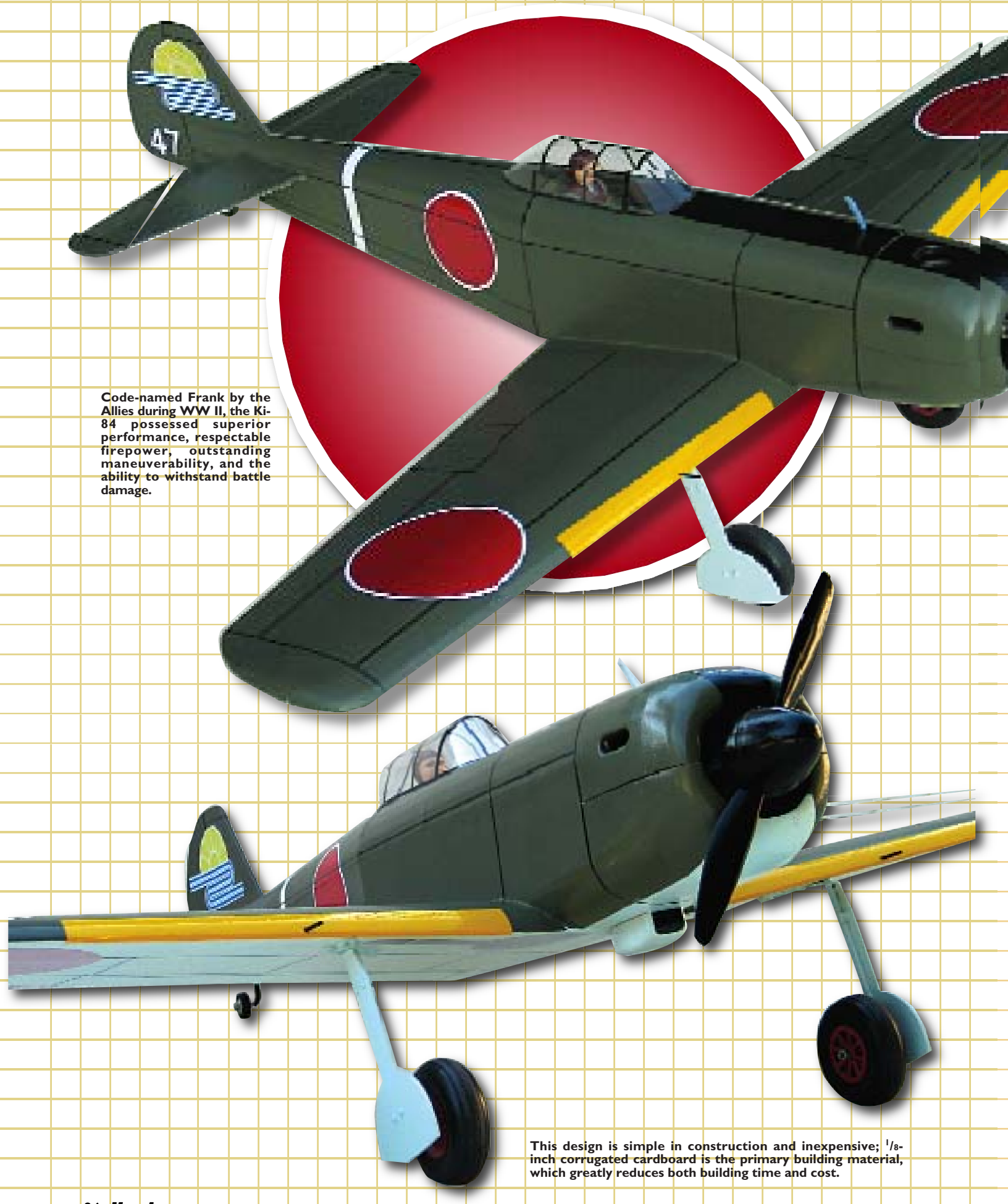


Code-named Frank by the Allies during WW II, the Ki-84 possessed superior performance, respectable firepower, outstanding maneuverability, and the ability to withstand battle damage.

This design is simple in construction and inexpensive; 1/8-inch corrugated cardboard is the primary building material, which greatly reduces both building time and cost.

Nakajima Ki-84 Hayate

by Chuck Felton

Frank gets a turn at circle burning

THE NAKAJIMA Ki-84 Hayate was undoubtedly the best fighter to be in service for the Japanese in any numbers. When introduced operationally in China in 1944, the Allied forces in World War II faced an adversary that was far superior to anything that Japan had previously fielded.

