# TALES FROM THREE CONSTRUCTION SITES: A QUALITATIVE INVESTIGATION INTO WORK ZONE SAFETY

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## ABSTRACT

Roads form the backbone of the South African economy, and the provision of adequate road infrastructure is key to facilitate socio-economic change. Many of South Africa’s roads are facing increasing growth in traffic volumes, congestion, and the infrastructure is aging. Construction works are needed to add capacity as well as to maintain existing infrastructure. The construction work has an impact on the safety of the travelling public as well as on workers on site, who are exposed to traffic constantly. Typically, roadwork zones are well-defined areas, but they are dynamic, and roadworks contracts necessitate constant change, which impacts on the segments under construction, making safe operation an ongoing effort. This paper explores work zone safety by making use of qualitative observations from three existing work zones on the national road network. The sites were largely rural, and safety concerns related to traffic accommodation were identified. The use of signage to safely redirect traffic, safety considerations in terms of personnel and equipment on site as well as public driving behaviour are key elements in ensuring safe work zone areas.

In line with the Safe System Approach, the process of designing and building safer roads and roadsides needs to be managed to minimise risk to both road workers and the travelling public.

## 1. INTRODUCTION

Roads in South Africa, play an important role in facilitating socio-economic change by connecting people to social, economic and education opportunities. Roads form the backbone of the South African economy, and the provision of adequate road infrastructure is key to facilitating socio-economic change (Development Bank of South Africa, 2024).

Road safety engineering is a key component of ensuring a safe road transport system, ensuring that the road and road environment is designed, constructed, and maintained for safe road traffic operations.

The Safe System Approach (SSA) forms the basis for the National Road Safety Strategy 2023 and SANRAL Horizon 2030 and has changed the way road safety is managed by road authorities. The SSA encourages designers to provide a safe environment and to consider the

ISBN: 978-0-7961-8245-6
Produced by: www.betaproducts.co.za

combined system as the major factor in mitigating accidents rather than the traditional approach that blamed the road user for casualties on the road (Buttler, 2014). Key concepts that have relevance to road safety engineering within the Safe System Approach (SSA) framework are the design and provision of self-explaining and inherently safe roads, as well as managing speed on the road network, well as, managing speed on the road network, which are described as follows (Austroads, 2018; SARSAM, 2022).

- A self-explaining road guide encourages the road user to make the correct decisions, consistent with the design and function of a road, to ensure safe travel from one point to another.
- The SSA advocates the need to adopt the viewpoint that roads or roadsides should be "*forgiving*." Inherently safe or forgiving road designs ensure that the design, from the onset, considers road and traffic characteristics (function, traffic volumes, traffic mix, roadway conditions, and speed of travel) as well as human abilities and limitations including sight distance, acceptable level of risk-taking (Labuschagne et al., 2016).
- A key safety system element is speed management. Higher speeds result in greater impact at the time of a crash, leading to more severe injuries and fatalities. This is important not only for occupants of vehicles but for vulnerable road users such as pedestrians, cyclists, and motorcycle riders. Therefore, the setting of speed limits and management of speed need to comply with the principle of *survivable speeds*.

Many South African roads are facing increasing growth in traffic volumes, congestion, and are aging. The total paved and gravelled provincial network is approximately 185 000 kilometres of which forty percent has reached the end of its design life, and approximately 80 % of the national road network is now older than the initial 20-year design life (National Treasury, 2021). Construction and repair work is needed to add capacity as well as to maintain existing infrastructure which has an influence on the travelling public as well as on-site workers, who are exposed to traffic. Road works are carried out either along road segments and/or at road intersections, and these areas are marked and separated from the remainder of the road space for safety reasons. Work zone functions include work planning, traffic accommodation, work operation, installation, and removal of works, among others. The temporary and continually variable nature of road construction and maintenance operations on roadways that are open to traffic makes such sites potentially more dangerous than a permanent hazard since even a driver familiar with the route cannot rely on his previous knowledge to predict conditions (Cronje, 2021; SARTSM Chapter 13). In line with the SSA, the South African Road Safety Assessment Methods also makes provision for future stage 4 road safety audits at construction works - Chapter 3.4.1. Work Zone Traffic Management Stage Road Safety Audit (SARSAM, 2022)

