NEWSLETTER

DEE HOWARD

Durrell “Dee” Howard passed away on February 12, after a lengthy illness; he was 88. With over 70 years in aviation, Howard was internationally recognized for his development and certification of aircraft safety and performance improvements, including jet engine thrust reversers.

I worked with Dee on a 16 plane BAC1-11 airliner to Business Jet Program in 1977 - we aquired the “fleet” from American Airlines. Dee designed a 28 passenger interior that we standarized on. “Your choice of fabric/ leather colors and the two stripes”. We had Aircraft Tank Service design the AUX fuel system, added long range NAV and COMM radios . . . . for approximately $3.0 million you had a very nice long range airplane.

Dee converted the first 747s to Business Jets. He had a great designer, Michael Reese, a guy who had as much imagination on interiors as Dee did on aircraft systems. They designed and installed the first three level elevator for the 747.

His jet engineThrust Reversers were almost a piece of art. He started with units for the Learjet 24/25s, then installed a scaled-up version on the Rolls Royce Tay engine conversions for UPS.

Dee was a dedicated collector of pre-1940 automobiles. His auto shop, located about a half mile from the airport had a Beverly Hills quality showroom and a Mercedes quality restoration shop. More next issue . . ..

COMPOSITE AICRAFT — FAA HDBK H8083-5A

History

The use of composites in aircraft construction can be dated to World War II aircraft when soft fiberglass insulation was used in B-29 fuselages. (This appears to be an error - adhesive impregnated scrim cloth was used at each “lap joint” - the rivets were then installed and you had a “composite bonded joint”. The scrim cloth was carried forward thru the jet transports of the late 1960s. . . **. it was a real headache and directly related to ALOHA)!**

By the late 1950s, European high performance sailplane manufacturers were using fiberglass as primary structures. In 1965, the FAA type certified the first all-fiberglass aircraft in the normal category, a Swiss sailplane called a Diamant HBV. Four years later, the FAA certified a four-seat single-engine Windecker Eagle in the normal category. By 2005, over 35 percent of new aircraft were constructed of composite materials. Composite is a broad term and can mean materials such as fiberglass, carbon fiber cloth, Kevlar© cloth, and mixtures of all of the above. Composite construction offers two advantages: extremely smooth skins and the ability to easily form complex curved or streamlined structures.

Composite Materials in Aircraft

Composite materials are fiber-reinforced matrix systems. The matrix is the “glue” used to hold the fibers together and, when cured, gives the part its shape, but the fibers carry most of the load. There are many different types of fibers and matrix systems.

In aircraft, the most common matrix is epoxy resin, which is a type of thermosetting plastic. Compared to other

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choices such as polyester resin, epoxy is stronger and has good high-temperature properties. There are many different types of epoxies available, with a wide range of structural properties, cure times and temperatures, and costs.

The most common reinforcing fibers used in aircraft construction are fiberglass and carbon fiber. Fiberglass has good tensile and compressive strength, good impact resistance, is easy to work with, and is relatively inexpensive and readily available. Its main disadvantage is that it is relatively heavy, and it is difficult to make a fiberglass load-carrying structure lighter than a well designed equivalent aluminum structure.

Carbon fiber is generally stronger in tensile and compressive strength than fiberglass, and has much higher bending stiffness. It is also considerably lighter than fiberglass. However, it is relatively poor in impact resistance; the fibers are brittle and tend to shatter under sharp impact. This can be greatly improved with a "toughened" epoxy resin system, as used in the Boeing 787 (should be 777) horizontal and vertical stabilizers. Carbon fiber is more expensive than fiberglass, but the price has dropped due to innovations driven by the B-2 program in the 1980s, and Boeing 777 work in the 1990s. Very well-designed carbon fiber structures can be significantly lighter than an equivalent aluminum structure, sometimes by 30 percent or so.

Advantages of Composites

Composite construction offers several advantages over metal, wood, or fabric, with its lighter weight being the most frequently cited. Lighter weight is not always automatic. It must be remembered that building an aircraft structure out of composites does not guarantee it will be lighter, it depends on the structure, as well as the type of composite being used.

A more important advantage is that a very smooth, compound curved, aerodynamic structure made from composites reduces drag. This is the main reason sailplane designers switched from metal and wood to composites in the 1960s. In aircraft, the use of composites reduces drag for the Cirrus and Columbia line of production aircraft, leading to their high performance despite their fixed landing gear. Composites also help mask the radar signature of "stealth" aircraft designs, such as the B-2 and the F-22. Today, composites can be found in aircraft as varied as gliders to most new helicopters.

Lack of corrosion is a third advantage of composites. Boeing is designing the 787, with its all-composite fuselage, to have both a higher pressure differential and higher humidity in the cabin than previous airliners. Engineers are no longer as concerned about corrosion from moisture condensation on the hidden areas of the fuselage skins, such as behind insulation blankets. This should lead to lower long-term maintenance costs for the airlines.

Another advantage of composites is their good performance in a flexing environment, such as in helicopter rotor blades. Composites do not suffer from metal fatigue and crack growth as do metals. While it takes careful engineering, composite rotor blades can have considerably higher design lives than metal blades, and most new large helicopter designs have all composite blades, and in many cases, composite rotor hubs.

