



Adhesives for Bio-based Materials

Guidance Playbook

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Glossary

Adhesive	Substance used to bond materials together by surface attachment
Biobased	A material or product that is derived wholly or partly from biological sources
Catalyst	Substance which accelerates polymerisation without being consumed itself
Crosslink	A chemical bond that link one polymer chain to another
Cure	The process by which an adhesive hardens and develops its final properties
Emissions	Gases or vapours released from materials, such as volatile organic compounds (VOCs)
Polymer	A large molecule composed of repeating structural units (monomers)
Polyaddition polymerisation	When monomers with reactive end groups join to build a polymer, e.g. polyurethane
Polycondensing polymerisation	When small molecules are released during polymerisation, such as water, e.g. phenolics
Resin	Viscous substance, either natural or synthetic, used as the base for adhesives
Substrate	The base material that is to be joined
Volatile organic compound (VOC)	Compounds that have a high vapor pressure and low water solubility

Context

The use of bio-based construction materials is growing. Many bio-based materials present fewer human and environmental health impacts compared to their petroleum- and mineral-based counterparts. However, particularly among highly processed composites, bio-based construction materials rely on adhesives to bind components together.

It is critical to understand the role and impact of these adhesives. The wide range of adhesive technologies, each with distinct technical properties and potential health impacts, adds complexity to the selection process. Depending on the application, the adhesive must be durable, fire-resistant, structurally sound, and, ideally, non-toxic over the course of the product lifecycle. Newer adhesives must also compete against well established glues on both cost and ease/speed of use.

Comprehensive, cross-disciplinary research is essential to navigate this complexity and inform product selection for various bio-based construction applications.

This guidance playbook is intended to address the broader range of bio-based construction materials, with particular focus on wood products, due to the expansion of mass timber use in the East Bay.

Scope



Purpose of this Playbook

To summarize information on adhesives for bio-based materials, such as engineered structural timber, bamboo, natural fiber composites, engineered wood flooring, and cork board.

Audience

Any professional looking to better understand the impact from adhesives in bio-based materials used for construction.

Geographic Scope

Limited to the standards and practices seen in the US, Canada, and Europe.

Surveyed Adhesives

- Urea formaldehyde (UF)
- Phenol formaldehyde (PF) and phenol resorcinol formaldehyde (PRF)
- Melamine formaldehyde (MF) and melamine urea formaldehyde (MUF)
- Polyurethane (PU or PUR)
- Emulsion polymer isocyanate (EPI)
- Soy-based binders

Adhesives: Overview

Adhesives join materials together by forming a strong, durable bond with the substrate. Each type of adhesive is suited for specific applications and material compatibility. Choosing the right adhesive involves matching its properties with the specific requirements of a given material, application, and the conditions to which it will be exposed to.

Bio-based construction materials come from renewable sources like wood, bamboo, and agricultural residues. These materials include engineered wood products, such as cross-laminated timber (CLT), and natural insulation materials like kenaf and hemp. Selecting the right adhesive is critical for these materials and requires consideration of factors like moisture resistance, flexibility, and emissions of volatile organic compounds (VOCs).

Adhesives: Overview

As noted earlier, the wide variety of adhesives present pros and cons in different aspects. This summary presents a very high-level view of some of the characteristics that make them commonly sought-after or avoided by manufacturers, contractors, designers, and specifiers.

