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PRESSURE AND HEAT APPLICATION ON CURING A COMPOSITE REPAIR

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ABSTRACT

The purpose of this research is to carry out a case study on a composite repair structure. It touches on the methods of conducting a repair on an aircraft part. Identifying the types of curing repair and damage generally associated with an aircraft, comparing the method and practice to apply whilst adhering to the Aircraft Maintenance Manual (AMM) and the Structure Repair Manual (SRM) as guidance for each of the repair. It is therefore used to basically define, discuss, identify and explain the composite repair on aircraft structure is and how a repair is carried out. It focuses on the types of curing repair generally carried out, comparing the method of repair for a composite part, and identifying the best method or solution to be implemented to the structure. In addition, this was done in hoping to provide an adequate knowledge about the criteria and the best solution upon doing a repair. Perhaps, it might be a useful tool while providing enough information which in return may be used as reference for those who are interested in pursuing within the corresponding field in the near future.

1 Introduction

As the introductory level, composites are widely used as an advanced material for aircrafts. Therefore it is described as an inhomogeneous material that has been created by the synthetic assembly of two or more materials in obtaining specific characteristics or its properties. The most significant advantage of a

composite structure lays in its high strength to weight ratio. Basically the combination of reduced weight and drag is now a substantial advantage for a composite part. Complex structures can be built in one piece, reducing the requirement for any fasteners to hold them. Composites are not prone to declination in the way that metals do when they corrode.

1.1 Objectives

The main objective of this case study is to provide a platform for composite repair structure on an aircraft part. Therefore the interest of the study includes:

i. Identifying the types of curing repair.

ii. Comparing the method of repair to a composite structure.

iii. Identifying the best method and solution to a composite structure.

2 Literature Reviews

2.1 Types of curing repair

Majority of the curing process is determined by the type of matrix and the prepreg material being used. The choices of matrix or prepregs are dictated by the original materials when they were manufactured. However in the best of interest in any repair conditions, consult the manufacturer's recommendation and instructions.

In general the curing process in maintenance of composite repair methods is no less different from the manufacturing process in the first place of the part. The basic same and exact principle is applied which involves the application of heat and pressure. In this case, the equipments and the facilities are similarly the same.

2.1.1 Pressure Application

Pressure application should be applied on the surface during the curing operation when doing a composite repair. This applied pressure will assists in the removal of excess resin that squeezes out. The sustaining

of pressure compacts the fibres together removes trapped air and maintains the contour of the repair relative to the original part. It also holds the repair securely to prevent shifting.

Indeed several methods may be useful in composite repairs, such as shot bags, spring clamps, clecos fastener etc. However the most commonly used acceptable method of curing when associating the part with pressure is by the application of the vacuum bagging system. It works by using atmospheric pressure in providing an even pressure over the surface of the repair.

2.1.2 Application of Heat

Most composite matrix system is cured by chemical reaction. Some may be cured at room temperatures and while others require heat to achieve maximum strength. Failure to follow the proper curing requirements and improper use of the curing equipment may cause defects in the repair.

2.2 Room Temperature Curing (COLD BOND REPAIR)

Certain types of composite may cure at *(65-80°F) over a period of 8-24 hours depending on the type of resin* used according to the Boeing 777 SRM. In some cases this curing can be accelerated by *applying low heat (140-160°F).* Do not expect to have a full curing strength less than 5-7 days. Basically they are used on light structural loaded parts only.

2.3 Heat Curing (HOT BOND REPAIR)

Advance composite curing mostly utilises resins that requires high temperatures during curing process in developing their full strength. In return the repair parts may require high heat setting for curing (250-750°F) according to the Boeing 777 structure repair manual in restoring the original strength. The amount of heat must be controlled by monitoring the surface temperature of the repair. Caution should always be exercise because overheating can cause severe damage.

2.4 Heat Lamps

This type of curing is not recommended due to the uncontrolled heating of the part. Heat lamp may cause localised heating in one spot causing uneven curing. Always consult the SRM for correct distance between the lamp and the part. The temperature applied in curing depends upon the distance of the part and the lamp itself. An example of the graph which is normally used to determine the distance between

the heat sources to the part is depicted in figure 1. Always consult the SRM and the manufacturer for the latest procedure.

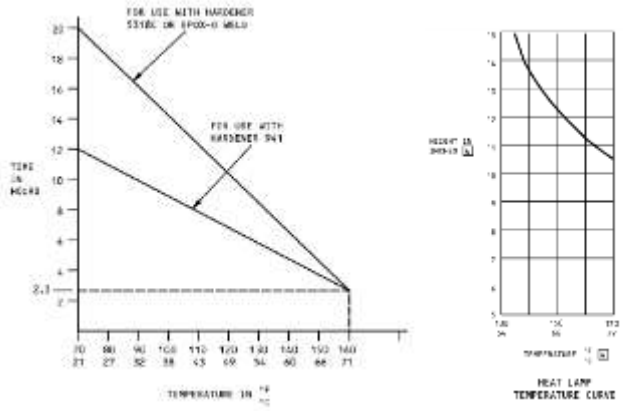

Figure 1. Heat lamp curing graph[1]

2.5 Heat Guns

Heat guns without heat controller or monitor is highly not recommended. It can produce up to 750°F of heat when left continuously and excessive heat can evaporate resins, leaving dry areas in the part.

