SEAOC 1999 CONVENTION

A Tale of Three Ballparks

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Abstract

Edison Field in Anaheim, Pacific Bell Park in San Francisco and the San Diego Padres ballpark address the special needs of a major league baseball facility through three very different structural solutions. This paper will highlight similarities and differences among the projects and provide the rationale behind those design decisions.

Introduction

"It was the best of sites, it was the worst of sites." This sentence (with apologies to Charles Dickens) could apply to most high-profile projects in California. They have the best sites by simply being in the Golden State, with the population, economy, scenery and weather that others envy. They also have seismic activity that brings severe lateral force requirements and complex geology.

While seismic forces are a challenge the designer of any California building must face, sports facilities add new twists to the design problem. Floor plates are very irregular to meet the sight line needs of spectators around the baseball diamond. Floor heights vary dramatically, to provide circulation to multiple levels of seating while still allowing room for valuable luxury suites. Large cantilevers are common, to bring the fans closer to the action. Construction types and mass distributions change dramatically with height, from heavy concourse floors to lighter upper seating, on up to canopies and topping out at field light supports. And the many sloping surfaces such as seating bowls and ramps can create inadvertent 'truss' action linking main floors and attracting interstory forces. None of these conditions are 'by the book,' as codes were written with typical buildings in mind, and not sports facilities. Creative approaches are needed to satisfy both the intent of code writers and the desires of ballpark owners. Such approaches are illustrated by the retrofit and renovation of Edison Field (ex-Anaheim Stadium), design of the new Pacific Bell Park nearing completion in San Francisco, and design development of the planned San Diego Padres Ballpark.

Seismic Upgrade

For Edison Field, owners City of Anaheim and the Walt Disney Corporation wanted to convert a dated 'multipurpose' stadium into a modern facility dedicated to baseball and providing desirable features such as dugout suites, luxury boxes and family fun areas. They chose to renovate to get 45,000 seats at half the cost of a new facility. They also chose to include a voluntary seismic upgrade program.

To execute the upgrade program, we had to become very familiar with the existing structural systems from 1965 and 1980. Analysis showed that the 1980 section, which closed the end of the stadium for football seating, was the more difficult to upgrade. This decision was straightforward – demolish the 1980 work, returning the stadium to a baseball-friendly 'horseshoe' plan.

The 1965 construction used reinforced concrete moment frames at lower seating bowls and concourses, with steel box members for upper moment frames and rakers. How to provide an economical seismic upgrade? There are three general approaches: Strengthen the structure, reduce the mass or isolate the building from ground motions. Because of the tremendous footprint of a major sports facility and the large number of support points requiring treatment, base isolation was not cost-effective for this project. But both of the other strategies

were used to advantage for improvements to seismic performance.

Strengthening was performed at main box cantilevers by adding 'kickers' to increase effective depth at the point of maximum moment. Mass reduction was used much more extensively, and with great effect. Precast concrete double tees were removed from canopy framing and replaced with much lighter metal roofing, eliminating concerns about canopy cantilevers, columns and precast anchors. The old press box was removed, relieving supporting members. And precast façade panels were stripped off the building perimeter and existing pedestrian ramps, relieving a large fraction of the dead load on critical frames and means of egress. In this way existing framing can now meet much higher seismic demand.

SMRF or Steel in San Francisco

If Edison Field was 'major surgery,' then Pacific Bell Park and San Diego Padres Ballpark were 'body building from scratch.' Both are designed to meet UBC Zone 4 seismic requirements, but do so in very different ways. The bent diagrams at the end of this paper illustrate the differences.

Pacific Bell Park in San Francisco has two-way Special Moment Resisting Frames of cast-in-place concrete. Lines of three-foot-square columns and beams run longitudinally along the inside, outside and center of each of the four concourse floors, and at all transverse bent lines, typically every 42'-6". The distributed nature of the lateral system provides good redundancy and minimizes system eccentricities.

Early studies for Pacific Bell Park included a steel Eccentric Braced Frame option, which would have given the 'old-time' look of steel framing in the concourses which the designers preferred. However, on this tight site circulation spaces would have been unacceptably compromised by the sloping braces, and an all-SMRF approach in steel that satisfied drift requirements at tall story heights would have been very heavy.

