ROAD TRAFFIC CRASHES ON THE KONONGO-KUMASI HIGHWAY - TWO YEARS AFTER RECONSTRUCTION

By

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CERTIFICATION

I hereby declare that this submission is my own work to the MSc and that, to the best of my knowledge, it contains no material previously published by another person nor material which has been accepted for the award of any other degree of the university, except where due acknowledgement has been made in text.

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ABSTRACT

Reconstruction of the 42Km Konongo–Odumase-Kumasi road began in December 2003 and was fully completed in November 2007. It undoubtedly incorporated one of the most comprehensive and elaborate road safety measures in Ghana, aimed at treatment of known accident black spots and other accident prone locations to reduce road traffic crashes (accidents) on this highway. The motivation for this study was from a personal desire to ascertain data-wise the effectiveness or otherwise of the measures implemented. The study, contrary to public perception, shows that the number of road traffic crashes is on the increase for all indicators except pedestrian fatalities. Analyzing crash records from 1999 to 2009, a total of 116 crashes were recorded in 2003, the last year before commencement of construction, whereas the year 2009 recorded a total of 148 crashes, representing 27% increase two years after construction completion. Total casualties for the year 2009 indicated a 53% increase over that for 2003, resulting in a 54% increase in fatalities. Hit-pedestrian crashes continue to dominate collision types. Post-construction records give 114 hit-pedestrian crashes of which 75 were fatal over the two year period. This, however, considered on yearly terms represents 7% and 17% reduction respectively over the pre-construction period. Resulting hit-pedestrian deaths reduced from 54% of all deaths during the pre-construction period to 51% during post-construction period. The study also shows that the Heavy Goods Vehicle (HGV) category now leads vehicle type involvement in fatal crashes with 22 fatal crashes (31%) of the 72 recorded within the two year post-construction period, even though it contributes just 5% to 9% of current vehicular traffic. The bus category held this position during the five year pre-construction period with 41% of all 186 fatal crashes. Furthermore, the minibus category which was not involved in any fatal crash during pre-construction period, made an entry during the four year construction period with 7% of fatal crash involvement, and increased its share to 11% for the post construction period. In general, the rural Konongo-Ejisu section of the highway with an annual traffic growth rate of about 9.8%, showed a 16% reduction in traffic crash rate relative to pre-construction rate. The peri-urban Ejisu-Kumasi section with an annual traffic growth rate of about 4.5%, on the other hand showed an increase of 24%. Spot speed measurements conducted within a typical town within the rural section of the highway showed speeds are within posted limits. Maintenance of traffic calming devices in addition to continual safety evaluation and remediation is strongly advised.

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1. INTRODUCTION

1.1 Background

The Accra – Kumasi – Gonokrom Highway designated as Route N6 is considered a very important link the Ghana's road network, forming part of historical north-south trading route linking the nation's capital with its second largest city, Kumasi. It also serves as an international transit route for Ghana's landlocked neighbours such as Niger, Mali and Burkina Faso. In Ghana's Economic Recovery Programme (ERP) and Poverty Reduction Strategy (GPRS) policies, the Accra-Kumasi highway has been identified as a priority trunk road for improvement. Consequently, improvements to several sections of the Accra-Kumasi Highway have either been completed, or on-going with support from the donor community.

The 42Km Konongo–Odumase-Kumasi road which forms part of the Accra – Kumasi – Gonokrom Highway was reconstructed between December 2004 and November 2007 with funding from DANIDA and Ghana Government.

The reconstructed section commences at Km212.700 on the outskirts of Odumase (in Kumasi direction) and ends at Km254.600 at the KNUST Hospital pedestrian crossing.

The highlights of the designs for the reconstruction comprised:

- Provision of 7.4 Km of dual carriageway from Fumesua to Kumasi and preparation for staged construction of additional 5.3 Km of dual carriageway from Fumesua to Ejisu (East);
- A combination of reconstruction and overlay of 35.4Km of existing two – lane road from Odumase to Fumesua;
- Comprehensive Road Safety Provisions for treatment of identified accident black spots and other accident prone locations

It is worth noting at this juncture that with the exception of provision of pedestrian guardrails within the brisk commercial area in the Konongo township, no road works were undertaken along the 3.6 Km Konongo–Odumase section of the highway under this rehabilitation project.

1.2 Problem Definition

The Konongo – Kumasi road had been identified from road safety audits as a very accident-prone road with high incidences of registered road traffic crashes from 1994-95, through to 2001 with resultant high casualties. Most of the crashes are reported to occur in towns and villages with a significant proportion involving pedestrians. Additionally, pedestrians again represent more than half of the fatalities recorded. The audit reports also identified speed to be a major problem on the road, and thus a major contributor to the poor safety conditions on the road.

In light of this, stake holders in the road development programme attached importance to the problem of road traffic safety in the development and operation of this highway.

1.3 Research Objective

The objectives of the research were to:

1. Establish the trend and characteristics of road traffic crashes after rehabilitation.
2. Establish the performance of the installed road safety measures.
3. Access drivers knowledge of use of the installed road safety devices
4. Observation of vehicular traffic and speeds on the highway.

1.4 Justification

The research is justified by the following:

1. Road traffic safety is a very important concept in the planning, design, construction and operation of road infrastructure.
2. There is the need to establish the performance of road safety devices on roads to justify their installation or planned installation on roads or otherwise.
3. Road safety devices are being installed on roads throughout the country, and therefore there is the need to address common problems associated with their provision and use.

1.5 Scope of Work

The research work covered the following:

1. Literature review.
2. Collection and study of road traffic crash records.
3. Study of as-built drawings.
4. Classified traffic volume counts and speed measurements.
5. Driver interviews.
6. Field observation of use of installed safety measures.

2 LITERATURE REVIEW

2.1 The Global Road Traffic Safety

According to a World Health Organization (WHO) and World Bank report on "The Global Burden of Disease" (1999), deaths from non-communicable diseases is expected to climb from 28.1 million a year in 1990 to 49.7 million by 2020 (an increase in absolute numbers of 77%). Road traffic crashes will contribute significantly to this rise. According to the report, road traffic injuries are expected to move from ninth place to take third place in the rank order of disease burden by the year 2020.

Road traffic injuries are a major public health problem and a leading cause of death and injury around the world. It is reported that each year nearly 1.2 million people die and millions more are injured or disabled as a result of road crashes, mostly in low-income and middle-income countries. It was in this regard that in 2004 the World Health Organization (WHO) dedicated World Health Day – for the first time – to the topic of road safety, culminating in the joint launch of the *World report on road traffic injury prevention*, which highlights the increasing epidemic of road traffic injuries. Beside creating enormous social costs for individuals, families and communities, road traffic injuries place a heavy burden on health services and economies. The cost to countries, possibly already struggling with other development concerns, may well be 1%–2% of their gross national product. As motorization increases, road traffic crashes are a fast-growing problem, particularly in developing countries.

2.2 Road Traffic Safety in Ghana

The year 1988 marked the turning point with the organisation and management of road safety activities in Ghana. In that year, the Ghana Road Safety Project (GRSP) was launched under the World Bank financed Transport Rehabilitation Project (TRP). The primary objective of the GRSP was to increase the knowledge, skills and capabilities of key Ghanaian organisations and professionals to tackle the country's road safety problems more effectively.

In 1996, among 29 African countries, Ghana ranked ninth in terms of fatalities per 10,000 vehicles. Ghana's fatality rate of around 36 per 10,000 vehicles in 1996 dropped to 18.76 per 10,000 vehicles in 2006. It is estimated that road traffic crashes costs Ghana about 1.6 % of her GDP. In view of the magnitude of the problem of road traffic crashes and fatalities, the National Road Safety Commission (NRSC) was established in 1999 through an Act of Parliament (Act 567). Among other functions, the Act mandates the NRSC with the responsibility of developing, promoting and co-ordinating road safety activities in Ghana.

Under the direction of the Ministry of Transportation (MOT) and with the collaboration of other stakeholders, the NRSC has since its establishment, been implementing data-led programmes and activities to address the road safety challenges of the country with the view to reversing the upward trend in road traffic crashes and casualties. The first of such programmes was the National Road Safety Strategy 1 (NRSS 1) covering the period 2001-2005 which was followed by NRSS 2 for the period 2006-2010 aimed at reducing fatality to under 1,000 a year by the year ending 2015. Table 2.1 below shows an overview of road crash statistics in Ghana for the period 2002-2008.

Table 2.1: National road traffic fatality indices (2002 – 2008)

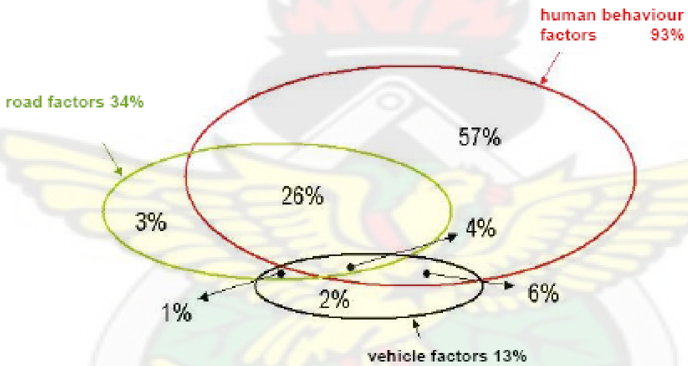
Year	Estimated Population (x106)	Registered Vehicles	Vehicles Per 1,000 Population	All Crashes	All Casualties	Fatalities	Fatalities Per 10,000 Vehicles	Fatalities Per 100,000 Population
2002	19.811	613,153	30.95	10,718	15,077	1,665	27.15	8.40
2003	20.508	643,824	31.39	10,542	16,185	1,716	26.65	8.37
2004	21.093	703,372	33.35	12,175	18,445	2,186	31.08	10.36
2005	21.694	767,067	35.35	11,320	15,813	1,779	23.19	8.20
2006	22.294	841,314	37.73	11,668	16,348	1,856	22.06	8.33
2007	22.911	932,540	40.70	12,038	16,416	2,043	21.90	8.92
2008	23.544	1,033,140	43.88	11,214	16,455	1,938	18.76	8.23

Road Traffic Crashes in Ghana, 2008 (BRRI)

2.3 Planning Road Traffic Safety Schemes

The Road Safety Manual (PIARC, 2003), recommends the use of Road Accident Investigation (RAI) in planning road traffic safety schemes. The RAI seeks to help road engineers detect the amount of road infrastructure deficiencies that influence an accident's occurrence, and to guide them in the implementation of appropriate improvement measures.

