



# Short-term and Time-dependent Behaviour of Wood-Plastic Composite Sandwich Panels



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New technology and marketing practices in natural fiber-based products

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# Outline

- **Context**
- **Objective**
- **Experimental**
- **Results**
- **Conclusion**
- **Acknowledgements**



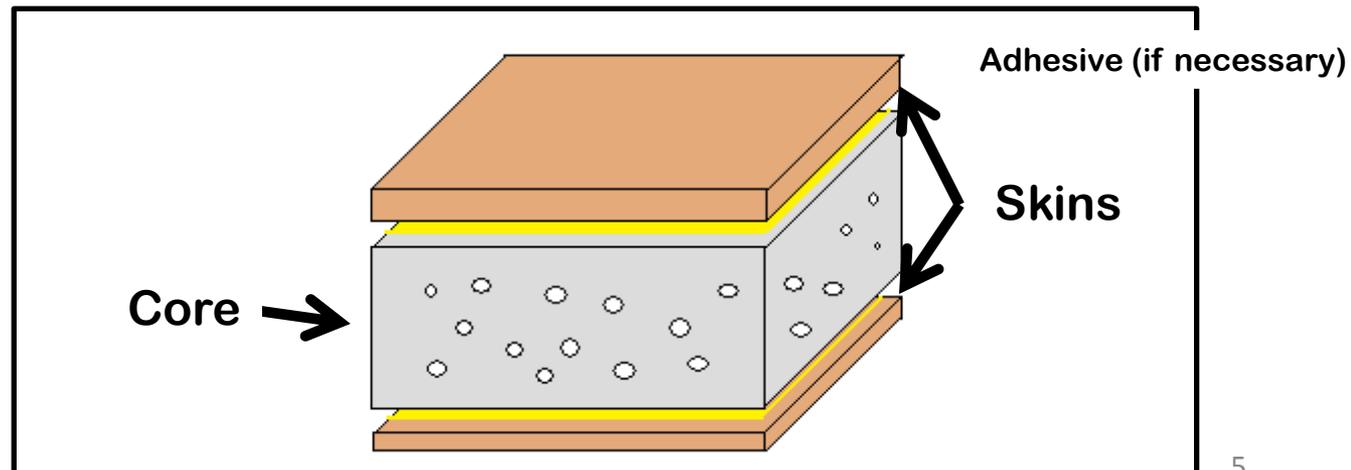
# Context

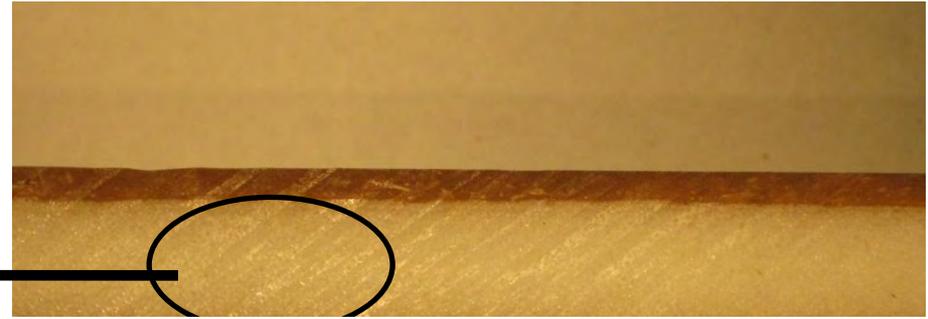
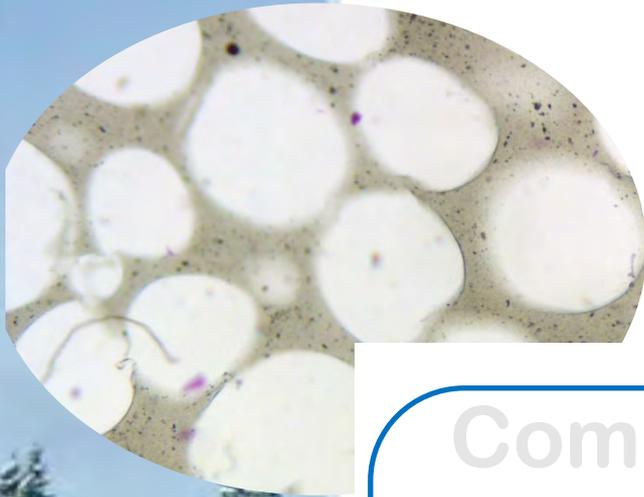
# Objective

**Sandwich structure: Composite made of a light weight material core which have weaker mechanical properties and two surface layers (skins) with superior mechanical properties**



**Best suited for bearing flexural load, this structure shows higher specific strength and specific stiffness**



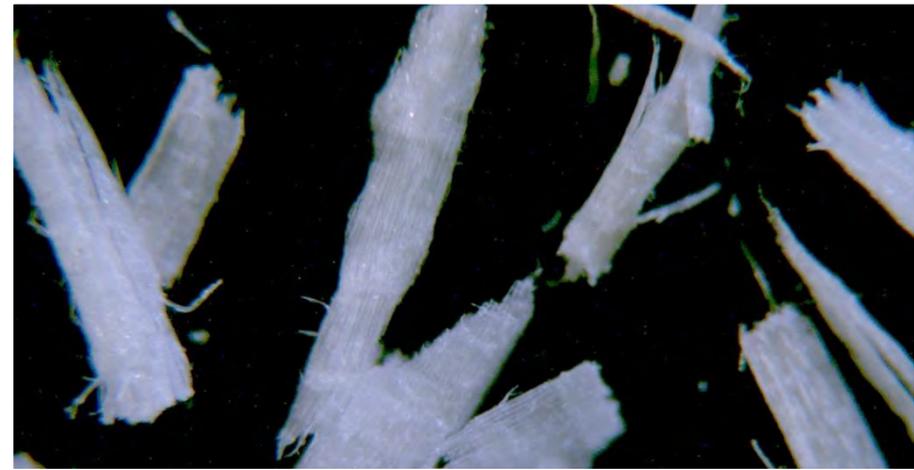
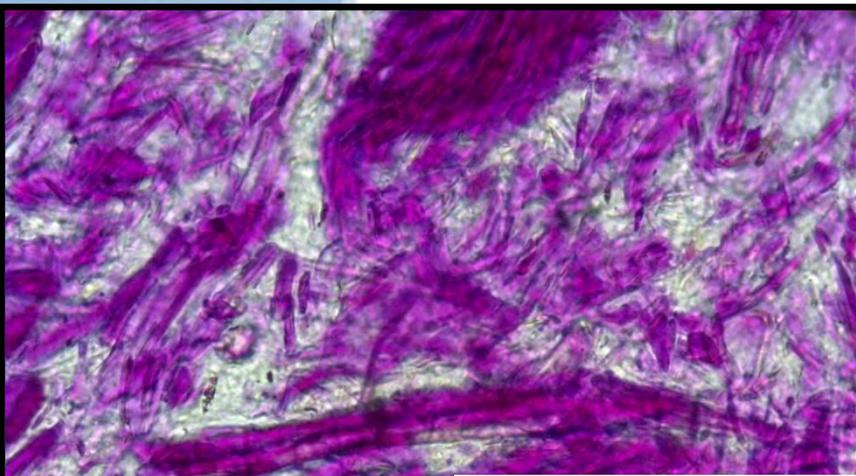


