PAPER 622 - WEAR RESISTANT PROTECTION OF WOODEN POLES IN ADVERSE ENVIRONMENTS

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TABLE OF CONTENTS

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1 INTRODUCTION

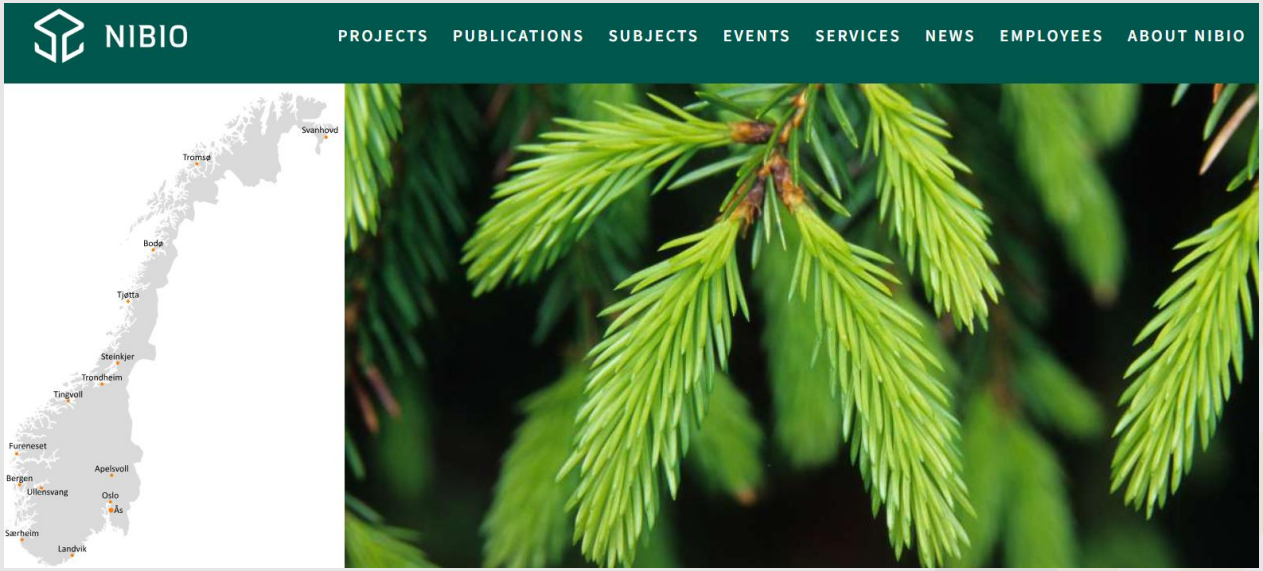
- Being independent of the refractory behaviour of some wood species and avoiding any form of impregnation treatment is an asset.
- Coatings help to drastically reduce the uptake of water by the underlying wood substrate, and may limit the access to oxygen.
- Water-tight coatings could be an alternative for certain areas of use. One example is the full coverage of wooden poles with polyethylene (PE) via an extrusion process.
- Shore D hardness of 62 neutralises the risks of marine borers
- The wood is first dried to a target moisture content of 14%. WOPAS standard PE thickness for power poles is 9 mm.
- The aim of the study at NIBIO, was to analyze different fastening and sealing solutions in both a short-term submersion test and a long-term outdoor weathering and to select the solution where water ingress could be strongly reduced or prevented.

The picture shows a cross section and a PE welded cap. Lengths can of 1-31 m, and ø 8-50 cm.

WOPAS uses such PE extrusion technology to wood which can be of different shape, square, cylindrical, or tapered.

2 MATERIAL AND METHODS

- Starting in May 2019 at NIBIO, different connection solutions were analyzed using water submersion test at the NIBIO laboratory for 1600 hours.
- The samples were stored between submersion cycles in the freezer and in room climate.
- Thereafter, the test pieces were exposed to outdoor climate for 700 days.
- Measurements were done twice per year.



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2 MATERIAL AND METHODS

2.1 Bolts and fasteners

- A variety of bolts and fasteners was used, 5 pcs of each, and in addition reference test bodies without penetration as well as samples with deliberate damages or missing sealant.







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2 MATERIAL AND METHODS

2.2 Full scale installation

- A 40 kV overhead line with 108 WOPAS poles was installed early 2019 and finalized in May.
- The fitters used WOPAS recommended fasteners, i.e. pin bolts with curved washer and mastic, French bolts with mastic and building board screws with gasket.

