Final Report – for information exchange purpose only

Ontario

Ministry of Transportation
Engineering Standards Branch Report

Use of New Technology Single Wide-Base Tires: Impact on Pavements

ESB-

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TECHNICAL REPORT

Publication Title	# Use of New Technology Single Wide-Base Tires: Impact on Pavements

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Abstract

In response to the request from the MTO Transportation Policy Branch, the Materials Engineering and Research Office (MERO) of the Ministry of Transportation (MTO) conducted an in-house study to assess the potential impact on pavements if the dual tires are replaced with new technology wide-base tires. The scope of the work included a literature search to assess the latest development in wide-base tire technology and to review the analysis of experimental data obtained from Michelin in support of their claims in addition to gathering information from research work done elsewhere.

The preliminary investigation based on limited data reveals that the axle load on the new technology wide-base tires mounted on single axles may be increased from the current value of 6000 kg to about 8000 kg. Alternatively if the axle load on wide tires is increased up to 9000 kg, the potential pavement damage could be 12 times more than the damage caused by conventional dual tires under the same loading. This assessment may be conservative because of the potential underestimation of the impact due to dual tires using the linear model used in the analysis. Further work is required to validate the linear model for axle loads on dual tires greater than 9072 kg. An analysis assuming a realistic non-linear relationship between the contact area and the axle load greater than 9072 kg for dual tires indicates that the damage due to wide-base tires may vary between 2.5 - 4.5 times the damage caused by dual tires, which is comparable to the findings of the Finnish study.

Key Words	Wide-base tire; impacts on pavements
Distribution	Unrestricted technical audience

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Executive Summary

Research in the past had shown that wide-base or “super-single” tires induce more damage to pavements than the conventional dual tires. This resulted in the restrictions on allowable weight on axles equipped with wide-base single tires. In Ontario, axles with single tires are limited by legislation to a maximum of 9000 kg with an exception of vehicles covered under Regulation 32/94 where the axle load is limited to the national standard of 6000 kg per axle. According to this dualistic regulatory system, the wide-base tires are an allowable and practical alternative to dual tires in Ontario for those vehicles not covered by Regulation32/94 – but are not a viable alternative for vehicles that fall under this regulation.

Michelin has approached Ontario and other provinces through the Task Force on Vehicle Weights and Dimensions (W&D) Policy, asking that provincial regulations be modified to accommodate the use of ‘new generation’ wide-base single ties as a viable replacement for dual tires. Michelin claims that their new technology wide-base tires cause no additional infrastructure wear as compared to dual tires based on their research. Should there be consensus amongst the provinces, this could also lead to a modification of the national standard.

In response to the request from the MTO Transportation Policy Branch, Engineering Standards Branch (ESB) conducted an investigation to assess the merits of using new technology wide-base tire as a viable option for replacement of dual tires. ESB examined different options to address the issue related to the use of new technology wide-base tires.

The investigation revealed that the current weight limit of 6000 kg for single tires for vehicles covered under Regulation 32/94 could be increased up to 8000 kg for wide-base tires without adversely increasing the pavement damage caused by single axles with dual tires at 10000 kg. However, as the axles of most tractor-trailers are in tandem groups with a typical combined allowable weight of 18,000 kg (9000 kg per axle), a more appropriate allowance for axles with single tires may be in the 7700 to 7800 kg range. If, on the other hand, the axle load on new technology wide-base tires is increased to the current limit of 9000 kg allowed for single tires for vehicles not covered under Regulation 32/94, the potential pavement damage could be more than 12 times the damage caused by conventional dual tires under similar loading.

This estimated damage is likely to be conservative because of the potential underestimation of the comparable damage caused by dual tires based on the linear model developed using limited data. The linear relationship between the load and the contact area beyond the maximum allowable load on dual tires appears to be unrealistic. Further work is required to determine the validity of the linear model outside the range of the observed data. An additional analysis was conducted based on the realistic assumption that the rate of increase in contact area decreases as the wheel load increases beyond the observed maximum axle load value of 9072 kg. This provides a non-linear relationship between the contact area and the wheel load after the load value of 4536 kg. The result of the analysis using the non-linear model showed that the damage due to wide tires could be 2.5 - 4.5 times the damage caused by dual tires, which are comparable to the findings of the Finnish study.

