Introduction to Aircraft Composite Technology
Disclaimer/ Provision

This course is designed to provide trainers with the general information on Introduction of Aircraft Composite Technology. Material discussed, presented or performed during lecturing and training do not relate with any specific aircraft types or manufacturers. Therefore the information presented during this training is mainly “FOR TRAINING PURPOSES ONLY”. It never be considered as an approved data for performing design, manufacturing, maintenance and other matters pertaining to aerospace field.
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Introduction to Aircraft Composite Technology

* Composites materials are fibrous reinforcements bonded together with a matrix materials and the constituents can be identified separately.
* Natural fiber - Occur naturally in your bones, in wood, horns etc
* Engineered fiber - synthetic fibers
* Allow the stiffness and strength of the material to change with direction of loading
Introduction to Aircraft Composite Technology

Natural Composites

Wood: Cellulose fibers bound by lignin matrix

Bones: Stiff mineral “fibers” in a soft organic matrix permeated with holes filled with liquids

Granite

Synthetic Composites

Concrete

Tyre

Plywood

Fiberglass
Classification of Composites

• Based on Matrix
  – Metal Matrix Composites (MMC)
  – Ceramic Matrix Composites (CMC)
  – Polymer Matrix Composites (PMC)

• Based on Reinforcement
  – Particulate Composites
  – Fibrous Composites
  – Laminate Composites
Constituents

Fiber/Filament Reinforcement
- High strength
- High stiffness
- Low density
- Carbon, Glass, Aramid, etc.

Matrix
- Good shear properties
- Low density
- Thermoset & Thermoplastic
- Epoxy, Polyester, PP, Nylon, Ceramics, etc.

Composite
- High strength
- High stiffness
- Good shear properties
- Low density
- Anisotropic!
## Composite Application in Various Industries

<table>
<thead>
<tr>
<th>Industry</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corrosion</td>
<td>Storage tanks, Piping systems, Ducting system</td>
</tr>
<tr>
<td>Oil Field</td>
<td>Piping system, drive, shafts &amp; Tubular structure</td>
</tr>
<tr>
<td>Paper &amp; pulp</td>
<td>Paper rollers, piping systems, ducting systems</td>
</tr>
<tr>
<td>Infrastructure</td>
<td>Column wrapping, tubular support, power poles,</td>
</tr>
<tr>
<td></td>
<td>light standarddd</td>
</tr>
<tr>
<td>Pressure Vessel</td>
<td>water heaters, Tanks, CNG tanks, breathing</td>
</tr>
<tr>
<td></td>
<td>apparatus</td>
</tr>
<tr>
<td>Aerospace</td>
<td>Rocket motor case, aircraft structures,</td>
</tr>
<tr>
<td>Marine</td>
<td>mast, boom structure, vessel structure</td>
</tr>
<tr>
<td>Sports &amp; Recreation</td>
<td>golf shafts, bicycle, wind surfing, amusement</td>
</tr>
<tr>
<td></td>
<td>rides</td>
</tr>
</tbody>
</table>
Overview of the Composite Industries
Composite Industries market
Composite Industries in Malaysia

Composites has been used in a wide range of applications in Malaysia and contributes to growth in a diverse range of industry value chains from utilities through to boat building, manufacturing and industrial applications, aerospace, automotive, construction, maritime, defence and oil and gas.

**RM 9.86 billion**
Malaysia Turnover, the second highest in South East Asia  
Source: MIGHT

**630,000**
Volume (tonne)

**>70**
Total Fabricators
Aeronautical Materials History

1903: Wood & Fabric
1920: Steel Tube & Fabric
1940: All aluminum
1980: non structure composite
2005++: primary structure application
Aircraft Structure Current Design Process

Metallic Structure

Non Metallic Structure
Aerospace Market Forecast

- Demand for 20 years (28,200 new passenger aircraft)

20-year new deliveries of passenger and freight aircraft:

- 19,520 single-aisle aircraft (+353 aircraft over GMF 2011)
- 6,970 twin-aisle aircraft (+60 aircraft)
- 1,710 very large aircraft (+30 aircraft)

Market value of $4 trillion
Composite Material Usage

Source: Hexcel Corp., Aerostrategy
Composite Material Usage

- Shape
- Weight
- Maintainability
- Tools
- Price
- Reliability
- Manufacturability Process

SOLUTION

- Design
- Material Resin & Fiber
- Price
- Mechanical Properties
- Compatibility Resin & Fiber
- Toxicity & Flamability
- Chemical Properties
- Impact Resistance
- Loads
- Environment
- Regulation
- Shape
- Weight
- Maintainability
- Facilities
- Tools
- Price
- Reliability
Composite Material Usage

