Owens Corning's eLUGant Designs

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Background

Owens Corning has several fiberglass fabrication plants across the US. As part of the fiberglass manufacturing process, the molten glass must be extruded through a bushing which is held against the molten glass channels by a frame supported with 8 lugs. Due to the design of the system and the sensitivity of the bushing, lugs can easily be overtightened, resulting in expensive repairs.

The eLUGant Designs team's mission is to design a fastening system that will secure the frame with an easy and consistent application. For this project, the team used several techniques such as material and environmental simulations to come up with iterative designs that will lead to the best solution.

Objective and Requirements

The eLUGant Designs team will provide Owens Corning a working prototype that will improve their manufacturing process with the following specifications:

1. Applies 200-300 pounds of force on the frame
2. Withstands temperatures up to 1100 °F
3. Resists corrosion from high humidity
4. Integrates easily with little to no skill
5. Costs less than $30 each

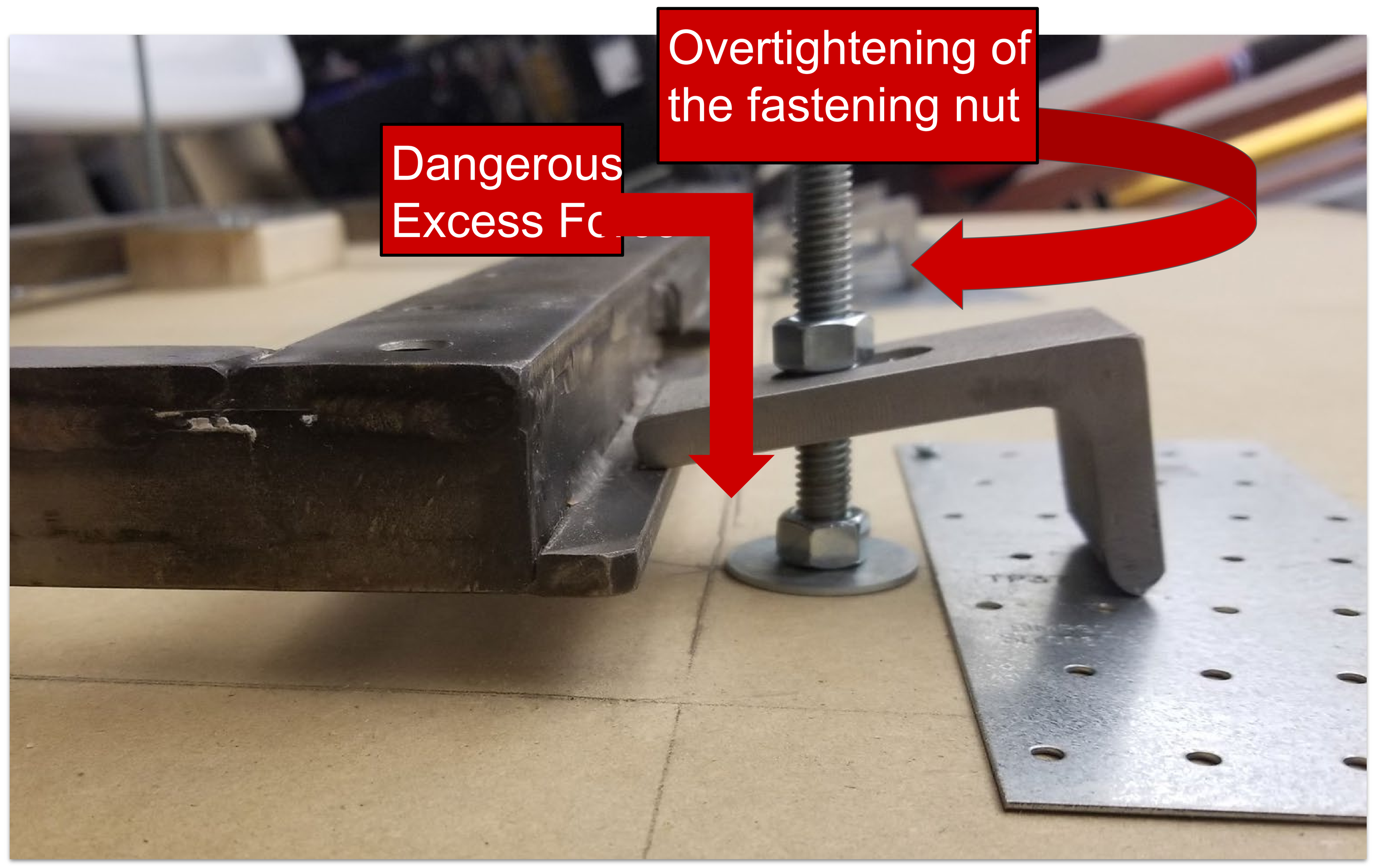

Figure 1. Current lug and frame system within the Owens Corning manufacturing plants.

