



*Multimodal Condition Assessment of Bridge
Decks by Non-Destructive Evaluation*

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Iowa Department
of Transportation



Multimodal Condition Assessment of Bridge Decks by Non-Destructive Evaluation (NDE) and Its Validation

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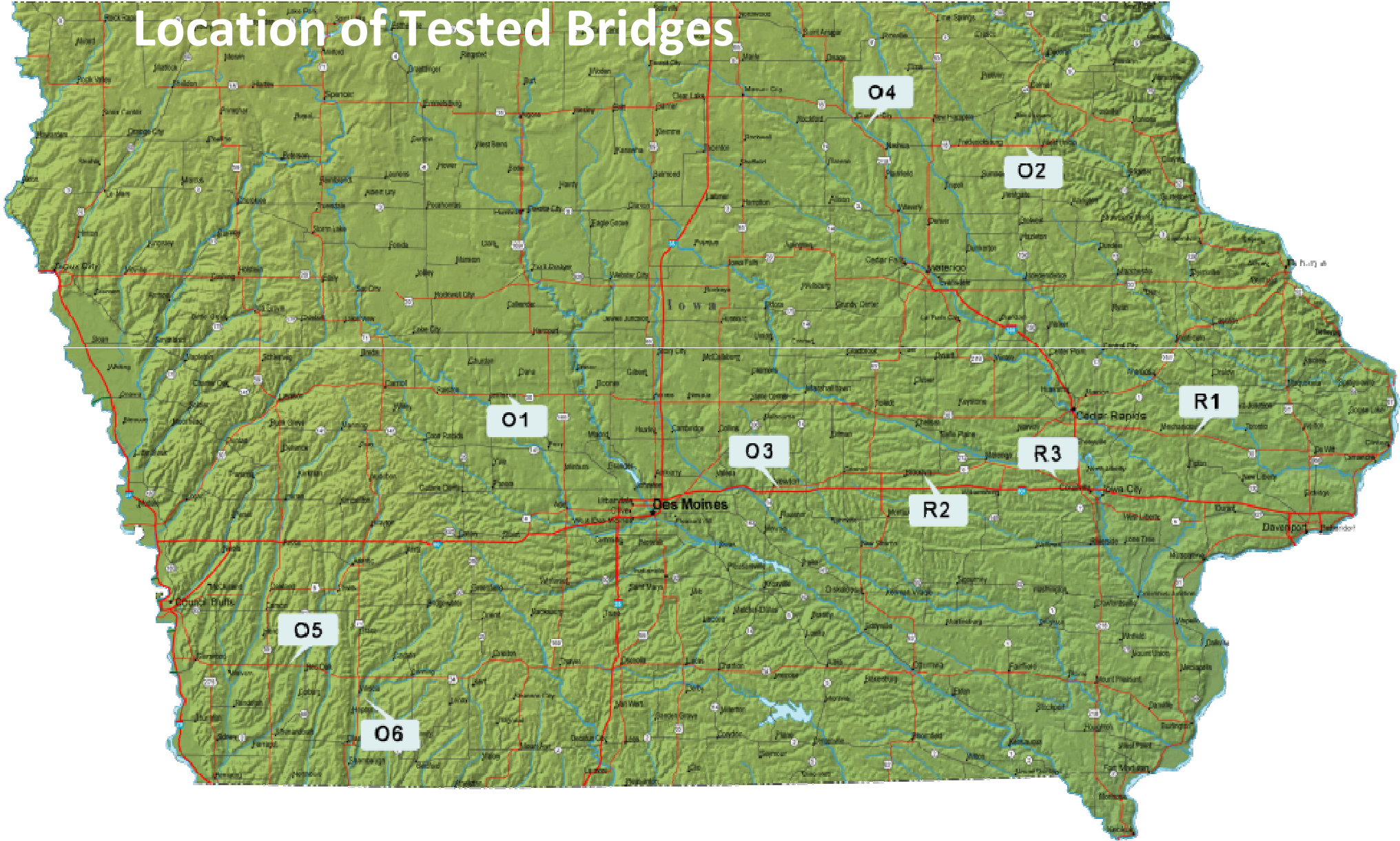
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Center for Advanced Infrastructure and Transportation (CAIT)

Norm McDonald, Ahmad Abu-Hawash

Iowa Department of Transportation

Location of Tested Bridges





Iowa Bridge Deck Evaluation

Implemented NDE technologies

- Ground penetrating radar (GPR)
- Impact echo (IE)
- Ultrasonic pulse echo
- Ultrasonic surface waves
- Half-cell potential
- Electrical resistivity

Complementary evaluations/validations

- Coring
- Chain drag

NDE Techniques





Deterioration Types Vs. NDE Method

Corrosion

- Half-cell potential – Likelihood of corrosion
- Electrical resistivity – Potential for corrosive environment
- GPR – Potential for corrosive environment

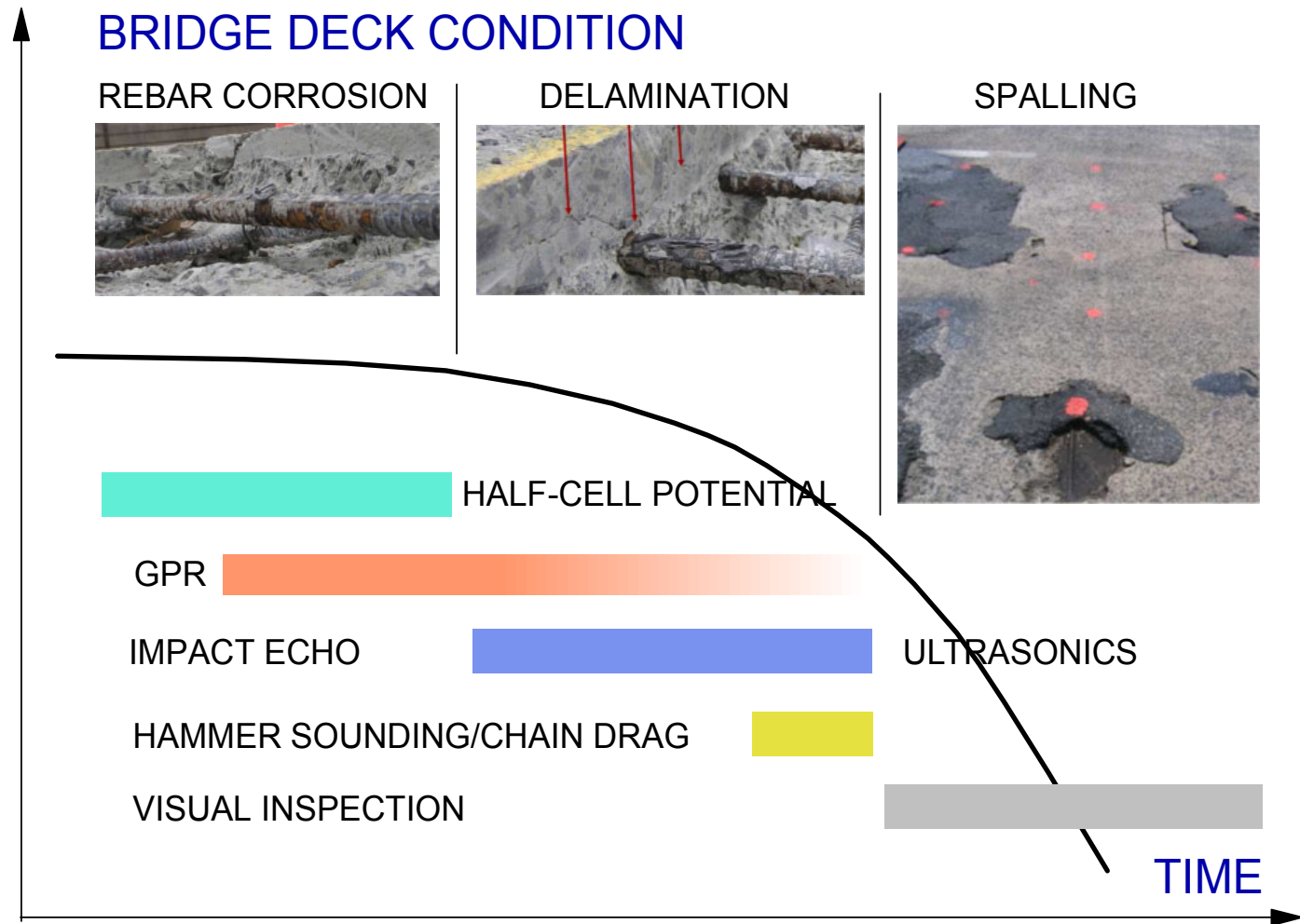
Concrete Degradation

- Ultrasonic surface waves (USW) – Modulus degradation
- GPR – Likelihood of deterioration

