Heavy-Duty Hardware

BY AMY BARABAS, PE, AND TOM BARABAS, PE

YOU COULD SAY that the University of Maryland has quite a bit of computing power.

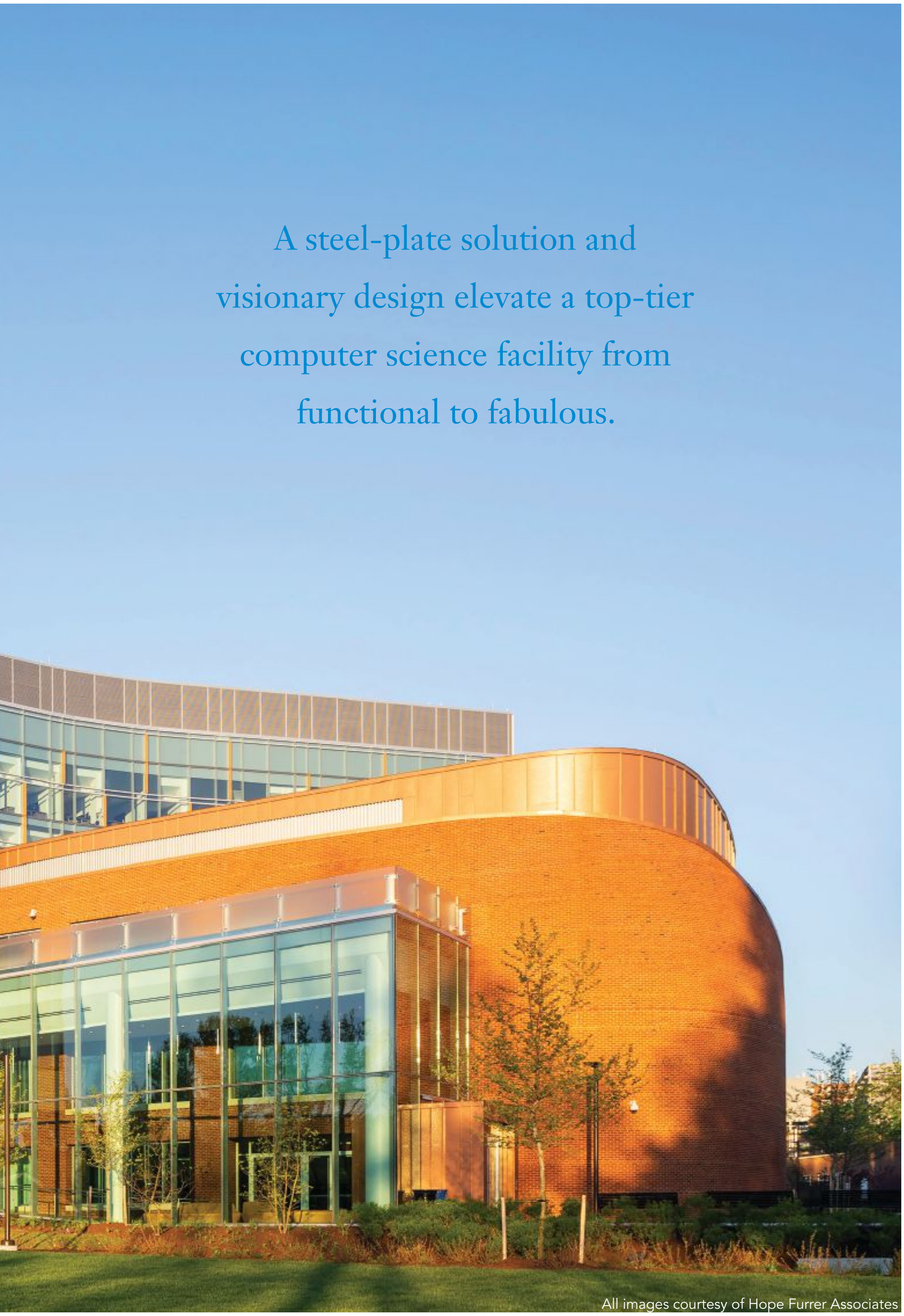
Opened last year on its College Park campus, the new Brendan Iribe Center for Computer Sciences and Engineering houses the school's highly ranked Department of Computer Sciences and the Institute for Advanced Computer Studies. The 215,600-sq.-ft building provides space for research in several tech fields, including cybersecurity, data science, virtual and augmented reality, and artificial intelligence, housing hacker and maker spaces, VR and AR labs, classrooms, and administration space.

