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ORIGINAL ARTICLE

Mechanical characteristics of antibacterial epoxy resin adhesive wood biocomposites against skin disease

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Abstract Moldy wood can cause some skin disease. However epoxy resin adhesive (EP) can inhibit mold growth. Therefore, antibacterial EP/wood biocomposites were reinforced and analyzed by the nonlinear finite element. Results show that glass fiber cloth and aluminum foil have the obvious reinforced effect under flat pressure, but this was not the case under side pressure. And when the assemble pattern was presented in 5A way, the strengthening effect was better. The nonlinear finite element showed that the aluminum foil and glass fiber cloth have the obvious reinforced effect. The mutual influence and effect of span, thickness and length on the ultimate bearing capacity of specimen were studied. And the simulation results agreed with the test. It provided a theoretical basis on the preparation of antibacterial EP/wood biocomposites against skin disease.

1. Introduction

This painful viral infection is caused by herpes zoster, the virus that causes chickenpox. After infection with chickenpox, the virus "hides" in the nervous system in a latent or dormant state. Exposure to chickenpox or other stressors may cause a reactivation of the virus, resulting in a shingles outbreak. People over the age of 50 are most likely to suffer from shingles (Xiao et al., 2013).

Shingles causes uncomfortable and painful symptoms due to inflammation of the sensory nerves, the nerves responsible for the perception of pain, touch, and temperature. The characteristic shingles rash appears as a band-like strip of red, oozing blisters. The rash typically wraps in a strip around the body and usually occurs on one side of the body. Shingles is contagious if an infected person has close contact with others who have not yet had chickenpox. Nerve pain due to shingles can sometimes persist for weeks to years after the rash heals. This painful, post viral condition is known as post-herpetic neuralgia. Some researches showed the herpes zoster came from moldy wood (Mateen et al., 2015).

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Insects and mold can damage wood over time. To prevent that damage, wood is often treated with pesticides (Barreto et al., 2010). Treated wood is commonly used to build telephone poles, road signs and marine pilings as well as decks, play structures and raised garden beds (Hernandez et al., 1997). Several wood preservatives are registered with the EPA, each with different uses and potential risks (Yin et al., 2001).

Wood preservatives can extend the life of wood and reduce the need for forest resources, but proper use is important (Peng et al., 2011, 2012a,b; Peng and Le, 2012). Some preservatives can slowly leach into the surrounding soil or water. Sometimes, touching the wood can leave a residue on exposed skin. Use the resources below to learn about selecting and using treated wood properly. Wood extractives contain plenty of nutrients and hormones (Qureshi et al., 2015). What's more, resin can strengthen and inhibit the wood mildew (Rasheed et al., 2015). Therefore, the antibacterial EP/wood biocomposites were reinforced and analyzed by the nonlinear finite element.

2. Material and methods

2.1. Test materials

Eucalyptus plantation wood veneer, with the format of 1.27 m × 0.64 m × 1.3 mm, the density of about 0.61 g/cm^3 and the water content of 5–8% was used.

Epoxy resin adhesive double component epoxy adhesive, of which the component A is the milky white to pale yellow viscous liquid and the component B is the yellowish brown to reddish brown viscous liquid. The working life is 1 h (25 °C), curing speed is 2.5–3.5 h (25 °C), tensile shear strength ⩾8 MPa (25 °C × 48 h) (Youngquist et al., 1979).

Glass fiber cloth, plain weave, with the warp and weft density of 128 × 68 was used.

2.2. Specimen design scheme

The design of the experiment is shown in Table 1. There are 5 groups of solutions in all, and each group has 3 parallel specimens. By comparing the schemes of 1A, 2A, 3A, and 5A, the enhancement effect of glass fiber cloth can be revealed; by comparing the schemes of 1A, 2A, 4A, and 5A, the enhancement effect of aluminum foil can be revealed.

2.3. Test methods

Assembling was done in accordance with the assemble patterns shown in Table 1 , with the double-sided glue consumption of 350 g/cm^2.After assembling, it was put into the compressor under the temperature of about 20 °C, and then pressure was raised to 4 MPa. After applying the pressure for 1 h, the power was turned off and the pressure was applied for 23 h, and then the glulam specimens were made with the format of 350 mm × 350 mm. The normal section of glulam is shown in Fig.1. The standard specimens were designed and made according to "The wood structure test method standard" (GB/T 50329-2002) and "Plywood" (GB 9846-2004), and tested. The test specimens of static bending strength and elastic modulus test: length * width = 300 mm * 50 mm, loading to failure at the speed of 10 Pa/s. The span is 270 mm, and the test loading mode referenced "man-made board and the veneer panel physico-chemical properties test method" (GB/T1 7657-1999). The static bending strength refers to the pressure intensity that artificial plate can bear in the stress bending to fracture, with the unit of MPa (Nasreen et al., 2015). The test adopted the type of loading in section and plane which can be seen in Fig. 2.

Table 1 Assemble pattern.

Text number	Assemble pattern
1A	Cross assembly of core seven layers wood veneer, parallel assembly of the three layers wood veneers on the two sides
2A	Cross assembly of core seven layers wood veneer, parallel assembly of the three layers wood veneers on the two sides; the half, glass fiber mesh cloth is arranged between the two layers of the wood veneers for reinforce; the other half, aluminum foil is arranged between the two layers of the wood veneers for reinforce
3A	Cross assembly of core seven layers wood veneer, parallel assembly of the three layers wood veneers on the two sides; glass fiber mesh cloth is arranged between the two layers of the wood veneers for reinforce
4A	Cross assembly of core seven layers wood veneer, parallel assembly of the three layers wood veneers on the two sides; aluminum foil is arranged between the two layers of the wood veneers for reinforce
5A	Cross assembly of core seven layers wood veneer, parallel assembly of the three layers wood veneers on the two sides; glass fiber mesh cloth or aluminum foil is arranged between the two layers of the wood veneers for reinforce, wherein the glass fiber grid cloth and aluminum foil distribute at intervals

3. Results and discussion

3.1. Analysis of the effect of EP/wood biocomposites

The average of the 3 parallel specimens of each group was calculated. Test results of 5 specimens are shown in Table 2.

From the data of experimental group 1A, 2A, 3A, and 5A we can know that glass fiber cloth played the role of reinforced EP/wood biocomposites. Under the plane compression, the static bending strength and elastic modulus of laminated timber reinforced with glass fiber cloth increased more than 2 times. Among them, the single glass fiber cloth increased the minimum; under the section compression, the failure load, static elastic modulus and bending strength of EP/wood biocomposites reinforced with glass fiber cloth did not increase significantly. From the data of experimental group 1A, 2A, 4A, and 5A we can know that aluminum foil played the role of reinforced EP/wood biocomposites. Under the plane compression, the static bending strength and elastic modulus of EP/wood biocomposites reinforced with aluminum foil increased more than 2 times. When reinforced with aluminum