Delamination

- Impact echo
- Ultrasonic pulse echo
- GPR – Likelihood of delamination in severely attenuated areas

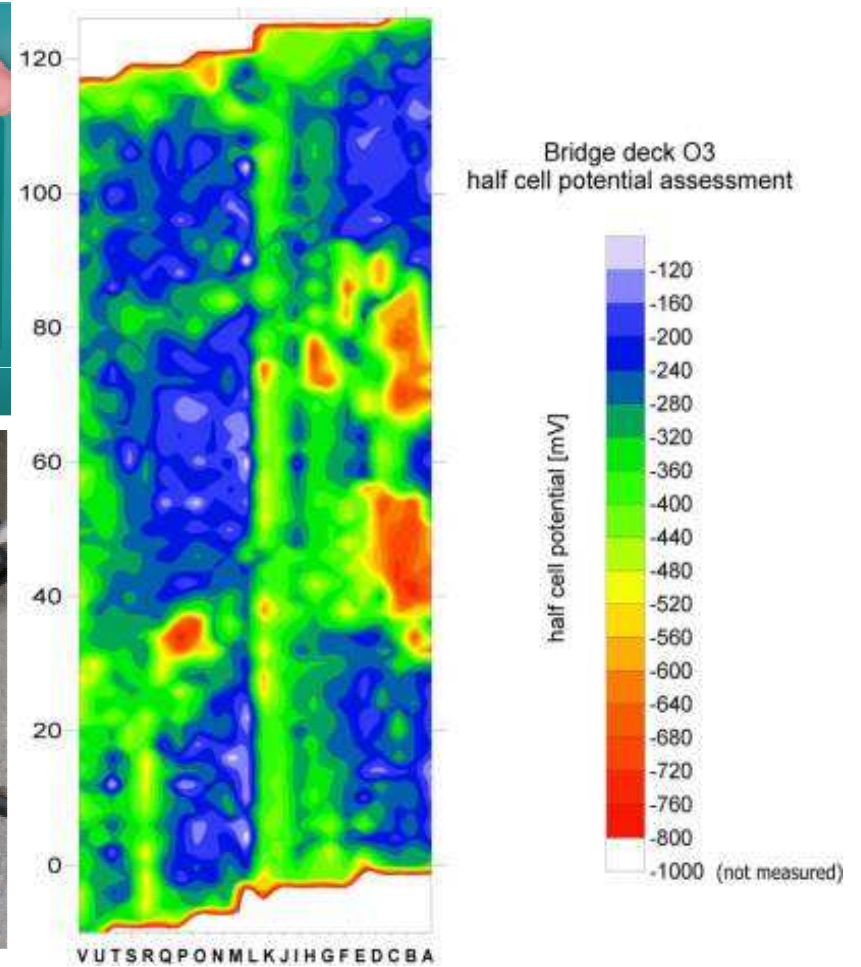
Bridge Deck Condition Assessment



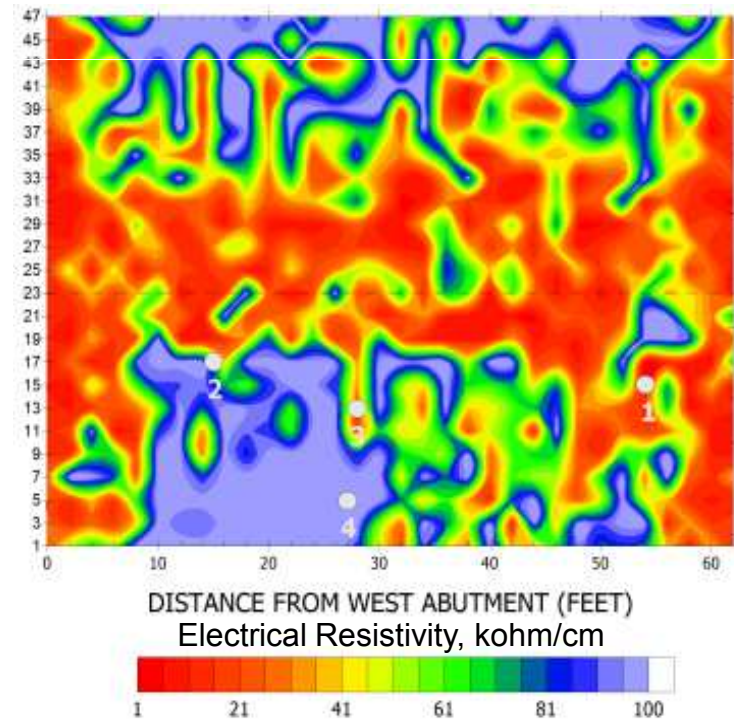
Data Collection – Test Grid



Half-Cell Corrosion Potential



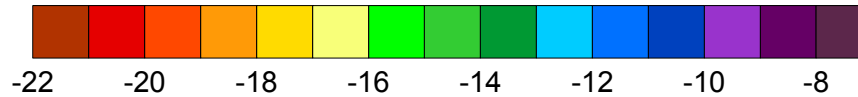
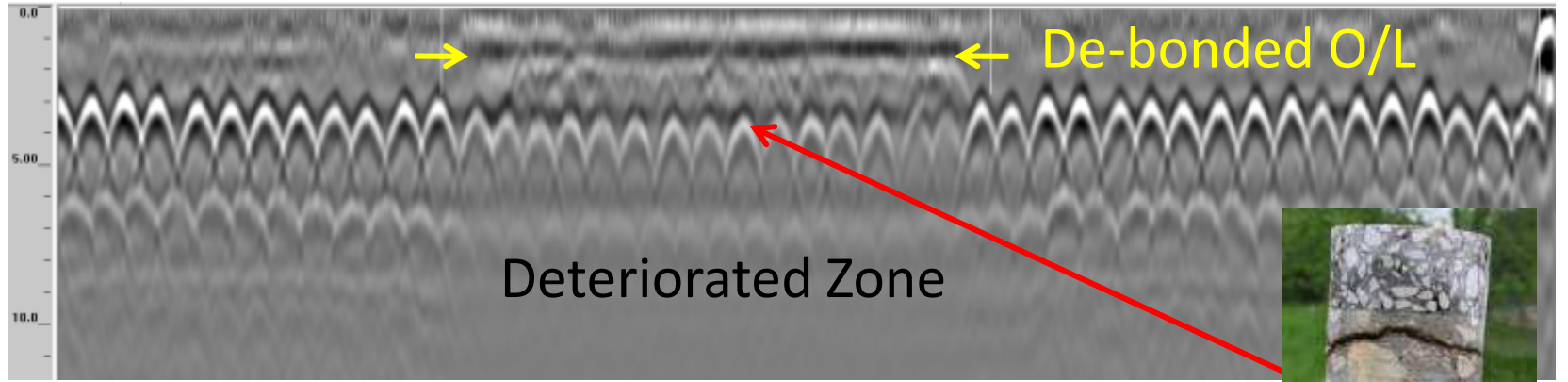
Electrical Resistivity – Wenner Probe



