NEW RESEARCH PROPOSALS

LIFE Forms Review Summary

Title	Level of Interest				
	VERY INTERESTED	INTERESTED	INTERESTED WITH CHANGE	NOT INTERESTED	ABSTAIN
(001) **BOISE-22: Using Notch Delamination to Study Moisture-Adhesive Interactions** *Sinha & Nairn (Oregon State University)*	3	5	0	0	2
(002) **O-02-VI: Monitoring Phenol Formaldehyde and Wax Content with Vis/Nir Smartphone Technology** *Via (Auburn University)*	6	4	0	1	0
(003) **O-03-HI: Incorporating Densified Wood Layers for Composite Reinforcement** *Hindman & Hu (Virginia Tech)*	1	3	0	6	1
(004) **O-09-SC: Near-infrared hyperspectral imaging and chemometric techniques for estimation of percent wood failure (PWF) in adhesive bonds** *Schimleck & Muszynski (Oregon State University)*	4	2	1	2	0
(005) **O-05-NE: A Fundamental Study of Lignin Reaction with Formaldehyde** *Mojgan Nejad (Michigan State University)*	4	5	0	0	1
(006) **O-06-PR: Effectively Incorporating Fire Retardant Pressure Treatments into Mass Timber Panels** *Gerald Presley (Oregon State University)*	3	4	2	2	1
(007) **O-07-PE: Understanding the fundamental influence of wood extractives on wood adhesion** *Peresin, Gururaja, Nairn, Simonsen, Frazier (Auburn, OSU, and VT)*	6	3	0	0	2
(008) **O-08-MU: Understanding the Effect of Thickness Tolerances on Local Bonding Pressure Distribution in CLT Layups** *Muszynski & Nairn (Oregon State University)*	0	3	1	2	3

Project: (001) BOISE-22: Using Notch Delamination to Study Moisture-Adhesive Interactions
Project Phase: New Proposal
Project PI: Sinha & Nairn (Oregon State University)

Level of Interest
Very Interested - 3
Interested - 5
Interested with Change - 0
Not Interested - 0
Abstain - 2

Summary of Responses to IAB Comments

Questions

- What do you plan to do for moisture exposure? Would expect a lot of variability within products. How do you plan to control that?

  Response 1: Will expose them to moisture using water sprinklers. We have, for other projects, developed and calibrated a moisture exposure system that can be used for moisture exposures. We can also use the multi-climatic modular environmental chamber to do so as well. -Ari Sinha

  Response 2: Fracture testing can have less variability than strength testing, but still an issue in wood products. Our experiments will test a sufficient number of specimens. The bending test to get multiple cracks in the tension layer tests that entire layer. Similar experiments in aerospace composite could account for variable by stochastic damage progression analysis. -John Nairn

- Are you considering use other types of adhesives like lignin-based adhesives and MUF?

  Response 1: Yes, we are open to suggestion on other adhesives. If awarded, we will discuss with the technical committee to identify the adhesive systems that is most relevant to the members. -Ari Sinha

- Is there a possibility to better understand other mechanical properties across the panel without notches? Will the test be focused on floor or wall applications?

  Response 1: The focus will be on notch delimitation achieved via bending test. This is applicable for floors and beams but also has some applicability in wall systems. -Ari Sinha

Response 2: Notching is a tool to measure delamination properties. The results of that test could be used in to predict delaminations in unnotched panels too. -John Nairn

- Can this test be applied to newer mass panel type products?

  Response 1: Yes. That is the whole intent of the work is to demonstrate that current method works and then apply to newer mass timber products. -Ari Sinha

  Response 2: ... and it is very important to do this. Cracking and delamination in mass panel types is controlled by their structure including thickness and orientation of all the layers. Design of mass panels needs to have tools to study different panel types and thereby to choose the best ones. -John Nairn

Suggestions

- Suggest investigating various configurations of layer thicknesses and location within the panel beam as an additional treatment.

  Response 1: Thanks for the suggestion. We will incorporate that in discussion with the technical committee (if funded) and formulate an experimental plan accordingly. -Ari Sinha

- Do you know that the point you focus your testing on is the weakest point in the construction.

