ChassisSim – Creating advanced tyre models using the Tyre modelling toolbox.

The purpose of this document is to lead you through a step by step process to create a tyre model using the tyre force modelling toolbox. This will lead you through the process of how to construct a fully functioning 3D model.

The prerequisites to start this are,

- The creation of the monster file.
- The setups for each run related to the monster file. This includes tyre pressure.
- You've already done a rough refinement using the tyre force quick start.

Once this is in place the procedure for constructing the tyre model will be outlined.

Tyre force modelling toolbox Introduction and setup

The tyre force modelling toolbox returns a very accurate picture of the tyre characteristics for a particular setup. This takes up where the tyre model quick start left off. To access it you select Simulate->Tyre force modelling. This brings up the tyre force modelling dialog that is shown overleaf in Fig-1.

What you need to do to use this toolbox is the following,

- Load in your curvature and bump profile in Circuit->Circuit Data
- If the circuit has significant on camber and altitude variations this also needs to be loaded in Circuit->Circuit Data

You are now ready to perform the tyre force modelling. As always we use the monster import file and this is imported using the relevant tab. Again if using the monster import file and the car is a monoshock leave the monoshock flag as 0. I should add at this point please ensure the steering angle is calibrated in degrees at the tyre as opposed to the steering wheel. This is very important.

The next option we need to configure is the sign of the lateral acceleration and steered angle from the data. If the lateral acceleration and steering angle is positive for a right hand turn then both these flags are entered as 1. In the example both these signs are set to –1 which means that this data has positive steer and lateral acceleration for a left hand turn.

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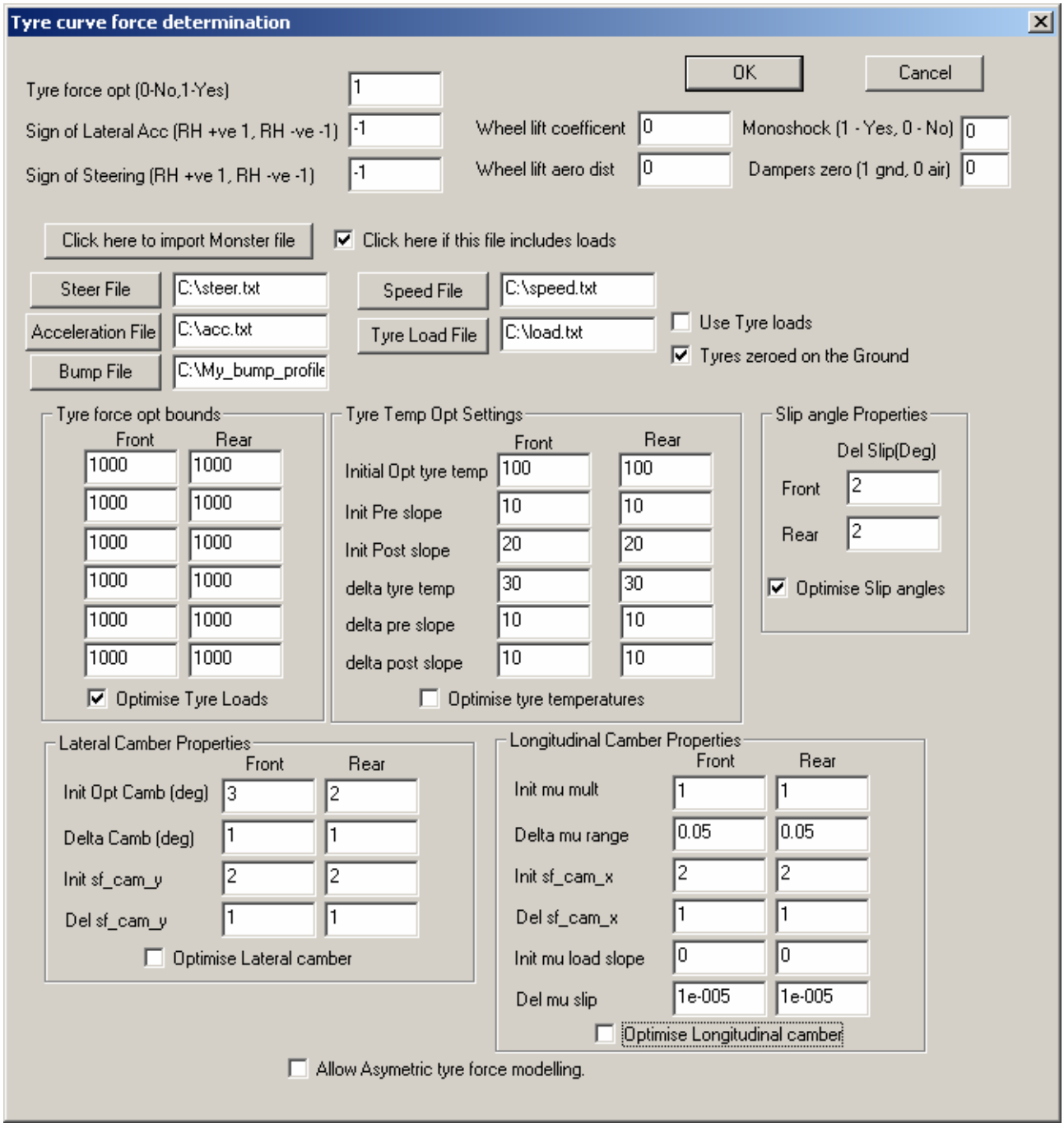

