

DURABILITY OF FRP COMPOSITE RETROFITS AFTER SERVICE IN A SUBARCTIC ENVIRONMENT

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Motivation and objective

- Motivation:** A lack of data on FRP's long-term performance from field studies.
- The objective:** Evaluate the effects of natural exposure on FRP retrofits after being in service for 10-15 years in Alaska's climate conditions.



Repair and strengthening of building structural elements with EBFPR

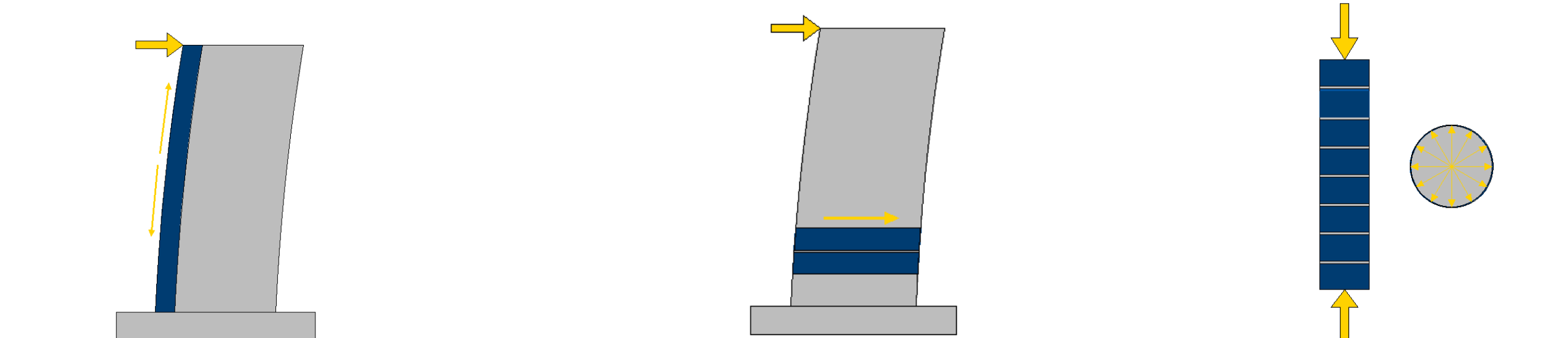
Flexural strengthening of beams

Shear strengthening of beams

Flexural strengthening of wall

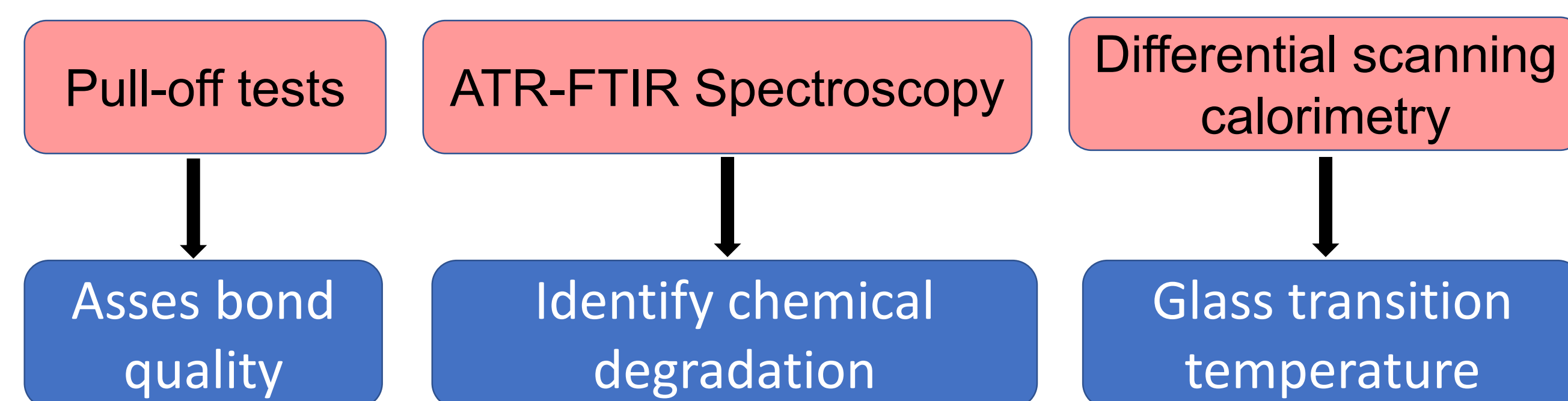