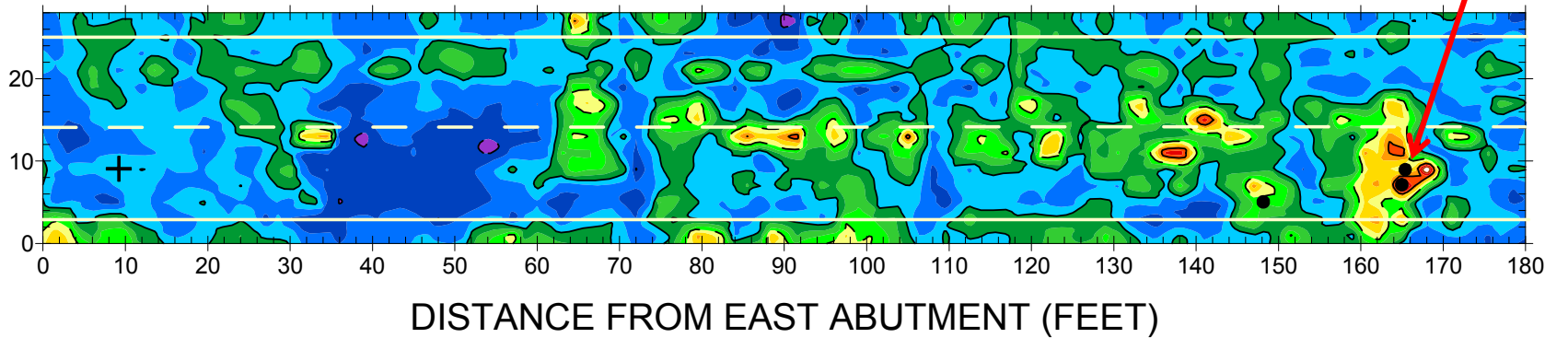
Ground Penetrating Radar (GPR)



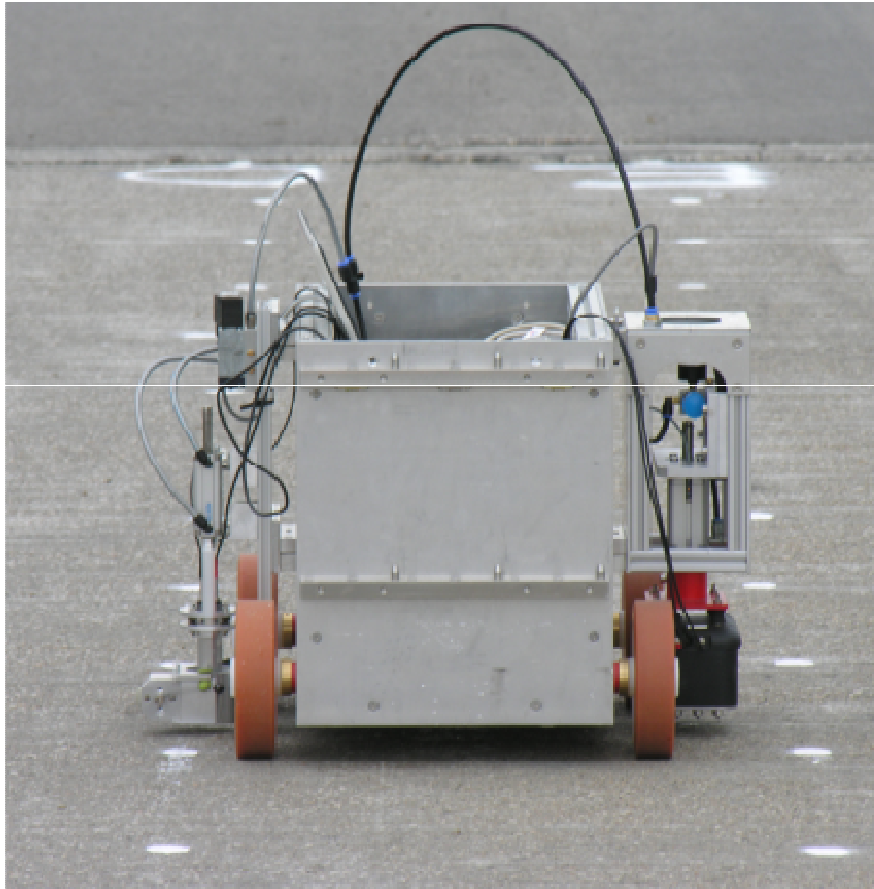
GPR – Raw Scan and Condition Map



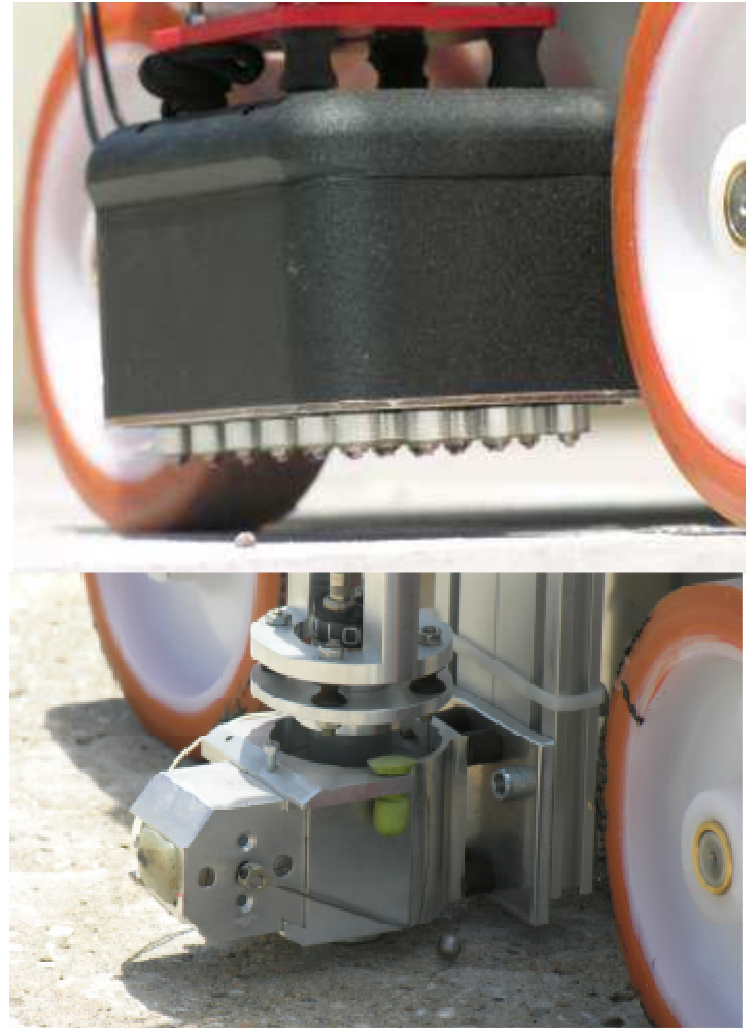
Top Rebar Amplitude (Normalized dB) - DEPTH CORRECTED



