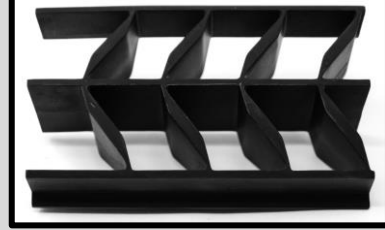


# DESIGN AND TESTING OF MODULAR EXPANSION JOINT



## NOISE MITIGATION STRATEGIES

Per Reinhall, Professor

Sawyer Thomas, PhD Student

Jeff Lipton, Assistant Professor

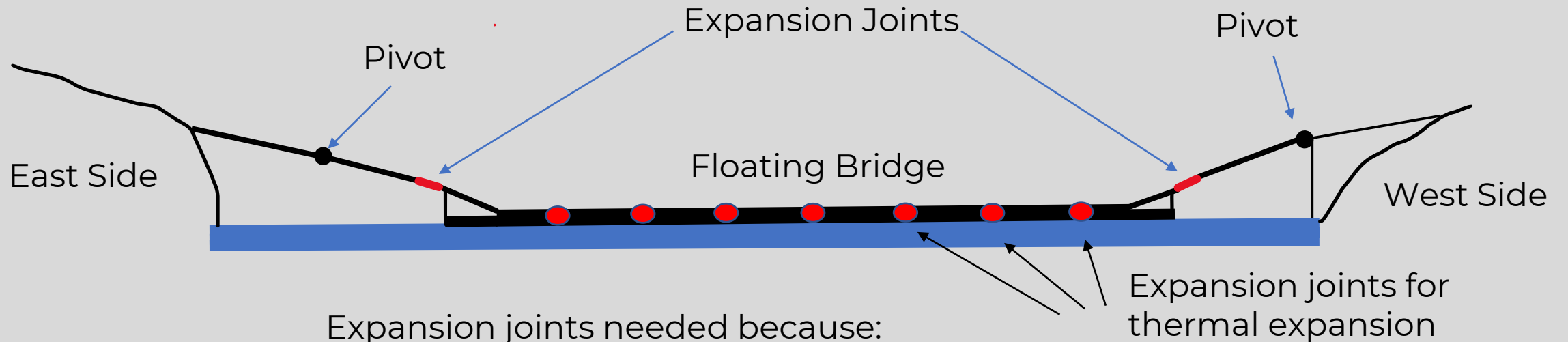
Waiel Elmadih, Research Scientist

Department of Mechanical Engineering

University of Washington



# The SR 520 Bridge Expansion Joint



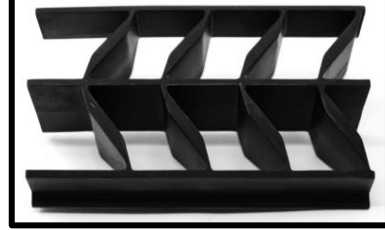
Expansion joints needed because:

- 1) Changes in water level
- 2) Temperature expansion
- 3) Motion caused by wind
- 4) Motion caused by ground motion