2.6 Oven Curing

This type of curing offers controlled and uniform heating of all repair surfaces. Some may incorporate vacuum ports to provide pressure while curing. A disadvantage to this is that the part must be removed from the aircraft and must be small enough to fit into the oven.

2.7 Hot Patch Bonding

This type of curing utilises a flexible silicon heating blanket that incorporates a temperature control. This is a preferred method of curing due to its ability to be controlled and provides an even heating of the part. Most hot patch bonding machines also incorporate a vacuum pump to apply pressure during the curing process.

[1] Heat lamp curing graph-Boeing-777 SRM

Figure 2. Hot bonding is accomplished with a heat blanket and used with vacuum bagging[2]

3.0 COMPARING THE METHOD OF REPAIR

Comparisons can be made on both pressure application and heat application and are discuss as follows depicted in Table 1.

PRESSURE APPLICATION	**HEAT APPLICATION**
Method commonly used on laminate structure and curing of honeycomb core of a part.	Includes heat guns, heat lamps. Temperature
Using atmospheric pressure to cure the part, vacuuming the part to cure it	May use room temperature but will take longer periods to set. Depending on the type of resin used
May take shorter periods of time to cure and settle in	Takes longer period to cure and settle in
May be carried out in the field(hangar) in-situ with the portable system	Must be taken out and repaired in an enclosed and controlled environment such as the laboratory
Offers controlled and uniform heating of repair surfaces	May constitute to localised heating and severe damage to the part
Done on structural parts or loads	Done on light structural loads
Quite expensive to carry out the repair	Not that expensive

[2] Hot bonding using a heat blanket and vacuum bagging. http://www.abarisonline.com

Not time consuming	Time consuming
Needs technical knowledge to produce and carry out the repair process	Fairly a simple and a straight forward repair to be dealt with

Table 1. The difference between pressure application and heat application for a composite repair.3

Since the reduced availability of natural resources, multiply by the cost production and the obvious reason of the human's ability to fabricate high strength to weight metallic components, this requires some development of newer materials to cater the demands of aerospace and aviation technology. This is where composite which is known as an advance material because of its high strength stiff fibres come in handy to replace the metal technology.

4. IDENTIFYING THE BEST METHOD

The best method for curing of a repair done to a composite structure predominantly depends on the type and severity of the part. Nevertheless pressure application may well suit most of the repairs done on a daily basis for an aircraft part. Due to this most of the aviation world approves repair done to a composite part and the aircraft through their SRM. This is done in-situ which may be in an enclosed environment such as in the hangar. Because of the nature of the repair, the structure repair manual of certain parts of the aircraft needs to be referred to.

An indication which leads to the necessity of using pressure application is that the part will definitely set faster and produces a great finish. Most of the materials in using the pressure curing repair application requires controlled storage conditions and have limited shelf life. Therefore these materials need to be subjected to room temperature conditions until moisture no longer condenses on the wrapper of the adhesive film and pre-impregnated material.

Then they are cut horizontally through their axes making sure they are free from other rolls and object. Sometimes the core plug may be cured separately from the repair plies. It is also an option to cure both at the same time given if the far side skin is accessible to place thermocouples and a heat blanket on it.

Partial core replacement can be carried out by cutting two plies of adhesive film to fit the core cavity. Remove the separator film from one ply of adhesive film and place the adhesive into the core cavity. The separator film is removed from the second ply of adhesive film and place the adhesive film into the core cavity as depicted in the Advisory Circular (AC) of the FAA.

Full depth core replacement may be performed by cutting one ply of adhesive film to fit the core cavity. According to AC 43.13.1B, if *however both skins are damaged, apply a caul plate against the exterior surface of the far side skin* to initiate the repair. Figure 3 from the Boeing 777 – SRM shows an example of how to carry out a vacuum bagging process.

