The BG-12A – A Sailplane of Simple Design

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History

In 1953 the need for a low cost simple-to-construct single place sailplane became evident. The basic parameters were developed, and construction started in the spring of 1954. This project was a part time one by necessity, so it was not until March of 1956 that the first flight tests were made. To save time, an old tubular BG-7 fuselage and empennage were modified for the first flight tests. From March through July, over 50 hours of air testing were completed. The sailplane was then flown at the 1956 National Soaring Contest by a young pilot of 17 years who won first place in the Youth division and 9th place in a field of 46 entries. The success of the design encouraged Mr. John Wolfe of Newport Beach, California, to request and receive the production rights. Production on the first twelve sailplane wings began in September of that year.

Design criteria

From the onset, the designer desired and planned a sailplane which could be constructed by a novice. It was the next step above model aircraft building. With a limited manufacturing concept, it was designed to use minimum tooling and semi-skilled labor, yet there had to be a good quality control to insure interchangeability and fast production. The performance parameters had to be reasonable yet a high L/D was desirable. Fair speed range, reasonable sinking speed, and slow flight characteristics were also desired. To allow for simplicity of construction some performance would have to be sacrified. Minimum sink could not be obtained yet a low landing speed was necessary. For this reason a simple flap was decided upon. The size of the craft was limited to a 50′ span, both for construction reasons and cost. When the standard class was inaugurated, 4.75″ were cut off each tip to comply with the 15 metre span limit.

Because this sailplane was to be homebuilt it was felt that a nonlaminar airfoil should be used. Also with flaps, it was desirable to have a low pitching moment. The airfoils selected were NACA 4415 R and 4406 R. These appeared to have the desired characteristics. The airfoil showed a low center of pressure movement and fair L/D. Its low Reynolds number characteristics were good and with a mild stall curve. We had used the 4400 series airfoils on previous gliders with success and the "R" series were only modified from the 50% chord point to the trailing edge. A slight upsweep is noticeable. When a mockup center section was placed on the fuselage skeleton, it was seen that simply fairing the curve of the upper airfoil camber into the flat top surface effected a very simple solution of good fuselage to wing intersection commensurate with prevailing flat top design. This led to a modified fuselage structure which is basically triangular rather than elliptical. A split flap was originally planned, but upon construction of the prototype we found it required too many man hours of labor and was rather complicated. Lloyd Licher, a well known model and glider enthusiast suggested a simple full flap which was attached to the rear spar and actuated by two push-pull tubes.

Originally the plans called for a removable "V" tail, but as the design progressed, too many problems presented themselves to be efficiently overcome. Due to the eccentric loading of the attaching parts, the loads in the wood spars and fuselage attaching bulkheads were too high for an efficient structure. Hence the standard tail configuration.

From a safety standpoint, a semi-monocoque fuselage with fibre-glass nose was in order. The instrument panel was placed well ahead of the pilot. To reduce pilot fatigue a slightly reclining seat was designed with adjustable leg supports. These may be moved in flight to ease the pilots discomfort. Adequate space and weight allowance was provided for water, oxygen, tiedown kit, radio, and other equipment. The prevailing CAA airworthiness requirements were used for determining structural loads. These, however, were later increased to allow for the effects of a cleaner fuselage and empennage configuration. The flap was designed to hold the glider to a terminal velocity of 160 mph.

Description

The sailplane is constructed of wood with $^1/_8$″ plywood covering the wing and fuselage. $^3/_{32}$″ plywood is used on the flaps and fixed tail surfaces. $^1/_{16}$″ plywood covers all controls.

Wing

The wing (fig. 1) was constructed in three parts to facilitate handling and building. A laminated main spar tapers outboard from the center line of the ship to the outer fittings and takes the main bending and longitudinal shear loads. Ribs are on 10″ centers and of three pieces, i.e., leading edge rib, main rib, and trailing edge rib. A small leading edge spar eliminates the need for steam forming a "D" tube. When building the wing, the plywood covering is first attached to the leading edge spar and glued and stapled rearwards along the ribs and main spar to the rear spar. All the plywood forming may be done without benefit of soaking or steaming. A contoured light weight leading edge strip is provided for the nose of the airfoil. Simple plate and strap fittings are used at the wing junction on both leading edge and rear spar. The main spar fittings are heat-

