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The Use of Poro-Elastic Finite Elements to Model the Structural Damping Effect of Fibrous Acoustical Treatments

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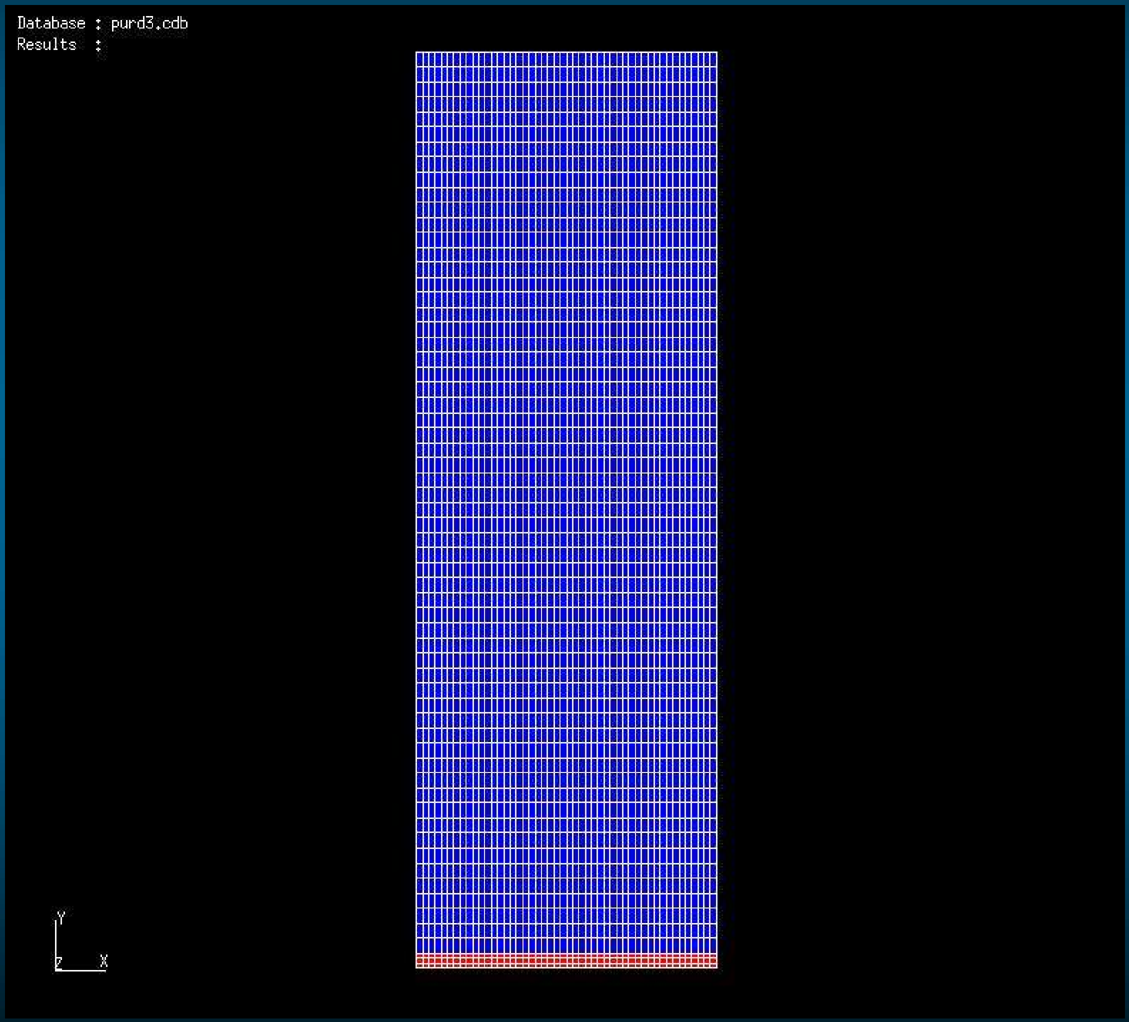
Background

- This work is based on fibrous acoustical treatments, which provide both absorption and damping.
- 3M has sold viscoelastic dampers for many years.
- 3M commissioned Purdue to study fibrous acoustical treatments.
- Will present verification of the Purdue study, and comparison to conventional damping techniques.

Analysis methods

- Comet / Safe, a commercially available poro-elastic FEA code was used for 3M work.
  - » Based on modified Biot theory
- Modal expansion procedure was used at Purdue.

