

Papp Laszlo Sportarena, Budapest

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Introduction

The multipurpose Papp Laszlo Sportarena situated near the centre of Budapest has quickly become the new symbol of the modern and dynamic Hungarian capital, capable of hosting a great variety of cultural and sporting events. At the very first glance, the visitor is captured by the smoothly rounded stone-like form of the building obtained by the architect from the revolution and subsequent distortion of a space curve in his computer model (Fig. 1). The outer shape is characterized by double curvature and symmetry along the longitudinal axis. Beyond this symmetry, every cross section of the model yields a different geometry, which was the main difficulty for the designers and builders.

Structural Solution

The 15 m high concrete superstructure around the arena is divided into seven movement blocks. The columns and shear walls are cast in situ, while the main beams of the grandstand and the seating elements are prefabricated. The slabs are made of prestressed precast hollow core planks. The main trusses of 90 m span are spaced every 10 m, supported by the concrete columns of the upper slab. Their height varies between 6,56 m and 10,62 m. The steel canopy on the east is cantilevered over the main entrance of the building. The west facade consists of a steel frame from ground level up to the roof.

The outer skin of the building consists of up to 40 m long continuous aluminium sheets on top of the thermal and acoustic insulation and waterproofing, radiating from the ridge of the roof down to the level of the elevated deck, without any apparent separation between roof and facade. Along the aluminium sheets, the movement joints are incorporated in the gutters. The main challenge in the structural design was to find the best way to coordinate the differential movements due to thermal expansion between the roof covering, the underlying steel structure and the concrete blocks below.



Fig. 1: General view of the Budapest Sportarena

Evolution of the Roof Model

The first approach consisted of a quasi space frame behind the curved front of the roof (Fig. 2). The radiating truss beams followed the geometry of the roof ribs and were connected to the first main truss. Longitudinal trusses were provided between the main trusses in order to redistribute the higher load of the first truss to the inside of the building and to limit the vertical differential movements. These secondary trusses are linked together up to six bays along the main axis, decreasing gradually toward the edge of the roof. The same principle was adopted at the back of the building for the distribution of the loads from the west wall. The trusses were clamped at the supports, slightly cantilevered at the ends and connected by a strong perimeter beam. The detailed calculations showed that the redistribution was not efficient enough and the

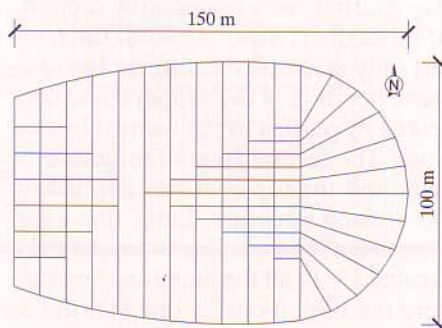


Fig. 2: Quasi space frame model

first truss still had to carry 1,7 times more load than the rest. The erection method of the secondary trusses presented some difficulties, which also ruled out this solution due to the very tight construction schedule.

In the new model, the radial beams became continuous by adding columns, and also shorter due to three new trusses transversally on the curved part. Their setting out is slightly different from the path of the roof ribs (shown in red on Fig. 3), in order to distribute the loads more evenly on the first truss. Along the perimeter of the roof, the steel structure under the covering follows the orientation of the ribs, but above the arena the main trusses are set in an orthogonal grid perpendicular to the axis of the building (Fig. 3). The roof structure is divided into two movement blocks between gridlines 8 and 9. Double purlins with sliding connection on opposite end were used between these two trusses. The wind bracings are situated in the middle of each movement block.

Many support conditions of the trusses were studied for the loads and the movements. Some examples are shown above (Fig. 4). To avoid the creation of a movement joint in the roof at the supports of the trusses and to provide continuity of the metal sheeting, the bearings had to be identical at both ends of the trusses to respect the symmetry of movements. These conditions could be best satis-

