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Assessment of Injury Rates Associated with Road Barrier Collision

Hawzheen Karim[a,*], Rolf Magnusson[b] and Mats Wiklund[c]

[a] *Highway and Railway Engineering, Swedish Royal Institute of Technology, 100 44 Stockholm, Sweden*
[b] *School of Technology and Business Studies, Dalarna University, Borlänge, Sweden*
[c] *Swedish National Road and Transport Research Institute, Linkoping, Sweden*

Abstract

This paper presents a study aimed at quantifying and comparing the risk of personal injuries associated with road barrier collisions. Documented data from actual barrier collisions, including post-impact collisions, in Sweden between 2005 and 2008 were analyzed. The analyses were based on the injury classification made by healthcare services. The injury rates, measured in number of injuries per vehicle kilometer travelled, were calculated for the different injury classes as a basis for evaluating barrier performance. The results show that the rate of injuries was higher due to collisions with flexible barrier systems, such as cable barrier, than with other semi-rigid and rigid barrier system, such as w-beam and concrete barriers. This result might be explained by a high rate of post-impact events, such as post-impact collisions, roll-overs and over-rides, associated with the placement and mechanical properties of the cable barriers. The study also showed a considerable difference in injury classifications made by the police and the healthcare services, as well as a considerable under-reporting of barrier collisions by the police.

Keywords: road barrier collision; road accident injuries; cable barrier collisions.

* Corresponding author. Tel.: + 46 702 363628; fax: + 46 23 778054.
E-mail address: hawzheen.karim@gmail.com.

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1. Introduction

The life-cycle costs for road barriers, are seldom considered during the initial selection of barrier types due to limited information regarding maintenance and socio-economic costs (Karim 2008; Karim and Magnusson 2008). Costs for injuries associated with road barrier collisions are a considerable part of the socio-economic costs. To estimate such costs for a particular barrier type it is necessary to quantify the specific risks of collision and injuries associated with that barrier (Karim et al. 2010). Unfortunately, it is often difficult to precisely quantify the injury risks associated with road barrier collisions because information regarding collisions, traffic condition and road barrier types is often unavailable.

The objective of this study was to quantify and compare the rate of injury associated with collisions with different barrier types. This study is unique in that barrier performance evaluations were based on actual collision data, post-impact collision data and an injury classification made by Swedish healthcare services. It shows how road barriers actually perform.

Since the study is based on Swedish data, the conclusions can be applied to other Nordic countries where the road design is similar. However, the study's methodology can be applied to similar studies. The results will be used in an ongoing research project to estimate accident costs as a part of the socio-economic costs in a model for calculating life-cycle costs for road barriers.

2. Literature review

Road barriers are used to prevent vehicles from veering off the roadway into oncoming traffic, crashing into solid roadside objects, or falling into ravines. Road barriers are also used to protect pedestrians and cyclists from traffic and to protect roadside obstacles. Road barriers are usually categorized as flexible, semi-rigid or rigid, depending on their deflection characteristics on impact (AASHTO 2006).

In general, the use of road barriers is a very effective way to reduce road injuries and fatalities. Installation of median cable barriers on 13 m wide roads reduced the number of fatal crashes by almost 76% in Sweden during the period 1998 – 2009 (Carlsson 2009). Fatal and disabling cross-median collisions on highways in Washington State were reduced by 75% on highways by using median cable barriers (Ray et al. 2008). Another study showed that the number of fatal collisions reported by police on French highways with roadside barriers was 50% less than on roads without barriers (Martin et al. 2001).

Despite the effectiveness of reducing injuries, road barriers themselves may cause severe or fatal injuries by inflicting severe impact forces on vehicle occupants during a crash (Road and Traffic Authority 2004; Insurance Institute for Highway Safety 2008; Stigson 2009). The severity of an impact into a road barrier depends on the barrier's flexibility, impact angle and impact speed. Flexible systems, such as cable barriers, generally impose lower impact forces upon vehicles than other systems, since more of the impact energy is dissipated by deflection of the barrier (AASHTO 2006). Because the impact event occurs over a large lateral distance, the time of the impulse event is extended. With flexible barriers, the risk of post-impact collisions has to be considered. Thomson (1999) showed that 65% of the cases involving impacts with flexible barriers resulted in severe secondary collisions (i.e., Post-impact collisions).

Impact speed is another factor affecting impact severity. According to Singelton et al. (2004), the injury risk is proportional to impact speed. It has been shown that a higher posted speed is associated with higher crash severity (Ydenius 2009).

The severity of a barrier impact also depends on the impact angel. Based on full-scale barrier crash tests, a study showed that the impact severity increased when the impact angel increased from 20° to 45° (Ydenius 2010). The most significant increase in injury risk occurred with concrete barriers. Based on this result, flexible or semi-rigid barrier systems showed potential for reducing injury severity. It is worth noting that Ydenius did not consider the risk for severe injuries due to secondary collisions. Bryden and Fortuniewicz (1986) showed that 25% of barrier collisions resulted in secondary collisions causing severe