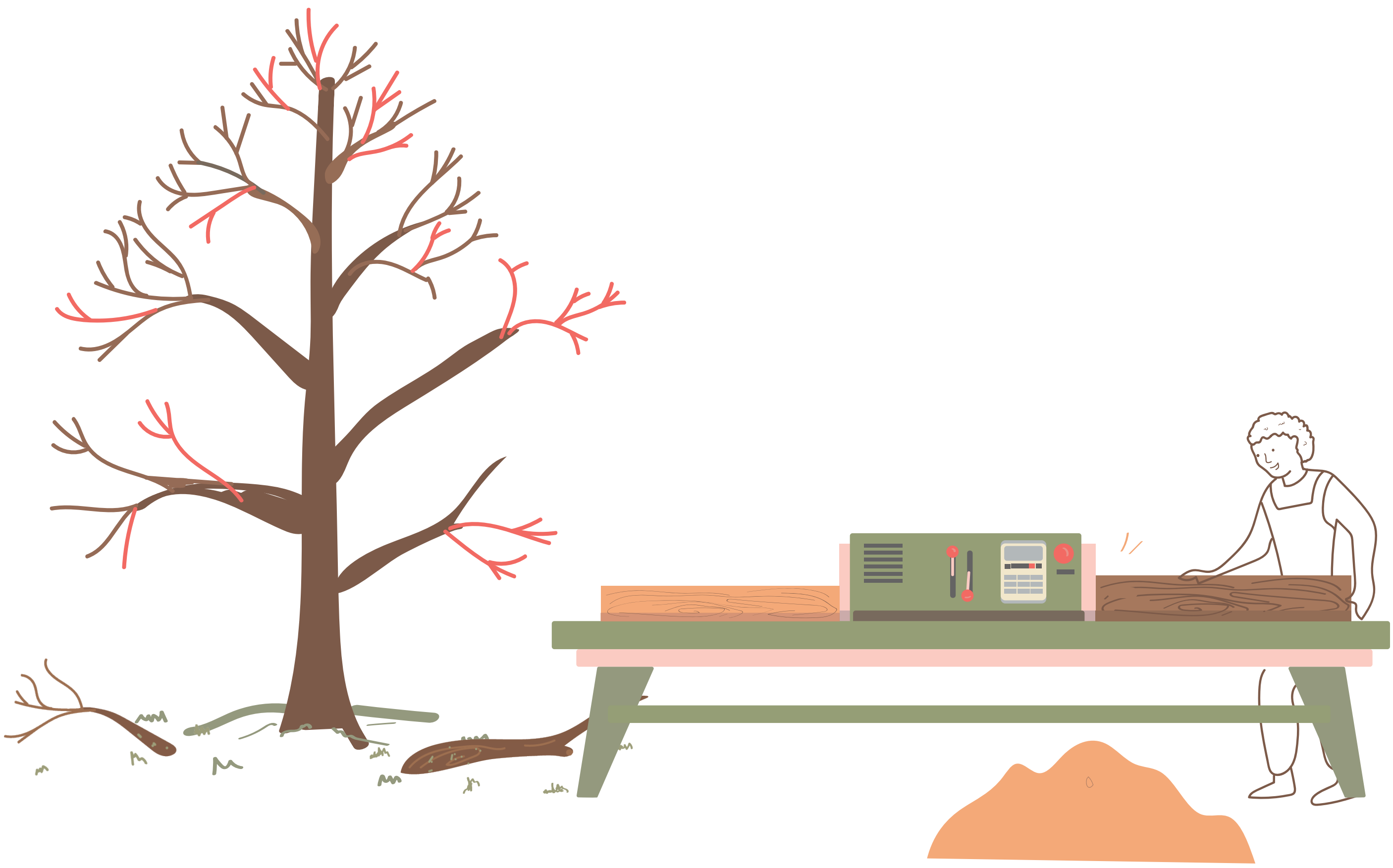
URWOOD

Towards value-added repair in Utrecht Region
with WOOD composite materials

Key results and milestones at a glance



Title: Urwood: Towards value added repair in Utrecht region
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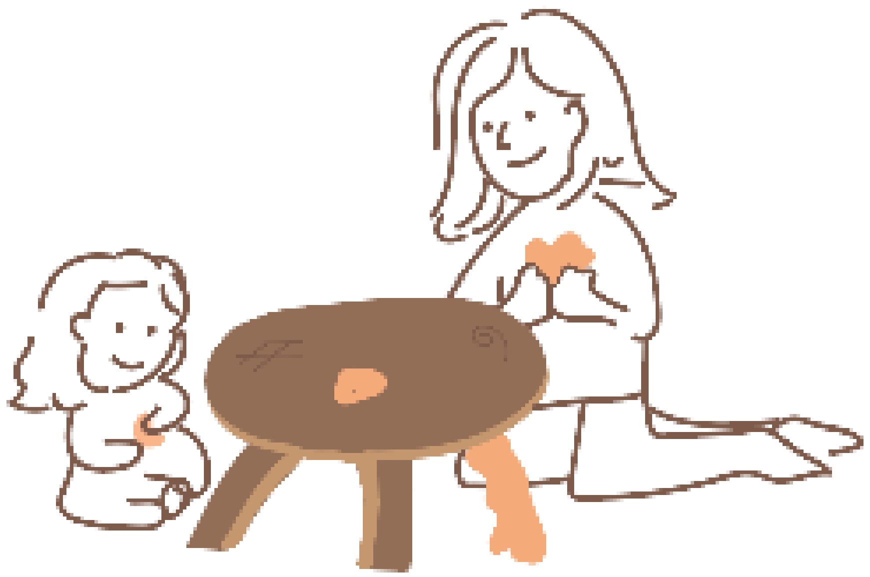
What to expect?

Introduction

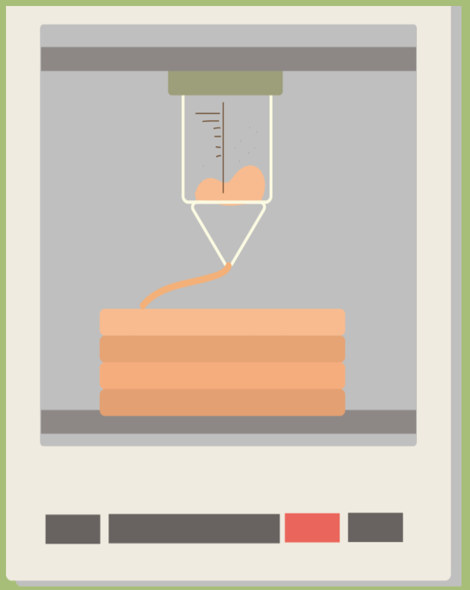
The URWOOD project, a collaborative effort between TU/e, WUR, and UU, reimagines Utrecht's abundant wood waste including branches, offcuts, bark, and shavings, as a resource for bio-based composite materials that replace epoxy in repair applications while laying the foundation for future applications and investigation trajectories. The following document distills the full material-development process into a clear, at-a-glance overview of key findings, technical milestones, and strategic insights.

