UNIVERSIDADE FEDERAL DO CEARÁ

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Nonlinear Multi-scale Finite Element Modeling of the Progressive Collapse of Reinforced Concrete Structures

Homework Assignment

This document presents the homework assignment related to the mini-course entitled '*Nonlinear multi-scale finite element* modeling *of the progressive collapse of reinforced concrete structures*', given at PROPEC of the UFOP between 5th and 9th of May 2014.
You will be evaluated on this project-based homework, to be sent via email to pberke@metalmat.ufc.br in a PDF format by the **1st August 2014**. This assignment is to be done in **group work**; one group is composed of three students.
You are free to write your document in English or in Portuguese language. Scanned hand-written notes are also accepted in order to save your time used for typesetting an electronic document. Your email should **include the MatLab input file** of the study you performed. The total volume limit of the report is set to **15 pages** (Times New Roman 12, 1,5 lines spacing if written in electronic format), excluding possible Appendices.

Objective

The objective of this assignment is to put you in a life-like practical situation in which you have to analyse the structural behaviour of a plane frame subject to extreme loading, using the computational tool which was presented to you during the computer labwork.
This task will require, among others, setting up a numerical model, successfully running the computation, but most importantly, interpreting the obtained numerical results with a critical mind.
As in a real-life scenario, you are asked to present the relevant results of your study in a written report with a volume constraint.
The evaluation considers with the largest weights the *quality and depth of the structural analysis* you performed, the *clarity of your argumentation* and *justification of modeling choices*, the presence of *critical mind with respect to the obtained results*.
Technical help for setting up and running the numerical model for the structure you chose will be available until the deadline of the submission of your report. I answer questions you ask via email and you are free to contact me via skype during regular work hours (user name: pezopedro_melo).

Choice of the planar frame

The choice of the *planar frame* to analyse is your task. Keep in mind that a structure with higher complexity (e.g. more elements) may yield more interesting results, however its in-depth analysis is more time and energy consuming. Conversely, you may be able to make more straightforward

deductions on the structural behaviour vs. sectional behaviour for simpler structures, but the overall result may be less "exciting".
In a similar manner, using a composite material (reinforced concrete) will lead to more complex structural response than when using a homogeneous material (steel only) in the section.
Please choose an existing structure/not yet constructed structure with a realistic design of practical interest, or one that is presented in the scientific literature (with the necessary citation of the sources).
You should consider applying an *extreme loading* – of your choice – that leads to the damage of the chosen structure. You are asked to analyse its response in this particular scenario.

Contents of the report
Your report is expected to allow retracing the complete nonlinear modeling procedure including

1. Choice of the structure,
2. Modeling choices and assumptions/simplifications,
3. Setup of the numerical model (geometry, loads and boundary conditions, material parameters, physical time, displacement or force driven computation, ...),
4. Analysis of the computed structural/sectional response (illustrated by relevant figures, curves),
5. Bibliography and Appendices, if necessary

Please take care to systematically *justify your choices and the assumptions you make*. Explain the computational results with a *critical mind* (do numerical predictions correspond to what you expected? if yes, why? if no, why?).
Note that the *multi-scale nature* of the simulation allows you to have a more in-depth understanding of the structural response, when making the link with the state of the section. You are *expected to benefit from this advantage* in your analysis.

Group composition
Since the above work requires using MatLab, it is advised to have at least one student in each group familiar with this programming language. Note that (i) technical help is available for setting up and running the input file and that (ii) your analysis as an engineer is of the highest importance in the evaluation. Therefore, only minor advantages can be taken from a deeper knowledge of the programming language, corresponding to the quicker set up of the input file.
Keep a homogeneous work distribution in mind when forming your group.