Taiyuan Botanical Garden Domes

Above: Taiyuan Paraboloid Domes, Botanical Garden – largest dome 88m diameter, 27m tall

Architect
Delugan Meissl Associated Architects

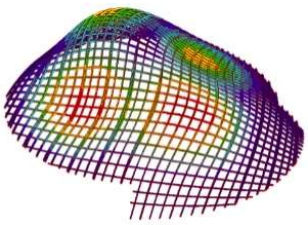
Client
City of Taiyuan
SKF Construction

Consulting Services
Structural and Erection Engineer

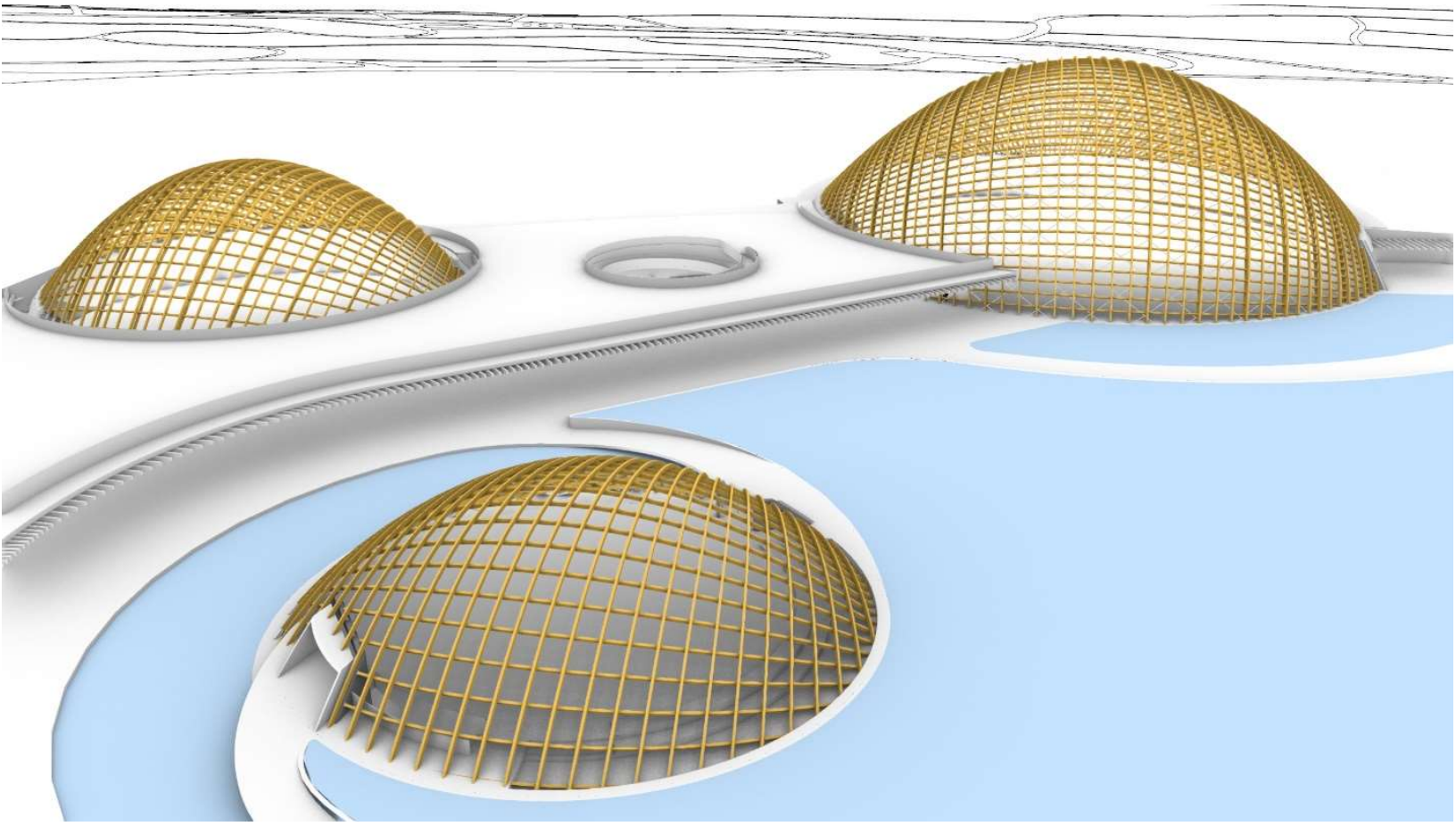
Construction Services
Design-Build

Area
130,000 sqft

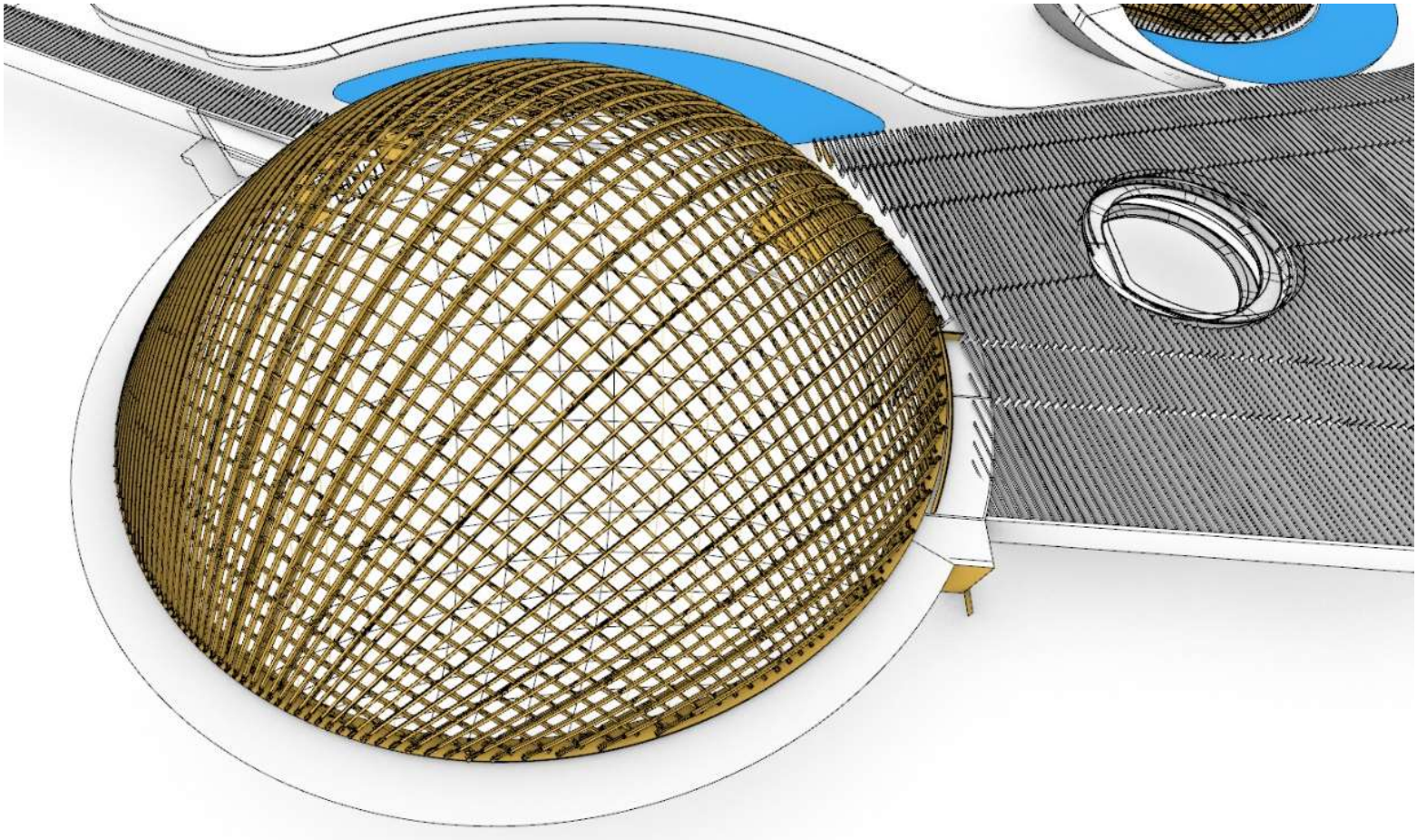
