BIOMECHANICS LABROTORY

Center of Gravity determination using Load Cell System

1. Object

To illustrate how to use Load Cell system in computing the center of mass for different types of bones

2. Introduction

Center of gravity of a body is defined as the point of application of the resultant force due to the earth's attraction on it.

The center of gravity of a body can often be described as its balance point or that point about which a body would balance without a tendency to rotate. At the point of center of gravity, the sum of all the forces and force movements acting on the body is zero, and all the weight of the body may be considered to be concentrated and about which all the parts exactly balance.

Knowledge of the weight, volume, and center of mass of segments of the human body is of significance to research in such diverse fields as physical education, prosthetics, and space technology.

Engineers or physicists may test a structure or material until it fails to determine designs and conditions appropriate to the physical characteristics of materials.

The center of gravity play important role in the medical rehabilitation, sports activity and engineering design fields. There are different methods for measuring human center of gravity: Reaction Board Method, Segmentation Method, Balance method, Suspension method and Load cell system method.

3. Load Cell System Method:

This method depends on the weight and length of the object. In this method the object suspended from load cells (Fig.1) to indicate the distributed weight of the object, the center of gravity calculate by taking moment about one of the load cells point. The moment equation is:

$$M_1 = W_2 L - W\ CGX \qquad (1)$$

Where:

M1 represents the moment about load cell 1.
W2 represents the distributed weight measured by load cell 2.
L represents the length of the object between the load cells.
W represents the total weight of the object.
CGX represents the center of gravity.

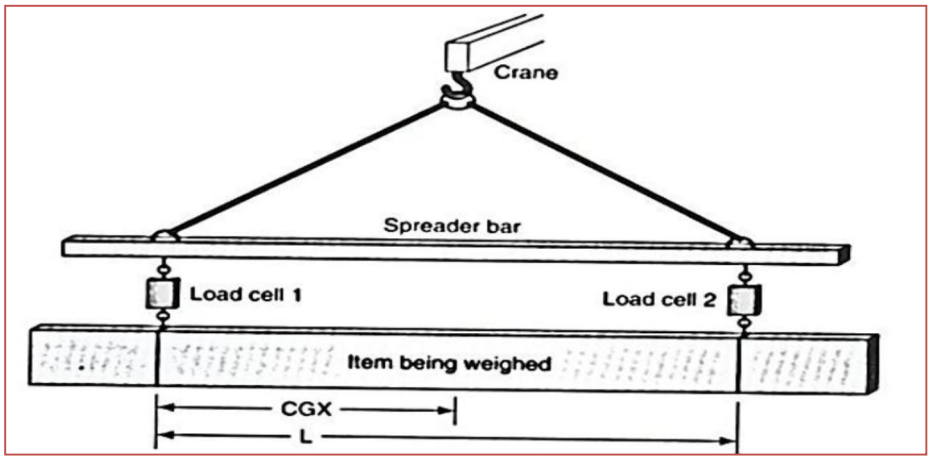

Figure.1 load cell system method

Load Cell system composes of the following components:

- ***The stand:*** The stand should make from solid hard material, bear the required weight without bending, and should be at convenient length (can adjusted at various lengths).

Figure.2 The stands

- ***The load cell (mass gauge):*** the load cell is used to measure the distributed weight of the bone with High accuracy and minimum error percentage. The load cell that are used (Fig. 3) are suspending mass gauge model, with a dynamic range from 5 grams to 10 kilograms, with error ratio ranging from:

$$1 \leq x \leq 5 \text{ for Integer number,}$$
$$0.1 \leq x \leq 0.5 \text{ for fractional number.}$$

Figure.3 The load cells

- ***The Suspending silk:*** The silk should make from strong material that can bear weight without changing its length and specifications. The silk that is used is made from nylon with good tension resistance and low elasticity.

- ***The bones models:*** The bones that are selected (Fig. 4) are (Femur, Tibia, and Humerus). They are artificial bone made from plastic. Two types of bone materials are available, (Femur1 and Humerus) is made from a material similar to that in bone and the other (Femur.2 and Tibia) is made from plastic.

