

RESEARCH UPDATES

LIFE Forms Review

Title	Level of Interest				
	VI	I	I w/ C	NI	A
M-01-KA: <i>Repeatable Measurement Method for Percent Wood Failure</i> Student: Talbot Rueppel PI: Fred Kamke & Lech Muszynski Site: OSU	11	3	0	0	0
I-29-FR: <i>Fundamentals of resole formulation</i> Student: Ryan Gray PI: Chip Frazier Site: VT	2	7	2	0	3
SWEETWATER-21: <i>Investigating Lignin Consistency from Batch-to-Batch</i> Student: Mohsen Siahkamari PI: Mojgan Nejad Site: MSU	4	4	2	1	3
N-02-MU: <i>Long-term response of wood-based composites in variable climate conditions</i> Student: Oluwafunbi Adeleye PI: Lech Muszynski, John Nairn, Mariapola Riggio Site: OSU	2	2	0	0	0
M-02-PR: <i>In-depth Characterization of Bondlines in CLT made with Preservative-Treated Lumber</i> Student: Cody Wainscott PI: Gerald Presley and Jed Capellazzi Site: OSU	4	7	0	1	1
M-05-NE: <i>Improving Durability of Wood Products by Reducing Lignin Degradation</i> Student: Dyllan Nelson PI: Mojgan Nejad Site: MSU	3	6	0	0	2
I-10-FR: <i>Carbon Isotope Ratios, novel view of CH₂O emissions</i> Student: Mark Cashman PI: Chip Frazier Site: VT	7	2	0	0	1
M-03-PR: <i>Preliminary Investigation of DMDHEU-Treated Strand Board</i> Student: Shane Johnson PI: Gerald Presley and Fred Kamke Site: OSU	2	4	0	1	1
N-06-CA: <i>Bench-Scale Characterization of Joints and Coatings</i> Student: Akhilesh Kulkarni PI: Scott Case & Brian Lattimer Site: VT	3	6	0	0	2
M-04-FR: <i>Wax Migration</i> Student: J.C. Stant PI: Chip Frazier Site: VT	3	8	0	0	1

Project: (001) M-01-KA: Repeatable Measurement Method for Percent Wood Failure

Project Phase: Project Update

Project PI: Fred Kamke & Lech Muszynski (OSU)

Level of Interest

Very Interested - 11

Interested - 3

Interested with Change - 0

Not Interested - 0

Abstain - 0

Summary of Responses to IAB Comments

Lech's Response: Thank you for all the comments and suggestions. It looks like there is a strong interest in continuing this line of research. We are happy to oblige. Pls consider O-09-SC in this cycle.

TalbotBRueppel's Response: Thank you everyone for your support and a special thank you to Fred, Lech, and Patty for motivating me throughout this project. I think we all agree that pursuit of this topic should continue. The O-09-SC proposal for hyperspectral imaging would be a great compliment to this effort and the hyperspectral images themselves would replace the gerrymandering grid approach.

Questions

- I imagine multiple follow-up experiments to broaden the database are necessary to build-up on what you have learned. Who does this work? How do we refine and polish for the good of the industry.

Response 1: A round-robin with 3+ labs using methods emerging from this study as most promising would be probably the healthiest approach. For that a training set containing a greater representation of low %WF would help with more meaningful stats. -Lech

Response 2: Much agreed, and an institution like the APA is best suited for building upon the training set. A plywood manufacturer should begin trials as soon as possible to test its real applicability in the mill environment. Another thesis at one of the sponsoring universities is also imperative. For the good of the industry, I think its most important to continue evaluating Douglas-fir and Southern pine because of their widespread use. -Talbot B. Rueppel

- This project is very interesting, there is any ideas what is the result with other kind of glue application, there is differences between glue spreaders, spray and extruder lines, in order to get a wood failure result?

Response 1: Excellent question. That can only be responded with comprehensive training sets representing each glue application technique with good representations of low %WF for more meaningful statistics. -Lech

Response 2: Agreed with Lech. Each glue application method should have its own training set because light will reflect differently with each. -Talbot B. Rueppel

- Is R2 the best means of evaluating PLS model fit (vs predicted residual sum of squares, etc)? Won't you naturally get better R2 values for datasets that span a more full range of % wood failure (from 0-100%), vs datasets that only had, e.g. 60-100%? What influence does the intensity, wavelength and angle of incidence of the LED light source. Does this depend on species?

Response 1: Yes, training sets including better representation of low %WF would allow for more significant statistics. As it is now, the best assessment scheme seems to be the triage for true positives, true negatives vs. false positives, false negatives... -Lech

Response 2: Oops... sorry, that response was meant for different question. Let us take the parameters one at a time: 1. the light intensity must be in sync with the image acquisition time to get good coverage of the reflected light spectrum. Too much will flood the image with white, too low would lose the brightest part. There is certainly a sweet spot to be found the intensity and acquisition time. 2. Selecting LEDs with narrower wavelengths is essentially the same as filtering the white light and allows us to use the fluorescent effect (wavelength shift in the reflected light detectable if a narrow or uniform wavelength source is used, but flooded with other effect when white light is used). So this is what we did. 3. Trying a variety of angles of incidents is doable with flat surfaces. With structured fracture surfaces we will lose the information from the "valleys" seen at an angle. Also finding an optimal angle of incident light and the sensor (camera) has to cover a range of possibilities. -Lech

Response 3: A training set having a wider range of PWF values would certainly lead to more telling statistics. It seemed that the R2 often correlated with the residuals, and the best measure of a model's accuracy was the false positive vs false negative prediction rates. Intensity is most affected by the surface topography of a specimen, but the slopes of the spectral profile and the wavelengths thereof is really where the materials are differentiated. While intensities may vary from one specimen to the next (even if both specimens have high PWF), the resulting slope derivative between certain wavelengths is what allows for the detection of even limited amounts of glue on that surface. The light scattering issue can be mitigated with a larger, more intense probe and light source. - Talbot B. Rueppel

- When its convenient, please provide an update on the review of the other low contrast timber and adhesives samples tested.

Response 1: That should be part of the written report and follow up publication. -Lech

Response 2: I ran out of time before being able to evaluate the soy-bonded yellow poplar (low contrast) lap shear specimens, but I did cut them myself, and they are ready to be broken and evaluated in a future study. If we want to avoid having to stain low contrast specimens every time, it is recommended to scan the training specimens first, then stain them to create the predictor values. Once a large enough training set is developed, staining would not be necessary. The hyperspectral imaging project proposal could mitigate the need for staining entirely. -Talbot B. Rueppel

- How was the splitting of the sample done (shear, splitting, etc.)? Was the view done top to bottom from the failure? Can this method be done in larger specimens, such as the ones for LVL? Can this method be done comparing both sides of each sample with mirroring grids?

Response 1: Responses in order: 1. Shear 2. Yes, the methods, each in their own way, can be adapted to specimens of various sizes. 3. I think this is precisely how we did it. -Lech

- How does wood thickness block imaging? can you simulate by using a cured film of PF resin with different thicknesses of microtomed wood

Response 1: Thanks! Sounds like a great idea. -Lech

- Does the work involved with the spectra analysis overcome the benefit of accuracy when compared to speed of sample processing? Why not just go straight to Image J?

