PDHonline Course G486 (2 PDH)

Motor Vehicle Accident Reconstruction
Special Topic 1 - Tire Failures

Instructor: Peter Chen, P.E., CFEI, ACTAR

2020

PDH Online | PDH Center

5272 Meadow Estates Drive
Fairfax, VA 22030-6658
Phone: 703-988-0088
www.PDHonline.com

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Discussion Areas

- Understanding the Importance of Tires as a Potential Cause of Motor Vehicle Accidents.
- Basics of Tire Design
- Tire Failure Forensic Analysis
- Special Considerations of Truck Tires
- Examples of Tire Failure Cases

NHTSA FAR Database

- The National Highway Traffic Safety Administration (NHTSA) keeps a database of traffic fatalities called the Fatal Accident Reporting System (FARS).
- The database can be found at www.nhtsa.gov/FARS. Take some time to investigate the website and the publicly available information that it holds.
- The database goes back to 1975, and the information recorded by NHTSA has changed over time.
- The FARS database contains data inputted by police or other traffic governing and/or investigating entities (i.e. sheriff's departments) detailing the factors behind traffic fatalities on U.S. roads.
- The FARS database may be queried by year and vehicle related Factors.

Query of FARS database

- A query of the FARS database in 2008 had some revealing information.
- Subsequent queries haven't greatly changed the general information gleaned in 2008.

STATE: All|YEAR: 2008|COUNT: Number of Vehicles/Drivers

OUTPUT OPTIONS: Submit Query | View Cases

Report:

Vehicle Related Factors(1)

State	None	Tires	Brake System	Steering System - Tie Rod, Kingpin, Ball Joint, Etc.	Suspension - Springs, Shock Absorbers, MacPherson Struts, Axle Bearing, Control Arms, Etc.	Power Train/Engine	Exhaust System	Headlights	Signal Lights	Other Lights	Horn	Wipers	Driver Seating And Control	Body, Doors, Hood, Other	Trailer Hitch	Wheels	Air Bags	Other Vehicles Defects	Safety Belts	Hit-and-Run Vehicle	Vehicle Registration For Handicapped	Vehicle Being Pushed By Non-Motorist	Reconstructed/Alt Vehicle
Alabama	1,202	27	3	0	0	0	0	0	1	0	0	0	1	0	1	0	0	0	0	24	0	0	0
Alaska	85	0	2	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	1
Arizona	1,111	33	1	0	3	2	0	0	0	0	0	0	0	0	0	0	0	2	1	69	26	0	1
Arkansas	755	6	1	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	15	0	0	0
California	4,345	62	13	0	3	4	0	3	0	0	0	0	0	0	0	1	1	0	2	278	21	1	2
Colorado	681	3	2	0	0	1	0	0	0	3	0	0	0	0	0	1	0	0	0	21	0	0	1
Connecticut	341	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	15	0	0	0
Delaware	142	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	9	0	0	0
District of Columbia	41	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0
Florida	3,997	33	1	0	2	1	0	2	0	0	0	0	0	0	0	2	0	2	0	181	0	0	1
Georgia	1,907	36	2	1	0	2	0	2	0	0	0	0	1	0	0	1	0	2	1	45	61	0	0
Hawaii	129	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	1
Idaho	297	3	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	1	0	0	0
Illinois	1,317	4	2	0	0	0	0	0	0	1	0	1	0	0	0	0	0	3	0	54	0	0	0
Indiana	1,059	7	3	0	0	0	0	0	0	1	0	0	0	0	0	0	0	2	0	24	19	0	0
Iowa	559	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0
Kansas	480	2	1	0	0	0	0	3	0	0	0	0	0	0	0	1	0	0	0	10	0	1	0

FARS Results:

Top Vehicle Related Factors-2008

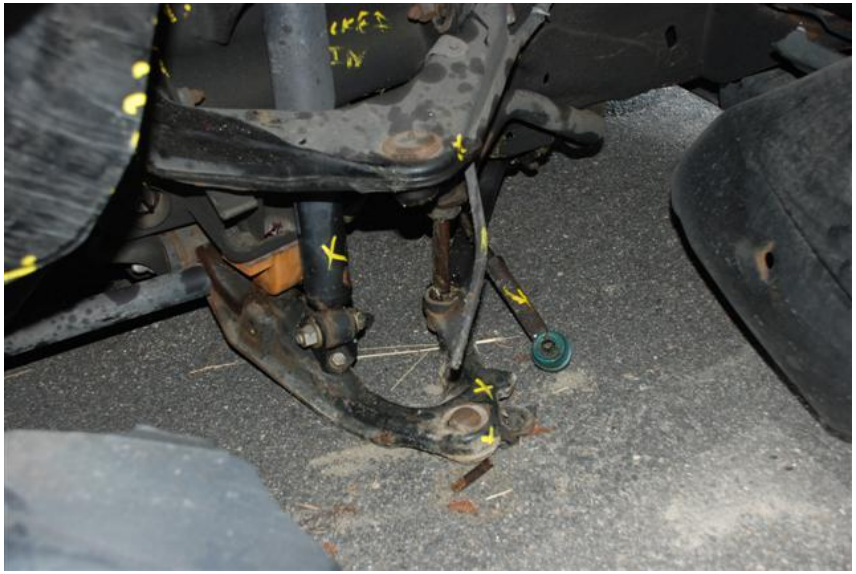
- Out of 47338 Reports

-Tires (492)
-Brake System (119)
-Steering System (20)

-Hit and Run Vehicle (1586)
-Vehicle Registration for Handicap (176)
-Other Vehicle Defects (39)
-Headlights (22)
-Other Working Veh (Not Constr., Police, Fire, EMT) (21)
-Unknown (473)

Other Factors:

- Airbags (5)
- Reconstructed/Altered Vehicles (17)
- Construction Vehicles (9)
- Police, Fire, EMT (15)

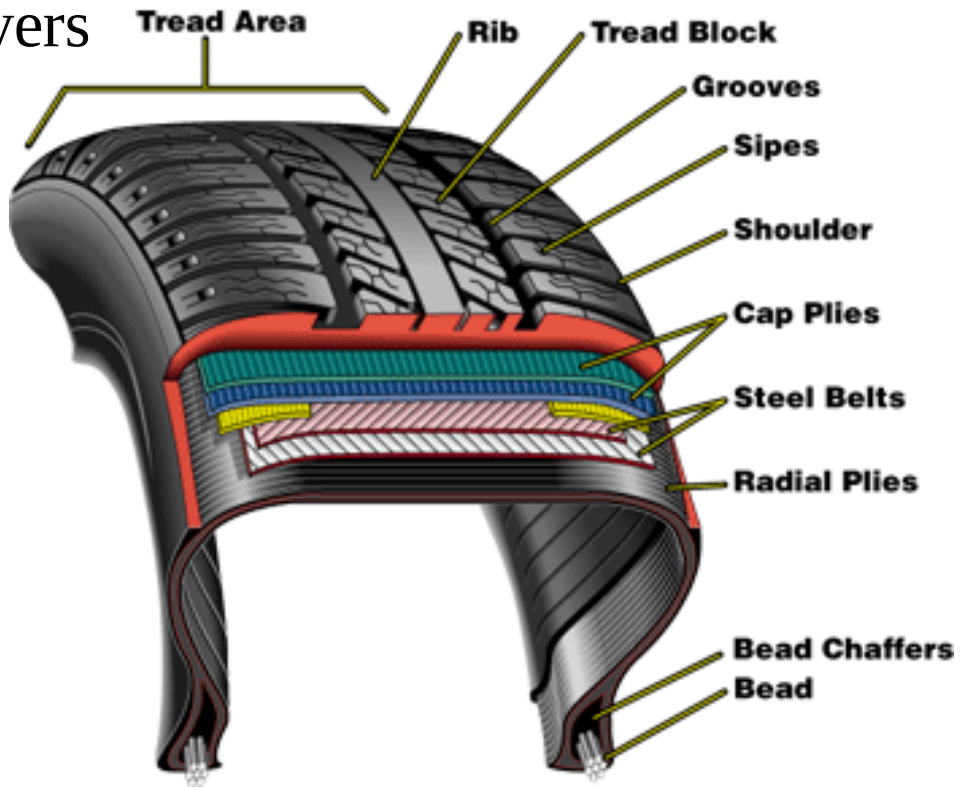


Conclusions from FARS Query

- Other than factors not related to motor vehicle components, the FARS database showed that Tires were by the top vehicle component identified as a factor in motor vehicle fatalities.
- Side Note: as indicated by the orange arrows, apparently what you don't know can harm you.

