EFFECTS OF WINDING ANGLES ON MECHANICAL PROPERTIES OF FILAMENT WOUND PIPES

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Abstract

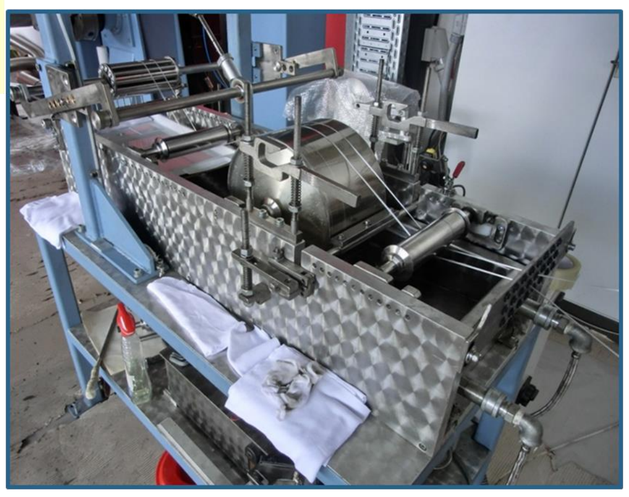
The aim of this study is to investigate the mechanical properties of continuous glass fiber reinforced composite tubes produced by filament winding technique with three different winding angles. With help of split-disk tests hoop tensile properties of selected specimens were determined, where reliable results were obtained with low standard deviations. It was observed that bigger winding angle lead to higher hoop tensile properties of filament-wound tubular samples.
Also, the effect of reinforcement direction on the mechanical performances of these composites has been presented. Fiber fracture and fiber-matrix debonding is observed to be the dominant failure mechanisms by samples winded with bigger winding angles, whereas delamination in addition to these mechanisms is detected by samples with smaller winding angles. From received results it is concluded that, mechanical properties of composite specimens are depended from winding angles in filament winding technology.
With help of conducted SEM analysis good merger between glass fibers and the epoxy matrix was seen, but cracks within plies and broken fiber were noticed, due to the high fiber branching.

Experimental

Materials

Epoxy matrix system from Huntsman:
Araldite LY1135-1 is an epoxy resin
Aradur 917 is an anhydride hardener
Accelerator 960 is an amine accelerator

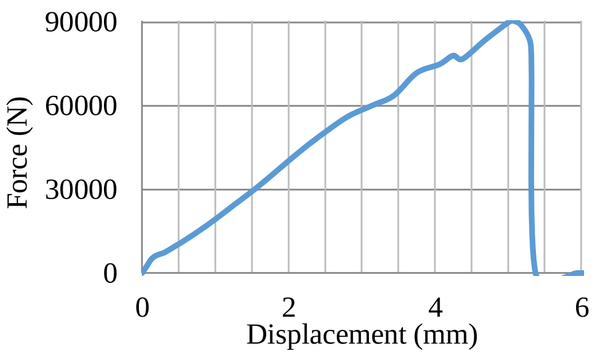
E-glass, continuous filament from Owens Corning – P185 1200 tex



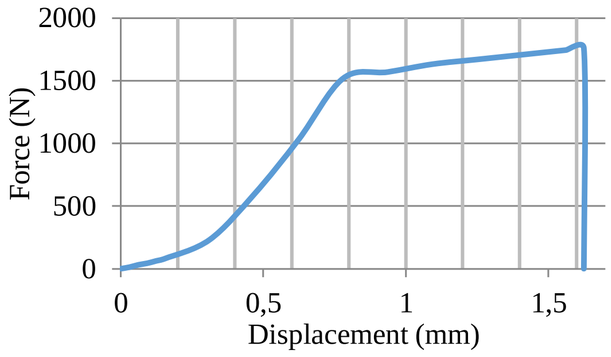
Dimensions and winding angles of test samples

Sample Designation		Weight (g)	Width (mm)	Thickness (mm)	Winding angle (^{0})
1	1 -1	52,8	14,06	3,64	90
	1-2	52,8	14,12	3,64	
	1-3	53,8	14,12	3,65	
2	2-1	42,2	13,97	3,18	10
	2-2	43,0	13,85	3,14	
	2-3	43,7	14,00	3,14	
3	3-1	53,6	14,01	3,18	45
	3-2	53,8	13,9	3,16	
	3-3	53,8	14,01	3,16	