Readers can expect a structured progression through the project's core dimensions: the regional context and circular opportunity; the systematic development of biodegradable binders benchmarked against industry standards; critical fabrication challenges, particularly around drying and dimensional stability; and the mechanical performance of optimized formulations. The report also captures community engagement with professional woodworkers, revealing practical usability needs and aesthetic considerations that shape real-world adoption. Finally, it outlines a forward-looking vision that transitions from repair fillers to additive manufacturing and verifiable biodegradability, positioning URWOOD as both a technical achievement and a catalyst for local circular innovation.



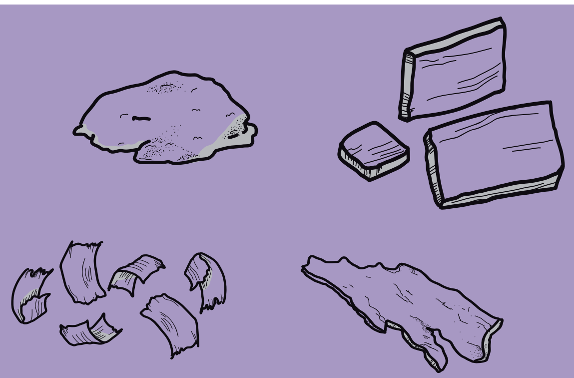
Context and Opportunities

The URWOOD project focuses on transforming wood waste into bio-based composite materials for value-added repair in the Utrecht region, emphasizing circularity and sustainability.



