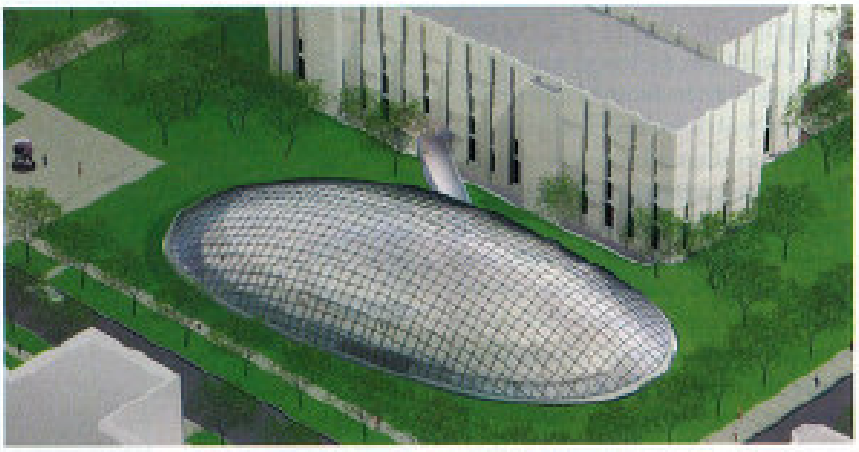
STRUCTURES

Subterranean Addition Designed for University Of Chicago Library

A 55 FT (17 M) DEEP subterranean addition planned for the University of Chicago's Joseph Regenstein Library will be elliptical in plan and feature an automated storage and retrieval system for more than 3 million books and other printed works, all housed beneath a 36 ft (11 m) high glazed grid shell dome. Named for the University of Chicago alumnus who donated $25 million of the $80 million required for the project, the Joe and Rika Mansueto Library structure is being constructed adjacent to the existing limestone facade of the Regenstein building, which dates to 1970, and will be connected to it via an enclosed bridge structure.

The location for both library buildings was once Stagg Field, the university's athletic facility. It was there that in December 1942 scientists conducted the world's first controlled nuclear chain reaction, notes Jonathan A. Sladek, S.E., LEED AP, a senior project engineer of Halvorson and Partners, the Chicago-based structural engineers of the Mansueto structure's ground-level and subterranean portions.



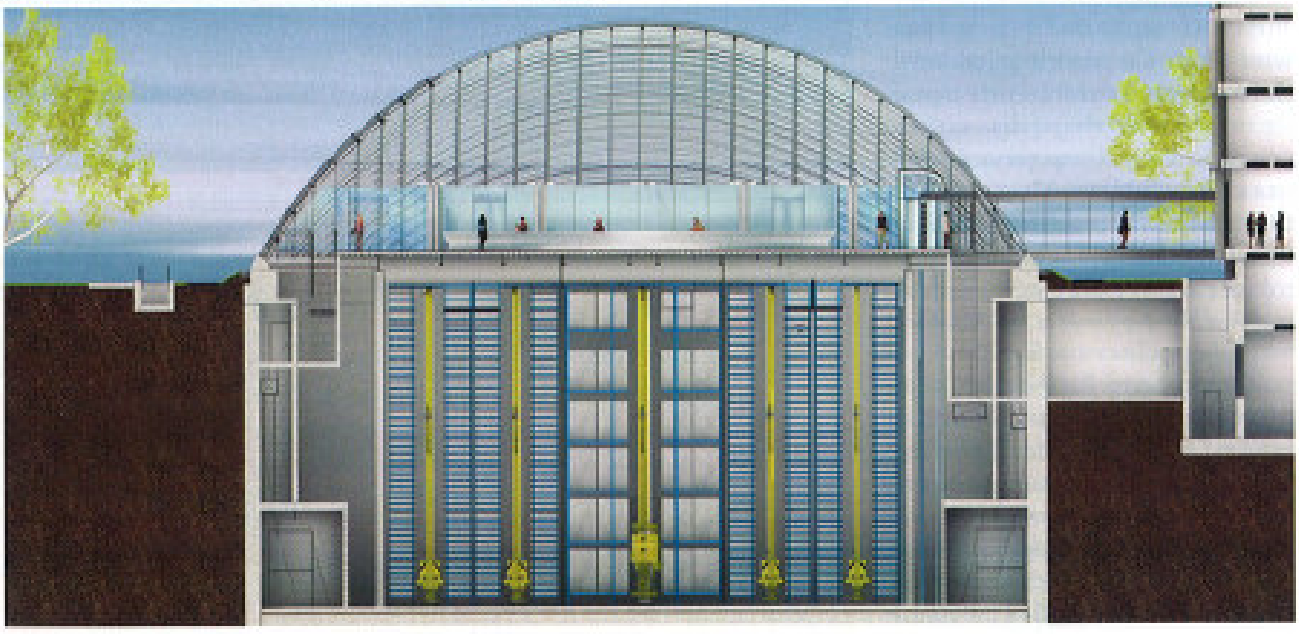
A 55 ft (17 m) deep subterranean addition to the University of Chicago's library system will feature an automated storage and retrieval system for more than 3 million books and other printed works, all housed beneath a 36 ft (11 m) high glazed grid shell dome and connected to the limestone facade of the existing library building via an enclosed bridge, above. The steel and glass dome, below, will be constructed from a grid of steel pipes and feature a column-free space of 120 by 240 ft (36.5 by 73 m). A reinforced-concrete ring beam approximately 5 ft (1.5 m) square in cross section and horizontally linked to the library addition's ground-floor slab diaphragm will support the dome and rest on a series of slurry walls.

