



SURFACE VEHICLE INFORMATION REPORT

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(R) Tire Performance Terminology

RATIONALE

Committee recommends to reaffirm the document. The Committee recognizes that some tire performance terminology may need to be reviewed and updated.

FOREWORD

This Terminology assembles existing tire terms and their definitions developed by different standards organizations into a lexicon of technical terms related to tire performance. Different aspects of tire performance mutually influence each other. To account for these real performance interactions, the terms and definitions pertaining to different aspects of tire performance are combined herein.

The terms and definitions herein have been collected from national and international standards (listed in Section 2). They have been carefully examined for their current relevance and technical accuracy, and then consolidated into this document. If a term carries more than one name, the one believed most descriptive is listed first, and the others are shown in parentheses. If more than one term has the same definition, the preferred term is listed first. Other terms are listed in parentheses. In some cases, existing definitions have been altered or new ones introduced to achieve consistency. Preference is given to terms that:

- Are technically correct and in compliance with mathematical and engineering conventions
- Were issued by an international rather than a national standards organization and
- Have been widely used for a long time

In cases, when a term or a definition appears to be inadequate or questionable, it is replaced by a new one and an explanation is given in the Notes.

Many terms and definitions related to tire performance, but originated by other organizations such as ISO, US Government, Tire and Rim Association, etc., or other SAE technical committees not affiliated with the SAE Highway Tire Forum Committee, have been adopted in this document and incorporated into Sections 3, 4, 18, 19, 20, and 21. Adopted terms and conditions are written, where possible and advisable in current circumstances, using exactly the same wording used in the original documents.

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1. SCOPE

This terminology aims to encompass all terms and definitions pertaining to the road performance of pneumatic tires designed for over-the-highway use, such as passenger car, light truck, truck and bus, and motorcycle tires. Not included are terms specific to the performance of agricultural, aircraft, industrial, and other off-highway tires. However, many terms contained in this document also apply to non-highway tires.

2. REFERENCES

2.1 Applicable Documents

The following publications form a part of this specification to the extent specified herein. Unless otherwise indicated, the latest issue of SAE publications shall apply.

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

SAE J670	Vehicle Dynamics Terminology
SAE J1269	Rolling Resistance Measurement Procedure for Passenger Car, Light Truck, and Highway Truck and Bus Tires
SAE J1270	Measurement of Passenger Car, Light Truck, and Highway Truck and Bus Tire Rolling Resistance
SAE J1982	Nomenclature - Wheels for Passenger Cars, Light Trucks, and Multiple Vehicles
SAE J2452	Stepwise Coastdown Methodology for Measuring Tire Rolling Resistance

2.1.2 ISO Publications

Available from American National Standards Institute, 25 West 43rd Street, New York, NY 10036-8002, Tel: 212-642-4900, www.ansi.org.

ISO 3911-2004 (E)	Wheels and rims for pneumatic tyres - vocabulary, designation, and marking.
ISO 8855-2011	Road vehicles - Vehicle dynamics and road holding ability - Vocabulary
ISO 13473	Characterization of pavement texture by use of surface profiles (Parts 1 through 5)

2.1.3 U.S. Federal Publications

Available from U.S. Government Printing Office, New Orders, P.O. Box 979050, St. Louis, MO, 63197-9000.

49CFR575.104	Uniform Tire Quality Grading
49CFR571.109	New Pneumatic Tires and Certain Specialty Tires - Passenger Cars
49CFR571.117	Retreaded Pneumatic Tires
49CFR571.119	New Pneumatic Tires for Motor Vehicles with GVWR of more than 4,536 kilograms (10,000 pounds) and Motorcycles
49CFR571.120	Tire Selection and Rims and Motor Home/Recreation Vehicle Trailer Load Carrying Capacity Information for Motor Vehicles with a GVWR of more than 4,536 kilograms (10,000 pounds)
49CFR571.129	New Non-Pneumatic Tires for Passenger Cars

49CFR571.138 Tire Pressure Monitoring Systems

49CFR571.139 New Pneumatic Radial Tires for Light Vehicles

NHTSA Tire Aging Project: Roadwheel Removal Codes v2.2 - 4/13/2006

2.1.4 Tire and Rim Association Publication

Available from Tire and Rim Association, 175 Montrose West Avenue, Suite 150, Copley, OH 44321. 330-666-8121, Tire and Rim Association Year Book

2.1.5 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org

ASTM F1016-07 Standard Practice for Tire Linear Treadwear Data Analysis

ASTM F1046-01 (2008) Standard Guide for Preparing Artificially Worn Passenger and Light Truck Tires for Testing

ASTM F1426-11 Standard Practice for Identifying Tire Tread Surface Irregular Wear Patterns Resulting From Tire Use

2.2 Related Publications

The following publications are provided for information purposes only and are not a required part of this SAE Technical Report.

2.2.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

SAE J341a Truck and Bus Tire Performance Requirements and Test Procedures

SAE J918c 1970-05 Passenger Car Tire Performance Requirements and Test Procedures

SAE J966 Test Procedure for Measuring Passenger Car Tire Revolutions Per Mile

SAE J1025 Test Procedures for Measuring Truck Tire Revolutions Per Kilometer/Mile

SAE J1106 Laboratory Testing Machines and Procedures for Measuring the Steady-State Force and Moment Properties of Passenger Car Tires

SAE J1269 Rolling Resistance Measurement Procedure for Passenger Car, Light Truck, and Highway Truck and Bus Tires

SAE J2013 Military Tire Glossary

SAE R-101 Dictionary of Automotive Engineering, D. Goodsell, 1989

SAE SP750 Glossary of Automotive Terms, 1988

SAE Paper 960999 The Role of Steer and Sideslip in the Mechanism of Slip Angle, W. Bergman, Dirk Pelargus, 1996

T. R. Giapponi, Tire Forensic Investigation: Analyzing Tire Failure, 2008.

2.2.2 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org

ASTM F408-99(2008) Standard Test Method for Tires for Wet Traction in Straight-Ahead Braking, Using a Towed Trailer

ASTM F421-07 Standard Test Method for Groove and Void Depth in Passenger Car Tires

ASTM F424-86 Standard Test Method for Tires for Wet Driving Traction in Straight-Ahead Motion Using Highway Vehicles

ASTM F435-86 Standard Test Method for Peak Wet Traction of Tires with Driving Torque Application Using Highway Vehicles

ASTM F538-09 Standard Terminology Relating to Characteristics and Performances of Tires

ASTM F724-94a (2004) Standard Practice for Outdoor Evaluation of Tire Sidewall Component Cracking Resistance

ASTM F762-08 Standard Practice for Determining Change in Groove (or Void) Depth with Distance Traveled for Passenger Car Tires

ASTM F870-94 (2005) Standard Method for Obtaining Tread Footprints of Passenger Car Tires for Calculation of Groove Area Fraction

2.2.3 American Chemical Society

Schuring, D. J. 1980. The Rolling Loss of Pneumatic Tires. *Rubber Chemistry and Technology*, Vol. 53, No. 3, pp. 600–727.

Schuring, D. J., and S. Futamura. 1990. Rolling Loss of Pneumatic Highway Tires in the Eighties. *Rubber Chemistry and Technology*, Vol. 62, No. 3, pp. 315–367.

2.2.4 ISO Publications

Available from American National Standards Institute, 25 West 43rd Street, New York, NY 10036-8002, Tel: 212-642-4900, www.ansi.org.

