Ministry of Labor and Skills

Automotive Body Repair and Paint Work

Level-IV

Based on March 2022, Curriculum Version 1

Module Title: - Repairing Fiber Glass/Composite Material Components

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Acknowledgment

Ministry of Labor and Skills wish to extend thanks and appreciation to the many representatives of TVT instructors and respective industry experts who donated their time and expertise to the development of this Teaching, Training and Learning Materials (TTLM).

Acronyms

CMM ------------------------Ceramic Matrix Materials

MMC------------------------ Metal Matrix Composites

NDI --------------------------Non Destructive inspection

NDT------------------------ --Non Destructive Test

OHS-------------------------- Occupational Health and Safety

PMC-------------------------- Polymer Matrix Composites

PPE-------------------------- Personal protective equipment

TTLM----------------------- Teaching, Training and Learning Materials

UV--------------------------- Ultra violet

Introduction to the Module

In automotive body repair and paintwork field, repairing fiber glass/composite material components module is very important for repairing any damage in vehicle body containing composite materials. Composite repairs are needed due to either manufacturing or in-service defects. Therefore, the composite materials damage needs to be detected and repaired quickly and cost effectively while conducting non-destructive testing to ensure the repair's success. Once the extent of the damage and the type of material is known, it is possible to determine whether the part in question should be repaired or replaced.

This module covers the units:

- Fundamentals of Composite Materials
- Composite materials repair procedures
- Cleaning up work area and maintain equipment

Learning Objective of the Module

- Understand Fundamentals of Composite Materials
- Carry out Composite materials repair procedures
- Clean up work area and maintain equipment

Module Instruction

For effective use this modules trainees are expected to follow the following module instruction:

1. Read the information written in each unit
2. Accomplish the Self-checks at the end of each unit
3. Perform Operation Sheets which were provided at the end of units
4. Do the “LAP test” giver at the end of each unit and
5. Read the identified reference book for Examples and exercise

Unit One: Fundamentals of Composite Materials

This unit is developed to provide you the necessary information regarding the following content coverage and topics:

- Construction of composite Materials
- Types of composite materials
- Application of composite materials for vehicle body
- Application of fiberglass for vehicle body
- Occupational Health and Safety (OHS) Requirements

This unit will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Understand construction of composite materials
- Identify types of composite materials
- Examine Application of composite materials for vehicle body
- Grasp application of fiberglass for vehicle body
- Observe Occupational Health and Safety (OHS) requirements

1.1. Construction of Composite Materials

A composite material can be defined as a combination of two or more materials that results in better properties than those of the individual components used alone. In contrast to metallic alloys, each material retains its separate chemical, physical, and mechanical properties. The two constituents are a reinforcement and a matrix. Composites are simply a combination of two or more constituent materials with different physical or chemical properties. When combined, they produce a material with characteristics different from their original properties. The two main components within a composite are the matrix and fiber. The matrix is the base material while the fiber is what reinforces the material. On top of the fiber reinforcements and matrix, composites can also include core materials, fillers, additives and surface finishes to provide unique performance attributes.

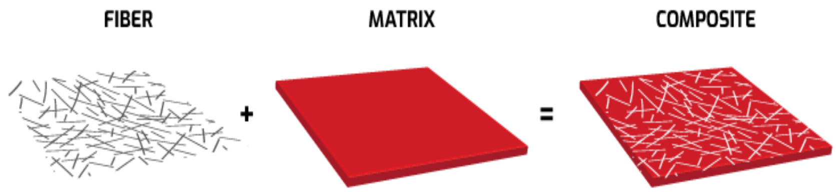


Figure 1-1: Constituent materials of composites

An example of a typical composite is fiber-reinforced polymer where the polymer act as matrix and the fibers simply acts as the reinforcement. The matrix binds the fibers together somewhat like an adhesive and makes them more resistant to external damage. The matrix is here soft in comparison to the fibers, so when combining the two of them mechanical properties (stiffness, strength, toughness etc.) is expected to increase, compared to the matrix material.

The main advantages of composite materials are their high strength and stiffness, combined with low density, when compared with bulk materials, allowing for a weight reduction in the finished part. Composite materials, and most especially advanced composites, are best noted for their low density, high modulus, and high strength. Other desirable properties are offered, however, by this interesting class of materials such as fatigue and creep resistance, proof against corrosion, excellent wear, high natural frequency, high damping characteristics, either electrically conductive or electrically resistant, dimensionally stable, and thermally insulating.

1.2. Types of Composites Materials

Composites materials is made up of two components. The matrix, which shapes the part geometrically, gives cohesion to the material, is usually flexible and not very strong and transmits the stresses from one fiber to another. The reinforcement, which provides stiffness and strength to composite materials. Therefore, composite materials can be classified according to either the type of matrix or reinforcement.

1.1.1 Metal Matrix Composites (MMC)

Metal matrix composites are composed of a metallic matrix (aluminum, magnesium, iron, cobalt, copper) and a dispersed ceramic (oxides, carbides) or metallic (lead, tungsten, molybdenum) phase. High strength, fracture toughness and stiffness are offered by metal matrices than those offered by their polymer counterparts. They can withstand elevated temperature in corrosive environment than polymer composites. Most metals and alloys could be used as matrices and they require reinforcement materials, which need to be stable over a range of temperature and non-reactive too.

MMC usually consist of a low-density metal, such as aluminum or magnesium, reinforced with particulate or fibers of a ceramic material, such as silicon carbide or graphite. Compared with unreinforced metals, MMCs offer higher specific strength and stiffness, higher operating temperature, and greater wear resistance, as well as the opportunity to tailor these properties for a particular application.

Titanium, Aluminum and magnesium are the popular matrix metals currently in vogue, which are particularly useful for aircraft applications. The melting point, physical and mechanical properties of the composite at various temperatures determine the service temperature of composites.

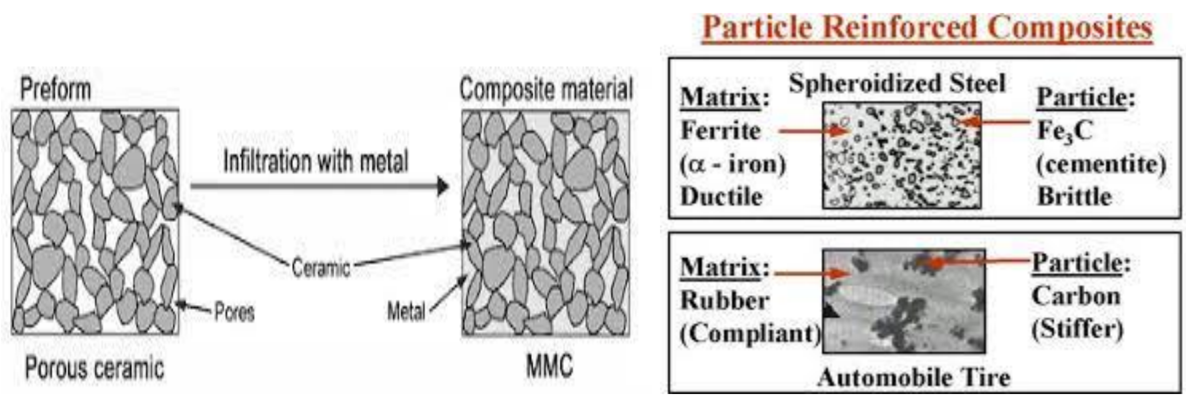


Figure 1-2: Metal Matrix Composites and its application

Since the day work on metal matrix composites commenced, aluminum and its alloys played a vital role as matrix materials due to the increase in demand for high-strength, lightweight components. Similarly, magnesium and titanium alloys are also employed as metal matrix material, but both have their demerits because magnesium quickly reacts with the atmosphere, so processing is complicated; as for titanium, it is highly reactive and forms inter-metallic with many reinforcement materials.

