

TOYO TIRE TALK

Subject: PCR Tire Performance and Contributing Factors Tread Crown Radius and Contact Patch

1. Introduction

A tire has to fulfill many performance requirements.

Some of these are Dry/Wet Handling, Ride, Comfort, Noise, Rolling Resistance, Wear, etc..

One of the design criteria that affects tire performance is the tire contact patch. Contact patch is changed by a combination of tire profile and construction.

- * Factors contributing to tire profile : tread width, tread crown radius, etc.
- * Factors contributing to tire construction : belt material, belt angle, presence of cap/edge ply, etc.

We shall review the relationship between the tire profile , especially tread crown radius and contact patch.

2. Tire Performance - Contact Patch Shape

The tire's contact patch contributes to a tire's performance in the following manner. (See Fig. 1)

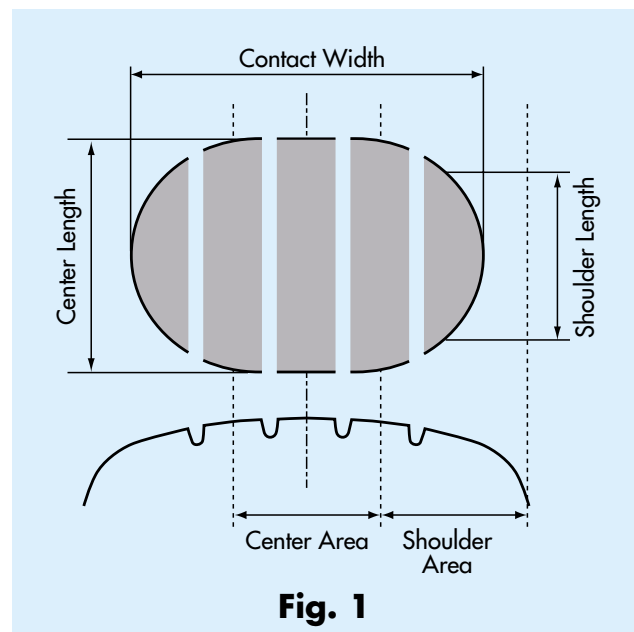
- * Bigger Center Area:

Better Straight Stability and Handling Response

- * Bigger Shoulder Area:

Better Cornering Performance

A tire designer has to decide tread width and crown radius according to the tire's required performance.



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3. Contact Patch Shape - Crown Radius

- * Smaller Crown Radius (see Fig. 2) :
Longer Center Length, Narrower Contact Width (In this case, center area's contact pressure is higher than shoulder area's.)
- * Bigger Crown Radius (see Fig. 2) :
Longer Shoulder Length, Wider Contact Width (In this case, shoulder area's contact pressure is higher than center area's.)

We would like to show you an example.
2 contact shapes from different Crown radius. (See Fig. 3 & Table 1)

Tire Size : 195/65R15

(Tires have the same construction.)

* Tire A : Crown radius = R360mm.

* Tire B : Crown radius = R620mm.

Tire A's contact patch is oval in shape,
tire B's contact patch is rectangular.

