Tire Pressure and Pavement Damage

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Thank you for the opportunity to present some thoughts on the role that tires play in the pavement loading and wear scenario.

I am here today wearing the hat of the U.S. Rubber Manufacturers' Association, or RMA. For those of you who may not be familiar with that group, it is the trade association of manufacturers or rubber products and has several divisions, the core one of which is, as you might expect, the tire division. The RMA includes in its membership most of the tire manufacturers, such as Goodyear, Michelin, Firestone, General, and numerous others, and often acts as the spokesman for these members on subjects or issues of common concern.

Our objectives this afternoon are several. First, I'd like to share with you some statistics and trends in the tire industry, some of which may be known to you and others of which may fall in the new information category.

Secondly, I'll address several specific points regarding tire inflation pressures and pavement loadings, and attempt to clarify what we believe to be misinformation, or perhaps merely information out of context, that is currently circulating in some circles.

Thirdly, we'd like to share with you some issues we believe to be of significant importance in tire/road pavement interface studies.

And finally, we hope to reinforce, what I hope is already your experience to date that the tire industry supports, and certainly intends to progress actively, further studies leading to a better understanding of the relationships the various components of trucks, operators, tires, and roads have in this very complex relationship.

First, make no mistake that our industry is in the midst of many changes. The market for medium over-the-road truck tires, and that includes tires ranging from 7.50-20 on the small end up to approximately 12.00-24 on the large end, is moving from bias ply to radial. At the end of 1985, radials accounted for slightly over 50% of the replacement tire market, and this is expected to grow to 70-75% in the next 4 years.

In the original equipment, or new vehicle market, the current figures are closer to 70% now and are expected to grow rapidly to 90% or more radial over the next 4 years.

Perhaps more important, however, is that today, over 90% of the new *Class 8* trucks (over 33,000 # GVW) are being built with radials as original equipment and its really the smaller trucks, such as city delivery units, farm trucks, and school buses that remain on bias ply tires.

This is primarily the result of those markets being slow to respond to lifecycle costing analysis, rather than emphasizing the low initial price offered by many bias ply tires. It has also been influenced by the tire industry's development lead times necessary to refine specialized versions of radials for these market segments.

This switch to radials is important because radial tires tend to have more uniform, or consistent unit pressure loading in the footprint area. This is due to the very rigid steel belt package running circumferentially under the tread area. This is, at least directionally, an improvement for pavement loading. The radial tire also, at a given load and inflation, tends to deflect slightly more than its bias counterpart, again, we believe, directionally offering improvement in pavement loading due to reduced peak pressure loadings in the footprint under similar usage conditions.

Another trend in tires is to newer low profile designs, such as the 75 and 80 aspect ratio tires especially for the line haul or high speed long distance carriers.

These tires, introduced to North America in 1982, currently have gained approximately 18% of the replacement market and over 35% of the original equipment fitments -- again heavily skewed toward the higher GVW, Class 8 vehicles. Low profile tires tend to have wider treads than their conventional size counterparts, again allowing

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lower unit pressure footprint loadings. The differences are not great and vary somewhat with individual sizes and types, but directionally they represent an improvement.

So, our industry is switching fairly rapidly from bias to radial tires, and from conventional sizes to low profile or wider tread designs in the high speed long distance carrier segments. Additionally, there is a trend from tubetype to tubeless truck tires, which have significant advantages in efficiency, durability and safety. They also eliminate the need for multi-piece rim and wheel hardware.

I believe my colleagues would agree that we have also seen usage or service conditions for our tires change in the last several years. Specifically, while peak truck speeds have remained the same, or perhaps even decreased slightly, there is little question that average trip speeds have climbed. This is due to diesels with higher torque outputs over a broader engine speed range and increased monitoring of driver behaviour. We are also seeing more consistent and somewhat higher truck (and tire) loading due to more loaded backhauls after deregulation and increased utilization of the efficiencies possible with computer assisted scheduling in an intensely competitive freight market.

