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Production of Drawings with a Three-Dimensional Volume Based CAD-System

Production de dessins à l'aide d'un logiciel tridimensionnel

Erstellung von Zeichnungen mit einem dreidimensionalen CAD-System

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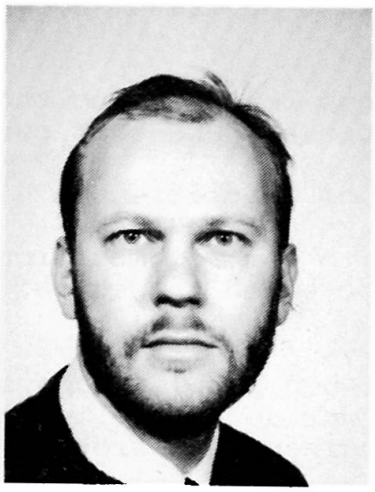

Ragnar Wessman, born 1956, received his engineering degree at the Technical University of Helsinki. For nine years he has been involved in steel structure design and CAD-development. Now he is responsible for the development of CAD/CAM tools for steel structure design and production in the leading Finnish engineering software house, Tekla Oy.

SUMMARY
A new revolutionary approach towards steel structure design will be presented. By building up a full three-dimensional model into a database, the entire building can be described. By this approach all design outputs, drawings, bills of material and input for NC-machines can be produced fully automatically and buildings can be designed essentially faster and more accurately than with traditional systems.

RÉSUMÉ
L'auteur présente une nouvelle approche dans la conception de structures métalliques. Par la constitution d'un modèle entièrement tridimensionnel au sein d'une banque de données, une construction entière peut être décrite. Grâce à cette technique, tous les résultats de la conception: plans, listes des matières et input pour les machines à commande numérique peuvent être obtenus de manière entièrement automatique. Ainsi, les projets sont conçus d'une manière nettement plus rapide et plus sûre qu'avec les logiciels traditionnels.

ZUSAMMENFASSUNG
Eine neue, fast revolutionäre Lösung für das Konstruieren im Stahlbau wird vorgestellt. Durch den Aufbau eines dreidimensionalen Volumenmodells in einer Datenbank kann ein Bauwerk vollständig dargestellt werden. Dadurch können automatisch alle Konstruktionsunterlagen, Zeichnungen, Stücklisten und Steuerinformationen für NC-Maschinen erzeugt werden. So wird das Konstruieren und Detaillieren wesentlich schneller und fehlerfreier als bei konventionellen Systemen.

1. GENERAL

When applying traditional CAD systems in building design an increase of productivity has been gained mainly in the field of automatic drafting. The traditional systems have not been able to facilitate the design work itself. Among others, the following problems have occurred:

- Only drawing - not design - has been facilitated by automation.
- The same parts must be drawn several times in several drawings.
- Different drawings representing the same structure are not connected together and thus can be contradictory.
- Producing bills of quantities is difficult.
- It is difficult to control modifications. One change in a structure must be added in several drawings.

To solve the above mentioned problems a system called BOCAD-3D (Building Oriented CAD) was developed in Germany. The special requirements of civil engineering were paid attention to in creating this system.

The system is based on a very advanced integration. A full three-dimensional model of the whole building is created and stored into a data base. The data base has been designed to effectively handle typical constructions consisting of thousands of different parts. All drawings can be produced automatically on the basis of the information fed into the data base.

The advantages of such a CAD system based on a three-dimensional volume model are as follows:

- Every part needs to be fed to the system only once. This reduces the need of input work.
- The whole building is described in the data base. In this way the compatibleness of the parts can be guaranteed.
- All production drawings can be produced automatically. The designer will not be tied to the screen to draw drawings.
- True bills of quantities can be listed and information for CAM can be produced.

The BOCAD-3D system has been used in Finland for three years mainly in design of steel structures. Many objects have been designed by using it. On the so far largest design object - a recovery boiler house delivered to USA - approximately 1500 drawings were automatically produced. The steel structure of this building consisted of about 1500 metric tons of steel. The BOCAD-3D system is used in Europe in more than 80 steel structural engineering companies, f.ex. BBC and KWU.

Tekla Oy is the representative of the BOCAD-3D system in Finland, Sweden, Norway and the Soviet Union.

2. CREATING THE MODEL

A model of the whole building is constructed interactively. The model is described by placing beams and columns (frames, parts) and defining joints between them. The designer does not have to do any drawing work using lines and arcs (as in a traditional system). The items he uses are beams and joints.

