Michelin Truck and Bus Tyre

Service Manual

Edition 2009 Asia Pacific

MICHELIN

A better way forward

SAFETY WARNINGS

BE SURE TO READ THE SAFETY INFORMATION PROVIDED HEREIN AS SERIOUS INJURY OR DEATH CAN RESULT FROM FAILURE TO FOLLOW SAFETY WARNINGS

WARNING: Tyre and rim servicing can be dangerous and must be done only by trained personnel using proper tools and procedures. Failure to read and comply with all procedures may result in serious injury or death to you or others.

WARNING: Re-inflation of any type of tyre and rim assembly that has been operated in a run-flat or underinflated condition (80% or less of recommended operating pressure) can result in serious injury or death. The tyre may be damaged on the inside and can explode while you are adding air. The rim parts may be worn, damaged or dislodged and can explosively separate.

WARNING: Use of gasoline, petrol or any other flammable material to lubricate, seal or seat the beads of a tyre can cause the tyre to explode or can cause the explosive separation of the tyre/rim assembly resulting in serious injury or death. The use of any flammable material during tyre servicing is absolutely prohibited.

WARNING: Any inflated tyre mounted on a rim contains explosive energy. The use of damaged, mismatched or improperly assembled tyre/rim parts can cause the assembly to burst apart with explosive force. If you are struck by an exploding tyre, rim part or the air blast, you can be seriously injured or killed.

WARNING: Re-assembly and inflation of mismatched rim parts can result in serious injury or death. Just because parts fit together does not mean they belong together. Check for proper matching of all rim parts before putting any parts together.

WARNING: Mismatching tyre and rim diameters is dangerous. A mismatched tyre and rim assembly may explode and can result in serious injury or death. This warning applies to any combination of mismatched components. Never assemble a tyre and rim unless you have positively identified and correctly matched the parts.

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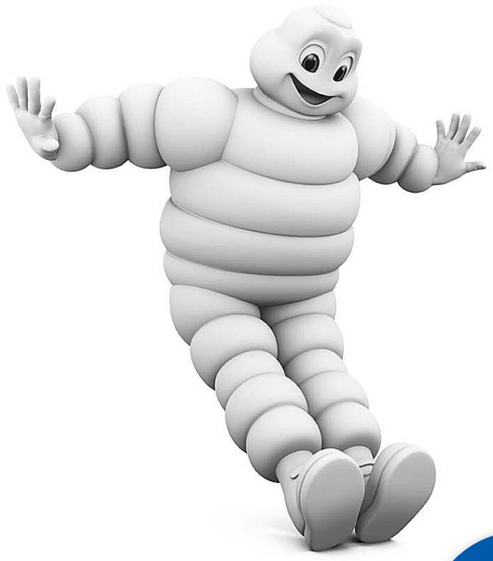
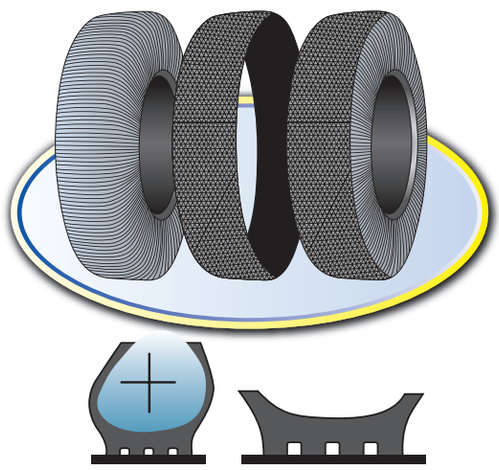


Tyre Selection Section One

Why The Michelin Radial?

Michelin introduced a new era in driving comfort with the radial tyre.



1. The body ply cords in a Michelin casing are laid radialy to the bead, a design feature that makes the tyre's walls extremely flexible. These supple walls "give" under load, absorbing unevenness in the road surface, resulting in a smoother ride.
2. Another innovation is the belt around the crown of the casing that braces and stabilizes the tread, helping to improve contact between the vehicle and the road, and to reduce unwanted movement in the tread-road contact area.
3. In other words, the two major features are its radial wall and tread bracing belts, which perform their functions independently.

When using the proper tyre pressure for the load conditions, the Michelin tyre offers increased fuel and cost efficiency, better road handling and ride comfort, and reduced downtime.

Fuel Efficiency: The steel braced tread and radial casing result in lower rolling resistance and less heat build up from internal friction when the tyre is in motion. This combination translates into lower fuel bills and extended casing life.

Lower Cost-Per-Mile: The radial construction of the Michelin tyre reduces friction and heat build up inside the tyre, delaying casing deterioration. This, combined with the radial's proven tread life advantages, helps provide a lower overall cost per kilometer. In addition, the retreadability of the Michelin truck tyre is a significant cost saver.

Road Handling: A Michelin radial tyre has sure footed grip on the road; its footprint is solid; its sidewalls and its tread work independently, and its contact area on the ground is not distorted. Improved road handling means greater dependability and performance.

Comfort: By its construction, a radial tyre deflects under load and this flexibility helps to cushion shocks and give a smoother ride.

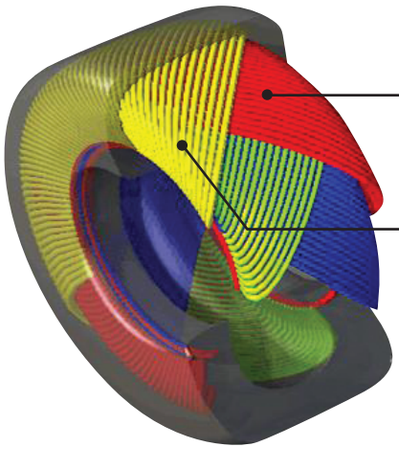
Reduced Down Time: The steel belts and protector ply help protect against punctures.

Repairability: Proper repairs within specifications can place the tyre back into service, lowering cost.

Regrooveability: Michelin tyres are designed with an undertread compound that is thick enough to allow high quality regrooving. This extends the life of the tread and contributes to improved tyre grip and lower fuel consumption.

Comparing Radial To Bias Ply

Bias or Cross-Ply Tyre:



The casing

is made up of several crisscross plies.

The crown

is not stabilized.

The crown and sidewall are formed by the same ply structure.

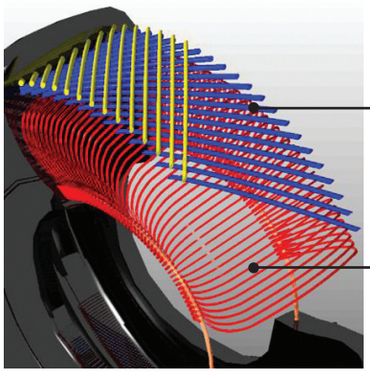
The tread is subjected to any flexing which occurs and this causes :

- deformation of the tyre contact area on the ground
- friction with the ground.

The casing plies tend to "scissor" in relation to each other. As a result, there is :

- Accelerated wear
- Poor grip
- High fuel consumption
- Fair road holding
- High heat built up
- Prone to crown punctures

Radial Tyre:



The crown

is stabilized by a belt made up of several plies.

The casing

has only one radial ply.

The sidewall and tread areas function separately.

The tread is unaffected by the flexing of the sidewalls, so there is :

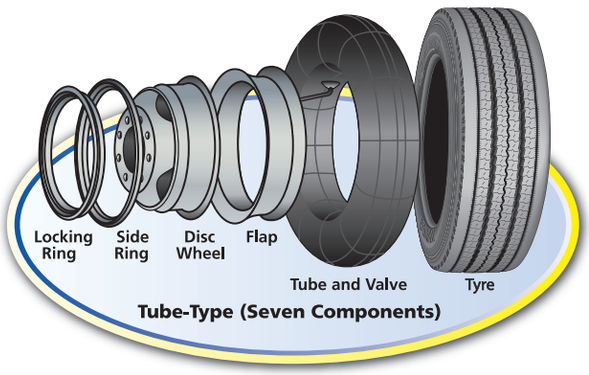
- less deformation of the tyre contact area on the ground
- less friction with the ground. There is no movement between casing plies.

Advantages :

- Longer tyre life
- Excellent grip
- Reduced braking distances
- Even ground pressure over the whole contact area. This provides excellent flotation.
- Lower fuel consumption
- Smoother and better road holding
- Cool running : giving added safety
- Excellent protection against punctures

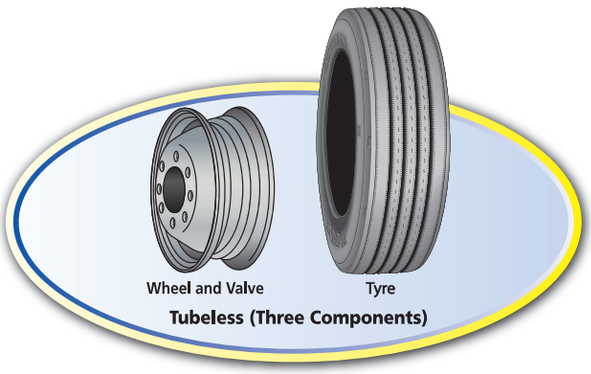
Tubeless Versus Tube-Type Tyres

The original design of a truck tyre required the use of a separate tube made of a different type of rubber designed to keep the air in the tyre and thus maintain the tyre pressure. Development of more sophisticated tyres led to the tubeless tyre which integrated the tube within the tyre construction process and eliminated the need for a separate tube. This technology advance simplified the fitting in both required components and effort required to fit the tyre to a wheel.



Tubeless Advantages:

- Ease of mounting
- Improved balance of tyre/wheel
- Better stability (lower aspect ratio)
- Reduction of run flats
- Improved brake drum ventilation leading to cooler brakes
- Fewer parts to inventory
- Safer - no risk of mis-matching multi-piece wheel parts
- Reduced cost of labor and maintenance
- Reduction of vehicle downtime
- Reduction of wheel and tyre weight



Which Michelin Tyre Is Right For You?

Michelin uses specific names to identify the most appropriate use of each tyre.

Principles of *MICHELIN* Tyre Naming

X	Z	U	3
MICHELIN Radial Technology	Tyre Position	Usage Segmentation	Product Evolution

Tyre *Position* Naming

Z	F	D	T
All positions	Front axle	Drive axle	Trailer axle

A — *Long Distance - Straight Highway*

Smooth and even surface, low cornering, high tyre mileage
Vehicles traveling long distances with minimum stops (normally involves high percentage of motorway use and limited acceleration and braking).

E — *Long Distance And Regional Operations*

Mixed motorway, all types of local and country roads with cornering, average tyre mileage
Vehicles traveling long distances predominantly using national roads with frequent acceleration and braking.

U — *Urban And Suburban*

Public transportation, delivery, variable mileage
Use in built-up areas with frequent starts and stops (local bus, municipal, utilities...).

Y — *On/Off Road*

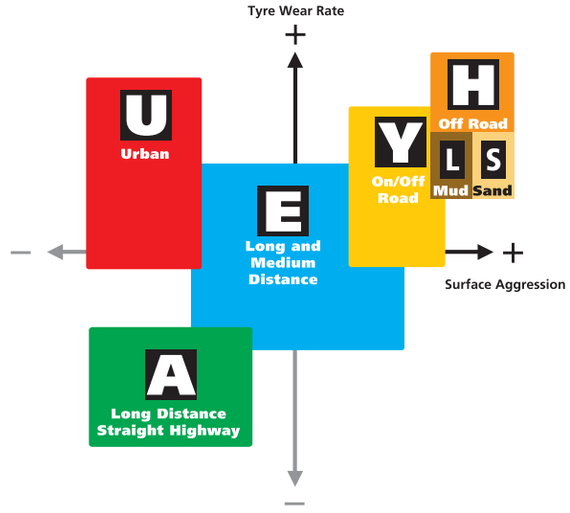
Mixed application, on/off road, aggressive surface, construction site access
Normally short distances on all road types when access to loading or unloading locations may be difficult.

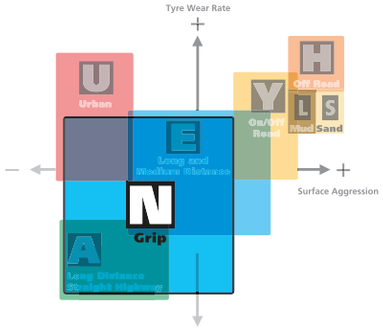
H — *Off Road (Quarries)*

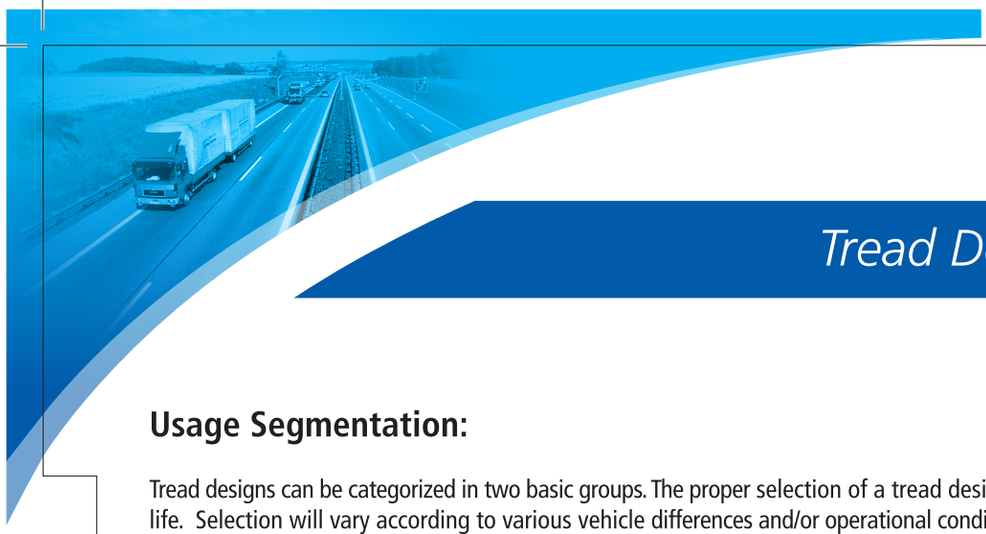
Off road, repeated aggressions
Vehicles which essentially work on sites where off-road traction and resistance to crown and sidewall aggressions is a necessity.

N — *Grip (Wet And All season)*

All types of roads (covering A, E, U segment).







Tread Design Considerations

Usage Segmentation:

Tread designs can be categorized in two basic groups. The proper selection of a tread design will enable the user to maximize tread life. Selection will vary according to various vehicle differences and/or operational conditions. Tyre tread mileage can be maximized or shortened depending on the tread design chosen.

Rib Tread Design:

- Characterized by grooves placed parallel to the bead, thus forming ribs.
- Usually significantly better for fuel economy, although does not provide enhanced wet or snow traction.
- Usually found on the steering axle and on other free rolling axles such as trailer, tag, pusher and dolly axles.
- Also placed on torque axles when traction is not a high priority.

Block Or Lug Tread Design:

- Characterized by grooves placed laterally and perpendicular to the bead.
- Selected primarily for traction and improved mileage.
- Usually found on the drive or torque axle.
- The increased tread depth is needed to offset the scrubbing and/or spinning that can occur when power is transmitted to the drive axle.

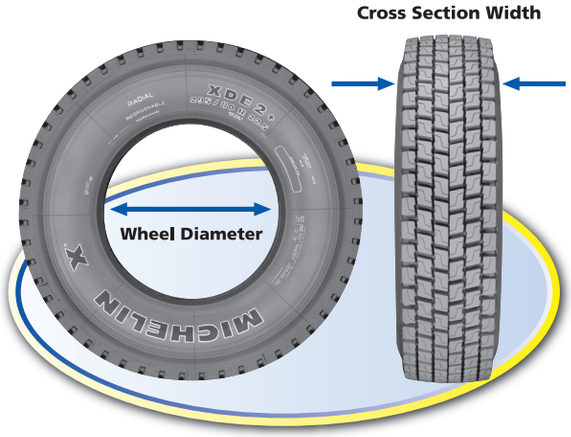
Due to constant innovation and development, the types and sizes of Michelin tyres are always changing. For the most current product offerings, please also refer to the product line brochures and technical data book.

Determining Michelin Tyre Size

1 Tyre Size: Michelin radial truck tyre sizes are designated by the nominal section width in inches or millimeters and the rim diameter (i.e. 11R22.5 or 295/80R22.5). The "R" indicates a radial tyre. Truck tyres sizes are marked in accordance with industry (ETRTO, T&RA) and ISO (International Standardization Organization) system and contain dimension and load index information. This index indicates the load capacity of the tyre in single and in dual usage (i.e. 144/141K). See page 12 for complete ISO load index. Below are examples for tubeless and tube-type tyres.

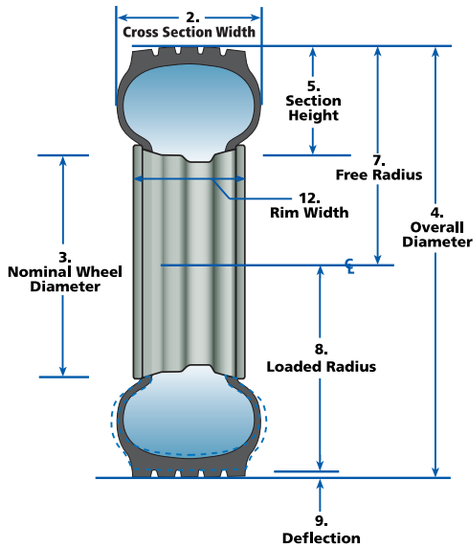
Example: 295/80R22.5

295 = cross section width in millimeters
80 = aspect ratio
R = radial
22.5 = rim or wheel diameter in inches



Example: 10.00R20

10.00 = cross section width in inches
R = radial
20 = rim or wheel diameter in inches



2 Cross Section Width: The maximum width (cross section) of the unloaded tyre including protruding side ribs and decorations as measured on the preferred rim.

3 Wheel Diameter: Diameter of rim seat supporting the tyre bead given in nearest half inch numbers, i.e. 22.5".

4 Overall Diameter: The diameter of the unloaded new tyre (measured from opposite outer tread surfaces).

5 Section Height: The distance from rim seat to outer tread surface of unloaded tyre.

6 Aspect Ratio: A nominal number, which represents the section height, divided by the section width and expressed as a percentage. Aspect ratio is sometimes called Series.

Example: Tyre Size Aspect Ratio

11R22.5 = 90 Series
275/80R22.5 = 80 Series
455/55R22.5 = 55 Series

7 Free Radius: One half the overall diameter of the unloaded new tyre.

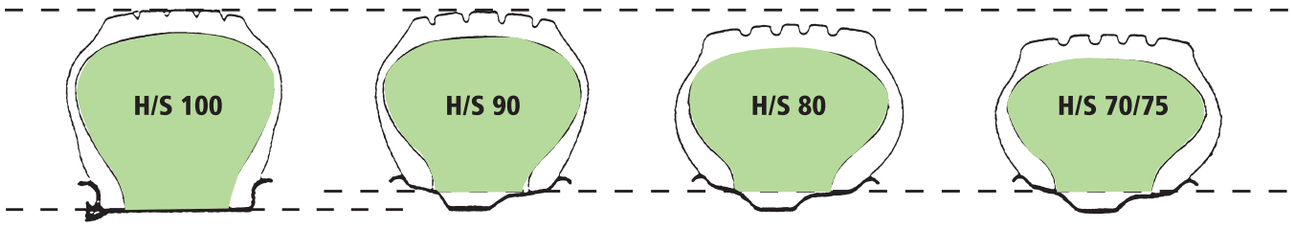
8 Loaded Radius: The distance from the wheel axle centerline to the supporting surface under a tyre properly inflated for its load according to the load and inflation tables found in the Technical Data Book.

9 Tyre Deflection: Free radius minus the loaded radius.

10 Minimum Dual Spacing: The minimum allowable lateral distance from tyre tread centerline to tyre tread centerline in a dual wheel arrangement.

11 Rolling Circumference: Distance traveled by the tyre during one complete revolution. Data is normally presented for the loaded tyre at its rated load and inflation in the drive position.

12 Rims: The approved rims are designated for each size tyre. Michelin tyres should only be mounted on the rims shown. The rim shown first is the preferred rim. Be sure to check rim manufacturers' specifications.



Tube–Type **Tubeless** **Tubeless** **Tubeless**

Recent developments in the transportation industry include the use of lower aspect ratio tyres on commercial vehicles. These tyres provide several advantages including better handling in an emergency situation and lower weight which can result in better fuel economy.

Positive	Negative
• better handling • good stability of vehicle • regular wear • outstanding retreadability (80 series) • lighter weight	• more sensitive to road hazard/impact (70 series and lower) • less comfort (70 series and lower)

Table of Equivalent Tyre Sizes:

100 Series	90 Series	Low Profile Series
7.50 R 15		215/75 R 17.5
8.25 R 15	9 R 17.5	235/75 R 17.5
10.00 R 15		285/70 R 19.5
7.00 R 16	8 R 17.5	205/75 R 17.5
7.50 R 16	8.5 R 17.5	215/75 R 17.5
		225/75 R 17.5
		225/80 R 17.5
8.25 R 16	9.5 R 17.5	235/75 R 17.5 245/70 R 19.5
	10 R 17.5	
	225/90 R 17.5	
7.5 R 20	8 R 22.5	
8.25 R 20	9 R 22.5	
9.00 R 20	10R 22.5	255/70 R 22.5
		275/70 R 22.5
10.0 R 20	11 R 22.5	295/80 R 22.5
		275/80 R 22.5
		275/70 R 22.5
11.00 R 20	12 R 22.5	295/80 R 22.5
		315/80 R 22.5
		305/70 R 22.5
		315/70 R 22.5
12.00 R 20	13 R 22.5	315/80 R 22.5

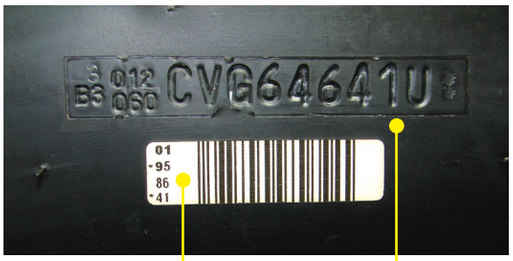
Truck Tyre Marking

Cross Section Width | Aspect Ratio (or series) | ISO Load/Speed Index | Tread Design | Radial | Rim Diameter

Example:

Tyre Size: 295/80R22.5
Cross Section width: 295 mm Aspect Ratio : 80
ISO Load/Speed Index: 152/148 M (see Page 12)
Tread Design: XZE 2+ (Michelin designation for tread pattern)
Rim Diameter: 22.5 inches

Tyre serial number and DOT (U.S. Department of Transportation) markings:

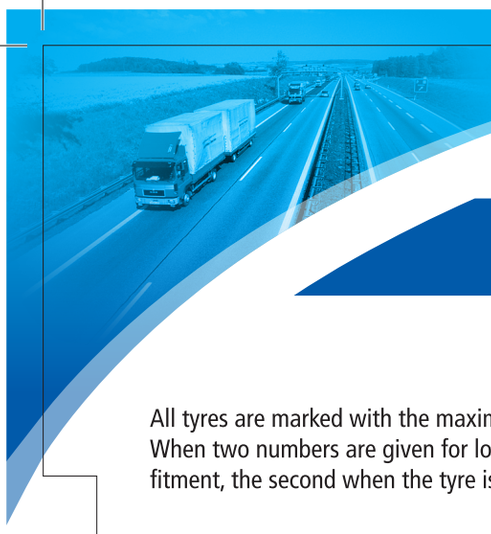


Bar Code | Serial Number

Plant Code | Production Date Code

DOT Example:

Plant Code - two character code assigned to manufacturing plant (Michelin Asia factories: 3L = Thailand; 7V = China)
Production Date Code - First two characters represent the week, the last two represent the year. Example 2007 = 20th week of 2007



ISO Load and Speed Index

All tyres are marked with the maximum load and speed capacity. These load and speed indices are shown in the following tables. When two numbers are given for load as in the case of 152/148, the first number represents the tyre load when operated in a single fitment, the second when the tyre is fitted in twin.

