Global Partnerships

International Design/Build Team Facilitates High-Rise Development in Trinidad and Tobago

By James W. Case, P.E.

The International Waterfront Project Complex.

The International Waterfront Project (IWP) in Port-of-Spain, Trinidad and Tobago (T&T) is a 1,700,000 square-foot complex consisting of a 23 story hotel, two 26 story office buildings, a 7 story parking structure, and a 2 story ballroom and conference structure. The project was delivered on a design/build basis with Bouygues Construction of France as the contractor and an American design team including TVS as the architect and Uzun and Case Engineers (U&C) as the structural engineer.

This approach provided the owner with a team of highly qualified construction and design professionals and fixed cost for the project. At the time of this magazine's printing, all major components of the project are topped out. The project is on schedule and within its $240,000,000 budget.

That being said, the team faced many challenges in delivering the project successfully. Working with new partners as part of an international team in a developing country was a learning experience for all.

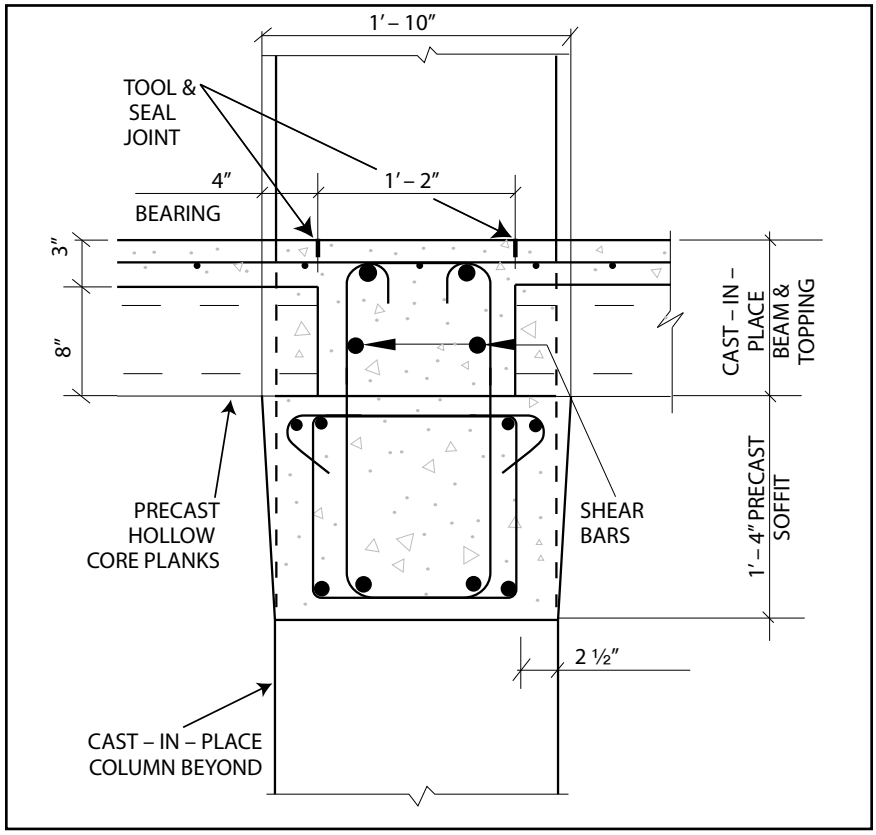
Code – What Code?

As for most projects, the first task undertaken was to establish design criteria. This was also the first window into the cultural adaptation which would characterize the design effort.