Response 1: Straight ImageJ is as good as necked eye when it comes to adhesives with good contrast against wood, but even more challenged than the necked eye when it comes to adhesive systems that form a transparent or low contrast bond line. We on a quest for a method that would work well with all or most systems used in the industry. -Lech

Response 2: The speed and overall accuracy of robust chemometric modelling far outweighs the excess processing power and thresholding times required for constant ImageJ processing of each individual specimen. Once a viable statistical model is developed from a representative training set, the cost, speed, ergonomic, and precision value of UV-VIS spectrometry is apparent. -Talbot B. Rueppel

- Is it possible to the experiment using both sides of the samples with mirroring grids? Can this be used in larger specimens like the ones used for LVL? How the samples were separated (shear, split, etc)? Can the grid method obtain different results depending on the direction of the sample? Or that does not impact the test? Would different 3D images can help to improve repeatability?

Response 1: The Fluorescence +ImageJ method can accommodate a variety of specimen sizes, the other techniques can also be used with other specimen sizes. -Lech

Response 2: The specimens were separated by shear. -Lech

Response 3: At first, we tried to mirror and account for the glue on both sides of the sample/grids when calculating new PWF values, but the results were always partial to wood failure and did not truly account for the glue present. Quantifying the half with more glue present (after evaluating both halves) gave us the best representative PWF value by accounting for the "weak half". This method can be used for larger specimens with optimized instrumentation, but the specs for this project were limited to lap shear specimens per ASTM D906, which I am under the impression that LVL is tested under? I could be wrong. A larger probe and/or stronger light source would be needed to capture a larger block shear surface per ASTM D905. Nonetheless, these specimen sizes are all that I am aware of when it comes to post shear QC testing. Samples were separated via shear per ASTM D906. Grid results would be relatively the same even when rotated, and 3D images could improve those results. -Talbot B. Rueppel

- - How is the approach effected by taking other ML techniques into account? - What would happen if you include other NDT methods?

Response 1: This is what Laurie and I are proposing in O-09-SC. Please consider funding that one. -Lech

Response 2: To me, this approach is intended to stand on its own and the most efficient way to develop predictor variables for statistical modelling is an enhanced visual evaluation method such as the grids or ImageJ. Other NDT methods would stand on their own and reach different (better or worse) results. The hyperspectral approach shows promise per the new proposal O-09-SC, but I think there is promise and more work to be done with this affordable UV-VIS method as well. -Talbot B. Rueppel

Response 3: I regress in that the hyperspectral approach would be a great compliment to the current UV-VIS approach when it comes to creating predictor values and replacing the still-subjective grid approach. -Talbot B. Rueppel

Suggestions

- It would be better to run an in-depth research on different substrates hardwood, softwood, hybrid wood composites, in addition to different resin types related wood failure estimation using PLS modeling. Time-of-Flight Secondary Ion Mass Spectrometry (TOF-SIMS) as a surface analytical technique may help provide a more robust testing method evaluating some tricky failures.

Response 1: Certainly. Now that we know the relative performance of the methods tried in this study the in-depth study may use only the most promising approaches. -Lech

- I would like to see this project continue, it has the potential to be very beneficial to industry. Especially with turn over in staffing.

Response 1: Thank you! We will send a continuation proposal in the next cycle. Also, consider O-09-SC proposal, in which Laurie proposes adding another diagnostics technique to consider. We consider all conclusions from this study to improve the analysis. -Lech

- If using the visual grid estimate as a surrogate ASTM standard, it would be good to have more validation that the grid estimate is really measuring the same property. I.e. in the plots of grid estimate vs ASTM % wood failure, what do the outlier specimen look like. Would multiple trained ASTM graders give those outlier specimen the same or similar grade? Are we sure there aren't fine wood fibers on those outliers that aren't apparent in the visual grid estimate photographs? In turn, if the chemometric model fits the visual grid estimate but not the ASTM measurement, are we sure that's because the ASTM estimate is imprecise, or is it because the chemometric method is also missing things like fine wood fibers? While the industry is very interested in a faster and more repeatable method of measuring wood failure, there's little appetite for something that evaluates samples using a different scale (a passing/failing ASTM should be passing/failing on the new method), so it's important to ensure the grid estimate surrogate method is valid.

Response 1: Thank you! All points well taken! -Lech

Response 2: We expect that if the grid images were evaluated by a different grader, the new results would be within 5% WF. The high-resolution images allowed for the detection of fine wood fibers, and the grid greatly improved the quantification of both materials on the surface. For these reasons, the models fit much better with the grid predictor values. There is actually no mention of a pass/fail threshold in the ASTM standard itself, but I believe PS-1 requires 85% minimum. A new standard should address this to correlate with both veneer-based and lumber-based specimens. - TalbotBRueppel

- Address the concern that fluorescence spectroscopy of certain samples with wood fiber "fuzz" present but glue seen may result in lower %WF than expected. Also, document how grid size impacts comparison with visual evaluation (gerrymandering effect).

Response 1: In our assessment the grid density used by Talbot substantially narrows the margin of uncertainty and variation compared to conventional ASTM assessment (even if based on a coarse grid). I am not sure a separate study on how the grid size affects the assessment is needed, but that can be definitely done if desired. -Lech

Response 2: The high-resolution images allowed for the detection of both wood fuzz and trace amounts of glue. There is still some subjectivity involved in the grid estimates, which is why hyperspectral imaging and/or ImageJ would make better predictors. -TalbotBRueppel

- In future work it would be good to trial other adhesives and timber species combinations to see how the method discriminates between the wood failure and adhesive. Additionally, may have some potential to assist in delamination assessments. Overall - excellent work.

Response 1: Thank you. Would there be an appetite for funding a follow up study that would include just the most promising methods and a wider array of adhesive system/specie combinations? -Lech

- It will be interesting to do this evaluation in different orientations to see its repeatability.
Response 1: Thank you. Please explain what exactly you mean by different orientation. Different orientation of fibers? That seems to be less relevant when the source/sensor is located perpendicular to the evaluated surface. More if the source/sensor is aimed at an angle to the surface. But then we have a wide range of possibilities of what exactly that angle should be for best readings. That seems like a sub-project on its own. Would there be an appetite to fund such project? -Lech

- Could using different angles provide with better measurements on rough veneer? Could you use 3-D imaging and depth measurements to provide better correlations?

Response 1: That is certainly a viable research approach, but goes somewhat against the grain of the speed of assessment, which is the target when we think of a standard method to replace visual assessment. -Lech

- This research is of high interest, and it will be good to do a continuing proposal to add more detail and repeatability.
- - could be useful to look at increasing the grid size and doing a sensitivity analysis as a function of grid size.

Response 1: We can definitely do that. I am not sure though what would be the use of this information. The grid density used by Talbot was very dense and in our assessment narrowed the margins of uncertainty to a level expected for the reference standard. -Lech

Comments

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- Great work. Congrats on finishing.
Response 1: Much appreciated, I would love to contribute to an ASTM standard eventually. -Talbot B. Rueppel

- Plywood allows for reading fine wood fiber while other products do not.
Response 1: I think some of the methods presented should allow calibration for both approaches (with and without fine fibers being counted as WF) -Lech

- Excellent presentation and discussion with audience. Very relevant topic for the engineered wood products industry. Suggest more work with a rotation of samples, say at 90 degree intervals, to look at this influence on reading result. If manual a first, perhaps this can be automated on a rotating carousel. Also suggest pursuing this topic at the ASTM Standards level, perhaps with the request to form a task group within the appropriate committee.

Response 1: Re: rotation of samples. Not sure it is going to make a difference for source/sensor positioned perpendicular to the specimen surface. May make a difference if source/sensor are

positioned at an angle, but then we open a sea of possibilities of combinations of the angles of the probe from that vertical position vs. the position of the specimen (say, 0 and 90). That is doable, but at a cost of \$\$\$ time and resources. -Lech

Response 2: Agreed with Lech, and the current standard and all subjectivity that comes with it internationally needs to be amended after this method is solidified. -Talbot B. Rueppel

- Good presentation of methods to improve upon visual evaluation of %WF. Well thought out and organized work. I liked the discussion of improvement of visual evaluation --> grid analysis with microscope --> fluorescence --> software imaging.