  Response 1: Yes, our composites are as good as their weakest link. Delamination around notches are an issue and one of the ways to gain further insights to the problem is using fracture mechanics. -Ari Sinha
  Response 2: We cut a notch to create a weakest link, but even an unnotched panel will have defects (such as non-glued timber edges or knots). Experiments on notched beams can provide properties for input to analysis of unnotched beams with other defects. -John Nairn

Comments

- Good project of general interest to industry despite outside our companies current market.

  Response 1: Thanks! -Ari Sinha

- Very interesting, and seems relevant. The PIs have the correct background for this work but abstain because the topic is outside our company focus.

  Response 1: Thank you! Any suggestions to make it relevant to your company are welcome and can be incorporated when finalizing the experimental plan. -Ari Sinha

- it is good to use an established technique on a new composite

  Response 1: Thanks for the comment. Yes, the technique has already been developed and validated through previous WBC projects. This is an extension of those techniques and a different application. -Ari Sinha

- Very important area for mass timber products such as mass veneer panels and CLT and glulam. Approach seems sound.

  Response 1: Thanks! -Ari Sinha

- The project is interesting, and it would be good to have more information about how it can translate into different mass composites.

  Response 1: Thanks! The experimental design will support the modeling work, which will be applicable widely or can be translated to different mass timber composites. The work will look at panelized layered composites in general. -Ari Sinha

  Response 2: Both experiments and modeling can apply to any mass composites. Our hypothesis is that these experiments will confirm this concept and the results will be wide-ranging methods for many mass timber products. -John Nairn

- This one is not directly related to our area of business but may be of value to the CLT industry (and glulam). Especially if it leads to integration into a manufacturing quality program.

Project: (002) O-02-VI: Monitoring Phenol Formaldehyde and Wax Content with Vis/Nir Smartphone Technology
Project Phase: New Proposal
Project PI: Via (Auburn University)

Level of Interest
Very Interested - 6
Interested - 4
Interested with Change - 0
Not Interested - 1
Abstain - 0

Summary of Responses to IAB Comments

BrianKVia's Response: The summary suggestion was to ensure we place a high priority on measuring the resin content of flakes. We will be sure to prioritize this effort. Others had questions about the accuracy/precision and we will identify weaknesses or limitations along with possible management operating procedures. One person preferred using a laboratory machine over a cost reduced system. We will address this by comparing both the laboratory and smartphone method.

BrianKVia's Response: The summary suggestion was to ensure we place a high priority on measuring the resin content of flakes. We will be sure to prioritize this effort. Others had questions about the accuracy/precision and we will identify weaknesses or limitations along with possible management operating procedures. One person preferred using a laboratory machine over a cost reduced system. We will address this by comparing both the laboratory and smartphone method.

Questions

- How do you think the accuracy will be in the low adhesive spread range used in OSB manufacture

  Response 1: I think the wood and resin chemistry is so different that the NIR should actually be better than the referenced used to calibrate it (for precision and accuracy). This has been shown in the literature for other applications. If we can make the grid size close to the local spot size (might be hard to do), then we should be spot on. We will try to minimize grid size and couple it with image analysis. -Brian K. Via

- Are you considering with collected information that software learn about and could predict performance of OSB boards? What is your opinion about the effect on readings of resin distribution on different kind of wood species? You can use this technology for different types of OSB boards?

Response 1: We will compare this hardware and software modeling performance to that of our laboratory system. NIR is very sensative to any change in species, or even how the board was pressed. What the mill can do is develop a QC multivariate outlier detection method. When a data point is flagged, one could back characterize it and then add it to evolve the model. -Brian K. Via

Response 2: PS - if the OSB boards are pressed differently, then it would be important to train the model with the wide variety of boards made by the company. It would always also be important to periodically validate the model and equipment to make sure there is no "drift." -Brian K. Via

Suggestions

- Change the focus to looking at distribution on flakes instead of finished panels. This will allow you to impact properties more effectively.

  Response 1: We will look at flakes and finished panels if you think this is ok? We will definitely prioritize around flakes given the feedback during the poster session. -Brian K. Via

- Suggest looking at the potential for this technology approach to be used for different applications, adhesive types & components, wood extractives etc.

