Pavement Tester

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Agenda

- Project Overview
- Problem Definition
- Concept Generation and Selection
- Modeling, Testing and Analysis
- Final Design
- Questions

Project Overview

Design and create a stationary linear mechanical device that would be able to measure the vertical distance a fixture (blade, tire, etc.) goes into a road sample surface in regards to a specific reference point and accurately measure that distance. The machine needs to allow the test specimens to be replaced as well as be user-friendly.

Problem Definition

- UDOT Survey

Max LengthxWidthxHeight	8x8x4 ft
Test Material	Small sections of road samples
Snow Plow Blade Size	Cut to length
Power Supply	110 and 220
Environmental Conditions	Snow, freezing temps, winter conditions
Tire size/type	Small Car
Willing to Pay	$10-20K
Sample	asphalt or concrete
Control the Load	Ability to change the load

- UDOT 3 years and 3 miles

Existing Customer Specifications

Permanent Specifications	Metric	Units
Data Storage	Removable internal Solid-State Drive	GB or TB
Testing Road Surfaces	Able to access sample easily	y/n
Safety	Hearing and Eye Protection Required	y/n
Ingress Protection	IP56 Rating	y/n
Material and Parts Cost	<$5000	US Dollars
Max Length x Width x Height	10x8x6	Feet
Snow Plow Blade Size	Cut to length size blade	Inches
Power Supply	110 and 220	Volts
Environmental Conditions	Snow, freezing temps, winter conditions, rain	GPM
Test Material Types	asphalt or concrete	y/n
Control the Load	Ability to change the load on blades/tires	lbs
Run Time	How long the device will run	Hours

Variable Specifications

Possible Changing Specifications	Metric	Units
Size of Test Sample	Small sections of road/Core samples	in^2
Max Applied Wheel Force	Amount of force applied to the wheel	Pounds
Max RPM	30	RPM
Tire Size	Small Car	inches
Design Type	Linear design or Rotational Design	y/n
Tire Weight	Small Car	Pounds
Mobility	If the device can be moved easily	Ft, lbs

Applicable Codes and Standards

- ANSI
- SAE

Concept Generation and Selection

- With our project being a continuation of the previous year, we were able to use some of the feedback that was given to the previous team. Dr. Seibi received some feedback from the Utah Department of Transportation (UDOT).
- The feedback gave us outline to follow for the concepts we generated.
- UDOT wanted a machine that could fit in a lab setting, cost less, use a linear motion for testing method, and be able to test the wear caused by tires/plows.

Concept Generation and Selection

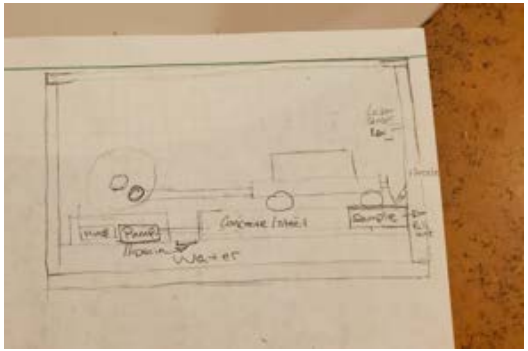
- At first, we adopted the previous road tester team's specifications (and its accompanied units), then tried to adapt it to our new scope. We also added specifications from brainstorming sessions and the research we had done.
- We looked at each specification from the previous year and voted on the relevance it had with our new scope. We kept the highest scored (scores >3.5) specifications.

