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### 3. Covered Skating Rink in Rotterdam (Netherlands)

*Owner and Manager: Mr. Tom Menken*

*Architect: Landers en Passchier, Van den Steen*

*Construction Timber Structures: B.V. Nemaho-Doetinchem*

*Main Contractor: Nederhorst Bouw Alblasserdam*

*Building Completed: Spring 1978*

*Dimensions and Arrangements of the skating hall:*

*Length: 91 m*

*Span: 52 m*

*Height: 12.70 m (at top-hinge)*

*Arch distance: 5.33 m*

The flexibility and co-operation during the preparation of this project, was one of the reasons, that the principal — Mr. Tom Menken — decided to realize this project as a timber construction. The skating hall is situated close to the city-center and the Central Railway of Rotterdam.

#### Design specifications of the timber structures

The roof consists of 2 layers of steel trapezoidal sheeting. The first sheet supports from arch to arch (without girders) and keeps vapour in. The profile of the second and exterior sheet has been mounted perpendicular to the profile of the first, covering isolating material. This sandwich construction enables to maintain a cold climate in the hall.

The main construction consists of glued laminated asymmetric three-hinged arches whereby Deal is used as basic material (*Picea Abies*). The longer one is of the biggest construction pieces ever made by Nemaho. For stability purposes perpendicular to the plane of the arch windbracings are placed (fig. 2) in four of the seventeen fields.

The connection between these windbracing-systems consists of connection-beams at distances of 4.70 m. The gable consists also of a glued laminated timber structure. For reasons of stability it is supported by a horizontal connection-beam into the next wind-bracing system.

#### Construction in detail

The arches (thick 185 mm) are manufactured of lamina with a thickness of 19 mm and with a radius of 3.30 m. The dimensions in the middle of the curve are 185 x 1300 mm<sup>2</sup> for the longer part and 185 x 1480 mm<sup>2</sup> for the shorter part. The entire length of the longest part is 39.75 m. The construction is calculated in accordance with the Dutch requirements NEN 3850 and NEN 3852, also with regard to buckling in the plane of the arch. The load distribution is calculated graphically by means of the construction of the equilibrium polygon for each condition of load.

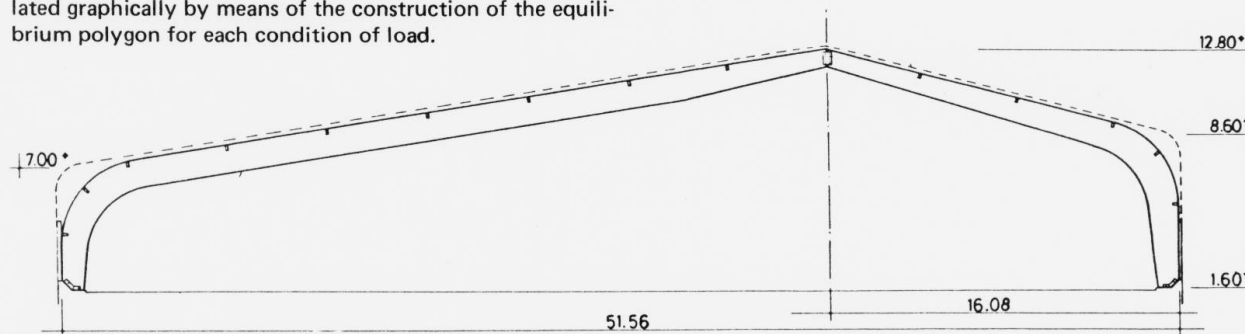
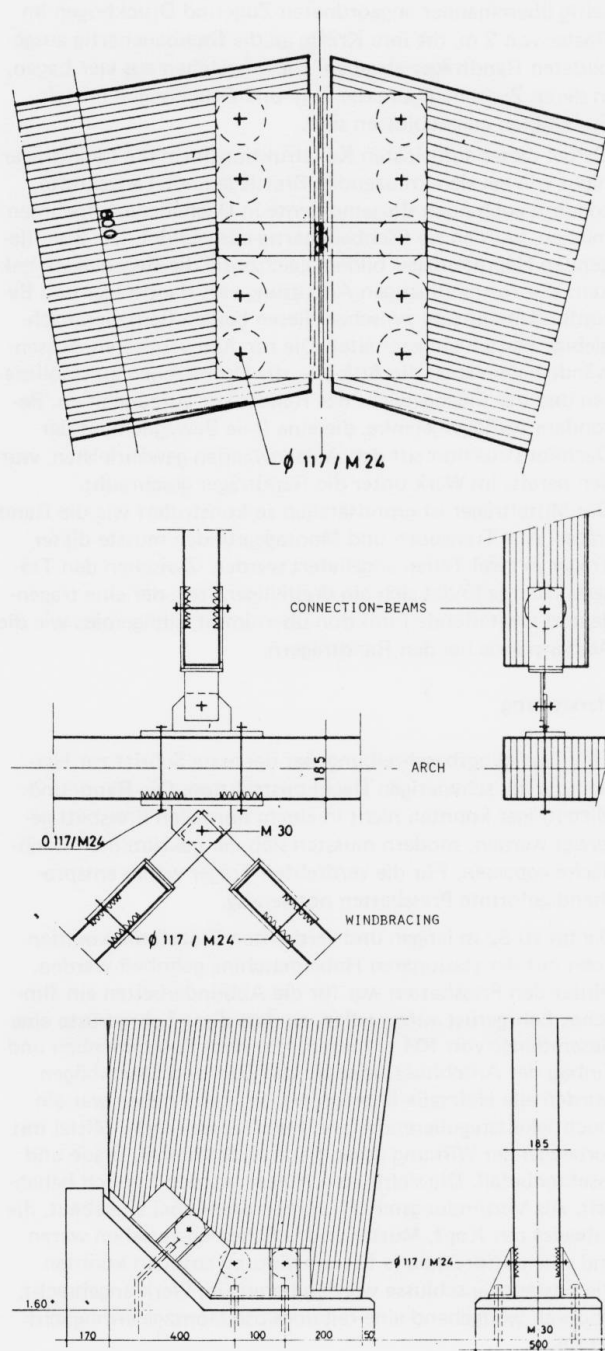


Fig. 1 View and details

The topconnection (scheme 3) is constructed with a view to reducing as much as possible the bending moments on the group of connectors resulting of the transverse force by keeping the distance from connectors to the hinge small. In designing the connection of the foundation, the premise was to reduce the number of connectors. Possible upward forces as a result of windloads parallel or perpendicular to the truss-plane can be taken completely by the bolt with clamping plate-connection.