The Chicago-based architecture firm Murphy/Jahn designed the project, which is scheduled to open in the spring of 2011.

The university did not envision an underground structure, and during the design phase it even considered a conventional aboveground building, notes Peter Hayes, an assistant principal architect at Murphy/Jahn. But the architect's desire to retain a sense of the open space that had existed at the site, which is close to a monument commemorating the nuclear research, ultimately led to the glass dome design, says Hayes.

Covering a column-free space of 120 by 240 ft (36.5 by 73 m), the dome will be constructed from a grid of steel pipes approximately 6.6 in. (168 mm) in diameter, explains Lucio Blandini, Ph.D., the associate project manager at Werner Sobek Stuttgart GmbH & Company KG, of Stuttgart, Germany, the structural engineers for the dome and the connecting bridge. In addition to Blandini, the Werner Sobek design team included Stephen Hagenmayer, the project manager, and Annette Kretsche, a senior engineer.

Flat insulated glass panels will clad



MURPHY/JAHN ARCHITECTS, CHICAGO

the dome, providing "the optimal balance between transparency and comfort by means of frit patterns with different densities," notes Blandini. The glass panels will be secured via clamps to customized hollow aluminum extrusions connected to the steel pipes.

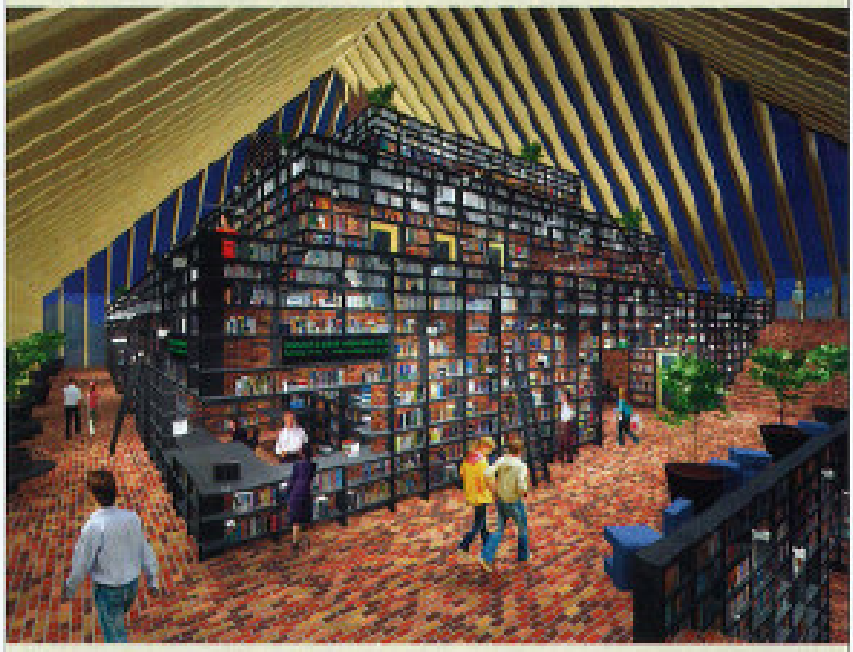
The steel and glass dome will be supported on a reinforced-concrete ring beam approximately 5 ft (1.5 m) square in cross section that will rest on a series of slurry walls and be horizontally linked to the ground-floor slab diaphragm. The ring beam's main function will be to transfer the vertical and horizontal reaction loads from the dome pipes to the walls and to the structural steel-framed slab of the library's at-grade floor. These loads, explains Sladek, will be transferred via radial steel beams that will be located at the base of each pipe. The ring beam, a key element of the structural design that will integrate all the other major structural components, will be expressed on the outside of the building as the base of the dome and will receive a finishing coat of concrete, Sladek adds.

The ring beam will connect to the slurry walls via a series of hooked, vertical steel bars. Moreover, some of the concrete for the beam will be placed in a recessed slot in the top of the walls, thereby locking the beam and walls together and imparting lateral stability, Sladek says.