Many automotive engine manufacturers already replaced forged steel with MMCs. Piston, piston ring, connecting rod, brake rotor, cylinder liner bearings, bushings, etc., are some of the components made by MMCs due to their wear resistance, high strength, specific stiffness, and fatigue strength.

1.1.2 Ceramic Matrix Composites (CMC)

Ceramic Matrix Composites are composed of a ceramic matrix and embedded fibers of other ceramic material (dispersed phase). Ceramics can be described as solid materials which exhibit very strong ionic bonding in general and in few cases covalent bonding. High melting points, good corrosion resistance, stability at elevated temperatures and high compressive strength, render ceramic-based matrix materials a favorite for applications requiring a structural material that doesn't give way at temperatures above 1500ºC. Naturally, ceramic matrices are the obvious choice for high temperature applications.

CMCs offer the possibility of structural materials capable of operating at temperatures above 1200 °C in air. The relationship between the fibers and the matrix material is not that found in most composites. The primary role of the fibers is to provide a mechanism to impede crack propagation in the matrix.

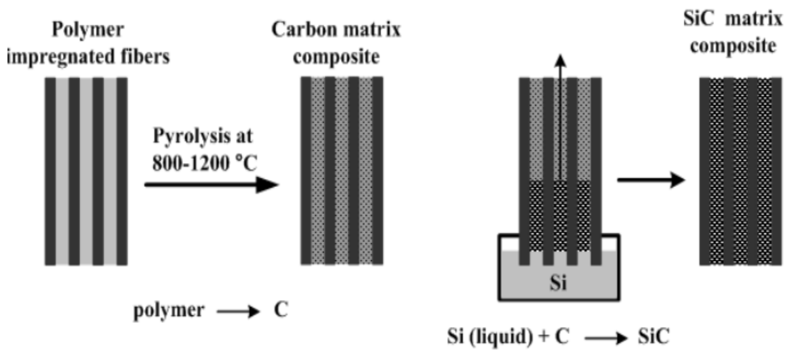


Figure 1-3: Structure of ceramic matrix composites

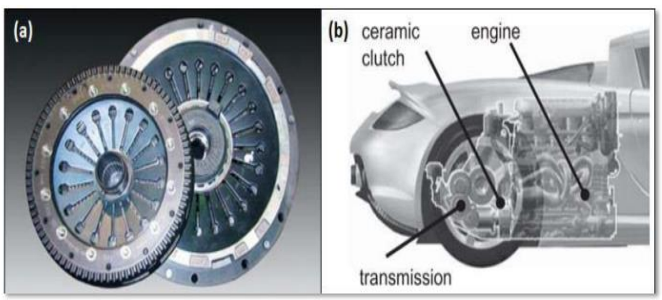


Figure 1-4: Application of CMC ceramics for automobile

1.1.3 Polymer Matrix Composites (PMC)

Polymer matrix composites (PMC) are composed of a matrix from thermoset (Unsaturated Polyester, Epoxy or thermoplastic (Polycarbonate, Polyvinylchloride and Nylon) and embedded glass, carbon, steel or Kevlar fibers. Polymer PMCs combine the advantages of the high elastic modulus and strength of the reinforcement with the shear strength and toughness of the polymer matrix. Some of the advantages with PMCs include their lightweight, high resistance to abrasion and corrosion, and high stiffness and strength along the direction of their reinforcements. Polymers are relatively weak materials with low stiffness and high viscoelasticity compared with the other two types of matrix. However, these matrices possess good deformability and shape versatility, and their electrical and mechanical properties can be greatly altered by using specific reinforcements.

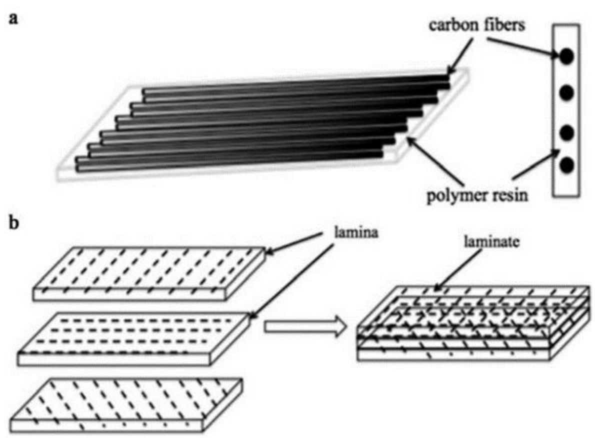


Figure 1-5: (a) Typical structure of carbon-fiber-reinforced polymer; (b) laminate formed by stacking single lamina

1.3. Application of Composite Materials for Vehicle Body

Automotive manufacturers are working to reduce weight and emissions, and increase the safety and durability of cars. For this reason, they cooperate with manufacturers of composite materials who have many years of experience with the extensive use of composites.

Primary reasons for conversion to composite material in automotive industry is weight reduction and lower cost, although other factors such as integration, noise reduction, improved styling, and overall part performance come into the equation as a secondary consideration. Using composites materials offer significant benefits compared to metals: they help to reduce mass, corrosion issues, provide a greater design freedom with higher space efficiency, faster assembly, better flame resistance and durability, and still meet stiffness performance.

Fig 1-6: Components a vehicle from fiber composite material

Composites are widely used for a range of automotive parts, from headlamp housings for forward-facing headlamps, to beneath-the-hood electrical and heat-shielding components, to exterior body parts and interior structural and cosmetic components. More specifically, composites are used in parts including:

- Bumpers and bumper beams
- Frames for windows/sunroofs
- Front-end grill opening panels
- Heat shields (e.g. engine, transmission)
- Pillars and coverings

1.4. Application of Fiberglass for vehicle body

Fiberglass is a glass filament or fine strands of glass that can be added to plastic to increase its stiffness and strength. That is why fiberglass is sometimes known as glass fiber reinforced plastic or glass reinforced plastic.

Currently, many vehicle parts being made of fiberglass. Almost every car has fiberglass components and body kits. It is mainly used in the front and rear bumpers, hoods, doors, and casings due to the high tensile strength of the fiberglass. Fiberglass is made from molten glass that is pulled or extruded through small holes in an industrial furnace, and stretched into fine fibers called yarn.

Glass fibers can be comprised of different types of glass. Flattened into a sheet, the glass fiber is randomly arranged or woven into a fabric. It is lightweight, strong and less brittle. Fiberglass is a material that has many qualities that make it suitable for automotive use. Fiberglass has waterproof properties, and it can easily absorb moisture, protecting auto parts from rust and corrosion. If you want to seal a welder auto part, a thin layer of fiberglass is enough. Fiberglass filler can also be used over bare metal.

