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# New Generation Single Tires

A review of the facts  
Presented by Ralph Beaveridge of Michelin North America (Canada) Inc.

R Beaveridge Page 1 Nov 30<sup>th</sup>



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# Agenda

- Introduction
- New versus old
- Pavement
  - HMA
  - Subgrade
- Real world duals
- Real world value
- Singles can save the world
- Equality for New Generation single tires

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# Introduction

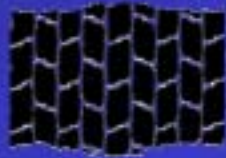


Transportation  
Responsibility  
Five years  
United with industry  
Michelin, father, Canadian



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# Apples versus watermelons



425/65R22.5  
XZY

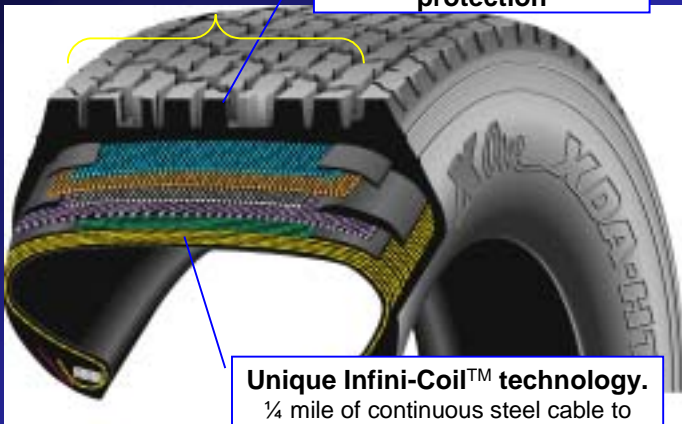
445/50R22.5 X  
One XDA



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## New technology to limit tread deformation



**Full width steel protection**

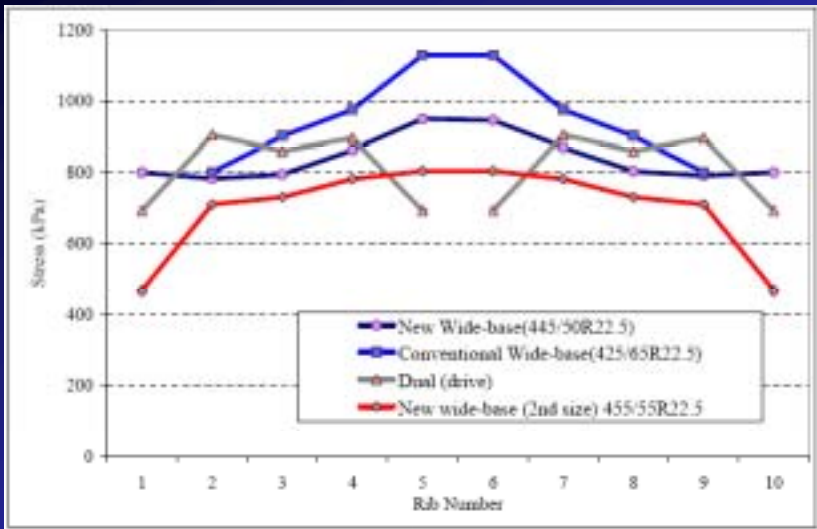
**Unique Infini-Coil™ technology.**  
1/4 mile of continuous steel cable to help eliminate casing growth




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## Even distribution of contact stress

