ROADSIDE ALLIGATORS, RETREAD TYRES AND TYRE DEBRIS SURVEYS – INSIGHTS FOR THE SOUTHERN AFRICAN TRANSPORTATION COMMUNITY

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ABSTRACT
Roadside alligators (aka "tire debris") are those unsightly shreds or fragments of rubber that are occasionally found on the roadway. During summer 2007, the University of Michigan Transportation Research Institute conducted a national tire debris survey that involved the collection of 39 metric tones of rubber and that provided 300 casings and 1,196 debris items for subsequent failure analysis. This paper presents the tire debris survey methodology, discusses the survey results and shares insights that may be applicable in a Southern African context. Overall, where the original equipment/retread status could be determined, there was a 60 / 40 percent split between original equipment (i.e., new) and retread tire casings tested compared to a 21 / 79 percent split for tire fragments. Road hazard or maintenance/operational reasons were two of the top three probable damage/failure causes. This result suggests that the majority of tire debris items found on U.S. highways is not as a result of manufacturing/process deficiencies. The study concludes that it is important for role players in the Southern African transportation industry to explore the lessons learned from the tire debris survey and recommends; firstly, that stakeholders continue to increase public awareness about the origins, characteristics, and impacts of tyre debris, and, secondly, ensure adherence to the highest standards in vehicle operations and associated tyre maintenance. Resolving these challenges has the potential to see a significant reduction in roadside tyre debris and enhance the road safety environment.

INTRODUCTION
Roadside alligators (aka "tyre debris") are those unsightly shreds or fragments of rubber that are found on the pavement or hard shoulder areas of major roads and freeways. A perception among many road users is that such tyre debris is generated primarily by heavy trucks that are running on retread tyres. Furthermore, this perception postulates that retread tyres are less safe than original equipment ((OE) i.e., new) tyres. In the U.S. there has been ongoing debate over the incidence and traffic safety impacts of tyre debris. Several nationally or regionally focused tyre debris studies conducted during the 1990s had the primary objective to determine the probable cause of tire failure and by so doing to validate or disprove whether a commercial medium- or wide-base truck tire's retread status is a contributing factor in the formation of tyre debris. Thus, during summer 2007, a national tyre debris collection exercise was conducted by the University of Michigan Transportation Research Institute (UMTRI) to gain a better understanding of the [OE/retread] tyre debris issue.

"For most fleets, tires represent the second largest item in their operating budget, right after fuel costs" (Bandag, 2007). Thus, savings in OE tyre purchase can significantly influence the bottom line and business sustainability for the trucking operator. However, commercial tyres can and do have a wider impact on transport sustainability, particularly in a Southern African context. On the positive side, well maintained and correctly pressured tyres enable trucks to operate at optimum efficiency while minimising downtime arising from punctures, etc. Such operational benefits have a positive impact on supply chain and business logistics. On the other hand; poor tyre management, incorrectly pressured tyres and shoddy retreading, etc., can significantly reduce tyre life-cycle and retreading capacity, contribute to traffic crashes (through tyre debris and the illegal reselling of substandard tyres) and shorten the time taken from production to the landfill, unauthorised dumping site or destruction through [illegal] burning. Indeed, "large

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quantities of scrap tyres are illegally dumped in the veldt or burnt to recover the scrap steel." (Bester et al, 2004) To accommodate for tyre loss through these methods, unnecessary expense is incurred to transporters and consumers as well as to society at large through resolving these negative environmental impacts. Thus, the management, operation and disposal of commercial tyres have a pivotal role in sustainable transport.

PAPER OBJECTIVES AND SCOPE OF STUDY

A better understanding of the tyre debris issue may enable a reduction in the level of subjective responses (i.e., misguided perceptions) by road users and safety advocates as to the causes and impacts of this type of roadside debris. The 2007 UMTRI Tyre Debris Survey (TDS) adopted a scientific approach to clarify this issue. Through the reporting of the TDS, the objectives of this paper are to: 1) Describe the TDS and the methodology followed, and 2) assess and discuss the potential significance of the TDS results with a focus on retread tyres and 3) share insights from the TDS and the U.S. retread tyre industry that may be of benefit to the Southern Africa transport community.

In any given location roadside alligators often represent tyre debris generated from all vehicle types, i.e., excluding tyre items deliberately dumped on the roadside. However, the larger fragments tend to be generated by commercial trucks, the subject of this study. The focus on the commercial medium tyre (i.e., a tyre with a rim diameter ≥ 50 cm and cross section ≤ 30 cm) is based on several factors: namely; 1) large tyre debris items may have a greater propensity to cause a serious traffic crash or personal injury; 2) a significant proportion of commercial medium tyres running on U.S. highways are retreads; and conversely 3) a negligible proportion (i.e., less than 0.5 percent) of passenger and light truck tyres running on U.S. highways are retreads.

