ABSTRACT
Compression steel circular and square hollow section (CHS and SHS) struts are optimized and compared to double-angle section ones showing the advantage of CHS and SHS struts (Section 6.2.1). It is shown that the optimum geometry of trusses depends on the shape of compression members (Section 6.2.2). Optimum design of tubular members with welded joints loaded in fatigue is treated in Section 6.3. Absorbed energy of CHS and SHS braces cyclically loaded in tension-compression is determined by closed formulae for hysteresis loop area (Section 6.4).

Compression aluminium-alloy CHS and SHS struts are optimized and it is shown that struts optimized considering the initial imperfections are practically safe and insensitive to imperfections (Section 6.5). CHS beams are optimized for bending in elastic and plastic range and stated that, in plastic range, it is more economic to design these beams without local buckling (Section 6.6). Minimum cost design of SHS Vierendeel trusses gives the optimum number of bays (Section 6.7). In the minimum cost design of a plate structure with rectangular hollow section (RHS) stiffeners the constraint on residual welding distortions is considered.
6.1 INTRODUCTION

The economy of structures can be achieved by minimizing a cost function. The safety and quality of a structure can be guaranteed by fulfilling the design constraints. These main aspects can be realized by structural optimization. The optimum design is a structural synthesis, which collects all important engineering aspects to develop modern structural versions. In the optimum design process the main structural characteristics are sought which minimize the cost function and fulfil the design constraints.

Analytical, theoretical and experimental research leads to formulation of design recommendations, rules, standards. Results of these investigations should be defined as design constraints. The cost function should contain the costs of materials, fabrication, assembly, transport, erection and maintenance. The main structural characteristics are as follows: materials, type, geometry, topology and dimensions of a structure, fabrication technology, connections, costs.

The main phases of structural optimization are as follows:
1) preparation - analytical phase: selection and mathematical formulation of main structural characteristics;
2) mathematical optimization using computer methods;
3) evaluation of computed results, comparison of optimum versions, definition of design rules, developing expert systems.

Comparison is the basis for designers to select the most suitable structural versions, but only optimized versions can be realistically compared to each other, thus, it is necessary to optimize all the candidate versions.

In recent years the structural optimization has been developed in great measure, but the industrial applications are very few. Our main aim is to bridge the gap between the theory and design and fabrication practice. The best way is to incorporate all important fabrication aspects into the optimum design procedure. We have developed a cost function which contains not only the material costs, but also the costs of fabrication. This cost function enables us to separate the minimum weight design from the minimum cost design and to show the difference between these optimum solutions.

Other aspect is to assure the quality of welded structures. The shrinkage of welds after welding can cause residual welding stresses and distortions. These stresses and distortions affect unfavourably the strength, stability, fatigue and assembly of structures, thus, they should be decreased or eliminated. The elimination can be achieved by including constraints on residual distortion in the optimum design process. We have developed a relatively simple calculation method for prediction of residual welding stresses and distortions which enables designers to define these constraints considering the fabrication tolerances prescribed by design standards.