ChassisSim
The Winner's Edge

ChassisSim Standard/Elite Quick Start

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Introduction

Congratulations on your purchase of ChassisSim Standard and or toolboxes that will take you to Elite. ChassisSim will become an indispensable tool as you seek to understand your race car and deduce the best possible setup for your race car.

The purpose of this manual is to show you what to do to get up and going with ChassisSim. This manual will show you how to get going with ChassisSim from a blank piece of paper to a fully functional car model. It is a step by step process that the reader can work through at their own pace. However it is presented in sequential order and the reader is advised to keep this order in place.

After working through this guide the user will have a functional model that will form the basis of their modeling.

The Purpose of race car simulation

Before starting on race car simulation it would be appropriate to discuss what we are trying to do with our race car simulator.

Our goal in race car simulation is to create a representative environment that we can run virtual test sessions with our car. What ChassisSim will return is the perfect simulated lap as if the perfect race driver has been piloting your car. The results can be viewed in either the ChassisSim viewer or they can be exported to a logger of your choice and compared against actual data or reviewed as a virtual test session in its own right.

Your goal when creating a simulation is to ensure everything the car does on the track is replicated on the simulator. Initially this may mean a sacrifice of some accuracy in the corners. This is perfectly ok and a natural part of the process. As you gain more experience in using ChassisSim and the vehicle modeling process this will sort itself out in time.

Also remember that ChassisSim is a tool and not a magic wand. Always review simulated data critically and view it as testing. Don't just take things at face value. If you use ChassisSim this way it will become an indispensable element of your race engineering toolbox.

Directory organization and ChassisSim files

The first step in starting to use ChassisSim is to understand what the various ChassisSim files are and what they actually do. To this end the following summary is presented in Table 1,

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Table – 1 – ChassisSim files

File Type	File extension	Description
ChassisSim car file	*.car	This stores your setup, and all the car modeling parameters such as tyres, aero and suspension geometry
ChassisSim template	*.ini	This stores the selection of springs and bars that relate to your car.
Curvature file	*.txt	This is the curvature file or the path the car takes around the circuit. This is typically prefixed by tr_mycircuitname.txt
Bump Profile	*.dat	This is the bump profile that represents all the road undulations for all 4 corners of the car. This is typically prefixed by the following convention bump_profile_mycircuitname.dat

The two major file types I want to touch on is the ChassisSim car file and template files.

The ChassisSim car file stores your specific setup. Think of a ChassisSim car file as a word processing document. A ChassisSim car file contains the specific setup you are working on and the model it pertains to. Consequently to save a setup and you go to File->Save As and save it as a car file. This stores your specific setup.

To store your car files I would recommend the following directory structure as Illustrated in Fig-1,

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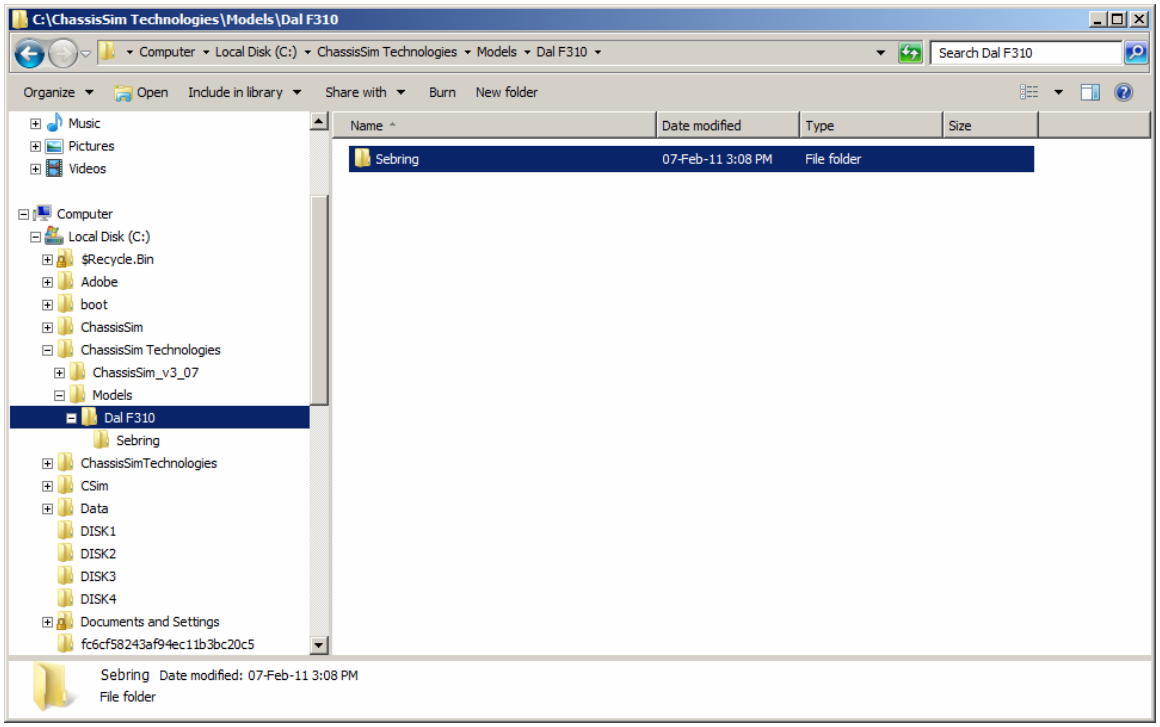

Fig-1 – Suggested Directory structure

Typically the suggested convention is,
C:\ChassisSim Technologies\Models\My Car Name\Circuit Name.

While this may seem long winded we have found this to be a reliable and almost fool proof method of storing your models.

The ChassisSim template is an ini file that is located in the ChassisSim version directory. When you select a ChassisSim template by going to the right hand side of the screen and selecting the car drop down box it does the following,

- Loads a car file that pertains to a particular car.
- Loads all the spring, bar, geometry and aero options that relate to that car.

For those of you who have had your modeling down for you, you just select the name of your car. You are then in a position of selecting your setup from the drop down menu items when you change a particular aspect of the setup. When you have selected all aspects of your setup to save it you simply go to File->Save As and save it in the appropriate directory as illustrated in Fig-1.

So how do you retrieve a setup you have just been working on? You perform the following tasks,

1. Open ChassisSim (obviously if ChassisSim is open you skip this bit).
2. Select the relevant template that most closely resembles your race car.

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3. Go to File->Open, navigate to the appropriate directory (as shown in Fig-1) and select your car file.

It's as straight forward as that!

