

AEROSPACE INFORMATION REPORT

AIR5556™

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Reaffirmed 2021-04

Landing Gear Alignment

RATIONALE

AIR5556 has been reaffirmed to comply with the SAE five-year review policy.

1. SCOPE

The purpose of this Aerospace Information Report is to provide the industry with methodologies for measuring tire/wheel gear alignment and the range of acceptable alignment settings for various types of non-military landing gear. This AIR will focus on the general aviation, corporate, and regional aircraft landing gear but could have applicability to commercial aircraft.

2. REFERENCES

The following publications for a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of the other publications shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

2.1 Applicable Documents

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.

AIR1489 Aerospace Landing Gear Terminology

951391 The Aircraft Tire Wear Problem

2.1.2 U.S. Government

Available from the Document Automation and Production Service (DAPS), Building 4/D, 700 Robbins Avenue, Philadelphia, PA 19111-5094, Tel: 215-697-6257, <http://assist.daps.dla.mil/quicksearch/>.

AC 90-89A Amateur Built Aircraft and Ultra-light Flight Testing Aircraft

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3. BACKGROUND

Beginning with fixed landing gear in the early days of aircraft development, the correct alignment of the tire/wheel to the centerline of the aircraft has been critical. Fixed landing gear were the easiest to adjust as third party suppliers developed shims to be placed between the gear and the mounting point. However, the means to measure the gear alignment has been crude, utilizing carpenter's square, duct tape, wooden blocks, etc. This equipment gets the gear close to proper alignment but is not accurate enough to optimize tire wear and reduce gear load. Some of these methods were developed by the home-built aircraft operators that had the desire to install the gear correctly but not the proper tools.

Tire wear due to a misalignment of the landing gear components can be attributed to several factors:

- braking forces causing a toe-out/toe-in condition
- load causing a positive or negative camber angle
- poor rigging of the landing gear during aircraft construction
- axle deflection
- landing gear component wear
- runway crown

These items show the complexity of the landing gear and the difficulty to account for all the static and dynamic forces acting on the landing gear assembly. The drag force caused by braking can generate a toe-out condition that changes as a function of the applied braking pressure. The shimmy damper, if installed, has an additional range of motion that can alter the toe condition. Axle deflection from aircraft loading has been identified in some cases to be a major contributor to camber wear. This can be further impacted in a dynamic mode as the aircraft "bounces" down the runway during takeoff or landing.

This AIR focuses on static conditions compensating for aircraft load and landing gear alignment. If some information of axle deflection as a function of braking is known, this can be applied in the final toe and camber settings. It is impossible to account for all of the items that impact gear alignment but an effort should be made to account for as many as possible.

4. REFERENCE DIAGRAM

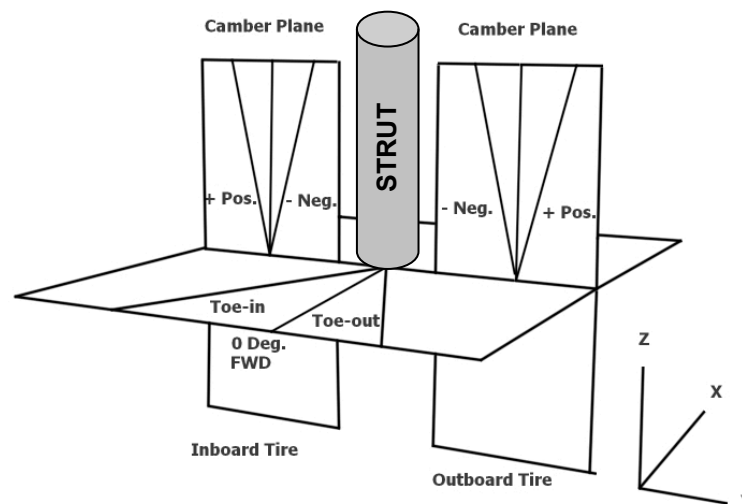


FIGURE 1 - SCHEMATIC DIAGRAM OF TOE AND CAMBER ORIENTATION FOR MULTI-TIRE GEARS

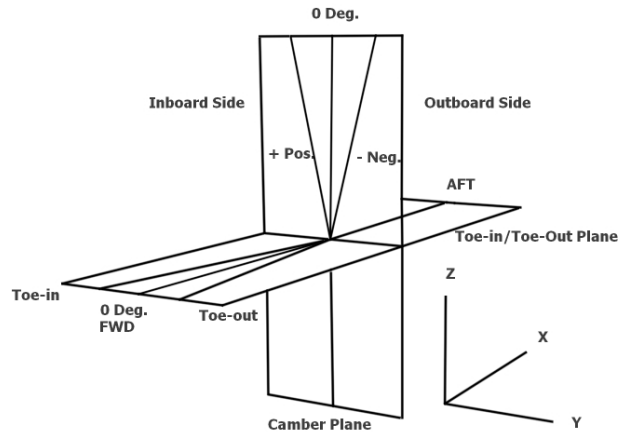


FIGURE 2 - SCHEMATIC DIAGRAM OF TOE AND CAMBER ORIENTATION FOR SINGLE TIRE GEAR

5. ALIGNMENT PROCEDURES

5.1 Field Expedient Method

This is the commonly used method to measure the gear alignment with common tools found in the aircraft maintenance shop.

