

The Mark Ortiz Automotive

CHASSIS NEWSLETTER

PRESENTED FREE OF CHARGE
AS A SERVICE TO THE
MOTORSPORTS COMMUNITY

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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.

BIG TIRES ON THE FRONT

Last issue, I mentioned that there is a performance gain to be had in a front-wheel-drive car by making the car markedly nose-heavy and using larger tires in front than in back. This was in a rather lengthy response to a reader's question partly relating to the Pontiac Grand Prix GXP. I have recently noticed in magazine reports about this car that GM is in fact using larger tires on the front of the V8 versions of this car: 255 section on the front, 225 on the rear.

TIRES IN THE SNOW

I have heard two schools of thought on tire pressure for winter driving. This applies to driving on snow-covered roads. The first is that tires should be kept at the upper end of the manufacturer's specifications to help in cutting through the snow. The thinking is that the contact patch is smaller, hence more weight per square inch, as well as less sidewall deflection – which may decrease the potential for hydroplaning on the snow. The other is that running the pressure at the lower end allows for better bite for the tread in the snow, and more stability. What do you think?

I'm with the low-pressure school.

It's said that one measurement is worth a thousand expert opinions. Really, you'd think this might be measurable. Surely somebody has tried measuring, say, how steep a hill a vehicle can climb, at various tire pressures. I would be willing to defer to any actual measurement that contradicts my expert opinion.

That said, I offer my expert opinion, and that expert opinion is based on a lot of time spent in Wisconsin, where there are long, snowy winters.

First, tire pressure effects in snow are surprisingly subtle compared to other variables, and effects due to other variables are surprisingly large. That explains why there is controversy about inflation pressures, even though people have been driving cars through more than a hundred winters now.

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One reason tire testing was moved indoors, with rollers or belts substituting for pavement, is that even on hard, dry pavement, weather, surface contamination, pavement temperature, pavement age, and other factors make enough difference that small variations in tire performance are hard to measure repeatably.

When we're dealing with snow, we have similar variability, exaggerated at least tenfold. Snow and ice come in dozens of different varieties and depths, and all of these have properties that are highly temperature-sensitive. Compared to snow, pavement is simple and consistent.

The explanation I have heard from sources that advocate high tire pressures is that the tire needs to penetrate the snow and get to the pavement, where it can find traction. But clearly, in most snow conditions that never happens, at any inflation pressure. If it did, we'd see bare pavement where the tire passed.

Instead, we see compacted snow, with an imprint of the tire tread. Or at least we see that if the tire is rolling, and not spinning or sliding – and if we are dealing with snow that has not already been compacted. We also usually see a small area alongside the track where the snow appears slightly raised, apparently having been pushed out of the way, perhaps just by the sidewall. This is not a lot of snow, however. Most of the snow stays put horizontally, and gets compacted vertically.

The tire evidently gets traction by packing the snow into a relatively solid form, and simultaneously interlocking with it. To break traction, the compacted snow projections residing in the tread grooves must be sheared off, and the layer of snow lying under the tread blocks must also fail in some manner.

The failure of the snow in the grooves is easily visualized as simple breakage. The failure of the snow under the tread blocks is a bit harder to visualize. It appears that the snow under the tread blocks contributes more to traction than one would imagine, because the tire's grip is greatly improved by siping the tread blocks. It also helps to roughen the surface of the tread blocks.

I do not claim to perfectly understand the mechanics of structural failure of snow in a tire contact patch, but I do know that it is normally a combination of breakage and melting. Ice (and snow is ice crystals) can be melted by mechanical pressure – or, stating it a bit differently, the melting point of ice is lowered by mechanical stress, either compressive stress or shear stress. Anyplace that the snow or ice liquefies, its mechanical strength disappears, and it turns into a lubricant. The closer the ice or snow is to its melting point, the less mechanical stress is required to turn it to liquid.