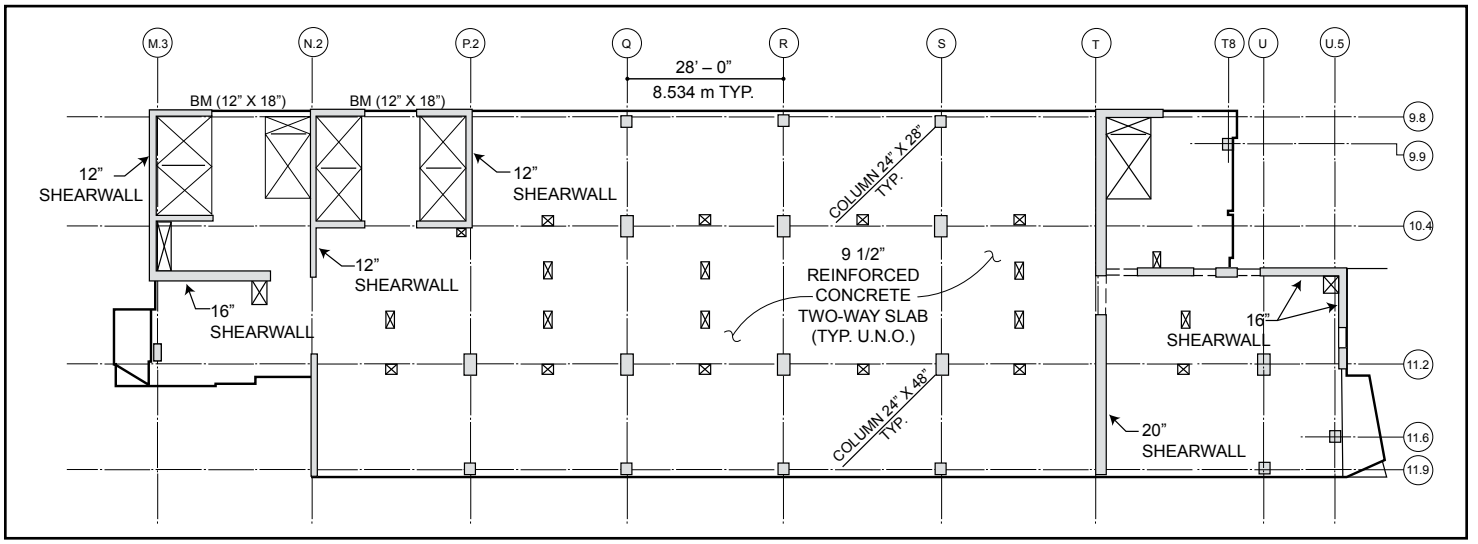
In the United States, we take for granted working with a legally adopted body of codes and building regulations. In T&T, few legally adopted building standards exist. At first this led to a state of euphoria, with associated visions of unlimited freedom and creativity. However, this was quickly replaced by the fear of choosing an inappropriate code or standard. Ultimately it was decided to use the 2003 IBC since it was the latest and most accepted American standard. Unfortunately, it did not contain wind and seismic design parameters for Trinidad and Tobago. Therefore, the 1997 UBC was used to generate seismic forces, and the Barbados Code was used to determine design wind speeds. Not being a consistent set of documents, much time was spent researching and resolving differing provisions. In retrospect, it would have been better to have commissioned site specific seismic and wind studies which were consistent with the 2003 IBC. Nonetheless, the approach proved workable and conservative.

Accommodating Project Specific Construction Practices

Much initial effort was devoted to understanding local construction practices. The design team researched available



Precast beam at carpark.



Hotel framing plan.

concrete mixes, steel strengths, formwork systems, etc. However, there were unanticipated nuances associated with answers to questions posed. For example, although 50 KSI structural steel was available, it did not necessarily conform to ASTM standards.

Similarly, initial design proceeded based upon 60 ksi rebar. However, in the course of the project an inexpensive 75 ksi rebar was located in Venezuela. U&C was asked to redesign the structure accordingly. Ultimately the deal fell through, and the design reverted to 60 ksi.

With regard to concrete strength, ini-tially only 35 MPa (5100 PSI) was available. However the contractor's batch plant ultimately proved able to produce 50 MPa (7600 PSI), and the design was revised accordingly.

Bottom line – be prepared to accommodate change throughout the project. Working in an island paradise is an adventure!

Structural Documentation

From the outset, it was agreed that structural documentation would be based upon American standards. However, as the project progressed, it became clear that the contractor's procedures were based upon more extensive structural documentation requirements. We worked together to resolve differences. However, for the next project, it was decided that the structural workscope would be expanded to include the production of "formwork" drawings.

While it was not a significant issue for this project, international contractors sometimes expect structural engineers to produce details which would be termed "shop drawings" in American practice. Therefore, it is important to discuss drawing standards when defining structural work scope on international projects, and to provide a contingency for unanticipated "extra" work.

A Firm Foundation

The site proved to be one of the biggest financial and technical challenges for the project. Unanticipated liquefiable soils threatened to create instability during a zone 3 seismic event. Considerable effort was expended to find the most cost effective way to address the problem. Ultimately a French firm, Menard, was engaged to dynamically compact the entire site.

Another challenge was posed by lower than anticipated precast pile capacities provided by the local geotechnical consultant. As a result, an international geotechnical expert was brought in to establish and monitor the achievement of higher allowable vertical and lateral loads.

