

REPAIR

| QUICK REPAIR GUIDE | | |
|--------------------|---------------|------|
| Problem | Procedure | Page |
| Maintenance | Cleaning | 15 |
| Cuts and Scratches | Resin Sealing | 16 |
| Cracks | Splicing | 17 |
| Chipped Flange | Resin Filling | |
| Burns | Burns | |
| Small Cracks | Glass Lay-Up | |
| Holes Mislocated | Hole Filling | |

CLEANING

Prior to any repairs, it is necessary to remove foreign material which may contribute to poor adhesion in the repair and/or electrical problems. Routine cleaning is recommended as a preventative maintenance measure. Two methods have been employed in cleaning Exel Composites FRP; one method involves a solvent wipe technique and the other method utilises steam cleaning.

Solvent Wiping

This method is popular because it does not rely on the accessibility of a steam line; for many Exel Composites shapes already in service, this is the only practical technique. In this procedure, the FRP shape should be wiped using a non-abrasive cloth and a solvent such as acetone (highly flammable). The cloth may require repeated soaking in these solvents as they evaporate readily (do not use gasoline). Do not wipe surfaces to be adhesively bonded with a solvent dampened cloth (see pg. 10 "Making the Adhesive Joint").

Note: Do not immerse Exel Composites FRP in solvents as prolonged soaking may cause damage.

Caution: Most solvents are flammable and the vapours can be harmful; do not apply by spraying.

Abrasive cloths may ultimately be required for complete cleaning. If these are used, some surface repair may be required prior to returning the part to service.

Steam Cleaning

The following procedure should be followed if the part is to be cleaning by steam:

1. The steam heat temperature should not exceed 250°F; the pressure should be below 85 psi.
2. For steam cleaning, elevate one end of the Exel Composites shape whenever possible; this permits drainage for the dirt and condensed water. Do not turn the steam jet directly onto any hose assembly (as in booms) for an extended period; this may cause hose damage.
3. Do not apply the steam jet directly to any adhesive joints as this may loosen the joints resulting in erroneous electrical readings or other problems.
4. Permit the FRP shape to dry for 24 hours after steam cleaning as the areas to be repaired must be dry.
5. Use the Solvent Wiping procedure for difficult substances such as road tar.

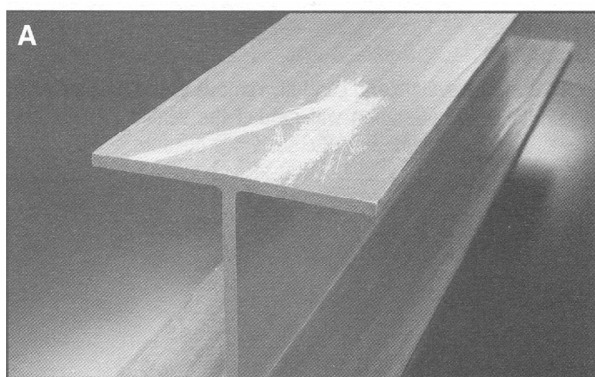
Inspection

Part of the cleaning procedure must be a thorough inspection of the FRP shape. Ruptures to the surface can be caused by bolts, tools, or other items striking the part. Minor impacts normally have a minimal effect on the electrical and/or mechanical properties of the structural shape, but may cause cosmetic problems.

If any question on the performance of the FRP exists, contact Exel Composites Customer Service Department on (03) 8727 9600.

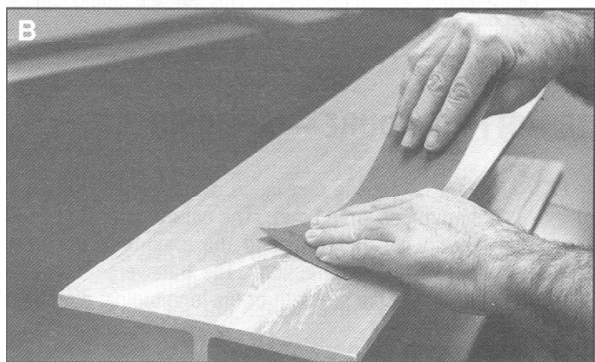
REPAIR PROCEDURE – RESIN SEALING

Exel Composites structural shapes are manufactured with a resin rich surface; this is accomplished using a synthetic surfacing veil in most products, improving corrosion and ultraviolet resistance. This veil also prevents “*Fibre Blooming*” – the emergence of glass fibres onto the surface of the part. If the surface has been drilled, cut, punched, sanded, or otherwise broken, exposing the glass reinforcement, the surface must be *Resin Sealed* to maintain optimum properties. Picture A is an example of such a defect.