Urea Formaldehyde (UF)	Phenol Formaldehyde (PF/PRF)	Melamine Formaldehyde (MF/MUF)	Polyurethane (PU/PUR)	Emulsion Polymer Isocyanate (EPI)	Soy-Based Adhesive
<ul style="list-style-type: none"> (-) Inferior moisture, temperature, and abrasion resistance (-) Higher VOC emissions relative to other formaldehyde-based adhesives (+) Lower cost 	<ul style="list-style-type: none"> (+) Superior temperature and chemical resistance, hardness (-) Higher cost than other formaldehyde-based resins 	<ul style="list-style-type: none"> (+) Superior moisture, temperature resistance compared to UF (+) More rigid than other adhesives. (+) Cost-effective (-) Does not eliminate hazards associated with formaldehyde 	<ul style="list-style-type: none"> (+) Properties are tunable depending on the needs of the application (-) More expensive than formaldehyde-based binders 	<ul style="list-style-type: none"> (-) Inferior moisture and temperature resistance and inferior adhesion relative to other adhesives (-) Higher cost (+) Less toxic in manufacture and use 	<ul style="list-style-type: none"> (-) Variable water resistance depending on formulation (-) Brittle (+) Cost fluctuates depending but is in the range of UF (+) Less toxic in use

Please note, this list covers the primary adhesives in use. Less-widely used adhesives such as polymeric methylene diisocyanate (pMDI), polyvinyl acetate (PVA) and epoxy are not included in the Playbook.

Adhesives are being developed all the time, including formulations that incorporate bio-based ingredients. It is possible that other product options become available that meet the needs of specific applications in the future.

PF is often used with Resorcinol Formaldehyde to improve its physical and workability properties. UF is often combined with MF to produce an adhesive with lower formaldehyde emissions and better moisture resistance.

Choosing among structural adhesive options

Because of the variability in formulations and performance needs of adhesives, these recommendations (green) are made based solely on the health hazards of the adhesives from the discovery methods of this study. See appendix for details.

	Biobased Material	Urea Formaldehyde (UF)	Phenol Formaldehyde (PF/PRF)	Melamine Formaldehyde (MF/MUF)	Polyurethane (PU/PUR)	Emulsion Polymer Isocyanate (EPI)	Soy-Based Adhesive
Structural	Cross-laminated timber (CLT)		⊙	⊙	⊙	⊙ (minor use)	
	Glue-laminated timber (Glulam)		⊙	⊙	⊙	⊙ (minor use)	
	Oriented strand board (OSB)		⊙	⊙			
	Plywood	⊙ (interior grades)	⊙ (exterior grades)				
	Blockboard	⊙	⊙	⊙			⊙
	Laminated veneer Lumber (LVL)		⊙		⊙	⊙	
	Laminated strand lumber (LSL)		⊙	⊙			
	Parallel Strand Lumber (PSL)		⊙				
	Oriented strand lumber (OSL)		⊙				
	Wood I joists (web to flange and web-web joints)		⊙			⊙	⊙ (minor use)
	End-jointed lumber		⊙		⊙	⊙	

Legend
 ⊙ Used in material
 ■ Recommended

Choosing among non-structural adhesive options

Because of the variability in formulations and performance needs of adhesives, these recommendations (green) are made based solely on the health hazards of the adhesives from the discovery methods of this study. See appendix for details.

	Biobased Material	Urea Formaldehyde (UF)	Phenol Formaldehyde (PF/PRF)	Melamine Formaldehyde (MF/MUF)	Polyurethane (PU/PUR)	Emulsion Polymer Isocyanate (EPI)	Soy-Based Adhesive
Non-Structural	Particleboard	⊙	⊙	⊙			⊙ (emerging use)
	Medium-density fiberboard (MDF)	⊙	⊙	⊙			⊙ (emerging use)
	Bamboo panels	⊙	⊙	⊙	⊙		
	Bamboo composites	⊙	⊙	⊙	⊙	⊙ (emerging use)	
	Flax fiber composites	⊙	⊙	⊙		⊙ (emerging use)	⊙ (emerging use)
	Kenaf fiber composites	⊙	⊙	⊙		⊙ (emerging use)	⊙ (emerging use)
	Engineered wood flooring	⊙		⊙	⊙	⊙	
Other	Agglomerated cork boards*	⊙		⊙	⊙		
	Window frames		⊙	⊙		⊙	
	Wood veneer	⊙				⊙	⊙ (emerging use)

Legend
 ⊙ Used in material
 ■ Recommended

* Unlike Agglomerated cork boards, cork insulation is made from expanded cork granules bonded together with their natural resins – there is no adhesive

How do these adhesives compare to each other?