Comet FEA model



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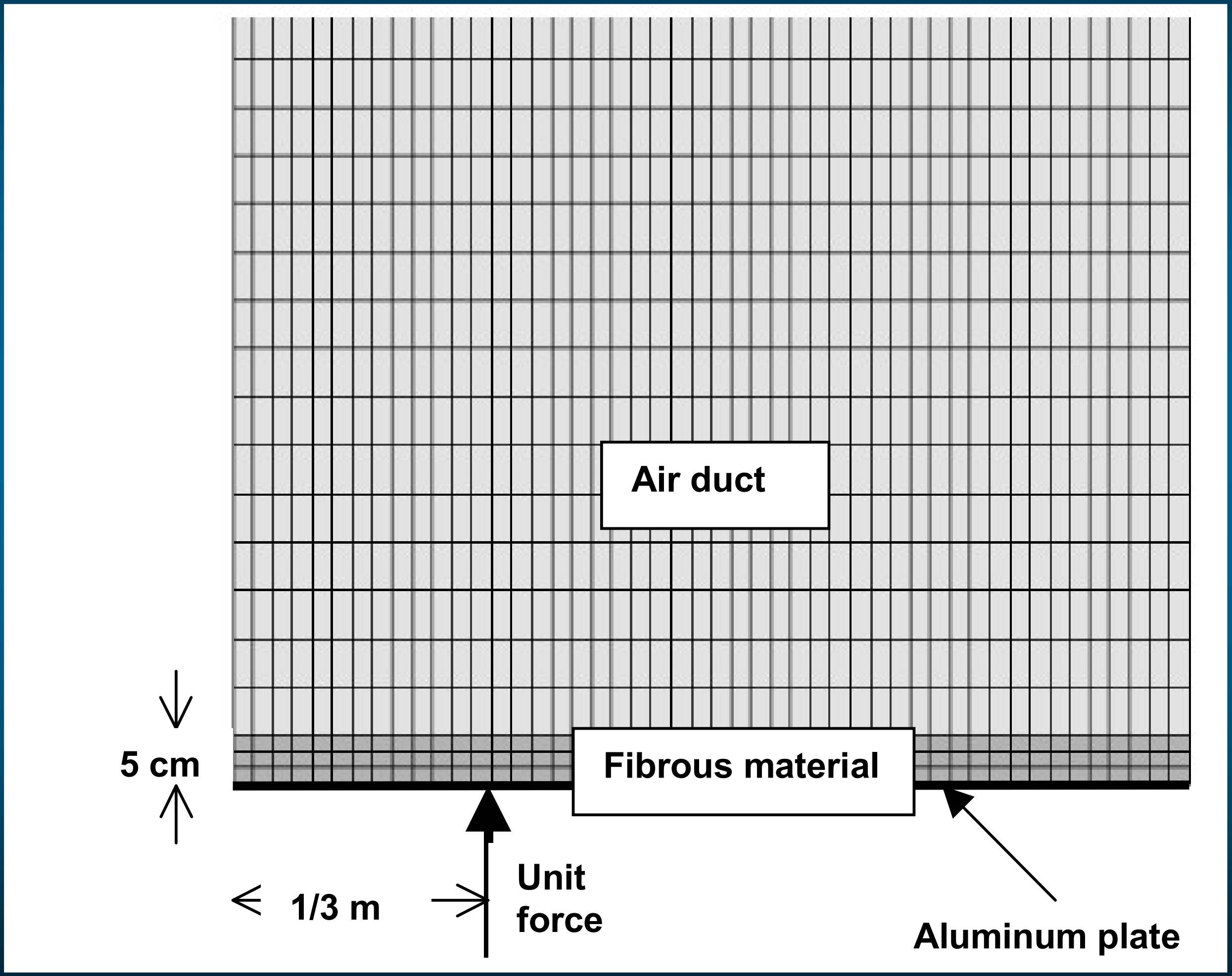
Comet FEA model- detail