Shear strengthening of walls

Column confinement



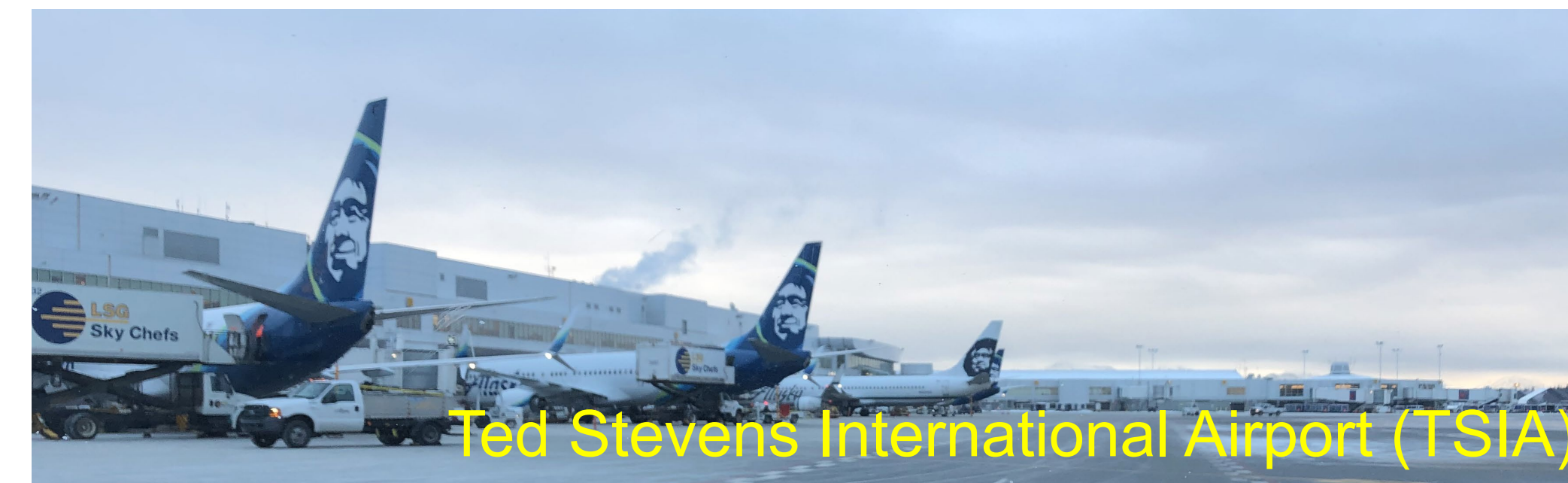
Experimental methods

Pull-off bond tests, spectroscopy and calorimetry were conducted on FRP samples collected from the McKinley Tower (MKT, retrofitted with GFRP) and Ted Stevens International Airport (TSIA, retrofitted with CFRP).



Inspected buildings

- The University of Delaware, in collaboration with a NIST team, conducted inspections of MKT and TSIA in 2019.



At MKT, carbon and glass FRP were applied to columns, walls, and beams. The majority of the EBFPR retrofits were applied on floors 5 through 14. At TSIA, CFRP was used to confine the columns.



