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:	$65,600,000
Name of Project:	AMERICAN UNIVERSITY, HALL OF SCIENCE
Location of Project:	4400 MASSACHUSETTS AVE. NW, WASHINGTON, D.C. 20001
Date construction was completed (M/Y):	10/2020
Structural Design Firm:	BALLINGER
Affiliation:	**All entries must be submitted by DVASE member firms or members.**
Architect:	BALLINGER
General Contractor:	WHITING-TURNER

Company Logo (insert .jpg in box below)

B A L L I N G E R

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.

With the construction of the new Hall of Science, American University was seeking to dramatically improve its science education and research on campus. The state-of-the-art facility co-locates biology, chemistry, neuroscience and environmental science from scattered obsolete buildings on their campus into one central location with teaching, research laboratories, and shared scientific core facilities. The project includes 128,000 GSF of space on five floors, including a 100+ seat lecture hall with tiered seating. The building's architectural design is characterized by extensive transparency, putting science and research on display, and linking the occupants inside the building to the lush arboretum campus outside. An exposed concrete superstructure within the building is one way this design concept of "transparency" was achieved. Many of the finish floors are polished concrete slabs, the majority of the concrete columns and shear walls are left exposed, as is the bulk of the underside of the floor and roof slabs. As such, even seemingly minor items such as the location and types of form ties for the shear walls required careful coordination with the contractors.

The superstructure for the 5-story L-shaped portion of the building consists of conventionally-reinforced 10-inch thick 2-way slabs supported by round and square concrete columns with 10-inch deep drop caps. Concrete beams are located around the perimeter, but no beams were used in the interior of the building to allow for a more open feel as most interior spaces do not have a finished ceiling to hide the underside of the structure above. Due to the relatively long spans for a flat plate two-way slab system (with column spacing as much as 35 feet in some locations) and the desire to avoid interior beams within the floor plate, a design approach was taken to join individual drop caps at the columns together into 'continuous drop caps' that worked like very shallow beams.

The Hall of Science has an irregular geometry with few exterior walls parallel to each other or coming together at a true 90 degree angle and has an asymmetric curve to the exterior wall on the east face of the building. These unconventional aspects of the building's shape did not allow for a regular column grid to be implemented and thus added an extra level of complexity to the design of the two-way slabs in the floor and roof levels. Additionally, since the architect's goal was a transparent design to the building that put the science and research on display, the columns along the east, west, and south faces of the building were pulled in from the exterior wall several feet to allow for an uninterrupted view through the exterior glass curtain wall facade of the students and faculty working within. Because of this, the floor and roof slabs were designed to cantilever out past the columns 6 feet on the east and west sides and up to 15 feet in the southeast and southwest corners of the building. The columns along the south edge of the building were offset 4 feet above the 1st floor level with concrete transfer girders to strike a balance between the "on display" design of the floor below and the need to maintain an uninhibited workspace on the upper floors.

The low roof level of the lecture hall is framed with 50-foot span steel beams with a concrete slab and steel deck roof structure to support the occupied roof terrace above. Other portions of the building that utilized steel framing include the screen wall around the rooftop mechanical equipment, the dunnage platform supporting the rooftop cooling towers, and the loading dock canopy that cantilevers 10 feet off of a concrete shear wall with no backspan.

The foundation system for the Hall of Science consists of isolated shallow spread footings at the columns, mat footings below the interior shear walls, and a continuous spread footing below the perimeter foundation walls. The footings bear on densified native soils and weather rock that provided an allowable bearing capacity of 7000 psf.

12" thick reinforced concrete shear walls served as the lateral system for the Hall of Science. Because of the steeply sloped project site, the ground floor level is at the exterior grade level on the west side of the building but is two stories below grade on the southeastern side. In addition to the wind and seismic design loads, the shear walls were designed to resist the significant amount of unbalanced lateral earth pressure pushing on the building resulting from this 30 foot change in grade from one end of the building to the other.