It can also be used for auto repairs or body parts as a finishing material. This means that fiberglass can help seal the finishing work on auto parts by bringing out a smooth feel and look. We recommend only applying a small amount of fiberglass to the welded part and then sanding it. After this, you can apply fiberglass filler to finish the process. Fiberglass car bodies are formed from chopped fiberglass preforms and fiberglass mats fused together with a polyester resin. When resin cures or hardens, it binds fiberglass filaments together to form a solid reinforced panel having unusual strength. A reinforced fiberglass body has a high resistance to impact, which means it will not dent. .Fiberglass is lightweight, strong and less brittle. The best part of fiberglass is its ability to get molded into various complex shapes. Depending on the raw materials used and their proportions, fiberglass can be classified into following major types:

- A-glass: Also called alkali glass and is resistant to chemicals.
- C-glass: Also called chemical glass and is very good resistance to chemical impact
- E-glass: Also called electrical glass and is a very good insulator of electricity
- S-glass: Also called structural glass and is known for its mechanical properties.

Properties of fiberglass

- Has a specific resistance greater than steel. So, it is used to make high-performance
- It is a good electrical insulator even at low thickness.
- Since fiberglass is a mineral material, it is naturally incombustible. It does not propagate or support a flame.
- It is not sensitive to variations in temperature and hygrometry.

- It can have varying sizes and has the ability to combine with many synthetic resins and certain mineral matrices like cement.
- It has low thermal conductivity

1.5. Occupational Health and Safety (OHS) Requirements Requirements

Automotive body, paint and interior repair involves the use of hazardous substances like solvents and paints. These substances can cause occupational asthma, skin sensitization/allergic dermatitis and affect the central nervous system. Safety is critical because chemicals used in composite processes can cause breathing if precautions are not taken.

Safety precautions while working with composites

Composite materials are very strong and durable, but they also require special safety precautions.

- Wear protective clothing: Including appropriate protective clothing, such as eyeglasses and gloves.
- Use safety-approved tools: Use approved tools and equipment
- Use recommended techniques: Follow the recommended techniques for cutting, drilling, and shaping composite materials.
- Avoid high temperatures: High temperatures can cause composites to become brittle and break.
- Dispose of material safely: Dispose any composite material in a safe and responsible manner.

Composites safety concerns include:

- Solvents: Recognize and identify the highly reactive chemicals that can react with the human body in a harmful way.
- Airborne dust: Fibers are often cut and sanded during processes that can be irritating to the skin and inhaled
- Equipment hazards: Know how to use all equipment and tools with proper personal protective equipment (PPE).
- Fire hazards: Solvents and resins can be flammable, and flashpoints vary.
- Waste disposal: Fibers and resins must be disposed of properly in approved containers.

Personal protective equipment (PPE)

Personal protective equipment, commonly referred to as "PPE", is equipment worn to minimize exposure to hazards that cause serious workplace injuries and illnesses. These injuries and illnesses may result from contact with chemical, radiological, physical, electrical, mechanical, or other workplace hazards. PPE must include full protective clothing including overalls, gloves, head and eye protection and respiratory protection, selected and used in compliance with relevant standards.

The following pieces of PPE will help guard against safety hazards:

- Eye protection: Use safety glasses for chance of solid objects striking the eye and wear a face shield when splash hazard is high
- Skin Protection
- Appropriate clothing: Use shop coat, aprons, coveralls,
- Gloves: Use approved rubber gloves
- Footwear: Use approved close toed safety shoes
- Mask and respiratory protection

Figure 1.7: Personal protective equipment

Self-Check 1.1

Part I: Choose the best answer from the alternatives given

1. The main advantages of composite material is________

A. High strength and stiffness
B. Combined with low density
C. Help to reduce mass, corrosion issues
D. All of the above

2.___________composed of a metallic matrix and a dispersed ceramic or metallic phase.

A. Metal matrix composites
B. Ceramic matrix composites
C. Polymer matrix composites
D. All of the above

3.One of the following is not the property of fiberglass.

A. It is a good electrical insulator even at low thickness.
B. It is sensitive to variations in temperature
C. Have varying sizes and has the ability to combine with many synthetic resins
D. None of the above

4.Safety is critical because chemicals used in composite processes can cause breathing if precautions are not taken.

A. True B. False

Part-II: Fill the blank space in the space provided

1.________ can be defined as a combination of two or more materials that results in better properties than those of the individual components used alone

2.________ is equipment worn to minimize exposure to hazards that cause serious workplace injuries and illnesses.

Part-III: Explain the following questions accordingly

1.List down three applications of composites for automotive body parts.

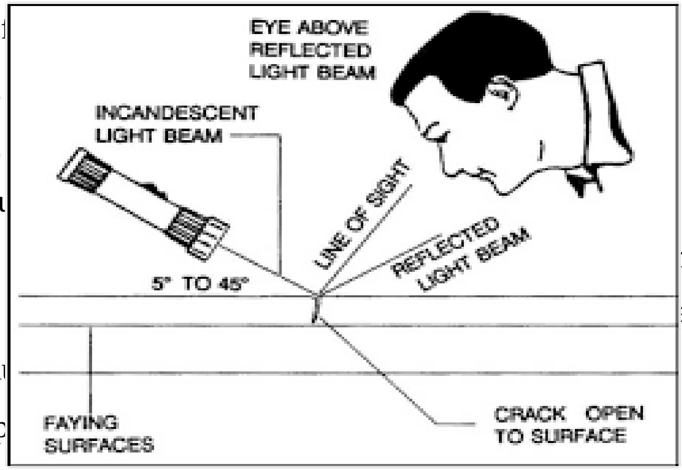
2.List down four types of fiberglass having application for automotive body parts.

3.List down four PPE will help guard against safety hazards:

Unit Two: Repairing Composite Materials

This unit is developed to provide you the necessary information regarding the following content coverage and topics:

- Inspecting f
- Identifying
- Identifying
- Carrying ou



This unit will also ... he cover page. Specifically, ... able to:

- Inspect failu
- Identify rep
- Identifying tools and equipment
- Carryout repairing

2.1 Inspecting Failures of Composite Materials

Damage to composite components is not always visible to the naked eye and the extent of damage is best determined for structural components by suitable non-destructive test (NDT) methods. The extent of composite material damage cannot be easily assessed by visual inspection alone. Accordingly, there are several non-destructive inspection (NDI) techniques for composites, such as tap testing, ultrasonic inspection, X-ray inspection, and thermography, which can be used to detect hidden damage.

2.1.1 Visual Inspection

A basic and useful part of the inspection of composite structures is a visual inspection. The inspector looks for visible signs of look for surface cracks, dents, scratches, bumps, or humps. It is the most basic type of NDT that many instances use because it can save both time and money by reducing the number of other tests.

Determining damage visually is self-explanatory, and major damage will be readily apparent. Heat damage changes the paint color, etc. Always remember that visual inspection only detects surface damage. It can be misleading because of the possibility of damage to the structure underneath.

Figure 2-1: Identifying composite failure using visual inspection

2.1.2 Tap Testing

Tap testing which is performed manually or with a special tap hammer, is one of the simplest methods that can be used in the field on composites. Such testing is often performed by tapping the surface of a structure and discriminating good areas from bad by analyzing differences in sound resonance. The change in sound will usually indicate a problem underneath-either a delamination or the damage of a laminate. When performing a tap test, be aware that the damage might be more substantial on the backside of the structure than where you are testing.

Even light damage will spread out in a cone-shaped area from the point of impact. This means delamination can occur on multiple plies, and usually they will be larger on the backside of the structure than on the impact side. This is true on both solid laminates and sandwich-type structures. While tap-test, try to gain access to the backside of the structure, where there will often be found a larger area of damage.

