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The Properties of Juncus: Implementing Indigenous Knowledge into Conservation Repairs

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The Properties of Juncus: Implementing Indigenous Knowledge into Conservation Repairs

A thesis submitted in partial satisfaction

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of Cultural Heritage

by

Makayla Marie Rawlins

2025

ABSTRACT OF THE THESIS

The Properties of Juncus: Implementing Indigenous Knowledge into Conservation Repairs

by

Makayla Marie Rawlins

Master of Arts in Conservation of Cultural Heritage

University of California, Los Angeles 2025

Professor Ellen J. Pearlstein, Chair

Southern California baskets are commonly made from a rush called *Juncus* (*Juncus textilis*) or *$óyla* in our language. There is extensive evidence of historic baskets that have been both made from and repaired with *$óyla* to extend their useful lives. When presented with a treatment for a basket from this region, common conservation practice encourages us to use an archival material unlike the original material, such as Tyvek (spun-bonded polyethylene) or Japanese tissue paper. In this thesis I describe specific details of analytical techniques used to research *$óyla* as a possible repair material, conducted as a part of my master's thesis research. To test the potential use of *$óyla*, a handful of analytical techniques were performed such as microfade testing, compressive strength and lap shear strength testing, and accelerated light aging. The goal is to reach conservators to emphasize the importance of implementing Indigenous knowledge into our

practices, as well as to reach source communities and share the information gathered about *$óyla* through these analytical techniques. By sharing this information with communities, Indigenous weavers can advocate for conservation repairs with original materials they are familiar with, rather than westernized practices. This does not mean Indigenous basket weavers need *$óyla* to be affirmed by art conservators; rather, this research will praise the strength and longevity of *$óyla.*

The thesis of Makayla Rawlins is approved by

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2025

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Preface

I would like to preface this paper with the fact that I am not an enrolled member in my tribal nation. I am a lineal descendant of the Soboba Band of Luiseño Indians. I am the daughter of Karyn Larieze, the granddaughter of Frederico Larieze, who was the son of Mary Miranda, the daughter of Manuela Diaz and Joseph Miranda. As families grew apart and divisions were made between siblings, my mom and I were left to piece together our history. My identity has been a journey for my entire life and continues to reveal new things every day. I state this solely to be transparent in my work, and so that other tribal members may understand where I am coming from.

This research has opened so many doors and introduced me to so many people from my community that I am forever grateful for. You will see throughout this paper my tone change and attempts to balance the many worlds and identities that I was juggling. I hope as you read through this, you see these worlds seamlessly melt together because, as I have learned through this academic journey, they are inseparable.

~

Fingers nimble, knowing with their eyes closed

Where each piece of *$óyla* goes

Thread it in, pull it out.

Breathing.

She is the first basket stitch

Being woven through the layers of time.

The rhythm of her grandmother's coils reach concentrically

Towards the edge of the universe.

An excerpt from *Milkyway $ungáal* by Camaray Davalos

~

1. Introduction

Basket weaving is one of the oldest known human traditions, practiced across cultures and continents. In California, Indigenous basketry is not only a traditional craft but also a deeply spiritual, ecological, and familial practice, one rooted in generational knowledge and interwoven with the land (Masiel-Zamora 2017). At the heart of this tradition is *Juncus textilis* or *$óyla* [1] in Chamteela (Luiseño language), commonly known as basket rush or California rush. It is a perennial plant Native to the coastal and inland regions of Southern California. In this thesis, I sought to examine the mechanical properties of *$óyla* to better understand its potential applications in conservation, especially in the repair of woven *$óyla* baskets within institutional collections. To do so, it is necessary to contextualize both the plant and the practice, understanding *$óyla* not merely as a plant, but as a cultural material, one that holds deep significance and requires thoughtful handling in conservation contexts.

$óyla has long been revered for its flexibility, tensile strength, and striking natural coloration, which can range from green to deep red, depending on environmental conditions (Masiel-Zamora 2017). It grows primarily in wetland areas, stream banks, and coastal plains—ecosystems that are increasingly threatened by climate change, urban development, and resource extraction. For California Native communities, *$óyla* is not simply a raw material; it is a relative. Its collection is ceremonial, conducted with prayers, gratitude, and land stewardship practices that sustain the health of both the plant and its habitat. Weavers pass down not just technical

[1] From this point on, you will see *$óyla* in place of the word *Juncus.* This connection to my Indigenous language is important to maintain throughout this paper. When sample naming is seen later in the methods and results section you will see "J" used to identify samples as *Juncus*. In these sections, "J" and *Juncus* may be used to remain consistent with the original naming convention for the samples.

skills but also ethical frameworks for harvesting, processing, and using *$oyla*, which includes knowledge of when and how to gather without harming the patch, how to age or prepare the fibers, and how to listen to the plant's readiness.

The art of weaving with *$óyla* involves a lifetime of learning. These skills are intimately connected to community identity, ceremony, and healing. The baskets created from *$óyla* are not merely utilitarian objects; they are imbued with stories, songs, and memories. As Rose Ann Hamilton, a basket weaver, mentioned, "… our ancestors live in these things. If they aren't at rest, we are in unrest." (personal communication October 2024). Within museums and cultural heritage institutions, such baskets are often admired for their aesthetic or ethnographic value, but rarely are their living traditions honored or incorporated into conservation strategies. Conservation treatments are typically under extreme time constraints for exhibitions, leading to a lack of communication and no effort to understand the cultural context of an item.

This gap between traditional knowledge and conservation science presents both a challenge and an opportunity. Historically, conservation approaches to basketry have relied on manmade industrial materials such as Tyvek or Japanese tissue. While these materials offer known aging properties and minimal invasiveness, they are foreign to the cultural context of the baskets themselves (Ledoux 2012, Alarcon et. al 2015). The question, then, is whether traditional materials—like *$oyla*—can be safely and effectively reintroduced into the conservation workflow, while remaining true to the American Institute for Conservation Code of Ethics (Mezzi, 2018, AIC Code of Ethics 1994). Could using *$óyla* for basket repair offer not only technical adequacy but also cultural appropriateness? Could it help bridge the divide between Indigenous knowledge systems and Western conservation protocols?

To answer these questions, this study investigates the mechanical behavior of *$óyla* under various conditions, including shear strength tests, compression, and exposure to light aging. These different techniques offer insights into the properties of *$óyla* and how it might perform as a repair material. It is crucial to assess whether *$óyla* can endure the stress of being stitched and how its appearance might change after prolonged exposure to light. The data are gathered through rigorous scientific methods but are interpreted with cultural awareness, informed by interviews with master weavers, cultural practitioners, and community experts. The voices of Indigenous basket weavers guide this work, offering perspectives on material choice, repair ethics, and cultural protocols that are too often absent from conservation literature.

This research is also situated within a broader conversation about decolonizing museum practices. As calls for restitution, repatriation, and cultural sovereignty gain momentum, institutions are increasingly being asked to reconsider how they handle, treat, and narrate the belongings of Indigenous peoples (Smith 1999, Gençay-Üstün et. al 2017, Jacobs et. al 2024). In this light, conservation is not a neutral, technical field—it is a site of cultural negotiation, power dynamics, and potential healing. By centering the lived expertise of Native weavers and respecting the agency of traditional materials like *$oyla*, this thesis contributes to a growing movement that seeks to make conservation more ethical, inclusive, and accountable.

Furthermore, the use of *$óyla* in conservation raises important questions about sustainability. While its cultural relevance is undeniable, it is equally critical to acknowledge the limited availability of *$óyla* and the communities' right to access it first and foremost. This research does not advocate for unrestricted institutional use of *$óyla* but rather emphasizes the need for collaboration and consent. It proposes that conservators consider relationships over resources—that they ask, rather than assume; that they learn from, rather than extract; and that they support the continuity of Indigenous practices rather than replicating or replacing them.

By combining scientific analysis with Indigenous-centered interviews, this study aspires to serve as a model for respectful interdisciplinary research. It demonstrates how knowledge can be generated not only in the lab but also through dialogue, reciprocity, and relationship-building. In studying *$oyla*, we are not simply evaluating a fiber—we are participating in a conversation about cultural stewardship, environmental ethics, and the future of conservation itself.

2. Literature Review

This thesis is meant to be a preliminary study on *$óyla* and its mechanical properties. The goal is to demonstrate multiple properties revealed through aging and analytical techniques. For this study, it is important to understand the plant's structure, basket weaving techniques that use this material, and the mechanical movements necessary for this fiber to be woven.

2.1 *Juncus*

There are approximately 440 species in the *$óyla* genus internationally (Licher & Rink 2019 p.14). The common species of *$óyla* used in weaving practices is *Juncus textilis* or *Juncus acutus*, with variation coming from where the material was gathered (Smalls 2011). The *Juncaceae* family can be found in wetlands or temperate climates (Licher & Rink 2019, M. Kat Anderson 2005). *Juncus textilis* is native and endemic to California and is more commonly found along coasts or near smaller water sources (Calflora 2025). If the plant is exposed to a large amount of water, the stem of the plant will be large and not as rigid, creating a less-than-ideal scenario for weaving.

To better understand the mechanical properties of *$óyla*, one must have a basic understanding of the plant anatomy and structure. The *Juncaceae* family consists of monocots. The plant organs, including roots, stems, leaves, flowers, fruit, and seeds, all contain different tissues for specific purposes. The stems of a monocot contain a single layer of cells, making up the epidermis (Florian 1990). The epidermis acts as a protective layer for the interior tissues of the plant's stem (Florian 1990).

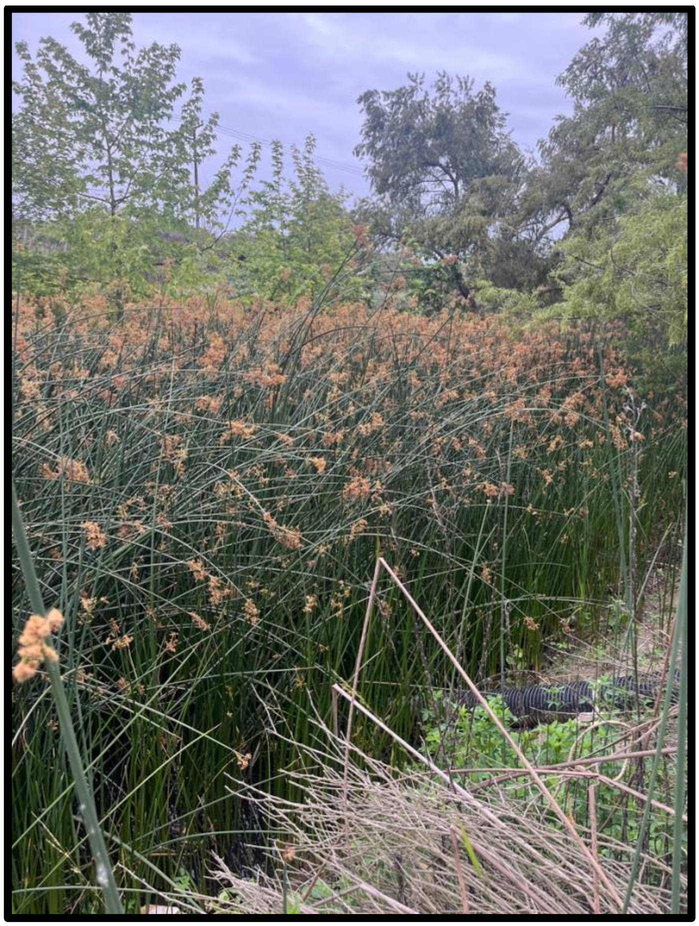


Figure 1. Image shows *$óyla* growing in a large patch and flowering

Structural support comes from rings of cells called the collenchyma and sclerenchyma. Chlorenchyma cells are specialized for photosynthesis, providing a green stem. The green coloration is visible on the epidermis level of the stem. The epidermis covers the entirety of the plant body and is covered by a waxy cuticle called cutin. A waxy cuticle is functional for waterproofing, acting as a protective barrier from ultraviolet and infrared energy, and a barrier from small organisms. Cutin is soluble in organic solvents, while tannins are more water soluble.

Tannins in *$óyla* have not been thoroughly researched, but it can be assumed that there are small amounts of tannins based on research that has been completed on other species of *$óyla* (El-Shamy 2012). This is important to consider because, as conservators, our choice of adhesives for repairs depends on the physical and chemical properties of the material. Tannins, in particular, can interact with certain adhesives or treatments, potentially causing discoloration or degradation over time. In this case, the cutin is more of a concern then the tannins, leading to a preference for water-based adhesives. Organic solvents will break down the cutin and waxes found on the cuticle of these plants, meaning water-based adhesives or no adhesive is best.

2.2 Conservation History of Basket Treatments

Basket repairs in conservation historically consist of minimal intervention and interventions that are easily removed (Toutloff 2021). This means that the adhesives used are weaker than the original materials, and the materials used, such as Japanese tissue paper and Tyvek, are strong but will not further damage the original fibers. Of course, the goal with treatment is always to make the intervention as minimal as possible but strong enough to withstand their current care and handling (AIC Code of Ethics 1994). This approach led to the use of many different adhesives, threads, and paper. Adhesives and threads have been introduced to basketry repairs for broken stitches and to repair tightly woven baskets. For example, some conservators will use wheat starch paste and forms of paper in order to continue using an organic material (Matsumaru 2021). Unwaxed dental floss and toned Japanese tissue paper have been used for tear repairs and loss compensation (Alarcon 2015, Morris 2008).

Japanese tissue paper and Tyvek have been used in basket repairs for decades (Brako et. al 1990, Alarcon et. al 2015, Jenkins et. al 2017). They are reliable materials introduced to aged baskets with little to no problem. The methods of introduction vary between the two materials. Japanese tissue paper, a natural cellulosic material, has been rolled into small, fibrous strands to bridge tears down the sides of baskets and pressed into place with an appropriate adhesive, typically wheat starch paste (Alarcon et al. 2015, Wills 2002). There is also the application of using Tyvek (high-density spun bonded polyethylene), a stiffer synthetic material, has been incorporated into flat weave baskets for its similar surface texture and ease of application (Alarcon et al. 2015, Brako et al. 1990). Although Tyvek is synthetic rather than natural, it has been integrated as a repair material due to its durability and aging properties. Tyvek and Japanese tissue paper can be toned with paints and are compatible with most adhesives used in conservation.

The use of an acrylic emulsion in the form of rods for loss compensation has been researched for a treatment (Ledoux, 2012). Lascaux 498HV is used with baked cellulose powder to form rods that mimic the foundation rods of a coil (Ledoux, 2012). This technique had not been used previously, but Lascaux and cellulose powder were chosen due to their ability to be molded into shape and imitate the curve of coiled basketry while retaining flexibility (CAMEO, 2022). The cellulose powder is an organic material that is compatible with the basketry material and the adhesive, making them an ideal repair material for this treatment.

Indigenous or traditional native methods of repairs consist of using the material found in the original construction (Roberts 1972). While the reintegration of original materials in conservation treatments is generally discouraged, primarily because it can obscure the distinction between original and restored elements, this risk can be effectively mitigated through careful and comprehensive documentation (AIC Code of Ethics 1994). Additionally, concerns have been raised about introducing too much tension to the older material, leading to clashes with the new material (Ledoux 2012). However, the proof of its feasibility is seen in collections worldwide.

2.3 Collaboration in Conservation

Collaboration and community engagement can be seen as buzzwords today in the conservation field. Many articles map out the importance and necessity of engaging communities while conducting conservation treatments (Lonetree 2012, McHugh 2016, Indian Arts Research Center 2019, Gupta 2022), while there has also been research on the downfalls of collaboration and what this truly means to the Indigenous community and the museum field (Talamantes 2013). The inclusion of Indigenous materials into a treatment process pushes the boundaries of what a collaboration looks like and what should be expected by an institution. There is a stigma around using materials not found in a sterile lab, where all variables can be controlled. The use of materials gathered in nature allows for too many variables, leading to discomfort for conservators. There is significant value in incorporating traditional materials into cultural items. It is a way for conservators to begin building trust with communities and using materials that are familiar to the source communities and the object rather than something foreign to both. This idea has been explored in other countries, such as Namibia, by reintroducing traditional leather practices and materials to the collections of the Ovahimba (Nghishiko-Ndjamba 2024). Indigenous techniques were explored to conserve 23 culturally significant items that were returned to the Ovahimba people from the Ethnographic Museum of Berlin, Germany. The study in Namibia acknowledged the validity of Indigenous preservation methods and advocates that "the way forward is co-conservation, a blend of Indigenous and scientific conservation methodologies" (Nghishiko-Ndjamba 2024). Another technique that has been investigated is the use of palm leaves to repair palm leaf manuscripts (Dong and Yu 2024).