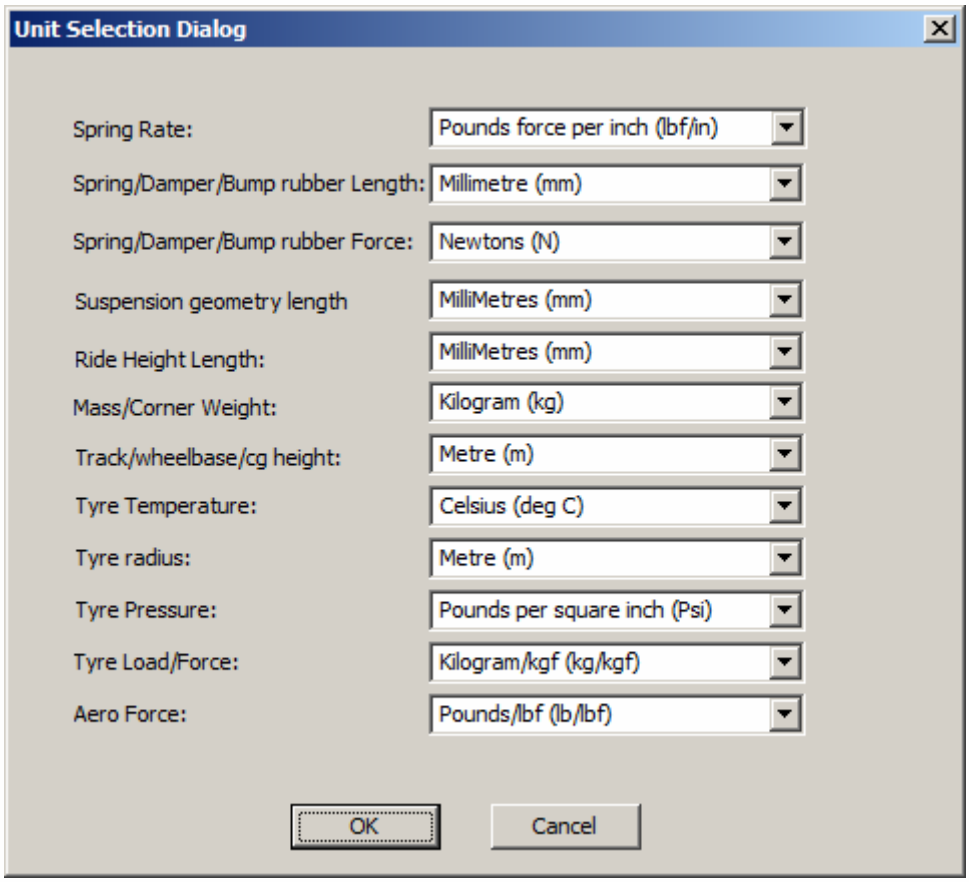
Setting up your Model for the first time.

To start your model for the first time this is what we will be doing,

- Selecting the most appropriate template that most resembles your car.
- Save the car file in an appropriate location as illustrated in Fig-1.
- We modify each element and save as we go.

For the purpose of illustration we are going to setup a F3 car. In particular it will be a Dallara F310 car. Don't worry if this is not your car. The techniques that will be discussed here will be identical to what you'll use for your car.

The other thing I would advise you to do is to setup the units you want to save the car model parameters in. This is accessed in View -> Select Units to use. This will display the following dialog and you simply select the units you desire.



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Step 1 – Select an appropriate template and save the car model.

This is done by going to the right hand side of the ChassisSim screen and clicking on the car menu. This will present a list of cars you can choose from. This process is illustrated in Fig-2.

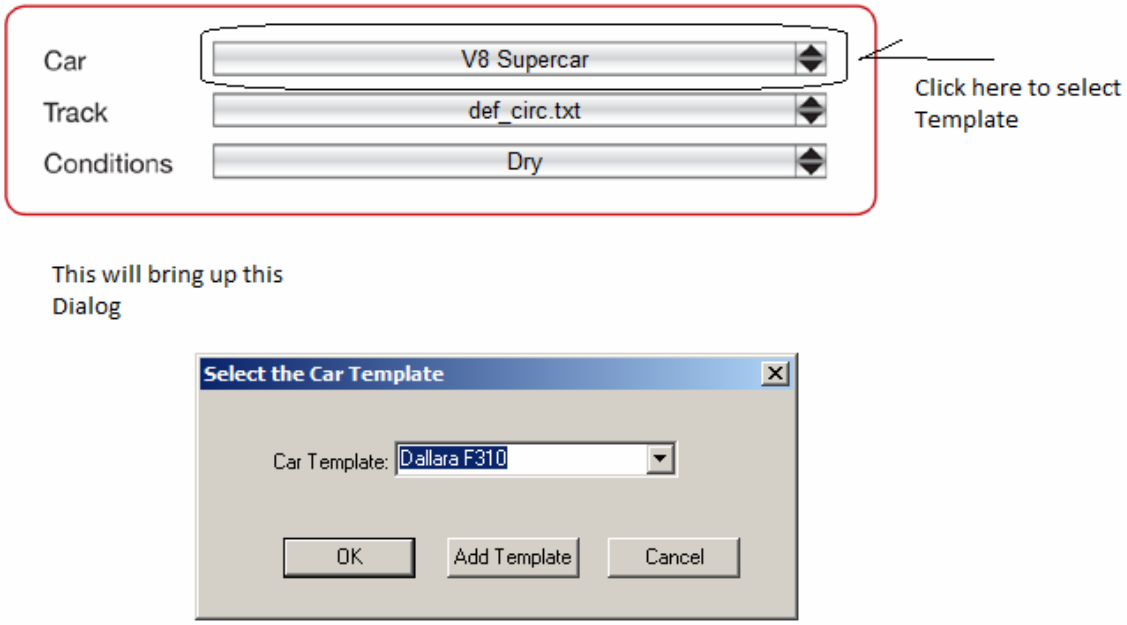

Fig-2 – Selecting a car template

When this is selected the Car drop down box will show Dallara F310. When this has been selected we'll now save the model. To do this, go to File->Save As and we'll save this in the same directory as we created in Fig – 1. This process is illustrated in Fig-3,

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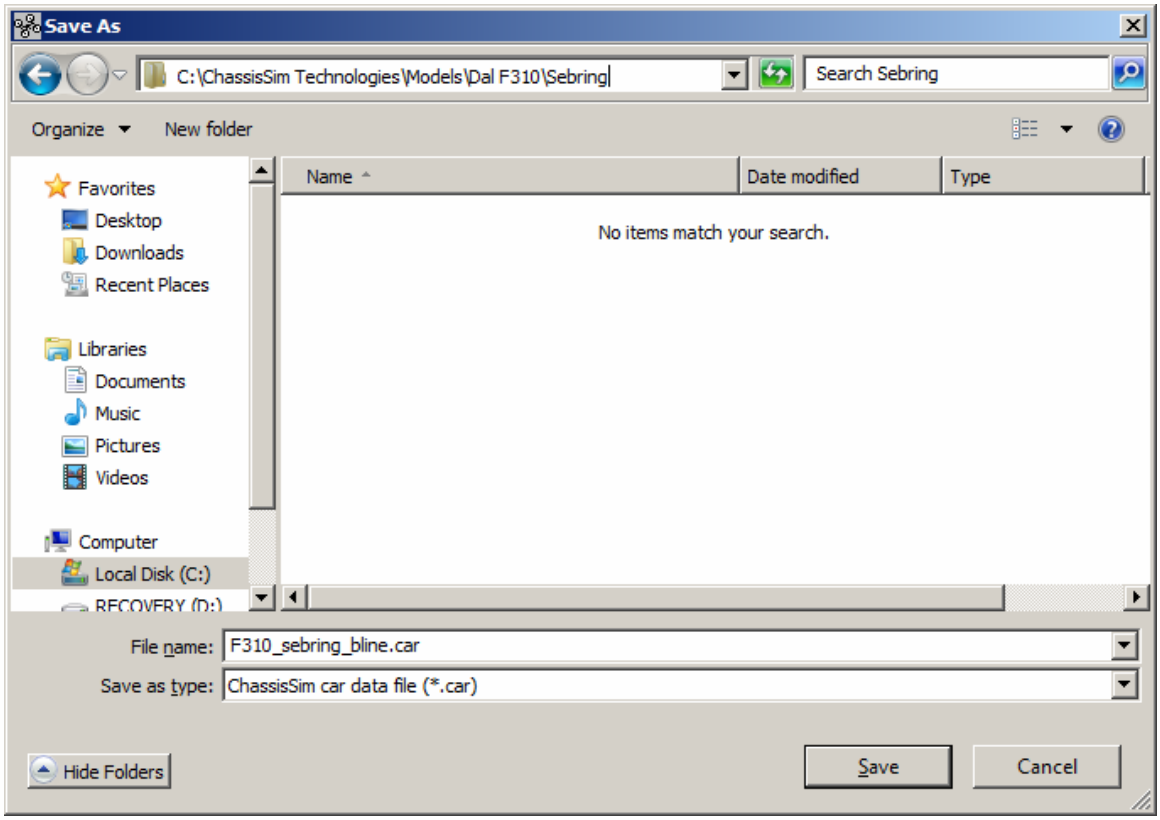

Fig-3 – Saving the base car file.