Load Capacity Index (LI)

LI	kg	LI	kg	LI	kg
115	1,215	138	2,360	161	4,625
116	1,250	139	2,400	162	4,750
117	1,285	140	2,500	163	4,875
118	1,320	141	2,575	164	5,000
119	1,360	142	2,650	165	5,150
120	1,400	143	2,725	166	5,300
121	1,450	144	2,800	167	5,450
122	1,500	145	2,900	168	5,600
123	1,550	146	3,000	169	5,800
124	1,600	147	3,075	170	6,000
125	1,650	148	3,150	171	6,150
126	1,700	149	3,250	172	6,300
127	1,750	150	3,350	173	6,500
128	1,800	151	3,450	174	6,700
129	1,850	152	3,550	175	6,900
130	1,900	153	3,650		
131	1,950	154	3,750		
132	2,000	155	3,875		
133	2,060	156	4,000		
134	2,120	157	4,125		
135	2,180	158	4,250		
136	2,240	159	4,375		
137	2,300	160	4,500		

Speed Category Symbols

Speed symbol	Speed in km/hr	MPH approx
A1	5	3
A2	10	6
A3	15	9
A4	20	12
A5	25	16
A6	30	19
A7	35	22
A8	40	25
B	50	31
C	60	37
D	65	40
E	70	43
F	80	50
G	90	56
J	100	62
K	110	68
L	120	75
M	130	81
N	140	87

Example:

A tyre with ISO load/speed index of 152/148M is designed to carry 3,550kg when fitted as a single or 3,150kg if fitted in twin. The maximum speed at which this tyre is rated is 130kph.

Some tyres are also marked with a second ISO rating known as Unique Point and is situated after the principal load/speed index as shown below. This load and speed capacity is provided for certain special circumstances.

152/148 M 153 / 150 J

All the information required to determine the proper tyre size is contained in the technical data book. A sample is shown below. To select the proper tyre size for a vehicle, it is necessary to know the maximum axle wheel end loads that the tyres will carry and the maximum continuous speed at which they will operate. The maximum load that a tyre can carry is different if it is mounted in dual configuration rather than single. The allowable axle loads and the required inflation pressures to carry these loads are shown in the charts for both single and dual mountings.

Specifications for 11R22.5 XZE2+

Type	PR (Ply rating)	Load / Speed index	Unique point	Nominal pressure for unique point (bar)	Nominal load per axle (single) (kg)	Nominal pressure for load (single) (bar)	Nominal load per axle (dual) (kg)	Nominal pressure for load (dual) (bar)	Maximum section width in service (mm)	Maximum diameter in service (mm)	Rolling circumference (mm)	Approved rim(s) ETRTO	Laden section width (mm)	Free section width (mm)	Diameter (mm)	Static laden radius (mm)	Rolling circumference (mm)	Minimum dual spacing (mm)	Recommended rim(s) by MICHELIN	Tube	Flap L/LB	Flap 2000	Seal
TL	16	148/145L			6300	8.00	11600	8.00	290	1070	3203	7.50-8.25	294	264	1057	490	3220	299	7.50				

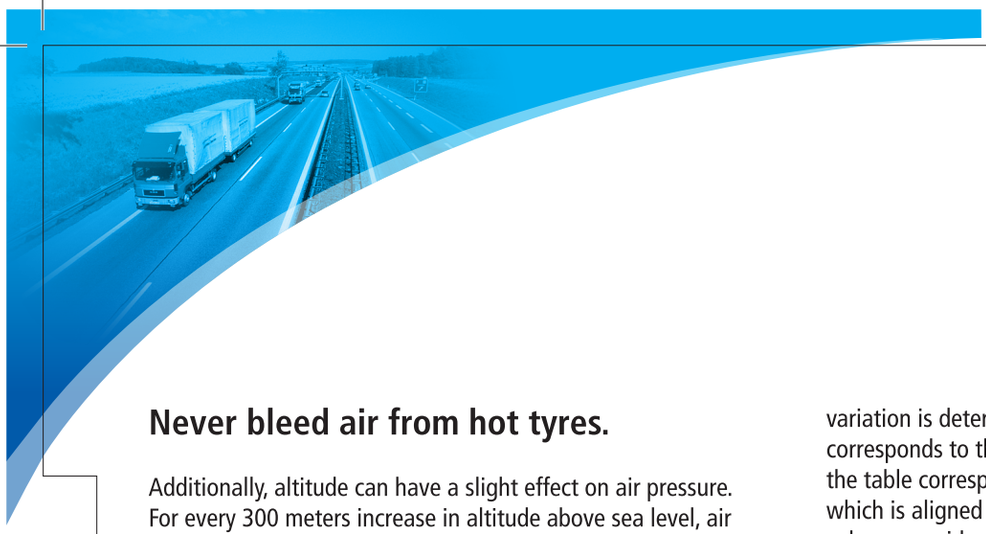
LOADS PER AXLE AND INFLATION PRESSURES

Table of Inflation Pressure (bar) in relation to maximum load per axle (kg)																			
psi	65	69	73	76	80	83	87	91	95	98	102	105	109	112	116	120	124	127	130
bar	4.50	4.75	5.00	5.25	5.50	5.75	6.00	6.25	6.50	6.75	7.00	7.25	7.50	7.75	8.00	8.25	8.50	8.75	9.00
single			4140	4320	4500	4680	4860	5040	5220	5400	5580	5760	5940	6120	6300				
dual			7620	7950	8290	8620	8950	9280	9610	9940	10270	10610	10940	11270	11600				

The carrying capacity of each tyre size is tabulated for various inflation pressures by axle load for single applications (2 tyres) and dual applications (4 tyres). Due to the effects of load distribution, bouncing and crowned roads, the four tyres in dual may not equally share the axle load. Therefore, to protect the tyre carrying the largest share of the load, the capacity for duals is not twice the capacity for a single formation, but is usually between 5 and 13% less depending on tyre size. Ensure that the air pressure between the dual tyres and/or axles does not differ by more than 10 psi. Also ensure tyres run in dual are within 8mm diameter to ensure equal loading.

WARNING: All vehicles should be weighed, fully loaded, on a scale. Each axle must be weighed separately. Actual gross axle weights should be compared with the load and inflation tables to determine the inflation pressure required. If the maximum load carrying capacity of the tyre is below the actual scale weight, then a tyre with greater carrying capacity should be used. This means either a tyre with a higher load capacity or a larger tyre size. If the maximum load can be carried by the minimum pressure (as listed on the Load Inflation Chart), then a smaller size tyre or a lower capacity tyre may be considered depending on the application and conditions of use of the vehicle.

Never reduce air pressure below minimum data book specification without consulting Michelin. Ambient temperature will affect the air pressure within the tyre. For every 6 degree temperature change, pressure readings will change between 1 and 2 psi. Consider this when checking pressures. All tyres should be checked when cold - at least 3 hours after the vehicle has stopped.



Never bleed air from hot tyres.

Additionally, altitude can have a slight effect on air pressure. For every 300 meters increase in altitude above sea level, air pressure will increase approximately 1.2 psi.

Variation of the loading capacity of the tyre can be done based on the following industry standard. The possible load variation is determined by accessing the correct column which corresponds to the tyre's stated ISO speed rating. Each row in the table corresponds to a decrease in the tyre's speed rating which is aligned with the speed column for that tyre. The final column provides the required increase in air pressure in order for the tyre to safely operate at the new reduced speed and increased load.

Speed (km/h)	Variation of the loading capacity						Pressure compensation (%)
Speed (km/h) / Speed in km/hr	F	G	J	K	L	M	
0	+150	+150	+150	+150	+150	+150	+40
5	+110	+110	+110	+110	+110	+110	+40
10	+80	+80	+80	+80	+80	+80	+30
15	+65	+65	+65	+65	+65	+65	+25
20	+50	+50	+50	+50	+50	+50	+21
25	+35	+35	+35	+35	+35	+35	+17
30	+25	+25	+25	+25	+25	+25	+13
35	+19	+19	+19	+19	+19	+19	+11
40	+15	+15	+15	+15	+15	+15	+10
45	+13	+13	+13	+13	+13	+13	+9
50	+12	+12	+12	+12	+12	+12	+8
55	+11	+11	+11	+11	+11	+11	+7
60	+10	+10	+10	+10	+10	+10	+6
65	+7.5	+8.5	+8.5	+8.5	+8.5	+8.5	+4
70	+5.0	+7.0	+7.0	+7.0	+7.0	+7.0	+2
75	+2.5	+5.5	+5.5	+5.5	+5.5	+5.5	+1
80	[0]	+4.0	+4.0	+4.0	+4.0	+4.0	0
85		+2.0	+3.0	+3.0	+3.0	+3.0	0
90		[0]	+2.0	+2.0	+2.0	+2.0	0
95			+1.0	+1.0	+1.0	+1.0	0
100			[0]	0	00	0	
110				[0]	00	0	
120					[0]	0	0
130					[0]	0	

The coefficients indicated in this table correspond to those of the ETRTO standard and are only given as an indication.

When the coefficients of this table lead to pressure above 10 bars, it is necessary to reduce the maximum loading charge to the corresponding value of a maximum pressure of 10 bars. If you have to use a pressure level above 10 bars, ask our advice concerning the tyres, contact the rim manufacturer about their resistance to the highest pressure you envisage using and respect the rules and regulations in force during fitting and their use.

Michelin Durable Technologies

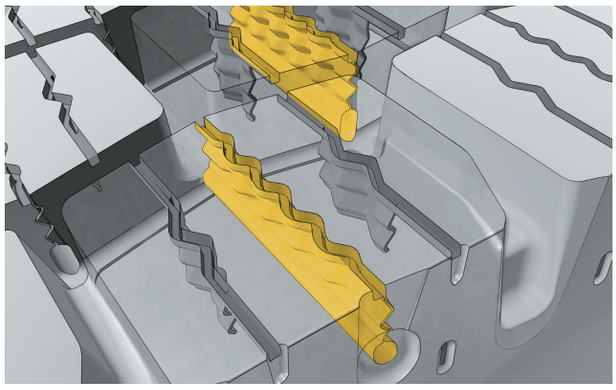
MICHELIN
Durable Technologies

Michelin Durable Technologies are a set of breakthrough technologies related to the tread pattern and architecture of the tyre which extend the performance of the tyre beyond what was possible before. These technologies are incorporated into the tyre to improve

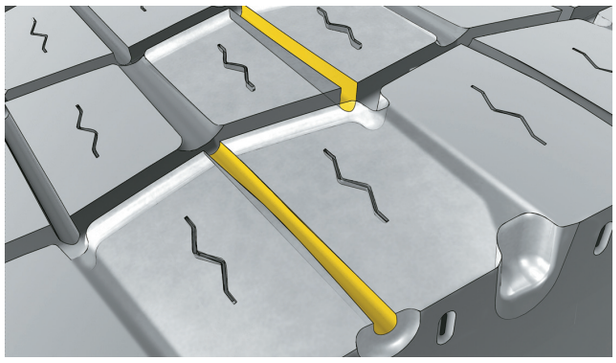
- Lifespan - better durability
- Long lasting performance - grip and road handling
- Endurance - retreadability and load capacity

Today Michelin Durable Technologies include:

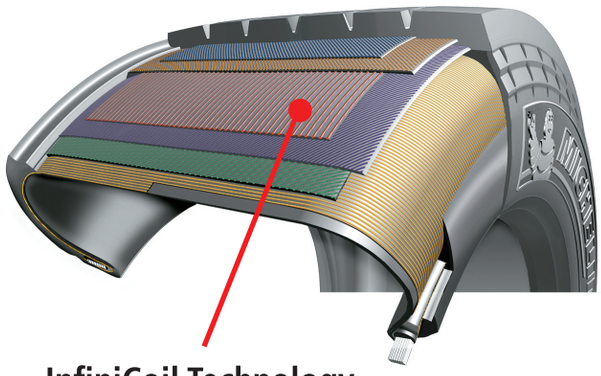
Double-wave sipes - enhance tread-block rigidity to optimize tyre mileage while delivering needed traction. As the tread block enters the contact patch, these interlocking sipes join together to form solid, rigid tread block. This locking together reduces the effect of tread block scrub as the tread leaves the contact area and provides much improved tread wear performance.



Rain drop sipes - located at the bottom of the tread groove and used in conjunction with the matrix siping, this groove provides a regeneration of the tread block pattern as the tyre reaches 2/3 worn. The creation of these new channels provides better traction and allows the end user to keep the tyres on the vehicle longer.

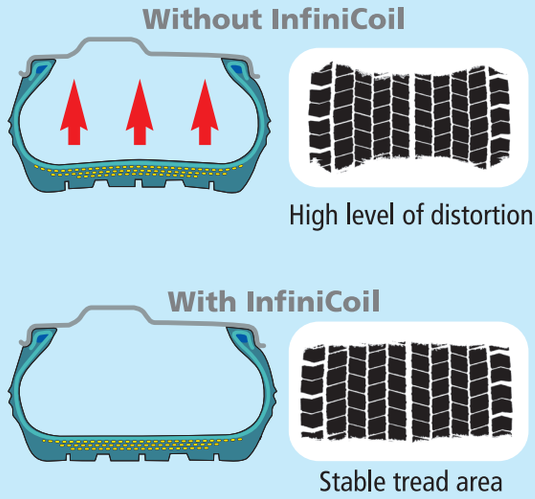


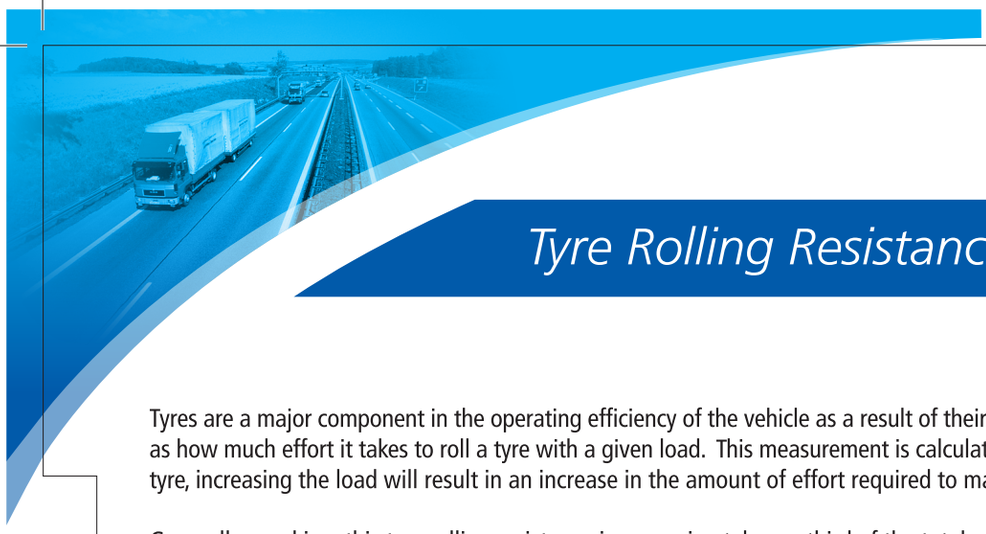
InfiniCoil - unique stabilizing belt construction that runs perpendicular to the radial ply. It provides good contact pressure between the tyre and the ground, helps extend tread life by optimizing tyre footprint loaded and unloaded and boosts crown endurance.



InfiniCoil Technology

Comparison of rolling footprints for the new X One Michelin



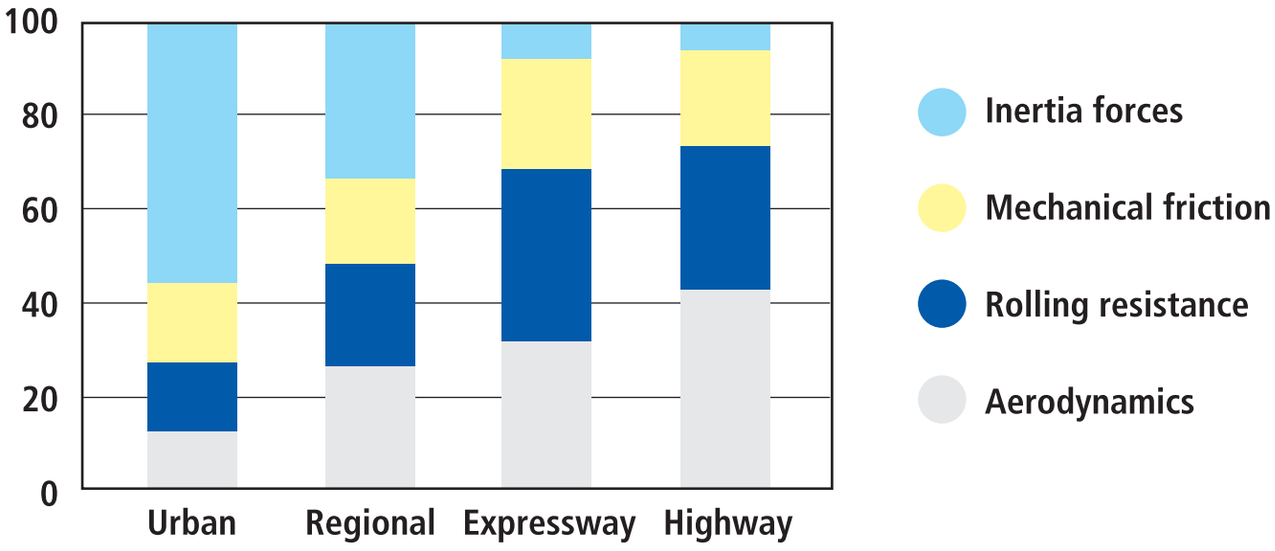


Tyre Rolling Resistance And Fuel Economy

Tyres are a major component in the operating efficiency of the vehicle as a result of their rolling resistance. Rolling resistance is defined as how much effort it takes to roll a tyre with a given load. This measurement is calculated in kilograms per ton (kg/T). For a given tyre, increasing the load will result in an increase in the amount of effort required to make that tyre roll.

Generally speaking, this tyre rolling resistance is approximately one third of the total vehicle resistance in 6x4 and 6x2 applications and as such, a change of 3% in rolling resistance approximately equals a 1% change in fuel consumption. Wind resistance and drive line friction account for the balance of the resistance.

The conditions of use play a significant role in the tyre's impact on fuel economy. As shown in the following chart, vehicles running longer distances at constant speed are more likely to show a change in fuel economy from lower rolling resistance tyres.



Other factors can impact the rolling resistance of a tyre:

Tyre wear - as the tread depth on the tyre decreases, the rolling resistance of the tyre also decreases. Tyres at removal tread depth are at their most fuel efficient state which is why regrooving is so critical to an overall tyre maintenance program.

Pressure - As the pressure decreases below that required to carry the load, the rolling resistance of the tyre increases. If the pressure is increased over that necessary for the load, there is a slight decrease in rolling resistance. Although this slight improvement in rolling resistance occurs, excessive pressure leads to much lower tread wear and casing endurance performance.

Speed - rolling resistance is near constant at speeds of 60-90 kph. Vehicle speeds above this level result in a very large increase in aerodynamic drag which can significantly decrease fuel economy.

Temperature - colder temperatures result in higher rolling resistance. When a vehicle first starts it operation for the day, the tyre will take up to one hour to fully reach a stable temperature and thus rolling resistance will decrease during this warm-up period.

Tube And Flap Size and Marking

Proper selection of tubes and flaps is essential to ensure proper performance of the tube-type tyre. The tube - made of butyl rubber - is designed to maintain the air pressure in the tyre while the flap protects the tube from chafing with the rim and prevents it from being pushed under the bead toe. Fitting the tube and flap properly is an essential step in the process and will be covered in detail later in this manual.

Tube and Flap Selection by Tyre Size

Tyre size	Std Rim Width (inch)	Tube size	Flap size	
			Flap + with metallic reinforcement	Flap with chafer reinforcement
7.00 R 16	5.50	16J	-	150-16
7.50 R 16	6.00	16J	-	16X6.50
8.25 R 16	6.50	16J	-	16X6.50
9.00 R 20	7.00	20M	20X7.50	200-20L
10.00 R 20	7.50	20N	20X7.50	200-20L
11.00 R 20	8.00	20P	20X8.50	220-20L
12.00 R 20	8.50	20Q	20X8.50	220-20L

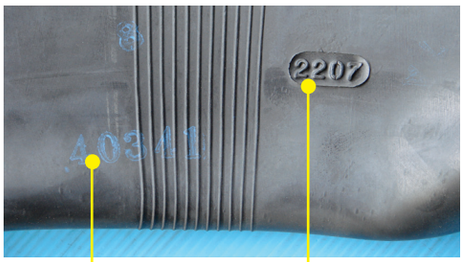
Flap types: There are currently two types of Michelin flaps

1. **Flap Classic** with 'nylon chafer' reinforcement of the valve hole area.

2. **Flap +** with a metal plate reinforcement.

Tube Markings

Dimension



Serial Number

DOT

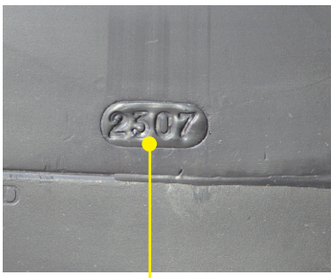
Valve

Example:

Tube Dimension - 20N78 (20N fitted with TR78A valve)
Tube Serial Number - 40341
Tube Date of Production - 22nd week of 2007
Valve number - TR78A

Flap Markings

Dimension



DOT

Example:

Flap Dimension - 16 x 6.50
Flap Date of Production - 23rd week of 2007

Servicing The Tyre

Section Two

WARNING: Tyre and rim servicing can be dangerous and must be done only by trained personnel using proper tools and procedures. Failure to read and comply with all procedures may result in serious injury or death to you or others. Re-inflation of any tyre and rim assembly that has been operated in a run-flat or underinflated condition (80% or less of recommended operating pressure) can result in serious injury or death. The tyre may be damaged on the inside and can explode while you are adding air. The rim parts may be worn, damaged or dislodged and can explosively separate. A tyre run underinflated should not be returned to service until the interior is carefully inspected.

Guide to tyre inflation:

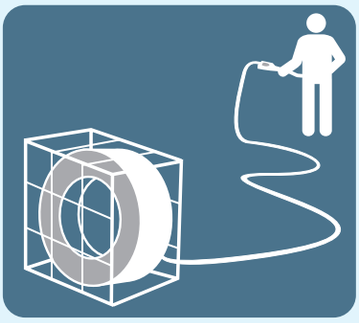
Without inflation cage

The tyre must be inflated in two stages.

- **1st stage:**
  - Pre-inflate up to 1.5 bar (20 psi)
  - General inspection of the tyre: if there is any blistering, distortion or any doubt, the tyre must be removed and inspected by a specialist.

- **2nd stage:**
  - Inflate to the correct pressure.
    To protect him/herself from any blow-out that may occur, the operator should be positioned in line with the tread pattern, at a minimum distance of 3 metres.

Throughout inflation:
- The tyre must be standing vertically in a fitting area.
- The operator must be equipped with hearing protection.



With inflation cage

Follow the maker's instructions. The cage must be placed in a clear area.

WARNING: Any inflated tyre mounted on a rim contains explosive energy. The use of damaged, mismatched or improperly assembled tyre/rim parts can cause the assembly to burst apart with explosive force. If you are struck by an exploding tyre, rim part or the air blast, you can be seriously injured or killed.

WARNING: Re-assembly and inflation of mismatched parts can result in serious injury or death. Just because parts fit together does not mean that they belong together. Check for proper matching of all rim parts before assembly. Mismatching tyre and rim components is dangerous. A mismatched tyre and rim assembly may explode and can result in serious injury or death. This warning applies to any combination of mismatched components and rim combinations. Never assemble a tyre and rim unless you have positively identified and correctly matched the parts.

Welding

Wheels or rims should not be repaired by welding. If a welding operation has to be undertaken, the tyre must be removed from the rim. If this is not done, there is a serious risk of explosion. The tyre should only be refitted when all items have returned to ambient temperature. Before any welding on the vehicle chassis or at proximity of the tyres, the tyre and wheel assemblies should be removed from the vehicle.