Span
Up to 300 ft

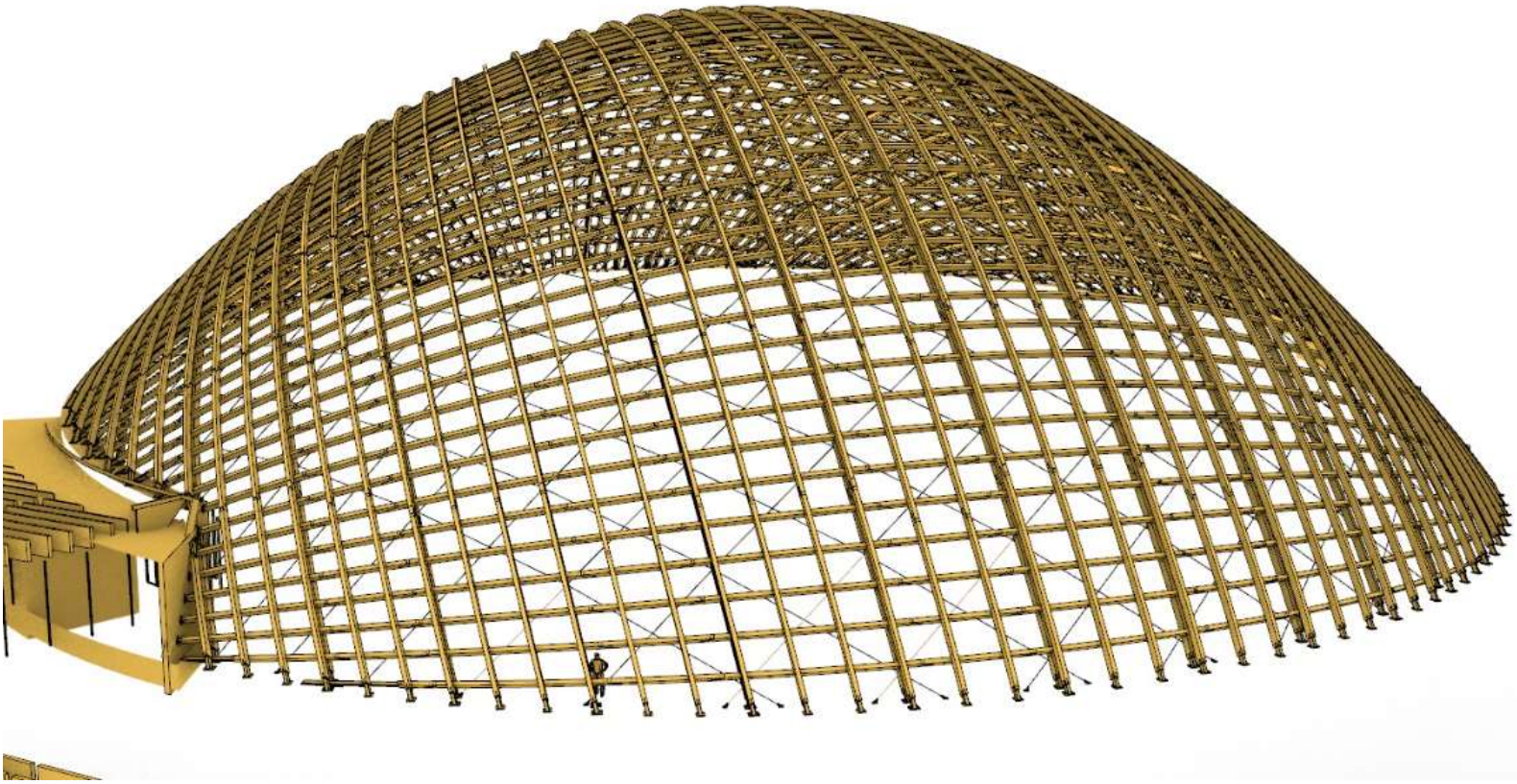


The client's desire is to "green" their traditionally industrial city

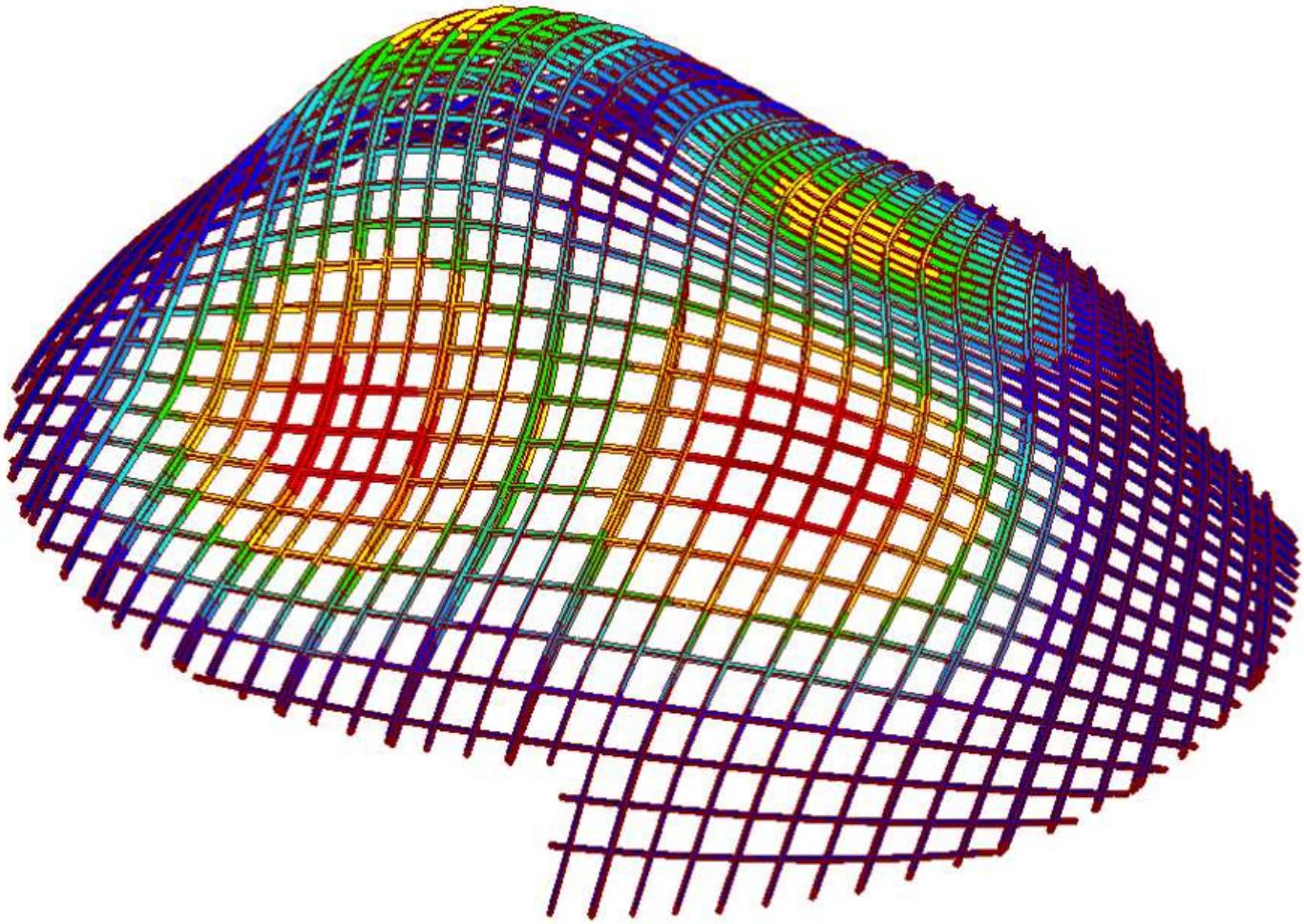


Early Models



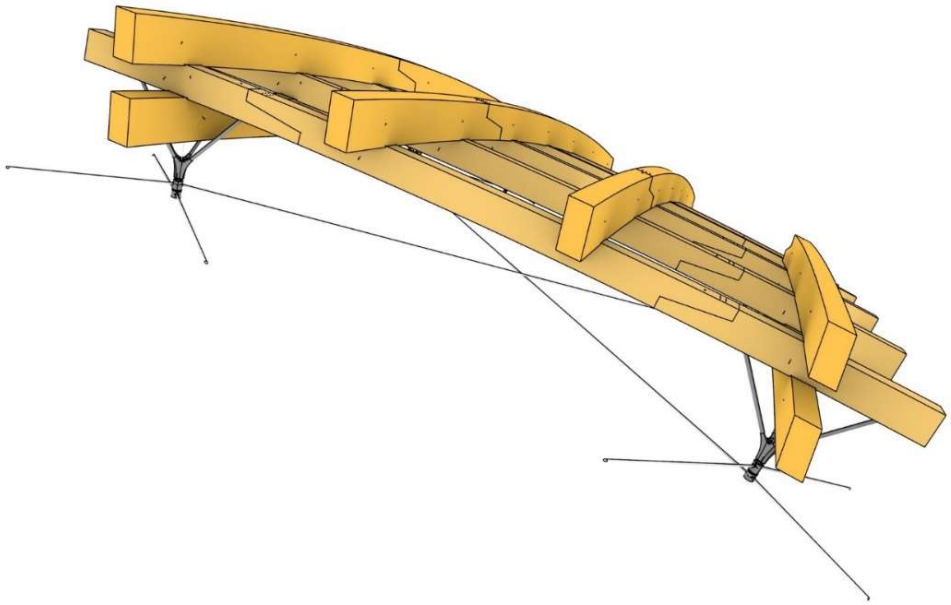


Fabrication 3D model of the large dome's glulam structure.
Cable diagrid was only required for large dome.

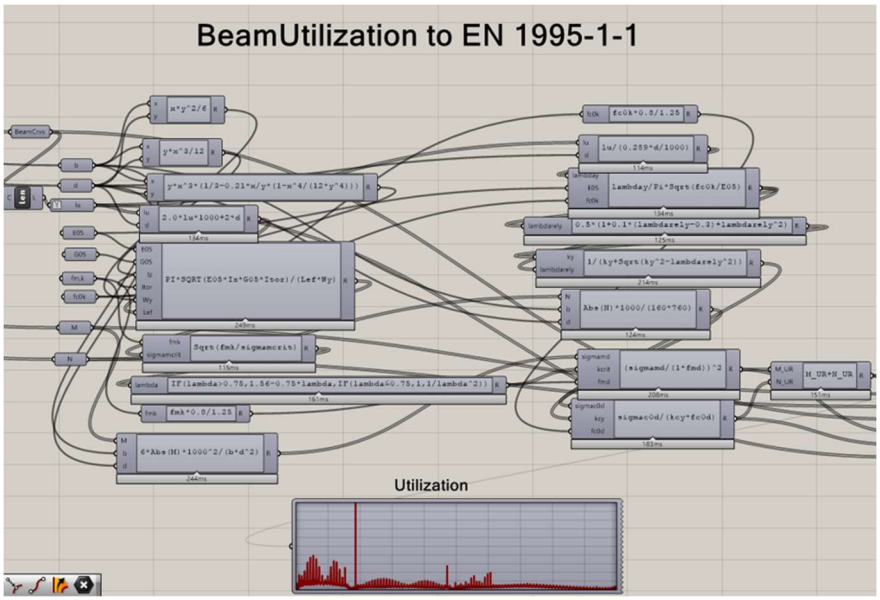


One of the numerous snap-through buckling mode shapes (no diagrid).

