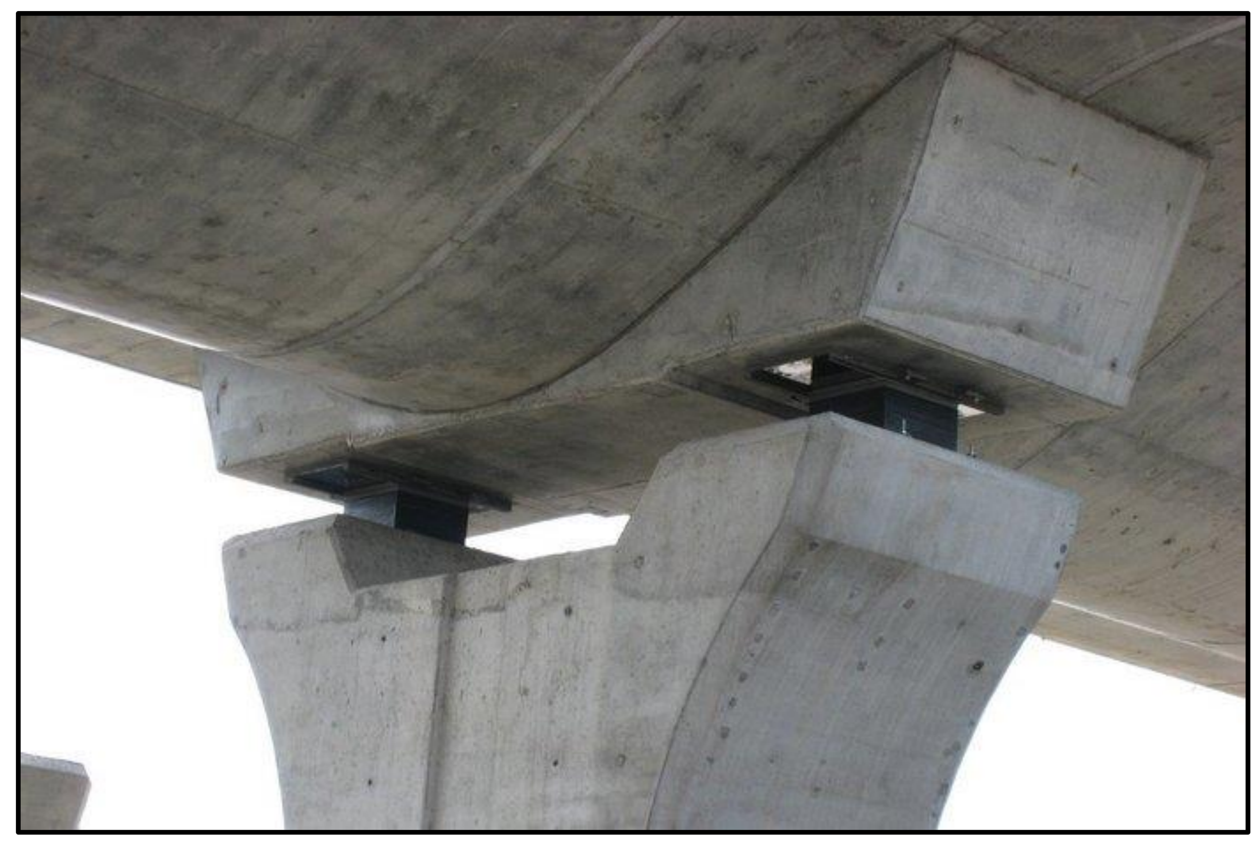
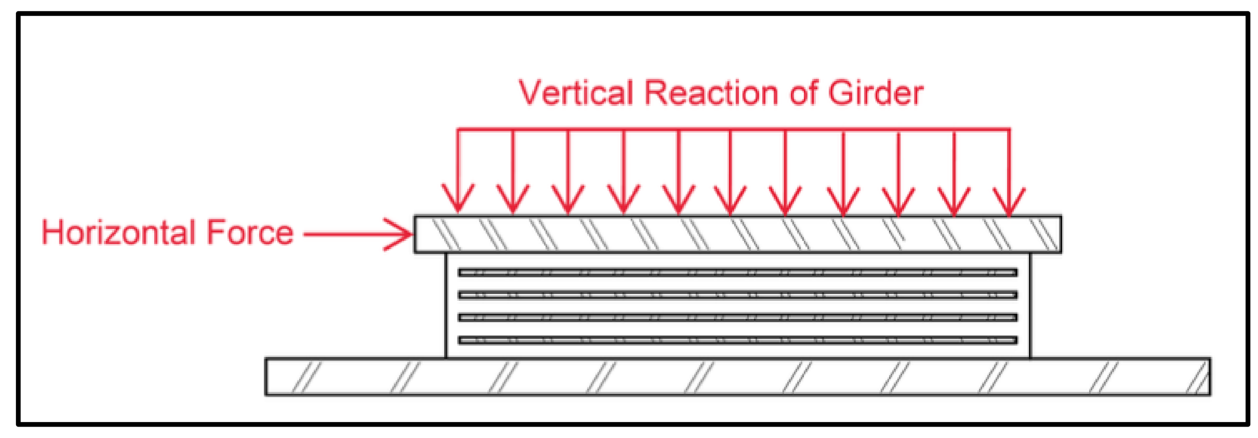
Maximum Horizontal Force and Deformation of Elastomeric Bridge Bearings

