

26.1 Types of Structural Loads

- An airframe is subjected to five fundamental types of stress:
- 1. Tension (Tensile Load): A stretching or pulling force. Components designed to resist tension are called Ties.
- 2. Compression: A squeezing or crushing force. Components designed to resist compression are called Struts.
- 3. Shear: A force that tries to slide one part of a structure over another. Riveted joints are primarily designed to resist shear.
- 4. Bending: A combination of tension and compression. The top of a bending beam is in compression, while the bottom is in tension.
- 5. Torsion: A twisting force.

26.2 Structural Concepts

- ☐ Stress: The internal force within a material that resists an external load. ($\text{Stress} = \text{Force} / \text{Area}$).
- ☐ Strain: The deformation or change in dimension of a material when a load is applied. ($\text{Strain} = \text{Change in Length} / \text{Original Length}$).
- ☐ Elastic Limit: The maximum load a material can withstand and still return to its original shape. Loads beyond this limit cause permanent deformation.
- ☐ Design Loads:
 - Design Limit Load (DLL): The maximum load the designer expects the airframe to encounter in service.
 - Design Ultimate Load (DUL): The DLL multiplied by a safety factor (typically 1.5). The structure must withstand the DUL without catastrophic failure.

26.3 Structural Design Philosophies

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- ☐ Safe Life: A philosophy where a component is designed to be removed from service after a specific number of hours or cycles, well before a fatigue failure is expected to occur.
- ☐ Fail-Safe: A design philosophy that uses redundancy, such as multiple load paths or backup systems. If one component fails, others are there to carry the load, preventing a catastrophic failure.
- ☐ Damage Tolerant: A more modern philosophy that assumes cracks or damage will eventually occur. The structure is designed to sustain these damages and allow them to grow slowly enough to be detected during regular inspections before they become critical.

26.4 Fuselage Construction

- ☐ Truss/Framework: An underlying rigid framework of tubes (usually steel) that carries the primary loads. The structure is then covered by a lightweight, non-load-bearing skin (fabric or aluminum). Common on light, unpressurized aircraft.
- ☐ Monocoque: A design where the outer skin carries almost all of the loads. It is very strong but susceptible to failure from dents or damage. It requires a very strong, heavy skin.
- ☐ Semi-Monocoque: The most common method of construction for modern aircraft. The outer skin is the primary load-bearing structure, but it is reinforced and stiffened by an internal framework of:
 - Formers/Frames: Give the fuselage its shape.
 - Stringers: Run lengthwise to stiffen the skin and prevent buckling.
 - Bulkheads: Solid partitions that provide significant structural strength, especially the pressure bulkhead at the rear of the cabin.

26.5 Wing Construction

- Modern aircraft use a cantilever monoplane design, where the wing is self-supporting without external bracing. The primary structural component is the Torsion Box (or wing box), which is designed to resist bending and twisting loads. It is composed of:
 - ☐ Spars: The main span-wise structural members of the wing. There is typically a front spar

- and a rear spar.
- ☐ Ribs: Run from the leading edge to the trailing edge, giving the wing its aerofoil shape and supporting the skin.
- ☐ Stringers: Run span-wise along the wing, stiffening the skin.
- ☐ Skin: The outer covering of the wing, which carries a significant portion of the flight loads.

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