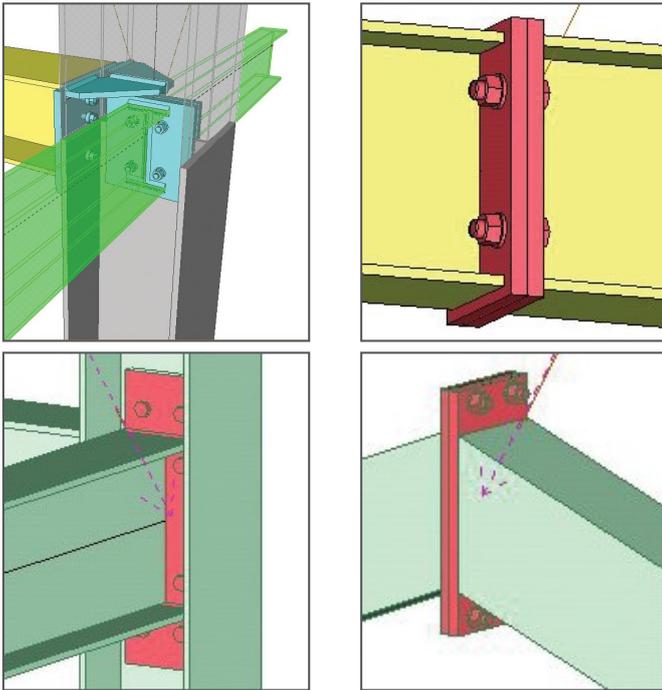## Connections Expert library system

P E *esasd.07*

It is often difficult to promptly arrive at a good solution for the geometry and arrangement of components in a steel connection. A reason for this are the many variables that are involved in the dimensioning and, in practice, no generally accepted guidelines exist.

Highlights

Intelligent design process that goes beyond the template rationale, automating decision-making in view of multiple criteria, such as load-bearing capacity, economy, practical feasibility, etc.

Applicable to frame connections (moment-stiff bolted or welded, hinged)

The extensive library contains connection solutions published in a number of connection design books (DSTV, SPRINT, Stahlbau Kalender, etc), as well as connection types internally developed by SCIA

The Expert System is an open library -- users may further extend the database with connections they design and would like to use in the future

Full integration into the 3D graphical user interface and design processes in SCIA Engineer

Experienced designers appreciate the ease of use, the automated workflow, and the possibility to store their own connection designs
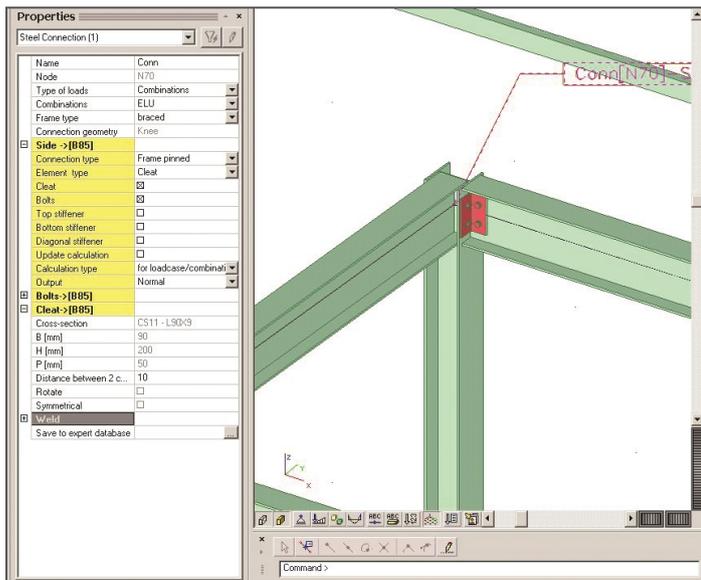
The esasd.07 module "*Connections expert library system*" is an intelligent library that makes it possible to quickly select an appropriate configuration for a steel connection. The Expert System proposes a list of possible solutions, filtered on the basis of:

- compatibility with the assigned cross-sections, joint angle, the presence of haunches, etc.;
- adequacy in view of the present internal forces (expressed as the resulting maximum unity check value);
- preferred bolt classes, joint orientation;
- pre-assigned priority per item in the Expert Library.

