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OPPONENT EXPERTISE
For Associate Professor Appointment Procedure

Applicant name: **Ing. Izabela Major, PhD.**

Work place of applicant: Czestochowa University of Technology, Faculty of Civil Engineering, Department of Applied Mechanics

Field of appointment: 5.1.7 Applied Mechanics

Analysis of selected wave phenomena in continuous compressible and incompressible hyperelastic structures

Opponent review is processed on the basis of the request of the Dean of the Faculty of Civil Engineering, University of Žilina, prof. Ing. Josef Vičan, PhD., No. KOR/12781/2012, from date 26.5.2014.

Introduction

Although development of analytical methods in mechanics experienced a large progress through the years, these methods are applicable only for some basic problems. In the last decades, with the development of computers, numerical methods gained popularity for the solution of problems in the field of continuum mechanics.
The finite element method (FEM), boundary element method (BEM) and mesh-less methods like the Meshless Local Petrov-Galerkin (MLPG) are only few numerical tools which are used to simulate wave propagation problems. Since the FEM is frequently more robust and effective in the solution of problems compared to other methods, it has been widely used for the numerical analysis of solids, fluids, including heat transfer, and multi-physics problems.
The submitted habilitation thesis (HT) covers the branch of Applied Mechanics. The numerical simulation of wave propagation is a very interesting problem from the point of view of experimental and computational mechanics. The main topics of the HT are focused on the analysis and approximate solution of travelling wave propagation problems with constant profile and on the acceleration wave problems in the incompressible materials.

Scientific erudition and publishing activities of the applicant

Ing. Izabela Major obtained the "PhD" title in 2005 at the Politechnika Czestochowa in the field of Mechanics. Since 1999 she has been working continuously at the Czestochowa University of Technology. Her scientific activities are mainly focused on computational and experimental methods in Applied Mechanics. Main scientific and research activities of the candidate are mainly in the area of wave propagation in compressible and incompressible hyperelastic solids and structures.

The main scientific contributions of this work can be summarized as:

1. The derivation and implementation of relations for calculation of the acceleration wave intensity. This can be useful for practical applications in industry.
2. Dispersion modelling of stress waves propagated in hyperelastic structures is a very interesting scientific problem. The phenomenon of material and geometric dispersion are so far very little studied. The results of analysis for the Zahorski material obtained in Chapter 7 may be very valuable for the study of dispersion properties of hyperelastic bodies. The obtained results will contribute to understand the behaviour of composite structures, too.

The aims of this work are carefully described. Content level of the HT corresponds to the requirements with regards to the needed habilitation level. From the contents of HT we can see that the candidate has good review from presented topics. She has used a wide range of foreign literature, however she cites older papers from journals and proceedings.
Publishing activities of Mrs. Izabela Major are very wide. In the publishing list papers in journals, contributions to scientific conferences, and also the authorship of one higher education textbook and two scripts are listed. The list of publications shows that the applicant has good experiences in the field of simulation modelling and expertize for industry, too.

Teaching activities

The attached curriculum vitae shows that the candidate had devoted all her previous professional life to pedagogical work. From this biography we can see the evident teaching activities of Mrs. Izabela Major during her work at the Czestochowa University of Technology. We can see from list of publications that. In the course of her professional work she led a total of 74 diploma and bachelor theses, which also shows the great interest in pedagogical work.

Comments and questions to HT:

- Technically the HT is well written, with a few typos. Arrangement of this work is good. In the theoretical part the applicant uses own pictures for better understanding.
- The used terminology is quite correct in this work, but the author used the incorrect terms, like circular coordinates, flat elements instead plane elements, spatial elements instead solid elements, etc.
- Large deformations are more difficult to mathematically model than either small deformations or fluid motions. For hyperelastic materials the finite deformation theory is valid. For solid motions we usually use Lagrangian description of motion. Thus a hyperelastic material is automatically a Cauchy elastic material, but this is not the case in reversed form. Using the Cauchy stress we define the first and second Piola–Kirchhoff stress tensors (2.PKST). On p. 22 is used the first or second PKST?
- The main difference between structural dynamics and wave propagation in structures arises due to high frequency excitations. Numerically solved problem comes under the category of wave propagation, when the duration time of displacements is large (of the order of tenths of seconds)?
- It is well-known, that standard FEM is not very attractive for solution of wave propagation problems. There for, for problems with short waves, very fine meshes are required to obtain reasonable solutions. But, in practice, when the used mesh is not very fine, the assessment of the numerical error between the "exact" solution and the finite element solution can be important. Could be the error estimation for the developed elements important?

- The implicit or explicit time integration methods can be effective in wave propagation problems. What method was used in the presented FEM simulations in the software ADINA?
- Almost all numerical examples in the HT were solved by using plane elements, only the numerical example in Chapter 8 was solved by using 3D solid elements. Why?
- It is well known that in FEM analysis large differences in magnitudes of the strain and stress can arise. It would be interesting shows the time course of the strain and the stress components.

The final evaluation:

On the basis of the guidelines referred to the nomination letter from the Dean of the Faculty of Civil Engineering , University of Žilina in Žilina to associate professor appointment procedure, Ing. Izabel Major, PhD. in the field Applied Mechanics, I can state: HT contains new scientific contributions in its area of research and its contribution to the habilitation is sufficient. The applicant complies with and in some points exceeds the conditions and Criteria for associate professor appointment procedure at the Faculty of Civil Engineering, University of Žilina in Žilina in all points and monitored areas. The Applicant's pedagogical activities have demonstrated great conditions for further development of the pedagogical work of the corresponding level of the associate professor.
The presented methods in HT can be interesting for future scientific research. The obtained results contribute to the development in the field of study of Applied Mechanics, which gives preconditions for the further development candidate in the scientific and research work. The submitted HT fulfils the scientific requirements of a dissertation according to the regulation of Ministry of Education of Slovak Republic about the appointment habilitation of associate professors and professors No. 6/2005 from 8th December 2004.
Given above, I consider that the action of the applicant in all monitored areas meets the requirements for the appointment of a professor in the field of Applied Mechanics, therefore,

I recommend

the habilitation commission to submit to Scientific Council of the Faculty of Civil Engineering, University of Žilina in Žilina a proposal for the appointment of

Ing. Izabela Major, PhD.

associate professor in the field of study 5.1.1 Applied Mechanics,

Žilina, 20th July, 2014

Prof. Ing. Milan Žmindák, CSc.