
Effect of Track Width on Dynamic Performance of Semitrailers with Wide Single Tires

Prepared for



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The Regulations

The national Memorandum of Understanding on Vehicle Weights and Dimensions (“the M.o.U.”) originally restricted the load on an axle with single tires to 6,000 kg (13,227 lb) [1]. The M.o.U. was amended in April 2008 to allow 7,700 kg (16,975 lb) on a single axle, or 15,400 kg (33,950 lb) on a tandem axle, where the axle was fitted with wide single tires with a width of 445 mm (17.52 in) or more [2]. The amendment does not mention fitment of wide single tires on a tridem axle.

Fitting wide single tires to an existing axle without exceeding the rating of wheel bearings and spindles may result in a track width less than the minimum of 2.50 m (98.4 in) specified in the M.o.U. [1]. It was recognized that some carriers might wish to retrofit existing trailers built for dual tires with wide single tires, so the amendment therefore included the following:

“It is understood that the minimum track width for trailer axles fitted with single tires must be no less than 2.3 m for trailers built in 2007 or earlier.

It is further understood that the minimum track width for all axles on trailers built in 2008 or later must be no less than 2.5 m.” [2]

The responses to this amendment by the various provincial Ministries, as determined from information posted on their web-sites, are various, as follows:

- British Columbia has updated its regulation in accordance with the amendment, and appears additionally to allow 7,700 kg per axle on a tridem;
- Alberta issues permits in accordance with the amendment, and additionally allows 19,000 kg on a tridem;
- Saskatchewan has implemented the amendment by special permit;
- Manitoba has also implemented the amendment by special permit
- Ontario has implemented the amendment, with up to 9,000 kg per axle, subject to tire width and the allowable axle group weight, allows 2.3 m track width for vehicles built before 2010, and allows wide single tires on all designated SPIF configurations;
- Quebec does not appear to have implemented the amendment, but does allow wide single tires provided the allowable axle group weight is reduced by 1,000 kg/axle with single tires, and allows the same weights as for dual tires by special permit;
- New Brunswick has implemented the amendment by special permit; and
- Nova Scotia has updated its regulation in accordance with the amendment, with 21,000 kg on a narrow tridem or 23,100 kg on a medium or wide-spread tridem, with no mention of a track width limit.

Study of Wide Single Tires

MTO sponsored an extensive study of the dynamic performance of various configurations with dual or wide single tires on the tractor, and/or dual or wide single tires on the trailer [3], as part of their process to determine the allowable load for wide single tires.

The configurations considered were:

- Tandem semitrailer;
- Wide-spread tridem semitrailer;
- Self-steer tri-axle semitrailer;
- Self-steer quad semitrailer;
- 7-axle B-train; and
- 8-axle B-train.

Five payload weights were considered for each configuration. Vehicles were loaded with the specified payload weight in a solid block of uniform density, with a height of 1.22, 1.83 or 2.44 m (48, 72 or 96 in), over a width of 2.44 m (96 in), and from the nose of a trailer rearward to 0.30 m (12 in) from the rear of a trailer.

The work determined the static roll threshold, high-speed offtracking, load transfer ratio and transient offtracking for all six vehicle configurations, for each payload weight, each payload heights, and with dual or wide single tires on the tractor, and dual or wide single tires on the trailer.

None of the configurations met the static roll threshold performance standard of 0.40 g when fitted with dual tires for the highest payload weights and the highest payload height of 2.44 m (96 in). All configurations met the performance standard when fitted with dual tires and the payload height was not more than 1.83 m (72 in). When wide single tires replaced the dual tires on the tractor or the trailer with no reduction in track width, there was a modest improvement in static roll threshold, of the order of 1.5 to 3%. There was a further improvement when wide single tires replaced the dual tires on both the tractor and the trailer, again with no reduction in track width.

These configurations also met the performance standards for the high-speed performance measures essentially for all payload weights and payload heights for tandem and tridem semitrailers, with a few exceptions for the highest payload weights and payload heights for the other configurations. When wide single tires replaced the dual tires on the tractor or the trailer with no reduction in track width, there was a modest improvement in all performance measures, with a further improvement when wide single tires replaced the dual tires on both the tractor and the trailer, again with no reduction in track width.

Effect of Track Width on Static Roll Threshold

The effect of narrow track width was considered briefly at the end of the study [3], for each trailer configuration, but only for the highest payload weight and highest payload height, and for each possible combination of dual and single tires.