Procedure

1. Sand the damaged area as in Picture B. Remove the dust and clean as required. Verify that the area to be repaired is free of moisture to insure proper adhesion of the sealant. Allow to dry if solvent cleaned.



2. Catalysed resins, paints (polyester, epoxy, or polyurethane), acrylic lacquers, or oil based paints can all be used as sealants. All of these products will effectively seal the surface but some resins will provide better corrosion resistance than the paints. Picture C is an example of catalysed resin being applied to the surface. Carefully follow the manufacturer's instructions for the use of these products as there are toxic and harmful vapors that may be generated on cure.



3. Cure the system and carefully remove excess sealant as in Picture D. Sanding will reopen the sealed surface and require a repetition of the sealing procedure.



4. Many users paint the Exel Composites structural shapes to enhance surface appearance. Structurally, the synthetic veil enables Exel Composites FRP to suffer only minimal damage due to ultraviolet radiation; however, some fading of the surface pigmentation will be observed. This surface fading can be minimized by painting.

REPAIR PROCEDURE – SPLICING

FRP is a composite consisting of uni-directional glass rovings and continuous strand mat. The uni-directional rovings are in the lengthwise direction and the maximum physical properties are also in that direction. The transverse direction has approximately $\frac{1}{4}$ the strength of the longitudinal direction.

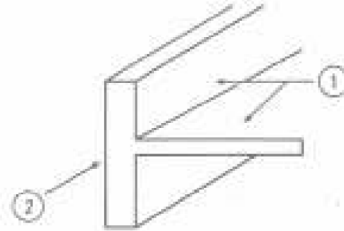
As a policy, Exel Composites does not ship fractured FRP profiles. However, during customer fabrication or in-plant operations these profiles may be damaged. The left flange in Picture E is an example of this damage. When the profile is fractured, its function in the structural application must be carefully reviewed from an engineering viewpoint. In general, if a profile has been struck by a blow severe enough to cause a fracture in excess of 4", the best repair is to replace the entire section. If replacement is not feasible, then the damaged section must be repaired to maintain its structural integrity. Failing to do so may result in the fracture propagating down the entire length of the structure.



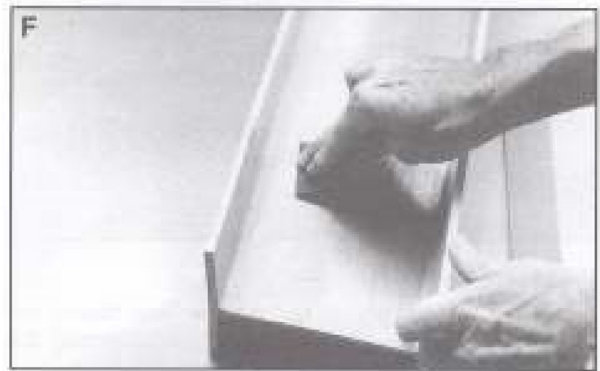
Procedure

1. This procedure will use a Exel Composites Wide Flange Beam as an example. The concepts will be similar for other structural FRP profiles, Exel booms, and Exel custom shapes; the "splicing profile" sections may be different.

2. Conceptually, the splice will be made using angles on each side of the beg/flange interface (see 1 on the sketch) and flat sheet on the back surface of the flange (see 2 on the sketch). Care must be exercised in selecting profiles with sufficient physical properties for the application.