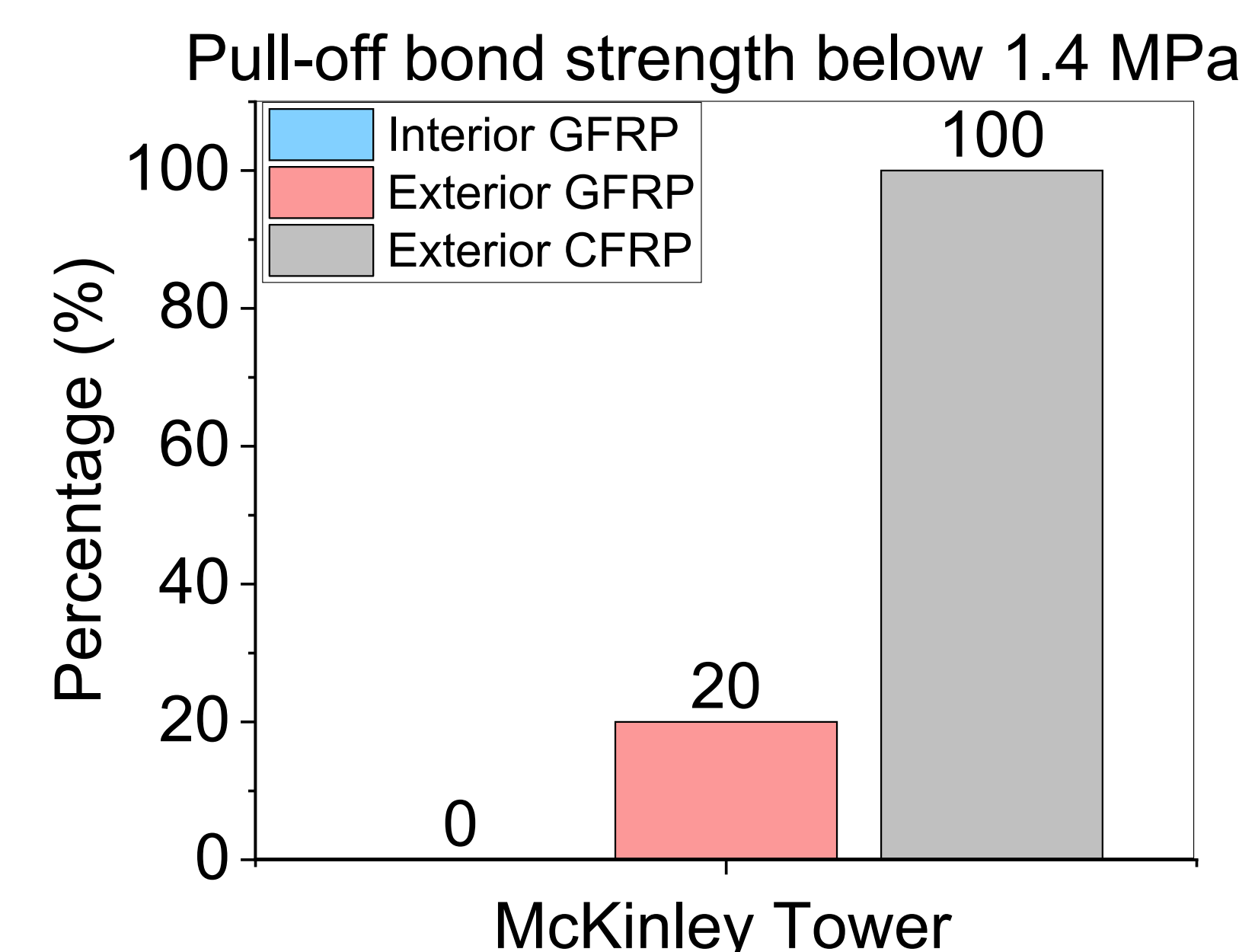
