CARBON FIBRE REPAIR KIT MANUAL

User Guide and Manual

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Introduction

DIY Carbon Fibre Repairs

This guide provides a generic overview for how to repair the outer surface of a carbon fibre part.

Please see our Carbon Fibre Repair Kit to purchase online.

Be advised that it is not intended to restore mechanical attributes; such work is taken at the users own risk and ideally professional assistance should be sought. It can however be used to provide cosmetic and waterproofing restoration to objects such as canoes, paddles and other objects.

If unsure, please read our 'Can Carbon Fibre be Repaired?'

Also note that this guide is suitable for both on- and off-site repairs using hand laminating techniques. It does not require specialist equipment such as vacuum pumps or autoclaves. The resin is fast-curing and designed to cure quickly. For structural repairs, consult a professional.

Installation Guide

In advance, make sure all the materials are at hand and in adequate quantities; stopping and starting work can lead to a sub-quality repair.

The following section contains instructions on how to repair a carbon fibre composite.

Note: we recommend that you practice in small areas using small quantities in advance if you are new or inexperienced with laminating. Resin Library is not liable for any outcome.

Note: use of material in applications not specified or not described in this manual, may result in improper function, personal injury, or damage of the product or material.

Planning & Preparation

Health & Safety

Please familiarise yourself with the Material Safety Data Sheets (MSDS) before starting.

Damaged carbon fibre is potentially hazardous. Please be careful when dealing with broken areas; exposed fibres are extremely sharp.

Risks associated with epoxy resin exposure should be considered in advance. Please consult the SDS sheet and plan accordingly. Epoxy has a range of health hazards which must be accounted for before use.

Perform work in a well-ventilated area or with a suitable mask. Wear protective gloves when dealing with sharp edges or tools.

The addition of hardener to the epoxy should be done carefully; the reaction is exothermic (generates heat).

Personal protective equipment (PPE) should be worn at all times. Recommended PPE includes safety goggles, gloves and overalls. A suitable mask is advised if work is being performed indoors.

For product or technical support, please email (sales@resinlibrary.com) or telephone us on 0333 567 0822.

Use of the products in applications not specified or not described in this manual, may result in improper function, personal injury, or damage of the product or material.

Tools & Materials

A carbon fibre repair kit should come with appropriate quantities of materials (and tools if selected) according to the surface area of the pond.

Materials

- Epoxy Resin
- Epoxy Resin Hardener
- Carbon fibre 2/2 twill (200 gram)
- Release Film
- Peel Ply

Tools

- Laminating brush
- Mixing stick
- Latex gloves
- Mixing pot
- Alcohol Wipe

Suitable Conditions

Repairs using carbon fibre should be performed in a clean, dry area away from other persons and instruments. This means:

- *Avoid water*: good resin curing, and bonding requires dry conditions – that is surface should be dried out and rain avoided by checking the weather forecast. Be sure to plan ahead and check the weather in advance for any rainfall.
- *Temperature*: any work with resin should be done at warm temperatures ideally around 20ºC, as this ensures the resin will cure correctly. Resin

will not cure adequately below 15°C and may require catalyst concentration adjustment. Temperatures above 30ºC may see curing that is too fast.

- *Dust and grease*: any impurities present on the surface (e.g., dust, grease, rust, etc.) – or in the surrounding atmosphere should be reduced as much as possible. Resin bonding and curing is greatly affected by impurities.

Carbon Fibre Repair Kit Instructions

The following section assumes adequate precautions have been taken to ensure a safe working environment. It also assumes users have the correct tools and materials available and have taken adequate care to prepare the underlying pond structure and surface.

1. Identify Repair Area

Carbon fibre damage is usually obvious and limited to small sections. However, quality repairs require inspections; it is important to determine the extent of all damage to determine which areas to repair.

In the absence of more sophisticated equipment, a simple 'coin tapping' approach can be used. For intact areas, a constant noise should be heard with any changes in the sounds (typically a deeper tone) indicative of damage.

Types of damage incurred by carbon fibre - and other composites - includes chipping, notches, trans-laminar cracks, bond failure, matrix cracking, and delamination. Diagnosing some of these can only be achieved via specialist equipment.