THE UMTRI TYRE DEBRIS SURVEY - METHOD

A tyre debris and casings collection exercise was conducted by UMTRI during summer 2007, i.e., July to September. The objective of this exercise was to collect a representative sample of tyre debris/fragments (n = 1,700) and casings (n = 300) for subsequent analysis in order to determine the OE or retread status, the probable cause of failure, and whether there was a higher incidence of retread versus OE tyre debris items in the sample. Five collection sites around the U.S. were selected according to average annual daily truck traffic (AADTT) interstate/freeway volumes. The sites selected were: Gainesville, Florida; Gary, Indiana; Taft, California; Tucson, Arizona; and Wytheville, Virginia. At each of the five survey sites, a truck stop and a state highway maintenance yard were identified as debris collection points. Determining whether tyre debris surveys have been conducted in Southern Africa discussions with Dave Mills indicated that there have been no formal surveys conducted in South Africa (Kotze, 2009). However, several informal surveys have been conducted by the tyre industry to determine the percentage split of roadside debris between OE and retread tyres and not to ascertain the reasons for tyre failures (see Fleetwatch Magazine, February 2007).

In order to maximize the collection of tyre debris, the summer season was selected as the time to conduct the collection exercise. (Note: high ambient temperatures can be a contributing factor in tyre debris generation). At each site, both the highway maintenance agency and the associated truck stop collected debris and casings simultaneously over a two-week period. Each collection site followed a pre-determined collection program where the primary tasks were to designate a collection receptacle (e.g., trailer, dumpster, or open space), collect and deposit the tyre/rubber debris, and finally permit the transportation of the collected items for failure analysis. A 16 meter (53-feet) trailer was positioned at the designated truck stop for loading with tyre casings. At the end of the collection period, the trailer was taken from the truck stop to the highway maintenance agency yard for loading of the tyre shreds/casings (i.e., collected by the highway agency) and then hauled to the tyre/rubber forensic consultant's testing facility. Debris collection guidelines were given to managers at each truck stop/highway maintenance agency. These guidelines were to ensure uniformity in the type of debris collected, enhance environmental safety, and to minimize any unforeseen logistical challenges.

THE UMTRI TYRE DEBRIS SURVEY - TYRE DEBRIS FAILURE DETERMINATION

Collected tyre debris from the five survey sites was transported to an independent tyre/rubber forensic consultant (i.e., Smithers Scientific Services Incorporated of Akron, Ohio) for failure analysis. Identifying a suitable institution to undertake this task a scoping exercise revealed that failure analysis in previous tyre debris studies in the U.S. have often been conducted by experts having a direct or indirect relationship to the trucking or tyre industries. Indeed, to enhance the objectivity of the failure analysis exercise the UMTRI study team did not involve analysts with linkages to the trucking or tyre industries despite assistance being offered. Currently in Southern Africa independent tyre forensic consultants (at least in South Africa) do not exist. Indeed, several inquiries with South African tyre industry experts confirmed this conclusion. The CSIR (South Africa) has conducted research on tyres, however, these studies have focused on simulating tyre loading and stress testing scenarios (e.g., Steyn & Haw, (2005) and De Beer et al (2005)).

Tyre failure analysts employed the industry-accepted and validated, scientific "observations to conclusions" methodology. Before commencing failure analysis determination the tyre debris collected required expert sorting, to eliminate the passenger and light-truck (i.e., bakkie) samples that did not qualify for analysis in the project. At the completion of the sorting process, the non-qualified fragments were isolated by placing them back into the trailer in which the particular shipment arrived. All of the qualifying contents of each trailer were then analyzed, prior to the arrival of the subsequent trailer, which eliminated the potential for samples from one geographic region to be intermingled with those from elsewhere.

After representative samples had been determined, visual and tactile means were employed as a practical method for determining the cause, or causes, of tyre failure. Simple tools (e.g., tread depth gauge, jeweler's loupe and a tape measure) were also used in the tyre failure analysis exercise. The failure analysis methodology applies equally to whole tyres, tyre casings, or fragments of tyres (i.e., tyre debris). Physical characteristics of each specimen examined were recorded, in order to determine the most likely category in which to place the sample. Seven general damage (i.e., failure) categories were utilized, five of which contained further sub-categories. However, if the sample did not provide sufficient information to be assigned to one of the six other descriptive categories, it was placed in the "Indeterminate" category. (NB. Tire failure is a sudden and catastrophic failure of a tyre resulting in the production of tyre debris potentially impacting vehicle or road safety). The damage/failure categories are presented in Table 1.