Code-named "Frank" by the Allies, the Hi-84 possessed superior performance, respectable firepower, outstanding maneuverability, and the ability to withstand battle damage to a degree that was previously unheard of in Japanese fighters. Although it didn't quite match the performance of the P-47, P-38, or P-51, it was close.

Frank was superior to the F6F Hellcat, which comprised the bulk of Allied fighters in the theatre. Its greatest failing was that it suffered at high altitude and proved to be hopeless at intercepting the Boeing Superfortress, which started bombing Japan in 1944.

The Hayate was a brilliant design, but because it was introduced so late in the war, it could rarely be employed in the offensive role for which it was designed. A total of more than 3,500 Ki-84s were produced, the majority by Nakajima.

The model I am presenting is simple in construction and inexpensive. The primary building material is 1/8-inch corrugated cardboard, which greatly reduces both fabrication time and cost. This design makes use of cardboard's unique features. The material can be used in large sections and folded.

The wing is built from two large pieces, with cardboard ribs and a single spar. The tail surfaces and fuselage are primarily cardboard, with little internal bracing required. The result is a quick-to-build aircraft that has a scalelike appearance and can take plenty of punishment at the flying field.

Cardboard varies in weight, but any 1/8-inch corrugated type will do well for this project. Sources of the material include box manufacturers and shopping centers where you can find stacks of discarded boxes.

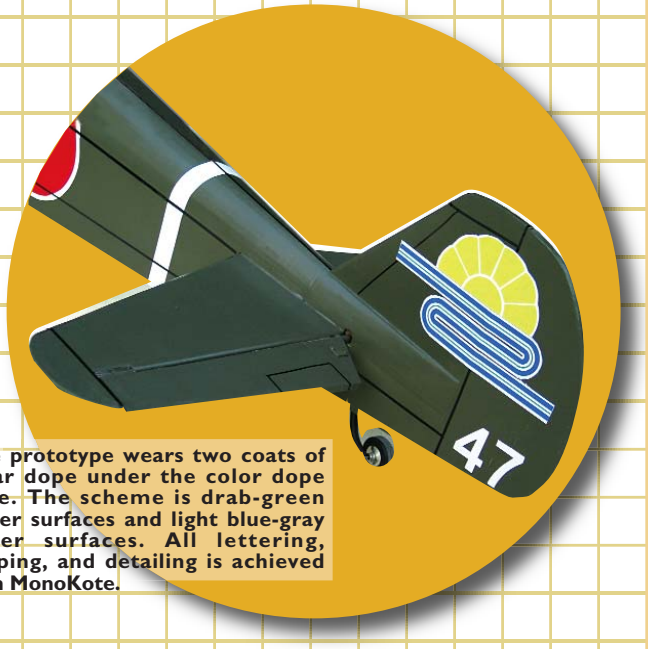
Look for cardboard with brown paper on one side and a white finished Kraft paper on the other. Having the white paper on the outside of the model results in a smoother finish and neater appearance.

I'll describe in the construction hints my method of folding the cardboard and using gummed paper tape to seal the joints and exposed corrugations.

The Hi-84 has a wingspan of 60 inches and a length of 54 inches. The bottom of the airfoil is flat with a curved upper surface, because of the scoring-and-folding technique I employed.

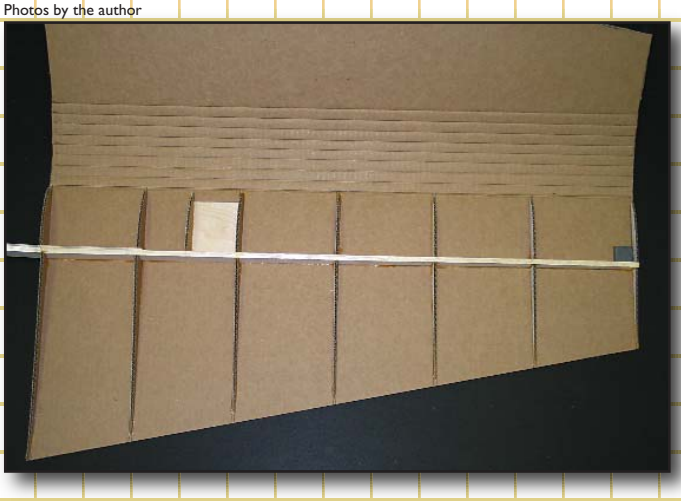
You can use a .40- to .50-size engine in this airplane. Mine is powered by a .40 and has a flying weight of 78 ounces. That figure combined with the 605-square-inch wing area results in a wing loading of 18.7 ounces per square foot.