Response 1: Credit goes to Talbot! -Lech

Response 2: Thank you very much, this topic really grew on me, and I think it was a great start. - Talbot B. Rueppel

- Very useful project for improving the objectivity and reliability of percent wood fibre failure. This is a major issue internationally. In future work it would be good to trial other adhesives and timber species combinations to see how the method discriminates between the wood failure and adhesive. Additionally, may have some potential to assist in delamination assessments. Overall - excellent work.

Response 1: Re: application of this method to assess delamination: that would work only under standards that allow splitting the delam specimen to assess WF%, but not for those that rely exclusively on the % delamination line assessed from the side. -Lech

- Good progress and interesting results. I would hesitate to say that this method could be taken to ASTM at the current state (need significantly more data and better understanding of how different wood characteristics influence readings). Hoping to see learnings from this work continue on as another project.

Response 1: Please consider O-09-SC being proposed this cycle. Alternatively, we will be happy to accommodate all these leads in a follow up proposal to be submitted in the following cycle -Lech

Response 2: Go Lech! Quantified hyperspectral images would serve as fantastic predictor variables to correlated to UV-VIS spectral results. -Talbot B. Rueppel

- It would be of great interest to continue this research to be able to incorporate the methodology in the ASTM standard. Talbot, good job presenting, it was clear and easy to understand.

Response 1: Please consider O-09-SC being proposed this cycle. Alternatively, we will be happy to accommodate all these leads in a follow up proposal to be submitted in the following cycle. -Lech

Response 2: Very much appreciated, and yes, the standard needs a change ASAP! -Talbot B. Rueppel

- Automation of this technique would be very helpful in a R&DLab environment especially if the throughput of samples can be increased.

Response 1: In our opinion, that would be more of a commercialization than a research step. Not sure if possible on the budgets available through WBC. -Lech

Response 2: Certainly. -Talbot B. Rueppel

- Good job Talbot, the presentation was clear and easy to understand. It will be good to continue this work to be able to incorporate it in the ASTM standards.

Response 1: Please consider O-09-SC being proposed this cycle (propose modifications). Alternatively, we will be happy to accommodate all these leads in a follow up proposal to be submitted in the following cycle. -Lech

Response 2: Thank you, and much agreed! We would all like to see it. -Talbot B. Rueppel

- The use of fluorescence to determine the failure surface is a very interesting concept across different material systems. I would be very interested to see if other techniques such as infrared thermography could be used instead of the current approach. The authors mention that the use of ImageJ would be quite helpful. It was not clear if they meant using ImageJ in addition to the grid technique that they have implemented using R-studio.

Response 1: The ImageJ script can analyze all kinds of images with good contrast between the adhesive system and wood. Fluorescence is one of the contrast enhancing techniques that we used. But in principle any other contrast enhancing technique should do. Fluorescence was our first choice for it works across a great variety of adhesive/wood pairings, and optimal wavelength may be found for odd combinations. The assumption is that on the industry side, each company is likely to work with a narrow selection of wood/adhesive combination, so it comes down to investing in just one or two light sources specific to their materials. The rest is the camera and the ImageJ script calibrated for the color scheme. Still, other techniques that cover a similarly wide spectrum of material combinations may be considered. Takes funding, time and resources. Consider O-09-SC proposed in this cycle. ;7) -Lech

Response 2: I am not sure the cost of Infrared Thermography, but the appeal of the current instrumentation was the cost and its semi-portability. I should have clarified - ImageJ would be used in place of the grid method to quantify PWF values to serve as predictor variables in the chemometric model. -Talbot B. Rueppel

Project: (002) I-29-FR: Fundamentals of resole formulation

Project Phase: Project Update

Project PI: Chip Frazier (VT)

Level of Interest

Very Interested - 2

Interested - 7

Interested with Change - 2

Not Interested - 0

Abstain - 3

Summary of Responses to IAB Comments

Questions

- It would be interesting provides some information about the performance of this type of adhesives on wood substrate.
Response 1: Agreed thank you. Ryan has been discussing delamination studies. -Chip Frazier
- Run, collect sample and rerun same sample and see how it changes.
Response 1: Thank you -Chip Frazier
Response 2: Thank you -Ryan Gray
- It would be good to learn how the PIs are planning to address the filler concentrationsizegeometry effects on the viscosity. Additionally, how do you think the bubble formation or atomization would change as a function of filler content and geometry?
Response 1: Ryan has all particle-size measurements and also some qualitative info on particle geometry. I can only imagine that filler content and geometry would have an impact; but I could not predict it. -Chip Frazier
- What are the longer-term variations in wood composite product quality over time due to the changes in viscosity and shear etc during spraying.
Response 1: Thank you- I don't know this answer -Chip Frazier
- Is the study focused into assesing the extender used in the adhesive or the adhesive itself? Is there interest in using this in pMDI? How can this study be utilized for coatings?
Response 1: Extender is not currently studied. Likewise, pMDI is not part of this study. -Chip Frazier

Suggestions

- Can you change the length of the capillary to mimic the time effect? Does a shorter capillary give a different result? This may be a way to investigate the effect of time in an atomizer tip.
Response 1: Capillary length is a big variable; it has a significant effect. But the topic is so new to me that I cannot comment on mimicry of time effects. But again, the capillary length is a very important variable. -Chip Frazier

- It would be better to investigate the spray patterns on different substrates and the effect of solids and viscosity on the substrate surface. Furthermore, jumping out of the box to Reference ink printing techs, it may be interesting to investigate the effect of electric charges on the spraying resoles on the wood and wood related substrates like paper, wood based or paper related hybrid materials.

Response 1: Thanks! Agreed- spray patterns should be simple and insightful. -Chip Frazier

- Understanding rheology behavior vs. change in solids to explain increase in viscosity would be important. Can sample be evaluated over time to see change? A few more minutes explaining the difference between rotational vs. capillary rheology.

Response 1: Thanks; the solids effect must be thoroughly measured. -Chip Frazier

- Interpret the differences between the CCR and Alder Bark and fillers on the extensional viscosity response and how that would affect the way the mix would land on the wood surface during application. What is the implication of Alder Bark being shear thickening?

Response 1: Thanks- I don't know that the alder shows shear thickening (strain hardening); maybe it does- it's just too early to say. To me, it makes no sense that only one filler would promote strain hardening- its too early. the data is not ready yet. -Chip Frazier

Response 2: Thank you, and I have some optimization to do with this method to make some truly conclusive statements. I want to look into a more sensitive pressure transducer and capillaries with larger diameters. -Ryan Gray

- I think it is important to first establish if spraying an adhesive actually changes its rheology.

Response 1: Thank you- agreed -Chip Frazier

Response 2: Thank you, and I will add this to my experiments. -Ryan Gray

- Would be helpful to extend out to other adhesives

Response 1: Thank you -Chip Frazier

- It will ne interesting if this project can also applied into curtain coaters besides spray coaters.

Response 1: Thank you -Chip Frazier

Comments

- It appears that there is no much new on this proyect,

Response 1: Apologies for that impression. Ryan has made good progress, and his presentation was a little heavy on capillary rheometry -Chip Frazier

- Very interesting, and excited to see new extensional rheology data. Agree with discussion, making sure to try to capture relevancy to what is happening in the mill. The final performance of the glue, in whatever form, should be relevant to how the glue was applied.

Response 1: Thank you -Chip Frazier

Response 2: Thank you -Ryan Gray

- Interesting research, in particular the share rates and solids influenced viscosities of PF resin during spraying which indeed filled in research gaps.