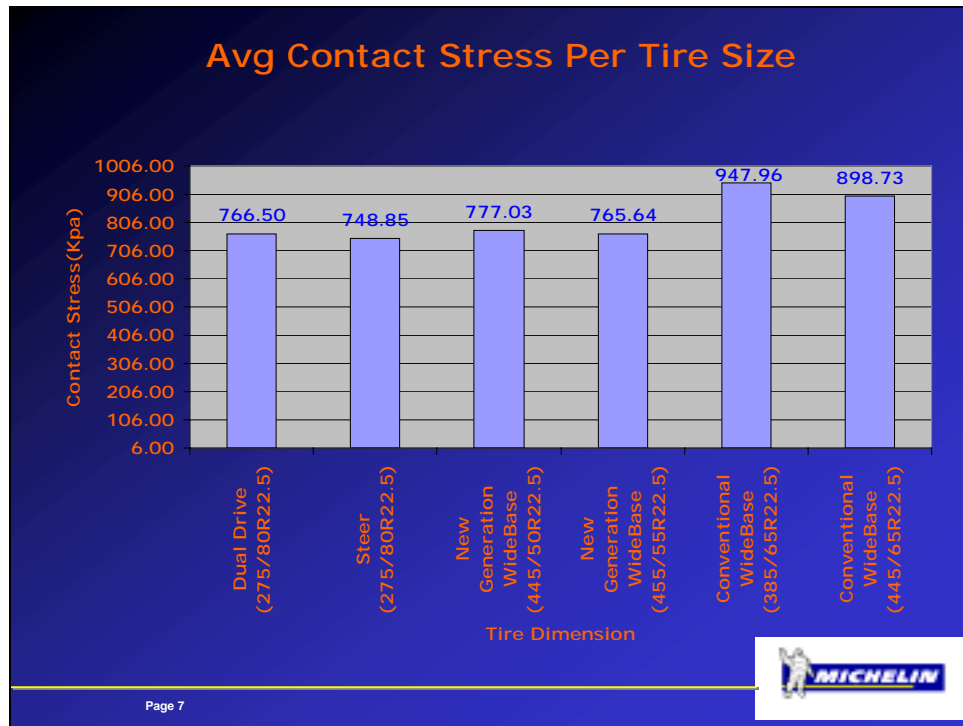


Roll Number	New Wide-base(445/50R22.5)	Conventional Wide-base(425/65R22.5)	Dual (drive)	New wide-base (2nd size) 455/55R22.5
1	500	500	500	450
2	500	500	500	500
3	500	500	500	500
4	500	500	500	500
5	500	500	500	500
6	500	500	500	500
7	500	500	500	500
8	500	500	500	500
9	500	500	500	500
10	500	500	500	500



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## Pavement

There have been two pavement arguments:

“singles are tougher on our weaker Canadian pavements...weaker meaning thinner HMA layer”

“we are not so concerned with the HMA layer as the subgrade. It is the destruction of the sub layer by single tires that concerns us”


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## Pavement...facts

Fact:  
Initial Virginia Tech (VT) study looked at strong pavements and applied US loads – 80,000 GW.

- US directed test on pavement impact of tires
- Clearly showed no impact of single versus dual configurations on HMA or subgrade with US loads

Up to 7,700kg/axle singles have no impact



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## Pavement...facts

Fact:  
Provincial governments are faced with shrinking monies for road maintenance and greater public and industry frustration with a National Highway System in generally poor condition.

- A product with negative impact on pavement life needs to be avoided
- Products that have a positive or neutral effect on pavements must be considered on other merits




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## Pavement...facts

Fact:  
Laval University study commissioned by the MTQ to examine pavement impact of new generation singles is the basis of the MTQ report.

- Canadian loads, weaker pavement
- HMA – ‘summer X One slightly positive, spring X One slightly negative’
- Regarding the subgrade – margin of error too large to use measurements



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## Pavement...facts

Fact:  
Tire contact stress is not evenly distributed across the contact patch

- Research based on this assumption is flawed

Fact:  
The tire contact patch is neither round nor spherical for all tires

- Research using this assumption has ignored an important advancement in tire design



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## Pavement...facts

Fact:  
Most single tire impact studies have looked at traditional single tires (apples and watermelons)

- Attributing those results to new generation singles is inaccurate and unfair.

Fact:  
The MTO study by J. Ponniah is a theoretical study.