This idea of collaborative practice may become normalized if it is introduced at the student level. By embedding collaborative methodologies into conservation education, emerging professionals can develop a deeper understanding of inclusive decision-making and culturally responsive care. This early exposure not only encourages collaboration to become a standard practice but also fosters long-term relationships with source communities. Since students do not commonly discover conservation until their bachelor's degree, courses have been specialized at the graduate level to begin introducing the idea of collaborative practice (Pearlstein 2017). This introduction will encourage emerging conservation professionals not to neglect this concept and continue implementing it throughout their career. McHugh mentions that this work, at its bare minimum, is about "human rights and cultural authority," and there is no better way to approach collaborative practice (McHugh 2016).

2.4 Analytical Methods

__Shear Strength Testing__

Shear strength testing and tensile testing are commonly used in engineering to test materials before use (TestResources 2023). For this study, tensile testing was explored initially as a base examination of the *$óyla* itself. It quickly became clear that the *$óyla* itself had a high tenacity and would not have been valuable data in comparison to shear strength testing. For this reason, adhesive joints were created to mimic potential treatment options. For example, a sample without adhesive may be tested by itself, demonstrating a tensile test, but if a lap joint is created, the adhesive will be tested instead of the material, demonstrating a shear strength test. For these tests, a lap joint was used with two different adhesives, Paraloid B72 and wheat starch paste, between two *$óyla* sample pieces and other samples, one of *$óyla* and one of Tyvek. The Tyvek is being integrated into the tests due to its common use in basketry repairs. By having the data of Tyvek and *$óyla* joints versus the *$óyla* and *$óyla* joints, it will be clearer as to which has better adhesion and strength.

This lap shear test requires clamps that will hold the sample along the vertical axis while the weight is slowly increased, causing the clamps to pull apart (ASTM D1002). This test resembles the steps of direct test for tensile testing as it focuses on the axial tension placed on the samples and the joint, but where this study differs is the lack of epoxy holding the sample in place and the lap joint (Özdemir et. al 2015). The use of a shear strength test on plant fibers is not common in the literature but can be used to provide quantitative information about the fibers (Aydemir 2014). Although these tests are not exact for what is being tested, a summary of many different tests is important to include as a reference.

Due to the lack of research around individual plant fibers being tested for tensile or shear strength tests, a search for standards around plant materials, organic materials or any composite with organic material was conducted. Rather than the plant fiber itself being tested, organic fibers have been analyzed in the form of paper, providing insight into how the various tests work and the potential results we would see. Kraft paper, for example, has been investigated with impregnating Kraft paper pulp at various fiber lengths with carboxymethyl cellulose to determine the tensile strength (Larsson et. al. 2017). Tyvek has also been investigated and can follow the ASTM standard D882. ASTM D882 is a standard tensile test for thin plastic film or sheeting. This test requires a sample of no more than 1mm thick and variations of clamps or grip systems. Tyvek has a standard, but Juncus does not. For this reason, various ASTM standards were looked at, such as ASTM D903 focusing on the strength of an adhesive bond for any material by peeling or stripping and D3822 for single, individual textile fibers. These standards guided the experimental design of similar materials and helped establish a testing framework.

Compressive testing

Compressive testing involves applying inward pressure on a sample, causing the sample to collapse on itself at the point of failure (Corrosionpedia 2024). ASTM standards for compression testing apply to plastics or composite material, not plant material alone making this test uncommon and difficult to find standards (Zwick/Roell n.d.).

The compression of plant fibers has not been evaluated in depth, specifically on grass elements such as *$oyla*. Additionally, research on the compression of a loop made from a plant fiber has not been evaluated either. Research has been conducted on flax, hemp, banana fibers (Padmaraj et al., 2016), and others, but not *$oyla*. There was one study that examined the elementary fibers of flax and made them into loops to test their compressive strength (Bos 2002). This study helped with the idea for the shape of compressive samples for this thesis. Due to the need to have the *$óyla* samples in the shape of a stitch, a loop seemed to be the best solution. Although the test with *$óyla* was modified from Bos 2002, in the sense that a complete loop was not created, rather a half ellipse was formed to fit into the clamps and not crack the samples prior to testing.

Most of the studies in the literature focus on composite materials rather than the fiber itself. For example, in the study by Padmaraj et al. 2016, the plant fibers were embedded in epoxy resin before testing. Embedding the fibers in resin puts an emphasis on the strength of the resin rather than the fiber alone. There are benefits to these tests, but for the sake of basket repairs and original repair material, it is imperative to understand the strength of the fiber by itself.

Microfade Testing

Microfade Testing (MFT) is a form of accelerated light aging. This technique tests a material's lightfastness without causing unnecessary damage to a large surface area. Instead, the technique only requires a pin-sized area to measure the color's fastness while providing more information to museum staff about their collection (Beltran 2021). This technique has proven to be helpful in some cases regarding plant fibers.

In one case study, focused on *muka*, a fiber commonly seen in Māori textiles, the lightfastness and the correlation between light exposure and damage to the fibers' tenacity were researched through accelerated light aging and MFT (Lowe et al. 2014). Results showed that with the simulation of a museum environment (e.g., UV filtered and an RH around 50%), the fiber faded at a rate equivalent to blue wool 2 and 3. This is quite a large change in a natural fiber.

Blue wool standards are used as a benchmark tool for comparison of the level of light fastness a material has. These standards consist of eight dyed wool samples, with the first six standards being acid dyed, while seven and eight are vat dyes (Pugh and Guthrie 2001). Each standard is designed in such a way to take twice as long to fade to a specific level as the standard below it (Pugh and Guthrie 2001, Canadian Conservation Institute 2017). These standards are measured with MFT and then the testing material results are compared to the blue wool fading spectra to aid in better understanding the materials lightfastness.

Accelerated Light Aging

Accelerated light aging chambers are also used to induce aging, but the aging will impact an entire sample rather than a single spot. For these tests, expendable samples are prepared, mirroring materials of interest, such as plant fibers. Some chambers can apply a UV-filter over the light allowing for similar museum conditions as well as controlled relative humidity and temperature. The benefit of an accelerated light aging chamber is being able to have a museum standard for a specific material without damaging the object itself, and by obtaining the data within a reasonable amount of time rather than waiting years to see the results. It is important to remember that these results have restrictions because the exact environment cannot be replicated in the chamber itself (AMNH blog 2025). In the experiment with *muka,* Lowe et. al (2016) used both dyed and non-dyed samples which is one of very few articles that has researched light fastness of undyed plant fibers. The accelerated light aging chamber played a significant role in understanding the structural damage to the fiber after prolonged exposure and added another layer of assurance to the experiment, using both MFT and accelerated light aging.

Similar to MFT, blue wools standards are also used as a benchmark for comparison of the sample's lightfastness under the same conditions. Although this technique does not provide a complete replicated environment, it does assist conservators in better understanding how a material may react to a certain amount of light exposure (Canadian Conservation Institute 2017).

3. Interviews

The methodology for conducting these interviews was shaped by guidance from my advisor, Dr. Mishuana Goeman, and adhered to the protocols established by the University of California, Los Angeles Institutional Review Board (IRB). Additionally, the interview process was grounded in an Indigenous methodological framework, drawing on the principles outlined by Kovach as a

“Conversational method” (2010). This process was thoroughly thought through to ensure the interviewees chosen were individuals I either had a relationship with already or were recommended to me by individuals I knew and trusted. By having a previously established relationship or a small connection with the interviewees it allows for a more personable conversation rather than trying to establish a relationship from scratch. All four of these weavers are teachers and highly knowledgeable. I chose to speak with weavers from different areas and backgrounds, but it was interesting to see, through the interviews, the common threads that are found in each of their stories.

Typically, interviews are recorded and transcribed, but for this research, I decided to conduct interviews as an open conversation with the interview questions acting more as conversation starters and guides, and refraining from recording or transcribing the conversation (Kovach 2010). At the same time, I took short handwritten notes for each question to refer to later while writing. This allowed participants to feel less pressured and share openly, while removing an obstacle with the IRB process, as there were no recordings to store later. Participants were informed they would receive a copy of the interview portion for review and a full copy of the thesis after approval by the committee.

Once interviewees were confirmed, I worked with them to schedule either an in-person, Zoom, or phone interview. Two participants were interviewed in person, one over Zoom, and the last over a phone call. The interviewees were Myra Masiel-Zamora (Payómkawish/ Cahuilla), Tima Lotah-Link (Šmuič), Rose Ann Hamilton (Cahuilla), and Abe Sanchez (Mexican of Purepecha descent). All the participants are cultural knowledge bearers and highly respected by their communities and other basketweavers. Myra is a curator for the Pechanga Cultural Resources Center and has been a friend and mentor to me through this process. Roseann teaches

Cahuilla basketweaving and provides workshops for all levels. Tima is a weaver and shares her knowledge with her community in the greater Los Angeles region, in addition to assisting museums in naming belongings in her Native language rather than in a Western vernacular. Abe is a teacher for the Santa Ynez Chumash and the Tongva Basketweaving Group, and shares his knowledge with Indigenous communities to help them revitalize their weaving traditions while encouraging them to continue these practices[2] (Abe Sanchez, personal communication, October 2024, Guzman-Lopez 2024).

The interview questions were created to have weavers reflect on their experiences, not only as a basket weaver, but also on their past or current relationships with museums. By listening to their stories and experiences, I gained a better understanding of the importance of *$óyla* and how the conservation community needs to better understand this relationship with materials. To learn more, I co-developed ten interview questions with Dr. Goeman:

1. Please introduce yourself and how long you have been weaving baskets.
2. What does it mean to you to be a weaver?
3. Have you had interactions with a museum curator or art conservator before?
4. If so, what kinds of museums?
5. Was it once or ongoing? What was the length of the meeting?
6. What has been your experience in those spaces?
7. Could you please describe the relationship with the professionals in those spaces?
8. When a basket is broken, what is your first instinct?
9. How do you assess the repair process?
10. Is there anything else you'd like to add or share about your experiences?

Although this study has been heavy with analytical techniques, it is important to remember that this study is a balancing act between many worlds: one being academia and the several

[2] Abe Sanchez has worked with the Santa Ynez Band of Chumash Indians for over eight years revitalizing their basket weaving traditions. In addition to this work, Abe also began working with the Tongva community revitalizing their weaving traditions. This weaving group began a little less than eight years ago and has grown on its own to teach the younger generation (Abe Sanchez, personal communication, October 2024).

paradigms used to conduct research, and the vast worlds that encompass my identity as an Indigenous woman (Wilson 2022). As I was interviewing these weavers, there was a common thread: weaving is a part of our identity, not just a label that can be placed on us. When asking Myra what it means to her to be a weaver, she remarked, “[Weaving] becomes a part of you.” It is not a sticker that you can add to your collection; it becomes a way of life, it changes the way you think about the world around you and how you interact with it, or, as Tima says, “When you become a weaver, you become an environmentalist.” We need the plants as much as they need us, so our connection to where we gather weaving materials becomes much more important and we become tied to the land.

These interviews serve as a reminder that my work with *$óyla* helps make this material more accessible to conservators by sharing information about an “unknown” material to most conservators, while on the other hand, it could make *$óyla* more accessible to weavers that prefer this as a repair material. At the same time, they reaffirm that Indigenous knowledge has long held the understandings I am now testing—this is not new to us. I asked participants to reflect on their experiences with museum staff and conservators, and their responses were revealing. Myra noted that while she has worked closely with conservators, their approach often centers heavily on the object itself, with little effort to understand the broader cultural context and connection to the land. She also observed a recurring lack of respect shown to tribal members during these interactions, with some conservators exhibiting a sense of superiority, assuming they know more about the material than the communities it comes from. In contrast, Abe shared that some institutions are more welcoming and open to community engagement. He emphasized the importance of finding someone on staff who shares an interest in baskets or related materials, describing that person as the key to building meaningful relationships (Teeter et al. 2009).

Gathering spaces are a vital part of the weaving tradition—without them, the practice cannot continue. All the participants emphasized that this knowledge begins with understanding how to care for the land and tend to the *$óyla* patch. Rose Ann highlighted that maintaining these spaces is a serious responsibility, not just for weavers, but for everyone. Myra echoed this sentiment, explaining that this knowledge does not belong solely to basket weavers. Instead, it is a communal practice involving many roles—tending to and protecting the gathering areas, collecting and processing materials, and weaving itself. Their loss would represent a deep and lasting impact on the community.

Questions eight and nine were designed to have the participants reflect on their experience repairing baskets or seeing broken baskets in a collection they had visited. All the weavers had a unique response to the questions. Some explained that they were sad when they saw a broken basket. Others saw it as a learning experience, a gift to see how the basket was constructed. Abe mentioned he is most excited when he comes across older baskets. He says, "The biggest teachers are the oldest baskets." Since this research focused on showing *$óyla* as a potential repair material, I wanted to ask weavers what their experience has been working with broken baskets, and if they have repaired any with *$óyla* or if they would repair a basket. The overarching theme among participants was that repairing a basket that is not yours is not encouraged and that incorporating unaged material would prove to be difficult.

Some weavers have repaired their personal baskets or have been asked to repair a basket and have been paid for their expertise, but this has not always been a positive experience. Tima shared a story with me of a time she was asked to repair a basket for a collector. It was a beautiful repair that she was proud of, believing the collector would cherish it and appreciate the work that had gone into it. Instead, all they saw was a way to make money—dipping the basket in dye to try to match the new color to the old—exposing the ancient basket to damage to create a more 'sellable' item." This was heartbreaking and discouraging to Tima, leaving her with no desire to repair another basket for a collector. Abe has repaired baskets when asked and says the most challenging part is color matching the newer material to the older material. This is something that, as conservators, we would inpaint and tone the new material. Still, a weaver would rather take the time to find or age the material to match the original color. Both Myra and Rose Ann have repaired their own baskets using newer, less aged *$óyla*, but they were clear that they would never repair a basket that was not theirs. Myra shared that she has received baskets through NAGPRA (Native American Graves Protection and Repatriation Act) that had been previously repaired by conservators. She chooses to leave those repairs intact, viewing them as part of the basket's story—evidence of its journey and life. As conservators, this is why we must remember that what we place on cultural belongings for a repair, will stay with them the rest of their lives (Teeter et. al 2021). No matter how "reversible" our treatments may seem, they have altered the material and have a lasting impact.

Interviewees have noted that it can be challenging to introduce fresh *$óyla* to an older basket. Roseann explained that it would be a "nightmare" to incorporate fresh *$óyla*; it is better to use aged *$óyla*. But regardless, whether fresh or aged, *$óyla* is being used for a repair; it is important to note that an experienced weaver should make these repairs. Rose Ann and I discussed her thoughts on conservators making these repairs, and she and I agreed that weavers should be approached about these repairs before the start of a treatment; they should be consulted prior to the proposal step so as to help guide the possible treatment. Fortunately, with the updated NAGPRA regulations, this will hopefully happen regularly, as tribes must be contacted before engaging with cultural belongings in any capacity, including baskets.

4. Experimental Design

This chapter outlines the experimental design created to investigate *$óyla* as a potential repair material for basket treatments on baskets made of *$óyla*. The objective of these experiments is to systematically test the relationships between fresh *$óyla* and aged *$óyla* and how they perform under controlled conditions. The main properties focused on were flexibility, shear strength, and light fastness. This design was selected based on its suitability for addressing the research objectives of understanding the physical properties of the material. The following sections detail the considerations of sample selection, sample preparation, instrumentation, and data collection procedures.

Four analytical techniques were chosen for testing the mechanical properties of *$óyla*: shear strength, compressive, accelerated light aging, and microfade testing. These techniques were chosen because they would provide the data necessary to understand the material and its ability to be incorporated into a treatment for *$óyla* baskets (Farke et al. 2013, Analytical Methods 2024, Seirawan et al 2019). These experiments were decided on as if *$óyla* was being introduced to the conservation community as a new material. The goal was to demonstrate the various properties of the material in a variety of techniques. In conversation with weavers, these analytical techniques are not to mimic the weaving motions, but to provide information for the conservator's perspective. The conservators will then know what *$óyla* is and can have a conversation with tribal members when consultations occur.

Material Preparation:

$óyla was acquired in several ways and in different regions leading to more variability to consider. This method of gathering was chosen due to the material availability and accessibility

within the given time restraints. This variability demonstrates the diverse environments and different locations where *Juncus textilis* can be found. The 5-7 year old *$óyla* was gathered from past UCLA/Getty cohorts around Agua Caliente in Palm Desert. The 1-2 year old *$óyla* was given to me for my own basket weaving practice and was most likely gathered in Temecula, CA. Lastly, the fresh *$óyla* was gathered by myself in January of 2024 in Los Angeles, CA. All of the *$óyla* is believed to be consistent as *Juncus textilis*, while the variation of where it was gathered remains (Small 2011).

The *$óyla* was then processed as if one was going to weave with the material. Long stalks of *$óyla* were taken, an awl was pierced through the center and then pulled up or down to begin the splitting process. Each stalk was split into three strands. Next, the pith must be removed. To do this, a small knife was used to scrape the pith away from the cuticle leaving a thin strand. Once the pith is removed a metal sizer can be used to create similar sized strands. The metal sizer used was a metal tin can lid with three different sized holes to pull the *$óyla* through.

