Bridging to Sustainability: The JHU Center for Sustainable Living

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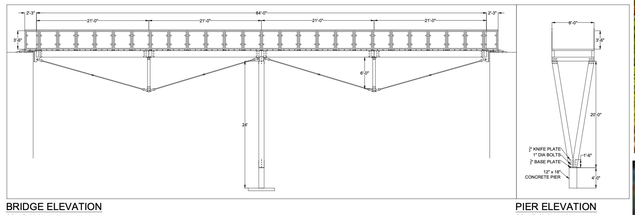
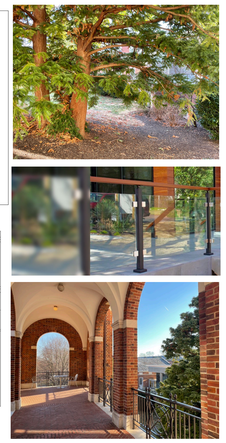
1. Pedestrian Bridge

The pedestrian bridge from Keyser Quad to the new green roof provides a new, faster route from the north side of campus to the south side of campus, facilitates contact between students and the Center for Sustainable Living, and provides an alternative accessible entrance to the green roof in addition to the elevator.

The major design feature of the pedestrian bridge is the cable truss system. This lightweight solution allows the girders to carry a large portion of the bridge's load more efficiently through axial compression rather than bending, reducing the size of the timber girders. Other design features include the form of the pier that recalls the shape of two nearby pine trees, knife plates used to connect timber members of different widths, and slip-critical cable connections designed to withstand repetitive pedestrian loading. The superstructure was analyzed under multiple live-loading scenarios to determine the worst-case loads on the structure.

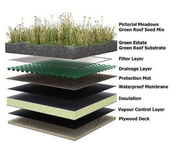


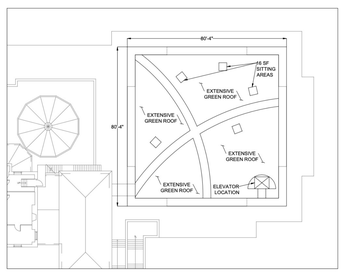


2. Glass Pavilion Green Roof

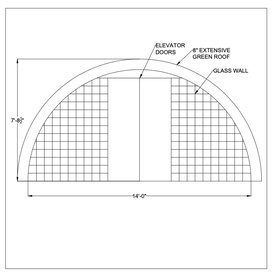
The extensive green roof on the Glass Pavilion absorbs rainwater runoff and insulates the Glass Pavilion to keep it warm during cold months and cool during hot months. The additional load is minimized by growing low-maintenance mosses, sedum, and small herbaceous plants that require only a few inches of soil and are resilient in extreme conditions. The walking paths direct most pedestrian loads onto the large exterior girders, while the seating areas are roped-off to avoid zoning the entire area for live loads.

A truss system reinforces the exterior girders of the Glass Pavilion to carry the additional loads by reducing the bending moment and transmitting most of the new load through axial compression, which the girder has excess capacity for. Portions of the girders over the columns will be wrapped in carbon fiber reinforcement to withstand the shear stress from the new roof loads. Although this is a stark comparison to the Glass Pavilion's nondescript concrete roof, it serves as a visual reminder that living sustainably is not always flashy – sometimes it's just practical.

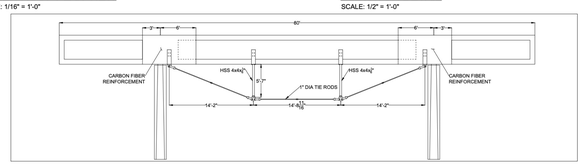




GREEN ROOF PLAN VIEW
SCALE: 1/16" = 1'-0"



ELEVATOR DETAIL
SCALE: 1/2" = 1'-0"



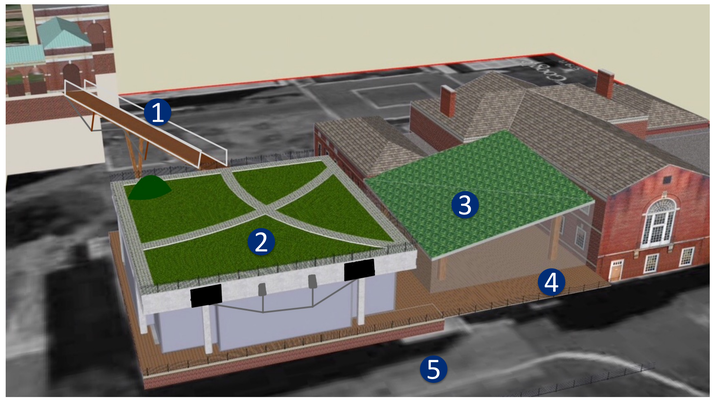
EXTERIOR GIRDER REINFORCEMENT
SCALE: 3/16" = 1'-0"

Project Overview

Our design team was tasked with developing Levering Hall, the Glass Pavilion, and the surrounding terraces to house the Johns Hopkins Center for Sustainable Living. Our team believes that sustainable living begins with sustainable building, and is therefore committed to creating design solutions that utilize renewable and recyclable materials and provide a meaningful positive benefit to the university community. To the greatest extent possible, all new construction was designed using mass timber in conjunction with thin steel members. This promoted the development of innovative design details to create structural forms that are well-suited to timber's material properties.

