Specialty Wood Products Research Partnership

HEXION Responsible Chemistry

Technical Report

Bonding of *Eucalyptus fastigata* veneer

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FOREST GROWERS RESEARCH

Laboratory report

Topic: Bonding of *E. fastigata* veneer

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Aim of this work:

To determine if two standard Hexion commercial phenolic resins will bond the *E. fasitgata* veneer. Previous Hexion NZ work has shown poor bonds with a number of different phenolic resins on *E. bosistoana* veneer and *E. quadrangulate*. The previous work has suggested the resins would need to be modified to get an acceptable bond.

Information on *E. fastigata* veneer:

- Veneer samples provided had a density of 470 to 720 kg/m^3 and were usually about 620 kg/m^3.
- Veneer moisture content was measure on the supplied samples of E. fastigata at 8.8 to 10% by the oven dry method. For the *E. fastigata* panels prepared the veneer was dried to 3 to 4% oven dried moisture in Hexion's laboratory.
- Veneer thickness was nominally 4.0+-0.2 mm.

Conclusions:

1. The bonds produced with the tolerant A Bond plywood resin on *E.* fastigata veneer dried to 3 to 4% moisture meet an AS/NZS 2269.0 Plywood A bond standard. The AS/NZS 2269.0 A bond standard requires a minimum average bond of not less than 4.5 with no bonds less than 2. This system containers a high % filler.
2. The bonds produced with the phenolic A Bond LVL resin on *E. fastigata* veneer dried to 3 to 4% moisture were variable and only meet the AS/NZS 4357.0 structural LVL A bond standard at the 15 minute open assembly time. The bonds produced at 5 minutes appeared to be starved. It is believed to be due to this system having a very low filler content. The standard requires a minimum average bond of not less than 4.5 with no bonds less than 2.

3. The bonds observed were not perfect with either system. By optimisation of the veneer peel, veneer moisture content, glue mix, hot and cold pressures it is believed this species could be commercially bonded with standard phenolic formulations.

4. The *E. fastigata* veneers central glue lines were consistent slower to heat up than the Radiata pine veneers central glue line for the same panel thickness and hot-pressing conditions.

Discussion of results:

1. *E. fastigata* plywood panels were significantly slower to heat up in the hot press than Radiata pine panels. This is expected as the mass of a *E. fastigata* panel is about 60% higher than a Radiata pine panel. The *E. fastigata* panels weighted about 2222 grams. The pine panels weight about 1368 grams (40 by 40 cm^2).

2. The *E. fastigata* veneer was not compressed as well as radiata in the hot press. I believe this is due to its higher density. This meant areas of rougher veneer were not compressed as much leading to areas of poor contact (See the photograph latter in the report).

3. It is believed the A Bond LVL resin did not perform as well at the 5-minute open assembly times as it does not contain much filler. The glue film was still very fluid and was squeezed into the veneer in the cold press. The glue film at the 15-minute open time has dried out.

4. It is believed the tolerant A Bond plywood resin performed much better on the *E. fastigata* veneer because of the high filler content in the glue mix helping hold the resin in the glue line and control the glue line thickness. Fillers are made of either wood flour or inorganic materials. Fillers have a particle size of a few micron to about 50 micron unlike the resin or wheat flour extender. Fillers are not readily compressible. The fillers act as a spacer that defines the glue line thickness. This reduce the chances of the glue being squeezed out of the veneer leaving a starved glue line.

5. The *E. fastigata* veneer was initially found to be about 8.8 to 10% moisture. This was found to be too high to bond with the phenolics used in this report. This would be expected. The veneer was dried to 3 to 4% oven dried moisture and acceptable bonds were archived.