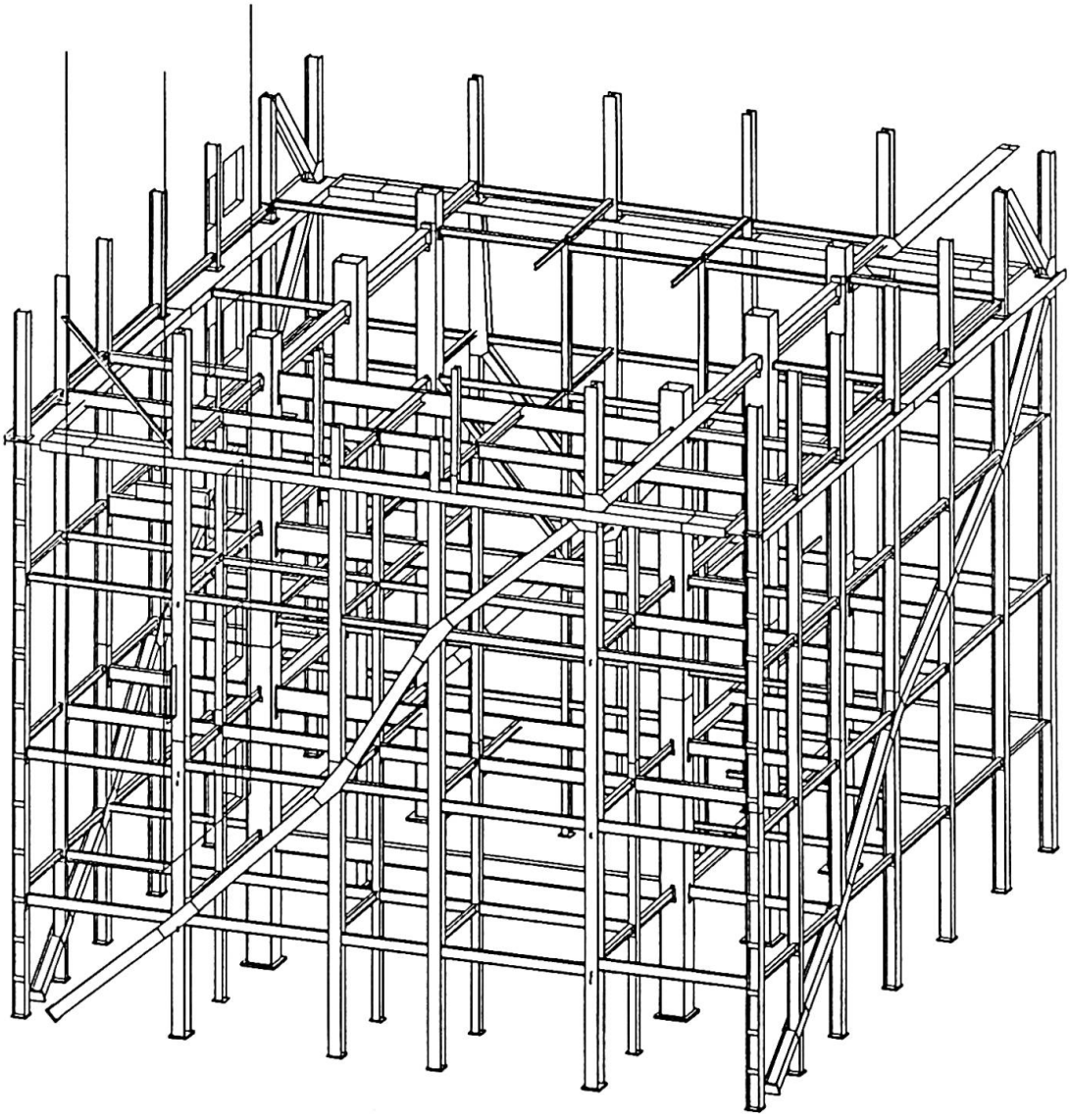

Fig. 1
The steel framework of the first assembly stage of a recovery boiler building.

The joint library of the system consists of 40-50 different types of joints. The user can modify existing joints and add own joint types in a simple manner.

The joints take care of cutting the beams to the appropriate length and also cut out parts of the flanges if necessary. They also check that all parts fit in their places and that minimum distances between screws and edges are not violated.