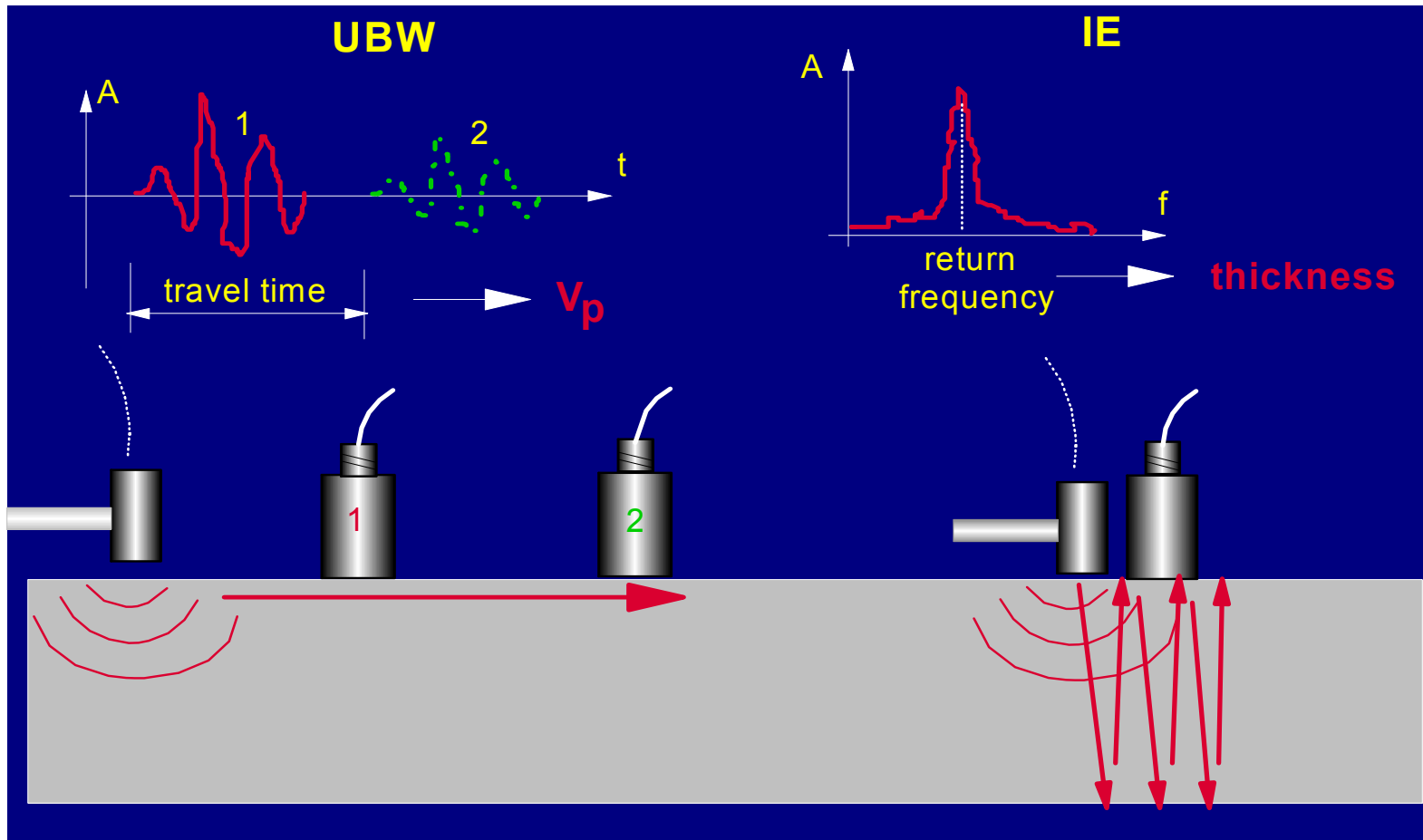
Impact Echo and Ultrasonic Testing



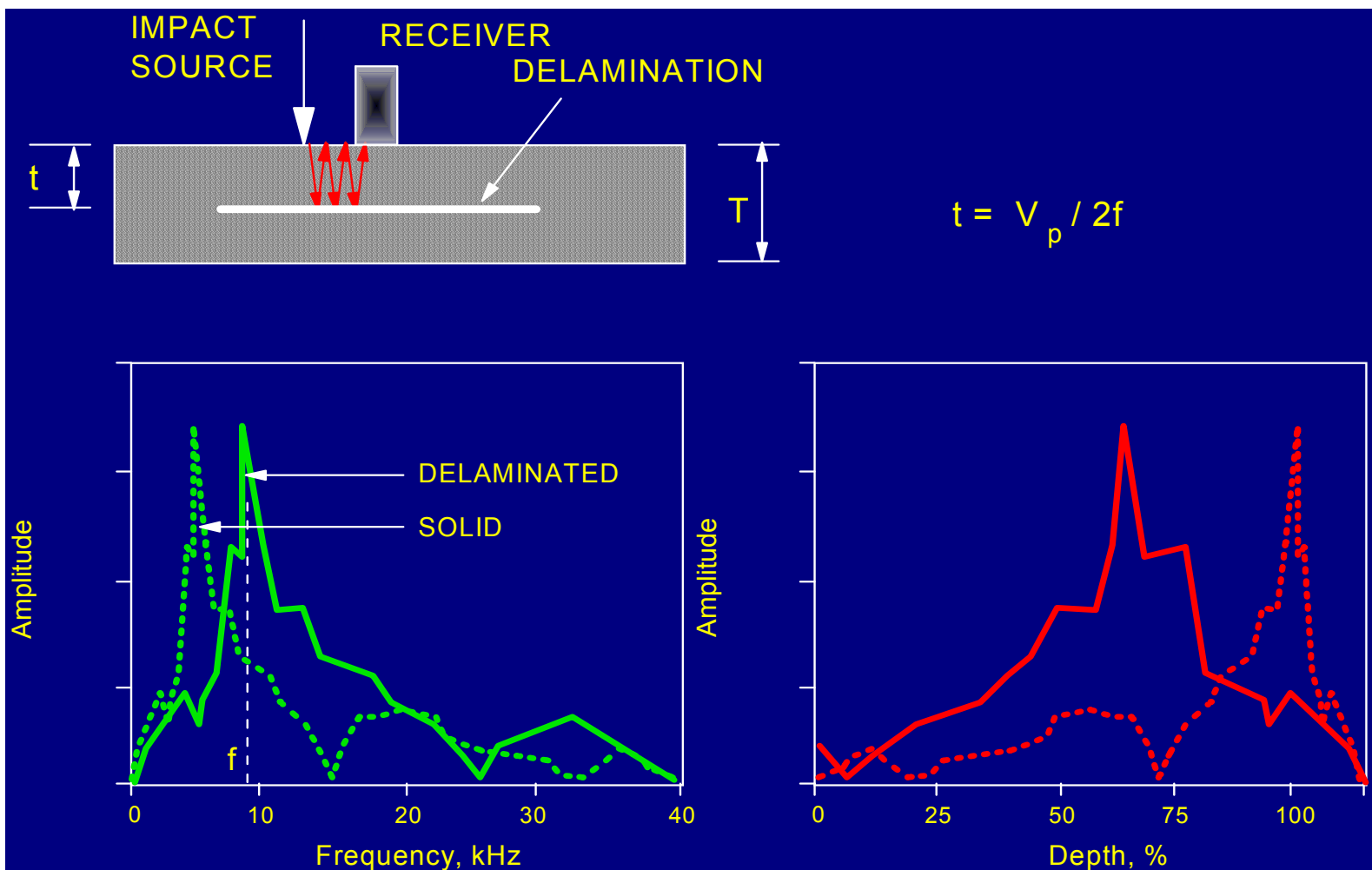
Stepper – Ultrasonics and Impact Echo



Evaluation of Modulus and Deck Thickness by UBW and IE

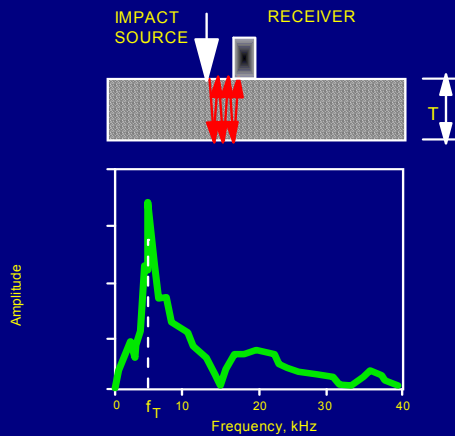


IE on a Delaminated Deck



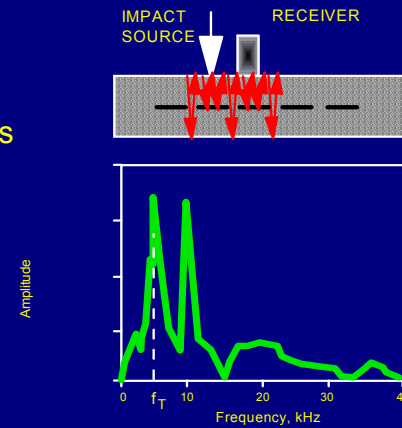
Deck Condition Grades

GOOD (INTACT) CONDITION



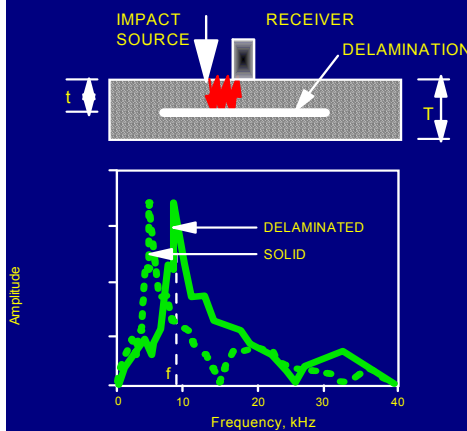
Concrete is well bonded and no signs of delamination are detected.

