Design Consistency of Horizontal Alignments on Two - Lane Trunk Roads

A thesis submitted to School of Graduate Studies of Addis Ababa University in partial fulfillment of the requirements for the degree of Master of Science in Civil Engineering

(Road and Transport Engineering)

BY
HAILU MEKONNEN GONET

FEBRUARY 2007

Addis Ababa University

School of Graduate Studies

Design Consistency of Horizontal Alignments

on Two - Lane Trunk Roads

By Hailu Mekonnen Gonet

Approved By Board of Examiners

Dr. – Ing. Girma Berhanu ------------------------------
Advisor

……………. -------------------------

Internal Examiner

_................. -------------------------

External Examiner

_................... -------------------------

Chairman

Signed Declaration

This thesis is my original work and has not been presented for a degree in any other university, and that all sources of material used for the thesis have been duly acknowledged.

HAILU MEKONNEN ------------------------------

……………

Dr. – Ing. Girma Berhanu ------------------------------

Advisor

……………

Acknowledgements

First and for most my gratitude goes to Ethiopian Roads Authority for financing my study at ADDIS ABABA UNIVERSITY for last two years.

I cannot fully express my gratitude to my advisor Dr. (Ing.) Girma Berhanu for his generosity and superb guidance starting from proposal writing to the completion of this thesis. With out his guidance and valuable comments and suggestions, it would not have been simple to shape this study at this current format.

I would like to extend my heartfelt acknowledgment to the staff members of Ethiopian Roads Authority for their cooperation and assistance during my study.

Lastly, I would like to thank my mother Tayech W/Hiowt and Mahlet Ashenafi for their love and moral support through their prayer. I am pent-up to the highest degree indebted to Almighty God who gave me health and era to reach here with happiness and glory.

Table of Contents

List of Tables Pages

List of Figures **Pages**

ABSTRACT

Design consistency is the conformance of highway's geometric and operational features with driver's expectancy. A technique to evaluate the consistency of a design is to evaluate changes in operating speeds along an alignment. To use operating speed as a consistency tool requires the ability to accurately predict speeds as a function of the roadway geometry. The current Ethiopian Roads Authority geometric design manual is based on the design speed concept. However, due to the constraints resulting from roadway elements, right-of-way, and environmental features, consistency in operating speed cannot be guaranteed. In order to make informed decisions to ensure highway geometric design consistency, the consistency of geometric design of operating speed on simple curve and tangent section was studied. Forty three sections for both of horizontal curve sections and tangent sections were selected, within easy reach of Addis Ababa. Roadway geometric design variables were obtained from design documents and through field measurements. The speeds of passenger cars, buses, and trucks were measured on each curve and its approaching tangent, under dry day time condition. This study was focused on two major issues, in evaluating the geometric design consistency of the selected alignments and in developing operating speed predicting models for the selected sections. Therefore, the results obtained from consistency evaluation shows that four sections between simple curves and tangents were in poor conditions. Whereas, consistency evaluation between design speed and operating speed shows that thirty seven sections in horizontal curves and thirty four sections in tangents sections was in a poor conditions. Two models were found for horizontal curves and tangents. Model found for the horizontal curves were governed by the combination of grade and superelevation. Furthermore model for tangent section were governed by grade.

INTRODUCTION

1. Introduction

1.1. General

Design consistency implies that the design or geometry of a road does not violate either the expectation of the motorists or the ability of the motorists to guide and control a vehicle in a safe manner. There is a strong relationship between geometric consistency and safety. One method of improving safety on roadways is ensuring their consistency of the geometric design. Designers are supposed to provide consistent design up to the expectancies of the driver. To develop a consistent design, however, the designer must have a good working knowledge of driver's expectancies. "Driver expectancy relates to the observable, measurable features of the driving environment which: increase a driver's readiness to perform a driving task in a particular manner, and because the driver to continue in the task until it is completed or interrupted." (Glemnon, 1978)

Researchers have developed a number of methods to evaluate design consistency of road alignments. In this study operating speed based consistency measure has been used to evaluate the design consistency of the road alignment and to produce regression model.

1.2. Background of the Problem

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 to driver expectancy. Generally, drivers make fewer errors in the vicinity of geometric features that conform to their expectations than at features that violate their expectations. (Alexander 1986)

In Ethiopia, design consistency on two-lane trunk roads has been assumed to be provided through the selection and application of a uniform design speed among the individual alignment elements. Geometric design inconsistencies related with speeds on highways are causes of major traffic accidents. Apart from this, it is known that in some part of the road alignments the drivers are using higher speeds than design speed.

The design speed concept is the mechanism for achieving consistency among the individual elements of an alignment. Design speed is the "the maximum safe speed that can be maintained over a specific section of highway when conditions are so favorable that the design features of the highway govern" (Alexander 1986). Implementing the design speed concept involves two steps. First, a design speed is selected "Consistent with the speed a driver is likely to expect," on the bases of the functional classification of the highway, development environment, and topography. Then "all of the pertinent features of the highway should be related to the deign speed to obtain a balance design" (Alexander 1986) .The design speed concept presumes that a design will be consistent if the individual geometric features share the same design speed. A fundamental limitation is that the design speed applies only to horizontal and vertical curves, not to the tangents that connect those curves. Design speed has no practical meaning on horizontal tangents. It provides no basis for establishing maximum tangent lengths to promote consistency by controlling the maximum operating speeds that can be attained. Design speed concept does not provide sufficient co-ordination among individual geometric features (grades, radius, curve length, superelevation, etc) to ensure consistency. It controls only the minimum value of the maximum safe speeds for the individual features along an alignment. For example, a highway with a 80 Km/h design speed could have only one curve with a maximum safe speed of 80 Km/h and all other features with maximum speeds of 112 Km/h or greater. As a result, operating speeds approaching the critical curve are likely to exceed the 80 Km/h design speed, but it might violate a driver's ad hoc expectancy and exhibit undesirable operating-speed profiles. Consequently, the design-speed concept currently used in Ethiopia does not explicitly consider the speeds that motorists are operating. Due to these situations drivers are using higher speeds than specified on the design and these situations are causing accidents to human lives and properties. This thesis research was made to evaluate the consistency of geometric design particularly on simple curves using operating speeds of passenger cars, buses and trucks.

1.3. Study Objective and Scope

Objectives

The specific objectives of the research are to:

I) Evaluate geometric design consistency.

II) Develop regression model relating operating speeds with geometric elements.

Scope

The scope of the study was limited to simple horizontal curves (Curve – Tangent – Curve) on two-lane trunk roads. Multi- lane highways was not included because inconsistency in the geometric design of these highways does not lead to hazardous conditions similar to those of two- lane highways. Operating speeds of different vehicle classes (Passenger cars, Buses and trucks) was observed only under dry day time condition. Rainy and dusty or foggy weather conditions were not included.

LITERATURE REVIEW

2. Literature Review

2.1. Design Consistency and Horizontal Curves

A consistent design is important because it is believed that motorists make fewer errors at geometric features that conform to their expectations than features that violate their expectancies. 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.

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.” (Fitzpatrick, 2002)

Methods of evaluating consistency can be grouped into the following areas:

I) Consistency Checklists: A method of evaluating design consistency based on subjective judgment, empirically derived measures, or combination of the two.

II) Speed Consistency: promote uniform vehicular speeds along the roadway, reduce speed variability, or provide the means to an iterative process to enable designers to more closely match predicted operating speeds and design speeds.

III) Driver workload: measures are intended to “manage” the workload on the driver so that a more consistent level of effort is required on the part of the driver. Extreme features, unusual features, or combinations of features are examined for their influence on driver workload.

The most significant geometric design element that influences driver behavior and posses the most potential for accident is the horizontal curve. The horizontal curves whose design speed is less than drivers' desired speed show operating speed inconsistency that increase accident potential .From research results it was indicated that "curve radius, superelevation and deflection angle have used in regression equations to predict operating speeds on horizontal curves. For tangents, tangent length is the primary alignment parameter that determines the speed" (Wooldridge, 2000).

The use of horizontal radius of curvature as a variable to predict 85th percentile speeds on curves have been used for many years. During this period, it becomes customary to predict the 85th percentile speed using geometric factors.

$$\mathbf{R = \frac{V^2}{127(e+f)}}$$

Where: R = radius of Curvature (m)

e = superelevation rate (m/m)

f = side-friction factor

V= vehicle speed (Km/h)

The objective in providing desirable horizontal alignment is to provide elements that are consistent with what drivers expect based on their experience on similar roadways and on previous sections of a particular roadway. Large differences and abrupt changes in horizontal alignment should be avoided so that driver workload is not excessive.

2.2. Previous Studies on Design Consistency

2.2.1. Design Speed Approach to Roadway Design

One of the unifying elements of roadway design is the concept of "design speed." The design speed concept assumes that curves meet or exceed the criteria for the selected design speed. Originally, the design speed concept had two fundamental principles:

–All curves along an alignment should be designed for the same speed.

- Design speed should reflect the uniform speed at which a high percentage of drivers desire to operate.

However, the design speed approach has two drawbacks. First, the design speed concept presumes that a design will be consistent if the individual alignment features share similar design speeds. Second, the design speed applies only to horizontal and vertical curves, not to the tangents that connect those curves. Consistency concerns develop when long tangents allow drivers to achieve their desired speeds but the resulting speed is in excess of the design speed of the following curve.

A road can be designed to a constant design speed but because it is constrained to minimum values at only certain locations the road can appear to the driver to have a wide variation in design standard. On designed section of road in an area with generally uniform topography, a driver tends to have speed expectancy. This expectancy should be reinforced by designing curves to approximately uniform standard. It is important that drivers are not presented with something unexpected; it is often more important that alignment standard are consistent than they are high. Research result show that "inconsistency of the horizontal alignment of a road significantly increased accident rates, which were affected not only by individual curve radius and average horizontal curvature, but also by the combination of the two. A sharp curve on an otherwise straight alignment would cause a higher accident rate than that on an alignment with a high degree of bendiness" (Road Research Laboratory, 1965).

Table 2.1 Regression equations of operating speeds on horizontal curves as a function of geometric variables. (Wooldridge, 2000)

Author	Equation	R^2	Sample Size	Location	Year
Taragin	V_{90} = 88.87* 2554.76/R	0.86	35 curves	Illinois, Maryland, Minnesota, New York, South Carolina	1953
Glennon et al	V_{85}=103.96* 4524.94/R	0.84	56 curves	Florida, Illinois,Ohio,Texas	1985
Lamm and Choveini	V_{85} = 94.39* 3189.94/R	0.79	261 curves	New York	1986
Islam and Senevirctry	V_{85}=103.03*24208.76/R *36597.92/R^2	0.98	8 curves	Utah	1994
Ottesen	V_{85}=103.64* 3400.73/R	0.8	138 curves	New York, Oregon, Pennsylvania, Texas, Washington	1993
Voigt	V_{90} = 99.61* 2951.37/R *0.014L*0.13I* 71.82e	0.84	41 curves	Texas	1996

Where:
V_{90} = 90th percentile speed on a curve (km/h) I = deflection angle (deg)
L = Length of Curve (m) R= radius of curvature (m)
V_{85} = 85th percentile speed on a curve (Km/h) e= superelevation (m/m)

2.2.2. Consistency Methodologies

Two types of design consistency methodologies is tried to be discussed under this sub -title: based on speed regression equations and alignment indices.

2.2.2.1. Speed Regression Equations

Speed profile equations predict operating speeds along a roadway and determine speed differences between successive features. These equations can be used to visually check operating speeds between tangent segments and horizontal curves along the roadway. Horizontal curves may restrict the desired speed of drivers. Thus, to safely and comfortably traverse sharper curves, drivers must decelerate on entering the horizontal curve. The speed-profile model then assumes that operating speeds remain constant throughout the curve. Several studies have investigated the relationship to operating speed of design speed and various roadway characteristics on rural two-lane highways. Horizontal curvature is the most researched design element related to operating speed. As evidenced by the vast number of studies available on the topic, a definite relationship exists between operating speed and horizontal curvature. In general, as the radius of the curve decreases or the degree of the curve increases, the operating speed decreases. Several models have been developed to predict the operating speed on a rural two-lane horizontal curve. Table 2.2 summarizes a sample of these models that predict speed at the midpoint of a horizontal curve. Table 2.3 summarizes the findings from the research on operating speed relationships on tangent sections of rural two-lane highways.

Table 2.2. Variables influencing midpoint horizontal curve operating speed for rural two-lane highways(Wooldridge, 2000).

Author(year)	Influencing Roadway or Roadside Variable						R^2
	Degree of curve	Radius	Length of curve	Deflection Angle	Inferred Speed	Grade	
Tarigan (1954)	X						74
Dept of Main Roads, New south Wales (1996)		X					83
Emerson (1969)		X					na
McLean (1979)		X			X		92
Glennon (1983)	X						84
Lamm (1988)	X						79
Krammes et al. (1993)	X		X	X			82
Islam et al. (1994)	X						98
Fitzpatrick et al(1999)		X				X	53 -76
Schurr et al. (2002)			X	X		X	46

Table 2.3. Variables influencing operating speed on tangent for rural two- lane highways. (Wooldridge, 2000)

Author (year)	Influencing Roadway or Roadside Variable					R^2
	Preceding & succeeding curves	Access Density	Tangent Length	Region of Country	Grade	
Parma (1999)		NF		X	X	NP
Polus et al. (2000)	X	NF	X			23-55

Np = not provided
NF = study design limited range for this variable
X = found to be statistically significant or correlated with operating speed

In determining the design consistency of their roads, German designers use a parameter for the horizontal alignment called the curvature change rate (CCR). The CCR is the sum of angular changes in the horizontal alignment divided by the length of the highway section. This parameter is used in an attempt to prevent unsafe changes in operating speeds and to describe the overall operating characteristics of a road. (Wooldridge, 2000)

The design speed consistency can be evaluated using three different categories and they are summarized as follows:

I) Good Designs: The change in the degree of curve is ≤5 deg and the change in operating speed V85 is less than or equal to 10 km/h between successive design elements. Design Speed Criterion: The difference between the operating speed and the design speed is less than or equal to10 km/h for the investigated curve or tangent. For these road sections, consistency in horizontal alignment exists and no improvements in geometric design would be necessary. No adaptations or corrections between design speed and operating speed have to be conducted.

II) Fair Designs: The change in the degree of curve is 5 <DC ≤ 10 deg and the change in operating speed 10 km/h < V85 ≤ 20 km/h between successive design elements. Design Speed Criterion: The difference between the operating speed and the design speed is 10 km/h < V85 − Vd ≤ 20 km/h for the investigated curve or tangent. These road sections exhibit minor inconsistencies in geometric design. Normally, correcting the existing alignment may be avoided by using low-cost warning devices. Superelevation rates in curves should be related to the expected 85th percentile operating speeds with respect to the degree of curve and not to the design speed.

III) Poor Designs: The change in the degree of curve is >10 deg and the change in operating speed V85 > 20 km/h between successive design elements. Design Speed Criterion: The difference between the operating speed and the design speed is >20 km/h for the investigated curve or tangent. These road sections represent strong inconsistencies in the horizontal geometric design that may result in critical driving maneuvers. Accident rates will be higher for these road sections. The 85th percentile operating speed should not be allowed to exceed the design speed by more than 20 km/h. If such a difference occurs, an increase in the design speed is recommended.

For example in the evaluation of horizontal curves, four different vertical grade conditions were considered: upgrades (0 to 4%), steep upgrades (greater than 4%), downgrades (-4 to 0%), and steep downgrades (less than −4%). Figure 2.1 shows that as R increases from 0 to 400 m, the 85th percentile speeds increase notably for all study locations. For radii greater than 400 m, the increase in speed is not as dramatic. The inverse of the radius was the variable most highly correlated to the 85th percentile speed of all the variables included within the correlation matrix (Figure 2.1). The regression model developed to fit the data for horizontal curves on grades included the single independent variable, $1/R$ (Wooldridge, 2000).

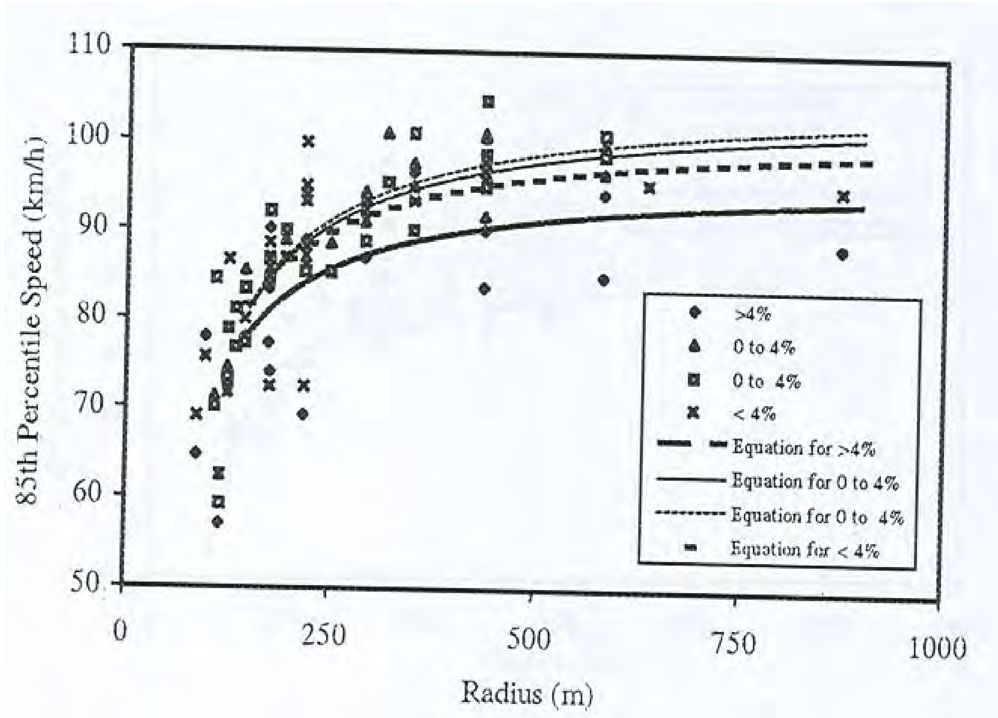

Figure 2.1 Horizontal curves on grades: V_{85} versus R

The estimation of speeds on curves is easier than the prediction of speeds on tangent sections because of the strong correlation of speeds on a few defined and limiting variables, such as curvature, superelevation, and the side friction coefficients between road surface and tires. On tangent sections, however, the speed of vehicles depends on a wide array of roadway characteristics (e.g., the length of the tangent section, the radius of the curve prior to and after the section, cross-section elements, vertical alignment, general terrain, and available sight distance).

2.2.2.2. Consistency Methods based on 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. They would be a function of the dimensions of horizontal and/or vertical alignment elements.
"Alignment indices did not explain the variation in measured speeds on long tangents" (Wooldridge, 2000). While a poor predictor of speeds on long tangents, alignment indices may be able to provide an indication of the

consistency of rural, two-lane highway. Indicators of geometric inconsistency include:

- A large increase/decrease in the values of alignment indices for successive roadway segments.
- A high rate of change in alignment indices over some length of roadway.
- A large difference between the individual feature and the average value of the alignment geometric elements.

For each of these indicators, a determination must be made of the amount of change in the alignment geometric elements value that would indicate a significant change in alignment consistency. Using the average of the geometry parameters along a roadway segment one can indicate the general character of the road. Average radius per roadway section, average vertical curve, curvature change rate per kilometer, and others are examples of alignment index measures that have been developed to define the general characteristics of a roadway section. Table 2.4 lists a sample of alignment indices. In theory, roadway sections with significant changes in horizontal or vertical alignment have alignment geometric element values requiring more driver information processing to perform the driving task (Wooldridge, 2000).

Table 2.4. Alignment indices selected for evaluation (Wooldridge, 2000).

Horizontal Alignment Indices	Vertical Alignment Indices
• Curvature Change Rate-CCR (degrees/Km) $\frac{\Sigma\Delta_i}{L}$ Where: Δ = deflection angle (degrees) L = length of section (Km) • Degree of curvature –DC (deg/Km) $\frac{\Sigma DC_i}{L}$ Where: DC=degree of curva. (degrees) L = length of section (Km) • CurveLength:Roadway Length~CL:RL $\frac{\Sigma(CL)_i}{L}$ Where:CL=curve length (m) L = length of section (m) • Average Radius –AVGR (meters) $\frac{\Sigma R_i}{n}$ Where:R=radius of curve (m) n = number of curves within section • Average Tangent ~AVGT(m) $\frac{\Sigma(TL)_i}{n}$ Where:TL=tangent length (m) n = number of tangents within section	• Vertical CCR-VCCR (degrees/Km) $\frac{\Sigma A_i}{L}$ Where: A = absolute difference in grades (degrees) L = length of section (Km) • Average rate of Vertical Curvature –VAVGK (m/Percent) $\frac{\Sigma L/\lvert A\rvert}{n}$ Where: L=length of vertical Curve (Km) A= algebraic difference in grades (%) n=number of vertical curves • Average Gradient- V AVG G(Km/m) $\frac{\Sigma/\Delta E_i/}{L}$ Where:ΔE=change in elevation b/n VPt_{vi} and VPt_i (m) L = length of section (Km) **Composite Alignment Indices** • Combination CCR –COMBO (degree/Km) $\frac{\Sigma\Delta_i}{L} + \frac{\Sigma A_i}{L}$ Where:Δ=deflection angle (deg.) A = absolute difference in grades (deg.) L = Length of section (Km)

2.2.3. Model Development

2.2.3.1. Models for simple curves

In simple horizontal curves, speed reduction is significantly affected by the degree of curves, gradient, and length of vertical curve within horizontal curve as well as pavement condition. "The degree of curves was found to be the most important variable. Gradient did not have significant influence on the speed of passenger cars. Superelevation rate, lane and shoulder widths, and grade up to 3 percent did not have a statistically significant effect on curve speed" (Wooldridge, 2000). In addition the research results indicate that "lane and shoulder widths, superelevation rate, prevailing terrain, and posted speed for passenger cars and trucks had no effect on the speed reduction" (Wooldridge, 2000).

2.2.3.2. Models for common tangent

The length of the common tangent between successive curves is considered one of the important geometric design consistency variables. For each type of vehicle, the research results indicate that the speed on the common tangent was found to be strongly correlated with the length of common tangent, degree of successive curves, and the deflection angles. However, the degrees of curves were also found to be positively correlated with their deflection angles (Fitzpatrick, 2002).

2.3 Review of Design Guides and Manuals

2.3.1 General

The discussion contained in this sub section is not intended to be an exhaustive review of the geometric design manuals and guide worldwide, but to cite some important points relevant to the consistency considerations given in specific manuals which are commonly referred.

2.3.2. AASHTO Geometric Design of Highways and Streets

This geometric design manual provides guidance on almost all aspects of road alignments. Design theories, concepts, policies and procedures are condensed and written for use by the designer. The manual has been developed to give the designer a basic working knowledge of geometric design of highways.

The AASHTO geometric design manual defines design speed as the maximum safe speed that can be maintained over a specified section of highway when conditions are so favorable that the design features of the highway govern. The adopted design speed should be the logical one with respect to the topography, the adjacent land use and the type of highway. When designing a substantial length of a highway, it is desirable to adopt a constant design speed.

AASHTO states three kinds of speeds for design. These speeds are operating speed, running speed and design speed. The operating speed is the most frequently used speed associated with a particular location or geometric feature. The average running speed of all vehicles is used as a measure for evaluating level of service and road user costs. The design speed is selected in order to fit the travel desires and habit of all drivers expected to use particular facility.

In the manual, the selected design speed establishes the limiting value of curve radius and minimum sight distance that should be used in design; there is no restriction on the use of flatter horizontal curves or greater sight distances where there are no constraints as a part of an economical design. Higher speed selection is encouraged in tangents between sections of curved alignments. The selection of design speeds depend on the average trip length.

2.3.3. South African Geometric Design Manual

In this design manual, the significance of consistency related to physical elements of the road to the requirements of the driver, vehicles and the environmental situations are considered. With the major response to drivers' requirements being related to consistency of design, the manual considers three elements of consistency for the evaluation of a road design:

> *I) Design consistency:* **-** This corresponds to relating the design speed to actual driving behavior which is expressed by the 85th percentile speed of passenger cars under free-flow conditions. Accordingly, if the difference between design speed and 85th percentile speed on an element such as a horizontal curve is less than 10 km/h, the design is considered good. A difference of between 10 km/h and 20 km/h results in a tolerable design and differences greater than 20 km/h are not acceptable.

II) Operating speed consistency:- seeks uniformity of 85th percentile speeds through successive elements of the road; the focus is on differences in operating speed in moving from one element, e.g. a tangent, to another, e.g. the following curve. A difference in operating speed between adjacent elements of less than 10 km/h is considered to be good design and a difference of between 10 and 20 km/h is tolerable. Differences greater than 20 km/h result in what is considered to be poor design.

III) Consistency in driving dynamics: **-** This relates side friction assumed with respect to the design speed to that demanded at the 85th percentile speed. The side friction assumed for the design should exceed the side friction demanded by 0,01 or more. A difference between -0, 04 and 0, 01 result in a fair design. A value of less than -0, 04 is not acceptable. A negative value for the difference between side friction assumed for design and the side friction demanded means that drivers are demanding more side friction than is assumed to be available - a potentially dangerous situation.

2.3.4 ERA Geometric Design Manual

According to the design manual, the design speed is used as an index which links road function, traffic flow and terrain to the design parameters of sight distance and curvature to ensure that a driver is presented with a reasonably consistent speed environment. In practice, most roads will only be constrained to minimum parameter values over short sections or on specific geometric elements. Design elements such as lane and shoulder widths, horizontal radius, superelevation, sight distance and gradient are directly related to, and vary, with design speed.

The manual, does not consider the operating speed to fix design speeds. The safety problem due to inconsistency of geometric design is a vital but the manual lack appropriate considerations on design consistency. This makes the manual weak comparing with manuals reviewed on this literature review.

2.3.5 AACRA Geometric Design Manual

This manual has been developed to set the framework for the planning and design of new and upgraded roads in Addis Ababa.

The manual consistently states high geometric standard (with design speed of 100 to 110 km/h or more), of which operating speeds on horizontal curves and straights are not significantly different and typically do not exceed 110 km/h. However, on roads where the geometric elements are designed for speeds less than 100 km/h, operating speeds will vary over the length of the road with higher speeds being used on straights and flatter radius of curvature.

The manual recommends that the design speed of successive horizontal curves should decrease by not more than 15km/h, with a desirable change not exceeding 10 km/h.

2.3.6 AUSTROADS Rural Road Design Manual

For the selection of speeds for geometric design, the guide defines four speed parameters.

I) Desired speed: this is the operating speed that a driver will adopt on the less constrained elements, (i.e. straight and large radius horizontal curves of a more or less uniform section of road) when not constrained by other vehicles.

II) Speed Environment: It is numerically equal to the desired speed of the 85^{th} percentile driver over that road section and thus by definition, is equal to the 85^{th} percentile of the observed free speed distribution on the longer straights (or flat radius curves) on the section, at lower traffic volumes. It can be measured on existing roads, but must be estimated for design of a new road and is a basic parameter to be used in road design. It is important to note that it applies to a section of road rather than to an individual element.

III) Design Speed: it applies to individual geometric elements and is the speed that is used to co-ordinate sight distance, radius, superelevation and friction demand for elements of the road so that a driver negotiating each element as its design speed will not be exposed to be exceeded by most drivers.

IV) Limiting Curve Speed Standard: This is the speed at which a vehicle is traveling on a curve of given radius and superelevation. It must be at least equal to the design speed, but due to the actual combination of radius and superelevation selected, it may be higher than the design speed, in which case a vehicle traveling at the design speed will not utilize the full design friction supply of the road surface. The limiting curve speed must never be below the design speed.

On roads of consistently high geometric standards, speeds on curves and straights are not significantly different. The speed selected by drivers on roads with speed environments below 100 Km/h is influenced by characteristics of the road and its surroundings. The 85th percentile speed on an individual road element, which is to be used as the design speed to co-ordinate the geometric features, is principally a function of two parameters: speed environment and horizontal curve radius. Sight distance appears to have only a limited effect on observed 85th percentile speeds.

The 85th percentile speed of operation on short sections or equivalent flatter radius of curves will be constrained by adjacent horizontal alignment. The length of straight or flat curve for the 85th percentile speed should be as high as the speed environment which can be taken as:

- 70 Km/h speed environment approx 250 m
- 90 Km/h speed environment approx 1 Km
- 110 Km/h speed environment approx 3 Km

2.4 Summary

One of the geometric design elements that influence driver behavior and posses the most potential for accident is the horizontal curve. The horizontal curves whose design speed is less than drivers' desired speed show operating speed inconsistency that increase accident potential. The design speed concept assumes that curves meet or exceed the criteria for the selected design speed. Originally, the design speed concept had two fundamental principles:

- All curves along an alignment should be designed for the same speed
- Design speed should reflect the uniform speed at which a high percentage of drivers desire to operate.

Two types of design consistency methodologies: based on speed prediction model and alignment indices (roadway segments). From these two methods speed prediction model is the most commonly used model. The design speed consistency can be evaluated using three different categories: Good Designs, Fair Designs and Poor Designs.

AASHTO states three kinds of speeds for design. These speeds are operating speed, running speed and design speed. The operating speed is the most frequently used measure of the design associated with a particular location or geometric feature. The average running speed of all vehicles is used as a measure for evaluating level of service and road user costs. The design speed is selected in order to fit the travel desires and habit of all drivers expected to use particular facility. With the major response to drivers' requirements being related to consistency of design, the South African manual considers three elements of consistency for the evaluation of a road design: Design Consistency, Operating speed consistency and consistency in driving dynamics.

The Design Speed is used in ERA geometric design manual as an index which links road function, traffic flow and terrain to the design parameters of sight distance and curvature to ensure that a driver is presented with a reasonably consistent speed in environment. AACRA manual recommends the design speed of successive horizontal curves should decrease by not more than 15km/h, with a desirable change not exceeding 10km/h.

AUSTROADS Rural Road Design guide states, on roads of consistently high geometric standards, speeds on curves and straights are not significantly different. The speed selected by drivers on roads with speed environments below 100 Km/h is influenced by characteristics of the road and its surroundings. The 85^{th} percentile speed on an individual road element, which is to be used as the design speed to co-ordinate the geometric features, is principally a function of two parameters: speed environment and horizontal curve radius. Sight distance appears to have only a limited effect on observed 85^{th} percentile speeds.

METHODOLOGY

3. Methodology

The core objectives of this research were to evaluating the geometric design consistency of selected road sections and develop regression model for two-lane trunk roads.

In order to achieve the objectives, five two-way, two-lane trunk roads located in the central Ethiopia were selected because of their proximity to Addis Ababa. These roads include Addis Ababa – Jimma, Addis Ababa – Tarmaber, Addis Ababa – Gohastion, Addis Ababa – Modjo-Awassa and Alemgena – Butagera roads. Table 3.1. shows the number of sites on the roads. In addition to their proximity to Addis Ababa, the availability of geometric design plans was also important. On these five trunk roads, forty three simple horizontal curve sections were selected whose operating speeds were measured. These sites are defined as simple horizontal curve proceeded by straight tangent section with a length of at least 300 m and selected considering the following criteria.

I) The selected section should be far from intersections or any physical features that may create abnormal Conditions that influences operating speeds,

II) The pavement and shoulder width be constant for both tangent and curve sections.

III) The tangent and subsequent curves should have the same pavement conditions.

Table 3.1 Number of sites by road

Road	No. of Sites
A.A- Awassa	24
A.A - Jimma	8
A.A - Tarmaber	5
A.A - Gohatsion	5
Alemgena - Butajira	1
Total	**43**

Factors which influence the choice of a driver's speed and considered to select design speed of geometric elements include:

1. Terrain (level, rolling, mountainous)
2. Driver Expect ions
3. Roadway Classification
4. Traffic characteristics, volume, traffic composition and trip length
5. Environmental Constraints
6. Land use
7. Speed Limit

Considering the above factors, the roadway geometric elements and other related data were obtained from design documents and through field measurements. These geometric characteristics included:

1. Radius of Curve
2. Length of Horizontal Curve
3. Tangent Length
4. Superelevation
5. Grade
6. Speed Limit
7. Widths of Pavement and Shoulder
8. Design Speed

During the data collection, each site proposed was evaluated through a site visit where the geometric elements were checked and recorded. Free – flow speeds were measured using laser speed gun radar. Table 3.2 shows the characteristics of the site.

Table 3.2. Characteristics of the site

	Minimum	Maximum
Radius (m)	170	2000
Curve Length	65	842
Tangent Length (m)	250	3821
Grade on Horizontal Curve (%)	0.125	8.875
Grade on Tangent (%)	0.1	6.5
Total Pavement Width on H.C(m)	7.3	17.8
Total Pavement Width on Tangent (m)	7.2	15.5
Superelevation on Horizontal Curves (%)	0.125	11.375

Speed measurements were taken at the middle of the curve, and on the preceding tangent about 250 m from the start of the curve. 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. (The vehicle classification as shown below in Table 3.3.)

Table 3.3.Vehicle classification

Passenger Vehicles	Car	Cars & minibus
	Land Rover	L.Rover, jeeps, S.wagon and land cruiser
Buses	Small Buses	Up to 27 passenger seats
	Large Buses	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 load

Fig.3.1. Speed measuring at the site

Fig. 3.2 Speed measuring and locating the center of horizontal curves

Fig. 3.3. Measuring pavement width and grade on curve and tangent

Fig. 3.4 Measuring superelevation on horizontal curve

Fig. 3.5 Road conditions and speed limit

Several techniques were utilized in analyzing the data collected for this study. The 85th percentile speed was determined for horizontal curves and tangents at each station (See Appendix B). Consistency evaluation between simple circular curves and tangents and between design speed and operating speed was examined. A graphical analysis was performed to examine the trend for any relationships that may exist between the 85th percentile speed and geometric elements. After examining the data graphically, correlation analyses were performed. The correlation analyses were used to check the existence of relationship that may have been determined visually through the graphical analysis. The regression analysis determined which indices and geometric variables may be useful in combination to predict the desired speeds of motorists. After all the possible relationships between the 85th percentile speeds and alignment indices were examined, an analysis of variance (ANOVA) was performed to determine if there were significant differences in the observed 85th percentile speeds due to passenger cars, buses and trucks. All of the statistical analysis were performed using EXCEL and were tested at a 90-percent confidence interval (i.e., significance level of a = 0.10) (See Appendix C).

EVALUATION OF DESIGN CONSISTENCY

4. Evaluation of Design Consistency

4.1 Evaluation of Design –Consistency between Simple Circular Curve and Tangent Section.

Road section of simple circular curve and tangent was taken for design consistency evaluation. After determining the 85^{th} percentile operating speed for simple circular curve and tangent sections, evaluation was performed for the consecutive road sections using the following criteria's.

Good Designs: The change in the degree of curve is ≤5 deg and the change in operating speed V85 is less than or equal to 10 km/h between successive design elements.

Fair Designs: The change in the degree of curve is 5 <DC ≤ 10 deg and the change in operating speed 10 km/h < V85 ≤ 20 km/h between successive design elements.

Poor Designs: The change in the degree of curve is >10 deg and the change in operating speed V85 > 20 km/h between successive design elements.

Table 4.1 Design consistency evaluation between simple curves and tangents, for V_{85} operating speed.