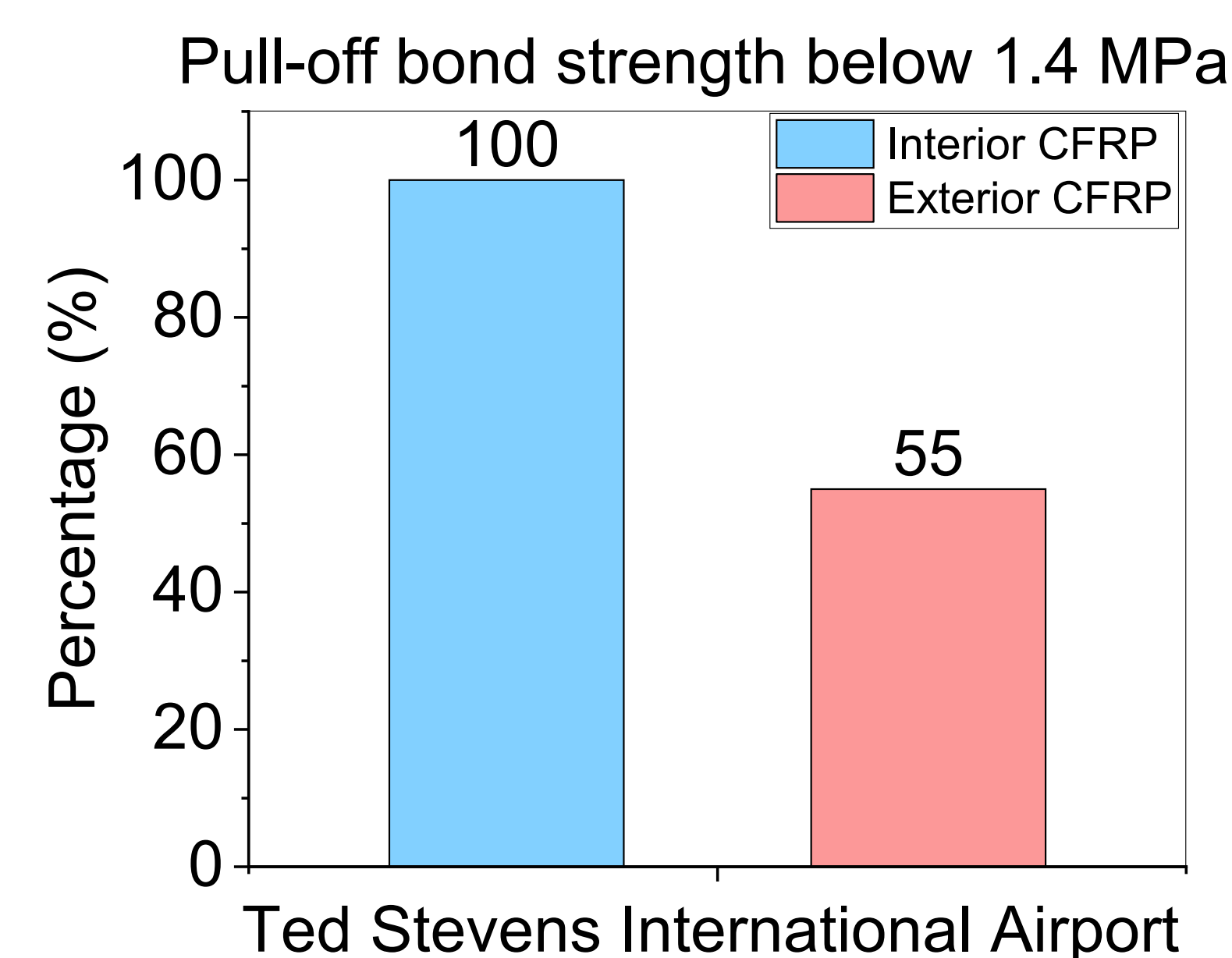
Pull-off bond tests



