World Aircraft Company
South America

Doc.-No. WA500AG – DROPTEST

FREE DROP TEST PROCEDURE FOR AIRCRAFT WA500 - AG

	Name/Function	Date	Signature
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AMENDMENT RECORD

Issue	Amendment Description	Date
01	*Initial Issue*	*20/01/2021*

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1 General Purpose

As a matter to complete all analysis developed in the landing gear assessment report (Ref [1]), a free drop test is performed over the WA500-AG (MXP 1000 Tayrona) in order to demonstrate the true energy absorption characteristics of the landing gear. Even though all compliance reports are referred to a maximum takeoff weight close to 700 kg (agricultural version), for drop test purposes a maximum weight of 600 kg will be assumed in order to be aligned with the American FAA-LSA's rules.

Since ASTM F2245 -the design consensus standard accepted by FAA- do not have specific requirements for testing and evaluating the landing gear's energy absorption characteristics; the rule that is taken as a reference for computations is CS-VLA 727.

2 Requirements

According to CS-VLA 727, which refers to CS-VLA 723(b); the landing gear may not fail but may field in a drop test from a height not less than 1.44 times the one given by the following formula:

$$h = 0.0132 * \left(\frac{M \cdot g}{S}\right)^{\frac{1}{2}}$$

Being:

h = Drop height in [m]

M = Static weight on main gear unit with nose wheel clear. With the aim of being conservative, M is assumed as the maximum takeoff weight = 600 kg.

S = Wing Surface = 12.61 m^2

g = Acceleration due to gravity = 9.81 m/s^2

Replacing the actual values for the aircraft:

$$h = 1.44 * 0.0132 * \left(\frac{600 \cdot 9.81}{12.61}\right)^{\frac{1}{2}} = 0.41\ m$$

In regard with the test weight, CS-VLA 727(b) permits that wing lift assumes a portion of the total weight and the aircraft be dropped with an effective mass given by:

$$M_e = M * \left(\frac{h}{h+d}\right)$$

With the new variable “d” refereeing to the total deflection of the landing system (Tire deflection + axle travel). In order to be conservative, only the portion of the shock absorber deflection will be considered and this value have been estimated in the Loads Report (Ref [2]), section 12.2, as 0.21 m.

Replacing the actual values for the aircraft:

$$M_e = 600 * \left(\frac{0.41}{0.41+0.21}\right) = 397\ kg\ \approx 400\ kg$$

2.1 General Procedure Description

In general terms, the testing involves dropping the fuselage section with the complete landing gear attached. The condition to be simulated is the Level Landing Condition, which was found to be the most critical.

A summary of the considerations during the test is presented:

- The accelerations are obtained by use of a recording accelerometer (G-meter) positioned inside cabin.

- Tire pressure is the same as that recommended by the manufacturer for use in service.

- A hosting sling with a quick-release mechanism is attached to hard points of the fuselage near the center of gravity. By means of this hoist the front end of the structure is raised until the tires are clear of the floor by the desired amount.

- The steel plates placed under the tires, is greased to prevent the tires from rolling off the rims.

-The quick-release system used allows the structure to drop freely.

- The specified height is measured from the bottom of the tire to the ground, with the landing gear extended to its extreme unloaded position.

- After the test, all structure is deeply inspected for any damage, crack or evident permanent deformation and the lectures for acceleration and deflection are registered.

3 Actual Testing

3.1 Date and Location of Test

The shock absorption test has been conducted in WACSA S.A.S facilities located in Jamundi – Colombia, on January 20th, 2021. Due to the current local mobility restrictions as a result of COVID-19; the presence of a Civil Aviation Authority delegate was not possible.

3.2 Test Setup and Equipment

3.2.1 Aircraft Weight

The aircraft configuration is weighed by leveling the complete fuselage and measuring the weight in 1 leg, and then multiply it by two obtaining a total aircraft structure weight of 94 kg. This value is discounted from the total sandbags weight.