Tyre Inspection

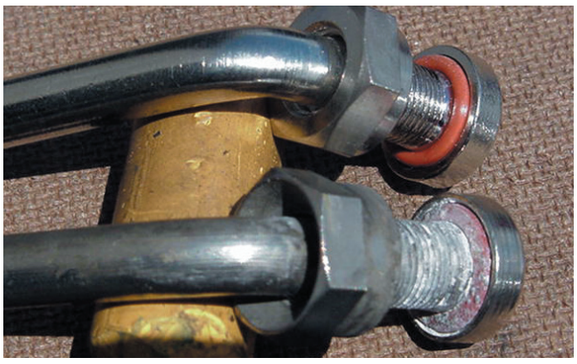
A visual inspection of a previously used tyre should always include a thorough inspection of both sidewalls and innerliner, as this may reveal any potential damage condition that would cause the tyre to become scrap. Examine the innerliner for creases, wrinkling, discoloration or insufficient repairs, and examine the exterior for signs of bumps or undulations, as well as broken cords.

WARNING: Never inflate or re-inflate any tyres that have been run underinflated or flat without careful inspection for damage, inside and out.

Mounting:

1. The wheel should be checked for any damage and bead seating surfaces cleaned of any rust or build-up of foreign matter. Check the rim flanges for excessive wear by using the wheel manufacturer's flange wear indicator.

2. Replace valve core and inspect valve stem for damage and wear. Check the condition of the rubber grommet on the valve body and replace as necessary. To prevent galvanic corrosion on aluminum wheels, lubricate the threads and o-ring of the valve stem with non-water based lubricant before installation.



3. Apply tyre lubricant to all surfaces of the rim and bead area of the tyre. When applying lubricant to the rim, lubricate the entire rim surface from flange to flange. The tyre should be mounted and inflated before the lubricant dries.

4. With short ledge up, lay the tyre over the rim opposite the valve side and work it on with proper tubeless tyre tools, making full use of the drop center well. Drop center wheels are typically designed with an off-set drop center to accommodate wheel width and brake clearance. This creates a "short side" and a "long side" on the wheel. (Some drop center wheels are designed with a symmetric rim profile facilitating tyre mounting from either side.) It is imperative that the tyre always be mounted and dismounted only from the short side. Failure to do this will likely result in damaged tyre beads that could eventually cause rapid air loss due to casing rupture. Care should be taken to ensure that any internal monitoring system molded in the tyre or on the rim is not damaged or dislodged during this service.

WARNING: Use of any flammable material such as petrol or diesel to lubricate, seal or seat the beads of a tyre can cause the tyre to explode or can cause the explosive separation of the tyre/rim assembly resulting in serious injury or death. The use of any flammable material during tyre servicing is absolutely prohibited.

1. Correctly position and properly torque the valve stem.

2. Fully lubricate both flanges and the drop center.

3. Fully lubricate both beads including inside the tip of the bead toe.

4. Place rim in correct position, short side up.

5. Do not use your knee to place the tyre, use the proper tools.

6. Work first bead on with proper tubeless tyre tools. The bead in the drop center.

7. Mount second bead using same method.

Demounting:

1. If still fitted on the vehicle, completely deflate the tyre by removing the valve core. In the case of a dual assembly, completely deflate both tyres before removing them from the vehicle. Run a stiff wire through the valve stem to ensure complete deflation.

2. With the tyre assembly lying flat (after deflating the tyre), break the bead seat of both beads with a bead breaking tool. Striking a wheel/rim assembly with a hammer of any type can damage the tyre or wheel and endanger the fitter. Use a steel duck billed hammer only as a wedge. Do not strike the head of a hammer with another hard faced hammer – use a rubber rim mallet.

3. Apply the vegetable-based lubricant to all surfaces of the bead area of the tyre.

4. Beginning at the valve, remove the tyre from the wheel. Make certain that the rim flange with the tapered ledge that is closest to the drop center is facing up. Insert the curved ends of the tyre irons between the tyre and rim flange. Step forward into the drop center and drop the bars down, lifting the tyre bead over the rim flange. Hold one tyre iron in position with your foot. Pull the second tyre iron out and reposition it a few centimeters from the first iron. Pull the second tyre iron towards the center of the wheel. Continue to work tools around rim until first bead is off the rim.

5. Turn the assembly over, use the levers to lift the wheel then push it free from the top bead.

1. Use a Slide Hammer .

2. Or a Duck Bill Hammer with a Rubber Rim Mallet as a wedge .

3. Lubricate both beads completely to avoid demount damage.

4. Be sure to start at the valve.

5. Step forward into the drop center laying the bars down.

6. Progresssively work around the rim until the first bead is off the rim.

7. Completely unseat the first bead.

8. Failure to work with small sections on a non-lubricated tyre may result in unnecessary damage to the bead.

9. Turn assembly over, insert levers between bead and wheel then lift wheel to expose the bottom bead.

10. Engage the slotted end of the levers on the rim flange and lift the rim past the top bead.

USING AUTOMATED TYRE CHANGING MACHINE

There are several tyre changing machines available for the mount and demount procedure. Consult the manufacturer's user manual for the machine you are using as each operates differently. Full lubrication of the wheel and beads is still required. Most of these machines generate a great deal of force and can damage the tyre bead if used improperly.

Directional Tyre Considerations

Truck tyres featuring directional tread designs have arrows molded into the shoulder or edge of the outer ribs to indicate the intended direction of tyre rotation. It is important, to maximize tyre performance, that directional tyres be mounted correctly on wheels to ensure that the directionality is respected when mounted on the vehicle. For example, when mounting directional drive tyres on a set of 8 wheels use the drop centers as a reference. Four tyres should be mounted with the arrows pointing to the left of the technician and four tyres with the arrows pointing to the right. This ensures that when the assemblies are fitted onto the vehicle that all tyres can be pointed in the desired direction of rotation.

Once directional tyres are worn greater than 50%, there is generally no negative effect of running them in a direction opposite to the indicated direction of rotation.

Operating directional tyres from new to 50% worn in the opposite direction of that indicated on the tyre will result in the premature onset of irregular wear, excessive noise levels and significantly reduced tread life.

Tyre And Rim Lubrication

It is essential that an approved tyre mounting lubricant be used. Preferred materials for use as bead lubricants are vegetable based and mixed with proper water ratios per manufacturer's instructions. Never use antifreeze, silicones, or petroleum-base lubricants as this will damage the rubber. Lubricants not mixed to the manufacturer's specifications may have a harmful effect on the tyre and wheel.

The lubricant serves the following three purposes:

- Helps minimize the possibility of damage to the tyre beads from the mounting tools.
- Helps ease the fitting of the tyre on to the rim by lubricating all contacting surfaces.
- Assists proper bead seating (tyre/rim centering) and helps to prevent eccentric mountings.

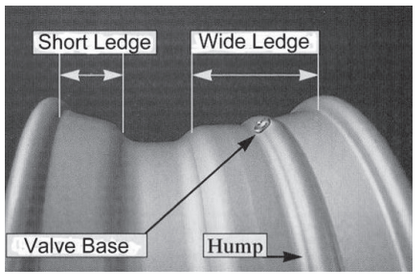
The Michelin product, Tiger Grease 80, is specifically formulated for commercial truck tyre mounting. It can be obtained through any authorized Michelin Truck tyre dealer.

WARNING: It is important that tyre lubricant be clean and free of dirt, sand, metal shavings or other hard particles.

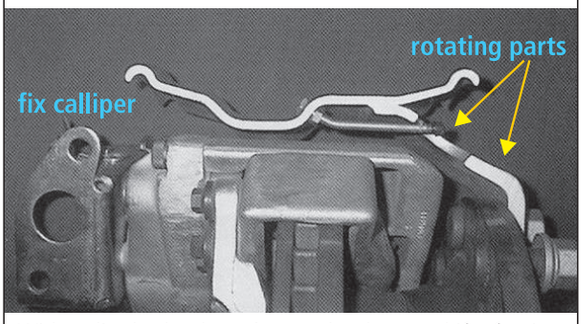
Avoid using excessive amounts of lubricants.

Fitting Tyres On Protected Valve Wheels

A new type of wheel has been introduced on the market which provides protection to the valve from damage when fitted on disc brake systems. This wheel features a safety hump which makes it very difficult to unseat or "break" the first bead.

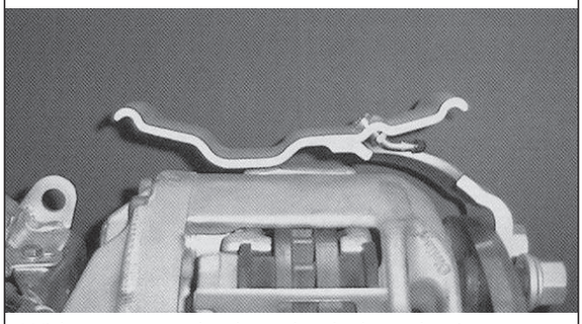


Disc Brake with Standard Wheel



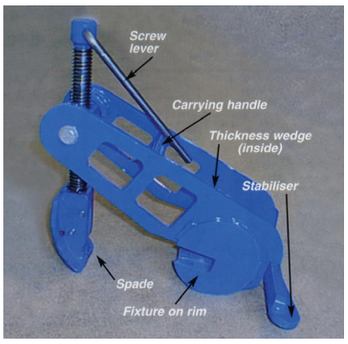
With a disc brake the valve can be damaged if a foreign object is trapped between the valve and the calliper, consequently the tyre may become flat.

Disc Brake with Protected Valve Wheel



With a protected valve wheel, the valve is protected as it is located outside of the disc wheel.

Without a dismounting machine, a special tool is needed to carry out the bead breaking operation to reduce the risk of damaging the tyre bead. Different tool models are available on the market.



The proper use of the tool during the initial bead breaking is shown in the following photographs.

Install the bead breaking tool on the rim

Place the spade at the interface of the rim and bead

Turn the screw lever until the spade has pushed the bead below the hump. Reposition the tool and repeat until the bead is completely clear of the hump.

Turn the tyre over to get the short side of the rim to the top and follow the normal tyre removal steps to remove the tyre from the rim.

Special Considerations For Urban And Low Profile Tyre Fitting

Michelin urban tyres are designed with thicker sidewalls to withstand the high incidences of curbing common in city driving conditions. Also, low profile tyres - those with series 70 and below - have shorter sidewalls, which makes the sidewall much more rigid compared to standard tyres. All this can present some special challenges during fitment, in both manual fitment and in using fitting machines.

The shorter and thicker sidewalls are more rigid and require additional force when fitting the second bead. This additional amount of force, if not carefully monitored, can lead to damage to the tyre bead in the final fitting stages. The following steps are recommended to help minimize this damage when the second bead is fitted.

1. Fit the first bead using the normal operating procedures. Proper lubrication of the tyre is very important, both beads should be well lubricated, and beads have to be lubricated in both outer and inner side.

2. On the second bead, place a fitting plier device on the rim to help hold the tyre in the in position while mounting the bead.

3. Begin to fit the second bead in the normal manner until reaching about 50% of the circumference of the tyre. Ensure that the portion of the bead already fitted is well positioned in the well or drop center of the wheel.

When using fitting machine, note the position of the mounting arm "plate" in relation to the bead and sidewall. The plate should be placed low in the sidewall, just above the rim flange to push the bead over the rim flange instead of twisting the rubber in the sidewall. Good lubrication of the outer and inner side of the bead is essential in order to ease the "guiding" of the bead over the flange.

4 At this point, the power generated by the fitting machine coupled with the stiffer sidewall can lead to damage of the bead.

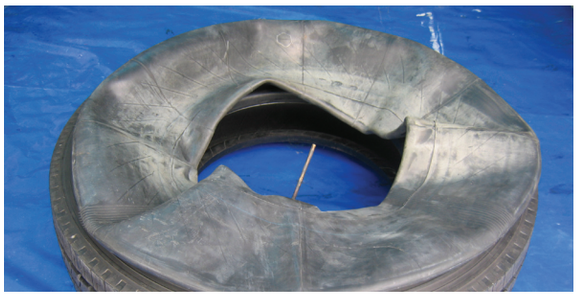
Therefore, this step must be performed by using a standard tyre fitting lever: while pushing with the plate at low rotation speed, proceed in 2 or 3 steps to fit with the lever the remainder of the tyre bead to the wheel.

Fitting Tube-Type Tyres

Since tube-type tyres require the use of more parts-including multi-pieces, the process of fitting and removing tyres is somewhat more complex. Begin with the proper selection of tube for the tyre to be fitted. Also ensure that the rim, side ring and lock-ring are compatible. Refer to the wheel manufacturer's documentation to confirm proper matching of components. As with tubeless tyres, the rim components should be free from excessive rust or corrosion.

Mounting

1. Carefully lay out the tube, make sure it is dry and free of any dirt or grit which can become trapped between it and the tyre after fitment. Ensure the valve is properly installed.



2. Insert the tube into the tyre making sure it is spread evenly around the circumference of the tyre.

3. Inflate the tube with a no more than 3 psi to ensure it is fitted well inside the tyre.

4. Place the valve through the valve hole in the flap and install the flap in the tyre. Check the flap wings to ensure against folding. This is easily accomplished by placing your hand into one tyre side, then the other, and then running your hand along the entire flap wing.

5. Place the rim on a clean floor and lubricate the bead seating area. Also apply fitting lubricant to both tyre beads and the exposed face of the flap.

WARNING: Re-assembly and inflation of mismatched parts can result in serious injury or death. Just because parts fit together does not mean they belong together. Check for proper matching of all rim parts before putting any parts together. Inspect the tyre and the rim for any damage that would require them to be placed out of service.

Mismatching tyre and rim component is dangerous. A mismatched tyre and rim assembly may explode and can result in serious injury or death. This warning applies to any combination of mismatched components and rim combinations. Never assemble a tyre and rim unless you have positively identified and correctly matched the parts.

6 Align the valve with the valve slot on the wheel then insert into the slot. Make sure the valve is centered in slot for a proper fit. Temporarily install the valve cap before inserting in the valve slot to protect the treads on the valve body from damage.

7 Fit the tyre over the rim and re-verify the valve is centered in the valve slot.

8 Install the side ring and lock ring. Position the open end of the lock ring opposite the tyre valve.

Position the mounted tyre and wheel assembly in a safety cage or positioned at least 3 meters from the technician and positioned vertically with the side ring and lock ring facing in a safe direction. Proceed with the inflation of the tyre

Demounting

1 Remove the valve core and completely deflate the tyre. Ensure that the valve is not blocked by debris by inserting a stiff wire into the valve body. **NEVER ATTEMPT TO DISASSEMBLE UNTIL THE TYRE IS COMPLETELY DEFLATED.**

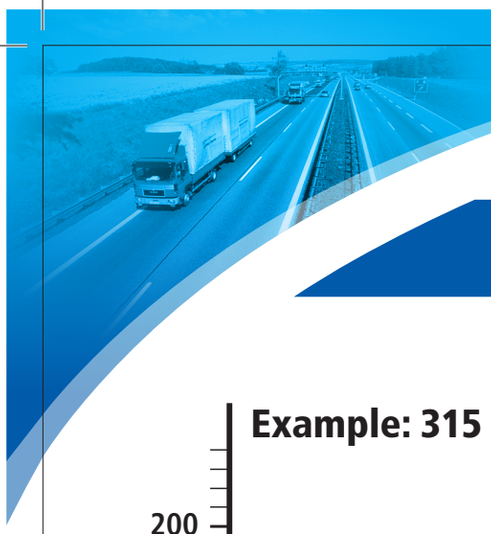
2 Use the fitting levers to spread the two ends of the side ring apart and begin prying it loose from the rim base.

3 Holding the flange down with one lever, pry one end of the side ring loose from the rim. Continue prying with alternate levers until it can be removed. Remove the lock ring and the loose side ring from the wheel and place safely aside. Push the valve through the slot in the rim and through the hole in the flap.

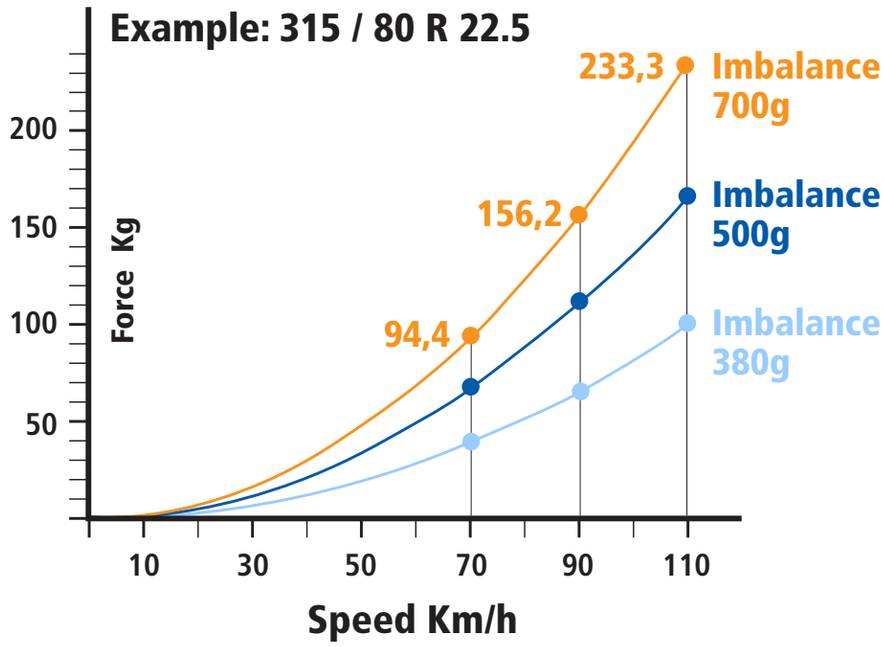
4 Turn the wheel over and place it on a wood block - or similar tool designed to facilitate removal of the tyre and tube from the rim.

5 Use the bead unseating tool to separate the tyre bead from the rim so the tyre falls to the floor.

6 Remove the flap and tube from inside the tyre.



Tyre Balance



Fitting a tyre/wheel assembly to a truck which is not properly balanced can lead to poor ride quality and uneven tread wear. The imbalance generates a significant force on each rotation which leads to vertical forces in the tyre. This vertical force can be felt by the driver and also causes the tyre footprint to abnormally change leading to uneven wear. The amount force is dependent on the mass of imbalance and the speed of the vehicle. The best time to balance is at the original fitting of a new tyre. Both static "bubble-type" balancers or more sophisticated computer balancers can be used to balance the tyre wheel assembly.

Mounting The Assembly On The Vehicle

When wheel assemblies are mounted on a vehicle, be sure the valves do not touch the brake drums or any mechanical part of the vehicle. Valves of twin tyres should be diametrically opposite to ensure easy access for pressure checks. Ensure that the inside valve is accessible so the air pressure can be checked and maintained. Tyres mounted in twin must be matched so that the maximum difference between the diameters of the tyres does not exceed 8 mm or a circumferential difference of 25 mm (generally 4 mm of tread depth holds true for casings of the same design from the same manufacturer). Failure to properly match dual tyres will result in the tyre with the larger diameter carrying a disproportionate share of the load. Mismatched duals can lead to rapid wear, uneven wear and excessive fatigue.

Tandem drive axles - like those on a 6x4 vehicle - should have all tyres closely matched to prevent any damage to the differential system. These tyres should be matched to within 8 mm in diameter of one another so that each axle has similar revolutions per kilometer when in operation. Equal tyre inflation should be maintained as well.

DUAL SPACING

It is also important that sufficient space is provided between dual tyres to allow air to flow and cool the tyres and to prevent the tyres from rubbing against one another. To make sure dual spacing is correct, simply measure from the outside edge of the outer tyre to the outside edge of the inner tyre of the twin fitment. This will give you the center to center distance of the twin tyres across that axle end. Refer to the minimum dual spacing column in the Technical Data Book.

Technical Considerations For Fitting Tyres

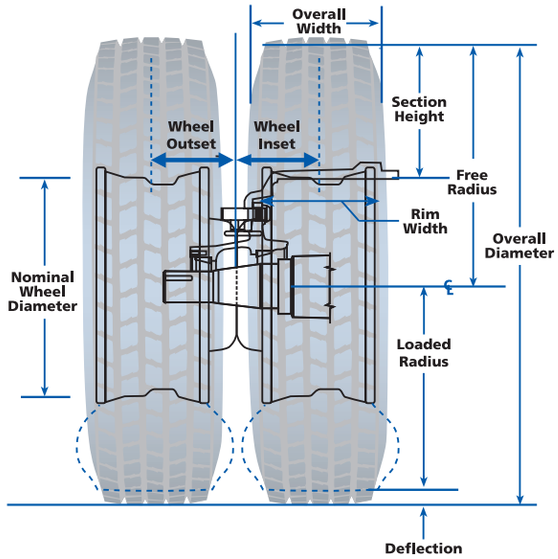
When fitting tyres of sizes different than those specified by the vehicle manufacturer, the following points must be considered:

1 GEAR RATIO

A change in tyre dimension will result in a change in engine RPM at a set cruise speed, which will result in a change in speed, tractive effort and fuel economy. Therefore the effect of a tyre size change on the gear ratio should be considered in individual operations. Generally, changes of 2% or less will have a negligible affect on gear ratio, tractive effort and indicated/actual speed. If a smaller wheel diameter is chosen, make sure that brake clearances are checked before making a recommendation. A change greater than 2% should be discussed with the vehicle manufacturer.

Rule of Thumb: When going from a lower to higher rolling circumference, the actual vehicle speed is greater than the speedometer reading. When going from a higher to a lower rolling circumference, the actual vehicle speed is less than the speedometer reading.

2 WHEEL DIAMETER



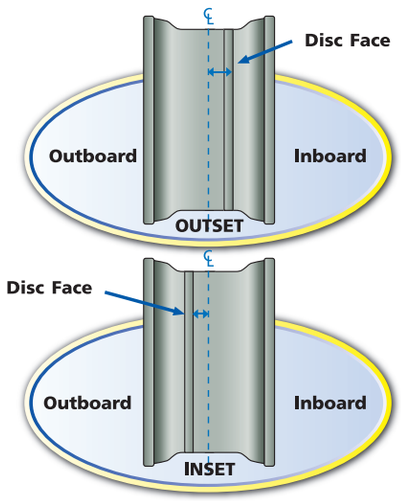
3 RIM WIDTH

An increase in the tyre section may require a wider rim with a greater outset.

4 OUTSET / INSET FOR DUAL WHEELS

The minimum outset required is determined by the distance that must be left between the dual tyres. Outset is the lateral distance from the rim or wheel centerline to the mounting surface of the disc. Outset places the rim centerline outboard of the mounting (hub face) surface.

Inset places the rim centerline inboard of the mounting (hub face) surface. OUTSET for front wheels: Wider rims may require a different outset or inset to avoid interference with vehicle parts.



Note: Use of outset wheels may change Gross Axle Weight Rating (GAWR) due to additional load forces placed on wheel bearings, consult vehicle manufacturer.

5 TYRE CLEARANCES

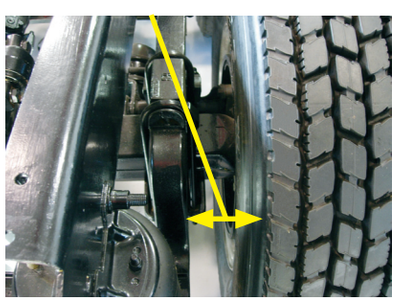
All clearances around a tyre should be checked:

- To the nearest fixed part of the vehicle, i.e., to parts which are not affected by spring deflection or steering mechanism.
- To the nearest part of the vehicle, which can be moved, i.e., parts that are affected by spring deflection or steering mechanism.

Consideration should be given to any additional clearance required by the use of chains. Minimum clearances permissible: 25 mm

a. Lateral Clearances

Lateral clearance is the smallest distance horizontally between the tyre and the nearest fixed point of the vehicle. An increase in the width of the inner wheel or any increase in the tyre section width will reduce lateral clearance.