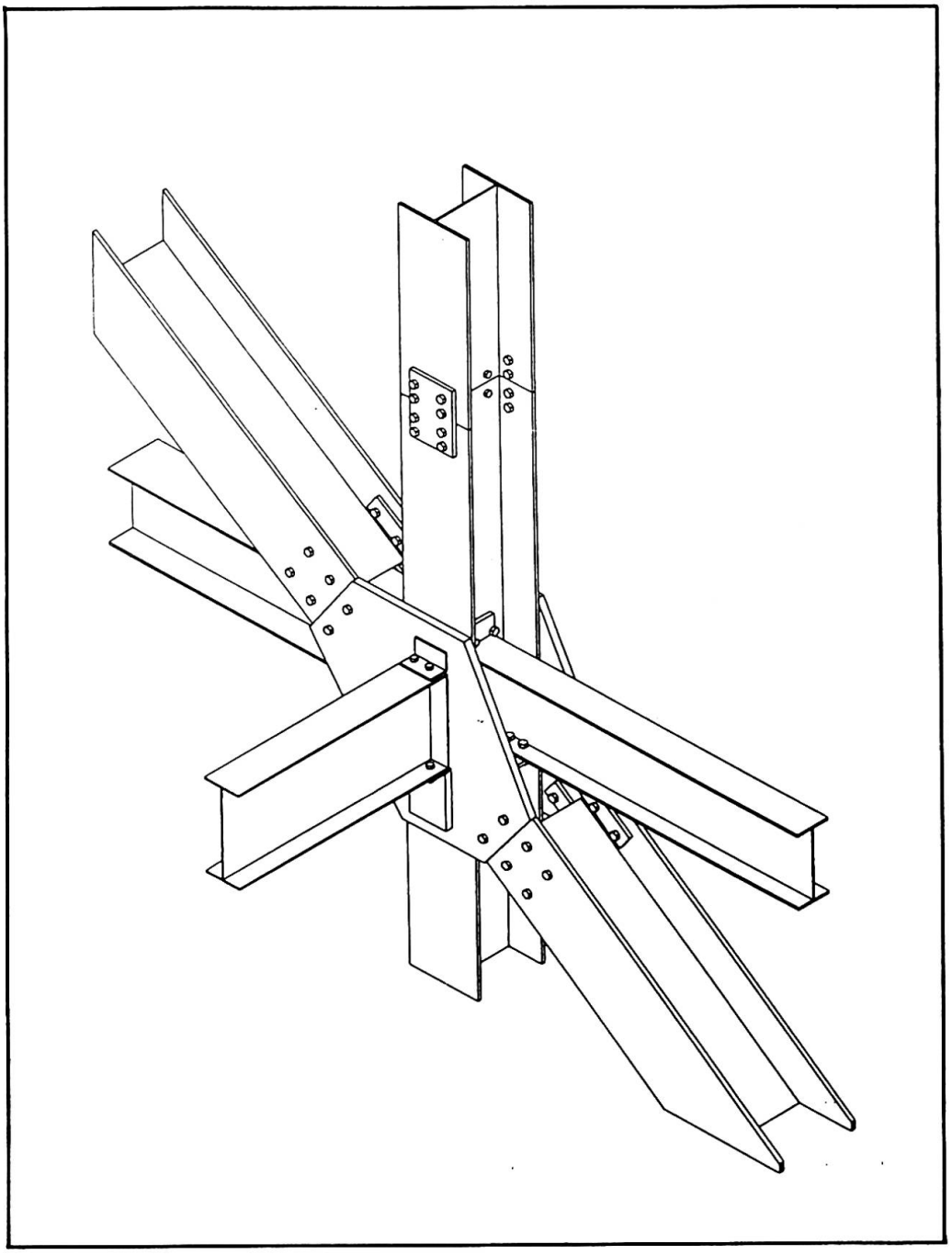

Fig. 2 An example of a complicated joint.

3. PRODUCING DRAWINGS

When the whole building or a certain part of it has been modelled, the user can produce all necessary drawings by just defining what drawings he wants.

3.1 Assembly drawings

All assembly drawings are produced as 3D-windows of the structure. All plan views, line drawings, perspective views, explosion drawings, sections and details can thus be produced. All necessary texts are added to the drawings automatically. In this way part numbers, profile names, assembly screws, component lists including weights, title blocks, frames, distribution and modification labels can be added automatically.