Advanced repairs: if more extensive damage has occurred to the underlying structure, this kit could be used as part of a short-term repair system. Alternative repair types, such as scarf or stepped repairs could be performed provided that suitable reinforcement has been used. They could also include bolted repairs, which are easy to apply, but not flush with the surface. Here, it is advisable for professional expertise to be sought.

Note: it is important to plan the repair process carefully. This document is intended for cosmetic and surface-restoration purposes. For higher-end parts or repairs that require greater structural demands, more specialist advice and procedures should be used.

2. Remove Damaged Material

Begin by removing damaged material. The aim is to extract loose debris/fragments of the carbon composite that are loose and protruding from the damaged section. This could be done by hand using a stanley knife or equivalent, but could be assisted through the use of a rotary tool.

Note: a more sophisticated technique would involve cutting slots down the length of any cracks. This will reduce tension in the part.

The aim should be to remove the damaged section(s) without affecting the underlying structure of the repair. If cracks are present, more sophisticated steps may be taken to address splits in the part.

Note: the repair area should extend beyond the damaged section being replaced. Usually this is an extra 5 - 10 cm beyond the confirmed damaged area. It will ensure the new laminate is able to bond well to the existing surface.

3. Sanding

Tape down both sides of the damaged area and create a gap beyond the damaged section. Using a 120 grit sandpaper, carefully sand the damaged area and the surrounding perimeter. Take care to not cause further damage to the carbon fibre reinforcement. Remove residual dust using a brush or air gun and use a solvent-soaked wipe to further clean the repair area.

Add ply to the face to further strengthen the repair. When preparing, aim to avoid sanding the fibres if possible.

Note: tape can be added to border the work area and protect the surrounding structures from cosmetic damage (e.g., scratches or excess resin). Several layers may be recommended to avoid sanding down through the tape itself and damaging the intact surface.

4. Cutting & Sizing Carbon Fibre

Cut the carbon fibre fabric to size before preparing the resin; this will minimise downtime. The carbon fibre should be large enough to cover the roughened area with 10 % extra (or 5 - 10 cm) depending on size. When cutting the fabric, start with an area that is greater than what is required and trim back if needed. Take care to avoid dislodging the carbon fibres. These can be held in position with tape during cutting if necessary.

Note: multiple layers of carbon fibre reinforcement can be applied if necessary to achieve a thicker laminate.

5. Clean the damaged area

Sanding and other debris will contaminate the surface. It is important to remove this prior to the application of the carbon repair system. This may involve a wipe down with a solvent-soaked wipe to create a clean finish.

6. Resin Mix Preparation and Quantities

When mixing the epoxy with hardener, it is advisable to have everything else in place; the pot life is 10 minutes. After this period the epoxy mixture will start to cure and will limit the saturation of fibres in resin and therefore the quality of the repair:

The epoxy resin-hardener ratio should be prepared in a specific quantity. Add 100 parts epoxy resin to 22 parts of hardener. This means for every 100 grams of epoxy, add 22 grams of hardener, totalling 122 grams.

Estimated quantities have been detailed in the table below. It should be noted that these are the minimum amounts of epoxy laminating mixture to prepare for the corresponding surface area of carbon fibre. Users may wish to prepare larger amounts provided the mixture can be used in the given timeframe (note the pot life is 10 minutes).

An excess amount of resin-hardener mixture is included in this repair kit.

The carbon fibre reinforcement weighs 200 gram per square meter. As a rule of thumb, aim to use 200 gram of epoxy resin-hardener mix. Note that additional resin is included in the kit to coat the base substrate and to account for additional requirements.
The final ratio of epoxy resin and hardener mix to carbon reinforcement may vary somewhat on a case-by-case basis and depending on the laminating technique.

Table 1. Minimum Quantities of Epoxy Resin and Hardener per Unit Area of Carbon Fibre

Carbon Fibre		Epoxy	Hardener	Total
Surface Area (m^2)	***Weight (grams)***	***Minimum Weight (grams)***		
0.1	20	3.6	16.4	20
0.25	50	9.0	41.0	50
0.5	100	18.0	82.0	100
1	200	36.0	164.0	200

Note: these are the minimum quantities required to achieve sufficient saturation of the carbon fibre fabric. In reality it is advisable to increase the quantities by approximately 25 – 50 % to account for surface wetting and insufficient laminating.

