# The New Nationals Ballpark

*Design-Build Collaboration at Its Finest*

*By Mark Tamaro, P.E., Tom Scarangello, P.E., and Dimitrios Frantzis, P.E.*

*In February 2006, the Washington DC Sports and Entertainment Commission authorized Clark/Hunt/Smoot A Joint Venture to construct a $611 million ballpark for the Washington DC Nationals baseball team, to be completed for opening day of the 2008 season. This event kicked off an ultra-fast-track design and construction schedule for the Nationals Ballpark that involved an innovative design process and unprecedented design-build collaboration.*

## Schedule

The design team (architects HOK/Devrouax & Purnell, PLLC, and structural engineers ReStl/Thornton Tomasetti A Joint Venture) was at the 50% Design Development level when the guaranteed maximum price (GMP) was accepted by the District of Columbia government. At that point the general contractor, Clark/Hunt/Smoot joint venture, assumed the design team's contracts and set to work with all of the designers and subcontractors to establish a design and construction schedule that would meet the opening day deadline. What resulted was a timeline of twelve early structural and architectural packages that would allow construction and material purchasing to begin immediately while the final design progressed towards its completion almost a year later.

## Site

The new 41,000 seat facility is located on South Capitol Street in a former industrial area along the Anacostia River. Poor soils conditions dictated the need for a deep foundation system, and the existence of contaminated soils ruled out the use of deep foundation systems that would have created additional spoils to be removed from the site. Fourteen inch square precast-prestressed piles were selected because they could achieve the required 100 ton capacity and had the shortest procurement lead time. In addition to the challenging soil conditions, the site also has a 100 year flood elevation that is approximately 6 feet above the final field level. The solution was to install a permanent below grade dewatering system, which would maintain the ground water elevation at a level ten feet below the playing surface. Despite the poor soil conditions, the site had a distinct advantage in that a concrete plant existed on an adjacent lot across the street from the site, encouraging the use of cast-in-place concrete for as much of the structural system as possible. Because the design would feature a playing field and a service level that would occur roughly twenty feet below the existing grade, it was determined that a concrete beam and slab system with cast-in-place rakers at the lower seating bowl would be used up to the main concourse. The construction schedule revealed that, by the time the main concourse concrete frame was complete, fabricated structural steel could be delivered to the site. Steel, therefore, would be utilized as the structural system for the remainder of the superstructure. The seating bowls would be filled in by precast risers once the concrete and steel structure was in place.

## Design Sequence

The critical path dates for specific design packages were established by working the construction schedule backwards from the completion deadline. Meetings with the designers and subcontractors were held regularly, with a focus on optimizing the construction schedule and determining what aspects of the structural design could be defined and completed the earliest. The result was a plan to release procurement packages and construction documents for seven consecutive areas of the structure that would follow the planned sequence of construction. The areas were separated at logical breaks in the structure, such as at expansion joints and at changes in the seating bowl geometry. Each area had a distinct construction package release for foundations, concrete superstructure, steel mill order and steel fabrication. The first packages for foundations and partial steel mill order where completed in mid-March 2006, less than two months after the

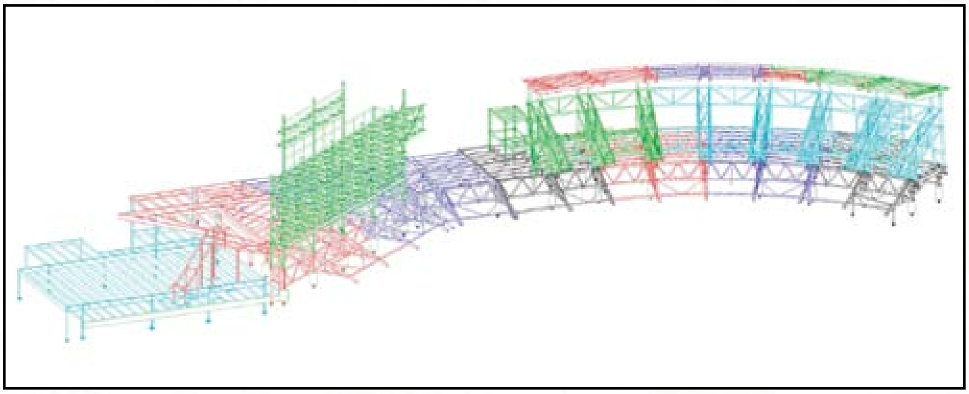

*Figure 1: Partial view of the Tekla model used through out the design and fabrication process; Courtesy of Banker Steel and Mountain Enterprises.*

