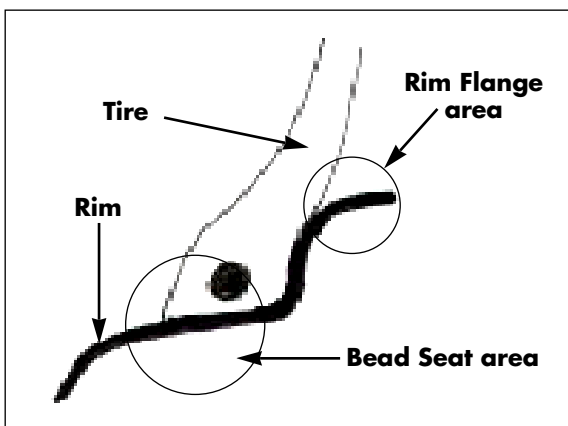


# TOYO TIRE TALK

## Subject: Wheel & Rim - Passenger Car

The tire works as a wheel only after it is installed on the rim and is inflated. Therefore, the tire and wheel assembly influences the function and the performance of the vehicle. The tire is designed and manufactured to suit a standard rim and once installed on the correct rim the tire will perform up to its desired level. It is needless to say that the life of the tire will be shortened if it is installed on an unsuitable rim.



The rim is actually the name for the cylindrical part where the tire is installed. A wheel is the name for the combination between the rim and disc plate. Once the disc plate is installed inside the cylinder this assembly becomes a wheel.

Toyo Tire Talk at this time would like to introduce basic technical knowledge about passenger vehicle rims.

### 1. History of Wheel/Rim

Several thousand years ago was the start of the history of wheel when the human race began to use the log to transport heavy objects. The original of the wheel were the round slices of a log and it was gradually re-inforced and used in this form for centuries on both carts and wagons.

This solid disc changed to a design having several spokes radially arranged to support the outer part of the wheel keeping it equidistant from the wheel centre.

A wooden wheel which used hard wood stakes as spokes was very popular as a wheel for many vehicles up to about 1920.

Afterwards the disc wheel, in which the spokes were replaced with a disc made of steel plate, was introduced and is still being used to this day.

Furthermore, a light alloy has come to be used currently as a wheel material for many types of vehicle.

# TOYO TIRE TALK

## 2. Type of Wheel/Rim (Dimensional)

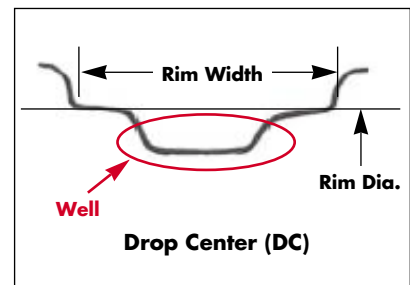
The rim used for vehicles is provided depending on each country's standard. This international standard, similar to tires, provides for a basic dimension for the rim diameter, width, and the flange shape, etc. and is common to every country in the world. Recently the shape of the rim has settled to 5 degree Drop Center Rim to provide for international harmony.

### A. Shape of Rim

Typical rim shape vehicles are made up of the following three types.

#### (1) Drop Center Rim ( DC )

Drop Center Rim (DC Rim) is shaped so there is a well between the bead seat part which is located on both sides of the rim. This well is to make the mounting and dismounting of the tire easy. In most cases there is a taper of 5 degrees in the bead seat area.

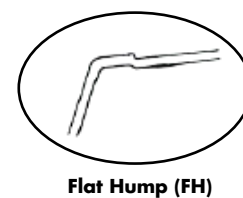
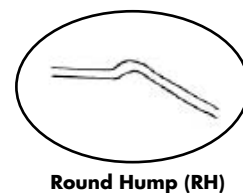
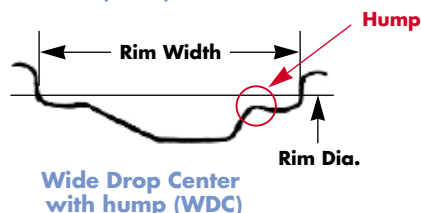
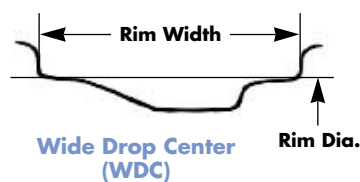


#### (2) Wide Drop Center Rim ( WDC )

Wide Drop Center Rim (WDC Rim) is basically the same as DC Rim. To expand the width of the rim, with a shallower well and a lower flange height, this rim is mainly applied to low aspect ratio tires. This design is currently applied to rims for tires of most passenger vehicles.