Response 1: Thank you -Chip Frazier

Response 2: Thank you -Ryan Gray

- Interesting work using capillary rheometer to predict spray behavior.
Response 1: Thank you -Chip Frazier
Response 2: Thank you -Ryan Gray
- Although the presented research is not really in my wheelhouse, I would be interested to know more about the effect of particulate size and geometry (ld ratio) effect on the viscosity studies. The presenter mentioned that to account for the size effects, a 5 times the size of the filler is typically chosen in determining the nozzle size (or spray size, I might have understood that wrongly). I was curious how this number 5 was arrived at.
Response 1: Thank you. The %x comment is in reference to the rheometer gap size, not the spray nozzle. And yes, particle effects will be important. -Chip Frazier
Response 2: Thank you. The 5x refers to the largest particle of the filler being 5x the gap we use for the traditional rheometer. Then applying this idea to the diameter of the capillary being used on the capillary rheometer. -Ryan Gray
- Solids loss is important to understand because of the impact it has on the viscosity.
Response 1: Thanks- yes, it's huge. That detail must be thoroughly analyzed. -Chip Frazier
- Very good fundamental research on the effects of sprayingatomisation on adhesive viscosity and other properties such as extensional shear. It is important for industry to understand better these effects in order to improve wood composite product quality.
Response 1: Thank you -Chip Frazier
- Ryan, you did a good job presenting.
Response 1: Thank you -Chip Frazier

Project: (003) SWEETWATER-21: Investigating Lignin Consistency from Batch-to-Batch (New)
Project Phase: Project Update
Project PI: Mojgan Nejad (MSU)

Level of Interest

Very Interested - 4

Interested - 4

Interested with Change - 2

Not Interested - 1

Abstain - 3

Summary of Responses to IAB Comments

Questions

- Did you evaluate commercial available Lignin? There is interesting to know differences between them, ej. Hardwood vs softwood and methods for obtained it
Response 1: Yes, in another study we fully characterized 17 commercially available lignins and plan to publish that paper very soon. -Mojgan Nejad
Response 2: Yes, in another study we fully characterized 17 commercially available lignins and plan to publish that paper very soon. -Mojgan Nejad
- Noticed MW was < Indulin AT, but Tg was greater, can you explain this? Also, good discussion around the double-Tg peak and the double TGA peaks...I believe all would be interested in greater investigation here. Heat-cool-heat... perhaps there is some lignin crosslinking over 140-C. Perhaps considering both the first and second heat to see if a change has occurred.
Response 1: We are trying to find correlations between lignins Mw and their Tgs, but have not found a high correlation. I truly appreciate all the comments/ suggestion about TGA and DSC data and plan to do more in-depth analysis and report back to the group. -Mojgan Nejad
Response 2: We are trying to find correlations between lignins Mw and their Tgs, but have not found a high correlation. I truly appreciate all the comments/ suggestion about TGA and DSC data and plan to do more in-depth analysis and report back to the group. -Mojgan Nejad
- Address carbohydrate shoulder on TGA spectrum. Discuss the two Tg peaks in polymer spectrum in more detail. Surprised one polymer would have two distinct Tg peaks. Are we seeing two distinct regions of a complicated polymer or some sort of 2nd polymer in system or reaction under heat?
Response 1: These data were based on Canadian Standard Association method for Kraft lignin. I will try running some control samples like pure cellulose and Xylan as hemicellulose representative and pure lignin to evaluate the accuracy of our TGA data, and run the same samples in DSC. -Mojgan Nejad
Response 2: These data were based on Canadian Standard Association method for Kraft lignin. I will try running some control samples like pure cellulose and Xylan as hemicellulose representative and pure lignin to evaluate the accuracy of our TGA data, and run the same samples in DSC. -Mojgan Nejad

- Interested to know whether it would be possible to optimise lignin yield and properties from plantation grown trees - for example can the lignin characteristics and yield be manipulated through silvicultural, site and genetic means.

Response 1: Yes, there many ongoing and published works on genetically modified trees, mostly focused on reducing the lignin content in trees to make them more suitable for biofuel productions. - Mojgan Nejad

Response 2: Yes, there many ongoing and published works on genetically modified trees, mostly focused on reducing the lignin content in trees to make them more suitable for biofuel productions. - Mojgan Nejad

- As the questions that were asked before, it will be good to have further understanding of the polysaccharides in the ligning and see if they can be used in a positive way.

Response 1: Residual polysaccharides in lignin is fine for some applications (like PU) as long as they do not interfere with lignin solubility. -Mojgan Nejad

Response 2: Residual polysaccharides in lignin is fine for some applications (like PU) as long as they do not interfere with lignin solubility. -Mojgan Nejad

Suggestions

- To clarify the two peaks on the thermal degradation TGA scan you could do a deconvolution of the peaks then spike with a pure material and see the shift in the peak heights.

Response 1: That is an excellent suggestion. We will try this and report back. -Mojgan Nejad

- It would be interesting to investigate the thermal introduced coupling reactions such as addition and thermolysis under heat at oxygen and inert atmosphere.

Response 1: Could you please elaborate more on this? we ran the samples both under N2 and air in TGA. -Mojgan Nejad

- Pursue your larger sample size. This work is interesting, and it is a question I have heard over and over--can natural materials be consistent enough for industrial use?

Response 1: Will do. Thanks for your support. -Mojgan Nejad

- Would be good to see future work study various lignin feedstock sources - for example from different hardwood species (eg eucalypts) and softwood species.

Response 1: If there are enough interest, I can present data that we have from analyzing 17 commercial lignins. -Mojgan Nejad

- Better to use the SG ratio to determine the performance for given applications of hardwood lignin. Quantify aliphatic and aromatic Hydroxyl groups in the lignins may help on the foam application.

Response 1: Sure, we can calculate the S/G ratio and report back next time. -Mojgan Nejad

Comments

- Good progress. We agree that getting the additional samples would improve the interpretation of results.

Response 1: Thanks, I will reach out to Sweetwater and ask for more lignin samples. -Mojgan Nejad

Response 2: Thanks, I will reach out to Sweetwater and ask for more lignin samples. -Mojgan Nejad

- Surprised that batch to batch consistency is good across batches and that it depends on process used. I enjoyed the thoughtfulness of how the work was presented.

Response 1: Thanks. Once we have more samples, we will model data and hopefully presenting it next time when we meet in Spring at MSU. -Mojgan Nejad

Response 2: Thanks. Once we have more samples, we will model data and hopefully presenting it next time when we meet in Spring at MSU. -Mojgan Nejad

- I am curious to learn more about the interpretation of the TGA. what other possible mechanisms could explain the two thermal events. This analysis is helpful for companies that want to use lignin as a raw material.

Response 1: We will isolate pure lignin samples form these lignins and analyze them in TGA to see whether we still these two peaks or not. -Mojgan Nejad

Response 2: We will isolate pure lignin samples form these lignins and analyze them in TGA to see whether we still these two peaks or not. -Mojgan Nejad

- Very impressive research. Essential for further development of bio-adhesives and improved sustainability and market appeal of wood composites

Response 1: Thanks, I appreciate WBC support. -Mojgan Nejad

Response 2: Thanks, I appreciate WBC support. -Mojgan Nejad

- Good job and good advance.

Response 1: I am happy to hear that. -Mojgan Nejad

Response 2: I am happy to hear that. -Mojgan Nejad

- Interesting topic characterizing lignins, but treatment or isolation of lignins may become a cost challenge for the following applications.