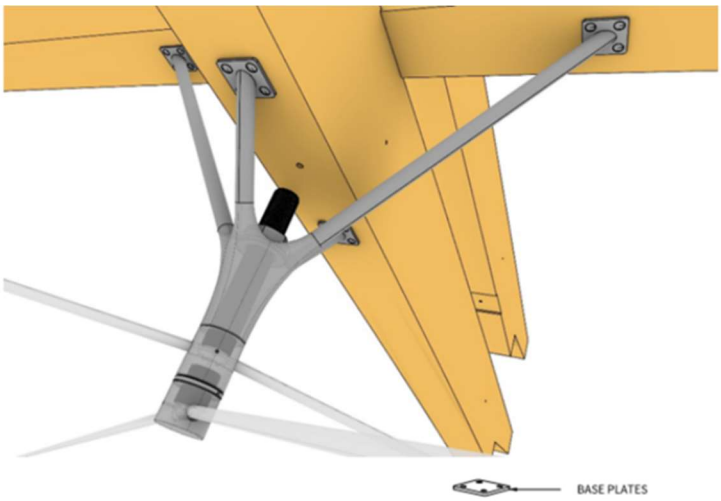
Parametric model generation with Neider Mead optimization allowed the structural analysis models to quickly be updated and reanalyzed to test different shell geometries and refine the structural performance.

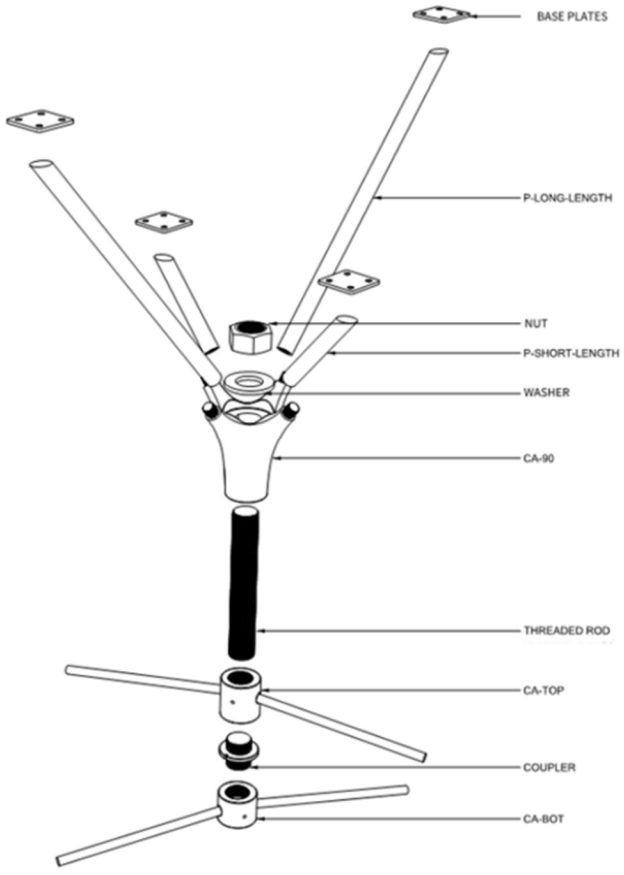


Partial view of large dome structure. Note cast stainless steel node connecting cable diagrid to glulam gridshell above.