Road	Stations	V_{85}^{th} On Curve Km/hr	V_{85}^{th} On Tangent Km/hr	Δ in V_{85} Km/hr	$V_{85} < 10$ Km/hr	$10 < V_{85} \leq 20$ Km/hr	$V_{85} > 20$ Km/hr
Addis Ababa to Awassa	26+428 - 26+800	96	106	10	Good		
	27+895 - 28+300	88	117	29			Poor
	30+484 - 30+868	118	96	22			Poor
	32+830 - 33+200	121	113	8	Good		
	49+378 - 49+700	111	113	2	Good		
	50+303 - 50+625	123	124	1	Good		
	59+543 - 59+905	123	133	10	Good		
	68+760 - 69+160	115	122	7	Good		
	71+973 - 72+325	122	136	14		Fair	
	86+705- 87+040	136	128	8	Good		
	88+410 - 88+770	140	125	15		Fair	
	97+700 - 98+110	141	126	15		Fair	
	99+490 - 99+900	151	129	22			Poor
	104+128 - 104+450	137	128	9	Good		
	105+348 - 105+685	142	126	16		Fair	
	116+372 - 116+750	128	135	7	Good		
	180+574 - 181+124	143	136	7	Good		
	189+400 - 189+780	136	137	1	Good		
	191+003 - 191+255	138	120	18		Fair	
	217+650 - 217+900	138	136	2	Good		
	227+640- 227+970	125	119	6	Good		
	231+545 - 231+900	122	123	1	Good		
	238+951 - 239+280	135	122	13		Fair	
	241+100 - 241+500	151	123	28			Poor
Addis Ababa to Jimma	35+266 - 35+627	141	138	3	Good		
	39+400 - 39+880	110	117	7	Good		
	52+768 - 53+080	128	136	8	Good		
	99+446 - 99+732	121	110	11		Fair	
	118+057 - 118+366	117	118	1	Good		
	122+105 -122+410	123	130	7	Good		
	132+814- 133+132	144	137	7	Good		
	166+098 - 166+425	117	132	15		Fair	
Addis Ababa to Tarma-ber	16+105 - 16+414	77	66	11		Fair	
	32+333 - 32+678	97	104	7	Good		
	44+912 - 45+213	105	122	17		Fair	
	46+344 - 46+632	103	106	3	Good		
	47+203 - 47+571	102	110	8	Good		
Addis Ababa to Gohatsion	11+175 - 11+550	108	104	4	Good		
	13+793 - 14+075	107	124	17		Fair	
	34+893 - 35+175	134	127	7	Good		
	45+763 - 46+067	99	105	6	Good		
	143+334 -143+637	104	120	16		Fair	
Addis Ababa to Butajira	35+000 - 35+350	124	114	10	Good		

From the table, results of design consistency evaluations between simple circular curve and tangent sections shows that twenty seven sections were under good design, twelve sections were under fair design and four sections were under poor design. Hence, evaluation of using operating speed between the two sections shows good results except for the poor design.

4.2 Design –Consistency Evaluation between Design Speed and Operating Speed.

Evaluation was performed between design speed used for design and existing 85th operating speeds of road segments. Because it was difficult to get the design speeds of the roads, the design speed was used as recommended by ERA Geometric Design Manual (2002). In order to assign the design speed for each section, the road was classified according to ERA Geometric Design Manual using the traffic volume determined in 2004. (Table 4.2 shows the classification of road design standard according to their traffic volume.)

Table 4.2. Classification of road design standard for the selected trunk roads.

Roads	Traffic Volume	Road Design Standard
Addis Ababa - Kality	17135	DS1
Kality - Nazerth	7203	DS2
Modjo - Awassa	1804	DS3
Addis Ababa - Jimma	1090	DS3
Addis Ababa - Debrebrhan	1020	DS3
Addis Ababa - Debremarkos	667	DS4
Addis Ababa - Butajira	424	DS4

Considering the above situations the following criterion was used for the evaluation of design consistency.

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 $10 \text{ km/h} < V85 - Vd \leq 20 \text{ km/h}$ 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 4.3. Design consistency evaluation between design speeds and operating speed of horizontal curves.

Road	Stations	V_{85}^{th} On Curve Km/hr	Design Speed Km/hr	Δ in V_{85} Km/hr	$V_{85} < 10$ Km/hr	$10 < V_{85} \leq 20$ Km/hr	$V_{85} > 20$ Km/hr
Addis Ababa to Awassa	26+428	96	100	4	Good		
	27+895	88	100	12		Fair	
	30+484	118	120	2	Good		
	32+830	121	100	21			Poor
	49+378	111	120	9	Good		
	50+303	123	85	38			Poor
	59+543	123	120	3	Good		
	68+760	115	85	30			Poor
	71+973	122	100	22			Poor
	86+705	136	100	36			Poor
	88+410	140	100	40			Poor
	97+700	141	100	41			Poor
	99+490	151	100	51			Poor
	104+128	137	100	37			Poor
	105+348	142	100	42			Poor
	116+372	128	100	28			Poor
	180+574	143	100	43			Poor
	189+400	136	100	36			Poor
	191+003	138	100	38			Poor
	217+650	138	100	38			Poor
	227+640	125	100	25			Poor
	231+545	122	85	37			Poor
	238+951	135	70	65			Poor
	241+100	151	60	91			Poor
Addis Ababa to Jimma	35+266	141	100	41			Poor
	39+400	110	100	10	Good		
	52+768	128	85	43			Poor
	99+446	121	100	21			Poor
	118+057	117	100	17		Fair	
	122+105	123	70	53			Poor
	132+814	144	100	44			Poor
	166+098	117	70	47			Poor
Addis Ababa to Tarma-ber	16+105	77	100	23			Poor
	32+333	97	85	12		Fair	
	44+912	105	85	20		Fair	
	46+344	103	85	18		Fair	
	47+203	102	100	2	Good		
Addis Ababa to Gohatsion	11+175	108	70	38			Poor
	13+793	107	70	37			Poor
	34+893	134	85	49			Poor
	45+763	99	70	29			Poor
	143+334	104	85	19		Fair	
Addis Ababa to Butajira	35+000	124	85	39			Poor

Table 4.4. Design consistency evaluation between design speeds and operating speed of tangent sections.

Road	Stations	V_{85}^{th} On Tangent Km/hr	Design Speed Km/hr	Δ in V_{85} Km/hr	$V_{85} < 10$ Km/hr	$10 < V_{85} \leq 20$ Km/hr	$V_{85} > 20$ Km/hr
Addis Ababa to Awassa	26+800	106	100	6	Good		
	28+300	117	100	17		Fair	
	30+868	96	120	24			Poor
	33+200	113	100	13		Fair	
	49+700	113	120	7	Good		
	50+625	124	85	39			Poor
	59+905	133	120	13		Fair	
	69+160	122	85	37			Poor
	72+325	136	100	36			Poor
	87+040	128	100	28			Poor
	88+770	125	100	25			Poor
	98+110	126	100	26			Poor
	99+900	129	100	29			Poor
	104+450	128	100	28			Poor
	105+685	126	100	26			Poor
	116+750	135	100	35			Poor
	181+124	136	100	36			Poor
	189+780	137	100	37			Poor
	191+255	120	100	20		Fair	
	217+900	136	100	36			Poor
	227+970	119	100	19		Fair	Poor
	231+900	123	85	38			Poor
	239+280	122	70	52			Poor
	241+500	123	60	63			Poor
Addis Ababa to Jimma	35+627	138	100	38			Poor
	39+880	117	100	17		Fair	
	53+080	136	85	51			Poor
	99+732	110	100	10	Good		
	118+366	118	100	18		Fair	
	122+410	130	70	60			Poor
	133+132	137	100	37			Poor
	166+425	132	70	52			Poor
Addis Ababa to Tarma-ber	16+414	66	100	34			Poor
	32+678	104	85	19		Fair	
	45+213	122	85	37			Poor
	6+632	106	85	21		Fair	
	47+571	110	100	10	Good		
Addis Ababa to Gohatsion	11+550	104	70	34			Poor
	14+075	124	70	54			Poor
	35+175	127	85	42			Poor
	46+067	105	70	35			Poor
	143+637	120	85	35			poor
Addis Ababa to Butajira	35+350	114	85	29			Poor

The results obtained between design speed and operating speed for horizontal and tangent sections shows highly inconsistence design. This shows the operating speed observed was grater by 20 Km/h from the design speed and this requires series consideration by the Ethiopian Roads

Authority in order to avoid the accident that may occur on the roads. Furthermore, the result shows that ERA Geometric Design manual did not consider the effect of operating speed on the design of the road alignments. Hence, the manual has to address the effects of operating speeds on design and safety.

DATA ANALYSIS AND DISCUSSIONS

5. Data Analysis and Discussions

5.1 Examination of Geometric Elements as Individual Estimators of Desired Speed

Data collected for the analysis were obtained from design documents and through field measurements have shown different characteristics. Radius, curve length and tangent length were found from the design documents. Whereas, Superelevation, Grades, pavement width and operating speed were measured directly from field observations.

After operating speed was measured average speed, standard deviation, variance and 85^{th} percentile speed was determined for each type of vehicle category at individual stations. Table 5.1. and Table 5.2. Shows operating speed characteristics on curves and tangent sections.

Table 5.1. Operating speed characteristics on curves

Operating Speed Characteristics on Curves											
Cars				Buses				Trucks			
Avg.	Std.	Var.	V85th	Avg.	Std.	Var.	V85th	Avg.	Std.	Var.	V85th
89	18	324	107	64	19	361	83	72	18	324	90
77	20	400	97	71	13	169	84	62	18	324	80
107	19	361	126	98	17	289	115	91	20	400	111
103	32	1024	135	94	18	324	112	90	22	484	112
96	23	529	119	92	14	196	106	86	18	324	104
113	23	529	136	99	19	361	118	93	17	289	110
113	21	441	134	104	17	289	121	95	15	225	110
101	27	729	128	93	17	289	110	82	24	576	106
91	20	400	129	102	18	324	120	88	23	529	111
120	22	484	142	108	15	225	123	101	31	961	132
125	23	529	148	108	15	225	123	113	27	729	140
130	21	441	151	107	16	256	123	119	24	576	143
131	20	400	151	111	16	256	127	115	24	576	139
123	23	529	146	106	14	196	120	113	23	529	136
127	21	441	148	103	21	441	124	105	22	484	127
108	23	529	131	106	20	400	126	108	20	400	128
131	19	361	150	122	18	324	140	108	23	529	131
123	21	441	143	116	15	225	131	105	21	441	126
130	18	324	148	110	12	144	122	111	23	529	134
123	20	400	144	118	18	324	136	102	25	625	127
133	20	400	153	108	18	324	126	114	13	169	127
122	12	144	134	110	35	1225	145	115	19	361	133
125	23	529	148	107	18	324	125	105	21	441	126
116	22	484	138	105	15	225	120	107	25	625	132
127	21	441	148	118	17	289	135	120	13	169	133
96	18	324	114	91	15	225	106	89	18	324	107
111	24	576	135	107	15	225	122	99	22	484	121
108	15	225	123	99	16	256	115	104	18	324	122
110	19	361	129	89	13	169	102	78	23	529	101
111	15	225	126	108	19	361	127	85	14	196	99
130	21	441	151	121	17	289	138	110	21	441	131
108	20	400	128	93	13	169	106	87	15	225	102
58	18	324	76	64	17	289	81	58	15	225	73
83	14	196	97	89	21	441	110	85	41	1681	126
94	17	289	111	94	10	100	104	83	11	121	94
90	12	144	102	96	11	121	107	87	12	144	99
88	16	256	104	92	14	196	107	82	11	121	93
96	16	256	112	90	17	289	106	88	16	256	104
89	23	529	112	79	18	324	97	84	22	484	106
103	13	169	143	96	12	144	118	90	12	144	120
88	14	196	102	79	17	289	96	81	16	256	97
92	29	841	121	77	18	324	95	69	20	400	89
106	19	361	125	95	22	484	117	98	32	1024	130

Table 5.2. Operating speed characteristics on tangents

Operating Speed Characteristics on Tangents											
Cars				Buses				Trucks			
Avg.	Std.	Var.	V85th	Avg.	Std.	Var.	V85th	Avg.	Std.	Var.	V85th
91	24	576	115	80	12	144	92	85	23	529	108
97	26	676	123	98	20	400	118	93	18	324	111
89	16	256	105	68	21	441	89	65	22	484	87
97	20	400	117	84	17	289	101	97	23	529	120
97	20	400	117	84	17	289	101	97	22	484	119
111	20	400	131	95	17	289	112	98	28	784	126
114	19	361	133	104	11	121	115	95	23	529	118
112	22	484	134	99	12	144	111	96	19	361	115
126	16	256	142	109	12	144	121	113	21	441	134
104	19	361	125	106	18	324	124	112	20	400	132
107	18	324	125	110	13	169	123	107	20	400	127
108	17	289	127	108	15	225	123	110	17	289	127
110	17	289	127	110	17	289	127	109	23	529	132
108	19	361	132	112	14	196	126	107	20	400	127
111	21	441	129	104	14	196	118	108	20	400	128
122	24	576	146	114	17	289	131	119	19	361	138
125	23	529	148	122	20	400	142	107	22	484	129
132	25	625	157	110	21	441	131	104	18	324	122
101	13	169	114	105	14	196	119	105	19	361	124
133	27	729	160	102	16	256	118	97	19	361	116
112	18	324	130	104	17	289	121	109	13	169	122
110	24	576	134	105	15	225	120	110	15	225	125
113	18	324	131	108	16	256	124	115	14	196	129
109	20	400	129	111	14	196	125	93	18	324	111
120	20	400	140	122	17	289	139	112	23	529	135
99	23	529	122	86	18	324	104	95	23	529	118
122	20	400	142	118	17	289	135	112	17	289	129
102	19	361	121	89	12	144	101	77	16	256	93
102	19	361	121	85	19	361	104	97	26	676	123
120	20	400	140	110	9	81	119	97	14	196	111
121	25	625	146	117	20	400	137	101	15	225	116
117	24	576	141	110	16	256	126	92	15	225	107
57	14	196	71	56	58	3364	114	49	52	2704	101
94	10	100	104	62	10	100	72	63	10	100	73
118	13	169	131	90	15	225	105	77	14	196	91
91	18	324	109	91	17	289	108	87	11	121	98
110	16	256	126	97	12	144	109	85	12	144	97
90	17	289	107	87	16	256	103	85	14	196	99
112	21	441	133	93	17	289	110	88	40	1600	128
122	17	289	139	101	16	256	117	97	13	169	110
94	25	625	119	84	19	361	103	77	10	100	87
94	21	441	115	104	22	484	126	80	32	1024	112
99	26	676	125	90	16	256	106	70	20	400	90

Considering the results of the operating speed characteristics a t- test was made in order to find whether the 85th percentile speed of passenger cars, buses and trucks were significantly different. (Table 5.3 to table 5.6 shows the result of t-test for each vehicle category in curves and tangents).

Table 5.3. t-Test for operating speed of passenger cars and buses

Horizontal Curve - Car & Buses

t-Test: Paired Two Sample for Means

	Variable 1	***Variable 2***
Mean	128.9534884	115.55814
Variance	342.6644518	221.395349
Observations	43	43
Pearson Correlation	0.814566391	
Hypothesized Mean Difference	0	
df	42	
t Stat	8.178964512	
P(T<=t) one-tail	1.57593E-10	
t Critical one-tail	1.681952358	
P(T<=t) two-tail	**3.15186E-10**	
t Critical two-tail	2.018081679	

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

Table 5.4. t-Test for operating speed of passenger cars and trucks

Horizontal Curve - Car & Trucks

t-Test: Paired Two Sample for Means

	Variable 1	***Variable 2***
Mean	128.9534884	115.3953488
Variance	342.6644518	304.5780731
Observations	43	43
Pearson Correlation	0.817537503	
Hypothesized Mean Difference	0	
df	42	
t Stat	8.149567809	
P(T<=t) one-tail	1.73137E-10	
t Critical one-tail	1.681952358	
P(T<=t) two-tail	**3.46274E-10**	
t Critical two-tail	2.018081679	

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

Table 5.5. t-Test for operating speed of passenger cars and buses

Tangent – Car & Buses
t-Test: Paired Two Sample for Means

	Variable 1	*Variable 2*
Mean	127.511628	116.3953488
Variance	244.017719	151.8161683
Observations	43	43
Pearson Correlation	0.579587	
Hypothesized Mean Difference	0	
df	42	
t Stat	5.54647434	
P(T<=t) one-tail	8.8941E-07	
t Critical one-tail	1.68195236	
P(T<=t) two-tail	1.7788E-06	
t Critical two-tail	2.01808168	

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

Table 5.6. t-Test for operating speed of passenger cars and trucks

Tangent - Car & Truck
t-Test: Paired Two Sample for Means

	Variable 1	*Variable 2*
Mean	127.5116279	116.0465116
Variance	244.0177187	190.6168328
Observations	43	43
Pearson Correlation	0.502637441	
Hypothesized Mean Difference	0	
df	42	
t Stat	5.093985431	
P(T<=t) one-tail	3.92098E-06	
t Critical one-tail	1.681952358	
P(T<=t) two-tail	7.84196E-06	
t Critical two-tail	2.018081679	

Since the P-value has less value, 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 any of the alignment features influence to the 85th percentile speeds on curves and tangents, graphical and correlation analyses were made for the combination of the data obtained.

5.2 Graphical Analysis

The influence of geometric features on the 85th percentile speeds on curves and tangents was first examined graphically. For all the geometric elements stated in table 5.7 & 5.8, graphs of the observed 85th percentile speeds against the geometric elements were developed. The graphs, which are shown in figures 5.1 to 5.8, were plotted in order to visually examine those geometric elements that may assure in estimating the desired speeds of motorists on horizontal curves and tangents.

Table 5.7. Geometric elements and 85th operating speed on curves.

Station (Km)	Radius (m)	Total Pavement Width	Grade %	Superelevation %	Curve Length (m)	85th Speed (Km/h)
26+428	540	14.9	3.3	3.3	244	96
27+895	360	12.1	1.6	6.1	690	88
30+484	900	17.8	2.0	0.1	268	119
32+830	600	15.3	2.1	4.3	240	121
49+378	800	10.8	2.5	5.1	145	111
50+303	360	12.3	0.1	3.5	145	123
59+543	950	12.6	0.1	3.9	225	123
68+760	360	11.7	2.5	7.6	300	116
71+973	400	10.2	0.8	4.6	795	122
86+705	600	10.3	1.1	4.1	170	136
88+410	450	10.6	1.3	3.9	220	140
97+700	580	10.4	1.2	4.1	320	141
99+490	850	10.3	1.1	4.1	320	142
104+128	400	10.8	1.1	3.5	145	137
105+348	900	10.4	1.3	2.5	175	142
116+372	550	10.4	0.3	4.3	256	129
180+574	600	10.1	1.5	4.4	600	143
189+400	570	10.5	0.3	6.0	355	136
191+003	460	10.5	0.7	4.6	665	139
217+650	540	10.2	0.8	3.4	300	138
227+640	1000	10.8	0.5	4.3	160	125
231+545	360	10.5	0.6	6.2	210	122
238+951	220	10.4	0.4	5.6	842	136
241+100	220	10.1	2.1	1.9	650	151
35+266	425	10.4	0.1	6.9	222	141
39+400	425	10.2	0.5	5.3	425	110
52+768	300	10.1	0.3	6.6	124	128
99+446	500	10.6	1.1	1.3	72	121
118+057	500	10.3	2.1	7.1	118	117
122+105	200	10.0	0.3	6.6	112	123
132+814	600	10.5	1.4	6.1	137	143
166+098	190	10.0	1.4	6.5	155	117
16+105	600	9.5	4.3	6.9	119	77
32+333	375	7.3	0.1	5.9	185	97
44+912	300	10.9	3.8	4.5	103	106
46+344	275	7.5	4.1	6.3	76	103
47+203	750	7.8	3.5	5.9	128	102
11+175	230	11.7	2.0	6.7	250	108
13+793	230	13.3	1.3	7.6	65	107
34+893	580	11.8	2.4	6.1	65	133
45+763	230	12.1	4.0	8.1	109	99
143+334	421	11.5	1.8	5.8	107	105
35+000	400	11.9	1.8	5.8	200	124

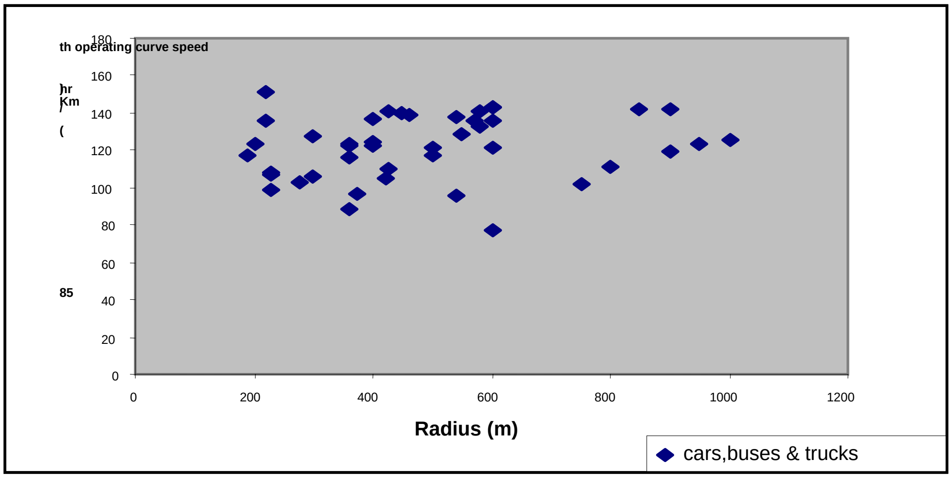

Figure 5.1. 85th Percentile horizontal curve speed versus radius

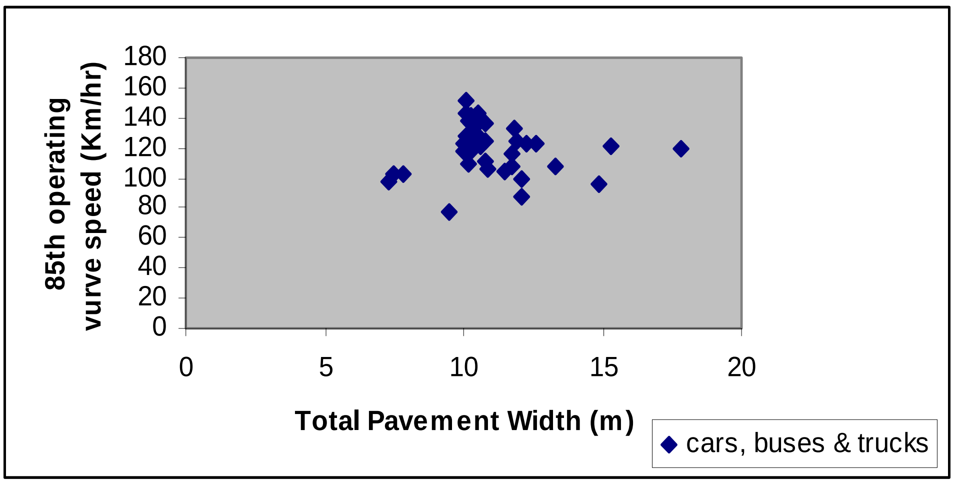

Figure 5.2. 85th Percentile horizontal curve speed versus total pavement width

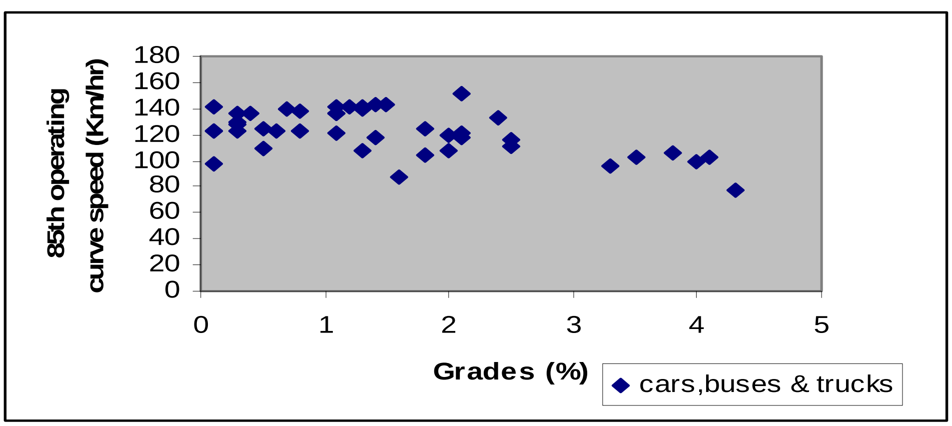

Figure 5.3. 85th Percentile horizontal curve speed versus grades

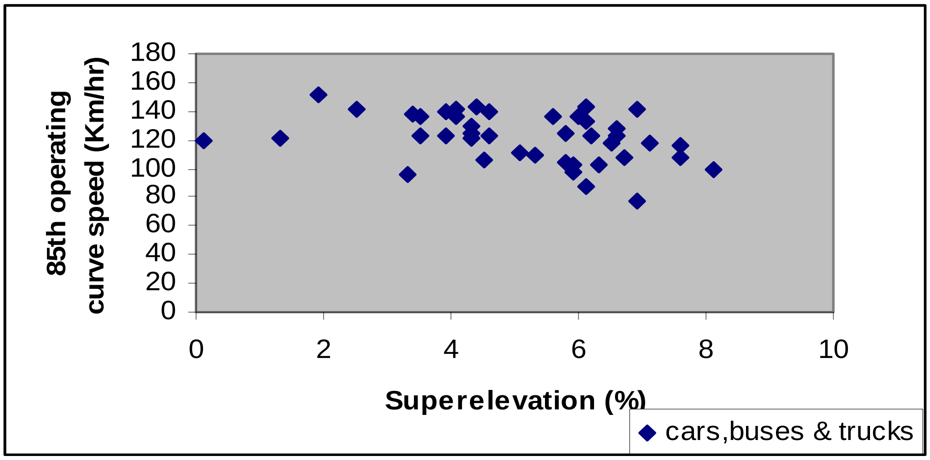

Figure 5.4. 85th Percentile horizontal curve speed versus superelevations

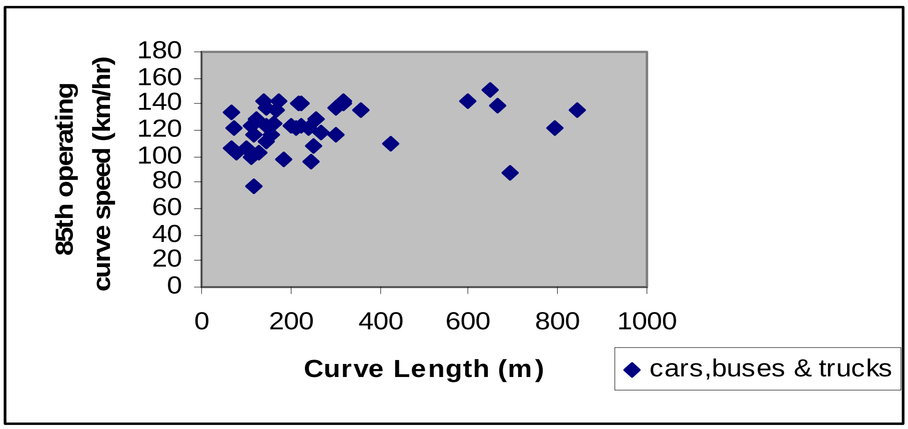

Figure 5.5. 85th Percentile horizontal curve speed versus curve length

From these graphs, there appeared to be a relationship between the 85th percentile speeds and several of the geometric elements. The apparent relationships are indicated below:

- As the radius increased, the 85th percentile horizontal curve speeds increases.
- As the grades increased, the 85th percentile horizontal curve speeds decreases.
- As the curve length increased, the 85th percentile horizontal curve speeds increases.

- As superelevation increased, the 85th percentile horizontal curve speeds decrease.
- Pavement width did not show relationships.

Table 5.8. Geometric elements and 85th operating speed on tangents.

Station (Km)	Tangent (m)	Total Pavement Width (m)	Grade (%)	85^{th} Speed (Km/hr)
26+800	1000	15.1	1.0	106
28+300	1650	12.0	2.9	118
30+868	332	15.5	3.8	98
33+200	250	15.0	2.5	114
49+700	540	10.8	2.5	114
50+625	3365	12.3	0.1	124
59+905	2860	11.8	0.1	124
69+160	650	11.7	2.5	121
72+325	700	10.6	0.6	136
87+040	800	12.0	0.9	128
88+770	700	10.3	0.9	125
98+110	1460	10.4	1.3	125
99+900	890	9.8	1.5	129
104+450	1060	9.8	1.3	129
105+685	1765	9.8	1.4	126
116+750	2500	9.9	0.5	134
181+124	2360	10.1	1.0	136
189+780	1220	10.2	0.4	137
191+255	780	10.3	0.3	120
217+900	565	9.4	3.8	136
227+970	2180	10.3	0.7	119
231+900	300	10.2	0.6	123
239+280	530	10.6	0.6	122
241+500	1440	10.0	1.1	122
35+627	523	10.4	0.3	138
39+880	1650	14.2	0.3	117
53+080	3590	10.2	0.3	136
99+732	456	9.8	0.1	110
118+366	3821	9.1	2.9	118
122+410	431	9.5	0.3	130
133+132	574	9.0	2.3	138
166+425	635	9.6	1.3	132
16+414	736	10.0	2.4	66
32+678	572	7.2	0.9	104
45+213	537	7.3	2.3	122
46+632	491	7.9	2.1	106
47+571	533	7.6	2.5	110
11+550	500	15.1	1.7	104
14+075	262	11.6	3.5	124
35+175	545	12.5	1.5	127
46+067	297	12.4	1.6	105
143+632	259	12.8	2.3	120
35+350	600	12.5	6.0	114

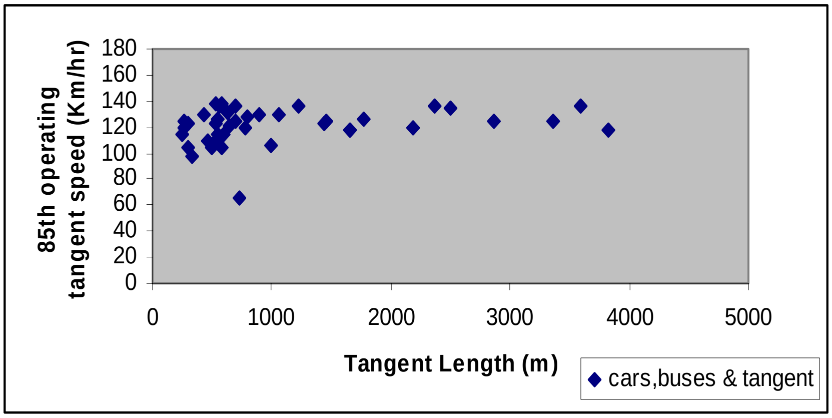

Figure 5.6. 85th Percentile Tangent speed versus tangent length

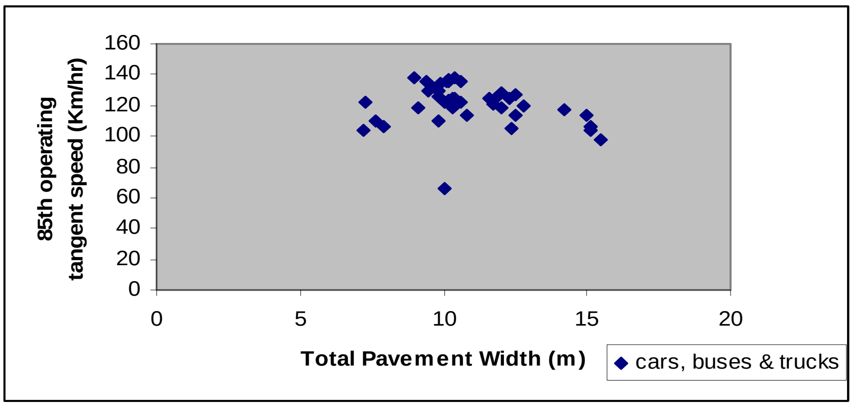

Figure 5.7. 85th Percentile Tangent speed versus total pavement width

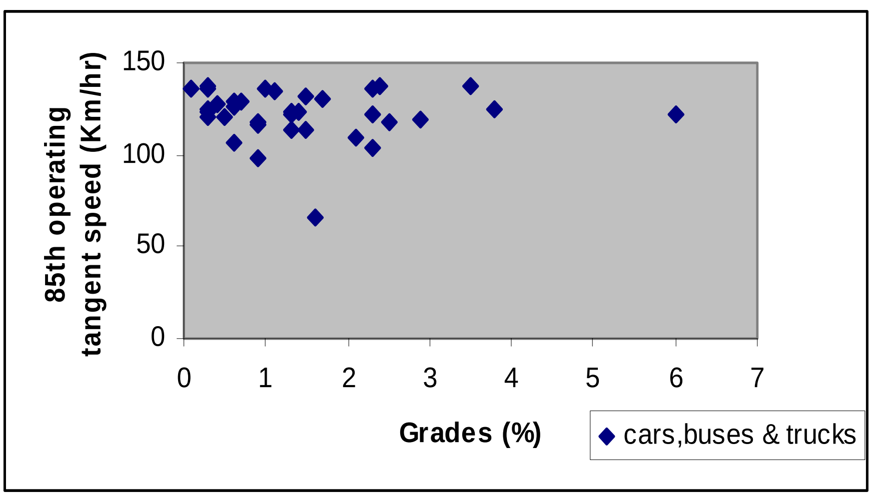

Figure 5.8. 85th Percentile tangent speed versus grades

The apparent relationships are indicated below:

- As the tangent length increased, the 85th percentile tangent speeds increases.
- As the grades increased, the 85th percentile tangent speeds decreases.
- Pavement width did not show relationships.

5.3 Correlation Analysis

To determine whether there was a relationship between the 85th percentile speed for horizontal curve and tangent with the geometric elements shown in the table, a correlation analysis were made between operating speed and geometric elements, and between geometric elements. The results of the correlation are listed in table 5.9 and table 5.10

Table 5.9. Correlation results of horizontal curves

	V85	Grade	Superelevation	Curve Length	Pavement Width
Radius	0.195	0.456	-0.459	-0.125	0.194
Total Pavement Width	-0.075	0.377	-0.305	-0.256	
Grade	-0.520		0.380	-0.267	
Superelevation	-0.478			-0.176	
Curve Length	0.421				

Table 5.10. Correlation results of tangents

	V85	Grade	Tangent Length
Total Pavement Width	-0.225	0.142	-0.07
Grade	-0.591		-0.310
Tangent Length	0.392		

From the correlation result in the Table 5.9 and 5.10, grades, superelevations and curve length was correlated with the operating speed on the horizontal curves whereas, grades and tangent length were correlated on tangents. Hence the correlated geometric elements have an effect on the 85th percentile of horizontal curve and tangent speed.

5.4 Regression Analysis

To determine whether there was a statically significant relationship for 90-percent confidence interval (significant level of a = 0.10) a regression analysis were made between the geometric elements and operating speeds. The analysis was made in two ways, first between the geometric elements and operating speed and second between the combination of the geometric elements and operating speeds. The results of the regression analysis are listed in Table 5.11 and Table 5.12.

Table 5.11 Regression analysis results of horizontal curves

		G	S	CL	1/CL	R^2	MSE	B_0
1	B_1	-7.9				**0.410**	3618.95	133.87
	p-value	**0.001**						
2	B_1		-3.79			**0.350**	1832.344	141.11
	p-value		**0.012**					
3	B_1			0.021		0.063	808.62	
	p-value			0.103				
4	B_1	-7.162	-2.990			**0.570**	2361.92	147.88
	p-value	**0.001**	**0.024**					
5	B_1		-3.46	0.022		0.179	1141.89	135.11
	p-value		0.016	0.196				
6	B_1	-7.433		0.010		0.296	1892.09	130.51
	p-value	0.001		0.396				
7	B_1	-6.881	-2.885	0.007		0.376	1597.83	145.19
	p-value	0.001	0.032	0.562				
8	B_1	-7.204			-628.12	0.298	1907.18	136.55
	p-value	0.001			0.355			
9	B_1		-3.233		-1060.2	0.19	1214.42	144.56
	p-value		0.033		0.136			
10	B_1	-6.829	-2.852		-2.852	0.37	1591.89	148.64
	p-value	0.002	0.036		0.036			

Where: G = Grade S = Superelevation CL = Curve Length
R^2 =Coefficient of determination MSE = mean square error B_o = Constant
B_1 = x constant p-value = probability value

Analysis of regression result indicates that, grade, superelevation and the combination of grade and superelevation was found to be a significant predictor of 85th percentile speed on curves. Whereas curve length, radius and pavement width was not a significant predictor of desired speeds of motorists on curves of two-lane trunk roads.

