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:	$87,600,000
Name of Project:	University of Michigan - Kraus Building Addition and Renovation
Location of Project:	Ann Arbor, Michigan
Date construction was completed (M/Y):	11/2020
Structural Design Firm:	Ballinger
Affiliation:	**All entries must be submitted by DVASE member firms or members.**
Architect:	Ballinger
General Contractor:	Walbridge

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.

The Edward Henry Kraus Building was designed and constructed by Albert Kahn in 1914 for the Natural Sciences program at the University of Michigan. The original building is a four-story, 183,000 square foot roughly "square" footprint with open interior courtyard. It is framed with one-way concrete joists, beams and slabs reinforced with Albert Kahn's patented "trussed joist" system formed with terra cotta tiles. Prevalent in the Midwest during this time period, the details and reinforcement of this type of construction were typically addressed by the craftsman contractors building the project. Therefore, existing drawings indicating the existing reinforcement, live load capacity, and detailing were not available. In addition, during the design phases, the building was off limits to the design team for survey given the critical nature of ongoing research within it.

The University charged Ballinger with creating a "transformation" for the building to serve as the new home for the rapidly growing School of Kinesiology. Through an extensive pre-design and schematic design process Ballinger shaped a strategy for the re-use of this 100-year-old landmark building in the heart of the campus. The resulting design strategy involved a gut renovation of the structure combined with an infill of the courtyard for larger and unique spaces, which included a one-story penthouse addition to house the new building infrastructure. The interior design is organized around a major commons space that brings daylight indoors, while providing a central gathering space for students and faculty.

Various structural modifications were required as part of the new design which triggered an upgrade of the building's gravity and lateral systems in accordance with the IEBC. These included the addition of the wind area and seismic mass of the new penthouse level, the removal and transfer of existing columns within the building footprint to allow for large unobstructed classrooms, the addition of multiple new shaft and elevator openings through the existing concrete joist framing, and the addition of snow drift on the existing roof due to the new, higher penthouse addition within the former courtyard footprint.

The central courtyard infill provided the ideal location for a new lateral system core designed to today's code standards. A core "ring" of concrete shear walls was integrated into the architectural design of the commons space to support new large classroom spaces. The new slab infills at each commons level in the existing courtyard were tied via reinforcing bar to the existing perimeter courtyard beams to transfer the existing building's diaphragm loads to the new shear wall core. The shear walls were then designed to resist the lateral forces of the entire building, including the new courtyard addition. Featured as a key architectural design element in the new commons space, the shear wall core concrete was placed with formwork liners on the face to be exposed in the commons area. The shear walls ranges from 10"-16" thick, with an additional 4" non-structural layer placed monolithically with the structural thickness to accommodate the custom formwork liner depth. Given the intricacy and sharpness of the formliner detail and edges, a self-consolidating concrete mix design with a slump of 28" was used. Because horizontal construction joints were not visually acceptable, the formwork for these walls were designed to support the pressure of a full story of highly liquid concrete. Form tie layouts were coordinated between Ballinger and the formwork engineer. Ballinger also coordinated, analyzed, and reinforced the various locations of door and MEP distribution openings through the shear walls to serve the space within the core. Finally, Ballinger coordinated the mix design requirements with the mix designer to prevent the heat of hydration of the mass concrete placement from melting the plastic formliner.

At the second floor, four existing concrete columns were to be demolished to accommodate an open plan for classrooms. New W12 columns were anchored to two sides of the columns above to transfer the load, and were supported by new 22'-8" long W24 transfer beams in the ceiling of the second floor. These transfer beams were supported by another set of W12 columns installed from the second floor ceiling to the foundation. The existing column footings were enlarged to support the new transfer posts and associated loads. These transfer beams provided complexity not only during design, but also during construction. The new beams and columns needed to be threaded through the existing structure, with the intent to minimize the required openings in the existing joist slab. Splices were proposed by the steel fabricator and installer, and thoroughly reviewed during the fabrication process.

To maximize daylight into the central commons, a 100'x50' opening was provided in the new penthouse roof framing to support a pneumatic ETFE cushion system skylight. The framing was designed and detailed to accommodate the horizontal and vertical deflections of the skylight base structure. To increase the available footprint area for daylight, four of the new steel infill columns were sloped 30° from the penthouse floor to the roof.

Additional unique challenges on this project include:

1. Existing Terra Cotta Tile Formwork: The existing tile formwork is required as part of the fire-rated assembly for the new construction. Although it is not preferred to suspend new building services from terra cotta given its brittle nature, the volume of terra cotta demolition and spray fireproofing of the concrete remaining above was bid by the contractors as extremely costly. We engaged Hilti to conduct pull tests on the tile in the field to establish an appropriate allowable hanger load as well as the installation technique, tools, and torque to be used with the toggle anchor. A significant savings to the owner was realized after this testing, with only the fire protection service and major piping 4" and greater requiring anchorage directly to structural concrete.

