The Silesian University of Technology

Doctoral Thesis

Analysis of local stability of doubly corrugated thin-walled structures

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Abstract

This PhD Thesis describes the stability analyses of doubly corrugated thin-walled steel panels which are used as a solution for arch buildings and roofing structures. As an example of such system the ABM MIC 120 prefabrication technology is chosen where factory on wheels makes cold-formed arch steel buildings or roofs in a very short time period as self-supporting panels. This technology comes from the USA and it is commonly used by the U.S. Army to build temporary buildings. Nowadays these structures are becoming a popular solution in civilian life all over the world.

The main problem of such structures lies in the lack of a proper theoretical model of the element due to its complex geometry. The author of this thesis has observed that in many projects, corrugation on panel's surface is neglected by engineers during calculation procedures. This leads to the significant overestimation of panel's ultimate load which in the worst case scenario, can cause a failure of a doubly corrugated structure.

This work discusses the influence of surface transverse geometric imperfections called corrugations on the local stability of cold-formed elements. Such elements are used to construct self supported arch buildings and roofs. The author of the thesis compares results obtained from the analytical investigation, from linear and nonlinear numerical stability analyses and experimental investigation. Two types of thin-walled elements are considered: a panel with smooth walls and panels with corrugations on their surfaces.

Due to corrugations it is very hard to build a reasonable panel's geometry model. This PhD Thesis shows a way to build panel's accurate geometrical model based on 3D optical scanning method. Such model is used in numerical analyses. The author also discusses the mechanical properties of a steel sheet used for prefabrication of thin-walled panels including influence of cold forming.

Finally, the conclusions are made which can be useful for design purposes and can be treated as a warning for engineers who often thoughtlessly use design standards.