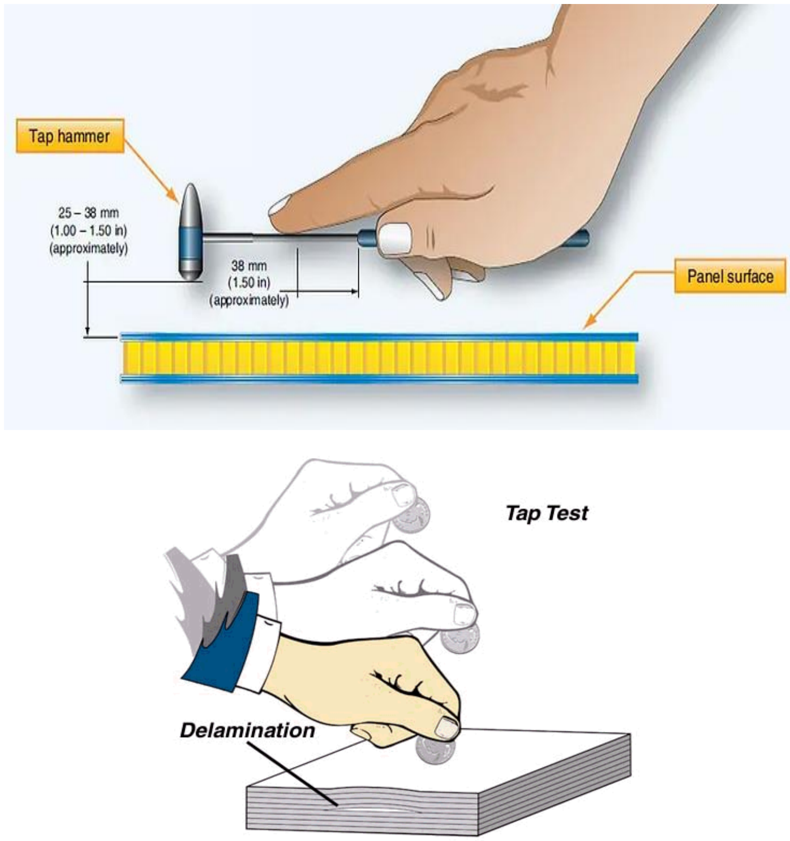


Figure 2-2: Composite damage detection using tap testing

2.1.3 Ultrasonic Inspection

Ultrasonic inspection is another type of non-destructive testing that may be considered for the inspection of composite structures. It consists of a transmitter and receiver circuit, transducer tool, and display devices. Based on the information carried by the signal, crack location, flaw size, orientation, and other characteristics could be achieved.

Alternatively, through-transmission ultrasonic overcome the core limitation of pulse-echo ultrasonic but require access to both sides of the item under inspection. Additionally, through-transmission equipment is typically fixed in a dedicated facility and not generally field deployable.

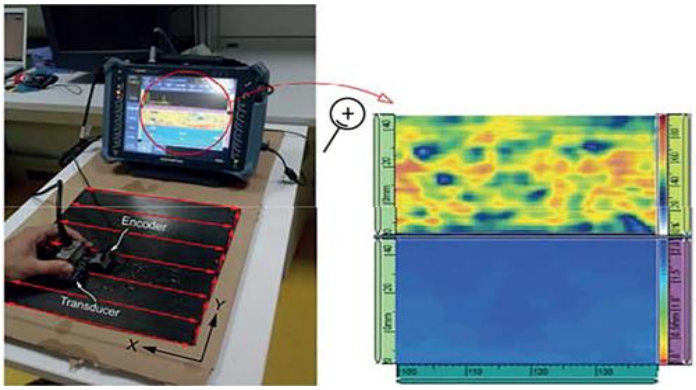


Figure 2-3: Ultrasonic inspection for composite materials

2.1.4 X-ray Inspection

X-ray inspections of composites are performed like those on metal structures. Images are based on material density. It can also see some delaminations if set up at an angle. X-ray equipment can provide the most detailed information to inspectors. However, the major limitation with this type of equipment is detecting delamination parallel to the image plane. Similar to ultrasonic equipment, X-ray equipment is also generally fixed in a dedicated facility and requires well-trained inspectors.

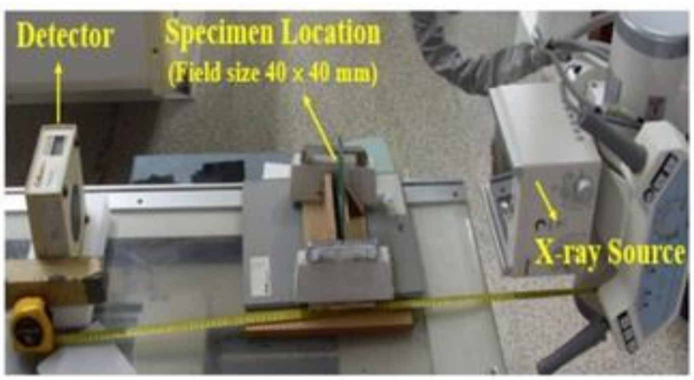


Figure 2-4: Composite material inspection using X-ray equipment

2.2 Identifying Repairing Methods

Repairing a damaged composite component to its original mechanical properties is extremely challenging. The characteristics of the repaired composite are generally never the same as the original. Consequently, there are typically three tradeoffs to consider when implementing a composite repair: strength, stiffness, and weight. For example, if attempting to match the original strength of a composite, the resulting repair is often heavier and stiffer. Key factors for implementing a successful repair include surface preparation, adhesive choice, repair materials, and processing conditions.

Composite repairs are needed due to either manufacturing defects or in-service defects. Once the defect is identified depending on the nature of the defect fill, bonded, bolted or injection repairs can be carried out. Repairs can be categorized as fill, injection, bolted, or bonded. Simple fill repairs are conducted with paste adhesives to repair such nonstructural damage as minor scratches, gouges, nicks, and dings. Injection repairs use low-viscosity adhesives that are injected into composite delaminations or adhesive debonds. Bolted repairs are usually done on thick, highly loaded composite laminates, whereas bonded repairs are often required for thin-skin honeycomb assemblies.

2.2.1 Filling Method

Fill repairs are nonstructural and therefore should be confined to minor damage. Two-part high-viscosity thixotropic epoxy adhesives are normally used for these types of repairs. The surface to be repaired should be dry and free of any contamination that would prevent the filler from adhering. before filling, the surface should be lightly sanded with 180- to 240-grit silicon carbide paper. Once the adhesive is mixed and applied to the surface, most epoxy adhesives will cure sufficiently within 24 hours at room temperature so that they can be sanded flush with the surface. Heat lamps are often used to accelerate the cure by heating the adhesive to 180 ºF (80 ºC) for one hour.

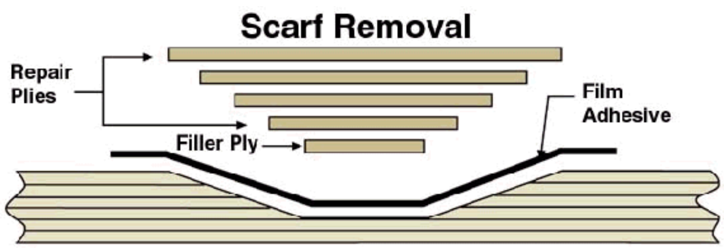


Figure 2-5: Repair applied to matrix cracks in a composite structure by filling and using a sealing patch.