## Common foamed core materials

- Polyethylene (HDPE) foam
- Foaming agent (azodicarbonamide)
- Expanded polystyrene
- Extruded polystyrene



100  $\mu\text{m}$



## Common skin materials

- Reinforced polymers
- Wood and wood composites
- Metal foils
- Polyethylene (HDPE)
- 40-60 (%) spruce fibers
- Maleated polyethylene

Skins poss  
con

Various types of concrete

**Experimental**

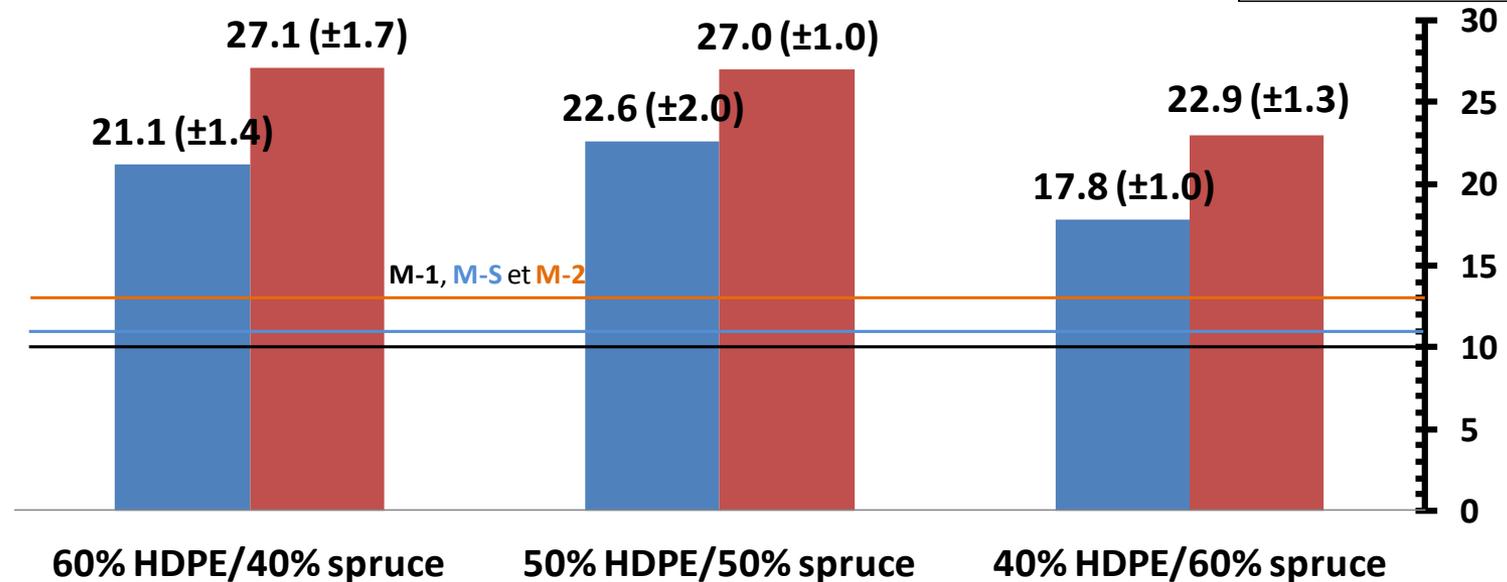
# Results

# Flexural Properties by Three-Points Bending

## Effect of fiber content on the flexural strength (MOR)

- Flexural strength of panels having two 1.59 mm (1/16") skins [MPa]
- Flexural strength of panels having two 3.18 mm (1/8") skins [MPa]

M-1, M-S et M-2

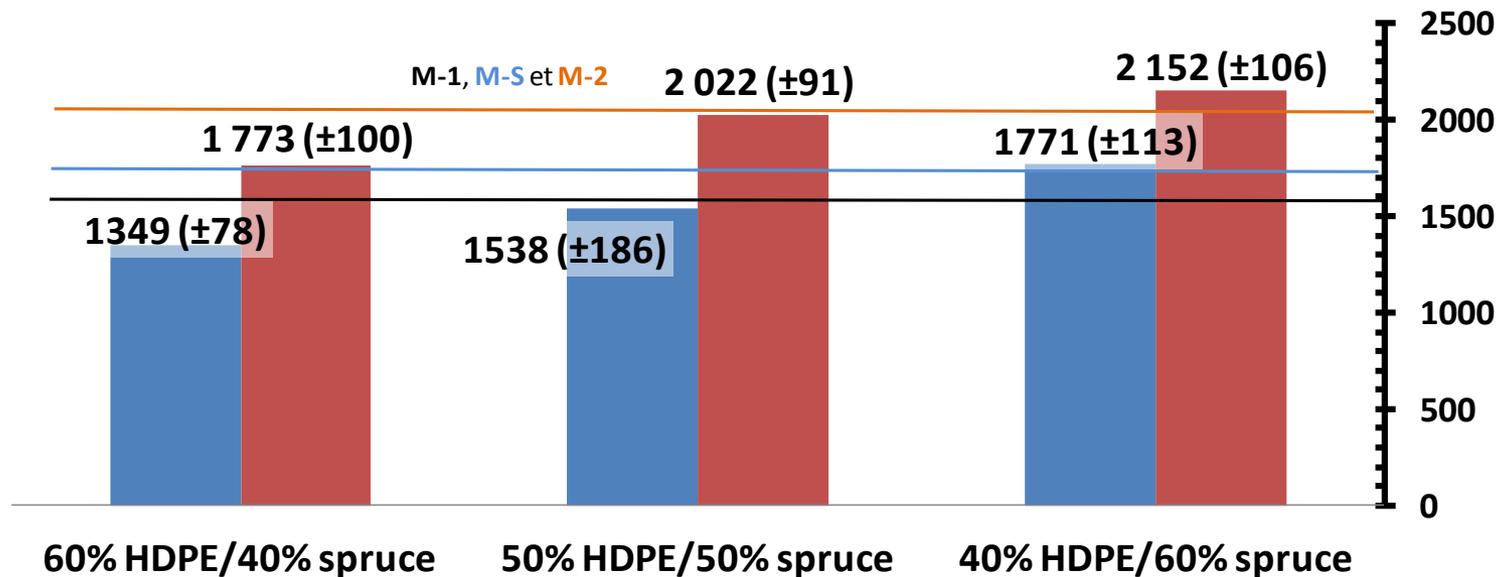


# Flexural Properties by Three-Points Bending

## Effect of fiber content on the flexural rigidity (MOE)

- Flexural rigidity of panels having two 1.59 mm (1/16") skins [MPa]
- Flexural rigidity of panels having two 3.18 mm (1/8") skins [MPa]

