The Design Position

Because the suspension moves relative to the chassis, some arbitrary position of the hub relative to the chassis must be chosen in which to write down the positions of all of the suspension members. This position is referred to as the *design position*. There is nothing special about this position in terms of car dynamics, it is not necessarily the position in which the suspension supports the weight of the car, nor the position at which the suspension rests when freely hanging. In order to achieve the ride-heights specified in $Car \rightarrow Chassis \rightarrow hRideF/RSetup$, the setup code will adjust the length of the pushrod, or the springs (according to the user's choice) such that the suspension supports the weight of the car at the specified ride height. The rocker angles and values of x-bump etc. are measured relative to the design position. In other words, the design position is the position at which $aRocker = 0$.

External Suspension

Geometry

When referring to the external suspension, we are really referring to how the hub moves relative to the chassis; this is constrained by the six suspensions members (upper and lower wishbone forward and rearward arms, toelink, and pushrod). These may be modified in the following locations:

Suspension -> Front/Rear -> External -> pickUpPts

The set of pickup points listed in the table below may be edited, all of which refer to a *right hand side* wheel. This set of pickup points defines the position of the suspension in the *design position*.

Various configurations are available for suspension pickup points:

- Double wishbone with pushrod on upright or wishbone.

Wishbones, pushrod, and trackrod are defined, and Canopy computes the kinematics. rRockerC is in the usual place, connecting the external and internal suspension.

- Double wishbone with coilover on any wishbone leg.

When running a coilover on a wishbone leg, it no longer makes sense to talk about external and internal suspension. In this configuration aRocker (in radians) becomes the coilover displacement (in meters). By doing this the internal suspension moves with the coilover, in effect breaking down the distinction between external and internal suspension by making them move with the same kinematics.

- MacPherson strut.

This option must be selected under both external and internal suspension; this gets rid of the internal pick-up-points which aren't required. Instead of rocker limits we define displacement limits xMacPhersonStrutMin and Max. The anti-roll bar can be connected to the damper strut or wishbone forwards/rearwards leg using the arbConnection option.

- Abstract set of mechanical advantages. These can be defined in place of actual pick-up-points.

In this final configuration, the hub movement in all 6 degrees of freedom is defined as a quadratic in terms of aRocker and xRack, and the hub is no longer physically connected to the rocker. The internal suspension doesn't have to match up with the external suspension, and the two are only related by the rocker angle. rRockerC is now used to define only the internal suspension kinematics and can be placed anywhere, although it might help to visualise the suspension if this corresponds to a position on the actual car. For pushrod suspension, rRockerC could be the normal position of the rocker pivot. With coilover we could manually set rRockerC as a wishbone leg pivot point (similar to "coilover on wishbone" option), allowing us to attach a spring and damper in the normal place.

In the coilover case, if we wanted to match up the movement of the internal suspension with the externals we could set dzHub_daRocker = length of wishbone leg (m). This would work for small rocker angles, although if the rotations get larger we'll need to use additional degrees of freedom and second derivatives to describe the hub movement, because in this example the external suspension has moved only vertically, whereas the internal suspension moves in an arc about rRockerC. The minimum required degrees of freedom for this configuration are zHub Sensitivity to aRocker and aSteer Sensitivity to xRack, with a linear relationship. To represent more complex kinematics, you can click on "Properties" and open up other degrees of freedom and a quadratic relationship.

PickUp Point	Definition
rAxleC	The axle centre point; at the centre of the wheel in all dimensions.
rAxleAxis	An arbitrary point on the axle axis *outboard of the axle centre.*
rFLWBI	The front lower wishbone inboard point.
rFLWBO	The front lower wishbone outboard point.
rRLWBI	The rear lower wishbone inboard point.