Module 2: Tires, Rims, and Wheels

Terms and Definitions

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- Aspect ratio is the tire size designation that is the ratio of the tire's section height to section width for a specified rim width.
- Bead chafing is the wear of the bead against the rim.
- Bead seating is the positioning of the bead on the rim.
- Capacity is the maximum amount that a tire, rim, or wheel can carry or store; it is expressed in load (pounds [lbs]) and cold inflation pressure (pounds per square inch [psi]).
- The casing is the tire structure excluding the tread and shoulder.
- Circumferential direction is 360 degrees around the tire.
- Delamination is the separation of layers of rubber.
- The demountable rim is the rim intended for use on a cast spoke wheel.
- The disc wheel is the permanent assembly of a disc and a rim for attachment to the vehicle's hub.
- Dual spacing is the distance from the center of a tire to the center of the other tire in a dual tire arrangement.

Note: Dual spacing is determined by adding two half-dual spacings (disc wheels) or two rim offsets plus one space band width (spoke wheels).

- Grooves are the spaces between two adjacent tread ribs or lugs.
- Mounting is the assembling of the tire on the rim.

Note: "Demounting" is the opposite of mounting.

- An out-of-balance condition exists when there is an unequal distribution of weight about the axis of rotation.
- Pi tape is the measuring device used to obtain the circumference of a tire for comparing and matching tires.
- Ply (plies) is the layer(s) of rubber-coated parallel cords.
- Radial direction is from bead to bead.
- To retread is to apply and cure new tread on a casing to extend the life of the tire.
- A rim clamp is the device used to hold a demountable rim on a spoke wheel.
- The rim well is the dropped center area of a single-piece rim made to a smaller diameter than the bead seat area of the rim.
- The rotating assembly is all the rotating parts including the hub, drum, wheel, rim, tire, and associated hardware.
- The spacer band is the metal band that separates two demountable rims on a rear spoke wheel.
- The spoke wheel is the casting with multiple spokes that provides a means of attaching a demountable rim to a vehicle.
- Torque is the measurement of nut tightness.
- Trajectory is the potential path or route a component may travel during an accident such as the sudden release of pressurized air or an explosion.
- The valve hole is the round hole in a single-piece rim that receives the valve stem.
- The valve slot is the elongated opening in a multipiece rim that receives the valve stem.
- The valve stem is the protruding part of a tire tube that allows for inflation/deflation of the tube-type tire assembly when properly mounted.
- Weathering is the fine hairline cracks in the sidewall surface of the tire caused by oxidation and other atmospheric conditions.

Functions of Tires, Rims, and Wheels

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- The tires support the weight of the vehicle and transfer the load to the road.
- The rims support the tires and contain the tires' inflation pressures.
- The wheels transfer the load from the axle to the tires.

Materials Used for Tires, Rims, and Wheels

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- The tires are rubber compounds including nylon, polyester, and other materials for casings and treads and steel for reinforcing plies and belts.
- The rims are steel or aluminum.
- The wheels are steel, cast iron, or aluminum.

Types of Tire Construction

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- Bias ply.
  - The body plies overlap and cross on the diagonal from tire bead to tire bead.
  - Not commonly used on highways.
- Radial ply.
  - Body plies are laid at right angles to the circumference of the tire and run from bead to bead. The plies are then secured with belts that wrap around the tire's circumference.
  - Commonly used and preferred over bias tires because they have less tread distortion, greater fuel efficiency, longer tread wear, and more puncture resistance. They also give the driver more steering control and traction, as well as a smoother ride.

Types of Tires

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- Tube type.
  - Uses a tube (inner tube) and flap to contain the pressurized air.
  - Requires a multipiece rim/wheel assembly and is therefore dangerous to mount/remount.
  - Less commonly used than tubeless.
- Tubeless.
  - Uses a thin layer of air and moisture-resistant rubber inside the tubeless tire to obtain an internal seal of the casing.
  - Requires a one-piece rim, which results in improved mounting safety.
  - More commonly used because it offers several advantages—less weight, reduced parts inventory, improved durability because of less heat, and reduced downtime from punctures.
- Low aspect.
  - Special type of radial tubeless tire that features section width wider than section height, and the typical ratio is 75% to 80% of conventional tires.
  - Has shorter sidewall height and wider tread width than conventional tires.
  - Popular because of improved tread wear, lighter weight, and improved stability and handling.
- Wide base.
  - Are larger tires and provide increased load capacity.
  - May be used instead of duals in some situations and are called super singles.