Note: to be accurate, it is advisable to use a digital weighing scale accurate to +/- 0.1 gram.

Example: 0.25 m2 of 200-gram carbon fibre fabric is approximately 50 grams. For a single layer, this would require 50 grams of epoxy-hardener mix.

Note: be advised that too much resin will create a brittle composite and too little will make it more fragile and permeable.

Place a clean paper mixing cup onto a calibrated digital weighing scale. Add in the resin and hardener, then carefully mix using a clean mixing tool. Take care to mix the corners of the cup and also to avoid introducing air bubbles into the mixture via vigorous mixing.

7. Wetting out the Carbon Fibre Cloth

Before placing the carbon fibre cloth to the repair area, users may wish to saturate the laminate in resin between two pieces of release film. The plastic sheeting is included in the carbon fibre repair kit.

The benefit here is that the fabric can be carefully wetted out in a gentle environment prior to transfer.

Place the pre-cut carbon fibre fabric onto the release film.

Using a clean brush, carefully apply the epoxy mix to the fabric. The aim should be to saturate the fibres and drive out air bubbles without using excessive quantities of resin.

8. Apply the carbon fibre to damaged section

Once the carbon fabric has been wetted out, carefully transfer it to the damaged section.

Carefully adjust the carbon fabric to ensure it is in position.

Note: the carbon fabric fibres should be delicately handled. It is important to ensure they are not dislodged as this will create voids in the laminate and reduce the repair strength.

Note: if multiple layers of reinforcement are required, apply them successively and when wet. It is generally advisable to only apply 2 - 3 layers of resin-saturated fabric at a time as this will avoid overheating and warping the laminate, since the epoxy-hardener reaction is exothermic.

9. Saturate the carbon fabric in epoxy

Apply additional resin until a consistent finish is achieved. If you are transferring dry fabric, ensure sufficient resin is applied once in place.

There should be an absence of dry blotches and uneven sections and bulges suggesting inefficient saturation.

10. Peel Ply

Peel ply is a fabric used to improve the surface finish of a laminate.

It is applied over the wet laminate and left until cured. When applying it, create an excess that covers the surface of the carbon repair. Once cured, the peel ply is carefully removed to reveal a clean, smooth surface.

Once the repair has cured, carefully peel off the peel ply material. It should come off cleanly, leaving behind a textured surface that is ready for additional layers of composite material or finishing.

11. Allow to Cure

Allow the laminate to cure. The repair should be hard and rigid.
The length of the curing process will depend on the size of the repair and the hardener type used.

12. Finish

Once the laminate has cured, sand the surface with sandpaper and wipe with a solvent. More refined sandpaper can be used if a smoother finish is required.

Apply a suitable polish; this is bespoke to each project. It is generally advisable to consult the manufacturer of the original part for a matching colour and paint type

Note: a final layer of resin may be applied for cosmetic and protective purposes. Epoxy resin is not UV resistant and at best offers limited resistance.

13. Dispose of Waste

Make sure to dispose of all waste in accordance with local regulations. Epoxy resin waste is hazardous and must be disposed of in the appropriate manner.