TABLE 1 Damage/Failure Determination Categories

Damage/Failure Category	Explanation (i.e., damage resulting from)
1 - Overdeflected Operation	The internal steel reinforcement material (steel radial sidewall ply) sustaining sufficient cyclic flex fatigue or the occurrence of belt/belt package detachment
2 - Excessive Heat	Operation of a tyre while underinflated, overloaded, or at excessive speeds
3 - Road Hazard	Punctures, cuts, and the striking of objects such as curbs, potholes, etc.
4 - Maintenance/ Operational	Improper repairs, excessive wear, incorrect tyre or wheel mounting or dismounting, locked brake skid damage, and by contact with some part of the vehicle upon which the tyre is operating
5 - Manufacturing/ Process Issues	Original tread or retreading process manufacturing issues that could be expected to contribute to the tyre's disablement
6 - Indeterminate Cause	The non-availability of sufficient pieces of the casing/fragment or other information in order to reach a conclusion as to a damage category assignment
7 - Excessive Intra-Carcass Pressurization	Compromise of the inner liner as the result of a road hazard, mounting damage, or by some other means resulting in pressure entering the tyre's structure at excessively high levels. This excessive intra-carcass pressure can separate the tyre's individual manufactured components and/or separate rubber from the reinforcement material (steel or fabric).

Source: Page & Woodrooffe, 2009

THE UMTRI TYRE DEBRIS SURVEY - RESULTS

Volumes of Tyre Debris and Casings Collected

Table 2 presents details of the tyre debris and casings collected and sampled from each site. Overall, more than 39 metric tons of rubber was collected from the five collection sites over the survey period, ultimately providing 1,496 samples. The tyre failure analysts were tasked only to test commercial medium/heavy truck debris items and other items not meeting this standard were discarded and not counted or recorded. However, it was estimated that 60 percent of the tyre items collected (i.e., casings and debris) were from medium/heavy trucks and 40 percent were from passenger cars and light trucks. After items belonging to the required category were sampled, the balance of the tyre debris items collected was isolated (i.e., put back into a trailer) resulting in the examination of 300 casings and 1,196 tyre fragments that met the study criteria.

TABLE 2 Weights (metric tones) of Collected Tyre Debris and Casings

Collection Site	Truck Stop	Highway Maintenance Yard	Total Weight Collected	# Casings Tested	# Tyre Fragments Tested	Total # Items Tested
Gainesville, FL	6.82	1.53	8.35	60	198	258
Gary, IN	11.69	1.94	13.63	60	259	319
Taft, CA	3.69	3.03	6.72	60	328	388
Tucson, AZ	3.76	2.41	6.17	60	161	221
Wytheville, VA	3.35	0.76	4.11	60	250	310
Total	29.31	9.67	38.98	300	1,196	1,496

Source: Page & Woodrooffe, 2000

Casings and Tyre Fragments Retread Status

Approximately 127 (42 percent) of the 300 casings analyzed were retreads and 169 (56 percent) were original tread casings (the balance was categorized as "unknown"). Of the 1,196 tyre fragments that were analyzed, approximately 214 (18 percent) were from original tread tyres, approximately 812 (68 percent) were from retreaded tyres, and in approximately 170 (14 percent) of the examinations, no determination as to original tread or retread could be made. Figure 1 illustrates these findings.