Background

Increasing demand in the use of single wide-base tires on load bearing axles has focussed efforts by tire and trucking industries to develop a 'new generation' wide-base single tires specifically designed as a replacement for dual tires. This created a need to examine the effect on pavement deterioration if dual tires were replaced with a 'new generation' single wide-base tires. Past studies have found that wide-base or "super-single" tires induce more damage on pavement than the conventional dual tires. This justifies the restrictions on allowable weight on axles equipped with wide-base single tires. A general assessment is that wide-base tires appear to cause 1.5 times more rutting than dual tires on flexible pavement [1]. This makes sense because under ideal condition the load/mm of tire width for 425 mm wide-base tires are greater than the load/ mm of tire width for 275 mm wide dual tires when the loads are equal. This means that the load induced pavement stress would be higher for single wide-base tires because of relatively smaller contact area. The counter argument is that one of the wheels in a dual tire assembly is frequently overloaded due to variability in pavement surface and that the average overload causes an increase in rutting similar to that caused by wide-base single and dual tire assemblies.

Review of literature also indicates that it is likely that past studies have overstated the adverse effects of single tires by ignoring the potential effects of three important contributory factors to pavement damage: (1) unbalanced loads between the two tires of dual set, (2) the random lateral placement of trucks within or beyond lane boundaries on highway, sometimes termed "wander", and (3) dynamic loadings caused by surface roughness. In reality, unbalanced loads between tires of a dual set do occur due to unequal tire pressures, uneven tire wear, and pavement crown. Pavement deterioration increases as loads on two dual tires become more unbalanced.

The effect of wander is considered beneficial to pavement deterioration because the repetitive loads are reduced particularly for single tires as the load is distributed over wider areas of pavement surface. Wander is expected to have a smaller beneficial effect on dual tires because the reduction in the number repetitive loadings is expected to be marginal due to the potential overlapping of the dual tire load distribution [2].

The third contributory factor to pavement deterioration is dynamic loading caused by road roughness. Pavement damage from dynamic loadings is typically localized and is approximately 2 - 4 times more severe than the damage due to static loading. It is commonly believed that wide-base tires having only two sidewalls are expected to absorb more of the dynamic loading than a pair of dual tires with four sidewalls [1]. This means that the tire absorbs more of the dynamic bouncing of the truck resulting in the reduced transmission of the dynamic load impact to the pavement.

According to a trucking industry survey conducted by University of Waterloo in the mid 80's [3], super-single tires are proven to be less expensive to purchase and maintain, and seem to provide a considerable fuel consumption savings (about 0.3 miles per gallon???) with a longer service life and unblemished safety record.

Finnish research in the mid 80's concluded that wide-base tires were more aggressive than dual tires by a factor of 2.3 - 4.0 under ideal conditions [2]. When the effect of uneven load distribution was simulated in the study, the damage factor was reduced to 1.2 - 1.9. When the wander effect was taken into account the difference between wide-base tires and dual tires was much smaller.

Issue

Michelin Tires has approached the Province of Ontario and other provinces through the Task Force on Vehicle Weights and Dimensions (VW&D) Policy asking that provincial regulations be modified to accommodate the use of ‘new generation wide-base single tires as a viable replacement for dual tires. This could lead to a modification of the national standard if consensus amongst the provinces is reached.

National standards in Canada limit the weight on any single tire to a maximum of 3000 kg as reflected in the Memorandum of Understanding (MOU) on Vehicle Weights and Dimensions (VW&D). This effectively limits the axle (with single tires) weight to 6000 kg rendering the use of wide-base single tires a non-viable option for replacement of dual tires. The national standards are considered a minimum limit, and jurisdictions may choose to exceed the limit.

