MG7101 Engineering Development Project 2020 Adjustable Height Handgrip Arm for Functional Capacity Evaluator Final Written Report

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Abstract—As the source of data input, Functional Capacity Evaluator is an irreplaceable part of the FCE (Functional Capacity Evaluation) system. It is a device consisting mainly of sensor, adjustable arm, handle, sensor box and sensor cradle. FCE is mainly used to evaluate the recovery effect of people after body injury. Subjects will grasp and use the handle on the adjustable arm and make various prescribed actions such as lifting, pushing, pulling, pressing and holding. Therefore, the goal of the project was to design a test device that could be easily and safely used by subjects of various physical conditions. In order to be able to adjust position and angle flexibly and firm, this design abandoned the multi-joint arm structure and chose to use the pluggable structure to create changing angles to balance the product's demand for flexibility and security.

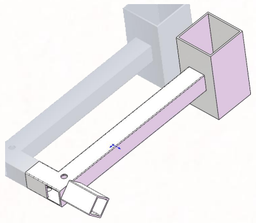
Index Adjustable, Arm, FCE, Firm, Flexible, Functional Capacity Evaluation, Functional Capacity Evaluator, Handgrip, Joint, Pin, Pluggable.

Introduction

- The whole Functional Capacity Evaluator can be basically divided into two parts. The largest adjustable arm is its main part, and the other part is composed of handle, sensor, sensor box and sensor cradle. The working principle of this device is to change the shape and position of the adjustable arm and the sensor attached to it through the force applied by the human. The force generated by this movement is displayed and recorded in the visible form through the sensor.
- The main purpose of this design is to provide users with better experience. For example, users who cannot stand can easily grasp the handle in different positions and heights, so that users can change the angle to exert force with the most comfortable posture when doing different movements, and can use the device in places with limited space.
- At the same time, the design of the adjustable arm must also be strong and safe in order to avoid secondary damage to the recovered user. Of course, these two requirements have different priorities, and if the two are in conflict, the design must give priority to ensuring product safety.

Product Formation

The whole adjustable arm is composed of four parts, the joinable part at the top, the supporting part in the middle, the sliding part at the end and the fixing components used for fixing during installation.



Whole adjustable arm without fixing components.

Joinable Part

- The whole joinable part is composed of two square tubes of different lengths welded together, and the two tubes have an Angle difference of 45 degrees. This is to meet the needs of flexible adjustment, and in the mediation can be precisely controlled Angle.
- On the longer square tube there are two square sockets, one in different directions. The shorter square tube also has a square socket in the other direction. You can choose a socket at will according to your needs.
- To reduce the uncontrollability of regulation, increase the firmness. In the connection mode, the fragile joint parts are abandoned, and the more solid and stronger plug structure is chosen.

Supporting Part

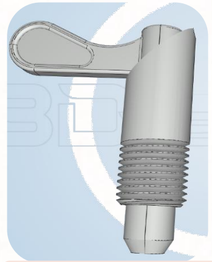
The supporting part has no special structure. It is a square tube of the same caliber as the joinable part, but much longer than the other two. Its left and right ends are welded to the other two parts and support them.

Sliding Part

The sliding part is also a square tube, but has a different caliber than the others. Because it needs to slide smoothly on a square tube with a cross section of 100*100mm. It is opposite the adjustable part and is connected to the supporting part by welding.

Fixing Components-Spring Pin

All 3 spring pins are used in the adjustable section. It is held in place by thread and has a 180-degree twist switch at the top.
The length of the plunger at the bottom varies as the switch twists. When the plunger reaches its maximum length, it will lock the part that goes into the socket. Compared with screws, this structure is more convenient to operate and can be operated by hand at any time.



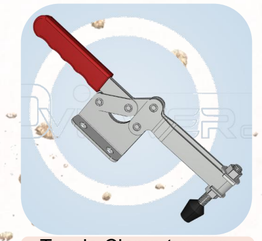
Spring pin switch-on.

To install the three spring pins, there will be three corresponding holes in the joinable section. At the same time, to prevent the switches from interfering with each other, they are mounted in different directions according to the corresponding ports.

Fixing Components-Toggle Clamp

Toggle clamp is used on the sliding part, which is welded on the other side surface of the sliding part against the supporting part.

The main body is a lever structure with a handle on the left and a fixture on the right. An adjustable screw with a rubber tip is attached to the fixing device. The rise and fall of the handle is synchronized with the rise and fall of the fixture.
The pressure generated by pushing the handle can be used to fixed the whole sliding part.

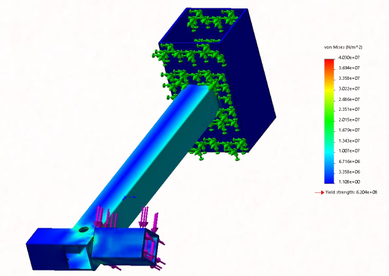


Toggle Clamp turn-on. Co-Mac. (n.d.).

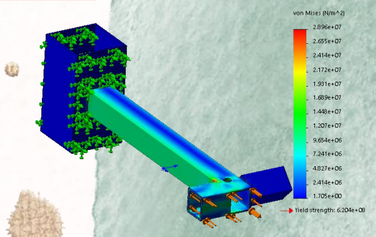
SolidWorks Analysis

- According to the actual use, the force analysis of the design scheme is carried out. The sliding part is fixed and a force is applied to a socket in the connectable part.
- To determine the maximum load of the adjustable arm. Because the strength level of females is generally lower than that of males, the selection of the maximum value is based on males.
- According to the Exercise Prescription on Internet (n.d.) data, an adult male with a moderate exercise level weighing 230 pounds or more has an average maximum stress of 175 pounds, a bench press of 250 pounds, and a hard pull of 390 pounds.
- So, choose 390 pounds as adjustable arm’s maximum load.

$$390\ Pounds = 0.454 \times 390 = 177\ Kilograms$$
$$Froce = weight \times acceleration\ (gravity = 9.8\ meter/second^2)$$
$$Froce_{maximum\ load} = 177 \times 9.8 = 1734\ Newtons$$



Pull right position stress stimulation.



Push left 2 positions stress stimulation.