SOCIETY OF WOOD SCIENCE AND TECHNOLOGY
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Doubletree Hotel Boise-Riverside, Boise, Idaho

STUDENT POSTER COMPETITION PRESENTATIONS
Wednesday, June 24, 2009 7:30 – 9:30 am

Poster Session 3:00 – 6:00 pm

POSTER 1

Thickness Swelling, Water Absorption and Vertical Density Profile of Medium Density Fiberboard Panels Affected by Continuous Press Pressure

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Vertical density profile (VDP) which is one of the most important panel characteristic is described as density variation in the direction of thickness in wood-based composites. Thickness swelling (TS) and water absorption (WA) are also important performance properties of the composites. The effects of the continuous press pressure on the VDP, TS, and WA of medium density fiberboard (MDF) panels were studied in this work. The MDF panels used in this study were produced using a commercial continuous press line at Kastamonu Integrated Wood Industry and Trade Inc. located in Kocaeli, Turkey. The panels bonded with urea formaldehyde resin were produced with four different press pressure levels. A total of 12 panels, three for each press pressure, were performed according to EN standards to obtain VDP, TS, and WA values. The VDPs of the panels were determined by using an X-ray density profiler (GreCon Measurement Systems). Results showed that the formation and shape of the VDP were influenced by continuous press pressure. Increasing press pressure resulted in increased peak density (PD) which is defining factor of VDP. TS and WA values obtained after 2 hours and 24 hours water soaking period significantly decreased with increasing press pressure. Because of the densification on the surface layers of the panels TS and WA values were affected positively. The panels produced with press pressure of 466 N/cm^2 had the lowest TS and WA values while the panels produced with press pressure of 370 N/cm^2 had the highest values. Continuous press pressure could effectively be used to achieve improved TS and WA in MDF panel production.

POSTER 2

Morphology Based Modeling of Micro-Mechanics and Failure Mechanisms in Bio-Materials with Polymer Matrices

Jie Ding, Oregon State University, 263 Richardson Hall, Corvallis, OR 97331

In this research a renewable biopolymer—poly(lactic acid) (PLA) is investigated as a potential replacement of petroleum-based polymers in advanced nanocomposites reinforced with Microfibrillated cellulose (MFC). MFC is extracted from wood, which is a renewable, sustainable, carbon neutral and recyclable material. This advanced MFC-PLA bio-based composite material is expected to allow for the substitution of petroleum-based plastics in various markets and applications. The objectives of this project include: 1) to describe the morphology of MFC and the MFC-PLA nanocomposites: to measure the size aspect ratio, net alignment, particle distribution, and degree of agglomeration of MFC in the PLA matrix, 2) to determine the mechanical properties (elastic modulus, tensile and compression strength) of individual MFC through micromechanical testing, 3) to investigate the structure-property relationships between the MFC and the PLA matrix, and 4) to

incorporate the morphological and mechanical data into predictive models and use the models to design the next generation of improved composite materials. Atomic Force Microscopy (AFM), Field Emission Scanning Electron Microscopy (FESEM), and different Transmission Electron Microscopy (TEM) will be employed in the investigation of morphology of MFC and the MFC-PLA nanocomposites. Currently, effective methodologies and experimental techniques for quantitative measurement of the micromechanical deformations in individual MFC whiskers and in MFC-PLA nanocomposites are being investigated.
This project is a work in progress. The conceptual framework and preliminary outcomes will be presented in the poster.

POSTER 3

Hygro-mechanical response of clear softwood specimens to compression under cyclic climate

Ning Guo, Oregon State University, 119 Richardson Hall, Corvallis, OR 97331

The principle objective of this research program is to create a systematic database of clearly defined mechano-sorptive characteristics for commonly used wood species. Such database is needed in for accurate modeling and prediction of long term behavior of wood and wood-based materials in structures exposed to changing environment. The specimens in this program include 4 softwood species: Red spruce, Douglas fir, Western hemlock and Ponderosa pine. In this project small longitudinal specimens are exposed to compression stress along the longitudinal axis (16-22% of the ultimate compressive stress) at room temperature (about 22±1° C) and varying moisture contents (MC). Cyclic changes of MC are executed in a small climate chamber by varying the relative humidity (RH) between 90% and lower RH (40%-50%). Free shrinkage and swelling is measured on unloaded reference specimens exposed to the same conditions. In a separate reference test series, specimens were subjected to sustained compressive load at a constant humidity of 65%, in order to determine the effect of visco-elastic deformation. The specimens for this reference tests were wrapped in Parafilm in order to protect them from even small variations of the ambient humidity. All deformations are measured by comparing successive digital images of the specimens using digital image correlation (DIC) software. The mechano-sorptive deformation characteristics are calculated by subtracting the free swelling/shrinkage and visco-elastic deformation determined on the reference specimens and specimens tested in constant humidity, respectively, from the total deformation measured on the regular specimens tested in cyclic climate. Apart from the mechano-sorptive characteristics the output of the test protocol will include: 1) free shrinkage/swelling coefficients for longitudinal and radial directions, determined on reference specimens; and 2) short-term (126 hours) visco-elastic creep compliance for compression in longitudinal direction and related Poisson ratios.

