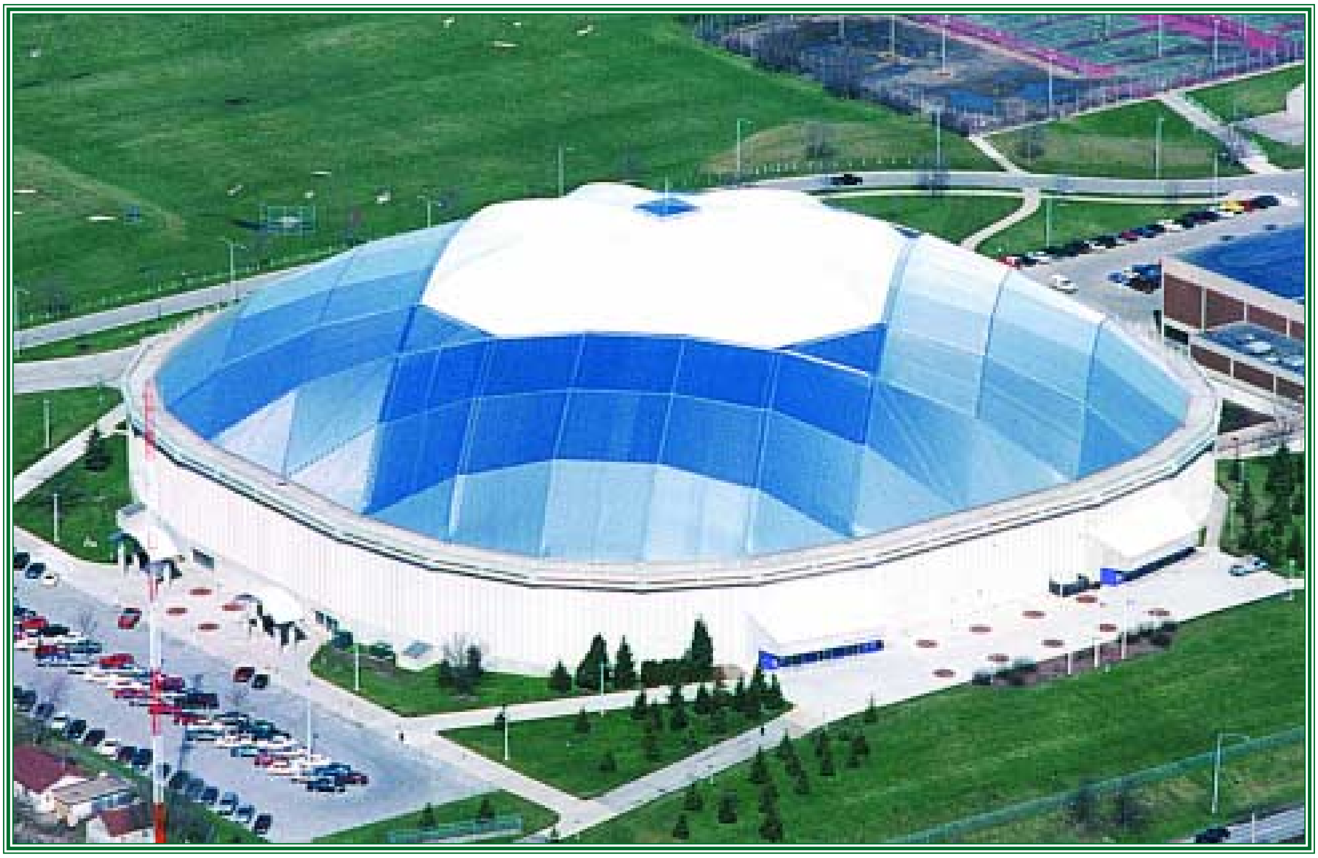
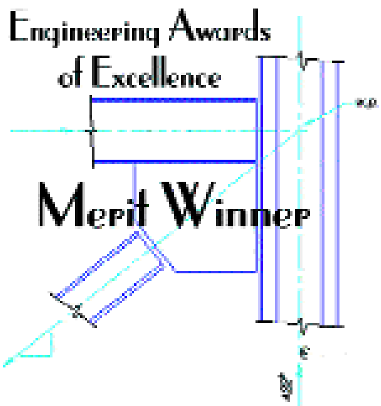