In Ontario, axles with single tires are limited by legislation to a maximum of 9000 kg with an exception of vehicles covered under Regulation 32/94 where the axle load is limited to the national standard of 6000 kg per axle. According to this dualistic regulatory system, the wide-base tires are an allowable and practical alternative to dual tires in Ontario for those vehicles not covered by Regulation 32/94 – but are not a viable alternative for vehicles that fall under this regulation which include tractor-trailers over 14.65 m length. More specifically, vehicles, which are covered by Regulation 32/94, include:

- A-train doubles with an overall length over 23 m;
- B-train or C-train doubles with box length over 18.5 m or an overall length over 23 m;
- intercity buses whose length exceeds 12.5 m; and
- tractor-semi-trailer with a semi-trailer over 14.65 m in length.

Axles equipped with dual tires, on the other hand, are treated the same whether vehicles are covered by Regulation 32/94 or not. Single axles may have up to 10,000 kg. Tandem axle groups, which are common on tractor-trailer configurations, are allowed weights of 17,000 to 19,100 kg (8,500 to 9,550 kg per axle). The most typical tandem spreads are allowed 18,000 kg (9,000 kg per axle).

In the United States, when singles tires are mounted on the tandem axles of tractors and trailers, the standard maximum legal axle weight is 7710 kg (17000 lbs) and the allowable axle weight under similar conditions in Quebec is 8000 kg. These different weight allowances are becoming an issue particularly when 'new generation' wide-base tires provide a viable alternative to dual tires on the tandem axles of tractors and trailers.

Scope and Objective

The scope of this study includes literature survey and the analysis of recent data from the experimental work conducted by Michelin Tires. The objective of this study is to:

1. Identify the number of available options to address the issue concerning the use of new technology wide-base tires for potential replacement of dual tires for vehicles covered under Regulation 32/94.

2. Select the most viable option and conduct an impact analysis on the selected option.

3. Make appropriate conclusions based on results and identify areas where additional research work is needed.

Available Options

Based on the aforementioned information, the potentially available options to address the current wide-base tire issues are:

1. Status quo: retain 9000 kg and 6000 kg caps;

2. Increase the 6000 kg cap to 7710 kg;

3. Increase the 6000 kg cap to 8000 kg;

4. Increase the 6000 kg cap to 9000 kg;

5. Consider a reduction of the 9000 kg cap for vehicles not covered under Regulation 32/94.

ANALYSIS OF OPTIONS

Option 1 may present issues with U.S. and Quebec trucks operating on Ontario highways. Option 2 would address issues associated with U.S. trucks but not with Quebec. Option 3 would address issues related to both U.S. and Quebec trucks but still will cause disparity within Ontario regarding trucks not covered by Regulation 32/94. Option 4 would provide consistent treatment for all trucks operating in Ontario in addition to accommodating movement of vehicles between US, Ontario and Quebec. While it is always difficult to reduce limits that are already granted, Option 5 might be considered in conjunction with Options 2 and 3 so that limits are the same for all vehicles.

Impact Assessment of Options

For the purpose of impact assessment, Option 4 is considered as a first step as it has the potential to address all the issues associated with movement of trucks within Ontario as well as across U.S. and Quebec borders. The impact of Option 4 is assessed by comparing the amount of pavement damage caused by the new wide-base tires with the damage caused by dual tires under similar loading conditions. In this case, the axle loading would be 9000 kg.

CRITERIA USED FOR IMPACT ASSESSMENT

The impact on pavement due to various tires under similar loadings can be compared on the basis of induced stress on pavement caused by these tires. The higher the induced stress the greater is the damage on pavement. Induced stress is defined as the load divided by the contact area at a given tire inflation pressure. It should be noted that different tire inflation pressures under the same loading would have different contact areas, which in turn would have different impacts on pavements. The greater the tire inflation pressure the lesser is the contact area and greater would be the induced stress under a given load.

Based on the foregoing premise, an attempt was made to evaluate the potential impact of increasing the axle load on wide-base tires from 6000 kg to 9000 kg. The experimental data obtained from Michelin is used for the analysis. The data includes contact area for conventional dual tires and new technology wide-base tires under different axle loading and tire inflation pressure. In the analysis of option 4, only the contact areas associated with a typical tire pressure of 720 kPa (104 psi) under various axle loading were considered. The corresponding percent differences in contact area between the wide-base tire and the dual tire are shown in Table 1.

