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SOME PRELIMINARY OBSERVATIONS ON RETREAD MANUFACTURING PRACTICES

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PRELIMINARY MEMORANDUM

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16. Abstract

The results of some retread manufacturing practices are presented as observed during analytical sectioning of passenger tires. Non-uniform buffing of the old tread has resulted in non-uniform tire cross-sections and other anomalies. These practices assume importance because retreads represent 12-17% of all tires sold in this country.

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PREFACE

The observations described in this report were made while performing analytical sectioning and failure analysis, as part of the program entitled "Nondestructive Testing of Tires." Discussions with experts in tire dynamics and in other aspects of tire manufacturing confirmed the conclusions that are reported.

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ILLUSTRATIONS

1. INTRODUCTION

The retreading of passenger tires is in many ways a complex business. Used tires which are collected at gas stations, tire dealers, and sometimes the local dump are deposited at the re- treader's shop. He then has the task of discarding those which he does not choose to retread, and he generally does this by a visual inspection. Often retreaders will discard more tires than they keep.

The tire carcass is usually a few years old and has been sub- jected to an environment of ozone, oxygen, road oils and heat that cause chemical degradation of the rubber and often the cord. Fur- thermore, the tire may have hidden bruises caused by road hazards. These problems, combined with non-uniform retreading procedures apparently contribute greatly to the higher failure rate reported for retreads as compared to new tires.

If a used tire passes visual inspection at the retreader's shop, the next step is to remove the old tread in preparation for the application of new tread stock. This is done by buffing or abraiding the tread with special grinding wheels. The tread should be buffed uniformly to a line about an inch or so beyond the shoul- der into the sidewall. The new tread is applied by one of several different methods which use either uncured rubber or precured stock. The purpose of this report is to document the known history of a limited group of retreaded tires and to comment upon observed processing non-uniformities.

2. NONDESTRUCTIVE TIRE TESTING STUDIES

Newly purchased retreaded tires were first examined for defects by the four nondestructive test (NDT) procedures: x-ray, holography, ultrasonics and infrared. They were then sent to a compliance center for high speed and endurance wheel testing according to the Motor Vehicle Safety Standard 109 (MVSS 109) which is used for new tires. They were subsequently returned to TSC for another round of NDT inspections. Analytical sectioning was then performed on all tires, both passed and failed, to verify the presence of any defects that had been detected by NDT. The extensive sectioning permitted close inspection of the tire structure, not only to discover the defect areas, but also to determine whether proper care was taken in the retreading process.

Analytical sectioning or failure analysis is the final step performed on all tires in this program and is used to verify the NDT discovered defects and to determine the precise tire layer in which the defect is located. Furthermore, it is of prime importance to determine the mode and mechanism of defect propagation and how it may have lead to tire failure.

3. RESULTS

Analytical sectioning was performed on one hundred and forty-seven retreaded tires that had been put through either the endurance or high speed compliance tests at a compliance center. Certain tire structures, were observed that resulted from manufacturing processes that should be considered unacceptable and could result in lateral non-uniformity or in failure. Not all tires showed these deficiencies, but they were observed with sufficient frequency to warrant these comments. The following manufacturing deficiencies are not necessarily in order of importance, since this has not yet been determined. Nor is this report intended to be a comprehensive guide to improving manufacturing processes.