This comparison was derived from a 4-point scale based on the range of property values, as described in the Appendix. This table illustrates how the performance of these adhesives are often more nuanced and often deserve evaluation case-by-case.

	Urea formaldehyde	Phenol formaldehyde	Melamine formaldehyde	Polyurethane	Emulsion polymer isocyanate	Soy-based adhesive
Aesthetic flexibility, i.e. color	Excellent	Poor	Good	Fair	Good	Fair
Cost	Excellent	Poor	Good	Fair	Fair	Excellent
Durability	Fair	Excellent	Good	Good	Good	Fair
Fire performance	Poor	Excellent	Good	Fair	Fair	Data gap
Manufacturing	Good	Good	Good	Fair	Fair	Fair
Health in manufacture	Poor	Poor	Poor	Fair	Fair	Poor
Health in use	Fair	Excellent	Good	Excellent	Excellent	Excellent
Health in fire	Data gap	Poor	Fair	Poor	Data gap	Data gap
Health at end of life	Data gap	Data gap	Data gap	Good	Data gap	Data gap



Properties

Many factors influence the selection of adhesives used in bio-based materials, including:

- Strength
- Appearance
- Cost
- Durability
- Fire resistance
- Ease of manufacture

The shear strength of adhesives used with wood is generally greater than the shear strength of the timber it is bonding and as a result, failure of a well-made dry bond occurs in the wood or bio-based substrate.

The color of the adhesive is important in selection if the bond will be visible in service. Clear or light-coloured glues similar in color to the substrate, are more versatile. For many non-visible applications, color is not a significant factor.

Adhesive cost is affected by the quantity purchased and the deal negotiated, thus the price comparison is based on broad industry analysis in the US. Data is widely available for the formaldehyde adhesives.

Durability, fire resistance and ease of manufacture are addressed on the following pages.

	Appearance	Cost	Comments
UF	Excellent	Excellent	<ul style="list-style-type: none"> • Clear/ colourless • 2025 Q3 market data for USA \$908/metric tonne (imarc, 2025)
PF	Poor	Poor	<ul style="list-style-type: none"> • Dark brown • 2023 December data for USA \$3085/metric tonne (imarc 2, 2025)
MF	Good	Good	<ul style="list-style-type: none"> • Light • 2025 December data for USA \$1080/metric tonne (Business analitiq, 2026)
PU	Fair-Good	Fair	<ul style="list-style-type: none"> • Mid to light-brown • 2025 Q3 market data for USA \$1750/MT (imarc 3, 2025)
EPI	Good	Fair-Good	<ul style="list-style-type: none"> • Light • The cost is based on polyvinyl acetate costs (intratec, 2025)
SOY	Fair-Good	Excellent	<ul style="list-style-type: none"> • Mid to light-brown • Pricing is similar to UF

Durability

Difference in durability

Whilst the dry bond strength of these adhesives should be higher than the shear strength of softwood, meaning that failure occurs in the wood or bio-based material rather than the adhesive bond, this is not necessarily the case should the adhesive become wet. The main factors affecting bond durability are the adhesive’s resistance to water, temperature, and the duration of the applied load.

ASTM D2559 (2024) must be met for adhesives used structurally in exterior conditions. It was developed for glulam, but its use has expanded to structural composite lumber, I-joists, etc. To comply, the adhesive must meet certain shear strength criteria. It must not delaminate beyond set levels after vacuum pressure wetting, drying, and steam cycles, and shall not exceed a total creep value after 7 days loading.

ASTM D5751 (2019) is the specification for non-structural lumber products, such as interior and exterior mouldings, window and door components and bonded lumber panels. For dry use applications, the samples must meet specified strength and perfect wood failure requirements under dry conditions, after a 2-cycle soak test, and after exposure to 104°C. For wet-use applications, they must also meet criteria for a boil test and a vacuum pressure wet test.