Table 5.12. Regression analysis results of tangents

		G	TL	1/TL	R^2	MSE	B_0
1	B_1	-4.461			**0.591**	2387.88	127.3
	p-value	**0.001**					
2	B_1		0.0049		**0.321**	976.33	114.21
	p-value		**0.03**				
3	B_1	-3.955	0.0027		0.263	1333.53	123.52
	p-value	0.0023	0.1964				
4	B_1		-3.7358	-2786.4	0.2686	1362.1	130.61
	p-value		0.00488	0.1554			

Where: G = Grade TL = Tangent Length R^2 =Coefficient of determination
MSE = mean square error B_o = Constant
B_1 = x constant p-value = probability value

Analysis of regression for tangent sections indicates that, grade and tangent length was found to be a significant predictor of 85th percentile speed on tangents. Whereas pavement width was not a significant predictor of desired speeds of motorists on tangents of two-lane trunk roads.

5.5 Regression- Equations for Simple Horizontal Curve and Tangent

From the analysis results three of these models for horizontal curves that used combination of the three variables were determined to be a significant estimator of 85th percentile speeds in horizontal curves. Whereas two for tangents that used combination of two variables were determined to be a significant estimator of the 85th percentile speeds in tangents. From the regression results a value with high values of R^2 was selected to show the regression equations for the collected data's in the field. The coefficient of determination shows that the combinations of grade and superelevation with 57 % of the values were speed predictors in curves whereas coefficient of determination for grades with 59.1 % was speed predictors in tangent sections. Hence, the regression equations with coefficient of determination with high value for curves and tangent section are stated below:

For Horizontal Curves

$$V_{85} = 147.88 - 7.162G - 2.990S \quad \text{------} \quad R^2 = 0.57$$

Where: V_{85} = 85th percentile Operating Speed of Horizontal Curves
G = Grade
S = Superelevation
R^2 = Coefficient of Determination

For Tangents

$$V_{85} = 127.3 - 4.461G \qquad \text{-----------} \qquad R^2 = 0.591$$

Where: V_{85} = 85th percentile Operating Speed of Tangents
G = Grade
R^2 = Coefficient of Determination

5.6 Relationship between observed speed and predicted speed

The geometry for Addis Ababa –Awassa road collected as part of this study was used to show a relationship between observed speeds and predicted sped. The road was chosen because it had several tangents along with several horizontal curves. The road is 275 km in length. The horizontal curve length ranged from 145 m to 842 m in length and the tangent length ranged from 250 m to 3365 m in length. Grades ranged from -3.3 to 2.1 percent, which resulted in the prediction of speeds on horizontal curves and tangents. Table 5.13 and Table 5.14 shows that results obtained for operating speeds using the regression equations developed for curves and tangent sections. Figure 5.9 and Figure 5.10 shows the relationship between observed speed and predicted speed for curves and tangent sections.

Table 5.13. Results of operating speeds using the regression equations developed for curves.

Road	Stations	Grade %	Superelevation %	V_{85} = 147.88 – 7.162G – 2.99S Speed Km/hr	V_{85}^{th} On Curve Km/hr
Addis Ababa to Awassa	26+428	3.3	3.3	114.9	96
	27+895	1.6	6.1	118.1	88
	30+484	2.0	0.1	133.2	118
	32+830	2.1	4.3	120.0	121
	49+378	2.5	5.1	114.6	111
	50+303	0.1	3.5	136.5	123
	59+543	0.1	3.9	135.4	123
	68+760	2.5	7.6	107.3	115
	71+973	0.8	4.6	128.8	122
	86+705	1.1	4.1	127.7	136
	88+410	1.3	3.9	127.4	140
	97+700	1.2	4.1	127.0	141
	99+490	1.1	4.1	127.6	151
	104+128	1.1	3.5	129.4	137
	105+348	1.3	2.5	131.1	142
	116+372	0.3	4.3	133.1	128
	180+574	1.5	4.4	124.0	143
	189+400	0.3	6.0	128.2	136
	191+003	0.7	4.6	129.5	138
	217+650	0.8	3.4	132.2	138
	227+640	0.5	4.3	131.4	125
	231+545	0.6	6.2	125.0	122
	238+951	0.4	5.6	128.6	135
	241+100	2.1	1.9	126.9	151

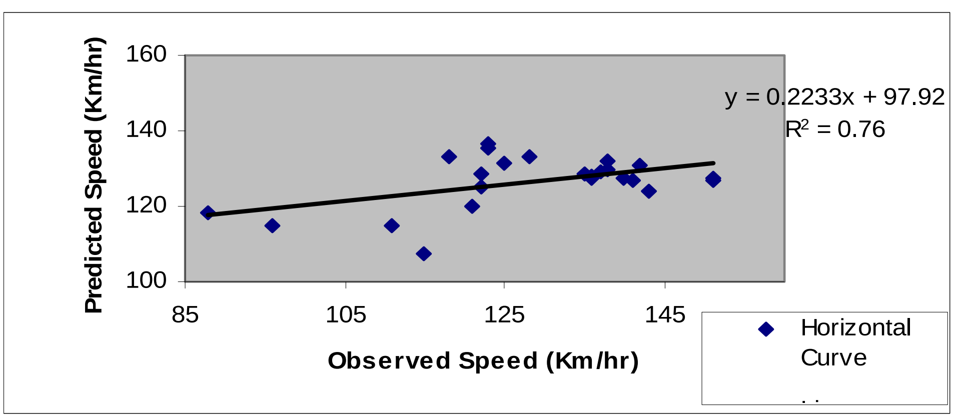

Figure 5.9. Observed speed versus predicted speed on horizontal curves.

Table 5.14. Results of operating speeds using the regression equations developed for curves.

Road	Stations	Grade %	Tangent Length (m)	V_{85} = 127.3 - 4.461G	V_{85}^{th} On Tangent Km/hr
Addis Ababa to Awassa	26+800	1.0	1000	122.8	106
	28+300	2.9	1650	114.5	117
	30+868	3.8	332	110.6	96
	33+200	2.5	250	116.1	113
	49+700	2.5	540	116.1	113
	50+625	0.1	3365	126.7	124
	59+905	0.1	2860	126.7	133
	69+160	1.8	1210	119.5	122
	72+325	2.5	650	116.1	136
	87+040	0.6	700	124.6	128
	88+770	0.9	600	123.4	125
	98+110	0.9	800	123.4	126
	99+900	0.9	700	123.4	129
	104+450	1.3	1460	121.5	128
	105+685	1.5	890	120.6	126
	116+750	1.3	1060	121.7	135
	181+124	1.4	1765	121.1	136
	189+780	0.5	2500	125.1	137
	191+255	1.0	2360	122.8	120
	217+900	0.4	1220	125.6	136
	227+970	0.3	780	126.2	119
	231+900	3.8	565	110.6	123
	239+280	0.7	2180	124.4	122
	241+500	0.6	300	124.8	123

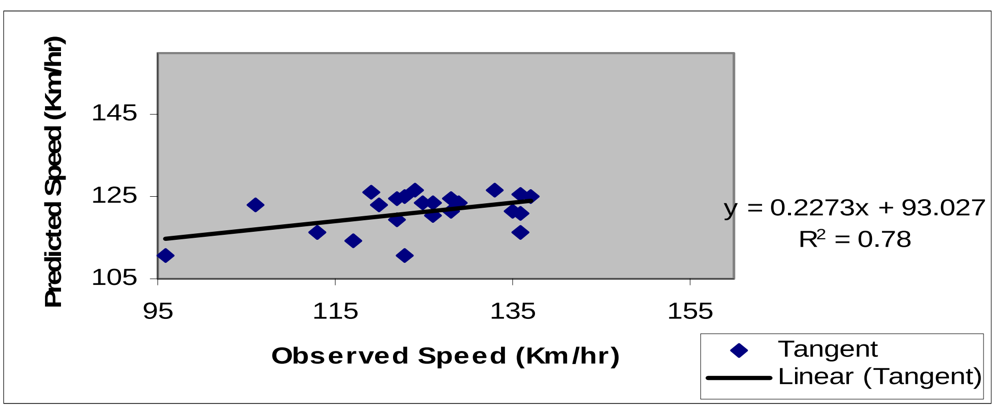

Figure 5.10. Observed speed versus predicted speed on tangents

5.7 Summary

It was hypothesized that motorists select the speed they drive based on previous alignment characteristics they have encountered. Since alignment indices quantify the general character of the roadway alignment, they were used in this research to represent the geometry motorists' encounter on tangent and horizontal curves. Using this principle, the objective of this analysis was to evaluate the applicability of using geometric elements in estimating the desired speeds of motorists on tangents and horizontal curves of two – lane rural highways.

Geometric elements were identified and developed. In order to compute and evaluate the indices, spot-speed and alignment data were collected from sites located in five roads across central Ethiopia. After the alignment data were entered into a computerized format, the geometric elements were calculated.

These geometric elements were then compared to observed 85^{th} percentile speeds on tangents and horizontal curves. Graphical and statistical analyses were performed to determine if the geometric elements were significant predictors of the desired speeds of motorists on tangents and horizontal curves of two-lane rural highways.

The result specify that combinations of geometric elements and other geometric variables were able to predict the 85^{th} percentile speeds of motorists on tangents and horizontal curves of two-lane rural highways. Grade and superelevation was predictor of the 85^{th} percentile curve speeds on two-lane rural highways. Whereas grade on the tangent section was the predictor of the 85^{th} percentile tangent speeds on two-lane rural highways.

CONCULSIONS AND RECOMMENDATIONS

6. Conclusions and Recommendations

6.1. Conclusions

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

- Results of design consistency evaluations between simple circular curve and tangent sections shows that twenty seven sections were under good design, twelve sections were under fair design and four sections were under poor design. Hence, from the evaluation result most of the sections show design consistency.

- The results obtained between design speed and operating speed for horizontal curves shows that five sections were under good design, six sections were under fair design and thirty two section were under poor design and in tangent sections three sections were under good design, nine sections were under fair design and thirty one section were under poor design and this results shows inconsistency and the operating speed observed was grater than 20 Km/h from the design Speed. Hence consideration should be made by the Ethiopian Roads Authority to incorporate this in the design procedure in order to reduce accidents that may occur due to this inconsistency.

- This study has produced significant relationships that can be used to calculate the expected speeds at tangents and simple horizontal curves which can be improved by further research works.
- Grade and superelevation were significant variables in the regression equations developed for the operating speeds of motorists on horizontal curves of two- lane rural highways.

- Grade was found as a variable in the regression equation for the operating speeds of motorists on tangent sections of two- lane rural highways.

6.2 Recommendations

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

- Further research should be conducted to extend all aspects of this research, such as by collecting more data in order to improve results and also by including the effects of vertical curves.

- From the consistency evaluation result it shows that our roads are highly inconsistency. Hence, the Ethiopian Roads Authority has to put into consideration the effect of consistencies and needs further research and incorporate consideration of design consistency in the design manual.

REFERENCES

7. References

The following references will form the basis for this study

1. AACRA Geometric design manual

2. A policy on geometric design of highways and streets. American association of state highway and traffic officials, Washington, D.C, 1994.

3. Austroads rural roads design, guide to the geometric design of rural roads.

4. Charles v. zegeer, j. Richard Stewart, Forrest m. concil, Donald W. Reinfurt, and Elizabeth Hamilton "safety effects of geometric improvements on horizontal curves"

5. Contractor report 94, a review of Geometric design and standard for rural roads in developing countries.

6. Dr. John F. Morrall, Dr. John B.l Robinson "design speed choices for Canadian two – lane highways"

7. Ethiopian roads authority. "Geometric design manual, 2002"

8. Fitzpatrick, k., Carlson, p., brewer, M.A., Wooldridge, M.D., and Miaou, S.P. (November 2002) "design speed, operating speed, and posted speed practices." draft final report from NCHRP 15 – 18.

9. Genevieve Giuliani, Michael S.Townes, Robert e. skinner. "Geometric design consistency on high – speed rural two – lane roadways"

10. Girma Berhanu, 2000 "Effects of road and traffic factors on road safety in Ethiopia"

11. G.J Alexander and h. Lynnfield, April 1986 "Driver expectancy in Highway design and traffic operations". U.S. department of transportation, Federal Highway Administration, Washington, D.C.

12. J.C. Glemnon and D.W. Hrwood. 1978 "Highway design consistency and Systematic design related to highway safety" transportation research Record 681, transportation research board, national research council, Washington, D.C, pp.77-88

13. Mark d. Wooldridge and Kay Fitzpatrick. 2003 "Geometric design consistency on high – speed rural two-lane roadways" transportation research board, Washington, D.C.

14. Road research laboratory (1965)

15. Ruediger Lamm, Elias m. Choueiri, john c. Hayward, and Anand Paluri "possible design procedure to promote design consistency in highway Geometric design on two - lane rural roads"

16. South African Geometric design manual.

17. Young – Jun Kweon, Kara m. Kockelman "the safety effects of speed limit changes: use of panel models, including speed, use, and design variables"

APPENDIX

8. Appendix

Appendix A – Data Collected from Field

Appendix B – Data Analysis for the 85^{th} Percentile Speed

Appendix C –Regression Analysis

B.2.Data Analysis for the 85 th percentile Speed of Tangents

Car, Buses and Trucks

	V	Mean M=Σv/n	v^2	$(v-m)^2 = \Sigma v^2 - (\Sigma v)^2/n$	Std $S=\sqrt{\Sigma(v-m)^2/n-1}$	85 % Speed V= m + s	
	80	85	6400	38528	21	106	106
	75		5655				
	59		3505				
Addis Ababa -	96		9216				
Awassa	104		10816				
	70		4956				
	102		10486				
26+800	112		12544				
	90		8028				
	50		2460				
T = 1000	133		17636				
	139		19377				
	93		8612				
	67		4516				
	59		3505				
	104		10816				
	72		5184				
	90		8028				
	77		5898				
	70		4956				
	101		10161				
	80		6400				
	101		10161				
	94		8911				
	75		5655				
	115		13271				
	126		15977				
	66		4303				
	144		20736				
	90		8028				
	96		9216				
	77		5898				
	67		4516				
	102		10486				
	96		9216				
	91		8317				
	62		3894				
	72		5184				
	70		4956				
	90		8028				
	72		5184				
	69		4733				
	70		4956				
	74		5417				
	80		6400				
	77		5898				
	70		4956				
	72		5184				
	90		8028				
	70		4956				
	72		5184				
	62		3894				
	91		8317				
	96		9216				
	102		10486				
	67		4516				
	77		5898				
	96		9216				
	80		6400				
	77		5898				
	101		10161				
	58		3318				
	67		4516				
	106		11151				
	64		4096				
	83		6922				
	85		7191				
	86		7465				
	104		10816				
	77		5898				
	74		5417				
	123		15178				
	74		5417				
	74		5417				
	99		9841				
	101		10161				
	102		10486				
	80		6400				
	91		8317				
	83		6922				
	90		8028				
	51		2621				
	50		2460				
	53		2788				
	112		12544				
	34		1129				
	115		13271				
	72		5184				
	115		13271				
	120		14400				
	7666		691433				

	112	96	12544	41753	22	117	117
	86		7465				
	98		9526				
	101		10161				
	106		11151				
	120		14400				
	98		9526				
	90		8028				
	72		5184				
28+300	128		16384				
	131		17213				
	74		5417				
T = 1650	53		2788				
	86		7465				
	93		8612				
	82		6659				
	133		17636				
	115		13271				
	70		4956				
	77		5898				
	61		3697				
	134		18063				
	53		2788				
	142		20278				
	144		20736				
	72		5184				
	70		4956				
	94		8911				
	94		8911				
	117		13642				
	115		13271				
	106		11151				
	69		4733				
	69		4733				
	82		6659				
	80		6400				
	98		9526				
	112		12544				
	130		16796				
	99		9841				
	61		3697				
	115		13271				
	112		12544				
	107		11492				
	98		9526				
	80		6400				
	69		4733				
	106		11151				
	112		12544				
	99		9841				
	107		11492				
	112		12544				
	61		3697				
	69		4733				
	115		13271				
	120		14400				
	128		16384				
	99		9841				
	106		11151				
	96		9216				
	110		12188				
	112		12544				
	104		10816				
	75		5655				
	70		4956				
	98		9526				
	91		8317				
	78		6147				
	61		3697				
	66		4303				
	122		14787				
	118		14019				
	99		9841				
	85		7191				
	118		14019				
	99		9841				
	107		11492				
	69		4733				
	86		7465				
	99		9841				
	104		10816				
	69		4733				
	74		5417				
	80		6400				
	123		15178				
	110		12188				
	104		10816				
	86		7465				
	82		6659				
	77		5898				
	8613		865979				

	117	74	13642	44796	22	96	96
	102		10486				
	72		5184				
	102		10486				
	74		5417				
	75		5655				
	94		8911				
	78		6147				
	82		6659				
	104		10816				
30+868	107		11492				
	101		10161				
	130		16796				
T = 332	78		6147				
	77		5898				
	83		6922				
	69		4733				
	93		8612				
	61		3697				
	80		6400				
	101		10161				
	106		11151				
	85		7191				
	72		5184				
	94		8911				
	96		9216				
	69		4733				
	98		9526				
	83		6922				
	83		6922				
	51		2621				
	80		6400				
	54		2959				
	77		5898				
	58		3318				
	42		1731				
	58		3318				
	109		11837				
	43		1866				
	72		5184				
	42		1731				
	61		3697				
	70		4956				
	93		8612				
	53		2788				
	43		1866				
	50		2460				
	53		2788				
	56		3136				
	58		3318				
	80		6400				
	51		2621				
	109		11837				
	72		5184				
	70		4956				
	109		11837				
	109		11837				
	72		5184				
	77		5898				
	80		6400				
	38		1475				
	114		12905				
	51		2621				
	67		4516				
	56		3136				
	69		4733				
	86		7465				
	59		3505				
	62		3894				
	66		4303				
	77		5898				
	80		6400				
	85		7191				
	86		7465				
	42		1731				
	48		2304				
	62		3894				
	43		1866				
	67		4516				
	90		8028				
	70		4956				
	69		4733				
	56		3136				
	48		2304				
	40		1600				
	107		11492				
	102		10486				
	24		576				
	32		1024				
	40		1600				
	6653		536571				

	117	93	13642	37872	21	113	113
	78		6147				
	58		3318				
	123		15178				
	82		6659				
	88		7744				
	106		11151				
	90		8028				
	96		9216				
	109		11837				
33+200	94		8911				
	109		11837				
	122		14787				
T = 250	93		8612				
	112		12544				
	123		15178				
	93		8612				
	90		8028				
	85		7191				
	136		18496				
	69		4733				
	70		4956				
	138		18934				
	110		12188				
	106		11151				
	74		5417				
	74		5417				
	90		8028				
	96		9216				
	88		7744				
	104		10816				
	66		4303				
	51		2621				
	77		5898				
	75		5655				
	99		9841				
	102		10486				
	96		9216				
	75		5655				
	75		5655				
	77		5898				
	66		4303				
	96		9216				
	98		9526				
	77		5898				
	101		10161				
	107		11492				
	77		5898				
	99		9841				
	56		3136				
	88		7744				
	51		2621				
	77		5898				
	75		5655				
	107		11492				
	96		9216				
	102		10486				
	75		5655				
	77		5898				
	104		10816				
	64		4096				
	88		7744				
	56		3136				
	99		9841				
	102		10486				
	98		9526				
	125		15575				
	118		14019				
	107		11492				
	77		5898				
	94		8911				
	120		14400				
	101		10161				
	96		9216				
	101		10161				
	96		9216				
	122		14787				
	107		11492				
	118		14019				
	107		11492				
	72		5184				
	54		2959				
	50		2460				
	91		8317				
	72		5184				
	136		18496				
	99		9841				
	99		9841				
	134		18063				
	99		9841				
	8346		811750				

	93	93	8612	37475	21	113	113
	112		12544				
	120		14400				
	123		15178				
	93		8612				
	90		8028				
	85		7191				
	136		18496				
	69		4733				
	70		4956				
49+700	138		18934				
	110		12188				
	106		11151				
T = 540	74		5417				
	74		5417				
	90		8028				
	96		9216				
	88		7744				
	117		13642				
	78		6147				
	58		3318				
	123		15178				
	82		6659				
	88		7744				
	106		11151				
	90		8028				
	96		9216				
	109		11837				
	94		8911				
	109		11837				
	75		5655				
	77		5898				
	66		4303				
	96		9216				
	98		9526				
	77		5898				
	101		10161				
	107		11492				
	77		5898				
	99		9841				
	56		3136				
	88		7744				
	51		2621				
	77		5898				
	75		5655				
	107		11492				
	96		9216				
	102		10486				
	75		5655				
	77		5898				
	104		10816				
	104		10816				
	66		4303				
	51		2621				
	77		5898				
	75		5655				
	99		9841				
	102		10486				
	96		9216				
	75		5655				
	101		10161				
	120		14400				
	94		8911				
	77		5898				
	107		11492				
	118		14019				
	125		15575				
	98		9526				
	102		10486				
	99		9841				
	56		3136				
	88		7744				
	64		4096				
	99		9841				
	134		18063				
	99		9841				
	99		9841				
	136		18496				
	72		5184				
	75		5655				
	50		2460				
	70		4956				
	72		5184				
	107		11492				
	118		14019				
	107		11492				
	122		14787				
	112		12544				
	96		9216				
	101		10161				
	8360		**814026**				

	122	101	14787	48518	23	124	124
	120		14400				
	125		15575				
	110		12188				
	131		17213				
	114		12905				
	120		14400				
	139		19377				
	131		17213				
50+625	141		19825				
	112		12544				
	118		14019				
T = 3365	142		20278				
	88		7744				
	88		7744				
	115		13271				
	120		14400				
	118		14019				
	83		6922				
	136		18496				
	109		11837				
	94		8911				
	109		11837				
	96		9216				
	90		8028				
	106		11151				
	82		6659				
	88		7744				
	115		13271				
	58		3318				
	101		10161				
	94		8911				
	99		9841				
	98		9526				
	101		10161				
	114		12905				
	77		5898				
	115		13271				
	120		14400				
	99		9841				
	115		13271				
	83		6922				
	115		13271				
	99		9841				
	101		10161				
	110		12188				
	96		9216				
	107		11492				
	75		5655				
	77		5898				
	104		10816				
	104		10816				
	66		4303				
	51		2621				
	77		5898				
	75		5655				
	99		9841				
	102		10486				
	96		9216				
	75		5655				
	64		4096				
	99		9841				
	134		18063				
	99		9841				
	136		18496				
	72		5184				
	75		5655				
	50		2460				
	70		4956				
	72		5184				
	107		11492				
	118		14019				
	107		11492				
	122		14787				
	112		12544				
	96		9216				
	101		10161				
	118		14019				
	94		8911				
	99		9841				
	74		5417				
	117		13642				
	83		6922				
	72		5184				
	112		12544				
	115		13271				
	131		17213				
	93		8612				
	90		8028				
	9000		948518				

	128	104	16384	34269	20	133	133
	93		8612				
	112		12544				
	102		10486				
	115		13271				
	96		9216				
	122		14787				
	112		12544				
59+905	75		5655				
	77		5898				
	122		14787				
T = 2860	120		14400				
	125		15575				
	110		12188				
	131		17213				
	114		12905				
	120		14400				
	139		19377				
	131		17213				
	141		19825				
	112		12544				
	118		14019				
	142		20278				
	88		7744				
	88		7744				
	115		13271				
	120		14400				
	118		14019				
	83		6922				
	136		18496				
	110		12188				
	101		10161				
	99		9841				
	115		13271				
	83		6922				
	115		13271				
	99		9841				
	120		14400				
	115		13271				
	77		5898				
	114		12905				
	101		10161				
	98		9526				
	99		9841				
	94		8911				
	101		10161				
	110		12188				
	104		10816				
	104		10816				
	115		13271				
	101		10161				
	107		11492				
	110		12188				
	114		12905				
	77		5898				
	101		10161				
	115		13271				
	99		9841				
	120		14400				
	115		13271				
	118		14019				
	78		6147				
	94		8911				
	99		9841				
	78		6147				
	125		15575				
	74		5417				
	146		21199				
	74		5417				
	117		13642				
	83		6922				
	75		5655				
	99		9841				
	72		5184				
	112		12544				
	115		13271				
	107		11492				
	74		5417				
	69		4733				
	131		17213				
	93		8612				
	77		5898				
	82		6659				
	90		8028				
	80		6400				
	78		6147				
	75		5655				
	75		5655				
	150		22620				
	102		10486				
	9384		**1012708**				

	142	97	20278	41305	22	119	119
	114		12905				
	109		11837				
	147		21668				
	114		12905				
	86		7465				
	109		11837				
	82		6659				
	115		13271				
	114		12905				
	75		5655				
63+060	142		20278				
	99		9841				
	54		2959				
T = 1210	91		8317				
	104		10816				
	96		9216				
	102		10486				
	117		13642				
	141		19825				
	138		18934				
	104		10816				
	102		10486				
	112		12544				
	120		14400				
	115		13271				
	147		21668				
	88		7744				
	120		14400				
	122		14787				
	85		7191				
	78		6147				
	72		5184				
	91		8317				
	70		4956				
	91		8317				
	98		9526				
	88		7744				
	102		10486				
	90		8028				
	72		5184				
	107		11492				
	82		6659				
	110		12188				
	101		10161				
	99		9841				
	115		13271				
	83		6922				
	115		13271				
	99		9841				
	120		14400				
	115		13271				
	77		5898				
	114		12905				
	101		10161				
	98		9526				
	99		9841				
	110		12188				
	104		10816				
	115		13271				
	101		10161				
	91		8317				
	96		9216				
	134		18063				
	78		6147				
	78		6147				
	75		5655				
	75		5655				
	70		4956				
	69		4733				
	86		7465				
	93		8612				
	72		5184				
	59		3505				
	53		2788				
	53		2788				
	54		2959				
	66		4303				
	102		10486				
	101		10161				
	93		8612				
	93		8612				
	96		9216				
	94		8911				
	62		3894				
	83		6922				
	93		8612				
	90		8028				
	112		12544				
	85		7191				
	8733		888658				

		102	**102**	**10486**	**33385**	**19**	**122**	**122**
		96		9216				
		104		10816				
		91		8317				
		54		2959				
		99		9841				
		142		20278				
69+160		114		12905				
		115		13271				
		82		6659				
T =	**650**	109		11837				
		86		7465				
		114		12905				
		147		21668				
		109		11837				
		114		12905				
		142		20278				
		110		12188				
		131		17213				
		114		12905				
		120		14400				
		139		19377				
		131		17213				
		141		19825				
		112		12544				
		118		14019				
		142		20278				
		88		7744				
		88		7744				
		115		13271				
		101		10161				
		77		5898				
		114		12905				
		110		12188				
		107		11492				
		101		10161				
		115		13271				
		104		10816				
		104		10816				
		110		12188				
		101		10161				
		94		8911				
		99		9841				
		98		9526				
		101		10161				
		114		12905				
		85		7191				
		78		6147				
		72		5184				
		91		8317				
		70		4956				
		98		9526				
		88		7744				
		102		10486				
		90		8028				
		107		11492				
		110		12188				
		101		10161				
		99		9841				
		115		13271				
		99		9841				
		72		5184				
		112		12544				
		115		13271				
		107		11492				
		74		5417				
		69		4733				
		131		17213				
		93		8612				
		77		5898				
		107		11492				
		74		5417				
		131		17213				
		77		5898				
		90		8028				
		80		6400				
		101		10161				
		91		8317				
		96		9216				
		134		18063				
		78		6147				
		86		7465				
		93		8612				
		72		5184				
		78		6147				
		110		12188				
		115		13271				
		118		14019				
		101		10161				
		110		12188				
		9221		**978086**				

	93	117	8612	26096	19	136	136
	106		11151				
	128		16384				
	112		12544				
	122		14787				
	112		12544				
	149		22141				
	125		15575				
	142		20278				
72+325	134		18063				
	152		23104				
	112		12544				
T= 700	133		17636				
	115		13271				
	162		26115				
	134		18063				
	98		9526				
	117		13642				
	133		17636				
	128		16384				
	120		14400				
	141		19825				
	131		17213				
	114		12905				
	120		14400				
	139		19377				
	131		17213				
	141		19825				
	112		12544				
	118		14019				
	110		12188				
	115		13271				
	114		12905				
	117		13642				
	138		18934				
	114		12905				
	110		12188				
	101		10161				
	115		13271				
	104		10816				
	104		10816				
	110		12188				
	88		7744				
	102		10486				
	90		8028				
	107		11492				
	96		9216				
	131		17213				
	109		11837				
	106		11151				
	104		10816				
	75		5655				
	88		7744				
	126		15977				
	125		15575				
	165		27159				
	126		15977				
	123		15178				
	101		10161				
	115		13271				
	96		9216				
	109		11837				
	91		8317				
	88		7744				
	102		10486				
	131		17213				
	150		22620				
	126		15977				
	112		12544				
	154		23593				
	83		6922				
	115		13271				
	102		10486				
	91		8317				
	120		14400				
	117		13642				
	8891		**1066273**				

	88	**103**	**7744**	**33010**	**21**	**123**	**123**
	109		11837				
	85		7191				
	86		7465				
	90		8028				
	96		9216				
	80		6400				
	78		6147				
	91		8317				
84+350	88		7744				
	150		22620				
	138		18934				
T= 600	142		20278				
	115		13271				
	120		14400				
	102		10486				
	85		7191				
	109		11837				
	110		12188				
	120		14400				
	107		11492				
	83		6922				
	85		7191				
	118		14019				
	99		9841				
	102		10486				
	134		18063				
	109		11837				
	93		8612				
	99		9841				
	104		10816				
	101		10161				
	107		11492				
	115		13271				
	117		13642				
	120		14400				
	106		11151				
	125		15575				
	126		15977				
	91		8317				
	83		6922				
	120		14400				
	74		5417				
	86		7465				
	85		7191				
	90		8028				
	75		5655				
	117		13642				
	118		14019				
	152		23104				
	107		11492				
	85		7191				
	94		8911				
	96		9216				
	99		9841				
	74		5417				
	69		4733				
	82		6659				
	149		22141				
	115		13271				
	157		24586				
	122		14787				
	77		5898				
	72		5184				
	99		9841				
	112		12544				
	122		14787				
	106		11151				
	86		7465				
	106		11151				
	101		10161				
	106		11151				
	102		10486				
	53		2788				
	74		5417				
	107		11492				
	91		8317				
	106		11151				
	106		11151				
	8098		**863025**				

	120	**109**	**14400**	**30018**	**19**	**128**	**128**
	102		10486				
	85		7191				
	109		11837				
	110		12188				
	120		14400				
	107		11492				
	83		6922				
87+040	118		14019				
	85		7191				
	102		10486				
T = 800	99		9841				
	109		11837				
	134		18063				
	99		9841				
	93		8612				
	90		8028				
	86		7465				
	85		7191				
	78		6147				
	88		7744				
	91		8317				
	138		18934				
	106		11151				
	122		14787				
	128		16384				
	112		12544				
	125		15575				
	134		18063				
	142		20278				
	118		14019				
	75		5655				
	117		13642				
	90		8028				
	86		7465				
	85		7191				
	120		14400				
	74		5417				
	126		15977				
	91		8317				
	83		6922				
	125		15575				
	120		14400				
	106		11151				
	126		15977				
	115		13271				
	107		11492				
	123		15178				
	138		18934				
	110		12188				
	115		13271				
	101		10161				
	88		7744				
	91		8317				
	96		9216				
	109		11837				
	101		10161				
	115		13271				
	96		9216				
	123		15178				
	125		15575				
	165		27159				
	126		15977				
	88		7744				
	126		15977				
	75		5655				
	125		15575				
	106		11151				
	88		7744				
	104		10816				
	131		17213				
	96		9216				
	109		11837				
	106		11151				
	107		11492				
	102		10486				
	122		14787				
	112		12544				
	122		14787				
	157		24586				
	149		22141				
	99		9841				
	96		9216				
	9008		**1007657**				

	115	**108**	13271	**23238**	**17**	**125**	**125**
	120		14400				
	107		11492				
	118		14019				
	99		9841				
	109		11837				
	99		9841				
	138		18934				
	150		22620				
	91		8317				
88+770	96		9216				
	80		6400				
	90		8028				
T = 700	86		7465				
	134		18063				
	120		14400				
	138		18934				
	102		10486				
	91		8317				
	109		11837				
	88		7744				
	120		14400				
	86		7465				
	107		11492				
	93		8612				
	118		14019				
	102		10486				
	109		11837				
	102		10486				
	120		14400				
	115		13271				
	123		15178				
	110		12188				
	101		10161				
	125		15575				
	83		6922				
	126		15977				
	120		14400				
	86		7465				
	117		13642				
	118		14019				
	91		8317				
	106		11151				
	115		13271				
	101		10161				
	106		11151				
	120		14400				
	117		13642				
	106		11151				
	75		5655				
	126		15977				
	123		15178				
	115		13271				
	109		11837				
	96		9216				
	126		15977				
	106		11151				
	131		17213				
	109		11837				
	107		11492				
	102		10486				
	125		15575				
	88		7744				
	157		24586				
	77		5898				
	99		9841				
	112		12544				
	82		6659				
	86		7465				
	106		11151				
	91		8317				
	102		10486				
	106		11151				
	86		7465				
	112		12544				
	99		9841				
	157		24586				
	94		8911				
	8432		**934758**				

	115	**109**	**13271**	**23434**	**16**	**126**	**126**
	107		11492				
	109		11837				
	138		18934				
	80		6400				
	134		18063				
	138		18934				
	120		14400				
	109		11837				
98+110	118		14019				
	99		9841				
	134		18063				
T = 1460	93		8612				
	85		7191				
	91		8317				
	78		6147				
	128		16384				
	130		16796				
	106		11151				
	109		11837				
	118		14019				
	109		11837				
	91		8317				
	109		11837				
	120		14400				
	91		8317				
	93		8612				
	120		14400				
	102		10486				
	120		14400				
	91		8317				
	117		13642				
	120		14400				
	83		6922				
	101		10161				
	123		15178				
	101		10161				
	118		14019				
	117		13642				
	85		7191				
	91		8317				
	106		11151				
	126		15977				
	107		11492				
	138		18934				
	115		13271				
	88		7744				
	120		14400				
	75		5655				
	125		15575				
	120		14400				
	106		11151				
	115		13271				
	125		15575				
	115		13271				
	101		10161				
	118		14019				
	91		8317				
	107		11492				
	107		11492				
	109		11837				
	106		11151				
	107		11492				
	102		10486				
	122		14787				
	112		12544				
	122		14787				
	94		8911				
	117		13642				
	122		14787				
	99		9841				
	122		14787				
	86		7465				
	106		11151				
	112		12544				
	157		24586				
	123		15178				
	120		14400				
	106		11151				
	109		11837				
	112		12544				
	86		7465				
	157		24586				
	112		12544				
	94		8911				
	102		10486				
	86		7465				
	99		9841				
	106		11151				
	86		7465				
	9840		**1099274**				

	134	**109**	**18063**	**31543**	**20**	**129**	**129**
	86		7465				
	115		13271				
	118		14019				
	138		18934				
	150		22620				
	96		9216				
	91		8317				
	80		6400				
	86		7465				
99+900	123		15178				
	120		14400				
	118		14019				
T = 890	102		10486				
	109		11837				
	85		7191				
	120		14400				
	118		14019				
	99		9841				
	134		18063				
	96		9216				
	90		8028				
	85		7191				
	109		11837				
	93		8612				
	99		9841				
	115		13271				
	138		18934				
	96		9216				
	90		8028				
	107		11492				
	118		14019				
	117		13642				
	86		7465				
	120		14400				
	126		15977				
	91		8317				
	125		15575				
	117		13642				
	107		11492				
	75		5655				
	125		15575				
	115		13271				
	118		14019				
	117		13642				
	138		18934				
	115		13271				
	91		8317				
	85		7191				
	117		13642				
	122		14787				
	86		7465				
	157		24586				
	112		12544				
	123		15178				
	120		14400				
	109		11837				
	112		12544				
	157		24586				
	94		8911				
	86		7465				
	106		11151				
	86		7465				
	106		11151				
	122		14787				
	112		12544				
	112		12544				
	86		7465				
	53		2788				
	91		8317				
	106		11151				
	149		22141				
	96		9216				
	94		8911				
	122		14787				
	77		5898				
	115		13271				
	149		22141				
	99		9841				
	8605		**968791**				

