



Fiberglass

Repair Manual

**A Detailed Step By Step
HOW TO
Through A Basic
Fiberglass Repair**

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INTRODUCTION TO FIBERGLASS REPAIR

This manual will walk you through the basics of fiberglass repair. I will approach the topic from a conceptual standpoint that will hopefully be applicable to many different projects. The intent of this manual is to provide information and guidance with the following:

- 1) Why repair versus replace
- 2) When to replace versus repair
- 3) Analyzing the break and deciding what materials to use
- 4) Preparing the area for repair
- 5) Methods of repair
- 6) Finishing the repair with gelcoat (when applicable)

Many people are intimidated by the thought of repairing fiberglass. In fact, fiberglass repair is easy. Most of the time repairing is much cheaper than replacing. I also find it more satisfying to do a repair myself. I always get that “special feeling of accomplishment” when I do a project like this on my own.

Before I begin, a word of caution; you should be very careful with repairs to pieces that provide structural support or handle weight (especially people weight). These types of repairs should only come with increasing experience. The other word of caution comes with aircraft in mind. Repairs on aircraft (not radio controlled but the kind that carry people) should only be made after consulting with the manufacturer or someone proficient with those types of repairs. While I am a strong advocate of doing most things myself, I am hesitant to mess with repairs that may fail and result in injury or death.



Commonly Used Elements of Fiberglass Repair

WHY REPAIR VERSUS REPLACE?

Now, let us begin. Most people look at a damaged piece of fiberglass and immediately think that replacing it is the answer. While this may sometimes be the case, most of the time it isn't.

Fiberglass is often seen as messy, smelly and difficult to work with. I would agree that it can be messy and smelly but I find fiberglass easy to work with. It fills into gaps and depressions, conforms to compound curves, cures quickly and is easy to finish. Fiberglass is also extremely durable and easily adheres to products manufactured with fiberglass.

The first consideration when evaluating the repair versus replace decision is whether or not you have enough access to the damaged area to make a repair. I find repairs much more feasible if you can gain access to both sides of the damaged piece.

Another consideration is the extent of damage. If the piece is damaged so extensively that its original shape is no longer apparent, you may be better off replacing the piece. This also goes for the location of the damage. You have to be realistic with your abilities and desire to tackle the task at hand. If the repair requires a clean cosmetic appearance and is going to be a match for an undamaged mirror image part, such as a headlight bucket or a fender flair, your repair will require an artistic eye and the ability to recognize asymmetries in your repair. Some people simply do not have the skills to accomplish a repair like this. Don't misunderstand me however, it is worth your while to attempt these repairs as we often learn valuable skills from this kind of work (projects that are over our heads).

The only other consideration when deciding to repair versus replace is the cost of fiberglass materials versus the cost of a new replacement part. I like to work with fiberglass so I have gelcoat, MEKP, resins and various types of cloth and mat on hand. These materials can be expensive if they are only going to be used once. For example, a quart of gelcoat can be \$15 or more. Likewise, a can of resin often runs at least \$13.00. Additionally, you can spend \$10 on cloth and another \$10 on miscellaneous supplies like gloves, brushes and acetone.

If your repair will have you using just a small amount of the materials that you purchase, from a financial standpoint it may make more sense to buy a new piece. I have never let this slow me down however; I look at it this way: I like to do this kind of work, so it is like a hobby. Secondly, I figure that if mine broke, other people's must break too. I will use the extra materials to build a mold of my piece once it is repaired and sell my duplicate pieces on eBay.

WHAT IS FIBERGLASS?

Before beginning any type of fiberglass repair, you must understand what fiberglass is and how to decide which type of cloth is best suited for your repair.

Fiberglass is a very durable bond that is formed between laminating resin and fiberglass cloth or mat that is made from spun glass. The strength of fiberglass lies in the direction of the fibers as well as the number of layers of material. When cured, it will be very ridged yet remain flexible depending on the number of layers used.

