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Development of Prototype Lightweight Buckling Restrained Braces

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Background and Objective

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- Steel braces are good at supporting building frames. However, they are prone to buckling when undergoing dynamic loading.
- Buckling Restrained Braces (BRBs) help alleviate this problem.
  - Connections for buildings to dissipate seismic energy
  - Metal core confined within a restraining member.
- Additive Manufacturing (AM) allows to manufacture a lightweight restraining member
- **Objective**: Feasibility of AM for component manufacturing for BRBs

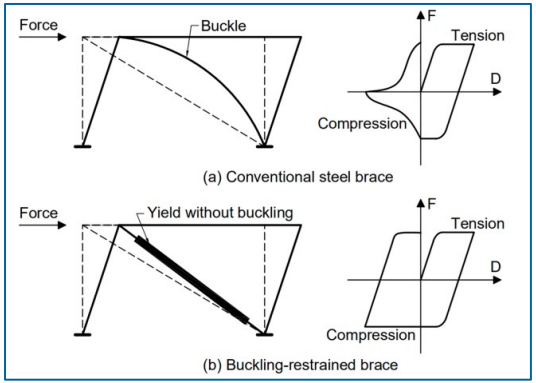


Fig. 1: Behavior of a frame without and with a BRB

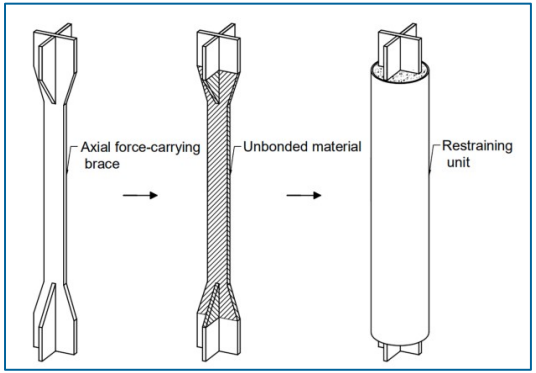
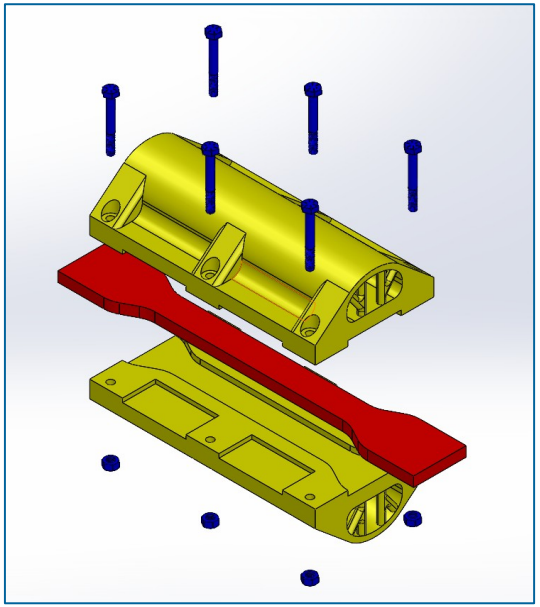


Fig. 2: Example of a BRB

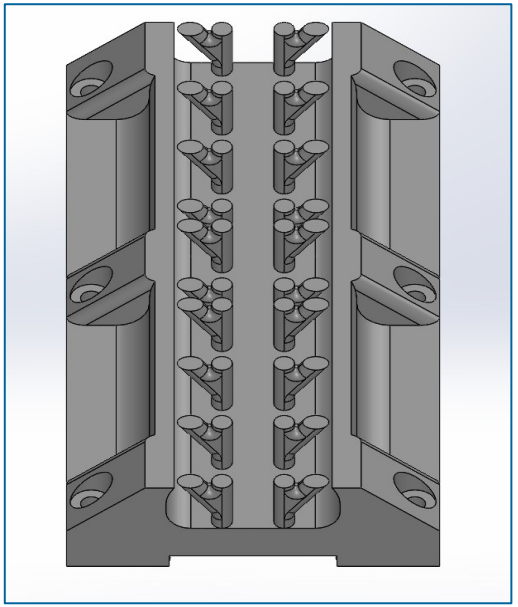
Methods

Methods

- Designing the model: Solidworks
  - Optimizing Stiffness-to-Weight ratio. Prototype is 8.5625” long, 4.5” wide, and 2.05” tall
  - “Branches” transfer the load from the boundary to the curved surface
  - Yielding Core: 13.5” long, 7.125” yield length, 0.38” x 1” cross section