American Concrete Institute guidelines (ACI 440.2R) require min bond strength of 1.4 MPa

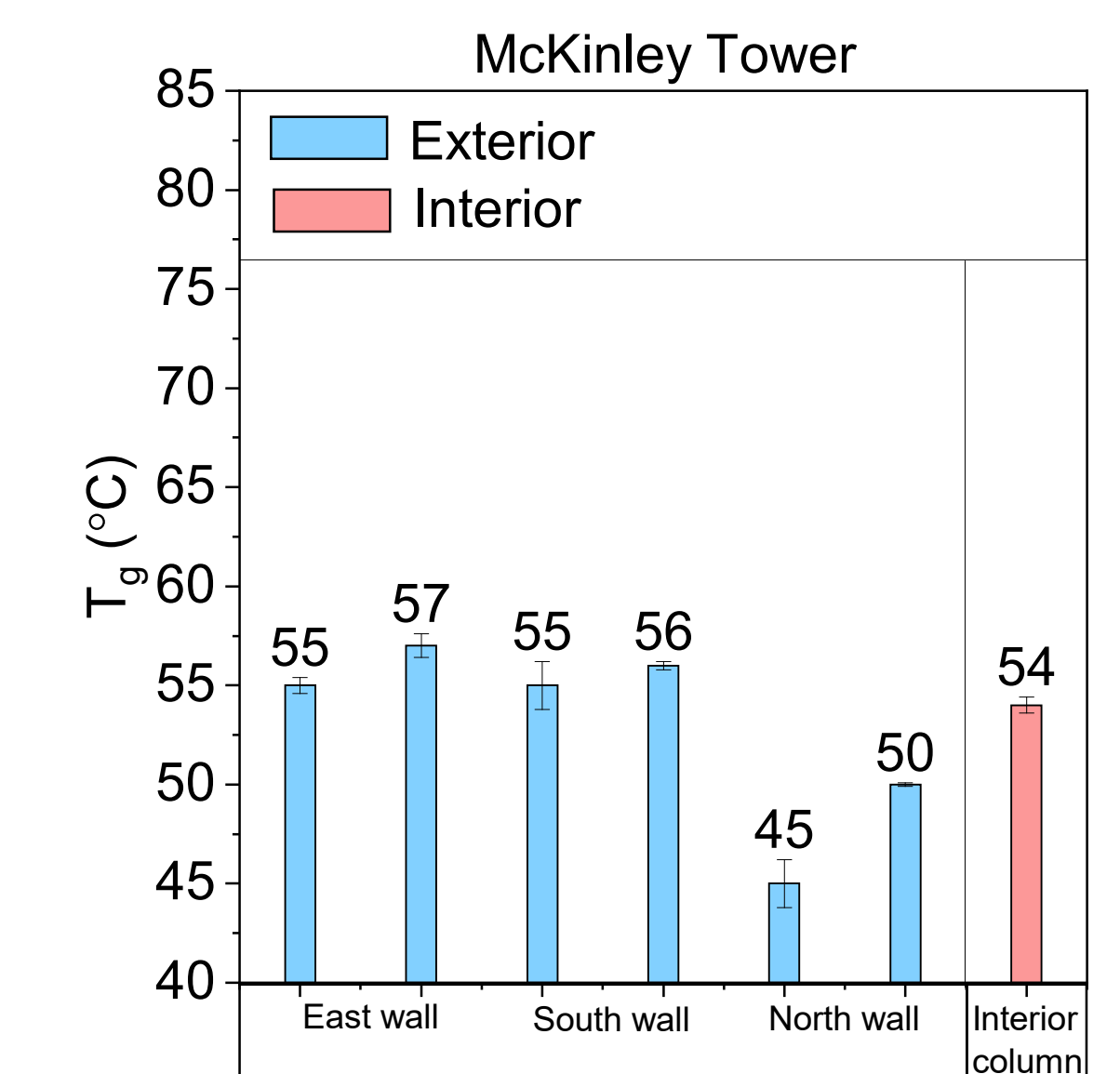
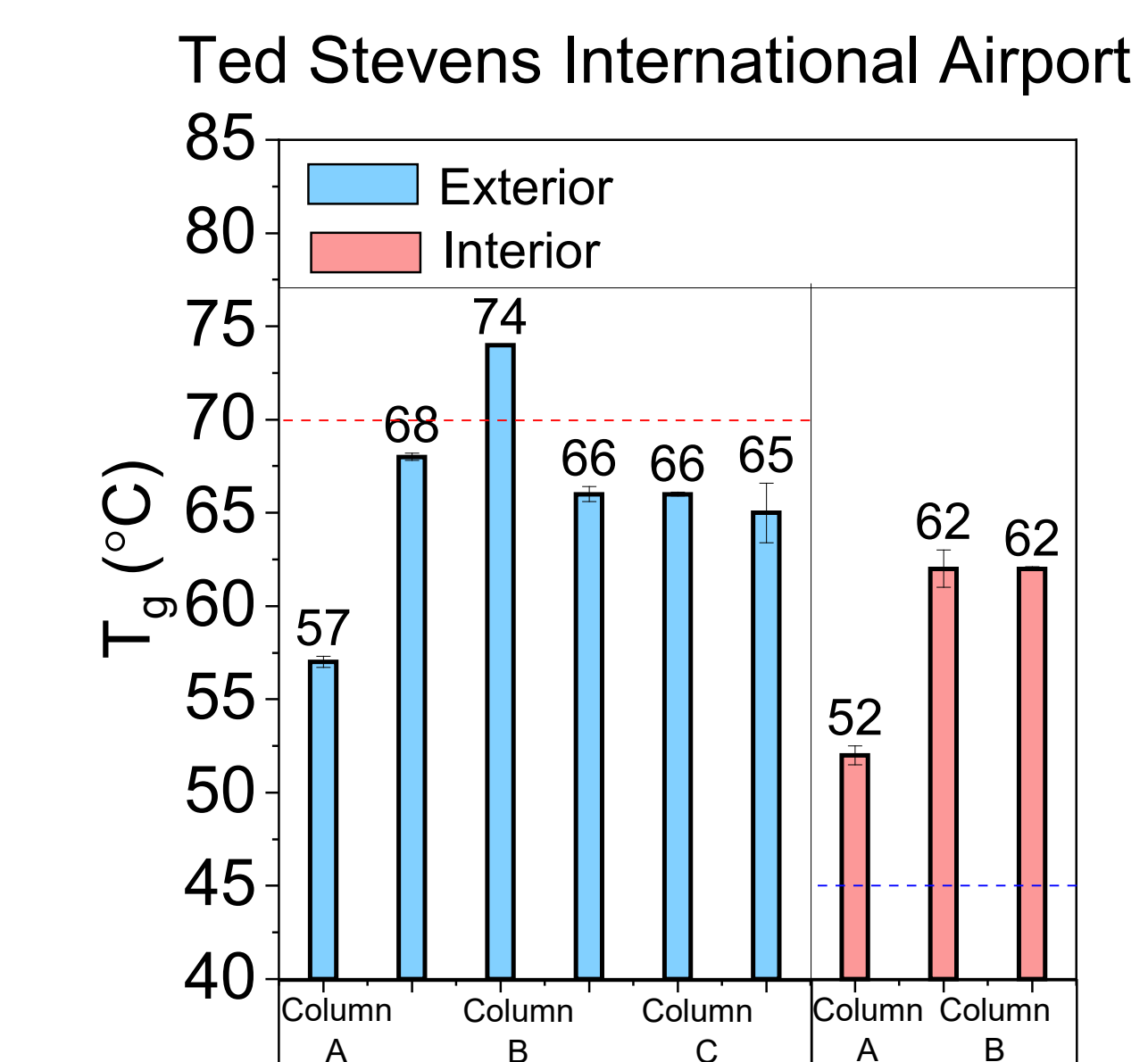