ISO 3877/1-1997 (E/F/R) Tyres, valves and tubes - List of equivalent terms - Part 1: Tyres

ISO 4223/1 – 2002 (E/F) Definitions of some terms used in the tire industry - Part 1: Pneumatic tyres

2.2.5 E.T.R.T.O Publication

Available from European Tyre and Rim Technical Organisation, Av. Brugmann, 32 - 1060 Brussels, Belgium, Tel: +32-2-344-40-59, info@etrto.org.

E.T.R.T.O. Standards Manual

2.2.6 ITEC Publications

M. G. Pottinger, "Pull: The Science of a Nuisance," International Tire Exhibition and Conference, Cleveland, Ohio, 21-23 September 2010.

2.3 Other Publications

"Radial Tire Wear Conditions and Causes," American Trucking Association, The Maintenance Council, Alexandria, VA

C. L. Clover and J. E. Bernard, "Longitudinal Tire Dynamics," *Vehicle Systems Dynamics*, Volume 29, Issue 4, 1998, pp. 231-260.

K. D. Marshall, "Tire Noise and Vibration," Chapter 9, *The Pneumatic Tire*, Edited by J. D. Walter and A. N. Gent, National Highway Traffic Safety Administration, Washington, D.C., 2005.

T., Unrau, H. J., and El-Haji, M., "Experimental Determination of the Effect of the Surface Curvature on Rolling Resistance Measurements," *Tire Science and Technology, TSTCA*, Vol. 37, No. 4, October – December 2009, pp. 254-278.

3. WHEEL TERMS

3.1 Wheel

A rotating load-carrying member between the tire and the hub, usually consisting of two major parts, the rim and the wheel disc, which may be: integral, permanently attached, or detachable. [ISO 3911, SAE J1982]

3.1.1 Wheel Offset

The measured distance from the attachment face of the wheel (Section 3.3.3) to the wheel plane (Section 3.5.1).

NOTE: Wheel offset is positive, if the mounted wheel increases the vehicle track (SAE J670) with respect to the hub face, and negative, if the mounted wheel decreases vehicle track with respect to the hub face.

3.1.1.1 Inset (Negative Offset) Wheel

A wheel so constructed that the wheel plane (Section 3.5.1) is located inboard of the attachment face. The inset, negative wheel offset [ISO 3911], is the distance from the attachment face to the wheel plane (see Figure 1A).

3.1.1.2 Zerooffset Wheel

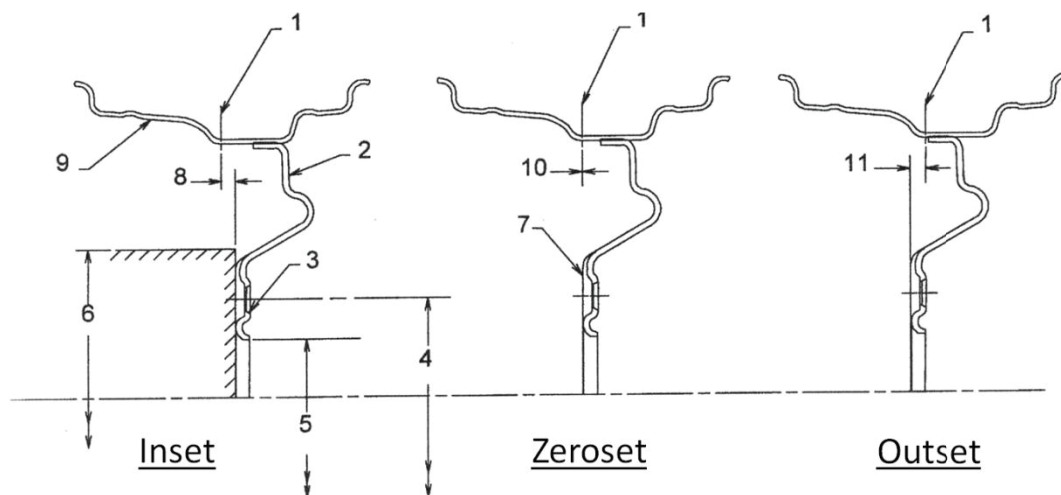
A wheel so constructed that the wheel plane is coincident with the attachment face (see Figure 1B). [ISO 3911]

3.1.1.3 Outset (Positive Offset) Wheel

A wheel so constructed that the wheel plane is located outboard of the attachment face. The outset, positive wheel offset [ISO 3911], is the distance from the attachment face to the wheel plane (see Figure 1C).

3.2 Rim (SAE J1982)

That part of the wheel on which the tire is mounted and supported. (See Figures 1 and 2.)



- | | |
|--|--------------------|
| 1. Wheel Plane (Rim Center Plane) | 7. Attachment Face |
| 2. Disc | 8. Inset |
| 3. Nut Seat | 9. Rim |
| 4. Pitch Circle Diameter of Bolt Holes | 10. Zero set |
| 5. Center Hole Diameter | 11. Outset |
| 6. Attachment Face Diameter | |

FIGURE 1 - WHEEL OFFSET (RIM TO DISC OFFSET - SAE J1982)

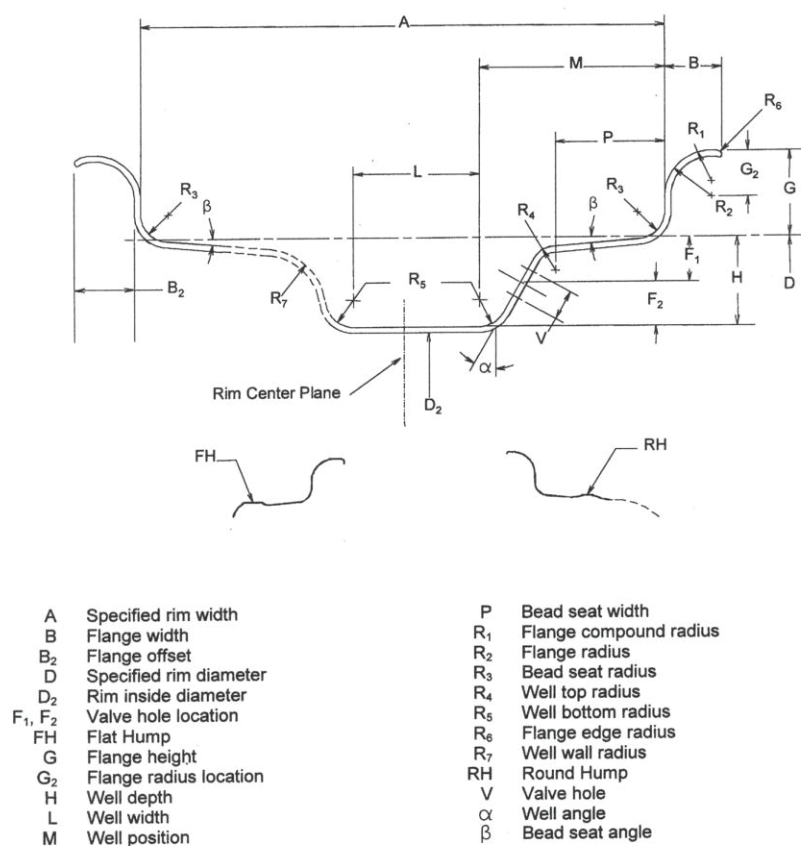


FIGURE 2 – RIM (SAE J1982)

3.2.1 Rim Flange

That part of the rim which provides lateral support to the tire.

3.2.2 Bead Seat

That part of the rim which provides radial support to the tire and air pressure seal for tubeless tires.

3.2.3 Well

That part of the rim so located with sufficient depth and width to enable the tire beads to be mounted and demounted over the mounting side rim flange.