Grasshopper sequence used for Member Utilization



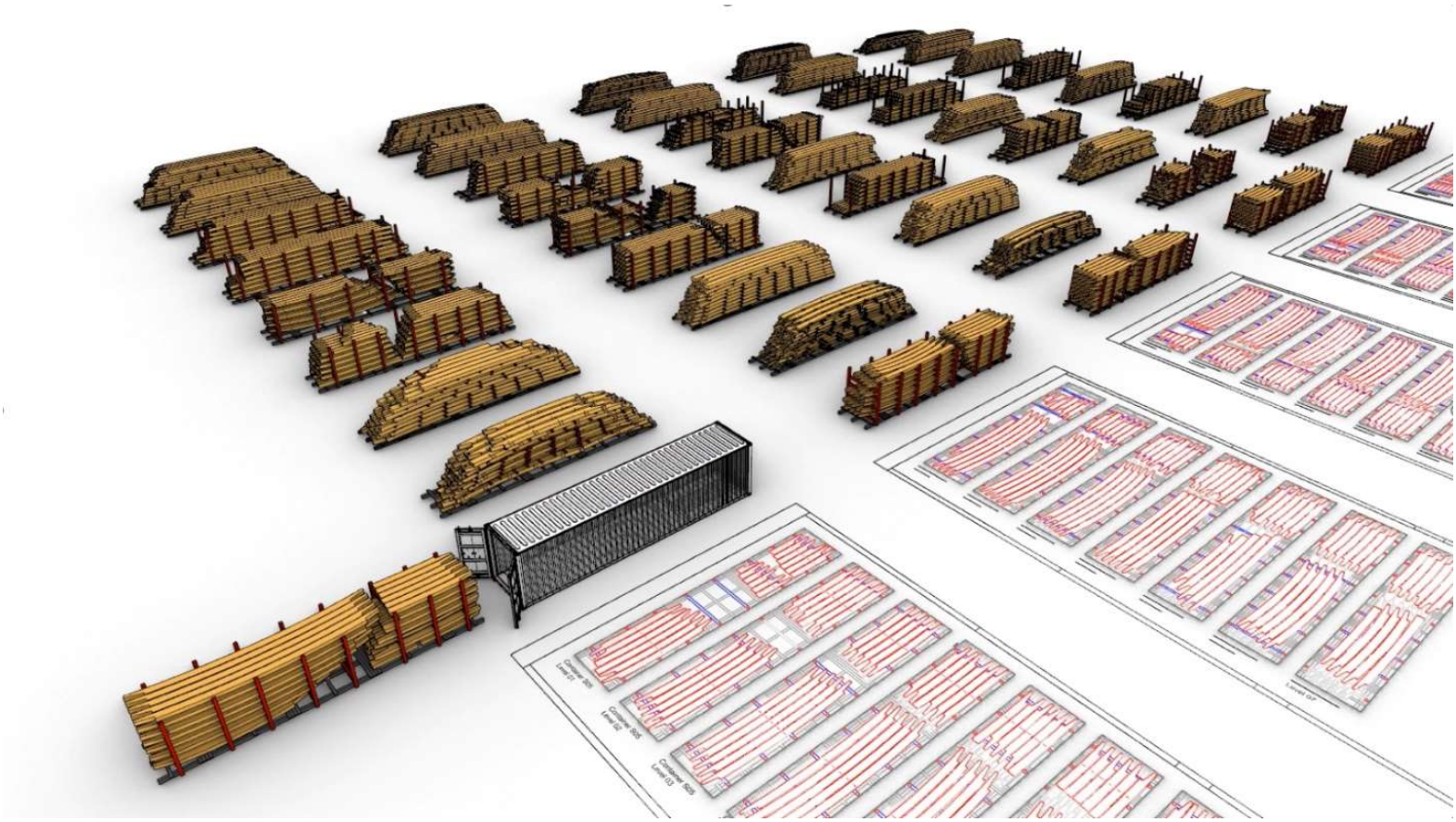


Cast steel node closeup: Form-found cast stainless steel node adapts to geometry of every node location.

Threaded bolt pulls tension into cable diagrid, greatly simplifying erection.

Each glulam member is unique with slight double curvature, and CNC-milled splices and screw holes

Optimization of CNC milling was included as a factor during overall geometrical optimization, reducing fibre waste and machine time.

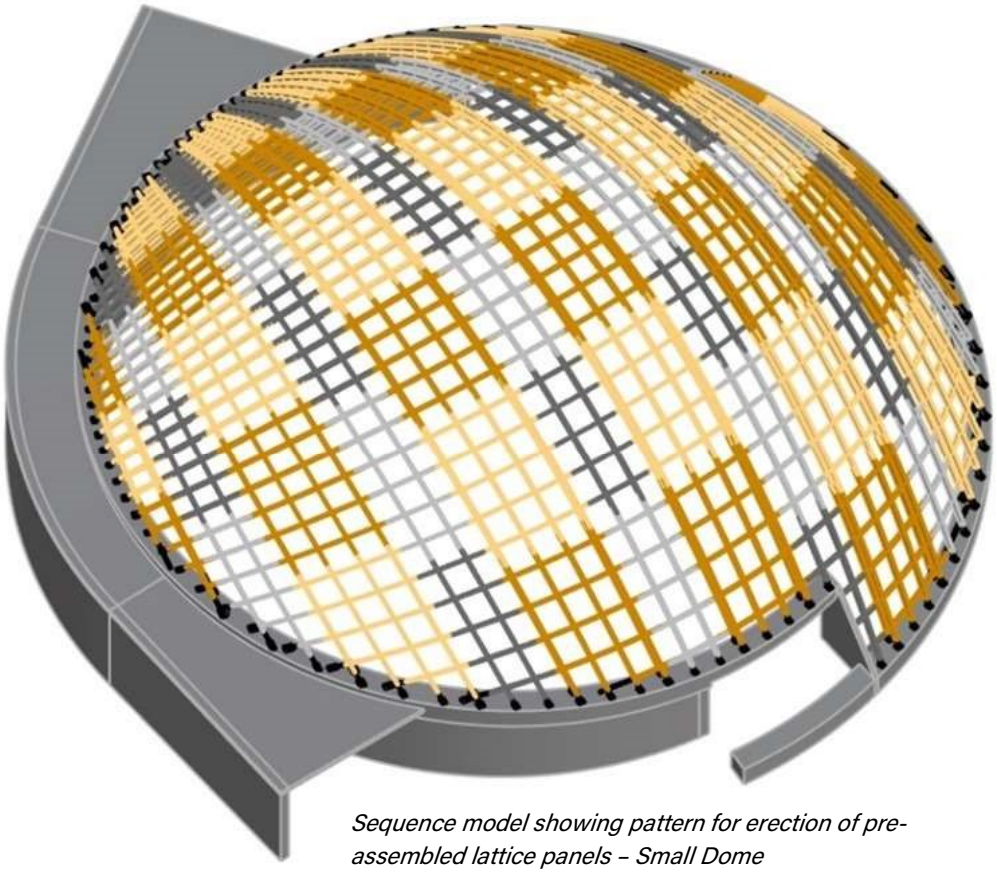


Shipping Container Packaging Plan:

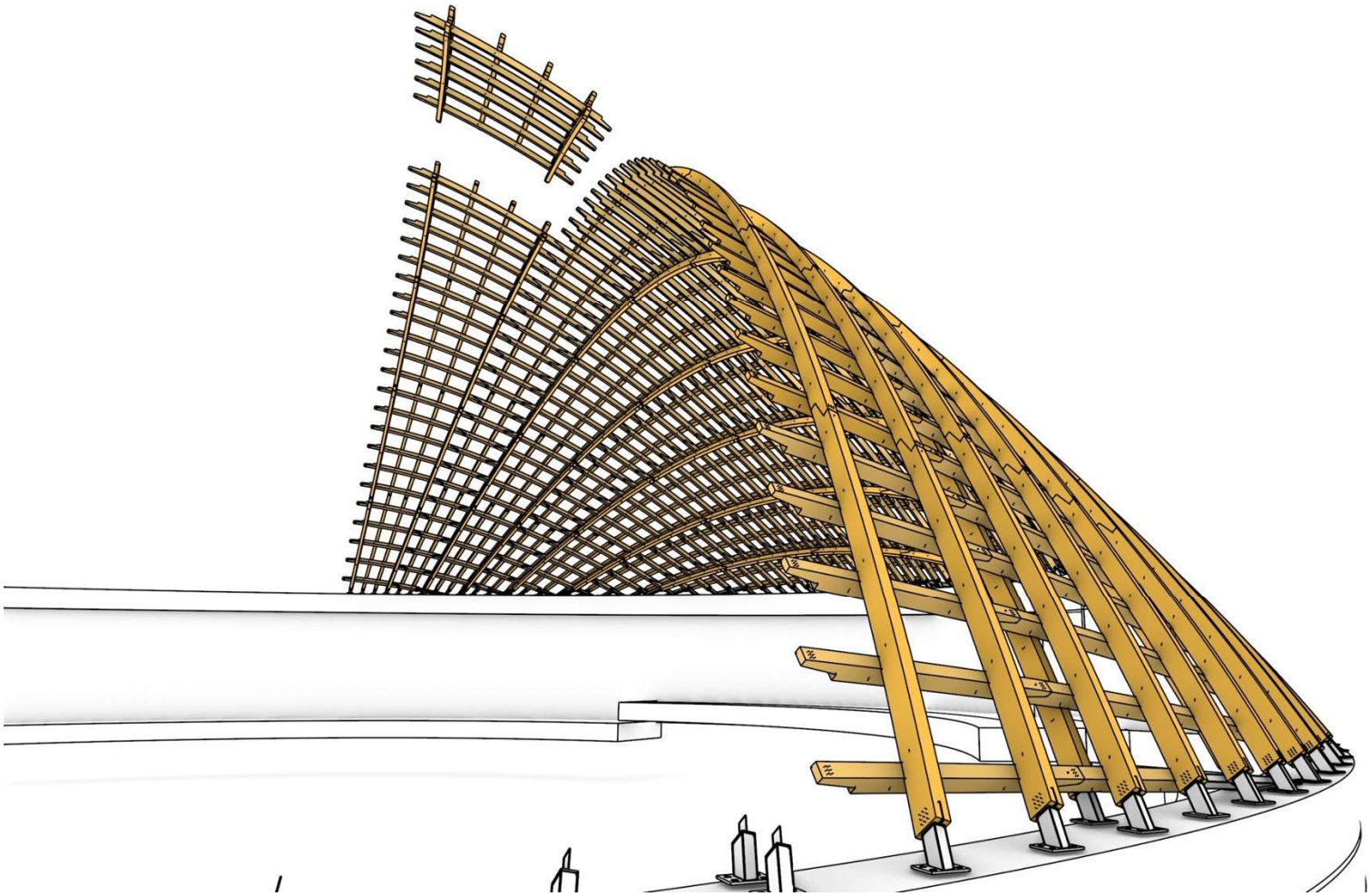
Using a numerical packing algorithm, packaging was preplanned during modelling, organized in the order the timber would be needed for site assembly in China.

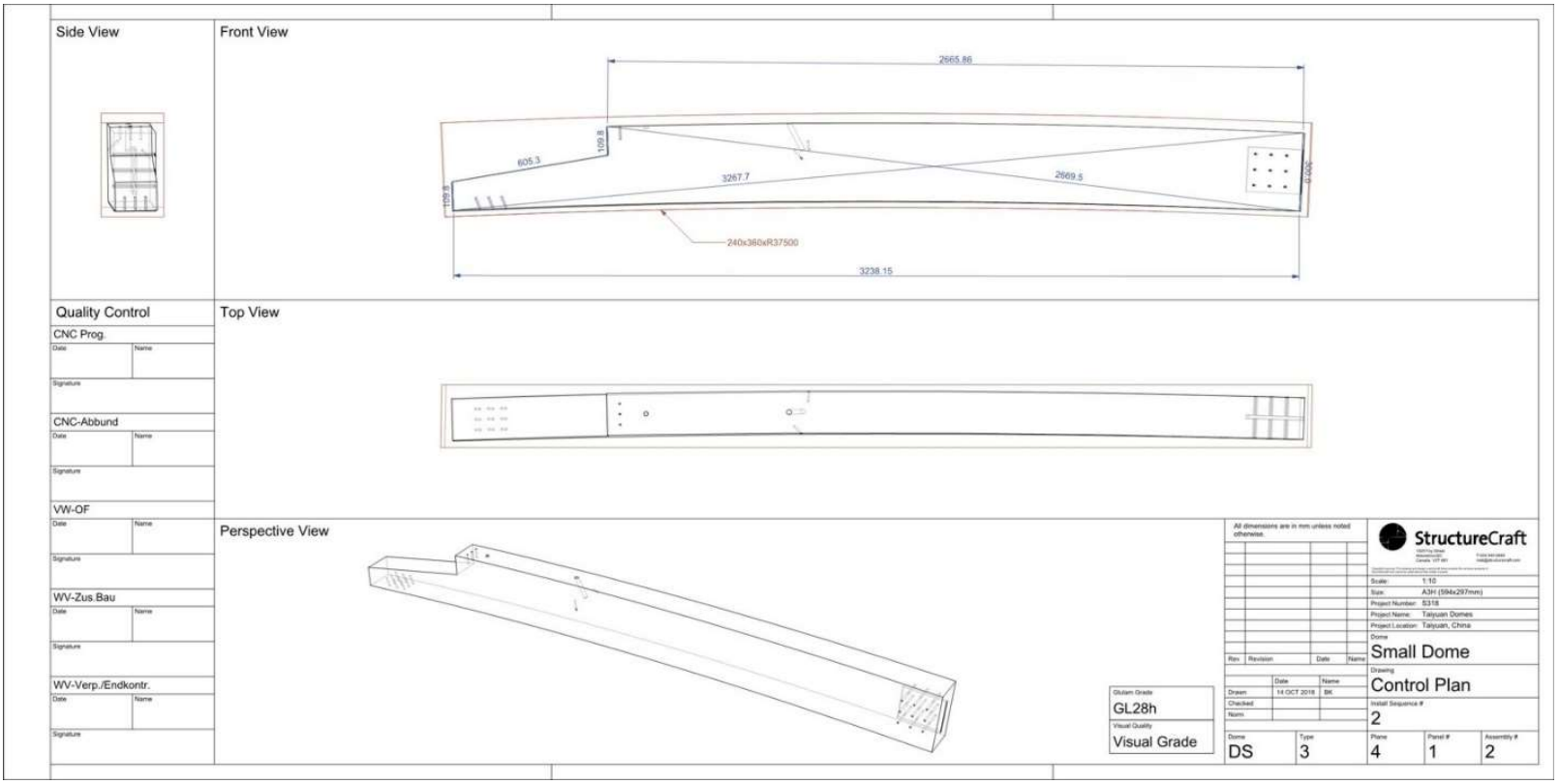
Gridshell members unpacked near site.

Each of the 2,400 members is doubly curved and unique.