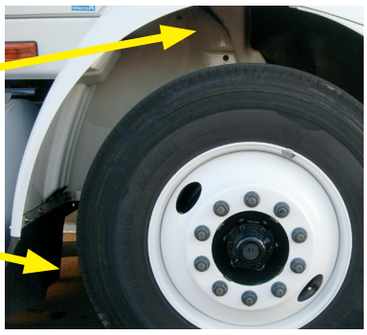


b. Vertical Clearances

Vertical clearance is measured between the top of the tread and the vehicle component immediately above the tyre (usually a fender). This will vary as the springs operate. The vertical movements of the whole axle, in relation to the whole chassis, are normally limited by an axle stop. When measuring vertical clearance, subtract the axle stop clearance from the total clearance; the difference is the remaining vertical clearance.

Vertical Clearance

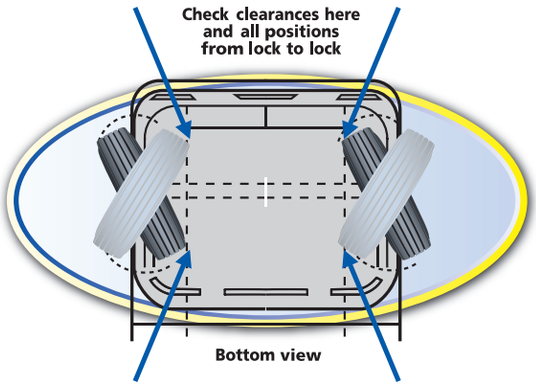
Body Clearance



When checking vertical clearance, consideration must be given to the degree of tread wear. Vertical and body clearances are decreased by any increase in the free radius of the tyre. When using tyre chains, a minimum of 50 mm clearance is needed to provide space between the dual assembly and the vehicle. Check to be sure that the body clearance is not less than the vertical clearance. A fender bolt may be closer to the tyre than the fender.

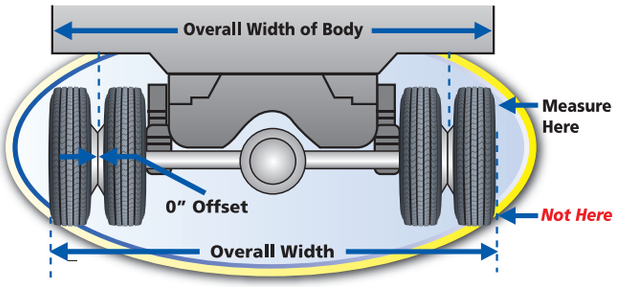
c. Front Wheel Clearances

The clearances of both front wheels must be measured on both steering lock positions. Clearances of front wheels must be checked by turning the wheels from full left lock to full right lock, since the minimum clearance might occur at some intermediate point. Steering Stops should be measured as they control the angle of the turn. Ensure they are present and are not damaged. Damage may indicate clearance issues or be a cause of abnormal tyre wear.



6 OVERALL WIDTH

When fitting larger tyres, the overall width of the vehicle across the tyres is increased by half of the increase in the cross section of each outside tyre and the increase in offset of each outside wheel.

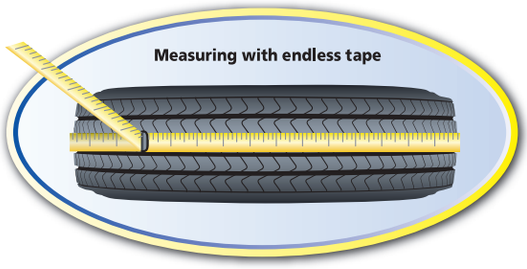


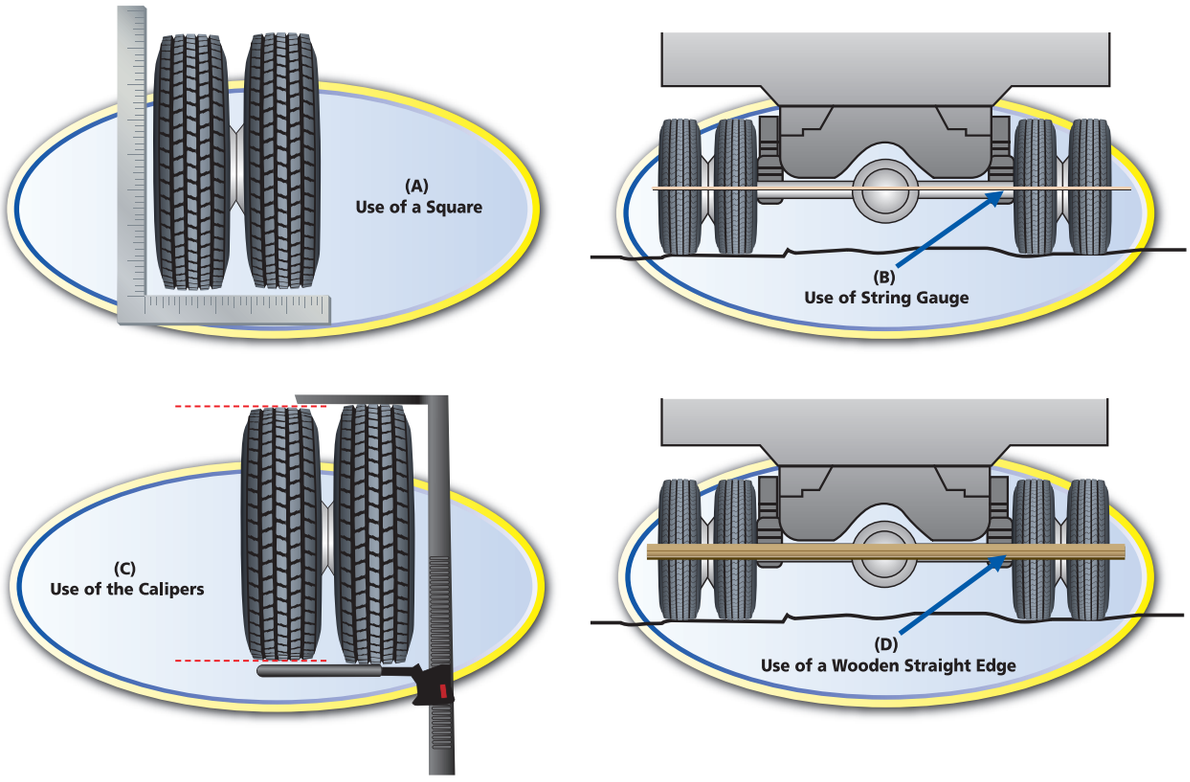
7 SPARE WHEEL RACK

Always check the spare wheel rack to see that the tyre will fit. Ensure that location is not in proximity to engine or engine exhaust.

MEASURING TYRES IN DUAL ASSEMBLY

If drive and trailer tyres are of equal tread depth and have equal inflation pressure, the inner tyre in the dual assembly is subjected to more deflection as it is under a heavier load and is affected by the condition of the road on which it operates. This result of road slope (motorway and primary roads) or road crown (secondary roads) on the inner tyre is more grip than the outer tyre achieves. Thus, the inner tyre dictates the revolutions per kilometer of the assembly, resulting in the outer tyre having more rapid tread wear. Measuring the circumferences of the tyres with an endless tape after they are on the rims and inflated, but before they are applied to a vehicle, is the most accurate method. The endless tape, as the name signifies, is a tape made of bending steel, one end of which passes through a slot at the other end of the tape and forms a loop. Measuring in this manner takes into account any irregularities in wear. Two tyres in twin fitment should be within 4 mm in tread depth, 8 mm in diameter or 25 mm in overall circumference. Tyres fitted across the drive axle should all be matched within these tolerances as well.

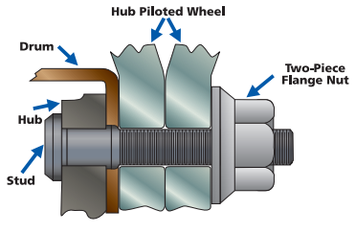




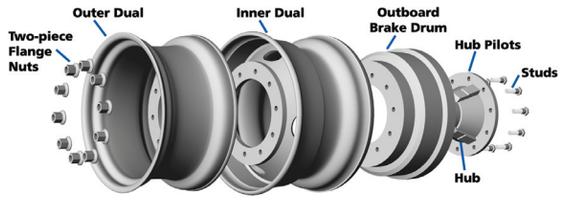
In checking tyres already on a vehicle, either (A) a square (similar to but larger than a carpenter's square), (B) a string gauge, (C) a large pair of calipers, or (D) a wooden straight edge long enough to lie across the treads of all four tyres, may be used.

Before servicing any truck wheel, it is essential to know the type of mounting system you will be working on. There are three primary systems of wheel attachment used on trucks and buses - two are designed for disc-type wheels and the third for demountable rims. Note that tubeless or tube-type tyres could be fitted on any of the three fitment methods.

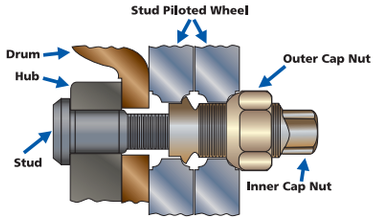
Hub Centered Disc Wheels



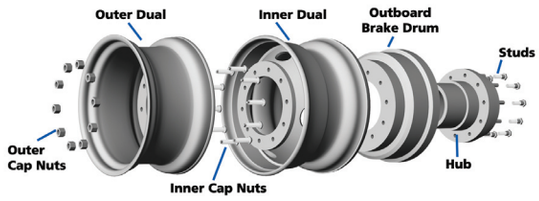
Hub Piloted Disc Wheels are designed to center on the hub at the center hole or bore of the wheel. The wheel center hole locates the wheel on pilots built into the hub. Hub piloted wheels are used with two-piece flange nuts which contact the disc face around the bolt hole. Only one nut on each stud is used to fasten single or dual wheels to a vehicle. All stud and nut threads are right hand. Hub piloted wheels have straight through bolt holes with no ball seat, which provides a visual way of identifying them.



Stud Centered Disc Wheels

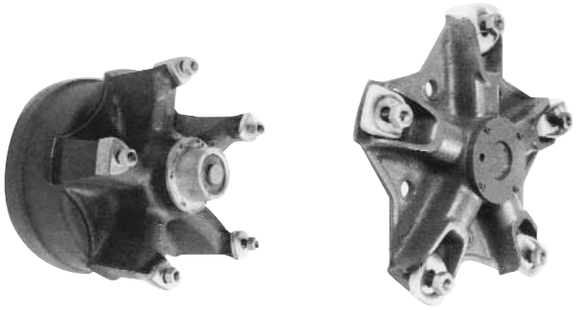


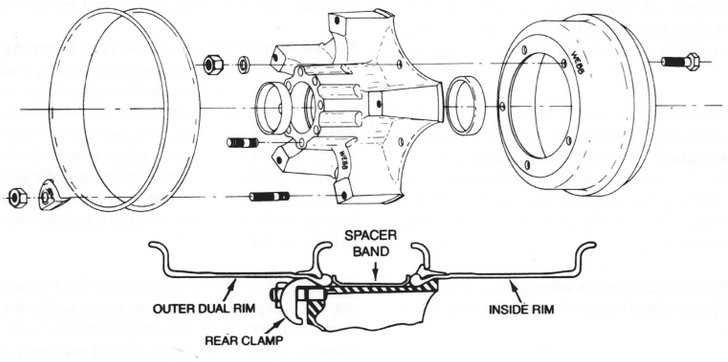
Stud Piloted Disc Wheels are designed to be centered by the nuts on the studs. The seating action of the ball seat nuts in the ball seat bolt holes centers the wheels. Stud piloted dual wheels require inner and outer cap nuts. Some systems use fasteners with left hand threads on the left side of the vehicle and right hand threads used on the right side of the vehicle.



Cast Spoke Wheels

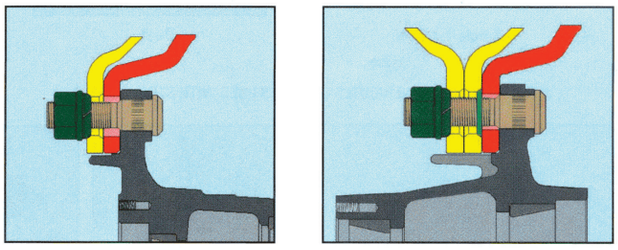
Cast Spoke Wheels consist of a metal casting which includes the hub with spokes. Demountable rims are attached to this axle component with clamps. Each cast spoke wheel requires specific clamps designed for that wheel. For a twin tyre fitment, the cast spoke system requires a spacer band to hold the two rims apart and provides for proper dual spacing



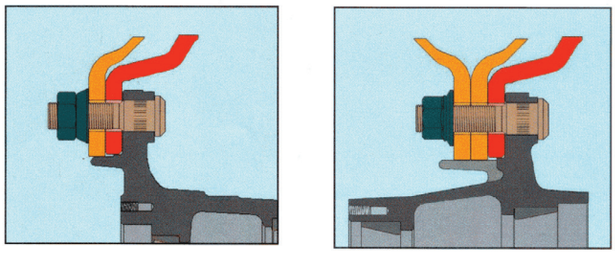


Wheel Fastener Systems

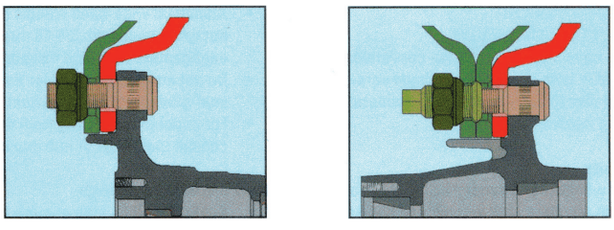
Examples of common wheel fastener systems from Asia, Europe and North America are shown in the following diagrams.



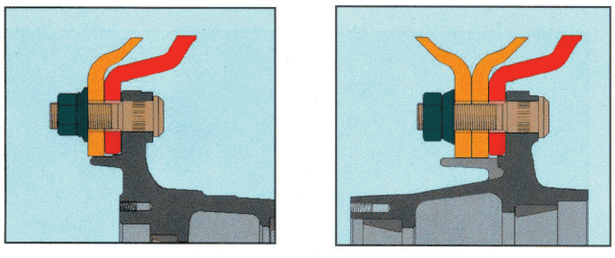
Stud Centered - European
Spherical Nut or Washer



Hub Centered - ISO



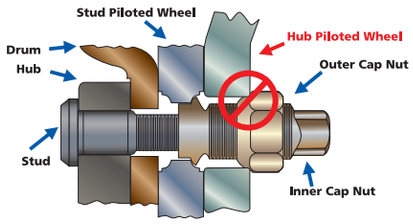
Stud Centered - North America/Japan
(Budd/JIN)



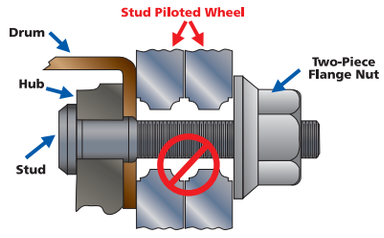
Hub Centered - North America

WARNING: Correct wheel components must be used. It is important to note that some hub centered and stud centered wheels may have the same bolt circle pattern. Therefore, they could mistakenly be interchanged. Each mounting system requires its correct mating parts. It is important that the proper components are used for each type of mounting, and that the wheels are fitted to the proper hubs. If hub centered wheel components (hubs, wheels, fasteners) are mixed with stud centered components, loss of torque, broken studs, cracked wheels and possible wheel loss can occur since these parts are not designed to work together.

Mixing hub and stud centered wheels will not allow the inner cap nut to fit into the inner wheel and will result in the inner cap nut interfering with the outer wheel. (Figure 1).



Flagure 1: Improper Mounting



Flagure 2: Improper Mounting

Ball seat stud centered wheels should not be used with flange nuts because they have larger bolt holes and do not have sufficient area near the bolt hole to support the flange nut. Slippage may occur. Also the center hole is too large to center the wheel. (Figure 2).

Special Considerations for Aluminum (Alloy) Wheels

It is also important to note that the aluminum wheel disc is usually much thicker than steel wheels and stud length must be checked when changing from steel wheels to aluminum. Aluminum wheel disc thickness is approximately double the thickness of steel. Because of this increase in disc thickness,

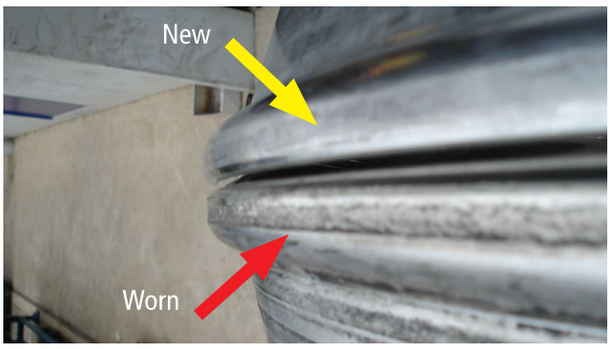
special consideration must be given to aluminum wheel attaching hardware. Wheel stud lengths are specifically designed to suit varying disc wheel mounting systems, brake drum mounting face thickness, and disc wheel material types. Failure to use the correct length studs may lead to insufficient clamp load of the disc wheels.

Maintenance of Wheel Systems

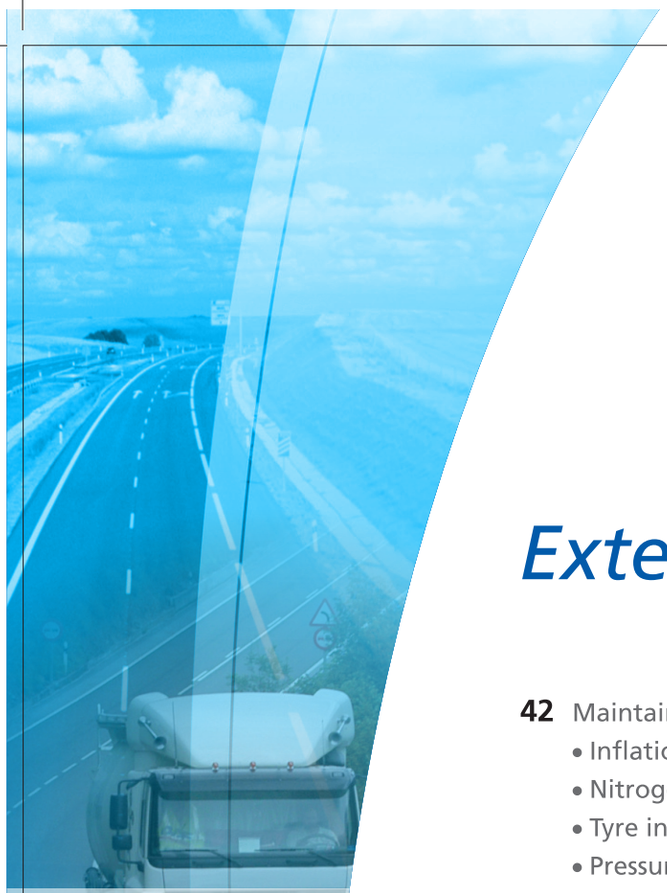
Following proper fitting, torquing and service procedures on wheels and wheel attachment hardware will extend the life of those components and ensure the safe operation of the vehicle. Frequent fitting and removing of tyres and wheels - common in such applications as city buses and refuse trucks - leads to wear and tear on the systems which must be managed. All parts should be clean and free of any excess rust or corrosion.

Applying the proper torque to the wheel nuts is the first step. Verify with the wheel manufacturer the proper torque specification for the particular system used on the truck. Both excessive and insufficient torque can lead to failure of the wheel system. Excess torque tends to stretch the wheel stud and can eventually lead to its failure. Broken studs can lead to detachment of the tyre/wheel assembly from the vehicle while running. Insufficient torque can lead to loosening of the wheel on the studs.

WARNING: A complete examination of the wheel, studs and lug nuts prior to each fitting should be part of all tyre maintenance programs. Cracks in the wheel and broken studs are often indicators of more serious problems such as overloading and improper wheel torque.

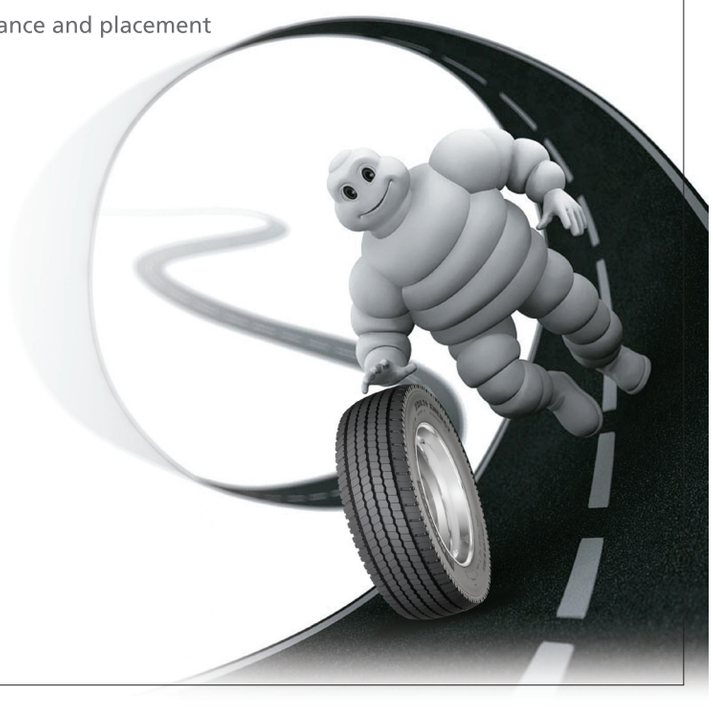


Aluminum wheels are more likely to wear in the outside edge of the flange due to flexing of the tyre's lower sidewall. This flexing can lead to abrasion of the softer aluminum by the rubber in the sidewall. Follow the wheel manufacturer's recommendations for maintenance procedures and service life of aluminum wheels.