Methods and Materials

The team is following the test and production plan to optimize a design that meets the requirements:

1. **Design Development**- Brainstorming a design that meets the necessary requirements.
2. **Design Analysis and Optimization** - Conducting finite element analysis (FEA), physical testing, and static force analysis to iterate through design adjustments in order to meet the application specifications.
3. **Manufacturing and Material Considerations**- Analyze viable manufacturing processes and materials for the prototype that are cost effective and efficient for the design using FEA.

Figure 2. 3D Printed Lug in physical testing setup.

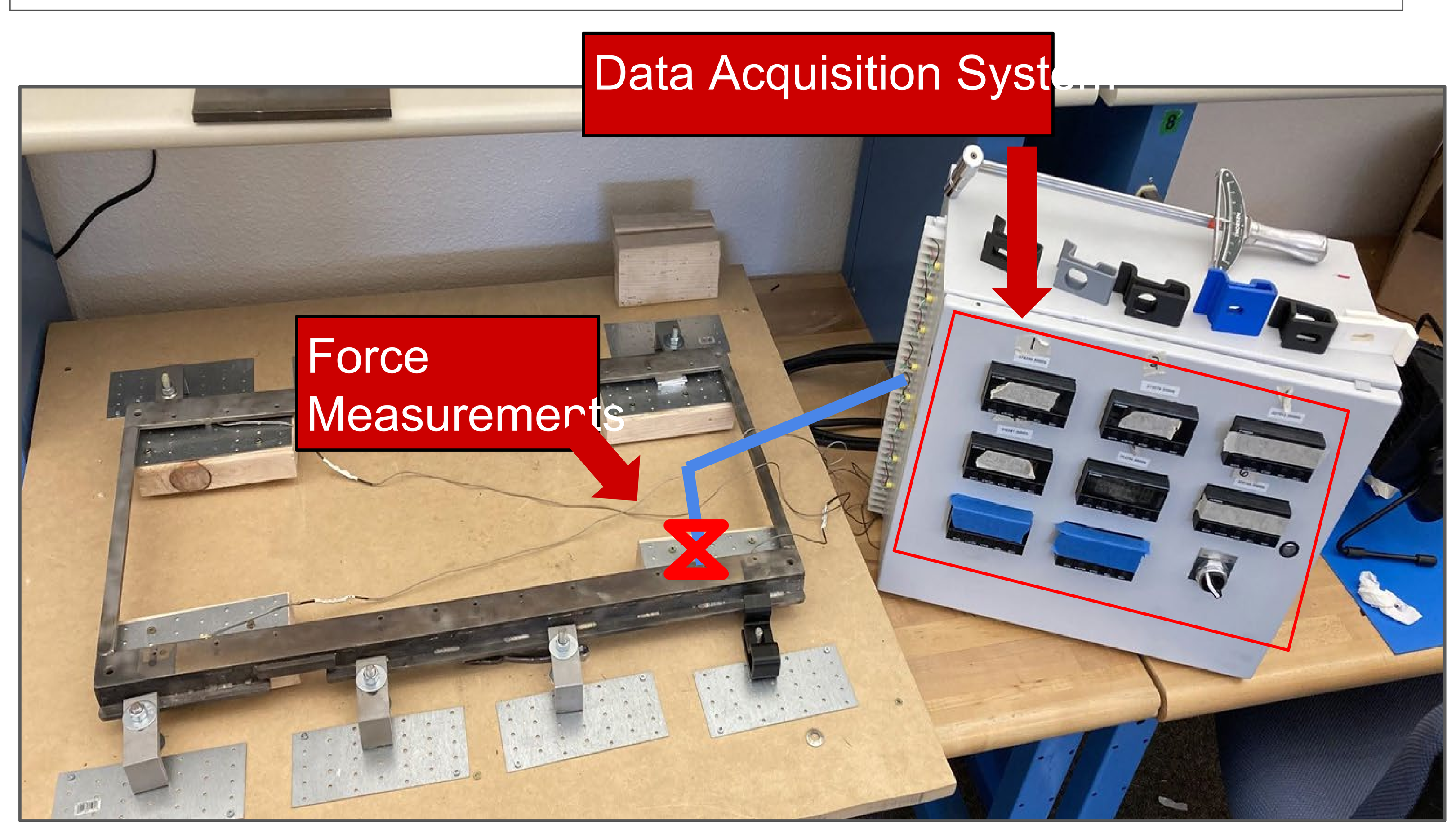

Figure 3. Physical testing setup with data acquisition system and adjustable mock frame with 8 testing locations.

