Numerical Simulation and Experimental Study of Trapezoidal Tear of Triaxial Woven Fabric

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1. Specifications of Triaxial weave fabric (TWF)

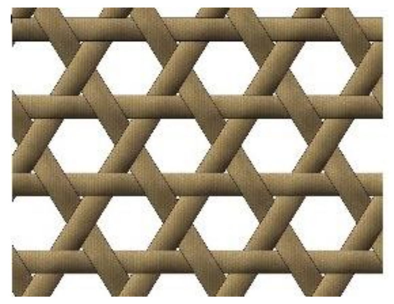

Fig.1 Triaxial weave fabric (TWF)

Table 1. Specifications of TWF

Construction	Warp1 /10cm	Warp2 /10cm	Weft /10cm	Density /g/m²	Thickness/ mm	Cover factor/%
TWF	33	33	33	194.04	0.43	62.57

2. Tear test

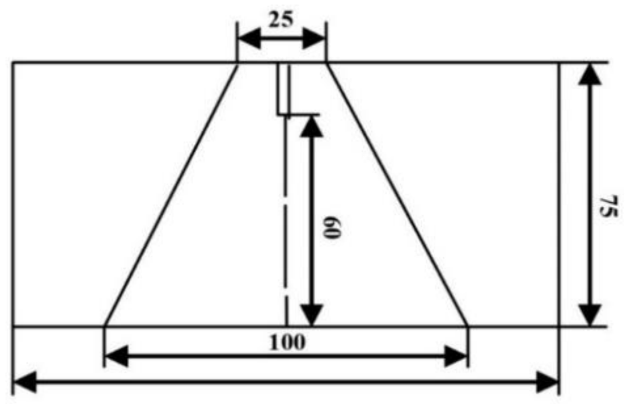

Fig.2 Dimensions of samples for trapezoidal-tear, units mm

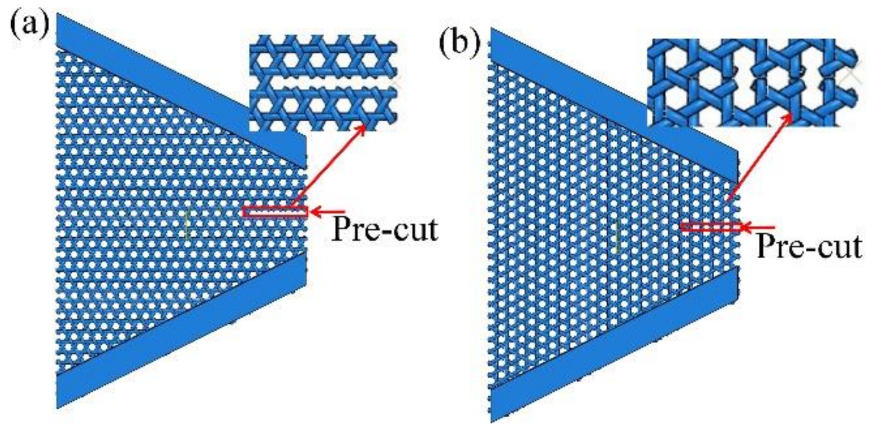

Fig.3 Pre-cut schematic diagram of TWF trapezoidal-tear: (a) the pre-cut is parallel to yarns; (b) the pre-cut is parallel to angle bisector of yarns.

