Making a Composite Prop

Jukka Tervamaki, Sept 10, 2000

This page describes a simple method of making a two bladed composite propeller. The basic idea is to make an open mold using an existing propeller as a plug. The curved side of the new propeller is made in the mold and the flat side is filled, ground, filed and sanded for the proper shape. This method requires the use of metal bushings (inserts) for propeller bolts instead of drilling holes and cutting fibers in the prop hub. The method was successfully used in making the propellers for the ATE-3 and JT-5 autogyros.
Since the laminating procedure is a pretty messy business I never took photos of the actual work. Instead I am using schematic pictures made using ClarisDraw and form•Z programs.

What are the characteristics of a composite propeller:

1) Easy to fabricate.
2) Mold can be made using an existing metal or wooden propeller as a plug.
3) By making the mold flexible and adjustable props with slightly different pitch values can be made
4) A fiberglass/epoxy propeller is about 50 to 70 percent heavier than a wooden prop but is lighter than a metal prop.
5) The weight difference results in different torsional vibration characteristics in power plants having a reduction drive.
6) A composite prop is much stronger than a wooden propeller.

What are the drawbacks of a composite propeller:

1) It may be too strong! In an aircraft with retractable gear a belly landing may result in a damaged crankshaft.
2) However, the leading edge of the prop is not as hard as metal. Therefore, grit and gravel will damage the leading edge of the prop. A pusher prop in particular needs continuous maintenance on dirt air strips.
3) The hub of a composite propeller may shrink if made of poor plastics and if the prop flange gets too hot (eg pusher propellers)**.**

THEREFORE, NOTE THE FOLLOWING!

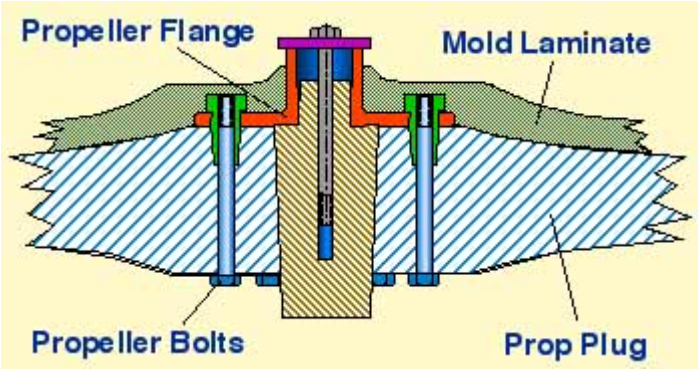
1) Don't use polyester resins, they are not heat resistant. Always use the best heat resistant epoxies.
2) With epoxies watch that the mixture ratio of resin and hardener is correct, otherwise the propeller will not cure completely and may get soft when heated by propeller flange.
3) To prevent shrinking, post cure a composite prop to at least 70...80 degrees C.
4) Use a heat insulation plate between hub flange and prop if the flange gets very hot when the engine runs for hours.

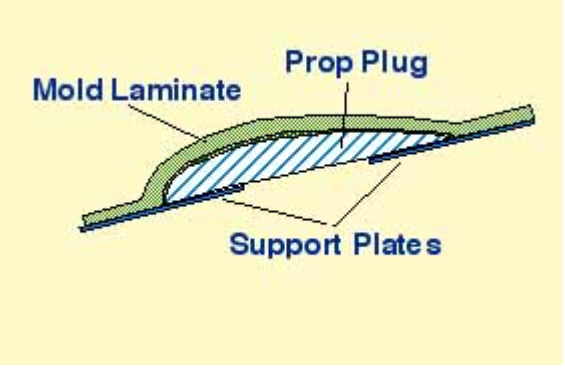
5) Use an epoxy with a reasonably long pot life (several hours). This will prevent the thick laminates from overheating and getting discolored when curing.