Production
- Simplified Manufacturing
  - Reduced number of parts
  - Reduced power breakdown
- Improved Performance
  - Reduced scheduled inspection
  - Longer life

Use
- Weight Saving
  - Lower production cost
  - Energy saving

Design
- Fatigue Strength corrosion
  - Reduce maintenance cost
  - Lower amortization rate

Composite Material Usage
Composite Material Usage

- Carbon fibres
- Kevlar fibre
- Carbon fibre composites (∥ fibres)
- Carbon fibre composites (⊥ fibres)
- Fiberglass composites
- Polymer resins
- Wood (∥ grain)
- Wood (⊥ grain)
- Alumina
- Titanium
- Steels
- Diamond
- Glass
Composite Material Usage

Major monolithic Carbon Fiber Reinforced Plastic (CFRP) and Thermoplastics applications

- Upper Deck Floor Beams
- CFRP Outer Flaps
- Wing
- Landing Gear Doors
- Center Wing Box
- Flap track panels
- CFRP Vertical Tail Plane
- Tail cone
- Un-pressurized Fuselage
- Horizontal Tail Plane
- Engine Cowlings
- Rear Pressure Bulkhead

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Composite - Advantages

- High stiffness-to-weight ratio
- Thermally insulating
- Recyclable
- Sustainable
- Radar transparent
- Dimensionally stable
- Corrosion resistant
- Improved weatherability
- Lost cost
- Low friction
- Tailorable
- Good fire performance
- Impact resistant
- Portability
- High fatigue strength
- Low part count
Composite - Disadvantages

- Poor Impact Resistance
- Low Interlaminar Strength
- Long Manufacturing Curing Time
- Humidity & Moisture Sensitivity
- Competency
- Delamination
- High cost of Inspection
- Long Repair Curing Time
- Disbonding
- Lightning Strike Protection
- Low Bearing Strength
- Temperature Sensitivity
• Trailing Edge and Trailing Edge Devices – General Arrangement

• 57-50-00
• General Arrangement
• Fairing Flap Track 2

NOTE: FOR VIEW 6 SEE SHEET 2.
- ITEMS 1 AND 5 ARE BONDED TOGETHER
- ITEMS 20, 25, 30, 35, 40 AND 50 ARE BONDED TOGETHER
- ADAPTATION SOLUTION
- ACCEPTABLE DEPRESSION OF 2.00mm (0.080in.) IS POSSIBLE IN THE AREA OF SPIGOT DUE TO THE MANUFACTURING PROCESS.

NOTE: FAIRING ITEM (6) IS MADE FROM CARBON FIBER CLOTH (PLY No’s -1 THRU -2).
HONEYCOMB WEDGES, EPOXY FILLER TO BACK (550), ADHESIVE PASTE TO BACK (550) CLOTH HONEYCOMB AND FILLER ARE BONDED TOGETHER WITH ADHESIVE FILM FRAMING TO BULK 3101.
- WARP FACE OF EACH CARBON FIBER PLY TO FACE AWAY FROM HONEYCOMB CORE.
- DIMENSIONS IN MILLIMETERS (INCHES IN BRACKETS).
- Epoxy film to add: 0150 or adhesive foam to back 3101 for norgud600924.
• Fairing Flap Track 2

NOTE: DIMENSIONS IN MILLIMETERS (INCHES IN BRACKETS).
TOP COVER (ITEM 121) IS MADE FROM CARBON FIBER CLOTH (PLY No. 11 - 1, 140 - 12) AND HONEYCOMB NOMEX BONDED TOGETHER.
WRAP FACE OF EACH CARBON FIBER PLY TO FACE AWAY FROM HONEYCOMB CORE.
PLY No. 11 THRU 12 ARE ITEM 243.
• Fairing  Flap Track 3
• Fairing Flap Track 3
- Fairing Flap Track 4

NOTE: DIMENSIONS IN MILLIMETERS (CIRCLES IN BRACKETS)

1. ITEMS S AND T ARE BONDED TOGETHER.
2. ITEMS 20, 25, 30, 35, 40 AND 55 ARE BONDED TOGETHER.
3. FOR VIEW SEE SHEET 2.
4. ADHESION SOLUTION.
5. ACCEPTABLE VIOLATION OF 2.20 mm (0.080 in.) IS POSSIBLE IN THE AREA OF SPIGOT DUE TO THE MANUFACTURING PROCESS.
• Fairing Flap Track 4
• **Fairing Flap Repairs**

1. **General**

   The repair data in this topic applies to damage that you will find on the Flap Track Fairings at Flap Tracks 2, 3 and 4.

