

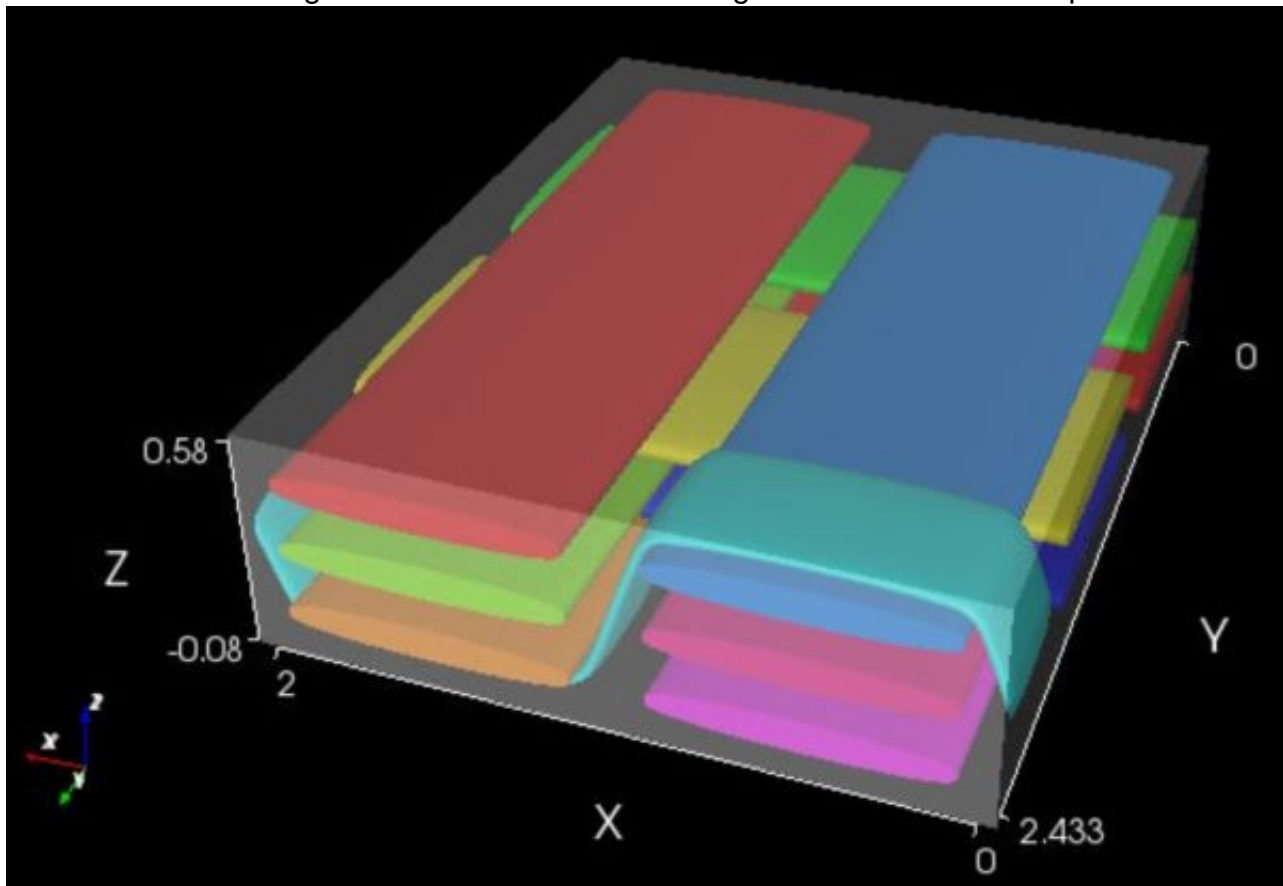
Predict failure index, strength ratio, and failure envelope of 3D orthogonal woven plate