Results

Our FEA results from previous semesters demonstrated a diversion of force from the frame into the above structure of about 53.7% which made the concept attractive to pursue further. Our physical tests which have been conducted on the testing bed outlined in Figure 3, has indicated that the "force dump" functionality is working in the way we theorized, as such the team sought out to find a material for this design that would have the same spring-like properties as a PLA 3D print at 45% infill density. The team has chosen to determine the material based on FEA and the considered materials can be seen below.

Material	Yield Strength	Price	Ranking
Ni201	103 MPa	$28/kg	1
Structural Steel	240 - 470 MPa	$0.55/kg	3
Carbon Steel	490 MPa	$0.66/kg	2

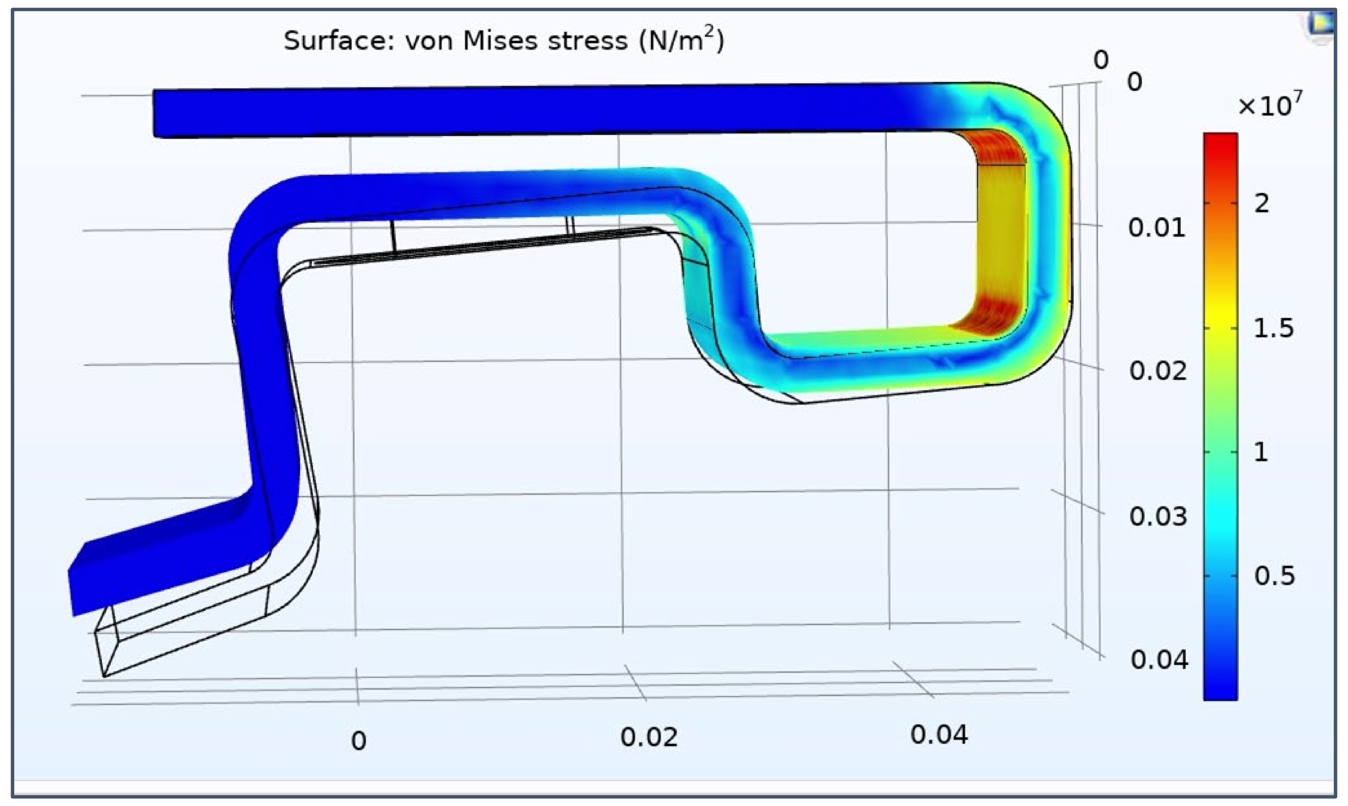

Figure 4. FEA results for design in figure 2 (final design), a total of 1740 pounds of force are transferred to the frame for a total of 43.5% of the original input force.

Conclusion

The team has iterated through several designs by using tools such as finite element analysis and physical testing. We have concluded that the outlined design is our best recommendation for a fastener to Owens Corning. This design should be made from a Nickel Alloy due to its formability and heat resistance, in particular, we suggest Ni-201. Based on our design's geometry, we suggest that they be manufactured by a roll forming or bending process. We recommend the "wire bending" process commonly used to bend thick strips of wire. Our final design considerations about the design will be outlined in a comprehensive report requested by Owens Corning.