VULNERABILITY AT ROAD CONSTRUCTION SITES, SOUTH AFRICA

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ABSTRACT

The increase in the scale of road construction projects in the country in the run-up to the World Cup creates the opportunity to focus attention on the issue of road safety through roadworks. Efforts to do so, however, are hampered by the lack of accurate and centralized data relating specifically to accidents through roadworks – involving road workers and general traffic. From international experience we know that roadworks present higher casualty risk than conventional roads. This paper looks at the characteristics and common causes of accidents through roadworks abroad. It focuses on the role of excessive speed as a factor in roadworks' accidents and looks at speed management through roadworks in the South African context, to develop specific conclusions which may ensure improved safety through roadworks in the future.

1 INTRODUCTION

Routine road maintenance, the upgrading of existing roads and construction of new roads are activities that are key to the management of an efficient road network. South Africa has a well-deserved reputation for having some of the finest roads on the continent. The hosting of the FIFA World Cup in 2010 created an extraordinary opportunity for the refurbishment of many primary roads across the country and, as a result, since 2004, the SA Roads industry has been engaged in an unprecedented number of road improvement projects.

Such development is, of course, excellent on a number of fronts, most notably those of improving our transport infrastructure and creating employment opportunities for the thousands of largely unskilled workers involved in the projects over this period.

The increase in the scale of road construction projects in the country in the run-up to the World Cup creates the opportunity to focus some attention on the issue of road safety through roadworks. In contemplating this subject, it initially seemed likely that casualty statistics through roadworks projects would be collected systematically and would be available for quantitative analysis.

Surprisingly, however, this is not the case. Instead, there is a confounding lack of statistics. Within the Department of Labour, whose responsibility it is to collate records of accidents at work, accident statistics for road workers fall within the general category of construction workers. No distinction is made within this. Nor does any one authority in SA collect or monitor accident statistics for road workers or through road works in general. This contrasts sharply with many other countries in Europe and North America in particular, who not only systematically collect such data but who use it to improve safety of road workers from year to year.

The possibilities for applying a quantitative and detailed analysis of road accidents through roadworks projects in South Africa have thus been frustrated by the systems that are currently in place, and which create structural obstacles to the collection and interpretation of data. In the absence of existing data we are able, in the interim, to examine trends that have emerged elsewhere and to begin to identify patterns and problems that may be found within roadworks sites in South Africa.

Longer-term, however, we cannot continue to rely on external data and it is essential that South Africa review its current system of accident reporting and ensure that accidents through roadworks - involving both workers and the public – are systematically collected and are made available for external and independent analysis.

2 QUANTIFYING THE PROBLEM

Roadworks, by their very nature, represent some of the highest risk work environments of all. These are roads which demand a great deal from the driver – attention, consideration and compliance with traffic regulations in an unforgiving road context. The efforts to improve safety on roads ironically create road safety challenges in the short-term; this is the paradox that countries across the world are dealing with on a daily basis. In general, international research confirms that road works or work zones do pose a significantly higher risk to road users (European Union Road Federation, SWOV: Roadworks and road safety; Hildebrand, Wilson and Copeland).

In terms of the casualty risk faced by road-workers themselves is concerned, a recent study in the Netherlands for the period 2006-2007, estimated from data on fatal crashes that the risks facing road workers is significantly higher than that of workers involved in general construction work (Venema, 2008). Similarly, in the United States, the US Bureau for Labor Statistics data indicates that the job-related death rate for work zone workers is 32 per 100,000 workers, a rate three times higher than other construction workers (ERF Discussion paper 2007).

Overall, most studies report an increase of the crash rate through roadworks when compared with conventional traffic. In Great-Britain, however, Freeman et al, studying the safety at crash zones in the UK did not find an increase of the crash rate in accidents at work zone sites between 1996 and 1999. However, Harlow, in 1986, had earlier found an increased safety risk of an average of 1.5 times that which had in turn prompted increased safety measures through work zones. As a result, in 2005 the EuroTest inspectors rated the layout and safety of UK road works sites as the best in Europe. The UK experience suggests that the development of safety measures specific to the roadwork context does have the potential to significantly improve casualty levels.