The Hayate's size and stability make it a good sport-flying model.

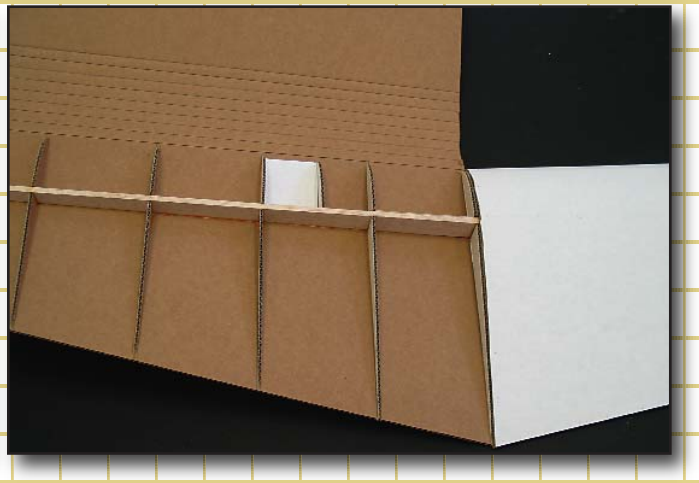


The prototype wears two coats of clear dope under the color dope base. The scheme is drab-green upper surfaces and light blue-gray lower surfaces. All lettering, striping, and detailing is achieved with MonoKote.

Photos by the author

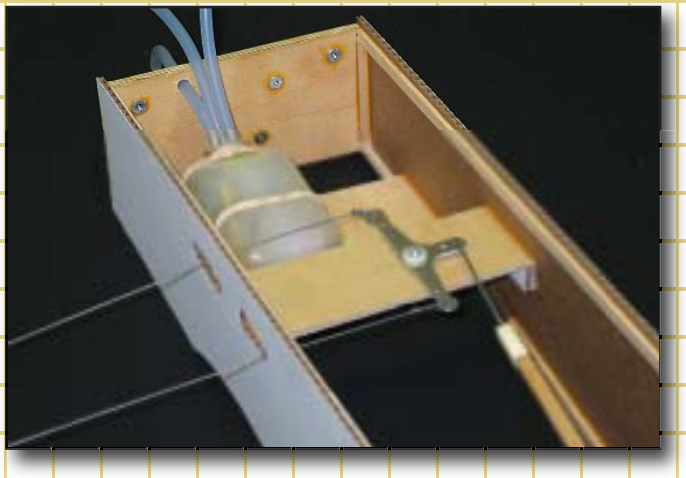


The right wing panel includes a single balsa spar, cardboard ribs, and LE folds to obtain a curved upper surface. The plywood spar joiner and plywood gear-mount insert are crucial.

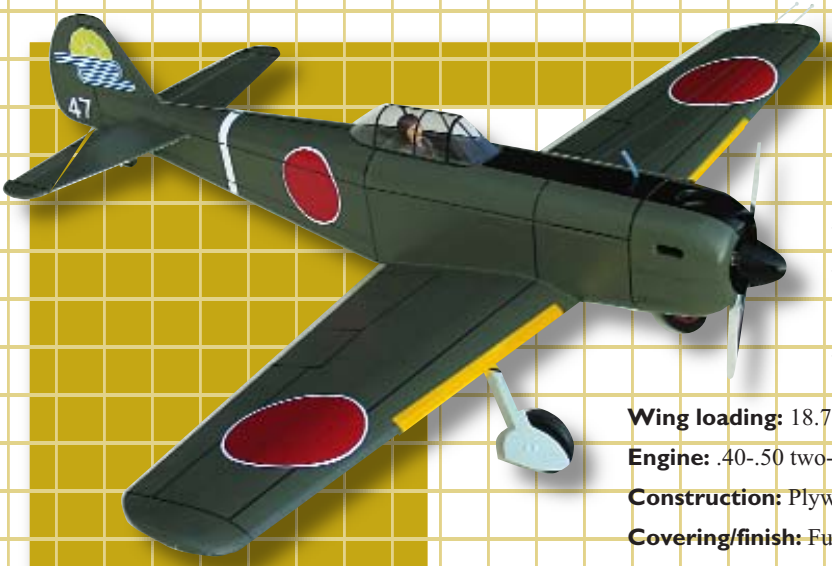


The right-wing-panel upper surface has been folded down and glued to the spar, ribs, and TE. Then the left wing is built in a similar fashion.

