

## ChassisSim – The Tyre model quick start guide.

The purpose of this document is to introduce the tyre modelling quick start guide and how you can use it to refine your tyre models. The tyre model quick start gives you access to the important features of the ChassisSim v3 tyre approximation as covered in CSim\_v3\_tyre\_model\_documentation.pdf in the help directory. The power of this feature is that it gives you access to tune in the camber/traction ellipse properties, peak slip angles and slip ratios and the traction circle radius vs load characteristic. Consequently this is the perfect tool to dial in your initial model.

### Introducing the ChassisSim tyre force quick start

To access the tyre modelling quick start click on the tyres and click on the tab that says Click here for Tyre model Edit/Quick Start. The following dialog will be displayed,

**Tyre Model Quick Start/Edit**

Camber/Ellipse Properties	Tyre Force curve properties
<input type="checkbox"/> Apply Camber Settings	<input type="checkbox"/> Apply Load settings
Opt Camber: 2.4999999	No of Load Pts: 20
Lateral camb sens: 1.0000000	No of Temp Pts: 10
Long camb sens: 1.7000000	<a href="#">Click here to edit TC Radius properties</a>
Init Long Mult: 0.9999999	Optimum tyre Temp: 59.999989
<input type="checkbox"/> Apply Spring Rate Settings	Pre opt tyre slope: 0
Tyre Spring Rate: 179.34	Post opt tyre slope: 0
Tyre Damp Rate: 0	Min Temp: 19.999991
<input type="checkbox"/> Apply Slip angle/ratio settings	Max Temp: 109.99998
Max slip angle: 0.1047229	Tyre Fn Mode: Square Fn
Max slip ratio: 0.1047229	<a href="#">Click here for adv Exp settings</a>
OK	Cancel

**Fig-1 – ChassisSim tyre model quick start.**

The tyre model quick start allows you to dial in and control the following tyre characteristics,

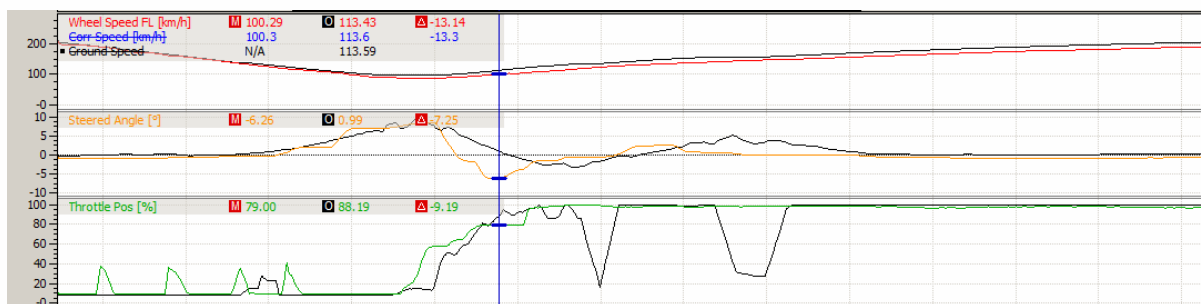
- Camber and traction ellipse properties
- Tyre spring rate. However please note this will apply a fixed spring rate.

- Maximum slip angle and slip ratio.
- The Traction Circle radius vs Load and temperature characteristics.

As can be seen all the parameters presented for camber/traction ellipse and the load characteristics are all based on the ChassisSim v3 tyre model approximation. Consequently this is the perfect tool to introduce to the ChassisSim tyre model and help you refine your tyre model.

## Using the ChassisSim tyre model quick start

The first aspect of the tyre model quick start is dialling in the camber and traction ellipse properties. This is actually your first go to when the mid corner speeds match up but the acceleration into and out of the corner is too good. This situation is illustrated in Fig-2,



**Fig-2 – Acceleration into and out of the corner.**

The actual data is coloured the simulated data is black. As can be seen from the speed trace the simulated lap is way too good on acceleration. If you see the scenario presented in Fig-2 reduce the Init long mult as seen in Fig-1. This has the immediate effect of flattening the traction ellipse, which in this case was necessary because we were simply too good on the way out of the corner.