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2 MATERIAL AND METHODS

2.3 Aging test

- Critical to the sealing function is the integrity of the PE over time.
- Test laboratory CESI of Milan, Italy, on behalf of power grid owner Enel Grids has conducted a test programme of 8 repeating steps during 2022.
- In addition to mechanical tests like impact protection (IK), bending fatigue and flame test, an ageing test of 1000 hours was made to simulate outdoor daily cycle.
- Pole sealed at the ends, was placed in a cylindrical chamber with circulating water.
- The water temperature was controlled and varied between 20 and 80 °C (figure 6).
- At the end of 1000 hours the pole was extracted from the steel tube and inspected for cracks to the PE and welded end caps.
- The pole was then tested with a bending test to compare any deviation to other non-aged WOPAS poles.
- The PE layer was thereafter separated from the wood, and the moisture content of the wood was measured, as well as visual inspection tracing any coloured water penetration

Figure 7: *Steel tube containing a WOPAS pole for age testing.*

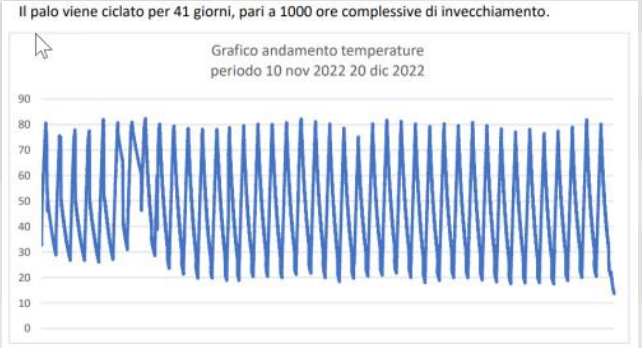

Figure 6: *Temperature variation during 1000 hours of water aging test.*

3 RESULTS

3.1 The influence of bolts and fasteners on water uptake

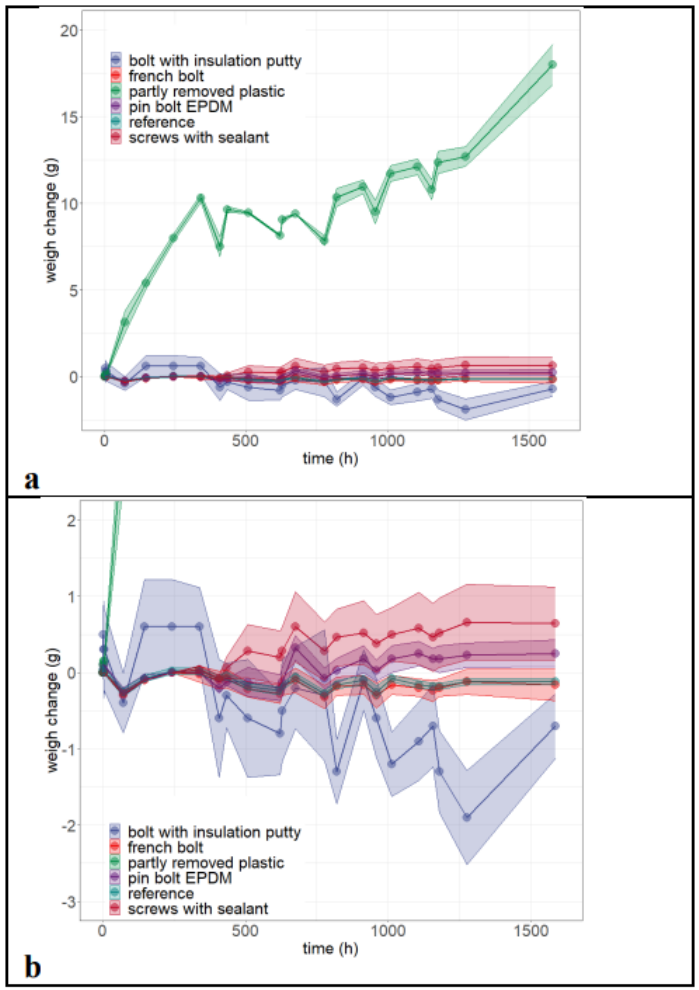

Figure 8: *Weight change due to water uptake during submersion test for more than 2 months. a) note the scale from 0-20, b) note the scale from -2 – 1. The colour-shaded areas show the standard deviation (N=5).*

- Minor weight changes during submersion and outside exposure were observed.
- Reference poles with partly removed plastic coating showed higher water uptake during water submersion and outside exposure.
- The test proved the good performance of the sealants and underlines therefore the importance of the sealing material and the care during installation.
- The total test period is 1400 days by 22 June 2023.

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3 RESULTS

3.1 The influence of bolts and fasteners on water uptake

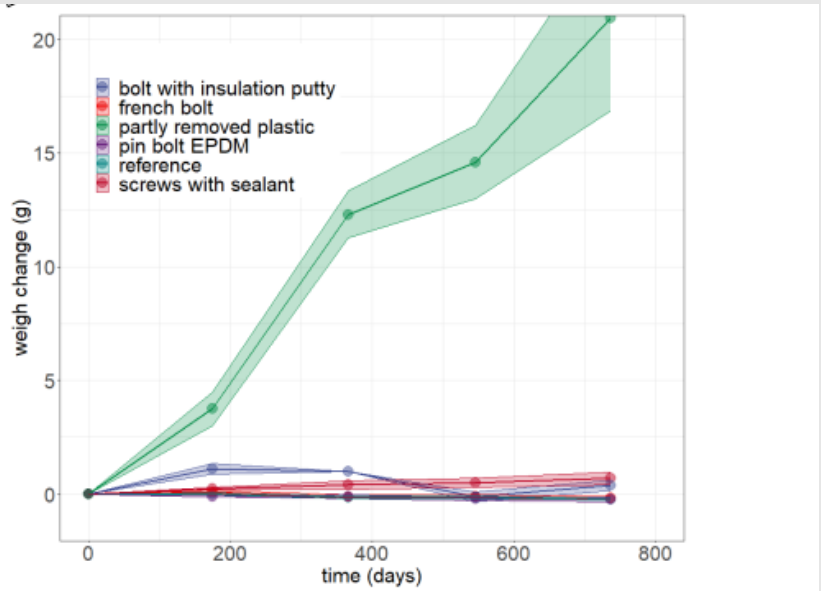

Figure 9 *Weight change due to water uptake during more than two years of outside exposure. The colour-shaded areas show the standard deviation (N=5).*