It appears from Table 1 that the contact area is about 6% less for wide-base tires under an axle load of 9072 kg and about 4% more under an axle load of 5400 kg. This reduction in contact area for new technology wide-base tires implies that there is a potential for increase (approximately 6%) in the induced pavement stress as compared to dual tires at an axle load of 9072 kg and at a tire pressure of 720 kPa. It was also observed that the induced stress due to wide-base tires would be relatively less as compared to the stress due to dual tires if the axle load were reduced to 5400 kg.

Table 1 - Percent Difference in Contact Area for Wide Tires

		Contact Area (mm^2) under Tire inflation pressure of 720 Kpa		
Axle Load (kg)	Load per wheel (kg)	TCA per wheel for Wide-base tire mm^2	TCA per Dual Tire set mm^2	Percent difference in Contact Area (Wide tire-Dual tire)
5400	2700	37093.5	35731	3.8
7720	3860	47632.5	48601	-1.99
9072	4536	52109	55420	-5.97

Note: TCA- Total contact area in mm^2
Load - per wheel position x 2 gives axle load

DATA ANALYSIS

Using this information, an analysis was carried out to assess the potential impact of increasing the load on wide-base tires beyond the current axle weight limit of 6000 kg allowed for single tires in comparison to the damage caused by an axle load of 9000 kg allowed for dual tires under Regulation 32/94. Based on the preliminary analysis the following observations can be made.

From the graph shown (Figure 1), it may be concluded that the induced stress and so the damage due to both tires are equal for an axle load of about 7300 kg (2x3650). This means that in theory, the axle load on the new technology wide-base tires may be increased from the current value of 6000 kg to about 7300 kg with no more damage than duals at 7300 kg. The regression Equation 1 and Equation 2 were developed, as shown in Figure 1, to establish a relationship between the contact area and the load for wide-base tire and dual tire.

$$A = 10.764 * L + 6771.1 \text{ (dual tires)} \qquad (1)$$

$$A = 29033 * Ln(L) - 192259 \text{ (wide tires)} \qquad (2)$$

Where, A is the total contact area, and
L is the load per wheel.

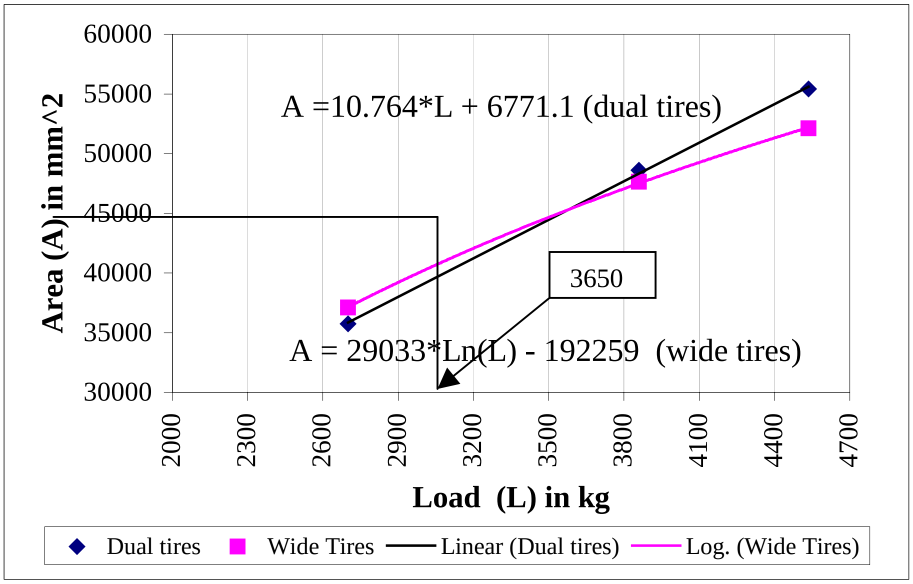

Figure 1 - Contact Area vs. Load for Dual and Wide Tires

The above equations were used to assess the load that could be increased on wide-base tires with no more damage than dual tires at the current allowable weights of 10000 kg on single axles under Regulation 32/94.