	99	110	9841	27777	19	128	128
	96		9216				
	118		14019				
	86		7465				
	109		11837				
	93		8612				
	96		9216				
	80		6400				
	91		8317				
	90		8028				
	150		22620				
	138		18934				
	109		11837				
104+450	102		10486				
	123		15178				
	150		22620				
T = 1060	134		18063				
	96		9216				
	134		18063				
	90		8028				
	96		9216				
	150		22620				
	99		9841				
	118		14019				
	107		11492				
	115		13271				
	120		14400				
	138		18934				
	88		7744				
	102		10486				
	123		15178				
	101		10161				
	125		15575				
	126		15977				
	86		7465				
	118		14019				
	106		11151				
	101		10161				
	106		11151				
	117		13642				
	120		14400				
	125		15575				
	118		14019				
	91		8317				
	107		11492				
	107		11492				
	85		7191				
	138		18934				
	117		13642				
	106		11151				
	120		14400				
	86		7465				
	106		11151				
	112		12544				
	86		7465				
	91		8317				
	106		11151				
	94		8911				
	122		14787				
	115		13271				
	149		22141				
	99		9841				
	122		14787				
	157		24586				
	112		12544				
	123		15178				
	120		14400				
	112		12544				
	96		9216				
	102		10486				
	86		7465				
	77		5898				
	99		9841				
	112		12544				
	91		8317				
	106		11151				
	82		6659				
	112		12544				
	77		5898				
	128		16384				
	133		17636				
	8875		1000236				

	93	108	8612	26257	18	126	126
	86		7465				
	101		10161				
	91		8317				
	83		6922				
	110		12188				
	120		14400				
	118		14019				
	134		18063				
105+685	91		8317				
	138		18934				
	83		6922				
T= 1765	120		14400				
	118		14019				
	109		11837				
	120		14400				
	80		6400				
	90		8028				
	86		7465				
	99		9841				
	106		11151				
	122		14787				
	112		12544				
	128		16384				
	134		18063				
	142		20278				
	115		13271				
	99		9841				
	138		18934				
	134		18063				
	115		13271				
	110		12188				
	126		15977				
	86		7465				
	91		8317				
	106		11151				
	101		10161				
	90		8028				
	117		13642				
	74		5417				
	83		6922				
	125		15575				
	106		11151				
	107		11492				
	110		12188				
	115		13271				
	101		10161				
	104		10816				
	122		14787				
	112		12544				
	102		10486				
	107		11492				
	109		11837				
	96		9216				
	131		17213				
	107		11492				
	109		11837				
	88		7744				
	126		15977				
	106		11151				
	112		12544				
	106		11151				
	112		12544				
	82		6659				
	77		5898				
	141		19825				
	109		11837				
	106		11151				
	101		10161				
	109		11837				
	69		4733				
	144		20736				
	77		5898				
	112		12544				
	106		11151				
	144		20736				
	144		20736				
	78		6147				
	8411		933286				

	163	**119**	**26634**	**17188**	**15**	**135**	**135**
	114		12905				
	131		17213				
	141		19825				
	142		20278				
	115		13271				
	118		14019				
	112		12544				
116+750	147		21668				
	66		4303				
	130		16796				
T = 2500	109		11837				
	131		17213				
	128		16384				
	142		20278				
	155		24087				
	106		11151				
	123		15178				
	136		18496				
	142		20278				
	152		23104				
	160		25600				
	88		7744				
	93		8612				
	102		10486				
	102		10486				
	120		14400				
	86		7465				
	104		10816				
	109		11837				
	106		11151				
	150		22620				
	141		19825				
	128		16384				
	117		13642				
	118		14019				
	110		12188				
	123		15178				
	101		10161				
	91		8317				
	120		14400				
	117		13642				
	83		6922				
	101		10161				
	123		15178				
	101		10161				
	131		17213				
	99		9841				
	93		8612				
	125		15575				
	123		15178				
	134		18063				
	94		8911				
	109		11837				
	120		14400				
	131		17213				
	125		15575				
	134		18063				
	125		15575				
	144		20736				
	86		7465				
	104		10816				
	144		20736				
	134		18063				
	118		14019				
	142		20278				
	104		10816				
	144		20736				
	133		17636				
	123		15178				
	85		7191				
	144		20736				
	86		7465				
	104		10816				
	117		13642				
	114		12905				
	9070		**1114150**				

	131	117	17213	25175	19	136	136
	125		15575				
	147		21668				
	106		11151				
	110		12188				
	138		18934				
	141		19825				
	128		16384				
181+124	99		9841				
	99		9841				
	120		14400				
T = 2360	122		14787				
	118		14019				
	139		19377				
	110		12188				
	131		17213				
	165		27159				
	131		17213				
	136		18496				
	176		30976				
	120		14400				
	150		22620				
	142		20278				
	118		14019				
	115		13271				
	94		8911				
	149		22141				
	82		6659				
	74		5417				
	134		18063				
	123		15178				
	120		14400				
	130		16796				
	144		20736				
	77		5898				
	122		14787				
	144		20736				
	131		17213				
	134		18063				
	118		14019				
	93		8612				
	134		18063				
	99		9841				
	144		20736				
	118		14019				
	122		14787				
	94		8911				
	101		10161				
	109		11837				
	67		4516				
	138		18934				
	138		18934				
	106		11151				
	131		17213				
	104		10816				
	96		9216				
	147		21668				
	59		3505				
	72		5184				
	70		4956				
	98		9526				
	107		11492				
	112		12544				
	104		10816				
	88		7744				
	94		8911				
	115		13271				
	125		15575				
	131		17213				
	128		16384				
	104		10816				
	102		10486				
	112		12544				
	115		13271				
	125		15575				
	8798		**1071281**				

	176	116	30976	32734	21	137	137
	96		9216				
	166		27689				
	152		23104				
	155		24087				
	141		19825				
	131		17213				
	134		18063				
	120		14400				
189+780	181		32689				
	147		21668				
	122		14787				
T = 1220	125		15575				
	88		7744				
	147		21668				
	147		21668				
	147		21668				
	131		17213				
	136		18496				
	78		6147				
	128		16384				
	88		7744				
	109		11837				
	128		16384				
	134		18063				
	123		15178				
	109		11837				
	115		13271				
	147		21668				
	150		22620				
	83		6922				
	109		11837				
	96		9216				
	125		15575				
	134		18063				
	93		8612				
	107		11492				
	101		10161				
	126		15977				
	126		15977				
	82		6659				
	134		18063				
	155		24087				
	101		10161				
	102		10486				
	85		7191				
	93		8612				
	96		9216				
	98		9526				
	106		11151				
	96		9216				
	117		13642				
	94		8911				
	77		5898				
	114		12905				
	125		15575				
	77		5898				
	77		5898				
	118		14019				
	141		19825				
	118		14019				
	123		15178				
	75		5655				
	90		8028				
	112		12544				
	88		7744				
	128		16384				
	131		17213				
	118		14019				
	104		10816				
	109		11837				
	88		7744				
	85		7191				
	104		10816				
	101		10161				
	106		11151				
	8821		1070154				

	96	104	9216	19412	16	120	120
	80		6400				
	86		7465				
	109		11837				
	120		14400				
	91		8317				
	90		8028				
191+255	109		11837				
	83		6922				
	118		14019				
T= 780	109		11837				
	102		10486				
	85		7191				
	88		7744				
	91		8317				
	112		12544				
	125		15575				
	106		11151				
	110		12188				
	118		14019				
	85		7191				
	99		9841				
	120		14400				
	88		7744				
	102		10486				
	88		7744				
	109		11837				
	102		10486				
	120		14400				
	93		8612				
	120		14400				
	85		7191				
	101		10161				
	101		10161				
	120		14400				
	117		13642				
	96		9216				
	91		8317				
	115		13271				
	101		10161				
	110		12188				
	101		10161				
	126		15977				
	91		8317				
	83		6922				
	90		8028				
	117		13642				
	125		15575				
	120		14400				
	101		10161				
	88		7744				
	88		7744				
	94		8911				
	96		9216				
	109		11837				
	88		7744				
	126		15977				
	125		15575				
	96		9216				
	115		13271				
	96		9216				
	91		8317				
	131		17213				
	109		11837				
	107		11492				
	102		10486				
	96		9216				
	123		15178				
	126		15977				
	75		5655				
	107		11492				
	125		15575				
	88		7744				
	106		11151				
	125		15575				
	86		7465				
	106		11151				
	112		12544				
	82		6659				
	77		5898				
	157		24586				
	8398		890191				

	152	112	23104	42533	24	136	136
	149		22141				
	157		24586				
	160		25600				
	139		19377				
	141		19825				
	106		11151				
217+900	90		8028				
	149		22141				
	134		18063				
T = 565	117		13642				
	90		8028				
	64		4096				
	136		18496				
	154		23593				
	134		18063				
	141		19825				
	165		27159				
	163		26634				
	99		9841				
	158		25091				
	157		24586				
	91		8317				
	154		23593				
	139		19377				
	131		17213				
	118		14019				
	163		26634				
	112		12544				
	114		12905				
	107		11492				
	86		7465				
	78		6147				
	90		8028				
	98		9526				
	99		9841				
	104		10816				
	138		18934				
	106		11151				
	96		9216				
	128		16384				
	106		11151				
	85		7191				
	102		10486				
	56		3136				
	90		8028				
	107		11492				
	45		2007				
	86		7465				
	96		9216				
	118		14019				
	107		11492				
	94		8911				
	77		5898				
	88		7744				
	117		13642				
	80		6400				
	115		13271				
	88		7744				
	96		9216				
	82		6659				
	86		7465				
	106		11151				
	86		7465				
	99		9841				
	125		15575				
	99		9841				
	112		12544				
	82		6659				
	107		11492				
	106		11151				
	122		14787				
	112		12544				
	122		14787				
	8304		987141				

	115	109	13271	7789	10	119	119
	109		11837				
	138		18934				
	130		16796				
	109		11837				
	118		14019				
	91		8317				
	120		14400				
	93		8612				
227+970	120		14400				
	102		10486				
	93		8612				
T = 2180	128		16384				
	130		16796				
	138		18934				
	86		7465				
	134		18063				
	120		14400				
	107		11492				
	115		13271				
	150		22620				
	109		11837				
	78		6147				
	120		14400				
	109		11837				
	85		7191				
	102		10486				
	93		8612				
	120		14400				
	102		10486				
	101		10161				
	101		10161				
	120		14400				
	91		8317				
	83		6922				
	115		13271				
	91		8317				
	107		11492				
	120		14400				
	138		18934				
	85		7191				
	118		14019				
	78		6147				
	85		7191				
	126		15977				
	118		14019				
	91		8317				
	106		11151				
	112		12544				
	102		10486				
	106		11151				
	109		11837				
	125		15575				
	86		7465				
	112		12544				
	109		11837				
	123		15178				
	112		12544				
	144		20736				
	122		14787				
	117		13642				
	99		9841				
	106		11151				
	86		7465				
	96		9216				
	123		15178				
	115		13271				
	125		15575				
	88		7744				
	106		11151				
	109		11837				
	106		11151				
	88		7744				
	123		15178				
	101		10161				
	115		13271				
	96		9216				
	109		11837				
	8509		948045				

	134	109	18063	15090	14	123	123
	90		8028				
	80		6400				
	91		8317				
	138		18934				
	99		9841				
	107		11492				
	115		13271				
	120		14400				
	176		30976				
231+900	134		18063				
	99		9841				
	93		8612				
T = 300	78		6147				
	91		8317				
	120		14400				
	102		10486				
	107		11492				
	88		7744				
	91		8317				
	112		12544				
	125		15575				
	128		16384				
	142		20278				
	134		18063				
	83		6922				
	118		14019				
	85		7191				
	78		6147				
	138		18934				
	120		14400				
	126		15977				
	118		14019				
	91		8317				
	106		11151				
	110		12188				
	101		10161				
	115		13271				
	91		8317				
	106		11151				
	126		15977				
	115		13271				
	101		10161				
	88		7744				
	90		8028				
	86		7465				
	118		14019				
	75		5655				
	110		12188				
	126		15977				
	106		11151				
	131		17213				
	96		9216				
	109		11837				
	106		11151				
	107		11492				
	102		10486				
	131		17213				
	109		11837				
	107		11492				
	102		10486				
	106		11151				
	131		17213				
	125		15575				
	123		15178				
	101		10161				
	109		11837				
	96		9216				
	91		8317				
	96		9216				
	109		11837				
	106		11151				
	142		20278				
	75		5655				
	123		15178				
	106		11151				
	112		12544				
	86		7465				
	122		14787				
	8586		960123				

	134	112	18063	8054	10	122	122
	138		18934				
	150		22620				
	91		8317				
	115		13271				
	120		14400				
	86		7465				
	96		9216				
	80		6400				
239+280	109		11837				
	134		18063				
T = 530	85		7191				
	120		14400				
	107		11492				
	109		11837				
	120		14400				
	102		10486				
	91		8317				
	138		18934				
	118		14019				
	99		9841				
	106		11151				
	109		11837				
	118		14019				
	128		16384				
	134		18063				
	118		14019				
	130		16796				
	99		9841				
	118		14019				
	126		15977				
	120		14400				
	118		14019				
	91		8317				
	115		13271				
	101		10161				
	115		13271				
	75		5655				
	125		15575				
	115		13271				
	106		11151				
	126		15977				
	118		14019				
	107		11492				
	110		12188				
	101		10161				
	115		13271				
	123		15178				
	106		11151				
	120		14400				
	86		7465				
	85		7191				
	117		13642				
	75		5655				
	133		17636				
	126		15977				
	125		15575				
	106		11151				
	131		17213				
	109		11837				
	96		9216				
	126		15977				
	106		11151				
	125		15575				
	126		15977				
	122		14787				
	117		13642				
	141		19825				
	102		10486				
	109		11837				
	96		9216				
	131		17213				
	125		15575				
	88		7744				
	126		15977				
	96		9216				
	109		11837				
	91		8317				
	107		11492				
	110		12188				
	109		11837				
	112		12544				
	112		12544				
	128		16384				
	9443		1082440				

	104	103	10816	29748	19	123	123
	96		9216				
	147		21668				
	109		11837				
	112		12544				
	128		16384				
	131		17213				
	67		4516				
241+500	120		14400				
	112		12544				
	110		12188				
T = 1440	77		5898				
	123		15178				
	69		4733				
	91		8317				
	101		10161				
	120		14400				
	115		13271				
	141		19825				
	133		17636				
	91		8317				
	90		8028				
	104		10816				
	107		11492				
	115		13271				
	125		15575				
	130		16796				
	82		6659				
	96		9216				
	120		14400				
	102		10486				
	122		14787				
	125		15575				
	83		6922				
	122		14787				
	90		8028				
	122		14787				
	122		14787				
	106		11151				
	115		13271				
	117		13642				
	123		15178				
	110		12188				
	118		14019				
	91		8317				
	115		13271				
	125		15575				
	120		14400				
	88		7744				
	106		11151				
	93		8612				
	109		11837				
	99		9841				
	96		9216				
	70		4956				
	83		6922				
	69		4733				
	115		13271				
	85		7191				
	54		2959				
	75		5655				
	99		9841				
	88		7744				
	118		14019				
	83		6922				
	64		4096				
	80		6400				
	106		11151				
	86		7465				
	93		8612				
	110		12188				
	107		11492				
	115		13271				
	122		14787				
	123		15178				
	102		10486				
	77		5898				
	93		8612				
	83		6922				
	88		7744				
	8274		885404				

	134	118	18063	28851	20	138	138
	130		16796				
	109		11837				
Addis Ababa -	141		19825				
Jimma	96		9216				
	144		20736				
	91		8317				
35+627	99		9841				
	101		10161				
	163		26634				
T = 523	106		11151				
	150		22620				
	139		19377				
	72		5184				
	128		16384				
	123		15178				
	126		15977				
	141		19825				
	125		15575				
	120		14400				
	96		9216				
	107		11492				
	118		14019				
	131		17213				
	102		10486				
	96		9216				
	130		16796				
	131		17213				
	120		14400				
	138		18934				
	128		16384				
	131		17213				
	109		11837				
	125		15575				
	122		14787				
	120		14400				
	128		16384				
	86		7465				
	90		8028				
	110		12188				
	130		16796				
	142		20278				
	114		12905				
	139		19377				
	117		13642				
	139		19377				
	142		20278				
	142		20278				
	102		10486				
	125		15575				
	112		12544				
	99		9841				
	155		24087				
	154		23593				
	85		7191				
	102		10486				
	115		13271				
	122		14787				
	128		16384				
	120		14400				
	109		11837				
	75		5655				
	120		14400				
	85		7191				
	114		12905				
	80		6400				
	82		6659				
	144		20736				
	115		13271				
	123		15178				
	8288		**1010150**				

	72	95	5184	30366	22	117	117
	99		9841				
	107		11492				
	117		13642				
	112		12544				
	102		10486				
39+880	104		10816				
	101		10161				
	157		24586				
T = 700	96		9216				
	131		17213				
	56		3136				
	91		8317				
	114		12905				
	69		4733				
	125		15575				
	131		17213				
	125		15575				
	102		10486				
	99		9841				
	102		10486				
	64		4096				
	70		4956				
	64		4096				
	99		9841				
	102		10486				
	85		7191				
	101		10161				
	104		10816				
	78		6147				
	77		5898				
	117		13642				
	90		8028				
	91		8317				
	88		7744				
	85		7191				
	74		5417				
	67		4516				
	90		8028				
	53		2788				
	69		4733				
	106		11151				
	86		7465				
	91		8317				
	109		11837				
	59		3505				
	86		7465				
	118		14019				
	96		9216				
	131		17213				
	134		18063				
	78		6147				
	90		8028				
	74		5417				
	123		15178				
	75		5655				
	104		10816				
	64		4096				
	72		5184				
	104		10816				
	112		12544				
	112		12544				
	83		6922				
	72		5184				
	6061		**604324**				

	93	118	8612	22705	18	136	136
	115		13271				
	122		14787				
	93		8612				
	138		18934				
	96		9216				
	141		19825				
	160		25600				
	141		19825				
53+080	154		23593				
	131		17213				
	128		16384				
T = 3590	133		17636				
	136		18496				
	101		10161				
	139		19377				
	134		18063				
	141		19825				
	93		8612				
	120		14400				
	91		8317				
	114		12905				
	91		8317				
	130		16796				
	126		15977				
	99		9841				
	133		17636				
	136		18496				
	118		14019				
	122		14787				
	96		9216				
	128		16384				
	133		17636				
	120		14400				
	139		19377				
	131		17213				
	101		10161				
	96		9216				
	115		13271				
	130		16796				
	144		20736				
	99		9841				
	118		14019				
	131		17213				
	99		9841				
	128		16384				
	98		9526				
	94		8911				
	138		18934				
	102		10486				
	85		7191				
	88		7744				
	110		12188				
	96		9216				
	110		12188				
	114		12905				
	104		10816				
	134		18063				
	112		12544				
	130		16796				
	102		10486				
	109		11837				
	130		16796				
	126		15977				
	106		11151				
	99		9841				
	149		22141				
	110		12188				
	8022		969160				

	90	90	8028	27826	20	110	110
	99		9841				
	99		9841				
	107		11492				
	125		15575				
99+732	77		5898				
	74		5417				
	86		7465				
T = 456	104		10816				
	98		9526				
	107		11492				
	83		6922				
	147		21668				
	134		18063				
	118		14019				
	77		5898				
	99		9841				
	128		16384				
	102		10486				
	78		6147				
	130		16796				
	122		14787				
	106		11151				
	78		6147				
	88		7744				
	99		9841				
	85		7191				
	120		14400				
	91		8317				
	101		10161				
	82		6659				
	86		7465				
	77		5898				
	88		7744				
	80		6400				
	109		11837				
	101		10161				
	106		11151				
	78		6147				
	83		6922				
	74		5417				
	85		7191				
	77		5898				
	106		11151				
	98		9526				
	102		10486				
	75		5655				
	69		4733				
	101		10161				
	77		5898				
	64		4096				
	93		8612				
	86		7465				
	67		4516				
	74		5417				
	109		11837				
	64		4096				
	51		2621				
	74		5417				
	69		4733				
	102		10486				
	59		3505				
	64		4096				
	70		4956				
	67		4516				
	78		6147				
	106		11151				
	54		2959				
	80		6400				
	102		10486				
	78		6147				
	70		4956				
	6488		**612467**				

	90	96	8028	28362	22	118	118
	99		9841				
	99		9841				
	107		11492				
	125		15575				
	77		5898				
	74		5417				
118+366	86		7465				
	104		10816				
	98		9526				
T = 3821	107		11492				
	83		6922				
	147		21668				
	134		18063				
	118		14019				
	77		5898				
	99		9841				
	128		16384				
	102		10486				
	78		6147				
	130		16796				
	122		14787				
	106		11151				
	78		6147				
	88		7744				
	99		9841				
	85		7191				
	120		14400				
	91		8317				
	101		10161				
	117		13642				
	102		10486				
	86		7465				
	61		3697				
	88		7744				
	61		3697				
	77		5898				
	91		8317				
	112		12544				
	93		8612				
	69		4733				
	85		7191				
	62		3894				
	86		7465				
	115		13271				
	64		4096				
	74		5417				
	112		12544				
	115		13271				
	120		14400				
	85		7191				
	109		11837				
	85		7191				
	64		4096				
	157		24586				
	70		4956				
	109		11837				
	93		8612				
	104		10816				
	56		3136				
	86		7465				
	5861		**591460**				

	130	111	16796	21737	19	130	130
	67		4516				
	130		16796				
	154		23593				
	131		17213				
	106		11151				
	122		14787				
122+410	104		10816				
	115		13271				
	141		19825				
T = 431	131		17213				
	158		25091				
	122		14787				
	122		14787				
	131		17213				
	126		15977				
	131		17213				
	131		17213				
	125		15575				
	64		4096				
	125		15575				
	128		16384				
	102		10486				
	118		14019				
	101		10161				
	112		12544				
	138		18934				
	101		10161				
	112		12544				
	118		14019				
	115		13271				
	99		9841				
	107		11492				
	110		12188				
	122		14787				
	125		15575				
	122		14787				
	120		14400				
	104		10816				
	106		11151				
	99		9841				
	112		12544				
	96		9216				
	104		10816				
	102		10486				
	118		14019				
	77		5898				
	114		12905				
	90		8028				
	82		6659				
	96		9216				
	118		14019				
	93		8612				
	110		12188				
	86		7465				
	78		6147				
	93		8612				
	115		13271				
	90		8028				
	107		11492				
	86		7465				
	110		12188				
	6902		790175				

	118	114	14019	33828	24	137	137
	130		16796				
	133		17636				
	154		23593				
	144		20736				
	170		28764				
133+132	163		26634				
	147		21668				
	112		12544				
T = 574	158		25091				
	138		18934				
	118		14019				
	109		11837				
	83		6922				
	107		11492				
	98		9526				
	104		10816				
	86		7465				
	74		5417				
	77		5898				
	125		15575				
	107		11492				
	134		18063				
	147		21668				
	99		9841				
	128		16384				
	102		10486				
	130		16796				
	122		14787				
	106		11151				
	93		8612				
	91		8317				
	150		22620				
	139		19377				
	131		17213				
	106		11151				
	128		16384				
	133		17636				
	101		10161				
	122		14787				
	128		16384				
	107		11492				
	99		9841				
	83		6922				
	136		18496				
	125		15575				
	77		5898				
	114		12905				
	90		8028				
	82		6659				
	96		9216				
	118		14019				
	93		8612				
	110		12188				
	86		7465				
	78		6147				
	93		8612				
	115		13271				
	90		8028				
	107		11492				
	86		7465				
	110		12188				
	7040		833208				

	82	111	6659	26726	21	132	132
	176		30976				
	134		18063				
	104		10816				
	120		14400				
	118		14019				
	114		12905				
	120		14400				
166+425	136		18496				
	66		4303				
	118		14019				
T = 635	122		14787				
	77		5898				
	104		10816				
	122		14787				
	122		14787				
	157		24586				
	131		17213				
	138		18934				
	115		13271				
	101		10161				
	122		14787				
	102		10486				
	128		16384				
	150		22620				
	126		15977				
	70		4956				
	106		11151				
	117		13642				
	112		12544				
	98		9526				
	149		22141				
	83		6922				
	123		15178				
	126		15977				
	118		14019				
	117		13642				
	109		11837				
	102		10486				
	115		13271				
	99		9841				
	107		11492				
	107		11492				
	117		13642				
	85		7191				
	102		10486				
	62		3894				
	128		16384				
	96		9216				
	90		8028				
	115		13271				
	115		13271				
	112		12544				
	93		8612				
	96		9216				
	99		9841				
	112		12544				
	85		7191				
	109		11837				
	93		8612				
	101		10161				
	102		10486				
	106		11151				
	6981		**800243**				

	38	54	1475	11025	12	66	66
	67		4516				
	46		2153				
Addis Ababa -	62		3894				
Tarmaber	53		2788				
	42		1731				
	46		2153				
16+414	48		2304				
	51		2621				
	64		4096				
T = 736	45		2007				
	51		2621				
	56		3136				
	54		2959				
	62		3894				
	38		1475				
	59		3505				
	66		4303				
	80		6400				
	62		3894				
	51		2621				
	54		2959				
	77		5898				
	59		3505				
	94		8911				
	48		2304				
	42		1731				
	70		4956				
	38		1475				
	75		5655				
	51		2621				
	54		2959				
	56		3136				
	50		2460				
	48		2304				
	70		4956				
	38		1475				
	67		4516				
	61		3697				
	53		2788				
	67		4516				
	50		2460				
	54		2959				
	58		3318				
	61		3697				
	67		4516				
	45		2007				
	50		2460				
	40		1600				
	50		2460				
	45		2007				
	35		1239				
	70		4956				
	61		3697				
	51		2621				
	51		2621				
	61		3697				
	45		2007				
	43		1866				
	61		3697				
	43		1866				
	56		3136				
	61		3697				
	64		4096				
	35		1239				
	32		1024				
	51		2621				
	34		1129				
	35		1239				
	29		829				
	58		3318				
	54		2959				
	72		5184				
	3939		223590				

	38	65	1475	14435	14	79	79
	51		2621				
	58		3318				
	101		10161				
	77		5898				
	75		5655				
	69		4733				
	66		4303				
25+555	102		10486				
	98		9526				
	78		6147				
T= 295	61		3697				
	58		3318				
	50		2460				
	72		5184				
	75		5655				
	46		2153				
	72		5184				
	61		3697				
	90		8028				
	109		11837				
	54		2959				
	54		2959				
	93		8612				
	74		5417				
	42		1731				
	56		3136				
	54		2959				
	58		3318				
	61		3697				
	66		4303				
	70		4956				
	69		4733				
	61		3697				
	56		3136				
	43		1866				
	53		2788				
	70		4956				
	62		3894				
	74		5417				
	72		5184				
	54		2959				
	77		5898				
	70		4956				
	59		3505				
	46		2153				
	56		3136				
	61		3697				
	50		2460				
	59		3505				
	56		3136				
	58		3318				
	59		3505				
	59		3505				
	56		3136				
	64		4096				
	75		5655				
	72		5184				
	77		5898				
	56		3136				
	53		2788				
	66		4303				
	77		5898				
	50		2460				
	46		2153				
	69		4733				
	56		3136				
	61		3697				
	78		6147				
	69		4733				
	80		6400				
	4616		**314540**				

	70	83	4956	22198	18	101	101
	82		6659				
	56		3136				
	72		5184				
	80		6400				
	112		12544				
	51		2621				
	82		6659				
	125		15575				
	74		5417				
	91		8317				
26+032	110		12188				
	98		9526				
	112		12544				
T= 297	77		5898				
	64		4096				
	70		4956				
	80		6400				
	109		11837				
	48		2304				
	90		8028				
	122		14787				
	75		5655				
	72		5184				
	78		6147				
	90		8028				
	74		5417				
	85		7191				
	64		4096				
	45		2007				
	80		6400				
	77		5898				
	85		7191				
	80		6400				
	72		5184				
	90		8028				
	90		8028				
	109		11837				
	98		9526				
	80		6400				
	104		10816				
	112		12544				
	115		13271				
	118		14019				
	98		9526				
	91		8317				
	77		5898				
	74		5417				
	69		4733				
	82		6659				
	48		2304				
	67		4516				
	102		10486				
	54		2959				
	70		4956				
	82		6659				
	67		4516				
	72		5184				
	80		6400				
	82		6659				
	77		5898				
	75		5655				
	62		3894				
	77		5898				
	85		7191				
	90		8028				
	93		8612				
	98		9526				
	5635		489190				

	99	90	9841	13620	14	104	104
	104		10816				
	96		9216				
	82		6659				
	96		9216				
	96		9216				
	93		8612				
32+678	94		8911				
	112		12544				
	83		6922				
T = 572	90		8028				
	98		9526				
	85		7191				
	78		6147				
	96		9216				
	78		6147				
	83		6922				
	112		12544				
	115		13271				
	109		11837				
	99		9841				
	96		9216				
	98		9526				
	94		8911				
	83		6922				
	99		9841				
	86		7465				
	88		7744				
	91		8317				
	93		8612				
	106		11151				
	94		8911				
	59		3505				
	66		4303				
	91		8317				
	93		8612				
	91		8317				
	91		8317				
	94		8911				
	109		11837				
	117		13642				
	118		14019				
	69		4733				
	77		5898				
	74		5417				
	66		4303				
	69		4733				
	70		4956				
	94		8911				
	98		9526				
	101		10161				
	102		10486				
	104		10816				
	102		10486				
	88		7744				
	54		2959				
	75		5655				
	70		4956				
	94		8911				
	90		8028				
	80		6400				
	85		7191				
	80		6400				
	70		4956				
	88		7744				
	91		8317				
	94		8911				
	106		11151				
	70		4956				
	78		6147				
	98		9526				
	86		7465				
	85		7191				
	75		5655				
	6642		**609713**				

	112	103	12544	27012	19	122	122
	117		13642				
	130		16796				
	106		11151				
	128		16384				
	110		12188				
45+213	138		18934				
	118		14019				
	122		14787				
T = 537	141		19825				
	112		12544				
	131		17213				
	112		12544				
	122		14787				
	93		8612				
	128		16384				
	90		8028				
	130		16796				
	112		12544				
	136		18496				
	120		14400				
	128		16384				
	115		13271				
	110		12188				
	110		12188				
	130		16796				
	91		8317				
	117		13642				
	104		10816				
	115		13271				
	90		8028				
	93		8612				
	123		15178				
	85		7191				
	109		11837				
	98		9526				
	91		8317				
	78		6147				
	96		9216				
	93		8612				
	93		8612				
	67		4516				
	96		9216				
	104		10816				
	75		5655				
	96		9216				
	70		4956				
	102		10486				
	104		10816				
	106		11151				
	78		6147				
	70		4956				
	80		6400				
	130		16796				
	126		15977				
	77		5898				
	91		8317				
	144		20736				
	96		9216				
	98		9526				
	83		6922				
	91		8317				
	78		6147				
	102		10486				
	82		6659				
	75		5655				
	80		6400				
	82		6659				
	107		11492				
	86		7465				
	82		6659				
	90		8028				
	104		10816				
	96		9216				
	101		10161				
	7725		822646				

	96	90	9216	17290	16	106	106
	78		6147				
	112		12544				
	109		11837				
	96		9216				
	94		8911				
46+632	99		9841				
	88		7744				
	93		8612				
T = 491	96		9216				
	96		9216				
	94		8911				
	90		8028				
	99		9841				
	78		6147				
	74		5417				
	125		15575				
	112		12544				
	51		2621				
	112		12544				
	64		4096				
	109		11837				
	90		8028				
	122		14787				
	90		8028				
	74		5417				
	85		7191				
	64		4096				
	77		5898				
	64		4096				
	104		10816				
	80		6400				
	98		9526				
	109		11837				
	72		5184				
	85		7191				
	80		6400				
	115		13271				
	118		14019				
	69		4733				
	77		5898				
	98		9526				
	91		8317				
	66		4303				
	91		8317				
	94		8911				
	93		8612				
	118		14019				
	75		5655				
	106		11151				
	94		8911				
	66		4303				
	85		7191				
	80		6400				
	94		8911				
	88		7744				
	102		10486				
	80		6400				
	99		9841				
	102		10486				
	67		4516				
	72		5184				
	82		6659				
	75		5655				
	102		10486				
	85		7191				
	90		8028				
	77		5898				
	98		9526				
	96		9216				
	6302		584722				

	122	100	14787	6053	10	110	110
	131		17213				
	128		16384				
	118		14019				
	110		12188				
	128		16384				
	130		16796				
47+571	112		12544				
	117		13642				
	90		8028				
T = 533	130		16796				
	112		12544				
	99		9841				
	96		9216				
	118		14019				
	96		9216				
	78		6147				
	99		9841				
	88		7744				
	96		9216				
	93		8612				
	78		6147				
	125		15575				
	112		12544				
	110		12188				
	128		16384				
	112		12544				
	90		8028				
	122		14787				
	131		17213				
	93		8612				
	91		8317				
	98		9526				
	115		13271				
	109		11837				
	94		8911				
	118		14019				
	96		9216				
	104		10816				
	102		10486				
	78		6147				
	109		11837				
	93		8612				
	96		9216				
	102		10486				
	78		6147				
	77		5898				
	98		9526				
	82		6659				
	67		4516				
	88		7744				
	102		10486				
	77		5898				
	96		9216				
	80		6400				
	94		8911				
	85		7191				
	67		4516				
	86		7465				
	90		8028				
	80		6400				
	98		9526				
	93		8612				
	106		11151				
	66		4303				
	78		6147				
	590403		676634				

	93	88	8612	16271	16	104	104
	102		10486				
	94		8911				
Addis Ababa -	83		6922				
Gohatsion	112		12544				
	102		10486				
	74		5417				
11+550	98		9526				
	101		10161				
	109		11837				
T = 500	85		7191				
	75		5655				
	70		4956				
	74		5417				
	107		11492				
	80		6400				
	118		14019				
	85		7191				
	61		3697				
	82		6659				
	64		4096				
	104		10816				
	78		6147				
	74		5417				
	99		9841				
	107		11492				
	98		9526				
	78		6147				
	118		14019				
	66		4303				
	88		7744				
	104		10816				
	90		8028				
	99		9841				
	88		7744				
	62		3894				
	74		5417				
	96		9216				
	98		9526				
	104		10816				
	64		4096				
	82		6659				
	61		3697				
	85		7191				
	118		14019				
	80		6400				
	107		11492				
	74		5417				
	66		4303				
	75		5655				
	66		4303				
	74		5417				
	85		7191				
	75		5655				
	70		4956				
	107		11492				
	74		5417				
	93		8612				
	102		10486				
	94		8911				
	83		6922				
	74		5417				
	98		9526				
	101		10161				
	109		11837				
	85		7191				
	5794		524844				

	126	101	15977	32363	23	124	124
	74		5417				
	98		9526				
	115		13271				
	85		7191				
	155		24087				
	112		12544				
	114		12905				
	155		24087				
14+075	88		7744				
	107		11492				
	94		8911				
T = 262	98		9526				
	106		11151				
	99		9841				
	104		10816				
	117		13642				
	101		10161				
	91		8317				
	118		14019				
	102		10486				
	125		15575				
	118		14019				
	128		16384				
	134		18063				
	109		11837				
	88		7744				
	98		9526				
	149		22141				
	154		23593				
	90		8028				
	82		6659				
	131		17213				
	106		11151				
	96		9216				
	80		6400				
	85		7191				
	85		7191				
	64		4096				
	91		8317				
	104		10816				
	90		8028				
	91		8317				
	66		4303				
	110		12188				
	112		12544				
	85		7191				
	22		502				
	83		6922				
	64		4096				
	91		8317				
	90		8028				
	101		10161				
	98		9526				
	109		11837				
	128		16384				
	85		7191				
	88		7744				
	96		9216				
	88		7744				
	98		9526				
	6168		**656038**				