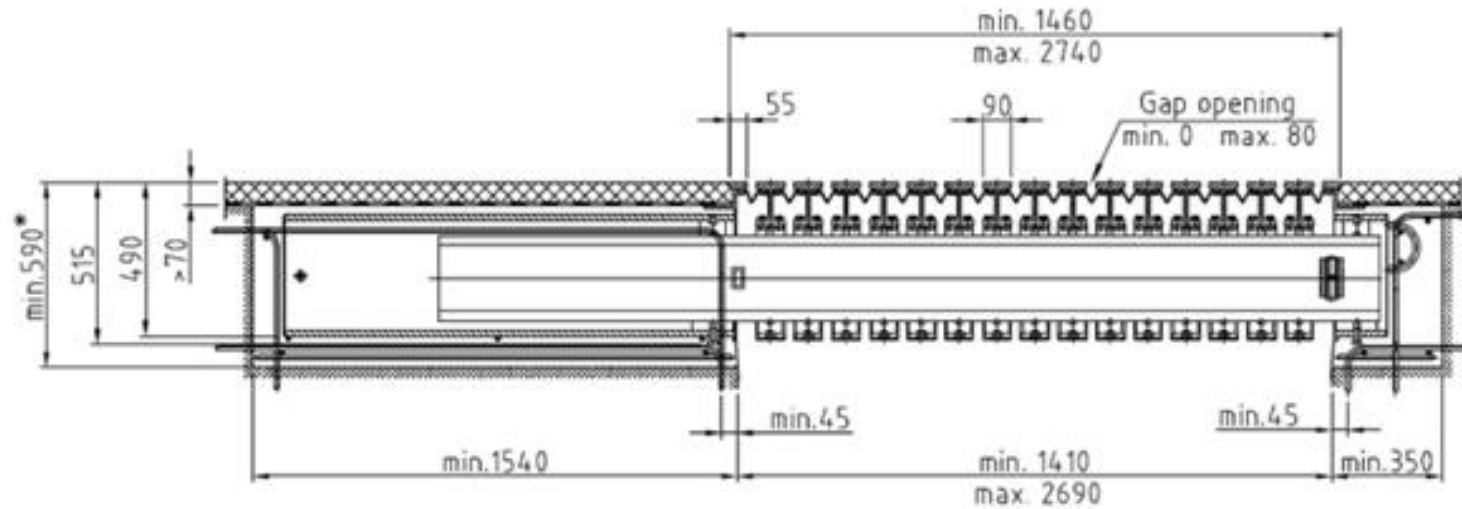




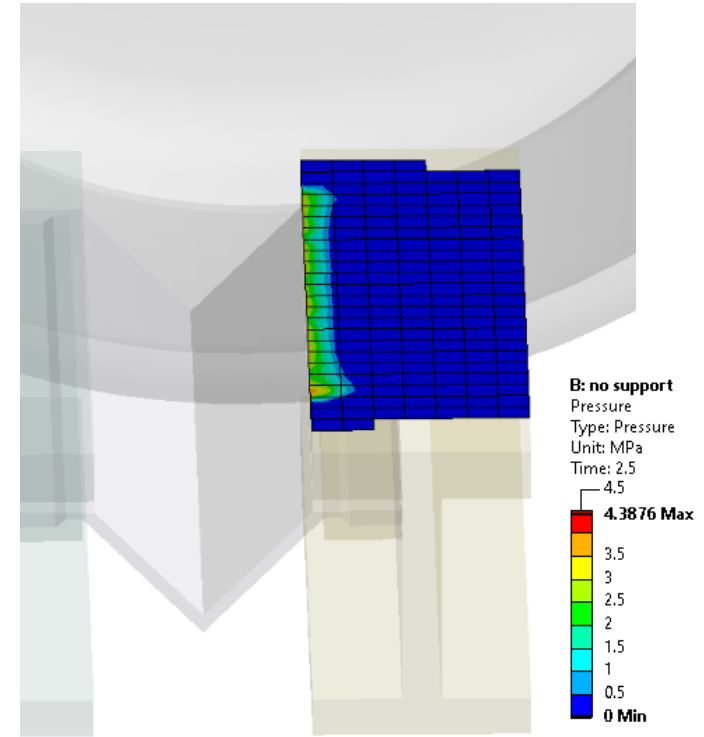
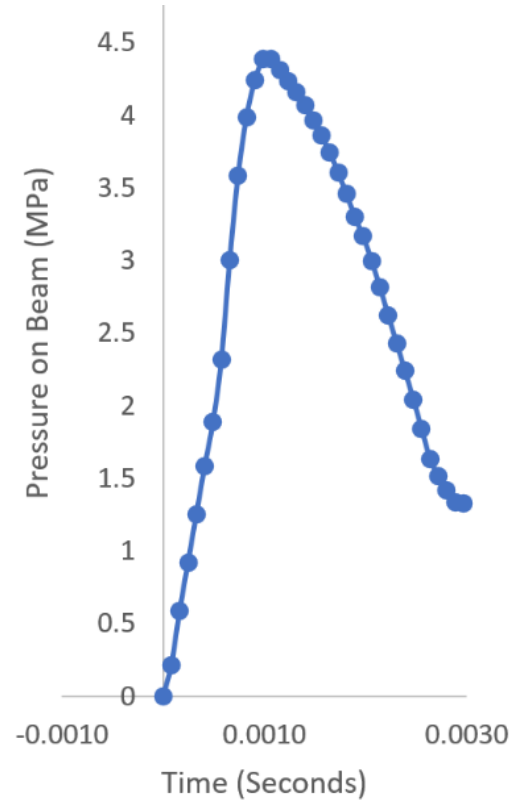
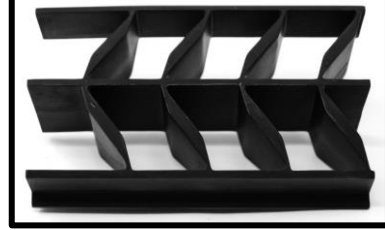
# Background: WA SR520 Bridge



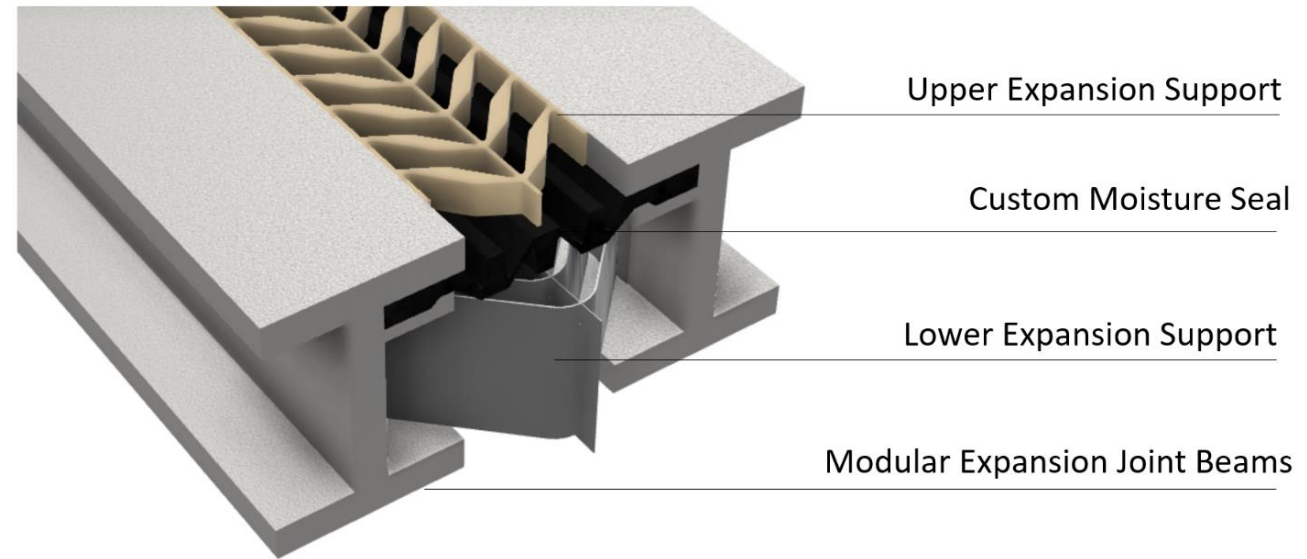
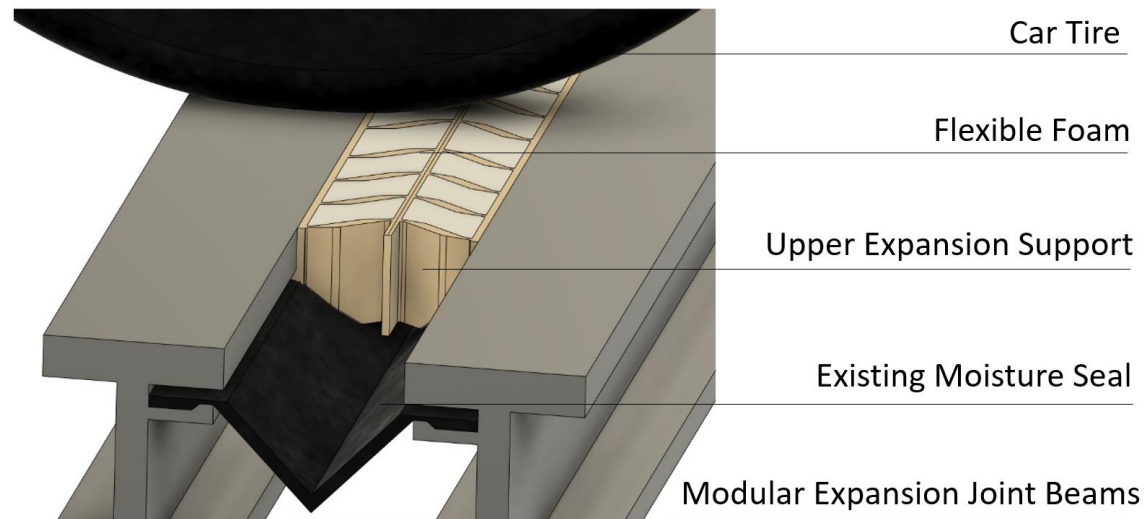
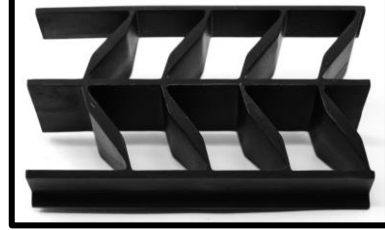
Engineering drawing of the expansion joint



