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Materiais Compósitos Laminados

Computational project – School year 2023/2024

Consider the composite laminated plate used in the experimental project. Assume that each lamina of the laminated plate is reinforced by long fibers, with the same material and volume fraction as in the experimental project, and that the material of the lamina can be modeled with the "cubic" RVE, whose cross section is shown in the figure 1. Consider that the dimensions of the RVE are, respectively, (a,b,c) whose values can be found in the table below.

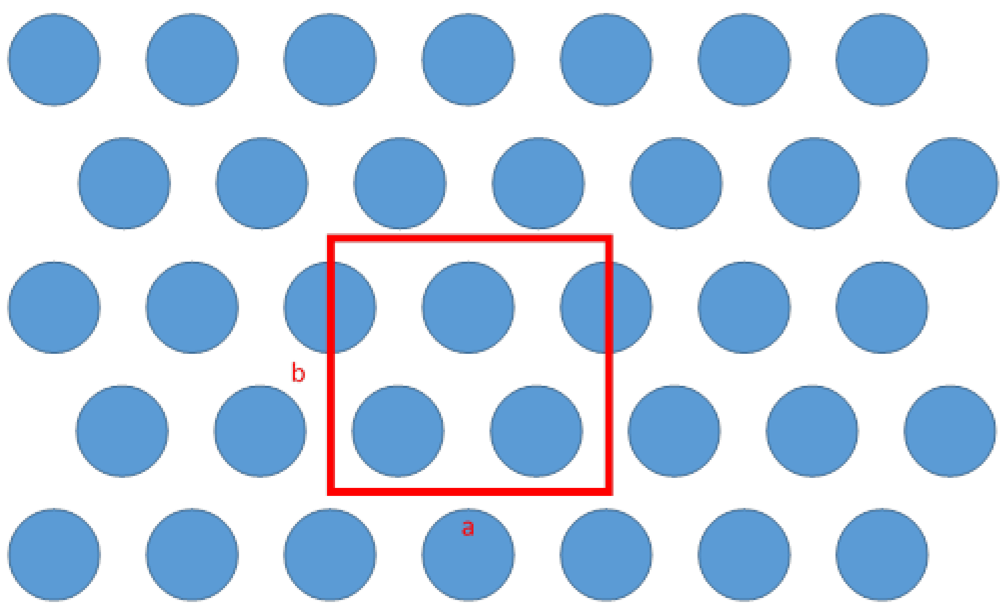

Fig1 – RVE definition

a	b	c
1	1	1.5

I - Characterization of the lamina equivalent properties:

1. (3v) Consider the RVE defined in figure 1 with dimensions listed it the previous table. Using a Finite Element program, define an appropriate finite element mesh, and compute the equivalent material properties assuming that the RVE is subjected to stress boundary conditions, using:
    a. the relation between average stress and average strain method.

    b. the stored elastic energy of deformation method.
2. (3v) Redo 1) but compute the properties assuming that deformation boundary conditions are applied to the RVE.
3. (1v) For the same material compute the equivalent properties using PREMAT software, for a periodic RVE with one fiber in a square array (a_1/b_1 =1) with the same volume fraction as your specimen. Define a suitable mesh for the computation.
4. (3v) Compare and comment the results obtained for the different sets of equivalent properties. Choose two sets that you consider may be representative of the lamina properties and justify your choice.

II - Modeling of the laminate:

1. (1v) Assuming that the laminate can one-dimensional (beam like) obtain the analytical solution for the traction and bending test for both sets of properties, assuming classical laminate plate theory.
2. (1v) Redo 1 assuming first order laminate plate theory.
3. (4v) Using a finite element program, create an appropriate finite element model using shell elements and reproduce the experimental tests for each set of lamina properties. Compare the numerical results with the experimental and analytical results, with respect to deformation, strain and stress distributions. Estimate the maximum load you can apply using the same failure criteria as in the first project and comment and discuss the results.
4. (2v) For the same laminate, for free boundary conditions, do a natural frequency analysis (first 10 non null frequencies) using FEM for each set of equivalent properties. Compare and discuss the results. Whenever possible, compare with analytical solutions and experimental results. Based on the experimental results, estimate the Young modulus in bending for the laminate and compare with the Young modulus obtained by the bending test (experimental and analytical).
5. (2v) For the bending loading case, using the Rayleigh-Ritz method, find an approximate solution for the CLPT considering and approximation of the transverse displacement w in the polynomial form up to 3rd degree. Comment and discuss the results. Whenever possible compare with experimental and analytical results.

Submit a report (2 students per group) with a maximum of 12 pages (font type Calibri 11 or bigger, line spacing 1.5), where you show the formulations of the problems to solve, figures and/or tables of all issues that you think are relevant to address. Comment all results, and present some conclusions and a reference list. The first 2 pages of the report must be these 2 pages.