Play Ball!

By Jeffrey D. Wells, P.E., S.E.

Playful structural steel elements and urbanist design make Hammons Field in Springfield, MO a popular new venue for America's favorite pastime.

Hammons Field in Springfield, MO is the cornerstone of the city's downtown redevelopment. A structural steel frame helped designers achieve the desired aesthetic for the new AA minor-league and Southwest Missouri State University ballpark, built by developer John Q. Hammons.

A stadium's architecture is critical for a good game-day experience, and the project team researched venues nationwide to guide the new ballpark's design. A common theme of successful venues was their old-time atmosphere and urbanist design principles. The design team chose a brick street presence with an articulated steel structure on the interior, similar to Coors Field in Denver.

The Overall Design

Pellham-Phillips-Hagerman Architects & Engineers (PPH) led the design effort, and the owner's in-house architectural staff was also an integral part of the team. Wells & Scaletty, the structural engineer, developed the concept for the exposed steel structure. CDFM2 of Kansas City, with expertise in sports architecture, assisted in the programming and schematic design.

The stadium plan included 8,000 seats and 28 box suites. Most seating was accommodated in the bowl, with the upper deck reserved for the suites and the party deck. A third level behind home plate section contains press boxes and three luxury suites. An important design goal was for fans to be able to see the field directly upon entering the main gate.

The bowl seating risers are concrete slab-on-grade. The sections along the first and third base lines are connected via bridges to the center section. Breaking up the structure in this manner helped define entrances and created more visual interest. The visitors' clubhouse, kitchen, and mechanical spaces are located below the concourse level.

The home team clubhouses, maintenance building, and an indoor practice facility are in the outfield. The project was sufficiently under budget that the practice facility could be added without increasing the project cost.

The Outfield berm accommodates 1,000 people. A sidewalk extends from concessions, restrooms, and stairs around the top of the berm. Handicapped-accessible platforms are provided along the berm. Large patio decks are located at the end of the first and third base lines.

In a traditional building, columns are often fire-protected with coatings or concealed by gypsum board, but baseball grandstands permit the exposure of steel framework. Exposed, painted steel was the only logical choice for Hammons Field, and a great deal of attention was focused on the steel detailing.

The $32-million-dollar facility included 874 tons of structural steel, 34 tons of bar joists, and 93,300 sq. ft of metal deck.

The Structural Concept

The design team wanted to create a structure that encouraged fans' eyes to roam. Engineers are used to drawing idealized structures with pins and rollers—items that have mathematical meaning but are not literal. Such idealizations rarely express themselves in the final structure, since connections are selected for strength and economy.

The design team wanted to create a stadium structure something that was visually playful and that would draw the attention of baseball fans. The goal was a structure that would encourage kids in the crowd to make the connection from the steel frame to their own toy building sets; and that would cause fans to imagine giant wrenches and tools required to construct the stadium.

Pipes were the preferred structural members. Their closed and curved section would stand up to rain and snow. The nooks and crannies created for bird nests would be minimized. Pipes are also relatively inexpensive. Standard weight and extra-strong 3″ pipes proved adequate.

The question emerged as to the best way to connect the pipes into trusses. Clevises supplied by Cleveland City Forge were used to make member-member connections, and they fit the desired "overgrown erector set" aesthetic. No. 3 clevises were used at the roof and no. 5 clevises were used for the floor framing. A325N bolts were used in the clevises instead of pins. Some of the pipes and rods were left-hand threaded on one end and right-hand threaded on the opposite end so their lengths could be adjusted in place.

Steel rods, 2″-diameter, were used for truss tension members. Pipes were then used for the compression struts. Truss top flanges were kept as double-angles to support the deck. The knee braces supporting the cantilevered suite risers took on the appearance of shock absorbers or hydraulic pistons.

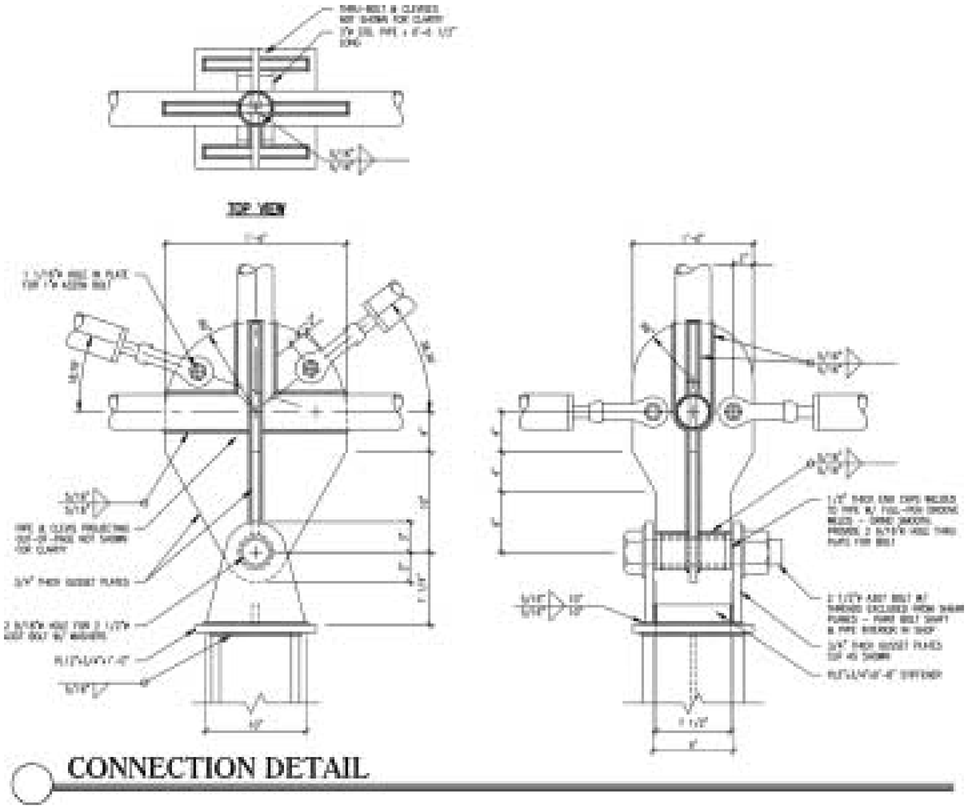
The connection from the roof canopy trusses to the columns was oversized intentionally. The metaphor was a piece of machinery frozen in place—it looks as if it was designed to move. The single 2½″-diameter through-bolt reinforced the hinge concept. The roof trusses were propped up on this big knuckle with a massive bolt passing through it. The height of this connection was kept low deliberately, so that it wouldn't get lost from view.