To follow the elliptical shape of the dome, the slurry walls will comprise a series of panels that will be approximately 25 ft (7.6 m) long and 30 in. (762 mm) thick and have an inward kink. Extending approximately 10 ft (3 m) below the 2 ft (0.6 m) thick reinforced-concrete slab that will form the mat foundation of the new library's underground structure, the walls will reach a depth of 65 ft (20 m). The extra depth will help to "lock the walls into the soil below" to resist the forces of the soil pushing against the slurry walls, says Sladek. Portions of the slurry walls will bear on hardpan clay, and other portions will bear on weathered rock, Sladek adds, but the mat slab will bear entirely on the clay.

Because the automated storage and retrieval system will require a large open space with a 50 ft (15 m) column-free height in the interior of the library's subterranean portion, there will be no

A MOUNTAIN OF BOOKS will be the indelible image left with those who view a public library currently under construction in the Dutch city of Spijkenisse. The building's glass and wood exterior will protect a multistory internal structure that will appear to be formed entirely of bookshelves. According to the project's architects—MVRDV, of Rotterdam, Netherlands—the library has been designed as an advertisement for reading in a suburb in which the demand for library books is not as robust as it might be. Because the area historically has been associated with agriculture, the silhouette of the building will suggest a traditional Dutch barn. Wooden trusses laced with glass panels will constitute the sloping roof and the walls of the building to form what the architects call a



bell jar over the bookcase structure. Methods originally developed for greenhouses will be used to protect the climate-controlled space from undue solar gain. Natural ventilation and an underground heat storage system will help to provide comfortable conditions year-round. Commercial facilities, offices, an auditorium, conference rooms, and exhibition spaces will be stacked vertically and be tucked behind the bookshelves—within the "mountain"—and will be accessible by a series of hidden stairways and terraces located along the exterior. From the top of the mountain visitors will enjoy panoramic views of Spijkenisse. The building is at a major intersection near the city's central market square. The structural engineering for the building was provided by the Velp, Netherlands, office of ABT bv.

BUSINESS BRIEF

Vanasse Hangen Brustlin, Inc. (VHB), an integrated transportation, land development, and environmental services firm headquartered in Watertown, Massachusetts, has opened an office in Albany, New York. The new office is part of the firm's multidisciplinary affiliate, VHB Engineering, Surveying and Landscape Architecture, P.C. VHB employs 600 people in 16 offices on the East Coast.

