Introduction

Load carrying members of machines and structures are designed in such a way as to satisfy the respective requirements that provide structural safety, durability and reliability.

Under static loads, the demands referring to:

- material strength,
- stability of elements,
- rigidity of structures

have to be fulfilled.

In case of dynamic loads, e.g., in the form of a pulse of load or time–variable loads, the following requirements have to be satisfied:

- fatigue resistance and durability,
- dynamic stability,
- fracture mechanics.

Under static loads, the structural element loses its stability (is subjected to buckling) at the moment when it transfers from one state of equilibrium into another one, for instance, a rod under compression transfers from the straight–line mode into the bent (buckled) mode.

The value of load (stress) at which a transition into another state of equilibrium occurs is referred to as critical load (stress). Compressed rods with a compact cross–section are usually subjected to global elastic buckling (the rod is buckled along its whole length).

In thin–walled structures such as plates, shells, beams or columns, most frequently a loss of local stability occurs. In these structures, due to an interaction of various buckling modes, an interactive (coupled) buckling can take place. A loss of stability in the structural element can lead to collapse of the whole structure. There are known many catastrophes of bridges caused by a loss of stability of one rod of the spatial bridge truss, often during its assembly. Buckling of the rod under compression is equivalent to its damage – the load carrying ability is exceeded.

On the other hand, plates subjected to in–plane load can operate safely after the local stability loss, provided that buckling took place within the range of elastic strains (at critical stresses lower than the elasticity limit that is often identified with the proportionality limit). Some shells, e.g., cylindrical shells subjected to axial compression, undergo buckling in a rapid way. Such buckling is connected with a phenomenon of shift to another energy level. Knowledge on the behavior of structures after a stability loss until they reach their load carrying ability (limit load carrying capacity) is very essential for design engineers of such structures, especially thin–walled ones.

Numerous factors exert an influence on the behavior of thin–walled structures after their stability loss (when they exceed critical loads, that is to say, in post–critical states), among them:

- geometry of the element, i.e., its shape and dimensions,
- mechanical properties and strength of the material,
  - isotropic, orthotropic, composite material,
  - $\sigma - \varepsilon$ relation,
- elasticity, viscoelasticity, plasticity,
- values of ε_{prop}, ε_{pl}, $R_{m,}$
- boundary and initial conditions,
  - values of strains, e.g., significant deflections that require nonlinear geometrical equations to be applied,
- initial imperfections,
  - kind of load – static, dynamic,
  - intensity and shape of a pulse in the dynamic stability,
  - interaction between walls in thin-walled columns and beams,
  - versatility of buckling modes:
    - ∗ global buckling – flexural, torsional, flexural–torsional,
    - ∗ local, lateral, distortional, interactive buckling, etc.,
  - change in the buckling mode during an increase in loading.

For dynamic loads, the critical value of load does not show a bifurcation nature and has to be determined on the basis of proposed and checked stability criteria.

A tendency to design very light–weight thin–walled structures requires that design engineers should know the behavior of structures in post–critical states, or even during their rupture. On the other hand, the complexity of stability problems and post–critical states results in significant difficulties in their solutions and analysis. The conducted numerical analyses have to be verified experimentally. The obtained results of analytical and numerical, numerical and experimental investigations are presented during conferences and symposia devoted to this topic. In September 2009 in Zakopane, XII Symposium on Stability of Structures was held. The Symposium is organized every three years by the Department of Strength of Materials and Structures at the Technical University of Lodz, the Group for Stability of Structures at the Committee on Machine Design of the Polish Academy of Sciences and the Lodz Division of Polish Association of Theoretical and Applied Mechanics. During the latest symposium, 57 contributions were presented and participants from 9 countries took part in it. Some of these papers have been extended and accepted for printing in a special issue of the journal "Mechanics and Mechanical Engineering". Among them, seven papers are devoted to dynamic stability of thin–walled shells and columns, four contributions present results of experimental investigations, two papers deal with stability and load carrying ability of thin–walled structures, one describes buckling of frames, in one stability of circular piezoresistive plates is discussed and one study presents an analysis of damage to the energy absorber.

Before printing, all the contributions have been thoroughly reviewed, according to the requirements imposed by "Mechanics and Mechanical Engineering".

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