M-1, M-S et M-2

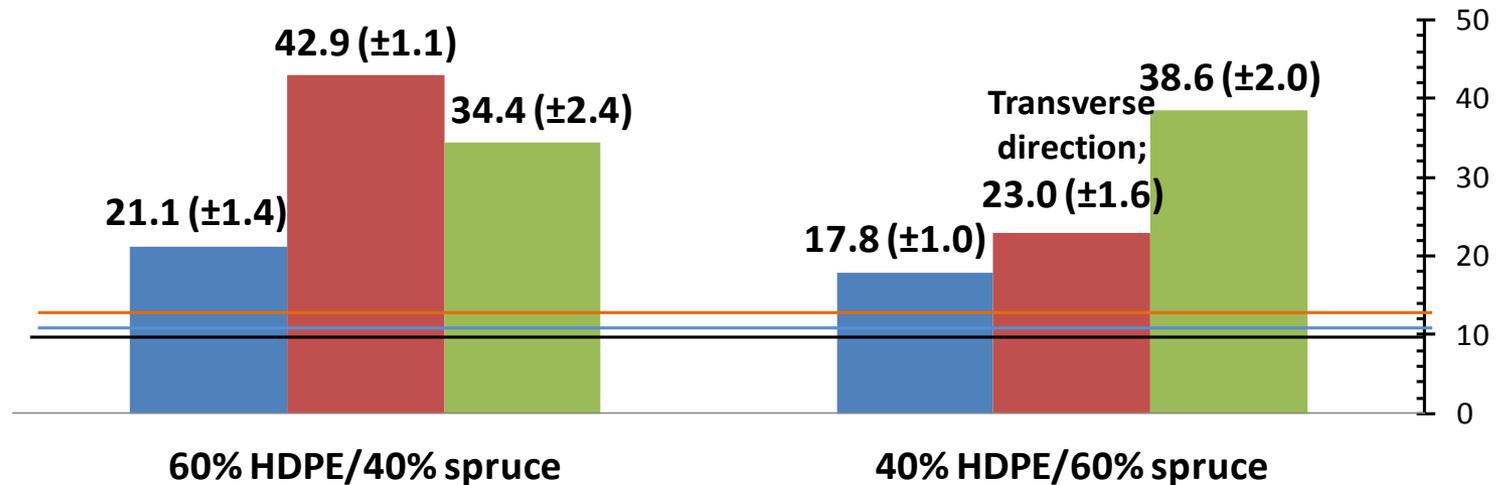


# Flexural Properties by Three-Points Bending

Effect of fiber content on the flexural strength (MOR) of panels having two 1.59 mm (1/16") composite skins

- Flexural strength of sandwich panels without veneer [MPa]
- Flexural strength of sandwich panels laminated with sugar maple veneers [MPa]
- Flexural strength of sandwich panels laminated with red oak veneers [MPa]