2. Snow Drift: The footprint of the courtyard infill extended up an additional story to provide a mechanical penthouse. This additional height of structure created a new snow drift condition on the existing roof. Upon analysis of the existing roof structure based on rebar GPR scanning and field cores and compressive strength tests indicating only 1800-2000 psf concrete at the roof level, we determined that the existing roof structure was incapable of supporting the increased loading. A steel-framed roof deck platform was constructed just above the existing roof level, spanning 25' between the existing columns.

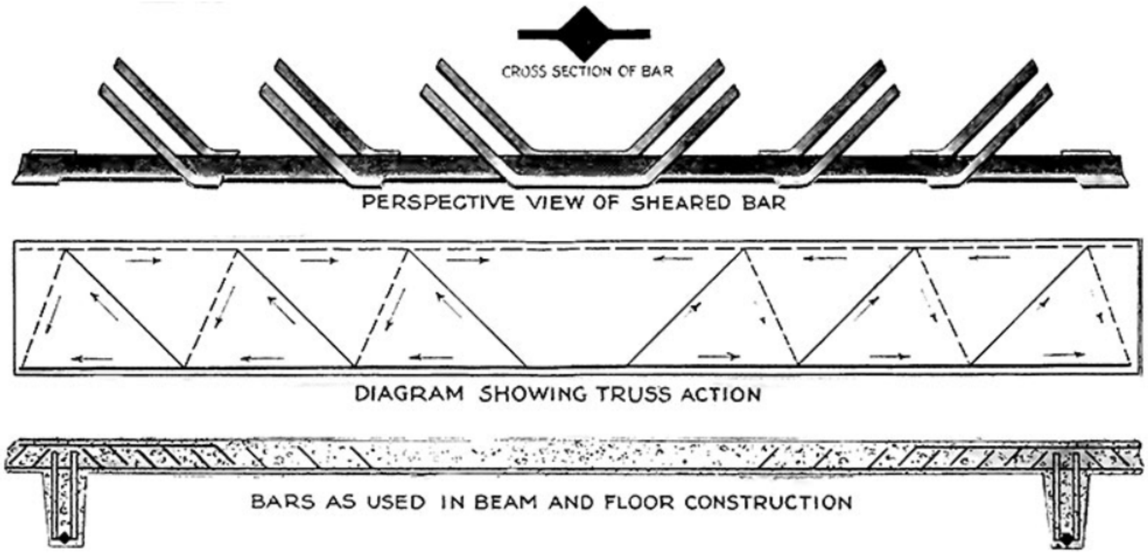
3. Monumental Stair: Multiple new stairs were required for circulation around the new commons, with geometries to match the new curving commons "ribbon" walls. To retain control of the architectural design intent, Ballinger did not delegate the design of these stairs to the stair contractor. Stair #5 required a new 34'x22' opening within the existing joist structure, as well as design of the 32' stringers which required new steel beams and posts connected to the existing structure. With the demolition of the floor at the intermediate levels to create the double-high space, the existing exterior wall was braced by and tied to a new wind load girt. Stair #6 required the design and detailing of two cantilevered angled stringer runs and a curved landing, supported from the new infill steel structure. Stair #7 required the design and detailing of 32' stringers supported off of the new infill steel structure.

The building opened to rave reviews and in-person learning in November 2020. Since an in-person ribbon cutting was not possible, the University celebrated with a series of YouTube videos: https://www.youtube.com/watch?v=shPmoebT79M