Step-2: Entering mass, wb, track and Inertia Characteristics

To enter the mass, wheelbase, track and Inertial characteristics you either click on the cockpit (open wheeler picture) or roof of the car (Touring car picture) or the mass drop down box on the right hand side. This will display the following dialog,

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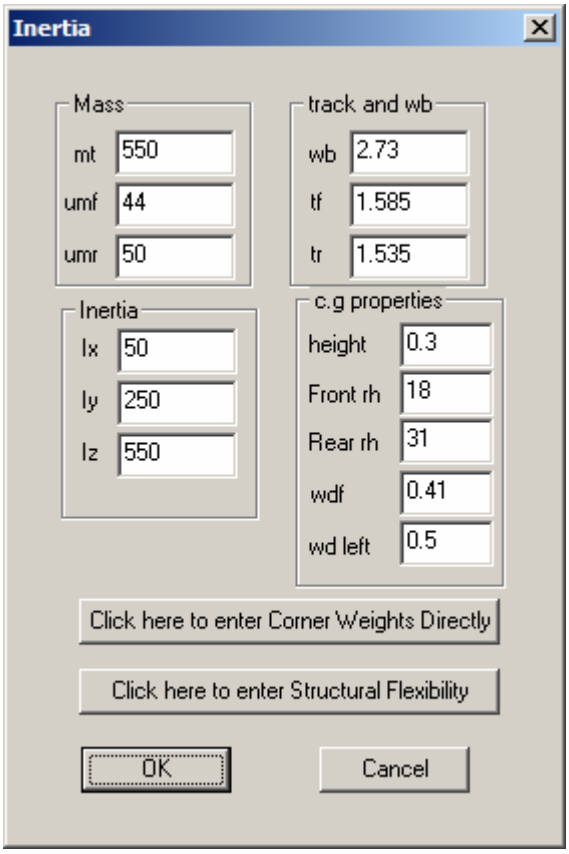

Fig-4 – Inertial dialog

As can be seen from Fig 4 all you need to do is enter the relevant entries. The units these are entered in are selected in View->Select units to use. The inertias I_x, I_y and I_z are entered in kgm^2.

Most of the entries are very straightforward. The main ones to focus on are,

- mt – total car mass
- umf and umr – Total unsprung weight for the front and rear respectively.
- wb – wheelbase, tf and tr – Front and rear track respectively.
- wdf – Total weight distribution on the front axle.
- Height – This is the total c.g height and Front rh and Rear rh is the front and rear ride height of the setup this centre of gravity height corresponds to.

The entries that take create the most confusion is the c.g height and moments of inertia. A rough guide to c.g height is presented below,

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Table-1 – Approximate c.g heights

Car Type	c.g height
Open Wheeler/Sports prototype	0.3m
GT car	0.35 – 0.45m
Touring car	0.5m
Road car	0.55 – 0.6m

A rough guide to inertias are presented in Table 2,

Table-2 – Approximate Inertias

Car	I_x (kgm^2)	I_y (kgm^2)	I_z (kgm^2)
Formula Ford	100	300	500
F3	150	400	600
GP2/IRL	200	800	1200
V8 Supercar/NASCAR	400	1300	2500

Step -3: Selecting Springs.

The next step is to select the springs. To do this click on the front spring on the car picture or the Front spring drop down box on the front of the car. This will display the following dialog,

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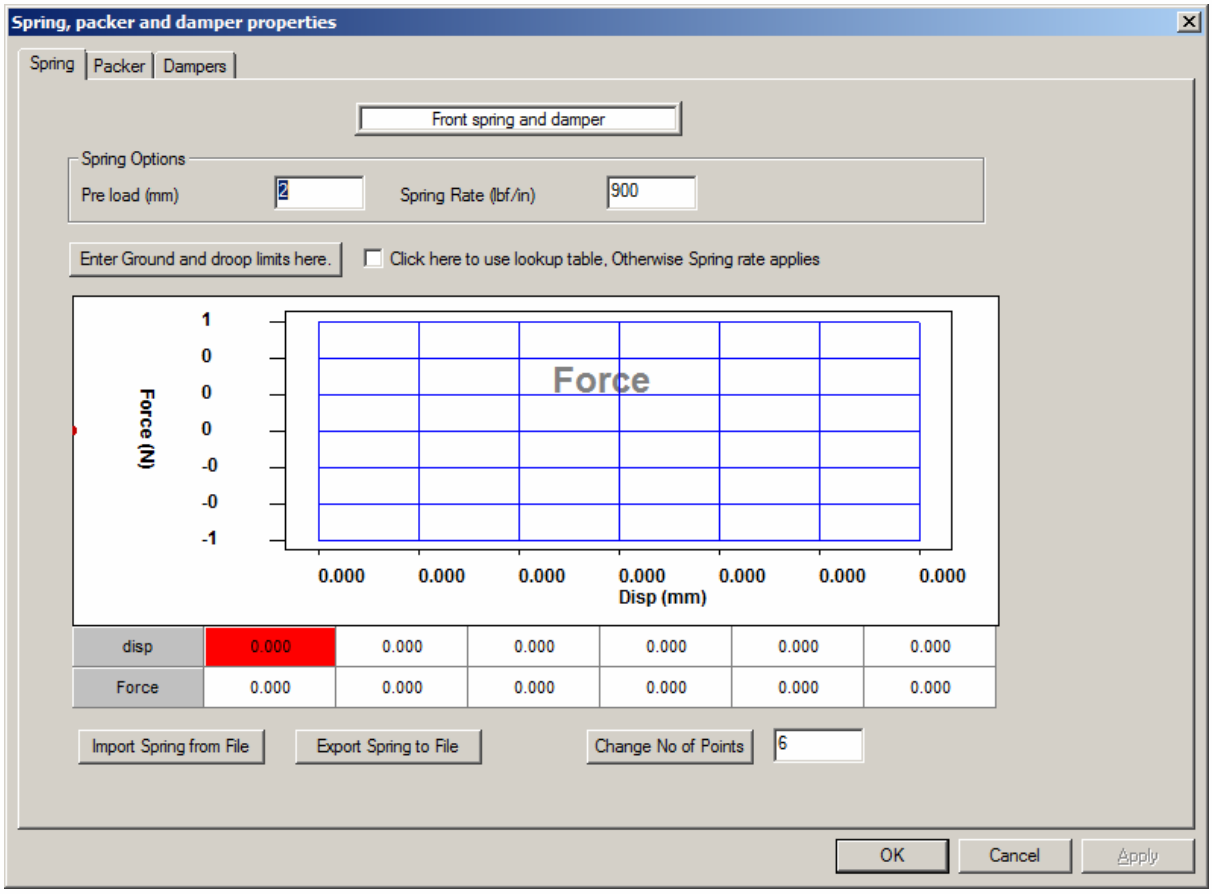

Fig – 5a – Spring/Bump Rubber/Damper Dialog.

To enter the spring rate the user has two options. You can either enter the spring rate as a linear rate as illustrated above. The pre load is entered in the appropriate edit box. Please note this preload is taken from the spring free length. Alternatively to use a non linear spring click on the check box that says Click here to use a non linear spring other wise spring rate applies. Click on the graphic control below and edit the properties of the non linear spring. Note the units for both of these can be changed by going into the view menu and selecting View->Select Units to use.

