Feasibility of Using Truck Position Data to Identify Accident Risk

Tony Parry, Jwan Kamla and Ian Dickinson*

Nottingham Transportation Engineering Centre, University of Nottingham, UK
** Microlise Ltd, UK*

ABSTRACT

In order to reduce accident risk, highway authorities prioritise maintenance budgets partly based upon previous accident history. As accident rates fall, this approach has become problematic as accident 'black spots' have been treated and the number of accidents at any individual site has fallen. Another way of identifying sites of higher accident risk might be to identify near miss incidents; where an accident nearly happened but was avoided. These incidents are likely to be of much greater number than accidents and therefore, of use in identifying sites at risk of accidents. This paper reports the early findings of a feasibility study that is investigating the use of truck position data for this purpose.

Most modern trucks fleets now record position as part of fleet management. This paper has used position data collected by a truck fleet management company for thousands of trucks in the UK, over a number of years. The data have been used to identify incidents of harsh braking and harsh cornering. To explore the hypothesis that these incidents could represent accident near misses and as such, identify sites of higher accident risk, we have investigated the relationship between the incidence of harsh braking and accident records, geometric information, traffic flow and accidents at a number of roundabouts. Successful implementation of this approach could help highway authorities to improve the allocation of road safety and maintenance budgets.

Keywords: road accidents, near miss incidents, truck position, harsh braking, roundabouts

1. INTRODUCTION

1.1 BACKGROUND

In the UK, overall road accident rates have been falling for many years (Department for Transport, 2013). In efforts to continue this reduction, highway authorities maintain budgets for road safety improvements and these must be prioritised to those locations where safety measures, such as junction improvements and resurfacing, will be most effective. In the past, priority could be given to sites with poor accident records, or 'black spots'. As accident rates have fallen, these locations have become less apparent and further methods are required to prioritise expenditure on road safety.

At the same time, the vehicles using the road networks have become more sophisticated, including in the number of sensors recording data for engine management and maintenance purposes. It may be feasible that, in some cases, these data could also be used by highway authorities to provide information about the road networks. For instance, a previous study has shown that vehicle accelerations could be used to detect road surface defects (Byrne et al, 2013). Amongst these data, truck fleet management companies often collect records of the position of vehicles within their fleet; this can be used for logistical reasons and can also be processed and combined with other data (e.g. engine speed or gear selection) to provide information about driver behaviour, for instance for use in driver training for fuel economy (see for example www.telematics.microlise.com).

This paper describes the early stages of a feasibility study of using these position data to assist highway authorities in identifying locations of accident risk. The position data were used to identify locations where trucks underwent sudden decelerations; incidents of 'harsh braking'. The accident records of these sites were then compared to the rates of harsh braking. If the two are related, then it may be plausible that sites of accident risk could be identified by rates of harsh braking. This might be more reliable than relying on accident rates alone, because incidents of harsh braking are more numerous than those of recorded accidents and the larger data set may form more robust evidence than the less frequent accidents.

1.2 DATA SOURCES

1.2.1 Truck position data

Truck position was recorded using standard GPS equipment, for purposes of delivery logistics etc. These data were also processed to derive accelerations, and decelerations above a certain threshold are flagged and their location recorded. The nominal threshold is $-10ms^{-2}$ for a duration of at least 1s, although tests on a test track, using a truck equipped with the same GPS equipment and accelerometers, revealed that the actual threshold can be as low as $-8.5ms^{-2}$. For the three years September 2009 to August 2011, over 200,000 incidents of harsh braking were recorded for the UK fleet served and analysed in this way by Microlise Ltd.

An inspection of the locations of these incidents revealed that a majority occurred on the approaches to roundabouts, see Figure 1 for an example. Nine roundabouts with a high occurrence of harsh braking incidents were selected for further analysis in this feasibility study.

Figure 1. Location of harsh braking incidents (left) and accidents (right) at M4 junction 18.

1.2.2 Accident and traffic data

Accident data for the nine roundabouts were collected from the STATS 19 database for the ten years 2002 to 2011. This includes all injury accidents reported by police, for all vehicles. Annual average daily traffic (AADT) data were acquired for trucks, from the TRADS database for local authority roads for the years 2009 to 2011 and for Highways Agency roads for the years 2009 and 2010.

1.2.3 Geometric data

Fleming (2008) reported that increased roundabout entry width (see also Maycock and Hall (1984)), circulatory roadway width and roundabout diameter were all associated with increased accident risk. These dimensions were calculated for the nine selected roundabouts from aerial photographs on an on-line mapping site.