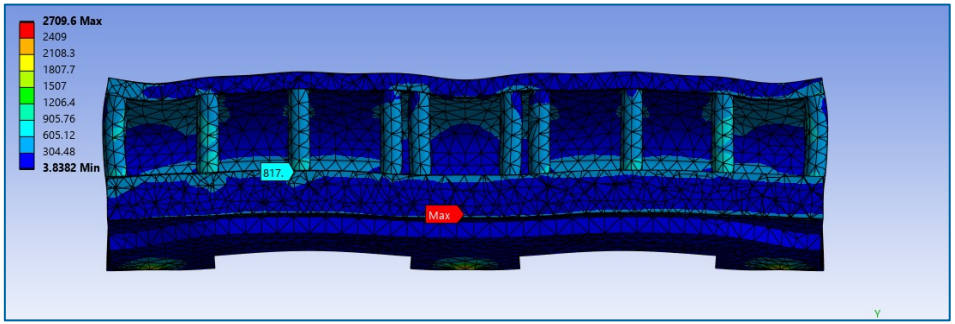
Overall Assembly

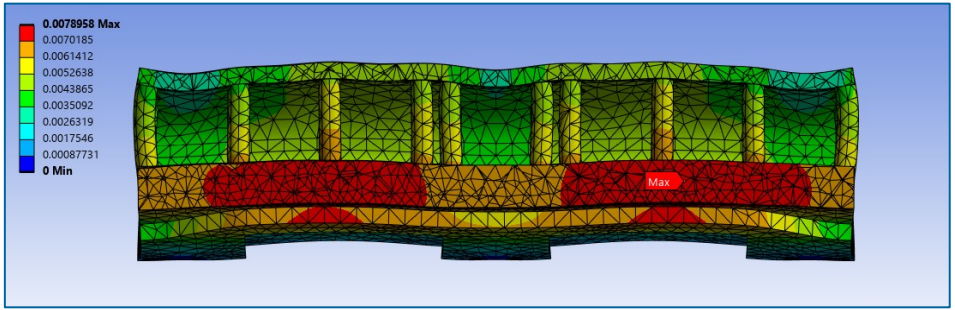


Restraining Member Cross section

Methods (continued)

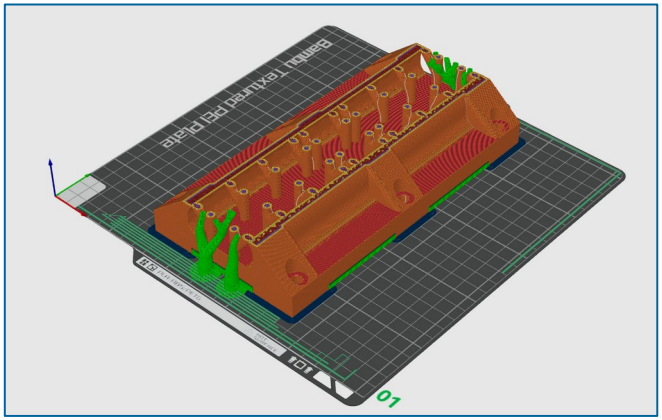
- Finite Element Analysis (FEA): Ansys
  - Structural Analysis:
    - 1250 lbf in the yielding zone
    - 2709 psi maximum stress
    - 0.0079 in max displacement