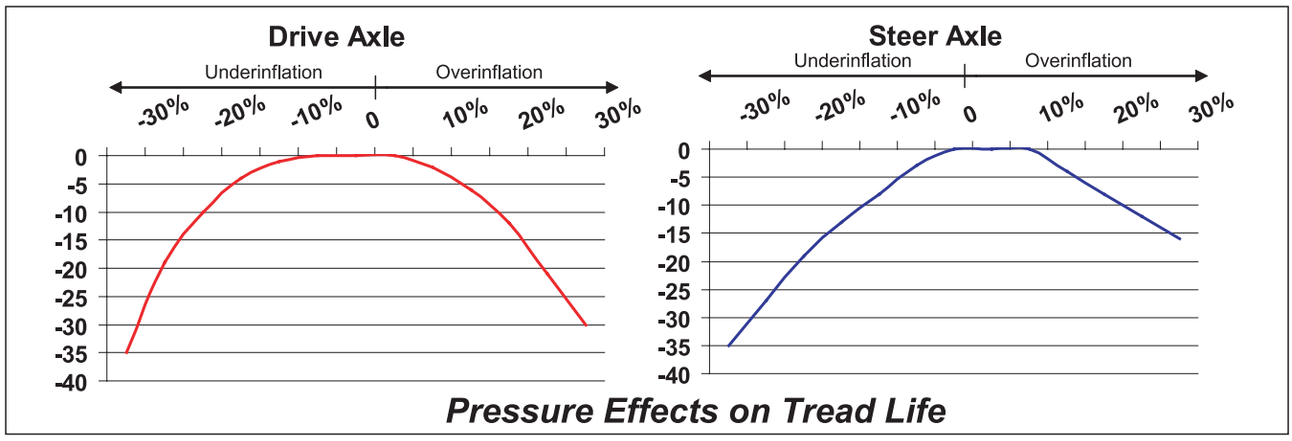
Extending Tyre Life

Section Three



Inflation Pressure

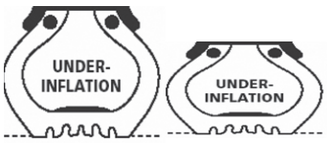
The most critical factor in tyre maintenance is proper inflation. No tyre or tube is completely impervious to loss of air pressure. To avoid the hazards of under inflation, lost-air must be replaced. Inflation pressure has a direct impact in tyre performance - both tread life and endurance - as shown in the following charts :

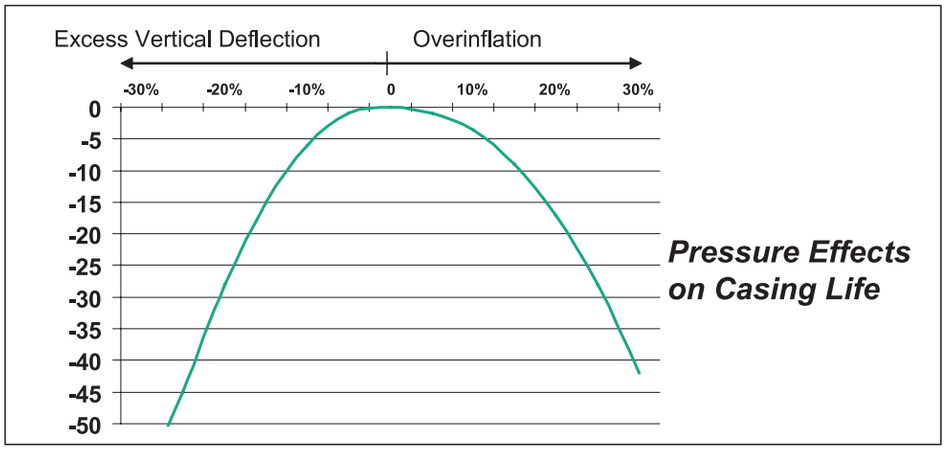


Pressure Effects on Tread Life

Deflection at nominal load

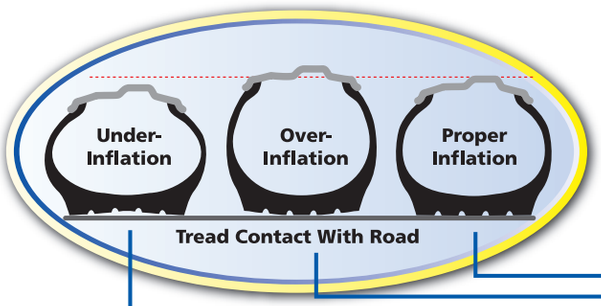
Excess deflection due to under inflation or overload





Pressure Effects on Casing Life

WARNING: Driving on any tyre that does not have the correct inflation pressure is dangerous and will cause tyre damage. Any under inflated tyre builds up excessive heat that may result in sudden tyre destruction. Pressures which are too high can lead to more rapid and uneven wear as well as being more vulnerable to road hazard damage. Consult a Michelin tyre dealer or Technical Data Book for the proper inflation pressures for your application.



UNDERINFLATION
Causes abnormal tyre deflection, which builds up heat and causes irregular wear. Similar to the rim being too wide.

OVERINFLATION
Causes tyre to run hard and be more vulnerable to impacts. It also causes irregular wear. Similar to the rim being too narrow.

PROPER INFLATION
The correct profile for full contact with the road promotes traction, braking capability and safety.

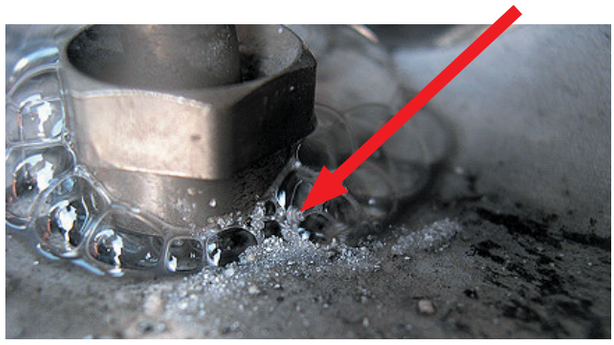
Underinflation has an impact:
- on safety
- on reducing the casing's endurance thus limiting retreading possibilities
- increases the tyre's rolling resistance leading to lower fuel economy
- the behavior of the vehicle

Overinflation has a negative effect on:
- tyre life especially for drive wheels
- crown aggression sensitivity - stone cutting, shock rupture
- comfort
- grip
- casing endurance and retreadability

Check inflation pressures on all tyres at least once a week, including spares, before driving when tyres are cold, especially when vehicle is used by more than one driver. The ideal time to check tyre pressures is early morning. Driving, even for a short distance, causes tyre to heat up and air pressures to increase. As a tyre rotates during operation, heat is generated inside which raises the internal pressure. During the first hour of operation, the tyre will gradually reach a point of equilibrium where the internal heat generation slows and is countered by the natural cooling of the tyre by the airflow around it.

Always inspect valve stems for proper installation, torque and verify there is a good airtight seal by use of a leak detector type spray such as a water/soap solution-applied from a spray bottle. It is also a good practice to periodically check existing fitments for slow leaks with this method.

Leaking Valve



Never bleed air from hot tyres, as they will then be under inflated. Make sure to check both tyres in a twin fitment. Pressures should be the same. Maximum allowable difference between tyres in dual or between axles should be no greater than 10 psi (0.75 bar). Mismatched pressure in the twin fitment will cause the tyres to rotate at different revolutions per kilometer resulting in uneven wear and tyre damage.

Remember, a drop in ambient temperature results in a drop in tyre pressure. More frequent checks may be required during cold weather conditions. Avoid outdoor air pressure checks when the temperature is below freezing. Ice can form in the valve stem thus promoting leaks. Check inside a heated facility if possible.

Use an accurate calibrated tyre gauge to check-pressures. (Do not use "Tyre Billys" to hit tyres as an inflation check. This is an unreliable method.)

NITROGEN IN TYRES

Nitrogen is an inert gas which makes up approximately 78% of the air around us. Tyres inflated with a normal air compressor already contain 78% nitrogen. Increasing the nitrogen percentage to 100% with a nitrogen inflation system will not adversely affect the inner liner of the tyres nor the performance of the tyres under normal operating conditions. While there are advantages for industrial and large off-the-road earthmover tyres, the advantage in commercial truck products is difficult to verify. Moisture, rather than oxygen, is the bigger concern for casing degradation. Using good equipment (air compressor, air lines and air dryer) will reduce the moisture content of the air in the tyre. Moisture, when present in the tyre, greatly accelerates the oxidation effects to the tyre and rim.

TYRE INSPECTION

While checking inflation pressures, it is a good time to inspect your tyres. If you see any damage to your tyres or wheels/rims, see any Michelin Truck Tyre dealer at once. Before driving, inspect your tyres, including the spare, and check your air pressures. If your pressure check indicates that one of your tyres has lost pressure of 5 psi or more, look for signs of penetrations, valve leakage, or wheel/rim damage that may account for the air loss. If the tyre is 20% below the maintenance air pressure, it must be considered flat. Remove and inspect for punctures or other damage. If run flat damage is detected, scrap the tyre.

WARNING: Tyres should be inspected for bulges, cracks, cuts or penetrations. If any such damage is found, the tyre must be inspected by any Michelin Tyre dealer at once. Use of a damaged tyre could result in tyre destruction, property damage and/or personal injury.

Sidewall abrasion

Sidewall damage from impact

Bead damage

PRESSURE MONITORING AND CENTRAL INFLATION SYSTEMS

Maintaining proper tyre inflation will maximize tyre life and casing durability. This results in reduced overall tyre costs, downtime, tyre replacement, irregular wear, wheel replacement, road debris and the natural resources required to manufacture tyres and retreads. Correct inflation will increase benefits such as fuel efficiency, safety, driver retention

and uptime, all of which have a direct effect on cost per kilometer. While inflation systems may reduce tyre labor, it is still necessary to inspect tyres to ensure they are serviceable, properly inflated and the systems are working correctly. All of these systems need to be properly installed and maintained to deliver the benefits they provide.

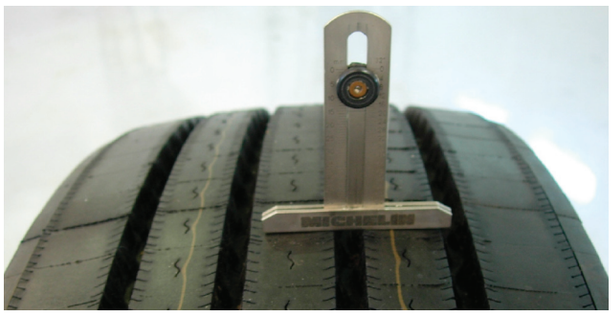
Some of the active systems - those that provide positive air pressure to the tyre - are capable of maintaining a cold inflation pressure within the capacity of the vehicle's air system. Proper air pressure maintenance is important for the optimal performance of the tyres so it is important to make sure the system can maintain the pressures needed and / or can detect accurately when the pressures are outside of the normal operating range for the loads being carried.

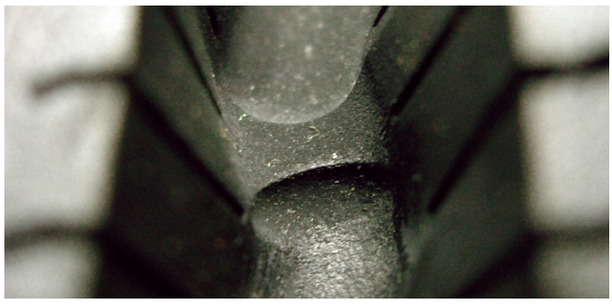
Tyres on vehicles with these systems should still be visually inspected before and after use. Systems on trailers can sometime allow slow leaks caused by nails or other small objects penetrating the crown area of the tyre to go undetected. A slow leak can be compensated for by the air inflation system.

The warning light of the system will only come on if the pressure in the tyre drops below a certain percent (usually 10%) of the regulated preset pressure. Even when the pressure drops below this point, the light will go off if the system is able to restore and maintain the preset pressure.

TREAD DEPTH MEASUREMENTS

Tyres should be measured for wear. This measurement can be taken in several spots across the tread and around the circumference. However, to calculate the remaining amount of rubber (knowing the new tyre tread depth) for a given number of kilometers run, the measurement should always be taken at the same spot on the tread and close to the center groove of the tyre, as shown below:





Wear bars

Wear bars: Michelin truck tyres contain "wear bars" in the tread grooves which show up when 1.6 mm (*) or less of tread remains. The location of the indicators is highlighted by the Michelin Man logo in the upper sidewall. Tread depths should not be taken on the wear bar indicators. When the tread is worn level with the wear indicators (from either regular or uneven wear), the tyre should be removed from service.

Note: Some countries specify a minimum tread depths for truck tyres. Removal of the tyre at this point also helps to ensure a proper and effective regrooving of the original tread.

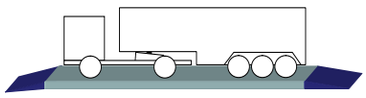
(*) 2 mm according to Chinese Regulation

OVERLOAD

WARNING: The maximum load that can be put on a truck tyre is dependent upon the specific design and load capacity assigned to that tyre. Consult a Michelin Tyre dealer or the Technical Data Book for complete information on the allowable loads. Tyres that are loaded beyond their maximum for the particular application will build up excessive heat that may result in sudden tyre destruction, property damage and personal injury.

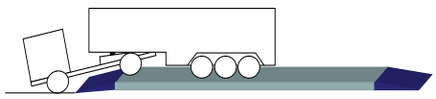
Do not exceed the gross axle weight ratings (GAWR) for any axle on the vehicle. Due to uneven distribution of load or particular vehicle configuration, it is possible to exceed the load capacity of just one axle while maintaining a total vehicle weight under the maximum level. Care should be exercised to ensure proper loading and special circumstances should be verified by weighing individual axles to confirm that no individual tyre overload exists. When verifying axle loads - ensure that the vehicle is in its normal loaded condition and is level on the weighbridge.

Overload can also lead to excessive deflection of axles which results in changes to the alignment geometry. An increase in camber can lead to more rapid shoulder wear on the tyre.



Weighbridge

Correct vehicle placement on weighbridge. Notice all axles at the same level.



Weighbridge

Front axle is off the weighbridge and tractor angled down the ramp. This will result in a shift of the load from the drive and trailer axles to the steer axle.

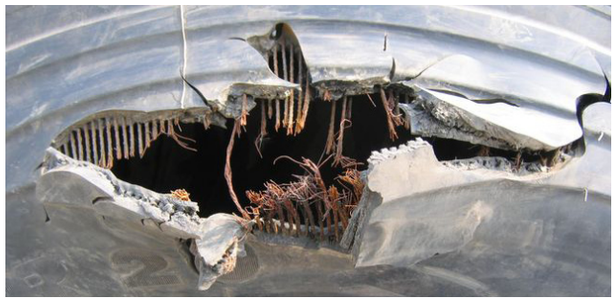
DRIVE AT PROPER SPEEDS

The maximum continuous speed at which Michelin truck tyres can be operated is indicated in the Michelin Technical Data Book. High speed driving can be dangerous and may be damaging to your tyres. When driving at highway speeds, correct inflation pressure is especially important. However, at these speeds, even with correct inflation pressures, a road hazard, for example, is more difficult to avoid. If contact is made, it has a greater chance of causing tyre damage than at a lower speed. Moreover, driving at high speed decreases the time available to avoid accidents and bring your vehicle to a safe stop.

STORAGE

WARNING: In order to avoid premature aging and degradation of tyres, they should be stored in a dark and closed area with the tyres standing vertically on their treads, one against the other. If this is not possible, they should be protected from exposure to the weather, sources of ozone (sun, arc-welding, mercury vapor lamps...) and ultraviolet (UV) radiation.

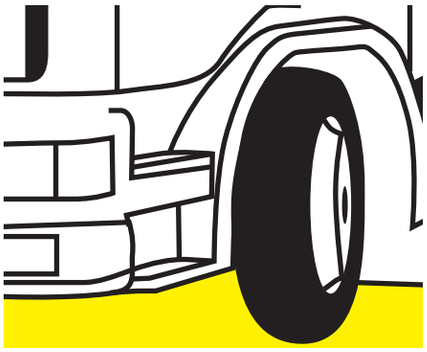
Avoid any storage condition where water is allowed to collect in the tyre. This water can over time migrate through the inner liner and lead to deterioration of the steel in the casing. Long-term exposure such as this can lead to failure of the tyre. With tube-type tyres, this is a particular problem because of the difficulty in detecting the water which has collected between the tyre and tube. Under pressurization, the liquid can pass through the inner liner and into the casing.



Tubes, flaps and rubber seals should be stored in their original packaging. They may be stored on shelves or in containers, on condition that the surfaces in contact with them are clean and smooth (to avoid risk of tearing, cuts or perforations). As with tyres, avoid areas of excessive heat, sources of ozone and ultraviolet light.

ROTATION

A number of factors lead to tyres on the same axle not wearing at the same rate. Specific causes and solutions by rotating the tyres are based on the wheel position.



Steer Axles

- Tyres on the driver's side will tend to wear faster due to the design and operation of the steering system.
- The opposite steer tyre is more likely to develop uneven wear because of effects of road crown and slower wear rate.

Recommendation - at 50% wear, rotate left and right tyres. If shoulder wear is present on the tyres, rotate on the rim at the same time.

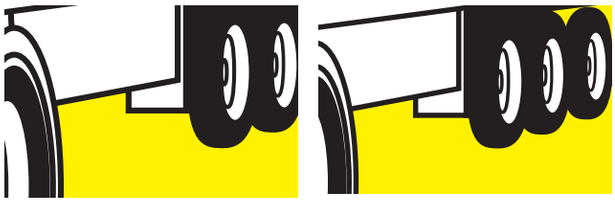
Drive Axles

- As a general rule, the inner tyres have more pronounced wear on the inside shoulder - particularly the inside tyre in the twin fitment. This effect is due to several factors: the tyre load, camber angle, bent drive axle, type of suspension, and route.
- On 3-axle vehicles, one drive axle may wear more quickly due to lateral scrub during hard cornering and maneuvering the vehicle in small confined areas like loading docks.
- Drive tyres are more likely to get heel/toe wear due to the effects of drive torque on the tread pattern. Many times, this wear pattern will disappear with additional kilometers driven.
- Tyres which are over inflated will wear more quickly in the middle of the tread band and may require more frequent rotation.

Recommendation

- On single drive axles at 80% worn, rotate the inside and outside tyres. Turn the tyre on the rim if uneven or more rapid wear is found on the shoulder.
- Twin drive axle trucks, rotate the front and rear axle tyres when the fastest wearing tyres are at 50% worn.
- Rotate tyres with heel/toe wear so that the tyre will run opposite it original direction of rotation.

Trailer Axles



- The inside shoulder of trailer tyres may develop more rapid or uneven wear due to the effects of road crown, axle camber, type of suspension and tyre load.
- On two and particularly three axle trailers, the wear of the tyres is affected by lateral forces or scrubbing while turning. The distance between the axles can affect this with larger axle spacing generally leading to more scrubbing. The result is a difference in wear between tyres fitted on each axle.

Typical expected milage

2-Axle	
Axle	Mileage
1	80%
2	100%

3-Axle	
Axle	Mileage
1	75%
2	100%
3	60%

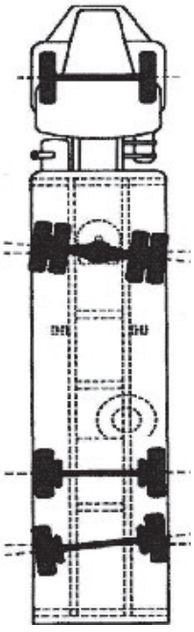
Recommendation

- Rotate tyres between faster and slower wearing axles when tyres are 50% worn - swap inside and outside positions.
- If inside shoulder wear is present, rotate the tyre on the wheel to minimize additional shoulder wear.

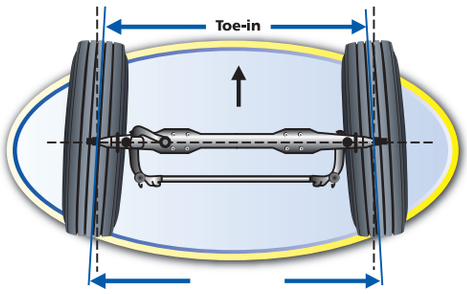
Many tyre problems can be traced to mechanical conditions in the vehicle. Therefore, to obtain maximum tyre performance, vehicles must be properly maintained.

ALIGNMENT

Alignment refers not only to the various angles of the steer axle geometry, but also to the tracking of all axles on a vehicle, including the trailer. The dual purpose of proper alignment is to minimize tyre wear and to maximize predictable vehicle handling and driver control. Toe misalignment is the number one cause of steer tyre irregular wear, followed by rear axle skew. One of the challenges of meeting this goal is that alignments are typically performed on a static, unloaded vehicle sitting on a level floor. The vehicle then operates over varying contoured surfaces, under loaded conditions, with dynamic forces acting upon it.

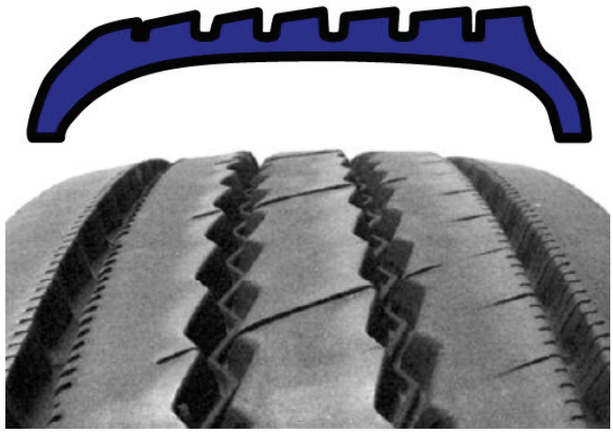


All these misalignment conditions may exist alone or (more likely) in combination with other misalignment conditions. Sometimes it is these interactions that produce the outcomes that are especially undesirable. As an example, a tyre running at slightly negative camber may perform especially badly if it is also subjected to tandem thrust misalignment.
The understanding for this phenomenon is that because of the camber issue, the wear burden imposed by the thrust misalignment is not being shared equally by the entire tread surface.



TOE

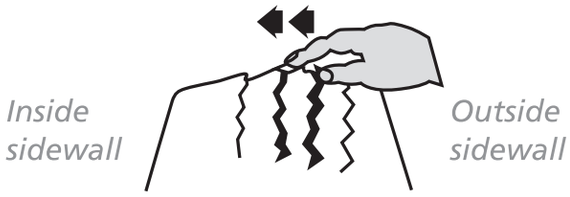
Toe is typically the most critical alignment condition affecting steer axle tyre wear. The purpose of setting toe at a given specification is to allow the tyre to run straight during normal operating conditions. Too much Toe-In results in scrubbing from the outside inward on both tyres and too much Toe-Out results



in scrubbing from the inside outward on both tyres. Total toe is the angle formed by two horizontal lines through the planes of two wheels. Toe-In is when the horizontal lines intersect in front of the wheels, or the wheels are closer together in front than in back. Toe-Out is when the horizontal lines intersect behind the wheels, or the wheels are closer together in back than in front. The effects of improper toe can be easily detected by feeling the tread surface with your hand. Steer axle toe is adjustable to reduce wear to the leading edge of the tyre and also to avoid road wander. Typical commercial vehicles require a slight amount of Toe-In with 1-2mm set on a static, unloaded vehicle so that tyres will have zero toe or straight ahead when the vehicle is loaded and operating on the road.

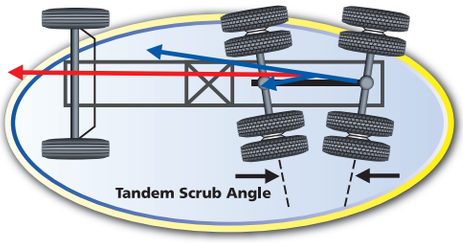
Excessive Toe-In

Excessive Toe-Out



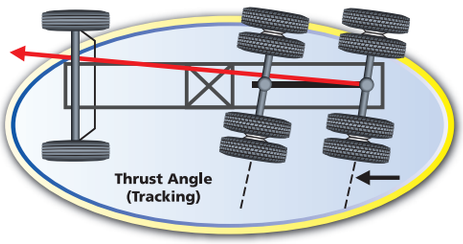
TANDEM AXLE PARALLELISM (SKEW/ THRUST)

Tandem axle parallelism is critical because it can have a detrimental effect on all tyres on the vehicle. Non-parallel drive axles tend to push the vehicle into a turn in the direction that the axle ends are closest. In order for the vehicle to go straight, the driver must correct by steering in the opposite direction.



The vehicle can then go straight, but all tyres are at an angle to the direction of travel, causing scrubbing. Excessive rear axle non parallelism is usually detected in steer tyre wear. If one steer tyre is scrubbing from the outside inward and the other steer tyre is scrubbing from the inside outward, then tandem

axle alignment is suspect. A similar pattern can be generated by the driver's compensation for a non lubricated 5th wheel or from a dog tracking trailer. This should not be confused with a light level of Toe-In on the right front and lighter Toe-Out wear on the left front that may be the result of secondary highway road crown. Misalignment of the tandem axles greater than 3mm (0.10 degrees) can lead to uneven and rapid tyre wear.



THRUST ANGLE (TRACKING)

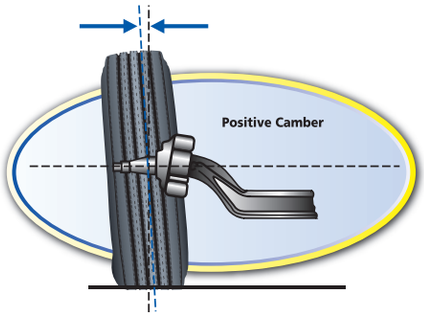
The relationship of the geometric centerline of the vehicle and the direction that the axle points generates a thrust angle. Ideally this relationship would result in a 0 degree value when the axle centerline is perpendicular to the geometric center line. However, deviation from this setting will increasingly cause the vehicle to travel away from the straight line, causing the tyres to "dog track" and scrub.