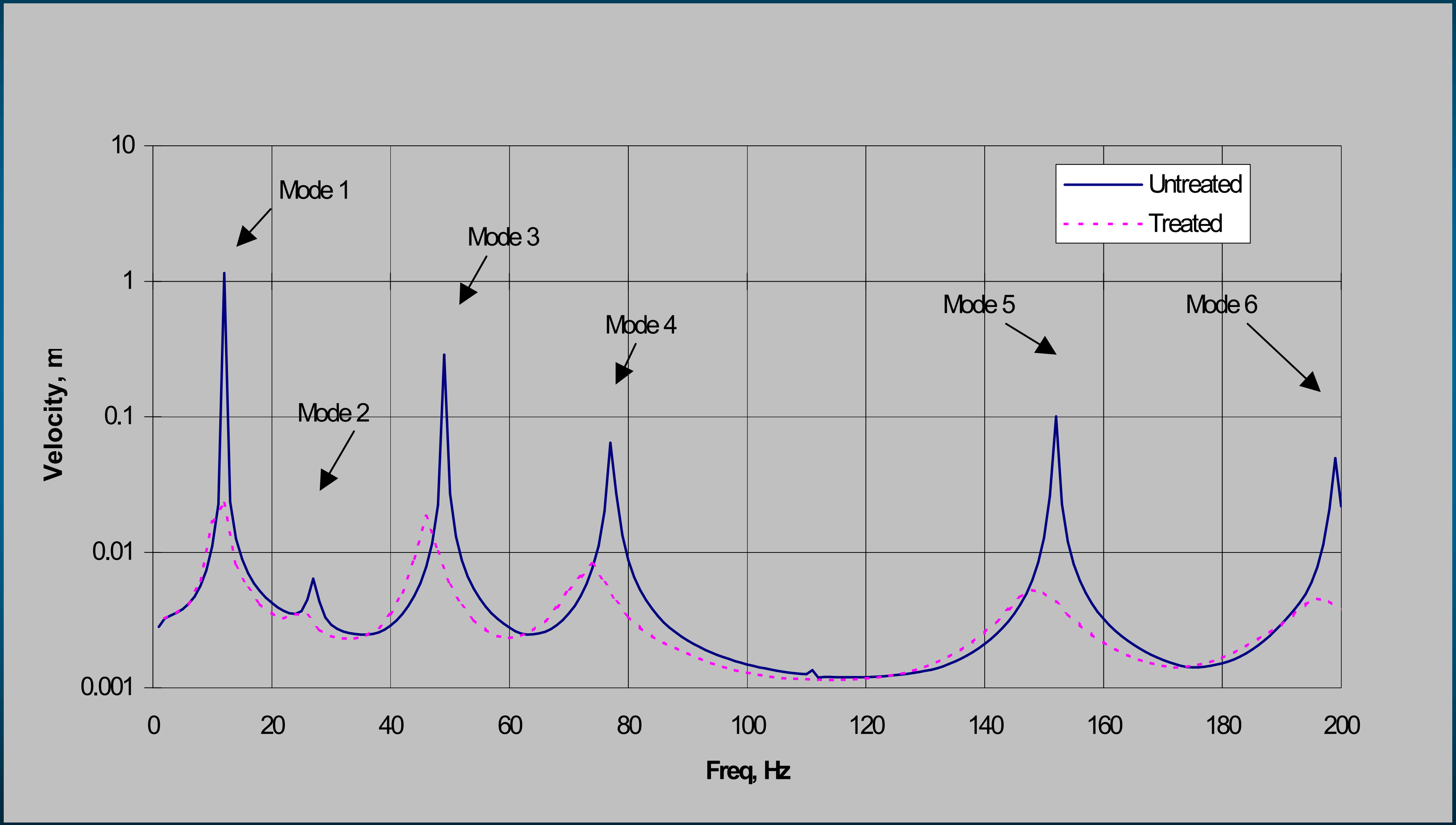
Aluminum plate properties

Thickness	1.27 mm
Length	1.0 m
Young's modulus	71,000 MPa
Poisson's ratio	0.33
Density	2700 kg/m^3

Material properties, poro-elastic

Porosity	.99
Tortuosity (Structure factor)	1.2
Flow resistivity	8882 Rayls/m
Young's modulus of solid	1000 Pa
Poisson's ratio of solid	0
Solid bulk density	11.43 kg/m^3
Fluid density	1.21 kg/m^3
Speed of sound in fluid	343 m/s
Prandtl number in fluid	.71
Specific heat ratio in fluid	1.4

Results - Treated and untreated plate



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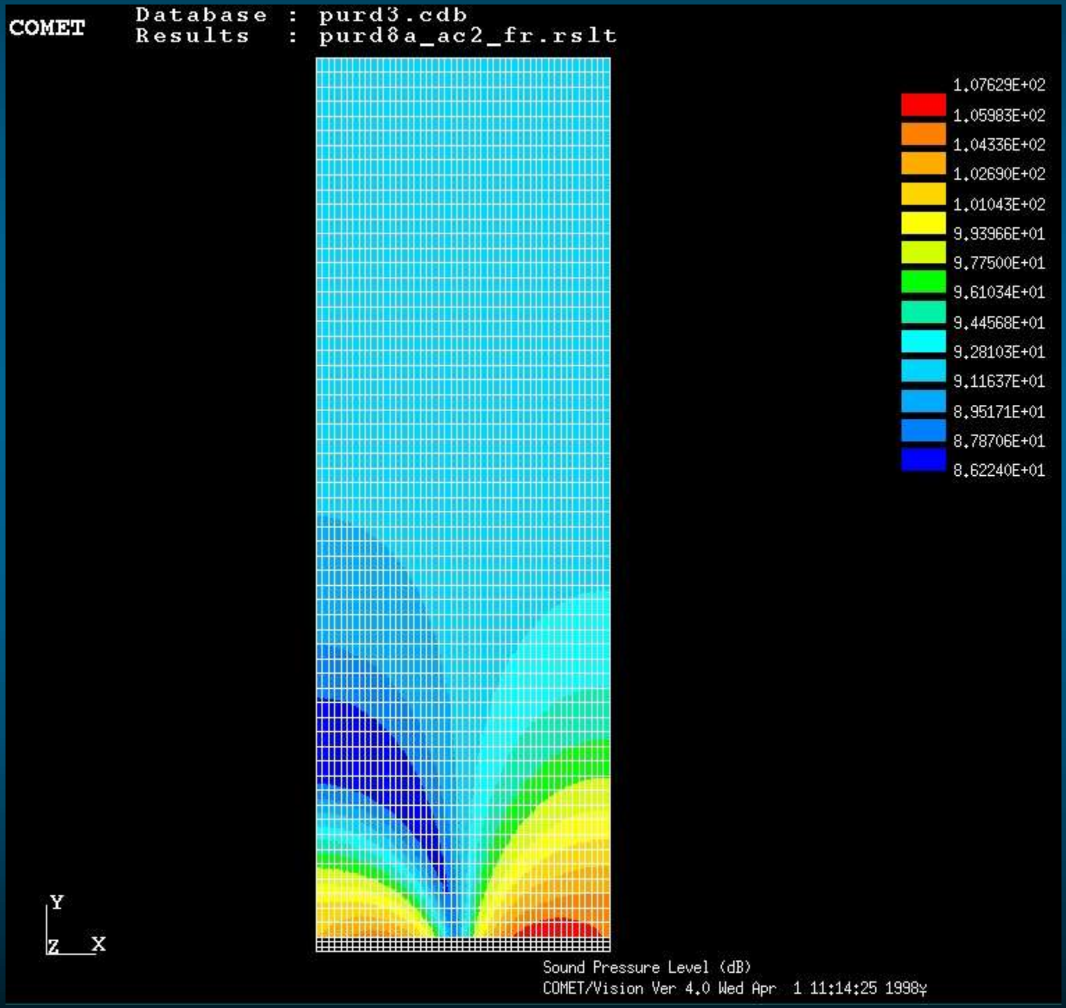
Results - SPL plot in duct