If you are using bump rubbers and have the gap specified as a ground gap, click on the tab that says Click here to edit Ground and droop limits. To use this feature please ensure you have the correct motion ratios installed. This will bring up the following dialog,

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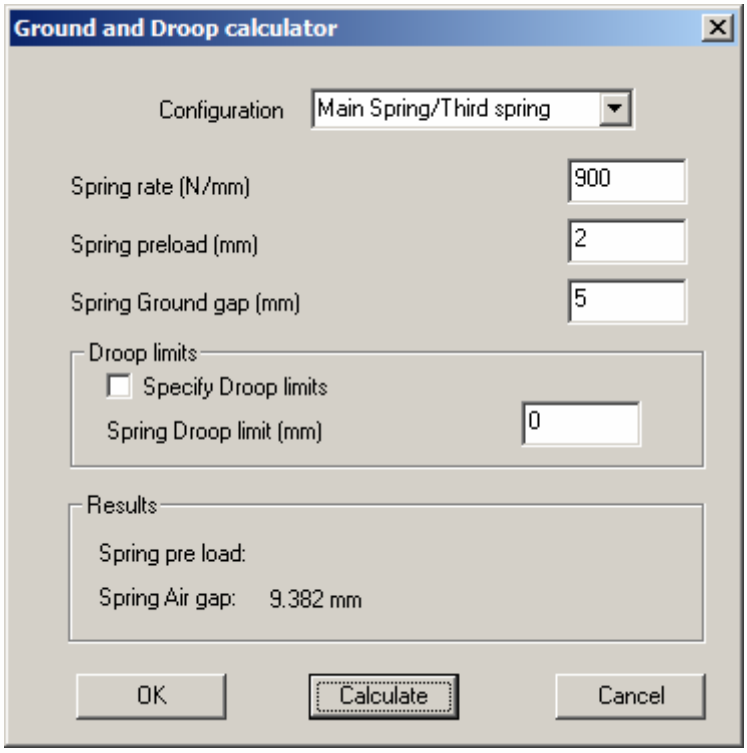

Simply enter your ground gap in the appropriate tab and click on OK. My personal preference is to do Calculate first just to see if the numbers make sense. When you click on OK this will update the air gap in the packer page automatically.

If you need to enter the bump rubbers click on the Packer tab. This will display the following dialog,

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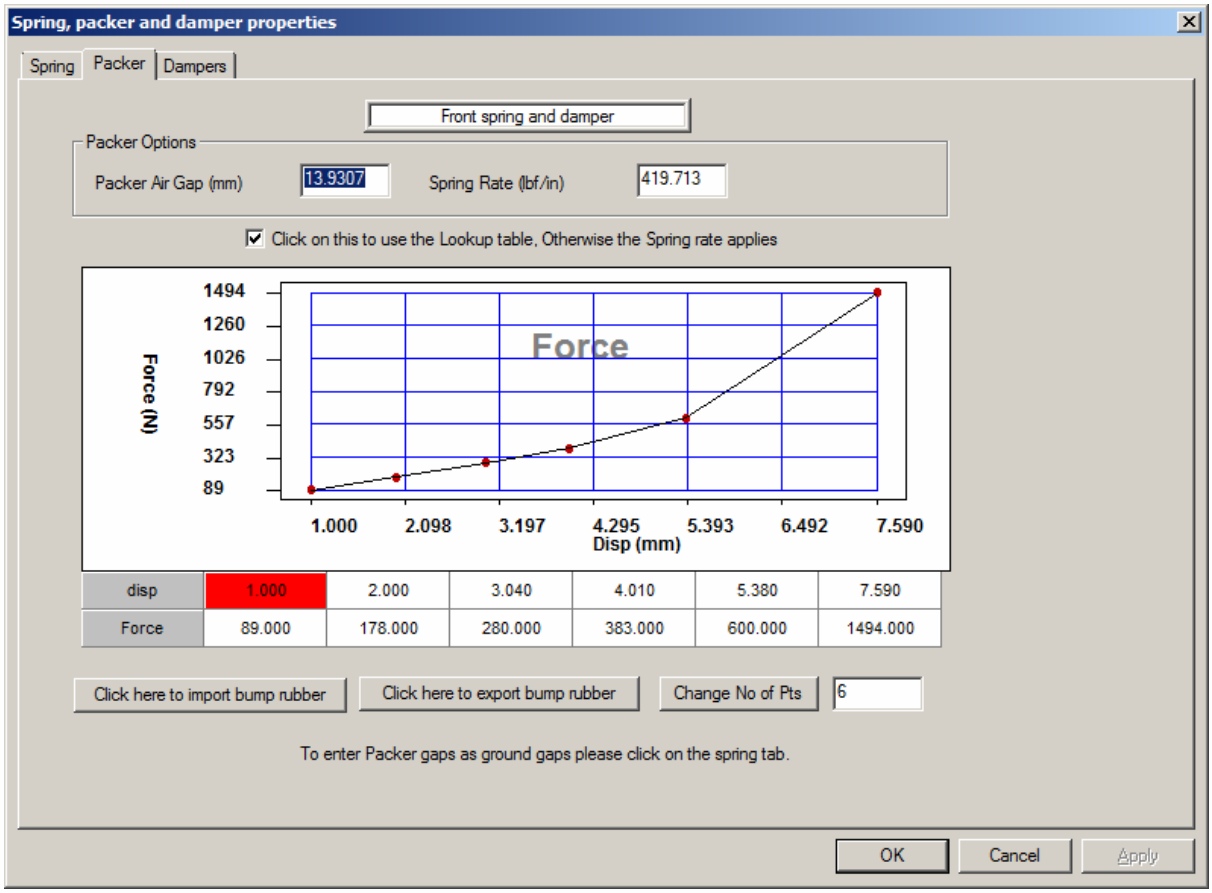

Fig-5b – Bump rubber dialog.

You will notice that the packer gaps are specified as an air gap. If your setup sheet has this specified as a ground gap, click on the tab that says click on here to enter as Ground gap in the Spring tab as we have just discussed. You enter the ground gap here and click on OK.

You have two options for entering the bump rubber. The first as illustrated in Fig-5 is to enter the numbers as a lookup table. Please note an origin of 0,0 is assumed. These can be exported out to file, or re imported back in. The format for this can be found in the ChassisSim help. Alternatively the Lookup table tab can be unclicked and a single spring rate is specified. The conventions here are identical to the non linear springs.

