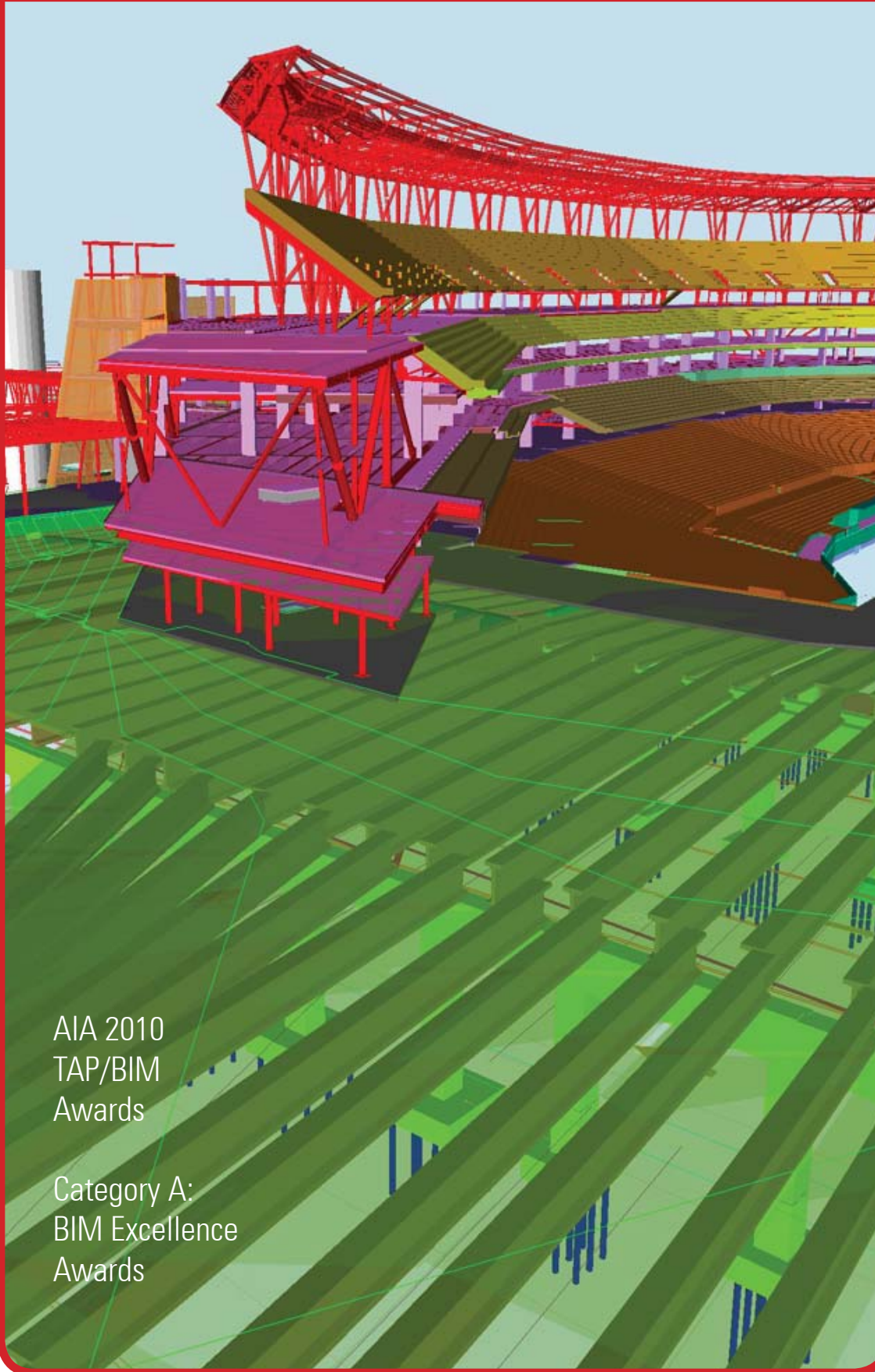


TARGET FIELD: REMOVING THE VARIABLES THROUGH BIM



AIA 2010
TAP/BIM
Awards

Category A:
BIM Excellence
Awards

contents

Introduction

Owner's Statement

Architect's Statement

Contractor's Statement

Cast in Place Coordination

Structural Steel

Working Within the Site

Bassett Creek

Building Around the Rail Lines

Following the Bridges

Two Structures, One Building

Summary

“The site conditions made this ballpark the most complex we’ve ever completed.”

- Senior Principal,
Sports Facility Engineer

Successes

- Structural shop drawings review durations were minimized in many cases to 2-3 days through collocation and electronic/model sharing.
- Responses to RFI’s were able to be determined as a team through model analysis. Often times resulting in same day turnaround of associated documentation.
- Involving field personnel in coordination activities improved constructability and provided a better understanding of upcoming work.

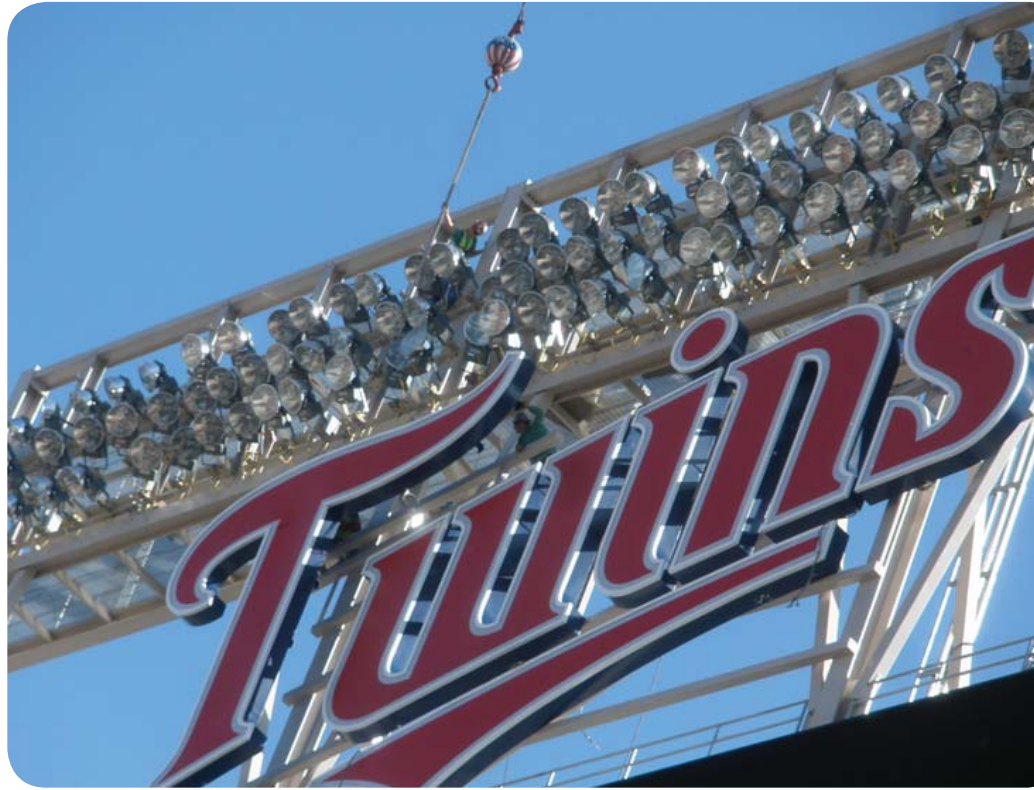
Challenges

- The central building information model was comprised of numerous models. A major challenge on a job of this size and speed is to reconcile design and construction models and maintain a single accurate base file.
- Sharing models without rights of reliance and a supporting contract structure.
- Hardware and network capabilities for managing large detailed models.