We also see improved maintenance on the part of the trucking industry as these businessmen devote additional attention to protect their greater investment in the more expensive radial tires. In fact, a worn out original tread *radial* truck tire casing today is worth from 3 to 4 times the value of its bias ply counterpart, due to its better durability, fuel economy and reduced downtime in the retread cycle.

In summary, the trucking industry has tires available today which generally double the original treadlife on both steer and drive axles compared to just 5 to 6 years ago, and offer from 2 to 10 percent better fuel economy. And here is where we believe several of the misunderstandings originate. Let's first consider inflation pressure. Radial and bias tires of a given size have been, and still are, designed to carry the same load at any given inflation pressure. Studies have consistently shown, however, that the radial tires run cooler, and therefore have a smaller increase in inflation pressure from cold to hot (or running) temperature.

To compensate for this, and to achieve equal hot (or running) pressures, cold inflation pressures for radials are specified 5 psi higher than for bias tires. This is based on research studies conducted in our industry in the 60's and early 1970's and this policy has not changed for at least the last 15 years.

If we were to compare the load versus recommended inflation pressure charts for popular sizes of truck tires, we would see that the inflation pressures are the same in today's 1986 tire and rim association yearbook as they were in 1972. It is also noteworthy that, to the best of our knowledge, there are no plans to change these specifications.

One question that often arises is whether or not to "bleed" air from "hot" tires when trucks are inspected at weigh stations or during other routine stops. It is common for inflation pressure to increase from 10 to 20 psi over the cold pressure in bias ply tires and from 5 to 15 psi for radials. This increase is normal and is, in fact, essential for tire durability. As a good general rule, recommended inflations are for cold tires and the industry recommends that pressure never be "bled" from hot tires.

It is a fact that most of today's popular radial truck tires are one higher ply rating or load range step above their older bias ply counterpart and, as such, are rated for slightly higher loads at approximately 10 psi higher inflation.

It is important to note that when this extra load capacity is required, the older, lower ply rating, bias tires would be overloaded. But the fact remains that *for comparable loads, yesterday, today, and for the foreseeable future, the recommended inflation pressure is not changed.*

Maintenance of proper tire inflation pressure continues to be a significant concern of the tire and trucking industry alike. Most of this attention has been directed to the correction of underinflation to improve highway safety, as underinflation generates excessive tire heat and can result in fatigue failures. The critical temperature for tire materials is around 240° F.

Truck tires normally reach summertime equilibrium temperatures around 200 F or slightly higher, but variations in tire designs or operating conditions bring some tires closer to the critical range of 240 F. *There is no current margin* which would permit reduction in today's operating inflation pressures without commensurate reductions in truck loads and/or speed, the other 2 primary variables in the tire durability equation.

Tire internal pressures, along with other tire variables, can also have significant effects on vehicle traction, stability and energy efficiency. The vast majority of truck radial tires in use today are operated at from 85 to 105 psi cold inflation pressures and are mounted on rims or wheels which have cold inflation ratings of from 105 to 120 psi. While it is true that higher inflation pressures result in lower tire rolling resistance, this point historically has been used to discourage underinflation, which can be a durability or safety concern, rather than to encourage higher than normal pressures.

Test data generated at Calspan in Buffalo, New York, on several popular bias and radial tires, size 11-22.5, indicate that raising inflation pressures by 10 psi would theoretically result in an approximate 4% reduction in bias truck tire rolling resistance but only a 2 1/2% change in radials. A 2 1/2% improvement in rolling resistance correlates to less than 1% improvement in actual truck fuel consumption. Since most over-the-highway truckers have already moved, or are currently converting, to radials, increasing recommended tire pressures to achieve lower fuel consumption is not being promoted since it would have little or no real life measurable effect in the pressure range used by these trucks.

Another noteworthy point is that several years ago, during the height of the oil supply crisis, a number of highly theoretical and experimental ideas were discussed in the truck and tire industry for fuel economy reasons.