#### (3) Wide Drop Center Rim with hump ( WDC )

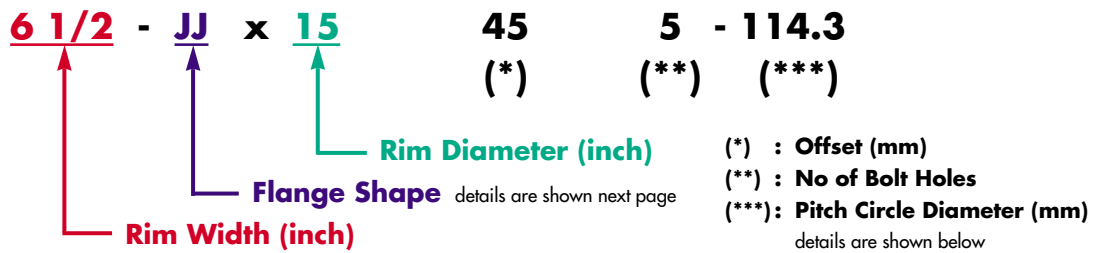
In addition, this design has a bump, which is called a hump, on the beginning of the bead seat area. This hump is to prevent the bead slipping down and air leakage from the rim due to the horizontal force applied to the tire when a vehicle tubeless tires turns at high speed.



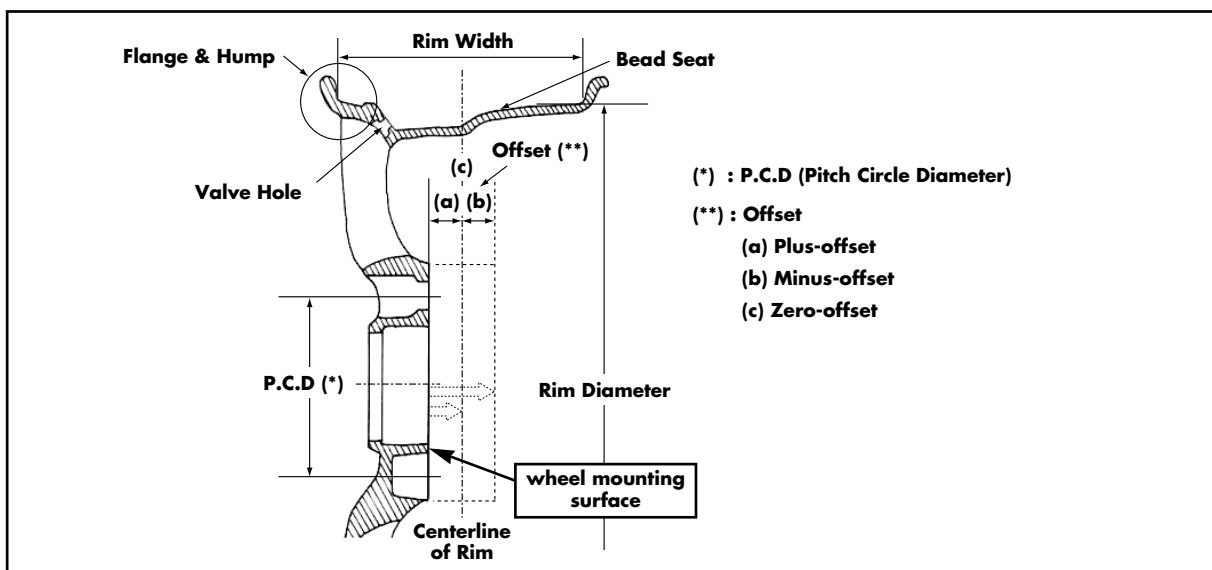
# TOYO TIRE TALK

## B. Rim Size Designation

Rim size designation is as below;

