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Assessment Of The Effects Of Road Geometric Design Consistency On Traffic Safety: The Case Study From Wolayita Soddo To Allaba Town

By

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A Thesis Submitted to the School of Graduate Studies In partial fulfillment of the requirements for the degree of Master of Science

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Advisor

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The undersigned have examined the thesis entitled "ASSESSMENT OF THE EFFECTS OF GEOMETRIC DESIGN CONSISTENCY ON TRAFFIC SAFETY A CASE STUDY FROM WOLAYITA SODDO TO ALLABA TOWN" presented by **Mulugeta Daniel Hakeko** , a candidate for the degree of **Master of Science** and hereby certify that it is worthy of acceptance.

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UNDERTAKING

I certify that research work titled “ASSESSMENT OF THE EFFECTS OF GEOMETRIC DESIGN CONSISTENCY ON TRAFFIC SAFETY A CASE STUDY FROM WOLAYITA SODDO TO ALLABA TOWN” is my own work. The work has not been presented elsewhere for assessment. Where material has been used from other sources it has been properly acknowledged / referred.

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ABSTRACT

The goal of transportation is generally stated as the safe and efficient movement of people and goods. To achieve this goal, designers use many tools and techniques. One technique used to improve safety on roadways is to examine the consistency of the design. In this study, road geometric design Consistencies were studied using operating speed and Vehicle stability techniques at 50 curves using as built data and operating speeds at each curves. In Addition to these data 328 accidents were collected in 12 sections of the road for five consecutive years to identify how and to which extent they affect traffic safety. The relationship between traffic accident rate and road geometric design consistency was examined through revealing the results of studies made in different Sections. As a research objective, this study has evolved to find the correlation between accident rate and road geometric constituents in selected Sections of road specific to Allaba to Wolayita Soddo Segments through examining the feasibility of single and multiple linear regression analysis over the indicated variables. Accordingly, ten crash locations with frequent crash occurrences have been determined and Inconsistent Sections were identified. Then the accident rates of these subsections were determined. Next, the values of geometric parameters about these sections were obtained from as-built road design outputs. Finally, a regression analysis was made between the selected geometric parameters and accident rates. At the end of the study, significant relationships were found between some geometric design parameters and Accident Rate

Key Words: *Traffic safety, Road geometry Design consistency, Accident Rate, As-built data*

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ACRONYMS

AADT	Annual Average Daily Traffic
AASHTO	American Association of State Highway and Transportation Officials
AR	Accident rate
DF	Degree of Freedom
ERA	Ethiopian Road Authority
ETRADA	Ethiopian Road Accident Data Acquisition
FHWA	Federal Highways Administration
MS	Mean of Squares
MVKm	Million Vehicle Kilometers
NRA	National Road Authority
PDO	Property Damages Only
RSDP	Road Sector Development Program
RTA	Road Traffic Accidents
SPSS	A statistical Package software for Social Science
SS	Sum of Squares
TRB	Transportation Research Board
TRL	Transport Research Laboratory
VIF	Variance Inflation factor
WHO	World Health Organization

CHAPTER 1 INTRODUCTION

1.1 Background

The goal of transportation is generally stated as the safe and efficient movement of people and goods. To achieve this goal, designers use many tools and techniques. One technique used to improve safety on roadways is to examine the consistency of the design. Design consistency refers to highway geometry's conformance with driver expectancy. Generally, drivers make fewer errors at geometric features that conform to their expectations. An inconsistency in design can be described as a geometric feature or combination of features that has such a high driver workload requirement those drivers may drive in an unsafe manner. This situation could lead to inappropriate driving maneuvers and/or an undesirable level of Crashes.

It is known that the availability of a road network of an appropriate level of service and quality is vital in expediting the overall economic development of one country. Traffic safety in this regard has a paramount effect on transportation systems of the whole world. Road crashes are global disasters affecting many lives and livelihoods, hindering development and leaving millions in greater vulnerability [1]. Road traffic Crashes are very common all over the world and nearly 1.3 million people die in road crashes each year, on average 3,287 deaths a day with an additional 20-50 million are injured or disabled. Road traffic Crashes rank as the 9th leading cause of death and account for 2.2% of all deaths globally. It is the leading cause of death among young people ages between 15 to 29, and the second leading cause of death worldwide among young people ages between 5 to 14 years. Unless action is taken, road traffic injuries are predicted to become the fifth leading cause of death by 2030 [2].

Road traffic accidents (RTAs) constitute major health, economic, and developmental challenges of developing countries, especially adversely affected sub Saharan African Countries [3]. According to the detailed analyses of global accident statistics by the UK Transport Research Laboratory (TRL), the change in road traffic accident fatalities in the low and middle-income countries was found increasing highly. In 1999, for instance, 750,000–880,000 people died in road traffic crashes of which, about 85% of these

occurred in developing countries [4] and in 2002 an estimated 1.2 million people were killed in road traffic crashes [5]. 90% of the traffic crashes occurred in low and middle income countries of which Sub-Saharan countries had faced the highest fatality rate (28.3 per 100,000 population), which is substantially higher than any continent in the world [6]. From the low-income countries, Ethiopia has been found one of the countries with the highest rate of fatalities per vehicle of accident in the world. According to the Ethiopian Government reports, at least 70 people die in every 10,000 vehicle- accidents per year and the traffic accident death rate per ten thousand motor vehicles in 2001/2-2004/5 was in the range of 129 and 145 [7].

Road safety engineers have been faced with the challenges of balancing between the type of roads and neighborhoods characteristics to address safety issues within the three major traffic safety pillars: human, vehicle, and infrastructure [8].

The roadway geometry, traffic conditions, and roadside environment are the primary inputs to the driving task that determine the workload requirement of the driver. How quickly and how well these inputs are handled depend on driver expectancy and other human factors. Once these inputs are processed, they are translated into vehicle operations. When an inconsistency exists that violates driver's expectation, the driver may adopt an inappropriate speed or inappropriate maneuvers, potentially leading to accidents. In contrast, when design consistency is ensured, all abrupt changes in geometric features for contiguous highway elements are eliminated, preventing critical driving maneuvers and minimizing accident risk [19].

Although the main concern of this study is the effect of highway geometric Consistency, the road user behavior is also an effective cause of traffic accidents on the design considerations. An error in perception or judgment or a faulty action on the driver's part can easily lead to a crash. However, the number of accidents can be seriously reduced if the road factor is evaluated better and highway design is made correctly [9]. Apparently, most of the developed countries have adopted Road geometry improvement technologies and traffic safety management systems to further enhance and strengthen transportation sector services for the wellbeing of their economic growth [10]. As a result, in these countries the potential improvement and advancement of Road geometric design technologies are becoming virtually unlimited.

But as for the developing countries, especially Ethiopia, there has been a huge gap between the ratio of the underlying transportation service demand to the service available and quality of constructed roads on traffic safety issues [11]. Hence, poor provision of road infrastructure facility needs an immediate remedy as for having faster economic growth and allow safe or free movement of people and goods throughout the country. Traffic safety problems at adverse geometric design features, and complex disturbances related to visibility obstruction due to fog and smoke, i.e. more likely to occur at night are the common events in many areas along road cuts, hilly and mountainous regions of the highlands of Ethiopia [12].

The Southern nations nationality is region of Ethiopia causing sever road traffic accidents in the country. Detailed studies on the main trunk road segment from Allaba to Wolayita Soddo will give an opportunity to deal with problems and provide the best remedial measures for the effects of different road geometric parameters independently to minimize loss of life and property damages by defining a methodology to better understand road geometric features that lead to traffic accident through addressing the proposed questions using a Post-accident approach to find correlations between road geometric parameters and traffic accidents integrating with a statistical regression analysis method [13].

Currently, several measures of design consistency have been identified in the literature and models have been developed to estimate these measures. Yet little work has been undertaken to quantify the safety benefits of geometric design consistency.

Therefore, understanding of the nature and type of road traffic accidents and identifying the contributing effects of road geometric features has a paramount importance to implement remedial solutions for these disastrous problems on the subject area. In light of these, in this research it was tried to assess and avail information on traffic accidents and the effects of geometric design consistency of the Allaba–Wolayita Soddo Road segment

1.2. Statement of Problems

Several studies have been undertaken so far throughout the world to identify the effect of road geometric factors on traffic safety related to human lives and severe property damages. In recent years, road traffic accident in Ethiopia is one of the worst accident records in the world, as expressed per 100, 000 vehicles.

Many of the major rural roads of the country have experienced an increase in the severity and extent of traffic accidents over considerably visible stretches. However, causes of traffic accidents in Ethiopia are limited only to traffic police officials and are mostly reported as the problem of drivers and passengers with little consideration of road and road environment factors due to lack of skill and experience about the effect of road constituents on traffic safety. Accidents might be improperly contributed to other factors like speed or careless driving, but some roads just weren't designed to be safe in geometry. Geometric design deficiencies on existing roads would lead to a potential accident, such as an accident happens at the sharp curves, layered pavement conditions, and inconsistency sections

Inadequacy of the design speed concept is the main source of deign inconsistency. It is inherited in geometric design standards which are developed based on the design speed concept. The concept has been in use still in Ethiopia Road Authority geometric design standard manual. When a driver negotiates a circular horizontal curve at constant speed, the vehicle experiences centrifugal acceleration acting away from the center of the curve, which is counteracted by the centripetal acceleration provided by a side friction between the tires and pavement and by a component of gravity if the road is super elevated.

The relationship is $e + f = v^2/127R$……..1.1

Before establishing the e, f and R required to provide sufficient centripetal acceleration, the design speed must be determined first

The design speed concept assumes that the motorist would choice an operating speed which less than or equal to the design speed. This assumption may not be in accordance with reality. Drivers adjust their speed according to a number of factors including their desired speed, the posted speed, traffic volume and their perceived alignment risk.

1.3. Objective of the Study

General Objectives

The general objective of the study is to assess the effects of the road geometric design consistency on the road safety with possible changes in Accident rate on two way rural roads

Specific objectives

The specific objectives of this study

- To investigate locations with high road traffic accidents in Allaba-Wolayita Soddo Road Segments.
- To identify inconsistent Sections in Allaba-Wolayita Soddo Road Segments.
- To quantify the relationship between the rate of traffic accident (AR) and geometric design inconsistency

1.4. Limitation of The research

The scope of the study was limited to horizontal curves on two-lane trunk roads. Multi-lane highways was not included Since they are limited in numbers and inconsistency in the geometric design of these highways does not lead to hazardous conditions similar to those of two- lane highways.

The terrain type covered in this study was also not include Escarpment

Operating speeds of different vehicle classes (Passenger cars, Buses and Trucks) was observed only under dry day time condition.

1.5 Significance of the Study.

Now a day's traffic Accidents has a serious effect on once country development so, without a doubt the research on determining design consistency effect on traffic Accident has a wide range of significance for both the researcher and Road Authorities to evaluate their Design manuals problems.

This research will initiate to develop the criteria to evaluate Road design consistency in the country. It is used to identify a section of Road to be maintained or repaired due to high accident related to inconsistency

Determining inconsistent section and relating with accident shows the existing situations and using these result we can predict what will happen in the future

1.6 Research Outline

The thesis work is organized in five chapters and associated Annex.

The first chapter is an introduction that includes back ground, statement of the problem and objectives and significance of the study as well as the overall thesis outline.

Chapter two covers the review of the main related facts from references used in the study and review of earlier studies. The various studies conducted in specific parts of the entire study area are well described and used in the study.

Chapter three gives a general description of the study area. This includes location, climate, and land Use/land and cover. Also describes data input for analysis used in the study with clear methods of collection. This chapter also briefs the methodology to be followed to address objectives of the study.

Chapter four is about result and discussion. And the last chapter, chapter five, is concerned with conclusions and recommendations.

Finally, annex in the form of tables and figures and serving as a supporting document to this thesis are attached to make the work a complete one.

CHAPTER 2 LITERITURE REVIEW

2.1 Geometric Design Consistency

The notion of using design consistency as a means of assessing roadway safety is not a novel one. Transportation professionals have long recognized the need to design roadways in a consistent manner; however, the manner in which they define "design consistency" has been subject to substantial discrepancy. Design consistency implies that the roadway does not violate the expectancy of the driver or impede their ability to guide and control their vehicle in a safe manner But It makes sense intuitively that drivers will make more errors at geometric features that violate expectations than those that conform to their expectations [14]. In order for a design to be considered inconsistent, however, it must possess a geometric feature or a combination of adjacent features, that violates driver expectations; which in turn, may surprise drivers and possibly make them drive in an unsafe manner [15].

Design consistency is the conformance of geometry of a highway with driver expectancy, and its importance and significant contribution to road safety is justified by understanding the driver–vehicle–roadway interaction. The roadway geometry, traffic conditions, and roadside environment are the primary inputs to the driving task that determine the workload requirement of the driver. How quickly and how well these inputs are handled depend on driver expectancy and other human factors. Once these inputs are processed, they are translated into vehicle operations. When an inconsistency exists that violates driver's expectation, the driver may adopt an inappropriate speed or inappropriate maneuver, potentially leading to accidents. In contrast, when design consistency is ensured, all abrupt changes in geometric features for contiguous highway elements are eliminated, preventing critical driving maneuvers and minimizing accident risk [19]

The inconsistencies that exist on a roadway can produce a sudden change in the characteristic of the roadway, which can surprise motorists and lead to speed errors. These speed errors result in critical driving maneuvers for motorists and an unfavorable level of accident risks. An inconsistency in design can be defined as "a geometric feature

or combination of adjacent features that have such unexpectedly high driver workload that motorists may be surprised and possibly drive in an unsafe manner." [19]

However, the term highway "section" is readily hard to define. A driver's expectancy is not merely limited to their experiences on the preceding segment of road; expectancy can be developed over a driver's career, or at the very least, their career within a certain region. Therefore a multifaceted definition of design consistency as the "conformance of a highway's geometric and operational features with driver expectancy." [20]

The purpose of this study is to directly quantify the effect of design consistency measures in a way that relates it to geometric features. Since the exact measures of design consistency that are used in this study have not yet been illuminated, it would not be prudent to assume a definition of consistency that limited potential results. Although many studies have followed similar approaches to modeling design consistency, it is important to recognize the unique contributions of each. Some of the most common measures used to develop a relationship between roadway safety and geometric design consistency are discussed in the subsequent sections.

2.2 Potential Measures of Geometric Design Consistency

Most of the research and development of design consistency measures focuses on four main areas: operating speed, vehicle stability, alignment indices and driver workload [19].Attempts to learn about and to provide information to the designer regarding design consistency and driver expectancy have been the subject of several major research projects and reports. In general, they can be grouped into the following areas: vehicle operations-based consistency, roadway geometrics-based consistency, driver workload, and consistency checklists.

The most common vehicle operations-based consistency measure is operating speed, although other methods such as conflicts and accidents have been suggested. A method for using operating speed as a consistency check is to predict speed using a speed profile model.

Roadway geometrics-based consistency focuses on evaluating the consistency of the design using only information that would be typically available from a set of roadway

plans. Driver workload assumes that there is a relationship between the effort required to perform a task and the roadway geometrics presented during that performance. Checklists largely consist of reminders to designers to examine design features for possible expectancy violations. Following is a brief summary of these different types of design consistency approaches

2.2.1 Operating Speed Consistency

Operating speed is a common and simple measure of design consistency. It is defined as the speed selected by the driver when not restricted by other users, i.e. under free-flow conditions, and is normally represented by the 85th percentile speed and denoted as V85.The difference between operating speed and design speed (V85-Vd) is a good indicator of any inconsistency at a single element whiles the speed reduction between two successive elements (change in V85) can identify any inconsistency experienced by drivers when travelling from one elements to next.

The safety of a road is closely linked to variations in the speed of vehicles travelling on it. These variations are of two kinds:

1. Individual drivers vary their operating speeds to adjust to features encountered along the road, such as curves, intersections, and accesses in the alignment. The greater and more frequent are the speed variations, the higher is the probability of collision.

2. Drivers travelling substantially slower or faster than the average traffic speed have a higher risk of being involved in collisions. A designer can therefore enhance the safety of a road by producing a design that encourages operating speed uniformity. Traditional North American design methods have merely ensured that all design elements meet or exceed minimum standards, but have not necessarily ensured operating speed consistency between elements.

Practices used in Europe and Australia have supplemented the design speed concept with methods of identifying and quantifying geometric inconsistencies in horizontal alignments of rural two-lane highways. In addition, recent research work in Canada and the United States has addressed design consistency for combined (horizontal and vertical) alignments. The focus of this work is on two-lane rural highways. These methods have not been perfected, particularly in predicting the performance of a newly

designed road. Their effectiveness is greater in evaluating existing roads and identifying priority improvements to reduce collision rates.

The most commonly used method to evaluate road consistency was developed based on mean accident rates. They presented two design consistency criteria related to operating speed, which include the difference between design and operating speed and the difference between operating speeds on successive elements.

Table 2-1: Design Evaluation Criteria based on Safety criteria I & II (Table 2.1) show the most common set of criteria used to determine the level of consistency of a highway section in relation to operating speed [16]

Consistency rate	Criteria I (Km/h)	Criteria II(Km/h)	Evaluation
Good	$\|V_{85}-V_D\|<10$	$\|V85_i-V85_{i+1}\|<10$	Consistency exists
Fair	$10<\|V_{85}-V_D\|\leq 20$	$10<\|V85_i-V85_{i+1}\|\leq 20$	Minor inconsistency exist
Poor	$\|V_{85}-V_D\|>20$	$\|V85_i-V85_{i+1}\|>20$	Strong inconsistency

Note: $V85_i$ and $V85_{i+1}$ are operating speeds on elements i and $i + 1$ respectively

The Table above classifies highway sections into three categories. Where, Good = no highway alignment corrections are required; Fair = no alignment correction is required, but corrections may be desirable to signs, camber etc.; and Poor = alignment redesign is recommended.

2.2.2 Alignment Indices

Alignment indices are quantitative measures of the general character of a roadway segment's alignment that appear to have several conceptual advantages for use in design consistency evaluations. If logically formulated, they should be easy for designers to use, understand, and explain. They would be a function of the dimensions of horizontal and/or vertical alignment elements. Therefore, they would provide a mechanism for quantitative assessment of successive elements from a system-wide perspective, which is fundamental motivation of design consistency research.

Alignment indices should also attempt to quantify the interaction between the horizontal and vertical alignments that is missing from current design policy. Under AASHTO design guidelines, horizontal and vertical alignments are usually designed separately to

meet certain criteria and are then brought together. Although it is assumed that design consistency will be maintained, this assumption is not always valid.

A simpler approach to evaluate design consistency can be based on the alignment indices which are quantitative measures of the general character of an alignment in a section of road. Examples of alignment indices include average radius (AR), ratio of maximum to minimum radius (RR), average rate of vertical curvature (AVC) and the CRR that is defined as the ratio of radius of a single horizontal curve to the average radius of the entire section. Analyses of collisions on the two-lane rural highways have shown that a significant relationship exists between collision frequency and alignment indices [22]

The initial step in determining alignment indices consisted of identifying all possible indices that could be useful for this research. Therefore, some of the alignment indices that had been used in other countries or proposed for use were included. Additionally, other indices thought to have some potential were developed.

Table 2-2: Alignment indices selected for evaluation (Wooldridge, 2000)

Horizontal Alinement Indices

• Curvature Change Rate - CCR (deg/km)

$$\frac{\sum \Delta_i}{\sum L_i}$$ where:
Δ = deflection angle (deg)
L = length of section (km)

• Degree of Curvature - DC (deg/km)

$$\frac{\sum (DC)_i}{\sum L_i}$$ where:
DC = degree of curvature (deg)
L = length of section (km)

• Curve Length: Roadway Length - CL:RL

$$\frac{\sum (CL)_i}{\sum L_i}$$ where:
CL = curve length (m)
L = length of section (m)

• Average Radius - AVG R (m)

$$\frac{\sum R_i}{n}$$ where:
R = radius of curve (m)
n = number of curves within section

• Average Tangent - AVG T (m)

$$\frac{\sum (TL)_i}{n}$$ where:
TL = tangent length (m)
n = number of tangents within section

Vertical Alinement Indices

• Vertical CCR - V CCR (deg/km)

$$\frac{\sum A_i}{\sum L_i}$$ where:
A = absolute difference in grades (deg)
L = length of section (km)

• Average Rate of Vertical Curvature - V AVG K (km/percent)

$$\frac{\sum \frac{L}{|A|}}{n}$$ where:
L = length of section (km)
A = algebraic difference in grades (%)
n = number of vertical curves

• Average Gradient - V AVG G (m/km)

$$\frac{\sum |\Delta E_i|}{\sum L_i}$$ where:
ΔE = change in elevation between VPI_{i-1} and VPI_i (m)
L = length of section (km)

Composite Alinement Indices

• Combination CCR - COMBO (deg/km)

$$\frac{\sum \Delta_i}{\sum L_i} + \frac{\sum A_i}{\sum L_i}$$ where:
Δ = deflection angle (deg)
A = absolute difference in grades (deg)
L = length of section (km)

2.2.3 Driver Work Load

As explained previously, the roadway, the vehicle, and the driver interact in an interrelated manner. Therefore, it is logical to include driver workload as a measure of design consistency. Driver workload can be defined as the time rate at which drivers must perform the driving task that changes continuously until it is completed [15]. Both the time available to perform the task and the complexity of the driving environment considerably affect the mental effort required.

Conceptually, driver workload can be a more appealing approach for identifying inconsistencies than operating speed because it represents the demands placed on the driver by the roadway, while operating speed is only one of the observable outputs of the driving task. However, the use of driver workload is much more limited than operating speed because of its subjective nature [34].

The driver is almost continuously processing visual and kinesthetic information, making decisions, and carrying out control movements. In other words, the task of driving involves, among other things, tracking the lane or path selected by the operator (driver). This action is a compensatory tracking task that requires a driver to visually evaluate the path ahead, predict the steering and speed control inputs necessary for maintaining the desired path, make the control inputs, then, using visual feedback, manipulate the controls to compensate for deviations. The tracking process continues until the vehicle reaches the desired destination or is otherwise brought to a stop.

Generally, little visual information processing capacity is required of the experienced driver to perform this basic task. This task is performed almost automatically if the roadway is free of traffic and obstacles and if the driver's visual evaluations are consistent with the tracking requirements. The presence of traffic, or the potential for obstacles, requires the operator to devote more processing capacity to visually evaluate the path ahead and to modify control input predictions

A consistent roadway geometry allows a driver to accurately predict the correct path while devoting little visual information processing capacity, thus allowing attention or capacity to be dedicated to obstacle avoidance and navigation.

A driver moving along a rural two-lane highway at design speed, with a certain amount of opposing traffic. It is a common-sense notion that the mental resources the driver brings to this driving task are finite. One cannot pay attention to everything at once. The driver is working at the control level (to use the Positive Guidance model) to steer the vehicle and perform the other tasks associated with second-to-second control, and at the guidance level to keep it on the nominal pathway constrained by the design of the facility and other factors, such as leading traffic [35]. This driver may also be allocating a certain amount of attention to wondering where he or she is (navigation level) while also attending to a radio talk show. Different models of attention allocation postulate either somewhat parallel capabilities for dividing attention, or more classically contend that people rapidly shift their attention among the various demands, somewhat like a computer timesharing arrangement.[36] As demand for attentional resources increases, performance on some or all of the different activities that a driver is doing tends to degrade. At the same time, as mental workload increases, different body functions and physiological processes also change in response to the "stress" that any kind of workload, mental or physical, brings. Some of these performance changes and physiological responses are easily measured. Others are rather difficult, especially in an actual driving situation.

There are five basic criteria for workload measures, in addition to the fundamental feeling of being loaded, however assessed:

1. Sensitivity: the measure should have a high signal/noise ratio.

2. Diagnosticity: the measure should be an indicator of the type of resource that is being stressed, e.g., physical vs. mental, visual vs. auditory, etc.

3. Selectivity: the measure should not be confounded with physical or emotional stress.

4. Obtrusiveness: the measure should be as transparent to the driver as possible. Ideally, the driver should not know he/she is being assessed, although this is normally unavoidable given human subject guidelines and requirements. The only countermeasure is sufficient acclimatization (a judgment call) to minimize interference effects from being a subject.

5. Compliance: the measure should track changes in workload rapidly enough to capture transient phenomena. [36]

2.2.4 Vehicle stability

Another method to evaluate design consistency is the study of vehicle stability. When insufficient side friction is provided at a horizontal curve, vehicles may skid out, rollover or be involved in head-on Crashes. According to this statement, locations that do not guaranty enough vehicle stability can be considered as geometric design inconsistencies. In this sense, a design consistency criterion which includes the difference between the assumed side friction of the road and the side friction demanded by the driver.

The difference between side friction assumed (f_{RA}, that depends on the design speed) and demanded (f_{RD}, that depends on the operating speed), denoted as Δf_R, was used to represent vehicle stability. According to this criterion, consistency is considered good when Δf_R is higher than or equal to 0.01, fair when its value is between 0.01 and -0.04, and poor when Δf_R is lower than -0.04. The consistency evaluation criterion for Δf_R, to predict the side friction assumed are dependent on either the operating speed or design speed of an element [23]

Table 2-3: Design Evaluation based on Safety criteria III shows the most common set of criteria used to determine the level of consistency of a highway section [16]

Consistency rate	Criteria III	Evaluation
Good	$\Delta f_R \geq 0.01$	Consistency exists
Fair	$0.01 > \Delta f_R \geq -0.04$	Minor inconsistency exist
Poor	$\Delta f_R < -0.04$	Strong inconsistency

Note: $\Delta f_R = f_R - f_{RD}$, where f_R and f_{RD} are side friction assumed and demanded on element *i*, respectively.

The Table above classifies highway sections into three categories. Where, Good = no highway alignment corrections are required; Fair = no alignment correction is required, but corrections may be desirable to signs, camber etc.; and Poor = alignment redesign is recommended

Vehicle stability is an important measure of Design consistency. when a horizontal curve lacks vehicle stability, meaning its friction assumed is insufficient, vehicle may slide out or be involved in head on collisions.

When a road way lacks vehicle stability, it violates drivers' expectation and their ability to guide and control the vehicle in the safe manner, thus can be considered as a geometric design inconsistency. As such, assessing vehicle stability can help identify inconsistent locations. The difference between side frictions assumed and side friction demand, which is denoted as change Δf_R is used to represent

Accounting for vehicle stability in highway design is an important issue to ensure safe traffic operation. Excessive centrifugal forces experienced on a vehicle moving on a horizontal curve may lead to vehicle roll-over.

In current design practice, the centrifugal force is balanced by the side friction between the vehicle's tires and the pavement and the weight component resulting from the super elevation according to the following model [24]

$$R = \frac{V2}{127(e + f)} \quad \text{..... 2.1}$$

Where

R = radius of curve (m); V = vehicle speed (km/h); f= side friction factor; and e = super elevation rate.

Several safety problems can be found in this practice regarding vehicle stability. For example, the effect of a vertical curve or grade combined with a horizontal curve has not been considered. First, the vehicle is represented by a point mass rather than a body; thus, the variation in the distribution of friction forces between different tires is not considered. Second, the formula assumes that the vehicle moves with a constant speed and that drivers follow a path with a certain radius equal to the curve radius that may not be true [25].

Alignment indices are a quantitative approach to evaluate design consistency based on vehicle stability that was represented by the difference between side friction supply and side friction demand. Studying 197 horizontal curves, the values of side friction supply f were determined for each curve from Table III-6 of the AASHTO guide [26].

The values of side friction demand f_{RD} were calculated for each curve using the AASHTO formula of 19 as follows:

$$f_{RD} = \frac{V_{85}^2}{R} - e \quad \ldots\ldots\ldots\ldots\ldots\ldots 2.2$$

Where f_{RD}= side friction demand; and V_{85} = observed operating speed (km/h).

2.3 Geometric Design Consistency and Relationship to Road Safety

One of the main reasons for accident occurrence can be lack of geometric design consistency, defined as the degree to which highway systems are designed to avoid critical driving maneuvers and ensure safe traffic operation. Also, a consistent highway design ensures that successive geometric elements act in a coordinated way, so that they produce harmonized driver performance without surprising events [27].

Design consistency implies that the design or geometry of a road does not violate either the expectation of the drivers or the ability of the motorist to guide and control a vehicle in a safe manner [28]. Keeping a roadway consistent in design is important because it is believed that drivers make fewer errors at geometric features that conform to their expectations than at features that violate their expectancies [29].An inconsistency in design can be defined as "a geometric feature or combination of adjacent features that have such unexpectedly high driver workload that motorists may be surprised and possibly drive in an unsafe manner."[30]

A consistent alignment is important because the relationship that exists between consistency and safety. The inconsistencies that exist on a roadway can produce a sudden change in the characteristic of the roadway, which can surprise drivers and lead to speed errors. These design inconsistencies arise when the general character of alignment changes between segments of the roadway. A consistent alignment would ensure that "most drivers would be able to operate safely at their desired speed along the entire alignment."[31]

Design consistency refers to the conformance of the highway geometry to driver expectancy. Expectancy, in general, can be thought of as a set of possible probabilities regarding a given situation. Those probabilities are subjective and are based upon learned

and experienced events. An operational definition of expectancy with regard to transportation has been given by Ellis: “Driver expectancy relates to the observable, measurable features of the driving environment which:

(1) Increase a driver’s readiness to perform a driving task in a particular manner, and

(2) Cause the driver to continue in the task until it is completed or interrupted.

A similar definition provided was: “Expectancy relates to a driver’s readiness to respond to situations, events, and information in predictable and successful ways.”[28]

Design consistency is assessed in terms of drivers’ operating speed, while accident potential is estimated in terms of traffic and geometric characteristics. Since the accident prediction algorithm does not explicitly consider design consistency and no provision is given to relate the results generated from the two separate evaluations, the safety benefits of considering design consistency remain unknown

One of the main reasons for accident occurrence can be lack of geometric design consistency. This concept can be defined as how drivers’ expectancies and road behavior fit. Thus, a road with a good consistency level is the one in which its behavior and what drivers expect are very similar, so drivers will not be surprised while driving along them. A poor consistency means bad fitting, surprising events and also high speed variability along different road segments and among different drivers, which may increase the likelihood of crash occurrence.

2.4 Models for Evaluation of the Impact of Design Consistency on Road Safety

Design consistency is assessed in terms of drivers’ operating speed, while accident potential is estimated in terms of traffic and geometric characteristics. Since the accident prediction algorithm does not explicitly consider design consistency and no provision is given to relate the results generated from the two separate evaluations, the safety benefits of considering design consistency remain unknown.

Foldvary (1979) and Jovanis and Delleur (1983) have used simple models using mean and variance. These models are used to study variations in accident rates for different

levels of exposure. These models are not able to incorporate the effect of risk factors on accident involvement.

In Oppe (1979) and Ceder and Livneh (1982) multiple linear regression models are used. In these models the dependent variable (either number of accidents or accident rate) is a function of a series of independent variables such as speed or traffic volume. Accident occurrence in these models is assumed to be normally distributed. These models generally lack the distributional property that is necessary to describe adequately the random and discrete vehicle accident events on the road and they are inappropriate for making probabilistic statements about accident occurrence.

Researches have investigated the relationship between design consistency and safety using log linear regression models. Their objective is to demonstrate explicitly that design consistency is indeed related to safety. Two models have been developed that relate accident frequency to traffic volume, curve length, and speed reduction ($\Delta V85$). A separate model has been developed that relates accident frequency to curve length and CRR. The models are shown below [32]

$Y = \exp(-7.1977)\ \mathrm{AADT}^{0.9224} \times L\mathrm{cr}^{0.8419} \exp(0.0662\Delta V_{85}) \quad [R^2 = 0.195]$

$Y = \exp(-0.8571)\mathrm{MVK} \exp(0.0780\Delta V_{85})\ [R^2 = 0.156]$

$Y = \exp(-5.932)\mathrm{AADT}^{0.8265}\ L\mathrm{cr}^{\ 0.7727} \times \exp(-0.3873\mathrm{CRR})\ [R^2 = 0.196]$

Where Y is the number of accidents that occurred on the horizontal curve during a 3-year period, AADT is the annual average daily traffic (vehicles per day), and MVK is the exposure (million vehicle-kilometers. of travel for a 3-year period).

Other models which show the relation between design consistency and safety was developed by Joanne C.W. Ng and Tarek Sayed [33]

$\text{Accidents per 5 years} = \exp(-3.159) \times L^{0.8898}\ V^{0.5906} \exp(-0.3606\mathrm{CRR})$

$\text{Accidents per 5 years} = \exp(-3.380)\ L^{0.8920} \times V^{0.5913} \exp[0.009091(V_{85} - V_{\mathrm{d}})]$

$\text{Accidents per 5 years} = \exp(-3.796) \times L^{0.8874}\ V^{0.5847} \exp(0.04828\Delta V_{85})$

Where L-section length (km); *V*-annual average daily traffic (vehicles/d); $V_{85} - V_d$,-difference between operating and design speed (km/h) of a single element

Although these equations are useful, consistency measures such as vehicle stability and driver workload are not considered. Also, no attempt has been made to combine several consistency measures in one model. Models which incorporate several consistency measures can be useful to predict the safety impact of improving design consistency in terms of accident reduction

This research used a comprehensive accident and geometric design database to investigate the effects of several design consistency measures on safety and to develop models that incorporate the measures to quantify their effects on safety.

CHAPTER 3 MATERIALS AND METHODOLOGY

This chapter deals with the description of the methodology followed for conducting different techniques to identify inconsistent Section and evaluate the effect of geometric design consistency on the safety of selected road sections to develop regression model for two lane trunk roads. It comprises an outline of the general steps followed, methodology of study sections, sources of data and data collection used in this work.

3.1 Research Approach

The research was achieved by a combination of literature review, and Geometric design and AADT were obtained from Ethiopian Road Authority and traffic accident data obtained from traffic police.

Many traffic Crashes are the product of several factors such as human error, surrounding weather conditions, vehicle characteristics and road conditions. However, this study concentrates mainly on the rate of traffic Crashes occurring on geometric design consistency of the road. Road geometry external factors to the roads environment such as drivers' behaviors, Vehicle characteristics were not explored in this study due to time, space and availability of data to cover all problems. Vehicles speed data was collected to determine consistency of the section using operating speed and Design speed value. Relationships were developed to bind road geometric design Consistency characteristics to Crash data in order to determine a correlation between change in radius of curve, super elevation and Crash frequency (or, rate of traffic Crashes). Single and Multiple regression analysis models are used to analyze the dynamics of changes, variations and interruptions in road traffic Crashes and road geometric design consistency of the subject trunk-road segment selected for the case-study from Allaba – Wolayita Soddo

3.2 Location of Study Area

3.2.1 Location and Accessibility

The site selection criterion was developed in order to identify potential study sites. Preliminary three characteristics were selected: annual average daily Traffic (AADT), Availability of geometric As-built data, and pavement conditions. The first step was to obtain AADT values from the Ethiopian Road Authority (ERA); highways with AADT between 1,000 vehicles per day (vpd) and 10,000 vpd were identified as potential study sites. This range of values was selected in order to increase the probability of collecting data from free-flow vehicles. As built data were very useful in identifying rural areas and highway segments with a wide variety of horizontal curve radii. The third and last step was to perform field visits in order to corroborate whether the potential sites were indeed appropriate for the research study; this included highway segments in good pavement conditions and free of signalized intersections.

Table 3.1 shows the selection criteria developed to identify appropriate highway segments to be included in the study [17]

Selection characteristics	**Criteria**
AADT	1000-10,000 vpd
Zone descriptions	Rural
Posted speed limit	35Km/h or higher
Terrain	All types
Pavement condition	Surface in good condition
Pavement surface type	Flexible
Access control	No signal intersections
Cross section	Two-lane, two way
Slope	No restrictions

Source: Speed and Design Consistency of Alignments in Two-Lane Rural Roads

The study was conducted on the already existed two way two lane road that has been fulfilled the above criteria and substantially constructed during the different road sector development phases of the country which had a well-recorded history of remarkable traffic safety problems at adverse geometric locations particularly from Allaba-Wolayita Soddo section. Through the investigation of a 130 km Section of national highway connecting Wolayita Soddo to the Shashemane , Hawassa and the capital of SNNPE, this study aims to evaluate the consistency of existing road network for smooth transportation of goods and people along Allaba – Wolayita Soddo road segment.