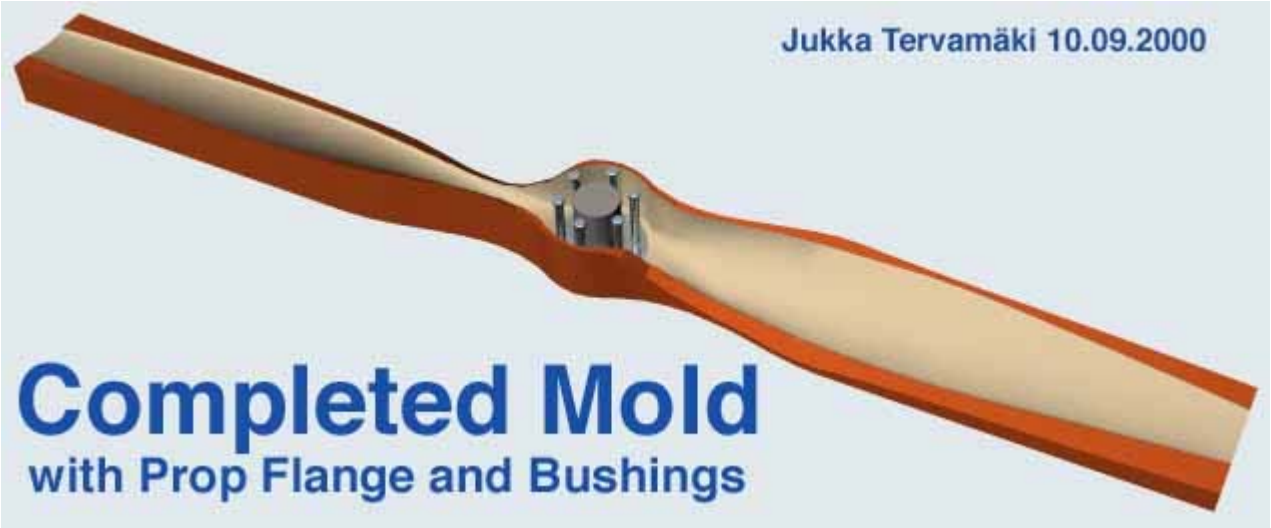
MAKING THE PROPELLER MOLD.

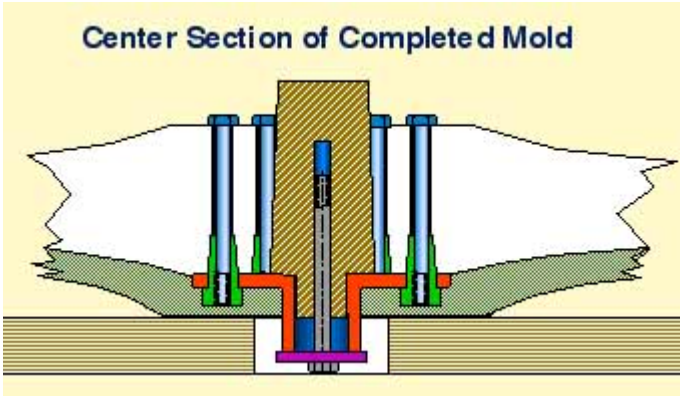
1) Make a copy of the propeller flange in steel or aluminium and bolt it onto the curved side (pusher side) of the prop serving as a plug. In some cases like VW based engines you can use the original prop flange.
2) Make support plates of 1 mm aluminium for the flat side of the prop blades. Use tape to fix them on the flat side of the blades.
3) Carefully apply a release agent (usually wax) on the prop. The flange does not need a release agent if it is permanently bonded onto the mold. However, if you are using the original flange be sure to tape and wax it over to be able to remove it later on from the mold. .
4) Apply gelcoat on the surfaces.
5) Laminate10....20 layers of bidirectional fabric using preferably epoxy resin onto the prop/flange assembly. If you want to adjust the pitch of the prop do not make the mold too thick and torsionally too stiff.
6) Let the laminate cure. Postcure the mold at elevated temperature as necessary.
7) Remove the original propeller from the mold.
8) Cut and clean the mold edges.
9) Fix the mold on a sturdy plank and build the pitch adjusting mechanism for each blade (Minimum two positions per blade.)
10) Since we are not going to cut laminated fibers by drilling holes for the propeller bolts but instead will use metal bushings you can reduce the propeller hub diameter and increase the central hole diameter thereby reducing the space in the hub to be filled with laminate. You can do this by casting glass/epoxy stuff on the walls of the hub using a round plastic bottle as a template (plug) and by making a large conical plug for the central hole in the prop.