## 2. PURPOSE OF THIS PAPER

This paper considers the qualitative contribution of the SANRAL Technical Excellence Academy (TEA) graduates-in-training to a work zone safety research project on three active construction sites, two sections on a former provincial road, and one on a national road. The TEA graduates in training are currently appointed as assistant resident engineers on the construction sites. The deployment and experience gained on-site counts towards the candidates' future professional registration with the Engineering Council of South Africa (ECSA).

## 3. PILOT SITE SELECTION, DATA COLLECTION AND OBSERVATIONS

### 3.1 Pilot Site Selection

Most of the research conducted for this study incorporates traditional national roads. However, SANRAL is increasingly taking ownership of former provincial routes. The assumption is that the different characteristics of the roads (class, type of traffic, volume of traffic), environment (rural, urban, semi-urban, adjacent land use), and subsequent behaviour (drivers, non-motorised transport, and public transport users) could potentially have implications for the management of work zones and construction areas on these roads. Three pilot sites were selected where SANRAL engineering candidates had been deployed. The sites were largely rural. The pilot sites selected for the research are indicated in Table 1 below.

**Table 1: Pilot site selection**

| Site | Functional Classification (TRH 26) | Type of Work | Work Zone Section Length |
|---|---|---|---|
| A | Class 2 rural (R2) – major arterial**<br>But gazetted as R1 as per IT IS TRH 26 route class | The improvement of national route (former provincial route*) | 27.5 km |
| B | Class 2 rural (R2) – major arterial**<br>But gazetted as R1 as per IT IS TRH 26 route class | The improvement of national route (former provincial route*) | 27.5 km |
| C | Class U1 - Principal arterial** | Upgrade of national road | 10.2 km |
| * Roads Agency Limpopo (RAL) Road Asset Management System (RAMS)<br>** Technical Recommendations for Highways (TRH) 26 (2023) | | | |

### 3.2 Data Collection and Consolidation

#### *3.2.1 Site Visits*

The site visits were conducted in June and July 2023. The site visits included a construction works tour/drive of the pilot sites as well as interviews with resident engineers, contractors, and safety personnel. Between August 2023 and December 2023, the graduates participated in an ongoing data collection exercise that consisted of qualitative observations on each site. Graduates participated in weekly feedback meetings where they highlighted work zone safety considerations in a discussion forum.

#### *3.2.2 Observation Sheet*

A data collection sheet was prepared for each site. Each observation sheet considered general site information as well as work zone safety observations in relation to the site layout (Table 2).

General site information was clustered according to:

- **Construction project** which entailed the identification of project type (upgrade, rehabilitation etc.), project size (km), roadway classification, area type (urban, rural), speed limit before and during the observation or construction phase.

- **Traffic Characteristics,** including traffic demand and volumes, seasonal and temporal variations in demand (hourly, daily, or weekly), occurrence of special events, percentages of different vehicle class, type of corridor (passenger, freight etc.), impacts of weather and other additional information.
- **Corridor, Network, and Community Issues** noted for the construction area included a description of access management (private and commercial properties, intersection control and management, accommodation of non-motorised transport and public transport users as well as managing livestock in the vicinity of the construction section.

In addition, all three sites have dedicated and trained traffic safety officers that are responsible for daily inspections. All three sites kept site diaries, site recordings and photographs. Sites are thus documented daily to ensure adherence to safety principles. Any changes to approved traffic accommodation plans are reviewed and signed off by the resident engineer.

Table 2 provides an overview of the type of site information that was collected for each safety-related observation.