Parts of a Radial Tubeless Tire

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- The tread is the part of the tire that contacts the road, is designed to provide traction and wear, and consists of lugs or ribs with grooves in between that can be measured for depth of tread.
- Belts (or belt plies) provide strength to the tire, stabilize the tread, protect the air chamber from punctures, and are commonly made of steel.
- Radial ply transmits all load, braking, and steering forces between the wheel and the tire tread and works with the belt plies to contain the tire's air pressure.
- The sidewall is the outside casing that protects the radial ply and is designed to withstand flexing and weathering.
- The bead assembly is the stiff area that secures the inflated tire against the rim.

Types of Tire Damage

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- Bead area.
  - Torn beads.
  - Kinked or distorted beads.
  - Deformed beads.
- Sidewall area.
  - Cuts and snags.
  - Sidewall separation.
  - Chain damage.
  - Weathering.
  - Impact breaks.
  - Petroleum product damage.
  - Blisters/bumps.
- Crown area (tread and shoulder).
  - Penetrations and road hazards (nails, glass, etc.).
  - Cuts and snags.
  - Belt lift/separation.
  - Tread lift/separation.
  - Brake skid damage.
  - Lug base cracking.
  - Impact breaks.
  - Chipping/flaking/chinking tread.
  - Excessive wear.
  - Groove cracking.
- Tire interior.
  - Penetrating objects.
  - Liner splice.
  - Liner bubbles or blisters.
  - Liner cracking.
  - Pulled/loose cords.

Types of Radial Tire Wear Conditions and Causes

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- Shoulder step/chamfer wear is typical in slow-wearing operations.
- Full shoulder wear, usually one side, is due to the improper toe condition, drive axle misalignment, or loose or worn wheel bearings.
- Feather wear is due to severe misalignment such as excessive toe; drive axle misalignment; worn, missing, or damaged suspension parts; or tie rod or other chassis misalignment.
- Erosion/river/channel wear is typical of slow wear on free-rolling axles, especially on light loads with frequent turning.
- Cupping/scallop wear is due to an out-of-balance condition, improper rim/wheel mounting, or lack of shock absorber control on some suspension types.
- One-sided wear is due to the improper alignment, worn king pins, loose front wheel bearings, excessive axle loads, or nonuniform tire and wheel assembly caused by improper bead seating or a bent wheel.
- Diagonal wear is due to runout and/or an out-of-balance condition with a slow rate of wear.
- Eccentric/out-of-round wear is due to excessive radial runout or other nonuniformity in the rotating assembly.
- Overall wear is due to heavy surface conditions such as mountainous terrain, frequent and severe turns, abrasive road surfaces, etc.
- Rib depression/punch wear is due to lack of shock absorber control, improper inflation pressure, loose or worn wheel bearings, improper bead seating, or out-of-balance condition.
- Erratic depression wear is due to lack of shock absorber control, improper inflation pressure, loose or worn wheel bearings, improper bead seating, or out-of-balance condition.
- Heal/toe wear is due to mismatched inflation pressures or tire diameters in a dual assembly.

- Alternate wear is due to mismatched inflation pressures or tire diameters in a dual assembly.
- Brake skid/flat spot wear is due to new brakes, unbalanced brakes, aggressive use of brakes, and driver abuse.

Tire Matching and Mixing

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- Do not change wheels or tires without checking the certified Gross Vehicle Weight Rating (GVWR). Tire and rim labels certify the minimum tire and rim combinations that can be installed.
- When pairing tires on a dual assembly, the tire diameters must not differ by more than 1/4 inch (6.4 mm), or the tire circumference by more than 3/4 inch (19 mm). The total tire circumference of one driving rear axle must match (as nearly as possible) the total tire circumference of the other driving axle.

Caution: Mismatching dual tires damages both the larger and smaller tire, as well as causing damage to the wheels. Blowouts can occur.

- Better tire and vehicle performance is usually obtained by using tires of the same size and construction.
- Using tires of different construction will result in loss of steering control and premature tire wear. However, it is permitted as an emergency measure if the following rules are observed:
  - Do not mix radial and bias ply tires on the same axle.
  - If both radial and bias ply tires are used, better handling is usually obtained by using the bias ply tires on the front axle.
  - Use either all radial or all bias ply tires on the nondriving rear axles.
  - However, all radial or all bias ply tires must be used on vehicles with tandem drive axles.
- Tire diameter differences can be measured by using an endless pi tape, square, matching stick, string gauge, or tire straight edge.