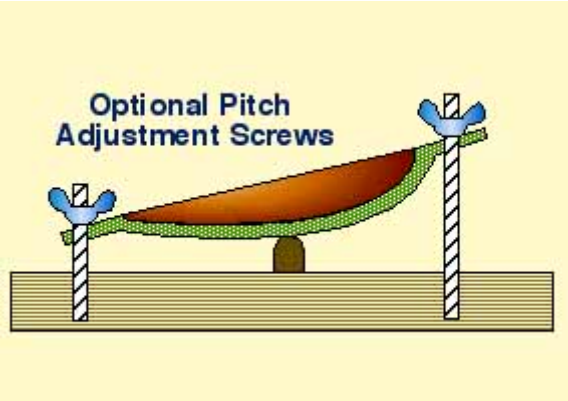
Laminating the Mold on the Plug







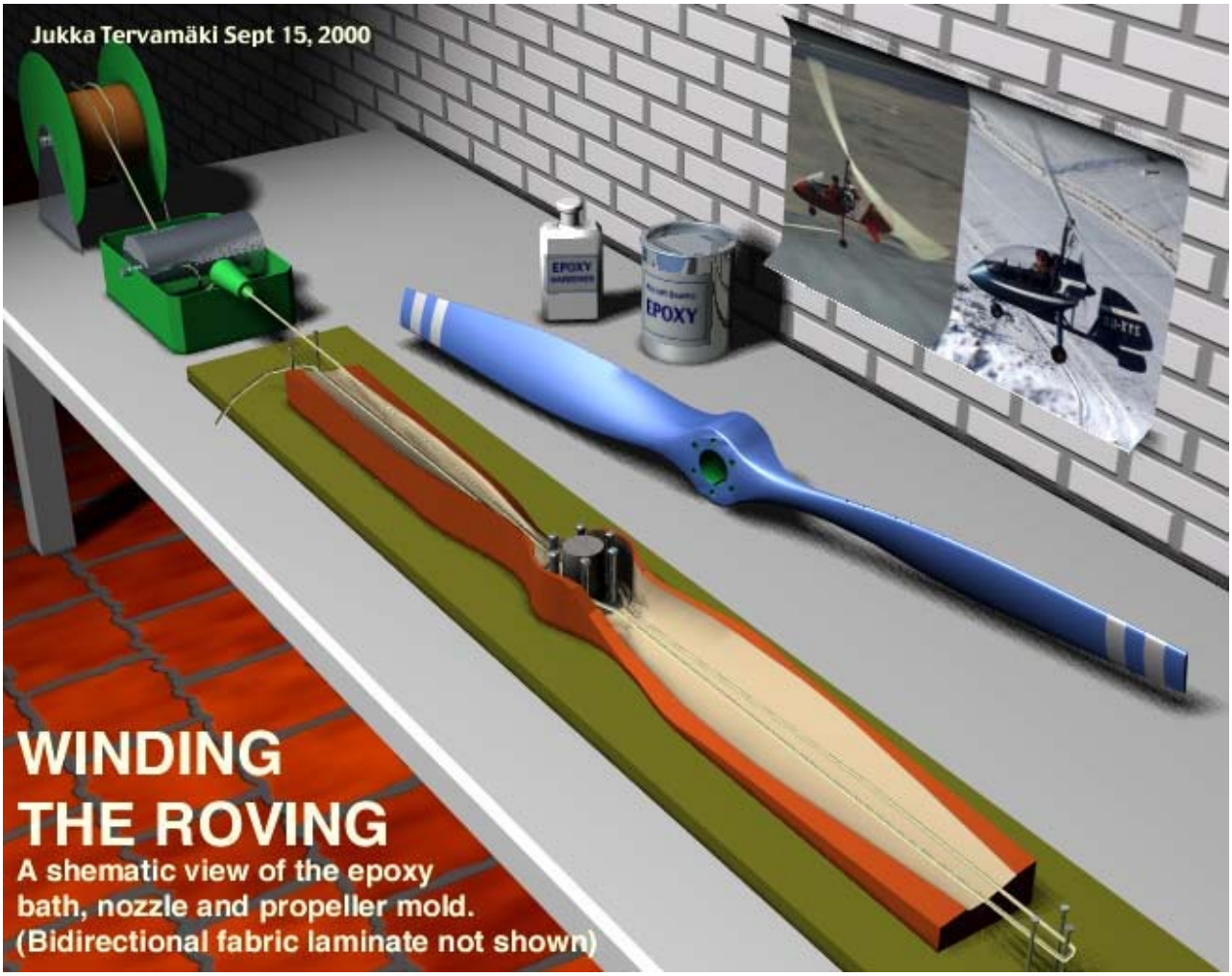




LAMINATING THE PROPELLER IN THE MOLD:

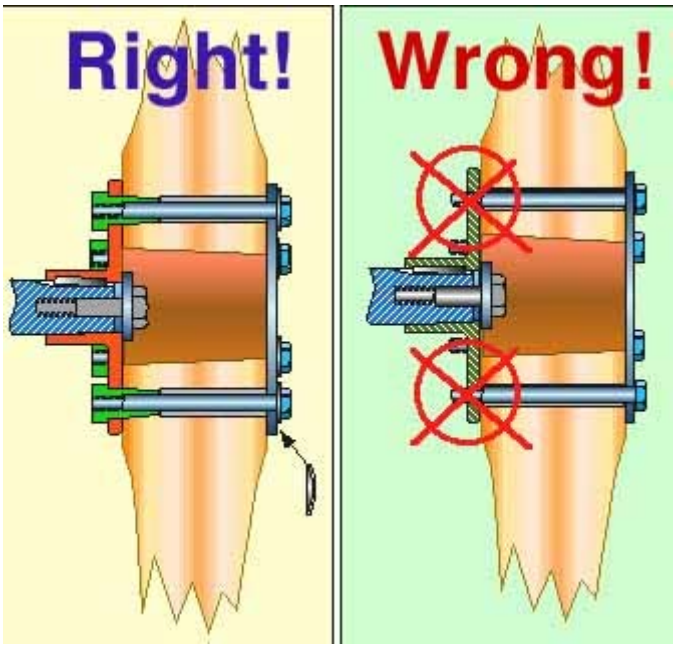
When the mold has been completed take the following steps to make a composite propeller:

1) Calculate the desired pitch of the propeller at .75 R and at the tip. You may try the various propeller design programs in the net. Adjust the pitch screws as necessary.
2) Apply release agent (wax) on all surfaces of the mold except the insert bushings.
3) Roughen the surfaces of the insert bushings and bolt them on the prop flange in the mold.
4) Laminate 3 layers of bidirectional fabric on the mold. Make the necessary holes for the insert bushings.
5) Fill the mold with unidirectional glass roving using a kind of filament winding method. By pulling the roving through an epoxy bath and a nozzle which squeezes out the extra epoxy the work will be quite fast. You can wind the first rounds of roving around nails at the end of the blade tips. Look at the picture below. When the blade tips are full, continue with ever decreasing lengths of rowing. Use randomly varying routes of rowing around the hub insert bushings.
6) Fill the remaining empty spaces in the propeller hub area with chopped glass/epoxy mixture. You can use glass microballoons, too
7) When the mold is nearly full, laminate 3 to 5 layers of bidirectional fabric on top to fill the mold.
8) Let the epoxy cure as per the epoxy specs.
9) Remove the prop from the mold and finish the edges and the flat surface by filling, grinding, filing and wet sanding.
10) Check the balance of the prop. Continue finishing until the prop is in balance.
11) Postcure the propeller in an oven to 70....80 degrees C.
12) Give it a final touch by painting the propeller. Check the balance after painting.



Mounting the propeller on the propeller flange.

The picture below shows the right and wrong method to install the propeller on the flange. It is dangerous to install the propeller so that the thin threaded portion of the bolts will carry all the torque loads. The propeller flange must have long nuts to carry the torque loads. In addition, use conical spring washers under the bolt heads to prevent any play from arising if the propeller shrinks due to an exessively hot flange.



If you have any comments on this page, send me e-mail!

COMMENTS

I've just found your composite propeller page and want to tell you my compliments. It is a wonderful page.
However, I like to say that there is a third way of bolting the prop through the hub, the way Lycoming, Fraklin and Continental do it with the wooden and metal propellers. You got the bolt through the rear of the hub and have the thread through the front of the propeller like studs to use castle nuts to tighten the assembly by help of a coverplate to the hub. (If there is enough space to get the bolts through from the rear.)
Go ahead and publish more of such great pages.
Best regards,
Christian

Note:

Great prop making ideas. I added a link to your site on our site. I might suggest you orient the carbon cloth plus and minus 45 degrees for increased torsional blade stiffness. Also use a metal blade as a mold when ever possible to take advantage of the increased prop efficiency afforded by the thinner blade. Thanks for doing that. Many of our readers need that sort of information.
Paul Lamar

Although this looks interesting please read below.

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