Introduction: Fitting In

Built on one of the most complex sites imaginable, the Minnesota Twins new stadium, Target Field, faced challenges that could only be surmounted through extensive use of building information tools and procedures. Situated on a roughly 8 acre site, the building expands to nearly 12 acres on the main concourse. At that elevation the building ties in with elements on every side of the job. To the north and south, two bridges. To the east, a 99,000 square foot plaza extending over an interstate highway. To the West, a smaller promenade spanning two heavy rail lines. And below, an underground creek of unknown size and location. Each of these elements presented potentially precipitous obstacles that could only be averted through careful and precise modeling.



Owner's Statement

"This is truly an historic day in Twins history," said Jerry Bell, president of Twins Sports, Inc. "Considering the complexity of the site and extreme level of attention to detail in design and construction, to be complete two months ahead of schedule is a feat to be recognized and celebrated."

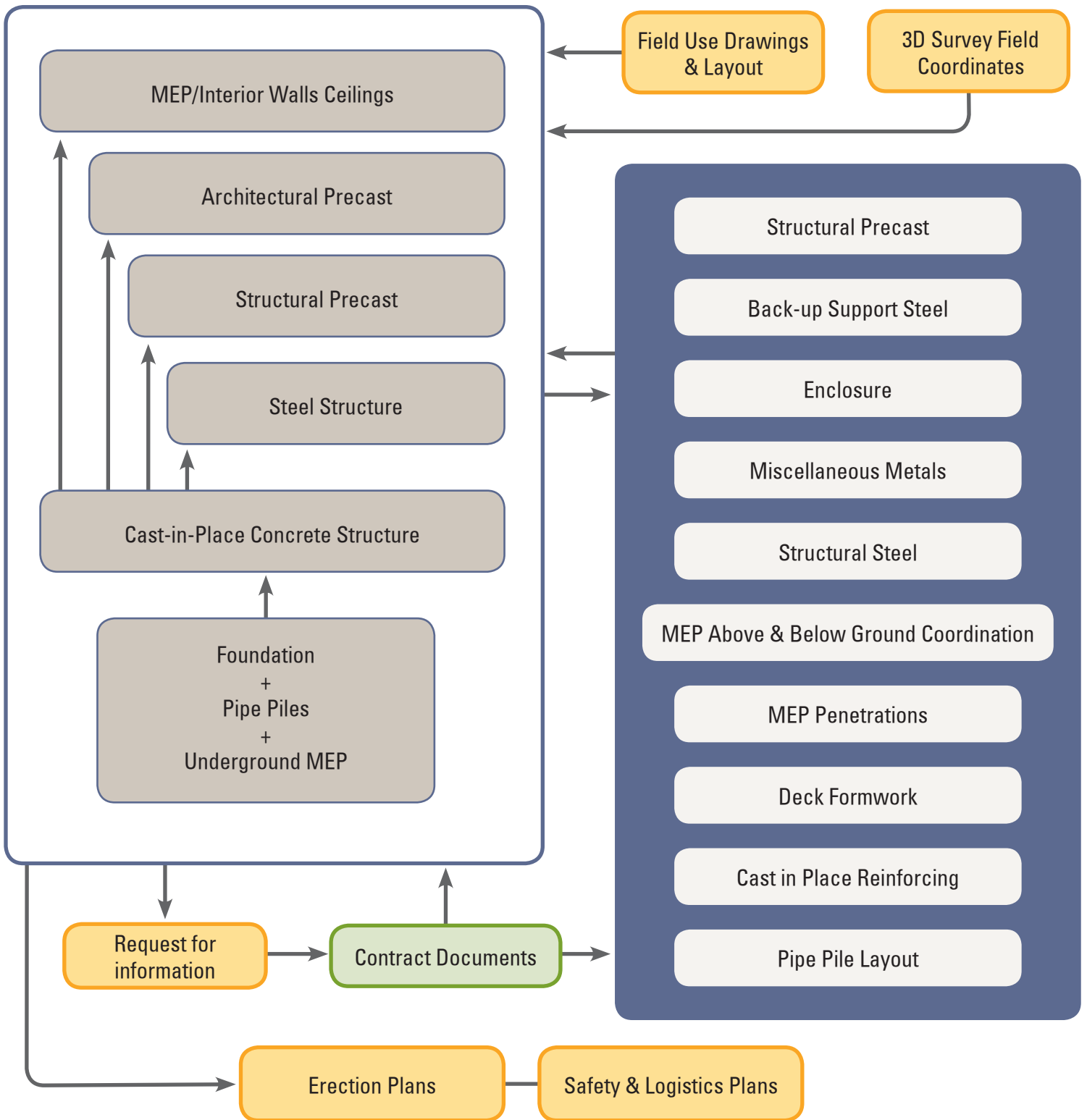
Architect's Statement

"Building information modeling was invaluable to maintaining the integrity of our design by giving us the flexibility to understand design options before any work is put in place."

Contractor's Statement

The construction BIM, created from the 2D contract documents, was this job's bible. We basically used it as the lexus of all design and construction information. It was crucial for shop-drawings, schedule logic review, for MEP coordination and constructability issues. In other words, it was used not only to track, but to choreograph construction activities. Our subs, for instance, could only have managed their extensive workforces amidst all the other workforces with the ability to pre-plan in great detail, an ability unthinkable without the model. This was the largest schedule and the most complicated site in company history and we finished it early—three months ahead of schedule. It would have never been done without BIM.

COORDINATION MODELS



The workflow diagram represents the development of the model. Specifically, creating a base model from the contract documents, in much the same way that the information would be processed in the field. Building upon this required incorporating shop drawing information as well as field verified 3D survey coordinates, the model was continuously developed in concert with the various stages of coordination. From this information, field assistance drawings and field use drawings were created to ensure that work was installed as coordinated, greatly reducing the need to work out problems after they were already put in place.



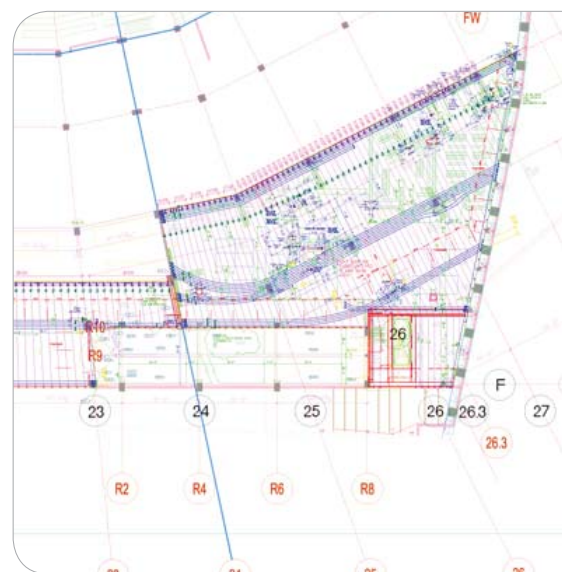
Main concourse pan and joist deck with reinforcing and sleeves

Cast in Place Design Through Coordination

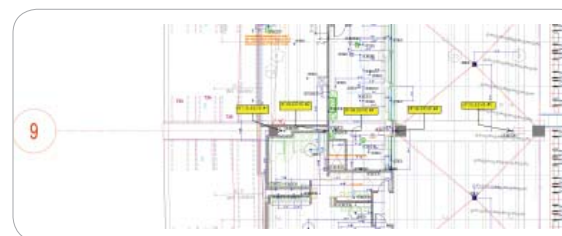
Apart from the spatial constraints on the project, time also served as a possible stumbling block. In many cases decks were being poured well in advance of the final, fully dimensioned interior plans. Heavy design team involvement was required to identify provisions for further programming and design development. To ensure deck sleeving and layout was able to work real-time with the evolution of the design, new technologies and systems had to be developed.