Its namesake, a former University of Maryland student and cofounder of Oculus VR, provided a generous donation to reinvigorate the Computer Sciences Department and propel the program to the forefront of technological education and innovation. Additional funding assistance from Oculus cofounder Michael Antonov, the State of Maryland, and the University allowed the $138 million project to move from vision to reality in a span of five years.

Site Logistics

Located at the main campus entrance along Baltimore Avenue, the selected site for the facility lies at the front door of a new "Innovation District." However, the site posed multiple challenges for the design team. The orientation of the building

A steel-plate solution and visionary design elevate a top-tier computer science facility from functional to fabulous.



All images courtesy of Hope Furrer Associates

left: The main tower of the Iribe Center is connected to the auditorium structure via a one-story lobby space.

below: Inside the atrium of the 215,600-sq.-ft building. The main stair stringer section incorporates helically curved HSS12×4×.375.

placed the eastern portion of the structure within the 100-year flood plain, and the western end of the building required loading dock access under the tower.

Due to the flood plain, usable space wasn't feasible at the ground level of the easternmost 120 ft of the building. Therefore, the first usable space for this area was the first elevated slab. In lieu of just functionally bringing down the building columns, the architectural team at HDR looked to create a dramatic effect for the supports at the east end. After several design iterations and structural studies, the team landed on a sloped steel column design with cantilevered steel transfer girders in all directions. In concert with the design of the east cantilevers, the decision to also cantilever transfer girders on the west end facilitated column-free access to the loading dock.

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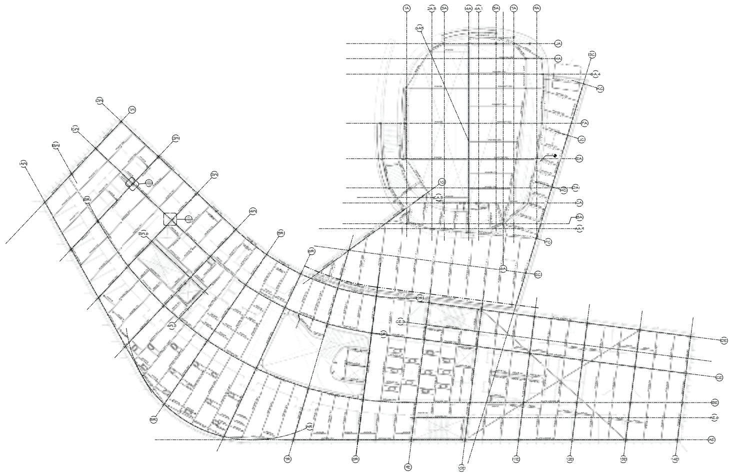
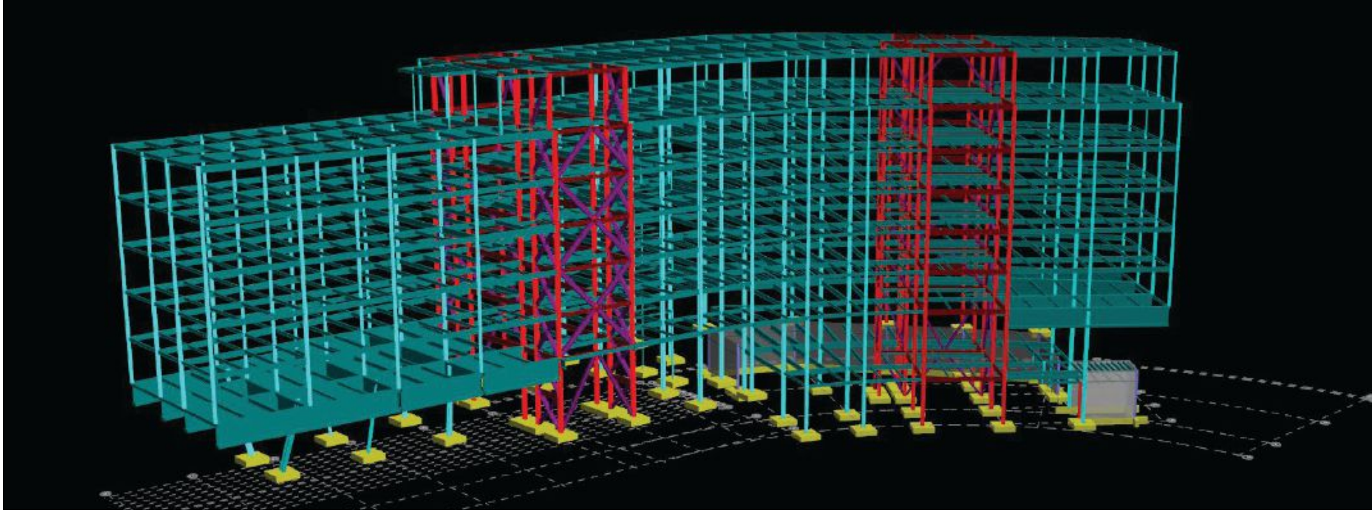
above: A plate girder at Littell Steel's shop, one of 19 the company fabricated for the project.

