ENTRY FORM

DVASE
2021 Excellence in Structural Engineering Awards Program

PROJECT CATEGORY (check one):

Buildings under $5M		Buildings Over $100M	
Buildings $5M - $15M		Other Structures Under $1M	
Buildings $15M - $40M		Other Structures Over $1M	
Buildings $40M - $100M	x	Single Family Home	

Approximate construction cost of facility submitted:	$87.65 Million
Name of Project:	University of Pennsylvania Museum Wharton Academic Research Building
Location of Project:	Philadelphia, PA
Date construction was completed (M/Y):	12/2020
Structural Design Firm:	Keast & Hood Structural Engineers
Affiliation:	**All entries must be submitted by DVASE member firms or members.**
Architect:	MGA Partners, Architects
General Contractor:	Hunter Roberts Construction Group

Company Logo (insert .jpg in box below)

KEAST & HOOD
STRUCTURAL ENGINEERS

Important Notes:

- Please .pdf your completed entry form and email to bsagusti@barrhorstman.com.
- Please also email separately 2-3 of the best .jpg images of your project, for the slide presentation at the annual virtual presentation and for the DVASE website. Include a brief (approx. 4 sentences) summary of the project for the DVASE Awards Presentation with this separate email.

- 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 new Wharton Academic Research Building (WARB) is located at the highly trafficked and visible intersection of the 37th Street Walkway and Spruce Street. The five-story, 80,450-sq.-ft structure features four levels of classrooms, group study rooms, research centers, and shared conference rooms. Operational functions are located at ground level and include a new electrical substation that powers half the campus and an enclosed loading dock that services multiple buildings. These elements cohabitate with a grand three-story lobby entrance featuring a monumental, spiraled circulation stair framed with architecturally exposed structural steel.

While the framing design itself was fairly straightforward, undermining this relative simplicity were significant constraints such as SEPTA setback requirements, avoiding major underground utility lines, and the inclusion of an underground substation below half of the building footprint. The ground floor level is primarily driven by the functional needs of a campus—where space for both a loading dock and primary campus substation were carved out—and a building height limitation set to prevent the addition from overshadowing neighboring properties.

WARB consists of four levels of structural steel framing above a concrete flat-plate podium level. Steel braced frames—employing wide-flange columns and beams with hollow structural section braces in both Chevron and V-oriented bracing layouts—serve as the lateral system for the full building height. The structure was designed and detailed to accommodate the need for a phased construction approach, allowing the new ground floor level electrical substation to be constructed and operational as part of Phase 1 before the decommissioning of the existing below grade substation along 37th street and the subsequent construction of the Phase 2 WARB superstructure commenced.

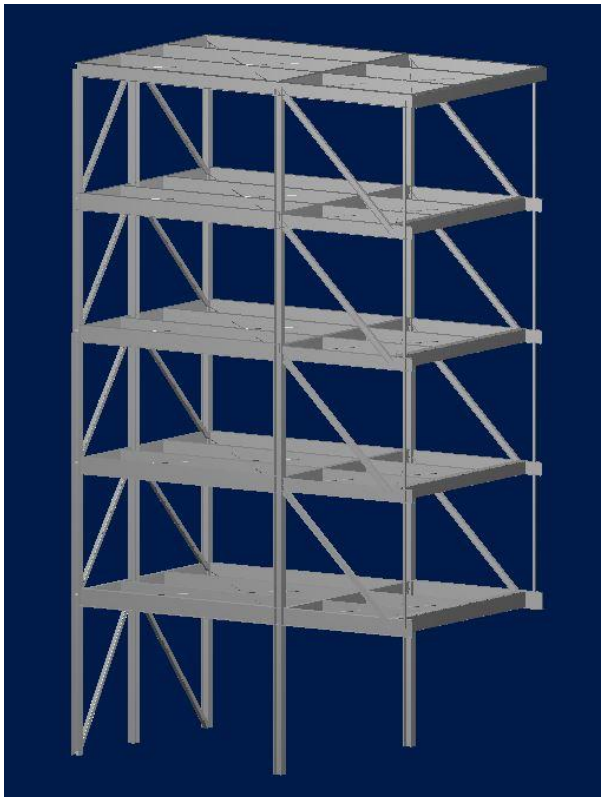
The building footprint fills out a triangular section on the University's campus, on the southeastern side, a below-grade SEPTA trolley line with setback requirements and above-grade right of way restrictions limited where building foundations, structural columns, and exterior walls could be located. In response, MGA created a glazed façade that respects the setback at grade, but as the building rises, the sloping curtainwall folds outward over and above. The building cantilevers out beginning on the second floor from a series of structural columns held back at the ground floor. The length of cantilever varies (extending as long as roughly 15 ft) increasing both with building height and along the length traveling north. Additionally, at the curtain wall face at each level, a column-free expression was desired. To achieve this, Keast and Hood employed Vierendeel trusses (20 in all) to serve as the back span to deep-beam cantilevers that extended out beyond a column line, held back to respect the SEPTA setback requirements at grade. In this application, Keast and Hood designed the trusses to span over the main corridors to open up the ceiling cavity and to permit with ease mechanical and plumbing lines to travel within this space.

