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# Enhancing the Fire Resistance of Cement-bonded Particleboard Made of Scots Pine and Poplar

## Basic fire performance

of Cement-Bonded Particleboard

**CBPB**

is

**B-s1, d0**

EN 13501-1:2007+ A1:2010

Aim is to increase fire performance of

**CBPB**

to

**A1 / A2**

EN 13501-1:2007+ A1:2010

## Materials

Wood in particle form:

poplar hybrid (*Populus cv. euroamericana I214*)

Scots pine (*Pinus sylvestris*)

Binder:

Portland cement CEM I 42.5

Additive:

water glass [WG] ( $\text{Na}_2\text{SiO}_3$ )

mixing water

Fire retardants:

Borax ( $\text{Na}_2\text{B}_4\text{O}_7$ ) in 25 g/l solution,

DSHP ( $\text{Na}_2\text{HPO}_4$ ) in 77 g/l solution,

DAHP ( $(\text{NH}_2)_4\text{HPO}_4$ ) in 150 g/l solution.

Alternate wood-cement compatibilizers:

montmorillonite [MM]

Polydiallyldimethylammonium chloride [PDDA]

( $\text{C}_8\text{H}_{16}\text{NCl}$ )<sub>n</sub>

## Methods

Pretreatment of wood particles

- Particles were treated with fire retardants by spray gun in a drum blender.
- Initial moisture content of wood particle: 18%.
- 1 liter of FR were sprayed on 3 kg of wood

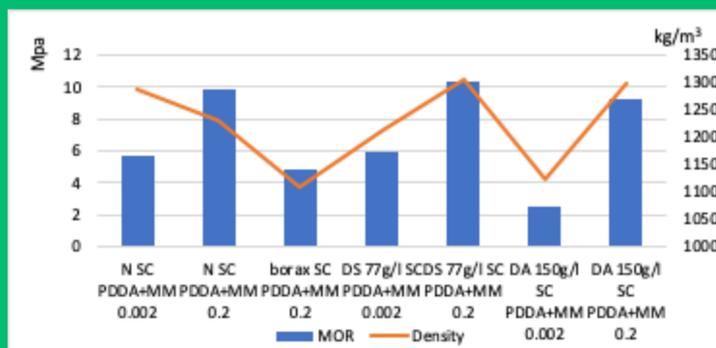
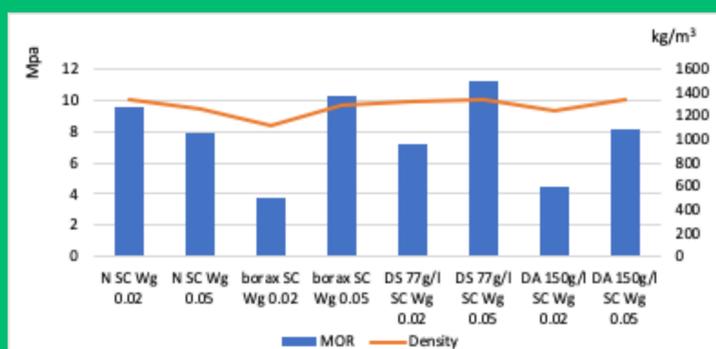
Experimental board production

- 3 layered boards, 400 mm x 400 mm x 12 mm
- Wood-cement ratio: 1:2.6
- Water glass ( $\text{Na}_2\text{SiO}_3$ )
- Alternate additives:
  - Sodium silicate 2%, 5% on cement weight.
  - PDDA + MM 0.2%, 20% on cement weight.
- Pressing: 7.9 MPa for 24 hours

Testing

- Bending properties - EN 310
- Incombustibility test - EN ISO 1182

## MOR of CBPB of Scots Pine

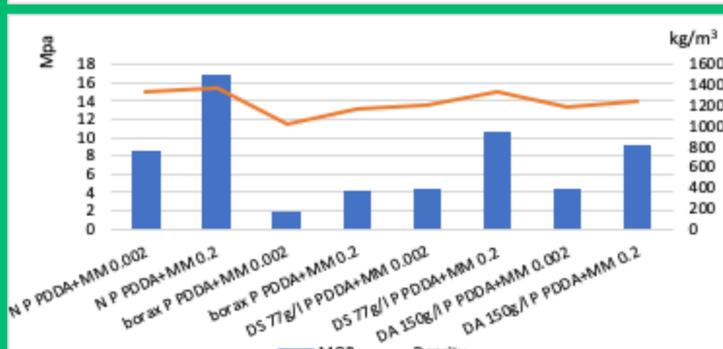
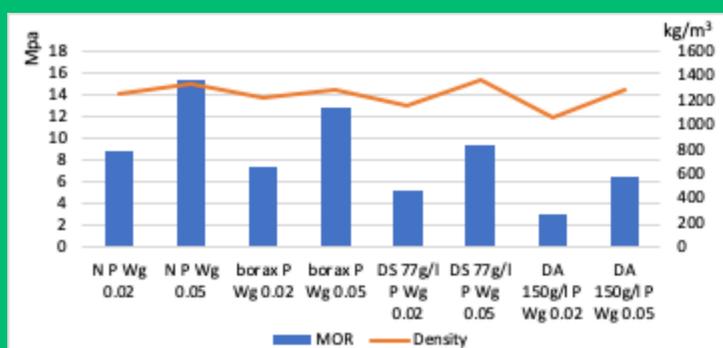


## Requirements

- MOR: min. 9 MPa
- A1:  $\Delta T \leq 30^\circ\text{C}$ ;  $\Delta m \leq 50\%$ ;  $t_f =$  (i.e. no sustained flaming)
- A2:  $\Delta T \leq 50^\circ\text{C}$ ;  $\Delta m \leq 50\%$ ;  $t_f \leq 20\text{s}$



## MOR of CBPB of poplar



## Fire performance

### Scots pine

	WG				PDDA+MM				
	un-treated	borax	DS 77g/l	DA 150g/l	un-treated	borax	DS 77g/l	DA 150g/l	DA 150g/l
$\Delta T$ (°)	58,32	51,08	47,8	49,28	57,23	48,94	34,32	58,32	51,08
$\Delta m$ (g)	38,64	35,69	38,64	34,54	38,29	39,65	37,06	38,64	35,69
$t_f$ (s)	871,2	769	645	770	967	762	523	871,2	769

### Poplar

	WG				PDDA+MM				
	un-treated	borax	DS 77g/l	DA 150g/l	un-treated	borax	DS 77g/l	DA 150g/l	DA 150g/l *
$\Delta T$ (°)	58,12	54,46	47,36	<b>23,52</b>	57,52	<b>30,00</b>	39,94	<b>29,36</b>	<b>19,68</b>
$\Delta m$ (g)	35,64	38	34,71	31,18	35,24	32,67	35,55	31,45	25,6
$t_f$ (s)	708	722	657	<b>0</b>	979	625	659	315	<b>0</b>

Note: \* samples soaked into SS let to dry 7 days before test

## CONCLUSIONS

- Fire retardants have big influence on the MOR
- With using 5% of WG additive boards from Scots pine or poplar particles pre-treated with borax or DAHP 77g/l fulfill the standard requirements.
- Using 20% of (PDDA+MM) additive boards from poplar or Scots pine pre-treated with DAHP 150g/l or DSHP 77g/l fulfill the standard requirements.
- Fire retardants didn't upgraded the CBPB's fire performance.
- Poplar with DAHP 150g/l pre-treatment upgraded the CBPB from B-ds1,d0 to class A1.
- WG improved fire performance of DAHP 150g/l.