POSTER 4

Development of Test Methods for the Tensile Fatigue Properties of Wood-PVC Composites

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Wood-plastic composites (WPCs) have been used in semi-structural applications such as decking, and piers/docks. One of the potential problems using bio-composites in semi-structural applications is their resistance to fatigue under various environmental and loading conditions. For WPCs only limited research exists regarding fatigue reliability. Only limited research regarding fatigue reliability of WPCs has been reported to date. The objective of this study is to develop a suitable method for application of dynamic tensile fatigue tests in constant climate conditions on small WPCs specimens in order to obtain a range of dynamic properties of the bulk composite. Wood PVC composite samples were produced by combining wood flour particles and Poly(vinyl chloride) at wood/PVC weight ratio of 40/60. Wood flour and PVC were compounded at 170 ºC in the Brabender Intelli-Torque Plasti-corder mixer and pressure molded in a laboratory press. The reference static tests and the preliminary fatigue tests were performed using Instron Electro plus E1000 testing machine. The data analysis includes determination of the S-N curve and fatigue life of the composite, as well as the analysis of the strain-stress hysteresis to determine changes in the

dynamic viscoelastic properties of the material (storage, and loss modulus). The S-N data are being collected for the applied-to-ultimate stress ratios between 90% and 25% at various frequencies beginning at 5 Hz. The effect temperature on the specimen temperature at maximum frequency has been investigated. The conceptual framework of the project in progress and the results available to-date will be presented.

POSTER 5

Anti-Sapstain Biocides for Fresh Southern Hardwood Logs When Delays Occur between Felling and Water-Spray Storage

Nathan E. Irby, Hofmann Fellow, North Carolina State University*;* Terry L. Amburgey, Professor, Shane C. Kitchens, Assistant Professor , Mississippi State University

Sapwood discolorations in highly valued southern hardwood species have been a costly problem for the U.S. forest products industry. Mold and sapstain fungal occurrences are more prevalent in the southeast than in other regions, so preventive measures must be implemented to keep hardwood logs and lumber discoloration-free. Since conditions that favor stain development are prolonged after tree felling, logs that cannot be transported to a water-storage facility within 7 days after felling should have a biocide applied to their ends and, preferably, their debarked areas. Treatment practices should incorporate accurate and consistent chemical/water concentrations**,** proper spray applicators, and sufficient coverage of freshly exposed log cross-sections within 24 hours of tree felling to prevent the growth of sapstain fungi for approximately 6 weeks.

POSTER 6

Sustainable Bio-Composites for West Coast Highways

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Highway systems employ a wide variety of roadside hardware and safety products on roadways and their perimeters. A majority of these products such as traffic signs, road markers, and guardrails are manufactured from nonrenewable materials. Products made from concrete, metals, and premium petroleum-based plastics have a relatively high environmental impact. Their use results in a significant carbon footprint from the energy required for production, and/or costs related to manufacture, maintenance, and replacement. Total or partial substitution of currently used materials with sustainable bio-based composites could potentially reduce the overall impact on the environment. The objective of this study is to determine an efficient methodology and criteria for the technical and economic feasibility of substituting current materials used in highway products with sustainable bio-based alternatives. The feasibility as well as the actual effect of such a replacement on the environment however, requires careful investigation. The use of a low value biomass waste from prescribed forest thinning, fire prevention, or other standard forest health operation can offset their cost, and create environmentally friendly business opportunities in rural areas of the region. The technical aspect of this project is concerned with whether sustainable material alternatives can meet the existing standard performance criteria of roadside hardware. The assessment, methodology, and criteria will be tested in a case study focused on one selected product. Application specific performance testing and economic analysis will help us determine the actual benefits of the replacement, decide whether further research into bio-composite substitution is justified, and guide future development in this field.

POSTER 7

Examining the Effect of Price, Wood Souce, and Environment Certification on Architects' Purchase Decisions of Wood Flooring

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Architects often have a major influence on the materials used in a building, and are considered environmentally-conscious when specifying materials. The combined effects of certified wood products, place-name branding, and the buy local movement were expected to impact architects' preferences with respect to wood flooring. The objectives of this study were to gain insight regarding the types of hardwood flooring specified by architects and why they choose them; understand the relative importance architects place on three flooring attributes: wood source, price, and environmental certification; and better comprehend architects' opinions with regard to the environment. Approximately 1,800 architects throughout Oregon and Washington were surveyed, and conjoint analysis was used to construct the questionnaire and to analyze the data. Price proved to be the most important flooring attribute, which was closely followed by wood source. Architects preferred wood flooring from Oregon and Washington over flooring from the rest of the United States or from other countries.

