Quasi-isotropic laminates, fiber failure or delamination ?

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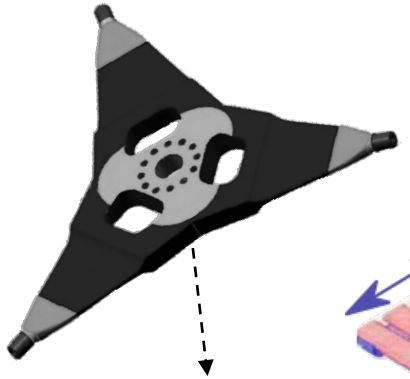
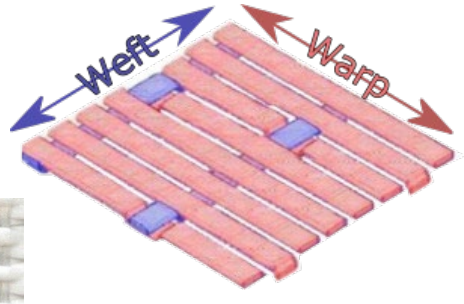
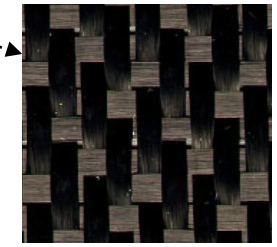
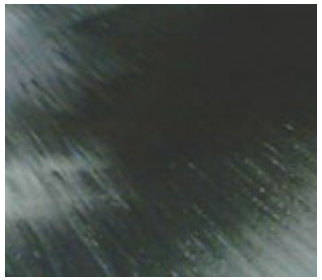
Materials







- **Glass/Epoxy Unbalanced Woven** : 1055 /M42ST
- **Carbone/PEEK Balanced Woven** : T300J/PEEK
- **Carbone/Epoxy UD** (and woven) : UD150/CHS/M10R

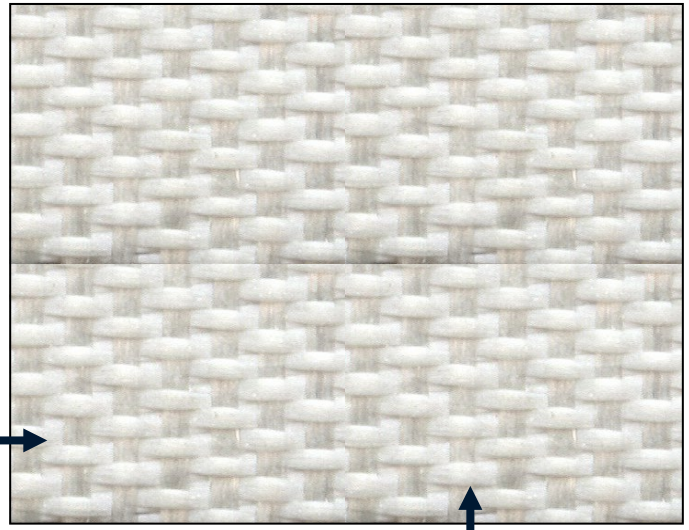


Model based on UD CDM in Plane Stress

(Ladevèze 1986)

Woven ply = 2 UD plies

(Hochard 2004)

