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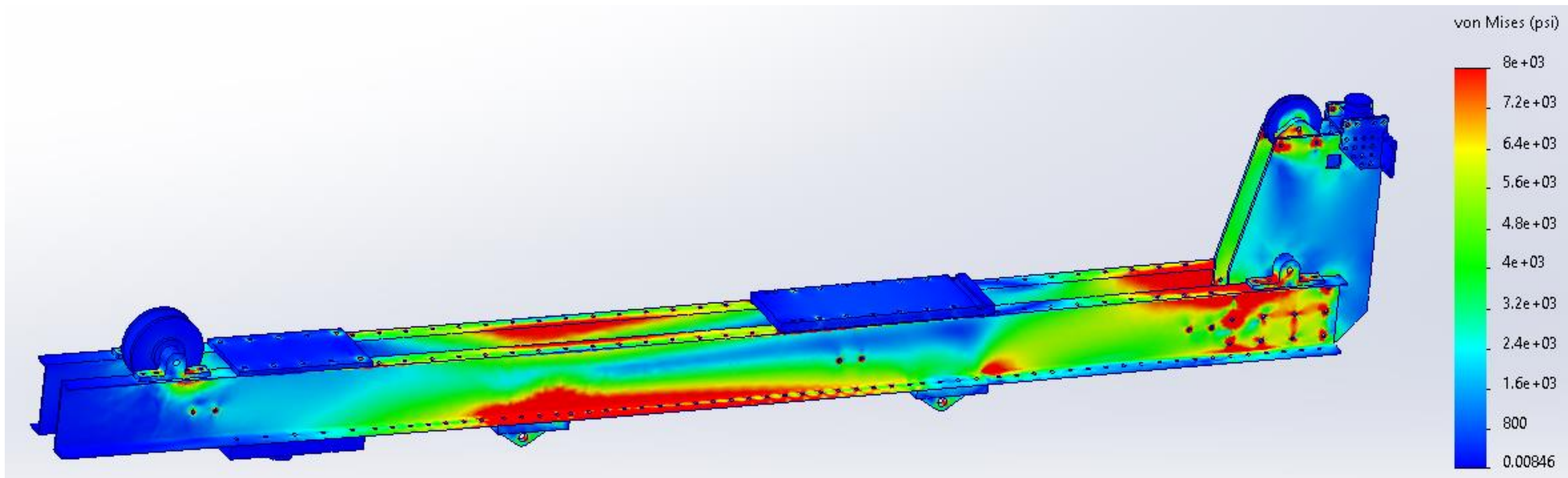

Modeling and Analysis of the 300 ft Drop Tower Incline Trolley

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Abstract

This project aims to explore the design and capabilities of the 300 ft Drop Tower Incline Trolley. The trolley was measured and modeled for further analysis. Finite element analysis is being performed to examine the trolley's response to loading. Aspects of its design are investigated to determine their applicability to a new trolley design for the 185 ft Drop Tower.

Introduction

The Drop Tower Facility performs mechanical testing at Sandia National Labs' Validation and Qualification Sciences Experimental Complex. A wide variety of drop tests can be conducted, including drops from a trolley moving on an incline. This project focuses on the trolley currently used with the 300 ft tower. From this tower, the trolley can drop a test item from up to 265 ft above the ground while in motion. Depending on the requirements of each test, items can be dropped into individually-designed targets or a 50-ft-deep lake with an extension down to 80 ft. A rocket pulldown can be used to achieve higher impact velocity and varying impact angle.

As the trolley is a critical piece of equipment moving important test items, it must be well-understood. Further, a second trolley will be designed for the 185 ft tower, which has a significantly higher loading capacity. Studying the former, including potential risks of failure, allows a better understanding of its function. The latter can then be designed with this information at hand, informing changes to be made for improvements such as greater efficiency, enhanced safety, or even new capabilities.