**Table 2: Work Zone Safety Observation sheet (simplified from original for purpose of this paper)**

| **PROJECT SPECIFIC INFORMATION** | |
|---|---|
| **Site** | |
| **Observer** | |
| **Project Characteristics** | Project type, Project size (km), Roadway classification, Area type (urban/rural), speed limit before construction |
| **Travel and Traffic Characteristics** | Traffic demand and volumes; Seasonal and temporal variations in demand (hourly, daily, or weekly); Occurrence of special events; Percentages of different vehicular volumes; Type of travel corridor (passenger, freight passenger); Impacts of weather |
| **Corridor, Network, and Community Issues** | Access to properties, Intersection management, other issues such as NMT and VRU accommodation, Fencing e.g. livestock in road or construction area. |

#### *3.2.3 Data Collation*

Data from the observation sheets were collated and interpreted qualitatively. This collation considered site characteristics, type, and volume of traffic as well as adjacent land use and community-type issues. Over the observation period, twelve observations were made across the three construction areas.

### 3.3 Discussion of Findings

#### *3.3.1 Sites' Characteristics*

All three sites were in the process of upgrading the existing road infrastructure. All three sites form part of the national road network (as proclaimed by the Minister of Transport). In terms of functional classification, guided by the Draft Technical Recommendations for Highways (TRH 26, 2019) the first two study sections are classified as Class 2 major rural arterials that function as a highway, connecting two towns. Access to private property should not be allowed. However, there are mining activities with access to mining operations in the area. Intersections are priority controlled. Before construction started, the roads were two-lane undivided roads with a speed limit of 120km/h. Public transport stops are not provided, and there is no provision for non-motorised transport facilities adjacent to the road. The segments under construction for the two Class 2 major rural arterial roads were approximately 27 kilometers in length. According to the South African Route and Destination Analysis (RDDA, 2012) guideline, this is a regional route that connects the town of Rustenburg to the Botswana border.

The third study section is classified as an urban Class 1 major arterial road. According to the RDDA (2012) guideline this is a national road that connects the province of Gauteng with the Komatipoort border post. The speed limit before construction varied between 100 km/h and 120 km/h.

Table 3 provides an overview of each of the project sites and the associated characteristics.

**Table 3: Travel and traffic characteristics**

| **Site** | **Class 2 major rural arterial (R2-Section 1)** | **Class 2 major rural arterial (R2-Section 2)** | **Class 1 major urban arterial** |
|---|---|---|---|
| **Speed limit** | 120 km/h | 120 km/h | 100 -120 km/h |
| **Cross section** | Two lanes | Two lanes, surfaced | |
| **Lane width** | 3,5 m - 3,7 m | 3,5 m - 3,7 m | 3,3 -3,7m |
| **Shoulder** | Gravel | No shoulder | No shoulder |
| **Traffic volumes** | AADT (2023) =7021. | AADT (2023) = 7378 | AADT (2019) = 13706 |
| **Peak times** | 5h00, 15h15 (Weekday Peak Time); Friday / Peak seasons | Peak seasons/holidays | Peak seasons/holidays |
| % traffic | 13.6% heavy vehicles | 16 % heavy vehicles | 20% heavy vehicles |

### *3.3.2 Travel and Traffic Characteristics*

The R2 construction sections (former provincial roads) accommodate approximately half of the annual average daily traffic (AADT) in comparison to the U1 construction section. The sections of construction work on the Class R2 roads are twice as long as the Class U1 section. The assumption is that the AADT influences the length of the construction project.

### *3.3.3 Community and Other Network Considerations*

All three sites indicated that accesses to adjacent properties are formalised and paved. On two of the sites (Class R2-1 and Class U1), provision has been made for closure of town intersections and existing access roads. Only one of the sites provided for accommodation of non-motorised transport movements close to the start of the project in town. All three sites, irrespective of class, indicated there was a need to make provision for fencing to manage livestock movements close to the construction area.

### *3.3.4 Work Zone Safety Observations*

Over the six-month period, four safety-related themes emerged from the observations. These observations related to:

- Traffic accommodation and road user behaviour.
- Construction related practices and personnel.
- Road markings and signage influencing behaviour.
- Accommodation of non-motorised transport users in the vicinity the roadworks.