3 CAUSES AND LOCTION OF CRASHES

A review of the literature confirms that internationally, the most prominent causes of accidents through workzones are reported to be as follows:

- Limited work space
- Unsatisfactory barriers between work and traffic
- Signing deficiencies – most commonly confusing or inadequate signage
- Deficiencies regarding the road closure and safe cordoning off of roadworks
- Deficiencies in temporary road marking
- Inappropriate speed limits

- Visual contact of the driver with the roadworkers
- Visual and auditory contact of roadworker with traffic
- Ability of the road worker
- Aggressive motorists invading the traffic stream near the taper to a work zone area in order to gain a time advantage.
- Excessive speeds
- Alcohol use

While the relevance of these causes still needs to be tested in the South African context it is likely that many of these are responsible for accidents through workzones in this country.

Looking again at the list of causes above, it is helpful to group the individual entries of the list into three themes: 1) the physical characteristics of the roadworks environment, 2) the ability of the roadworker, and 3) the behaviour of the traffic that passes through the workzone. All three themes are interdependent – the design and layout of the workzone must be based on an understanding of traffic flow and behaviour, as well as the functions and abilities of the workers. Driver behaviour will be influenced by the physical layout of the construction area and specifically by the instructions - direct or implicit - that are provided to the driver through the use of signs, road markings and hazard markings. Breaking the list of causes into themes is helpful, not only because it starts to introduce a clearer sense of who could be instrumental in improving specific elements of the roadworks, but by identifying patterns of interdependence it helps to isolate those aspects which have the greatest potential for harm.

One of the causes that has most relevance to all three themes is that of vehicle speed. We know from the broader body of road safety research that speed is the single most important determinant of injury severity in accidents (Wramborg, 2005; Richards and Cuerden, 2009). This has to do with driver reaction and response time to avoid or prevent an impact, as well as the energy that is expounded as a result of the impact – the higher the speed, the more energy being released. It makes sense, then, in the design of a temporary road environment with limited space, vulnerable workers and unexpected driving conditions, that the prevailing speed regime requires careful planning and execution.

Traffic that is successfully managed at a reduced and consistent speed poses fewer risks to workers and generates fewer opportunities for vehicle conflicts than traffic driving at erratic speeds. Most roadworks situations thus require some reduction in the normal cruising speed of the traffic – this requires speed limits that are credible and enforceable.
A common finding in international experience is that drivers frequently exceed temporary speed limits (commonly by 20 km/hour or more); usually ignore the required safe following distance of 2 seconds between the vehicle in front and their own vehicle, and often change their speed abruptly (ERF). Speed is increasingly recognised as being a major facet of workzone safety and the correct choice of the limit and of mechanisms to achieve compliance with that limit is of growing interest internationally. This is a theme that we will come back to later in the paper.

4 ROADWORKS ACCIDENTS IN SOUTH AFRICA

Within South Africa, while contractors generally do investigate injury accidents, as required through their contractual appointments with the highways authorities as per the Standard Specifications for Road and Bridge Works for State Road Authorities, COLTO, 2004, they have no obligation to report accident data to any authority unless an injury has been sustained by a road worker, in which case they are required to report that injury to the Department for Labour. The Department for Labour does not, however, disaggregate such data into sectors within the industry, and having ten regional offices across the country it becomes a logistical impossibility for external researchers to manually sift such data out in order to investigate the specifics of road worker casualties. In any event, that information, while it would provide essential data on the injuries sustained by road workers themselves, would not include data that related to accidents, or injury accidents to other traffic through the workzone area.

Motor accident records for all public roads are held by the South African Road Traffic Management Corporation (RTMC). Unfortunately the problems with accuracy, reliability and completeness of this data are legendary. Furthermore the data that is collected seldom specifies the exact location or circumstances of a traffic accident, and it is impossible to use this database to identify accidents that occur through roadworks.

We find ourselves in a situation, then, where casualty data for road works sites is not available.

