BASE*Line*

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How the Heck Do We Build This?!

The Importance of Formwork Considerations in Structural Design.

While structural analysis and optimization of a structure's design is important, all too often engineers get lost in the numbers and don't stop to think about how the building will actually be constructed. For concrete-framed buildings the largest cost driver is not the quantity of structural materials; rather, it is the cost of temporary formwork systems and the labor to install and remove them. On a typical project the cost of formwork amounts to 40 to 60% of the structure's cost. For a variety of reasons many engineers don't consider the impact of formwork, often inadvertently adding to the cost of a project. BASE is not one of those engineers. We enjoy the thought process in considering how a project will get built and how to build it efficiently. Experience gained over the years in design-build and design-assist projects, and interacting with contractors provides us with the knowledge to help achieve those goals. Over the past 15 years BASE has been involved in over 50 buildings totaling almost 30,000,000 SF of formed concrete construction.

Tunnel Forms

Starting with a road trip in 2006, BASE travelled with members of Hawaiian Dredging Construction Company's construction team to projects in four cities in five days to study applying this forming technology to projects. Seven buildings and 2,500,000 SF of structure later BASE has become an expert in the structural design of tunnel form buildings, including construction-related aspects such as early stripping and rotation of formwork. BASE travelled again this year to Miami to study different ways to support upper floor tunnel forms on transfer slabs to create longer span open spacing on the lower floors.

The Westin Nanea Ocean Villas, Ka'anapali, HI

Country Club Village Six, Honolulu, HI

Flat and Band Slabs

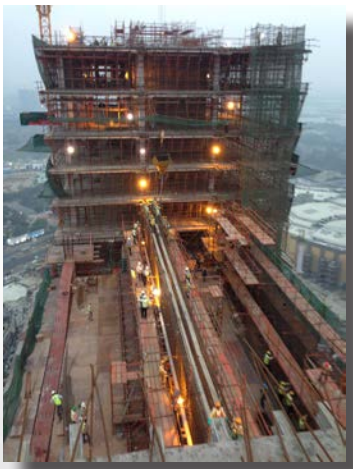
The predominant structural system for mid and high rise residential construction consists of flat and banded concrete slab systems where the soffit of the concrete structure becomes the finished ceiling of the residential unit. Over the years and depending on the unique nature of each project, these slab systems have been formed utilizing old school stick built forms, flying form tables, and column hung tables. Over the past 20 years European formwork companies have entered the US market. This added competition has driven innovation from both US and European suppliers, resulting in labor-efficient handset lightweight form panel systems that are slowly taking a larger share of the market.

Trump International Hotel Waikiki, Honolulu, HI

The Ritz-Carlton Residences Waikiki Beach, Honolulu, HI

Wave One
Noida, India

When the client required an architectural design incorporating "good chi" for all occupants, it meant a large 120' x 200' aperture in the building's elevation extending from Level 16 to Level 32, visually creating two separate towers until Level 32. The aperture was made possible by three deep post-tensioned concrete transfer girders at Level 32 constructed 415' above ground level and spanning 111.5' between the towers, designed to carry the weight of nine additional floors above it. Each transfer girder has a depth of 14.75' at the ends and 20.33' at mid-span.



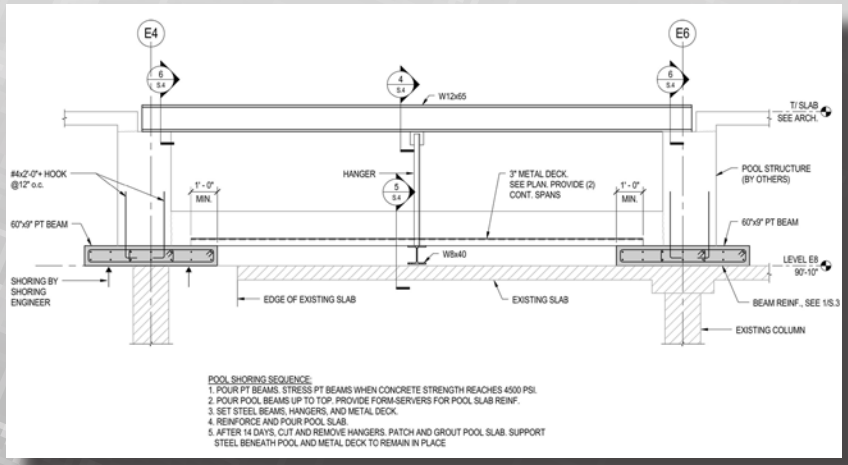
BASE worked closely with the project's contractor, Leighton India Contractors Pvt. Ltd., and post-tensioning supplier, VSL, to horizontally slice the transfer girder with a construction joint, and design the lower half of the beam to carry the load from the wet weight of concrete of the upper half to reduce the required reshoring. A detailed shoring and reshoring analysis was done to determine the concentrated loads imposed on the lower level post-tensioned floors to reduce the amount of reshoring required.

167 W Erie
Chicago, IL

The 167 W Erie development consists of a 39-story mixed-use tower with a new amenity deck atop an adjacent existing eight-story office building. The floor-to-floor heights of the new development resulted in the 10th floor of the new tower, connecting the landscape deck, to be constructed only five feet above the existing roof resulting in shallow interstitial space to support conventional formwork.

In order to avoid reshoring in the existing building, the project's concrete contractor, Adjustable Forms, planned on using rolling truss table-forms supported on screw jacks located next to existing columns. BASE developed a thin concrete pad to cantilever off the new building columns to support the truss and prevent overloading the existing roof.

BASE also designed formwork support for a pool, which involved creating wide-shallow post-tensioned beams in 9" of available space between the bottom of the pool and top of roof deck. The beams are designed to span between existing columns and carry the weight of the concrete pool beams. Once the pool beams are constructed, steel beams with tension hangers would span across the width of the pool to carry a sacrificial metal deck formwork that supported the pool bottom.



Pool section detail.

Vipul Aarohan
Gurgaon, India

Special projects require special attention to formwork challenges. This 2,400,000 SF project includes three 430-foot tall towers connected at the top with three levels of interconnected sky parks. Each of these sky parks cantilevers up to 36' from the residential tower below. BASE is working with Leighton India Contractors Pvt. Ltd. to develop a cantilevered forming system required to construct the skyparks at 400' in the air. Concepts include a segmented forming sequence to "launch" the slab further out from its supporting tower. Special consideration to sequencing the work to reduce the amount of wet weight of concrete that must be carried by the formwork during each phase of construction helps to reduce cantilever formwork requirements.