3. Composites Revolution

Boeing 777 boasted an all-composite empennage and floor beams. The fiber/resin system for Boeing 787 was kept the same but automated fiber placement techniques enable a weight saving of 20%. The automated fiber placement allows for precise accurate positioning of fibers onto a mandrel that creates the stringers and then spreads over the fuselage skin to varying thicknesses. Autoclave curing cures the epoxy resin after which the mandrels are disassembled and removed. The fuselage of the 787 is made in five different sections.

Composites allow for an appropriate increase of thickness in parts susceptible to high probability of impact damage such as doors, door surrounds, wing tips, wing leading and trailing edges and wing-to-body fairings are all prone to ground (service) vehicle impact damage. (Aircraft Technology Engineering & Maintenance, 2005)

Boeing 787 CFRP fuselage design braves larger pressures (from a cabin altitude of 8,000ft to a cabin altitude of 6,000ft) without adding much weight to the airframe structure. The outstanding corrosion resistance of composites has allowed Boeing to consider placing a cabin humidifier for making the passenger cabin environment more comfortable. Windows on the Boeing 787 are much larger than its predecessors. Airbus is driven by similar motivations for incorporating Fiber metal laminated (FML) composites in its new A350 (Aircraft Technology Engineering & Maintenance, 2005; Wall, 2005).

Dessault Aviation designed a one-piece business jet fuselage using pre-preg carbon fiber slit tape with honeycomb core. The single-piece manufacturability has drastically reduced simplified the structure by eliminating thousands of fasteners previously used in multi segment fuselage. (Leininger, 2005)
Different failure criteria have been developed over time to explain the failure in composite materials. The most popular failure criteria are the maximum stress criterion, Hashin’s criterion, Tsai-Hill criterion, Puck’s criterion, Cheung and Chang’s criterion, and maximum strain criterion. Hashin’s failure criterion has been used by many researchers and it is one of the most reliable methods to predict the strength of laminated composites (Sun & Tao 1998).

Hashin’s failure criterion was originally developed for unidirectional fibre-reinforced laminate. Even though a three-dimensional failure criterion is available, but it is limited to the scope of unidirectional laminates (Hashin and Rotem 1973; Hashin 1980). The criterion is based on two failure mechanisms which are associated with failure in fiber and failure in matrix, distinguishing in both cases between tension and compression.

**Mechanical Properties of Fiber Metal Laminate**