Project Description

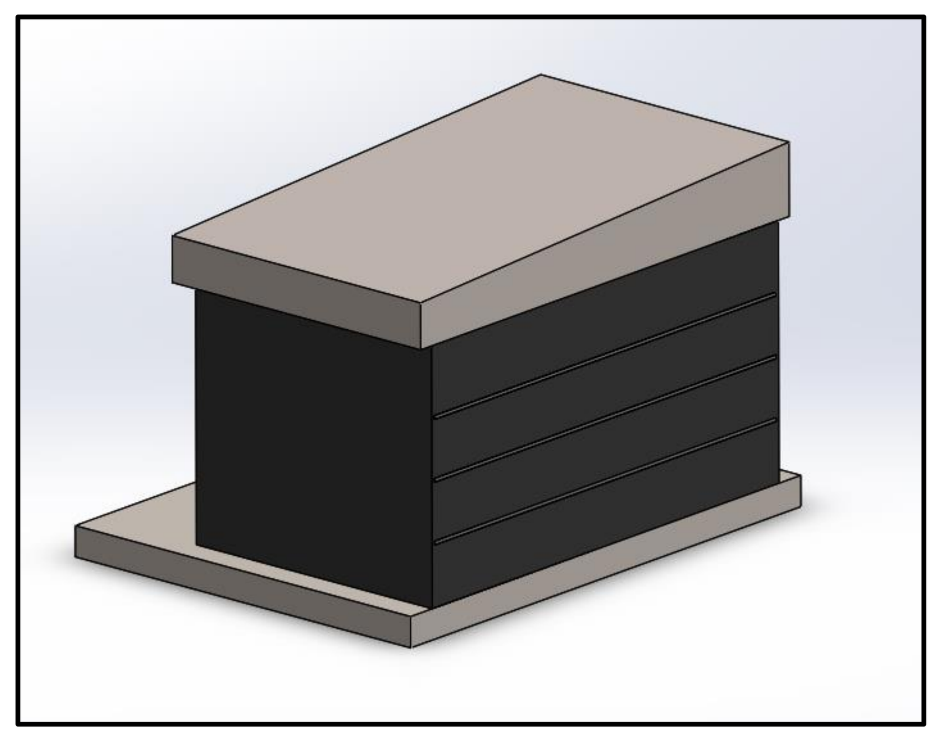
Bridges can be protected from severe damage due to seismic or extreme weather events by supporting the superstructure with elastomeric bearings. These bearings allow for vertical forces to be transferred between superstructure and substructure. It's assumed that the elastomeric bearings by NYSDOT won't experience forces large enough to cause significant damage during a seismic event. However, the maximum amount of deformation that the elastomeric bearings can withstand before experiencing permanent damage or ultimately severing is unknown. The objective of this project is to determine the maximum horizontal shear force the bearings can withstand before permanent deformation.



