Fuselage outer material selection (should be in the weight estimation)

What design factors are decided for fuselage material of a plane?

* Most important point for fuselage is the weight of it?

What materials were considered for the fuselage?

Fuselage weight estimation and how it is done? (Unsure if this detail is needed)

CFRP fuselage pls don’t change (wrote last line in structural layout for this if change need to delete that make sure)

We are following the a350 and scaling it (need to multiply by the length of the plane)  
  
  
1. Airbus A350-1000

* Maximum Takeoff Weight (MTOW): Approximately 700,000 pounds (318,000 kg)
* Operating Empty Weight (OEW): Approximately 308,000 pounds (140,000 kg)
* Extensive Use of Composites: Around 53% of the A350 is made from composite materials, which significantly reduces weight compared to traditional aluminum-heavy aircraft.

2. Boeing 777X (777-9 variant)

- Maximum Takeoff Weight (MTOW): Approximately 775,000 pounds (351,534 kg)

- Operating Empty Weight (OEW): Approximately 436,000 pounds (198,000 kg)

Hybrid Material Design: The 777X uses an aluminum fuselage but incorporates composite wings, achieving some weight savings but not to the same extent as a fully composite fuselage.

|  |  |  |
| --- | --- | --- |
| Material | Pros | Cons |
| CFRP pure (a350 wings, fuselage) |  |  |
| Hybrid (777x, wings parts only) |  |  |

When determining between a fuselage primarily constructed from aluminum against one made from carbon fiber reinforced plastic (CFRP). It is clear to see that aluminum has lower maintenance and production cost overall, and easier to repair in the field, and proven to be more reliable in the aeronautical industry with its fatigue resistance and durability. However, by mainly using CFRP the fuselage has a lighter overall weight leading to better fuel efficiency making it more profitable. It also allows for larger seamless panels, is corrosion resistant, and has inherent crack stopping abilities for better structural integrity. Given that our proposed aircraft will be operating over a long-term basis, it is more advantageous to make a long-term investment in CFRP as the initial production cost will be offset by long-term savings in maintenance and fuel costs, resulting in lower overall costs and higher fleet utilization. Additionally, wind facing elements are made out of aluminum alloy or titanium such as the nose cone. This ensures that in the event of bird strike or tail strike, repairs will be simpler and quicker as evident with flight AF356 where a tail strike caused an extremely costly repair for Air France with a maintenance turnaround time of 4 months.

* Attachment of carbon parts to aluminum compromises the structural integrity

Structural layout

Fuselages reinforce for what forces, different types of loads?

Main loads experienced

* Pressurization Loads – due to the difference between cabin and ambient pressure at altitude.
* Bending Loads – primarily from lift on the wings versus the weight of the fuselage creating a bending moment
* Torsional Loads – caused by asymmetric forces, like crosswinds or maneuvering.
* Shear Loads – due to lateral forces, particularly from lift and drag.

What kind are usually for aircraft? (Description of aircraft structure)

* Stiffening members (done)
* Frames (done)
* Bulkheads (done)
* Stringers (done)
* Longerons (done)
* <https://air.flyingway.com/books/Airframe-Stuctural-Design.pdf> (airframe-structural design book)

In the FAR 25 regulations it is mentioned several times that the fuselage must meet specific strength properties (FAR 25.307, FAR 25.365, FAR 25.571, FAR 25.613) and can handle cyclic pressurization, torsion, shear and bending loads in regular operation. Longerons are positioned longitudinally throughout the aircraft whereas Stringers are integrated in intervals around the circumference of the fuselage, running longitudinally down the aircraft from nose to tail. This configuration helps with distributing the primary loads such as shear, bending and buckling and helps with providing resistance to cyclic pressurization while also reinforcing the aircraft skin securing it to the airframe. With longerons and stringers in placed, the CFRP skin panels are made to be as large as possible to reduce joints and splices as these areas are prone to stress concentration and potential fatigue points. Bulkheads are also used throughout the airframe at points of concentrated forces especially at the wing-fuselage junction and the boundary between the pressurized tail section and the unpressurized aft section helping distribute load to the fuselage skin. Moreover, it is imperatives that “Doublers” (overlapping material) are placed on critical areas such as joints, wing-fuselage junctions, landing gear attachment points and engine pylons to reinforce these attachment points. There was also a consideration to use failsafe straps. However, since the fuselage material made from composites, its cracking mechanism differs to metals, cracks tend to be localized due to the layered structure of the material.