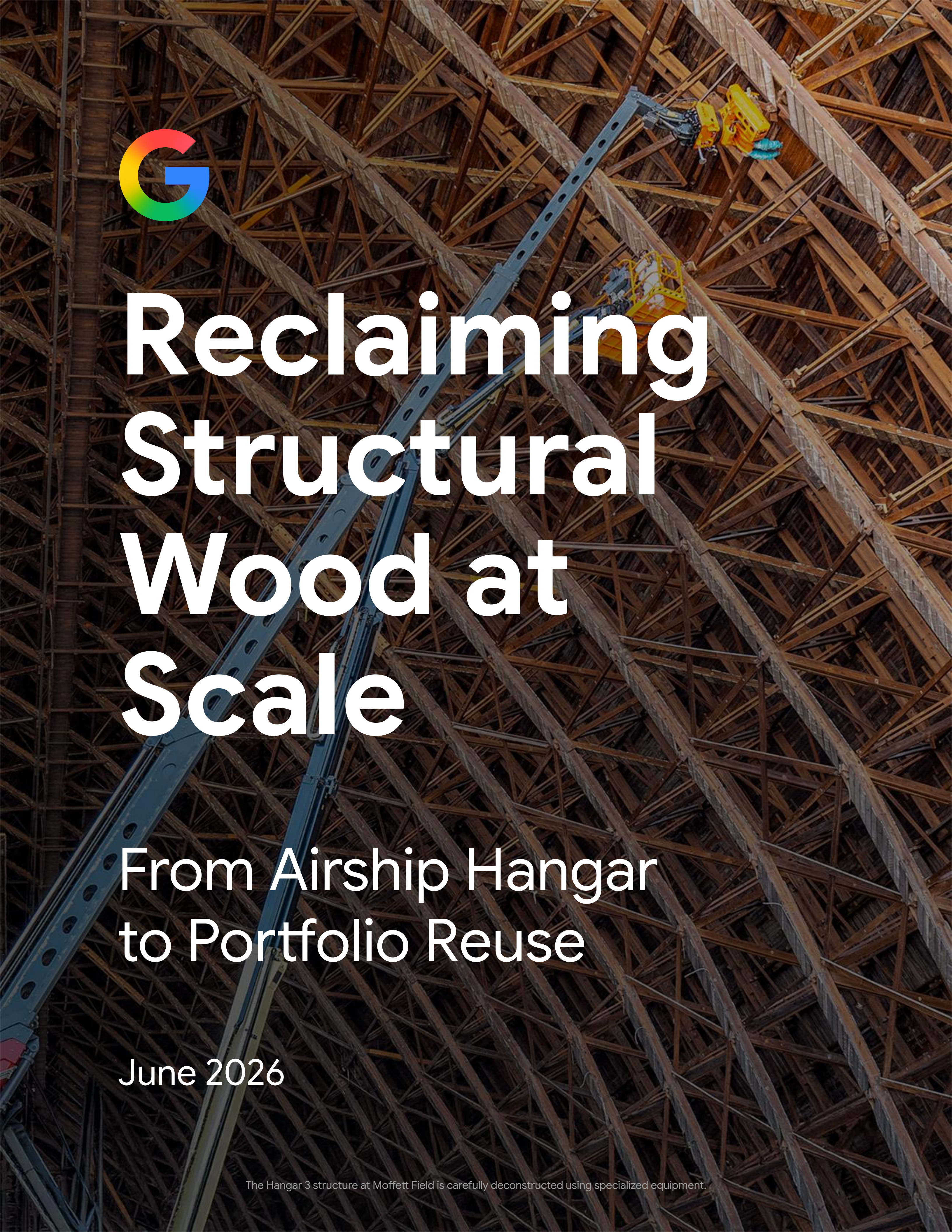


Reclaiming Structural Wood at Scale

From Airship Hangar to Portfolio Reuse

June 2026

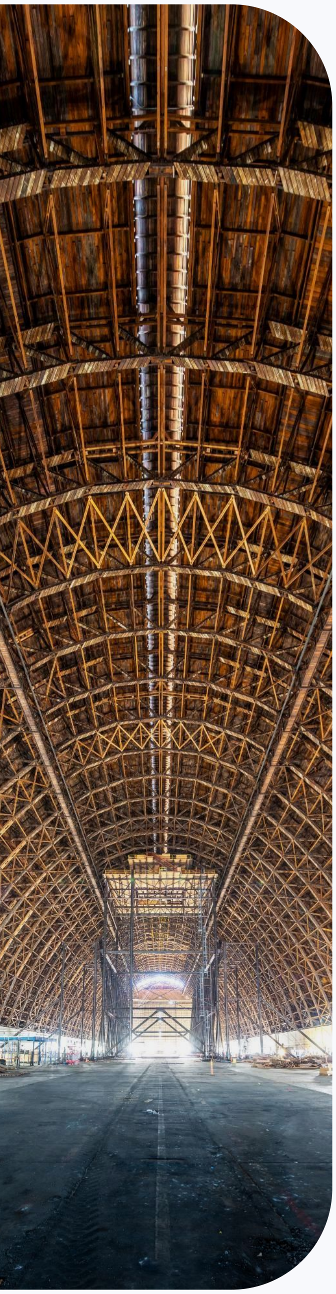
The Hangar 3 structure at Moffett Field is carefully deconstructed using specialized equipment.

Table of Contents

Exterior view of Hangars 2 & 3 at Moffett Field.

Executive Summary

This white paper documents the process for a unique and challenging deconstruction project and large scale reuse effort.



The intricate wooden framework of the hangar stretching down its entire length.

Hangar 3, built in 1943 to house airships (blimps) for coastal defense, was one of the largest freestanding wood structures of its era. Approximately three million board feet of Douglas-fir went into its construction. After decades of environmental exposure, seismic loading, and material fatigue, extensive engineering assessments determined that the failing structure could not be saved.

Most people assumed that the wood from Hangar 3 was equally unsalvageable. Yet today, the unique characteristics of that wood are being showcased throughout the Google real estate portfolio. Hangar 3 wood lives on as part of modern structural mass timber applications and through many aesthetic finish applications, including in public-facing settings.

While most of Hangar 3's huge timber frame structure was too damaged or too contaminated with fire retardant chemicals to be reusable, approximately 119,000 board feet of lumber (weighing 178 tons) was selectively salvaged during dismantling.

Some of the recovered material was repurposed by Google's real estate team for architectural reuse, primarily high-visibility and low-exposure exterior applications, while a lot of the material was used in Google's mass-timber program. Google led an extensive process of material evaluation and design to adapt the lumber for new structural applications. Some of the wood is slated for structural reuse, while the remainder will be used as a veneer in high-visibility structural assemblies.

This deconstruction and reuse project is unique in many ways. Nonetheless, the rigorous and well-documented effort offers specifics that validate and advance previously available industry guidance on deconstruction and reuse.

As the reuse industry develops, and practical experience grows, many challenges are being addressed through new business models, processes, and tools. Circular economy pathways are well established for furnishings and other high-value finishes. The Hangar 3 story can help advance best practices for reuse of wood structures, including, when possible, in new structural applications.

Portfolio-wide insights:

- Case study proof that reuse is possible even under the most difficult conditions.
- Rigorous testing and disassembly protocols for contaminated materials to enable selective safe salvage.
- Strategies for internal market engagement and project management for use of salvage lumber.
- Digital chain-of-custody systems allow for rigorous yet flexible logistics and tracking, critical for managing Hangar 3 disassembly concurrently with the timelines of several projects that were considering incorporation of reused materials.

Reuse becomes more challenging the more unique the material, the earlier it needs to be incorporated in both design and construction, and the more extensive the performance requirements. This effort advances understanding for how to accomplish structural reuse of mass timber.

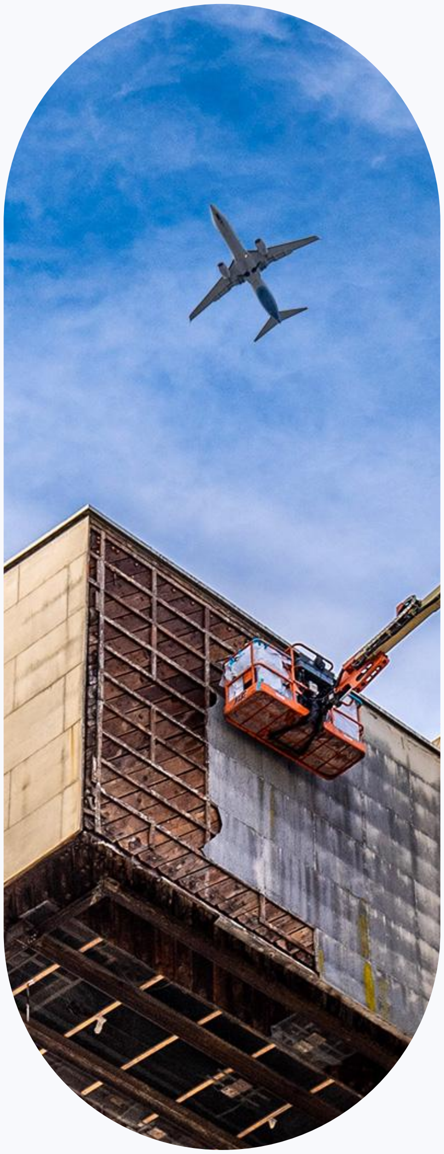
Structural reuse insights:

Adaptive reuse is common at the building scale, but structural disassembly is uncommon and structural reuse at the material scale remains vanishingly rare due to variability, lack of grading standards, and the absence of prescriptive code pathways. While final fabrication and code approval processes remain underway at the time of publication, the work completed to date establishes a documented, replicable pathway for evaluating reclaimed structural lumber at scale.

This paper describes:

- Testing partnerships and methodologies to assess and bound variability of structural performance characteristics.
- An approach for developing a conservative tier of options for safe structural reuse based on performance testing.
- A roadmap for navigating typically prescriptive code and regulatory processes to accommodate structural reuse through a performance pathway based on building code provisions for alternate materials, design, and methods.

This experience demonstrates that reclaimed lumber can be evaluated, qualified, and integrated within contemporary code frameworks when supported by testing, documentation, and jurisdictional engagement.



A worker in a boom lift basket removes exterior cladding high on the corner section above the hangar door.