Figure 1. Aircraft structure weighing procedure

Figure 2. Total structure weight = 47kg x 2 = 94kg

3.2.2 Sandbag Weight

Since the total aircraft weight to be dropped must be 400 kg, and the structure itself weighs 94 kg, the deadweight should be 306 kg. This load is simulated by using sandbags; for these purposes 15 sandbags of 20 kg are employed plus 1 sandbag of 6kg:

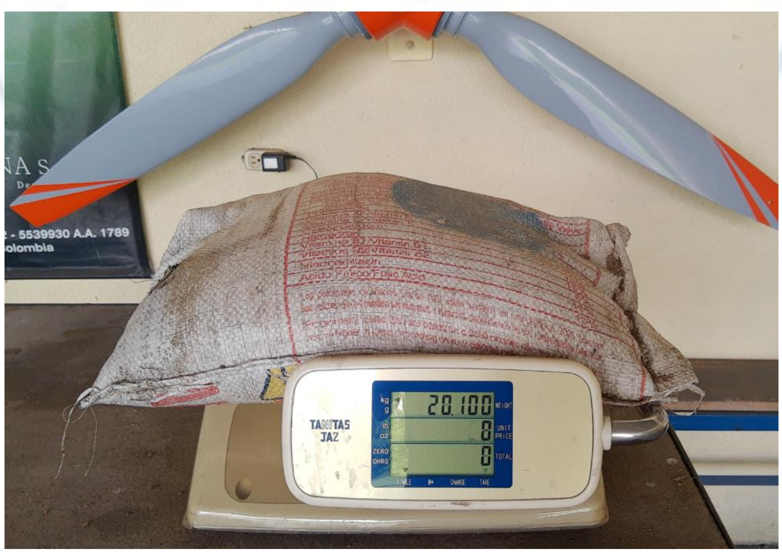

Figure 3. Sample of a 20kg sandbag used as deadweight.

3.2.3 Test Setup

The structure is positioned in such a way that when touches the ground, it does it in a level position (with nose wheel just above the floor), thus, all shock load should be absorbed only by the main landing gear and transmitted directly to its joints and the fuselage. It is considered this condition the most severe one because al dynamic load its divided only by two (the main landing legs).

Figure 4. Aircraft position when touching the ground (level)

A structure around the tail section is constructed in order to restrain any pitching movement the aircraft could tends when dropped. This is a flexible system that serves as a pivot point around which the aircraft will rotate and helps it to touch the ground in a level position, and, at the same time is made of rigid bungees that gives the tail some degree of flexibility allowing it to move with the purpose of inflicting the least damage possible to the structure.