- Joseph clearly indicated he would defer to any valid physical tests




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## Pavement...facts

Fact:  
When addressing the issue of subgrade impact, both VT and COST Action clearly stated that impact of wide base tires on lower layers including subgrade, is equivalent to dual tire configurations because they carry the same load and distribute it over the same area at greater depths.

- Single tires have no negative impact at the subgrade




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## Pavement...facts

Fact:

Laval University indicated that impact measurements at the subgrade were so small as to be virtually nonexistent. But concluded that there was no difference between duals and singles at that level

- Single tires have no negative impact at the subgrade



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## Pavement...facts

Fact:

VT, Laval confirm that HMA impact is virtually identical under test conditions.

- The real world has another dimension.

What part of the tire supports ~5% of the load and what supports ~95%?



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## Real world duals...facts

Fact:

The Transportation Research Board (TRB) published a study on real world tire pressure conditions

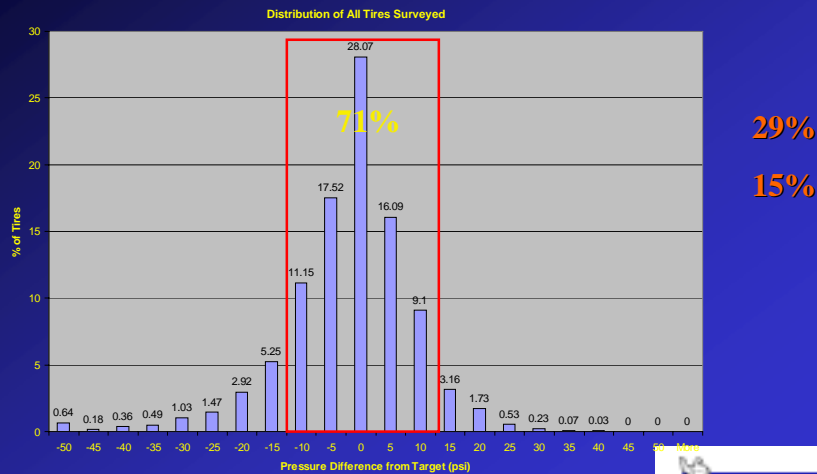
- 71% of duals are within 10% of each other
- 29% of the general population of duals in the real world are more than 10% apart in psi
- 15% of the population is off by more than 20%



## Chances are your fleet is under pressure: TRB Survey

"Commercial Vehicle Tire Condition Sensors" FMCSA-PSV-04-002, Federal Motor Carrier Safety Administration, December 2003

Kneib, R., Nicosia, B., Fisher, P., "Commercial Vehicle Tire Condition Sensors" FMCSA-PSV-04-002, Federal Motor Carrier Safety Administration, December 2003



## Real world duals...facts

Fact:

14% of duals on the road today are impacting the pavement as 1.2 to 1.6 tires

15% of duals on the road are impacting the pavement as 1 to 1.2 tires

- 100% of single tires have one air pressure
- eliminating mismatched dual pressures will have a large positive impact on pavement damage on the order of 15 to 20%



## Pavement & the real world

Under test conditions:

HMA – singles present slight positive in summer, slight negative in spring thaw

Subgrade – singles are neutral as strain is distributed over the same area

Under real world conditions

29% of mismatched duals create far more negative impact than single tires



## The Québec example

Fact:

Quebec has estimated \$40M as the annual increase in road maintenance costs if new generation single tires replaced 100% of the dual population

- This does not consider the mismatched duals dimension
- Eliminating 100% of mismatched duals would save the province of Québec several times \$40M



## Real world value

"We have a responsibility to ensure the trucking industry has an opportunity to deliver its service in the most efficient effective and socially responsible manner"



## Fuel Efficiency: Where does fuel go?

At 100 km/h:

- aerodynamic drag** (red arrow): Aerodynamic drag consumes approximately 40% of the fuel.
- mechanical losses** (yellow arrow): Mechanical losses (engine, drive train etc.) consume approximately 25% of the fuel.
- rolling resistance** (green arrow): Rolling resistance of tires accounts for approximately 35% of the fuel consumed.

