CASE STUDY: ADIDAS NORTH AMERICAN HEADQUARTERS EXPANSION

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ABSTRACT

The Adidas North American Headquarters Expansion project, located in Portland, Oregon, USA, consists of two new structures creating 19,800 m^2 (213,000 ft^2) of mass timber framed office and amenity space. By understanding project holistic goals and limitations, mass timber was incorporated into the structure primarily for schedule, weight, and aesthetic advantages over alternate structural systems. Completed in the fall of 2020, the project is a case study for the success of mass timber in an office campus environment.

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1 CAMPUS EXPANSION

In an effort to increase office and creative collaboration space as well as improve employee amenities, including available parking, Adidas held a schematic design competition. Working with a small site that already had several buildings and a 3-story below grade parking structure, LEVER Architecture won the competition with a design that would add two new buildings to the campus. As seen in Figure 1, the larger North Building provides 5-levels of below grade parking and 5-levels of above grade office space. The smaller South Building located on top of the existing garage primarily acts as an amenities space. The design also incorporated significant landscape architecture design by Gustafson Guthrie Nichol (GGN), including a new full-sized soccer pitch situated between the new structures.

Coming out of the design competition, the North Building was envisioned as a post-tensioned concrete structure, but when the design and construction team were asked by ownership to cut two months off an already fast-tracked schedule, several systems utilizing prefabricated elements were evaluated. The hybrid precast concrete and mass timber system ultimately selected reduced the construction schedule by three months and was cost-neutral.

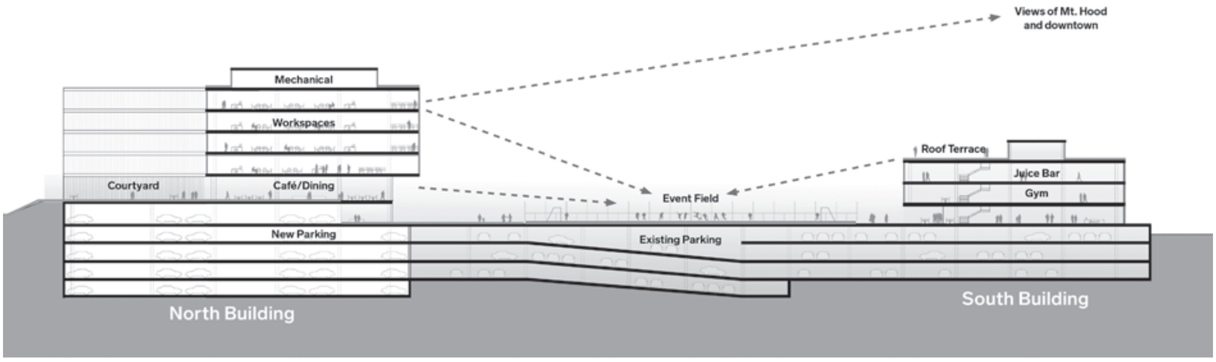

Figure 1: Campus section view (looking East)

LEVER had always planned the South Building as mass timber primarily for aesthetic and light-weight advantages. As leaders in the early adoption of mass timber, particularly cross-laminated-timber (CLT), in the growing United States market, the design team realized the benefits of timber to meet the specific needs of the building. The team was also able to navigate common sticking points with owners and building officials, including fire performance, acoustics, cost-effective design and material procurement, and moisture mitigation.

The project design was a collaborative effort between LEVER Architecture, KPFF (Structural Engineer), Turner Construction (General Contractor), as well as manufacturers Knife River (precast concrete), and DR Johnson Wood Innovations (mass timber). Designers and contractors worked closely throughout the accelerated design process, sharing 3D models, coordinating details, and planning constructions sequencing. Reduced scale mock-ups were used to validate design, detailing, and moisture control methods prior to full scale construction.

The client and architect both strive to use local materials in an honest way. All glued-laminated and CLT components for the project were produced approximately 320 km (200 miles) south of the project site at DR Johnson's facility. Douglas-Fir, a species native to Oregon, was used for all timber components.

