INTRODUCTION TO AIRCRAFT STRUCTURES

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The Course

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- Fatigue & Damage Tolerance

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INTRODUCTION TO AIRCRAFT STRUCTURES : COURSE OBJECTIVES

Or ‘what you should know about after completing this course’

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Course Objectives

- To understand some basic concepts of an Aircraft Airframe and the purpose of the major structural elements
- To apply the learning you have from Structures and Materials Year 1 to practical Aircraft structures
- To understand the importance of ‘First Principles’ in the design and analysis of Aircraft Structures
- To introduce the concepts of Static Strength, Structural Requirements and Fatigue and Damage Tolerance with respect to modern Aircraft Structures

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INTRODUCTION TO AIRCRAFT STRUCTURES : HOW DID WE GET HERE FROM 1903 ?

Or ‘A journey through recent history’

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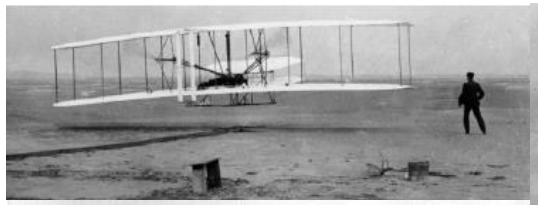
1903 to 2018 – A really quick journey !















To be continued ……

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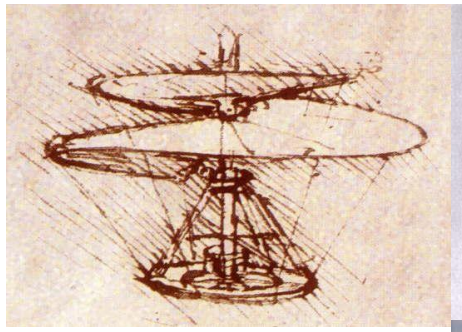
What about Vertical Flight ?













To be continued ……

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INTRODUCTION TO AIRCRAFT STRUCTURES : MAJOR LOADS ACTING ON AN AIRCRAFT STRUCTURE

Or ‘So what loads does and airframe have to carry ?’

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Major Loads on Aircraft Structures

- **Aerodynamic / Inertia loads**

- Aerodynamic forces reacted by inertia provide the basic loading on aircraft structures.

- For stability reasons the centre of gravity is normally located forward of the centre of pressure, and so a small downward tail load is required to maintain moment equilibrium.

- Manoeuvres and gusts create the highest loads.

- Emergency Landing Inertias are a key design driver

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Major Loads on Aircraft Structures

- Typical values of Flight ‘g’ are:
- + 2.5 (transport aircraft)
- + 4.5 (light aircraft)
- + 8.0 to - 6.0 (aerobatic aircraft)
- + 9.0 to – 3.5 (fighter)