So, when we compact snow, we make it stronger, but only up to the point where we start to get localized melting. The unit loading required to reach this point depends on how cold the snow or ice is. Moreover, short of the point where we encounter melting by compression alone, we see an increased likelihood of melting by the combination of compression and shear. In other words, as unit loading increases, we gain hardness but lose melt resistance. The hardness gain is fairly

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independent of temperature. The melt resistance loss is heavily affected by temperature, or at least its importance is.

From this, we might logically expect that the ideal contact patch size would be smaller in really cold weather than when we're near thaw temperature.

I suspect that this is academic, however. I think the optimum contact patch size is far bigger than we can ever get with a tire. Consider the transportation devices that people have devised specifically for snow: snow cats, snowmobiles, snowshoes, cross-country skis. All of these operate by compacting the snow minimally, over a large area, and then trying to get maximum purchase on that large interface. For best performance on snow, or any other soft surface, we really want a belt or track, not a tire.

It would seem to follow that the more we can get a tire to act like a track, the better it should work. That would suggest a radial tire, at low pressure.

Note that it does not necessarily follow that we want a wide tire. It is generally agreed that for most winter conditions, a tire should be narrow. I think, based on the reasoning above, there will be winter conditions where a wide tire may be preferable. These may include bare ice and hard-packed snow, probably even shallow soft snow. But in snow of significant depth, narrow tires are better.

The reason for this doesn't have to do with an increase in traction when the tire is narrow, as such. Rather, it has to do with the force required to move the tires, which is less when the tires are narrow.

As the tire rolls forward, it is resisted by the snow in front of it. To advance, the tire must, in effect, climb a ramp of snow. The ramp of snow is not strong enough to support the tire, and it is continually collapsing under the weight of the car. The amount of collapse is fairly similar regardless of the width of the tire; for any practical tire size, we will compact the snow to a pretty solid state, no matter what. Yet the snow has substantial resistance to this compaction, and this translates to a resistance to the wheel's forward motion. The taller and wider the mass of snow we must compact, the greater the resistance to motion. The height of the snow we must compact depends on the snow's depth. The width we must compact depends on the width of the tire.

It would also seem that a narrow tire should provide more directional control, since it is better shaped to act like a blade or rudder.

From this reasoning, we might expect that the ideal tire for deep snow would resemble a bicycle tire. Such a tire would be easy to push along, and should have good directional stability.

However, it doesn't quite work that way with really narrow tires, as anybody who has tried riding a bicycle in deep snow will attest. The problem is that the ramp of compacted snow that the tire rides on is so narrow that the tire is forever sliding off the side of it into the soft snow alongside. As soon as the tire moves forward again, another narrow compacted ramp is formed beneath it, and again it

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slides off one side or the other – no predicting which side. The result is that the tire absolutely will not run straight.

So there is such a thing as too narrow. The tire needs to be wide enough to sit on top of the compacted ramp it is making for itself. A square-shouldered profile, or one with concave shoulders that compact a sort of retaining berm along the side of the main compacted ramp, also can be expected to help.

Returning to the question of inflation pressure, this also affects resistance to forward motion. And even this relationship is not as straightforward as one might think. Based on our experience with tires on pavement, on a smooth, hard surface, the higher the inflation pressure, the easier the tire rolls, at least within practical limits.

But on a rough surface, a softer pressure can actually roll more easily. For this to be so, the surface must have roughness as opposed to waviness: the ups and downs must come fairly close together. The tire rolls easier because it can yield to the bumps rather than having to climb over them. This was realized very early in the history of the pneumatic tire. John Dunlop immediately noticed that his new pneumatic tire would roll further across his bumpy back yard than a solid tire.

This has relevance to driving in snow because often the situation that gets us stuck is one where one or more wheels are in a fairly modest-sized depression, and we have to move the tire over the lip of the depression with the meager traction available. In at least some such situations, soft inflation will make getting over that lip easier.

It will be apparent that I am writing here from a mixture of practical experience and inference. I invite readers with further experience, or contradictory experience, to comment.