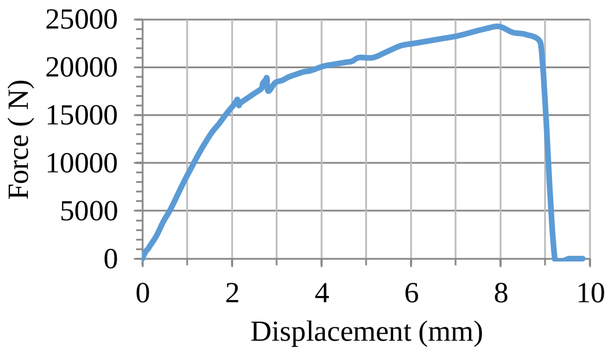
Result and discussion



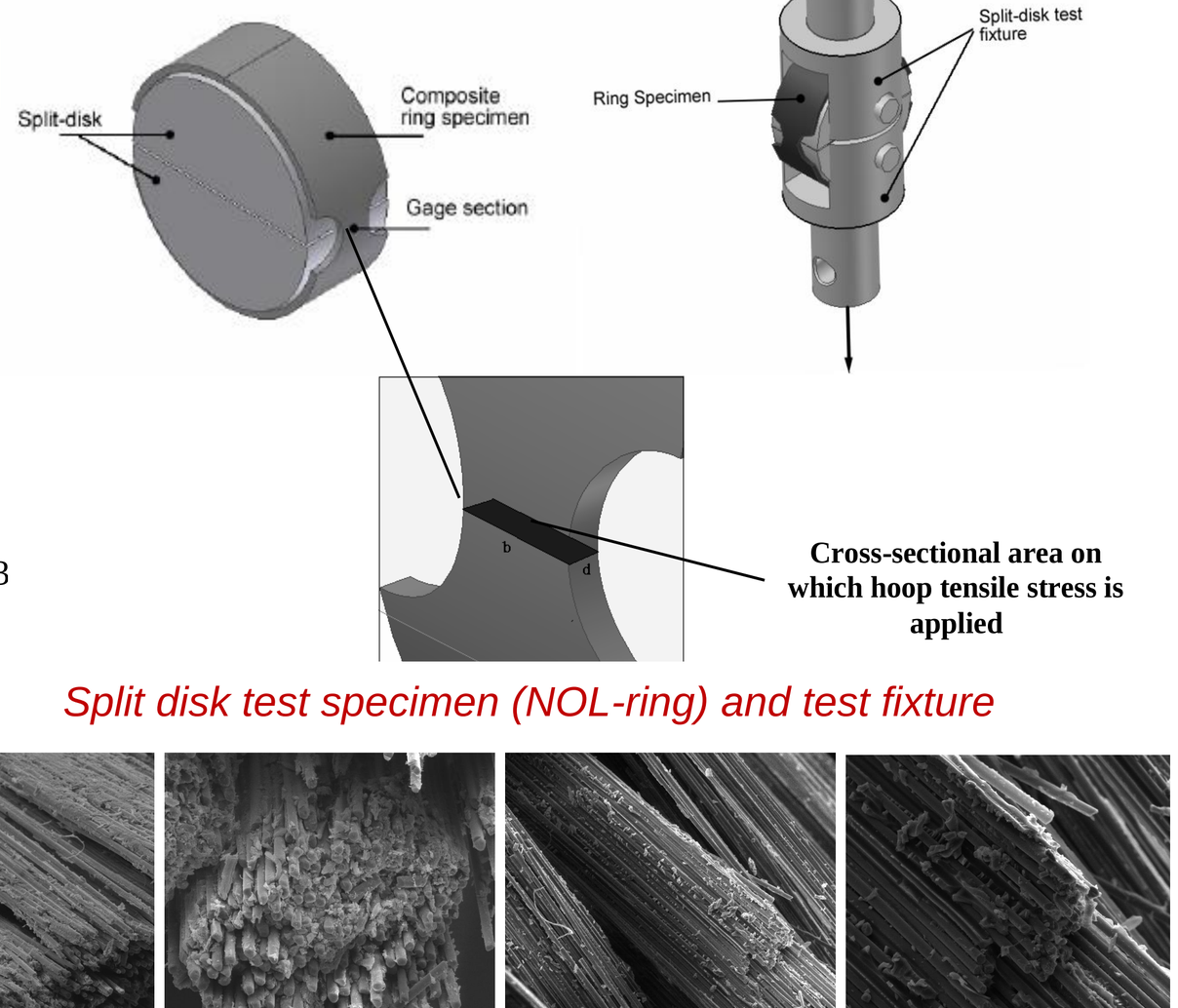
a) Force and displacement of sample 1-2



b) Force and displacement of sample 2-3



c) Force and displacement of sample 3-2



Split disk test specimen (NOL-ring) and test fixture

Hoop tensile strength results of split-disk tests

Sample Designation	Fmax (N)	Fmax average (N)	Tensile strength (MPa)	Tensile strength average (MPa)
1 -1	94500	92583,33	923,24	901,15
1-2	90250		877,97	
1-3	93000		902,25	
2-1	1600	1536,25	18,00	27,45
2-2	1250		14,34	
2-3	1759		20,00	
3-1	25000	24541,67	280,57	277,30
3-2	24225		275,76	
3-3	24400		275,57	

SEM photographs of failure section so split-disk specimens