Project: (005) N-02-MU: Long-term response of wood-based composites in variable climate conditions (New)

Project Phase: Project Update

Project PI: Lech Muszynski, John Nairn, Mariapola Riggio (OSU)

Level of Interest

Very Interested - 2

Interested - 2

Interested with Change - 0

Not Interested - 0

Abstain - 0

Summary of Responses to IAB Comments

Questions

- I am wondering why the experiment is being performed at 80% RH? Is it meant to emulate elevated MC levels that may occur during construction? Seems like 80% RH would be an unreasonably high sustained service condition. It would be of interest to understand the behavior as material equilibrates to service conditions Do you anticipate extending this to bending members (tension) as a next phase?

Response 1: The RH levels may but are not meant to replicate any specific condition during construction or service life. The mechano-sorptive deformations depend on cumulative moisture content change experienced by the material anywhere within the hygroscopic range. So the selection of the RH conditions for the cycles is guided by the desire to generate possibly substantial MC changes in a short period of time. The low RH is reflecting the highest annual ambient RH in the lab. That way we avoid adding an air dryer to the setup (unnecessary cost and complication). -Lech

Response 2: For this project, we will mainly be focusing on the testing in compression due to the test time of various composites we will be testing but definitely, this research can be extended to tensional testing with appropriate redesign of the mechanical fixtures for tensional loading of the specimen. -Funbi

- Will this study be done in different composites (CLT, OSB, plywood, etc.)?

Response 1: Our immediate plan is to perform the tests on solid wood, CLT, and MPP specimens. MPP is produced using a hybrid of LVL and Plywood, we wanted to see if the outcomes will warrant testing conventional plywood and/or conventional LVL separately. Currently, we do not plan testing OSB specimens, but it is a possibility if there is a compelling need. Extending the material matrix takes time, resources and money. -Lech

Response 2: In addition to the composites listed by Lech, we are considering performing tests on GLULAM as well as it is increasingly becoming a prominent structural element especially as long span beams. -Funbi

Suggestions

- Make sure there is a correlation between the time it takes to test and the test conditions to "long term" time frame. Consider the conditioning time requirements on the Mass Ply sample versus the other sample type.

Response 1: Thanks! Good suggestions. There is good literature and new data coming from a parallel project on the long-term effect triggered by visco-elastic creep/relaxation at constant ambient conditions. Here we are concerned with the much less researched effect of mechano-sorption. In real life applications the moisture changes that trigger this effect are slow. Using shin specimens in our lab approach we are able to shorten the time needed to accumulate moisture content change equivalent to years of service. -Lech

Response 2: Will consider that with Lech. Thank you for the suggestion - Funbi -Funbi

- The research looks interesting, but to be an actual climate study it must include temperature variations as well.

Response 1: This is a great comment. However, extending the research plan to temperature variations would substantially expand the test matrix and require additional equipment. Both are beyond current scope and funding. On the other hand, compared to the effect of moisture variation the direct effect of temperatures within the range expected in service on mechanical properties of wood (including elastic and creep) is secondary. The effect of temperature on the sorption isotherm translates to shifting the amplitude of moisture content changes, which again would be a secondary effect in the mechano-sorptive effect where cumulative moisture content change over multiple cycles is believed to be the trigger. I am confident that we are going to cover all primary effects within the current scope of the project. On the other hand -Lech

Comments

- Interesting new approach. Curious to see what effect levels will be observed over relatively narrow cycling in temp and RH.

Response 1: We use methodology developed back in a 2005-8 project. This method allows obtaining a confident measurable effect in relatively short time. The previous research results could not be published due to a glitch detected in the loading apparatus creating random hysteresis. That was detected too late to adjust or redo. This time around we are taking precautions and monitoring the loading procedures to avoid that kind of issues. -Lech

- The poster was well presented. The poster needs to specify that the materials to be tested plan to be used in structural applications where they will be covered from exterior conditions.

Response 1: Great comment! Will do in all further communications. -Lech

Response 2: Thank you! Duly noted and will make necessary changes. -Funbi

Project: (006) M-02-PR: In-depth Characterization of Bondlines in CLT made with Preservative-Treated Lumber

Project Phase: Project Update

Project PI: Gerald Presley and Jed Capellazzi (OSU)

Level of Interest

Very Interested - 4

Interested - 7

Interested with Change - 0

Not Interested - 1

Abstain - 1

Summary of Responses to IAB Comments

Questions

- PLEASE share a metric of the variation and number of specimens in the data. Average values are not appropriate on their own.
Response 1: I can have Cody revise his presentation to include this. -Gerald Presley
Response 2: Yes, I can reevaluate how some of my graphs or tables are represented. -Cody Wainscott
- There are organic preservative that may also find use in CLT treatment. Some contain carriers co-solvents that may need to be studied for compatibility with traditional CLT adhesives. Any plans to look at other preservatives?
Response 1: I would like to continue this research, but the scope of this project is nearly complete. WE had one all-organic preservative in this study that contained, propiconazole, tebuconazole, imidacloprid, permethrin, and IPBC. there were also some proprietary ingredients in there that I suspect contained at least one Quaternary ammonium compound. I agree there are a lot of compatibilities to investigate further, O-06-PR proposal starts this process to some degree using fire retardants, but the characterization pipeline I am proposing could be used for various organic preservatives. -Gerald Presley
Response 2: Piggybacking off this comment, there are a number of other preservatives we can continue too investigate, but I believe it is important to reevaluate our data now and propose a follow up project. -Cody Wainscott
- Why was the mass of preservative introduced for the mixed system so much lower than with the neat O or B formulations?
Response 1: The PTI+borate system tested here was only a dip treatment, s the chemical retentions we measured for borates was about half as much as the pressure treated stuff destined for Hawaii. In Cody's DMA analysis he aimed to recreate the retentions he measured in the lumber that went into CLT panels to gain a better understanding of what may have went on in those panels when it comes to preservative-resin interaction. -Gerald Presley
- Why was maple chosen as the wood substrate?

Response 1: Maple was chosen because it has a constant cell size, takes up preservatives well and was a species we had on hand. DF naturally has a resistance to preservative pressure treatment which is why it is usually incised. Maple was easier to use. -Cody Wainscott

Response 2: This was a standard test species used by our collaborators for DMA analysis that they had on hand. I don't think it would be an issue to use softwoods in the future, but treatability is a potential concern and veneer would have to be limited to sapwood for Douglas-fir. -Gerald Presley

- -
- What was the solids of the PUR versus the MF and what was the impact of that on the adhesive penetration? MF adhesives are water based and differences in penetration could be due to that or the treatment.

Response 1: This is a test we could not do unfortunately because the panels were made offsite and then shipped to us. This would be another good point to examine in a follow up project were we could instead make the panels ourselves. -Cody Wainscott

Suggestions

- Just as the DMA work required gluing of home-made specimens, the adhesive penetration work also requires this level of controlled experimentation. This work was fundamentally flawed from the beginning by using panels that were laid up previously. To answer the questions we are attempting to answer, controlled experiments are required. Please also provide a greater interpretation of the differences between the two resins. You should understand and be able to speak to what you expect to see from the two resin types. MF and PUR adhesive penetration and cure studies have been done before. Do your results make sense by comparison?

Response 1: Yup, completely agree. I have read some papers on MF and PUR in CLT panel creation but there is very little information on the interaction of adhesives and preservatives. With that said, I did find some papers that came out this year but haven't had time to read them. -Cody Wainscott

Response 2: Cody should have an analysis of this in any publication and thesis chapter based on his review of the literature. -Gerald Presley

- There was work by MacMillan Bloedel in the early 1990's looking at PF resins and borates interactions. Believe there was a patent as well. Researchers involved included Dr. Bob (Robert) Knudson and Dr. Chris Lim (deceased). A literature search should turn up what is in public domain. Involved treatments of OSB in-process.

