Design & Analysis of Composite Structures I
AE4ASM109 – Part A

Assignment
Deadline 08-04-2024 23:59

Introduction

For the analysis of the assignment use the following UD material properties:

Property	Mean	Std	unit
E1	145.3	3.28	GPa
E2	8.5	1.28	GPa
v12	0.31	0.018	-
G12	4.58	0.83	GPa
Xt	1932	128.3	MPa
Yt	108	8.2	MPa
S	132.8	6.21	MPa

1. Calculation of the ABD matrix and stress analysis (25% of the grade)

1a. (10% of the grade)

Calculate the engineering constants (in-plane and flexural) of the following laminate $[15/\pm\Theta/75_2]_{ns}$ as a function of angle θ. Present your results in plots. How does n affect the results?

Make sure you select the appropriate number of Θ and n in order to draw your conclusions.

1b. (15% of the grade)

A composite laminate $[0_2/90/30/90]_T$ is subjected to the following in-plane and flexural loadings:

1. $N_x=0.2\times10^2$ [N/m], $N_y=1.8\times10^4$ [N/m] and $M_x=18\times10^3$[N]

Calculate the stresses and strains for each ply through the thickness and plot the results for the principal coordinate system.

2. Progressive damage analysis (55% of the grade)

2a. (40% of the grade)

For the quasi-isotropic laminate $[0/90/\pm45]_{2s}$ plot the biaxial stress failure envelopes for

i. axial loading Ny-Ns utilizing Puck and Max. Stress failure criteria.

You should indicate the FPF and LPF in each plot and for each loading ratio.

Report the global failure strains as well (for each loading step where failure occurs).

2b. (15% of the grade)

Which regions of the failure envelopes have the smallest and largest damage tolerance, respectively? Which criterion provides more conservative results? Why? Motivate your answer by comparing the mathematical formulations of the criteria.

3. Reliability analysis (20% of the grade)

The $[0/90/\pm45]_{2s}$, is loaded with a resultant force N, at 30^0 angle respectively to X-axis. Calculate the probability of First Ply Failure failure for N=850N/mm and N=1200N/mm utilizing the Monte Carlo Simulation. Your limit state should be based on Puck criterion. Select one of the two approaches presented during the class utilizing the theorem of large numbers to study the convergence of your calculations. Motivate your selection. The Elastic and strength properties should be considered random variables and independent.

NOTE I:

For 1 and 2 parts use mean values.

For the analysis of the LPF, you should use the following sudden degradation rule:
You zero all the elastic properties of the failed lamina if Tension or Compression FF is observed, otherwise you should use 0.10 degradation factor for the transverse elastic properties. If the same lamina fails for 2nd time (no matter the failure mode), zero all the properties.

Furthermore, use the following values of the compression strengths
Xc=1480 MPa
Yc=220 MPa

In case you miss values, use values presented in the slides or literature. Indicate your source in your report.

NOTE II:

You can team up with your colleagues (up to 3 persons) and deliver one report. You will receive separate grades. At the end of the report a section with your contribution should be explicitly provided.

*You should deliver your report and code via email to d.zarouchas@tudelft.nl no later than **08-04-2023 23:59am**. The report should include your names, email addresses, and student numbers. The one who submits the report and code **SHOULD** copy-paste the other team-members.*