	117	105	13642	19494	18	123	123
	86		7465				
	117		13642				
	85		7191				
	110		12188				
	117		13642				
	88		7744				
	90		8028				
	136		18496				
	90		8028				
28+806	114		12905				
	117		13642				
	146		21199				
T = 359	110		12188				
	109		11837				
	133		17636				
	122		14787				
	101		10161				
	141		19825				
	91		8317				
	138		18934				
	122		14787				
	130		16796				
	99		9841				
	83		6922				
	83		6922				
	138		18934				
	122		14787				
	96		9216				
	115		13271				
	134		18063				
	102		10486				
	69		4733				
	115		13271				
	99		9841				
	93		8612				
	104		10816				
	98		9526				
	86		7465				
	85		7191				
	88		7744				
	110		12188				
	109		11837				
	66		4303				
	93		8612				
	83		6922				
	90		8028				
	122		14787				
	102		10486				
	122		14787				
	102		10486				
	112		12544				
	109		11837				
	90		8028				
	114		12905				
	99		9841				
	83		6922				
	91		8317				
	101		10161				
	6213		673713				

	120	**108**	**14400**	**20259**	**19**	**127**	**127**
	112		12544				
	99		9841				
	133		17636				
	130		16796				
	147		21668				
	150		22620				
	120		14400				
	118		14019				
	122		14787				
	138		18934				
	125		15575				
	155		24087				
35+175	99		9841				
	96		9216				
T = 545	128		16384				
	120		14400				
	112		12544				
	99		9841				
	118		14019				
	122		14787				
	80		6400				
	88		7744				
	94		8911				
	102		10486				
	80		6400				
	109		11837				
	96		9216				
	88		7744				
	109		11837				
	102		10486				
	104		10816				
	98		9526				
	109		11837				
	142		20278				
	80		6400				
	88		7744				
	99		9841				
	112		12544				
	120		14400				
	128		16384				
	77		5898				
	102		10486				
	104		10816				
	104		10816				
	109		11837				
	80		6400				
	94		8911				
	109		11837				
	104		10816				
	102		10486				
	109		11837				
	98		9526				
	80		6400				
	109		11837				
	77		5898				
	102		10486				
	112		12544				
	80		6400				
	6344		**702400**				

	128	85	16384	24738	20	105	105
	112		12544				
	66		4303				
	51		2621				
	122		14787				
	66		4303				
	122		14787				
	112		12544				
46+067	75		5655				
	104		10816				
	112		12544				
T = 297	77		5898				
	125		15575				
	118		14019				
	56		3136				
	85		7191				
	126		15977				
	91		8317				
	93		8612				
	70		4956				
	74		5417				
	61		3697				
	109		11837				
	96		9216				
	48		2304				
	74		5417				
	54		2959				
	67		4516				
	90		8028				
	91		8317				
	85		7191				
	56		3136				
	77		5898				
	75		5655				
	104		10816				
	112		12544				
	91		8317				
	93		8612				
	109		11837				
	96		9216				
	90		8028				
	61		3697				
	75		5655				
	77		5898				
	85		7191				
	56		3136				
	75		5655				
	77		5898				
	91		8317				
	75		5655				
	66		4303				
	74		5417				
	85		7191				
	75		5655				
	70		4956				
	91		8317				
	75		5655				
	90		8028				
	77		5898				
	85		7191				
	5120		**461645**				

	82	93	6659	38812	27	120	120
	70		4956				
	117		13642				
	125		15575				
	75		5655				
	109		11837				
	74		5417				
143+637	112		12544				
	90		8028				
	93		8612				
T= 259	86		7465				
	90		8028				
	154		23593				
	90		8028				
	109		11837				
	77		5898				
	82		6659				
	98		9526				
	74		5417				
	77		5898				
	94		8911				
	77		5898				
	53		2788				
	109		11837				
	109		11837				
	146		21199				
	112		12544				
	120		14400				
	104		10816				
	110		12188				
	114		12905				
	109		11837				
	80		6400				
	128		16384				
	78		6147				
	117		13642				
	104		10816				
	115		13271				
	32		1024				
	38		1475				
	26		655				
	46		2153				
	50		2460				
	106		11151				
	61		3697				
	115		13271				
	128		16384				
	107		11492				
	93		8612				
	64		4096				
	80		6400				
	104		10816				
	101		10161				
	107		11492				
	75		5655				
	5091		510090				

	117	88	13642	24319	20	108	108
	67		4516				
	70		4956				
Addis Ababa -	80		6400				
Butajira	67		4516				
	98		9526				
	75		5655				
	93		8612				
	67		4516				
27+735	106		11151				
	112		12544				
	64		4096				
T= 660	67		4516				
	77		5898				
	70		4956				
	104		10816				
	82		6659				
	99		9841				
	74		5417				
	112		12544				
	120		14400				
	70		4956				
	74		5417				
	83		6922				
	70		4956				
	101		10161				
	78		6147				
	106		11151				
	70		4956				
	109		11837				
	96		9216				
	99		9841				
	99		9841				
	69		4733				
	115		13271				
	80		6400				
	93		8612				
	115		13271				
	118		14019				
	136		18496				
	112		12544				
	96		9216				
	88		7744				
	88		7744				
	75		5655				
	115		13271				
	98		9526				
	99		9841				
	77		5898				
	51		2621				
	56		3136				
	67		4516				
	114		12905				
	99		9841				
	62		3894				
	67		4516				
	56		3136				
	72		5184				
	118		14019				
	104		10816				
	72		5184				
	80		6400				
	5470		506985				

	74	89	5417	40860	25	114	114
	80		6400				
	61		3697				
	96		9216				
	109		11837				
	133		17636				
	80		6400				
	109		11837				
	80		6400				
35+350	122		14787				
	122		14787				
	85		7191				
T = 600	147		21668				
	131		17213				
	158		25091				
	106		11151				
	141		19825				
	106		11151				
	96		9216				
	109		11837				
	106		11151				
	67		4516				
	83		6922				
	117		13642				
	67		4516				
	70		4956				
	80		6400				
	67		4516				
	98		9526				
	75		5655				
	117		13642				
	64		4096				
	115		13271				
	86		7465				
	109		11837				
	67		4516				
	69		4733				
	99		9841				
	99		9841				
	96		9216				
	77		5898				
	70		4956				
	83		6922				
	86		7465				
	90		8028				
	96		9216				
	99		9841				
	35		1239				
	32		1024				
	83		6922				
	32		1024				
	78		6147				
	85		7191				
	67		4516				
	86		7465				
	80		6400				
	62		3894				
	42		1731				
	88		7744				
	85		7191				
	88		7744				
	83		6922				
	82		6659				
	78		6147				
	74		5417				
	5757		**550717**				

Tangent (m)	Total Pavement Width (m)	Grade %	85th Percentile Speed Km/hr
1000	15.1	1.0	106
1650	12.0	2.9	117
332	15.5	3.8	96
250	15.0	2.5	113
540	10.8	2.5	113
3365	12.3	0.1	124
2860	11.8	0.1	133
1210	12.1	1.8	119
650	11.7	2.5	122
700	10.6	0.6	136
600	15.3	0.9	123
800	12.0	0.9	128
700	10.3	0.9	125
1460	10.4	1.3	126
890	9.8	1.5	129
1060	9.8	1.3	128
1765	9.8	1.4	126
2500	9.9	0.5	135
2360	10.1	1.0	136
1220	10.2	0.4	137
780	10.3	0.3	120
565	9.4	3.8	136
2180	10.3	0.7	119
300	10.2	0.6	123
530	10.6	0.6	122
1440	10.0	1.1	123
523	10.4	0.3	138
1650	14.2	0.3	117
3590	10.2	0.3	136
456	9.8	0.1	110
3821	9.1	2.9	118
431	9.5	0.3	130
574	9.0	2.3	137
635	9.6	1.3	132
736	10.0	2.4	66
295	10.2	6.1	79
297	7.8	4.9	101
572	7.2	0.9	104
537	7.3	2.3	122
491	7.9	2.1	106
533	7.6	2.5	110
500	15.1	1.7	104
262	11.6	3.5	124
359	13.3	1.6	123
545	12.5	1.5	127
297	12.4	1.6	105
259	12.8	2.3	120
660	11.5	6.5	108
600	12.5	6.0	114

Appendix B

B.1. Data Analysis for the 85 th percentile Speed of Horizontal Curves

Car,Buses and Trucks

	V	Mean M=Σv/n	v^2	$(v-m)^2 = \Sigma v^2 - (\Sigma v)^2/n$	Std $S=\sqrt{\Sigma(v-m)^2/n-1}$	85 % Speed V= m + s	
	82	75	6659	38238	21	96	96
	136		18496				
	96		9216				
Addis Ababa -	83		6922				
Awassa	56		3136				
	93		8612				
	104		10816				
26+428	85		7191				
	93		8612				
	104		10816				
R = 540	107		11492				
	90		8028				
	80		6400				
	78		6147				
	86		7465				
	106		11151				
	77		5898				
	72		5184				
	90		8028				
	64		4096				
	70		4956				
	115		13271				
	115		13271				
	107		11492				
	93		8612				
	91		8317				
	96		9216				
	74		5417				
	69		4733				
	64		4096				
	94		8911				
	48		2304				
	45		2007				
	54		2959				
	93		8612				
	72		5184				
	43		1866				
	45		2007				
	58		3318				
	40		1600				
	86		7465				
	91		8317				
	56		3136				
	32		1024				
	64		4096				
	58		3318				
	56		3136				
	77		5898				
	64		4096				
	45		2007				
	54		2959				
	40		1600				
	58		3318				
	64		4096				
	56		3136				
	77		5898				
	86		7465				
	94		8911				
	74		5417				
	91		8317				
	80		6400				
	96		9216				
	86		7465				
	85		7191				
	85		7191				
	82		6659				
	91		8317				
	45		2007				
	46		2153				
	83		6922				
	88		7744				
	90		8028				
	50		2460				
	62		3894				
	72		5184				
	64		4096				
	74		5417				
	45		2007				
	59		3505				
	62		3894				
	80		6400				
	66		4303				
	40		1600				
	69		4733				
	59		3505				
	104		10816				
	94		8911				
	83		6922				
	48		2304				
	74		5417				
	6752		544788				

	88	70	7744	29009	18	88	88
	78		6147				
	88		7744				
	88		7744				
	90		8028				
	70		4956				
	72		5184				
	99		9841				
	80		6400				
27+895	58		3318				
	40		1600				
	69		4733				
R = 360	42		1731				
	45		2007				
	45		2007				
	58		3318				
	64		4096				
	106		11151				
	88		7744				
	106		11151				
	102		10486				
	101		10161				
	77		5898				
	48		2304				
	67		4516				
	80		6400				
	91		8317				
	93		8612				
	102		10486				
	80		6400				
	69		4733				
	56		3136				
	56		3136				
	35		1239				
	54		2959				
	61		3697				
	64		4096				
	90		8028				
	75		5655				
	75		5655				
	75		5655				
	78		6147				
	82		6659				
	83		6922				
	80		6400				
	61		3697				
	69		4733				
	75		5655				
	56		3136				
	56		3136				
	82		6659				
	78		6147				
	80		6400				
	83		6922				
	80		6400				
	90		8028				
	61		3697				
	75		5655				
	82		6659				
	69		4733				
	80		6400				
	104		10816				
	38		1475				
	72		5184				
	70		4956				
	40		1600				
	46		2153				
	74		5417				
	48		2304				
	61		3697				
	54		2959				
	51		2621				
	59		3505				
	46		2153				
	34		1129				
	50		2460				
	56		3136				
	51		2621				
	59		3505				
	77		5898				
	85		7191				
	94		8911				
	37		1354				
	69		4733				
	66		4303				
	66		4303				
	62		3894				
	48		2304				
	88		7744				
	85		7191				
	6314		471916				

	110	99	12188	34455	20	118	118
	134		18063				
	134		18063				
	128		16384				
	109		11837				
	85		7191				
	107		11492				
	88		7744				
	93		8612				
	106		11151				
30+484	112		12544				
	114		12905				
	109		11837				
R = 900	102		10486				
	106		11151				
	82		6659				
	82		6659				
	138		18934				
	114		12905				
	134		18063				
	101		10161				
	96		9216				
	86		7465				
	61		3697				
	120		14400				
	141		19825				
	117		13642				
	104		10816				
	101		10161				
	90		8028				
	134		18063				
	85		7191				
	94		8911				
	83		6922				
	109		11837				
	114		12905				
	94		8911				
	118		14019				
	117		13642				
	72		5184				
	106		11151				
	72		5184				
	98		9526				
	96		9216				
	83		6922				
	86		7465				
	98		9526				
	96		9216				
	75		5655				
	109		11837				
	85		7191				
	85		7191				
	88		7744				
	104		10816				
	118		14019				
	136		18496				
	102		10486				
	123		15178				
	96		9216				
	77		5898				
	128		16384				
	133		17636				
	109		11837				
	83		6922				
	78		6147				
	74		5417				
	114		12905				
	69		4733				
	86		7465				
	61		3697				
	59		3505				
	115		13271				
	114		12905				
	85		7191				
	77		5898				
	75		5655				
	90		8028				
	80		6400				
	82		6659				
	99		9841				
	70		4956				
	69		4733				
	80		6400				
	91		8317				
	90		8028				
	93		8612				
	117		13642				
	115		13271				
	90		8028				
	112		12544				
	8891		912827				

	51	96	2621	56657	25	121	121
	94		8911				
	75		5655				
	77		5898				
	82		6659				
	98		9526				
	32		1024				
	131		17213				
	125		15575				
	85		7191				
32+830	80		6400				
	82		6659				
	134		18063				
R = 600	130		16796				
	155		24087				
	64		4096				
	85		7191				
	152		23104				
	157		24586				
	107		11492				
	136		18496				
	72		5184				
	114		12905				
	141		19825				
	128		16384				
	131		17213				
	109		11837				
	82		6659				
	72		5184				
	109		11837				
	109		11837				
	104		10816				
	98		9526				
	96		9216				
	120		14400				
	123		15178				
	50		2460				
	86		7465				
	96		9216				
	91		8317				
	64		4096				
	80		6400				
	45		2007				
	107		11492				
	99		9841				
	83		6922				
	122		14787				
	96		9216				
	86		7465				
	96		9216				
	104		10816				
	91		8317				
	99		9841				
	104		10816				
	109		11837				
	96		9216				
	80		6400				
	86		7465				
	96		9216				
	98		9526				
	90		8028				
	96		9216				
	37		1354				
	22		502				
	78		6147				
	78		6147				
	102		10486				
	83		6922				
	126		15977				
	94		8911				
	90		8028				
	106		11151				
	88		7744				
	106		11151				
	101		10161				
	101		10161				
	93		8612				
	120		14400				
	67		4516				
	109		11837				
	106		11151				
	82		6659				
	74		5417				
	118		14019				
	106		11151				
	102		10486				
	90		8028				
	64		4096				
	90		8028				
	82		6659				
	8602		878740				

	61	92	3697	31087	19	111	111
	106		11151				
	86		7465				
	114		12905				
	61		3697				
	58		3318				
	122		14787				
	74		5417				
	82		6659				
	93		8612				
49+378	106		11151				
	91		8317				
	94		8911				
R = 800	98		9526				
	74		5417				
	75		5655				
	86		7465				
	115		13271				
	69		4733				
	88		7744				
	86		7465				
	107		11492				
	117		13642				
	146		21199				
	141		19825				
	118		14019				
	128		16384				
	93		8612				
	101		10161				
	104		10816				
	82		6659				
	90		8028				
	99		9841				
	85		7191				
	96		9216				
	88		7744				
	118		14019				
	91		8317				
	75		5655				
	80		6400				
	75		5655				
	118		14019				
	69		4733				
	85		7191				
	96		9216				
	112		12544				
	112		12544				
	80		6400				
	101		10161				
	82		6659				
	75		5655				
	85		7191				
	88		7744				
	90		8028				
	118		14019				
	112		12544				
	96		9216				
	101		10161				
	91		8317				
	85		7191				
	107		11492				
	99		9841				
	67		4516				
	67		4516				
	80		6400				
	94		8911				
	72		5184				
	80		6400				
	88		7744				
	86		7465				
	94		8911				
	74		5417				
	69		4733				
	93		8612				
	90		8028				
	128		16384				
	96		9216				
	101		10161				
	101		10161				
	59		3505				
	58		3318				
	93		8612				
	106		11151				
	99		9841				
	78		6147				
	115		13271				
	96		9216				
	62		3894				
	69		4733				
	66		4303				
	8253		787850				

	125	102	15575	39804	21	123	123
	117		13642				
	117		13642				
	168		28224				
	141		19825				
	144		20736				
	107		11492				
	70		4956				
	114		12905				
50+303	107		11492				
	141		19825				
	128		16384				
R = 360	96		9216				
	115		13271				
	69		4733				
	88		7744				
	86		7465				
	107		11492				
	117		13642				
	146		21199				
	141		19825				
	118		14019				
	128		16384				
	93		8612				
	101		10161				
	104		10816				
	88		7744				
	106		11151				
	86		7465				
	118		14019				
	98		9526				
	78		6147				
	141		19825				
	96		9216				
	99		9841				
	80		6400				
	96		9216				
	114		12905				
	128		16384				
	106		11151				
	128		16384				
	120		14400				
	112		12544				
	117		13642				
	82		6659				
	90		8028				
	99		9841				
	85		7191				
	96		9216				
	88		7744				
	118		14019				
	91		8317				
	75		5655				
	80		6400				
	75		5655				
	118		14019				
	69		4733				
	106		11151				
	112		12544				
	80		6400				
	118		14019				
	83		6922				
	83		6922				
	70		4956				
	104		10816				
	99		9841				
	104		10816				
	102		10486				
	104		10816				
	115		13271				
	99		9841				
	104		10816				
	90		8028				
	123		15178				
	104		10816				
	70		4956				
	118		14019				
	107		11492				
	99		9841				
	67		4516				
	67		4516				
	72		5184				
	80		6400				
	88		7744				
	86		7465				
	94		8911				
	74		5417				
	69		4733				
	93		8612				
	90		8028				
	9141		968184				

	99	104	9841	32542	19	123	123
	96		9216				
	93		8612				
	90		8028				
	86		7465				
	83		6922				
	112		12544				
	102		10486				
59+543	99		9841				
	125		15575				
	115		13271				
R = 950	107		11492				
	117		13642				
	117		13642				
	146		21199				
	118		14019				
	123		15178				
	125		15575				
	117		13642				
	117		13642				
	168		28224				
	141		19825				
	144		20736				
	107		11492				
	70		4956				
	114		12905				
	107		11492				
	141		19825				
	128		16384				
	96		9216				
	117		13642				
	112		12544				
	136		18496				
	106		11151				
	128		16384				
	114		12905				
	96		9216				
	80		6400				
	99		9841				
	96		9216				
	141		19825				
	78		6147				
	98		9526				
	115		13271				
	115		13271				
	120		14400				
	104		10816				
	110		12188				
	83		6922				
	77		5898				
	75		5655				
	102		10486				
	96		9216				
	101		10161				
	115		13271				
	83		6922				
	99		9841				
	114		12905				
	99		9841				
	98		9526				
	99		9841				
	83		6922				
	54		2959				
	85		7191				
	88		7744				
	93		8612				
	112		12544				
	110		12188				
	82		6659				
	94		8911				
	96		9216				
	96		9216				
	93		8612				
	99		9841				
	118		14019				
	83		6922				
	83		6922				
	70		4956				
	104		10816				
	99		9841				
	104		10816				
	102		10486				
	104		10816				
	115		13271				
	99		9841				
	88		7744				
	90		8028				
	123		15178				
	104		10816				
	70		4956				
	9354		1004652				

	104	**92**	**10816**	**52389**	**24**	**116**	**116**
	157		24586				
	118		14019				
	150		22620				
	98		9526				
	104		10816				
	43		1866				
68+760	80		6400				
	83		6922				
	83		6922				
R = 360	83		6922				
	72		5184				
	51		2621				
	139		19377				
	50		2460				
	93		8612				
	107		11492				
	120		14400				
	118		14019				
	96		9216				
	90		8028				
	136		18496				
	96		9216				
	118		14019				
	101		10161				
	98		9526				
	115		13271				
	110		12188				
	109		11837				
	112		12544				
	104		10816				
	72		5184				
	94		8911				
	101		10161				
	106		11151				
	64		4096				
	64		4096				
	86		7465				
	102		10486				
	54		2959				
	80		6400				
	70		4956				
	69		4733				
	101		10161				
	115		13271				
	120		14400				
	98		9526				
	102		10486				
	115		13271				
	114		12905				
	99		9841				
	99		9841				
	102		10486				
	96		9216				
	99		9841				
	96		9216				
	114		12905				
	85		7191				
	78		6147				
	91		8317				
	91		8317				
	102		10486				
	107		11492				
	112		12544				
	61		3697				
	59		3505				
	80		6400				
	66		4303				
	98		9526				
	104		10816				
	54		2959				
	48		2304				
	48		2304				
	50		2460				
	107		11492				
	75		5655				
	50		2460				
	45		2007				
	85		7191				
	93		8612				
	78		6147				
	67		4516				
	83		6922				
	120		14400				
	107		11492				
	120		14400				
	122		14787				
	70		4956				
	74		5417				
	72		5184				
	8275		**813266**				

	93	99	8612	39189	23	122	122
	75		5655				
	90		8028				
	142		20278				
	136		18496				
	112		12544				
	152		23104				
	134		18063				
	109		11837				
71+973	99		9841				
	117		13642				
	123		15178				
R = 400	115		13271				
	82		6659				
	91		8317				
	117		13642				
	94		8911				
	133		17636				
	134		18063				
	93		8612				
	104		10816				
	118		14019				
	104		10816				
	80		6400				
	93		8612				
	107		11492				
	120		14400				
	118		14019				
	96		9216				
	90		8028				
	50		2460				
	93		8612				
	120		14400				
	109		11837				
	114		12905				
	70		4956				
	112		12544				
	123		15178				
	115		13271				
	120		14400				
	114		12905				
	99		9841				
	102		10486				
	94		8911				
	101		10161				
	94		8911				
	99		9841				
	110		12188				
	90		8028				
	35		1239				
	83		6922				
	106		11151				
	94		8911				
	48		2304				
	61		3697				
	99		9841				
	37		1354				
	98		9526				
	99		9841				
	101		10161				
	67		4516				
	99		9841				
	102		10486				
	67		4516				
	51		2621				
	122		14787				
	91		8317				
	98		9526				
	96		9216				
	94		8911				
	112		12544				
	98		9526				
	104		10816				
	107		11492				
	75		5655				
	83		6922				
	120		14400				
	107		11492				
	7757		810573				

	136	**110**	**18496**	**52153**	**26**	**136**	**136**
	98		9526				
	112		12544				
	120		14400				
	107		11492				
	114		12905				
	110		12188				
	107		11492				
86+705	88		7744				
	90		8028				
	91		8317				
R = 600	133		17636				
	176		30976				
	118		14019				
	123		15178				
	150		22620				
	98		9526				
	114		12905				
	126		15977				
	134		18063				
	149		22141				
	114		12905				
	115		13271				
	168		28224				
	157		24586				
	118		14019				
	115		13271				
	110		12188				
	109		11837				
	112		12544				
	106		11151				
	101		10161				
	130		16796				
	70		4956				
	109		11837				
	106		11151				
	112		12544				
	128		16384				
	93		8612				
	117		13642				
	102		10486				
	134		18063				
	115		13271				
	114		12905				
	107		11492				
	102		10486				
	114		12905				
	102		10486				
	85		7191				
	120		14400				
	130		16796				
	165		27159				
	99		9841				
	98		9526				
	94		8911				
	106		11151				
	120		14400				
	96		9216				
	82		6659				
	112		12544				
	160		25600				
	91		8317				
	106		11151				
	91		8317				
	90		8028				
	82		6659				
	171		29309				
	56		3136				
	56		3136				
	66		4303				
	90		8028				
	75		5655				
	77		5898				
	168		28224				
	106		11151				
	107		11492				
	91		8317				
	69		4733				
	72		5184				
	8702		**1010783**				

	109	**116**	**11837**	**44009**	**24**	**140**	**140**
	112		12544				
	115		13271				
	110		12188				
	115		13271				
	149		22141				
	114		12905				
	134		18063				
	98		9526				
	126		15977				
88+410	150		22620				
	115		13271				
	176		30976				
R = 450	133		17636				
	90		8028				
	107		11492				
	144		20736				
	152		23104				
	125		15575				
	101		10161				
	150		22620				
	126		15977				
	107		11492				
	122		14787				
	123		15178				
	126		15977				
	98		9526				
	152		23104				
	98		9526				
	176		30976				
	104		10816				
	114		12905				
	130		16796				
	85		7191				
	109		11837				
	102		10486				
	112		12544				
	107		11492				
	128		16384				
	114		12905				
	93		8612				
	102		10486				
	101		10161				
	85		7191				
	130		16796				
	117		13642				
	94		8911				
	88		7744				
	102		10486				
	134		18063				
	112		12544				
	165		27159				
	69		4733				
	98		9526				
	107		11492				
	158		25091				
	77		5898				
	120		14400				
	91		8317				
	112		12544				
	90		8028				
	106		11151				
	171		29309				
	160		25600				
	106		11151				
	96		9216				
	120		14400				
	165		27159				
	91		8317				
	102		10486				
	99		9841				
	109		11837				
	101		10161				
	85		7191				
	93		8612				
	107		11492				
	123		15178				
	117		13642				
	109		11837				
	131		17213				
	9293		**1123461**				

	118	**118**	**14019**	**44282**	**22**	**141**	**141**
	112		12544				
	110		12188				
	123		15178				
	112		12544				
	134		18063				
	150		22620				
	118		14019				
	176		30976				
97+700	133		17636				
	90		8028				
	110		12188				
R = 580	107		11492				
	112		12544				
	149		22141				
	157		24586				
	152		23104				
	150		22620				
	134		18063				
	115		13271				
	112		12544				
	125		15575				
	123		15178				
	152		23104				
	133		17636				
	176		30976				
	149		22141				
	109		11837				
	122		14787				
	126		15977				
	102		10486				
	88		7744				
	130		16796				
	102		10486				
	93		8612				
	112		12544				
	130		16796				
	104		10816				
	94		8911				
	93		8612				
	102		10486				
	130		16796				
	109		11837				
	130		16796				
	115		13271				
	102		10486				
	102		10486				
	134		18063				
	128		16384				
	112		12544				
	70		4956				
	101		10161				
	115		13271				
	102		10486				
	114		12905				
	112		12544				
	93		8612				
	70		4956				
	101		10161				
	115		13271				
	160		25600				
	96		9216				
	165		27159				
	102		10486				
	109		11837				
	93		8612				
	123		15178				
	109		11837				
	106		11151				
	158		25091				
	165		27159				
	120		14400				
	106		11151				
	160		25600				
	109		11837				
	101		10161				
	123		15178				
	112		12544				
	90		8028				
	112		12544				
	120		14400				
	130		16796				
	112		12544				
	106		11151				
	91		8317				
	106		11151				
	120		14400				
	106		11151				
	158		25091				
	99		9841				
	10662		**1307469**				

	112	**120**	**12544**	**38981**	**22**	**151**	**151**
	123		15178				
	133		17636				
	149		22141				
	122		14787				
	149		22141				
	107		11492				
	133		17636				
	150		22620				
	123		15178				
99+490	112		12544				
	125		15575				
	176		30976				
R = 850	122		14787				
	150		22620				
	128		16384				
	134		18063				
	126		15977				
	123		15178				
	133		17636				
	144		20736				
	101		10161				
	110		12188				
	109		11837				
	123		15178				
	152		23104				
	176		30976				
	133		17636				
	98		9526				
	149		22141				
	101		10161				
	93		8612				
	128		16384				
	112		12544				
	109		11837				
	130		16796				
	104		10816				
	88		7744				
	117		13642				
	85		7191				
	102		10486				
	128		16384				
	130		16796				
	138		18934				
	106		11151				
	115		13271				
	88		7744				
	118		14019				
	106		11151				
	125		15575				
	91		8317				
	106		11151				
	120		14400				
	109		11837				
	117		13642				
	93		8612				
	165		27159				
	123		15178				
	112		12544				
	165		27159				
	107		11492				
	158		25091				
	106		11151				
	171		29309				
	102		10486				
	125		15575				
	126		15977				
	126		15977				
	75		5655				
	106		11151				
	106		11151				
	131		17213				
	109		11837				
	109		11837				
	115		13271				
	126		15977				
	102		10486				
	88		7744				
	88		7744				
	75		5655				
	9598		**1190597**				

	112	115	12544	38967	22	137	137
	107		11492				
	110		12188				
	88		7744				
	91		8317				
	133		17636				
	118		14019				
	150		22620				
	126		15977				
	134		18063				
	114		12905				
	157		24586				
	115		13271				
104+128	118		14019				
	110		12188				
	109		11837				
R = 400	115		13271				
	109		11837				
	123		15178				
	176		30976				
	98		9526				
	149		22141				
	80		6400				
	150		22620				
	112		12544				
	114		12905				
	133		17636				
	176		30976				
	134		18063				
	114		12905				
	88		7744				
	118		14019				
	125		15575				
	106		11151				
	106		11151				
	130		16796				
	99		9841				
	102		10486				
	85		7191				
	114		12905				
	101		10161				
	130		16796				
	104		10816				
	85		7191				
	99		9841				
	93		8612				
	117		13642				
	94		8911				
	102		10486				
	114		12905				
	102		10486				
	128		16384				
	106		11151				
	109		11837				
	115		13271				
	102		10486				
	88		7744				
	75		5655				
	106		11151				
	126		15977				
	102		10486				
	125		15575				
	165		27159				
	102		10486				
	109		11837				
	85		7191				
	99		9841				
	117		13642				
	158		25091				
	98		9526				
	165		27159				
	112		12544				
	109		11837				
	131		17213				
	106		11151				
	112		12544				
	90		8028				
	107		11492				
	98		9526				
	165		27159				
	112		12544				
	96		9216				
	9406		1117996				

	126	113	15977	64782	29	142	142
	109		11837				
	152		23104				
	112		12544				
	157		24586				
	110		12188				
	176		30976				
	118		14019				
	112		12544				
105+348	128		16384				
	110		12188				
	118		14019				
R = 900	152		23104				
	176		30976				
	109		11837				
	126		15977				
	122		14787				
	123		15178				
	122		14787				
	107		11492				
	123		15178				
	112		12544				
	152		23104				
	133		17636				
	150		22620				
	90		8028				
	107		11492				
	134		18063				
	123		15178				
	118		14019				
	115		13271				
	70		4956				
	93		8612				
	102		10486				
	93		8612				
	102		10486				
	128		16384				
	112		12544				
	134		18063				
	107		11492				
	85		7191				
	104		10816				
	114		12905				
	94		8911				
	88		7744				
	107		11492				
	109		11837				
	102		10486				
	101		10161				
	85		7191				
	96		9216				
	144		20736				
	144		20736				
	93		8612				
	117		13642				
	69		4733				
	126		15977				
	120		14400				
	91		8317				
	112		12544				
	109		11837				
	101		10161				
	131		17213				
	112		12544				
	90		8028				
	56		3136				
	75		5655				
	126		15977				
	99		9841				
	91		8317				
	106		11151				
	69		4733				
	106		11151				
	96		9216				
	120		14400				
	126		15977				
	99		9841				
	130		16796				
	8810		**1034895**				

	93	**108**	**8612**	**32834**	**21**	**128**	**128**
	106		11151				
	112		12544				
	46		2153				
	72		5184				
	117		13642				
	109		11837				
	130		16796				
116+372	139		19377				
	112		12544				
	125		15575				
R = 550	90		8028				
	126		15977				
	82		6659				
	125		15575				
	106		11151				
	130		16796				
	126		15977				
	82		6659				
	152		23104				
	126		15977				
	123		15178				
	104		10816				
	114		12905				
	125		15575				
	104		10816				
	72		5184				
	93		8612				
	91		8317				
	106		11151				
	102		10486				
	77		5898				
	107		11492				
	141		19825				
	128		16384				
	107		11492				
	94		8911				
	88		7744				
	130		16796				
	104		10816				
	85		7191				
	88		7744				
	102		10486				
	134		18063				
	85		7191				
	130		16796				
	104		10816				
	104		10816				
	96		9216				
	69		4733				
	70		4956				
	102		10486				
	117		13642				
	128		16384				
	91		8317				
	106		11151				
	115		13271				
	90		8028				
	141		19825				
	109		11837				
	122		14787				
	128		16384				
	114		12905				
	91		8317				
	144		20736				
	130		16796				
	115		13271				
	117		13642				
	88		7744				
	93		8612				
	78		6147				
	104		10816				
	107		11492				
	136		18496				
	134		18063				
	88		7744				
	115		13271				
	8283		**923891**				

	146	120	21199	39391	23	143	143
	136		18496				
	123		15178				
	144		20736				
	123		15178				
	133		17636				
	157		24586				
	133		17636				
180+574	139		19377				
	101		10161				
	110		12188				
R = 600	131		17213				
	130		16796				
	174		30415				
	136		18496				
	101		10161				
	123		15178				
	141		19825				
	157		24586				
	112		12544				
	134		18063				
	154		23593				
	146		21199				
	130		16796				
	88		7744				
	106		11151				
	120		14400				
	126		15977				
	136		18496				
	141		19825				
	128		16384				
	136		18496				
	146		21199				
	131		17213				
	139		19377				
	114		12905				
	91		8317				
	98		9526				
	142		20278				
	120		14400				
	136		18496				
	144		20736				
	107		11492				
	131		17213				
	104		10816				
	115		13271				
	94		8911				
	98		9526				
	120		14400				
	139		19377				
	128		16384				
	133		17636				
	112		12544				
	139		19377				
	142		20278				
	115		13271				
	141		19825				
	96		9216				
	90		8028				
	72		5184				
	75		5655				
	104		10816				
	93		8612				
	72		5184				
	74		5417				
	78		6147				
	128		16384				
	131		17213				
	120		14400				
	104		10816				
	109		11837				
	118		14019				
	122		14787				
	131		17213				
	77		5898				
	82		6659				
	93		8612				
	9242		1148575				

	104	115	10816	33889	21	136	136
	144		20736				
	93		8612				
	117		13642				
	117		13642				
	141		19825				
	173		29860				
	141		19825				
	96		9216				
189+400	107		11492				
	144		20736				
	138		18934				
R = 570	122		14787				
	134		18063				
	131		17213				
	154		23593				
	133		17636				
	93		8612				
	122		14787				
	98		9526				
	94		8911				
	118		14019				
	144		20736				
	118		14019				
	106		11151				
	155		24087				
	118		14019				
	110		12188				
	122		14787				
	110		12188				
	114		12905				
	122		14787				
	138		18934				
	115		13271				
	122		14787				
	126		15977				
	110		12188				
	78		6147				
	133		17636				
	134		18063				
	104		10816				
	118		14019				
	94		8911				
	110		12188				
	117		13642				
	125		15575				
	62		3894				
	61		3697				
	88		7744				
	93		8612				
	101		10161				
	102		10486				
	120		14400				
	82		6659				
	110		12188				
	90		8028				
	101		10161				
	114		12905				
	94		8911				
	134		18063				
	133		17636				
	142		20278				
	144		20736				
	104		10816				
	115		13271				
	125		15575				
	112		12544				
	109		11837				
	131		17213				
	110		12188				
	93		8612				
	96		9216				
	107		11492				
	77		5898				
	83		6922				
	128		16384				
	8718		1034028				