Response 1: Thank you for the literature suggestion. I'll be sure to look for this. -Cody Wainscott

- This study requires more research as the current methods are not novel. Below are suggestions to improve the experimental design: - It will be good to add a chemical analysis (FTIR, GC-MS, etc.) to quantify the chemical bonding sites that have been occupied by the preservatives vs adhesives, and evaluate how they can compete for those same bonding spot. - Anatomical analysis of the treated wood will be essential to comprehend if the reduced absorption is because of blocks or chemical saturation. SEM of the cell walls can be a really good tool for this.

Response 1: Would you suggest an FT-IR microscope to investigate this further? I would be interested in what options are available but perhaps in a future experiment where we control the press/bonding process. -Gerald Presley

Response 2: Yes, I have thought of using FTIR and DSC as other tools for resin and preservative interaction. The SEM is one I was not aware of and will look into. -Cody Wainscott

- Consider what level of additional adhesive penetration is actually better. Sometimes more penetration leads to weaker bonds.
Response 1: Thank you for this input. -Gerald Presley
- If possible in the future to study the interactions between other wood preservatives and adhesives.
Response 1: I agree it would be good to look at some of the other systems. -Gerald Presley

Comments

- Good development on the additional DMA work, but still very concerned with the understanding and grasp of the concepts of the various techniques used. The description of DMA method and interpretation of results needs significant work. As for the adhesive penetration work, this is not a controlled experiment and if the results are to be shared, the assumptions and relevancy needs to be reported.
Response 1: Thank you for the input. As Cody writes up a summary of this work we will be sure he comes up to speed on the details of the DMA method which can be discussed in publication in more depth. I agree that the microscopy work has deficiencies and we will certainly report these in any publication. We will remove discussion of statistical differences for that data in publication because we really do not have the replication to justify those conclusions. This microscopy work still has merit as "preliminary investigation" and warrants further investigation in a controlled study because Cody's observations indicate there may be a difference. -Gerald Presley
- Great topic and industry relevant. CLT products need protection from biological attack to ensure long service life. Treating with borate based preservatives is a logical match for this product. Meeting bond quality requirements with treated laminates requires understanding this interaction.
- Good & relevant to industry research. CLT products need to be protected from biological attack. Some preservatives can negatively affect bond quality. Borates are PF resins are one such combination. Some work in this area was conducted by MacMillan Bloedel in the early 1990's. There was a patent issued (US) but I am unsure how much of the work may have been published. Drs. Robert (Bob) Knudson (later worked at Forintek) and Dr. Chris Lim (deceased, later worked at Univ. of British Columbia) were two of the principal scientists.
Response 1: Thank you for this information we can follow up and try to find more information. -Gerald Presley
Response 2: Thank you for the information. I'll try to find these papers for reference. -Cody Wainscott
- Good progress. Looking forward to reading the paper
- Cody did a good job presenting, but his work requires more depth.
Response 1: We would like to continue to pursue this research topic but have gone beyond the original scope of the project already and are aiming to wrap this specific project up. -Gerald Presley
Response 2: Yes, this project could be used to reevaluate new test methods to further analyze adhesive curing in presence of preservatives. -Cody Wainscott
- Great project - of interest and usefulness to the wood composites industry
- need to fix panel construction issues
Response 1: Yes, panels were given to us as is and before I even was placed on the project, but moving forward, this initial data could be used for a more in-depth newer project. -Cody Wainscott

Project: (007) M-05-NE: Improving Durability of Wood Products by Reducing Lignin

Degradation

Project Phase: Project Update

Project PI: Mojgan Nejad (MSU)

Level of Interest

Very Interested - 3

Interested - 6

Interested with Change - 0

Not Interested - 0

Abstain - 2

Summary of Responses to IAB Comments

Questions

- Good discussion about digging deeper into not just the coating degradation, but how has the wood beneath been affected, and are they correlated with each other? i.e. if a check opens up does it then provide a greater accelerated degradation of the coating... or does the coating significantly degrade and then does wood degradation follow... perhaps a combination of all of the above.
Response 1: We plan to look into this after 2000 of QUV study. We will do a visual assessment after the QUV test too. -Mojgan Nejad
- What was the root cause of delta E reduction from 300 to 800 hrs?
Response 1: I believe is mainly related to resin erosion and peeling off from the plywood surfaces. We will see if we continue to see the same trends. -Mojgan Nejad
- Are you planning to do some trials of effect in real conditions of exposure like Florida exposure? There is any reference of effect if the additive are apply over the surface as a stain instead as a coating?
Response 1: It was not part of this proposed project, but we can certainly do natural weathering tests in Michigan and Florida if there are enough interests from members. -Mojgan Nejad

Suggestions

- Over 5000h QUV exposure would be more practical in the external application under harsher conditions.
Response 1: The 5000 hrs will be helpful when we want to test the performance of exterior coatings rather than resins which we tested in this study. -Mojgan Nejad
- It will helps if you show information about CIE Lab results , not only DE because some times DE not show strong results.
Response 1: Sure, we will include changes in L, a, b in addition to Delta E, next time. -Mojgan Nejad

- We would look at surface checking on the samples as a measurement of degradation.
Response 1: Yes, we are planning to visually assess all samples for checking, cracking, mildew and coating erosion and peeling, following the ASTM test methods designed for wood coatings. -Mojgan Nejad

Comments

- Great research topic can even be applied on external coating application.
Response 1: We would love to test exterior coatings performance applied to wood-composite panels. -Mojgan Nejad
- Interesting topic. Work looks promising. Liked the discussion of weathering of wood vs. coating discoloration. Excellent presenter.
Response 1: Thank you so much. -Mojgan Nejad
- Good progress and interesting results. Looking forward to seeing the 2000h data
Response 1: Thanks, Look forward to seeing you all in MSU. -Mojgan Nejad
- Good project of interest to the wood composites industry internationally
Response 1: Glad to hear this. -Mojgan Nejad

Project: (008) I-10-FR: Carbon Isotope Ratios, novel view of CH₂O emissions

Project Phase: Project Update

Project PI: Chip Frazier (VT)

Level of Interest

Very Interested - 7

Interested - 2

Interested with Change - 0

Not Interested - 0

Abstain - 1

Summary of Responses to IAB Comments

Questions

Suggestions

- Better to provide solid proof of proposed intermediates during addition reaction via ¹³C NMR or HSQC.

Response 1: Thank you- I'm not clear on the topic here. -Chip Frazier

Response 2: Deep investigations into resin development mechanisms and intermediates/moieties is beyond the scope of this project. We plan to draw upon and correlate to literature investigations for this knowledge. Thank you, Mark -Mark Cashman

Response 3: Deep investigations into resin development mechanisms and intermediates/moieties is beyond the scope of this project. We plan to draw upon and correlate to literature investigations for this knowledge. Thank you, Mark -Mark Cashman

- Don't rush slides in early part of presentation. We would like to see what you put on them and if you don't plan on presenting a certain slide, maybe don't include it in the slide deck. Upgrades to equipment sound promising. Really interested in relative amounts of formaldehyde emissions from wood and resin. What about potential relative differences based on curing temp?