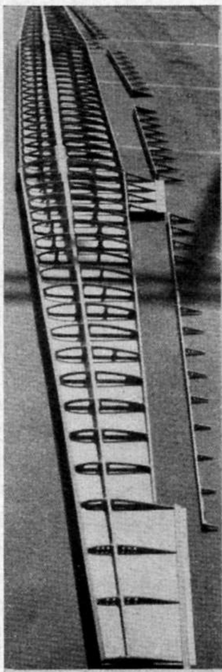


FIG. 1

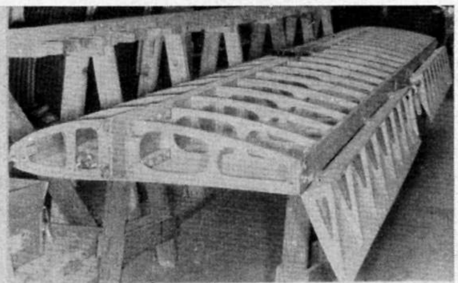


FIG. 2

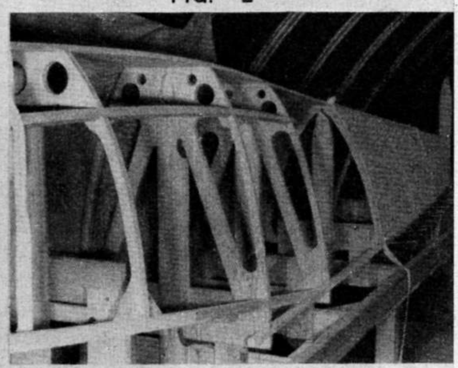


FIG. 3

treated steel bars using tapered pins while "pip" pins (quick disconnect type) are used on aileron and flap systems as well as fuselage to center section and front and rear outer panel leading and rear attach points.

The outer panels are constructed in much the same way as the center section.

The flaps (fig. 2) are attached to the rear spar and connected with a chrome-molybdenum torque tube. A single X-rayed casting controls their operation and is attached directly to the chrome-moly torque tube

The ribs for the wing and control surfaces are all routed from 1/4" Douglas fir plywood, and are glued and stapled to their respective spars.

The ailerons are of the simple type with no aerodynamic or static balance. They are attached to the rear spar with milled piano type hinges.

Fuselage

The fuselage structure consists of cutout 3/4" Douglas fir plywood bulkheads (fig. 3 and 4). There are three longerons aft of the wing and five in the cockpit area. The bottom longeron is of 1/2" Douglas fir plywood and is in the form of a keel. Thi skid is shock mounted to the keel and held in place with rubberized nylon cloth which closes the skid and shock mount area. A standard tow hook is provided and attaches to the first bulkhead and keel. A 10" wheel attached to the keel completes the landing gear. Shoulder harness is attached to the main bulkhead immediately under the main spar, while the seat belt is attached directly to the keel plywood through reinforcing plywood plates. The seat is of 3/8" Douglas fir plywood as is the back. Both are piano hinge attached to each other and the main bulkhead forward of the wing. Two bolts hold the back in place. Quick removal of these permit access to a storage compartment under the wing and to all controls under the seat. A blown plexiglass canopy covers the cockpit from nose cone to wing.

Control system

The control system is of the push-pull type except in the rudder and flap systems which use 1/8" aircraft cable. Aluminum alloy tubing is used wherever possible with steel rod end bearings rivited at the ends. Low cost X-rayed castings of aluminum alloy are used throughout the control system. Wherever possible, ball or roller bearings are used to reduce friction.

Empennage

The empennage (fig. 5) is constructed along the same general lines as the wing and aileron, i.e., routed ribs connecting a built-up main spar and leading edge spar (in the stabilizers) and trailing edge in the elevator and rudder. A simple aluminum alloy horn is used in the elevator while a bent steel plate horn completes the rudder.

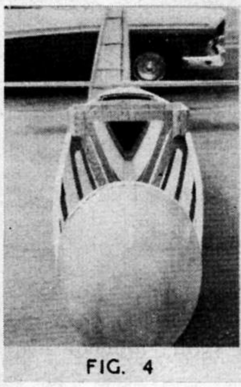


FIG. 4

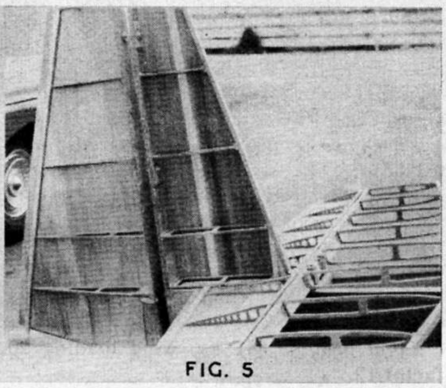


FIG. 5

One of the secrets of low production hours is the use of a staple gun and low pressure glues. The first gliders were constructed with vinyl adhesives which are only water resistant, but offer the advantages of no mixing, fast setting, and excellent end grain bond. New adhesives are being tried, namely the epoxy resins which may be set up quickly under a heat lamp. Only low pressure is required with most of the epoxys, and phenomenal bonding strengths are obtained.