Table 2 - Induced Stress Caused by Wide Tires Under Various Loads

Load Per wheel (kg)	Axle Load (kg)	Wide-Base Tires		Dual Tires	
		Contact Area/wheel (mm^2)	Stress/wheel (Pa)	Contact Area/wheel (mm^2)	Stress/wheel (Pa)
3000	6000	40189.87	732.27	-	-
3250	6500	42513.75	749.93	-	-
3500	7000	44665.33	768.72	-	-
3750	7500	46668.40	788.27	-	-
3900	7800	47807.09	800.28	-	-
4000	8000	48542.14	808.37	-	-
4250	8500	50302.26	828.84	-	-
4500	9000	51961.74	849.57	55209.1	799.60
5000	10,000	-	-	60591.1	809.52
8650	17,300			99879.7	849.59

Note: The analysis shows that the load on wide tires may be increased up to 7800kg - 8000 kg to produce the same stress by dual tires at an axle load of 9000 kg-10000 kg.
If the load on wide tires were increased to 9000 kg, the induced stress would increase to 849.57 kPa, which is equivalent to the stress produced by dual tires under 17300 kg.

Consequently, the contact areas and the corresponding induced stresses caused by dual and wide-base tires due to typical axle loads used in Ontario are estimated using Equation 1 and Equation 2 as shown in Table 2. The estimated induced stress values given in Table 2, show that the induced stress of 808.37 Pa caused by wide-base tires under axle load of 8000 kg (i.e. 4000 kg per wheel) is the same as the induced stress caused by dual tires under axle load of 10000 kg. In other words, the axle load on wide-base tires can be increased up to 8000 kg to produce the same impact on pavement as the dual tires under the axle load of 10000 kg. Thus, the current axle load limit of 6000 kg for single tires under Regulation 32/94 can be increased up to 8000 kg for wide-base tires with no more damage than dual tires at 10000 kg.

IMPACT ANALYSIS

However, if the axle load on wide-base tires is increased to 9000 kg according to Option 4, the induced stress on pavement would be 849.57 Pa which is the same as the induced stress caused by dual tires under an axle load of 17300 kg as shown in Table 2. Thus, the question remains, "What is the impact of increasing the load up to 9000 kg on wide-base tires?

Table 3 - ESAL Calculation for Single Axle Loads

Axle Load on single wide tire, Kg	Equivalent Axle Load on single dual tires Kg	Axle Load, kN	Load per wheel, kN	LEF	ESAL
7800	9000	88.29	88.29	1.4569149	1.4569149
8000	10000	98.1	98.1	2.1868055	2.1868055
9000	17300	169.713	169.713	18.264135	18.264135

Note: Table 3 indicates that the ESAL for dual tire under an axle load of 9000 kg is 1.45 and the ESAL for dual tires under 17300 kg is 18.2641 which is the same as the ESAL for wide tires under 9000 kg. This means that the damage due to wide tires under 9000 kg would be 12 -13 times more than the damage caused by dual tires under similar loading.

A separate analysis was carried out to determine the impact of increasing the load on wide-base tires up to 9000 kg as shown in Table 3. In this analysis, the Equivalent Single Axle Load (ESAL) concept was used to assess the impact on pavement due to Axle loads. The ESAL corresponding to a single axle load of 9000 kg on dual tires is 1.46. According to Table 2, the increase in load up to 9000 kg on wide-base tire is equivalent to a single axle load of 17300 kg on dual tires. The corresponding ESAL value for an axle load of 17300 kg for dual tires is 18.264135, almost 12 times more than the ESAL for dual tires less than 9000 kg. This means that wide-base tires under an axle load of 9000 kg can potentially cause 12 times more damage than the damage by dual tires under the same loading.