Civil Engineering NEWS

intermediate floor slabs to provide internal bracing against the lateral earth pressures. Indeed, Sladek compares the form to a "giant bathtub-type structure." To compensate, the design features external bracing: four levels of permanent posttensioned tieback anchors, 400 in all, will radiate outward along the perimeter of the underground structure, extending beneath the adjacent buildings and streets.

Each anchor will measure up to 100 ft (30.5 m) in length, and some will extend as much as 50 ft (15 m) into the public easement, Sladek notes. The first level of tiebacks will be located approximately 10 ft (3 m) beneath the ground-floor slabs; the next level will be 15 ft (4.6 m) lower, and two more levels will follow at 10 ft (3 m) intervals. To accommodate the greater lateral earth pressures deeper in the excavation, the anchors at the three lowest levels of tiebacks will be spaced approximately 6 ft (1.8 m) apart and will feature capacities of up to 170 kips (756 kN); the anchors at the uppermost level will be spaced approximately 12 ft (3.7 m) apart and have capacities of approximately 120 kips (534 kN), Sladek says. If the anchor system were not included, he notes, the 30 in. (762 mm) thick slurry walls would need to be much thicker to resist the lateral earth pressures of up to 5,000 psf (239 kPa) surrounding the subterranean structure.

The Joe and Rika Mansueto Library's automated storage and retrieval system is being designed by HK Systems, of Milwaukee. To create the required column-free interior space in the subterranean portion of 80 by 200 ft (24 by 61 m) with, as mentioned above, a height of 50 ft (15 m), a partition wall ring located approximately 5 ft (1.5 m) in from the edge of the slurry walls will be used. The five storage aisles will each have an automated crane, a robotic arm, and elevators to bring bins of material up to a series of ground-level stations from which the library staff can distribute the requested items.

"The complex mix of structural

elements implemented in this project creates a secure vault for books below while providing patrons an open volume to enjoy them above," says Sladek.

Because much of the subterranean portion of the library will be below the area's water table and within 1 mi (1.6 km) of Lake Michigan, the design includes a collection and pumping system located in the gap between the slurry walls and the interior partition walls to remove any moisture that penetrates the outer barrier.

The ground-level slab will form the floor of the library's reading room and create a column-free space above the book racks that extends for 80 ft (24 m). The slab's framing will take the form of six 48 in. (1,200 mm) deep built-up steel plate girders that will be spaced 30 ft (9 m) apart and be supported on rectangular hollow steel columns 16 in. (406 mm) square in cross section that in turn will bear on the foundation slab. The radial steel beams that will connect the floor slab diaphragm to the ring beam will typically be W 12 × 53 members and will be used primarily to transfer axial loads, says Sladek.

The project will also include a one-story mechanical equipment structure for the library that will be located underground in the space between the Mansueto and Regenstein buildings. To avoid the bell caissons that form part of the Regenstein building's foundation, the mechanical equipment space will be founded on straight-shaft reinforced-concrete caissons that extend as much as 80 ft (24 m) below grade to reach bedrock, Sladek notes.

Library patrons will use an elevated, enclosed bridge to move between the Mansueto and Regenstein buildings. This climate-controlled glass box structure will be constructed on a skewed alignment and will be supported on two steel beams that will connect to the library structures. There will be no intermediate supports along the approximately 50 ft (15 m) span, says Sladek.

Given the innovative character of the project, good collaboration on the part of the university, the design team, and other consultants was essential to "clarifying all open issues and finalizing the overall design," notes Blandini.

—ROBERT L. REID

BUSINESS BRIEF

PBS&J, a subsidiary of the PBSJ Corporation specializing in engineering, planning, sciences, and architecture, has established a new sustainable building design group that will operate from the firm's Orlando, Florida, office. The new group will offer services focused on integrating sustainable design into all project elements and providing guidance on attaining certification under the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) Green Building Rating System. The PBSJ Corporation has nearly 3,900 employees and operates more than 80 offices worldwide.