[3] Table 1: The difference between pressure application and heat application

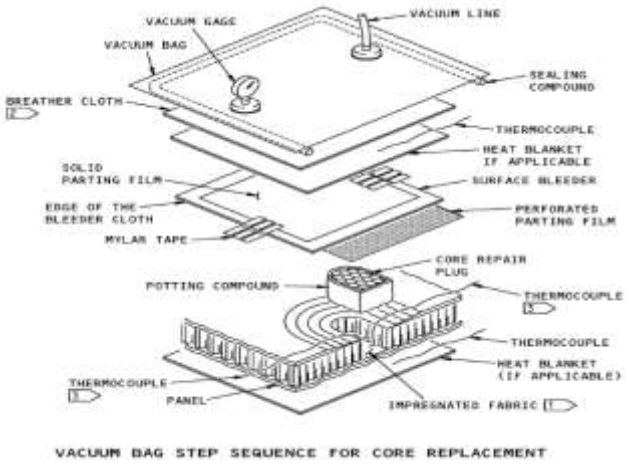

Figure 3. Vacuum bag step sequence for core replacement.[4]

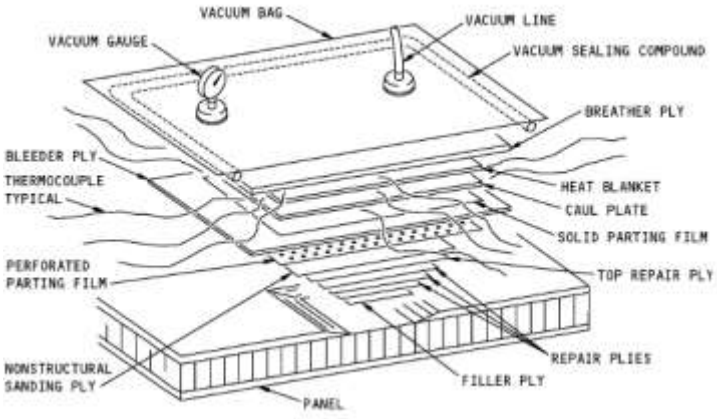

Figure 4. Vacuum bag step sequence for ply replacement.[5]

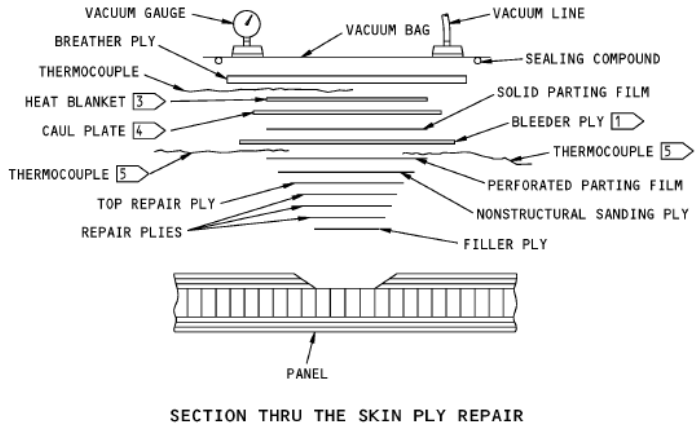

Figure 5. Application of pressure on a skin ply repair.[6]

[4] Vacuum bag step sequence for core replacement. Boeing-777 SRM
[5] Vacuum bag step sequence for ply replacement. Boeing-777 SRM

5.0 CONCLUSION AND RECOMMENDATION

Composite repair is ultimately a wide scope which needs to be covered. It has many different approaches as to how the repair is carried out. Generally in the aircraft maintenance industry, the Structural Repair Manual (SRM) is consulted in providing the necessary procedures and recommendations in order to carry out a specific repair.

Determining the material of the underlying repair is vital as these may restore the composites structural integrity as closely and as near as possible to the original part. The difference on the sort of repair carried out to any advance composite repair is where it is carried out whether it is done in the hangar or in a repair facility.

The types of composite repair may vary from manufacturer. Basically there are many types of composite repair depending on the types of material being used, the curing time cycle, and the method in carrying out the repair procedures. However all the procedures pertaining to the repair should be referred to the manufacturers guide and recommendation's to make sure the repair is satisfactory. Ultimately these repairs meant nothing more than to restore the parts structural integrity, enabling the aircraft to continue flying.

If all the recommended procedures are to be followed, evidently there will be no problems encountered in performing these repair to an aircraft. As long as the correct procedure is maintained and there is a high degree of safety in performing the repair, it can be satisfactorily done anywhere provided that the equipment, materials and tools needed is readily available.

References

AC 43.13.1B 2010. Acceptable Methods, Techniques & Practices – Aircraft Inspection, Repair & Alteration, Aviation Supplies & Academic Inc.

Advisory Circular (AC) Composite Aircraft Structure., 2010. Federal Aviation Administration Advisory Circular, 20-107A

Boeing-777. (2009) Structural Repair Manual. Boeing Aircraft Inc.

Campbell FC,. 2010. Manufacturing processes for advanced composites structures. Elsevier.

European Aviation Safety Agency (EASA). http://www.easa.europa.eu/home.php

[6] Application of pressure on a skin ply repair. Boeing-777 SRM)

Repair of Advance Composite. http://www.netcomposites.com/Education.asp?sequence=67

Sanderson., J. 2011 A&P Technician Airframe Textbook. Eaglewood, Colorado: Jeppesen Sanderson Inc.

Sanderson., J. 2003. Aviation Dictionary Textbook. Eaglewood, Colorado: Jeppesen Sanderson