   The General repairs are listed in Table 201.

   The Specific repairs are listed in Table 202.

   NOTE: For the detailed definition of Repair Categories, given in Table 202, refer to SRM Chapter 51-11-14.

   NOTE: For Damage/Repair Data Recording, refer to SRM Chapter 51-11-15.

2. **Safety Precautions**

   **WARNING:** OBEY THE SAFETY PRECAUTIONS IN THE FAIRING-FLAP-REMOVAL/INSTALLATION (REFER TO AMM CHAPTER 57-55-11, PAGE BLOCK 401).

   **WARNING:** OBEY THE MANUFACTURER’S INSTRUCTIONS WHEN YOU USE CLEANING AGENTS, ADHESIVES, SEALANTS AND PAINTS. THESE MATERIALS ARE DANGEROUS.

   **WARNING:** WEAR THE CORRECT PROTECTIVE GLOVES, CLOTHES AND FILTER MASK, WHEN YOU CUT, ABRADE OR DRILL COMPOSITE MATERIALS. THE DUST FROM COMPOSITE MATERIALS CAN GET INTO YOUR LUNGS OR ONTO YOUR SKIN AND CAUSE YOU INJURY.

   **WARNING:** IMMEDIATELY REMOVE DUST WITH A VACUUM CLEANER WHEN YOU WORK WITH CFRP COMPOSITE MATERIALS. CARBON DUST IS ELECTRICALLY CONDUCTIVE AND CAN CAUSE AN EXPLOSION.

   **WARNING:** OBEY THE MANUFACTURER’S INSTRUCTIONS WHEN YOU USE A BUTANE LAMP.

   **CAUTION:** OBEY THE GIVEN INSPECTION INSTRUCTION REFERENCE WHICH LEADS TO THE APPLICABLE INSPECTION PROGRAM DEFINED IN THE STRUCTURAL REPAIR INSPECTIONS, IF NECESSARY.

   **CAUTION:** FOR REPAIR EFFECTIVITY RELATED TO AIRCRAFT TYPE, REFER TO PARAGRAPH 3 GIVEN IN THE INTRODUCTION OF THE SRM.

   **CAUTION:** OBEY THE FLIGHT HOUR RESTRICTIONS AND DAMAGE DATA CONTAINED IN THE ZONE TABLES IN SRM CHAPTER 57-55-11 PAGE BLOCK 101.

   **CAUTION:** OBEY THE REPAIR EFFECTIVITY PER WEIGHT VARIANT AND AIRCRAFT TYPE GIVEN IN THE RELEVANT REPAIR.
- **Fairing Flap Repairs**
• Fairing Flap Repairs – Wet Lay up Repair

5. Moveable Fairing, Top cover, Fixed Aft Fairing and Fixed Fwd Fairing – Repairs

CAUTION: OBEY THE REPAIR EFFECTIVITY PER WEIGHT VARIANT AND AIRCRAFT TYPE GIVEN IN TABLE 203.

A. Wet Lay-Up Repairs – Specific Repair Materials

This paragraph contains the specific repair materials and related data applicable to Wet Lay-Up Repairs to the Moveable Fairing, Top Cover, Fixed Aft Fairing and Fixed Fwd Fairing. This data is valid for the aircraft shown in Table 203 and is necessary to find the correct repair.

You must refer to the Zone Tables in SRM 57-55-11 Page Block 101 to find the references to wet lay-up repairs.

<table>
<thead>
<tr>
<th>AIRCRAFT TYPE</th>
<th>WEIGHT VARIANT</th>
</tr>
</thead>
<tbody>
<tr>
<td>A320-100</td>
<td>000, 001, 002</td>
</tr>
<tr>
<td>A320-200</td>
<td>000, 001, 002, 003, 004, 005, 006, 007, 008, 009, 010, 011, 013, 014, 016</td>
</tr>
</tbody>
</table>

Effectivity per Weight Variant and Aircraft Type

Table 203

NOTE: Refer to Paragraph 23 'Weight Variant Information' in the INTRODUCTION of the SRM. Tables in the subparagraphs give the necessary data about all weight variants and their required information for allowable damage and repair applicability.

(1) Repair Materials.