The concrete SMRFs took little floor space and provided needed stiffness economically. They did this through two special framing variations. First, at the lowest lift of columns from Service (ground) Level to Main Concourse, all three longitudinal frames have columns on a 14'-2", 28'-4" pattern, and each bay has two transverse frames acting. At Main Concourse, some columns of the middle line must stop, reducing the number of transverse frames to one per bay. To compensate for this loss of stiffness, 'flying beams' were added, 11 feet up, to cut the effective story height in half.

Architect HOK still did get their exposed steel on cantilevered rakers at Club, Suite and Upper Concourse levels. Their treatment also contrasts with the San Diego Padres Ballpark. At Pacific Bell, because the concrete SMRF system handles all lateral loads, we were careful to support cantilevers in a way which would not engage two levels and respond to interstory movements. The low Club raker reaches 33'-6" past a steel post, with a short backspan held down by a rotationally-flexible connection to the main column. Story drift is handled by post bending. The Suite and 24'-5" long Upper Concourse rakers are moment-connected to main framing. At Upper Concourse, a backup girder up to 7'-6" deep provides ample strength and stiffness. The short concrete post below has ductile detailing to accept yielding earlier than its full-height neighbors, and is not considered as part of the SMRF system.

Braced Frames but not Ordinary

At the San Diego Padres Ballpark the design is still in development, so its description will be general in nature. Structural design of this facility follows from the raker cantilevers. They are also steel trusses for an historical ballpark feel, but are 60% longer than those in Pacific Bell Park to bring fans even closer to the action. This makes it impractical to limit their end supports to one level of backup framing. Instead, they use the entire concourse framing system as their backup, creating a Bearing Wall or Ordinary Braced Frame plane at each transverse bent. Recognizing the importance of this bracing to both overall lateral stability and cantilever support, it is being designed assuming very low ductility demand and connected for a high overstrength factor. While such criteria may seem to impose a significant penalty on the structural design, in fact most member sizes are being governed by vibration control requirements. Keeping each cantilever natural frequency well above 3 Hz will minimize its response to enthusiastic patrons and maintain their comfort.

In the longitudinal direction, a series of parallel-chord trusses reprise the 'old-time' look along the ballpark façade. With the addition of 'kickers' these lines also form Ordinary Braced Frames.

Steel framing is used above the Main Concourse, including floors of composite beams and metal deck

slabs. From Main Concourse down to grade, cast-in-place concrete framing is used. Shear walls provide lateral stability there.

Best of Sites, Worst of Sites

This phrase certainly applies to the foundation conditions at Pacific Bell Park. Right on San Francisco Bay with views of the city, the Bay Bridge and the Berkeley Hills, it will provide a uniquely San Franciscan experience to all visitors. However, it is also on 'made ground.' Half the site consists of rubble over soft Bay Mud and the other half is loose hydraulic sand fill subject to liquefaction. This fill is also retained by a bulkhead of 70-year-old precast concrete elements on wood piles. Keeping the site in place was the challenge.

The solution developed had four parts. First, the whole ballpark structure is tied together by a continuous foundation mat 'donut' consisting of a grid of 4'-6" deep beams, a foot-thick slab at grade level, and a central hole for the field. The top of the old bulkhead is tied to this mat to keep it from tilting in a seismic event.

Second, passive pressure between the beam grid and engineered fill compacted in each cell between the beams provides some lateral resistance. Available resistance was calculated to include the loss of six inches of fill settlement due to Bay Mud consolidation, and a limit set by friction between the cell soil and its base.

Third, gravity loads from the ballpark are carried by over 2000 precast, prestressed 16" square piles, driven into stiff Bay Clay or dense Colma Sand below the Bay Mud or hydraulic fill. These piles also provide significant lateral resistance.

And fourth, lateral pressure against the old bulkhead was reduced, and local resistance was increased, by the introduction of stone columns in the sand fill behind the bulkhead. Installing these stone columns, using crushed concrete from buildings previously on the site, caused immediate local densification and provided a relief path for pore water pressure to reduce the likelihood of future liquefaction.

Piles and Padres

While the San Diego site is not as complex, it has its own challenges. The primary challenge is a function of the ballpark geometry. It has dramatic overhangs, and in the event of equally dramatic plays on the field it is likely that full live load can occur on the cantilevers with none on the main concourse backspans. This places very large downward loads on the field-side columns and the potential for uplift on the street-side columns, calling for a mix of gravity and uplift pile types. The actual foundation design is still being refined, with due regard for both reliability and constructability.