3. Cut the angles and plate to be used as a splice 6" longer than the fracture. A good "rule of thumb" is to use the same thickness on the "splicing profiles" as the damaged profile. For Exel structural shapes, the same colour should be used for the "splicing profiles" as the damaged profile; the various grades of Exel Composites FRP are colour coded for corrosion and flammability resistance.
4. The procedure will utilise an epoxy adhesive for the bond. Trace the outline of the "splicing profiles" onto the damaged profiles and sand as in Pictures F and G. The tracing will aid in avoiding sanding where no bonding is to occur. Sanding is necessary for best adhesion of the epoxy bond.



REPAIR PROCEDURE – SPLICING



5. Clamp all of the profiles into position as shown in Picture H and drill holes for the subsequent insertion of Fibrebolt. Pre-drilling will insure minimum movement of the profiles after the epoxy adhesive has been applied; movement of the epoxy joint can damage the adhesive strength. The Fibrebolt will hold the splice together while the adhesive “sets” and serve as an additional bond. The Fibrebolt should not be considered as the primary bond.



6. Mix enough epoxy adhesive to cover all of the bonding surfaces. MMFG's epoxy repair kit requires that one part of hardener be added to one part of base until a uniform grey colour appears. An example of this mixing is seen in Picture I. Care must be exercised in using epoxy adhesives; the epoxy is toxic and the vapors may be harmful. Detailed instructions and precautions can be found on MMFG's Epoxy Adhesive Kit.



addition to the damaged section. The mechanical clamp supplied by the Fibrebolt will squeeze the epoxy into the damaged area. Do not permit the profiles to stand after applying the adhesive; proceed to the next stem immediately.

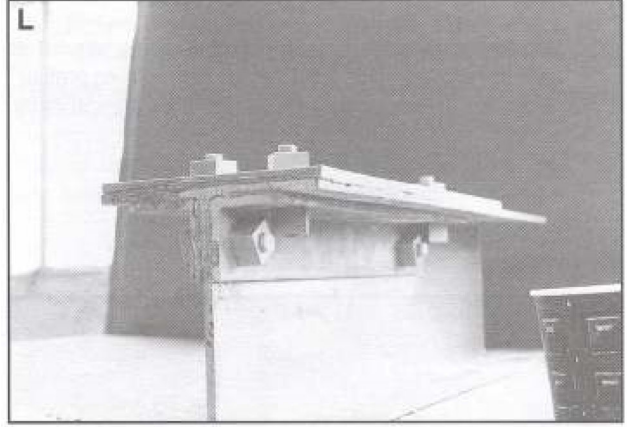
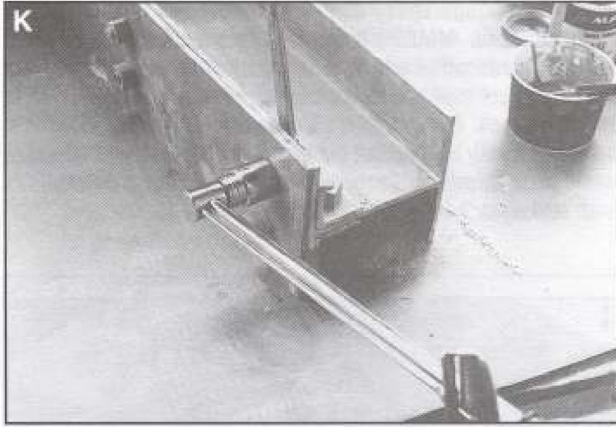
8. After coating with adhesive, place the “splicing profiles” onto the damaged profile. Insert the Fibrebolt and tighten



with a torque wrench as seen in Picture K (Consult Exel Composites publications for the amount of torque that can be applied with the size of Fibrebolt used). Remove excess adhesive from the repaired section before it cures. Wait 48 hours for the adhesive to cure prior to using the damaged section.