At the southwest corner of the site, a large masonry tower cantilevers 13 ft over an outdoor seating area, with steel columns held back for both aesthetic effect and in response to SEPTA setback. At grade, two round concrete columns rise, supporting what appears to be a heavy concrete frame supporting the massive masonry tower above. But concealed within the concrete columns and beams is an integral wide-flange steel structure extending up throughout either side of the tower in the form of two vertically oriented trusses, working as a system to support the massive weight of the building skin while managing deflection.

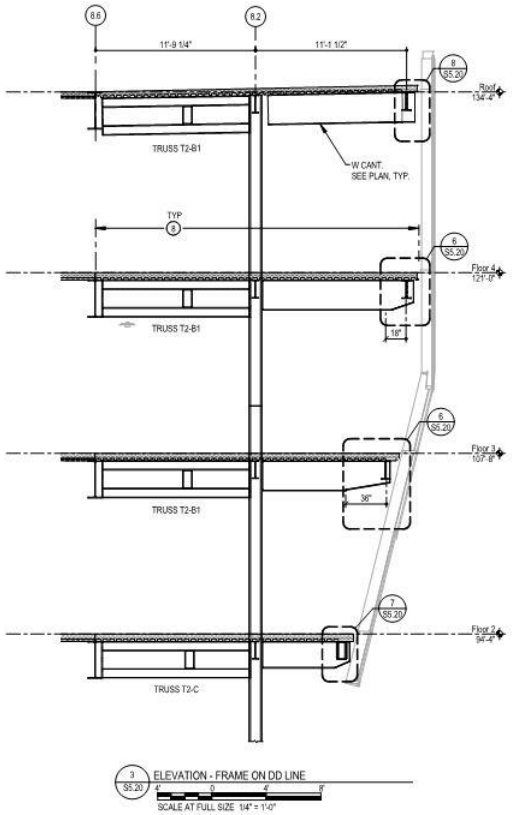
- The following 5 pages (maximum) can be used to portray your project to the awards committee through photos, renderings, sketches, plans, etc...

The structural creativity implemented on the WARB project includes a mixture of steel elements that remain hidden as well as plenty that are prominently displayed, all while navigating the constraints of a small, triangular parcel of land adjacent to a busy urban transit system.

The project is comprised of not only the new WARB structure but an electrical substation (a replacement for a dated, underground facility from the 1950s that powers half the campus), restorations to the campus' Woodland Walk and necessary underground utility upgrades.



Above: Vibration analysis model for the braced frames.