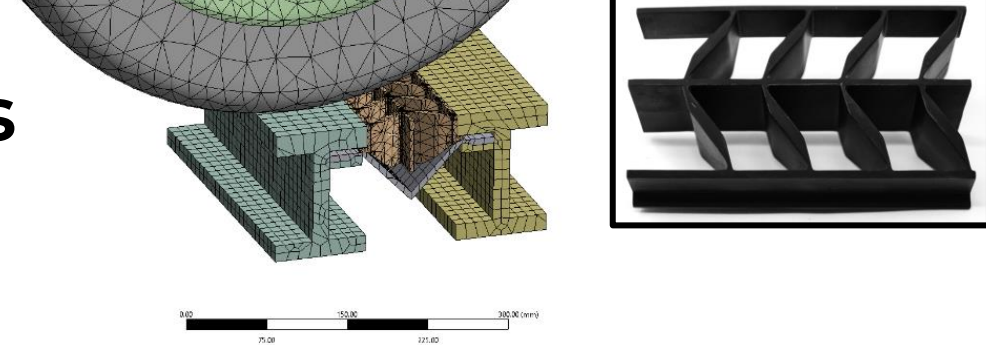
# Source of Noise



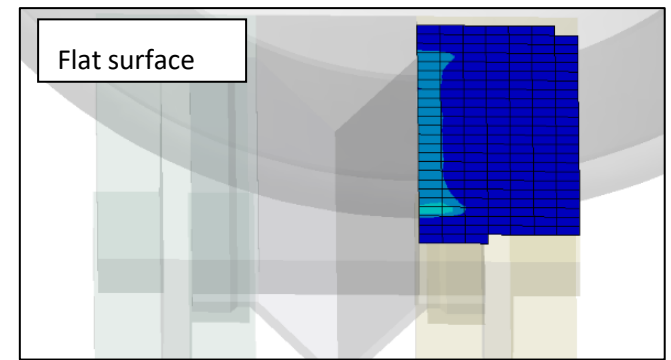
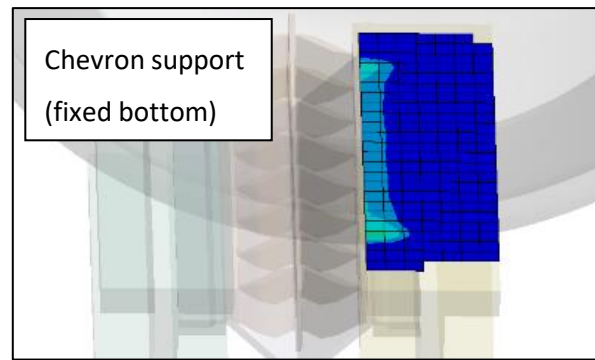
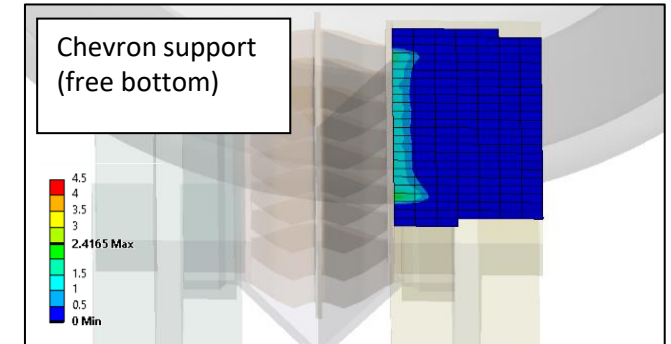
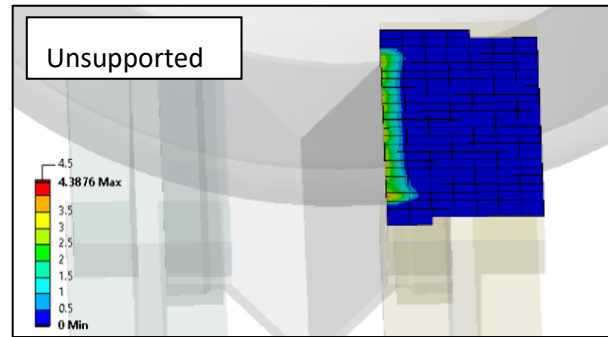
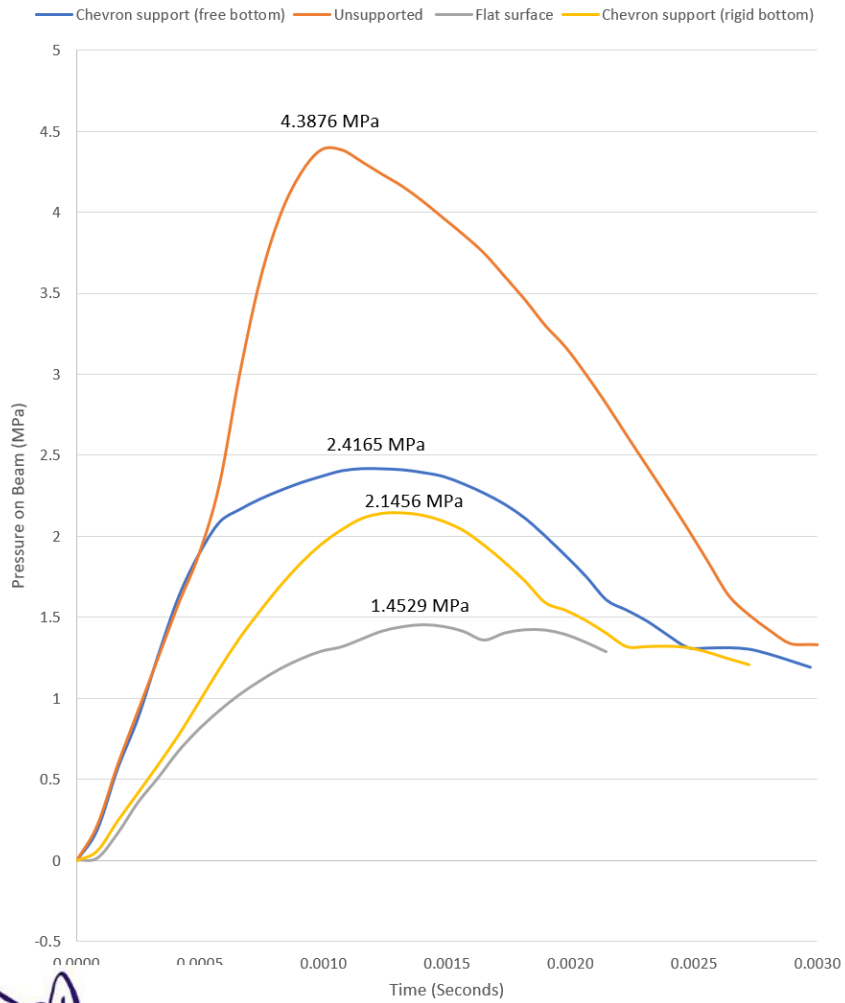
# Proposed Solutions



