EMBRAER COMPOSITE MATERIAL APPLICATION

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Keywords: *Composite Structures, Rudder Conception, Manufacture*

Abstract

We are going forward in composite use. The hard work made by academy and researchers, government organization, composite training centers, composite committees, research centers and industries justify this improvement. The phrase, the composite is the future, was modified to, the composite is now! New procedures are coming up and the product's quality is getting improved. Each aeronautical application has its own particularities, resulting in high complexity and variety of manufacturing process. However, the search of high quality and low cost structures will always be a goal to be reached. In this way, the EMBRAER is looking also. Therefore the purpose of this work is to describe "EMBRAER Composite Material Application". As an example, the evolution in the rudder's conception and manufacturing will be presented. Likewise, historical evolutions applications are described.

1 EMBRAER Evolution

Composite materials began in the year 70's with the "Bandeirante" aircraft at EMBRAER and only non-structural components, fairings in hand wet lay-up process, were made with FRP. Structural composite technology was introduced in 1982 with "Brasília" aircraft, with fairings, leading edges and flaps. The beginning of integrated structures, our next step in the middle of the year 80's, was introduced by the MD-11 Composite Outboard Flap (McDonnel Douglas Aircraft) program that required significant investments for new installations and equipment. Structural bonding was introduced with AMX, a military aircraft and aluminium and fiber-glass/nomex core was introduced in the wing tip for 777 aircraft in the same year 80's. Structural composite parts became more integrated and complex in subsequent programs. As example, the CBA 123 aircraft was a learning in innovations. Beyond all surfaces control was introduced nacelle in CFRP. In the year 90's, ERJ 145 aircraft with ailerons, spoilers, flaps, tabs and shrouds. S-92A Sykorsky helicopter with integrated box structure for fuel. And the great change in terms of component integration took place with the project of the rudder in ALX-314 a military training aircraft. In the year 2000's in the ERJ 170 airplane was included rudder and elevator. The next generation, Embraer Phenom family, in the very light jet, is being included the vertical tail with a design totally integrated and a thermoplastic application.

In the Figure 1, an idea of the EMBRAER Composite Material Evolution is shown.

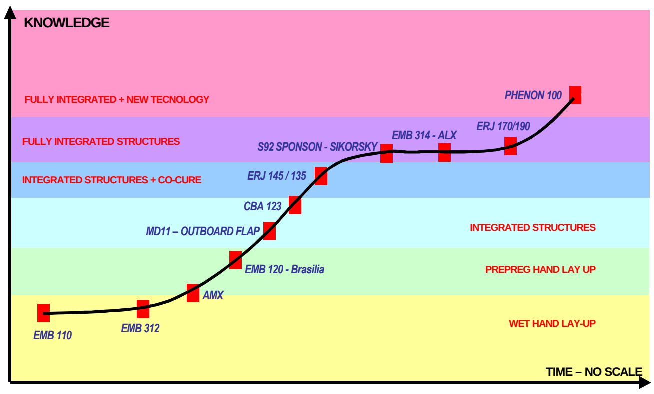

Fig 1 EMBRAER Composite Material Evolution

2 Evolution on Rudder's Conception

The EMB-120 "Brasília" aircraft rudder is a model of traditional project made in aluminium. It presents a relatively high components number with a lower integration level. As consequence, demands a long time in the fabrication and assembling of components. Transversal section sketch of this rudder is showed in the Figure 2.

A considerable improvement of FRP was possible with the CBA-123 aircraft design. In this case, carbon/epoxy and integration concepts between components were used. Transversal section of this rudder conception is presented in the Figure 3.

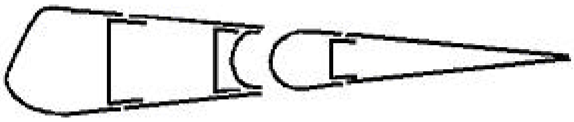

Fig 2 EMB-120 “Brasília” Rudder.

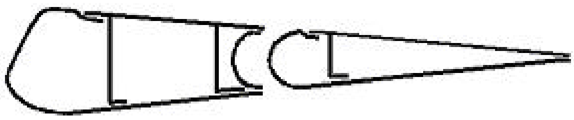

Figure 3: CBA-123 Rudder.

Following the development, Figure 4, in the aircraft ALX-314 “Super-Tucano” the rudder was made as a unique structure, so-called “one-shot” process .

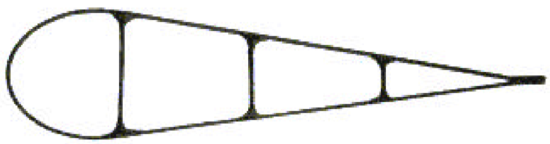

Fig. 4 ALX-314 “Super Tucano” Rudder

From the rudder conception for the EMB-120 “Brasília” and CBA-123 “Vector” aircraft’s, figures 2 and 3, is it possible to infer a reduction in the rudder components number and as a consequence in the fabrication time.

In the rudder case for the ALX-314 “Super Tucano” (figure 4), the comparison is done using the ALX-312 “Tucano” metallic rudder. These rudders are quite similar, but the components number reduced from 100 to 33 and the weight reduced from 16 kg to 12 kg, or 25 %.

From the figures 2, 3 and 4 is it possible to observe the evolution in terms of rudder design and fabrication. This rudder evolution conduct to lighter aircraft’s, easier to build and faster production when compared with the metallic design.

3 Challenge and Considerations

The use of the composite material is growing, but some signs still appoint the doubts about the use. Lightning strike, repair, durability under impact, post-buckling, metal-composite interfaces, are some of those signs. These issues are being analyzed and continue being a challenge. Knowing about that, EMBRAER has been investing in trainings and incentives the development [1], [2], [3], [4], [5], [6].

So, the design of composite material structures is a team work, where raw materials suppliers, conception designer, engineers, researches, manufacturers and end users are all involved in this task. Each link of this chain brings specific information. In this way is it possible to optimize the performance of the whole.

An entirely integrated project, result in a single structure, however, make difficult the defects inspection and as consequence the repairing of the piece. Each component has its owns particularities and design specifications, so sometimes is not interesting to have an entire integrated project. As a counterpart, the number of components is lower and the final assembling gain is substantial. That’s why; every new process alternative must be aligned with the particularities from materials performance and the design specifications.

In creating the Phenom family, figure 5, Embraer expanded its legacy of technical advancement. Timeless engineering was applied with breathtaking innovation. Integrated design using CATIATM v.5 software sped aeronautical answers to questions on fluid dynamics, integration and manufacturing. The level of technology used to create this jet is unprecedented in executive aviation.

Fig. 5 Phenom 100 by Embraer

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