Front Bias, Left Bias, and Cross Weight: Suspension Tuning with Weight Adjustmen...

Static Weight: Front Bias and Left Bias

The most fundamental way of changing the handling of your car is by redistributing the weight. The weight distribution of a car is determined by literally placing a scale under each wheel. When making weight distribution adjustments, you must consider the weight transitions that the car experiences while you are driving. For example, when you accelerate, weight shifts toward the back of the car onto the rear wheels. When you turn right, weight shifts to the left side of the car. You can feel these weight transfers on your body while you are driving.

The most useful weight adjustment for road racing is front bias, or the weight distribution between the front and rear wheels. The purpose of adjusting front bias is to balance the weight of the car evenly between the front and rear wheels while the car is turning. If the front tires have more weight on them while turning, then they will have to exert more force on the racetrack than the rear tires to keep from sliding. The same goes for the rear tires. This can be seen from basic physics:

F = ma = (m * v^2) / R
F = Force
m = mass
a = acceleration
v = velocity
R = radius

It can be determined that the acceleration of an object of mass ?m? traveling around a circle of radius ?R? with a velocity ?v? is v^2/R, and the force necessary to stay on the circular path with this velocity is just the object?s mass multiplied by that acceleration. Let?s assume that your car has more weight on the front tires than on the rear tires. Looking at the formula above, we can see that mass is the only thing that changes the force that the tires must exert since the square of velocity and radius are essentially identical for the front and rear of the car. Therefore, since the front has more mass, the front tires will have to provide more force than the rear tires to keep from sliding. Eventually, the front tires will begin to slip before the rear tires, which is the definition of understeer.

Making the weight on the front tires and the rear tires equal in a turn does not necessarily mean that the weight distribution should be 50/50 (50% front, 50% rear) while the car is standing still. The type of track you plan to drive on determines the ideal weight distribution. If the track requires getting on the throttle early in the turns, then weight will be transferred to the rear of the car while you are in the turn. Therefore, you should add weight to the front of the car to offset the weight transfer when you get on the throttle.

Instead of using a 50/50 distribution, you might want to try 55/45. The front of the car will be heavier than the rear when the car is standing still, but when you accelerate in a turn, weight will shift to the rear and balance the car. If you are driving on a track with short, sharp turns, then you will probably be getting on the throttle late in the turn. Therefore, you want a more even weight distribution to start out with (possibly 51/49) so that the weight will be evenly distributed as you drive through the turn.

Generally, if you are driving on a road coarse with approximately the same number of left and right turns, front bias should be the only weight adjustment that you work with. However, there are two other adjustments that can improve handling if you will be racing on an oval or a track with predominantly right or left turns: left weight bias and cross weight. Left bias is adding weight to the left side of the car so that it will be balanced in left turns. The same can be done for right turns.

Cross Weight

Cross weight (AKA wedge) is slightly more complicated. Front bias and left bias adjustments are made by actually moving components of the car around to try to achieve the desired weight distribution (e.g. moving the battery to the left side or rear of the car). Cross weight is adjusted by lowering or raising the upper spring perches on each corner of the car to raise or lower that corner.

To understand how cross weight works, imagine a car that is perfectly level with the ground (equal ride height at each corner). If you raise the left rear corner (increase cross weight), that corner now carries more weight because it is sticking up. In addition, the car is leaning towards the right front (trying to compress the right front spring) so that corner is holding more weight than it did when the car was level. The left rear and right front hold more of the weight of the car than the right rear and left front.

If you lower the left rear corner of the car, then the left front and right rear corners are sticking up more than the left rear. Therefore, the left front and right rear hold more of the weight while there is less weight on the left rear. Since the left rear corner is lowered, the car leans in that direction, which also takes weight off of the right front tire. In summary, by lowering the left rear (decreasing cross weight), the weight on the left front and right rear increases, and the weight on the right front and left rear decreases.

Cross weight is usually measured as a percentage of the total weight of the car. Take the following weight distribution as an example:

Left front: 750 lbs., Right front: 700 lbs.
Left rear: 700 lbs., Right rear: 750 lbs.

The cross weight is simply the left rear/right front (diagonal) weight divided by the total weight of the car and multiplied by 100 to make it a percentage. In this case, the cross weight is:

[(2 * 700) / (2 * 700 + 2 * 750)] * 100 = 48.3 %

Cross weight will not change left bias or front bias weight distribution. Using the example above, you can see that front bias is 50% ((750+700)/(750+700)), and left bias is also 50%. Assume you decrease cross weight to 46.6 % with the following settings (while keeping total weight the same as before):

Left front: 775 lbs., Right front: 675 lbs.
Left rear: 675 lbs., Right rear: 775 lbs.

The front bias and left bias are both still 50%.

Decreasing cross weight adds oversteer to the car in left turns. The front tires grip better since the left front starts out with more weight than the right front. In the turn, weight transfers from the left front to the right front, which balances the front of the car and maximizes grip. On the other hand, the rear of the car is not balanced in a turn. The right rear holds much more weight than the left rear. Therefore, the rear tires do not grip as well as the front tires, which creates oversteer. With the same kind of reasoning, you can see why increasing cross weight creates understeer.

Cross weight is usually difficult and time consuming to adjust on a street car even if you have installed aftermarket suspension components such as coilovers. Unless you are building a pure race car for oval tracks, you don?t have to worry about cross weight adjustments. Remember that the weight distribution of your car, particularly front bias, is the most fundamental characteristic that affects how your car handles. Keep in mind that the weight of the driver affects weight bias. Placing parts on the right side of the car will help balance the weight of the driver on the left side.

For more information on weighing a car and making weight adjustments, visit
http://www.grmotorsports.com/news/012005/understanding-corner-weights.php.

Visit my website for more information about suspension setups:
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I have been an automotive enthusiast throughout my life and have participated successfully in various amateur racing series. I specialize in tuning the Nissan S platform cars, particularly the US domestic market Nissan 240SX. Visit my website http://www.240edge.com to get information about 240SX performance modifications.

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