For serie 21-25 og 26-30 ble det ikke registrert noe vannopptak, og bilde 11 og 12 viser snitt av hhv. prøve 24 og 28.

Bilde 11: Oppdeling av prøve 24 ettet testperioden.

Bilde 12: Oppdeling av prøve 28 ettet testperioden.

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3 RESULTS

3.2 Survey of full-scale installation

- Of the 108 poles a selection of eight poles was installed in different environments, such as arable land, forest, swamp, rocky ground and gravel. Several methods were used for the survey, such as classical hammer sound surveying, non-destructive electronical moisture meter and drilling resistance measurement.
- The visual inspection showed no deviations. The moisture measurements demonstrated no elevated values of wood moisture content. The resistograph showed no unusual values, which could indicate deterioration of wood components.
- The hammer control noted two anomalous sounds, one behind a mark caused by the installation of the poles using excavator grab john and another at a random place. Both locations were examined with moisture measurement and resistograph.

Figure 5 *Drilling measurement using a resistograph, close to pin bolt with curved washer and mastic.*

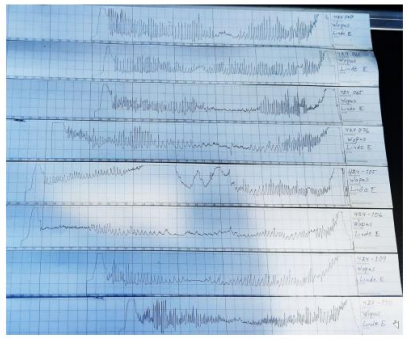

Figure 11: *Paper print-outs of drilling measurement using a resistograph*

Figure 10: *Anomalous sound from hammer was followed up using resistograph, in turn showing normal values.*

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3 RESULTS

3.3 The resistance of the coating to heat and water

- After the aging test, the pole was tested for bending, impact (IK) and the PE was removed to measure the moisture level and for visual inspection of any coloured fluid.
- The moisture level was observed at two positions, as shown in figure 12, and the moisture level was 10,5-10,7%.
- It has been pointed out by CESI and Enel Grids that the specification and aging method have been defined by them for their test, and cannot be extrapolated.

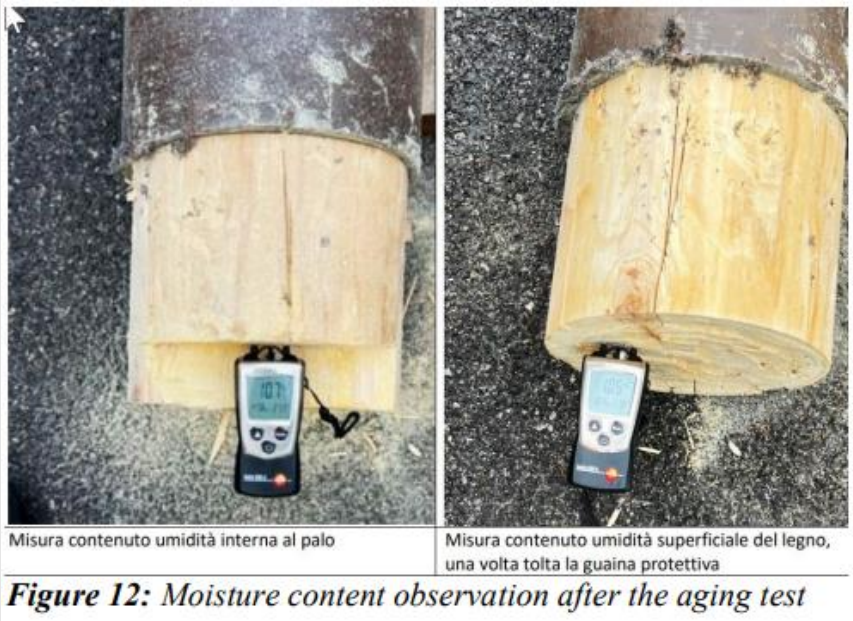

Figure 12: *Moisture content observation after the aging test*

4 CONCLUSION

- Sealant and careful installation play a crucial role for the long-term performance of installed poles in service.
- Various solutions of bolt connections including sealants can be used in large-scale installations. In addition, the performance in service as poles for electrical power lines shows promising results so far.
- The characteristics and lifetime of polyethylene of PE100 quality is witnessed from water infrastructure, automotive, sea farming and other adverse environments. The combination with wood represents an interesting use, without the need for using biocides or wood modification agents.

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THANK YOU

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