2 NORTH BUILDING STRUCTURE

The above-grade portion of the North Building adds 5-stories of office space, conference center, prototype

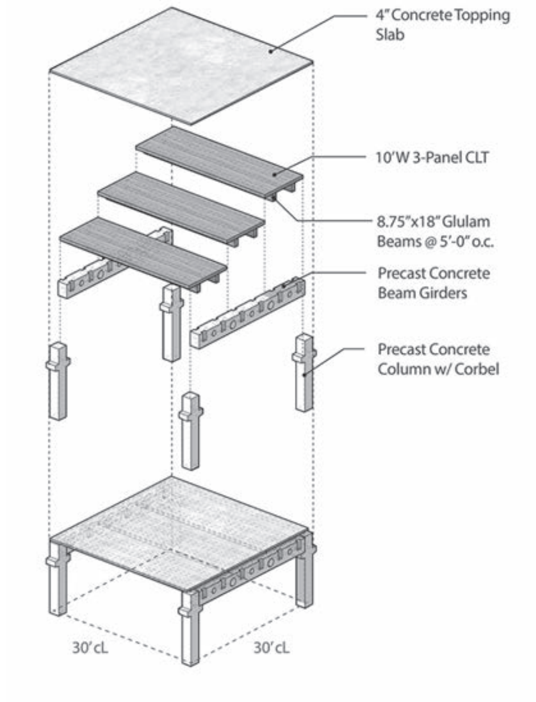

Figure 2: North Building structural assembly

lab, food hall, and café totalling 16,900 m^2 (182,000 ft^2). The structure utilizes a hybrid precast concrete and mass timber structural frame. Precast concrete girders and columns form a 9.1 m x 9.1 m (30 ft x 30 ft) frame which support timber floor panels composed of glued-laminated beams and CLT as shown in Figure 2.

The use of concrete girders allowed for shallower depths compared to a timber member of similar strength and stiffness. This was an important factor due to the limited floor-to-floor heights driven by the maximum height permitted for the building type in the

Figure 3: North Building Construction photo

Oregon Structural Specialty Code [1], the governing building code based on the International Building Code [2]. For increased structural efficiency the girders are pre-tensioned and act in composite action with the cast-in-place topping slab. The girders are also designed with a regular pattern of (five) circular penetrations to allow for mechanical, electrical, plumbing, and fire protection systems routing as seen in Figure 3.

Typical timber floor panels consist of 105 mm x 3 m x 9.1 m (4 1/8 in x 10 ft x 30 ft) 3-ply CLT panels attached to (2) 222 mm x 457 mm (8¾ in x 18 in) glued-laminated timber beams with self-drilling screws. The 9.1 m (30 ft) grid spacing, largely driven by the below grade parking layout, worked well with 3 m (10 ft) wide panels to optimize DR Johnson's CLT manufacturing process. With a maximum press size of approximately 250 mm x 3 m x 12.8 m (10 in x 10 ft x 42 ft), two 3-ply panels were pressed simultaneously, reducing manufacturing time and costs.

The double-tee panel and beam system, similar in geometry to double-tee precast concrete framing common for parking structures, was pre-assembled off site by the timber manufacture to increase erection speed. The precast concrete girders are notched at beam locations for simple bearing connections to further facilitate faster erection and provide erection tolerance between materials. Since precast construction allows for larger tolerances during manufacturing and erection compared to mass timber, it was important to detail all interfaces between materials to accommodate realistic dimensional deviations. The simplistic design and pre-fabrication of timber allowed both the timber and precast to be installed by a single crew of ironworkers (typical of precast) using tower cranes. CLT panels are oriented with the strong axis parallel to the glulam beams for longer panel cantilever lengths over perimeter girders as shown in Figure 4. The first timber panels were erected in October 2019 and the full 16,900 m^2 (182,000 ft^2) floor area was completed in just two months.

