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EXPERT SYSTEMS FOR DESIGN OF STEEL STRUCTURES

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The research project "Expert systems for design of steel structures" was started in 1993, and so far three reports have been published: Heinisuo (1994), Hyvärinen (1994) and Heinisuo (1994b). The first report (Heinisuo 1994) was an introduction to the project setting goals and defining the design process of steel structures. The main goal of this project is to enable application independent automated data exchange between organizations (e.g. from one designer to the others and to manufacturers) and inside organisations (e.g. from designer's CAD-system to his FEA-system and vice versa). For this, neutral methods and models for presenting the product data are needed, as well as expert rules (e.g. for generating a FEM-model from a CAD-model). The main activity has been focused on these two areas.

In report Hyvärinen (1994) a hierarchical aggregation form of steel skeleton is presented. There the skeleton is composed of primitive entities, which are material (steel profiles, plates, bolts etc.) or logical (cutting of profiles and bars, bevelling, bending etc.). These primitives together define the basic elements of steel skeleton, namely the steel parts (bars, fittings and connectors). The steel skeleton is then erected using these steel parts and joints between them. Joint is a logical element containing connections and (as a structural analysis element) the zone of interaction between the parts being connected. Intermediate levels of hierarchy (in addition to primitives, parts and skeleton) are usually needed for defining the elements occurring in the course of manufacture, and these are also presented in the aggregation form. For computer implementation, the approach following (loosely) the standard ISO-10303 has been selected - i.e. product data model for steel skeleton has been written in EXPRESS.

The report Hyvärinen (1994) also deals with cost calculation of steel skeleton. In addition to presenting the skeleton in a very detailed manner using the hierarchical aggregation form, the costs have to be defined similarly, and therefore the cost shares have been defined. The aggregation form, being capable of defining the different stages during the manufacture and erection of steel skeleton, can be used together with unit cost data for accurate cost calculation and thereby for better cost estimation and cost effective design.
The first report to focus on the structural analysis of steel skeletons is Heinisuo (1994b). There some expert rules for analyzing steel bars and joints have been proposed. The first problem to solve is what parts of the structure can be handled as bars (i.e. using beam elements in FE-analysis), and where the disturbance caused by joints must be taken into account (i.e. which parts of bars need to be taken into the analysis model of the joints). The rules of thumb for some cases have been proposed. Also some guidelines for structural analysis of bars and joints have been given. In particular, some consideration has been given to the question what kind of beam elements should be used for bars, and a number of joint models for analysis purposes have been studied.

In the future the joints are to be studied in more detail. Proper parameters need to be found for presenting each type of joint in the vast variety of joints used in steel structures. Then the appropriate structural analysis models have to be evaluated and correct design criteria must be presented. This work will take a lot of effort, and only a few exemplary joints can be studied in this project.

References