You also adjust the camber sensitivity multipliers and peak lateral camber depending on the camber sensitivity you see with the tyre. The peak lateral camber as seen in Fig-1 is the actual tyre camber where the tyre produces its peak lateral force. This should not be confused with static camber on your setup sheet. As a rough rule of thumb I will for my initial model set it about 1 – 1.5 deg greater than the camber in the setup sheet. That being said this will also be affected by camber gain you see in the corners as well. In terms of camber sensitivity you should find the following guide useful,

**Table – 1 : Approximate values for camber sensitivity settings**

Car Type	Lat Camb sensitivity	Long Camb sensitivity
Open Wheeler	3	2
GT car	2	2

Sedan	0.5 – 1	0.5 - 1
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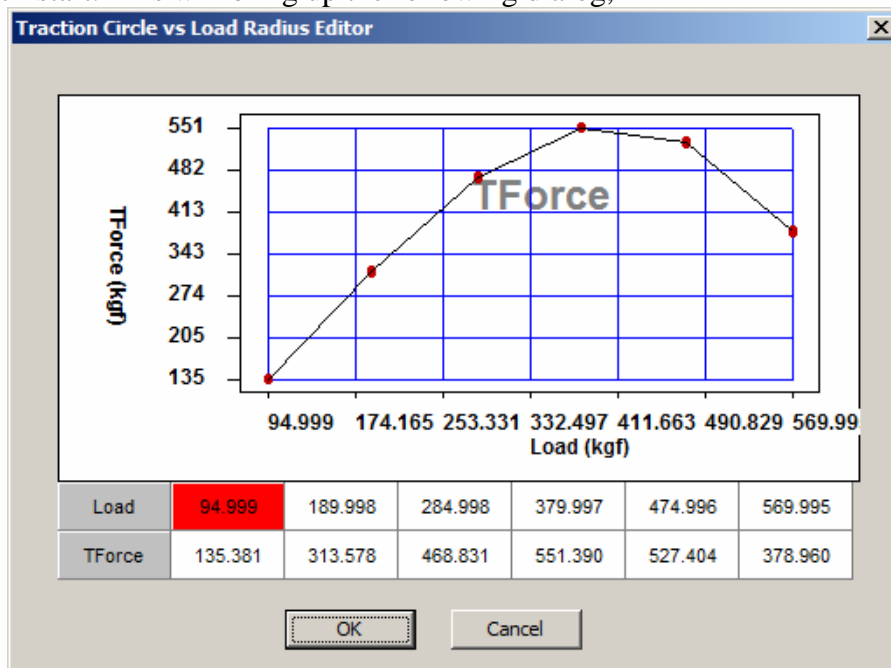
The more sensitive the car is to camber the more you increase the camber sensitivity numbers by.

The next point on the list is to compare simulated to actual steer and adjust the maximum slip angles. This is actually one area were you need to be very careful. If you have a good driver you should be able to achieve good correlation. However if you have a bad driver don't expect miracles because the less skilled drivers aren't as sensitive in detecting when the self aligning torque is dropping off. This all being said some rough rules of thumb are,

- If the simulated steering lock is down everywhere increase the front and rear slip angles by say a degree.
- If you don't have enough understeer, increase the front slip angles and decrease the rear slip angles.
- If you are dealing with either a locked diff or Limited slip diff with significant lock ratio and you have significant understeer, drop the max rear slip ratio.