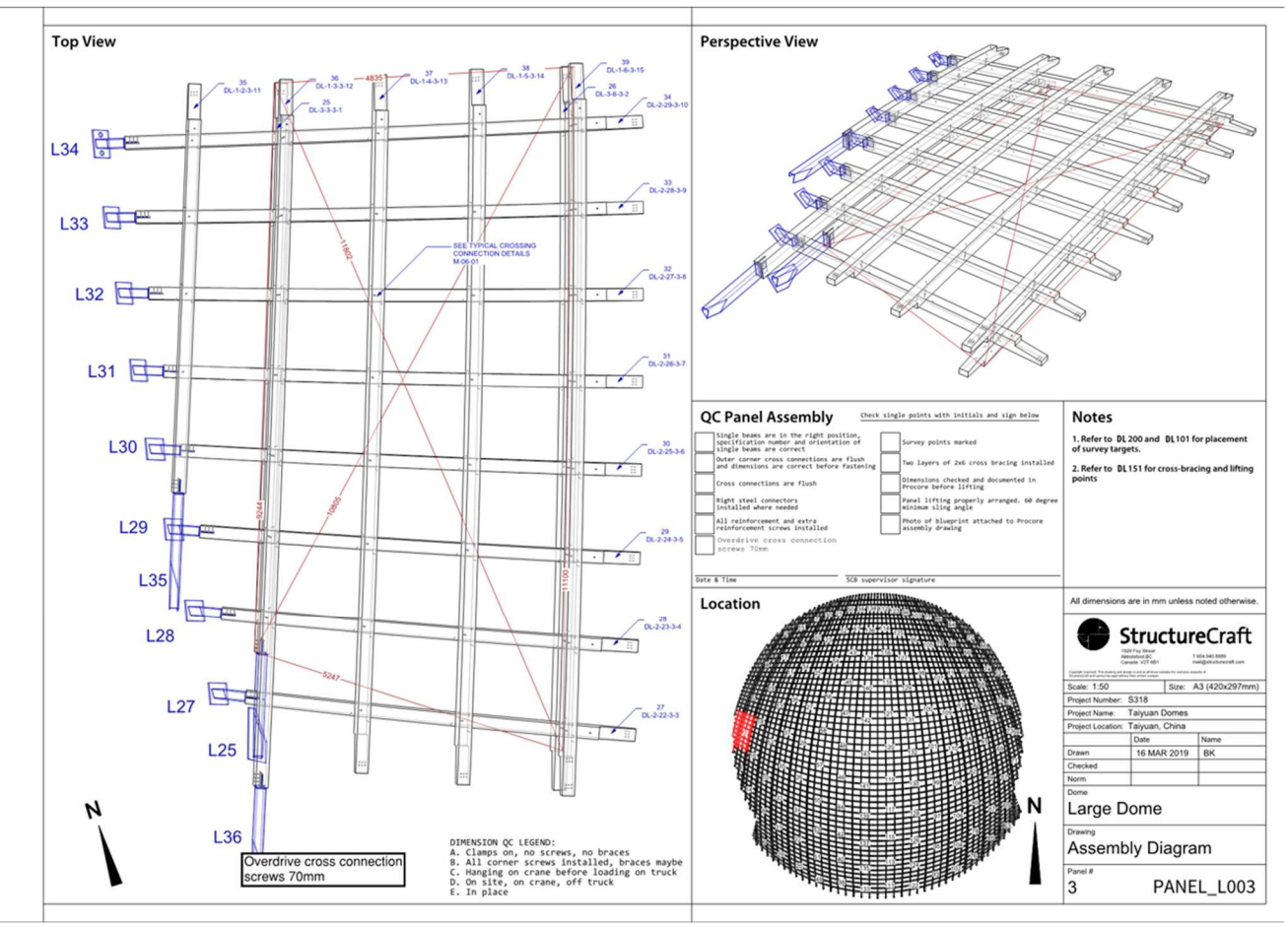
Sequence model showing pattern for erection of pre-assembled lattice panels – Small Dome





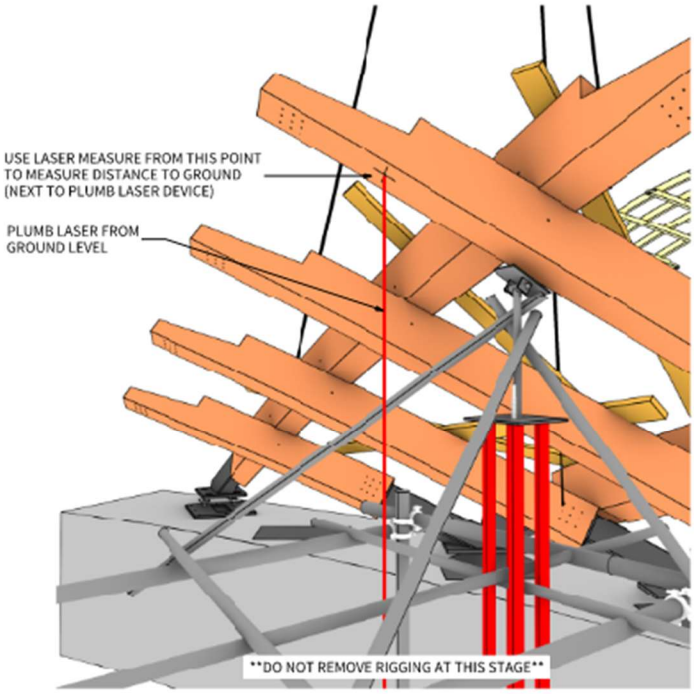
Member Drawing. Note slight cross-sweep

Axial tension tests at half lap splice by Tongji University.