The wing was originally covered with "Silkspan", a strong light model paper and given four light coats of dope. This protection was good for about one year. It was then decided to fibre glass the wing. Two thousandths (0.002") thick glass cloth was used and applied with a sun cure polyester resin. This was brushed through the cloth and smoothed with a "squee gee" or hard rubber strip. To obtain a non-wrinkle glass surface, during this operation, nailing strips with staples were used at the trailing edge and root end of the wing. By working away from these fastenings a very smooth and quick application of glass and resin was obtained. After the resin was cured, two coats of cold cure resin were applied and the entire wing sprayed with primer surfacer and two coats of enamel. This type finish has been in service for over a year and appears in excellent condition.

Test flights

The XBG-12 A was first flown in March of 1956. Its characteristics were explored by many pilots. The flaps were extremely satisfactory, mainly for glide path control. Low landing speed and visibility were definitely enhanced. The comparison performance tests indicated minimum sinking speed of 2.1 ft/s at 45 mph and L/D of 31.8 at 48 mph. The performance dropped off rapidly with increase in airspeed and this was attributed to the high parasitic drag of the old fuselage, external flap control rods and tail struts. Flight tests showed it would be desirable to up the rough air range of the sailplane, so for production, the design ultimate load factor was increased to 12 g positive and 7.6 g negative, the gross weight to 750 lb. (340 kg).

The wing incidence was decreased on the new fuselage and a new experimental stress analysis run on the wing using higher loading to compensate for the heavier fuselage and added equipment. We were able to hold an ultimate load factor of 8 g but had to increase the skin thickness adjacent to the wing-fuselage attach fittings. In September of 1957 the new fuselage and empennage was flown and comparison tests indicated a slightly higher sinking speed due to increase in gross weight. There was a noticeable increase in high speed performance. The center section was now contoured and fibre glassed. The right tip was contoured while the left tip was left in its original configuration. A tip skid in the form of a small end plate was added and the aircraft flown in comparison tests with other calibrated sailplanes. At speeds of 42 to 50 mph, the contoured tip (right) swung ahead of the original left tip. From 50 to 60 mph there was no apparent difference but at high speeds the contoured tip again would sweep ahead of the original tip. Unfortunately at this writing no absolute differential data is available.

The few comparison tests run to date with the new fuselage and contoured wing show a mean sink speed of 2.5 ft/s at 47 to 51 mph and mean max. L/D of 34 at 52 to 54 mph. Flaps reduce the stall speed to approximately 38 mph. The landing approach is conventional except the nose is well down and visibility is excellent. With flaps set at 45° the sinking speed is greater than a competitive design with top and bottom spoiler configuration. Angle of descent with

full flap is in the order of 45° at 80 mph with gross weight of 725 lb. (330 kg).

Nearly 300 flight hours have been accomplished at this writing with over 70 different pilots at the controls. Some felt that the elevator controls were too sensitive at high speeds, and rudder and aileron sluggish at low speeds. The ailerons were given increased differential which helped the rate of roll but did not noticeable decrease the adverse yaw. More rudder movement was incorporated and is now quite satisfactory.

The stabilizer-elevator design was slightly changed, increasing the area and reducing the aspect ratio. More elevator control pressure is expected.

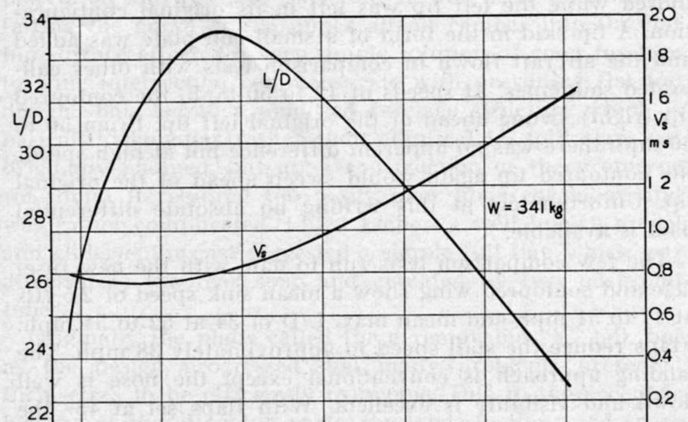
Spins were investigated on the original configuration with and without flaps and found to be quite normal except it was difficult to hold the spin for more than a turn and a half.