7. Spread the adhesive over the surfaces to be bonded as seen in Picture J. This must include the splicing profiles in

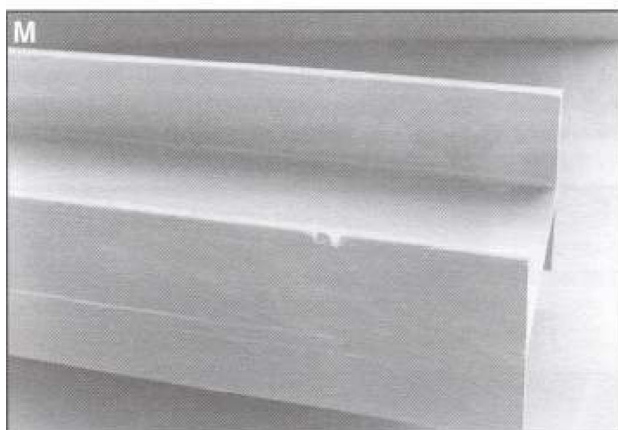
REPAIR PROCEDURE – SPLICING



9. After the epoxy adhesive cures, it may be desirable to chip away any of the epoxy that has squeezed from the joints. An example of epoxy squeeze out is shown in Picture L. The repair will be functional whether or not the excess is chipped away. If the adhesive is still soft after 24 hours at room temperature (70°F), it may be an indication of an off ratio mix of epoxy. If still soft after 48 hours, a new repair may be required.
10. In repairing crosswise cracks, the same procedure is employed.

REPAIR PROCEDURE – RESIN FILLING

This procedure will discuss repair techniques when a portion of the flange has received minor damage due to chipping. An example of this can be seen in Picture M. In this situation, the repair is not severe enough to warrant a splice repair; however, some repair is required to prevent the absorption of contaminants. The following procedure will be less expensive than Resin Splicing and still functional.



Procedure

1. Sand the damaged area to remove all loose material and to provide a good bonding surface. After sanding, the damaged area must be cleaned and dried.



2. Epoxy or catalyzed resin may be used in this repair. If epoxy is used, the mixing procedure of the previous section is applicable. If catalyzed resin is used, mix 4 ounces of

Hetron 92 with a few drops of DDM catalyst. (The exact ratio can be altered for ambient temperature). If so desired, milled fibre, Cab-o-Sil, or another filler may be added to improve the workability of the filling paste. Pigment can be added to match the colour of the section to be repaired.

NOTE: If the resin/catalyst combination begins to 'smoke' the ratio of catalyst to resin is too high. Make a new mix of resin using less catalyst.

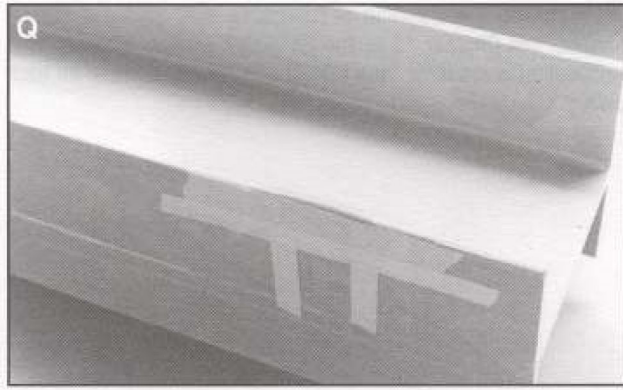


3. Using a spatula or putty knife, fill the damaged area as seen in Picture O.
4. Cover the repair with cellophane and press together, massaging the repaired area to remove entrapped air as seen in Picture P.

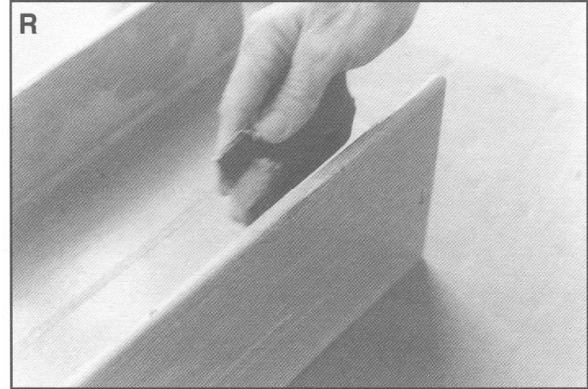


REPAIR PROCEDURE – RESIN FILLING

5. Tape the cellophane securely into position protecting the repair while the resin cures, as seen in Picture Q. Allow 24 hours for proper curing.



