

ACOUSTIC EMISSION MONITORING OF TEXTILE REINFORCED CEMENT PLATES

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INTRODUCTION

Textile Reinforced Cement is a sustainable and lightweight alternative of concrete

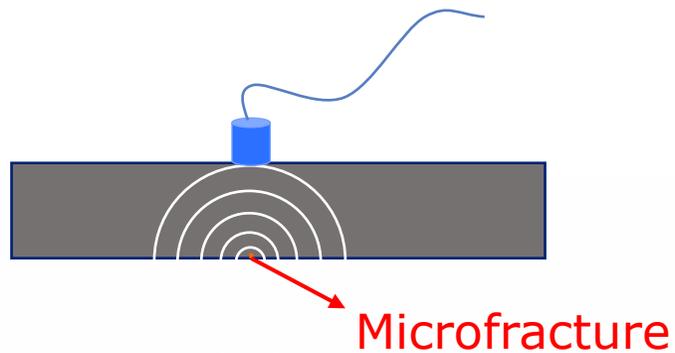


While it exhibits certain advantages, its mechanical and fracture behavior needs to be studied. Along with the possibility to monitor its structural condition.

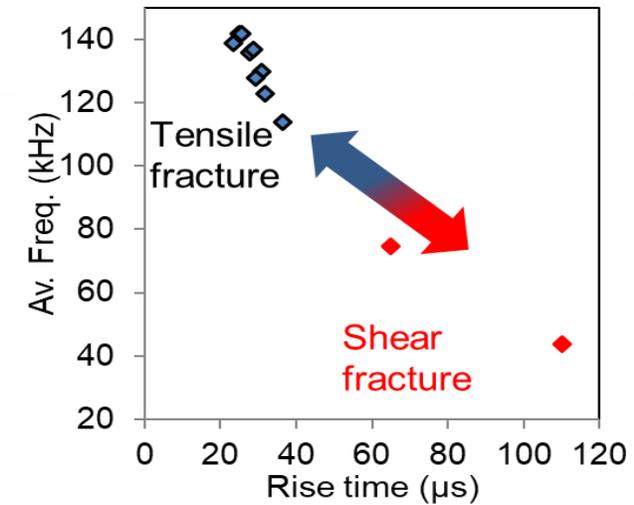
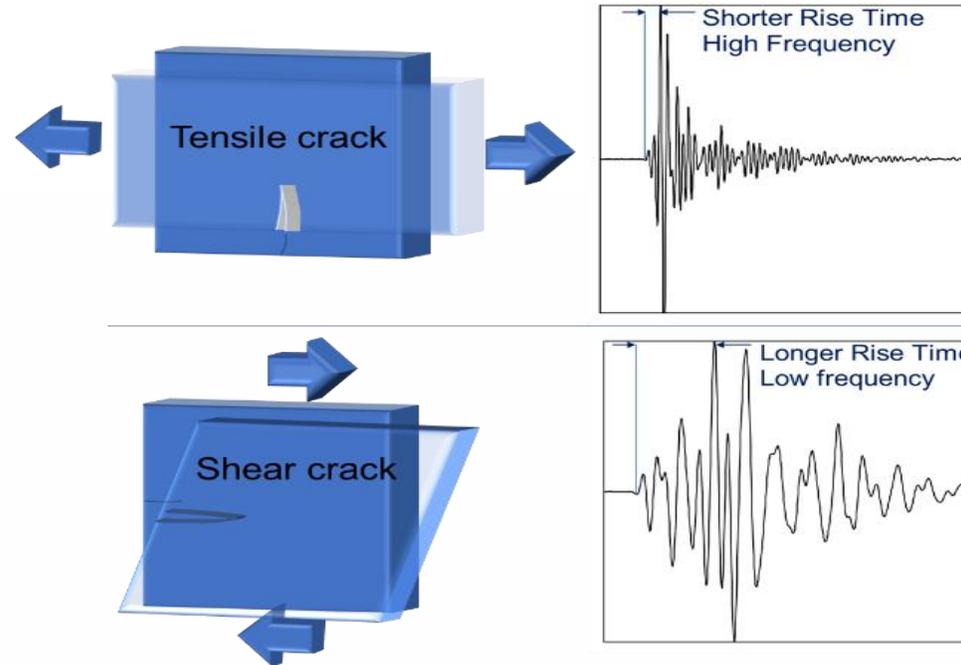
Developments in the Built Environment,
<https://doi.org/10.1016/j.dibe.2020.100013>