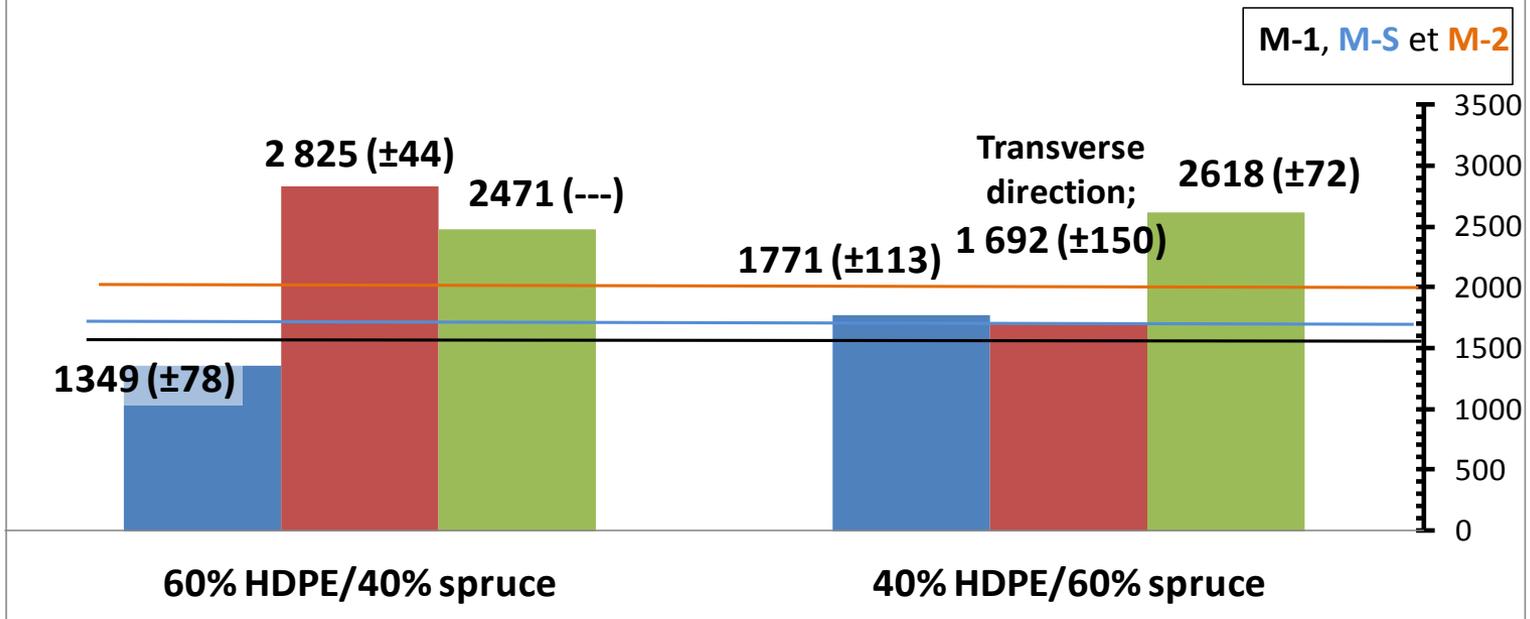
M-1, M-S et M-2



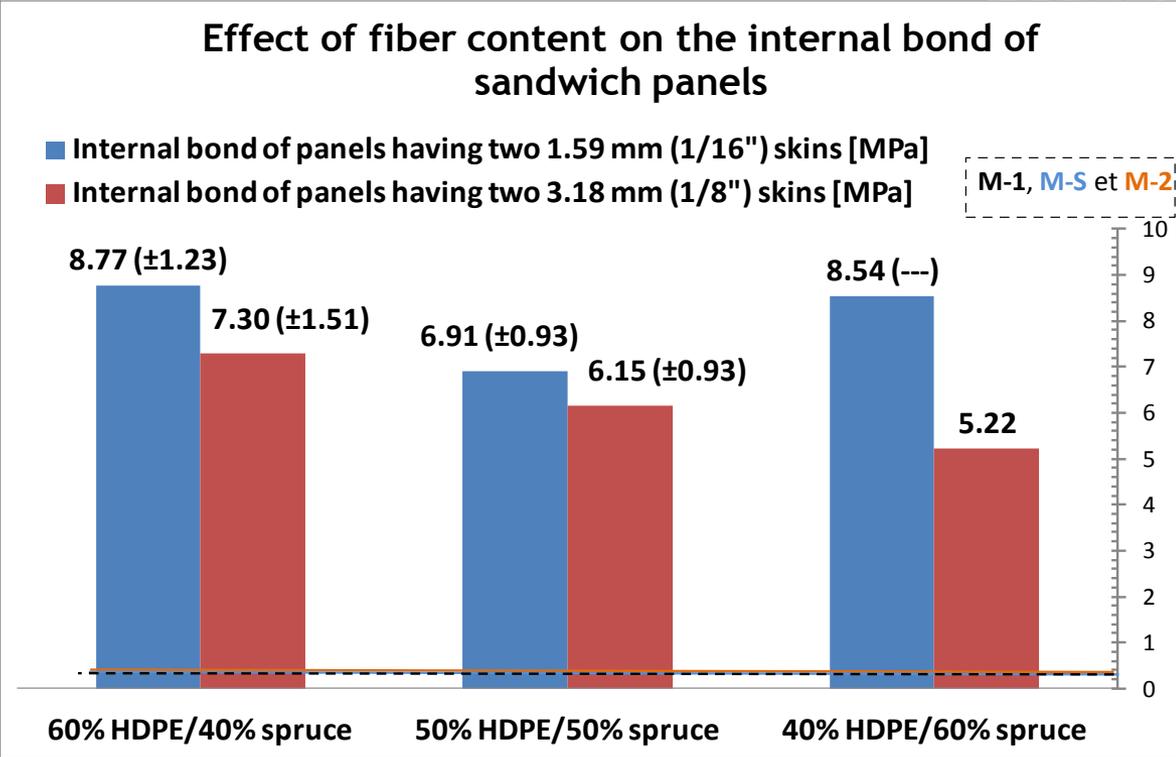
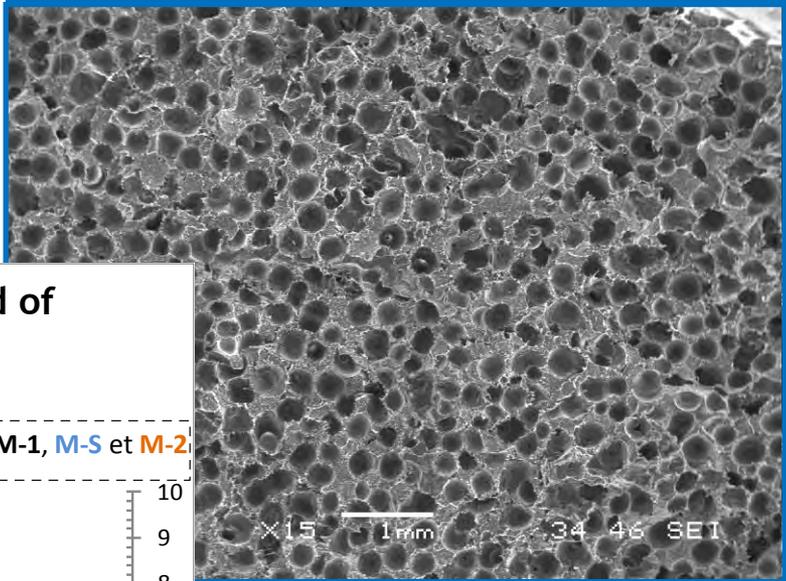
# Flexural Properties by Three-Points Bending

Effect of fiber content on the flexural rigidity (MOE) of panels having two 1.59 mm (1/16") composite skins

