

Daylight under Large Roofs

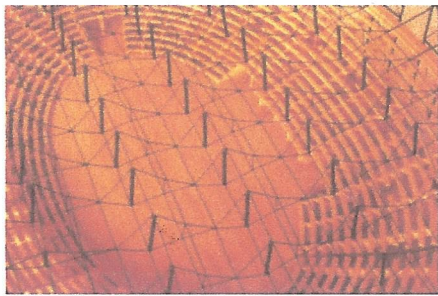
Bernhard TOKARZ, Ingenieurgruppe Tokarz Frerichs Leipold

Habichtshorststraße 37, D-30655 Hannover, Germany
Tokarz@ibft.net

Abstract

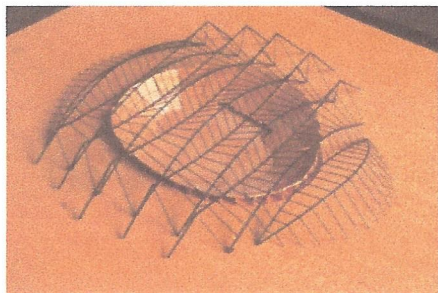
The goal is to illuminate large halls – sports halls, exhibition halls with wide-spanning roofs – with natural light. The best solution to create a bright uniform lighting of large spaces is to integrate the construction of windows into the roof structure. Three new developments of such structures are shown in models.

A suitable form-scheme is the saw-tooth roof as it is commonly used in industrial buildings. Through ribbon windows facing north daylight is admitted without glare and without heating up the inside. The sunlit south facing parts of the roof are opaque and thermally insulating covered. The reflecting undersides of these sloping parts create a very even light. The multiple surface refraction guarantees favourable acoustic conditions as well.



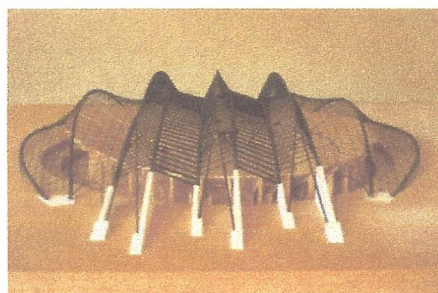
The structure principle 1 is called the “mirror-surfaces roof”. This structure combines the principle of the prestressed cable net with the lighting system of the saw-tooth roof in one principle of construction. The structure consists of two symmetrically shaped layers of prestressed cable nets, connected by tension- and compression-members between them, the upper one forming a surface like a saw-tooth roof, the lower forming the mirror image of the upper net. The theoretical area in the middle between both is a simple two-direction curved saddle surface. The nets are

completely visible inside the hall. In combination with the strong compression members at the highest amplitude and sophisticated details it structures the large space inside.



The structure principle 2 is called the “arch-ridge-valley roof”. The principle is the tightening of a mat of cables between a series of crosswise running rigid arches, alternately curved hill like and valley like. The steeply inclined north facing surfaces carry the windows, the gently sloped carry the thermally insulating panels. The arches which support the cable net are supported by trestle-systems at the outer edges of the hall.

The structure principle 3 is called “The three-chord-arch-supported tent” This roof is a unit consisting of 3 different structures: Three high three-chord truss arches are spanning above the inner zone of the hall, running parallel to the longitudinal axis. The north-facing surfaces of the truss-arches carry the ribbon windows. The 2 flat inclined areas between the three-chord-arches are formed by rigid girders at the level of the bottom chords. The outer zones of the hall are covered by simply shaped two direction curved prestressed cable nets, supported by flat steel tube arches similar to the ribs of umbrellas.



Conclusion: The 3 principles for the construction of wide-spanning roofs for large halls contain – fully integrated – the construction for the lighting of the halls with daylight. The results are form-rich roofs, the opposite to many previously built monotonous designs and surfaces. The development goes from highly complex constructions to the combination of simple constructions to highly varied forms.

Topic: Conceptual Design, Tension and Membrane Structures

Keywords: large halls, daylight illumination, saw-tooth roof, prestressed cable net, three-chord-arch