# Understanding worker perceptions of common incidents at roadworks in Queensland

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## Abstract

The process of building safer roads and roadsides needs to be managed to minimise risks to both the road using public and roadworkers. However, detailed and accurate data on fatalities and injuries at roadworks across Australia are not available. The lack of reliable safety records and consequent poor understanding of the hazards at roadworks motivated this research to examine the common trends in incidents and to understand workers' perceptions of the causes of incidents at roadworks. To achieve these aims, 66 roadworks personnel were interviewed in Queensland including road construction workers, traffic controllers, engineers, and managers. Qualitative analyses identified several major issues and themes. Vehicles driving into work areas, traffic controllers hit by vehicles, rear end crashes at roadwork approaches, and reversing incidents involving work vehicles and machinery were the most common types of incidents. Roadworkers perceived driver errors, such as violation of speed limits, distracted driving, and ignoring signage and traffic controllers' instructions as the main causes of the incidents.

## Introduction

While roadworks are essential for maintaining and improving the mobility and safety of all road users, the process of building safer roads and roadsides needs to be managed to minimise risks to both the motorists and roadworkers. Reports from highly motorised countries including the Netherlands, United States and Great Britain show that around 1-2% of road fatalities occur at roadworks (NWZSIC, 2012a, 2012b; SWOV, 2010). Numerous studies have found that crash rates increase significantly during roadworks compared with pre-work periods (Doege & Levy, 1977; Garber & Zhao, 2002; Khattak, Khattak, & Council, 2002; SWOV, 2010; Whitmire II, Morgan, Oron-Gilad, & Hancock, 2011). Roadwork crashes are also reported to be more severe than other crashes (Pigman & Agent, 1990), possibly associated with the relatively high proportional involvement of trucks (Bai & Li, 2006; Krux & Determan, 2000; SWOV, 2010).

Compared to some other countries, relatively little is known about roadwork crashes across Australia, primarily because it is difficult to identify roadwork crashes in official records (Haworth, Symmons, & Mulvihill, 2002). Thus, it is difficult to obtain accurate comparative information on crash rates, crash severity and other variables of interest. Based on New South Wales (NSW) data, it is estimated that nationally each year at least 50 deaths and 750 injuries occur in crashes at roadworks with a cost of more than $400 million (Debnath, Blackman, & Haworth, 2012). Approximately 1% of traffic crashes reported in NSW in 2007 (n=45,395) occurred at a 'roadworks/detour/diversion' location (RTA, 2008). Of these crashes (n=467), about 3% were fatal and 43% involved injury, while the remaining 54% of crashes resulted in property damage only. Earlier research (Cottril et al., 1990) found that approximately 160 roadworks casualty crashes were reported annually in Victoria, with an estimated community cost of $7 million. Muthusamy and Kumar (1995) reported five fatalities and 52 serious injuries to roadworkers in Victoria in 1990-1994.

Under-reporting of crashes at roadworks has been identified as a substantial issue (Cottril et al., 1990; Muthusamy & Kumar, 1995). Since 1989 in Victoria 'roadwork' crashes no longer need be reported as such unless police determine that roadworks actually contributed to the crash. Similarly in the Queensland Department of Transport and Main Roads (TMR) crash database, crashes at roadworks are only identifiable if ‘roadworks’ was reported as a contributing circumstance. In addition to these issues which impede identification of crashes at roadworks, there might be also be significant underreporting of incidents where a public vehicle is not involved (whether inside or outside a work zone) or the severity level is low. Workplace Health and Safety (WHS) datasets provide an alternative source of information about roadworks incidents but these datasets are managed separately by respective organisations and include data from their worksites only and there is little consistency among the datasets. There is likely to be significant under-reporting in WHS datasets as well, in that they may not include details or consequences of incidents occurring outside of the roadworks site or when the workers were not there (despite the presence of roadworks contributing to the incident).

The increased risk of crashes and fatalities at roadworks warrants proper understanding of the common hazards and incidents at roadworks. However, the lack of reliable data limits safety analysts’ ability to untangle the common hazards at roadwork zones. Where appropriate data are lacking, researchers have relied on surrogate data sources, such as traffic conflicts, simulated crash scenarios, and road user perceptions. The key advantage of studying worker perceptions is that it enables incorporation of real life experiences into the data, potentially encompassing a time range much longer than that for the other two (quantitative) alternatives. Furthermore, perception studies allow researchers to identify the common hazards at roadworks while distinguishing between the public and workers regarding their involvement in and contribution to crashes at roadwork sites.