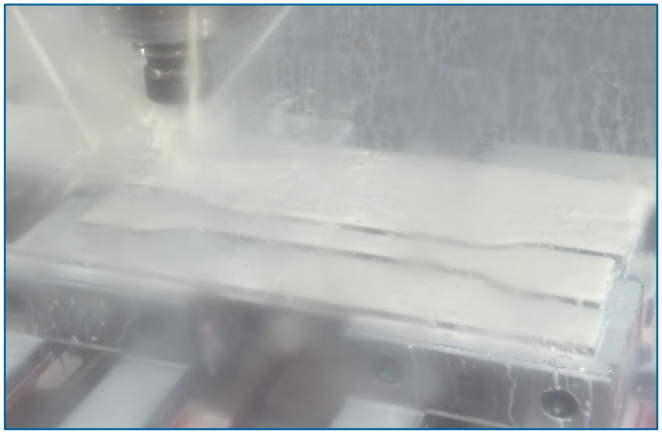




Methods

- Fusion Deposition Modeling (FDM) Printer: Bambu X1-Carbon
  - Filament: PLA-Matte
  - Bambu Slicer: triangular infill pattern, 30% infill, 4 wall loops, supports on build plate only, brim to minimize warping.
  - Clearance: 0.01” with 0.4mm nozzle
  - 9 hours and 5 minutes print time
- CNC Machined Aluminum Core: 6061-T6