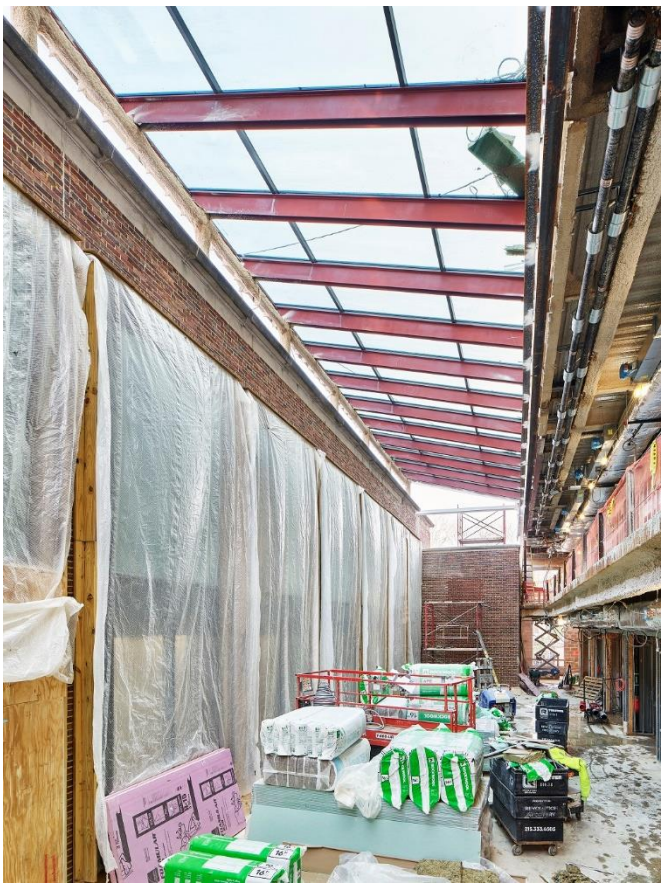


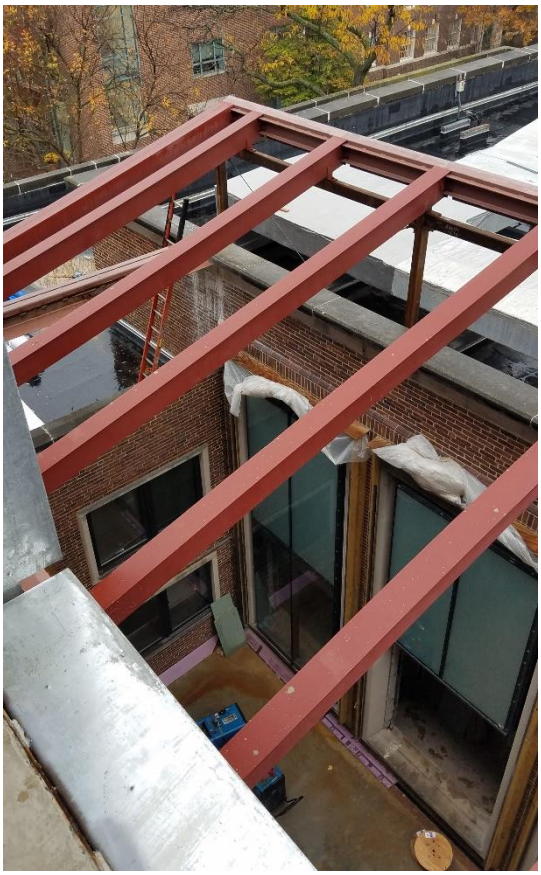
Above: Truss framing for the cantilevering glazed façade.

Along the walkway the façade respects the setback at grade, but as the building rises, the sloping curtainwall folds outward over and above.

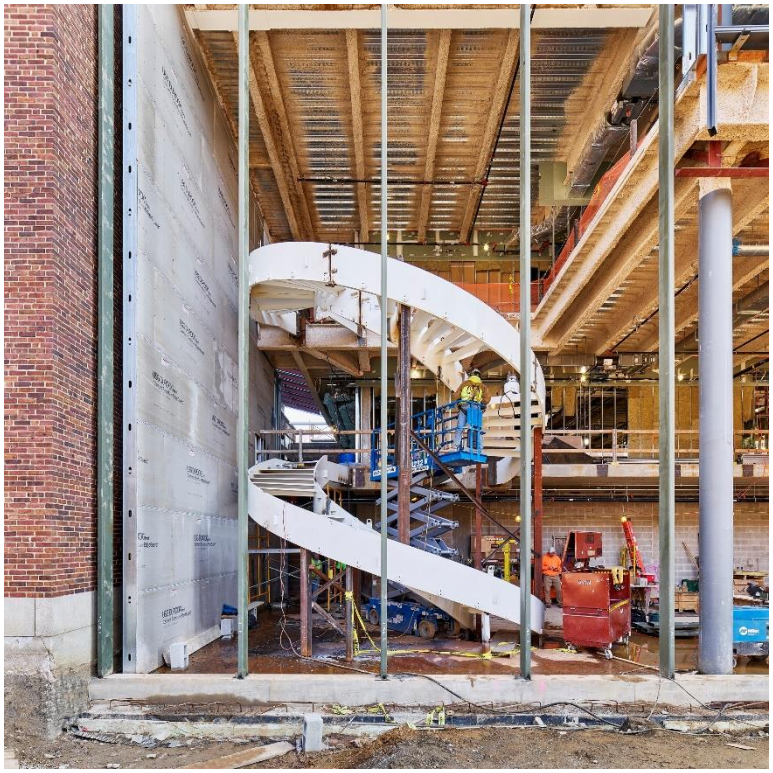
Above: Vierendeel trusses serve as the back span to deep-beam cantilevers that extended out beyond the column line, for SEPTA setback requirements at grade. In this application, Keast and Hood designed the trusses to span over the main corridors to open up the ceiling cavity and to permit mechanical and plumbing lines to travel within this space.