3.2.4 Valve Hole

The hole or slot in the rim which accommodates the valve for tire inflation.

3.3 Disc

That part of the wheel which is the supporting member between the hub (axle) and the rim. (See Figure 3.)

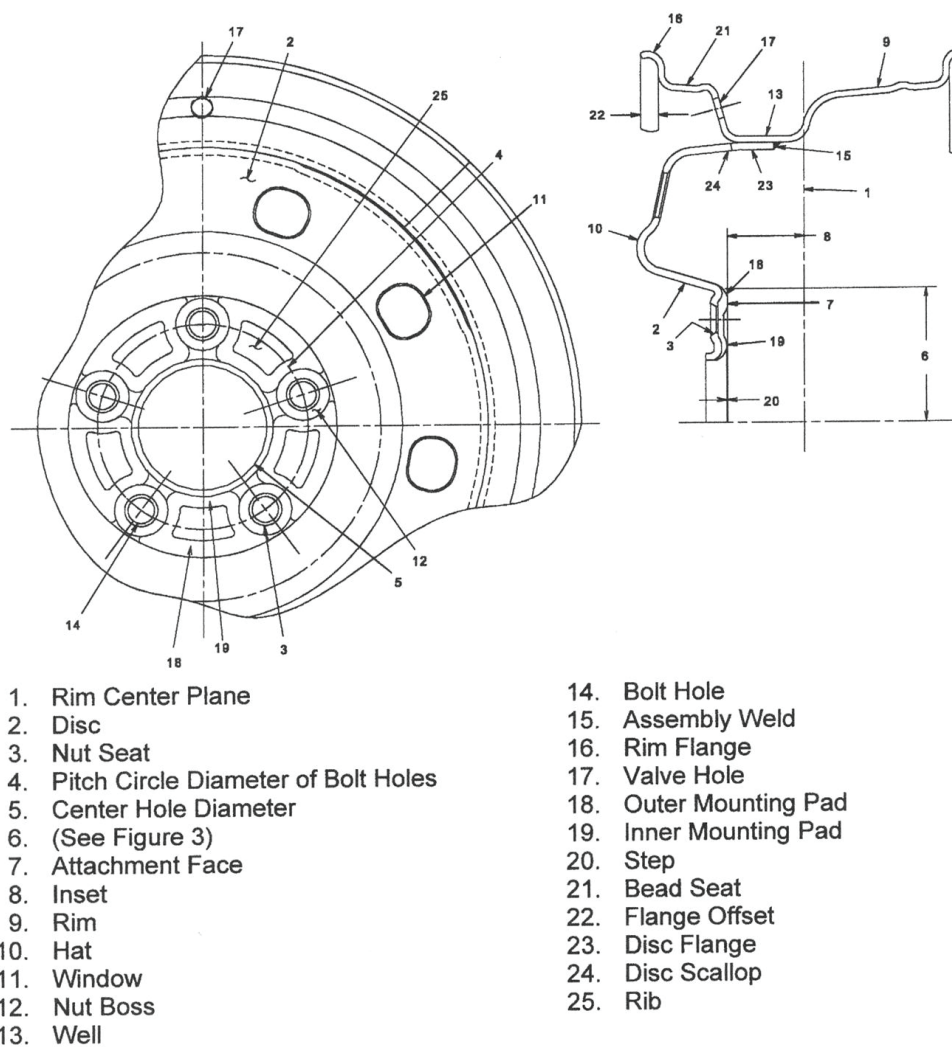


FIGURE 3 - DISC WHEEL (J1982)

3.3.1 Disc Flange

The part of the disc that supports the rim.

3.3.2 Attachment Face

The surface of the disc that contacts the hub face. This surface is often considered the datum for axial rim measurements.

3.3.3 Bolt Hole

Mounting stud clearance hole.

3.3.4 Bolt Circle

A circle locating the centers of the bolt holes that are used to attach the wheel to the hub.

3.3.5 Center Hole

The clearance hole for the pilot of the hub.

3.4 Wheel Designations and Dimensions

3.4.1 Wheel Plane (Rim Center Plane)

A plane normal to the wheel-spin axis, which is located halfway between the rim flanges.

NOTE: The term "wheel plane" has been adopted from the ISO 8855 and SAE J670 terminologies. The term "rim center plane" has been adopted from the SAE J1982 nomenclature.

3.4.2 Rim Width

The distance between the inside surfaces of the rim flanges.

3.4.3 Measuring Rim Width (Design Rim Width)

The specific rim width assigned to each tire size designation to determine basic tire dimensions.

3.4.4 Specified Rim Diameter

The diameter at the intersection of the bead seat and the projection of the vertical portion of the rim flange. See Figure 2.

3.4.5 Rim Diameter Code (Rim Diameter Designation/Nominal Rim Diameter)

The nominal rim diameter assigned for tire/rim matching.

NOTE: The term "nominal" implies a convenient figure designating or approximating an actual dimension. Nominal exists in name only, and it is not real, true, actual, or measured. Nominal is used primarily for identification rather than for measurement.

3.4.6 Rim Profile (Rim Contour)

The radial cross-sectional shape of a rim.

3.4.7 Rim Contour Designation

A code comprised of numbers and/or letters to show the designated width and contour of the rim. Example: 6 J.

3.4.8 Rim Size Designation

Rim diameter designation x rim contour designation. Example: 17 x 6.5 J, which denotes a 17 inch nominal rim diameter, 6.5 inch nominal rim width, and J rim profile.

3.4.9 Test Rim (Model Rim Assembly)

A rim on which the tire is mounted for testing that is approved by a standardizing body and used for the determination of tire dimensions or performance characteristics.

4. GENERAL TIRE TERMS

4.1 Pneumatic Tire

A flexible, hollow semi-toroid mounted on the rim and which becomes load bearing when filled with compressed gas (usually air).

4.1.1 Inner Tube

A low-diffusion hollow section rubber torus which retains compressed air within a tube-type tire and thus allows maintenance of a prestressed state in the tire structure.

4.2 Tire Designation (for Some Metric Size Tires)

The numbers or letters indicating tire size designation and service description.

4.2.1 Tire Size Designation (for Metric Passenger Car and Light Truck Tires)

The numbers or letters indicating intended tire application, nominal section width, nominal aspect ratio, construction, and nominal rim diameter, such as P205/60R17.

4.2.2 Service Description (Load/Speed Index)

A code consisting of load index and speed symbol, which is not part of the tire size designation. Example: 90 H.

4.2.2.1 Load Index

A numerical code associated with the maximum load a tire can carry at the speed indicated by its speed symbol under specified service conditions.

4.2.2.2 Speed Symbol

A symbol indicating the speed category at which the tire can carry a load corresponding to its load index under specified service conditions.

COMPLETE DESIGNATION EXAMPLE: Based on the Tire and Rim Association Year Book: P205/60R17 90H denotes a passenger car tire (P) with nominal section width of 205 mm, nominal aspect ratio 60, radial ply construction (R), with nominal rim diameter of 17 in, load index 90, and speed symbol H.

4.2.3 Tire Structure (Construction)

The generic type of tire structure is identified by a letter code. The letter "D" is used for diagonal tire, letter "B" for bias belted tire, and letter "R" for radial tire.

4.2.3.1 Diagonal Tire (Bias Tire, Cross Ply Tire)

A pneumatic tire structure in which the ply cords extend to the beads and are laid at alternate angles substantially less than 90 degrees to the circumferential centerline of the tread, Figure 4A.