ACOUSTIC EMISSION



- Average Frequency (AF)
- Duration
- Rise Time (RT)
- Amplitude
- RA value



ACOUSTIC EMISSION

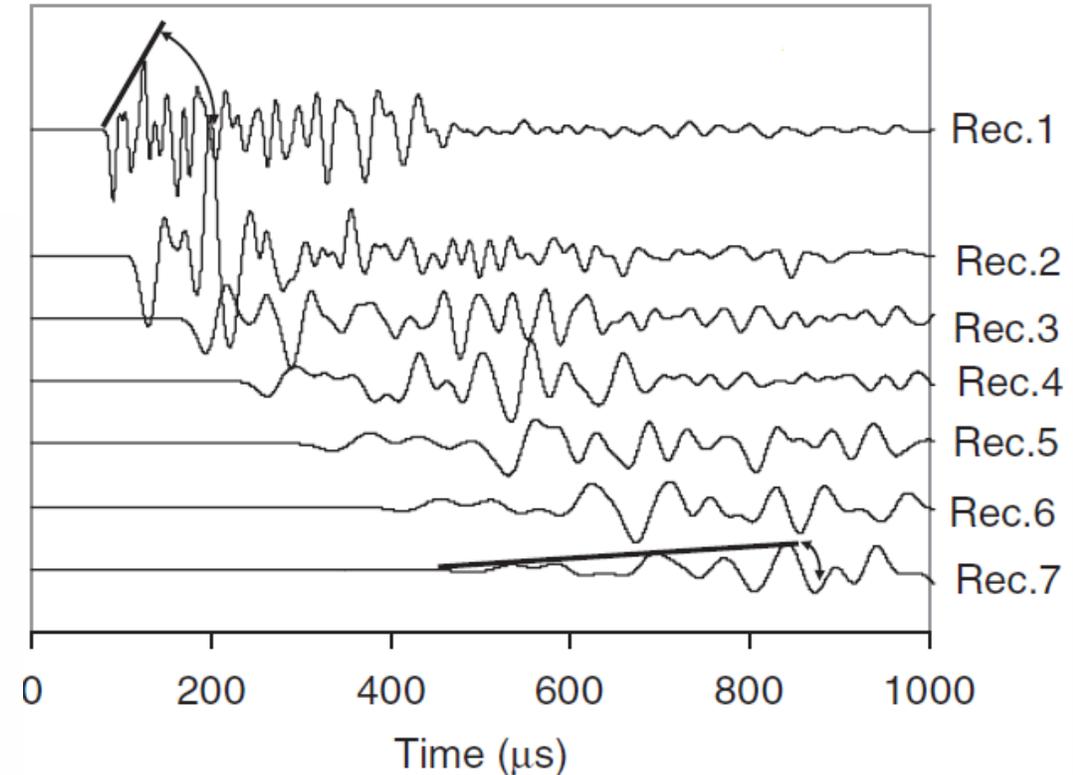
PROBLEM STATEMENT

Frequency content and waveform shape are severely distorted due to:

- Scattering
- Damping
- Reflections
- Wave dispersion
- Geometry (curvature, width, dimensions of the member)

Consequence: sensors at different distances will receive different waveforms

The present study aims to examine AE in curved plates with different widths.



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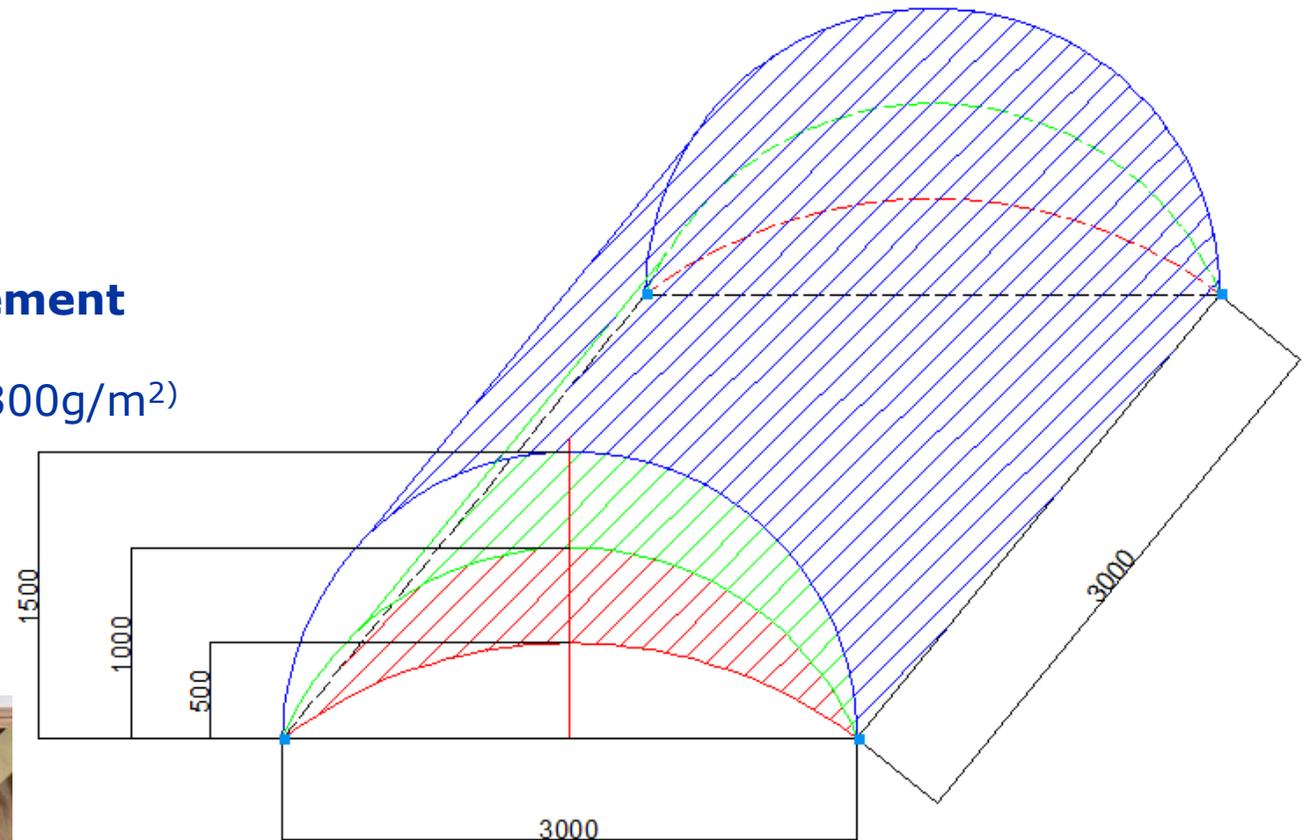
EXPERIMENTAL DETAILS

MATERIALS

Textile Reinforced Inorganic Phosphate Cement

Reinforcement: E-glass chopped fiber mats (300g/m²)

Fiber volume fraction: 20%



EXPERIMENTAL DETAILS

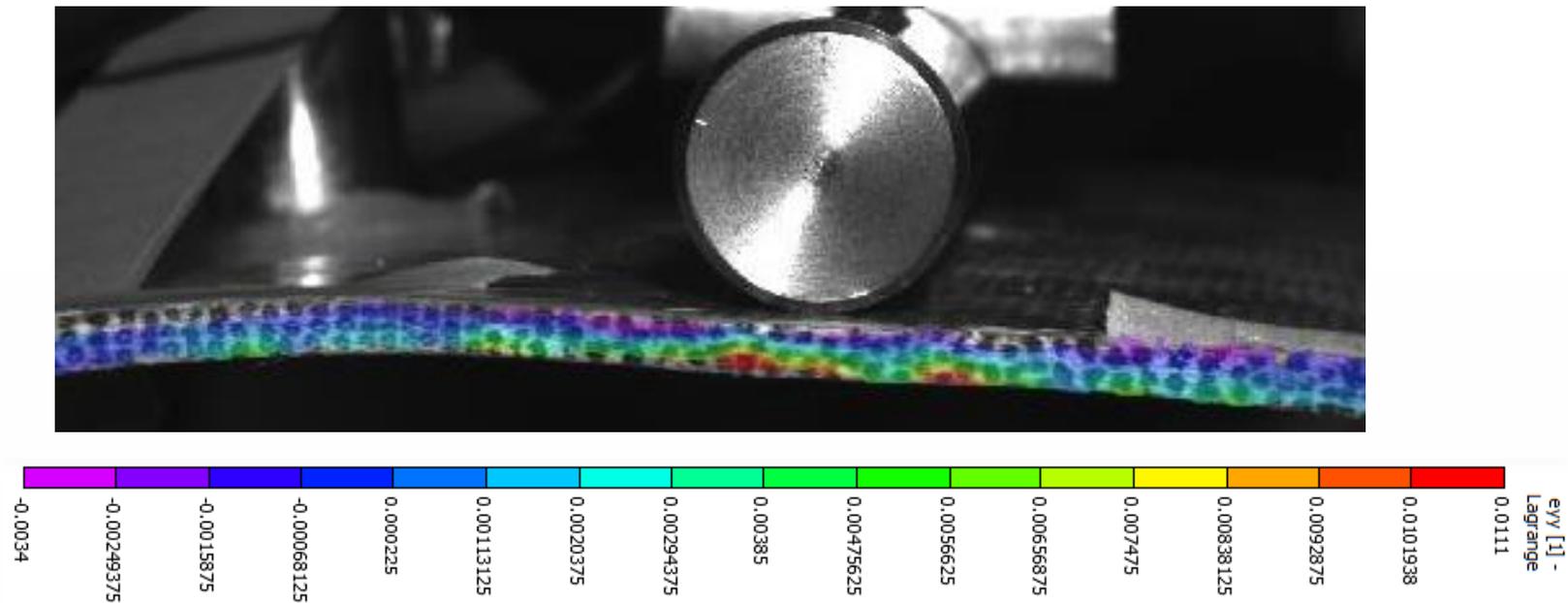
MECHANICAL EXPERIMENTS WITH AE

- 3P bending
- R15 AE sensors
- Micro-II Digital AE System
- Pencil lead break excitation
- Propagation speed: 2730 m/s



RESULTS

DIGITAL IMAGE CORRELATION

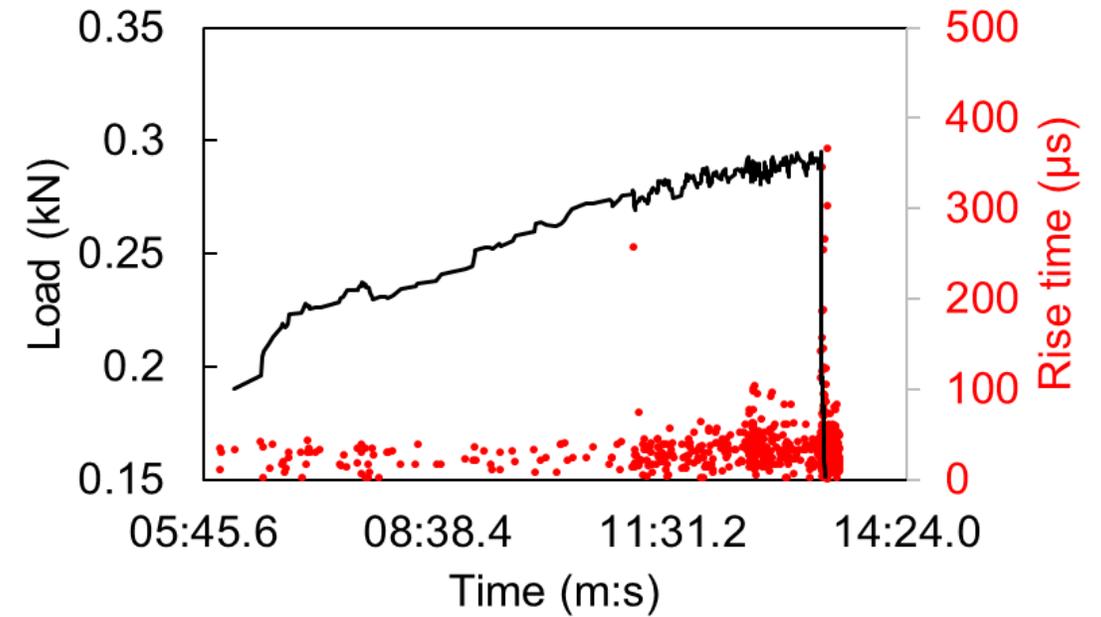
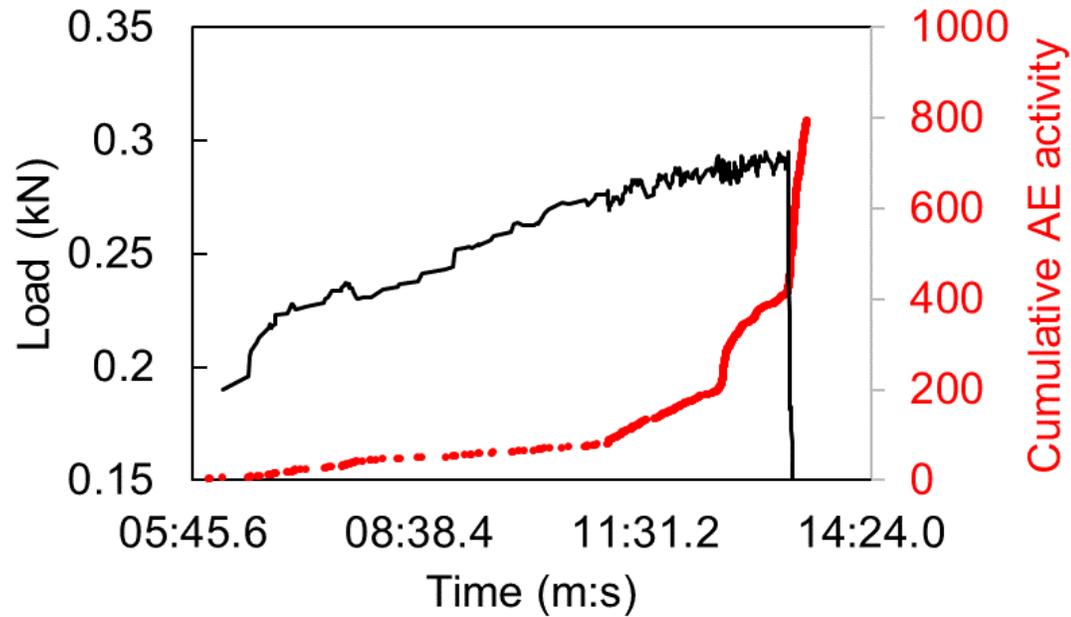


The strain field was calculated by DIC. This helps in the interpretation of AE signals



RESULTS

LOAD AND ACOUSTIC EMISSION – 5 CM BEAM



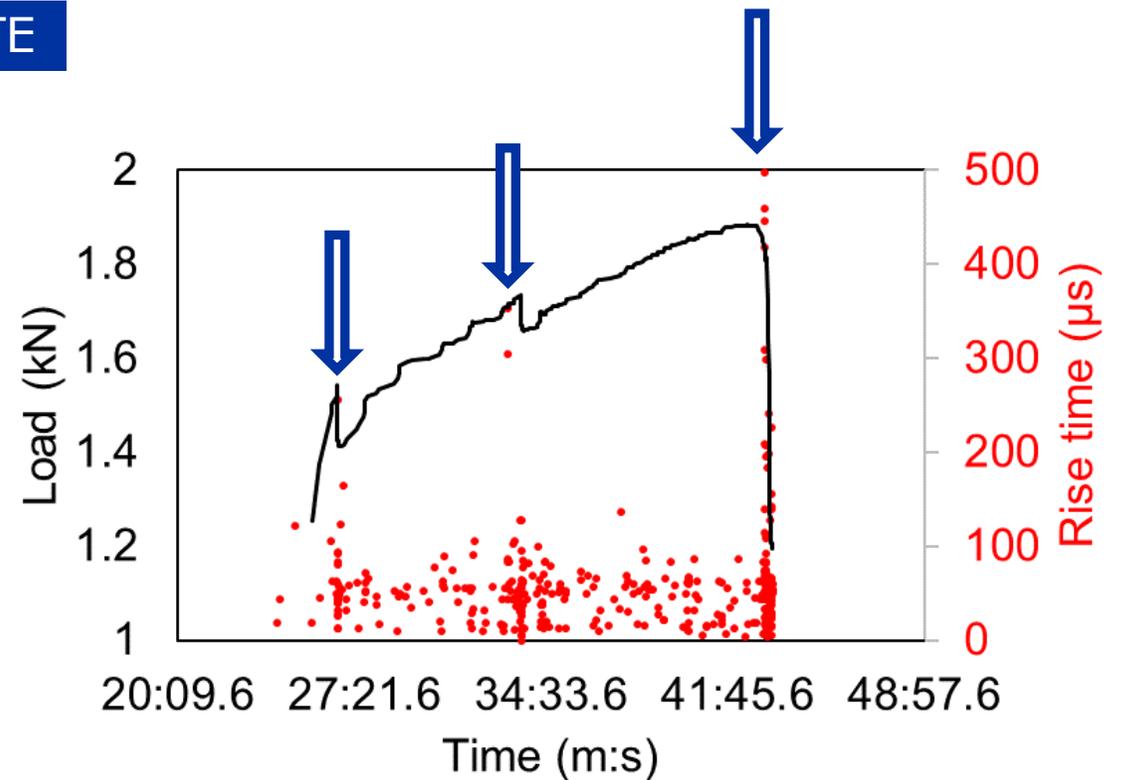
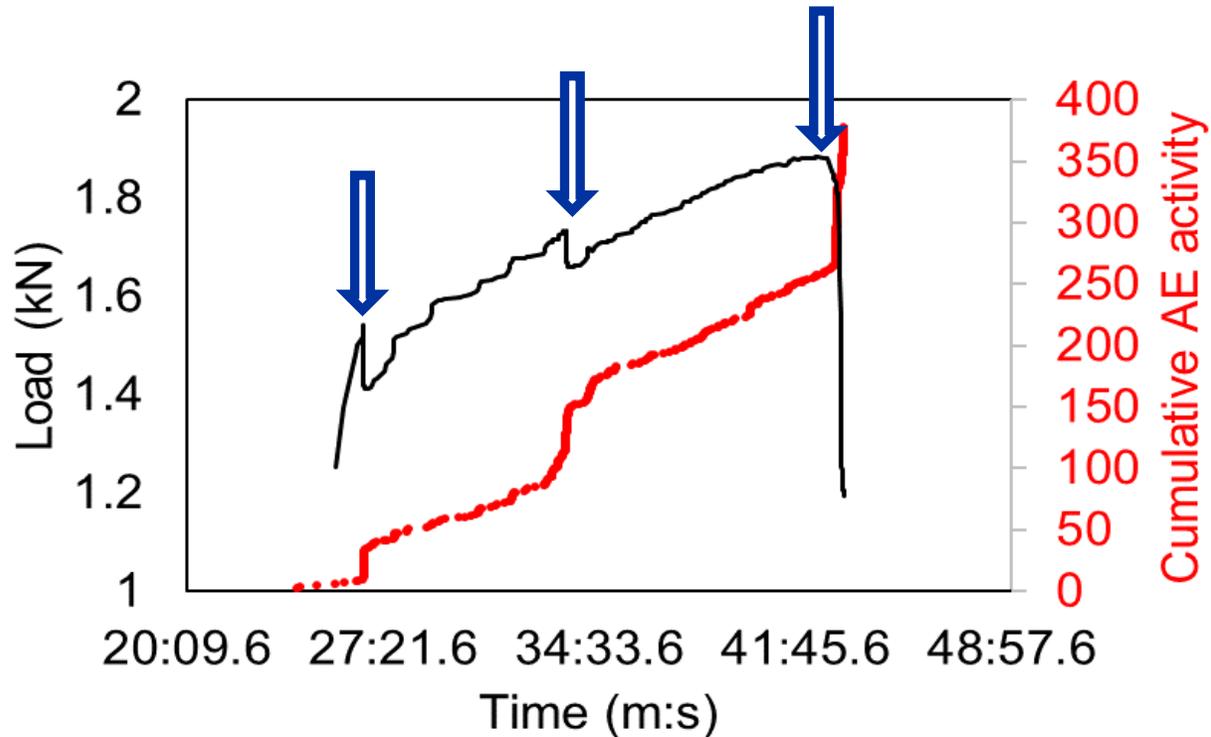
AE increases as the load reaches its maximum.

AE RT increases gradually signifying the shift from matrix cracking to delaminations, while at the macroscopic failure the values are the highest.



RESULTS

LOAD AND ACOUSTIC EMISSION – 30 CM PLATE

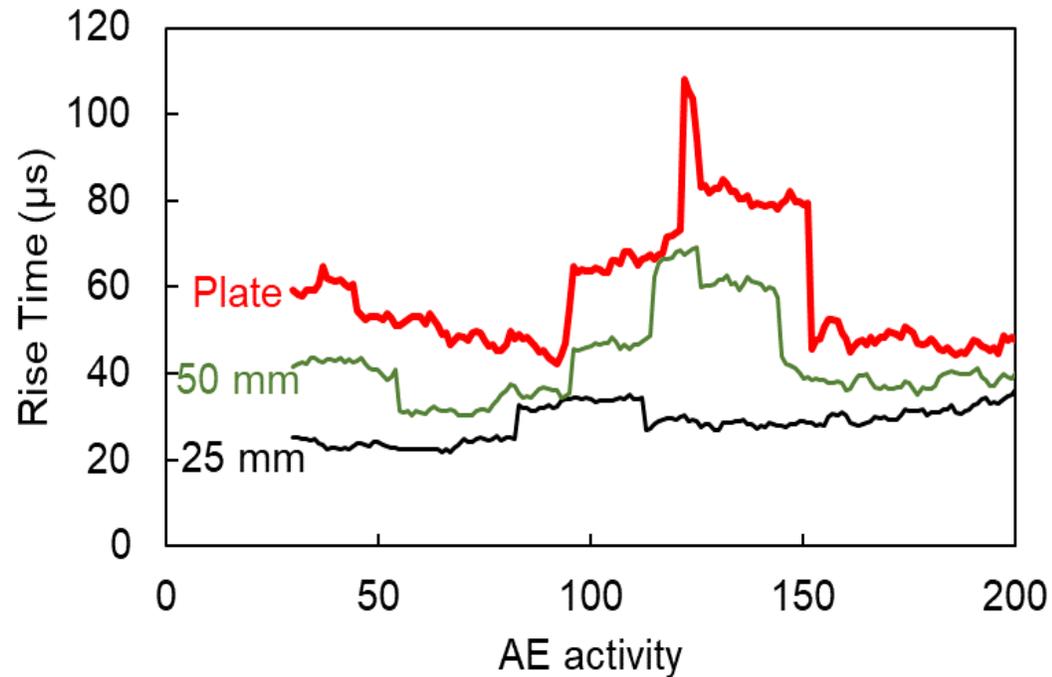


Transient load drops are escorted by AE increasing rate, while at the same time, higher RT values are exhibited.



RESULTS

AE PARAMETERS (RISE TIME) VS. SPECIMEN WIDTH



While the general trends are similar for all different specimens, there are consistent differences relatively to the vertical dimension of the specimens.

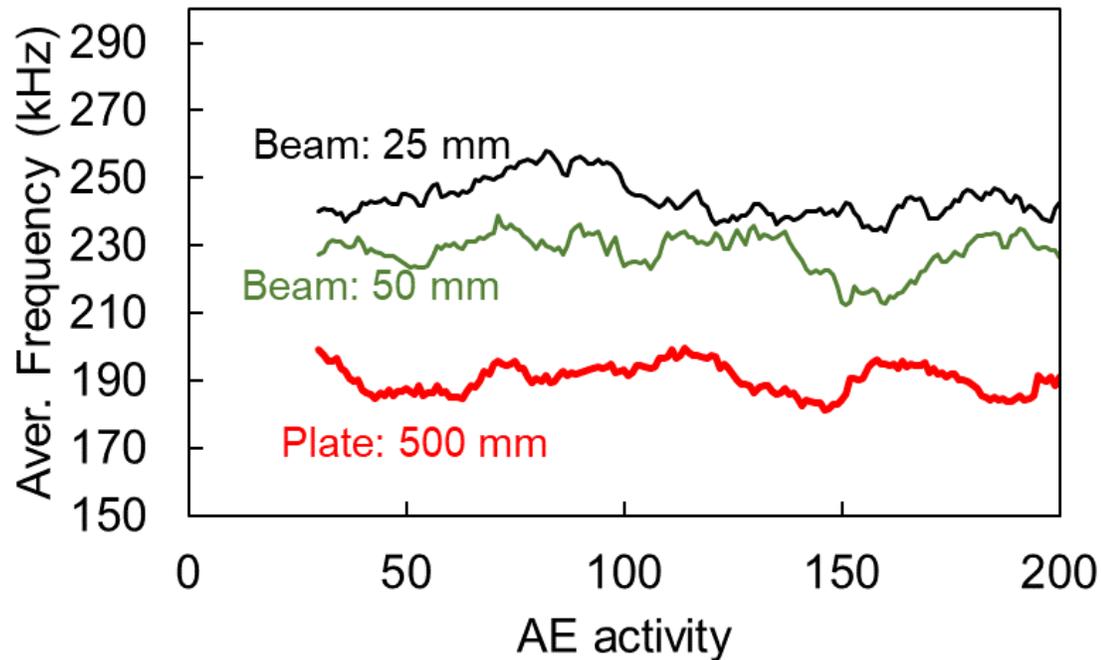
Thin beams show the lowest rise time, while the wider plate exhibits the longest.

This shows the strong effect of dimensions on the AE signature, even though the dominant damage mechanism remains the same.



RESULTS

AE PARAMETERS (AVERAGE FREQUENCY) VS. SPECIMEN WIDTH



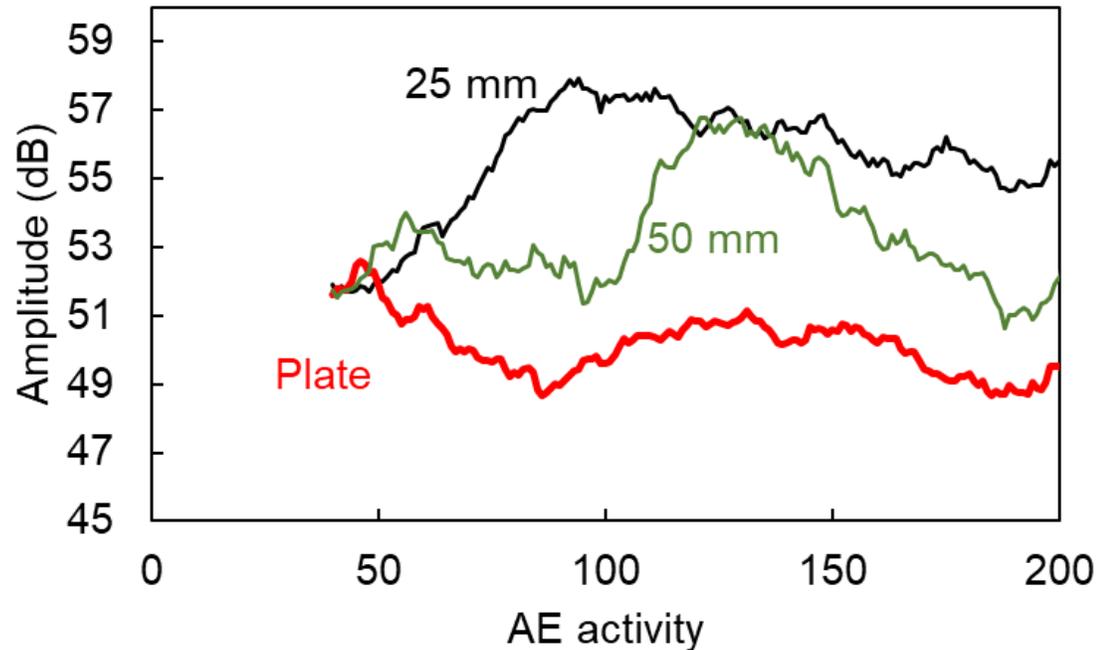
Thin beams show the highest AF, while the wider plate exhibits the longest.

This shows the strong effect of dimensions on the AE signature, even though the dominant damage mechanism remains the same.



RESULTS

AE PARAMETERS (AVERAGE FREQUENCY) VS. SPECIMEN WIDTH



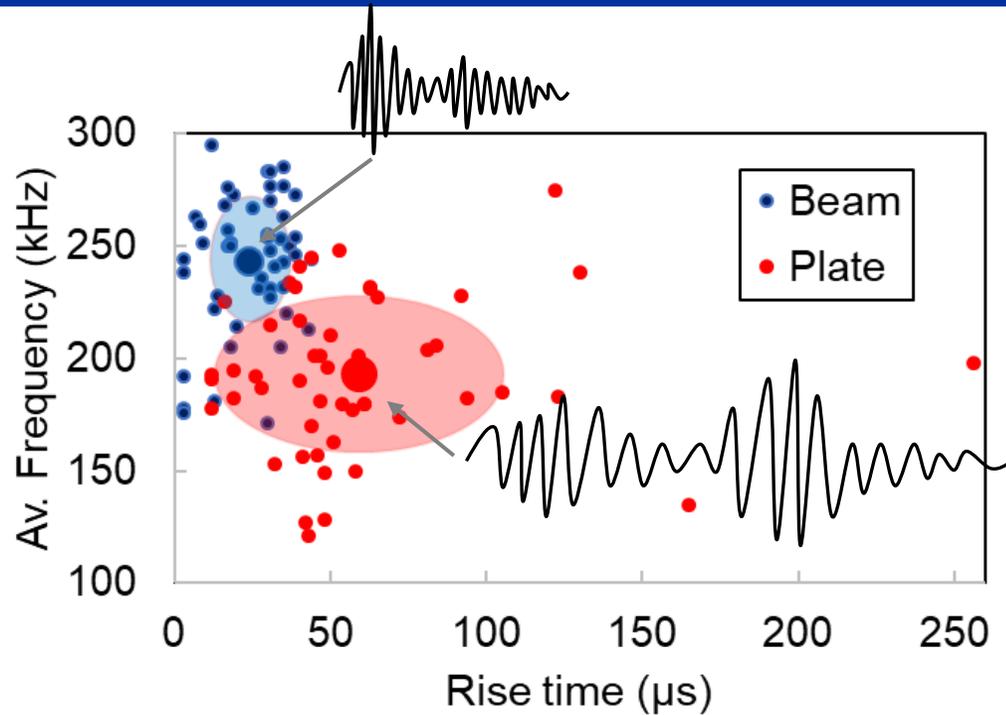
Thin beams show higher Amplitude, while the wider plate exhibits the lowest.

The reason can be sought in the 2D spreading of the wave energy in the case of the plate, something that is limited in the thin beams.

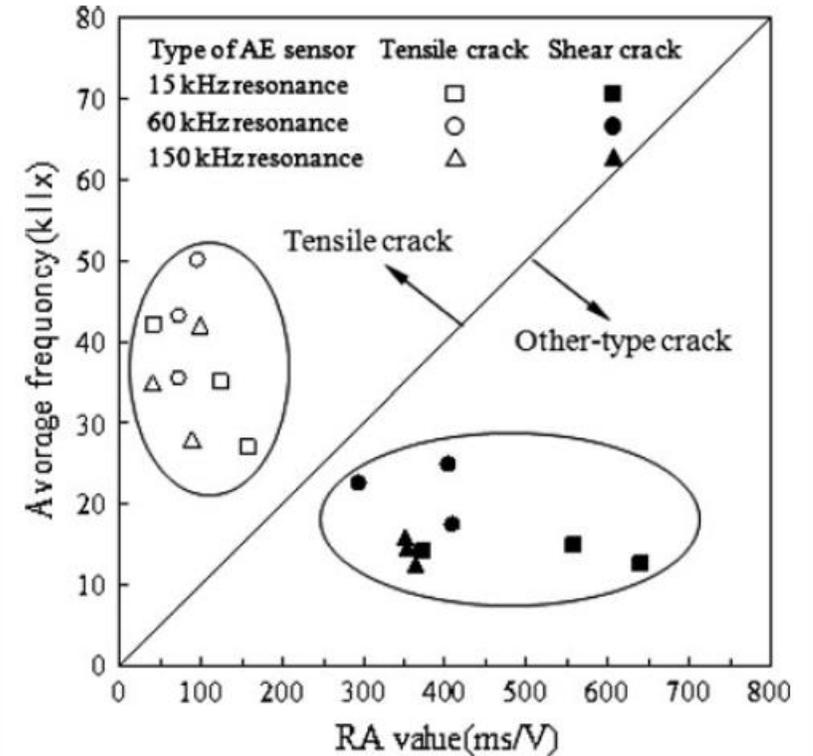


RESULTS

CRACK CLASSIFICATION BASED ON THE AE PARAMETERS



AE data coming from the same mechanism (matrix cracking) show much different values depending on the specimen size.



Materials and Structures

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CONCLUSIONS

AE can closely monitor the fracture behavior of curved TRC specimens

The geometry (width) of the components plays a very important role, as plates exhibit much lower frequency and longer duration compared to the beams for the same fracture mechanism

This can lead to erroneous conclusions when the analysis is based on small laboratory specimens.

Future work should involve a methodology to correct for the differences or at least establish a distance within which the characterization is reliable.



Thank you

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