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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](mailto: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.

## **LIFE AFTER RACECARTECH**

Since the Racecartech site has closed, I am making occasional posts at [www.rpmnet.com](http://www.rpmnet.com) and the Weekend Auto Racers forum at <http://netpaths.com/cgi-bin/tech.pl>.

## **THE BIG TRACKS AND THEIR BIG WRECKS**

There is now widespread recognition of the prevalence of huge, multi-car wrecks at almost every race at Daytona and Talladega. Most observers agree that this relates to the large packs of cars running close together at high speeds. New rules against putting the left wheels on the apron to pass have not solved the problem. Restrictor plates on the engines, aerodynamic drag-inducing additions to bodies, and restrictions on spring and damper calibration have all been instituted with minimal impact on the problem.

I wish I had a simple solution myself, but I don't. I do, however, have some thoughts on the fundamental causes of the problem.

There is an "elephant at the dinner table" here – a problem that really should be clear to everybody, but that nobody wants to mention. That problem is the design of these tracks: they are 2 ½ miles or longer, with bankings of 30 degrees or more. This means that unless the cars can do well over 200 mph, they can run wide open all the way around the track. If they run fast enough to be grip-limited in the turns, they become really hard to contain when they get out of control, and impacts occur at pretty ferocious speeds. Concern about these factors is what has led to all the efforts to slow the cars.

But now that the cars can run wide open all the way around the track, drafting becomes the key to victory, just as it is in that other power-limited sport, bicycle racing. Bicycle racing is also subject to massive pileups, for very similar reasons. This fact should tell us something about the prospects for eliminating the pileups by slowing the cars. Slowing the cars further may reduce injuries and deaths somewhat, but the pileups will still occur.

It has been suggested that smaller engines be used rather than restrictor plates. This might improve the throttle response of the engines, but it will not change the fact that they will be running at full power except when drafting another car. We might expect a bit more passing, but these races already have an abundance of passing.

As long as there are no turns small or flat enough to slow the cars, there is no way out of the dilemma. Either the cars will run in huge drafting packs, or they will run so fast that they will be excessively dangerous to drivers and spectators when they crash, even though they will probably crash in smaller numbers at a time.

The only avenue that might offer some promise is to reduce the grip of the tires sufficiently so that even with modest power, the cars will have to slow significantly for the turns. Trouble is, that would require a pretty significant grip reduction. I hesitate to advocate making the cars really slidey when the wind already moves them around so much, and when they already take forever to stop following loss of control.

## **SELECTING SPRINGS**

*When a new car is built, is there a way to calculate best spring rates to try first, and thereby minimize testing?*

There is no method that works for all types of car. Spring rates are only one of many tuning and design variables, and all these variables interact with each other. You can measure some of these factors; others you can only guess at. With more resources, you can measure more, and guess at fewer. For example, with wind tunnel testing, aerodynamic effects become much less of a guess. The track or road conditions are another important variable. Any given car will want different setups, including springs, for different conditions.

A common method is to simply borrow a spring combination from a car that is estimated to be similar, and test from there. Many race cars are built to existing class rules and are similar to ones already running, with small variations. When using this method or any other, it is vital to go by *wheel rate*, the rate at the wheel. Many suspensions have one wheel rate in ride and another in roll, and you need to look at both.

In oval track racing especially, many different spring combinations can be made to work fairly decently, because we can vary diagonal percentage, stagger, and other factors to suit the springs. Even in road racing and figure 8 racing, the car can be adjusted to suit various spring packages by varying roll center heights, anti-roll bars, and aerodynamic surfaces. In many cases, the difference between a superior spring package and an inferior one will be seen in the car's transient behavior, and its response to varying conditions.

That said, we can state some definite rules for the ways spring choices relate to other factors.

## **RELATIONSHIPS BETWEEN SPRING CHOICES AND OTHER FACTORS**

## OTHER FACTORS REMAINING EQUAL:

Stiffer springs at one end of the car call for stiffer springs at the other end.

Wider or stickier tires at one end of the car call for stiffer springs at that end and/or softer ones at the other end.

Rougher surfaces call for softer springs, with higher ride heights. This assumes that suspension travel is available to do this. If bottoming is a problem, stiffer springs may be needed to overcome that.

More aerodynamic downforce calls for stiffer springs.

A stiffer anti-roll bar calls for softer springs at that end of the car, and/or stiffer springs at the opposite end.

To correct an understeering car (tight condition), use stiffer rear springs and/or softer fronts.

To correct an oversteering car (loose condition), use softer rear springs and/or stiffer fronts.

More diagonal percentage calls for softer front springs and/or stiffer rears.

More rear tire stagger calls for softer rear springs and/or stiffer fronts.

A lower roll center at one end of the car calls for stiffer springs at that end. A lower roll axis calls for stiffer springs at both ends.

More weight at one end of the car calls for softer springs at that end and/or stiffer springs at the opposite end, to preserve similar cornering balance. This requirement is at odds with the need to add spring rate proportionally to weight, to preserve similar ride characteristics. In some cases it will not matter whether similar ride characteristics are preserved. In other cases, we may want to work with anti-roll bars and suspension geometry as well as springs, to reduce relative roll resistance at the end that's seeing the weight increase.

On banked ovals, there is a *critical angle* of banking, at which the left suspension neither compresses nor extends in steady-state cornering. For typical stock car chassis on asphalt, the critical angle will be around 15 degrees. On dirt, the critical angle will be somewhat smaller than this. Below the critical angle, left side spring changes have effects as described above. Near the critical angle, left spring changes have little effect on steady-state cornering balance. Above the critical angle, effects of left spring changes on steady-state cornering balance work *backwards*: a stiffer left front loosens the car; a stiffer left rear tightens the car.

On ovals, assuming the car does not generate large jacking forces (true for most pavement cars, but not for some dirt cars), and assuming that the car is not slowed primarily by the rear wheels, stiffer left springs and/or softer rights loosen the car when braking and turning left together (entry), and tighten it when turning left and applying substantial power (exit). Conversely, stiffening the rights tightens entry and loosens exit.

Anything that reverses direction of suspension position change reverses effects of spring changes.