

Aerobatic Wing

Honeycomb variant

Material properties

Carbon fibre layups will be modelled using UD plies whose properties are as follows:

The screenshot shows the 'Define Material - 2D ORTHOTROPIC' dialog box. The title is 'CCF800/AC531'. The material type is 'Carbon Fiber'. The color is '55'. The layer is '1'. The material type is 'Carbon Fiber'. The dialog is divided into several tabs: General, Function References, Nonlinear, Creep, Electrical/Optical, and Phase. The General tab is active. It contains fields for Stiffness (E), Shear (G), Poisson Ratio (nu), Limit Stress/Strain, Specific Heat (Cp), Mass Density, Damping (2C/Co), Reference Temp, Tsai-Wu Interaction, Thermal Expansion (A), and Thermal Conductivity (k). The values are as follows:

Property	Value
Stiffness (E) 1	163800.
Stiffness (E) 2	8630.
Shear (G) 12	4120.
Shear (G) 1z	4120.
Shear (G) 2z	4120.
Poisson Ratio (nu) 12	0.31
Limit Stress/Strain (Stress Limits)	
Tension Dir 1	2209.
Compression Dir 1	1052.
Shear Dir 1	131.
Tension Dir 2	70.
Compression Dir 2	199.
Specific Heat (Cp)	0.
Mass Density	1.6E-9
Damping (2C/Co)	0.
Reference Temp	0.
Tsai-Wu Interaction	2.78E-6
Thermal Expansion (A) 1	0.
Thermal Expansion (A) 2	0.
Thermal Conductivity (k) 1	0.
Thermal Conductivity (k) 2	0.
Thermal Conductivity (k) 3	0.
Thermal Conductivity (k) 4	0.
Thermal Conductivity (k) 5	0.
Thermal Conductivity (k) 6	0.
Thermal Conductivity (k) 7	0.
Thermal Conductivity (k) 8	0.
Thermal Conductivity (k) 9	0.
Thermal Conductivity (k) 10	0.
Thermal Conductivity (k) 11	0.
Thermal Conductivity (k) 12	0.
Thermal Conductivity (k) 13	0.
Thermal Conductivity (k) 14	0.
Thermal Conductivity (k) 15	0.
Thermal Conductivity (k) 16	0.
Thermal Conductivity (k) 17	0.
Thermal Conductivity (k) 18	0.
Thermal Conductivity (k) 19	0.
Thermal Conductivity (k) 20	0.
Thermal Conductivity (k) 21	0.
Thermal Conductivity (k) 22	0.
Thermal Conductivity (k) 23	0.
Thermal Conductivity (k) 24	0.
Thermal Conductivity (k) 25	0.
Thermal Conductivity (k) 26	0.
Thermal Conductivity (k) 27	0.
Thermal Conductivity (k) 28	0.
Thermal Conductivity (k) 29	0.
Thermal Conductivity (k) 30	0.
Thermal Conductivity (k) 31	0.
Thermal Conductivity (k) 32	0.
Thermal Conductivity (k) 33	0.
Thermal Conductivity (k) 34	0.
Thermal Conductivity (k) 35	0.
Thermal Conductivity (k) 36	0.
Thermal Conductivity (k) 37	0.
Thermal Conductivity (k) 38	0.
Thermal Conductivity (k) 39	0.
Thermal Conductivity (k) 40	0.
Thermal Conductivity (k) 41	0.
Thermal Conductivity (k) 42	0.
Thermal Conductivity (k) 43	0.
Thermal Conductivity (k) 44	0.
Thermal Conductivity (k) 45	0.
Thermal Conductivity (k) 46	0.
Thermal Conductivity (k) 47	0.
Thermal Conductivity (k) 48	0.
Thermal Conductivity (k) 49	0.
Thermal Conductivity (k) 50	0.
Thermal Conductivity (k) 51	0.
Thermal Conductivity (k) 52	0.
Thermal Conductivity (k) 53	0.
Thermal Conductivity (k) 54	0.
Thermal Conductivity (k) 55	0.
Thermal Conductivity (k) 56	0.
Thermal Conductivity (k) 57	0.
Thermal Conductivity (k) 58	0.
Thermal Conductivity (k) 59	0.
Thermal Conductivity (k) 60	0.
Thermal Conductivity (k) 61	0.
Thermal Conductivity (k) 62	0.
Thermal Conductivity (k) 63	0.
Thermal Conductivity (k) 64	0.
Thermal Conductivity (k) 65	0.
Thermal Conductivity (k) 66	0.
Thermal Conductivity (k) 67	0.
Thermal Conductivity (k) 68	0.
Thermal Conductivity (k) 69	0.
Thermal Conductivity (k) 70	0.
Thermal Conductivity (k) 71	0.
Thermal Conductivity (k) 72	0.
Thermal Conductivity (k) 73	0.
Thermal Conductivity (k) 74	0.
Thermal Conductivity (k) 75	0.
Thermal Conductivity (k) 76	0.
Thermal Conductivity (k) 77	0.
Thermal Conductivity (k) 78	0.
Thermal Conductivity (k) 79	0.
Thermal Conductivity (k) 80	0.
Thermal Conductivity (k) 81	0.
Thermal Conductivity (k) 82	0.
Thermal Conductivity (k) 83	0.
Thermal Conductivity (k) 84	0.
Thermal Conductivity (k) 85	0.
Thermal Conductivity (k) 86	0.
Thermal Conductivity (k) 87	0.
Thermal Conductivity (k) 88	0.
Thermal Conductivity (k) 89	0.
Thermal Conductivity (k) 90	0.
Thermal Conductivity (k) 91	0.
Thermal Conductivity (k) 92	0.
Thermal Conductivity (k) 93	0.
Thermal Conductivity (k) 94	0.
Thermal Conductivity (k) 95	0.
Thermal Conductivity (k) 96	0.
Thermal Conductivity (k) 97	0.
Thermal Conductivity (k) 98	0.
Thermal Conductivity (k) 99	0.
Thermal Conductivity (k) 100	0.

