

ABSTRACT

Cerebral palsy is a disorder that affects gross motor function. The disease is usually acquired prenatally and caused by abnormal brain development in regions associated with movement such as the motor cortex and pyramidal tracts. There is no cure for cerebral palsy but treatment options include surgery, medication, and therapy. Matt Jahnke is the adult program director for United Cerebral Palsy (UCP) of Greater Dane County and he has tasked the team with creating a spider cage to aid in physical therapy. Spider cages are structures used in physical therapy to help motor impaired individuals gain strength, muscle control, balance, and independence. The team fabricated a spider cage out of 80/20 Inc. aluminum based on a panels design that contains a wire-mesh caging for harness attachment points. Coinciding with fabrication, deflection simulations were completed to determine how sound the overall structure is and adjustments were made to the design as needed. Due to time limitations, full scale testing will be conducted next semester. Once fabricated and tested, UCP will be able to use the spider cage for therapy needs within its facility.

BACKGROUND

Cerebral palsy is a group of non-progressive, non-contagious motor conditions caused by a delay in physical development [1]. There is no cure, but there are treatments to improve the lives of those affected.

Effects of Cerebral Palsy:

- Lack of motor control with voluntary movements.
- Stiff or tight muscles and exaggerated reflexes.
- Disturbances in sensation, perception, communication, and behavior [1].

Treatment:

- Surgery, medication, and therapy.
- Spider cage enhances physical therapy to improve control of gross motor functions [2].



Figure 1: A patient using a commercially available spider cage for muscle development [3].

MOTIVATION

UCP does not currently have a spider cage therapy unit within its facility and commercially available units are expensive and difficult to transport. Fabricating a relatively inexpensive and portable model that has the same level of functionality as a commercial model is desirable to UCP.

DESIGN CRITERIA

- The cage should be able withstand a load of 300lbs from any point on the top of the frame.
- A therapist should be able to connect resistance bands to virtually any point on the top and sides of the cage between the framing members.
- The cage must be able to function with any size patient.
- The cage must be relatively lightweight, transportable in sections, and able to fit onto a noncommercial trailer.
- Assembly of the cage should require between 2-4 people.

FINAL DESIGN

Design Considerations:

- Angled members provide added support to top face of cage.
- Members are connected with anchors torqued into other members for stability.
- The cage is designed to be broken down into smaller panels for portability.
- Slots on bottom members provide opportunity for attachment to a base platform for stabilization.
- Mesh provides ample connection locations on each face.

Specifications:

- A 6.5' x 6.5' x 6.5' cage with an open face.
- Wire mesh encloses three sides of the cage and the top to allow for attachments.
- Total weight: 240 lbs.

