Course M-1/R-1
Advanced Composite Structures: Fabrication & Damage Repair-Phase 1

Course Summary

Our most popular class, Advanced Composite Structures: Fabrication & Damage Repair-Phase 1 is designed to meet the needs of a wide range of personnel; from the novice to the seasoned professional.

This course is a prerequisite for both our repair and manufacturing programs and is highly recommended to anyone seeking a better understanding of advanced composite materials, processes, layup/lamination, vacuum bagging, adhesive bonding, tooling, repair, and inspection methods and techniques.

Note: Engineers involved in composite repair design and anaylsis are advised to take the ER-1 course, and engineers involved in structures design are advised to take the ES-1 course.

Introduction

Balanced with theoretical and practical presentations, the hands-on exercises in this course are extensive; they will work with prepreg carbon fiber unidirectional tape to explore the effects of orientation; “balance” and “symmetry” in a laminate. The students will also work with dry glass fabric and liquid epoxy resin in an exercise designed to teach fundamental vacuum bagging, bleeder & breather concepts. Mid-week, teams work with prepreg glass and carbon fiber fabrics, along with Nomex® honeycomb and polyurethane foam core materials, making sandwich panel structures, utilizing laminate “nesting” techniques. And finally, basic repair methods and techniques will be presented along with performing a “wet layup” repair in the lab. On the last day, the final repaired part will be cut in half for evaluation of the manufactured and repaired panel.

Topics

Key Lecture Elements:

- History of composites, recent developments and terminology.
- Introduction to advanced composite materials/structures.
- Resin/adhesive systems: thermosets vs. thermoplastics, mix ratios, viscosity, service temperature limits, cold storage requirements/shelf life limits, pot life, etc.
- Material Forms: dry cloth and wet resins vs. prepregs, weave/styles, etc.
- Fundamentals of Fabrication: prepreg cloth handling, ply orientation, layup procedures, vacuum bagging.
- Fabrication Methods: wet layup, prepreg layup, filament winding, RTM, infusion, press molding, pultrusion as well as automated tape layup (ATL) and fiber placement (AFP).
- Curing methods: oven/autoclave/hot bonder cures. Viscoelastic properties.
- Health and Safety Issues: proper handling, personal protection, allergic reactions, waste disposal.
- Introduction to adhesive bonding technology: co-curing vs. secondary bonding, surface preparation, cleanliness, bond line thickness and clamping pressure requirements.
- Principles of Tooling: types of tools, thermal characteristics of various tooling materials.
- Drilling and fastening; proper speed and feed requirements, use of mechanical and adhesive bonded fasteners.
- Primer on repair design; permanent vs. temporary repairs, scarf vs. stepped vs. mechanical patch repair scenarios.
- Inspection methods and techniques: non-destructive inspection methods, defect detection, documentation, acceptable vs. unacceptable defects, defect prevention.

Workshop Exercises:

- Panel layup using prepreg carbon uni-tape materials; symmetric and asymmetric laminates.
- Panel layup using dry glass cloth and liquid epoxy resin materials. Vacuum bagging with varied bleeder/breather sequences to evaluate resin bleed and flow characteristics.
- Sandwich panel layup, bagging and processing of nested glass fabric/foam and carbon fiber/honeycomb sandwich core panels.
- Vacuum bagging using non-autoclave bleeder/breather schedules. Installation of pleats to minimize bridging in high-angle core transitions. Vacuum debulking, leak checking, and identification of other potential bagging problems.
- Oven curing; vacuum, ramp rate, soak, and cooling requirements.
- Composite repair; damage removal, scarf preparation, core and skin repair using wet layup materials and processes.
- Introduction to hot-bond repair equipment; demonstration of bonders, heat blankets and thermocouple placement.

Course Benefits

Students come away with a fundamental understanding of advanced composite materials & processes at a level sufficient to put learned skills into practice immediately upon entry or return to the workplace.

Prerequisites

None - This course is a prerequisite for subsequent manufacturing and technical repair courses.

Teaching Method

Active classroom lecture and workshop exercises: 50% Theory and 50% Practical

CEU

3.6