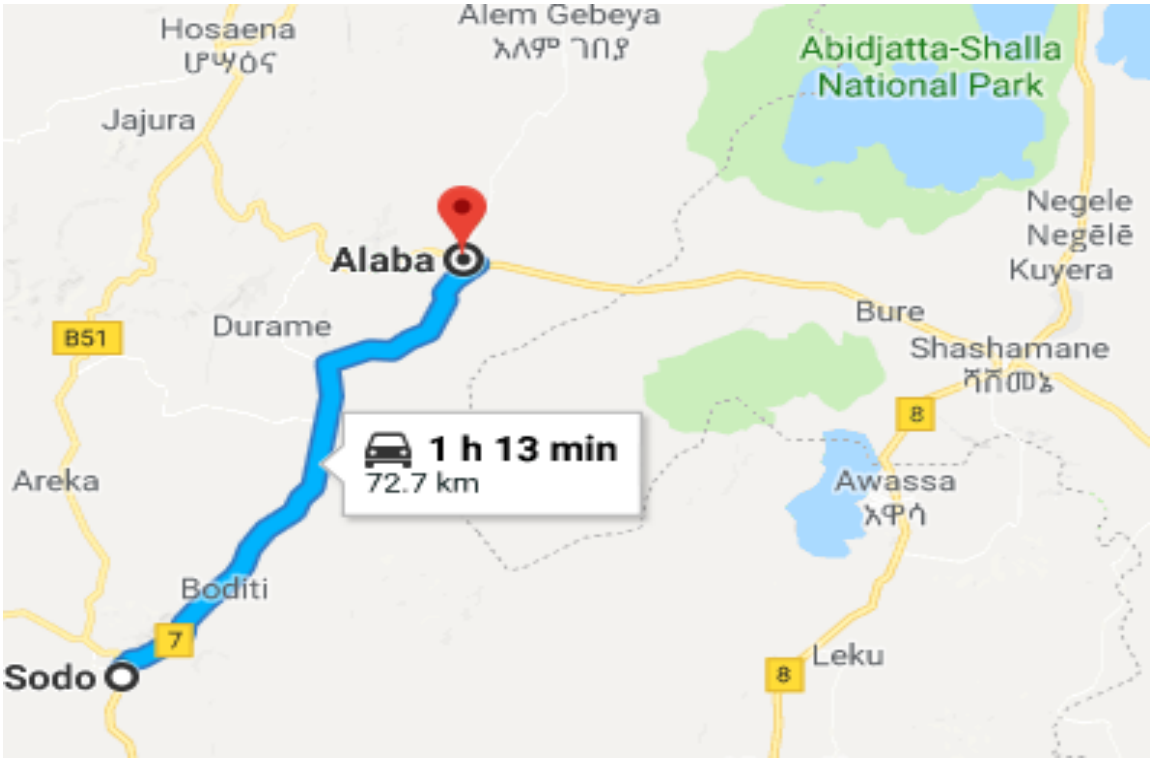

Fig.3-1: Location of the study area (Source: Google Earth, 2018).

It is located between Allaba special Woreda and Wolayita Soddo town, the capital of Wolayita Zone, at a distance of about 292 Km from Addis Ababa and 7° 00' North latitude and 37° 45' East and 1,500 – 2,800 m above sea level at the edge of the East African Great Rift Valley. Inhabitants of the Wolaita Zone are primarily the Wolaita ethno-linguistic communities (Google Earth, 2018). The Road connects Wolayita Soddo and Allaba Towns passing through different kebeles and villages having ample raw material resources for Construction and are predominantly agriculturalists, practicing mixed crop-livestock production and living in permanent settlements. Within their landholdings, community members maintain fruit orchards, nurseries, medicinal plants, vegetables, root and tuber crops, ornamentals, spices, as well as open areas for raising domestic animals.

3.3 Data Collection and Sampling Techniques

Since Non-probability sampling represents a group of sampling techniques and has free distribution that help researchers to select a unit sample from a population, purposive sampling method was adopted for this study. Data was also analyzed and interpreted using both descriptive (i.e., case reports on traffic Crashes, road geometric study) and statistical methods of approach. For evaluation of the effects of road geometric Consistency, a five year Crash data was collected from police commission reports until the end of year 2009 E.C

The existing geometric design consistency and traffic Crash data have been used to find statistical correlations between road geometric consistency and accident rates. The road data is from the Ethiopian Road Authority (ERA) while Crashes were collected from traffic police commission offices recorded in a database system. After choosing an area and a period of investigation the analysis method was designed in following phases:

- Road Traffic Crash was collected from Wolayita Soddo and Bodti Traffic Police commission offices
- Road geometric design data was collected from ERA as built road design values
- Spot speed data was conducted for 50 horizontal curves at twelve sections and used to determine geometric consistency
- Locations with high Crash frequency was investigated and combined with the road geometric design inconsistency sections data,
- Data was statistically analyzed and interpretation of results were made
- Conclusion and Recommendations have also been stated with Possible suggested values as future areas of work.

For evaluation of the effects of the road geometric parameters, statistical regression technique was adopted, for the results to be considered significant, final regression equations have a regression coefficient of R^2 i.e. Significant at the 0.05 level for simple regression analyses and different from 0 at the 0.05 level for multiple regression. For every reported Crash data the following information have been recorded databases: Crash ID, date, type, place and description, number of killed, severe and light injuries, weekday, time, road condition (wet, dry or snow), lighting conditions etc.

To take advantage of the databases for traffic safety purposes, geometric measurements at Crash locations have been extracted and recorded together with the traffic Crashes for further analysis.

There are two types of Study variables that are taken into consideration:

Independent Variables**:** Variation of Speed, Side friction, Radius, Super elevation, combination of geometric elements in Sections of the road

Dependent Variables**:** Rate of Road Traffic Crash or Road Traffic safety

3.4 Methods of Data Collection and Materials

The materials used for this research are: - SPSS to develop Analysis statistical relation, Digital camera and measuring tape, and Stop watch

Data collection process to conduct the research is both quantitative and qualitative data types. In this study both primary and secondary data source was used. The research was conducted first by identifying the main road geometric consistency.

Secondary data was collected through reviewing the existing relevant documents, reports, literatures whereas primary research data was collected through site visits, and direct measurements at Crash locations have been extracted and recorded together with the type of Crashes occurred for further analysis.

Quantitative as well as qualitative data types have been employed. The data needed for this work was collected from both primary and secondary sources. The study was achieved by a combination of literature review, and analysis of road geometric, traffic

and Crash data obtained from ERA and Police Commission offices of include Wolayita Soddo Districts. It specifically comprised of time series data on yearly road traffic Crashes and corresponding As- built road geometric design values for the path from include Allaba – Wolayita Soddo covering the periods from 2005 to 2009. For the collection of these primary data, this research made use of tape meter and Stop watch.

The data was collected as soft copies, hard copies and maps. Additional data was also used for the verification of the collected primary data sources from Google earth through internet and some were modified and presented in the form of tables and figures for practical analysis purpose

3.4.1 Geometric Design Data

It is well known that one of the major factors which affect the rate of traffic Crash and traffic safety is the effect of road geometric consistency variation on the speed of traffic movement and mode of vehicular maneuver.

Turning movements on sharp curve areas are known to generate overturning, out of control and maneuvering problems at the road surface, which can lead to severe crashes and property damages. The main criterion considered during the selection of sections within the trunk-road segment to be evaluated was the requirement of hazardous road geometrical setups and common occurrence of traffic Crashes pertinent to the statistical correlation analysis. For this purpose, operating Speed measurements were made on a number of locations, in which the source of traffic Crash was deemed and verified to be road geometric design factors.

Hence, the selection of specific sections of road to be evaluated was desired to ensure consistency in this regard. To this effect, as shown in table 3.1 below most of the sections selected for evaluation are on curves (radius varying from 45m to 600m). The data is obtained from Ethiopian Road Authority it is used to select the site with the design inconsistency. The data which is used for the selected site is summarized from As-built data as follows

Another criterion considered was the requirement of several road geometric constituents relevant to the statistical correlation analysis. For this purpose, measurements were made on a number of locations, in which the source of traffic Crash was deemed and verified

by the aforementioned criteria to be the road geometric characteristics. Out of the various locations, twelve sections having frequent Crash occurrences were selected within Road segment where Crashes were expected to happen, as shown in table 3.2 below. The chosen parameters were Tangent, Horizontal Alignment (Radius), Super-elevation and other Traffic safety features.

The following geometric components were collected from the given as-built road alignment design values at locations where traffic police has already ranked as dangerous sub- sections.

Table 3-2: Details of As-built geometric Design outputs

No.	Stations		T	R	L	C	e	Design speed
	From	To						
1	35+402.7	35+595.7	98.1	430	192.9	191.4	7.8	85
2	36+967.5	37+201.9	120	440	234.4	231.7	7.8	85
3	40+822.8	40+869.4	23.4	190	46.6	46.5	7.9	70
4	40+884.3	40+946.5	31.2	250	62	61.9	7.3	70
5	42+295.9	42+475.8	91.7	370	179.8	178	5.7	70
6	42+571.8	42+760.3	95	580	188.5	187.7	4.3	70
7	55+495.3	55+588.2	47	550	93.9	93.7	4.9	70
8	55+603.7	55+581.9	39.2	340	78.3	78	6.7	70
9	55+698.6	55+878.8	93.9	260	180	176.6	7.3	70
10	55+889.9	55+973	41.8	320	83.2	82.9	6.7	70
11	56+182.9	56+423	183	122	240	203	8	50
12	56+546.5	56+590.4	25.3	120	49.9	49.5	8	50
13	56+604.8	56+673.5	42.6	46	68.8	62.5	8	40
14	56+705.7	56+752.3	23.4	200	46.3	46.5	7.9	70
15	56+767	56+640.8	37.6	150	73.7	72.9	8	60
16	56+840.9	56+873.5	16.3	200	32.6	32.5	7.9	70
17	57+267.5	57+349	41	240	81.5	81.1	7.3	70
18	57+349	57+455	54.4	190	106	104.7	7.9	70
19	57+472.8	57+611.4	74.3	156	138.7	134	8	60
20	57+671.6	57+698.8	13.6	130	27.1	27.1	8	60
21	57+705.6	57+770.3	36	58	64.8	61.5	8	40
22	57+774.7	57+802.3	13.9	150	27.7	27.6	8	60
23	57+838.5	57+929.4	46.9	150	90.9	89.5	8	60
24	58+362.9	58+472.7	55.4	330	109.8	109.3	6.7	70
25	58+516	58+590.4	37.7	190	74	73	7.8	70
26	58+601.7	58+687.9	47	86	86.2	82.7	8	50
27	58+809.3	58+868.8	30	170	59.5	59	8	60
28	58+876.2	59+006	66	300	130	129	6.7	70
29	59+032.5	59+123	45.5	320	90.4	90	6.7	70
30	59+575.7	59+643.2	36.4	73	67.45	65	8	40
31	59+715.8	59+798.8	55.4	49	82.9	73.4	8	40
32	60+011.9	60+072.9	30.7	210	61	60.8	7.9	70
33	60+078	60+195.5	61	170	117	115	8	60
34	60+240.7	60+326.6	47.6	80	85.9	81.9	8	40
35	60+398	60+522	67	130	124	119	8	60
36	60+586	60+655.5	35	140	69	68.4	8	60
37	60+695	60+820	63	380	124	124	5.7	70
38	61+260	61+426.7	84.9	360	166.7	165.2	5.7	70
39	62+626.9	62+965.8	186	330	339.8	325	6.7	70
40	63+240.8	63+312	38.3	80	71.5	69	8	40
41	63+315.9	63+371	27.6	550	55.2	55.2	4.9	70
42	63+550.7	63+692	71	500	141.7	141.3	2.5	50
43	63+727	63+833	53	380	105.6	105.3	2.5	50
44	64+002.5	64+066.5	32	280	64	63.8	2.8	50
45	64+078.5	64+128.7	25.7	100	50	49.8	4	50
46	64+529	64+629.7	53	125	100.5	97.8	3.9	50
47	64+629.7	64+676.5	23.8	100	46.8	46.3	4	50
48	64+827	64+869.6	22.9	45	42.4	40.9	4	40
49	64+876.7	64+946	35.9	110	69.5	68.3	4	50
50	65+860	65+986.8	64.8	240	126.5	125	3	50

Source: Ethiopian road Authority (ERA), Soddo District Road Construction Corporation

Within a sections with high Crash values without less than 600Km radius the curve with less Radius value at a section was selected to identify inconsistency such sampling Locations are Buge, Fate and Kawo shafe

3.4.2 Traffic Data

The traffic movement on this road has increased greatly indicating an indication of socioeconomic activities in areas at or neighboring to the subject Road. The means of transportation has increased remarkably in the study area, which indicates that transportation of people and distribution of goods has also improved. Special noticeable was a decrease AADT traffic in 2007 due to the opening of Allaba-Hull Bergi road project that used to travel Addis Ababa from Wolayita soddo but traffic data was collected with rout of Allaba to shashemene.

Table 3-3: Traffic data of the study area during study period [shashemene - Soddo]

Vehicles Type	2005	2006	2007	2008	2009
Cars	9	19	23	28	35
Land Rover	139	192	160	180	190
Small Buses	216	275	217	270	297
Large Buses	100	104	175	195	205
Small Trucks	143	198	153	162	180
Medium Trucks	193	192	185	190	198
Heavy Trucks	112	130	147	152	192
Truck-Trailers	109	145	173	185	199
Total	1019	1255	1233	1262	1396

Source: Traffic Survey and Safety Measures Report of Ethiopian road Authority

3.4.3 Accident Data

The accident data which has been collected for this research includes accidents that occurred on a two-lane road segment from two police stations over the five-years study period and police commission offices have provided accident reports as paper copies from 2005-2009 E.C.

Based on this only Geometric feature related Accident data collect for this study purpose was stated at the appendix E

The police report data for an accident was a brief outline which gave information including date and time, location of accident, vehicles involved, vehicle information as well as driver, passenger and pedestrian information, a summary of the accident and

accident scene diagram or traffic accident plan, and the final rest positions of the vehicles.

These reports have various codes for the vehicle type, alcohol and drug use, safety equipment used, severity level, road conditions (wet, dry or snow) at the time of accident, traffic control devices present, contributing causes concerning the driver/pedestrian and other similar information, all of which is intended to aid traffic police officers in explaining the accident events.

To take advantage of the database for traffic safety purposes, geometric consistency at accident locations have been extracted and recorded together with the traffic accidents for further analysis.

To enable systematic analysis of the road crash problem at any location, the following information about each crash is required

Where crashes occur: location by map co-ordinates, road name, road classification, and road Layout and type of traffic control;

When crashes occur: by year, month, and day of month, day of week and time of day;

Who was involved: people, vehicles, animals, and roadside objects?

What was the result of the crash: fatal, personal injury, or property damage; and

What were the environmental conditions: light condition, weather and pavement surface condition; and how (or why) did the crash occur.

Therefore, road accident data were collected from Wolayita Soddo and Bodti Police Commission booklet compiled by traffic police officers during 2005-2009. From these, the collected data include;

- Location, name and classification of the road & intersection;
- Location type of the area that is nearest for religious, recreation, hospital, residential, open area, asphalt plant, pedestrian crossing, narrow bridge culvert, and others;
- Date, month, years, day of the week, time, Holiday.

- Light conditions(day light, dark hour with good, street, dark hour with poor street light, dark hour with no street light);
- Weather condition (fine, moist, cloudy, light rain, heavy rain, hot, cold wind, other);
- Classification of the accident (fatal, serious injury, light injury, property damage only);
- Involvement (pedestrian, animal and other objects);
- Nature of the accident (over turning, head-on collision, rear-end collision);
- Name, sex, age, education, address of the driver, type and license number.
- Vehicle involved (load, vehicle defect / brake, steering tires and other);and
- Other than drivers involved in accidents (age, status).

From Table 3.4 below, it could be seen that 124 accidents were happened with Trucks Vehicle Such as Small Trucks, Large Trucks and Truck-Trailers from 2005 to 2009 which constitute 37.8% of the total number of road traffic accidents in the five-year analysis periods.

This was followed closely by Passenger Vehicles such as land rover, mini buses, car, pick-up etc. constituting 37.2% with a total of 122 accidents. Buses were the third from the list of type of vehicles with a total of 82 traffic accidents in the same analysis period.

Table 3-4: Number of accidents observed through various types of vehicles in study period

Types of Vehicles involved	**Accidents occurred each analysis period**						
	2005	2006	2007	2008	2009	Sum	%
Passenger Vehicles	20	29	34	23	16	122	37.20
Buses	13	7	17	23	22	82	25
Trucks	25	26	29	26	18	124	37.80
Total	58	62	80	72	56	328	100

Source: Police Commission, Bodti and Wolayita Soddo Road Traffic Accident Statistics Office

Table 3.5 below shows the yearly variation in accident's severity of the subject road during the analysis periods. It is observed that severity of accidents are increasing relatively in most of the years. However in 2004 the degree of accident severity was relatively low and almost twice as high in the year 2007. It was due to an increase in the no of vehicles, bad traffic environment and increase in night driving. Injuries are the dominating types of accidents constituting the highest variation in accident's severity.

Table 3-5: Annual Variation of accidents by their degree of severity.

Year(E.C)	**Total number of Accidents**	**Fatal**	**Injuries**	**PDO**
2005	58	12	31	15
2006	62	11	28	23
2007	80	14	48	18
2008	72	19	32	21
2009	56	13	24	19
Percentage (%)	100	21	49.70	29.3
Total	**328**	**69**	**163**	**96**

(**Source**: Police Commission, Bodti and Wolayita sodo Road Traffic Accident Statistics Office).

The most important feature of Table 3.3 is that the number of people who were killed by road accidents in the subject road seems to be increasing as years go by except that there were a decrease in fatal, slight and serious in 2006 and 2009.

3.4.4 Speed Data

In order to obtain information from vehicles those were solely influenced by highway geometric characteristics and design consistency at selected locations of road segment

The operating speed at horizontal curves with small radius and posted speed of 35mph were selected at a distance of 30m and for more radius 50m was used

The location for the speed measurements differed for each site because of the existing geometry and traffic control. The speeds were measured separately for three different vehicle types: Passenger Cars, Buses and Trucks.

Table 3.6: Vehicle Classification by class

Passenger Vehicles	Car	Cars & minibus
	Land rover	Land Rover, jeeps, wagon and land cruiser
Buses	Small Bus	Up to 27 passenger seats
	Large Bus	Over 27 passenger seats
Trucks	Small & Light Trucks	3.5 tons load
	Medium sized trucks	3.6 tons to 7.5 load
	Trucks & Tankers	7.6 to 12 tons load
	Truck trailers & tanker	Above 12 tons

(**Source**: Road Asset Management and Contract Implementation Coordinate Directorate).

Spot speed data were gathered using stopwatch method

During the data collection in stopwatch spot speed study five key step was used:

1. Appropriate study length was obtained using posted speed limit which was 30m
2. Proper location and layout was selected.
3. The elapse time observations data was recorded on stopwatch form.
4. Vehicle speeds were calculated.
5. The frequency distribution table was generated for each stations and 85^{th} speed percentiles was determined.

1. Obtain Appropriate Study Length

The study length is important because it was used in the calculation of vehicle speeds. Table 3.6 provides recommended study lengths, which were based on the average speed of the traffic stream.

Using these recommended study lengths made speed calculations straight forwarded and was less confusing. If these lengths are not appropriate, another length can be used assuming it is long enough for reliable observer reaction times.

Table 3-7: Recommended spot speed study lengths [37]

Traffic Stream Average Speed	Recommended Study Length(meter)
Below 40 Km/h	28
40–64.4 Km/h	50
Above 64.4 Km/h	75

Source :(Handbook of Simplified Practice for Traffic Studies)

2. Record Observations on Stopwatch Spot Speed Data Form

On the stopwatch spot speed data form, the observer recorded the date, location, posted speed limit, weather conditions, start time, end time, and down time. As the front wheels of a vehicle (or only the lead vehicle in a group) crossed a mark of the predetermined study length, the observer started the stopwatch. The watch was stopped when the vehicle's front wheels passed a reference line in front of the observer. A slash was recorded on the data form corresponding to the elapsed time observed. The collected data were in appendix A

3. Calculate Vehicle Speeds

To calculate vehicle speed, use the predetermined study length and the elapsed time it took the vehicle to move through the course (as recorded on the stopwatch data form) in the following formula (Robertson 1994):

$V = T/3.6D \ldots\ldots\ldots\ldots\ldots\ldots\ldots 3.1$

Where V = spot speed (m/s), D = length (m), and T = elapsed time (seconds). In the equation, 3.6 is a constant that converts units of meter per second into kilometer per hour

The data observed and calculated values were present in appendix A

The following format were used to measure operating speed at the selected site

4. Speed Percentiles and How to Use them

Speed percentiles were tools used to determine effective and adequate speed limits. The two speed percentiles most important to understand are the 50th and the 85th percentiles. The 50^{th} percentile is the median speed of the observed data set. This percentile represents the speed at which half of the observed vehicles are below and half of the observed vehicles are above.

The 85th percentile was the speed at which 85% of the observed vehicles were traveling at or below. This percentile was used in evaluating/recommending posted speed limits based on the assumption that 85% of the drivers were traveling at a speed they perceive to be safe (Homburger et al. 1996). In other words, the 85^{th} percentile of speed was normally assumed to be the highest safe speed for a roadway section. The speed collected at the October month by selecting the dates with less traffic. Using the speeds from selected sites the 85^{th} percentile speed was used to evaluate consistency

3.4.4.1 Sample Size

The minimum sample size required to estimate a variable with an accuracy of ± ε units at a certain confidence level were used as stated below

The speed variable was normally distributed and a large sample (≥ 30) was available to calculate the standard deviation, the *z*-statistic can be used instead of the *t*-statistic. There are other methods available which approximate the equation below using certain assumptions and are easier to work with.

Use of the *z*-statistic in place of the *t*-statistic is also suggested for ease of calculation, and an adjustment factor was introduced to balance the discrepancy. The "modified" equation is:

$$n = \left(\frac{z \times \sigma}{\varepsilon}\right)^2 + \varepsilon_n$$

Based on numerical results, the value of ε_n is recommended as 2, 3 and 4 for confidence levels 90%, 95% and 99%, respectively. Another work suggested a constant value of ε_n 2 for in situations with less than 30 observations.

A minimum of 100 free-flow vehicles was desired for each study site. This sample size was determined by the following equation [Institute of Transportation Engineers (ed. Robertson), 1994]

$$N= (S*K/E).^2 \quad \ldots\ldots 3.3$$

N=Number of Measured Speeds, S=estimated sample standard deviation, mph, K=constant corresponding to the desired confidence level and E=permitted error in the speed estimate, mph

Standard deviation = 5 mph=8.046 Km/h

Acceptable confidence level = 95%

Permitted error = 1 mph =1.609 Km/h

The value of K at 95% is 1.96 using this value the sample size were N= 100 per each curves

The data of operating speed were obtained after collecting of speeds at each locations of road segment that was identified for this study was described in (appendix A)

CHAPTER 4 DATA ANALYSIS AND EVALUATION

4.1 Traffic Accident Distribution

The accident data which has been collected for this research purpose includes accidents that occurred on a two-lane two way road segment by excluding pedestrian and Animal related crashes from two police stations over the five-years study period and police commission offices have provided accident reports as paper copies from 2005-2009 E.C. Based on this only Geometric feature related Accident data collect for this study purpose

The accident database for the study was obtained from the Traffic police commissions of nearby Woradas; accidents from 2005 to 2009 inclusive were examined. The data base contained 328 accidents. These accidents did not include all the accidents occurred on the Sections.

Only accidents that could have been caused by the alignment of the road were needed for analysis. These accidents were extracted in line with previous research (Anderson et al., 1999). Only non-intersection accidents that involved the following were considered:

(a) A single vehicle running off the road,

(b) A multiple-vehicle collision between vehicles travelling in opposite directions, or

(c) Multiple-vehicle collision between vehicles travelling in the same direction.

(d) A single vehicle rolls over

All accidents involving parking, turning, or passing maneuvers; animals in the roadway; pedestrians and bicycles or motorcycles were excluded**.**

A Statistical Result visualized in Figure 4.1 below shows the total number of accidents distributed over the five years of analysis period. It is understood that the number of years and traffic volume exhibit an influence on the accident situation.

The most significant feature of the chart is that the number of road traffic accidents in the subject area seems to be increasing as years go by except a significant reduction

observed in 2008 and 2009 with a total number of accidents being 72 and 56 respectively. In 2005 there were 58 accidents, this was increased to 62 in 2006. However, there was a sharp increase in 2007 with a total number of road traffic accidents being 80. This observation support what many researchers stated so far that as years go by, the number of vehicles will be increasing and the number of traffic accident increases accordingly and as such the number of people who are likely to be killed in road accidents will surely increase

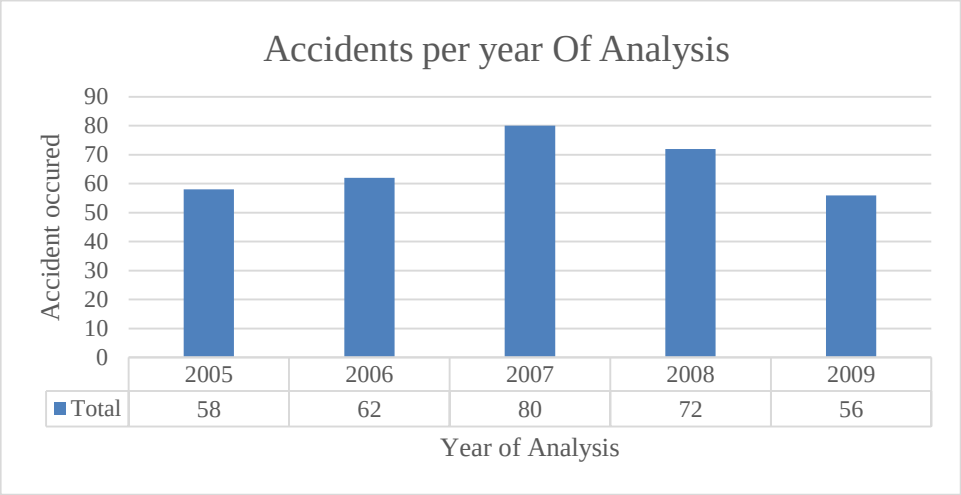

Figure 4.1: Total number of accidents distributed over the five years of analysis period.

The chart below shows the annual variation in accident's severity of the total stretch during the years 2005-2009. It is observed that severity of accidents are increasing relatively in most of the years. However In the year 2009 the degree of accident severity was low and high in the year 2008. It was due to an increase in the no of vehicles and bad traffic environment.

Injuries are the dominating types of accidents constituting the highest variations in accident's degree of severity (49.7%) injuries followed by PDO (29.3%) and fatal (21%) types as shown below.

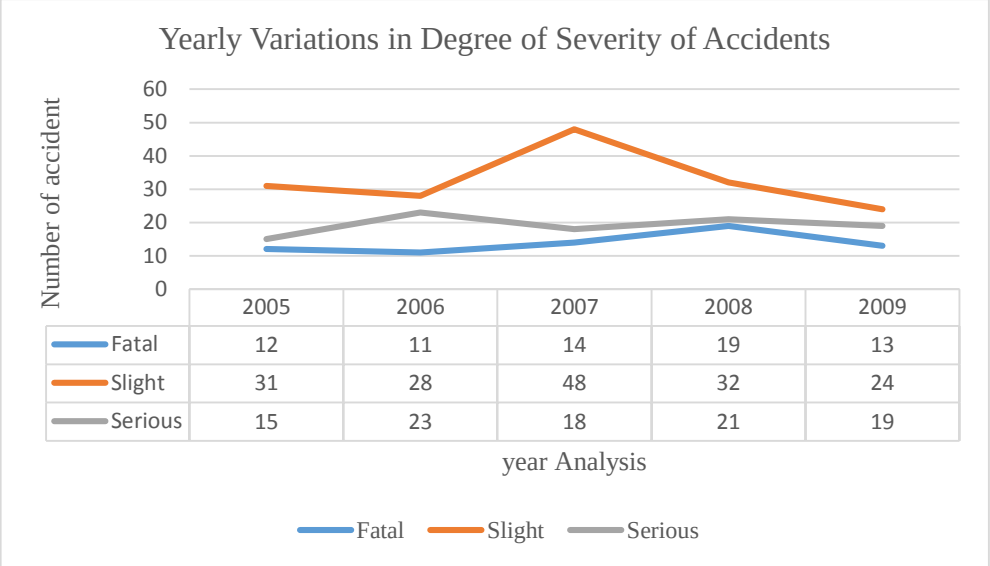

Figure 4.2: Distribution of accident severity over the analysis period.

The total number of accidents occurred by various types of vehicles in Wolayita Soddo-Allaba road segment is shown in the figure 4.3 below.

The chart clearly shows that Passenger Vehicles, Buses and Trucks are the three major causes of road traffic accidents of the subject area. The Passenger Vehicles and Buses are known to be the major carriers of people in all corners of the country followed by cars, goods vehicles, pickups, cycle and the heavy duty vehicles.

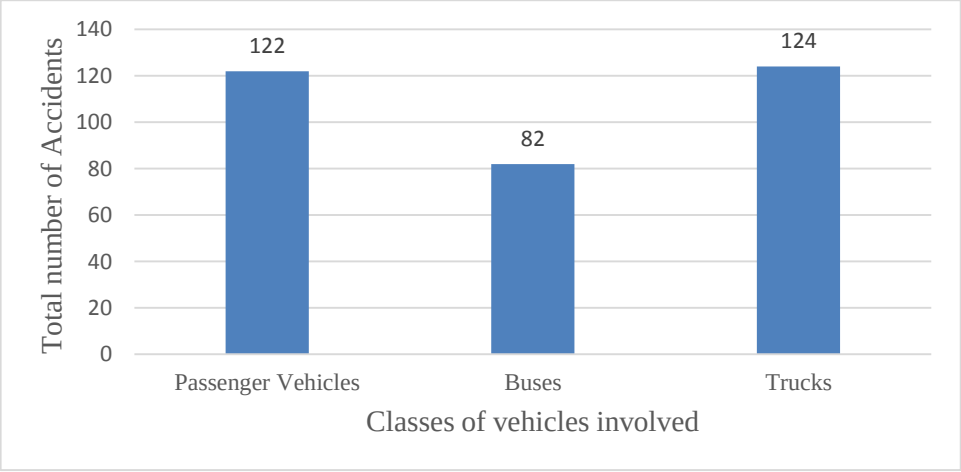

Figure 4.3**:** Total number of accidents occurred by various types of vehicles

By dividing accidents according to vehicle types involved, Figure 4.3 shows that Trucks and passenger Vehicles were the dominating vehicle types representing 38% and 37% respectively followed by Bus.

4.2 Spatial Distribution of Accidents in spots in Allaba-Soddo Road Segments

Table 4.1 Location and Severity type of Accidents in study period and total percentage

No	Locations	2005			2006			2007			2008			2009			Total	
		Fatal	Injury	PDO	Fatal	Injury	PDO	Fatal	Injury	PDO	Fatal	Injury	PDO	Fatal	Injury	PDO		%
1	Fate	1	0	0	0	2	2	1	2	2	0	3	2	1	2	2	17	5.18
2	Shashe gale	0	0	0	1	2	0	1	5	0	1	4	1	0	1	0	16	4.48
3	Washe gale	3	2	0	0	2	2	2	1	1	4	1	0	2	4	3	27	8.23
4	Kawo Shafe	0	0	0	0	0	1	1	3	0	0	1	2	0	0	0	7	2.13
5	Delibo	3	7	4	5	9	6	5	10	6	2	9	7	2	2	2	80	24.39
6	Kokate	3	7	2	2	2	0	0	7	6	1	6	7	2	4	4	51	15.55
7	Maria Chare	1	5	2	1	6	6	1	6	7	4	3	1	2	1	2	42	12.8
8	Buge	0	3	3	1	1	3	1	5	2	3	1	1	3	2	1	30	9.15
9	Gacheno	0	3	1	0	1	1	1	2	1	0	0	1	0	5	2	18	5.49
10	Teba	0	1	0	0	0	2	0	2	0	1	0	0	1	2	1	8	2.44
11	Shoya	0	2	1	0	0	0	0	0	0	0	0	0	0	0	2	5	1.52
12	Ado kayisha	1	1	2	2	2	3	1	5	1	2	1	2	0	1	2	26	7.93

4.3 Identification of Black Spots in Allaba-Soddo Road Segments

A location whether link or node that experiences abnormal crash frequencies, rate is considered as an accident black spot. The method also incorporates exposure data such as traffic volume and length of the road section to determine if the critical accident rate at particular location is significantly higher than the average for each factor. Accordingly, accident rate calculation and black spot identification were undertaken by using the following analytical methods (**Quality control /critical crash rate factor /method).**

1. Determination of the location's during accident rate: it is determined on the basis of exposure data, such as traffic volume and length of the road section being considered at rate per million vehicle kilo meters (**AR)** it is obtained from expression;

For Road sections:

AR = U x 106 / (AADT x 365 x n x L) injury accidents per million vehicle.-km

U = number of reported injury accidents during the period n

n = number of years

L = section length (km

2. Determining the critical crash rate: critical crash rate factor method involved the following expression. The result provides the data for calculating critical accident rate (Rc) as shown in Equation (2). It is based on the assumptions that the crashes are approximated by Poisson Distribution

4.3.1 Accident Rate

The accident database for the study was obtained from the Traffic police commissions of nearby Woradas; accidents from 2005 to 2009 inclusive were examined. The data base contained 328 accidents of varying degree. These accidents did not include all the accidents occurred on the Sections.

Only accidents that could have been caused by the alignment of the road were needed for analysis. These accidents were extracted in line with previous research (Anderson et al., 1999). Only non-intersection accidents that involved the following were considered:

(a) A single vehicle running off the road,

(b) A multiple-vehicle collision between vehicles travelling in opposite directions, or

(c) Multiple-vehicle collision between vehicles travelling in the same direction.

(d) A single vehicle rolls over

All accidents involving parking, turning, or passing maneuvers; animals in the roadway; pedestrians and bicycles or motorcycles were excluded**.**

Rate of accident is the ratio of “total no. of accidents” and the “total no. of vehicles” passed on a particular road section during the same period of time. It is in accident per Million Vehicle Kilometers (MVKM) as given in the equation below [20].

In this case, road accident data of the segment selected for the case study have been collected from two traffic police stations of Bodti and Wolayita Sodo Towns. As-built road geometric design data was also taken from the ERA, at selected accident locations.

$$AR = \frac{\textbf{Accidents} * 10^6}{AADT_m * 365 * T * L} \quad \text{.....4}$$

Where, AR = Accident rate (MVKM)

$AADT_m$ = Average annual daily traffic.

L = Length of investigated section (Km)

T = length of investigated time period (yr.)

365 = number of days/yr.