Flat fuselage sides are lined with balsa strips and have cardboard supports for bellcrank and fuel tank mounting.



The plywood firewall has blind nuts for the Hayes KM-40 Motor Mount and for the cowl mounting bolts. The pushrod is simply 1/4 square spruce stock.



Type: CL Sport Scale

Skill level: Intermediate

Wingspan: 60 inches

Wing area: 605 square inches

Length: 54 inches

Weight: 78 ounces

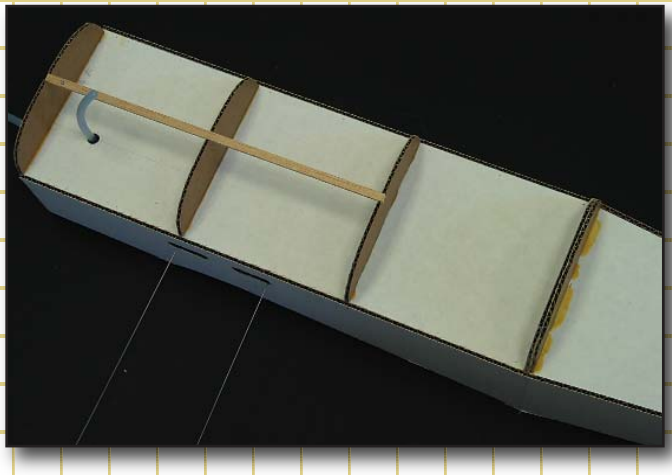
Wing loading: 18.7 ounces/square foot

Engine: .40-.50 two-stroke glow

Construction: Plywood, balsa, corrugated cardboard

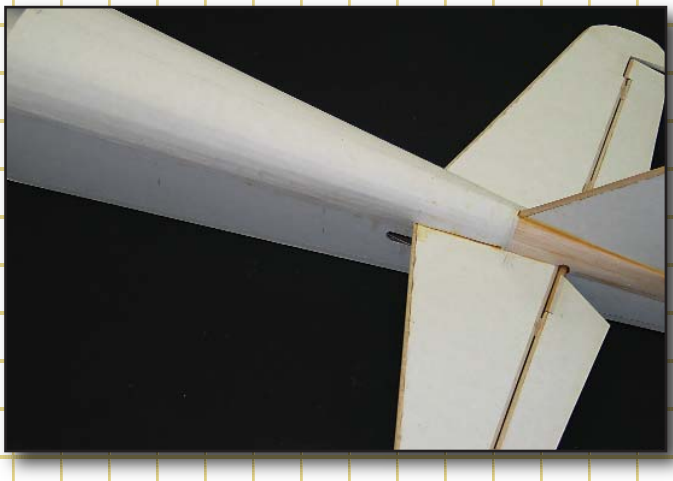
Covering/finish: Fuelproof paint (as shown) or heat-shrink film

Other: 6-ounce fuel tank, 3-inch spinner, 3 1/2-inch wheels, 1-inch tail wheel, engine mount, 3-inch bellcrank

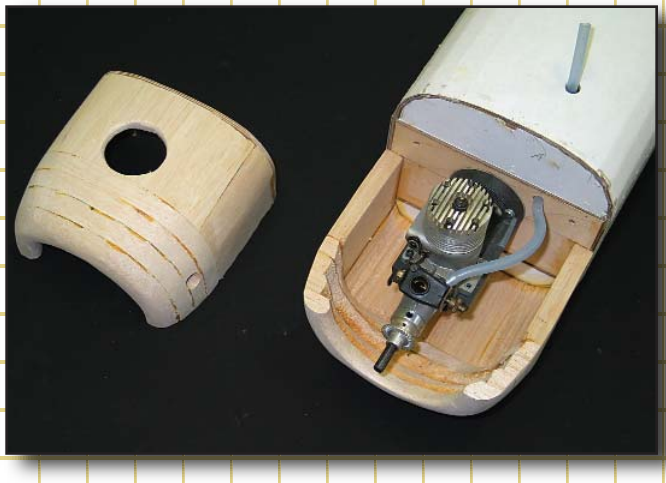


This closed fuselage top box section shows the cardboard formers held with a single centerline balsa stringer. Cardboard can be sanded slightly to improve the shape of the formers.

Scored and folded top decking pieces are glued over the cardboard formers. Gummed paper tape is used to cover and seal all seams.



The empennage LEs are capped with 1/8 x 1/4 balsa strips and rounded off. Elevators are joined with 1/4-inch-diameter dowel and attached with nylon hinges. Balsa fairings complete the aft fuselage section.