3. Finite element model

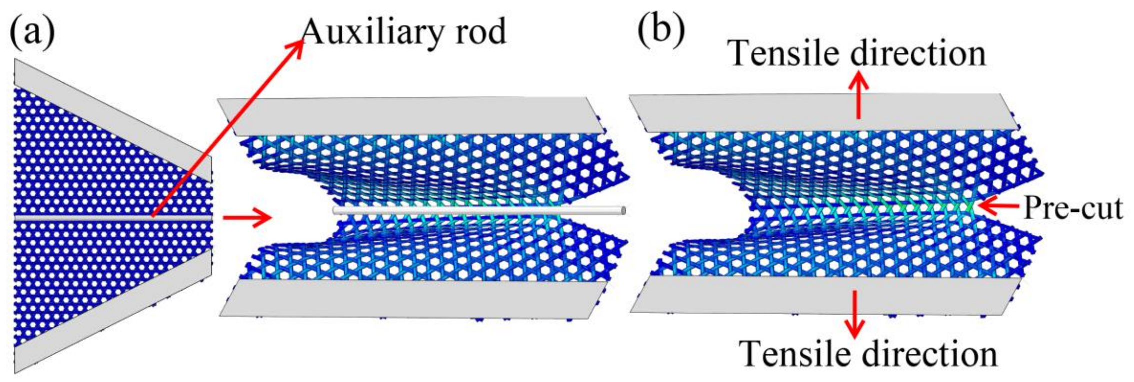

Fig.4 The morphology during trapezoidal tear of the finite element simulation: (a) Step-1; (b) Step-2.

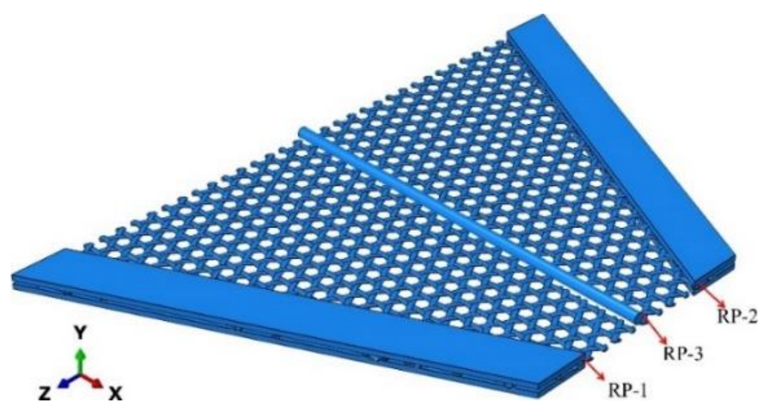

Fig.5 Boundary conditions of finite element model during the trapezoidal tear process

Table2. Boundary conditions in finite element model of samples

Step	Regions	Settings
Step-1	RP-1	VR2=-0.463648 radians；U1=U2=U3=UR1=UR3=0
	RP-2	VR2=0.463648 radians；U1=U2=U3=UR1=UR3=0
Step-2	RP-1	V1=0.833333mm/s；U1=U2=UR1=U2=UR3=0
	RP-2	V2=-0.833333mm/s；U1=U2=UR1=U2=UR3=0
	RP-3	VR3=0.5 radians；U1=U2=U3=UR1=UR2=0