An accident rate of between 2 to 3 accidents per million vehicle miles (MVM) is considered by some states to be an average rate on rural two-lane roads excluding intersections [Permit Writers Workshop]

Table 4.2: The Fatal accident rates were computed with mean AADT

Sections	Local Name	Length of Section(Km)	Fatal Crashes	year of Analysis	Accident rate (AR)
Section 1	Fate	3	3	5	0.74
section 2	Shashe gale	2	3	5	1.11
section 3	Washe gale	2	11	5	4.07
section 4	Kawo Shafe	0.3	1	5	2.47
section 5	Delibo	3.7	18	5	3.60
section 6	Kokate	2.5	8	5	2.37
section 7	Maria Chare	2.5	9	5	2.67
Section 8	Buge	5	8	5	1.19
section 9	Gacheno	3	1	5	0.25
section 10	Teba	3	2	5	0.49
section 11	Shoya	1.5	0	5	0
section 12	Ado kayisha	3.5	6	5	1.27

Most of the section in the table 4.2 have Accident Fatal rate of more than one which shows there was more than one fatal per a kilometer with a million vehicles except Fate, Gacheno, Teba and Shoya

Table 4.3: The Injuries Crash rates were computed with mean AADT

Sections	Local Name	Length of Section(Km)	Injury Crashes	year of Analysis	Accident rate (AR)
Section 1	Fate	3	6	5	1.48
section 2	Shashe gale	2	1	5	0.37
section 3	Washe gale	2	6	5	2.22
section 4	Kawo Shafe	0.3	1	5	2.47
section 5	Delibo	3.7	25	5	5.00
section 6	Kokate	2.5	16	5	4.74
section 7	Maria Chare	2.5	10	5	2.96
Section 8	Buge	5	10	5	1.48
section 9	Gacheno	3	5	5	1.23
section 10	Teba	3	2	5	0.49
section 11	Shoya	1.5	3	5	1.48
section 12	Ado kayisha	3.5	10	5	2.12

Most of the sections in the table 4.3 have Crash injury rate of more than one which shows there was more than one fatal per a kilometer with a million vehicles except Shashe gale and Teba

Table 4.4: The Property damage accident rates were computed for roadway sections with mean AADT

Sections	Local Name	Length of Section(Km)	PDO Crashes	Year of Analysis	Accident rate (AR)
Section 1	Fate	3	8	5	1.98
section 2	Shashe gale	2	12	5	4.44
section 3	Washe gale	2	10	5	3.70
section 4	Kawo Shafe	0.3	6	5	14.81
section 5	Delibo	3.7	37	5	7.41
section 6	Kokate	2.5	26	5	7.70
section 7	Maria Chare	2.5	23	5	6.81
Section 8	Buge	5	12	5	1.78
section 9	Gacheno	3	12	5	2.96
section 10	Teba	3	5	5	1.23
section 11	Shoya	1.5	2	5	0.99
section 12	Ado kayisha	3.5	10	5	2.12

Table 4.5 The Total accident rates were computed for roadway sections mean AADT

Sections	Local Name	**Length of Section(Km)**	**Number of Crashes**	**year of Analysis**	**Accident Rate**
Section 1	Fate	3	17	5	4.20
section 2	Shashe gale	2	16	5	5.93
section 3	Washegale	2	27	5	10.00
section 4	Kawo Shafe	0.3	8	5	19.75
section 5	Delibo	3.7	80	5	16.01
section 5	Kokate	2.5	50	5	14.81
section 6	Maria Chare	2.5	42	5	12.44
Section 8	Buge	5	30	5	4.44
section 9	Gacheno	3	18	5	4.44
section 10	Teba	3	9	5	2.22
section 11	Shoya	1.5	5	5	2.47
section 12	Ado kayisha	3.5	26	5	5.50

All the sections in the table 4.5 have Accident rate of more than three which shows there was more than three accident rate per a kilometer with a million vehicles except Teba and Shoya

4.4 Evaluation of Design Consistency

4.4.1 Geometric Design Consistency Evaluation Criteria Based on Design Speed

Evaluation was performed between design speed used for design and existing 85th operating speeds of road segments.
Good Designs: The difference between the operating speed and the design speed is less than or equal to10 km/h for the investigated curve or tangent.
Fair Designs: The difference between the operating speed and the design speed is 10 km/h < $V85 - V_d \leq 20$ km/h for the investigated curve or tangent.
Poor Designs: The difference between the operating speed and the design speed is >20 km/h for the investigated curve or tangent.
Table 4.6 Design consistency evaluation based on design speeds in horizontal curves

Stations	Sections	Change in Speed(V)	Performance based on Criteria
51+000-54+000	1	>20	Poor
54+000-56+000	2	>20	Poor
56+000-58+000	3	>20	Poor
58+000-58+300	4	>20	Poor
58+300-62+000	5	>20	Poor
62+000-64+500	6	>20	Poor
64+500-67+000	7	>20	Poor
29+000 -34+000	8	>20	Poor
34+000 -37+000	9	>20	Poor
37+000-40+000	10	>20	Poor
40+000-41+500	11	>20	Poor
41+500-45+000	12	>20	Poor

Source: Design Evaluation summary based on operating speed from Appendix C Table

The performance of all the Sections in the Table 4.6 above was determined by using the speed value from the site for passenger vehicles and design speed from As-built data. The Design speed in each section has Variable value with different topography. The table shows that the speed in the sections was much more than the design speed which geometry of the road does not allow

4.4.2 Vehicle stability

Another method to evaluate design consistency is the study of vehicle stability. When insufficient side friction is provided at a horizontal curve, vehicles may skid out, rollover or be involved in head-on Crashs.

According to this criterion, consistency is considered good when Δf_R is higher than or equal to 0.01, fair when its value is between 0.01 and -0.04, and poor when Δf_R is lower than -0.04. The consistency evaluation criterion for Δf_R, to predict the side friction assumed are dependent on either the operating speed or design speed of an element

Table 4.7: Design consistency evaluation based on Vehicle stability of horizontal curves

Stations	**Sections**	**Change in Side friction (*ΔfR*)**	**Performance based on Criteria**
51+000-54+000	1	$-0.04 \leq \Delta fR \leq 0.01$	fair
54+000-56+000	2	< -0.04	Poor
56+000-58+000	3	< -0.04	Poor
58+000-58+300	4	$-0.04 \leq \Delta fR \leq 0.01$	fair
58+300-62+000	5	< -0.04	Poor
62+000-64+500	6	< -0.04	Poor
64+500-67+000	7	< -0.04	Poor
29+000 -34+000	8	$-0.04 \leq \Delta fR \leq 0.01$	fair
34+000 -37+000	9	< -0.04	Poor
37+000-40+000	10	$-0.04 \leq \Delta fR \leq 0.01$	fair
40+000-41+500	11	< -0.04	Poor
41+500-45+000	12	$-0.04 \leq \Delta fR \leq 0.01$	fair

Source: Design Evaluation summary based on operating speed from Appendix C

Table 4.7 Shows that Sections 1, 4,8,10 and 12 have fair performing side friction since due to curves without less than six hundred diameters are less in number for these sections whereas rest Sections with poor performance need more side friction than provided and contains more number of curves having less than six hundred diameters

Table 4.8: Summary of Study section performance and Prioritization based on Crashes frequency and Rate

Sections	**Study Section Performance**		**Accident Conditions**				**AR**	**Prioritization Based on**	
	Based on V	**Based on Stabilit**	**Fatal**	**Injuries**	**PDO**	**Total**		**Total Accident**	**AR**
1	**Poor**	**fair**	**3**	**6**	**8**	**17**	**4.2**	**8**	**10**
2	Poor	Poor	3	1	12	16	5.93	9	6
3	Poor	Poor	11	6	10	27	10	5	5
4	Poor	fair	1	1	6	8	19.75	11	1
5	Poor	Poor	18	25	37	80	16.01	1	2
6	Poor	Poor	8	16	26	50	14.81	2	3
7	Poor	Poor	9	10	23	42	12.44	3	4
8	Poor	fair	8	10	12	30	4.44	4	8
9	Poor	Poor	1	5	12	18	4.44	7	8
10	Poor	fair	2	2	5	9	2.22	10	12
11	Poor	Poor	0	3	2	5	2.47	12	11
12	Poor	fair	6	10	10	26	5.5	6	7

Table 4.8 shows that based on Crash frequency the top three high Crash locations (Section 5, 6 &7) perform poor with both methods (i.e Design speed and vehicles

stability). Most of the sections such as Section 1, Section 4, section 10 and section 12 ranked 8, 11, 10 & 6 respectively perform fair on vehicle stability have low Crash frequency.

Based on Accident Rate Section 1, Section 8, Section 10 and section 12 ranked 10, 12, 8 & 7 respectively perform fair on vehicles stability have low Accident rate and Section 4 shows the Crash in this section was due to high speed but it was not indicate that there is no contribution of stability since its performance is not good

4.5 Examination of Operating Speed with Traffic Accident Rate

Data collected for the analysis were obtained from design and Crash report documents, and through field measurements have shown different characteristics. Radius, curve length, Super elevation, Grades and tangent length and Crashes were found from the documents. Whereas operating speed and length of the sections were measured directly from field observations.

Considering the results of the operating speed characteristics a t- test was made in order to find whether the 85^{th} percentile speed of passenger cars, buses and trucks were significantly different.

(Table 4.9 to table 4.10 shows the result of t-test for each vehicle category in curves

Table 4.9 t-Test for operating speed of passenger cars and buses

Test for Cars and buses		
t-Test: Paired Two Sample for Means		
	Variable 1	Variable 2
Mean	108.0169492	99.762712
Variance	152.8544111	75.379111
Observations	118	118
Pearson Correlation	0.853538557	
Hypothesized Mean Difference	0	
Df	117	
t Stat	13.36711125	
P(T<=t) one-tail	1.31438E-25	
t Critical one-tail	1.657981659	
P(T<=t) two-tail	**2.62877E-25**	
t Critical two-tail	1.980447599	

Since the P-value is less, the observed values have no significant difference.

Table 4.10: t-Test for operating speed of passenger cars and Trucks

Test for Cars and Trucks and t-Test: Paired Two Sample for Means

	Variable 1	Variable 2
Mean	108.0169492	95.74576271
Variance	152.8544111	55.54164856
Observations	118	118
Pearson Correlation	0.719594816	
Hypothesized Mean Difference	0	
Df	117	
t Stat	15.31172951	
P(T<=t) one-tail	5.10407E-30	
t Critical one-tail	1.657981659	
P(T<=t) two-tail	**1.02081E-29**	
t Critical two-tail	1.980447599	

Since the P-value is less, the observed values have no significant difference

Table 4.11: t-Test for operating speed of Buses and Trucks

Test for Buses and Trucks and t-Test: Paired Two Sample for Means

	Variable 1	Variable 2
Mean	99.76271	95.74576
Variance	75.37911	55.54165
Observations	118	118
Pearson Correlation	0.884214	
Hypothesized Mean Difference	0	
df	117	
t Stat	10.74374	
P(T<=t) one-tail	1.88E-19	
t Critical one-tail	1.657982	
P(T<=t) two-tail	**3.77E-19**	
t Critical two-tail	1.980448	

Since the P-value is less, the observed values have no significant difference.

Hence, the result of the test shows that no significant different between the observed data and because of this combined effect was considered for analyses. To determine whether the 85th percentile speeds influence to accident rates on inconsistent sections, graphical and correlation analyses were made for the combination of the data obtained in the following section.

4.6 Examination of Horizontal Alignment Indices with Road Accident Rate

As it has been stated in the Highway design and traffic safety engineering handbook that accident rate (AR) considers the geometric components and traffic volume to allow a direct comparison of different roadway sections with respect to traffic safety at the selected sections.

Alignment indices in the literature include average radius of a section (Rav), ratio of maximum radius to minimum radius on a section of highway (RR) and the ratio of the radius of a single horizontal element to the average radius of the entire section (CRR).

Table 4.12 Different Variables that represents the characteristics of Road sections

Sections	Length (Km)	Average Radius	Rmin/Rmax	No. of Curves	Average Tanget	Max.super elevation	Max.Side friction	Min.change in side friction	Max change in Speed	Max demand side friction	Max operating speed	Rmax to Rav	Max.of indT to Av. T	Accident Rate
1	3	2366.67	0	V	50.8	0.25	0.011	-0.03	43	0.03	125	2.96	4.72	4
2	2	888.57	0.124	7	86.51	0.073	0.075	-0.13	54	0.2	125	2.36	1.49	6
3	2	724.23	0.0092	18	45.3	0.08	0.138	-1.21	54	0.19	124	6.9	4.04	10
4	0.3	1557.5	0.15	2	33.3	0.079	0.05	-0.1	54	0.05	124	1.41	1.66	20
5	3.7	654.7	0	25	39.3	0.08	0.177	-1.04	54	0.18	124	4.58	2.16	16
6	2.5	1088.18	0.016	11	52	0.067	0.157	-0.62	62	0.6	120	4.59	3.59	15
7	2.5	1140	0.015	8	36.11	0.04	0.157	-1.07	59	1.32	115	2.63	1.79	12
8	5	252.8	0	9	80.76	0.025	0	-0.02	40	0	125	8.99	8.99	4
9	3	2546.25	0	8	43.26	0.078	0.01	-0.09	40	0.02	124	2.75	2.78	4
10	3	2416.67	0	5	59.24	0.025	0.02	-0.03	40	0.04	125	0.11	4.29	2
11	1.5	1968	0.03	5	31.57	0.079	0.02	-0.16	49	0.04	119	3.05	1.23	1
12	3.5	1467.86	0	14	49.88	0.057	0.02	-0.09	45	0.05	119	3.41	2.29	6

4.6.1 Scatter Plot

In the subject study, the rate of traffic Crash is taken as the dependent variable whereas the average radius of a section (Rav), Number of Horizontal curve (Nc), ratio of maximum radius to minimum radius (RR), radius of a single horizontal element to the average radius of the entire section (CRR), Superelevation (e) and Side frictions (f) are independent variables

Table 4.13: The Variables that correlates for the Regression Analysis

Y=AR	**Nc.**	f_{min}	V_{max}	f_{av}	$R_{av.}$	T_{av}
4	6	-0.03	43	-0.017	2367	50.8
6	7	-0.13	54	-0.077	889	86.51
10	18	-1.21	54	-0.32	724	45.3
16	25	-1.04	54	-0.26	655	39.3
15	11	-0.62	62	-0.17	1088	52
12	8	-1.07	59	-0.32	1140	36.11
4	9	-0.02	40	-0.002	253	80.76
4	8	-0.09	40	-0.04	2546	43.26
2	5	-0.03	40	-0.02	2417	59.24
6	14	-0.09	45	-0.04	1468	49.88

Scatter diagrams at Appendix F in part 3 provide a visual method of displaying a relationship between variables as plotted in a two dimensional coordinate system. Inspection of the scatter diagrams indicate that, although no simple curve will pass exactly through all the points, there is a reasonable indication that the points lie scattered randomly around a straight line, particularly for the maximum Change in speed, Average radius of curvature, and Average super elevation and straight-line fit is suggested.

Relatively the scatter plot shows a linear response and hence, a linear regression model expresses the association between the subject parameters. A linear relationship is usually practiced in solving different engineering problems because of its simplicity.

4.6.2 Correlation Analysis

To determine whether there was a relationship between the Accident Rate with the geometric indices elements shown in the table, a correlation analysis were made between operating speed and geometric elements. The results of the correlation are listed in table below in table 4.13

Table 4.14: The result of correlation of variables from excel sheet and SPSS 16.1

Pearson Correlation													
AR	Ls	Rav	Rmi to Rm	Nc	Tav	emax	fmin	Vmax	f_D	Ri/Rav	Ti/Tav	Vav	fav
1	-0.204	-0.533	-0.042	0.676	-0.488	-0.117	-0.837	0.86	0.591	0.236	-0.376	-0.84	-0.819
-0.204	1	-0.197	-0.491	0.114	0.2	-0.169	0.363	-0.559	-0.377	0.456	0.662	0.503	0.442
-0.533	-0.197	1	-0.252	-0.52	-0.285	0.39	0.487	-0.508	-0.224	-0.735	-0.192	0.585	0.467
-0.042	-0.491	-0.252	1	-0.23	0.618	-0.057	0.104	0.346	0.09	-0.203	-0.38	-0.286	0.017
0.676	0.114	-0.524	-0.228	1	-0.413	-0.089	-0.659	0.362	-0.064	0.422	-0.204	-0.5	-0.586
-0.488	0.2	-0.285	0.618	-0.41	1	-0.171	0.583	-0.247	-0.38	0.181	0.42	0.316	0.563
-0.117	-0.169	0.39	-0.057	-0.09	-0.171	1	0.142	-0.107	-0.225	-0.113	-0.019	0.316	0.156
-0.837	0.363	0.487	0.104	-0.66	0.583	0.142	1	-0.752	-0.594	-0.257	0.333	0.836	0.991
0.86	-0.559	-0.508	0.346	0.362	-0.247	-0.107	-0.752	1	0.726	0.069	-0.497	-0.931	-0.789
0.591	-0.377	-0.224	0.09	-0.06	-0.38	-0.225	-0.594	0.726	1	-0.127	-0.376	-0.699	-0.664
0.236	0.456	-0.735	-0.203	0.422	0.181	-0.113	-0.257	0.069	-0.127	1	0.632	-0.155	-0.187
-0.376	0.662	-0.192	-0.38	-0.2	0.42	-0.019	0.333	-0.497	-0.376	0.632	1	0.537	0.406
-0.84	0.503	0.585	-0.286	-0.5	0.316	0.316	0.836	-0.931	-0.699	-0.155	0.537	1	0.873
-0.819	0.442	0.467	0.017	-0.59	0.563	0.156	0.991	-0.789	-0.664	-0.187	0.406	0.873	1

4.7 Regression Analysis

To determine whether there was a statically significant relationship for 95-percent confidence interval (significant level of a = 0.05) a regression analysis were made between the geometric features and Accident Rate. The analysis was made in two ways, first between the geometric features that represent a section and Accident Rate and second between the combinations of the geometric features and Accident Rate.

Table 4.15: The results of the regression analysis

	Nc	fmin	Vmax	fav	Rav	R^2	B0	MSE
B1	0.524602							
P-value	0.035008					0.44536	2.1774	97.121
B1		-8.30149						
P-value		0.00233				0.70643	4.4059	154.05
B1			0.5032					
P-value			0.0014			0.74195	-16.71	161.8
B1				-31.248				
P-value				0.00353		0.67545	4.0444	147.3
B1	0.15802	-6.99394						
P-value	0.466895	0.03021				0.72931	3.2181	79.521
B1				-27.895	-0.0011			
P-value				0.01613	0.44394	0.70334	6.0087	76.689
B1		-4.38057	0.3083					
P-value		0.10507	0.0624			0.82736	-9.035	90.212
B1	0.421368				-0.0015			
P-value	0.134398				0.455	0.49085	5.3652	53.52
B1	0.416701		0.3216					
P-value	0.001196		0.0197			0.88741	-16.03	96.76
B1	0.222307			-24.946				
P-value	0.283211			0.03079		0.72795	2.3746	79.373
B1		-7.53229			-0.001			
P-value		0.012			0.50365	0.72589	6.0414	79.148
B1			0.4656		-0.0008			
P-value			0.008		0.57786	0.75392	-13.82	82.205
B1	0.275649	-1.29957	0.3712					
P-value	0.107056	0.63331	0.0238			0.89196	-13.85	64.837
B1		-28.0053	0.4619	99.3379				
P-value		0.02517	0.0086	0.04381		0.91697	-14.23	66.655
B1			0.3092	-13.685	-0.0006			
P-value			0.1345	0.27285	0.67123	0.802	-8.139	58.298
B1	0.188723			-23.911	-0.0007			
P-value	0.417912			0.05586	0.67364	0.73655	3.791	53.54
B1	0.114656	-21.3757	0.4533	76.8501				
P-value	0.540678	0.19175	0.0162	0.21009		0.92355	-15.06	50.35
B1		-29.1519	0.4779	103.662	0.0003			
P-value		0.04412	0.0193	0.06767	0.76901	0.91853	-15.37	50.077
B1	0.327485		0.4094	-2.164	0.00042			
P-value	0.097691		0.0441	0.84903	0.73076	0.89162	-16.58	48.609
B1	0.299627	-1.18773	0.389		0.00039			
P-value	0.142063	0.69099	0.042		0.74284	0.8945	-15.47	48.766
B1	0.140861	-21.8049	0.4785	79.043	0.0005			
P-value	0.515409	0.23047	0.0319	0.24667	0.65638	0.92771	-17.17	40.462

Where Nc = number of Horizontal Curve f_{min}= Minimum side friction
R2 =Coefficient of determination Vmax=Maximum change in side friction,
fav=Average side friction Rav=average raduis
MSE = mean square error Bo = Constant B1 = x constant p-value = probability value

Source: Excel sheet 2010 and SPSS 16.1 for selected variables with their correlations

Analysis of regression result indicated that, Number of Horizontal Curve, Minimum Side friction, Max change in speed, Average side friction and the combination of Number of Horizontal Curve and Max change in speed, and Combination Average side friction, Max change in speed and min Side friction was found to be a significant predictor of Accident Rate that describes inconsistency. Whereas Average Radius was not a significant predictor of desired speeds of Accident Rate that describes inconsistency of Section of roads.

From the analysis results three of these models that used combination of the three variables were determined to be a significant estimator of Accident Rates. From the regression results a value with high values of R^2 and P-value less than 0.05 were selected to show the regression equations for the collected data's in the field.

The coefficient of determination shows that the combinations of Number of Horizontal Curve and Max change in speed with 88.7 % of the values were Accident rate predictors in curves whereas Combination of Average side friction, Max change in speed and min Side friction with coefficient of determination 91.7% was Accident rate predictors in Road sections. Hence, the regression equations with coefficient of determination of high value and with p-value less than are stated below

Therefore, from the results of single and multiple linear regression analysis models, a combination of road geometric constituents correlates better with traffic Crashs than individual geometric characteristics as shown in the above table.

Table 4.16 the regression equation determined with high correlation coefficient and with p value less than 0.05

Regressions	Model number	Formula	P-value	R^2
Single linear	1	AR=2.177+0.525(Nc)	0.035008	44.5%
	2	AR=4.406-8.301(f_{min})	0.00233	70.6%
	3	AR=0.503(Vmax)-16.708	0.0014	74.2%
	4	AR=4.044-31.249(fav)	0.00353	67.55%
Multiple Linear	5	AR=0.417(Nc)+0.322(Vmax)-16.03	0.001196	88.74%
			0.0197	
	6	AR=99.338(fav)+0.462(Vmax)-28.005(fmin)-14.23	0.02517	91.7%
			0.0086	
			0.04381	

AR-Accident Rate
f_{min}-Minimum change in side friction
Nc-Number of Horizontal curves
Vmax-maximum change in speed
fav-Average change in side frictions

CHAPTER 5 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

Geometric design consistency is the conformance of geometry of a highway with driver expectancy. When inconsistency exists which violates driver's expectation, the driver may adopt an inappropriate speed or inappropriate maneuver, leading to collisions.

Despite its importance to road safety, Geometric design consistency is not ensured in a current design practice of ERA manual. The inadequacy of the design speed concept, the fact that the design speed may not be the maximum permissible safe speed, and progressive changes to geometric design standards, which result in sections along the same highway with inconsistent is one of the sources of design inconsistency

The following general conclusions were developed based on the findings of the study:

- Different sections were selected with average crash rates greater than two. The crash distributions were prioritized through total crash frequency of which 80 crashes in Delibo, 50 crashes in Kokate and 42 crashes in Maria Chare were identified as high crash locations. The distribution of crashes based on accident rate result in high Crash locations in Kawo Shafe with 19.75 accident rate, Delibo with 16.01 accident rate and Kokate with 14.81 accident rate.

- Results of design consistency evaluations using operating speed criteria shows that the change in design speed and operating speed were more than 20Km/h in each of the stations and all the sections were under poor design performance.

- Finding from design consistency evaluations based on Vehicles Stability indicated that the change in design side friction and demanded side friction of five sections were between 0.01 and -0.04 which was under fair design conditions. The corresponding result for the rest of the seven sections were less than -0.04 which was under poor design performance. They need realignment during maintenance. Hence, most of the sections showed design inconsistency from the evaluation.

- This study used both operating speed and vehicle stability methods to investigate inconsistent sections. The vehicle stability method was better in evaluating the sections performance related to road safety.

- This study has produced significant relationships that can be used to calculate the expected Accidents rate due to geometric design inconsistency problems which can be improved by further research works as follows.

  Using Scatter Plot & SPSS 16.1 software package techniques, correlations were done to test the relation between road geometric consistency and accident rate. For each model, regression coefficients, variances and standard error of estimates were calculated. There is a strong statistical relationship between minimum change in side friction, average change in side friction and maximum change in speeds on horizontal curves with accident rate. They have good correlation coefficients and standard error of ($p<0.05$). The resulting linear regression analysis equation with their corresponding correlation coefficients are: $AR = 4.406 - (8.301 * f_{min})$, with $R^2 = 0.706$, $AR=0.503*Vmax-16.708$ with $R^2=0.742$ and $AR=4.044-(31.249*fav)$ with $R2=0.6755$.

  Relatively an improved correlations than the single regression were obtained when multiple regressions were used as given in the following relationship: $AR=0.417(N_c) + 0.322(V_{max})-16.03$ with $R^2 =0.887$ and standard error of ($P<0.05$) and $AR=99.338(f_{av})+0.462(V_{max})-28.005(f_{min})-14.23$ with $R^2=0.917$ and ($P<0.05$).

5.2 Recommendations

The following recommendations are made based on the findings and conclusions of this study:

- The performance evaluations of the road sections based on operating speed showed that all the sections were poor and drivers were using operating speed of 20 km/h more than the provided design speed. Therefore it is better to provide speed breaker in entrances and exits of horizontal curves.

- It was investigated that based on vehicle stability performance, seven sections were poor and these sections need alignment corrections during maintenance activities. The rest of the five sections indicated fair performance which do not require realignment corrections but correction can be achieved by providing desirable signs.

- The consistency evaluation result showed that roads are highly inconsistent. Hence, the Ethiopian Roads Authority has to consider the effect of consistencies by conducting further research and incorporate design consistency criteria in the geometric design manual.

- The accuracy of collision prediction models are limited to independent variables related to operating speed and vehicle stability methods. Therefore prospective researchers should be devoted to improve the models by using the two other evaluating methods which are drivers work load and alignment indices.

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APPENDIX A

Data Collected from the field

1. Section 3-Station from 56+000-58+000

Passenger Car			Buses			Truck		
Record (Sec)	**Frequency**	**Speed (Kph)**	**Record (Sec)**	**frequency**	**Speed (Kph)**	**Record (Sec)**	**frequency**	**Speed (Kph)**
1.06	1	102	1.02	1	106	1.12	1	96
1.08	1	100	1.06	1	102	1.06	1	102
1.03	1	105	1.01	1	107	1.11	1	97
1.01	1	107	1.11	1	97	1.11	1	97
1.15	1	94	1.12	1	96	1.02	1	106
1.04	1	104	1.11	1	97	1.12	2	96
1.06	2	102	1.16	2	93	1.06	1	102
1.01	1	107	1.11	1	97	1.12	1	96
1.07	1	101	1.02	1	106	1.02	1	106
1.07	1	101	1.17	1	92	1.17	3	92
1.16	3	93	1.16	3	93	1.06	1	102
1.09	1	99	1.12	1	96	1.12	1	96
1.02	1	106	1.09	1	99	1.04	1	104
1.08	1	100	1.08	1	100	1.18	2	92
1.07	2	101	1.06	2	102	1.06	1	102
1.09	1	99	1.04	1	104	1.04	1	104
1.05	1	103	1.05	1	103	1.05	1	103
1.06	1	102	1.16	1	93	1.16	1	93
1.07	1	101	1.07	1	101	1.17	3	92
1.05	3	103	1.15	3	94	1.15	1	94
1.04	1	104	1.04	1	104	1.04	1	104
1.06	1	102	1.03	1	105	1.03	1	105
1.09	1	99	1.09	1	99	1.13	1	96
1.07	1	101	1.07	1	101	1.07	1	101
1.08	3	100	1.04	3	104	1.14	1	95
1.01	1	107	1.11	1	97	1.01	1	107
1.07	1	101	1.07	1	101	1.11	3	97
1.03	3	105	1.13	3	96	1.03	1	105
1.09	1	99	1.09	1	99	1.05	1	103
1.03	1	105	1.03	1	105	1.03	1	105
1.05	1	103	1.15	1	94	1.15	3	94
1.07	3	101	1.07	3	101	1.07	1	101
1.01	1	107	1.11	1	97	1.11	1	97
1.15	1	94	1.15	1	94	1.05	2	103

1.07	2	101	1.07	2	101	1.07	1	101
1.05	1	103	1.05	1	103	1.05	1	103
1.06	1	102	1.06	1	102	1.06	1	102
1.05	1	103	1.05	1	103	1.05	1	103
1.08	1	100	1.11	1	97	1.11	1	97
1.01	1	107	1.01	1	107	1.01	1	107
1.02	1	106	1.02	1	106	1.09	3	99
1.05	3	103	1.05	3	103	1.05	1	103
1.06	1	102	1.16	1	93	1.06	1	102
1.02	1	106	1.02	1	106	1.02	1	106
1.04	1	104	1.04	1	104	1.14	1	95
1.02	1	106	1.02	1	106	1.12	3	96
1.05	1	103	1.05	1	103	1.05	1	103
1.07	3	101	1.07	3	101	1.12	1	96
1.06	1	102	1.06	1	102	1.06	1	102
1.03	1	105	1.13	1	96	1.13	1	96
1.08	1	100	1.08	1	100	1.04	1	104
1.09	1	99	1.19	1	91	1.09	1	99
1.09	3	99	1.09	3	99	1.14	3	95
1.01	1	107	1.11	1	97	1.11	1	97
1.01	1	107	1.11	1	97	1.11	1	97
1.02	1	106	1.02	1	106	1.02	1	106
1.06	1	102	1.06	1	102	1.06	1	102
1.08	1	100	1.08	1	100	1.08	1	100
1.08	2	100	1.08	2	100	1.18	1	92
1.02	1	106	1.02	1	106	1.12	2	96
1.05	1	103	1.05	1	103	1.05	1	103
1.08	1	100	1.08	1	100	1.08	1	100
1.05	1	103	1.05	1	103	1.05	1	103
1.03	2	105	1.03	2	105	1.03	3	105
1.01	1	107	1.12	1	96	1.12	1	96
1.01	1	107	1.11	1	97	1.11	1	97
1.03	1	105	1.03	1	105	1.13	2	96
1.01	1	107	1.11	1	97	1.11	1	97
1.06	1	102	1.06	1	102	1.12	1	96
1.09	1	99	1.11	1	97	1.11	1	97
1.17	1	92	1.17	1	92	1.19	1	91
1.13	3	96	1.13	3	96	1.13	1	96
1.12	1	96	1.12	1	96	1.22	1	89
1.15	1	94	1.25	1	86	1.15	3	94
1.16	1	93	1.18	1	92	1.08	1	100
1.14	1	95	1.16	1	93	1.06	1	102
1.11	1	97	1.11	1	97	1.01	1	107
Total	**100**		**Total**	**100**		**Total**	**100**	

Curve with Radius 122m

Passenger Car			Buses			Truck		
Record (Sec)	**Frequency**	**Speed (Kph)**	**Record (Sec)**	**frequency**	**Speed (Kph)**	**Record (Sec)**	**frequency**	**Speed (Kph)**
1.16	1	93	1.12	1	96	1.11	1	97
1.18	1	92	1.16	1	93	1.16	1	93
1.13	1	96	1.11	1	97	1.21	1	89
1.11	1	97	1.13	3	96	1.11	3	97
1.15	3	94	1.12	1	96	1.12	1	96
1.14	1	95	1.18	1	92	1.14	1	95
1.16	1	93	1.16	1	93	1.16	1	93
1.11	1	97	1.15	1	94	1.17	1	92
1.07	1	101	1.12	1	96	1.12	1	96
1.17	1	92	1.14	1	95	1.17	1	92
1.16	1	93	1.16	1	93	1.16	1	93
1.09	1	99	1.12	1	96	1.12	3	96
1.12	1	96	1.09	3	99	1.14	1	95
1.08	3	100	1.08	1	100	1.18	1	92
1.07	1	101	1.16	1	93	1.16	1	93
1.19	1	91	1.04	1	104	1.14	3	95
1.15	1	94	1.15	3	94	1.15	1	94
1.06	3	102	1.17	1	92	1.14	1	95
1.17	1	92	1.17	1	92	1.17	1	92
1.05	1	103	1.15	1	94	1.15	1	94
1.14	1	95	1.04	1	104	1.16	1	93
1.16	3	93	1.09	3	99	1.13	3	96
1.09	1	99	1.11	1	97	1.14	1	95
1.17	1	92	1.07	1	101	1.17	1	92
1.08	1	100	1.14	1	95	1.14	1	95
1.11	1	97	1.11	1	97	1.11	3	97
1.17	1	92	1.17	3	92	1.15	1	94
1.13	3	96	1.13	1	96	1.13	1	96
1.09	1	99	1.19	1	91	1.14	1	95
1.13	1	96	1.13	1	96	1.16	1	93
1.05	1	103	1.15	1	94	1.15	1	94
1.07	1	101	1.17	1	92	1.17	1	92
1.11	1	97	1.11	1	97	1.11	2	97
1.15	1	94	1.15	1	94	1.15	1	94
1.12	1	96	1.07	2	101	1.12	1	96
1.15	2	94	1.15	1	94	1.15	1	94
1.06	1	102	1.16	1	93	1.06	1	102
1.15	1	94	1.05	1	103	1.15	1	94
1.08	1	100	1.11	1	97	1.11	1	97

1.21	1	89	1.14	2	95	1.09	2	99
1.13	1	96	1.12	1	96	1.19	1	91
1.15	2	94	1.15	1	94	1.05	1	103
1.06	1	102	1.16	1	93	1.16	1	93
1.12	1	96	1.14	1	95	1.07	3	101
1.14	1	95	1.15	3	94	1.14	1	95
1.09	3	99	1.12	1	96	1.12	1	96
1.15	1	94	1.15	1	94	1.15	1	94
1.12	1	96	1.17	1	92	1.12	1	96
1.16	1	93	1.16	1	93	1.16	1	93
1.13	1	96	1.13	1	96	1.13	3	96
1.18	1	92	1.08	3	100	1.14	1	95
1.19	3	91	1.09	1	99	1.09	1	99
1.09	1	99	1.19	1	91	1.14	1	95
1.11	1	97	1.11	1	97	1.15	1	94
1.01	1	107	1.21	1	89	1.11	3	97
1.06	1	102	1.12	3	96	1.02	1	106
1.16	1	93	1.06	1	102	1.06	1	102
1.18	1	92	1.18	1	92	1.08	2	100
1.12	1	96	1.08	1	100	1.18	1	92
1.18	3	92	1.12	1	96	1.12	1	96
1.15	1	94	1.15	3	94	1.05	3	103
1.08	1	100	1.08	1	100	1.08	1	100
1.05	2	103	1.05	1	103	1.15	1	94
1.13	1	96	1.13	1	96	1.03	2	105
1.11	2	97	1.12	2	96	1.12	1	96
1.17	1	92	1.16	1	93	1.19	1	91
1.13	1	96	1.11	2	97	1.13	1	96
1.09	1	99	1.21	1	89	1.14	1	95
1.16	3	93	1.06	1	102	1.12	1	96
1.19	1	91	1.21	1	89	1.16	2	93
1.17	1	92	1.17	2	92	1.19	1	91
1.13	2	96	1.13	1	96	1.14	1	95
1.12	1	96	1.19	1	91	1.22	1	89
1.15	1	94	1.15	1	94	1.15	1	94
1.13	1	96	1.16	1	93	1.18	1	92
1.17	1	92	1.14	1	95	1.16	1	93
1.21	1	89	1.09	1	99	1.12	1	96
Total	100	Total		100		Total	100	