2.2.2 Injection Method

Low-viscosity two-part epoxy adhesives are injected under low or moderate pressure, as shown in the two examples in Figure 2 below. If the delamination does not extend to an edge, small-diameter, flat-bottom holes 0.050 in. (1.3 mm) in diameter are drilled to a depth usually determined by pulse-echo ultrasonic. Two or more holes are generally required, one for injection and one for venting. to help the resin flow into tight delamination, it is helpful to preheat the delaminated area to 120 to 140 ºF (50 to 60 ºC). Preheating reduces the resin's viscosity and helps it flow into the delamination.

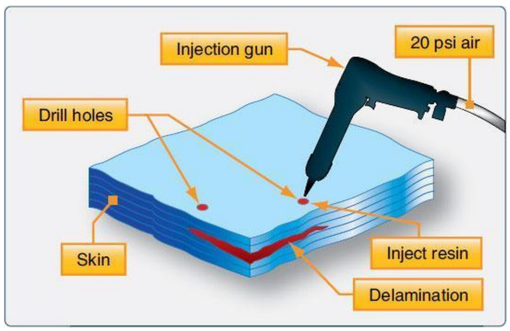


Figure 2-6: Internal Delamination and Edge Delamination

2.2.3 Bolting method

A typical bolted repair consists of an external patch, a center plug in the damaged area, and a two-piece internal patch. the internal patch is split into two pieces so that it can be inserted inside the skin. Normal composite drilling and fastener installation procedures are used. After all of the holes have been drilled and reamed to their final sizes, the patch is removed and deburred. A layer of woven glass cloth is impregnated with sealant to provide both sealing and corrosion protection. The full-size holes in the patch are countersunk, and the patch is installed with either one-sided blind fasteners.

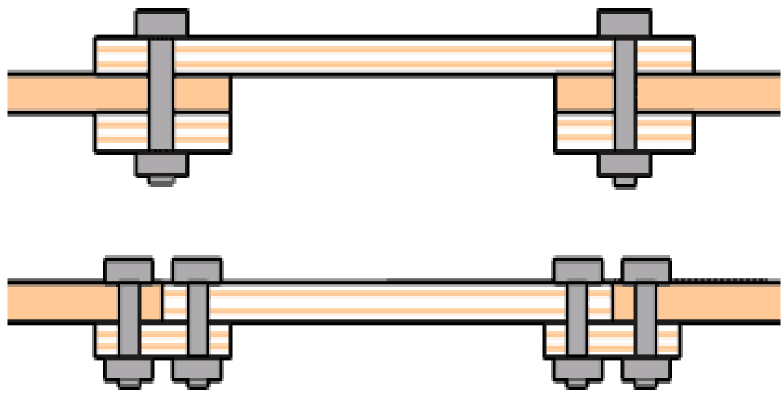


Figure 2-7: Bolted Repairs

2.2.4 Bonding Method

A composite bonded repair generally comprises three basic structural elements: a damaged skin laminate, a repaired patch laminate, and a layer of bonding adhesive. Furthermore, the skin damage is normally cleaned up before the repair to become a through or a part-through hole with a straight or scarf edge.

A typical hot-bonded field repair procedure consists of the following steps:

- The damaged area is mapped out with pulse-echo ultrasonic to determine whether the repair falls within the limits of the structural repair manual. (If it does not, then a strength engineer should be consulted for an alternative course of action.)
- The damaged plies are carefully removed using high-speed routers with depth control.
- The repair area is bagged with a heat blanket and subjected to full vacuum (22 in. (559 mm) of Hg vacuum minimum)
- The cured patch is un-bagged and the area cleaned up. The quality of the repair is inspected with pulse-echo ultrasonic. The repaired area is refinished to match the rest of the structure.

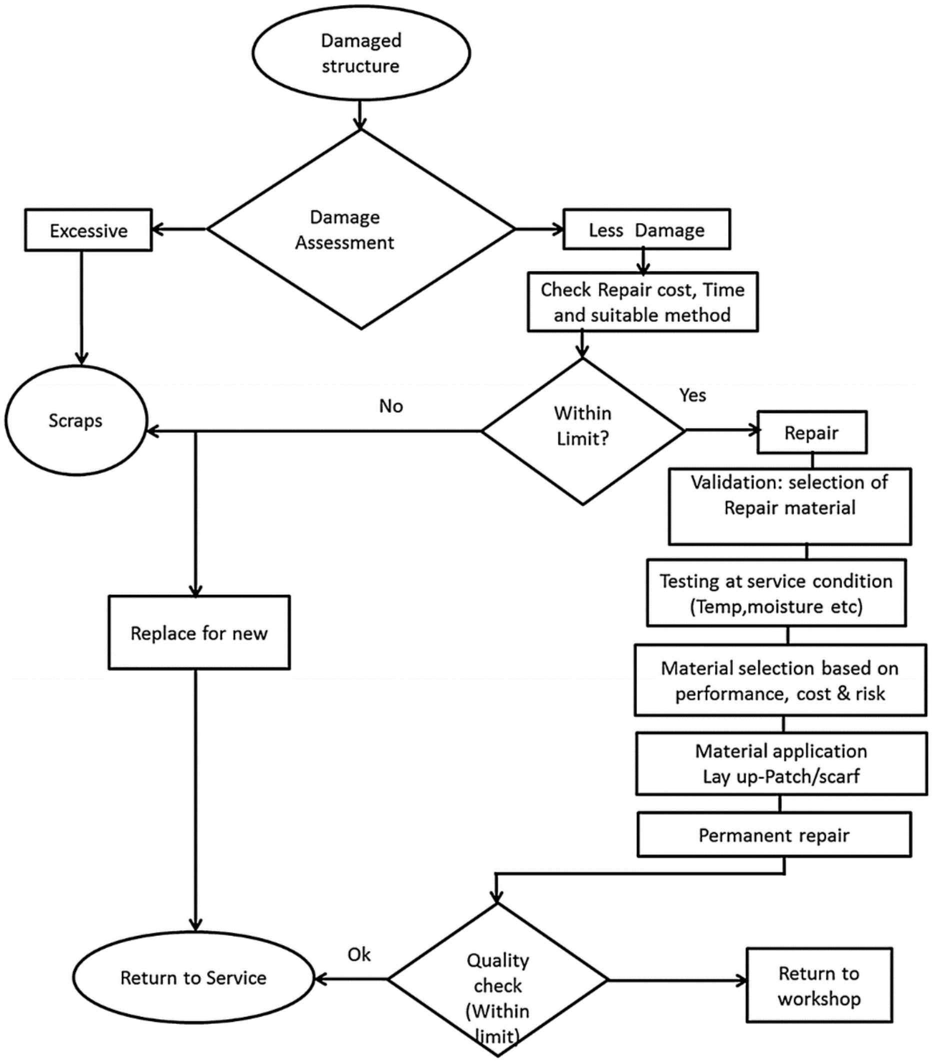


Figure 2-8: Flow chart for the repair of a damaged structure made of composite

Figure above shows a chart which indicates the usual repair process and the time required to complete the activity. Usually a drying procedure is required before application of the repair patch to remove all the moisture in the skin absorbed. The damage location is then cleaned and the repair laminates are placed. The repair patch/scarf is then cured on top of the original parent structure using a heating blanket under vacuum. It is clearly seen that the drying and curing process activity is taking more time compared to the other activities in the repair process.

