S.O.R.A.C.

Sub-Orbital Rocket, Amateur Class

Project SORAC
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Nose Cone Fabrication Process

Simple procedure for creating glass-epoxy nose cones.

Rev.	Date	Name	Description
--	09/01/2001	Michael Yamamoto	Original document creation.
A	10/19/2001	Michael Akers	Editing and final document layout.
B	11/02/2001	Michael Akers	Added more sections. One section inspired by Robert DeHate on using a plastic sheet to contain styrofoam debris during fabrication.

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Section
1

Prerequisites, Disclaimers, and Copyrights

What you need to know before using this information

Prerequisites

It is assumed that the user of this information is familiar with the techniques surrounding the use of epoxy compounds, fiberglass handling, glass-epoxy construction techniques, and overall safety issues.

The issue of safety can not be stressed too greatly. BE CAREFULL!!

Copyright Notice

This copyright covers only those items not covered by other copyright or patents pertaining to the construction materials and certain construction methodologies.

Disclaimer

The final product of this process will be solely dependent upon the skill of the person using the process, and the time and effort the person performing the process steps are willing to dedicate.

The use of specific named products is not an indication of merit nor is it a guarantee that if the products mentioned are used the product will be correct in fit and form. These products are mentioned only because they were on hand at the time the product was created and this document generated.

Section
2

Nose Cone Construction Process

Itemized step by step procedure

The art of nose cone making

Ever wonder how those people in high power rocketry made their nose cones? Alternatively, why did they choose to make their nose cones out of fiberglass as opposed to wood or some other easily worked material? Well, this document is written just for this purpose; to give you a step by step procedure for creating fiberglass nose cones.

Why fiberglass? The rockets created by the Project SORAC group, as an example, typically have a launch acceleration profile of 11 to 40 G's, and typically will go supersonic to transonic or even hypersonic (in the future). At these speeds, wood, plastic, and other type of "easily" worked material simply shreds and comes apart. Usually, quite spectacularly at that! Fiberglass, using several common techniques, which we will, for the most part, not be getting into, can be laid up to counteract dynamic flight stresses encountered during supersonic and high acceleration flight.

One of the secrets of making fiberglass nose cones dynamically stable is to "cross hatch" every other layer or so. This means that you use two types of fiberglass mat. A 0-90 mat and a –45 - +45 mat. If you look at the type specs for rolls of fiberglass mat these numbers will then mean something.

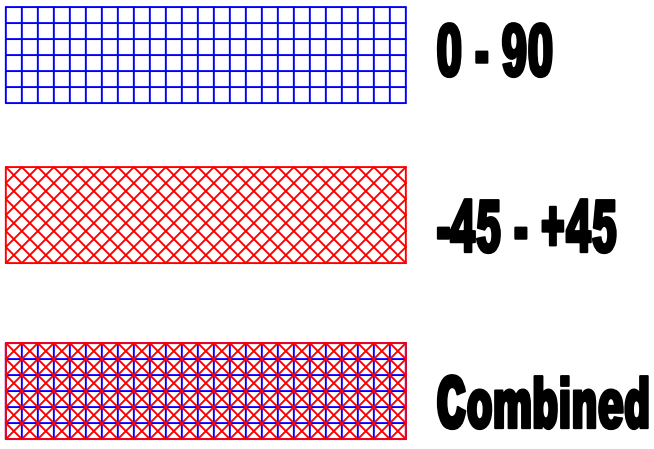

Figure 1. Fiberglass weaves, and how they look combined.

As you can see in Figure 1 above, by alternating the weave types you can build a matrix of fiberglass that is dimensionally sound and extremely tough and stable.

Actually, when you have completed creating this nose cone set, and after they are fully cured, you can use them to hold up you full size pickup truck, loaded!

The styrofoam lathe

So, what is a styrofoam lathe? It is the one tool you are absolutely going to need to make nose cones. The process of creating nose cones described here uses the "Lost Styrofoam" method. Meaning that after construction is done, the styrofoam is removed. Using a styrofoam lathe greatly eases the creation of the styrofoam core used in fabricating the nose cone.