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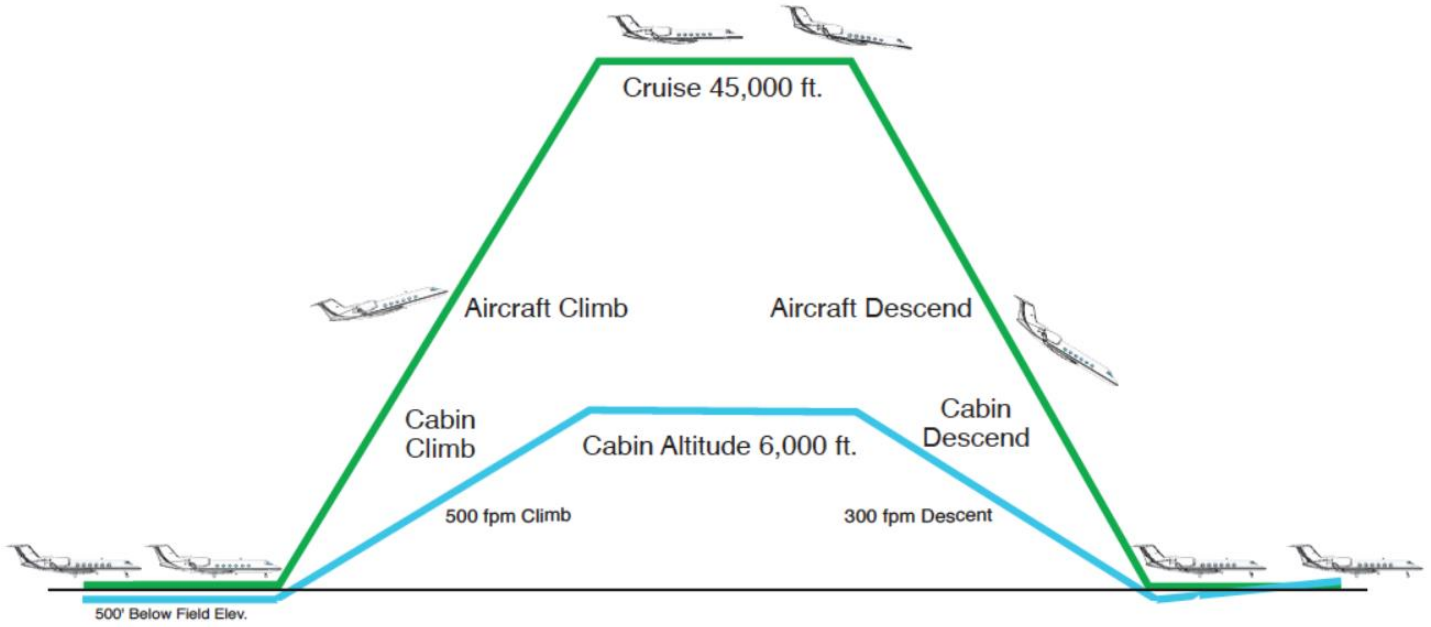
Major Loads on Aircraft Structures

- **Cabin pressurisation loads**

- For pressurised aircraft, the once per flight pressurisation cycle is a significant source of fatigue loading.



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Major Loads on Aircraft Structures

- **Landing loads**

- Landing the Aircraft produces high overall loading on the whole structure as well as local loading in the undercarriage and attachment. This is another source of fatigue loading, related to the number of flights but not the number of flight hours.

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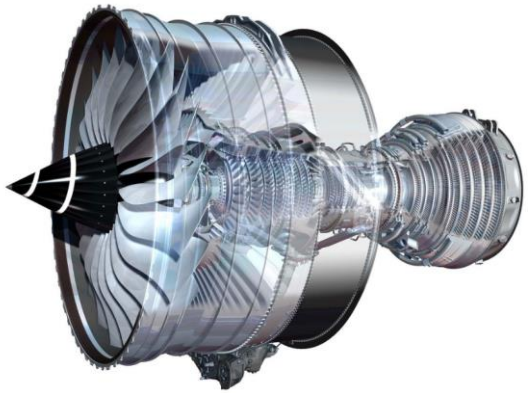
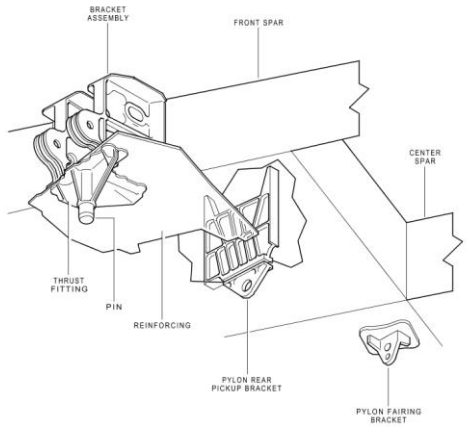
Major Loads on Aircraft Structures

- **Engine loads**

- In addition to thrust forces, engines produce large inertia loads due to their weight. There are also secondary loadings due to torque and gyroscopic effects.
- There is a specific Airworthiness requirement on large commercial aircraft to ensure the structure can cope with a ‘sustained engine imbalance’ in flight