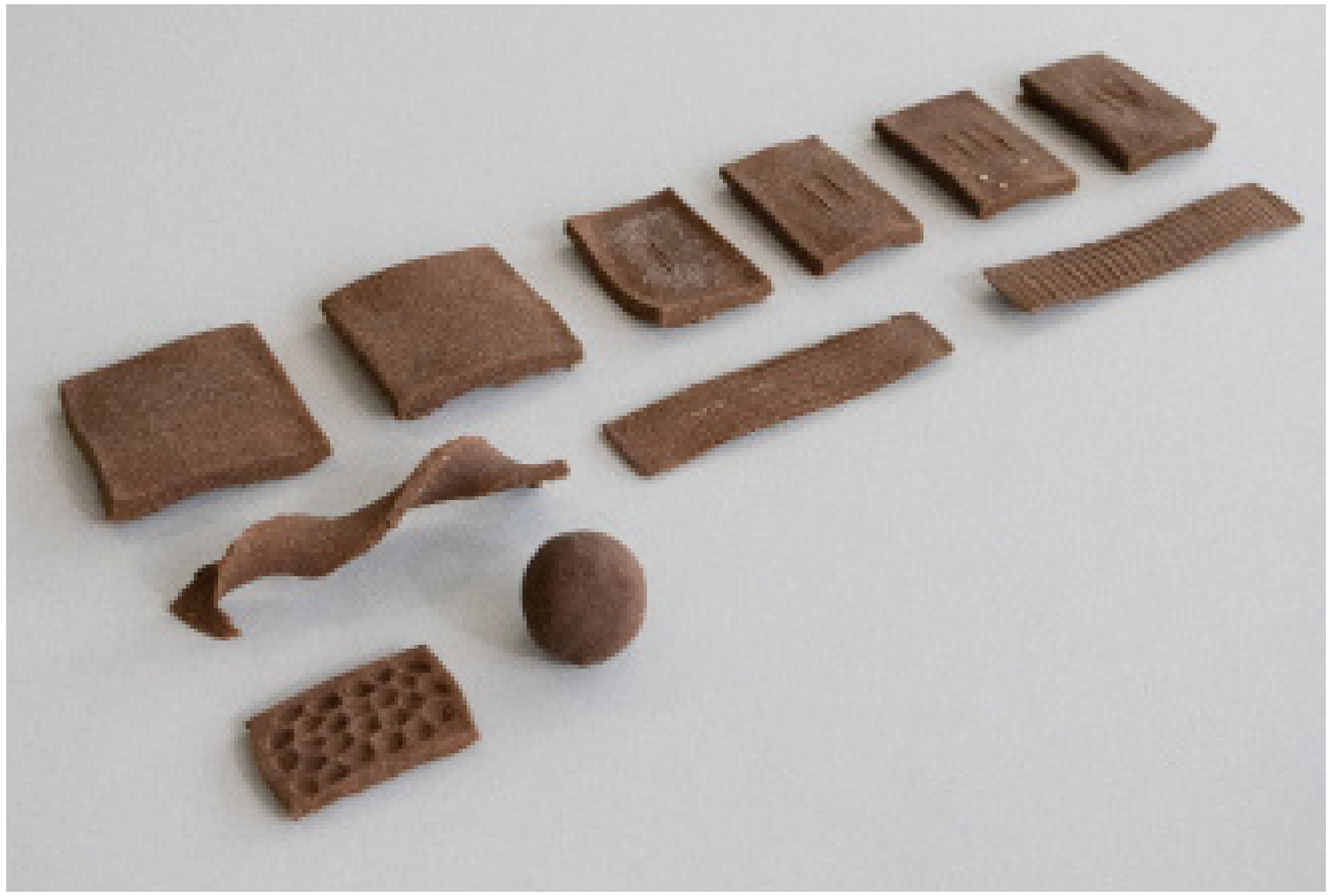
Collaboration between TU/e, WUR, and UU was formalized to bridge material science innovations with community-based circular practices and design.