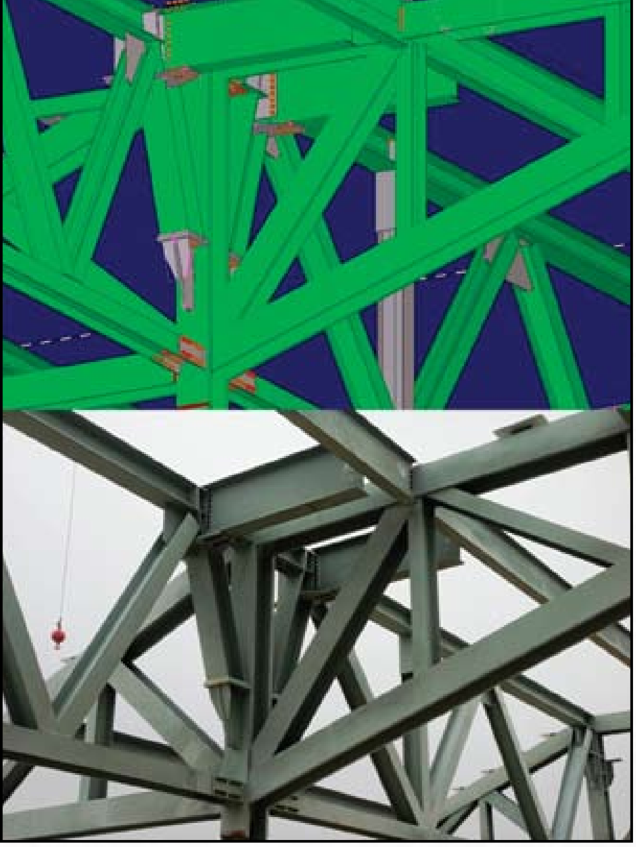

*Figure 2: View from the Tekla model (above), Courtesy of Mountain Enterprises. Actual in place steel (below) Courtesy of Thornton Tomasetti*

acceptance of the GMP. Subsequent packages were issued for construction on a monthly basis until the structural frame for the entire building was completed roughly seven months later. During this frenetic period, the designers and contractors had to manage a project that simultaneously had each area of the building in different states of project development, i.e. design, shop drawing production and review and construction. Even with such an intense pace of design, many potential pitfalls were avoided, in part because the architects, engineers, and contractors used their wealth of past ballpark experiences to identify critical design issues and to apply past "lessons learned" to create new design approaches.

## Building Information Modeling (BIM)

Before any of the individual area design packages were released for construction, material reservations needed to be prepared for the advanced purchase of precast piles and structural steel. A combination of preliminary two- and three- dimensional finite element models where used to develop the foundation loads and to estimate the steel tonnage quantities. Two-dimensional graphical depictions of the radial bents, out-of-plane trusses, ramp structures, and composite floor framing, along with estimates for field lighting and score board structures, were compiled to establish the initial mill reservations. This compilation of steel tonnage estimates was performed hand in hand with the general contractor, Clark/Hunt/Smoot, their steel subcontractor, Banker Steel, and the design team. All three parties provided separate checks of the estimated tonnage, and a consensus estimate was established.

Once the steel mill reservation was made, the design team continued to focus on the design of the first building area to be released for its structural steel mill order. This design process was largely performed in a virtual environment, where three-dimensional finite element analysis models were used to evaluate and size the structure for gravity, lateral and thermal loads, and for vibration serviceability requirements. As the steel frame design developed, a detailed model was created by the design team using Tekla Structures software. The Tekla model generated by the design team defined the primary structural geometry and member sizes. Portions of the model were released to Banker Steel for the mill orders for seven different sub-divided areas of the ballpark. Once the Tekla model was handed over to the Banker Steel's detailer, Mountain Enterprises, the mill order for that particular area was made and Mountain Enterprises took ownership of the model, beginning their process of detailing the structure and coordinating with the design team. as the design advanced toward completion (*Figure 1*).