The carved-balsa cowl has two bolts that attach to the blind nuts in the rear of the plywood firewall that also serve as cowl attach points.

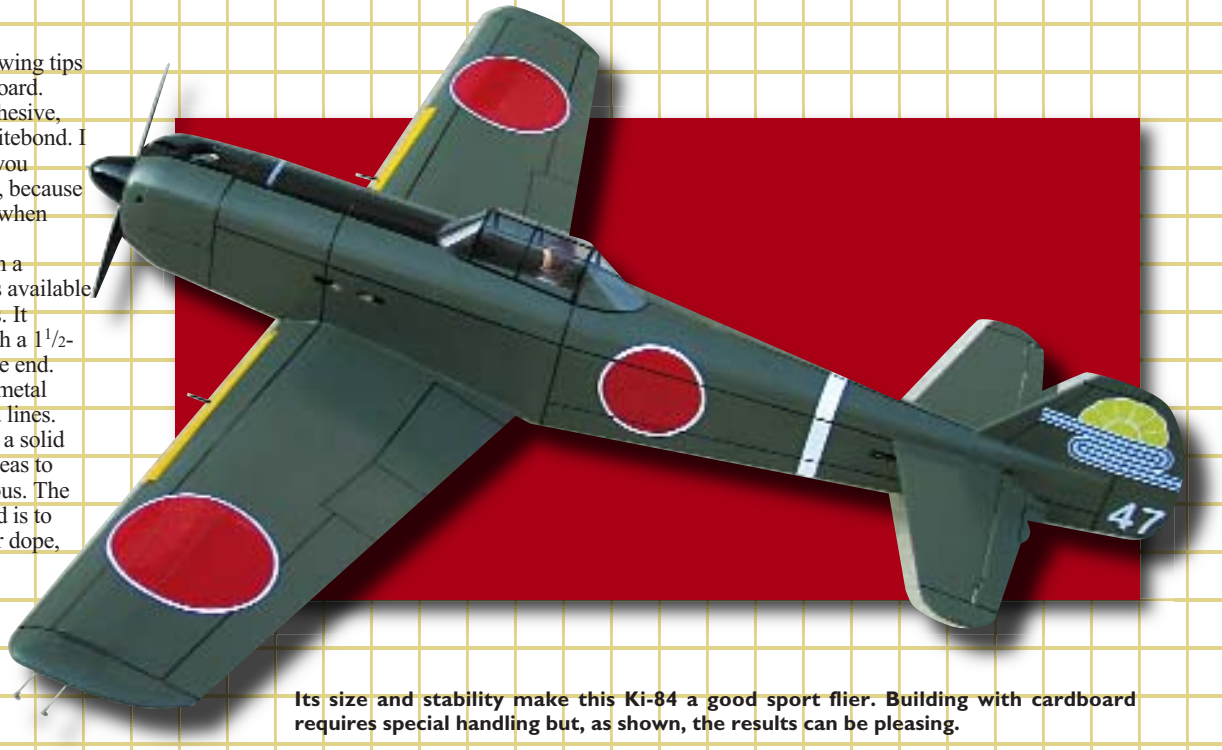
Take a look at the following tips for working with cardboard.

Use water-based adhesive, such as white glue or Titebond. I don't recommend that you employ contact cement, because parts cannot be shifted when gluing surfaces.

Score fold lines with a screening tool, which is available at most hardware stores. It consists of a handle with a 1 1/2-inch-radius wheel at one end. Run the wheel along a metal straightedge on the fold lines.