Exploring the problem of accidents through road works without a sense of the scale of the problem is problematic. However, we know from general accident statistics that the incidence of accidents in conventional traffic is higher in SA than in most other countries. In fact the Automobile Association of South Africa has recently estimated that the likelihood of being involved in a collision in SA is as high as one in ten (*http://www.aa.co.za/content/619/whose-fault-is-it-anyway-/*). Extrapolating the experience of higher accident risks through road works from Europe and Australia, it appears inevitable that the risk of accidents through road works in South Africa would be elevated.

This assumption gains even more credibility in the light of the findings by Slater, Van As and Joubert, 1999, whose study found a considerable extent of speeding in South Africa. They note in their report: "*Most persons… simply continue to ignore speed limits as if they do not exist and treat them with contempt. South African data on the main causes contributing to fatal accidents … indicate that excessive speeding may be one of the most important reasons for death on our roads* (p.3).

5 MANAGEMENT OF ROADWORKS IN SOUTH AFRICA

The Road Traffic Act of 1966 (RTA), including the Road Traffic Regulations 2000, and the South African Road Traffic Signs Manual (SARTSM - specifically Volume 2, Chapter 13 – Roadworks Signing) lays out the obligations that the road authorities have in terms of managing traffic on roads and through roadworks.

The SARTSM Chapter on Roadworks Signing (Chapter 13) itself recognizes the risks involved to roadworkers and road users through work zones and lays down, in some detail, procedures and guidelines to mitigate that risk.

Work zone traffic management is, of course, not driven by road safety concerns alone. Traffic management involves continuously balancing the often contradictory objectives of safety (of workers and drivers), against objectives such as construction time, project costs and the need to keep traffic flowing as smoothly as possible while work is ongoing. Cost pressures and the financial risks associated with delays in project completion mean that safety can take second place to construction progress.

The safe management of traffic through workzones relies on a number of underlying assumptions, two of which are of particular interest here.

- The first is that signing and road marking will be carried out in accordance with the regulations and guidelines.

- The second is that the public recognize and understand the instructions conveyed to them through the medium of the traffic signs themselves.

In looking at the management of workzones on South Africa's roads, it is clear that neither of these assumptions has been robustly tested. Focusing specifically on the management of speed through roadworks, these assumptions are looked at in more detail below. The choice of speed management as a particular focus is rooted in the significance of this factor as a determinant of injury severity in road traffic accidents in general, and also because the impact of the mis-management of speeds has arguably greater impact in situations where there is less forgiveness built into the road environment. The management of speed, finally, allows one particular factor to be tested across the two different assumptions.

Assumption 1: That contractors sign their work zones in accordance with the regulations and guidelines.

In its introduction the SARTSM correctly recognizes the heightened propensity for risk through road works when it says: "*The temporary and continually variable nature of road construction and maintenance operations on roadways which are open to traffic makes such sites potentially more hazardous than a permanent hazard since even a driver familiar with the route cannot rely on his previous knowledge to predict conditions*" (1999, 13.1.1).

The document goes on to say: "*Great care should be taken that only those temporary signs appropriate to the current work activity are displayed.* ***All actions required of a driver should appear obviously realistic to him***."

One of the basic requirements of SARTSM is the obligation to select an appropriate speed limit for the workzone. Vol 2, Ch 13 states as follows:
"*Speed limits should be applied realistically and should, where appropriate, be capable of being altered to suit changing local conditions and/or time of day* (1999.13.1.2).
Further, "*it is essential that speed limits are realistic and that the public can learn to respect and rely on them*" (1999, 13.4.1).

The most basic requirement of the SARTSM, then, is the application of a realistic limit. However we see all too often that this requirement is not being carried out with the requisite care. This results in situations where a dangerously inappropriate speed limit is imposed by the contractors. Generally this limit is too low – 60 km per hour being the most commonly used limit through roadworks, irrespective, in many cases, of the context: the

nature of the road, volume of traffic, previous (permanent) limit, proximity of road workers etc.