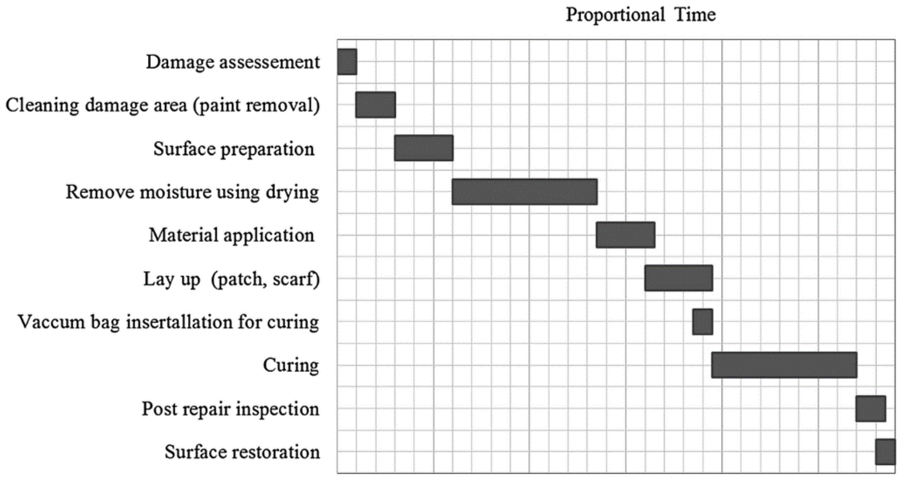


Figure 2-9: A summary of repair procedure of composite repair with time

2.3 Tools and Equipment

Composite repair always starts with damage assessment and removal of broken areas.

1. Dual Action Air Sander: Drastically cuts down the time spent on sanding and body fill.
2. Grinder: If you are exploring body kit fabrication or custom work, you will need a grinder along with some attachments. Depending on how you outfit it, this could be a method to remove rust or an entire mirror.
3. Block Sander: Every good auto tech will have a block sander on hand even if he also has a fast-acting air sander. They are needed for color sanding and buffing, shaping body filler, cutting high spots and finding low spots.
4. Body Hammer and Dolly: You will need this collaborative set of auto-body repair tools to fix the bodywork of a car. While the hammer does the heavy lifting and physical shaping, the dolly holds the shape and directs the metal where to go when the hammer is manipulating it.
5. Air Paint Spray Gun: Like most tools, these vary in quality. For an even coat, look for one that atomizes correctly.
6. Putty knives: Putty knives or body fill spreaders are used to mix body filler, which is also known as Bondo. They come in both metal and plastic, but metal is more durable and easier to clean.
7. Suction Cup Dent Pullers: A handy tool for a quick fix, the suction cup removes surface dents with a suction force that pulls the metal to a convex position.

8. Stud Welder Dent Pullers: Similar to a screw-in dent puller, but will not leave holes that need to be filled. These tool spot-welds a stud in place to pull the dent; after the dent is pulled, the stud is snapped off and the area is ground down. Stud welder dent pullers cost more than a screw-in model, but the results will be worth it.

Figure 2-10: Essential Auto body repair tools

2.4 Carryout Repairing Composite Materials

Repairs of composite structures in vehicles cover a formalized group of procedures. External object impact is the main type of damage in composite material structures. To ensure continuing operation, it is necessary to identify the damage severity and detectability as part of the ongoing maintenance process. Methods of analytical assessment of residual strength in damaged composite components are needed to ensure that only the necessary repairs are undertaken.

The repair scheme selected for structural restoration must be the simplest and least intrusive to restore the stiffness and strain capability of the structure to the required design strength without compromising other functions of the component or structure and can be implemented in either a depot repair facility or a field repair environment. It is necessary to restore the capability of the structure to withstand design ultimate loads and to maintain this capability for full service life.

Repairing a composite is not always so straightforward. Although damage to the composite exterior is readily apparent, detecting damage beneath it is often difficult. After assessing all the damage, repairing a composite structure usually means greater downtime because of the cure time's resins and adhesives require.

Self-Check 2.1

Part I: Choose the best answer from the alternatives given

1. Which of the following composite failure inspection method is self-explanatory and major damages will be readily apparent.

A. Visual Inspection

B. Tap Testing

C. Ultrasonic Inspection

D. None of the above

2. ________is performed manually or with a special tap hammer, is one of the simplest methods that can be used in the field on composites.

A. Visual Inspection

B. Tap Testing

C. Ultrasonic Inspection

D. None of the above

3. Drying and curing process activity takes more time compared to the other activities in the composite materials repairing process.

A. True B. False

Part-II: Explain the following questions accordingly

1. List down with their advantages at least five vehicle body repairing tools and equipment for composite materials repairing?

2. Compare and contrast the following types of repairing methods for a damaged composites?

A. Fill Repairs

B. Injection Repairs

C. Bolted Repairs

D. Bonded Repairs

Operation Sheet 2.1

Operation Title: Repairing using fiberglass

Purpose: To make repairs using fiberglass

Conditions or situations for the operations:

- Safe working area
- Properly operated tools and equipment
- Appropriate working cloths fit with the body

Equipment Tools and Materials:

- Hammer and dolly
- Body filler putty
- Orbital Sander
- Primer
- Topcoat resin

Quality Criteria: Assured performing of all the activities according to the procedures

Precautions:

- Wearing proper clothes, eye glass, glove
- Make working area hazard free
- Read and interpret manual, which guide you how to use tools and equipment.

Steps in doing the task

Step 1: Allow the part to dry out: avoid all sources of moisture, from rain to water ingress.

Step 2: Remove loose debris: if there is debris on the surface, particularly loose fragments, it should be removed in advance

Step 3: Perform surface abrasion: Sand the surface to create a smooth, non-porous surface.

Step 4: Remove excess dust and debris: once surface grinding or blasting has been performed, there is likely to be a degree of dust and debris.

Step 5: Prepare the glass fiber mat. Once the primer has (or before) been applied, glass fiber matting should be cut and sized to dimensions that exceed the existing area to be repaired by around 10 %.

Step 6: Mix the resin ingredients: Careful mixing is needed to achieve

Step 7: Laminate apply catalyzed polyester resin to the glass fiber mat

Step 8: Once the laminate has been consolidated, allow it to harden or 'cure'. Recommended time: 12 hours (winter) and 6 hours (summer).

Step 9: Sanding down: for aesthetic purposes, it may be desirable to scale back any uneven regions of the laminate back.

Step 10**:** Topcoat preparation: once the laminate has hardened, prepare the topcoat.

Step 11: Apply topcoat: Once mixed, apply a single layer of topcoat resin avoid applying too much as this will create a brittle outer surface.

Step 12: Allow time to cure: once the topcoat has been applied, provide adequate time for it to cure. Recommended time: 12 hours (winter) and 6 hours (summer).

Quality Criteria: Assured performing of all the activities according to the procedures

Operation Sheet 2.2

Operation Title: Repairing Holes in panels

Purpose: To make repairs Holes in panels using fiberglass

Conditions or situations for the operations:

- Safe working area
- Properly operated tools and equipment
- Appropriate working cloths fit with the body

Equipment Tools and Materials:

- Wire brush
- Angle grinder
- Ball-peen hammer
- Masking tape
- Permanent marker
- Fiberglass filler
- Cardboard
- Sandpaper
- Automotive primer
- Automotive paint

Quality Criteria: Assured performing of all the activities according to the procedures

Precautions:

- Wearing proper clothes, eye glass, glove
- Make working area hazard free
- Read and interpret manual, which guide you how to use tools and equipment.