- Flexural rigidity of sandwich panels without veneer [MPa]
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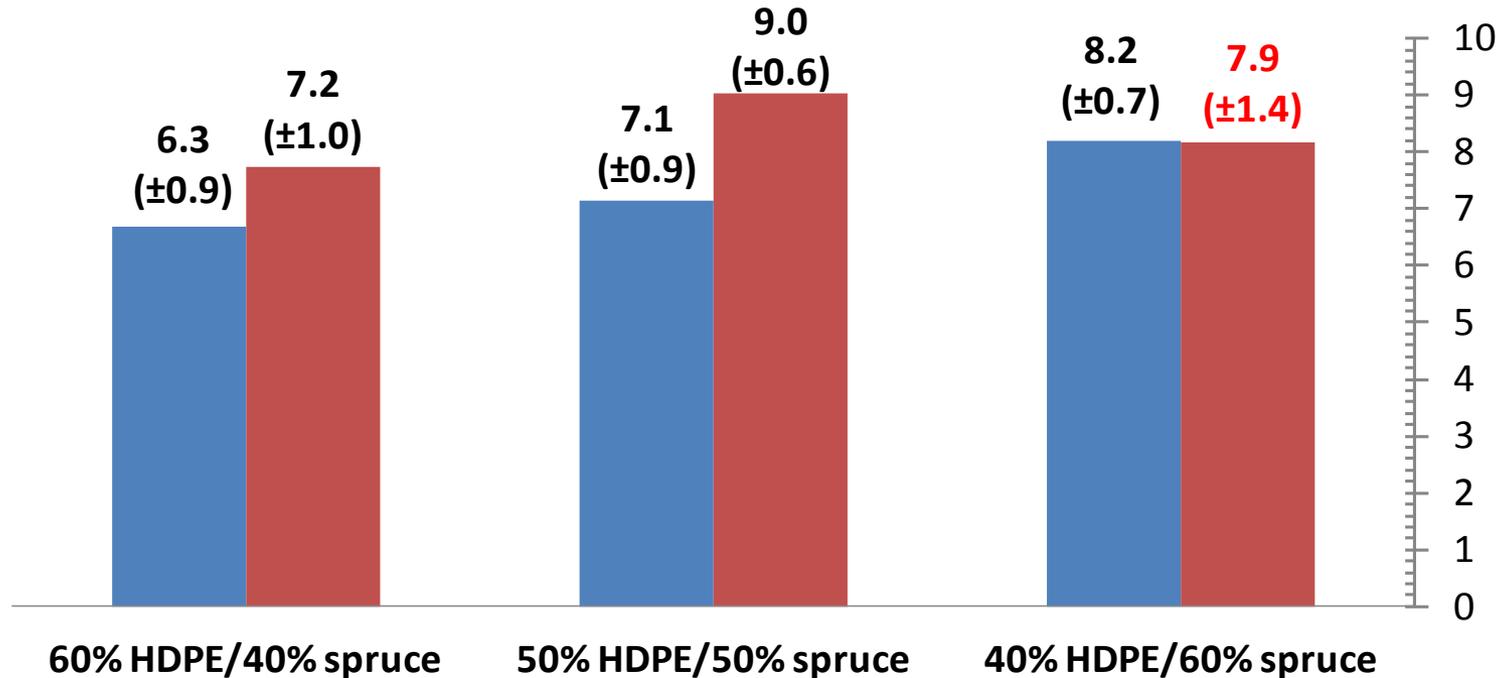
# Internal bond



# Brinell hardness number

## Effect of fiber content on the Brinell hardness number (HBW)

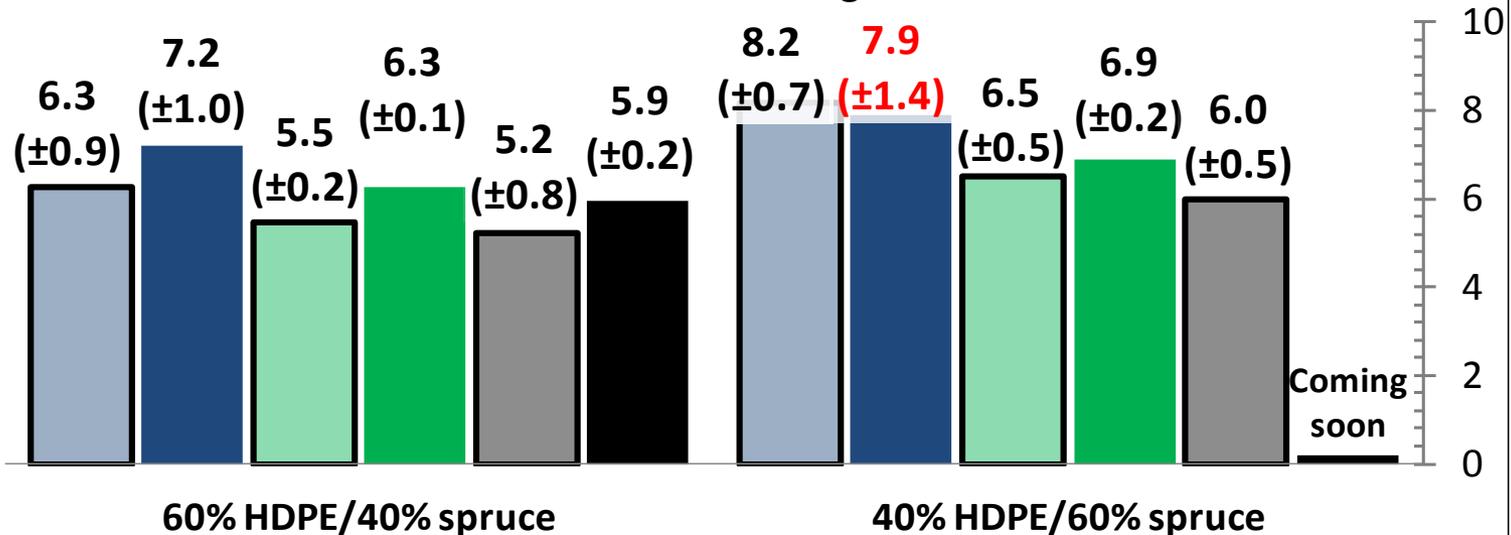
- HBW 10/1000 of panels having two 1.59 mm (1/16") skins [kgf/mm<sup>2</sup>]
- HBW 10/1000 of panels having two 3.18 mm (1/8") skins [kgf/mm<sup>2</sup>]



# Brinell hardness number

## Effect of fiber content on the Brinell hardness number (HBW 10/1000) [kg<sub>f</sub>/mm<sup>2</sup>]

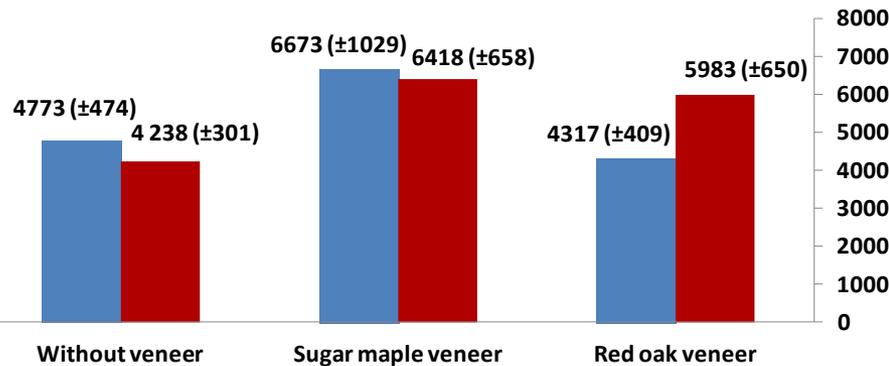
- Without veneer and having two 1.59 mm skins
- Without veneer and having two 3.18 mm skins
- Veneered with maple sugar and having two 1.59 mm skins
- Veneered with maple sugar and having two 3.18 mm skins
- Veneered with red oak and having two 1.59 mm skins
- Veneered with red oak and having two 3.18 mm skins



