

Mechanics of Composite Materials, Second Edition

Autar K Kaw *University of South Florida, Tampa, USA*

TABLE OF CONTENTS

1. INTRODUCTION TO COMPOSITE MATERIALS

Chapter Objectives
1.1 Introduction
1.2 Classification
1.2.1 Polymer Matrix Composites.....
1.2.2 Metal Matrix Composites
1.2.3. Ceramic Matrix Composites.....
1.2.4. Carbon-Carbon Composites
1.3 Recycling
1.4 Mechanics Terminology
Summary
Key Terms
Exercise Set
References
General References
Videos

2. MACROMECHANICAL ANALYSIS OF A LAMINA

Chapter Objectives
2.1 Introduction
2.2 Review of Definitions

2.1.1	Stress
2.2.2	Strain
2.2.3	Elastic Moduli
2.2.4	Strain Energy.....
2.3	Hooke's Law for Different Types of Materials
2.3.1	Anisotropic Material.....
2.3.2	Monoclinic Material.....
2.3.3	Orthotropic Material (Orthogonally Anisotropic)/ Specially Orthotropic.....
2.3.4	Transversely Isotropic Material.....
2.3.5	Isotropic Material
2.4	Hooke's Law for a Two Dimensional Unidirectional Lamina.....
2.4.1	Plane Stress Assumption
2.4.2	Reduction of Hooke's Law in Three Dimensions to Two Dimensions
2.4.3	Relationship of Compliance and Stiffness Matrix to Engineering Elastic Constants of a Lamina
2.5	Hooke's Law for a Two Dimensional Angle Lamina
2.6	Engineering Constants of an Angle Lamina
2.7	Invariant Form of Stiffness and Compliance Matrices for an Angle Lamina
2.8	Strength Failure Theories of an Angle Lamina
2.8.1	Maximum Stress Failure Theory
2.8.2	Strength Ratio.....
2.8.3	Failure Envelopes
2.8.4	Maximum Strain Failure Theory
2.8.5	Tsai-Hill Failure Theory.....
2.8.6	Tsai-Wu Failure Theory

2.8.7	Comparison of Experimental Results with Failure Theories.....
2.9	Hygrothermal Stresses and Strains in a Lamina.....
2.9.1	Hygrothermal Stress-Strain Relationship for a Unidirectional Lamina
2.9.2	Hygrothermal Stress-Strain Relationship for an Angle Lamina.....
Summary	
Key Terms	
Exercise Set	
References	
Appendix A: Matrix Algebra	
Appendix B: Transformation of Stresses and Strains.....	

3. MICROMECHANICAL ANALYSIS OF A LAMINA

Chapter Objectives.....	
3.1	Introduction
3.2	Volume and Mass Fractions, Density and Void Content
3.2.1	Volume Fractions
3.2.2	Mass Fractions.....
3.2.3	Density
3.2.4	Void Content
3.3	Evaluation of the Four Elastic Moduli
3.3.1	Strength of Materials Approach
3.3.1.1.	Longitudinal Young ' s Modulus
3.3.1.2.	Transverse Young ' s Modulus
3.3.1.3.	Major Poisson ' s Ratio
3.3.1.4.	In-Plane Shear Modulus
3.3.2	Semi-Empirical Models.....

3.3.2.1.	Longitudinal Young's Modulus
3.3.2.2.	Transverse Young's Modulus
3.3.2.3.	Major Poisson's Ratio
3.3.2.4.	In-Plane Shear Modulus
3.3.3	Elasticity Approach
3.3.3.1.	Longitudinal Young's Modulus
3.3.3.2.	Transverse Young's Modulus
3.3.3.3.	Major Poisson's Ratio
3.3.3.4.	In-Plane Shear Modulus
3.3.4	Elastic Moduli of Lamina with Transversely Isotropic Fibers.....
3.4	Ultimate Strengths of a Unidirectional Lamina
3.4.1	Longitudinal Tensile Strength
3.4.2	Longitudinal Compressive Strength
3.4.3	Transverse Tensile Strength
3.4.4	Transverse Compressive Strength
3.4.5	In-Plane Shear Strength.....
3.5	Coefficients of Thermal Expansion of a Unidirectional Lamina
3.5.1.	Longitudinal Thermal Expansion Coefficient
3.5.2.	Transverse Thermal Expansion Coefficient
3.5	Coefficients of Moisture Expansion of a Unidirectional Lamina.....
Summary	
Key Terms	
Exercise Set	
References	

4. MACROMECHANICAL ANALYSIS OF A LAMINATE

Chapter Objectives.....	.....
4.1 Introduction .....	.....
4.2 Laminate Code.....	.....
4.3 Stress-Strain Relations for a Laminate .....	.....
4.3.1 One Dimensional Isotropic Beam Stress-Strain Relations.....	.....
4.3.2 Strain-Displacement Equations .....	.....
4.3.3 Strain and Stress in a Laminate .....	.....
4.3.4 Stress and Moment Resultants Related to Mid-Plane Strains and Curvatures.....	.....
4.4 In-Plane and Flexural Modulus of a Laminate.....	.....
4.4.1 In-Plane Engineering Constants of a Laminate .....	.....
4.4.2 Flexural Engineering Constants of a Laminate .....	.....
4.5 Hygrothermal Effects in a Laminate .....	.....
4.5.1 Hygrothermal Stresses and Strains .....	.....
4.5.2 Coefficients of Thermal and Moisture Expansion of Laminates.....	.....
4.5.3 Warpage of Laminates .....	.....
Summary .....	.....
Key Terms .....	.....
Exercise Set .....	.....
References .....	.....

5. FAILURE, ANALYSIS AND DESIGN OF LAMINATES

Chapter Objectives.....	.....
5.1 Introduction .....	.....
5.2 Special Cases of Laminates.....	.....
5.2.1 Symmetric Laminates .....	.....

5.2.2	Cross-Ply Laminates.....
5.2.3	Angle-Ply Laminates
5.2.4	Antisymmetric Laminates
5.2.5	Balanced Laminates
5.2.6	Quasi-Isotropic Laminates
5.3	Failure Criteria For a Laminate
5.4	Design of Laminated Composite
5.5	Other Mechanical Design Issues
5.5.1	Sandwich Composites
5.5.2	Long Term Environmental Effects.....
5.5.3	Interlaminar Stresses.....
5.5.4	
	Impact.....
....	
5.5.5	Fracture Resistance.....
5.5.6	Fatigue Resistance.....
	Summary
	Key Terms
	Exercise Set
	References

6.ANALYSIS OF BEAMS

6.1	Introduction
6.2	Symmetrical Beams
6.3	Nonsymmetrical Beams
	Summary

Key Terms
Exercise Set
References

Index to Subjects