Analogue for Egg Drop Model

Introduction

The second phase of the bungee challenge lab was to further experiment and build on prior experimentation from the first bungee lab. During the second phase, our group aimed to create an analogue model that could then be used during the actual egg drop.

During the phase one, we used Hooke’s law and determined the spring constant or ‘K’. However, the second phase relied on the theory of conservation of energy. Since the total energy of the experimental system is in theory conserved, a model could then be created to replicate during the final egg drop.

Therefore, we chose to keep components such as mass, and drop height constant in order to examine the relationship with a varying cord length. We predicted that by collecting data points with differing cord length, a pattern or relationship could be determined. In turn, with any given height, the model could define the necessary cord length to drop the egg without it breaking.

Method

Experiment Setup

Before data was collected, several measurements were taken. The total length of our given bungee cord was .249 m +/- .1 cm. An imitation egg with a mass of 135 g was created based on the average mass of real eggs used during the final egg drop. The bungee cord was then tied to a preset drop apparatus. A measuring tape was securely fastened from the top of the
apparatus to the bottom of the floor allowing us to measure cord displacement.

Data Collection

Data was collected for the following cord lengths 0.2 m, 0.31m, 0.35m, 0.39m, and 0.44m +/- 0.001m. For each cord length, 5 trials were conducted.

For each cord length, Partner A dropped the mass from the starting height at the top of the apparatus. Partner B recorded the drop using an IPad slow motion capture application. The video was then replayed and Partner C recorded the stretched bungee cord directly into an excel document.

Results

Averages and standard deviation were taken for each cord length giving stretched cord length. Stretched cord length was then compared to the equilibrium length or the rest length of the cord. A linear relationship was determined yielding the equation

\[ y = 3.29x + 0.1001 \]

Figure 2: Comparison of Stretched and Equilibrium Length of Cord

<table>
<thead>
<tr>
<th>Equilibrium Length (m)</th>
<th>Stretched length (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.2</td>
<td>0.743</td>
</tr>
<tr>
<td>0.31</td>
<td>1.152</td>
</tr>
<tr>
<td>0.352</td>
<td>1.273</td>
</tr>
<tr>
<td>0.396</td>
<td>1.3784</td>
</tr>
<tr>
<td>0.445</td>
<td>1.5664</td>
</tr>
</tbody>
</table>
Figure 3: Equilibrium vs. Stretched Bungee Cord.

The linear equation shows that there is a replicable, scaled relationship that can be used to determine cord length for a given height.

Discussion

The linear relationship generated by the data collected during the experiment represents a usable model that could be scaled to the actual egg drop experiment. Knowing the mass and drop height are constant it allows for an appropriate cord length to be determined with any given height.

During the experiment there were some areas of uncertainty. For instance, we varied cord length by tying the bungee cord so that it was near the desired length. A better way if the experiment was replicated would be to have precut bungee cord lengths. Another source of uncertainty was determining the stretched length of the cord based off the slow motion video. The image was often blurry and therefore made us approximate the length. However, we did account for this in our measurements by taking uncertainty. Perhaps a better way would be to use higher quality video or have a different set up for an apparatus.
Conclusion

By conducting this experiment, we were able to generate a successful scaled model that we felt confidently recreated the egg drop experiment but on a much smaller scale. To produce a final check of confidence in our work, we calculated the cord length needed to drop the mass as close to the floor without hitting the ground. To do so, we used the linear equation and found the needed cord length. We then tested our prediction and captured it in slow motion. To our satisfaction, the equation proved successful and the mass did not touch the ground. As a result, when we are given the height during the final egg drop experiment, we will be able to calculate a cord length that will keep the egg secure.