Partners & Contributors

Ackerstein Sustainability
Sustainability Consulting

Blitz Design
Architect of Record

Cambium Carbon
Digital Inventory Management & Salvage Consulting

CBRE / Turner & Townsend
Project Manager

Devcon
General Contractor

DLR Group
Architect of Record, Engineer of Record

EKI
Environmental Consultant

Elevate Environmental Services
Water Management Consultant / Vendor

FERMA
Demolition Contractor

Google / Planetary Ventures
Client, Owner

Groundworks
Landscape Architect

Hardy Wentzel Consulting Inc.
Mass Timber Consultant

HT Harvey
Ecological Consulting

Jamestown LP
Development Manager

KPFF
Hangar 3 Engineer

Langan Treadwell
Geotechnical Engineering

Mercer Mass Timber
Engineered Wood Products Manufacturer

NASA Ames Research Center
Hangar 3 – Authority Having Jurisdiction

NOVO Construction
General Contractor

Oregon State University, Wood Science & Engineering Lab
Wood Scientists

RMW Architecture
Architect

Sam Burbank
Documentarian

Sares Regis
Project Manager

SERA Architects
Architect

Stantec
NEPA Planning & Design

ToxServices
Hazard Assessment

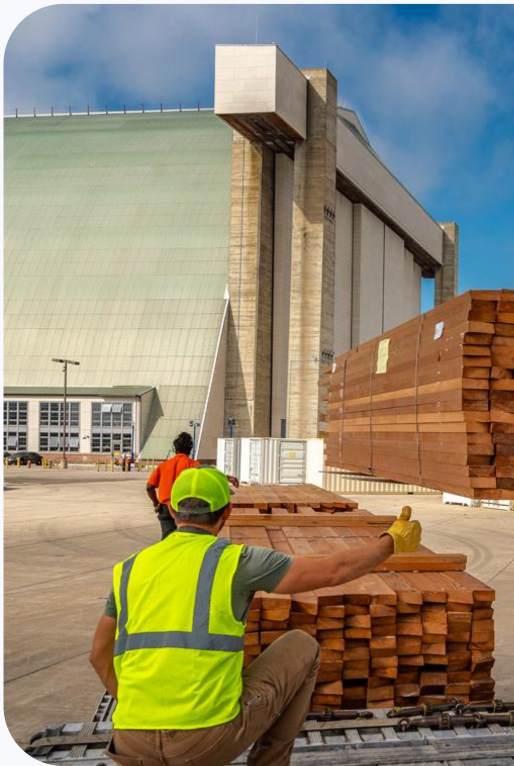
Turner & Townsend
Project Manager & Project Controls

Urban Bloc
Vendor of Commercial Modular Units

Washington State University, Composite Materials & Engineering Center (CMEC)
Wood Scientists

Webcor
General Contractor

Team members neatly stack salvaged boards before shipping them for testing and reuse, with Hangar 2 in the background.



Introduction: Why This Matters

A worker wearing protective gear is planing a reclaimed board.

The building industry has made measurable progress in reducing embodied and operational carbon, yet the material systems that shape our cities still follow a one-way path from extraction to disposal. Even as mass timber gains momentum for its renewable origins, structural wood is almost always treated as a single-life product, moving from harvest to fabrication to disposal with limited mechanisms for material recovery or structural reuse.

Adaptive reuse of whole buildings is common. When it comes to materials, interior products are sometimes reclaimed and reused, but reuse of primary structural systems remains quite rare. We explored the challenges and opportunities of materials reuse in our August 2020 white paper "Accelerating The Circular Economy Through Commercial Deconstruction and Reuse."

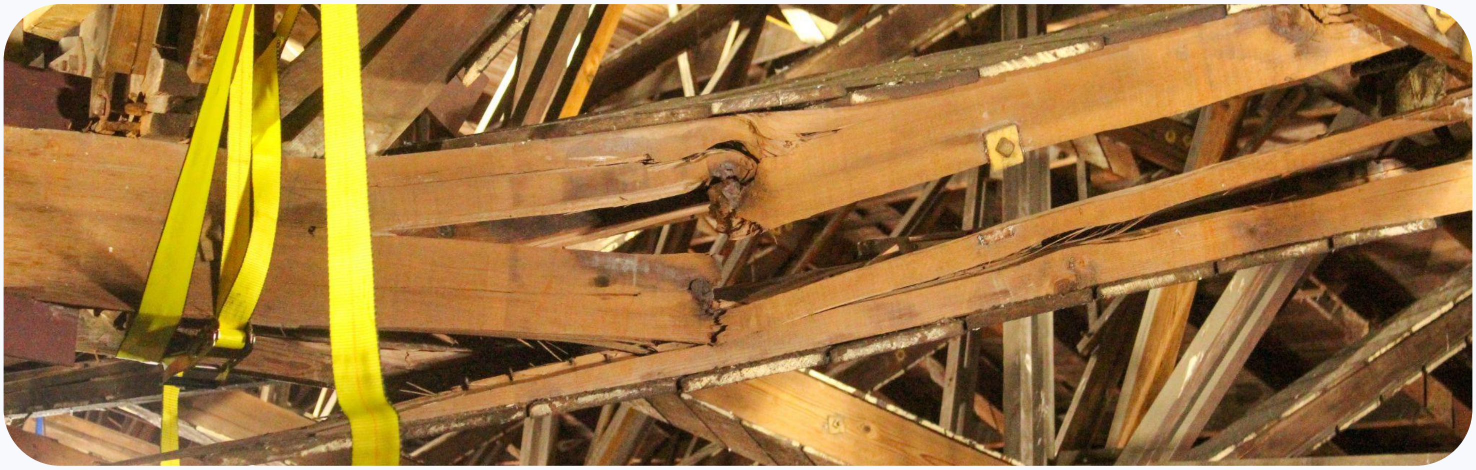
When structural wood is reused, it's usually for nonstructural applications. The reasons are practical. Large-scale lumber reclamation is often dismissed as unpredictable, labor-intensive, and economically burdensome. Reclaimed lumber exhibits variability that complicates both aesthetic and structural reuse.

Historic members lack contemporary grade stamps. Building codes, lumber grading standards, and ANSI standards for engineered wood products provide no prescriptive pathway for returning previously used dimensional lumber to structural service. Without a documented validation process, reclaimed structural wood is perceived as a regulatory, financial, and technical risk, leading most salvaged lumber to be diverted to landfill or lower-value applications such as mulch.

When it's reused, it's almost always in applications such as finishes, furniture, or architectural features. For aesthetic purposes, the unique characteristics may be valued highly enough to be able to absorb the cost of processing reclaimed lumber. For structural uses, it's cheaper and more efficient to order uniform, pre-graded, lumber and so the complex process of accommodating structural reuse is rarely even attempted.

At the same time, global population growth and urbanization continue to intensify demand for housing and infrastructure. In 1960, the world population stood at approximately three billion people. Today it exceeds eight billion and continues to rise. New construction remains necessary, but reconstruction and material reuse must play a larger role in meeting that demand responsibly. Continuing to rely exclusively on virgin resources while expanding development footprints is neither efficient nor sustainable.

Hangar 3 at Moffett Federal Airfield represented a rare convergence of conditions: historic timber construction at monumental scale, structural deterioration necessitating deconstruction, and a private stewardship model willing to question conventional disposal pathways. This paper focuses on the deconstruction, salvage, and reuse of Hangar 3, a massive freestanding timber structure at Moffett Federal Airfield, located at what is now NASA Ames Research Center in the heart of Silicon Valley.



Damaged wooden beams within a complex truss structure, secured with yellow straps.

History of Hangar 3

Hangar 3 at Moffett Federal Airfield was completed in 1943 at a federally operated airship base in Silicon Valley, California. Established in the early 1930s as a Naval Air Station supporting lighter-than-air aviation, Moffett Federal Airfield became a strategic West Coast hub for blimp operations and coastal defense. The site's first major structure, Hangar 1, was completed in 1933 as a steel-framed airship hangar.

A decade later, under wartime material scarcity, steel was prioritized for ships and the Navy turned to timber for Hangars 2 and 3. Hangar 3 alone was constructed from approximately three million board feet of Douglas-fir lumber, widely assumed to have originated in the Pacific Northwest based on historic timber supply patterns.

Hangar 3 was 1,000 feet long and 171 feet high. It was constructed of parabolic open-web timber arches resting on reinforced concrete bent frames. The wood trusses were assembled on the ground and hoisted into place, where they were fastened together with bolted steel plates. The building could house as many as ten blimps.

Intended to be a semi-permanent wartime structure, Hangar 3 stood for more than 80 years as one of the largest freestanding wood structures of its era. However, given its accelerated construction timeline, Hangar 3 faced structural challenges from the outset: remediation was needed to strengthen the trusses as early as 1946.

Efforts to repair and shift to removal

In 2014, Planetary Ventures, a subsidiary of Google, entered a long-term lease of the airfield and assumed management of the historic hangars.

Originally, the plan was to repair Hangar 3 to address its hazardous structural conditions and restore it for future use. Yet efforts to rehabilitate the damaged trusses proved ineffective, and structural engineers could not identify a feasible pathway to safely repair Hangar 3's progressing structural damage. A temporary internal shoring system was installed and monitored for defects on a yearly basis while long-term options were evaluated.

The structure was at high risk of catastrophic failure in an earthquake or high wind event. Ultimately, it was concluded that long term preservation was not viable. In 2019, NASA applied to the California Office of Historic Preservation for permission to remove the building.[1]

Once engineering assessments confirmed Hangar 3 as an unacceptable structural hazard, the question became how best to remove the structure. Traditional demolition was not an option: it would have been too disruptive to the site and created a cloud of historic contaminants. After a public review process, the project advanced toward deconstruction, or the systematic dismantling and removal of the structure.

Deconstruction of Hangar 3 commenced in 2023 and finished in 2025. As of 2026, Hangar 3 is Google's largest ever deconstruction project.

A worker in protective gear removes the exterior cladding above a hangar door.

[1]**NASA Ames Environmental Management Division:** Hangar 3 Building Demolition Project: https://environment.arc.nasa.gov/NEPA.html, viewed May 2026.