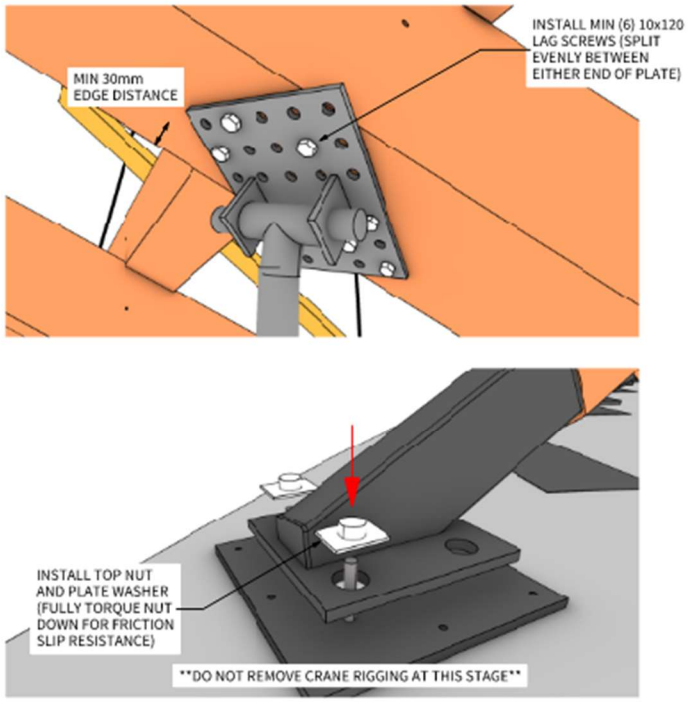


Lattice Panel Assembly Diagram

Shop Pre-Assembly of Lattice Panels

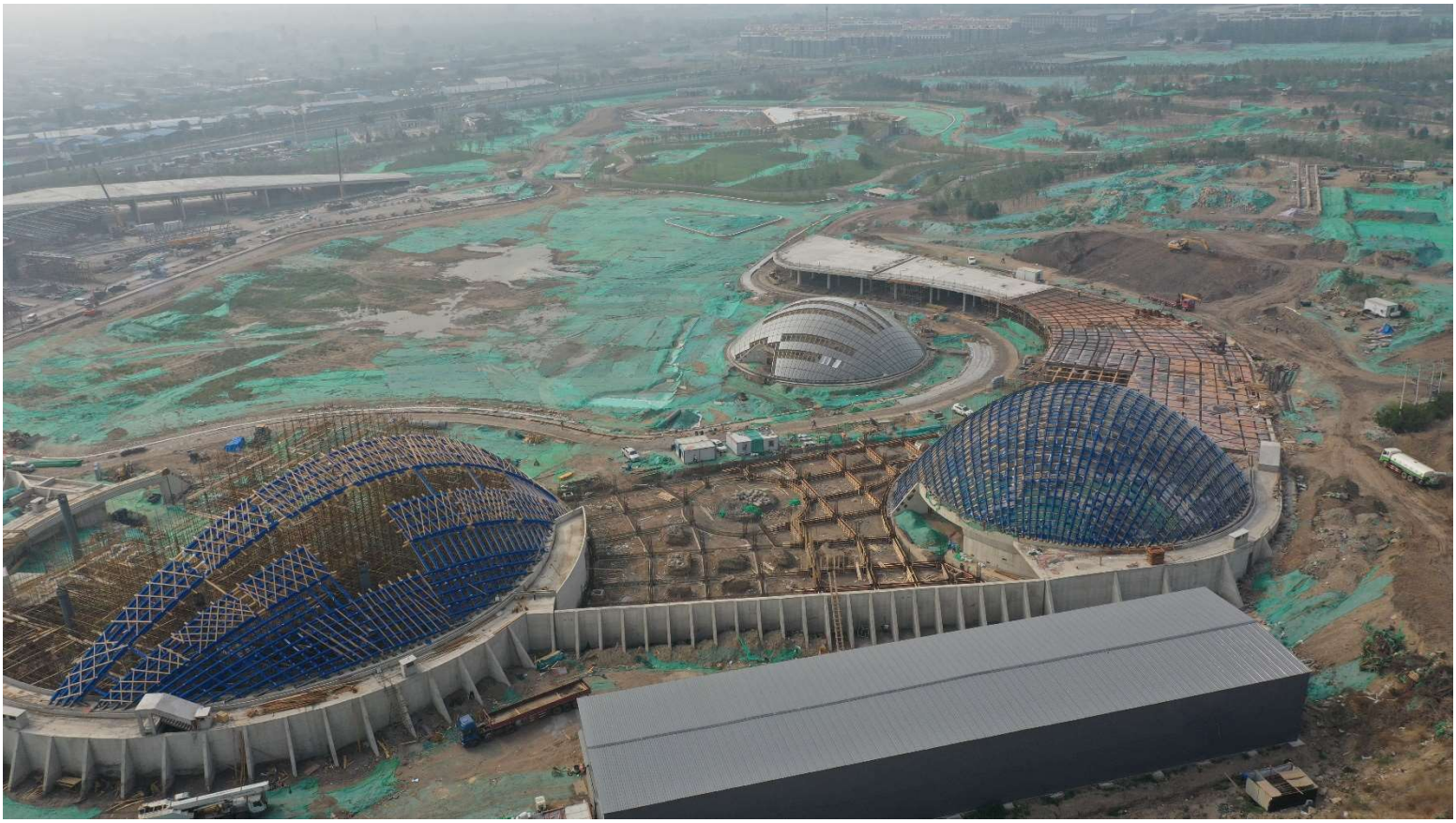


4 - SURVEY TARGETS
NTS



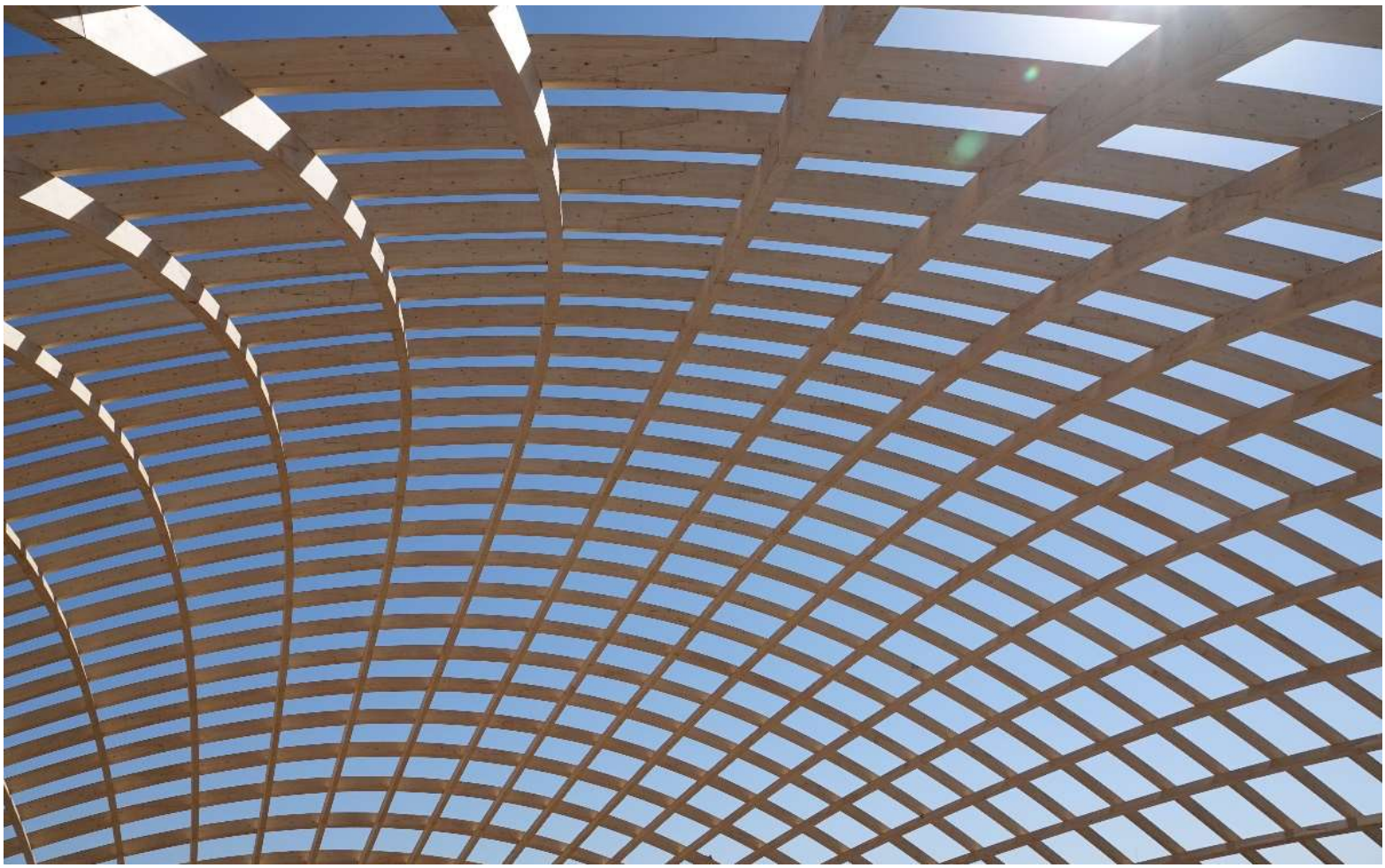
5 - SECURE PANEL
NTS

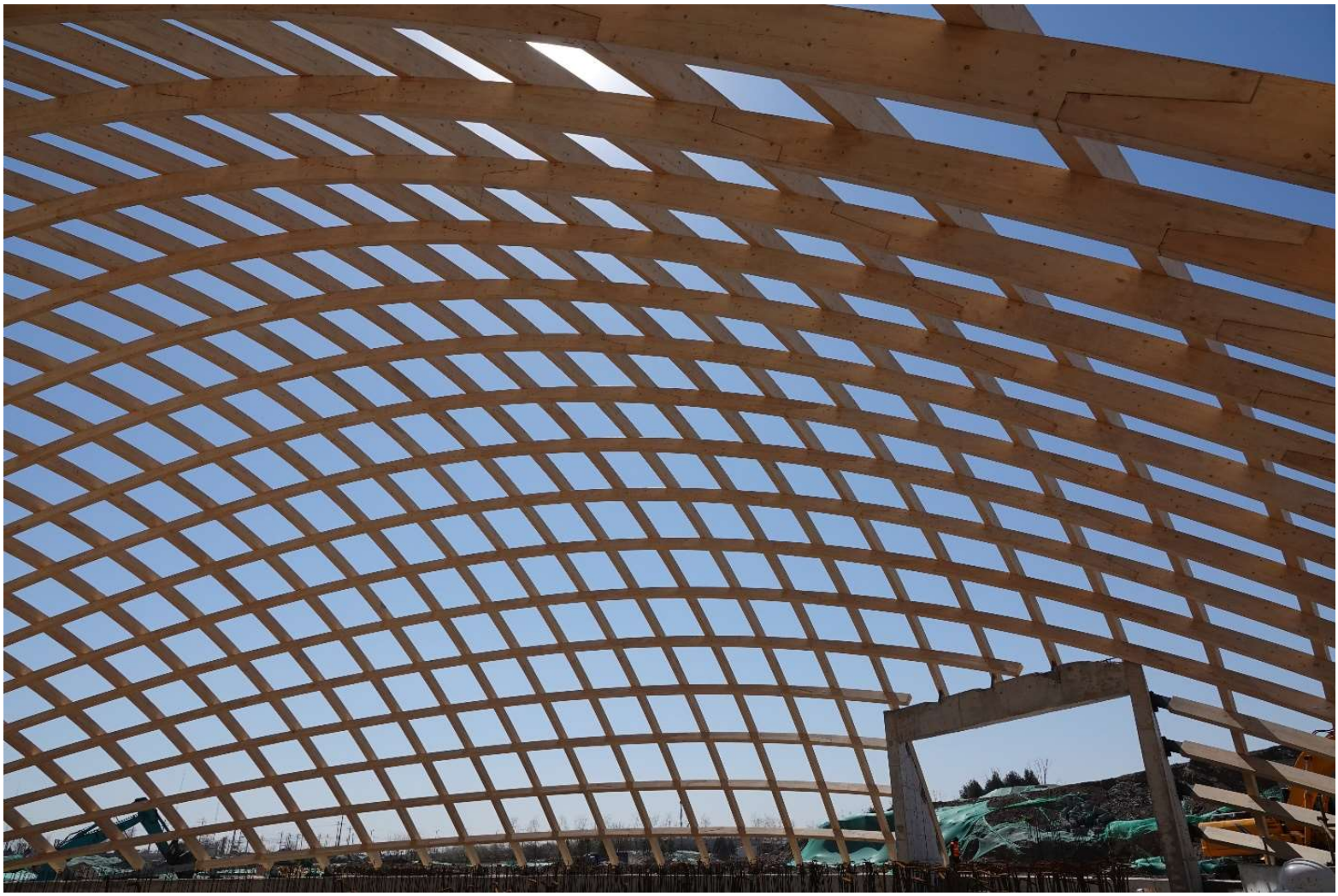
Adjustable Shoring Detail

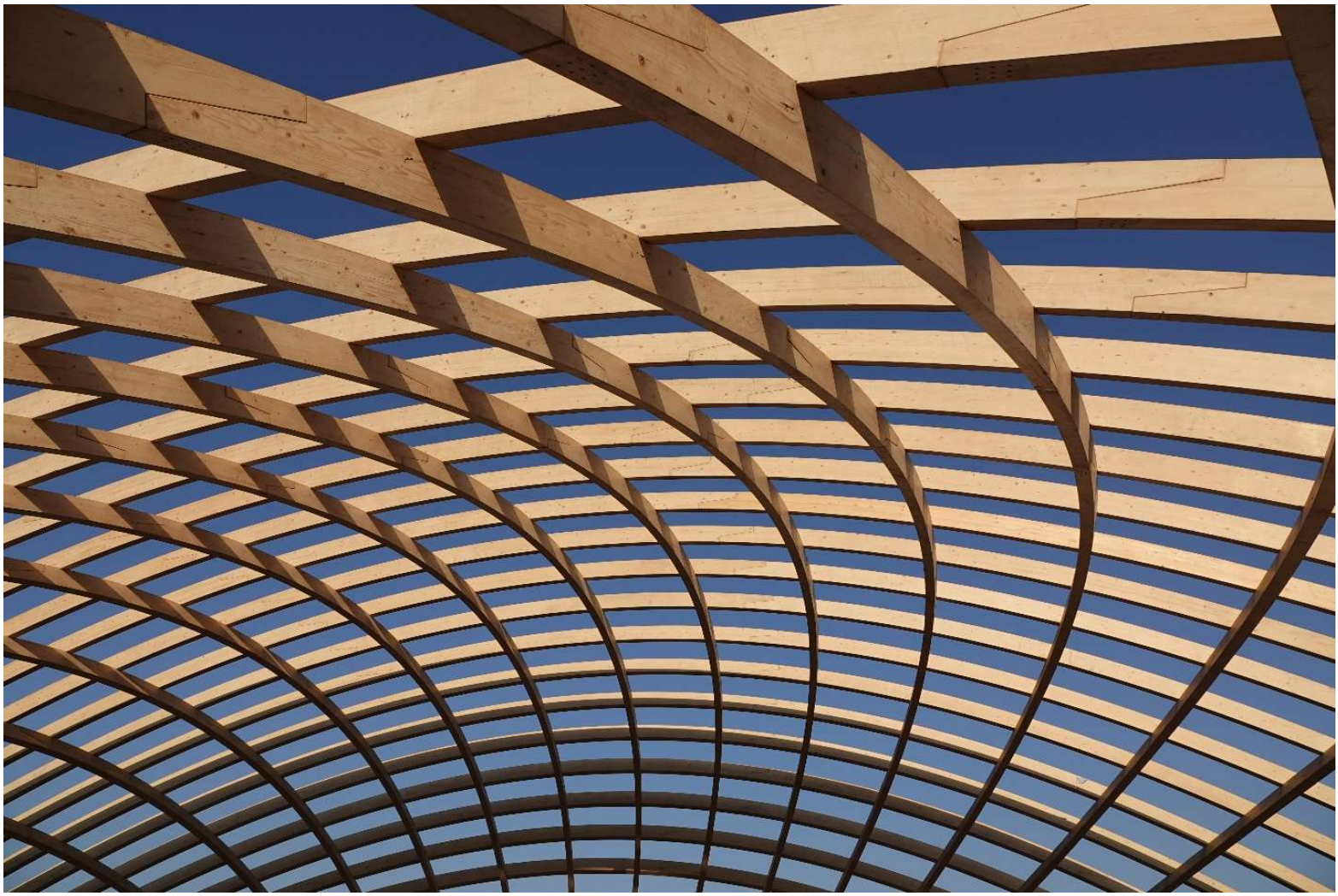


Domes during construction

Typical Half Lap Joint







Parabolic Dome

Because of the parabolic shape, each beam has a variable radius in the strong axis with the double curvature adding a sweep in the weak-axis direction (thus biaxid curvature in members)

Lattice Panel Installation

Each unique panel of doubly curved Glulam beams was sequentially assembled and erected, with single members infilled to stitch structure together.

Doubly curved Glulam lattices craned into place. The outside diagonal timbers were temporary, to hold the lattice geometry until erection was complete.

Doubly curved glass installation

Large Dome Gridshell with diagrid cables

Middle Dome: Note gridshell density gradation

Taiyuan Botanical Garden is now open to the public.