The information in this sub-paragraph details the specific repair materials that must be used where applicable.
• Fairing Flap Repairs – Wet Lay up Repair

<table>
<thead>
<tr>
<th>ITEM</th>
<th>NOMENCLATURE</th>
<th>QTY</th>
<th>MATERIAL/REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>-</td>
<td>5H Satin Weave Carbon Fabric at a weight of 285g/m²</td>
<td>A/R</td>
<td>This fabric is to be used for wet lay-up repairs (Refer to SRM Chapter 51-77-11, Table 6B(8)(b))</td>
</tr>
<tr>
<td>-</td>
<td>Plain Weave Carbon Fabric at a weight of 135g/m²</td>
<td>A/R</td>
<td>This fabric may be used as an alternative for 5 harness satin weave fabric in wet lay-up repairs (Refer to SRM Chapter 51-77-11, Table 6B(8)(b))</td>
</tr>
<tr>
<td>-</td>
<td>Hysol EA9396A/B</td>
<td>A/R</td>
<td>Material No. 08-070. This resin is to be used in wet lay-up repairs (Refer to SRM Chapter 51-77-11, paragraph 6B(2)) OR</td>
</tr>
<tr>
<td>-</td>
<td>Hysol LY5052/HY5052</td>
<td>A/R</td>
<td>Material No. 08-090. This resin is to be used in wet lay-up repairs (Refer to SRM Chapter 51-77-11, paragraph 6B(2)).</td>
</tr>
<tr>
<td>-</td>
<td>Cleaning Agent</td>
<td>A/R</td>
<td>Material No. 11-026. (Refer to SRM Chapter 51-35-11).</td>
</tr>
</tbody>
</table>

**NOTE:** Any room temperature repair that has already been done in accordance with the Structural Repair Manual and uses the resins given in SRM 51-77-11 is acceptable.

**NOTE:** With the exception of the specified materials given in this paragraph, use all other materials detailed in SRM 51-77-11.

**NOTE:** Each damaged ply must be replaced with a carbon ply of equal weight and construction. You must lay up the repair plies in the same direction as the original plies with the cover ply or filler plies placed at +/- 45° to the adjacent ply. (Refer to SRM Chapter 57-55-11 Page Block 001.)
• Fairing Flap Repairs – Wet Lay up Repair

(2) Repair Instructions

The materials listed in paragraph 5.A.(1) must be used, as applicable, and together with the materials detailed in the repair references in the Zone Tables. The Zone Tables are found in SRM 57-55-11 Page Block 101.

CAUTION: OBSEY THE REPAIR EFFECTIVITY PER WEIGHT VARIANT AND AIRCRAFT TYPE GIVEN IN TABLE 204.

B. Fixed Forward Flap Track Fairing - Repair

This paragraph contains the specific repair materials and related data applicable to the Fixed Forward Flap Track Fairing. This data is valid for the aircraft shown in Table 204 and is necessary to find the correct repair.

<table>
<thead>
<tr>
<th>AIRCRAFT TYPE</th>
<th>WEIGHT VARIANT</th>
</tr>
</thead>
<tbody>
<tr>
<td>A320-100</td>
<td>000, 001, 002</td>
</tr>
<tr>
<td>A320-200</td>
<td>000, 001, 002, 003, 004, 005, 006, 007, 008, 009, 010, 011, 013, 014, 016</td>
</tr>
</tbody>
</table>

Effectivity per Weight Variant and Aircraft Type

Table 204

NOTE: Refer to Paragraph 23 'Weight Variant Information' in the INTRODUCTION of the SRM. Tables in the subparagraphs give the necessary data about all weight variants and their required information for allowable damage and repair applicability.
### Fairing Flap Repairs – Wet Lay up Repair

**1. Repair Materials**

For this repair use only the materials that follow:

<table>
<thead>
<tr>
<th>ITEM</th>
<th>NOMENCLATURE</th>
<th>QTY</th>
<th>MATERIAL/REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Cleaning Agent</td>
<td>A/R</td>
<td>Material No. 11-026 (Refer to SRM Chapter 51-35-00)</td>
</tr>
<tr>
<td>2</td>
<td>Lint Free Cloth</td>
<td>A/R</td>
<td>Local resources</td>
</tr>
<tr>
<td>3</td>
<td>Water Resistant Abrasive Cloth, Grade 280</td>
<td>A/R</td>
<td>Local resources</td>
</tr>
<tr>
<td>4</td>
<td>Water Resistant Abrasive Cloth, Grade 400</td>
<td>A/R</td>
<td>Local resources</td>
</tr>
<tr>
<td>5</td>
<td>Laminating Resin</td>
<td>A/R</td>
<td>HYSOL EA9396 or EA9390 or CIBA GEIGY LY5052/HY5052</td>
</tr>
<tr>
<td>6</td>
<td>Style 7781 Glasscloth (MIL-C-9084C, Type VIII)</td>
<td>A/R</td>
<td>Local resources</td>
</tr>
<tr>
<td>7</td>
<td>Style 120 Glasscloth (MIL-C-9084C, Type III)</td>
<td>A/R</td>
<td>Local resources</td>
</tr>
<tr>
<td>8</td>
<td>Low Viscosity Adhesive</td>
<td>A/R</td>
<td>Material No. 08-010A or Material No. 08-017</td>
</tr>
<tr>
<td>9</td>
<td>Butane Lamp</td>
<td>A/R</td>
<td>Local resources</td>
</tr>
</tbody>
</table>
• Fairing Flap Repairs – Wet Lay up Repair

(2) Repair Instructions

(a) Remove the fairing from the aircraft (Refer to AMM Chapter 57-55-11, Page Block 400).

(b) Assess the damage to make sure of the size of the damage and the damage zone (Refer to SRM Chapter 57-55-11, Page Block 101).

(c) Remove the surface protection 15.00 mm to 20.00 mm (0.591 in. to 0.787 in.) more than the intended position of the final repair ply (Refer to SRM Chapter 51-77-11).

CAUTION: USE ONLY THOSE CLEANING AGENTS SHOWN IN SRM Chapter 51-35-00, MATERIAL NO. 11-026.

(d) Refer to SRM Chapter 51-77-11, Paragraph 4.M and prepare the area. Use lint-free cloth (Item 2) and cleaning agent (Item 1) to degrease the repair area. Use water resistant abrasive cloth grade 280 and 400 (Items 3 and 4) to hand abrade the area.

WARNING: YOU MUST OBEY ALL THE MANUFACTURER’S SAFETY INSTRUCTIONS WHEN YOU USE THE BUTANE LAMP ON THE FAIRING SURFACE.

CAUTION: SEALS MAY HAVE TO BE REMOVED OR PROTECTED BEFORE YOU USE THE BUTANE LAMP ON THE FAIRING SURFACE.
• Fairing Flap Repairs – Wet Lay up Repair

(e) Take the Butane Lamp (Item 9) and set the flame height to about 25.40 mm (1.000 in.). A blue flame is required.

(f) Sweep the flame over the repair area in a steady motion. The burner outlet must be about 12.00 mm to 18.00 mm (0.500 in. to 0.750 in.) above the fairing surface. A maximum of two sweeps should be made across the fairing surface. You must not stop the burner over the fairing surface and the movement must be continuous.

\[ \text{NOTE: A swept length of about 50.00 mm (1.969 in.) should take 5 seconds.} \]

\[ \text{NOTE: If repair plies are to be applied to the inside and the outside face of the fairing you must apply the flame treatment to both faces.} \]

(g) Prepare the laminating resin (Item 5). Prepare the Style 7781 Glasscloth (MIL-C-9084C Type VIII) (Item 6) and Style 120 Glasscloth (MIL-C-9084C Type III) (Item 7).

(h) Impregnate the glasscloth with laminating resin (Item 5) (Refer to SRM Chapter 51-77-11, Paragraph 4.H.).

\[ \text{CAUTION: THE REPAIR PLYES MUST BE APPLIED OVER THE REPAIR AREA IN LESS THAN 45 MINUTES OF THE FLAME TREATMENT. IF YOU CANNOT COMPLY WITH THIS YOU MUST REPEAT THE SURFACE TREATMENT. YOU MUST NOT CONTAMINATE THE PREPARED SURFACE IN ANY CIRCUMSTANCE.} \]
• Fairing Flap Repairs – Wet Lay up Repair

<table>
<thead>
<tr>
<th>PLY No.</th>
<th>PLY MATERIAL</th>
<th>PLY ORIENTATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1, 6</td>
<td>120 STYLE GLASS</td>
<td>0°</td>
</tr>
<tr>
<td>2 THRU 5</td>
<td>7781 STYLE GLASS</td>
<td>0°</td>
</tr>
</tbody>
</table>

CAUTION: OBEY THE REPAIR EFFECTIVITY PER WEIGHT VARIANT AND AIRCRAFT TYPE GIVEN IN TABLE 204.

NOTE: DIMENSIONS IN MILLIMETERS (INCHES IN BRACKETS).

PLY OVERLAPS