Timeline:
Efforts to repair and shift to removal

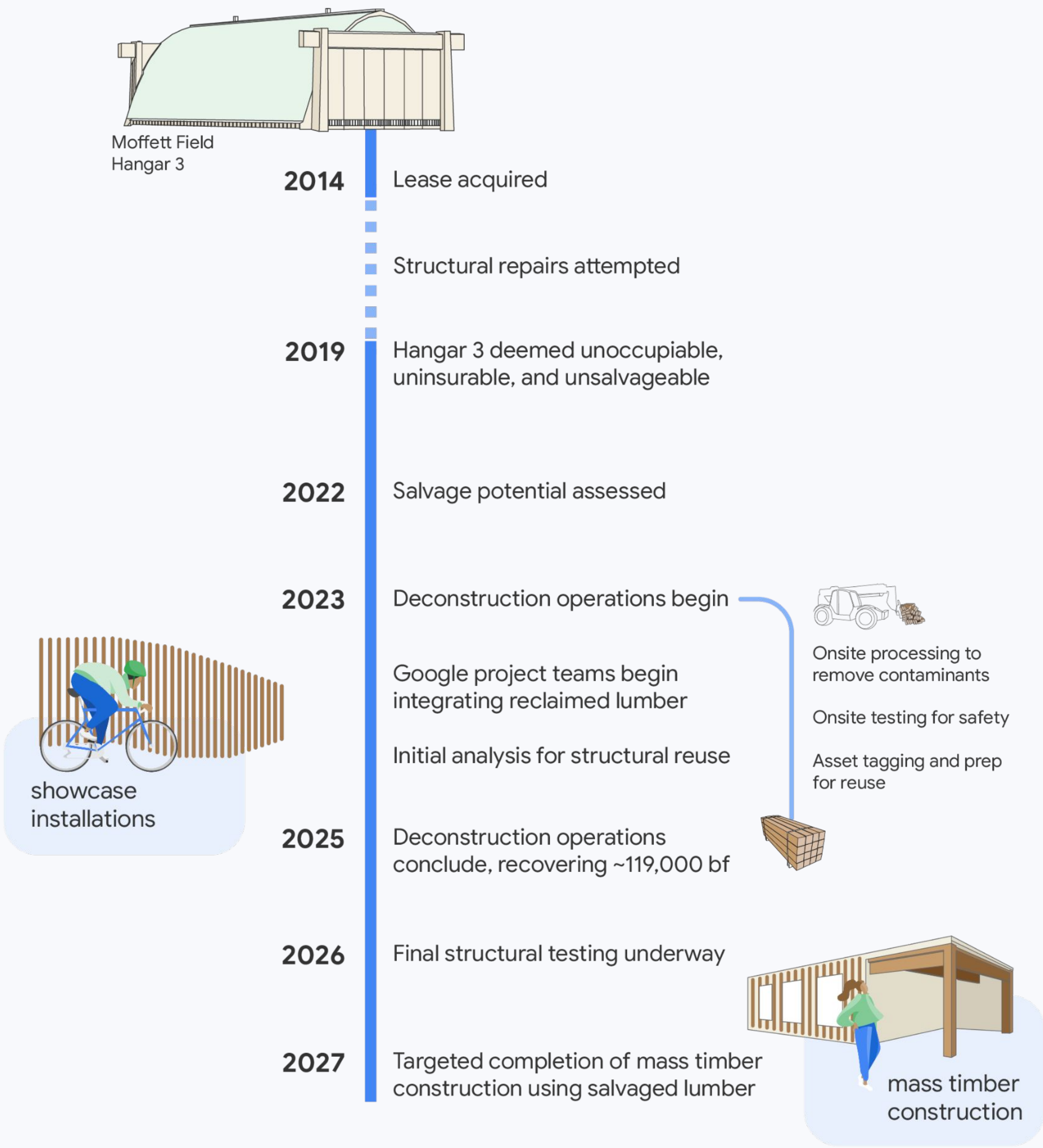
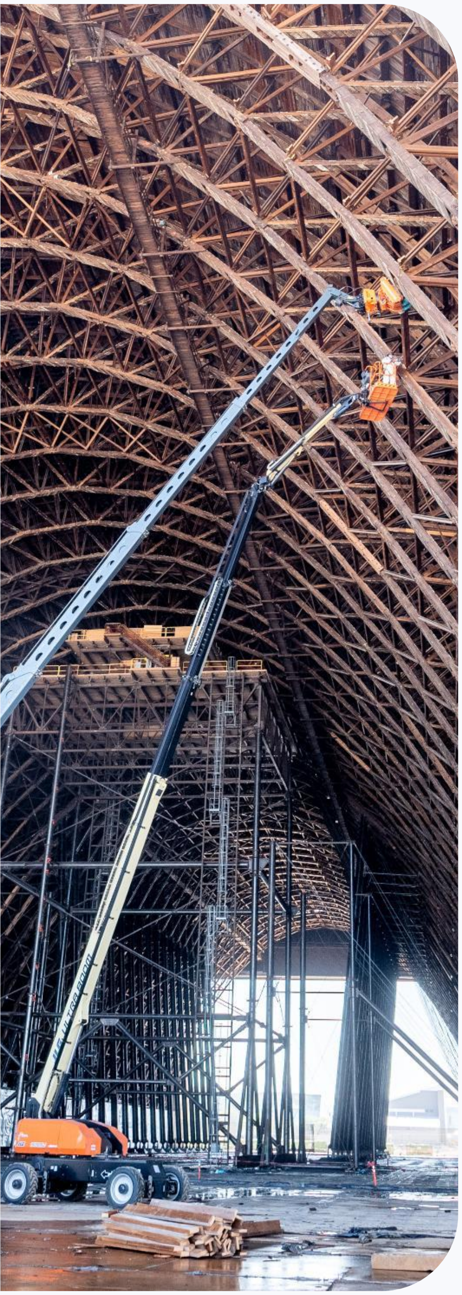


Figure 1: Timeline from attempting structural repair to mass timber construction.

From Deconstruction to Reuse-Ready



Temporary steel pillars supporting the Hangar 3 structure.

Deconstruction planning was already underway when Google's sustainability team entered the discussion: could portions of the lumber be recovered for reuse as the structure came down?

Salvage was not part of the original deconstruction scope. It required integrating material recovery into a deconstruction schedule, assessing the level of chemical contamination throughout the structure, identifying which members could be safely salvaged, and establishing protocols for on-site processing to enable reuse.

Choosing selective recovery

The Google team kicked off this unique salvage project by working with EKI to conduct a thorough assessment of the hangar's reuse potential. The priority was to preserve everything that could be salvaged, which meant that the team had to analyze the condition of the material prior to dismantling.

Environmental exposure and moisture conditions

Repeated moisture cycling affects wood's long-term performance. Checking, splitting, and localized degradation occurred as the structure transitioned between wet and dry conditions over decades of service. Roof leaks accelerated deterioration in several already stressed wood trusses.

The equilibrium moisture content (EMC) for wood in the South Bay typically ranges between 11 and 14%, fluctuating seasonally with marine layer humidity and dry summer conditions. Given Hangar 3's semi-enclosed configuration, interior moisture levels likely stabilized toward the lower end of this range. However, the water intrusion caused by roof leaks, combined with fire-retardant chemical treatments, contributed to observable surface degradation in several large members.

Contaminant and surface treatment assessment

Surface treatments became a defining factor in salvage feasibility. Hangar 3 was treated in the 1940s with fire-retardant chemicals and creosote to deter pests. Subsequent evaluation revealed that in Hangar 3, the fire-retardant treatment had penetrated deeply into several large primary members, including 6x14 inch sections within the main arch truss system. Such extensive saturation was atypical for Douglas-fir of that size and severely limited reuse opportunities.

In contrast, smaller secondary elements, such as 3x6 inch members in bracing components between the primary arches, exhibited lighter treatment penetration. These members ultimately demonstrated greater potential for salvage and requalification than the larger primary arches originally presumed to be the most viable candidates.

Environmental testing was conducted to assess worker safety, machining emissions, and post-occupancy exposure risk. Toxicity evaluations informed decisions regarding which members could safely be resurfaced, cut, and remanufactured without violating emission permit thresholds or introducing health concerns.

Water cannons control dust as the hangar is deconstructed.

Once all salvageable wood was identified, the team proceeded with careful disassembly of the structure and on-site processing of all non-hazardous lumber. This shift reframed deconstruction from total removal to selective recovery. Ultimately, approximately 119,000 board feet of high-quality old growth Douglas-fir dimensional lumber were recovered from an original volume of nearly three million board feet. At the time, the intended end use of the material was not defined.

Controlled deconstruction methodology

The Hangar 3 team approached deconstruction innovatively to minimize exposure to contaminants and maximize efficiency. Crews first reviewed lumber members' conditions to evaluate if they were fully intact and worthy of salvage in each individual truss bay. Salvage was a practice of precision: selected pieces were stabilized with a long-reach excavator, cut free, and lowered in a controlled manner.

Moving bay by bay, salvageable members were cut at height and allowed to free fall onto prepared steel landing plates, contained by moveable shipping containers and protective netting that prevented risk of falling debris to neighboring facilities. The material was continuously sprayed with water and a proprietary tackifier to minimize dust and hazardous exposure to the environment. This sequencing minimized damage, kept materials clean, and preserved a clear chain of custody, steps critical for lumber intended for future reuse.

Of the wood not cleared for reuse, approximately 4,700 tons was characterized and successfully disposed of as hazardous waste. In addition, over 11,000 tons of concrete debris and steel were recycled.

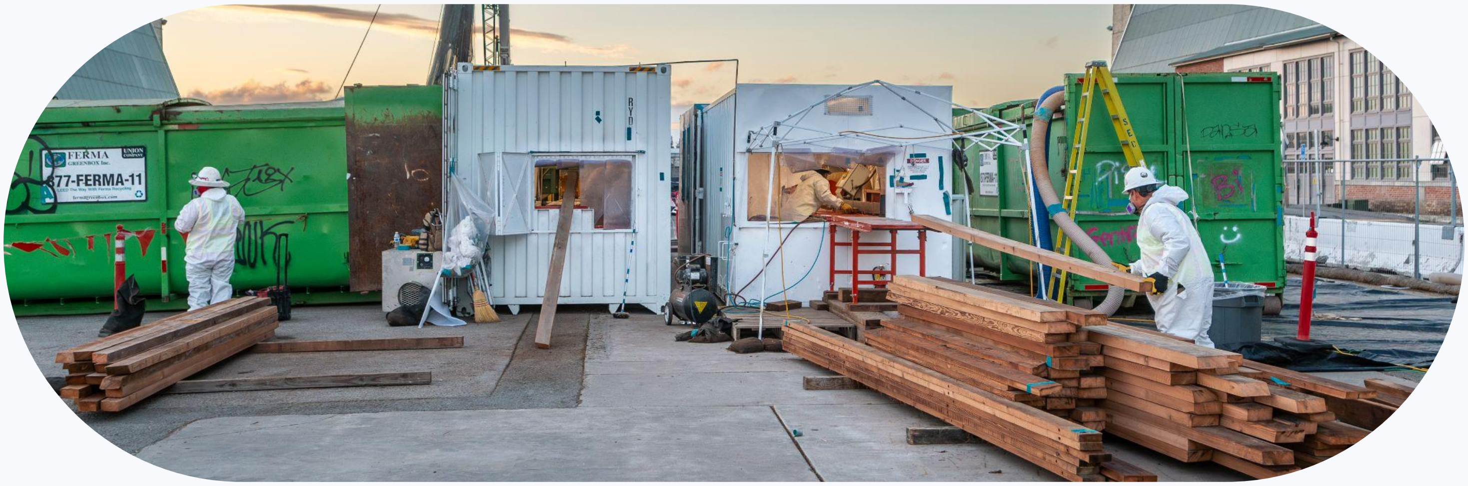
Handling, cataloging, and transport

Once on the ground, each salvaged member was palletized per truss bay and moved to a designated on-site storage and processing area. Because of the legacy fire-retardant treatment, recovered members required controlled on-site planing before leaving the site. The team constructed and deployed a custom on-site planer to remove the outer layer of treated wood under controlled conditions.

Deconstruction crews operated under enhanced PPE protocols; negative air, dust suppression, and containment measures were implemented to protect workers, prevent airborne particulate migration, and safeguard surrounding site conditions.

Preliminary surface-removal testing was conducted to determine the depth required to reduce residual fire-retardant contamination. The standard protocol to adequately eliminate contaminants from salvaged members was to plane off a quarter inch of material per side. In certain cases where testing showed that a single quarter-inch pass did not sufficiently reduce chemical presence, a second quarter-inch pass was taken.

After surface preparation, members were palletized again and grouped for documentation. Each grouping received a QR code linking it back to its original location within the hangar. The digital catalog recorded structural role, elevation, orientation, and origin, preserving both engineering data and historic context.