The project established that a large underused stream of wood waste exists in Utrecht, particularly branches, offcuts, and bark, creating a strong regional opportunity for circular reuse rather than disposal.



Researchers mapped four accessible waste wood streams and confirmed that wood shavings are widely available at high volume, whereas fine wood flour is scarce, influencing achievable scale and processing strategies early on.

The workshop highlighted new social applications, such as educational play materials and visible repair techniques, framing URWOOD as a catalyst for community circular literacy.



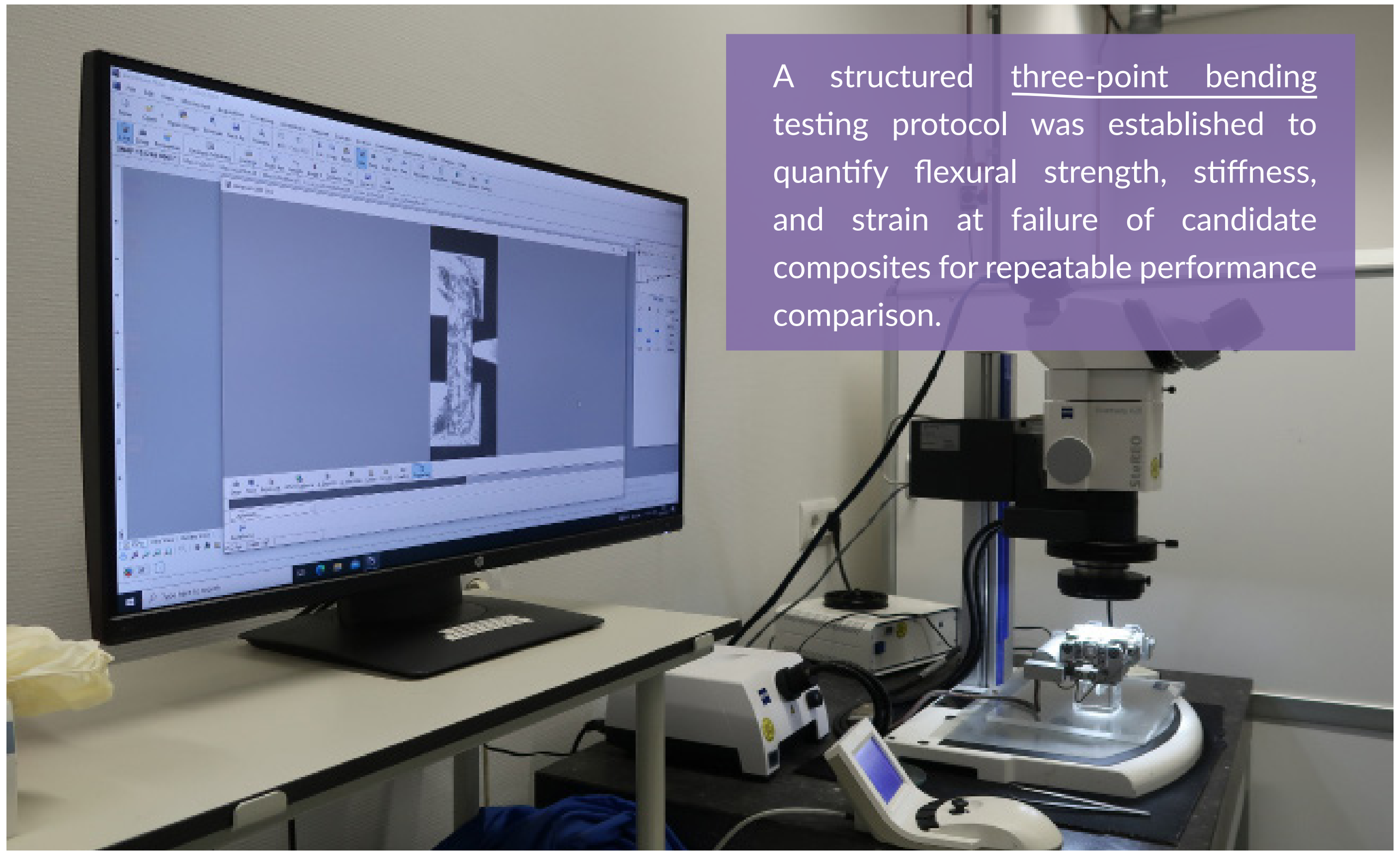
Results confirmed a dual value proposition: not just a technical epoxy replacement, but a material family enabling sustainable repair culture, local resource economy, and new circular craft practices.