Perceptions of roadworkers, road users, and transport agencies regarding safety around and within roadwork zones have been examined to a limited extent in recent years. For example, Haworth et al. (2002) examined safety at Victorian roadworks by analysing perceptions of roadworkers working in small groups. Earlier, Benekohal, Shim and Resende (1995) surveyed 930 Illinois truck drivers to understand their perceptions regarding traffic control in roadworks and to identify the locations of incidents and risky driving situations. MVA Consultancy (2006a, 2006b) studied high risk drivers’ perceptions of roadworks and roadworkers in order to understand the causes of speeding at roadwork zones and the potential initiatives to improve safety at roadworks. Maze, Kamyab and Schrock (2000) studied effectiveness of speed reduction strategies as perceived by 34 state transport agencies in the US. These studies identified a number of major issues needing attention, including poor compliance with reduced speed limits, lack of conspicuity (particularly in small operations), the effectiveness of signage, and poor public awareness, among others. Despite the valuable contribution of these and other studies, there remains a need for greater knowledge about the common types of incidents at roadworks, their causes, and how to reduce their occurrence.

This paper documents a qualitative study examining roadworkers’ perceptions of the common incidents at roadworks and their causes. Sixty-six roadwork personnel working across Queensland were interviewed and the interviews were qualitatively analysed to identify the major issues and themes. The following sections of the paper outline the research methodology in terms of design, participation and analyses, followed by the results of the study and a critical discussion of the findings.

## Method

### *Study design*

This qualitative study involved brief semi-structured interviews with people directly involved in roadworks who were asked to describe any serious incidents at roadworks that they had experienced, seen or heard about. As noted by Mullen (2004, p.277), who conducted semi-structured interviews to investigate factors influencing workplace safety behaviour, ‘the semi-structured format allowed the questions to be asked in different sequences that resulted in the issues emerging naturally throughout the conversation'. The current study adopted this use of generally broad, unobtrusive and non-directive questions that avoid leading participants toward particular responses or stated positions that may be construed as biased (socially desirable responses for example).

Participants were recruited from the TMR infrastructure and road maintenance arm (RoadTek) and from private organisations undertaking road construction, maintenance and traffic control in Queensland. Participant recruitment was facilitated by the industry partners of this study, including the Australian Workers Union (AWU), Leighton Contractors, GHD and TMR. Potential participants were first provided with a brief description of the study, after which consenting volunteers were subsequently interviewed. Interviewees were assured that their anonymity would be preserved in any subsequent reports, publications or correspondence with stakeholders and their employers. The QUT Human Research Ethics Committee approved the study in May 2012 (Approval Number 1200000195).

The semi-structured interview format was piloted with two groups of four and five RoadTek participants. These pilot interviews provided an opportunity to test the suitability and appropriateness of the questions before finalising the interview schedule. It was decided to run the subsequent interviews separately with each individual to remove the possibility of particular participants dominating discussion in a group setting. A total of 66 participants were interviewed (63 face-to-face and 3 by telephone). Two researchers each ran individual interviews simultaneously at each location until all volunteering participants were interviewed. The interviews were recorded on digital voice recorders and later transcribed by an external commercial transcription service. Interviews ranged in duration from 7 to 38 minutes. Approximately 72% of interviews ran between 10 and 20 minutes, reflecting the original study design. Approximately 20% of interviews exceeded 20 minutes duration, while a small proportion (8%) of interviews ran less than 10 minutes.

### *Qualitative analysis*

Transcripts of the interviews were analysed thematically using QSR Nvivo software (version 10). Due to resource constraints and to eliminate the inter-coder biases, all transcripts were coded by the same researcher. This researcher conducted about 50% of the interviews and therefore had sufficient understanding on the common themes arising in the interviews. This helped the researcher to code the qualitative data into some preconceived themes, as well as in emergent themes as the coding exercise progressed. The coding process involved two phases. In the first phase, each participant's response to each of the questions in the semi-structured interview was coded as a single theme with 'respondent-question' as the smallest unit coded. In the second phase, data relating to the themes for the units were analysed for coding to sub-themes under each theme of the first phase. The second phase involved an iterative process of coding as responses to one question were often found to have clues to the sub-themes for other questions. Since the interviews were semi-structured, respondents had the opportunity to talk in detail about their responses, which often overlapped with responses to other questions. Therefore, multiple coding within and between themes was possible from responses to a particular question.