Conclusion

To the casual observer, it may appear that 'all modern baseball parks are alike.' But other than the size of the infield, they are all quite different. Even when comparing three facilities in similar climatic and seismic conditions, dramatic differences can result from apparently minor design changes. Mass reduction, strength enhancement, concrete SMRFs, steel OBFs, all are valid approaches to provide practical solutions to the unique challenges of each new ballpark.

Acknowledgements

Edison Field

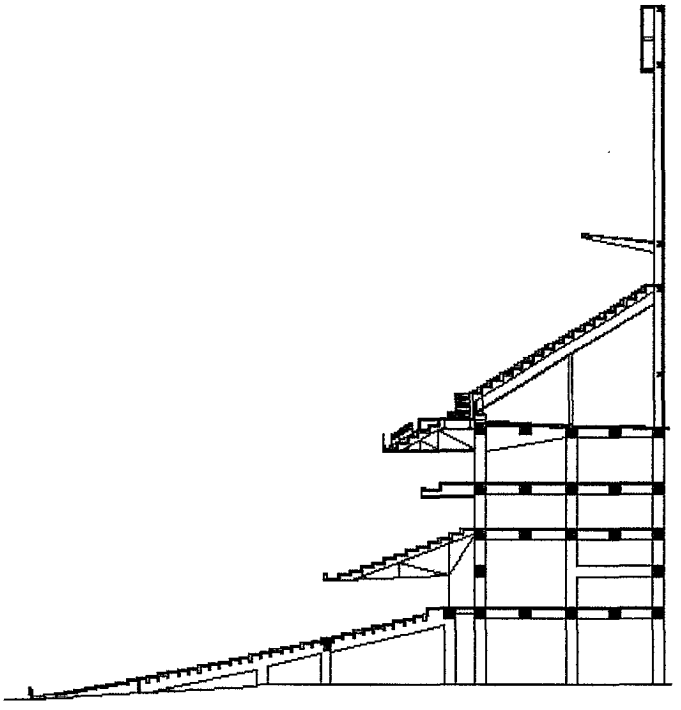
Team-	Anaheim Angels
Owner-	City of Anaheim /Walt Disney Corporation
Architect-	HOK Sports Facilities Group, Robert A.M. Stern Architects

Pacific Bell Park

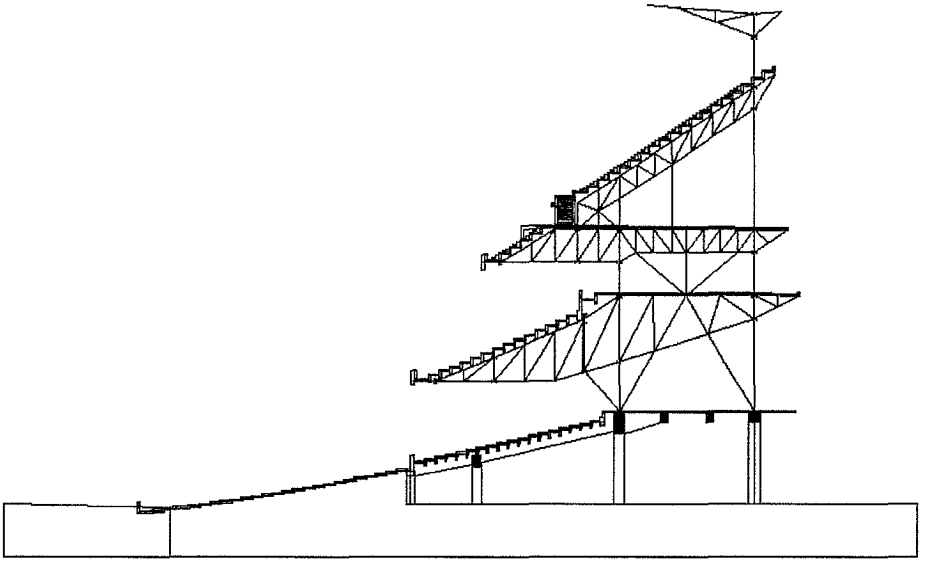
Team-	San Francisco Giants
Owner-	China Basin Ballpark Co./Giants
Guarantor-	Kajima/Urban Development
Architect-	HOK Sports Facilities Group, Michael Willis Architects
Found. Engr.-	Rutherford & Chekene
Geotech. Engr.-	Treadwell & Rollo

San Diego Padres Ballpark

Team-	San Diego Padres
Owner-	San Diego Padres
Developer-	Hines
Architect-	HOK Sports Facilities Group, Antoine Predock Architects



Pacific Bell Park Typical Bent



San Diego Padres Ballpark Proposed Bent