Athletic Aesthetic

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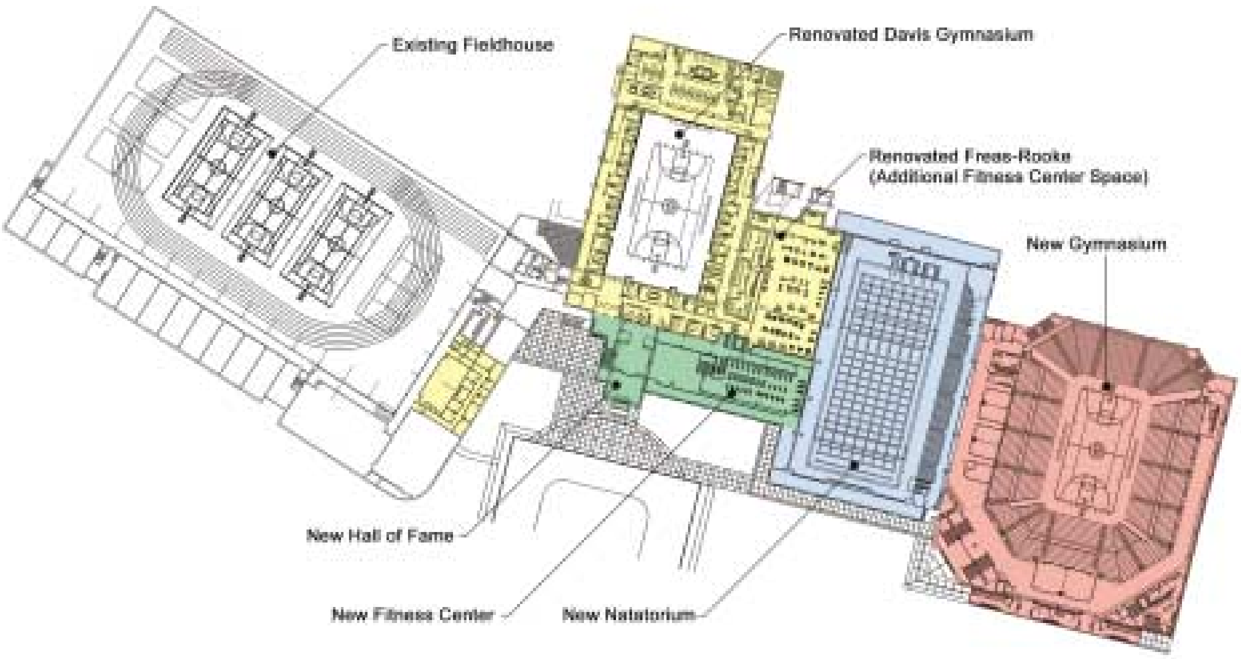
Bucknell University's recently expanded student recreational facilities prominently feature exposed structural steel architectural elements.



The overall facility plan shows relationship between the existing, renovated structures and the new construction.

Colleges and universities are increasingly aware that campus athletic and recreation centers are a monumental fixture of student life. The center's location, components and services are major attractions for students, student athletes, professors and community members. Creating a multi-functional campus recreation and athletic center ultimately enhances student and community life and increases recruiting potential for intercollegiate varsity athletics.

Bucknell University in Lewisburg, PA, recognized this need and sought to upgrade and expand its on-campus recreation center. Through a collaborative design process led by architect/structural engineer Ewing Cole Cherry Brott, the Bucknell trustees, and the Athletic Department, the University envisioned a facility balancing the needs of students and varsity athletic programs while maximizing the existing facility's renovation potential. The center would address students' needs and accommodate intercollegiate student athletes and associated staff. The new facility would also house university gatherings and events including indoor sports, group meetings, classroom learning, commencement, convocation ceremonies and special events.

Creating a "place to be" meant providing visual connections between spaces within the building and the surrounding campus. The building celebrates activity, and so should create enough interest to draw people there. Using exposed steel as the aesthetic enhanced lightness and openness, and was cost effective.

The new Kenneth G. Langone Recreation and Athletics Center is a combination of new construction and renovation to Bucknell's existing facilities. Renovations to existing facilities encompassed approximately 40,000 sq. ft. The new 140,000-sq.-ft addition to this complex contains three primary venues:

- 16,000-sq.-ft Krebs Fitness Center and Berger Family Weight Room (with new & renovated spaces).
- New 45,000-sq.-ft Arthur D. Kinney Natatorium, with a 54-meter by 25-yard Olympic-size pool and seating for 500 spectators.
- New 70,000-sq.-ft Gary A. Sojka Pavilion (Gymnasium), seating more than 4,000 spectators for basketball, campus functions and concerts.

MATERIAL CHOICES

Steel was the natural choice for the gymnasium and natatorium roofs due to the long spans required. Initially, concrete was evaluated for the concourse and seating bowl levels of the gym and natatorium. It ultimately proved too costly and too heavy. Weight of the structure became important early in the design phase when the geotechnical evaluation required the use of continuous strip footings to span over potential sink holes. The average allowable bearing pressures were kept below 2500 psf, and the foundations were designed to span over an 8'-diameter sinkhole or loss of support without adversely affecting the superstructure.