Above: View from the southwest, showing one of the building's vertically oriented trusses.

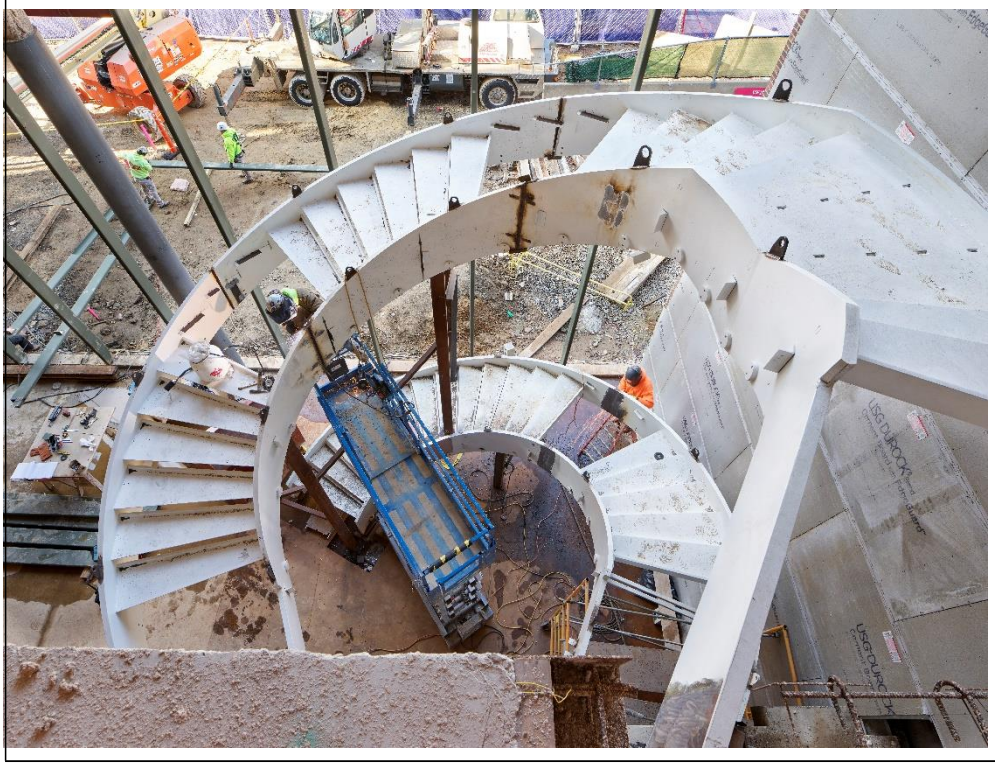




Above: A prominent design feature, the two-story atrium space unifying WARB with Steinberg-Dietrich Hall. Bridging the gap between these two spaces is a series of AESS rafters comprised of plate members joined to create a double-T profile. These built-up members, in turn, support a glazed skylight roof, allowing natural light to spill into the space below and onto the adjoining corridor balconies of the new building. To allow for the different structural effects of the existing and new building, an expansion joint was introduced using slide bearings beneath the base plates of each skylight frame post.



The feature stair in the building's West Lobby, a grand, spiraling steel structure that connects the ground, first, and second levels. At the second floor, it ties into a horizontal steel truss introduced within the floor framing; at the first floor it anchors to large steel embedment plates cast within the flat plate concrete slab system; and at ground level it bears on top of a massive concrete base that cantilevers partially over the repurposed existing substation basement. To provide the necessary stability and stiffness and ensure proper support and load transfer, a hidden network of structural steel plates was introduced at the floor landings and is concealed by decorative metal plating.

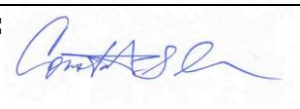


By signing, signatory agrees to the following and represents that he or she is authorized to sign for the structural design firm of record.

All entries become the property of DVASE and will not be returned. By entering, the entrant grants a royalty-free license to DVASE to use any copyrighted material submitted.

If selected as an award winner, you may be offered the opportunity to present your project at a DVASE breakfast seminar. Would you be willing to present to your colleagues? ☐ ***yes*** ☐ ***NO***

Submitted by:

Print name: Constantine G. Doukakis, PE	**Signature:** 	**Date: 4/2/2021**
Submitting Firm:	Keast & Hood Structural Engineers	
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