To enter damper data Click on the Damper tab. This is illustrated in Fig 5c

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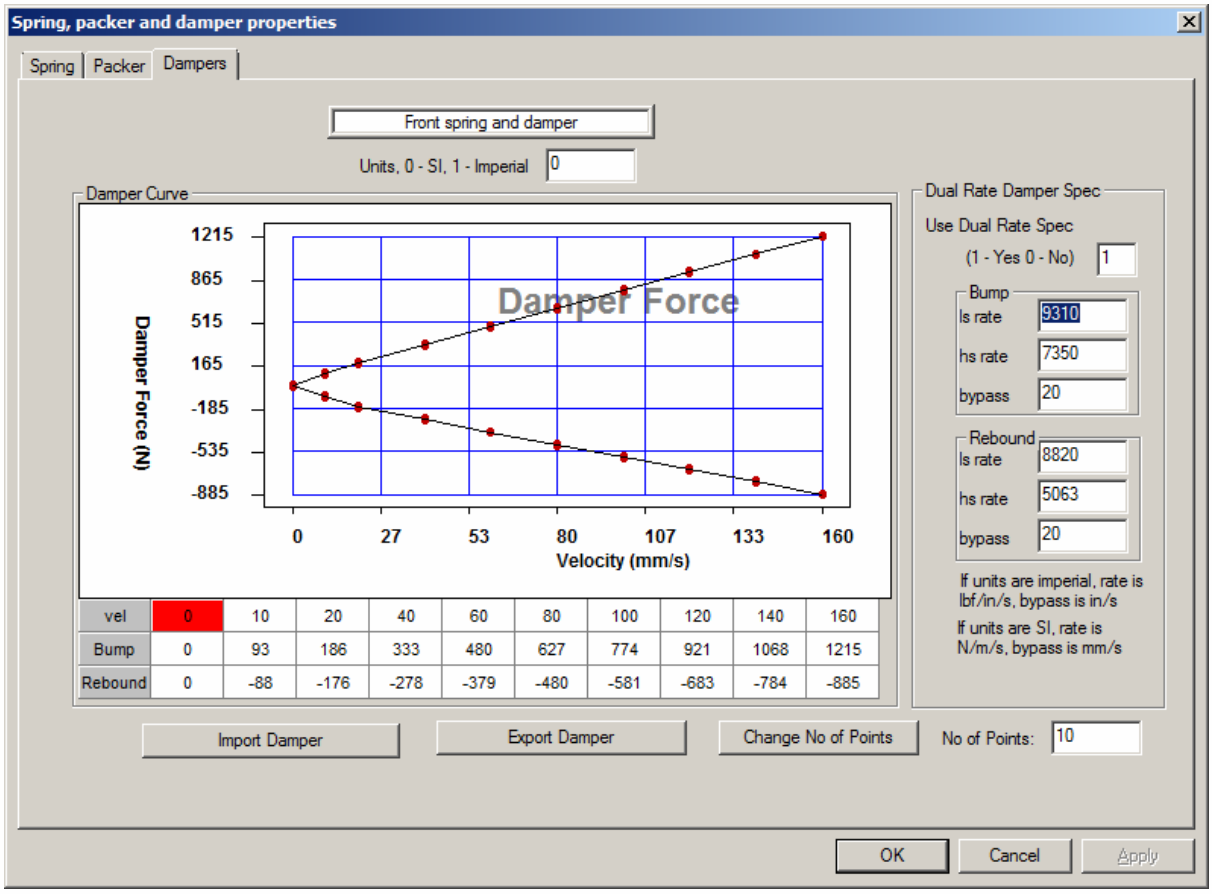

Fig-5c – Damper control.

The user has to options,

- Set the dual rate edit control to 0 and edit the numbers manually. As with the bump rubber control simply click on the control and use the arrow keys to start editing. Note the conventions are bump force is positive, rebound force is negative.
- Import an ascii file with damper information. This is detailed in the ChassisSim help.
- Set the dual rate edit control to 1 and specify the damper by damping rates. Please note these rates are in N/m/s.

One you are happy with your selection click on OK.

Step-3: Selecting Roll bars

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To select Roll bar either click on the front roll bar image on the left hand side or on the right hand side of the screen select the front roll bar drop down box on the right hand side. This will display the following dialog,

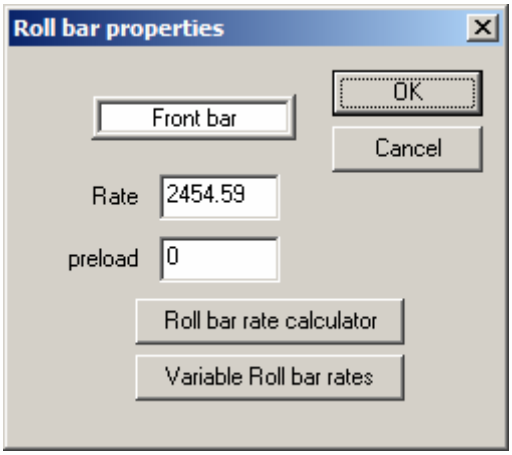

Fig-6: Roll bar input dialog.

You enter your bar rate in either N/m, N/mm or lbf/in depending on the units you selected. Press OK on both dialogs and choose File->Save.

Step-5: Suspension Geometry

To adjust the suspension geometry click on either the front or rear wishbone/ or live rear axle picture. This will bring up the following dialog,

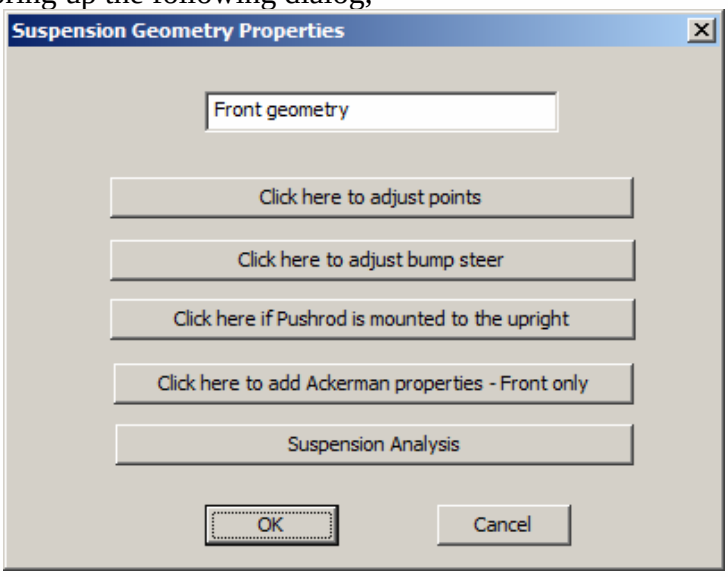

Fig-7 – Suspension Geometry dialog box

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For the time being edit the geometry pick up points. The rest we can refine later. This will bring up the following dialog,

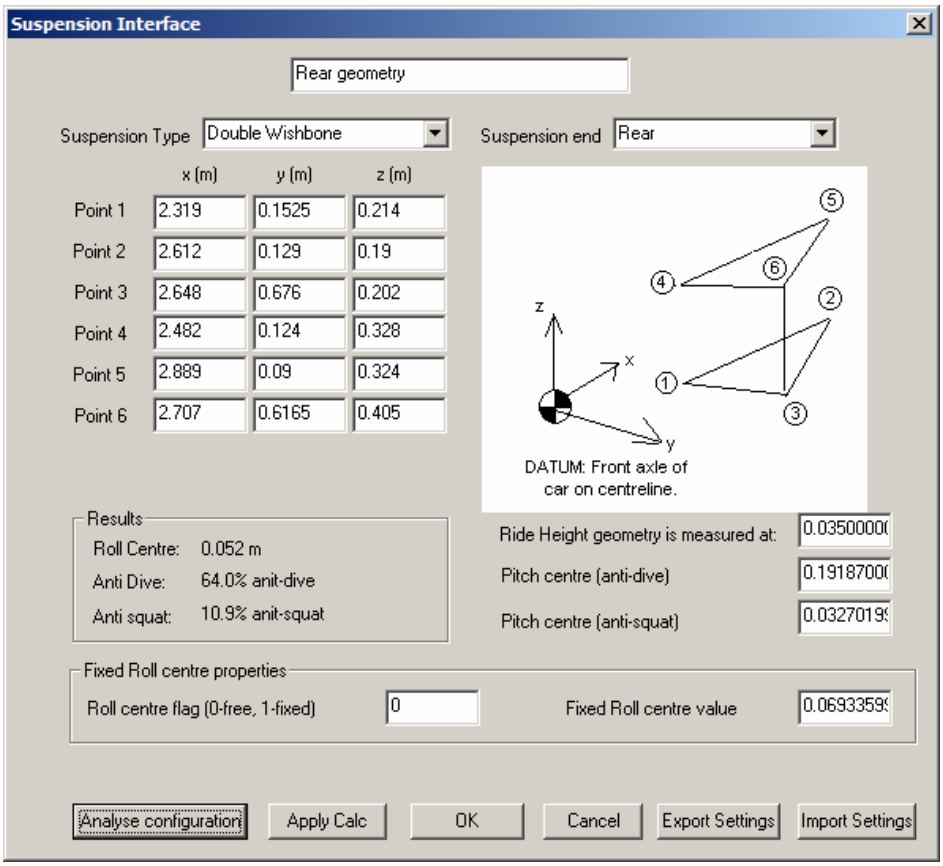

Fig-8 – Geometry input

The user manually edits the points and the operation of this dialog is covered in the online help. The user selects OK presses OK on the main dialog and goes File->Save. Note if the geometry hasn't been measured up and you know the roll centre location, as a temporary fix – The roll centre flag can be set to 1.