Recommendations:

1. This work indicates that the phenolic resins used to bond Radiata pine are likely to be able to be modified to bond *E. fastigata* veneer with minor modifications to the glue mix / in mill conditions.
2. It is important that the veneer moisture content be controlled to a level of 3 to 5% to ensure the *E. fastigata* is successfully bonded with the phenolics evaluated. Veneer that has sat for a period of time is likely to have picked up moisture. This will lead to excessive glue flow and failed bonds and should be re dried.
3. The higher total solids highly tolerant plywood glue mix performed better on the *E. fastigata* veneer and is the system I would use in a mill trial.

Laboratory panels:

The *E. fastigata* veneer was supplied in veneer sheets that were nominally 400 mm square. 5 ply plywood panels were prepared. The panels were prepared under the following conditions:

- No separation of Sap wood and Heart wood was attempted.
- The sheets of veneer were selected from the material provided but was re dried.
- A thermocouple wire was place in the central top glue line of one panel made with the Fast curing LVL resin and tolerant plywood resin with *E, fastigata* and Radiata pine veneers.
- 5-minute and 15-minutes open assembly time was used for all the panels.
- Pre-press time of 10 minutes at about 9kgf/cm^2.
- 10-minutes closed assembly.
- 12-minute hot press time at 150^o C hot press pressure was 12kgf/cm^2.
- Two well proven Hexion resins were used.
    - A fast curing catalysed LVL resin – RCA.
        - Panels made with this adhesive system were labelled P1, P2, P3, P4.
    - A very tolerant phenolic plywood - Glue mix
        - Panels made with this adhesive system were labelled P5, P6, P7, P8.

Adhesives systems used and glue mix:

Phenolic LVL resin:

100 parts phenolic resin at 42.5% solids.

2 parts of Liquid catalyst.

The viscosity was about 2000 cps at 25^{o} C.

Tolerant phenolic plywood glue mix:

100 parts phenolic resin at 45% solids.

17.7 parts Filler.

15.6 Parts Extender (Wheat flour).

8.2 parts water.

The viscosity was about 3000 cps at 25^{o} C.

Bond results on Panels;

The bonds on each of the plywood panels prepared were tested by chiselling, dry or after a 6-hour pressure steam test.

The percentage wood fibre failure was rated using the AS/NZS 2098.2, table 1, scale of 0 to 10. 0 to 5% wood fibre failure is a 0. 50% wood fibre failure is a 5 and >95% wood fibre failure is a 10.

The results are as follows:

The bonds produced with the tolerant plywood resin meet the requirements for AS/NZS4357.0 or AS/NZS 2269.0 A bond standard on the *E. fastigata* veneer dried to 3 to 4%.

Wood species	Open assembly	Glue spread	Adhesive	Dry Bonds				Average	6 Hour pressure steam				Average	Comment
Pine	5 minutes	190 gsm	**Tolerant Plywood**	7	8	8	8	7.8	5	7	7	7	6.5	
Pine	15 minutes	190 gsm	**Tolerant Plywood**	7	8	8	8	7.8	8	7	6	7	7.0	
Fastigata P5	5 minutes	175 gsm	**Tolerant Plywood**	9	9	9	6	8.3	7	9	7	6	7.3	
Fastigata P6	5 minutes	175 gsm	**Tolerant Plywood**	9	7	7	8	7.8	7	7	6	7	6.8	
Fastigata P7	15 minutes	175 gsm	**Tolerant Plywood**	8	9	8	9	8.5	2	7	9	8	6.5	
Fastigata P8	21 minutes	175 gsm	**Tolerant Plywood**	3	2	7	8	5.0	5	6	3	5	4.8	Dry out too longer Open time

The bonds produced with the phenolic LVL resin meet the requirements for AS/NZS4357.0 at the 15 minute open assembly time on the *E. fastigata* veneer dried to 3 to 4%. There were some glue lines that showed wash out on the 5-minute open assembly time.