Main Concourse Sleeve Layout

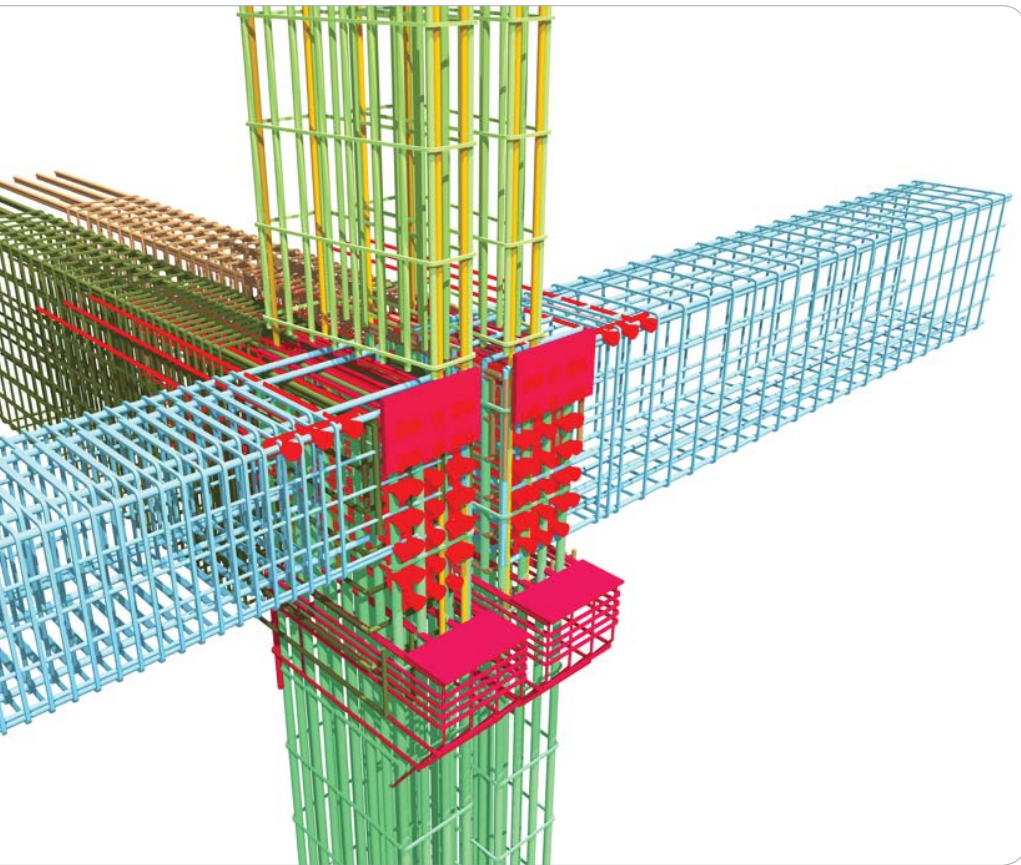


Mezzanine Sleeve Layout

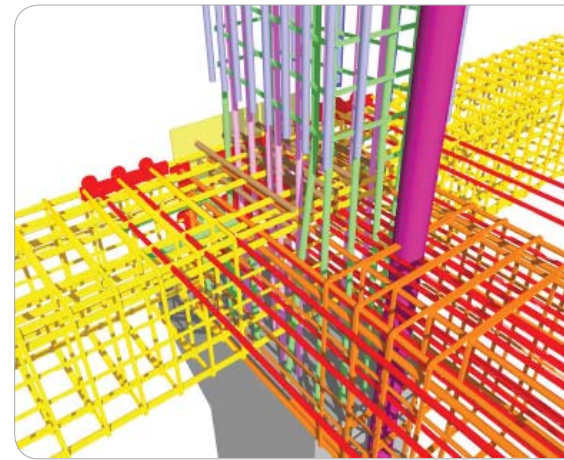


Sleeve Layout Detail

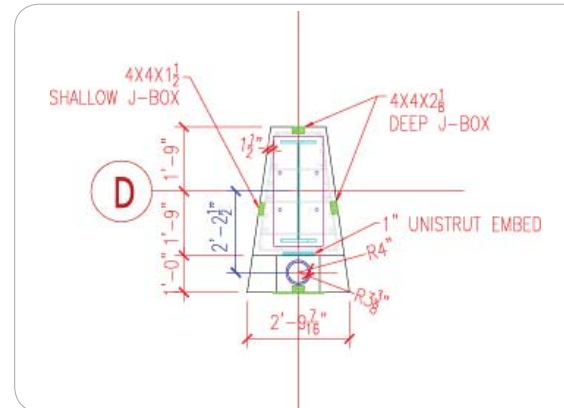
55,000 cubic yards of concrete
5,000 tons of rebar



Main concourse column intersection at grid



D-Line column model with pipe penetration



D-line column section

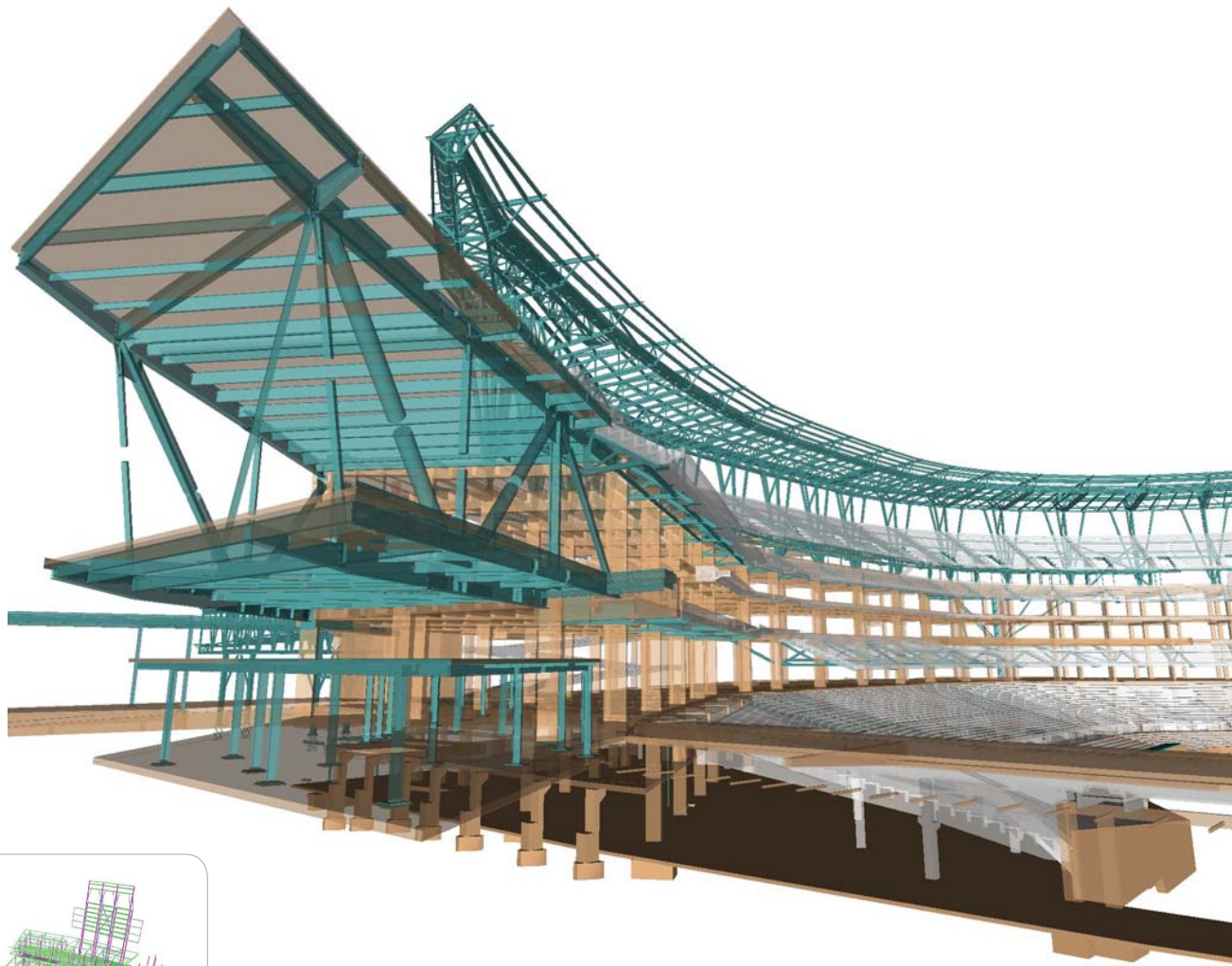
Cast in Place Design Through Coordination

Traditional methods of layout rely on using tape measures to triangulate locations from marked grid. This is a time consuming task that does not have a high degree of accuracy, especially with complex radial geometry. Using a robotic total station and dynamic tags created within the 3D model, the mechanical contractor was able to place over 5,000 sleeves and openings with an extremely high degree of efficiency. This was especially important to ensure accurate layout while at the same time reducing the time and labor required.