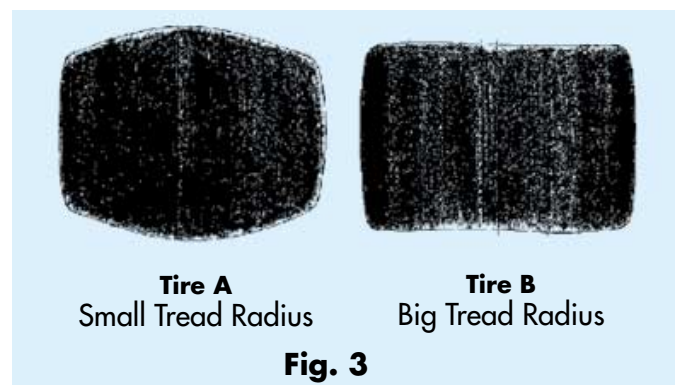
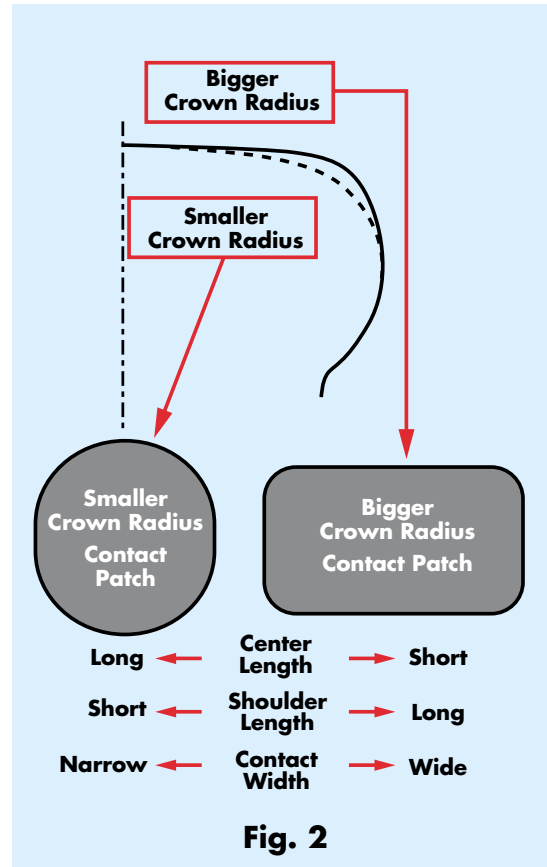


Table 1. Dimentions of Contact Patch

	Tread Radius [mm]	Center Length [mm]	Shoulder Length [mm]	Contact Width [mm]	Contact Area [mm ²]
Tire A	360	148	111	130	168
Tire B	620	128	126	136	170

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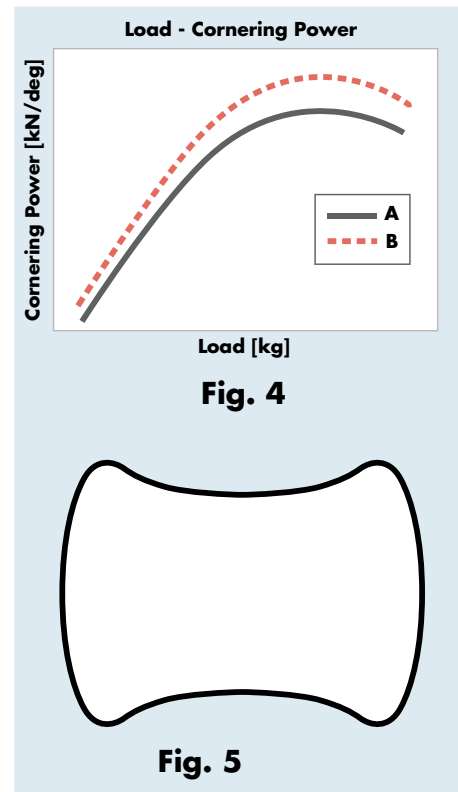
4. Crown Radius - Tire Performance

Fig. 4 shows comparison data in cornering power between Tire A (smaller crown radius) and Tire B (bigger crown radius). Tire B has higher cornering power than tire A, this means a larger crown radius tire has better cornering performance than a smaller crown radius tire.

An UHP tire which requires High Cornering Performance usually adopts larger (flatter) crown radius.

The bigger crown radius makes a contact patch close to a rectangle shape, and provides higher cornering performance. When a much larger crown radius is used to obtain higher cornering performance, the contact patch will become butterfly shaped. (Fig. 5)

In this case, other tire performance criteria will be reduced. For example, longer shoulder length may contribute to excessive shoulder wear.



5. Conclusion

The table below shows the relationship between Crown Radius and Contact Patch. This verifies that the contact patch is an important item for tire performance.

Table 2. Comparison Table of Tread Radius

	Center Length	Shoulder Length	Contact Patch	Straight Stability	Limit of Tire Grip	Wear
Tread Radius Bigger	▼	△	Rectangle Shape	▼	△	Shoulder Wear
Tread Radius Smaller	△	▼	Oval Shape	△	▼	Center Wear

△: Increased ▼: Reduced

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Note: In the previous case, we have shown the tread shape with one constant radius. In the case of a constant crown radius the contact patch shape change, while cornering, will not be smooth. Therefore, to provide a smooth cornering transition, we usually utilize two or three crown radii on the same tire. This provides uniform distribution of contact pressure and leads to an even contact shape as well as smooth cornering.