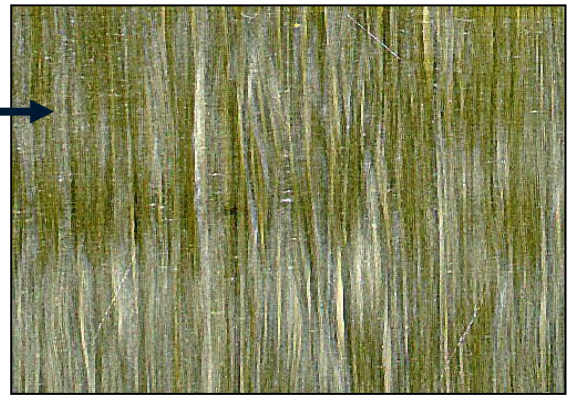


83 % fibres in the warp direction

17 % fibres in the weft direction

Same strain

83 % UD at 0°

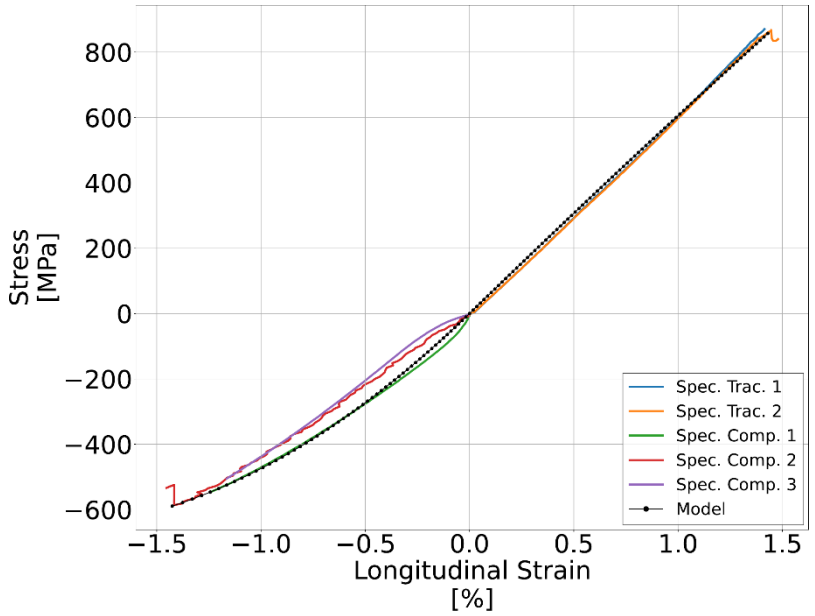


17 % UD at 90°

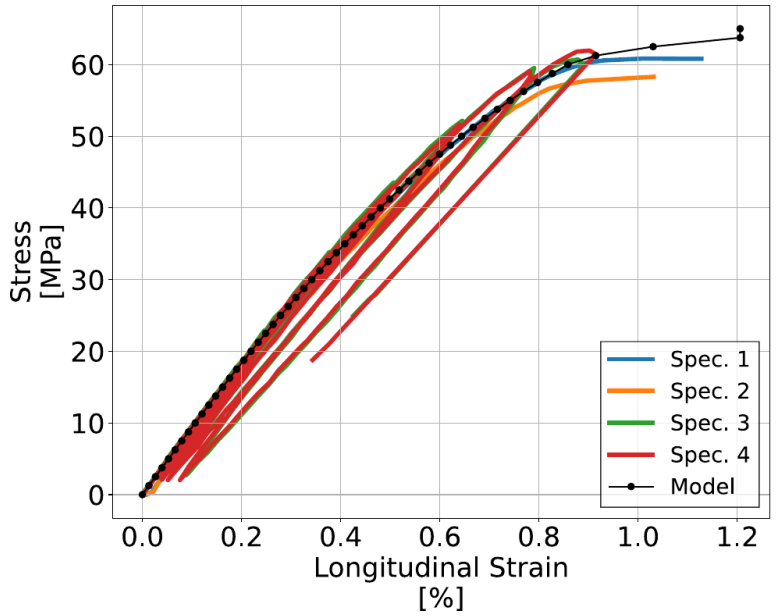
LMA Damage model:
Identification on Unidirectional Carbon/Epoxy