LIMITATION OF THE ANALYSIS

The above analysis was carried out based on the assumption that the regression equations 1 & 2 are valid outside the range of the data used for developing the model. Generally speaking, this assumption is considered reasonable if the number of observations used for developing the model is large. In this case, only three data points were available and as such, caution must be exercised in the estimation of contact area based on the linear regression model for dual tires outside the range of data particularly when the estimated load of 8650 kg per wheel is almost 100% more than the maximum load limit of 4536 kg per wheel observed in the experiment. It appears that, in reality, it is highly unlikely that the dual tire would be capable of carrying a load of 8650 kg and a large contact area of 99879.7 mm^2 required to produce an induced stress of 849.49 kPa. This means that the inflation pressure has to be increased to compensate for a potentially limited contact area under a dual tire resulting in a non-linear relationship between the contact area and the load in the higher load range.

Thus the extrapolation of linear regression model may not be valid beyond the range of observed experimental data. The potential non-linear relationship in the higher load range in turn would give a load less than the estimated 8650 kg using the linear model to produce an induced stress of 849.59 Pa for dual tires. It is, therefore, important that further experimental investigation should be carried out beyond the current load range to validate the estimated load required to produce an induced pavement stress of 849.59 kPa.

SUPPLEMENTARY ANALYSIS

The apparent limitation of the linear model for dual tires used in the initial analysis is likely to overestimate the difference between the impact on pavement due to the use of wide-base tires and dual tires. In other words, the initial analysis provides a very conservative estimate of the impact. A supplementary analysis was carried out under a hypothesis that the relationship between the contact area and the load for dual tires beyond the observed experimental data is non-linear. Further, this non-linear trend was modelled by a set of power functions to yield three possible outcomes as shown in Figure 2. The three non-linear power equations (1A, 1B, and 1C) developed to predict the trend are given below. These models were used to estimate the load required for dual tire to produce a similar induced stress of 849.59 kPa caused by wide-base tire under 4500 kg per wheel load and the results are shown in Table 4.