4. Results and Discussion

(1) Tear load-displacement curves of samples

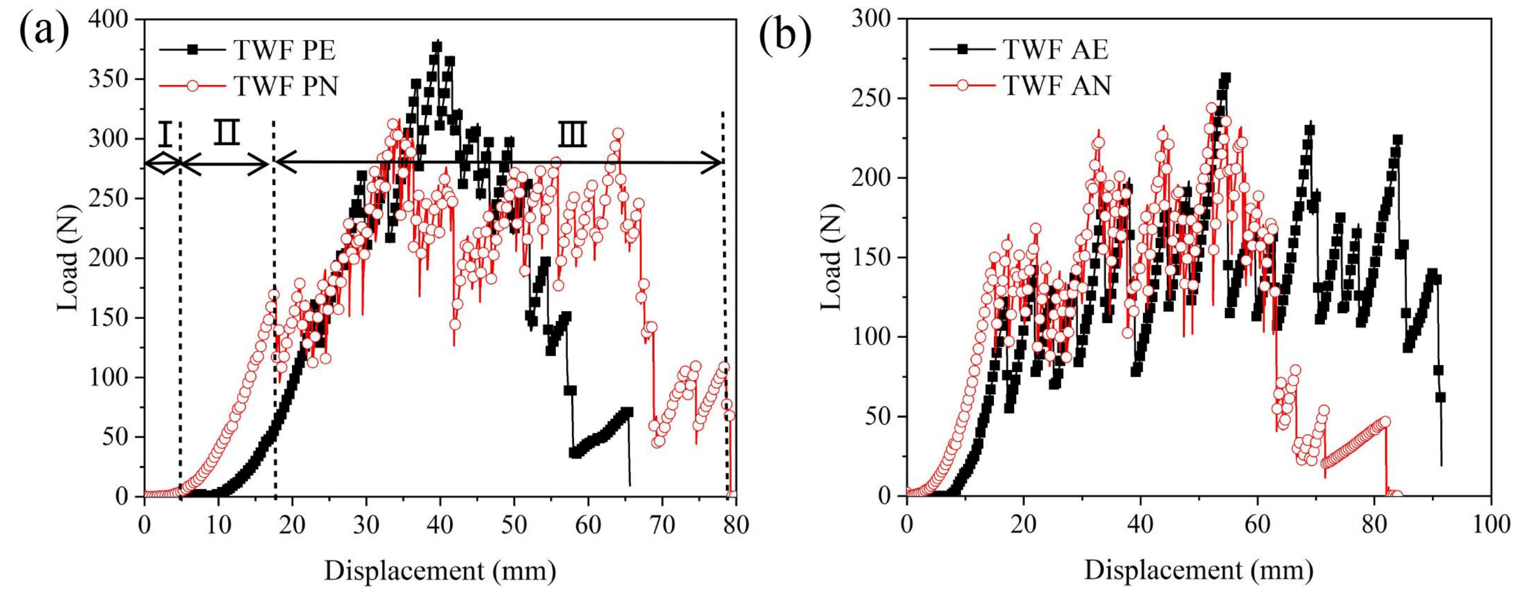

Fig. 6 Tear load-displacement curve of TWF. Note: PE, PN respectively denotes the results of experiment and finite element analysis， AE, AN respectively denotes the results of experiment and finite element analysis