Figure 2.1 below depicts the link between individual areas of the road safety system. It indicates the important role of the road environment itself, particularly its pivotal interaction with human behaviour.



(Source: PIARC Road Safety Manual, 2003)

Figure 2.1 Road traffic crash contributing factors

The diagram shows the level of influence that road environment factors have on human behaviour factors. This means that Road Engineers can only work around the road factors in order to influence human behaviour factors to achieve improvements in road traffic safety. Indeed, the World Report on road traffic injury prevention, published by WHO and the World Bank in 2004, mentions *excessive speed; and poor infrastructure design and management* as among the key road injury 'risk factors', the major contributing factors to road crashes and injury severity.

The Konongo-Kumasi road project sought to address road traffic safety concerns by provision of traffic calming measures in human activity zones and to some extent, improvement in road geometric layout in non-human activity zones which had been identified as accident prone.

2.4 Vehicle Speed and Road Crash and Severity

The Road Safety Audit of the Kumasi –Konongo Road (Consia, 2000), showed that 94% of motorists exceeded the speed limits through the villages. In some villages the average speed was between 35% and 65% above the speed limit while in one village the lowest speed measured was 50% above the limit and the highest 150% above the 50Km/h posted speed limit.

Speed studies conducted in 2006 in four towns along the project road prior to installation of speed humps revealed that most vehicles exceeded the posted speed limit of 50Km/h (BRRI-Carl Bro, 2006). On average, between 88% and 98% of the drivers travelling through the designated towns travelled far in excess of the speed limit.

Undoubtedly, excessive speed constituted a major problem on the Konongo – Kumasi road, and thus a major contributor to the poor safety conditions on the road.

Studies in the United States showed that motor-vehicle-pedestrian collisions are a serious problem. In 1998, 5,220 pedestrians were killed in the United States and 69,000 were injured. Nationally, 12.6 percent of traffic fatalities were pedestrian fatalities. Of the pedestrian fatalities, 69 percent occurred in urban areas and 78 percent occurred at non-intersection locations. While most crashes and fatalities occur in urban areas, a higher fraction of rural crashes result in death. One reason for such higher rates is that vehicle speeds tend to be higher in rural areas than in urban areas.

2.5 Traffic Calming in Road Traffic Safety

Two kinds of problem in relation to traffic speed are recognised by road safety engineers: excess speed, which is speed in excess of the legal limit, and inappropriate speed, which is speed which is deemed too high relative to the operating conditions. Both these problems are encountered on national roads at the interface between rural and urban sections, and within the urban areas themselves (Crowley and MacDermott, 1996).

Traffic calming is a way of reducing vehicle speeds by self-enforcing traffic engineering methods and is commonly applied in urban and residential road safety management and in the road safety management of through routes in towns and villages.

The transition zone between a high speed and a low speed road presents a difficult safety management problem. These transition zones usually occur on the approaches to towns and villages.

New research by the Danish Road Directorate show that the risk of being killed is approximately 95% at 70 Km/h and approximately 40% at 50 Km/h (Figure 2.2).

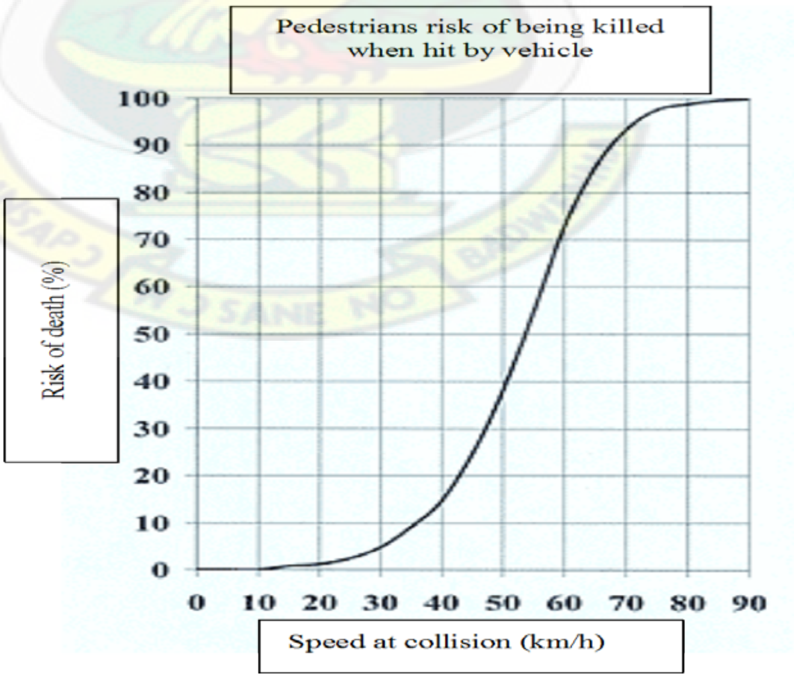


Figure 2 2. Pedestrian fatality risk diagram

The concepts of speed management and traffic calming were developed in response to the problem of high speed relative to the environment in road safety.

In the Republic of Ireland, traffic calming schemes have been in place on the approaches to some of the towns and villages on the National Route network since 1993 and the overall general public reaction has been positive (O'Connor, 1999). As a natural consequence, local authorities were faced with an increased demand for further traffic calming schemes in view of their cost effectiveness, given the limited resources available.

In Ghana, when rumble strips were installed at the crash hot-spot of Suhum Junction on the main Accra-Kumasi highway as a traffic calming measure, the number of traffic crashes fell by around 35% (Afukaar, 2003). Fatalities fell by some 55% and serious injuries by 76% between January 2000 and April 2001.

The safety benefits of lowered travel speeds include:

- Greater time to recognise hazards
- Reduced distance travelled while reacting to hazards
- Reduced stopping distance of the vehicle after braking
- Increased ability of other road users to judge vehicle speed and time before collision
- Greater opportunity for other road users to avoid a collision
- Less likelihood for a driver to lose vehicle control.

2.6 Traffic Calming Measures in Ghana

The "Traffic Calming Measures Design Guidelines" of February 2008, published by Road Safety and Environment Division (RSED) of the Ghana Highway Authority (GHA) serves as the standard for the design and installation of traffic calming devices on the country's highways.

2.6.1 Types of Traffic Calming Measures

Seven types of traffic calming measures are commonly used on Ghanaian roads. They are:

1. Road Humps
2. Rumble Strips
3. Jiggle Bars
4. Raised Islands / Centre Islands
5. Narrowing the road
6. Town Gates
7. Pre-warnings

The seven measures can be divided into three groups of:

1. Vertical deflection (road humps, rumble strips and jiggle bars)
2. Horizontal deflection (raised island and narrowing)
3. Visual deflection (town gates and pre-warnings)

Their applications are shown in Table 2.2 overleaf.

Table 2.2 Application of types of traffic calming measures

Type of traffic calming measure	Road Class / Type				Desired Speed		
	Traffic Road			Local Road	Km/h		
	Motorway	Primary[1]	Secondary[2]		≥ 60	50	≤ 40
1. Road Humps		x	x	x		x	x
2. Rumble Strips		x	x	x		x	x
3. Jiggle Bars	x	x	x	x	x	x	x
4. Traffic Islands		x	x	x		x	x
5. Narrowing		x	x	x	x	x	x
6. Town Gates		x	x	(x)	x	x	x
7. Pre-Warnings	x	x	x	(x)	x	x	x

NB. (x) indicates that it is possible to use the measure, but often it is not necessary.
1. National roads
2. Inter regional roads

A few of the calming devices are described in the ensuing sections.

2.6.2 Road Humps

Road humps are one of the most simple and effective traffic calming devices. They can have a tremendous accident reducing effect at low cost if used properly. Humps should only be used on roads with speed limits of 50 Km/h or less, for instance through town/village areas with many pedestrians on highways. They can be used in circular or trapezoidal hump profiles. On roads with heavy bus traffic speed cushions could be used. Table 2.3 gives design features for circular humps.

Table 2.3 Recommended design for circular humps

Desired speed	Radius	Chord length	Crown height
50km/h	113m	9.5m	10cm
40km/h	53m	6.5m	10cm
30km/h	20m	4.0m	10cm

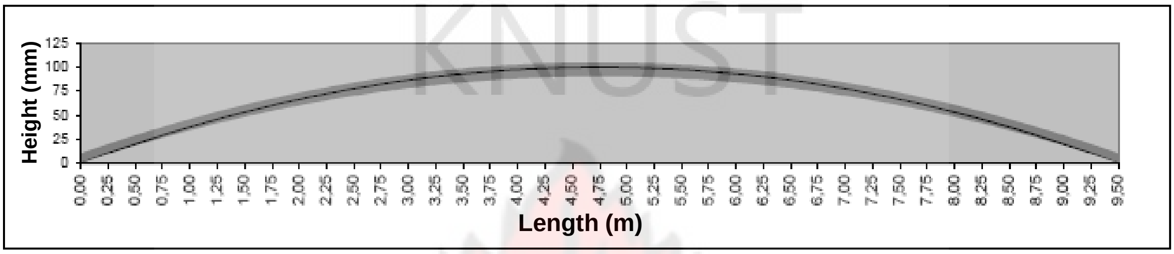


Figure 2.3 50km/h circular hump design cross section

2.6.3 Design of Trapezoidal Humps

The basic requirements of trapezoidal humps are almost the same as for the circular humps but the profile changes from a circular to a trapezoidal shape, in other words a raised, flat area with two ramps. For trapezoidal humps the following measures for different speed levels should be used.