Tire Composition/Construction/Engineering

- Two most common: Bias and Belted Tires
- Composed of Several Layers
- Designed for:
  - Handling
  - Ride Comfort
  - Traction
  - Tread Wear
  - Fuel Economy



Tire Design Standards

- The National Highway Transportation Safety Administration (NHTSA) promulgates the safety standard for vehicles under the Federal Motor Vehicle Safety Standard (FMVSS).
- Tires and Rim Specifications are defined within the FMVSS. See the following for a quick summary www.nhtsa.gov/cars/rules/import/FMVSS/index.html

FMVSS Tire Standards

- Standard 109 – New Pneumatic Tires for Passenger Cars
- Standard 110 – Tire Selection and Rims for Passenger Cars
- Standard 117 – Retreaded Pneumatic Tires
- Standard 119 – New Pneumatic Tires for Vehicles Other Than Passenger Cars
- Standard 120 - Tire Selection and Rims for Vehicles Other Than Passenger Cars
- These standard may be viewed in the Code of Federal Regulations database located here: 49 CFR Part 571
- Please follow the hyperlink for Standard 109 and review the information contained within.

Tire Manufacturing

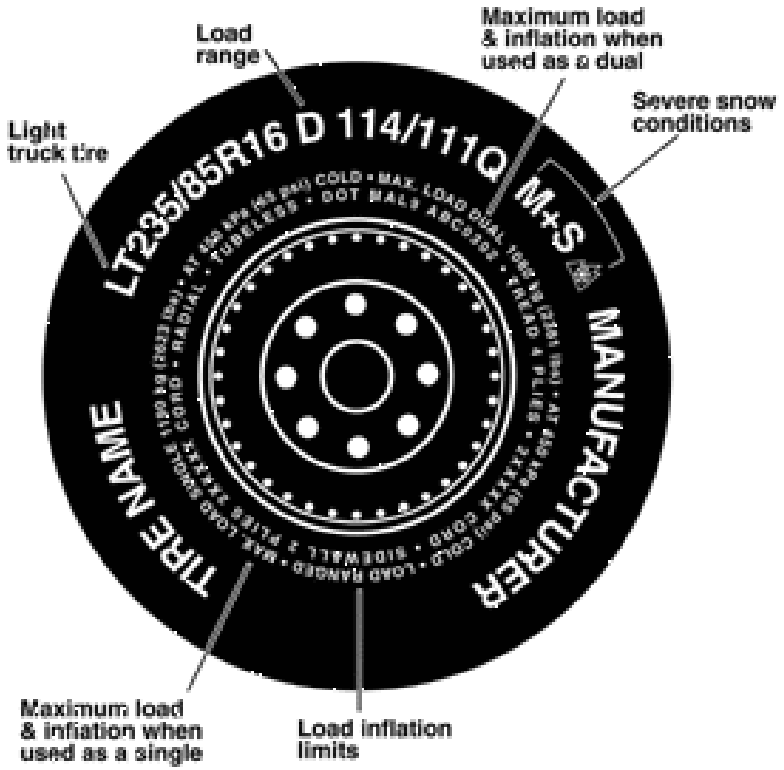
- How tires are made are best summarized by short publicly available videos.
- Please take the time to review the following videos:
  - How Tires are Made located at: http://youtu.be/nFLQU17e31M
  - Also, How Tires are Retread located at: http://youtu.be/M2_NYEvNrw0
- The videos should take approximately 15 minutes.