### *Participants*

A total of 66 roadworks personnel were interviewed who had an average of 9.84 years (S.D. = 9.04 years) of roadwork related experience. Nine participants were categorised as inexperienced in roadwork (less than 2 years), 35 were experienced (2-10 years) and 22 were highly experienced (more than 10 years). Approximately two-thirds of participants (n=43) were currently working at urban sites while the rest (n=23) were working in rural locations. Some participants had experience in both urban and rural settings. Most of the participants were male (n=61) and aged between 30 and 54 years (n=48). There were five participants aged below 30 years and 13 participants aged above 54 years.

Among the respondents, 25 were traffic controllers, 15 were workers who undertake physical labour and operate machinery, 21 were managers, engineers, or supervisors, and the remaining five were directors, planners, or designers. The participants were further classified based on their exposure to traffic (as their work roles imply). The traffic controllers, who are the first to interact with traffic in a work site, were categorised as 'fully exposed to traffic'. The workers, who usually work behind barriers or have some form of physical protection/separation from traffic, were categorised as 'semi-exposed to traffic'. The remaining participants, who mostly work from regional or site offices with occasional visits to roadwork sites, were categorised as 'non-exposed to traffic'.

About 50% (n=32) of the respondents worked across the whole site, whereas 11 respondents (all traffic controllers) worked only at either end of site. Another 11 respondents (non-exposed to traffic) mainly do office-based works, but sometimes work on site. Twelve respondents (8 non-exposed and 4 semi-exposed) had an approximately 50-50 split of office and on-site work. About 40% (n=26) of respondents reported that they walk on foot when they work on site, another 47% (n=31) reported to be mostly on foot and sometimes in vehicle. Only nine participants (including 7 non-exposed) reported staying inside vehicles when working on site. The high proportion of participants who walk around on foot while working on site indicate that the respondents should have thorough understanding on the common hazards in sites.

Most of the participants worked during daytime (n=49), while seven respondents (including 5 traffic controllers) worked only at night. The remaining 10 respondents had both day and night work experience.

## Results

### *Common types of incidents at roadworks*

A cross tabulation of types of incidents reported and number of respondents reporting those incidents is shown in Table 1. The non-exposed group reported most of the 'vehicle drive into work area' type of incidents. The 'traffic controller hit by vehicle' type was consistently reported by all groups. However, the semi-exposed group reported fewer 'rear end' and 'reversing related' incidents. It is surprising that semi-exposed roadworkers did not report many of the reversing incidents, because they are more exposed to the work vehicles and machinery than the other two groups are and may therefore be more likely to be involved in or to see reversing incidents.

***Table 1. Frequencies of common incident types reported by exposure level of respondents***

| Exposure level | No. of respondent | Vehicle drive into work area | Traffic controller hit by vehicle | Rear end | Reversing |
|---|---|---|---|---|---|
| Fully-exposed | 25 | 4 | 8 | 8 | 6 |
| Semi-exposed | 15 | 3 | 6 | 2 | 2 |
| Non-exposed | 26 | 18 | 8 | 9 | 7 |

The most commonly reported type of incident involved a public vehicle driving into a work area. Twenty five of the 66 respondents (38%) reported seeing or learning from others of incidents where a public vehicle drove into a work area, either at the approaches or in the middle of the work zone. Most of these incidents involved the public vehicle hitting a work vehicle, machinery, or roadworker after entering into work area. Typical examples of this type of incident include vehicle missing detour, driving through closed lanes and traffic controls, and failing to slow/stop at traffic control:

> *There have been a couple of instances where we have had a lane closed down and somebody's driven into the closed lane, which is always a danger for those people working in the closed lane. That's what a lot of our job is...* (Inexperienced urban male traffic controller).

> *(There were) two incidents where one person missed the side-track altogether and ended up in the paddock and another incident, once again, where a person missed the detour and went straight through...* (Highly experienced rural male project manager).

A public vehicle hitting a traffic controller was the second most commonly reported (n=22) incident type. It should be noted that some of the codes might overlap with the 'vehicle driving into work area' type of incident codes as some incidents involve a traffic controller being hit by a vehicle that drove into work area.

> *One of the most common instance that happened in our area - not that it happened very often, but the most common is traffic controllers being struck by vehicles...* (Experienced rural male project manager).

Traffic control educators also seem to have serious concerns about traffic controllers being hit by vehicles, and therefore advise trainee traffic controllers to be well aware of this safety hazard.

