Compression tests on surrogate bone materials

Engineering

Compression Tests on Surrogate Bone Materials Introduction In the conduction of the compression tests on surrogate bone materials, two sets of variables were considered to facilitate the accomplishment of the research objectives. Known and unknown variables play the role of facilitating the conduction of the research and provide narrowed focus on the topic. Among the known variables include the dimensions of the form block, rate of strain, displacement measures, and theoretical elastic modulus. On the other hand, the unknown quantities as applied in the experiment included strain rate, the effect of the elastic modulus, and the experimental elastic modulus.

Objectives

The core objectives of undertaking this experiment is to compare both high and low densities of bone water when subjected to strain rate of 5, 10, 50, and 100 percent. Through the use of wet or dry bone materials, this experiment will attempt to determine the quantitative differences between elastic modulus of both the wet and dry forms at the different rates of strain. The experiment will also compare experimental and statistical analyses. Finally, the experiment will aim at creating a spring dashpot model for the simulation of the experiment.

Hypothesis

The test will show that higher elastic modulus will result provided that higher density bone wet foam and dry foams are used. Additionally the experiment will show that strain rate increase results correspondingly increase stiffness while at the same time the material shows viscoelastic tendencies.

Methods

a. Experiment Preparation

During the test preparation stage of the experiment in which the creation of mathematical model, formulate the compressed block-equilibrium with the application of FBD. The dimensions of each block were measured, rate of strain calculated, soaking samples in water for the wet form, and calculation of displacement measures.

Figure 1

b. Geometric Measurements

The geometric measurements on the other hand, included the dimensions of all blocks, rate of strain, and displacement measurements as presented in table 1 below;

State

Density

Height (m)

Width (m)

Length (m)

Surface Area (m2)

5% Displacement(m)

50% Displacement(m)

100% Strain Rate (m/s)

We

Low

0. 0406

0. 0430

0. 0427

0. 0018361

N/A

0. 0203

0. 0406

High

0. 0428

0. 0435

0. 0425

0. 00184875

0. 00214

N/A

0. 0428

Dry

Low

0. 0418

0. 0399

0. 0429

0. 00171171

N/A

0. 02093

0. 0418

High

0. 0406

0. 4176

0. 0451

0. 01883376

0. 00203

N/A

0. 0406

c. Testing Protocol

The testing protocol applied in the collection of data included the placement of each sample on the MTS. Time-based intervals were taken into account in applying various rates of strain to each sample. Finally, each sample was subjected to varying rates of strain per second. Among the applied rates included 5, 10, 50, and 100 percent.

Discussion and Analysis

According to the output table of the experiment, dimensions were taken into consideration that differed from one material to another. However, despite the almost identical dimensions for height, width, and length, it is shown that the dimensional differences are reflected on the results. For the strain rates applied, the results in displacement show that under 100% rate, the displacement was equal to the block height in all cases. However, one major observation is that the differences in surface areas do not have direct relationship with the displacement at different strain rates. For the wet materials, it is observed that surface area is negatively proportional to the displacement at 50% strain rate. Additionally, high density wet and dry materials had negative proportionality for surface area as compared to displacement at strain rate 5%, 50%, and 100%.

Limitation

From the experiment preparation to the experiment conclusion, a few limitations were encountered among them human error of in accounting the dimensions, inaccuracy in the calculation of linear area will eventually affect elastic modulus calculation output. Variability in soaking time of the materials and assignment of block in MTS have the potential of affecting outcome. Finally, before compression, leakage of water has the potential of affecting the results.

Conclusion

The objectives for undertaking this experiment were to compare both high and low densities of bone water when subjected to strain rates of 5, 50, and 100 percent. By using wet or dry bone materials, this experiment attempted to determine the quantitative differences between elastic modulus of both wet and dry materials at different rates of strain.

For the strain rates of 5, 50, and 100%, the displacement results showed that under 100% rate, the displacement and block height in all cases were equal. Using wet materials, it is observed that surface area is negatively proportional to the displacement at 5% and 50% strain rates. High density for wet and dry materials showed negative proportionality for surface area as compared to displacement at strain rate 5%, 50%, and 100%. Among the experiment limitations encountered included human error in accounting of the dimensions and inaccuracy in calculating linear area which had the potential of affecting the outcome.