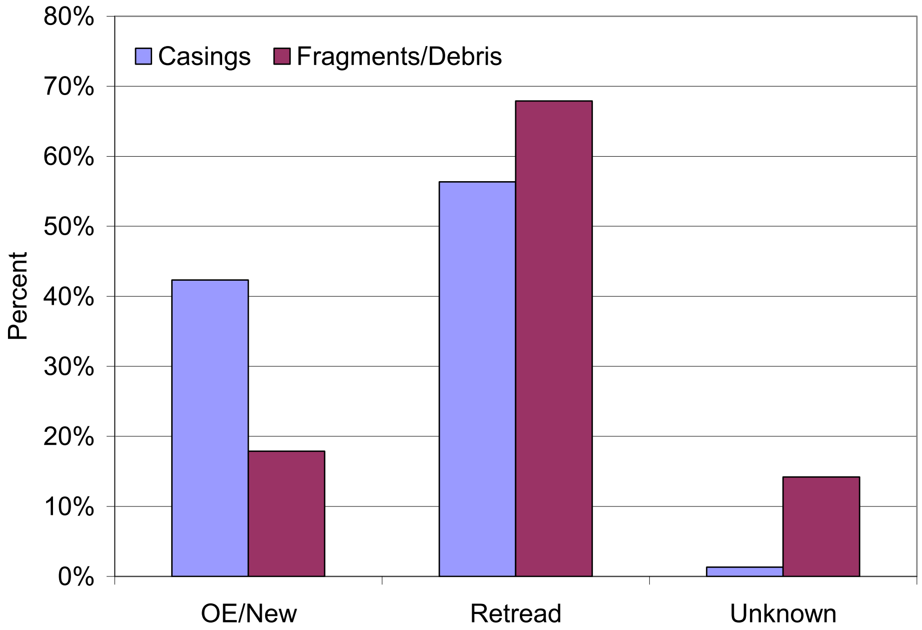

Figure 1 Retread Status of Casings and Tyre Fragments Analysed

Casings and Tyre Fragments Failure/Damage Condition

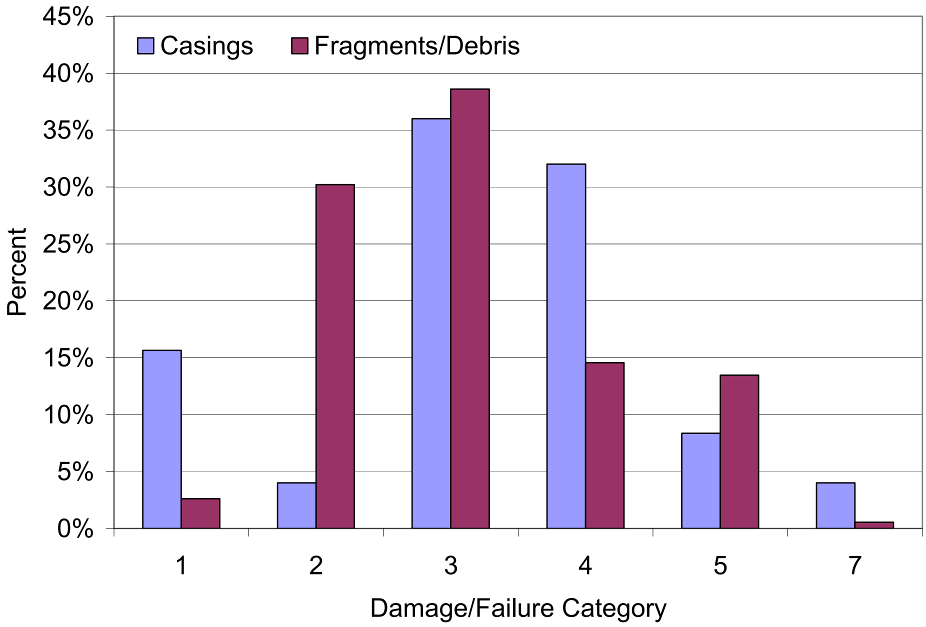

FIGURE 2 Tyre Casings & Fragments Damage/Failure Category Determination (Note: Excluding Indeterminate Category).

Source: Woodrooffe et al, 2008

Damage/Failure Categories:

Category 1 – Overdeflected Operation
Category 2 – Excessive Heat
Category 3 – Road Hazard
Category 4 – Maintenance/Operational
Category 5 – Manufacturing/Process
Category 6 – Indeterminate (excluded)
Category 7 – Excessive Intra-Carcass Pressurization

Approximately 275 (91.7 percent) of the 300 tyre casings that were examined provided sufficient information for the tyre failure analysts to categorize the most likely reason the particular casing had come out of service. The remaining 25 (approximately 8.3 percent) were categorized as indeterminable. The 300 casings were analyzed and assigned to the various categories as follows: excessive heat – 11 items, excessive intra-carcass pressurization – 11 items, indeterminable – 25 items, maintenance/operational – 90 items, manufacturing/process – 23 items, overdeflected operation – 43 items, and road hazard – 97 items. Of the 1,196 tyre fragments examined, 728 (61 percent) provided sufficient information for the tyre failure analysts to categorize the most likely reason that the tyre containing the fragment had become unserviceable. The remaining 468 of the tyre fragments examined were categorized as indeterminable. The analyses of the 728 tyre fragments were assigned to the damage/failure categories as follows: excessive heat – 220 items, excessive intra-carcass pressurization – 4 items, indeterminable – 468 items, maintenance/operational – 106 items, manufacturing/ process – 98 items, overdeflected operation – 19 items, and road hazard – 281 items. The resulting percentages of the 275 casings and 728 tyre fragments examined (i.e., excluding the indeterminate category) according to their determined damage/failure category are presented in Figure 2