Laminating resins are of primarily two types; these being polyester resin and epoxy resin. Most applications that use mat also use a general purpose polyester resin. This combination of polyester resin and mat is most often found in marine applications. Epoxy resins are often found in the automotive industry and are often used with woven cloth. If you are unsure as to what type of resin was used in the original construction, repairing with epoxy resin is a safe decision. Both carbon fiber and Kevlar are repairable with epoxy resin or a resin known as vinyl ester.

I have seen many repairs done just with laminating resin. Laminating resin cures extremely hard, it's waterproof, and by itself, very brittle and prone to cracking. Incidentally, usually the more laminating resin that you apply, and the thicker it gets, the more likely it is to crack.

The true strength and benefits of fiberglass come from the combination of cloth or mat combined with laminating resin. Let me quickly discuss the differences between woven cloth and strand mat.

Woven cloth looks like its name implies. It has a woven appearance with a predictable crossing pattern. This type of cloth provides a good combination of strength and flexibility. You would be more likely to find this type of material in the marine and aircraft industry.



Figure 1 Woven fiberglass Cloth

Note the unmistakable appearance of woven cloth. Cloth comes in a variety of weights. When selecting cloth for a repair job, you should try to use a cloth of similar weight. For most projects you will probably use 1 oz or 1.5 oz material.

Mat, on the other hand, looks like a mess of fibers laying in every possible direction. Mat has no predictable pattern other than that it is unpredictable. Since its' fibers run in every direction, once saturated with laminating resin, it provides extreme rigidity in every direction. This material is best suited for objects that require more strength with little flexibility such as automotive applications.



Figure 2 Mat

Fiberglass mat looks like matted, disorganized material. Mat is very ridged and will provide excellent strength under all directions of stress. As with cloth, mat is available in many different weights. Most lay-ups are made of multiple layers of material in the 1oz to 1.5 oz weight.

Carbon Fiber and Kevlar are similar to mat and cloth only they provided added benefits (and are much more expensive). These materials provide for a much stronger, stiffer and lighter lay-up than traditional mat or cloth.

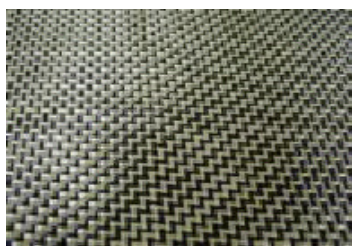


Figure 3 Kevlar

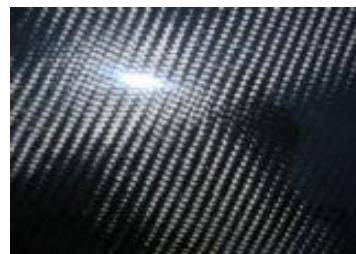


Figure 4 Carbon Fiber

Both Kevlar and carbon fiber are specialty materials that can be used with resin. These materials produce very light and very strong finished products. These materials are often unfinished in order to show off the natural beauty of the material. There are companies that make fiberglass that is dyed to look like these materials. This is an inexpensive way to get the carbon fiber look.

Fiberglass cloth, mat, carbon fiber and Kevlar all come in different weights or thicknesses. It is important when doing fiberglass repair to try to come close to the weight of the original material used in building the damaged piece. You also want to use the same type of material. For instance, you wouldn't use mat to repair a part made with cloth and you certainly wouldn't want to use fiberglass cloth to repair a piece made of carbon fiber. The reason for using the same material for repair that was used in the original lay-up of the piece is because different materials have different properties. For example, fiberglass mat is more ridged than fiberglass cloth and carbon fiber is more ridged than fiberglass mat.

Another consideration is the thickness and or number of layers used in a repair. You want to use approximately the same number of layers and or thickness that was used in the original build. One of the common misconceptions of fiberglass repair is that more is better. This is not the case. By matching the thickness and or layers of the original build you will better approximate its original characteristics.

Now we have discussed the basic materials needed for repairing damaged fiberglass. Fiberglass may be a new material for you to work with but you shouldn't let it intimidate you. The ability to repair fiberglass is a valuable skill for the hobbyist or the do-it-yourselfer to possess. The bottom line is that you can do this yourself! If you can get to it, you can usually fix it. There are no great mysteries behind fiberglass repair. Outside of catastrophic damage, repair is usually your best (and cheapest) bet.

