IMPACT FORCES AND MATERIAL PROPERTIES OF A SOCCER HEADGEAR

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INTRODUCTION: The Fédération Internationale de Football Association (FIFA) has recently allowed players to wear headgear in international games. Previous research (Broglio et al, 2003, Naunheim et al, 2003) indicated that not all headgears were effective in attenuating impact. The purpose of this study was to determine the stiffness and shock absorbency of the material used in a Full 90 -True Play Technology soccer headgear. A second objective was to examine a measure of energy efficiency. The final objective was to develop an algorithm to predict the force of impact based on velocity.

METHOD: The material testing was completed using a custom force analysis system (Bauer & Zerpa, 1996) in the Lakehead University Research Centre. The system included a force plate and an inclined sled. The platform was interfaced to a computer for analogue to digital data conversion (sampling frequency of 1000HZ). The sled was dropped, with and without the headgear attached, starting at a distance of .02m and at a 10 degree angle of inclination. The distance was incrementally increased by .02m for each successive trial up to a total of18 trials. The vertical ground reaction force was measured and the velocity of impact computed for each trial. The differences between the force-time records for the two headgear conditions were calculated to determine the material stiffness. The resulting force values were conditioned using a two point moving average. The strain (compression) of the material was obtained by manipulating the impulse-momentum relationship. In addition, the amount of energy absorbed by the headgear during deformation and restoration was calculated by multiplying the stress by the strain values. The efficiency of the material was computed by dividing the energy losses (deformation minus restoration) by the amount of energy input into the system during low and high impact conditions and was expressed as a percentage. Finally, a curve fitting approach was used to develop a polynomial equation to predict the force absorption of the headgear when impacted at different velocities.

RESULTS AND DISCUSSION: The relationship between stress and strain was plotted in order to determine the properties (stiffness) of the headgear. The material was determined to be viscoelastic. The average efficiency for the low and high impact conditions were 7.0% and 25.4% respectively. The data was interpolated using a non-linear least square quadratic function in order to predict the net force absorbed by the headgear when impacted at different velocities. The energy efficiency demonstrated the ability of the material to store energy and offer protection. The resulting equation will be used in future research to estimate the force based on kinematic data.

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