DISCUSSION

Tire Debris Survey Results

Overall, there was a 60 / 40 percent split between OE and retread tyre casings tested. This ratio correlated with the steer/drive and trailer wheel proportions (i.e., 10 versus eight) of a typical 18-wheeler tractor-trailer. Accepting U.S. trucking industry practices where there is a higher probability that steer/drive tyres will be new compared to their trailer counterparts this result suggests that the retread casings tested were not overrepresented in the sample. In the case of tyre debris, again, U.S. industry practices indicate an increased probability that trailer axle tyres will be running on retreads when compared to steer or drive axle tyres. In addition to this, the insulation of the driver's cab from the following trailer may result in a failure of a trailer axle tyre while in service to go unnoticed by the operator. Noting that the generation of tyre fragments is a direct result of the continued operation of an incapacitated tyre, i.e., the longer an incapacitated tyre is run along the ground increases the generation of shreds. If a higher percentage of trailer wheels (when compared to steer or drive tyres) are retreads and a failure occurs (unnoticed) in any of these tyres, it is likely that the majority of shreds found on the roadsides will be derived from trailer tyres that in all probability will be retreads. This result also suggests that the retread tyre fragments tested were not overrepresented in the sample.

The U.S. Retread Tyre Industry and Number of Retread Plants in Operation

Various sources are available that provide estimates of the number of retread plants in the U.S., one such source is the Tire Retread and Repair Information Bureau (TRIB) a retread tyre advocacy group whose members represent retread manufacturers or vendors; and the National Highway Traffic Safety Administration (NHTSA). In 2005, TRIB members in the U.S. approximated 1,094 compared to 5,679 NHTSA issued retread manufacturer codes. Note, there is the possibility that the NHTSA estimates of U.S. retread plants may be on the high side as the possession of a TIN does not imply that the plant is still operational. In the case of South Africa 2008 estimates indicate that there were 87 retread plants of which more than 80 percent of these plants where operated by four OEMs (see Table 3).

Table 3 2008 Commercial Medium Retread Tyre Market (South Africa) (in 000s)*

Company	#Factories	Owned/ Franchise	# Units Retread	Market Share %
Maxiprest (Bridgestone)	15	Owned	225	32%
Trentyre (Goodyear)	15	Owned	200	28%
Bandag	27	Franchise	145	20%
Leadertread	16	Franchise	70	10%
Other (Independents)	14	Owned	70	10%
TOTAL	87		710	100%

*Notes on estimates: 1) Both Maxiprest and Trentyre have consolidated factories to cut overheads; 2) Bandag opened a new factory in 2008 which is owned by Putco; 3) Michelin has closed all their Ricamic factories except one that is operated by Brian Addendorf in Pietersburg

Source: Kotze, H (2009)

Table 4 presents commercial medium OE and retread tyre data by number of units produced for the period 2001 to 2007, showing consistent growth in the number of OE and replacement tyres produced. Estimates for retread tyres have fluctuated during the same period. It is evident from Table 4 that OE truck tyre production by members of the Rubber Manufacturers Association (RMA) accounted for 25 to 40 percent of the replacement (aftermarket) medium-truck tyre production. However, this disparity is to be expected, as OE truck tyre production is directly linked to new truck and trailer production rather than to the overall demand for medium-truck tyres. Table 3 also presented 2008 data for the commercial tyre retread market in South Africa. It is evident when comparing U.S. retread data with South Africa that the latter market is significantly smaller than the former.

Table 4 Commercial Medium Tyre Production Statistics (2001 to 2007) (in 000s)

Year	Original Equipment (RMA members only)	Total Industry Replacement (Aftermarket)	Retread Tyres (Estimate)
2001	3,441	13,572	15,560
2002	3,862	14,721	15,560
2003	4,160	15,516	15,463
2004	5,742	16,288	15,061
2005	6,238	17,523	15,249
2006	6,828	16,859	14,690
2007	4,468	16,573	na

Source: RMA Factbooks 2007 and 2008

An estimate as to the number of retread tyres in operation (i.e., on the road at any one time) in the U.S. is not known. However, it is possible to determine the percentage split between OE and retread tyres used in truck operations. Discussions with U.S. tyre industry representatives indicated the following: 1) tyre sales were approximately 2 to 1 for retreads versus OE tyres; 2) trucking industry practice (and a legislative requirement for the front wheels of commercial buses, see U.S. Federal Motor Carrier Safety Administration, Regulation §393.75) prohibits the use of retread tyres in the steering position; 3) trucking fleets may have up to 50 percent of drive tyres as retreads, however, some fleets use only OE drive tyres; and 4) focusing on the trailer fleet, the proportion of retread tyres may increase to between 70 and 100 percent. (Woodrooffe et al, 2008) In the case of South Africa, estimates for 2007 indicated that 50 percent of heavy commercial tyres [in use] were retreads. (Sevitz, 2007)