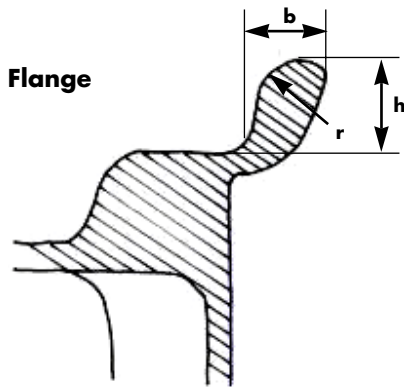


## C. Rim Nomenclature



- (1) **Wheel:** Wheel is generally composed of rim and disc.
- (2) **Rim:** This is a part where the tire is installed.
- (3) **Disc:** This is a part of the rim where it is fixed to the axle hub.
- (4) **Offset:** This is a distance between wheel mounting surface where it is bolted to hub and the centerline of rim.
- (5) **Flange:** The flange is a part of rim which holds the both beads of the tire.
- (6) **Bead Seat:** Bead seat comes in contact with the bead face and is a part of rim which holds the tire in a radial direction.
- (7) **Hump:** It is bump what was put on the bead seat for the bead to prevent the tire from sliding off the rim while the vehicle is moving.
- (8) **Well:** This is a part of rim with depth and width to facilitate tire mounting and removal from the rim.

# TOYO TIRE TALK



Dimension

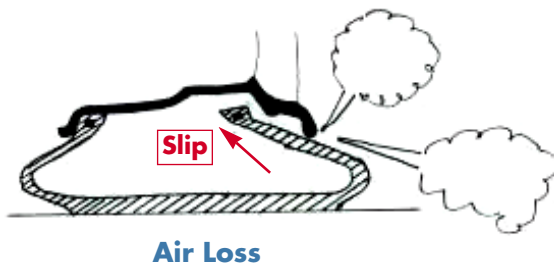
Unit : mm

Symbol	h	b	r
B	14.0 +1.0, -0.5	10.0	7.5
J	17.5 +1.0, -0.5	13.0	9.5
JJ	18.0 +0.7, -0.7	13.0	13.0

tolerance

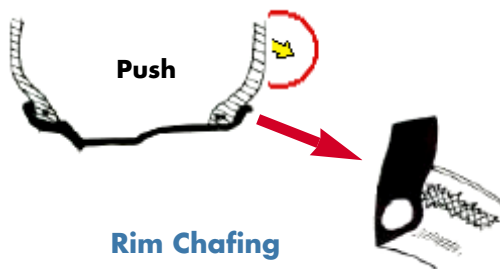
## D. Rim Width

The width of the rim is provided in TRA, ETRTO, and JIS, etc. according to the size of the tire. Generally rim width difference of about plus/minus one inch is allowed to be used in comparison to the design rim; you should confirm the most suitable rim size for the tire from the tire dealer. The tire manufacturer designs the tire to become the best profile when the tire is mounted on a design width rim. Generally, it is best to use the design width rim to obtain the optimum performance from the tire.



Air Loss

When the car installed with Tubeless tires under greatly decreasing the air pressure turns rapidly a large side force is applied to the tire. The bead sometimes drops into the well of the rim, and the air comes out suddenly. This situation is made worse when an overly wide rim is used.



Rim Chafing

If the tire is used on a narrow rim, the stress concentrates on the bead part where it touches the rim and flange. The rubber in this part and the ply cord wear out, and becomes damage which is called Rim Chafing.

Moreover, if severe cornering is repeated with the air pressure of the tire lowered, Rim Chafing might occurred to the tire.

# TOYO TIRE TALK

## 3. Type of Wheel/Rim (Material)

Steel and light alloy are the main materials used in a wheel however some composite materials including glass-fiber are being used for special wheels.