Figure 2. After splitting the $óyla, the pith must be removed.

After the *$óyla* was processed, each sample was cut to be two inches in length using a tape measure and a box cutter. This dimension of each sample was decided based on feasibility for each analytical technique. The clamps and plates for tensile and compressive testing required enough sample to be secure to the respective holders. They were then documented and stored in individual polyethylene bags for each test with a cobalt strip to help record the relative humidity in the bags under guidance of my thesis advisor. The relative humidity for these bags were roughly around 50%-60%.

Figure 3. $óyla sample preparation, using a tape measure to measure 2in samples and how samples were bagged after preparation.

Figure 4. Tools used to prep the $óyla samples. An awl, small knife, and a metal sizer.

5. Methods

This section outlines the experimental methodologies employed in this study to characterize the mechanical and light resistance properties of *$óyla* fibers. The analysis was conducted through four primary techniques: tensile testing, compressive testing, microfade light testing, and accelerated light aging preceded and followed by color measurement. Each method aims to assess different properties and behaviors of *$óyla* fibers under specific conditions. Accelerated light aging was completed at the UCLA/Getty Conservation labs at the Getty Villa, while the other three techniques were completed at the Getty Conservation Institute (GCI) labs.

5.1 Accelerated Light Aging

Objective:

The purpose of accelerated light aging is to simulate long-term exposure to light and assess the degradation of the *$óyla* fibers. For this analysis, the Q-Lab Q-Sun Xenon Test Chamber Model Xe-1 was used with a window glass filter but without a UV filter to imitate collection spaces without UV film over the windows. The window filter that was placed in the chamber filters out UV below 365nm which is equivalent to the UV filtered out from an average window. The goal was to provide data that could be representative of under-resourced cultural centers or personal collections that are in homes without museum-standard environments. It is important to collect data with these variables in mind to make the data more inclusive and show that even if the environment is not in pristine condition, it may still be safe for materials.

Sample Preparation:

Samples were prepared using the clamps provided by the manufacturer. The sample tray is a small rectangular tray with a metal backing that is pressed into place by a metal ring from the back. The two-inch samples that were prepared were placed in the trays with a blue wool standard for comparison. Half of the samples were covered with aluminum foil to compare the exposed side to the unexposed side after testing. It is important to note that approximately 1/8in on each end of the samples was covered by the tray to hold the sample in place.

Testing Procedure:

Before placing the samples in the chamber, the samples were documented with the X-Rite Ci64 Handheld Spectrophotometer to measure the color before testing and after testing to quantify the difference. These measurements were taken in the top half of the samples (See Figure 1) to avoid the area covered by foil and the sample tray.

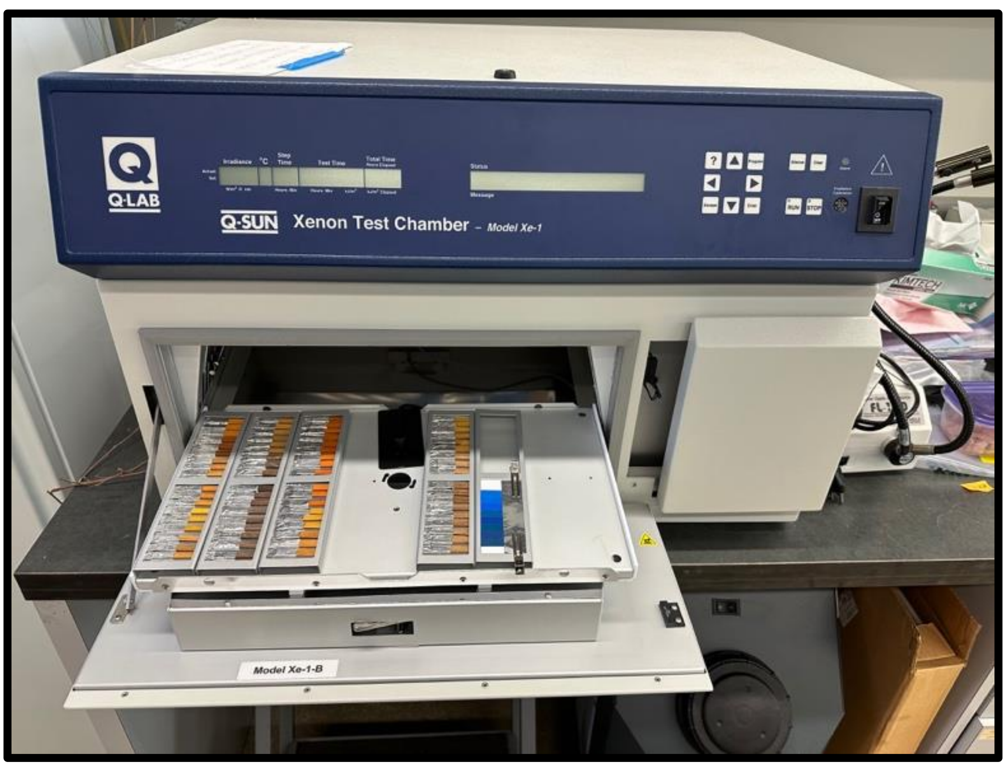


Figure 5. Q-Sun Xenon Test Chamber with Cheyenne Caraway's dyed rivercane samples. An example of how samples were wrapped and prepared with foil. Picture courtesy of Cheyenne Caraway

The Q-Sun Xenon accelerated light aging chamber was used to conduct these tests in the UCLA/Getty Conservation Lab. The tests were run without a UV filter placed over the xenon arc lamp within the chamber. The chamber was calibrated to deliver 0.26 W/m^2 at 420 nm. Samples were in the chamber for 24 hours at 20,600 lux (Dissi, 2023), which is equivalent to approximately 16 months of light exposure at 542,400 lux (Dissi, 2023). It was also noted that the light aging chamber does reach an internal temperature of about 40 °C.

5.2 Microfade Testing

Objective:

The goal of microfade testing (MFT) is to have a comparison for the accelerated light aging chamber and to see if there was a point where *$óyla* would plateau and stop fading. The microfade testing would demonstrate how resistant or not *$óyla* was to fading under extreme light exposure conditions. Unlike the accelerated light aging chamber, MFT tests a pinpoint area,

Figure 6. One sample from the 7-year age group was prepped for MFT testing with the gray background and the orientation of the sample in the tray.

extremely small, meaning there could be variability between measurements, unlike the accelerated light aging chamber, which affects the samples overall and not just a single spot.

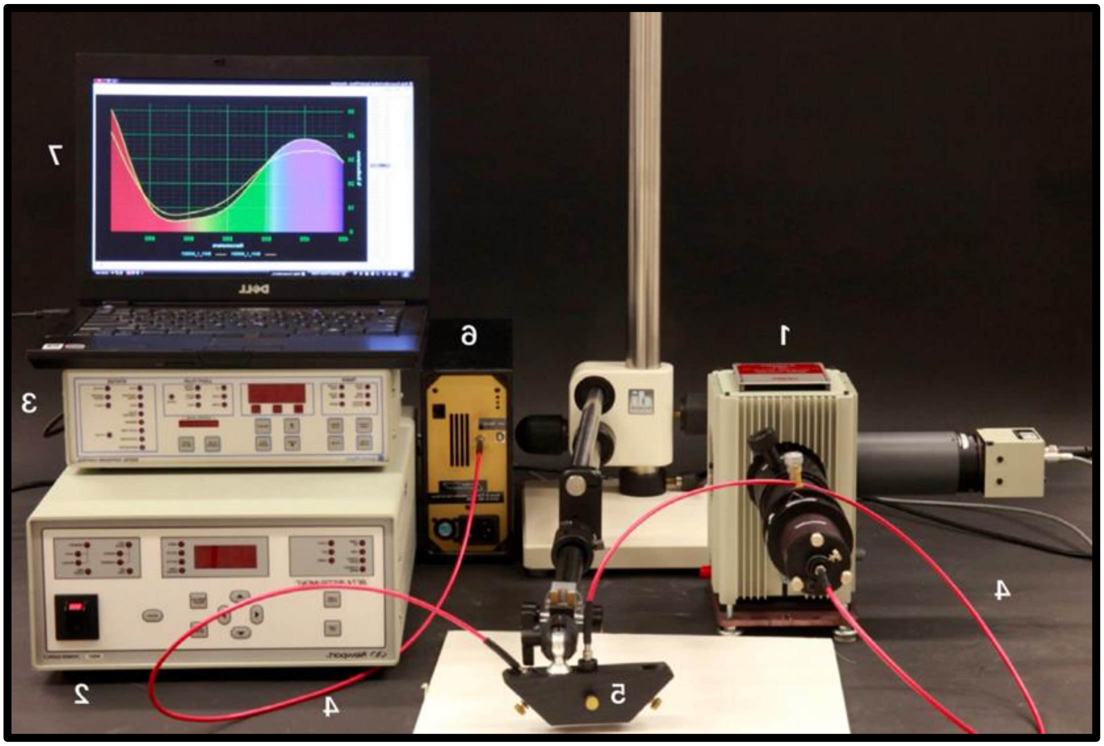


Figure 7. Whitmore MFT components. Shown are the (1) xenon-arc light source, (2) power supply, (3) digital exposure controller, (4) fiber optic cables, (5) 0/45 measurement head, (6) spectrophotometer, and (7) laptop. (Beltran et. al 2021)

Sample Preparation:

These samples were prepared at the same time as the other two-inch samples used for all the other techniques. They were given a dot in Sharpie on the back (non-cuticle side) to signify the number sample it was. The Q-Sun Xenon metal tray used for light aging was used to hold the samples in place under the MFT. Behind the samples there was a light gray background paper placed to block the metal backing plate.

Testing Procedure:

For these tests the Whitmore Microfade Testing instrument was used at the GCI labs. The Whitmore has a xenon arc lamp as well, with a spectrophotometer, and a 0/45 degree measurement head (See Figure 3). There were three samples prepared per age group, but due to time restrictions, only 2 samples were run, and only one spot was tested per sample. Tests ran for 15 minutes for 60 sec intervals.

5.3 Lap Shear Strength Testing

Objective:

This technique is being used to best understand the tensile strength of an acrylic resin, Paraloid B-72 and a water-based adhesive, wheat starch paste. These were applied to the *Juncus* fiber itself and to Tyvek, a typical repair material. The strength of these adhesives with both the fiber and Tyvek is important to know how likely it is that a repair will fail, whether with *Juncus* or Tyvek. These materials were being tested to evaluate *Juncus* as a compensation material for basketry repairs using common adhesives used to make these repairs.

Sample Preparation:

Two types of tensile samples were prepared. One sample type was two, two-inch pieces of *Juncus* adhered together (represented as JJ in sampling labeling). Another sample type was a two-inch piece of *Juncus* adhered to a two-inch piece of Tyvek (represented as JT in sampling labeling). Both sample types were prepared with each of the adhesives, 20% B-72 in acetone, and a thick wheat starch paste that was strained twice. Samples of *Juncus* were categorized as follows:

7-Years Old			
B-72		Wheat Starch Paste	
JJ	Sample 1	JJ	Sample 1
	Sample 2		Sample 2
	Sample 3		Sample 3
JT	Sample 1	JT	Sample 1
	Sample 2		Sample 2
	Sample 3		Sample 3
1-Year Old			
B-72		Wheat Starch Paste	
JJ	Sample 1	JJ	Sample 1
	Sample 2		Sample 2
	Sample 3		Sample 3
JT	Sample 1	JT	Sample 1
	Sample 2		Sample 2
	Sample 3		Sample 3
Fresh			
B-72		Wheat Starch Paste	
JJ	Sample 1	JJ	Sample 1
	Sample 2		Sample 2
	Sample 3		Sample 3
JT	Sample 1	JT	Sample 1
	Sample 2		Sample 2
	Sample 3		Sample 3
Total number of samples: 36 samples			

Table 1. This table breaks down all the samples prepared for lap shear strength testing, including Juncus and Tyvek joints (JT), and Juncus and Juncus joints (JJ) with both types of adhesives, Paraloid B-72 and wheat starch paste. For the clarity of sample naming conventions, "J" for Juncus will be used rather than the "$" for $oyla.

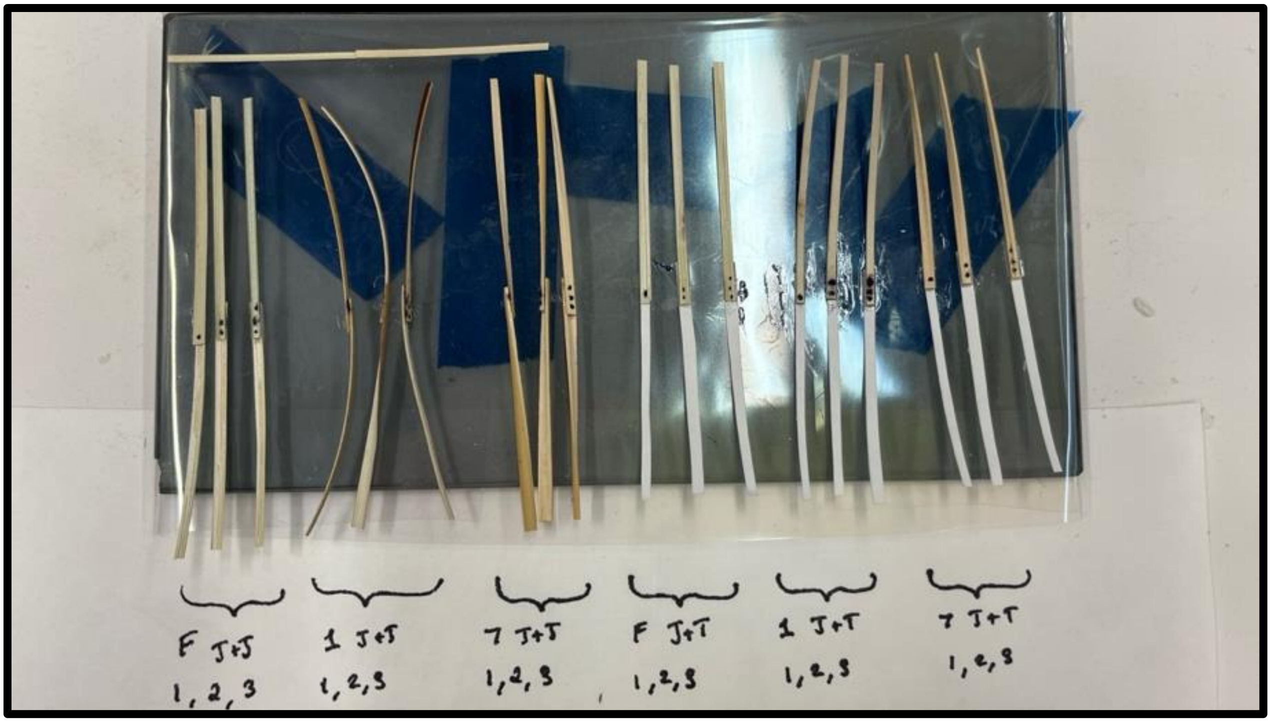


Figure 8. Prepared lap shear samples in respective groups with three samples per group. For the clarity of sample naming conventions, "J" for *Juncus* will be used rather than the "$" for $oyla.

The wheat starch paste was applied with 1-2 brushstrokes on one piece of *$oyla,* while the B-72 was applied using a micro-pipette in an effort to use a consistent amount of adhesive for each sample. The dimensions of these bonded areas were approximately 6.35mm x 2.5mm (LxW). Pressure was applied overnight with a small weight to ensure contact between the *Juncus* or Tyvek samples. There was variability in the application of the adhesives due to the surface of the samples and how the adhesive dried. The surface of the *$óyla* itself has ridges where air bubbles could be trapped and cause gaps in the surface contact (See Appendix 1 p.18-20). Samples were left for a week prior to testing and testing was completed in the GCI labs where the relative humidity was consistently between 50-60%.

Testing Procedure:

The instrument used for testing the tensile strength of these materials was the Instron 5900 series with 250N side action tensile grips with smooth jaw faces, with sandpaper adhered to the surface to better grip the *$óyla* samples. The temperature and relative humidity of the GCI labs were relatively consistent between a temperature of 65F-70F and 52%-57% on the days of testing. ASTM D3822-01 standard (2017) was referenced when developing this testing procedure, although standards have not been developed specifically for this material. The loading rate for all samples was 10mm/min. Since the initial load was unable to be consistent due to variability with the size of samples, it was decided to keep the elongation of the clamps as consistent as possible, and correct the load for all data after testing was complete.

The end of each side of the samples was placed into the top and bottom jaw faces and secured at a similar location on each sample. The distance from the joint was measured and marked where the clamp would be placed.