It is a mandated requirement for all establishments that intend to manufacture retread tyres (which are to be sold to a third party in the U.S.) obtain a three-letter authorization code from NHTSA. This three letter code (i.e., Tyre Identification Number (TIN)) is a unique identifier for each retread plant (i.e., domestically and internationally) and was instituted as a method by which new tyre manufacturers, tyre brand-name owners, tyre distributors, retreaders, and retread tyre brand-name owners can identify and record any tyre used on a motor vehicle. Currently, in South Africa retreaded tyres do not have a unique numbering system (nor is it a mandated requirement) that enables identification of which plant did the retreading. Indeed, the current situation is further complicated by the fact that several retreading plants buy their tread rubber from the same company. Thus in the case of crash reconstruction and analysis (where a failed OE/retread tyre may have contributed to the crash) it would be difficult if not impossible to determine whether the plant of origin or the retread manufacturing process precipitated the chain of events leading to the tyre failure.

Retread Tyre Manufacturing Standards and Regulatory Regime

U.S. fatality traffic crashes involving tyre debris often make local headlines and quickly stir up public resentment against large trucks and the assumed retread tyres that they use. This negative attitude towards tyre debris is confirmed by Phelan (2007) where he states that because "tire debris on roadsides is so visible compared to other forms of litter, some individuals and environmentalists have called for a ban on the use of retread tires." In recent years, several U.S. states have tried to introduce legislation related to restricting the use of retread tyres to certain vehicle categories. However, all these attempts have been defeated. Currently, there are no nationally mandated manufacturing or performance standards for medium- or heavy-duty retread tyres in the U.S. With respect to the South African commercial tyre industry, the following status quo was determined. The retread industry is largely self-regulated although most factories have South African Bureau of Standards (SABS) approval. SABS inspectors are mandated to visit retread plants to renew certificates. However, retread manufacturing companies are challenged by SABS officers in their lack of fulfilling this requirement. Nevertheless, proactive initiatives by Bandag Incorporated have provided excellent technical assistance and support to their franchised plants in addition to rating them on an annual basis (Kotze, 2009). The commercial retread tyre industry in South Africa is represented by the Tyre Dealers and Fitment Association (TDAFA) under the auspices of the Retail Motor Industries (RMI) Federation.

Discussions with U.S. tyre industry representatives revealed that the various OE manufacturers do apply their own standards for retread tyres, but there are no uniform manufacturing or performance standards applied throughout the retread tyre industry. Indeed, several challenges exist in adopting a uniform commercial retread standard, namely:

- Recognizing that the retread is being used on a casing that has already passed applicable U.S. Department of Transportation (DOT) standards. Since domestically produced casings for retreading are already in existence it is assumed that they [i.e. the casings] have met the required standards.
- Accommodating multiple combinations of brand casings, retread processes and brand tread designs, each having unique performance standards and ratings. Each component of the retread process aims to produce a quality product at a competitive advantage to the retreader. Collapsing such processes (some of which are proprietary) to accommodate a measureable

and enforceable standard may have limited impact on improving existing retread quality and require considerable effort.

Earlier it was noted that it is a mandated requirement for all establishments that intend to manufacture retread tyres which are to be sold to a third party in the U.S. to obtain a TIN. Indeed, the regulations go on further to describe how such a TIN should be displayed on each retreaded casing as follows: “Each tire retreader, except tire retreaders who retread tires solely for their own use, shall conspicuously label one sidewall of each tire it retreads by permanently molding or branding into or onto the sidewall…a tire identification number.” (Code of Federal Regulations (CFR) part 574.5 (Office of the Federal Register, 2007)). Figure 3 illustrates the mandated markings to be present on a tyre casing.

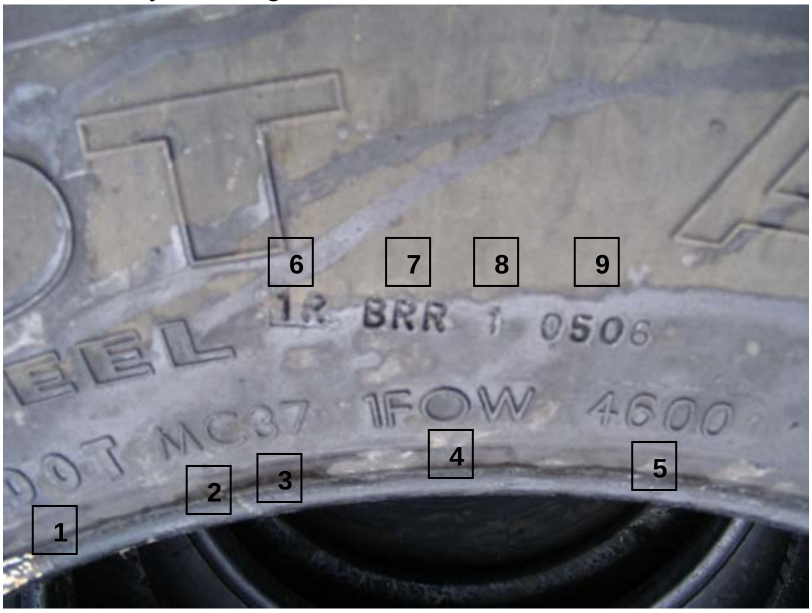

Figure 3 Mandated Tire Identification Marks on a Casing
Source: Woodrooffe et al, 2008