Wood species	Open assembly	Glue spread	Adhesive	Dry Bonds				Average	6 Hour pressure steam				Average	Comment
Pine	5 minutes	190 gsm	**LVL Resin**	7	9	4	8	7.0	9	8	6	7	7.5	
Pine	15 minutes	190 gsm	**LVL Resin**	7	9	9	7	8.0	8	8	8	8	8.0	
Fastigata P1	5 minutes	165 gsm	**LVL Resin**	7.5	2	8	7	6.1	2	2	7	5	4.0	Wash out
Fastigata P2	5 minutes	165 gsm	**LVL Resin**	6	5	9	7	6.8	3	5	5	6	4.8	Wash out
Fastigata P3	15 minutes	165 gsm	**LVL Resin**	7	6	7	3	5.8	7	7	4	2	5.0	
Fastigata P4	15 minutes	165 gsm	**LVL Resin**	8	3	8	7	6.5	5	7	8	7	6.8	

Picture of Dry bonds:

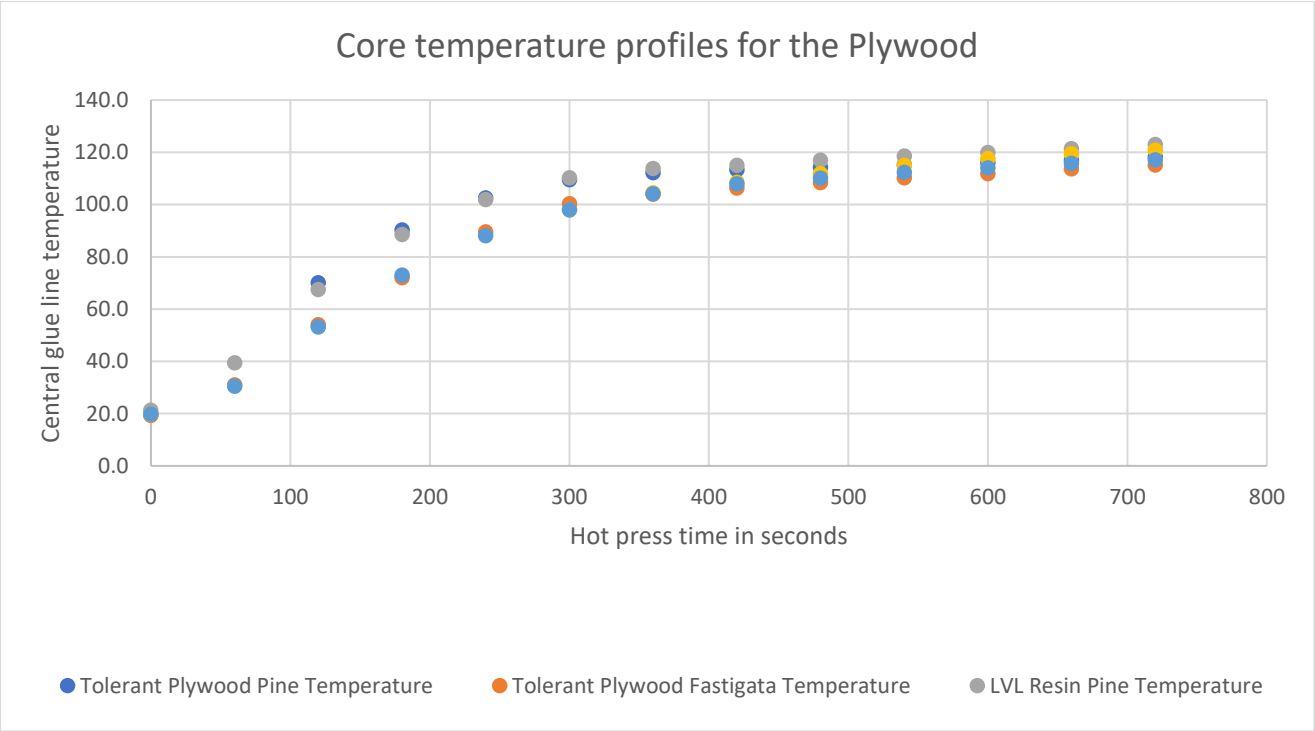
This is a picture of a dry chiselled Phenolic bond produced on the *E.* fastigata veneer using the Highly tolerant plywood resin. There is excellent dry wood fibre failure. The veneer has not being discoloured.