Steps in doing the task

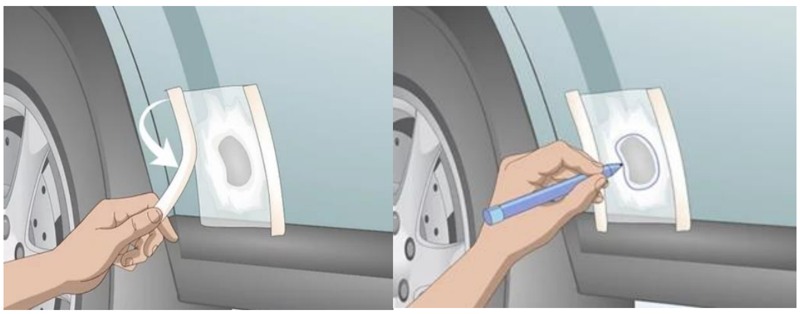
Step 1: Remove the paint 2 inches (5 cm) around the rust with a drill fitted with a wire brush.

Step 2: Cut the affected metal away from the hole with tin snips or a grinder.

Step 3: Treat the exposed metal with a rust inhibitor.

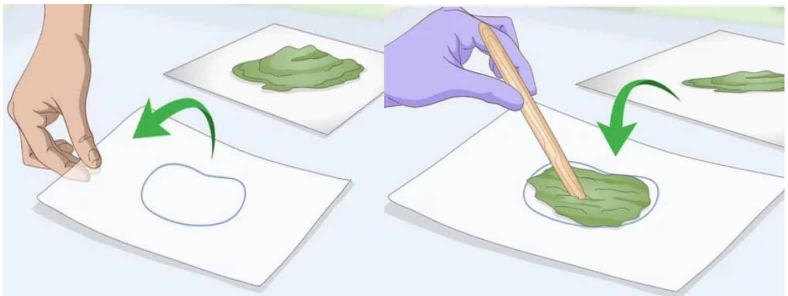
Step 4: Use a ball-peen hammer to tap the edges of the hole inward.

Step 5: Tape a sheet of wax paper over the hole using masking and trace the hole with a marker on the wax paper.tape.

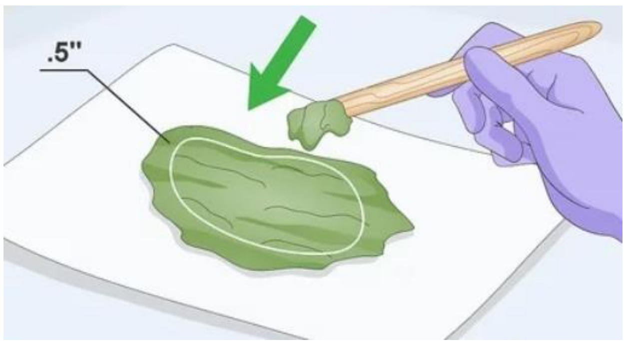


Step 7: Mix the fiberglass filler mixture with the hardener with a dowel.

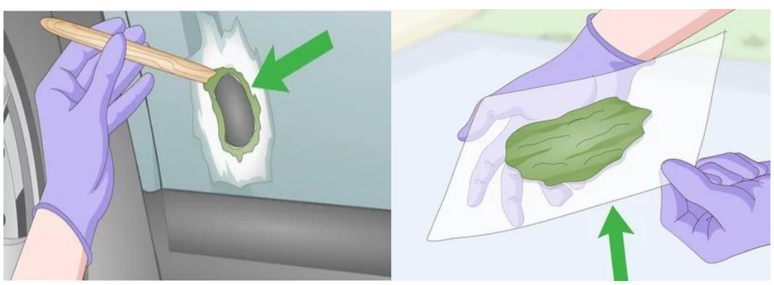
Step 8: Lay the wax paper on the table so you can see the traced hole and Dab the mixture onto the drawn hole on the wax paper.



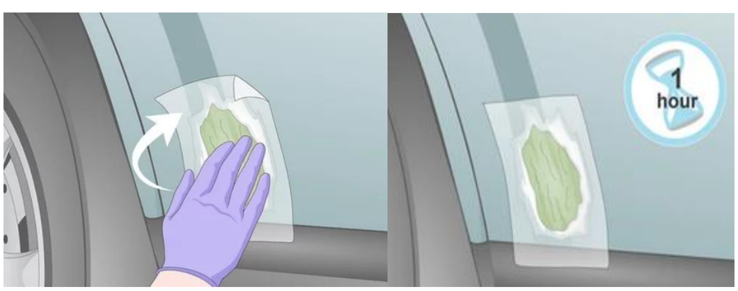
Step 9: Keep adding the mixture until it extends .5 inches (1.3 cm) beyond the hole.



Step 10: Use the dowel to apply the mixture directly to the edges of the hole and Pick up the wax paper with the mixture facing outward.

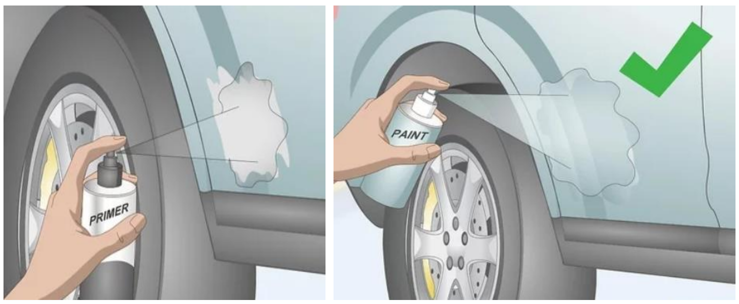


Step 11: Press the mixture directly into the hole so it's flat against the vehicle and wait an hour for the mixture to dry.



Step 12: Peel the wax paper away from the vehicle. Sand any imperfections out with 220-grit sandpaper and water.

Step 13: Add a spray-on primer to prevent further rust and Paint the repair if you desire a professional finish



Quality Criteria: Assured performing of all the activities according to the procedures

Operation Sheet 2.3

Operation Title: Repairing Split or Cracked Panels

Purpose: To make repairs on Split or Cracked Panels using fiberglass

Conditions or situations for the operations:

- Safe working area
- Properly operated tools and equipment
- Appropriate working cloths fit with the body

Equipment Tools and Materials:

- Epoxy repair material
- Hacksaw blade
- Grit abrasive paper
- C clamps
- Spatula or putty knife

Precautions:

- Wearing proper clothes, eye glass, glove
- Make working area hazard free
- Read and interpret manual, which guide you how to use tools and

equipment.

Steps in doing the task

Step 1: Clean surface as previously described. Then, using a hacksaw blade, cut along break line and remove broken portion of panel Remove dirt, etc., from inner surface of damaged area.

Step 2: Scuff area around hole with coarse No. 80 grit abrasive paper to provide a good bonding surface.

Step 3: Remove all cracked and fractured material along break, and bevel edge of break area approximately 30 deg. To permit better patch adhesion.

Step 4: Use C clamps or other suitable means to bring surfaces on each side of break into proper alignment.

Step 5: Clean repair surface well with solvent.

Step 6: Cut three pieces of fiberglass cloth large enough to overlap repair area by

about 2 in.