Key:

1. DOT required symbol (i.e., “DOT” for new or “DOT-R” for retread tires)
2. Manufacturer’s Identification Mark (MC = The Goodyear Tire & Rubber Company, Danville, VA)
3. Tire Size (manufacturer specified)
4. Tire Type Code (optional)
5. Date of Manufacture 4600 = Week 46 of 2000 (i.e., 12 to 18 November, 2000)
6. R = Retread (1R could indicate 1st retread)
7. Retreader’s Identification Mark (BRR = Southern Tire Mart LLC, Dallas, TX)
8. Tire Type Code (optional)
9. Date of Retread 0506 = Week 5 of 2006 (i.e., 30 January to 5 February, 2006)

Original Casing #1 to #5

First Retread #6 to #9

Road Safety and Traffic Accidents

In any year since 1995, large trucks have accounted for 8 percent of all vehicles involved in fatal crashes in the U.S. However, this percentage is higher than their corresponding proportion of the total motor vehicle fleet which approximates 3.5 percent per year. Trucks account for a similar proportion of the total vehicle fleet in South Africa, i.e., 3.4 percent (as at March 2008). However, trucks in South Africa were involved in ten percent of fatal traffic crashes in the 12 month period ending March 2008. (Road Traffic Management Corporation, 2008) Thus, trucks in both countries are over-involved in fatal crashes. From the mandatory crash reports that are completed at each and every police reported crash in the U.S., vehicle defects that may have contributed to the crash are also recorded. Subsequently, all crash data is captured electronically in the Fatality Analysis Reporting System (FARS) and made freely available (in aggregated format) to the public on an annual basis. Recorded defects of trucks involved in fatal crashes in the U.S. between 2000 and 2006 are presented in Table 5.

Table 5 Average Annual Vehicle Defects Coded TIFA 2000 – 2006

Rank	Vehicle Defect	N	%
1	None	4,868	93.68%
2	Brake System	89	1.71%
3	Unknown	75	1.45%
4	Tyres	42	0.82%
5	Other Lights	7	0.14%
6	Trailer Hitch	6	0.12%
7	Steering	6	0.12%
8	Suspension	6	0.11%
9	Power Train/Engine	5	0.10%
9	Signal Lights	3	0.05%
	Other Vehicle Defects	23	0.44%
	Total Trucks/Year	5,197	

Source: Trucks Involved in Fatal Accidents (TIFA) a dataset managed by UMTRI. TIFA is an extension of the FARS dataset and contains additional information on truck configuration.

It is evident from Table 5 that an overwhelming majority of trucks involved in a fatal crash in the U.S. did not have a recorded defect. However, the most common vehicle defect noted in fatal truck crashes occurs in the brake system followed by tyre deficiencies. It is not a requirement when completing the crash report to capture the OE/retread status of a suspect tyre, if known. Nevertheless, in the crash narrative such details may be noted by the police officer. Of any known defect recorded on a crash report, tyres have never accounted for more than one percent in any year between 2000 and 2006. In fact, over the seven years of fatal crash data used here, there were 297 cases where a tyre defect was recorded. Within a South African context, according to reports, 53 percent of all vehicle crashes (irrespective of the resulting personal injury or property damage) is caused by tyre failures. (Sevitz, 2008) However, the incapacitated tyre as a possible symptom of poor vehicle maintenance may also be the result of the poor physical conditions (e.g., potholes) of certain sections of the road infrastructure.

Rubber/Tyre Environmental Implications and Disposal

In the current environment where recycling is encouraged, U.S. tyre industry advocates state that 26.5 litres (7 gallons) of oil are required to make a retread, compared to 83.3 litres (22 gallons) to make a new tyre. This cost differential enables savings to U.S. truck operators of approximately U$2 billion per year (Condra, 2007) and the continued popularity of the retread tyre to maintaining the bottom line and business sustainability. Apart from direct operating cost savings of retread tyres, there are other benefits that can be achieved, such as reductions in the dependence on and use of fossil based fuels and in the volume of tyre scraps (i.e., waste) generated. The growth in scrap tyre generation from all vehicle types (in a South African context some reports estimate that 10 million scrap tyres are generated per year (Bester et al, 2004)) has been balanced by the increasingly environmentally friendly uses developed for scrap tyres to reduce the numbers of tyres that may end up in landfills, stockpiles or illegal dumpsites.