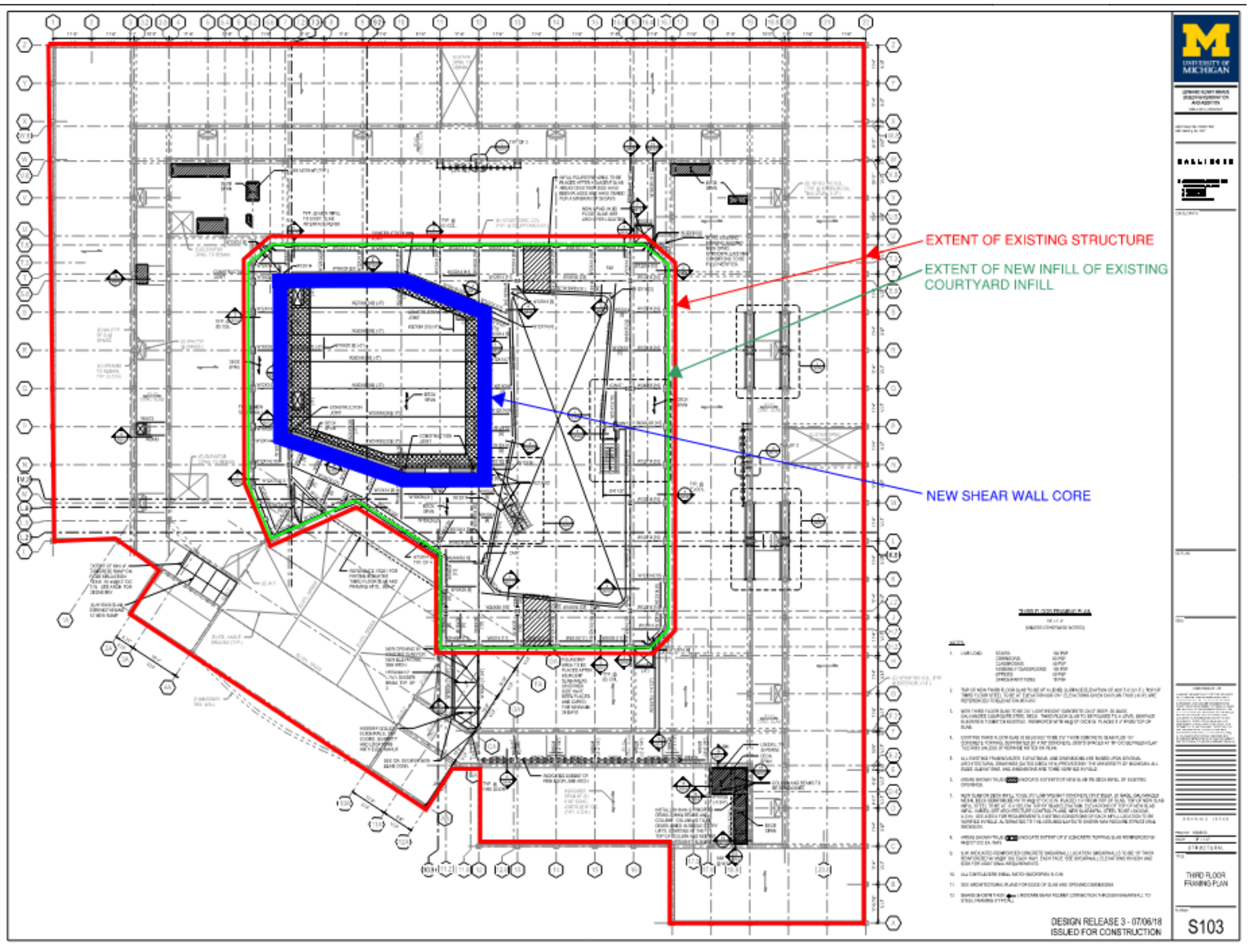
- The following 5 pages (maximum) can be used to portray your project to the awards committee through photos, renderings, sketches, plans, etc…

Building Perspective - Original Condition

Building Perspective - During Construction of New Addition/Courtyard Infill and Snow Platform

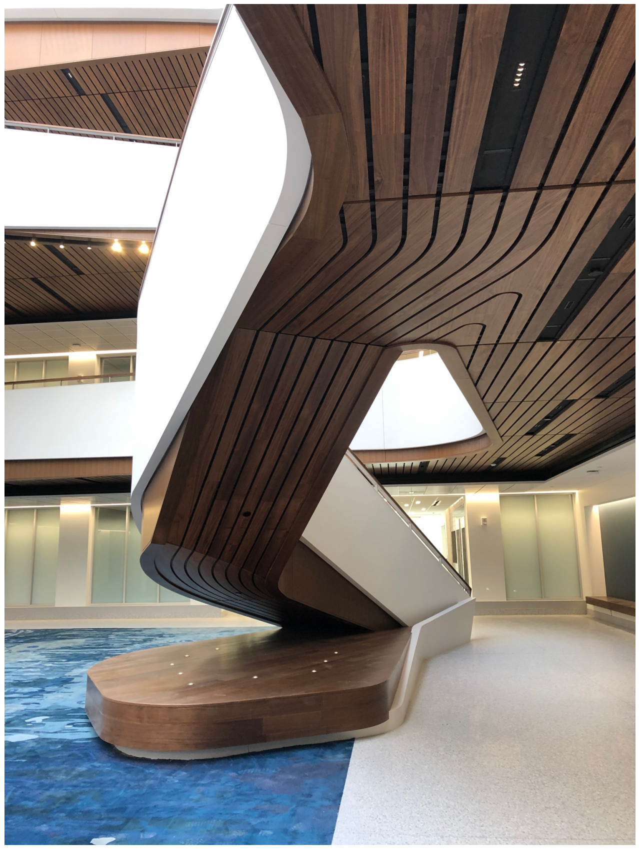


Patented Albert Kahn Trussed Joist Reinforcement Diagrams



New and Existing Third Floor Framing Plan

New Commons Infill Showing Monumental Stairs #6 + #7 and ETFE Skylight



Monumental Stair #6

Transfer Girders and Columns @ Classrooms

Completed Exposed
Concrete Shear Wall

Shear Wall
Construction

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:

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