Workers using planing machines housed in trailers to accommodate onsite salvage.

Early sorting and grading assumptions

From the start, grading assumptions were pragmatic. Surface contamination, drop impacts, and decades of service were all expected to limit how the material could be reused. But real-time visual inspections showed most members remained strong and stable after recovery.

The process took longer than anyone expected with multiple rounds of handling, planing, sampling, and documentation often coordinated across several regulatory groups. For many involved, it was a first-of-its-kind project.

Applications Across Google's Portfolio

Establishing criteria for reuse applications

Multiple pieces of heavy machinery, including a high-reach excavator, collaborate to tear down the massive wooden sections of the hangar.

The project team enlisted ToxServices to set exposure-based parameters for reuse of the salvaged lumber. The team took a conservative approach to reuse by prioritizing outdoor applications within Google's portfolio with high visibility and relatively low exposure. Reusing the material internally within Google ensured that the lumber was installed in places that met safety criteria while keeping the Hangar 3 wood story alive.

Initially, the team created customized reports including detailed safety analysis for each proposed application of the lumber. Realizing this customized approach was not scalable, the team created general "rules of engagement" for project teams, enabling a more streamlined process.

Brokering supply and demand to enable reuse

After salvaging the material, the biggest challenge – common to all reuse projects – was successfully linking available salvaged materials with active projects. With limited storage options, finding construction projects that could commit to using the lumber emerged as a priority. One key barrier to uptake of the salvaged lumber was the unpredictable – and often lengthy – timeline between the design phase of construction projects and the window when the material could actually be delivered to the construction site.

There was also uncertainty on the supply side, because each Hangar 3 truss was tested for chemical contamination as the structure was deconstructed. As a result, supply and demand were constantly shifting targets. While designers recognized the value and beauty of the wood, the material needed to be available at the right time or teams might revert to established procurement channels.

The team worked hard to navigate this ebb and flow, and support those engaging with the reuse process. It provided samples with a QR code to access an internal website showcasing the beauty and quality of the wood. To facilitate a more predictable and controlled reuse process, the Hangar 3 team partnered with Cambium Carbon for digital inventory management and asset tagging to catalog and track the wood.

Applications large and small

The first installation of Hangar 3's salvaged boards can be found at the **Moffett Park Green Link Bridge** in Sunnyvale, California. This project uses 4,750 board feet as a decorative façade on a ramp retaining wall, creating a publicly accessible landmark. This pedestrian and bicycle bridge over Valley Water's West Channel connects Green Link Pathways on either side, providing a key connection that improves car-free transportation options in the neighborhood.


Moffett Park Green Link Bridge showcases the wood in a decorative facade.

Meanwhile, the **Huff Campus Project**, in Mountain View, is using the salvaged boards as vertical slats in a courtyard security fence that adds a natural design feature to the landscape. The project will rip and re-saw salvaged boards down to an actual installation dimension of 1" x 5".


A security fence made using the salvaged boards for the Huff Campus in Mountain View, CA.

Creekside in San Jose features shops, restaurants, and events, drawing residents and visitors into an evolving urban environment. The project used 1,200 board feet of salvaged material as finish cladding on commercial modular units as part of newly created tenant spaces.

The remaining material – including trim scrap captured from the Huff Campus fencing – continues to be used in a number of small applications to showcase the legacy lumber.

Opportunity to explore structural reuse

As the team explored applications across Google's real estate portfolio, an interest in structural reuse emerged. Could reclaimed lumber be requalified and integrated into a new primary structural system?

Google teams were already developing a mass-timber strategy for Google campuses and were exploring high-performance applications like glue-laminated (glulam) beams and columns and cross-laminated timber (CLT) panels. We ultimately focused on a site in The Dalles, Oregon because of the unique circular economy story it offered, as the Hangar 3 lumber is presumed to have come from Oregon originally.

Case Study: Assessing Reuse in Structural Members

Workers loading salvaged boards onto a flatbed truck to be shipped for testing and reuse.

With the project approved, Google launched into the work of validation for structural reuse. This validation and other technical details required a number of additional steps. These are outlined below, along with lessons learned and ways this work advances the potential for lumber reuse in structural members.

The roadmap below is specific for reuse in structural members. The *starred steps are unique to efforts seeking to reuse structural materials in new structural members, and are described in more detail below.

Roadmap for structural requalification

PHASE	STEP
Pre-deconstruction material intelligence	Historical research and performance context used to assess feasibility and inform deconstruction strategy (species identification, contaminant evaluation, load service history).
Deconstruction strategy and material recovery	Controlled removal, documentation, and preparation of reclaimed wood for evaluation and reuse.
Testing, analysis, and *structural validation	Visual grading, contaminant removal, wood science testing, and analysis to establish reliable structural properties.
*Regrading and structural remanufacture	Conversion of validated reclaimed material into mass timber products using modern grading and fabrication processes.
*Code pathways and jurisdictional engagement	Establish approval through early coordination with the Structural Engineer of Record and Authority Having Jurisdiction (AHJ), documented testing, and performance-based engineering justification.
*Design integration and implementation in structural systems	Incorporation of validated reclaimed lumber into the final structural system, translating testing and approvals into built applications.

Testing, analysis, and structural validation

If reclaimed lumber is to reenter structural service, it must do more than appear sound; it must satisfy contemporary expectations for strength, stiffness, predictability, and safety. If this wood was to serve again, this time within contemporary engineered wood assemblies, it had to earn that right through testing.

This validation process was not linear. It began before deconstruction, continued after on-site processing, and extended into manufacturer-level qualification. The effort evolved alongside the project's ambitions, moving from basic waste classification to rigorous structural verification.

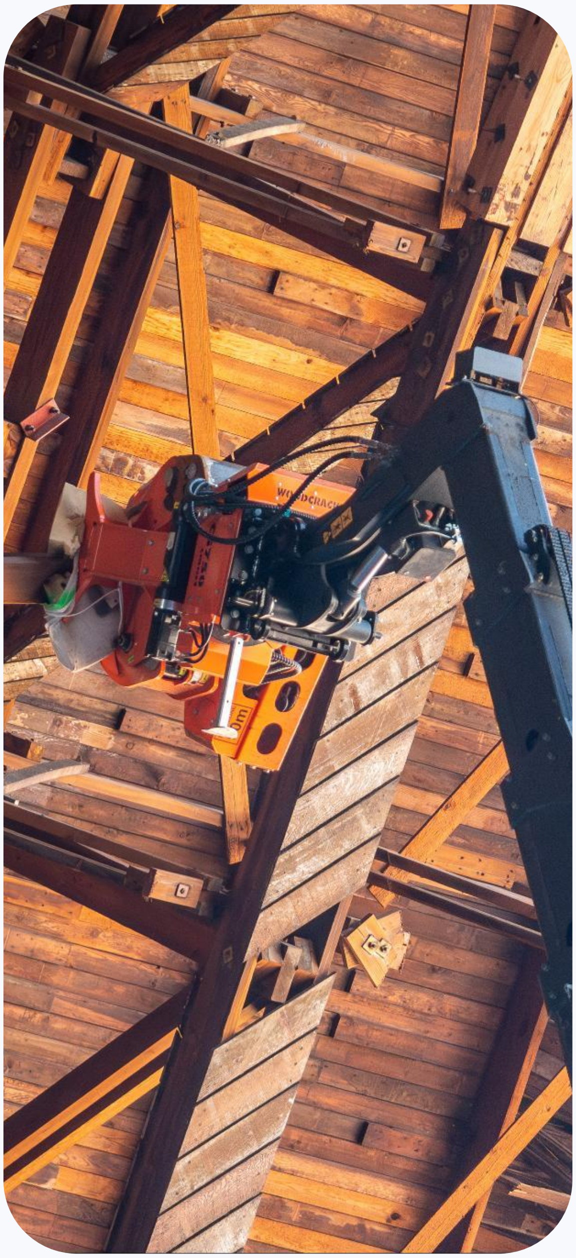
Structural load history

Wood subjected to prolonged or repeated loading experiences changes in structural capacity over time. Sustained loads can induce creep, resulting in gradual deformation, reduced strength and stiffness. Cyclic loading, particularly in seismically active regions, can introduce fatigue-related micro-damage that's not always visible upon inspection. These factors directly influence residual structural integrity and must be evaluated before reclaimed lumber is considered for structural reuse.

Hangar 3's long-span timber arches operated in a seismically active region for more than 80 years. Damage records note a progressive dip in the roof structure, attributed to earthquake-related buckling and cumulative core distress. Digital scanning of the structure conducted during preservation evaluation confirmed sagging and settlement in several truss assemblies, prompting temporary shoring to stabilize the roof assembly.

Although wind loads were considered in original design, seismic forces governed structural performance in this region. The cumulative effect of these events warranted conservative assumptions regarding residual strength and stiffness prior to reuse consideration.

Given the uncertainty associated with load history, environmental exposure, chemical treatment, and aging, conservative design assumptions were necessary at this stage. In some cases, non-destructive evaluation and in-situ testing were identified as prerequisites before advancing to formal structural validation.



Salvageable boards are carefully removed from the intricate framework.

Wood science testing with Oregon State University

Small-batch samples were sent to Oregon State University Wood Science and Engineering Lab for preliminary mechanical testing to characterize the static bending properties of the reclaimed Douglas-fir—specifically its modulus of rupture and modulus of elasticity.

Over 200 boards were evaluated. Each was measured for width and thickness prior to testing. Using standard static bending procedures, controlled loads were applied to determine strength and stiffness performance. Longer pieces were placed over wider spans, and sensors tracked how much each board deflected during testing.

Following bending strength tests, samples were extracted to determine moisture content and density, two variables that help explain how lumber behaves under stress. 30 boards were also scanned using imaging equipment designed to detect internal characteristics; however, the wood's darkened surface reduced predictive accuracy relative to typical new lumber.

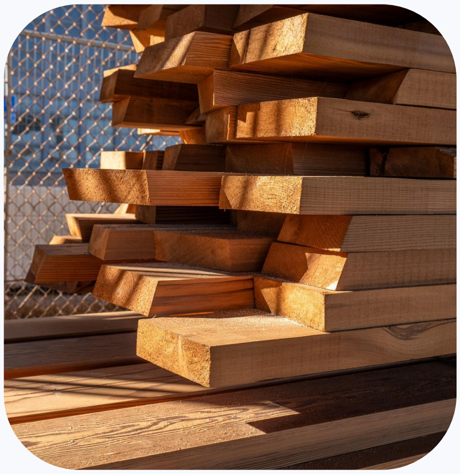
Despite its age, results indicated consistent structural behavior within viable performance ranges. A limited number of glulam specimens manufactured from selected boards demonstrated comparable bending strength and stiffness to new lumber. Collectively, the testing established a measurable performance baseline for the reclaimed Douglas-fir, informing subsequent grading, manufacturing correlation studies, and structural validation efforts.

Wood strength and stiffness testing at Oregon State University's Wood Science and Engineering Lab.