3.1 NON-UNIFORM BUFFING

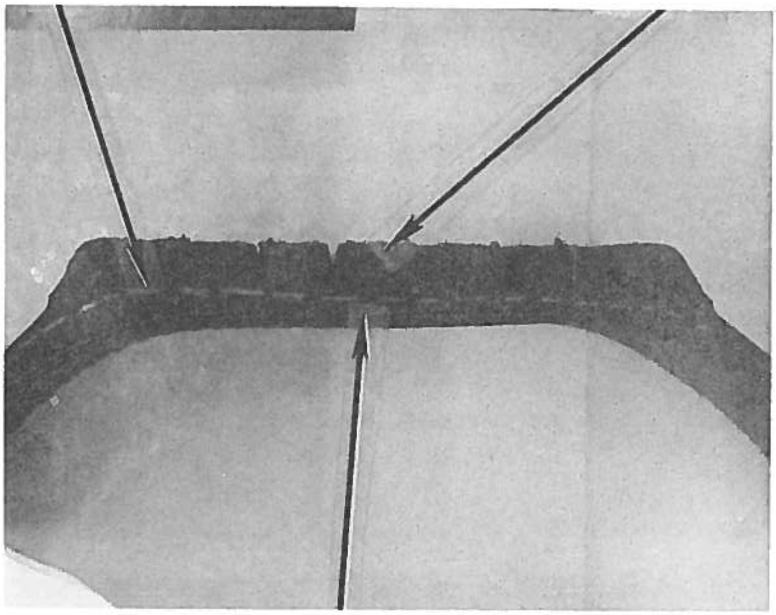
Non-uniform buffing was the most common anomaly observed. Retread shops that were visited had templates corresponding to the different tire sizes and styles which are supposed to be used as guides to provide for even removal of the old tread. The templates appeared to be seldom used. The cross section of the tire shown in Figure 3-1 is an example of this.

Non-uniform buffing results in non-uniform application of the new rubber, and although the final thickness of the tread may be uniform around the tire, the differences in modulus and resiliency in different parts of the tread would be emphasized, contributing to instability.

3.2 BUFFING INTO FABRIC

This is a special case of non-uniform buffing. When the buffer misjudges and buffs into the fabric, he is likely to damage the cords. On sectioning a tire which was buffed through the tread, the junction line is seen to disappear into the outer cord ply, as shown in Figure 3-2. To verify damage to the cords, the tread was stripped from this specimen. Figure 3-3 shows some of the abraided cord appearing through the rubber. A radiograph of the