- Identification of LMA damage model parameters

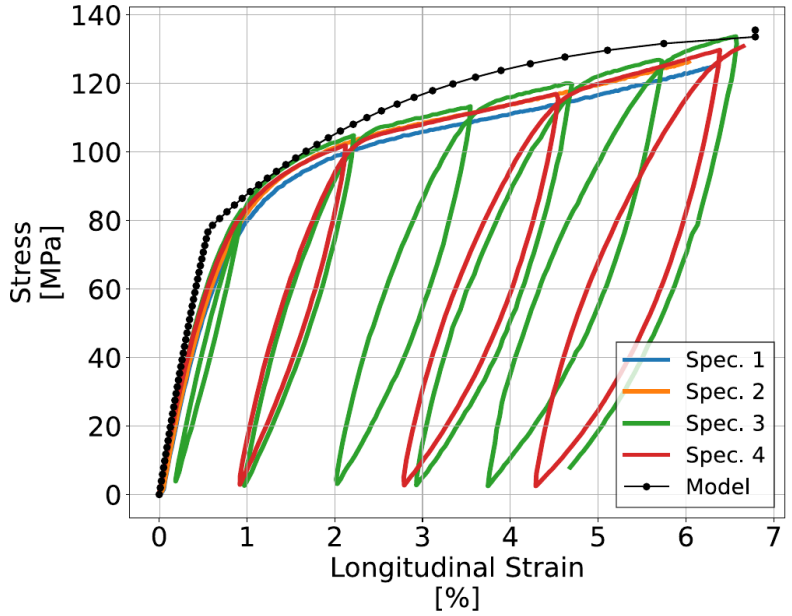
$[0,90]_{4s}$



$[60,-60]_{2s}$



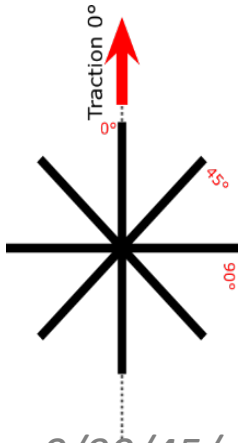
$[45,-45]_{2s}$



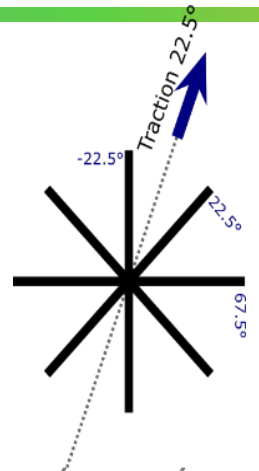
E_1^{*UD}	E_2^{*UD}	G_{12}^{*UD}	ν_{12}	γ	σ_{tens}^{*UD}	σ_{comp}^{*UD}	a	b	n	m	R_0	h
GPa	*GPa*	*GPa*			*MPa*	*MPa*					*MPa*	*MPa*
115	*8*	*4.5*	*0.31*	*25*	*1750*	*1050*	*0.76*	*0.41*	*0.73*	*0.71*	*44.9*	*2804*