Table 1 shows the effect on static roll threshold if dual tires on a tandem semitrailer are replaced by wide single tires. The first column shows the payload weight. Then four columns present the static roll threshold for each of two payload heights, where the first column of each three (headed “**Dual**”) has dual tires on the semitrailer, the second (headed “**S Wide**”) has wide single tires with 83.5 in track axles, the third column (headed “**S Narr**”) has wide single tires with 77.5 in track axles on rims with zero outset, and the fourth column (headed “**S Out**”) has wide single tires with 77.5 in track axles on rims with 2 in outset. Entries highlighted in bold do not meet the performance standard of 0.40 m customarily used by MTO. Table 2 shows the corresponding results for a tridem semitrailer. The values in Table 1 and Table 2 differ slightly from corresponding previous results [3], because of a change in the process used to scan for rollover since that study was completed.

Table 1: Tandem Axle Semitrailer

Payload Weight (lb)	Payload height							
	2.44 m (96 in)				1.83 m (72 in)			
	Dual	S Wide	S Narr	S Out	Dual	S Wide	S Narr	S Out
58,000	0.357	0.369	0.346	0.362	0.419	0.430	0.408	0.424
53,000	0.366	0.377	0.354	0.371	0.426	0.437	0.415	0.430
45,000	0.381	0.393	0.372	0.387	0.438	0.450	0.430	0.445
35,000	0.407	0.419	0.397	0.412	0.457	0.473	0.449	0.466
25,000	0.446	0.456	0.436	0.450	0.488	0.502	0.484	0.497

Table 2: Tridem Axle Semitrailer

Payload Weight (lb)	Payload height							
	2.44 m (96 in)				1.83 m (72 in)			
	Dual	S Wide	S Narr	S Out	Dual	S Wide	S Narr	S Out
58,000	0.359	0.372	0.346	0.364	0.425	0.434	0.410	0.426
53,000	0.378	0.393	0.367	0.385	0.439	0.452	0.427	0.444
45,000	0.407	0.422	0.396	0.413	0.458	0.475	0.450	0.466
35,000	0.436	0.450	0.425	0.441	0.484	0.500	0.474	0.493
25,000	0.476	0.487	0.464	0.480	0.521	0.537	0.508	0.523

The results presented in Table 1 and Table 2 used nominal dimensions that resulted in the following specific track widths:

- 77.5 in track axles for dual tires, with a nominal tire width of 11 in, and a dual tire spacing of 12.5 in, for a track width of 101 in (2.57 m);
- 83.5 in track axles for wide single tires with wide track axles, with a nominal tire width of 18 in, and zero rim outset, for a track width of 101.5 in (2.58 m);
- 77.5 in track axles for wide single tires with narrow track axles, with a nominal tire width of 18 in, and zero rim outset, for a track width of 95.5 in (2.43 m); and
- 77.5 in track axles for wide single tires with narrow track axles, with a nominal tire width of 18 in, and 2 in rim outset, for a track width of 99.5 in (2.53 m).

The actual width of any specific tire, the actual spacing of dual tires, and the actual rim outset of wide single tires, may all vary from the nominal values used to generate the results in Table 1 and Table 2. The assumptions for wide and narrow track axles result in close to the widest likely track width for 83.5 in track axles, and close to the narrowest possible track width for 77.5 in track axles with zero outset rims. The results presented in Table 1 and Table 2 therefore represent about the range of best to worst that would be possible. It is understood that many U.S. manufacturers have adopted the 77.5 in track axle with 2 in outset rims for new semitrailers built with wide single tires, and the actual track width would vary between about 2.35 and 2.49 m (92.5 and 98.0 in), depending on the tire used, and other details. Results for any specific track width could be estimated by interpolation from the results presented in Table 1 and Table 2 using the track widths given above. Since another specific alternative track width would almost certainly be intermediate between the wide and narrow track widths used in the analysis, the result would be intermediate between the results presented in those tables. The suspension for wide single tires on 83.5 in track axles was assumed 3 in outboard of the suspension on 77.5 in track axles.

It is evident from Table 1 and Table 2 that replacement of dual tires with wide single tires on 83.5 in track axles improves the static roll threshold. Replacement of dual tires with wide single tires on 77.5 in track axles with zero outset rims degrades the static roll threshold, for all payload weights and payload heights. However, if rims with 2 in outset are used, the static roll threshold in this case is slightly better than with dual tires. Tandem and tridem semitrailers with the high payload height of 2.44 m (96 in) do not meet the static roll threshold performance standard of 0.40 g for the three or two highest payload weights, respectively, and for one more with wide single tires on 77.5 in track axles with zero outset rims. They also do not meet the static roll threshold performance standard for the two or one highest payload weights, respectively, with wide single tires on 77.5 in track axles, with a payload height of 1.83 m (72 in).