# Rolling Simulations

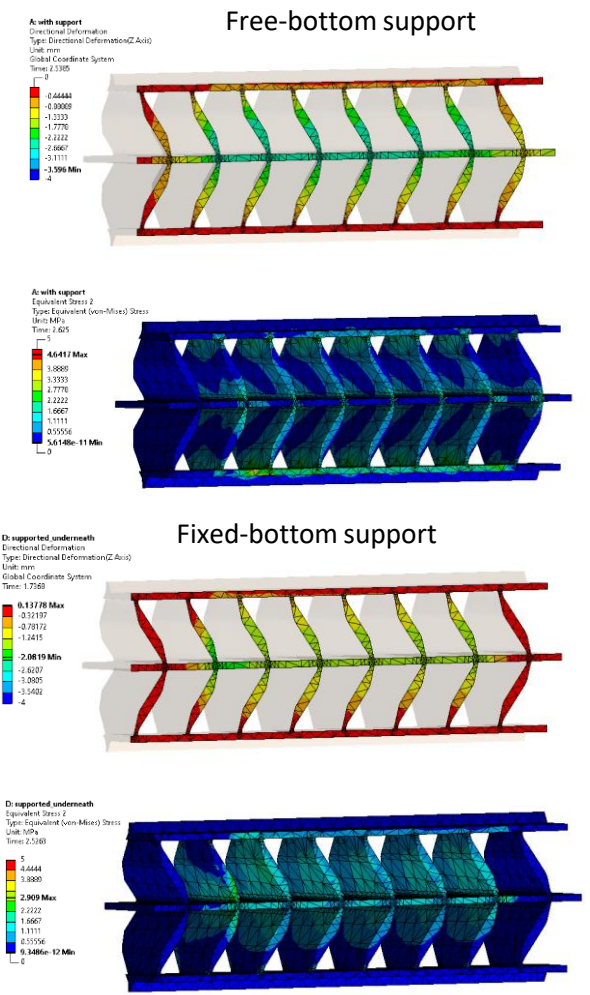
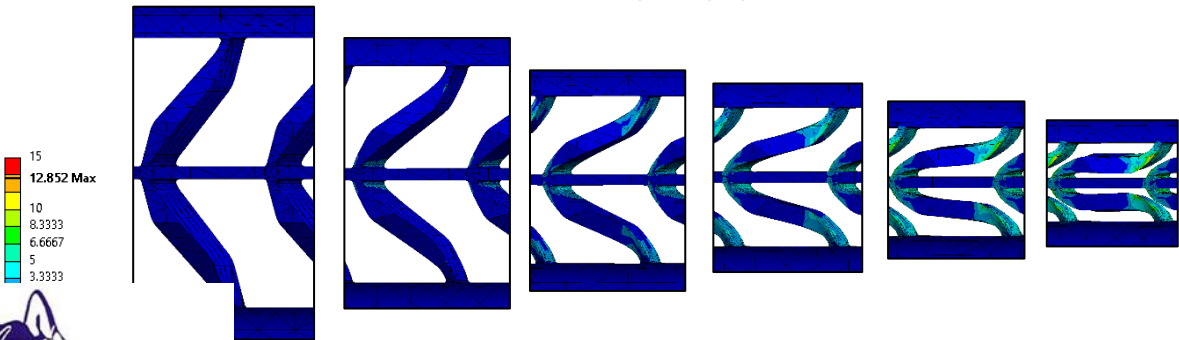
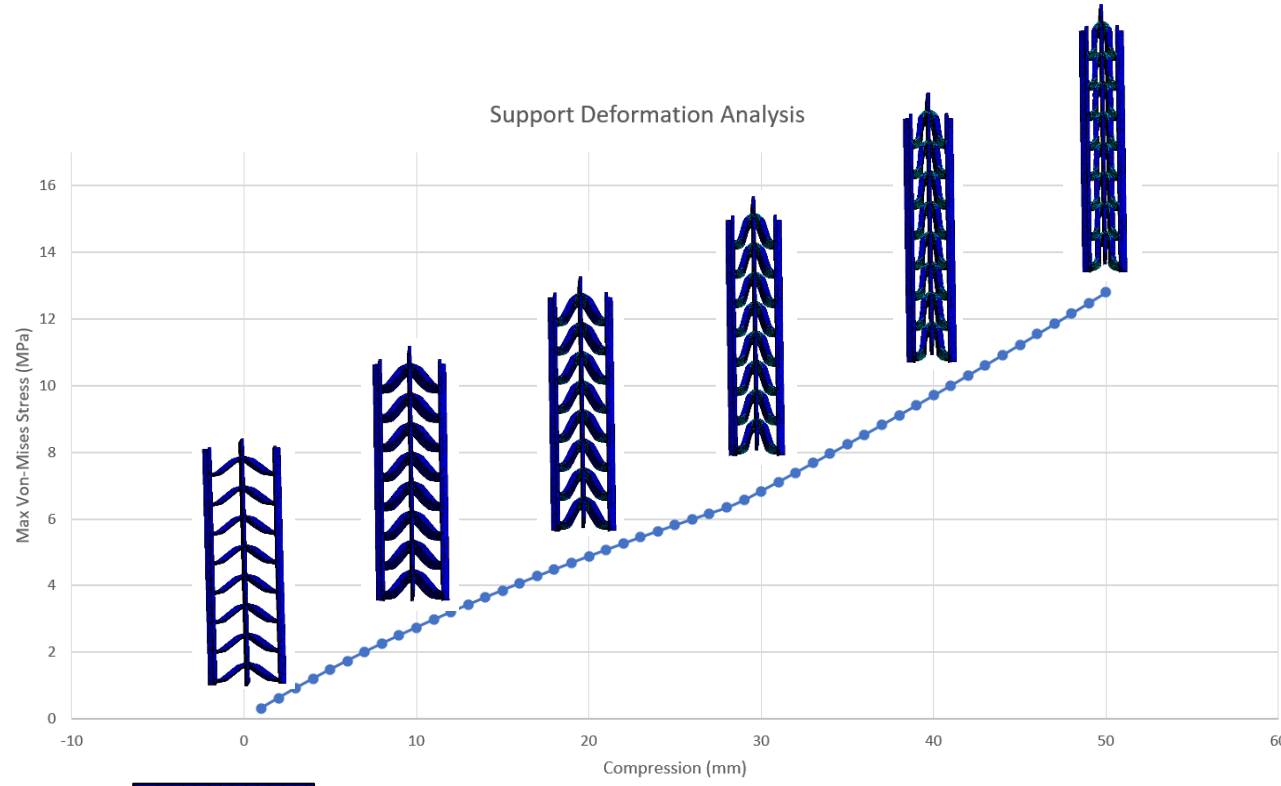
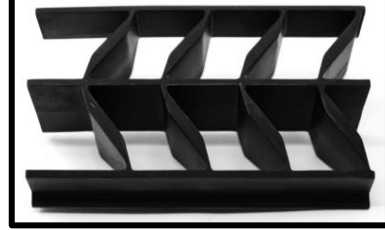


