

STEERING AND SUSPENSION SYSTEMS

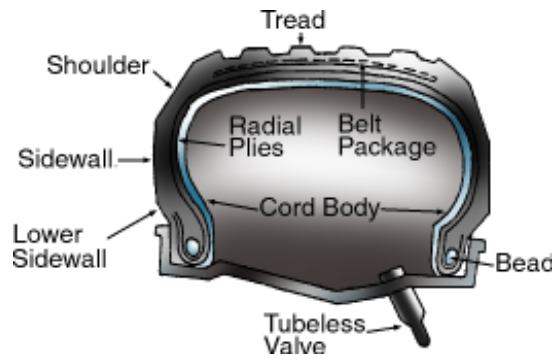
UNIT 12: WHEEL AND TIRE DESIGN

LESSON 2: TIRE DESIGN

- I. Purpose and basic design of tires
 - A. Automotive tires provide traction and absorb road shocks. They must perform well on a variety of road surfaces and in various driving conditions.
 1. Tires must provide traction on asphalt, concrete, gravel, and dirt.
 2. Tires must also function as effectively on wet or snow-covered roads as on dry roads.
 - B. Most of the tires used today are tubeless; however, some tube tires are still produced.
 1. In a tubeless tire, the tire and wheel retain air under pressure.
 - a. A synthetic gum rubber liner is built into the tire to prevent air from leaking through the tire fabric.
 - b. Tire manufacturers use natural and synthetic rubber components in the construction of the tire.
 2. In tires using tubes, both the tire and an inner tube are mounted on a wheel. The tube is inflated and retains the air inside the tire. Tires with tubes are seldom used in today's cars and light trucks.

II. Tire construction

- A. The three basic types of cord body construction for passenger tires are bias, belted bias, and radial ply. All tire types have the following components: beads, cord body, tread, and sidewall.



1. Beads are bands of strong steel wire that fasten to the tire plies and are molded to the inner circumference of the tire. The beads hold the tire in position on the rim.
2. The cord body consists of layers of rubber-impregnated fabric (plies). These layers are molded together in rubber to form the tire.
 - a. The cord body connects to the steel bead wires.
 - b. The way the plies are assembled determines the design of the tire's construction (radial plies, belted bias, etc.).
 - c. The number of plies determines the tire's load-carrying capacity.
3. The tread is the part of the tire that contacts the road. The tread rubber is molded directly to the cord body.
 - a. Rubber is also molded to the cord body sidewalls.
 - b. Manufacturers use varying tread designs and rubber compounds to comply to specific tire designs.
4. The sidewall connects the tread to the bead. The tire's sidewall is made from rubber compounds that absorb shocks and irregularities in the road. The flexibility in the sidewall gives the vehicle a smooth ride.

STEERING AND SUSPENSION SYSTEMS

- B. Tires are made from various compounds, as listed below.
1. Fabric (steel, nylon, aramid fiber, fiberglass, polyester)
 2. Rubber (natural and synthetic)
 - a. The sidewall rubber is not as thick as the rubber on the tread.
 - b. The rubber compounds contain antioxidants that help prevent cracking from the sun's ultraviolet radiation.
 3. Reinforcing chemicals (carbon black, silica, resins)
 4. Antidegradants (antioxidants)
 5. Adhesion promoters (cobalt salts, brass on wire, resins on fabrics)
 6. Curatives (cure accelerators, activators, sulfur)
 7. Processing aids (oils, tackifiers, peptizers, softeners)

III. Cord body construction

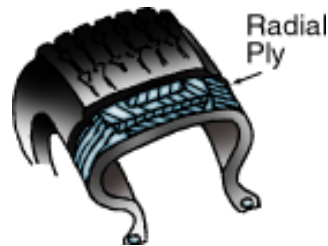
- A. Bias ply tires consist of two or more plies placed one on top of another. The cords run in a crisscross (bias) pattern from bead to bead. Plies are constructed of rayon, nylon, polyester, etc.



- B. Belted bias tires are constructed like bias ply tires, but they have two or more layers of tread-reinforcing plies or belts that wrap around the circumference of the tire under the tread.