SPECIFICATION	VALUE
MAX APPLIED BLADE FORCE	280Lbs per 4ft section
MAX APPLIED WHEEL FORCE	175Lbs
DATA STORAGE	Removable Solid-State Drive
TESTING SURFACE ACCESS	Be able to access sample easily
SAFETY	Hearing and Eye Protection Required
INGRESS PROTECTION	IP56 Rating
ROAD CONDITION RECREATION	Wetting Nozzles
MATERIAL AND PARTS COST	<$5000
DESIGN TYPE	Linear

Final Specs	*Metric*	*Units*	*Average Score*
Testing Road Surfaces	Able to access sample easily	y/n	5
Max Length x Width x Height	8x8x8	Feet	3.75
Test Material Size	3x1.5x1 (24"x12"X3")	ft	3.75
Control the Force/Load	Ability to change the load on test fixture	lbs/N	4.5
Cycle Counter	Complete Cycles	Cpm/#	4.5
Measure Force	amount of force applied to sample	Pounds	4.5
Safety	Hearing and Eye Protection Required	y/n	4.25
Design Type	Linear Motion	y	5
Material and Parts Cost	<5000	US Dollars	3.75
Environmental Conditions	Wet (salt water)	GPM	3.5
Modularity	Wheel hub and plow bracket	y/n	3.25
Tire Size	205/50/15 +hub	inches	3.25
Data Storage	Computer/Arduino/pi	GB	4.25
Mobility	Anchoring System	Ft/lbs or Qty	4.25
Upgradeable/Retrofit	Ability to modify later	MFG processes	3.5
Data Collection	Horizontal and Vertical Displacement	inches, ft	4
User Friendly Interface	Matlab/Programmable	Y/n	4.75
Speed of a Cycle	How quickly the device will cycle on the sample.	RPM	3.25

Concept Generation and Selection

- Initial concept generation was broken up into 3 different sessions. Each individual team member came up a concept and presented that concept to the team at each session.
- We graded each concept on whether the concept fulfilled each specification on a 1-5 scale. We gave the concept a 5 if it fulfilled the specification.



Concept Generation and Selection

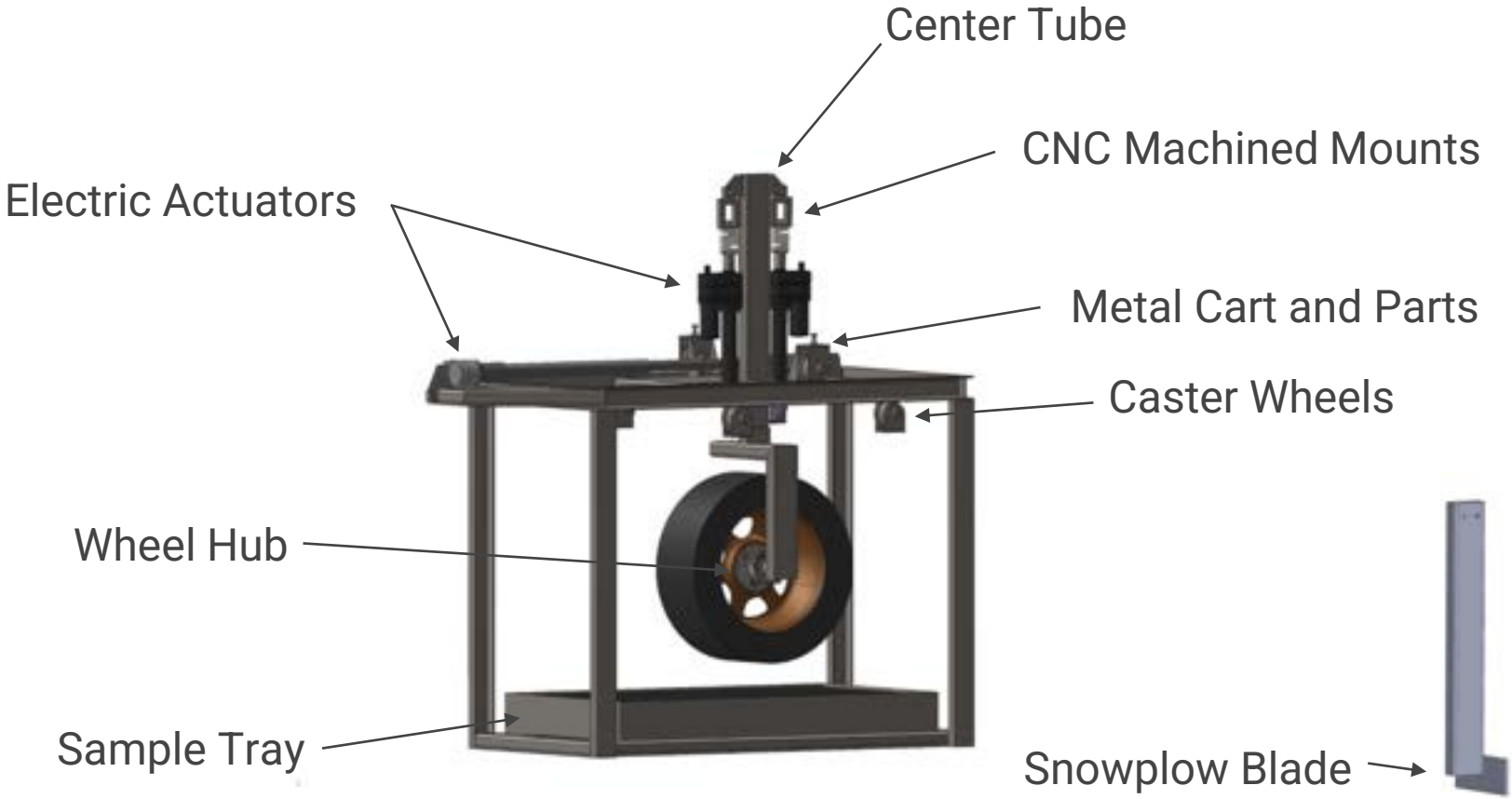
- Each concept was scored in a matrix to show which concept fulfilled each specification the best.
- We decided, as a team, to take the best scored attributes from each concept and combine them into a single concept.

