



Course E-7

Sandwich Structure Design & Analysis

Course Summary

This course is specifically designed for civil, mechanical, structural and aeronautical engineers who are responsible for the design and fabrication of sandwich structures. Participants without engineering training in composite laminate design are strongly encouraged to take our *E-4 Composite Laminate Analysis* course as a prerequisite.

Introduction

This course will cover the design requirements of sandwich structures; the application of composite materials as the face skins is of particular interest and a focus of the design analysis in the course. Detailed stress analysis will be discussed with respect to design detail such as joints, and holes. Other aspects of the course to be covered include environmental and longevity aspects, component quality and in-service support issues. Several design exercises are undertaken during the course on classroom computers. Case studies will be used to reinforce the lectures. Participants in the course will be provided with a comprehensive set of course notes and other related documents, and a CD with the software files used on the course.

Key Lecture Topics:

- Introduction to Sandwich Structures – explanation of the fundamental behavior and performance issues with sandwich structures.
- Sandwich Structure Applications – the application of sandwich structures in real world situations highlighting the specific design requirements for each application is discussed.
- Design Requirements for Sandwich Structures – development of the design requirements specific to sandwich structures are discussed in detail with a focus on the life-cycle impact.
- Terms, Definitions and Global Properties – general and specific terms, definitions and global properties are discussed.
- Constituent Material Properties and Effects – a review lecture on the core and facing properties with their individual impact on the composite facings is presented in this section.
- Sandwich Structure Manufacture – as a sandwich structure is built by the laminating process the structural properties are developed simultaneously. These engineering and physical properties are discussed, including the effects on the overall structural performance.
- Composite Facings Properties – the specific properties of composite facings are explained in some detail with an insight into how in-plane, flexural and coupling stiffness effect facing properties.
- Tutorial – sandwich properties with composite facings design analysis.
- The Design Process – a discussion on the basic approach to sandwich structure design, including several design hints to ensure successful design outcomes are discussed.
- Case study – design of a sandwich beam structure will highlight an approach to overcoming the problem of too many unknowns when using composite facings.
- Sandwich Panel Bending Behavior – a design analysis approach for sandwich panel bending behavior is covered in-depth. Specific impact of changes to core type and thickness, as well as facing properties is investigated for a range of panel aspect ratios and edge constraints.
- Sandwich Panel Buckling Behavior – a design analysis approach for sandwich panel buckling behavior is covered in-depth. Specific impact of changes to core type and thickness, as well as facing properties is investigated for a range of panel aspect ratios and edge constraints.
- Sandwich Panel Vibration Behavior – a design analysis approach for sandwich panel vibration and natural frequency behavior is covered in-depth. Specific impact of changes to core type and thickness, as well as facing properties is investigated for a range of panel aspect ratios and edge constraints.
- Tutorial – development of sandwich panel design with computer analysis.
- Structural Detail-Holes – this section reviews the stress state in sandwich panel facing with a hole. Through the thickness holes and one-sided facing holes are considered.
- Structural Detail-Joints – the joining of sandwich structures with either adhesives or bolts is discussed with respect to the stress state of the joint and methods of producing quality and structurally efficient joints.
- Tutorial – a computer based detailed stress analysis of sandwich structures is undertaken to better understand detailed structural features in sandwich structures.
- Case study – design of a sandwich panel with an approach to include the effects of selecting skin and core property, and geometry constraints.
- Operational Environmental Effects and Operational Issues - damage types and effects, damage tolerance, and maintenance and repair requirements are reviewed.

- Sandwich Panel Test Methods – the test methods associated with sandwich panels are reviewed.

Workshop Exercises:

- Numerical analysis and stress calculations are performed on PC based programs.
- These exercises will highlight the unique design analysis issues with sandwich structures particularly with composite materials facings.
- Each exercise will clearly show that a good understanding of composite materials and behavioral characteristics of the sandwich structure. This understanding is essential in the development of effective and efficient structural sandwich components.

Course Benefits

Attendees will learn specific design requirements and analysis of advanced composite sandwich structures.

Prerequisites

E-4 Composite Laminate Analysis or equivalent engineering experience with composite laminate analysis.

Teaching Method

Active classroom lecture and workshop exercises

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