> *When I actually did my Level 2 course, they advised that there had been a lot of traffic controllers being hurt/killed by doing the job. But I guess that just comes down to the negligence of people not paying attention to the signs that we provide for the client that we are trying to protect...* (Inexperienced urban male traffic controller).

Drivers impaired by drugs or alcohol were specifically highlighted as serious threat to traffic controllers.

> *They have got all the closures, everything in place; everything is meant to be what it's meant to be and then you have a driver who is under the influence, smash into the site, kill the traffic controller...* (Experienced urban male project engineer).

The third most commonly reported type of incident was rear end crashes (n=19), most of which were reported to occur at the work zone approaches. Typically, a lead vehicle had stopped or decelerated near the traffic controller (showing stop/slow) and a following vehicle failed to notice the traffic controller's signals, subsequently crashing into the leading vehicle/s.

> *I was actually doing stop/go, so actually stopping one end. I pulled up a guy on a motorbike and then a car come from behind, come from the uni, and didn't see any of the signs, didn't see any of the flashing lights, didn't see the motorbike until the last second and ran up the back - I jumped out of the way. He flipped over, fell on the ground and then I went back to that car and found that it was a female who had borrowed her partner's car, who had been drinking...* (Experienced urban male traffic controller).

> *We have had third party accidents on-site; like, at the Stop signs or stop/go person. There was about eight cars piled up and a semi-trailer driver coming through. He must have been half asleep, didn't see a sign, didn't see anything until he felt a big*

> *bump on the front of his truck and he ploughed into all the cars. So often get rear-enders on stop/go...* (Highly experienced rural male project manager).

While the three most common types of incidents involved public vehicles (which are mostly at fault), the fourth common type reported involved vehicles and machinery used by roadworkers. Incidents involving a reversing vehicle, mostly a work vehicle or machinery, were reported by 15 respondents. Roadworkers report that they get used to hearing reversing beepers all the time, and therefore sometimes do not notice if a work vehicle or machinery is reversing onto them.

> *You can hear the beepers going but you become blasé because you hear them all the time and you are not looking up - you know, you are watching the traffic coming the other way and they are behind you and you hear "beep, beep, beep" all day because the machinery is reversing; going forward, reversing, going forward. So you become blasé about that fact. Like, you can't have mirrors on your head, so you can't see, you know...* (Experienced urban male traffic controller).

Machinery operators and drivers also sometimes failed to see who is behind when reversing, even though reversing beepers and cameras are available in many vehicles. A respondent also reported that a reversing beeper was manually turned off by the driver because it annoyed him.

> *There was a truck reversing on-site... no reversing beeper. It was manually turned off because it annoyed him. So he turned it off, the driver of the vehicle, and our traffic controller was to the side of the vehicle. When the vehicle was reversing, he did not see our traffic controller there. The back of the tip truck struck him on the head; he fell onto the road and the truck kept on reversing not realising that he had hit someone. He was looking at the passenger-side rear view mirror, instead of the driver side review mirror...* (Highly experienced urban male traffic controller).

Human error, often triggered by factors such as not following others' instructions, is thought to contribute many of the reversing related incidents.

> *Oh, the common types of accidents on roadworks are associated with equipment, i.e. trucks reversing into people, excavators going over the banner because they are not watching or they have a spotter but they are not watching. So there's quite a bit of human error. Due to the attitude - attitude being that they don't want to take instructions from certain people, you know, people who are - everybody is proud of themselves. They think that somebody else telling them what to do is undermining their authority and that's normally what happens...* (Experienced urban female project engineer).

Five respondents reported incidents where roadworkers were hit by machinery moving in non-reverse directions. The other notable types of incidents (reported by a few participants only) were head-on crashes (vehicle not stopping at traffic controller and crashed into incoming vehicle), vehicle and machinery roll over, trailer detached (or goods fallen) from vehicles, and roadworker falling from height.

***Causes of incidents at roadworks***

The three groups of respondents reported quite consistently about the causes of incidents: driver distraction, driver error, and drink driving (Table 2). However, in case of the cause 'ignoring signage and instructions of traffic controllers', the semi-exposed group reported less frequently than the other two groups. The respondents of the semi-exposed group usually do not work at the approaches of work zones, where the signage and traffic controllers are located; therefore, they might have less understanding about how frequently motorists ignore signage and traffic controllers and get involved in crashes.

