A new methodology for condition assessment of utility wood poles based on ultrasonic waves

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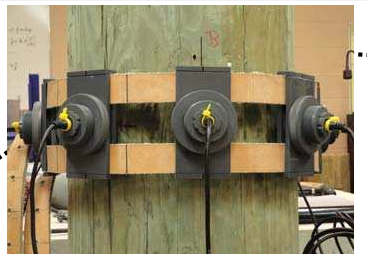
Background

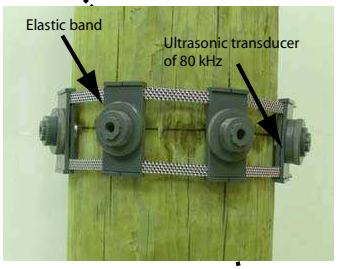
- 5% of the wood pole infrastructure (1.7 million) will require replacement within the next f ve years (17,000 poles per year).
- 50% of the wood pole distribution system is more than 35-year old.
- Between 1997 and 2004, 55,000 poles showed early internal decay.
- The Hydro-One transmission's system contains about 100,000 poles.
- Current inspection methods (sounding and visual inspection) are subjective.
- Resistographs and core sample inspection methods are only used for poles identif ed as suspected.

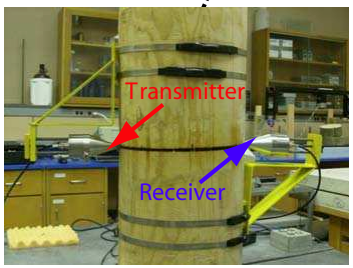
Therefore...

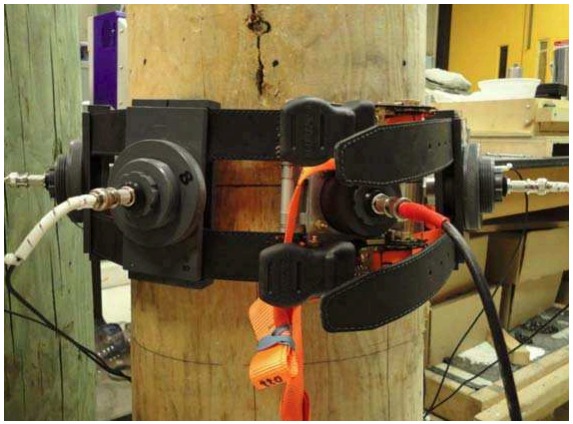
- Hydro-One needs a reliable non-destructive method for the condition assessment of wood-pole infrastructure for
  - ✓ planning maintenance programs by creating a data base to detect problems before they occur,
  - ✓ maintaining staff and public safety by addressing unexpected pole failures,
  - ✓ improving the reliability of the electric system network by detecting early deterioration on new poles, and
  - ✓ reducing the cost of replacing utility poles too early or too late.