Tire Impact Pressure by Support Type

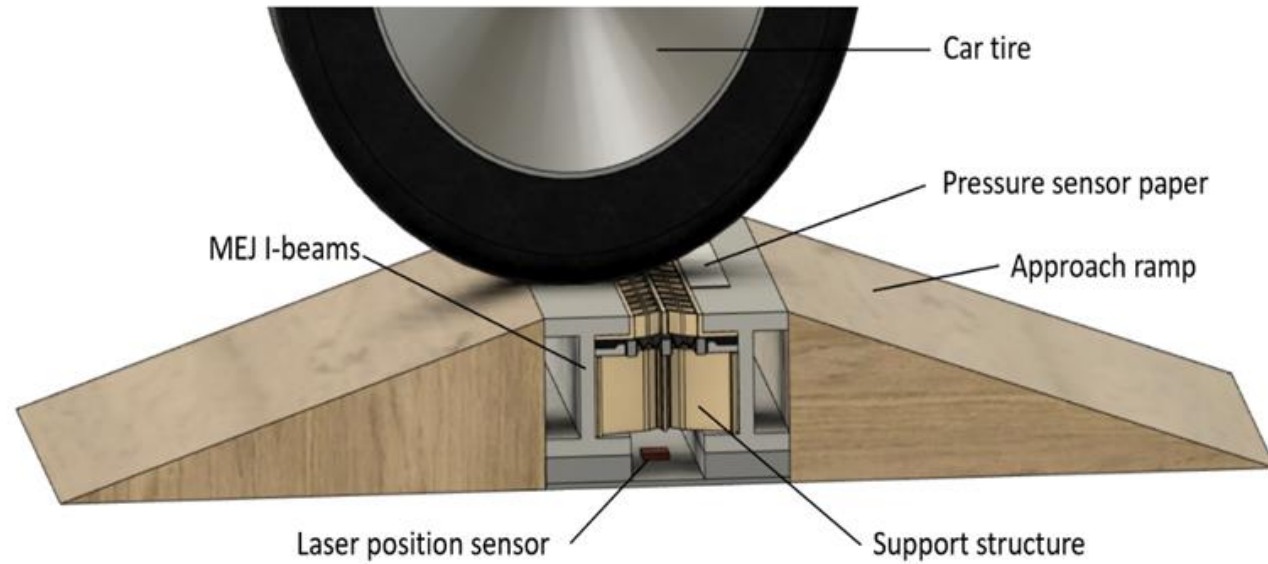
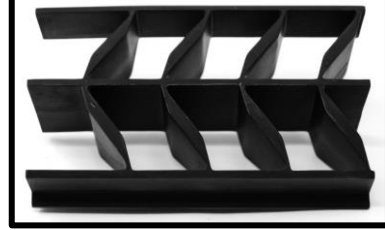