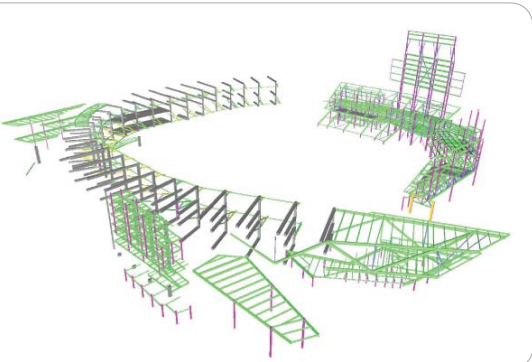


D-line column in the field with pipe penetration

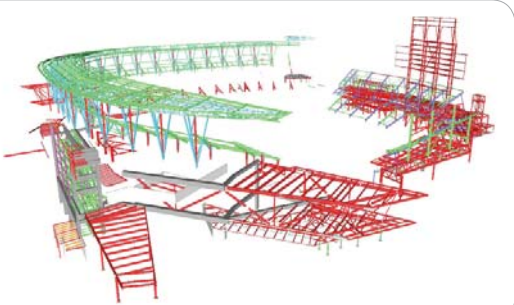
70% of construction waste was diverted from landfills



View from plaza looking west at metro club



Snapshot of the steel model, February 25, 2008

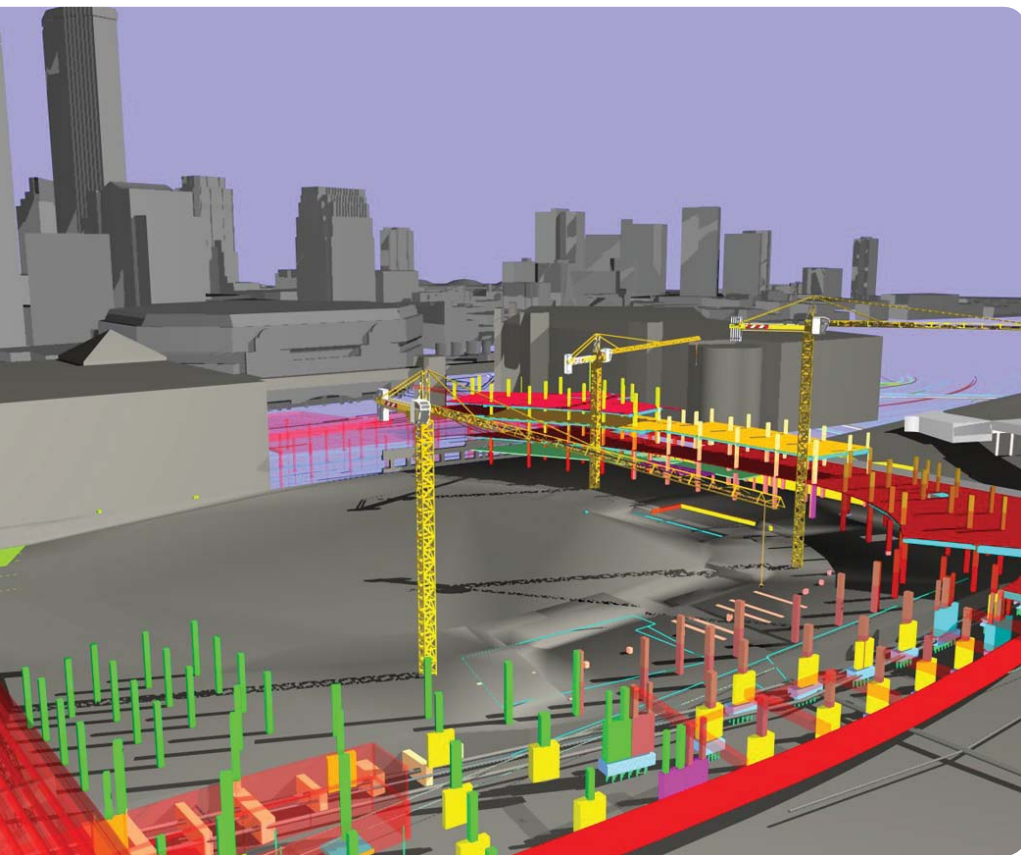


Snapshot of the steel model, June 20, 2008

Structural Steel Shop Drawing Review

A critical component of the project schedule was delivering the 3,000+ tons of structural steel on time. This meant that traditional shop drawing review methods, especially for many of the intricate connections would not be sufficient to maintain field progress. The result was a period of collocation by the design team, general contractor, and steel fabricator and detailers. The model created by the detailer was reviewed by the structural engineer where the accuracy of forces, connections, length and locations were discussed face to face. By using the model as the primary means for real-time coordination, the traditional RFI & 2D shop drawing review process became a formality. This allowed for significant efficiencies in the design, detail and review process.

3,000 tons of steel
Canopy: 1,387 tons, Scoreboard: 257 tons

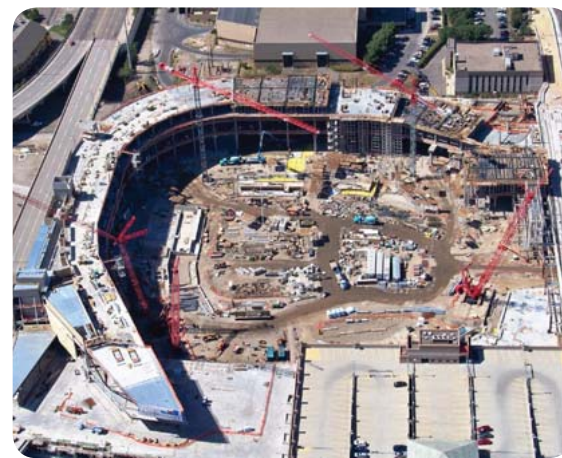


4D model shot looking east

Working Within the Site

Due to the complexities of the job site: bordered on the North and South by bridges, East by an active hi-way, and the West side by an active railroad, the stadium needed to be built from the inside out. During preconstruction, a 4D model of the ballpark was created using design models (structural & architectural) in part to determine the scheduling of the cranes, all of which were to operate inside the building footprint. A total of 3 tower cranes (123' tall to 166' tall) were used for cast in place structure and three primary crawler cranes for steel, precast concrete enclosure, and precast concrete stadia. Coordinating tradeflow for up to five of these cranes simultaneously within a tight site required a virtual review of each crane's pick locations and their ability to reach the proper building elements.

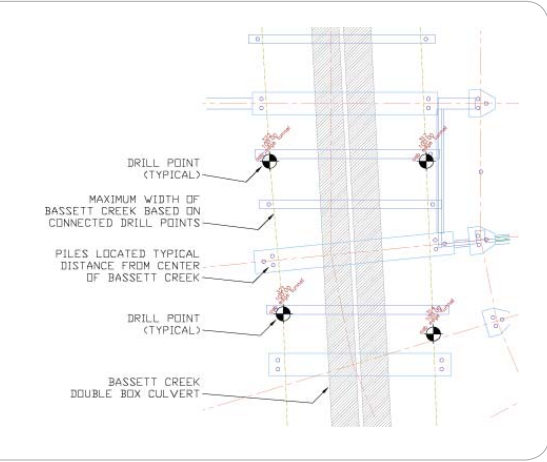
Another major component of ensuring successful installation was the steel erector's use of the model to communicate with the fabricator. Initial as-builts were first gathered to verify field fit-up. Trusses and major structural components were then evaluated for access & safety.