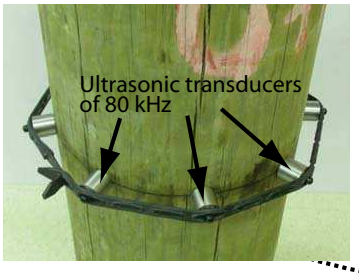
Prototype

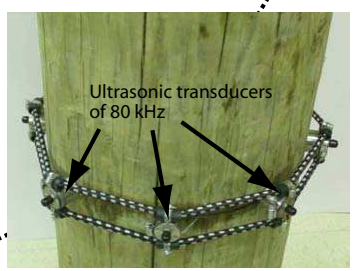



Elastic band
Ultrasonic transducer of 80 kHz


Transmitter
Receiver

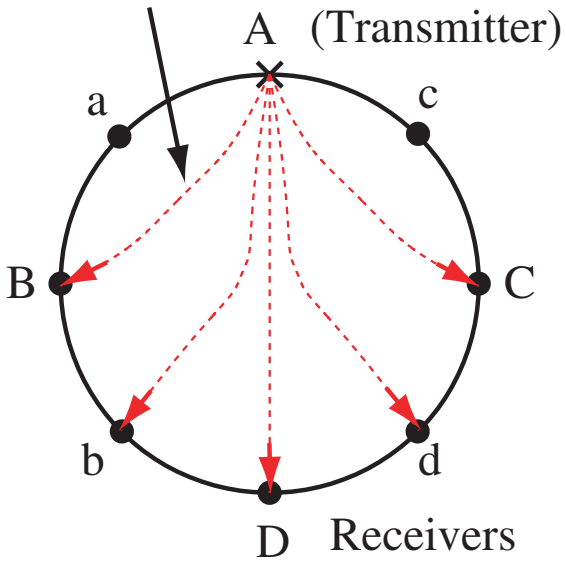



Ultrasonic transducers of 80 kHz


Ultrasonic transducers of 80 kHz

Methodology

Curved raypaths

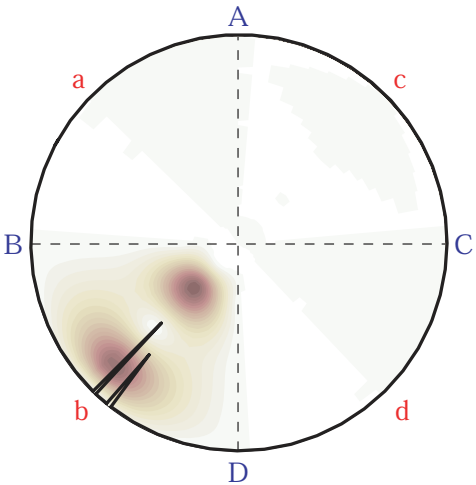


Cylindrical orthotropic model

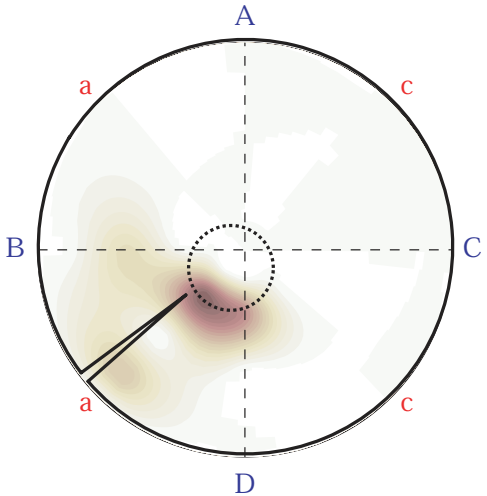
$$DI = \frac{\text{(measured parameter)-(expected value)}}{\text{(standard deviation)}}$$

- Travel time
  - Wave velocity — DI — Tomographic imaging (decay location) ①
  - Modulus of elasticity — DI — Condition rating (remaining strength) ②
- Full waveform analysis — Wave attenuation — DI — Confirmatory assessment ③
  - Overall dissimilarity index