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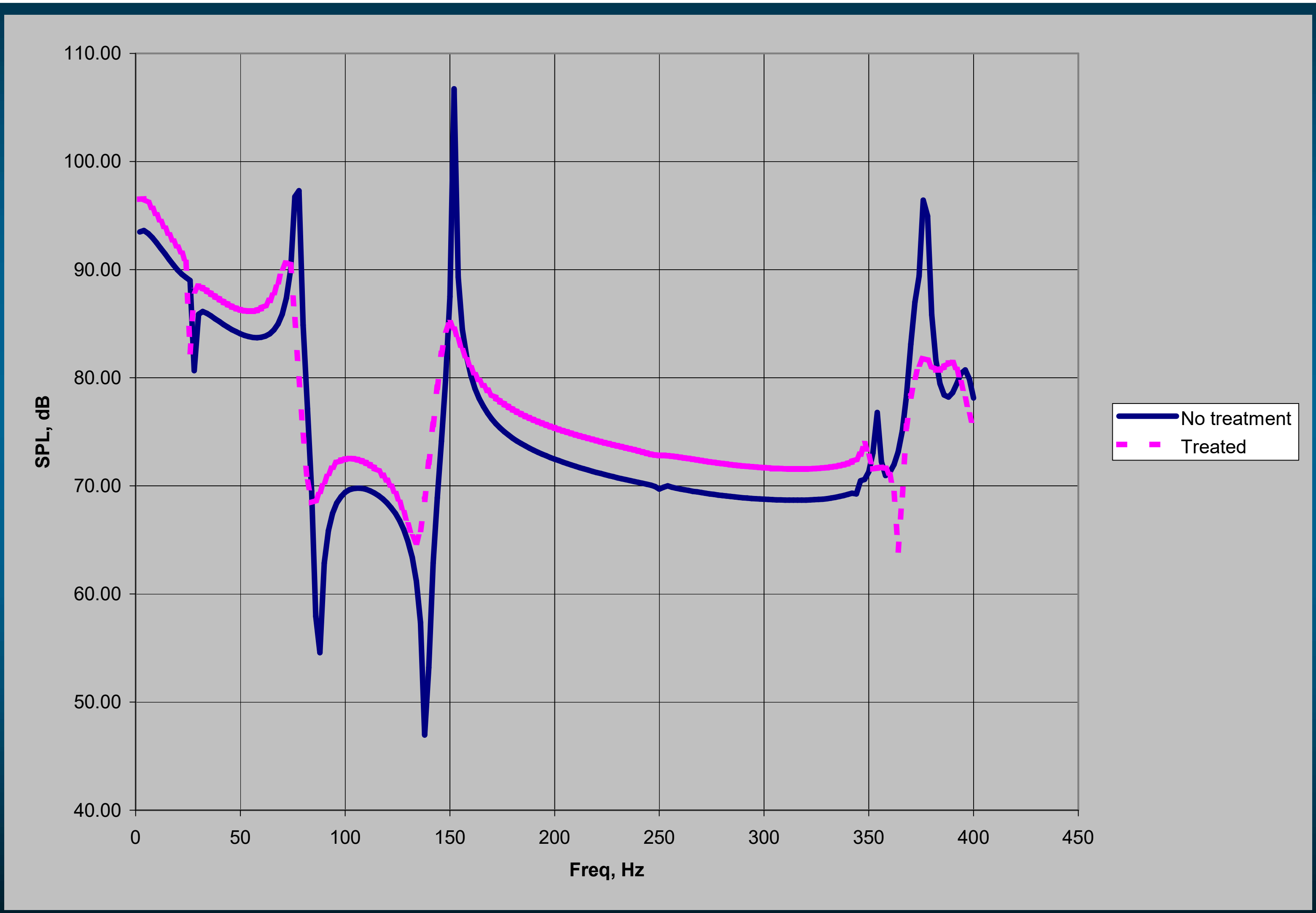
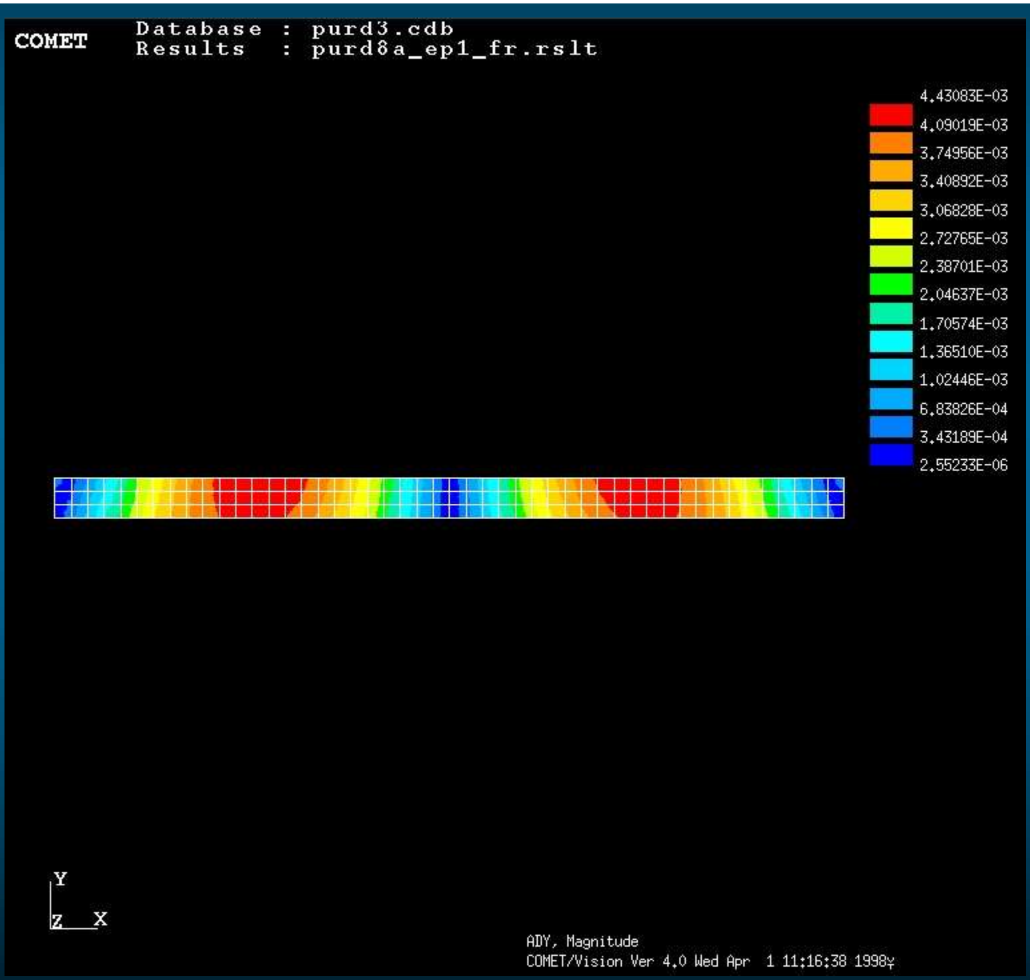
Results - SPL at duct outlet