Aside from the trends I have already mentioned, these ideas generally did not progress beyond the academic discussion or trial stage, and, to the best of our knowledge, there is no trend toward any of these concepts which involve significantly higher unit footprint pressures.

One other issue that should be discussed, and we believe it warrants careful, *but separate* consideration, is that of single wide base tires. These designs, in sizes such as 15R22.5, and 16.5R22.5 have to date been used in place of conventional size tires on steer axles when extra load capacity is required. Typical applications are front axles of redi-mix concrete trucks, heavy sand and gravel haulers and other such slower speed vehicles. Today, approximately 95% of the wide base tires sold in our industry's domestic market are used in these applications.

However, in parts of Europe, similar wide base tires are becoming more commonly applied to trailer axles, replacing the traditional duals.

Most of these fitments use 6 tires, 3 on each side of a triple axle trailer which is pulled by a single drive axle tractor with conventional dualed tires on the drives. When the wide base tires are used in place of duals, the primary advantages are reduced empty or tare weight and improved fuel economy.

There are a few applications currently evaluating wide base singles in the U.S. and Canada in line haul service. Virtually all are radial tire designs and are considered to be experimental in nature. Nearly all are fitted to tandem axle trailers, with the remainder on tandem drive axles.

There is little question that the single footprint contact area of these tires is smaller than the combined footprints of the duals they replace, especially if the duals are low profile designs. Therefore, the *static* pavement loading of the single tires is higher.

Once the truck is in motion, however, these tires have radial spring rates that are generally lower than the dual assembly. This suggests that *dynamic* pavement loadings at the footprint are lower, or improved.

Currently, studies are underway to quantify the magnitude of these static to dynamic spring rate changes, and, the jury is still out, so to speak. Nevertheless, the performance advantages of single wide base tires can be expected to have an increasing appeal to efficiency minded truckers, and we might expect to see some new designs of these tires emerge in future years. We encourage viewing the wide base single tires replacing duals as a separate issue, apart from any other issues on conventional or low profile dualed tires.

One further trend we should consider together with the dynamic tire/road interface pressure issue concerns truck suspension designs for the heavier over-the-road trucks.

Many of these class 7 and 8 vehicles are now being manufactured with suspensions that are softer riding than their predecessor designs of very recent years.

This trend is in part, attempting to create a more comfortable cab environment for the driver and to reduce vibration of mechanical componentry and to lessen cargo damage. Practically, this is being achieved by using longer, wider taper leaf springs having only 3 or 4 leaves on steering axles, compared to older stacked springs with 11 to 14 leaves.

On drive axles, we are seeing more active, or height controlled air spring suspensions and other softer riding designs. The improved ride is generally achieved by having more jounce and rebound suspension travel for comparable load ratings and nearly all of these newer designs employ shock absorbers. We believe that another beneficial effect of these designs is to reduce peak pressure inputs to the road surface, although we are not aware of studies to date which quantify this.

It is also interesting to compare our North American truck tire inflation pressures to those commonly used in western Europe which tend to be from 10 to 20 psi higher than ours for comparable tire sizes. This corresponds to tire load ranges, or ply ratings, which are one step higher yet than our current radial ply designs here, and which are necessary for the higher individual axle loads commonly found on the European equipment.

In summary, there are trends in the North American markets to radials which offer significant performance advantages for truckers and to low profile designs for the higher speed, long distance carriers. These, we believe, should alleviate some of the pavement loading concerns. On the other hand, trucks are running fewer empty or lightly loaded miles than in the past.

Cold inflation pressures recommended for radial truck tires today remain unchanged from earlier years and are nearly always in the 85 to 105 psi range, although this can result in hot operating pressures of 100 to 120 psi, except for some very specialized applications in limited areas which are not typical of over-the-highway operations.

We are not aware of any current plans by manufacturers in our industry to introduce new products which utilize inflation pressures beyond these values.