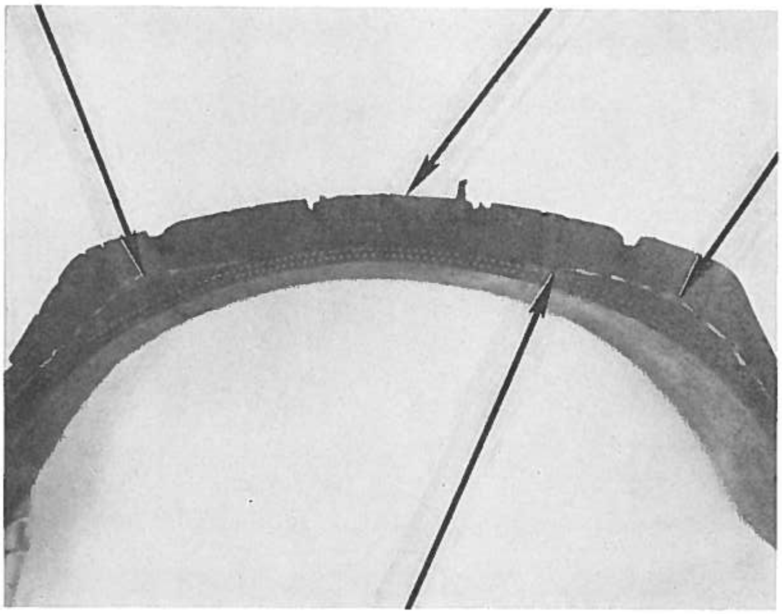
JUNCTION NEW TREAD



OLD CARCASS

Figure 3-1. An Example of Non-Uniform Buffing

JUNCTION NEW TREAD



JUNCTION

OLD CARCASS

Figure 3-2. Buffing into the Cord Ply

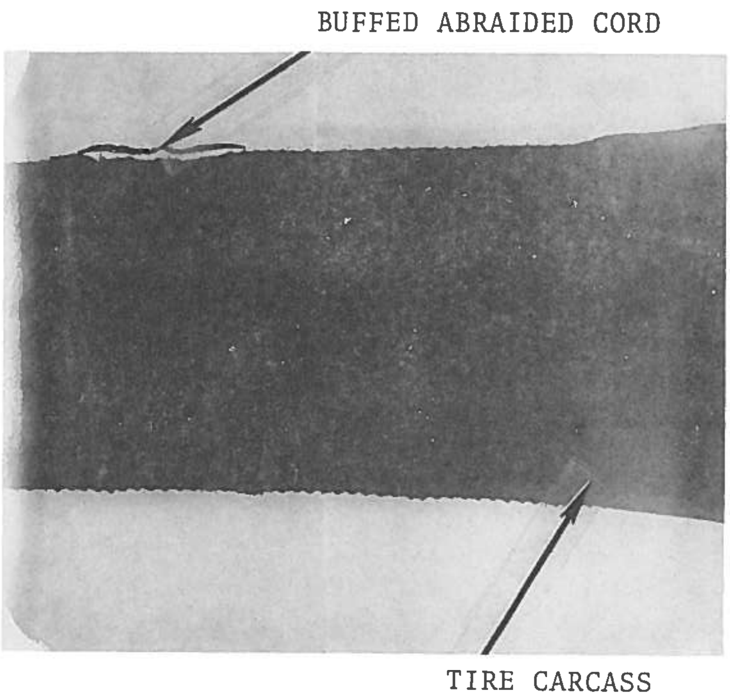


Figure 3-3. Buffed Cord Showing through Rubber

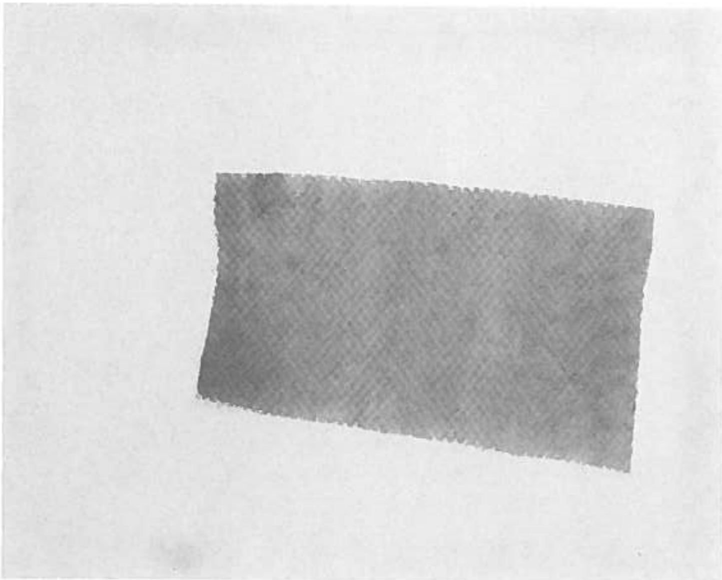


Figure 3-4. Radiograph of Section of Tread in Figure 3-3. Faint or Missing Cords Have Been Buffed

specimen shown in Figure 3-4 indicates cords which were partly removed by buffing.

Motor Vehicle Safety Standard 117, Section 5.2.1 states, "No retreaded tire should be manufactured with a casing on which cord fabric or bead wire is exposed either before or during processing". This regulation was promulgated specifically to prevent damage to the cord and weakening of the fabric.

3.3 VARIATION IN SHOULDER THICKNESS

Another common anomaly is the variation in thickness from one shoulder to the opposite shoulder in the same tire. Figure 3-5 shows one such tire with a one quarter inch difference in the two shoulders. This differs from the situation described in 3.1 in which the overall thickness has been adjusted. The uneven distribution of rubber in the tread can have an adverse effect on lateral stability and could have caused the large separation created in this tire.