4.2.3.2 Bias Belted Tire (Belted Tire)

A pneumatic tire structure of the diagonal (bias ply) type in which the carcass is topped by a belt comprised of two or more layers, Figure 4B.

4.2.3.3 Radial Ply Tire

A pneumatic tire structure in which the ply cords extend to the beads and are laid substantially at 90 degrees to the circumferential centerline of the tread, the carcass being topped by a belt, Figure 4C.

4.2.3.4 Tube-Type Tire

A pneumatic tire which requires an inner tube for air retention.

4.2.3.5 Tubeless Tire

A pneumatic tire which does not require an inner tube, inflation pressure is retained by the tire innerliner, the rim, and the valve.

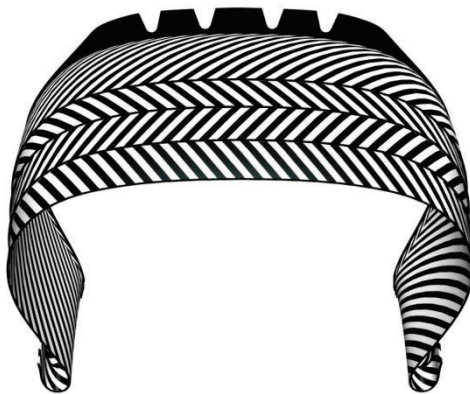


FIGURE 4A – DIAGONAL (BIAS) TIRE

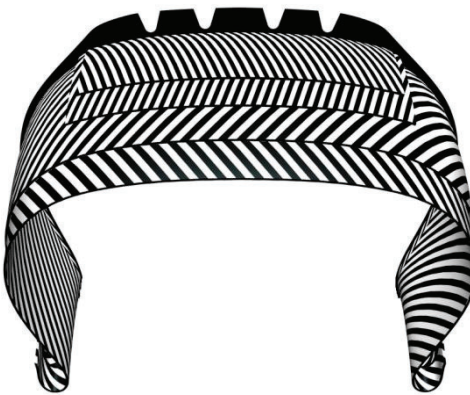


FIGURE 4B – BIAS BELTED TIRE



FIGURE 4C – RADIAL TIRE

4.2.3.6 Retreaded Tire

A tire to which a new tread has been affixed to an existing carcass or casing in place of the initial tread.

4.2.3.7 Unidirectional Tire

A tire with a tread pattern intended to rotate in a single direction during use. It is sometimes referred to as a directional tire.

4.2.4 Tire Condition

4.2.4.1 New Tire

A tire, whose chemical and physical state is essentially equivalent to that existing immediately after manufacturing and which is being mounted on a vehicle rim for the first time after leaving the factory.

4.2.4.2 Broken-in Tire

A tire which has experienced one or more periods of initial operation, resulting in a physical state in which the tire will exhibit consistent, repeatable performance properties, and generally does not have a significant tread depth reduction.

4.2.4.3 Worn Tire

A tire which has experienced use resulting in a measureable reduction in tread depth.

4.2.4.4 Aged Tire

A tire which has experienced a modification of the material properties within one or more components. The material properties modifications can either occur naturally in storage, in normal use, or under specific controlled conditions.

4.2.4.5 Grown Tire

A tire which has changed in size due to use in service and inflation.

4.2.5 DOT Code

The DOT code is comprised of the symbol DOT and the Tire Identification Number (TIN). The TIN is comprised of letters and numbers molded or branded into or onto the sidewall of the tire. An example DOT code: DOT YY XX ZZZZ DDDD. YY indicates the tire plant, XX indicates the tire size, ZZZZ is an optional code and DDDD represents the week and year of manufacture. (4007 would indicate the 40th week of 2007). See 49 Code of Federal Regulations part 574 for details.

4.2.6 Uniform Tire Quality Grading

UTQG, a DOT required system of passenger car tire grading that assigns grades to tires and indicates that the tire is certified by the manufacturer to comply with DOT requirements as determined in standardized tests for treadwear, traction, and temperature resistance. (Reference 49CFR Part 575.104.)

4.3 Tire Design Dimensions

The dimensions of a tire mounted on its measuring rim as specified by a tire and rim standards organization such as the Tire and Rim Association (T&RA).

4.3.1 Section Width

The width of an unloaded, new tire inflated to the recommended pressure 24 hours prior to measurement thus taking account inflation growth (see, for example, the T&RA Year Book). Molded on sidewall elements such as curb ribs, lettering, and decorations are excluded.

4.3.2 Overall Width

The width of an unloaded new tire inflated to recommended pressure 24 hours prior to measurement thus taking account inflation growth (see, for example, the T&RA Year Book). Molded on sidewall elements such as curb ribs, lettering, and decorations are included.

4.3.2.1 Tire Maximum Overall (Grown) Tire Width

The overall width including allowances for as manufactured size, growth, and growth in-service.

4.3.3 Section Height

The height of radial cross section of a tire including 24-hour inflation growth. It is calculated as half the difference between the tire overall diameter and the nominal rim diameter.

4.3.4 Aspect Ratio

Ratio of section height to section width of a tire times 100.

4.3.5 Overall (Outside) Diameter

The diameter of the largest part of the unloaded new tire mounted on the test rim and inflated to the recommended pressure including 24-hour inflation growth (see, for example, the T&RA Year Book).

4.3.5.1 Overall (Grown) Diameter in Service (Gross Service Diameter - Static)

The tire overall diameter after an appreciable amount of time in service. When referenced by a standardizing body, the grown tire diameter is based on the new tire design diameter plus allowances for manufacturing variations and growth in service.

4.3.5.2 Maximum Overall (Grown) Diameter in Service Motorcycle (Gross Service Diameter - Dynamic)

The tire overall diameter plus tolerances for manufacturing and service, plus allowance for dimensional changes due to centrifugal forces.

4.3.6 Size Factor

The sum of section width and overall diameter of a tire.

4.4 Tire Components and Elements

See Figure 5 an illustration based on a radial tire.

4.4.1 Sidewall

The portion of the tire between the bead and the tread.

4.4.1.1 Curb Rib (Sidewall Rib)

A raised circumferential protective rib located on the sidewall.

4.4.1.2 Rim Protector

A feature (for example: a protruding circumferential rubber rib) incorporated into the lower sidewall area of the tire intended to help protect the rim from damage.

4.4.1.3 Sidewall Rubber

The layer of rubber compound on the outside of the sidewall; it may include molded on sidewall elements such as curb ribs, lettering, and decorations.

4.4.1.4 White Sidewall

A sidewall containing white or light-colored compounds used for decoration or lettering.

4.4.1.5 Black Sidewall

A sidewall without light-colored compounds.

4.4.1.6 Cover Strip (Cover Gum Strip)

A thin layer of compound (usually black) covering part of the white sidewall surface of the finished tire.

4.4.1.7 Veneer

An extended cover strip.

4.4.1.8 Upper Sidewall

The upper sidewall is the sidewall region between the point of mid-section height and the tread.

4.4.1.9 Lower Sidewall

The lower sidewall is the sidewall region between the point of mid-section height and the bead.