  Response 1: This could be a future study that we would be willing to consider. -Brian K. Via

- This project is interesting, but it will be good to learn if it can also assess particleboard and alternative resins (MDI, UF, etc.).

  Response 1: We would be glad to look at particleboard if we get a chance. We would also be willing to look at different resins. I don't want to take on too much in this project and would prefer to promise this next. But if someone feels strongly different, I will keep my mind open. -Brian K. Via

- Cost-effective testing methods for data collection and analysis would turn this research topic more promising.

Comments

- Unsure of the value proposition to industry of of a $500 sensor, when a $100k sensor that performed well would be an easy sell. It seems like there's little benefit in limiting to low cost hardware, although there's already been numerous efforts using higher cost hardware with only mixed success.

Response 1: One value proposition would be the ability to use the smartphone to measure the resin content live in the manufacturing plant. If companies are willing to pay more, then it should allow us to provide a more robust system. Because of your suggestion, we will also cross correlate to our laboratory NIR which we paid $70,000. We will compare the two systems. -Brian K. Via

- Interesting idea.

  Response 1: Thank you. -Brian K. Via

- Include measurements on flakes before going into the press. it could be a good QC tool.

  Response 1: Will make sure to include resinated flakes into the study. -Brian K. Via

- Excited to see the breadth of its capabilities in a mill

  Response 1: Thank you. -Brian K. Via

- Promising technology for a wide range of applications.

  Response 1: Thank you. -Brian K. Via

- Really interesting topic. We will looking forward for results

  Response 1: Thank you. -Brian K. Via

- Fantastic research topic, expect to see more data results to further validate the testing methods.

- Subject is directly relevant to industry needs.

Project: (003) O-03-HI: Incorporating Densified Wood Layers for Composite Reinforcement
Project Phase: New Proposal
Project PI: Hindman & Hu (Virginia Tech)

Level of Interest
Very Interested - 1
Interested - 3
Interested with Change - 0
Not Interested - 6
Abstain - 1

Summary of Responses to IAB Comments

DanielHindman's Response: Thank you all for your feedback. I appreciate the interest in this topic. To summarize the feedback, I think the two biggest comments were the challenge of adhesion and more practical concerns of how the lignin extraction process influences the cost and productivity of the material. The proposed work could be amended to include a greater emphasis on adhesion. I would have to consult with Dr. Hu about opportunities to explore different levels of lignin removal or more details of the lignin removal process, but I do believe that some modification of the Superwood product could be possible.

Questions

- It will be interesting how the manufacturing process would look like in an industrial setting. What is the impact of moisture and the difference of swell in lamination? What are the benefits of incorporating a densified layer in a composite? What other implication are for removing the lignin?

  Response 1: I had not thought of the effects of lignin removal - both the expense of the process and possibly use as feedstock for other processes? High strength products such as FRP have been used for a long time. I think the use of densified products could expand the field. Over time, there is some swelling from moisture. That would be important to document (shrinkage/swelling, etc.) -Daniel Hindman

Suggestions

- On adhesive testing, we would suggest looking at surface preparation and a wide variety of adhesive types. It may be that the type you think won't work at all would be the best option.

Response 1: Yes, I think this is a good approach. Happy to take suggestions. -Daniel Hindman

Comments

- Would like to know more about how the product is manufactured to understand if it is something that could be practically implemented. Otherwise, there have been other densified wood products that show good results but at an impractical price point

  Response 1: I thought the material was really interesting given the different process used and what I saw as relatively high compression, low springback, and high mechanical properties. This was one of my purposes to engage the WBC to help develop this further. -Daniel Hindman

- Cool concept worth exploring. Exploring adhesive bond-ability with different adhesive chemistries and molecular weights would be valuable. As would understanding the extent and nature of delignificaitonlignin changes.

  Response 1: I think the major challenge to the material is adhesion. Would be happy to explore this in more detail. -Daniel Hindman

- Cost of delignification is a concern. also we are not sure where this would be used. being difficult to glue might limit its application also this would need to go into a high value product.