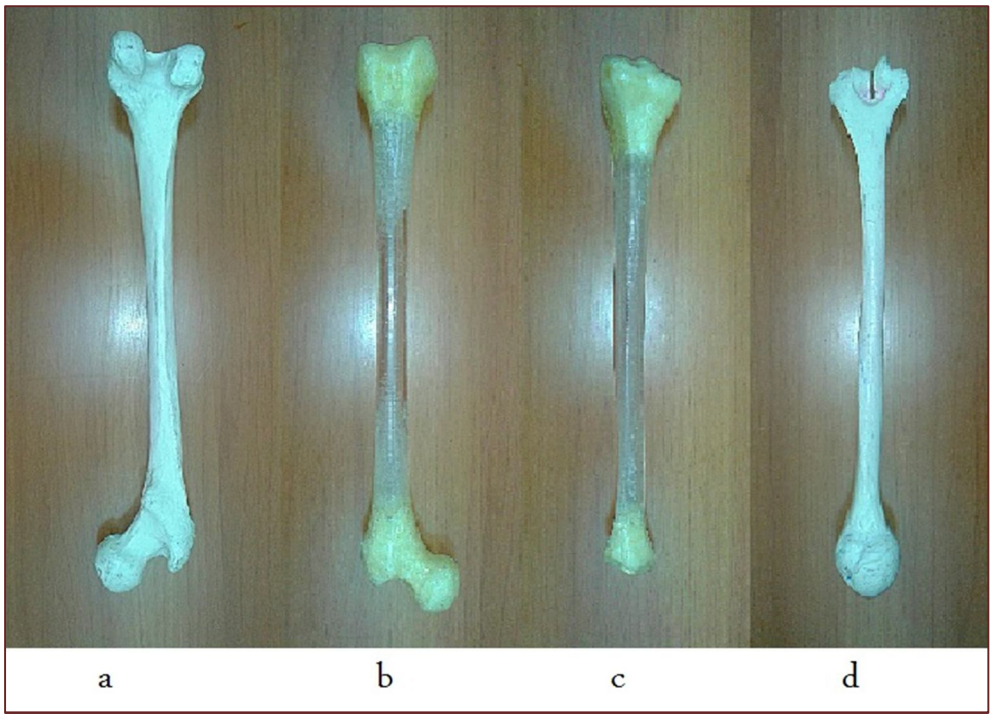

Figure.4 The artificial bones used in the experiment, a: Femur1, b: Femur2, c: Tibia, and d: Humerus

4. Procedure:

a) Fix the stand in a right position and in a comfortable high, then, fix the load cells on the stand.

b) Weight the bones by suspending the bones using the nylon silk.

c) Suspend the bones from both ends as indicated in Figure.5.

d) Measure the length between the suspending points using a meter tape.

e) Record the reading on both load cells.

f) Apply equation (1) to compute the COM from both the proximal and distal ends.

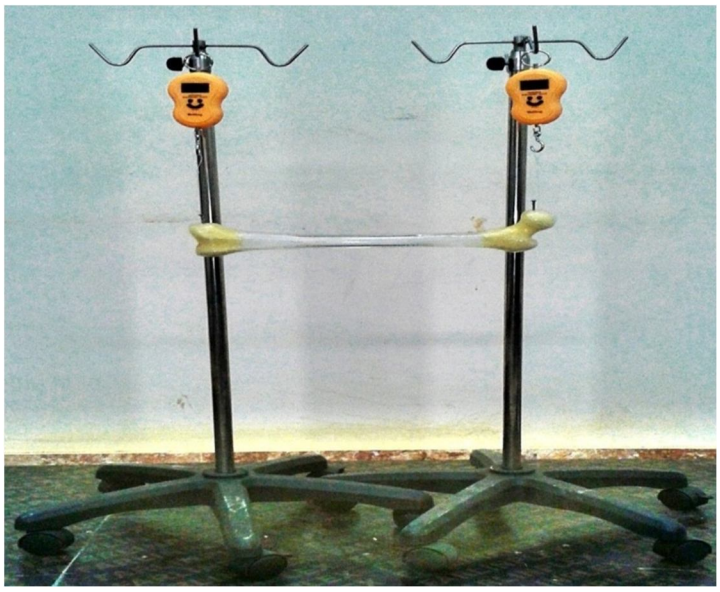

Figure.5 The load cell system method procedure

5. Discussion:

Discuss the errors that are expected in this method.