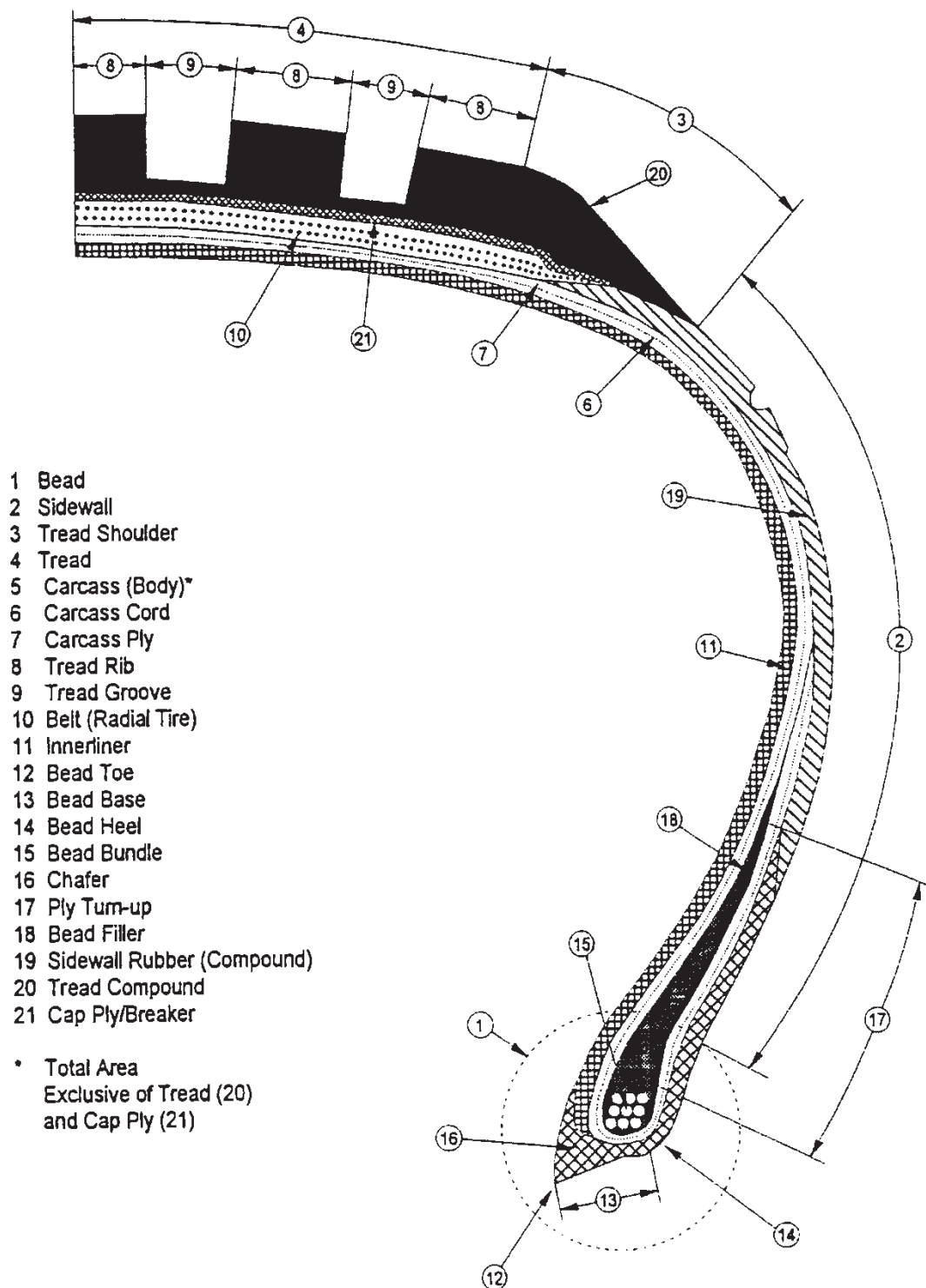


FIGURE 5 - TIRE COMPONENTS AND TIRE ELEMENTS USING A RADIAL TIRE AS AN EXAMPLE

4.4.2 Bead

The part of a tire that comes into contact with the rim and is shaped to secure the tire to the rim. (See figure 5.)

4.4.2.1 Bead Base

Inner portion of the bead that is seated on the bead seat.

4.4.2.2 Bead Toe

Inner portion of the bead base.

4.4.2.3 Bead Heel

Outer portion of the bead base.

4.4.2.4 Bead Bundle (Bead Coils, Bead Cord)

A circumferentially stiff hoop made of steel wires embedded in the bead which resists the inflation pressure generated forces.

4.4.2.5 Bead Filler (Apex)

A rubber compound fillet between the bead bundle and adjacent ply cords.

4.4.2.6 Bead Face

The portion of the bead above the bead heel that interfaces with the rim flange.

4.4.2.7 Chafer (Rim Strip; Clinch Strip)

A layer of rubber compound, with or without fabric reinforcement, applied to the bead for resisting damage caused by movement relative to the bead seat and rim flange.

4.4.2.8 Flipper

A partial ply wrapped around the bead bundle but not extending the full height of the sidewall.

4.4.3 Tread

The portion of the tire designed to contact the road surface in normal service.

4.4.3.1 Tread Band

An annular volume of rubber that includes the outer pavement contacting periphery of a tire.

4.4.3.2 Tread Shoulder

The outermost portion of the tread adjacent to the sidewall.

4.4.3.3 Shoulder Rib

A rib at or near the outer edge of the tread band.

4.4.3.4 Shoulder Row

A row located at or near the tread shoulder

4.4.3.5 Tread Contour

The surface contour across the tread of an inflated, unloaded tire without consideration of grooves, sipes, etc.

4.4.3.6 Tread Crown

The crown is the region between the tread shoulders of the tire when looking from the inside center of the tire to the tire's outside.

4.4.3.7 Tread Arc Width

The peripheral distance between the two tread shoulders measured along the tread contour.

4.4.3.8 Tread Chord Width

The distance between the two tread shoulders measured parallel to the spin axis of an inflated, unloaded tire.

4.4.3.9 Tread Pattern

The molded geometric configuration on the peripheral tread face, generally composed of tread elements and voids.

4.4.3.10 Tread Element (Projection)

A raised portion of the tread pattern, contacting the road surface when passing through the footprint.

4.4.3.11 Tread Rib

An essentially continuous, circumferential tread element.

4.4.3.12 Lug or Block

A discontinuous tread element.

4.4.3.13 Row

A sequence of tread elements along a circumferential line.

4.4.3.14 Groove

A void that is molded or cut into the tread rubber and is relatively narrow compared to its length. Sipes and Kerfs (Section 4.4.3.18) are not grooves.

4.4.3.15 Void

An open space between tread elements or ribs. Sometimes used to describe the volume of the open space.

4.4.3.16 Groove Depth (Groove Depth, Tread Depth)

The depth of a groove or void measured perpendicular to the reference plane defined by the edges of adjacent tread elements.

4.4.3.17 Tread Wear Indicator (Wear Bar)

Raised bottom portions of a groove or void, spaced regularly around the tire across the tread to provide a visual indication of wear-out.

4.4.3.18 Sipe (Kerf)

A narrow slot usually less than 1 mm wide. Typically molded into a tread element.

4.4.3.19 Notch

A slot with a closed end, wider than a sipe, but in most cases, narrower than a groove.

4.4.4 Carcass (Body; Casing)

The rubber-bonded cord structure that provides the tire's stiffness when prestressed by the inflation pressure.

NOTE: Sometimes casing is used to describe a used or treadless tire. Thus, it is necessary to distinguish between meaning when using the term casing.

4.4.5 Cord

An assembly formed by twisting together textile or non-textile filaments that is the structural reinforcing element for plies.

4.4.5.1 Cord Angle

The angle between a cord in a ply and the tread circumferential center line.

4.4.6 Ply

A sheet of rubber-coated cords.

4.4.6.1 Carcass Ply

The ply extending from bead to bead.

4.4.6.2 Ply Turn-Up

The portion of the ply passed around the bead bundle (see Figure 5).