  Response 1: Yes, I agree. This may be limited to more high-value uses. However, this might open avenues for other uses (aeronautics, military?) that could incorporate wood composites. -Daniel Hindman

- Still has the same bond challenges of other natural high dnesity wood species.

  Response 1: This is one of the reasons that I thought of engaging the WBC - what we learn from this densified wood can be applied to other products and can have more impact on the larger industry. -Daniel Hindman

- There are many sources of naturally dense wood and other materials that may be more cost effective to use. Concerns over adhesion of the densified layer. Concern regarding economic viability .

  Response 1: I agree with you that other products are available and exist. I would hope that the ideas and methods we use could then be applied to larger samples from industry. I think the use of densified wood could be helpful for the industry and improve wood composite properties and abilities. -Daniel Hindman

- While it is interesting on the whole, it is not relevant to our industry. Others may find it more relevant.
- In the 1980's-1990's there was a pin connected truss on the market. It used metal webs & pins with densified LVL chords to perform under high reaction loads at the pin location.

Project: (004) O-09-SC: Near-infrared hyperspectral imaging and chemometric techniques for estimation of percent wood failure (PWF) in adhesive bonds
Project Phase: New Proposal
Project PI: Schimleck & Muszynski (Oregon State University)

Level of Interest
Very Interested - 4
Interested - 2
Interested with Change - 1
Not Interested - 2
Abstain - 0

Summary of Responses to IAB Comments

Questions

- How much of this will build off the previous project? Seems like that project laid a good foundation to be expanded on

  Response 1: This project is intended as a follow up of M-01-KA. Yes, we do build on the outcomes and experience gained on that one. –Lech

  Response 2: Agreed. The imaging component provides for easier acquisition of data that represents a complete surface and subsequently a representative spectrum (as opposed to using a probe that is essentially a "spot" measurement). We are also using a different wavelength range (NIR vs UV) which may aid in the ID of important wavelengths for characterizing wood vs resin and their specific bond vibrations. -Laurie

- How this method can be applied in a mill?

  Response 1: That is an excellent question. I think the first thing is to find out if the method is effective across a wide spectrum of wood/adhesive combinations and how it compares to other methods assessed in M-01-KA. Once that is established, adapting the best performing method to use in mills is a commercialization question. That can be discussed and hypothesized but not solved on the time frame and budget level available in this WBC format. Would benefit a potential manufacturer of the device. Clearly against the grain of the pre-competitive spirit of this Center. –Lech

Response 2: I'm aware of NIR-hyperspectral imaging systems being used in quality control eg food safety, in production environments. So I think the technology can be used in a mill. As noted by Lech our first task will be to examine how well it performs in determining % wood failure. -Laurie

Suggestions

- Would recommend using a different data set in addition to the one already used by Talbot

  Response 1: Yes, that would be interesting. {particularly if that data set has greater representation of low WF%, which would provide for more reliable regression). Still, using the data set used in M-01-KA is necessary for meaningful comparison of the effectiveness of these methods. –Lech

  Response 2: As noted by Lech some comparative work existing data sets would be required but the addition of new samples that expands the range of %WF represented would certainly be beneficial. I'd be interested in knowing if the reviewer has a data set in mind. -Laurie

- Would be great to include a wide variety of timbers including some from tropical and sub-tropical areas.

  Response 1: Yes, that would be interesting. Including tropical timbers may in fact increase the representation of low WF%, which would provide for more meaningful regression. Still, as explained above, we may only add it on top of the sets used in M-01-KA, which is necessary for meaningful comparison of the effectiveness of these methods. –Lech

  Response 2: To be clear, we are not saying no, to adding wood/adhesive combinations. Just need to keep a cap on that to fit within time/scope/budget triangle. –Lech

  Response 3: Perhaps Suggestion 1 and 2 are linked with the additional data set in 1 being a tropical / subtropical hardwood? -Laurie

- The research, rather than going smaller, it will be great to see the application of Talbot's methodology in bigger samples.