Traction on Quasi-Iso

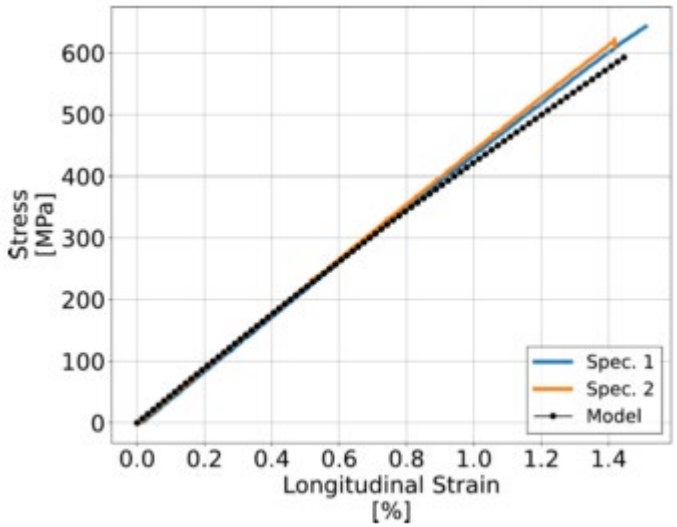
Unidirectional Carbon/Epoxy

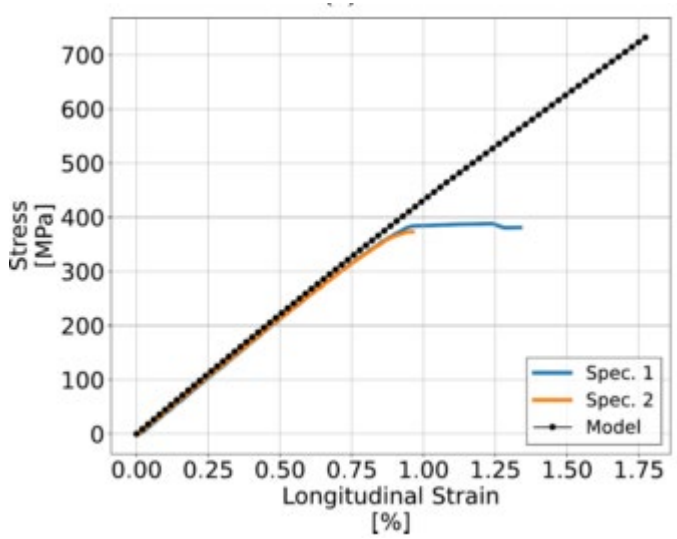


Q-iso 0/90/45/-45



Q-iso 22.5/-67.5/67.5/-22.5



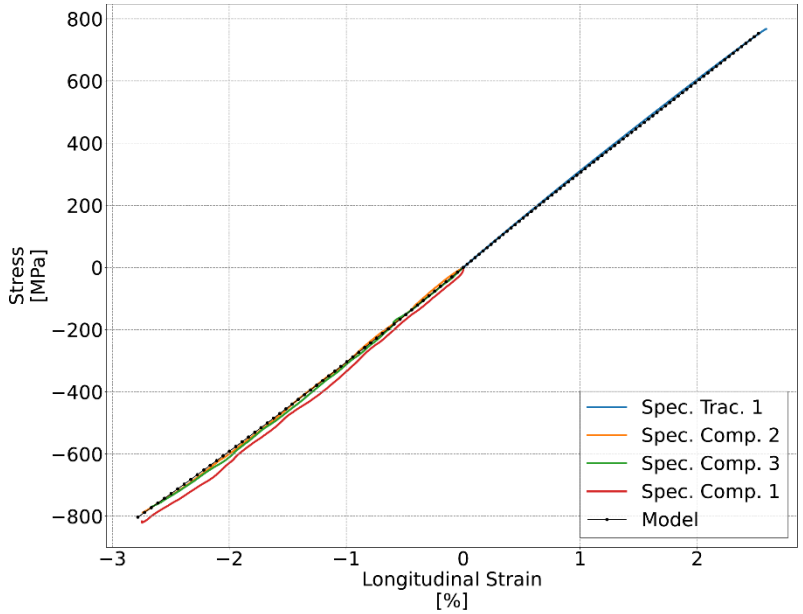


LMA Damage model

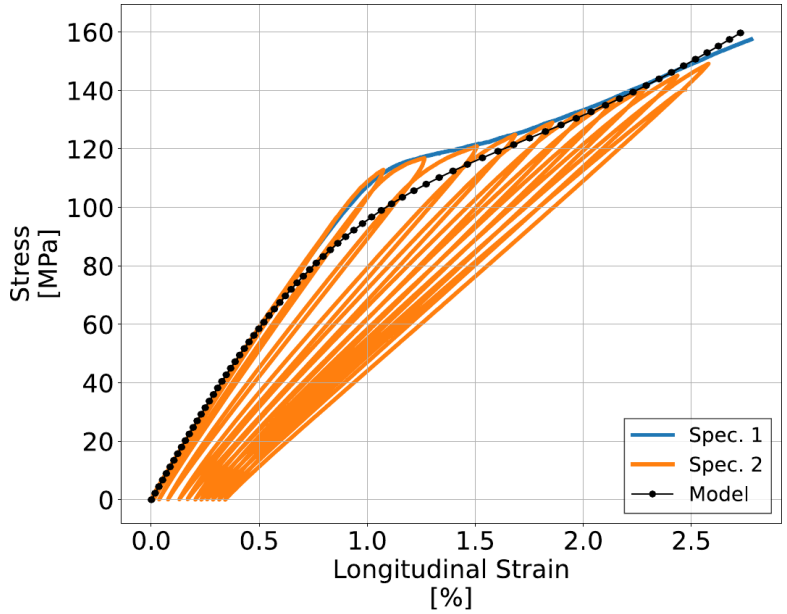
Identification on Unbalanced Woven Glass/Epoxy