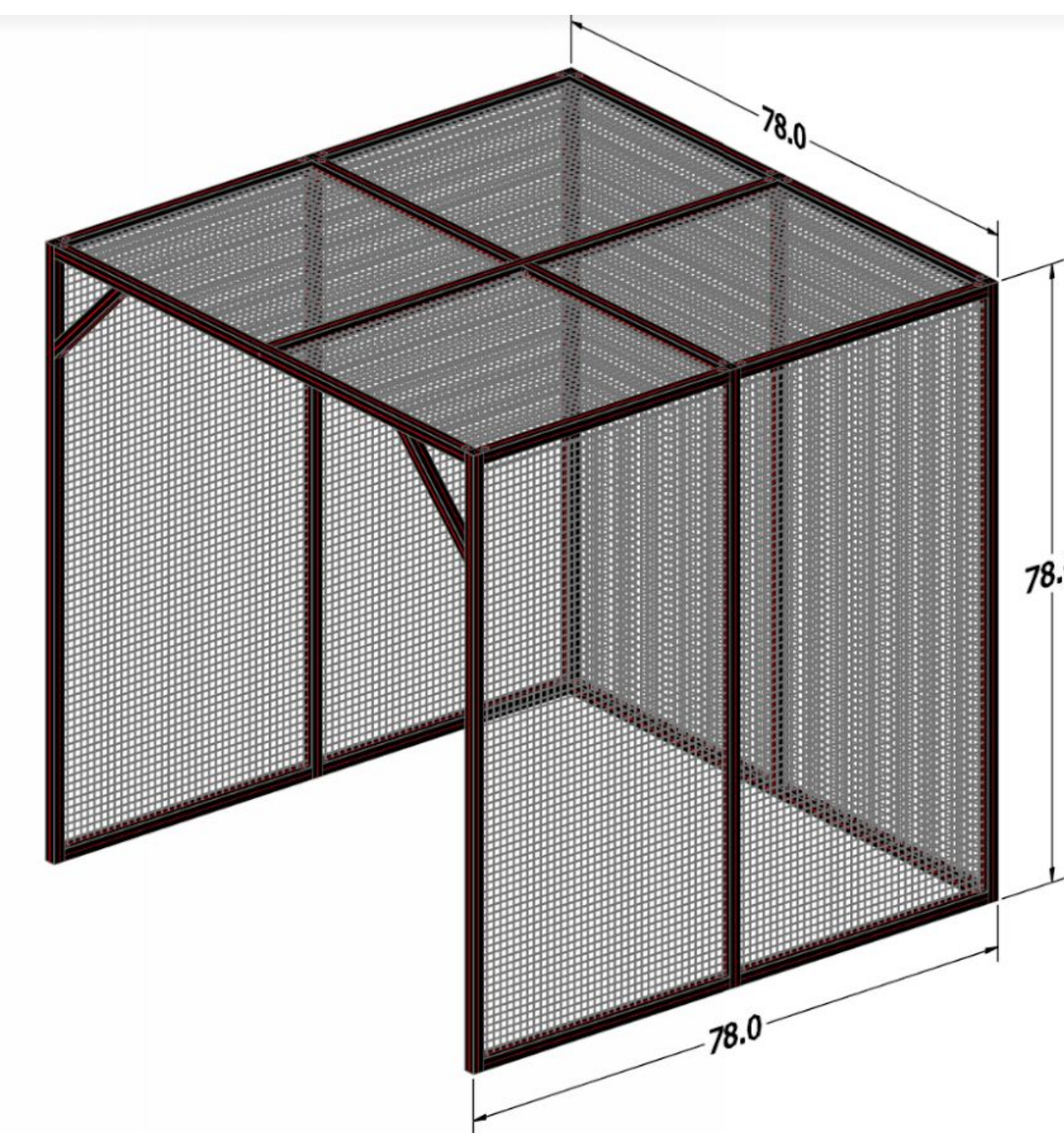


Figure 2: The final design for UCP's spider cage which has a frame made of 80/20 and wire mesh for for therapy attachments.

Materials:

- Aluminum extruded 80/20, 1515-LS series of various lengths.
- 80/20 Anchor fasteners
- 12 gauge thermoplastic coated wire mesh with 1" x 1" openings.
- Wire mesh retainers.

TESTING

Mesh Deflection

- 1" x 1" mesh
- 2" x 2" mesh
- Weights 5 - 50lbs
 - Increments of 5lbs



Figure 3: 1" x 1" mesh with an applied load of 50lbs. (left) and 2" x 2" mesh with an applied load of 50lbs. (right).

Beam Deflection

- Online deflection calculator from 80/20Inc. website
- Input: material, properties, length, load
- Output: Deflection

RESULTS & DISCUSSION

Mesh Deflection:

- 1" x 1" mesh showed less deflection for any given load than the 2" x 2" mesh
- 1" x 1" mesh showed no permanent deformation
- 2" x 2" mesh had a permanent deformation of 0.75"