Results - Normal particle displacement in fibrous treatment



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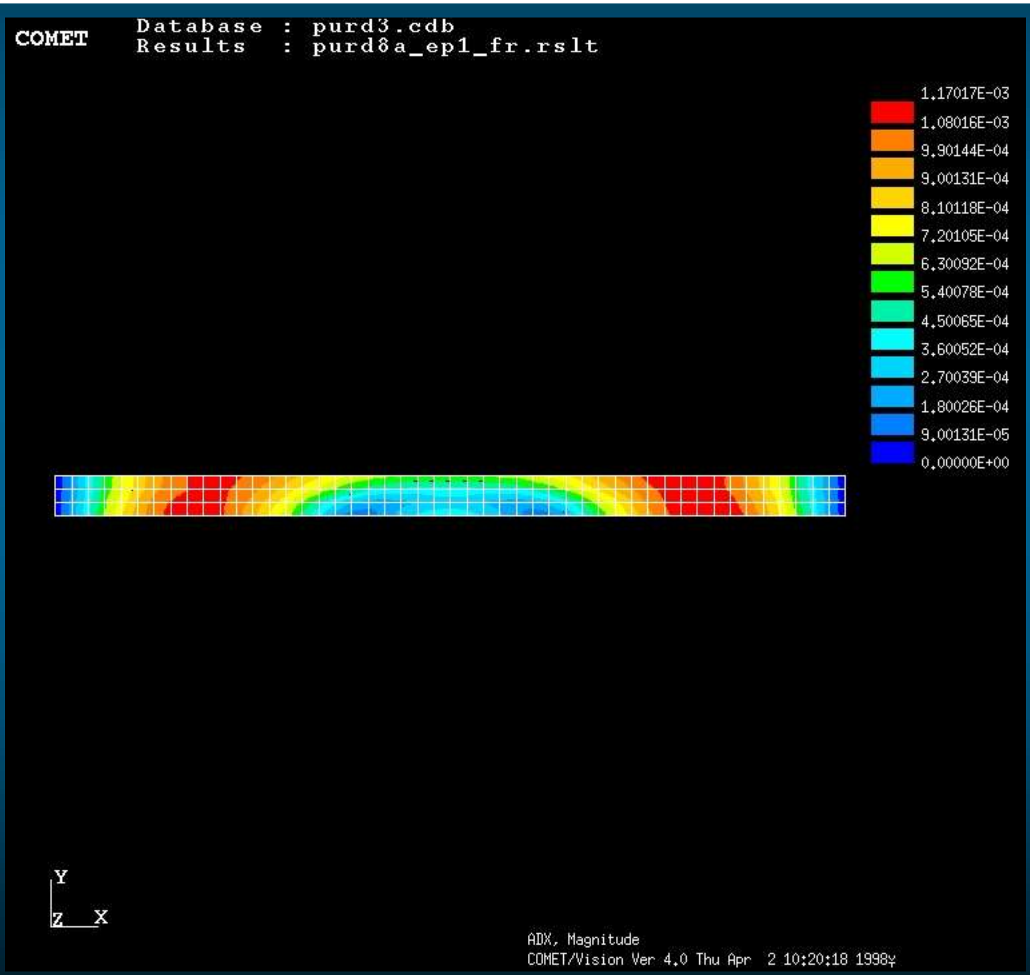
Results - Parallel particle displacement in fibrous treatment