Tracking to the right generates a positive thrust angle; tracking to the left creates a negative thrust angle. Typically, vehicles with axle trust greater than 0.25 degrees can lead to rapid or uneven tyre wear. Excessive thrust angle can affect any vehicle - rigid truck, tractor or trailer.

CAMBER

Camber is the angle formed by the inward or outward tilt of the wheel referenced to a vertical line.

- Camber is positive when the wheel is tilted outward at the top.
- Camber is negative when the wheel is tilted inward at the top.
- Excessive positive camber may cause smooth wear on the outer half of the tyre tread.

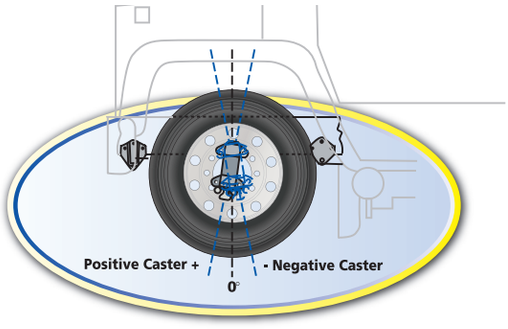


- Excessive negative camber may cause wear on the inner half of the tread.
- Negative camber can also be a cause of inside shoulder wear on trailer axle in dual or single configuration.
- A free rolling tyre is more sensitive to camber than a driven tyre.

- Generally, the vehicle will pull to the side with the most amount of positive camber. (If difference is more than 1/2 degree)
- Typical camber values for a static, unloaded vehicle are zero plus or minus one half a degree (-0.5 to +0.5 degree).

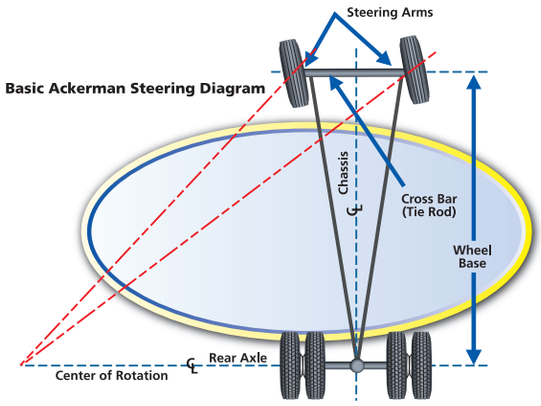
Camber is often a contributor to wear occurring on the interior ribs/blocks of the inner twin drive and trailer tyres, and can sometimes affect the interior ribs/blocks of the outer dual as well. Overloading of the axle leads to excessive negative camber and wear on the inside shoulder of the tyre.

Camber correction by bending axles is NOT RECOMMENDED by Michelin. Consult the axle manufacturer if camber is found to be incorrect (outside manufacturer specification).



CASTER

Positive (+) caster is the backward tilt at the top of the kingpin when viewed from the side. Negative caster is the forward tilt of the top at the kingpin when viewed from the side. The purpose of caster is to provide self aligning forces on the steer tyres to stabilize the vehicle when driving straight down the road under braking, free wheeling, and power conditions. Insufficient caster reduces stability and can cause wander. Excessive caster increases steering effort and can cause shimmy. Either of these conditions may also have a detrimental effect on tyre wear. Excessive caster beyond the vehicle manufactures specification may result in induced camber causing excessive tyre wear, particularly fleets that are in local and regional operations. Caster is adjustable with shims. Adjusting only one side is not recommended. Caster on both sides should be equal or not more than one-half degree difference. Generally, the vehicle will pull to the side with the least amount of positive caster. Typical values on modern vehicle range from 2 to 5 degrees positive caster.



TOE-OUT ON TURNS (TURNING RADIUS)

Toe-Out on turns is the difference in the arcs described by the steering tyres in a turn. The purpose is to prevent the inside tyre from scrubbing around a turn since the outside tyre (loaded tyre) determines the turning radius of the steer axle. Improper geometry results in tyre scrub in turns, which generally appears as toe wear on the tyre.

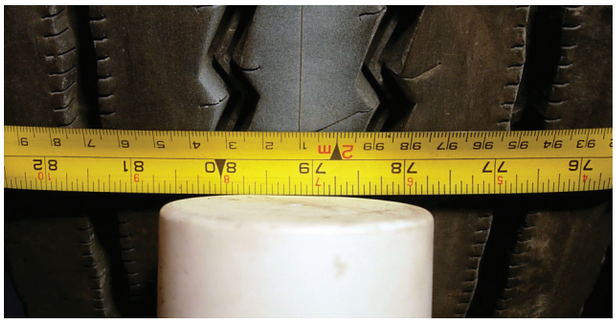
PERIODIC ALIGNMENT CHECKS

Verification of proper axle geometry and alignment should be part of the overall routine vehicle maintenance program. Specific alignment angle settings and tolerances should match the recommendations of the vehicle manufacturer. Suggested periodic checks include the following:

- New vehicles prior to placing into service and again after some period where the new components have settled after running some kilometers. Verification of proper torque on the suspension system fasteners can also be done at this time. Follow the recommendations of the vehicle manufacturer.
- When tyres are noted to have uneven wear which suggests misalignment.
- When any steering or suspension component such as leaf springs are replaced.

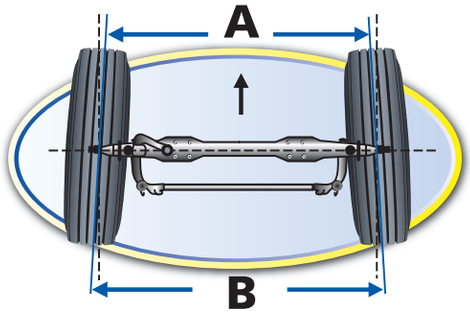
Field Alignment Verification

The following simple procedures can be used to verify the key basic alignment angles on trucks, tractors and trailers.



TOE:

Mark a reference line around the full circumference of each steering axle tyre. Measure the distance between the lines on the left and right tyres at the height of the hub center.



Measure first at the rear of the tyre (letter B on the diagram) then measure across the front (letter A). Subtract the front reading from the rear. A positive value indicates Toe-In while a negative shows Toe-Out. An alternative to the scribe line it to use a small thumb tack or push-pin on both tyres. Lightly push the pin into the center tread rib of each steer tyre at the height of the hub center. Start with the pins at the rear of the tyre, measure the distance between the two pins and record the value. Carefully roll the vehicle forward until the pins are exactly at the height of the hub in the front of the vehicle. Measure the distance across the pins again and record. Subtract the front reading from the rear-positive is Toe-In, negative is Toe-Out.

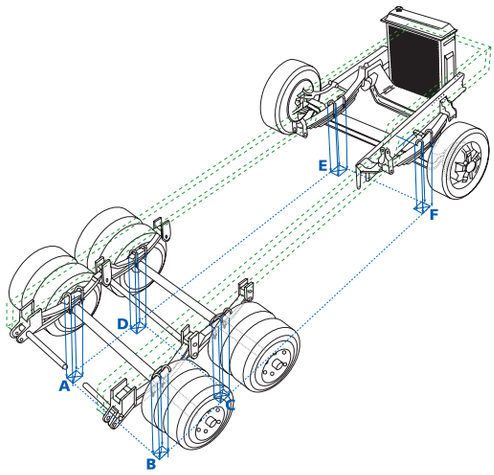
Drive And Trailer Axle Parallelism:

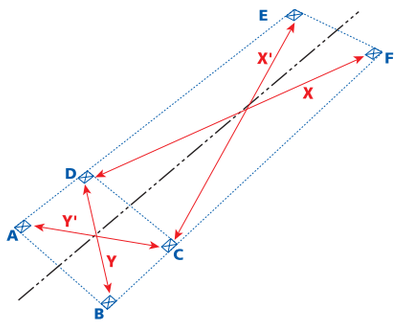
On a truck, tractor or trailer with multiple axles, the drive/trailer axles should all be parallel. An easy method of verifying is to measure the distance between the ends of the axle hubs on each side of the vehicle. The difference between these two measurements should be no larger than 3mm. The easiest way of accomplishing this measurement is by using a trammel bar as shown in the photo.

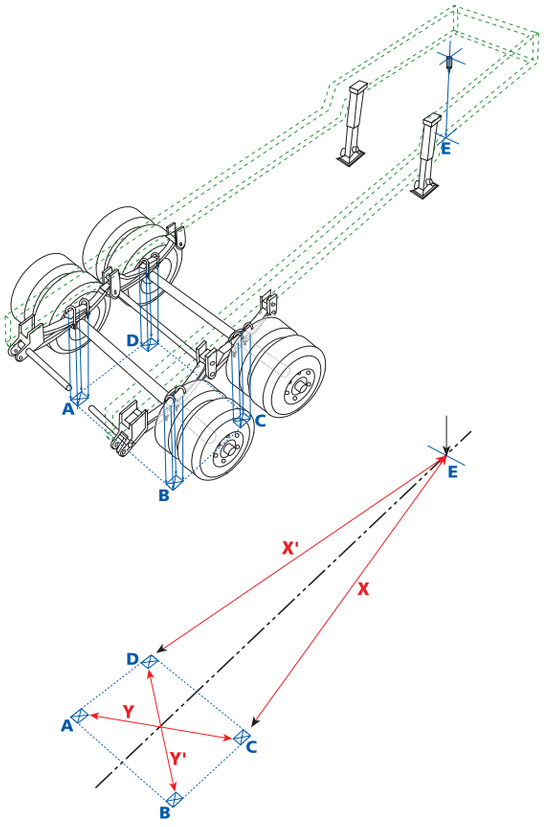
Alternate Drive/Trailer Axle Angle Verification:

With the vehicle in on a flat surface and with the suspension in a relaxed position, select two points on the front and rear axles. These two points on each axle must be equal distance from the chassis center (e.g., at the point where the springs meet the axles). Using a plumb line, mark four points on the ground, move the vehicle away and measure the distance between the marks as shown on the diagram.

For Truck/Tractor: If AD = BC and DE = CF, the axles are parallel. If X = X' and Y = Y' the wheels are symmetrical or tracking. Variance greater than 3mm may indicate a misalignment condition.



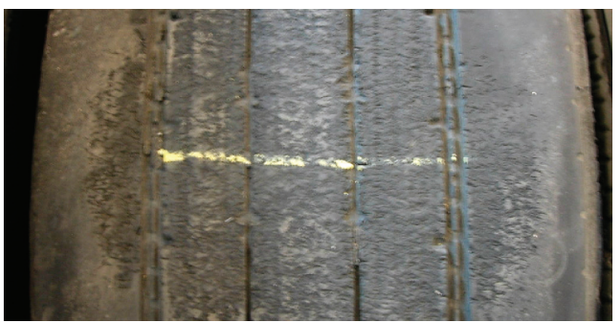




For Trailers: If AD = BC and CE = DE, the axles are parallel and symmetrical. Variances more than 3mm between axle ends and 3mm from the trailer king pin to the lead axle suggest a misalignment condition.

BRAKING SYSTEM

Air brake issues as they apply to tyre wear and damages can result from imbalance or component problems. Distorted, brittle and/or discolored rubber in the bead area are signs of the "outside to inside" breakdown of rubber due to excessive heating of the rim. Temperatures reaching 140-degrees Celsius can lead to very rapid degradation of the tyre, an unwrapping of the casing ply and rapid loss of air. Temperatures below this but still elevated above normal can lead to degradation of the rubber and premature aging of the casing.



Braking system considerations which can affect tyre performance:

1. Brake imbalance can be the result of the air system, including valves, not actuating the brakes simultaneously. This may be the result of dirt, leaks and/or valve cracking pressure.

Summary of tyre issues due to brake

Problem	Possible Causes	Result
Brake Heat	1. Overuse on down grades due to improper gear. 2. Brake dragging due to mis-adjustment of wheel bearings. 3. Repeated stops without cooling time. 4. Improper adjustment or brake balance leads to one or more brakes assuming excessive amount of braking.	Bead damage to the tyre ranging from simple distortion to complete unwrapping of the casing from the bead wire.
Lock Up	1. Out-of-round brake assembly. 2. Slow release valves. 3. Mis-adjustment slack adjusters. 4. Brake Drum runout.	Flat spots and odd wear.

2. Another source of brake imbalance is the improperly adjusted slack adjuster. Any of these brake imbalance situations can result in one or more wheel positions locking up and flat spotting the tyres.
3. Component situations, such as out of round brake drums or unevenly worn brake shoes, also result in tyres developing uneven wear and flat spots.

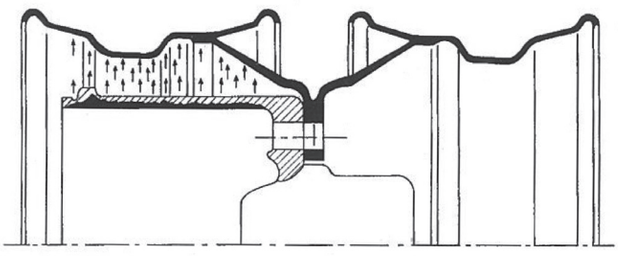
4. Brake drums which are not balanced properly may result in ride disturbance.
5. Brake lock (flat spots) conditions may be evidence of deficiency in the Anti Lock Brake System for those vehicles fitted with it.

Disc Brakes

Traditional drum brake systems are being replaced on some modern commercial vehicles with air disc brakes. The disc brake offers advantages over drum which involve both performance and maintenance. The disc brake system is less like to develop "brake fade" or a normal decrease in braking efficiency as the brake components get hot, better cooling and better controllability of the braking effort. Maintenance is simplified with improved life of brake components and easier service. Disc brakes will still develop excessive heat if a brake balance or mechanical problem is encountered.

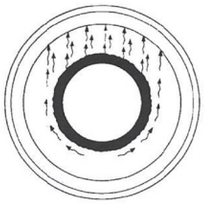
BRAKE HEAT

Brake temperatures on commercial vehicles often reach very high temperatures. Brake drums can reach temperatures of 300° C or more and are in very close proximity to the wheels.



Radiation

This heat can be easily transferred to the wheels and tyres. Brake drum heat is transferred to the wheel primarily through radiation and convection. The hot brake drum radiates heat in all directions to the wheel. In addition, the drum heats the air between the drum and the wheel. The heated air rises and



Convection

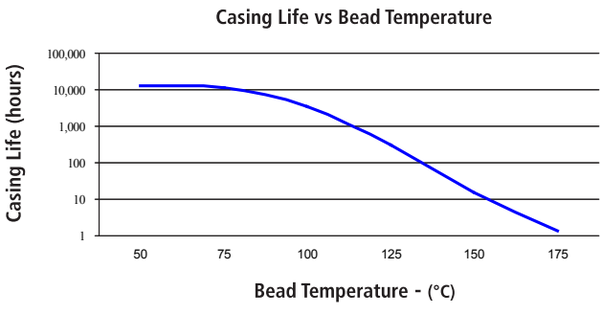
transfers additional heat energy to the wheel through convection. Much of the heat is transferred to the wheel in the bead mounting area due to its close proximity to the brake drum. The wheel then directly conducts heat to the tyre bead resulting in elevated temperatures in the tyre bead area. Excessive bead heat can affect tyre life in many truck tyre applications. Vehicles in urban and refuse service are most commonly associated with bead heat issues but any application that experiences hard braking can be affected.

Results of bead heat:

1. **Immediate failure:** In some cases, after periods of hard braking where brake drums reach very high temperature (in excess of 300° C), immediate failure can occur. This normally happens when a truck is brought to a stop for a period of time with very high brake temperatures. Often this occurs when an over the road truck stops at the bottom of a long descent. As the heat rises from the brake drum there is excessive heat buildup in the portion of the tyre bead directly above the brake drum (inner bead of inside dual). The high temperature can cause a breakdown of the rubber products in the bead area and allow the steel body cables to unwrap from the bead. This process results in a rapid air loss.
2. **Premature aging of the casing:** Heat is a tyre's worst enemy! A tyre subjected to high heat conditions over an extended period of time will experience accelerated aging

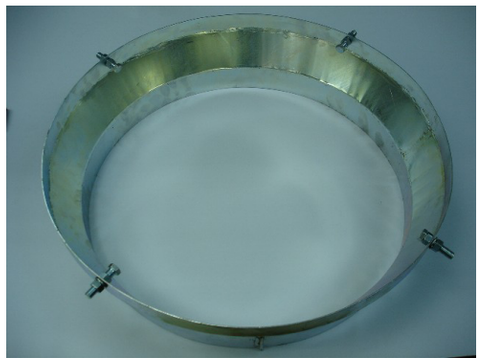
of the rubber products. The accelerated aging may result in a blowout during operation or it may render the casing unsuitable for retread. Bead damage as a result of brake heat is recognizable in different stages of severity. In its early stages it is apparent when the rubber in the bead area starts to split or crack indicating that the steel casing plies are starting to unwrap. More advanced stages are indicated when the casing ply fully unwraps from the bead. In extreme cases, the casing ply unwraps from the bead all the way around the tyre. At this point, the tyre completely separates from the bead wire. The bead wire can entangle itself around the axle if this type of separation occurs.

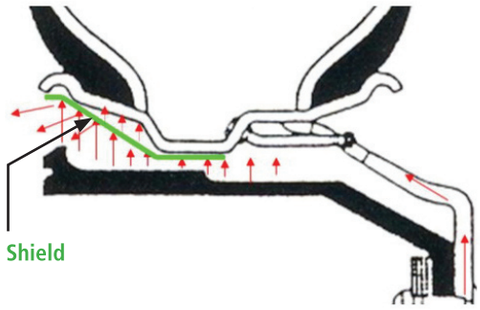
The chart below shows the relationship between rim temperature in the bead and the rapid loss of casing life when abnormal brake temperatures create excess heat.



Heat Shield

Some vehicles operating in challenging usage conditions can develop very high levels of brake heat even though the braking system is operating normally. These conditions can include constant stop-and-go routes, high ambient temperatures and operating in mountainous terrain. Michelin has developed a heat shield to reduce the transmission of heat from the brake to the rim in these operating conditions. The heat shield is fitted between the wheel and brake Rim. Temperature reductions of 60° to 70° C are possible.





Brake Drum

5TH WHEEL MAINTENANCE AND PLACEMENT

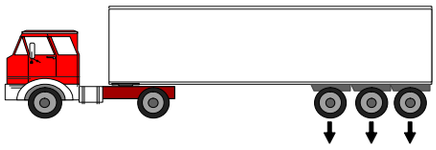
Placement of the 5th wheel can be determined by the need to properly distribute the load between the drive axle the steer axles. Insufficient lubrication of the 5th wheel can lead to poor vehicle handling and also contribute to uneven tyre wear.

Proper amount of lubrication

Insufficient lubrication

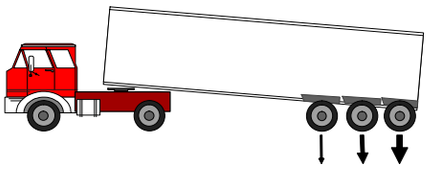
The height of the 5th wheel should be matched with the semi-trailer so the loaded, running condition of the trailer has the frame parallel to the ground. In cases where the tractor 5th wheel is too high or the trailer kingpin is too low, there can be a shift in the individual axle loading. The mismatched height could be the result of different tyre sizes on tractor and trailer or inappropriate matching when selecting vehicles.

Many air ride suspension systems are designed to equalize the ride height for each axle. In these cases, there will be no significant axle load difference across the trailer axles.

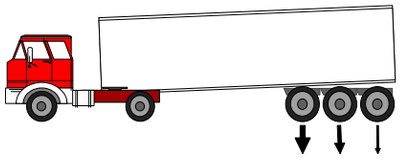


Normal Position

5th Wheel Height versus Trailer Trailer Load Distribution			
5th Wheel Position	% of Normal Axle Load		
	Axle 1	Axle 2	Axle 3
+ 10% (too high)	95%	95%	110%
Normal	100%	100%	100%
- 10% (too low)	110%	105%	85%



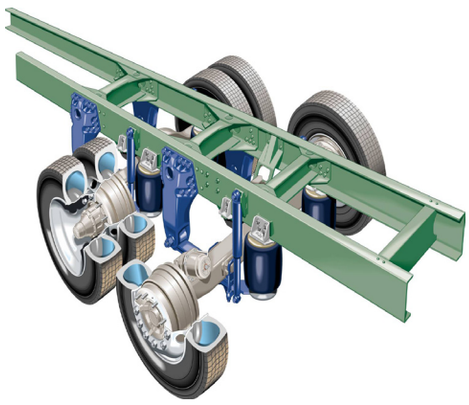
5th Wheel Too High - Will take load off the tractor axles



5th Wheel Too Low - Will add more load to the tractor axles

SUSPENSIONS

Forming the link between the truck and the tyre, the suspension system provides a very important contribution to tyre performance. The suspension must support the load and maintain the tyre in the proper operating position on the road. If the suspension is in good operating order, the tyres will track straight and be evenly loaded. This promotes slow, even wear and low tyre cost per kilometer. Different truck manufacturers use different suspension systems. Some of these are adjustable for making minor changes, and some are not adjustable.



All suspensions have parts that move and are, therefore, subject to wear. Worn or broken suspension parts are one of the main causes of uneven tyre wear and handling concerns. An inspection for worn or broken front and rear suspension parts should be part of any investigation of uneven wear.

Some common components which should be part of this inspection include:

Front Axle And Suspension:

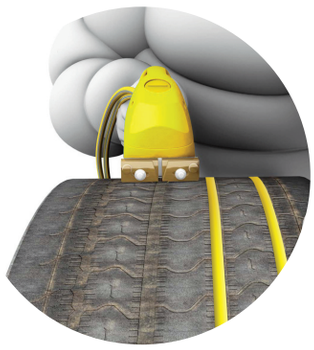
- Leaf Springs: Inspect angle of spring shackle (more vertical . is preferred). If spring hanger is horizontal, springs may be worn and require replacement.

- Spring Shackle Pins and Bushings: Inspect for zero play. Any play is beyond tolerance.
- Spring Eye and Bushings: Inspect for excessive wear. Use Frame Jack or long metal bar.
- Shocks: Inspect for leaks or signs of lockup. If leaks or signs of shock lockup appear, replace shocks. Inspect shock mounts and mount bushings for zero play.
- Front wheel bearing: Jack up the front of the vehicle with the wheels approximately 25mm off the floor. Use jack stands under axle for safety. Using a long bar, place one end beneath the wheel. Lift the wheel several times to feel for bearing play.
- Kingpin: Place one end of the bar in one of the wheel slots. Lift several times to feel for Kingpin play.

NOTE: It is often difficult to determine the difference between excessive wheel bearing and kingpin play. One clue is to watch the brake chamber when moving the bar. If the brake chamber moves when you move the bar, then the entire spindle is moving which indicates excessive kingpin play. If you feel movement with the bar and the brake chamber is not moving, then the excess play is probably in the wheel bearings.

Drive/Trailer Axles and Suspension:

- Wheel bearings: Follow same procedure reviewed above.
- Leaf Springs: Check for damaged or missing leaf spring elements.
- Leaf Spring attachment: Check for looseness or excessive wear in seating surfaces.
- Load Leveling Device: Look for signs of looseness or binding in the system.
- Air Bags: Verify air bag height with manufacturer's specifications and that all are at the same height; should only be checked when truck air system is at normal operating pressure.
- Shocks: Inspect for leaks or signs of lockup. If leaks or signs of shock lockup appear, replace shocks. Inspect shock mounts for zero play in bushings and pivot points.



Regrooving consists of removing some rubber from the existing under tread of the tyre. For detailed discussion of regrooving, see the Regroove Manual for Michelin truck tyres.

For this, when a tyre is designed, MICHELIN prescribes an under tread that is thick enough to allow high quality regrooving without affecting the strength or toughness of the product.