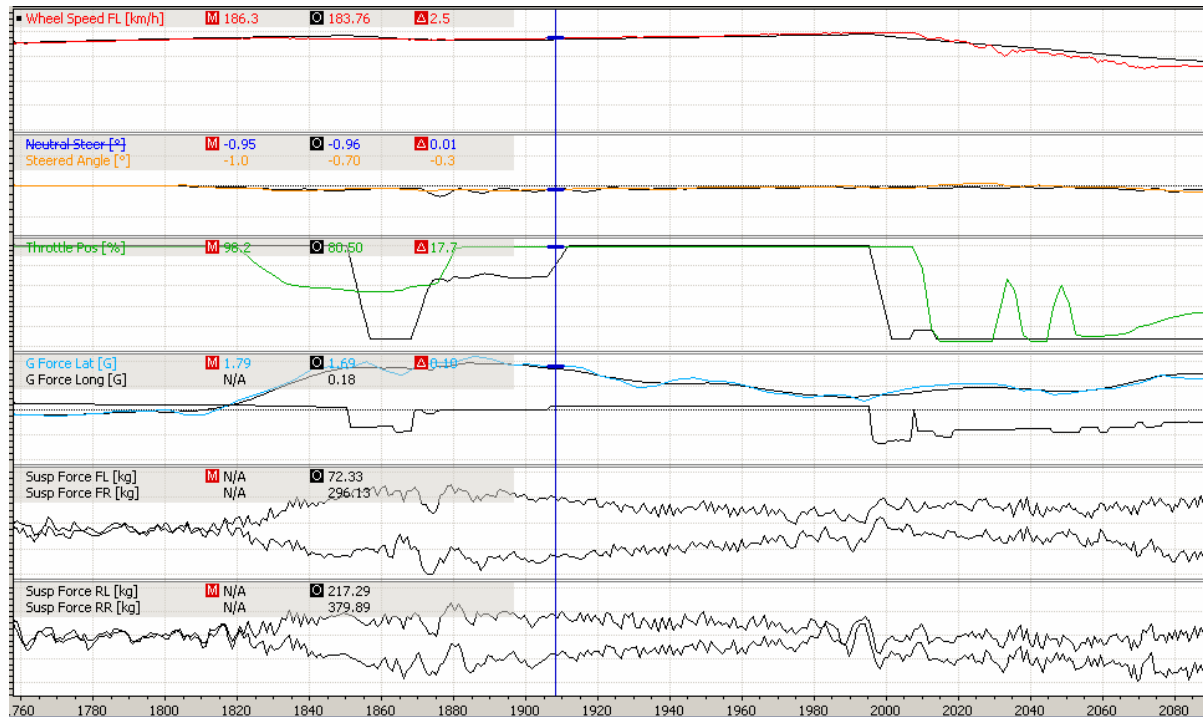
The increments you should be working in is in the order of say 0.5 – 1 deg or 2% of slip ratio. I should also say at this point in the game you are not looking for perfect correlation, you want it approximately in the ball park. We'll discuss the refinement shortly. Also in the tyre model quick start peak slip angle is in radians and peak slip ratio is in % divided by 100.

The last point on the list for manual refinement is the traction circle radius vs load characteristic. You access this by clicking on the Edit TC radius load characteristic button of the tyre quick start. This will bring up the following dialog,



**Fig-3 TC Radius vs Load characteristics.**

This is your go to adjustment when you have some corners that match up well but other that don't. When you have this situation you look at the tyre load plots. An example of such a plot is shown in Fig – 4



**Fig – 4 – A plot of simulated speeds and tyre loads.**

What you are looking for here is noting where the speed differences and adjusting the tyre forces at the tyre loads where you see the speed differences. This is greatly expedited by using Fig-3.

To apply the changes you want please ensure you click on the relevant check boxes.

I also want to point out that the goal of this exercise is not to achieve perfect correlation, but it is teaching you about your tyre. Typically you are looking for correlation to say 3km/h, steering to within about 2 deg. However I guarantee you if you do this exercise properly it will teach you an awful lot about your tyre and is the best preparation for using the tyre modelling toolbox.

### Using the quick start with tyre force estimation

For those users without the tyre force modelling you can still get quite a way down the road using the tyre force quick start with the tyre force estimation. The tyre force estimation only

adjusts the traction circle radius so it leaves the other tyre characteristics untouched. So the suggested procedure is,

- Run the tyre force estimation.
- Refine using the tyre model quick start.
- Run the tyre force estimation.

You loop through this process and stop when good correlation is achieved. It does require manual input but it goes a very long way to determining an accurate and usable tyre model.

## Conclusion

As we have seen the ChassisSim tyre model quick start is a simple but powerful way to edit and more importantly understand what's going on with your tyres. It allows you to control the camber and traction ellipse properties, it can approximate tyre spring rates, and you can dial in max slip angle/slip ratio properties and the traction circle vs Load and temperature characteristic. The goal of using the tyre model quick start edit is to refine your results and lay a platform for using the tyre force modelling toolbox.

Your goal depends on what toolboxes you have. If you have access to the tyre modelling toolbox your intentions are on broad brush strokes that put you in the ball park. If you don't have this, the tyre model quick start in combination with tyre force estimation will go along way to help you determine the tyre model.