# Chevron Deformation

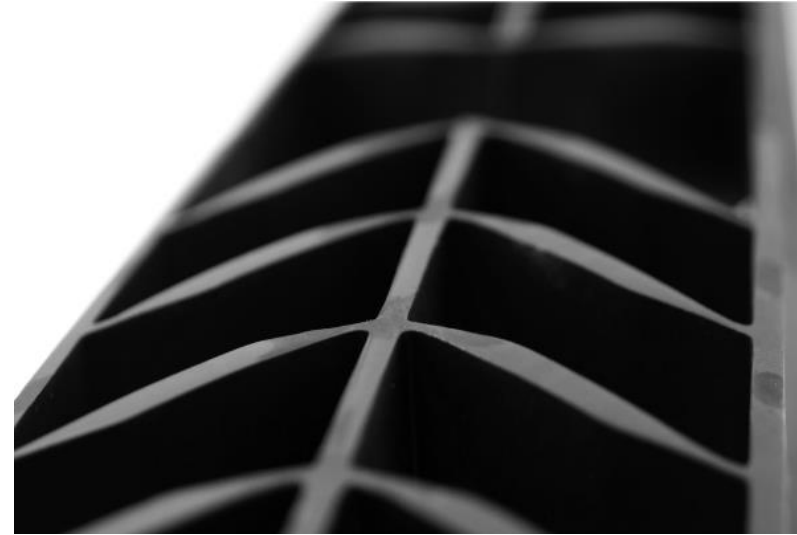
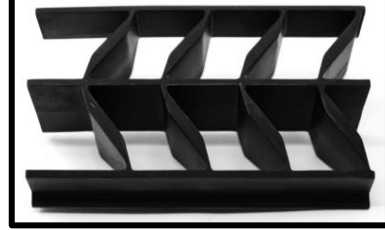


# Static and High-Speed Physical Testing



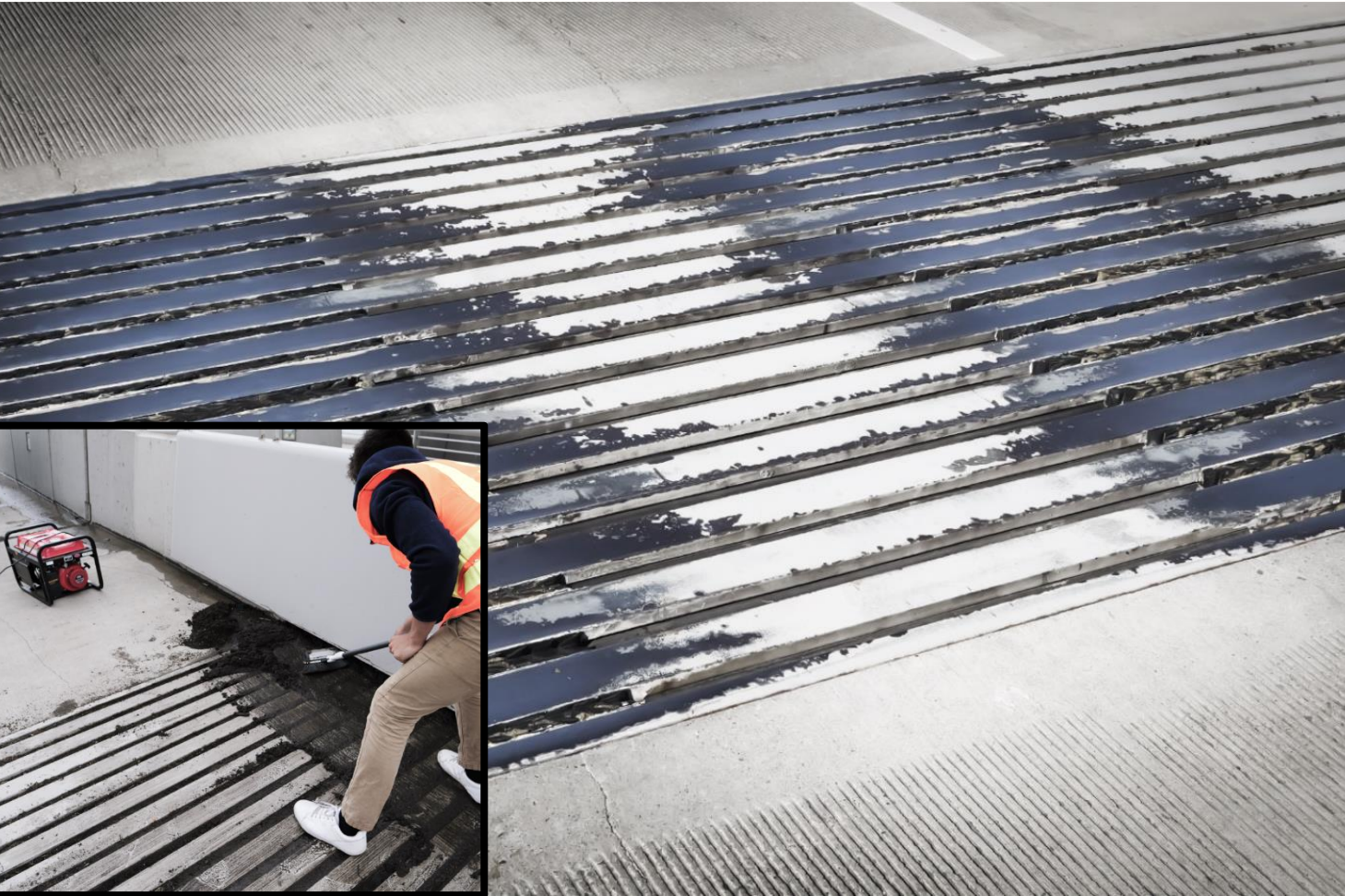
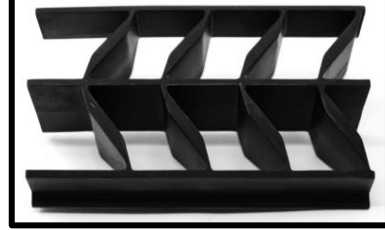