$$A_1 = 71.192*(L_1)^{0.7911} \qquad (1A)$$

$$A_2 = 205.65*(L_2)^{0.6651} \qquad (1B)$$

$$A_3 = 652.62*(L_3)^{0.5279} \qquad (1C)$$

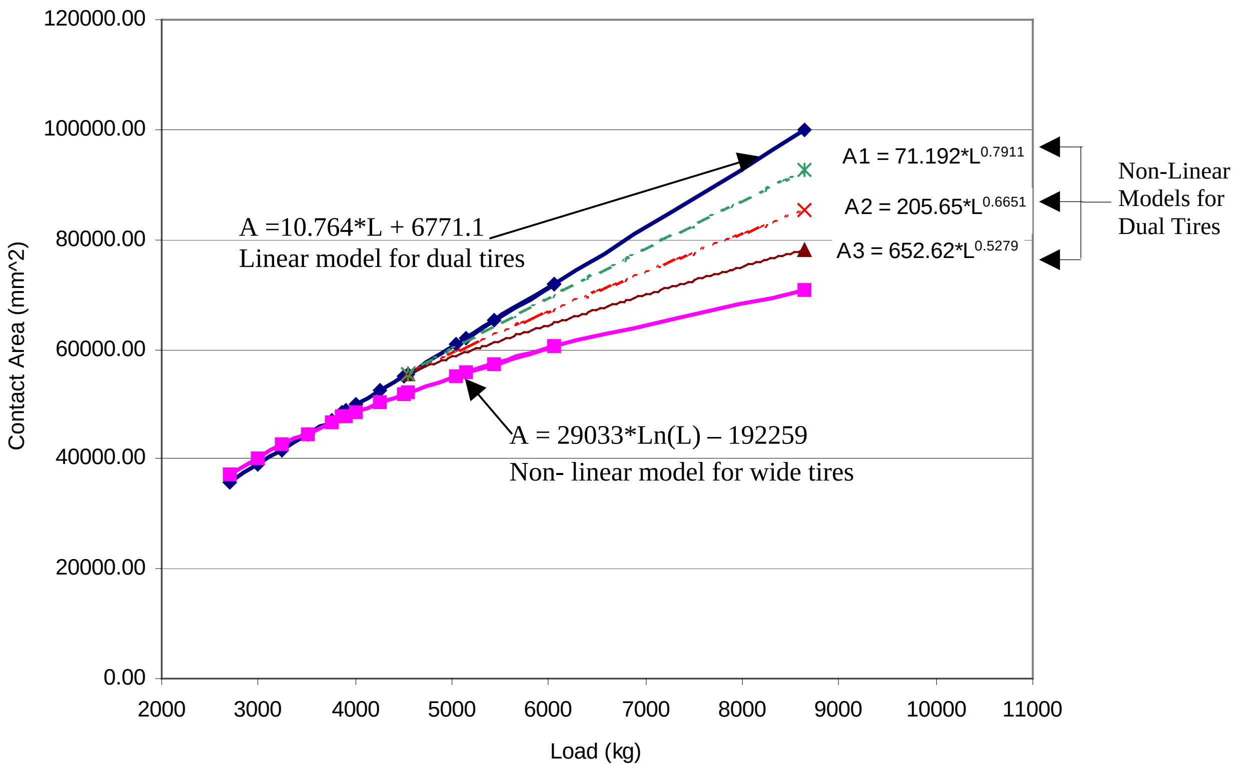

Figure 2 - Modified Non-Linear Models for Dual Tires Beyond a Wheel Load of 4536 kg

As seen in Table 4, these models identified three possible estimates of load per wheel (5146.8 kg, 5425.6 kg, and 6047.5 kg) required for dual tires to produce the same impact (contact area) as wide-base tire under a wheel load of 4500 kg. The corresponding axle loads are obtained by multiplying the wheel loads by 2 and rounding them off to the nearest hundredth as shown in columns 1and 2 of Table 5. To assess the impact associated with the revised equivalent wheel loads on dual tires, an additional analysis was carried out to determine ESAL values as shown in Table 5 for the respective axle loads. The estimated ESALs for these loads are shown in column 8 of Table 5, which indicate that there is a potential increase in damage due to wide-base tires in the range between 2.5 - 4.5 times more than the damage caused by dual tires. These values are comparable to results of the Finnish study [2] implying that the assumption of non-linear relationship beyond a wheel load of 4560 kg as modelled by power functions is quite reasonable. However, these assumptions need to be verified with a carefully planned experimental data.

Table 4 - Induced Stress Caused by Wide and Dual Tires Under Various Loads

Load per wheel, kg	Wide Tires		Dual Tires – linear Model		Dual Tires – Non linear Model 1A		Dual Tires – Non linear Model 1B		Dual Tires – non linear Model 1C	
	Contact Area, mm^2	Stress Pa	Contact Area, mm^2	Stress Pa	Contact Area, mm^2	Stress Pa	Contact Area, mm^2	Stress Pa	Contact Area, mm^2	Stress Pa
2700	37093.50	714.06	35731.00	741.29	35833.90	739.16	35833.90	739.16	35833.90	739.16
3000	40189.87	732.27	39063.10	753.40	39063.10	753.40	39063.10	753.40	39063.10	753.40
3250	42513.75	749.93	41754.10	763.58	41754.10	763.58	41754.10	763.58	41754.10	763.58
3500	44665.33	768.72	44445.10	772.53	44445.10	772.53	44445.10	772.53	44445.10	772.53
3750	46668.40	788.27	47136.10	780.45	47136.10	780.45	47136.10	780.45	47136.10	780.45
3860	47632.50	794.97	48601.00	779.13	48320.14	783.66	48320.14	783.66	48320.14	783.66
3900	47807.09	800.28	48750.70	784.79	48750.70	784.79	48750.70	784.79	48750.70	784.79
4000	48542.14	808.37	49827.10	787.52	49827.10	787.52	49827.10	787.52	49827.10	787.52
4250	50302.26	828.84	52518.10	793.87	52518.10	793.87	52518.10	793.87	52518.10	793.87
4500	51961.74	**849.57**	55209.10	799.60	55209.10	799.60	55209.10	799.60	55209.10	799.60
4536	52109.00	853.94	55420.00	802.93	55596.60	800.38	55596.60	800.38	55596.60	800.38
5032	55209.10	894.23	60941.54	810.11	60383.21	817.60	59592.05	828.46	58726.57	840.67
5146.4	55858.55	903.82	62166.95	812.11	61461.29	821.43	60485.28	834.69	59424.17	**849.59**
5425.6	57392.39	927.39	65172.26	816.68	64084.47	830.55	62648.39	**849.59**	61104.80	871.05
6047.5	60542.95	979.90	71866.39	825.50	69829.01	**849.59**	67337.17	881.03	64707.45	916.83
8650	70934.28	1196.27	99879.70	**849.59**	92643.34	915.95	85406.99	993.55	78170.63	1085.53

