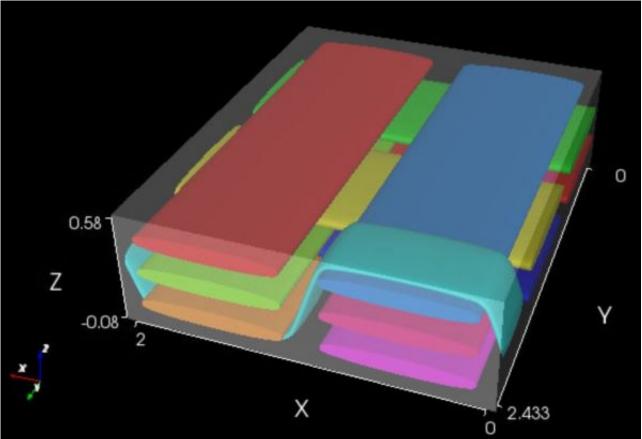
Predict failure index, strength ratio, and failure envelope of 3D orthogonal woven plate

Problem Description

In this example, failure index, strength ratio, and failure envelope of a 3D orthogonal woven plate are predicted using MSG failure functions. For computing failure index and strength ratio, an external load can be defined. Since we are using MSG plate model, the load is in terms of plate stress resultants such as {N11, N22, 2N12, M11, M22, 2M12}. Therefore, the corresponding strength constants are also in terms of plate stress resultants. For the failure envelope analysis, a biaxial loading case is assumed with N11:N22 = 1:1.

Solution Procedure



* step 1 The SG of an 3D orthogonal woven plate is first created as shown in the figure below, which is created using the 3D weave function in texgen4sc with the default parameters.

* step 2 Once the SG is created, we need to perform homogenization analysis using mesoscale function just as in the previous example. Note that this example is using MSG plate model as shown in the figure below.

No. of Concession, Name	This wizard will create SwiftCom	p input file for you.		
and the second second	Assign voxel seed in each direc	tion:		
-	X Voxel Count:	Æ		
	Y Voxel Count:	15		
CHAR -	Z Voxel Count:	15		
TYPE AND AND A	Type of analysis:	I Elastic	Thermoelastic	Viscoelastic
THUS		Thermoviscoelastic		
-510	Type of models	🔲 Solid Model	Plate/Shell Model	🗌 Beam Model
	Type of plate theory	Kirchhoff-Love plate	🔲 Reissner-Mindlin plate	
	Type of beam theory	🔲 Euler-Bernoulli beam	🔲 Timoshenko beam	
	Aperiodic boundary conditions	□ y1	□ y2	🗌 уЗ
	Import viscoelastic or thermovi	iscoelastic properties S	elect file	
		_		

The results will pop up. Note that the results are plate stiffness/compliance matrix as shown here.

The Effective Stiffness	s Matrix				
		•			
2.3465290E+004	1.1176154E+003	5.3332831E-006	1.3668846E-004	2.8000076E-005	4.5222908E-002
1.1176154E+003	4.6876025E+004	-1.4886148E-006	2.5025207E-005	4.1557023E-005	1.7199057E-002
5.3332831E-006	-1.4886148E-006	1.8711398E+003	1.1012656E-001	4.2754330E-003	4.0978901E-005
1.3668846E-004	2.5025207E-005	1.1012656E-001	3.7709755E+002	2.9800292E+001	1.8979951E-007
2.8000076E-005	4.1557023E-005	4.2754330E-003	2.9800292E+001	1.2171061E+003	-2.6507946E-008
4.5222908E-002	1.7199057E-002	4.0978901E-005	1.8979951E-007	-2.6507946E-008	5.4879443E+001
The Effective Complian	ce Matrix				
4.2664584E-005	-1.0172065E-006	-1.2074767E-013	-1.5352175E-011	-5.7089572E-013	-3.4838574E-008
-1.0172065E-006	2.1357119E-005	2.0078655E-014	-9.9475385E-013	-6.8146296E-013	-5,8550387E-009
-1.2074767E-013	2.0078655E-014	5.3443362E-004	-1.5622849E-007	1.9478330E-009	-3.9906505E-010
-1.5352175E-011	-9.9475385E-013	-1.5622849E-007	2.6569747E-003	-6.5054826E-005	-9.0909000E-012
-5.7089572E-013	-6.8146296E-013	1.9478330E-009	-6.5054826E-005	8.2321392E-004	6.2185037E-013
-3.4838574E-008	-5.8550387E-009	-3.9906505E-010	-9.0909000E-012	6.2185037E-013	1.8221759E-002
In-Plane Properties					
E1 = 3.5513097					
E2 = 7.0943628E+004					
G12 = 2.8350603					
nu12= 2.3841941					
etal21= -2.25935					
eta122= 3.75699	59E-011				

* step 3 Once the homogenization analysis is finished. We can perform the failure analysis by using the initial failure analysis as shown in the figure below. The load is assumed that N11=1 N/mm, N22=1 N/mm and other components are 0. The matrix failure criterion is Mises and the yarn failure criterion is Tsai-Wu.