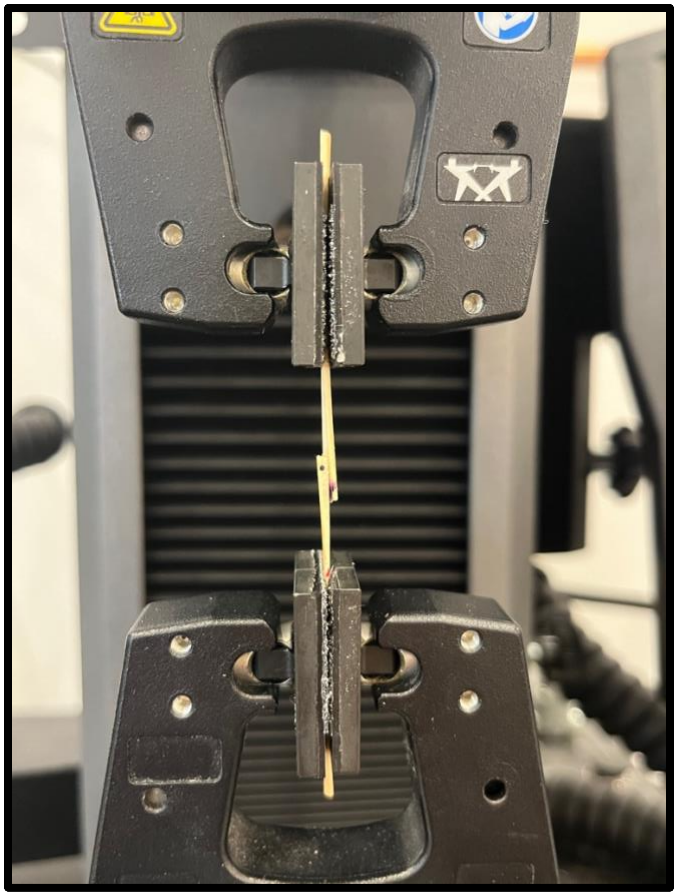


Figure 9. Sample that has completed shear strength testing with the clamps still holding the sample in place.

5.4 Compressive Testing of *\$óyla* Loops

Objective:

The purpose of compressive testing was to determine the flexibility of the new and aged *\$oyla*, and to measure and compare the stress a sample from each age group could withstand. This test was used to mimic the possible stresses the fiber would undergo during a repair and its shape as a finished stitch in a basket repair. Although the size of the samples is not representative of that of a basket stitch, it was the necessary size for the compressive clamps available for testing.

Sample Preparation:

Samples were prepared in a "C" shape to fit between the Instron compressive clamps. *$óyla* fibers were dampened to increase flexibility and placed along the handle of a wooden hammer, and were allowed to dry into shape. Each age group had five samples to increase the number of data points. Once the samples had dried, they were sealed in a small polyethylene bag for easy transport to the GCI lab.

Figure 10. Preparation of compressive loop samples of *$oyla.*

Testing Procedure:

The machine used to test all samples was the Instron 5944 series with 2 kN compression plates. The temperature and relative humidity of the GCI labs were relatively consistent between temperature of 65F-70F and a 52%-57% relative humidity on the days of testing. Tests began by marking samples with a red dot for the number of sample it was (e.g. one dot was sample 1, two dots indicated sample 2, etc.). After marking the samples, they were taped with electrical tape to the compression clamps. Samples were placed with the indicating dot on the top clamp while the curve was on the right-hand side (See Appendices, Figure A.23).

Since the initial load was unable to be consistent due to variability with the size of samples, it was decided to keep the elongation of the clamps as consistent as possible. The distance between the ends of the samples was 16.5mm. It is understood that there were some samples that began with additional compression compared to others due to this consistent distance. For this reason, the initial load was not corrected in order to maintain accurate data for each sample.

Before the test began, a Nikon D500 camera with a G series lens was setup on a tripod in front of the sample and the Instron Universal machine. The camera was set to take bursts of images while the test ran in order to capture the moment of failure. Images were also taken on the Keyence Digital Microscope before and after analysis to observe the breaking pattern on the fiber.

6 Results

6.1 Microfade Testing

Microfade testing results are meant to be viewed with the accelerated light aging results, acknowledging that the blue wool standards are the key comparison tool between techniques. As Lowe et. al mentions, microfade testing is a newer technique, leading to a lack of confidence in its results. This is why it is beneficial to have accelerated light aging data to support or not support MFT data. (Lowe2014).

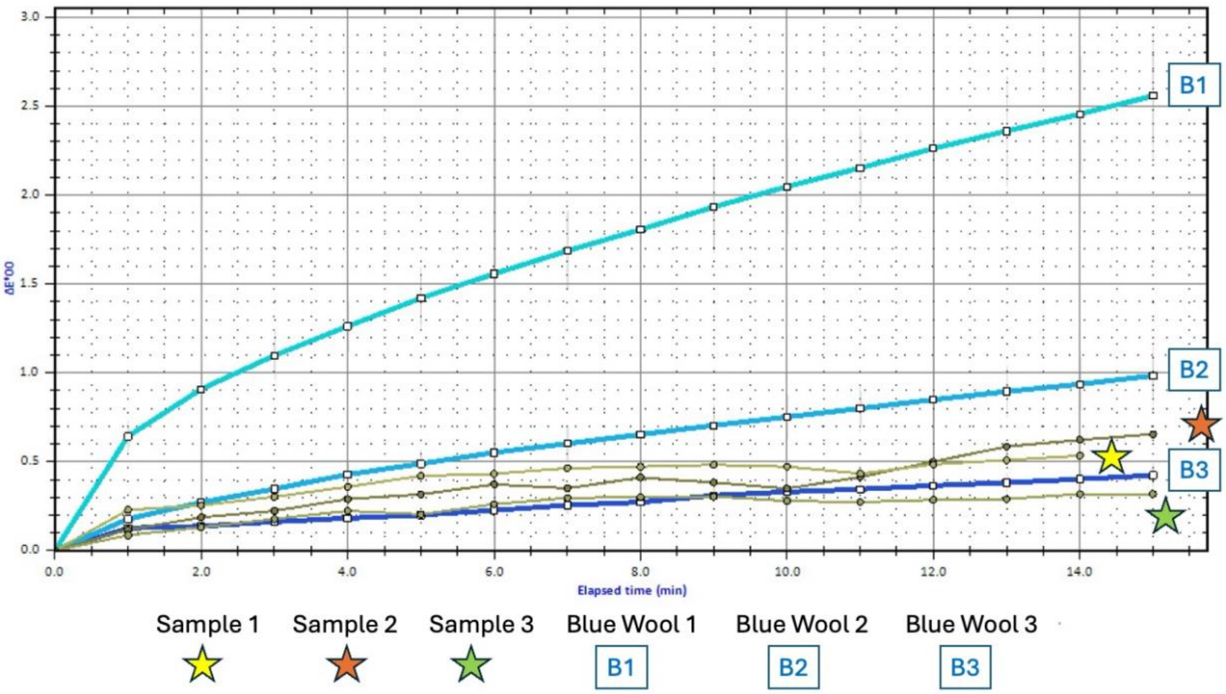


Figure 11. MFT spectra including blue wool spectra 1-3 and samples 1-3 for the fresh age group.

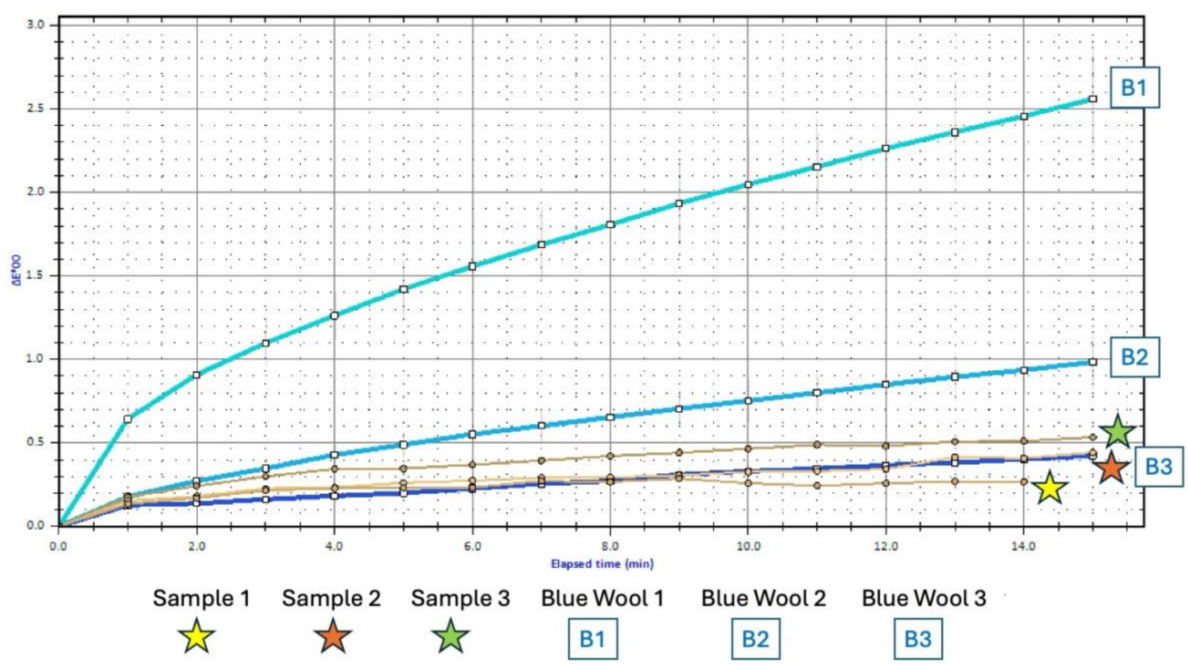


Figure 12. MFT spectra including blue wool spectra 1-3 and samples 1-3 for the 1-year age group.

The results of the fresh samples of *$óyla* from the MFT tests show the light fastness between blue wool 2 and blue wool 3, meaning the age group is not extremely fugitive, as blue wool 1 represents the most fugitive materials. At around 10 minutes, sample 2 reading 1 begins to drop above blue wool 3, demonstrating its higher light fastness. Approximately within the first minute of testing, the first sample reading was between blue wool 1 and blue wool 2 but quickly shifted to between blue wool 2 and 3, and remained consistent.

In the 1-year sample readings, there were similar results showing consistency between blue wool 2 and 3. There was a drop around the 10-minute mark, like the fresh age group samples. The consistency of the readings is important to note, as this shows its lightfastness and its resistance to an extreme number of fluctuations. It is evident that sample 1

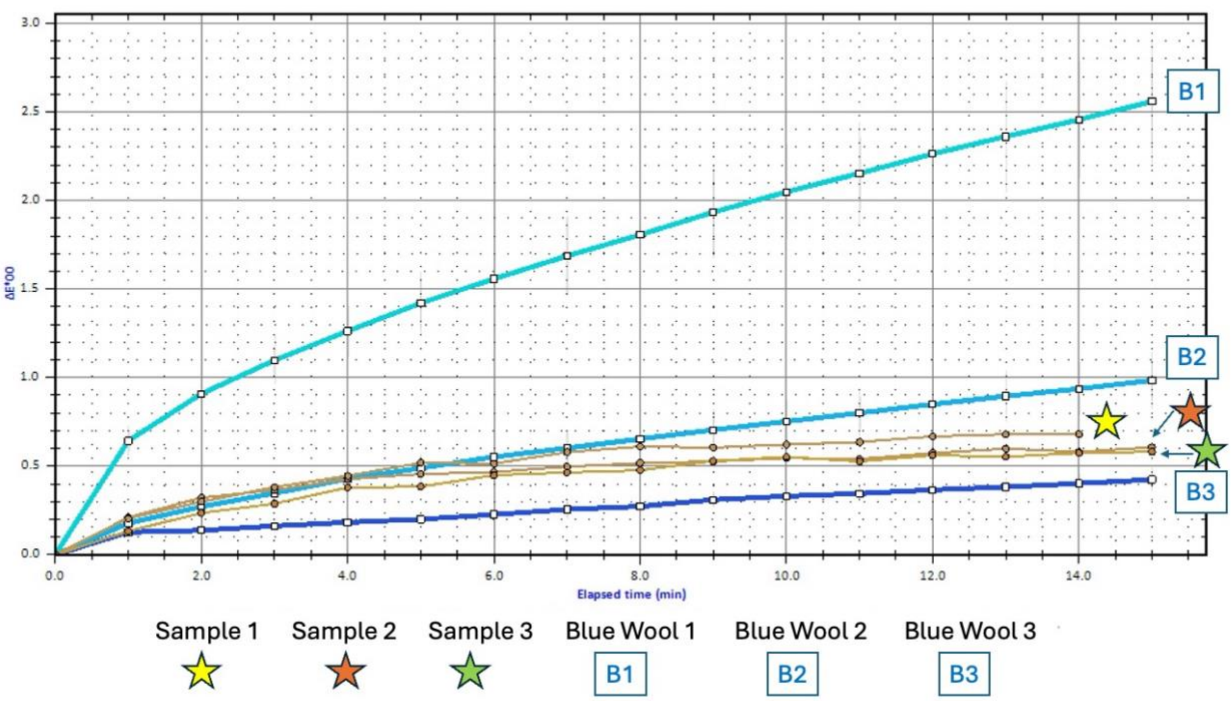


Figure 13. MFT spectra, including blue wool spectra 1-3 and samples one through three for the seven-year age group.

reading 1 was stopped 1 minute early by mistake, and due to time restraints could not be redone. The data collected is still representative overall.

The 7-year samples all remained consistently between blue wool 2 and 3 without rising above blue wool 3 for most of the runs. At the beginning of the tests, one of the samples went above blue wool 2 at the two-minute mark but quickly dropped back down to or below the blue wool 2 standard. It is interesting to note that all three sample age groups tested with MFT resulted in close ΔE values, like the accelerated light aging ΔE values. It is evident that sample 1 reading 1 was stopped 1 minute early by mistake, and due to time restraints could not be redone. The data collected is still representative overall.

6.2 Accelerated Light Aging

After samples were exposed for 24 hours of the accelerated light parameters, the color of the samples was measured using the XRite Ci64 Handheld Spectrophotometer. These measurements were processed in the Pantone iQC software, which provided the L*a*b* values that were entered into the CiEΔE2000 Chromatic Difference Matrix (Sharma 2005). The matrix provides L* a* b*, and ΔE values, allowing for a comparison with blue wool values. The L* values represent the lightness, a* represents green to red color values, b* represents yellow to blue color values, while ΔE values represent the measure of color difference (Beltran et. al. 2001).

The values in the table below are the L*a*b* values for each sample before and after testing. The readings taken after testing are indicated in the sample name with an "_a" at the end. The far right column provides the ΔE values for each "after treatment" sample.

Name	Average L*	Average a*	Average b*	DE
7yr_Sample1_1	68.50625	5.85875	25.52	
7yr_Sample1_1_a	68.7255	6.13325	26.3005	0.42
7yr_Sample2_1	66.97225	6.2465	20.16975	
7yr_Sample2_1_a	66.5195	5.85625	20.0365	0.52
7yr_Sample3_1	67.48875	6.018	20.57075	
7yr_Sample3_1_a	67.2445	5.97875	21.184	0.40
1yr_Sample1_1	66.495	4.4105	15.387	
1yr_Sample1_1_a	65.3535	3.9615	15.0655	1.07
1yr_Sample2_1	64.25925	4.67575	19.05025	
1yr_Sample2_1_a	64.20875	4.764	19.38875	0.19
1yr_Sample3_1	64.0055	3.1025	14.8695	
1yr_Sample3_1_a	63.6385	2.82	14.0135	0.65
Fresh_Sample1_1	60.695	-4.0525	12.78575	
Fresh_Sample1_1_a	60.78475	-4.554	13.64475	0.69
Fresh_Sample2_1	63.34475	-2.5935	13.94625	
Fresh_Sample2_1_a	63.107	-2.95825	15.22125	0.85
Fresh_Sample3_1	72.34975	-4.411	20.754	
Fresh_Sample3_1_a	72.96475	-4.0185	21.79425	0.86

Table 2. A summary of all samples and readings before and after treatment in the accelerated light aging chamber. L*a*b* values are shown to demonstrate the overall changes, with the ΔE shown for each "after treatment" sample, or every other reading. The colors coordinate with the age of the samples and are consistent with the lap shear strength testing table (Table 1).

These results are in alignment with my visual inspection of the samples. With the naked eye there was little to no perceptible change in the color of the samples. This aligns with the ΔE results in the table above. Only one sample reached a ΔE of at least one which still showed an imperceptible change visually. One ΔE unit difference will show little to no visual change and would be considered a stable material (Mokrzycki and Tatol 2012).