FAIR CONDITION



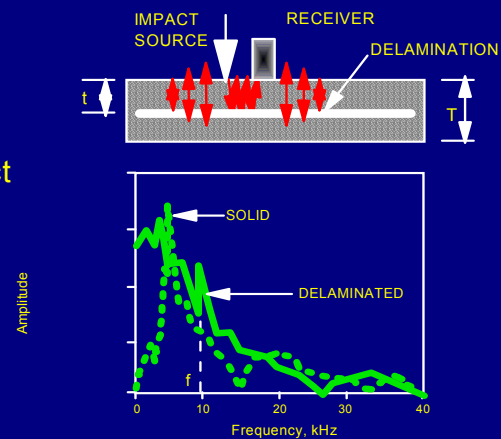
Concrete is bonded or in contact, but there are signs of delamination at some depths.

POOR CONDITION



Delamination has occurred, however grain to grain contact between the two concrete layers exists.

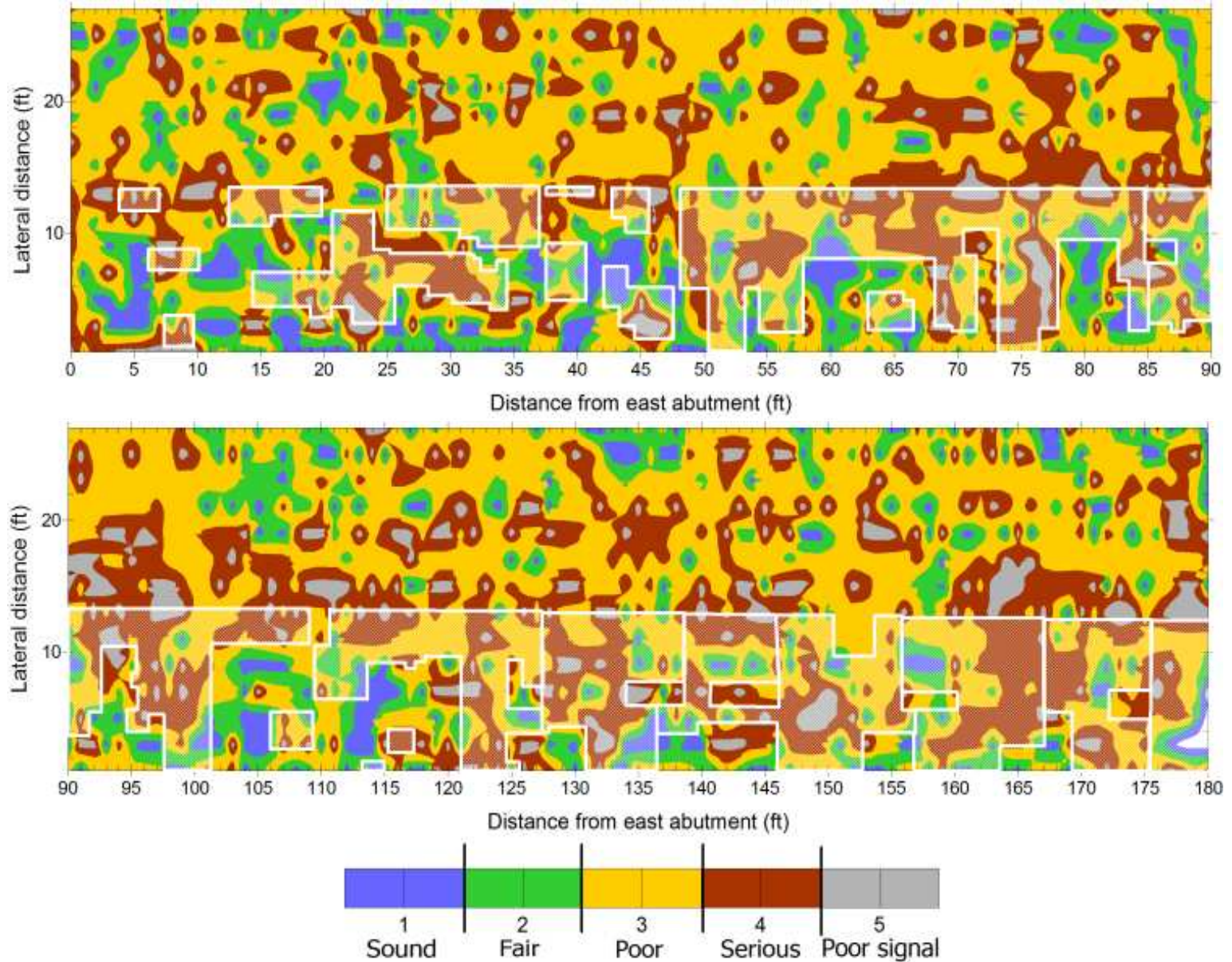
SERIOUS CONDITION



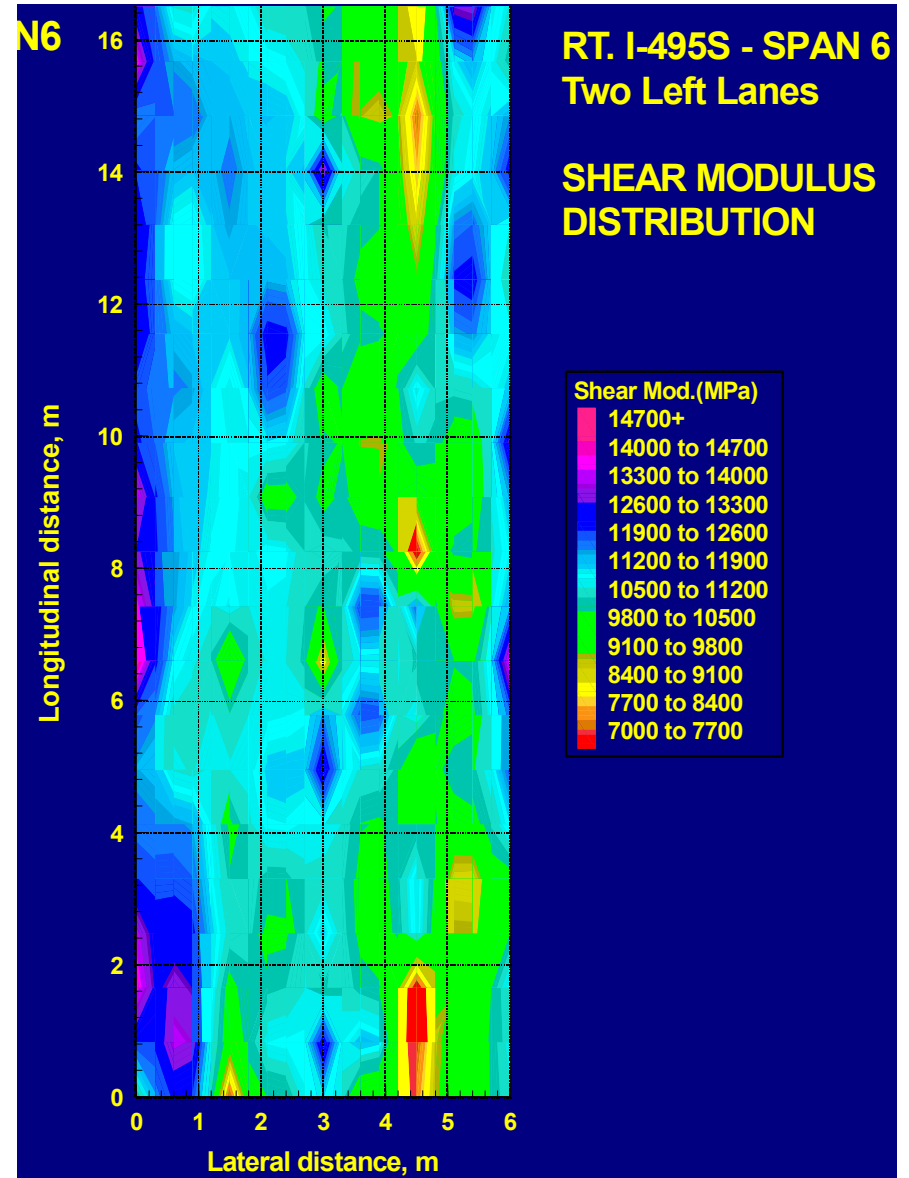
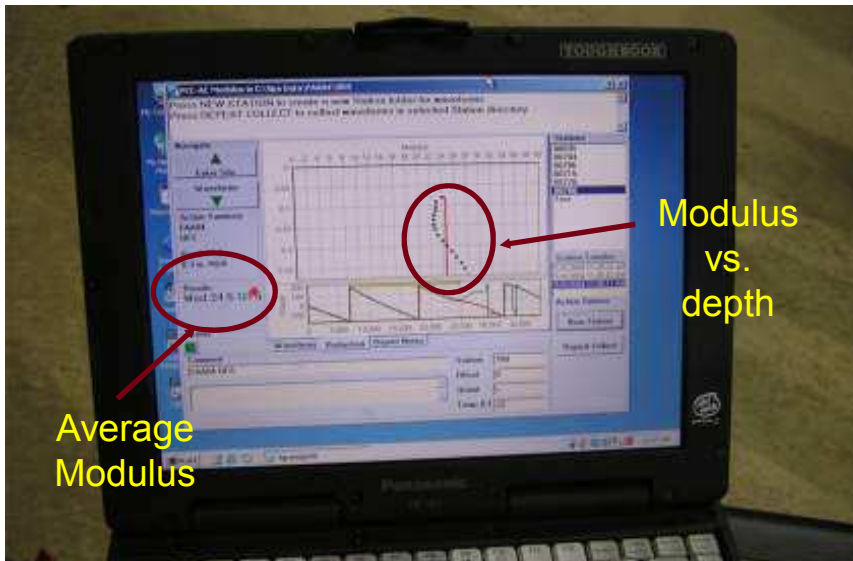
There is complete loss of bonding and separation of concrete layers.

