

Zeitschrift: IABSE congress report = Rapport du congrès AIPC = IVBH
Kongressbericht

Band: 11 (1980)

Artikel: Computer application in design and construction of space frame

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DOI: <https://doi.org/10.5169/seals-11338>

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COMPUTER APPLICATION IN DESIGN AND CONSTRUCTION OF SPACE FRAME

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For the construction of large span structure, architects often use space frames. When an architect designs a space frame having a curved surface, the sorts of members and joints vary so greatly. Computers can be effectively used to construct complex space frames through accurate information management.

I DESIGN OF SPACE FRAME SHAPE AND GRID PATTERN

Space frames can be constructed in any shape desired.
 Definition of the space frame shape

Expanding

Space frame A

II STRUCTURAL CALCULATIONS

Computers can be used to present diagrams and figures, showing stress distribution and so on.

Examples of stress distribution

Space frame A

Space frame B

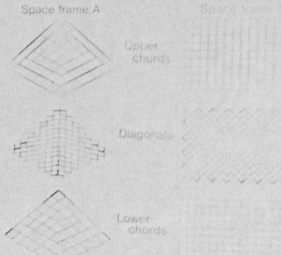
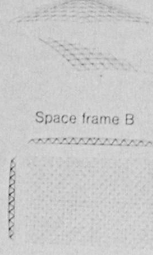
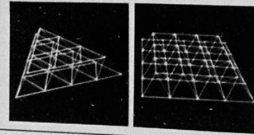
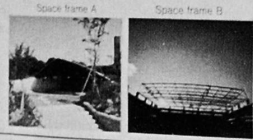
Upper chords

Diagonals

Lower chords

Examples of grid patterns

Space frame B



III DESIGN OF MEMBERS AND JOINTS

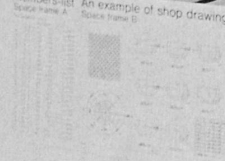
The preparation of lists and drawings of members and joints is easy if computers are applied.

An example of joint



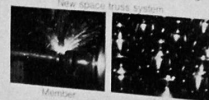
An example of members list

An example of shop drawing



IV MANUFACTURE OF MEMBERS AND JOINTS

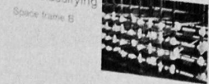
Members and joints are manufactured with a high level of quality control, according to the lists and the drawings.



V MARKING

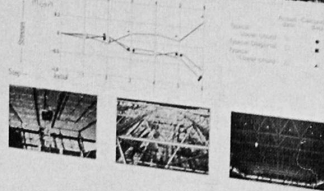
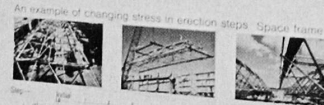
Members and joints are marked with identification numbers.

An example of classifying



VI ON-SITE ASSEMBLY AND ERECTION

Members and joints are assembled and erected to the designed shape according to the assembling lists. Computers can be also used for the safety analysis at the time of erection.



The flow from the design to the construction of space frames can be regarded as a process where a space frame designed as software at the initial stage is gradually converted into hardware through information management by computer, and eventually into a space frame as a physical entity.



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BACKGROUND

In Japan, the construction of huge space structures, such as sports halls and exhibition halls, has recently become more widespread. Space frames are an important method for constructing steel structures having extensive column-free space. In space frames technology, computers have been used for structural analysis, however, computer can also be used for design and construction, from the standpoint of information management.

FURTHER COMMENTS

I. Design of Space Frame Shape and Grid Pattern.

When the plane on the nondimensional coordinates is divided by a grid, such as "Example of grid patterns", the space frame on the three dimensional coordinates is also divided by a certain rule based on the isoparametric shape function of the finite element method. The member lengths, the joint coordinates and the joint angles are automatically determined.

II. Structural Calculations.

"Examples of stress distribution" shows the magnitudes of stress by the thickness of the line of the members, the qualitative tendency of stress distribution is visually portrayed. The line in black indicates compression stress, while the line in white indicates tension stress.

III. Design of Members and Joints.

"An example of member list" shows the sequential number marked on a member, the number of joints at both ends, and the length of a member. "An example of shop drawing" shows the drilling positions of a joint.

IV. Manufacture of Members and Joints.

Manufactures make the members and joints, accurately observing each specification, with no idea as to where they are used in the space frame.

V. Marking.

VI. On-Site Assembly and Erection.

Computers can be also used for the safety analysis at the time of erection. The figure shows the changing stress at each of erection and the calculation results.

FUTURE POSSIBILITIES

The concept of computer controlled information management is not limited to such examples and will become increasingly important to general building structures.