The Steel Challenge: Collegiate Sports Facilities

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These projects can present both structural challenges and opportunities in which structural steel excels as a solution.

IN RECENT YEARS, COLLEGIATE SPORTS FACILITIES and the extensive activities, equipment and programming that go along with them have become the heartbeat of campus health and wellness. Given the huge recruiting potential associated with these buildings and the trend toward integrating multiple campus functions under one roof, it is no surprise that the project size for new facilities, once averaging 40,000 sq. ft, continues to grow. Among the largest, for example, the Recreational and Physical Activity Center at Ohio State University, completed in 2007, offers more than half a million sq. ft of recreation, meeting, fitness and aquatic space.

In the past 20 years, the average cost to build these state-of-the-art recreational facilities has increased from $2 million to more than $50 million. Moreover, according to Kerr & Downs Research, the growth in recreational facilities construction is expected to continue, despite the slowdown in the economy. Today many university officials view their sports facilities as economic drivers within the surrounding community and among their alumni/donor base.

For the structural engineer, the size and complexity of these facilities can present both structural challenges and opportunities in which structural steel excels as a solution. Many of the challenges in designing large student sports and recreation centers are unique to these structures. One of the most unique is accommodating the sheer number of different activities housed under one roof.

Every recreation center will likely house a multi-purpose gymnasium, weight training area, cardio area, aerobic rooms, indoor jogging track, locker rooms and offices. In addition, many also will include more specialized areas for racquetball/handball/squash courts, rock climbing walls, outdoor pursuits, indoor and outdoor pools, and hockey rinks. To complicate things further, smaller universities also often put other departments into the same building. It is not uncommon to see athletic, kinesiology, biomechanical/anatomy labs and even nursing programs sharing a building.

With each of these functions and services come special needs and design issues. The most obvious to the structural engineer is the need for large open spaces. With gymnasiums, minimum spans of 100 ft should be expected, with much larger spans for competition gyms with bleacher seating. In addition, most designs call for expanses of 60 ft or more in the main workout areas that house cardio machines and weights. Steel, whether as fabricated trusses or long-span joists, offers an economical solution. Combining that with acoustical steel roof deck can provide an appealing open space with good sound qualities.

Another major issue is support of jogging tracks. Students want the ability to exercise indoors in a climate-controlled and secure area, regardless of weather or location. And as recreation centers have grown, so has the complexity of the jogging tracks, and you can be assured that at some point the track will be cantilevered. We have tried most methods of accomplishing this including concrete systems, composite systems, steel systems hung from the roof structure and steel cantilevered systems. Each has its benefits, but steel systems that are cantilevered from support columns are our preference. Even though vibration may be more of an issue when designing with steel, the ease of fabrication and construction make this the most economical system.

Vibrations of the structure are an important design consideration in these facilities. Jogging tracks that can have anywhere from one to more than 50 people at a time can experience significant vibrations if not addressed in the design. Additional mass helps, but this same mass can significantly affect the beam and column sizes. This has to be considered in conjunction with the actual track width (cantilever length), support spacing and the natural frequency of the structure. Unfortunately there is no magical answer; the final solution will likely vary with each individual case. Similarly, these same design criteria need to be considered for other areas of the

Texas A&M University–Corpus Christi
Corpus Christi, Texas
Area: 67,000 sq. ft
Cost: $20.5 million
Completion: January 2009

68-in.-deep steel joists span 123 ft over the Dugan Wellness Center gymnasium. A drag truss at the end of the gym is designed to carry hurricane wind forces from the high roof level to the braced frames.

building such as dance and martial arts rooms that may have an entire class bouncing at exactly the same rhythm, as well as aerobic areas set up with treadmills.

Sports and recreation centers also require coordination with specialized manufacturers, equipment providers and sub-consultants. Specialized manufacturers include flooring (sport courts, wood flooring, and rubberized or composite track flooring), aerobic equipment, basketball goals (to be hung from the roof structure) and prefabricated racquetball courts. In addition, it is common to have specialized sub-consultants designing pools, rock climbing walls, food vending areas and hockey rinks, all of which require coordination with the structure.

The following four projects completed for the University of Texas and Texas A&M systems demonstrate the steel requirements behind this burgeoning and competitive niche business.

Dugan Wellness Center

The Dugan Wellness Center represents Phase I of a multiple-phase project that will ultimately meet the needs of several campus departments: Recreational Sports, Athletics, Kinesiology and Nursing. The three-story facility contains a gymnasium with two regulation NCAA Division II basketball courts and seating for 1,500 spectators, weight and cardio areas, locker rooms, and group exercise rooms. In addition, the university opted to incorporate its new Emergency Operations Center (EOC) into this project to save the cost of constructing a separate structure. Located on the Texas coast, the structure was designed to withstand hurricane force winds of 120 mph.