One more word about fiberglassing materials; they are all toxic. Uncured resin, the cloth itself and especially fine particles from the sanding process are dangerous to your health. The cloth can cause a rash, uncured resin can cause damage to your nervous system and fiberglass dust from sanding can cause a variety of health issues.

In order to protect yourself from these materials you should always wear disposable rubber gloves and a good quality respirator. These items are quite inexpensive considering the protection that they can afford the user.



Figure 5 Respirator



Figure 6 Protective Gloves

The fume mask is made by 3M. It is available at most hardware stores for under \$30.00 and is well worth the price. Once you have one of these you will find yourself using it for all kinds of garage chores. The gloves are from Costco and are cheap. I think of all the time I save by not having to scrub resin and gelcoat off of my hands.

ASSESSING THE DAMAGED AREA:

For this tutorial in fiberglass repair, I will be fixing a hole that was mysteriously punched into the side fairing of my prized 1983 Honda Interceptor while parked at the Home Depot. Those of you familiar with this bike will know that the original fairing was plastic and was kind of a half fairing. This is an aftermarket fairing that is made of fiberglass and painted to match the bike.

Before beginning a repair process, you first have to access the damaged area. If the damaged area can be reached from both sides, there is an excellent chance that it can be repaired. The other important assessment is to gain an understanding of the scope of the damage. Is the damaged area a crease type of break or is it a puncture type? Usually the break will be a combination of these two. I am able to easily remove the fairing on this bike and access both sides of the damaged area. This makes for a much easier repair.

With a simple fiberglass repair project, I begin by examining the damaged area. Next, I like to use a sharpie in order to draw a line around the entire area that I intend to repair. Drawing a line will help me keep track of what I am repairing. This sounds funny, but my next step in this process is going to generate quite a bit of fiberglass dust and I don't want to remove too much or too little material because of a lost perspective.



Figure 7 Outside of Fairing

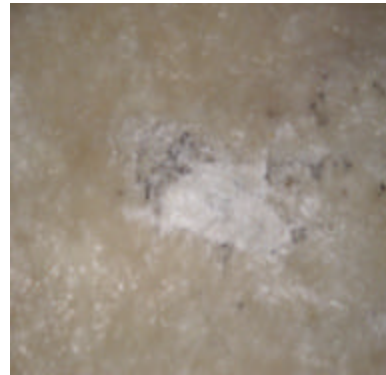


Figure 8 Inside of Fairing

The picture on the left shows the damage on the outside of the fairing. Scratched paint, chipped gelcoat, and damaged fiberglass scrub the looks out of my bike. The photograph on the right shows the damage from the inside of the fairing. The white looking area in the center of the picture is broken fiberglass strands. It is obvious that the material used in the construction of this fairing is mat.



Figure 9 Defined Area of Damage

I like to outline the area that needs repair with a sharpie. It is easy to loose track of what material needs to be removed once you get started. Cutting fiberglass throws a lot of dust and can cloud the area that needs repair.

The Repair Process Begins: Removing Damaged Material

With my damaged area outlined, I break out the dremel tool. My two favorite tool attachments for fiberglass work are the ½ inch sanding drum and the carbon cut off wheel. For this project, since the area is small, I have chosen the sanding drum. With the sanding drum, I will begin to remove material from my panel. You will soon see just how much dust this throws. It is very important to wear a particle mask during this process. Inhaled fiberglass and healthy pink lung material don't mix well. Just in case you were wondering, your lungs will lose.



Figure 10 Damaged Area Removed

A Dremel tool with a sanding drum will remove material quickly. Carbon cutoff wheels are also great for removing fiberglass. Make sure to wear a mask during this process as it will save your lungs. Just as a side note, you should also wear your mask while sweeping or vacuuming up the mess you will make. This stuff is bad news for the lungs. No amount of time saved here by not donning your mask is worth 20 years of chronic obstructive pulmonary disease in the later part of your life.

