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Condon-Johnson & Associates Installs Dramatic Supports to Keep Building Safe

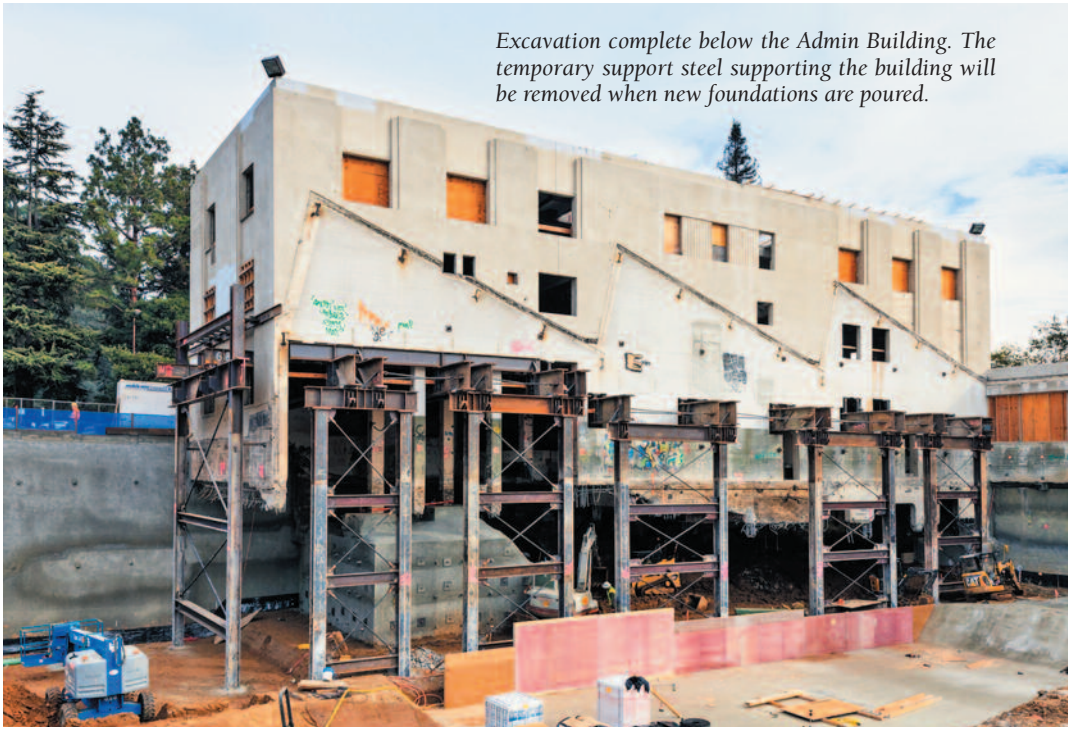
By Simon Burnworth, P.E., Project Manager, Condon-Johnson & Associates

Surrounded by a bustling downtown center and unversity campus, construction is transforming what used to be a block of run down concrete buildings into a modern museum. It is the site of the new Berkeley Art Museum and Pacific Film Archive, owned by the University of California, Berkeley. ADSC Contractor Member, Condon-Johnson & Associates, Inc. (CJA) was contracted by Plant Construction to perform the demolition, excavation, shoring, and temporary building support required to reuse the existing buildings and to make way for the new building.

The funding for the new museum was raised through a $103 million capital campaign from private, non-state sources. The need for a new building was determined in 1997 when a survey found the existing museum did not meet seismic standards. UC Berkeley selected Plant Construction Company to construct the new museum in downtown Berkeley. Degenkolb Engineers of San Francisco, California was the shoring engineer responsible for designing the excavation shoring and building underpinning systems. The new museum will boast a 82,000 square foot floor

CJA performs demolition, excavation, shoring, and temporary building support...

Soldier pile and tieback shoring with shotcrete fascia (left) and soil nail shotcrete shoring (above) at the Press Building excavation.