# Support Fabrication



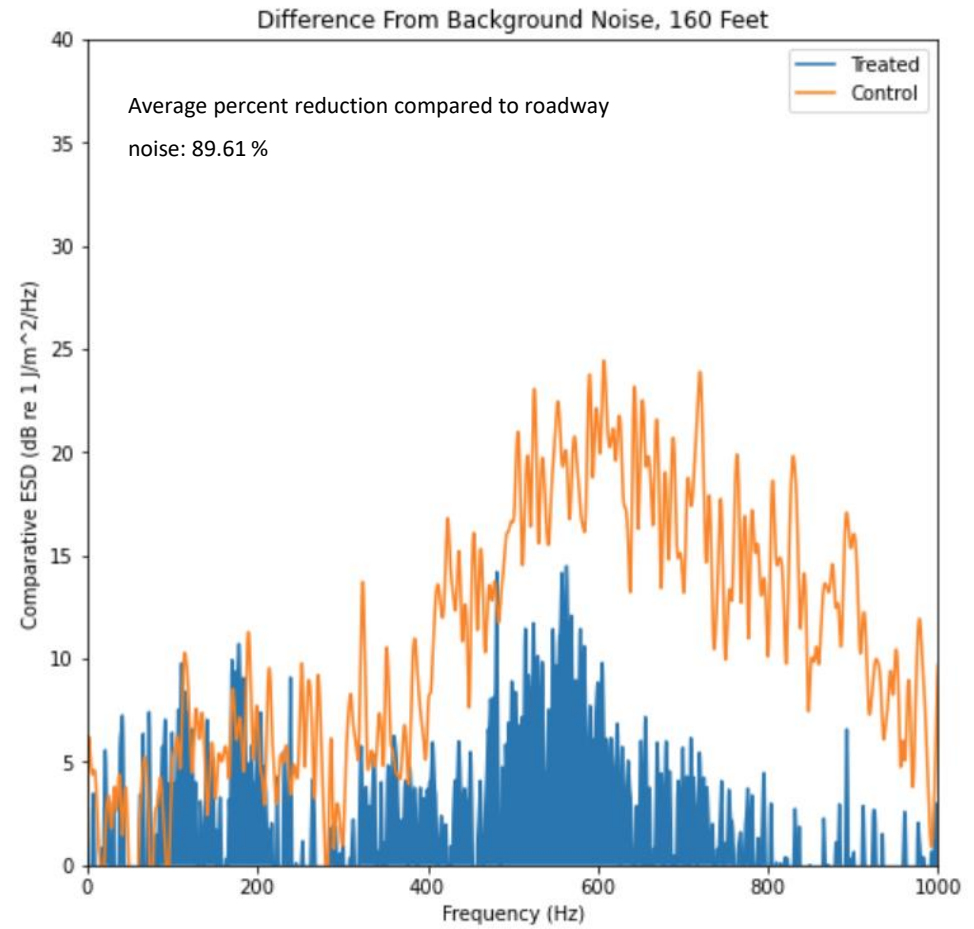
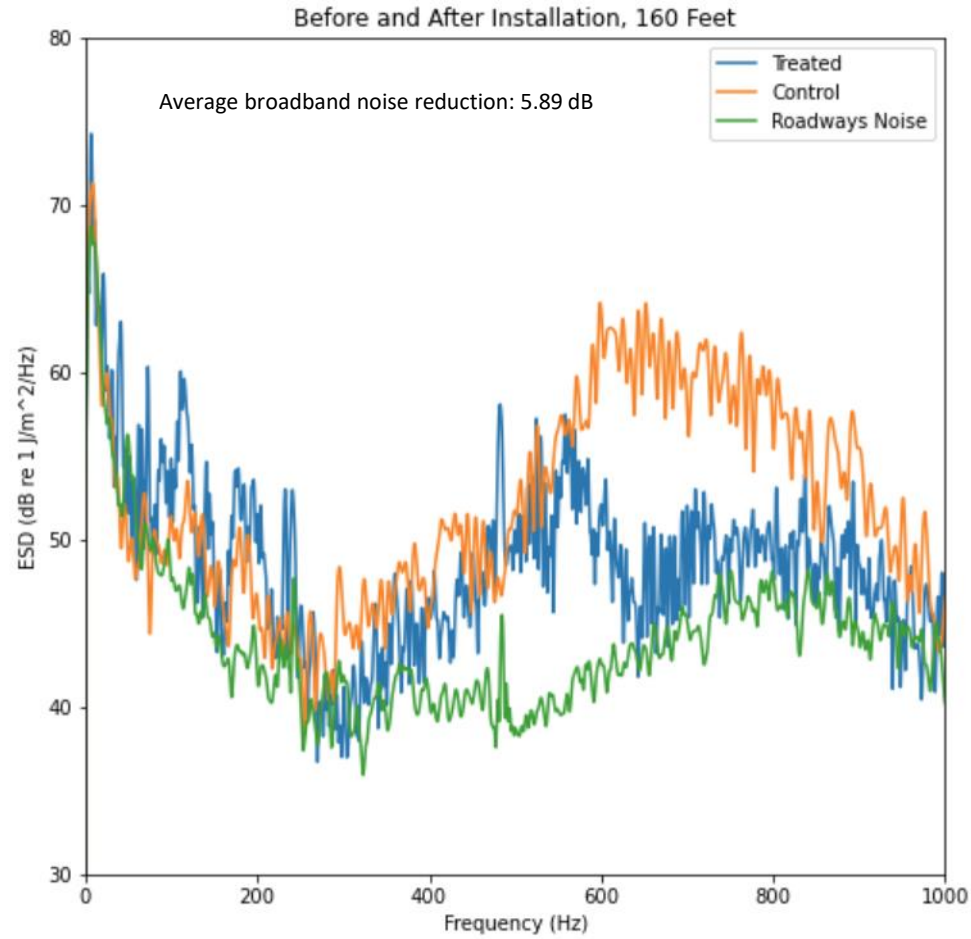
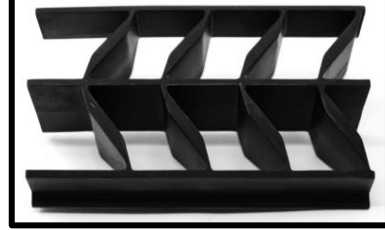