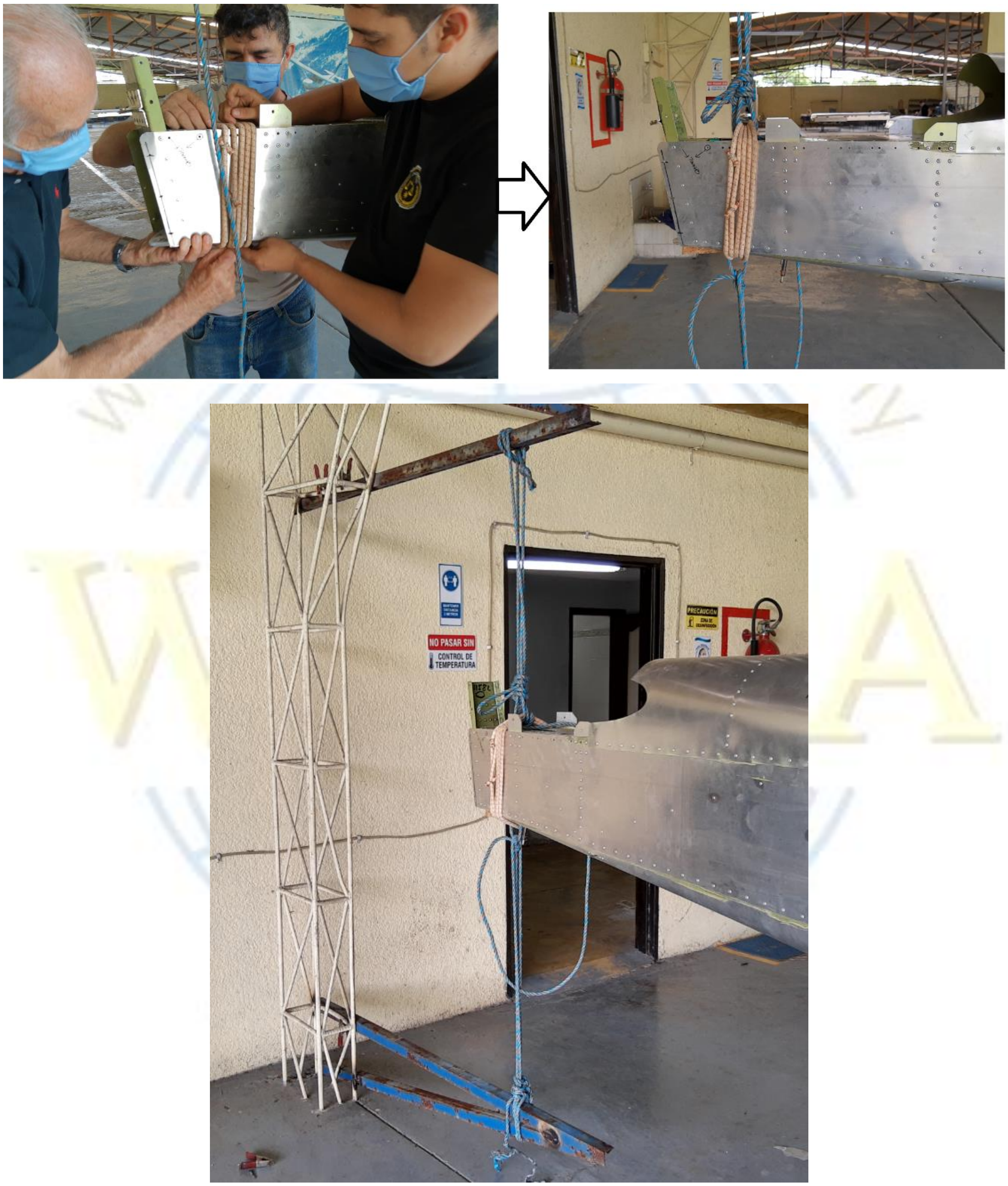

Figure 5. Bungees restraint system

Two plates of galvanized steel with a layer of grease between them are positioned under the wheels; these lubricated plates allow the tires to move freely laterally without resistance and thus, all kinetic energy is absorbed directly by the legs deflections reducing to a minimum the energy transformed into heat due to friction.

Figure 6. Lubricated plates under the wheels

For vertical deflection measures, a simple system consisting of an aluminum stick inserted into a bucket of sand is employed. The functioning of this arrangement is straightforward: the sand permits the stick to keep vertical and mark a zero reference; when the aircraft is dropped, its bottom plunges the stick into the sand and then another mark can be made. After the test is finished, the stick is taken out the bucket and the distance measured between the two marks will correspond to the total vertical deflection of the landing gear.

Figure 7. Stick and its zero reference mark employed to measure vertical deflections

A g-meter is positioned close the load in order to register the accelerations the structure is subjected during the test:

Figure 8. G-meter used to register accelerations

The structure is loaded with 15 sandbags of 20 kg plus 1 sandbag of 6kg:

Figure 9. Process of weighing and loading the aircraft

Figure 10. Process of weighing and loading the aircraft

Figure 11. Totally loaded structure

Finally, all the structure is raised to the required height:

Figure 12. Process of lifting the aircraft

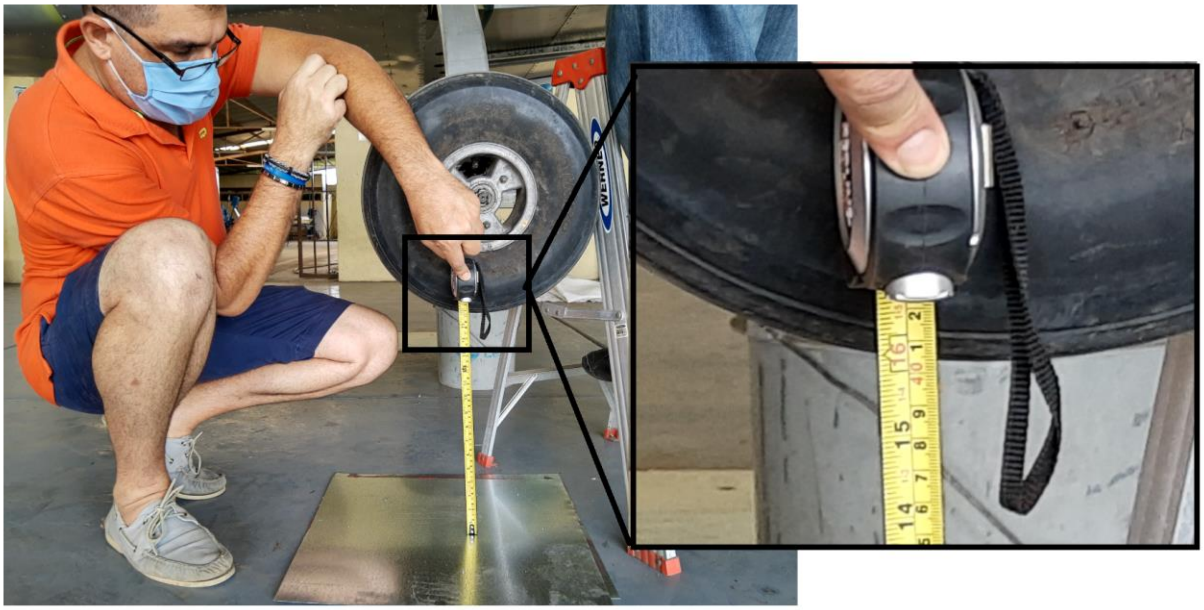

Figure 13. Aircraft raised at required height of 0.41m (41cm)

Figure 14. Aircraft raised at required height of 0.41m (41cm)

3.3 Dropping and Results

Figure 15. Sequence shot of the drop test. From highest height to the position of maximum deflection (Side view)

Figure 16. Final position after the drop (Side View)