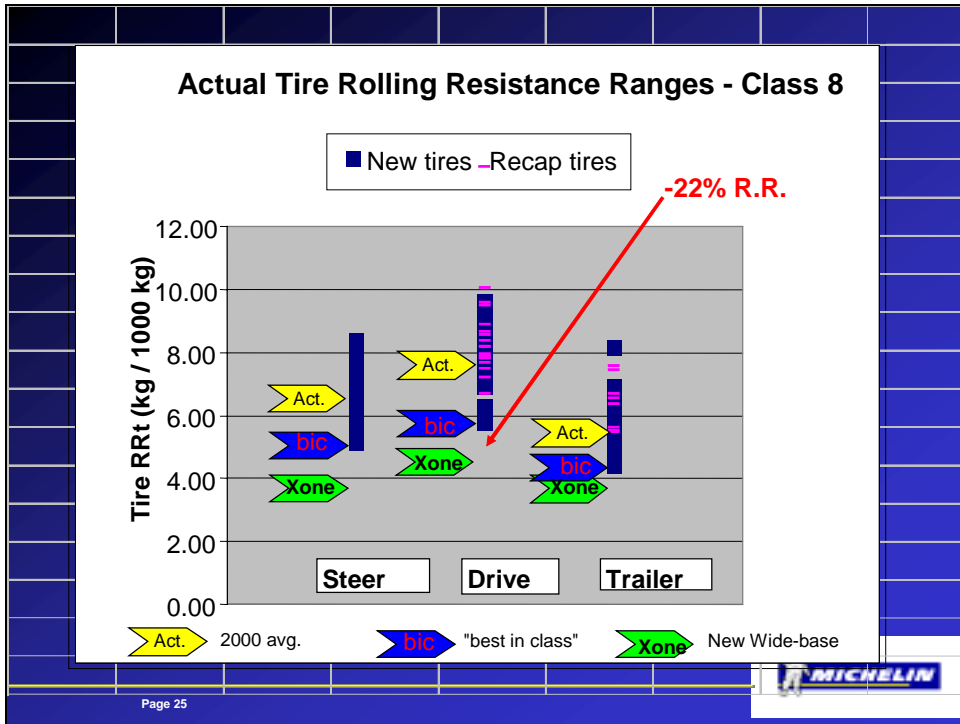
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## Do tires make a difference in your fuel consumption?

Tire Model	Rolling Resistance Index
XZA-1+	100
XT-1	90
XZE	130
XDA Energy	105
XDA3	120
XDA-HT	155
XOne XTA	75
XOne XDA	95

Remember: 35% of your fuel is consumed by tires

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## Weight Efficiency: How much weight will single tires save on a tractor?

	X One 445/50R22.5 XDA (lb)	Dual 275/80R22.5 XDA2	Difference
Tire	176	249	73
Wheel	70	100	30
<b>Total</b>	<b>246</b>	<b>359</b>	<b>103</b>

Aluminum to aluminum wheel comparison

	X One 455/55R22.5 XDA-HT (lb)	Dual 11R22.5 XDA-HT	Difference
Tire	191	270	79
Wheel	70	100	30
<b>Total</b>	<b>261</b>	<b>380</b>	<b>109</b>


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## On a trailer?