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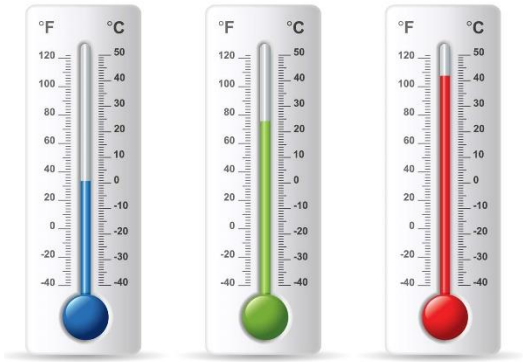
Major Loads on Aircraft Structures



- **Thermally induced loads**

- Differential thermal expansion can cause large forces where there are temperature gradients (e.g. the leading edge of a supersonic aircraft) or where different materials join together (e.g. connecting a carbon fibre outer wing to a metal wing root).

- A typical temperature operating range for a large long range commercial aircraft is from up to + 50 Deg C on ground to – 56 Deg C at cruise altitude !

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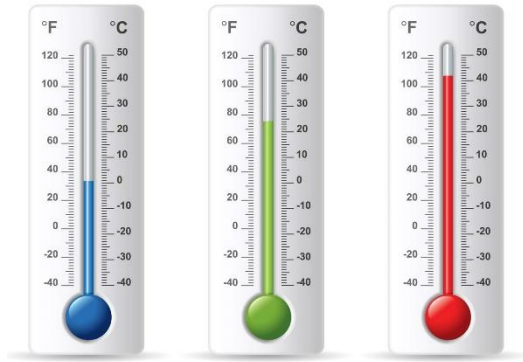
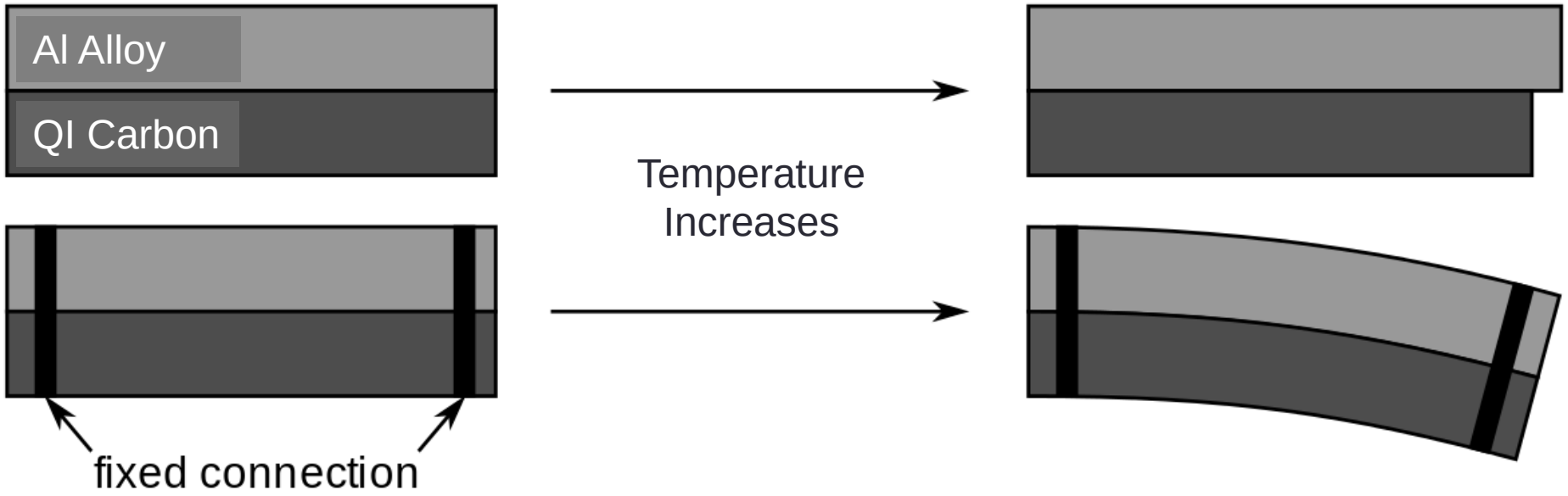
Major Loads on Aircraft Structures