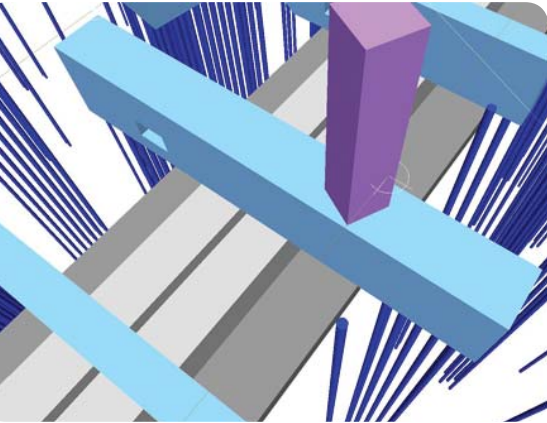
Site progress, August 26, 2008

“It was like stuffing 12 pounds of potatoes into an 8 pound bag.”

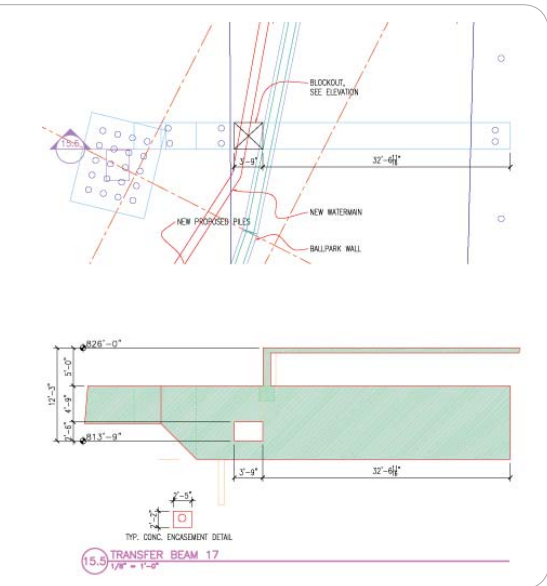
- Nadine Post,
Engineering News-Record



Field verified coordinates of the creek



Model shot of transfer beam and creek



Field use drawing of transfer beam

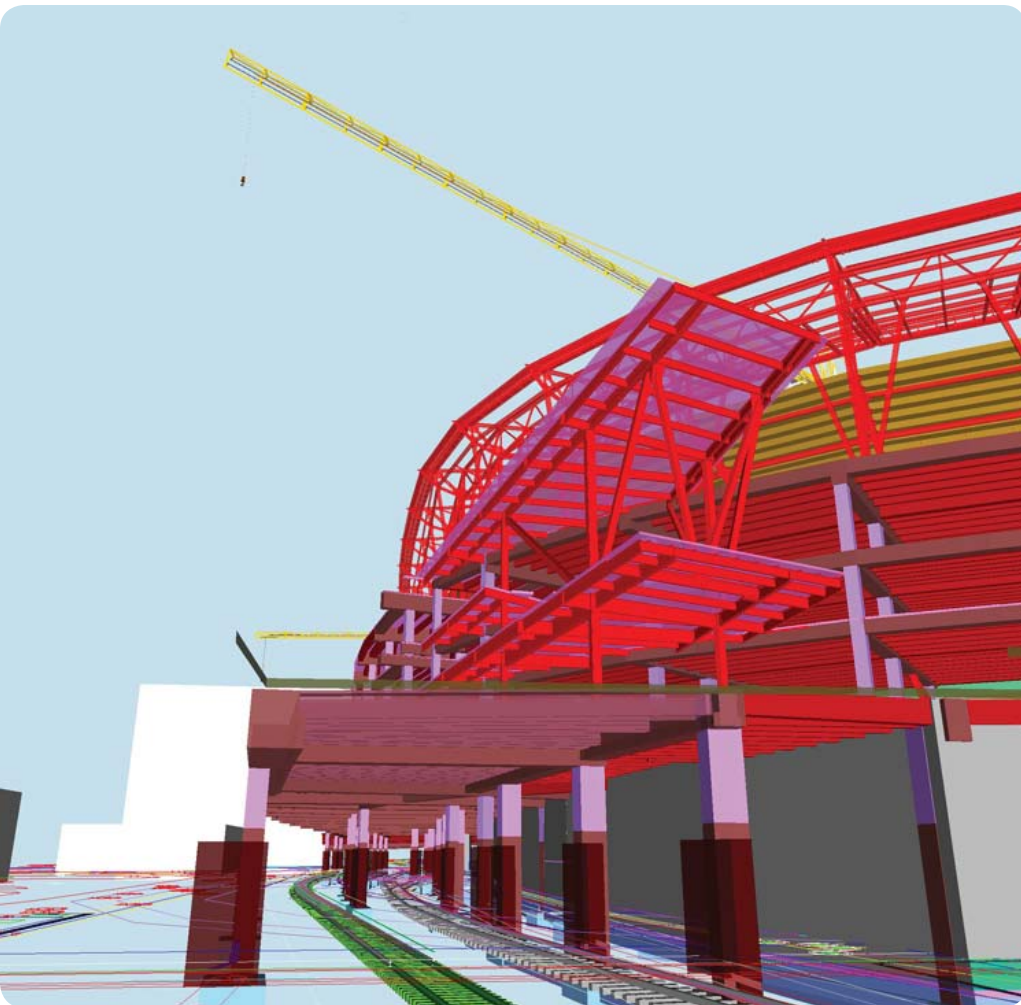


Transfer beam #11 in the field

Bassett Creek

Building above, and around, an active underground storm-water culvert proved to be a true challenge. Situated roughly 20-30' below grade, the 32' wide twin box culvert known as Bassett creek ran the entire length of the project. The exact profile of the structure was an unknown and rather than completely remove the sub-grade all the way down to the culvert, boring was conducted at 90' increments. From this information, a model was created which and then used in concert with the design parameters to define the ballpark foundations. 24 large transfer beams and 29 smaller grade beams were required to disperse building loads beyond the edge of the structure by up to twelve, 100' deep steel piles per beam. The geometry of each of these, as derived from the model, was shared with the steel reinforcing and temporary shoring subcontractors for their shop drawings.

90% of rainfall is captured + treated



Model shot looking north over BNSF and Northstar rail lines

Building Around the Rail Lines

Running below the main concourse on the western edge of the stadium are two rail lines, Burlington Northern Santa Fe and Minnesota's new heavy gauge commuter train service (Northstar). Trains for these lines moved through the construction site up to 14 times a day, during work hours. In addition to presenting scheduling challenges--work had to be stopped each time a train passed--these functioning railroads also required that stringent clearances be adhered to, both above and below grade.