Passenger vehicles			Buses			Trucks		
Record	**Number**	**Speed**	**Record**	**Number**	**Speed**	**Record**	**Number**	**Speed**
1.14	1	95	1.12	2	96	1.15	1	94
1.15	1	94	1.06	1	102	1.14	1	95
1.13	1	96	1.11	1	97	1.12	2	96
1.11	1	97	1.03	1	105	1.11	1	97
1.15	1	94	1.12	1	96	1.1	1	98
1.09	3	99	1.08	2	100	1.09	1	99
1.06	1	102	1.16	1	93	1.06	1	102
1.11	1	97	1.15	1	94	1.18	1	92
1.09	1	99	1.12	1	96	1.19	3	91
1.12	1	96	1.14	1	95	1.12	1	96
1.16	3	93	1.06	3	102	1.18	1	92
1.09	1	99	1.12	1	96	1.19	1	91
1.12	1	96	1.09	1	99	1.12	1	96
1.08	1	100	1.08	1	100	1.18	1	92
1.07	2	101	1.16	1	93	1.07	1	101
1.19	1	91	1.14	3	95	1.19	3	91
1.15	1	94	1.15	1	94	1.15	1	94
1.16	2	93	1.17	1	92	1.16	1	93
1.07	1	101	1.27	1	85	1.07	1	101
1.15	1	94	1.15	1	94	1.15	1	94
1.14	1	95	1.14	2	95	1.14	2	95
1.06	3	102	1.19	3	91	1.06	1	102
1.09	1	99	1.11	1	97	1.09	1	99
1.07	1	101	1.17	1	92	1.07	1	101
1.08	1	100	1.14	1	95	1.08	1	100
1.09	1	99	1.11	1	97	1.09	3	99
1.07	1	101	1.17	1	92	1.07	1	101
1.11	1	97	1.13	1	96	1.11	1	97
1.09	3	99	1.19	2	91	1.09	1	99
1.13	1	96	1.13	1	96	1.13	1	96
1.15	1	94	1.15	1	94	1.15	1	94
1.07	1	101	1.17	1	92	1.07	1	101
1.02	1	106	1.11	1	97	1.02	1	106
1.15	1	94	1.15	3	94	1.15	2	94
1.17	3	92	1.17	1	92	1.17	1	92
1.15	1	94	1.15	1	94	1.15	1	94
1.06	1	102	1.16	1	93	1.06	1	102
1.15	1	94	1.15	3	94	1.15	3	94
1.08	1	100	1.11	1	97	1.08	1	100
1.11	2	97	1.14	1	95	1.11	1	97
1.12	1	96	1.12	3	96	1.12	1	96
1.15	1	94	1.15	1	94	1.15	1	94
1.16	1	93	1.17	1	92	1.16	1	93
1.12	1	96	1.14	1	95	1.12	3	96
1.14	1	95	1.15	1	94	1.14	1	95

1.12	3	96	1.12	1	96	1.12	1	96
1.15	1	94	1.16	1	93	1.15	1	94
1.17	1	92	1.17	2	92	1.17	2	92
1.06	1	102	1.16	1	93	1.06	1	102
1.14	1	95	1.13	1	96	1.14	1	95
1.08	1	100	1.18	1	92	1.08	1	100
1.12	1	96	1.09	3	99	1.12	3	96
1.09	3	99	1.19	1	91	1.09	1	99
1.09	1	99	1.11	1	97	1.09	1	99
1.11	1	97	1.21	1	89	1.11	1	97
1.12	1	96	1.12	1	96	1.12	1	96
1.16	1	93	1.16	1	93	1.16	1	93
1.18	3	92	1.18	1	92	1.18	3	92
1.08	1	100	1.08	1	100	1.04	1	104
1.12	1	96	1.12	1	96	1.12	1	96
1.15	1	94	1.15	3	94	1.15	1	94
1.08	1	100	1.08	1	100	1.18	1	92
1.12	2	96	1.05	1	103	1.12	1	96
1.13	1	96	1.13	1	96	1.13	3	96
1.11	1	97	1.12	1	96	1.15	1	94
1.12	1	96	1.16	1	93	1.12	1	96
1.13	1	96	1.11	1	97	1.14	1	95
1.11	2	97	1.21	2	89	1.11	1	97
1.06	1	102	1.16	1	93	1.06	2	102
1.13	1	96	1.21	1	89	1.14	1	95
1.15	1	94	1.18	1	92	1.15	1	94
1.03	3	105	1.17	1	92	1.13	1	96
1.12	1	96	1.19	1	91	1.12	1	96
1.15	1	94	1.13	2	96	1.14	3	95
1.06	1	102	1.16	1	93	1.07	1	101
1.14	1	95	1.16	1	93	1.11	1	97
1.09	1	99	1.19	1	91	1.19	1	91
	100			**100**			**100**	

Passenger Vehicle			Buses			Trucks		
Record	**number**	**speed**	**Record**	**number**	**speed**	**Record**	**number**	**speed**
1.21	1	89	1.22	1	89	1.18	1	92
1.18	1	92	1.16	1	93	1.16	1	93
1.14	1	95	1.13	1	96	1.11	1	97
1.19	1	91	1.16	1	93	1.11	1	97
1.17	3	92	1.15	1	94	1.14	1	95
1.18	1	92	1.18	3	92	1.14	1	95
1.16	1	93	1.17	1	92	1.17	3	92
1.13	1	96	1.15	1	94	1.12	1	96
1.21	1	89	1.13	1	96	1.22	1	89
1.17	1	92	1.14	2	95	1.17	2	92
1.16	1	93	1.19	1	91	1.16	1	93
1.19	3	91	1.17	1	92	1.12	1	96
1.14	1	95	1.09	1	99	1.14	1	95
1.18	1	92	1.18	1	92	1.18	1	92
1.17	1	92	1.16	1	93	1.16	1	93
1.19	1	91	1.14	1	95	1.14	3	95
1.15	1	94	1.15	3	94	1.15	1	94
1.16	3	93	1.19	1	91	1.14	1	95
1.17	1	92	1.17	1	92	1.17	1	92
1.15	1	94	1.15	1	94	1.15	1	94
1.14	1	95	1.14	1	95	1.16	1	93
1.16	3	93	1.19	1	91	1.13	3	96
1.19	1	91	1.11	3	97	1.14	1	95
1.17	1	92	1.17	1	92	1.17	1	92
1.18	3	92	1.14	1	95	1.14	1	95
1.19	1	91	1.21	2	89	1.11	1	97
1.17	1	92	1.17	1	92	1.15	1	94
1.15	1	94	1.2	1	90	1.13	2	96
1.19	1	91	1.19	3	91	1.14	1	95
1.23	1	88	1.13	1	96	1.16	1	93
1.15	2	94	1.15	1	94	1.15	1	94
1.17	1	92	1.17	1	92	1.17	3	92
1.18	1	92	1.11	1	97	1.11	1	97
1.16	1	93	1.15	1	94	1.15	1	94
1.13	1	96	1.17	1	92	1.12	1	96
1.15	1	94	1.15	3	94	1.15	1	94
1.16	1	93	1.16	1	93	1.06	2	102
1.15	1	94	1.15	1	94	1.15	1	94
1.18	3	92	1.18	1	92	1.11	1	97
1.21	1	89	1.14	1	95	1.09	1	99
1.19	1	91	1.12	1	96	1.19	1	91
1.15	1	94	1.15	2	94	1.05	3	103
1.11	1	97	1.16	1	93	1.16	1	93
1.12	1	96	1.14	1	95	1.07	1	101
1.14	3	95	1.15	1	94	1.14	1	95
1.19	1	91	1.12	1	96	1.14	1	95
1.15	1	94	1.15	3	94	1.15	1	94
1.12	1	96	1.17	1	92	1.12	1	96
1.16	1	93	1.16	1	93	1.16	3	93
1.23	1	88	1.13	1	96	1.14	1	95
1.18	1	92	1.18	1	92	1.14	1	95
1.19	3	91	1.19	3	91	1.19	1	91
1.19	1	91	1.19	1	91	1.14	3	95
1.11	1	97	1.11	1	97	1.15	1	94

1.01	1	107	1.21	1	89	1.11	1	97
1.1	1	98	1.12	1	96	1.12	1	96
1.13	1	96	1.16	1	93	1.16	2	93
1.18	1	92	1.18	1	92	1.18	1	92
1.15	3	94	1.11	3	97	1.18	1	92
1.18	1	92	1.12	1	96	1.12	1	96
1.15	1	94	1.15	1	94	1.15	1	94
1.18	1	92	1.18	1	92	1.18	2	92
1.15	1	94	1.15	1	94	1.15	1	94
1.13	1	96	1.13	1	96	1.13	1	96
1.16	3	93	1.15	3	94	1.12	1	96
1.17	1	92	1.16	1	93	1.11	1	97
1.13	1	96	1.11	1	97	1.19	2	91
1.19	1	91	1.19	1	91	1.14	1	95
1.12	1	96	1.16	1	93	1.15	1	94
1.16	1	93	1.21	1	89	1.19	2	91
1.17	1	92	1.12	2	96	1.19	1	91
1.23	2	88	1.13	1	96	1.14	1	95
1.13	1	96	1.18	1	92	1.22	1	89
1.14	1	95	1.14	1	95	1.15	1	94
1.17	1	92	1.16	1	93	1.18	1	92
1.18	2	92	1.15	2	94	1.19	1	91
1.1	1	98	1.09	1	99	1.19	3	91
Total	**100**	**Total**	**Total**	**100**		**Total**	**100**	

Station 56+752.3								
Passenger Vehicle			**Buses**			**Trucks**		
Record	**number**	**speed**	**Record**	**number**	**speed**	**Record**	**number**	**speed**
1.21	1	89	1.21	1	89	1.15	1	94
1.09	1	99	1.18	1	92	1.16	1	93
1.1	1	98	1.13	1	96	1.21	1	89
1.11	1	97	1.21	1	89	1.13	1	96
1.12	1	96	1.15	1	94	1.12	1	96
1.14	1	95	1.14	3	95	1.14	3	95
1.19	1	91	1.16	1	93	1.19	1	91
1.17	2	92	1.11	1	97	1.17	1	92
1.12	1	96	1.09	1	99	1.12	1	96
1.17	1	92	1.18	1	92	1.17	1	92
1.16	1	93	1.16	1	93	1.16	2	93
1.12	3	96	1.09	3	99	1.12	1	96
1.15	1	94	1.12	1	96	1.14	1	95
1.2	1	90	1.18	1	92	1.19	1	91
1.16	1	93	1.17	1	92	1.16	1	93
1.13	1	96	1.19	1	91	1.14	1	95
1.13	3	96	1.15	3	94	1.17	3	92
1.14	1	95	1.16	1	93	1.14	1	95
1.17	1	92	1.17	1	92	1.15	1	94
1.15	1	94	1.15	1	94	1.15	1	94
1.16	1	93	1.14	1	95	1.16	1	93
1.19	1	91	1.16	1	93	1.15	3	94
1.14	3	95	1.09	3	99	1.14	1	95
1.17	1	92	1.17	1	92	1.17	1	92
1.14	1	95	1.08	1	100	1.14	1	95
1.19	1	91	1.11	1	97	1.21	1	89
1.15	1	94	1.17	1	92	1.15	1	94
1.13	1	96	1.13	1	96	1.15	3	94
1.14	2	95	1.09	1	99	1.14	1	95
1.17	1	92	1.13	2	96	1.16	1	93
1.15	1	94	1.06	1	102	1.15	1	94
1.17	1	92	1.07	1	101	1.17	1	92
1.16	1	93	1.11	1	97	1.11	2	97
1.15	3	94	1.15	3	94	1.15	1	94
1.12	1	96	1.12	1	96	1.12	1	96
1.15	1	94	1.15	1	94	1.15	1	94
1.14	1	95	1.06	1	102	1.06	1	102
1.15	1	94	1.15	2	94	1.15	3	94
1.11	2	97	1.08	1	100	1.11	1	97
1.09	1	99	1.21	1	89	1.09	1	99
1.19	1	91	1.13	1	96	1.19	1	91

1.15	1	94	1.15	3	94	1.05	1	103
1.16	1	93	1.06	1	102	1.16	3	93
1.17	1	92	1.12	1	96	1.07	1	101
1.14	1	95	1.14	1	95	1.14	1	95
1.12	3	96	1.09	1	99	1.12	1	96
1.14	1	95	1.15	1	94	1.15	1	94
1.13	1	96	1.12	3	96	1.12	1	96
1.16	1	93	1.16	1	93	1.16	3	93
1.15	1	94	1.13	1	96	1.13	1	96
1.14	1	95	1.18	1	92	1.14	1	95
1.09	3	99	1.17	1	92	1.09	1	99
1.14	1	95	1.15	1	94	1.14	1	95
1.15	1	94	1.11	2	97	1.15	1	94
1.11	1	97	1.13	1	96	1.13	3	96
1.12	1	96	1.16	1	93	1.09	1	99
1.16	3	93	1.16	1	93	1.06	1	102
1.13	1	96	1.18	1	92	1.12	1	96
1.18	1	92	1.12	3	96	1.18	1	92
1.12	1	96	1.18	1	92	1.12	1	96
1.15	1	94	1.15	1	94	1.07	2	101
1.18	3	92	1.18	1	92	1.08	1	100
1.15	1	94	1.15	2	94	1.15	1	94
1.13	1	96	1.13	1	96	1.09	1	99
1.12	1	96	1.11	1	97	1.12	1	96
1.19	1	91	1.17	1	92	1.17	1	92
1.13	3	96	1.13	2	96	1.13	2	96
1.14	1	95	1.09	1	99	1.15	1	94
1.17	1	92	1.16	1	93	1.12	1	96
1.16	1	93	1.19	1	91	1.16	1	93
1.19	1	91	1.17	2	92	1.18	1	92
1.14	1	95	1.13	1	96	1.14	3	95
1.22	3	89	1.12	1	96	1.22	1	89
1.15	1	94	1.15	1	94	1.15	1	94
1.17	1	92	1.13	1	96	1.17	1	92
1.16	1	93	1.16	2	93	1.15	1	94
1.14	1	95	1.19	1	91	1.13	2	96
Total	**100**	**Total**	**Total**	**100**		**Total**	**100**	

Station 56+873.5								
Passenger Vehicle			Buses			Trucks		
Record	number	speed	Record	number	speed	Record	number	speed
1.12	1	96	1.18	2	92	1.16	1	93
1.18	1	92	1.09	1	99	1.14	1	95
1.14	1	95	1.15	1	94	1.12	2	96
1.13	1	96	1.13	1	96	1.17	1	92
1.16	1	93	1.12	1	96	1.13	1	96
1.19	3	91	1.08	2	100	1.09	1	99
1.16	1	93	1.16	1	93	1.16	1	93
1.11	1	97	1.15	1	94	1.18	1	92
1.19	1	91	1.17	1	92	1.19	3	91
1.12	1	96	1.14	1	95	1.12	1	96
1.16	3	93	1.16	3	93	1.18	1	92
1.14	1	95	1.12	1	96	1.19	1	91
1.1	1	98	1.19	1	91	1.12	1	96
1.18	1	92	1.08	1	100	1.18	1	92
1.17	2	92	1.16	1	93	1.17	1	92
1.19	1	91	1.14	3	95	1.19	3	91
1.15	1	94	1.15	1	94	1.15	1	94
1.16	2	93	1.17	1	92	1.16	1	93
1.17	1	92	1.27	1	85	1.07	1	101
1.15	1	94	1.15	1	94	1.15	1	94
1.14	1	95	1.14	2	95	1.14	2	95
1.16	3	93	1.19	3	91	1.06	1	102
1.09	1	99	1.11	1	97	1.19	1	91
1.17	1	92	1.17	1	92	1.11	1	97
1.19	1	91	1.14	1	95	1.18	1	92
1.09	1	99	1.11	1	97	1.09	3	99
1.17	1	92	1.17	1	92	1.07	1	101
1.11	1	97	1.13	1	96	1.11	1	97
1.09	3	99	1.19	2	91	1.19	1	91
1.13	1	96	1.13	1	96	1.13	1	96
1.15	1	94	1.15	1	94	1.15	1	94
1.07	1	101	1.17	1	92	1.17	1	92
1.12	1	96	1.11	1	97	1.12	1	96
1.15	1	94	1.15	3	94	1.15	2	94
1.07	3	101	1.17	1	92	1.17	1	92
1.15	1	94	1.15	1	94	1.15	1	94
1.16	1	93	1.16	1	93	1.09	1	99
1.15	1	94	1.15	3	94	1.15	3	94
1.18	1	92	1.11	1	97	1.08	1	100
1.11	2	97	1.14	1	95	1.11	1	97
1.12	1	96	1.12	3	96	1.12	1	96

1.15	1	94	1.15	1	94	1.15	1	94
1.16	1	93	1.17	1	92	1.16	1	93
1.12	1	96	1.14	1	95	1.12	3	96
1.14	1	95	1.15	1	94	1.14	1	95
1.12	3	96	1.12	1	96	1.12	1	96
1.15	1	94	1.16	1	93	1.15	1	94
1.17	1	92	1.17	2	92	1.17	2	92
1.06	1	102	1.16	1	93	1.06	1	102
1.14	1	95	1.13	1	96	1.14	1	95
1.08	1	100	1.18	1	92	1.08	1	100
1.12	1	96	1.09	3	99	1.12	3	96
1.09	3	99	1.19	1	91	1.09	1	99
1.09	1	99	1.11	1	97	1.09	1	99
1.11	1	97	1.21	1	89	1.11	1	97
1.12	1	96	1.12	1	96	1.12	1	96
1.16	1	93	1.16	1	93	1.16	1	93
1.18	3	92	1.18	1	92	1.18	3	92
1.07	1	101	1.08	1	100	1.08	1	100
1.12	1	96	1.12	1	96	1.12	1	96
1.15	1	94	1.09	3	99	1.15	1	94
1.18	1	92	1.08	1	100	1.18	1	92
1.12	2	96	1.05	1	103	1.12	1	96
1.13	1	96	1.13	1	96	1.13	3	96
1.14	1	95	1.12	1	96	1.15	1	94
1.12	1	96	1.16	1	93	1.12	1	96
1.13	1	96	1.11	1	97	1.14	1	95
1.11	2	97	1.21	2	89	1.11	1	97
1.16	1	93	1.16	1	93	1.12	2	96
1.15	1	94	1.09	1	99	1.14	1	95
1.15	1	94	1.18	1	92	1.15	1	94
1.13	3	96	1.17	1	92	1.13	1	96
1.12	1	96	1.19	1	91	1.12	1	96
1.14	1	95	1.17	2	92	1.14	3	95
1.16	1	93	1.16	1	93	1.17	1	92
1.14	1	95	1.14	1	95	1.11	1	97
1.15	1	94	1.21	1	89	1.21	1	89
Total	**100**		**Total**	**100**		**Total**	**100**	

Station 56+640.8								
Passenger Vehicle			**Buses**			**Trucks**		
Record	**number**	**speed**	**Record**	**number**	**speed**	**Record**	**number**	**speed**
1.11	1	97	1.19	1	91	1.18	1	92
1.18	1	92	1.16	1	93	1.16	1	93
1.14	1	95	1.19	1	91	1.11	1	97
1.17	1	92	1.16	1	93	1.11	1	97
1.16	2	93	1.15	1	94	1.15	1	94
1.18	1	92	1.18	3	92	1.14	1	95
1.16	1	93	1.17	1	92	1.17	3	92
1.11	1	97	1.15	1	94	1.12	1	96
1.21	1	89	1.13	1	96	1.22	1	89
1.19	1	91	1.14	2	95	1.17	2	92
1.16	1	93	1.19	1	91	1.16	1	93
1.19	2	91	1.17	1	92	1.12	1	96
1.14	1	95	1.19	1	91	1.14	1	95
1.14	1	95	1.18	1	92	1.18	1	92
1.17	1	92	1.16	1	93	1.16	1	93
1.19	1	91	1.14	1	95	1.17	3	92
1.15	1	94	1.15	3	94	1.15	1	94
1.16	2	93	1.19	1	91	1.14	1	95
1.17	1	92	1.17	1	92	1.17	1	92
1.15	1	94	1.15	1	94	1.15	1	94
1.14	1	95	1.14	1	95	1.16	1	93
1.16	3	93	1.19	1	91	1.13	3	96
1.19	1	91	1.11	3	97	1.14	1	95
1.17	1	92	1.17	1	92	1.17	1	92
1.18	2	92	1.14	1	95	1.14	1	95
1.19	1	91	1.21	2	89	1.11	1	97
1.17	1	92	1.17	1	92	1.15	1	94
1.15	1	94	1.2	1	90	1.13	2	96
1.19	1	91	1.19	3	91	1.14	1	95
1.23	1	88	1.13	1	96	1.16	1	93
1.15	2	94	1.15	1	94	1.15	1	94
1.17	1	92	1.17	1	92	1.17	3	92
1.18	1	92	1.11	1	97	1.11	1	97
1.16	1	93	1.15	1	94	1.15	1	94
1.13	1	96	1.17	1	92	1.12	1	96
1.15	1	94	1.15	3	94	1.15	1	94
1.16	1	93	1.16	1	93	1.06	2	102
1.15	1	94	1.15	1	94	1.15	1	94
1.18	3	92	1.18	1	92	1.11	1	97
1.21	1	89	1.14	1	95	1.09	1	99
1.19	1	91	1.12	1	96	1.19	1	91
1.15	1	94	1.15	2	94	1.15	3	94
1.11	1	97	1.16	1	93	1.16	1	93
1.12	1	96	1.14	1	95	1.07	1	101
1.14	3	95	1.15	1	94	1.14	1	95
1.19	1	91	1.12	1	96	1.14	1	95
1.15	1	94	1.15	3	94	1.15	1	94

1.12	1	96	1.17	1	92	1.12	1	96
1.16	1	93	1.16	1	93	1.16	3	93
1.23	1	88	1.13	1	96	1.14	1	95
1.18	1	92	1.18	1	92	1.14	1	95
1.19	3	91	1.19	3	91	1.19	1	91
1.19	1	91	1.19	1	91	1.14	3	95
1.11	1	97	1.11	1	97	1.15	1	94
1.1	1	98	1.21	1	89	1.11	1	97
1.12	1	96	1.12	1	96	1.12	1	96
1.13	1	96	1.16	1	93	1.16	2	93
1.18	1	92	1.18	1	92	1.18	1	92
1.15	3	94	1.11	3	97	1.18	1	92
1.18	1	92	1.12	1	96	1.12	1	96
1.15	1	94	1.15	1	94	1.15	1	94
1.18	1	92	1.18	1	92	1.18	2	92
1.15	1	94	1.15	1	94	1.15	1	94
1.13	1	96	1.13	1	96	1.13	1	96
1.16	3	93	1.15	3	94	1.12	1	96
1.17	1	92	1.16	1	93	1.11	1	97
1.13	1	96	1.11	1	97	1.19	2	91
1.19	1	91	1.19	1	91	1.14	1	95
1.12	1	96	1.16	1	93	1.15	1	94
1.16	1	93	1.21	1	89	1.19	2	91
1.17	1	92	1.12	2	96	1.19	1	91
1.23	2	88	1.13	1	96	1.14	1	95
1.13	1	96	1.14	1	95	1.22	1	89
1.14	1	95	1.14	1	95	1.15	1	94
1.17	1	92	1.17	1	92	1.11	1	97
1.18	2	92	1.15	2	94	1.19	1	91
1.09	1	99	1.19	1	91	1.13	3	96
1.12	1	96						
1.21	1	89						
1.18	2	92						
Total	**100**		**Total**	**100**		**Total**	**100**	

Station 57+611.4								
Passenger Vehicle			**Buses**			**Trucks**		
Record	**number**	**speed**	**Record**	**number**	**speed**	**Record**	**number**	**speed**
1.22	1	89	1.21	1	89	1.19	1	91
1.18	1	92	1.19	1	91	1.21	1	89
1.24	2	87	1.18	1	92	1.14	1	95
1.17	1	92	1.19	1	91	1.17	3	92
1.16	1	93	1.19	2	91	1.13	1	96
1.19	1	91	1.18	1	92	1.19	1	91
1.16	1	93	1.18	1	92	1.16	1	93
1.15	2	94	1.19	1	91	1.18	1	92
1.19	1	91	1.21	3	89	1.19	1	91
1.17	1	92	1.19	1	91	1.16	2	93
1.16	1	93	1.18	1	92	1.18	1	92
1.14	1	95	1.17	1	92	1.19	2	91
1.15	1	94	1.19	1	91	1.15	1	94
1.18	1	92	1.18	1	92	1.18	1	92
1.17	2	92	1.19	2	91	1.17	1	92
1.19	1	91	1.14	1	95	1.19	1	91
1.15	1	94	1.15	1	94	1.21	2	89
1.16	1	93	1.19	1	91	1.16	1	93
1.17	3	92	1.27	3	85	1.17	1	92
1.15	1	94	1.15	1	94	1.15	1	94
1.14	1	95	1.14	1	95	1.14	1	95
1.16	1	93	1.19	1	91	1.16	1	93
1.09	1	99	1.11	1	97	1.19	3	91
1.17	2	92	1.17	3	92	1.21	1	89
1.19	1	91	1.14	1	95	1.18	1	92
1.09	1	99	1.11	1	97	1.19	1	91
1.17	1	92	1.17	1	92	1.17	1	92
1.11	1	97	1.13	1	96	1.11	1	97
1.09	2	99	1.19	1	91	1.19	1	91
1.13	1	96	1.13	1	96	1.17	1	92
1.15	1	94	1.15	1	94	1.15	3	94
1.17	1	92	1.17	1	92	1.17	1	92
1.12	1	96	1.19	1	91	1.19	1	91
1.15	3	94	1.15	3	94	1.15	1	94
1.21	1	89	1.17	1	92	1.17	1	92
1.15	1	94	1.15	1	94	1.15	1	94
1.16	1	93	1.16	1	93	1.19	1	91
1.15	1	94	1.15	1	94	1.15	3	94
1.2	1	90	1.16	1	93	1.18	1	92
1.21	1	89	1.14	1	95	1.16	1	93
1.12	2	96	1.12	3	96	1.17	1	92

1.15	1	94	1.15	1	94	1.15	1	94
1.26	1	86	1.17	1	92	1.16	1	93
1.12	1	96	1.14	1	95	1.19	2	91
1.24	1	87	1.15	2	94	1.15	1	94
1.12	3	96	1.22	1	89	1.17	1	92
1.15	1	94	1.16	1	93	1.15	1	94
1.17	1	92	1.17	1	92	1.17	1	92
1.16	1	93	1.16	1	93	1.16	3	93
1.14	1	95	1.17	2	92	1.14	1	95
1.17	1	92	1.18	1	92	1.18	1	92
1.12	2	96	1.19	1	91	1.15	1	94
1.11	1	97	1.19	1	91	1.19	1	91
1.19	1	91	1.11	1	97	1.19	2	91
1.11	1	97	1.21	1	89	1.11	1	97
1.12	1	96	1.22	1	89	1.22	1	89
1.16	3	93	1.16	1	93	1.16	1	93
1.18	1	92	1.18	3	92	1.18	1	92
1.17	1	92	1.18	1	92	1.18	3	92
1.12	1	96	1.22	1	89	1.22	1	89
1.15	1	94	1.19	1	91	1.15	1	94
1.18	3	92	1.18	2	92	1.18	1	92
1.17	1	92	1.15	1	94	1.22	1	89
1.13	1	96	1.13	1	96	1.23	3	88
1.14	1	95	1.22	3	89	1.15	1	94
1.16	3	93	1.16	1	93	1.22	1	89
1.19	1	91	1.14	1	95	1.14	1	95
1.14	1	95	1.21	1	89	1.21	2	89
1.14	3	95	1.16	3	93	1.17	1	92
1.16	1	93	1.19	1	91	1.14	1	95
1.19	1	91	1.18	1	92	1.15	1	94
1.13	1	96	1.17	1	92	1.13	3	96
1.15	3	94	1.19	1	91	1.12	1	96
1.17	1	92	1.17	3	92	1.14	1	95
1.16	1	93	1.16	1	93	1.17	1	92
1.19	1	91	1.24	1	87	1.19	1	91
1.21	1	89	1.21	1	89	1.21	2	89
Total	**100**		**Total**	**100**		**Total**	**100**	

Station 57+770.3								
Passenger Vehicle			Buses			Trucks		
Record	number	speed	Record	number	speed	Record	number	speed
1.22	1	89	1.21	1	89	1.18	1	92
1.18	1	92	1.2	1	90	1.21	1	89
1.24	1	87	1.18	1	92	1.24	1	87
1.17	3	92	1.19	1	91	1.17	2	92
1.16	1	93	1.22	1	89	1.23	1	88
1.19	1	91	1.19	2	91	1.19	1	91
1.21	1	89	1.18	1	92	1.16	1	93
1.15	1	94	1.19	1	91	1.18	1	92
1.19	1	91	1.21	1	89	1.19	1	91
1.17	1	92	1.23	1	88	1.16	1	93
1.16	1	93	1.18	1	92	1.18	3	92
1.22	2	89	1.22	1	89	1.19	1	91
1.15	1	94	1.19	3	91	1.22	1	89
1.18	1	92	1.18	1	92	1.18	1	92
1.17	1	92	1.19	1	91	1.17	1	92
1.19	1	91	1.23	1	88	1.19	1	91
1.15	1	94	1.18	1	92	1.21	1	89
1.16	1	93	1.19	1	91	1.16	1	93
1.24	2	87	1.27	1	85	1.17	3	92
1.19	1	91	1.15	1	94	1.15	1	94
1.24	1	87	1.24	1	87	1.24	1	87
1.16	1	93	1.19	3	91	1.16	1	93
1.19	1	91	1.21	1	89	1.19	2	91
1.17	1	92	1.17	1	92	1.21	1	89
1.19	3	91	1.14	1	95	1.18	1	92
1.09	1	99	1.21	1	89	1.19	1	91
1.17	1	92	1.17	1	92	1.17	1	92
1.21	1	89	1.16	1	93	1.21	1	89
1.19	1	91	1.19	1	91	1.19	2	91
1.23	1	88	1.13	3	96	1.17	1	92
1.15	3	94	1.15	1	94	1.19	1	91
1.17	1	92	1.17	1	92	1.17	1	92
1.22	1	89	1.19	1	91	1.19	1	91
1.15	1	94	1.15	1	94	1.15	2	94
1.21	1	89	1.17	1	92	1.17	1	92
1.15	3	94	1.15	1	94	1.18	1	92
1.16	1	93	1.16	1	93	1.19	1	91
1.15	1	94	1.15	2	94	1.17	1	92
1.2	1	90	1.16	1	93	1.18	1	92
1.21	1	89	1.24	1	87	1.16	1	93
1.12	1	96	1.22	1	89	1.17	1	92
1.15	3	94	1.15	2	94	1.15	3	94
1.26	1	86	1.17	1	92	1.16	1	93
1.22	1	89	1.14	1	95	1.19	1	91
1.24	1	87	1.15	2	94	1.19	1	91
1.22	1	89	1.22	1	89	1.17	1	92

1.15	1	94	1.16	1	93	1.15	1	94
1.17	2	92	1.17	1	92	1.17	1	92
1.16	1	93	1.16	1	93	1.16	1	93
1.23	1	88	1.17	1	92	1.14	3	95
1.17	1	92	1.18	1	92	1.18	1	92
1.22	1	89	1.19	3	91	1.15	1	94
1.21	2	89	1.19	1	91	1.19	1	91
1.19	1	91	1.11	1	97	1.19	1	91
1.21	1	89	1.21	1	89	1.21	1	89
1.22	1	89	1.22	1	89	1.22	1	89
1.16	1	93	1.16	1	93	1.19	1	91
1.18	1	92	1.2	1	90	1.18	2	92
1.17	2	92	1.19	3	91	1.18	1	92
1.16	1	93	1.22	1	89	1.22	1	89
1.17	1	92	1.19	1	91	1.25	1	86
1.18	1	92	1.18	1	92	1.18	1	92
1.17	1	92	1.15	1	94	1.22	1	89
1.13	1	96	1.23	1	88	1.23	1	88
1.14	3	95	1.22	3	89	1.25	3	86
1.16	1	93	1.16	1	93	1.22	1	89
1.19	1	91	1.19	1	91	1.24	1	87
1.18	1	92	1.21	1	89	1.21	1	89
1.17	1	92	1.16	1	93	1.17	1	92
1.16	2	93	1.19	1	91	1.24	1	87
1.19	1	91	1.18	3	92	1.15	3	94
1.23	1	88	1.17	1	92	1.23	1	88
1.15	1	94	1.19	1	91	1.22	1	89
1.17	1	92	1.17	1	92	1.24	1	87
1.18	3	92	1.16	1	93	1.17	1	92
1.19	1	91	1.24	2	87	1.19	1	91
1.21	1	89	1.21	1	89	1.21	2	89
1.23	1	88	1.19	1	91	1.2	1	90
1.17	1	92	1.18	1	92	1.21	1	89
1.15	1	94	1.2	1	90	1.19	1	91
			1.23	1	88	1.17	1	92
						1.23	1	88
Total	**100**		**Total**	**100**		**Total**	**100**	

Stations 55+472.2								
Passenger Vehicle			Buses			Trucks		
Record	number	speed	Record	number	speed	Record	number	speed
1.1	1	98	1.12	1	96	1.14	3	95
1	1	108	1.19	3	91	1.19	1	91
1.2	2	90	1.18	1	92	1.11	2	97
1.12	1	96	1.15	1	94	1.13	1	96
1.08	1	100	1.16	1	93	1.04	1	104
1.01	1	107	1.12	3	96	1.08	2	100
1.14	2	95	1.22	1	89	1.13	2	96
1.15	3	94	1.3	2	83	1.27	1	85
1.22	1	89	1.24	1	87	1.16	1	93
1.18	3	92	1.32	1	82	1.08	2	100
1.13	1	96	1.24	1	87	1.11	1	97
1.15	1	94	1.21	3	89	1.18	1	92
1.11	2	97	1.19	2	91	1.14	1	95
1.14	1	95	1.18	1	92	1.29	3	84
1.16	3	93	1.14	1	95	1.11	2	97
1.3	1	83	1.17	1	92	1.26	1	86
1.22	1	89	1.18	1	92	1.16	2	93
1.26	3	86	1.19	3	91	1.14	1	95
1.09	1	99	1.2	1	90	1.16	1	93
1.12	1	96	1.13	1	96	1.17	2	92
1.18	2	92	1.15	3	94	1.2	1	90
1.15	1	94	1.17	1	92	1.16	1	93
1.07	2	101	1.18	1	92	1.12	2	96
1.04	1	104	1.28	2	84	1.14	1	95
1.09	2	99	1.27	3	85	1.3	2	83
1.28	2	84	1.23	1	88	1.32	3	82
1.22	1	89	1.26	2	86	1.12	1	96
1.18	1	92	1.27	1	85	1.15	1	94
1.06	1	102	1.17	1	92	1.16	2	93
1.07	3	101	1.13	2	96	1.12	1	96
1.01	1	107	1.12	3	96	1.23	1	88
1.03	1	105	1.09	1	99	1.11	3	97
1.06	3	102	1.11	3	97	1.09	1	99
1.09	1	99	1.12	1	96	1.21	1	89
1.04	2	104	1.15	1	94	1.14	1	95
1.05	1	103	1.08	2	100	1.28	2	84
1.12	3	96	1.12	2	96	1.29	1	84

1.11	1	97	1.18	1	92	1.3	1	83
1.13	1	96	1.13	1	96	1.32	1	82
1.14	2	95	1.15	2	94	1.35	1	80
1.18	2	92	1.24	1	87	1.24	3	87
1.17	2	92	1.26	1	86	1.34	1	81
1.12	1	96	1.28	1	84	1.23	1	88
1.08	2	100	1.32	3	82	1.35	1	80
1.04	1	104	1.29	1	84	1.25	1	86
1.06	1	102	1.27	1	85	1.24	3	87
1.21	3	89	1.17	1	92	1.21	1	89
1.12	1	96	1.13	2	96	1.31	1	82
1.1	1	98	1.14	1	95	1.1	2	98
1.12	1	96	1.15	2	94	1.13	1	96
1.18	1	92	1.14	1	95	1.15	1	94
1.2	2	90	1.23	2	88	1.21	2	89
1.18	1	92	1.19	1	91	1.17	1	92
1.11	2	97	1.2	1	90	1.12	2	96
1.12	1	96	1.23	1	88	1.18	1	92
1.28	2	84	1.25	3	86	1.16	1	93
1.29	1	84	1.22	1	89	1.29	3	84
1.19	1	91	1.27	1	85	1.28	1	84
1.07	1	101	1.15	1	94	1.23	1	88
1.2	2	90	1.17	1	92	1.35	2	80
1.14	1	95	1.34	2	81	1.25	1	86
1.17	1	92	1.36	2	79	1.28	1	84
1.19	2	91	1.3	1	83	1.21	2	89
1.21	1	89	1.15	1	94	1.12	1	96
1.25	1	86	1.13	1	96	1.13	3	96
1.27	1	85	1.14	1	95	1.17	1	92
1.29	1	84	1.21	1	89	1.22	1	89
						1.24	1	87
Total	**100**	**Total**	**Total**	**100**		**Total**	**100**	