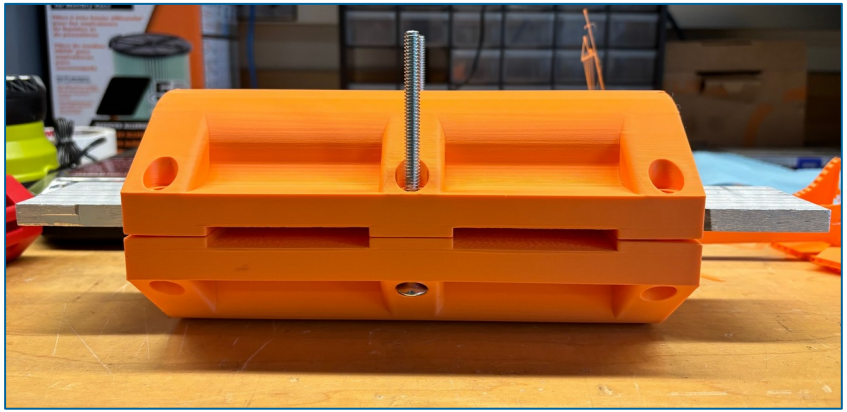


Prototype

Prototype



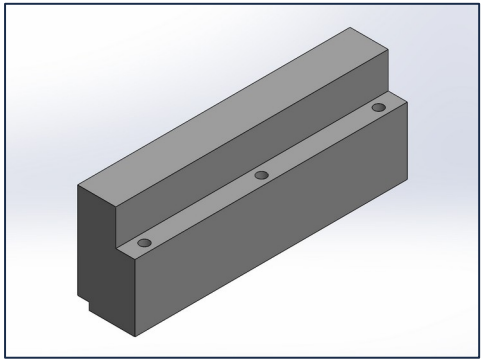


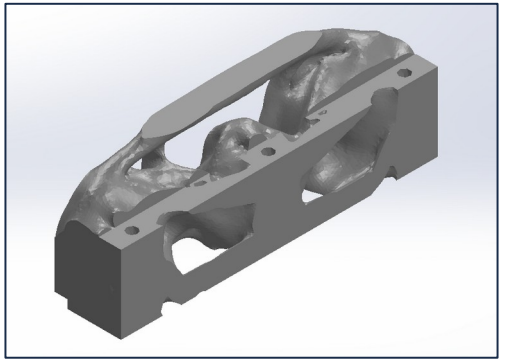


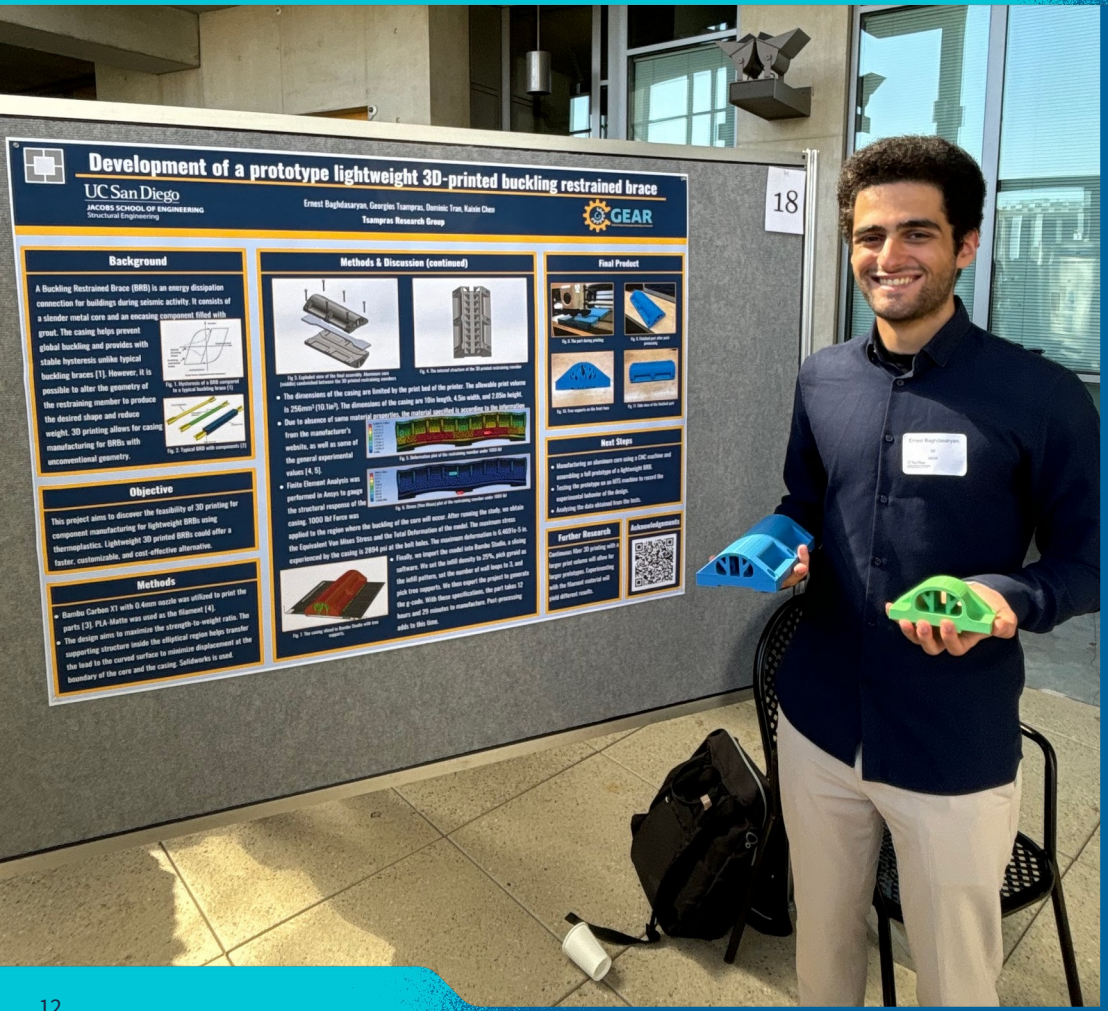
Conclusion and Further Research

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- 3D printing allows for rapid prototyping to show proof of concept. Larger print volume will allow for full scale manufacturing.
- High-end and advanced materials, such as steel and carbon-fiber polymers, can be used to manufacture functioning parts.
- Topology Optimization is a useful method with assisting with final geometry.







Acknowledgements

I want to express my utmost gratitude to Professor Tsampras and Tsampras Research Group for their guidance and support throughout the project.

Thank you GA for allowing me to continue my project in the summer and take classes at the same time.

Things I've learned:

- Read and understand research papers
- Research processes and academia
- CNC Milling
- Advanced CAD skills
- Analysis and Topology Optimization
- 3D Printing: equipment, materials, etc.

Thank you!