The main failure mode was a cohesive failure (in the concrete) indicating good adhesion. However, adhesive failure was observed for the exterior column at TSIA which suggests that some degradation of the CFRP may have occurred in the subarctic climate of Anchorage.



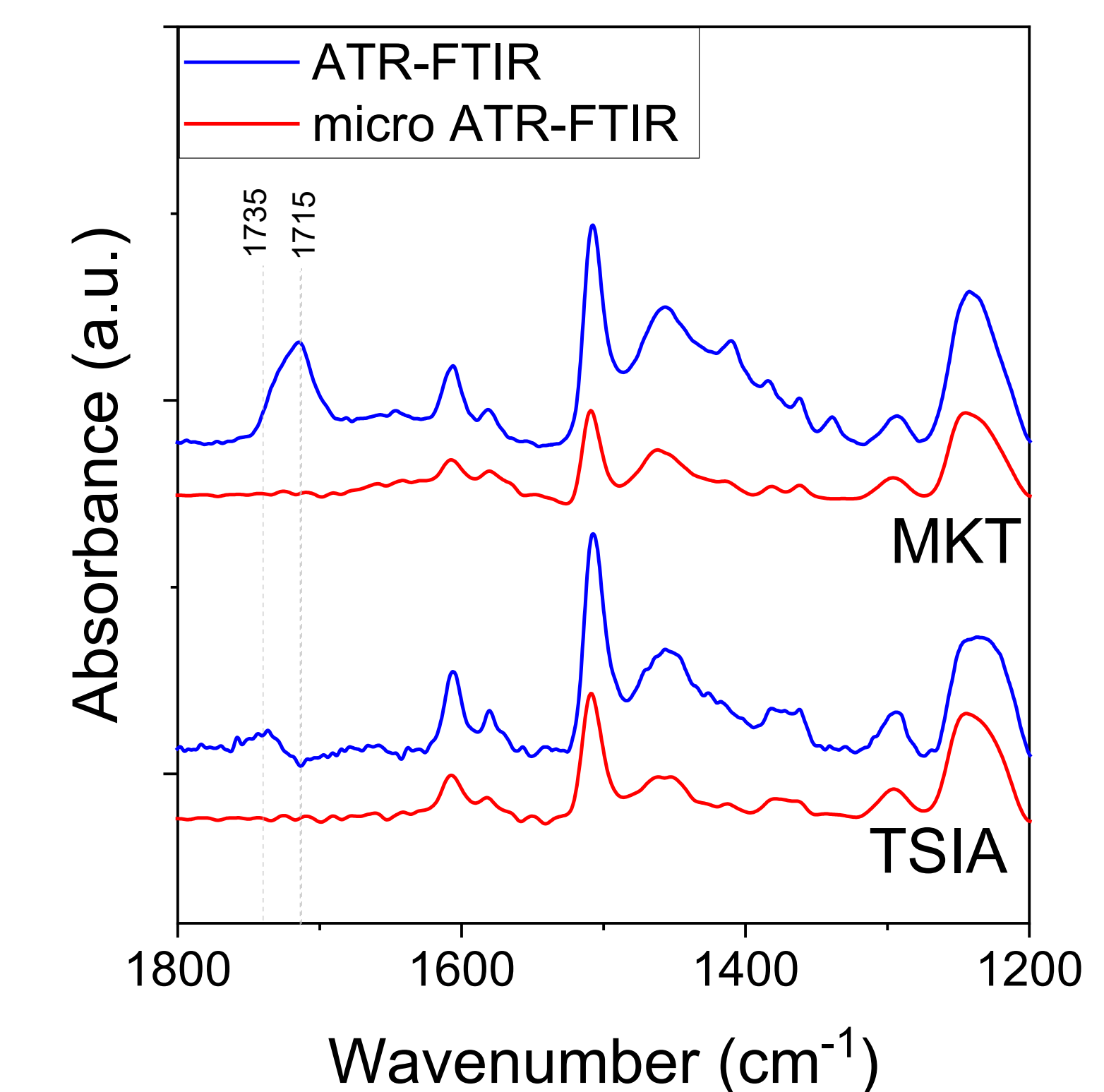
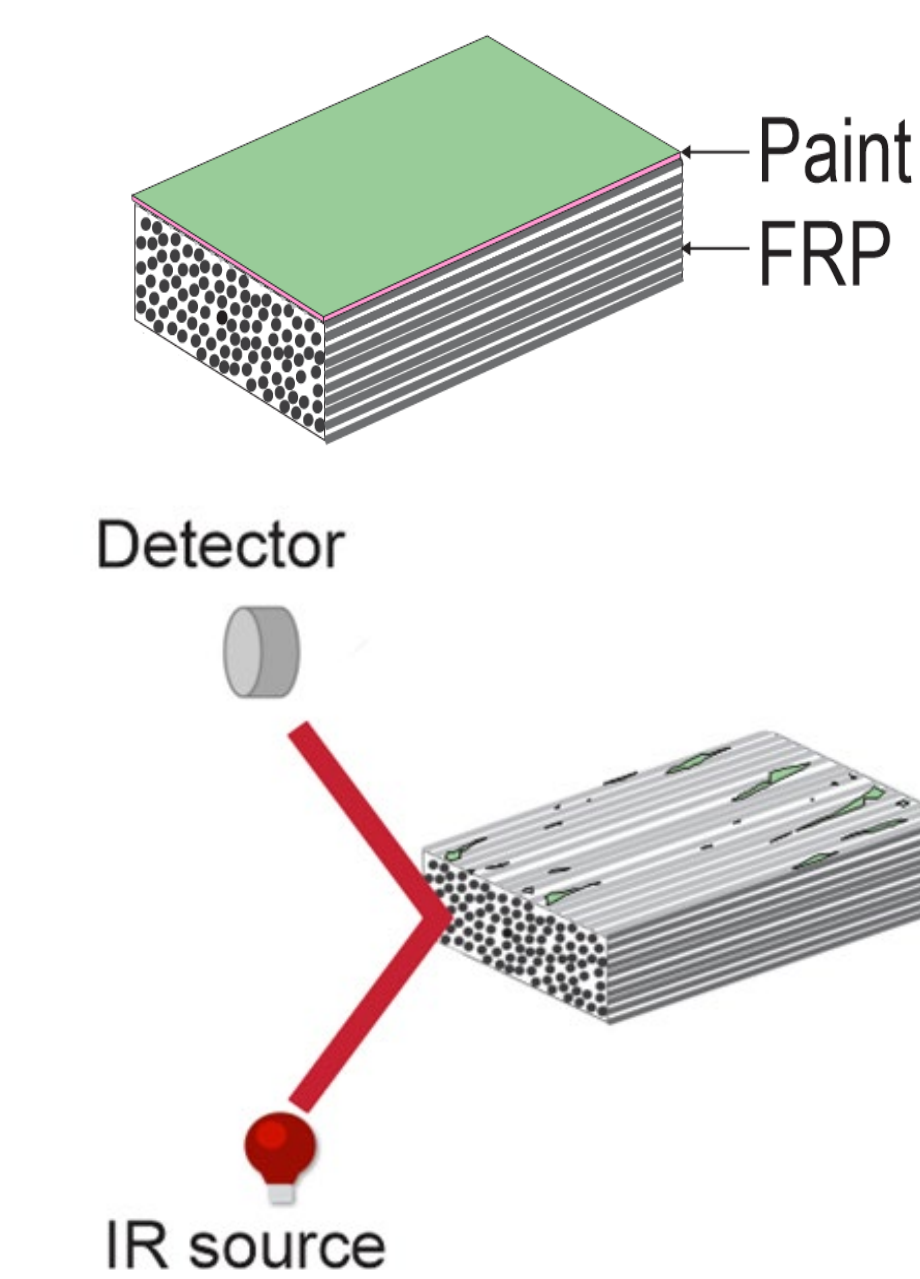
Differential Scanning Calorimetry

- At TSIA, most exterior samples had significantly higher T_g values than the maximum T_g values measured on the interior samples.
- At MKT, exterior T_g was below ACI 440.2R recommendation



FTIR Spectroscopy

- ATR-FTIR: Presence of 1720 cm^{-1} related to chemical degradation present at MKT.
- Micro-FTIR on the cross-section: if any degradation occurred it was limited to the surface layer of less than 100 microns.



Conclusions

- CFRP-concrete bond is more vulnerable to deterioration under subarctic climate than GFRP-concrete bond
- T_g values of exterior retrofits were below minimum values recommended in ACI 440.2 at both buildings
- No evidence of chemical degradation at TSIA and MKT

Acknowledgments

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