Table 3 shows an estimate of the cumulative distribution of payload weight of tandem and tridem semitrailers. Each value is the percentage of trucks with a payload less than the given weight. The payload weight was determined from the gross weight of trucks sampled for the 1999 Commercial Vehicle Survey, less a nominal tare weight of 14,515 kg (32,000 lb) for a tractor-tandem semitrailer, or 15,649 kg (34,500 lb) for a

Table 3: Approximate Distribution of Payload Weights

Payload (lb)	Tandem	Tridem
0	0.6%	0.5%
1,000	2.1%	0.6%
3,000	4.2%	1.2%
5,000	7.2%	2.5%
8,000	11.0%	4.0%
10,000	15.1%	5.6%
12,000	19.6%	7.7%
14,000	24.3%	9.4%
17,000	29.4%	11.0%
19,000	33.8%	12.7%
21,000	38.2%	15.0%
23,000	42.2%	17.0%
25,000	46.3%	19.7%
28,000	50.1%	22.6%
30,000	53.6%	26.0%
32,000	57.2%	29.2%
34,000	60.7%	32.4%
36,000	64.4%	36.2%
39,000	68.8%	40.4%
41,000	74.7%	44.7%
43,000	82.3%	48.7%
45,000	89.5%	53.3%
47,000	93.7%	58.7%
50,000	96.0%	63.4%
52,000	97.5%	67.6%
54,000	98.5%	71.6%
56,000	99.1%	76.2%
58,000	99.4%	81.3%
61,000	99.6%	85.8%
63,000	99.6%	89.5%
65,000	99.7%	92.4%
67,000	100.0%	95.7%
69,000		97.1%
71,000		97.7%
74,000		98.0%
76,000		98.2%
78,000		98.7%

tractor-tridem semitrailer. The tare weight of actual trucks varies somewhat from the nominal values used, but the overall distribution of payload should be representative for the discussion that follows.

A tandem semitrailer can carry a payload up to about 58,000 lb at the allowable gross weight in eastern Canada, or about 53,000 lb in western Canada. However, these principally carry payloads up to about 45,000 to 50,000 lb, which is the standard payload for the semitrailer for operation into the U.S. at an allowable gross weight of 36,287 kg (80,000 lb). The reason for this is simply that there are trucks available in Canada that can carry more than 58,000 lb of payload, so a tandem semitrailer only serves a narrow market for payload weights above 50,000 lb, and most of these are probably vehicles with a specialized body style. By interpolation, Table 1 shows that a tandem semitrailer with dual tires only meets the static roll threshold performance standard of 0.40 g with a high payload height for payloads up to 38,000 lb. Table 3 shows that about 67% of tandem semitrailers have a payload less than 38,000 lb. However, not all of the 33% of other payloads have a high payload height. If it is assumed (arbitrarily) that about one third of these trucks will have a high payload height, then about 89% of payloads will either be less than 38,000 lb in weight, or no more than 1.83 m (72 in) in height, so will meet the performance standard. By interpolation, Table 1 shows that a tandem semitrailer with wide single tires on 77.5 in track axles with zero outset rims only meets the static roll threshold performance standard of 0.40 g with a high payload height for payloads up to about 33,000 lb. Table 3 shows that about 59% of tandem semitrailers have a payload less than 33,000 lb, but not all of the 41% of other payloads will have a high payload height. If it is assumed (arbitrarily) that about one third of these trucks will have a high payload height, then about 86% of payloads will either be less than 33,000 lb in weight, or no more than 1.83 m (72 in) in height, so will meet the performance standard. Consequently, even though use of wide single tires on 77.5 in track axles with zero outset rims on a tandem semitrailer actually reduces the static roll threshold of a vehicle for any payload, about 86% of trips by tractor-tandem semitrailers with wide single tires on 77.5 in track axles might nevertheless meet the static roll threshold performance standard of 0.40 g, compared to about 89% of trips by tractor-tandem semitrailers with dual tires on axles with the same track width. If 10% of tandem semitrailers would be converted to wide single tires with 77.5 in track axles and zero outset rims, then about 88.7% of all trips by tractor-tandem semitrailers might meet the static roll threshold performance standard of 0.40 g, compared to about 89% of trips by tractor-tandem semitrailers if all semitrailers had dual tires.