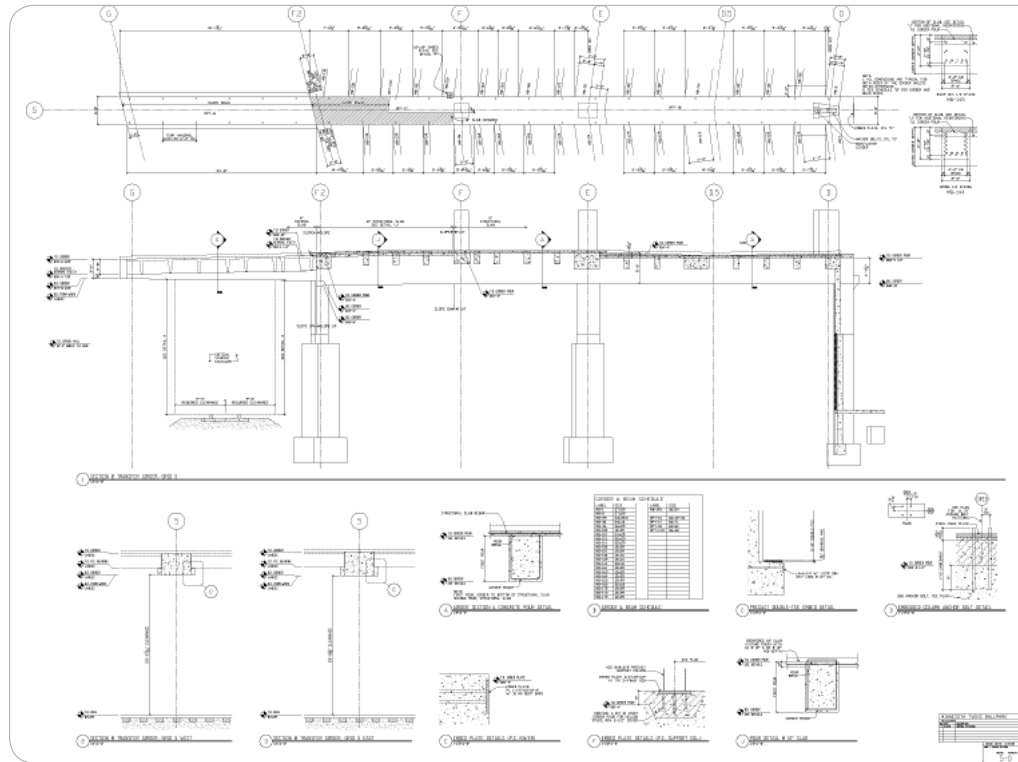
Scoreboard:
57 feet tall, 101 feet wide



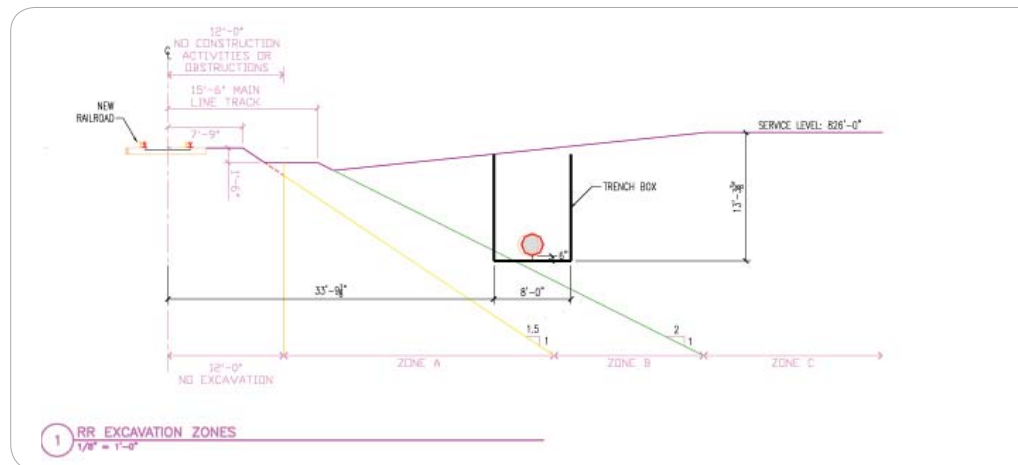
Cast in place girder over rail lines



Northstar train at Target Field Station and model shot looking south



Field use drawing generated from model of railroad girder

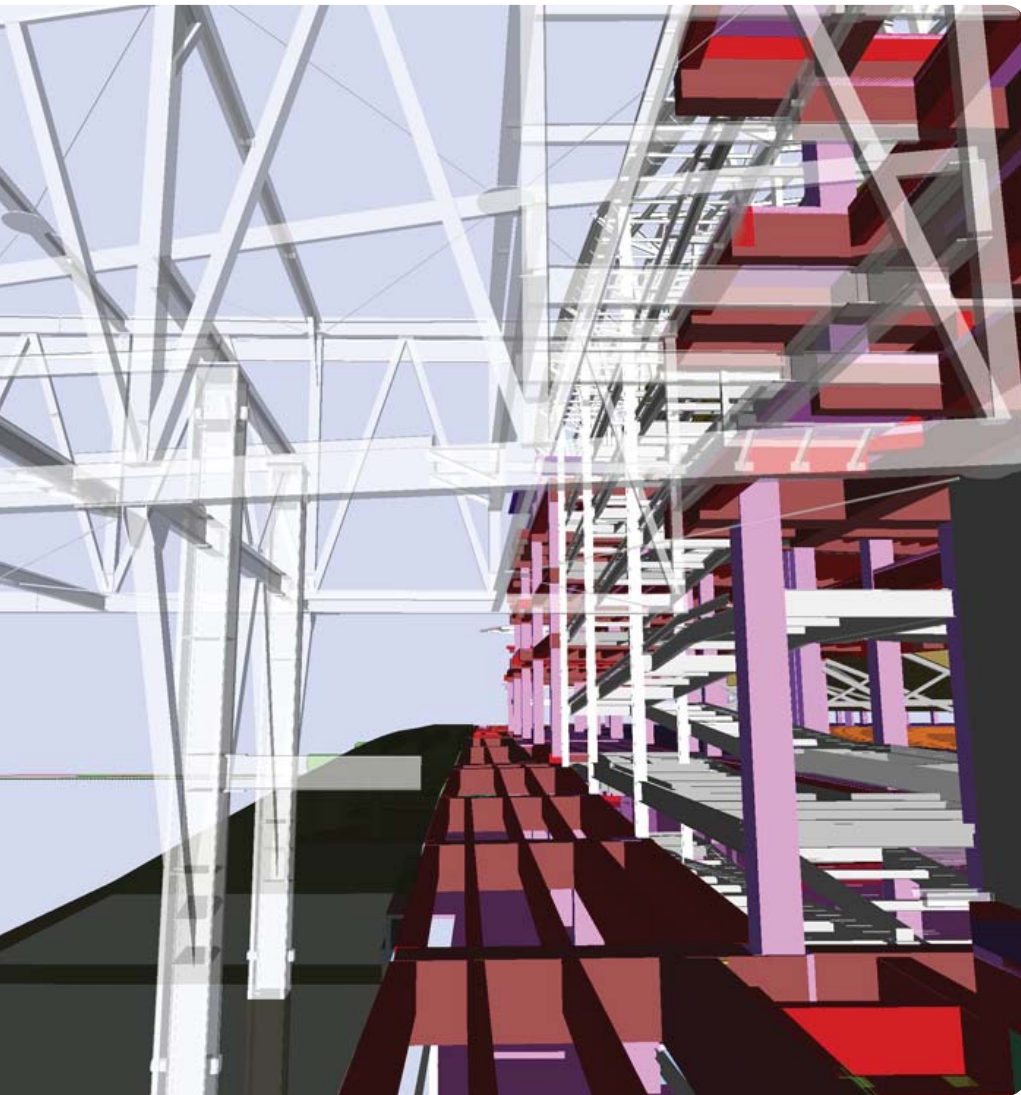


Section from model showing excavation in relation to rail line zones of influence

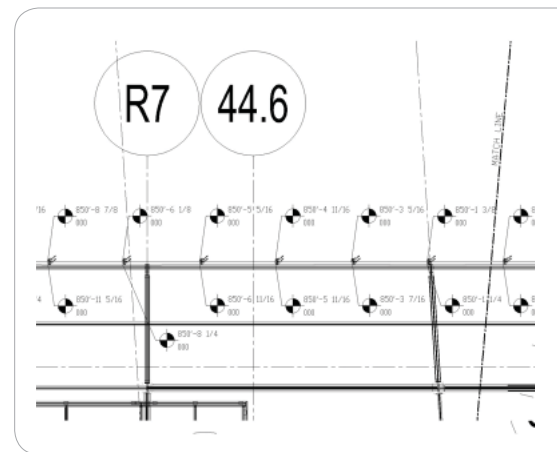
Building Around the Rail Lines

Accessed by:
 light rail, city bus,
 pedestrian bridges,
 Northstar commuter rail,
 Cedar Lake bike trail,
 I-394, I-94

