WYDZIAŁ MECHANICZNY
POLITECHNIKA LUBELSKA
ul. Nadbystrzycka 36, PL-20-618 LUBLIN
Tel. (0 81) 538 4573,fax. (0 81) 538 4205, e-mail: g.litak@pollub.pl

Prof. dr hab. Grzegorz Litak, Lublin, 10 lipca 2016

Reviewer report of PhD dissertation submitted by Mr Piotr Brzeski, entitled „Energy transfer in systems of coupled oscillators" prepared under main supervision of dr hab. inż. Przemysław Perlikowski and subsidiary supervisor dr inż. Anna Jach, Łódź 2016.

The concept of energy transfer is an important issue in science and technology. It is connected to the damping and energy harvesting process. There is a number of approaches to that problem however is a tuned mass damper is the one which is the most popular solution. That treatment originated from the linear systems where by adding additional degrees of freedom, vibrations are transfered out the sensitive frequency region. Consequently it became a standard method for linear systems. However recently, it is also applied in many nonlinear systems including the pendulum based absorbers. The PhD candidate analyzed dynamical responses of nonlinear oscillating systems with such a damper. It should be noted that such a response is nontrivial for larger amplitudes of vibration, because of nonlinearities which bake the superposition principle and can lead to multiple solutions or nonlinear resonance.

The structure of the thesis, the chapters and their discussion:

This dissertation is based on the series of six published papers of the PhD candidate. It is divided into 8 sections: 1. Introduction, 2 The Doctoral Thesis and Main Objective, 3. Thesis Organization, 4. Investigated models, 5. Obtained results, 6. Conclusions, 7 Bibliography (including 69 papers), and 8. Articles. The additional and last section 9 includes Abstract, doctoral thesis and the main aim in Polish.

- In the first section the author included the introduction to the problems of tuned mas damper (TMD) and tuned mas absorber (TMA). There is also a discussion about previous developments in this field.
- In the second section the author provides the thesis "*Proper choice of system parameter's values leads to increase in energy flow between subsystems and increase the chance of energy extracting*". He also provides the main objective of the thesis: *The main aim of the thesis is the description of the energy transfer phenomena in systems of coupled oscillators and identification of parameter's values which leads to increase in energy flow. Analysis of the coexistence of stable solutions for the systems with adjusted parameters values and finally, investigation of the possibility to control the system to reach given solution.*
- In the third section is a short information about the dissertation structure.
- The section 4 is related to the discussion of dynamical models and equations behind them.
- The section 5 and 6 are direct continuations of Sec. 4 where the author presented the main results obtained for the earlier specified dissertation thesis and the main aim and the conclusions, respectively.
- In the section 7 the references to the previous sections are listed.

- In the section 8 the author provides the research articles. Most of them are published in good scientific journals such as: Journal of Theoretical and Applied Mechanics, Communications in Nonlinear Science and Numerical Simulation, International Journal of Nonlinear Mechanics, Journal of Sound and Vibration, International Journal of Structural Stability and Dynamics. The articles are extended versions of the sections 5 and 6 including Synchronization of two forced double-well Duffing oscillators with attached pendulums; Numerical optimization of tuned mass absorbers attached to strongly nonlinear Duffing oscillator; The application of inerter in tuned mass absorber; Novel type of tuned mass damper with inerter which enables changes of inertance; The use of tuned mass absorber to prevent overturning of the rigid block during earthquake; Basin stability approach for quantifying responses of multistable systems with parameters mismatch.

Minor critical remarks and questions to the doctoral student:

Most of the described material in the dissertation -models, results and conclusions were published in good journals. There are small number of misprints and awkward phrases including

- The author is using the L2 norm for FRC analysis. I should be better explained why the interval of \omega integration was taken as (0.65, 1.35) page 301 in the paper no. 2.
- Notation T and T(\dot(\phi)) is confusing in the paper no. 3 (see pages 21,22). “General forces Q” - does it mean generalized force. Equation 10 should be simplified.
- Can the candidate tell more (algorithm, assumptions, equations) about the simulations of the system with noise studied in the paper 4?
- It would be interesting to look more closely into the model in paper 5. For instance that is the Fourier spectrum of the studied earthquake excitation and what is the FCR for harmonic excitation with a particular frequency.
- Paper 6 shows an interesting two-parameter bifurcation diagram (Fig. 4). What was the choice of initial conditions for this plot?

Main achievements:

The candidate main achievement is to show that simple modifications to conventional devices allow to increase the efficiency of suppression and to avoid the coexistence solutions.

Summary

The analysis presented in the dissertation and in the series of attached research papers demonstrates that proper selection of the parameters of TMD and TMA increases energy transfer from the main structure to the vibration absorbers. The simplest TMD and TMA with appropriately optimized parameters offers good damping properties for the various excitations. A novel type of tuned mass damper inerter and CVT, which offer offers the best damping properties. The ability to easily retuning and allows the intro-

WYDZIAŁ MECHANICZNY
POLITECHNIKA LUBELSKA
ul. Nadbystrzycka 36, PL-20-618 LUBLIN
Tel. (0 81) 538 4573,fax. (0 81) 538 4205, e-mail: g.litak@pollub.pl

duction of a simple control system, which can increase its advantages. Another advantage of the proposed solution is that it minimizes TMD mass inertia due to its composition is generally based on moving mass inertance. The results indicate that the correct tuning of the parameters of the device can successfully minimize the risk of an undesirable behavior. Therefore the candidate has proven the assumed thesis and reached the main aim of the dissertation.

It should be also noticed that Mr. Brzeski has published more papers than these listed in he dissertation. In the Web-of-Sience (9.06.2016) one can find 10 papers and his citation h index is 5. He was able to collaborate with researchers from leading Universities and Scientific Institutions. While working on his PhD degree Mr. Brzeski demonstrated ingenuity and perseverance. The dissertation was prepared and printed carefully.

In conclusions, the work presented meets the requirements of doctoral dissertations. I put the request for admission MSc. Piotr Brzeski to the public defense.

Taking into account his experience and publishing activity, I recommend this thesis for an award for best PhD thesis.