Tire Testing Methodology

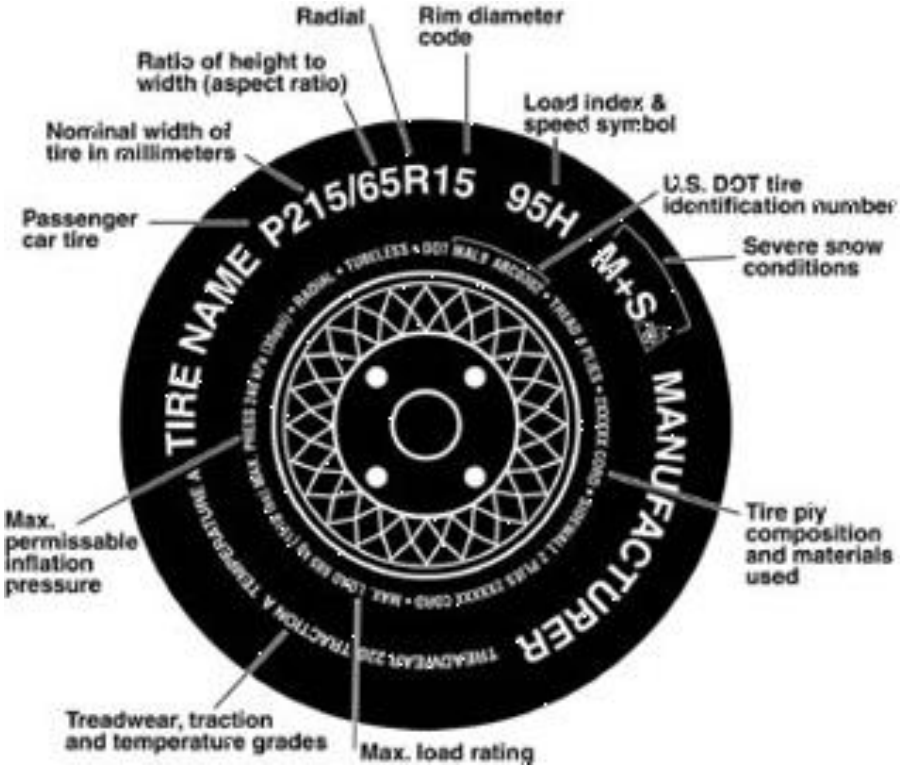
- Testing methodology for tire designs for anything beyond form and fit are generally found in:
- Society of Automotive Engineering (SAE) J Standards
- American Society of Testing and Materials (ASTM) F Standards
- and again in the Code of Federal Regulations with regards to Uniform Tire Quality Grading Standards

Tire Markings

Light Truck



Passenger Car



Tire Ratings for Passenger Cars

- Speed: A (lowest) to Z (highest), except H is between U and V.
  - Q is usually the minimum rated tire (99 mph) put on by OEM.
  - R is 106 mph
  - H is 130 mph
  - ZR is >186 mph
- Traction: A to C, A being the best
- Tread Wear: 100, 200 (2x life), 300 (3x life)

Passenger Car Tire Defect Investigations

- By far, the most common question asked during a tire defect investigation is: "Was the accident caused by the tire failing, or was the tire damage caused by the accident."
- If a tire failure has been established, the next question is why.
- The next slide has some common failure modes and causes.

Common Tire Failure Modes and Causes

- Tread Separation
  - Heat
  - Speed
  - Under Inflation
- Sidewall Failure
  - Occurs during inflation process
  - Operating Under Inflated
  - Rubbing or Contact with Curbs or other objects
- Bead Failure
  - Over Inflation
  - Installation
- Running Over Sharp Objects

Other Causes of Tire Failure

- Beyond the common failure causes, we may need to delve deeper into:
  - Age of tire
  - Rot
  - Manufacturing defect
  - Material defect
  - Improper handling of tire or storage
  - Improper selection of tire or incompatible tire/rim/vehicle selection
  - Tire Design
  - Tire testing and rating
  - Previous Tire Repairs: Plug, Patch, Fix-a-flat

Tire Age as Consideration for Tire Failure

- Current tire manufacturer recommendation for passenger cars is five years maximum in storage. After five years, the "new" tire should not be sold.
- Storage condition (i.e. outside, or exposed to moisture, or etc.) could shorten the storage life.
- Date codes can be checked on the tire markings. Date code formatting has changed over time.
- Since 2000, the DOT required date code to have the year in last two digits, and week number in the preceding two digits. Example: 2505 means 25th week of 2005.
- Prior to 2000, the DOT required date code to have the year in the decade in the last digit, and the week number in the preceding digits. Example 255 means 25th week of 1995.
- Automobile manufacturers may also recommend a max shelf life less than five years for "new" tires.