Table 2.4 Recommended designs for trapezoidal humps

Desired speed	Length of ramp	Length of hump (including ramps)	Ramp height	Gradient of slope
50km/h	1.0m	12.0m	7.5cm	7.5%
40km/h	1.7m	7.4m	10cm	6.0%
30km/h	1.0m	6.0m	10cm	10.0%

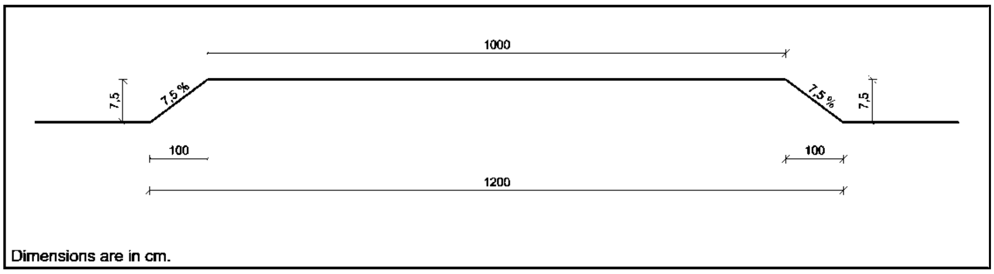


Figure 2.4 50km/h trapezoidal hump design cross section

2.6.4 Distance between humps

Table 2.5 gives distances between humps for long section calming with several humps.

Table 2.5 Desired speed – hump spacing relationship

Desired speed	Distance between humps
50km/h	250m
40km/h	100m
30km/h	75m

2.6.5 Humps with zebra crossing

To protect pedestrians in zebra crossings, which are not regulated with traffic signals, the zebra crossing could be placed on top of a trapezoidal hump. The flat–topped speed humps are effective in slowing down vehicles sufficiently to enable pedestrian to use the crossing safely.

When a zebra crossing is placed on top of a speed hump, it is still necessary to pre-warn the vehicles about the zebra crossing and the speed hump. A simple design plan for a zebra crossing on top of a trapezoidal hump is shown as Figure 2.5 below.

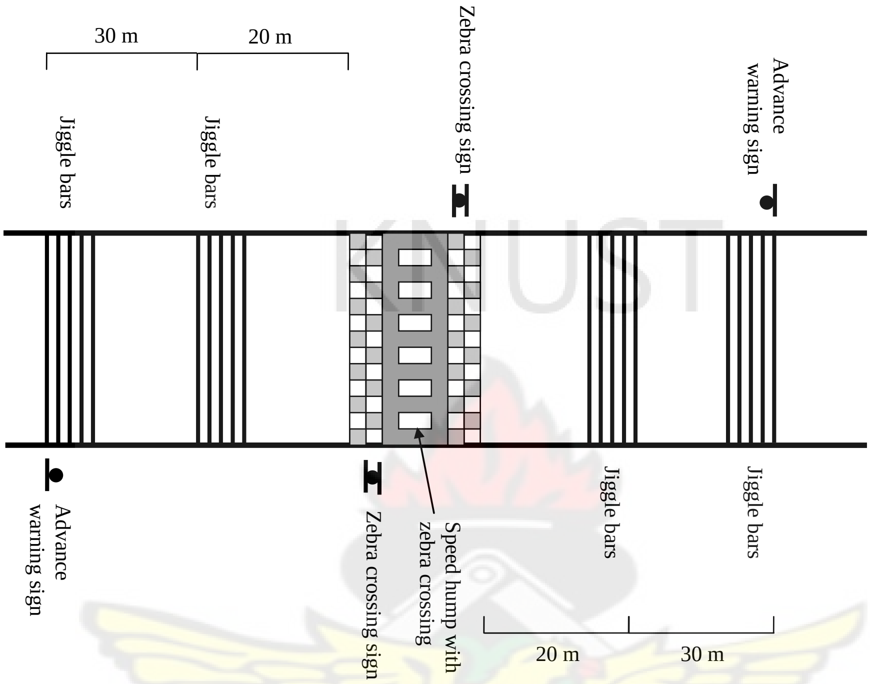


Figure 2.5 Plan of trapezoidal hump-pedestrian crossing

The following principles can be applied:

- Jiggle bars 50m before the pedestrian crossing / road hump.
- Warning sign “Road hump”, 50m before the pedestrian crossing / road hump.
- Jiggle bars 20m before the pedestrian crossing / road hump.
- Pedestrian (Zebra) crossing/road hump.
- Information sign “Pedestrian crossing” on both sides next to the pedestrian crossing / road hump.

If road humps are used in combination with a pedestrian crossing the location should be lit at night with street lights, solar studs or reflectors.

2.6.6 Rumble Strips

Rumble strips alert drivers and create an impression of speed. They do not reduce speed significantly but are effective in combination with road-humps. They can typically be used on the approach to villages, trading areas, dangerous intersections or road humps.

The rumble strips must extend over the full width of the road and hard shoulders to avoid the drivers from by-passing the rumble strips.

Rumble strips should be 15 - 25mm high and made of thermoplastic, line flex, asphalt or concrete. They are usually laid in a pattern – typically 2 or 3 groups of 4 or 5 strips. The recommended width of rumble strips varies between 30cm and 50cm. The space between the rumble strips varies between 50 and 200cm.

2.6.7 Traffic Islands

Traffic islands, also known as centre islands, are raised kerb islands used in road narrowing as speed reducing device. They serve the purpose of separating two-way car traffic and also to allow pedestrians to cross the road in two stages, serving as refuge area. Special attention should be paid to visibility of traffic islands to prevent collisions by provision of pre-warning signs, delineators, road markings, street lights etc. Traffic islands are most effective in combination with rumble strips and road humps. Traffic islands are not used for road sections with speed limits above 50Km/h. Figure 2.6 shows a typical traffic island layout plan design on the Konongo-Kumasi Road (Cowi, 2002).

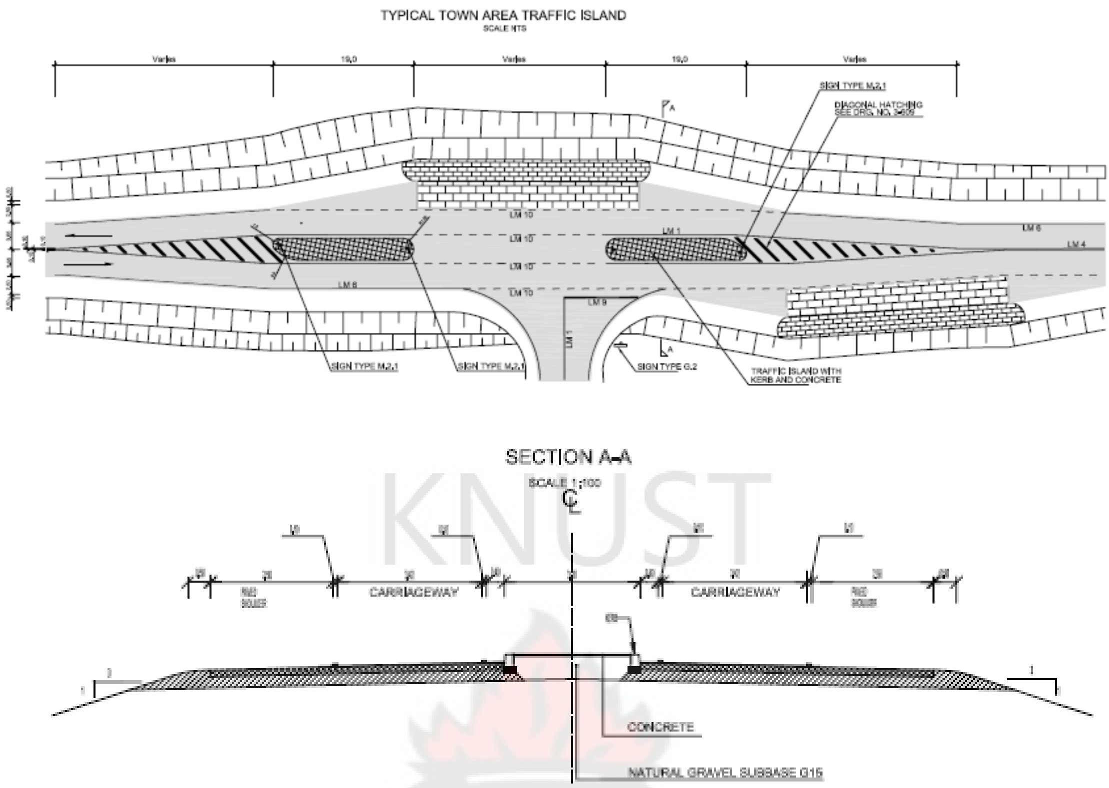
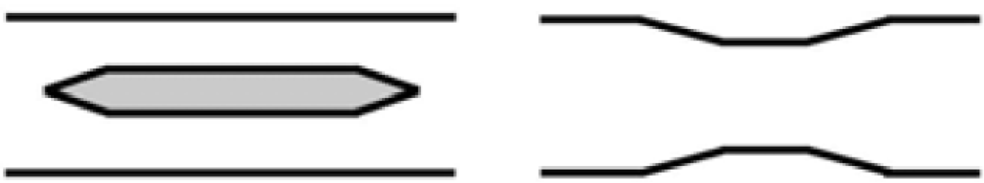


Figure 2.6 Traffic island layout

2.6.8 Road Narrowing

Road narrowing involves reduction in road lane width. There are basically two ways of narrowing the road, from the centre of the road and; narrowing from the roadside as shown in Figure 2.7. In both cases the space available for traffic is reduced, encouraging drivers to slow down to negotiate the narrowing safely.