# Maximum impact force recorded for 95 Joules impact energy

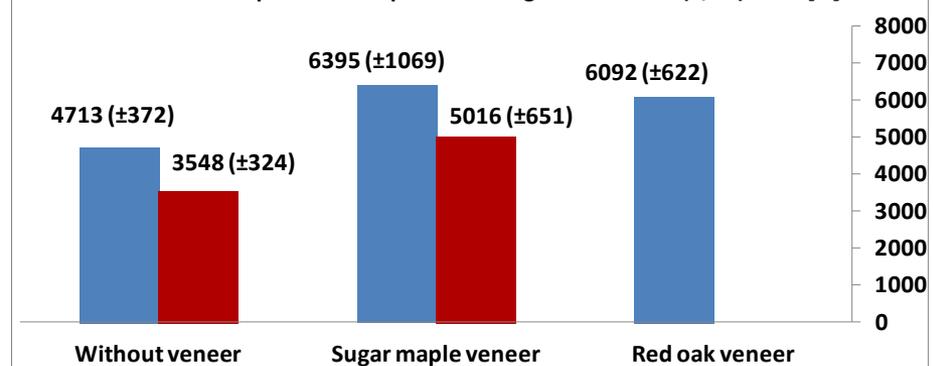
Effect of wood veneers on the maximum force of panels which contains 40% spruce in the skins

■ Maximum impact force of panels having two 1.59 mm (1/16") skins [N]  
■ Maximum impact force of panels having two 3.18 mm (1/8") skins [N]



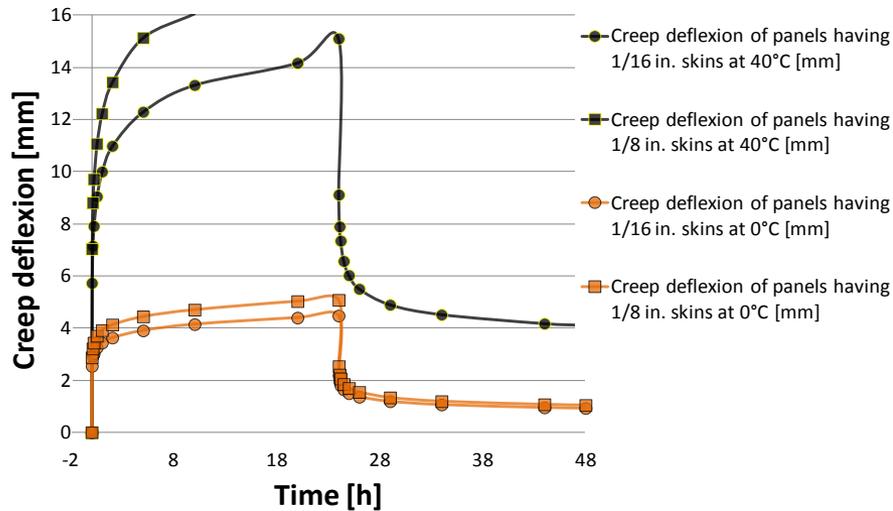
Effect of wood veneers on the maximum force of panels which contains 60% spruce in the skins

■ Maximum impact force of panels having two 1.59 mm (1/16") skins [N]  
■ Maximum impact force of panels having two 3.18 mm (1/8") skins [N]

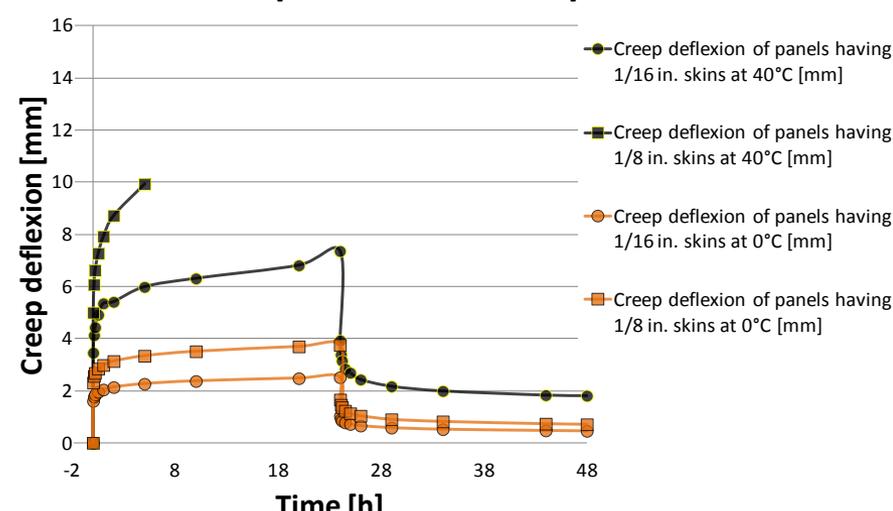


# Creep Properties by Three-Points Bending

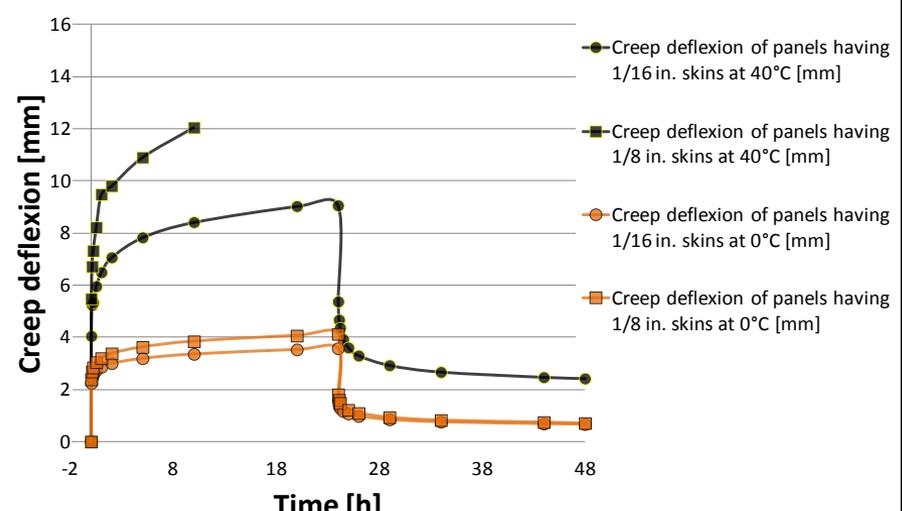
## Effect of skins thickness (40% spruce) and temperature on creep deflexion