SwiftComp Wizard	2
New Property	Initial failure analysis
	Choose failure criterion for matrix:
	 Max principal stress Max principal strain Max shear stress Max shear strain Mises Xt: 69 Xc: 250 S: 50
	Choose failure criterion for yarns:
-3 10-	Xt: 1518.86 Yt: 49.21 Zt: 49.21
	Xc: 1215.09 Vc: 178.29 Zc: 178.29
	R: 56.96 T: 41.80 S: 41.80
	Type of analysis: Strength constants I index and strength ratio Envelope Type of load: stress-based strain-based
	Load: [110000] Envelope:
	< Back Einish & Cancel

The results are the failure index (first column) and strength ratio (second column) as shown below:

PREDICT FAILURE INDEX, STRENGTH RATIO, AND FAILURE ENVELOPE OF 3D ORTHOGONAL WOVEN F

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1	1	2.7980992E-003	3.5738547E+002
2	2	2.2853606E-003	4.3756771E+002
3	3	2.0122313E-003	4.9696075E+002
4	4	1.9876429E-003	5.0310849E+002
5	5	1.9754270E-003	5.0621967E+002
5	6	2.0085003E-003	4.9788391E+002
7	7	2.3605184E-003	4.2363576E+002
8	8	2.8574179E-003	3.4996631E+002
9	9	1.9636977E-003	5.0924335E+002
10	10	1.3425460E-003	7.4485345E+002
11	11	1.1953621E-003	8.3656662E+002
12	12	1.1712002E-003	8.5382502E+002
13	13	1.2379212E-003	8.0780586E+002
14	14	1.7064759E-003	5.8600302E+002
15	15	2.7403341E-003	3.6491900E+002
16	16	2.3413599E-003	4.2710222E+002
17	17	2.0319362E-003	4.9214144E+002
18	18	1.8357956E-003	5.4472294E+002
19	19	1.8774802E-003	5.3262880E+002
20	20	1.8754991E-003	5.3319141E+002
21	21	1.8553801E-003	5.3897312E+002
22	22	2.0398963E-003	4.9022099E+002
23	23	2.1728593E-003	4.6022307E+002
24	24	1.8375566E-003	5.4420091E+002
25	25	1.4951278E-003	6.6883912E+002
26	26	1.4155522E-003	7.0643809E+002
27	27	1.3976349E-003	7.1549442E+002
28	28	1.4090984E-003	7.0967364E+002
29	29	1.7136374E-003	5.8355403E+002
30	30	2.1624672E-003	4.6243477E+002
31	31	2.2441061E-003	4.4561172E+002
32	32	1.9081643E-003	5.2406388E+002
33	33	1.7491718E-003	5.7169912E+002
34	34	1.8121274E-003	5.5183759E+002

* step 4 Next, we want to perform a failure envelope analysis in terms of N11 and N22. The parameters are defined in the following:

SwiftComp Wizard						×
Statements	Initial failure analysis					
	Choose failure criterio	n for matrix:				
TR C	Max principal stres	s 🔲 Max principa	il strain] Max shear stre	iss 🔲 Max shear strain	🗹 Mises
The A	Xt: 69	Kc: 250	S: 50			
	Choose failure criterio	n for yarns:				
STATUS -	🗌 Max stress 🔲 Ma	ix strain 🔲 Tsai-H	ill 🖸 Tsa	ai-Wu 🔲 Hasi	nin	
-510	Xt: 1518.86	vt: 49.21		49.21		
	Xc: 1215.09	Yc: 178.29	Zc:	178.29		
	R: 56.96	T: 41.80	s:	41.80		
	Type of analysis: 📋 g	Strength constants	🗌 Index	and strength ra	tio 🖸 Envelope	
	Type of load: 🔽 stres	ss-based 🗌 strai	n-based			
	Load:	_				
	Envelope: 1 2	-				
				<	Back Einish	Cancel

The results are given as:

PREDICT FAILURE INDEX, STRENGTH RATIO, AND FAILURE ENVELOPE OF 3D ORTHOGONAL WOVEN F

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1	1	7.6150021E+001	0.000000E+000
2	2	-1.5327679E+002	0.000000E+000
3 4	з	0.000000E+000	2.0823237E+002
4	4	0.000000E+000	-2.9687614E+002
5 6 7	5	7.3318611E+001	2.5061235E+001
6	6	-1.6143597E+002	-5.5180871E+001
7	7	6.9117516E+001	4.7250494E+001
8	8	-1.6791831E+002	-1.1479323E+002
9	9	6.4810260E+001	6.6458916E+001
10	10	-1.7222834E+002	-1.7660951E+002
11	11	6.0769129E+001	8.3086648E+001
12	12	-1.7450098E+002	-2.3858662E+002
13	13	5.7016562E+001	9.7444933E+001
14	14	-1.7368422E+002	-2.9683738E+002
15	15	5.3557387E+001	1.0983958E+002
16	16	-1.5146692E+002	-3.1063993E+002
17	17	5.0384195E+001	1.2055372E+002
18	18	-1.3175019E+002	-3.1523725E+002
19	19	4.7481898E+001	1.2983934E+002
20	20	-1.1614138E+002	-3.1758881E+002
21	21	7.8953749E+001	-3.8475834E+001
22	22	-1.3952749E+002	6.7994699E+001
23	23	7.9894701E+001	-7.7868758E+001
24	24	-1.2166528E+002	1.1858014E+002
25	25	7.8944358E+001	-1.1541377E+002
26	26	-1.0514654E+002	1.5372040E+002
27	27	7.6497802E+001	-1.4911599E+002
28	28	-9.0921851E+001	1.7723257E+002
29	29	7.3115152E+001	-1.7815281E+002
30	30	-7.9100938E+001	1.9273781E+002
31	31	6.8543344E+001	-2.0041573E+002
32	32	-6.9478402E+001	2.0314978E+002
33	33	6.2749517E+001	-2.1405418E+002
34	34	-6.1643080E+001	2.1027984E+002
		F. 30000135.003	0.040000124000