C17 Appearances Are Deceiving: Observation is an Unreliable Gauge of Object Mass and Behavior

David Pienkowski, PhD, University of Kentucky, Department of Orthopaedic Surgery, 740 South Limestone, Suite K401, Lexington, KY 40536-0284*

The goal of this presentation is to show how observation-based perception can be dangerously misleading and can lead to personal harm. While quantitative mechanical analyses are not universally used for directing human behavior (and thereby preventing accidents); such analyses are useful for explaining subsequent events that have caused human injury. Visual observation is an unreliable gauge of object mass and dynamic mechanical behavior.

Objects of everyday living, e.g., sheets of diamond-patterned steel flooring, may appear manageable due their commonplace size and diminu- tive thickness, but the weight of these objects in certain positions or when placed in motion can be dangerously deceptive. This presentation will im- pact the forensic science community by demonstrating injuries resulting from vision based misperceptions of objects such as these and others do occur; questions regarding causation and injury mechanism often accompany such accidents. This study clearly demonstrates the usefulness of an integrated set of analytical methods, based on engineering principles coupled with biome- chanical analyses, to explain the cause and extent of human injury in this particular set of circumstances. While such analytical techniques are commonly applied to vehicular accidents, this presentation demonstrates the value of the same techniques when applied to accidents in the workplace. This statement is also valid for other environments (home, office, recreational settings, etc.) where injuries occur when humans interact with structural, vocational, or recreational objects.

A "mining" accident occurred in a coal loading tower. Contract workers previously stacked four steel 4'X8' diamond-patterned sheets (0.125") against a steel frame. These sheets leaned against the frame at about an 11° angle. The next day an employee was found prone on the floor underneath these sheets. The edge of a nearby piece of machinery kept the full weight of these sheets from bearing on the lower extremities of this employee. He had fractures of the left proximal femur, right proximal tibia, and right proximal fibula. The objective of this study was to determine whether the sheets fell, or were pulled, onto this employee.

Sheet weights were obtained from specifications. The post-accident scene was photographed and inspected. Dimensions of all relevant structures were measured. All medical records were obtained and analyzed. Vibration measurements were performed by an independent contractor. Reenactment of the incident was done with a thin plywood sheet and ample padding on soft earth. Analyses of the steel sheets were done for a variety of resting, static, and dynamic falling scenarios.

Each steel sheet weighed 360 lbs (1,440 lbs total). All personnel underestimated these weights by a factor of two or more. Site inspection revealed a sturdy steel frame securely bolted to a steel floor. No scratches were evident on the floor near the fallen sheets. No shoe damage was seen. Vibration amplitudes were insufficient to dislodge the steel sheets from their resting position. Bone and soft tissue injuries were consistent with a fall, impact of the left hip against the steel floor, and impact of the plates against the right knee. Analysis showed that only 115 foot-pounds of energy were required to get the plates vertical by a "clean-and-jerk" type effort. Static analyses showed that small angular changes from vertical resulted in large (irresistible?) horizontal forces. Dynamic analyses quantified the extra forces needed to keep the plates from moving past vertical. Only a small window of "opportunity" to arrest plate motion existed; efforts outside this window would require arresting forces likely beyond the employee's expectations or abilities.

The data and analyses supported the hypothesis that the employee misjudged the mass of the plates and pulled them in such a manner that, once moving, he could not stop their continued motion.

Human Injury, Injury Mechanism, Injury Analysis