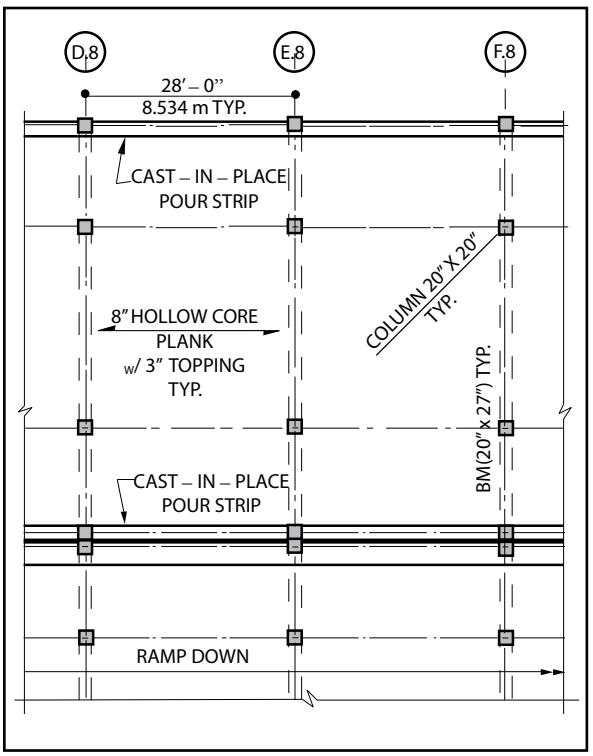
These foundation challenges demonstrate both the challenges and opportunities as-sociated with working on an international design-build team.

Building Lateral Load Systems

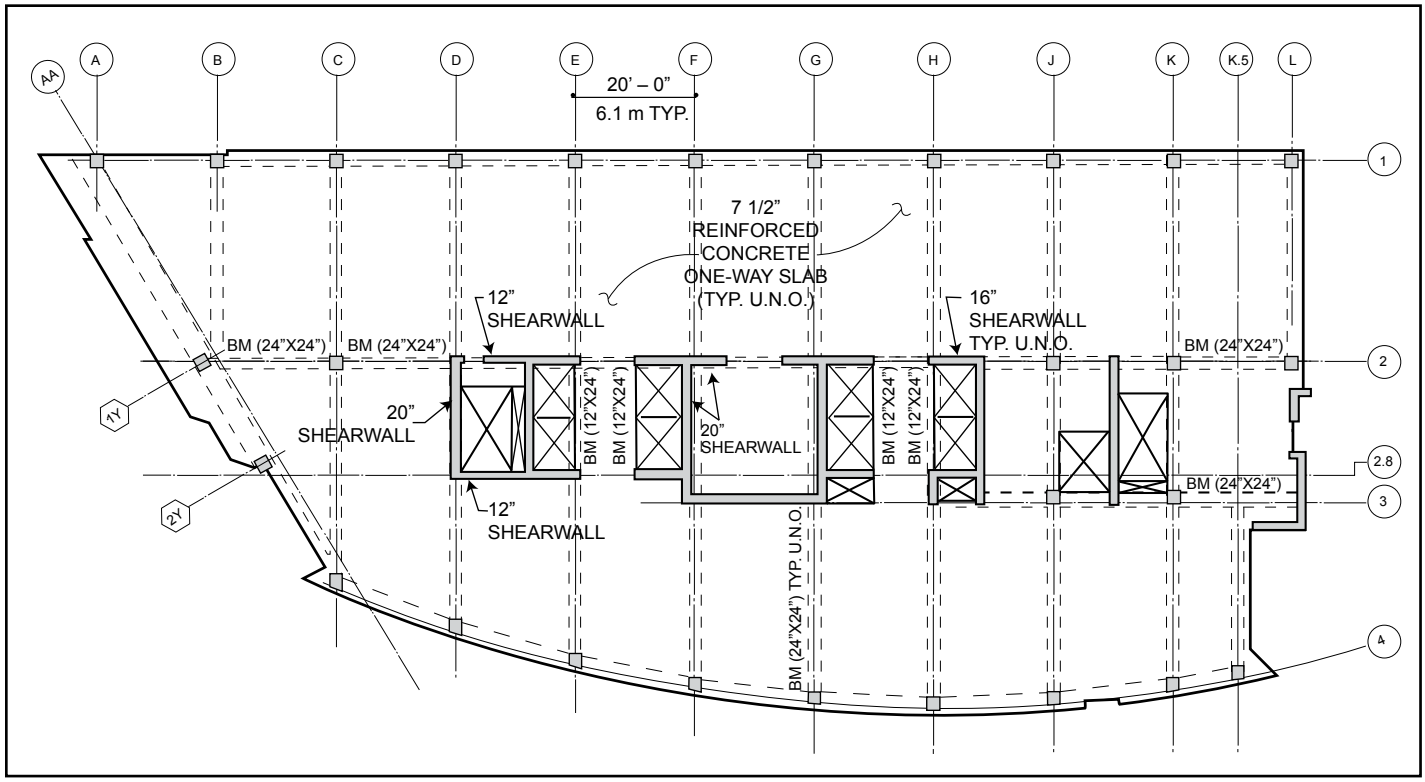
The project was designed for a 3 second wind gust speed of 100 mph (per the Barbados code) and for seismic zone 3 (per the 1997 UBC). Earthquake loads predominated and determined the lateral load resisting systems for all buildings. Nonetheless, wind loads controlled the design of the office building in the transverse direction. Seismic design was based upon a dynamic analysis procedure.

