University of Transilvania Braşov

HABILITATION THESIS

Summary

Virtual modeling and simulations on metal and composite structures in the field of mechanical engineering

Domain: Mechanical Engineering

Author: Assoc. Prof. Dr. ITU Călin
University Transilvania Braşov

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SUMMARY

The habilitation thesis entitled "Virtual modeling and simulations on metal and composite structures in the field of mechanical engineering" contains a synthesis of scientific, professional and academic achievements from obtaining the PhD title in July 2014 in the field of Engineering Sciences, Mechanical Engineering profile.

The presentation of the research carried out during this period, from 2014 to the present, reflects the experience gained on the basis of research and development projects and through the teaching activity carried out for almost 20 years in the Faculty of Mechanical Engineering.

The habilitation thesis is structured on two modules:

Module 1: **Scientific and professional achievements carried out in three main directions**

I. Vibration research on high inertia structures,

II. Research in the field of mechanical systems,

III. Research in the field of sandwich composites

Module 2: **Career evolution and development plans**

1. The general development framework of the university career

2. The premises for the development of the university career

The first research direction presented in the first chapter is focused on the dynamic analysis of the vibrations of structures with very high inertia, especially in the field of civil engineering. This chapter focuses mainly on the study of the free responses of structures taking into account the factors of modal participation, the effective modal mass, the shape of their own modes and their own frequencies. The forced response of a structure under the action of excitations based on displacement type is also studied, and the degree of appreciation of the structural behavior is highlighted by the known transmissibility as a ratio between an output quantity and an input quantity. It is generally desirable for this parameter to be under unit value, which would mean a good degree of damping of the structure, but in many cases this ratio is higher than unitary value, especially near resonance areas. Numerical studies are presented in tabular form, and for a more explicit interpretation of the results for the analyzed systems, the plots with the mode shapes obtained are presented, based on which the vulnerable areas in terms of rigidity can be identified very well. In general, the requirements on such high inertia structures require as much rigidity as possible in order to minimize the deformation energy at the base as much as possible.

The second research direction in the second chapter debates the dynamic phenomena that occur in mechanical systems with various applications. The studies related to the dynamics of mechanical systems within this chapter were carried out taking into account current calculation methods: multibody systems method, finite element method, respectively methods for calculating and simulating the vibrations of mechanical systems. Based on the method of multibody systems, a comparative theoretical research was performed between a classical variant of a motor mechanism and a revolutionary one that uses an oscillating arm having as evaluation parameters, the kinematic quantities of bodies (position, speed, acceleration), and as dynamic quantities the forces in joints with involvement on energy parameters (power and motor torque). Another dynamic study was performed on an NVH inertial damper used in the propulsion systems of EV electric motors taking into account vibrations. For an assessment of the degree of performance from a dynamic point of view, various areas of damage were applied to this shock absorber at different elevations and depths, based on which the degree of dynamic rigidity from the modal analyses was assessed. Also, an analysis of forced vibrations on the ideal shock absorber was performed taking into account several damping coefficients. Other dynamic studies were performed on a metallic structure taking into account the symmetry. This method of treating simplify models can offer significant advantages, especially on very large and laborious models that have at least a symmetry in relation to a plan, especially in terms of the times to obtain analysis solutions. Such a dynamic analysis of eigenmodes is recommended to be used especially in cases where for a structure we aim to improve certain rigidities that have a symmetrical character by increasing the eigenfrequencies characteristic of them. A final approach in this chapter refers to the demands that appear in a towing hook for use on cars. Theoretical and experimental studies are presented for different scenarios, finally centralizing the obtained results.

Within the third research direction are presented approaches in the field of layered composite materials, based on knowledge from doctoral studies. The methodology for obtaining elastic constants for composite materials is presented as an introductory part, and then to continue with the presentation of a solution to improve the plate solution proposed and analyzed in doctoral studies, taking into account some ribs aimed at increasing structural rigidity and implicitly the possibility of extending its use to a medium to heavy traffic area.

The second module of this habilitation thesis contains a brief presentation on the evolution and development of the author's teaching career, scientific and academic activity, also pointing out several directions for future actions.

An important aspect of this personal development plan is based on the desire for continuous improvement and self-improvement, the implementation of the most important news and information in teaching and research, with a view to prepare and training highly qualified specialists in the technical field.