April 3, 2017

Mr. Vassiliades,

I was so excited to hear that the Professional Engineers in California Government Organization awarded me a Special Award in Engineering Research for my Runaway Truck Project. I am currently an 8th grader at St. John Fisher Catholic School and am getting ready to enter high school. I really like Math and Science, so recently I participated in our school's Science Fair and was nominated to enter the LA County Science Fair in Pasadena. To my surprise, your Organization must have liked what they saw. I am very grateful for that very generous award and I would like to tell you and others a bit about the project.

Every day I drive down Hawthorne Boulevard on the Palos Verdes peninsula and pass a runaway truck lane. Luckily I have never seen a truck have to use this lane, but I wanted to explore how these lanes work for my science fair project.

I did some research about runaway truck lanes.

- Studies have found that rounded gravel does better than crushed gravel in arrester beds. Rounded gravel has a more uniform grade so therefore has a higher rolling resistance than crushed gravel. Rounded stones get displaced quickly and allow the truck to sink into the arrester bed faster.
- Pea gravel is frequently used in arrester beds, but some studies have shown that larger gravel sizes and deeper beds stop a truck faster.
- Sand has a rough fine-scale texture that interacts with tire rubber molecules and provides adhesion. It has a higher coefficient of rolling friction and can stop a truck quickly, but sometimes too quickly, causing the truck to jump or even overturn after making contact.

On US interstates, there is a 6% grade maximum, with exceptions for up to 7% grades on mountainous roads with speeds <60 mph. The portion of Hawthorne Boulevard in Palos Verdes between Palos Verdes Drive North and Silver Spur has an 8.2% grade, according to veloroutes.org. In the continental US, the steepest street is Canton Avenue in Pittsburg, PA, with a 37% grade. I used a 21% grade for my first 2 experiments after some trial and error; I needed a large enough grade so that the truck would accelerate down the ramp but a small enough grade so that the truck would stop within the boundaries of the arrester bed.

For my 1st experiment, I measured how far a toy dump truck carrying 10 pounds in its bed traveled on a horizontal arrester bed. I predicted that sand would stop the truck in the shortest distance given it has the highest coefficient of rolling friction of all of the materials I tested. I released the truck down a 97" long 97-inch wooden ramp with a 21% grade. The truck traveled on a 2 inch-deep determine horizontal arrester bed filled with 100 pounds of the following fills: sand, round pebbles, jagged pebbles, round rocks, and jagged rocks.

My experiment showed that round pebbles stopped the truck in the shortest distance, and they stopped the truck most consistently; that is, the range of distances traveled by the truck was the smallest.

My hypothesis about sand dissipating the kinetic energy the fastest was incorrect. Although the sand has a higher coefficient of rolling friction, my sand was likely packed too tightly and my bed was too shallow.

For my 2nd experiment, I wanted to explore the relationship between truck weight and stopping distance on an arrester bed filled with round pebbles (since the round pebbles did the best job in experiment 1).

I predicted that the heaviest truck would sink into the arrester bed the fastest and have its kinetic energy dissipated the fastest.

I filled the horizontal arrester bed with round pebbles and determined measured the distance traveled by the truck carrying an additional while carrying the following weights: with 0, 3, 6, 10, and 20 pounds on the round-pebble horizontal arrester bed.

My hypothesis was correct. The heaviest truck had its kinetic energy dissipated the fastest by the pebbles.

For my 3rd experiment, I wanted to explore the relationship between truck weight and stopping distance up a gravity escape ramp (as seen in this diagram here).

I predicted that the heaviest truck would travel farthest up the gravity escape ramp due to greater mass and speed.

I filled the horizontal arrester bed with round pebbles and determined measured the distance traveled by the truck carrying while carrying the following weights: with 0, 2, 4, 6, 8, 10, and 18 pound weights up a gravity escape ramp. The ramp while carrying the following weights: with 0, 2, 4, 6, 8, 10, and 18 pounds weights attached.

My hypothesis was somewhat correct. My 2 heaviest trucks traveled the farthest up the gravity escape ramp, but based on my graph here, you can see that the relationship is not linear. At some point, the force of gravity must outweigh the greater mass and speed and cause the truck not to travel as far up the ramp.

From my charts, I can also conclude that the round-pebble arrester bed was a more efficient way to stop a truck than a gravity escape ramp. With 10 lbs in the truck, the mean stopping distance of the truck was 31 inches on the arrester bed vs. 69 inches on the gravity escape ramp. In fact, every arrester bed fill material tested did better than the gravity escape ramp. Plus you don't have the issue of rollback with the arrester bed.

In summary, this was a very enlightening project. I got to dig deeper into engineering and physics concepts. I was able to envision how engineers might test something on a small scale before implementing it in a big project in the field. My father and grandfather are both engineers, and I will likely follow in their footsteps. Thank you again for your award and support of the next generation of engineers.

Regards,
Lukas Jarasunas