Narrowing the road from the centre. *Narrowing from the roadside*

Figure 2.7 Road narrowing techniques

2.6.9 Gateway Treatment

Town Gates are normally used on traffic roads to make a clear entrance to an area with a lower speed limit. First and foremost, a gate must function visually by means of signs, centre islands, ghost islands, humps, rumble strips, planting, change of road surface, portals, lighting etc. In addition, the carriageway can be slightly narrowed. "Gateway treatment" uses signs with town name on both sides of the carriageway and other features to encourage slower driving on approach to cities, villages and small settlements. Figure 2.8 is a typical Gateway treatment layout.

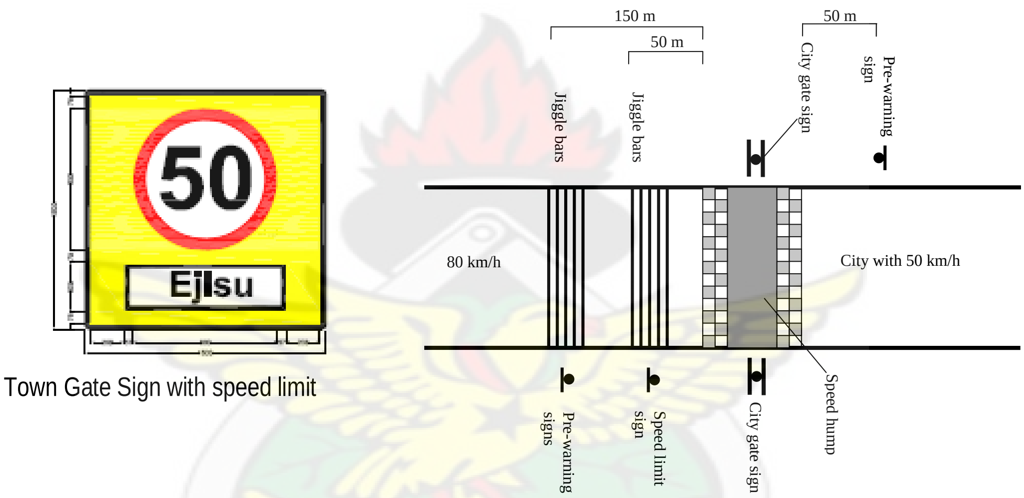


Figure 2.8 Typical gateway treatment layout

2.6.10 Pre-Warnings

The purpose of pre-warnings is to warn drivers about a hazard, settlement or speed limit ahead and ensure that they are aware of the need to slow down.

Figure 2.9 Pre-warning signs, speed humps (LHS), rumble strips/jiggle bars (RHS)

2.7 Pre-construction Road Traffic Safety Situation on Konongo-Kumasi Road

According to the road safety audit of 2000, most of the accidents (75%) happened in towns and villages with vehicle-pedestrian collision type representing 19% of all casualties. Pedestrians represented 64% of the fatalities. Figure 2.10 below shows crash casualty-collision type distribution for the year 2000 (Cowi, 2002),

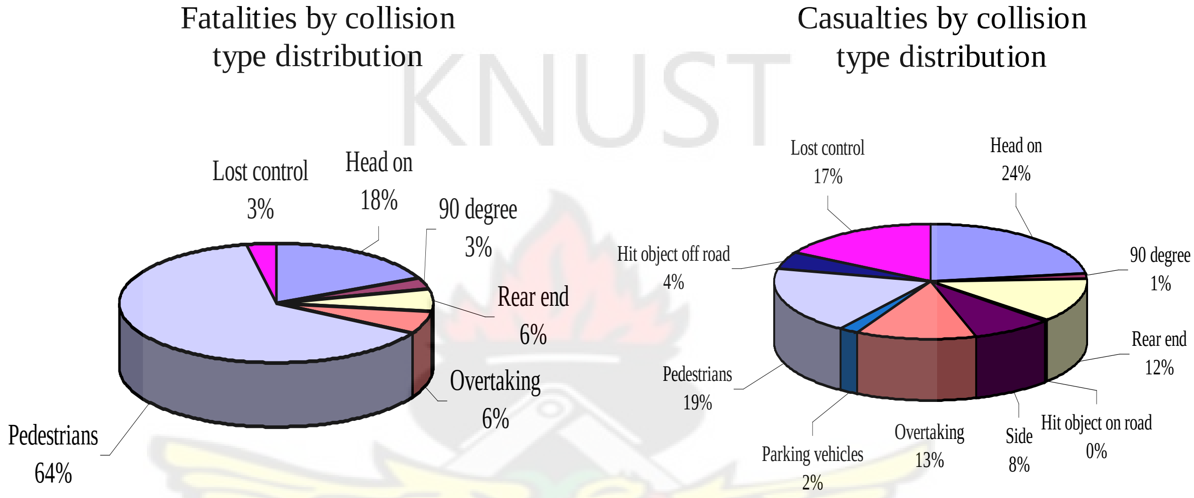


Figure 2.10 Fatalities by collision type (LHS) and casualties by collision type (RHS)

A review of the findings and recommendations contained in the audit report was made during the design studies stage of the Konongo-Kumasi Road rehabilitation project in a bid to identify issues contributing to the poor road traffic safety situation associated with the highway (Cowi Consult, 2002). Proposals were made in the designs towards addressing these issues during the construction stage. A summary of the identified issues and the corresponding countermeasures proposed is presented in Table 2.6

Table 2.6: General crash situations and potential countermeasures

General Accident Situation	Potential Countermeasure
Pedestrian/vehicle conflicts	pedestrian/vehicle segregation (sidewalks or wide shoulders) raised pedestrian crossings speed control devices
Loss of control	road markings delineation speed control devices guardrails
Darkness	reflective signs reflective road markings delineation
Poor visibility	improve sightlines realignment conspicuity
Poor driving behaviour/ lane discipline	education road markings enforcement median barriers
Collision with roadside obstacles	better delineation guardrails frangible posts
Skidding	restoring surface texture
Turning movements	turn prohibition channelisation/turning lanes acceleration/deceleration lanes
Overtaking	prohibition/lane markings advance warning
Light/heavy vehicle conflicts	bus bays/lay bys climbing lanes
Parked vehicles	parking controls parking provision
Roadside stalls	service roads/wide shoulders
Excessive Speeding	speed limits enforcement speed control devices

The above table indicates that speed controlling devices were proposed as a prime counter-measure to address the identified accident situation. The extensive presence of speed breaking devices as part of the general traffic calming scheme on the rehabilitated highway is as a result of these design proposals. The as-built project drawings revealed that a number of reviews and modifications were made to the original designs as a result of the safety audits conducted during construction.

2.8 Road Safety and Geometric Design

In order to further enhance road safety, a number of curves were improved by increasing their radii. The design and as-built reports state several alignment improvements, notable among them are;

- at Besease (Km239.60 - Km240.20) - horizontal curve radius was increased from 518m to 600m for 80Km/h design speed.
- two steep crests at Km244.65 and Km246.00 improved to comply with the sight distance requirements for 100Km/h design speed
- vertical alignment improvement approaching the railway crossing at Km250 involving up to 3m deep cutting at two crests (Km248.10 and Km249.60) and about 3m fill around Km250.10.
- horizontal alignment improvement from Km215.10 to Km216.20 involving increasing curves radii from 370m to 700m with up to 17m realignment inside the curves in flat terrain and, improving vertical curve with up to about 4m deep cutting over a length of about 100m. Accident statistics indicate that the two curves between Km215 and km216 had clearly been among the most accident prone location along the entire road, both in respect of number of accidents and severity. Over a five year period 31 accidents were reported with 18 people killed and 58 injured.
- Adoption of minimum stopping sight distance for 80Km/h in the towns, although 50Km/h speed restriction apply for such sections. This was considered an important means of improving road safety in towns and villages where most accidents occur and involving pedestrians.
- climbing lanes at the following locations: Km212.40 to Km213.40 (LHS), Km219.80 to Km220.40 (RHS), and Km225.00 to Km225.60 (RHS)

2.9 Traffic Crash Data Evaluation

The PIARC Road Safety Manual of 2007, gives several methods of identification of road safety deficiencies. Identification of crash black spots are emphasised as the first step of the road safety improvement programmes. These black spots have a significantly high potential for accident reduction, and also a high cost-effectiveness ratio. Several methods, such as using accident frequencies, accident rates and accident severity are known to detect road deficiencies. Accident data basically can be used in two ways:

- To determine the common characteristics of accidents in order to elaborate the effective countermeasures.
- To identify the locations, together with the traffic volume data, where the probability of accidents is significantly higher than average (black spots).

In the first case, simple frequency tables can be used to have an overview about the most frequent characteristics of road accidents. In the second case use is made of traffic volume data as well for the evaluation. For this purpose the most used accident rates are as follows:

Accident density (A_d): $= \frac{A}{L.T}\left[\frac{accident}{kmyear}\right]$

where:

L: the length of the investigated road section or road network (Km)

A: the number of accidents occurred on the section or network with length “L”.