	Durability	Comments
UF	Fair	<ul style="list-style-type: none"> • Can not meet ASTM D2559 • Expected to meet ASTM D5751 dry use requirements • INT to BS1204:1979
PF	Excellent	<ul style="list-style-type: none"> • Can meet ASTM D2559 • Can meet ASTM D5751 dry and wet use requirements • WBP to BS1204:1979
MF	Good	<ul style="list-style-type: none"> • Can meet ASTM D2559 • Can meet ASTM D5751 dry and wet use requirements • MR or sometimes WBP to BS1204:1979
PU	Good	<ul style="list-style-type: none"> • Can meet ASTM D2559 • Can meet ASTM D5751 dry and wet use requirements • Not tested to old wood glue standards
EPI	Good	<ul style="list-style-type: none"> • Can meet ASTM D2559 • Can meet ASTM D5751 dry and wet use requirements • Not tested to old wood glue standards
SOY	Fair	<ul style="list-style-type: none"> • Can not meet ASTM D2559 • Expected to meet ASTM D5751 dry use requirements • INT to BS1204:1979

BS 1204 (British Standards Institution, 1979) is an old classification of adhesive durability with the following classifications in decreasing order of resistance: WBP = weather-proof & boil-proof>BR =Boil resistant> MR = moisture resistant and moderately weather resistant > INT = Interior

Fire

Factors affecting structural fire performance

The fire performance of bio-based products is largely determined by the timber or bio-based material that makes up most of the board. However, the adhesive's high-temperature properties are critical in determining when it will lose sufficient strength for the product to fail. This becomes critical in structural applications.

High temperature testing of timber adhesives show that while all adhesives generally retain their strength up to 120°C, polycondensation adhesives (PF, MF) maintain strengths comparable to the timber substrate far better than the polyaddition adhesives (one-component PU*, EPI and soy), with performance sustained up to 270°C (Aicher et al, 2024), (Bernaczyk et al, 2023).

Where the product is intended for structural use, the adhesive's performance must be tested in accordance with ASTM D7247-17 (2017). Both studies noted that PU high-temperature performance varied significantly between products, even among similar systems.

	Fire	Comments
UF	Poor	<ul style="list-style-type: none">High temperature performance typically up to 120°CDecomposition temp >200' (Hurley, 2016)
PF	Excellent	<ul style="list-style-type: none">High temperature performance typically up to 270°CDecomposition temp 450°C-480°C (Hurley, 2016)
MF	Good	<ul style="list-style-type: none">High temperature performance can be up to 270°C
PU	Poor - Good	<ul style="list-style-type: none">High temperature performance typically up to 120°CDependent on the adhesive system – always check ASTM D7247 testing for structural applications
EPI	Moderate	<ul style="list-style-type: none">High temperature performance typically up to 120°C
SOY	N/A	<ul style="list-style-type: none">No data

Polyaddition involves monomers with reactive end groups joining without by-product formation, typical of polyurethanes and polyureas. **Polycondensation**, used for polyesters, polyamides, and phenolic resins, releases small molecules like water or methanol during polymerisation. Because polycondensation involves irreversible bond formation, these polymers resist heat better than polyaddition types, which can depolymerise with heat. Although UF is a polycondensation adhesive, its lower crosslink density and less stable structure make it less heat-resistant than PF and MF.

*Note: One-component polyurethane needs no mixing, which leads to easier application. Two-component requires mixing two parts (a polyol and an isocyanate) before use, producing a faster, more controlled, reaction that delivers higher strength.

Manufacturing

Appropriate selection

It is difficult to truly compare manufacturing properties of adhesives against one another, given the wide variety of available products, formulations, and manufacturing techniques.

Adhesives may be applied as droplets to bind small particles together, as continuous films for lamination, or as bonding layers to assemble components such as finger-joints or I-beams. They may be spread using hand techniques or an automated process. Curing can occur at room or elevated temperatures. Some uses will require a short pot life and rapid curing time, whilst others will need the adhesive to remain workable for longer.