Highrise buildings in T&T are normally constructed of structural steel. However, given Bouygues' experience in delivering concrete projects internationally, both concrete and steel options were considered. Ultimately, concrete was selected based upon cost and schedule.

All buildings are less than 240 feet tall, with the exception of the two 26 story office buildings which are 360 feet tall. Because of the office buildings' height and seismic classification, a dual system of special concrete shearwalls and moment frames was used. For other structures, lateral forces were resisted by special concrete shearwalls alone. The dual system carried a significant rebar tonnage premium. Team members watched rebar tonnages anxiously, since quantities had been agreed upon prior to beginning design. Miraculously, overall delivered tonnages were within 1% of initial estimates.



Carpark framing plan.



Office framing plan.

Building Gravity Load Systems

A variety of gravity load systems were used for the project, depending on the height, span and function of the related component. Each system had its pros and cons, and much was learned by watching it go together.

For the hotel, a 9.5-inch conventionally reinforced flat plate was used. A post-tensioned system was considered but rejected based upon the lack of local resources. The system worked out well due to the simplicity of formwork and rebar placement.

For the office buildings, a 7.5-inch slab with 24-inch beams was chosen based upon the need for special moment frames. The system was considerably more difficult to form and reinforce than the hotel, necessitating careful field supervision to ensure quality.

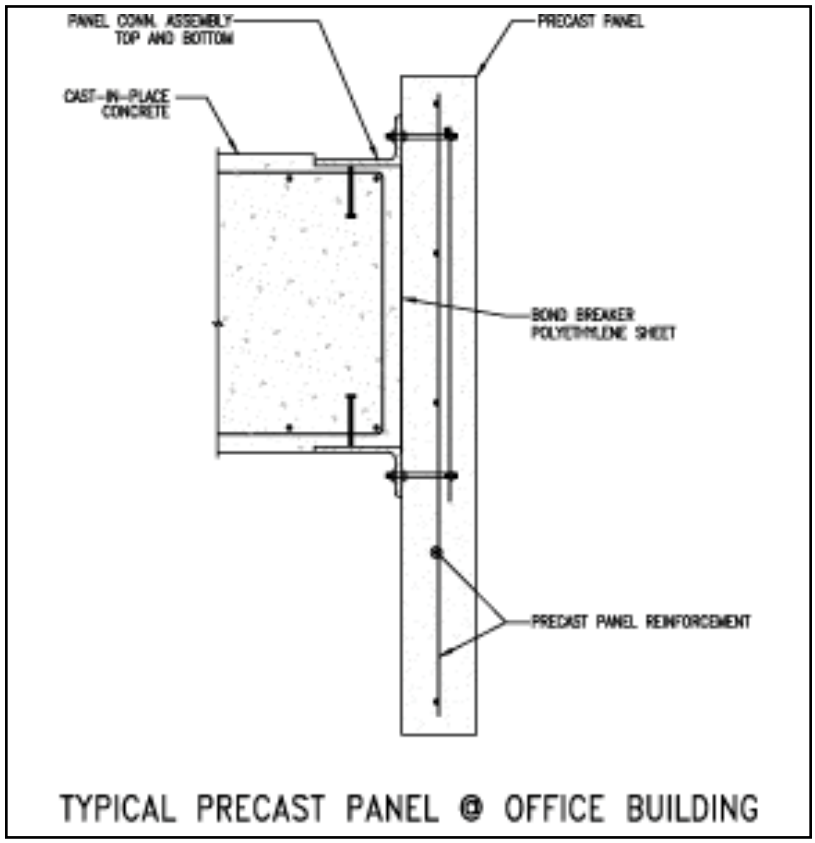
In order to save time, precast panels were set in place prior to pouring adjacent concrete floors. Formwork systems were specially designed to accommodate the panels which also served as edge forms for wet concrete.