While none of the samples in any of the age groups (fresh, one-year old, and seven-year old) underwent significant color change, shifts in specific color properties can de described. After reviewing this table, it is apparent that the older *Juncus* represented by samples “7_Sample_X”, experienced a decrease in the L* values, meaning darker, a* values mostly shifted toward a greener color, and b* values mostly increased, leaning more toward yellow. For the one-year age group the L* generally decreased, a* also decreased (toward green), while the b* decreased slightly (toward blue). This decrease in the b* values for the one-year age group may have been due to the fibers starting off in a cooler tone compared to the other age groups.

Lastly, for the fresh samples, the L* leaned towards a slight increase meaning the samples were lighter after testing. The a* for these samples began in the negative values, which represents the brighter green color that the samples started at. There was an overall decrease in the a* values meaning the samples moved more towards the green rather than warmer red values. For the b* values they all increased meaning there was a shift towards yellow for all three samples. As seen in the table, Sample 2 had a significant b* jump from 13.95 to 15.22, representing a larger shift towards yellow in this fresh *Juncus* sample, but still resulting in no visual change.

6.3 Lap Shear Strength Testing

The sample naming convention is outlined by age, adhesive, and the conservation material used for repair in conjunction with *$óyla*. In Figure 14, the sample groups are organized by adhesive first. The B-72 sample group is a long-dashed line, while the wheat starch paste is a solid line. The second categorization is differentiated by color, according to the repair material being tested: Juncus–Juncus (JJ) or Juncus-Tyvek (JT). The B72JJ is seen in shades of blue, the B72JT is seen in orange shades, and the WJT is seen in green shades. This decision was to assist in visualizing the trends among all sample groups while making the groups more apparent

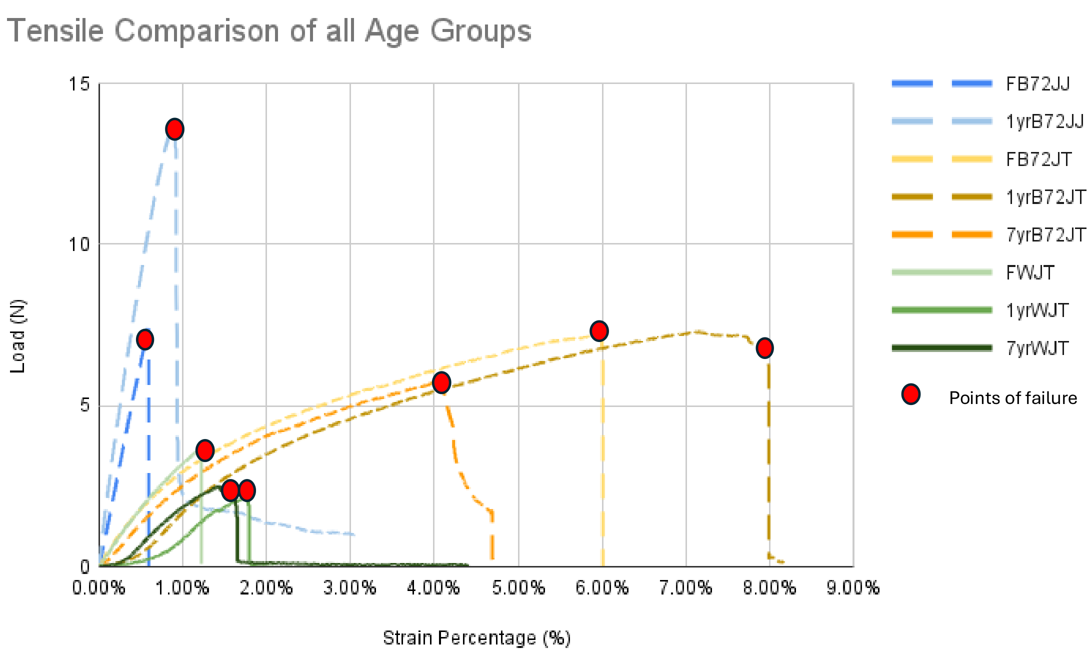


Figure 14. This graph represents the results of lap shear testing for each age group of *$óyla (Juncus)* with the respective adhesive and lap joints. For the clarity of sample naming conventions, "J" for *Juncus* will be used rather than the "$" for *$oyla.*

The terms high load and low load refer to the force level at which the lap joint failed during testing, as well as the manner in which it failed. If a sample reaches the highest load at failure, it could be very strong; however, if it fails quickly at the highest load, it indicates that it is brittle and unreliable for strong repairs. A low load represents the fragility of the joint rather than its stability. As for strain, a high strain percentage refers to the amount of deformation a sample underwent.

Figure 14 represents shear strength testing results across all age groups and adhesive types. The 7yrB72JJ and all age groups in WJJ were left out of these results due to the inability to test the prepared sample or unusable results. Most samples from 7yrB72JJ, 7yrWJJ, 1yrWJJ, and FWJJ, groups failed prematurely, and due to time and material restrictions, samples could not be recreated or retested. It is apparent in these results that the fresh and 1-year age group B72JJ samples are extremely brittle and failed early on, with the 1yrB72JJ reaching the highest load at 13.57 N. On the other hand, the WJT groups failed at a lower load, with the highest around 3.53 N for the FWJT samples. The B72JT sample groups performed better with a higher

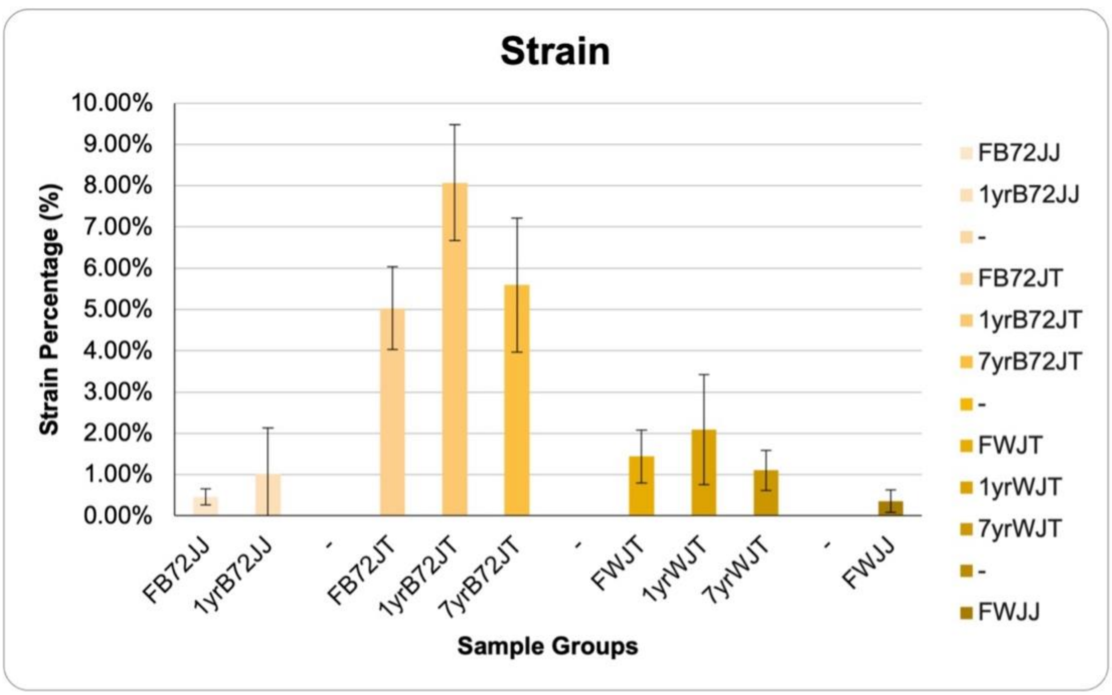


Figure 15. Strain results for lap shear testing for each age group and sample type. For the clarity of sample naming conventions, “J” for *Juncus* will be used rather than the “$” for *$óyla*.

strain percentage overall. In Figure 15, the fresh, 1-year, and 7-year samples in the B72JT group had the highest strain rates, ranging from 5% to 8%, respectively.

The B72JT sample group performed the best, with the highest strain percentages, but also larger error bars indicating more variation in results. The inconsistencies within these sample groups may have led to larger errors and a higher standard deviation. The JJ groups consistently show a low strain percentage, meaning a low stress response. The WJT groups show a moderate strain percentage between 1% and 2%. The standard deviation for most of these sample groups is high and should be kept in mind when looking at these results.

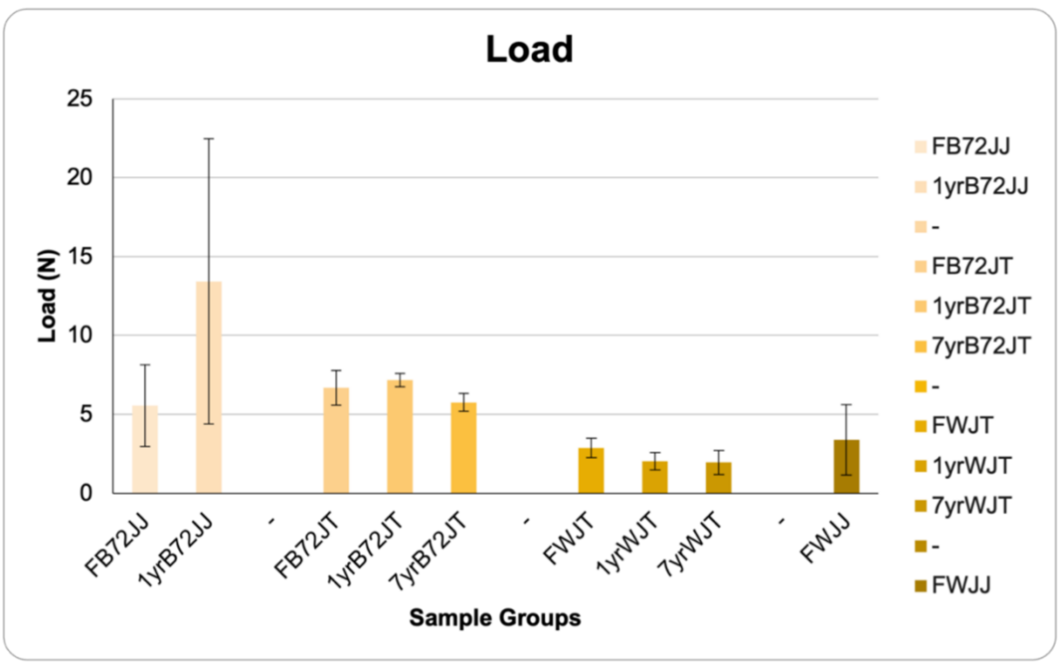


Figure 16. Load results for lap shear testing for each age group and sample type. For the clarity of sample naming conventions, “J” for *Juncus* will be used rather than the “$” for *$óyla*.

The load results in Figure 16 demonstrate that the B-72 groups still performed best, with one outlier, 1yrB72JJ. Although it appears to have the highest load, it also has the largest error bar, meaning there was high variability in its results. This variability most likely comes from the lack of adhesion and contact at the joint due to the textured surface of the *$óyla*. The B72JT groups are more consistent regardless of the age of the *$óyla,* and has relatively high load results between 6N and 7.5N. The WJT group is also consistent but has a low load capacity. The FWJJ group performed better than the WJT group, but still low, and only one age group could be tested in the JJ sample groups.

Overall, the low performance of the JJ sample group can be explained by the irregular shape of the samples and the textured surface. These variables lead to poor adhesion and reduced strength of the joint.

6.4 Compressive Testing of *$óyla* Loops

The goal of this analysis was to test the flexibility of the *$óyla* fiber in the shape of a loop. The loop was created to mimic the shape of a basketry stitch and was then tested under compression to imitate potential stresses placed on the fiber. The strain percentage calculation in Figure 17 shows that the fresh age group had the highest strain percentage, meaning that the fresh *$óyla* could distribute the stress being placed on it quickly, allowing it to fracture later. In contrast, the 7-year age group has a lower strain rate due to the lack of flexibility of the *$óyla.* The 1-year age group is right in the middle, as anticipated. These results demonstrate the younger the *$óyla*, the more flexible it will be, allowing for a higher strain. Within these parameters, the 1-year aged *$óyla* is the ideal age for flexibility and use as a repair material.

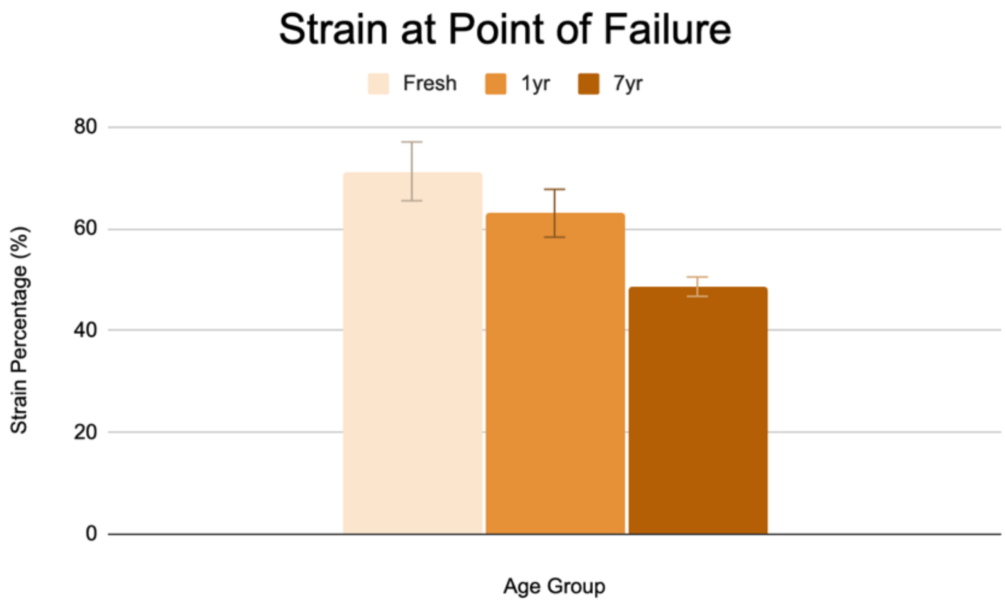


Figure 17. Compressive strain results for all three age groups, fresh, 1-year, and 7-year. Each bar represents the average of 5 samples from each age group with an error bar included.

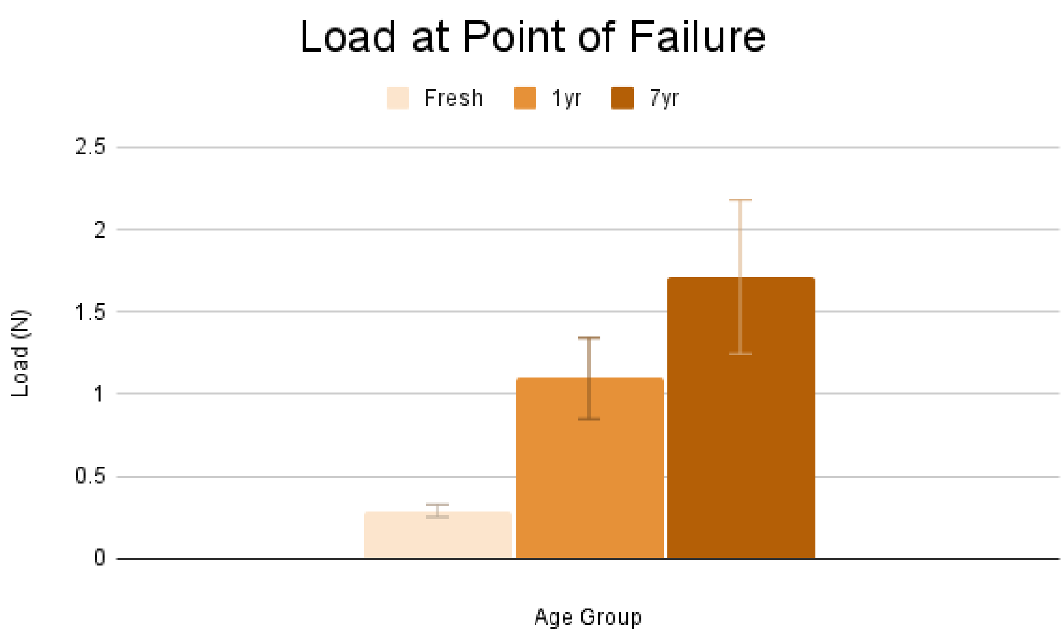


Figure 18. Compressive load results for all three age groups, fresh, 1-year, and 7-year. Each bar represents the average of 5 samples from each age group with an error bar included.

The fresh age group shows failure at the lowest load in Figure 18, increasing as the samples increase with age. A low load means that the fresh age group loops have a low compressive strength, whereas the 7-year age group loops have a higher compressive strength. Similar to the strain results, the 1-year aged *$óyla* would be the most ideal as a repair material based on these results.

Due to the lack of rigidity in the fresh age group, there were moments where structural flaws caused issues for a couple of the tests. Sample 5 of the fresh age group and sample 5 of the 7-year age group had small cracks before testing, leading to a noticeable difference in their line graphs. However, with averages, their data was useful for overall comparison. Due to a small sample size, these readings were kept.