Step 7: Apply mixture of resin and hardener to layers of glass cloth and to inner surface of repair area. Make sure cloth is in full contact with scuffed area beyond break. Allow saturated cloth to cure. Then, mix patch material

Step 8: Scuff break area with abrasive paper to provide a good bonding surface. Using a small spatula or putty knife, trowel mix into break area on outer surface, leaving sufficient material to grind down smooth and flush when hardened.

Quality Criteria: Assured performing of all the activities according to the procedures

Operation Sheet 2.4

Operation Title: Repairing scratches and gouges

Purpose: To make repairs scratches and gouges on Panels using fiberglass

Conditions or situations for the operations:

- Safe working area
- Properly operated tools and equipment
- Appropriate working cloths fit with the body

Equipment Tools and Materials:

- epoxy adhesive,
- polyester body filler,
- polyester resin,
- hardener
- Glazing putty.

Quality Criteria: Assured performing of all the activities according to the procedures

Precautions:

- Wearing proper clothes, eye glass, glove
- Make working area hazard free
- Read and interpret manual, which guide you how to use tools and equipment.

Steps in doing the task

Step 1: Starting with 1973 models, many automobiles are equipped with complete front-end panels of fiberglass polyester. In addition, many rear end finishing panels, valence panels, fender extensions and specialty hoods are made of this particular material.

Step2: All types of damages to fiberglass polyester body parts can be repaired

Step 3: Use a power drill with burr bit to rout length of scratch or gouge. Form a V-groove tapered no more than 45 deg. Do not cut through laminate.

Step 4: Use 360 grit paper to remove flaky edges and feather painted surface back about 1/2 in. beyond damaged area. Clean surface with dry cloth or air.

Step 6: Mask undamaged surface, leaving a working area of approximately 5 in. around repair area.

Step 7: Follow manufacturer's instruction and mix enough body filler on hard surface (Formica) to reestablish surface.

Step 8: Apply and spread filler with a plastic squeegee. Remove all air bubbles. Allow filler to extend above original surface to allow for shrinkage.

Step 9: Let filler set until it is rubbery, but not fully hardened. Then, plane or file filler to original contour, but leave level slightly higher than original surface.

Step 10: Use a heat gun or heat lamp to shrink filler. Use a minimum temperature of 125 deg. F, keeping heat source at least 12 in. from surface

Step 11: After filler has set, sand with 360-grit paper, using an orbital sander. Sand until surface is smooth and even with original surface

Step 12: If filler has fine pinholes, apply a thin coating of glazing putty. If filler is pockmarked, do not use glazing putty. Instead, apply another layer of body filler and repeat refinishing steps.

Step 13: Complete repair by cleaning with air. Then, spot prime, wet sand with 400 grit paper and paint

Quality Criteria: Assured performing of all the activities according to the procedures

Unit Three: Cleaning Work Area and Maintain Equipment

This unit is developed to provide you the necessary information regarding the following content coverage and topics:

- Cleaning work area
- Maintaining tool and equipment

This unit will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Clean work area
- Maintain tools and equipment

1.6. Cleaning Work Area

Cleaning work area must be a habit to clean tools after each use before you return them to storage. Wipe them down with a rag or old towel and be sure they are free of dust, grease and debris before you put them into their proper places. Common work area practices:

- Inspect vehicles for leaks and use drip pans as needed for leaks and dirty parts to reduce the need for floor cleaning.
- Wipe up spills as soon as they occur.
- Sweep and use a biodegradable detergent for cleaning shop floors.
- Some shops avoid using detergent altogether by washing with water.
- Discharge wash down waste water to the sanitary sewer instead of storm drains so that it is treated before reaching the environment.
- Test the composition of your sump sludge so that they may be disposed of properly.
- Encourage employees to find ways to reduce leaks and spills and keep work areas clean.
- Use a laundry service to clean rags and uniforms.

1.7. Maintaining Tools and Equipment

To guard against accident and provide effective means for work, tools and equipment must be kept on good working condition. Good work cannot be produced with dull or in appropriate tools.

Proper tools maintenance maybe accomplished by:-

i. Regular Sharpening: Tools to be issued from tools room only when sharp and tools in individual kits kept sharp by the one to whom they are assigned
ii. Re-conditioning before tools are in use again: Handles broken or loose and defective parts replaced or repaired

Regular maintenance is important for keeping equipment in good working order. It is essential to refer to manufacturer's operational manual for recommended equipment scheduled maintenance, repair, and/or adjustments.

All tools, equipment, and vehicles must be properly maintained so that workers are not endangered. Keep all tools clean and replace them in a suitable box or cabinet.

The successful maintenance program is:

- Well organized and scheduled
- Controls hazards
- Defines operational procedures
- Trains key personnel.

A general requirement for equipment maintenance includes:

- Obtaining a copy of the maintenance schedule recommended by the manufacturer.
- Ensuring that maintenance is performed as required.
- Ensuring that the person(s) performing the maintenance are competent
- Specifying who is responsible for overseeing equipment maintenance
- Setting up a system for removal and tagging of damaged or defective tools and equipment.

Advantages of proper equipment maintenance

- Increases equipment up-time
- Enhances efficiency when running

- Reduces overall costs
- Improves the lifespan of the equipment
- Maintains the value of the equipment

In addition to these common maintenance procedures, there are several tips that can help prolong the life of composite materials. These include:

- Avoid exposing composite materials to extreme temperatures, as this can cause warping, cracking, or other forms of damage.
- Protect composite materials from UV rays by storing them in a shaded area or using a UV-resistant coating or film.
- Regularly inspect composite materials for signs of damage or wear such as cracks and chips.
- Use caution when working with composite materials, as they can be brittle and prone to cracking or breaking if handled improperly.
- Follow the manufacturer's recommendations for maintenance and care of composite materials, including the use of specific cleaning and maintenance products.
- To guard against accident and provide effective means for work, tools must be kept on good working condition. Proper tools maintenance maybe accomplished by:

Self-check 3.1

Part-I: Choose the best answer from the alternatives given

1. The successful maintenance program is______?
A. Well organized and scheduled
B. Controls hazards
C. Defines operational procedures
D. All of the above
2. Which one of the following is not the general requirements for equipment maintenance
A. Ensuring that maintenance is performed as required.
B. Ensuring that the person(s) performing the maintenance are competent
C. Setting up a system for removal and tagging of damaged or defective tools and equipment.
D. Plan to replace new tools and equipment with new one
3. Successful maintenance program is______|
A. Well organized and scheduled
B. Controls hazards
C. Defines operational procedures
D. All

Part-II: Matching

A	B
__1. Regular Sharpening	a. Replacing or repairing defective tools
__2. Regular maintenance	b. Wipe up spills as soon as they occur.
__3. Common work area practices	c. Issued from tools room only when sharp
__4. Re-Conditioning	d. keeping equipment in good working order.

Part-II: Explain the following questions accordingly

1. List down the two ways of disposing materials?
2. List down common maintenance procedures that can help prolong the life of composite materials?
3. Explain the advantages of successful maintenance program?

LAP Test

Practical Demonstration

Name: ____________________ Date: _____________________

Time started: _____________ Time finished: _______________

Instruction: Given necessary templates, tools and materials you are required to perform the following tasks accordingly..

Task1: Repair using fiberglass

Task 2: Repair Holes in panels

Task 3: Repair Split or Cracked Panels

Task 4: Repair scratches and gouges

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