Abstracts for the 2021 Winter NAFE Conference

Forensic Engineering Analysis of a Collision Involving Aftermarket Bumper and Grille Guard Structure

By Ben T. Railsback, M.S., P.E. (NAFE 571S), Stephen D. Knapp, P.E. (NAFE 819S)

Bull bars, brush guards, grille guards, push bumpers, and other various aftermarket bumpers can be added to or replace original equipment bumpers from a vehicle manufacturer. The addition or replacement of the bumper system modifies the stiffness of the original equipment and modifies intervehicular friction. The modification may have marginal benefits for protecting the front end of the vehicle that is modified from property damage but can result in devastating outcomes in terms of personal injury for a vehicle struck by the aftermarket bumper system. Analysis of a collision involving an aftermarket bumper system is complicated by the increase in stiffness of the front end of the modified vehicle and the potential increase in intervehicular friction. Methods to determine the stiffness of the modified bumper system and the change in intervehicular friction will be presented. The safety, or change in safety, of vehicles with bull bars, brush guards, grille guards and similar modifications will also be presented.

Overheating poor electrical connections

By Chris Korinek, PE, CFEI, CQE

Overheating poor electrical connections are a ubiquitous ignition source of structure fires. Yet, knowledge of the intimate processes which occurs between conductors at the connection point is under-researched and relatively undocumented in the literature. A filament or pool of liquid oxide acts as a bridge between conductors and stably carries the current for a period of hours to days, resulting in the primary hazardous situation with respect to ignition of surrounding materials.
This paper displays the said phenomena from a materials science perspective and presents vivid documentation of what happens between conductors in the form of high magnification photography, (real time videography for .ppt), cross sectioning, scanning electron microscopy, and specialized techniques for examination under the compound metallurgical microscope.
The second part of the paper is a case study showing how the data learned from this research informed expert opinions at trial and influenced the results.

Goals, Methodology, and Tools for Investigating Electrical Shocks

Chris W. Korinek, PE, CFEI, CQE

This paper will discuss the Forensic Engineering factors of a shock investigation. It will include the effects of electricity on the human body, how stray voltage and current can occur, and why a person might not be protected from this stray current flowing through their body. We will cover pertinent standards of care, how to plan and execute the examination of an incident scene, a case

study, and levels of protection such as grounding, bonding, double-insulated devices, and GFCIs. One of the main Engineering goals is to construct as much as possible of the 3 dimensional equivalent circuit of the physical surroundings, building, ground conditions, devices, electrical services, along with the person and their clothing and actions to understand how current entered and exited the person. Compiling an accurate and complete history of the structures, devices, and utility service are crucial to whether pertinent standards of care were met.

Forensic Engineering of Pedestrian and Worker Fall Incidents – The Evolution of Analysis Techniques and Safety Requirements

By Chris Shiver, PE

Fall injury and fatality claims and legal cases involving both ordinary pedestrians, as well as employees/contractors at work sites have increased dramatically over the course of the authors 38 year engineering career. As a result forensic engineers are also more frequently being contacted by insurer's and attorneys to analyze these incidents to determine probable cause(s) and to ascertain as to whether location features were designed, constructed, installed, manufactured and/or maintained in accordance with the standard of care, including requirements specified in applicable codes and standards. The proper contemporary analysis techniques for these incidents are addressed, as well as what constitutes proper basis for establishing a standard of care for an involved installation and/or equipment. This paper will expand on and update information provided in approximately two dozen past NAFE papers, most of which are more than 10 to 30 years old, on various aspects of fall incident analysis.

Current Assessment of Stand-Up Forklift Underride Accidents

By Richard M. Ziernicki, Ph.D., P.E., F 308, Ricky Nguyen, M.S., P.E., William Pierce

Research has shown the most common form of accidents involving stand-up forklifts are collisions. Since forklifts are commonly used in storage warehouses, colliding into storage racks have been known and documented for decades. Depending on the forklift model configuration and storage rack configuration, when the height of the first rack beam from the floor is close to or above the height of the forklift's operator compartment and is at a height that is lower than the forklift's overhead guard, the rack beam can intrude into the forklift's operator compartment. These kinds of collisions are typically referred to as horizontal intrusion accidents (also known as "underride" accidents). When the forklift is not equipped without horizontal intrusion guarding, the horizontal intrusions accidents are serious, and many times are deadly. This paper presents physical testing, Finite Element Analysis evaluation, and analysis of one major forklift manufacturers accident database which shows third corner post are effective guards in reducing and/or preventing the consequences of horizontal intrusion accidents. Further, this paper shows the third corner post design meets and well exceeds design requirements of the materials handling industry standards.

A Forensic Analysis of a Metal Fragment from a Backhoe Impacting the Carotid Artery of the Operator

By Dr. J. William Jones, Dr. Lawrence Kashar, Corey Arzoumanian, Esq, Arash Homampour, Esq, C.L. Pederson.

The authors investigated a matter that involved a large backhoe that was digging a trench in supposedly rock-free soil. The operator struck a rock and a small metal chip was ejected at great velocity from the hardened tooth, impacting the operator in the neck. The operator died from a severed carotid artery. The forensic investigation included extensive metallurgical testing of the backhoe tooth, an analysis of the fracture mechanism and numerous tests to show how the accident occurred. It was concluded that the fragment failed in a Hertzian Cone, which is associated with brittle materials and not normally found in metals. Physical testing of exemplar materials verified that metals can and do fail in a Hertzian Cone. Additional tests were conducted on the window glass and at a rock quarry. Testing showed that side window glass was not capable of stopping the projectile, whereas windshield glass would have prevented the fatality.