7 Discussion

In general, the samples behaved in a manner that was anticipated for the respective age group, with a couple of outliers that might be due to the variability of the plant fiber's surface rather than the instruments themselves. During accelerated light aging, the data resulted in very minute changes represented in the ΔEs, with a couple of outliers. Sample 2 in the 1-year age group for accelerated light aging was different and larger than I had predicted, but as stated previously, it resulted in a change that could not be seen visually. The MFT and accelerated light aging results are comparable to each other and reflect the light fastness of *$óyla*. However, as Indigenous basket weavers have observed since time immemorial, there is a visible color difference between fresh and aged *$óyla,* and it is apparent that the color change is seen rapidly when samples with chlorophyll are exposed to air (Vincent Beltran, personal communication, 2024). As Abe Sanchez mentioned to me, the hardest part to repair a basket is matching the colors of the repair fibers with the older fibers (personal communication, June 2024). From this, it is possible that the fresh *$óyla* used in my study had already undergone this rapid change, therefore resulting in low ΔE values. In order to record this rapid change, the *$óyla* would need to be gathered and immediately tested the same day or at most the following day. Due to scheduling and access to the analytical equipment, this was not possible for this study. The rapid change only impacts the purpose of measuring the change in color. It is important to note that this change is not of a concern to weavers usually as the *$óyla* is typically split at the time of gathering and then stored until use, which could be months or years.

As for compressive and shear strength testing, it is noticeable that with age, the Juncus does become more brittle, and shows weak tendencies when adhered. *$óyla* (*Juncus)* to *$óyla* (*Juncus)*. *$óyla (Juncus)* to Tyvek gave better results in the case that the standard deviations were less and there was more consistency with the results. Although Tyvek was not tested on its own here, it has been tested by others and demonstrates high tenacity (Preservation Equipment n.d.). *$óyla* was also not tested alone for the official experiments, but was tested preliminarily by Alexandra Bridarolli, a Getty Conservation Institute (GCI) scientist assisting me during this research. Alexandra noticed that the *$óyla* fiber was far too strong to give informative results for the questions that were being asked. As mentioned earlier in the literature review and methods section, for this reason lap joints were chosen and demonstrated the potential result of a failure in a conservation treatment with these materials.

7.1 Sustainability

The goal of this project was to build a greater understanding of the material properties of *$óyla*, and to open a dialogue between California basket weavers and conservators. The objective was not to present Tyvek or Japanese tissue as the sole repair materials, but to use them as comparative references to highlight and better understand the potential of *$óyla* as a complementary conservation material. When seeing how strong *$óyla* truly is, the possibilities of it becoming more accepted as a repair material increased, but so does the necessity of understanding its need as a community belonging. The gathering places for sourcing this material are critically important to weavers and their communities, which is why they are not shared openly. Myra mentioned during her interview how her grandmother had a relationship with the plants in a particular area, and this is true for other weavers and Indigenous people as we are caretakers of the land (personal communication with Myra Masiel-Zamora October 2024). It is difficult enough for weavers to access their plants, let alone to compete with conservators over gathering to make repairs. The sustainability of working with a plant material that is still used by tribal communities is not easily navigated, but the important part is that a dialogue is initiated, weavers are invited to take part in the process and are allowed to take the reins and lead the treatment how they see fit. This research does not support art conservators going out and finding a patch of *$óyla* and collecting for themselves. Instead, this research encourages art conservators to begin a conversation and maybe build a relationship with local weavers to allow communities to care for their belongings in the way they want.

7.2 Future Work

This research on basket repair material is essential not only for the thousands of baskets in collections worldwide, but for the weavers to regain the authority over a technique that has been with them since time immemorial. This work would include conservators working with weavers to attempt these various repairs using Indigenous materials, rather than all archival material. We keep in mind that these colonial mindsets are ingrained in institutions, and it will take time to become more communicative and transparent (personal communication with Myra Masiel-

Zamora October 2024). Using Indigenous materials also means that gathering is necessary, and over-gathering is possible. This is why building relationships is so crucial, to avoid over-gathering.

These techniques were a great starting point, with all of them requiring more than one sample. All techniques had at least three samples each, with compressive being the only technique with five samples since it was a newer technique, and we were uncertain how it would work. If this work were to be revisited, the sample size must be increased in order to see a clearer trend and account for premature sample failures.

Additionally, if this work were to be repeated, running these same tests but with wet or damp samples would be insightful, as this is how the material is handled typically. When weaving with *$óyla,* the elements are dipped in water, or soaked until flexible enough to weave without fracturing. Testing this way would prove to be meaningful and representative of the actual weaving technique.

8 Conclusions

This study of *$óyla* began as a material inquiry but evolved into a deeper reflection on the relationship between culture, science, and stewardship. Through shear strength, compressive, and light aging tests, this research has demonstrated that *$óyla* is not only mechanically viable as a repair material but also culturally resonant. Its strength, flexibility, and durability align well with conservation needs, while its presence within the basket weaving tradition of California Native peoples offers a rich, living connection to the objects themselves.

Yet beyond the data lies a more important finding: *$óyla* cannot be understood in isolation from the people who have used it, honored it, and sustained it for generations. The interviews with weavers reaffirmed that basketry is not simply a skill, but a worldview. Repairing a basket is not a technical act; it is a spiritual and relational one. It involves decisions about who has the right to intervene, what materials are appropriate, and how to preserve both the function and the meaning of the object. These decisions cannot be made in a vacuum. They must be guided by community knowledge and cultural authority.

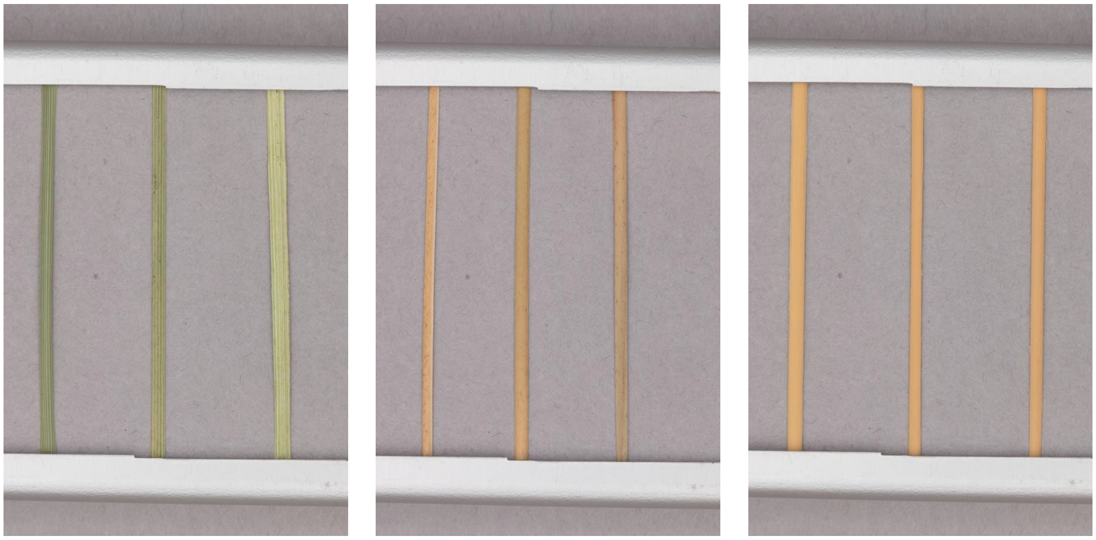
This research does not suggest that *$oyla* should immediately replace current conservation materials. Rather, it proposes that its inclusion be considered when appropriate, in consultation with Native weavers and source communities. It is not enough to test a material's mechanical properties; we must also test our willingness to change the systems that determine what is considered legitimate, standard, or safe.

Sustainability remains a core concern. As stewards of cultural heritage, art conservators must avoid creating demand that competes with Indigenous communities for their own resources. This research urges conservation professionals to view *$óyla* not as a new commodity, but as a potential site of relationship-building. If a basket requires treatment, the first question should not be "What can we use?" but "Who should we talk to?" The knowledge, experience, and authority of Indigenous weavers must guide conservation decisions from the outset.

Ultimately, this thesis informs conservators about an unknown material to them, so they can feel more confident incorporating it into collaborative treatments. It demonstrates that technical excellence and cultural sensitivity are not mutually exclusive—in fact, they are mutually reinforcing. When materials are treated not just as specimens but as cultural beings, when traditions are respected not as relics but as living practices, conservation has the potential to heal rather than merely preserve.

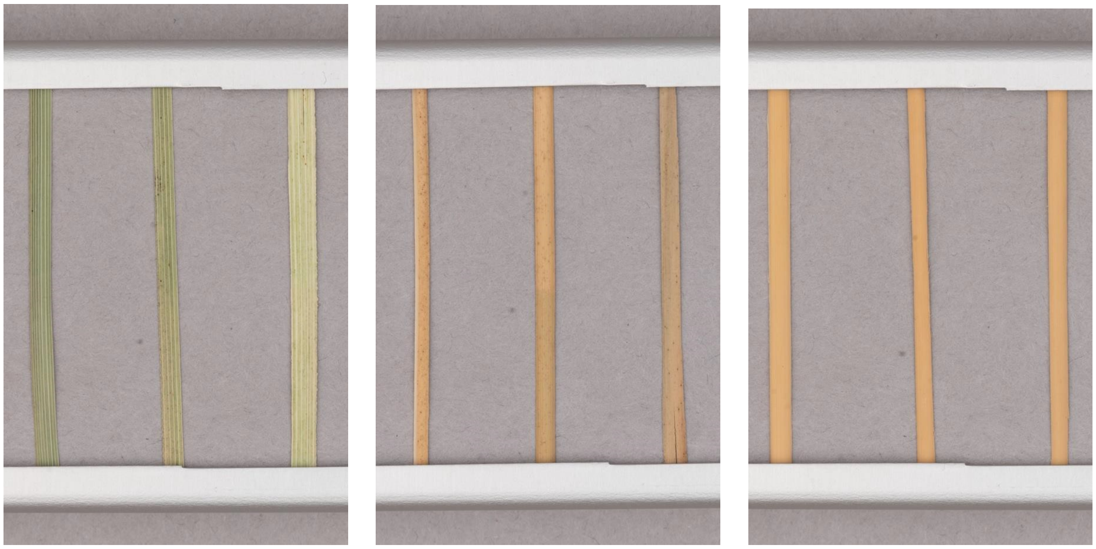
$óyla is strong, adaptable, and luminous. So too are the communities that have cared for it. Let this research be a small contribution to honoring that care, and to envisioning a future in which conservation is as relational as it is rigorous.

A Supplemental Images of Analytical Results



(a) Front BT (b) 1yr BT (c) 7yr BT

Figure A.19: Before images of accelerated light aging samples.



(a) Front AT **(b)** 1yr AT **(c)** 7yr AT

Figure A.20 After images of accelerated light aging samples.

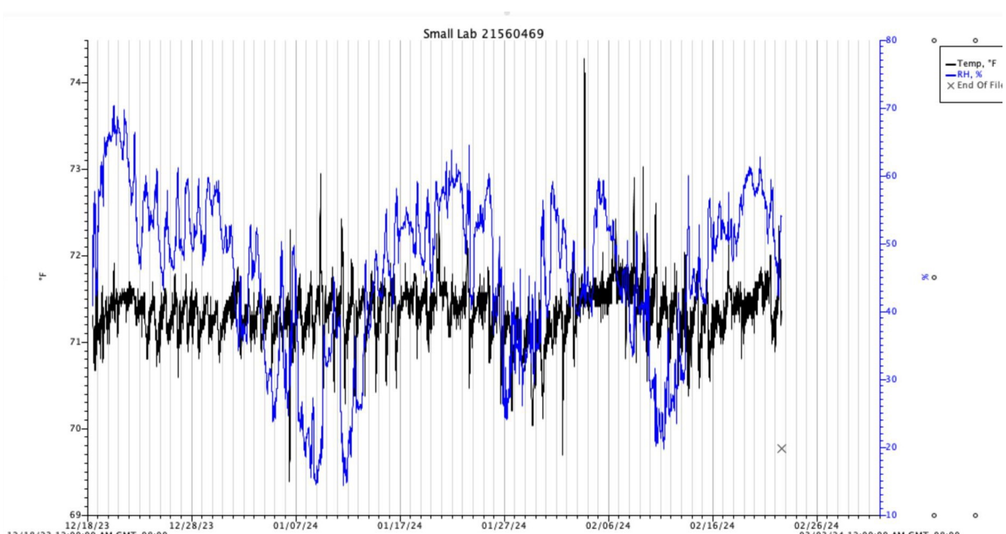


Figure A.21: Data from the environmental data logger for UCLA/Gerry Lab

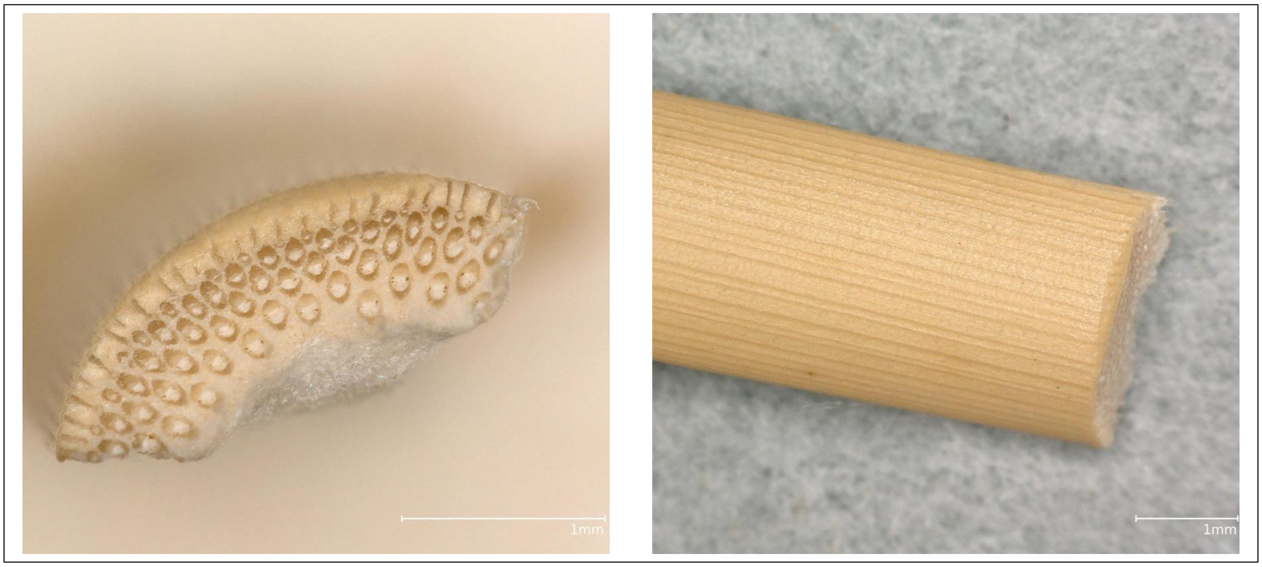


Figure A.22: 7yr $oyla cuticle and cross section.

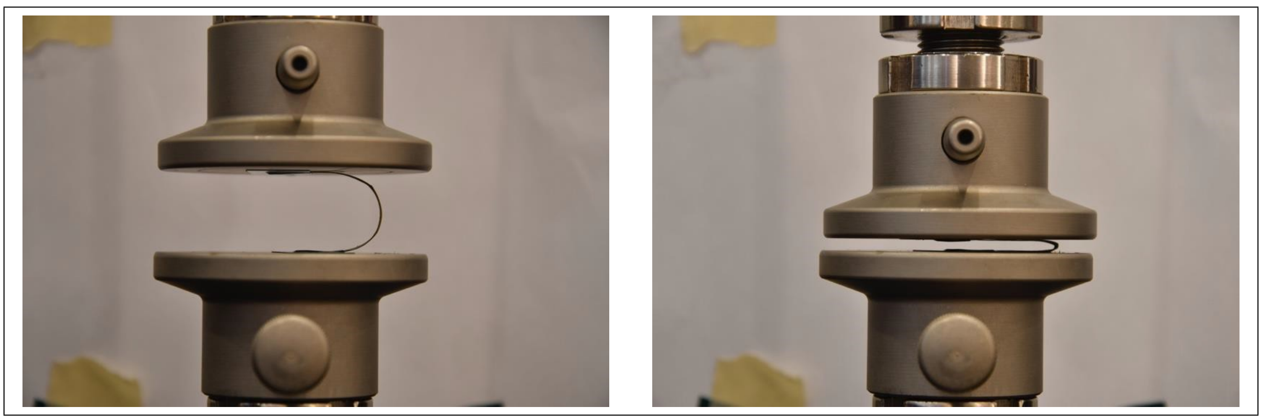


Figure A.23: Sample 1, fresh, before (left) and after(right)of compressive testing of $oyla loop.