After 24 hours, remove the tape and cellophane and carefully sand the repaired area as seen in Picture R. Complete this repair by employing the Resin Sealing repair procedure.



REPAIR PROCEDURE – BURNS

Occasionally, Exel Composites FRP shapes may be exposed to sparks or flames from cutting and/or welding. The resultant damage may range from cosmetic to structural. The extent of the damage can only be ascertained after removal of the charred area using sanding techniques. Portions of the FRP which have not been discoloured can be assumed to have received insufficient heat to cause property problems.

After the char has been removed, the size of the imperfection will dictate the nature of the repair. An engineering decision must be made on which of the procedures presented in this manual is to be employed. At a minimum, the surface should be resealed; if the char area is large and deep, the part should be replaced.

As with all charring, any smoke released may be hazardous if inhaled. The area around the charred part should be ventilated before affecting a repair.

REPAIR PROCEDURE – GLASS LAY-UP

This technique applies when the crack is small and the structural integrity is not threatened. The technique is similar to some procedures used in automotive body repair.

Procedure

1. Sand the damaged area. Taper both sides of the damaged area approximately 2" to 3" above and below the crack and 2" to 3" on either side of the crack.
2. Remove all dust and clean the area to be repaired.
3. Cut a piece of glass mat to cover within ½" at the edges of the sanded area.
4. Cut a piece of 10 mil veil to cover all of the sanded area (multiple pieces may be used to overlap at joints).
5. Weigh the glass veil and mat. Weigh 4 times that weight in resin and add 1% - 5% of DDM catalyst (start with 1%). Stir thoroughly. The pot life of this mixture is dependent upon the percent catalyst and the ambient temperature and must be determined on sight. *Do not* attempt to use catalysed resin after it begins to gel (becoming like jelly).
6. Paint the sanded area with this resin/catalyst mixture.
7. Apply glass material and thoroughly wet with the resin/catalyst mixture.
8. Add layers of glass and resin to obtain the desired repair thickness removing air from each layer.
9. Cover with cellophane until the repair is cured.
10. Sand to a smooth finish and coat with resin mixture for corrosion protection.

SUGGESTIONS FOR HOLE FILLING

A relatively common problem in structural fabrication is hole mislocation. This can occur because of shop error, a drawing error, or a design change after the hole or holes have already been drilled. How the hole is repaired depends on a number of factors including how the load on the structure will be applied, how important appearance is, and the proximity of other holes.

What follows are two suggested techniques for hole filling.

Fibrebolt Procedure

1. Drill the mislocated hole to the nearest tap size.
2. Tap the hole to the smallest Fibrebolt size you have on hand.
3. Apply epoxy adhesive to both the Fibrebolt threads and the hole edges.
4. Screw the Fibrebolt into the hole.
5. Cut the Fibrebolt as close to the material being penetrated as possible.
6. Grind flush.
7. Reseal area with resin after epoxy has cured.

This procedure works well when no other holes are very near the mislocated hole and the new hole location does not intersect the old hole. If another hole is very close or the right location would intersect the mislocated hole, the counterbore procedure (that follows) is suggested.

Counterbore Procedure

1. Using a flattened bit, approximately twice the diameter of the mislocated hole, counterbore halfway through the material with the centre of the counterbore being the centre of the mislocated hole.
2. Using a hole saw, cut a plug of the counterbore from an FPR plate which is half the thickness of the material being repaired. Sand the plug and epoxy it in place. Let the adhesive cure.
3. After the adhesive has cured, and again using a hole saw, cut a similar plug that is the same size as the original hole. Working from the opposite side of the material being repaired as before, epoxy this plug into place. Let it cure.
4. Sand and reseal with resin as necessary.

Neither of these repair techniques will restore original Exel Composites FRP properties.

** For more information on fabrication of fibreglass structural shapes, see Chapter 13 of the Exel Composites Design Manual. This publication is available from Exel Composites. Call +61 3 8727 9600.*

TYPICAL CONNECTIONS