End uses can be in permanent structural components, such as glulam or CLT, in furniture and fit-out, or for purely decorative purposes. A higher-cost adhesive can provide downstream benefits, such as reduced assembly time or improved performance. For example, one-component polyurethane needs no mixing, which leads to easier application. Two-component PU requires mixing two parts (a polyol and an isocyanate) before use, producing a faster, more controlled, reaction that delivers higher strength.

Manufacturing		Comments
UF	Good	<ul style="list-style-type: none"> Water-based Powders will last ~12 months, liquid resins only weeks Typically hot press for panel manufacture (120°C, 5 minutes) Short pot life Easy clean up with water before cure (Goodlyglue, 2025)
PF	Good	<ul style="list-style-type: none"> Water-based For resins & hardeners ~1-2 years shelf life depending on manufacturer Typically cold set, 2-8 hours at room temperature, but can be heated for faster cure Warm water clean up before cure (Woodstick, 2025)
MF	Good	<ul style="list-style-type: none"> Water-based Powders will last ~12 months, liquid resins only weeks Typically hot cured Easy clean up with water before cure (Goodlyglue, 2025)
PU	Fair	<ul style="list-style-type: none"> Generally solvent-less system Unopened one-component PU lasts 1-2 years, two-component PU ~1 year 1-part moisture cure 1-2 hours Solvent clean-up needed (Newtop 2025)
EPI	Fair	<ul style="list-style-type: none"> Water-based Shelf life: Part A (emulsion) 1 year, part B (isocyanate catalyst) 6-12 months Cure ~1 hour at room temperature, 4-8 hours for full cure Easy clean up with water before cure (Adhesives +Coatings, 2025)
SOY	Fair	<ul style="list-style-type: none"> Water-based One-component adhesive so does not require mixing of a catalyst or two-components. Shelf life 6-12 months Generally hot press cure as slow at room temperature Easy clean up with water before cure (Goodlyglue, 2025)

Health

Hazards & Risks

Adhesives present potential health hazards throughout the lifecycle of bio-based products – from manufacturing to use, potential fire, and at end-of-life. Different populations may encounter different hazards at stages, which may prompt building-industry stakeholders to adopt a precautionary approach to protect human health.

Hazard-based Assessments

In the building industry, material health assessments usually focus on inherent hazard properties of chemicals in building materials. These are often based on a synthesis of toxicological and epidemiological studies. These assessments often rely on list-based screenings to qualitatively assess hazard for a given material.

Risk Assessments

Risk assessments, which consider both hazard and exposure and are often quantitative, are considerably more resource-intensive. Risk assessments are not typically performed as part of a building materials selection process.

The findings summarized in the following sections were synthesized from a list-based screening process using the [Pharos](#) tool and supplemented with primary literature.

The following pages discuss potential health impacts of each of the six adhesives considered in this report, organized by lifecycle stage. The discussions are primarily hazard-based and supplemented with qualitative consideration of potential exposure routes and intensities.

In general, across each of the six adhesives, the highest identified hazards occur during the manufacturing phase. Emissions during potential fire and end-of-life stages are less studied but crucial for assessing overall safety.

Health in Manufacture

Manufacturing

The manufacturing of adhesives often involves hazardous chemicals, including volatile organic compounds (VOCs), formaldehyde, phenol, melamine, and isocyanates. Due to the volatility of these chemicals and the range of hazards they pose, it is critical for manufacturing plants to adhere to the required and recommended exposure controls to protect workers. However, elimination or substitution of the hazardous chemicals remains the most effective way to reduce manufacturing-related health impacts (CDC, 2025).