***Table 2. Frequencies of common incident causes reported by exposure level of respondents***

| Level of exposure | No. of respondent | Ignoring signage and traffic controllers | Driver distraction | Driver error | Drink driving |
|---|---|---|---|---|---|
| Fully-exposed | 25 | 11 | 4 | 2 | 2 |
| Semi-exposed | 15 | 4 | 2 | 2 | 2 |
| Non-exposed | 26 | 11 | 8 | 2 | 1 |

The most common cause of incidents at roadworks reported was drivers ignoring signage and instructions from traffic controllers (26 out of 66). Typically, roadwork sites display two forms of signage: warning signs, and regulatory traffic control signs. The warning signs are placed ahead of the start of work zone in order to inform motorists about the upcoming roadworks. The regulatory signs are usually placed within a work zone to display information on speed limits, travelling directions etc. Ignoring or failing to notice the speed reduction signage result in drivers speeding though roadwork sites, which roadworkers reported as a very common phenomenon (40 out of the 66 respondents reported that most drivers violate the posted limits). Ignoring traffic controller instructions (e.g., stop/slow) could result in vehicles driving into work-area/closed-lanes, rear end crashes with vehicles stopping/stopped near traffic controller, or head-on crashes with oncoming vehicles when violating a 'stop' instruction.

The issue of motorists not obeying roadwork signage and instructions of traffic controllers seems to be a very common occurrence at roadworks.

> *(Motorists) not paying attention to the speed signs that controllers have put down on the road. Not being able to stop in time, even though they are given adequate warning of approaching controllers on the road; they just don't adhere to signage and that's a daily occurrence...* (Highly experienced urban male traffic controller).

Roadworkers also felt that many motorists lack proper understanding of roadwork signage and require education to improve public awareness of roadworks.

> *I don't think a lot of people understand what goes on at roadwork sites. They don't look at signs. They just drive through, "Oh, we have got to slow down. Okay." They probably don't even look at the signs, half of them, or they don't understand them...* (Experienced urban male traffic controller).

Distracted driving was the second most reported cause of incidents at roadworks (n=14). Drivers reportedly were often distracted from driving to see what happening around in roadworks (i.e., looking at machinery) or to use mobile phone and in-vehicle devices (e.g., radio).

> *When they (motorists) are in the roadworks, they might be looking at the machines and not concentrating on what they are doing. Car at the front stops and they run into the back of it. That would probably be the most common. Maybe when people (are) in the roadworks, (they) are looking around at the machines and they are not concentrating on driving...* (Highly experienced male supervisor).

Driver inattention, because of fatigue or too many roadworks within a short distance, also plays a big role in causing roadwork incidents. Such distracted driving often result to rear end crashes with preceding vehicles.

*Over the last two/three years we have had probably five to six times as many roadworks as normal because of the flood damage. ... My personal view is that people are being bombarded with so many roadwork signs. You know, they will drive and they will come across a job and then 10 Ks up the road they will come across another one, and then 10 Ks up the road they will come across another one and my personal view is that they are so bombarded with so many roadwork signs, that after a while they stop seeing them. And they get fatigued. It is a pretty long, straight road. There is not much to keep them awake. The scenery is pretty dull; it's flat and straight and you put the radio on and I know you sort of go into a - you zone out a bit. You are on automatic pilot...* (Highly experienced rural male project manager 1).

Driver errors other than those related to distraction or ignoring signage were also reported to be important causes of incidents at roadworks (n=6). Misjudgement of stopping distance, pressing accelerator instead of braking were the most common errors reported.

*One lady said that she went to put her foot on the brake and put it into the clutch and rolled into the car in front. Another lady said she was driving her friend's car and once again went to put the foot where she thought was the clutch and there was nothing and rolled into the car in front. Another person said they just misjudged the distance of the car in front. None of them - they were all just little hits but the point is that they were all accidents...* (Highly experienced rural male project manager 2).

Driving under the influence of alcohol or drugs was another major reported cause of incidents at roadworks (n=5). Drunk drivers were reported to speed and eventually running though ‘stop’ traffic control.

*I have had people that have been believed to have been on drugs and things, come flying down, either not stop or just only stop just in a nick of time...* (Inexperienced urban male traffic controller).