Capstone Concept Matrix				
Specifications VS. CONCEPT	Mason's Concept	Caleb's Concept	Josh's Concept	Eric's Concept
Testing Road Surfaces	5	5	4	5
Max Length x Width x Height of Machine	5	5	5	2
Test Material Size	4	5	5	5
Control the Force/Load	5	3	3	5
Cycle Counter	5	4	4	3
Measure Forces	5	4	4	4
Safety	1	5	3	3
Design Type	5	5	5	5
Material and Parts Cost	3	3	4	2
Environmental Conditions	3	3	4	4
Modularity	5	5	3	5
Power Supply	5	5	5	5
Tire Size	5	4	5	5
Ingress Protection	4	1	5	3
Data Storage	3	2	3	4
Mobility	5	3	4	2
Weight	2	3	4	2
Test Area (Tire)	5	5	5	5
Upgradeable/Retrofit	5	5	3	5
Data Collection	3	3	3	5
User Friendly Interface	3	3	3	5
Total Score	**4.3**	**4.05**	**4.2**	**4.2**

Concept Generation and Selection

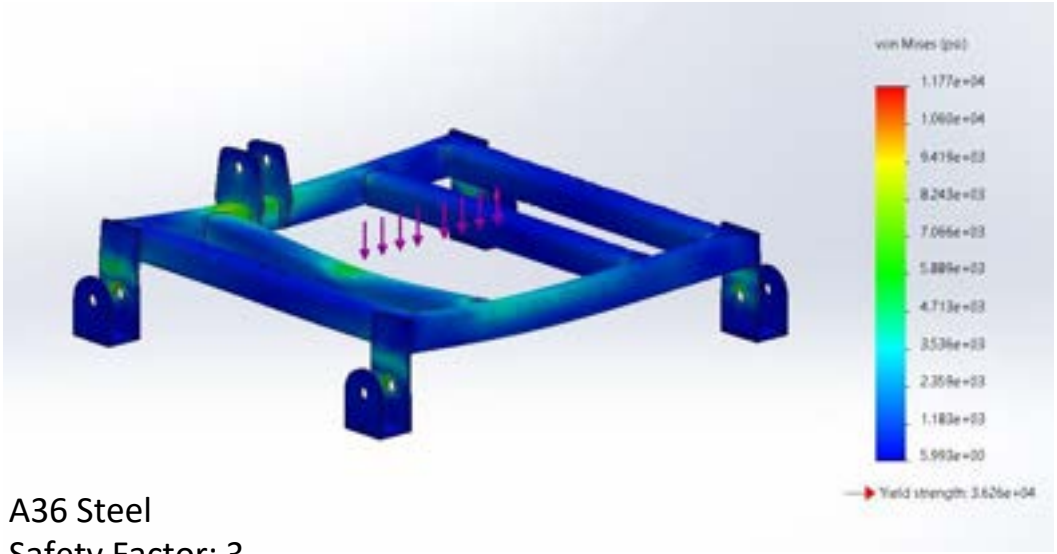
- As a team, we generated a model that represented our final selection of the best attributes for our end concept.

