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LIGHTWEIGHT SANDWICH PANELS USING SMALL-DIAMETER TIMBER -STRANDS AND RECYCLED NEWSPRINT

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Abstract

As the natural resources of this planet are being stretched to the limit, it is necessary to look towards Small diameter timber is often used for production of structural panels for building construction, but new value added products using this timber need to be developed to pay for fuel reduction treatments in our national forests for their removal. A lightweight sandwich panel construction with a thin-walled core provides a system to use these undervalued lignocellulose based materials for production of structural and non-structural panels Analysis of the core design was investigated to determine a process that can be utilized for engineering design of future sandwich panel cores. The most crucial design parameter for the core is to ensure sufficient width of the corrugated ribs so that flexural failure of the sandwich panel occurs in the face plies as opposed to failure at the interfaces between the core and faces due to shear or crushing/buckling of the walls. Small-diameter Ponderosa Pine wood-strands were utilized in fabrication of lightweight sandwich panel that has a specific bending stiffness (D, lb-in2/in) 88% stiffer than commercial OSB. The sandwich panels designed within this study utilize 60% less wood-strands and resin by weight compared to OSB panels of equivalent thickness. A case study was performed on the wood-strand sandwich panels to determine their potential in structural flooring as an alternative for OSB. The sandwich panel can support a 40 psf live load and a 20 psf dead load without exceeding IBC (2006) deflection limits. Sandwich panels consisting of old newsprint (ONP) cores were designed for non-structural applications such as shelving units, doors, furniture, etc. The newspapers were Shredded into strips and hot-pressed using a powdered phenol formaldehyde resin. ONP strips Were oriented to take advantage of the 4:1 ratio in strength and 7:1 ratio in Young's Modulus due To their directional dependent properties. The ONP sandwich panels have a bending stiffness (D,Lb-in2/in) 83% stiffer than particle board and over 125% stiffer than a medium density Fibreboard.

Keyword: Small diameter timber , wood-strands , old newspaper, Fibreboard.

Introduction of an Innovative Lightweight Sandwich Panel Using Environmentally Conscious Substrates

Introduction:

In the world today, there is a seemingly endless search to be more environmentally conscious When it comes to the utilization of our planet's raw materials. Following the push of sustainable Building materials and environmentally conscious design, this research is a contribution to the Science of sustainable building construction materials. The concept of lightweight sandwich Panels has been around for a long time. Most sandwich panels today consist of two dense outer Faces and a foam core. The largest market for sandwich panels is the aerospace industry with the Use of high-performance aluminium and honeycomb cores, but sandwich panels are also widely Used for structural parts in the marine, wind energy, and transportation industries (Black 2003). However, lightweight sandwich panels have not become a major component of the building and Infrastructure construction industry. Structural Insulated Panels (SIPs) have had the most success Penetrating the residential construction market. However, SIPs account for only 2% of the Residential construction market (Miller 2006).Researchers at the Forest Products Laboratory (FPL) have been developing an innovative new Type of core for lightweight sandwich panels suited more for non-structural applications, such as Furniture. This new type of sandwich panel consists of a hollow 3D fibreboard core (Hunt 3D Engineered Fibreboard, 2004). This innovative core has significant benefits in the light framed Construction industry. The hollow cavities of the core allow for electrical and plumbing conduit, As well as heating and ventilation, or just filled with foam insulation (Wigand et al. 2004). The Biggest disadvantage of this process is the use of massive amounts of water for wet forming of The three dimensional core, which results in dealing with release of effluents, an environmental hurdle with stricter regulations being implemented. A dry forming process for manufacturing Three dimensional medium density fibre cores has also been developed at WSU in collaboration With a private entrepreneur (Yadama et al. 2008). These 3-D fibre-based panels are well suited For non-structural applications. There is a need for a lightweight sandwich panel that can replace Structural panels, such as oriented strand board (OSB), and also be utilized to develop hybrid Structural panelised elements. This type of sandwich panel has possible applications in the field As floor, wall, or roofing panels, doors, crates, industrial shelving, furniture, and building systems That provide both structural and insulation performance.

