

Spider Cage to Support Cerebral Palsy Patient

Product Design Specifications | February 7, 2017

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Function:

A spider cage is a structure used in physical therapy to help motor impaired individuals gain strength, muscle control, balance, and independence. Patients develop muscle strength through the use of therapy bands that can be attached to various points on the spider cage. Commercial spider cages are available but expensive. The spider cage needs to function the same as a commercial spider cage, be structurally sound, transportable, able to be assembled by the client, and able to support any size patient.

Client Requirements:

- The cage shall be able to be transported by trailer.
 - The structure will need to fit through a doorway with dimensions 82in. x 42.5in.
- The client cannot offer any budget aside from buying harnesses and bungees.
 - The client has already supplied the previous spider cage team with money, with which steel for the structure was purchased. These steel members were to originally make up the spider cage but were lost.
 - The University of Wisconsin-Madison BME and ME departments have supplied the team with a budget.
- The cage should be able to be assembled by the client and 2-4 others and must include assembly instructions as well.
- Bungees must be able to be attached to any point of the cage.
 - The spider cage shall have full mesh members on the three walls and the ceiling of the cage that have bungee attachment points This will allow the client to attach therapy bands to any location on each wall as well as the ceiling of the cage.
- The cage shall be able to hold 350lbs. from any point on the cage.
- Therapists should be able to reach any point on the cage to attach therapy bands. A maximum height shall be set between 6ft. and 7ft.
- The cage shall be able to fit any size patient.

Design Requirements:

1. Physical and Operational Requirements

- a. Performance Requirements:** The cage must be able to support 350lbs. from any structural member or resistance band connection point. The cage must have at least four adjustable/movable resistance band connection points on each section of the cage (top, back, left side, right side). The maximum height of the cage must not exceed 7ft. There must be enough room within the cage for a patient and physician to work comfortably and simultaneously. The cage must be modular for transportation and installation using a maximum of four persons and a generic towable trailer. Modular sections must be able to fit through an 82in. x 42.5in. doorway.
- b. Safety:** Ensure the cage can perform as expected with a safety factor of 3 when a load is applied in a “worst-case” loading scenario. Mark, protect, or remove all possible pinch points. Use non-corrosive and non-toxic materials. Remove all sharp edges. Develop an instruction manual informing users of proper lifting and handling techniques to avoid injury when transporting. Develop a maintenance plan for maintaining and cleaning intricate/detailed portions of the cage to avoid dust/dirt build up.
- c. Accuracy and Reliability:** Resistance band connection points must have fixed adjustment locations or position references for tracking patient progress. Connection points for the modular sections must have appropriate tolerances for proper rigidity while in use, yet they must have enough clearance for assembly/disassembly.
- d. Life in Service:** The cage is expected to remain functional for as long as possible without replacing structural components and it is anticipated that it will be used an average of 6 times a day.
- e. Shelf Life:** The cage and its components should be stored in a dry, temperature controlled area.
- f. Operating Environment:** The cage will be used in a physical therapist’s office with two faces against walls and the base resting on a carpeted floor. Not meant for climbing, only to support body weight via bungee cords.
- g. Ergonomics:** Cage must be easy and relatively quick to assemble and disassemble; instructions for doing so should be included with cage. The flooring of the cage and the top exposed member require cushioning to avoid injury from falls or head bumps. It is also important that retainers on the base be covered to avoid tripping.

- h. Size:** The cage should be tall enough for a therapist and patient to stand up comfortably and perform exercises (such as stepping up on a stool) but small enough to fit on a trailer. The height must not exceed 7ft.
- i. Weight:** There is no minimum weight limit but the weight should not compromise the stability of the cage. Since the cage will be assembled in pieces, each piece must have a low enough weight to allow it to be carried to and from a trailer and assembled.
- j. Materials:** The material should be as lightweight as possible while still retaining its structural integrity. The chosen material for the cage is 80/20 aluminum which can be easily assembled and disassembled. No machining is required to assemble these materials.
- k. Aesthetics, Appearance, and Finish:** The cage should be free of sharp corners or places that could snag on clothing or the harnessing itself. The functionality of the cage is more important than the appearance, but the cage should appear clean, with no points of concern such as material defects visible. Harnessing for the patient should look or be professionally sewn with sturdy attachment points for the bungee cords.

2. Production and Characteristics

- a. Quantity:** Only one spider cage needs to be created and tested, there will be no manufacturing of the design. An instruction manual of how to assemble the cage will be included.
- b. Target Product Cost:** Commercial spider cages can cost up to \$5,000, therefore, a final cost that is less than half of this is a desired target.

3. Miscellaneous

- a. Standards and Specifications:** None required as of now.
- b. Customer:** The cage is being built for United Cerebral Palsy of Greater Dane County. The cage will be used to prove therapy for numerous current and future patients. It is required that the cage be able to support the height and weight of any given patient.
- c. Patient-related Concerns:** The cage will need to be used with a patient under the supervision of an occupational therapist.

- d. **Competition:** There are a few cages available online for purchase but they are not modular nor are they in the price range that the client seeks.