ENTRY FORM

DVASE
2017 Excellence in Structural Engineering Awards Program

PROJECT CATEGORY (check one):

Buildings under $2M		Buildings Over $100M	
Buildings $2M-$10M		Other Structures Under $5M	
Buildings $10M - $30M		Other Structures Over $5M	
Buildings $30M - $100M	X	Single Family Home	

Approximate construction cost of facility submitted:	$38 Million
Entry Fee:	**FREE**
Name of Project:	The Verge
Location of Project:	Cincinnati, Ohio
Date construction was completed (M/Y):	Construction Completion August 2016
Structural Design Firm:	Michael A. Beach & Associates
Affiliation:	**All entries must be submitted by DVASE member firms or members.**
Architect:	Kitchen and Associates
General Contractor:	KBS, Inc.

Company Logo (insert .jpg in box below)

Provide a concise project description in the following box (one page maximum). Include the significant aspects of the project and their relationship to the judging criteria.

The Verge, is a 245,000 square foot apartment building with 495 beds within 178 apartment units and 385 parking spaces designed to serve students attending The University of Cincinnati. The project is located at the corner of West McMillan Street and West Clifton Avenue just one block from the University's main campus. The project will attain LEED Silver certification from the U.S. Green Building Council upon completion late this summer.

The building is comprised of a partial 5-story/4-story wood framed bearing wall structure with open web wood floor and roof trusses above a reinforced concrete post-tensioned podium structure with a mixed-use occupancy. The two-story parking garage with accommodations for 385 vehicles is located in the basement (see the attached building cross-section). The foundations for the building are comprised of a mixed system of drilled reinforced concrete caissons and conventional spread footings bearing on native bedrock with allowable bearing capacities of 55 to 80 ksf.

The first challenge of this project was the overall schedule. In order to meet an aggressive project opening date of August 2016, foundation packages needed to be issued first before the upper level portions of the structure were finalized. The design of the foundation was further complicated by existing grades along the project site footprint which slope 20 feet from north to south. The profile for the soil being retained in the north-south direction created large unbalanced lateral earth pressures on the lower level portions of the structure. In order to resist the large overturning and sliding forces from the unbalanced grade, reinforced concrete shear walls were introduced in the basement areas in select locations between parking spaces. Foundations were connected together with grade beams in order to deal with sliding forces.

The second challenge on this project was the design of the two and three story reinforced concrete structure for the parking garage and podiums that would support the four and five story wood framed apartment units for the top of the building. As is typical with mixed-use projects, limited continuity of columns from the garage level column grid to the retail and apartment use column grid created a situation requiring the design of 46 reinforced concrete transfer girders. Column bay sizes varied but were typically on the order of 26 to 30 feet. Due to the inherent confinement of the perimeter garage concrete retaining walls, slab changes in elevation, and constructability concerns, the first supported garage floor level and ground level of the building were designed as conventionally reinforced concrete (including the heavily reinforced transfer girders). However, the concrete podium levels that support the four and five story wood framed apartment buildings were designed using post-tensioned concrete. What became a critical design consideration for the post-tensioned concrete transfer levels was punching shear at the concrete columns. The punching shear forces were quite large especially at the podium transfer slab supporting the five-story wood framed building areas. The thickness of the five story transfer podium is 14" and the four story transfer podium is 12" thick. Careful coordination of apartment utilities and plumbing penetrations through the podium transfer slabs was required to avoid punching shear problems. There were several large openings required in the post-tensioned slabs to route ductwork and major utilities from the lower levels through the podiums and serve the upper apartment floors. In addition to the large openings, there were a few hundred sleeve penetrations required through the slabs that ranged in size from 2" diameter to 8" diameter. Post tensioning arrangement and the final locations of these openings were carefully coordinated to avoid shear issues in the concrete slabs.

Adapt concrete design software was used to design all of the concrete elements of the concrete structure including the post-tensioned levels. Due to the overall project footprint, pour strip locations needed to be carefully located in the post-tensioned podium levels to minimize concerns associated with shrinkage of the concrete as a result of shortening from the large post-tension forces. All of the post tensioning for the slabs was completed within 24 to 48 hours of each slab pour once the slab concrete reached a minimum compressive strength of 3,000 psi. Three foot wide pour strips between adjacent post-tensioned slabs were left formed and were not filled with concrete until 28 days after the initial post tensioning was made.

