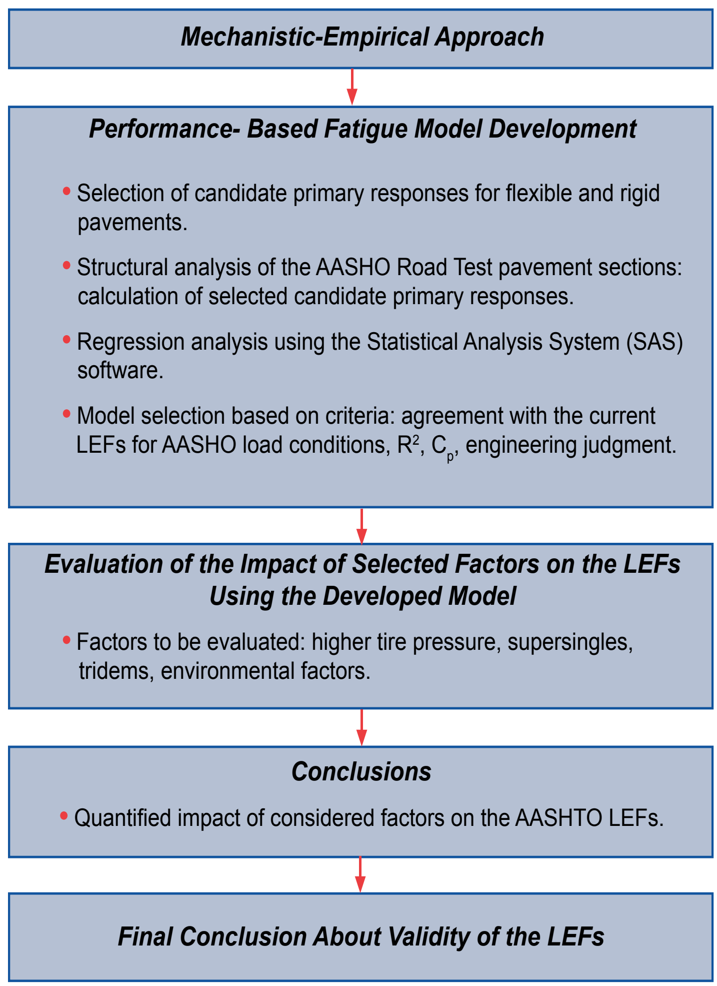

Figure 1: Validation of the AASHTO LEFs

What We Found ...

The major findings from this research are summarized as follows:

1. For the same axle load, the damage to both flexible

Table 1: 18-kip Equivalent for Tandem and Tridem Axles

Pavement Type	Pavement Thickness	Tandem Axle		Tridem Axle	
		PBFM	AASHTO	PBFM	AASHTO
Flexible	3 inch	27.5 kip	33 kip	34.5 kip	48 kip
	6 inch	29.5 kip	33 kip	39 kip	48 kip
Rigid	6 inch	29 kip	29 kip	39 kip	39 kip
	8 inch	28 kip	29 kip	38 kip	39 kip
	12 inch	25.5 kip	29 kip	36 kip	39 kip

and rigid pavements increases as tire pressure increases and pavement thickness decreases. An increase of tire pressure from 75 psi to 120 psi for dual tires at axle loads of 18 to 30 kips causes about 17 to 18 percent more damage to flexible pavements with a 6-inch thick AC surface and 50 to 56 percent more damage to a 3-inch thick AC surface. For the same increase of tire pressure, the damage to rigid pavements is increased by 6 to 12 percent for an axle load ranging from 18 to 30 kips and a pavement with a PCC surface layer ranging from 6 to 12 inches.

2. Supersingles with high tire pressure cause more damage to both flexible and rigid pavements than the normal dual tires used in the AASHO Road Test. For flexible pavements with a 6-inch thick AC surface, the damage is 39 to 57 percent greater; for a 3-inch thick AC surface layer, the damage is 48 to 69 percent greater. For rigid pavements, the increased damage is in the range of 56 to 65, 45 to 53, and 31 to 37 percent for a PCC surface layer of 6, 8, and 12 inches, respectively.
3. The equivalent axle loads of tandem and tridem axles to an 18-kip axle load are summarized in Table 1.
4. The LEFs for both flexible and rigid pavements do not change significantly owing to the changes in environmental conditions.
5. The impact of traffic characteristics on the LEFs is expressed in terms of the increase in pavement damage as summarized in Table 2.