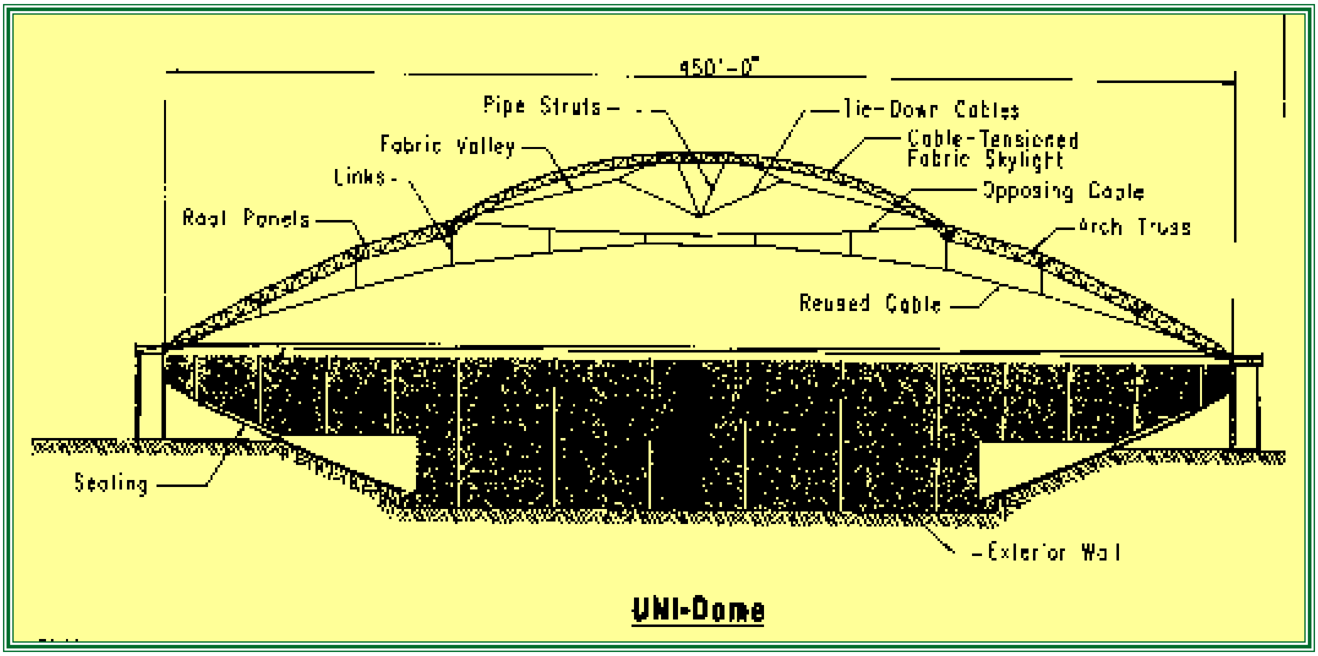