As stated earlier sustaining the high demand for the retread tyre is the potential cost savings that can be realized with each successive retread when compared to the purchase of an OE tyre. The TDS also involved determining the number of retreads per retreaded casing. Indeed, a significant majority of the 127 retread casings, i.e., (90 (70 percent) were in the first retread stage with 27 (21 percent) in the second retread stage and 5 (4 percent) in the third retread stage. In the case of five retread casings the number of retreads could not be determined. However, for commercial medium truck retreads in highway service, one would anticipate that the majority of retreaded tyres operating would be in the first retread stage, with progressively fewer in the second stage or greater. Discussions with U.S. tyre industry leaders revealed that there is no limit on the number of times a casing can be retreaded. If there is a limit it is dependent upon the retread inspector, casing repair personnel and what type of repairs are required before the casing is sent for retreading. (Woodrooffe et al, 2008)

An important part of the whole survey exercise was the ultimate disposal of the tyre casings and debris collected. This task had to be undertaken according to state and University of Michigan Occupational Safety and Environmental Health (OSEH) standards. In addition, some states, e.g., Florida, required permitting for the transport of waste rubber within and out of their state. Indeed, in all U.S. states there are strict and enforceable regulations regarding the storing, transporting, removal and disposal of waste tyres. The violation of these regulations may result in the suspension of an operating permit, a punitive fine or imprisonment. Ultimately, the casings and debris collected as part of the TDS were to be disposed of in the state of Ohio and this task was governed according to Ohio Environmental Protection Agency guidelines. Ohio is one of several U.S. states that permits the disposal/destruction of waste tyres sourced in another state. After failure analysis testing all the collected tyre casings and fragments were taken to Liberty Tire Inc. in Minerva Ohio, for shredding.

SOUTH AFRICAN TRUCKING INDUSTRY PERSPECTIVES ON RETREADS

In South Africa the use of retreads by the trucking industry depends on the nature of the trucking company and what type of arrangement they may have with their tyre supplier. The larger transport players (e.g., 100 or more truck tractors) buy new tyres at competitive rates as the price differential between OE and retread tyres is very small negating any price advantage of the retread tyre. Due to the perceived benefits of fitting new tyres on all axles all of the time South African trucking companies on the whole have adopted this strategy and subsequently sell their used casings. Indeed, it is generally accepted that in recent years the demand for retreads has shrunk, however, it is anticipated that demand will start to pick up again in the near future.

The majority of small trucking operators, as well as companies on cost per kilometer (CPK) agreements will fit new tyres to the steer and drive positions and use the casings generated from these positions for retreading and fitment to the trailer axles. In this way trucking companies can control the quality of the casings used for retreading as it is an accepted industry practice that the better the quality of a casing the more times it can be retreaded. Another factor that may influence the split between OE and retread tyres is the fact that cheap imported OE tyres from China have flooded the South African commercial tyre market. Some industry players have argued that the quality of these tyres is somewhat suspect, however, as these imported tyres are priced competitively as a stock retread they often give more mileage than a retread tyre and are the preferred choice for certain trucking companies operating in a highly competitive transport market.

RECOMMENDATIONS

It is important on role players in the Southern African transportation industry to explore the lessons learned from the TDS and to firstly, continue to increase public awareness about the origins, characteristics, and impacts of tyre debris, and, secondly, ensure adherence to the highest standards in vehicle operations and associated tyre maintenance. Resolving these challenges has the potential to see a reduction in roadside tyre debris and enhance the road safety environment, i.e., achieve a significant reduction in tyre blowout crashes.

SUMMARY AND CONCLUSIONS

In the U.S. it is fair to say that misunderstandings by the typical road user have incorrectly attributed the nature, extent, and contributing factors precipitating the formation of the roadside alligator. Indeed, the OE versus retread proportions of the collected tire debris broadly correlated with accepted industry practices and expectations, in particular the OE/retread tire mix on the typical 18-wheeler tractor-trailer combination. The study results showed a strong similarity between casings and tire fragments with respect to probable damage/failure cause where the OE/retread status was known. In these cases, road hazard or maintenance/operational reasons were two of the top three probable damage/ failure causes. The importance of this result suggests that the majority of tire debris items found on U.S. highways is not a result of manufacturing/process deficiencies. In any given location roadside alligators often represent tyre debris from all vehicle types as inadequate tyre inflation pressure has the potential to precipitate tyre failure for all types of tyre (i.e., OE and retread) and not just the commercial medium. Indeed, the TDS findings are similar to earlier U.S. studies of tyre debris that prove the direct link between deficient tire maintenance and inflation pressures and premature tire failure.

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