### A. Wire Spoke Wheel

Wire spoke wheel is a structural where the outside edge part of the wheel (rim) and the axle mounting part are connected by numerous wires called spokes. Today's vehicles with their high horsepower have made this type of wheel construction obsolete. This type of wheel is still used on classic vehicles. Light alloy wheels have developed in recent years, a design to emphasize this spoke effect to satisfy users fashion requirements.

### B. Steel Disc Wheel

This is a rim which processes the steel-made rim and the wheel into one by welding, and it is used mainly for passenger vehicle especially original equipment tires.



### C. Light Alloy Wheel

These wheels based on the use of light metals such as aluminium and magnesium have become popular in the market. This wheel rapidly become popular for the original equipment vehicle in Europe in 1960's and for the replacement tire in United States in 1970's. The features of each light alloy wheel is explained as below;

#### (1) Aluminium Alloy Wheel

Aluminium is a metal with features of excellent lightness, thermal conductivity, corrosion resistance, characteristics of casting, low temperature, machine processing and recycling, etc.

This metals main advantage is reduced weight, high accuracy and design choices of the wheel.

This metal is usefull for energy conservation because it is possible to re-cyle aluminum easily.



# TOYO TIRE TALK

## (3) Magnesium Alloy Wheel

Magnesium is about 30% lighter than aluminium, and also, excellent as for size stability and impact resistance. However, its use is mainly restricted to racing, which needs the features of lightness and high strength at the expense of corrosion resistance and design choice, etc. compared with aluminium.

Recently, the technology for casting and forging is improved, and the corrosion resistance of magnesium is also improving. This material is receiving special attention due to the renewed interest in energy conservation.

## (4) Titanium Alloy Wheel

Titanium is an excellent metal for corrosion resistance and strength (about 2.5 times) compared with aluminum, but it is inferior due to machine processing, designing and high cost. It is still in the development stage although there is some use in the field of racing.

## (5) Composite Material Wheel

The composite materials wheel, is different from the light alloy wheel, and it (Generally, it is thermoplastic resin which contains the glass fiber reinforcement material) is developed mainly for low weight. However, this wheel has insufficient reliability against heat and for strength. Development is continuing.

## 4. Manufacturing Method of Wheel/Rim

The steel disk wheel and the light alloy wheel are the most typical installation. The method of manufacturing the light alloy wheel, which has become popular in recent years, is explained here. The manufacturing method for the light alloy wheel is classified into two. They are cast metal or the forged manufacturing method.

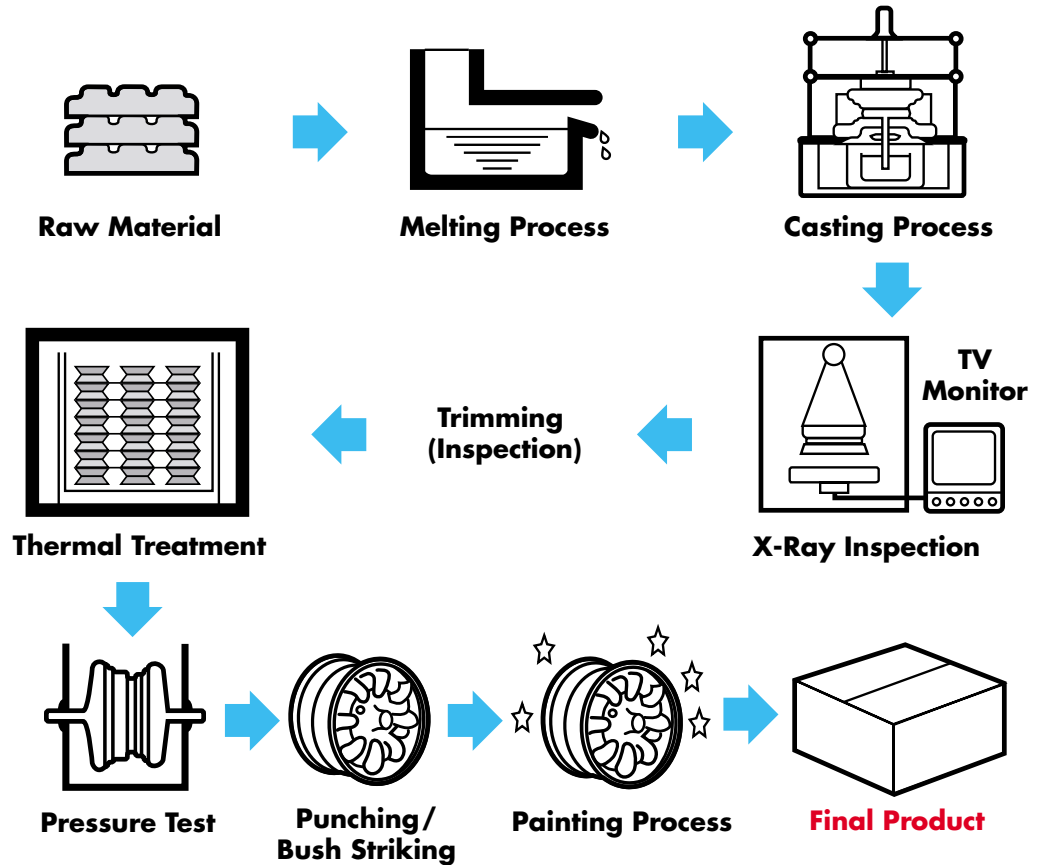
The aluminum alloy wheel is manufactured both ways, and the casting manufacturing method is used as for the magnesium alloy wheel. There are the following three methods of manufacturing the aluminum alloy wheel.