  Response 1: Yes, in principle, all the alternative methods proposed, though in different ways, can handle specimens of sizes alternative to current standard. –Lech

  Response 2: Yes, larger samples can certainly be tested, and while likely unnecessary, maximum image size is approx 200 x 300 mm. It is also a likely requirement that a standard area be tested but as an average spectrum is obtained from the image of the scanned surface a standard area isn't required (as long as per cent wood failure is assessed over the whole surface). A final thought is that Talbot used a probe, whereas here we are collecting images. To test a larger area Talbot would

have needed to sample more points across the surface. In comparison with the images we will use all we need to change is the size of the region of interest in the image (here the region of interest = the surface over which % wood failure is being assessed). -Laurie

- Study application for OSB, especially with light colored wood (e.g. aspen) and light colored colorless adhesives (e.g. pMDI).

  Response 1: What would be the need, the purpose of turning the %WF assessment methods on OSB? The evaluation of bond Integrity of OSB is done by the internal bond tests and do not involve visual examination of the fractured area. The challenge is that OSB has low resin contents (~2.5%), delivered as fine droplets rather than a continuous coating. Tat is a challenge even if resins with good contrast against aspen are used, even more for colorless pMDI. -Lech

Comments

- Interested in a method, but feel like more validation of the fundamentals on the previous uvvis method, and determining whether it's really evaluating the same fundamental percent wood failure property is in order.

  Response 1: Thanks for the comment. Happy to include that in the scope of the project. –Lech

  Response 2: The images we will collect will allow us to ID % wood and % resin, by pixel. This will be done by selecting a region of an image that is clearly wood and a region of the same image that is resin and using the contrasting spectra of these pixels to categorize all pixels. Hence at a fundamental level we are using differences that exist in wood and resin chemistry to categorize pixels which should relate directly to % wood failure. Note - preliminary work showed that resin and wood NIR spectra are different. -Laurie

- Would simple visible image classification methods perform well? They at least seem more capable to measure the same visual surface qualities that a trained ASTM evaluator is trying to assess.

  Response 1: Only if there is good contrast between the bondline and the substrates (wood/veneer). For clear or low contrast bond lines the simple image is not sufficient. This is what motivates this project and its predecessor M-01-KA discussed this morning. –Lech

  Response 2: An advantage of Talbot's work (or this proposed work) is that a spectrum that should represent the surface chemistry of the sample is obtained. Different proportions of % wood and % resin, i.e. different levels of % wood failure, should provide different spectra. -Laurie

- Very beneficial project for industry - much needed solution to percent wood failure assessment methods.

Response 1: Thank you! It follows up on the M-01-KA project discussed this morning. -Lech
Response 2: Yes, thank you. -Laurie

- Direct benefit to industry. Innovation in this area helps overcome qualified trained staff turnover in quality departments.

  Response 1: Thank you! -Lech

Project: (005) O-05-NE: A Fundamental Study of Lignin Reaction with Formaldehyde
Project Phase: New Proposal
Project PI: Mojgan Nejad (Michigan State University)

Level of Interest
Very Interested - 4
Interested - 5
Interested with Change - 0
Not Interested - 0
Abstain - 1

Summary of Responses to IAB Comments

Questions

Suggestions

Comments

- Great idea; good to know more about these systems... they are the furture

  Response 1: Thanks, yes we are hoping to have a fundamental study around lignin-based phenolic adhesives. -Mojgan Nejad

- Is interesting to understand the interactions of lignin and adhesives.

  Response 1: Glad to hear that. -Mojgan Nejad

- Excited by the fundamental approach and methods for probing lignin co-reactivity in the solid state.

  Response 1: Thanks, happy to hear this. -Mojgan Nejad

- 13 C NMR is a good technique to evaluate how formaldehyde reacts. I am a bit concerned about how much information can be derived from solid state NMR. perhaps it has gotten much better over the last 10 years.

  Response 1: I used solid-state NMR for lignin before and the quality of 13C NMR was great. I am hoping by comparing lignin monomers reaction with formaldehyde-C13 we would be able to identify the methylene peaks in lignin. Dr. Wang is an expert in NMR that would help me with the Analysis. -Mojgan Nejad

- Great project to support bio-adhesives development and to understand the fundamental linkages between lignin and carbohydrates.