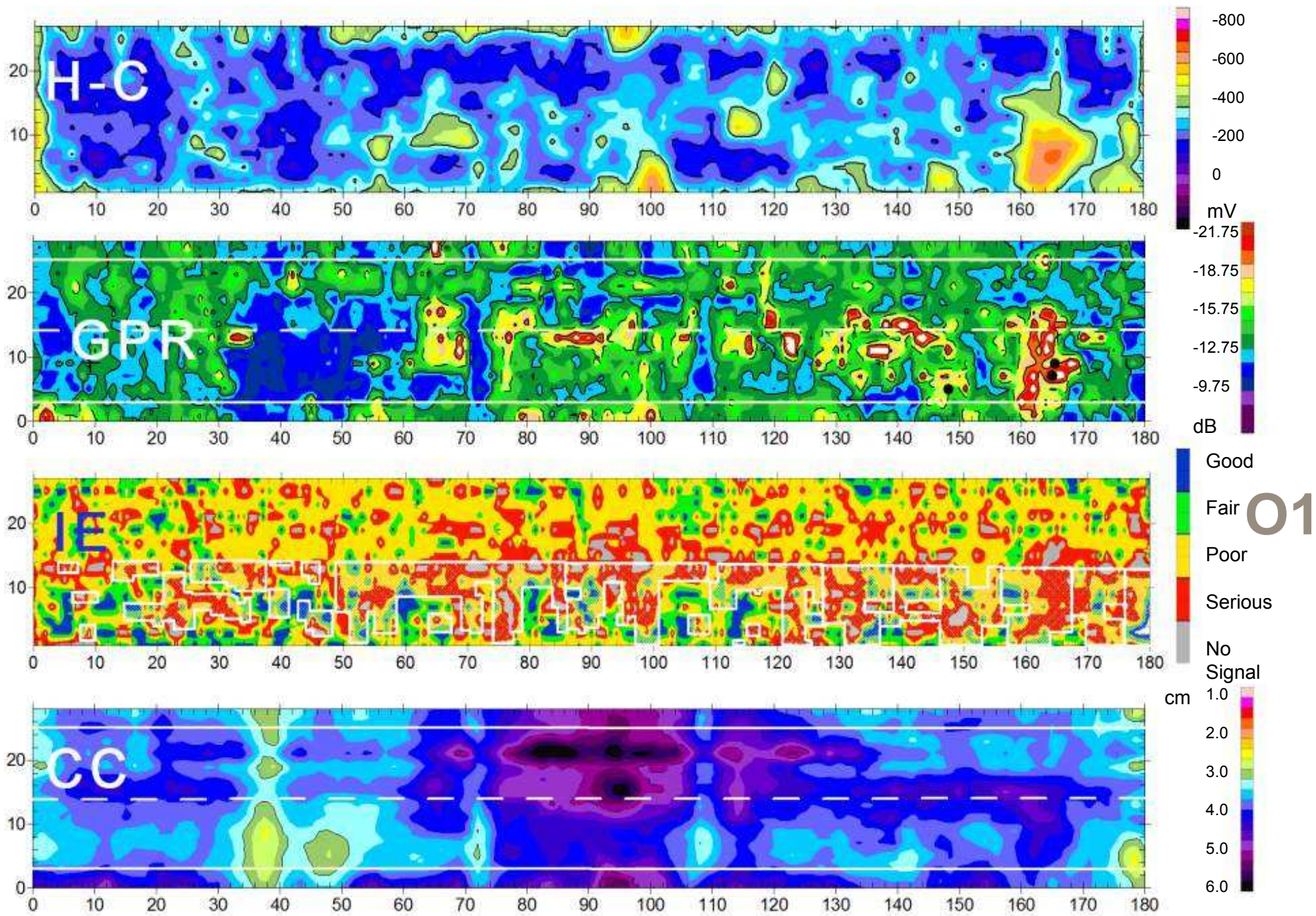
Impact Echo Delamination Assessment

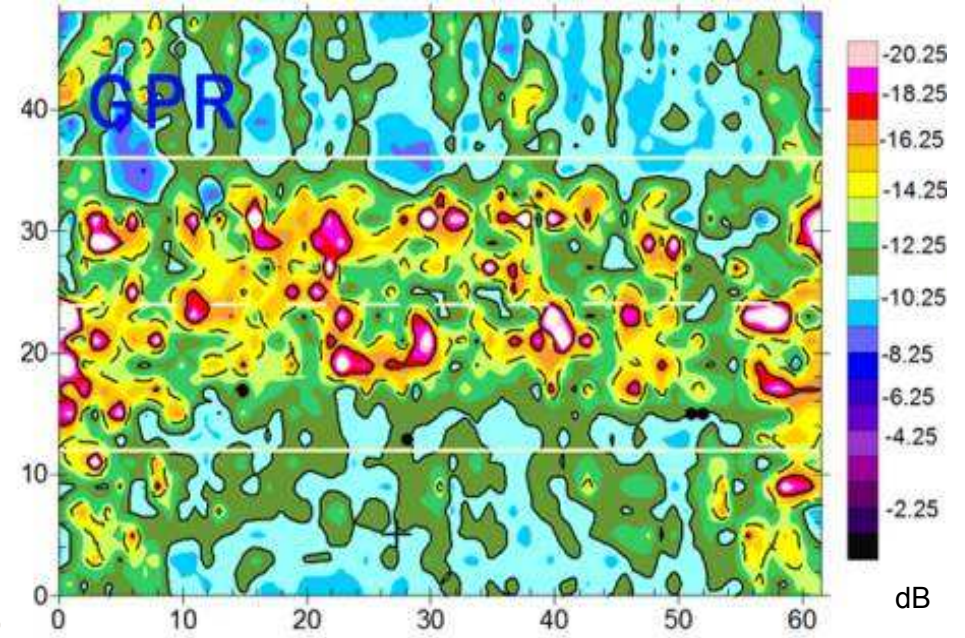
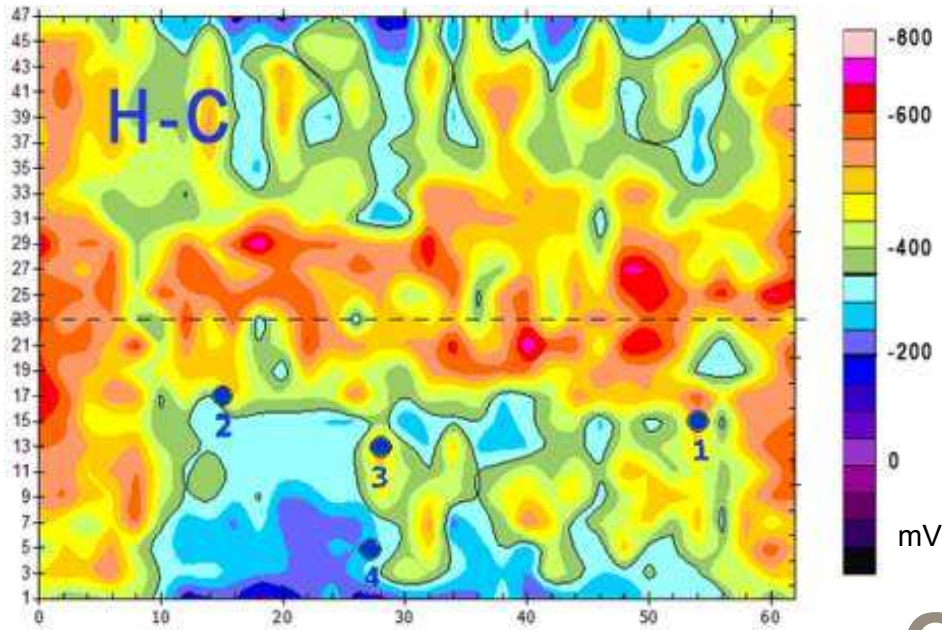
Note:
White lines
represent
boundaries
determined
by chain
drag



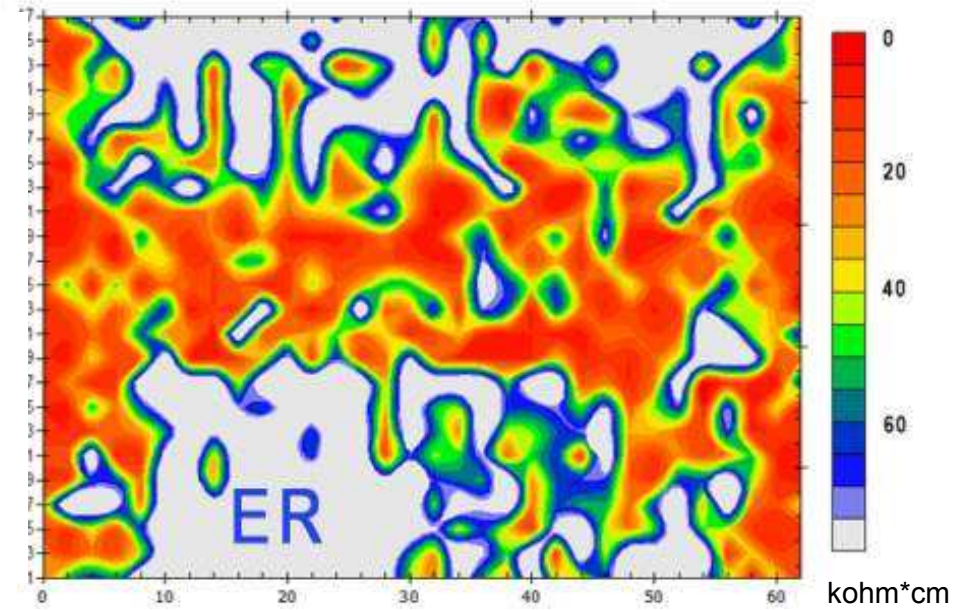
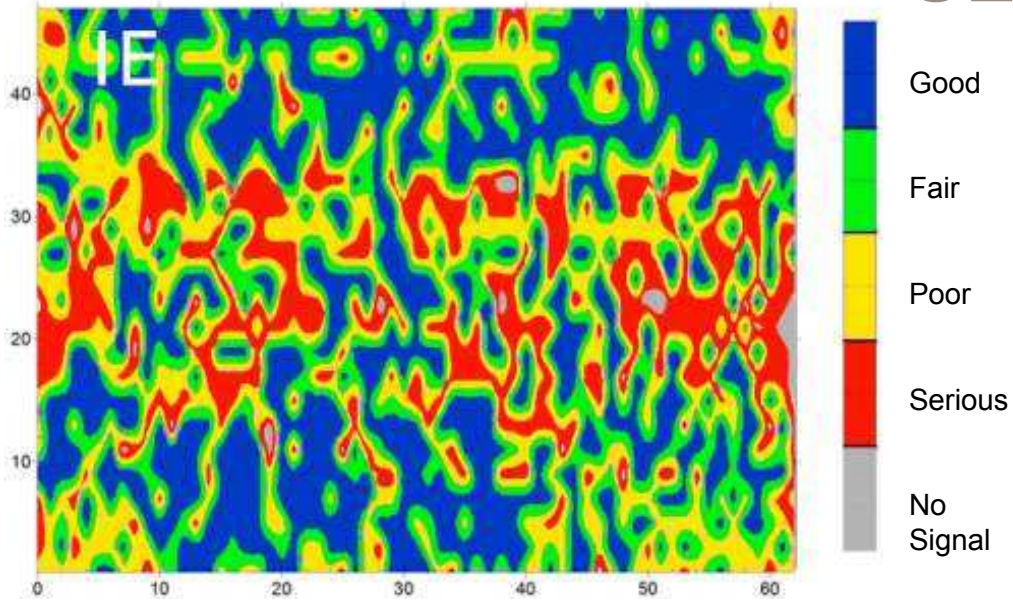
Modulus Evaluation by USW