	Manufacturing Hazard Level	Comments
UF	Very high	<ul style="list-style-type: none"> UF is made from formaldehyde, a known carcinogen (IARC, 2006) skin (MAK, 2025) and respiratory (AOEC, 2025) sensitizer, and hazardous component of smog. Formaldehyde emissions during curing depend on the temperature and formaldehyde-to-urea ratio.
PF	Very high	<ul style="list-style-type: none"> PF is made from formaldehyde. (See above.) PF, the product of formaldehyde and phenol, is a suspected immunotoxicant (Habitable, 2008).
MF	Very high	<ul style="list-style-type: none"> MF is made from formaldehyde (see above). Formaldehyde, methanol, ammonia, melamine dust, and VOC emissions during curing depend on temperature and formaldehyde-to-melamine ratio.
PU	High	<ul style="list-style-type: none"> Diisocyanates, used in the production of PU, are skin, mucous membrane, respiratory tract, and eye irritants and their primary adverse effect is asthma (AOEC, 2025). Isocyanates can cause "sensitization" leading to severe reactions on repeated exposure, which is particularly significant for workers.
EPI	High	<ul style="list-style-type: none"> EPI adhesive includes isocyanate crosslinkers in the manufacturing process (see above) (AkzoNobel, 2025).
SOY	Very high	<ul style="list-style-type: none"> The soy-based adhesive is made from a soy protein mixed with a resin that includes epichlorohydrin (Spayde, et al. 2013). IARC found epichlorohydrin to be probably carcinogenic to humans (IARC, 1987), and the compound is on California's Proposition 65 list as a known carcinogen (OEHHA, 2025).

Health in Use

Use

Adhesives-related health impacts primarily arise from chemical off-gassing from the installed product. The extent to which adhesives off-gas and, in turn, affect indoor air quality depends on environmental (e.g., temperature and humidity) and chemical factors (e.g., concentration and reactions with indoor air).

In this context, formaldehyde is a significant concern due to its volatility and carcinogenicity. Ongoing research continues to examine how formaldehyde from wood-based products affects typical indoor formaldehyde concentrations. For example, measured emissions from composite wood products have ranged from 12 to 212 $\mu\text{g}/\text{m}^2\text{hr}$, compared to 3 to 7 $\mu\text{g}/\text{m}^2\text{hr}$ for solid wood (Salthammer, 2019). Newer PF and MF formulations meeting European standards can achieve emission levels comparable to those naturally present in untreated wood.

	Use Phase Hazard Level	Comments
UF	High	<ul style="list-style-type: none"> UF has a higher proportion of unreacted formaldehyde than other formaldehyde-based resins, like PF (CARB, 2025). UF emissions depend on the urea-to-formaldehyde ratio and the ambient temperatures and humidities present. High temperatures/humidities can lead to long-term formaldehyde release due to hydrolysis (Zhang, et al. 2018).
PF	Low	<ul style="list-style-type: none"> PF emits 90% less formaldehyde than UF, but emissions are not eliminated (HBN, 2008).
MF	Moderate	<ul style="list-style-type: none"> MF emits much less formaldehyde than UF because its chemical bonds are inherently stronger and the adhesive formulation ensures that no free formaldehyde remains after polymerisation (Chimar Hellas S.A. (2008).
PU	Low	<ul style="list-style-type: none"> PU adhesives do not contain added formaldehyde. While data are limited, once cured, diisocyanate emissions are theoretically insignificant and the cured resin poses minimal hazard.
EPI	Low	<ul style="list-style-type: none"> EPI adhesives do not contain added formaldehyde. While data are limited, once cured, diisocyanate emissions are theoretically insignificant and the cured resin poses minimal hazard.
SOY	Low	<ul style="list-style-type: none"> Soy-based adhesives do not contain added formaldehyde. While data are limited, once cured, diisocyanate emissions are theoretically insignificant and the cured resin poses minimal hazard.

Health in Fire

Fire

The following table summarizes hazards associated with the combustion of adhesives in bio-based products. It does not include hazards related to combustion of the bio-based materials themselves.