These data are given in Table 1.

Table 1. Selected roundabout data.

Roundabout	**Approach**	**Truck AADT**	**Harsh braking incidents (2009-2011)**	**Accidents (2002-2011)**	**Diameter (m)**	**Roadway width (m)**	**Entry width (m)**
A4174 / A4017	A4174 e/b	4002	140	6	71	14	17
	A4174 w/b	3204	205	15			10
	A4017 n/b	246	15	12			13
M4 J18	M4 e/b	12777	112	15	190	11	8
	M4 w/b	12108	233	8			8
	A46 n/b	2145	87	6			7
	A46 s/b	1173	15	2			8
A5 / B4386	A5 n/b	3074	70	5	70	10	8
	A5 s/b	2900	24	3			9
A460 / Sarendon Rd	A460 e/b	3384	108	6	45	9	9
	A460 w/b	3435	167	0			8
M6 Toll / A34 / A5	A34 e/b	636	2	8	70	12	8
	M6 Toll w/b	771	5	1			9
	A5 n/b	50978	158	6			11
	A34 / A5 s/b	4193	20	5			13
A5 / B4154	A5 e/b	5096	129	9	61	9	10
	A5 w/b	5379	146	9			9
A5 / A452	A5 e/b	5097	110	3	119	10	8
	A5 w/b	3567	143	3			7
	A452 n/b	834	0	4			8
M53 J9	M53 e/b	9108	8	12	145	9	9
	M53 w/b	7668	197	4			10
M602 J2	M602 e/b	5018	291	5	150	12	10
	M602 w/b	2576	42	5			7
	A576 n/b	2843	17	3			10
	A576 s/b	1021	10	5			11

2. ANALYSIS

2.1 ROUNDABOUTS

Comparing the total number of accidents with the total number of harsh braking incidents for each roundabout, Figure 2, suggests that they are related. The correlation appears relatively weak but this is to be expected, given the number of factors that contribute to accidents.

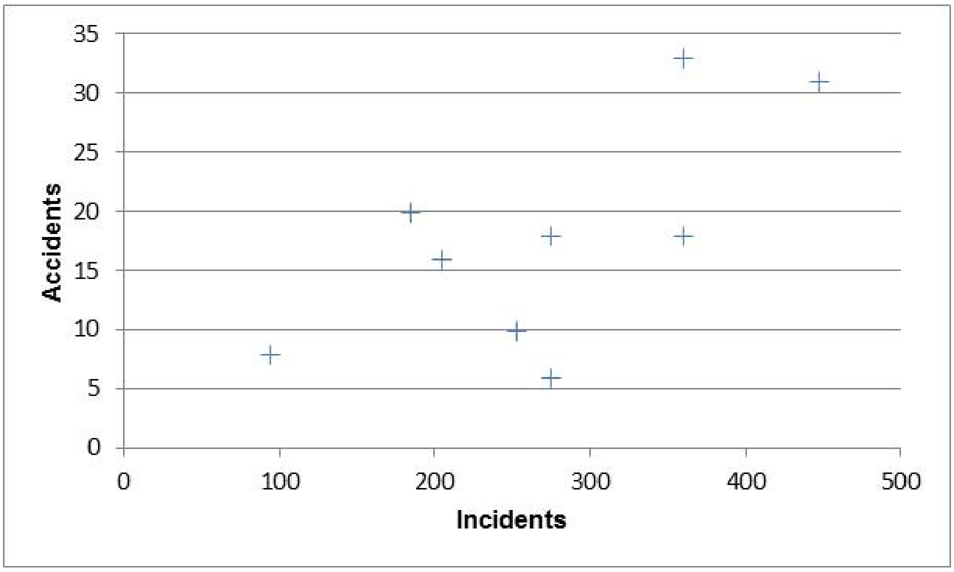

Figure 2. Number of accidents and harsh braking incidents at each roundabout

Dividing the number of accidents and the number of incidents by the truck traffic volume, to normalise by exposure and provide an estimate of risk of accidents and incidents, reveals a similar relationship, Figure 3. These data have a little less scatter than the un-normalised numbers, around a linear best fit relationship, although this is not shown because there is no suggestion that there is a causal link between the two, or that any relationship between them should be linear.

The A460/Sarendon Rd roundabout appears to lie below the general trend, circled in Figure 3. This roundabout has the smallest diameter and roadway width. There is a clear relationship between roadway width and the number of accidents, although this is not as clear for incident numbers, Figure 4.