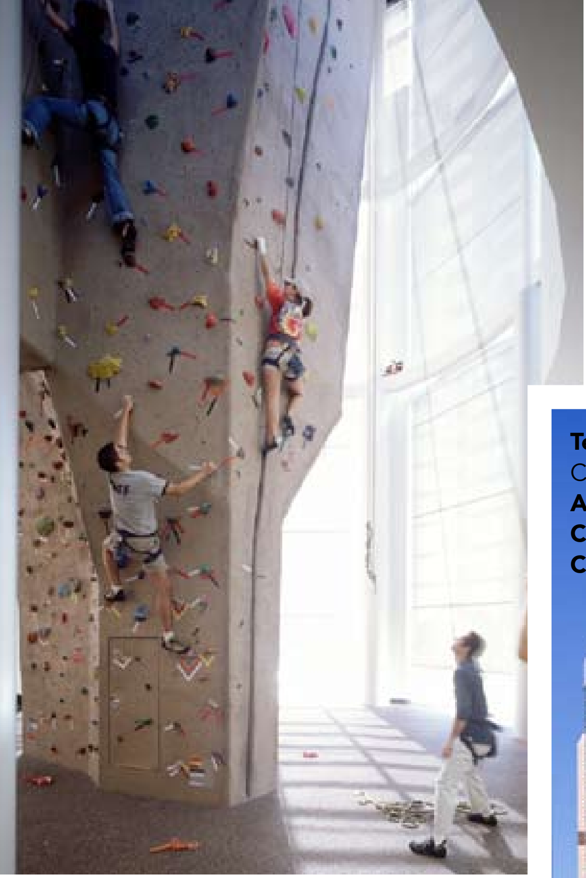
Both concrete and steel systems were considered for this project. Several factors influenced the choice of structural steel, including the 123-ft span over the gymnasium, greater versatility, the ability to accommodate a shortened construction schedule with the release of an early steel package, and sustainability goals.

The upper level floors consist of a composite steel framing system with 3½-in. of lightweight concrete over a 3-in. composite steel deck. Prefabricated steel joists supported on wide-flange girders provide the roof level framing, along with 68-in.-deep joists spanning the gymnasium. Roof framing over the EOC uses composite steel framing to meet hurricane design standards. The lateral system consists of a combination of steel braced frames and concrete masonry unit (CMU) shear walls.

Final steel quantities included 392 tons of structural steel and 62 tons of joists, all of which was recycled.

Owner/Developer The Texas A&M University System
Architect F&S Partners Inc., Dallas
Structural Engineer Jaster-Quintanilla, Dallas
Engineering and Steel Detailing Software
RAM Structural System
Contractor
Fulton-CoastCon Construction, Corpus Christi, Texas

From left: John Hoenig, P.E. LEED AP; associate/senior project manager; Thomas L. Scott, P.E., LEED AP, principal; and Stephen H. Lucy, P.E., principal, Jaster-Quintanilla (www.jqeng.com).



Above: Composite steel cantilevered running track in the Jerry D. Morris Recreation Center gymnasium is supported by composite steel columns.

Texas A&M University–Commerce
Commerce, Texas
Area: 51,442 sq. ft
Cost: $9.99 million
Completion: June 2003

Above and center: Interior and exterior views of the architecturally exposed steel supporting the curtain wall around the climbing wall at the Jerry D. Morris Recreation Center.

Jerry D. Morris Recreation Center

The Jerry D. Morris Recreation Center houses a multi-court gymnasium, 45-ft climbing rock, a cantilevered three-lane jogging track, four racquetball courts, a large fitness room with cardiovascular and weight equipment, an aerobics room, snack area, locker rooms and co-located kinesiology classrooms. One of its unique architectural design features is an elliptical tower of exposed steel and curtain wall around the climbing wall.

Steel was the structural material of choice for the 102-ft spans over the gymnasium and racquetball courts. Architectural aesthetics and the flexibility required for the complex architectural forms also were factors in this selection.

The upper level floors consist of a composite steel framing system with 3½-in. of lightweight concrete over a 3-in. composite steel deck. Prefabricated steel joists supported on wide-flange girders were used for the five different levels of roof framing. The lateral system consists of a combination of steel braced frames and CMU shear walls. Composite steel beams and columns provide additional strength and stiffness for the cantilevered running track.

Final quantities included 225 tons of structural steel and 120 tons of steel joists, all recycled.

Owner/Developer The Texas A&M University System
Architect F&S Partners Inc., Dallas
Structural Engineer
Jaster-Quintanilla, Dallas
Engineering and Steel Detailing Software RAM Structural System and RISA-3D
Contractor Lee Lewis Construction, Inc., Dallas

Double-pitched top chord trusses span the TSU Recreation Sports Center gymnasium, where the jogging track is cantilevered from the W14x99 columns.