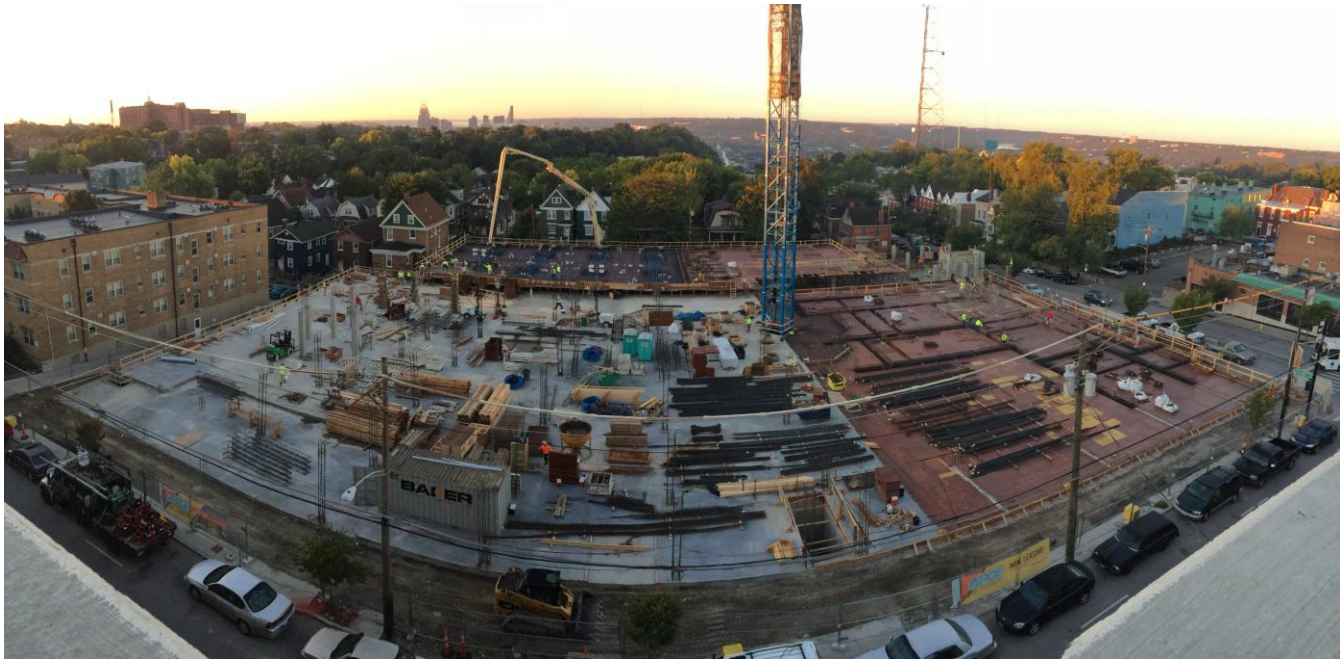
The final intricate portion of the design was the four and five story wood bearing wall structures over the podiums. In order to construct a wood framed structure of this size and height Type 3A construction was necessary. Type 3A construction required all exterior perimeter walls to be 2 hour fire rated. This meant that fire retardant treated lumber needed to be utilized for the studs and plywood sheathing. The fire-retardant treatment process reduces the strength of the members from both a gravity and lateral perspective and was a significant part of the design. Another complicated detail of the two hour fire rating is the continuity of the rating through the floor construction. This meant that the floor framing could not bear on the walls as is typical in platform construction. The framing instead was supported off the walls (balloon framed) with pre-engineered metal hangers from the wall double top plate which extended to the underside of the floor sheathing. The hanger selection for this application was critical because the drywall needed to be behind the hanger which required the top flange of the hanger to cantilever from the wall top plate over the drywall. Technical bulletins from Simpson for this type of condition were followed and reduced hanger capacities were utilized. The 2 hour fire rating also meant that engineered lumber headers and posts could not be utilized in the 2 hour walls since these products are not available in fire-retardant treated materials. Therefore, in a few locations, headers for longer span openings needed to be designed with a steel flitch plate. Using a steel flitch plate of up to 1/2" thick plate sandwiched between dimensional fire retardant treated lumber members the larger openings in the fire-rated walls were able to be accommodated.