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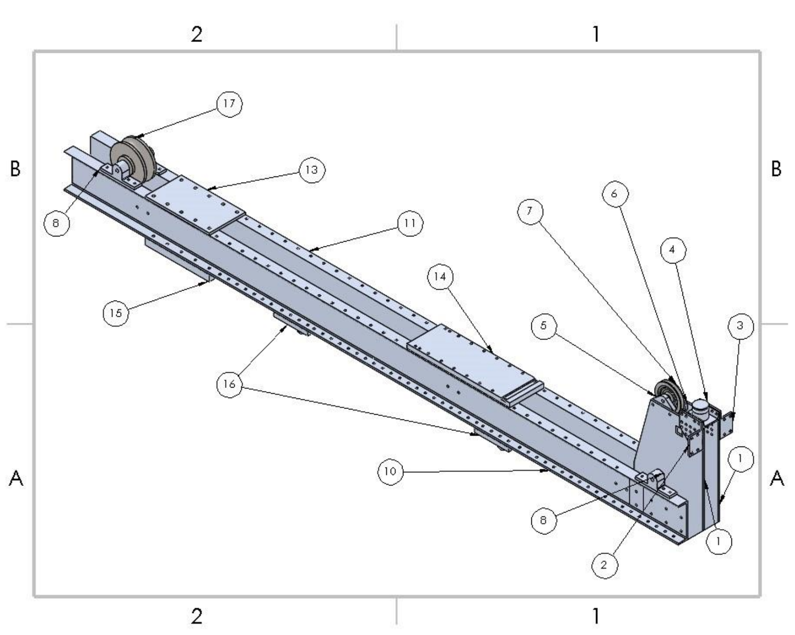
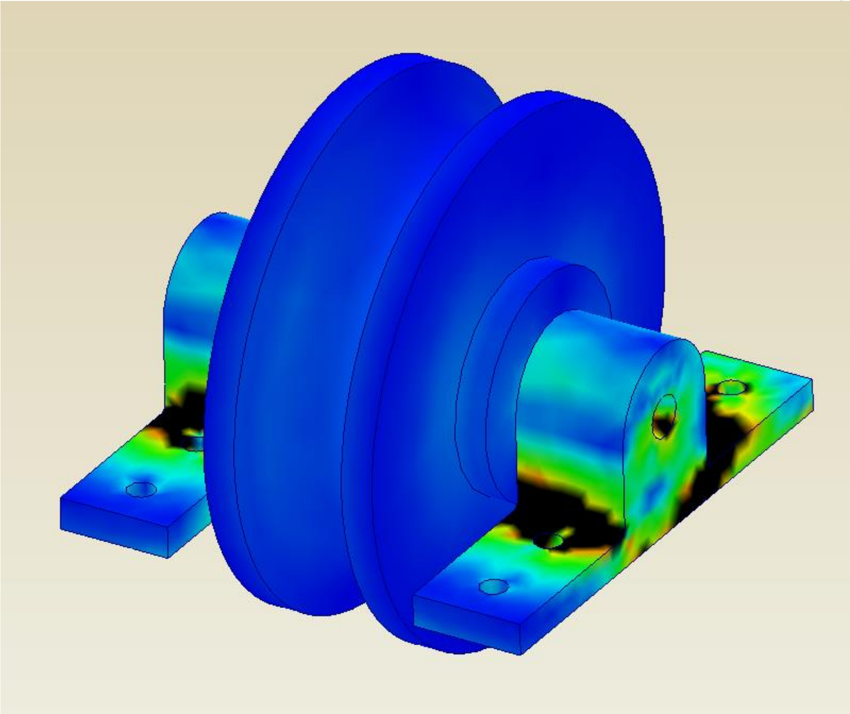
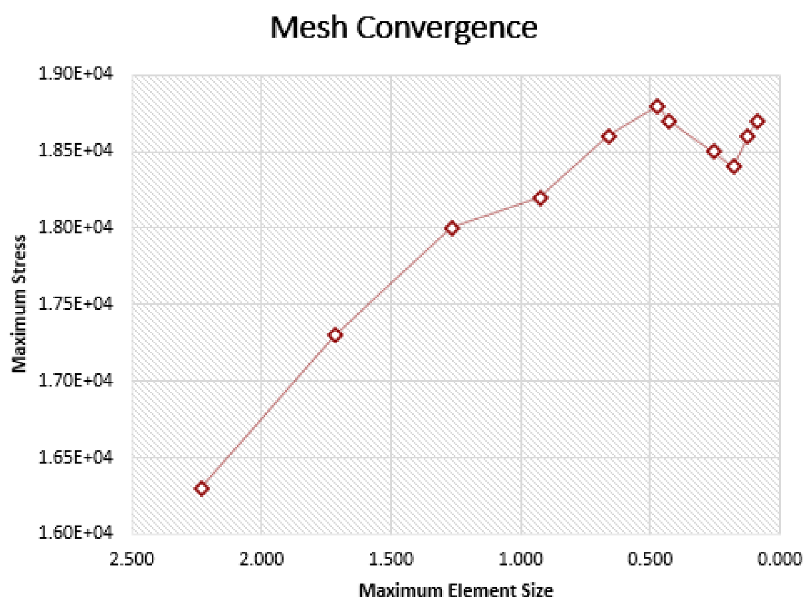


Drawing of the full trolley assembly.



Stresses on and around one sheave.



Results of a mesh convergence study.

Methods

First, dimensions of each component of the incline trolley were measured or estimated. Where feasible, measuring tape was used directly on the trolley for accurate results. However, some parts were not easily accessible. Pictures were taken so that they could be used to clarify unclear aspects of the design, including any remaining dimensions.

The trolley was then modeled using SolidWorks. Drawings of the full assembly and each separate component were made.

With the model complete, finite element analysis using SolidWorks Simulation was performed to investigate the mechanical performance of the trolley. To ensure reliable results, mesh convergence studies will be performed on each component of the trolley. This isolation ensures that each is simulated with adequate detail. Mesh control will then be applied in full assembly simulations for the best results. Throughout this process, stress anomalies in SolidWorks will be located and addressed to mitigate their effects on the results.

Each component will be individually investigated. Maximum stress, stress concentrations, and any areas that exceed the yield stress of the part will be investigated. Then, the full assembly will be analyzed similarly. Areas of high stress will be noted. Predicted displacement, especially under high loading, will also be considered.

Discussion

With the results of this project, the current trolley will be better understood, and design changes for the new trolley can be considered. This project modeled the existing trolley with a reasonable level of accuracy, leaving only a few uncertainties that can be clarified in the future. The analysis will mitigate the limitations of finite element analysis software to allow high confidence in the results.

Once analysis is complete, locations and values of high stress and displacement will verify expectations or call attention to unexpected results. Implications for the new trolley design can then be considered. Results can indicate where to strengthen weak points, conserve material, or otherwise increase performance for tests. Further, they can indicate how the new trolley can be designed with a greater capability for testing. In particular, performance of this design informs design changes that must be made so that the new trolley design can match the much higher loading capacity of the 185 ft tower.

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