1. These belts do not extend to the sidewalls. They are positioned under the tread area only.
 2. The belts are usually constructed of fiberglass, rayon, or steel.
 3. The added belts allow for better wear and handling and increased puncture resistance.
- C. In radial ply tires, the plies of the cord body run in straight lines parallel to each other and perpendicular to the beads.



1. The plies are at right angles to the tire tread. Two or more belts, made of either fabric or steel, lay on top of the cord body under the tread section.
2. Radial ply tires are used on a majority of today's passenger cars.
 - a. They offer better traction, increased tread life, and a softer ride at medium and high speeds.
 - b. They also create less rolling resistance, a measurement of how much friction a tire produces as it rolls on the road. Lower rolling resistance allows for better fuel economy.



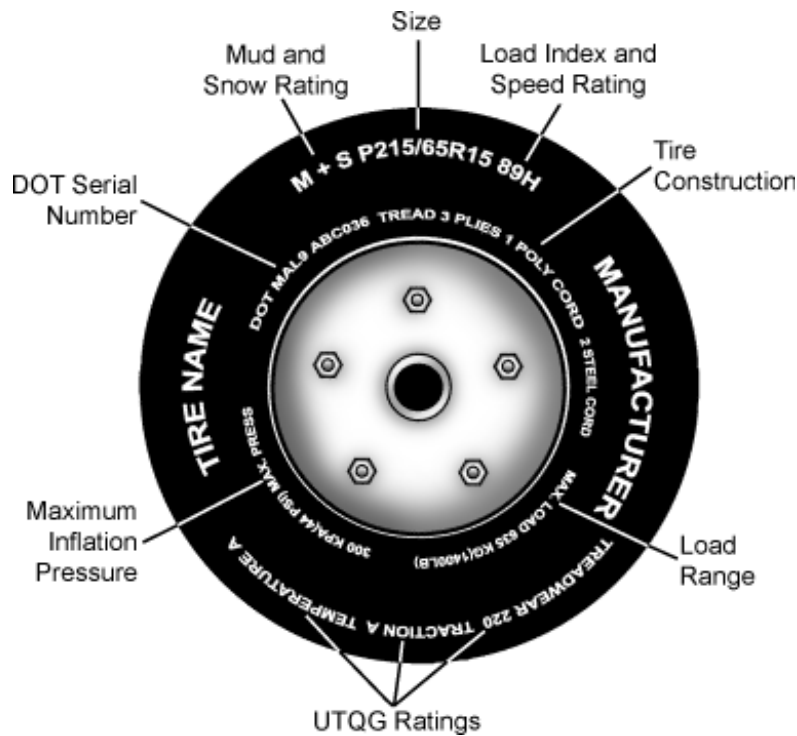
NOTE: Do not use both radial and bias ply tires on the same vehicle because these two types of tires have different handling characteristics.

IV. Grades and ratings

- A. The Uniform Tire Quality Grading Standards, developed by the National Highway Traffic Safety Administration, are quality standards used for passenger car tires. These standards provide the criteria to rate tires in the categories of tread wear, traction, and ability to dissipate heat.

STEERING AND SUSPENSION SYSTEMS

NOTE: A tire's rating in these various categories is molded into the tire's sidewall during its construction. The following graphic shows some of the information found on tires.



1. In the category of tread wear (length of tread life), each tire is assigned a grade number (e.g., 90, 100, etc.). The tread life increases as the number increases. For example, a tire with a grade of 180 should wear twice as long as one with a grade of 90.
2. The letters A, B, and C are used to rate a tire's ability to provide traction on wet roads. A tire with an A rating offers the best traction under wet conditions, whereas C offers minimum traction under wet conditions.
3. The letters A, B, and C are also used to indicate the tire's ability to dissipate or resist heat. A tire with a rating of A has the greatest ability to dissipate or resist heat, whereas a tire rated C has the least ability to resist heat.

- B. A tire's speed rating indicates the maximum speed at which a tire can operate safely. Speed ratings are not valid if the tire is damaged, under- or overinflated, or overloaded. Letters are used to designate the maximum speed rating of the tire, as listed below.