UD plies have thickness of 0,155 mm.

For the honeycomb material, aramid was chosen. Honeycomb properties are modelled using 2D Orthotropic material model. Shear modulus and strenghts were obtained using Ashbys approximations. Cell size is 4,8 mm, while honeycomb core height is 5 mm. Honeycomb core height was tested in manual iterative process where it was noticed that after increasing the height above 5 mm, the skin began to buckle.

The screenshot shows the 'Define Material - 2D ORTHOTROPIC' dialog box. The title is 'ECA 4.8 mm'. The material type is 'Carbon Fiber'. The color is '55'. The layer is '1'. The material type is 'Carbon Fiber'. The dialog is divided into several tabs: General, Function References, Nonlinear, Creep, Electrical/Optical, and Phase. The General tab is active. It contains fields for Stiffness (E), Shear (G), Poisson Ratio (nu), Limit Stress/Strain, Specific Heat (Cp), Mass Density, Damping (2C/Co), Reference Temp, Tsai-Wu Interaction, Thermal Expansion (A), and Thermal Conductivity (k). The values are as follows:

Property	Value
Stiffness (E) 1	101.1
Stiffness (E) 2	9.9
Shear (G) 12	1.6
Shear (G) 1z	33.3
Shear (G) 2z	19.6
Poisson Ratio (nu) 12	0.24
Limit Stress/Strain (Stress Limits)	
Tension Dir 1	2.4
Compression Dir 1	2.4
Shear Dir 1	3.
Tension Dir 2	1.5
Compression Dir 2	1.5
Specific Heat (Cp)	0.
Mass Density	4.8E-11
Damping (2C/Co)	0.
Reference Temp	0.
Tsai-Wu Interaction	0.08165
Thermal Expansion (A) 1	0.
Thermal Expansion (A) 2	0.
Thermal Conductivity (k) 1	0.
Thermal Conductivity (k) 2	0.
Thermal Conductivity (k) 3	0.
Thermal Conductivity (k) 4	0.
Thermal Conductivity (k) 5	0.
Thermal Conductivity (k) 6	0.
Thermal Conductivity (k) 7	0.
Thermal Conductivity (k) 8	0.
Thermal Conductivity (k) 9	0.
Thermal Conductivity (k) 10	0.
Thermal Conductivity (k) 11	0.
Thermal Conductivity (k) 12	0.
Thermal Conductivity (k) 13	0.
Thermal Conductivity (k) 14	0.
Thermal Conductivity (k) 15	0.
Thermal Conductivity (k) 16	0.
Thermal Conductivity (k) 17	0.
Thermal Conductivity (k) 18	0.
Thermal Conductivity (k) 19	0.
Thermal Conductivity (k) 20	0.
Thermal Conductivity (k) 21	0.
Thermal Conductivity (k) 22	0.
Thermal Conductivity (k) 23	0.
Thermal Conductivity (k) 24	0.
Thermal Conductivity (k) 25	0.
Thermal Conductivity (k) 26	0.
Thermal Conductivity (k) 27	0.
Thermal Conductivity (k) 28	0.
Thermal Conductivity (k) 29	0.
Thermal Conductivity (k) 30	0.
Thermal Conductivity (k) 31	0.
Thermal Conductivity (k) 32	0.
Thermal Conductivity (k) 33	0.
Thermal Conductivity (k) 34	0.
Thermal Conductivity (k) 35	0.
Thermal Conductivity (k) 36	0.
Thermal Conductivity (k) 37	0.
Thermal Conductivity (k) 38	0.
Thermal Conductivity (k) 39	0.
Thermal Conductivity (k) 40	0.