### *3.3.5 Traffic Accommodation and Road User Behaviour*

Table 4 provides an overview of road user behaviour in the vicinity of the construction sites on the rural class R2 road. The speed limit on the sections differed for various construction phases (between 40 km/h and 60 km/h). In two of the observations, lane widths were sufficiently wide however, there were no shoulders. Although, these construction sites were on the same road, different companies were responsible for the construction work on the respective sections.

**Table 4: Traffic accommodation and road user behaviour (Rural Class 2 Sections 1)**

| **Road** | **Activity** | **Observation** | **Number of observations** | **Safety implication and mitigation measures** |
|---|---|---|---|---|
| Class R2 (section 1) | To reduce speed, traffic calming devices (speed humps were erected across the construction section. The speedhumps were well marked, and solar road studs used to make them more visible at night. Speedhumps erected across the new temporary road (single lane) and lane where traffic is shifted during construction of permanent layer works commenced on opposite side. | The open lane without the speedhump gives motorists the space to circumnavigate the speedhump by driving on the construction area. | 1 | Drivers must pass the oncoming traffic lane twice in doing so increasing the risk of head-on collisions. The problem was addressed the same day by shifting delineators to barricade motorists from driving in the open lane. Barriers were later placed for the deep excavations as a safety precaution. |
| Temporary posted speed limit at time of observation | 60 km/h | | | |
| Cross section considerations | • Lane widths – 3,7 m<br>• Gravel shoulder<br>• One lane in each direction | | | |
| Sight distance | • Horizontal and vertical sight distance considered good. | | | |
| Channelling and protection | • Delineators channel traffic | | | |
| Law enforcement and awareness | • No active law enforcement<br>• Traffic calming warning signs erected next to speed humps.<br>• Speed humps fitted with road studs to increase awareness at night | | | |

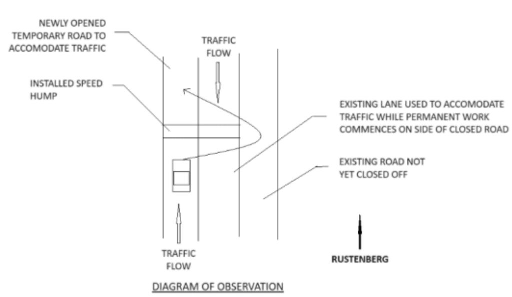
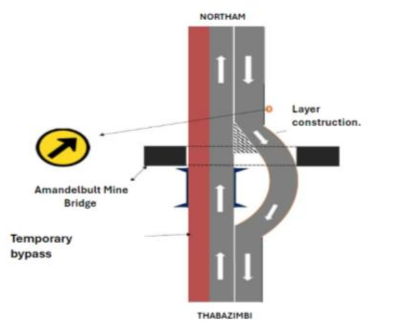


**Table 4: Cont'd**

| Road | Activity | Observation | Number of observations | Safety implication and mitigation measures |
|---|---|---|---|---|
| Class R2 (section 2) | To widen the bridge there was not enough space to accommodate two lanes.<br>The solution was to build a bypass that would accommodate one lane of traffic. | Drivers would avoid the bypass and drive in the oncoming traffic lane. | 1 | Head-on collisions and putting construction workers at risk, disruption of construction works.<br>To mitigate the errant driver behaviour, additional flag personnel were added to alert and channel drivers to make use of the bypass. |
| Temporary posted speed limit at time of observation | • 40 km/h | | | |
| Cross section considerations | • Lane widths – 3,7 m<br>• No shoulder<br>• One lane in each direction (travelling south -east)<br>• Bypass constructed on eastern side to accommodate traffic. | | | |
| Sight distance | • Horizontal and vertical distance considered good. | | | |
| Channelling and protection | • Concrete barriers and delineators to channel traffic | | | |




Thabazimbi to Northam view

Northam to Thabazimbi view

| Road | Activity | Observation | Number of observations | Safety implication and mitigation measures |
|---|---|---|---|---|
| Class R2 (section 2) | Various construction phases | Frequent occurrences rear-end / head tail crashes | 6 | Inattention and speed too high for circumstances result in rear- end / head tail crashes. Although law enforcement has been engaged to aid on the site there has been a reluctance to enforce speed. |