T: the number of years.

This rate is typically calculated yearly. Accident frequency maps can be produced on the basis of the accident density in order to show the most dangerous parts of the network. This evaluation method produces a rate which does not take into account the traffic volume; therefore it has a high value in case of high traffic volume also.

The other well-known relative number is the accident rate.

$$\text{Accident Rate } (A_r): = \frac{A.10^6}{365.AADT.L.T}\left[\frac{accident}{10^6 vehiclekmyear}\right]$$

where:

AADT: Annual Average Daily Traffic (vehicle/day).

In most cases this Accident rate is also calculated yearly.

3. METHODOLOGY

3.1 Field Work

3.1.1 Classified Traffic Volume Counts

Twelve-hour classified traffic volume counts were undertaken manually at two locations, namely the Oduom railway line crossing and, near the Akyeakrom Junction on the outskirts of the Ejisu town. These two locations were chosen to coincide with the Ghana Highway Authority traffic count stations. The counts were one-day 6.00am-6.00pm counts.

The counts were tabulated and traffic patterns developed using Microsoft Excel spreadsheet.

3.1.2 Speed Measurements (Jul-31, 2010)

In order to assess typical speed levels pertaining in human settlements on the highway, spot speed measurements were conducted at Manhyia, a town located at Km238.50 thereabout. The vehicle speeds were taken at the in/out 50km/h limit inscribed town gate locations (Km238.00 and Km238.45), mid-way between speed tables and on the speed tables (Km238.35 and Km238.45). Vehicles in both directions were measured for different classes of vehicles. Only free-flowing vehicles were measured

3.1.3 Interviews

Spot interviews using pre-prepared questionnaires were conducted with drivers from a cross section of the driving public in and around Kumasi. Their responses to specific questions on the questionnaire relating to the use, and the appropriateness of the road traffic safety measures installed on the road were noted, more particularly with regard to the roundabouts and speed tables/rumble strips found between Kumasi (KNUST) and Konongo (Odumase). The interviews covered passenger bus drivers at the Accra - Kumasi bus terminals in Asafo area, cargo truck drivers at Akwatia line cargo terminal, KNUST junction taxi/trotro terminal and other drivers who pull up randomly at fuel stations between Kentinkrono and Ejisu.

3.1.3 Vehicles Manoeuvre Observation

Large buses and heavy goods vehicles manoeuvres were observed at the four roundabouts between the KNUST Police station and Ejisu. Additionally, observations of roundabout single lane entry manoeuvres for all vehicles were made. Speed table and rumble strips approach characteristics were observed and noted. Road shoulder and bus stop/lay-by use along the highway were observed in addition. Finally, pedestrian use of walking and crossing facilities was part of the observations made.

Discussions were also held with a representative of the project consultant, COWI, for information on the project.

3.2 Secondary Data Collection

3.2.1 Accident Records

Accident records for the Konongo - Kumasi highway for the period 1999-2009 were collected from the Building and Road Research Institute (CSIR-BRRI), Kumasi. The records were for the pre-construction period 1999 - 2003, construction period 2004-2007, and post-construction period 2008 - 2009.

3.2.2 Accident, Traffic and Speed Studies Reports

Report on previous accident, traffic and speed studies were obtained from sources such as GHA - Planning Division, GHA - Road Safety and Environment Division, BRRI and Department of Civil and Geomatic Engineering of KNUST. As-built drawings were obtained from COWI Consult.

4. RESULTS AND DISCUSSIONS

4.1 Road Traffic Crash Records

The road traffic crashes (accidents) characteristics for the Konongo-Kumasi highway is summarised for the period 1999-2009 and presented in Table 4.1. The crash records are grouped into three periods, pre-construction (1999-2003), construction (2004-2007) and post-construction (2008-2009). The project design consultants included 1999-2001 data in their design studies hence its inclusion in the pre-construction period for completeness of analysis. It is deemed pertinent to isolate the four-year construction period for study since vehicular movement are regulated and directed by constructional activities and crash records and resulting trends thereof may be influenced.

Table 4.1 Road traffic crash characteristics on the Kumasi-Konongo Road (1999-2009)

	Pre-construction					Construction				Post-const		
	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	
CRASH SEVERITY												Total
Fatal	27	27	31	29	24	31	21	12	28	23	27	280
Hospitalised	30	46	33	38	37	41	19	29	41	35	39	388
Injured Not-Hospitalised	29	36	35	37	30	23	20	18	45	27	37	337
Damage Only	50	34	33	42	25	23	29	49	71	36	45	437
Total	136	143	132	146	116	118	89	108	185	121	148	1442
CASUALTY INJURY												Total
Fatal	32	29	57	46	28	41	22	14	56	27	43	395
Hospitalised	104	80	84	121	72	83	40	49	77	66	105	983
Injured Not-Hospitalised	100	129	90	174	122	120	137	61	131	103	191	1358
Total	236	238	231	341	222	244	199	124	264	196	339	2634
CASUALTY CLASS												Total
Driver	55	79	60	65	51	60	44	33	73	48	72	640
Passenger	148	113	131	231	128	146	133	72	148	112	223	1585
Pedestrian	34	46	43	45	43	38	22	19	43	37	44	414
Total	237	238	234	341	222	244	199	124	264	197	339	2639
VEHICLE TYPE												Total
Car	50	79	65	78	68	61	53	38	103	71	84	750
HGV	48	43	41	64	42	44	47	74	87	55	58	603
Bus	74	66	58	72	54	61	26	25	47	23	34	540
Minibus	1	3	0	0	3	0	15	24	26	27	27	126
Pickup	25	20	15	13	10	6	6	10	21	6	23	155
Other	1	5	1	1	1	3	4	5	3	14	13	51
Total	199	216	180	228	178	175	151	176	287	196	239	2225

4.1.1 Crash Severity

From Table 4.1, a total of 1,442 crashes were recorded for the period 1999-2009, of which 280 (19.4%) were fatal, and 725 (50.3%) were injury crashes. On year-by-year basis, years 2001 and 2004 recorded the highest number of fatal crashes with 31 such events. Year 2006 recorded the least with 12 fatal crashes. Year 2007 recorded the highest injury crashes with 86 events, and Year 2005 with 39 injury crashes. The highest recorded crashes of 185 were in year 2007, and the least of 89 in year 2005.

Fatal crashes represented 20.5% of all crashes for the pre-construction period, 18.4% for the construction period, and post-construction period, 18.6%. Injury crashes are 52.1% for all pre-construction crashes, 47.2% for the construction period and, 51.3% for post construction.

In general the trends indicate a sinusoidal pattern for all crashes. Appendix C-Figure C1 is a graphical illustration of the severity trends.

4.1.2 Casualty Injuries

Casualties recorded from 1999 to 2009 totalled 2,634 of which 395 (15.0%) were fatal. Fatal injuries for the pre-construction period were 192, representing 15.1% of 1,268 casualties for that period. One hundred and thirty three fatalities (16.0%) out of 831 casualties were recorded for the construction period and 70 fatalities (13.1%) out of 535 casualties for the post-construction period.

Yearly fatalities records indicate year 2001 as having the highest number of 57 persons, followed by year 2007 with 56 persons. Year 2006 recorded the least fatalities of 14 persons. Year 2009 recorded 296 injured persons, the highest for the entire 11 years, whereas year 2006 recorded the least with 110 injured persons. A graphical presentation of the trends is shown as Appendix C-Figure C2.

4.1.3 Casualty Class

Examination of the crash casualty class records in Table 4.1 shows that a total of 2,639 casualties for the 11 years. In all, 1,585 passengers sustained various degrees of casualties representing 60.1%, followed by drivers with 24.2% and pedestrians, 15.7%. Year-by-year trends for all three categories are shown in Figure 4.1 below.

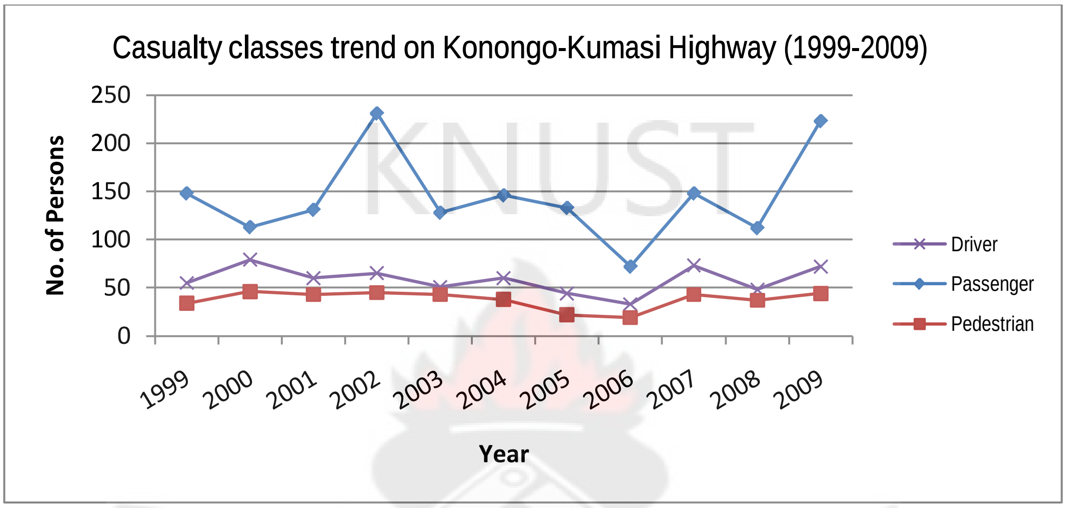


Figure 4.1 Traffic crash casualty trends

The lowest figures for all three classes occurred in 2005-2006. Passengers have remained at the top of the casualty classes over the years, peaking in year 2009 with 233 injured persons.