APPENDIX B

Data Analysis for 85th percentile speeds

Station 51+581.9														
Passenger Vehicles					**Buses**					**Trucks**				
V	**f**	**fc**	**fc%**	**V%**	**V**	**f**	**fc**	**fc%**	**V%**	**V**	**f**	**fc**	**fc%**	**V%**
100	1	1	1	1%	95	2	2	2	2%	95	1	1	1	1%
101	1	2	2	2%	98	1	3	3	3%	100	1	2	2	2%
102	2	4	4	4%	99	1	4	4	4%	101	1	3	3	3%
104	1	5	5	5%	100	2	6	6	6%	102	7	10	10	10%
105	2	7	7	7%	101	3	9	9	9%	103	8	18	18	18%
106	3	10	10	10%	102	1	10	10	10%	105	8	26	26	26%
108	5	15	15	15%	103	3	13	13	13%	106	9	35	35	35%
109	2	17	17	17%	105	1	14	14	14%	107	5	40	40	40%
110	1	18	18	18%	106	2	16	16	16%	108	17	57	57	57%
111	1	19	19	19%	107	1	17	17	17%	109	5	62	62	62%
112	3	22	22	22%	108	5	22	22	22%	110	8	70	70	70%
113	7	29	29	29%	109	2	24	24	24%	111	3	73	73	73%
114	3	32	32	32%	110	4	28	28	28%	112	7	80	80	80%
115	10	42	42	42%	111	7	35	35	35%	113	7	87	87	87%
116	4	46	46	46%	112	6	41	41	41%	114	1	88	88	88%
117	6	52	52	52%	113	7	48	48	48%	115	6	94	94	94%
118	10	62	62	62%	114	3	51	51	51%	116	3	97	97	97%
119	4	66	66	66%	115	6	57	57	57%	120	2	99	99	99%
120	6	72	72	72%	116	9	66	66	66%	124	1	100	100	100%
121	2	74	74	74%	117	4	70	70	70%					
122	4	78	78	78%	118	11	81	81	81%					
123	1	79	79	79%	119	4	85	85	85%					
124	5	84	84	84%	120	6	91	91	91%					
125	2	86	86	86%	121	2	93	93	93%					
126	4	90	90	90%	122	5	98	98	98%					
127	5	95	95	95%	124	1	99	99	99%					
128	3	98	98	98%	126	1	100	100	100%					
129	2	100	100	100%										
V85	**125Kph**				**V85**	**119Kph**				**V85**	**113Kph**			

Station 51+581.9														
Passenger Vehicles					Buses					Trucks				
V	**f**	**V^2**	**Vf**	**V^2f**	**V**	**f**	**V^2**	**Vf**	**V^2f**	**V**	**f**	**V^2**	**Vf**	**V^2f**
100	1	10000	100	10000	95	2	8975	189	17950	95	1	8975	95	8975
101	1	10201	101	10201	98	1	9604	98	9604	100	1	10000	100	10000
102	2	10404	204	20808	99	1	9781	99	9781	101	1	10226	101	10226
104	1	10816	104	10816	100	2	10000	200	20000	102	7	10342	712	72393
105	2	11025	210	22050	101	3	10226	303	30678	103	8	10580	823	84637
106	3	11236	318	33708	102	1	10342	102	10342	105	8	10952	837	87615
108	5	11664	540	58320	103	3	10580	309	31739	106	9	11236	954	101124
109	2	11881	218	23762	105	1	11080	105	11080	107	5	11344	533	56721
110	1	12100	110	12100	106	2	11211	212	22422	108	17	11664	1836	198288
111	1	12321	111	12321	107	1	11480	107	11480	109	5	11881	545	59405
112	3	12544	336	37632	108	5	11617	539	58087	110	8	12100	880	96800
113	7	12769	791	89383	109	2	11901	218	23802	111	3	12321	333	36963
114	3	12996	342	38988	110	4	12046	439	48186	112	7	12544	784	87808
115	10	13225	1150	132250	111	7	12346	778	86420	113	7	12769	791	89383
116	4	13456	464	53824	112	6	12500	671	74997	114	1	12996	114	12996
117	6	13689	702	82134	113	7	12656	788	88594	115	6	13225	690	79350
118	10	13924	1180	139240	114	3	12979	342	38936	116	3	13456	348	40368
119	4	14161	476	56644	115	6	13145	688	78867	120	2	14400	240	28800
120	6	14400	720	86400	116	9	13486	1045	121374	124	1	15376	124	15376
121	2	14641	242	29282	117	4	13662	468	54647					
122	4	14884	488	59536	118	11	13841	1294	152249					
123	1	15129	123	15129	119	4	14161	476	56644					
124	5	15376	620	76880	120	6	14400	720	86400					
125	2	15625	250	31250	121	2	14641	242	29282					
126	4	15876	504	63504	122	5	14884	610	74420					
127	5	16129	635	80645	124	1	15376	124	15376					
128	3	16384	384	49152										
129	2	16641	258	33282										
∑					∑					∑				

100	**373497**	**11681**	**1369241**

100	**332795**	**11291**	**1279232**

100	**226387**	**10839**	**1177227**

Passenger Vehicles		**Buses**			**Trucks**	
S^2=	48.317071	**S2=**	44.373583		**S^2=**	23.3882
St. dev.	6.951048173	**St. dev.**	6.66135		**St. dev.**	4.83613
mean=	116.81	**mean=**	112.90878		**mean=**	108.393
operating speed	**124.761**	**operating speed=**		**119.5**	**operating speed**	**113.229**

Station 51+318.2														
Passenger Vehicles					Buses					Trucks				
V	**f**	**fc**	**fc%**	**V%**	**V**	**f**	**fc**	**fc%**	**V%**	V	f	fc	fc%	V%
93	1	1	1	1	95	1	1	1	1	93	2	2	2	2
94	1	2	2	2	96	1	2	2	2	94	4	6	6	6
95	1	3	3	3	99	1	3	3	3	95	1	7	7	7
96	2	5	5	5	100	2	5	5	5	96	7	14	14	14
97	1	6	6	6	101	3	8	8	8	98	3	17	17	17
99	1	7	7	7	102	4	12	12	12	99	2	19	19	19
100	1	8	8	8	103	1	13	13	13	100	3	22	22	22
101	1	9	9	9	104	1	14	14	14	101	6	28	28	28
102	1	10	10	10	105	4	18	18	18	102	6	34	34	34
103	1	11	11	11	106	6	24	24	24	103	7	41	41	41
105	2	13	13	13	107	1	25	25	25	104	3	44	44	44
106	3	16	16	16	108	7	32	32	32	105	7	51	51	51
107	1	17	17	17	109	7	39	39	39	106	2	53	53	53
108	6	23	23	23	110	9	48	48	48	107	6	59	59	59
109	1	24	24	24	111	6	54	54	54	108	12	71	71	71
110	5	29	29	29	112	5	59	59	59	109	1	72	72	72
111	2	31	31	31	113	10	69	69	69	110	5	77	77	77
112	3	34	34	34	114	3	72	72	72	111	5	82	82	82
113	9	43	43	43	115	7	79	79	79	113	3	85	85	85
114	1	44	44	44	116	8	87	87	87	114	2	87	87	87
115	14	58	58	58	117	3	90	90	90	115	1	88	88	88
116	2	60	60	60	120	3	93	93	93	117	1	89	89	89
117	3	63	63	63	121	5	98	98	98	118	3	92	92	92
118	8	71	71	71	124	2	100	100	100	121	1	93	93	93
119	3	74	74	74						122	4	97	97	97
120	7	81	81	81						126	3	100	100	100
121	2	83	83	83							100			
122	6	89	89	89										
123	1	90	90	90										
124	5	95	95	95										
126	1	96	96	96										
128	1	97	97	97										
129	1	98	98	98										
134	1	99	99	99										
136	1	100	100	100										
	100													
85th speed	**121Kph**				**85th speed**	**115Kph**				**85th speed**	**113Kph**			

Stations 55+472.2														
Passenger Vehicles					**Buses**					**Trucks**				
V	**f**	**fc**	**fc%**	**V%**	**V**	**f**	**fc**	**fc%**	**V%**	V	f	fc	fc%	V%
83	1	1	1	1%	79	2	2	2	2%	80	4	4	4	4%
84	6	7	7	7%	81	2	4	4	4%	81	1	5	5	5%
85	1	8	8	8%	82	4	8	8	8%	82	5	10	10	10%
86	4	12	12	12%	83	3	11	11	11%	83	3	13	13	13%
89	7	19	19	19%	84	4	15	15	15%	84	11	24	24	24%
90	6	25	25	25%	85	6	21	21	21%	85	1	25	25	25%
91	3	28	28	28%	86	6	27	27	27%	86	3	28	28	28%
92	13	41	41	41%	87	3	30	30	30%	87	7	35	35	35%
93	3	44	44	44%	88	4	34	34	34%	88	3	38	38	38%
94	5	49	49	49%	89	6	40	40	40%	89	7	45	45	45%
95	6	55	55	55%	90	2	42	42	42%	90	1	46	46	46%
96	11	66	66	66%	91	9	51	51	51%	91	1	47	47	47%
97	5	71	71	71%	92	10	61	61	61%	92	6	53	53	53%
98	2	73	73	73%	93	1	62	62	62%	93	8	61	61	61%
99	4	77	77	77%	94	11	73	73	73%	94	2	63	63	63%
100	3	80	80	80%	95	4	77	77	77%	95	7	70	70	70%
101	6	86	86	86%	96	17	94	94	94%	96	14	84	84	84%
102	5	91	91	91%	97	3	97	97	97%	97	8	92	92	92%
103	1	92	92	92%	99	1	98	98	98%	98	2	94	94	94%
104	4	96	96	96%	100	2	100	100	100%	99	1	95	95	95%
105	1	97	97	97%						100	4	99	99	99%
107	2	99	99	99%						104	1	100	100	100%
108	1	100	100	100%							100			
	100													
85th speed	**101Kph**				**85th speed**	**96Kph**				**85th speed**	**95Kph**			

Station 55+588.2														
Passenger Vehicles					**Buses**					**Trucks**				
V	**f**	**fc**	**fc%**	**V%**	**V**	**f**	**fc**	**fc%**	**V%**	V	f	fc	fc%	V%
82	2	2	2	2	79	2	2	2	2	80	1	1	1	1
83	1	3	3	3	81	2	4	4	4	81	1	2	2	2
84	3	6	6	6	84	6	10	10	10	82	5	7	7	7
85	1	7	7	7	85	3	13	13	13	83	2	9	9	9
86	1	8	8	8	86	5	18	18	18	84	7	16	16	16
87	1	9	9	9	87	2	20	20	20	86	7	23	23	23
89	7	16	16	16	88	2	22	22	22	87	6	29	29	29
90	4	20	20	20	89	6	28	28	28	88	3	32	32	32
91	3	23	23	23	90	2	30	30	30	89	8	40	40	40
92	11	34	34	34	91	3	33	33	33	90	1	41	41	41
93	5	39	39	39	92	17	50	50	50	92	8	49	49	49
94	3	42	42	42	93	5	55	55	55	93	7	56	56	56
95	3	45	45	45	94	7	62	62	62	94	4	60	60	60
96	13	58	58	58	95	3	65	65	65	95	6	66	66	66
97	6	64	64	64	96	16	81	81	81	96	11	77	77	77
98	1	65	65	65	97	2	83	83	83	97	5	82	82	82
99	2	67	67	67	98	3	86	86	86	98	2	84	84	84
100	6	73	73	73	99	4	90	90	90	99	4	88	88	88
101	3	76	76	76	100	1	91	91	91	100	4	92	92	92
102	7	83	83	83	103	2	93	93	93	101	1	93	93	93
103	5	88	88	88	104	1	94	94	94	102	1	94	94	94
104	3	91	91	91	105	3	97	97	97	104	3	97	97	97
105	1	92	92	92	106	3	100	100	100	105	3	100	100	100
106	3	95	95	95		100					100			
107	5	100	100	100										
	100													
85th speed	**102Kph**				**85th speed**	**98Kph**				**85th speed**	**98Kph**			

Station 55+581.9														
Passenger Vehicles					**Buses**					**Trucks**				
V	**f**	**fc**	**fc%**	**V%**	**V**	**f**	**fc**	**fc%**	**V%**	V	f	fc	fc%	V%
82	1	1	1	1	82	4	4	4	4	80	1	1	1	1
84	9	10	10	10	83	2	6	6	6	82	1	2	2	2
85	1	11	11	11	84	6	12	12	12	84	10	12	12	12
86	4	15	15	15	85	7	19	19	19	85	1	13	13	13
87	2	17	17	17	86	7	26	26	26	86	4	17	17	17
89	9	26	26	26	87	13	39	39	39	87	6	23	23	23
90	4	30	30	30	88	4	43	43	43	88	6	29	29	29
91	4	34	34	34	89	3	46	46	46	89	13	42	42	42
92	19	53	53	53	90	1	47	47	47	91	1	43	43	43
93	8	61	61	61	91	5	52	52	52	92	11	54	54	54
94	6	67	67	67	92	13	65	65	65	93	13	67	67	67
95	6	73	73	73	94	12	77	77	77	94	6	73	73	73
96	12	85	85	85	95	4	81	81	81	95	8	81	81	81
97	10	95	95	95	96	12	93	93	93	96	15	96	96	96
98	2	97	97	97	97	4	97	97	97	97	3	99	99	99
100	3	100	100	100	99	1	98	98	98	99	1	100	100	100
	100				100	2	100	100	100		100			
						100								
85th speed	**96Kph**				**85th speed**	**95Kph**				**85th speed**	**95Kph**			
Station 52+318.2														
Passenger Vehicles					**Buses**					**Trucks**				
V	**f**	**fc**	**fc%**	**V%**	**V**	**f**	**fc**	**fc%**	**V%**	V	f	fc	fc%	V%
81	1	1	1	1	81	4	4	4	4	84	3	3	3	3
82	3	4	4	4	82	1	5	5	5	85	8	11	11	11
83	2	6	6	6	84	5	10	10	10	86	2	13	13	13
84	1	7	7	7	86	3	13	13	13	87	10	23	23	23
86	7	14	14	14	87	11	24	24	24	88	10	33	33	33
87	3	17	17	17	88	7	31	31	31	89	13	46	46	46
88	9	26	26	26	89	10	41	41	41	90	1	47	47	47
89	12	38	38	38	90	3	44	44	44	91	2	49	49	49
90	2	40	40	40	91	2	46	46	46	92	6	55	55	55
91	4	44	44	44	92	12	58	58	58	93	9	64	64	64
92	13	57	57	57	93	4	62	62	62	94	5	69	69	69
93	4	61	61	61	94	6	68	68	68	95	7	76	76	76
94	10	71	71	71	95	7	75	75	75	96	13	89	89	89
95	8	79	79	79	96	16	91	91	91	97	6	95	95	95
96	12	91	91	91	97	3	94	94	94	99	2	97	97	97
97	3	94	94	94	99	3	97	97	97	100	2	99	99	99
99	2	96	96	96	100	2	99	99	99	101	1	100	100	100
100	3	99	99	99	101	1	100	100	100		100			
101	1	100	100	100		100								
	100													
85th speed	**121Kph**				**85th speed**	**115Kph**				**85th speed**	**113Kph**			

Station 56+163.5														
Passenger Vehicles					**Buses**					**Trucks**				
V	**f**	**fc**	**fc%**	**V%**	**V**	**f**	**fc**	**fc%**	**V%**	V	f	fc	fc%	V%
92	1	1	1	1	86	1	1	1	1	89	1	1	1	1
93	4	5	5	5	91	1	2	2	2	91	2	3	3	3
94	3	8	8	8	92	3	5	5	5	92	9	12	12	12
95	1	9	9	9	93	8	13	13	13	93	1	13	13	13
96	2	11	11	11	94	5	18	18	18	94	7	20	20	20
97	1	12	12	12	96	9	27	27	27	95	5	25	25	25
99	9	21	21	21	97	12	39	39	39	96	18	43	43	43
100	11	32	32	32	99	6	45	45	45	97	12	55	55	55
101	13	45	45	45	100	6	51	51	51	99	4	59	59	59
102	9	54	54	54	101	11	62	62	62	100	3	62	62	62
103	9	63	63	63	102	7	69	69	69	101	3	65	65	65
104	3	66	66	66	103	9	78	78	78	102	9	74	74	74
103	9	75	75	75	104	9	87	87	87	103	10	84	84	84
104	3	78	78	78	105	4	91	91	91	104	4	88	88	88
105	6	84	84	84	106	7	98	98	98	105	5	93	93	93
106	6	90	90	90	107	2	100	100	100	106	4	97	97	97
107	10	100	100	100		100				107	3	100	100	100
	100										100			
85th speed	**105Kph**				**85th speed**	**103Kph**				**85th speed**	**103Kph**			
Station 56+590.4														
Passenger Vehicles					**Buses**					**Trucks**				
V	**f**	**fc**	**fc%**	**V%**	**V**	**f**	**fc**	**fc%**	**V%**	**V**	**f**	**fc**	**fc%**	**V%**
88	3	3	3	3	89	5	5	5	5	89	2	2	2	2
89	4	7	7	7	91	13	18	18	18	91	11	13	13	13
91	15	22	22	22	92	17	35	35	35	92	17	30	30	30
92	23	45	45	45	93	10	45	45	45	93	11	41	41	41
93	9	54	54	54	94	25	70	70	70	94	13	54	54	54
94	21	75	75	75	95	8	78	78	78	95	19	73	73	73
95	6	81	81	81	96	11	89	89	89	96	14	87	87	87
96	10	91	91	91	97	9	98	98	98	97	7	94	94	94
97	6	97	97	97	99	2	100	100	100	99	1	95	95	95
98	2	99	99	99		100				101	1	96	96	96
107	1	100	100	100						102	1	97	97	97
	100									103	3	100	100	100
											100			
85th speed	**95Kph**				**85th speed**	**95Kph**				**85th speed**	**95Kph**			

Station 56+752.3														
Passenger Vehicles					Buses					Trucks				
V	**f**	**fc**	**fc%**	**V%**	**V**	**f**	**fc**	**fc%**	**V%**	V	f	fc	fc%	V%
82	4	4	4	4	80	1	1	1	1	89	4	4	4	4
83	2	6	6	6	82	1	2	2	2	90	1	5	5	5
84	6	12	12	12	84	10	12	12	12	91	6	11	11	11
85	7	19	19	19	85	1	13	13	13	92	14	25	25	25
86	7	26	26	26	86	4	17	17	17	93	11	36	36	36
87	13	39	39	39	87	6	23	23	23	94	15	51	51	51
88	4	43	43	43	88	6	29	29	29	95	16	67	67	67
89	3	46	46	46	89	13	42	42	42	96	23	90	90	90
90	1	47	47	47	91	1	43	43	43	97	4	94	94	94
91	5	52	52	52	92	11	54	54	54	98	1	95	95	95
92	13	65	65	65	93	13	67	67	67	99	5	100	100	100
94	12	77	77	77	94	6	73	73	73		100			
95	4	81	81	81	95	8	81	81	81					
96	12	93	93	93	96	15	96	96	96					
97	4	97	97	97	97	3	99	99	99					
99	1	98	98	98	99	1	100	100	100					
100	2	100	100	100		100								
	100													
85th speed	**97Kph**				**85th speed**	**96Kph**				**85th speed**	**95Kph**			
Station 56+873.5														
Passenger Vehicles					Buses					Trucks				
V	**f**	**fc**	**fc%**	**V%**	**V**	**f**	**fc**	**fc%**	**V%**	V	f	fc	fc%	V%
91	5	5	5	5	85	1	1	1	1	89	1	1	1	1
92	13	18	18	18	89	4	5	5	5	91	9	10	10	10
93	15	33	33	33	91	8	13	13	13	92	12	22	22	22
94	12	45	45	45	92	16	29	29	29	93	5	27	27	27
95	8	53	53	53	93	12	41	41	41	94	14	41	41	41
96	24	77	77	77	94	14	55	55	55	95	13	54	54	54
97	8	85	85	85	95	10	65	65	65	96	26	80	80	80
98	1	86	86	86	96	16	81	81	81	97	6	86	86	86
99	7	93	93	93	97	6	87	87	87	99	7	93	93	93
100	1	94	94	94	99	7	94	94	94	100	3	96	96	96
101	5	99	99	99	100	5	99	99	99	101	2	98	98	98
102	1	100	100	100	103	1	100	100	100	102	2	100	100	100
	100					100					100			
85th speed	**97Kph**				**85th speed**	**97Kph**				**85th speed**	**96Kph**			

Station														
Passenger Vehicles					Buses					Trucks				
V	f	fc	fc%	V%	V	f	fc	fc%	V%	V	f	fc	fc%	V%
88	4	4	4	88	88	4	4	4	4	89	2	2	2	2
89	3	7	7	89	89	1	5	5	5	91	8	10	10	10
91	14	21	21	91	91	15	20	20	20	92	20	30	30	30
92	25	46	46	92	92	15	35	35	35	93	10	40	40	40
93	16	62	62	93	93	11	46	46	46	94	17	57	57	57
94	14	76	76	94	94	25	71	71	71	95	15	72	72	72
95	8	84	84	95	95	9	80	80	80	96	16	88	88	88
96	10	94	94	96	96	11	91	91	91	97	8	96	96	96
97	4	98	98	97	97	9	100	100	100	99	1	97	97	97
98	1	99	99	98	98	100				101	1	98	98	98
99	1	100	100	99	99					102	2	100	100	100
	100										100			
85th speed	**95Kph**				**85th speed**	**95Kph**				**85th speed**	**95Kph**			
Station 57+611.4														
Passenger Vehicles					**Buses**					**Trucks**				
V	**f**	**fc**	**fc%**	**V%**	**V**	**f**	**fc**	**fc%**	**V%**	**V**	**f**	**fc**	**fc%**	**V%**
86	3	3	3	3	85	3	3	3	3	88	3	3	3	3
87	3	6	6	6	87	1	4	4	4	89	12	15	15	15
89	4	10	10	10	89	13	17	17	17	91	19	34	34	34
90	3	13	13	13	91	18	35	35	35	92	25	59	59	59
91	7	20	20	20	92	28	63	63	63	93	11	70	70	70
92	21	41	41	41	93	10	73	73	73	94	17	87	87	87
93	15	56	56	56	94	12	85	85	85	95	6	93	93	93
94	17	73	73	73	95	6	91	91	91	96	5	98	98	98
95	7	80	80	80	96	6	97	97	97	97	2	100	100	100
96	14	94	94	94	97	3	100	100	100		100			
97	3	97	97	97		100								
99	3	100	100	100										
	100													
85th speed	**95Kph**				**85th speed**	**94Kph**				**85th speed**	**94Kph**			

Station 57+770.3														
Passenger Vehicles					**Buses**					**Trucks**				
V	**f**	**fc**	**fc%**	**V%**	**V**	**f**	**fc**	**fc%**	**V%**	V	f	fc	fc%	V%
88	3	3	3	3	88	1	1	1	1	89	5	5	5	5
89	9	12	12	12	89	7	8	8	8	91	19	24	24	24
91	17	29	29	29	90	2	10	10	10	92	26	50	50	50
92	34	63	63	63	91	20	30	30	30	93	18	68	68	68
93	16	79	79	79	92	27	57	57	57	94	17	85	85	85
94	16	95	95	95	93	12	69	69	69	95	13	98	98	98
95	2	97	97	97	94	21	90	90	90	96	1	99	99	99
96	2	99	99	99	95	6	96	96	96	99	1	100	100	100
97	1	100	100	100	96	3	99	99	99		100			
	100				97	1	100	100	100					
						100								
85th speed	**94Kph**				**85th speed**	**93Kph**				**85th speed**	**93Kph**			
Station 56+673.5														
Passenger Vehicles					**Buses**					**Trucks**				
V	**f**	**fc**	**fc%**	**V%**	**V**	**f**	**fc**	**fc%**	**V%**	V	f	fc	fc%	V%
86	1	1	1	1	85	1	1	1	1	86	4	4	4	4
87	6	7	7	7	87	4	5	5	5	87	5	9	9	9
88	4	11	11	11	88	4	9	9	9	88	4	13	13	13
89	15	26	26	26	89	16	25	25	25	89	15	28	28	28
90	1	27	27	27	90	3	28	28	28	90	1	29	29	29
91	13	40	40	40	91	26	54	54	54	91	19	48	48	48
92	26	66	66	66	92	20	74	74	74	92	31	79	79	79
93	11	77	77	77	93	9	83	83	83	93	7	86	86	86
94	17	94	94	94	94	11	94	94	94	94	11	97	97	97
95	3	97	97	97	95	2	96	96	96	95	3	100	100	100
96	2	99	99	99	96	3	99	99	99		100			
99	1	100	100	100	97	1	100	100	100					
	100													
85th speed	**93Kph**				**85th speed**	**93Kph**				**85th speed**	**93Kph**			

Station 58+472.7														
Passenger Vehicles					**Buses**					**Trucks**				
V	**f**	**fc**	**fc%**	**V%**	**V**	**f**	**fc**	**fc%**	**V%**	V	f	fc	fc%	V%
86	2	2	2	2	87	6	6	6	6	87	4	4	4	4
87	9	11	11	11	88	12	18	18	18	88	4	8	8	8
88	4	15	15	15	89	18	36	36	36	89	20	28	28	28
89	21	36	36	36	90	4	40	40	40	90	2	30	30	30
90	1	37	37	37	91	22	62	62	62	91	12	42	42	42
91	16	53	53	53	92	28	90	90	90	92	33	75	75	75
92	23	76	76	76	93	6	96	96	96	93	19	94	94	94
93	12	88	88	88	94	4	100	100	100	94	3	97	97	97
94	8	96	96	96		100				95	3	100	100	100
95	4	100	100	100							100			
	100													
85th speed	**93Kph**				**85th speed**	**92Kph**				**85th speed**	**92Kph**			
Stations 58+217.4														
Passenger Vehicles					**Buses**					**Trucks**				
V	**f**	**fc**	**fc%**	**V%**	**V**	**f**	**fc**	**fc%**	**V%**	V	f	fc	fc%	V%
100	1	1	1	1	95	2	2	2	2	95	1	1	1	1
101	1	2	2	2	99	1	3	3	3	101	1	2	2	2
102	2	4	4	4	100	3	6	6	6	102	6	8	8	8
104	1	5	5	5	101	2	8	8	8	103	5	13	13	13
105	2	7	7	7	102	1	9	9	9	105	6	19	19	19
106	6	13	13	13	103	3	12	12	12	106	7	26	26	26
108	10	23	23	23	105	1	13	13	13	107	4	30	30	30
109	1	24	24	24	106	3	16	16	16	108	16	46	46	46
110	2	26	26	26	107	1	17	17	17	109	6	52	52	52
111	2	28	28	28	108	4	21	21	21	110	9	61	61	61
112	2	30	30	30	109	3	24	24	24	111	5	66	66	66
113	6	36	36	36	110	5	29	29	29	112	8	74	74	74
114	2	38	38	38	111	6	35	35	35	113	6	80	80	80
115	13	51	51	51	112	4	39	39	39	114	2	82	82	82
116	3	54	54	54	113	6	45	45	45	115	10	92	92	92
117	5	59	59	59	114	5	50	50	50	116	4	96	96	96
118	10	69	69	69	115	8	58	58	58	120	1	97	97	97
119	3	72	72	72	116	8	66	66	66	124	3	100	100	100
120	4	76	76	76	117	4	70	70	70		100			
122	4	80	80	80	118	13	83	83	83					
123	1	81	81	81	119	5	88	88	88					
124	7	88	88	88	120	5	93	93	93					
125	1	89	89	89	121	2	95	95	95					
126	4	93	93	93	122	3	98	98	98					
127	4	97	97	97	124	1	99	99	99					
128	3	100	100	100	126	1	100	100	100					
	100					100								
85th speed	**124Kph**				**85th speed**	**118Kph**				**85th speed**	**114Kph**			

Station 58+037.4														
Passenger Vehicles					**Buses**					**Trucks**				
V	**f**	**fc**	**fc%**	**V%**	**V**	**f**	**fc**	**fc%**	**V%**	V	f	fc	fc%	V%
103	3	3	3	3	102	2	2	2	2	1	1	1	1	101
105	13	16	16	16	103	4	6	6	6	5	6	6	6	102
106	2	18	18	18	104	4	10	10	10	4	10	10	10	103
107	14	32	32	32	105	12	22	22	22	14	24	24	24	105
108	12	44	44	44	106	7	29	29	29	4	28	28	28	106
109	8	52	52	52	107	7	36	36	36	14	42	42	42	107
110	9	61	61	61	108	18	54	54	54	17	59	59	59	108
111	5	66	66	66	109	8	62	62	62	7	66	66	66	109
112	3	69	69	69	110	6	68	68	68	7	73	73	73	110
113	6	75	75	75	111	5	73	73	73	10	83	83	83	111
114	8	83	83	83	112	8	81	81	81	2	85	85	85	112
115	11	94	94	94	113	3	84	84	84	4	89	89	89	113
116	1	95	95	95	114	2	86	86	86	6	95	95	95	114
117	4	99	99	99	115	13	99	99	99	3	98	98	98	115
118	1	100	100	100	117	1	100	100	100	2	100	100	100	116
	100					100				100				
85th speed	**114Kph**				**85th speed**	**114Kph**				**85th speed**	**114Kph**			
Station 59+006														
Passenger Vehicles					**Buses**					**Trucks**				
V	**f**	**fc**	**fc%**	**V%**	**V**	**f**	**fc**	**fc%**	**V%**	V	f	fc	fc%	V%
82	3	3	3	3	82	1	1	1	1	80	3	3	3	3
84	9	12	12	12	84	6	7	7	7	82	2	5	5	5
85	1	13	13	13	85	5	12	12	12	84	8	13	13	13
86	2	15	15	15	86	6	18	18	18	85	2	15	15	15
87	1	16	16	16	87	13	31	31	31	86	5	20	20	20
89	18	34	34	34	88	3	34	34	34	87	4	24	24	24
90	3	37	37	37	89	5	39	39	39	88	6	30	30	30
91	10	47	47	47	90	1	40	40	40	89	15	45	45	45
92	26	73	73	73	91	11	51	51	51	90	1	46	46	46
93	7	80	80	80	92	23	74	74	74	91	5	51	51	51
94	5	85	85	85	93	3	77	77	77	92	13	64	64	64
95	6	91	91	91	94	9	86	86	86	93	15	79	79	79
96	5	96	96	96	95	4	90	90	90	94	4	83	83	83
97	4	100	100	100	96	10	100	100	100	95	8	91	91	91
	100					100				96	9	100	100	100
											100			
85th speed	**95Kph**				**85th speed**	**94Kph**				**85th speed**	**94Kph**			

Station 60+195.5														
Passenger Vehicles					**Buses**					**Trucks**				
V	**f**	**fc**	**fc%**	**V%**	**V**	**f**	**fc**	**fc%**	**V%**	V	f	fc	fc%	V%
83	1	1	1	1	79	1	1	1	1	80	1	1	1	1
84	5	6	6	6	81	1	2	2	2	82	2	3	3	3
85	1	7	7	7	84	4	6	6	6	83	2	5	5	5
86	1	8	8	8	85	5	11	11	11	84	7	12	12	12
87	1	9	9	9	86	4	15	15	15	86	8	20	20	20
89	17	26	26	26	87	3	18	18	18	87	2	22	22	22
90	3	29	29	29	88	2	20	20	20	88	4	26	26	26
91	7	36	36	36	89	11	31	31	31	89	23	49	49	49
92	29	65	65	65	90	4	35	35	35	90	1	50	50	50
93	8	73	73	73	91	6	41	41	41	91	9	59	59	59
94	12	85	85	85	92	30	71	71	71	92	22	81	81	81
95	5	90	90	90	93	14	85	85	85	93	12	93	93	93
96	9	99	99	99	94	8	93	93	93	94	6	99	99	99
97	1	100	100	100	95	3	96	96	96	96	1	100	100	100
	100				96	4	100	100	100		100			
						100								
85th speed	**94Kph**				**85th speed**	**93Kph**				**85th speed**	**92Kph**			
Station 60+522														
Passenger Vehicles					**Buses**					**Trucks**				
V	**f**	**fc**	**fc%**	**V%**	**V**	**f**	**fc**	**fc%**	**V%**	V	f	fc	fc%	V%
84	1	1	1	1	84	2	2	2	2	84	4	4	4	4
85	1	2	2	2	85	1	3	3	3	85	3	7	7	7
86	6	8	8	8	86	7	10	10	10	86	2	9	9	9
87	5	13	13	13	87	12	22	22	22	87	7	16	16	16
88	12	25	25	25	88	8	30	30	30	88	14	30	30	30
89	19	44	44	44	89	18	48	48	48	89	19	49	49	49
90	2	46	46	46	90	5	53	53	53	90	1	50	50	50
91	8	54	54	54	91	7	60	60	60	91	9	59	59	59
92	22	76	76	76	92	23	83	83	83	92	14	73	73	73
93	7	83	83	83	93	5	88	88	88	93	12	85	85	85
94	8	91	91	91	94	4	92	92	92	94	5	90	90	90
95	4	95	95	95	95	5	97	97	97	95	6	96	96	96
96	5	100	100	100	96	3	100	100	100	96	4	100	100	100
	100					100					100			
85th speed	**93Kph**				**85th speed**	**93Kph**				**85th speed**	**93Kph**			

Station 59+123														
Passenger Vehicles					Buses					Trucks				
V	f	fc	fc%	V%	V	f	fc	fc%	V%	V	f	fc	fc%	V%
89	5	5	5	5	85	1	1	1	1	89	6	6	6	6
90	1	6	6	6	89	3	4	4	4	90	1	7	7	7
91	4	10	10	10	91	8	12	12	12	91	7	14	14	14
92	14	24	24	24	92	18	30	30	30	92	14	28	28	28
93	12	36	36	36	93	13	43	43	43	93	8	36	36	36
94	13	49	49	49	94	14	57	57	57	94	15	51	51	51
95	14	63	63	63	95	10	67	67	67	95	9	60	60	60
96	19	82	82	82	96	16	83	83	83	96	18	78	78	78
97	6	88	88	88	97	7	90	90	90	97	7	85	85	85
99	6	94	94	94	99	4	94	94	94	99	7	92	92	92
100	1	95	95	95	100	5	99	99	99	100	3	95	95	95
101	3	98	98	98	103	1	100	100	100	101	3	98	98	98
102	2	100	100	100		100				102	2	100	100	100
	100										100			
85th speed	**96Kph**				**85th speed**	**96Kph**				**85th speed**	**97Kph**			
Station 60+655.5														
Passenger Vehicles					**Buses**					**Trucks**				
V	**f**	**fc**	**fc%**	**V%**	**V**	**f**	**fc**	**fc%**	**V%**	**V**	**f**	**fc**	**fc%**	**V%**
86	3	3	3	3	86	2	2	2	2	87	3	3	3	3
87	13	16	16	16	87	5	7	7	7	88	3	6	6	6
88	7	23	23	23	88	8	15	15	15	89	23	29	29	29
89	19	42	42	42	89	29	44	44	44	90	4	33	33	33
90	1	43	43	43	90	1	45	45	45	91	13	46	46	46
91	14	57	57	57	91	20	65	65	65	92	37	83	83	83
92	18	75	75	75	92	24	89	89	89	93	13	96	96	96
93	13	88	88	88	93	6	95	95	95	94	3	99	99	99
94	8	96	96	96	94	5	100	100	100	95	1	100	100	100
95	2	98	98	98		100					100			
97	2	100	100	100										
	100													
85th speed	**93Kph**				**85th speed**	**92Kph**				**85th speed**	**92Kph**			
Station 58+687.9														
Passenger Vehicles					**Buses**					**Trucks**				
V	**f**	**fc**	**fc%**	**V%**	**V**	**f**	**fc**	**fc%**	**V%**	**V**	**f**	**fc**	**fc%**	**V%**
85	1	1	1	1	87	8	8	8	8	86	1	1	1	1
86	2	3	3	3	88	12	20	20	20	87	2	3	3	3
87	9	12	12	12	89	29	49	49	49	88	5	8	8	8
88	8	20	20	20	90	3	52	52	52	89	28	36	36	36
89	25	45	45	45	91	21	73	73	73	90	2	38	38	38
90	3	48	48	48	92	26	99	99	99	91	15	53	53	53
91	11	59	59	59	93	1	100	100	100	92	34	87	87	87
92	20	79	79	79		100				93	11	98	98	98
93	12	91	91	91						94	1	99	99	99
94	5	96	96	96						95	1	100	100	100
95	4	100	100	100							100			
	100													
85th speed	**92Kph**				**85th speed**	**91Kph**				**85th speed**	**91Kph**			