Three major benefits to using BIM modeling were realized on this project:

1) *Benefit to the Overall Schedule*: The designers created Tekla models with the overall geometry and major steel elements in a format that was directly transferable to the steel detailers. As a result, the team was able to eliminate several months from the time period normally required by the steel bidders to do detailed take-offs of all member sizes and lengths that are necessary to produce a bill of materials for the mill orders.

2) *Detailing Benefits*: The model's ability to view complex connections in three dimensions and to rotate and view complex geometries in real time during coordination meetings allowed the designers to coordinate connections with the steel detailers with a much higher degree of accuracy than can be achieved using traditional drawings. The architects could also approve the appearance of exposed connections because the model displayed the exact geometry, bolting, welding and pieces of the connections (*Figure 2*).

*Figure 4: Start of precast seating-tub erection. Staged structural analyses were performed to allow precast erection prior to complete construction of the steel frame.*

*Figure 3: Photo of 75 foot long by 14 foot high typical prefabricated raker truss, which was designed to maximize shop assembly and simplify erection.*

3) *Coordination Benefits*: Once the initial model was created for the steel frame, the steel detailers were able to add other construction elements into the model. For example, the precast seating treads and risers were added to the model to verify that the bearing seats and connections to the steel matched what was required by the precaster. By doing this, numerous geometry conflicts, such as precast stems conflicting with steel members that may not have otherwise been realized until construction, were identified during detailing. Information from other trades was also added to provide the building managers with an integrated model for future work.

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*Figure 5: Simultaneous construction activity including earth work, pile installation, cast-in-place concrete forming and placement, steel erection, and precast erection.*

**Project Team**

**Owner:**
*DC Sports and Entertainment Commission*

**Architect:**
*HOK/Devrouax & Purnell, PLLC*

**Structural Engineer:**
*ReStl/Thornton Tomasetti A Joint Venture*

**Contractor:**
*Clark/Hunt/Smoot A Joint Venture*

**Concrete subcontractor:**
*Clark Concrete Contractors LLC*

**Structural Precast subcontractor:**
*Sidley Precast Group*

**Steel Fabricator:**
*Banker Steel Company LLC*

**Steel Detailer:**
*Mountain Enterprises*

**Steel Erector:**
*Bosworth Steel Erectors, Inc*

## Design-Build Collaboration

Much of the architectural coordination during the early phases of design focused on establishing the structural geometry and details critical to the mill order. The design-build team also worked with the architects and engineers to achieve the desired vision, while optimizing the structural systems and enhancing constructability. The team developed seemingly minor details, such as setting the concrete raker rebars down from the top of concrete which allowed the precast bearing seats to be post-installed precisely where needed with drilled-in mechanical fasteners that would not conflict with these rebars.

The design-build collaboration process also facilitated more significant decisions such as those involving the geometry of the large truss elements. The team's intent was to shop fabricate as much of the steel assemblies as possible. Precise limitations for shipping sizes of prefabricated trusses (*Figure 3*) were established early in the design along with plans for erection sequencing that would allow the precast seating to be installed prior to completion of the steel frames (*Figure 4*). The aesthetics of the structure also benefited from the design-build collaboration, which allowed the design architects to participate in the connection design and detailing process. For example, with their input, details were established that eliminated the use of large, unsightly gusset plates. Virtually all connections were viewed in the three-dimensional models and approved before the production of shop drawings.

## Conclusion

The design and construction schedule for the Nationals Ballpark is the most aggressive schedule ever undertaken for a Major League baseball park. Part of the success to date can be attributed to the high level of cooperation amongst the Design Build team, and the confidence to undertake creative delivery methods, that utilized BIM modelling as a tool for coordination and for accelerating material procurement.▪

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*Figure 6: Rendering from South-West vantage point. Rendering courtesy of HOK/Devrouax & Purnell, PLLC*