Pipes were considered for the columns but wide-flanges proved to be the more economical. Keeping the truss bottom-chord connections low served more than an aesthetic goal. The short unbraced lengths meant that W8x48 and W8x58 columns sufficed.

Precast-concrete slabs were originally planned for the Suites Level. The General Contractor, Killian Construction Company, proposed using a cast-in-place slab over metal deck. The 6″ overall-depth slab with 3″, 16 ga. composite metal deck proved to be less expensive. The seating risers at the front of the Suites Level remained a precast-concrete section. The precast concrete risers spanned 28′ between column lines.

Special Analysis

RISA-3D was used to analyze and design the steel superstructure. To reduce lateral displacements, the Suites Level was tied to masonry shear walls surrounding some of the stairwells and the street-frontage structures. Calculated wind forces were slightly magnified because the bowl seating acted like an escarpment. Wind load acts on all the exposed truss members. The overall magnitude of the force on the open structure was surprisingly large, and depending upon wind direction, can exceed the force on the structure if it were considered completely enclosed.



Above and below, right: Structural details using clevises, threaded rods, pipe sections, and plates serve as functional architectural elements.

Steel framing supports precast concrete risers.

Continuous connections from bay-to-bay meant that compression forces were introduced to the bent-bottom truss chords. This presented a potential buckling instability exacerbated by fabrication tolerances at the knee joint.

Bucking stability was assessed in two ways. First the linear elastic buckling load (minimum eigenvalue) was calculated. This is the critical load assuming the structure is geometrically perfect. Then, small imperfections were modeled and a Newton-Raphson incremental-iterative analysis was performed to account for non-linear geometry. By including the geometric-stiffness matrix, the restraining effect of the truss webs and the torsional resistance of the center, vertical pipe web could be taken into account.

Most of the concourse level is a slab-on-grade. However, the portions used for certain areas like the kitchens and the visitors' clubhouse required a structural slab. RAM Structural System was used to design non-composite steel beams and girders supporting a composite metal deck and slab. A drainage fabric and rigid insulation were placed over this slab, and a second concrete slab placed over it. From the concourse level it is impossible to tell when you are on grade or over an occupied space.

Alternate Framing Considerations

Traditional wide-flange beams and girders were considered for the superstructure. In fact, the owner requested an alternate design be prepared for cost comparison. Overall tonnage increased in this alternate design. Although connections were more traditional, the alternate price was only $35,000 less than the clevis-connected trusses. "The cost difference was trivial, and considering how much the steel design added to the overall project, we opted to go with the custom trusses," said Jim Thomas, project director for John Q. Hammons Industries.

Fabrication and Erection

AISC-member fabricator Doing Steel built the trusses in the shop as complete units. The overall goal was to minimize field welding that interrupted the shop-applied primer. Where adjustments were required, the clevises could be spun around, lengthening or shortening the member. Some specific column gusset plates had to be shipped loose and field-welded. Gusset plates were plasma-cut on a Versagraph burn table with a Burny No. 5 CNC control. Other cuts were made by a Kaltenbach CNC robotic coping machine. This German device is the first fully robotic coping machine in the United States (see the "Robotics" sidebar on p. 58). For assembly, Doing Steel made their own tools and wrenches to handle the large clevises and bolts.

The Double-A franchise for the park has not yet been named, but the team is planned for the 2005 season. Hammons Field opened April 2, 2004 with a 9,000-plus crowd for the NCAA Division I SMSU Bears. "I don't know of any finer place to play," said SMSU Athletic Director Bill Rowe after completing their first season. "At the collegiate level, this is absolutely the tops. Nothing was overlooked." ★

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John Q. Hammons

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Design Consultant
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Steel Fabricator/Detailer
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Engineering Software
RISA-3D
RAM Structural System

General Contractor
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