- ① **One piece rim:** This is a method of the casting or the forge at the same time by one as for the rim and disc.
- ② **Two pieces rim:** This is the methods which separately manufacture the rim and disc similar to the manufacture of the steel wheel and these components are welded afterwards.
- ③ **Three pieces rim:** This is a method to manufacture each flange separately, and combining later to the disc by welding.

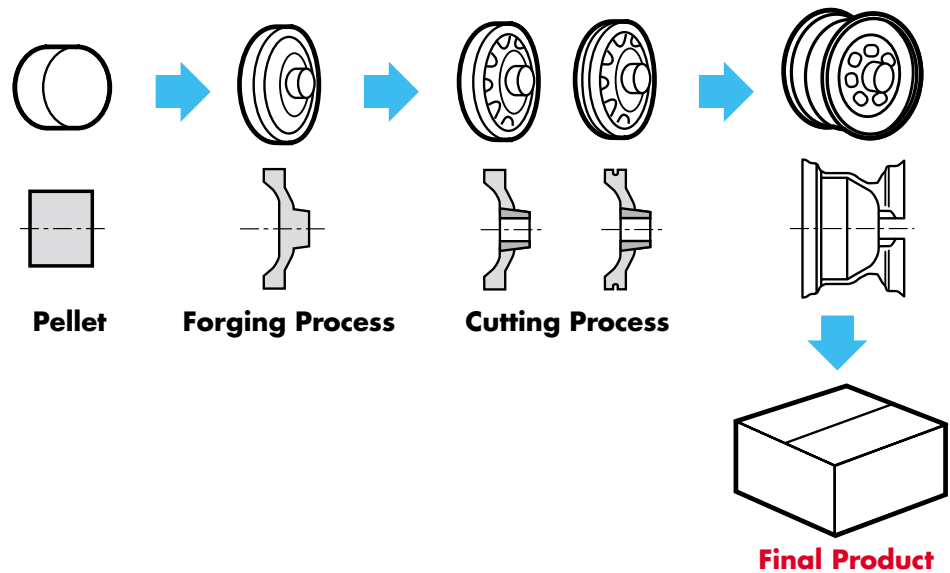
Each method is shown in the figure from next page.

