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400 COMMONWEALTH DRIVE, WARRENDALE, PA 15096

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RECOMMENDED PRACTICE FOR MEASUREMENT OF STATIC MECHANICAL STIFFNESS PROPERTIES OF AIRCRAFT TIRES

1. INTRODUCTION

The static mechanical stiffness properties of aircraft tires are fundamental to any computation of wheel and landing gear shimmy characteristics, and are important guides in anti-skid system and aircraft wheel design. While the mechanical stiffness properties of aircraft tires are frequency sensitive, the static or low frequency values are important because they are the ones most easily obtained by laboratory testing and are most commonly found in literature.

The following recommended methods for measurement of such properties are believed to represent practices which will give reliable and repeatable measurements, either at one facility or among different facilities, using equipment which is commonly available in most tire testing installations.

2. MECHANICAL PROPERTY TESTS

2.1 Tire Preparation:

2.1.1 Tire Conditioning: Before break-in of the tire, it will be conditioned by mounting on its design rim and inflating it to the rated inflation pressure. It will be allowed to remain in this condition for 24 hr at an ambient temperature between 60°F and 90°F.

2.1.2 Tire Inflation and Ambient Temperature: After the tire has been soaked for 24 hr on the design rim as indicated in 2.1.1, the tire pressure will be adjusted to the rated pneumatic inflation pressure with a gage which can be calibrated to within one percent. All tests shall be carried out at temperatures between 60°F and 90°F.

2.1.3 Break-in Procedure: The preferred method of tire break-in is to prepare the test tire by inflating it to rated inflation pressure and performing two taxi tests under rated load on a roadwheel or dynamometer. Each taxi test shall be two miles in duration. Between tests the tire shall be allowed to cool to room or ambient temperature before beginning the second test.

2.1.4 Alternate Break-in Procedure: In the event that adequate dynamometer or trailer equipment is not available for break-in of the test tire as indicated in 2.1.3, such break-in may be performed by inflating the tire to rated inflation pressure and carrying out sufficient vertical load deflection cycles on it. These load deflection cycles are performed by loading the tire under direct vertical load against a hard flat unyielding surface until such time as the tire deflection measures 50% of section height. The load is then removed. This load deflection test is to be carried out at four locations equally spaced around the tire, with the centerline of the contact patch being located at 90 deg. intervals around the circumference of the tire.

2.2 Loading Apparatus:

The tire is to be mounted on a suitable yoke and loaded vertically against a flat unyielding surface under camber angles of $0^{\circ} \pm 1/4^{\circ}$, and under caster angles of $0^{\circ} \pm 1/4^{\circ}$ (See Fig. 1). The load weighing system shall be accurate within $\pm 1\%$ of the load applied to the tire.

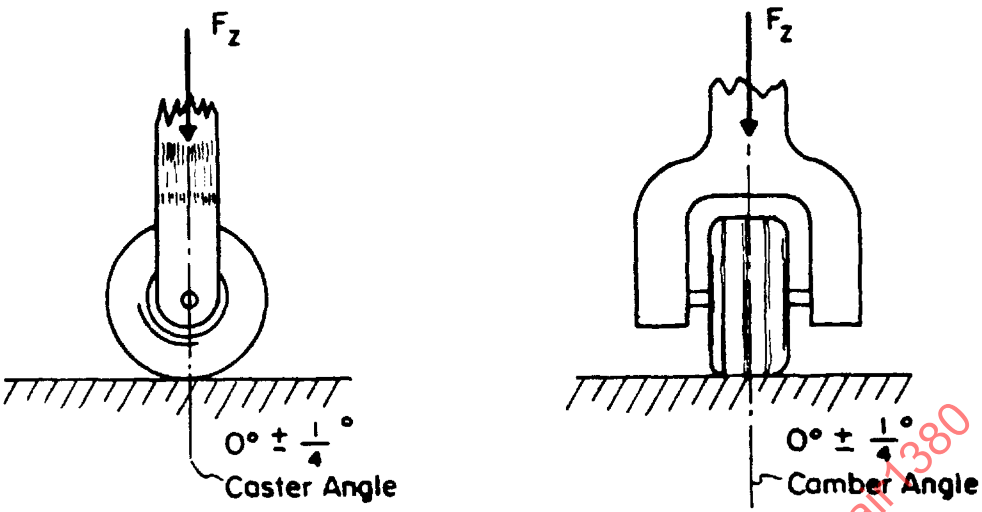

FIGURE 1

2.2.1 The surface of the plate in contact with the tire will be covered with a material designed to prevent tire slippage insofar as practical. Suitable materials are

(a) Serrated metal or expanded screen surfaces
(b) Roughened or dimpled metallic surfaces

The surface of the plate should be renewed after each load application if any rubber particles embedded in the prepared surface change the friction coefficient significantly.