5.1.1 Measuring Aircraft Toe

This is a quick yet accurate method to measure total tire toe. Total toe includes the sum of each tire's individual toe measurement. The accuracy of the measurements will be based on the set-up and the precision of the tools used to make the measurements. This method gives a total toe measurement since it is not referenced from the aircraft centerline but relative to the two landing gears. In a tricycle gear configuration, this will configure the main landing gear parallel to the direction of travel and not necessarily to the fuselage.

Gear alignment is a problem in basic geometry where the objective is to determine the angle if the tire/wheel assembly is out of plane both vertically and horizontally to either the aircraft centerline or the direction of travel. It is normally desirable to measure from the aircraft centerline but establishing this centerline can be very difficult and is recommended if more precision equipment is available and the relative measurement must be reduced.

Initial Condition (Set-up)

- Select the aircraft center of gravity (CG) configuration that best represents normal aircraft operational weight and load distribution. In the absence of a specified typical operational weight, the average of Maximum Landing Weight (MLW) and Maximum Takeoff Off Weight (MTOW) could be used.
- Verify that the tire is inflated to the correct operational pressure.
- Verify that all moveable gear components are within manufacturing tolerance.
- Ensure the aircraft is on a flat and level surface.
- Verify that the aircraft has been rolled forward along the centerline of the aircraft at least the length of the fuselage to remove any residual forces acting on the landing gear.
- If the aircraft is equipped with a tail wheel, the aircraft should be initially set up in flight configuration (run-on landing configuration) with the tail elevated to achieve a wings level condition at the chord.

Procedure

- a) Determine the Outside Diameter (OD) of the tire along its centerline and record this value. This should be measured parallel to the ground and through the axle centerline.
- b) Mark a "+" on the leading edge of the tire at a height H_1 as close as possible to the tire's equator and along the tire centerline for tire number one. Record H_1 .

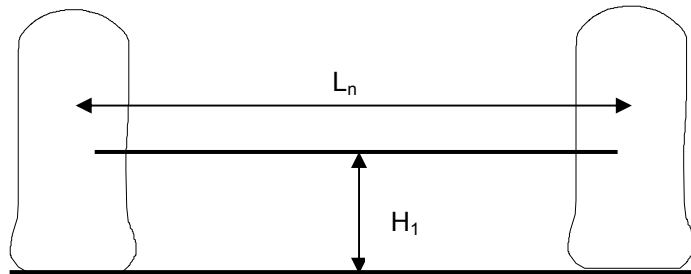


FIGURE 3

- c) Mark another "+" on the leading edge of the tire along the centerline of the second tire on the opposite landing gear at the same height H_1 . Make sure that the reference point is the same.
- d) Measure the linear distance between the two marks as L_1 .
- e) Move the aircraft forward along its centerline to rotate the tires 180 degrees.
- f) Recheck that the height H_1 for the "+" of both tires is the same. Adjust the aircraft location if required.
- g) Measure the distance between the "+" marks rotated 180 degrees as L_2 .
- h) Calculate the Total Toe angle:

$$\theta = \tan^{-1} \frac{(L_2 - L_1)}{OD}$$

NOTE: The inboard wheel flange could be used if a continuous line of sight exists between the front and back of the two wheels. In this case the OD measurement would be replaced by the flange diameter.

5.1.2 Level Method for Measuring Camber

The level method is a quick yet accurate method to measure tire camber. Precision of the measurements will be based on the set-up and the tools used to make the measurements. A digital level, if used, will generate good accuracy for this measurement.

Initial Condition (Set-up)

- Select the aircraft center of gravity (CG) configuration that best represents normal aircraft operational weight and load distribution. In the absence of a specified typical operational weight, the average of Maximum Landing Weight (MLW) and Maximum Takeoff Off Weight (MTOW) could be used.
- Verify that the tire is inflated to operational pressure.
- Ensure the aircraft is on a flat and level surface.
- Verify that the aircraft has been rolled in the forward direction at least the length of the aircraft.
- If the aircraft is equipped with a tail wheel, the aircraft should be initially set up in flight configuration (run-on landing configuration) with the tail elevated to achieve a wings level condition at the chord.
- Confirm that the level has been properly calibrated.