AE 760AA: Micromechanics and multiscale modeling

Lecture 11 - Project Description

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schedule

- Feb 27 - Project Description
- Mar 4 - SwiftComp
- Mar 6 - Work Day
- Spring Break

outline

- final project
- swiftcomp

final project

final project

- Choose some multi-scale problem that we can use techniques from this class in
- This could be related to research you are doing (modeling composite properties in a 3D-print)
- You can also choose (or modify slightly) cases 3-6 from the Micromechanics challenge
- Remember this project is in place of the final exam, you should demonstrate what you have learned in this course

final project

- There are three main parts to the analysis you will do on the final project
  1. A simplified model which can be solved using an analytical method (Eshelby)
  2. A parametric finite element model (validate to Eshelby, then scale to correct volume fraction)
  3. Some micromechanics software analysis (SwiftComp, CRAFT, MAC/GMC, etc.)

project report

- In your report you should assume that the reader is already familiar with Finite Elements and the Eshelby method
- The reader may not, however, be familiar with the micromechanics tool you are using
- You should describe the method that your chosen software is using (i.e. Variational Asymptotic Method for SwiftComp, Fourier Transforms for CRAFT, Method of Cells for MAC/GMC. etc.)
- Make some conclusions about the software you are using
  - Have you demonstrated that the results from this method are correct?
  - What advantages does it have over analytic methods and finite elements?
  - Are there cases where you would expect your software to have difficulty?

project rubric Projects will be graded on the following rubric

- Analytic Model - 25%
- Finite Element Analysis - 25%
- Micromechanics Software - 25%
- Conclusion - 15%
- General Presentation - 10%

project abstract

- Homework 5 will be your project abstract
- Due 3/18 (after Spring Break)
- Describe what problem you want to solve and what you will use to solve it
- List a few challenges you expect to face, how they could be overcome

analytical method

- I think homework 6 or 7 will be over the analytical model for your problem
- Due date will be provided later
- This is just to make sure things are on track for your final project

swiftcomp

swiftcomp

- SwiftComp is a software built on the Variational Asymptotic Method, applied in particular to composites
- You are not required to use SwiftComp in your project (we will also discuss Fourier and Method of Cells methods), but it may be the easiest
- SwiftComp itself is a command-line tool, but Dr. Yu has merged it with a couple other software tools to give some form of GUI
- gmsh4sc - modifies gmesh to work build mesh for SwiftComp, runs SwiftComp from the gmesh gui
- texgen4sc - uses a textile software (for composite weaves) and runs swiftcomp from the texgen gui
- plugins for Ansys and ABAQUS - if you use either of these software programs, you can run Swiftcomp from them as a plugin

swiftcomp

- SwiftComp can either be run in the cloud or downloaded to run locally
- Right now Dr. Yu only has the linux executables for download, I contacted him to get the Windows files
- We will run through a few demos, but before we get lost in some of the software details, it is important to remember the big picture

micromechanics

- In micromechanics, we are trying to represent a periodic structure with some effective property
- For example, if we have a beam with a very complex cross-section, we can calculate the inertia of that cross-section and then model the beam as a straight line
- We may, however, need to know the local stresses at certain points in the beam, the ability to recover local stresses is what SwiftComp calls "dehomogenization"

workflow

- Thus the general workflow in Swiftcomp is
  1. Run SwiftComp to homogenize some unit cell (beam cross-section, fiber weave, etc.)
  2. Run FEA to get displacements/stresses using homogenized stiffness
  3. Run SwiftComp with FEA displacement/stress data to find the local stresses

links

- Until I can get all the files available, you should be able to run SwiftComp in the cloud
- For **gmesh** (arbitrary shapes)
- For **texgen** (woven composites)