	112	118	12544	34115	21	138	138
	133		17636				
	144		20736				
	125		15575				
	123		15178				
	152		23104				
	109		11837				
191+003	150		22620				
	134		18063				
	118		14019				
R = 460	149		22141				
	125		15575				
	152		23104				
	109		11837				
	122		14787				
	126		15977				
	149		22141				
	123		15178				
	176		30976				
	152		23104				
	144		20736				
	118		14019				
	122		14787				
	98		9526				
	122		14787				
	144		20736				
	133		17636				
	98		9526				
	118		14019				
	110		12188				
	102		10486				
	130		16796				
	128		16384				
	112		12544				
	101		10161				
	99		9841				
	104		10816				
	130		16796				
	102		10486				
	114		12905				
	93		8612				
	102		10486				
	101		10161				
	114		12905				
	112		12544				
	115		13271				
	130		16796				
	104		10816				
	94		8911				
	115		13271				
	144		20736				
	93		8612				
	120		14400				
	130		16796				
	112		12544				
	106		11151				
	99		9841				
	101		10161				
	123		15178				
	85		7191				
	165		27159				
	160		25600				
	109		11837				
	91		8317				
	107		11492				
	98		9526				
	106		11151				
	123		15178				
	91		8317				
	102		10486				
	101		10161				
	85		7191				
	93		8612				
	107		11492				
	109		11837				
	85		7191				
	165		27159				
	112		12544				
	106		11151				
	90		8028				
	9406		1140119				

	122	**114**	14787	**42909**	**24**	**138**	**138**
	133		17636				
	98		9526				
	106		11151				
	133		17636				
	131		17213				
	91		8317				
217+650	133		17636				
	128		16384				
	98		9526				
R = 540	106		11151				
	120		14400				
	138		18934				
	125		15575				
	118		14019				
	104		10816				
	158		25091				
	166		27689				
	130		16796				
	131		17213				
	98		9526				
	141		19825				
	115		13271				
	165		27159				
	141		19825				
	102		10486				
	142		20278				
	115		13271				
	118		14019				
	94		8911				
	99		9841				
	98		9526				
	120		14400				
	106		11151				
	110		12188				
	91		8317				
	128		16384				
	117		13642				
	138		18934				
	114		12905				
	141		19825				
	93		8612				
	102		10486				
	144		20736				
	150		22620				
	133		17636				
	130		16796				
	112		12544				
	115		13271				
	80		6400				
	70		4956				
	117		13642				
	138		18934				
	131		17213				
	112		12544				
	77		5898				
	67		4516				
	88		7744				
	35		1239				
	130		16796				
	82		6659				
	99		9841				
	96		9216				
	96		9216				
	82		6659				
	96		9216				
	117		13642				
	112		12544				
	115		13271				
	130		16796				
	96		9216				
	112		12544				
	80		6400				
	120		14400				
	106		11151				
	120		14400				
	93		8612				
	160		25600				
	8894		**1057144**				

	118	119	14019	2677	6	125	125
	104		10816				
	158		25091				
	166		27689				
	130		16796				
	106		11151				
	104		10816				
	133		17636				
	131		17213				
227+640	122		14787				
	133		17636				
	141		19825				
R = 1000	142		20278				
	115		13271				
	118		14019				
	106		11151				
	120		14400				
	149		22141				
	115		13271				
	125		15575				
	152		23104				
	176		30976				
	152		23104				
	150		22620				
	134		18063				
	112		12544				
	118		14019				
	152		23104				
	157		24586				
	149		22141				
	130		16796				
	109		11837				
	115		13271				
	134		18063				
	70		4956				
	112		12544				
	93		8612				
	88		7744				
	114		12905				
	112		12544				
	128		16384				
	134		18063				
	93		8612				
	112		12544				
	102		10486				
	112		12544				
	85		7191				
	130		16796				
	109		11837				
	93		8612				
	85		7191				
	139		19377				
	125		15575				
	125		15575				
	93		8612				
	120		14400				
	91		8317				
	107		11492				
	112		12544				
	130		16796				
	112		12544				
	106		11151				
	109		11837				
	102		10486				
	128		16384				
	112		12544				
	130		16796				
	120		14400				
	106		11151				
	128		16384				
	109		11837				
	126		15977				
	123		15178				
	126		15977				
	91		8317				
	109		11837				
	106		11151				
	117		13642				
	120		14400				
	93		8612				
	112		12544				
	9674		1187215				

	176	115	30976	4170	7	122	122
	123		15178				
	114		12905				
	120		14400				
	110		12188				
	98		9526				
	114		12905				
	157		24586				
	118		14019				
	109		11837				
231+545	112		12544				
	112		12544				
	120		14400				
R = 360	98		9526				
	144		20736				
	101		10161				
	107		11492				
	123		15178				
	46		2153				
	134		18063				
	98		9526				
	110		12188				
	115		13271				
	149		22141				
	176		30976				
	126		15977				
	150		22620				
	98		9526				
	176		30976				
	122		14787				
	65		4225				
	65		4225				
	102		10486				
	99		9841				
	93		8612				
	128		16384				
	109		11837				
	98		9526				
	133		17636				
	134		18063				
	115		13271				
	114		12905				
	102		10486				
	106		11151				
	109		11837				
	115		13271				
	101		10161				
	94		8911				
	112		12544				
	125		15575				
	102		10486				
	130		16796				
	99		9841				
	158		25091				
	120		14400				
	112		12544				
	144		20736				
	106		11151				
	90		8028				
	136		18496				
	133		17636				
	106		11151				
	107		11492				
	91		8317				
	96		9216				
	128		16384				
	99		9841				
	102		10486				
	106		11151				
	126		15977				
	123		15178				
	109		11837				
	131		17213				
	120		14400				
	91		8317				
	144		20736				
	120		14400				
	130		16796				
	96		9216				
	82		6659				
	106		11151				
	9317		1113377				

	150	113	22620	40269	23	135	135
	115		13271				
	176		30976				
	133		17636				
	112		12544				
	115		13271				
	107		11492				
	110		12188				
	109		11837				
238+951	126		15977				
	152		23104				
R = 220	146		21199				
	176		30976				
	98		9526				
	150		22620				
	125		15575				
	101		10161				
	134		18063				
	149		22141				
	98		9526				
	114		12905				
	99		9841				
	157		24586				
	134		18063				
	110		12188				
	99		9841				
	120		14400				
	112		12544				
	98		9526				
	114		12905				
	141		19825				
	102		10486				
	114		12905				
	93		8612				
	109		11837				
	85		7191				
	106		11151				
	128		16384				
	93		8612				
	134		18063				
	99		9841				
	114		12905				
	102		10486				
	85		7191				
	130		16796				
	70		4956				
	106		11151				
	112		12544				
	114		12905				
	102		10486				
	136		18496				
	120		14400				
	112		12544				
	123		15178				
	109		11837				
	120		14400				
	136		18496				
	98		9526				
	107		11492				
	136		18496				
	136		18496				
	102		10486				
	99		9841				
	131		17213				
	109		11837				
	85		7191				
	99		9841				
	83		6922				
	96		9216				
	56		3136				
	74		5417				
	77		5898				
	91		8317				
	106		11151				
	96		9216				
	82		6659				
	99		9841				
	96		9216				
	106		11151				
	130		16796				
	9026		1058537				

	120	110	14400	145794	41	151	151
	94		8911				
	114		12905				
	86		7465				
	130		16796				
	138		18934				
	112		12544				
	136		18496				
241+100	75		5655				
	146		21199				
	147		21668				
R = 220	126		15977				
	109		11837				
	101		10161				
	107		11492				
	94		8911				
	78		6147				
	136		18496				
	126		15977				
	154		23593				
	77		5898				
	133		17636				
	93		8612				
	130		16796				
	98		9526				
	122		14787				
	102		10486				
	146		21199				
	128		16384				
	128		16384				
	98		9526				
	115		13271				
	86		7465				
	102		10486				
	110		12188				
	96		9216				
	101		10161				
	128		16384				
	99		9841				
	91		8317				
	102		10486				
	101		10161				
	130		16796				
	94		8911				
	88		7744				
	102		10486				
	134		18063				
	85		7191				
	130		16796				
	64		4096				
	114		12905				
	64		4096				
	102		10486				
	101		10161				
	149		22141				
	106		11151				
	118		14019				
	83		6922				
	128		16384				
	78		6147				
	75		5655				
	91		8317				
	85		7191				
	75		5655				
	125		15575				
	123		15178				
	149		22141				
	102		10486				
	83		6922				
	128		16384				
	114		12905				
	128		16384				
	102		10486				
	157		24586				
	109		11837				
	117		13642				
	131		17213				
	102		10486				
	120		14400				
	8702		996713				

	139	123	19377	22171	18	141	141
	115		13271				
	133		17636				
Addis Ababa -	136		18496				
Jimma	130		16796				
	98		9526				
	141		19825				
35+266	154		23593				
	138		18934				
	150		22620				
R = 425	83		6922				
	163		26634				
	128		16384				
	101		10161				
	133		17636				
	131		17213				
	154		23593				
	115		13271				
	122		14787				
	133		17636				
	128		16384				
	99		9841				
	115		13271				
	166		27689				
	138		18934				
	102		10486				
	106		11151				
	138		18934				
	99		9841				
	128		16384				
	109		11837				
	128		16384				
	110		12188				
	115		13271				
	134		18063				
	102		10486				
	131		17213				
	128		16384				
	128		16384				
	115		13271				
	115		13271				
	126		15977				
	88		7744				
	125		15575				
	110		12188				
	141		19825				
	106		11151				
	141		19825				
	102		10486				
	138		18934				
	114		12905				
	74		5417				
	144		20736				
	131		17213				
	125		15575				
	128		16384				
	128		16384				
	114		12905				
	125		15575				
	106		11151				
	112		12544				
	141		19825				
	112		12544				
	99		9841				
	139		19377				
	117		13642				
	106		11151				
	8221		1030851				

	122	93	14787	21084	17	110	110
	88		7744				
	93		8612				
	88		7744				
	88		7744				
	80		6400				
39+400	91		8317				
	112		12544				
	107		11492				
R = 425	91		8317				
	90		8028				
	90		8028				
	104		10816				
	90		8028				
	67		4516				
	99		9841				
	99		9841				
	138		18934				
	109		11837				
	122		14787				
	109		11837				
	51		2621				
	112		12544				
	90		8028				
	70		4956				
	77		5898				
	80		6400				
	109		11837				
	112		12544				
	117		13642				
	123		15178				
	94		8911				
	102		10486				
	102		10486				
	112		12544				
	80		6400				
	86		7465				
	78		6147				
	90		8028				
	91		8317				
	96		9216				
	75		5655				
	106		11151				
	58		3318				
	83		6922				
	66		4303				
	96		9216				
	93		8612				
	90		8028				
	94		8911				
	99		9841				
	78		6147				
	82		6659				
	107		11492				
	64		4096				
	98		9526				
	82		6659				
	64		4096				
	106		11151				
	51		2621				
	90		8028				
	94		8911				
	94		8911				
	94		8911				
	77		5898				
	104		10816				
	77		5898				
	112		12544				
	122		14787				
	102		10486				
	77		5898				
	6582		631337				

	114	107	12905	29934	21	128	128
	118		14019				
	115		13271				
	94		8911				
	99		9841				
	134		18063				
	99		9841				
	102		10486				
	150		22620				
52+768	131		17213				
	106		11151				
	51		2621				
R = 300	102		10486				
	115		13271				
	64		4096				
	125		15575				
	122		14787				
	131		17213				
	115		13271				
	96		9216				
	101		10161				
	104		10816				
	152		23104				
	107		11492				
	117		13642				
	138		18934				
	114		12905				
	152		23104				
	69		4733				
	91		8317				
	118		14019				
	118		14019				
	114		12905				
	115		13271				
	106		11151				
	136		18496				
	130		16796				
	104		10816				
	101		10161				
	104		10816				
	125		15575				
	101		10161				
	114		12905				
	96		9216				
	93		8612				
	85		7191				
	94		8911				
	101		10161				
	82		6659				
	112		12544				
	131		17213				
	96		9216				
	107		11492				
	122		14787				
	99		9841				
	62		3894				
	125		15575				
	133		17636				
	109		11837				
	101		10161				
	64		4096				
	96		9216				
	78		6147				
	104		10816				
	66		4303				
	83		6922				
	7053		783601				

	90	105	8028	16968	16	121	121
	106		11151				
	98		9526				
	115		13271				
	109		11837				
99+446	102		10486				
	82		6659				
	115		13271				
R = 500	118		14019				
	152		23104				
	109		11837				
	126		15977				
	131		17213				
	123		15178				
	107		11492				
	110		12188				
	109		11837				
	93		8612				
	94		8911				
	93		8612				
	117		13642				
	104		10816				
	117		13642				
	110		12188				
	125		15575				
	112		12544				
	94		8911				
	94		8911				
	83		6922				
	104		10816				
	122		14787				
	102		10486				
	107		11492				
	72		5184				
	109		11837				
	96		9216				
	102		10486				
	118		14019				
	99		9841				
	69		4733				
	112		12544				
	99		9841				
	106		11151				
	112		12544				
	96		9216				
	69		4733				
	98		9526				
	138		18934				
	74		5417				
	128		16384				
	134		18063				
	101		10161				
	104		10816				
	90		8028				
	90		8028				
	115		13271				
	115		13271				
	114		12905				
	112		12544				
	93		8612				
	96		9216				
	99		9841				
	112		12544				
	85		7191				
	82		6659				
	6811		730698				

	147	96	21668	29560	21	117	117
	141		19825				
	139		19377				
	94		8911				
	112		12544				
	88		7744				
	86		7465				
118+057	110		12188				
	109		11837				
	85		7191				
R = 500	152		23104				
	109		11837				
	133		17636				
	125		15575				
	106		11151				
	109		11837				
	107		11492				
	94		8911				
	96		9216				
	94		8911				
	114		12905				
	101		10161				
	114		12905				
	107		11492				
	122		14787				
	109		11837				
	91		8317				
	80		6400				
	101		10161				
	138		18934				
	83		6922				
	93		8612				
	115		13271				
	102		10486				
	93		8612				
	85		7191				
	77		5898				
	74		5417				
	82		6659				
	91		8317				
	114		12905				
	101		10161				
	90		8028				
	82		6659				
	74		5417				
	70		4956				
	82		6659				
	99		9841				
	107		11492				
	85		7191				
	78		6147				
	74		5417				
	61		3697				
	67		4516				
	101		10161				
	82		6659				
	75		5655				
	70		4956				
	58		3318				
	70		4956				
	98		9526				
	80		6400				
	78		6147				
	74		5417				
	61		3697				
	6235		627679				

	109	104	11837	24345	19	123	123
	90		8028				
	106		11151				
	109		11837				
	125		15575				
	107		11492				
	106		11151				
122+105	104		10816				
	109		11837				
	114		12905				
R = 200	83		6922				
	128		16384				
	133		17636				
	117		13642				
	112		12544				
	128		16384				
	134		18063				
	104		10816				
	104		10816				
	85		7191				
	101		10161				
	120		14400				
	101		10161				
	101		10161				
	86		7465				
	133		17636				
	138		18934				
	122		14787				
	112		12544				
	107		11492				
	62		3894				
	109		11837				
	125		15575				
	107		11492				
	104		10816				
	83		6922				
	125		15575				
	126		15977				
	130		16796				
	101		10161				
	102		10486				
	104		10816				
	120		14400				
	106		11151				
	104		10816				
	123		15178				
	125		15575				
	126		15977				
	104		10816				
	122		14787				
	112		12544				
	64		4096				
	82		6659				
	66		4303				
	112		12544				
	96		9216				
	80		6400				
	82		6659				
	98		9526				
	75		5655				
	80		6400				
	64		4096				
	109		11837				
	93		8612				
	77		5898				
	78		6147				
	94		8911				
	72		5184				
	7066		**758502**				

	136	122	18496	29501	21	144	144
	88		7744				
	141		19825				
	163		26634				
	147		21668				
	123		15178				
132+814	147		21668				
	123		15178				
	141		19825				
R = 600	138		18934				
	131		17213				
	154		23593				
	115		13271				
	133		17636				
	122		14787				
	128		16384				
	99		9841				
	115		13271				
	166		27689				
	138		18934				
	102		10486				
	106		11151				
	138		18934				
	99		9841				
	128		16384				
	141		19825				
	154		23593				
	138		18934				
	150		22620				
	83		6922				
	147		21668				
	120		14400				
	126		15977				
	93		8612				
	118		14019				
	141		19825				
	134		18063				
	115		13271				
	134		18063				
	102		10486				
	99		9841				
	115		13271				
	126		15977				
	94		8911				
	125		15575				
	141		19825				
	106		11151				
	141		19825				
	102		10486				
	144		20736				
	114		12905				
	117		13642				
	154		23593				
	104		10816				
	101		10161				
	134		18063				
	75		5655				
	83		6922				
	83		6922				
	96		9216				
	128		16384				
	128		16384				
	114		12905				
	125		15575				
	106		11151				
	96		9216				
	8069		**1015949**				

	48	98	2304	24058	19	117	117
	96		9216				
	117		13642				
	93		8612				
	123		15178				
	128		16384				
	117		13642				
	128		16384				
166+098	104		10816				
	109		11837				
	90		8028				
R = 190	106		11151				
	109		11837				
	125		15575				
	107		11492				
	106		11151				
	104		10816				
	109		11837				
	114		12905				
	83		6922				
	128		16384				
	144		20736				
	138		18934				
	136		18496				
	90		8028				
	109		11837				
	85		7191				
	83		6922				
	107		11492				
	106		11151				
	70		4956				
	115		13271				
	112		12544				
	83		6922				
	102		10486				
	85		7191				
	77		5898				
	83		6922				
	93		8612				
	114		12905				
	90		8028				
	74		5417				
	91		8317				
	99		9841				
	93		8612				
	102		10486				
	91		8317				
	101		10161				
	90		8028				
	101		10161				
	88		7744				
	67		4516				
	99		9841				
	90		8028				
	98		9526				
	85		7191				
	64		4096				
	96		9216				
	86		7465				
	64		4096				
	80		6400				
	74		5417				
	112		12544				
	96		9216				
	107		11492				
	62		3894				
	91		8317				
	6563		**666977**				

	22	60	502	18746	17	77	77
	82		6659				
	77		5898				
Addis Ababa -	109		11837				
Tarmaber	69		4733				
	70		4956				
	46		2153				
16+105	58		3318				
	45		2007				
	42		1731				
R = 600	32		1024				
	77		5898				
	43		1866				
	62		3894				
	45		2007				
	42		1731				
	40		1600				
	50		2460				
	56		3136				
	53		2788				
	66		4303				
	53		2788				
	48		2304				
	69		4733				
	64		4096				
	61		3697				
	59		3505				
	54		2959				
	85		7191				
	75		5655				
	61		3697				
	51		2621				
	64		4096				
	77		5898				
	93		8612				
	112		12544				
	48		2304				
	66		4303				
	40		1600				
	56		3136				
	82		6659				
	56		3136				
	53		2788				
	50		2460				
	53		2788				
	61		3697				
	50		2460				
	77		5898				
	54		2959				
	70		4956				
	75		5655				
	80		6400				
	43		1866				
	40		1600				
	61		3697				
	43		1866				
	48		2304				
	67		4516				
	45		2007				
	40		1600				
	62		3894				
	66		4303				
	80		6400				
	43		1866				
	53		2788				
	70		4956				
	77		5898				
	4018		**259658**				

	80	85	6400	10474	12	97	97
	72		5184				
	74		5417				
	77		5898				
	74		5417				
	43		1866				
	86		7465				
32+333	75		5655				
	80		6400				
	77		5898				
R = 375	74		5417				
	85		7191				
	85		7191				
	88		7744				
	83		6922				
	94		8911				
	88		7744				
	91		8317				
	90		8028				
	42		1731				
	94		8911				
	96		9216				
	88		7744				
	93		8612				
	94		8911				
	86		7465				
	94		8911				
	101		10161				
	98		9526				
	86		7465				
	96		9216				
	107		11492				
	90		8028				
	70		4956				
	83		6922				
	80		6400				
	83		6922				
	83		6922				
	85		7191				
	77		5898				
	75		5655				
	98		9526				
	86		7465				
	101		10161				
	94		8911				
	91		8317				
	86		7465				
	96		9216				
	98		9526				
	91		8317				
	77		5898				
	78		6147				
	77		5898				
	115		13271				
	82		6659				
	83		6922				
	86		7465				
	67		4516				
	72		5184				
	77		5898				
	101		10161				
	98		9526				
	78		6147				
	72		5184				
	69		4733				
	86		7465				
	88		7744				
	93		8612				
	94		8911				
	98		9526				
	99		9841				
	6050		525934				

	83	91	6922	15706	15	105	105
	88		7744				
	43		1866				
	104		10816				
	102		10486				
	96		9216				
44+912	72		5184				
	112		12544				
	99		9841				
R = 300	94		8911				
	117		13642				
	96		9216				
	149		22141				
	102		10486				
	90		8028				
	83		6922				
	94		8911				
	112		12544				
	96		9216				
	102		10486				
	78		6147				
	83		6922				
	109		11837				
	96		9216				
	82		6659				
	91		8317				
	88		7744				
	94		8911				
	88		7744				
	85		7191				
	98		9526				
	115		13271				
	91		8317				
	98		9526				
	99		9841				
	90		8028				
	83		6922				
	83		6922				
	107		11492				
	96		9216				
	77		5898				
	75		5655				
	96		9216				
	86		7465				
	94		8911				
	96		9216				
	91		8317				
	101		10161				
	86		7465				
	101		10161				
	102		10486				
	107		11492				
	88		7744				
	62		3894				
	93		8612				
	80		6400				
	66		4303				
	96		9216				
	98		9526				
	85		7191				
	90		8028				
	75		5655				
	82		6659				
	86		7465				
	96		9216				
	77		5898				
	66		4303				
	101		10161				
	98		9526				
	80		6400				
	69		4733				
	74		5417				
	78		6147				
	80		6400				
	85		7191				
	6806		633400				

	112	91	12544	9072	12	103	103
	96		9216				
	104		10816				
	78		6147				
	83		6922				
	109		11837				
46+344	96		9216				
	91		8317				
	88		7744				
R = 275	94		8911				
	88		7744				
	85		7191				
	112		12544				
	102		10486				
	72		5184				
	90		8028				
	94		8911				
	88		7744				
	94		8911				
	101		10161				
	98		9526				
	102		10486				
	86		7465				
	80		6400				
	85		7191				
	74		5417				
	86		7465				
	77		5898				
	72		5184				
	74		5417				
	85		7191				
	77		5898				
	83		6922				
	90		8028				
	107		11492				
	96		9216				
	98		9526				
	85		7191				
	94		8911				
	91		8317				
	96		9216				
	101		10161				
	102		10486				
	118		14019				
	117		13642				
	91		8317				
	91		8317				
	101		10161				
	98		9526				
	94		8911				
	109		11837				
	70		4956				
	80		6400				
	94		8911				
	88		7744				
	106		11151				
	78		6147				
	98		9526				
	86		7465				
	88		7744				
	72		5184				
	98		9526				
	93		8612				
	80		6400				
	106		11151				
	66		4303				
	6038		**561531**				

	85	87	7191	14532	15	102	102
	77		5898				
	75		5655				
	43		1866				
	77		5898				
	74		5417				
	80		6400				
47+203	90		8028				
	88		7744				
	101		10161				
R = 750	98		9526				
	86		7465				
	85		7191				
	86		7465				
	77		5898				
	74		5417				
	88		7744				
	94		8911				
	109		11837				
	83		6922				
	96		9216				
	112		12544				
	70		4956				
	85		7191				
	101		10161				
	78		6147				
	77		5898				
	106		11151				
	123		15178				
	120		14400				
	104		10816				
	77		5898				
	101		10161				
	98		9526				
	112		12544				
	91		8317				
	114		12905				
	112		12544				
	88		7744				
	58		3318				
	85		7191				
	83		6922				
	83		6922				
	90		8028				
	96		9216				
	98		9526				
	75		5655				
	86		7465				
	96		9216				
	72		5184				
	86		7465				
	82		6659				
	78		6147				
	77		5898				
	69		4733				
	88		7744				
	86		7465				
	99		9841				
	78		6147				
	93		8612				
	62		3894				
	88		7744				
	96		9216				
	66		4303				
	90		8028				
	67		4516				
	86		7465				
	101		10161				
	80		6400				
	6027		541012				

	115	92	13271	20043	16	108	108
	72		5184				
	91		8317				
Addis Ababa -	88		7744				
Gohatsion	122		14787				
	85		7191				
	96		9216				
11+175	93		8612				
	102		10486				
	96		9216				
R = 230	72		5184				
	99		9841				
	98		9526				
	125		15575				
	102		10486				
	90		8028				
	109		11837				
	50		2460				
	109		11837				
	94		8911				
	82		6659				
	96		9216				
	94		8911				
	86		7465				
	80		6400				
	112		12544				
	110		12188				
	90		8028				
	106		11151				
	112		12544				
	96		9216				
	98		9526				
	53		2788				
	104		10816				
	99		9841				
	94		8911				
	102		10486				
	104		10816				
	90		8028				
	104		10816				
	93		8612				
	75		5655				
	88		7744				
	74		5417				
	83		6922				
	96		9216				
	107		11492				
	66		4303				
	48		2304				
	80		6400				
	93		8612				
	104		10816				
	90		8028				
	104		10816				
	102		10486				
	94		8911				
	99		9841				
	104		10816				
	53		2788				
	98		9526				
	96		9216				
	70		4956				
	45		2007				
	88		7744				
	75		5655				
	93		8612				
	104		10816				
	90		8028				
	104		10816				
	102		10486				
	94		8911				
	99		9841				
	104		10816				
	93		8612				
	75		5655				
	88		7744				
	74		5417				
	7064		668096				

	56	85	3136	29337	22	107	107
	50		2460				
	67		4516				
	93		8612				
	96		9216				
	85		7191				
	62		3894				
	90		8028				
	94		8911				
13+793	99		9841				
	118		14019				
	120		14400				
R = 230	93		8612				
	99		9841				
	96		9216				
	117		13642				
	120		14400				
	58		3318				
	93		8612				
	157		24586				
	80		6400				
	94		8911				
	77		5898				
	53		2788				
	75		5655				
	83		6922				
	94		8911				
	90		8028				
	62		3894				
	85		7191				
	72		5184				
	35		1239				
	67		4516				
	99		9841				
	90		8028				
	86		7465				
	99		9841				
	83		6922				
	75		5655				
	53		2788				
	77		5898				
	94		8911				
	80		6400				
	58		3318				
	93		8612				
	90		8028				
	99		9841				
	80		6400				
	99		9841				
	94		8911				
	90		8028				
	62		3894				
	85		7191				
	96		9216				
	141		19825				
	67		4516				
	50		2460				
	56		3136				
	94		8911				
	99		9841				
	62		3894				
	90		8028				
	85		7191				
	5357		484818				

	106	110	11151	28432	23	134	134
	133		17636				
	120		14400				
	144		20736				
	133		17636				
	110		12188				
	162		26115				
	106		11151				
	48		2304				
	138		18934				
	107		11492				
	162		26115				
34+893	144		20736				
	133		17636				
R = 580	106		11151				
	133		17636				
	138		18934				
	120		14400				
	107		11492				
	144		20736				
	96		9216				
	109		11837				
	80		6400				
	102		10486				
	94		8911				
	88		7744				
	80		6400				
	125		15575				
	101		10161				
	142		20278				
	109		11837				
	98		9526				
	104		10816				
	102		10486				
	109		11837				
	88		7744				
	98		9526				
	142		20278				
	101		10161				
	104		10816				
	109		11837				
	67		4516				
	128		16384				
	94		8911				
	101		10161				
	109		11837				
	80		6400				
	96		9216				
	104		10816				
	77		5898				
	80		6400				
	112		12544				
	120		14400				
	5840		671933				

	82	83	6659	13411	16	99	99
	98		9526				
	96		9216				
	75		5655				
	86		7465				
	82		6659				
	94		8911				
	110		12188				
45+763	72		5184				
	99		9841				
	83		6922				
R = 230	85		7191				
	126		15977				
	91		8317				
	93		8612				
	70		4956				
	74		5417				
	82		6659				
	96		9216				
	75		5655				
	86		7465				
	77		5898				
	83		6922				
	83		6922				
	107		11492				
	83		6922				
	90		8028				
	67		4516				
	54		2959				
	74		5417				
	48		2304				
	96		9216				
	109		11837				
	61		3697				
	67		4516				
	86		7465				
	72		5184				
	94		8911				
	80		6400				
	88		7744				
	110		12188				
	54		2959				
	74		5417				
	72		5184				
	99		9841				
	48		2304				
	107		11492				
	75		5655				
	82		6659				
	77		5898				
	75		5655				
	93		8612				
	72		5184				
	83		6922				
	4498		388012				

	75	80	5655	30521	25	104	104
	141		19825				
	54		2959				
	107		11492				
	106		11151				
	74		5417				
	109		11837				
143+334	141		19825				
	53		2788				
	62		3894				
R = 421	94		8911				
	91		8317				
	144		20736				
	106		11151				
	74		5417				
	94		8911				
	75		5655				
	61		3697				
	61		3697				
	66		4303				
	109		11837				
	69		4733				
	102		10486				
	70		4956				
	75		5655				
	59		3505				
	53		2788				
	64		4096				
	74		5417				
	75		5655				
	74		5417				
	75		5655				
	61		3697				
	109		11837				
	106		11151				
	29		829				
	106		11151				
	64		4096				
	45		2007				
	67		4516				
	54		2959				
	75		5655				
	74		5417				
	62		3894				
	53		2788				
	94		8911				
	75		5655				
	74		5417				
	94		8911				
	75		5655				
	54		2959				
	4058		**353347**				

	149	101	22141	34468	23	124	124
	117		13642				
	96		9216				
	118		14019				
	120		14400				
Addis Ababa -	126		15977				
Butajira	93		8612				
	67		4516				
	106		11151				
35+000	109		11837				
	96		9216				
	106		11151				
R = 400	107		11492				
	90		8028				
	54		2959				
	109		11837				
	102		10486				
	114		12905				
	99		9841				
	133		17636				
	93		8612				
	83		6922				
	109		11837				
	118		14019				
	90		8028				
	112		12544				
	136		18496				
	102		10486				
	117		13642				
	107		11492				
	128		16384				
	131		17213				
	83		6922				
	75		5655				
	67		4516				
	88		7744				
	72		5184				
	101		10161				
	131		17213				
	102		10486				
	86		7465				
	78		6147				
	70		4956				
	91		8317				
	75		5655				
	104		10816				
	134		18063				
	106		11151				
	90		8028				
	82		6659				
	51		2621				
	61		3697				
	94		8911				
	109		11837				
	126		15977				
	42		1731				
	138		18934				
	142		20278				
	112		12544				
	117		13642				
	122		14787				
	82		6659				
	109		11837				
	74		5417				
	6451		684749				

Radius (m)	Tot.Pavt. Width	Grade %	Superelevation %	Curve Length (m)	85th Percentile Speed Km/hr	1/R
540	14.9	3.3	3.3	244	96	0.001852
360	12.1	1.6	6.1	690	88	0.002778
900	17.8	2.0	0.1	268	118	0.001111
600	15.3	2.1	4.3	240	121	0.001667
800	10.8	2.5	5.1	145	111	0.00125
360	12.3	0.1	3.5	145	123	0.002778
950	12.6	0.1	3.9	225	123	0.001053
360	11.7	2.5	7.6	300	116	0.002778
400	10.2	0.8	4.6	795	122	0.0025
600	10.3	1.1	4.1	170	136	0.001667
450	10.6	1.3	3.9	220	140	0.002222
580	10.4	1.2	4.1	320	141	0.001724
850	10.3	1.1	4.1	320	151	0.001176
400	10.8	1.1	3.5	145	137	0.0025
900	10.4	1.3	2.5	175	142	0.001111
550	10.4	0.3	4.3	256	128	0.001818
600	10.1	1.5	4.4	600	143	0.001667
570	10.5	0.3	6.0	355	136	0.001754
460	10.5	0.7	4.6	665	138	0.002174
540	10.2	0.8	3.4	300	138	0.001852
1000	10.8	0.5	4.3	160	125	0.001
360	10.5	0.6	6.2	210	122	0.002778
220	10.4	0.4	5.6	842	135	0.004545
220	10.1	2.1	1.9	650	151	0.004545
425	10.4	0.1	6.9	222	141	0.002353
425	10.2	0.5	5.3	425	110	0.002353
300	10.1	0.3	6.6	124	128	0.003333
500	10.6	1.1	1.3	72	121	0.002
500	10.3	2.1	7.1	118	117	0.002
200	10.0	0.3	6.6	112	123	0.005
600	10.5	1.4	6.1	137	144	0.001667
190	10.0	1.4	6.5	155	117	0.005263
600	9.5	4.3	6.9	119	77	0.001667
375	7.3	0.1	5.9	185	97	0.002667
300	10.9	3.8	4.5	103	105	0.003333
275	7.5	4.1	6.3	76	103	0.003636
750	7.8	3.5	5.9	128	102	0.001333
230	11.7	2.0	6.7	250	108	0.004348
230	13.3	1.3	7.6	65	107	0.004348
580	11.8	2.4	6.1	65	134	0.001724
230	12.1	4.0	8.1	109	99	0.004348
421	11.5	1.8	5.8	107	104	0.002375
400	11.9	1.8	5.8	200	124	0.0025

Correlation Result for Horizontal Curves

	r
Radius	0.19546
T.Pav.Width	-0.07539
Grade	-0.52061
Superelevation	-0.478
Curve Length	0.421

Radius (m)	85th Percentile Speed Km/hr	Tot.Pavt. Width	Grade %	85th Percentile Speed Km/hr	Superelevation %	Curve Length (m)	85th Percentile Speed Km/hr
540	96	14.9	3.3	96	3.3	244	96
360	88	12.1	1.6	88	6.1	690	88
900	118	17.8	2.0	118	0.1	268	118
600	121	15.3	2.1	121	4.3	240	121
800	111	10.8	2.5	111	5.1	145	111
360	123	12.3	0.1	123	3.5	145	123
950	123	12.6	0.1	123	3.9	225	123
360	116	11.7	2.5	116	7.6	300	116
400	122	10.2	0.8	122	4.6	795	122
600	136	10.3	1.1	136	4.1	170	136
450	140	10.6	1.3	140	3.9	220	140
580	141	10.4	1.2	141	4.1	320	141
850	151	10.3	1.1	151	4.1	320	151
400	137	10.8	1.1	137	3.5	145	137
900	142	10.4	1.3	142	2.5	175	142
550	128	10.4	0.3	128	4.3	256	128
600	143	10.1	1.5	143	4.4	600	143
570	136	10.5	0.3	136	6.0	355	136
460	138	10.5	0.7	138	4.6	665	138
540	138	10.2	0.8	138	3.4	300	138
1000	125	10.8	0.5	125	4.3	160	125
360	122	10.5	0.6	122	6.2	210	122
220	135	10.4	0.4	135	5.6	842	135
220	151	10.1	2.1	151	1.9	650	151
425	141	10.4	0.1	141	6.9	222	141
425	110	10.2	0.5	110	5.3	425	110
300	128	10.1	0.3	128	6.6	124	128
500	121	10.6	1.1	121	1.3	72	121
500	117	10.3	2.1	117	7.1	118	117
200	123	10.0	0.3	123	6.6	112	123
600	144	10.5	1.4	144	6.1	137	144
190	117	10.0	1.4	117	6.5	155	117
600	77	9.5	4.3	77	6.9	119	77
375	97	7.3	0.1	97	5.9	185	97
300	105	10.9	3.8	105	4.5	103	105
275	103	7.5	4.1	103	6.3	76	103
750	102	7.8	3.5	102	5.9	128	102
230	108	11.7	2.0	108	6.7	250	108
230	107	13.3	1.3	107	7.6	65	107
580	134	11.8	2.4	134	6.1	65	134
230	99	12.1	4.0	99	8.1	109	99
421	104	11.5	1.8	104	5.8	107	104
400	124	11.9	1.8	124	5.8	200	124