Excavation complete below the Admin Building. The temporary support steel supporting the building will be removed when new foundations are poured.

plan, presenting approximately fifteen art exhibitions and 380 film programs each year.

Occupying the site is a "New Deal Era" three story concrete Administration Building and the single story University Press Building. Plans for the new museum included repurposing portions of existing structures instead of leveling them to make room for an entirely new structure. 16,000 square feet of temporary shoring was installed by CJA to support the street on three sides and a parking lot on the fourth. Over 400,000 lbs of steel was carefully measured, fabricated, and welded

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Photo property of Alejandro Velande, provided courtesy of Degenkolb Engineers.

Excavation below the Admin Building completed. W36 girders installed through the window openings transfer loads to support piles outside the building. Photo property of Alejandro Velande, provided courtesy of Degenkolb Engineers.

together to support the existing structures during excavation and construction.

Historical Significance

The University Press Building, vacant since 2005, is where the signatory copies of the United Nations Charter was printed in 1945. Adjacent to the University Press is the Administration Building, boasting an Art Deco style exterior and reinforced concrete construction. The design for the new museum incorporates portions of the Print and Administration buildings into the new design, while upgrading the structures to meet current seismic code requirements.

The museum site is further complicated by the presence of Strawberry Creek, flowing in a 1900 era concrete culvert only 50 feet from the site underneath Center Street. Groundwater from the watershed is also carried in a gravel layer located 12-15 feet deep, flowing year round from the hills and campus down into the site.

Of the existing buildings onsite, the original plan included saving the entire Administration Building and the two exterior walls of the Print Building. The south wall of the Print Building faces Center Street and the west wall faces a parking lot. Condon-Johnson offered to save the project time and money through a value engineering proposal to remove the west wall and planned soldier pile shoring, replacing it with a soil nail and shotcrete system. Two other walls of the shoring design were also value engineered to use soil nails, which in total saved the project $280,000 and several weeks in the schedule.

Shoring Installation

High groundwater, varying soil layers, buried obstructions, and tight working spaces were all challenges that were overcome during soldier pile installation. Condon-Johnson's Soilmec SR-60 and R-312/2* drilled 30 inch diameter holes to depths ranging from 45 to 77 feet deep. Concrete for the project was supplied by Central Ready Mix and placed using Condon-Johnson's Schwing 32M Boom Pump. To control groundwater during pile installation the shafts were flooded with water to maintain a pressure head on the water entering the shaft at 15 feet. As concrete was placed in the pile, water was pumped out of the shaft and stored in on-site tanks. The same water was subsequently used over and over again to flood the shafts and prevent additional water from infiltrating the shafts. This procedure minimized the amount of water that needed to be handled and disposed of from dewatering the shafts. In total, 95 soldier

Bracing between building support piles installed as excavation progressed. Photo property of Alejandro Velande, provided courtesy of Degenkolb Engineers.

A total of 94 tiebacks were installed in six inch drilled holes with depths ranging from 30 to 75 feet.

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Tremie placed concrete for piles at the Admin Building.

Stub beams attached to shoring piles behind the Press Building Wall "floats" the wall above excavation and shoring

piles were installed on the project in just three weeks.

Strand tiebacks, supplied by ADSC Associate Member, Dywidag-Systems International, were installed using CJA's Klemm 803-2* horizontal drill rig. A total of 94 tiebacks were installed in six inch drilled holes with depths ranging from 30 to 75 feet. All tiebacks passed load testing despite varying conditions including man-made fill, caving gravels, and groundwater. Daily planning and orchestration kept the shoring installation moving around site. Several of the tiebacks required an unusual installation where the temporary shoring extended inside of the existing building and behind the existing basement wall. To accomplish this, the drill rig was positioned in the lower level of the building to install the tiebacks through the basement wall.