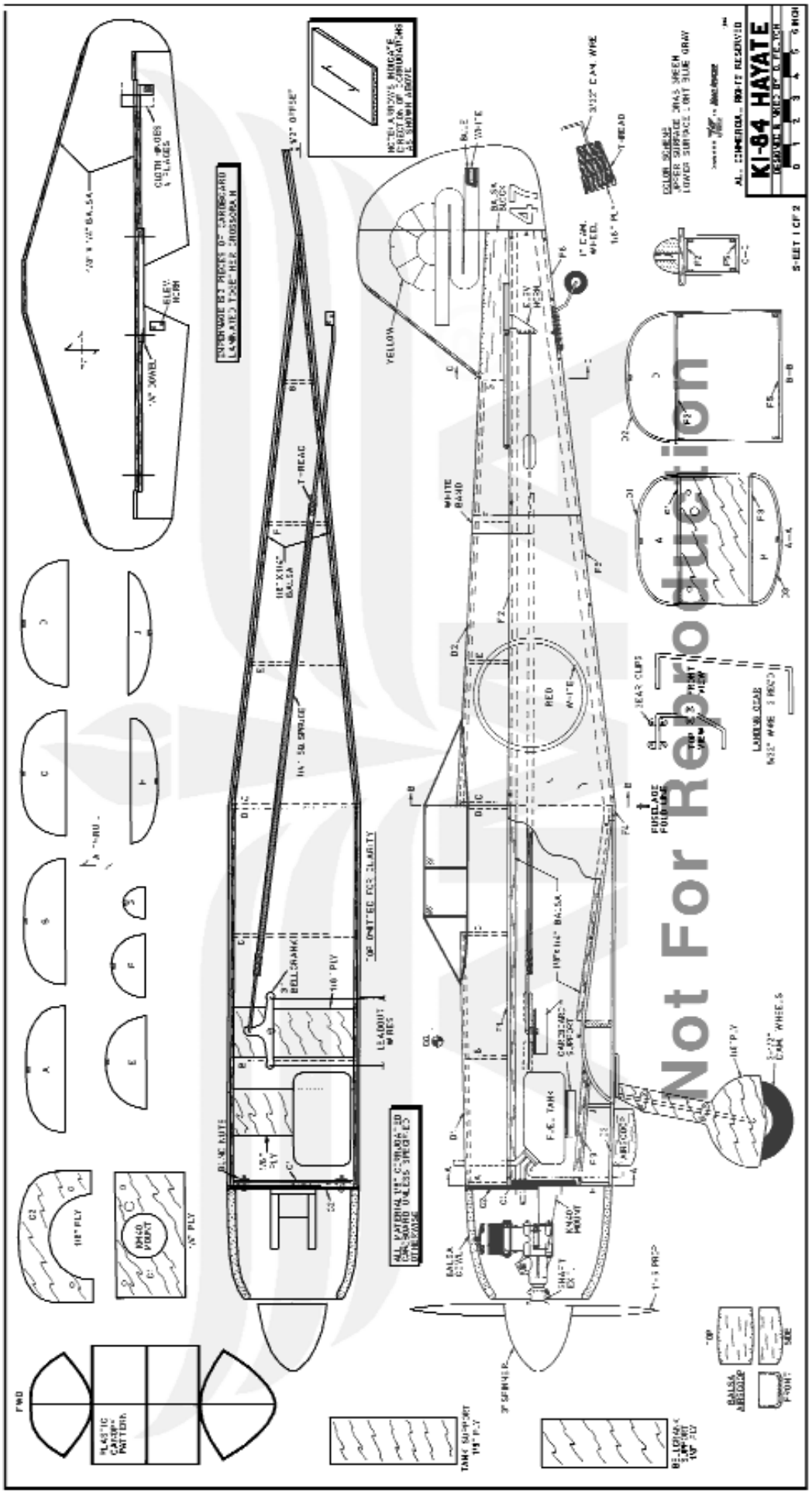
Cardboard provides a solid surface with no open areas to cover, and it is nonporous. The easiest finishing method is to apply two coats of clear dope, sanding lightly between each layer with 400-grit sandpaper. Follow that with two coats of color dope.