Correlation Result for Tangents

	r
Pavement Width	-0.225
Grade	-0.595
Tangent Length	0.392

Tangent (m)	85th Percentile Speed Km/hr	Total Pave Width (m)	Grade %	85th Percentile Speed Km/hr
1000	106	15.1	1.0	106
1650	117	12.0	2.9	117
332	96	15.5	3.8	96
250	113	15.0	2.5	113
540	113	10.8	2.5	113
3365	124	12.3	0.1	124
2860	133	11.8	0.1	133
1210	119	12.1	1.8	119
650	122	11.7	2.5	122
700	136	10.6	0.6	136
600	123	15.3	0.9	123
800	128	12.0	0.9	128
700	125	10.3	0.9	125
1460	126	10.4	1.3	126
890	129	9.8	1.5	129
1060	128	9.8	1.3	128
1765	126	9.8	1.4	126
2500	135	9.9	0.5	135
2360	136	10.1	1.0	136
1220	137	10.2	0.4	137
780	120	10.3	0.3	120
565	136	9.4	3.8	136
2180	119	10.3	0.7	119
300	123	10.2	0.6	123
530	122	10.6	0.6	122
1440	123	10.0	1.1	123
523	138	10.4	0.3	138
1650	117	14.2	0.3	117
3590	136	10.2	0.3	136
456	110	9.8	0.1	110
3821	118	9.1	2.9	118
431	130	9.5	0.3	130
574	137	9.0	2.3	137
635	132	9.6	1.3	132
736	66	10.0	2.4	66
295	79	10.2	6.1	79
297	101	7.8	4.9	101
572	104	7.2	0.9	104
537	122	7.3	2.3	122
491	106	7.9	2.1	106
533	110	7.6	2.5	110
500	104	15.1	1.7	104
262	124	11.6	3.5	124
359	123	13.3	1.6	123
545	127	12.5	1.5	127
297	105	12.4	1.6	105
259	120	12.8	2.3	120
660	108	11.5	6.5	108
600	114	12.5	6.0	114

Apeendix A

Data Collected from Field

Road **Addis Ababa - Awassa** Width of Pave.(m) = 10.45 Grade(%) = 3.25
Station **26+306 to 26+550** Shoulder Width (m) = 2 Left Supper elevation(%) = 3.25
Horizontal Curve 26+428 2.4 Right Radius(m) = 540

	Speed (Km/hr)																													
Cars	82	136	96	83	56	93	104	85	93	104	107	90	80	78	86	106	77	72	90	64	70	115	115	107	93	91	96	74	69	64
Buses	94	48	45	54	93	72	43	45	58	40	86	91	56	32	64	58	56	77	64	45	54	40	58	64	56	77	86	94	74	91
Trucks	80	96	86	85	85	82	91	45	46	83	88	90	50	62	72	64	74	45	59	62	80	66	40	69	59	104	94	83	48	74

Road **Addis Ababa - Awassa** Width of Pave.(m) = 10.3 Grade(%) = 1
Station **26+550 to 27+550** Shoulder Width (m) = 2.6 Left Supper elevation(%)
Tangent 26 + 800 2.2 Right Tangent (m) = 1000

	Speed (Km/hr)																													
Cars	80	75	59	96	104	70	102	112	90	50	133	139	93	67	59	104	72	90	77	70	101	80	101	94	75	115	126	66	144	90
Buses	96	77	67	102	96	91	62	72	70	90	72	69	70	74	80	77	70	72	90	70	72	62	91	96	102	67	77	96	80	77
Trucks	101	58	67	106	64	83	85	86	104	77	74	123	74	74	99	101	102	80	91	83	90	51	50	53	112	34	115	72	115	120

Road **Addis Ababa - Awassa** Width of Pave.(m) = 7.4 Grade(%) = 1.625
Station **27+740 to 28+050** Shoulder Width (m) = 2.3 Left Supper elevation(%) = 6.08
Horizontal Curve 27+895 2.4 Right Radius (m) = 360

	Speed (Km/hr)																													
Cars	88	78	88	88	90	70	72	99	80	58	40	69	42	45	45	58	64	106	88	106	102	101	77	48	67	80	91	93	102	80
Buses	69	56	56	35	54	61	64	90	75	75	75	78	82	83	80	61	69	75	56	56	82	78	80	83	80	90	61	75	82	69
Trucks	80	104	38	72	70	40	46	74	48	61	54	51	59	46	34	50	56	51	59	77	85	94	37	69	66	66	62	48	88	85

Road **Addis Ababa - Awassa** Width of Pave.(m) = 6.95 Grade(%) =2.875
Station **28+050 to 29+700** Shoulder Width (m) = 2.4 Left Supper elevation(%)
Tangent 28+300 2.6 Right Tangent (m) = 1650

	Speed (Km/hr)																													
Cars	112	86	98	101	106	120	98	90	72	128	131	74	53	86	93	82	133	115	70	77	61	134	53	142	144	72	70	94	94	117
Buses	115	106	69	69	82	80	98	112	130	99	61	115	112	107	98	80	69	106	112	99	107	112	61	69	115	120	128	99	106	96
Trucks	110	112	104	75	70	98	91	78	61	66	122	118	99	85	118	99	107	69	86	99	104	69	74	80	123	110	104	86	82	77

Road **Addis Ababa - Awassa** Width of Pave.(m) = 8 Grade(%) = 2
Station **30+350 to 30+618** Shoulder Width (m) = 6.5 Left Supper elevation(%) = 0.125
Horizontal Curve 30+484 3.3 Right Radius (m) = 900

	Speed (Km/hr)																													
Cars	110	142	141	134	134	128	109	85	107	88	93	106	112	114	109	102	106	82	82	114	101	96	86	61	120	141	117	104	101	90
Buses	134	85	94	83	109	114	94	118	117	72	106	72	98	96	83	86	98	96	75	109	85	85	88	104	118	136	102	123	96	77
Trucks	128	133	109	83	78	74	114	69	86	61	59	115	114	85	77	75	90	80	82	99	70	69	80	91	90	93	117	115	90	112

Road **Addis Ababa - Awassa** Width of Pave.(m) = 10.45 Grade(%) =3.75
Station **30+618 to 30+950** Shoulder Width (m) = 2 Left Supper elevation(%) =
Tangent 30 + 868 2.4 Right Tangent (m) = 332

	Speed (Km/hr)																													
Cars	117	102	72	102	74	75	94	78	82	104	107	101	130	78	77	83	69	93	61	80	101	106	85	72	94	96	69	98	83	83
Buses	51	80	54	77	58	42	58	109	43	72	42	61	70	93	53	43	50	53	56	58	80	51	109	72	70	109	109	72	77	80
Trucks	38	114	51	67	56	69	86	59	62	66	77	80	85	86	42	48	62	43	67	90	70	69	56	48	40	107	102	24	32	40

Road **Addis Ababa - Awassa** Width of Pave.(m) = 11.06 Grade(%) = 2.125
Station **32+710 to 32+950** Shoulder Width (m) = 2.5 Left Supper elevation(%) =4.25
Horizontal Curve 32+830 1.7 Right Radius (m) = 600

	Speed (Km/hr)																													
Cars	51	94	75	77	82	98	32	131	125	85	80	82	134	130	155	64	85	152	157	107	136	72	114	141	128	131	109	82	72	109
Buses	109	104	98	96	120	123	50	86	96	91	64	80	45	107	99	83	122	96	86	96	104	91	99	104	109	96	80	86	96	98
Trucks	90	96	37	22	78	78	102	83	126	94	90	106	88	106	101	101	93	120	67	109	106	82	74	118	106	102	90	64	90	82

Road **Addis Ababa - Awassa** Width of Pave.(m) = 10.95 Grade(%) =2.5
Station **32+950 to 33+200** Shoulder Width (m) = 2.4 Left Supper elevation(%)
Tangent 33 + 200 1.7 Right Tangent (m) = 250

	Speed (Km/hr)																													
Cars	117	78	58	123	82	88	106	90	96	109	94	109	122	93	112	123	93	90	85	136	69	70	138	110	106	74	74	90	96	88
Buses	104	66	51	77	75	99	102	96	75	75	77	66	96	98	77	101	107	77	99	56	88	51	77	75	107	96	102	75	77	104
Trucks	64	88	56	99	102	98	125	118	107	77	94	120	101	96	101	96	122	107	118	107	72	54	50	91	72	136	99	99	134	99

Road **Addis Ababa - Awassa** Width of Pave.(m) = 6.93 Grade(%) = 2.5
Station **49+305 to 49+450** Shoulder Width (m) = 1.8 Left Supper elevation(%) = 5.143
Horizontal Curve 49 + 378 2.1 Right Radius (m) = 800

	Speed (Km/hr)																													
Cars	61	106	86	114	61	58	122	74	82	93	106	91	94	98	74	75	86	115	69	88	86	107	117	146	141	118	128	93	101	104
Buses	82	90	99	85	96	88	118	91	75	80	75	118	69	85	96	112	112	80	101	82	75	85	88	90	118	112	96	101	91	85
Trucks	101	120	94	77	107	118	125	98	102	99	56	88	64	99	134	99	99	136	72	75	50	70	72	107	118	107	122	112	96	101

Road **Addis Ababa - Awassa** Width of Pave.(m) = 6.93 Grade(%) = 2.5
Station **49+450 to 49+990** Shoulder Width (m) = 1.8 Left Supper elevation(%) =
Tangent 49+700 2.1 Right Tangent(m) = 540

	Speed (Km/hr)																													
Cars	93	112	120	123	93	90	85	136	69	70	138	110	106	74	74	90	96	88	117	78	58	123	82	88	106	90	96	109	94	109
Buses	75	77	66	96	98	77	101	107	77	99	56	88	51	77	75	107	96	102	75	77	104	104	66	51	77	75	99	102	96	75
Trucks	101	120	94	77	107	118	125	98	102	99	56	88	64	99	134	99	99	136	72	75	50	70	72	107	118	107	122	112	96	101

Road **Addis Ababa - Awassa** Width of Pave.(m) = 7.2 Grade(%) = 0.125
Station **50+230 to 50+375** Shoulder Width (m) = 2.5 Left Supper elevation(%) =3.5
Horizontal Curve 50 + 303 2.6 Right radius (m) = 360

	Speed (Km/hr)																													
Cars	125	117	117	168	141	144	107	70	114	107	141	128	96	115	69	88	86	107	117	146	141	118	128	93	101	104	88	106	86	118
Buses	98	78	141	96	99	80	96	114	128	106	128	120	112	117	82	90	99	85	96	88	118	91	75	80	75	118	69	106	112	80
Trucks	118	83	83	70	104	99	104	102	104	115	99	104	90	123	104	70	118	107	99	67	67	72	80	88	86	94	74	69	93	90

Road **Addis Ababa - Awassa** Width of Pave.(m) = 7.2 Grade(%) = 0.125
Station **50+375 to 53+740** Shoulder Width (m) = 2.5 Left Supper elevation(%)
Tangent 50+625 2.6 Right Tangent(m) = 3365

	Speed (Km/hr)																													
Cars	122	120	125	110	131	114	120	139	131	141	112	118	142	88	88	115	120	118	83	136	109	94	109	96	90	106	82	88	115	58
Buses	101	94	99	98	101	114	77	115	120	99	115	83	115	99	101	110	96	107	75	77	104	104	66	51	77	75	99	102	96	75
Trucks	64	99	134	99	136	72	75	50	70	72	107	118	107	122	112	96	101	118	94	99	74	117	83	72	112	115	131	93	90	80

Road **Addis Ababa - Awassa** Width of Pave.(m) = 7.3 Grade(%) =0.125
Station **59+430 to 59+655** Shoulder Width (m) = 2.7 Left Supper elevation(%) = 3.869
Horizontal Curve 59+543 2.6 Right Radius (m) = 950

	Speed (Km/hr)																													
Cars	99	96	93	90	86	83	112	102	99	125	115	107	117	117	146	118	123	125	117	117	168	141	144	107	70	114	107	141	128	96
Buses	117	112	136	106	128	114	96	80	99	96	141	78	98	115	115	120	104	110	83	77	75	102	96	101	115	83	99	114	99	98
Trucks	99	83	54	85	88	93	112	110	82	94	96	96	93	99	118	83	83	70	104	99	104	102	104	115	99	88	90	123	104	70

Road **Addis Ababa - Awassa** Width of Pave.(m) = 7 Grade(%) = 0.125
Station **59+655 to 62+515** Shoulder Width (m) = 2.4 Left Supper elevation(%)
Tangent 59+ 905 2.4 Right Tangent (m) = 2860

	Speed (Km/hr)																													
Cars	128	93	112	102	115	96	122	112	75	77	122	120	125	110	131	114	120	139	131	141	112	118	142	88	88	115	120	118	83	136
Buses	110	101	99	115	83	115	99	120	115	77	114	101	98	99	94	101	110	104	104	115	101	107	110	114	77	101	115	99	120	115
Trucks	118	78	94	99	78	125	74	146	74	117	83	75	99	72	112	115	107	74	69	131	93	77	82	90	80	78	75	75	150	102

Road **Addis Ababa - Awassa** Width of Pave.(m) = 7.2 Grade(%) =0.75
Station **62+520 to 62+810** Shoulder Width (m) = 2.3 Left Supper elevation(%) = 1.389
Horizontal Curve 62 + 665 2.6 Right Radius (m) = 1700

	Speed (Km/hr)																													
Cars	72	78	74	82	90	86	117	130	94	86	69	69	128	78	115	104	123	171	173	120	94	72	104	102	90	104	82	53	53	149
Buses	128	74	85	138	69	67	93	85	115	109	99	94	101	110	104	104	99	115	120	98	102	115	114	99	99	102	96	99	96	114
Trucks	114	98	80	74	128	80	114	114	74	72	72	70	72	75	101	104	72	83	96	130	102	90	106	110	53	67	96	109	88	93

Road **Addis Ababa - Awassa** Width of Pave.(m) = 7 Grade(%) = 1.75
Station **62+810 to 64+020** Shoulder Width (m) = 2.4 Left Supper elevation(%)
Tangent 63+060 2.7 Right Tangent (m) = 1210

	Speed (Km/hr)																													
Cars	142	114	109	147	114	86	109	82	115	114	75	142	99	54	91	104	96	102	117	141	138	104	102	112	120	115	147	88	120	122
Buses	85	78	72	91	70	91	98	88	102	90	72	107	82	110	101	99	115	83	120	99	120	115	77	114	101	98	99	110	104	115
Trucks	101	91	96	134	78	78	75	75	70	69	86	93	72	59	53	53	54	66	102	101	93	93	96	94	62	83	93	90	112	85

Road **Addis Ababa - Awassa** Width of Pave.(m) = 7 Grade(%) =2.5
Station **68+610to 68+910** Shoulder Width (m) = 2.6 Left Supper elevation(%) =7.57
Horizontal Curve 68+760 2.1 Right Radius (m) = 360

	Speed (Km/hr)																													
Cars	104	157	118	150	98	104	43	80	83	83	83	72	51	139	50	93	107	120	118	96	90	136	96	118	101	98	115	110	109	112
Buses	104	72	94	101	106	64	64	86	102	54	80	70	69	101	115	120	98	102	115	114	99	99	102	96	99	96	114	85	78	91
Trucks	91	102	107	112	61	59	80	66	98	104	54	48	48	50	107	75	50	45	85	93	78	67	83	120	107	120	122	70	74	72

Road **Addis Ababa - Awassa** Width of Pave.(m) = 7 Grade(%) = 2.5
Station **68+910 to 69+560** Shoulder Width (m) = 2.6 Left Supper elevation(%)
Tangent 69 + 160 2.1 Right Tangent (m) = 650

	Speed (Km/hr)																													
Cars	102	96	104	91	54	99	142	114	115	82	109	86	114	147	109	114	142	110	131	114	120	139	131	141	112	118	142	88	88	115
Buses	101	77	114	110	107	101	115	104	104	110	101	94	99	98	101	114	85	78	72	91	70	98	88	102	90	107	110	101	99	115
Trucks	99	72	112	115	107	74	69	131	93	77	107	74	131	77	90	80	101	91	96	134	78	86	93	72	78	110	115	118	101	110

Road **Addis Ababa - Awassa** Width of Pave.(m) = 7.4 Grade(%) = 0.75
Station **71+870 to 72+075** Shoulder Width (m) = 1.5 Left Supper elevation(%) =4.594
Horizontal Curve 71+973 1.3 Right Radius (m) = 400

	Speed (Km/hr)																													
Cars	93	75	90	142	136	112	152	134	109	99	117	123	115	82	91	117	94	133	134	93	104	118	104	80	93	107	120	118	96	90
Buses	50	93	120	109	114	70	112	123	115	120	114	99	102	94	101	94	99	110												
Trucks	90	35	83	106	94	48	61	99	37	98	99	101	67	99	102	67	51	122	91	98	96	94	112	98	104	107	75	83	120	107

Road **Addis Ababa - Awassa** Width of Pave.(m) = 6.9 Grade(%) = 0.597
Station **72+075 to 72+775** Shoulder Width (m) = 1.8 Left Supper elevation(%)
Tangent 72+325 1.9 Right Tangent(m) = 700

	Speed (Km/hr)																													
Cars	93	106	128	112	122	112	149	125	142	134	152	112	133	115	162	134	98	117	133	128	120	141	131	114	120	139	131	141	112	118
Buses	110	115	114	117	138	114	110	101	115	104	104	110	88	102	90	107														
Trucks	96	131	109	106	104	75	88	126	125	165	126	123	101	115	96	109	91	88	102	131	150	126	112	154	83	115	102	91	120	117

Road **Addis Ababa - Awassa** Width of Pave.(m) = 6.85 Grade(%) =0.5
Station **82+880 to 83+100** Shoulder Width (m) = 1.7 Left Supper elevation(%) = 11.375
Horizontal Curve 83+270 1.7 Right Radius (m) =700

	Speed (Km/hr)																													
Cars	98	176	152	125	98	126	118	122	123	107	98	150	101	125	126	152	114	144	173	114	134	130	96	118	142	166	147	149	114	115
Buses	106	128	114	122	112	115	109	115	96	102	106	94	88	93	118	117	102	134												
Trucks	67	104	72	88	101	102	99	98	109	101	82	155	85	107	93	125	107	123	72	117	96	107	115	72	85	110	109	75	131	88

Road **Addis Ababa - Awassa** Width of Pave.(m) = 12.25 Grade(%) =0.875
Station **83+100 to 83+700** Shoulder Width (m) = 1.6 Left Supper elevation(%)
Tangent 84+350 1.4 Right Tangent (m) = 600

	Speed (Km/hr)																													
Cars	88	109	85	86	90	96	80	78	91	88	150	138	142	115	120	102	85	109	110	120	107	83	85	118	99	102	134	109	93	99
Buses	104	101	107	115	117	120	106	125	126	91	83	120	74	86	85	90	75	117	118											
Trucks	152	107	85	94	96	99	74	69	82	149	115	157	122	77	72	99	112	122	106	86	106	101	106	102	53	74	107	91	106	106

Road **Addis Ababa - Awassa** Width of Pave.(m) = 6.9 Grade(%) =1.125
Station **86+620 to 86 +790** Shoulder Width (m) = 1.7 Left Supper elevation(%) = 4.058
Horizontal Curve 86+705 1.7 Right Radius (m) = 600

	Speed (Km/hr)																													
Cars	136	98	112	120	107	114	110	107	88	90	91	133	176	118	123	150	98	114	126	134	149	114	115	168	157	118	115	110	109	112
Buses	106	101	130	70	109	106	112	128	93	117	102	134	115	114	107	102	114	102	85											
Trucks	120	130	165	99	98	94	106	120	96	82	112	160	91	106	91	90	82	171	56	56	66	90	75	77	168	106	107	91	69	72

Road **Addis Ababa - Awassa** Width of Pave.(m) = 9 Grade(%) = 0.875
Station **86+790 to 87+590** Shoulder Width (m) = 1.6 Left Supper elevation(%)
Tangent 87+040 1.4 Right Tangent (m) = 800

	Speed (Km/hr)																													
Cars	120	102	85	109	110	120	107	83	118	85	102	99	109	134	99	93	90	86	85	78	88	91	138	106	122	128	112	125	134	142
Buses	118	75	117	90	86	85	120	74	126	91	83	125	120	106	126	115	107	123	138	110	115	101	88							
Trucks	91	96	109	101	115	96	123	125	165	126	88	126	75	125	106	88	104	131	96	109	106	107	102	122	112	122	157	149	99	96

Road **Addis Ababa - Awassa** Width of Pave.(m) = 7.2 Grade(%) =1.25
Station **88+300 to 88+520** Shoulder Width (m) = 1.7 Left Supper elevation(%) =3.85
Horizontal Curve 88+410 1.7 Right Radius (m) = 450

	Speed (Km/hr)																													
Cars	109	112	115	110	115	149	114	134	98	126	150	115	176	133	90	107	144	152	125	101	150	126	107	122	123	126	98	152	98	176
Buses	104	114	130	85	109	102	112	107	128	114	93	102	101	85	130	117	94	88	102	134										
Trucks	112	165	69	98	107	158	77	120	91	112	90	106	171	160	106	96	120	165	91	102	99	109	101	85	93	107	123	117	109	131

Road **Addis Ababa - Awassa** Width of Pave.(m) = 7.5 Grade(%) = 0.875
Station **88+520 to 89+220** Shoulder Width (m) = 1.5 Left Supper elevation(%)
Tangent 88 + 770 1.3 Right Tangent (m) = 700

	Speed (Km/hr)																													
Cars	115	120	107	118	99	109	99	138	150	91	96	80	90	86	134	120	138	102	91	109	88	120	86	107	93	118	102	109	102	120
Buses	115	123	110	101	125	83	126	120	86	117	118	91	106	115	101	106	120	117												
Trucks	106	75	126	123	115	109	96	126	106	131	109	107	102	125	88	157	77	99	112	82	86	106	91	102	106	86	112	99	157	94

Road **Addis Ababa - Awassa** Width of Pave.(m) = 7.3 Grade(%) = 1.2
Station **97+540 to 97+860** Shoulder Width (m) = 1.3 Left Supper elevation(%) =4.1
Horizontal Curve 97+700 1.8 Right Radius (m) = 580

	Speed (Km/hr)																													
Cars	118	112	110	123	112	134	150	118	176	133	90	110	107	112	149	157	152	150	134	115	112	125	123	152	133	176	149	109	122	126
Buses	102	88	130	102	93	112	130	104	94	93	102	130	109	130	115	102	102	134	128	112	70	101	115	102	114	112	93	70	101	115
Trucks	160	90	165	102	109	93	123	109	106	158	165	120	106	160	109	101	123	112	90	112	120	130	112	106	91	106	120	106	158	99

Road **Addis Ababa - Awassa** Width of Pave.(m) = 7.9 Grade(%) = 1.3
Station **97+860 to 99+320** Shoulder Width (m) = 1.2 Left Supper elevation(%)
Tangent 98+110 1.3 Right Tangent(m) = 1460

	Speed (Km/hr)																													
Cars	115	107	109	138	80	134	138	120	109	118	99	134	93	85	91	78	128	130	106	109	118	109	91	109	120	91	93	120	102	120
Buses	91	117	120	83	101	123	101	118	117	85	91	106	126	107	138	115	88	120	75	125	120	106	115	125	115	101	118	91	107	107
Trucks	109	106	107	102	122	112	122	94	117	122	99	122	86	106	112	157	123	120	106	109	112	86	157	112	94	102	86	99	106	86

Road **Addis Ababa - Awassa** Width of Pave.(m) = 6.9 Grade(%) =1.125
Station **99+330 to 99+650** Shoulder Width (m) = 1.7 Left Supper elevation(%) = 4.058
Horizontal Curve 99+490 1.7 Right Radius (m) =850

	Speed (Km/hr)																													
Cars	112	123	133	149	122	149	107	133	150	123	112	125	176	122	150	128	134	126	123	133	144	101	110	109	123	152	176	133	98	149
Buses	101	93	128	112	109	130	104	88	117	85	102	128	130	138	106	115	88	118	106	125										
Trucks	91	106	120	109	117	93	165	123	112	165	107	158	106	171	102	125	126	126	75	106	106	131	109	109	115	126	102	88	88	75

Road **Addis Ababa - Awassa** Width of Pave.(m) = 7.3 Grade(%) =1.5
Station **99+650 to 100+540** Shoulder Width (m) = 1.2 Left Supper elevation(%)
Tangent 99+900 1.3 Right Tangent (m) = 890

	Speed (Km/hr)																													
Cars	134	86	115	118	138	150	96	91	80	86	123	120	118	102	109	85	120	118	99	134	96	90	85	109	93	99	115	138	96	90
Buses	107	118	117	86	120	126	91	125	117	107	75	125	115	118	117	138	115	91	85											
Trucks	117	122	86	157	112	123	120	109	112	157	94	86	106	86	106	122	112	112	86	53	91	106	149	96	94	122	77	115	149	99

Road **Addis Ababa - Awassa** Width of Pave.(m) = 7.2 Grade(%) =1.125
Station **104+055 to 104+200** Shoulder Width (m) = 2 Left Supper elevation(%) = 3.5
Horizontal Curve 104+128 1.6 Right Radius (m) = 400

	Speed (Km/hr)																													
Cars	112	107	110	88	91	133	118	150	126	134	114	157	115	118	110	109	115	109	123	176	98	149	80	150	112	114	133	176	134	114
Buses	88	118	125	106	106	130	99	102	85	114	101	130	104	85	99	93	117	94	102	114	102	128								
Trucks	106	109	115	102	88	75	106	126	102	125	165	102	109	85	99	117	158	98	165	112	109	131	106	112	90	107	98	165	112	96

Road **Addis Ababa - Awassa** Width of Pave.(m) = 7.3 Grade(%) = 0 1.3
Station **104+200 to 105+260** Shoulder Width (m) = 1.2 Left Supper elevation(%)
Tangent 104+450 1.3 Right Tangent (m) = 1060

	Speed (Km/hr)																													
Cars	99	96	118	86	109	93	96	80	91	90	150	138	109	102	123	150	134	96	134	90	96	150	99	118	107	115	120	138	88	102
Buses	123	101	125	126	86	118	106	101	106	117	120	125	118	91	107	107	85	138	117	106	120									
Trucks	86	106	112	86	91	106	94	122	115	149	99	122	157	112	123	120	112	96	102	86	77	99	112	91	106	82	112	77	128	133

Road **Addis Ababa - Awassa** Width of Pave.(m) = 6.9 Grade(%) =1.3
Station **105+260 to 105+435** Shoulder Width (m) = 1.65 Left Supper elevation(%) =2.5
Horizontal Curve 105+348 1.8 Right Radius (m) = 900

	Speed (Km/hr)																													
Cars	126	109	152	112	157	110	176	118	112	128	110	118	152	176	109	126	122	123	122	107	123	112	152	133	150	90	107	134	123	118
Buses	115	70	93	102	93	102	128	112	134	107	85	104	114	94	88	107	109	102												
Trucks	101	85	96	144	144	93	117	69	126	120	91	112	109	101	131	112	90	56	75	126	99	91	106	69	106	96	120	126	99	130

Road **Addis Ababa - Awassa** Width of Pave.(m) = 7.3 Grade(%) = 1.4
Station **105+435 to 107+200** Shoulder Width (m) = 1.2 Left Supper elevation(%)
Tangent 105+685 1.3 Right Tangent (m) = 1765

	Speed (Km/hr)																													
Cars	93	86	101	91	83	110	120	118	134	91	138	83	120	118	109	120	80	90	86	99	106	122	112	128	134	142	115	99	138	134
Buses	115	110	126	86	91	106	101	90	117	74	83	125	106	107	110	115	101	104												
Trucks	122	112	102	107	109	96	131	107	109	88	126	106	112	106	112	82	77	141	109	106	101	109	69	144	77	112	106	144	144	78

Road **Addis Ababa - Awassa** Width of Pave.(m) = 6.9 Grade(%) =0.25
Station **116+244 to 116+500** Shoulder Width (m) = 2 Left Supper elevation(%) =4.348
Horizontal Curve 116+372 1.5 Right Radius (m) = 550

	Speed (Km/hr)																													
Cars	93	106	112	46	72	117	109	130	139	112	125	90	126	82	125	106	130	126	82	152	126	123	104	114	125	104	72	93	91	106
Buses	102	77	107	141	128	107	94	88	130	104	85	88	102	134	85	130	104													
Trucks	104	96	69	70	102	117	128	91	106	115	90	141	109	122	128	114	91	144	130	115	117	88	93	78	104	107	136	134	88	115

Road **Addis Ababa - Awassa** Width of Pave.(m) = 6.8 Grade(%) = 0.5
Station **116+500 to 119+000** Shoulder Width (m) = 1.5 Left Supper elevation(%)
Tangent 116+750 1.6 Right Tangent(m) = 2500

	Speed (Km/hr)																													
Cars	163	114	131	141	142	115	118	112	147	66	130	109	131	128	142	155	106	123	136	142	152	160	88	93	102	102	120	86	104	109
Buses	106	150	141	128	117	118	110	123	101	91	120	117	83	101	123	101														
Trucks	131	99	93	125	123	134	94	109	120	131	125	134	125	144	86	104	144	134	118	142	104	144	133	123	85	144	86	104	117	114

Road **Addis Ababa - Awassa** Width of Pave.(m) = 6.8 Grade(%) =1.5
Station **180+274 to 180+874** Shoulder Width (m) = 1.8 Left Supper elevation(%) = 4.41
Horizontal Curve 180+574 1.5 Right Radius (m) =600

	Speed (Km/hr)																													
Cars	146	136	123	144	123	133	157	133	139	101	110	131	130	174	136	101	123	141	157	112	134	154	146	130	88	106	120	126	136	141
Buses	128	136	146	131	139	114	91	98	142	120	136	144	107	131	104	115	94													
Trucks	98	120	139	128	133	112	139	142	115	141	96	90	72	75	104	93	72	74	78	128	131	120	104	109	118	122	131	77	82	93

Road **Addis Ababa - Awassa** Width of Pave.(m) = 6.8 Grade(%) =1.0
Station **180+874 to 183+234** Shoulder Width (m) = 1.6 Left Supper elevation(%)
Tangent 181+124 1.7 Right Tangent (m) = 2360

	Speed (Km/hr)																													
Cars	131	125	147	106	110	138	141	128	99	99	120	122	118	139	110	131	165	131	136	176	120	150	142	118	115	94	149	82	74	134
Buses	123	120	130	144	77	122	144	131	134	118	93	134	99	144	118															
Trucks	122	94	101	109	67	138	138	106	131	104	96	147	59	72	70	98	107	112	104	88	94	115	125	131	128	104	102	112	115	125

Road **Addis Ababa - Awassa** Width of Pave.(m) = 6.85 Grade(%) =0.25
Station **189+175 to 189+530** Shoulder Width (m) = 1.9 Left Supper elevation(%) = 5.985
Horizontal Curve 189+400 1.7 Right Radius (m) = 570

	Speed (Km/hr)																													
Cars	104	144	93	117	117	141	173	141	96	107	144	138	122	134	131	154	133	93	122	98	94	118	144	118	106	155	118	110	122	110
Buses	114	122	138	115	122	126	110	78	133	134	104	118	94	110	117	125														
Trucks	62	61	68	93	101	102	120	82	110	90	101	114	94	134	133	142	144	104	115	125	112	109	131	110	93	96	107	77	83	128

Road **Addis Ababa - Awassa** Width of Pave.(m) = 6.8 Grade(%) = 0 1.3
Station **189+530 to 190+750** Shoulder Width (m) = 1.7 Left Supper elevation(%)
Tangent 189+780 1.7 Right Tangent (m) = 1220

	Speed (Km/hr)																													
Cars	176	96	166	152	155	141	131	134	120	181	147	122	125	88	147	147	147	131	136	78	128	88	109	128	134	123	109	115	147	150
Buses	83	109	96	125	134	93	107	101	126	126	82	134	155	101	102	85														
Trucks	93	96	98	106	96	117	94	77	114	125	77	77	118	141	118	123	75	90	112	88	128	131	118	104	109	88	85	104	101	106

Road **Addis Ababa - Awassa** Width of Pave.(m) = 6.9 Grade(%) =0.65
Station **190+670 to 191+005** Shoulder Width (m) = 1.7 Left Supper elevation(%) =4.6
Horizontal Curve 191+003 1.9 Right Radius (m) = 460

	Speed (Km/hr)																													
Cars	112	133	144	125	123	152	109	150	134	118	149	125	152	109	122	126	149	123	176	152	144	118	122	98	122	144	133	98	118	110
Buses	102	130	128	112	101	99	104	130	102	114	93	102	101	114	112	115	130	104	94	115										
Trucks	144	93	120	130	112	106	99	101	123	85	165	160	109	91	107	98	106	123	91	102	101	85	93	107	109	85	165	112	106	90

Road **Addis Ababa - Awassa** Width of Pave.(m) = 6.9 Grade(%) = 0.25
Station **191+005 to 191+805** Shoulder Width (m) = 1.6 Left Supper elevation(%)
Tangent 191+255 1.8 Right Tangent (m) = 780

	Speed (Km/hr)																													
Cars	96	80	86	109	120	91	90	109	83	118	109	102	85	88	91	112	125	106	110	118	85	99	120	88	102	88	109	102	120	93
Buses	120	85	101	101	120	117	96	91	115	101	110	101	126	91	83	90	117	125	120	101	88									
Trucks	88	94	96	109	88	126	125	96	115	96	91	131	109	107	102	96	123	126	75	107	125	88	106	125	86	106	112	82	77	157

Road **Addis Ababa - Awassa** Width of Pave.(m) = 6.8 Grade(%) =0.75
Station **217+580 to 217+800** Shoulder Width (m) = 1.67 Left Supper elevation(%) = 3.434
Horizontal Curve 217+650 1.75 Right Radius (m) =540

	Speed (Km/hr)																													
Cars	122	133	98	106	133	131	91	133	128	98	106	120	138	125	118	104	158	166	130	131	98	141	115	165	141	102	142	115	118	94
Buses	99	98	120	106	110	91	128	117	138	114	141	93	102	144	150	133	130	112												
Trucks	115	80	70	117	138	131	112	77	67	88	35	130	82	99	96	96	82	96	117	112	115	130	96	112	80	120	106	120	93	160

Road **Addis Ababa - Awassa** Width of Pave.(m) = 6.8 Grade(%) = 3.75
Station **217+800 to 218+160** Shoulder Width (m) = 1.5 Left Supper elevation(%)
Tangent 217+900 1.1 Right Tangent(m) = 565

	Speed (Km/hr)																													
Cars	152	149	157	160	139	141	106	90	149	134	117	90	64	136	154	134	141	165	163	99	158	157	91	154	139	131	118	163	112	114
Buses	107	86	78	90	98	99	104	138	106	96	128	106	85	102																
Trucks	56	90	107	45	86	96	118	107	94	77	88	117	80	115	88	96	82	86	106	86	99	125	99	112	82	107	106	122	112	122

Road **Addis Ababa - Awassa** Width of Pave.(m) = 6.83 Grade(%) =0.5
Station **227+560 to 227+720** Shoulder Width (m) = 1.75 Left Supper elevation(%) =4.3
Horizontal Curve 227+640 2.2 Right Radius (m) =1000

	Speed (Km/hr)																													
Cars	118	104	158	166	130	106	104	133	131	122	133	141	142	115	118	106	120	149	115	125	152	176	152	150	134	112	118	152	157	149
Buses	130	109	115	134	70	112	93	88	114	112	128	134	93	112	102	112	85	130	109	93	85									
Trucks	139	125	125	93	120	91	107	112	130	112	106	109	102	128	112	130	120	106	128	109	126	123	126	91	109	106	117	120	93	112

Road **Addis Ababa - Awassa** Width of Pave.(m) = 6.83 Grade(%) =0.65
Station **227+720 to 229+900** Shoulder Width (m) = 1.65 Left Supper elevation(%)
Tangent 227+970 1.8 Right Tangent (m) = 2180

