C7 Analysis of Cutaneous/Cortical Head, Extremity, and Thoracic Trauma Associated With Glass Impact in Automotive, Industrial, and Residential/Commercial Building Construction Applications Utilizing the Forensic Engineering Method

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After attending this presentation, attendees will understand how to utilize the Forensic Engineering Method to teach the forensic engineering analysis of the signature of physical evidence remaining on soft tissue and cortical trauma as a function of the varied material properties of glass.

This presentation will impact the forensic science community by providing new insight into incident causation, trauma biomechanics and prevention involving glass-like material property impacts.

Glass is utilized in various applications as a retention material. In building construction to prevent falls from height and in vehicles as a retention mechanism to prevent occupant ejection (Willke).[1] Over time, glass has been designed to help reduce occupant glass trauma upon impact. Tempered glass and high penetration resistant (HPR) laminated glass are commonly utilized due to their preferential tensile properties and the mechanisms by which they shatter. Tempered glass is treated with either heat or chemicals to increase its strength, and is designed to have outer compression and inner tension allowing it to divaricate throughout the circumscription of the plate boundaries, thereby creating diminutive fragments (Lawn).[2] HPR laminated glass is composed of two layers of glass interpolating a polymer interlayer. The design of this glass allows it to withstand higher breakage and penetration forces, and causes the glass to fracture into small fragments while the component itself remains largely intact (Rieser).[3]

In order to analyze the injury trauma associated with glasses possessing different material properties, a wide variety of glass related trauma incidents were examined. Occupant retention requirements varied in vehicular, industrial, residential, and commercial building applications. Given these different retaining surface properties and human dynamics, data were gathered relating to the glass composite responses both with, and without, visible fracture patterns; these data were analyzed and the results used to study the inter-relationship between retaining surface properties, human dynamics, and trauma sustained by humans.

Data collection methods included observation, research, experimentation and/or calculation. The forensic engineering methodology utilized, and outlined in Figure 1, illustrates the ultimate objective of uncompromised data collection that results in systematically considered, iteratively derived, and objectively balanced findings.

Test designs consisting of a drop test mechanism were utilized to generate a range of impact velocities. A glass suspension and release mechanism was designed that demonstrated a dramatic improvement in experimental repeatability. The glass suspension mechanism also enabled experiments that included a pre-failed condition of microscopic, as well as linear and spider web glass fracture patterns, to be performed. Instrumentation protocol included use of a anthropometric dummy to simulate the subject. Triaxial accelerometer data were collected at a frequency significantly exceeding Nyquist, conditioned to boost the signal; converted from an analog to a digital signal, adjusted via a dac card to format compatibility, and passed through a Butterworth filter.

Data analytics for a variety of configurations are presented, including alternatives. Ranges of acceleration required to achieve glass fracture modalities were measured and associated with specific trauma sustained. The results provide new insight into incident causation, trauma biomechanics, and prevention involving human impact with glass.

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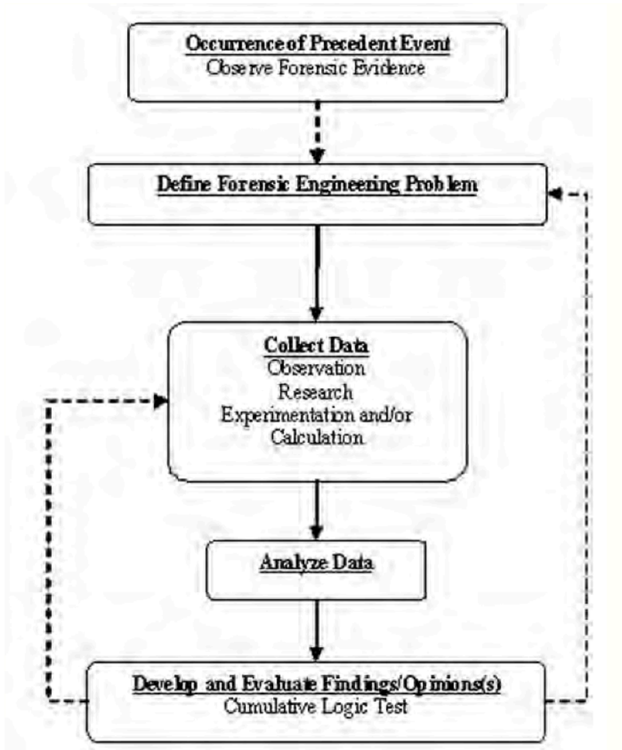

Figure 1: Forensic Engineering Method

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2. Lawn, B.R., Marshall, D.B. "Contact fracture resistance of physically and chemically tempered glass plates: a theoretical model." Physics and Chemistry of Classes, Vol. 18, No. 1, February 1997.
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