Problem Description

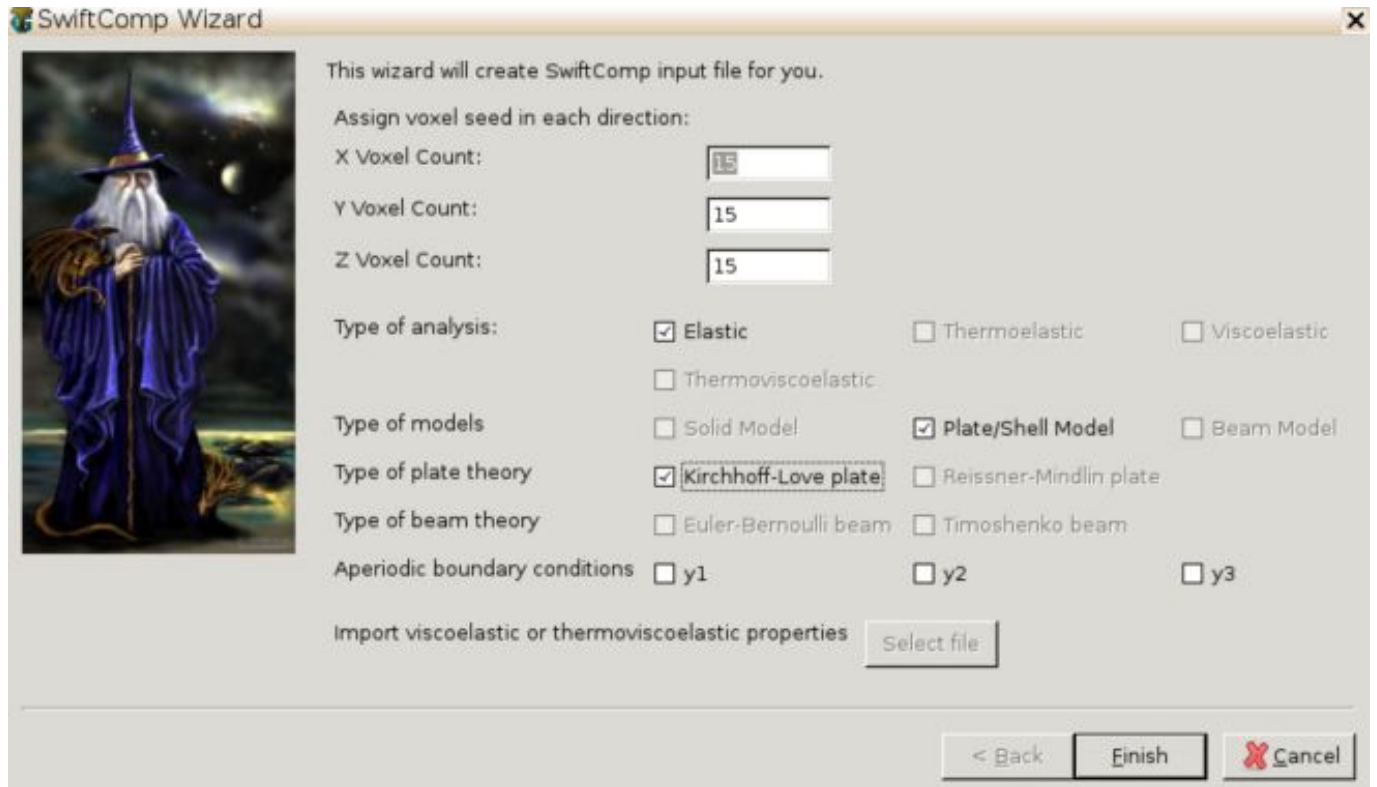
In this example, failure index, strength ratio, and failure envelope of a 3D orthogonal woven plate are predicted using MSG failure functions. For computing failure index and strength ratio, an external load can be defined. Since we are using MSG plate model, the load is in terms of plate stress resultants such as $\{N_{11}, N_{22}, 2N_{12}, M_{11}, M_{22}, 2M_{12}\}$. 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 $N_{11}:N_{22} = 1:1$.

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.