Characterization of Old Newsprint and Wood-Strand Plies:

Characterization of ONP strip properties need to be analysed for identifying potential Weaknesses and determine challenges inherent to the material that could possibly be overcome Through the manufacturing process of thin plies. This chapter discusses the material properties of The ONP under investigation. This analysis includes understanding of directional properties of ONP in paper form, which is lacking in the past studies on ONP. Once knowledge of the Constituent material is obtained, a manufacturing process can be developed to form ONP mats That will be hot-pressed into ONP plies. Analysis of the small-diameter timber wood-strands for this study does not include testing of Individual wood-strands. As a starting point, recommendations in the manufacturing process for Wood-strands were taken from Weight (2007, Weight and Yadama 2008). Wood-strand mats Were hot-pressed into plies. These plies were tested for tensile strength and internal bond (IB) to Establish their properties.

Wood-strands:

Wood strands were produced from small diameter Ponderosa pine logs as described by Weight (Weight 2007, Weight and Yadama 2008). Forty Ponderosa Pine logs 4-7 inches in diameter and 8 ft long from Northwest Washington were used for stranding. These logs were ripped on a band Saw into boards of ½ inch thick and then debarked. These boards were fed into a CAE strander Operating at 500 rpm in stacks of ten. The strands were dried and stored in large plastic bags to Reduce moisture absorption. For use in this study, the strands were dried to a MC of 2-5%. During the drying process, a significant amount of fines were produced and therefore were sorted Out using a shake table with a 1.0 inch by 1.0 inch square holed screen.

Manufacturing Process:

The manufacturing process for the cores was very similar to that of the flat mats produced for Tensile specimens in Chapter 2. Calculations for furnish and resin content were based on forming A mat with dimensions of 36 inches by 26 inches by ¼ inch thick. Target resin content based on Solid content for ONP and wood-strand cores was 10 and 8 percent respectively. The final Dimensions of the cores were approximately 31½ inches by 26 inches by ¼ inch thick.

The wood-strand faces followed the same protocol as those of previous manufacturing processes. Calculations for mat furnish and resin content were based on dimensions of 36 inches by 27 Inches by ¼ inch. Wood-strands were dried to a moisture content (MC) of less than 4-5%. The Press schedule was adjusted to allow for vapour pressure to escape prior to reaching the final Thickness and during the degassing stages of the pressing schedule by cycling the press. See Appendix D for the pressing schedule for the wood-strand faces.

The faces were bonded to the core using a modified diisocyanate (MDI) adhesive. MDI reacts With ambient moisture to expand and cure. Both the faces and cores were placed in a Conditioning room to bring their MC up so the adhesive would cure faster. Approximately 16.5 Ounces of MDI was applied to each core along the interface surface. The panels were clamped And allowed to dry for 24 hours prior to cutting for test specimens. A

Summary and Conclusion:

Initial newsprint tensile tests further support the benefits of orienting the ONP strips because of the 4:1 ratio of tensile strength in the MD. Because of the utilization of the strength in the MD of newsprint, ONP plies could produce strength properties comparable to wood-strands from small diameter timbers. However, they differ significantly in their respective stiffness properties. The wood-strands are significantly stiffer and therefore are more likely to be able to produces sandwich panels of strong enough properties for structural applications. ONP's weakness appears to be its inability to bond to itself. Despite this inherent weakness in the ONP, application in a non-structural system is still feasible. An analysis of MC and its effect on structural properties of ONP should be conducted. It might be possible to increase IB strength by reducing the moisture within the material. Additives added to newsprint to improve the printing process have significant detrimental effects in the fibres bonding ability (Nourbakhsh 2008). Wood-strand panels have sufficient.

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