A tridem semitrailer can carry a payload up to about 74,000 lb in eastern Canada, or up to about 67,000 lb in western Canada, depending on the tridem spread. Using the same procedure as described above for a tandem semitrailer, by interpolation, Table 2 shows that a tridem semitrailer with dual tires only meets the static roll threshold performance standard of 0.40 g with a high payload height for payloads up to about 48,000 lb. Table 3 shows that about 60% of tridem semitrailers have a payload less than 48,000 lb, but not all of the 40% of other payloads will have a high payload height. If it is assumed (arbitrarily) that about one third of these trucks will have a high payload

height, then about 87% of payloads will either be less than 48,000 lb in weight, or no more than 1.83 m (72 in) in height, so will meet the performance standard. By interpolation, Table 2 shows that a tridem semitrailer with wide single tires on 77.5 in track axles only meets the static roll threshold performance standard of 0.40 g with a high payload height for payloads up to about 43,000 lb. Table 3 shows that about 49% of tandem semitrailers have a payload less than 43,000 lb, but not all of the 51% of other payloads will have a high payload height. If it is assumed (arbitrarily) that about one third of these trucks will have a high payload height, then about 83% of payloads will either be less than 33,000 lb in weight, or no more than 1.83 m (72 in) in height, so will meet the performance standard. Consequently, even though use of wide single tires on 77.5 in track axles with zero outset rims on a tridem semitrailer actually reduces the static roll threshold of a vehicle for any payload, about 83% of tractor-tridem semitrailers with wide single tires on 77.5 in axles might nevertheless meet the static roll threshold performance standard of 0.40 g, compared to about 86% of tractor-tridem semitrailers with dual tires on axles with the same track width. The difference from the tandem semitrailer reflects the use of tridem van semitrailers for backhauls at tandem semitrailer weights in markets where there is not significant backhaul traffic at tridem weights.

So, if all tandem and all tridem semitrailers would be converted to wide single tires on 77.5 in track axles with zero outset rims, the actual number of trips made by each of these configurations with a static roll threshold less than the performance standard would increase by only 3%. There would be no such increase if rims with 2 in outset would be used.

Effect of Track Width on High-speed Performance Measures

The high-speed performance measures are load transfer ratio performance, high-speed offtracking and transient offtracking.

Replacing dual tires with wide single tires on 77.5 in track axles on a tandem or tridem semitrailer has a similar negative effect on the load transfer ratio performance measure as on the static roll threshold performance measure [3]. However, the load transfer ratio performance standard is exceeded for no more than 2% of trips by either tandem or tridem semitrailers, at the highest payload weight, and the highest payload height. Consequently, there should be negligible difference in the proportion of trips that exceed the load transfer performance standard between these semitrailers with dual tires, and those with wide single tires on 77.5 in track axles.

Tandem and tridem semitrailers meet the high-speed offtracking and transient offtracking performance measures for all payload weights and all payload heights with dual tires, wide single tires on 83.5 in track axles, and wide single tires on 77.5 in track axles [3]. Use of wide single tires improves both performance measures regardless of track width, though the improvement is slightly less for 77.5 in track axles than for 83.5 in track axles.

Conclusions

The provinces have not all implemented the change to the M.o.U. to allow wide single tires that was ratified in April 2008. Consequently, the cut-off date of manufacture of 31 December 2007 for conversion of trailers built with dual tires to wide single tires may be restrictive for carriers in provinces that have not yet implemented the change. The amendment to the M.o.U. only addresses single and tandem axle groups. Some provinces have extended it to tridem axle groups, but the weights allowed are inconsistent between provinces. It is also not evident whether provinces allow wide single tires on vehicles other than tractor-semitrailers. These issues need to be clarified.

Retrofit of wide single tires on 77.5 in track axles with zero outset rims on any semitrailer actually reduces the static roll threshold of the vehicle for any payload, compared to the original dual tires. If all these semitrailers would be converted, it is possible that 86% of trips made by tractor-tandem semitrailers, or 83% of trips made by tractor-tridem semitrailers, might still meet the static roll threshold performance standard of 0.40 g, which is a reduction of 3% from the existing fleet with dual tires. There would be no such reduction if rims with 2 in outset would be used.

References

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