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WELCOME

This newsletter is a free service intended to benefit racers and enthusiasts by offering answers to chassis questions. Selected questions will be presented, at my discretion. Readers are invited to submit questions by mail to: 155 Wankel Dr., Kannapolis, NC 28083; by phone at 704-933-8876;
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Mark Ortiz

BRAKE FAILURE IN PAVEMENT LATE MODELS

I've been getting both questions and comments from various people about brake failures in pavement Late Models. It appears that brakes on these cars go away a lot, especially the fronts. These failures occur when the car is running under green for long periods, and also following restarts after red flags. Very often, the car doesn't lose brakes entirely. It just loses the fronts, sometimes gradually, sometimes suddenly, and spins on entry.

Although pads and rotors can fail from extreme heat, it appears that the majority of problems in these cars are related to fluid boiling in the front calipers. This is certainly the case when the front brakes suddenly don't work following a red-flag heat soak.

Better ducting helps, especially under green-flag conditions. Juggling weight distribution and brake balance to make the rears do more of the work helps a little. Making sure the fluid is fresh is essential. But the clients who say they've really licked the problem are using both heat-shielded calipers and/or reduced-conductivity pistons, and brake fluid recirculating systems. In general, applying these measures on just the front brakes seems to be sufficient. This will of course depend somewhat on brake bias.

POLAR MOMENT OF INERTIA (YAW INERTIA)

Mark, one of my racing buddies used the term "polar moment of inertia" in a conversation we were having the other day. I have heard this expression before, but do not understand what it is. Could you explain what it is, and what effect it has on race cars – also, can you measure it somehow, and how does it relate to suspension design and/or coilover placement?

The way racers use the term, it means polar moment of inertia in yaw. A car also has a polar moment of inertia in roll, and in pitch.

Yaw is rotational, or angular, motion about a vertical axis (i.e. rotation as seen from above, or rotation that changes the direction the car points). To take a turn, we must accelerate the car in yaw in the direction of the turn during entry, then decelerate it in yaw (accelerate it in the direction opposite the turn) during exit. We must start it rotating to make it turn, then stop the rotation to make it go straight again.

The car acts as a giant flywheel – its inertia opposes these accelerations. When it's running straight, it doesn't want to start rotating. Once it's rotating, it wants to keep rotating. This effect tightens entry and loosens exit.

The polar moment of inertia is the magnitude of this inertial effect. We increase it by moving masses away from the center of gravity. We decrease it by centralizing masses. A mid-engine car, like an Indy car, has a small polar moment of inertia in yaw. A stock car with the engine between the front wheels and 200 pounds of ballast, the battery, and the fuel load behind the rear axle has a large polar moment of inertia in yaw. So does a VW beetle, an Audi front-drive sedan, or a Porsche 911, with the engine outside the wheelbase.

Most people don't try to measure yaw inertia. GM built a giant turntable fixture to measure it. You can mathematically estimate it by breaking the car down into components, weighing these or calculating their mass, and multiplying the masses by the square of their distance from the CG. Most of us don't bother. For a pure racing car, we just try to put all the heavy stuff as close to the middle, or the expected CG, as possible.

For a production-based car, we often face the issue as a choice between placing components or ballast toward the rear bumper to get more rear percentage, or more centrally to reduce yaw inertia. In such cases I usually go for the rear percentage, especially for oval track applications. An exception would be where you can get more than enough rear percentage, and still fall short of legal minimum weight. Then it makes sense to centralize the ballast.

On an oval track car, we can use asymmetrical setups to make the car enter and exit as loose or tight as we want, even if the car has a lot of yaw inertia. Also, we don't encounter such abrupt changes of direction on an oval as we see in a chicane or sharp turn on a road course. Consequently, minimizing yaw inertia is more important in road racing than on oval tracks.

Both large and small polar moments of inertia are mixed blessings for any car. A car with a small polar moment and a short wheelbase will be twitchy (e.g. older Toyota MR2), unless it's set up very tight (e.g. Pontiac Fiero). When such a car encounters a slippery patch in mid-turn, it will do a big wiggle and possibly spin, whereas a car with more yaw inertia will be more stable.

So a car with a small polar moment should have a long wheelbase if possible. Suspension geometry requirements don't really change with yaw inertia. Moving coilovers toward the center of the car reduces yaw inertia, but not a lot since coilovers aren't very heavy.