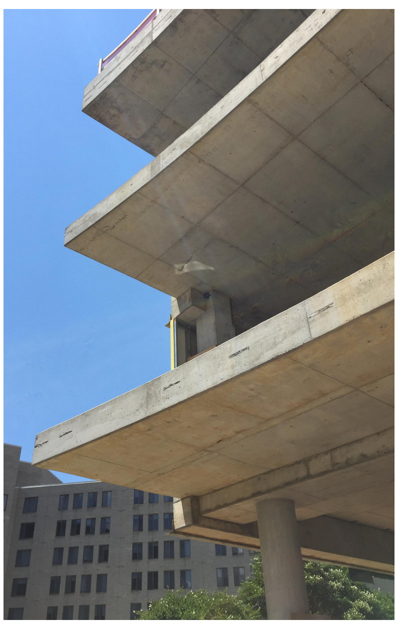
The construction schedule for the Hall of Science was very aggressive and to meet its demands the MEP contractors needed to be installing their work soon after the concrete floor slabs were placed. However, the cantilevered slabs and transfer girders required the shoring system to be left in place longer than what is typical and they would have interfered with the MEP contractors' work. To resolve this schedule crunch, it was decided to utilize the Maturity method for determining the strength of the in-place concrete since the Maturity method has proven to be much more accurate in predicting early-age strength of concrete that the traditional cylinder compression tests. With constant communication between the project engineer, the testing agency, and the construction manager throughout the placement of the slabs the shores and reshores were able to be safely removed in time to keep the overall construction schedule on track.

American University was the first university in the United States to reach carbon neutrality and this commitment to sustainability carried through in the design of the Hall of Science, which was awarded LEED Gold Certification. The concrete structure contributed to the LEED certification of the building by utilizing recycled materials in place of portland cement in the concrete mix designs. Fly ash was used in the portions of the concrete structure left exposed in the final construction, including the polished concrete slabs, and slag cement was used in the mix design for the balance of the concrete structure.

As a research facility with vibration-sensitive equipment on every floor, limiting floor vibrations due to footfall was a critical part of the design of the floor structures. Using finite element models of the concrete floor structures, each of the elevated floor slabs in the Hall of Science were designed for a maximum vibrational velocity of 4000 micro-inches per second for different walking speeds of people traveling through the primary corridors and pathways in the spaces. The final decision to specify a 10-inch slab thickness was a direct result of the vibration analysis, and ensure that the slab structures have enough mass to properly dampen the floor vibrations.

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





October 2018: Due to the steeply sloped project site, the bottom 2 levels of the building on the southeastern side were constructed below grade with temporary sheeting and soldier piles around the perimeter of the building. The uneven lateral earth pressure on the building structure results in a significant lateral load onto the shear walls in addition to the wind and seismic forces.

May 2019: The building superstructure was topped out and the concrete gained the required strength to allow for the removal of the shoring. Plywood enclosures are visible around the concrete columns to protect the surfaces that are to be left exposed in the final fitout. The longspan steel framing above the lecture hall to support the roof terrace above is in place.

June 2020: The exterior masonry and glass curtain wall facade erection is complete and the roof terrace above the lecture hall is finished.

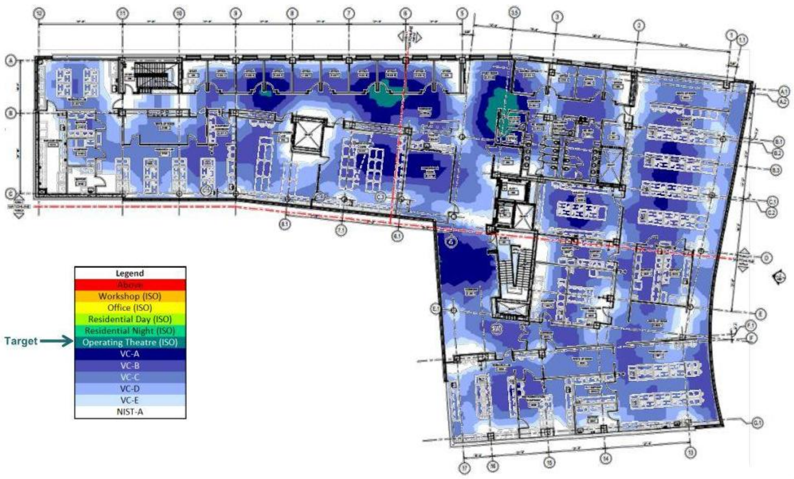


Figure 4 – Vibration response of third floor (102-132 steps/minute)

With students and faculty using microscopes and other types of vibration-sensitive equipment, limiting the floor vibrations due to footfall was a critical part of the design of the floor structures. Floor slabs were designed for a maximum vibrational velocity of 4000 micro-inches per second. The diagram above depicts the anticipated walking speeds and pathways that were used for the vibration analysis of the 3rd floor level, and the diagrams to the left show the output of the finite element modeling analysis of the 3rd floor structure.