Table 5 - ESALS for Revised Single Axle Loads on Dual Tires

Axle Load on Single Wide tires (kg)	Equivalent axle load on single dual tires (kg) *	Axle Load KN	Load per Wheel	LEF	ESAL	Comments
7800	9000	88.29	88.29	1.4569149	1.4569149	Linear model
9000	10,300	101.043	101.043	2.4509519	2.4509519	Model 1C
9000	10,850	106.4385	106.4385	2.9960014	2.9960014	Model 1B
9000	12,100	118.701	118.701	4.566051	4.566051	Model 1A

Summary and Conclusions

An investigation was carried out to assess the potential impact of using new technology wide-base tires as a viable alternative to dual tires. The use of wide-base tires would become a viable option only if the current weight limit of 6000 kg an axle with single tires is increased for vehicles covered under the Regulation 32/94. This study provides the results of the analysis of different options available to allow the use of wide-base tires as a viable option for replacement of dual tires. The latest available information and the results of the experimental investigation conducted by Michelin Tires were used to assess the impact of increasing the load from 6000 kg to 9000 kg for single tires of vehicles which are not covered by this Regulation 32/94. The conclusions based on the investigation are summarized as follows:

1. In general, the potential damage on pavement due to new technology wide-base tires is less than the damage caused by dual tires under an axle load of less than 7300 kg.

2. More specifically, under an axle load of 5400 kg, the damage due to wide-base tires is 4 % less than the damage due to dual tires.

3. At an axle load of 7300 kg, the impacts on pavement caused by new technology wide-base tires and the conventional dual tires are the same.

4. The impact on pavement caused by new technology wide-base tires at an axle load of 8000 kg, is the same as the impact caused by dual tires at 10000 kg. This means that the current limit of 6000 kg for single tires covered under Regulation 32/94 could be increased up to 8000 kg for new technology wide-base tires with no more damage than dual tires at 10000 kg.

5. If the axle load on new technology wide-base tire is increased up to the current limit of 9000 kg allowed for vehicles not covered under Regulation 32/94, the initial assessment based on limited data indicates that the potential pavement damage could be more than 12 times the damage caused by conventional dual tires under similar loading. This assessment may be conservative because of the potential overestimation of the damage assessed

by extrapolation of the linear model well outside the range of the experimental data.

6. Subsequent analysis by assuming a non-linear relationship between the contact area and the load for dual tires beyond the range of the available data indicates that the damage due to wide-base tire under an axle load of 9000 kg is likely between 2.5 - 4.5 times the damage caused by dual tires. This finding is comparable to the damage reported by Finnish study.

Recommendation

Based on the analysis and data provided by Michelin, policy consideration may be given to increasing the 6,000 kg axle limit in Ontario Regulation 32/94 to as much as 8,000 kg. Such weights would cause no more damage to pavement than axles equipped with dual tires loaded to 10,000 kg, which is the Highway Traffic Act limit for single axles equipped with dual tires.

The majority of Ontario tractors and trailers operate on tandem axles rather than single axles. Dual tire equipped tandem axles are typically limited to 8,500 to 9,550 kg per axle, with 9,000 kg most common. A more appropriate maximum limit for axles equipped with single tires may therefore be in the 7,700 to 7,800 kg range.

Single tire equipped axles loaded to the current Highway Traffic Act limit of 9,000 kg cause significantly more damage to pavement than dual tire equipped axles loaded to 10,000 kg. Policy consideration should therefore also be given to a reduction in the 9,000 kg axle limit for single tires.

Further experimental work is recommended to validate the different models used in predicting the contact area for dual and wide-base tires outside the range of the experimental data.

References

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