It also became apparent that each steel structure would become as unique as its function. Although in the end this facility would become a single "multi-purpose" facility, the steel structures would need to be designed and detailed independently for the specific needs of each building. Utilizing steel also helped the design team "fast-track" the project and issue an early steel package to meet the aggressive schedule.

Exposed long-span-joist roof and center-hung score board in gymnasium.

LATERAL SYSTEMS

Each of the three new buildings utilized a different lateral system to suit the specific functions, geometry, and uses. HSS X-braced frames were located along the perimeter of the natatorium to provide a cost-effective solution without compromising the function of the space. Since the pool required a column-free space, all the building columns were located along the perimeter. The braces were positioned to avoid interfering with links to adjacent structures. The braces remained architecturally exposed where possible, and provided a visually interesting contrast to the masonry façade of the existing pool facility, Freas-Rooke. Because one existing structure and two new structures surrounded the natatorium, the design team was able to minimize the lateral drift and keep expansion-joint sizes to a minimum.

The fitness center required unobstructed floor plans to allow for the maximum flexibility of spaces and fitness equipment. A second floor level overlooks the main corridor and campus, and serves to connect the existing field house to the fitness center and natatorium, both physically and visually. Both floors of the fitness center have a glass end-wall that allows students to see into the natatorium while exercising, and helps bring a sense of openness and light into the space. Given the uses and the geometry of the space, the preferred solution was a steel moment frame. The steel frame allowed new columns to be placed in strategic locations so the new framing could cantilever and infill around the existing structures. This reduced the impact to existing foundations and the amount of shoring and underpinning that was required.

The gymnasium posed a new set of challenges for providing a cost-effecting lateral system. It required a 48' clear height over the court, and a 158'-10" clear span in the short direction. X-bracing was not an option for the majority of the building due to the conflicts with concession spaces and the circulation of the concourse. Moment frames did not seem economical due to the clear height of the spaces, as well as the number of costly connections this would add. As a result, the team developed a system utilizing both an X-braced frame and 'trussed' frame system. The northern end of the gym contained an expansion "bump" that followed the shape of the seating bowl, and provided a cost-effective way to add 1,000 seats to the project. Once again, HSS X-braces were introduced to follow this geometry and provide lateral stability in both directions, since the outer braces were at 45 degrees to the main axis of the building. The southern end of the gym contained the main circulation spaces including two monumental stairs and an open concourse. Therefore, a moment frame composed of trusses was utilized in lieu of conventional beams and girders. These trusses were composed of wide-flange chords and double-angle web members. These 5'-deep trusses were then able to develop the necessary moments and rigidity to control lateral drift, while also significantly reducing the un-braced lengths of the columns.

A 3D model was created using STAAD 2000 to analyze the hybrid lateral structure. The 3D model distributed the forces relative to the differing stiffness of the X-braces and the trussed frames. Seismic and wind loads were applied in the two principal directions in addition to directions 45 degrees to the main axes. This accounted for any torsional forces due to an irregular center of rigidity. The design team also introduced horizontal x-bracing at the bottom-chord level of the roof framing to add to the stiffness of the roof diaphragm.

EXPOSED STRUCTURE

The decision to allow structural elements to be exposed was made early in the design of the facility. This decision was made to provide aesthetic, functional and economic benefit to the project. Each of the three structures contained high-volume spaces where the height of the roof structure allowed the elimination of fireproofing.

The natatorium was particularly well suited to feature the exposed structure as a design element. The architectural design team wanted to retain the façade of the existing pool and expose it to view from within the natatorium and fitness center. The existing façade was a solid wall of brick accentuated by recessed brick arches. The brick arches extend to nearly the full height of the existing façade and repeat in a consistent pattern with a spacing of 15’-7 ½” between arch centers. The columns in the natatorium were set 4’ from the existing façade to clear existing foundations, and the column spacing was set at 31’-3” to visually frame two brick arches within each column bay.

Exposed steel was also utilized as a design feature in the roof structure of Ramer Schaffner Memorial Hall. This hall of fame is located at the main entrance to the fitness center and showcases the university’s athletic history as well as Bucknell’s two recipients of the Congressional Medal of Honor. The hall of fame was designed as a dramatic two-level space with painted steel roof trusses and exposed cellular acoustic metal deck high overhead.

NATATORIUM FRAMING

The natatorium required 123’-8” spans across the short direction of the 54-meter pool. The 8’-deep long-span roof joists were located at 10’-3” centers to coordinate with the column spacing, and provided an economical span for supporting 3” cellular roof deck.

The location and configuration of the joist panel points, supplementary bracing members and banding trusses were carefully coordinated with the mechanical, electrical and plumbing trades. Exposed ductwork and sprinkler piping were located within the depth of the roof joists. Diagonal bracing members between top and bottom chords of adjacent roof joists were placed carefully to create symmetry and order within the roof structure while providing erection stability and bottom-chord bracing of the roof joists. Indirect lighting was used to illuminate the roof structure and reduce glare on the surface of the water. The exposed roof structure is painted white to enhance visual impact and maximize indirect lighting methods.

