TECH CORNER

BY NEAL PFEIFFER

Wing Structural Check
for Sailplanes, Old & New

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The inspection sheet used for gliders in Germany includes an interesting item, the oscillation frequency for wing bending. For inspection sheets in the original German, it is identified as "Flügelbiege – Schwingungszahl", and in sheets written in English, it is called the "Wing warping rate of oscillation." In either case, the value is defined by some number of oscillations per minute.

These newly built LK-10 wings will soon be completed and their natural bendingfrequency determined. Photos by Armstrong & Thomas Evelo

So what is the importance of this number?

A typical wing is constructed of one or more spars with ribs and skins that provide the aerodynamic shape. This structure acts like a beam. When a vertical load is applied near the tip of a wing and then released, the wing will continue to vibrate up and down for some time. These up and down oscillations will occur at a timing that is called the natural bending frequency of the wing. This is a primary bending characteristic of the wing.

The bending frequency is due to the physical dimensions of the structural members of the wing and the characteristics of the material from which the wing is constructed. For a newly constructed wing, its frequency is recorded on the original inspection sheet. This reflects a baseline value of the new structure that can be used for comparison at any time in the future.

For normal usage, and with proper protection from the elements, the value should not change by any significant amount over the years.

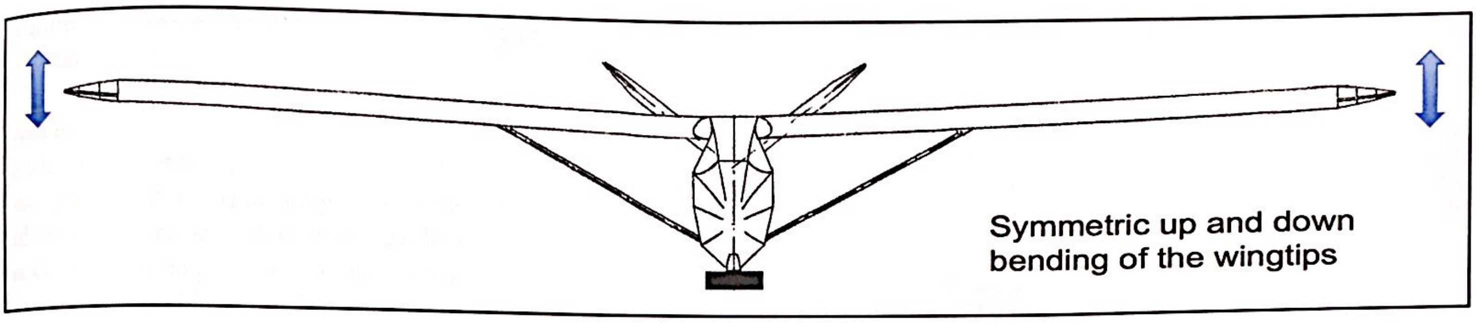
The wing bending frequency should be measured regularly, at least at each annual inspection. If the frequency changes by any noticeable amount, it is a warning to investigate the integrity of the wing structure.

The frequency can change by either a change to the stiffness of the structure, delamination or gross glue failure, or by a failure in some part of the structural material. This could occur if the aircraft experienced a very hard landing or a ground loop with the wing digging in. It could also occur if the glider experienced an overload during an aerobatic maneuver or the aircraft executed a significant event above maximum rough air airspeed. One should carefully read the flight manual and consider the airspeed margin that is available before undertaking a maneuver that applies a significant load factor.

Note that this frequency is measured for all German gliders, regardless of material. But for vintage, wood gliders, this can be a very important tool to keep track of structural health.