- **Thermally induced loads**

- Coefficient of Expansion typical Aircraft Aluminium Alloy – 24.7 µm / m -°C
- Coefficient of Expansion Quasi-Isotropic Carbon Laminate – almost negligible



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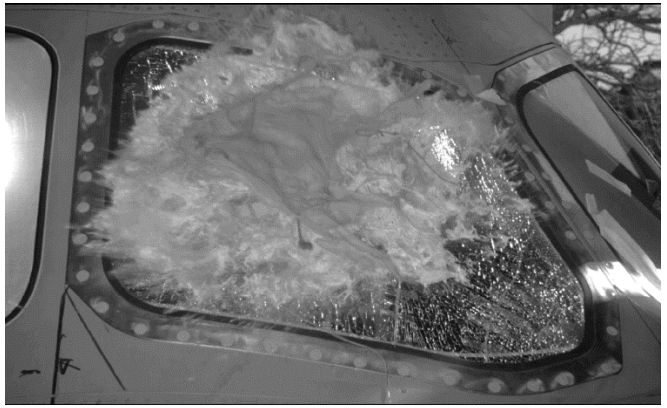
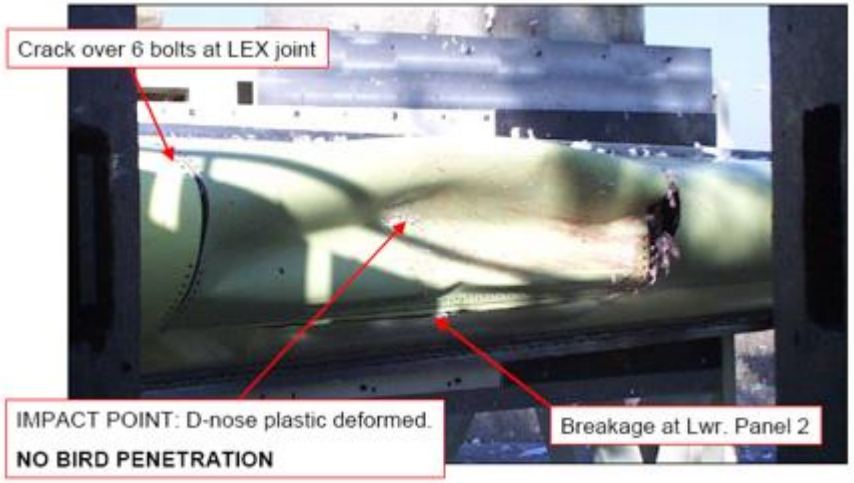
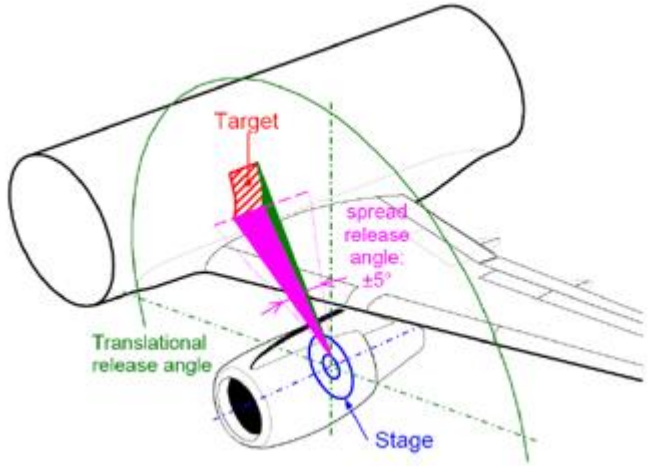
Major Loads on Aircraft Structures

- **Impact/crash loads**

- The structure must be able to withstand impacts for example due to birdstrike or uncontained engine turbine failures.







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Major Loads on Aircraft Structures

- **Impact/crash loads**

- Passengers must also be protected in survivable crashes. Seats must remain attached, rupture of fuel tanks prevented and no detrimental deformation on cabin doors or door frames.

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