4.1.4 Traffic Crash Vehicle Type

Cars continue to be the dominant crash vehicle category on the Konongo-Kumasi highway, losing the position only once to heavy goods vehicles (HGV) in 2006. The car category hit an all-time high of 103 crash involvements in year 2007 for all categories. That same year HGV recorded a category high of 87 involvements and also the second placed all-time high. Figure 4.2 shows trends for vehicle category involvement in crashes over the years.

Vehicle type-crash severity records summarised in Table D3 of Appendix D, indicate that the bus category involvement in fatal crashes was the highest during the pre-construction period with 77 (41%) fatal crashes, followed by car with 52 (28%) and HGV with 36 (19%). During the construction period, however, HGVs recorded the highest number of fatal crash involvement with 47 (36%) crashes, followed by car category with 34 (26%), bus with 25 (19%) and minibus category 10 (8%) in that order. Minibus category which did not record any fatal crash the earlier period has now become prominent. For the two year post-construction period, the HGV category recorded the highest number, 22 (31%) of fatal crash involvements followed by car with 21 (26%). Bus and minibus categories recorded 11 (15%) and 8 (11%) fatal crash involvements respectively.

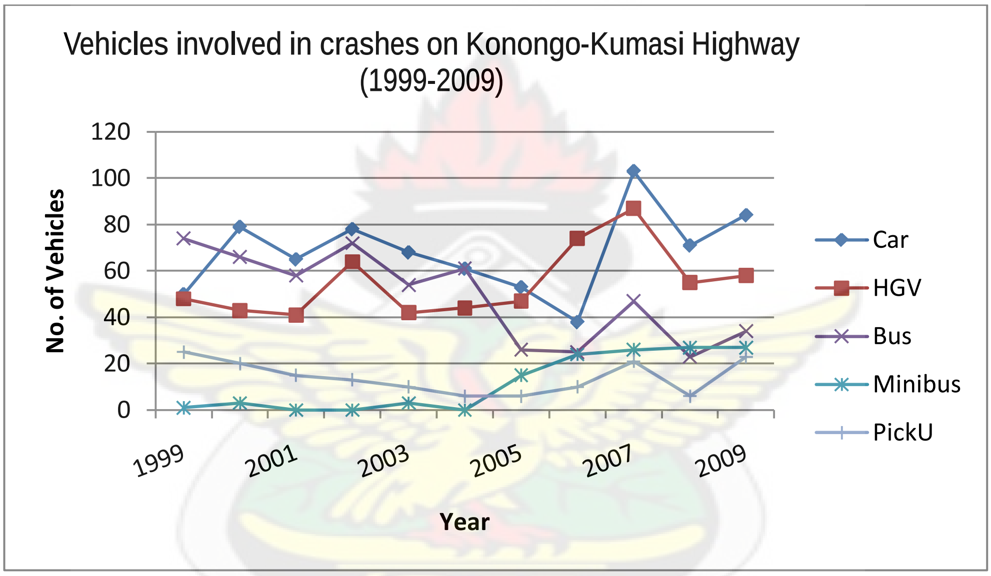


Figure 4.2. Crash vehicle type trends

4.1.5 Collision Type

Table 4.2 gives collision type-severity statistics for the pre-construction period. Hit-pedestrian crash is the most dominant collision type. One hundred and seventy four hit-pedestrian crashes were recorded which constituted 25.9% of the 673 crashes obtained over this 5-year pre-construction period. Seventy five of the hit-pedestrian crashes resulted in fatalities. This represents 54.3% of the 138 fatal crashes for the period. Similarly, 76 of the 184 hospitalisation injuries crashes were hit-pedestrian collisions representing 41.3% of the total.

Head-on and rear-end collision types trail vehicle-pedestrian crashes as next pre-dominant collision types.

Table 4.2: Pre-construction period crash statistics (1999-2003)

COLLISION TYPE	CRASH SEVERITY				
	Fatal	Hospitalised	Injured Not-Hospitalised	Damage Only	Total
Head On	18	19	23	15	75
Rear End	13	18	30	66	127
Right Angle	4	4	4	10	22
Side Swipe	2	11	20	27	60
Overturned	9	15	10	5	39
Hit Object	2	6	5	10	23
Hit Parked Vehicle	2	4	6	9	21
Hit Pedestrian	75	76	23	0	174
Other	13	31	46	42	132
Total	138	184	167	184	673

The statistics for the 2004-2007 construction period are similar to those of the pre-construction period. The construction period however witnessed an 8.5% reduction in the proportion of fatal hit-pedestrian to total fatal crashes over the 4-year construction period at 45.6% i.e. 42 out of 92 total fatal crashes. Table 4.3 below shows the collision type-severity statistics for the period.

Table 4.3: Construction period crash statistics (2004-2007)

COLLISION TYPE	CRASH SEVERITY				Total
	Fatal	Hospitalised	Injured Not-Hospitalised	Damage Only	
Head On	13	10	5	8	36
Rear End	6	12	21	56	95
Right Angle	5	5	8	7	25
Side Swipe	4	8	18	39	69
Ran Off Road	7	13	12	23	55
Hit Object	1	3	3	4	11
Hit Parked Vehicle	6	6	2	7	21
Hit Pedestrian	42	57	15	0	114
Other	8	16	22	28	74
Total	92	130	106	172	500

Hit-pedestrian crashes continue to dominate the collision types for the post-construction period. It represents 24.2% of total crashes for the period. Fatal hit-pedestrian collisions represent 51.0% of all 49 fatal crashes for the two year post-construction period. From Table 4.4, it is evident the general trend of dominant collision types is maintained, i.e., hit-pedestrian, head-on and rear-end hierarchy is maintained for crashes resulting in serious injuries i.e. fatal and hospitalised injuries.

Table 4.4: Post-construction period crash statistics (2008-2009)

COLLISION TYPE	CRASH SEVERITY				Total
	Fatal	Hospitalised	Injured Not-Hospitalised	Damage Only	
Head On	6	4	7	1	18
Rear End	6	3	16	35	60
Right Angle	1	6	7	4	18
Side Swipe	2	9	11	17	39
Ran Off Road	5	15	5	10	35
Hit Object	1	4	2	6	3
Hit Parked Vehicle	3	5	2	7	17
Hit Pedestrian	25	26	14	0	65
Other	0	2	0	1	3
Total	49	74	64	81	268

It is evident that pedestrians continue to be the most vulnerable group of road users on the Konongo-Kumasi highway despite the institution of elaborate traffic calming measures within settlements along the highway.

Table 4.5: Summary of dominant collision types – crash severity

PERIOD	Hit-pedestrian (per year)		Head-on (per year)		Rear-end (per year)	
	Fatal	Hospitalised (Serious Injury)	Fatal	Hospitalised (Serious Injury)	Fatal	Hospitalised (Serious Injury)
Pre-construction (1999-2003)	15.0	15.2	3.6	3.8	2.6	3.6
Construction (2004-2007)	10.5	14.3	3.3	2.5	1.5	3.0
Post-construction (2008-2009)	12.5	13.0	3.0	2.0	3.0	1.5

Table 4.5 gives a summary of collision type – severity on yearly averages for each of the three periods considered.

4.1.6 Kilometric Crash Analysis

The Konongo-Kumasi highway traverses three significantly different road environments categorised as follows,

- the Konongo-Odumase section (Km196-Km200.9), characterised by brisk congested urbanised commercial activity.
- Odumase-Ejisu section (Km201-Km229.9), rural environment with stretches of small towns and villages.
- Ejisu-Kumasi -KNUST (Km230-Km243), peri-urban environment made up of a number of fast developing settlements forming a continuum with the Kumasi Metropolis.

Tables 4.6 – 4.8 give road traffic crash statistics for the three sections of the road. The pre-construction period records detailed in Table 4.6 has the Odumase-Ejisu section recording 281 (41.8%) crashes out of a total of 673, the highest in absolute numbers. However, in terms of crash rate i.e. crashes per kilometre, the same section returned the lowest crash rate. The Konongo-Odumase section exhibited the reverse statistics when records are expressed as crash rates.

Table 4.6: Crash severity kilometric records – pre-construction period (1999-2003)

CRASH SEVERITY)					
Chainage	Fatal	Hospitalised	Injured Not-Hospitalised	Damage Only	Total
Km196-Km200.9 (Konongo-Odumase, urban)	22	38	28	37	**125**
Km201-Km229.9 (Odumase-Ejisu, rural)	65	69	69	78	**281**
Km230-Km243 (Ejisu-KNUST, peri-urban)	51	77	70	69	**267**
Total	**138**	**184**	**167**	**184**	**673**

For the construction period, the Ejisu-Kumasi section recorded the highest number of crashes in absolute terms, i.e. 219 crashes out of the 500 total. In terms of crash rate (crashes per kilometre), the Konongo-Odumase section recorded the highest rate with 18.6 crashes per kilometre, ahead of the Ejisu-Kumasi section which had crash rate of 16.6 for the same period. Table 4.7 gives the records for the sections for the construction period.

Table 4.7: Crash severity kilometric records – construction period (2004-2007)

ACCIDENT SEVERITY					
Chainage	Fatal	Hospitalised	Injured Not-Hospitalised	Damage Only	Total
Km196-Km200.9 (Konongo-Odumase, urban)	14	21	23	33	**91**
Km201-Km229.9 (Odumase-Ejisu, rural)	41	40	38	71	**190**
Km230-Km243 (Ejisu-KNUST, peri-urban)	37	69	45	68	**219**
Total	**92**	**130**	**106**	**172**	**500**

Table 4.8 contains the crash trends for the post-construction period of 2008-2009. The Ejisu-Kumasi section recorded the highest number of crashes with 132 out of the 269 for the period representing 49.1% of total crashes. The Konongo-Odumase section had the lowest of 43 crashes (16.0%). In terms of crash per kilometre, the Odumase-Ejisu section posted the lowest rate of 3.2 crashes per kilometre, the highest being the Ejisu-Kumasi section with 10.1 crashes per kilometre.