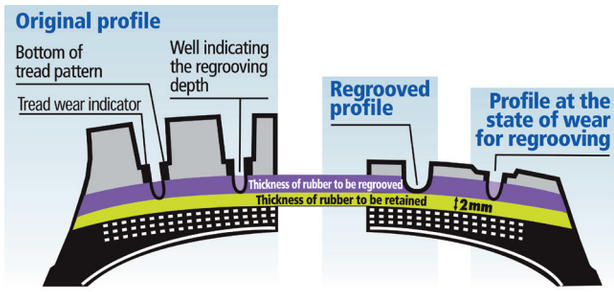
Regrooving offers several advantages and should be part of an overall tyre management program.

Safety - Regrooving gives new sharp edges and a tread depth which is about the same as a tyre with one third of its original tread remaining. The regroove process restores the main longitudinal grooves which assist with water evacuation from under the tyre. On some tread patterns, it also restores the transverse grooves which provide the grip or traction of the tyre. Carried out in accordance with Michelin's recommendations it has no adverse effect on the product regarding the strength of the crown block or casing.

Economy - Increased tread mileage - When a tyre is worn the tread blocks are shorter and have less slip as the tread block leaves the ground. This results in the tyre wearing more slowly and a larger number of kilometers per millimeter of tread rubber.

Economy - Increased fuel performance - A tyre is regrooved when it is at its lowest level of rolling resistance. As a worn tyre has less rubber deformation in the tread pattern, it generates less heat and so offers lower rolling resistance and uses less fuel.

Preservation of the environment - By extending the life of the tyre, regrooving reduces the number of worn tyres that cannot be reused. Additionally, the increased fuel economy also means lower CO2 emissions.



The process of regrooving involves removing of some of the original tread groove as shown in the following diagram.

It should be done when the tyre has 3-4 mm of original tread remaining. The correct regroove depth and width is specified in the Michelin Regroove Manual. In all cases, the tyre is designed to be regrooved and still have 2 mm of under tread to provide protection of the steel working plies.

Selection of the tyres to regroove should take into account the overall condition of the tyre. Do no regroove any tyre which

- Has multiple holes and cuts, places where the tread has been torn off.
- If the metal layers of the crown can be seen through damage or cuts.

Use the following chart to determine if the usage conditions are appropriate for regrooving. Tyres used in very aggressive environments may not be suited to regrooving due to aggression in the tread from stone and gravel roads.

Regrooving For Different Usage Conditions:

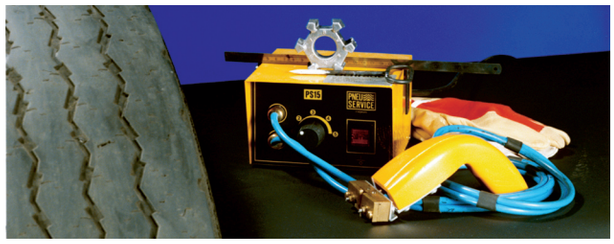
Usage Condition	Front Axle	Drive Axle	Trailer Axle
A *Long Distance - Straight Highway*	✓	✓	✓
E *Long Distance and Regional Operations*	?	✓	✓
U *Urban and Suburban*	?	✓	✓
Y *On/Off Road*	?	?	?
H *Off Road (Quarries)*	✗	✗	✗
N *Grip (Wet and All season)*	✓	✓	✓

✓ *<< Recommended*

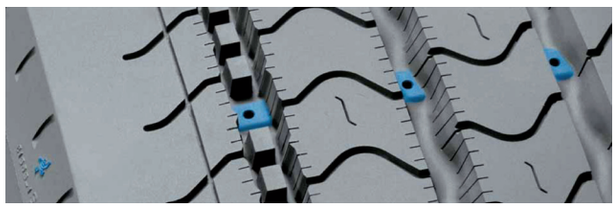
? *<< Fitment suggested only if fleet does not experience tread cutting damage due to usage conditions*

✗ *<< Not Recommended*

Use the proper tools for regrooving including a stand which can safely hold the tyre during the process yet still provides an easy way to rotate the tyre. Verify the correct regroove blade size as well as the depth and width to regroove from the Regroove Manual.

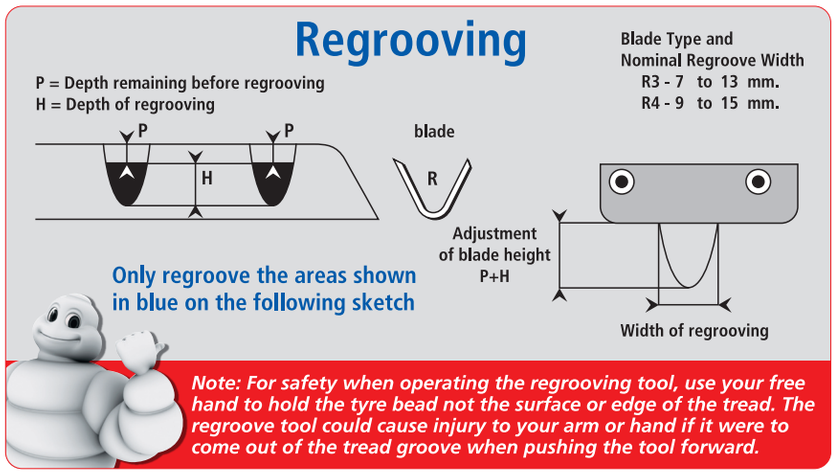


Many Michelin tyres have a regrooving well in the center of the tread wear indicators to allow high-quality regrooving. Some tyres do not have these indicators but are still fully designed for and ready to be retreaded. Just follow the steps below to ensure the proper depth is obtained.



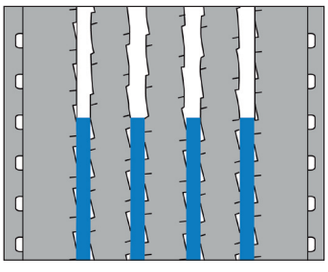
Regroove Steps:

1. Inspect the tyre thoroughly while checking for any exposed steel cords or casing damage which would otherwise prevent the tyre from operating safely.
2. Verify the remaining tread depth is between 2mm and 4mm by checking several locations around the tyre. If any area of the tyre has no measurable tread depth remaining, the tyre should not be regrooved.
3. Confirm the recommended regroove pattern, regroove depth and regroove tool blade shown in the Michelin Regroove Manual.
4. Place the tyre in a regrooving stand or other location where it can be safely handled throughout the regrooving process.
5. Begin with the first groove by measuring the remaining tread depth in the most worn area. Add this remaining tread depth to the recommended regroove depth to establish the regroove tool setting. For example, if the first groove has 2mm of tread remaining and the recommended regroove depth is 3mm, set the regroove tool to a total depth of 5mm.
6. Regroove a small section of this first rib (10-15cm in length). Using a tread depth gauge, measure the resulting tread depth to verify the correct reading. In the example above this tread depth reading should be 5mm. If the reading is not correct, adjust the tool accordingly. Once the regrooved tread depth is correct, proceed with the remainder of the rib.
7. Repeat steps 5 and 6 for the remainder of the tyre.



Follow the guidelines in the diagram below for proper setting of the regroove blade depth. Ensure that the blade size and maximum regroove depth match the specifications for the tyre being regrooved.

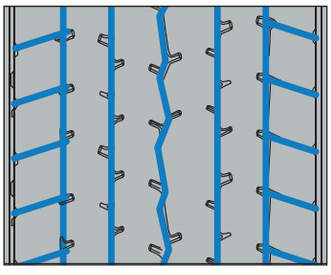
Typical Regroove Recommendations:



XZE 2 - XZE 2 +

19.5 and 22.5" Rim Diameter

Theoretical depth of regrooving	Width of regrooving	Blade
19.5": H = 3 mm. 22.5": H = 3 mm.	7 to 8 mm. 8 to10 mm.	R3 R3



XD COACH

295/80 R 22.5

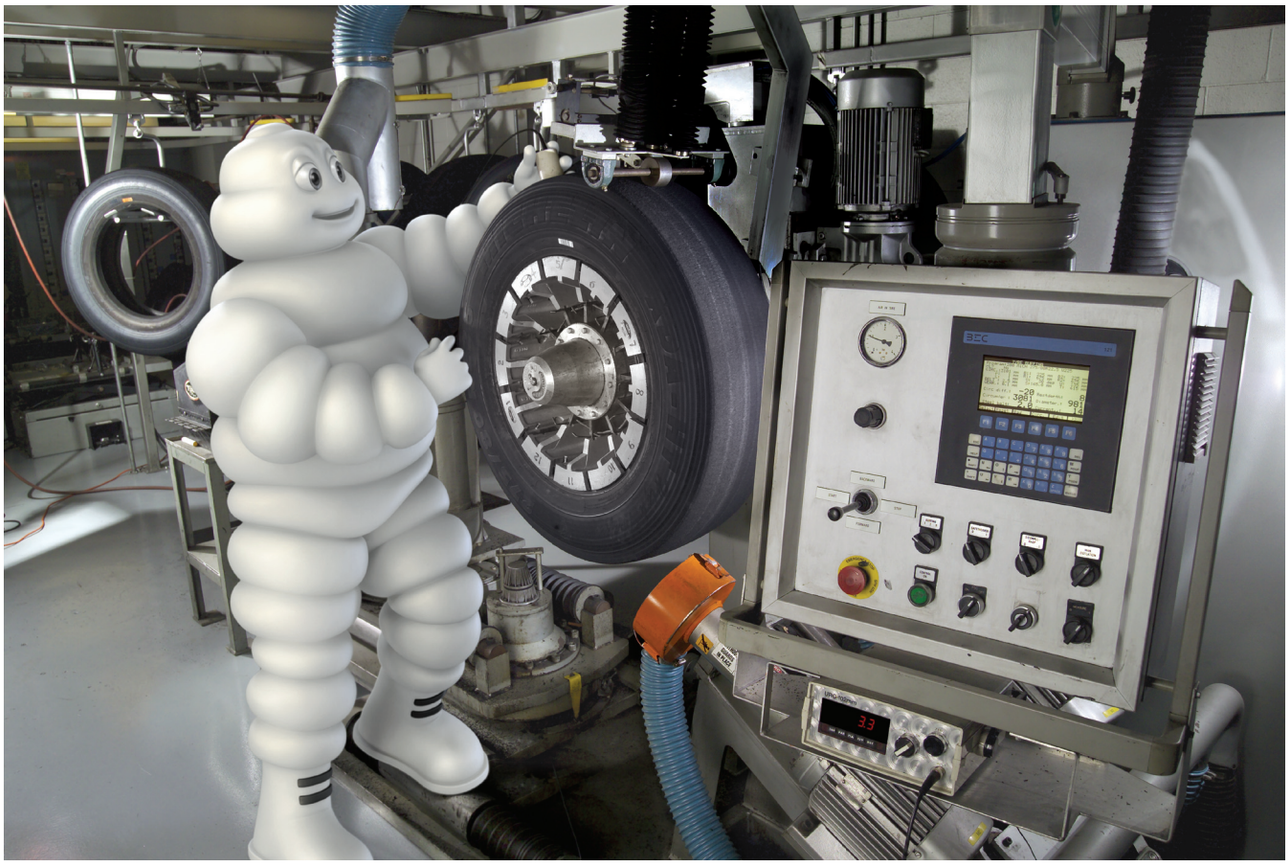
Theoretical depth of regrooving	Width of regrooving	Blade
H = 3 mm.	6 to 8 mm.	R3

Retread

Since Michelin radial tyres are manufactured to very precise tolerances, it is necessary for similar standards of accuracy to be maintained during the retreading process. Suitably designed modern equipment for radial tyres must be provided in the retread shop. The proper tread designs, tread width, tread compound and tread depths must be selected according to the type of tyre and its anticipated service.

The tyre must be processed with precision to maintain the design characteristics of the Michelin radial. As there is very little margin for error when retreading radial tyres, perfection should be the only standard acceptable

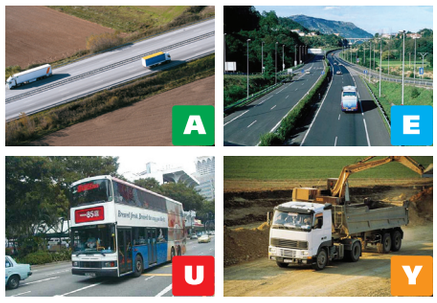
Michelin Retreading forms the core of the ultimate retread service package offering top quality products, unrivalled technology, a superb service scheme and mileage comparable to that of a new tyre. Dimensional data for Michelin Retread tyres will be equivalent to new tyres. For additional details, please refer to the Michelin Retread Data Book.



Regrooving – along with retreading – can result in a significant cost savings over the life of the tyre. The following scenarios show the large positive impact on total cost per kilometer when a complete life-cycle program, which includes regrooving and retreading, is implemented by a fleet.

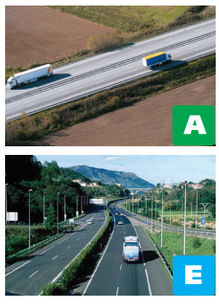
Scenario 1 : New Tyre Only (One Life)

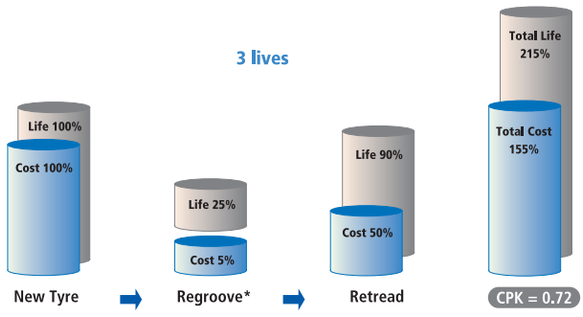
Segments mostly involved



Scenario 2 : One Regroove And One Michelin Retread

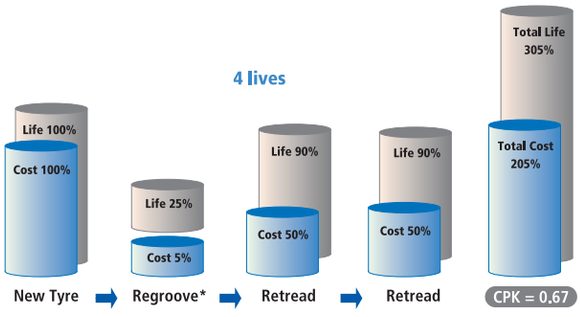
Segments mostly involved





Scenario 3 : One Regroove And Two Michelin Retreads

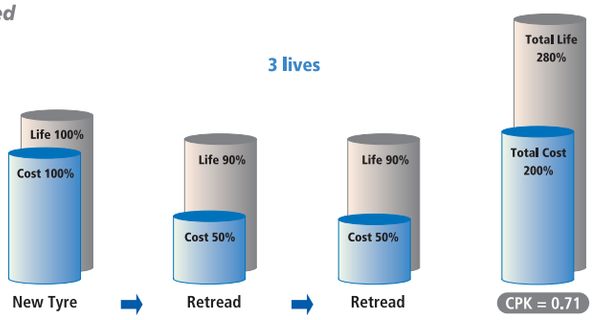
Segments mostly involved



** The possibility of Scenario 3 depends on your casing conditions.*

Scenario 4 : Two Michelin Retreads

Segments mostly involved



Tyre Repair

Introduction

A properly made repair can provide many additional kilometers to an otherwise useless tyre. However, the tyre must be carefully inspected to determine whether its condition justifies the cost of repairing, and if it can be safely re-used under normal operating conditions.

WARNING: Always demount the tyre from the wheel and complete a thorough tyre and wheel inspection prior to returning the components to service

Whatever the quality of the products used, the success of the repair will depend mainly on the methods applied, the care taken to carry out the various procedures, and the competence and conscientiousness of the repairer.
For a more detailed look at tyre repair, refer to the Michelin Truck Tyre Repair Manual.

NOTE: These procedures are applicable for Michelin patches only. Refer to the specifications provided by the manufacturer for other brands of radial repair materials. Never use bias type patches to repair Michelin radial tyres.

Repair Types

Tyre repairs generally fall into three categories - crown, sidewall and bead. Each area of the tyre has a limit to the size of repair which is safely possible. Refer to the charts at the end of this section for specific recommendations by tyre size.

Crown punctures which are small - 6mm or less - can be repaired with a simple one or two-piece repair system which utilizes a chemical cure process for proper vulcanization of the repair to the tyre. This method is readily available on the market and does not require the patch material to be cured with heat. Larger punctures to the crown and all sidewall and bead repairs must be done with uncured rubber that requires heat and pressure for vulcanization. These repairs should only be performed by qualified technicians at tyre dealers and retread factories.

Inspection

The first and most important step, in the repair process is a through initial inspection of the tyre to be repaired. The objective of initial inspection is to determine if it is technically worthwhile to repair the tyre. This demands a high level of proficiency on the part of the inspector.

A well lighted, clean area with adequate working space and inspection stand are required for proper inspection of radial tyres. The casing must be clean and dry. Damages often remain undetected in tyres that are dirty and wet. Draw a line on the tyre to mark the start and finish point for your inspection of the interior and exterior of the tyre. Using a portable light closely examine the interior and exterior for penetrations, separations or other damages. Use your hand and portable shop light to help detect any abnormalities.

Make one full revolution for each of the following areas:

1. Check the interior of the tyre crown, sidewalls and beads for damage.
2. Check the exterior of the tyre crown, sidewalls and beads for damage.
3. Carefully inspect the bead areas. Make sure that there are no broken, bent, exposed or separated bead wires and that the bearing area is not worn, damaged or deformed.

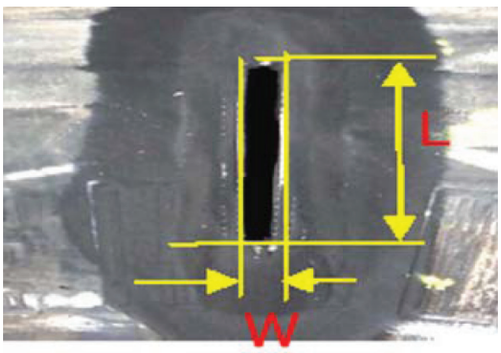
The portable shop light can be used to cast shadows. This will assist you in detecting pulled cables, separations, bulges or other abnormalities in the sidewall and bead area. Do not use excessive force when probing injuries, as the damage may be enlarged needlessly. Measure any damage to see if it is within repair limits. Mark all damages found with a grease pencil.

Grazing Light Method

Measuring Damages

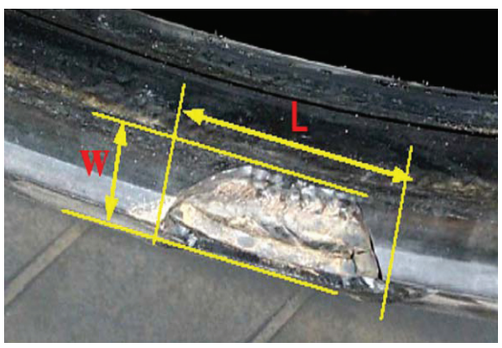
SIDEWALL DAMAGE

The size is measured within a rectangle:
L = Length of damage along the cords.
W = Width of damage across the cords.



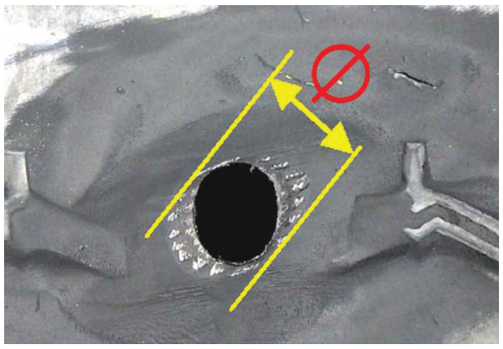
BEAD DAMAGE

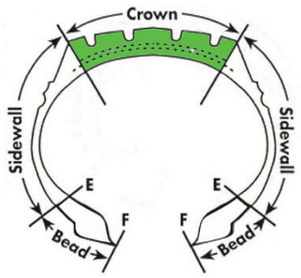
The size is measured within a rectangle:
L = Length of damage along the bead.
W = Width of damage along the casing ply.



CROWN DAMAGE

The size is determined by the maximum diameter of the damage measured on the casing ply.





NOTE ON BEAD DAMAGE: Bead repairs are limited to rubber repairs only. If damage to the steel casing ply or bead wire exists, the tyre must be scrapped.

Crown Puncture Repair with Combination Unit

1. Locate the injury and mark both the outside and inside of the tyres. (Photo 1-1 and 1-2)

Photo 1-1

Photo 1-2

2. Remove the object from the tyre. (Photo 1-3)

Photo 1-3

3. Choose a probing awl with adequate size. Inspect the injury carefully without expanding the damage looking for residual damage to the tyre. Determine the angle to perpendicular. If the angle of the penetration is greater than 25 degrees, it cannot be repained with a combination unit due to the stress created on the stem by the large angle. (Photo 1-4)

Photo 1-4

4 Choose the correct size of the combination unit and the carbide cutter. (photo 1-5)

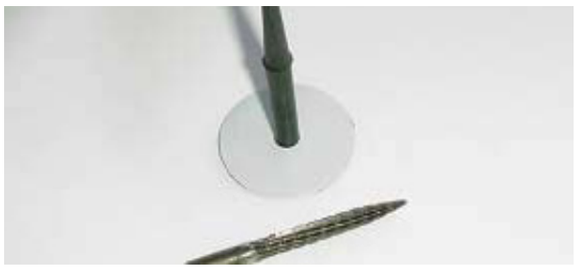


Photo 1-5

5 Center the correct repair unit over the injury referring to the cross line. Draw a circle around the repair unit about 10mm (3/8") larger than the repair unit. (Photo 1-6)

Photo 1-6

6 Using the correct size carbide cutter for the injury on a low speed (2,700 - 4,000 rpm) buffer, follow the direction of the damage. Work from the inside of the tyre to the outside. Repeat the process three times. (Photo 1-7) Repeat the process from the outside of the tyre to ensure proper injury preparation. The steel must be ground back into and firmly embedded in solid rubber without separation.

Photo 1-7

7 Using a low speed (2,700-4,000 rpm.) buffer with a pencil stone to refresh the grinded area from outside and inside of the. The movement should be quick and with adequate light force. This is to remove any scorched rubber to ensure the right bonding. (Photo 1-8)

Photo 1-8

8 Use a low speed (2,700 - 4,000 rpm) buffer and ball or dome rasp (36 grit) to buff the area outlined for the repair unit to a smooth (RMA2) texture. Remove all traces of venting ribs in the area outlined for the repair. Do not buff through the liner. (Photo 1-9)

Photo 1-9

9 Brush the buffed area with a hand held soft wire brush to loosen and remove buffed particles. Vacuum out the residue. (Photo 1-10).