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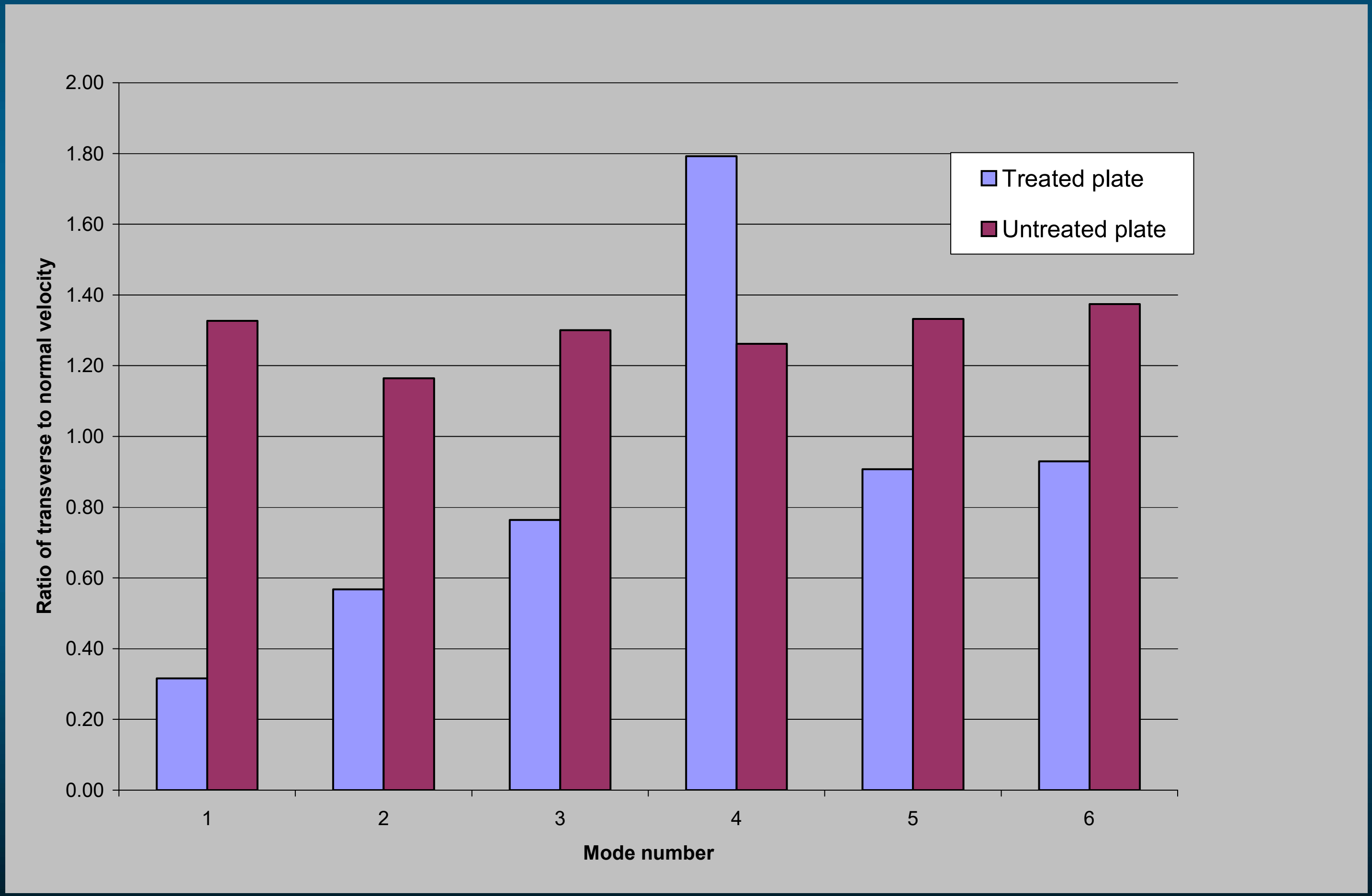
Results - Transverse / normal velocity ratio