Response 1: Thank you. Presently, press temperature is not a study variable. -Chip Frazier

Response 2: Apologies, for the sake of time I didn't drag out the discussion of the early slides which are a part of the presentation formatting and have been shown and discussed in my previous presentations. However, these slides are available in the google drive to look at at your convenience. Thank you and thanks to the WBC members for the suggestions for how to upgrade the heated transfer line. As Dr. Frazier mentioned, press temperature is not a study variable for this current work. We're simply utilizing a relevant, industry suggested press temperature. Thank you, Mark - Mark Cashman

Response 3: Apologies, for the sake of time I didn't drag out the discussion of the early slides which are a part of the presentation formatting and have been shown and discussed in my previous presentations. However, these slides are available in the google drive to look at at your convenience. Thank you and thanks to the WBC members for the suggestions for how to upgrade the heated transfer line. As Dr. Frazier mentioned, press temperature is not a study variable for this current

work. We're simply utilizing a relevant, industry suggested press temperature. Thank you, Mark - Mark Cashman

- We would suggest you look at adding water to the neat wood sample. Add the amount of water equal to the amount of water added at the adhesive application rate used for the adhesive panel. This may allow you to use the same amount of raw furnish in the panel. Also, the amount of moisture within the panel will affect the formaldehyde generated during pressing. This may give you a better overall comparison.

Response 1: agreed- thank you -Chip Frazier

Response 2: Yes, this is a great suggestion! I plan to re-do these experiments and do exactly this. Thank you, Mark -Mark Cashman

Response 3: Yes, this is a great suggestion! I plan to re-do these experiments and do exactly this. Thank you, Mark -Mark Cashman

Comments

- Great research topic with sound experimental design to collect formaldehyde emission during different stages of press.
Response 1: thank you -Chip Frazier
Response 2: Thank you I appreciate it! Separately collecting emissions across the different segments should provide some interesting insight! -Mark Cashman
- Important topic, relevant to Industries represented at the meeting. Well thought out work.
Response 1: thank you -Chip Frazier
Response 2: Thank you I appreciate it! -Mark Cashman
- Excellent presentation! Great progress. Glad you are synthesizing the resin!
Response 1: thank you -Chip Frazier
Response 2: Thank you I appreciate it! I agree, synthesizing the resin in-house provides an additional layer of depth and control for this research. -Mark Cashman
- Nice efforts and attention to details. Looking forward too see results.
Response 1: thank you -Chip Frazier
Response 2: Thank you I appreciate it! Also very much looking forward to being able to get some end results. -Mark Cashman
- the use of cystamine is a good idea
Response 1: thank you -Chip Frazier
Response 2: Thank you, I agree! Based on literature and preliminary in-house investigations cysteamine should prove to be a great formaldehyde derivatization agent for this work. Time will tell. -Mark Cashman
- This is a very important project given regulatory requirements concerning formaldehyde emissions. Project has been well designed and implemented.
Response 1: thank you -Chip Frazier
Response 2: Thank you I appreciate it! -Mark Cashman

- HCHO emissions are driven by density face in particular. board construction is critical and VDP will be important.

Response 1: Yes density profile within/across the board will certainly have a strong influence on emissions. Our main goal on this front is to be systematic and consistent with resination and panel pressing procedures. However density profiles will surely vary across the different wood furnishes and may be worth looking into. Thank you for the suggestion! -Mark Cashman

Project: (009) M-03-PR: Preliminary Investigation of DMDHEU-Treated Strand Board

Project Phase: Project Update

Project PI: Gerald Presley and Fred Kamke (OSU)

Level of Interest

Very Interested - 2

Interested - 4

Interested with Change - 0

Not Interested - 1

Abstain - 1

Summary of Responses to IAB Comments

Questions

- I would like to know more about the specifics of the treating process. May be able to provide some guidance on this. If you would like to measure some vertical density profiles of panels, we can help with this. After treatment, what was the curing drying step and was the weight of the mat calculated using the initial weight gain or dried weight values? I'm guessing latter but please clarify.

Response 1: The treating process was simple. Aspen strands were placed in a solution of DMeDHEU diluted to a retention-appropriate concentration and weighed down in the pressure vessel below the solution. the chamber was closed and a full vacuum was drawn for one hour I believe and then pressure was applied for one hour. Shane correct me if you revised the treatment cycle times. I believe Shane weighed the treated strands after the curing process prior just prior to forming the mat so it would be using dried weight values. -Gerald Presley

Response 2: Yes, as Dr. Presley stated, the treatment was done in a pressure cylinder with full vacuum occurring for 60 minutes, followed by 60 minutes of pressure at ~40-50 PSI. I had taken weighted strand weights prior to treatment, then strand weights post treatment while still wet, followed by a final weight after the drying/curing process. I used the final weight of these strands compared to the original dry weights to determine the treatment concentration. The mat weight was then determined by calculations which Dr. Kamke had prepared, which i followed by combining the necessary weighted strands and resin amounts to get final panel weights. -Shane Johnson

Suggestions

- Please have a discussion with the advisory committee on the board density issue before proceeding further with making and testing panels. This is a complicated issue and the density will have a large impact on properties.

Response 1: Yes we can schedule something for early November. I will reach out to the committee after the WBC meeting. -Gerald Presley

Response 2: I Look forward to having a discussion with the advisory committee, however I have already completed a secondary set of panels for this project and only have testing left to do. If we acquire more chemical solution and would like to do another round of panels at a different density parameters, this may be a possibility, however the suggested timeline would most likely need to be extended in order for this to occur. -Shane Johnson

- Based on questions from the audience, there were some issues arising from the methodology that need to be addressed - example strand orientation, low number of replicates for the higher concentration, density profiling etc.

Response 1: This is a very good point, as my orientation had been fairly random, i could see issues arise with strength capabilities which have been discussed individually with various members. The low number of replicates for the higher concentrations was due to a bonding issue that arose from the overlooked density change, however with the second set of panels, there is significantly less bond issues present for these samples and therefore should result in higher numbers of replicated for these higher concentrations. There was in fact density profiling calculations completed, I was confused by the question, however before doing any of my material testing the density for each sample was calculated. -Shane Johnson

- The bending test results will not match industry standards requirements due to the lack of orientation. One way to deal with this is to test a non-oriented panel made with an adhesive and application rate that is known to meet industry standards. Experimental results can be compared to this control result.
- It is suggested to include a solid sawn aspen reference block in future fungal decay testing. Test against surface molds. Test for corrosion of fasteners (e.g. mild steel nails or galvanized nails). Make some panels using pMDI adhesive. Try making some panels using a variety of adhesive levels, holding panel density constant.

Response 1: these are all useful suggestions which could be applied to further research on this project. -Shane Johnson

- The usefulness of bending tests with randomly oriented strands is questionable. Perhaps bending tests could be substituted for additional IB specimens.

Response 1: I agree with the bend tests being questionable, in my results i found that there was less variability among the bend tests as opposed to the IB tests, but more IB tests could be performed if this is a more viable and relevant operation -Shane Johnson

Comments

-
- Good work; good find of the density differences. Great presentation skills for an undergrad! NOW that you know the density was an issue, you should BLOCK your data or remove altogether the panels made with lower density. It is good you saw that issue, but it should not be compared with the rest of the data. Also, once you have all conditions with the same strand content, normalizing by panel density (measure dimensions and weight of each specimen), and then normalize results by density. OR do statistics and account for it as a co-variant.

Response 1: We agree, the next round of testing Shane will be doing will be on an entire new set of panels and we will use data from these for any publication while only referring to the low density panel data. Shane can collect density data easily on these new panels and we will be sure to include that. -Gerald Presley

Response 2: Yes, with my second set of panels, the density should not be an issue. I only included the low density panels in this first set of data to show the issues which we experienced and the result differences from the less dense panels, to the panels which were created post density calculation change. -Shane Johnson

- Interesting and useful project. Overall, good work.
- Nice presentation and relevant to industry. OSB mills in the southeast will eventually want to see some work using southern yellow pine resource.
- Good presenter, and topic is a benefit to board manufacturers.
- Good undergraduate work with some lessons learned.