Table 4.8: Crash severity kilometric records – post-construction period (2008-2009)

ACCIDENT SEVERITY					
Chainage	Fatal	Hospitalised	Injured Not-Hospitalised	Damage Only	Total
Km196-Km200.9 (Konongo-Odumase, urban)	1	15	13	14	**43**
Km201-Km229.9 (Odumase-Ejisu, rural)	28	23	20	23	**94**
Km230-Km243 (Ejisu-KNUST, peri-urban)	21	36	31	44	**132**
Total	**50**	**74**	**64**	**81**	**269**

4.2 Vehicle traffic counts

The GHA has traffic records from counts at two stations on the study road section, at the customs control post (Km228.8), between Konongo and Ejisu, and at the railway crossing (Km250.0) between Kumasi and Ejisu. Data from previous counts is shown in Table 4.9 below.

Table 4.9: Summary of previous traffic counts on Konongo-Kumasi Highway

Date	Customs Border Post	Ejisu (East)	Railway Crossing
	ADT		
August 2000 - Consia	3,628		10,400
September 2000 - Carl Bro	4,000		11,250
Nov-Dec 2001 - Cowi	4,901		12,955
Sept 2008 – Lamda Consult		8,271	15,922

For the current research, classified traffic volume counts were undertaken at two locations, Ejisu (Bonwire Jn) and Oduom (railway crossing), to represent rural and peri-urban situations, respectively. The counts were one day 12-hour counts, and were conducted in the month of March 2010. Summaries of the two classified counts are presented as Tables E1 and E2 in Appendix E of this report.

Table 4.10 and 4.11 gives vehicular traffic distributions for different years for the Konongo-Ejisu and the Ejisu-Kumasi sections respectively of the highway.

Table 4.10: Comparism of classified counts for Konongo-Ejisu section

	Carl Bro, Sept 2000			Cowi, Nov-Dec 2001			Lamda, Sept 2008			Mar 2010		
Vehicle Class		%			%			%			%	
Cars	990	24.7	69	1,337	27.3	69	2,688	32.50	76	2,697	33.5	79
Pickup & 4WD	1,758	43.9		738	15.1		1,348	16.30		1,364	17.0	
Minibus				1,328	27.1%		2,278	27.54		2,271	28.2	
Small Bus	192	4.8	20	309	6.3	22	302	3.65	15	296	3.7	14
Large Bus	160	4.0		216	4.4		285	3.45		278	3.5	
Light Truck	15	0.4		31	0.6		339	4.10		320	4.0	
Medium Truck	440	11.0		504	10.3		306	3.70		276	3.4	
Heavy Truck	102	2.5	11	135	2.8	9	177	2.14	9	157	2.0	7
Semi-trailer,	30	0.7		32	0.7		53	0.64		40	0.5	
Semi/full tr., 4ax.	219	5.5		152	3.1		137	1.66		127	1.6	
Semi/full tr., 5ax.	89	2.2		96	2.0		199	2.41		188	2.3	
Semi/full tr., 6ax.	12	0.3		23	0.5		159	1.92		28	0.34	
Total ADT	4,007			4,901			8,271			8,041		

It is observed as expected that light vehicles category comprising cars, pickups/4WDs and minibuses were the most dominant modes accounting 69%of the traffic mix in 2000 and 79% in 2010. Medium vehicle category, the next most dominant mode, reduced in proportion from 22% in year 2001 to 14% in 2010. The heavy vehicles category, the least dominant of the three categories, reduced in proportion from 11% in 2000 to 7% in 2010.

The average daily traffic, ADT, rose from about 4,000 in 2000 to 4,900 the year after and then to 8,270 in 2008, and declined slightly in 2010 to 8,041.

Table 4.11: Comparism of classified volume counts for Ejisu-Kumasi section

	Carl Bro, 2000			Cowi, 2001			Lamda, 2008			Current-Mar 2010		
Vehicle Class	ADT	%		ADT	%		ADT	%		ADT	%	
Cars	4,083	36.3	86	4,769	36.8	69	4,747	29.8	76	2,697	29.3	83
Pickup & 4WD	5,614	49.9		1,624	12.5		2,753	17.3		1,364	17.6	
Minibus				4,598	35.5		6,388	40.1		2,271	36.5	
Small Bus	247	2.2	11	416	3.2	22	204	1.3	15	296	2.2	12
Large Bus	186	1.7		249	1.9		277	1.7		278	3.1	
Light Truck	68	0.6		122	0.9		513	3.2		320	3.0	
Medium Truck	706	6.3		758	5.9		377	2.4		276	3.2	
Heavy Truck	71	0.6	3	119	0.9	9	175	1.1	9	157	1.5	5
Semi-trailer,	39	0.3		26	0.2		23	0.1		40	0.3	
Semi/full tr.,	145	1.3		153	1.2		177	1.1		127	1.2	
Semi/full tr.,	54	0.5		100	0.8		263	1.7		188	1.8	
Semi/full tr.,	36	0.3		21	0.2		25	0.2		28	0.3	
Total ADT	11,249			12,955			15,922			17,415		

Table 4.11 shows that the general trend of vehicle category proportionality is maintained for the Ejisu-Kumasi section of the highway. The light vehicle category remains the dominant mode followed by medium and heavy in that order. The ADT rose from 11,249 in 2000 to 17,415 in 2010.

4.3 Vehicle travel speeds

Vehicle speeds were measured at Manhyia town at the two town gates with inscribed 50Km/h limits (Km237+975 and Km238+580), on the speed tables and, in-between the two speed tables mid-town. The location of the gates more or less coincided with the location of the 50km/h limit rumble strips. Table 4.12 gives the distribution of the measured speeds.

Table 4.12: Summary of speed statistics at Manhyia Town

Speed Measurement Location	Speed Statistics		
	Mean (Km/hr)	*Std. Dev* (Km/hr)	85th Percentile
Gates	66	13	76
Mid-town	40	9	47
Speed Tables	24	5	21

Mean speeds measured on the speed tables and in-between speed tables are 24Km/h and 40Km/h respectively. The speed tables are about 85m apart.

The town gates with inscribed limits and the nearby rumble strips did not slow down vehicles considerably. The 50Km/h rumble strips at the outskirts town are almost flattened within the vehicle wheel-paths making it easy for vehicles to pass over without reducing speed. Figures 4.3, 4.4 and 4.5 show the speed distribution at Manhyia town.

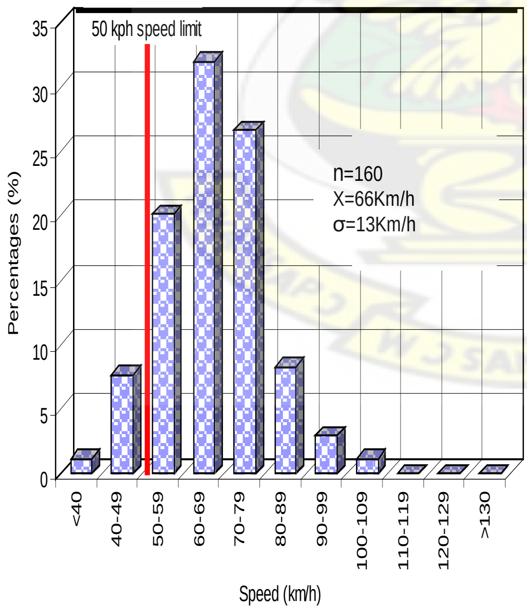


Figure 4.3. Speeds at town gates

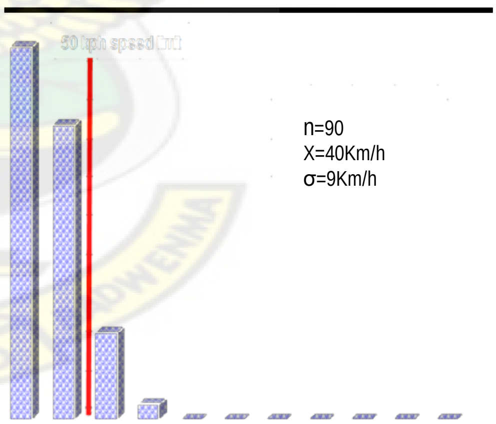


Figure 4.4. Speeds between speed tables

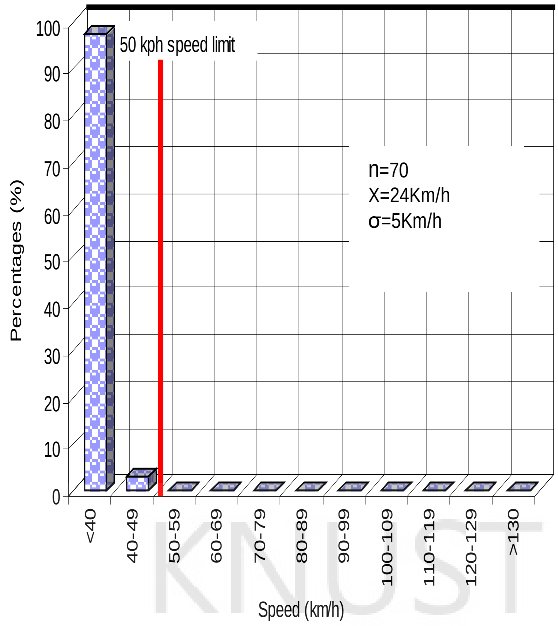


Fig. 4.5. Speeds on speed tables

In general, all categories of vehicles are compelled by the presence of the speed table to travel at speeds below the 50Km/h limit in the vicinity of the speed tables within the town.