  Response 1: Thanks, appreciate your support. -Mojgan Nejad

- Relevant to our work in regard to environmentally friendly alternatives to use of formaldehyde

Project: (006) O-06-PR: Effectively Incorporating Fire Retardant Pressure Treatments into Mass Timber Panels
Project Phase: New Proposal
Project PI: Gerald Presley (Oregon State University)

Level of Interest
Very Interested - 3
Interested - 4
Interested with Change - 2
Not Interested - 2
Abstain - 1

Summary of Responses to IAB Comments

Questions

- Is the idea that fire retardant treated mass timber would be used in exposed situations? I would think that the visual change of the treatment would make for undesirable aesthetics and if so, building owners would elect for using gypsum

  Response 1: Yes interior exposed would be the final application. Some fire retardant products do not have dye added in the formula and retain the visual appearance of the wood. Borate and phosphate treatments may precipitate on the wood surface and lead to some white crystalline "blooms" but these can be reduced with best management practices at the treating plant. -Gerald Presley

- how much is treated lumber used in CLT or other laminated composites? could FRT be applied after the composite is formed?

  Response 1: To my knowledge little to none is used in North America. There are treated mass timber products made in Australia/New Zealand, but some of these contain copper-based treatments and are not interior appearance products due to green coloration. Fire retardants can be applied as a spray in theory, like some of the preservative formulas, but surface application does not improve performance to the same degree as pressure treatment. Overall retention is lower and you get much lower penetration into the wood. Penetration is important for phosphate/borate fire retardants because these function by enhancing charring and starving the fire of fuel. Deeper penetration enables the formation of a larger insulating char layer more rapidly. -Gerald Presley

- Since many FRT formulations contain boron, could a joint benefit of both fire and insectdecay protection be promoted?

Response 1: Yes but borate retentions must be high enough. Product literature for some of the borate-containing fire retardants list a range of 0.1-1% borates. Also, not all fire retardants contain borates. Treatment to AWPA standards for non-formosan termite retentions would require about 0.6% boric acid equivalent (BAE) for Douglas-fir. Work at OSU suggests that you may get protection from fungal growth at borate levels as low as 0.1% BAE. In summary, you may have some protection against decay, but these products are not likely to have enough boron to protect wood in high termite pressure areas such as Hawaii. The American Wood Protection Association also does not have a retention standard for fire retardant treated wood and only specifies strength reduction tolerances for the finished product. Fire retardant treated lumber may vary in their borate content and therefore would vary in their ability to prevent decay or insect attack. -Gerald Presley

Suggestions

- This project and the Thickness tolerance in CLT project, look correlated. It might be good to collaborate and present as a single project. The methodology should also be revised, as there is no chemical characterization or fire testing to evaluate the retained effectivity of the treatment.

  Response 1: I agree that fire performance will need to be tested as a practical measure, but this could be something done at a later time once functional fire retardant-CLT formulations are determined in this test. The main objective of this research is to identify what level of fire retardant is going to enable a functional bond using MF and PUR resins. Once we determine that level I think a larger scale measurement of fire performance would be something we pursue. -Gerald Presley

- If the idea is to develop a database then consider using block shear tests instead of the Mode-l method since that method is less utilized outside of OSU

  Response 1: We could use block shear tests, but the idea of the mode-I fracture method was to get better resolution among treatments. In Cody Wainscott's current research project, he was not able to resolve statistical differences among several of the preservative treatments using block shear tests despite there clearly being a difference in performance in delamination tests. It was recommended that we try the mode-l fracture test for bondline characterization because this method may be more sensitive to detecting differences in bondline integrity among our treatments. -Gerald Presley

Comments

- Start with DMA, identify where adhesion is compromised, and work backwards. Don't start with all the progressive planing... See the max uptake you can get away with and still form good bonds, then have industry figure out a way to make that work. Start with the fundamentals... chemical interactions on adhesive cure and penetration.