Thermal Conductivity (k) 41	0.
Thermal Conductivity (k) 42	0.
Thermal Conductivity (k) 43	0.
Thermal Conductivity (k) 44	0.
Thermal Conductivity (k) 45	0.
Thermal Conductivity (k) 46	0.
Thermal Conductivity (k) 47	0.
Thermal Conductivity (k) 48	0.
Thermal Conductivity (k) 49	0.
Thermal Conductivity (k) 50	0.
Thermal Conductivity (k) 51	0.
Thermal Conductivity (k) 52	0.
Thermal Conductivity (k) 53	0.
Thermal Conductivity (k) 54	0.
Thermal Conductivity (k) 55	0.
Thermal Conductivity (k) 56	0.
Thermal Conductivity (k) 57	0.
Thermal Conductivity (k) 58	0.
Thermal Conductivity (k) 59	0.
Thermal Conductivity (k) 60	0.
Thermal Conductivity (k) 61	0.
Thermal Conductivity (k) 62	0.
Thermal Conductivity (k) 63	0.
Thermal Conductivity (k) 64	0.
Thermal Conductivity (k) 65	0.
Thermal Conductivity (k) 66	0.
Thermal Conductivity (k) 67	0.
Thermal Conductivity (k) 68	0.
Thermal Conductivity (k) 69	0.
Thermal Conductivity (k) 70	0.
Thermal Conductivity (k) 71	0.
Thermal Conductivity (k) 72	0.
Thermal Conductivity (k) 73	0.
Thermal Conductivity (k) 74	0.
Thermal Conductivity (k) 75	0.
Thermal Conductivity (k) 76	0.
Thermal Conductivity (k) 77	0.
Thermal Conductivity (k) 78	0.
Thermal Conductivity (k) 79	0.
Thermal Conductivity (k) 80	0.
Thermal Conductivity (k) 81	0.
Thermal Conductivity (k) 82	0.
Thermal Conductivity (k) 83	0.
Thermal Conductivity (k) 84	0.
Thermal Conductivity (k) 85	0.
Thermal Conductivity (k) 86	0.
Thermal Conductivity (k) 87	0.
Thermal Conductivity (k) 88	0.
Thermal Conductivity (k) 89	0.
Thermal Conductivity (k) 90	0.
Thermal Conductivity (k) 91	0.
Thermal Conductivity (k) 92	0.
Thermal Conductivity (k) 93	0.
Thermal Conductivity (k) 94	0.
Thermal Conductivity (k) 95	0.
Thermal Conductivity (k) 96	0.
Thermal Conductivity (k) 97	0.
Thermal Conductivity (k) 98	0.
Thermal Conductivity (k) 99	0.
Thermal Conductivity (k) 100	0.

To increase the stiffness of the Spar webs, foam material is inserted into the middle. Foam was modelled as an isotropic material, with properties that represent the weakest values from an orthotropic material model of the foam. Foam inserts for both the front and aft spar have thicknesses of 2 mm. Foam properties are given below:

Define Material - ISOTROPIC

ID: 2 Title: Mycell M80 (Airex) Color: 55 Layer: 1 Material Type...

General Function References Nonlinear Ply/Bond Failure Creep Electrical/Optical Phase

Stiffness

Youngs Modulus, E	53.
Shear Modulus, G	25.
Poisson's Ratio, nu	0.1

Thermal

Expansion Coeff, a	0.
Conductivity, k	0.
Specific Heat, Cp	0.
Heat Generation Factor	0.

Limit Stress

Tension	1.63
Compression	1.03
Shear	0.92

Mass Density: 8.E-11

Damping, 2C/Co: 0.

Reference Temp: 0.

xy Load... Save... Copy... OK Cancel