left: Web penetrations allow for continuous splice plates of perpendicular plate girders on the top and bottom of the flanges.

below: An overhead plan view of the main building and auditorium structure.



The east of end of the structure after substantial completion of steel erection.



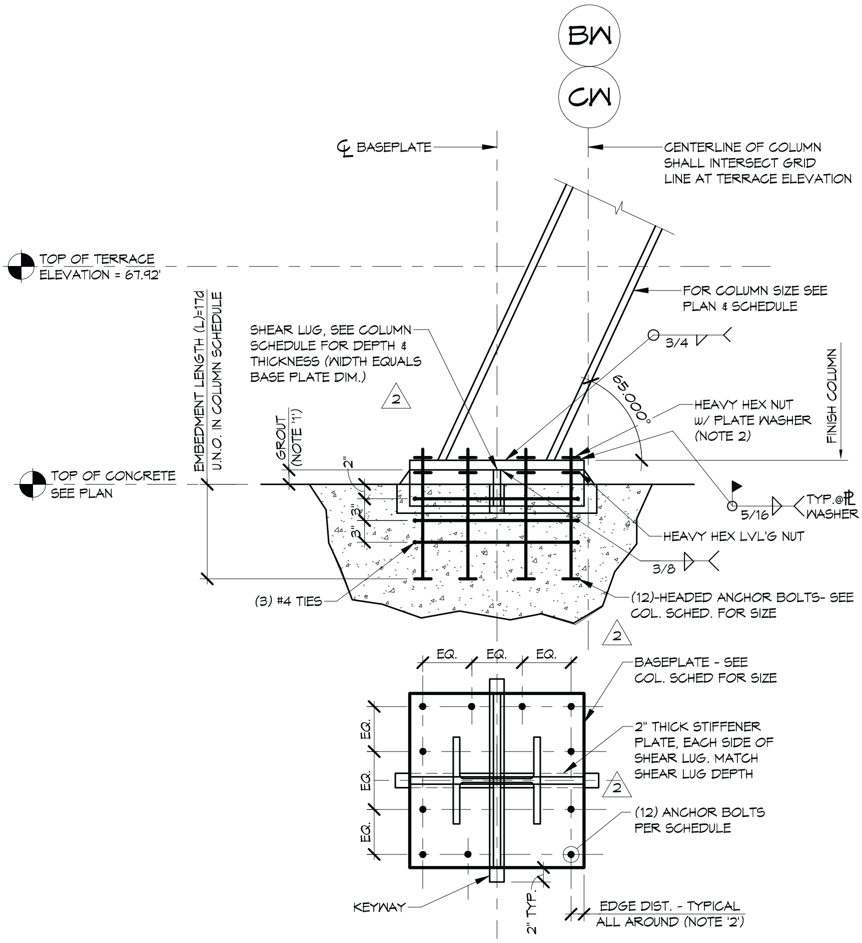
A 3D structural model of the main building (braced frames are shown in red and purple).

