AMT 2106 –AIRCRAFT MATERIALS CONSTRUCTION AND REPAIR II
(Composite)

PRELIM PERIOD

MODULE IV

Core Materials

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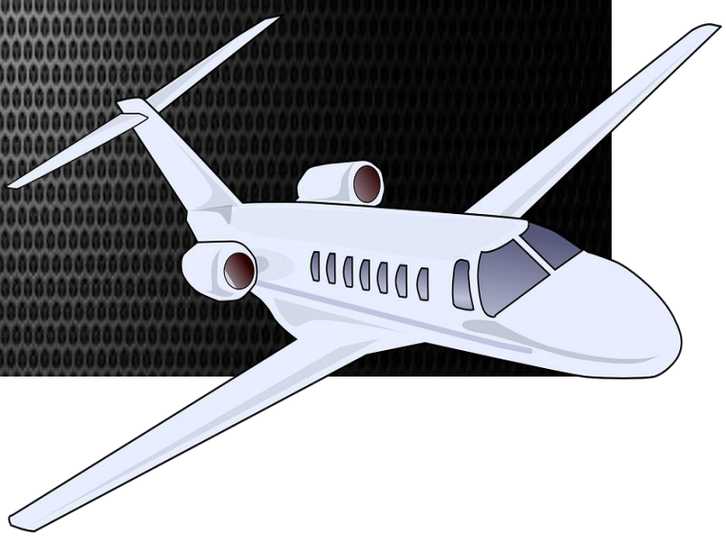

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REFERENCES	Ref no.
School of Materials Science and Engineering (2013) Citation Sandwich Panel Retrieved fomhttp://www.materials.unsw.edu.au/tutorials/online-tutorials/6-sandwich-panels	**1**
A&P Technician Airframe Textbook - Jeppesen	**2**
David Cripps, Gurit(2019) citation Core Materials retrieved from https://netcomposites.com/guide/core-materials/	**3**
FAA HANDBOOK PDF(2012) CITATION .CHAPTER 7 ADAVANCE COMPOSITE MATERIAL	**4**

This module briefly discusses, under the type of the reinforcing materials that focus on different core used in aviation industry. This module emphasizes the main function of adding core materials to the structures and also addresses the construction and fully describes the difference of each type to one other. It also deliberates the advantages of using the core material when apply in the structural component depending to its size and area of applications.

TIMEFRAME

You should be able to complete this module including all the self-assessments, research works, assignments, and other performance tasks within **1.5** hours.

LEARNING OUTCOMES

Course Learning Outcomes (CLO)	Module Learning Outcome (MLO)	Topic Learning Outcomes(TLO)
CLO 4. Execute and apply the techniques/ methods applicable to understand the different materials in composite.	**MLO 1.** Explain deeper understanding the concept and importance of core materials in application to aircraft composite structures **MLO 2..** Demonstrate understanding of facts and ideas by comparing the different types of core materials being used in aircraft applications .	**TLO9.** Discussion by recalling facts and ideas by comparing the different types of core materials being used in aircraft applications

MODULE VI: CORE MATERIALS

Engineering theory shows that the flexural stiffness of any panel is proportional to the cube of its thickness. The purpose of a core in a composite laminate is therefore to increase the laminate's stiffness by effectively 'thickening' it with a low-density core material. This can provide a dramatic increase in stiffness for very little additional weight.

The figure below shows a cored laminate under a bending load. Here, the sandwich laminate can be likened to an I-beam, in which the laminate skins act as the I-beam flange, and the core materials act as the beam's shear web. In this mode of loading it can be seen that the upper skin is put into compression, the lower skin into tension and the core into shear. It therefore follows that one of the most important properties of a core is its shear strength and stiffness.

In addition, particularly when using lightweight, thin laminate skins, the core must be capable of taking a compressive loading without premature failure. This helps to prevent the thin skins from wrinkling, and failing in a buckling mode.

Figure 1.
Different core maerials

Core materials are the central members of an assembly and are used extensively in advanced composite construction. When bonded between two thin face sheets, a component can be made rigid and lightweight.

Composite structures manufactured in this manner are sometimes referred to as **sandwich construction.**

A core material gives a great deal of compressive strength to a structure. For example, the sheet metal skin on a rotor blade has a tendency to flex in flight. This constant flexing causes metal fatigue. A composite blade with a central core material provides uniform stiffness throughout the blade and eliminates most of the flexing associated with metal blades.

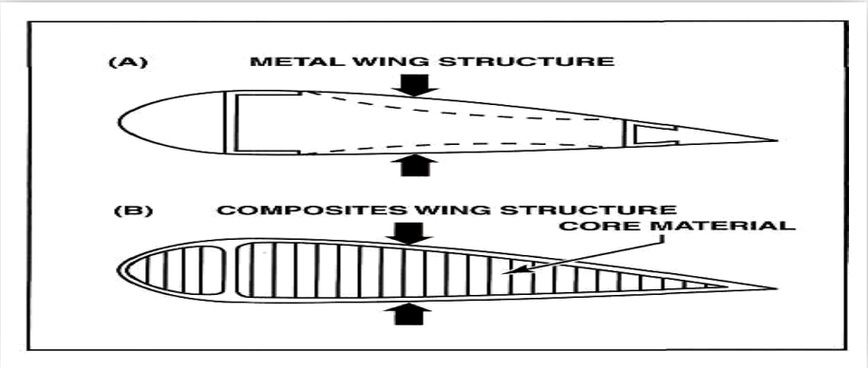


Figure 2.
Metal skins bend and flex when forces are applied to it in flight. The use of composite construction keeps the structure from flexing, eliminating fatigue.

The two most common types of core materials utilized in sandwich construction are honeycomb and foam cores. In addition, wood cores are also occasionally used in composite construction.

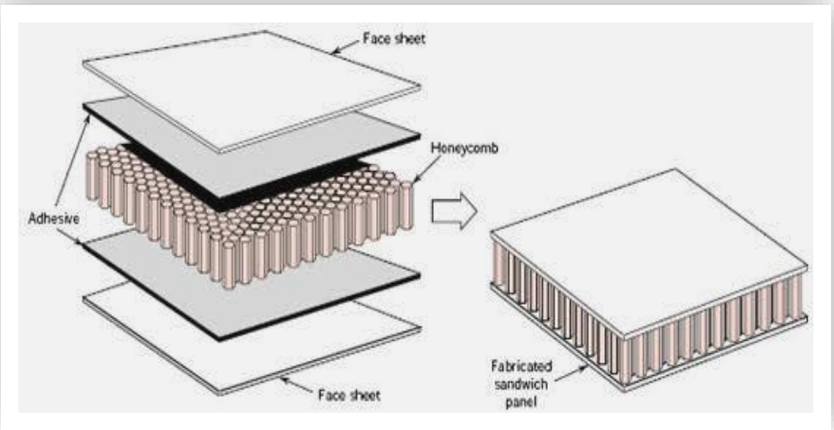


Figure 3
Typical sandwich construction

Two Popular Core Structures

1. Foam
2. Honeycomb

- ✓ The core materials gives a great deal of compression strength to a structures.
- ✓ The used of core materials dramatically increase the strength of the structures with out adding a significant weight.

1. **Honeycomb**

✓ This core materials consist of six sided shape of a natural honeycomb, which provide a core with a very high strength to weight ratio.

Manufacturers construct honeycomb from the ff:

1. Aluminum
2. Kevlar
3. Carbon
4. Fiberglass
5. Paper
6. Steel

NOMEX is a paper impregnated material which is widely used as an advance composite core material

Ribbon direction is a direction in which the honeycomb can be pulled apart. Pulling one side of the honeycomb that is perpendicular to the ribbon direction separates it, revealing the ribbon direction. If the pull is parallel to the ribbon, it is nearly impossible to tear the honeycomb. It is important to line up the ribbon direction of the replacement honeycomb core with that of the original when performing a repair honeycomb core repair to ensure consistent structural strength along with uniform compressive strength.

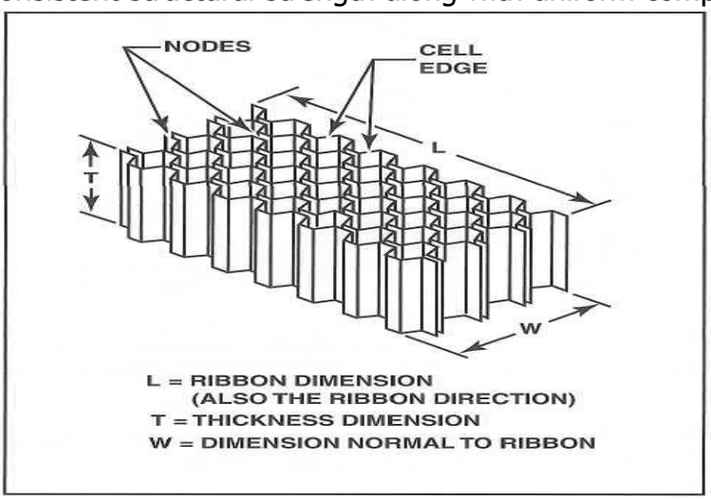


Figure 4

Honeycomb comes in a variety of core configurations. Some are more flexible than others and may be bent to form a curve. Crimping the core material into ribbons and joining them together forms the honeycomb shape.

Honeycomb cores range from paper and card for low strength and stiffness, low load applications (such as domestic internal doors) to high strength and stiffness, extremely lightweight components for aircraft structures. Honeycombs can be processed into both flat and curved composite structures, and can be made to conform to compound curves without excessive mechanical force or heating.

Honeycomb cores can give stiff and very light laminates but due to their very small bonding area they are almost exclusively used with high-performance resin systems such as epoxies so that the necessary adhesion to the laminate skins can be achieved.

Nomex honeycomb is made from Nomex paper – a form of paper based on Kevlar, rather than cellulose fibres. The initial paper honeycomb is usually dipped in a phenolic resin to produce a honeycomb core with high strength and very good fire resistance. It is widely used for lightweight interior panels for aircraft in conjunction with phenolic resins in the skins. Special grades for use in fire retardant applications (eg public transport interiors) can also be made which have the honeycomb cells filled with phenolic foam for added bond area and insulation.

Nomex honeycomb is becoming increasingly used in high-performance non-aerospace components due to its high mechanical properties, low density and good long-term stability. However, it is considerably more expensive than other core materials.

2. FOAM CORE

- ✓ There are many different types of foam core materials available, depending on the specific application.
- ✓ Foam core materials offer different densities and temperature characteristics for high-heat applications and fire resistance.
- ✓ When using foams in a repair operation, it is important to use the proper type and density.

note

- ✓ Always refer to the manufacturer's repair guidelines for recommended materials and procedures.

Common types of foam core used in A/C constructions

1. Styrofoam
2. urethane foam
3. poly vinyl chloride (PVC)
4. and strux

a. <u>Styrofoam</u>

Styrofoam is commonly used on home-built aircraft and should only be used with an epoxy resin.

- ✓ Polyester resins dissolve Styrofoam.
- ✓ Do not confuse aircraft-quality Styrofoam with the type of Styrofoam used to make Styrofoam cups. Styrofoam cups use foam with large cell configurations that can not be used for structural applications Aircraft-quality

b. URETHANE

Urethane foam can be used with epoxy or polyester resins.

- ✓ However, urethane cannot be cut with a hot wire. Subjecting urethane foam to high heat produces a hazardous gas.
- ✓ Instead of a hot wire cutter, urethane is cut with a number of common tools.
- ✓ Knives are typically used to rough out the shape, and another piece of urethane foam is used to sand the piece to its desired size and shape

The polyurethane foam world is very large and diverse – chances are good you are sitting on some kind of flexible polyurethane foam right now – but the useful products for composite-core applications are rigid foams.

c. POLY VINYL CHLORIDE (PVC), AND STRUX

- ✓ OTHER FOAM CORE MATERIALS include **poly vinyl chloride (PVC),** and **strux** (cellular, cellulose acetate) foam.
- ✓ PVC foam can be used with either polyester or epoxy resins and cut with a hot wire.
- ✓ Strux foam is commonly used to build up ribs or other structural support

WOOD CORES

- ✓ Balsa wood or laminations of hard wood which are bonded to laminates of high-strength materials are occasionally used for other types of composite sandwich construction.
- ✓ Wood core materials provide high compressive strength to composite structures

Wood can be described as 'nature's honeycomb', as it has a structure that, on a microscopic scale, is similar to the cellular hexagonal structure of synthetic honeycomb. When used in a sandwich structure with the grain running perpendicular to the plane of the skins, the resulting component shows properties similar to those made with man-made honeycombs. However, despite various chemical treatments being available, all wood cores are susceptible to moisture attack and will rot if not well surrounded by laminate or resin.

Balsa

The most commonly used wood core is end-grain balsa. Balsa wood cores first appeared in the 1940's in flying boat hulls, which were aluminium skinned and balsa-cored to withstand the repeated impact of landing on water. This performance led the marine industry to begin using end-grain balsa as a core material in FRP construction. Apart from its high compressive properties, its advantages include being a good thermal insulator offering good acoustic absorption. The material will not deform when heated and acts as an insulating and ablative layer in a fire, with the core charring slowly, allowing the non-exposed skin to remain structurally sound. It also offers positive flotation and is easily worked with simple tools and equipment.

Balsa core is available as contoured end-grain sheets 3 to 50mm thick on a backing fabric, and rigid end-grain sheets up to 100mm thick. These sheets can be provided ready resin-coated for vacuum-bagging, prepreg or pressure-based manufacturing processes such as RTM. One of the disadvantages of balsa is its high minimum density, with

100kg/m3 being a typical minimum. This problem is exacerbated by the fact that balsa can absorb large quantities of resin during lamination, although pre-sealing the foam can reduce this. Its use is therefore normally restricted to projects where optimum weight saving is not required or in locally highly stressed areas.

Sandwich Panels

Sandwich panels are used in applications where high stiffness combined with low structural weight is required. Sandwich panels are based on a simple structure of two high strength skins bonded to either side of a light weight core. This provides a very light and very stiff structure.

The design of the sandwich structure ensures that the skins carry the large majority of the tensile and compressive stresses that are produced under load.

The skins are designed to be strong and resist tensile and compressive stresses. They are usually made of aluminium, titanium, or fibre reinforced polymers. The core is designed to resist shear stresses and is usually made of polymer foams, or expanded metal or polymer honeycombs

Mastery Check

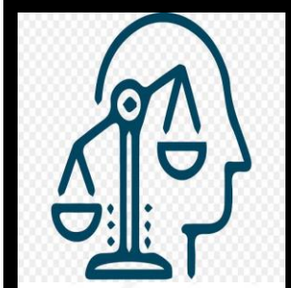
Self-Assessment: Before we proceed with our module, let's check how well you have understood the discussion so far. Using the table below, kindly explained in your own words the difference of each terms. 2-3 sentences only.
Time frame: 5 mins – 10 mins

Terms	
Core Materials	
Sandwich Constructions	
Foam Core	
Ribbon Directions	
HoneyComb	

Rubrics for Self- Assessment

These basic rubric examples ensure that all parts of the activity are present. They help students keep track of each element of activity. Checklists also let teachers see whether a student fully participatedin activity.

CRITERIA	INADEQUATE (Below Standard) 65%-74%	ADEQUATE (Meets Standard) 75%-84%	ABOVE AVERAGE (Exceeds Standard) 85%-92%	EXEMPLARY (Far Exceeds Standard) 93%-100%	SCORE
Organization	Writing lacks logical organization. It shows some coherence but ideas lack unity. Serious errors.	Writing is coherent and logically organized. Some points remain misplaced and stray from the topic. Transitions evident but not used throughout essay.	Writing is coherent and logically organized with transitions used between ideas and paragraphs to create coherence. Overall unity of ideas is present.	Writing shows high degree of attention to logic and reasoning of points. Unity clearly leads the reader to the conclusion and stirs thought regarding the topic.	
Level of Content	Shows some thinking and reasoning but most ideas are underdeveloped and unoriginal.	Content indicates thinking and reasoning applied with original thought on a few ideas.	Content indicates original thinking and develops ideas with sufficient and firm evidence.	Content indicates synthesis of ideas, in-depth analysis and evidences original thought and support for the topic.	
Development	Main points lack detailed development. Ideas are vague with little evidence of critical thinking.	Main points are present with limited detail and development. Some critical thinking is present.	Main points well developed with quality supporting details and quantity. Critical thinking is weaved into points.	Main points well developed with high quality and quantity support. Reveals high degree of critical thinking.	
Grammar & Mechanics	Spelling, punctuation, and grammatical errors create distraction, making reading difficult; fragments, comma splices, run-ons evident. Errors are frequent.	Most spelling, punctuation, and grammar are correct allowing reader to progress the essay. Some errors remain	Essay has few spelling, punctuation, and grammatical errors allowing reader to follow ideas clearly. Very few fragments or run-ons.	Essay is free of distracting spelling, punctuation, and grammatical errors; absent of fragments, comma splices, and run-ons.	
				GRADE (score/4)	



HONESTY CLAUSE

My signature below constitutes my pledge that all of my writing is my own work, with the exceptions of those portions which are properly documented

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Subject Instructor

Student Signature	**Parent Signature**