Rubber Guardrail Optimization

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INTRODUCTION

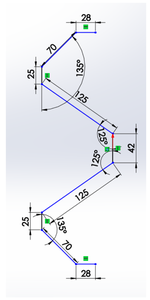
I attended the University of Comillas Pontificias during the summer of 2018 for two months in Madrid, Spain. At this university I worked on a research project regarding guardrails. The objective was to analyze whether or not a rubber layer over the guardrail would add enough protection to warrant the cost. A balance between the rubber and metal thickness could be achieved while optimizing cost and still maintaining a desired level of safety.

ANSYS:
The first step in my research was to become familiar with the software Ansys. Ansys is a powerful tool used by engineers to simulate many engineering problems such as finite element analysis or computational fluid dynamics. I practiced learning the finite element capabilities in static structural and explicit dynamic problems.

3D Modeling:
The second step was to create a model of a guardrail. This was done by looking at the image of a guardrail to base the shape and dimensions off of. Most of the modeling was completed in Solidworks with some additions being made in Ansys Design Modeler.

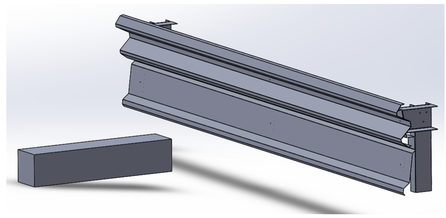
3D MODELING

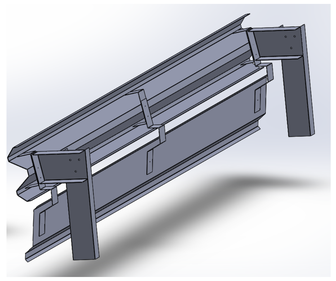
- The guardrail was created by the assembly of two guards that are connected by thin metal pieces and supported by metal posts.
- The guards were drawn using a line and then extruded to have a thickness and length.



The figures on the left is the shape for the upper guard and the shape on the right is the shape for the lower guard. They are connected by thin pieces of metal..

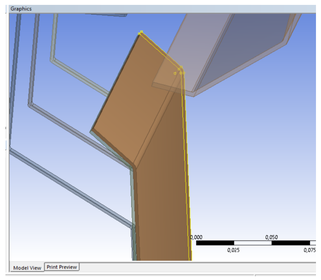
3D MODELING CONT.





The above figures are the fully assembled views of the guardrail in Solidworks.

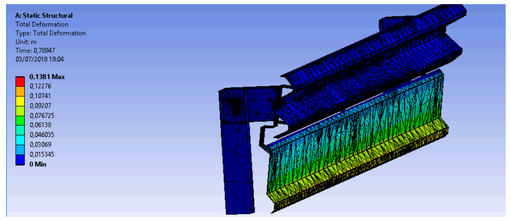
The above figure shows a better view of the connection between the guards and the stands. The purple is the upper guard, the blue is the connection to the support, the green is the support, and the red and yellow are connectors leading to the lower guard.



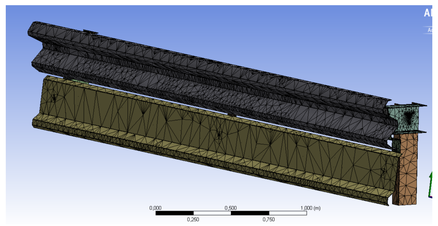
After completion of the model in Solidworks, a layer of metal and a layer of rubber were added to the guardrail in Ansys Design Modeler. They were created as parameters with variable thicknesses in order for the software to optimize their thickness to obtain the desired results.

ANSYS SIMULATIONS

Static Structural
The first simulation performed was a simple force placed on the guardrail. This was done in order to test if the guardrail model was functioning properly with all of its connections and supports.

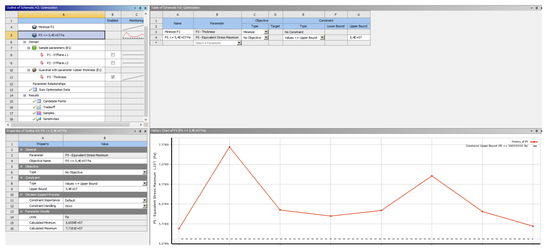


The figure above is the results from the static structural analysis.



The figure above shows the mesh used to perform the dynamic analysis optimization.

- Ansys was used to optimize the guardrail as a projectile crashes into it by minimizing the total thickness of the rail while keeping the deformation of the projectile under a specified value.



The figure above shows the software used to generate plots of the optimization results

- Ansys was able to take into consideration the different variables as well as uncertainty in other values such as the projectile velocity.

RESULTS

- There was not enough time to do enough simulations to reach an exact optimal solution. Much more testing needs to be done at different speeds and materials.
- Certain trends were able to be seen by the results. The rubber did seem to have a significant effect on the deformation of the projectile, but as the rubber got thicker its effectiveness began to increase by smaller amounts.
- The ratio of metal thickness to rubber thickness did not remain constant based off of the projectile speed and deformation limit.
- Other tests that could be done include different thicknesses of the connecting components.

CONCLUSIONS

Ansys is a powerful simulation tool that can be used in a variety of engineering applications. It was useful in this project to discover the effect of adding rubber to guardrails. I hope to develop more experience with Ansys in other topics of engineering.

ACKNOWLEDGEMENTS

Professor Jesus Jiminez

Professor Francisco Jose Valdez

For supervision and resources for the project

ILLINOIS