Step 6 – Entering Aero characteristics

The aero characteristics of the car are edited by clicking on the front and rear wing, These are what the controls do,

- The front wing dictates the ride height sensitiviy maps. This is how downforce varies with ride heights, roll and side slip.
- The rear wing dictates the maximum magnitude of these maps and how the aero balance is offset.

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While at first this may seen cumbersome, it is in fact a very elegant of minimizing the number of aeromaps that are required.

If you wish to edit the ride height sensitivity maps click on the front wing. This will display the ride height senstitivity maps. This is described in detail in the ChassisSim online help. A thing to keep in mind is that rear ride height entries are the columns and the rows are front ride heights. Some racecar manuals have this the other way round. Given the purpose of this document is a quick start if you have an aeromap that is off the same type of car this step can be omitted and returned to later.

However what you do need to do is click on the rear wing and enter your maximum downforce, drag and aero balance offset. This dialog is shown below in Fig – 9.

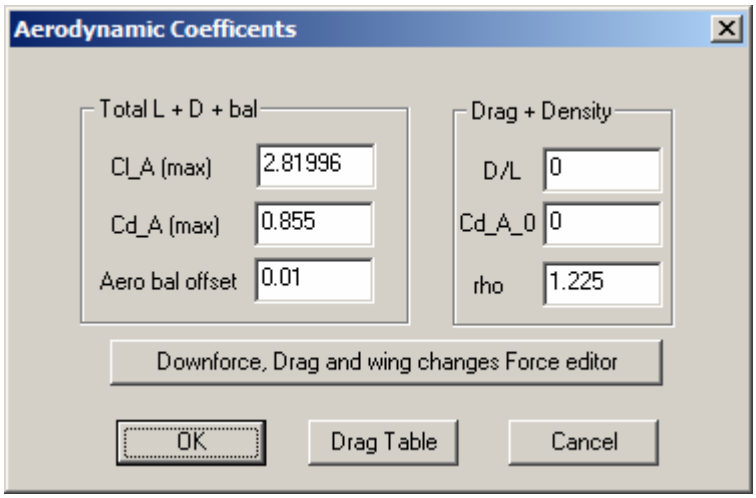

Fig-9 – Max Downforce, Drag and aero balance editor.

As you can see you enter your maximum C_LA, C_DA and aero balance offsets as well as the air density. What you need to do to get going is look at your particular setup and calculate your downforce, drag and aerobalance. This is outlined in the appendix. Then click on the tab that says Click here to edit Aero values directly. This will bring up the following dialog,

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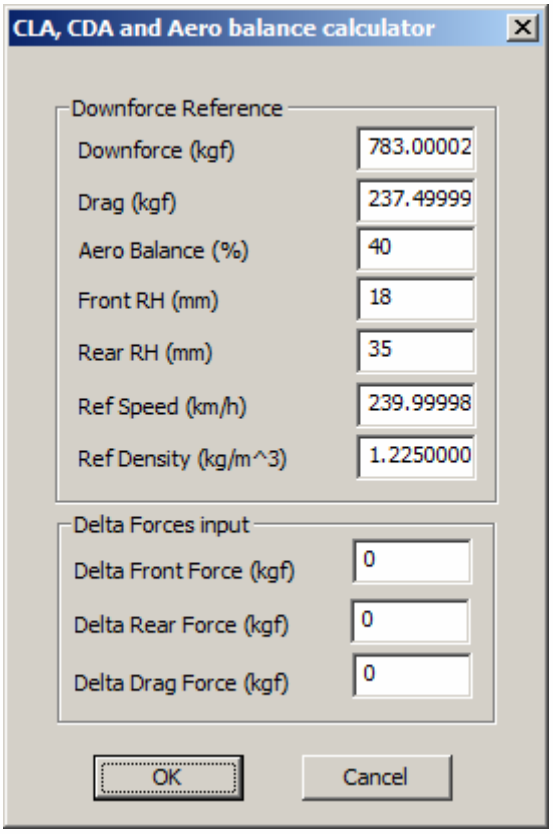

Fig-12: Downforce, drag and aero balance calculator

There are two sections to fill in. The first is you enter a reference condition this can pertain to your current wing configuration or some other reference. Downforce and drag are entered as forces for a given front and rear ride height and a reference speed. Aero balance is entered as a percentage at the reference condition. Then in the delta's you put the delta front downforce, delta rear downforce and delta drag forces that pertain to your wing setting. In this case we have put the reference as our current configuration because all the deltas are zero.

Step 7 – Entering tyre information.

To enter the tyre information either click on the tyres or click on the drop down box on the right hand side that says Front or rear tyres. This will bring up the following dialog,

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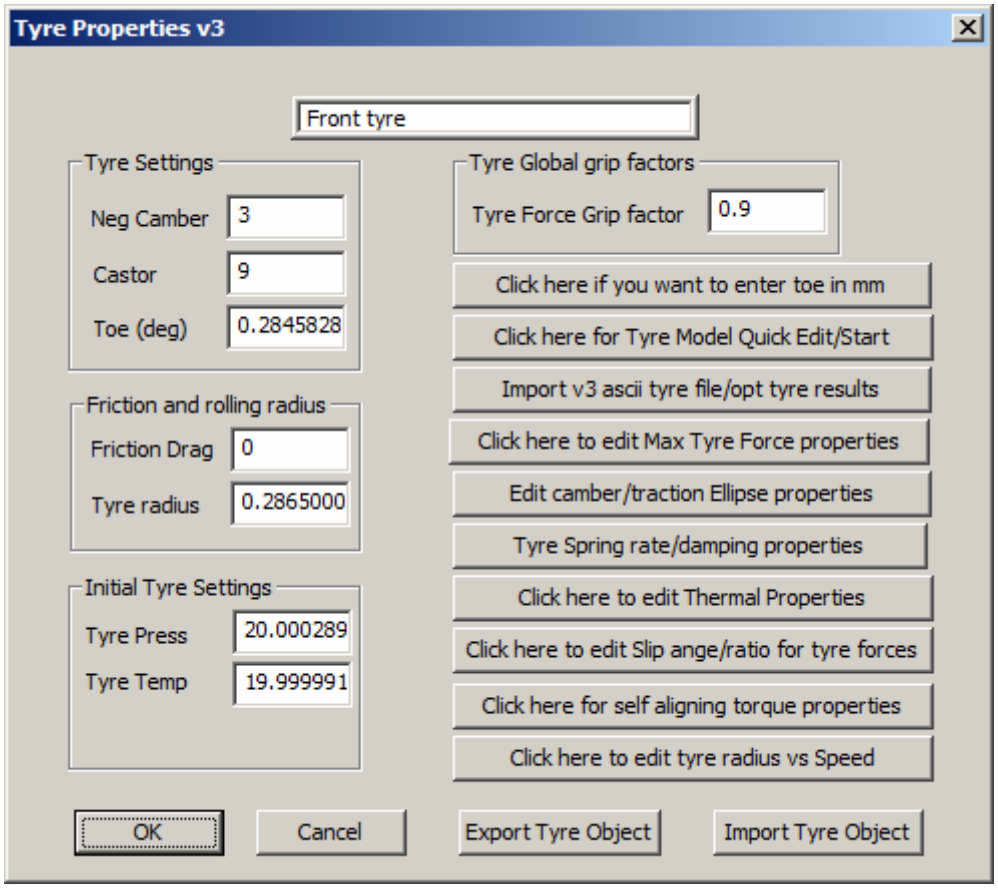

Fig-13: Tyre Properties dialog.

