Posudek práce

předložené na Matematicko-fyzikální fakultě
Univerzity Karlovy

✔ posudek vedoucího ❑ posudek oponenta
❑ bakalářské práce ✔ diplomové práce

Autor/ka: David Cichra
Název práce: Implicit constitutive relations in lowerdimensional models in continuummechanics
Studijní program a obor: Matematika – Matematické modelování ve fyzice a technice
Rok odevzdání: 2020

Jméno a tituly vedoucího/~~oponenta~~: Mgr. Vít Průša, PhD.
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Odborná úroveň práce:
❑ vynikající ✔ velmi dobrá ❑ průměrná ❑ podprůměrná ❑ nevyhovující

Věcné chyby:
✔ téměř žádné ❑ vzhledem k rozsahu přiměřený počet ❑ méně podstatné četné ❑ závažné

Výsledky:
❑ originální ✔ původní i převzaté ❑ netriviální kompilace ❑ citované z literatury ❑ opsané

Rozsah práce:
❑ veliký ✔ standardní ❑ dostatečný ❑ nedostatečný

Grafická, jazyková a formální úroveň:
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Tiskové chyby:
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Slovní vyjádření, komentáře a připomínky vedoucího/oponenta:

Viz přiložený dokument.

Případné otázky při obhajobě a náměty do diskuze:

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Práci
✔ doporučuji
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❑ výborně ✔ velmi dobře ❑ dobře ❑ neprospěl/a

Místo, datum a podpis vedoucího/oponenta:

Praha, 29. ledna 2020

Vít Průša

MASTER THESIS REVIEW

IMPLICIT CONSTITUTIVE RELATIONS IN LOWER DIMENSIONAL MODELS IN CONTINUUM MECHANICS

BY DAVID CICHRA

1. Overview

The author studies the so-called implicit constitutive relations, which provide a novel approach to the purely phenomenological description of the response of continuous bodies. In particular, the author focuses on the application of implicit constitutive relations in description of finite deformation of elastic and inelastic solids.

In the first chapter the author derives a representation formula for isotropic solids described by an implicit relation between the Cauchy stress tensor and the Hencky strain tensor, this part closely follows recent paper by Průša et al. (2020). (I wanted David to participate in the writing of the paper Průša et al. (2020), but his contribution to this paper was at the end minimal, hence he is not listed as a co-author.) The derived representation formula is complementary to the formula derived by Gokulnath et al. (2017), and it provides one a representation formula that clearly separates the volume-changing and volume-preserving deformations and the corresponding parts of the stress tensor.

The next two chapters are focused on the modelling of plastic response of solids. (A general inelastic response is covered as well.) In particular the author investigates two settings wherein one can effectively use one-dimensional constitutive relations. This part of the thesis follows a new approach to the modelling of inelastic response introduced by Rajagopal and Srinivasa (2015, 2016). The author analyses the phenomenology behind the models, and he develops proof-of-concept codes for numerical solution of the corresponding governing equations. (The code is written in `Mathematica`.) The first set of numerical simulations concerns one-dimensional response as in Rajagopal and Srinivasa (2015) (inelastic spring, ordinary differential equation), while the second set of numerical simulations deals with a one-dimensional continuum as in Wang et al. (2018) (one-dimensional beam, partial differential equations). These two chapters represent main individual and independent contribution of the author.

The last chapter is devoted to the generalisation of the concepts introduced by Rajagopal and Srinivasa (2015, 2016) to the full thermodynamical setting. The author shows that the models can be developed in such a way that they are consistent with the first and second law of thermodynamics, and he derives complete system of evolution equations for the mechanical quantities and the temperature. (All deformations are considered to be finite, no simplifications are made.) The last chapter has been recently submitted as a research article to a journal focused on the mechanics of solids, see Cichra and Průša (2019).

2. Decision

The scientific content of the thesis is very good, and I presume that it will lead to a journal publication. On the other hand, the performance of the student at the time of writing the thesis was below average. The research was in fact conducted in the last four months, and it required sustained support from the supervisor. The student had only occasionally taken the initiative or suggested an alternative method or approach. (I am convinced that David can do better than that, his performance during writing the thesis has been influenced by other factors.) For these reasons the thesis can hardly aspire for better than average grade. I propose that the student can defend the thesis.

Praha, 29th January 2020

Vít Průša

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