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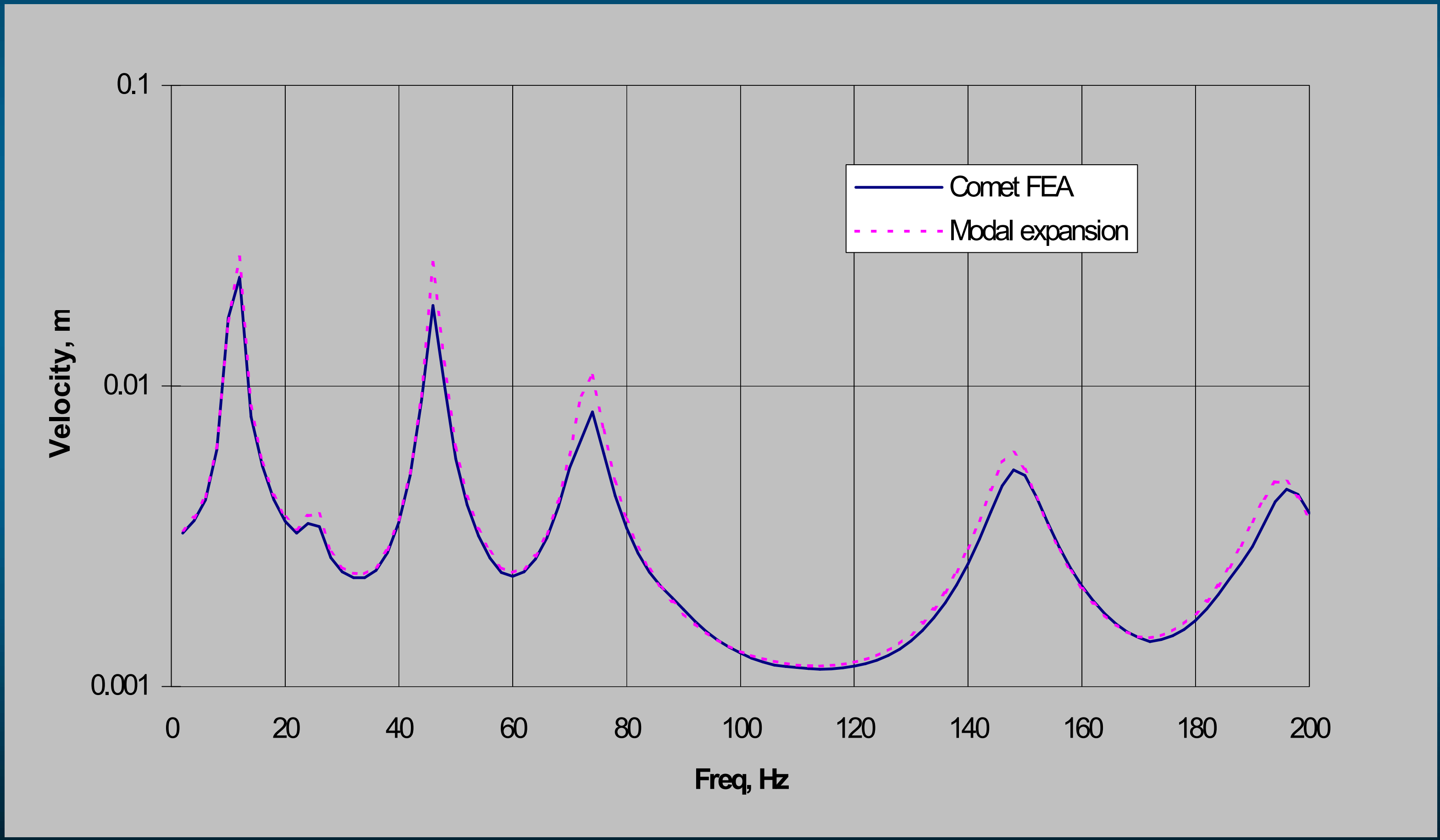
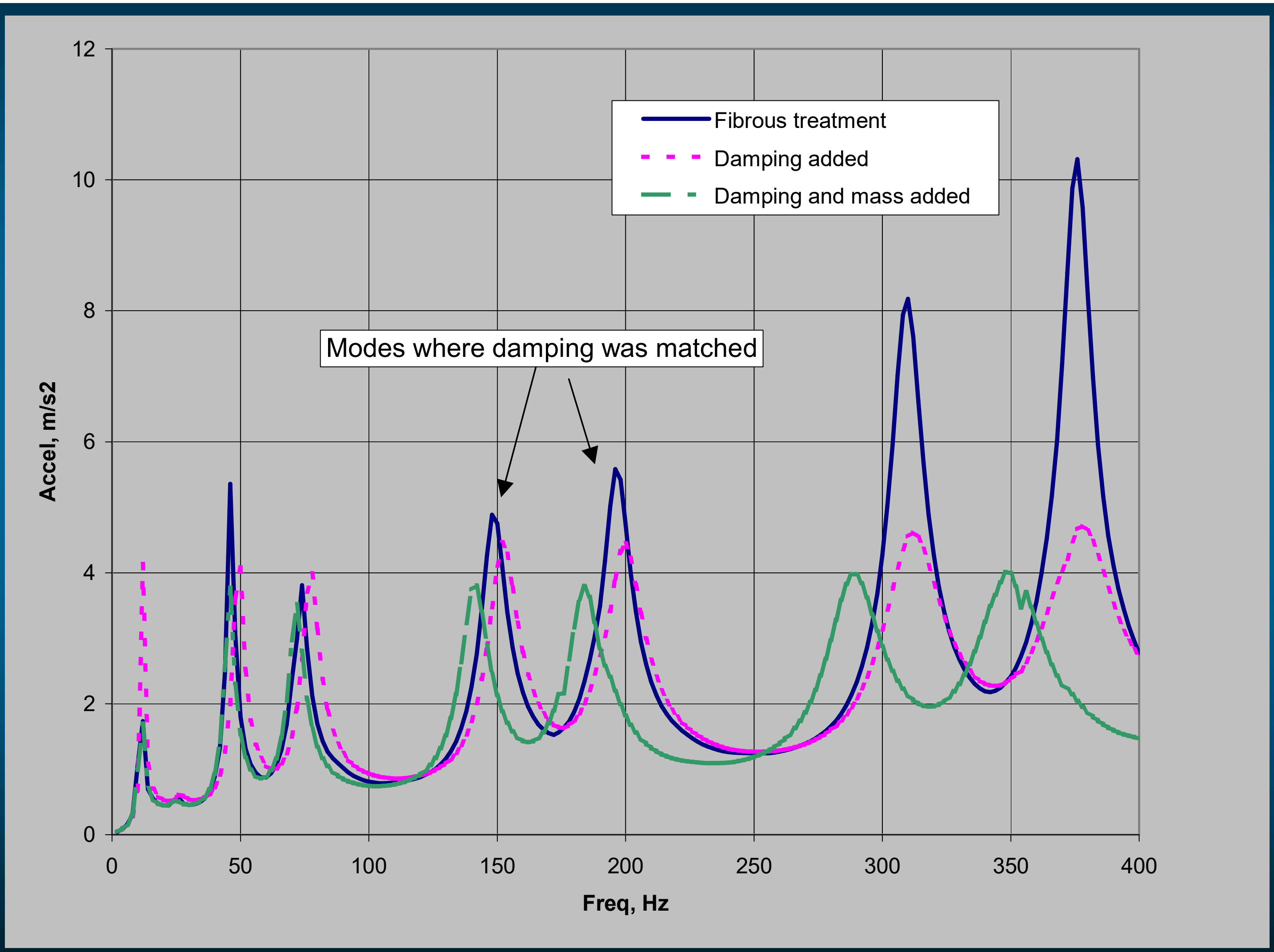
Results - Comparison to independent results