4.4.6.3 Belt (Breaker)

An assembly of plies located under the tread that does not extend into the sidewalls.

NOTE: It provides additional tread area stiffness/strength. For radial ply constructions, it restrains the overall diameter, provides circumferential tread stiffness and is the source of cornering forces.

4.4.6.4 Cap Ply

An additional ply, under the tread and over the belt assembly of a radial ply tire, with cords oriented at approximately zero degrees to the circumferential line. It provides additional circumferential stiffness.

4.4.7 Innerliner

A low air diffusion layer covering the inside of the carcass of a tubeless tire.

4.4.8 Juncture

The interface between two different tire components, or different compounds (materials) within the same components.

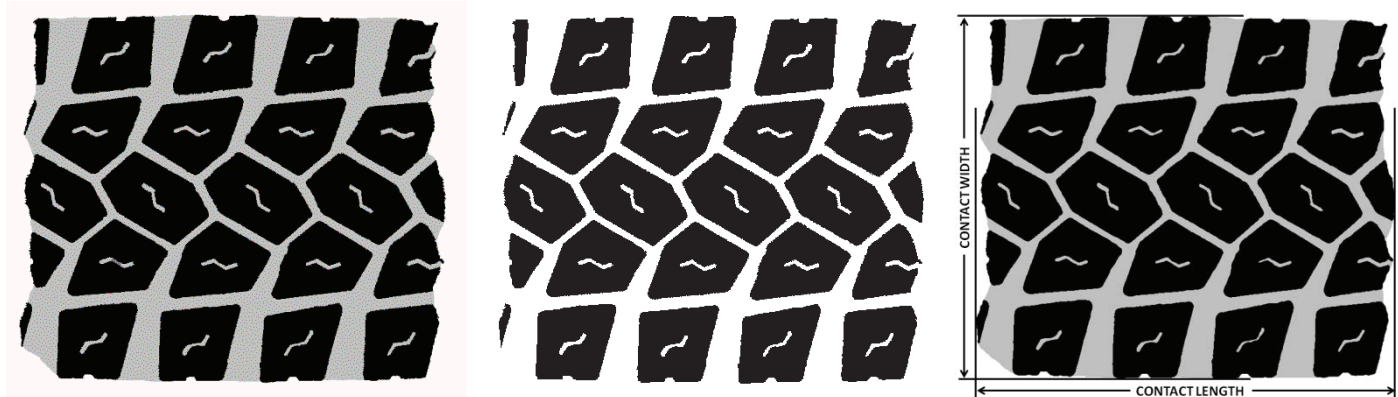
4.4.9 Splice

The joint formed by overlapping or butting the ends of a tire component during tire building.

4.4.10 Footprint (Contact Patch)

The contact area of a tire loaded against a flat or curved surface, Figure 6.

NOTE: A flat surface should be assumed in mathematical analysis of tire forces and moments for simulating vehicle control.



(A) – GROSS CONTACT AREA

(B) – NET CONTACT AREA

(C) – CONTACT LENGTH AND WIDTH

FIGURE 6 – CONTACT AREAS AND DIMENSIONS

4.4.10.1 Gross Contact Area

The area of the footprint in Figure 6A as described by the size and shape of the footprint including grooves and voids in the tread pattern.

NOTE: The grooves and voids are shown in gray in Figures 6A and 6C. Tread compound in contact in Figure 6 is shown in black.

4.4.10.2 Net Contact Area

The area of the footprint, area of tread compound in contact, as described by the size and shape of the footprint excluding grooves and voids in the tread pattern.

4.4.10.3 Contact Width

The distance between the extreme edges of the footprint measured in the plane perpendicular to the wheel plane of the straight free-rolling tire.

4.4.10.4 Contact Length

The distance between the extreme points of the front and back edges of the footprint measured parallel to the wheel plane of the straight free-rolling tire.

4.4.10.5 Footprint Aspect Ratio

The tire footprint contact width divided by the tire footprint contact length times 100.

4.5 Special Tire Outer Surfaces

4.5.1 Tire Face

The intended outboard sidewall of the tire when mounted on a vehicle.

4.6 Tire Inflation Pressure

The gage pressure of the filling gas within a tire under usage conditions.

4.6.1 Cold Tire Inflation Pressure

The gage pressure of the inflating gas within the tire with the tire, rim, and gas in thermal equilibrium at prevailing atmospheric temperature.

NOTE: ISO and TRA accepted pressure equivalencies appear in TABLE 1 in APPENDIX A – TABLES.

4.6.1.1 Maximum Cold Inflation Pressure

The highest permissible cold inflation pressure for a given tire.

5. WHEEL PLANE GEOMETRY AND ROAD SURFACE

5.1 Wheel (Tire-Wheel Assembly)

An assembly consisting of the wheel disc, rim, an inflated tire, nuts, bolts, valve, and balance weights capable of: (a) rotating about an axle, (b) carrying the load supported by the axle, (c) generating tire shear (tractive) forces between the tire tread surface and the road surface, necessary for control of vehicle motion, and (d) transmitting disturbance forces due to road surface irregularities.

NOTE: The term "wheel" used in this section and following sections of this document indicates the "tire-wheel-assembly". The usage of the term "wheel" is completely different from the usage in Section 3 where "wheel" indicates the "wheel rim - disc assembly". The usage of "wheel" instead of "tire-wheel assembly" in performance terms is common. Some examples are: wheel load, wheel torque, locked wheel, spinning wheel, etc. The term "tire" is also commonly used in performance definitions. Examples include: tire noise, tire wear, tire-road friction, tire power loss, etc. In some instances the use of the terms "tire" and "wheel" in performance definitions appears to be interchangeable. The forces and moments generated by the tire are called wheel forces and moments in ISO 8855 and tire forces and moments in SAE J670 (2008). This terminology uses the terms "tire" and "wheel" selectively in accordance with common usage.

5.2 Wheel Plane Geometry

5.2.1 Wheel Plane

Defined in 3.5.1.

5.2.2 Wheel Center

The point at which the wheel-spin axis intersects the wheel plane.

5.2.3 Wheel-Spin Axis

The axis of wheel rotation coincident with the Y_W axis (Section 6.5.4).

5.2.4 Contact Line

The intersection of the wheel plane and the road plane.

5.2.5 Contact Center (Center-of-tire Contact, Tire Coordinate System Origin)

This is the Tire Coordinate System Origin. It is defined by the geometry of the wheel mounted on the spindle, and is the intersection of the contact line and the normal projection of the wheel-spin axis onto the road plane.

5.2.6 Circumferential Line

A circle of intersection of the tread surface of an unloaded tire with any plane parallel to the wheel plane.

5.2.7 Equatorial Line

The circle of intersection of the tread surface of an unloaded tire with the wheel plane.

5.2.8 Loaded Radius (Wheel Center Height), R_L

The distance between wheel center and the center of contact in the wheel plane at a specified operating condition (load, speed, etc.). R_L is reported as an absolute value. (See Figure 7.)

NOTE: In equations it is necessary to assign proper signs to terms containing loaded radius.

NOTE: On a flat road surface, loaded radius is equal to the moment arm of the shear force or its longitudinal or lateral components with respect to the wheel center. However, on a curved road surface, loaded radius is not equal to the moment arm of the shear force or its components. On a curved surface the effective moment arm is ρ as shown in Figure 7.

5.2.8.1 Static Loaded Radius, R_{STAT}

The radius measured by placing a non-rolling tire onto a test surface under the appropriate load using the definition of loaded radius.