2.3 Vertical Load Deflection Curves: Vertical load deflection curves shall be obtained on the inflated tire by means of applying a vertical load designated F_z in Fig. 1, and measuring the corresponding deflection between the wheel flange and the unyielding flat surface against which the tire acts. The load will be applied beginning from the point of contact of the tire with the flat surface until such time as the tire bottoms, with continuous recording of load and corresponding deflection. Load will then be reduced until its value reaches zero once more, again continuously monitoring load and corresponding deflection. The total load deflection loop or curve shall be presented as indicative of the vertical load deflection characteristics of the tire.

This test shall be carried out at four locations around the tire, each separated by 90 degrees. Four curves shall be performed for each tire tested.

The time rate of the tire deflection shall be not more than 20 inches per minute.

2.3.1 This recommended practice is constructed around the measurement of such load deflection curves at rated inflation pressure. It should be understood that any inflation pressure may be used for this test, and it is left to the specification of the using agencies to define pressures other than rated pressures. Accordingly, such load deflection curves as are described in this section shall clearly state the inflation pressure at which they were obtained.

2.4 Lateral Load Deflection Curves:

2.4.1 Lateral load deflection curves shall be obtained by first loading the inflated tire described in 2.1.4 to the rated deflection under rated load conditions, followed by lateral displacement of the tire yoke or the flat surface against which the tire rests in a direction perpendicular to the wheel plane. The lateral displacement may be obtained either by displacement of the yoke or the flat surface or both.

2.4.2 Load deflection curves will be obtained by increasing the lateral load from zero to a value equal to 30% of the rated vertical load, then by decreasing this lateral force to zero and increasing it in the opposite direction to 30% of the rated vertical load, and finally by decreasing it to zero and arriving back in the central position. This lateral load deflection loop shall be obtained at a deflection rate not more than 20 inches per minute.

2.4.3 During this process of lateral deflection the vertical load of the tire will change somewhat, unless appropriate correction is made. It is the intent of this recommended practice that such correction be carried out during the course of the test so that the vertical load on the tire will remain constant during the lateral load deflection process.

2.4.4 The vertical sinkage of the tire accompanying this vertical load adjustment should be measured and recorded using the same vertical deflection measuring techniques as in 2.3. It should be presented as a plot of vertical sinkage vs. lateral force with the accompanying vertical load and inflation pressure clearly stated.

2.4.4.1 Such lateral load deflection curves will be obtained at four points around the periphery of the tire, separated by 90 deg, such points representing the centerline of the contact patch under loaded conditions. All four curves will be performed as indicative of the tire lateral force deflection characteristics.

2.4.5 The lateral deflection of the tire will be defined as the deflection between the lateral motion of the flat surface and the wheel flange of the tire at a point immediately above the centerline of the contact patch of the tire.

2.5 Measurement of Shift of the Contact Patch Centroid During Lateral Loading: During the course of the lateral deflection process the centroid of vertical forces in the contact patch will shift a distance somewhat different from the mechanical displacement of the flat surface with respect to the wheel flange. It is desirable to obtain a measurement of this distance. This can be done in two ways:

(a) Preferably, the loading plate can be instrumented with multiple load cells so that the position of the centroid of vertical forces may be determined accurately by appropriate recording of the load cell signals, followed by sufficient data processing to solve for the unknown centroid of vertical forces.

(b) Such vertical contact pressure centroids may also be obtained approximately by appropriate photographic recording of a circumferential line scribed around the plane of symmetry of the tire, such a line indicating approximately the location of the contact patch with respect to the wheel plane of symmetry.

2.6 Fore-Aft Load Deflection Curves: Fore-aft motion is obtained by displacement between the tire rim and loading plate, beginning from the position of rated tire inflation and rated load or rated deflection. The displacemement for fore-aft loading is in a direction parallel to the wheel plane. This fore-aft displacement may be obtained either by displacement of the yoke, or of the loading plate or both.

During such loading processes the wheel must be securely blocked to prevent rotation such that no flat spots occur on the force-deflection curve.