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Review of Bachelor’s Thesis

FE simulations for assessment of material response to quasi-static loading

by Bohumil Hora

The bachelor thesis is focused on the prediction of materials mechanical response under uni-axial quasi-static loading by means of numerical modelling. Key parameters of Finite Element (FE) analysis are studied in detail. Conclusions of these parametric studies are successfully applied to predict the stress-strain curve of auxetic structures which is compared with experimental data. With recent development in manufacturing methods, the study of Auxetic structures has become an important topic due to their unique characteristics arising from the macroscopic negative Poisson´s ratio. During compression of auxetic structures complex physical phenomena have to be taken into account which makes FE analysis a very challenging task.

The numerical simulations required in this bachelor’s thesis assignment are performed in commercially available FE tools (Ansys and LS-DYNA). Due to the relatively high number of parameters studied, the author has developed scripts in Matlab to automate the analysis process in both FE programs. Such automation is above the initial scope of the thesis and gives the author valuable skills for further development. In general, the thesis to a sufficient extent covers all assigned tasks. The outcomes of the parametric studies performed in both programs are presented and general conclusions are drawn. The calculated stress-strain curves from numerical analysis are compared against measured data, nevertheless the reference for the measured data is missing in the thesis. The thesis is also missing a comprehensive description of the measured curve with an explanation of the physical principles driving the curve shape that is crucial for understanding the deformation process and thus also for its modelling. The deformation processes are occasionally mentioned in the results comparison, nevertheless this part described in the chapter 6.2 as a main outcome of the thesis would deserve deeper discussion.

The thesis displays a methodical and logical flow, with clear chapters sectioning. The use of language is generally professional and understandable. The theoretical part covers all important topics and provides sufficient background to the performed analysis. Furthermore, the literature chosen, and review corresponds to the necessary citation practices and standards. The graphical design of the thesis is in general good with two minor notes. First, it’s good practise to show legend for contour plots (figs. 4.33 and 5.23). Second, there is room for improvement of the block diagrams showing the simulation process, especially it’s alignment.

Questions to the author:

1) In the explicit calculations the linearly increasing deformation speed is introduced with peak strain-rate at the end of simulation (fig. 5.3). In simulation set 1 (chapter 5.2.4) the cube is deformed up to a strain of 2.5%. In simulation set 2 (chapter 5.2.5)

the cube is deformed up to a strain of 50%. What strain rates are achieved at the end of these simulation sets?

2) Referring to the same simulation sets as in the first question; for simulation set 1 it’s concluded that the internal energy of the model is significantly lower compared to the kinetic energy. Is this true for simulation set 2 as well?
3) In the figure 5.9 there is a significant discrepancy in the prescribed solution. What might cause such a discrepancy?

In summary, the author proved good orientation in numerical modelling methods and their application to this defined experimental case. Despite the comments I stated above, the thesis exceeds expectations from a bachelor’s student. Therefore I propose a grade “A“ (excellent).

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