A note on removing material; remove only as much as you need to. Remove the damaged area only; you don't want the repair to grow too large. While fiberglass repairs are very strong, they are a secondary bond that will not be as durable as the original. This is just something to keep in mind.

At this point of this repair, I have to start thinking about the finished product. This fairing has been painted. Once the repair is complete, I will repaint it. This being the case, my fiberglass repair and, from a cosmetic standpoint, the gelcoat finish does not have to be perfect. Once the repair is complete, I will skin it with glazing putty, sand it smooth and then repaint. For the purpose of this manual, however, I will address the proper finishing of gelcoat at the appropriate time in the proper sequence of the repair.

Despite the particulars of this example of repair, I will still want to make the surface of the repair as close to perfect as possible. Simply the fact that the area will be skinned and painted is no reason to skimp effort during the fiberglass repair.

In order to prepare the hole in my fairing for gelcoat and resin, I like to use my drum sander to put a 45 degree bevel around the edges of my repair.



Figure 11 Beveling the Repair

Keeping the finished product in mind, the edge of the repair is beveled to allow for an overlap of new gelcoat over the original lay-up. This helps produce a seamless finish.

Now that my Dremel tool work is complete, I like to inspect both the front and backside of my repair process. I like to make sure that I have removed all the material that I needed to.

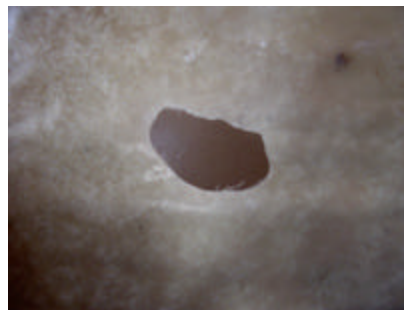


Figure 12 Backside of Repair

After the damaged material has been removed, you should be left with clean edges. I like to do a final inspection in order to make sure that the damaged material has indeed been removed.

PREPARING TO LAY NEW MATERIAL

Above is a photograph of the backside of my repair. The damaged fiberglass has been removed and the area is now ready for fiberglassing. In this photograph it is also apparent that this piece was originally constructed using chopped mat. I have polyester resin in my shop so we will go with a repair using chopped mat, polyester resin and white gelcoat.



Figure 13,14 & 15 From left to right: Resin, Fiberglass Mat and Gelcoat

These are the basic materials that will be needed for this particular repair. Remember, I decided to go with fiberglass mat because I earlier determined that mat was used in the original construction of my fairing.

A quick note on gelcoat; gelcoat is like paint in that you can take a chip sample with you when you purchase your gelcoat, the gelcoat that you purchase can be color matched to your chip sample. As with all cases of color matching, this process should get you very close to your original color.

A second consideration with gelcoat is that there are basically two types. Tooling gelcoat is made to use when constructing fiberglass molds. Finishing gelcoat is used for making parts with molds and for finishing repairs like with this project.

Now it is time to prepare for gelcoat application. Since my fairing is painted, I need to remove the paint from the area immediately around my repair site. I only need to remove a half inch or so around the perimeter of the hole I made. Taking the paint off down to the original gelcoat finish of my fairing will insure that my gelcoat adheres to the fairing.

One final step before I start adding material to this repair is to clean the area that

will accept fiberglass. Cleanliness of the piece to be repaired is essential for a strong bond between the original material and the material that will be used to repair the damaged area. I like to use acetone on a rag (sparingly) to wipe the back surface around the perimeter of the hole I made as well as for cleaning the front area where I removed the paint.

CREATING A SUPPORT FOR THE NEW MATERIAL

After the final preparation has been completed, I need to provide a foundation or backing for my gelcoat and repair to rest upon. For a repair of this size, masking tape will do just fine.

For larger repairs, especially ones that involved a distortion of the original part, you may need to brace the piece with clamps and use a flexible yet firm material to work against. For example, you may need to use a piece of cardboard to provide a foundation / backing for the repair. Depending on the type of support needed, you may have to build an elaborate support structure with clamps.