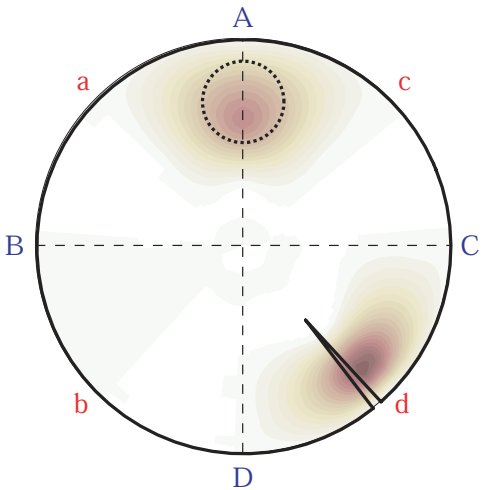
Preliminary results: new pole



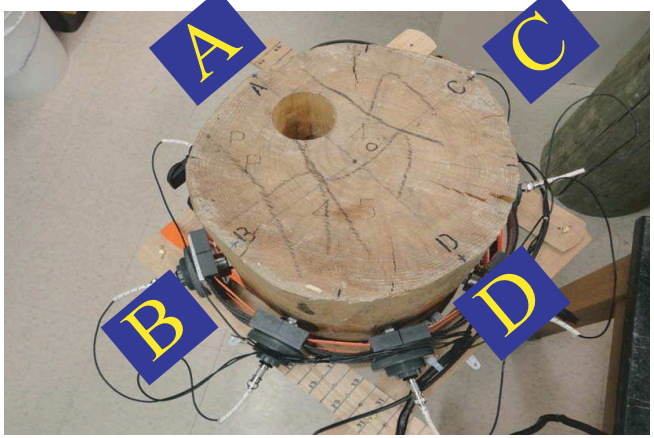
Section 02



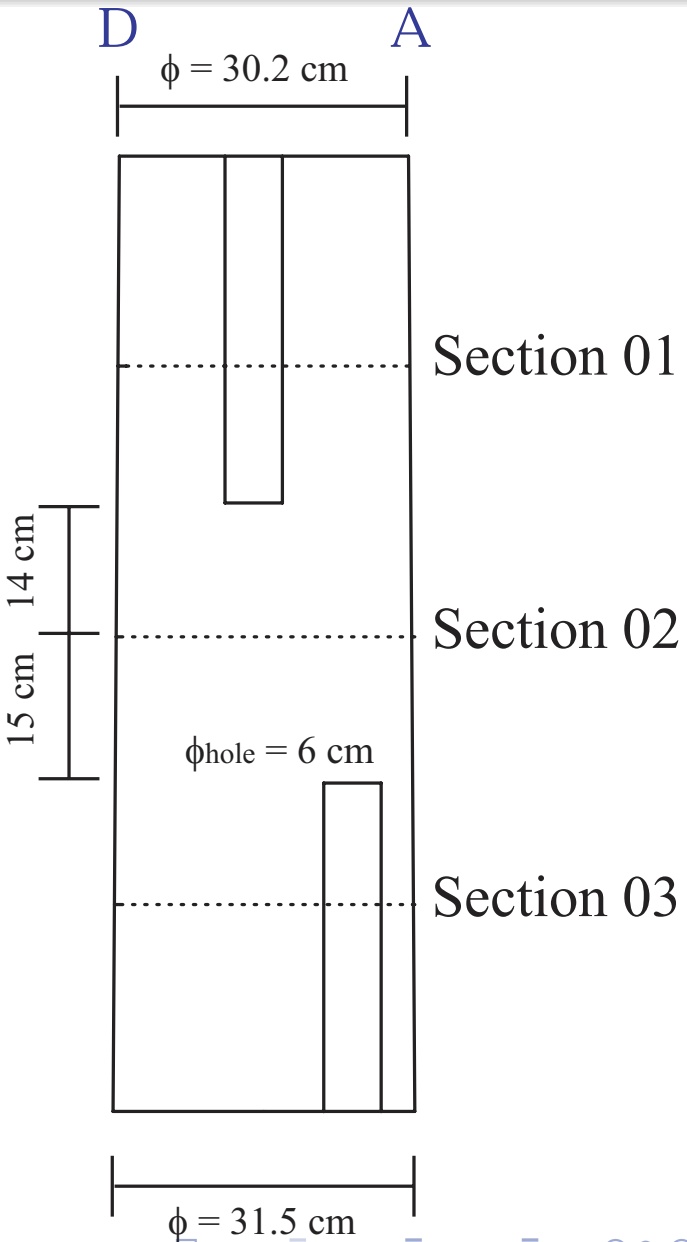
Section 01



Section 03

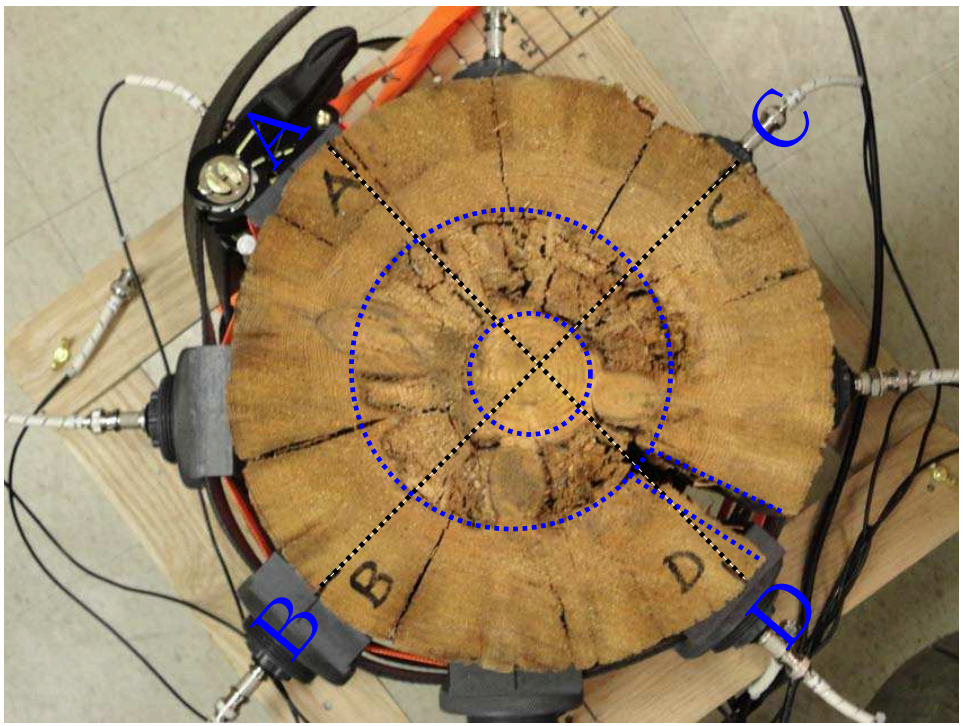


Red pine pole

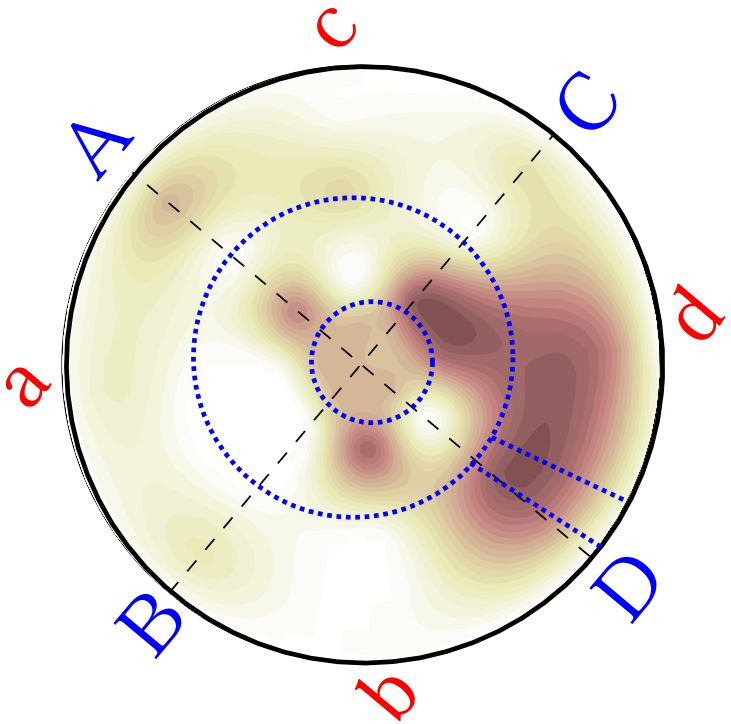


Preliminary results: in-service pole

Top section



At 22 cm from the top section



Next steps

- Complete the calibration of the methodology with 80 wood poles available in the NDT Lab.
- Test the methodology on a sample of 30 poles in the field. Hydro-One's Kleinburg Training Facility.
- Perform the condition assessment of a sample of 100 in-service poles selected by Hydro-One.

  Next year: development of a wireless and portable prototype.

Acknowledgements

- Hydro-One Ontario

- Ontario Centres of Excellence

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- Natural Sciences and Engineering Research Council of Canada

- WISE Institute

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