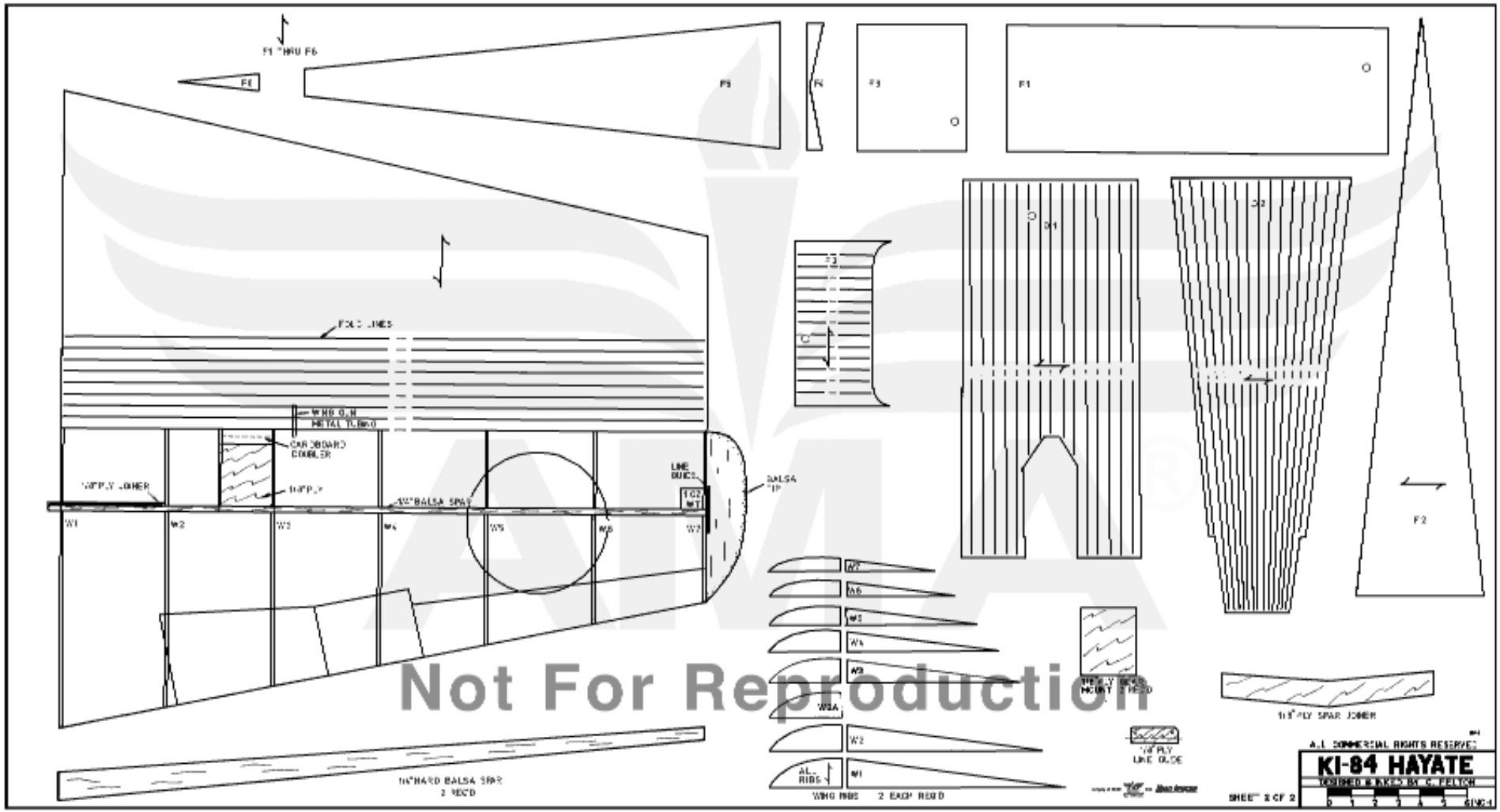
There is also a



Its size and stability make this Ki-84 a good sport flier. Building with cardboard requires special handling but, as shown, the results can be pleasing.

Full-Size Plans Available—see page 155





wide variety of finishing materials you can use on cardboard, such as Solarfilm, MonoKote, and vinyl paper. If you do use any of those, do not dope the surface of the cardboard; this will result in a better bond.

Cover all seams, joints, and exposed edges with strips of gummed paper tape. Obtain a 1-inch-wide roll from a stationery store. To use this material, simply cut a thin strip to length, dip it in water, and smooth it over the seam.

CONSTRUCTION

Cut out all cardboard and wood parts, making sure to note the direction of the corrugations. Score and fold cardboard parts as the plans indicate.

Empennage: The fin, rudder, stabilizer, and elevator are each made from two pieces of 1/8-inch-thick cardboard. They are laminated together cross-grain, to make 1/4-inch-thick surfaces.

Add a 1/8 x 1/4 balsa strip to the fin LE, and round it off. Add 1/8 x 1/4 balsa strips to the stabilizer LEs and TEs, and round those off. Glue the elevators to the 1/4-inch-diameter dowel. Add 1/8 x 1/4 balsa strips to the remainder of the elevator LE, and round off.

Seal all raw edges with gummed paper tape. Hinge elevators to the stabilizer with nylon flex hinges at four places.

Wing: Make the two wing spars from hard 1/4 balsa. Connect the segments with a 1/8 plywood joiner on the forward side.

Glue 1/8 plywood gear mounts into the bottom of each wing panel. Adhere the right-side spar into the bottom of the right-hand wing panel. Install ribs W1 through W7. Add a cardboard doubler over the plywood gear mount.

Bond a 1-ounce weight to the right wingtip. Glue the left wing panel to the left spar in a similar fashion. Add the ribs to the left wing and the cardboard doubler over the plywood gear mount.

