Ph.D. Thesis Review

Author: Haluk Yilmaz
Title: Loss of Stability of Thin-walled Conical Shells With Circumferential Ring Loaded by Axial Force.
University: University of Pardubice, Faculty of Transport Engineering

Reviewer: Miroslav Španiel, Czech Technical University in Prague, Faculty of Mechanical Engineering

Thin-walled shell structures are considered as a topic of high importance in many industrial branches. There are available either analytical models describing mechanical response of shells (unfortunately no general closed form analytical solution has been found for general shape and loading) either standards providing designers with procedures for dimensioning and strength analysis of shell structures based on combination of analytical models, experiments and numerical analysis. The thesis are focused on stability loss of particular group of thin-walled shells of conical shape with small base angle. Such shells are out of scope of standards, as some assumptions are not met due to the specific geometry. The main objective of the thesis can be understood as the methodology of assessment of load carrying capacity of shallow conical shells based on dimensionless criteria calibrated using number of finite element calculations.

Meeting the objectives of the dissertation Author formulated the partial objectives of the dissertation as:

- Determination of the load carrying capacity of the conical shells which have a base angle of less than 25°. Author has created and verified geometrically non-linear FE model of investigated structure including mesh sensitivity study.
- Investigation of the influence of the radial stiffness on the limit load. The dimensionless parameter Γ describing the stiffness of the circumferential ring has been taken from literature.
- Evaluation of the effect of the initial geometrical imperfection on the load carrying capacity. Chapter 5.6 deals with geometrical imperfection. Study based on European Convention for Constructional Steelwork (ECCS) recommendation reduction parameter α confirmed, that shallow conical shells are less imperfection sensitive then standard conical shells or cylinders. The author recommends common value $\alpha = 0.7$. Maybe more research should be done to get even less conservative evaluation.
- Derivation of the dimensionless similarity parameters to evaluate limit load in a wide range of the conical shell geometries. I found this part as the most important step of the work. Author applied dimensionless parameters r_e and Γ to express dimensionless normalized limit axial force $F_{Normalized}$.

- Suggestion of a new methodology to estimate load carrying capacity for conical shells with a base angle less than 25°.

I note that the objectives of the dissertation were fulfilled.

Author's insight on the „state of the art". Author is familiar with relevant codes Recommendations for Design of Steel Shell Structures ECCS or European Standard for Design Steel Structures EN 1993-1-6-2007. In the dissertation he has commented on relevant articles dealing with both experimental and analytical research of of thin-walled shells collapse and he has shown a good orientation in basic concepts of mechanics of collapse including namely analytical and numerical approaches.

The theoretical contributions of thesis. The author has formulated a dimensionless criterion for determining the ultimate load for the loss of stability of a shallow conical shell with reinforced bottom edge. author has proven that dimensionless parameters have the ability to describe the ultimate load when identifying the parameters of the criterion equation using FEM calculations of selected cases.

The thesis contribution for practice. Author has kept close connection with standards through all his work. Consequently, his conclusions are not limited to idealized cases, but he also attempted to include the influence of geometrical imperfections or plasticity on the approaches and data contained in the recommendations of those standards. Despite the fact that the work of the applicant is not a routinely applicable procedure for assessing the ultimate load of shallow cone shells, this aspect of the author's approach allows using it in practice with some caution.

Suitability of the methods used. The methodology used in the thesis is considered appropriate. It includes dimensionless approach, non-linear finite element analysis, and, partial imperfection analysis. In my opinion, author should have made an attempt to formulate criterion equation more general, than in form of Eq. 5.2. It requires number of values of parameters a, b and there is still the question of non-monotonic dependencies $a(\Gamma)$, $b(\Gamma)$ in table 5.7.

The formal level of dissertation. The formal level of dissertation is standard. The work has a logical structure, the chapters titles are accurate. The author does not violate citation ethics. The work is written in good English with a minimum of mistakes and misspellings. Charts and pictures are printed at the appropriate size, with the appropriate captions. There are some compromised specifications, e.g. in the figure 4.2, page 37 symbol θ is used to describe the angle $\mathrm{d}\theta$ between the z-axis and the edge of shell element. The same angle is in the picture dimensioned and described as $\frac{\mathrm{d}\theta}{r}$. In nomenclature, θ is declared as „axis" with no dimension.

Conclusion Despite some of the above-mentioned shortcomings, I can say, that the author of the thesis proved his ability to perform research and to achieve scientific results. **I recommend the thesis for presentation with the aim of receiving the Degree of Ph.D.**

6. 2. 2019
Miroslav Španiel

Question

1. Have you tried to formulate more general criterial equationl instead of the form of Eq. 5.2? In your opinion is there In your opinion, is there a chance to build and calibrate such a more general criterial equation including all dimensionless parameters, as

$$F_{Normalized} = f\left(\frac{r_e}{t_{shell}}, \Gamma, \alpha\right) ?$$