The windbracing-construction consists of laminated beams with dimensions 110 x 250 mm<sup>2</sup> whereas the crossconnection has been performed by a ship-lap indentation. The connection of the summers and the connection beams to the steelparts has been performed one-axial by means of bolts M24 mm and clamping-plates Ø 117 mm. The loads parallel to the arch are transmitted by an asymmetric bolt/clamping-plate connection.

#### Transport and erection

All connection parts were shipped from the factory in Doetinchem to Rotterdam, where they were unloaded and transported by trailer to the building-site in the city-center. This last has been done in 3 nightly conveyances, by which the parts of the arches had to be transported horizontally to prevent damage to the overhead lines of the tramways. The greatest length of a transport was 38.50 m with a width of 6 m. The complete erection has been performed with the assistance of a 100-tons mobile crane with a gig of 30 m and a jip of 45 m. The totalerection was finished within 15 working days.

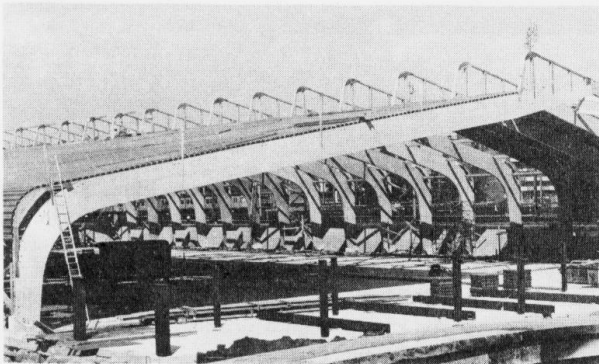


Fig. 2



Fig. 3

#### Quantities of the timber structure

413 m<sup>3</sup> glued laminated timber of which 322 m<sup>3</sup> for arches and gables;  
81 m<sup>3</sup> for windbracing-systems and connection beams;  
12000 KGF galvanized iron work;  
1800 bolts M24/M30 mm  
2160 one-sided clamping-plates Ø 117 mm.

(H.E. Lüning and J. Tepper)

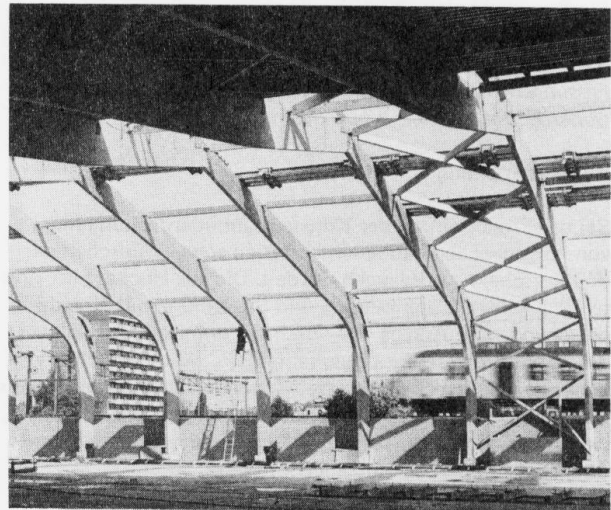


Fig. 4

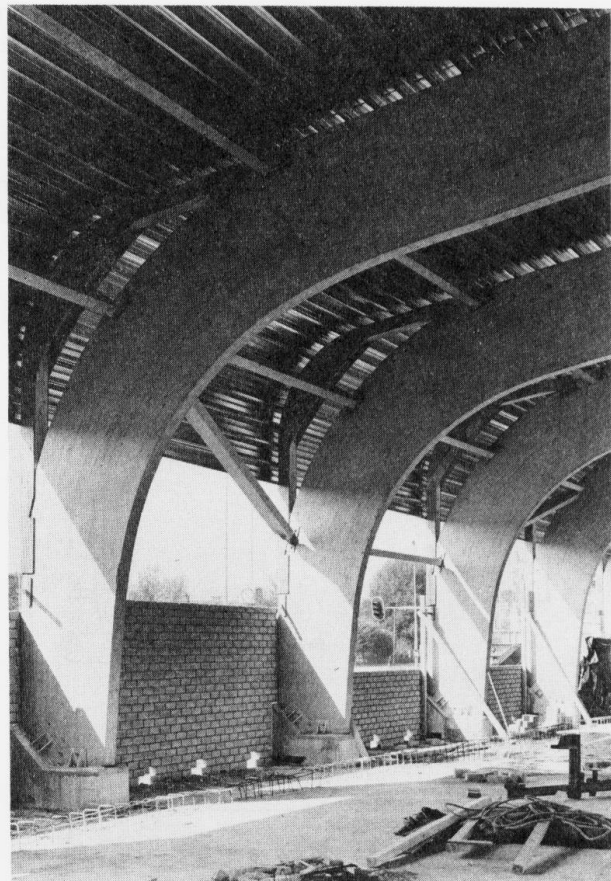


Fig. 5