Cantilevered Framing

After settling on the design concept for the east end of the building, the structural engineering team at Hope Furrer Associates was tasked with coming up with the most efficient structural framing. With the 25-ft floor-to-floor height from the ground floor to the first floor, ample room existed to provide structural steel transfer girders to support the five steel-framed stories above, capped with a rooftop terrace. The design team reviewed both truss and plate girder concepts and discussed both options with fabricator Cives Steel. Since few utilities would be located in the space designated for structure—the plate girders were located above an outside terrace/entrance area and there were no large ducts as would be the case if they were located at a roof—the simplicity of fabricating and erecting plate girders made the most sense.

The grid of transfer girders is supported by three pairs of sloping columns. The column pairs are spaced 30 ft apart in the east-west direction, and the easternmost pair is set in 30 ft from the exterior of the building above, creating a cantilever. The columns in each set slope equal and opposite to each other and vary from vertical 5° to 25°, with the largest slope located at the easternmost set of columns. Column sizes for the sets of sloping members were W14×257, W14×605, and W14×730, respectively from west to east. The resulting axial, shear, and moment forces on the easternmost set of columns resulted in 48-in. × 48-in. × 5-in. base plates with a 3½-in. × 8-in. shear lug and 12 1¼-in. grade 105 anchor rods.

In addition to supporting the 30-ft cantilever to the east, the transfer girders also support cantilevers beyond the sloping columns in the north and south directions,



above: A detail of the bottom of a sloped column.

below: East-end cantilevered plate girders and sloped columns during steel erection.

ranging from 10 ft to 20 ft depending on the column slope. The total depth of the plate girders was 7 ft, 4 in. and the girders were built from flange plates ranging from 26 in. × 2 in. thick to 28 in. × 3 in. and web plates ranging from 1 in. to 1½ in. thick. Camber was provided at the end of the most heavily loaded cantilevered sections to account for a portion of the dead load deflection and reduce the impacts on the curtain wall.

Since plate girders were required in both directions, spliced connections would need to be designed to transfer the full moment across the perpendicular member. Due to the loads, splice plates would be required on the top and bottom of each flange to allow the bolts to be in double shear, which required web cut-outs of the intersecting plate girders to allow for the plates to pass through.

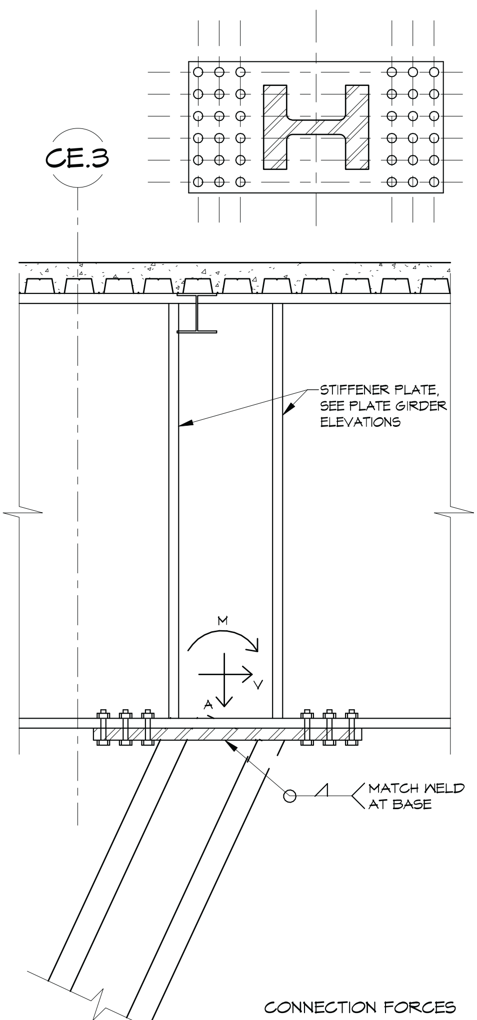
Due to the sloping columns, lateral stability of the transfer level was critical to the design. In accordance with ASCE 7-10: *Minimum Design Loads for Buildings and Other Structures*, Section 4.3.3, partial loading of the structure produced more unfavorable load effects for some members than the same load applied over the full structure. Loading one side of the structure, and therefore only one of the sloping columns, provided the controlling load effect. To resist the resulting instability, moment connections were provided at column to transfer girder joints and horizontal bracing was provided at both the top and the bottom of the plate girders. This bracing went back to braced frame towers at the north and south sides of the building. These towers were instrumental in stabilizing the structure at this end and since they were exposed to view (and coated with intumescent paint) at the exterior, HDR requested