	X One 445/50R22.5 XTA (lb)	Dual 275/80R22.5 XT-1	Difference
Tire	156	216	60
Wheel	70	100	30
<b>Total</b>	<b>226</b>	<b>316</b>	<b>90</b>

	X One 455/55R22.5 XTE (lb)	Dual 11R22.5 XTE	Difference
Tire	175	222	47
Wheel	70	100	30
<b>Total</b>	<b>245</b>	<b>322</b>	<b>77</b>

Aluminum to aluminum wheel comparison



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## For a tandem/tandem set-up

Weight Saving Calculator		Duals	X One
<b>Drive</b>	Tire	275/80R22.5 XDA-HT	445/50R22.5 X One XDA-HT
	Tire weight	126.2 lbs	175.9 lbs
	Wheel	8.25X22.5 Aluminum	14.00X22.5 Aluminum
	Wheel weight	50.0 lbs	70.0 lbs
	Qty per vehicle	8	4
<b>Total weight</b>		<b>1409.6 lbs</b>	<b>983.6 lbs</b>
<b>Trailer</b>	Tire	275/80R22.5 XZE	445/50R22.5 X One XTE
	Tire weight	117.9 lbs	159.4 lbs
	Wheel	8.25X22.5 Aluminum	14.00X22.5 Aluminum
	Wheel weight	50.0 lbs	70.0 lbs
	Qty per vehicle	8	4
<b>Total weight</b>		<b>1343.2 lbs</b>	<b>917.6 lbs</b>
<b>Total</b>		<b>2752.8 lbs</b>	<b>1901.2 lbs</b>
<b>Weight Saving</b>		<b>851.6 lbs</b>	



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## Maintenance Efficiency: How can singles reduce maintenance costs?





Pressure checks  
Mismatched pressures  
One tire to mount  
No hidden dual

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## Will single tires reduce your flats?




**Why?**  
**Air pressure maintenance!!!**

Where do flats occur?

- Trailer (54%)
- Drive (43%)
- Steer (3%)

- One valve stem
- Outside – easily accessible
- No “camouflage” from inside dual

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## Comfort Safety: 14 DOF Model

Note: Beaming DOFs not shown

I don't get excited by engineer's drawings, but it gives you an idea of the depth of the research

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## Dual vs. Wide-Base Tires

**X-One Drive and Trailer Tires @ Smooth Highway – 65 mph (per Axle Loads)**

Axle	Static Axle Load (N)	Probability = 68.3% Dyn. Load Range (N)	Probability = 95.45% Dyn. Load Range (N)
Steer*	4.0434e+004	± 4.7061e+003	± 9.4122e+003
1 <sup>st</sup> Tractor Drive	8.3041e+004	± 5.0498e+003	± 1.0100e+004
2 <sup>nd</sup> Tractor Drive	5.6362e+004	± 5.1569e+003	± 1.0314e+004
1 <sup>st</sup> Trailer	8.3149e+004	± 5.4067e+003	± 1.0813e+004
2 <sup>nd</sup> Trailer	7.8599e+004	± 5.3703e+003	± 1.0741e+004

**Standard Dual Drive and Trailer Tires @ Smooth Highway – 65 mph (per Axle Loads)**

Axle	Static Axle Load (N)	Probability = 68.3% Dyn. Load Range (N)	Probability = 95.45% Dyn. Load Range (N)
Steer*	4.0434e+004	± 4.7004e+003	± 9.4009e+003
1 <sup>st</sup> Tractor Drive	8.4041e+004	± 7.2585e+003	± 1.4517e+004
2 <sup>nd</sup> Tractor Drive	5.7362e+004	± 7.4685e+003	± 1.4937e+004
1 <sup>st</sup> Trailer	8.3169e+004	± 6.8590e+003	± 1.3718e+004
2 <sup>nd</sup> Trailer	7.8619e+004	± 6.7071e+003	± 1.3414e+004

**Average Dynamic Axle Load Range Reduction with Wide Base Tires**

25.6%

\* Steer Axle tires are XZA2 275/80R22.5 for both cases

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## Summary of Results


Average dynamic axle load range reduction with wide base tires = 25.6%

Wide base tires reduce vertical and longitudinal rms accelerations of driver by about 38% at wheel-hop frequencies (~11 Hz)

### A perspective check:

Steel frame to leaf-spring – 15 to 20%  
Leaf-spring to air-ride 20 to 25%  
Add the X One and the improvement is huge