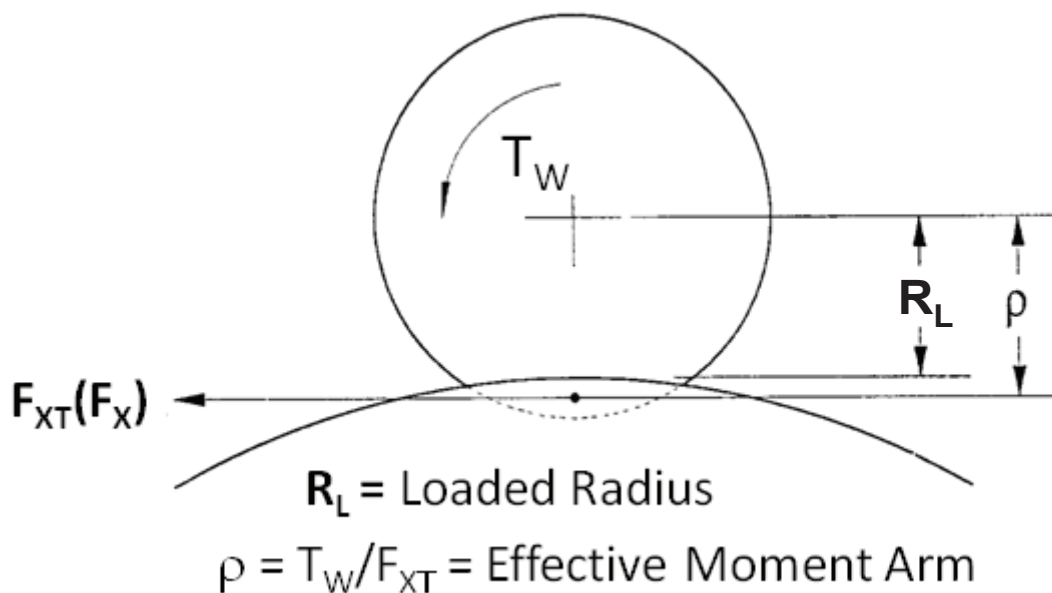


FIGURE 7 - WHEEL CENTER HEIGHT AND EFFECTIVE MOMENT ARM FOR A CURVED ROAD SURFACE

5.2.8.2 Rolling Loaded Radius (Dynamic Loaded Radius), R_{ROL}

The radius measured by placing a rolling tire onto a test surface under the appropriate load using the definition of loaded radius.

5.3 Road Surface

The surface, flat, curved, undulated, or other shape, supporting the wheel (tire) and providing the friction necessary to generate tire shear forces in the road plane.

NOTE: The road surface at any point may have general curvature in the direction of the X_T -axis and the direction of the Y_T -axis of a tire axis system (see 6.2) and be inclined so that the road plane (Section 5.3.1), the plane tangent to the road surface, is inclined in the direction of both the X_T -axis and Y_T -axis. The road plane generally is not horizontal as is implied in the SAE terminology prior to J670 (2008), and it is not identical with the ground plane employed in ISO 8855 terminology. In this terminology, SAE J2047, tire forces and moments are defined with respect to the road plane.

5.3.1 Road Plane

A plane representing the road surface within each tire contact patch. For an uneven road a different road plane may exist at each tire contact patch.

NOTE: For a typical road surface changing with a wavelength greater than several times the dimensions of the tire contact patch, a plane tangent to the road surface at the center of contact is an adequate representation of the road plane. When the individual road planes at each tire contact patch are essentially coplanar, the average plane can be taken to be the road plane. However, in the case of road surfaces with a wavelength similar to or less than the size of the contact patch, an equivalent road plane must be determined. This equivalent plane may not be coincident with the road surface at the tire contact center. This happens in the case of many ride events and the determination depends on the requirements of the analysis being performed. Very small wavelength, small amplitude, road surface undulations such as the pebbles forming the road surface macrotexture may be ignored in detail.

5.3.1.1 Road Plane Pitch Angle, θ_T

The angle from the normal projection of the X_T -axis onto the ground plane to the X_T -axis. The angle is positive for clockwise rotation about the positive branch of the Y_T -axis (See Figures 8A & 8B.)

5.3.1.2 Road Plane Roll Angle, ϕ_T

The angle from the normal projection of the Y_T -axis onto the ground plane to the Y_T -axis. The angle is positive for clockwise rotation about the positive branch of the X_T -axis. (See Figure 8A & 8B.)

5.3.2 Ground Plane

A horizontal plane in the inertial reference, normal to the gravitational vector.

NOTE: A positive Road Plane Pitch Angle, θ_T , in the Z-Up system signifies a road plane tipped downward in the X_T^+ direction, but upward in X_T^+ direction in the Z-Down System. Correspondingly, a positive Road Plane Roll Angle, ϕ_T in the Z-Up system signifies a road plane tipped upward in the Y_T^+ direction, but downward in Y_T^+ direction in the Z-Down System. Positive Road Surface Curvature about the Y-Axis, K_X , in the Z-Up system signifies a road surface that is concave downward along X. Positive K_X in the Z-Down system signifies a road surface that is convex upward along X. Positive Road Surface Curvature about the X-Axis, K_Y , in the Z-Up system signifies a road surface that is concave upward along Y. Positive K_Y in the Z-Down system signifies a road surface that is convex downward along Y.

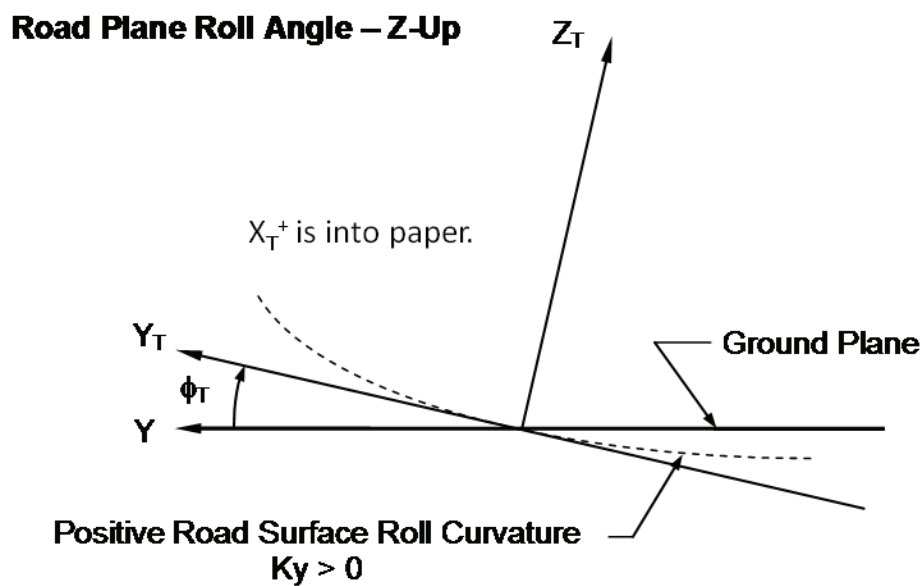
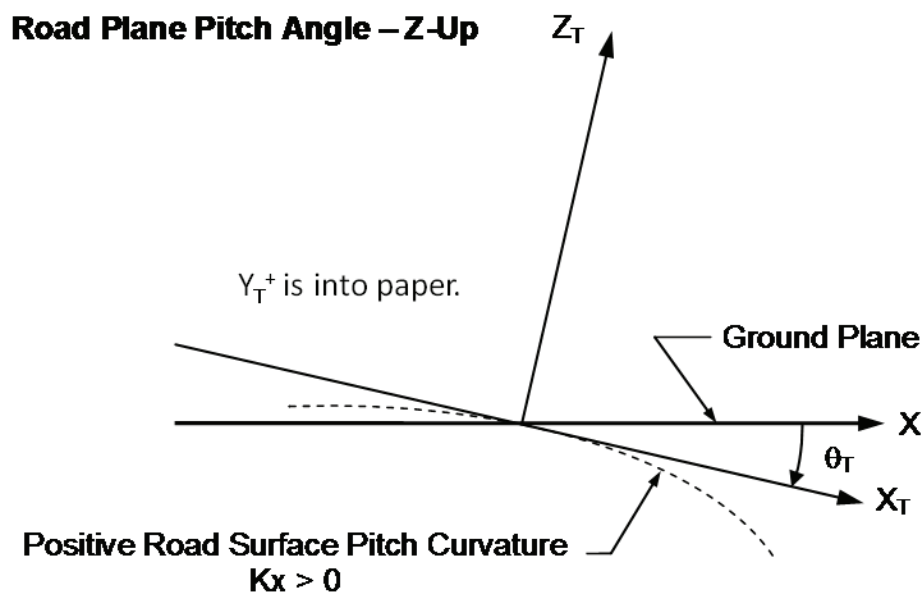