Response 1: We can certainly start with the fundamentals, but I still think variable planing may be a good avenue for generating test material for mode-I fracture tests simply because it is going to be difficult to regenerate a range of retention levels in test-ready samples. Treating small pieces of lumber with waterborne preservative solutions may lead to dimensional changes that can make bonding the specimens difficult. I am happy to start with DMA analysis though. -Gerald Presley

- Interesting and well planned.
- Relevant to our work in collaboration with work by Prof Jeff Morrell, in the National Timber Durability Centre (Australia)
- Not directly related to our industry but very important topic for the CLT industry and overall performance acceptance of wood composites in this growing field of use. Success of CLT helps the rest of the wood composite industry by providing confidence to Architects and Engineers; ensuring they will consider specifying wood for their projects.
- Very interesting and beneficial project for industry.

Project: (007) O-07-PE: Understanding the fundamental influence of wood extractives on wood adhesion
Project Phase: New Proposal
Project PI: Peresin, Gururaja, Nairn, Simonsen, Frazier (Auburn, OSU, and VT)

Level of Interest
Very Interested - 6
Interested - 3
Interested with Change - 0
Not Interested - 0
Abstain - 2

Summary of Responses to IAB Comments

SoledadPeresin's Response: We are excited about the positive feedback for this project. The majority of the comments were based on the choice of wood species and how would this translate to commercially available sources relevant to other the forest products industry in the US and South America. We are specifically looking at spotted gum as brought by our members from Queensland Gov, however this project aims at setting the base for method development that will allow us to study any wood species. Additionally, the diversity of expertise on the leading team is very promising in terms of meaningful advances on the state of the art of the understanding interactions and impact of wood sources resin systems and adhesion performance in wood composites.

Questions

- Are you considering physical and chemical interactions? What kind of adhesives system are you considering to use?

  Response 1: We will be looking at surface interactions as a whole. At the moment weâ€™ll look into relevant resins systems for spotted gum on glulam applications, specifically PU, PRF and RF. - Soledad Peresin

Suggestions

- There are times that extractives and density interact. How will you account for this? One idea may be to have a second stand-alone project looking at adhesive penetrations in high density species. You could take the results of both initial studies and develop a follow-up study looking at possible solutions.

Response 1: A former OSU graduate student looked on bonding between regular wood and densified version of that same wood (i.e., very high density species with very little penetration). The interface methods worked for both and the effect of density was rather small (i.e., penetration was not requirement for good bonding in that species). -John Nairn

- It will good to communicate the final application as well as to review the cost of adhering a difficult wood.

  Response 1: The initial request from Queensland regarding final applications is glulam. Spotted gum is a commercially relevant wood species with natural durability characteristics and high stiffness values leading to high demand of products if the adhesion solution can be found.. Review of these costs are out of the scope of this project. -Soledad Peresin

- It will be helpful to find alternatives to improved wood failure on inactivated veneer surfaces. Very interested project

  Response 1: Great suggestion, thanks for the support! -Soledad Peresin

- highly relevant to our work

  Response 1: Great! Looking forward to interact with you to advance this project. -Soledad Peresin

Comments

- Full support... with expansion. More collaboration, and characterization... dig baby dig, let's figure out how to bond hard to bond materials!

  Response 1: Thank you!! Appreciate the support! -Soledad Peresin

- Excited to have Dr. Gururaja involvement on the project and with the center. While Spotty Gum isn't a direct issue our company faces, I'm hopeful some of the methods and techniques developed will be applicable.

  Response 1: Great to be part of this community. -Suhasini Gururaja

  Response 2: Thanks for the support! Spotted gum is certainly a specific wood species brought by our guest members from Queensland Gov. However, we are confident that these studies will be translatable to a variety of wood species of commercial value for the forestry industry. -Soledad Peresin

- good information to have for some members. incorporation of North American species would be helpful.

  Response 1: We are proposing techniques development at the moment, and we are positive that will be relevant for additional wood species relevant to the American forestry industry. -Soledad Peresin

- Good to see so much collaboration on this. Sounds like this would turn into a pretty large commitment potentially evolving into a very large body of work

  Response 1: Thank you! We are excited to have such an excellent team onboard! For sure, this is a multi-year effort and we hope to count with support for a successful project that will benefit all WBC members. -Soledad Peresin

- Excellent project proposal. Addresses an extremely challenging problem which if successfully mastered will provide major breakthroughs in the gluing of wood materials with high extractives. Equally the lessons learnt will have relevance to other gluing processes where extractives (resins) are an issue for high quality adhesion. This project will be very beneficial for the international wood composites industry including improved efficiencies in production lines, product quality and higher economic viability.