a specific configuration and the use of hollow structural section (HSS) members—HSS20×12×½—for the braces to contribute to the overall expression of the building.

At all floors above the transfer level, additional horizontal bracing was provided to create a horizontal truss at the cantilevered end to resist the imposed lateral loads and provide a load path back to the braced frame towers. The braced frame towers at each side of the building were connected via moment-connected beams to provide additional resistance to the torsion induced on the building frame from lateral loads on the cantilevered diaphragm. Since the west end also required 30-ft cantilevers at the transfer level, the same depth and similarly sized plated girders were provided. However, this end only required plate girders in one direc-

A 48-in. × 48-in. × 5-in. base plate with shear lugs supporting a sloping W14×730 column.

A detail of the top of a sloped column.



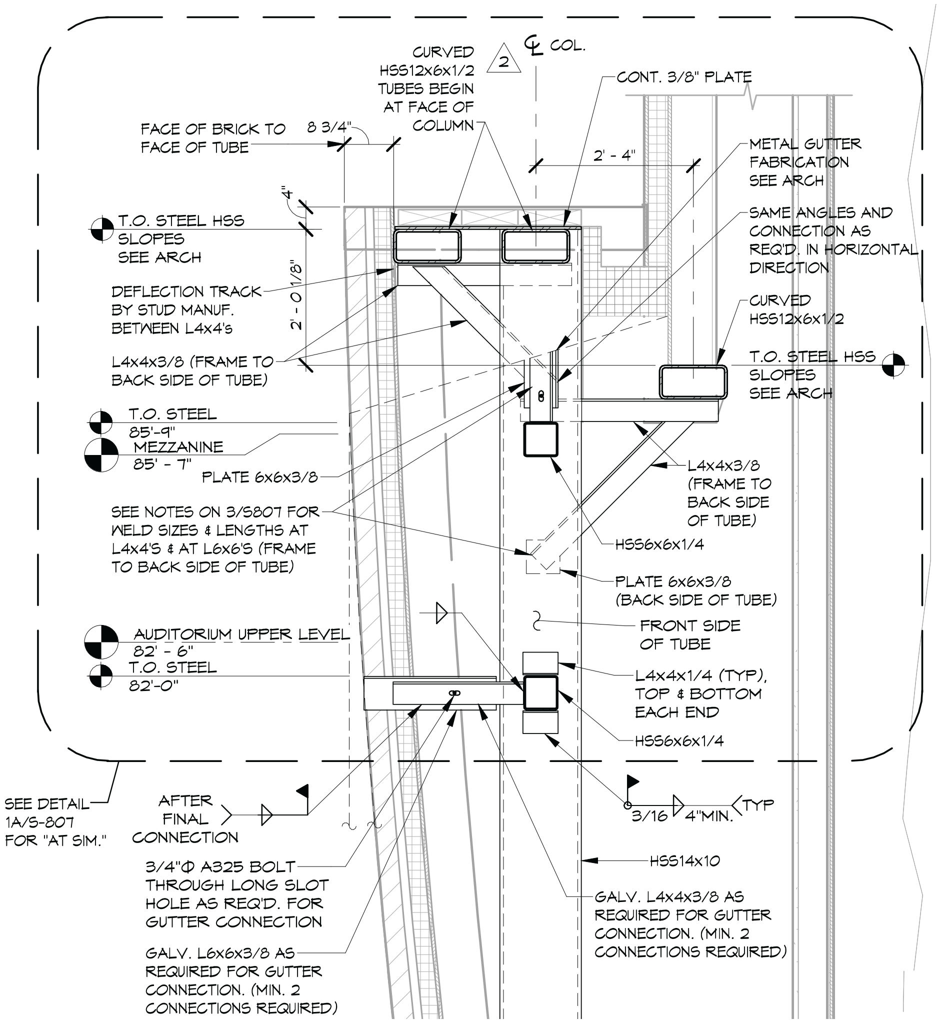
CONNECTION FORCES

	A	M	V
@ 101 + 102	1373	177	103
@ 103 + 104	2859	385	487
@ 105 + 106	2525	1498	938

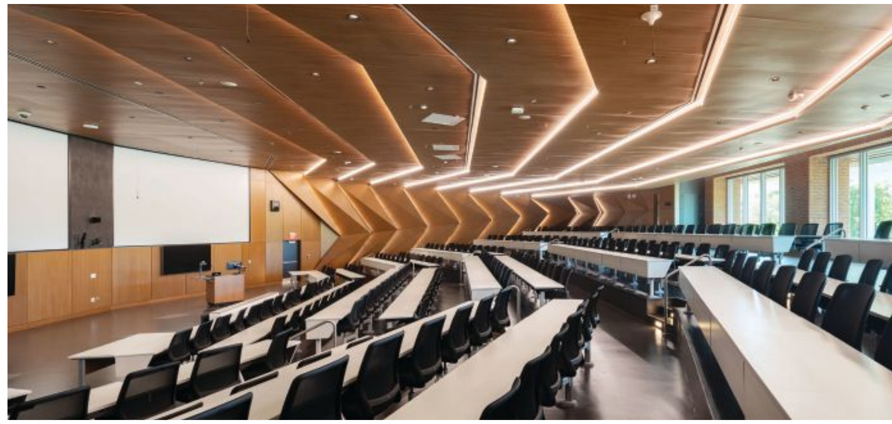
tion. Also, due to the size and weight of the plate girders, Cives subcontracted plate girder fabrication to Littell Steel. (Of the roughly 3,000 tons of steel fabricated for the project, Cives was responsible for 2,550 and Littell provided 450 in the form of 19 plate girders.) In addition, a specialized erection plan had to be developed for the sloped columns and plate girders, with stability for these elements being provided through temporary shoring and the tower's braced frames.

above: A rooftop terrace provides an attractive outdoor oasis on top of the building.

above: Steel framing for the auditorium.