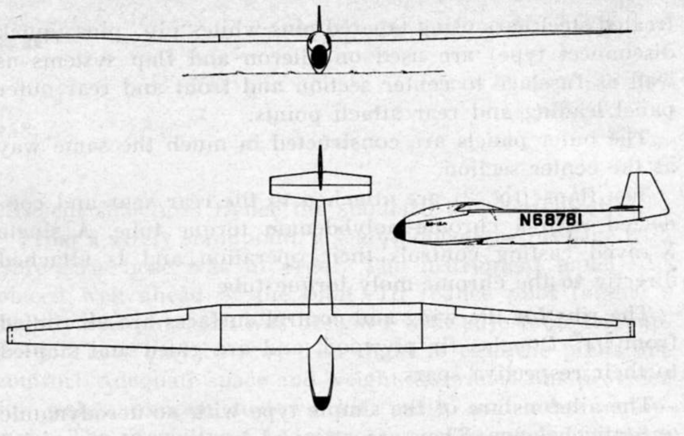
The sailplane has been flown at calibrated speeds up to 135 mph in smooth air with no unusual characteristics being encountered. Tows of 100 mph have also been investigated. Unfortunately, due to the XBG-12 A's low maximum maneuvering and rough air limitation, there is no data on high speed rough air tows or maneuvers. This will have to await testing of the production sailplane.

Production

The present gliders are being produced in kit form and production of parts is being simplified still further. In the United States we are permitted to furnish kits for the home builders under CAR part 1.7, Experimental Aircraft.

Although type certification has been applied for, it will be some time before the necessary details and flight tests have been completed, to place the BG-12 A in the "type certificated" standard class.





Complete detailed plans are furnished with each kit and all welding and machine work is finished. Every part is furnished to build a complete glider from staples and staple gun to instruments. A brief resume of typical home builders construction hours are as follow:

Wing

(Includes center section, outer panels, control system, flaps and ailerons complete except for top skin installation) 183 hours.

Fuselage

(Including bulkheads, longerons and skins on sides and bottom) 24 hours.

Horizontal tail

(Except for top skin) 3 hours.

Vertical tail

(Includes installation on fuselage except for one skin) 5 hours.

Conclusion

In conclusion I wish to thank Messrs. John K. Lake, Lloyd Licher, Paul Bikle and John C. Wolfe for their encouragement and aid in the development and flight testing of the XBG-12 A. Our investigations of the sailplane indicate it is of a high performance category, can be constructed at low cost, and assembled by anyone with model aircraft construction experience. In the United States this places high performance within reach of every neophyte. We feel that the plain flaps on this glider have supplanted the spoiler dive brake design and are simpler to construct, maintain, and are of lower cost. Since simplicity and low cost were the key parameters of the "standard class", we feel the "flap rule" should be amended so that this American design, along with others utilizing plain flaps for dive brakes in place of the spoiler type, may join in "standard class" competitions.

Summary of Dimensions and Weights

Wings: Span 15 m, area 12.8 m², aspect ratio 17.9, wing root chord 1.14 m, wing tip chord 0.31 m. Root/tip airfoils NACA 4415/06R, dihedral angle 1°, aerodynamic twist root/tip —4°.

Ailerons: Span 4.26 m, area 2×0.65, max. deflection up 30°, max. deflection down 10°.

Flaps: Plain trailing edge type, span 4.27 m, area 1.25 m², mean chord ratio 0.263 constant, max. deflection down 70°.

Fuselage: Length 5.87 m, max. width 0.61 m, max. cross section 0.473 m².

Horizontal tail: Span 2.41 m, area of elevator and fixed tail 1.57 m², area of elevator 0.57 m².

Vertical tail: Area of fin and rudder 0.84 m², area of rudder 0.65 m².

Weight: Empty including instruments, excluding radio and oxygen 224.8 kg.

Total weight: 341 kg, wing loading 26.3 kg/m², ultimate load factor 12.

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