Recreation Sports Center

The Recreation Sports Center at Tarleton State was designed to interface with the university's main campus via a plaza and sweeping curvilinear curtain wall at the cardio theater and strength training areas. The facility consists of a three-court multi-purpose gymnasium, four racquetball courts, strength training, a rock climbing wall, cardio theatre, aerobics and martial arts rooms, locker rooms, two classrooms and administrative offices.

Both the 106-ft roof span over the gymnasium and the cantilevered, upper level jogging track posed structural challenges. Additionally, the second floor had aerobic and dance rooms that created vibration and in-floor ducting issues. Steel was chosen for its ability to satisfy all these needs and still meet the architectural aesthetics.

The upper level floors consist of a composite steel framing system, typically spanning approximately 35 ft, with 3½ in. of lightweight concrete over a 3-in. composite steel deck. Prefabricated steel joists supported on wide-flange girders were used for the roof framing, with double-pitched top chord trusses spanning the gymnasium. The lateral system consists of a combination of steel braced frames, moment frames and CMU shear walls. The upper level jogging track is cantilevered from W14×99 columns.

All recycled steel was used for this project—373 tons of structural steel and 215 tons of joists.

Tarleton State University
Stephenville, Texas
Area: 72,000 sq. ft
Cost: $12.2 million
Completion: November 2007

Owner/Developer The Texas A&M University System
Architect(s) Randall Scott Architects, Inc., Dallas
Associate Hastings & Chivetta Architects, St. Louis
Structural Engineer Jaster-Quintanilla, Dallas
Steel Fabricator and Detailer Basden Steel & Erection Inc., Burleson, Texas (AISC Member)
Engineering and Steel Detailing Software Used RAM Structural System
Contractor Satterfield & Pontikes Construction, Inc., Irving, Texas


University of Texas at Tyler
Tyler, Texas
Area: 127,000 sq. ft
Cost: $19.3 million
Completion: August 2003

Left and above: The serpentine track in the Herrington Patriot Center is hung from the castellated steel roof beams used to accommodate the long span over the weight room.

Herrington Patriot Center

At 127,000 sq. ft, the Herrington Patriot Center is one of Jaster-Quintanilla's largest and most comprehensive collegiate sports facilities. It is a multi-functional educational facility with offices and labs for the health and kinesiology faculty. Research and teaching labs include a biomechanical/anatomy lab and an exercise physiology lab. The complex also includes a 30,000-sq.-ft convocation center with three full basketball and volleyball courts and chairback seating for 2,000 spectators. In addition, the center houses a recreation and therapy heated pool and spa with sundeck, a student lounge, and a 6,340-sq.-ft fitness center. Two racquetball courts, dance studios, and an overhead suspended walking/jogging track complete the center's offerings.

Steel accommodated the versatility required by the facility, and met the aesthetic desires of the architect for an exposed articulated structure. Typical floor framing, including the elevated track, consists of a composite steel system with a 3-in. composite deck and beams spaced at 10 ft. Typical roof framing used open web steel joists at approximate 6 ft spacing with wide-flange steel girders and 1½-in. steel decking.

The roof at the competition gymnasium/convocation center consisted of 152-ft span, double pitched open-web steel joists at 15 ft spacing, supporting 3-in. acoustical steel decking. The joists were 96 in. deep at midspan and designed to support a suspended score board and rigging for light and sound grids used for musical performances.

The roof over the fitness area and supporting the walking/running track consists of 40-in.-deep castellated steel beams spanning approximately 64 ft and spaced at 12 ft supporting 3-in. acoustical metal decking. Because the serpentine jogging track was suspended from the roof, the use of castellated beams allowed greater flexibility in track configuration. Hanger location was not as critical as it would have been with open web joists or other truss options. All framing in this area was architecturally exposed.

All stairs within the facility are architecturally exposed with steel tube framing cantilevered from one central column at each landing supporting steel channel stringers. Lateral stability is provided by steel braced frames.

The project used 610 tons of steel.

Owner/Developer
The University of Texas System
Primary Architect
Hastings & Chivetta, Inc., St. Louis
Associate Architect Wiginton Hooker Jeffry Architects, Dallas
Structural Engineer
Jaster-Quintanilla, Dallas
Engineering and Steel Detailing Software Used RAM Structural System, RISA 3-D
Contractor C Construction Co. Inc., Tyler, Texas

For today's collegiate sports facilities, which have become the centerpieces of campus life, steel provides a structural solution for even the most ambitious multipurpose facility. It is versatile to accommodate building next to existing conditions, drops in floor slabs, long spans and special conditions such as hanging or cantilevered jogging tracks. Steel also works well with projects on a tight schedule when early release packages can be incorporated, and helps to meet sustainability goals that are set by many major universities and colleges now. In short, steel ensures not only the integrity and performance of the structure itself but also enables the fulfillment of the architect's aesthetic vision. MSC