Post-deconstruction mechanical properties evaluation

Building on the insights gained from the Oregon State University testing phase, the next stage of analysis shifted toward understanding how the reclaimed lumber would perform under additional, manufacturer-led mechanical properties evaluation.

When the material arrived at Mercer Mass Timber, the manufacturer elected to conduct its own structural validation in addition to the ample third-party contaminant testing. The rationale was twofold: employee health and safety, and structural certainty.



Rough cut salvaged boards resting outside the demolition site.

Visual grading, machine stress rating correlation, and material characterization

Unlike conventional lumber deliveries, the reclaimed boards arrived at Mercer Mass Timber in Spokane, Washington, with angled cuts from deconstruction. Each piece had to be squared before stiffness testing. Their darkened surfaces again complicated visual digital grading that performs careful scanning for slope of grain, knot structure, and checking.

In some cases, certified lumber graders supplemented machine evaluation with targeted visual inspection and tactile judgment. Each board was then tested for modulus of elasticity using an inline machine stress rating system. In conventional lumber production, machine stress rating systems sort boards by calibrated equipment to meet defined strength and stiffness thresholds. In this case, the team was effectively reverse-engineering that process to characterize the structural properties of reclaimed material.

As an additional measure of caution, approximately 60 pieces of lamstock specimens were destructively tested to establish baseline tensile strength properties. These early breaks were revealing: the wood retained meaningful capacity, but variability was greater than in typical new lumber.

Compared to new mass timber lumber feedstock, the reclaimed lumber demonstrated variety in mechanical properties. Variability, however, is not a disqualification. It is a design parameter.

Salvaged boards are neatly stacked prior to loading to be shipped for testing and reuse.

Validation, enhanced quality control, and comparative performance

Mercer Mass Timber elected to perform more quality control tests than required by manufacturing norms. As an initial safeguard, contaminant testing confirmed no reasonable imminent air-quality risk beyond standard sawdust exposure. Third-party analysis indicated contaminants remain bound within resting wood fibers unless mechanically disturbed.

Ongoing correlation studies aim to tighten predictive design value accuracy between visual grading, machine scanning, and destructive testing outcomes. Following additional moisture stabilization analysis, adhesive application strategies and press times were adjusted to ensure high quality bond performance. Adhesive bond performance and finger joint testing was conducted consistent with standard mass timber manufacturing practices, as bonding performance introduces another layer of structural dependency.

The reclaimed lumber from Hangar 3 did not simply "pass" or "fail." Some pieces were culled. Others exceeded expectations. What emerged was a statistically informed, quality-controlled material stream, one that demanded more oversight than new lumber, but rewarded that rigor with structural credibility.

Salvaged wood upon arrival at Mercer Mass Timber.

Regrading and structural remanufacture

When the lumber from Hangar 3 arrived at Mercer Mass Timber's manufacturing facility, it resembled an archival artifact more than a typical feedstock. Each board carried the marks of its long service life, including angled cuts from disassembly, bolt holes from the previous structure, deep patina, and irregular dimensions that no modern sawmill would intentionally produce. It was clear from the outset that this material could not simply be planed and processed like new lumber. It required interpretation, careful preparation, and an approach tailored to its history. Only contemporary scanning, grading, and fabrication technologies made this level of material reinterpretation possible.

The Hangar 3 material arrived as historic true-cut lumber – often more than two inches thick – cut at angles and rarely squared. Before structural evaluation could begin, ends had to be squared, surfaces cleaned, and dimensions rationalized. Moisture content added another layer of complexity. The lumber was drier than typical production stock. Standard in-line scanners struggled with the wood's darkened patina, so technicians reverted to first principles: weigh, oven dry, and weigh again.

Squared and cleaned lumber next to the original salvaged condition of the wood.

The same darkened surface that gave the lumber its rich character also interfered with optical grading systems. Light refracted differently and knots were harder to detect. Machinery vendors had to reprogram the software and recalibrate scanning parameters, and programmers adjusted algorithms one grading parameter at a time. The process deviated substantially from standard production workflows.

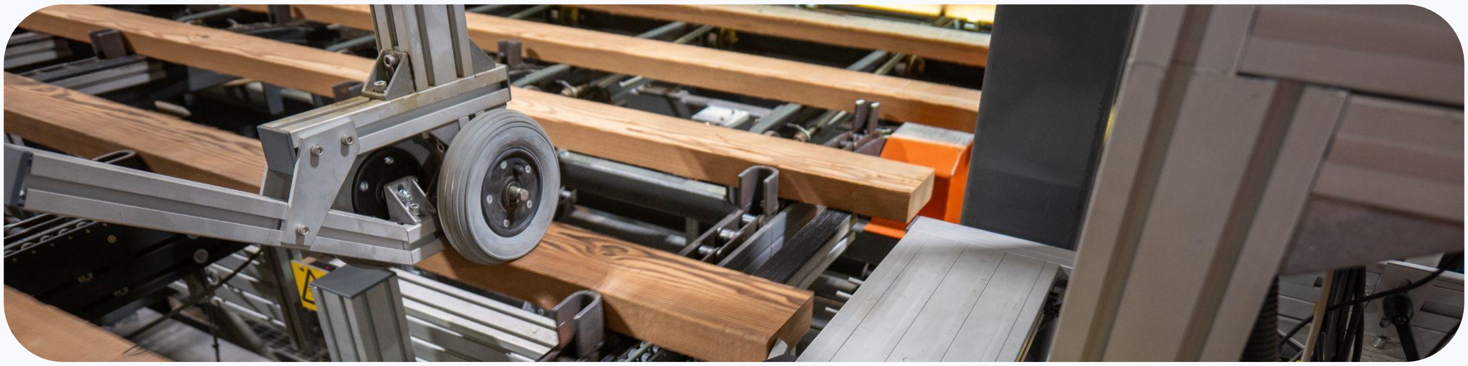
Further complicating the effort, no standardized lumber grading rules exist for reclaimed structural lumber. With no guidance on residual strength, prior loading history, or treatment chemical exposure, the team treated the process as a wood-science problem rather than a conventional grading exercise. This meant validating everything through rigorous testing.

Environmental safety and contaminant testing

Although previous environmental assessments had been completed, the manufacturer repeated them to ensure safe working conditions. Historic preservative treatments raised concerns about heavy metals, and semi-volatile organic compounds. Simulated sanding and planing showed that most contaminants had diminished over time, and the heavy metals tests came back negative, but PPE requirements and dust-collection controls remained in place. Boards exceeding allowable limits were isolated for disposal, while most continued through the production stream.

Mechanical validation and redundancy

The regrading process blended human judgment with machine verification. Certified lumber graders visually evaluated slope of grain, checks, and knot size, while machine stress rating systems measured stiffness and strength. Destructive testing revealed wide tensile strength variation: some pieces exhibited strong tensile behavior, while others were brittle. Approximately 30 L1 and 30 302-24 glulam tension lamination samples, representing common glulam lamination grades, were destructively tested to map this variability. With no standardized grading pathway for reclaimed lumber, the team built redundancy into the evaluation process.



Machine verification of lumber regrading.

Adhesive strategy and manufacturing adaptation

The results directly informed manufacturing. Planning required multiple passes because the material exceeded modern dimensional norms, and the wood's density further challenged equipment. Adhesive application systems required modifications, since most adhesives used in mass timber manufacturing depend on moisture to cure. Options considered included raising ambient humidity, misting on adhesive lines, and longer press times. These steps were tested and verified by quality control practices during production.

End grain of the salvaged wood.

Strategic structural deployment

After scanning and grading established structural capacity, final independent testing and AHJ approval of glulam columns made from the reclaimed wood was still pending at the time this paper was published.

Beyond the mechanics of testing and qualification, equal consideration was given to how reclaimed lumber is strategically deployed. Higher-performing boards could be prioritized for outer lamellas in exposed CLT panels, where both structural demand and visual expression are greatest. Hybrid layups offer another pathway, pairing reclaimed faces with new lumber cores to balance performance, efficiency, and aesthetic value, extending the available reclaimed supply across a greater number of elements.

Structural application sensitivity

Not all structural applications place equal demands on reclaimed material. Glulam beams, which function primarily in bending, are more sensitive to variability than compression members. Bending introduces both tension and compression stresses across the member depth, making defects such as slope of grain, knots, checks, and shake more consequential, particularly in tension zones.

Compression members like glulam columns, by contrast, are generally less sensitive to surface defects provided fiber continuity along the grain remains intact. While buckling remains a design consideration, its influence is largely geometry dependent rather than defect driven. Additional testing is currently underway to validate these assumptions.

For reclaimed lumber, this distinction is amplified. Load history, potential fatigue, and material variability make bending applications more demanding than compression applications. These principles informed both regrading thresholds, and strategic application placement decisions during remanufacture.

Material intake and grading results

Of the tens of thousands of board feet shipped to Mercer Mass Timber for evaluation, approximately 66,000 board feet met dimensional and grading criteria suitable for potential use in glulam and CLT panels. The remaining boards fell outside mass timber manufacturing tolerances (too thick or too thin) but were retained for alternative reuse pathways.

A worker wearing protective gear is stacking reclaimed boards.

Code pathways and jurisdictional engagement

Reclaiming structural lumber is as much an exercise in code as in material science. In the United States, there are thousands of AHJs, each charged with ensuring safety through local enforcement of adopted building codes. Any one of them can be a gatekeeper or a partner.

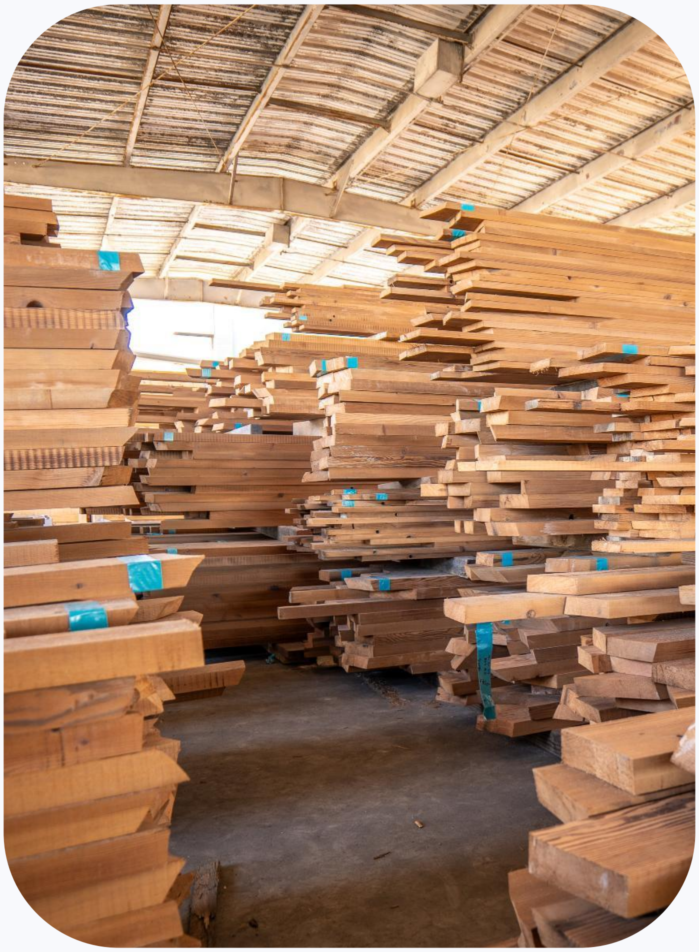
For The Dalles project, the team engaged Wasco County and the City of The Dalles under the Oregon Structural Specialty Code (OSSC). Oregon building codes allow used or salvaged dimensional lumber to be reused. However, the code does not provide prescriptive pathways for incorporating that lumber into newly manufactured mass timber products such as glulam beams and columns or CLT panels. That gap required a performance-based approach. Section 104.10 of the OSSC, based on the International Building Code provision for alternate materials, design and methods, provides a mechanism for evaluating innovations that fall outside prescriptive requirements. Under this section, project teams will submit technical evidence demonstrating that a proposed material or system performs at least equivalently to what the code requires for safety, strength, and durability.