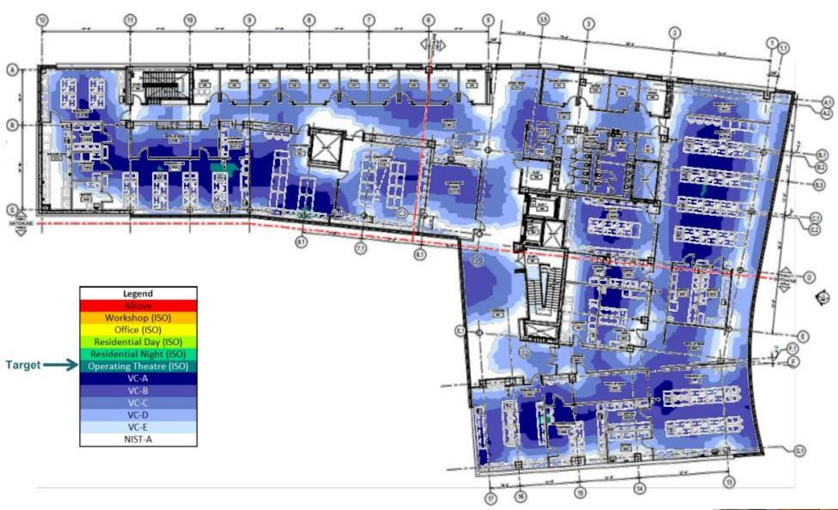
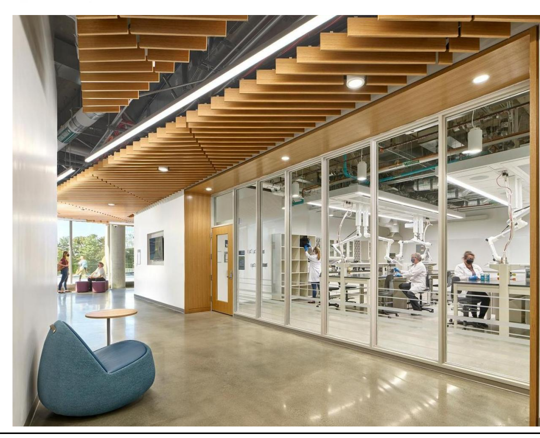
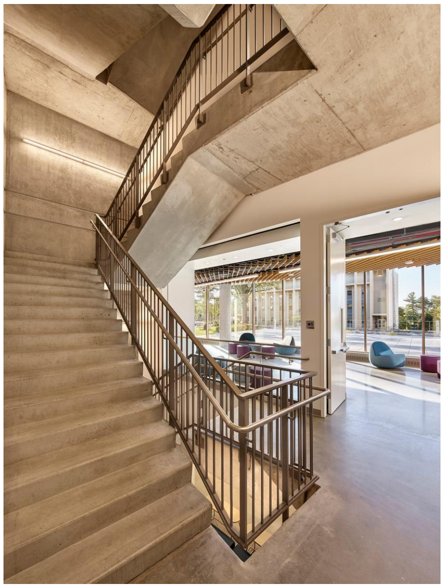
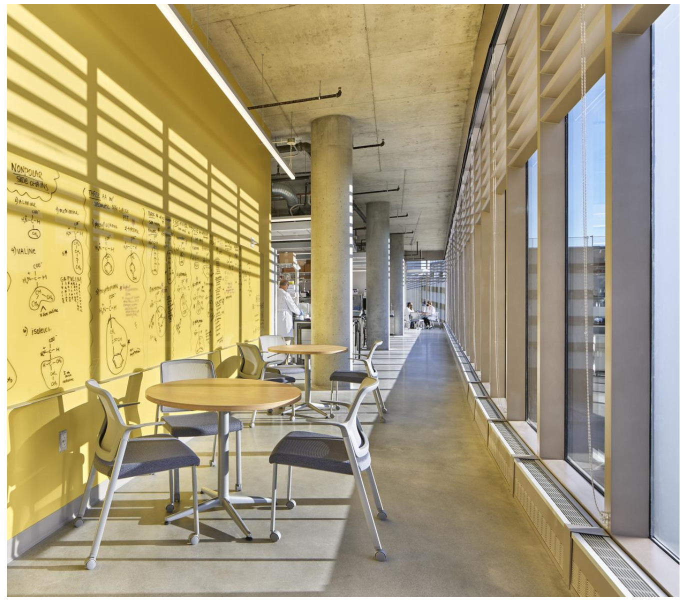


Figure 3 – Vibration response of third floor (75-108 steps/minute)



Looking east at the south end of the building, prior to the construction of the masonry facade, where the columns along the south face of the building above the 1st floor level are offset 4'-0" with cantilevered transfer girders. Additionally, the floor slabs in the foreground are cantilevered 15'-0" beyond the column centerline.

Looking south at the curved east face of the building where the columns are set back 6'-0" from the edge of the slab.



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:	**Signature:**	**Date:**
Angela M Fante, PE, SECB	Angela Fante	4.1.2021

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