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THE ELA ROTOR

1. DESCRIPTION

The ELA rotor is a “semi-rigid” design. It is composed by two rotor blades of 8H12 airfoil and a hub bar that is connected to the rotor-head (teeter towers).

The rotor blades are composed by a “EN AW-6005A” aluminum extruded spar, from the root to the tip, polystyrene foam and carbon fiber skin. This kind of complex construction allows getting a very stable rotor blade thanks to its precise chord-wise balance and its high stiffness.

The hub bar is manufactured from mechanized 7075 T6 aluminum alloy. This part connects both rotor blades giving them a fixed aerodynamic pitch and a pre-coned angle.

At the top of the hub bar, there is a mechanized aluminum block that holds the alignment of the rotor blades and connects to the rotor head (teeter towers) by two axial/radial bearings.
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2.- ASSEMBLY PROCEDURE

Introduction:

This rotor assembly manual provides the necessary instructions to assemble the rotor in your gyroplane. Rotors are quite long so it’s necessary to send them disassembled. All rotors have been flown and tested at the factory before package, it is vital to assembly them correctly in your gyroplane. Don’t do this job if you are not absolutely sure you are going to do it correctly, it is a critical part of the gyroplane. ELA Aviación will not be responsible if the operator does not perform this procedure correctly.

Instructions:

The rotor comprises of three basic parts: Its two rotor blades and the blade-supporting hub bar. Put the blades on stands or tables.

Insert the hub bar in one of the rotor blades. The red marks must be aligned. IMPORTANT. Insert the main bolt completely in.
Aided by another person, hold the other blade to insert it in the other end of the hub bar. Keep the angle between the two blades as shown in the photograph. Insert the bolt completely in before releasing the blade end.
Tighten the Allen grub screw (only those that are not sealed with red paint) to 12 N/m. Then, tighten the M-8 nut that blocks the grub screw to 20 N/m. Mark the bolts with paint.
Tighten to 100-120 N/m the main bolt and bend the safety extension of the washer where it coincides. **IMPORTANT.**

Mount the rotor in the correct position on the gyroplane, in such a way that the hub bar´s red marks are in the same side. Tighten the 12mm central bolt strong **by hand!** Then tighten the M-5 bolt to 8 N/m and put safety pin.
3.- Rotor Settings

It is important to keep the stick and cabin vibrations within acceptable limits. High rotor vibrations make the flight uncomfortable and shorten the life of the gyroplane.

The ELA rotor design allows making adjustments to reduce those vibrations. In case of unacceptable vibrations, please follow these instructions in the correct order:

1) Teeter bolt tightening: Verify that the teetering bolt has the correct tightening torque (see the “Assembly Procedure”).

2) Rotor controls friction: Verify the rotor controls have some amount of friction in roll acting in the green plastic bracket of the torsion control rod. If any doubt, see latest update of the ELA maintenance manual.

3) Propeller vibration: Propeller vibration usually occurs when the blades have a different pitch or they are damaged by impact of stones, for example.

4) Rotor mass balance:

   4.1) Option 1: It is possible to lay some tape in one of the tips of the rotor blades to make one blade heavier and make a trial flight to analyze the result. Once you have arrived to the best choice, you can weigh the tape, remove the Allen bolt of the tip of the rotor blade and introduce the same weight with a small screw or lead shot.

   4.2) Option 2: Park the gyroplane inside the hangar to avoid wind current. Loosen the teeter bolt to avoid friction between the teeter towers and the hub bar. Place a transparent rubber hose filled with water from tip to tip of the rotor blades to verify that the water level corresponds with the height of the blades tips.
5) Rotor tracking: It is possible to slightly modify the pitch of the rotor blades by adding shims between the hub bar and the block. There are several ways to determine if the rotor is tracked. Both rotor blades should fly at the same height. The procedure we recommend is not the only one but it is the easiest for people without special equipment.

This procedure can be performed only with no turbulent wind. Park the gyroplane in a clear area without obstacles in radius of 10 meters. Prepare a cartoon flag with a 3.5 meters stick. Paint with crayon a little of the leading edge of both rotor blades with different colors. The person on board of the gyroplane connects the pre-rotator and brings the rotor between 180 and 200 rpm. Another person should approach to the gyroplane from the front and carefully touch with the flag the rotor blades tips. After that it is possible to analyze if the blades have the same level.
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If the blades don’t fly at the same height, it is necessary to place some shims between the hub bar and the block.

Thickness: We have at the factory three different shims: 0,05mm, 0,1mm and 0,2mm of thickness. Usually 1 cm of different height in the rotor blades is equivalent to place one 0,1mm shim.
6) Alignment: It is possible to offset the hub bar against the teeter towers to arrive to a smoother option.

Inside the block, there is a threaded axle. This threaded axle can be rotated to move the hub bar transversely. After a trial flight to analyze the level of vibrations, slightly loosen the two grub screws of the block that holds the threaded axle fixed in its position. Then, remove the rubber seal, insert a 6mm diameter rod in one of the drills of the threaded axle and turn it half the way or all the way from stop to stop for a new flight test. Remember to tighten again the grub screws before going to fly.

If blade Nº: 1 is pointing in flight direction and you rotate the threaded axle as shown if the photo above, the blades and hub bar with move to the right side of the gyroplane.
4) ROTOR SETTINGS WITH VIBRATION ANALYZER MACHINE

The best way to analyze, measure and improve the rotor vibrations is using an analyzer vibration machine. The vibration machine shows in a plot the level of vibrations and the phase.

Vibration machine used in ELA.

4.1) The tracking adjustment after analyzing the results moves in the following directions:

When increasing pitch in blade Nº1 (decreasing in blade Nº2), the vibration dot moves this way:

When increasing pitch in blade Nº2 (decreasing in blade Nº1), the vibration dot moves this way:

4.2) The dot in the plot moves this way when the hub bar is moved to the right:

When the hub bar is moved to the left, the dot is moved in this direction: