

DIMENSION EFFECTS ON THE ACOUSTIC BEHAVIOUR OF TRC PLATES

ir. Nicolas Ospitia
Prof. Dr. ir. Dimitrios Aggelis
Dr. ir. Eleni Tsangouri

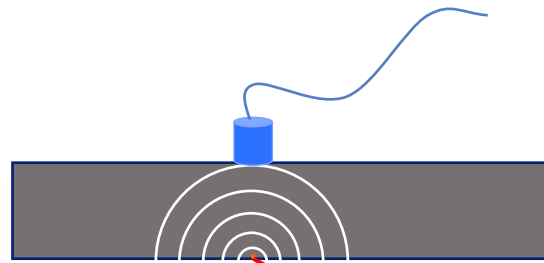


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MECHANICS OF MATERIALS
& CONSTRUCTIONS



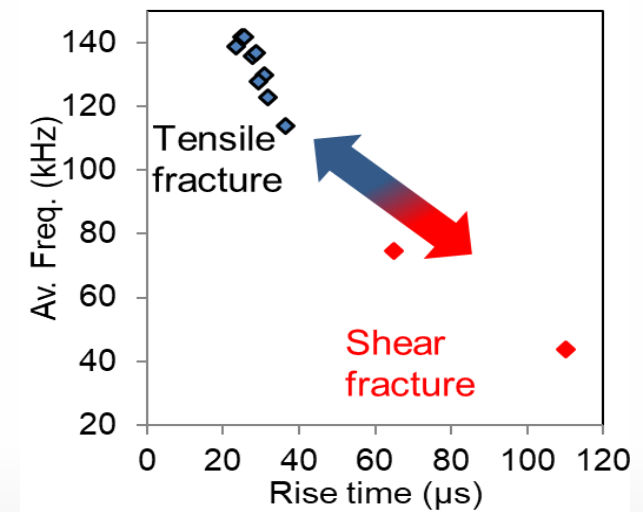
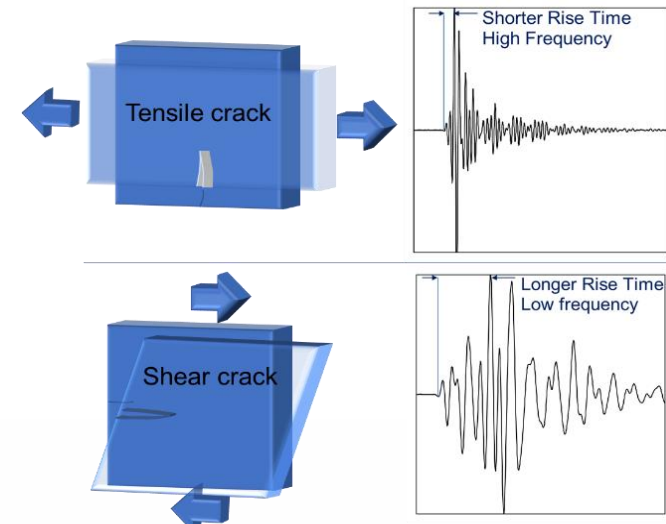
ACOUSTIC EMISSION

LITERATURE REVIEW



Microfracture

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



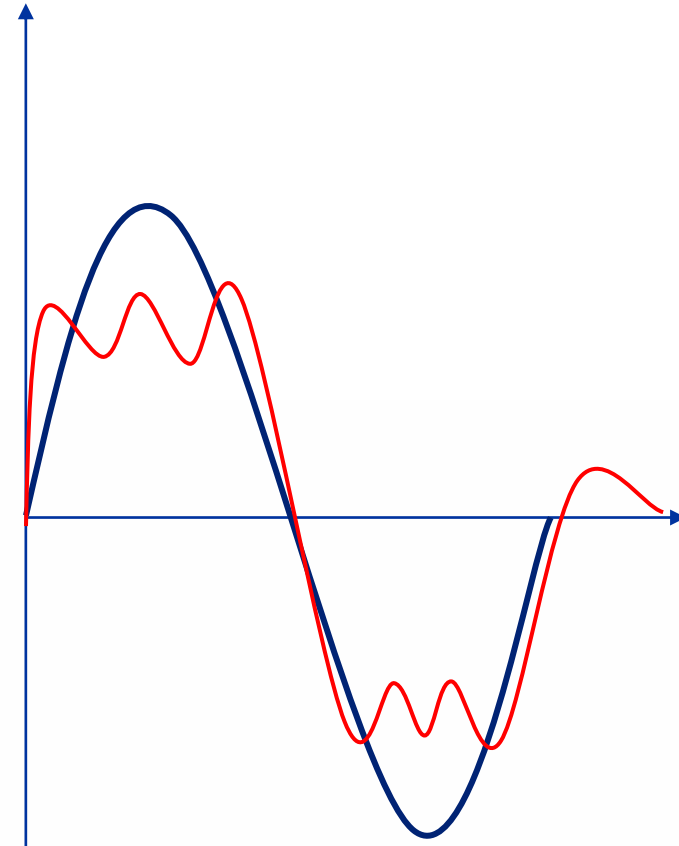
ACOUSTIC EMISSION

PROBLEM STATEMENT

Frequency content and waveform shape are severely distorted due to:

- Scattering
- Damping
- Reflections
- Wave dispersion

The present study aims to examine wave propagation from artificial sources and mechanical tests.



EXPERIMENTAL DETAILS

MATERIALS

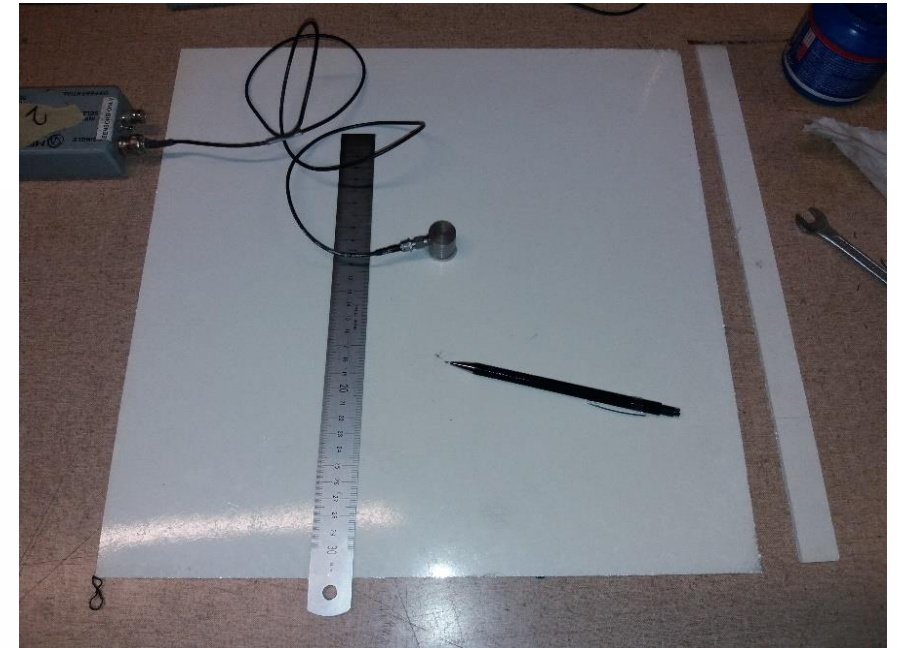
Textile Reinforced Inorganic Phosphate Cement

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

Fiber volume fraction: 20%

Plate: 400 x 400 x 2.5 mm²

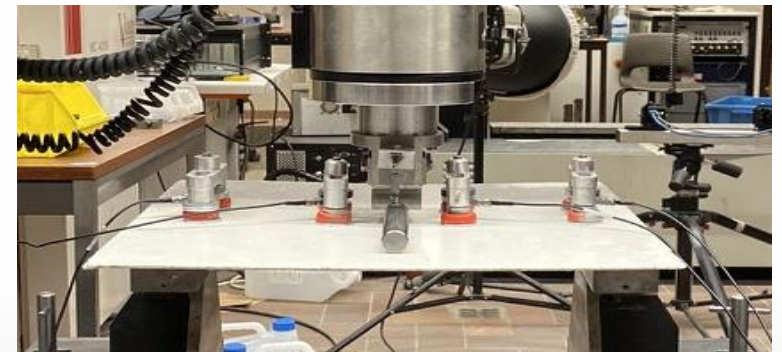
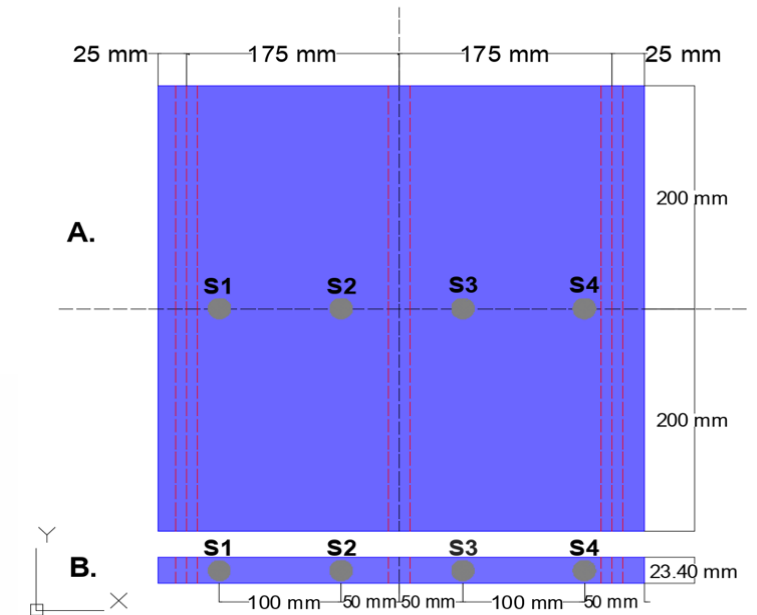
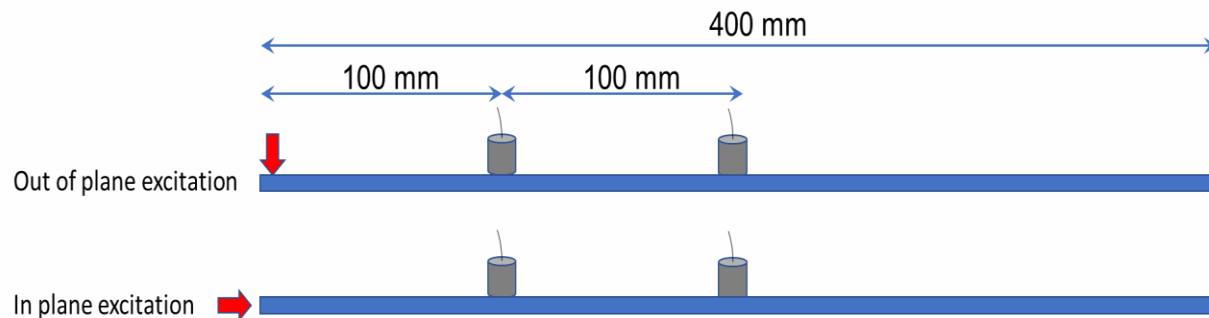
Beam: 400 x 20 x 4.5 mm²



EXPERIMENTAL DETAILS

WAVE PROPAGATION EXPERIMENTS

- R15 AE sensors
- Micro-II Digital AE System
- Pencil lead break excitation
- Propagation speed: 2730 m/s
- Sampling rate 10 MHz



Results

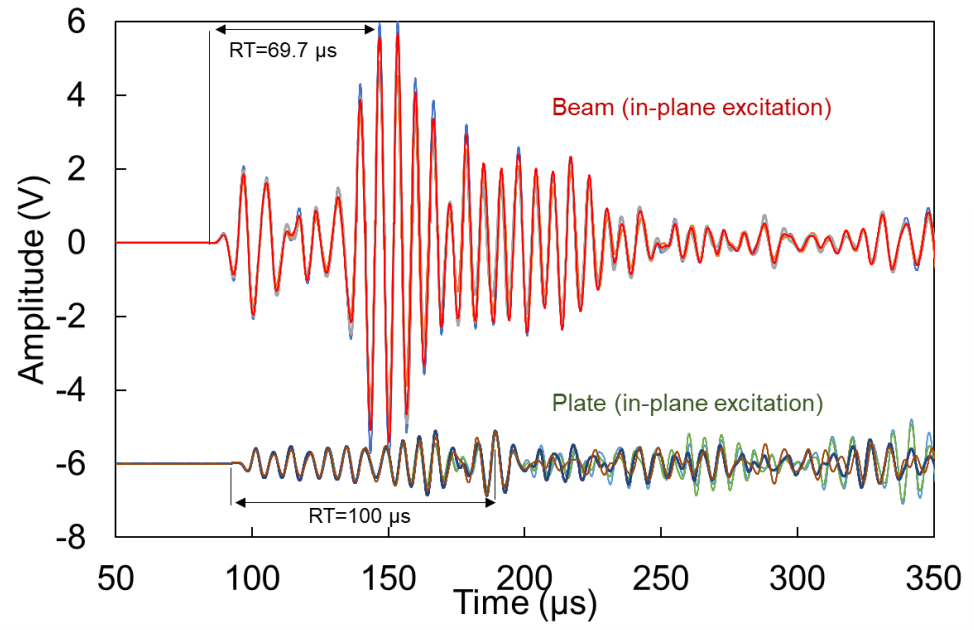


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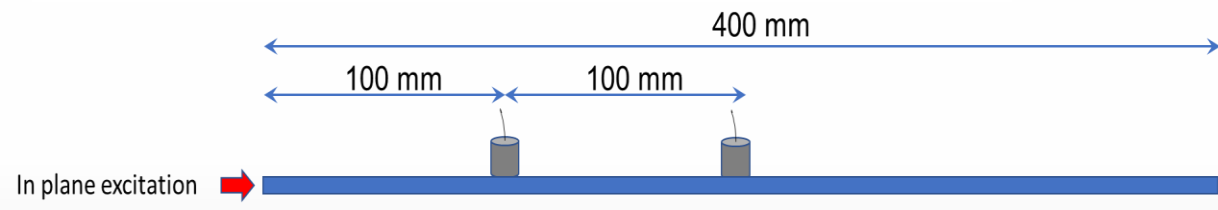
RESULTS

ARTIFICIAL EXCITATION



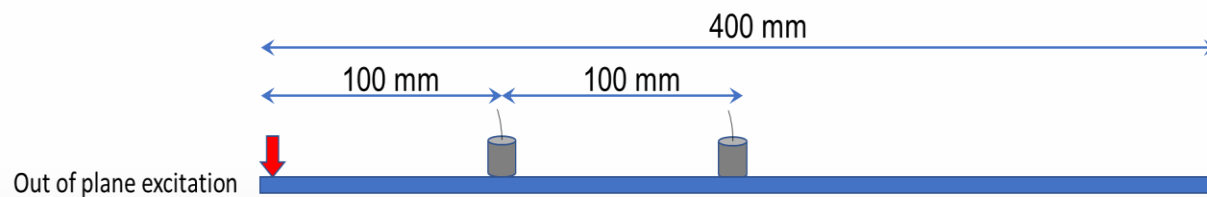
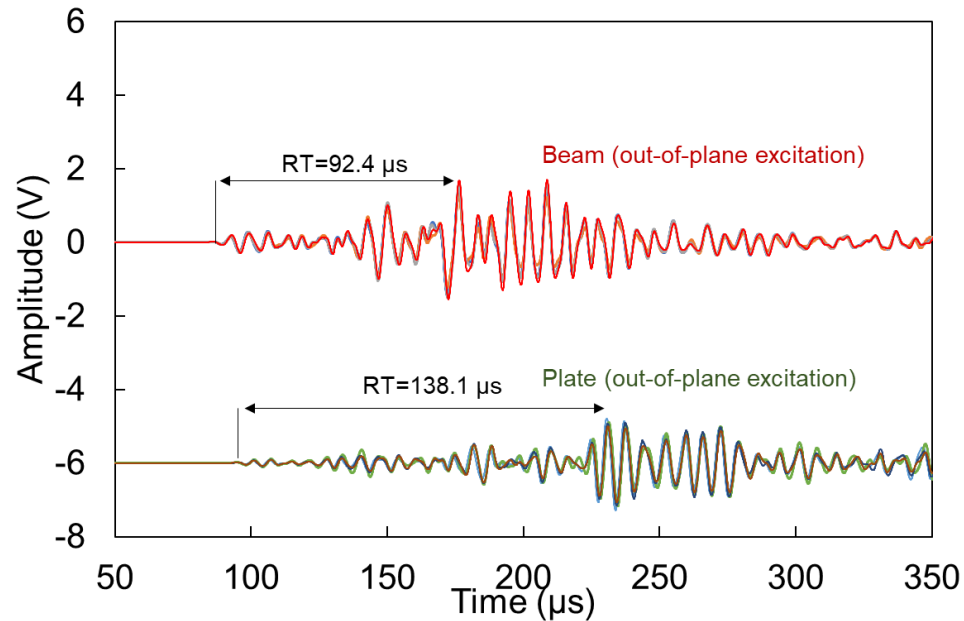
- Simulates a matrix crack
- RT Beam < RT Plate
- A Beam > A Plate

Attributed to the spreading of the energy in the plate geometry, as well as absence of reflections from the edges



RESULTS

ARTIFICIAL EXCITATION



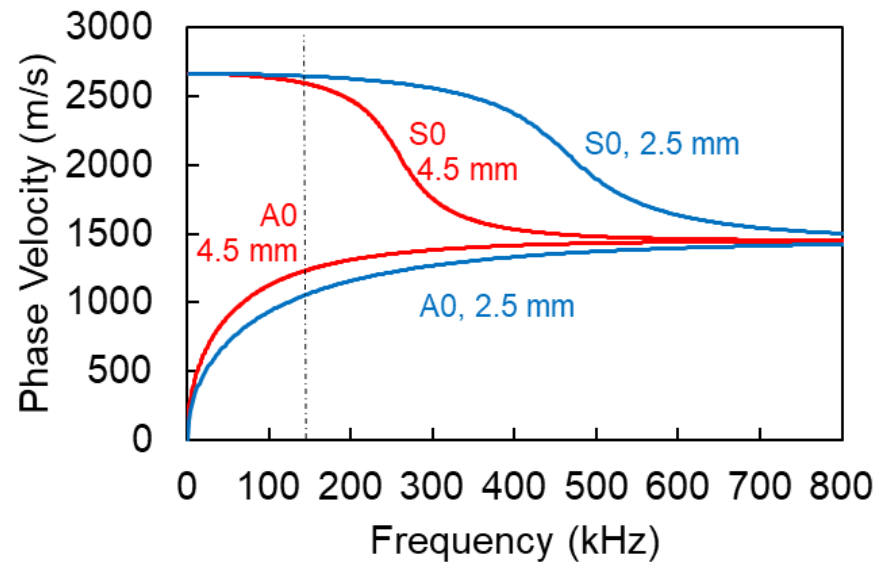
- Dominant "antisymmetric" mode
- RT Beam < RT Plate
- A Beam > A Plate

Attributed to the spreading of the energy in the plate geometry, as well as absence of reflections from the edges



RESULTS

DISPERSION CURVE



- Dispersion curves for symmetric, S0, and antisymmetric, A0, wave velocities (3000 and 1550 m/s).
- S0 is expected much faster than A0 for both cases.
- No strong differences in the onset of the waveforms due to similar velocity of S0.



RESULTS

ARTIFICIAL EXCITATION

	Out of plane (simulating delamination)	In plane (simulating cracking)	Out of plane (simulating delamination)	In plane (simulating cracking)	Out of plane (simulating delamination)	In plane (simulating cracking)
	RT (μ s)	RT (μ s)	Amp (dB)	Amp (dB)	PF (kHz)	PF (kHz)
Beam	92.4	69.7	84.6	95.1	152.6	157.5
Plate	138.1	100	80	78.8	145.3	145.3

- RT 40% higher in Plate
- A(dB) lower in Plate
- PF higher for the beam

Higher amplitude in beams is interpreted as the effect of immediate reflections¹ and 1D propagation in beam contrary to a 2D propagation in plate.



RESULTS

ARTIFICIAL EXCITATION

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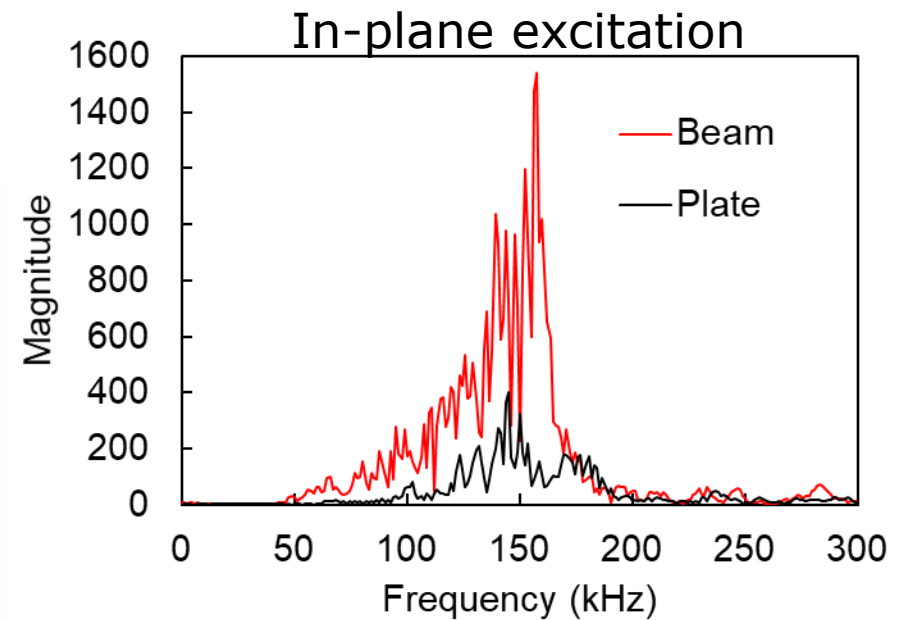
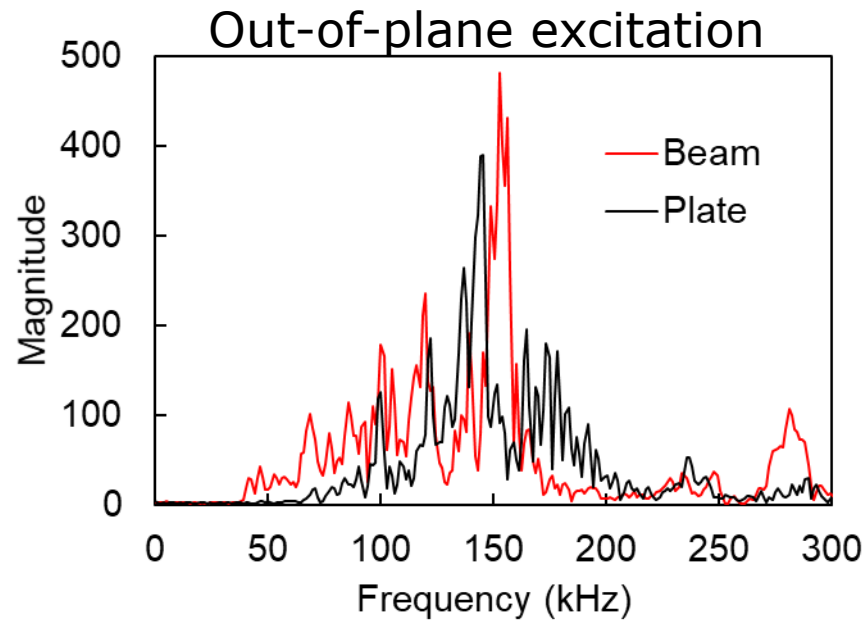
- Shorter RT for in-plane excitation

Reasonable due to excitation mode S0(In-plane) is faster than AO(Out-of-plane).



RESULTS

ARTIFICIAL EXCITATION

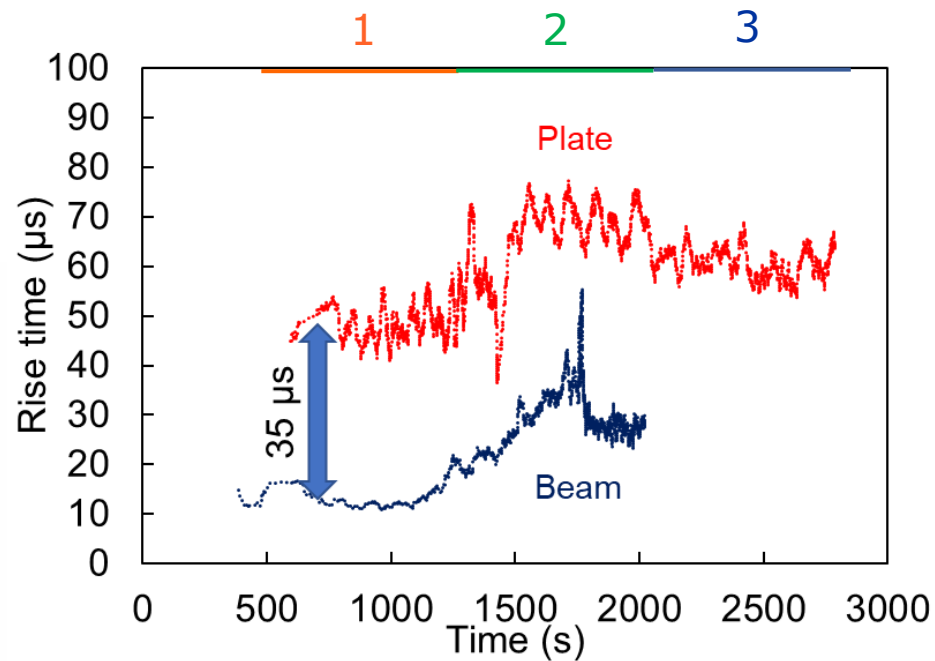


The band of frequencies does not seem to differ much, but the peak is always higher for the beam

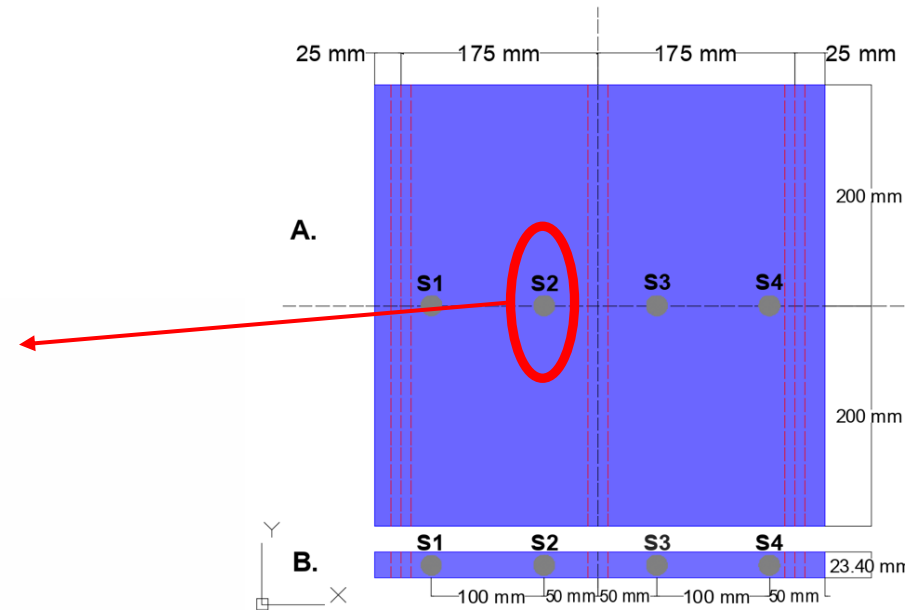


RESULTS

MECHANICAL TEST



200 points sliding average



1. Matrix cracking
2. Shift to pull-out and delamination

AE Rise time from real cracking shows the same trend with the artificial sources, it is much higher for the plate specimen



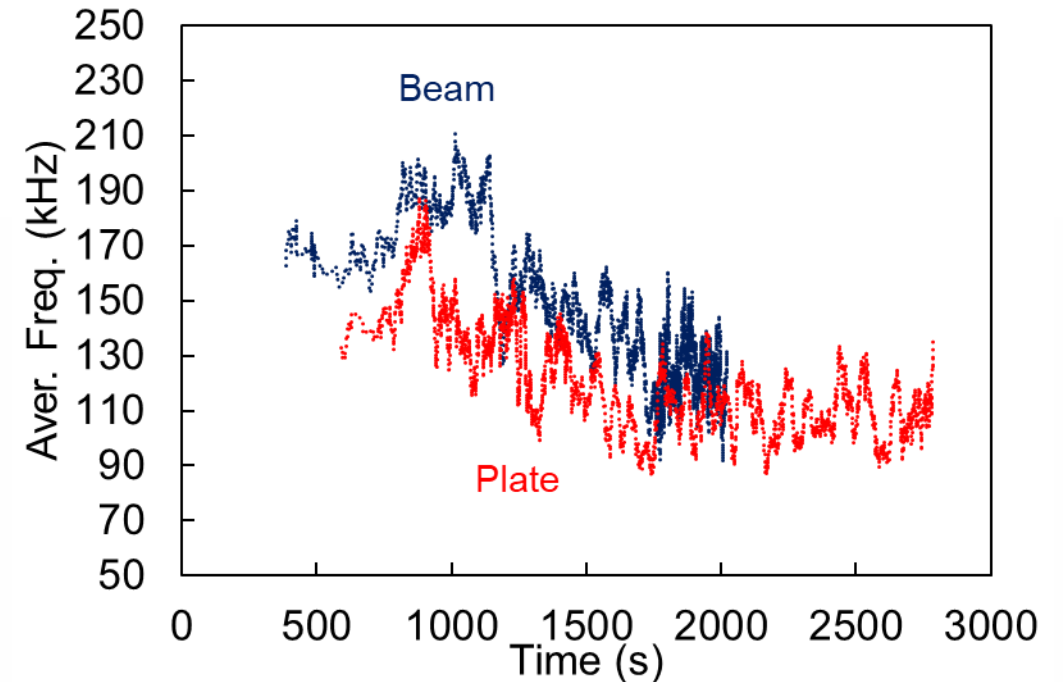
RESULTS

MECHANICAL TEST

Initial 170 kHz AF for the beam

Initial 140 kHz for the plate

Resonant sensors at 150 kHz

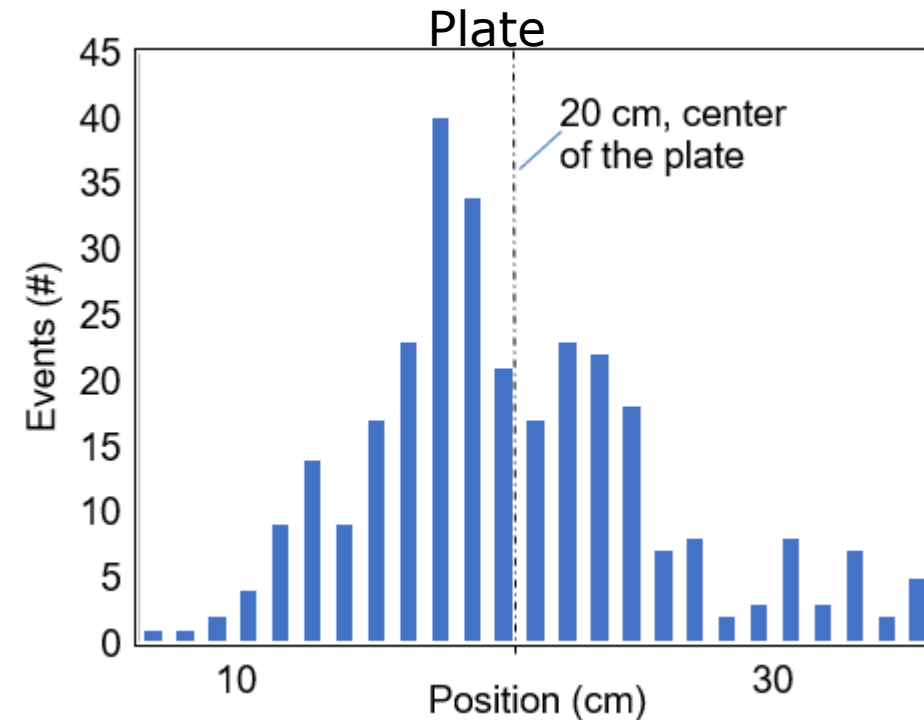
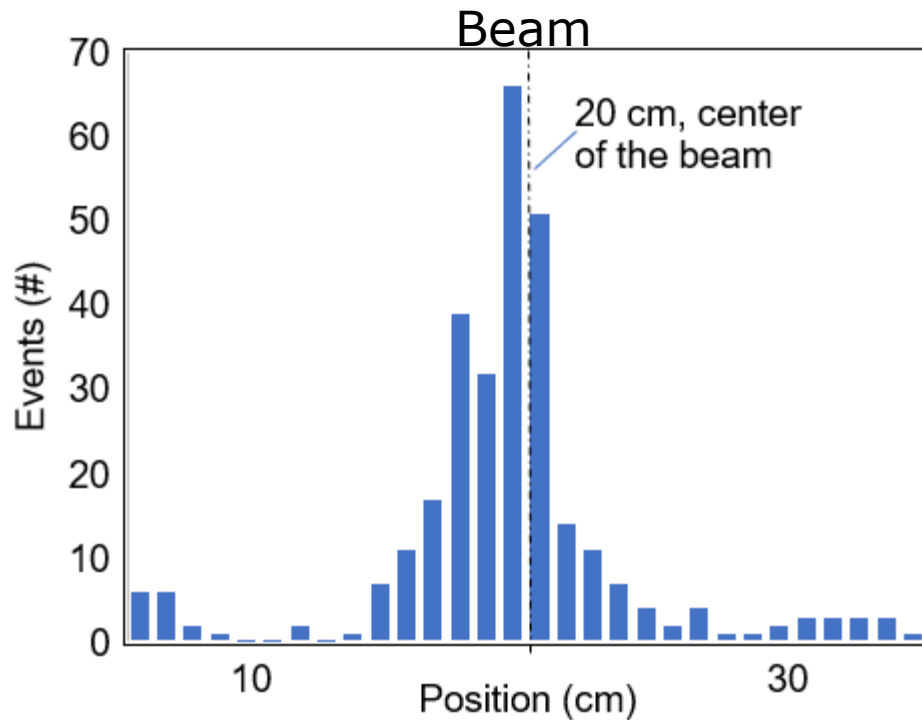


Frequency parameters are higher for the beams showing again similar trends like pencil lead sources.



RESULTS

MECHANICAL TEST



AE localization in both specimens exhibit their peak close to the center, validating the existence of the cracking source on the zone where it is expected.



RESULTS

MECHANICAL TEST VS ARTIFICIAL EXCITATION

(Average values in cracking signals First 300 hits)

	RT (μ s)	Amp (dB)	A.F. (kHz)	I.F. (kHz)
Beam	14	56.4	170.1	389.1
Plate	46	60.4	136.6	274.3

- RT higher in Plate
- A(dB) higher in Plate
- AF and IF higher for the beam

Artificial in-plane excitation

	RT (μ s)	Amp (dB)	P.F. (kHz)
Beam	69.7	95.1	157.5
Plate	100	78.8	145.3

- RT higher in Plate
- A(dB) lower in Plate
- PF higher for the beam

For the same type of source (cracking), higher values of RT in the plate could be wrongly interpreted as shear signals, while the reason is just the difference in geometry and wave propagation conditions. The only difference in trends between the artificial and the actual cracking is in the amplitude. In the mechanical test is higher in the plate than in the beam. The reason is related to the constrain of a typical crack within the width of the beam, while in plate there is no such limitation → higher release of energy



Conclusions



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CONCLUSIONS

GENERAL CONCLUSIONS

- In-plane excitation on a TRC sample (simulating matrix crack) produces shorter AE waveforms than the corresponding out-of-plane excitation (simulating delaminations), clearly showing that fracture mode characterization based on AE is possible in the cementitious composites.
- Plate geometries exhibit longer waveform characteristics like RT and duration, and slightly lower frequency for the same artificial excitation (pencil lead break).
- Cracking signals from actual mechanical testing show the same trends with artificial excitation between beams and plates, with a difference on the energy-related parameters, that seem higher for plates. This is attributed to the unrestricted crack dimensions and propagation increments in the large geometries.



ACKNOWLEDGMENTS

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Thank you

Further questions: Nicolas.ospitia.patino@vub.be



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