3.4 TIRE CONFIGURATION

Many retreaders use a standard tread matrix design to retread all tires within their individual size categories. Thus, a tire originally designed and built with the new wider tread may be remolded with a narrow tread, and a snow tire reappears as a regular passenger tread. These retreads may now flex in a manner and in locations for which they were not originally designed, possibly resulting in unusual hysteresis heating and degradation. Figure 3-6 shows two tires of different sizes that were probably retreaded in the same mold. Figure 3-7 is a portion of a former snow-treaded tire that was remolded as a regular tread and appears to have torn itself apart.

3.5 SHOULDER SEPARATIONS

Separations were often found in the junction (interface) region between the new and old tread stock. Even more frequently, the junction was porous and relatively easy to peel. Figure 3-8

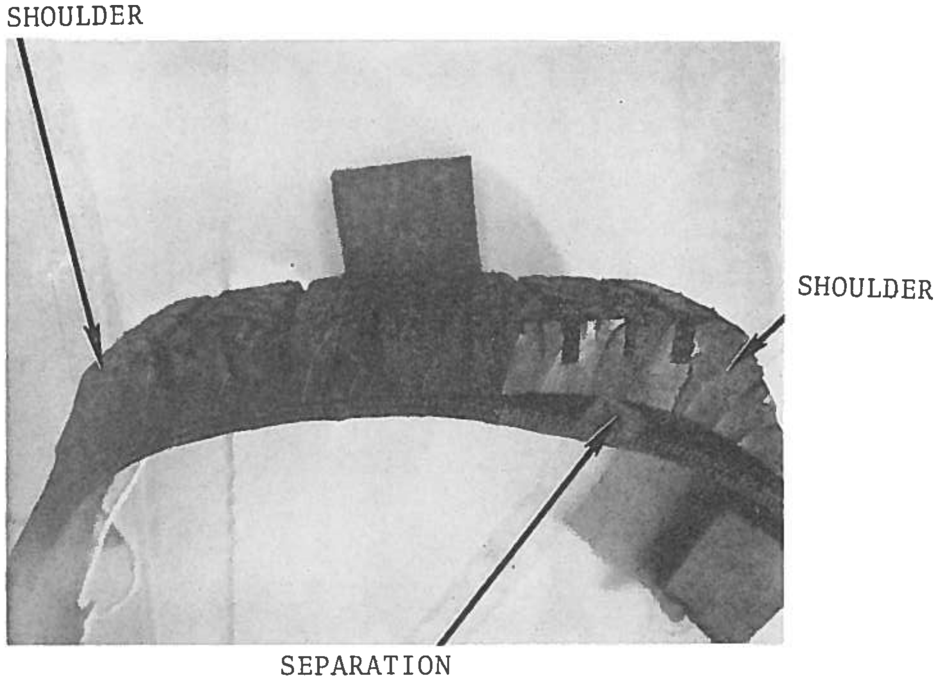


Figure 3-5. Shoulders Differ in Thickness by One Quarter of an Inch

Figure 3-6. Tires of Different Size Retreaded and Cured in the Same Mold

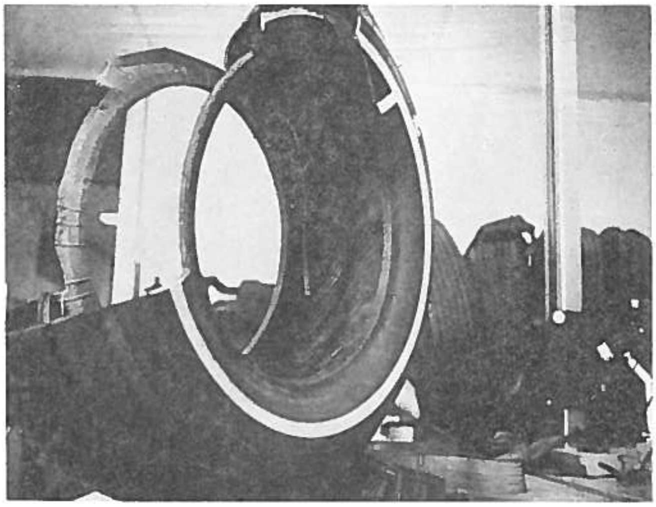
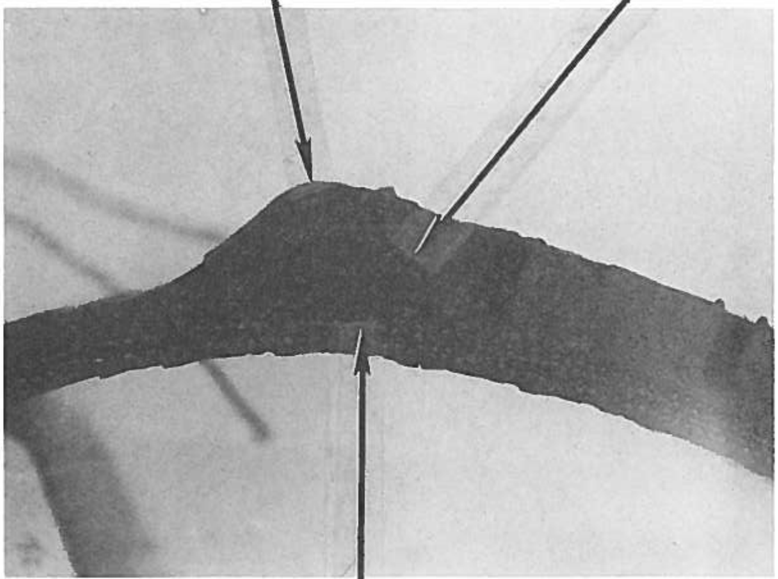


Figure 3-7. Tire Failure Resulting from Improper Remolding

TREAD STOCK POROSITY



CARCASS

Figure 3-8. Severe Porosity in Rubber and Junction Area shows one extreme example of junction and tread stock porosity. This problem can be caused by: 1) the use of a poor adhesive; 2) incomplete filling of the mold; 3) allowing the buffed surface to become contaminated with oil or dirt; 4) insufficient pressure applied to the inner surface while in the mold; or 5) inadequate mold temperature.

4. SUMMARY AND RECOMMENDATIONS

