CALIFORNIA STATE SCIENCE FAIR
2014 PROJECT SUMMARY

Name(s)

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Project Number

34644

Project Title

What Is the Best Material for a Helmet Lining to Reduce G-forces?

Abstract

Objectives/Goals

The objective is to determine the best material to create a safer helmet for impact sports by reducing g-forces upon impact, which may reduce the risk of athletes developing Chronic Traumatic Encephalopathy (CTE). The hypothesis was that a crushable material would decrease g-forces to the head by limiting rebounding behavior and spreading the impact over a longer time-frame with a constant deceleration.

Methods/Materials

Six materials were tested. The elastic modulus of each material was determined by testing specimens on a Materials Testing System. Helmet linings were made by designing a mold on CAD software and using a HAAS computer machining center to cut out the mold. A silicone skin bound the test specimens together. To test the helmet lining specimens, a Riddell 360 helmet was fitted with a test lining and placed on a dummy head with a three-axis accelerometer embedded inside. To simulate a severe football helmet impact, the dummy head with helmet was attached to a NOCASE drop test station and released from 5 feet, recording g-forces and high-speed video.

Results

The materials testing indicated that three of the materials were elastic and required a continuous increase in pounds of force throughout the compression test. Three materials were crushable and maintained constant load throughout the compression test. Two of the crushable materials (Mousse and Dry Foam) crushed at the same pounds of force, ~20 lbs. throughout the compression test. All three crushable materials performed with lower peak g-forces than the Riddell 360 control test lining- currently the official helmet of the NFL. The best lining, Dry Foam, performed with 30.1 less g-forces or a 25.2% reduction from the control.

Conclusions/Discussion

The crushable materials, with constant load displacement material behavior, resulted in the highest energy absorption. Upon impact (head drop test), the peak g-force was spread out over a longer period of time resulting in a lower peak g-force, thus supporting the hypothesis that crushable materials would outperform elastic materials. Because the crushable linings do not rebound upon impact, they perform best on the first hard hit, and would therefore have to be replaceable. Implementation of a one-time use crushable lining is feasible because as awareness of sports related brain injuries grow, new technologies for safer football helmets will be embraced.

Summary Statement

This project suggests an innovative and dramatic change to current sports helmets by using a crushable and replaceable helmet lining that could reduce g-forces by 25% over the current NFL helmet, thereby reducing potential for brain injury.

Help Received

Testing equipment, high-speed camera, supplies and mentoring at San Diego Composites under the supervision of President Robert Kolozs; Mother taught me graphing on Excel; my brother showed me how to use CAD software