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REFEREE'S REPORT

on the dissertation thesis titled

Loss of stability of thin-walled conical shells with circumferential ring loaded by axial force

Author of thesis:	**M.Sc. Haluk YILMAZ**
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Programme of study:	**P3710 Technique and Technology in Transport and Communications**
Branch of study:	**3708V024 Technology and Management in Transport and Telecommunications**
Supervisor:	**doc. Ing. Petr TOMEK, Ph.D.**
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Up-to-dateness of the dissertation theme

The thesis is devoted to a detailed investigation of the influence of circumferential ring on the loss of stability of the truncated conical shells loaded by an axial force. The author has compared such shell structures with different shell thicknesses and base angles. The main aim of the author was to propose new method for calculation of load carrying capacity of the conical shells with a base angle less than 25° loaded by axial force and he proposed the method which is applicable for different radial stiffnesses of the circumferential rings. The shell structures are very effective due to their relative lightweight nature and high carrying capacity, but their stability can be serious problem. This is the reason why the topic of the dissertation is highly actual and modern.

The analysis of thesis, the methodology, methods of writing

The structure of dissertation thesis follows a prescribed standard of doctoral dissertations. The dissertation consists of 10 chapters (including references, student publications, and appendices with tables) on 101 pages.
The first chapter introduces reader to the problem which is analyzed in the thesis. It contains basic description of shell structures, methods of solution and aims of author. The description of specific terminology and more details about topic can be found in chapter two.
The third chapter is devoted to review of literature. In this review are described several treatments for solving problems of stability of thin-walled conical shells by experimental, analytical as well as numerical methods. At the end of the chapter are given aims of dissertation.
The chapter four is devoted to the thorough description of problem. It includes analytical study, definition of the model, derivation of rigidity parameter and numerical

study consisting of assessment of influence of mesh quality, boundary conditions and material to the results.
The fifth chapter contains discussion of results – numerical solutions, influence of boundary conditions and base angle, conical shell with circumferential ring, similarity criteria and influence of initial imperfection.
The chapter six represents the load carrying capacity estimations for the conical shells, especially for fixed and simply supported conical shells as well as for conical shells with a circumferential ring.
The chapter seven is devoted to the formulation of final conclusions of work.

The achievements of defined aims and objectives

The main goal was to propose a new method to estimate load carrying capacity of the conical shell structure with a base angle less than 25° for different radial stiffnesses under axial loading. The study also aims to derive two dimensionless similarity parameters. These parameters should allow evaluation of load carrying capacity of the conical shell for numerous configurations of geometrical dimensions in a wide range. The goal of the author was also to investigate the effect of radial stiffness of circumferential ring on the load carrying capacity under axial loading and accordingly, the study includes the following topics:

- determination of the load carrying capacity of the conical shells which have a base angle of less than 25°;
- investigation of the influence of the radial stiffness on the limit load;
- evaluation of the effect of the initial geometrical imperfection on the load carrying capacity;
- derivation of the dimensionless similarity parameters to evaluate limit load in a wide range of the conical shell geometries.

All aims of the dissertation thesis are fulfilled on an excellent level. I do appreciate the careful style of Mr. Yılmaz research effort, which is always very well focused to the point and demonstrates a lot of knowledge. Most importantly, Mr. Yılmaz brings his own views and original treatments to the solution of problems.

A statement on the results of dissertation thesis

In the dissertation are given results from solutions of problems that were not fully covered in literature, especially solution of the load carrying capacity for axially loaded conical shell structures with base angle of the conical shell less than 25°. For such shell structures was proposed new method to estimate the load carrying capacity. Theoretical treatment and numerical results presented in this thesis are from this point of view unique.
In the thesis were used normalized design parameters in order to predict load carrying capacity of the conical shell structures under the axial load with lower base angles (i.e. 10, 15 and 20°). Moreover, normalized design parameters were derived and similarity approach was proposed which estimates load carrying capacity of the shells of different shell geometry configurations at the same base angle.
Further, there was proposed simple expression for calculation of the normalized load of the conical shell structure as a function of the dimensionless geometrical shell parameters and two constant coefficients of "a" and "b" which are selected considering the base parameters of structure. The prediction of the load capacity of the conical shell structures under the axial load for a variety of the shell

configurations can be performed without complex non-linear FEM analysis or numerical solutions.
Implementation of the linear theory in the load carrying capacity calculations results to high deviations due to the presence of the circumferential ring and highly nonlinear shell response of the shell structures for low base angles. The proposed expression for the normalized load minimizes this deviation and they do not cross the acceptable limits.

A statement on the significance for profession or scientific development

The dissertation fulfills gap in the knowledge of determination of the load carrying capacity of conical shells under axial loading. Developed numerical solutions and procedures contribute to broader application of achieved results. Accordingly, the dissertation thesis is significant for theory as well as for practice.

Remarks

Thesis is well organized and easy to read with a nice graphical layout and with only a negligible number of misprints or errors.

Some remarks to the dissertation thesis:

- Page xiv ... (list of symbols) Use [*deg*] no [*de g*].
- Page 17 and 18, position of Fig. 2.1.
- Page 20 Use ... Young's modulus ... no ... Young's Modulus ...
- Page 25 Use ... Poisson's ratio ... no ... Poisson's Ratio ...
- Page 38 Use ... shear forces ... are calculated ... no ... shear forces ... is calculated ...
- Page 45 Use ... 1.5 mm ... no ... 1.5mm ...
- Page 46 Do not use all capitals in title of book in Czech language.
- Page 73 Use ... load can be calculated ... no ... load can calculate ...
- Page 95 ... There are several errors in individual items of Reference list, e.g. [19,20,22,37, etc.].

Question and demand to the author:

1. Fixed support means that there is ideal infinitely high stiffness of this support without radial and axial movement. Are you able to assess how decreasing of this infinite value to the certain real ones can change magnitude of critical load?
2. I would like to ask you to describe into more details experiment you want to accomplish by hydraulic press (page 94).

A statement on the extend and quality of publications related to the dissertation thesis

Mr. Yılmaz published as author or co-author several papers in foreign journals. Especially, I appreciate paper "Empirical equations to estimate non-linear collapse of

medium-length cylindrical shells with circular cutouts“ published in journal Thin-Walled Structures. The extend and quality of publications is good.

Conclusion:

The work represents an extensive theoretical and numerical study combining a serious methodological work with collection of interesting results and their proper interpretation. I think that the author, Mr. Haluk Yılmaz, fully satisfies the requirements of the PhD. degree. I recommend to submit the dissertation thesis for defence and to award him the degree „**philosophiae doctor** (**Ph.D.**)“.

Košice, 11. 1. 2019

prof. Ing. Jozef Bocko, CSc.