GYMNASIUM FRAMING

The gymnasium roof plan is approximately 210’ by 215’. It was necessary to span 159’ clear in the short direction so that the columns fell behind the seating bowl. Although several different options utilizing trusses and joists were explored, it became apparent that super long-span joists were the most economical solution for the majority of the roof. These joists support not only roof dead weight and snow loads, but also a center hung scoreboard and 72 “strong points” for rigging. Rigging points were coordinated with the truss panel points and bridging locations to provide lateral stability for bridling loads. These strong points will allow the University to hold concerts and other events within the gymnasium, and can support a total weight of 90,000 lb.

New Columbia Joist Co. was consulted on maximum shipping and fabrication dimensions so that the total depth of joists could be economical. The joist bridging and bracing was coordinated with the exposed ductwork that ran within the depth of the steel roof framing to create an organized and aesthetically pleasing roof system.

On the north end of the Gym, a header truss picked up the sloped roof framing over the expansion “bump” and allowed the bottom chord X-bracing to tie into the corner columns and X-braced frames. The top and bottom chords of this truss were composed of wide flange and WT members and double-angle web members. The end connections allowed for a seated top chord to allow for easier erection, while the bottom chord framed to the side of the column. The depth of this truss matched that of the joists and the trusses used to create the frame action in the north-south direction. These shorter trusses created the upper trussed frame and provided support for the joists that ran east-west. The panel points were coordinated with the joist locations, and each joist had a bottom-chord extension to provide for maximum lateral stability.

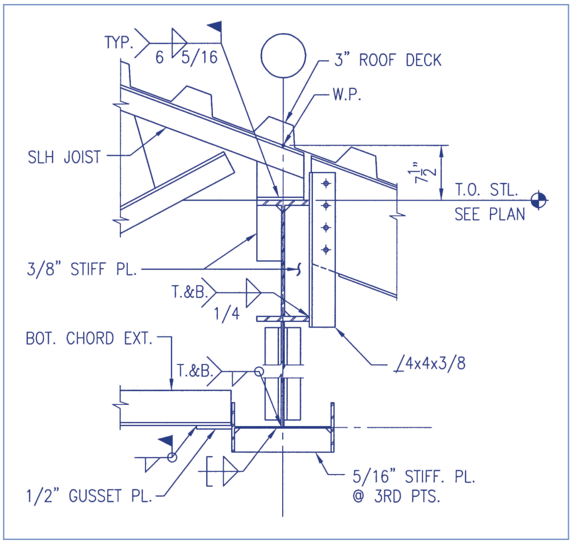
SPECIAL COATINGS FOR EXPOSED STRUCTURE

The majority of the natatorium’s roof structure did not require fireproofing. However, there were two locations where the architectural team preferred the visual impact of an exposed structure and fireproofing was a code requirement. The first location occurs where the roof structure extended over the tiered precast seating platform. The seating platform was elevated above the pool deck to provide desirable sight lines of the entire pool for event spectators. As a result, the underside of the roof joists were located only 20’ above the occupants. The other condition was the exposed lateral cross bracing located in front of the existing façade of Freas Rooke. In both locations, an intumescent coating was applied to the steel to provide the necessary fire rating and maintain visual consistency with the remainder of the exposed structure.

The natatorium environment, with its high humidity and concentration of corrosive chemicals, presented additional challenges to providing an exposed structure. All exposed steel elements were coated with a three-part application of protective Tnemec paint. The steel was shop coated with a compatible, zinc-rich primer prior to erection. The final two coats were field applied after all field welding and final connections were completed. The roof deck was specified as a cellular deck with G90 galvanizing and shop applied finish coat of Tnemec paint. The cellular roof deck was attached to the roof joists with powder-actuated fasteners in lieu of puddle welds to further protect the coating of the roof joists and deck.

CONNECTIONS

An effort was made to keep the majority of field connections to simple bolted connections. Moment connections were limited to the fitness center



Section through the moment-frame trusses at the southern end of the gymnasium.

View of tubular X-brace and roof framing during construction of the natatorium.

and to a portion of the first floor of the gymnasium. These moment connections were shop welded and field bolted wherever possible. Also, since the majority of the connections for the roof framing were to remain exposed, careful attention was paid to these connections. The lateral frame trusses and majority of structural wide flange connections were field bolted. The roof joists had seated connections to the wide flange trusses, and required only simple fillet welding from above, and were not visible from below. Bridging and bracing, as well as additional angle braces, generally had an erection bolt and were fillet welded after the steel was erected and final adjustments made. The result was a streamlined structure without large bolted gusset plates.

SUMMARY

The design team faced numerous challenges in attaining the demanding and diverse needs of the facility. Overall, each of the structures came together to create a unique, multi-purpose activity center. The steel structures were not only instrumental in defining the functions of the buildings, but also became an integral part of the architecture. The result is a fully integrated work of engineering and architecture that meets the university's expectations. ★

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