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Accessible Zipline

Introduction

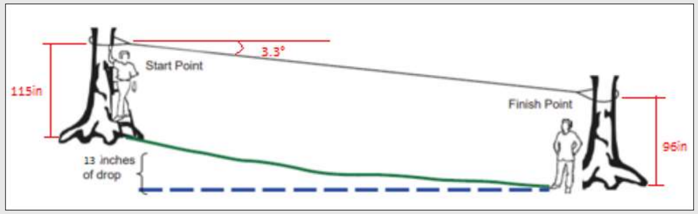
- Group 18 was presented with the project of designing a zipline for a six-year-old child with cerebral palsy. Due to the child's movement disability, a specialized seat needed to be designed for the zipline to be accessible to the child. It was important that the seat was designed specifically for the child to provide the support and comfort needed.
- Cerebral palsy is a permanent movement disorder that normally appears early in childhood. Cerebral palsy typically has symptoms that include variations in muscle tone, stiff muscles, exaggerated reflexes, tremors or involuntary movements, slow movements, difficulty walking, difficulty speaking, and learning difficulties.
- Due to the child's condition, safety was a number one priority and testing was to be done to ensure that the zipline motion be comfortable in moving and stopping.

Design Process

- The zipline design was made up of several key components; the cable, the zipline trolley, the seat or securement method, and the braking method.
- The critical design component of the project was the seat or securement method used by the child. Three concepts were considered for this seat including:
  - Rigid seat
  - Harness
  - Pediatric Sling
- The sling was chosen due to its advanced support structure and preference of the client.
- The braking mechanism was chosen to be a combination of a natural zipline stop and an active braking system of a spring break. This braking system was verified in testing.
- The zipline components were all designed to operate safely within the max loading limit of the pediatric sling of 450 lbs.

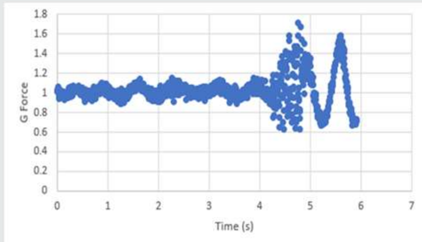
Testing Procedures

- Testing was done for this zipline design to determine the behavior of the zipline passenger during motion and during braking.
- The designed zipline was installed and tested at various cable angles until a controlled stop was observed.
- An accelerometer was then attached to the sling to verify and quantify the braking acceleration of the zipline.
- Slow motion videos were taken of the zipline during braking for each trial to determine the tilt angle of the passenger.

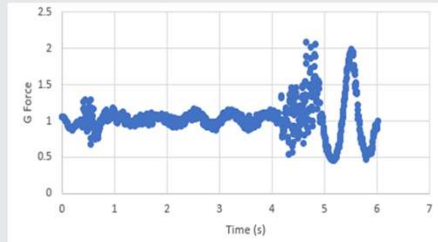


Data and Results

- The accelerometer data was compiled in Excel and graphed as shown below. Both graphs represent the G forces acting on the passenger of the zipline. The maximum G force on the passenger was the main point of interest. As seen below, the maximum G force on the passenger without a push was 1.8 Gs and 2.1 Gs with a push. According to ASTM F2291 standard, anything less than 2.5 G forces is considered comfortable, so the results were excellent.



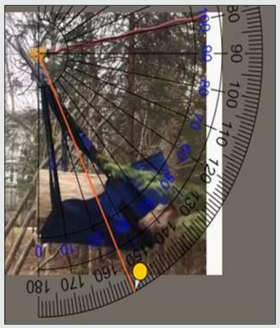
Trial Without Push



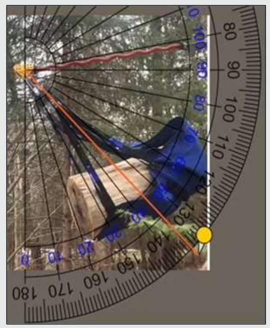
Trial With Push

- From slow motion video, the tilt angle of the sling was increased to a maximum of 25° for a trial with no push and to a maximum of 45° for a trial with a push. From observation it was determined these maximum angles indicated a safe and controlled stop and presented no risk to the passenger.

Before Impact



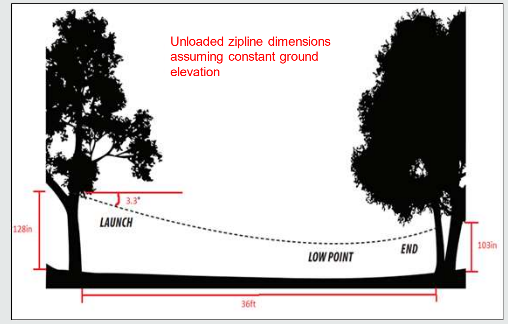
After Impact Without Push



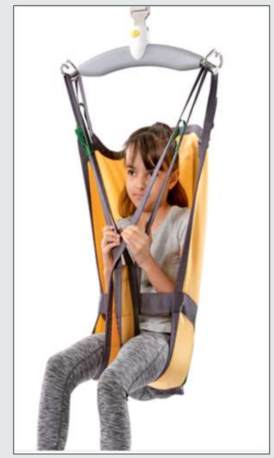
After Impact With Push

Conclusion and Recommendations

- From results in testing, the braking mechanism was determined to be successful in safely stopping the zipline passenger.
- Using the given parameters of the client's backyard, a dimensioned zipline setup could be recommended so that a safe ride and stop is achieved. The recommended setup can be seen below:



- From slow motion videos and observations during testing, the sling was determined to be a good design choice as it holds and maintains the dummy weight quite well. The recommended sling for client use is from Guldmann and is shown in the adjacent figure.
- For improved safety it is recommended that vertical straps be sewn into the sling in addition to the existing horizontal straps.
- It is also recommended that all parts are to be made of stainless or galvanized steel in order to prevent oxidation of parts due to harsh outdoor conditions



References

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- Guldmann. (2020). Basic High Kids Pediatric Sling. Retrieved November 05, 2020, from https://www.guldmann.com/us/products/slings/abc-kids/basic-high-kids
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