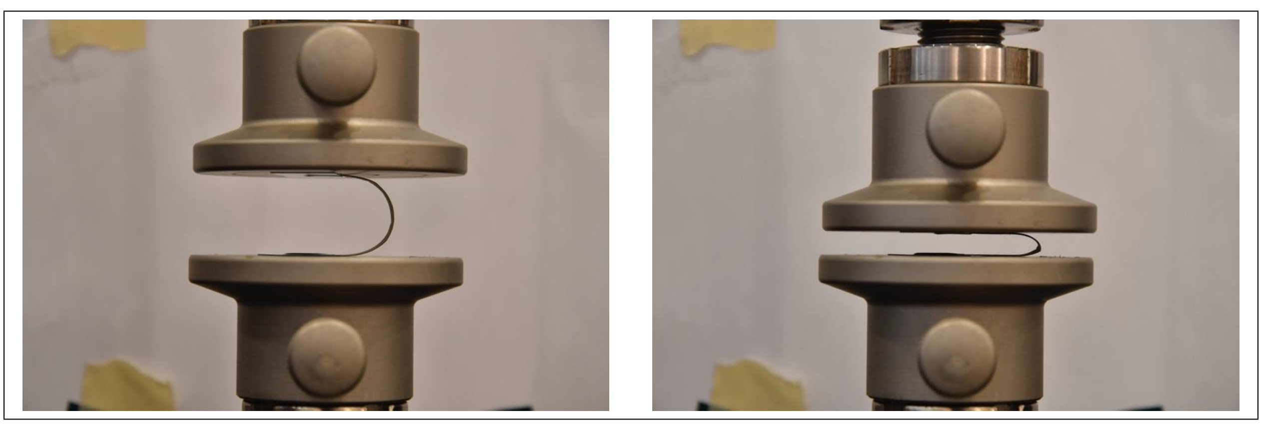


Figure A.24: Sample 2, fresh, before (left) and after(right)of compressive testing of $oyla loop.

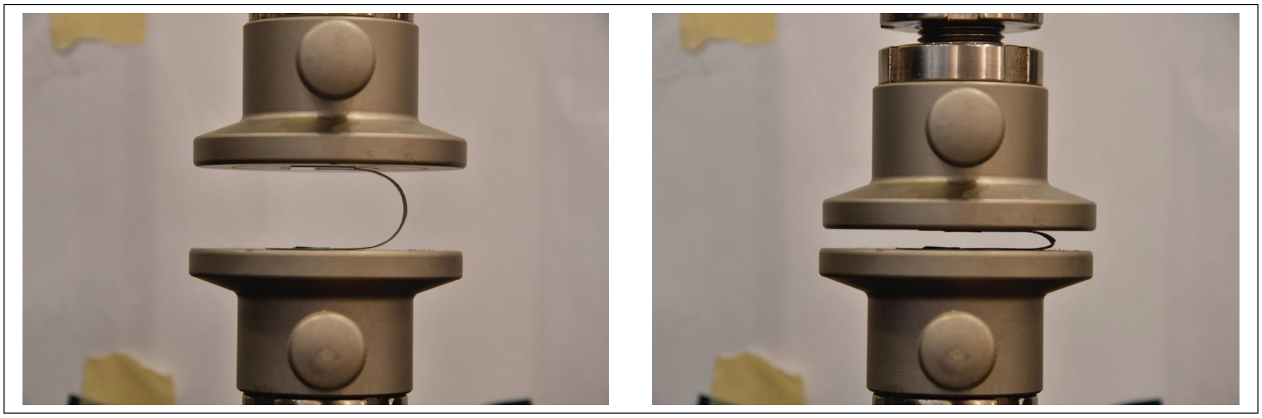


Figure A.25: Sample 3, fresh, before (left) and after(right)of compressive testing of \$oyla loop.

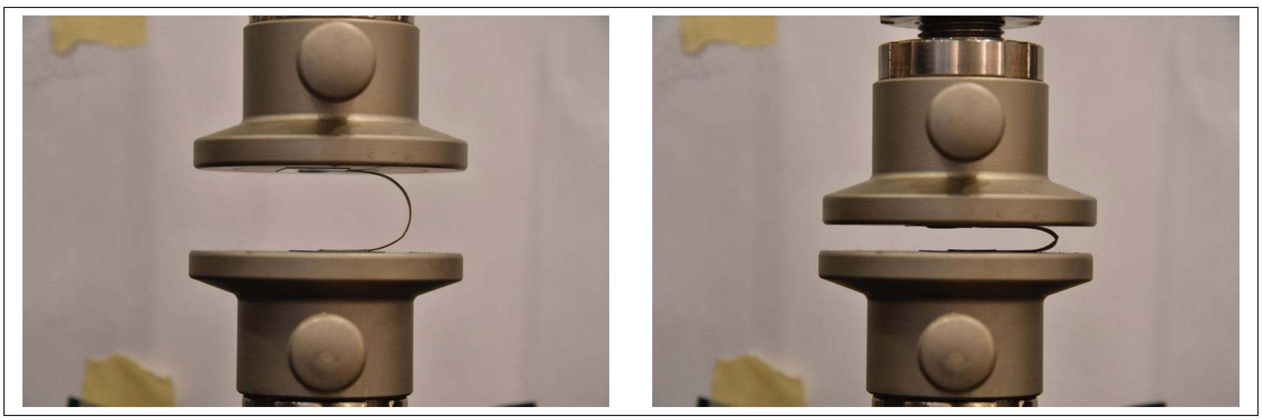


Figure A.26: Sample 4, fresh, before (left) and after(right)of compressive testing of \$oyla loop.

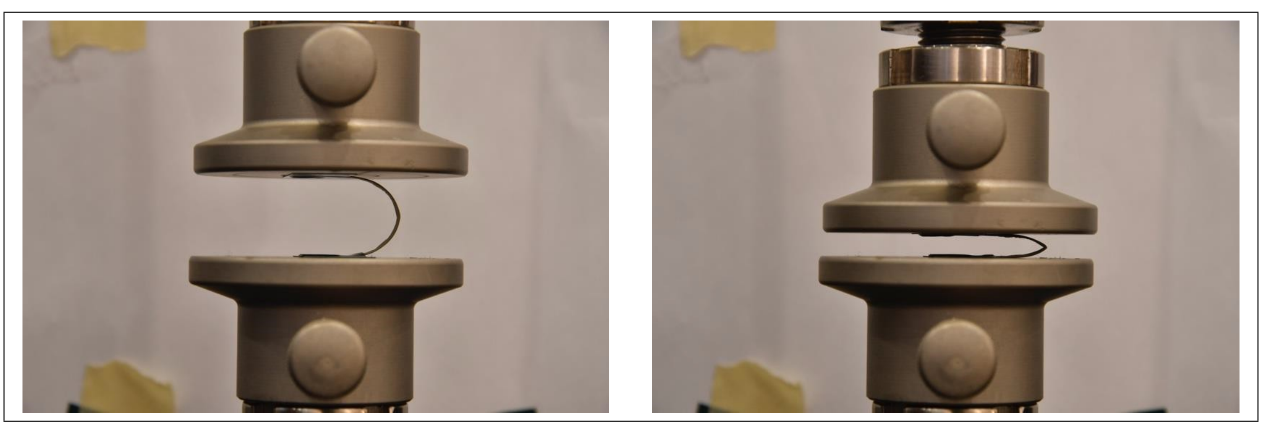


Figure A.27: Sample 5, fresh, before (left) and after(right)of compressive testing of \$oyla loop.

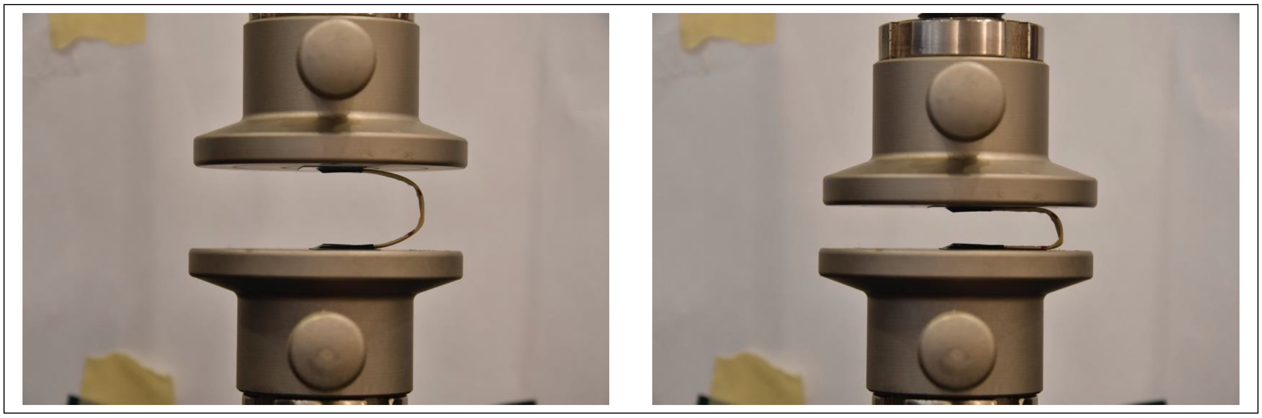


Figure A.28: Sample 1, 7 yr, before (left) and after(right)of compressive testing of $oyla loop.

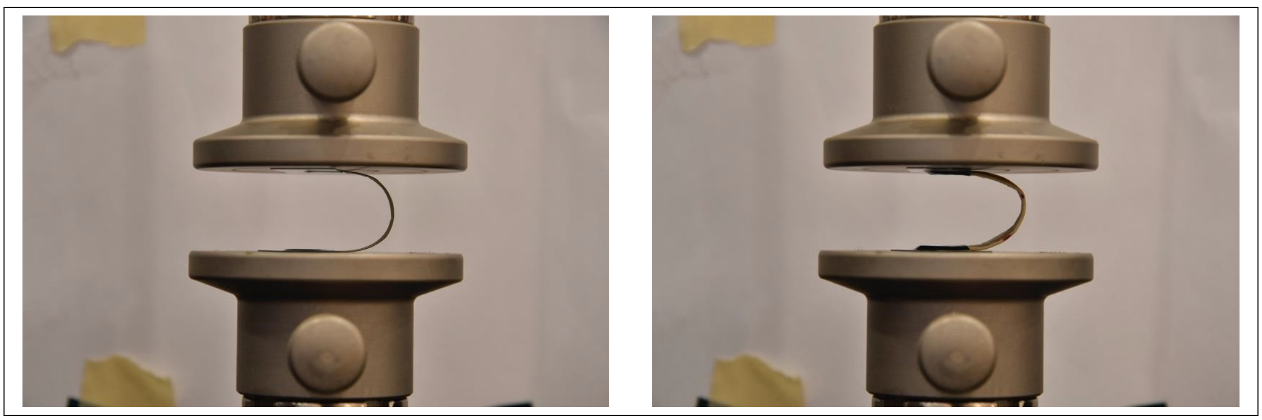


Figure A.29: Sample 2, 7 yr, before (left) and after(right)of compressive testing of $oyla loop.

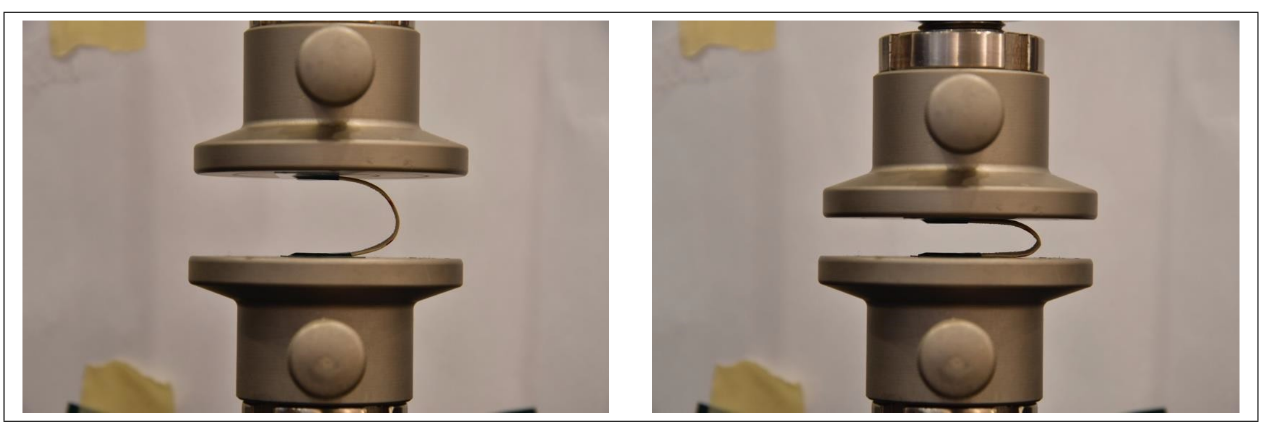


Figure A.30: Sample 3, 7 yr, before (left) and after(right)of compressive testing of $oyla loop.

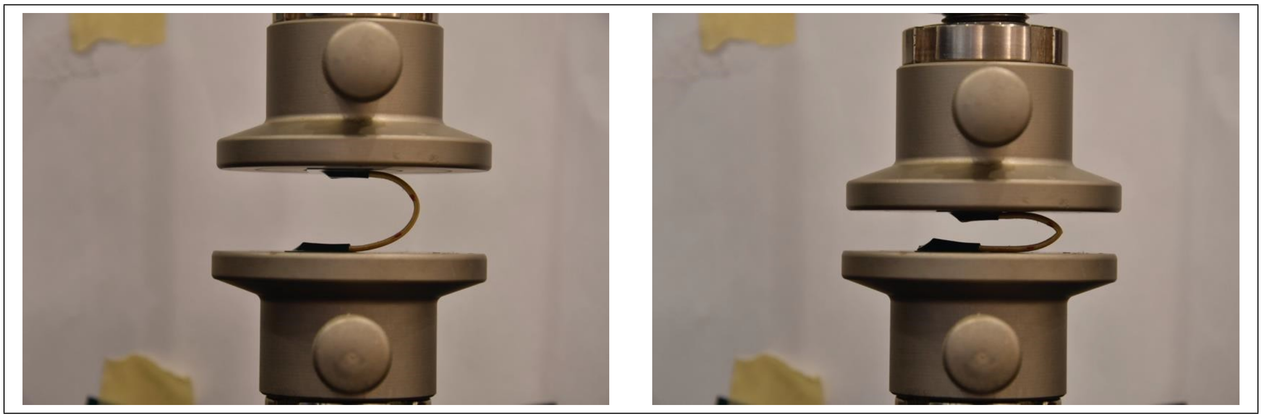


Figure A.31: Sample 4, 7 yr, before (left) and after(right)of compressive testing of $oyla loop.

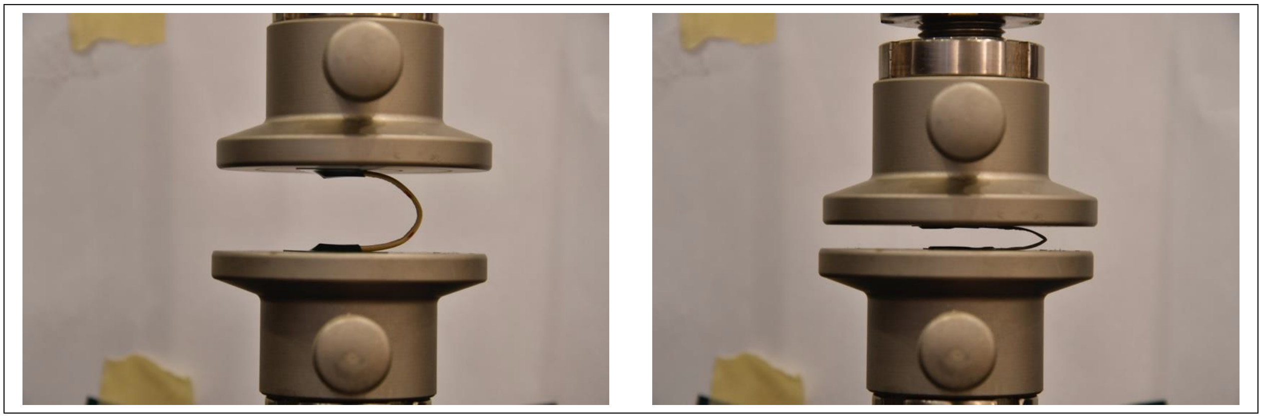


Figure A.32: Sample 5, 7 yr, before (left) and after(right)of compressive testing of $oyla loop.