Styrofoam Lathe materials list

- One 10 foot long, 1-inch diameter, steel rod.
- Two pillow blocks, 1-inch ID. (Or more, depending upon how creative you want to get)
- One ½ horse power AC motor.
- One ¼ horse power AC motor with planetary reduction gear to reduce speed to 2 to 5 rpm. (Optional, and not shown)
- One 3-inch pulley wheel for motor. (V-Groove)
- One 12-inch pulley wheel for rod. (V-Groove)
- V-Groove belt. (Automotive fan belt)

Depending upon your circumstances, the lathe can be constructed on a handy work bench in your garage or it can be constructed using a couple of saw horses (With sand bags to make them stay put!). It is simply up to you.

Figure 2. Styrofoam Lathe.

Note:

Building this in your living room (if you are married) will get you seriously hurt. DON'T DO IT!

Other useful tools and supplies

Many other tools and items will make construction go a lot faster and smother. Here are some specific examples:

- 2 inch putty knife
- 4 inch putty knife
- Iceing knife (very springy)

(WARNING!!! DO NOT USE YOUR WIFE'S ICEING KNIFE!!!! BUY ONE FOR THIS PROJECT AND NEVER GET IT ANY WHERE NEAR THE KITCHEN!!)

- 80 through 300 grit sandpaper (standard and wet/dry)
- Wood putty
- Course through very fine steel wool
- Wood or denatured alcohol (Gallon size)
- Shop Rags (automotive type, purchased in large bundles)
- Latex gloves, disposable type.
- Plastic mixing cups up to pint (16 oz.) size.
- Thin ping-pong paddles (don't laugh, these come in very handily)
- Large industrial strength shop vacuum. The type that fits on top of a plastic 33 gallon trash can.

Foam, styrofoam and others

Not all foams are made equal! Styrofoam comes in two grades; large grain, and small grain. The small grain styrofoam is easy to shape and use, the large grain is a bit more difficult to use, you'll just have to spend more time in the finishing phase to get things right. One of the best foams to use is the pink home insulation foam. It comes in a variety of densities and has a uniform small cell structure. It is easy to form and requires less finishing than styrofoam. It is also easy to get from OSH, Home Depot, etc.

The styrofoam core

Using 2" thick styrofoam stock, cut square sections that are 1" to 2" over the expected nose cone outside diameter. Next, trim the corners to create an even sided octagon of styrofoam. See figure 2. below.