Modeling - Solidworks 3D

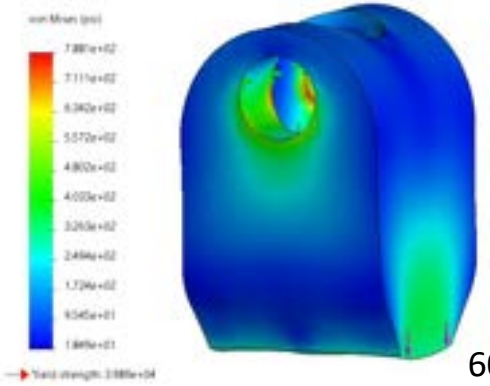


Exploded Model

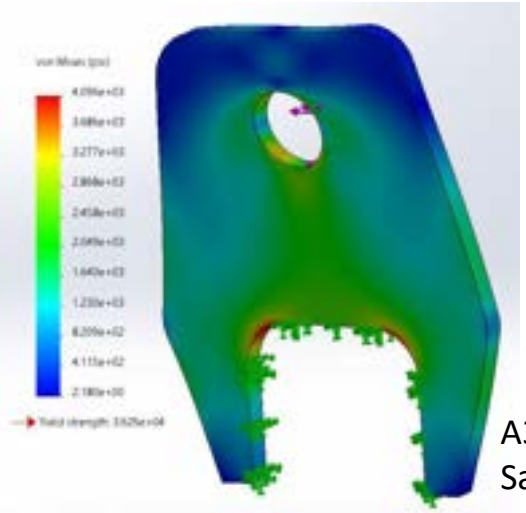
Analysis - Solidworks Stress



A36 Steel
Safety Factor: 3

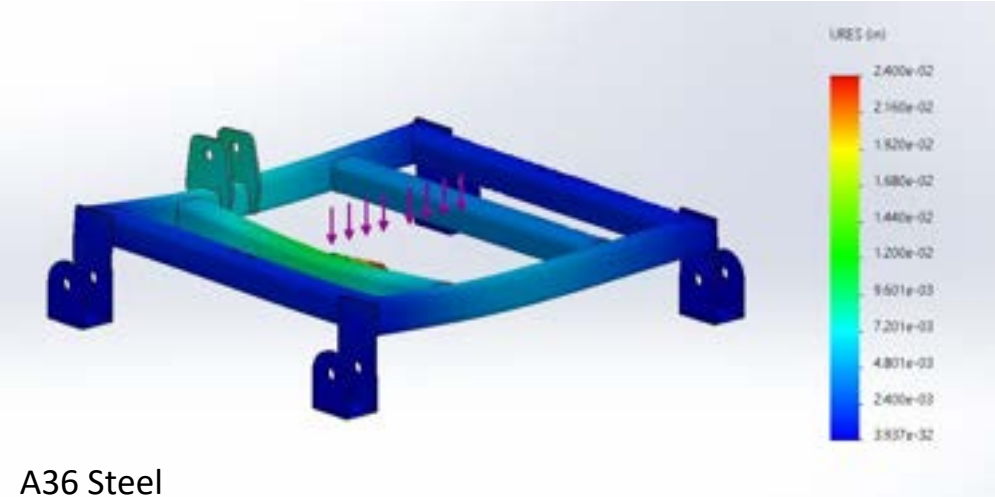


6061 Al
Safety Factor: 50

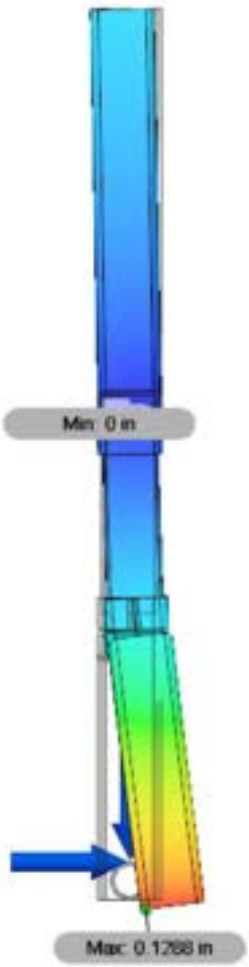