Each reclamation effort to repurpose structural lumber is case specific, and project teams must work closely with the local AHJ to understand jurisdictional requirements and establish an appropriate approval pathway.

When reclaimed lumber does not fit neatly

Modern building codes are largely prescriptive and assume ANSI-certified glulam and CLT, made from newly manufactured lumber with grade stamps. Reclaimed Douglas-fir does not carry contemporary mill certification. Instead, due diligence lies at the forefront of the process, with consistent testing and retesting for exhaustive verification. The uncertainty lies not in measured performance, but in historical exposure: more than 80 years of in-situ loading inside the hangar. That unknown has prompted thoughtful caution from both Mercer Mass Timber and DLR Group.

To address this, the alternate design options remain conservative. Reclaimed lumber is being considered primarily for glulam columns in lower-stress applications rather than primary long-span beams. Mercer now digitally grades and sorts each piece of reclaimed lumber to ensure it meets the grade requirements for glulam column applications. In addition, the column cross-sections have been increased in size to provide an additional margin of safety and further enhance design reliability.



Reclaimed wood from the hangar stacked and sorted for future use.

Performance-based submission

Because ANSI certification for glulam and CLT is not available when using reclaimed lumber as feedstock, the team pursued approval through an alternate means and methods request. The submission package included comprehensive lumber grading and machine stress rating documentation for every board of reclaimed lumber. It also included laboratory testing data, detailed manufacturing quality control protocols for both glulam and CLT production. It also incorporated conservative structural calculations developed for the building planned in The Dalles, Oregon. Collectively, this documentation demonstrates that the finished mass timber engineered wood product assemblies meet or exceed the strength and stiffness values assumed in the building design, ensuring structural performance and public safety.

Face-to-face meetings and interactions with the AHJ were identified as a best practice to present the full package, address questions, and identify any concerns. In the event of a rejection, the code requires the AHJ to identify specific provisions that are not satisfied, enabling refinement and resubmission as necessary. This rigor is intentional, reflecting the role of building codes as legal frameworks rooted in public safety and occupant protection.

Moving forward with confidence

The path ahead requires a polished, comprehensive submission and disciplined coordination among Google, DLR Group, Mercer Mass Timber, and the AHJ. While approval is never guaranteed, the utmost diligence in grading every piece, testing beyond minimum standards, and designing conservatively, all make reclaimed lumber not an exception to the code, but a material capable of meeting it.

Design integration and implementation

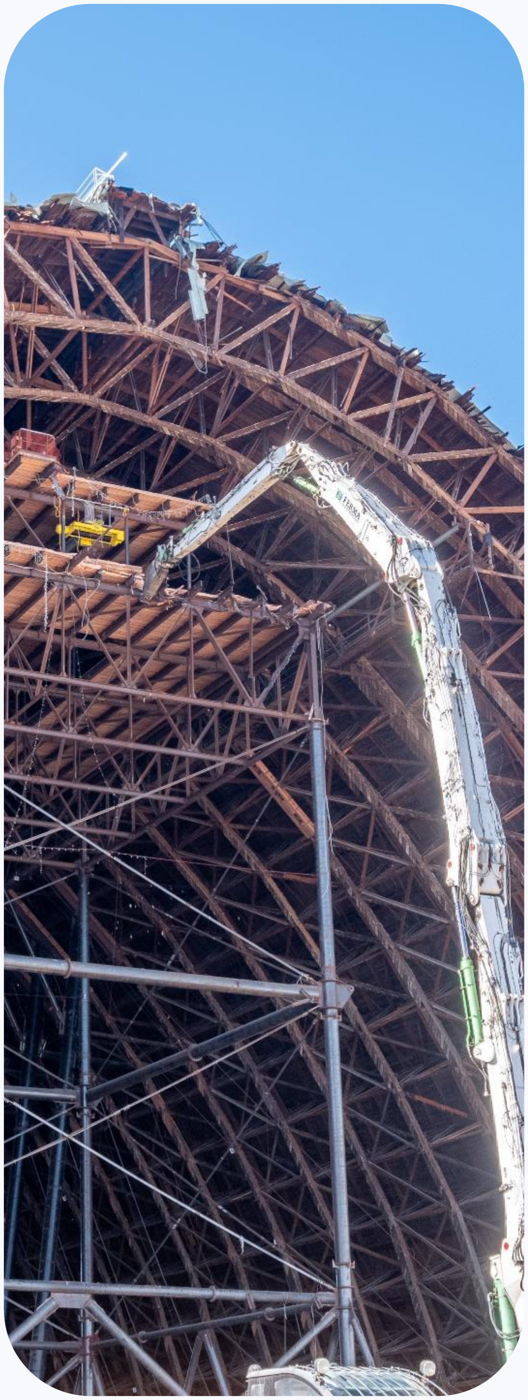
As testing and grading established structural viability, the question became architectural: where and how should this material return to service? Structural clearance alone was insufficient. The team had to determine how reclaimed members could align with span requirements, connection detailing, fire protection strategy, moisture control, fabrication tolerances, and the performance expectations of a repeatable mass timber prototype.

This section provides context for Google's prototypical mass timber building system and describes how the reclaimed lumber was ultimately calibrated to a deployment site in The Dalles, Oregon.

Google campus design evolution

Through controlled dismantling, approximately 119,000 board feet of dimensional lumber were safely reclaimed from Hangar 3. The volume was modest relative to the original structure, but significant in implication. Stacked and cataloged on pallets, the salvaged wood remained in suspension. No longer part of the hangar, not yet assigned to a new path.

That moment of suspension coincided with parallel work already underway. Since 2019, Google and DLR Group have been developing a repeatable office building prototype to support Google's corporate office development program on Google campuses across North America. Two structural systems were studied within the same footprint: a pre-engineered metal building and a mass timber alternative. Both were designed to be scalable, site-agnostic, and operationally consistent. Several campuses advanced under the metal model, and the mass timber alternative remained under study.



Temporary scaffolding erected to support the failing structure.

To better understand long-term environmental and operational implications, the team conducted a comparative life-cycle assessment comparing a pre-engineered metal building to a mass timber structural system fabricated from new lumber.

Environmental performance was not the only metric under evaluation. User experience remained central to the office design. The shift from industrial data halls to exposed timber workplaces created a warmer, more human-scaled environment, qualities often associated with improved occupant comfort and engagement. Embodied carbon reductions and improved user experience reinforced one another, and leadership aligned around mass timber as the structural direction for future data center office buildings.

With that direction established, another question arose: could the salvaged Hangar 3 lumber be responsibly integrated into a mass timber system? The reclaimed material became a focused test case within an already validated prototype. One deployment site was located in The Dalles, Oregon, within the Pacific Northwest timber region historically associated with Douglas-fir harvest. The geographic proximity introduced a compelling circular dimension, returning reclaimed wood to structural service within the same regional economy from which it was likely sourced decades earlier.

Sustainability through structural reuse

The exploration of mass timber as a structural system for office buildings reduces embodied carbon relative to conventional concrete and steel construction. Structural reuse extends that strategy further.[2]

In a world experiencing rapid population growth and increasing pressure on material resources, extending the service life of structural resources becomes an important sustainability strategy.

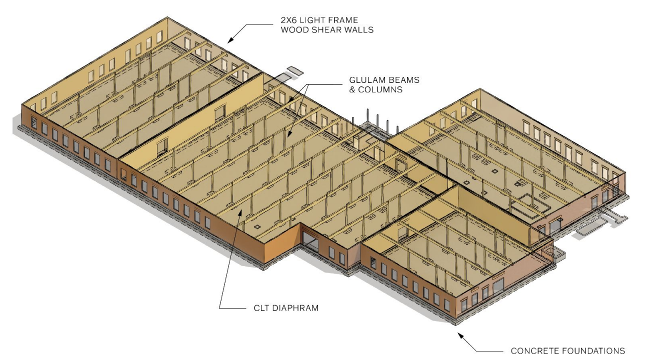


Figure 2: Mass Timber Structural System.

Calibrated structural deployment

The integration of reclaimed lumber into The Dalles project was never intended as an aesthetic gesture. It was approached as a structural decision informed by material testing, calibrated by engineering judgment, and supported by manufacturer validation. Throughout the evaluation process, the central question was not whether the material could perform, but how conservatively it should be deployed.

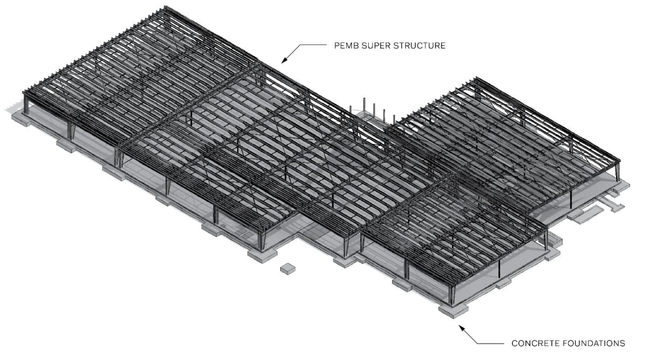


Figure 3: Pre-engineered Metal Building Structural System.

[2]**Carbon Leadership Forum.** Reclaimed and Reused: Recommended LCA Modeling Guidance to Support EPDs for Reused Construction Materials: https://carbonleadershipforum.org/reclaimed-and-reused-recommended-lca-modeling-guidance-to-support-epds-for-reused-construction-materials/. July 2024.

Given variability in mechanical properties, reclaimed lumber will be used according to a hierarchy of structural demand. Initial applications prioritized elements with predictable load paths and lower sensitivity to flexural variability. Column compression members and select CLT face layers provided opportunities when the material was deemed unsuitable for higher-demand roles. Long-span beams were also evaluated but ultimately ruled out due to variability observed during tensile strength testing.