Elastomeric Bridge Bearing Location



Elastomeric Bridge Bearing Force Diagram



Cross-section of CAD Model of Bearing

Deliverables

- Research Paper – modeling and testing, explains how the models were calibrated based on testing results, & recommendations on how to determine the maximum horizontal force and deformation of elastomeric bearings
- FEA modeling using ANSYS
- Complete Physical Testing – design of bearing fixture for testing equipment

Progress Update

- 3-D model design of the bearing in SOLIDWORKS software
- Conceptual model discussed and approved by the DOT Team
- Research of material properties and bearing requirements in progress
- On track for more profound research of testing bearings until failure
- Research of physical testing possibilities – includes design of bearing fixture for test equipment
- Learning ANSYS for modeling and testing the bearing design

$G := 130\text{psi}$ shear modulus of 50 durometer elastomer (LRFD Table 14.7.6.2-1)

$n := 4$ number of elastomer layers

$A_{brg} := 19\text{in}\cdot 16\text{in} = 304\cdot\text{in}^2$ area of elastomer

$K_{brg.exp} := \frac{G\cdot A_{brg}}{n\cdot h_{rt}} = 26\cdot\frac{\text{kip}}{\text{in}}$ stiffness (LRFD Equation 14.6.3.1-2)

Example Expansion Bearing Stiffness Calculation

$$H_{bu} = GA\frac{\Delta_u}{h_{rt}} \qquad (14.6.3.1\text{-}2)$$

where:

G = shear modulus of the elastomer (ksi)
A = plan area of elastomeric element or bearing (in.^{2})
Δ_u = shear deformation from applicable strength and extreme event load combinations in Table 3.4.1-1 (in.)
h_{rt} = total elastomer thickness (in.)

Force due to deformation of elastomeric element

Component	Material	Standard	Yield Strength, Min. (ksi)	Tensile Strength, Min. (psi)	Ultimate Elongation, Min., (%)
Rubber Bearing	Neoprene (Grade 50)	D412, D746		2000	400
Masonry Plate	Steel	A36	36	58	~23
Internal Plate	Rolled Mild Steel	A36	36	58	~23
Sole Plate	Steel	A36	36	58	~23

Table of Components and Material Requirements

Mr. Andrew Esposito

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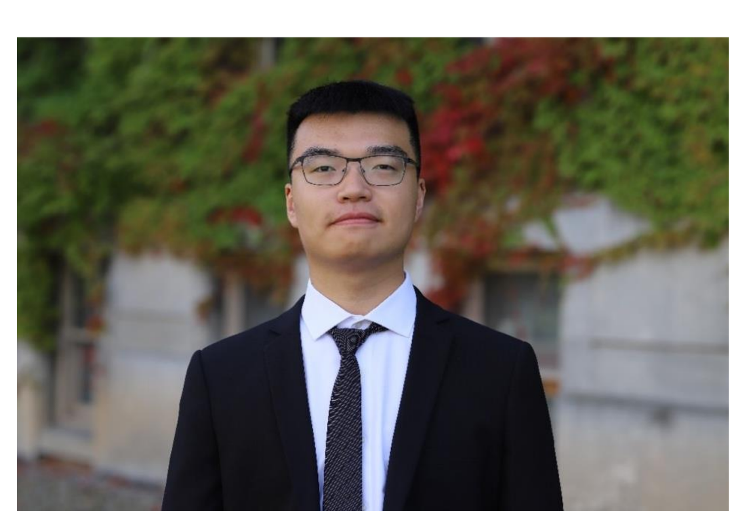

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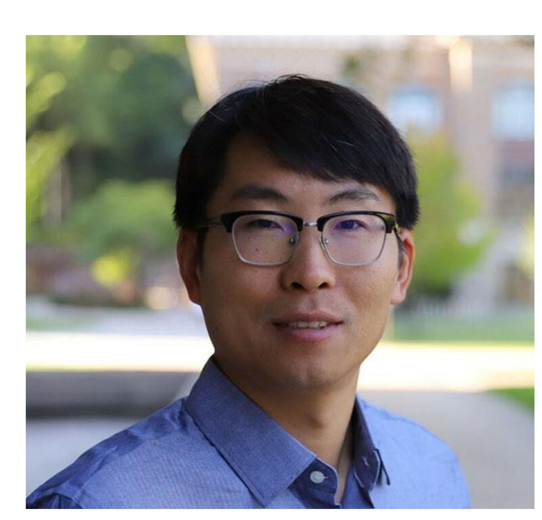

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