Appendix

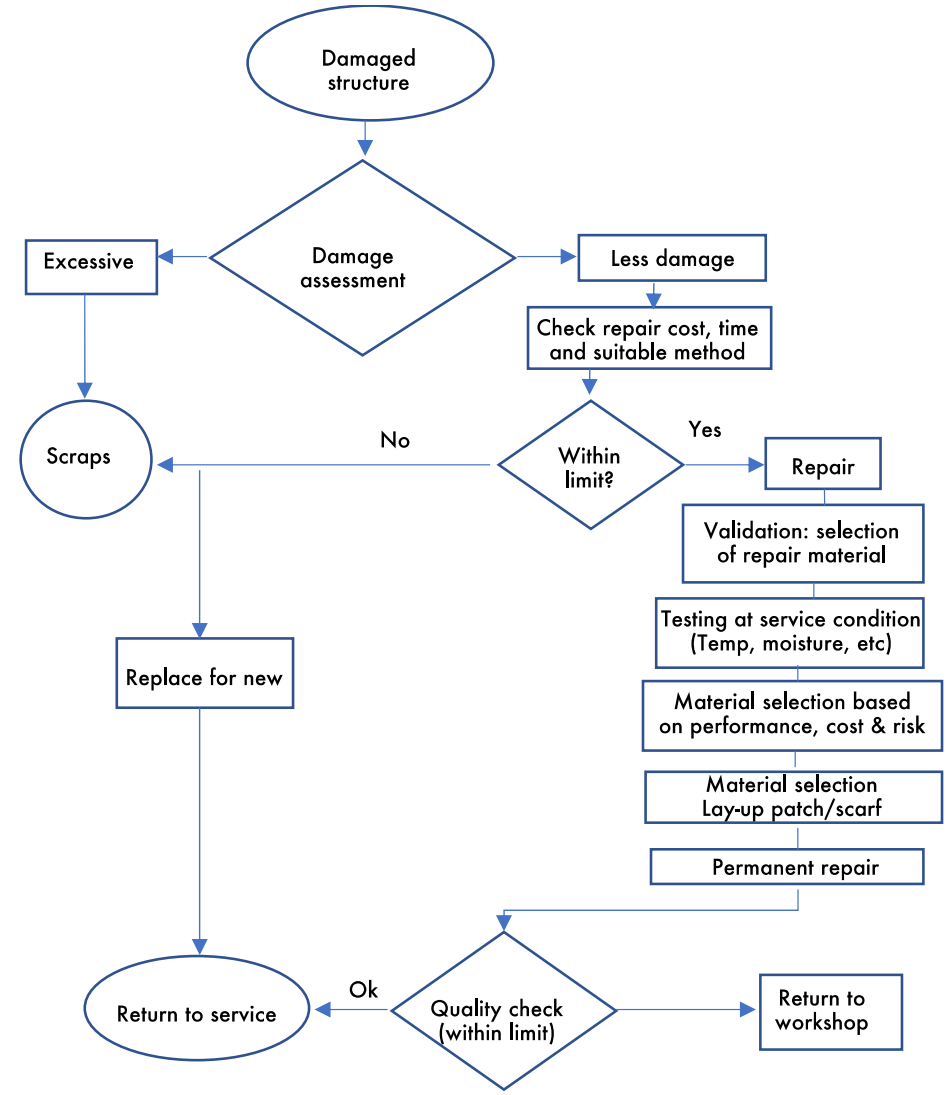


Figure 1. Decision tree adapted from the aerospace industry can be used to evaluate a damaged structure for repair

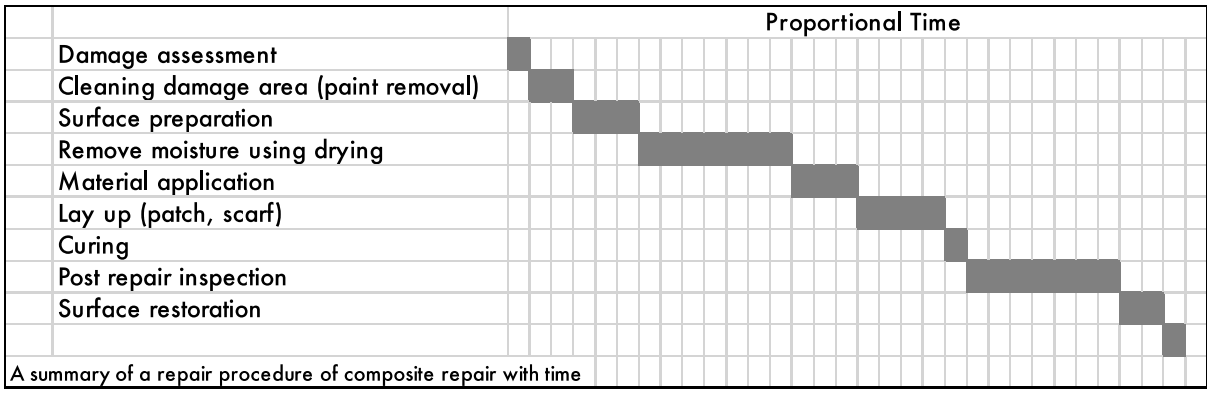


Figure 2. Summary of repair procedure of composite repair with time.