Collaboration to Meet a Demanding Schedule

The original schedule for the shoring and excavation demanded that the work be completed in only four months. CJA succeeded in keeping the job on schedule in a complex and congested work site. Through multiple value engineering proposals CJA worked with Plant Construction and Degenkolb Engineers to keep the project on schedule. Bringing the shoring contractor on board

Bringing the shoring contractor on board early on proved to be invaluable to the timely completion of the job.

early on proved to be invaluable to the timely completion of the job. CJA and Degenkolb shared ideas and brainstormed daily to adjust designs and develop solutions that were quickly and cost-effectively implemented in the field.

The constantly evolving design meant that shop drawings had to be produced in a matter of days, not weeks, to maintain the flow of material to the field. The structural support system for the Administration Building alone consisted of over 1,600 individual rods, plates, and beams. Each unique piece had to be detailed, cut, fabricated, and welded in the correct spot. The bracing systems included 1,674 feet of rod cut and threaded into 126 unique lengths, based on field measurements of the existing structure. CJA developed all the shop drawings in-house, using a team of project engineers and engineering interns who created CAD drawings daily to keep up with the pace of the job. Combined with rapid approval from Degenkolb, steel was installed within three days of the shop drawing being produced. Breaking the required shop drawings into independent packages allowed for the components of the building support to be installed incrementally as shoring design was completed.

Support Existing Buildings

The Press Building consisted of a basement and a single story structure covered by a "sawtooth" truss roof design. The roof trusses were determined to have historic and architectural value and were to be incorporated in the new museum roof. The trusses were carefully removed and stored off site by the demo subcontractor, Stomper. Plans called for the upper portion of the south

East Buttress frame at Admin building captures vertical loads through W36 girders and horizontal loads through high strength rods attached to floor slabs at 1st and 2nd levels.

wall facing Center Street to be preserved, while the basement wall below it was to be demolished. In order to preserve the upper portion during construction and excavation, soldier piles were installed adjacent to the wall on the exterior of the building. Condon-Johnson utilized their Soilmec SR-60 to install 23 piles in 30 inch holes along the wall. Every third beam was extended above grade to the top-of-wall in order to utilize the beams as excavation support and structural bracing.

Connecting the press building wall to the soldier pile supports were stub beams with welded connections to the original steel embedded in the structure. The basement wall was then removed in sections and lagging boards installed between soldier beams to retain the soil behind. The result was a system that allowed for the excavation to continue below the "floating" wall and for the permanent structure to be built beneath it.

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The larger challenge was building a support system for the Admin building, three stories plus a basement of 80 year old concrete construction. The support system needed to be installed quickly, and have an open design to allow access under and around the building for new construction. Access inside the building was limited, and systems strictly using interior support elements were quickly ruled out due to high construction cost and lengthy durations. The solution was to install piles on either side of the building and run steel "needle" girders across the full width of the building.

To temporarily support the weight of the building, 27 soldier piles were installed to depths of 70 feet around the perimeter of the structure. On top of the piles horizontal spreader beams spanned the distance between support piles. Resting on top of the spreader beams, all loads were collected by 18 each W36x393 girder beams 48 feet long. The girders, referred to on the project as "needle" girders, were threaded through the window openings on the east and rolled on custom made saw horse rollers through the building to the window openings on the west. Once approved by the designer, Condon-Johnson was able to use its own steel in another value engineering effort to reduce the owners cost.

Support beams hanging from W36 girders above capture loads from columns in the Admin Building basement. Columns were demolished after jacking procedure transferred building weight to temporory supports.

The lateral support system was constructed to resist seismic and soil pressure forces. Although the building supports will not remain in place after the new museum is finished, earthquake loading was considered since the project was located less than a mile from the Hayward Fault. A second row of piles was installed to the east of the building, acting as a backstay to the braced frame capturing loads from the first and second floors. Horizontal rods bolted to the floor slabs transferred loads to the east brace frame, eliminating the need for a braced frame on the west side of the building.

