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Department of Power Mechanical

*Study of The Thermal and Mechanical
Properties of The Glass/Polyester Composite*

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بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

وَالْحَمْدُ لِلَّهِ الَّذِي

عَلَّمَ الْقُرْآنَ

DEDICATION : TO MY PARENTS

TO MY WIFE

TO MY SON

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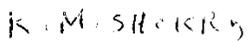
STATEMENT

This dissertation is submitted to Ain Shams University for the degree of Master of Science in Mechanical Power Engineering .

The work included in this thesis was carried out by the author in the Mechanical Power Engineering Department , Ain Shams University from 1995 To 1998 .

No part of this thesis has been submitted for a degree or qualification at any other University or Institution .

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ABSTRACT

This research work discusses the thermal conductivity and mechanical behaviour of glass/polyester composite and polyester base matrix. Fiber/glass polyester composite was fabricated by hand-lay-up method and cured at room temperature and atmospheric pressure. Three fiber reinforcement geometry were tested unidirectional, bidirectional and chopped.

The test specimens of unidirectional glass/polyester composite (6layers) are in the shape of a plate 3.2, 4.2, and 6.5 mm nominal thickness and of three fiber volume fractions 24 % , 36 % and 45 % respectively. The bidirectional and chopped glass/polyester composite were fabricated in the shape of plate having a thickness of 1.9 and 3.2 mm and fiber volume fraction of 26 % and 25 % respectively.

Tensile, compressive and flexural test were carried out to obtain the fracture strength, fracture strain and stiffness. A regression analysis was employed to predict the equations controlling the performance of fiber reinforced glass/polyester.

The thermal conductivity agree closely with Thornburg and Pears. The tensile, compressive and flexural elastic modulus show high discrepancy with RM which is mainly due to th strain rate effect.

Experimental results for tensile and compressive strengths agree closely with Chamis solution, while for flexural strength are closely related to Jones solution.

Moreover, the fractures in tensile, compressive and flexural are discussed.

Keywords : Composite material ; Thermal conductivity ;
Tensile strength ; Compressive strength ;
Flexural strength ; Fracture surface

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ARABIC SUMMARY	

LIST OF SYMBOLS

D	Diameter of fiber	mm
E_{11C}	Longitudinal compressive stiffness	MPa
E_{22C}	Transverse compressive stiffness	MPa
E_f	Elastic modulus of fiber	MPa
E_{11f}	Longitudinal flexural stiffness	MPa
E_{22f}	Transverse flexural stiffness	MPa
E_m	Elastic modulus of matrix	MPa
E_r	Elastic modulus of random fiber	MPa
E_{11T}	Longitudinal tensile stiffness	MPa
E_{22T}	Transverse tensile stiffness	MPa
E_{11}, E_{22}, E_{33}	Lamina elastic modulus in direction X_1, X_2, X_3 respectively	MPa
FRP	Fiber reinforced plastic	-----
G_m	Shear modulus of matrix	MPa
G_f	Shear modulus of fiber	MPa
G_r	Shear modulus of random fiber	MPa
GFRP	Glass fiber reinforced plastic	-----
GL	Gauge length	mm
K_{11}	Longitudinal thermal conductivity	W/m k
K_{33}	Transverse thermal conductivity	W/m k
K_f	Thermal conductivity of fiber	W/m k
K_m	Thermal conductivity of matrix	W/m k
L	Fiber length	mm
q	Heat flux density	Watt
S_{11T}	Longitudinal tensile strength	MPa
S_{22T}	Transverse tensile strength	MPa
V_f, V_m	Fiber and matrix volume fraction	%
V_v	Void content	%
v_c	Volume of lamina composite	mm ³
v_f	Volume of fiber	mm ³
v_m	Volume of matrix	mm ³
W_f	Fiber weight fraction	%
W_m	Matrix weight fraction	%
w_c	Total weight of lamine composite	gm
w_f	Weight of fiber	gm
w_m	Weight of matrix	gm
X_o	Average static tensile strength	MPa
ϵ	Strain	mm/mm
ρ_c	Composite density	kg/m ³

σ_{mT}	Matrix tensile stress	MPa
σ_{11C}	Longitudinal ultimate compressive strength	MPa
σ_{22C}	Transverse ultimate compressive strength	MPa
σ_{11F}	Longitudinal ultimate flexural strength	MPa
σ_{22F}	Transverse ultimate flexural strength	MPa
σ_f	Strength of fiber	MPa
σ_m	Strength of matrix	MPa
σ_{11T}	Longitudinal ultimate tensile strength	MPa
σ_{22T}	Transverse ultimate tensile strength	MPa
τ_f	Shear stress of fiber	MPa
τ_m	Shear stress of matrix	MPa

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