Apply glue to the top of the wing spar, the top of the ribs, and the wing TE. In turn, fold each top wing surface down and pin it securely in place until dry. Add the balsa tips to the wing.

Make a line guide from 1/8 plywood. Cut a slot in the left-wing balsa tip and glue the line guide in place. Cover the TE, centerline seam, and wingtip seams with gummed paper tape.

Fuselage: This section's edges are outlined on the drawing with a triangular symbol. Line the upper and lower edges of each fuselage side with 1/8 x 1/4 balsa strips, as shown in the fuselage side view. The strips are recessed 1/8 inch from the edges.

Bevel the strips at the aft end of the fuselage so that the cardboard sides will come together. Add cardboard supports to each fuselage side above the fuel tank and below the bellcrank.

Make the firewall, C1, from 1/4 plywood. Locate mounting holes for the Hayes KM-40 Motor Mount on the face of C1. Drill mounting holes and install blind mounting nuts on the backside of C1.

Drill a hole in C1 for a fuel line. Drill two holes in C1 and install blind nuts for the cowl hold-down bolts. These holes in C1 must align with the holes in C2.

Glue C1 to the right side of the fuselage. When dry, adhere the left side of the fuselage to C1. Attach the fuel tank to the 1/8 plywood support with rubber bands.

Make a pushrod from 3/32-inch-diameter wire and 1/4 square spruce, and attach it to the bellcrank along with the leadout wires. Install tank and bellcrank assemblies by gluing the plywood supports to the cardboard supports on the insides of the fuselage. Be sure to bring the pushrod end through the cutout in the left aft fuselage.

Bond the fuselage sides at the tail. Glue F1 and F2 in place, to cover the top fuselage. Cover the bottom fuselage with F3, F4, F5, and F6. Make sure to bring out fuel-tubing fill and overflow lines during all covering operations.

Add fuselage formers A through D to the top fuselage, adding a 1/8 x 1/4-inch centerline stringer. Cover bulkheads A through D with decking piece D1. Glue the horizontal stabilizer assembly to the rear fuselage.

Add formers D through G with a centerline balsa stringer, and cover with decking piece D2. Formers H and J are glued to the forward bottom fuselage, with centerline stringer, and covered with decking piece D3.

Fabricate the cowl from 1/2 balsa sheet and carve to shape. The bottom half is glued to the model, while the top half is removable.

The latter has a 1/8 plywood former, C2, glued to the back. The two holes in C2 must align with the blind nuts in firewall C1.

Sand, carve, and hollow the cowl to shape. Test-fit the engine in the cowl, and drill mounting holes. Use a shaft extension to give adequate spinner clearance. Cut holes in the cowl block for the cylinder head, exhaust, and needle valve. Apply epoxy to the inside of the cowl and front of the firewall.

Glue the rudder to the fin with the TE offset 1/2 inch to the outside of the flying circle. Adhere the fin assembly to the fuselage/stabilizer. When dry, add balsa to the root of the fin and sand to fall into the fuselage shape.

Make the tail wheel gear from 3/32-inch-diameter wire. Bend as shown, place on the 1/8 plywood support, wrap with nylon thread, and smear the thread with glue. When dry, glue in place in the bottom fuselage cutout.

Bond the wing to the fuselage. Make the main gear from 5/32-inch-diameter wire, as shown. Make gear fairings from 1/8 plywood, and attach the gear assemblies to the 1/8 plywood supports in the bottom wing with nylon gear clips.

Final Assembly: As I instructed you to do, give the model two coats of clear dope, sanding lightly after each coat with 400-grit sandpaper. Follow that with two coats of color.

The color scheme I used consists of drab-green upper surfaces and light blue-gray lower surfaces. I made lettering, striping, aileron outlines, and all detailing from MonoKote.

Make the canopy from thin plastic, and use epoxy to attach it to the fuselage. Outline the canopy with thin strips of MonoKote.

Pass leadout wires through the wingtip line guide and tie off. Attach the nylon control horn to the elevator and hook up the pushrod. Attach 3 1/2-inch-diameter wheels to the main gear and a 1-inch-diameter wheel to the tail gear.

Add an 11 x 6 propeller and a 3-inch spinner to the engine, and your fighter will be complete. Ensure that you balance it at the point shown on the plans.

If you have comments, suggestions for, or questions concerning the cardboard Ki-84 Hayate, please contact me. I'd love to see a photo of your completed cardboard model.

You can visit my Web site to see more cardboard designs and building techniques. MA

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Sources:

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