HDC WICKERSHEIMER ENGINEERING

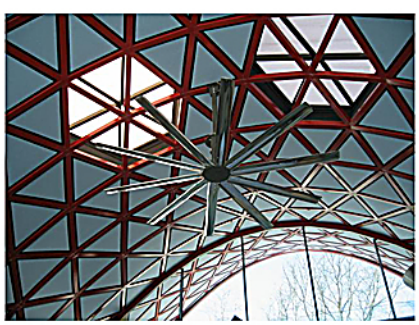
Structural Division - HDC Engineering, LLC

PROJECT PROFILE

Residence - Hypar Roof

Rockford Area, Illinois

Owner: Unavailable, Rockford Area, IL
A/E: Richard L. Johnson & Associates, Rockford, IL



Range of Services

- Structural Consulting Services: structural planning for roof; computer analysis of hypar roof; engineering design of Roof
- Construction documents for hypar roof; field coordination of roof as required; curtainwall analysis

Project Overview

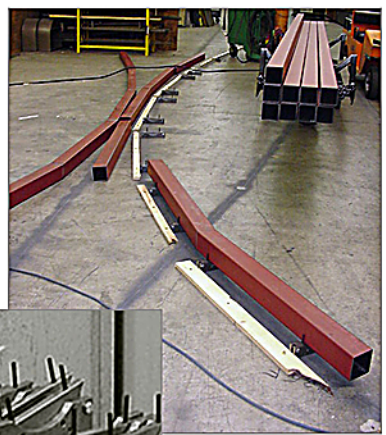
The structural planning for this roof began with a wood shell concept. The pros were ease of construction, lightness and contractor familiarity with the material. The cons were strength, stiffness and connectivity given the span and shape of the hypar. The decision to try a steel grid was based on the owner's professional involvement in the steel fabrication industry, the ability to express the arches and straight line generators of the hypar geometry, and of course the strength and stiffness of steel. The disadvantage would be fabrication of components, since every arch segment would have a different pitch (vertical angle) and roll (twist along its longitudinal axis), while each straight line generator element between the arches would have a different yaw (horizontal angle) at each end as well as a pitch in some cases – creating a compound angle cut. Luckily the owner, a mathematician, provided the equations to determine the necessary angles for the construction documents to become fabrication drawings. A computer model was generated to determine forces within the hypar grid, members were sized and deformations determined. After the hypar roof was finalized, the end wall parabolic window framing structural mullions were analyzed. The hyperbolic paraboloid (HP) form in architectural application is generally utilized as a diamond segment extracted from the overall saddle shape generated from the mathematical equation. This permits straight line forms for economical formwork and the pouring of concrete to create a shell, since the HP in this diamond shape produces minimal shell stresses. This grid application is unique and does not rely on the skin as part of the structure.

The foundation, first floor framing, as well as the mezzanine level was designed by the engineers at R.L. Johnson & Associates. The two images directly to the left are courtesy of the owner's website.

integrating STRUCTURAL design *focused on* quality

Residence - Hypar Roof

Rockford Area, Illinois



1 2

Fabrication Process

1) Jigs for arch segments "roll"

2) Arch Layout using "Jigs"

3) Arch Segments Welded, showing "Roll"

4) Straight line Generators intersecting Arch

5) Compound Cuts on Straight Line Generators

6) Arches that create interior opening

3

5

6

4

integrating STRUCTURAL design focused on quality