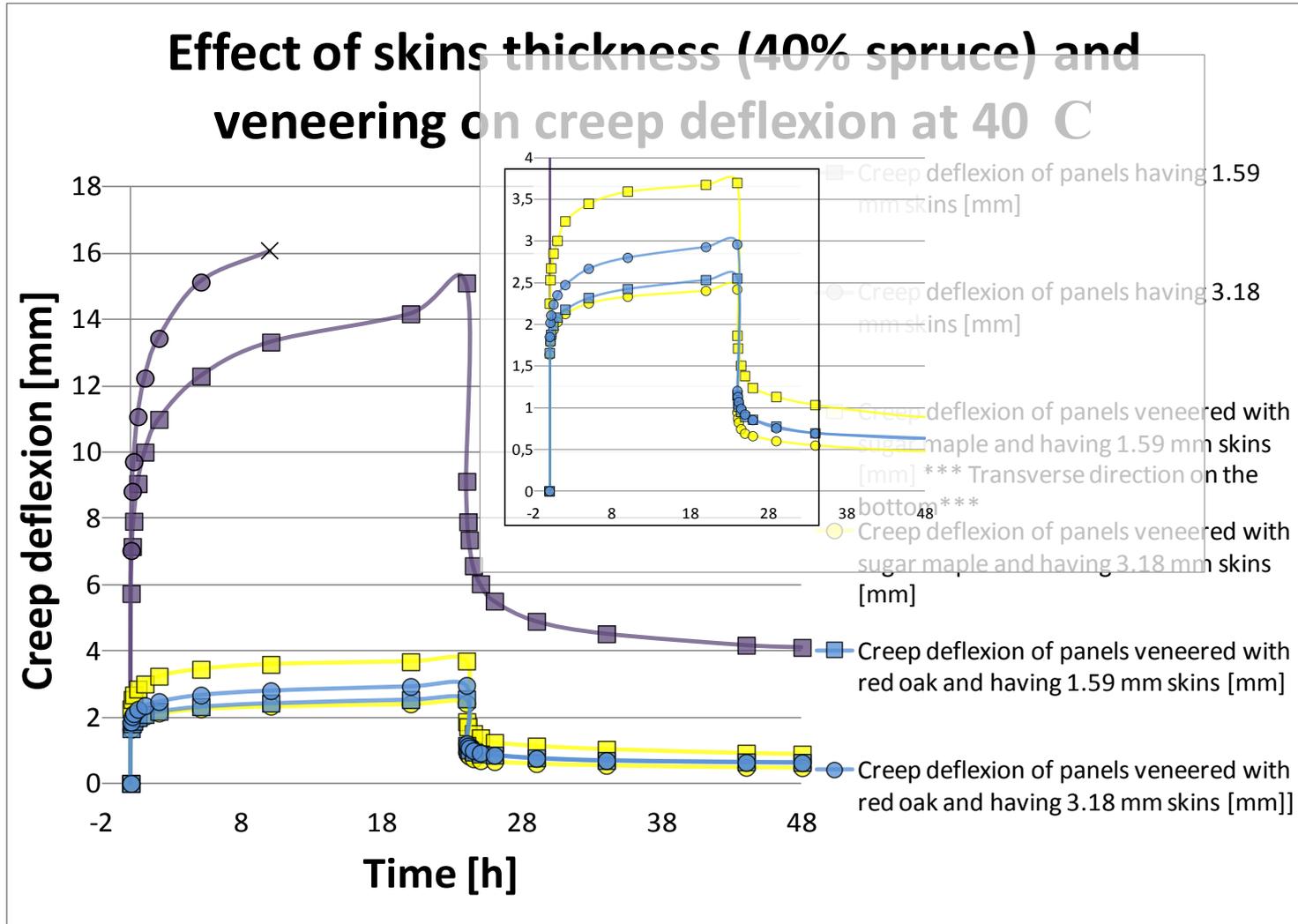
## Effect of skins thickness (60% spruce) and temperature on creep deflexion



## Effect of skins thickness (50% spruce) and temperature on creep deflexion



# Creep Properties by Three-Points Bending



# Conclusion

# Composite structures veneered with wood



- 0.8 mm paper back sugar maple or red oak veneer were laminated successfully over top and bottom skins.

- The addition of wood veneer on both sides helps to increase flexural properties.

- The addition of wood veneer on both sides also allows to add more fibers in the skins without diminishing the elongation at break significantly.

- Maximum forces recorded (violent impact of 95 Joules) increase for sandwich panels laminated with veneers.

- The total and residual deflections in creep mode decrease when panels are laminated with veneers.



# Acknowledgements

This study has been carried out with financial support from the Natural Sciences and Engineering Research Council of Canada granted to the ForValueNet network.



## Wood-plastic composite skins

- Polyethylene (HDPE)
- 40-60 (%) spruce fibers
- Maleated polyethylene
- Other additives

