THE NORTHERNMOST UNIVERSITY
of Technology in Scandinavia

Älvsbacka Bridge – A Bridge in Cold Climate

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Älvsbacka Bridge

- Span 130 m, main beams 1100 x 645 mm.
- 23 m high pylon towers, 900 x 900 mm.
- Untreated spruce and protective cladding.
- The deck is built in five sections, and assembled on site.
- The bridge deck has a 1 m camber.

Health monitoring system

- GNSS for Displacement and vibration.
- 3-axis accelerometers for vibration.
- Load cells for cable tensions.
- Weather station for temperature and RH.
- MC-sensors for determining MC.
- Web camera to differentiate traffic and weather loads.

Engineered woods

- Glulam
- CLT
- LSL
- PSL
- We know the properties of wood in elevated temperatures.

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Engineered woods in cold climate

- Nordic countries, Russia, USA, Canada etc.
- 17 january 2013 -23° C, but it gets colder!

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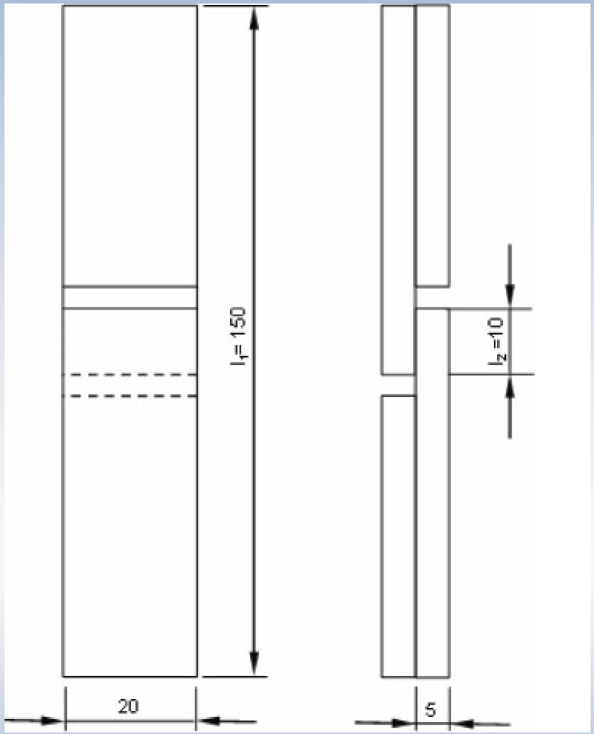
Specimens

- Specimens cut to 150mm x 20mm x 10 mm
- Six types of adhesive:
  - One-component polyurethane (PUR)
  - Polyvinyl acetate (PVAc)
  - Emulsion-polymer-isocyanate (EPI)
  - Melamine-formaldehyde resin (MF)
  - Melamine-urea- formaldehyde resin (MUF)
  - Phenol-resorcinol-formaldehyde resin (PRF)



Glue line stability in cold climate

- Universal testing machine in climate chamber
- Temperatures from 20° C to -60° C
- Tested according to EN 302-1

Shear strengths of wood and adhesives bonds at different temperatures

Temp./Glue	1-PUR	2-PVAc	3-EPI	4-MF	5-PRF	6-MUF	7-Wood
20°C	10.9 (1.0) [1] A [2]	9.6 (0.6) A	10.0 (1.1) A	9.8 (0.9) A	9.8 (1.0) A	8.7 (0.7) A	10.1 (0.9) A
-20°C	10.8 (2.3) A,B	8.1 (1.2) B	8.3 (1.6) B	9.4 (2.3) A	9.7 (1.8) A	7.9 (1.1) A,B	9.5 (1.1) A,B
-30°C	10.2 (2.9) A,B	8.2 (1.2) B	8.3 (2.0) B	8.1 (2.5) A,B	9.2 (2.0) A,B	7.2 (1.9) B,C	9.0 (0.9) A,B,C
-40°C	9.9 (1.5) A,B	7.9 (1.9) B	7.3 (1.5) B	7.7 (1.4) B	9.3 (1.4) A,B	7.2 (1.3) B,C	8.7 (1.3) B,C
-50°C	9.2 (1.3) B,C	7.9 (1.8) B	7.8 (1.4) B	7.5 (1.2) B	8.4 (1.7) A,B	6.6 (0.9) C	8.8 (1.5) B,C
-60°C	7.9 (1.4) C	7.7 (1.1) B	7.2 (1.5) B	7.3 (1.7) B	8.0 (1.4) B	6.6 (1.3) C	8.0 (0.9) C
Total shear strength change (%) [3]	27.1	19.3	27.5	25.0	18.7	24.5	27.1

[1] Values in parentheses are standard deviations based on 15 specimens.
[2] Values in the same capital letter in each column are not statistically different at the 0.05 significance level.
[3] Total shear strength change (%)=(Shear Strength $_{20°C}$ - Shear Strength $_{-60°C}$)/ Shear Strength $_{20°C}$*100.

Conclusions

- As temperature is lowered the shear strength is reduced.
- Except for PUR have a shear strength below 10 MPa already at -20° C, not meeting the EU requirement.
- MUF showed the lowest shear strength of the tested adhesives.