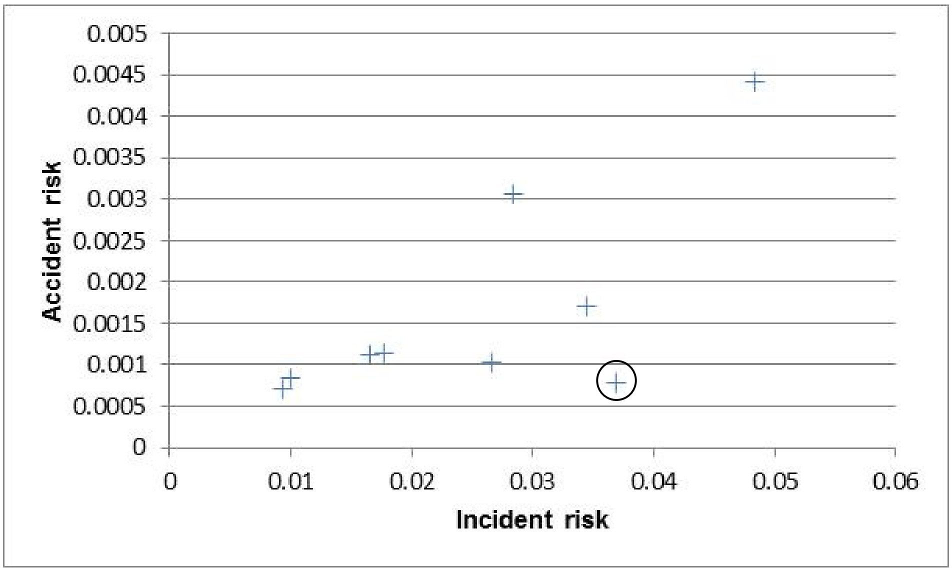

Figure 3. Accident risk and incident risk at each roundabout

It should be remembered that the accident numbers are those involving all vehicles, not just those involving trucks. For these accidents, 28% involved trucks. Also, the truck AADTs are for all trucks, not just those that are monitored in this study.

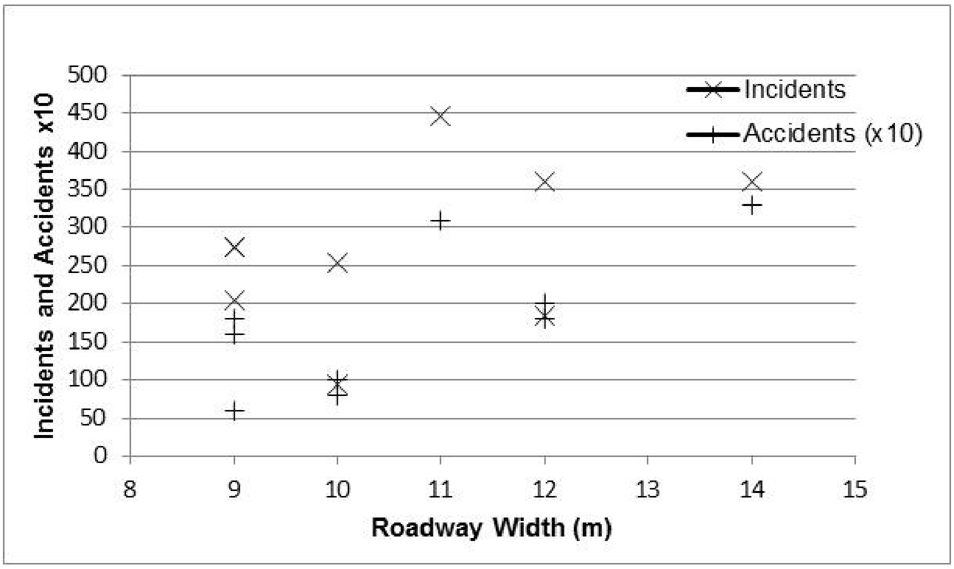

Figure 4. Accident and incident numbers against roadway width

2.2 INDIVIDUAL APPROACHES

Repeating the exercise in Figures 2 and 3, for the individual roundabout approaches shows some very marked outliers to the general trend. The A460 w/b approach to the A460/Sarendon Rd roundabout lies below the general relationships, having no accidents but a number of harsh braking incidents (see Table 1); this accounts for this roundabout lying below the general trend in Figure 3 and could be related to geometry, as mentioned above.