- Identification of LMA damage model parameters

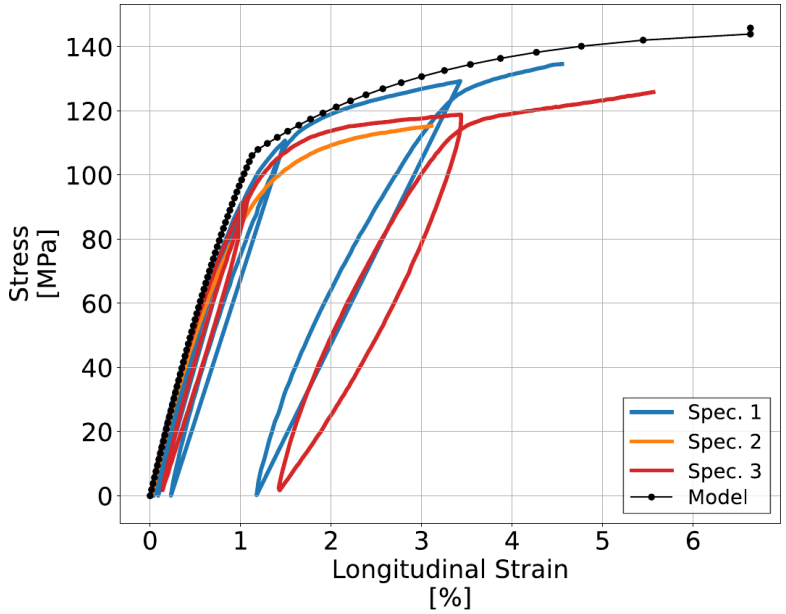
$[0]_8$



$[90]_8$



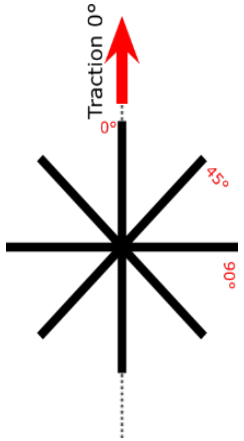
$[45, -45]_4$



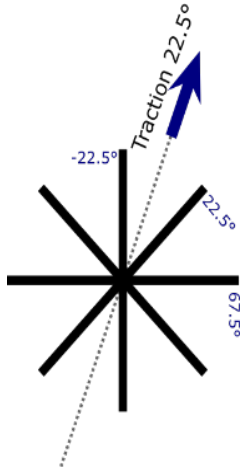
E_1^{*UD}	E_2^{*UD}	G_{12}^{*UD}	ν_{12}	γ	σ_{tens}^{*UD}	σ_{comp}^{*UD}	a	b	n	m	R_0	h
GPa	*GPa*	*GPa*			*MPa*	*MPa*					*MPa*	*MPa*
35,5	*10*	*3,8*	*0,25*	*3.0*	*900*	*900*	*1.35*	*0.25*	*0.85*	*0.75*	*42*	*3785*