Cambers and castors are entered in deg. Note Negative camber is set as positive. Toe is entered as degrees. If you want to enter toe in mm, click on the tab that says "Click here if you want to enter toe in mm.

Tyre radius is entered in the appropriate edit control. Note this is the rolling tyre radius.

The tyre pressure and baseline tyre temperature is entered in the relevant tab. Note the baseline Tyre temp represents the tyre temperature as measured when coming into the pits. If in doubt, leave at the default settings.

Apply your changes and press on OK and save the car file.

If the chosen template closely resembles your car, for the time being don't worry about editing the other parameters. However if they are different I would refer you to the document in the help folder called CSim_v3_tyre_model_documentation.pdf. This will give you an introduction to the ChassisSim v3 tyre model. Select your baselines from that and click on the tab that says click here for Tyre model quick start. There are some simple default settings that

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allow you to construct a baseline tyre model quickly. We are also going to discuss how to refine this in the document CSim_modelling_in_minutes.pdf.

Step 8 – Entering the engine properties.

To enter the engine parameters click on the engine graphic on the car. This will bring up the following dialog,

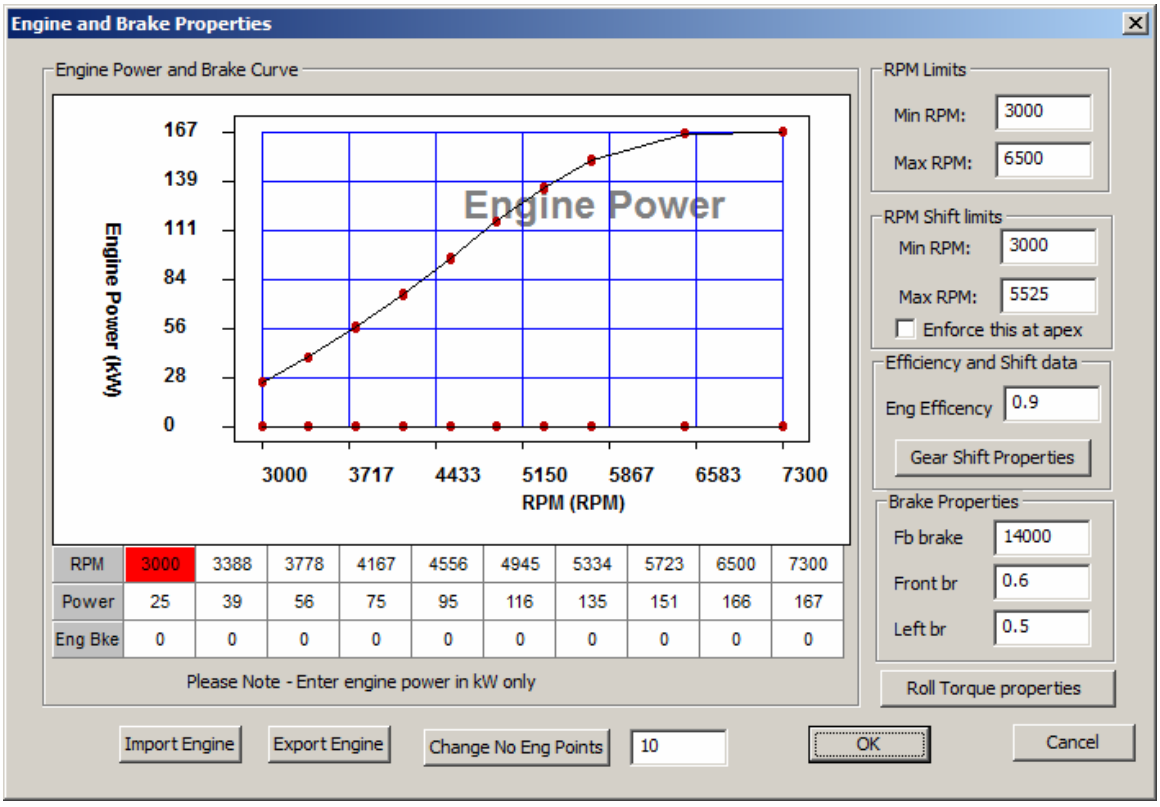

Fig-14: Engine Property dialog.

The critical thing to note is the engine curve and max RPM or redline.

The horsepower curve is the 100% throttle curve of power in kW vs RPM. This is entered by clicking on the control and using the left and right arrow keys to move the curve around. If in doubt the Engine brake parameters should be left at zero.

Modify this to your needs press OK and go to File->Save.

Step 9: Entering the gear ratios.

To enter gear ratios either click on the bell crank (open wheeler picture) or the gearbox graphic on the open wheeler picture. This will bring up the following graphic,

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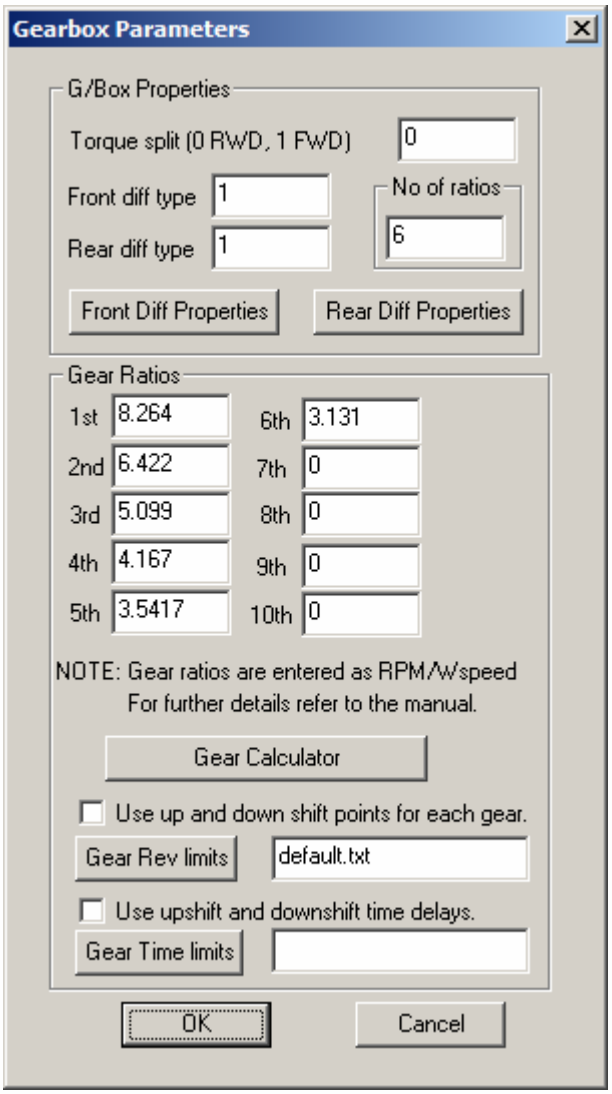

Fig-15 Gear ratio graphic

Gear ratios are entered as the ratio of Engine speed/wheel speed. Effectively it is a torque multiplier. It is effectively the inverse of the current ratio multiplied by the final drive ratio. The documentation for all of the gearbox controls can be found in the ChassisSim online help within the software.