Station 60+072.9														
Passenger Vehicles					Buses					Trucks				
V	**f**	**fc**	**fc%**	**V%**	**V**	**f**	**fc**	**fc%**	**V%**	V	f	fc	fc%	V%
87	3	3	3	3	89	3	3	3	3	86	1	1	1	1
88	1	4	4	4	91	4	7	7	7	89	10	11	11	11
89	5	9	9	9	92	25	32	32	32	91	9	20	20	20
90	3	12	12	12	93	16	48	48	48	92	24	44	44	44
91	9	21	21	21	94	14	62	62	62	93	17	61	61	61
92	12	33	33	33	95	3	65	65	65	94	19	80	80	80
93	15	48	48	48	96	23	88	88	88	95	14	94	94	94
94	15	63	63	63	97	7	95	95	95	96	4	98	98	98
95	16	79	79	79	99	5	100	100	100	97	1	99	99	99
96	19	98	98	98		100				99	1	100	100	100
97	1	99	99	99							100			
99	1	100	100	100										
	100													
85th speed	**95Kph**				**85th speed**	**95Kph**				**85th speed**	**94Kph**			
Station 60+655.5														
Passenger Vehicles					**Buses**					**Trucks**				
V	**f**	**fc**	**fc%**	**V%**	**V**	**f**	**fc**	**fc%**	**V%**	**V**	**f**	**fc**	**fc%**	**V%**
89	3	3	3	3	85	2	2	2	2	89	2	2	2	2
91	7	10	10	10	89	5	7	7	7	91	7	9	9	9
92	31	41	41	41	91	9	16	16	16	92	25	34	34	34
93	18	59	59	59	92	31	47	47	47	93	14	48	48	48
94	16	75	75	75	93	19	66	66	66	94	20	68	68	68
95	10	85	85	85	94	14	80	80	80	95	11	79	79	79
96	10	95	95	95	95	12	92	92	92	96	21	100	100	100
97	2	97	97	97	96	6	98	98	98		100			
99	3	100	100	100	99	2	100	100	100					
	100					100								
85th speed	**93Kph**				**85th speed**	**92Kph**				**85th speed**	**92Kph**			
Station 58+687.9														
Passenger Vehicles					**Buses**					**Trucks**				
V	**f**	**fc**	**fc%**	**V%**	**V**	**f**	**fc**	**fc%**	**V%**	**V**	**f**	**fc**	**fc%**	**V%**
87	4	4	4	4	85	1	1	1	1	88	1	1	1	1
89	4	8	8	8	87	1	2	2	2	89	10	11	11	11
90	8	16	16	16	89	9	11	11	11	91	16	27	27	27
91	7	23	23	23	91	20	31	31	31	92	29	56	56	56
92	10	33	33	33	92	22	53	53	53	93	10	66	66	66
93	12	45	45	45	93	14	67	67	67	94	22	88	88	88
94	18	63	63	63	94	11	78	78	78	95	5	93	93	93
95	15	78	78	78	95	12	90	90	90	96	5	98	98	98
96	14	92	92	92	96	5	95	95	95	97	2	100	100	100
97	3	95	95	95	97	5	100	100	100		100			
98	4	99	99	99		100								
99	1	100	100	100										
85th speed	**92Kph**				**85th speed**	**91Kph**				**85th speed**	**91Kph**			

Station 59+643.2														
Passenger Vehicles					Buses					Trucks				
V	**f**	**fc**	**fc%**	**V%**	**V**	**f**	**fc**	**fc%**	**V%**	V	f	fc	fc%	V%
85	3	3	3	3	86	10	10	10	10	86	11	11	11	11
86	15	18	18	18	87	14	24	24	24	87	13	24	24	24
87	12	30	30	30	88	15	39	39	39	88	18	42	42	42
88	13	43	43	43	89	32	71	71	71	89	30	72	72	72
89	33	76	76	76	90	8	79	79	79	90	4	76	76	76
90	5	81	81	81	91	20	99	99	99	91	20	96	96	96
91	9	90	90	90	92	1	100	100	100	92	4	100	100	100
92	10	100	100	100		100					100			
	100													
85th speed	**90Kph**				**85th speed**	**90Kph**				**85th speed**	**90Kph**			
Station 59+798.8														
Passenger Vehicles					**Buses**					**Trucks**				
V	**f**	**fc**	**fc%**	**V%**	**V**	**f**	**fc**	**fc%**	**V%**	**V**	**f**	**fc**	**fc%**	**V%**
85	2	2	2	2	86	20	20	20	20	86	14	14	14	14
86	17	19	19	19	87	15	35	35	35	87	18	32	32	32
87	12	31	31	31	88	18	53	53	53	88	20	52	52	52
88	18	49	49	49	89	31	84	84	84	89	29	81	81	81
89	34	83	83	83	90	5	89	89	89	90	7	88	88	88
90	4	87	87	87	91	11	100	100	100	91	12	100	100	100
91	8	95	95	95		100					100			
92	5	100	100	100										
	100													
85th speed	**90Kph**				**85th speed**	**89Kph**				**85th speed**	**89Kph**			
Station 60+326.6														
Passenger Vehicles					**Buses**					**Trucks**				
V	**f**	**fc**	**fc%**	**V%**	**V**	**f**	**fc**	**fc%**	**V%**	**V**	**f**	**fc**	**fc%**	**V%**
85	2	2	2	2	2	1	1	1	1	86	15	15	15	15
86	13	15	15	15	15	10	11	11	11	87	16	31	31	31
87	15	30	30	30	30	10	21	21	21	88	20	51	51	51
88	13	43	43	43	43	16	37	37	37	89	33	84	84	84
89	31	74	74	74	74	33	70	70	70	90	4	88	88	88
90	5	79	79	79	79	10	80	80	80	91	12	100	100	100
91	10	89	89	89	89	19	99	99	99		100			
92	11	100	100	100	100	1	100	100	100					
	100					100								
85th speed	**91Kph**				**85th speed**	**90Kph**				**85th speed**	**89Kph**			

Stations 56+640.8														
Passenger Vehicles					Buses					Trucks				
V	f	fc	fc%	V%	V	f	fc	fc%	V%	V	f	fc	fc%	V%
87	4	4	4	4	85	1	1	1	1	88	1	1	1	88
89	4	8	8	8	87	1	2	2	2	89	10	11	11	89
90	8	16	16	16	89	9	11	11	11	91	16	27	27	91
91	7	23	23	23	91	20	31	31	31	92	29	56	56	92
92	10	33	33	33	92	22	53	53	53	93	10	66	66	93
93	12	45	45	45	93	14	67	67	67	94	22	88	88	94
94	18	63	63	63	94	11	78	78	78	95	5	93	93	95
95	15	78	78	78	95	12	90	90	90	96	5	98	98	96
96	14	92	92	92	96	5	95	95	95	97	2	100	100	97
97	3	95	95	95	97	5	100	100	100		100			
98	4	99	99	99		100								
99	1	100	100	100										
	100													
85th speed	**95Kph**				**85th speed**	**95Kph**				**85th speed**	**95Kph**			
Stations 59+441.1														
Passenger Vehicles					**Buses**					**Trucks**				
V	**f**	**fc**	**fc%**	**V%**	**V**	**f**	**fc**	**fc%**	**V%**	**V**	**f**	**fc**	**fc%**	**V%**
100	1	1	1	1	95	2	2	2	2	95	1	1	1	1
101	1	2	2	2	98	1	3	3	3	100	1	2	2	2
102	4	6	6	6	99	1	4	4	4	101	1	3	3	3
104	1	7	7	7	100	2	6	6	6	102	5	8	8	8
105	2	9	9	9	101	3	9	9	9	103	3	11	11	11
106	5	14	14	14	102	1	10	10	10	105	6	17	17	17
108	6	20	20	20	103	2	12	12	12	106	6	23	23	23
109	8	28	28	28	105	1	13	13	13	107	10	33	33	33
110	3	31	31	31	106	2	15	15	15	108	12	45	45	45
111	1	32	32	32	107	2	17	17	17	109	6	51	51	51
112	3	35	35	35	108	6	23	23	23	110	12	63	63	63
113	6	41	41	41	109	5	28	28	28	111	9	72	72	72
114	2	43	43	43	110	5	33	33	33	112	4	76	76	76
115	9	52	52	52	111	9	42	42	42	113	7	83	83	83
116	4	56	56	56	112	15	57	47	47	114	1	84	84	84
117	11	67	67	67	113	9	66	56	56	115	11	95	95	95
118	12	79	79	79	114	3	69	59	59	116	2	97	97	97
119	5	84	84	84	115	9	78	68	68	120	1	98	98	98
120	2	86	86	86	116	9	87	77	77	122	1	99	99	99
121	2	88	88	88	117	4	91	83	83	124	1	100	100	100
122	3	91	91	91	118	1	92	92	92		100			
123	1	92	92	92	119	2	94	94	94					
124	5	97	97	97	120	2	96	96	96					
126	1	98	98	98	121	1	97	97	97					
127	2	100	100	100	122	1	98	98	98					
					124	2	100	100	100					
	100					100								
85th speed	**120Kph**				**85th speed**	**117Kph**				**85th speed**	**114Kph**			

Station 63+371														
Passenger Vehicles					**Buses**					**Trucks**				
V	**f**	**fc**	**fc%**	**V%**	**V**	**f**	**fc**	**fc%**	**V%**	V	f	fc	fc%	V%
89	2	2	2	2	89	4	4	4	4	89	3	3	3	3
91	3	5	5	5	91	4	8	8	8	91	5	8	8	8
92	10	15	15	15	92	7	15	15	15	92	11	19	19	19
93	10	25	25	25	93	10	25	25	25	93	12	31	31	31
94	15	40	40	40	94	14	39	39	39	94	14	45	45	45
95	6	46	46	46	95	10	49	49	49	95	18	63	63	63
96	22	68	68	68	96	18	67	67	67	96	16	79	79	79
97	3	71	71	71	97	11	78	78	78	97	7	86	86	86
99	8	79	79	79	99	6	84	84	84	98	1	87	87	87
100	6	85	85	85	100	6	90	90	90	99	4	91	91	91
101	3	88	88	88	101	4	94	94	94	100	2	93	93	93
102	8	96	96	96	102	2	96	96	96	101	1	94	94	94
103	3	99	99	99	103	2	98	98	98	102	2	96	96	96
107	1	100	100	100	104	2	100	100	100	103	2	98	98	98
						100				105	1	99	99	99
										106	1	100	100	100
85th speed	**96Kph**				**85th speed**	**96Kph**				**85th speed**	**97Kph**			
Station 57+698.8														
Passenger Vehicles					**Buses**					**Trucks**				
V	**f**	**fc**	**fc%**	**V%**	**V**	**f**	**fc**	**fc%**	**V%**	**V**	**f**	**fc**	**fc%**	**V%**
86	1	1	1	1	86	1	1	1	1	86	6	6	6	6
87	4	5	5	5	87	6	7	7	7	87	21	27	27	27
88	6	11	11	11	88	16	23	23	23	88	16	43	43	43
89	15	26	26	26	89	31	54	54	54	89	30	73	73	73
90	2	28	28	28	90	6	60	60	60	90	6	79	79	79
91	14	42	42	42	91	12	72	72	72	91	20	99	99	99
92	30	72	72	72	92	22	94	94	94	92	1	100	100	100
93	12	84	84	84	93	5	99	99	99		100			
94	12	96	96	96	94	1	100	100	100					
95	1	97	97	97		100								
96	2	99	99	99										
99	1	100	100	100										
	100													
85th speed	**93Kph**				**85th speed**	**91Kph**				**85th speed**	**90Kph**			

Station 62+965.8														
Passenger Vehicles					Buses					Trucks				
V	**f**	**fc**	**fc%**	**V%**	**V**	**f**	**fc**	**fc%**	**V%**	V	f	fc	fc%	V%
89	1	1	1	1	86	2	2	2	2	86	2	2	2	2
91	4	5	5	5	87	7	9	9	9	87	18	20	20	20
92	8	13	13	13	88	4	13	13	13	88	16	36	36	36
93	11	24	24	24	89	14	27	27	27	88	43	79	79	79
94	19	43	43	43	90	1	28	28	28	89	8	87	87	87
95	22	65	65	65	91	20	48	48	48	91	13	100	100	100
96	24	89	89	89	92	33	81	81	81		100			
97	6	95	95	95	93	10	91	91	91					
98	5	100	100	100	94	7	98	98	98					
	100				95	1	99	99	99					
					95	1	100	100	100					
						100								
85th speed	**96Kph**				**85th speed**	**92Kph**				**85th speed**	**89Kph**			

Station 52+585.5														
Passenger Vehicles					Buses					Trucks				
V	**f**	**fc**	**fc%**	**V%**	**V**	**f**	**fc**	**fc%**	**V%**	V	f	fc	fc%	V%
100	1	1	1	1	95	1	1	1	1	95	14	14	1	1
101	1	2	2	2	101	1	2	2	2	100	9	23	2	2
102	2	4	4	4	102	6	8	8	8	101	10	33	3	3
104	1	5	5	5	103	5	13	13	13	102	7	40	10	10
105	2	7	7	7	105	6	19	19	19	103	26	66	18	18
106	6	13	13	13	106	7	26	26	26	105	8	74	26	26
108	10	23	23	23	107	4	30	30	30	106	9	83	35	35
109	1	24	24	24	108	16	46	46	46	107	5	88	40	40
110	2	26	26	26	109	6	52	52	52	108	1	89	57	57
111	2	28	28	28	110	9	61	61	61	109	2	91	62	62
112	2	30	30	30	111	5	66	66	66	110	1	92	70	70
113	6	36	36	36	112	8	74	74	74	111	1	93	73	73
114	2	38	38	38	113	6	80	80	80	112	1	94	80	80
115	13	51	51	51	114	2	82	82	82	113	1	95	87	87
116	3	54	54	54	115	10	92	92	92	114	1	96	88	88
117	5	59	59	59	116	4	96	96	96	115	1	97	94	94
118	10	69	69	69	120	1	97	97	97	116	1	98	97	97
119	3	72	72	72	124	3	100	100	100	120	1	99	99	99
120	4	76	76	76		100				124	1	100	100	100
122	4	80	80	80							100			
123	1	81	81	81										
124	7	88	88	88										
125	1	89	89	89										
126	4	93	93	93										
127	4	97	97	97										
128	3	100	100	100										
	100													
85th speed	**124Kph**				**85th speed**	**110Kph**				**85th speed**	**107Kph**			

APPENDIX C

Data Analysis for Geometric Consistency Evaluations

Appendix –C-1 Based on Operating Speed and Design speed

Station		Design speed, V_D	Operating speed,V_{85}	Change in speed (ΔV)= (V_{85}- V_D)	Change in the speed (Km/hr.)			Number of Accidents per 5 years
					Good	Fair	Poor	
Section 1								
51+103.9	51+581.9	**85**	125	40			poor	
52+250.2	52+318.2	**85**	121	36			poor	
52+523.4	52+585.5	**85**	124	39			poor	
Section 2								
55+279.8	55+472.2	70	101	31			Poor	
55+495.3	55+588.2	70	102	32			Poor	
55+603.7	55+581.9	70	96	26			Poor	
55+698.6	55+878.8	70	95	25			Poor	
55+889.9	55+973	70	96	26			Poor	
Section 3								
56+103.8	56+163.5	70	105	35			Poor	
56+182.9	56+423	50	100	50			Poor	
56+546.5	56+590.4	50	95	45			Poor	
56+604.8	56+673.5	40	93	53			Poor	
56+705.7	56+752.3	70	97	27			Poor	
56+767	56+640.8	60	95	35			Poor	
56+840.9	56+873.5	70	97	27			Poor	
57+267.5	57+349	70	97	27			Poor	
57+349	57+455	70	95	25			Poor	
57+472.8	57+611.4	60	95	35			Poor	
57+671.6	57+698.8	60	93	23			Poor	
57+705.6	57+770.3	40	94	54			Poor	
57+774.7	57+802.3	60	96	36			Poor	
57+838.5	57+929.4	60	95	35			Poor	
Section 4								
57+984.2	58+037.4	70	114	44			Poor	
58+150.5	58+217.4	70	124	54			Poor	
58+362.9	58+472.7	70	93	23			Poor	
Section 5								
58+516	58+590.4	70	93	23			poor	
58+601.7	58+687.9	50	92	42			poor	
58+809.3	58+868.8	60	93	33			Poor	
58+876.2	59+006	70	95	25			Poor	
59+032.5	59+123	70	96	26			poor	
59+180.6	59+226.5	70	115	45			Poor	
59+243.3	59+293.6	70	124	54			Poor	
59+395.5	59+441.1	70	119	49			Poor	

59+464.6	59+515.2	70	113	43			Poor	
59+575.7	59+643.2	40	90	50			Poor	
59+715.8	59+798.8	40	90	50			Poor	
59+852.1	59+995.2	70	124	54			Poor	
60+011.9	60+072.9	70	95	25			Poor	
60+078	60+195.5	60	94	34			Poor	
60+240.7	60+326.6	40	91	51			Poor	
60+398	60+522	60	93	33			Poor	
60+586	60+655.5	60	93	33			Poor	
60+695	60+820	70	95	25			Poor	
60+877.4	60+877.4	70	114	44			Poor	
60+977.4	60+977.4	70	110	40			Poor	
61+141.6	61+141.6	70	125	55			Poor	
61+260	61+426.7	70	115	45			Poor	
61+441.4	61+498.8	70	124	54			Poor	
Section 6								
62+626.9	62+965.8	70	96	26			Poor	
62+967.6	63+059.4	70	120	50			Poor	
63+240.8	63+312	40	89	49			Poor	
63+315.9	63+371	70	100	30			Poor	
63+550.7	63+692	50	95	45			Poor	
63+727	63+833	50	97	47			Poor	
63+890.3	63+941.4	50	112	62			Poor	
64+002.5	64+066.5	50	93	43			Poor	
64+078.5	64+128.7	50	90	40			Poor	
64+158	64+238.3	50	111	61			Poor	
64+298.3	64+350.8	50	110	60			Poor	
Section 7								
64+529	64+629.7	50	91	41			Poor	
64+629.7	64+676.5	50	90	40			Poor	
64+827	64+869.6	40	88	48			Poor	
64+876.7	64+946	50	90	40			Poor	
65+860	65+986.8	50	93	43			Poor	
66+281.4	66+330.9	50	109	59			Poor	
66+402.8	66+481.6	50	105	55			Poor	
66+575.5	66+624.1	50	115	65			Poor	
Section 8								
29+025.3	29+025.3	85	124	39			Poor	
29+168.7	29+168.7	85	120	35			Poor	
30+698.5	30+698.5	85	112	27			Poor	
30+825.9	30+825.9	85	115	30			Poor	
31+032.4	31+032.4	85	125	40			Poor	
31+648.7	31+648.7	85	119	34			Poor	
32+112.0	32+112.0	85	120	35			Poor	
32+327.1	32+327.1	85	125	40			Poor	
32+696.3	34+103.3	85	114	29			Poor	
Section 9								
34+147.0	34+225.4	85	120	35			Poor	
34+765.8	34+765.8	85	114	29			Poor	
34+959.6	35+019.5	85	125	40			Poor	
35+186.9	35+240.2	85	112	27			Poor	
35 +402.7	35+595.7	85	110	25			Poor	

35+740.5	35+740.5	85	119	34			Poor	
35+896.6	35+960.8	85	124	39			Poor	
36+967.5	37+201.9	85	110	25			Poor	
Section 10								
37+302.5	37+364.3	85	124	39			Poor	
38+380.4	38+432.4	85	119	34			Poor	
38+618.7	38+661.2	85	120	35			Poor	
39+416.7	39+416.7	85	125	40			Poor	
39+685.4	39+731.1	85	115	30			Poor	
39+746.4	40+253.5	85	125	40			Poor	
Section 11								
40+731.6	40+621.97	70	110	40			Poor	
40+822.8	40+859.4	70	93	23			Poor	
40+884.4	40+946.5	70	95	25			Poor	
41+154.2	41+232.1	70	115	45			Poor	
41+257.4	41+295.4	70	119	49			Poor	
Section 12								
41+621.9	41+621.9	70	115	45			Poor	
41+831.3	41+831.3	70	110	40			Poor	
42+182.1	42+291.6	70	111	41			Poor	
42+296.0	42+475.8	70	96	26			Poor	
42+571.8	42+760.3	70	109	39			Poor	
42+921.6	43+148.2	70	111	41			Poor	
43+234.4	43+234.4	70	100	30			Poor	
43+399.0	43+399.0	70	119	41			Poor	
43+500.7	43+500.7	70	111	41			Poor	
43+780.9	43+780.9	70	115	45			Poor	
44+040.4	44+040.4	70	112	42			Poor	
44+210.5	44+210.5	70	115	45			Poor	
44+300.7	44+300.7	70	119	49			Poor	
44+490.4	44+490.4	70	109	39			Poor	

Appendix-C-2 Based on Vehicle Stability

Stations									Design Evaluation		
From	To	e	R	V_D	V_{85}	f_{RD}	f_R	Δf_R	good	fair	Poor
Section 1											
51+103.9	51+581.9	0.025	2200	85	125	0.001	0.03	-0.03		fair	
52+250.2	52+318.2	0	7000	85	121	0.008	0.02	-0.01		fair	
52+523.4	52+585.5	0	5000	85	124	0.011	0.02	-0.01		fair	
Section 2											
54+439.1	54+696.2	0	1850	70	124	0.021	0.07	-0.04			poor
55+279.8	55+472.2	0.034	800	70	101	0.014	0.07	-0.05			poor
55+495.3	55+588.2	0.049	550	70	102	0.021	0.10	-0.08			poor
55+603.7	55+581.9	0.067	340	70	96	0.046	0.15	-0.10			poor
55+698.6	55+878.8	0.073	260	70	95	0.075	0.20	-0.12			poor
55+889.9	55+973	0.067	320	70	96	0.054	0.16	-0.11			poor
Section 3											
56+103.8	56+163.5	0.031	900	70	105	0.012	0.07	-0.05			poor
56+182.9	56+423	0.08	122	50	100	0.081	0.57	-0.48			poor
56+546.5	56+590.4	0.08	120	50	95	0.084	0.51	-0.43			poor
56+604.8	56+673.5	0.08	46	40	93	0.194	1.40	-1.21			poor
56+705.7	56+752.3	0.079	200	70	97	0.114	0.29	-0.18			poor
56+767	56+640.8	0.08	150	60	95	0.109	0.39	-0.28			poor
56+840.9	56+873.5	0.079	200	70	97	0.114	0.29	-0.18			poor
57+267.5	57+349	0.073	240	70	97	0.088	0.24	-0.15			poor
57+349	57+455	0.079	190	70	95	0.124	0.30	-0.17			poor
57+472.8	57+611.4	0.08	156	60	95	0.102	0.38	-0.27			poor
57+671.6	57+698.8	0.08	130	60	93	0.138	0.44	-0.31			poor
57+705.6	57+770.3	0.08	58	40	94	0.137	1.12	-0.98			poor
57+774.7	57+802.3	0.08	150	60	96	0.109	0.40	-0.29			poor
57+838.5	57+929.4	0.08	150	60	95	0.109	0.39	-0.28			poor
Section 4											
57+984.2	58+037.4	0.025	1700	70	114	-0.002	0.04	-0.04		fair	
58+150.5	58+217.4	0	2200	70	124	0.018	0.06	-0.04		fair	
58+258.6	58+294.4	0	2000	70	117	0.019	0.05	-0.03		fair	
58+362.9	58+472.7	0.067	330	70	93	0.050	0.14	-0.09			poor
Section 5											
58+516	58+590.4	0.079	190	70	93	0.124	0.28	-0.16			poor
58+601.7	58+687.9	0.08	86	50	92	0.149	0.69	-0.55			poor
58+809.3	58+868.8	0.08	170	60	93	0.087	0.32	-0.23			poor
58+876.2	59+006	0.067	300	70	95	0.062	0.17	-0.11			poor
59+032.5	59+123	0.067	320	70	96	0.054	0.16	-0.11			poor
59+243.3	59+293.6	0	1800	70	124	0.021	0.07	-0.05			poor

59+395.5	59+441.1	0	1800	70	119	0.021	0.06	-0.04			poor
59+575.7	59+643.2	0.08	73	40	90	0.093	0.79	-0.70			poor
59+715.8	59+798.8	0.08	49	40	90	0.177	1.22	-1.04			poor
59+852.1	59+995.2	0.028	1000	70	124	0.011	0.09	-0.08			poor
60+011.9	60+072.9	0.079	210	70	95	0.105	0.26	-0.15			poor
60+078	60+195.5	0.08	170	60	94	0.087	0.33	-0.24			poor
60+240.7	60+326.6	0.08	80	40	91	0.077	0.74	-0.66			poor
60+398	60+522	0.08	130	60	93	0.138	0.44	-0.31			poor
60+586	60+655.5	0.08	140	60	93	0.122	0.41	-0.28			poor
60+695	60+820	0.057	380	70	95	0.045	0.13	-0.09			poor
61+260	61+426.7	0.057	360	70	115	0.050	0.23	-0.18			poor
61+441.4	61+498.8	0.034	800	70	124	0.014	0.12	-0.10			poor
Section 6											
62+626.9	62+965.8	0.067	330	70	96	0.050	0.15	-0.10			poor
62+967.6	63+059.4	0.038	750	70	120	0.013	0.11	-0.10			poor
63+240.8	63+312	0.08	80	40	89	0.077	0.70	-0.62			poor
63+315.9	63+371	0.049	550	70	100	0.021	0.09	-0.07			poor
63+550.7	63+692	0.025	500	50	95	0.014	0.12	-0.10			poor
63+727	63+833	0.025	380	50	97	0.027	0.17	-0.14			poor
64+002.5	64+066.5	0.028	280	50	93	0.042	0.22	-0.17			poor
64+078.5	64+128.7	0.04	100	50	90	0.157	0.60	-0.44			poor
Section 8											
64+529	64+629.7	0.039	125	50	91	0.118	0.48	-0.36			poor
64+629.7	64+676.5	0.04	100	50	90	0.157	0.60	-0.44			poor
64+827	64+869.6	0.04	45	40	88	0.240	1.32	-1.08			poor
64+876.7	64+946	0.04	110	50	90	0.139	0.54	-0.40			poor
65+860	65+986.8	0.03	240	50	93	0.052	0.25	-0.20			poor
Section 8											
29+025.3	29+025.3	0	0	85	124						
29+168.7	29+168.7	0	0	85	120						
30+698.5	30+698.5	0	0	85	112						
30+825.9	30+825.9	0	0	85	115						
31+032.4	31+032.4	0	0	85	125						
31+648.7	31+648.7	0	0	85	119						
32+112.0	32+112.0	0	0	85	120						
32+327.1	32+327.1	0	0	85	125						
32+696.3	34+103.3	2.5	2275	85	114	-2.475	-2.46	-0.02		fair	
Section 9											
34+147.0	34+225.4	0	5000	85	120	0.011	0.02	-0.01		fair	
34+959.6	35+019.5	0	5000	85	125	0.011	0.02	-0.01		fair	
35+186.9	35+240.2	2.5	2500	85	112	-2.477	-2.46	-0.02		fair	
35 +402.7	35+595.7	7.8	430	85	110	-7.668	-7.58	-0.09			poor
35+896.6	35+960.8	0	7000	85	124	0.008	0.02	-0.01		fair	

36+967.5	37+201.9	7.8	440	85	110	-7.671	-7.58	-0.09			poor
Section 10											
37+302.5	37+364.3	0	3000	85	124	0.019	0.04	-0.02		fair	
38+380.4	38+432.4	0	3000	85	119	0.019	0.04	-0.02		fair	
38+618.7	38+661.2	0	3000	85	120	0.019	0.04	-0.02		fair	
39+685.4	39+731.1	0	3000	85	115	0.019	0.03	-0.02		fair	
39+746.4	40+253.5	2.5	2500	85	125	-2.477	-2.45	-0.03		fair	
Section 11											
40+731.559	40+621.970	3.1	900	70	110	-3.057	-2.99	-0.06			poor
40+822.776	40+859.352	7.9	190	70	93	-7.697	-7.54	-0.16			poor
40+884.338	40+946.469	7.3	250	70	95	-7.146	-7.02	-0.13			poor
41+154.147	41+232.075	0	6000	70	115	0.006	0.02	-0.01		fair	
41+257.361	41+295.347	0	2500	70	119	0.015	0.04	-0.03		fair	
Section 12											
42+182.1	42+291.6	0	1800	70	111	0.021	0.05	-0.03		fair	
42+296.0	42+475.8	5.7	370	70	96	-5.596	-5.50	-0.09			poor
42+571.8	42+760.3	4.3	580	70	109	-4.233	-4.14	-0.09			poor
42+921.6	43+148.2	0	5000	70	111	0.008	0.02	-0.01	good		
43+234.4	43+234.4	3.1	900	70	100	-3.057	-3.01	-0.04			poor
43+500.7	43+500.7	2.5	1700	70	111	-2.477	-2.44	-0.03		fair	
43+780.9	43+780.9	0	2200	70	115	0.018	0.05	-0.03		fair	
44+040.4	44+040.4	0	3000	70	112	0.013	0.03	-0.02		fair	
44+210.5	44+210.5	0	2500	70	115	0.015	0.04	-0.03		fair	
44+300.7	44+300.7	0	2500	70	119	0.015	0.04	-0.03		fair	

APPENDIX D

Details of the Statistical Regression Out put

Appendix D-1 Single Linear Regression

1. Number of Horizontal curves

SUMMARY OUTPUT Number of Curve								
Regression Statistics								
Multiple R	0.6673542							
R Square	0.4453616							
Adjusted R Squ	0.3760318							
Standard Error	3.8882984							
Observations	10							
ANOVA								
	df	*SS*	*MS*	*F*	*Significance F*			
Regression	1	97.1208	97.12075	6.42381	**0.035007959**			
Residual	8	120.951	15.11886					
Total	9	218.072						
	Coefficients	*Standarc*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95*	*Lower 95.0*	*Upper 95.0*
Intercept	2.1773633	2.60584	0.835569	0.42765	-3.831723461	8.18645	-3.83172	8.18645
No. Curve	0.5246023	0.20698	2.534524	0.03501	0.047299656	1.0019	0.0473	1.001905

2. Minimum Change in Side friction

SUMMARY OUTPUT								
Regression Statistics								
Multiple R	0.8404943							
R Square	0.7064307							
Adjusted R Squ	0.6697346							
Standard Error	2.82885							
Observations	10							
ANOVA								
	df	*SS*	*MS*	*F*	*Significance F*			
Regression	1	154.053	154.0525	19.2508	0.002325083			
Residual	8	64.0191	8.002393					
Total	9	218.072						
	Coefficients	*ndard Er*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*Upper 95.0%*
Intercept	4.4059055	1.21302	3.632178	0.00666	1.608675571	7.20314	1.608676	7.2031355
Δf min	-8.3014856	1.89204	-4.38757	0.00233	-12.66454792	-3.9384	-12.6645	-3.938423

3. Change in Speed

SUMMARY OUTPUT								
Regression Statistics								
Multiple R	0.861367844							
R Square	**0.741954563**							
Adjusted R Square	0.709698884							
Standard Error	2.652178328							
Observations	10							
ANOVA								
	df	*SS*	*MS*	*F*	*Significance F*			
Regression	1	161.7992699	161.7993	23.00229	**0.001362363**			
Residual	8	56.27239905	7.03405					
Total	9	218.071669						
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*pper 95.0%*
Intercept	-16.70844635	5.219724208	-3.20102	0.012593	-28.745152	-4.67174	-28.7452	-4.67174
ΔVmax	0.503236154	0.104926764	4.79607	0.001362	0.261274603	0.745198	0.261275	0.745198

4. Average Side friction

SUMMARY OUTPUT								
Regression Statistics								
Multiple R	0.821858451							
R Square	0.675451313							
Adjusted R Square	0.634882727							
Standard Error	2.974367029							
Observations	10							
ANOVA								
	df	*SS*	*MS*	*F*	*Significance F*			
Regression	1	147.2967952	147.2968	16.64961	0.003532217			
Residual	8	70.77487377	8.846859					
Total	9	218.071669						
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*pper 95.0%*
Intercept	4.044388733	1.35080433	2.99406	0.017227	0.929428362	7.159349	0.929428	7.159349
f av	-31.24849992	7.658206685	-4.08039	0.003532	-48.9083562	-13.5886	-48.9084	-13.5886

Appendix D-2 Multiple Linear Regression

I. With Two Variables

1. Average Radius and Average Tangent of the Section

2.3	SUMMARY OUTPUT								
	Regression Statistics								
	Multiple R	0.8490181							
	R Square	0.7208317							
	Adjusted R Squ	0.6410693							
	Standard Error	2.9490606							
	Observations	10							
	ANOVA								
		df	*SS*	*MS*	*F*	*Significance F*			
	Regression	2	157.193	78.59648	9.03724	0.011495599			
	Residual	7	60.8787	8.696958					
	Total	9	218.072						
		Coefficients	*ndard Er*	*t Stat*	*P-value*	*Lower 95%*	*Jpper 95%*	*ower 95.0%*	*Jpper 95.0%*
	Intercept	24.897368	4.22874	5.88765	0.00061	14.89797524	34.8968	14.89798	34.896761
	Rav	-0.0043859	0.00125	-3.49725	0.01003	-0.0073513	-0.0014	-0.00735	-0.00142
	Tav	-0.2017062	0.06084	-3.31521	0.01285	-0.345576107	-0.0578	-0.34558	-0.057836

2. Number of Curve and Minimum Side friction

2.1	SUMMARY OUTPUT								
	Regression Statistics								
	Multiple R	0.8539988							
	R Square	**0.729314**							
	Adjusted R Squ	0.6519752							
	Standard Error	2.9039123							
	Observations	10							
	ANOVA								
		df	*SS*	*MS*	*F*	*Significance F*			
	Regression	2	159.043	79.52136	9.43011	**0.010318824**			
	Residual	7	59.0289	8.432706					
	Total	9	218.072						
		Coefficients	*ndard Er*	*t Stat*	*P-value*	*Lower 95%*	*Jpper 95%*	*ower 95.0%*	*Jpper 95.0%*
	Intercept	3.2180519	1.98366	1.622277	0.14877	-1.4725665	7.90867	-1.47257	7.9086703
	No.Curve(Nc)	0.1580197	0.20542	0.769264	0.4669	-0.327713897	0.64375	-0.32771	0.6437534
	Δf min	-6.9939443	2.58097	-2.70981	0.03021	-13.09697293	-0.8909	-13.097	-0.890916