Traction on Quasi-iso

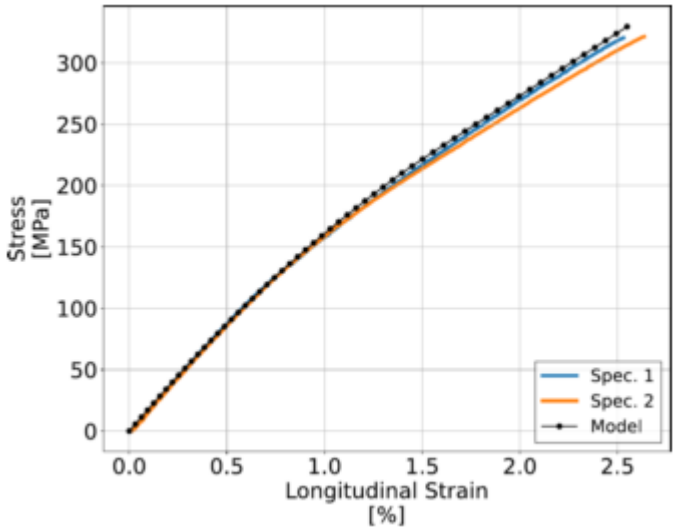
Unbalanced Woven Glass/Epoxy

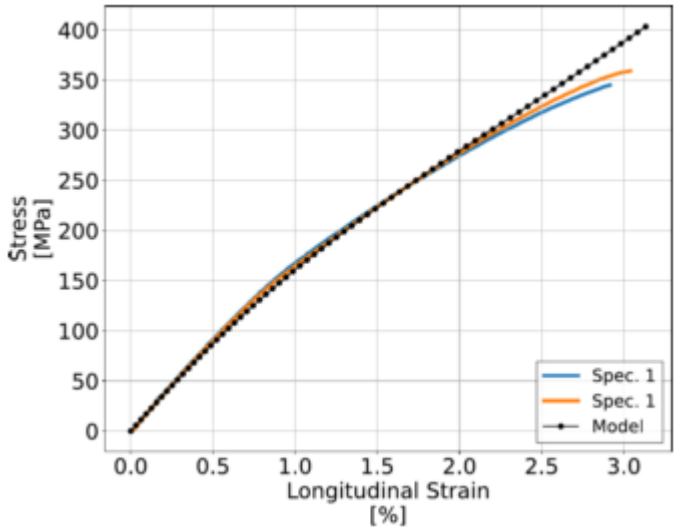


Q-iso 0/90/45/-45



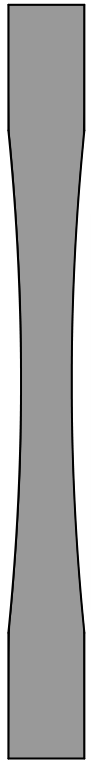
Q-iso 22.5/-67.5/67.5/-22.5





Traction on Quasi-iso

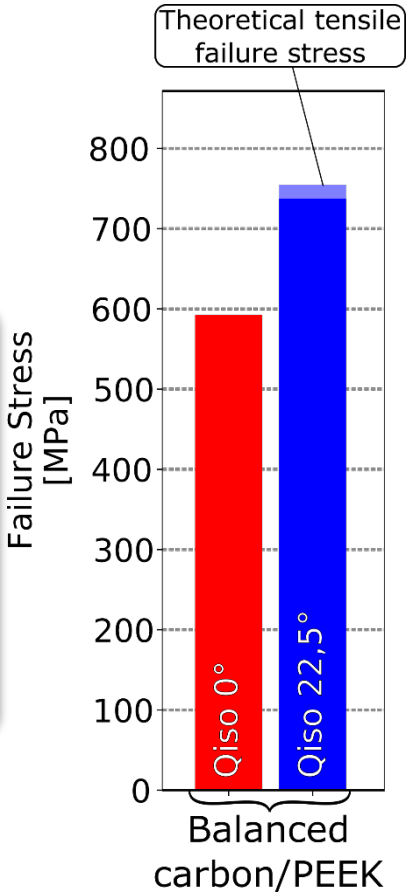
Balanced Woven Carbone/PEEK



Failure in fibre direction

$[0,\ 45]_s$ laminate

Thickness	Virtual Ply	11	22	σ_{12}	d_{12}
		σ	σ		
δ	0	1625	-6	0	0
δ	90	-527	96	0	0,35
δ	45	565	52	4	0,25
δ	-45	565	52	-4	0,25