Material Development and Technical Baseline

A sustainability-driven binder shortlist was developed focusing on biodegradable, safe, and locally viable materials including methyl cellulose, CMC, sodium alginate, casein, and starch, replacing epoxy and wood glue.

Researchers completed multi-method milling trials and determined that bead milling produces the finest particles with the best mechanical results, but yield limitations demand future industrial-scale processing exploration.

Initial baseline tests using epoxy and wood glue provided essential performance benchmarks, confirming epoxy as the gold standard and clarifying the challenge biobased binders must meet.



A structured three-point bending testing protocol was established to quantify flexural strength, stiffness, and strain at failure of candidate composites for repeatable performance comparison.

Fabrication Insights

The project identified

drying, water balance, and warping

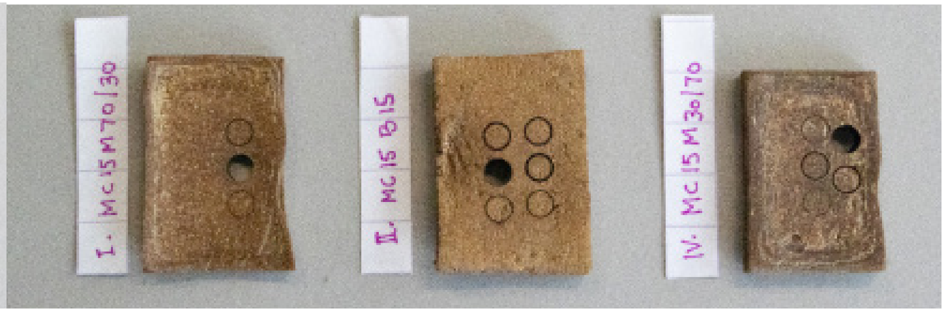
as critical process parameters, influencing not only mechanical results but also workshop compatibility and user trust in repairs.

Drying under physical weight does not solve the warping issue, because it traps water within the material and prevents uniform evaporation, leading instead to internal stresses and later distortion.

Avoiding warping by drying slowly is absolutely possible in principle, because controlled evaporation can maintain shape integrity, but it increases production time significantly.

A vacuum-assisted drying approach, similar to paper-making processes, could remove both trapped air and excess water, improving dimensional stability while increasing speed.

Freeze-drying represents a promising innovation pathway, as it extracts water without liquid-phase shrinkage, preserving geometry—but requires evaluation for energy efficiency and scaling.



Diffrent finishing and proccessing results

For **repair applications**, limited warping may not matter, because a second application is already a practice, allowing **sanding and smoothing to correct shrinkage.**

Exploring non-water-based binders or mixed solvent systems could reduce shrinkage dramatically, since both wood and cellulose swell with water—switching to an oil-based carrier may allow better dimensional stability.

Sensorial and finishing tests made clear that surface texture and grain matching are essential for user adoption, demonstrating that aesthetics are as important as structural quality in furniture and craft repair.

Results showed that fine, uniform particle sizing contributes directly to smooth finishing and wood-like feel, informing priorities for the next phase of formulation refinement.