Plywood sheathed shear walls were utilized to resist lateral wind and seismic forces with a continuous rod hold-down system at the wall ends. Lateral seismic drift for the shear walls was calculated considering the effects of rod elongation, plate crushing and nail slip. Rod sizes varied up to 7/8" diameter and were anchored into the post-tensioned concrete slabs to develop the required tension hold-down capacity.

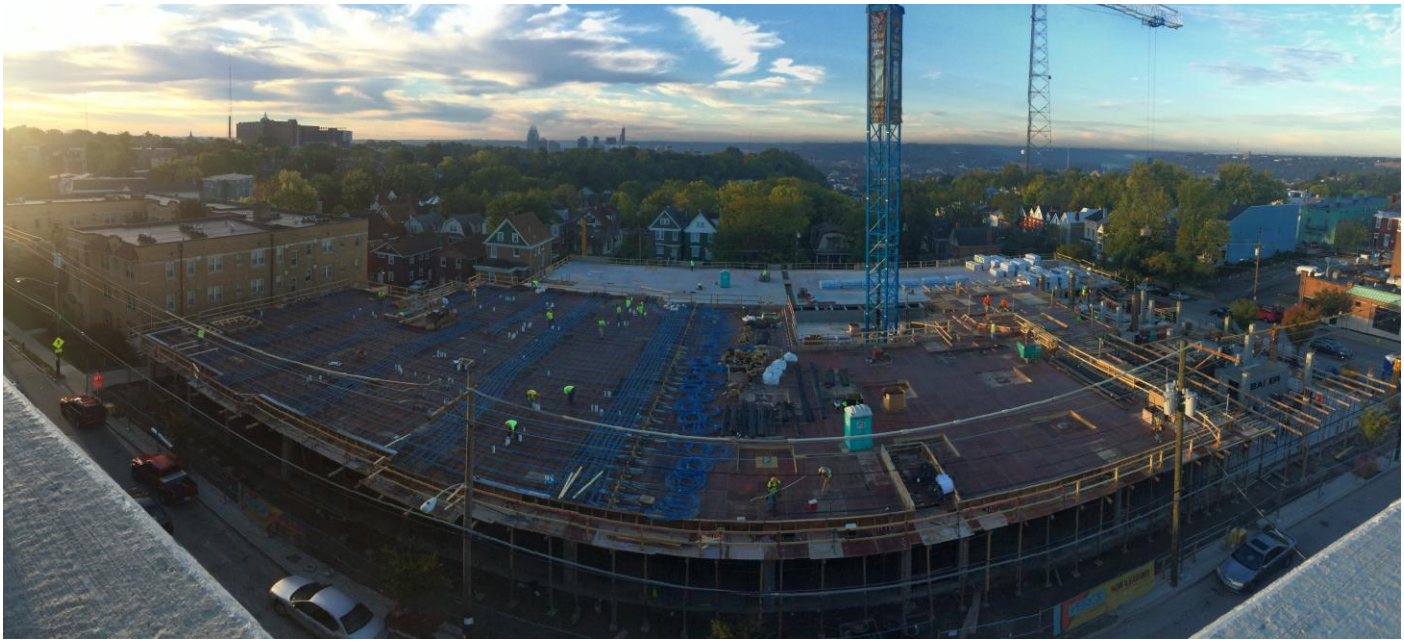
Wood shrinkage for the building was also a major consideration and estimates for the total shrinkage at each floor were provided on the drawings for contractor reference especially for the plumbing risers. Estimated shrinkage for the roof of the 5-story building was calculated to be approximately 1.1" and 0.9" for the four story structure.

Foundation construction.