The A4017 n/b approach to the A4174/A4017 roundabout lies markedly above the general relationship having a low number of trucks yet a high number of accidents. The A34 e/b approach to the M6 Toll/A34/A5 roundabout has an unusually low number of harsh braking incidents. The geometry of these approaches and roundabouts is typical and would appear not to be a possible explanation for these numbers. In general the entry width for the approaches shows no correlation to the accident or incident numbers.

3. DISCUSSION

For these nine roundabouts, there appears to be a relationship between reported accident numbers over ten years and incidence of harsh braking recorded over the last three of those years (Figure 2). This correlation is clearer when the numbers are normalised by truck traffic count, to generate an estimate of risk (Figure 3). The accident records are for all accidents in the STATS 19 database and any correlations concern overall accident risk, rather than just for trucks, which will be of more interest to highway authorities than truck accidents alone.

These relationships suggest that records of the harsh braking incidents represent an indication of future accident risk that is a useful supplement to accident records when making decisions about prioritising road safety measures. An advantage of using incident records in this way is that they are far more frequent than accidents and therefore, may be less prone to random variation; when accidents occur at rates of one or two a year, it is difficult to know if a single additional accident represents a significant increase in risk.

This small data set supports previous researchers' conclusions that roundabout geometry is linked to accident rate. This link is weaker for the harsh braking incidents.

Relationships between accidents and incidents are less pronounced for individual approaches to the roundabouts, than for the roundabouts as a whole. This is not explained by the geometry of the approaches. Risk of accidents (and harsh braking) at an individual approach is probably influenced to some extent by the geometry and traffic on the roundabout as a whole, for instance in terms of sight lines and conflicts with other vehicles at give way lines. This could explain to some extent the better relationships for whole roundabouts, than for individual approaches.

As time passes more truck data of this type will become available, for a larger number of trucks. This could lead to more reliable indications of accident risk and allow time series to be established. If accident numbers continue to fall, identifying risk by alternative means, such as this, will become increasingly important.

The company involved in this feasibility study have begun to record incidents of harsh cornering in addition to harsh braking and this will provide additional information on 'unusual' truck movements. Further data still could be acquired from inbuilt sensors, including for instance steering wheel movements or ABS pre-activation, which could also be interpreted in terms of handling and safety risk. Compilation and interpretation of these data could provide better information about potential 'near misses' and a wider study than this initial investigation may lead to a better understanding of the relationship between truck sensor outputs and accident risk at individual sites or for routes.

In conclusion, this initial study appears to confirm that it is feasible that truck position data can be interpreted in terms of accident risk and be used to supplement accident data in safety investigations. A more extensive study should be made, including more sites and additional data, in order to trial the use of these data in this way.

REFERENCES

Byrne, M., Parry, T., Isola, R. and Dawson, A. Identifying road defect information from smartphones. Road and Transport Research, vol. 22 no. 1. 2013

Department for Transport (2013). Reported Road Casualties Great Britain: 2012. Department for Transport, London, UK.

Fleming, P. (2008). Enhancing Intersection Safety through Roundabouts: An ITE Informational Report. Chapter 4: Design. Institute of Transportation Engineers. Report No. IR-127. Washington D.C., USA.

Maycock, G. and Hall, R.D. (1984). Accidents at Four Arm Roundabouts. Transport and Road Research Laboratory, TRL LR 1120. Crowthorne, UK.

Author Biographies

Dr Tony Parry is an Associate Professor in the Nottingham Transportation Engineering Centre in the Faculty of Engineering, University of Nottingham. He has a long track record of multidisciplinary transport research, particularly in the fields of pavement condition measurement, road safety and sustainability, for a range of research funding organisations in the UK, EU and US, and for industry. Tony is a member of the Chartered Institution of Highways and Transportation, Asset Management Panel. He managed the research that led to the current road surface skid resistance standards for trunk roads in England.

"Ian Dickinson, Director of Technical Services, has been with Microlise since 1995 and has overall responsibility for all hardware and software product development. He holds a BSc (Hons) in Electrical and Electronic Engineering from The University of Nottingham and has more than 28 years product development experience."

Jwan Kamla was born in, Erbil, Iraq. She graduated in Civil Engineering from Salahaddin University in Erbil in 2004 with a Bachelor degree. In 2005 she worked in Salahaddin University as an engineer in pavement laboratory until 2007. In 2009 she finished her Master degree in Traffic Engineering in Salahaddin University, Erbil. She worked in the same university for one year as a lecturer, by that time she was supervised two undergraduate students in civil engineering department with projects on traffic engineering. In 2011 she joined Nottingham Transportation Engineering Centre as a PhD student under Dr Tony Parry's supervision.