Tables

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Table 1
Summary of material properties of the HTS40/977-2 toughened composite system.

Material Properties	Symbol	Data
Properties of the HTS40 carbon fibre		
Density*	ρ_f	1.76 g/cm^3
Average fibre diameter	d_f	6.96 µm
Elastic modulus*	E_f	239 GPa
Tensile strength*	σ_{fu}	4629 MPa
Failure strain in tension*	γ_{fu}	1.80 %
Properties of the Cycom®977-2 thermoplastic toughened epoxy resin		
Density	ρ_m	1.31 g/cm^3
Elastic modulus	E_m	3.5 GPa
Tensile strength	σ_{mu}	81 MPa
Failure strain in tension	γ_{mu}	2.50 %
Physical properties of UD HTS40/977-2 composite laminate		
Density	ρ_c	1.54 g/cm^3
Fibre volume fraction	V_f	58%
Initial Half Fibre wavelength	λ_o	10 d_f
Initial misalignment angle	ϕ_o	0.92^o
Laminate width	w	0.01 m
Overall Laminate thickness	t_o	2.16 mm
No. of plies	n	8
Ply thickness	t_p	270 µm
Compressive Properties of UD HTS40/977-2 composite laminate		
Longitudinal compressive modulus	E_1	112 GPa
Longitudinal compressive strength	σ_1	1396 MPa
Compressive failure strain	ε_1	1.5 %
Principal Poisson Ratio	ν_{12}	0.3
Tensile properties of $[\pm45]_{2s}$ HTS40/977-2 composite laminate		
Tensile modulus at 0.2% strain	$E_{[\pm45]}$	22 GPa
Tensile strength	$\sigma_{[\pm45]}$	202 MPa
Failure strain	$\varepsilon_{[\pm45]}$	7.6 %
In-Plane Shear Properties of HTS40/977-2 composite laminate		
Elastic in-plane Shear Modulus	G_{12}^{e}	4.4 GPa
Plastic in-plane Shear Modulus	G_{12}^{p}	0.68 GPa
In-plane shear yield strength	τ_y	52MPa
In-plane shear strain at yield	γ_y	1.8 %
In-plane shear strength	τ_{ult}	101 MPa
In-plane shear strain at shear strength	γ_{ult}	17 %

*[manufacturer datasheet]

Table 2
Input data for the compressive failure predictions of the UD HTS40/977-2 CFRP composite laminate using several types of failure models.

Failure mode	Reference	Eqn.	Input data
Fibre kinking	Budiansky [18]	(1)	τ_y = 52 MPa, σ_{Ty} = 40 MPa, γ_y = 0.018, ϕ_o =0.92°, β = 20°
Fibre microbuckling (non-linear matrix)	Berbinau et al [12] (incorporated a newly developed elastoplastic shear stress-strain behaviour)	(10)	V_f = 0.58, r_f = 3.5 μm, E_f = 239 GPa, ϕ_o = 0.92°, τ_y = 52 MPa, τ_{ult} = 101 MPa, G_{12}^e = 4.4 GPa, G_{12}^p = 0.68 GPa, λ_o = 10d_f = 70μm,
Combined modes model (fibre microbuckling and plastic kinking models)	(a new developed model based on Berbinau [12] and Budiansky [18])	(12)	V_f = 0.58, r_f = 3.5 μm, E_f = 239 GPa, ϕ_o = 0.92°, τ_y = 52 MPa, γ_y = 0.018, τ_{ult} = 101 MPa, γ_{ult} = 0.18, G_{12}^e = 4.4 GPa, G_{12}^p = 0.68 GPa, λ_o = 10d_f = 70μm,

Table 3
Summary of the input data for the study of the effects of non-linear shear stress-strain (τ-γ) response, initial fibre misalignment ϕ_0, initial half-wavelength λ_0 and fibre volume fraction V_f on the compressive strength of the UD HTS40/977-2 composite laminate.

Programme name	τ_y (MPa)	τ_{ult} (MPa)	G_{12}^e (GPa)	G_{12}^p (GPa)	ϕ_0	γ_y (%)	λ_0	V_f
τ_y = 45 MPa	45	85	3.7	0.58	1°	1.8	10d_f	0.55
τ_y = 52 MPa	52	101	4.4	0.68	1°	1.8	10d_f	0.55
τ_y = 60 MPa	60	115	5.0	0.80	1°	1.8	10d_f	0.55
τ_y = 68 MPa	68	130	5.7	0.90	1°	1.8	10d_f	0.55
ϕ_0 = 1°	52	101	4.4	0.68	1°	1.8	10d_f	0.55
ϕ_0 = 2°	62	101	4.4	0.68	2°	2.6	10d_f	0.55
ϕ_0 = 3°	65	101	4.4	0.68	3°	3.1	10d_f	0.55
ϕ_0 = 5°	72	101	4.4	0.68	5°	4.5	10d_f	0.55
λ_0 = 8d_f	52	101	4.4	0.68	1°	1.8	8d_f	0.55
λ_0 = 10d_f	52	101	4.4	0.68	1°	1.8	10d_f	0.55
λ_0 = 12d_f	52	101	4.4	0.68	1°	1.8	12d_f	0.55
λ_0 = 15d_f	52	101	4.4	0.68	1°	1.8	15d_f	0.55
V_f = 50%	52	101	4.4	0.68	1°	1.8	10d_f	0.50
V_f = 55%	52	101	4.4	0.68	1°	1.8	10d_f	0.55
V_f = 60%	52	101	4.4	0.68	1°	1.8	10d_f	0.60
V_f = 65%	52	101	4.4	0.68	1°	1.8	10d_f	0.65