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Passenger Car Tire Defect Investigation

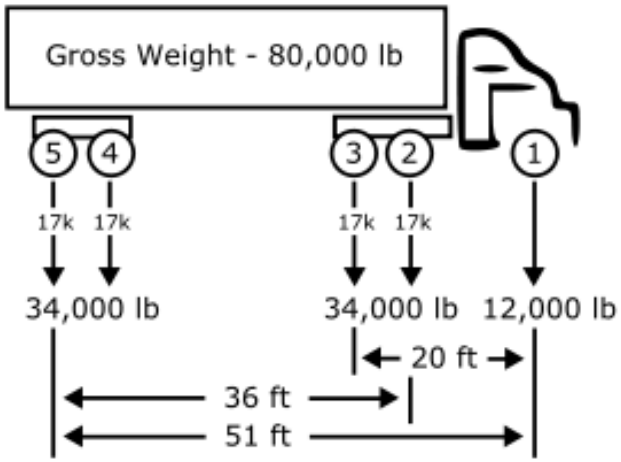
- Preserve the Subject Tire (any and all pieces)
- Preserve Wheel and wheel components
- Preserve Exemplar Tires (usually located on same vehicle)
- Materials, Metallurgical, Engineering, and Accident Reconstruction investigation

Commercial Tire Markings

- Markings can be interpreted by manufacturer publications
- Re-Treads are Common and are Sometimes Marked
- Life = 100,000 miles, Re-tread up to 7 times

Commercial Vehicle Tire Factors: Weight

- Federal Standards
  - 20 K Single Axle
  - 34 K Tandem Axle
  - 80 K Gross Vehicle Weight



- State Regulations
- **Tire Rating**

- Bridge Limitations

- Hazmat Loads
- Liquid Loads

Commercial Tire Investigation Additional Requirements

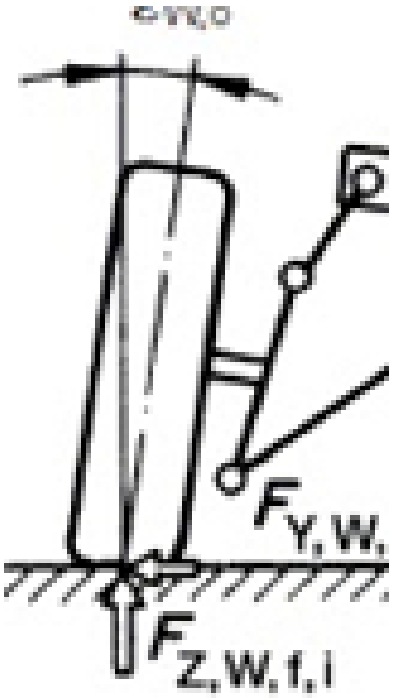
- Gross Vehicle Weight
- Tractor Make, Model, Configuration Information
- Trailer Make, Model, and Physical Information.
- Load
- Load Location
- Driver Log, Service, Maintenance, Repair, Mileage Records
- Tire Records Including Number of Retreads and Mileage on Each Tire

Tread Wear and Tire Damage Analysis

The following slides contain examples of tread wear and tire damage.

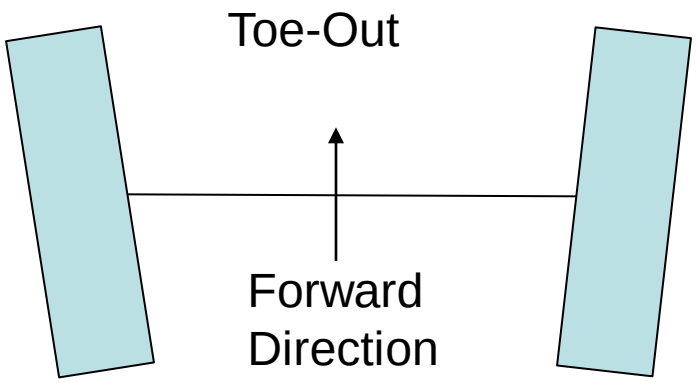
Misalignment

This tire wear is an example of vertical misalignment of the tire called camber wear.