# TOYO TIRE TALK

## (1) Casting Method

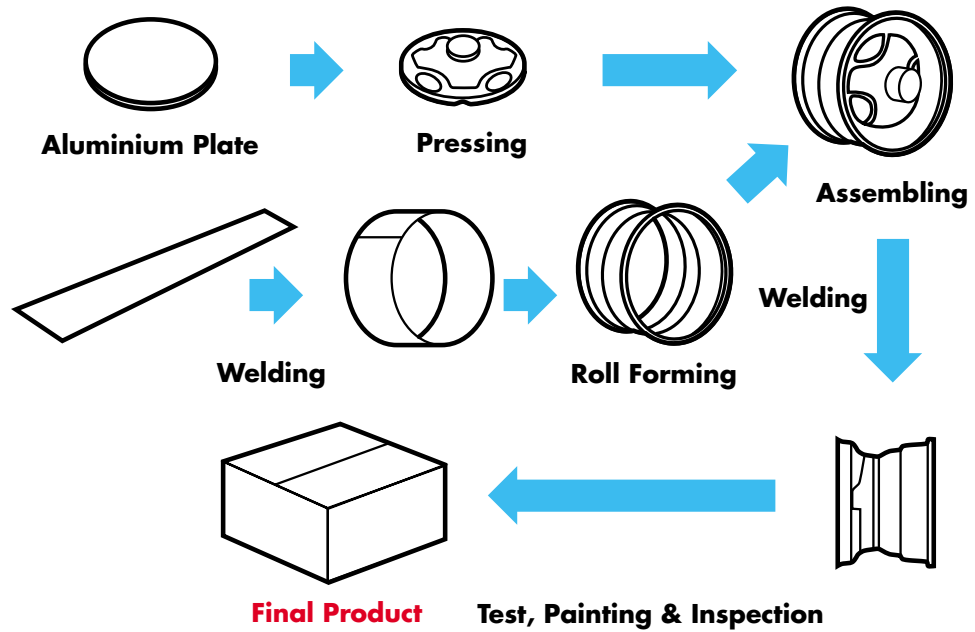


## (2) Forging Method ( One piece )

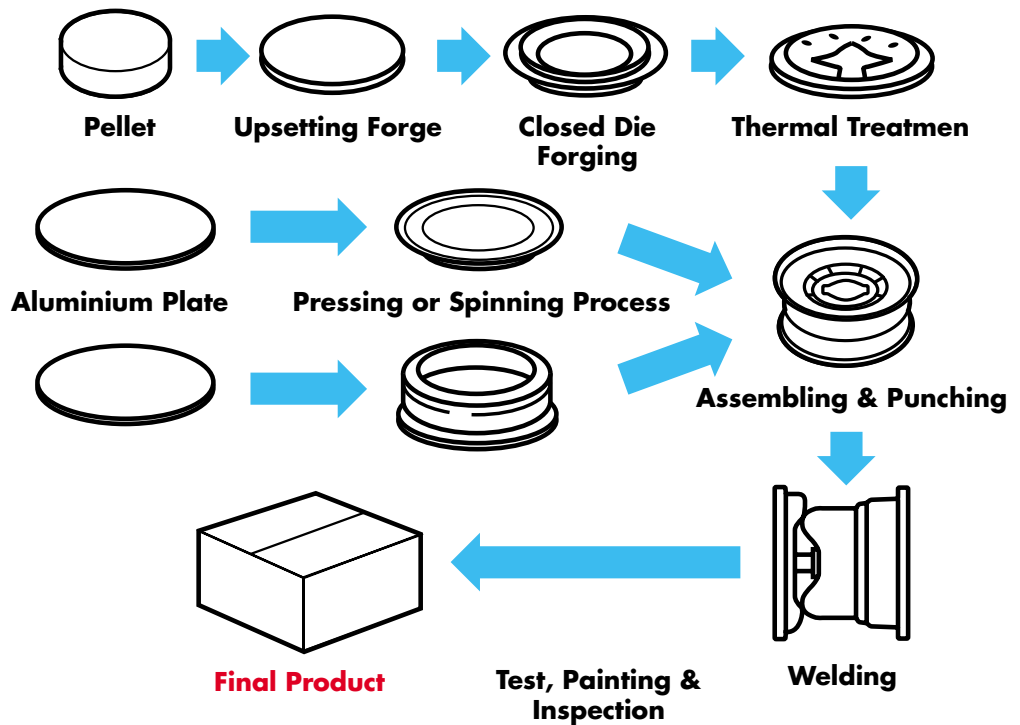


# TOYO TIRE TALK

## (3) Forging Method ( Two piece )



## (4) Forging Method (Three Pieces)



# TOYO TIRE TALK

## 5. Test of wheel

Wheels are part of a vehicle and as such subjected to a high load. The durability of the wheel is important for the safe operation of the vehicle. Therefore, it is necessary to examine a wheel for both strength and fatigue resistance.

