Transportation ite Talk
CANADIAN INSTITUTE OF TRANSPORTATION ENGINEERS MEMBER NEWSLETTER
Volume 30, Number 3

Transportation Engineering Meets CSI

Forensic Engineering of Collisions

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On the popular television series, "CSI" stands for Crime Scene Investigation. However, in the forensic engineering world of roadway collisions, CSI might appropriately stand for 'Civil Suit Investigation'. Instead of uttering profound one-liners like Horatio Caine, forensic engineers work behind the scenes providing their clients with expert opinion and facts to assist them in dealing with their legal matters.

Forensic engineering is the investigation of products, materials, transportation facilities, or structures that fail or do not function as designed, causing person injury, death, or property damage. Forensic engineering is a broad reaching field of applied science. This article is a synopsis of the forensic engineering aspects of roadway collisions and how these investigations compare to traditional transportation engineering reviews and audits.

Forensic engineering investigations of collisions consider three categories of potential contributing factors: the driver, the vehicle, and the roadway environment. A thorough assessment of all contributing factors, no matter how minor, is critical to transportation facility owners, insurance industry and legal professionals. A seemingly minor contribution of a road design or maintenance deficiency, for example, can have major financial consequences when it comes to liability exposure in court.

With the escalating long-term medical costs of injuries, it is currently commonplace in Canada to see claims on the order of ten million dollars for catastrophic roadway collision injuries. With most personal insurance policy limits set at one million

dollars, it is common for plaintiffs to pursue other parties including the road authority or facility operator for the remaining claim balance. For this reason, expertise in road design, road maintenance, and transportation safety are critical on a forensic engineering team.

FORENSIC ENGINEERING VERSUS TRADITIONAL ENGINEERING

Forensic engineering in terms of collisions differs from traditional transportation engineering in a number of aspects, including:

- The majority of work involves failures or collisions at a specific location as opposed to design, operations and maintenance work within a system;
- Contributory or mitigating aspects are an important part of the investigation, as opposed to focusing on the primary cause of the collision;
- The specific road user actions and their opportunity to avoid a collision or injury are an integral part of each assignment; and
- Forensic engineers must be familiar with legal issues pertaining to their investigation and must be able to communicate their findings to legal or quasi-legal clients.

While the driver, the vehicle and the roadway environment are all considerations in a transportation engineering safety review, the latter is generally the focus, with negligible attention given to specific road user actions or vehicle performance and damage from any one collision. This is a necessary reality in transportation engineering as the road safety engineer is typically reviewing a transportation facility with an aggregated collision history in hand, and little or no opportunity to access specifics from one or more of the relevant collisions.

Traditional roadway safety engineering in most jurisdictions relates to assessing the nominal safety of a facility during its planning, design and operation stages) i.e., whether a roadway, design alternative, or design element meets minimum design criteria or accepted standard). In some cases proactive safety programs will include a determination of:

- Higher collision risk locations within the jurisdiction through some form of network screening process;
- Site specific roadway characteristics or operations which may be contributing to the higher-than-expected or dominant collision types;
- The collision risk or potential associated with the deficiency(ies);
- Potential countermeasures or remedial action that are required to correct the deficiency and the timeline for which they should be completed.

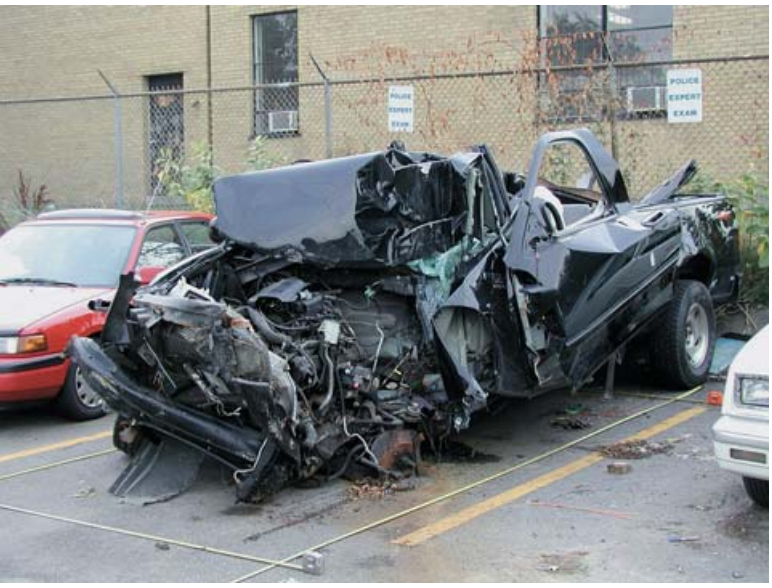
Forensic engineering investigations would also endeavour to answer a host of other questions posed by their clients, including but not limited to:

- Did the safety deficiency, hazard, or environmental condition contribute to the collision? Did it contribute to the severity of the collision?
- Did the responsible authority have actual or constructive knowledge of the defect or condition, and had reasonable opportunity to either correct the roadway deficiency or to warn of its hazard?
- What do the vehicle damages, final resting positions, skid marks and road side damage suggest?
- Does the road user injuries suggest anything about apparent actions prior to the collision, i.e., Were they belted? What was their speed and direction? What last minute actions were they undertaking?
- Notwithstanding the roadway factors, did the road users take reasonable steps to evade the collision? (i.e., "opportunity to avoid" assessment)

A FORENSIC COLLISION INVESTIGATION

A forensic engineering collision investigation begins with the gathering and review of the available physical 'evidence' and reported information. The gathering of physical evidence may include site examinations and surveys, vehicle examinations and crush measurements, seatbelt and filament examinations, Police interviews, and 'black box' downloads. Comparisons are then made between the severity of the observed vehicle damage and crash test data using exemplar vehicles. All available information is considered, and the impact is reconstructed mathematically using the basic physics principles of energy and momentum conservation.

The reconstruction can then continue with a human factor assessment, an assessment of avoidance opportunities, including braking and swerving, an assessment of roadway and environmental factors, a full operational safety review, an assessment of vehicle deficiencies, and a biomechanical



assessment of the sustained injuries in terms of restraint usage.

Forensic Engineers also use computer analysis and simulation to test thousands of combinations and permutations of collision scenarios to find a solution that closely matches the known physical constraints. This analysis can then be presented in computer animation format, to convey the findings to the court visually in a helpful manner.

In reporting their findings, a Forensic Engineer must act in good faith as an unbiased investigator and expert witness, for the ultimate purpose of assisting the court to understand the circumstances of the collision. Regardless of whether the Forensic Engineer is retained by the plaintiff, the defendant, or a third party, it is his or her task to provide the client with unbiased findings, whether 'good news' or 'bad news', so that the client can proceed 'forearmed and forewarned'.

WHY A FORENSIC ENGINEERING GROUP?

Police investigations typically do not address roadway or environmental issues, even when a detailed reconstruction is done. There are a number of reasons for this seemingly counterintuitive fact. The officer's primary responsibility is to attend to the injured and document the scene evidence. Also, police investigations typically focus on driver and pedestrian actions (or inactions), in terms of whether or not charges should be laid. Brief Police comments such as "lost control on curve" or "failed to stop in time" could be a red flag for a road design or operations problem. Furthermore, officers are not trained in traffic engineering and the associated standards, which are numerous and complex, nor do they have the luxury of time to assess the design and operational safety of a particular road.

In traditional transportation engineering, road safety professionals will undertake in-service safety reviews and audits, involving a review of only the roadway characteristics; however, there may be other driver-related factors, vehicle factors and environmental factors that need to be considered.

In forensic engineering, the ideal consulting team will combine expertise in all of these areas with expertise in road factors, allowing for a comprehensive assessment of the collision. The outcome of this combined effort will be an understanding of the impact, the pre-impact circumstances, and the relevance of any road or environmental factors to the collision. The presence of a road deficiency does not necessarily mean that the road was hazardous, or that it contributed to the cause of the collision. As a simplified example, consider a collision during dry conditions on a horizontal curve that is too sharp, but that still provides a high factor of safety on dry roads. In such a case, the road did not pose a hazard at the time of the specific collision.

In summary, road design, operations and maintenance deficiencies can easily be overlooked in the initial stages of a collision and/or claim investigation. In large loss investigations, it is critical for any potential road issues to be identified early by a qualified expert, to properly assess exposure to liability.

ABOUT THE AUTHORS

Jason Young, B.E. Sc., M.A.Sc., P.Eng., is a Senior Investigator of the Collision Reconstruction Team at Giffin Koerth Forensic Engineering and Science in Toronto. Jason has been involved in over 500 forensic investigations and has a Master's Degree in Biomedical Engineering from the University of Toronto. These investigations have included a variety of system users/vehicles including pedestrians, cyclists, motorcyclists, transit vehicles, heavy trucks and trains. Jason has presented seminars on road design issues in collision reconstruction to both the insurance and legal industries in Ontario. Jason is a member of the Canadian Association for Technical Accident Investigators and Reconstructionists (CATAIR) and has completed the C.S. Anderson Road School course at the University of Guelph on Practical Urban Maintenance.

Russell Brownlee, B.Sc., M.A.Sc., FITE, P.Eng., is the Head of the Road Assessment team and is a Transportation Safety Engineer at Giffin Koerth Forensic Engineering and Science. Russell has over 13 years of public and private sector experience in the areas of road user safety, rail safety and transportation engineering. He is a recognized expert in undertaking in-service safety reviews of transportation facilities and, in the recent past has completed in-service safety studies encompassing over 330 kilometres of roadway and 150 intersections and accesses. The study locations represented a variety of operating conditions from constrained freeway work zones to remote locations on rural highways. Russell is an active member of the Institute of Transportation Engineers (ITE). He has been a member of the Traffic Engineering Council Executive Committee for a number of years and is the current Chair of the Transportation Safety Council Executive Committee.

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