Sectioning of retreaded tires has revealed manufacturing practices that could cause non-uniform operation or early failure. In a number of tires, separations were observed that could easily be attributed to built-in structural anomalies. Comparable practices would not be tolerated in new tire manufacture. Thirty to forty million tires are retreaded each year, representing 12-17% of all tires manufactured.

The following are recommendations that should be considered as processing requirements. This list is by no means complete.

a. Buffing machines with templates that would be set for specific tire dimensions that would not operate without the guidance of the template, or, as an advanced alternative, a device that would guide the buffer by continuous determination of rubber thickness by ultrasonics. A device of this type should be developed for this application.

b. Strict observance of the regulation concerning the unacceptability of exposed fabric. If, with the proper template in place, fabric is exposed, this may indicate undue warping of the carcass and would constitute sufficient reason for rejection.

c. Strict adherence to the use of the proper matrix size in retreading as dictated by measurement of the carcass, and a ban on the retreading of snow tires as regular tires.

d. With the use of a new matrix or a new batch of rubber or adhesive, examination of the first tire produced for adhesion of new stock to old, and for porosity at the interface.

e. Greater reliability in maintaining the proper temperature and pressure in equipment, and in cleanliness of the buffed surface.

f. Requirement for tire manufacturers to use the generic name for the cord material in labeling, rather than a trade name such as "Nygen". The MVSS 109, S. 4.3 (e) requires only "Composition of the material used in the ply cord." This is loosely interpreted to allow the use of trade names.

g. Publication of the results of all compliance type test results to guide the retreaders in the selection of carcasses by culling out those with poor records.