### (1) Endurance test in direction of radius of rim

The tire on the test rim is rotated under high pressure condition on steel drum and the durability of the rim is examined. Sometimes, test is done giving camber angle and adding a side force.

### (2) Test of disc

The rim flange is tested by applying a load from an arm mounted to the hub. A bending moment is applied while the rim rotates.

### (3) Impact Test

The case where the wheel collides with curb of the road or a large obstacle is assumed and the fall impact examination is done.

### (4) Others

The test for welding between rim and disc and the nut seat tightening etc. are provided in the vehicle test standard. Moreover, nondestructive testings such as X ray and color check, etc. are adopted to the light alloy wheel to detect the defects in the casting process. Bead Unseating Test, provided in the tire safety standards, for a mounted tire and the rim is also applied.

In addition tests are carried out in the field with the assembly mounted on a vehicle under various road surfaces.

## 6. Use limit of wheel

Though we think it is possible to permanently use a wheel until it rusts away there is a limit to a wheel's useful life. If a rim is used in severe operations such as racing or rallying hidden damage is caused. This may result in an accident or sudden rim failure whilst damage is caused. This may result in an accident or sudden rim failure whilst the vehicle is in service. The life of a rim is varied according to using conditions. A rim normally lasts longer than a tire so at time of a tire change a rim should be checked for damage or sign of failure. If any are found the rim should be scrapped.

In the case of steel wheel, cracks and corrosions by rust at the joint parts of rim and disc, nut seats, between decoration holes of the rim or the flange is bent, you should scrap the rim.

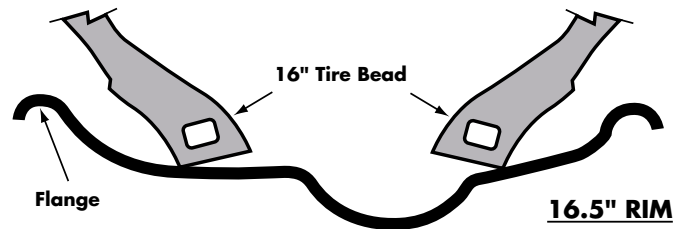
# TOYO TIRE TALK

## WARNING

**If you install a tire on a different size rim •••  
you could be dead wrong !!**

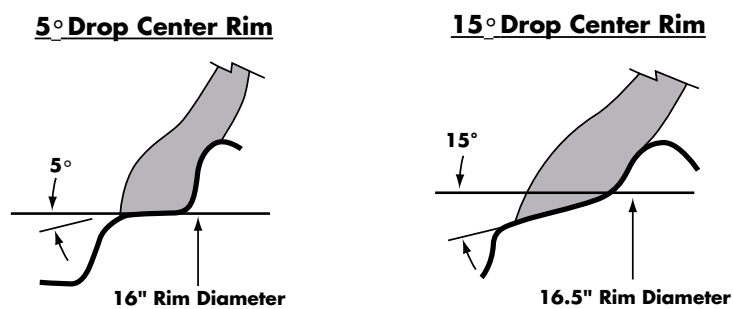
Although it is possible to pass a 16 inch tire over the lip or flange of a 16.5 inch rim, it can not be positioned properly.

Attempting to seat the rim by inflating will cause an explosive force that could cause injury or death.



Rims of different diameters and tapers can not be interchanged.

The diagram below illustrates the difference between rims of two different tapers and diameters.



Every rim include information on diameter and width. Always make sure the stamped rim size matches the tire bead diameter. Most wheels include a warning label inside the rim to protect employees who mount tires and wheels.

**We think that this issue was very simple for you, therefore, we will introduce you more usefull information of rim such as an application, correct usage and inspection etc. on next opportunity.**