

— DESIGN CONSIDERATIONS —

Davenport North Family YMCA Metal Roofs

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Project Background

Two prominent entities in the Davenport, Iowa, community collaborated to achieve something neither could do on its own. The Davenport North Family YMCA is a unique joint-use facility developed by the Davenport Community School District and the Scott County Family YMCA. Capital funding was provided primarily by the school district and the operating funds for the facility are provided by the YMCA. Thus, both parties have a vested interest in making the most of their funds to provide lifecycle value.

The 50,000-square-foot building contains an indoor swimming pool located in the natatorium. Indoor pools not only generate a lot of maintenance attention, they create challenges for the design of the structure around them. Considerable attention was given to maintenance concerns during planning of this space. All aspects of the roof design were thoughtfully considered to reduce the maintenance impact to the

owner and to extend the life of the roof system.

Design Impact

The curved roof was chosen to provide a striking profile from both the exterior and interior of the natatorium and the health and physical education room. This complemented the roofline of the recently-constructed auditorium, located adjacent to the YMCA. All roofs visible from the ground were metal finished to match the color of the roof on the auditorium addition.

Secrets of the Curved Roof

Despite its unique and striking appearance, the construction of the roof was quite simple and was accomplished using standard construction techniques and without expensive field fabrication.

The radii of the roofs vary from 325 feet at the health and physical education room to 341 feet at the natatorium. The barrel-vaulted roof is actually an “offset” curve,

designed to provide a unique look to the building. However, the roof is also practical, since the required 18-foot head clearance above the end of the diving board is established at the high point of the roof. The use of a curved roof allowed remaining areas of the natatorium to have a lower clear height, which decreased the expense of heavily reinforced masonry walls typically found in this type of facility.

The curved appearance was achieved from an approach coined as “locally rigid, globally flexible.” This uses the inherent flexibility of unrestrained metal decking and the metal roof panels to its advantage. Simply stated, the curve of the roof uses flexing of the deck and panels to follow the tangent points along the curves. Thus, to the surprise of many people on the construction team, the curved roof system required virtually the same amount of work to install as a traditional straight-sloped roof.



Roof Structural System

Steel joists were selected for the roof system because they are lightweight, easily transportable, low cost, and meet the needs for clear spans ranging from 50 to 94 feet. The joist-bearing elevations are “stepped” to create the prominent curved effect of the roof.

To facilitate attachment of the roof decking applied on a curve, a special continuous shim plate was designed to accommodate the variety of slopes presented along the curved profile established by the structural framing and steel deck. Each of these plates was then adjusted to match the slope of the tangent point of the curve at the top of each joist.

Galvanized decking is commonly used to enhance corrosion resistance, which was a particular concern at the natatorium. The 20-gauge thickness of the base material was selected for its structural characteristics. It received a heavy-duty, G90 galvanized coating.

Even the installation method of the decking was carefully considered. The typi-

cal process of attachment – welding – would have damaged the galvanized coating and required a thorough touch-up with galvanizing paint (at locations up to 32 feet above the floor). Rather than introducing methodologies that would predictably compromise the integrity of the steel deck and its connection, a creative solution was developed.

The decking is secured to the joist shims using stainless steel, powder-actuated fasteners spaced at six inches on center. This forms a tight, secure anchor with virtually no damage to the galvanized coating. The use of stainless steel anchors mitigates corrosion potential of the fastener intended for the deck-to-joist connection. Stainless steel sealing caps create a tight Neoprene seal over the head of the anchors at the deck level, providing added corrosion protection.

Special Roof System Features

Metal roof panels were selected for the finished roofing because they could be fabricated to be continuous over the entire length of the barrel-vaulted roof. This eliminated end-to-end seams within the roof

High humidity from the pool creates a constant pressure for vapors to flow through the roof. To resist chemical corrosion and the passage of moisture, the steel joists, shim plates, and decking were coated with a Tnemec 9-mil epoxy polyimide prior to installation of the roof and insulation system.

system. The continuous roof panels, over 125 feet long, eliminated a significant number of end-to-end joints. This was particularly beneficial when the roof slope along the curved panel varied by as much as 30%. The majority of the roof had a slope of less than 2%.

The roof panels were 24-gauge, hot-dipped galvanized steel with a Kynar finish. The panels contained a 2-1/2 inch rib at 16-inch centers, along with two 3/8-inch intermediate stiffener ribs to minimize oil-canning of the panels and telegraphing of structural members. The result is a roof system that is both colorful and free of distortion.

These design requirements lead to the selection of Merchant & Evans, Inc. Zip-Rib panels, which were used in the previous auditorium project. It was decided that the color of the metal roofs would match the slate blue color on the adjacent auditorium addition.

A concealed clip anchoring system was selected to allow for cleaner lines, eliminating penetrations of the roof panels and allowing for thermal expansion and contraction that occurs in the temperature extremes of the upper Midwest.

Gutters at the ends of the curved roof were reinforced beyond the typical requirements in response to a concern for potential snow and ice loads.

A 20-year warranty provided by the roof panel manufacturer for weathertightness and architectural finish eased the owner's mind on any questions concerning the longevity of this roofing system.

Challenges of Natatorium Roof

The natatorium houses an eight-lane, 25-meter swimming pool. The 4,650 square foot pool surface is a source of constant water evaporation, creating key challenges:

- Relative humidity is typically around 60%. This is significantly higher than the normal 30-50% level in most buildings. Thus, there is constant “pressure” for humidity to flow through the roof to a less humid exterior environment.