(2) Tear damage evolution analysis

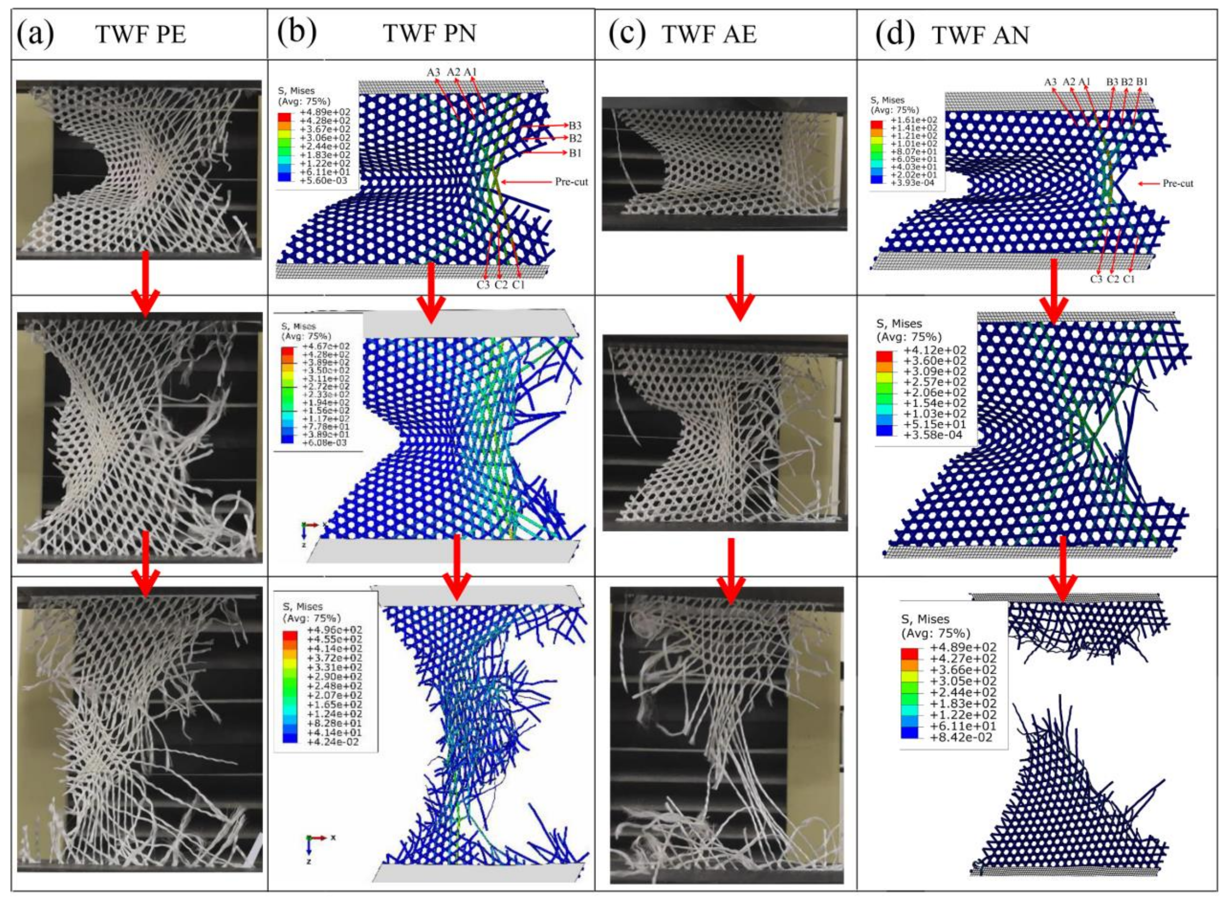

Fig.7 Tear damage morphology of TWF :(a) and (c) Failure processes of TWF from experiment; (b) and (d） Failure processes of TWF from FEA

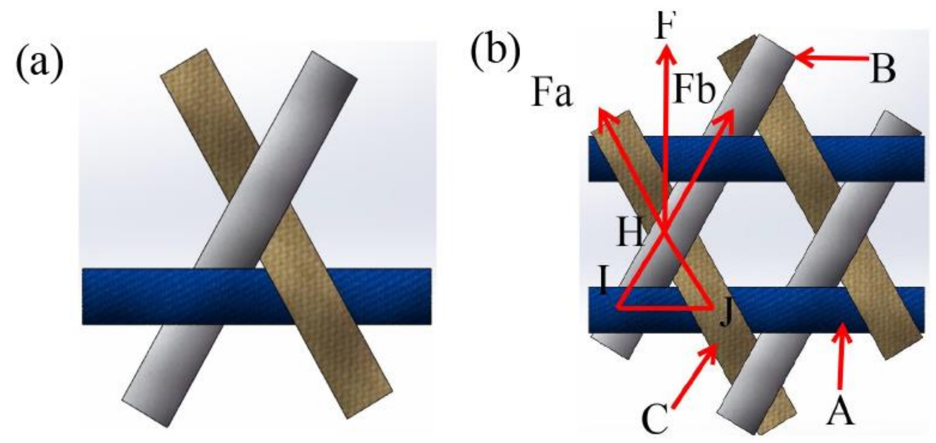

Fig.8. Schematic diagram of the self-locking feature of TWF. (a) interlacing structure；(b) self-locking feature

5. Conclution

The tear process of TWF can be basically divided into three stages, namely initial stage, pre-cut opening stage and tear opening expansion stage, which correspond low modulus region, high modulus region and oscillation region of the tear load-displacement curve, respectively.

FEA results of tearing property of TWF maintain high consistency with experimental test results, which verifies the accuracy of the finite element model and related parameter settings.