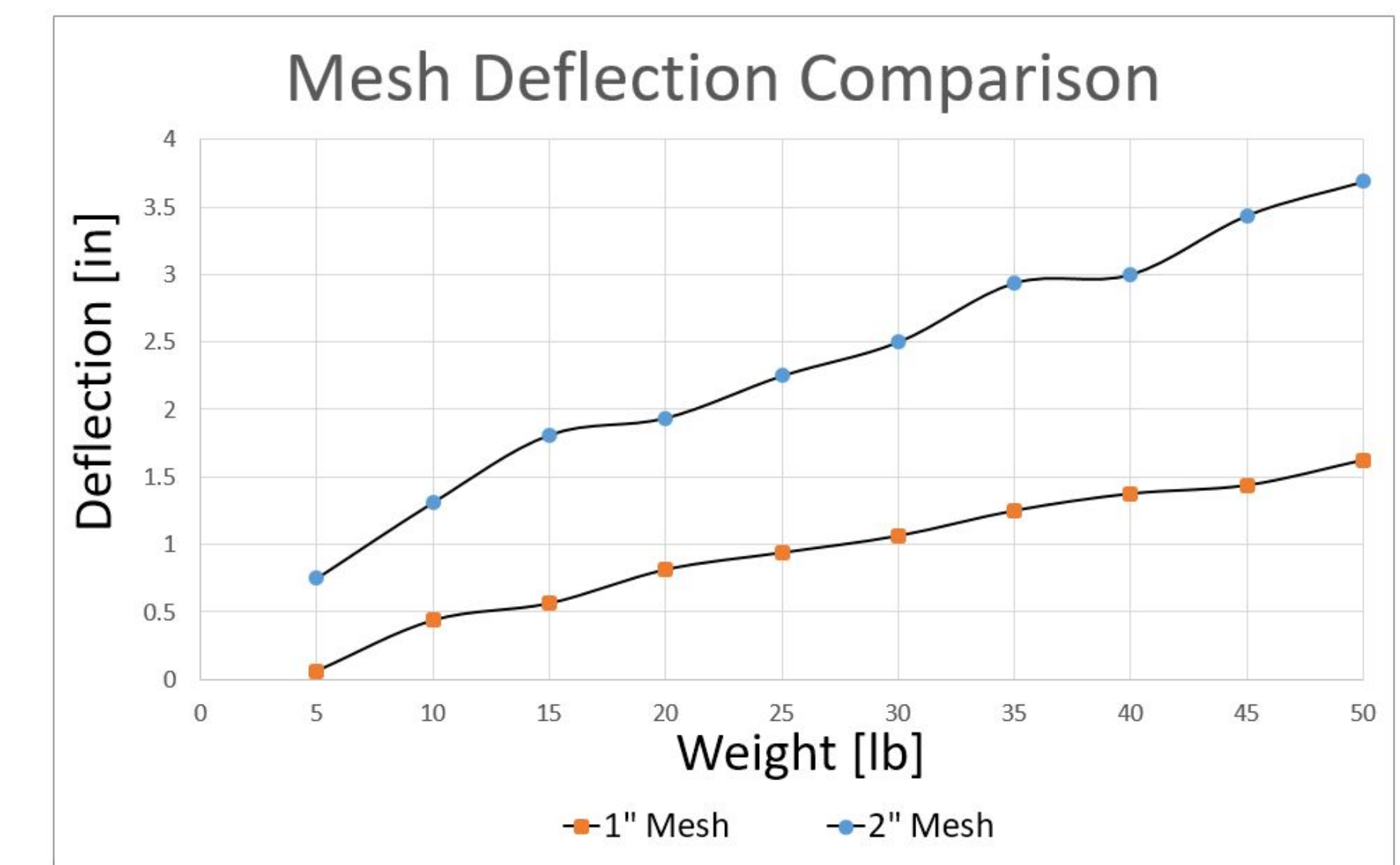


Figure 4: Mesh deflection comparison graph of the 1" x 1" and 2" x 2" mesh.

Beam Deflection:

Beam Supported Two Ends Deflection Report

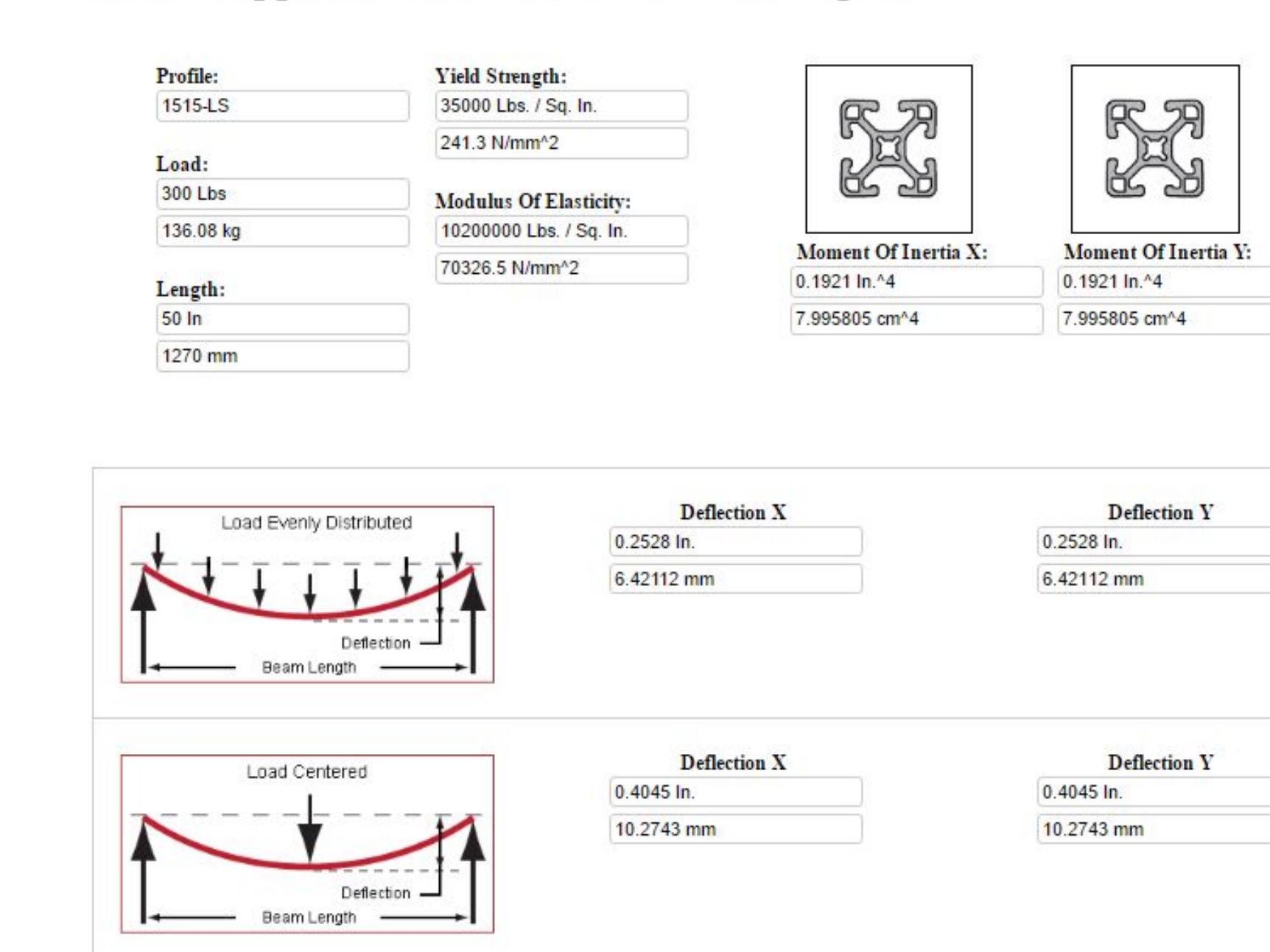


Figure 5: Screenshot of beam deflection calculator from the 80/20 Inc. website.

Input:

- Series: 1515-LS
 - Load: 300 lbs.
 - Length: 50" to account for angle supports
 - Yield Strength: 35 ksi
- ### Output:
- Evenly distributed load deflection: 0.2528"
 - Point load deflection: 0.4045"

FUTURE WORK

- Develop and perform various tests for cage stability, durability, and functionality.
- Explore possible options for reinforcing and optimizing the cage design.

ACKNOWLEDGEMENTS

The team would like to thank all of the individuals who provided guidance and help throughout the semester including: Dr. Joseph Towles, Travis Dick, Matt Jahnke, Rob Bewalda, Heidi Ploeg, Victoria Larkin, and Emily Katz

REFERENCES

- [1] A. Colver, C. Fairhurst, and P. O. D. Pharoah, "Cerebral palsy," (in English), *The Lancet*, vol. 383, no. 9924, pp. 1240-9, 2014, Apr 05 2015-02-07 2014.
- [2] NIH, "NINDS Cerebral Palsy Information Page", 2016. [Online]. Available: http://www.ninds.nih.gov/disorders/cerebral_palsy/cerebral_palsy.htm. [Accessed: 7- Oct- 2016].
- [3] TheraSuit Method. *Universal Exercise Unit*. Available: <http://www.suiththerapy.com/ueu.htm>