3. Minimum change in side friction and Maximum change speed

SUMMARY OUTPUT								
Regression Statistics								
Multiple R	0.909594541							
R Square	0.827362229							
Adjusted R Square	0.778037151							
Standard Error	2.319094865							
Observations	10							
ANOVA								
	df	*SS*	*MS*	*F*	*Significance F*			
Regression	2	180.424262	90.21213	16.77366	0.002137841			
Residual	7	37.64740694	5.378201					
Total	9	218.071669						
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*pper 95.0%*
Intercept	-9.035273547	6.150889211	-1.46894	0.185302	-23.5798153	5.509268	-23.5798	5.509268
Δf min	-4.380568073	2.353969866	-1.86093	0.105068	-9.94682231	1.185686	-9.94682	1.185686
ΔVmax	0.308328643	0.139239691	2.214373	0.062393	-0.02092091	0.637578	-0.02092	0.637578

4. Number of Curve and Maximum Change in Speed

SUMMARY OUTPUT								
Regression Statistics								
Multiple R	0.942026							
R Square	0.887414							
Adjusted R Squa	0.855246							
Standard Error	1.87281							
Observations	10							
ANOVA								
	df	*SS*	*MS*	*F*	*gnificance F*			
Regression	2	193.5197	96.75987	27.58721	0.000479			
Residual	7	24.55192	3.507418					
Total	9	218.0717						
	Coefficients	*andard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*pper 95.0%*
Intercept	-16.0296	3.692764	-4.34082	0.003393	-24.7616	-7.29761	-24.7616	-7.29761
X3=no.C	0.321624	0.106948	3.007295	0.019737	0.068732	0.574516	0.068732	0.574516
X7=max change	0.416701	0.079484	5.242549	0.001196	0.22875	0.604652	0.22875	0.604652

II. With More than Two Variables

1. Max. change in speed, Average side friction and min. change in side fricti

SUMMARY OUTPUT								
Regression Statistics								
Multiple R	0.957584							
R Square	0.916968							
Adjusted R Squ	0.875451							
Standard Error	1.737193							
Observations	10							
ANOVA								
	df	*SS*	*MS*	*F*	*gnificance F*			
Regression	3	199.9646	66.65488	22.08696	0.001213			
Residual	6	18.10703	3.017838					
Total	9	218.0717						
	Coefficients	*andard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*pper 95.0%*
Intercept	-14.2299	5.039522	-2.82367	0.030208	-26.5612	-1.89867	-26.5612	-1.89867
ΔVmax	0.46192	0.120508	3.833102	0.008628	0.167047	0.756793	0.167047	0.756793
f av	99.33794	39.03882	2.544594	0.043809	3.813393	194.8625	3.813393	194.8625
Δf min	-28.0053	9.450254	-2.96345	0.02517	-51.1293	-4.88137	-51.1293	-4.88137

2. Max. change in speed, Average side friction and Average Radius

SUMMARY OUTPUT								
Regression Statistics								
Multiple R	0.895545							
R Square	0.802							
Adjusted R Sc	0.703001							
Standard Erro	2.682602							
Observations	10							
ANOVA								
	df	*SS*	*MS*	*F*	*gnificance F*			
Regression	3	174.8936	58.2978507	8.101027	0.015665			
Residual	6	43.17812	7.19635281					
Total	9	218.0717						
	Coefficients	*andard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*pper 95.0%*
Intercept	-8.13877	8.543877	-0.9525855	0.377582	-29.0449	12.76734	-29.0449	12.76734
ΔVmax	0.309154	0.178798	1.72906692	0.134528	-0.12835	0.746657	-0.12835	0.746657
f av	-13.6851	11.33805	-1.2070101	0.27285	-41.4284	14.05807	-41.4284	14.05807
Rav	-0.00057	0.001279	-0.4460197	0.671227	-0.0037	0.002559	-0.0037	0.002559

3. Max. change in speed, Average side friction and Number of Curves

SUMMARY OUTPUT								
Regression Statistics								
Multiple R	0.942735							
R Square	0.888749							
Adjusted R Sc	0.833124							
Standard Erro	2.010831							
Observations	10							
ANOVA								
	df	*SS*	*MS*	*F*	*gnificance F*			
Regression	3	193.811	64.6036721	15.9774	0.002883			
Residual	6	24.26065	4.04344211					
Total	9	218.0717						
	Coefficients	*ndard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*pper 95.0%*
Intercept	-14.8232	5.993671	-2.473145	0.048252	-29.4892	-0.15723	-29.4892	-0.15723
ΔVmax	0.389572	0.132289	2.94484531	0.025785	0.065871	0.713272	0.065871	0.713272
f av	-2.6585	9.905197	-0.2683942	0.797385	-26.8956	21.57865	-26.8956	21.57865
Nc	0.302624	0.134898	2.24334756	0.066042	-0.02746	0.632708	-0.02746	0.632708

4. Max. change in speed, Average Radius and min. change in side friction

SUMMARY OUTPUT								
Regression Statistics								
Multiple R	0.911317							
R Square	0.830498							
Adjusted R Squ	0.745747							
Standard Error	2.482053							
Observations	10							
ANOVA								
	df	*SS*	*MS*	*F*	*gnificance F*			
Regression	3	181.1082	60.36938	9.799292	0.009951			
Residual	6	36.96352	6.160586					
Total	9	218.0717						
	Coefficients	*ndard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*pper 95.0%*
Intercept	-7.8111	7.53902	-1.03609	0.340101	-26.2584	10.63621	-26.2584	10.63621
ΔVmax	0.295782	0.153708	1.924318	0.10265	-0.08033	0.671892	-0.08033	0.671892
Rav	-0.0004	0.001195	-0.33318	0.750332	-0.00332	0.002526	-0.00332	0.002526
Δf min	-4.2216	2.564162	-1.64638	0.150785	-10.4959	2.052682	-10.4959	2.052682

5. Max. change in speed, Average Radius and Number of Curve

SUMMARY OUTPUT								
Regression Statistics								
Multiple R	0.943795							
R Square	0.89075							
Adjusted R Sc	0.836125							
Standard Erro	1.992669							
Observations	10							
ANOVA								
	df	*SS*	*MS*	*F*	*gnificance F*			
Regression	3	194.2473	64.7490987	16.3066	0.002733			
Residual	6	23.82437	3.97072881					
Total	9	218.0717						
	Coefficients	*andard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*pper 95.0%*
Intercept	-17.6629	5.476939	-3.2249576	0.018024	-31.0645	-4.26131	-31.0645	-4.26131
ΔVmax	0.432519	0.092292	4.68639773	0.003373	0.206688	0.658351	0.206688	0.658351
Rav	0.000446	0.001041	0.42805207	0.683552	-0.0021	0.002992	-0.0021	0.002992
Nc	0.344429	0.125647	2.7412532	0.03368	0.036983	0.651875	0.036983	0.651875

6. Max. change in speed, Average Radius and Number of Curve

SUMMARY OUTPUT								
Regression Statistics								
Multiple R	0.944435							
R Square	0.891958							
Adjusted R Squ	0.837937							
Standard Error	1.98162							
Observations	10							
ANOVA								
	df	*SS*	*MS*	*F*	*gnificance F*			
Regression	3	194.5108	64.83692	16.51131	0.002645			
Residual	6	23.56091	3.926818					
Total	9	218.0717						
	Coefficients	*andard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*pper 95.0%*
Intercept	-13.8503	5.838365	-2.37229	0.055348	-28.1362	0.435687	-28.1362	0.435687
ΔVmax	0.371249	0.123528	3.005372	0.023842	0.068986	0.673512	0.068986	0.673512
Δf min	-1.29957	2.586891	-0.50237	0.633311	-7.62946	5.030328	-7.62946	5.030328
Nc	0.275649	0.145537	1.894005	0.107056	-0.08047	0.631766	-0.08047	0.631766

APPENDIX E

Details of Road Geometric, Traffic and Accident Data

Appendix E-1 Road Geometric Data for sampling section with radius less than 600

No.	Total deflection angle	Stations		T	R	L	C	M	e	Design speed
		From	To							
1	26’49 33	0 +096.2	0+188.9	47.7	200	93.6	92.8	5.4	7.9	70
2	24 11 29	0+241.8	0+444.5	102.9	480	202.7	201.2	10.7	4.9	70
3	8 44 30	1+011.3	1+ 064.8	53.5	700	106.8	106.7	2.04	3.8	70
4	26 27 38	1+128.5	1+239.3	56.4	240	110.8	109.8	6.4	7.3	70
5	32 27 28	1+ 242.4	1+409.5	85.9	295	167.1	164.9	11.7	6.7	70
6	11 56 55	1+ 413	1+475.6	31.4	300	62.5	62.4	1.6	6.7	70
7	59 23 43	1+ 680.9	1+966.7	168.2	295	305.8	292.3	38.7	6.7	70
8	51 37 30	10+734.5	10+986.8	135.4	280	252.3	243.8	27.9	8	85
9	29 58 44	10+330.9	11+498.4	85.7	320	167.4	165.5	10.9	6.7	70
10	30 43 56	11+972.9	12+214.2	123.7	450	241.4	238.5	16.1	5.7	70
11	31 30 34	17+576.4	17+961.4	197.5	700	384.9	380	26.3	5.1	85
12	25 42 57	35 +402.7	35+595.7	98.1	430	192.9	191.4	10.8	7.8	85
13	30 31 45	36+967.5	37+201.9	120	440	234.4	231.7	15.5	7.8	85
14	14 02 44	40+822.8	40+869.4	23.4	190	46.6	46.5	1.4	7.9	70
15	14 14 23	40+884.3	40+946.5	31.2	250	62	61.9	1.9	7.3	70
16	27 50 41	42+295.9	42+475.8	91.7	370	179.8	178	10.9	5.7	70
17	18 37 20	42+571.8	42+760.3	95	580	188.5	187.7	7.6	4.3	70
18	9 46 48	55+495.3	55+588.2	47	550	93.9	93.7	2.0	4.9	70
19	13 11 12	55+603.7	55+581.9	39.2	340	78.3	78	2.2	6.7	70
20	59 42 07	55+698.6	55+878.8	93.9	260	180	176.6	15.4	7.3	70
21	14 53 45	55+889.9	55+973	41.8	320	83.2	82.9	2.7	6.7	70
22	112 52 44	56+182.9	56+423	183	122	240	203	54.5	8	50
23	23 49 40	56+546.5	56+590.4	25.3	120	49.9	49.5	2.6	8	50
24	85 38 54	56+604.8	56+673.5	42.63	46	68.8	62.5	12.3	8	40
25	13 21 32	56+705.7	56+752.3	23.4	200	46.3	46.5	1.3	7.9	70
26	28 08 35	56+767	56+640.8	37.6	150	73.7	72.9	4.5	8	60
27	9 20 05	56+840.9	56+873.5	16.3	200	32.6	32.5	0.6	7.9	70
28	19 27 31	57+267.5	57+349	41	240	81.5	81.1	3.4	7.3	70
29	31 59 11	57+349	57+455	54.4	190	106	104.7	7.3	7.9	70
30	50 55 39	57+472.8	57+611.4	74.3	156	138.7	134	15	8	60
31	11 59 15	57+671.6	57+698.8	13.6	130	27.1	27.1	0.7	8	60
32	63 59 31	57+705.6	57+770.3	36	58	64.8	61.5	8.8	8	40
33	10 34 46	57+774.7	57+802.3	13.9	150	27.7	27.6	0.6	8	60
34	34 42 16	57+838.5	57+929.4	46.9	150	90.9	89.5	6.8	8	60
35	19 04 05	58+362.9	58+472.7	55.4	330	109.8	109.3	4.6	6.7	70
36	77 75 10	58+516	58+590.4	37.7	190	74	73	5.6	7.8	70
37	57 27 52	58+601.7	58+687.9	47	86	86.2	82.7	10.6	8	50
38	20 02 48	58+809.3	58+868.8	30	170	59.5	59	2.6	8	60
39	24 53 31	58+876.2	59+006	66	300	130	129	7	6.7	70
40	16 11 49	59+032.5	59+123	45.5	320	90.4	90	3	6.7	70

41	52 56 31	59+575.7	59+643.2	36.4	73	67.45	65	7.6	8	40
42	97 01 07	59+715.8	59+798.8	55.4	49	82.9	73.4	16.5	8	40
43	16 38 49	60+011.9	60+072.9	30.72	210	61	60.8	2.2	7.9	70
44	39 33 49	60+078	60+195.5	61	170	117	115	10	8	60
45	61 33 04	60+240.7	60+326.6	47.6	80	85.9	81.9	11.3	8	40
46	54 41 22	60+398	60+522	67	130	124	119	14.5	8	60
47	28 17 14	60+586	60+655.5	35	140	69	68.4	4.2	8	60
48	18 49 37	60+695	60+820	63	380	124	124	5	5.7	70
49	26 32 10	61+260	61+426.7	84.9	360	166.7	165.2	9.6	5.7	70
50	59 00 19	62+626.9	62+965.8	186.7	330	339.8	325	42.8	6.7	70
51	51 13 03	63+240.8	63+312	38.3	80	71.5	69	7.8	8	40
52	5 44 59	63+315.9	63+371	27.6	550	55.2	55.2	0.7	4.9	70
53	16 14 32	63+550.7	63+692	71	500	141.7	141.3	5	2.5	50
54	15 55 33	63+727	63+833	53	380	105.6	105.3	3.7	2.5	50
55	13 05 57	64+002.5	64+066.5	32	280	64	63.8	1.8	2.8	50
56	28 51 07	64+078.5	64+128.7	25.7	100	50	49.8	3	4	50
57	46 04 15	64+529	64+629.7	53	125	100.5	97.8	9.9	3.9	50
58	26 48 14	64+629.7	64+676.5	23.8	100	46.8	46.3	2.7	4	50
59	54 02 41	64+827	64+869.6	22.9	45	42.4	40.9	4.9	4	40
60	36 11 04	64+876.7	64+946	35.9	110	69.5	68.3	5.4	4	50
61	30 12 50	65+860	65+986.8	64.8	240	126.5	125	8	3	50
62	50 50 38	73+023	73+546.8	275.7	580	514.7	497.9	56	6.5	85
63	19 51 38	75+480.6	75+660.8	91	520	180	179.3	7.8	4.9	70
64	13 15 24	75+675.7	75+791.4	58	500	115.7	115.4	3.3	4.9	70
65	15 58 03	79+970.4	80+132.1	81	580	161.6	161.1	5.6	4.3	70
66	9 28 08	80+132.8	80+208.8	38	460	76	75.9	1.5	4.9	70
67	27 47 56	81+100	81+352	25	520	252	249.8	15	4.9	70
68	17 18 44	84+836.6	84+977.6	7o	460	138.9	136.4	5.2	2.5	50
69	51 38 48	84+978	85+338.6	193	400	360.5	348.4	39.9	2.5	50

Appendix E-2- Traffic Accident Data of the sampling Section for the study period

No.	Type of severity	Type of crashes	Date	Vehicle Types	Vehicle ownership	Road Geometry	Road condition	Weather condition	Location (kebele)
1	fatal	Run off	28/4/05	land rover	Government	Rolling	Dry	Good	Woshe gale
2	slight	Head-on	29/5/05	TOYOTA	Government	Flat	Dry	Good	Buge
3	PDO	Roll-over	3/6/2005	Land rover	Owner	Flat	Dry	Good	Buge
4	fatal	Roll-over	8/6/2005	Truck	Employee	Rolling	Dry	Good	Woshe gale
5	PDO	Run off	21/06/05	Truck	Employee	Flat	Dry	Good	Buge
6	fatal	Run off	24/06/05	TOYOTA	Employee	Rolling	Dry	Good	Ado kayishe
7	fatal	Head-on	8/7/2005	Toyota/Truck	Employee	Flat	Dry	Good	Fate
8	slight	Roll-over	4/8/2005	Bus	Employee	Rolling	Dry	Good	Woshe gale
9	slight	Run off	4/9/2005	Truck	Owner	Rolling	Dry	Good	Woshe gale
10	slight	Roll-over	5/9/2005	Truck tailer	Employee	Flat	Dry	Good	Buge
11	slight	Head-on	13/9/05	M/truck	Employee	Flat	Dry	Good	Gacheno
12	slight	Head-on	10/10/2005	Truck/minbus	Employee	Rolling	Dry	Good	shoya
13	PDO	Head-on	16/10/05	M/truck	Employee	Flat	Dry	Good	Buge
14	fatal	Head-on	25/10/05	Truck/Bus	Employee	Rolling	Dry	Good	Woshe gale
15	slight	Rear-end	8/11/2005	Truck tailer	Employee	Flat	Dry	Good	Gacheno
16	slight	Run off	13/11/05	Authomobil	owner	Flat	Dry	Good	Buge
17	PDO	Roll-over	27/11/2005	Bus	Employee	Flat	Dry	Good	Gacheno
18	slight	Run off	15/11/05	Toyota	Employee	Flat	Dry	Good	Gacheno
19	slight	Roll-over	22/11/05	M/truck	Employee	Rolling	Dry	Good	Ado kayishe
20	slight	Roll-over	1/12/2005	M/truck	employee	Flat	wet	Rainy	Teba
21	PDO	Roll-over	10/12/2005	Bus	Employee	Rolling	Dry	Good	Ado kayishe
22	slight	Roll-over	14/12/05	bajaj	Employee	Rolling	Dry	Good	shoya
23	PDO	Run off	5/13/2005	truck tailer	employee	Rolling	dry	good	Shoya
24	PDO	Head-on	1/1/2006	minbus	employee	Flat	Dry	Good	Teba
25	fatal	Head-on	14/01/2006	Bus/motor	Employee	Rolling	Dry	Good	Ado kayishe
26	PDO	Roll-over	17/1/06	M/truck	Employee	Rolling	Dry	Good	Woshe gale
27	PDO	Head-on	5/2/2006	Min Bus	Owner	Flat	Dry	Good	Gacheno
28	PDO	Roll-over	10/2/2005	M/truck	Owner	Rolling	Dry	Good	Ado kayishe
29	PDO	Head-on	22/2/06	Bus	Employee	Rolling	Dry	Good	Ado kayishe
30	PDO	Run off	9/3/2006	pickup	employee	Flat	Dry	Good	Teba
31	slight	Head-on	16/4/06	land cruser	Employee	Rolling	Dry	Good	Ado kayishe
32	slight	veh-veh	2/5/2006	Min Bus	Employee	Rolling	Dry	Good	Ado kayishe
33	fatal	Head-on	6/5/2009	Truck/Bus	Employee	Rolling	Dry	Good	Woshe gale
34	PDO	Rear-end	12/5/2006	Min Bus	Employee	Flat	Dry	Good	Buge
35	PDO	Run off	22/5/06	Dolifin	Employee	Rolling	Dry	Good	Woshe gale
36	slight	Head-on	20/6/06	Toyota/minbus	Employee	Flat	Dry	Good	Fate
37	PDO	Roll-over	1/7/2006	Truck tailer	Employee	Flat	Dry	Good	Buge
38	fatal	Run off	2/7/2006	Dolifin	Employee	Rolling	Dry	Good	Shashe Gale
39	PDO	out of	29/6/08	Truck	Employee	Rolling	Dry	Good	Ado kayishe

		road							
40	slight	Roll-over	25/8/08	Truck	Employee	Rolling	Dry	Good	Shashe Gale
41	slight	Head-on	3/9/2008	bus/Truck	Employee	Flat	Dry	Good	Fate
42	fatal	Head-on	9/9/2008	Truck	Employee	Flat	Dry	Good	Buge
43	slight	Run off	13/9/06	land cruser	Employee	Rolling	Dry	Good	Woshe gale
44	fatal	veh-veh	22/9/06	Minbus	Employee	Rolling	Dry	Good	Ado kayishe
45	slight	Run off	25/09/06	Min Bus	Owner	Rolling	Dry	Good	Shashe Gale
46	PDO	veh-veh	26/9/06	Minbus/Truck	Employee	Rolling	Dry	Good	Ado kayishe
47	slight	Head-on	28/9/06	Minbus/Truck	Employee	Flat	Dry	Good	Gacheno
48	fatal	Run off	15/10/08	M/truck	Employee	Flat	Dry	Good	Buge
49	slight	Head-on	10/10/206	Bus	Employee	Flat	Dry	Good	Buge
50	slight	veh-veh	18/10/2006	Toyota	Owner	Rolling	Dry	Good	Woshe gale
51	PDO	Head-on	22/10/06	Truck tailer	Employee	Flat	Dry	Good	Buge
52	fatal	Roll-over	24/10/08	Truck	Employee	Rolling	Dry	Good	Woshe gale
53	fatal	Head-on	30/10/06	Min Bus	Employee	Flat	Dry	Good	Buge
54	slight	Run off	28/11/06	Min Bus	Employee	Rolling	Dry	Good	Shashe Gale
55	slight	Roll-over	1/12/2008	Truck	Employee	Rolling	Dry	Good	Shashe Gale
56	PDO	Head-on	13/12/06	Pickup	Employee	Rolling	Dry	Good	Ado kayishe
57	slight	Rear-end	13/12/06	minbus/Bus	Employee	Flat	Dry	Good	Fate
58	fatal	Head-on	30/12/008	Truck	Employee	Rolling	Dry	Good	Ado kayishe
59	fatal	Rear-end	3/1/2007	Truck/minbus	Employee	Rolling	Dry	Good	Shashe Gale
60	PDO	Roll-over	9/1/2007	Truck	Employee	Flat	Dry	Good	Gacheno
61	slight	Run off	13/1/07	truck tailer	employee	Flat	Dry	Good	Teba
62	slight	Roll-over	29/1/07	Bus	Employee	Rolling	Dry	Good	Ado kayishe
63	PDO	Roll-over	12/2/2007	M/truck	Employee	Flat	Dry	Good	Buge
64	slight	Rear-end	9/2/2007	Truck/minbus	Employee	Rolling	Dry	Good	Shashe Gale
65	slight	Run off	16/2/07	Dolifin	Employee	Rolling	Dry	Good	Shashe Gale
66	PDO	Head-on	3/3/2007	Truck	Employee	Flat	Dry	Good	Buge
67	slight	Run off	4/3/2007	Minbus	Employee	Rolling	Dry	Good	Woshe gale
68	PDO	Head-on	7/3/2007	Minbus	Employee	Rolling	Dry	Good	Ado kayishe
69	slight	Roll-over	12/3/2007	M/truck	Employee	Rolling	Dry	Good	Ado kayishe
70	slight	Head-on	17/3/07	Truck/Truck	Employee	Flat	Dry	Good	Fate
71	slight	Rear-end	26/3/07	Truck	Employee	Rolling	Dry	Good	Shashe Gale
72	slight	Roll-over	27/3/07	Bus	Employee	Rolling	Dry	Good	Shashe Gale
73	slight	Roll-over	1/4/2007	M/truck	Employee	Flat	Dry	Good	Gacheno
74	slight	out of road	28/4/07	M/truck	Employee	Rolling	Dry	Good	Ado kayishe
75	slight	Roll-over	2/5/2007	Min Bus	Employee	Rolling	Dry	Good	Ado kayishe
76	slight	Run off	12/5/2007	Minbus	Employee	Rolling	Dry	Good	Shashe Gale
77	slight	Head-on	16/5/07	Min Bus	Employee	Flat	Dry	Good	Gacheno
78	slight	Roll-over	21/5/07	pickup	Employee	Rolling	Dry	Good	Ado kayishe
79	PDO	veh-veh	30/5/07	Min bus	Employee	Rolling	Dry	Good	Woshe gale
80	slight	veh-veh	13/06/07	Dolifin	Employee	Flat	Dry	Good	Buge

81	slight	Roll-over	16/06/07	bus	Employee	Flat	Dry	Good	Fate
82	slight	Head-on	20/06/07	minbus	Employee	Flat	Dry	Good	Buge
83	fatal	Roll-over	25/06/07	Min Bus	Owner	Rolling	Dry	Good	Ado kayishe
84	fatal	Roll-over	26/06/07	TOYOTA	Employee	Flat	Dry	Good	Buge
85	fatal	Head-on	28/06/07	Min Bus	Employee	Rolling	Dry	Good	Woshe gale
86	slight	Roll-over	1/7/2007	Min Bus	Employee	Flat	Dry	Good	Buge
87	slight	Head-on	16/8/2008	Min bus	Employee	Rolling	Dry	Good	Shashe Gale
88	PDO	Roll-over	9/9/2007	M/truck	Employee	Flat	Dry	Good	Fate
89	fatal	Rear-end	28/7/07	M/truck/min bus	Employee	Flat	Dry	Good	Fate
90	slight	Roll-over	18/10/2007	minbus	employee	Flat	Dry	Good	Teba
91	slight	veh-veh	23/10/07	Min Bus	Employee	Flat	Dry	Good	Buge
92	fatal	Head-on	20/10/07	Dolifin/Ambulan	Employee	Rolling	Dry	Good	Woshe gale
93	slight	Rear-end	20/11/08	TOYOTA/ Min bus	Employee	Rolling	Dry	Good	Shashe Gale
94	fatal	Head-on	21/11/08	Truck	Employee	Rolling	Dry	Good	Ado kayishe
95	PDO	Roll-over	27/11/07	Truck Trailer	Employee	Flat	Dry	Good	Fate
96	slight	Roll-over	11/12/2007	M/truck	Employee	Flat	Dry	Good	Buge
97	fatal	Run off	29/12/07	Dolifin	Employee	Flat	Dry	Good	Gacheno
98	fatal	Head-on	8/1/2008	Truck/minbus	Employee	Rolling	Dry	Good	Woshe gale
99	slight	Head-on	22/1/08	Truck	owner	Rolling	Dry	Good	Ado kayishe
100	slight	Head-on	8/2/2008	Min Bus	Employee	Rolling	Dry	Good	Woshe gale
101	PDO	Head-on	16/2/08	land cruser	Employee	Flat	Dry	Good	Buge
102	fatal	Head-on	25/10/2008	Min Bus	Employee	Flat	Rainy	Good	Buge
103	fatal	Head-on	8/1/2008	Minbus	Employee	Rolling	Dry	Good	Shashe Gale
104	slight	veh-veh	1/11/2008	Bus	Employee	Flat	Dry	Good	Buge
105	fatal	Roll-over	14/11//2008	Truck	Employee	Rolling	Dry	Good	Woshe gale
106	fatal	Head-on	17/11/2008	bus/Min bus	Employee	Rolling	Dry	Good	Woshe gale
107	PDO	Roll-over	14/12/2008	Bus	Employee	Rolling	Dry	Good	Ado kayishe
108	fatal	Run off	28/12/2008	bus	employee	Flat	wet	Rainy	Teba
109	slight	veh-veh	18/01/2009	Truck/Toyota	Employee	Rolling	Dry	Good	Woshe gale
110	PDO	Head-on	16/01/2009	bus/bus	Employee	Rolling	Dry	Good	shoya
111	slight	veh-veh	18/01/2009	truck/toyta	Government	Flat	Dry	Good	Gacheno
112	slight	Head-on	11/2/2009	bus/taxi	employee	Flat	Dry	Good	Teba
113	PDO	Head-on	8/3/2009	Min bus/ambula	Government	Flat	Dry	Good	Gacheno
114	PDO	Roll-over	12/1/2009	Truck	Owner	Flat	Dry	Good	Gacheno
115	slight	veh-veh	20/03/2009	Min bus/toyt	Owner	Rolling	Dry	Good	Ado kayishe
116	slight	Run off	4/4/2009	Bus	Employee	Rolling	Dry	Good	Woshe gale
117	PDO	veh-veh	15/02/2009	Bus-Truck	Employee	Rolling	Dry	Good	Ado kayishe
118	fatal	Run off	15/05/2009	Truck	Owner	Flat	Dry	Good	Buge
119	fatal	Head-on	21/05/2009	Bus/Ambulanc	Owner	Flat	Dry	Good	Teba
120	fatal	Run off	2/6/2009	Truck	Owner	Flat	Dry	Good	Buge
121	slight	Rear-end	29/05/2008	truck/Truck Taile	Owner	Flat	Dry	Good	Fate

122	slight	Head-on	8/8/2009	bus/Min bus	Owner	Flat	Dry	Good	Gacheno
123	PDO	Run off	29/08/2009	Bus	Government	Flat	Dry	Good	Buge
124	PDO	Rear-end	25/8/2009	bus/Min bus	Employee	Rolling	Dry	Good	Woshe gale
125	slight	veh-veh	27/08/2008	truck	Owner	Flat	Dry	Good	Fate
126	PDO	veh-veh	28/08/2009	Min Bus	Owner	Rolling	Dry	Good	Woshe gale
127	PDO	Roll-over	3/10/2009	Truck	Owner	Rolling	Dry	Good	Ado kayishe
128	slight	veh-veh	9/10/2009	bajaj/ambul ance	Owner	Flat	Dry	Good	Buge
129	PDO	Run off	15/10/2009	truck	Employee	Rolling	Dry	Good	shoya
130	slight	Head-on	16/10/2009	Truck /Toyota	Owner	Flat	Dry	Good	Gacheno
131	slight	Rear-end	25/10/2009	motor - bajaj	Owner	Flat	wet	Rainy	Teba
132	PDO	Head-on	15/10/2009	Truck/minb us	Employee	Rolling	Wet	Good	Woshe gale
133	slight	Head-on	20/12/2009	Bus/Ambul anc	Owner	Flat	Dry	Good	Gacheno
134	slight	Head-on	28/12/2009	Min Bus/ambula	Owner	Rolling	Rainy	Good	Woshe gale
135	slight	Rear-end	16/11/2009	Truck/Bus	Employee	Rolling	Dry	Good	Woshe gale
136	fatal	Head-on	1/1/2010	Bus/Truck	Owner	Rolling	Dry	Good	Woshe gale
137	PDO	Roll-over	25/1/2008	motorcycle	Owner	Flat	Dry	Good	Fate
138	PDO	Rear-end	23/2/2009	Bus/Ambul anc	Employee	Flat	Dry	Good	Fate
139	fatal	Head-on	5/3/2009	Bus/Truck	Employee	Flat	Dry	Good	Buge
140	PDO	Head-on	30/4/2009	abadula/aba dul	Owner	Flat	Dry	Good	Fate
141	PDO	Roll-over	25/2/2008	Truck	Employee	Rolling	Dry	Good	Shashe Gale
142	PDO	Rear-end	28/2/2008	truck/bajaj	Owner	Flat	Dry	Good	Fate
143	slight	Head-on	11/3/2008	motor/bajaj	Owner	Flat	Dry	Good	Gacheno
144	slight	Run off	7/2/2009	Truck	Owner	Flat	Dry	Good	Gacheno
145	fatal	Head-on	14/2/2009	bus/bus	Employee	Flat	Dry	Good	Fate
146	slight	Rear-end	1/3/2009	Min Bus/Bus	Owner	Flat	Dry	Good	Buge
147	slight	Head-on	10/10/2009	Minbus	Owner	Flat	Dry	Good	Fate
148	slight	Head-on	19/11/2009	Mini Bus/Truck	Employee	Rolling	Rainy	Wet	Shashe Gale
149	fatal	Head-on	10/9/2007	Bus	Owner	Rolling	Dry	Good	Delibo
150	fatal	Head-on	5/3/2007	bus	Employee	Rolling	Dry	Good	Delibo
151	PDO	Run off	4/10/2007	Truck	Employee	Rolling	Dry	Good	Delibo
152	PDO	Run off	22/10/07	Truck	Employee	Rolling	Dry	Good	kokate
153	Slight	Head-on	6/11/2007	bus and M/bus	Employee	Rolling	Dry	Good	Kawo shafe
154	fatal	Run off	21/7/07	pickup	Owner	Rolling	Dry	Good	Delibo
155	PDO	Head-on	19/4/07	bus with bus	Owner	Rolling	Dry	Good	kokate
156	Slight	Head-on	25/11/07	pickup/min bus	Owner	Rolling	Dry	Good	kokate
157	PDO	Roll-over	1/5/2007	truck-tailer	Employee	Rolling	Dry	Good	Delibo
158	PDO	Run off	30/03/07	bus	Employee	Rolling	Dry	Good	kokate
159	PDO	Run off	18/1/07	minbus	Employee	Rolling	Dry	Good	Delibo
160	Slight	Rear-end	7/1/2007	Toyota	Employee	Rolling	Dry	Good	kokate
161	slight	Head-on	8/6/2005	TOYOTA	Employee	Rolling	Dry	Good	Delibo
162	fatal	Rear-end	21/06/05	minbus	Governme	Rolling	Dry	Good	Delibo

163	slight	Head-on	24/06/05	land rover	Governm	Rolling	Dry	Good	kokate
164	PDO	Roll-over	8/7/2005	Truck	employee	Rolling	Dry	Good	Maria Chare
165	fatal	Rear-end	23/7/05	Truck	Owner	Rolling	Dry	Good	kokate
166	fatal	Run off	14/7/05	TOYOTA	employee	Rolling	Dry	Good	Delibo
167	PDO	Head-on	4/8/2005	Hilux toyota	employee	Rolling	Dry	Good	Delibo
168	fatal	Roll-over	11/8/2005	truck tailer	Employee	Rolling	Dry	Good	kokate
169	fatal	Head-on	4/9/2005	bus	employee	Rolling	Dry	Good	Maria Chare
170	slight	Run off	5/9/2005	bus	Owner	Rolling	Dry	Good	kokate
171	slight	Run off	13/9/05	Toyota	employee	Rolling	Dry	Good	Maria Chare
172	slight	Head-on	27/9/05	Truck	Employee	Rolling	Dry	Good	kokate
173	slight	Roll-over	10/10/2005	truck tailer	employee	Rolling	Dry	Good	Maria Chare
174	slight	Head-on	14/10/05	M/truck	owner	Rolling	Dry	Good	Delibo
175	slight	Head-on	16/10/05	Nissan	Employee	Rolling	Dry	Good	kokate
176	slight	Rear-end	25/10/05	M/truck	employee	Rolling	Dry	Good	Delibo
177	PDO	Rear-end	3/11/2005	Hilux toyota	Employee	Rolling	Dry	Good	kokate
178	slight	Head-on	8/11/2005	M/truck	employee	Rolling	Dry	Good	Delibo
179	fatal	Roll-over	13/11/05	Truck	governt	Rolling	Dry	Good	Delibo
180	PDO	Run off	2005	bus	employee	Rolling	Dry	Good	Delibo
181	fatal	Head-on	27/11/2005	truck tailer	Employee	Rolling	Dry	Good	kokate
182	slight	Head-on	15/11/05	authomobil	employee	Rolling	Dry	Good	Maria Chare
183	slight	Run off	22/11/05	Truck	Employee	Rolling	Dry	Good	kokate
184	slight	Head-on	1/12/2005	bus	owner	Rolling	Dry	Good	Maria Chare
185	slight	Run off	10/12/2005	Toyota	Owner	Rolling	Dry	Good	kokate
186	PDO	Head-on	15/12/05	M/truck	employee	Rolling	Dry	Good	Maria Chare
187	slight	Roll-over	14/12/05	M/truck	employee	Rolling	Dry	Good	Delibo
188	slight	Head-on	5/13/2005	bus	employee	Rolling	Dry	Good	Delibo
189	slight	Head-on	4/3/2005	M/truck	employee	Rolling	Dry	Good	Delibo
190	PDO	Rear-end	28/4/05	Truck	employee	Rolling	Dry	Good	Delibo
191	slight	Roll-over	29/5/05	truck tailer	Employee	Rolling	Dry	Good	kokate
192	slight	Run off	30/5/05	minbus	employee	Rolling	Dry	Good	Maria Chare
193	PDO	Head-on	3/6/2005	land rover	employee	Rolling	Dry	Good	Delibo
194	PDO	Roll-over	17/1/2006	M/truck	employee	Rolling	Dry	Good	Maria Chare
195	fatal	Rear-end	17/1/06	Truck	employee	Rolling	Dry	Good	Delibo
196	slight	Run off	5/2/2006	Truck	employee	Rolling	Dry	Good	Delibo
197	PDO	Roll-over	10/2/2005	bus	Employee	Rolling	Dry	Good	kokate
198	PDO	Run off	22/2/06	truck tailer	employee	Rolling	Dry	Good	Delibo
199	PDO	Roll-over	22/2/06	Truck	owner	Rolling	Dry	Good	Delibo
200	PDO	Run off	1/2/2006	pickup	owner	Rolling	Dry	Good	Maria Chare
201	PDO	Head-on	9/3/2008	minbus	employee	Rolling	Dry	Good	Delibo
202	PDO	Rear-end	12/3/2008	land cruser	owner	Rolling	Dry	Good	Delibo
203	PDO	Run off	16/4/06	bus	employee	Rolling	Dry	Good	Delibo
204	slight	Head-on	16/4/06	pickup	employee	Rolling	Dry	Good	Maria Chare
205	slight	Head-on	18/4/06	land cruser	employee	Rolling	Dry	Good	Maria Chare