  Response 1: Thank you so much! We certainly appreciate the support! -Soledad Peresin

Project: (008) O-08-MU: Understanding the Effect of Thickness Tolerances on Local Bonding Pressure Distribution in CLT Layups
Project Phase: New Proposal
Project PI: Muszynski & Nairn (Oregon State University)

Level of Interest
Very Interested - 0
Interested - 3
Interested with Change - 1
Not Interested - 2
Abstain - 3

Summary of Responses to IAB Comments

Questions

- What is the recommendation for thickness?

  Response 1: Currently the PRG 320 specifies that the thickness differences in the laminations should be within 0.3 mm along the lamination and within 0.2 mm across the lamination from the nominal target (to which all are planed). The point is, that the source of that recommendation (the original study, pub, report) could not be identified, manufacturers do not monitor thickness tolerances after planing, so the effect is largely unknown. The problem does exist as indirectly acknowledged by EN making delamination test optional, and most lab/pilot scale fabrications facing issues with delamination. That is typically blamed on poor compatibility between the adhesive and the surface and shuts down promising products, without even examining thickness tolerance as possible source of the issue. -Lech

- once the effect is understood, how can it be controlled?

  Response 1: In our opinion the best response would be adhesives that can form acceptable bond under a known variation of clamping pressures. In North America, that would mean a bond that can pass the delamination test with less than 5% delamination. It is a tall order, particularly for labs scale or pilot plant scale production where new adhesive systems are developed/prototyped. -Lech

- Are there examples of where thickness variation has caused issues in practice?

  Response 1: Yes, 18 out of 20 reposts on research developing new or improved adhesive systems or examining new adhesive/specie pairing report delamination failures. Even for systems and pairing

that we know are chemically compatible. The rate of failure in the industry is naturally much less advertised, but there are anecdotal examples of failures, and we have seen gaps visible with a necked eye in specimens delivered by industrial partners. The problem exists but is not much spoken about. -Lech

Suggestions

- This project and the Fire retardant in CLT project, look correlated. It might be good to collaborate and present as a single project.

  Response 1: Thanks for the suggestion! Let me see the other project and communicate with the team. -Lech

- Perhaps controlling the thickness variation in the feedstock can be a strong focus to resolve the problem.

  Response 1: That is not easy to accomplish even in the full scale production line operations. Even less in labs or pilot lines where the research and development of new and improved adhesives is conducted. In our opinion, thorough understanding of the impact of thickness tolerance on bond integrity in cross laminated composites is a necessary step for deciding whether the solution should be tightening tolerances or developing smarter adhesives that can deliver acceptable resilient bonds in a range of clamping pressure conditions resulting from thickness tolerance distributions. -Lech

Comments

- Very important to the industry; not sure how to solve the downstream effect of variable thickness.

  Response 1: IMO, the best way is by developing adhesive systems that are tolerant to the variation in clamping pressures and can produce acceptable bonds under these varied conditions. However, such development needs a known target. The goal of this project is to quantify the scale of the variation and its potential impact. That is the guideline needed for development of such adhesive systems. -Lech

- this is somewhat less relevant for adhesive suppliers.

  Response 1: Not if you see your company serving the CLT industry. See my response to the previous comment. -Lech

- I don't know that there is much better thickness control than precision planers, and therefore, the only remedy would be in the adhesive. The work will be important to understand the impact of "standard" thickness tolerances on mechanical bonding performance.

  Response 1: Agree! And that understanding may guide development of adhesives that can safely handle the range of clamping pressures generated in cross-laminated layups with measurable thickness tolerances. -Lech

- Beneficial project. Improved understanding of the effect of thickness tolerances variation on adhesive bond performance will help with improvements in product quality and reduced costs in production. The introduction of a QA system as a consequence of this project will be very beneficial for industry.

  Response 1: Thank you! We aspire to support the CLT industry with good science. -Lech