Speed limits that are too low are potentially dangerous because they are treated as incredible and are ignored, creating a context where, in the absence of any other sensible limit, drivers will drive at whatever speed they are comfortable with. This creates a traffic flow characterized by considerable speed differentials. This factor alone is widely recognized by researchers as causing the greatest opportunities for vehicle conflict and is effectively expressed by the British Columbia (Canada) website on workzones (*http://www.th.gov.bc.ca/trafficcontrol/tc_guidelines2.htm#first*) as follows: "*The potential for vehicular accidents increases as the difference in speed between vehicles increases. Speed differential is the number one cause of speed related accidents. … Understanding the effects of large speed differentials is critical to ensuring a safe work zone for both motorists and workers*".

SARTSM details in full the relevant considerations that must be taken into account in every decision on design speeds, namely:

- The road geometry (taking into account superelevation and side friction factors)
- Stopping sight distance
- Width of roadway
- Workmen near or crossing the roadway
- Construction vehicles near, entering or leaving the roadway.
- Proximity of fixed objects or excavation.

Unfortunately, what is not laid out in either SARTSM or in the industry's specification document on road works (Standard Specifications for Road and Bridge Works for State Road Authorities, COLTO, 2004), is who is responsible for following the process of determining the most appropriate temporary speed limit and for approving that limit. In the course of the research for this paper a number of contractors have admitted that the setting of limits is an activity carried out with little consideration, often by fairly junior technicians, and with little reference to the guidance laid out in the seven-page section on the setting of speed limits included in the SARTSM.

In reality, without an appropriate limit in place there is no chance of retaining the public's respect for that limit. That immediately creates a context of disrespect and non-compliance with one aspect of the works which could well encourage non-compliance with others aspects as well.

The resolution of the speed limit problem requires that considerably more care to be taken in the setting of such limits, and the approval of each limit by a senior member of the Engineering team. Slater, Van As and Joubert recommended in 1999: "*In order to prevent the abuse of speed limits at work zones, it is proposed that all such limits be certified by a qualified professional (1999: 8)".* This proposal would help to ensure that temporary limits were accorded the correct level of deliberation.

Over and above the choice of a temporary speed limit, in looking at the marking of limits through the use of the prescribed signing, again our experience tells us that mistakes are regularly made. Signs can be misleading, incorrect for the context or inadequate. An example of the inadequacy of the speed limit signing on the N1 South is well illustrated in the question posted on the Arrive Alive website last year:

Speed signs at Construction Zones *Frustrated N1 driver 09-Jun-2009*

***Question**:*
If you are travelling on the N1 South near the Diepkloof interchange the speed limit drops to 60km by the construction site. The freeway then splits into N1 & N12. If you continue on the N1 South there are signs that signal 60km zone. If you take the N12 split there are no road works and no signs at all until +- 1km then its 120km. I want to know if once you take the N12 split is that automatically a 120km zone and if not why don't they put up a sign that says 60km? The JMPD are trapping under the bridge just after the split on the N12, but before you can see the 120km sign, is this allowed if there aren't any speed reduction signs.

***Answer**:*
The previous road sign will apply if there are no other intersecting roads.

The speed limit that is posted applies, but if it clearly looks that the lower limit should not apply it may be worthwhile taking it up with JHB Metro.

I have had quite a few enquiries on this as I know of about 12 persons who were charged who were all under the impression that the speed limit is 120 km/h there.

This extract from the website highlights an incident when the posted limit was not only unclear, but was also being used as a basis for prosecution.

In terms of roadworks safety in South Africa, we assume that the contractors are abiding by the rules and guidance provided in the legislation and supporting documents but practical experience tells us that this is not always the case. Of course, in a large industry such as this there will be a range of compliance, some examples of excellence and some contractors who regularly cut corners more than others. However without a sustained effort to enforce compliance it is impossible to ensure that best practice is being applied, and standards will inevitable fall. As mentioned previously poor or inadequate signing has been found to be one of the key causes of injury through roadworks. When signing problems relate specifically to the signing of a mandatory speed limit, mistakes and deficiencies can have particularly dangerous consequences.

Assumption 2: The public recognize and understand the instructions conveyed to them through the medium of the traffic signs themselves.

The very first paragraph of Chapter 13 (Roadworks Signing) of the SARTSM reads as follows:
"*The temporary and continually variable nature of road construction and maintenance operations on roadways….makes such sites potentially more dangerous than a permanent hazard…..* ***In order to clearly identify these temporary conditions from permanent ones, exclusive signs with a yellow background are used***" (1999, 3.1.1).