The Researchers Recommend ...

To implement new LEFs, it is important that TxDOT consider the predicted traffic stream. The Department uses a common set of equivalency factors for rigid

Table 2: Summary of Impact of Traffic Characteristics on the LEFs

Changing Traffic Condition	Increase in Pavement Damage				
	Flexible Pavement		Rigid Pavement		
	3-inch thick AC	6-inch thick AC	6-inch thick PCC	8-inch thick PCC	12-inch thick PCC
Increased tire pressure in dual tires	50-56 %	17-18 %	10-12 %	8-10 %	6-7 %
Supersingles	48-69 %	39-57 %	56-65 %	45-53 %	31-37 %
Tandems	58 %	41 %	5 %	6 %	34 %
Tridems	120 %	88 %	4 %	6 %	21 %

Table 3: Recommended LEFs for Different Traffic Loading and Pavements

Pavement Structural Capacity		Traffic Loading Characteristic					
		Increased Tire Pressure in Dual Tires	Supersingles	Tandem Axles on Dual Tires	Tridem Axles on Dual Tires	Tandem Axles on Supersingles	Tridem Axles on Super-singles
	Low	2.0	1.8	1.8	3.1	3.2	5.5
	Medium	1.5	1.6	1.7	2.6	2.7	4.1
	High	1.17	1.5	1.6	1.9	2.4	3.3
	Very High	1.07	1.3	1.5	1.7	2.1	2.3

and flexible pavements, even though the recommended AASHTO LEFs are different for rigid and flexible pavements. The AASHTO Design Guide and the TxDOT procedures also provide for changes in the LEFs based on pavement thickness. Currently, TxDOT does not consider this factor in evaluating ESALs, since it is relatively small.

To implement new LEFs, TxDOT would have to determine whether to calculate computer-based LEFs interactively with a design or to use fixed LEFs as it currently does. It is worth noting that current computer technology makes it easy to establish ESALs based on pavement design thickness interactively in the design process.

As a first stage implementation, it is recommended that TxDOT build a testing section. This would entail using a matrix of load equivalency factors in the test section design that would be a compromise between rigid and flexible, as shown in Table 3. This matrix of load equivalency factors is larger than that currently used by TxDOT, since it adds numbers for supersingles and for tridems. However, it is still a manageable matrix and produces a single set of equivalencies for use in design.

As a second stage, it is recommended that the research team work with the TxDOT staff and review the details for developing a more comprehensive implementation activity based on the feedback from the first-stage implementation. This effort would require additional application of the PBFM and would be an ideal project for the TxDOT Implementation Program.

For More Details...

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The research is documented in the following reports:

1713-1 *Evaluation of the AASHTO 18-kip Load Equivalency Concept* Draft, April, 1999
1713-2 *Impact of Changing Traffic Characteristics and Environmental Conditions on Performance of Pavements* Draft, August, 2003
1713-3 *Impact of Trunnion Axle Groups on the Performance of Highway Infrastructure,* March 2001
To obtain copies of a report: CTR Library, Center for Transportation Research,
(512) 232-3138, email: ctrlib@uts.cc.utexas.edu

TxDOT Implementation Status July 2003

The primary application of the new Load Equivalence Factors (LEFs), developed in this study, is in the calculation of 18-kip equivalent single axle load data used in the structural design of pavements. TxDOT is in the process of implementing the use of total axle load spectra for structural pavement design along the lines of the new AASHTO 2002 Pavement Design Guide. Therefore, TxDOT will not implement the finding of this project for structural pavement design. However the LEFs developed here could be used in the research field to compare with designs made using the total axle load spectra.

Contact Dr. German Claros, P.E., Research and Technology Implementation office, (512) 467-3881, gclaros@dot.state.tx.us, for further information.

Your Involvement Is Welcome!

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