As the user selects one of the proposed items (i.e. a connection configuration), all connection components are immediately assigned to the joint and the exact ULS bearing capacity is calculated. In this way, any differences between stored library values for the resistance and actual values will be taken into account. A full design report is included in the project documentation.

How it works

The library

- The connection database includes connections of type moment-stiff (bolted and welded) and pinned;
- A large number of useful proposals for joint geometry have been taken from standard connection tables in publications such as:
  - Steel moment connections according to Eurocode 3. Simple design aids for rigid and semi-rigid joints, Sprint Contract RA351;
  - Bemessungshilfen für nachgiebige Stahlknoten mit Stirnplattenanschlüssen, Ernst and Sohn Berlin, DSTV;
  - Bemessungshilfen für profilorientiertes Konstruieren, Stahlbau-Verlagsgesellschaft mbH Köln, Stahlbau Kalender,.
  - These tables contain a number of practical and generally accepted solutions. SCIA has provided a supplementary set of predefined configurations, including haunched types;
- Besides geometrical and material data, resistance and stiffness values are stored for each configuration; these values were previously calculated (or referenced from the mentioned publications) at ultimate limit state.

- For welded and bolted beam-to-column and beam-to-beam moment connections, the system stores a unity check value related to moment capacity. For bolted base-plate connections, the system stores the unity check for combined bending moment and normal force. For pinned connections, the system stores the unity check related to shear force capacity.

More on the selection of suitable items and special features

The displayed list of suitable connections is filtered according to the following search criteria:

- the overall geometry (beam-to-column, beam-to-beam, base connection) and joint type (welded, bolted, rigid, pinned) have to match;

- the angle between beam and column should be in the tolerance range defined in the Connection Setup;

- the beam material and cross-section geometry should fit in the tolerance range defined in the Connection Setup;

- the column material and cross-section geometry should fit in the tolerance range defined in the Connection Setup (optional);

- local constraints should be fulfilled - e.g. a top haunch will not be considered for a new connection, bolt positions should comply with requirements related to strength, practical feasibility and maintenance;

- every library item is assigned a priority (a value between 1 and 5); this feature aims to not only prioritise, but also standardise the commonly selected solutions as much as possible, thus limiting costs for production and labour.

Other ways to filter search results:

- by limiting target unity check values, e.g. between 0.75 and 1.0;

- by neglecting connections of low priority;

- by excluding certain bolt classes;

- by excluding sources - limiting to certain publications, to SCIA connection only, to user-defined only;

- by limiting to matching beam/column cross-section only.

The obtained list of suitable connections may be sorted in function of any of the properties listed in the table.

- Strictly speaking, an optimal design for a connection will have the largest unity check value that is still lower than 1.0;

- The larger the tolerance limits set by the user in the Connection Setup, the greater the difference between the resistance/stiffness/unity check values stored in the library, and the actual values calculated afterwards.

The selection process

- The user creates an empty connection item and immediately calls the Expert System.

- The Expert System searches the library for suitable connections and proposes a list of possible solutions. The generated list contains the connections that comply with the filter criteria set in the Setup. The criteria include tolerances on geometry, bolt diameter, and ranges of unity checks.

- The user selects a matching solution while being guided by the displayed pre-calculated unity check values, the assigned priority per item, the item source (name of publication or other), used bolt class, etc..

- The user selects one of the proposed items and the node is furnished with connection components identical to the ones in the library item. The actual connection resistance and stiffness are calculated.

- If needed, the connection may further be optimised by the user in an interactive fashion, or a new solution may be called from the Expert Library.

Integration with standard connection design

- The connection configuration is shown in the 3D window of SCIA Engineer immediately after selection from the Expert System Library.

- All connection checks are then processed; a calculation report may be displayed in the Preview and may be added to the project documentation.