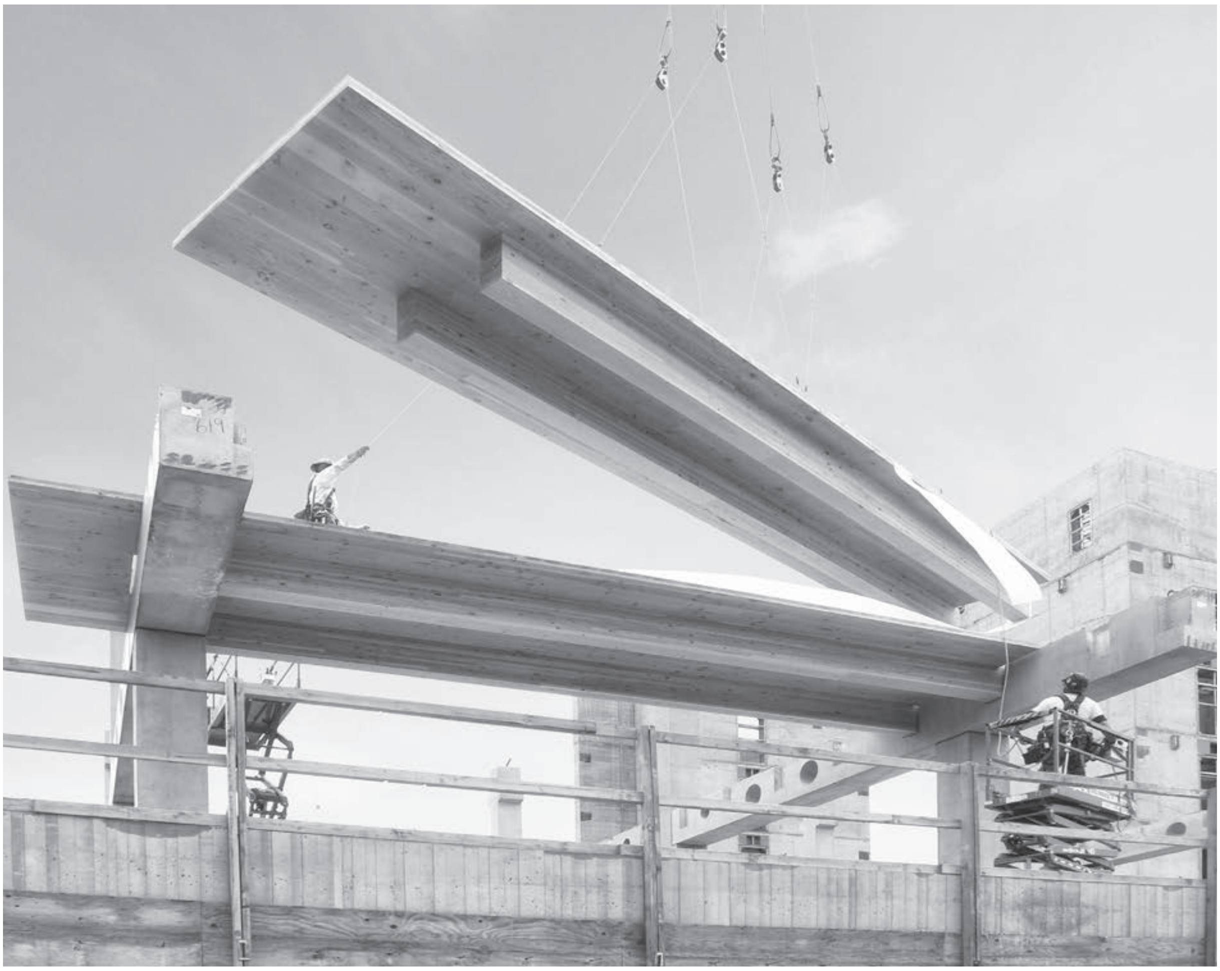

Figure 4: Timber floor panel placement

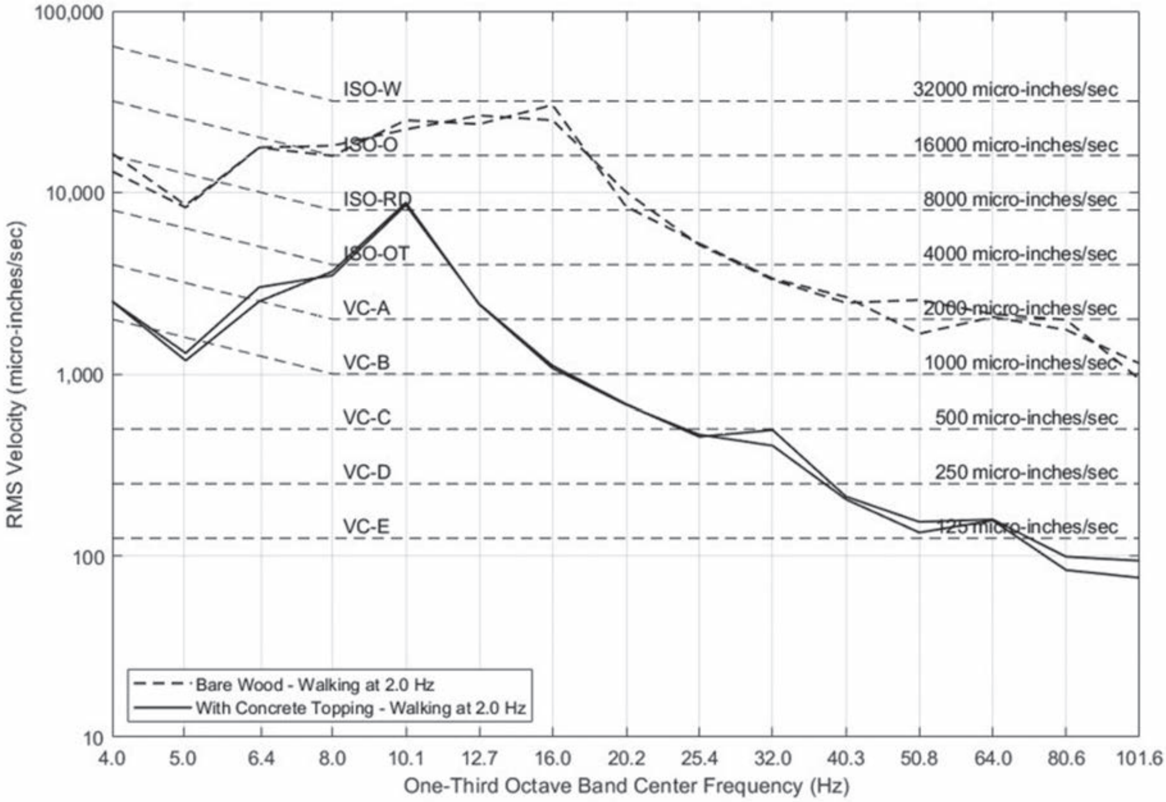

Figure 5: RMS Velocity vs. 1/3 Octave Band Center Frequency Plot

A 100 mm (4 in) reinforced concrete topping slab serves several purposes:

- As a structural diaphragm for the lateral force-resisting system.
- As a structural deck spanning between glulam beams in a 1-hour fire event.
- As an exposed, polished concrete floor.
- As a space for routing of electrical conduit.
- To improve acoustic and footfall vibration performance.

Due to the relatively large bay sizes and timber's inherent lightweight nature, floor vibrations were a particular concern for the design team. KPFF performed finite element modelling in SAP2000 along with post-processing procedures provided in CCIP-016 [3] "A Design Guide for Footfall Induced Vibration of Structures" to ensure the floor would meet the targeted performance levels of 0.5%g maximum acceleration limit and 400 µm/s (16,000 µin/s) root-mean-square (RMS) velocity limit. In-situ testing using an accelerometer and data acquisition system was performed during construction to verify the results and to investigate the influence of the concrete topping slab, which was connected to the timber using a combination of perpendicular 6 mm screws spaced in a grid at 0.61 m (2 ft) each way and inclined 8 mm screws spaced at 0.3 m (1 ft) along beam lines for increased stiffness. While the screws are relied on for partial composite behaviour between timber and concrete for vibration performance, no composite action was assumed for strength design or deflection calculations. A plot of measured data is provided in Figure 5. Prior to placing the topping slab (Bare Wood in Figure 5) two dominant natural frequencies were measured at 12.0 and 15.1 Hz; with the additional mass and stiffness from the topping slab (With Concrete Topping in Figure 5) the fundamental natural frequency dropped to 10.6 Hz. Walking excitation tests at a 2.0 Hz (120 steps/min) walking pace showed maximum 1/3 octave band RMS velocities of 30,400 µin/s and 8,800 µin/s for the floors without and with concrete topping slabs respectively. The work completed for the project was also used to influence recommendations presented in the U.S. Mass Timber Floor Vibration Design Guide [4].