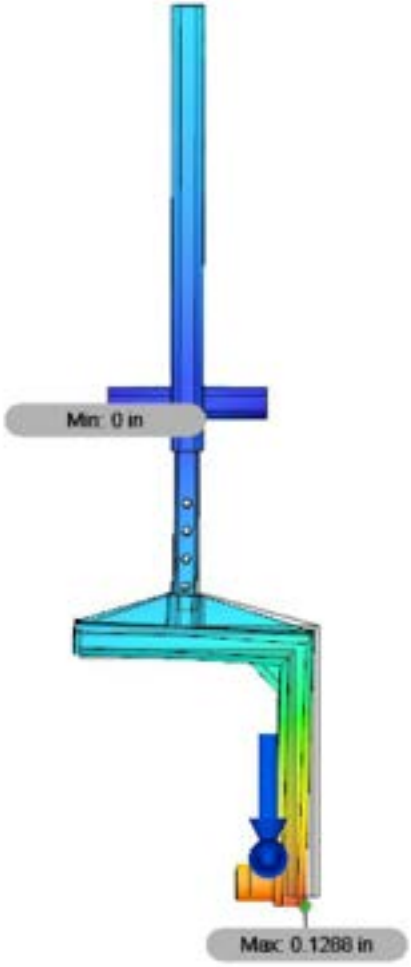
A36 Steel
Safety Factor: 8

Analysis - Solidworks Deflection



A36 Steel
Max Deflection: 0.024 in



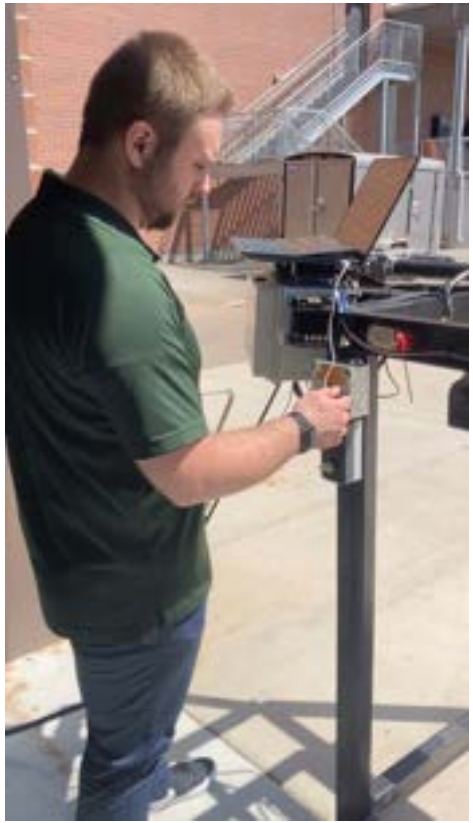


Final Design

Goal of Project:

- Lab Setting
- Test Paint
- Apply a Load
- Use Tires or Blades

Demonstration



Questions?