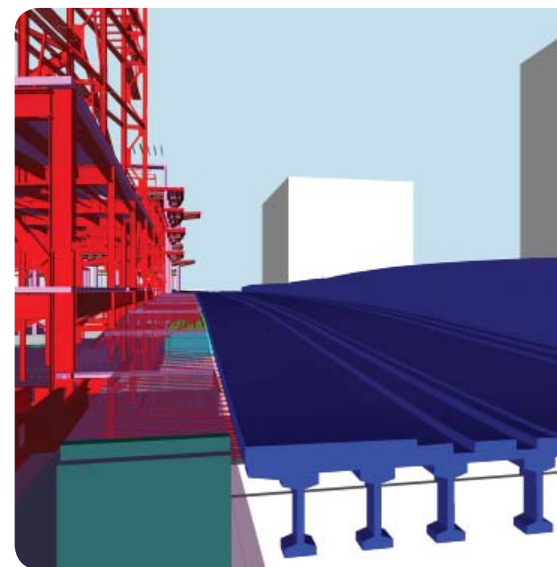
Above the track are 14 large, post-tensioned girders, 8 of which are cantilevered over 34'. These girders support precast double-tees and hollow core panels, all covered by a topping slab. Below the slab, engineered shoring for footings and utilities were evaluated based on depth and proximity to the active rail line. All of this led to extensive preplanning of work through detailed field use drawings. Contained within a single document were specific geometry details, rebar and embed layout, and pour information. The core of this system was a detailed model that incorporated contract documentation, shop drawings and team review comments. It was this information that facilitated the intensive communication with the field. Ensuring that every piece put in place met even the tightest clearances, which were often times less than an inch.



Model shot looking west along 7th Street



5th Street bridge steel elevations plan



Model shot looking west along 5th Street

Following the Bridges

The north and south ends of the ballpark main concourse are defined by the 5th Street and 7th Street bridges. The 5th Street Bridge was torn down and rebuilt to accommodate the extension of the Metro Transit Hiawatha Line, the local light rail transit system. The 7th Street Bridge is an existing structure that was to be modified to accommodate the ballpark design. Upon completion of the 5th St Bridge, the survey team acquired the as-built conditions and real-world coordinates at the locations of the tie-in points with the ballpark structure. The same survey was completed for the 7th St Bridge. From this information, a virtual profile was created of both bridges which was merged with the design to ensure that the elevations and extents of the bridges and the building were consistent.

