Low Cost Impact Testing Device

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Abstract

The purpose of this project is to produce a machine that will simulate blunt force trauma on bone samples, in particular a pig skull. The customer wants a device that can deliver a range of velocities, up to 6 m/s, with a variable amount of mass to break bone. The device must be able to deliver certain energy levels (different masses at different impact velocities). The main consideration for this project is the mechanics of the device. The only data acquisition the group must consider is integration of an existing force plate. Research suggests that such an impact machine ought to be able to deliver up to 68.5 Joules of energy to break a bone over an impact time ranging from 0.005 to 0.01 seconds [1].

A vertical-drop impact design was chosen, which can easily provide the required energy. The vertical design incorporates a slide that moves on a three-rail system supported by a rib/brace structure. The impact head is attached to the slide and can be easily replaced for versatility purposes. The slide has a mass of 15 kg by itself, extensible by adding separate weights. The release mechanism is a three-ring quick release [2], with two strings that must be released in a particular pattern to avoid premature release. The three rings provide a mechanical advantage. The slide will be stopped by three rubber stops so the impact head does not come into contact with the force plate. When the machine is not in use, a lock will be used to block slide motion in order to prevent accidental injury or damage. To bolster adjustability, the machine has been designed in many subassemblies for which positioning can be tweaked to affect overall machine performance. This adjustability is important in compensating for manufacturing tolerances and ensuring the machine remains operational over many high energy impacts.

The bone samples will be held in place using Bondo casts to minimize attachment effects on bone damage. The Bondo allows the customer to test different types of bone samples. All design decisions were made using decision techniques and impact/stress analyses. In terms of manufacturing processes, this device has been designed in several pieces using SolidWorks software so it can easily be put together and taken apart.

The machine is currently in the manufacturing process, and will be completed by April 1st. All of the manufacturing will be completed at the University. Several tests will be conducted to ensure that the machine will achieve the targeted capabilities. To refine alignment, the rails will be dusted with chalk and the slide will be released. The dust will show the unwanted contact and the machine can be adjusted accordingly.

A motion capture system will be used to validate the acceleration and maximum velocities of the slide in comparison to theoretical values, resulting in a calibration between drop height, mass, and speed.

Reference:

1. Yoganandan, N., et al. "Biomechanics Of Skull Fracture." Journal of Neurotrauma 12.4 (1995): 659-668.

2. Aerofoam UAV Systems. N.p., n.d. Web. 17 Feb. 2016. <http://www.aerofoam.com/3_ring_release.htm>.