Optimised Recipes

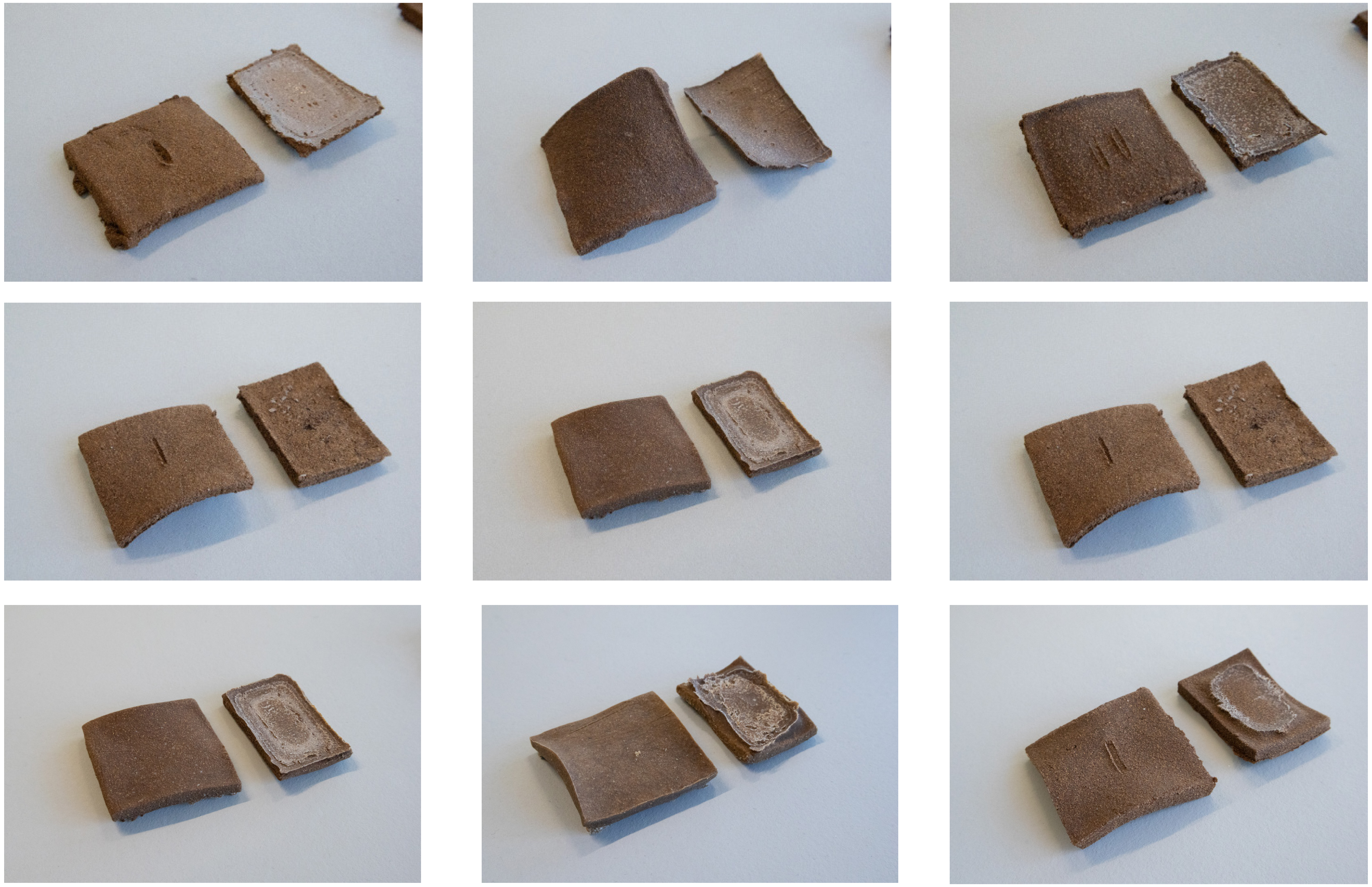
Mechanical performance objectives are satisfied, with **results being comparable to present** epoxy and wood glue based solutions, showing that the materials are technically valid beyond a research prototype.

Optimization experiments demonstrated that sodium alginate-based composites could approach epoxy's mechanical strength, marking a major milestone in achieving credible, eco-friendly wood filler performance.

MC15W30 is the best-performing formulations when considering both mean modulus and standard deviation, making them optimal candidates for optimized additive manufacturing applications.

Methyl cellulose emerged as the most promising binder for real-world repair tasks due to its strong adhesion, minimal shrinkage, and workable tactile properties, combining both practical usability and sustainability.

Multiple recipe series (Binder, Bark, Wood, and Mixed) showed that composite behavior is highly tunable, enabling formulas tailored to specific use cases such as structural repair.