S	112 mph
T	118 mph
U	124 mph
H	130 mph
V	149 mph
Z	+149 mph

- C. A tire's load range is given to identify the maximum weight each tire size can carry.

1. The P-metric system indicates load range in kilograms and pounds.
2. The alphanumeric system indicates load range with letters.
 - a. For cars and light trucks, the letters that designate a common load range are B, C, D, and E.
 - b. Cars usually have a load range of B, whereas light trucks have tires with load ranges of C, D, or E.
 - c. Some manufacturers use other designations: SL (standard load) and XL (extra load).

- D. A tire's ply ratings are a general indication of its load-carrying capacity.

1. The ply rating is molded into the tire's sidewall.
2. The ply rating number is not necessarily the same as the number of actual plies. For example, a tire with a two-ply sidewall may actually have a four-ply rating. A tire would receive this rating if it had the carrying capacity of four plies.

STEERING AND SUSPENSION SYSTEMS

3. The following table represents common ratings that usually, but not always, correlate with each other. The maximum pressure (max press) listed below is measured in pounds per square inch (psi)

Common Comparisons for Car and Light Truck Radial Tires		
Load Range	Ply Rating	PSI Max Press
B	4	35
C	6	50
D	8	65
E	10	80

E. Load index

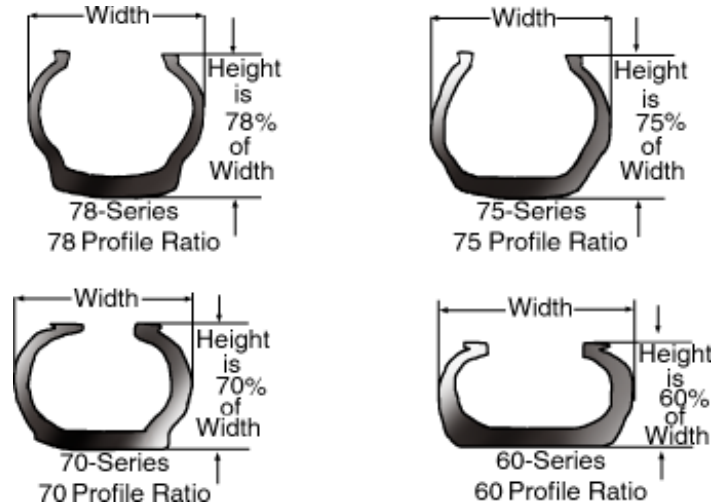
1. Some manufacturers use a new marking system to designate load index. These two- to three-digit numbers usually precede a speed-rating letter. The higher the load index number, the greater the load that the tire can carry.
2. For example, a tire sidewall may have a marking of 90H. The 90 stands for the load index; the H stands for the speed rating.

- F. Some tire manufacturers use the letters M and S to identify that the tire performs as required in mud or snow. Tires with this designation are commonly called all-season tires.

V. Sizing

- A. In order to understand tire sizing, it is first important to understand aspect ratio.
1. Aspect ratio is the relationship of a tire's height to its width.

- Another term for aspect ratio is profile, or series. For example, a 70-series tire is 70% as tall as it is wide. The most common series are 60, 70, 75, and 80.



- B. A combination of U.S. and metric units is used to designate most tires today. A common tire size is P225/60R16. Below is an explanation of the alphanumeric designations.

- The first letter indicates the tire type.
 - P = passenger car (as shown in the above example)
 - T = temporary
 - C = commercial
 - LT = light truck
- The next three digits indicate the section width in millimeters. In the example above, 225 = 225 millimeters. Section width is the measurement from the outer sidewall to the inner sidewall at the widest part of the tire when the tire is mounted and inflated.
- The next two digits indicate the aspect ratio: section height/section width. In the example above, the section height is 60% of the section width.
- The next letter indicates the construction type.
 - R = radial (as shown in the example cited)