For the parking deck, a precast system of hollow core planks and beam soffits with a cast-in-place topping was used. Columns and shearwalls were cast-in-place. This was a novel system for T&T. In fact, the contractor convinced a local precaster to begin production of 8-inch hollowcore panels for this project. The system worked well, minimizing formwork and field quality control issues. There are plans to implement it on a larger scale in the next project.

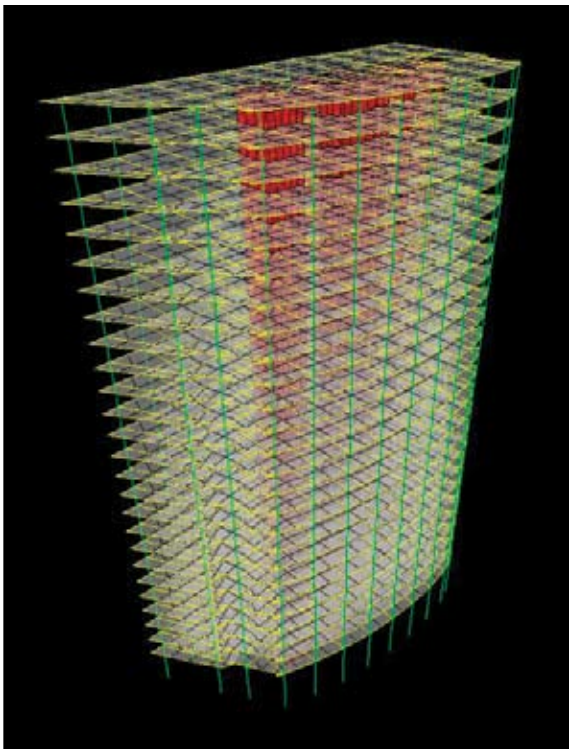
Guidelines for International Design-Build Projects

Based upon the experience on the International Waterfront Project, the following guidelines for structural engineers working on international design-build projects are provided:

- Work with a reputable partner.
- Do your homework. Learn and respect local standards and practices.
- Strive to accommodate contractor preferred systems and methodologies.
- Define structural contract document requirements before beginning work.
- Anticipate cultural differences.
- Establish a fee which anticipates greater than anticipated time for the following: learning new ways of doing things, incorporating structural changes, conforming to new documentation standards, and traveling to the site.

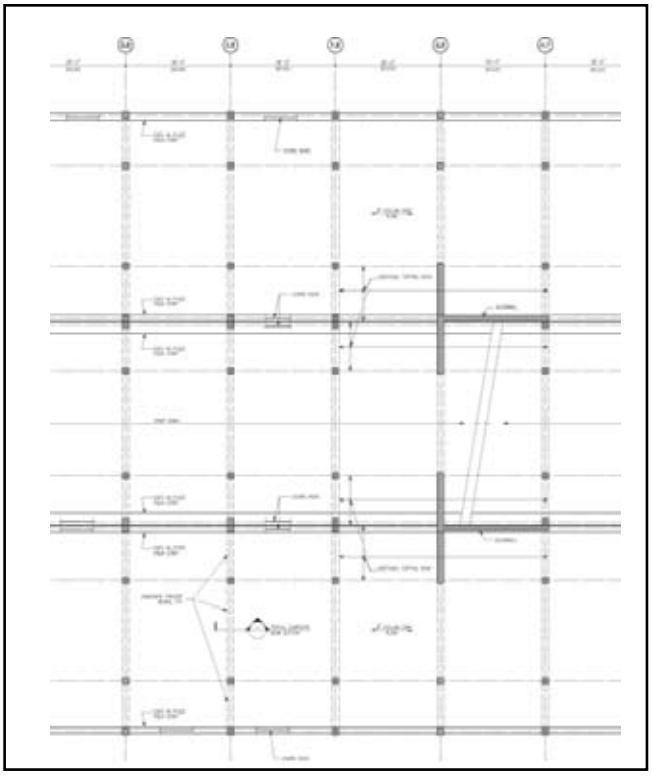


Typical precast panel at office building



3D model of 26 story office bulding

IWP complex under construction.



Parking deck – partial framing plan.

- Be careful about material standards. Push for standards with which you are familiar. Where not possible, carefully review local standards to ensure quality.
- It's a jungle out there. Push for full time structural site representation.

Conclusion

From the owner's viewpoint, the International Waterfront project was a success. They received a high quality project delivered on schedule and within budget. Given that, it is likely that international design-build work will grow. If so inclined, go after it, but be prepared to learn and face a few bumps along the way. But isn't that what makes life interesting?▪

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