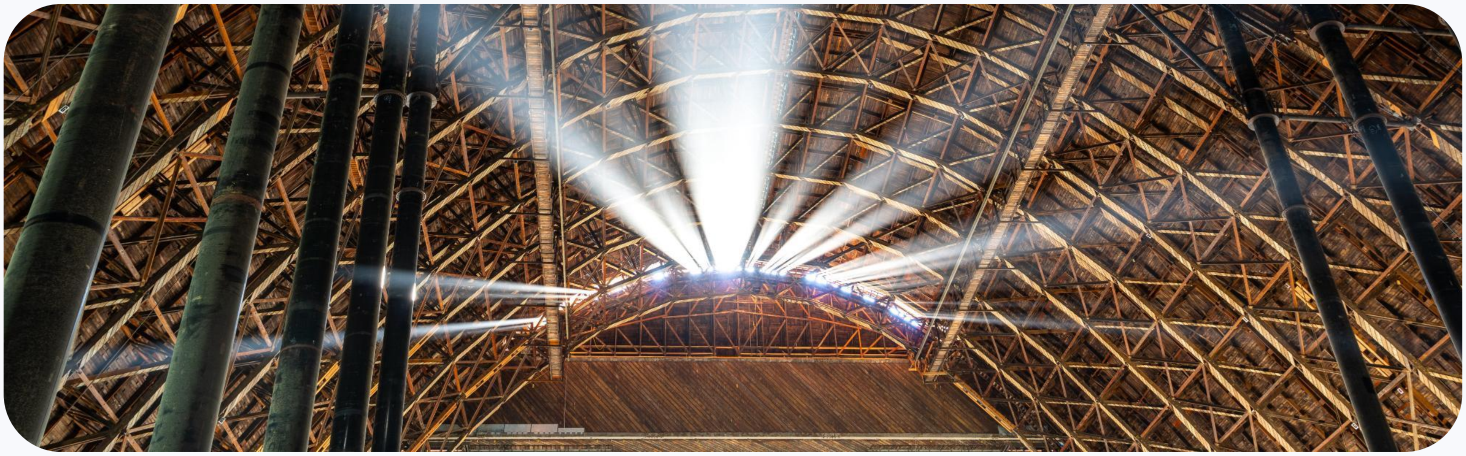
Design values were derived from testing results while remaining intentionally conservative. Members could be oversized, or layups adjusted to buffer inherent variability. In this framework, uncertainty became a design parameter rather than a barrier.

Hybrid configurations were also identified as a deployment strategy for two primary reasons: the limited quantity of salvaged material from Hangar 3 and the variability in measured strength properties when used as a bending member.

Cleaned and squared wood loaded for regrading.

For The Dalles project, Mercer Mass Timber settled on the use of reclaimed lumber as a fourth, non-structural face layer applied to a three-ply CLT panel. The assembly is manufactured and certified as a structural three-ply panel, with design values assigned to the approved layup, while the reclaimed fourth layer functions solely as an aesthetic surface and does not contribute to structural capacity.

These deployment strategies demonstrate a scalable model in which reclaimed material is expressed where appropriate, supported where necessary, and integrated with intention. Even so, structural reuse remains inherently case-specific, requiring each reclamation site to undergo its own testing protocols, engineering evaluation, and development strategy.



Center point of the hangar ceiling, highlighting the symmetry and structural details.

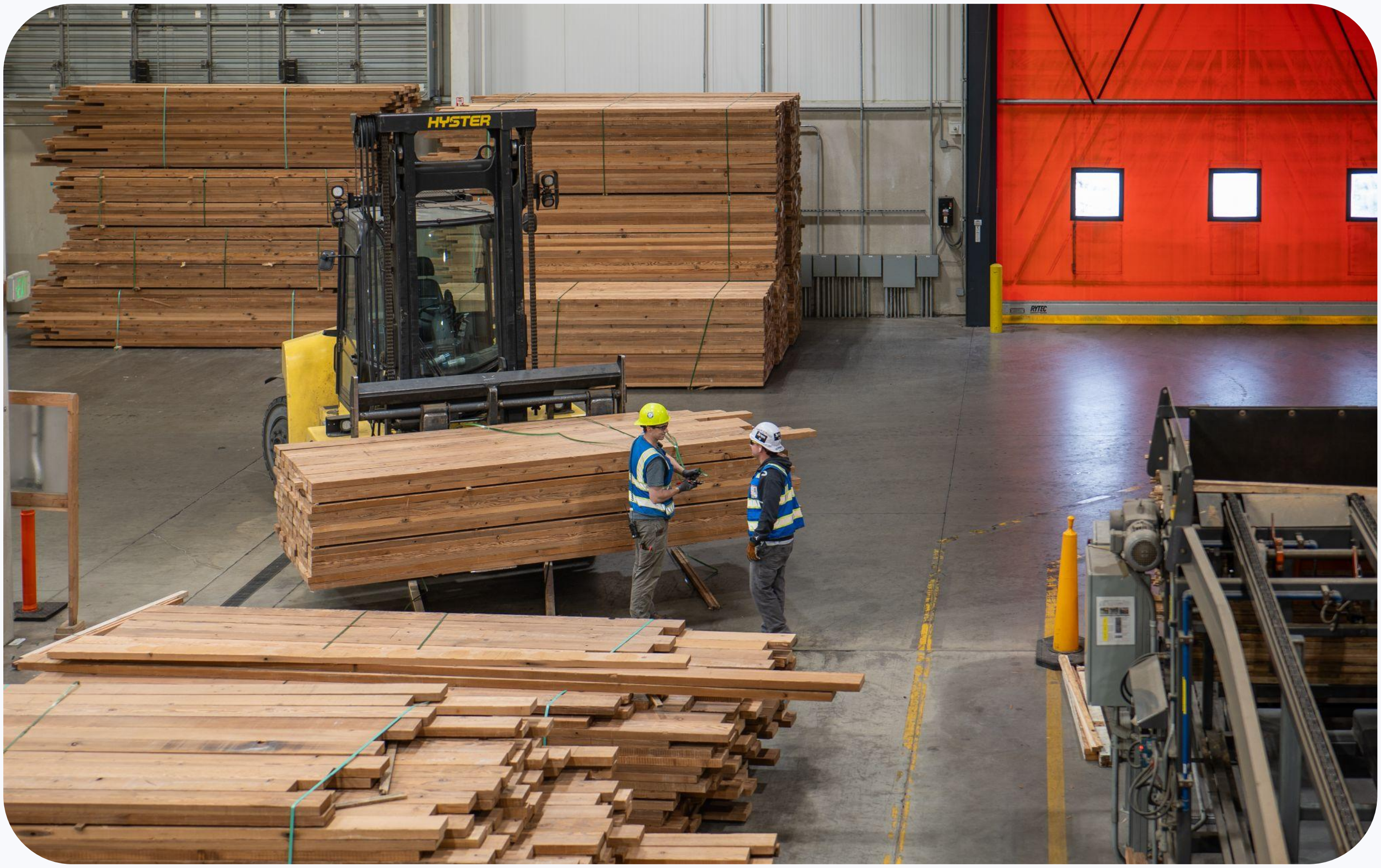
Final deployment

As of the writing of this report, Mercer Mass Timber is fabricating glulam columns with the reclaimed lumber for final testing by Washington State University. The Pacific Lumber Inspection Bureau (PLIB) is certifying the testing process and will provide final grading and third party-ISO certification. PLIB was engaged to ensure the independence of the testing process.

Once this final testing is complete, the project will be submitted to the city and county for final approval, with construction scheduled for the fall and winter of 2026–2027. The glulam columns will use about 6,000 board feet of the reclaimed wood. This represents all of the material that testing ultimately showed could meet conservative structural requirements for the columns.

A larger quantity, about 44,000 board feet, has been incorporated as an architectural face and a bottom layer of the CLT assembly. This application will make the reclaimed lumber visible in the finished space while virgin lumber carries the primary structural load.

The remaining material is being reserved for other nonstructural applications that showcase the wood. Much of this material is one inch thick, making it appropriate for millwork but not mass timber.



The salvaged wood at Mercer Mass Timber.

Insight for Scaling Beyond Hangar 3

Salvaged boards ready for their journey back to the Pacific Northwest for reuse, with Hangar 2 in the background.

This white paper documents the process for a unique and challenging deconstruction project and large-scale reuse effort. Hangar 3 was assumed unsalvageable. Yet today the unique characteristics of salvaged wood from Hangar 3 can be admired throughout the Google portfolio, including many aesthetic finish applications as well as anticipated structural reuse. This initiative illustrates that with a skilled and motivated team, rigorous process, and commitment to the goal, salvage is possible even under the most challenging circumstances.

As the reuse industry develops, and practical experience grows, many challenges are being addressed through new business practices, business models, and tools. For furnishings and other high-value finish items, pathways for a circular economy are largely established. White papers including Google's 2020 report "Accelerating the Circular Economy Through Commercial Deconstruction and Reuse" and Hennepin County's 2024 "Project Manager's Guide to Material Reuse in Commercial Buildings"[3] provide critical guidance spanning the spectrum of reuse from interior finish products to structural materials.

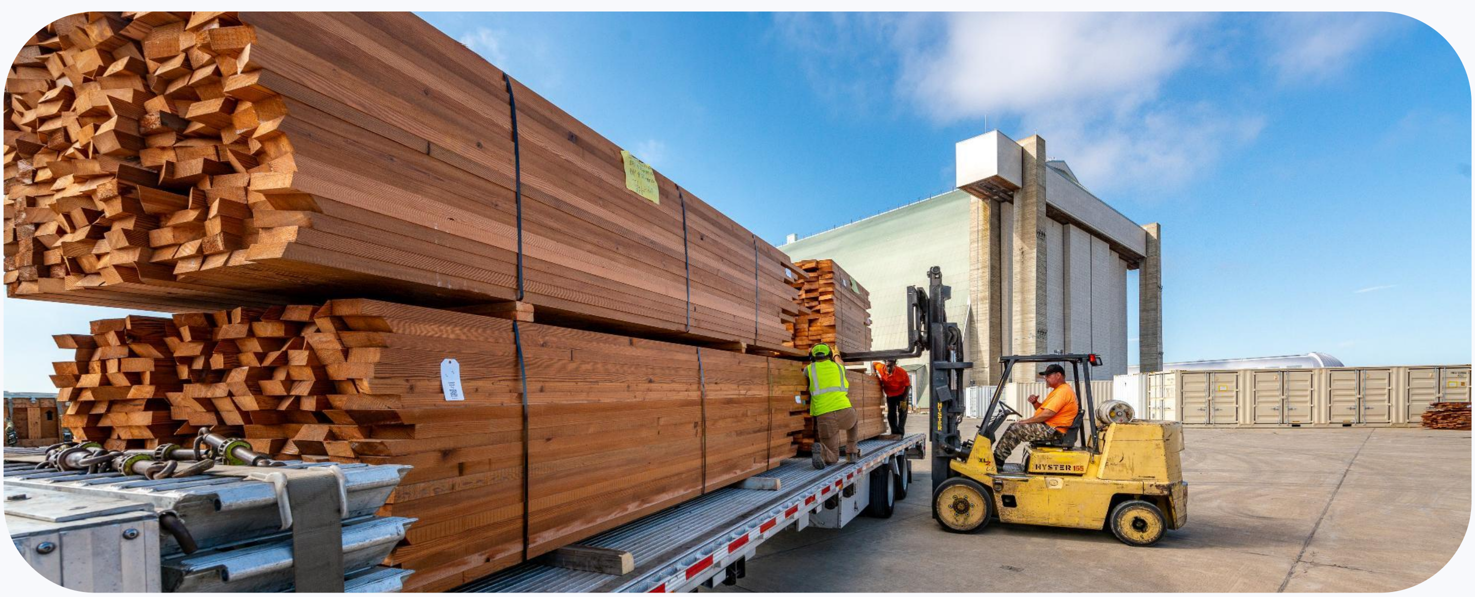
The Hangar 3 experience also highlights the importance of considering future deconstruction and material reuse when designing new buildings. Google's industry-leading work promoting the manufacture and use of materials without hazardous ingredients[4] helps to ensure that future reuse efforts won't be saddled with a toxic burden.