University of Northern Iowa Air Dome Retrofit

Cedar Falls, Iowa

The UNI-Dome at the University of Northern Iowa, completed in 1975, was the first indoor stadium with a full-size, air-supported fabric roof system in the US. Using concepts developed by the late David Geiger of Geiger Berger Associates, PC, this technology drastically reduced roof construction costs and, in some cases, reduced the construction schedule. Not incidentally, the infusion of natural light through the translucent canopy overhead further adds an extremely appealing architectural and aesthetic element, creating a sense of light and space not present in a conventional, rigid-roofed structure. After the completion of the UNI-Dome, air-supported roof structures began to replace conventional, rigid roof structures entirely for stadium size covers, and were subsequently constructed for eight other indoor stadiums.



Despite the advantages, there will still some drawbacks. Snow removal is a major problem for air-supported domes. The stability of the roof depends on the maintenance of an interior pressure larger than the exterior load. In the original UNI-Dome roof, the 450'-diameter dome was kept inflated by two 125-hp fans operating 24 hours a day to create air pressure of 4.5 lb. per sq. ft. (the interior design pressure is limited to not more than 5 lb. per sq. ft.). However, in northern Iowa, snow loads may be as high as 40 lb. per sq. ft. Snow can be melted by hot air directed to the roof surface, but with a heavy snowfall this may be insufficient to reduce the exterior load. In the winter of 1994, the UNI-Dome, like other facilities in colder climates, resorted to manual snow removal to prevent deflation. This led to a rip in the fabric and deflation of the roof. As it was approaching the end of its life span, the university decided to replace the original roof, rather than repair it.

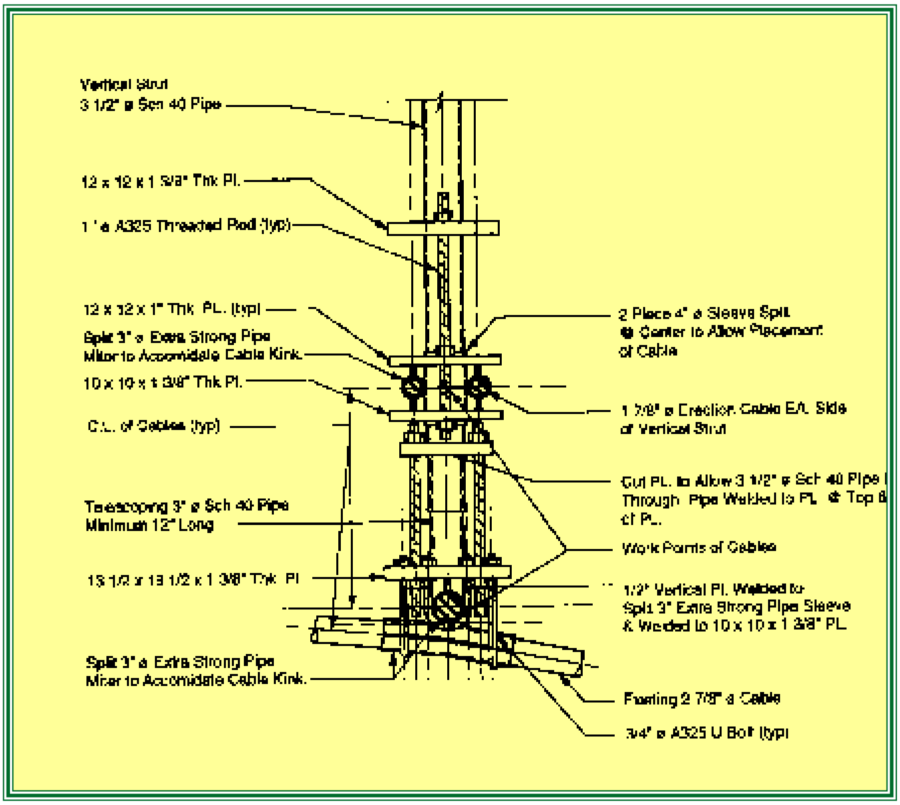
The replacement of an existing air-supported dome roof with an aesthetically appealing, cost-effective, low-maintenance alternative is a sizable challenge. The University of Northern Iowa achieved these goals with the

Jurors' Comments

"A very innovative solution to a complex problem."

"The solution of adding a new stadium roof with minimal changes to the existing building is a concept that can be used for other similar buildings."

"Retrofiting without a major interruption to the existing structure simplified construction and proved cost effective."