STEERING AND SUSPENSION SYSTEMS

- b. B = belted bias
 - c. D = diagonal (bias)
5. The next digit indicates the rim diameter in inches. In the example cited, 16 in.
- C. Alphanumeric sizing was once the accepted standard by which tires were sized.
- 1. A typical alphanumeric size is FR70-15. Below is an explanation of what the letters and numbers mean.
 - a. F = size range
 - b. R = radial ply construction
 - c. 70 = aspect ratio
 - d. 15 = rim diameter in inches
 - 2. Metric sizing eventually replaced the alphanumeric system.
- VI. Specialty tires: compact spares
- A. A temporary-use spare is a type of compact spare tire that is most commonly supplied with passenger cars today.
- 1. The compact spare tire takes up less space in the vehicle's trunk or luggage compartment than a full-size spare tire.
 - 2. Temporary-use spares are designated with a T in the alphanumeric size.
 - 3. Inflation on temporary spares is usually about 60 psi, but the top speed is rated at only about 50 mph.



- B. A space-saver spare is another type of spare tire that is supplied with the vehicle.
 - 1. This type of tire is inflated with a special air compressor that comes with the vehicle. Normal inflation is about 35 psi.
 - 2. While inflating the tire, ensure that there are no folds in the sidewall of the tire.
- C. A lightweight-skin spare is an additional type of spare tire that is included in the vehicle. This type of tire is a bias ply tire with a reduced tread depth. The estimated tread life is only about 2,000 miles.



CAUTION: Do not substitute compact spare tires for normal tires. They are not rated for the speed or distance of normal (passenger) tires. Use them only for emergencies. Drive the vehicle only a short distance and at reduced speeds until reaching a service facility.

VII. Other specialty tires

- A. Some tire manufacturers are designing and producing run-flat tires. These tires, also called extended mobility tires (EMTs), eliminate the need for a spare and safety stands.
 - 1. Run-flat tires have stiffer sidewalls that support the vehicle even if the tire loses its air pressure.
 - 2. Automotive manufacturers that install these tires as normal tires usually install a tire pressure monitoring system on the vehicle. This system alerts the driver if a tire has lost or is losing pressure.
 - 3. The driver can safely operate the vehicle on run-flat tires for about 125 miles with no air pressure to reach a service facility.
- B. Self-sealing tires have a special sealant lining on the inside of the tire that seals small punctures with diameters up to 3/16 in.

STEERING AND SUSPENSION SYSTEMS

VIII. Forms of identification for tires

A. Tire placard

1. Most vehicles have a placard that is permanently located on the vehicle. It is usually on the driver's door jamb. An placard example is shown below.

	MFD BY			03/99
GVWR		GAWR FRT		GAWR RR
2200KG(4850LB)		1134XG(2500LB)		1225KG(2700LB)
THIS VEHICLE CONFORMS TO ALL APPLICABLE U.S. FEDERAL MOTOR VEHICLE SAFETY AND THEFT PREVENTION STANDARDS IN EFFECT ON THE DATE OF MANUFACTURE SHOWN ABOVE.				
1GNCT18W4XK187526 TYPE: M.P.V.				
MODEL: T10516 PAYLOAD = 348KG(768LB)				
TPBS	TIRE SIZE	SPEED RTG	RIM	COLD TIRE PRESSURE
FRT	P235/70R15	S	15X7J	220KPA(32PSI)
RR	P235/70R15	S	15X7J	220KPA(32PSI)
SPA	P235/70R15	S	15X7J	240KPA(35PSI)
SEE OWNER'S MANUAL FOR MORE INFORMATION.				

2. The driver and service technician should refer to the tire placard for tire information (e.g., inflation pressure, maximum vehicle load, and tire size).

B. DOT/MOT number

1. Tires have a number designated by the DOT (U.S. Department of Transportation) or MOT (Canada Ministry of Transportation).
2. This number identifies where and when the tire was manufactured and identifies the tires for warranties and recalls.

C. Tire Performance Criteria (TPC) specification

1. The TPC specification, molded on the sidewall, serves as a rating and identifier for original equipment tires on GM vehicles.
2. This specification ensures that the tire has met the size and performance standards (noise, handling, rolling resistance, traction, endurance, etc.) for the specific vehicle.