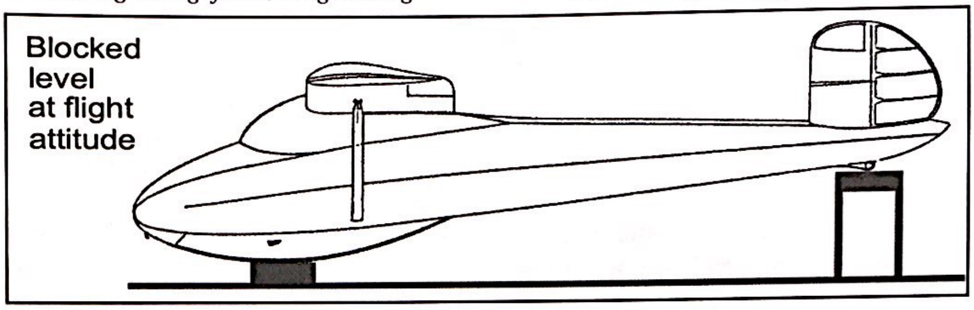
The measurement should be done annually and also immediately following any time that there is concern that a landing may have been too hard or any other significant event occurred that could stress the airframe.

In order to measure the frequency, a structural vibration is induced by applying rhythmic movement up and down on a wingtip in time with the natural vibrational frequency of the wing, so that the entire wing (left and right)



Above: Wing Testing of Ka3, Wing Bending

Below: Wing Testing of Ka3, Blocking Up



attains a symmetrical up and down bending motion. The natural frequency is best found with an initial vigorous push to the wingtip, after which a slight tapping with fingertips at the proper rhythmic time is sufficient to build up and maintain a useable amount of up and down motion.

A group of three people is needed to measure the frequency. One excites the wing and keeps it oscillating. Another counts a predetermined number of cycles and the third person keeps track of the times with a stopwatch. The number of cycles can be selected so that a period of 15 to 20 seconds is measured. The counting and timing is started once the oscillation is stabilized. This should be repeated for a total of at least three measurements. The frequency per minute is calculated by dividing the number of oscillations by the fraction of a minute of time. The average of the three measurements should be recorded in the inspection record.

The manufacturer may specify blocking the glider so that it is off its tire and leveled at a flight attitude. Do not let worries over getting the glider fully supported keep you from making the measurement, since the basics are similar if the measurement is done on the glider's wheel and tailskid. There may be some difference with the axis of the rotation slightly shifted; that could be remedied with a box under the tail skid. If the tire is fully aired up, the spring in the tire should be secondary to the wing oscillation. Just note how the measurement was made so that it can be compared to future measurements.

Also, vibrate the wing without timing it and just look along the entire span of the wing. Check for any unusual bumps or behavior and any sounds of loose joints or foreign material rattling inside. If anything seems unusual, investigate.

The following lists have been collected for various vintage glider types. The measurements are in cycles per minute.

About the Author: *Neal Pfeiffer is an aeronautical engineer with over 34 years working in industry. Most of his work has been with general aviation airplanes. He is retired from Beech Aircraft and managed the Advanced Design group there for several years. He was a Principal Engineering Fellow for Aerodynamics and Advanced Design at Beech. He then consulted for four years following retirement before joining the new Mooney International Corp as the Chief Technical Officer. In his spare time, he repairs and restores vintage wood gliders. He owns three airworthy gliders, a Ka-6BR, a Ka-6E, and a Ka-2b, which he tries to fly regularly. Last fall, in a partnership, he bought the Phönix glider serial number 6 of 8, one of the first fiberglass gliders. Most of the Phönix gliders are in museums, but they plan to keep this glider maintained and flying regularly well into the future.*

From Werkstattpraxis (by Hans Jacobs):

	Cycles Per Minute
Kranich II	180
Weihe	240
Olympia	230
Rhönsperber	210
Grunau Baby IIb	310
ES-49	270

From specific inspection sheets:

		Cycles Per Minute
Ka-6BR	S/N 337	192
Ka-6BR	S/N 461	186
Ka-6CR	S/N 6534	184
Ka-6E	S/N 4135	187
Ka-2	S/N 38	208
Ka-2B	S/N Balgo-2	220
K-7	S/N 536	210
ASK-14	S/N 14004	190

From aircraft handbooks:

	Cycles Per Minute
Mg23	180
Kestrel	124-130
DG 600 (15 meter)	148
DG 600 (17 meter)	128
ASH 26E	126