Types of Rims

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- Single-piece rim.
  - Is a continuous one-piece assembly.
  - Dropped in center of rim base to allow for mounting.
  - Used for tubeless tires.
- Multipiece rim.
  - Used on tube-type tires and can consist of either a two-piece or three-piece construction. For instance, a two-piece rim consists of a rim and a split side ring.
  - Caution must be used during the demounting and mounting process, because the pieces can come apart with great force.

Tire and Rim Sizes

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- The tire section width and rim diameter for standard tires are sized according to tire section width and rim diameter.
- The aspect ratio is also stated for low-profile tires.
- The design rim width is approximately 75% of the tire width. For example, an 11-22.5 tire uses an 8.25 rim ($11 \times 0.75 = 8.25$).
- Most tire sizes have two or three approved alternative rim widths.
- The location of tire size marking is on the outside surface of the tire, along with the manufacturer's name, style name, and DOT code numbers (required by law) that identify manufacturing plant and date.
- The Federal Motor Vehicle Safety Standard (FMVSS 120) requires that the rim size, type, and manufacturer's information must be stamped on the rim and rim components.

Cast Spoke Wheels

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- Assembly.
  - Consist of a wheel and brake drum assembly installed on the axle and a tire and rim assembly that mounts on the wheel.
  - Rim clamps and rim (hex) nuts hold the tire and rim assembly in place on the spoke wheel hub assembly.
- Typical designs.
  - Typical designs include three, five, and six cast spokes.
- Spacer bands.
  - Spacer bands (available in different widths) are used with duals on rear cast spoke wheels to hold the two rims apart and to provide proper dual spacing.

Disc Wheels

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- Assembly.
  - Consist of a rim and disc welded together.
  - After the tire is mounted on the rim/wheel, the assembly is held in place on the hub with wheel studs and nuts.
- Installing hub-piloted disc wheels.
  - Location of wheel is determined by positioning the wheel center hole on a machined pilot (continuous or interrupted) on the hub.
  - Fastening is accomplished by flange nuts bearing against the flat face of the wheel disc.
- Installing stud-piloted disc wheels.
  - Locating and fastening of the wheel are accomplished by spherical nuts that fit into a corresponding chamber at each wheel hole.
  - Use double cap nuts that include inner cap nuts used to fasten inner wheels to a vehicle and outer cap nuts used to fasten single wheels and outer wheels to a vehicle.

Mounting Hardware for Wheels

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- Rim clamps, studs, and nuts.
  - These types of mounting hardware are used for cast spoke wheels.
- Hub-piloted.
  - Flanged nuts and cone nuts are used for mounting hub-piloted disc wheels.
- Stud-piloted.
  - Studs and double-cap nuts are used for mounting stud-piloted disc wheels.

Types of Rim and Wheel Damage

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- Cracked rim, wheel, or disc.
- Sprung or broken lock rings or side rings.
- Tubeless rim leaks.
- Corroded parts.
- Damaged inner or outer wheel cap nuts.
- Out-of-round wheel or rim (distortion).
- Out-of-round or elongated stud holes on wheel.
- Cracked or bent valve cores.
- Damaged/worn clamps, rim spacer, rim studs, or spoke-wheel nuts.

Wheel Tightening Sequences

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- Spoke wheels.

Note: Uneven tightening will cause threads to protrude more on some studs and will result in uneven alignment.

- Disc wheels.

Note: Always tighten top nut first.

Tire and Wheel Assembly Runout and Balancing

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- Lateral runout versus radial runout.
  - Lateral runout is a variation in the rotating assembly in a side-to-side direction (wobble).
  - Radial runout is a variation in the radius of the rotating assembly.
- Checking amount of runout.
  - A runout gauge is commonly used to check runout.
    - Lateral runout should be checked on a smooth surface along the tire's upper sidewall.
    - Radial runout should be checked on a smooth rib in the center of the tread.
- Rotating assembly balance and runout limits.
  - If runout exceeds suggested limits, check for bent rims, improperly adjusted wheel bearings, improper tire bead seating, tire flat spots, improperly tightened rim clamps, and rear rim spacers.
- Making corrections.
  - Correct excessive runout before checking tire/wheel assembly balance.
- Problems with out-of-balance rotating assemblies.
  - Out-of-balance rotating assemblies can contribute to driver discomfort because of excessive vibration, poor tire mileage, poor steering, mechanical failures, and irregular tire wear.
- Balancing rotating assemblies.
  - Rotating assemblies can be balanced in two ways—statically and dynamically. The goal of both is to obtain an on-center rotating wheel and assembly.
    - Static balance is when the weight is equally distributed about the axis of rotation in such a manner that there is no tendency for the assembly to rotate by itself. The rotating assembly will remain at rest when stopped at any point in a rotation.
    - Dynamic balance is when the weight is equally distributed about the axis of rotation in such a manner that the horizontal and vertical forces are constant during rotation. The rotating assembly is in balance when in motion and the weight is equally distributed around the perimeter of the tire as well as on both sides of the tire centerline.
- If the suggested limit is exceeded.
  - If out-of-balance and exceeds suggested limits, correct by adding weight to the rim or wheel flange, half on each side of the rim or wheel.
- Marking the tire/wheel position.
  - If a tire/wheel assembly is removed for balancing, be sure to mark the tire/wheel position on the brake drum or hub so it can be reinstalled in the same position.