The concept, however, remains the same. See the photographs below.

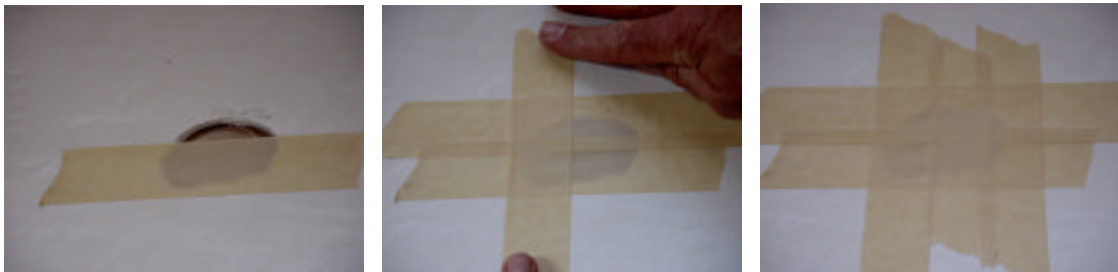


Figure 16, 17 & 18 I pull the tape tight across the outside of my repair.

I want to preserve the integrity of the bevel that I created on the outside of this repair with my drum sander. I will “back fill” the gap formed by the tape and the beveled edge with gelcoat with my gelcoat laden brush. This was a simple repair that required a simple type of support. Some repairs require elaborate support systems that incorporate wooden forms and clamps.

GELCOAT APPLICATION

With my hole backed with tape, it is time to prepare the gelcoat. Gelcoat should be mixed with MEKP according to the manufacturers directions. I like to apply the gelcoat in a thickness that replicates the original finish. In the case of this repair, the gelcoat of the original piece was quite thin. Therefore, I will apply one thick layer of gelcoat and let it dry to a tacky finish.



Figure 19, 20 & 21 I use a disposable brush to apply the gelcoat to the project.

You can see that I am applying the gelcoat directly onto the masking tape that I used as a backing for this repair. Masking tape releases easily from both gelcoat and resin. It is important that whatever material that you use as a backing will not stick to your finished product.

LAYING FIBERGLASS MAT AND RESIN

After the gelcoat dries to a tacky finish, you can lay the fiberglass. In this case, I will be using an epoxy resin and fiberglass mat. The absence of visible woven material on this fairing is a sure giveaway that mat was used in its construction.

I like to begin this step by selecting the weight and size of my material. This is a fairly light lay-up so I am going to use two layers of 1 ½ ounce mat. I tear the mat into pieces that will cover my damaged area and provide enough overhang to overlap the edges of the hole by about one inch.

The next step is to prepare the epoxy resin for use. Mix the epoxy resin with the MEKP per manufacturer's instructions. Once the resin has been catalyzed with MEKP, you can lay your mat over the backside of the hole and begin to saturate it with a resin soaked brush. See the photographs below.



Figure 22 Applying the resin and mat.

This photograph shows the piece of fiberglass mat that I selected to fill the damaged area. Notice that it completely covers the hole plus some. I like to use an overlap of approximately 1 inch over the original material. This overlap will insure a strong bond.



Figure 23 saturating the mat

This photograph shows me applying catalyzed resin with a disposable brush. The mat should be thoroughly saturated with resin. For this repair, I don't want to put so much pressure on the brush that I push the tape off the face of the fairing. Note that I am wearing gloves in this picture. I also have a respirator on to protect me from the fumes of the resin. It is always important to protect yourself from these materials as they are hazardous.



Figure 24 Finishing the mat application

In this photograph, I am finishing a second layer of mat on this repair. You can also see that a thread of carbon fiber made its way into my repair. This won't affect the performance or integrity of the repair but it will look funny if I don't remove it.



Figure 25 the finished repair from the inside surface

I will let this sit overnight before I remove the tape and examine the repair. Sometimes gelcoat cures a bit slower than resin. Even though the resin is hard and not tacky to the touch, the gelcoat may be soft. Pulling the tape off uncured gelcoat will make for more work on this repair. Patience is a virtue.