While the sentiment is commendable, the introduction of a second parallel range of road signs for use exclusively through roadworks creates the potential for confusion in the minds of the public. The following extract from the Arrive Alive website suggests that there is indeed some confusion over the role of the temporary speed limit sign in particular:

Yellow temporary signs *Johan 27-May-2009*

***Question**:*
Good day! A lot of confusion is caused by the “recommended " yellow signs with red border and black lettering. These are the signs used mostly when road works are in progress. However the confusion is e.g. on a weekend when nobody is working. Most K53 driving schools teach the learners that this is a recommended speed limit only. Please send me the road traffic act regarding this matter because it seems to be a big bone of contention.

***Answer**:*
Please note that the yellow signs with black lettering and red borders (regulatory, warning, guidance, etc) are most definitely NOT "recommended" signs - they are termed "temporary" signs and are as applicable and enforceable (the regulatory signs) as their white, black lettering red border counter parts.

Yellow temporary signs are used (or supposed to be used) to only indicate "temporary" conditions (usually for a short period of time - however, you wonder about road works that last forever) - to indicate situations and conditions which are not normal and which could be potentially dangerous.

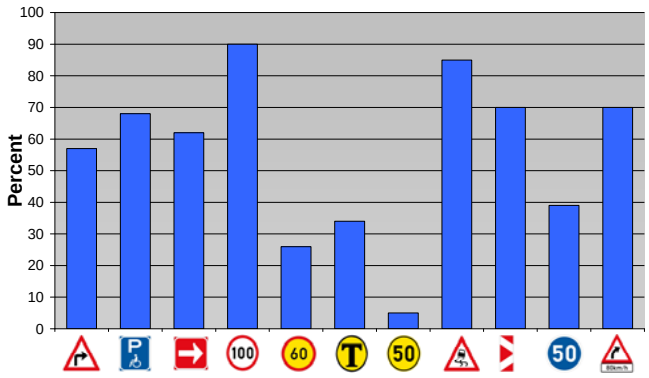
As part of the research for this paper we decided to test how familiar drivers were with some of the signs through roadworks, concentrating primarily on the use of temporary speed limit signs.

In all, a total of 191 surveys were carried out. Respondents were shown a table of 11 traffic signs, three of which were yellow backed, temporary signs. Five of the signs related to speed – including maximum and minimum speeds in conventional use and in a temporary limit, as well as a recommended speed at a specific location (in this case, on a bend).

The results suggest that there is significantly less understanding of temporary signs than there is of conventional road signs. Only three respondents in the survey correctly identified the three yellow backed signs as belonging to a temporary limit. That is around 1.5 percent.

The graph below shows the comparable accuracy with which individual signs were recognized. The conventional speed limit sign (column 4 below) received the most positive responses – 89.5 percent of the sample correctly understood the status and meaning of this sign. Hazard warning signs fared fairly well (columns 1 and 9), with the red-bordered triangle sign eliciting a large degree of recognition.

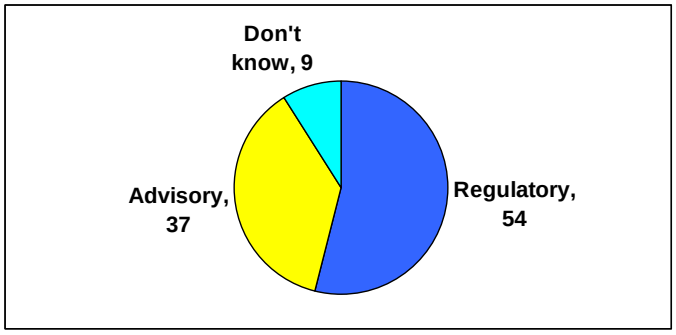
Table 1 - Correct identification of sign by percent



Looking specifically at the temporary speed limit sign (columns 5 and 7), the number of respondents who recognized these signs to be both regulatory signs and a temporary limit was very small. Only 26.2 percent of respondents correctly identified the temporary maximum speed limit sign, and 4.7 percent recognized the minimum sign. The latter result is undoubtedly a function of the fact that this is very seldom used, so seldom seen. However the recognition rate of the temporary maximum sign was surprisingly low, especially given the high profile of roadworks project presently in place.