Two trapezoid-shaped special cast-in-place reinforced concrete shear wall cores serve as the lateral force-resisting system. The hybrid timber and concrete floor structure resulted in an approximate 20% reduction in seismic mass and demands applied to the shear walls, compared to a cast-in-place post-tensioned concrete system.

Figure 6: South Building framing

3 SOUTH BUILDING STRUCTURE

To expand the campus's amenities, a new mass timber, 4-story, 2,900 m^2 (31,000 ft^2) South Building was added to provide exercise classrooms, locker rooms, meeting spaces, a juice bar, and a rooftop terrace as seen in Figure 6. It is located on top of an existing 3-story post-tensioned concrete parking garage originally constructed in 2000. Due to the added gravity and seismic demands, existing columns and foundations in the parking garage below the new structure were strengthened for the added loads. However, the lighter timber frame allowed for reduced garage strengthening compared with the same sized building of a heavier material.

Four buckling-restrained braced frames serve as the lateral force-resisting system to form a steel-framed "core" in the center of the floor plate. Back-of-house stairs, an elevator, and mechanical shafts are all located within this steel-framed area. Outside of the steel core, the structure was formed of glued-laminated beams, columns, and girders supporting 175 mm (6 $^{7}/_{8}$ in) 5-ply CLT panels.

Tall 4.6 m (15 ft) floor-to-floor heights accommodate stacked framing with 311 mm x 610 mm (12 ¼ in x 24 in) beams spanning over the top of double 311 mm x 838 mm (12 $^{1}/_{4}$ in x 33 in) girders. As seen in Figure 6, by stacking the glulam system, the floors can cantilever significantly past perimeter columns, increasing the usable floor area. Architectural and mechanical teams coordinated to strategically locate mechanical system routing adjacent to or above girders for minimal aesthetic impact.

A key component of the framing system was the double glulam girder-to-column connection, which uses a solid steel plate extending through the column and into each of the girders for bearing load transfer as shown in Figure 7. Self-drilling screws are used to reinforce the girders for shear and bearing stresses. To meet the 1-hour fire resistance rating requirements for the primary structural frame and connections, all steel components are embedded within the wood with adequate cover to prevent excessive heat transfer to the steel.

This unique detail created complexities for the installation team during construction. Multi-span girders were slid onto the steel bearing plates from the side with very little installation tolerances. The

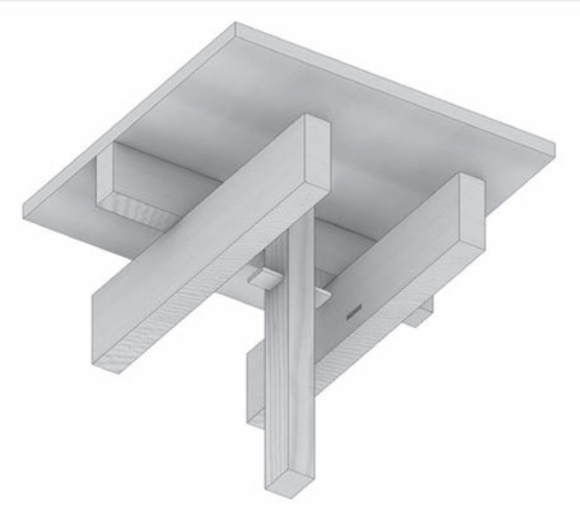

Figure 7: Exploded view of the double girder to column connection

connection also required temporary stability bracing for the column when only one side of the double-girder was in place.

Similar to the North Building, 75 mm (3 in) reinforced concrete topping slabs are used for finished floors and structural diaphragms for levels 2 and 3. CLT floor panels with plywood splines and steel plate chords and collectors serve as the structural diaphragm for the roof deck and penthouse roof levels.

CONCLUSION

The Adidas North American Headquarters expansion project is a case study for the versatility and viability of mass timber construction on two separate buildings, one featuring a hybrid precast concrete-mass timber structural system and another with a steel and mass timber structure. A collaborative effort between the design, construction, and fabrication teams resulted in successful designs and project delivery which leverage the unique advantages of timber.

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- Jason Rea – KPFF Consulting Engineers
- Eric McDonnell – formerly with KPFF Consulting Engineers

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