Central glue line temperatures:

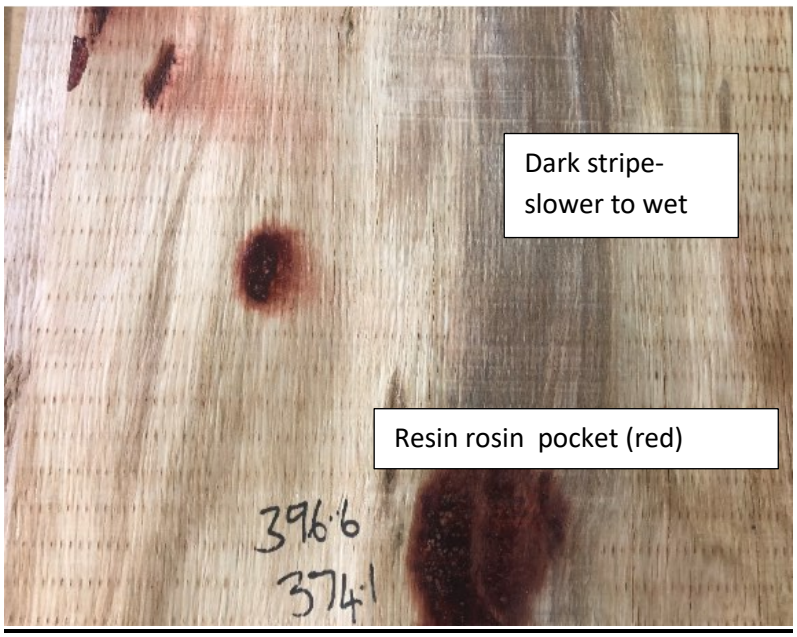
The pine veneers second (Central glue line) glue line reached 100°C in about 240 seconds where the *E. fastigata* veneer (Central glue line) took 310 seconds to reach 100°C.

Core temperature profiles					
	Tolerant Plywood	Tolerant Plywood	LVL Resin	LVL Resin	LVL Resin
	Pine	Fastigata	Pine	Fastigata	Fastigata
Time Sec	Temperature	Temperature	Temperature	Temperature	Temperature
0	19.6	19.3	21.3	19.8	19.8
60		30.9	39.4		30.4
120	70.0	54.0	67.5		53.1
180	90.2	72.0	88.5		73.0
240	102.5	89.5	101.9		88.0
300	109.5	100.3	110.2	97.9	98.0
360	112.2	103.9	113.8	104.4	104.1
420	113.3	106.3	115.0	108.5	107.9
480	114.3	108.4	117.0	111.8	110.1
540	115.2	110.2	118.5	115.0	112.3
600	116.0	111.8	119.9	117.5	114.0
660	117.0	113.6	121.4	119.4	115.7
720	118.2	115.1	122.9	120.8	117.1

The graph below is a plot of the pine and *E. fastigata* plywood panels top central glue lines temperature. The *E. fastigata* veneer independent of the adhesive used is much slower to reach 100° C.



This is a picture of one of the sheets of *E. fastigata* veneer that shows areas high in rosin as well as the dark stripe which is slower to wet.



Typical sheet of *E. fastigata* veneer. This sheet was dried at 105˚C to 0% moisture and had a veneer moisture of 9.8%.

This is an example of a sample of a A bond glue line that was chiselled. It shows an acceptable bond. The plywood veneer has become much darker in the 6-hour pressure steam test.

This is an example of one of the *E. fastigata* veneer glue lines with a lower A bond score. The low score occurred in an area where poor glue transfer occurred. The poor glue transfer occurred in an area of rougher veneer where good contact between the two veneer did not occur in the cold and hot press.