FINISHING THE REPAIR

After the fiberglass has cured, I can remove the tape and examine my repair. Usually, with a painted piece, I would not worry about the cosmetic appearance of the gelcoat as my intent would be to sand, fill and paint over the gelcoat anyway. Since, however, we are talking about fiberglass repair, I will take this opportunity to show you how to put a nice smooth finish on an exterior gelcoat surface.

You can see in the picture below that the gelcoat finish is good but it is definitely visible. I want this repair to blend and look like it was never damaged.



Figure 26 Repair is Semi-Finished

From a structural strength standpoint, this repair is done. Cosmetically, it still needs some help. This repair needs some more gelcoat applied to the outer surface and a bit of finish sanding to produce a nice looking repair.

Gelcoat can be applied much like a thick, sandable paint. To begin finishing this project, I will first tape off the area in which I will be working. I do this to limit the “damage” to my surrounding surfaces.



Figure 27 Taped for Finishing

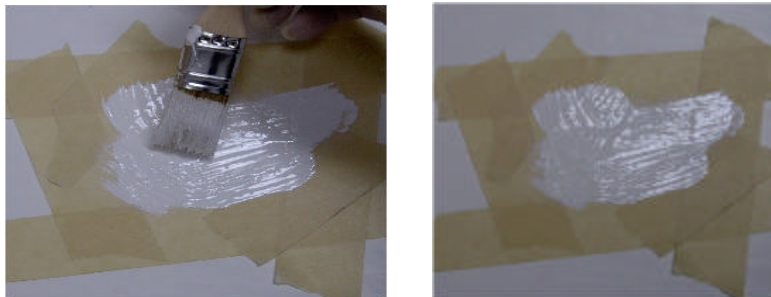
I always like to protect the surrounding area from my raw materials.

The next step is to roughen the surface of the gelcoat that I just used for the repair. I use 60 grit paper to accomplish this task. Just a few passes will do. Roughening the surface gives the new gelcoat that I will apply something to stick to.



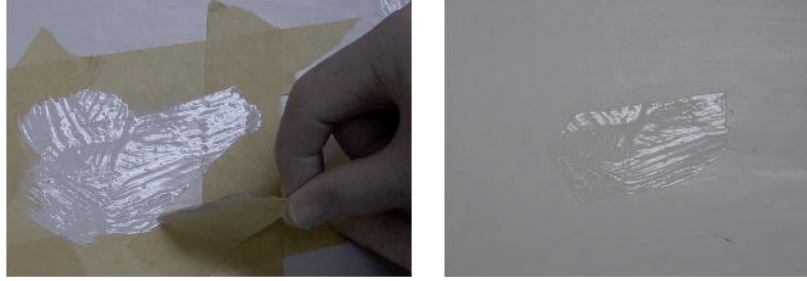
Figure 28 Sanding to Roughen the Surface

With the repair taped off and sanded, I can apply the gelcoat. I don't need much gelcoat for this job so I mix just what I need with a few drops of MEKP (following manufacturer's directions) and apply the gelcoat with a disposable brush. See photographs below.



Figures 29 & 30 Gelcoat application to the surface of the repair.

Once the gelcoat has been applied, and before it begins to cure, I like to remove my masking tape. Removing the tape before the gelcoat cures saves me one more hassle down the road.



Figures 31 & 32 Removing the masking tape and the gelcoated outer surface.

The gelcoat will need some time to cure. Just a note on gelcoat; gelcoat cures best without exposure to air. It is not uncommon for the outer surface of a gelcoat repair to have a slight tackiness do to its' contact with air. If you encounter this problem, there are several things that you can do to get the surface to fully harden. I sometimes just cover the gelcoat with saran wrap or wax paper. Either of these prevents air from getting to the gelcoat allowing it to cure. You can also spray it or brush it with PVA mold release agent. The PVA also provides an air-free environment for the gelcoat to cure.