Results from previous speed studies prior to the installation of the speed humps, indicated most vehicles exceeded the posted speed limit of 50 Km/h (BRRI/Carl Bro, 2006). The report further stated that, on the average, between 88% and 98% of the drivers travelling through the designated towns travelled far in excess of the speed limit with mean speeds ranging from 70Km/h to 89Km/h. Speed measurements carried out by BRRI after the installation of the speed humps indicated a sharp reduction of mean speeds to between 30Km/h and 35Km/h

4.4 Driver Interviews

The results of the 104 drivers interviewed via questionnaire regarding the presence of roundabouts and speed humps and tables on the highway are summarised in Table 4.13.

Table 4.13: Summary of driver interviews on road safety devices

Total number of drivers interviewed	104
Number of drivers opposed to presence of devices	63
Number of commercial drivers interviewed	63
Number of commercial drivers opposed to presence of devices	48
Number of private drivers interviewed	41
Number of private drivers opposed to presence of devices	15
Number of female drivers interviewed	22
Number of female drivers opposed to presence of devices	7
Number of drivers who think the highway is now safer to users	104

The above results generally show mixed reactions. There was the total agreement that the road is now safer to use, however the appropriateness of the speed humps and tables on a road designated as a major highway was of much concern to the majority.

4.5 Field Observations

Field observations indicated a fair degree of proper use of road safety measures and facilities provided on the highway. Generally pedestrians used the walkways, shoulders and crossing points especially within the divided dual carriageway section from KNUST to Fumesua. At the roundabouts, pedestrians used the cobbled lane narrowing area as waiting zone before stepping onto the zebra marking area when crossing to obtain a shortened crossing distance to the median island. It was noted that few vehicles gave way to the pedestrians at the designated crossings. Due to the low vehicle speeds within the roundabouts, pedestrians are able to identify gaps which allow them to cross conveniently. Similar observations were made in the case of towns along the two-lane single carriageway section between Ejisu and Odumase. Pedestrians crossed one lane at a time using the raised traffic islands appropriately and took advantage of the lower speeds in-between the speed tables.

Truck manoeuvres around the roundabout also showed a fair knowledge of use by large buses and heavy trucks as they most often used the truck aprons. Drivers exhibited patience in getting in-lane at the lane-narrowing sections approaching the roundabouts. Smaller vehicles sometimes sneaked in front of slower moving heavy vehicles when approaching the roundabouts instead of waiting or soliciting gaps from those already in lane.

Turning movements within the towns between Ejisu and Odumase appear to be safe as the turning vehicles take refuge within the area between the raised traffic islands before crossing or joining the opposite lane. For the ghost islands, however, it was observed that some through traffic tend to use them as overtaking lanes and thus create unsafe traffic situations.

It was also observed that a number of road signs and road studs (cat eyes) are either damaged, defaced or vandalised. Flattening deformation of the 50Km/h rumble strips is prevalent in most places and has rendered the strips less effective. The ramps of the speed tables were also observed to be fast deteriorating. A number of pedestrian crossing markings are faded.

Photographs of some field observations are presented in appendix I of this report.

4.6 Discussions

The road traffic crash records for the Konongo-Kumasi highway show marked reductions in crash numbers and severity from 2004 to 2006, the peak of the period of construction. The years 2005 and 2006 constituted the best performing years. This may be due to intense traffic regulation and direction as well as relatively low speeds imposed by the construction on traffic. A sharp rise in crash events was witnessed towards the end of the works period i.e. 2007. This may be attributed to the situation when road surface works had been substantially completed but without the installation physical speed reducers such as speed table and rumble strips, leading to excessive speeds and resultant crashes. With the installation of the speed reducers within towns along the highway thereafter, a marked reduction was achieved in 2008 over the 2007 figures but still higher than the 2005-2006 levels. This however was disappointingly short-lived as a sharp rise was witnessed in the year 2009 with fatal and serious injury crashes almost equalling those of 2007 and pre-construction levels.

Crash casualty trends also follow that of crash severity, with 2008 figures showing a significant reduction over 2007 figures but rising in 2009.

Driver and passenger injuries in 2009 far exceed the 2008 levels and in most cases exceeded pre-construction levels. Pedestrian injuries in 2009 also show an increase. Table 4.14 gives an overview of the crash situation over the years on per kilometre basis.

Table 4.14 Yearly crash indices

Period	Pre-construction					Construction				Post-construction	
Year	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Crash Severity											
Total Crashes/Km	2.89	3.04	2.81	3.11	2.47	2.51	1.89	2.30	3.94	2.57	3.15
Fatals/Km	0.57	0.57	0.66	0.62	0.51	0.66	0.45	0.26	0.60	0.49	0.57
injuries/Km	1.26	1.74	1.45	1.60	1.43	1.36	0.83	1.00	1.83	1.32	1.62
Crash Casualty											
Total Injuries/Km	5.02	5.06	4.91	7.26	4.72	5.19	4.23	2.64	5.62	4.17	7.21
Fatalities/Km	1.06	0.72	0.70	0.89	0.53	0.49	0.62	1.04	1.51	0.77	0.96
Injuries/Km	4.34	4.45	3.70	6.28	4.13	4.32	3.77	2.34	4.43	3.60	6.30
Casualty Class											
Total Casualties/Km	5.04	5.06	4.98	7.26	4.72	5.19	4.23	2.64	5.62	4.19	7.21
Drivers/Km	1.17	1.68	1.28	1.38	1.09	1.28	0.94	0.70	1.55	1.02	1.53
Passengers/Km	3.15	2.40	2.79	4.91	2.72	3.11	2.83	1.53	3.15	2.38	4.74
Pedestrian/Km	0.72	0.98	0.91	0.96	0.91	0.81	0.47	0.40	0.91	0.79	0.94

Vehicle type involvement in crashes exhibited a generally declining trend from year 2000 for all categories until 2005/2006 when the trend upturned for all. Hitherto third placed HGV category moved up to second place. Additionally, percentage representation of the minibus category increased significantly from the year 2005. Likewise the crash indicators, vehicle type involved in crashes also exhibited a roller-coaster trend in the last five of the 11 years analysis period ending on the incline. In general, the car category constitutes the most dominant vehicle type involved in crashes consistently since 1999.

Hit-pedestrian crash is the most dominant collision type and, also resulting fatalities and hospitalised injuries surpass all others over the entire 11-year period and sub-periods. Hit-pedestrian crashes saw a net decline from the construction from the pre-construction high. It is however on the increase for the 2-year post-construction period. Analysis of the records shows that the Ejisu-Kumasi peri-urban section of the highway is a major contributor to the post-construction increase in road traffic crashes observed. Head-on and rear-end collisions types are the next pre-dominant collision types. The former's trend shows a consistent decline in fatal and hospitalised injuries over the three periods.

The latter saw an increase in fatalities in the post-construction period but a consistent decline in serious injury types.

From the crash records it is evident that pedestrians continue to be the most vulnerable group of road users on the Konongo-Kumasi highway despite the institution of elaborate traffic calming measures within settlements along the highway.

Crash records analysis for the three sections of the highway i.e. the urban Konongo-Odumase, rural Odumase-Ejisu and peri-urban Ejisu-Kumasi sections shows that the Odumase-Ejisu section recorded the *highest crash per kilometre per year reduction of 16% over the three periods*, followed by the Konongo-Odumase section with 14%. The Ejisu-Kumasi section rather experienced an *increase of 24%* at the end of the 2-year post-construction period over that of the pre-construction period. This situation should however be considered against the backdrop that this section of the highway has about twice the traffic volume as the Odumase-Ejisu section and it is also experiencing intense urbanisation as a result of the Kumasi Metropolis sprawl.

Though the installed speed tables are perceived by a large section of the driving public to be a nuisance, vehicle speeds in general have been fairly controlled within mid town sections of settlements along the highway for all categories of vehicles by the installation. However, the rumble strips and gateway speed limit signs appear to be fast losing their effectiveness as speeds continue to exceed posted limits.

5 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

Based on the results of this study, the following may be drawn:

1. Road traffic crash numbers are on the increase contrary to the general perception.
2. The Ejisu-Kumasi section of the highway is the major contributor to the increase in crashes.
3. The Konongo-Ejisu section achieved relative reduction in crash rate.
4. Passengers continue to be the most dominant class of crash casualties.
5. Pedestrian fatality still has the highest crash fatality proportion.
6. Heavy goods vehicle (HGV) category is now the most involved in crashes; they constitute 31% of total fatal crashes and 26% of all crashes, even though they compose up to only 9% of the vehicular traffic.
7. Posted speed limit signs and 50Km/h rumble strips appear to be fast loosing their effectiveness in reducing speeds.
8. Speed tables are very effective in reducing speeds.
9. Majority of drivers object to the presence of speed tables on the highway

5.2 Recommendations

From the findings of this study, the following recommendations are made:

1. The Ejisu-Kumasi section should be classified as an urban road and speed limit set at 50km/h with the necessary traffic calming measures effected.
2. Reconstruction of deteriorated 50Km/h rumble strips and other road safety furniture should be undertaken as a matter of urgency.
3. In view of the rapidly expansion of the settlements along the highway, a re-evaluation of the positions of the traffic calming devices is advised.

4. Implementation of planned traffic calming devices should be done as soon as road work is completed for sections of the road, as against the practice of completing the entire stretch before commencing the installation of traffic calming devices.
5. Road safety education should be carried out on sustained basis for both residents along the corridor and the driving public.

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APPENDICES