- Temperatures as high as 80 degrees F are needed to maintain proper comfort levels for occupants, most of whom are clad in swimming suits.
- Elevated corrosion potential due to the introduction of pool treatment chemicals carried to all areas of the building by the movement of air heavily laden with moisture. When this settles on internal surfaces and condenses, there is a potential for corrosion to occur.
- Provide long-term value and performance for the owner.

Thus, the roof system of the natatorium was designed with two purposes in mind. It had to do more than keep the harsh Iowa winter weather outside; it must also respond to these internal stresses successfully in order to achieve its intended purpose.

The following considerations were used in the design and specification of the roof system.

- Diminish the vulnerability of the metal joists, decking, shim plates, and fasteners to corrosion from airborne pool treatment chemicals, and oxidation resulting from the high moisture level inherent in the natatorium.
- Minimize the number of fastener penetrations through the structural decking to reduce thermal bridging from the interior to the exterior.
- Contain the moisture within the "shell" of the natatorium where it could be treated by the ventilation and dehumidification system.
- Reduce the visibility of fasteners in the interior areas.
- Avoid opportunities for chemical-laden moist air to condense and cause damage to the structure.
- Superinsulate the roof for energy efficiency and to reduce the potential for condensation on the metal surfaces.

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Corrosion Protection Measures

Considering the corrosive atmosphere of the natatorium, a special coating product was selected that had previously been used successfully in this type of environment to protect the structure. The Tnemec product, a 9-mil epoxy polyamide coating, is designed for use in harsh, corrosive environments. The product not only inhibits chemical corrosion, it also resists the passage of moisture. The steel joists, shim plates, and decking were coated on all sides and edges prior to the installation of the roof and insulation system.

As another layer of protection (and to minimize the visual impact of any anchoring penetrations), after the installation of the roof system, a second coat of the special coating was applied to the interior side of the steel decking and roof joists.

Roof Anchorage Considerations

Each metal anchor provides an opportunity for thermal transmittance to the exterior; therefore, considerable effort was made to minimize the quantity of these fasteners.

Thermal bridging goes both ways, depending on the relative indoor/outdoor temperatures.

These fasteners were then topped with Neoprene-gasketed sealing caps to provide added sealing protection. All anchors were specified to be placed at the top flute of the corrugated metal deck, where the visual impact was diminished.

The metal roof system was installed according to UL 216A, using stainless steel fasteners and clips that provided the required uplift class of UL-90. This reduced the quantity of fasteners required to anchor the metal roof system to the galvanized deck to only one clip per four square feet (about half the norm).

Vapor Containment Measures

Careful attention was paid to the high humidity level in the atmosphere of the natatorium. The typical roof vapor retarder in the Midwest region is polyethylene sheeting with a perm rating of about .5.

For this project, however, that would not meet the needs to minimize vapor migration into the structure of the building. Instead, a





The YMCA's curved roof profile complements the recently-constructed auditorium (left). All roofs visible from the ground are metal finished to match the color of the roof on the auditorium addition.

self-adhering modified bitumen membrane vapor retarder was installed directly over the galvanized metal decking to further isolate the moisture-laden air from passing into the insulation and condensing. This material had a perm rating of 0.025, considerably less than the polyethylene. This greatly enhanced the ability of the design to keep the moist air inside the natatorium where it could be treated with the ventilation and dehumidification system.

Super Insulation Benefits

The super-insulated roof system provides long-term benefits to the owner, including improved energy efficiency and less opportunity for condensation to occur in the roof system. The 4.5 inches of polyisocyanurate insulation exceeded the energy code requirement by 36% at very little extra cost and added benefit to the owner.


In addition, the thicker insulation layer greatly reduced the potential for corrosive condensation to occur. This was of particular concern in the winter where there is a tendency for warm, moist, chemical-bearing air to travel to the dry exterior environment.

The insulation system was installed using one stainless steel fastener per four square feet to hold the insulation in place on the slope of the barrel-vaulted structural base during construction. The specifications required the contractor to penetrate the metal roof deck only at the top flute of the decking to reduce the visibility of anchors.

A self-adhering modified bitumen roof membrane was installed over the insulation system to protect the insulation from the

elements and to provide ice and water protection from moisture entering from the exterior, and condensation from under the metal roof.

Excellent Results Achieved

The roofs had two purposes: to protect the interior from the elements and to protect the roof system from internal corrosive forces, prolonging its performance and useful life. The owner received outstanding long-term value through the use of this roofing system. The attention to every detail of the roof system construction resulted in a symbiotic effect – a roof system that is far greater than the sum of its parts. 

DEDICATED TO BILL STEVENSON



This article is dedicated to William "Bill" John Stevenson III, PE, RRC, RRO, CDT, who died August 4, 2005, in a drowning accident. Bill was a 17-year employee of Shive-Hattery, where he established the Building Envelope Team in the West Des Moines, Iowa, office. He is survived by his wife of 25 years, Anita, and four children: Laura Stevenson of Chicago, Michael Stevenson of Iowa City, and Kayla and Erica Stevenson, at home. Shive-Hattery has established a memorial fund. Contributions may be directed to the Bill Stevenson Children's Scholarship Fund, c/o U.S. Bank, 520 Walnut Street, Des Moines, Iowa, 50309.

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