The five key components of our proposed design include:

1. A pedestrian bridge from Keyser Quad to the new green roof
2. The addition of an accessible green roof to the Glass Pavilion
3. The Center for Sustainable Living Learning Laboratory (CSL^3), which serves as a studio space and assembly area for the new Center
4. Extensions of the existing terraces surrounding the Glass Pavilion
5. Reinforcement of the existing structural system and foundations of Levering Hall and the Glass Pavilion



5. Foundations

The capacity of the existing spread footing foundations under the eight columns of the Glass Pavilion and six columns of Levering Kitchens underneath the CSL^3 Pavilion were estimated to determine the required amount of reinforcement for the new loads. The existing dead loads were estimated from the architectural drawings, while the live and snow loads were calculated in accordance with ASCE 7-16. The factored load effects were applied to the eight pavilion columns to determine the minimum required column reinforcement and foundation dimensions. The capacity of the columns and foundation of Levering Kitchens was estimated by halving those of the Glass Pavilion because the columns are half as large in the architectural plans.

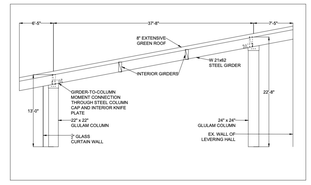
It was assumed that the existing foundations and columns could carry an additional ten percent load. The new to existing load ratio was less than ten percent for the Glass Pavilion columns, but over twenty-five percent for the Levering Kitchens columns. Steel plates will be used to create an HSS section to reinforce the existing concrete column. New concrete will be poured around the existing foundation and anchor bolted together to create a larger footing.

Value	Pavilion Column	Levering Column	Bridge Pier
Applied Load (k)	784	601	72
Footing Width (ft)	13	12	5
Footing Area (sf)	169	144	25
Footing Depth (ft)	2	1.75	0.5
Bearing Pressure (ksf)	4.64	4.17	2.9

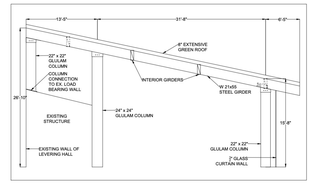
3. CSL^3 Pavilion

The CSL^3 Pavilion is a more practical use of space than the existing conical skylight. The skylight will be replaced with a translucent glass floor and two glass curtain walls of the pavilion will allow natural light into Levering Kitchens below. The west curtain wall can accordion-fold to open the CSL^3 to the outdoors. Existing walls of Levering Hall will serve as the south and east walls of the new pavilion, with windows above that ventilate the space in warm weather. The lateral system uses the existing skylight basin to create fixed end conditions for the five major columns. These cantilever columns are attached to the roof girders through moment-resisting knife-plate connections so that the entire pavilion can act as a frame.

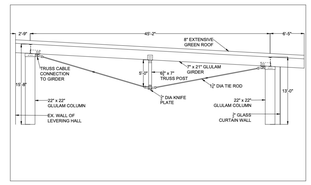
The roof of the pavilion is a non-accessible extensive green roof. The double slope of the roof was designed to visually unite the two roofs of Levering Hall that are at different heights. The north, south, and middle girders use a similar cable truss system as the bridge to reduce the required timber member sizes. The point loads that these four girders exert on the east and west girders created significant moments that could not reasonably be supported by timber, so wide-flanged steel shapes were specified instead. These are notably the only superstructure details for which a conventional steel W-shape was specified instead of a timber alternative.



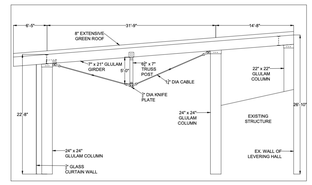
EAST ELEVATION
SCALE: 3/16" = 1'-0"



WEST ELEVATION
SCALE: 3/16" = 1'-0"



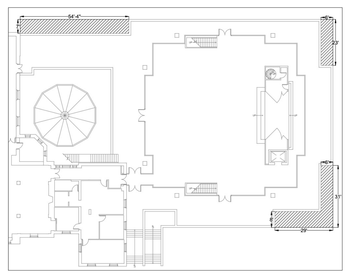
NORTH ELEVATION
SCALE: 3/16" = 1'-0"



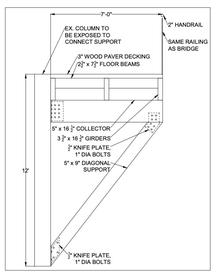
SOUTH ELEVATION
SCALE: 3/16" = 1'-0"

4. Terrace Extensions

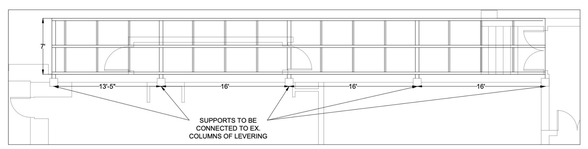
The surrounding terraces will be extended to create more space around the two pavilions. The diagonal supports of these extensions anchor into the existing concrete columns at the lower level of Levering Hall to reduce the amount of new construction materials required. One notable auxiliary use for these diagonal supports is for theater groups to hang posters for their performances outside the west entrance to Arellano Theater in the lower level of Levering Hall. The underside of the new terrace above this entrance will also accommodate a small section of marquee lights to welcome audience members on performance nights.



TERRACE EXTENSION LOCATIONS
SCALE: 1/16" = 1'-0"



TYPICAL SUPPORT DETAIL
SCALE: 1/2" = 1'-0"



TYPICAL FRAMING PLAN
SCALE: 1/4" = 1'-0"