Because adhesives can make up only 1-2% of engineered wood products like glulam and CLT, their contribution to the overall toxic emissions may be small compared to that associated with the emissions associated with wood combustion. While the adhesive content is likely to be higher for other bio-based products (possibly up to 12%) it is still likely that the combustion of other buildings, furniture and/or personal belongings will pose the most significant hazards.

	Fire Hazard Level	Comments
UF	Data gap	<ul style="list-style-type: none"> No data found.
PF	High	<ul style="list-style-type: none"> A study of PF combustion products found formaldehyde released between 400° and 500°C at concentrations higher than those in the atmosphere (Junod, 1976).
MF	Moderate	<ul style="list-style-type: none"> During combustion, nitrogen containing compounds in MF may emit higher concentrations of nitrogen oxides (NOx) and hydrogen cyanide (HCN); however, those concentrations are low relative to those from polyurethane combustion (Junod, 1976).
PU	High	<ul style="list-style-type: none"> Combustion of polyurethanes can emit higher concentrations of NOx and hydrogen cyanide, both of which are hazardous to human health. Emissions levels depend on temperature, though the extent of conversion to these compounds is relatively minor (AWC, n.d.; Busker, et al. 1999).
EPI	Data gap	<ul style="list-style-type: none"> No data specific to EPI resin was found. Like polyurethane, EPI contains isocyanates, which contribute to the emissions of hazardous nitrogen-containing compounds discussed above. It is possible, therefore, that EPI poses similar hazard to polyurethane in fire.
SOY	Data gap	<ul style="list-style-type: none"> No data found.

Health in End-of-Life

End-of-Life

Materials that reach their end of life can be recycled or sent to landfills. The presence of adhesives can affect both the recycling potential and the degradation of construction and demolition (C&D) waste in landfills. Like plastic, adhesives generally degrade very slowly and can emit toxic byproducts as they do so.

Significant data gaps compromised our ability to assess the health and environmental hazards present at end-of-life. It is likely that the slow degradation observed for polyurethane is generalizable to the other polymers included in this review.

Comments	
UF	No end-of-life impacts identified. (No data found.)
PF	No end-of-life impacts identified. (No data found.)
MF	No end-of-life impacts identified. (No data found.)
PU	Limited evidence suggests that polyurethane resin does not rapidly degrade in a landfill, with one study observing no changes after over 700 days. This is not surprising, as polyurethane is a plastic. Incineration presents similar issues as those described on the previous page.
EPI	No end-of-life impacts identified. (No data found.)
SOY	No end-of-life impacts identified. (No data found.)

Appendix: Scoring Method

Health

The potential health impacts of each adhesive were evaluated on a ten-point scale using data from the Pharos database, supplemented with findings from the primary literature. The ten-point scale was interpreted using the following rubric:

2.5	Poor	Poses significant hazards with probable exposure.
5	Fair	Poses moderate or significant hazards with probable or possible exposure.
7.5	Good	Poses low or moderate hazard with possible or unlikely exposure.
10	Excellent	Poses low hazard.
5	Data gap	No data found; score of 5 assigned.

Health impacts were scored for each adhesive at several lifecycle contexts: manufacturing, use, fire, and end-of-life. The use phase was weighted most heavily (40%). Manufacture and end-of-life were each weighted at 25%, while fire was weighted at 10%. See Health intro for more on Pharos database use of hazards versus risks.

Properties, durability, fire and manufacturing

The range of properties were sourced for each adhesive for each consideration from references, standards and product literature. The range was split into 3 and the best performance assigned 3 points and the worst 1 point. The range in the total score was split into 4 and assigned the following rankings:

Poor	Lowest quartile
Fair	Lower middle quartile
Good	Upper middle quartile
Excellent	Highest quartile
Data gap	No data found; No score assigned

Where the data could not be split in this way, a ranking was made based on the information available.

In some cases it was not possible to decide if a property was good or bad, eg a long cure time could be beneficial in some applications, but bad for others. Where data could not be found no ranking is given.

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