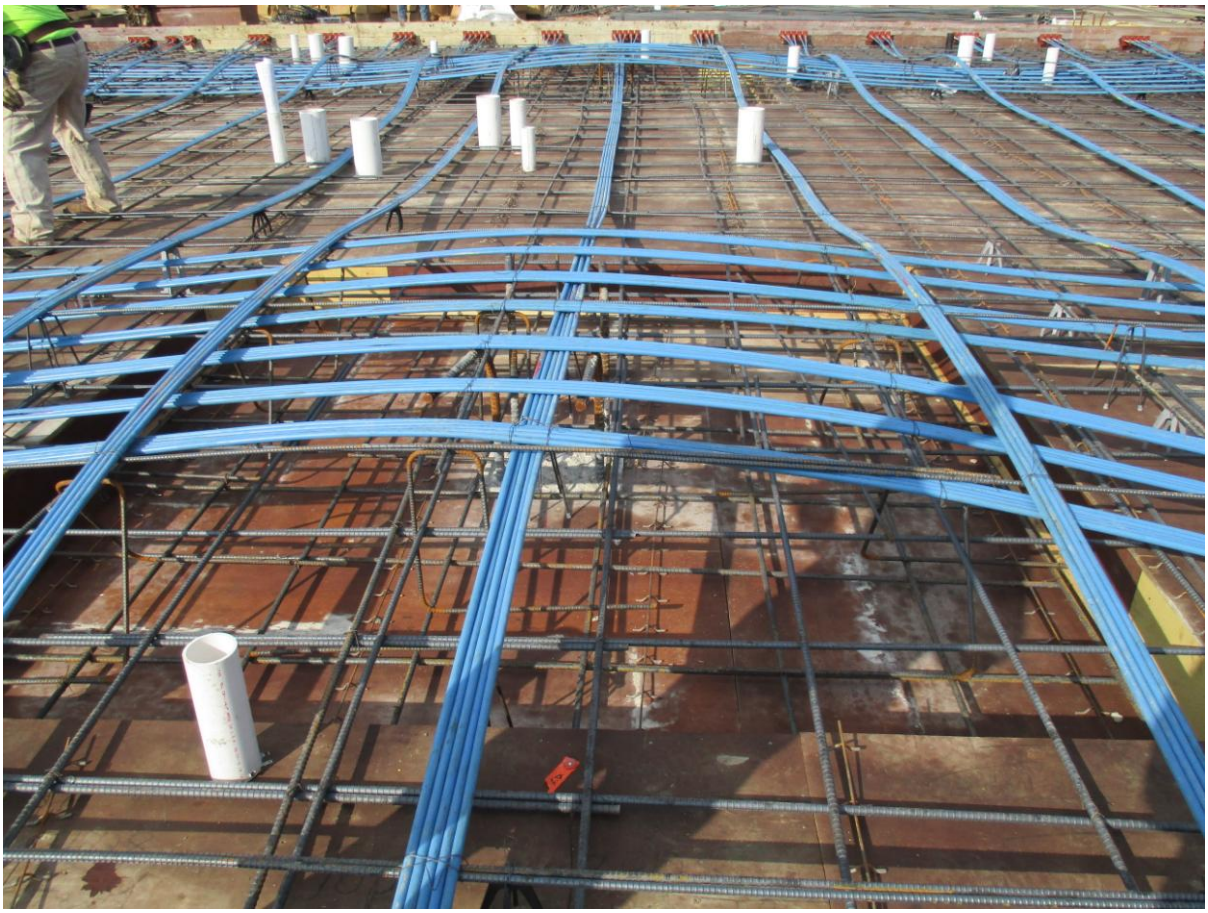
Parking Level P1 slab construction.



First floor slab construction.



2nd floor podium slab construction.



2nd floor transfer slab post-tension reinforcing over column and slab penetrations.

Transfer beams and slab folds below first floor in parking level.

Fifth floor wood framing under construction.

Project nearing completion July 2016.

By signing, signatory agrees to the following and represents that he or she is authorized to sign for the structural design firm of record:

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Submitted by:

Print name:	**Signature:**	**Date:**
Paul Constantini		**04/12/17**

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