Once the gelcoat has fully cured, I can begin sanding. I always get the best results by using a sanding block. For this project, I don't have much material to remove. Therefore, I begin sanding with 320 grit paper. I progressively use higher grit paper all the way up to either 1200 or 1500 grit (wet sanding of course).



Figure 33 Ready for final sanding.

Gelcoat can be polished to a high luster with patience and the right materials. Progressively finer wet sanding followed by rubbing compound, polishing compound and wax will produce a mirror finish on gelcoat. See photograph below.

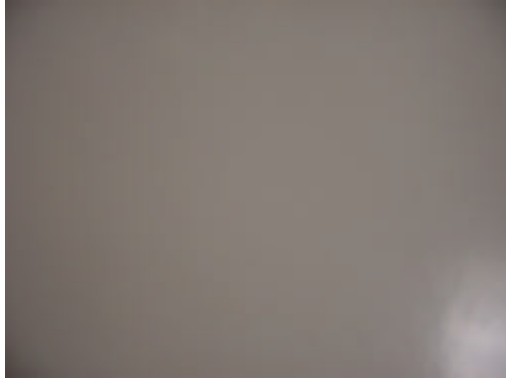


Figure 35 Polished to a shine and ready to paint.

I had indicated early on in this manual that my goal was to prepare this panel for painting. I usually use body filler to smooth the surface of a repair that will be painted, however, in this case the outer application and subsequent sanding / polishing of gelcoat has essentially become the body filler.

At this point, the only step left in the repair of this fairing piece is painting.

In summary, I started with a hole in my fairing that was repaired with less than \$50 dollars of materials and a few hours of my time. Not only do I enjoy this kind of work (although I must admit that I never enjoy finding my vehicles damaged), but I get the satisfaction and added experience of repairing it myself. Additionally, at this point in my life, I have more time than money. A repair like this would be expensive at a body shop, if you could even find a place that would do it.

Materials List

THIS IS A LIST OF THINGS THAT YOU WILL NEED TO MAKING A REPAIR OR A MOLD.

- 1) **Laminating Resin:** This is the basis of any fiberglass project. You will use this for both your mold and the pieces that you make with your mold. Resin is usually bought by the gallon but can be purchased in smaller quantities.
- 2) **MEKP:** This is what catalyzes or hardens the laminating resin and the gelcoat.
- 3) **Gelcoat:** This is what you will use to make your pieces. Gelcoat is sprayed or brushed into the cavity of your mold before mat and resin are laid down. Gelcoat comes in many colors and can be color matched much like paint.
- 4) **Fiberglass Mat:** This adds strength and form to the resin. Mat is bought by the yard and comes in many different weights.
- 5) **PVA:** This is sprayed or wiped onto the plug or mold cavity to prevent the resin and gelcoat from sticking. PVA goes on after the mold release wax.
- 6) **Rollers & Brushes:** Used for applying and spreading resin and gelcoat. These should be disposable as they are very difficult to clean.
- 7) **Fume Mask:** Keeps you from becoming horribly ill and full of cancer from your materials. A fume mask is a must.
- 8) **Latex Gloves:** These keep your hands clean. I use a lot of these.
- 9) **Acetone:** Used to clean up your tools after you are finished. This stuff cuts right through both the resin and the gelcoat.

Glossary Of Terms:

Clay: Used to keep laminating resin from seeping into areas that you don't want it to go. This can be anything from quality modeling clay to play dough. I have even used silly putty in a pinch. Soft clay is much easier to work with.

Dump Gun: Used for applying thick materials with an air compressor. Gelcoat is nicely applied with this type of air gun.

Finishing Gelcoat: Used to build your products. This stuff can be buffed to a shine just like paint.

Gel: A term used to describe the resin or gelcoat when it begins to cure and is in transition from a liquid to a solid. The material will have a sticky jelly like consistency.

Laminating Resin: This is the resin used with fiberglass mat to make fiberglass. Laminating resin gives the mat form and strength.

Lay-Up(s): A Lay-Up is the process of applying layers of fiberglass mat.

Mat: Chopped mat used for giving your mold and pieces strength and form.

MEKP: Hardener used with both laminating resin and gelcoat.