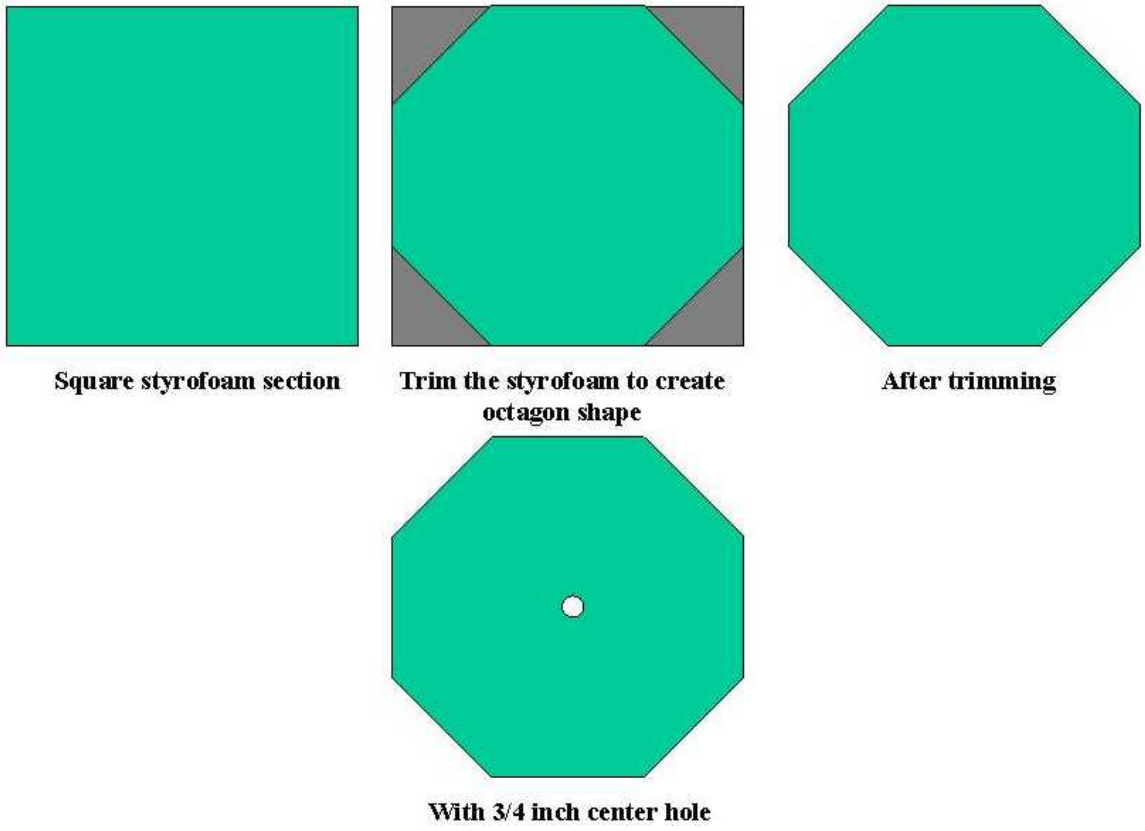

Figure 3. Styrofoam core section.

Perforate center of each disc with 3/4" hole.

On the 1" rod, apply contact cement (water based) and mount styrofoam discs to 2X desired Nose Cone length. (2 nose cones are going to be made at the same time back to back).

On the styrofoam lathe, slowly trim the styrofoam to + 1/16" of required diameter.

Smooth down styrofoam surface (1/16" excess) with hardwood surface to required diameter.

With 6" plastic putty knife, apply thin layer (2-4 mil) of 100% silicon caulk over entire styrofoam shape, and let cure.

Laying up the fibergalss

Apply 10-11 mil fiberglass and Tap Plastic General Purpose epoxy, 2 layers at a time. There will be excess fiberglass fabric as the diameter decreases at ends, but slit the fabric and overlay excess fabric (result will be a thicker wall at the small diameter end).

With plastic putty knife, and rotating the mold squeeze out excess epoxy.

Apply next 1-2 layers of fiberglass using the +45 - -45 degrees weave (this improves considerably flexural strength). Apply these alternating orientation layers until desired wall thickness is obtained. Let epoxy cure.

Grind down rough surface with 150-grit sandpaper or rasp, with mold rotating or not.

Cut mold into two nose cones, remove from rod, dissolve styrofoam cores with lacquer thinner or acetone. Silicon rubber softens and is easily pealed/scraped away from inside.

Fill in exterior surface with wood caulk, let cure and sand.

If instrument core cylinder is to be added, then rough sand inside end of NC, make centering ring and epoxy cylinder to inside.

Adding features

Pockets (looks like NACA duct) containing pull-away electrical/other disconnects have been made by cutting out the recess and using the cutout to fab the "box" which is then epoxied to the inside edge of the cutout recess. For symmetry of air friction load on pockets, make the pockets in pair's 180 degrees apart.

Keeping it clean

A suggestion from Robert DeHate involves using a large plastic sheet. He stapled some cardboard to the front of his lathe bench so it stuck up ~4in in front of the lathe. He then draped plastic over it, across the bench, up the wall about five feet and overhead stapled to 2x4s and draping down one foot from the bench. He put the lathe in the middle of this envelope. When he formed the foam most of the foam debris piled up behind the lathe, and as the pile got huge he would clean it up. Most of it stayed in the plastic. The ends were mostly open to allow access and the plastic behind him, not attached to anything, just draped.

The use of an industrial shop vacuum cleaner (the type that clamps on top of a 33 gallon plastic trash can) goes a long way in keeping things tidy while performing this type of operation. Another idea is to use some stiff wire (1/16 inch dia.) and make a form that will keep a plastic trash bag from being sucked up around the vacuum filter. Once the bag is full, simply remove the form and toss the bag. Reinstall a new bag and the form and off you go again.

Now a word of caution guy's, make sure that you keep ahead of any foam debris, and make sure that you clean up thoroughly after you finish forming the foam and before you start laying up the glass-epoxy. Being beaten about the head, shoulders, and back (not to mention other available, and choice, targets) by your significant other, if you leave a mess for them to clean up, is to be avoided at all costs! Unless, of course, you like wearing welts and bruises from being beaten with a sawed off, lead weighted, broom stick! Think I'm kidding? Go ahead and try it….