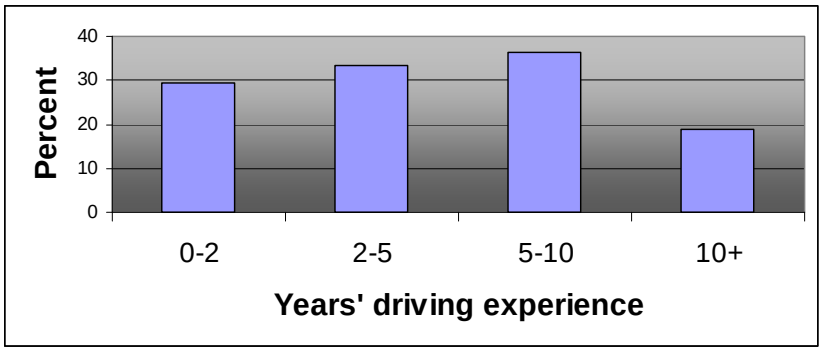
In terms of sign status, 36.6 percent of respondents believed that the yellow backed speed limit sign was a recommended or advisory speed limit only. A number of respondents believed that the temporary sign related only to trucks or works vehicles. Others thought it was a limit for certain times of the day.

Table 2 - Respondents' choice on sign status: temporary maximum speed limit



Looking at the relationship between successful recognition of the temporary maximum speed limit sign and number of years driving, an interesting pattern emerges. Namely, that it is drivers who have more than ten years driving experience that are least likely to recognize and understand this sign.

Table 3 - Accuracy of sign identification (temporary maximum speed) by years' driving experience.



Regardless of who is most or least likely to understand the sign, the results of the survey show that a significant percentage – approximately 74 percent of drivers - did not know exactly what was required on them. This is a significant failing.

Our understanding was that similar yellow backed signs had been in use in Australia some time ago. The Department for Roads and Transport in the State of Victoria confirmed this to be the case, and in an email to the University of Stellenbosch explained the change as follows:

"*In regard to temporary speed limits, such as those used during road works, many years ago these signs were black on yellow to signify that the speed limit was temporary. This was a regulatory sign. We found from experience, however, that many people thought these were just advisory speed limits and not regulatory. We decided that we should use the conventional black, white and red speed limit signs at road works sites so that road users would recognise them as the usual regulatory signs"* (email received 11 January 2010).

6 CONCLUSION AND RECOMMENDATIONS

The working environment of road workers poses some of the highest risks to any group within the construction industry. Yet little attention is placed on their safety relative to other sectors and very little is being done by South African policy-makers or by the construction industry as a whole to ensure that the safety of roadworkers – and the safety of the public who pass through the workzone - is optimised.

More research is required urgently to establish the real level of casualty through roadworks and to begin to identify common causes for such accidents. International research has allowed us to speculate about what the problems may be, but we need to build very clear local data in order to develop the most appropriate solutions possible.

In looking specifically at the issue of speed management through roadworks, it is clear that both road workers and the general public are more exposed to risk where speeds are poorly set or demarcated. This leads to a number of recommendations:

1 The quality of roadworks signing, and the setting of appropriate speed limits through roadworks must be better ensured. Speed limit setting must become a more scientific and considered process, and the setting of unrealistic limits should not be accepted. Some of the greatest risks through our roadworks are being brought about by drivers choosing to ignore the limit because it is entirely inappropriate.

More thought will result in more credible limits. More credible limits will result in higher levels of respect and compliance, and hence in increased safety levels.

2 In terms of immediate interventions, the use of yellow backed temporary speed limit signs appear to cause more confusion than it does highlight an enhanced risk, and the use of these signs needs to be reconsidered. Our research echoes the experience of Australia, where it was found that temporary yellow backed speed limit signs actually created more potential for error on the part of drivers. South Africa needs as much clarity in road signing as possible, and any areas of potential confusion must be re-examined.

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