

# STRUCTURAL DESIGN & ANALYSIS

in our structural system, the laminated plywood frame handles the primary loading and is stabilized by secondary systems made from wood, which are the purlins and angled slats.

The team as a whole faced challenges due to the innovative design of the structural members, which evolved over time.

- It evolved from a dovetail design to dowel connection
- We considered a reciprocal frame before settling on a traditional frame structure
- The reclaimed material faces uncertainties regarding the quality of the member materials
- Lateral bracing design helps to resist some lateral forces

NDS 2024 sets the standards to follow for the dowel-type connections, but not very much for wooden dowels. Most dowel types used in timber are metal. We chose to implement a dowel size of 1-inch diameter, based on several methods used in larger scale timber connections. Consequently, a 3-inch minimum spacing, both from the element edge and center-to-center between dowels, was incorporated, according to NDS provisions. Our team adopted an unconventional and innovative design in the overall structure, due to lack of research with wooden dowel connections, as discussed previously.

The metal base connections were recommended by researchers at the Tallwood Design Institute, and after various tests for both structural integrity and constructability, we elected to use two (2) steel angle brackets per column.

# KARAMBA 3D ANALYSIS

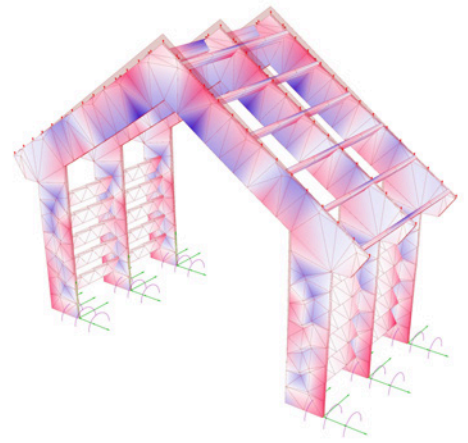
Karamba 3D allowed the ability to simulate and analyze simple 3D models of various design iterations throughout the term. We were able to accurately define material properties and dimensions in order to analyze load applications in different scenarios throughout the design process.

The analyses from Karamba 3D throughout the design process output displacement values which then influenced critical design choices like member depth, connection placement, and more structural roofing system considerations for the final build.

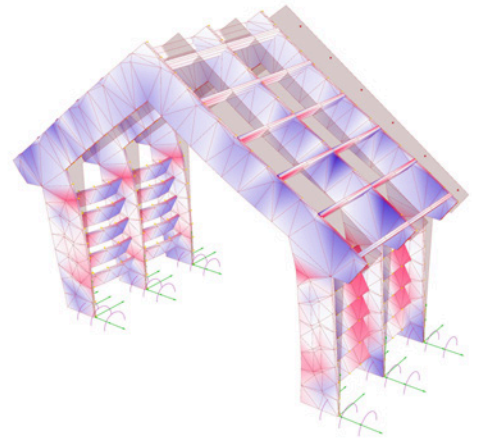
The Karamba analysis was able to prove that structural stability is achievable amongst a roofing system dead load and potential wind loads for the final design proposal. The bracing panels between the frames were also proven to provide enough lateral stability within the frame even with a smaller cross section of 1/2".

Potential modifications and adjustments to the structure:

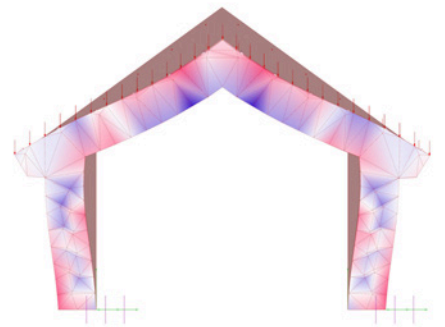
- Modular roofing system following rest of structure
- Thicker members, columns and panels
- Ground connection thrust force counter design
- More even dowel spacing, for better distribution of loads.



Karamba 3D Model



Deflection from force or wind load perpendicular to frame depth



Deformation from a much heavier roof system or snow load