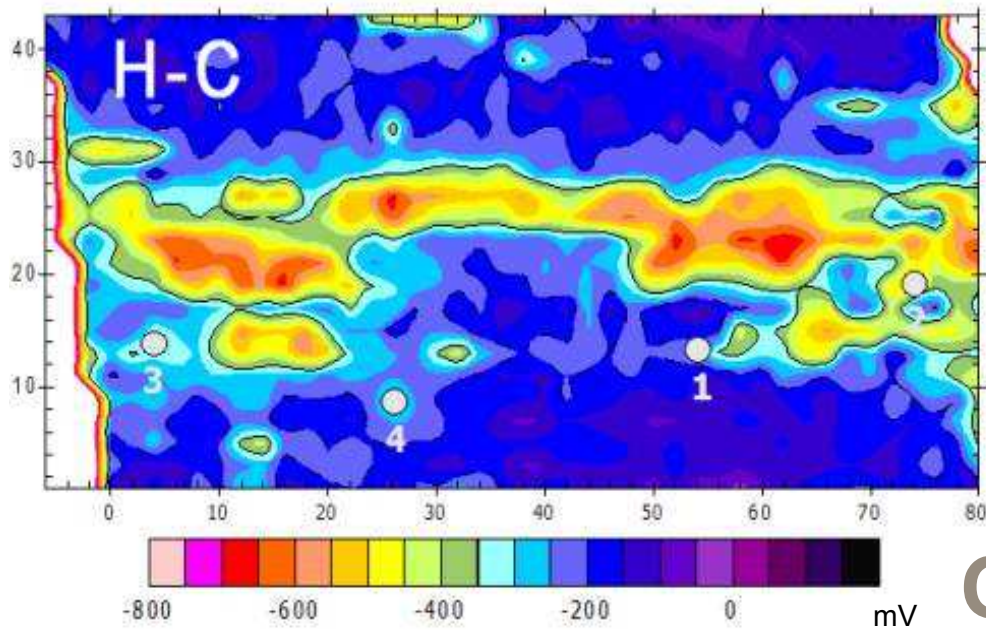




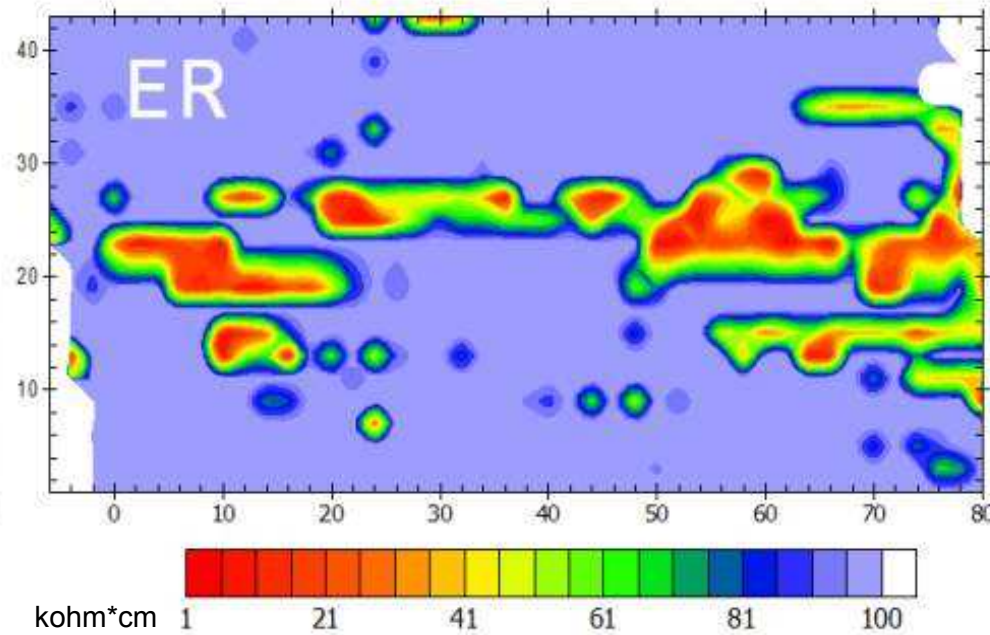
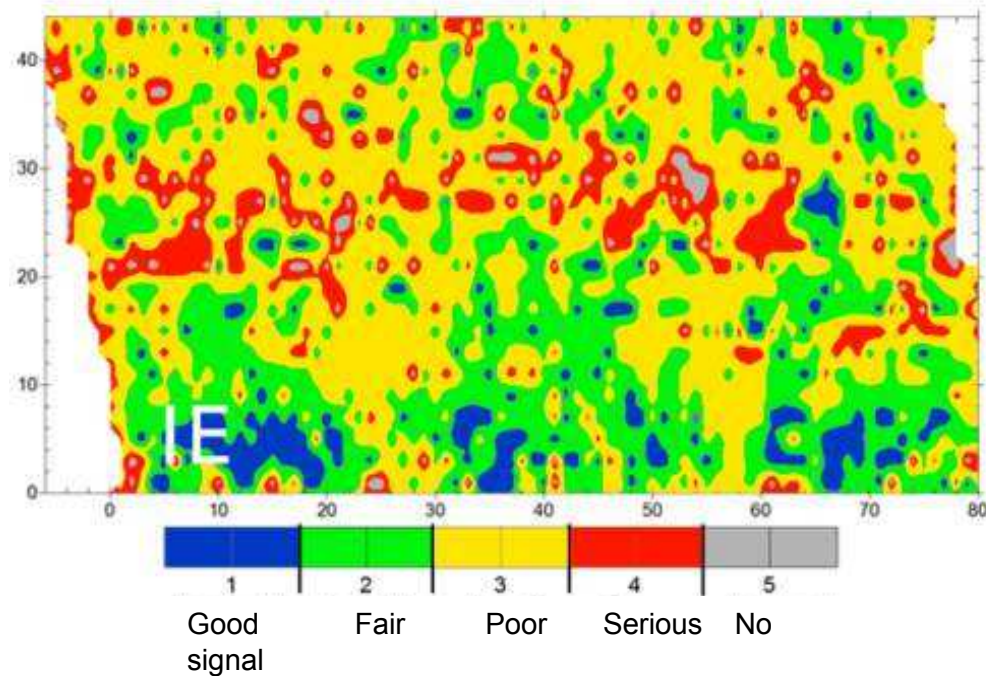
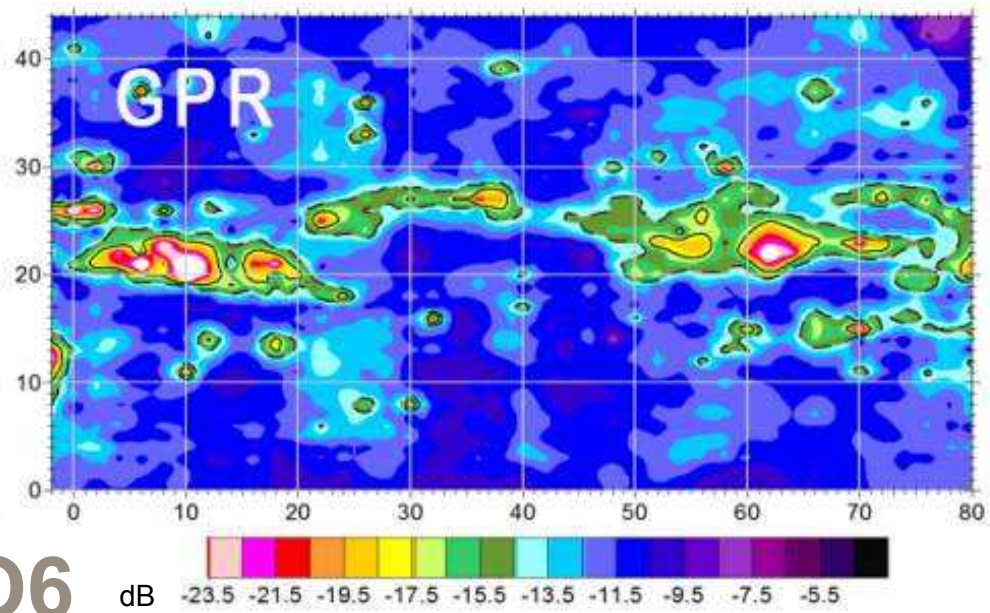


O2





O6





Conclusions

- Condition assessment of bridge decks using NDE technologies has shown their ability to detect and characterize different types and levels of deterioration.
- **Half-cell potential** and **electrical resistivity** measurements enable assessment of likelihood and severity of corrosion.
- **GPR** provides information about deterioration/alteration of concrete.
- **Impact echo** and ultrasonic measurements enable detection and characterization of delamination in the deck. Delamination detection was validated through the comparison with cores taken and selected locations.
- **Complementary approach** in NDE bridge deck evaluation provides a more comprehensive condition assessment.



Thank you!
Questions?