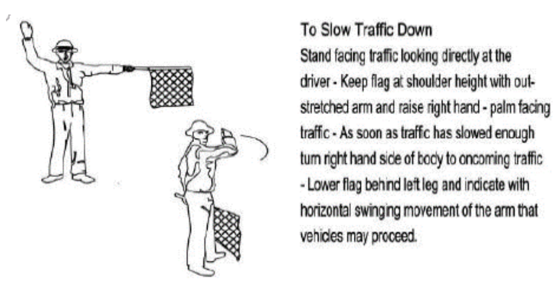
| | | | | |
|---|---|---|---|---|
| Temporary posted speed limit at time of observation | 60 km/h | | | |
| Cross section considerations | • Lane widths – 3,2 m<br>• No shoulder<br>• Two lanes in opposite directions | | | |
| Sight distance | • Horizontal and vertical sight distance considered good. | | | |
| Channelling and protection | • Concrete barriers and delineators to channel traffic | | | |
| Law enforcement and awareness | • No active law enforcement | | | |

On the Class U1 road the speed limit was 60 km/h throughout the construction area. This road carries double the AADT of the rural class 2 roads and heavy vehicles make up approximately one fifth of the stream traffic. Driver behaviour impacting construction safety included inattention, driving at speeds too high for prevailing circumstances and making illegal and dangerous turns to avoid construction areas (Table 5). Although law enforcement officials are present in the vicinity of the construction works, no active law enforcement on the construction zone is conducted.

**Table 5: Traffic accommodation and road user behaviour (Urban Class 2)**

| **Road** | **Activity** | **Observation** | **Number of observations** | **Safety implication and mitigation measures** |
|---|---|---|---|---|
| Class U1 | Closure of the east bound 60 km/h lane for the asphalt pavement rehabilitation. | Drivers grew impatient as traffic backed up to 10-20 km. | 1 | Drivers make illegal and unsafe turns to avoid the construction area.<br>The construction work was stopped, and the work replanned. |
|   | | | | |
| Class U1 | Transition area - merging of oncoming traffic (on the U1 from the border post, with the oncoming traffic merging from R570). | Oncoming traffic speed too high for the merge area | Various | Speed differential and merging behaviour resulting in head tail and sideswipe collisions.<br>Use was made of a robotic flagger at the start of the section to raise awareness of the changing environment.<br>The taper lengths were increased to provide drivers with more guidance into the construction area. |
| Temporary posted speed limit at time of observation | 60 km/h | | | |
| Cross section considerations | • Lane widths – 9 m<br>• 0 - 4m shoulder<br>• Two lanes in opposite directions | | | |
| Sight distance | • Horizontal and vertical distance considered good. | | | |
| Channelling and protection | • Concrete barriers and delineators to channel traffic | | | |
| Law enforcement and awareness | • No active law enforcement on construction zone<br>• Visible enforcement for cross border traffic operations | | | |

## Table 6: Construction related practices and construction personnel

| Road | Activity | Observation | Number of observations | Safety implication and mitigation measures |
|---|---|---|---|---|
| R2 (Section 1) | Excavator located between the temporary road deviation and the permanent lane cranes over the temporary road. | Due to limited space, the excavator operator needed to work in the construction zone and the travel way. | 1 | The excavator hand can collide with an oncoming vehicle.<br>A single flag person (approximately) 100 m away alerts the operator when the road is clear for him to swing the crane arm. |
|  | |  | |  |
| U1 | Construction of the subsoil drainage on the LHS. Material had to be brought to the subsoil trench by a Tractor-Loader-Backhoe (TLB).<br>This resulted in the TLB slightly protruding into the roadway. | A stop-and-go station was implemented directing road users to come to a stop whenever the TLB would manoeuvre on the road or requiring working space. | 1 | Drivers grew impatient and forced the flag personnel out of the way.<br>Drivers passed the TLB in an unsafe manner. |
| R2 (Section 2) | Stop-and-go station implemented at bridge works | Drivers ignore the stop-and-go station. | 2 | Drivers get injured, and subject site staff in danger. |
| R2 Section 2 | Flag personnel indicating to traffic when to slow down due to seal works (brooming after the bridge). | Two vehicles travelling in the same direction.<br>The first vehicle reduced speed; the second vehicle collided with the front vehicle.<br>from the rear end left-hand side. | 1 | Back vehicle driver lost control and entered the work zone where he struck the flag lady. |
| Temporary posted speed limit at time of observation | 60 km/h | | | |
| <br> | | (South African Road Traffic Signs Manual Volume 2 Chapter 13, 2012) | | |