However, there are still far too few real-world examples documenting reuse of salvaged materials, particularly reuse in new structural members. This project serves as an outer-bound test case through which numerous methodologies were developed to address specific challenges. While few projects would require all of these specific methodologies, each may be applicable to select projects. All projects aiming to salvage and reuse structural wood would do well to consider the best practices below.

[3] **Hennepin County Energy and Environment Department:** Project Manager's Guide to Material Reuse in Commercial Buildings: https://www.hennepincounty.gov/choose-to-reuse/-/media/hennepinus/residents/recycling/documents/project-manager-guide-building-material-reuse.pdf, July 2024.
[4] **Google: Healthy materials:** Creating a building with a focus on wellness and non-toxic materials: https://visit.withgoogle.com/stories/healthy-materials/, December 2024.

Best practices for reuse of reclaimed structural wood

Phase	Best practice for salvage and reuse of structural wood
Establish goal and project team	Establish an internal mandate for deconstruction and selective recovery. Assemble a team with the experience to deliver the desired level of ambition. Work to optimize retention of material value (aesthetic, performance) as well as maximize diversion from landfill.
Pre-deconstruction material intelligence	Use historical research and performance context to assess feasibility and inform deconstruction strategy (species identification, contaminant evaluation, load service history).
Deconstruction strategy and material recovery	Controlled removal, documentation, and preparation of reclaimed wood for evaluation and reuse.
Testing, analysis, and structural validation	Contaminant testing and removal. Define guidelines for appropriate reuse. Additional testing for reuse in structural members.
Material management and processing	Set clear expectations and timeframe for reuse pathways. Track materials meticulously and retain flexibility in storage and tracking.
Reuse in structural members (see Roadmap for structural requalification)	Structural validation, regrading, and remanufacture. Jurisdictional engagement – early coordination with officials to establish and follow a performance pathway.
Design integration and implementation	Incorporate reclaimed material into final projects. Additional testing and calibration for reuse in structural members.
Future circularity – design for the next cycle	Design with healthy materials from the outset to support future circularity. Consider design practices that optimize for service life, future reuse, and retention of structural and aesthetic value in the next cycle.



Salvaged boards are neatly stacked and loaded on a flatbed truck to be shipped for testing and reuse, with Hangar 2 in the background.

Trailblazing for structural reuse

The Hangar 3 reclamation effort began not as a structural ambition, but as an act of circularity. It grew to encompass a test of whether reclaimed lumber could satisfy the same expectations placed on virgin lumber in manufactured mass timber: strength, predictability, safety, and code compliance.

This test revealed both constraints and opportunity.

Variability is real. Historic chemical treatment complicates salvage. Load history cannot be erased. No prescriptive code pathway exists. These realities explain why structural reuse has historically been dismissed as impractical.

Yet the absence of a prescriptive path for reuse does not equate to impossibility.

Through phased testing, conservative engineering, manufacturer-level quality control, and performance-based code engagement, reclaimed Douglas-fir from Hangar 3 demonstrated measurable structural viability. Not as a universal substitute for new lumber, but as a calibrated, deployable material stream governed by data.

The broader implications are significant.

STRATEGIC OUTCOME	**Supplychain resilience**	**Compounded carbon benefits**	**Procedural precedent**
WHAT CHANGES	**Structural lumber that remains viable is reclaimed and reintroduced** into the construction supply chain rather than discarded.	**Reuse preserves the carbon already stored** within harvested wood while reducing demand for additional timber extraction.	**A coordinated roadmap integrates wood science,** engineering validation, manufacturing adaptation, and regulatory review.
WHY IT MATTERS	**Extends the service life of harvested timber,** reduces landfill burden, and moves wood from a linear consumption model toward a circular material economy.	**Amplifies the embodied carbon advantages of mass timber** by extending the life of existing material.	**Demonstrates how reclaimed structural lumber can be evaluated responsibly** while maintaining safety and code compliance.

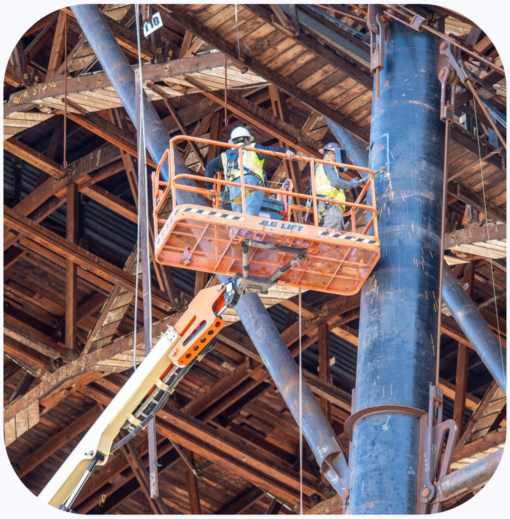
For structural reuse to scale, repetition must follow. Each subsequent project will refine grading correlations, strengthen statistical baselines, and clarify approval pathways. Over time, performance-based reuse can inform future code evolution, shifting reclaimed lumber from alternate means and methods toward recognized practice.

The question posed at the outset was whether reclaimed lumber could return to structural service at scale. The answer is conditional but affirmative: yes.

This roadmap does not claim that every reclaimed structure can be requalified. It charts a credible path by which, under the right conditions, reclaimed structural lumber can be reused for new structural applications. This opens up greater potential for climate-conscious construction that does not depend solely on virgin resources.

This path was outlined using a project that exhibited a host of challenges that together represent an extreme case. For many salvage efforts only a subset of these challenges will be encountered. For new mass timber projects, these insights can support teams in rethinking linear material pathways and opening up design for structural reuse.

The future of mass timber need not be defined only by what we harvest next. It can also be shaped by what we choose to steward, validate, and use again.



Top: Workers using an aerial lift to access and work on a large steel support column during deconstruction.

Middle: A worker wearing a protective suit, uses a hand tool to remove unsalvageable pieces from boards.

Bottom: Reclaimed boards are sorted and stacked under a covered outdoor storage area, with the remaining arch of the main hangar visible in the distance.

Sources

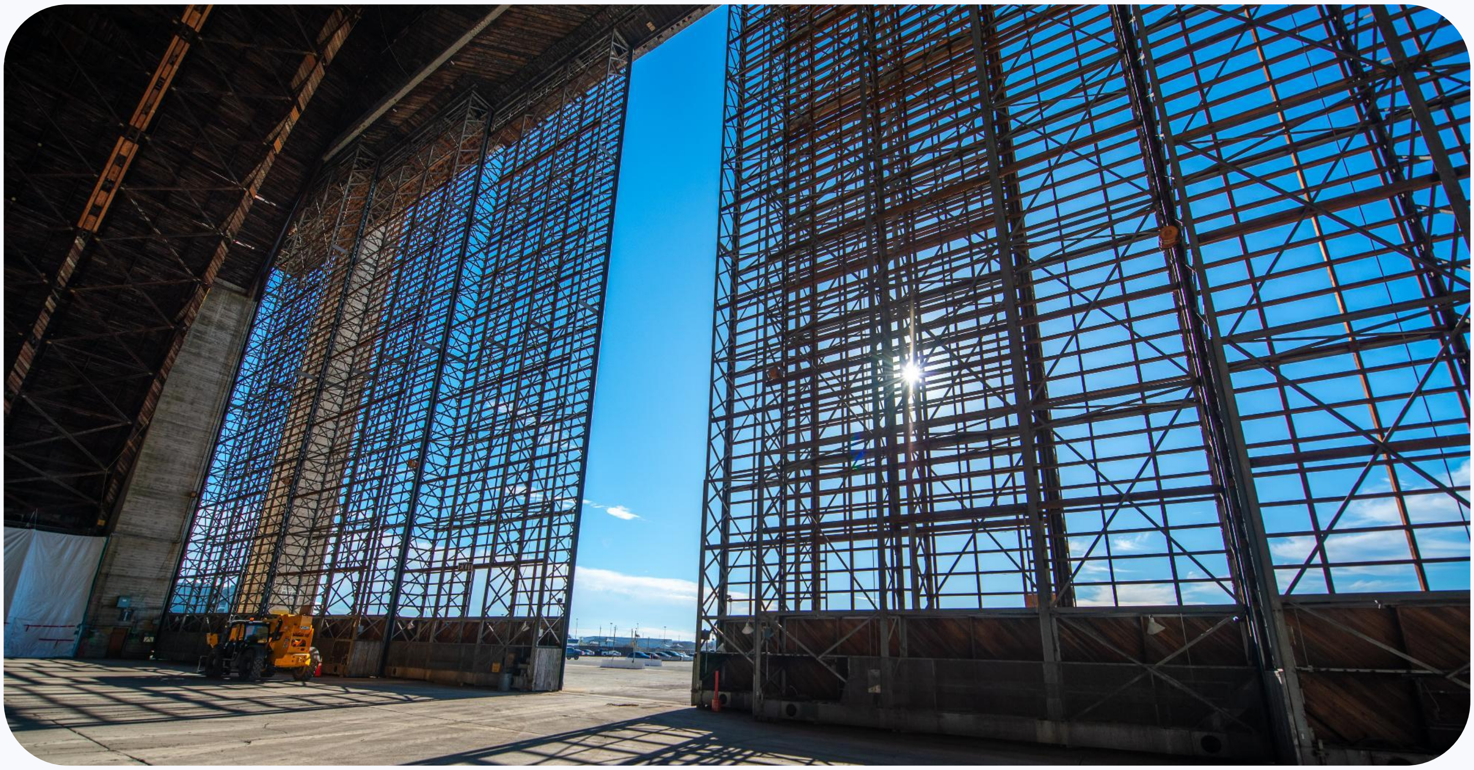
Carbon Leadership Forum
Reclaimed and Reused: Recommended LCA Modeling Guidance to Support EPDs for Reused Construction Materials
July 2024

Google and Ellen MacArthur Foundation
Accelerating the Circular Economy Through Commercial Deconstruction and Reuse
August 2020

Hennepin County Energy and Environment Department
Project Manager's Guide to Material Reuse in Commercial Buildings
July 2024

Inverse Square Films
The Beginning, End, and Future of Hangar 3
Directed by Sam Burbank
November 2025

NASA Ames Environmental Management Division
Hangar 3 Building Demolition Project
June 2022



Sunlight streams through the immense, exposed wooden lattice of the hangar doors.