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

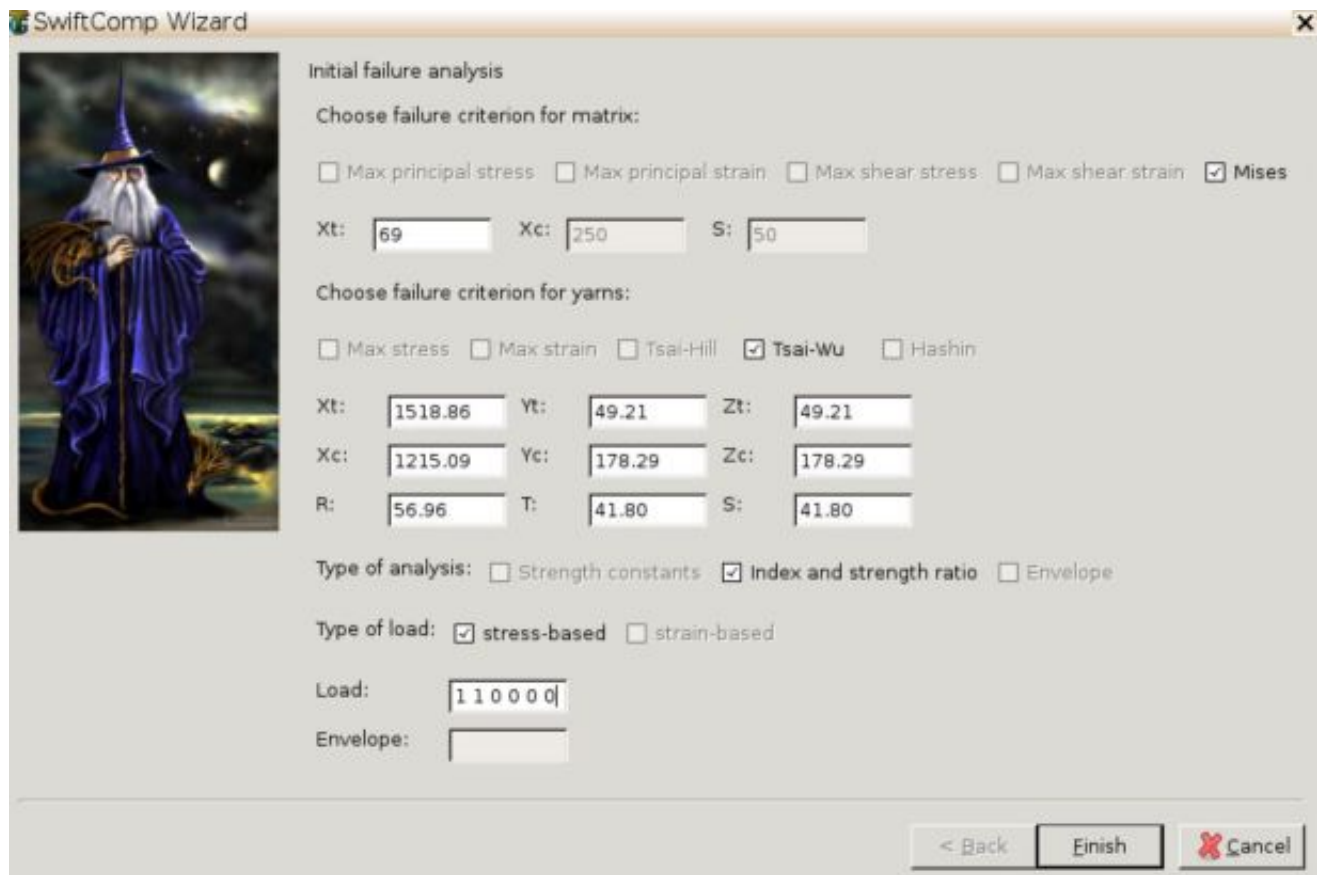
The Effective Stiffness Matrix					
2.3465290E+004	1.1176154E+003	5.3332831E-006	1.3668846E-004	2.8000076E-005	4.5222908E-002
1.1176154E+003	4.6876025E+004	-1.4886148E-006	2.5025207E-005	4.1557023E-005	1.7199057E-002
5.3332831E-006	-1.4886148E-006	1.8711398E+003	1.1012656E-001	4.2754330E-003	4.0978901E-005
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 Compliance 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 =	3.5513097E+004
E2 =	7.0943628E+004
G12 =	2.8350603E+003
nu12 =	2.3841941E-002
eta121 =	-2.2593576E-010
eta122 =	3.7569969E-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 $N_{11}=1$ N/mm, $N_{22}=1$ N/mm and other components are 0. The matrix failure criterion is Mises and the yarn failure criterion is Tsai-Wu.

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



Initial failure analysis

Choose failure criterion for matrix:

Max principal stress Max principal strain Max shear stress Max shear strain Mises

Xt: Xc: S:

Choose failure criterion for yarns:

Max stress Max strain Tsai-Hill Tsai-Wu Hashin


Xt:	<input type="text" value="1518.86"/>	Yt:	<input type="text" value="49.21"/>	Zt:	<input type="text" value="49.21"/>
Xc:	<input type="text" value="1215.09"/>	Yc:	<input type="text" value="178.29"/>	Zc:	<input type="text" value="178.29"/>
R:	<input type="text" value="56.96"/>	T:	<input type="text" value="41.80"/>	S:	<input type="text" value="41.80"/>

Type of analysis: Strength constants Index and strength ratio Envelope

Type of load: stress-based strain-based

Load:

Envelope:

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

test.sc.fi X			
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
6	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:

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

SwiftComp Wizard



Initial failure analysis

Choose failure criterion for matrix:

Max principal stress Max principal strain Max shear stress Max shear strain **Mises**

Xt: Xc: S:

Choose failure criterion for yarns:

Max stress Max strain Tsai-Hill **Tsai-Wu** Hashin

Xt: Yt: Zt:
Xc: Yc: Zc:
R: T: S:

Type of analysis: Strength constants Index and strength ratio **Envelope**

Type of load: **stress-based** strain-based

Load:

Envelope:

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The results are given as:

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

test.sc.fi ✕			
1	1	7.6150021E+001	0.0000000E+000
2	2	-1.5327679E+002	0.0000000E+000
3	3	0.0000000E+000	2.0823237E+002
4	4	0.0000000E+000	-2.9687614E+002
5	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
35	35	5.7000000E+001	0.0000000E+000