FIGURE 8A – ROAD PLANE ORIENTATION TO GROUND PLANE FOR Z-UP AXIS SYSTEM (POSITIVE ANGLES SHOWN) ROAD SURFACE CURVATURE

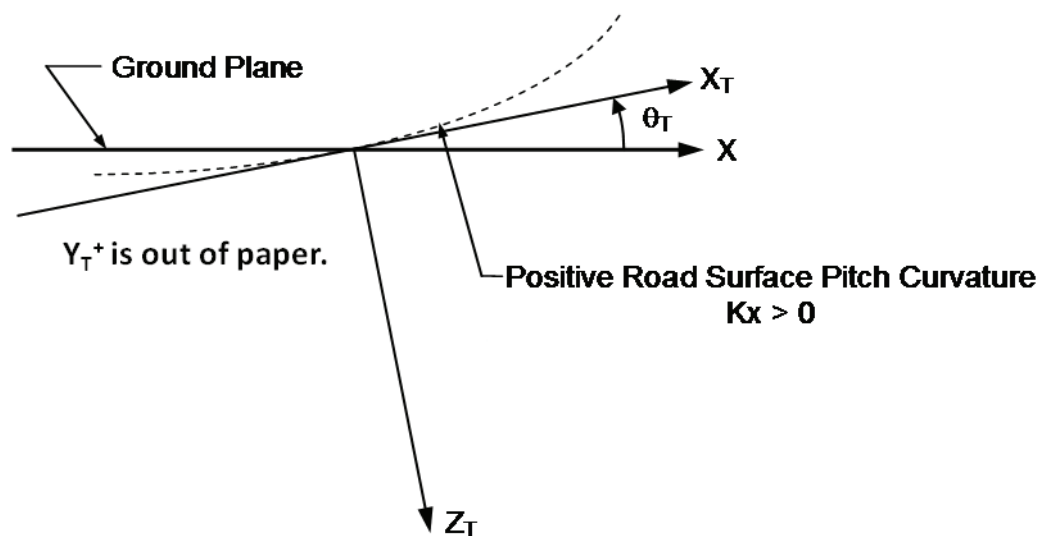
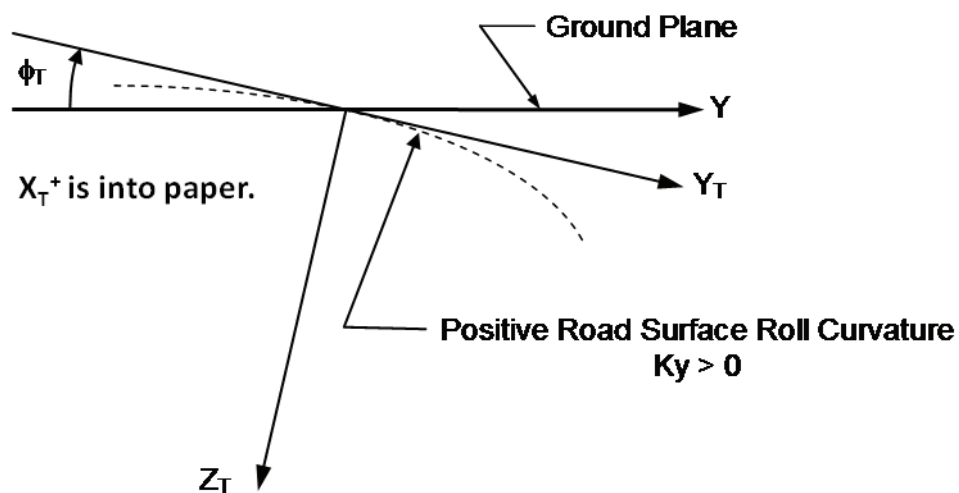
Road Plane Pitch Angle – Z-Down**Road Plane Roll Angle – Z-Down**

FIGURE 8B – ROAD PLANE ORIENTATION TO GROUND PLANE FOR Z-DOWN OR SAE AXIS SYSTEMS (POSITIVE ANGLES SHOWN)

5.3.3 Road Surface Curvature

The curvature of the road surface determined about the X and Y axes in the ground plane.

5.3.3.1 Road Surface Pitch Curvature, K_X

The first derivative of the road plane pitch angle with respect to distance traveled along the X-Axis. (See Equation 1.)

$$K_X = d\theta_T / dX \quad (\text{Eq. 1})$$

5.3.3.2 Road Surface Roll Curvature, K_Y

The first derivative of the road plane roll angle with respect to distance traveled along the Y-Axis. (See Equation 2.)

$$K_Y = d\phi_T / dY \quad (\text{Eq. 2})$$

6. COORDINATE SYSTEMS DESCRIBING TIRE BEHAVIOR

In the context of SAE J670 (2008) this terminology contains coordinate systems not axis systems.

6.1 Reference Frame

A geometric environment in which all points remain fixed with respect to each other at all times.

6.2 Axis Systems

A set of three orthogonal directions associated with the X, Y, and Z axes. Right-handed coordinate systems are assumed throughout this document except where differences are explicitly noted. For right-handed systems

$$\hat{Z} = \hat{X} \times \hat{Y} \quad (\text{Eq. 3})$$

6.2.1 Base Vectors $\hat{X}$, $\hat{Y}$, $\hat{Z}$

The set of three orthogonal unit vectors selected as a base to represent all other vectors within an axis system.

NOTE: The base vector symbology chosen is the same as that used in SAE J670.

6.3 Coordinate System

Systems used to assign a unique ordered trio of values (X, Y, Z) to each point in a reference frame. A coordinate system consists of an axis system plus an origin point.

6.4 Earth-Fixed Coordinate System X_E , Y_E , Z_E

Right-handed orthogonal coordinate system fixed in the inertial reference. The X_E and Y_E axes are parallel to the ground plane. The Z_E axis is aligned with the gravitational axis. The positive Z_E axis points upward in the Z-Up orientation. The positive Z_E axis points downward in the Z-Down orientation. The compass orientation of the X_E axis is arbitrary and should be based on the needs of the analysis or test. The location of the origin is generally an arbitrary point defined by the user.

NOTE: This coordinate system is usually used for describing the trajectories of the vehicle and its component parts. This system can also be used to describe the direction of the wind velocity, which influences vehicle motion.