# Installation





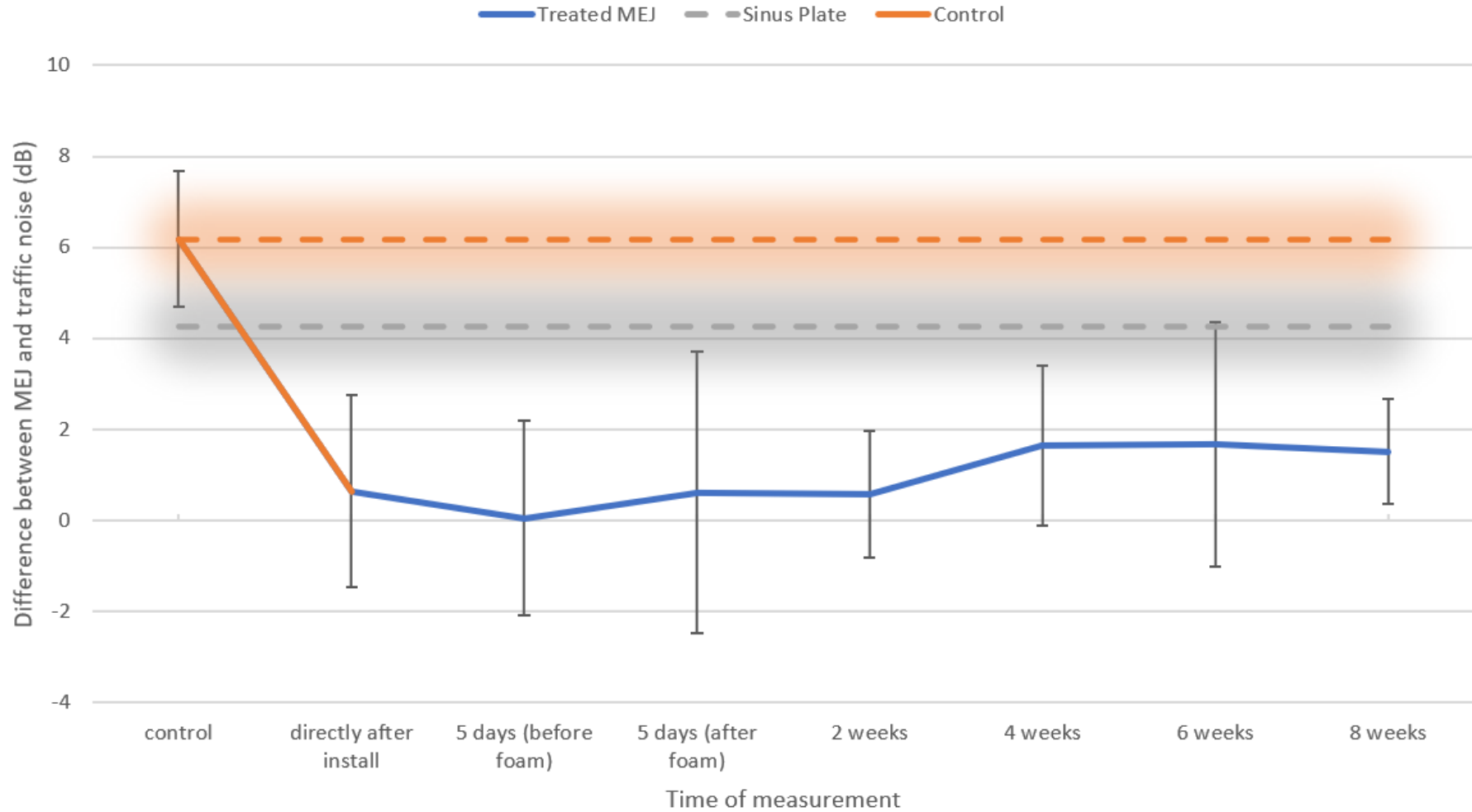
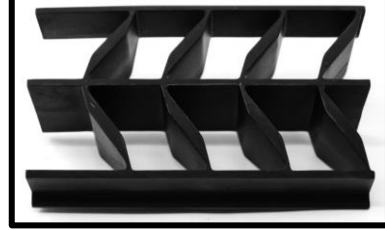
# Results





# Results Over Time

Noise Compared to Background Over Time, 160 Feet



# Phase 2 Issues

- The 3D printed and molded urethane chevrons not durable enough.
- Chevrons need to be flush with roadway to limit compression.
- The design specification of the SR 520 bridge states that the expansion joint should be able to close completely (no gaps between the I-beams).
- Foam durability



# Summary

- The polymer noise abatement system is acoustically very effective. More than 85% of the noise from the expansion joint is removed.
- The system is relatively easy to install and remove
- We believe that the treatment should be able to hold up well with time if the material is changed to a mixture of natural and synthetic rubber. The goal is a service life of 5 years.
- Further durability testing is necessary.





# **SR 520 Expansion Joint Noise Mitigation Study – Phase 2**

**Opportunities for additional investigation**

Evan Grimm, State Bridge & Structures Engineer

March, 13 2023

## Phase 2 effort: Overview & questions

Overview	Remaining Questions
<ul style="list-style-type: none"><li>• Developed an approach and materials to reduce noise generation</li><li>• Tested and validated the approach in the laboratory</li><li>• Installed materials on the SR 520 bridge to confirm the noise reduction</li></ul>	<ul style="list-style-type: none"><li>• How the system will perform over time</li><li>• How the system will impact the existing Mageba joint components</li><li>• The “cost” (materials, maintenance, staffing and traffic impacts) of this system</li></ul>

## How will the system perform over time?

- How long will the materials last, and how often will they need to be replaced?
- What happens at extreme temperatures?
- Do noise mitigation properties drop off over time?





## How will the system impact the existing joint and bridge?

- The joint is a system. Adding a foreign material to the system may have impacts:
  - Leakage
  - Need for frequent replacement
  - Roadway drainage issues
- We can't guarantee the noise mitigation material won't adversely impact performance or durability.
  - If joint gaps are inhibited from closing during high temps, it may create overstress elsewhere.
- The joint manufacturer (Mageba) hasn't been consulted. Adding noise mitigation may create warranty/support issues.

## What are the costs?

- What are the short and long-term costs to install and maintain this system?
- What will it cost to keep the system functional?
- What happens if the Mageba seals are impacted?



# Next steps – Phase 3

- Noise ✓
- Long term durability ?
- Cost ?
- Compatibility ?



# Phase 3 - Work Plan & Tasks

Budget ~ \$800k

- 1) Development of a highly durable sound attenuation system based on Phase 2.
- 2) Installation and monitoring of the system on the east expansion joint of SR 520 bridge.
- 3) Analysis of the bridge at extreme levels of joint opening and closing.
- 4) Development of tools for the installation, removal, and maintenance of the system.
- 5) Cost analysis for sustained use of the noise attenuation system





# Questions