*3.3.6 Construction Related Practices and Personnel*

Construction related safety observations were made in relation to the operation of construction equipment (two observations), drivers' disregard for flag personnel instructions (various). Heavy vehicle equipment (Table 6) needs to operate on construction sites, often with little space to do so. Stop-and-go procedures were implemented along with flag operations to regulate the traffic during these operations. However, drivers seemed to have a disregard for these measures, and appeared to be willing to engage in risky behaviour to pass these equipment-occupied areas.

Human behaviour influencing construction safety included a lack of regard for traffic accommodation measures (bypassing the traffic calming measure and not using the erected bypass). In addition, inattention, and speeds too high for circumstances contributed to rear-end and side swipe collisions.

*3.3.7 Road Markings and Signage Influencing Road User Behaviour*

Road markings and road signs serve as visual guidance for drivers to safely manoeuvre through construction areas. Road markings are removed on construction sites as specified in contract documentation. However, in some instances (and where not properly removed) the remaining paint can confuse drivers (Table 7).

**Table 7: Construction related practices and construction personnel**

| Road | Activity | Observation | Number of observations | Safety implication and mitigation measures |
|---|---|---|---|---|
| R2 Section 2 | Changing phases of construction affect the previous phases of road marking. | Temporary road markings still visible | 4 | Still visible road markings on old construction area confuses motorists. |

*3.3.8 Accommodation of Non-Motorised Transport Users*

Construction activities have an impact on local traffic movement including that of pedestrians and cyclists who then need to find alternative routes for travelling. The last safety observation was made on the national road and highlight the need to make provision for NMT and public transport users in the draft traffic accommodation plan.

**Table 8: Accommodation of NMT**

| Road | Activity | Observation | Number of observations | Safety implication and mitigation measures |
|---|---|---|---|---|
| U1 | Shoulder Closure<br>Prior to construction, local farm workers on either side of the U1 road would wait for the bus on the existing gravel shoulder. Upon construction activities commencing, this resulted in no shoulder during the duration of the project on the north side of the contract. | Pedestrians crossing the N4 at an informal bus stop adjacent to the construction work zone. | Multiple | This resulted in the bus stopping in the middle of the road on the westbound carriageway when dropping off the farm workers.<br>During afternoon peak hours in the afternoon, the workers were subjected to cross the national road to the wait for the bus.<br>This however is not a formalised bus stop nor safe crossing zone.<br>The engineer consulted the public transport company and proposed alternative stopping places for the public transport vehicles. |
|   | | | | |

## 4. DISCUSSION

This research considered inputs from graduate engineers on three different construction sites over a period of six months. A limitation of the research is the small sample size. In future research should consider the selection of sites with varying characteristics and includes sites with different functional classifications to be compared.

However, despite the limitations, the observations made over six months clearly indicate that despite measures implemented to ensure safe work zone operations, there are safety concerns that stem from the way in which traffic is managed, having implications for road user behaviour (speed too high for circumstances, indications of inattention, disregard for instructions from site personnel), operation of equipment and the safe accommodation of non-motorised transport on these sites.

Planning and design of safe work zone areas should be a consideration from the onset. The layout and design of the work zone, including signage, barriers, and traffic flow arrangements, play a significant role in construction safety and these components must be carefully planned to minimize confusion and risk for both drivers and workers. There is a need to clearly delineate of work areas and traffic paths, to ensure optimal placement and visibility of signage and warnings and to manage traffic flow and guide behaviour.