Disadvantages of Composites

Composite construction comes with its own set of disadvantages, the most important of which is the lack of visual proof of damage. Composites respond differently from other structural materials to impact, and there is often no obvious sign of damage. For example, if a car backs into an aluminum fuselage, it might dent the fuselage. If the fuselage is not dented, there is no damage. If the fuselage is dented, the damage is visible and repairs are made.

In a composite structure, a low energy impact, such as a bump or a tool drop, may not leave any visible sign of the impact on the surface. Underneath the impact site there may be extensive delaminations, spreading in a cone-shaped area from the impact location. The damage on the backside of the structure can be significant and extensive, but it may be hidden from view. Anytime one has reason to think there may have been an impact, even a minor one, it is best to get an inspector familiar with composites to examine the structure to determine underlying damage. The appearance of "whitish" areas in a fiberglass structure is a good tip-off that delaminations of fiber fracture has occurred.

A medium energy impact (perhaps the car backing into the structure) results in local crushing of the surface, which should be visible to the eye. The damaged area is larger than the visible crushed area, and will need to be repaired. A high energy impact, such as a bird strike or hail while in flight,results in a puncture and a severely damaged structure. In medium and high energy impacts, the damage is visible to the eye, but low energy impact is difficult to detect. Impact energy affects the visibility, as well as the severity, of damage in composite structures. High and medium energy impacts, while severe, are easy to detect. Low energy impacts can easily cause hidden damage.

If an impact results in delaminations, crushing of the surface, or a puncture, then a repair is mandatory. While waiting for the repair, the damaged area should be covered and protected from rain. Many composite parts are composed of thin skins over a honeycomb core, creating a "sandwich" structure. While excellent for structural stiffness reasons, such a structure is an easy target for water ingress (entering), leading to further problems later. A piece of "speed tape" over the puncture is a good way to protect it from water, but is not a structural repair. The use of a paste filler to cover up the damage, while acceptable for cosmetic purposes, is not a structural repair, either.

The potential for heat damage to the resin is another disadvantage of using composites. While "too hot" depends on the particular resin system chosen, many epoxies begin to weaken over 150° F. White paint on composites is often used to minimize this issue. For example, the bottom of a wing that is painted black facing a black asphalt ramp on a hot, sunny day, can get as hot as 220 °F. The same structure, painted white, rarely exceeds 140 °F. As a result, composite airplanes often have specific recommendations on allowable paint colors. If the airplane is repainted, these recommendations must be followed. Heat damage can also occur due to a fire. Even a quickly extinguished small brake fire can damage bottom wing skins, composite landing gear legs, or wheel pants.

Also, chemical paint strippers are very harmful to composites, and must not be used on them. If paint needs to be removed from composites, only mechanical methods are allowed, such as gentle grit blasting or sanding. Many expensive composite parts have been ruined by the use of paint stripper, and such damage is generally not repairable.

Fluid Spills on Composites

Some owners are concerned about fuel, oil, or hydraulic fluid spills on composite surfaces. These are generally not a problem with modern composites using epoxy resin. Usually, if the spill doesn't attack the paint, it won't hurt the underlying composite. Some aircraft use fiberglass fuel tanks, for example, in which the fuel rides directly against the composite surface with no sealant being used. If the fiberglass structure is made with some of the more inexpensive types of polyester resin, there can be a problem when using auto gas with ethanol blended into the mixture. The more expensive types of polyester resin, as well as epoxy resin, can be used with auto gas, as well as 100 octane aviation gas (avgas) and jet fuel.

Lightning Strike Protection

Lightning strike protection is an important consideration in aircraft design. When an aircraft is hit by lightning, a very large amount of energy is delivered to the structure. Whether flying a light general aviation (GA) airplane or a large airliner, the basic principle of lightning strike protection is the same. For any size aircraft, the energy from the strike must be spread over a large surface area to lower the "amps per square inch" to a harmless level.

If lightning strikes an aluminum airplane, the electrical energy naturally conducts easily through the aluminum structure. The challenge is to keep the energy out of avionics, fuel systems, etc., until it can be safely conducted overboard. The outer skin of the aircraft is the path of least resistance.

In a composite aircraft, fiberglass is an excellent electrical insulator, while carbon fiber conducts electricity, but not as easily as aluminum. Therefore, additional electrical conductivity needs to be added to the outside layer of composite skin. This is done typically with fine metal meshes bonded to the skin surfaces. Aluminum and copper mesh are the two most common types, with aluminum used on fiberglass and copper on carbon fiber. Any structural repairs on lightning-strike protected areas must also include the mesh as well as the underlying structure.

For composite aircraft with internal radio antennas, there must be "windows" in the lightning strike mesh in the area of the antenna. Internal radio antennas may be found in fiberglass composites because fiberglass is transparent to radio frequencies, where as carbon fiber is not.

The Future of Composites

In the decades since World War II, composites have earned an important role in aircraft structure design. Their design flexibility and corrosion resistance, as well as the high strength-to-weight ratios possible, will undoubtedly continue to lead to more innovative aircraft designs in the future. From the Cirrus SR-20 to the Boeing 787, it is obvious that composites have found a home in aircraft construction and are here to stay.

THE NEXT ISSUE — A LARGE COMPOSITE AIRCRAFT "CUSTOMER" SPEAKS OUT . . .
The United States Air Force had 21 B-2A "stealth bombers" -- lost one on Guam. When asked about the future of large composite aircraft, they had some interesting comments. If you are a "composites afficionado you may be surprized! Following that article, we will look at some other very interesting facts about CFRPs.

SEE YOU SOON — JIM