right: The auditorium's brick ledge and gutter required sloping and curved HSS members for support.



The elevated auditorium seating was constructed of wide-flange raker beams.

Auditorium Structure

Beyond the main tower and connected via a one-story lobby space sits a steel-framed auditorium structure housing a 100-seat lecture hall directly below a 300-seat auditorium. The elevated auditorium seating was constructed of wide-flange raker beams with tapered WT shapes welded to the top flange and bent plates to create the seating tiers.

To create a column free space in the auditorium, a 90-ft-long truss was designed to span the length of the building. The bottom chord supports the penthouse floor structure, which houses the MEP equipment needed for the auditorium, and the top chord supports the roof structure. The truss is segmented with the top chord following the shape of the curved roof.

The exterior of the auditorium is curved both horizontally and vertically and cannot be described by a defined shape, incorporating multiple radii in both directions that provided direction for construction. The exterior is clad with brick and required a setback for an internal gutter system. Due to the unique geometry, the brick ledge and gutter are supported by sloping and curved HSS members.

The completion of the Brendan Iribe Center for Computer Science and Engineering establishes the University of Maryland as a focal point for the nation's technology community. Since opening, the facility has worked to foster the student creativity needed to develop the ideas and breakthrough technologies that can change the world, stimulate economic development, and solidify the university as a high-tech resource for the business community. ■

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