206	slight	Head-on	2/5/2006	land cruser	Employee	Rolling	Dry	Good	Kawo shafe
207	slight	Head-on	4/5/2006	M/truck	Employee	Rolling	Dry	Good	kokate
208	slight	Head-on	6/5/2006	minbus	Employee	Rolling	Dry	Good	kokate
209	slight	Head-on	12/5/2006	Dolifin	employee	Rolling	Dry	Good	Maria Chare
210	PDO	Roll-over	22/5/06	truck	employee	Rolling	Dry	Good	Maria Chare
211	fatal	Run off	19/6/06	land cruser	Employee	Rolling	Dry	Good	kokate
212	PDO	Head-on	20/6/06	truck tailer	employee	Rolling	Dry	Good	Delibo
213	PDO	Head-on	1/7/2006	Dolifin	employee	Rolling	Dry	Good	Maria Chare
214	slight	Rear-end	2/7/2006	truck	employee	Rolling	Dry	Good	Delibo
215	slight	Head-on	29/6/06	minbus	employee	Rolling	Dry	Good	Delibo
216	PDO	Roll-over	11/8/2006	truck	employee	Rolling	Dry	Good	Maria Chare
217	fatal	Head-on	25/8/06	truck	employee	Rolling	Dry	Good	Delibo
218	PDO	Run off	2/9/2006	bus	employee	Rolling	Dry	Good	Delibo
219	slight	Head-on	3/9/2006	Truck	employee	Rolling	Dry	Good	Maria Chare
220	slight	Head-on	26/9/06	land cruser	employee	Rolling	Dry	Good	Delibo
221	fatal	Rear-end	28/9/08	minbus	employee	Rolling	Dry	Good	Maria Chare
222	fatal	Rear-end	15/10/08	minbus	owner	Rolling	Dry	Good	Delibo
223	slight	Head-on	10/10/2006	Truck	employee	Rolling	Dry	Good	Delibo
224	PDO	Head-on	18/10/2008	minbus	owner	Rolling	Dry	Good	Delibo
225	slight	Run off	19/10/08	minbus	Employee	Rolling	Dry	Good	kokate
226	fatal	Run off	22/10/06	M/truck	governme	Rolling	Dry	Good	Delibo
227	slight	Head-on	24/10/06	bus	employee	Rolling	Dry	Good	Maria Chare
228	slight	Head-on	30/10/06	Truck	owner	Rolling	Dry	Good	Delibo
229	slight	Run off	18/11/06	M/truck	government	Rolling	Dry	Good	Delibo
230	PDO	Rear-end	19/11/06	truck tailer	government	Rolling	Dry	Good	Delibo
231	fatal	Roll-over	28/11/06	truck	owner	Rolling	Dry	Good	Maria Chare
232	fatal	Rear-end	1/12/2008	minbus	Owner	Rolling	Dry	Good	kokate
233	slight	Head-on	28/12/08	minbus	Employee	Rolling	Dry	Good	kokate
234	slight	Head-on	13/12/08	minbus	employee	Rolling	Dry	Good	Delibo
235	fatal	Head-on	30/12/06	truck	owner	Rolling	Dry	Good	Delibo
236	fatal	Roll-over	2/13/2006	truck tailer	owner	Rolling	Dry	Good	Delibo
237	fatal	Head-on	3/1/2006	truck	Owner	Rolling	Dry	Good	kokate
238	PDO	Roll-over	9/1/2006	truck	Employee	Rolling	Dry	Good	Maria Chare
239	slight	Rear-end	13/1/06	truck tailer	owner	Rolling	Dry	Good	Maria Chare
240	slight	Roll-over	28/1/06	truck tailer	owner	Rolling	Dry	Good	Delibo
241	slight	Run off	29/1/06	bus	employee	Rolling	Dry	Good	Delibo
242	PDO	Roll-over	12/2/2007	M/truck	owner	Rolling	Dry	Good	Delibo
243	slight	Run off	9/2/2007	Bus	owner	Rolling	Dry	Good	Maria Chare
244	slight	Run off	30/5/07	truck tailer	governme	Rolling	Dry	Good	Delibo
245	PDO	Head-on	13/06/07	minbus	governme	Rolling	Dry	Good	Delibo
246	slight	Roll-over	16/06/07	bus	employee	Rolling	Dry	Good	Delibo
247	PDO	Head-on	20/06/07	M/truck	Employee	Rolling	Dry	Good	kokate
248	slight	Head-on	21/06/07	M/truck	owner	Rolling	Dry	Good	Maria Chare
249	slight	Head-on	23/06/07	bus	owner	Rolling	Dry	Good	Maria Chare

250	fatal	Rear-end	25/06/07	minbus	owner	Rolling	Dry	Good	Delibo
251	slight	Roll-over	26/06/07	minbus	Owner	Rolling	Dry	Good	kokate
252	slight	Roll-over	28/06/07	Dolifin	owner	Rolling	Dry	Good	Maria Chare
253	slight	Roll-over	1/7/2007	bus	Employee	Rolling	Dry	Good	Kawo shafe
254	slight	Run off	4/7/2007	pickup	owner	Rolling	Dry	Good	Delibo
255	slight	Roll-over	11/7/2007	truck	owner	Rolling	Dry	Good	Delibo
256	slight	Head-on	11/8/2007	TOYOTA	Owner	Rolling	Dry	Good	kokate
257	slight	Roll-over	14/8/07	truck tailer	owner	Rolling	Dry	Good	Delibo
258	slight	Rear-end	16/8/2007	Truck	Employee	Rolling	Dry	Good	Kawo shafe
259	slight	Head-on	15/09/07	M/truck	owner	Rolling	Dry	Good	Maria Chare
260	slight	Roll-over	9/9/2007	minbus	Employee	Rolling	Dry	Good	kokate
261	PDO	Head-on	28/7/07	Dolifin	owner	Rolling	Dry	Good	Delibo
262	slight	Head-on	12/10/2007	truck	owner	Rolling	Dry	Good	Delibo
263	slight	Rear-end	18/10/2007	Bus	employee	Rolling	Dry	Good	Delibo
264	PDO	Head-on	23/10/07	Truck	employee	Rolling	Dry	Good	Maria Chare
265	slight	Head-on	20/10/07	land cruser	employee	Rolling	Dry	Good	Delibo
266	slight	Rear-end	28/10/07	minbus	employee	Rolling	Dry	Good	Delibo
267	slight	Run off	4/11/2007	minbus	Employee	Rolling	Dry	Good	kokate
268	fatal	Head-on	20/11/30	bus	Employee	Rolling	Dry	Good	kokate
269	fatal	Roll-over	20/11/07	Bus	employee	Rolling	Dry	Good	Maria Chare
270	fatal	pedestrian	21/11/07	bus	Employee	Rolling	Dry	Good	Kawo shafe
271	fatal	Roll-over	27/11/07	minbus	employee	Rolling	Dry	Good	Delibo
272	fatal	Head-on	11/12/2007	bus	employee	Rolling	Dry	Good	Delibo
273	slight	Roll-over	22/12/2007	bus	Employee	Rolling	Dry	Good	kokate
274	slight	Head-on	29/12/07	truck/toyot a	employee	Rolling	Dry	Good	Maria Chare
275	fatal	Head-on	10/2/2008	bus	employee	Rolling	Dry	Good	Maria Chare
276	PDO	Head-on	10/2/2008	truck	owner	Rolling	Dry	Good	Delibo
277	PDO	Head-on	14/3/2008	truck/truck	owner	Rolling	Dry	Good	Delibo
278	fatal	Roll-over	13/5/2008	bus	employee	Rolling	Dry	Good	Maria Chare
279	PDO	Roll-over	17/6/2008	truck tailer	Owner	Rolling	Dry	Good	Kawo shafe
280	slight	Run off	19/06/2008	Truck	Owner	Rolling	Dry	Good	kokate
281	slight	Roll-over	1/7/2008	bus	employee	Rolling	Dry	Good	Delibo
282	slight	Run off	19/11/2008	min bus	owner	Rolling	Dry	Good	Maria Chare
283	PDO	Head-on	18/2/2008	truck	Employee	Rolling	Dry	Good	kokate
284	PDO	Head-on	25/2/2008	truck/truck	owner	Rolling	Dry	Good	Delibo
285	slight	Head-on	28/2/2008	bus/min bus	owner	Rolling	Dry	Good	Delibo
286	PDO	Head-on	11/3/2008	bus	Owner	Rolling	Dry	Good	kokate
287	slight	Head-on	15/3/2008	bus/truck	employee	Rolling	Dry	Good	Delibo
288	PDO	Rear-end	20/4/2008	bus	Employee	Rolling	Dry	Good	kokate
289	fatal	Head-on	1/5/2008	bus/truck	employee	Rolling	Dry	Good	Maria Chare
290	slight	Roll-over	23/06/08	bus	employee	Rolling	Dry	Good	Maria Chare
291	fatal	Run off	25/06/08	bus	employee	Rolling	Dry	Good	Delibo
292	slight	Head-on	26/06/08	bus	owner	Rolling	Dry	Good	Maria Chare

293	slight	Run off	28/06/08	minbus	Owner	Rolling	Dry	Good	Kawo shafe
294	slight	Head-on	1/7/2008	minbus	Owner	Rolling	Dry	Good	kokate
295	slight	falling	4/7/2008	Dolifin	owner	Rolling	Dry	Good	Delibo
296	slight	Roll-over	11/7/2008	bus	employee	Rolling	Dry	Good	Maria Chare
297	slight	Rear-end	19/8/2008	pickup	Owner	Rolling	Dry	Good	kokate
298	slight	Run off	15/8/2008	bus	owner	Rolling	Dry	Good	Delibo
299	PDO	Head-on	19/6/2008	truck	owner	Rolling	Dry	Good	Delibo
300	slight	Run off	10/6/2008	truck tailer	Employee	Rolling	Dry	Good	kokate
301	slight	Head-on	19/11/2008	bus	Employee	Rolling	Dry	Good	Kawo shafe
302	slight	Run off	18/2/2008	Truck	owner	Rolling	Dry	Good	Delibo
303	PDO	Roll-over	25/2/2008	truck	Employee	Rolling	Dry	Good	kokate
304	PDO	Head-on	28/2/2008	truck/bus	Owner	Rolling	Dry	Good	kokate
305	slight	Head-on	11/3/2008	min bus/bus	owner	Rolling	Dry	Good	Delibo
306	PDO	Head-on	15/3/2008	bus	Owner	Rolling	Dry	Good	kokate
307	slight	Head-on	20/4/23008	bus/truck	employee	Rolling	Dry	Good	Delibo
308	PDO	Rear-end	1/5/2008	bus	Employee	Rolling	Dry	Good	kokate
309	fatal	Rear-end	20/5/2008	bus	employee	Rolling	Dry	Good	Delibo
310	PDO	Rear-end	5/2/009	bus	employee	Rolling	Dry	Good	Delibo
311	slight	Roll-over	7/2/2009	Truck	Owner	Rolling	Dry	Good	kokate
312	fatal	Head-on	14/2/2009	bus	employee	Rolling	Dry	Good	Maria Chare
313	PDO	Head-on	16/2/2009	Truck	Owner	Rolling	Dry	Good	kokate
314	slight	Head-on	1/3/2009	truck/bus	owner	Rolling	Dry	Good	Delibo
315	fatal	Run off	5/6/2009	bus	employee	Rolling	Dry	Good	Delibo
316	PDO	Head-on	7/7/2009	bus	Employee	Rolling	Dry	Good	kokate
317	slight	Head-on	12/7/2009	min bus	owner	Rolling	Dry	Good	Maria Chare
318	PDO	Roll-over	20/7/2009	bus	employee	Rolling	Dry	Good	Maria Chare
319	fatal	Head-on	11/9/2009	bus	employee	Rolling	Dry	Good	Maria Chare
320	slight	Head-on	10/10/2009	min bus/bus	Owner	Rolling	Dry	Good	kokate
321	slight	Rear-end	19/11/2009	mini/bus	employee	Rolling	Dry	Good	Maria Chare
322	slight	Run off	19/1/2009	minbus	owner	Rolling	Dry	Good	Delibo
323	fatal	Roll-over	10/2/2009	bus	Employee	Rolling	Dry	Good	kokate
324	PDO	Roll-over	14/3/2009	truck tailer	owner	Rolling	Dry	Good	Delibo
325	PDO	Head-on	13/5/2009	truck/min bus	Owner	Rolling	Dry	Good	kokate
326	fatal	Run off	17/6/2009	bus	employee	Rolling	Dry	Good	Delibo
327	PDO	Roll-over	19/06/2009	truck tailer	Owner	Rolling	Dry	Good	kokate
328	slight	Rear-end	1/7/2009	min bus/bus	Owner	Rolling	Dry	Good	kokate

Appendix F

Details of Maps and Charts

1. Location with Severity Type

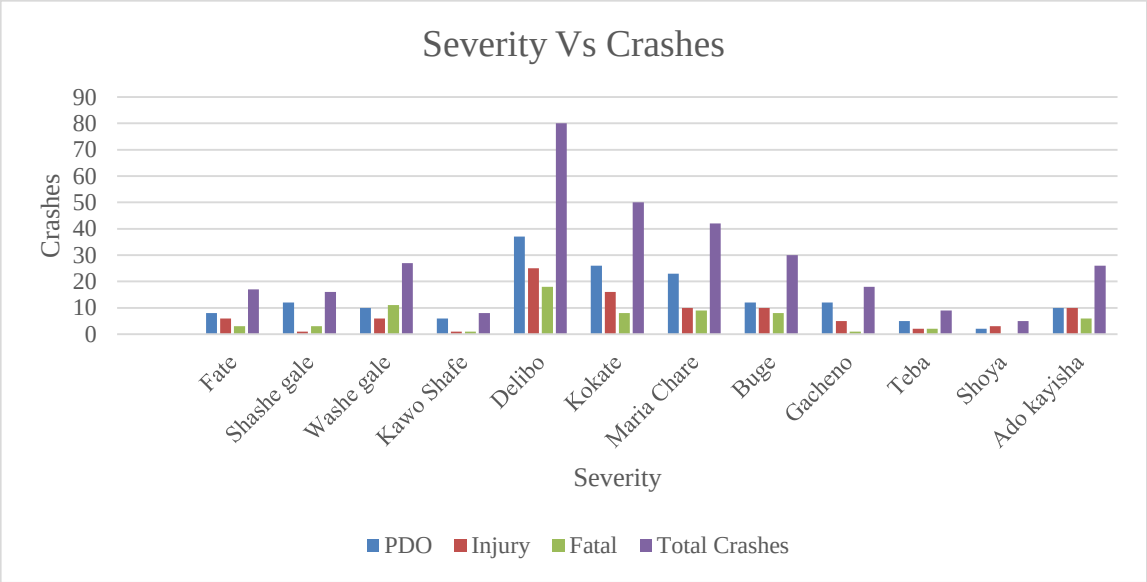

Figure F-1.1: Distribution of Total Severity Type over the Study Locations.

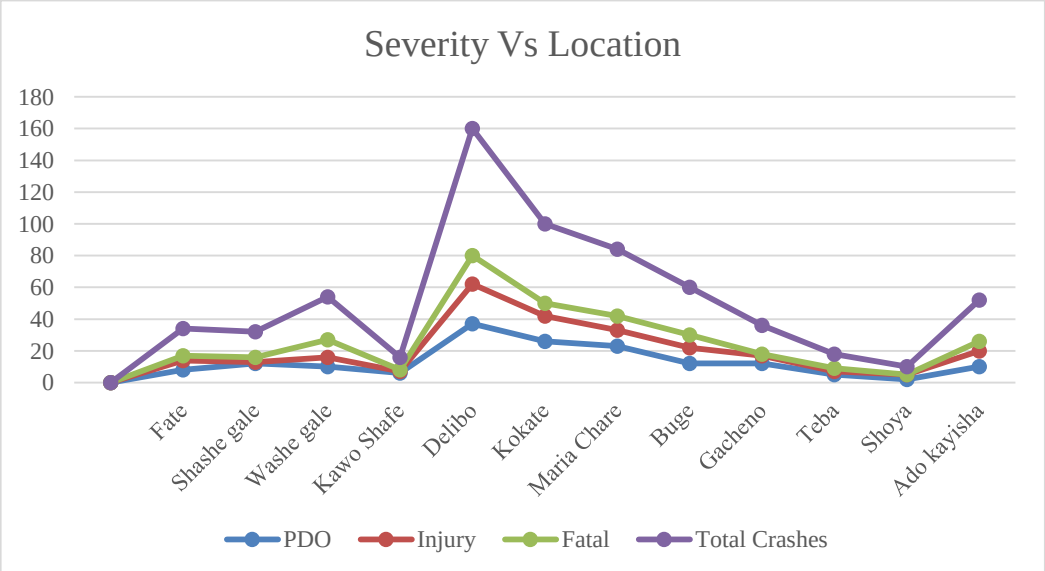

Figure F-1.2: Distribution of Total Severity Type over the Study Locations.

2. Total Crashes with Their Locations

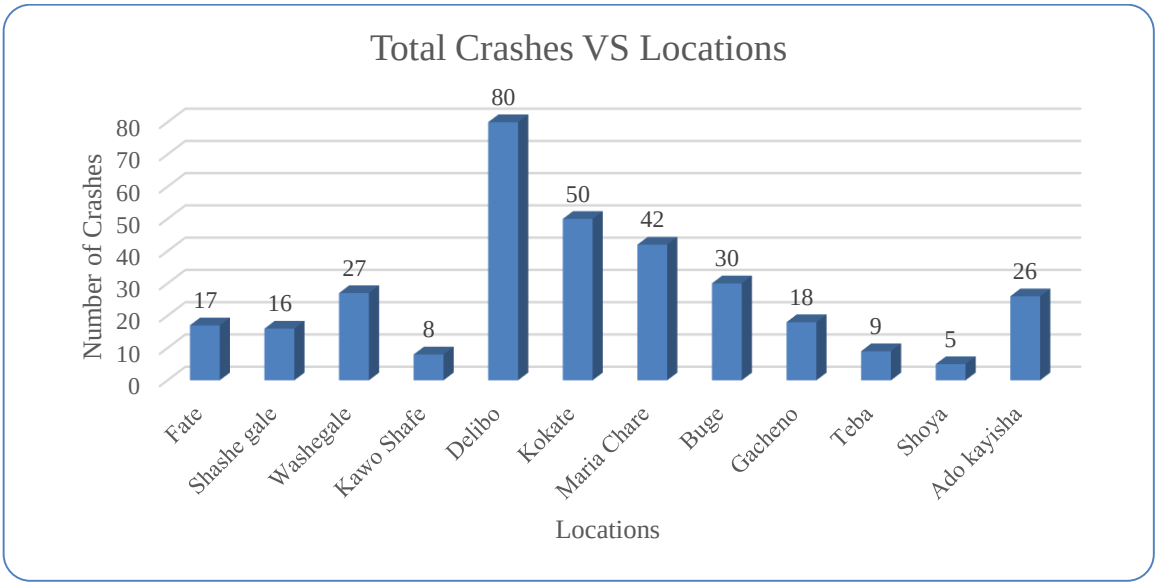

Figure F-2.1: Distribution of Total Crashes over the Study Locations.

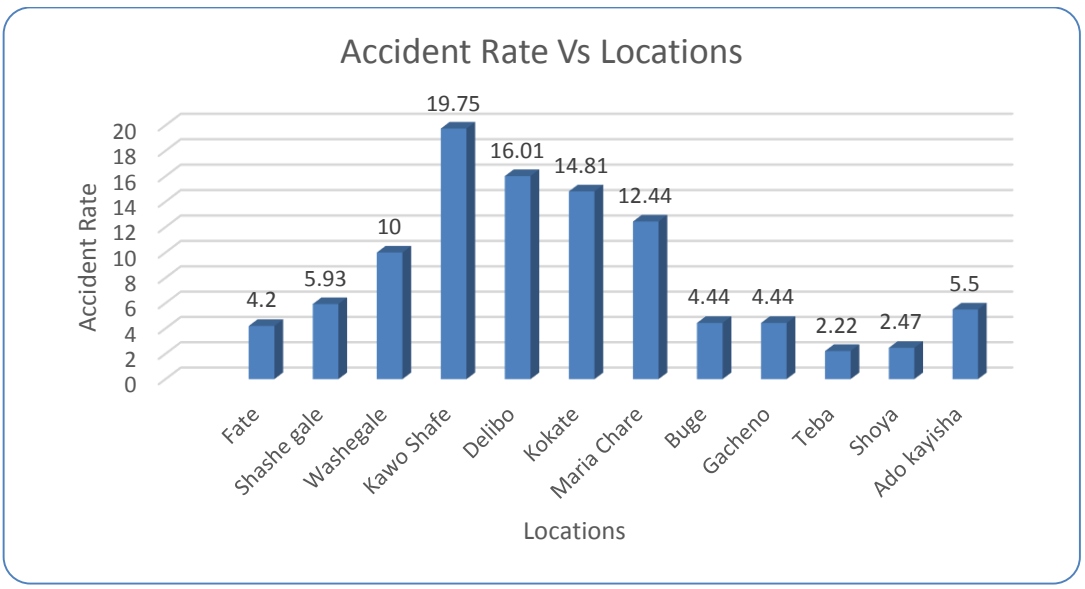

Figure F-2.2: Distribution of accident Rate over the Study Locations.

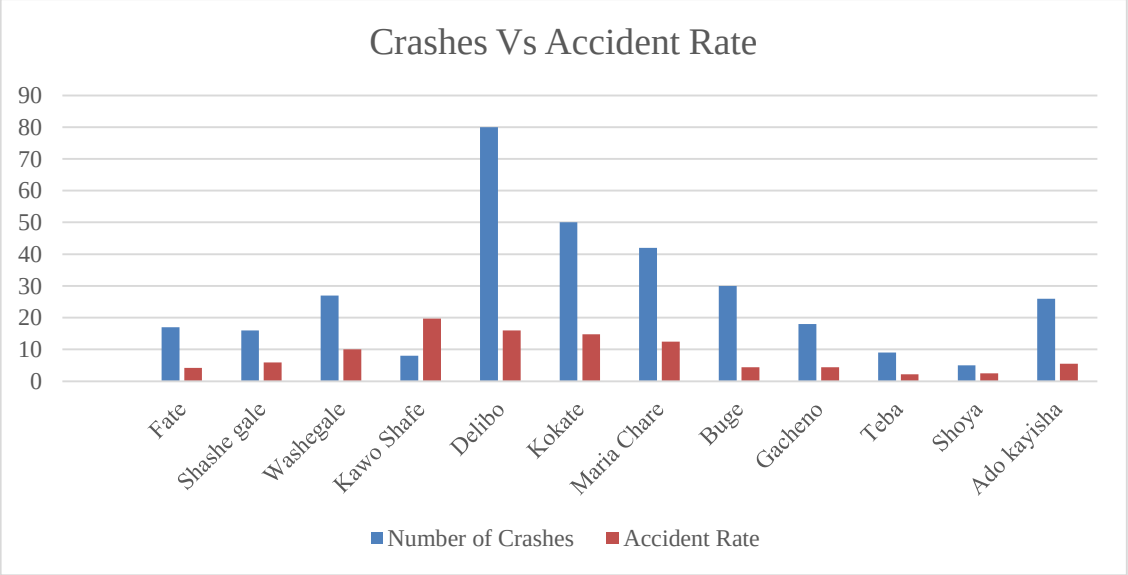

Figure F-2.3: Distribution of AR and Total number of Accidents over the Study Locations.

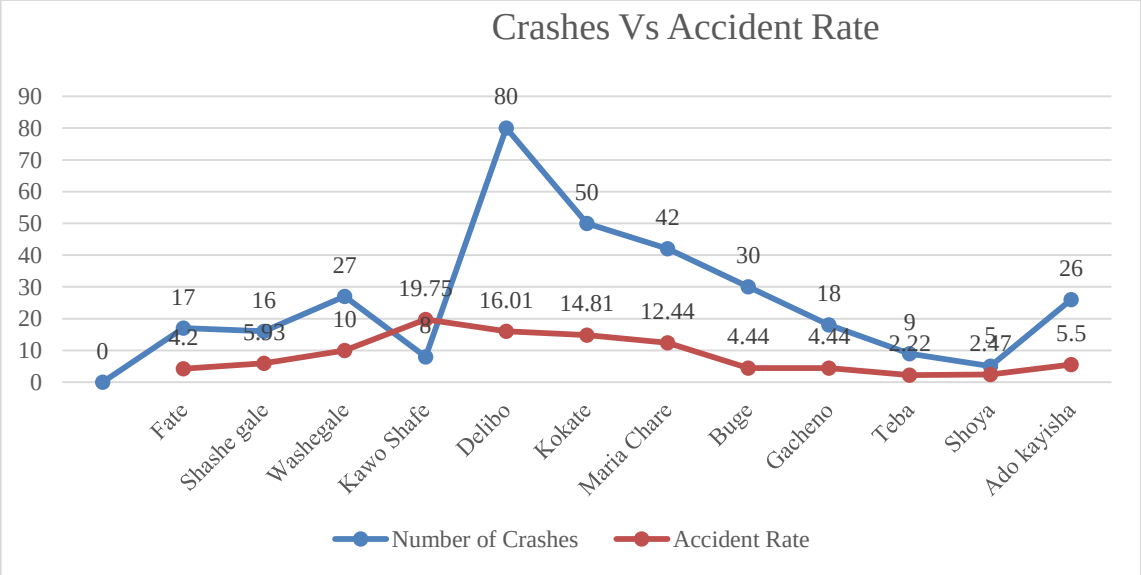

Figure F-2.4: Distribution of AR and Total number of Crashs over the analysis period.

3. Scatter Plot

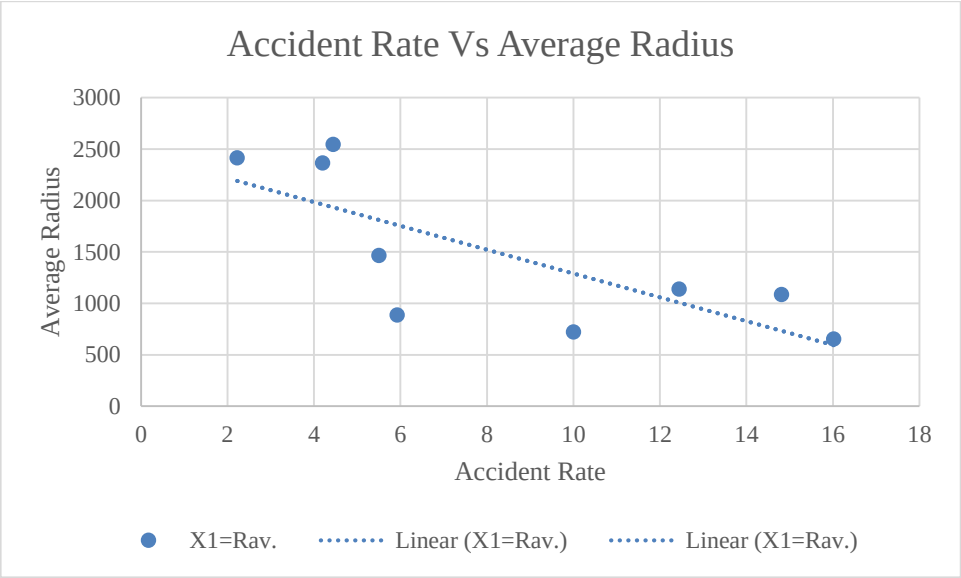

Figure F-3.1: Scatter Diagram of Average Radius versus Accident Rate

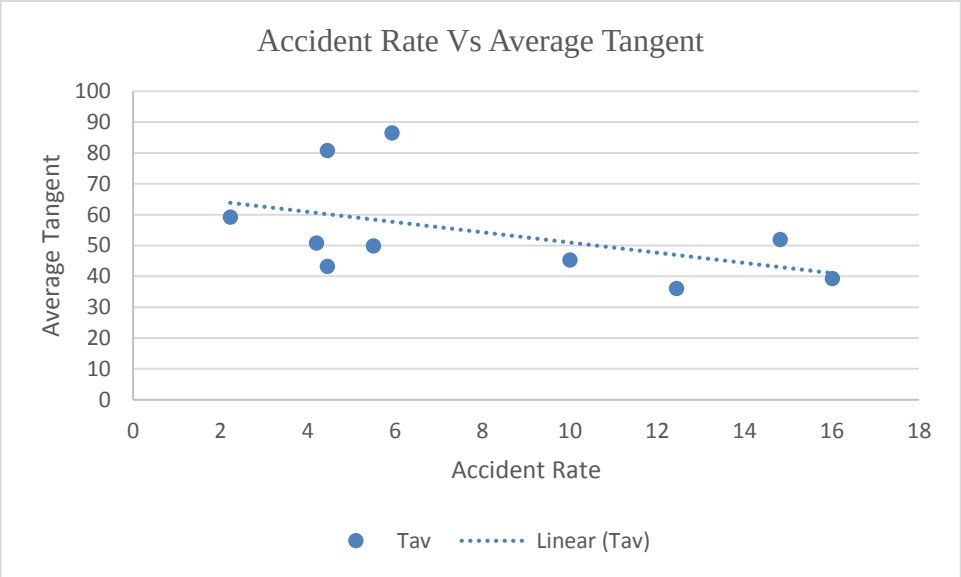

Figure F-3.2: Scatter Diagram of Average Tangent versus Accident Rate

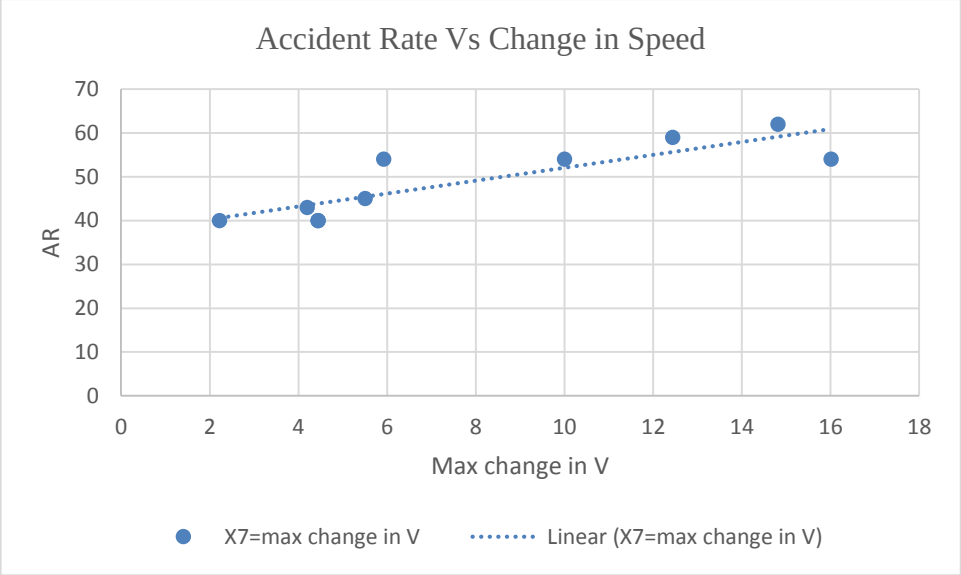

Figure F-3.3: Scatter Diagram of Maximum Change in speed versus Accident Rate

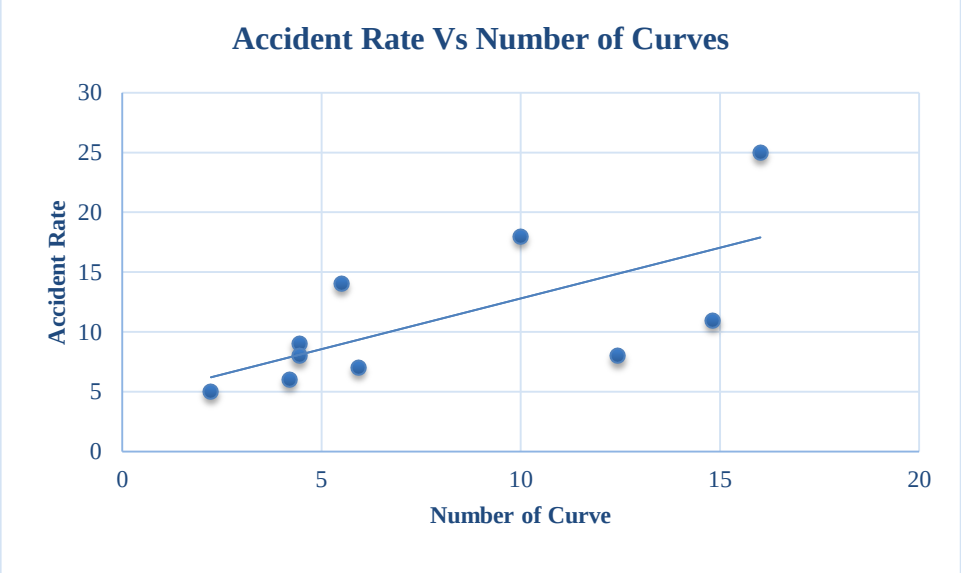

Figure F-3.4: Scatter Diagram of Number of Curve versus Accident Rate

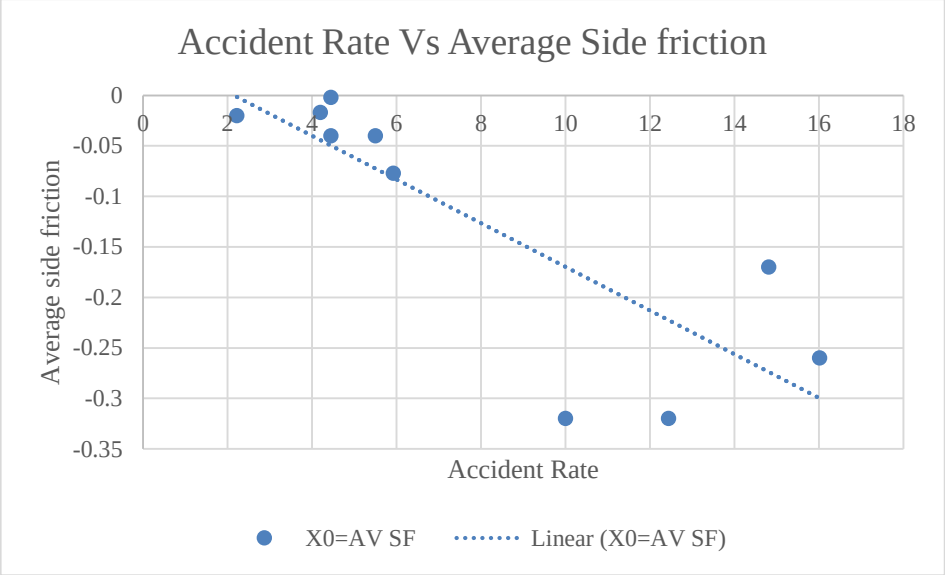

Figure F-3.5: Scatter Diagram of Average Side friction versus Accident Rate