Photo 1-10

10 Apply a thin even coat of cement to the buffed area from the center out. Then cement the hole using a blunt probe. Allow cement to dry per manufacturer instructions. Temperature and humidity can affect drying time. (Photo 1-11)

Photo 1-11

11 Remove the protective poly carefully to permit handling of the unit without contaminating the tacky surface of the repair unit. (Photo 1-12)

Photo 1-12

12 With the beads relaxed, insert the repair unit until the pincers can grasp it from the outside of the tyre. Do not dimple the unit into the hole. Use pincers to pull the repair unit just flush with the liner and stitch into place. (Photo 1-13 and 1-14)

Photo 1-13

Photo 1-14

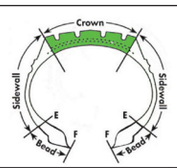
13 Stitch the repair unit into place from the center out toward the edges of the repair unit. (Photo 1-15)

Photo 1-15

14 Cut the insert off on the outside of the tread flush with the surface. The tyre is now ready to be placed back into service. (Photo 1-16)

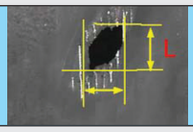
Photo 1-16

Repair Limits - Crown

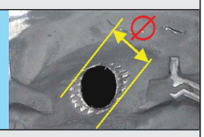


REPAIR LIMITS : CROWN AREA

L x W on casing ply

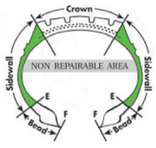


Ø MAXI on crown plies



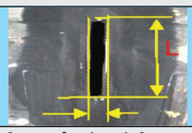
Tyre Size Category	Measurements on casing ply (NC) in mm											
	L x W	L x W	L x W	L x W	L x W	Ø	L x W	Ø	L x W	Ø	L x W	Ø
A									na		na	
B	40 x 5 20 x 10	80 x 5 40 x 10	120 x 5 60 x 10	160 x 5 80 x 10	200 x 5	10	70 x 15 50 x 20	15	100 x 15 70 x 20 60 x 25	25	130 x 25 105 x 30 90 x 35 80 x 40	35
C												
D							75 x 10 50 x 15 35 x 20		100 x 10 50 x 20 40 x 25			
Recommended Michelin patch →	ERX SLA 21	ERX SLA 23	ERX SLA 25	ERX SLA 27	ERX SLA 29	ERX SLA 21	ERX SLA 41		ERX SLA 43		ERX SLA 45	

Repair Limits - Sidewall



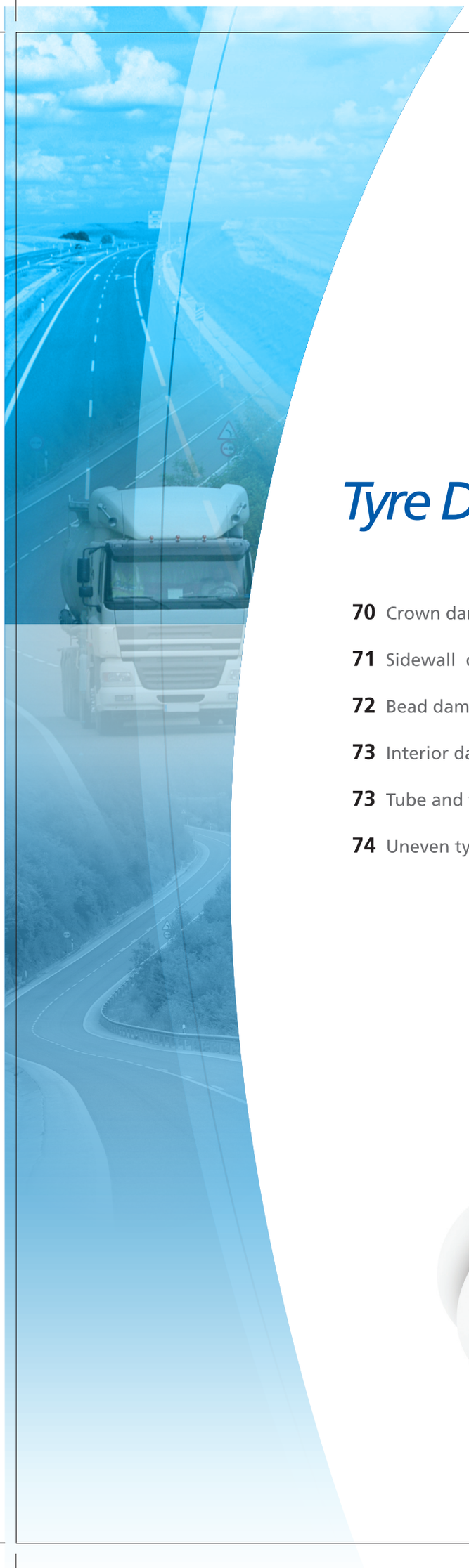
REPAIR LIMITS : SIDEWALL AREA

L x W on castng ply



Tyre Size Category	Bead FE	Measurements on casing ply (NC) in mm							
		L x W	L x W	L x W	L x W	L x W	L x W	L x W	L x W
A	65							Oa	Oa
B	75	40 x 5 20 x 10	80 x 5 40 x 10	120 x 5 60 x 10	160 x 5 80 x 10	200 x 5	70 x 15	120 x 20	160 x 20
C	75	40 x 5 20 x 10	80 x 5 40 x 10	120 x 5 60 x 10	160 x 5 80 x 10	200 x 5	70 x 15	100 x 15 75 x 20	160 x 20
D	75	40 x 5 20 x 10	80 x 5 40 x 10	120 x 5 60 x 10	160 x 5 80 x 10	200 x 5	70 x 10 50 x 15	100 x 10 70 x 15	130 x 20
Recommended Michelin patch		ERX SLA 21	ERX SLA 23	ERX SLA 25	ERX SLA 27	ERX SLA 29	ERX SLA 41	ERX SLA 43	ERX SLA 45

15"-16"-20"≤24"		17.5"-19.5"-22.5"≤24.5"										
H/S 100	H/S 80	H/S 90	H/S 90	H/S 80	H/S 75	H/S 70	H/S 65	H/S 60	H/S 55	H/S 45	Category	Examples
6.50-7.50	205-225	7-8.5	225	205-225	205-235	225-245	205	205			A	225/75 R17.5 Category A
8.25-10.5	275	9-11		235-275		255-295		295-305			B	275/70 R22.5 Category B
11.00-16.00	325-475	12-13		295-315		305-315	305	315			C	315/80 R22.5 295/80 R22.5 Category C
19.5	365	15-24			350		385-445		385-425	445-495	D	385/65 R22.5 Category D

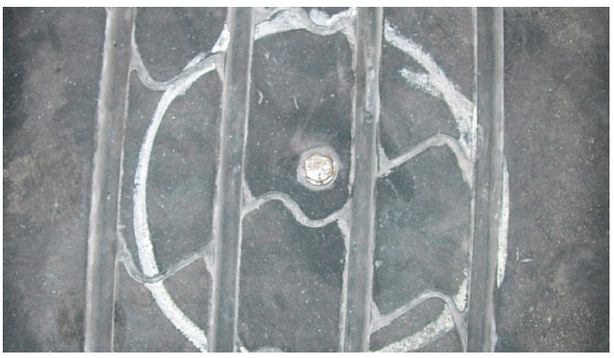


Tyre Damage And Wear

Section Four

Crown Damage

Identification of the root cause for a tyre failure is an important part of the overall tyre maintenance program. This section provides examples of several common damages, some of which may have more than one potential cause. For a more detailed look at tyre damage, please consult the publication "Michelin Tyre Guide for Diagnosing Tyre Wear and Premature Removal"



Crown puncture can lead to other damages if not repaired.

Multiple tread cuts - tyre design not intended for severe environment

Crown rupture usually related to impact damage.

Crown detachment or separation - overload, underinflation, tyre not matched to usage conditions.

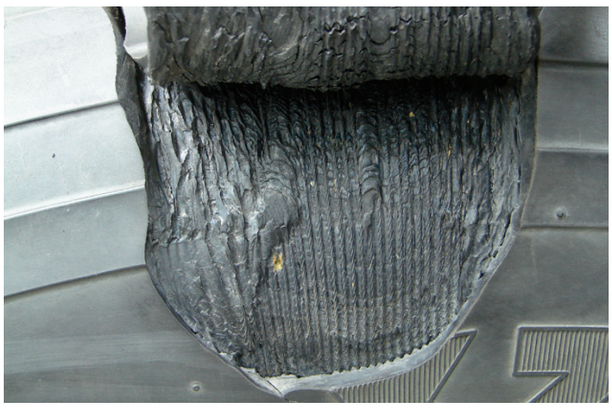
Shoulder scrubbing - high lateral force on tyre; maneuvering in confined areas.

Brake skid - wheel locking due to hard braking or faulty brake system components.

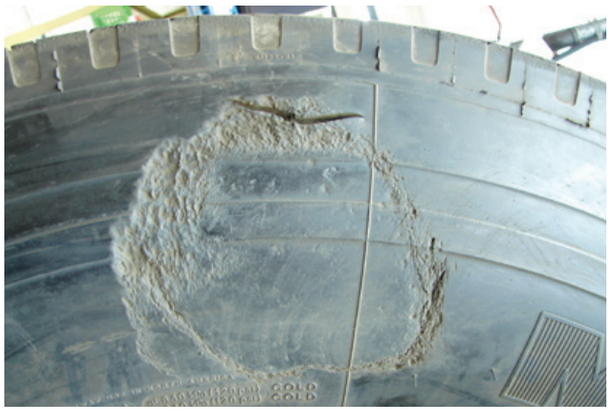
Sidewall Damage

Sidewall cut or puncture - penetration of sidewall by foreign object.

Tyres in twin fitment touching - under inflation, overload, improper wheel offset.



Air infiltration - puncture, fitting damage or other damage which compromises the inner liner.



Object trapped between twin tyres - solid object jammed between both tyres - (both tyres may be damaged).

Curbing - repeated contact with curb or other fixed object.

Sidewall impact/pinching - tyre sidewall pinched between rim and fixed object while running.

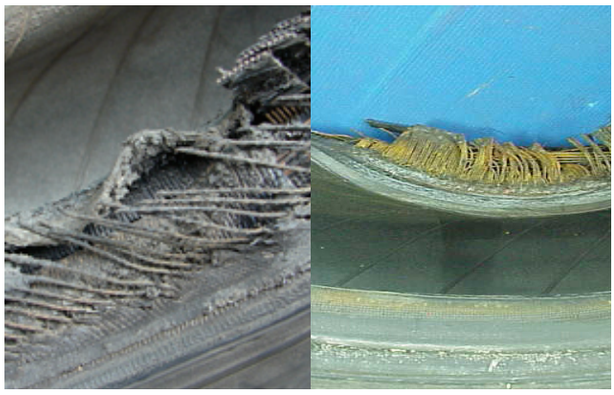
Sidewall rupture - running tyre while underinflated or flat or overload.

Bead Damage

Fitting damage - improper use of fitting equipment.

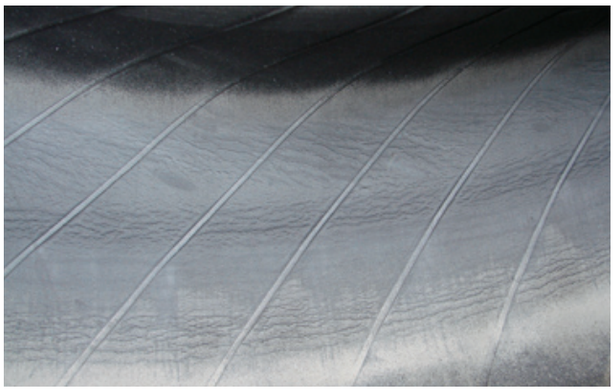
Bead deterioration from Foreign Matter - debris trapped between tyre and wheel; rust and corrosion on wheel bead surfaces.

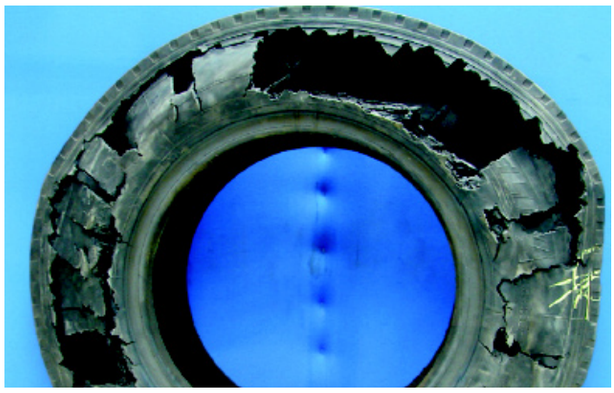
Excessive wear in bead portage Area - overload; under inflation.



Bead deterioration from Excessive Heat - excessive braking; continuous braking on downhill routes; poorly adjusted or faulty braking system.

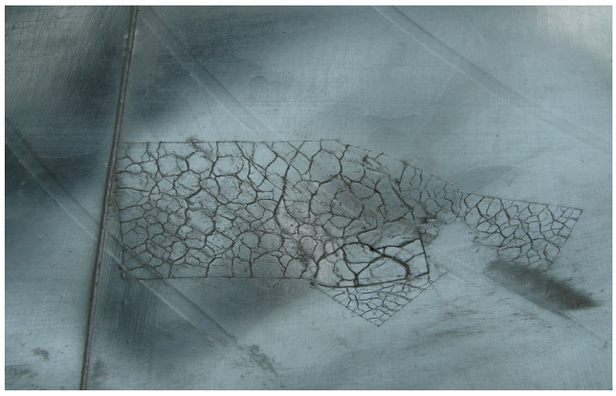
Interior Damage





Runflat tyre operated with very low or zero air pressure.

Tube And Flap Damage

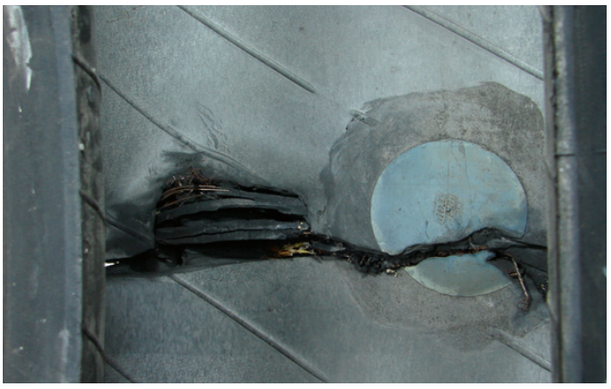


Foreign matter damage - contamination trapped between tube and tyre.

Valve damage - damage due to over tightening; poor fitment, valve chafing against brake drum.

Tube damaged by flap - improper installation of flap leads to cutting of tube.

Other Damages:



Repair failure - original damage not fully removed; poor workmanship in repair preparation or installation.

Uneven Tyre Wear

Wear	Causes				
tram-line wear	slow wear rate	usage conditions			
heel/toe wear	air pressure match (twin)	tread depth matching (twin)	air pressure	slow wear rate	lack of tyre rotation
	matching design/usage	high engine torque	high center of gravity	driver influence	heavy braking
feathered wear	alignment	worn component	scrubbing	high wind drift on vehicle	
center wear	presssure	improper rim width			
sloped wear	camber	axle overload	bent axle		
both shoulders worn	pressure	improper rim width			
shoulder cupping	mechanical problem	alignment	shock absorber	brake system	
	high center of gravity	pressure mismatch in twin	balance	poor bead seating	
diagonal wear	alignment	worn component			
odd aspect	alignment	tyre matching	air pressure matching	slow wear rate	mechanical problem

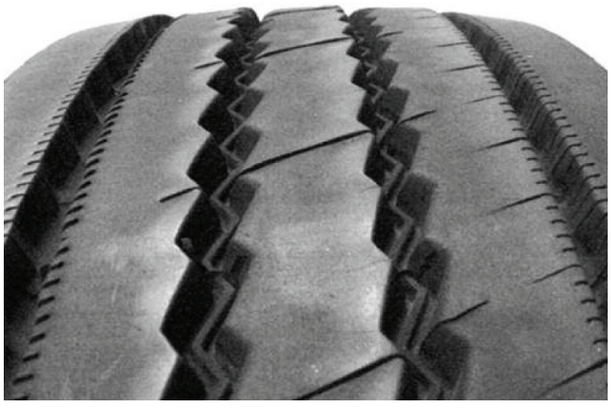
Uneven wear on tyres can be the result of one or several factors. These factors can be related to conditions of operation such as route distance, load and speed. Selection of the tyre must be carefully considered to ensure it is suited for these conditions. Additionally, the condition of the vehicle can have a major impact on tyre wear. Improper axle geometry settings and worn steering and suspension components will have a major impact on tyre wear.

Tram line wear

Center wear

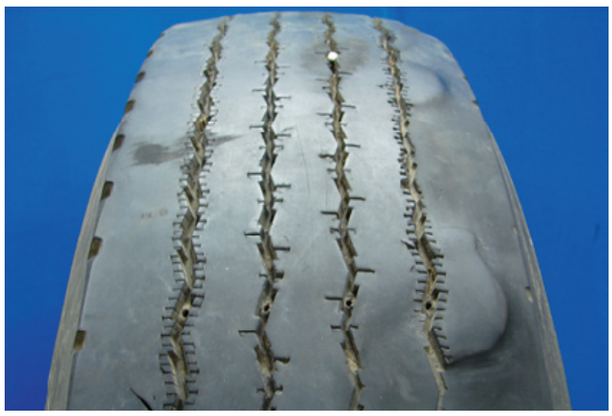
Heel and toe wear

Sloped wear



Feathered wear

Both shoulders worn

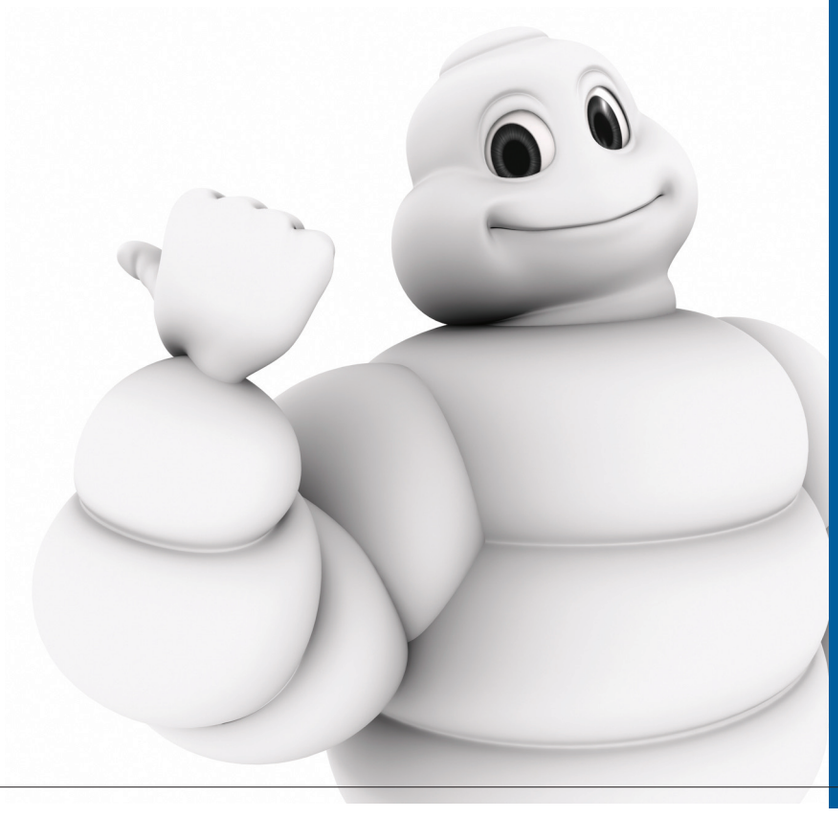


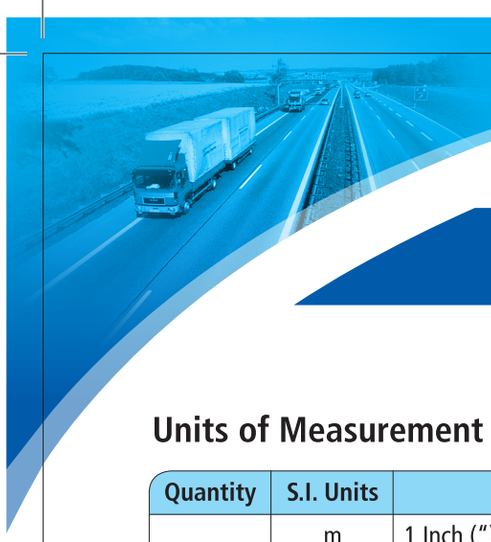
Shoulder cupping

Odd aspect wear

Diagonal wear

Appendix
Section Five





Units of Measurement

Quantity	S.I. Units	Other Units
Length	m (meter)	1 Inch (") = 0.0254 m or 25.4 mm 1 mile = 1609 m (1.609 km) 1 kilometer = 0.621 mile
Mass	kg (Kilogram)	1 pound (lb) = 0.4536 kg 1 Kilogram (kg) = 2.205 lbs.
Pressure	kg (Pascal)	1 bar* = 100 kPa 1 psi = 6.895 kPa 1 bar = 14.5 psi 1 kg/cm2 - 98.066 kPa
Speed	m/s (meter per second)	1 kilometer per hour (kph)* = 0.27778 m/s 1 mile per hour (mph) = 0.4470 m/s (or 1.60935 kph)

**Non S.I. unit to be retained for use in specialized fields.*

Load Range/Ply Rating

B - 4
C - 6
D - 8
E - 10
F - 12
G - 14
H - 16
J - 18
L - 20
M - 22

Pressure Unit Conversion Table

kPa	bar	psi*	kg/cm²*
100	1.0	15	1.0
150	1.5	22	1.5
200	2.0	29	2.0
250	2.5	36	2.5
300	3.0	44	3.1
350	3.5	51	3.6
400	4.0	58	4.1
450	4.5	65	4.6
500	5.0	73	5.1
550	5.5	80	5.6
600	6.0	87	6.1
650	6.5	94	6.6
700	7.0	102	7.1
750	7.5	109	7.7
800	8.0	116	8.2
850	8.5	123	8.7
900	9.0	131	9.2
950	9.5	138	9.7
1000	10.0	145	10.2
1050	10.5	152	10.7

** Values in psi and kg/cm² rounded to the nearest practical unit.*

Cold Climate Pressure Correction Table

Because the air pressure inside a tyre will decrease when the vehicle is taken from a warm environment to a cold one, some adjustments may be necessary when adjusting the tyre pressures of a vehicle to be operated in very cold temperatures. These adjustments are only necessary if the pressures are verified and adjusted inside a heated garage with an air supply that is also at the higher room temperature. (No adjustment necessary if done outside.)

In extreme cases, the following table should be used to ensure that the operating pressure and deflection of tyres are adequate at the outside ambient temperature. Using the load and pressure charts in the Technical Data Book, determine the appropriate "Recommended Pressure" required for the axle load. Then find the same pressure down the left column of the table to the right. Going across to the relevant outside ambient temperature you will find the corrected inflation pressure to be used.

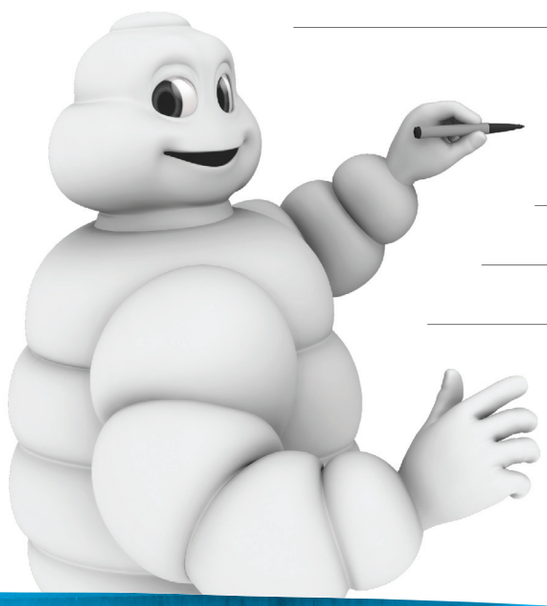
For example:

- A log truck has a front axle loaded weight of 5,700 kg.
- The truck is equipped with 11R22.5 XZE 2+ tyres.
- The recommended pressure for this fitment is 105 psi.
- The truck is parked overnight in a heated garage.
- The outside high forecasted for today is -29°C.
- The tyre pressures are checked and adjusted prior to leaving the heated garage. According the chart below, the tyres should be adjusted to 128 psi.

Adjusted Inflation Pressure (psi) when inflating indoors at 18°C

Recommended Pressure (psi)	Outside Ambient Temperature (°C)										
	10°	4°	-1°	-7°	-12°	-18°	-23°	-29°	-34°	-40°	-46°
75	78	80	81	83	86	88	90	92	95	98	100
80	83	85	87	89	91	93	96	98	101	104	107
85	88	90	92	94	97	99	102	104	107	110	113
90	93	95	98	100	102	105	108	110	113	116	119
95	98	101	103	105	108	111	113	116	119	123	126
100	103	106	108	111	113	116	119	122	125	129	132
105	109	111	114	116	119	122	125	128	132	135	139
110	114	116	119	122	125	128	131	134	138	141	145
115	119	122	124	127	130	133	137	140	144	148	151
120	124	127	130	133	136	139	143	146	150	154	158
125	129	132	135	138	141	145	148	152	156	160	164
130	134	137	140	144	147	150	154	158	162	166	171

Memo



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