On the east and south sides of the building, where no excavation would occur, 10 underpinning pits were installed to support the existing spread footings. The hand dug pits extended 13 feet deep through clay, gravel, and cobble layers with perched groundwater. Inside the building, a complex system of adjustable rods, hanging beams, shims, and support beams were carefully installed to link the load bearing columns of the existing structure to the girder beams. The 23 "hanging" beams that captured the first floor loads had to be installed in the basement prior to demolition of the walls. To do this, small window openings were surgically cut in the walls

Jacking the W36 needle girders using two hydraulic jacks to lift each end of the beam. Under the weight of the building, the middle of the beam did not move.

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Drilling soil nails to support columns in the Admin Building basement while building "floats" overhead.

and the beams pushed and pulled into place using excavators, hoists, chain falls, and come-alongs.

Jacking Procedure

Condon-Johnson's scope included taking on the jacking of the Administration building to temporarily "float" the building during

Condon-Johnson's scope included taking on the jacking of the Administration building to temporarily "float" the building during construction and excavation.

construction and excavation. Degenkolb Engineers developed the multi-part sequence of jacking, cutting, shimming, and setting down to limit deflection of the existing structure. Condon-Johnson used a total of eight 100 ton jacks and a manifold system to load 58 jacking points around the perimeter of the building. Survey monitoring was performed full time during jacking to ensure movement remained within allowable limits.

The multi-part sequence succeeded in keeping the building flat, offsetting the needle girders over three inches deflection in the middle. In sequence, the columns in the interior of the building were jacked first, then the concrete support columns chipped and rebar cut to separate the interior columns from their footings. Jacks then lifted the building very slightly while shims were installed beneath the severed columns. Finally, the exterior walls were shimmed tight to the needle girder and the entire girder jacked to load. This process was repeated for each pair of girder beams, one after the other, until the entire building was resting on the steel supports and removed from its original foundations. With the building weight transferred to the temporary supports, the needle girders raised three inches at the jacking points while moving less than 1/16 of an inch in the middle. The entire jacking process took eleven days to complete.

Excavation Beneath the Buildings

Of the existing columns supporting the building, two were identified as needing to remain in service when the rest of the building was on temporary supports. An inventive solution was needed to keep the columns in service, while at the same time allowing for excavation to occur around them. The solution was to install a three sided soil nail wall boxing in the columns and installing select nails flat, effectively acting as tie rods to secure the third side of the wall. The nails had to be installed from the outside and the building and exterior support steel with the rig positioned over 20 feet from the face of cut. ADSC Associate Member, Williams Form Engineering supplied the No. 8 soil nail bar used on the project.

In tandem with the shoring installation, Ryan Engineering performed the excavation and off-haul to make way for the new building foundation. The excavation was surrounded on two sides by the existing structures and a third side by an adjacent building, which left only one side in which to remove the soil. Ryan Engineering used four excavators in series, casting

In all, CJA crews worked over 22,000 man hours in four months without a single lost time injury.

dirt to one another, moving dirt across the site where it was loaded into trucks.

The excavation and shoring was completed in November 2013. Condon-Johnson will return to the site to remove the temporary support steel this summer (2014) after the permanent foundation and basement walls are completed. In all, CJA crews worked over 22,000 man hours in four months without a single lost time injury. All players worked efficiently as a team to overcome obstacles and deliver a complex, constantly changing project

ADSC

PROJECT TEAM

Project Name:	Berkeley Art Museum & Pacific Film Archive
Project Owner:	University of California, Berkeley
General Contractor:	Plant Construction Company
Shoring Engineer:	Degenkolb Engineers
Geo-Support Contractor:	Condon-Johnson & Associates, Inc.
Demolition Contractor:	Stomper
Excavation Contractor:	Ryan Engineering
Dewatering Contractor:	Viking

**Denotes ADSC Associate Member (Manufacturer and/or Supplier)*