Equivalent viscous damper



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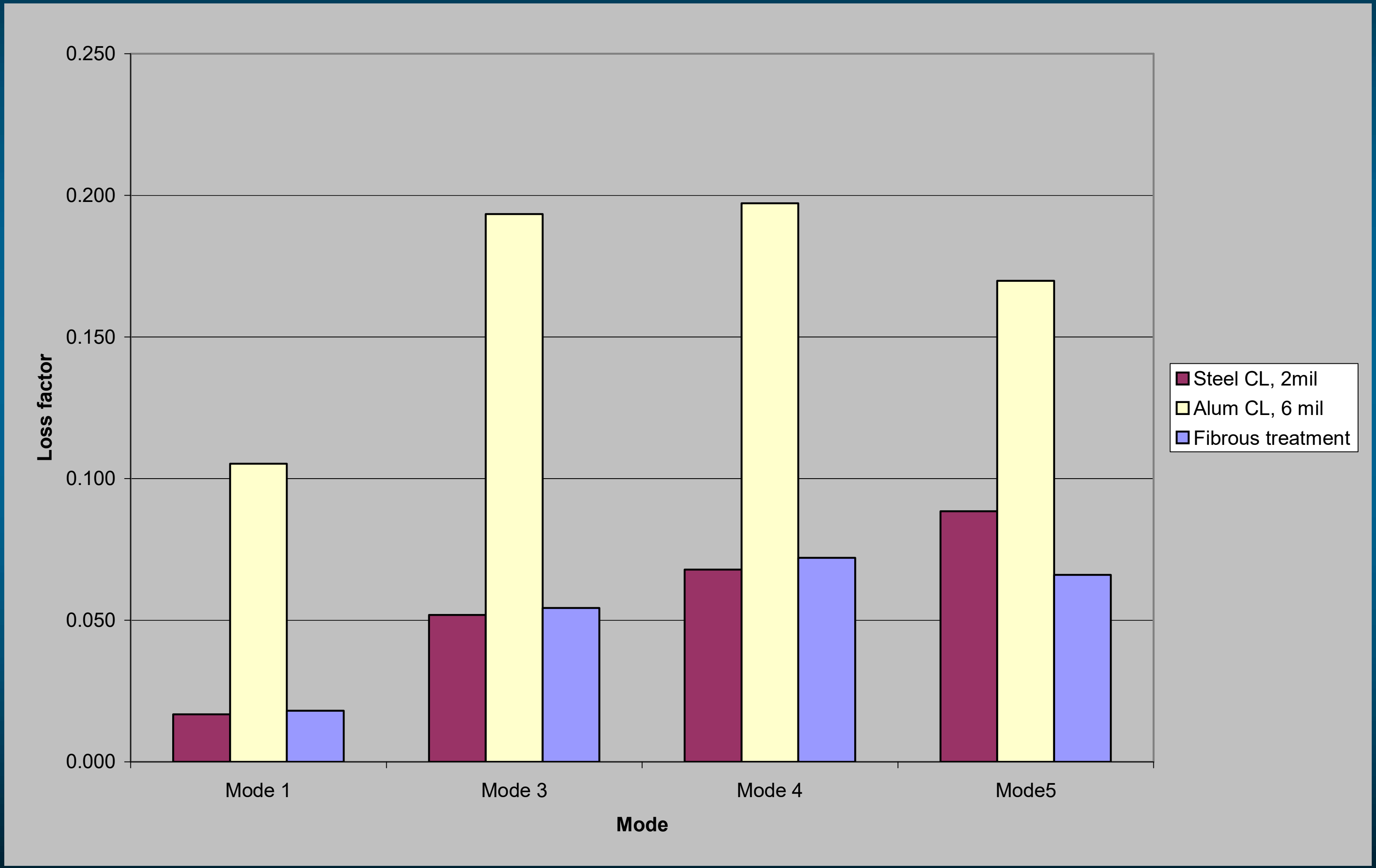
Viscoelastic damper - FEA model

- Modeled constrained layer damper with ANSYS.
- Used published viscoelastic material properties.
- Used modal strain energy method to determine modal damping

Viscoelastic damper comparison



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Summary

- Successfully duplicated modal expansion results using FEA method.
  - » Two independent methods have predicted a damping effect due to the fibrous acoustical treatment.
- Now have a better understanding of this damping effect.