Step 10: Entering motion ratios

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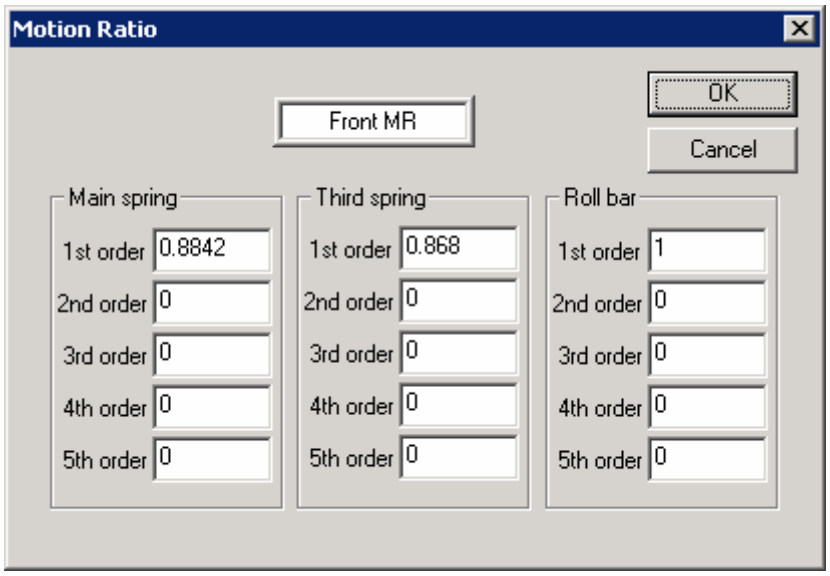
If the currently selected template matches your car then this step can be omitted. If it hasn't all you need to do is click on the bell crank of the car picture. This will bring up the following dialog,



Motion ratios are plotted as Damper Movement/wheel movement. Please note most race car manuals have it the other way around so take the inverse of it. Also to start off with stick with a linear ratio as illustrated above.

Running your first Simulation.

To run your first simulation Select a circuit from the available drop down list on the right hand side of the screen. This is illustrated in Fig 16

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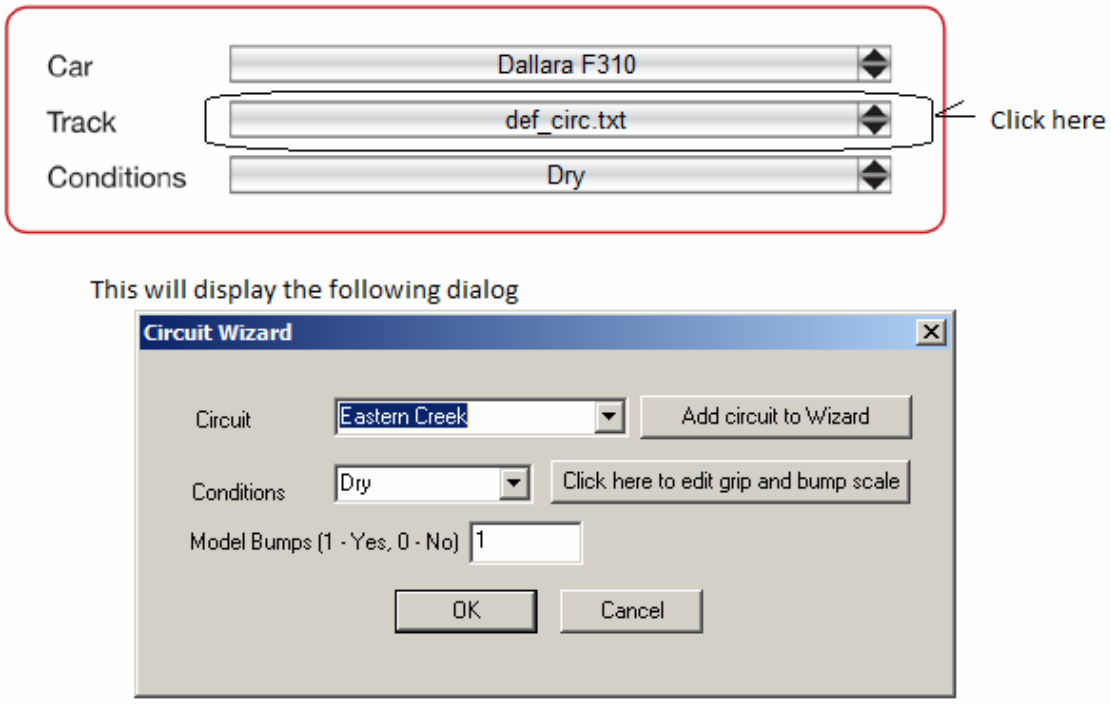

Fig-16 – Selecting a circuit from the Drop down menu.

As illustrated select Eastern Creek.

The next step is to record this to data. Go to Simulate->Data logging options this will display the following over leaf. As you can see for the purposes of illustration we are logging the file to Motec Interpreter. As you can see we specify the car and circuit name and the comment we wish to log this too.

You can also see we have specified a file location for the log file. This can be specified in any direction the user wishes by clicking on the tab that says Data File output name. This brings up a windows file save dialog where you can specify where you want the data file.

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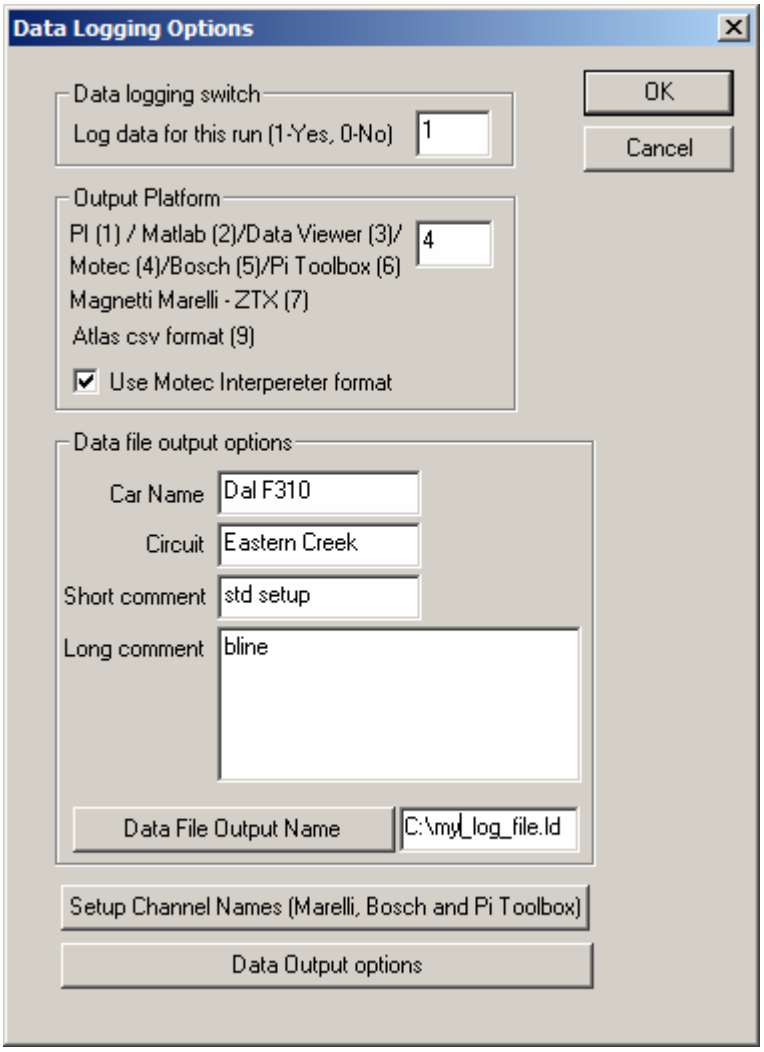

Fig 17: Data logging options

Once this is completed you are ready to run your first simulation. To do this you go to Simulate->Simulate or click on the Start button on the main screen. This will bring up the simulation window. To commence the simulation you click on the Start simulation tab. This will start the simulation. When it is completed you will see the lap time reflected. Congratulations you have just run your first simulation!

Now that we have this our next steps from here will be the following,

- Creating the monster file. This is covered in CSim_creating_monster_file.pdf.
- We then match the baseline model to your data. This is covered in CSim_modelling_in_minutes.pdf.
- Lastly we will show you how to create a track map – This is covered in CSim_track_creation.pdf

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