Misalignment

This tire wear is an example of either a toe-out or toe-in misalignment of the tire. Note that the center tread is worn less than the edges of the tread.



View is from Top Down

Tread Separation

The outer tread of this tire separated or delaminated from the inner core and steel belt sections of the tire.

Pending Tread Separation

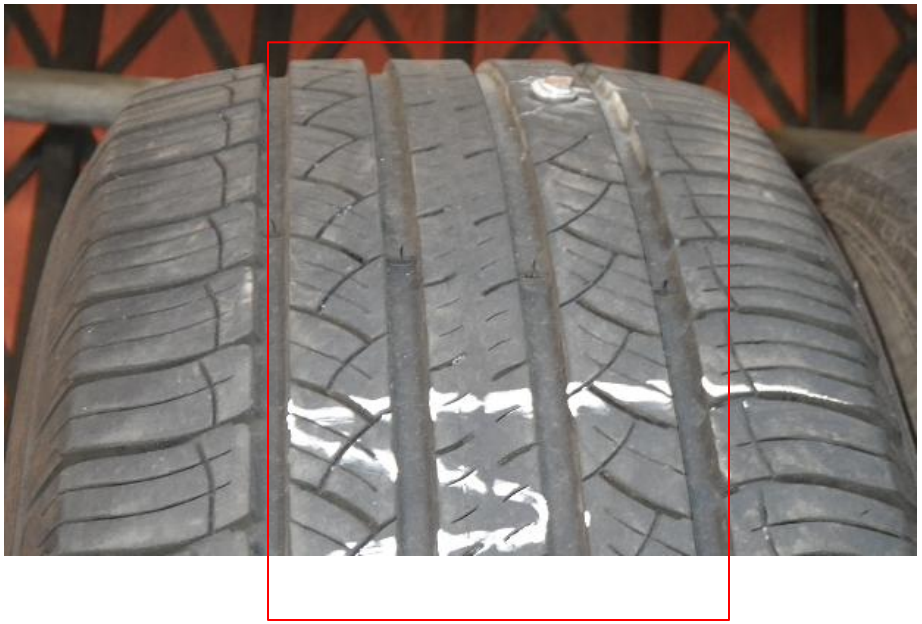
- This tire had 47,000 miles on a 50,000 mile rated tire.
- Tread depth was fine.
- 0.5 to 1.0 inch long cracks appeared at 44,000 miles.
- By 47,000 miles, the cracks grew into one crack around the circumference on the inside and outside of the tread.
- Result of normal aging, heat, loading, duty cycle.

Suspension Failure

Although probably pulled for the large object penetration through the tread, this tire has alternating patches of higher levels of tread wear. The "cups" usually appear in a cyclical pattern. One "cup" usually means a locked wheel skid, not suspension failure

Cupping is a sign of impending suspension failure: Shocks/struts, shock/strut mounts, leaf springs, and or coil springs.

Over Inflation



Although probably pulled for the large object penetration through the tread, this tire has signs of over-inflation. The center treads are worn more than the edge treads

Underinflation

Opposite wear pattern as over inflation, under inflation wears the edge of the tire treads before the center.

Running While Flat

Driving with a severely under inflated tire, or on a tire that has gone flat results in sidewall contact with the ground. The sidewall heats up quickly and residual heat damage looks like this.

Case Study #1: Firestone and Ford Explorer

- One of the most well known cases of tire failure defect and investigation involved Firestone and Ford.
- Please take the time to review the following article: NYU Stern, The Ford-Firestone Case
- The case comes with many complex questions of causation:
  - Tire Design and Testing
  - Manufacturing
  - Was it the Vehicle's use of the Tire or Vehicle Interaction
  - Tire Pressure Guidance
  - Consumer's Use