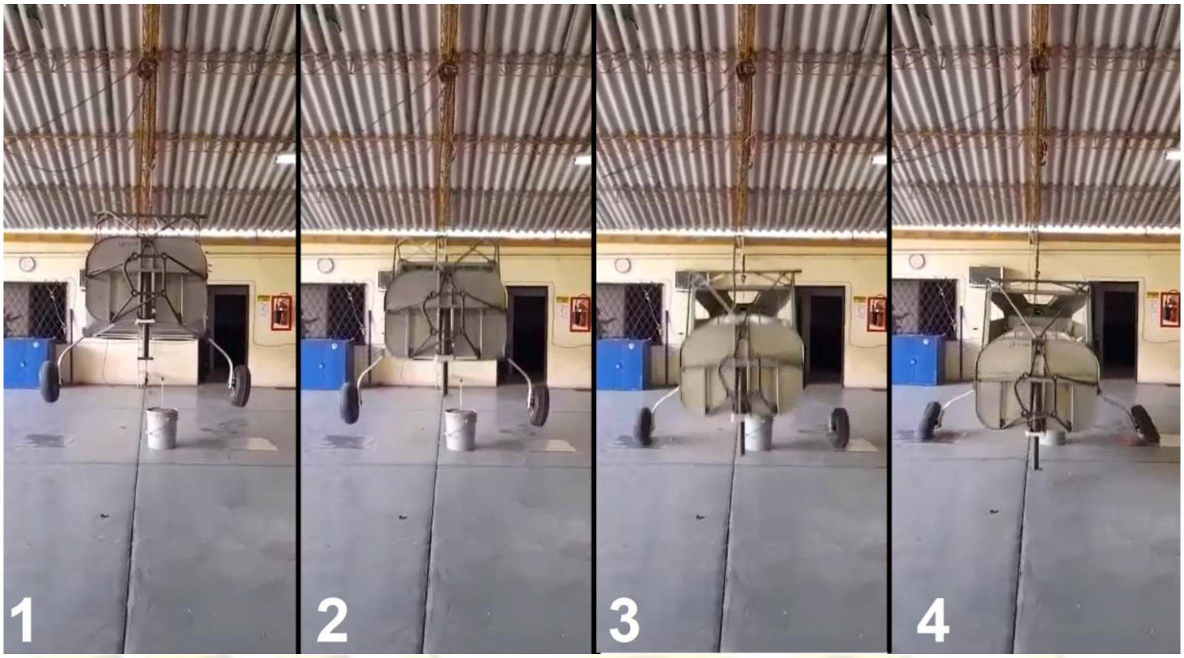

Figure 17. Sequence shot of the drop test. From highest height to the position of maximum deflection (Frontal view)

Figure 18. Final position after the drop (Frontal View)

The maximum vertical deflection observed was 26,5cm (0.265m):

Figure 19. Maximum vertical deflection measured (0.265m)

And the maximum acceleration registered during the drop test was a little over 3g's:

Figure 20. Maximum vertical deflection measured

After the test, the aircraft was unloaded, the lubricated plates removed and the structure inspected, the aircraft returned almost to its initial condition, just a little lateral deformation was observed in the legs, but since all the test was carried out over a brand new structure, our experience as manufacturer indicate us that during the initial landing cycles of any new aircraft, a "settling" deformation would be expected. This deformation corresponds to that settling. Besides, this landing conditions corresponds to the worst case in which all shock impact is supported only by the main landing gear, in real life this force would be distributed also with the nose wheel.

Figure 21. Overlapping image showing the settling deformation of the brand new landing gear system (before and after the test)

Regarding the landing gear joints to the fuselage as well as the internal fuselage structure, no permanent dislocation nor fractures were detected. All structure remained intact:

Figure 22. Both left and right internal side as well as all surrounding structure remained intact after the test

Figure 23. Underneath inspections showed no signal of failure.

A summary of the technical aspects and results of the test is presented:

Parameter	***Value***	***Units***
Effective Weight dropped	*400*	*[kg]*
Tire Inflation Pressure	*35*	*[psi]*
Maximum Landing Gear System Stroke (shock absorber + tire)	*0.265*	*[m]*
Maximum acceleration (Load Factor)	*3.1*	*G's*

4 Conclusions

Shock absorption test (drop test) was carried out for the main landing gear system of aircraft WA500-AG (MXP 1000 Tayrona) simulating the worst possible scenario and using the load and height required for an aircraft with maximum weight of 600 kg, as limited by FAA's LSA category. Satisfactory results were obtained. First, the general structure demonstrated to support landing loads during critical conditions presenting no fractures, permanent deformations nor any anomalies that could affect its capacity to perform its duties safely. Indeed, the test was performed over a structure that conforms a current in-production aircraft that will be used in aerial spraying labors in Colombia- South America.

Likewise, the maximum load factor registered during the test was around 3.1 g's, this results is consistent with data obtained in the Landing Gear Assessment Report, Section 3.2 (Ref [1]), where a theoretical maximum load factor of 3.15 g's was estimated; confirming in this way the compliance of the shock absorption requirements.

5 References

[1] World Aircraft Company South America, Doc.-No WA500-AG-LDG - Landing Gear System Assessment for Aircraft WA500-AG, Cali: 2016, Unpublished.

[2] World Aircraft Company South America, Loads Determination For Aircraft WA500-AG, 2016, Un-Published.

[3] European Aviation Safety Agency (EASA), Rotax 912 Series Engine Type Certificate EASA.E.121, KG, BRP-Powertrain GmbH & Co., 26/Feb/2010.