Fig-1: Tyre modelling toolbox.

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Tyre Force Modelling Toolbox procedure

Once we have this configured we need to indicate what we want to optimise. It depends on what you want to do. If you want a rough ball park, simply select Loads and slip angles and leave the other options blank. Then press OK. When the tyre force optimisation is done it will output the results in a series of files in the same directory as the car directory. The front tyre force output file is called Opt_fnt_tyre_file.txt and the rear tyre force output file is called Opt_rear_tyre_file.txt. Once again the user is advised to rename these files once the optimisation routine is completed. To import these into ChassisSim, click on the relevant tyre and click on the tab that says click here to import optimised tyres/v3 approximation.

Once the initial TC Radius vs Load characteristic has been determined our next goal is to determine the camber/traction circle ellipse characteristics. This is done by clicking on the lateral and longitudinal properties. The initial start points are numbers taken from the ChassisSim v3 approximation as we discussed in the tyre model quick start. The procedure here is to take a start point and specify a delta you want to search in. So for example in the example presented in Fig-5 when we specify an optimum camber of 3 and a delta of 1 it will be trialling optimum cambers between 2.5 and 3.5 degrees. To run this all you need to select is the lateral and longitudinal multipliers and press OK.

I should also add that if the correlation you achieved from the tyre model quick start is good you can combine, Load, slip angle and camber properties in your first optimisation.

Once this is completed the next step is to refine the thermal model. You must do this first before you create a 3D tyre model. What we are looking for is a temperature plot that looks like this,

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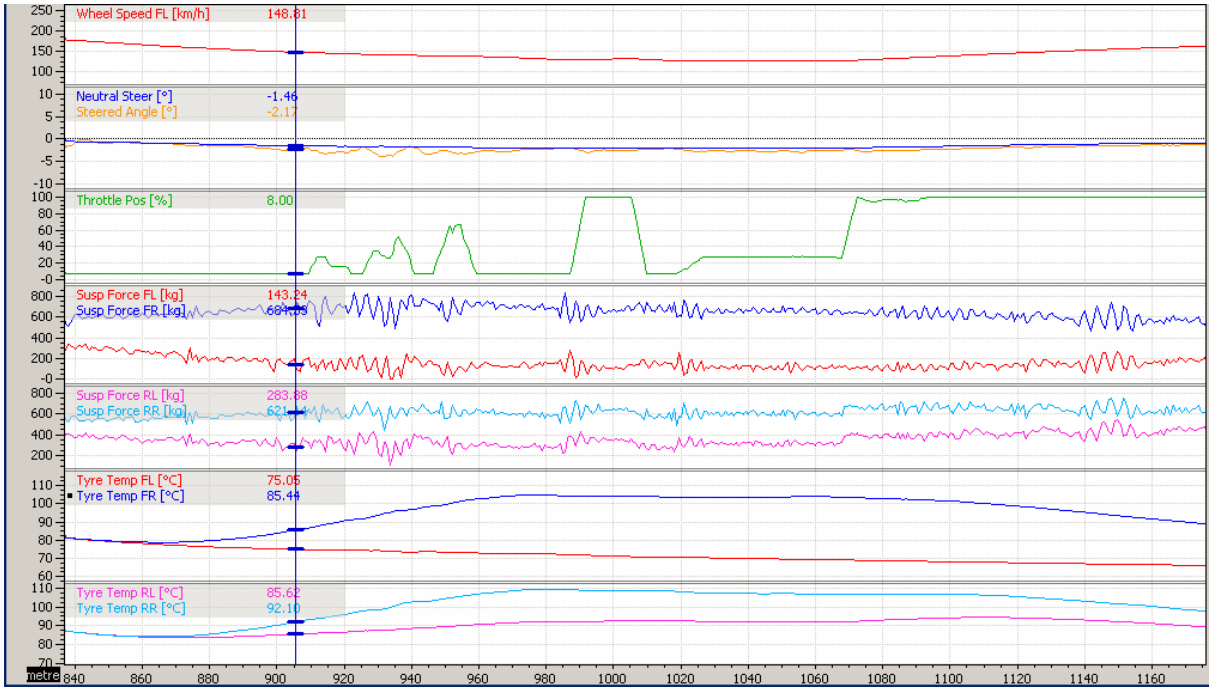