Failure in fibre direction

$[22.5,\ -22.5]_s$ laminate

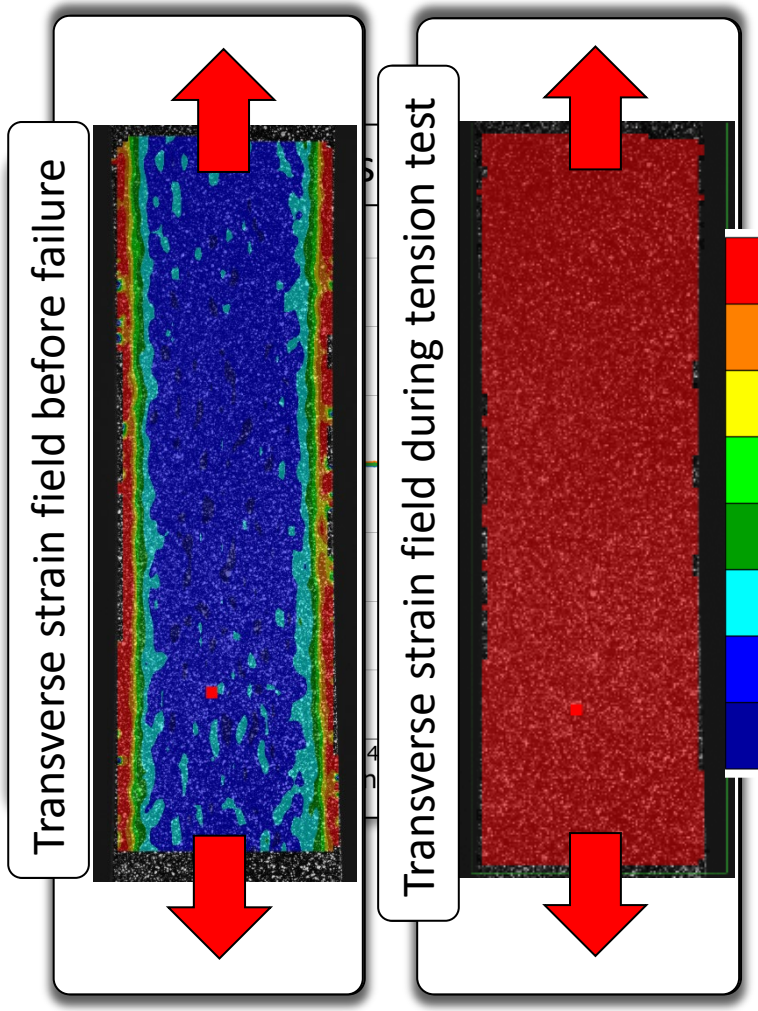
Thickness	Virtual Ply	11	22	σ_{12}	d_{12}
		σ	σ		
δ	22,5	1625	18	47	0,15
δ	-67,5	-225	86	-28	0,44
δ	67,5	-225	86	-28	0,44
δ	-22,5	1625	18	45	0,15

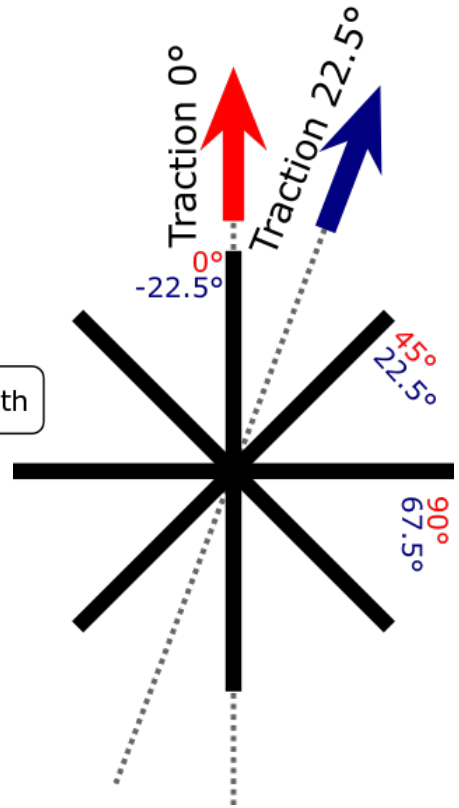
E_1^{*UD}	E_2^{*UD}	G_{12}^{*UD}	ν_{12}	γ	σ_{tens}^{*UD}	σ_{comp}^{*UD}	a	b	n	m	R_0	h
GPa	*GPa*	*GPa*			*MPa*	*MPa*					*MPa*	*MPa*
109	*10*	*4.5*	*0.29*	*0.0*	*1625*	*1625*	*0.43*	*0.31*	*0.72*	*0.72*	*60*	*10712*

Failure of Quasi-iso

UD C/E et Woven G/E and C/E,TP

(Cocchi, 2020)







Conclusion

A simple test :

- to qualify the resistance to delamination
- a limit of plane stress models