Final samples made by varying amounts of bark, wood, and methyl cellulose

Community Engagement

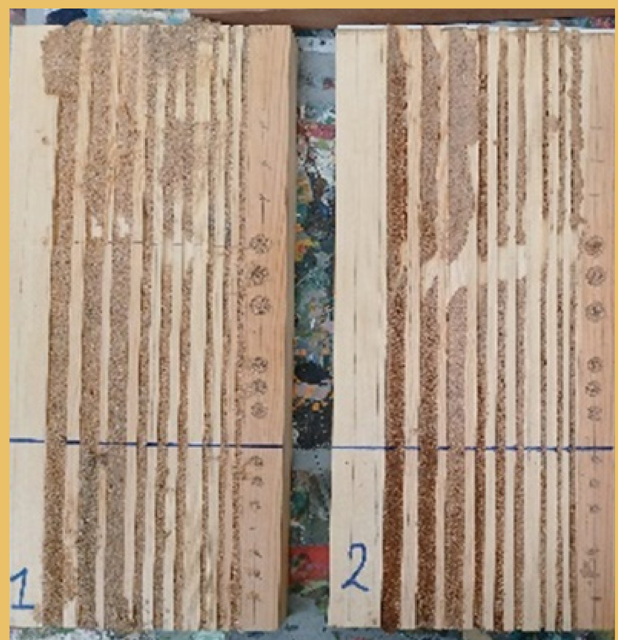
A co-creation workshop with professional woodworkers validated the project's relevance to active makers, confirming strong interest in replacing epoxy with healthier, more environmentally responsible materials

Mixed-method feedback collection through observation, interviews, reflection booklets produced actionable insights on usability, sanding, drying time, and binder flexibility under real repair conditions.

Participants expressed a clear need for transparent binders that allow custom wood dust mixing, highlighting the importance of visual integration with surrounding wood.

Participants demonstrated high diligence and gave actionable critique, especially that the coarse putty sagged and did not satisfy their expectations for precise repair—reinforcing the need to improve particle size and drying for real professional workflows.

Take-home kits empowered participants to test materials within their own workflows, enabling feedback grounded in genuine craft practices rather than laboratory assumptions.



The fact that participants repeatedly said "it doesn't feel like wood" signals that the goal is not to mimic wood perfectly but to create a new natural composite identity rooted in circularity.

Bark plays a crucial role in sensorial character, offering earthy color and grain-like texture that communicates origin and care—a strength rather than a defect.

Future Directions

While wood fillers are a necessary bridge for adoption within current craft practices, the long-term strategic direction for URWOOD points toward additive manufacturing using locally sourced bio materials. Fillers sustain what exists, but additive manufacturing can create circular futures

Printing biobased wood composites is a promising direction, but it requires significant changes and further research, since current binders are not thermoplastics and therefore cannot be 3D-printed.

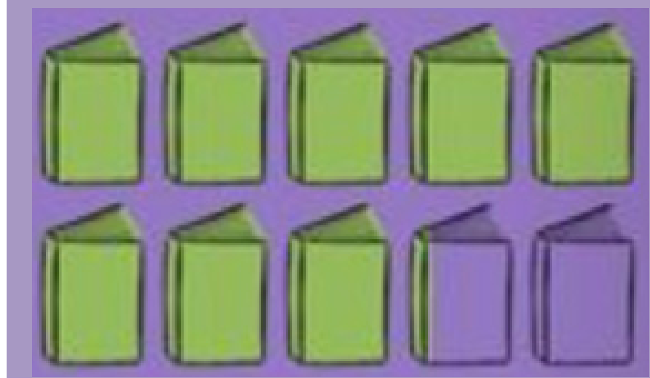
Additive manufacturing can transform low-value waste into high-value products, not just repairs, but new applications supporting local entrepreneurship and circular industry growth.

Future work must show how the material can be recovered or biodegraded, for example by producing pellets for soil-decomposition testing or industrial composting scenarios.

Collaboration among researchers and departments clarified roles, interests, and expertise, helping define what makes our partnership unique and guiding future direction.

The academic research focus differs from the URWOOD project goals, highlighting the need to clearly formulate research questions that contribute scientifically while supporting project outcomes.

There is potential to publish on biocomposite fabrication, including process development and recipe optimization.



We are interested in scaling the biocomposite approach and continuing collaboration with the municipality, even beyond a research context.

Modeling of material behavior presents an additional avenue for further research.