Fig-2 – Expected temperature plot for the tyre model.

What you are looking for is a temperature delta of 30-40^{0}C from the rest condition with the delta occurring just after the mid corner condition.

The thing that controls that is the thermal properties tab in the ChassisSim tyre edit dialog. This dialog looks like this,

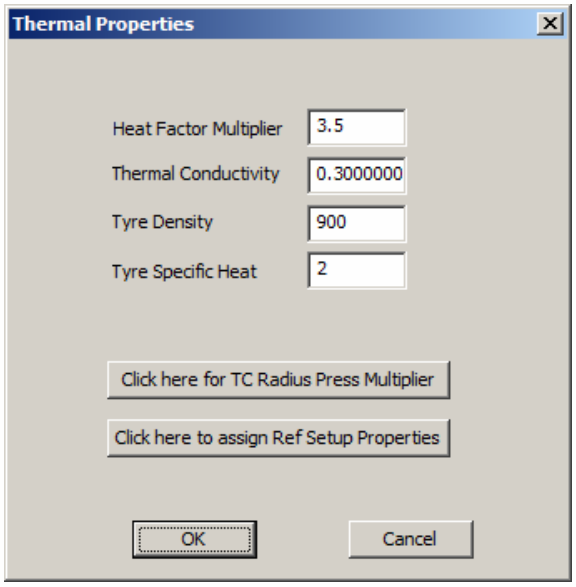

Fig-3 – Thermal properties tab

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The Heat factor multiplier controls the magnitude of the peak. The bigger this is the bigger the temperature rise is. The thermal conductivity controls the lag. The bigger the number the more the lag is. You will be adjusting this to replicate what was seen in Fig-2.

Once this process is completed you are know ready to construct a 3D tyre model. To facilitate this you select the tyre force modelling toolbox and click on the optimise load and temperature toolbox. For the temperature settings these are again taken from the ChassisSim v3 tyre approximation. Also we specify a start point and a temperature range to look in. Once this is done click on OK and let the optimisation run.

It would also be wise to add you know you are heading in the right direction when the optimised values fall within the bounds you have set. This is a clear indication you have found the right settings. If the optimisation results are against the limits try expanding the search range.

Once you are at this point you have a 3D tyre model you can use in anger.

You Tube video Tutorials

There are series of tutorials on the ChassisSim You Tube channel that are the perfect compliment to what we have discussed here. This is called Modelling tyres using ChassisSim and the links for the videos are shown below,

Part – 1 - http://www.youtube.com/watch?v=KZsGn2Fpi1g&feature=plcp
Part – 2 - http://www.youtube.com/watch?v=2n34XWv60IY&feature=relmfu
Part – 3 - http://www.youtube.com/watch?v=-XUcnbvgF2s&feature=relmfu

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Conclusion

What has been presented is a sequential procedure to go from an initial tyre model to a fully functional tyre model. Remember the process is.

- Use the tyre force quick start to dial in the approximate properties.
- Move on to tyre force modelling and estimate Traction Circle radius vs Load.
- Then move on to the camber/lateral/longitudinal properties. Note if the initial correlation is very good then this can be combined with the traction circle vs load radius.
- Dial in the temperature properties.
- Construct the 3D tyre model.

Remember at all steps in the process reference back to actual data and use commonsense. Remember this is a calculator not a magic wand. If used this way you can go along way to quantifying what's going on with the tyres.

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