Consistency across work zone sites is important. Two of the sites were on the same road link, yet the sites and the safety measures implemented for the different projects differed (e.g. speed calming on one section while not on the other which could influence driver perception and behaviour when transitioning between sites). In addition, the two R2 major arterial sites on one road link differed from the U1 major arterial in terms of construction section length, average daily traffic as well as temporary posted speed limits. Adherence to signage regulations promote uniformity and clarity in work zone communication, reducing confusion and improving overall safety. Compliance with established signage standards and guidelines ensures consistency and effectiveness in conveying information to drivers (Illman, 2010). Standardised signs reduce confusion, and research show that drivers are more likely to comply if they understand and can follow temporary work zone signs, that are consistent with normal road signs.

A major factor in determining whether a crash will occur is linked to whether a work zone is easily visible and recognized. Effective signage, well-placed barriers, thoughtful traffic flow arrangements, and stringent speed management are all crucial components (Campbell, 2008). *Each element of the work zone must be designed with the goal of* minimizing confusion and risk, thereby protecting both the workers in the work zone and the motorists passing through the construction area. Temporary road signs are the most common tools to achieve both work zone conspicuity and legibility. Misinterpretation or ignorance of signs can lead to dangerous behaviours (Federal Highway Administration, 2023). Driver reaction to the perceived road environment (including the behaviour of other drivers), can vary. To assist drivers in terms of expectations, and perception of the work zone areas as well as to guide the driver through the construction area there is a need to plan and equip the site with special traffic control devices including signs, channelizing devices, barriers, pavement markings, and work vehicles. However, these additions to the road environment, creates more complex environments for drivers than a normal road section does, eventually requiring additional cognitive workloads (risk or hazard assessment, situational awareness and so forth) and driving actions (levels of driving control) to manoeuvre through these areas safely.

The observations made on the three sites point to the fact that although the driver is the centrepiece, the driver cannot be treated individually, without consideration of the adjacent environment, the actual roadway (e.g. road markings that are still visible), NMT movements and site personnel. On all three sites different measures to ensure compliance with work zone safety were present. However errant driver behaviour, non-compliance with work zone safety measures as well as numerous observations related to speeding behaviour were evident on all three sites.

Observations related to construction workers, flag people and the management of traffic through the construction area, again highlighted driver behaviour as the biggest cause for safety concerns. Construction worker behaviour, equipment specific training and management of ad hoc situations (and resulting driver behaviour) such as operating heavy machinery in the roadway, is key to ensure safe operation of heavy construction equipment in the vicinity of traffic. NMT activities were observed on the national road. Design and planning of construction zones potentially need to consider accommodating non-motorised transport and public activities.

## 5. CONCLUSION

The SSA recognises that humans make mistakes and that errant behaviour (mistakes made while believing to be doing the right thing) and violations (non-compliance or failure to follow instructions), are a major cause of accidents in construction zones. These errors can lead to severe consequences, including injuries, fatalities, and significant property damage. Human errors in construction are attributed to a variety of factors, including workers' physiological and psychological limitations, poor decision-making, and unsafe behaviour. These errors are often the result of a combination of individual actions and systemic issues within the construction environment.

Work zone safety is a multifaceted issue that requires attention to various human factors affecting both workers and the public. The presence of multiple and varied work zones, especially work zones that change on a day-to-day basis, complicates the safe navigation of these work zones even more. The design of a work zone is a complex task that requires careful consideration of numerous factors including taking cognisance of human limitations and mitigating measures to ensure safety. The process of building safer roads and roadsides needs to be managed to minimise risks to both road workers and the travelling public. Within the SSA context, road work construction zones must be designed and managed in a proactive manner that facilitates travel through an environment that is a) forgiving, b) self-explanatory, and c) ensures drivers adapt their behaviour accordingly. Speed that is too high for prevailing conditions is also considered a key contributor to crashes and needs to be managed effectively within construction zones.

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