Note: Tire balancing and other types of tire service are commonly performed in shops with special equipment and specially trained personnel because of the expense and hazards associated with tire service.

Safety Precautions to Follow When Servicing Tires, Rims, and Wheels

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- Although most school shops are not equipped for complete tire service, you should understand and follow all safety precautions and manufacturer's recommendations when working on or around tires, rims, and wheels.

Caution: Inflated tires, multipiece rims, and damaged components are especially dangerous because they can explode with great force.

- Never stand in front of or over an inflated tire, and stay out of the trajectory and warn others.
- Block the wheel on the other side of the vehicle before placing the jack in position.
- Always use a wood block with the hydraulic jack.
- Do not add air to tire and rim assemblies that have been operated in a seriously underinflated or flat condition (80% or less of recommended pressure).

Caution: Tires driven seriously underinflated or flat can be damaged as well as the rim components, and both the tire and the rim components can explode.

- Always deflate the tire completely before removing it from the vehicle, and deflate both tires of a dual assembly. Remove the valve core and exhaust all the air pressure before removing the tire, and never attempt to unseat beads of an inflated tire.
- Never attempt to lift or move a heavy tire or wheel without help. Use a cable or chain sling if necessary.

- Make sure the rim parts match properly. Although the rims and rim components from different manufacturers may look similar, they are not interchangeable. Check identification stamping on the rim and rim components to verify the match.
  - Examples: the correct size Goodyear rings on matching Goodyear rim bases, and the correct size Firestone rings on matching Firestone bases.

Caution: Mismatched tires and rims/wheels can explode during inflation or unseat later causing a vehicle accident.

- Carefully remove rust, dirt, and other foreign materials from all rim surfaces and rim components to ensure safe, positive seating. This is especially important in the rim gutter and bead seat areas.
- Check to make sure the tire diameter matches the rim/wheel diameter.
- Inspect all parts for damage and replace as needed.
- Never attempt to rework, weld, heat, or braze rim or wheel parts.
- Always use a restraining device or cage and a clip-on air chuck, and remove valve/gauge when inflating a tire.
- Never exceed maximum load or inflation pressures. If given tires and rims/wheels have different capacity limits (load and inflation), use the lesser limit.
- Always check for proper seating of the bead before removing the tire/rim from the restraining device.
- Never attempt to correct the seating by hammering, striking, or forcing parts while the tire is inflated.
- Tighten the stud nuts in the correct sequence, and torque to the manufacturer's specifications.

Tire Maintenance

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- The most important factor in tire maintenance is proper inflation. Driving on tires with incorrect pressure is the most common cause of tire damage.
- Proper inflation allows the tread to make full contact with the road for best traction, braking ability, and safety.
  - Underinflation causes abnormal tire deflection, which builds up heat and causes irregular wear.
  - Overinflation causes the tire to run hard, be more vulnerable to impacts, and wear irregularly.
- Keep both tires in a dual assembly at the same pressure, as unequal pressures can damage both tires, as well as the wheel bearings and other wheel components.
- If significant low pressure is found, check tire for punctures, valve leakage, or wheel/rim damage.
- Check tire tread depth periodically. In most countries, there are specifications that must be complied with. For instance, in the United States, federal law currently requires truck tires on the front axles to have at least $^{2}/_{32}$ inches (1.6 mm) tread depth. All other tires must have a tread depth of at least $^{1}/_{32}$ inches (0.8 mm). However, this is the absolute minimum, and tires should never be allowed to get to this point without replacement.
- Keep all petroleum products (grease, lube oils, fuel) away from tires, as petroleum products can cause rubber to become soft and spongy.