## Foamed polyethylene core

- Polyethylene (HDPE)
- Foaming agent (azodicarbonamide)
- Other additives

**Melt compounding step**



# Blowing methodology of wood-plastic composite sandwich panel inside a hot press

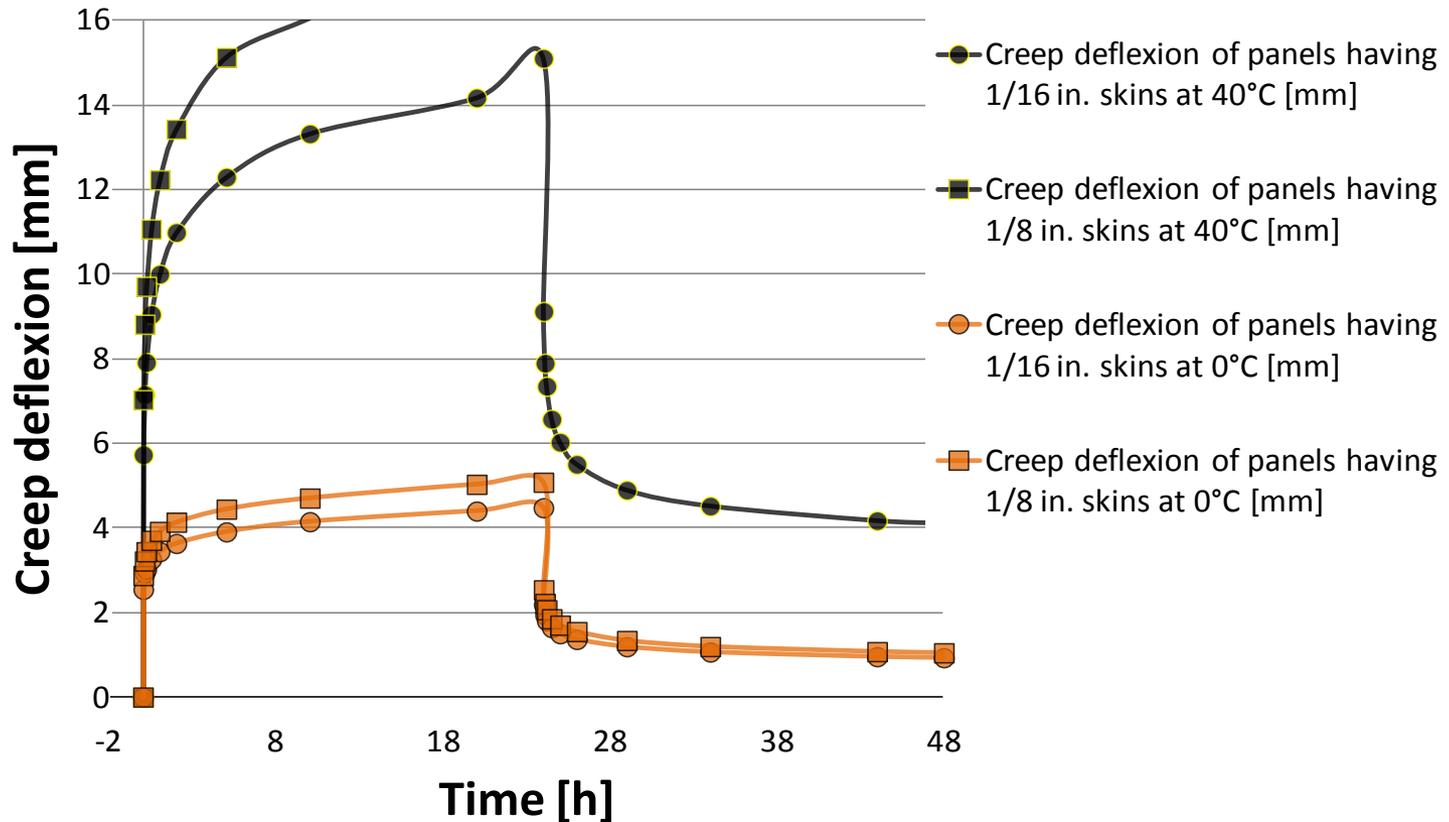
- 1) Hot pressing of the three layers
- 2) Activation of the chemical blowing agent
- 3) Partial solidification (crystallisation) of the surface layers
- 4) Foaming of the foam core layer

Forming and foaming step



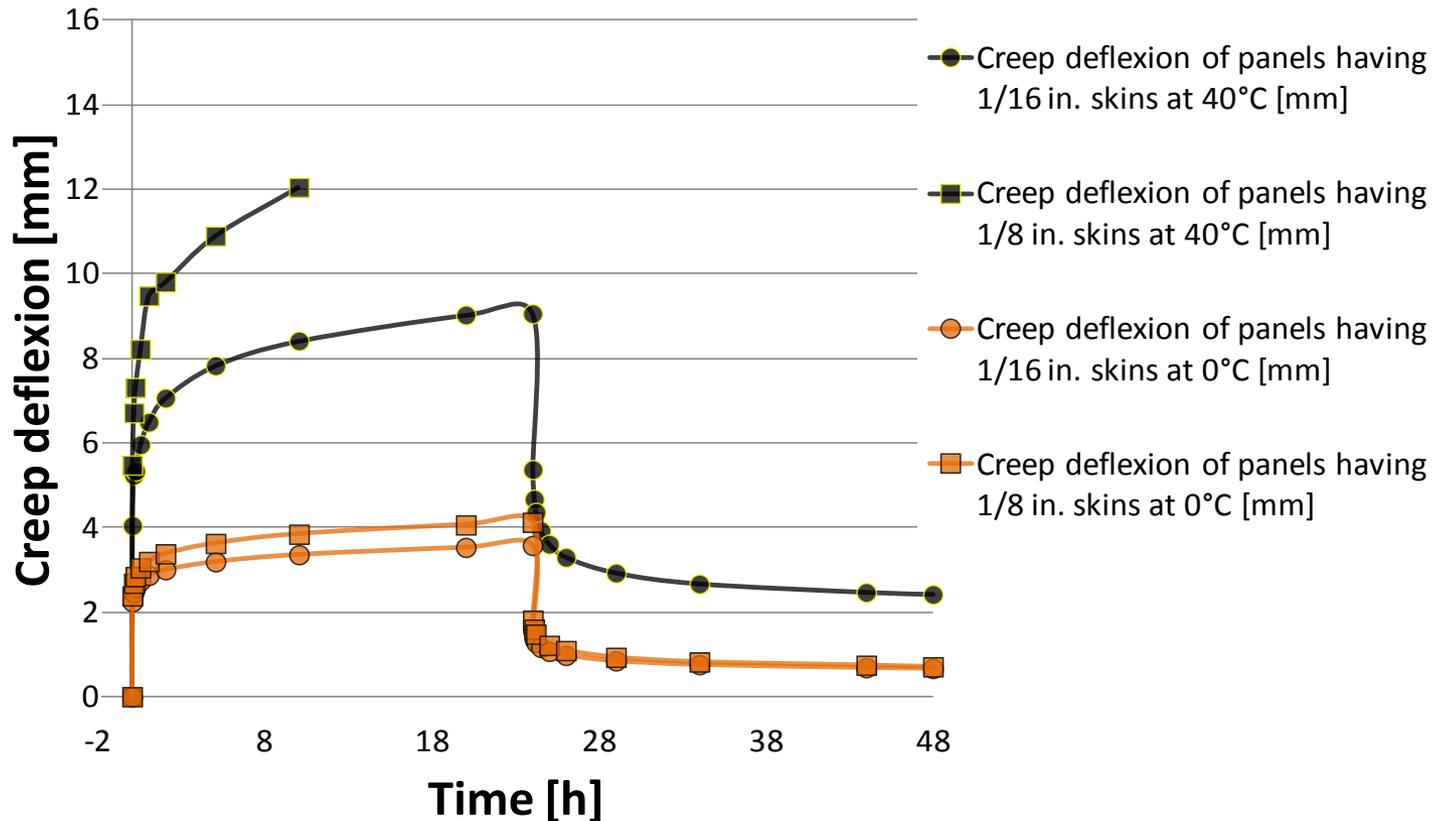
# Creep Properties by Three-Points Bending

## Effect of skins thickness (40% spruce ) and temperature on creep deflexion



# Creep Properties by Three-Points Bending

## Effect of skins thickness (50% spruce ) and temperature on creep deflexion



# Creep Properties by Three-Points Bending

## Effect of skins thickness (60% spruce ) and temperature on creep deflexion