## Discussion

The top three most common types of incidents at roadworks reported were public vehicles infringing into a roadwork area, traffic controllers being hit by public vehicles, and rear end crashes involving two or more public vehicles. All of these incidents occurred at the approaches to roadwork zones where the signage and traffic controllers are located. This finding clearly highlights that the approach areas including the taper zones were perceived as the most hazardous areas in roadwork zones. This was because driving conditions had usually been changed at these areas, and motorists were required to adapt to the changed conditions but often failed to do so. Motorists need to adjust their speeds as per the posted warning and regulatory traffic control signage at the approaches. In cases where a traffic controller or portable traffic light is present at the taper zone, motorists need to slow down to posted limits or to stop as instructed by traffic controllers and lights. Furthermore, there are often detours or lane changes required at these areas. Motorists, who are inattentive, distracted or just willing not to oblige the posted signage and traffic controllers may speed through, fail to keep their vehicles in designated lanes, and in worst case hit traffic controllers and vehicles in front.

Roadworkers perceived that most incidents at roadworks occur because of driver error. The most commonly reported causes of incidents were drivers ignoring signage or traffic controllers’ instructions, and distracted driving. While distracted driving may result in failing to notice signage and traffic control measures, some motorists may willingly disregard them even when they have apparently seen them. Human errors including driver inattention and excessive speed have also been consistently identified as the major causes of roadwork zone crashes in the research literature (e.g. Arnold Jr, 2003; Yong Bai & Li, 2011). Driver inattention, including not noticing road signs, is likely an important factor in noncompliance with the lower speed limits usually imposed in roadwork zones. A large number of studies have reported that poor speed limit compliance is a major factor contributing to roadwork zone crashes (for a list see Garber & Patel, 1995). Research in Victoria found that more than 40% of cars and more than 70% of trucks exceeded signed speed limits at roadworks (Haworth et al., 2002).

Increased enforcement at approaches of roadwork zones could potentially improve motorists' compliance with signage and instructions of traffic controllers. A review of roadwork speed compliance by Debnath et al. (2012) found that active enforcement is the most effective method among all types of measures targeting speed reduction, such as informational, physical or educational measures. Visible police presence with flashing lights is the most effective enforcement measure. Other forms of enforcement measures, such as speed camera and increased traffic fines are not as effective as visible police presence is in terms of keeping motorists' speeds within posted limits. Debnath et al. (2012) also noted that better compliance with speed limits could be achieved through enforcement, but the measure also needed to ensure proper public awareness of roadworks safety.

The other most reported types of incidents at roadworks involved a work vehicle or machinery reversing into other work vehicles or roadworkers, and workers getting hit when the work vehicles and machinery are not reversing. These incidents typically occur within the actual work area where the vehicles, machinery and roadworkers are present. These areas are usually physically separated from the path of public traffic; therefore, the chance of a public vehicle being involved in such incidents is minimal.

Although most work vehicles and machinery are equipped with reversing beepers and cameras, continuous beeping sounds could blend with background noises and roadworkers may fail to notice the alerts. In a typical worksite, there are many vehicles and machines working at the same time with continuous movements in all directions. When working for long hours, there is high possibility of misjudging the beeping alerts as background noise and being habituated to the alerts.

To protect roadworkers from being hit by work vehicles and machinery, it is common practice to have a spotter who oversees the movements from a higher position and alerts roadworkers of potential dangers. However, respondents reported that some roadworkers tend to disobey the alerts and believe that they understand their safety better than others do. Such attitudinal problems may reduce the effectiveness of having a spotter on site.

While this qualitative study has produced useful insights, the methodology has some limitations. The sample size was limited to 66 participants who were commonly working on medium to large worksites in Queensland. Thus, the results may be less generalisable to smaller worksites and other parts of Australia. There was no ability within this study to validate the comments provided by roadworkers, but another study we are currently conducting is examining WHS datasets and will thus provide an interesting comparison.

## Conclusion

Before this study, little was known about the common types of incidents at roadworks and their causes, primarily because of unavailability of reliable and accurate historical incident data. There is a clear need in Australia to improve both data availability and data quality to better understand roadwork traffic crashes and how to reduce their occurrence. This study identified that most roadwork incidents occur at approaches and taper zones. Public vehicles were mostly involved in these incidents: encroaching into work areas, hitting traffic controllers, and rear-ending with vehicles stopped or slowed at traffic control. Driver error in the form of ignoring signage and instructions of traffic controllers, distracted driving, and drink driving were commonly reported as major causes of these incidents. The common types of incidents within work areas involved work vehicles and machinery hitting objects or workers. Misjudging reversing beepers and ignoring spotters' instructions were the major causes reported.

While this study identified the common types of incidents and their causes as perceived by roadworkers, it is also necessary to understand the perceptions of motorists in order to obtain a balanced assessment of roadwork hazards. A subsequent study planned within the current research program will therefore examine motorists' perceptions of hazards to complement the research presented above.

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