Sections and details from different parts of the structure can be added.

3.2 Workshop drawings

The greatest advantage of using this 3D system is that all workshop drawings and component drawings can be produced automatically. Workshop drawings constitute the main part of all drawings. By automatizing this routine work notable increase of productivity is achieved.

With the BOCAD-3D system a complete workshop drawing can be produced of every different assembly part and component. The drawing contains all the information needed in manufacturing.

The user need not input any measure lines nor tell where sections must be drawn from. All this is done automatically.

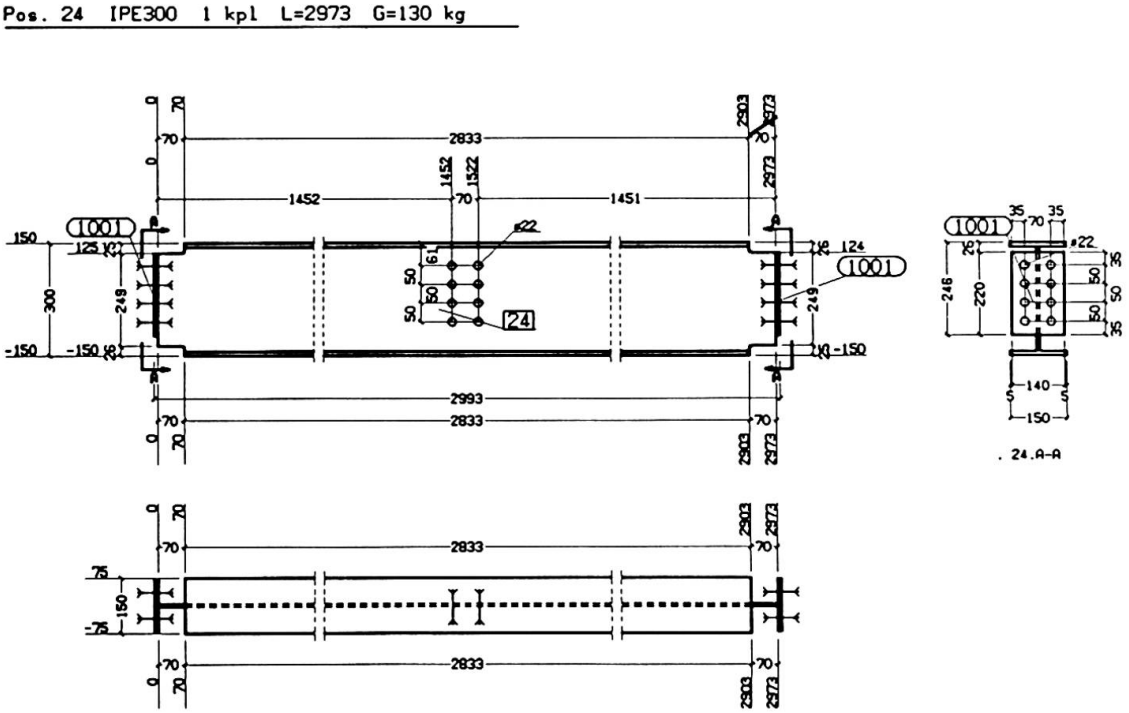

Fig. 3 An automatically produced workshop drawing of a typical beam.

4. INFORMATION FOR AUTOMATIC PRODUCTION

Besides workshop drawings, many different kinds of input data for NC-machines can easily be produced from the 3D data base. Several companies use the BOCAD-3D-system in computer-aided manufacturing on a very advanced level - only the welding work is done manually.

5. CONCLUSIONS

The traditional CAD systems - drawing systems - can not make the design process itself any more effective. By using modern data bases the whole geometry of a building can be modelled into a data base. A designer using a system based on a three-dimensional volume model need not waste time on drawing the drafts on the screen. He only creates a model of the structure and after that all drawings are produced automatically. After creating the model all the workshop drawings can be produced overnight. This may mean hundreds of drawings of one plane of a building.

A data base which contains all the data of a building facilitates revisioning and reduces mistakes. Every part needs to be fed to the data base and revisioned only once. When a part has been revisioned, the change is automatically shown in all drawings drawn out after the revision. Producing the workshop drawings from a common data base assures that all parts fit together and no measurement faults occur. With the help of BOCAD-3D complicated steel structure objects can be designed in a time remarkably shorter than manually. At the same time the quality of plans have improved considerably.