9,900 square feet
of pedestrian bridge construction over I-394



Field photo looking west along 5th Street



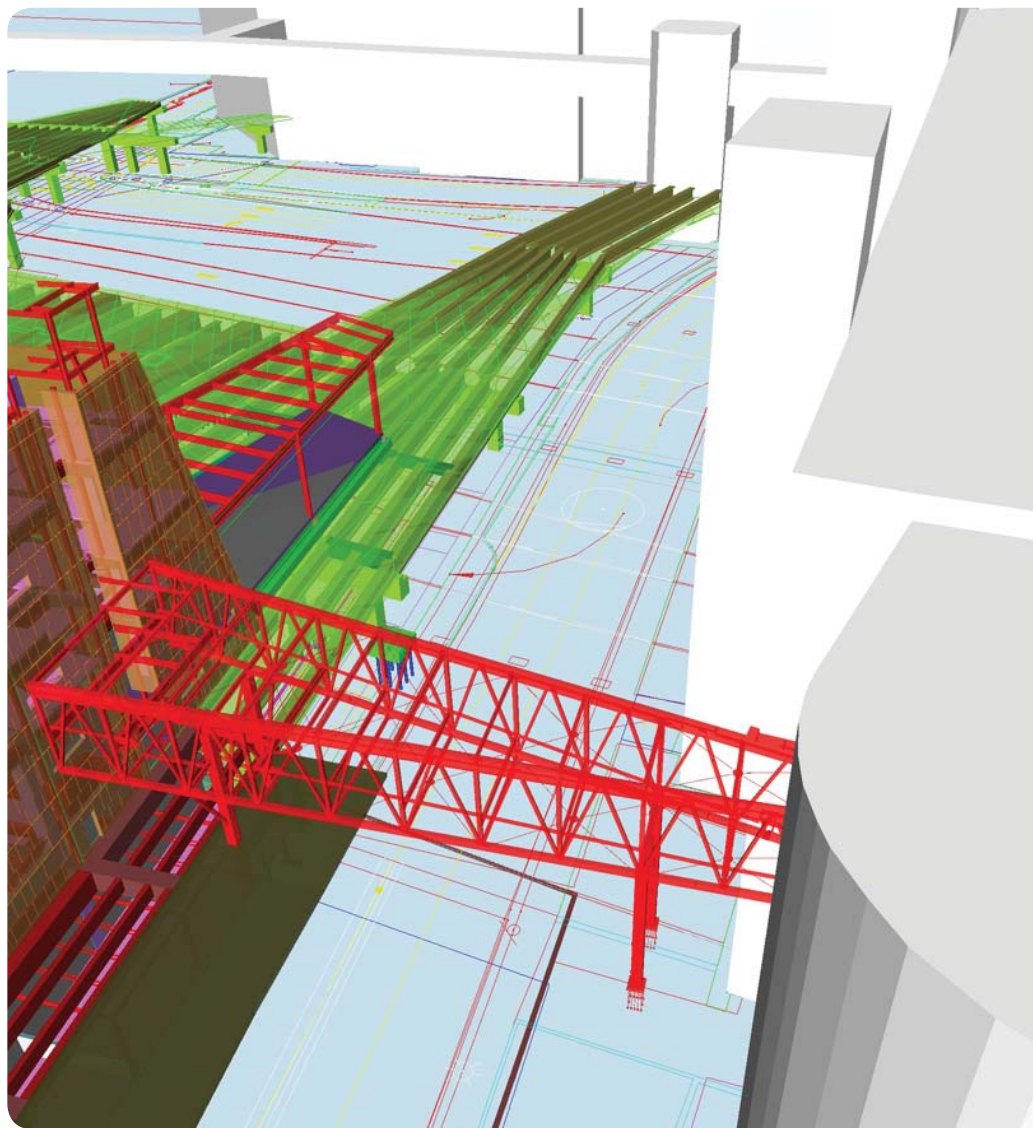
Retail store/plaza structure progress



Retail store/plaza structure progress, April 9, 2008



Retail store/plaza structure progress, July 25, 2008

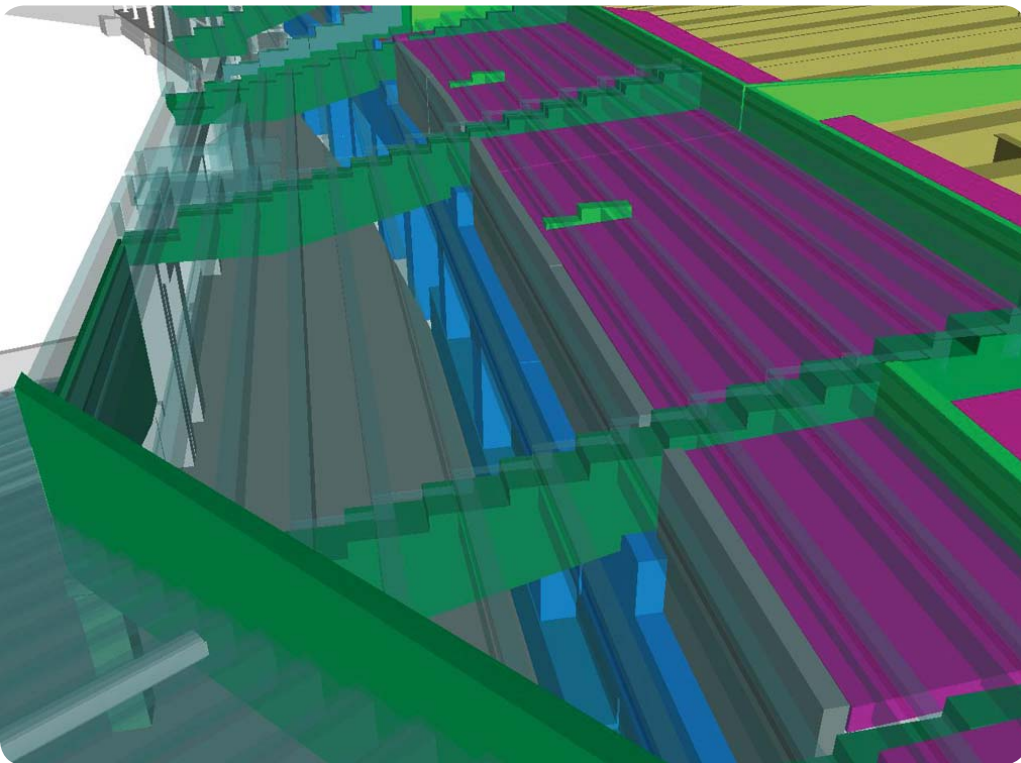


Model shot retail store, skyway connection and plaza structure looking east

Two Structures, One Building

The 394 plaza bridge connection provided an intensive stretch of coordination. Essentially two completely distinct structure types had to be merged to support each other. Similarly, two completely distinct structural engineering firms in different parts of the country with specialized design experience had to work with two different companies doing the cast in place concrete structures. A similar technique to coordinating the 5th and 7th street bridge structures was used to better understand the interface. Specifically, modeling of the primary structural components; pre & post tensioned beams, structural & topping slabs. Due to the complexity of this connection, three dimensional as-builts were gathered as components were completed.

over 100,000
square feet of limestone



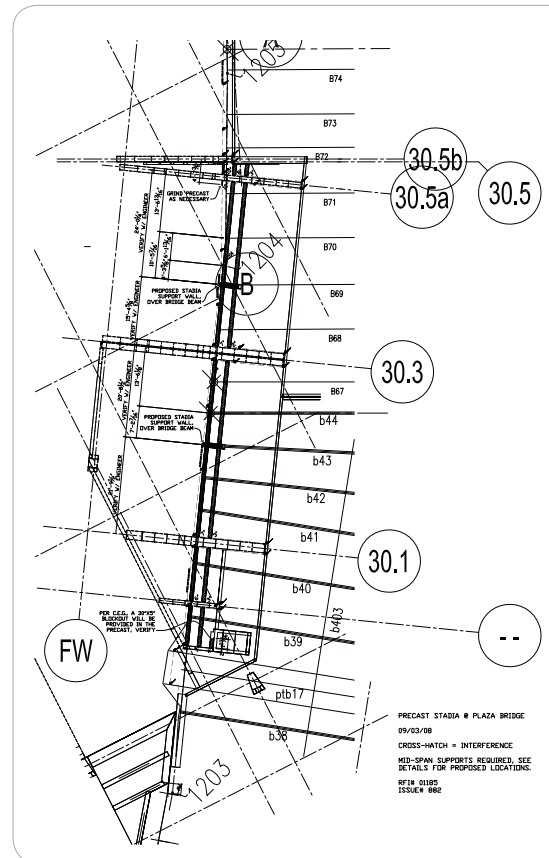
Model shot of the right field overlook, precast plaza bridge

Two Structures, One Building

This information was fed back into the model and used as a baseline for shop drawing review and coordination. This was especially valuable for evaluating the precast stadia seating sections that relied on both building and plaza structures for support. By modeling each precast piece it was determined that a number of pieces had to be altered to accommodate the field-verified bridge elevations. This was accomplished in the factory before the pieces had gone into production thereby preventing costly field fit-up and rework issues.

over 2,000,000
total workhours

over 3,100
tradespeople



Coordination plan generated from model of structure at overlook

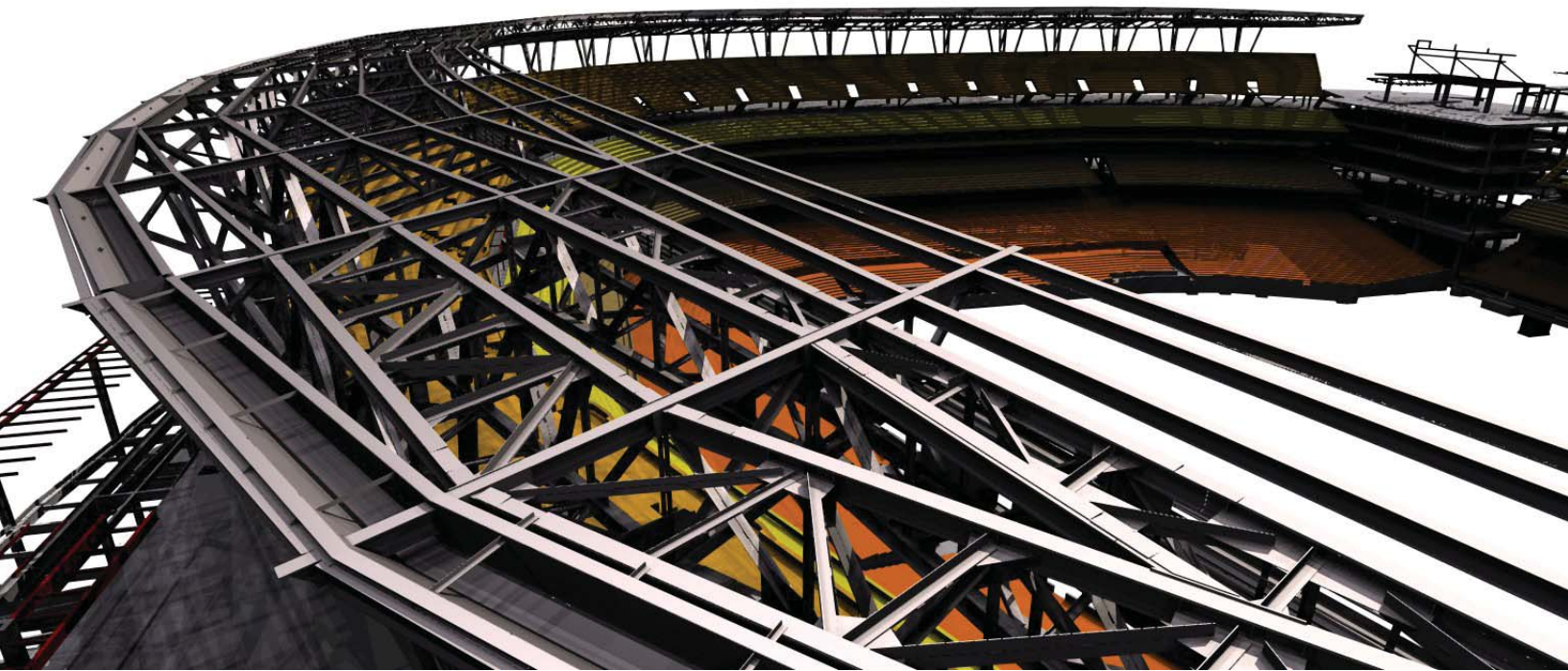


Service level looking north with overlook structure progress above

“I’ve never seen
a sports facility
of this complexity
completed this far
ahead of time.”

- Jeffrey Applebaum,
Lead Management Consultant to
the Minnesota Twins

Opening Day: April 12, 2010



Canopy steel rendering

Proactive Collaboration Results in Success

Phased design with heavy overlap of construction activities typically leads to strained relationships and substantial rework. This is especially true on a job where nearly one million dollars of work was being put in place per day by up to 900 workers. Target Field, however, served as a shining example of how total team collaboration can be achieved through use of building information modeling. The best evidence for this was the unprecedented early issuance of a certificate of occupancy, over three months prior to the contractual substantial completion date. All parties agree that modeling provided a forum for communication where complex issues could be resolved without impacting critical path activities.