**Comfortable and alert**

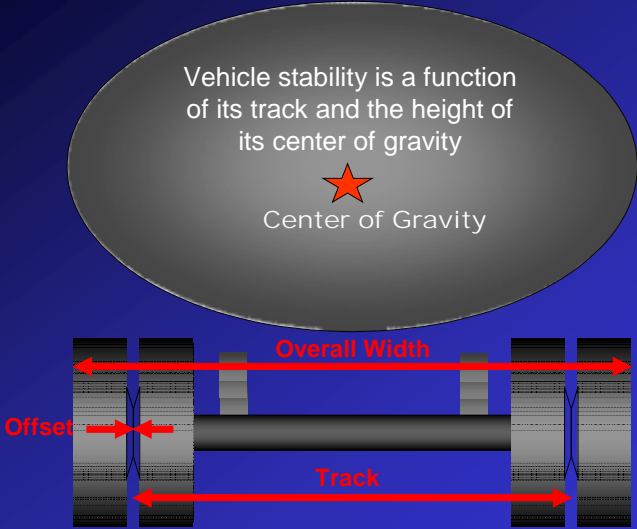


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## Stability Safety: What factors impact vehicle stability?

Vehicle stability is a function of its track and the height of its center of gravity

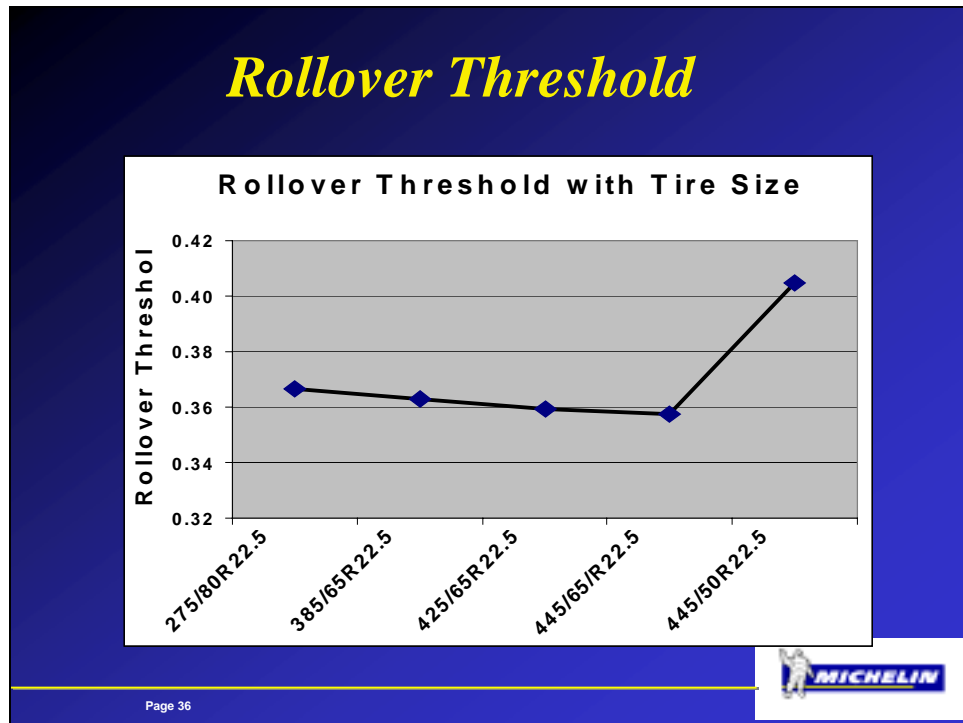
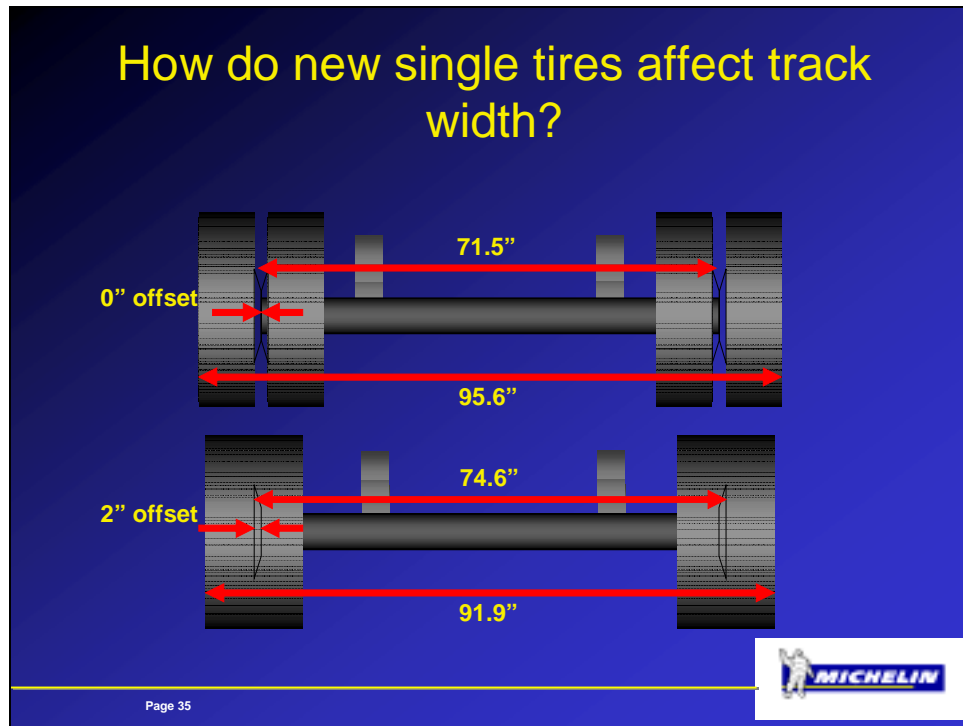
★  
Center of Gravity