Project: (010) N-06-CA: Bench-Scale Characterization of Joints and Coatings (New)

Project Phase: Project Update

Project PI: Scott Case & Brian Lattimer (VT)

Level of Interest

Very Interested - 3

Interested - 6

Interested with Change - 0

Not Interested - 0

Abstain - 2

Summary of Responses to IAB Comments

Questions

- What about reproducibility of results? Can more uniform heating source be used if you don't have variation on expansion across sample? Loss of intumescent coating due to air current movement-- can that be evaluated to see if certain coatings are less prone to this issue?

Response 1: We haven't focused on reproducibility due to this being a relatively short project, but that is something to surely do next. The non-uniform expansion occurred in the cone calorimeter likely due to edge effects. However, this data was only used to inform us on how to correlate DFT with final thickness and not the final result. In the furnace, the heating and the expansion was more uniform. This intumescent coating remained well intact during the experiments with not observed material falling from the surface, even with the jet flames impinging on the surface. Loss of intumescent coating due to air current movement can be evaluated in the extension of the project, but we would need to expand on the number of coatings being evaluated. -Akhilesh Kulkarni

- Do you think this method could be applied to intumescent overlays?

Response 1: If this is in regards to things like intumescent mats, the approach is applicable. However, it would be dependent on the thickness increments that the mats come in as to how well the scaled test samples can approximate the full scale. If this means overlaying the coating on top of an existing coating or thinner coatings for surface flammability reduction, the approach would have to be further explored for this application. -Akhilesh Kulkarni

Suggestions

- You do need to consider the loss of material due to parameters such as wind blow. Watch out when you scale up to account for the rate of expansion as coating is increased.

Response 1: Thank you for the comment and input on this application. The burners in the bench scale furnace test include the impact of higher velocity flaming on the surface so the test includes this. No material loss was observed for this coating. The approach explored scaling the dry film thickness so that the expansion rate / thickness is scaled to preserve the temperature profile in the material. This worked well down to half-scale but not as well at quarter scale showing some limitations in the approach. This may be different for other coatings, which would need to be explored in future projects. -Akhilesh Kulkarni

- Further work is required to validate that the scaled down approach represents what happens at a larger scale - eg charring processes.

Response 1: Thank you for the comment. In this study, it was found that the scaling worked down to half scale but below that the dry film thickness scaling could not be done to get as scaled response at quarter scale. When comparing half and full-scale thicknesses, the coating expansion, temperature profiles, and wood charring were well represented. Keeping the same dry film thickness at half and quarter yielded reasonable scaling results. This needs to be evaluated on additional coatings in future projects. -Akhilesh Kulkarni

Comments

- This project is beneficial to industry, given the constant need to ensure laboratory scale work and tests are relevant to larger scale industrial processes. Also if a bench scale approach can be validated then this will reduce the costs and resources required for larger scale tests.
Response 1: Thank you for the comment. We agree that the bench scale test would be a useful tool to assist industry in evaluating fire resistance designs prior to large scale testing. Further validation of this approach would enhance the confidence in the methods across broader applications and material systems. -Akhilesh Kulkarni
- Topic is relevant to industry given the ever evolving fire codes, including the wildland urban interface (WUI).
- Very good and thorough study! Cool use of video to map thickness growth during exposure.
- Interesting project.
- Very interesting work

Project: (011) M-04-FR: Wax Migration

Project Phase: Project Update

Project PI: Chip Frazier (VT)

Level of Interest

Very Interested - 3

Interested - 8

Interested with Change - 0

Not Interested - 0

Abstain - 1

Summary of Responses to IAB Comments

Questions

- Is there a way to see the wax on the flakes? If so, you may be able to use that to look at the flakes before and after pressing to see wax movement of the flakes themselves.

Response 1: Thank you. We could devise a spectroscopic method to do this; but solvent-extraction is the simplest, most robust, and quickest method -Chip Frazier

Response 2: Thank you. I have seen studies in literature that use florescence microscopy to look at wax/resin interaction and particle coverage. A similar method could likely be applied to this work. In addition to being faster, solvent extraction and GC analysis also have the benefit of being able to look at compositional changes in the wax. -JC Stant

- Have different furnish moisture contents been tried? Is steam injection pressing a possible next step? Would a wood species with a higher natural resin content (e.g. pine) behave differently complicate the issue?

Response 1: Thank you. Different moisture levels will be used; not yet. No; steam injection is not an option in our press. Yes it's likely that natural wax variation could complicate the method. -Chip Frazier

Response 2: Thank you. Once the method is proven reliable, variables like MC will be tweaked in a series of experiments. There will also be several control experiments to account for extractives and natural wax. These controls could be repeated if different species of wood were studied. -JC Stant

- This project seems particularly relevant to OSB - does it also have relevance to particleboard ?

Response 1: Thank you- yes we think it's most relevant to particleboard and OSB, less so for MDF-type products -Chip Frazier

Response 2: Thank you. Yes, I believe the fundamentals explored in this study will be relevant to PB and OSB. -JC Stant

Suggestions

- Not well-versed in this topic, but impressed with what has been done so far.
Response 1: thank you -Chip Frazier
Response 2: Thank you! -JC Stant
- It will be interesting to include other fiber based composites such as MDF to compare the fiber size.
Response 1: thank you- that would be interesting for a future project -Chip Frazier
Response 2: Thank you. I agree, and once this method is proven it could be applied to different fiber types in the future. -JC Stant
- interested to compare the GC for the same base slack vs. the emulsion MADE FROM the same base slack. We can ensure you have the correct samples for this.
Response 1: thank you -Chip Frazier
Response 2: Thank you. I'll get in touch to check if what we have is from the same batch or if we need a new shipment. -JC Stant

Comments

- Interested if small scale panel can accurately predict large scale panel phenomenon for Industry R&D. Good presentation.
Response 1: Thank you- we don't believe the small scale predicts very well; but at this stage we seek the fundamental insight: does the wax composition change, and how much? -Chip Frazier
Response 2: Thank you, As Dr. Frazier says I do not believe the small scale can perfectly model a large scale. But I do believe the fundamentals will be applicable industry scales. -JC Stant
- It will be interesting to see how the needle valve works out. This could be very useful for future projects as well
Response 1: Thank you -Chip Frazier
Response 2: Thank you, trying to get constant flow while increasing lab scale pressures has been a very interesting problem to tackle. I hope others find it useful in the future. -JC Stant
- This is an interesting topic, driving toward a further understanding of what is going on when we close the press and make a wood composite. Some work with an OSB matrix, as mentioned in previous feedback, would be more relevant to us. But the work with PB is still relevant and valuable.
Response 1: Thank you -Chip Frazier
Response 2: Thank you, I think the fundamentals investigated in this project will be applicable to other particle types. Once the method is proven, the experiments could be reproduced with different particle sizes in the future. -JC Stant
- Very interesting project. Scientifically sound methodology.
Response 1: Thank you -Chip Frazier
Response 2: Thank you, I have enjoyed developing the method and look forward to sharing results. - JC Stant

- Nice presentation. Looking forward to seeing updates.
Response 1: Thank you -Chip Frazier
Response 2: Thank you! -JC Stant
- Good work. consider doing different pressures and moisture contents. it will be difficult to get the same pressures seen in industry. automated extraction is a real time saving device.
Response 1: thank you -Chip Frazier
- J.C. Did a good presentation. The long term goal can
Response 1: thank you, but did you mean to complete a thought? -Chip Frazier
- Fantastic work!
Response 1: Thank you -Chip Frazier