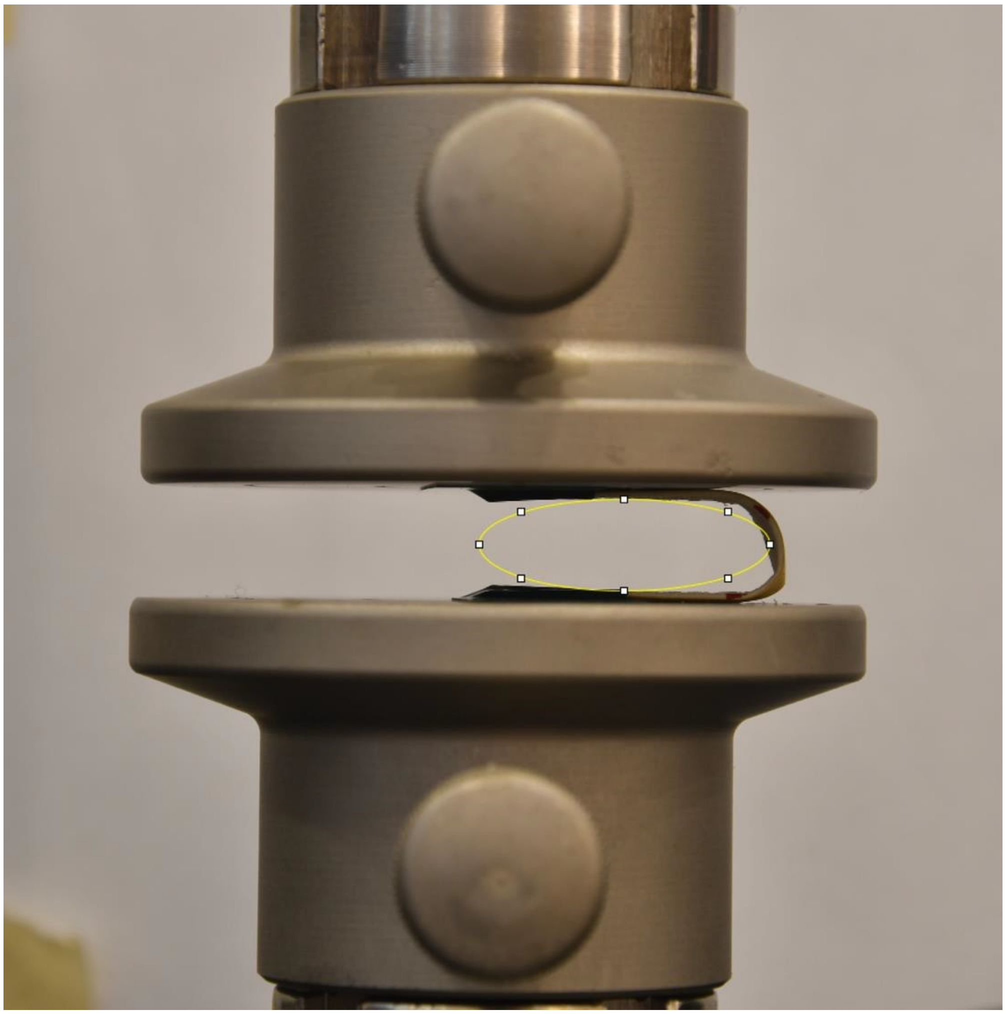


Figure A.33: How compressive angles were calculated at the point of failure: Used ImageJ to create an ellipse and take the arctan calculation with the width and height to determine the angle at which the fiber failed. This data was then connected to the load at the point of failure. This data was helpful, but was determined to be subjective based on how the angle was measured on ImageJ.

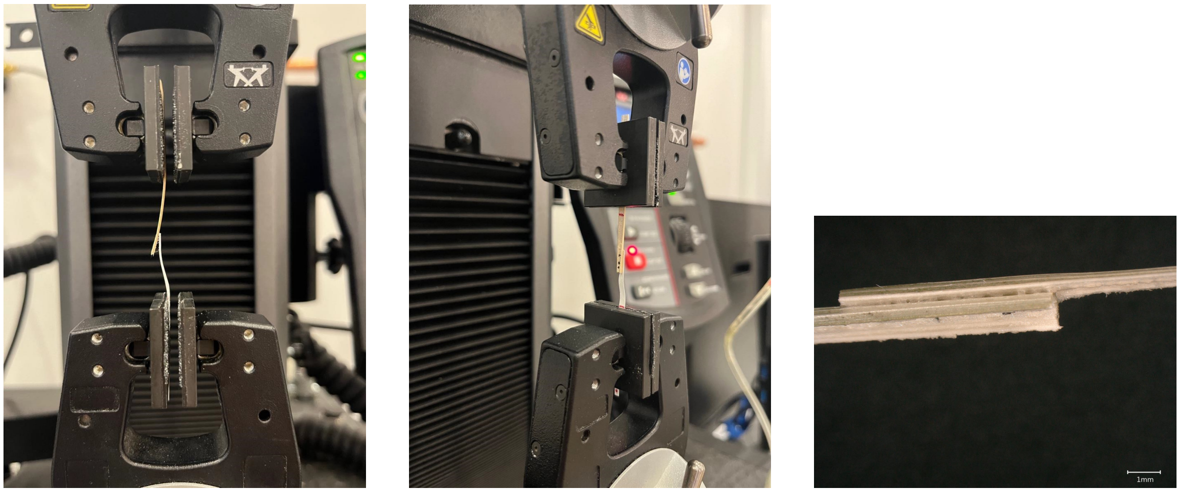


Figure A.34: Sheer strength testing.

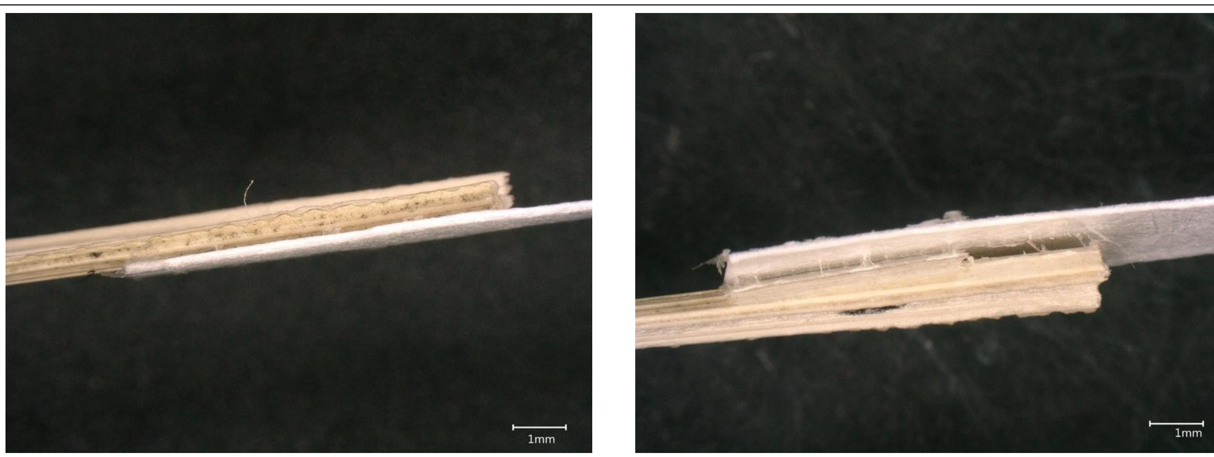


Figure A.35: Fresh $oyla Sample2 JT wheat starch paste, before (left) and (after) sheer strength testing.

Figure A.36: 1yr sample 1 JJ B72 BT.

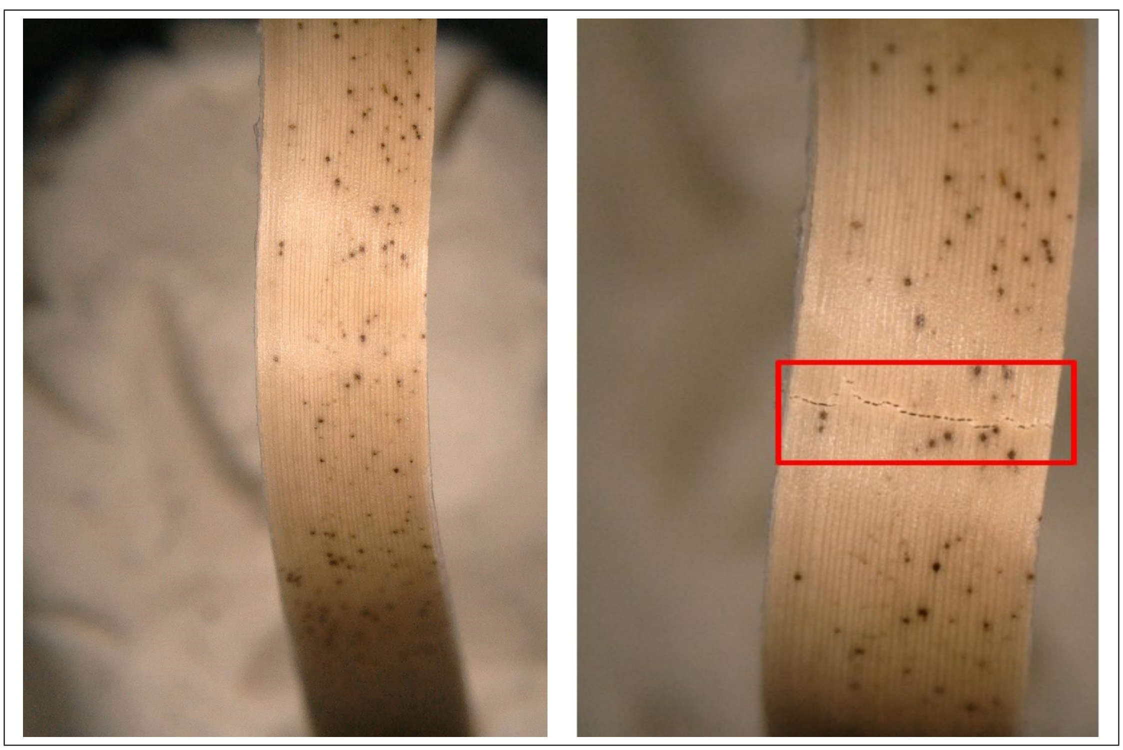


Figure A.37: 1yr Sample 4 Apex Before and After Compressive Testing.

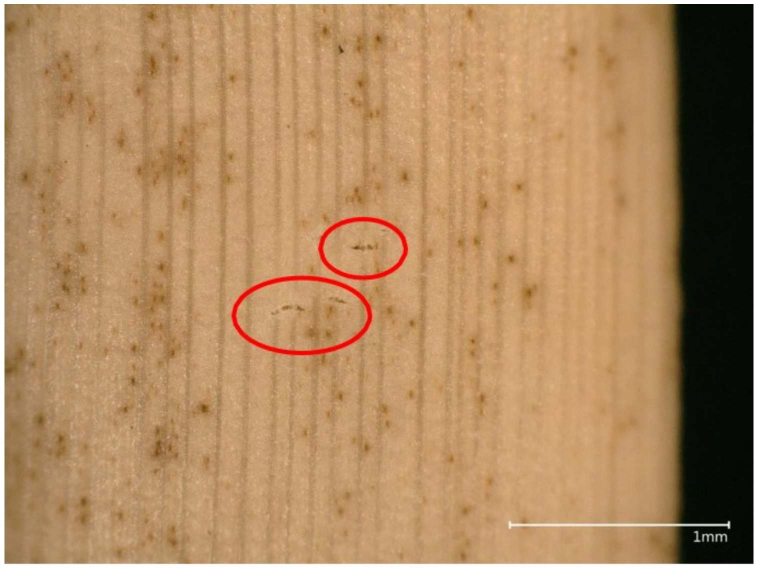


Figure A.38: Image detailing the breaks in the sample prior to compressive testing, leading to early failure of 7yr $oyla Sample 5 BT.

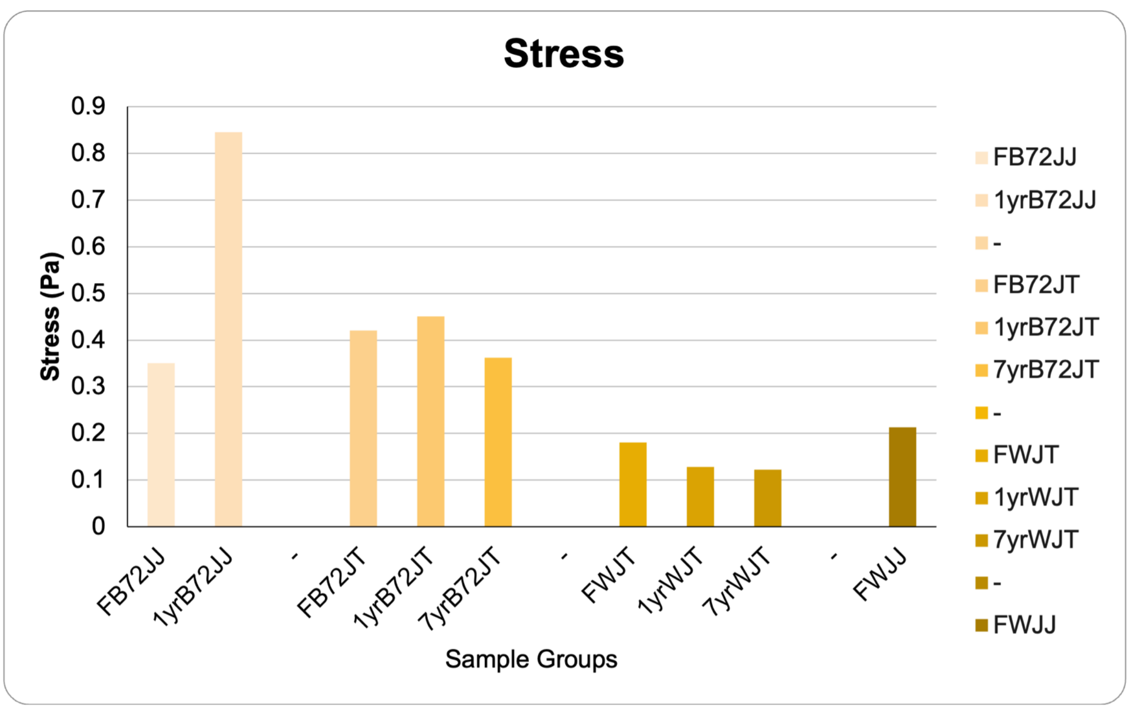


Figure A.39: Stress results for hear strength testing.

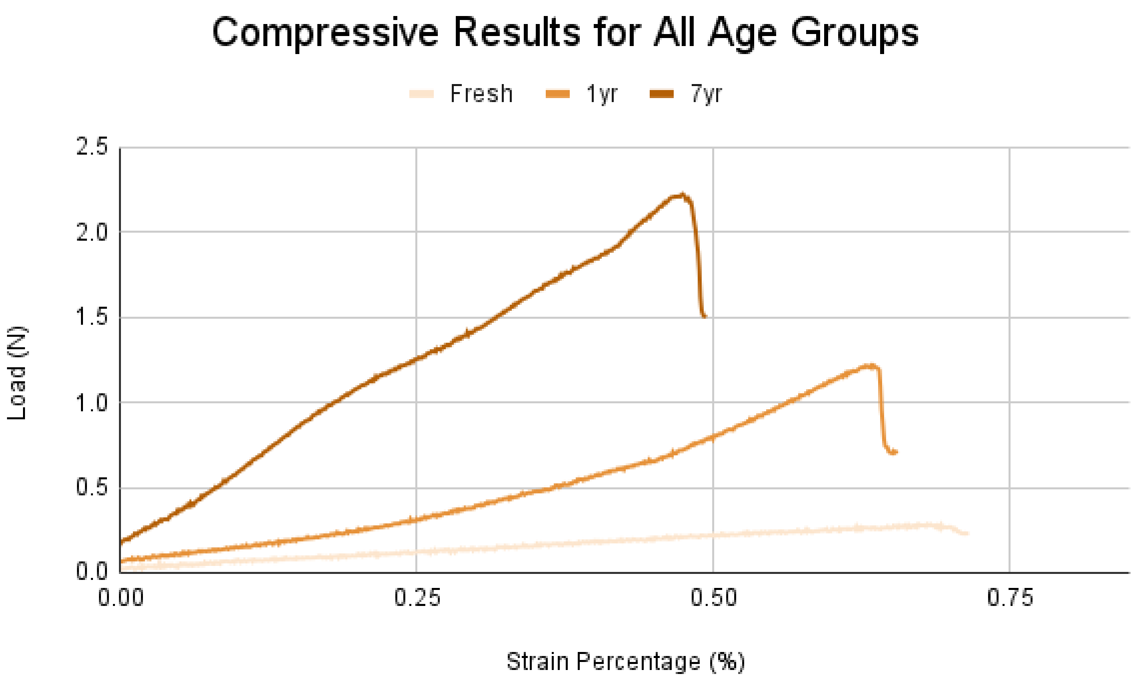


Figure A.40: Compressive results for all age groups. This graph shows the point of failure for the most representative sample from each age group.

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