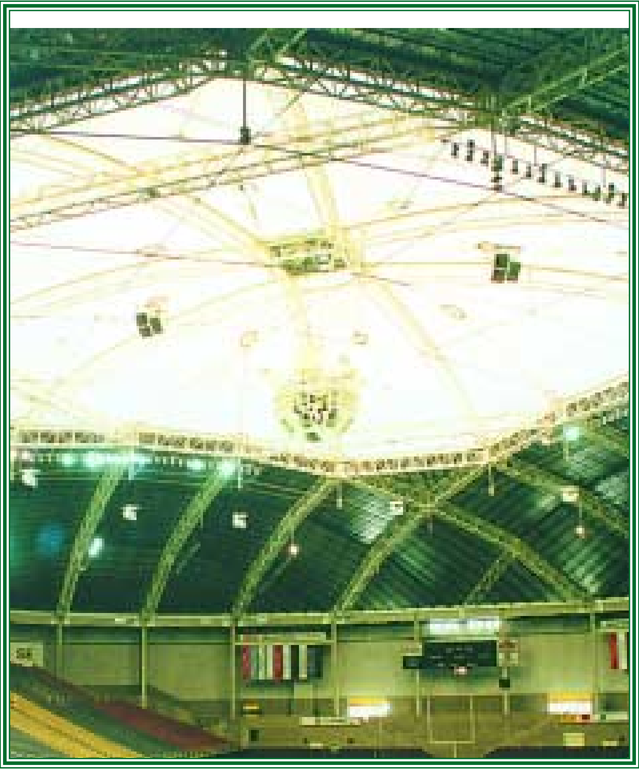


assistance of Light Structures Design Consultants of White Plains, NY (a subsidiary of DeNardis Associates). For the past 5 years, LSDC has developed alternative designs for the replacement of air-supported domes at several facilities, including Syracuse University and the University of South Dakota-Vermillion. For the UNI-Dome replacement, LSDC developed a hybrid cable-arch scheme, the first of its kind, which offers both functionality and aesthetic value.

The hybrid design utilizes the ingenuity of the existing roof geometry and maximizes use of the existing structural components (the cable net, columns, and a reinforced concrete circumferential girder). The structure's periphery was prestressed with a post-tensioning system of tendons, converting the existing concrete compression ring into a tension ring. The existing cable net, connected and stressed against the arches, gives the arches stability and allows them to be slender and lightweight. All structural components were shop fabricated in segments and field bolted. The translucent center skylight, 45,000 sq. ft in area, is enclosed with an arch supported (PTFE) fabric tensile roof. To optimize energy efficiency and lower heating costs, stainless steel, and standing-seam insulated roof panels on metal deck cover 75% of the roof.

The main support for the replacement roof is a 6'-deep, 4'-wide steel box-truss arch system. There are four main cross arches, 2" in each direction, each 400'-long and 220' apart. Between these are sixteen secondary arches (four per side), each 107'-long, spaced every 44', which span from the structure's perimeter to the middle third of the main arches. The center skylight is a cable-supported irregular polygon, with a crown supported by pipe struts and cables. The reused cables (twelve 2 7/8"-diameter cables) are linked to the arches or cables above by rigid vertical members. In this hybrid roof design, the under-slung linked secondary cable system is located below and along the plan centerline of the arches. In addition to resisting uplift, this causes the crossed arch system to act as a pre-stressed shell. The cable system effectively diffuses the loads applied to the arches, creating a structure that can be considered fully utilized in terms of strength.

In the U.S., there are now 20 air-supported sports facilities in structural distress. Roof replacement or even construction of new facilities using a hybrid cable-arch design offers unique possibilities. As a symbiosis of conventional roof technologies and contemporary lightweight, long span technologies, it unites the better of these two schools. In particular, the "skylight" section is both architecturally appealing and cost-effective. While replacement of the UNI-Dome roof utilized the existing cable geometry, design of a new structure allows the design of cable geometry for a specific application. This could allow both the magnitude and spatial distribution of the pre-stress to vary. It would then be possible to use an initial state of flexural pre-stress on the arches rather than simple axial load as was done for the UNI-Dome. It would also be possible to investigate the effect of cables going slack in conditions of extreme loading, giving a structure whose behavior would change in response to the type and magnitude of load.



Project Team

Owner:
University of Northern Iowa, Cedar Falls, IA

Structural Engineer and Architect:
Light Structures Design Consultants (a division of De Nardis Associates, Inc.), White Plains, NY

General Contractor:
Penn Co. Construction, Inc., Eagan, MN