Lesson Plan

NEUROHEADWAY

Neuroscience Into Education

Aircraft Structural Design

Learning Objectives

- What are structural components
- What components combine to form aircraft structures
- What should we choose – metals or composites
- Introduction to sandwich structures
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Lesson Plan

Slide	Topic	Description	Time
1	Aircraft Structural Design	Introduction to structural design.	2
2	Recap	Recap of module 4.	4
3	Structural Components	Introduction to basic structural components and how the combine to form a secondary component.	5
4-5	Bending strength and activity	Importance of bending strength. Activity to test bending strength for plate and stiffened plate.	15
6	Metals vs Composites	Property comparison of composites and metals.	5
7	Sandwich Structures	Introduction to sandwich structures.	4
8	Demo	Bending strength demonstration of sandwich structures.	5
9	Sandwich structures vs stiffened plate	Property comparison of sandwich structures and stiffened plate.	5
10	Limitations of sandwich structures	Limitations of sandwich structures applied to aircrafts	5
11	Home Activity	Beam design to carry load	4
12	Summary		5
13	Next module	Introduction to the next module	1

Power point Example

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Neuroscience Into Education

Aircraft Structural Design

Aerospace Engineering

Recap

We learnt about different types of materials and their charecteristics in terms of cost, weight, strength and stiffness.

We learnt about the desirable qualities that aircraft materials should possess.

We compared different material groups for strength, stiffenss, weight and cost.

We looked into the process of material selection for aircrafts through an activity.

In the following modules we will look at the structural design of aircrafts and see how we can use the above materials to our best advantage.

Aircraft Structures
Components

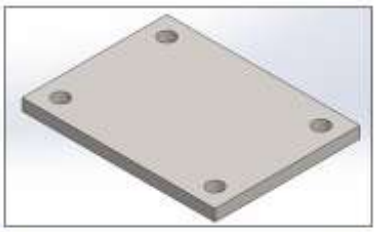
Structures on an aircraft can be broken down into two basic components –

Beams and Plates

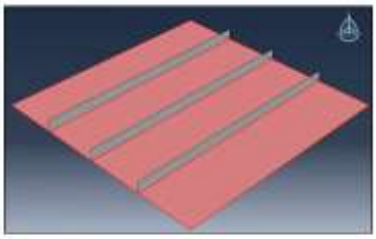
Structures can be made from metals, composites and ceramics.

Beam

Plate



Stiffened Plate: Plate + Beam



One of the main properties that our structure should possess is *'Bending Strength'*.

In other words, it is the ability of the structure to resist bending.

Activity 1
Bending strength assessment of beam, plate and stiffened plate

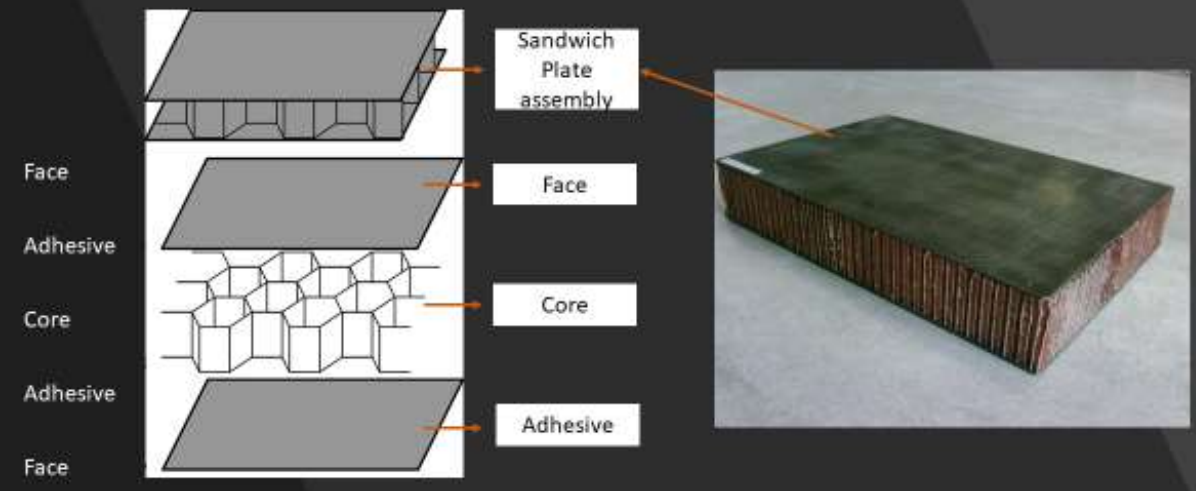
Which material should one choose – Composites or Metals?

Comparison of Cured Laminate Properties with Those for Metals

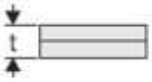
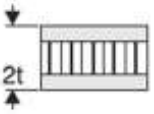
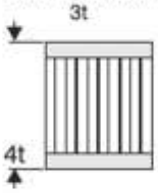
Material	Density* (10^3 Kg/m^3)	Ultimate Tensile Strength* (MPa)	Tensile Modulus (GPa)	Specific Strength (MPa/Kgm^{-3})	Specific Modulus (GPa/ Kgm^{-3})
E-Glass	2.08	1103	44.8	0.53	0.022
S-Glass	1.99	1931	51.7	0.97	0.026
Kevlar-49	1.38	1448	75.8	1.05	0.055
Type HMS Graphite	1.63	1172	206.8	0.72	0.127
Type AS Carbon	1.55	1724	137.9	1.11	0.089
Emerging High Strain Graphite	1.63	2413	310.3	1.48	0.190
Aluminum (7075-T6)	2.77	572	68.9	0.21	0.025
Titanium (6A1-4V)	4.43	1103	113.8	0.25	0.026
Steel (4130)	8.00	1379	200.0	0.17	0.025

→ Higher the better!

Sandwich Structures (Alternate structural arrangements)

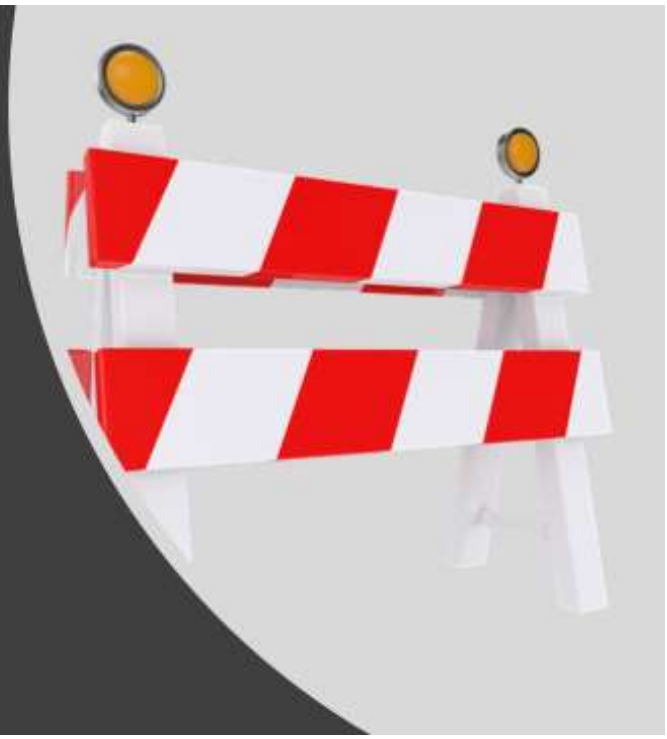


Sandwich Structures vs plate

	Solid Material	Core Thickness t	Core Thickness 3t
			
Stiffness	1.0	7.0	37.0
Flexural Strength	1.0	3.5	9.2
Weight	1.0	1.03	1.06

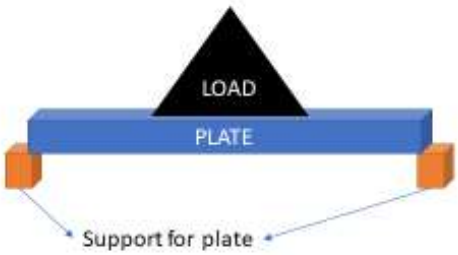
Limitations of Sandwich Structures

- High cost of raw materials
- Complicated to design and validate
- Difficult to recycle
- Not suitable for structures with limited space availability. Eg, in aircrafts, we cannot have walls made of thick sandwich panels due to lack of space.



Home Activity

- Combine all that you have learnt to design a plate of dimensions 10 cm x 5 cm. You may stiffen the panel using beams or choose to make a sandwich structure. The limitation on height of the structure is 2 cm.
- Bring your panel to class and mount it between two supports as shown in the figure and apply a load on top.
- Measure applied load and measure weight of the empty panel. Find the ratio between the two loads. This defines the load carrying capacity of your panel.
- Compare your designs.



Summary

Aircraft structures are made of materials possessing high strength, high stiffness and low weight.

These materials are use to make structural arrangments to resist external loads.

Structures are fundamentally made of beams and plates.

Alternate structural arrangements like sandwich structures provide higher strenght and stiffness with marginal increase in weight compared to a plate.