The diagram illustrates the relationship between vehicle stability, track, and center of gravity. It shows a top-down view of a vehicle chassis with four wheels. A red star marks the center of gravity. Three red double-headed arrows indicate: 'Overall Width' (the distance between the outer edges of the front and rear wheels), 'Track' (the distance between the inner edges of the front and rear wheels), and 'Offset' (the distance from the center of the track to the center of the vehicle chassis).



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## Aquaplaning Safety

**Fig. 1 Contact stress between the tire and the road for dual and single tires for fully loaded vehicle**

Tire No.	Single Empty Tire	Single Full	Dual Full
1	~100	~100	~100
2	~100	~100	~100
3	~100	~100	~100
4	~100	~100	~100
5	~100	~100	~100
6	~100	~100	~100
7	~100	~100	~100
8	~100	~100	~100

Hydroplaning happens with 0 load several times the force required for X Ones

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## What New Generation Single Tires Deliver

Improved efficiency

- Minimum 4% on fuel
- Weight savings ~ 200 lbs/axle
- Maintenance

Improved safety

- Alertness
- Stability
- Aqua traction

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## Make the world a better place?

Some numbers

- 18 billion
- 6.8 billion
- 4%
  - 273 million
  - 46,600 kgs
  - 640 kgs

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## Equality for New Generation single tires

Facts:

- Impact neutral at the subgrade
- Impact positive at the HMA for summer conditions
- Impact negative at the HMA for spring thaw conditions
- Impact positive for all conditions due to matched pressures

Overall new generation singles are impact positive and they will help us save the world

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## Challenge

Fact:  
Old generation singles have a huge negative impact.

Fact:  
If full equality is given single tires there is a likelihood of old generation single tires being used.

- Traditional single tires are more complex to install on existing vehicles and do not deliver the same advantages as the new generation singles
- Do we need to differentiate?



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