The Mark Ortiz Automotive

CHASSIS NEWSLETTER

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WELCOME

Mark Ortiz Automotive is a chassis consulting service primarily serving oval track and road racers. This newsletter is a free service intended to benefit racers and enthusiasts by offering useful insights into chassis engineering and answers to questions. Readers may mail questions to: 155 Wankel Dr., Kannapolis, NC 28083-8200; submit questions by phone at 704-933-8876; or submit questions by e-mail to: markortiz@vnet.net. Readers are invited to subscribe to this newsletter by e-mail. Just e-mail me and request to be added to the list.

LOAD TRANSFER QUESTION

For argument's sake, let's assume the following:

1) *Total rear roll resistance is 600 lb/inch of rear suspension travel.*
2) *The static weight on each rear tire is 400 lb.*
3) *The car's rear suspension compresses 1 inch when cornering at the limit. Thus there is 600 lb of load transfer onto the outside rear tire.*

This car starts to corner and 400 lb of load is transferred from the inside rear tire to the outside rear tire. This leaves zero load on the inside rear tire. The car continues to speed up in the turn, reaching the limit of adhesion, and now there is 600 lb of load on the outside rear tire. Where does this additional 200 lb of load come from? Does it all come off the inside front tire? If you have rear anti-roll bar, it can actually push the inside tire up into the tire well. I guess this would be a negative load on the inside rear tire?

If I understand the question correctly, you are supposing that the outside rear suspension compresses one inch from static, implying that the tire gains 600 lb of transferred load, which would make its load 1000 lb.

If we are assuming that the car is in steady-state cornering, on a flat, smooth, unbanked turn, with no geometric anti-roll or pro-roll, and no aerodynamic downforce, you are describing an impossible case. Unless something adds load to the rear wheel pair beyond the static value, the outside wheel cannot have more load than the total for the wheel pair.

There can be no such thing as a negative tire load, unless the tire can somehow pull upward on the road surface. Short of creating a tread compound that is sticky beyond our usual conception, or nailing the tire to the road (either of which would make it very difficult for the car to attain enough speed to corner hard), that just can't happen.

It is also impossible for load to transfer from the front wheels to the rear wheels when the car is only accelerating laterally.

What will happen if the rear suspension reaches 100% load transfer, and then further lateral acceleration is applied to the car, is that the inside rear wheel will lift off the ground. The car will continue to roll, but without any further motion of the rear suspension. That implies that the rear ride height, measured from middle of the frame to ground, will increase as the wheel lifts.

The anti-roll bar will push the inside tire up into the wheel well only in the sense that it may prevent the inside suspension from reaching full droop – not in the sense of compressing the inside suspension beyond static position. The suspension's ride displacement from static will be zero. Its roll displacement will be two-thirds of an inch per wheel. The inside wheel will be off the ground, yet the suspension will be extended only 2/3" beyond static. The outside wheel will be compressed 2/3" from static. The average displacement of the two wheels, from static, will be zero.

We may say that in this situation, the rear suspension is saturated in terms of load transfer: it has absorbed all the load transfer that it can. Any further load transfer must be absorbed by the front suspension alone. This implies that the inside front wheel will lose load, but that load will not go to the outside rear; it will go to the outside front. The total load on the front wheels, and the total load on the rear wheels, cannot change.

Remember, though, that we made a number of simplifying assumptions here: purely lateral acceleration; no bumps; no banking; no geometric anti-roll or pro-roll; no aerodynamic downforce. In the real world, any combination of these might be present, meaning that we could very well have data acquisition traces showing an inch of compression from static on the outside rear.

To know how much added load we would need to get that added 1/3" of ride compression, we would need to know the rear suspension's wheel rate in ride as well as in roll. The required extra load wouldn't necessarily be 200 pounds. If the wheel rate in ride were 300 lb/in, we'd have that condition. (100 lb/wheel divided by 300 lb/in = 1/3 in/wheel)

If the only factor compressing the rear suspension is banking of the turn, and if the tires are racing slicks with a coefficient of friction around 1.30, we'd need about a 25 degree banking to generate 200 lb of extra load. A banking around 35 degrees would do this without the tires generating any cornering force.

If the turn is flat, and the only factor compressing the rear suspension is aerodynamic downforce, we'd need 200 lb of that at the rear axle if the wheel rate in ride is 300 lb/in. If the wheel rate in ride is less, these values decrease. If the wheel rate in ride is greater, the values increase.

The suspension geometry can generate a downward jacking force. This would be most likely in a lowered strut-style suspension, when most or all of the load is on the outside tire. In most cases, this will not be enough to compress the suspension a third of an inch unless the ride rate is very soft, but the effect could add to other effects to produce that much compression.

Forward acceleration will usually compress the rear suspension. In a front wheel drive car, it always will. We think of steady-state cornering as purely lateral acceleration, but actually there will be a car-longitudinal (x-axis) component, even at constant speed, because of the car's attitude angle or drift angle.

Since any or all of these effects can be present, it is entirely possible for the rear suspension to be compressed more than we would calculate for pure cornering on a flat surface. But something has to add ride compression for the condition described here to occur.