POSTER 8

3-D micron-scale assessment of an adhesive bond in response to cyclic moisture

Günter G. Modzel, Graduate Research Assistant, Oregon State University, Corvallis, OR, 97331

Wood-based composites are a staple in residential and commercial construction in North America. Adhesive bonds in such products as plywood, oriented strand board, and laminated veneer lumber are exposed to weather conditions of the construction site, which includes cyclic moisture exposure. Wood as a hygroscopic material responds to cyclic water exposure with swelling and shrinking. This scenario can put a severe stress on the adhesive bond, which can ultimately result in delamination. To date, no quantitative, three-dimensional analysis of the influence of swelling and shrinking on the bondline has been performed on the micron scale. However, the significance of such an approach has obvious implications towards understanding the durability of wood-adhesive bonds. To analyze this effect, the bondline of wood samples has been imaged with x-ray microtomography (XMT), a non-destructive technique for the investigation of the internal structure of materials. Samples were scanned before and after moisture cycling. Radiographs of bonded assemblies were analyzed which represented a volume of approximately 2 mm^3. The digital images were processed to enhance contrast, which was followed by segmentation and three-dimensional reconstruction of the bondline. This rendering enabled a direct comparison of the cellular structure surrounding the bondline before and after the moisture cycle. The reconstruction further enabled a study of the flow of the adhesive through the microstructure of the wood.

POSTER 9

Volatile Organic Compound Emissions and Performance of OSB from Extracted Southern Yellow Pine

Juan Jacobo Paredes, University of Maine, School of Forest Resources and AEWC, Orono, ME 04469

The impact of a hot water extraction procedure on VOC emissions and properties of OSB from Southern yellow pine was evaluated. Southern yellow pine strands were extracted with hot water extracted using a rotating digester at 160°C for 22.9 or 53.6 min, corresponding to an severity factor (SF) of 3.29 (LSF) and 3.59 (HSF). Weight loss was 6.3 ± 0.1% and 9.3 ± 0.9% for the LSF and HSF conditions, respectively. The extract contained a mixture of hemicelluloses with some acetic acid and lignin also removed. Panels were manufactured without (control and HSF) and with resin (control, LSF, and HSF). Resinated panels were blended with 3.1% pMDI resin and 1% wax. VOCs emissions decreased from 38.2 to 24.2 mg/kg-wood due to the HSF extraction condition. Emissions decreased to 22.1, 17.0, and 15.6 mg/kg-wood for control, LSF, and HSF, respectively, when resin was added. Panel density and density profiles were equivalent for all panels. The equilibrium moisture content of the panels decreased with increases in weight loss. Water absorption and thickness swell were significantly enhanced in the panels made from extracted strands.

Flexural modulus of elasticity (MOE) exhibited significant increases in both dry and wet conditions. Both flexural strength (MOR) and internal bond (IB) were slightly reduced in the dry condition as extraction level increased. However, both properties were significantly increased when tested in the wet condition. The extraction procedure shows promise for improvement in OSB performance, reduced environmental impact, and generation of a co-product of value as a chemical feedstock.

Poster 10

Thermal Degradation of Strength of Plywood and OSB: A Kinetics Approach

Arijit Sinha, Wood-based Composite Center Fellow*,* Oregon State University, Corvallis, OR 97331

As wood based composites such as oriented strand board (OSB) and plywood are being heavily used in building construction, it is highly imperative to categorize their response when exposed to elevated temperatures for a sustained period of time. The essence of fire resistant structural design is to ensure that structural integrity be maintained during and after the fire, preventing collapse for a sufficient period of time so that occupants may safely evacuate and firefighters may safely extinguish the fire. Another aspect is to assess post fire structural integrity and residual strength of existing structure. The objective of this project is to (a) to study the effect of exposure time on bending strength (MOR) of OSB and Plywood at elevated temperatures, (b) to interpret any relationships between different temperature and time of exposure using kinetics model for thermal degradation of strength, and (c) to develop a master curve representing temporal behavior of OSB and plywood at a reference temperature. 1152 samples in total were tested in bending as a function of exposure time and several temperatures. These results were fit to a simple kinetics model, based on the assumption of degradation kinetics following the Arrhenius activation energy model. Furthermore, using this data a master curve was obtained which predicts degradation of strength with time on exposure at a given reference temperature. Master curve at $t_{ref} = 150^{o}C$ suggests that although plywood had higher initial strength, OSB performs better in terms of strength degradation after exposure to elevated temperature.