	Speed (Km/hr)																													
Cars	115	109	138	130	109	118	91	120	93	120	102	93	128	130	138	86	134	120	107	115	150	109	78	120	109	85	102	93	120	102
Buses	101	101	120	91	83	115	91	107	120	138	85	118	78	85	126	118	91	106												
Trucks	112	102	106	109	125	86	112	109	123	112	144	122	117	99	106	86	96	123	115	125	88	106	109	106	88	123	101	115	96	109

Road **Addis Ababa - Awassa** Width of Pave.(m) = 6.93 Grade(%) =0.6
Station **231+440 to 231+650** Shoulder Width (m) = 2 Left Supper elevation(%) = 6.2
Horizontal Curve 231+545 1.6 Right Radius (m) = 360

	Speed (Km/hr)																													
Cars	176	123	114	120	110	98	114	157	118	109	112	112	120	98	144	101	107	123	46	134	98	110	115	149	176	126	150	98	176	122
Buses	102	99	93	128	109	98	133	134	115	114	102	106	109	115	101	94	112	125	102											
Trucks	130	99	158	120	112	144	106	90	136	133	106	107	91	96	128	99	102	106	126	123	109	131	120	91	144	120	130	96	82	106

Road **Addis Ababa - Awassa** Width of Pave.(m) = 6.9 Grade(%) = 0.55
Station **231+650 to 231+950** Shoulder Width (m) = 1.5 Left Supper elevation(%)
Tangent 231+900 1.75 Right Tangent (m) = 300

	Speed (Km/hr)																													
Cars	134	90	80	91	138	99	107	115	120	176	134	99	93	78	91	120	102	107	88	91	112	125	128	142	134	83	118	85	78	138
Buses	120	126	118	91	106	110	101	115	91	106	126	115	101	88	90	86	118	75	110											
Trucks	126	106	131	96	109	106	107	102	131	109	107	102	106	131	125	123	101	109	96	91	96	109	106	142	75	123	106	112	86	122

Road **Addis Ababa - Awassa** Width of Pave.(m) = 6.85 Grade(%) =0.35
Station **238+872 to 239+030** Shoulder Width (m) = 1.85 Left Supper elevation(%) =5.6
Horizontal Curve 238+951 1.7 Right Radius (m) = 220

	Speed (Km/hr)																													
Cars	150	115	176	133	112	115	107	110	109	126	152	146	176	98	150	125	101	134	149	98	114	99	157	134	110	99	120	112	98	114
Buses	141	102	114	93	109	85	106	128	93	134	99	114	102	85	130	70	106	112	114	102										
Trucks	136	120	112	123	109	120	136	98	107	136	136	102	99	131	109	85	99	83	96	56	74	77	91	106	96	82	99	96	106	130

Road **Addis Ababa - Awassa** Width of Pave.(m) = 6.9 Grade(%) = 0.55
Station **239+030 to 239+560** Shoulder Width (m) = 1.84 Left Supper elevation(%)
Tangent 239+280 1.9 Right Tangent (m) = 530

	Speed (Km/hr)																													
Cars	134	138	150	91	115	120	86	96	80	109	134	85	120	107	109	120	102	91	138	118	99	106	109	118	128	134	118	130	99	118
Buses	126	120	118	91	115	101	115	75	125	115	106	126	118	107	110	101	115	123	106	120	86	85	117	75						
Trucks	133	126	125	106	131	109	96	126	106	125	126	122	117	141	102	109	96	131	125	88	126	96	109	91	107	110	109	112	112	128

Road **Addis Ababa - Awassa** Width of Pave.(m) = 6.7 Grade(%) =2.125
Station **240+900 to 241+250** Shoulder Width (m) = 1.7 Left Supper elevation(%) =1.94
Horizontal Curve 241+100 1.7 Right Radius (m) = 220

	Speed (Km/hr)																													
Cars	120	94	114	86	130	138	112	136	75	146	147	126	109	101	107	94	78	136	126	154	77	133	93	130	98	122	102	146	128	128
Buses	98	115	86	102	110	96	101	128	99	91	102	101	130	94	88	102	134	85	130											
Trucks	64	114	64	102	101	149	106	118	83	128	78	75	91	85	75	125	123	149	102	83	128	114	128	102	157	109	117	131	102	120

Road **Addis Ababa - Awassa** Width of Pave.(m) = 6.75 Grade(%) = 1.125
Station **241+150 to 241+800** Shoulder Width (m) = 1.7 Left Supper elevation(%)
Tangent 241+500 1.5 Right Tangent(m) = 1440

	Speed (Km/hr)																													
Cars	104	96	147	109	112	128	131	67	120	112	110	77	123	69	91	101	120	115	141	133	91	90	104	107	115	125	130	82	96	120
Buses	102	122	125	83	122	90	122	122	106	115	117	123	110	118	91	115	125	120	88	106										
Trucks	93	109	99	96	70	83	69	115	85	54	75	99	88	118	83	64	80	106	86	93	110	107	115	122	123	102	77	93	83	88

Road **Addis Ababa - Jimma** Width of Pave.(m) = 7 Grade(%) =0.125
Station **35+155 to 35+377** Shoulder Width (m) = 1.9 Left Supper elevation(%) = 6.857
Horizontal Curve 35+266 1.45 Right Radius (m) = 425

	Speed (Km/hr)																													
Cars	139	115	133	136	130	98	141	154	138	150	83	163	128	101	133	131	154	115	122	133	128	99	115	166	138	102	106	138	99	128
Buses	109	128	110	115	134	102	131	128	128	115	115	126	88	125	110	141	106	141	102	138	114	74	144							
Trucks	131	125	128	128	114	125	106	112	141	112	99	139	117	106																

Road **Addis Ababa - Jimma** Width of Pave.(m) = 7.05 Grade(%) =0.25
Station **35+377 to 36+300** Shoulder Width (m) = 1.8 Left Supper elevation(%)
Tangent 35+627 1.5 Right Tangent (m) = 523

	Speed (Km/hr)																													
Cars	134	130	109	141	96	144	91	99	101	163	106	150	139	72	128	123	126	141	125	120	96	107	118	131	102	96	130	131	120	138
Buses	128	131	109	125	122	120	128	86	90	110	130	142	114	139	117	139	142	142	102	125										
Trucks	122	99	155	154	85	102	115	122	128	120	109	75	120	85	114	80	82	144	115	123										

Road **Addis Ababa - Jimma** Width of Pave.(m) = 6.95 Grade(%) =0.5
Station **39+213 to 39+638** Shoulder Width (m) = 1.7 Left Supper elevation(%) =6.324
Horizontal Curve 39+400 1.5 Right Radius (m) = 425

	Speed (Km/hr)																													
Cars	122	88	93	88	88	80	91	112	107	91	90	90	104	90	67	99	99	138	109	122	109	51	112	90	70	77	80	109	112	117
Buses	123	94	102	102	112	80	86	78	90	91	96	75	106	58	83	66	96	93	90	94	99									
Trucks	78	82	107	64	98	82	64	106	51	90	94	94	94	77	104	77	112	122	102	77										

Road **Addis Ababa - Jimma** Width of Pave.(m) = 7.2 Grade(%) = 0.25
Station **39+638 to 40+038** Shoulder Width (m) = 3.5 Left Supper elevation(%)
Tangent 39+880 3.5 Right Tangent (m) = 1650

	Speed (Km/hr)																													
Cars	72	99	107	117	112	102	104	101	157	96	131	56	91	114	69	125	131	125	102	99	102	64	70	64	99	102	85	101	104	78
Buses	77	117	90	91	88	85	74	67	90	53	69	106	86	91	109	59	86	118												
Trucks	96	131	134	78	90	74	123	75	104	64	72	104	112	112	83	72														

Road **Addis Ababa - Jimma** Width of Pave.(m) = 7.1 Grade(%) =0.25
Station **52+706 to 52+830** Shoulder Width (m) = 1.5 Left Supper elevation(%) =6.62
Horizontal Curve 52+768 1.5 Right Radius (m) = 300

	Speed (Km/hr)																													
Cars	114	118	115	94	99	134	99	102	150	131	106	51	102	115	64	125	122	131	115	96	101	104	152	107	117	138	114	152	69	91
Buses	118	118	114	115	106	136	130	104	101	104	125	101	114	96	93	85	94	101	82											
Trucks	112	131	96	107	122	99	62	125	133	109	101	64	96	78	104	66	83													

Road **Addis Ababa - Jimma** Width of Pave.(m) = 7.33 Grade(%) = 0.25
Station **52+830 to 56+420** Shoulder Width (m) = 1.4 Left Supper elevation(%)
Tangent 53+080 1.45 Right Tangent(m) = 3590

	Speed (Km/hr)																													
Cars	93	115	122	93	138	96	141	160	141	154	131	128	133	136	101	139	134	141	93	120	91	114	91	130	126	99	133	136	118	122
Buses	96	128	133	120	139	131	101	96	115	130	144	99	118	131	99	128	98													
Trucks	94	138	102	85	88	110	96	110	114	104	134	112	130	102	109	130	126	106	99	149	110									

Road **Addis Ababa - Jimma** Width of Pave.(m) = 7 Grade(%) =0.125
Station **99+410 to 99+482** Shoulder Width (m) = 1.65 Left Supper elevation(%) = 1.286
Horizontal Curve 99+446 1.9 Right Radius (m) =500

	Speed (Km/hr)																													
Cars	90	106	98	115	109	102	82	115	118	152	109	126	131	123	107	110	109	93	94	93	117	104	117	110	125	112	94	94	83	104
Buses	122	102	107	72	109	96	102	118	99	69	112	99	106	112	96	69	98													
Trucks	138	74	128	134	101	104	90	90	115	115	114	112	93	96	99	112	85	82												

Road **Addis Ababa - Jimma** Width of Pave.(m) = 7 Grade(%) =0.125
Station **99+482 to 99+938** Shoulder Width (m) = 1.4 Left Supper elevation(%)
Tangent 99+732 1.37 Right Tangent (m) = 456

	Speed (Km/hr)																													
Cars	90	99	99	107	125	77	74	86	104	98	107	83	147	134	118	77	99	128	102	78	130	122	106	78	88	99	85	120	91	101
Buses	82	86	77	88	80	109	101	106	78	83	74	85	77	106	98	102	75													
Trucks	69	101	77	64	93	86	67	74	109	64	51	74	69	102	59	64	70	67	78	106	54	80	102	78	70					

Road **Addis Ababa - Jimma** Width of Pave.(m) = 7 Grade(%) =2.125
Station **117+998 to 118+116** Shoulder Width (m) = 1.9 Left Supper elevation(%) = 7.143
Horizontal Curve 118+057 1.4 Right Radius (m) = 500

	Speed (Km/hr)																													
Cars	147	141	139	94	112	88	86	110	109	85	152	109	133	125	106	109	107	94	96	94	114	101	114	107	122	109	91	80	101	138
Buses	83	93	115	102	93	85	77	74	82	91	114	101	90	82	74	70	82	99												
Trucks	107	85	78	74	61	67	101	82	75	70	58	70	98	80	78	74	61													

Road **Addis Ababa - Jimma** Width of Pave.(m) = 7 Grade(%) = 2.875
Station **118+116 to 121+937** Shoulder Width (m) = 1.1 Left Supper elevation(%)
Tangent 118+366 1 Right Tangent (m) = 3821

	Speed (Km/hr)																													
Cars	120	120	120	72	101	112	107	109	134	104	120	118	114	120	136	66	118	122	77	104	115	72	104	114	115	66	86	104	88	85
Buses	117	102	86	61	88	61	77	91	112	93	69	85	62	86	115	64	74													
Trucks	112	115	120	85	109	85	64	157	70	109	93	104	56	86																

Road **Addis Ababa - Jimma** Width of Pave.(m) = 7.15 Grade(%) =0.25
Station **122+048 to 122+160** Shoulder Width (m) = 1.1 Left Supper elevation(%) =6.57
Horizontal Curve 122+105 1.8 Right Radius (m) = 200

	Speed (Km/hr)																													
Cars	109	90	106	109	125	107	106	104	109	114	83	128	133	117	112	128	134	104	104	85	101	120	101	101	86	133	138	122	112	107
Buses	62	109	125	107	104	83	125	126	130	101	102	104	120	106	104	123	125	126	104	122	112	64								
Trucks	82	66	112	96	80	82	98	75	80	64	109	93	77	78	94	72														

Road **Addis Ababa - Jimma** Width of Pave.(m) = 7 Grade(%) = 0.25
Station **122+160 to 122+591** Shoulder Width (m) = 1.15 Left Supper elevation(%)
Tangent 122+410 1.3 Right Tangent (m) = 431

	Speed (Km/hr)																													
Cars	130	67	130	154	131	106	122	104	115	141	131	158	122	122	131	126	131	131	125	64	125	128	102	118	101	112	138	101	112	118
Buses	115	99	107	110	122	125	122	120	104	106	99	112	96	104	102	118														
Trucks	77	114	90	82	96	118	93	110	86	78	93	115	90	107	86	110														

Road **Addis Ababa - Jimma** Width of Pave.(m) = 7 Grade(%) =1.375
Station **132+745 to 132+882** Shoulder Width (m) = 1.2 Left Supper elevation(%) =6.143
Horizontal Curve 132+814 2.3 Right Radius (m) = 600

	Speed (Km/hr)																													
Cars	136	88	141	163	147	123	147	123	141	138	131	154	115	133	122	128	99	115	166	138	102	106	138	99	128	141	154	138	150	83
Buses	147	120	126	93	118	141	134	115	134	102	99	115	126	94	125	141	106	141	102	144										
Trucks	114	117	154	104	101	134	75	83	83	96	128	128	114	125	106	96														

Road **Addis Ababa - Jimma** Width of Pave.(m) = 7.1 Grade(%) = 2.25
Station **132+882 to 133+456** Shoulder Width (m) = 1.2 Left Supper elevation(%)
Tangent 133+132 1.3 Right Tangent(m) = 574

	Speed (Km/hr)																													
Cars	118	130	133	154	144	170	163	147	112	158	138	118	109	83	107	98	104	86	74	77	125	107	134	147	99	128	102	130	122	106
Buses	93	91	150	139	131	106	128	133	101	122	128	107	99	83	136	125														
Trucks	62	128	96	90	115	115	112	93	96	99	112	85	109	93	101	102	106													

Road **Addis Ababa - Jimma** Width of Pave.(m) = 7.05 Grade(%) =1.375
Station **166+020 to166+175** Shoulder Width (m) = 1.7 Left Supper elevation(%) = 6.525
Horizontal Curve 166+098 1.2 Right Radius (m) =190

	Speed (Km/hr)																													
Cars	48	96	117	93	123	128	117	128	104	109	90	106	109	125	107	106	104	109	114	83	128	144	138	136	90	109	85	83	107	106
Buses	70	115	112	83	102	85	77	83	93	114	90	74	91	99	93	102	91	101	90											
Trucks	101	88	67	99	90	98	85	64	96	86	64	80	74	112	96	107	62	91												

Road **Addis Ababa - Jimma** Width of Pave.(m) = 7 Grade(%) =1.2857
Station **166+175 to 166+810** Shoulder Width (m) = 1.3 Left Supper elevation(%)
Tangent 166+425 1.3 Right Tangent (m) = 635

	Speed (Km/hr)																													
Cars	82	176	134	104	120	118	114	120	136	66	118	122	77	104	122	122	157	131	138	115	101	122	102	128	150	126	70	106	117	112
Buses	98	149	83	123	126	118	117	109	102	115	99	107	107	117	85	102														
Trucks	99	70	83	77	83	114	82	96	118	93	78	115	102	70	91	104	93													

Road **Addis Ababa - Tarmaber** Width of Pave.(m) = 7.2 Grade(%) =4.25
Station **16+045 to 16+164** Shoulder Width (m) = 0.9 Left Supper elevation(%) = 6.944
Horizontal Curve 16+105 1.4 Right Radius (m) = 600

	Speed (Km/hr)																													
Cars	22	82	77	109	69	70	46	58	45	42	32	77	43	62	45	42	40	50	56	53	66	53	48	69	64	61	59	54	85	75
Buses	61	51	64	77	93	112	48	66	40	56	82	56	53	50	53	61	50	77	54	70										
Trucks	75	80	43	40	61	43	48	67	45	40	62	66	80	43	53	70	77													

Road **Addis Ababa - Tarmaber** Width of Pave.(m) = 7 Grade(%) = 2.857
Station **16+164 to 16+900** Shoulder Width (m) = 1.1 Left Supper elevation(%)
Tangent 16+414 1.9 Right Tangent (m) = 736

	Speed (Km/hr)																													
Cars	38	67	46	62	53	42	46	48	51	64	45	51	56	54	62	38	59	66	80	62	51	54	77	59	94	48	42	70	38	75
Buses	51	54	56	50	48	70	38	67	61	53	67	50	54	58	61	67	45	50												
Trucks	40	50	45	35	70	61	51	51	61	45	43	61	43	56	61	64	35	32	51	34	35	29	58	54	72					

Road **Addis Ababa - Tarmaber** Width of Pave.(m) = 8.1 Grade(%) =5.625
Station **25+218 to 25+305** Shoulder Width (m) = 2.2 Left Supper elevation(%) =8.67
Horizontal Curve 25+262 1.8 Right Radius (m) = 170

	Speed (Km/hr)																													
Cars	50	88	77	90	59	83	53	53	62	69	35	93	80	58	67	56	45	51	43	88	128	80	64	74	40	38	72	82	56	90
Buses	59	80	58	48	64	59	80	80	88	85	61	69	66	51	58	56	61													
Trucks	80	70	56	29	32	58	86	90	30	22	26	69	45	70	66	85	82	40	45	54										

Road **Addis Ababa - Awassa** Width of Pave.(m) = 7.1 Grade(%) = 6.125
Station **25+305 to 25+600** Shoulder Width (m) = 2.7 Left Supper elevation(%)
Tangent 25+555 1 Right Tangent (m) = 295

	Speed (Km/hr)																													
Cars	38	51	58	101	77	75	69	66	102	98	78	61	58	50	72	75	46	72	61	90	109	54	54	93	74	42	56	54	58	61
Buses	66	70	69	61	56	43	53	70	62	74	72	54	77	70	59	46	56	61	50											
Trucks	59	56	58	59	59	56	64	75	72	77	56	53	66	77	50	46	69	56	61	78	69	80								

Road **Addis Ababa - Tarmaber** Width of Pave.(m) = 6.9 Grade(%) =1.25
Station **25+680 to 25+782** Shoulder Width (m) = 0.9 Left Supper elevation(%) =1.45
Horizontal Curve 25+731 0.8 Right Radius (m) = 2000

	Speed (Km/hr)																													
Cars	62	91	86	78	77	101	61	62	70	72	85	70	70	72	45	91	75	85	86	88	85	61	77	66	74	123	128	64	120	61
Buses	91	53	51	75	114	112	88	62	58	48	50	104	77	102	88	101	98	112	101											
Trucks	58	66	58	43	51	53	72	66	61	46	45	50	58	64	77	56	62	61	58	66										

Road **Addis Ababa - Tarmaber** Width of Pave.(m) = 7.2 Grade(%) = 4.86
Station **25+782 to 26+079** Shoulder Width (m) = 0.2 Left Supper elevation(%)
Tangent 26+032 0.4 Right Tangent(m) = 297

	Speed (Km/hr)																													
Cars	70	82	56	72	80	112	51	82	125	74	91	110	98	112	77	64	70	80	109	48	90	122	75	72	78	90	74	85	64	45
Buses	80	77	85	80	72	90	90	109	98	80	104	112	115	118	98	91	77	74	69											
Trucks	82	48	67	102	54	70	82	67	72	80	82	77	75	62	77	85	90	93	98											

Road **Addis Ababa - Tarmaber** Width of Pave.(m) = 7.3 Grade(%) =0.125
Station **32+243 to 32+428** Shoulder Width (m) = 0 Left Supper elevation(%) = 5.89
Horizontal Curve 32+333 0 Right Radius (m) =375

	Speed (Km/hr)																													
Cars	80	72	74	77	74	43	86	75	80	77	74	85	85	88	83	94	88	91	90	42	94	96	88	93	94	86	94	101	98	86
Buses	96	107	90	70	83	80	83	83	85	77	75	98	86	101	94	91	86	96	98	91										
Trucks	77	78	77	115	82	83	86	67	72	77	101	98	78	72	69	86	88	93	94	98	99									

Road **Addis Ababa - Tarmaber** Width of Pave.(m) = 7.2 Grade(%) =0.875
Station **32+428 to 33+000** Shoulder Width (m) = 0 Left Supper elevation(%)
Tangent 32+678 0 Right Tangent (m) = 572

	Speed (Km/hr)																													
Cars	99	104	96	82	96	96	93	94	112	83	90	98	85	78	96	78	83	112	115	109	99	96	98	94	83	99	86	88	91	93
Buses	106	94	59	66	91	93	91	91	94	109	117	118	69	77	74	66	69	70	94	98	101	102	104							
Trucks	102	88	54	75	70	94	90	80	85	80	70	88	91	94	106	70	78	98	86	85	75									

Road **Addis Ababa - Tarmaber** Width of Pave.(m) = 7.1 Grade(%) =3.75
Station **44+860 to 44+963** Shoulder Width (m) = 1.7 Left Supper elevation(%) =4.51
Horizontal Curve 44+912 2.1 Right Radius (m) = 300

	Speed (Km/hr)																													
Cars	83	88	43	104	102	96	72	112	99	94	117	96	149	102	90	83	94	112	96	102	78	83	109	96	82	91	88	94	88	85
Buses	98	115	91	98	99	90	83	83	107	96	77	75	96	86	94	96	91	101	86	101	102	107								
Trucks	88	62	93	80	66	96	98	85	90	75	82	86	96	77	66	101	98	80	69	74	78	80	85							

Road **Addis Ababa - Tarmaber** Width of Pave.(m) = 7.3 Grade(%) = 2.25
Station **44+963 to 45+500** Shoulder Width (m) = 0 Left Supper elevation(%)
Tangent 45+213 0 Right Tangent (m) = 537

	Speed (Km/hr)																													
Cars	112	117	130	106	128	110	138	118	122	141	112	131	112	122	93	128	90	130	112	136	120	128	115	110	110	130	91	117	104	115
Buses	90	93	123	85	109	98	91	78	96	93	93	67	96	104	75	96	70	102	104	106	78	70								
Trucks	80	130	126	77	91	144	96	98	83	91	78	102	82	75	80	82	107	86	82	90	104	96	101							

Road **Addis Ababa - Tarmaber** Width of Pave.(m) = 7 Grade(%) =4.1
Station **46+306 to 46+382** Shoulder Width (m) = 0.3 Left Supper elevation(%) =6.3
Horizontal Curve 46+344 0.2 Right Radius (m) = 275

	Speed (Km/hr)																													
Cars	112	96	104	78	83	109	96	91	88	94	88	85	112	102	72	90	94	88	94	101	98	102	86	80	850	74	86	77	72	74
Buses	85	77	83	90	107	96	98	85	94	91	96	101	102	118	117	91	91	101	98	94	109									
Trucks	70	80	94	88	106	78	98	86	88	72	98	93	80	106	66															

Road **Addis Ababa - Tarmaber** Width of Pave.(m) = 7 Grade(%) = 2.1
Station **46+382 to 46+873** Shoulder Width (m) = 0.4 Left Supper elevation(%)
Tangent 46+632 0.45 Right Tangent (m) = 491

	Speed (Km/hr)																													
Cars	96	78	112	109	96	94	99	88	93	96	96	94	90	99	78	74	125	112	51	112	64	109	90	122	90	74	85	64	77	64
Buses	104	80	98	109	72	85	80	115	118	69	77	98	91	66	91	94	93	118	75	106	94	66								
Trucks	85	80	94	88	102	80	90	102	67	72	82	75	102	85	90	77	98	96												

Road **Addis Ababa - Tarmaber** Width of Pave.(m) = 6.9 Grade(%) =3.5
Station **47+139 to 47+267** Shoulder Width (m) = 0.3 Left Supper elevation(%) =5.9
Horizontal Curve 47+203 0.6 Right Radius (m) = 750

	Speed (Km/hr)																													
Cars	85	77	75	43	77	74	80	90	88	101	98	86	85	86	77	74	88	94	109	83	96	112	70	85	101	78	77	106	123	120
Buses	104	77	101	98	112	91	114	112	88	58	85	83	83	90	96	98	75	86	96											
Trucks	72	86	82	78	77	69	88	86	99	78	93	62	88	96	66	90	67	86	101	80										

Road **Addis Ababa - Tarmaber** Width of Pave.(m) = 7 Grade(%) = 2.45
Station **47+267 to 47+800** Shoulder Width (m) = 0.25 Left Supper elevation(%)
Tangent 47+517 0.3 Right Tangent(m) = 533

	Speed (Km/hr)																													
Cars	122	131	128	118	110	128	130	112	117	90	130	112	99	96	118	96	78	99	88	96	93	78	125	112	110	128	112	90	122	131
Buses	93	91	98	115	109	94	118	96	104	102	78	109	93	96	102	78	77	98												
Trucks	82	67	88	102	77	96	80	94	85	67	86	90	80	98	93	106	66	78												

Road **Addis Ababa - Gohatsion** Width of Pave.(m) = 7.57 Grade(%) =2
Station **11+050 to 11+300** Shoulder Width (m) = 2.4 Left Supper elevation(%) = 6.737
Horizontal Curve 11+175 1.7 Right Radius (m) =230

	Speed (Km/hr)																													
Cars	115	72	91	88	122	85	96	93	102	96	72	99	98	125	102	90	109	50	109	94	82	96	94	86	80	112	110	90	106	112
Buses	96	98	53	104	99	94	102	104	90	104	93	75	88	74	83	96	107	66	48	80	93	104	90	104	102	94	99	104	53	98
Trucks	96	70	45	88	75	93	104	90	104	102	94	99	104	93	75	88	74													

Road **Addis Ababa - Gohatsion** Width of Pave.(m) = 7.25 Grade(%) =1.655
Station **11+300 to 11+800** Shoulder Width (m) = 4.1 Left Supper elevation(%)
Tangent 11+550 3.7 Right Tangent (m) =500

	Speed (Km/hr)																													
Cars	93	102	94	83	112	102	74	98	101	109	85	75	70	74	107	80	118	85	61	82	64	104	78	74	99	107	98	78	118	66
Buses	88	104	90	99	88	62	74	96	98	104	64	82	61	85	118	80	107	74												
Trucks	66	75	66	74	85	75	70	107	74	93	102	94	83	74	98	101	109	85												

Road **Addis Ababa - Gohatsion** Width of Pave.(m) = 7.6 Grade(%) =1.25
Station **13+760 to 13+825** Shoulder Width (m) = 2.7 Left Supper elevation(%) = 7.6316
Horizontal Curve 13+793 3 Right Radius (m) = 230

	Speed (Km/hr)																													
Cars	56	50	67	93	96	85	62	90	94	99	118	120	93	99	96	117	120	58	93	157	80	94	77	53	75	83	94	90	62	85
Buses	72	35	67	99	90	86	99	83	75	53	77	94	80	58	93	90	99													
Trucks	80	99	94	90	62	85	96	141	67	50	56	94	99	62	90	85														

Road **Addis Ababa - Gohatsion** Width of Pave.(m) = 7.3 Grade(%) =3.5
Station **13+825 to 14+087** Shoulder Width (m) = 1.7 Left Supper elevation(%)
Tangent 14+075 2.6 Right Tangent (m) = 262

	Speed (Km/hr)																													
Cars	126	74	98	115	85	155	112	114	155	88	107	94	98	106	99	104	117	101	91	118	102	125	118	128	134	109	88	98	149	154
Buses	90	82	131	106	96	80	85	85	64	91	104	90	91	66	110	112														
Trucks	85	22	83	64	91	90	101	98	109	128	85	88	96	88	98															

Road **Addis Ababa - Gohatsion** Width of Pave.(m) = 7.95 Grade(%) =8.875
Station **28+350 to 28+556** Shoulder Width (m) = 2.4 Left Supper elevation(%) =7.673
Horizontal Curve 28+453 1.4 Right Radius (m) = 395

	Speed (Km/hr)																													
Cars	104	99	91	130	106	117	85	128	107	91	98	104	101	91	130	109	93	90	109	94	93	98								
Buses	102	72	82	91	126	101	91	102	106	99	83	91	98	99	104	91														
Trucks	72	94	86	61	83	82	98	78	93	90	109	94	93	85	106	91	104	98												

Road **Addis Ababa - Gohatsion** Width of Pave.(m) = 7.31 Grade(%) = 1.625
Station **28+556 to 28+915** Shoulder Width (m) = 3.1 Left Supper elevation(%)
Tangent 28+806 2.9 Right Tangent (m) = 359

	Speed (Km/hr)																													
Cars	117	86	117	85	110	117	88	90	136	90	114	117	146	110	109	133	122	101	141	91	138	122	130	99	83					
Buses	83	138	122	96	115	134	102	69	115	99	93	104	98	86	85	88	110	109												
Trucks	66	93	83	90	122	102	122	102	112	109	90	114	99	83	91	101														

Road **Addis Ababa - Gohatsion** Width of Pave.(m) = 7.3 Grade(%) =2.4
Station **34+860 to 34+925** Shoulder Width (m) = 2.2 Left Supper elevation(%) = 6.7376.1
Horizontal Curve 34+893 1.8 Right Radius (m) =580

	Speed (Km/hr)																													
Cars	106	50	133	120	144	133	110	162	106	48	138	107	162	144	133	106	133	138	120	107	144									
Buses	96	109	80	102	94	88	80	125	101	142	109	98	104	102	109	88														
Trucks	98	142	101	104	109	67	128	94	101	109	80	96	104	77	80	112	120													

Road **Addis Ababa - Gohatsion** Width of Pave.(m) = 7.2 Grade(%) =1.52
Station **34+925 to 35+470** Shoulder Width (m) = 2.6 Left Supper elevation(%)
Tangent 35+175 2.7 Right Tangent (m) =545

	Speed (Km/hr)																													
Cars	120	112	99	133	130	147	150	120	118	122	138	125	155	99	96	128	120	112	99	118	122									
Buses	80	88	94	102	80	109	96	88	109	102	104	98	109	142	80	88	99	112	120	128										
Trucks	77	102	104	104	109	80	94	109	104	102	109	98	80	109	77	102	112	80												

Road **Addis Ababa - Gohatsion** Width of Pave.(m) = 7.9 Grade(%) =4
Station **45+708 to 45+817** Shoulder Width (m) = 2.7 Left Supper elevation(%) =8.1
Horizontal Curve 45+763 1.5 Right Radius (m) = 230

	Speed (Km/hr)																													
Cars	82	98	96	75	86	82	94	110	72	99	83	85	126	91	93	70	74	82	96	75	86									
Buses	77	83	83	107	83	90	67	54	74	48	96	109	61	67	86	72														
Trucks	94	80	88	110	54	74	72	99	48	107	75	82	77	75	93	72	83													

Road **Addis Ababa - Gohatsion** Width of Pave.(m) = 7.2 Grade(%) =1.625
Station **45+817 to 46+114** Shoulder Width (m) = 2.8 Left Supper elevation(%)
Tangent 46+067 2.4 Right Tangent (m) = 297

	Speed (Km/hr)																				
Cars	128	112	66	51	122	66	122	112	75	104	112	77	125	118	56	85	126	91	93	70	74
Buses	61	109	96	48	74	54	67	90	91	85	56	77	75	104	112	91	93	109	96	90	
Trucks	61	75	77	85	56	75	77	91	75	66	74	85	75	70	91	75	90	77	85		

Road **Addis Ababa - Gohatsion** Width of Pave.(m) = 7.4 Grade(%) =1.8
Station 143+280 to 143+387 Shoulder Width (m) = 2.25 Left Supper elevation(%) =5.8
Horizontal Curve 143+334 1.9 Right Radius (m) = 421

	Speed (Km/hr)																				
Cars	75	141	54	107	106	74	109	141	53	62	94	91	144	106	74	94	75	61			
Buses	61	66	109	69	102	70	75	59	53	64	74	75	74	75	61	109	106				
Trucks	29	106	64	45	67	54	75	74	62	53	94	75	74	94	75	54					

Road **Addis Ababa - Gohatsion** Width of Pave.(m) = 7.3 Grade(%) = 2.3
Station **143+387 to 143+646** Shoulder Width (m) = 2.1 Left Supper elevation(%)
Tangent 143+637 2.4 Right Tangent (m) = 259

	Speed (Km/hr)																				
Cars	82	70	117	125	75	109	74	112	90	93	86	90	154	90	109	77	82	98	74	77	94
Buses	77	53	109	109	146	112	120	104	110	114	109	80	128	78	117	104					
Trucks	115	32	38	26	46	50	106	61	115	128	107	93	64	80	104	101	107	75			

Road **Addis Ababa - Butajira** Width of Pave.(m) = 6.9 Grade(%) =7.125
Station **27+317 to 27+485** Shoulder Width (m) = 2.5 Left Supper elevation(%) = 4.93
Horizontal Curve 27+401 2.45 Right Radius (m) =600

	Speed (Km/hr)																													
Cars	86	115	56	109	83	93	133	99	114	102	109	54	90	107	106	96	77	94	93	58	106	80	86	128	96	110	98	104	50	114
Buses	85	72	146	112	77	90	99	69	136	104	72	91	80	128	115	80	93													
Trucks	53	64	110	96	59	64	72	64	104	69	69	61	72	104	69	61														

Road **Addis Ababa - Butajira** Width of Pave.(m) = 6.85 Grade(%) =4.2
Station **27+485 to 28+145** Shoulder Width (m) = 2.95 Left Supper elevation(%)
Tangent 27+735 2.7 Right Tangent (m) =660

	Speed (Km/hr)																													
Cars	117	67	70	80	67	98	75	93	67	106	112	64	67	77	70	104	82	99	74	112	120	70	74	83	70	101	78	106	70	109
Buses	96	99	99	69	115	80	93	115	118	136	112	96	88	88	75	115														
Trucks	98	99	77	51	56	67	114	99	62	67	56	72	118	104	72	80														

Road **Addis Ababa - Butajira** Width of Pave.(m) = 6.9 Grade(%) =1.75
Station **34+900 to 35+100** Shoulder Width (m) = 1.7 Left Supper elevation(%) = 5.797
Horizontal Curve 35+000 1.85 Right Radius (m) = 400

	Speed (Km/hr)																													
Cars	149	117	96	118	120	126	93	67	106	109	96	106	107	90	54	109	102	114	99	133	93	83	109	118	90	112	136	102	117	107
Buses	128	131	83	75	67	88	72	101	131	102	86	78	70	91	75	104	134	106	90	82										
Trucks	51	61	94	109	126	42	138	142	112	117	122	82	109	74																

Road **Addis Ababa - Butajira** Width of Pave.(m) = 6.85 Grade(%) =6
Station **35+100 to 35+700** Shoulder Width (m) = 1.9 Left Supper elevation(%)
Tangent 35+350 2 Right Tangent (m) = 600

	Speed (Km/hr)																													
Cars	74	80	61	96	109	133	80	109	80	122	122	85	147	131	158	106	141	106	96	109	106	67	83	117	67	70	80	67	98	75
Buses	117	64	115	86	109	67	69	99	99	96	77	70	83	86	90	96	99													
Trucks	35	32	83	32	78	85	67	86	80	62	42	88	85	88	83	82	78	74												

C.1.5 Grade and 1/Radius

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.552494
R Square	0.30525
Adjusted R	0.270512
Standard E	14.8857
Observatio	43

ANOVA

	df	*SS*	*MS*	*F*	*ignificance F*
Regressior	2	3894.265	1947.132	8.787329	0.000686
Residual	40	8863.363	221.5841		
Total	42	12757.63			

	Coefficients	*andard Erro*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*Upper 95.0%*
Intercept	139.2438	6.091526	22.85861	1.42E-24	126.9324	151.5553	126.9324	151.5553
X Variable	-7.80124	1.956972	-3.98638	0.000277	-11.7564	-3.84605	-11.7564	-3.84605
X Variable	-2226.54	1997.511	-1.11466	0.27165	-6263.66	1810.58	-6263.66	1810.58

RESIDUAL OUTPUT

Observation	*Predicted Y*	*Residuals*	*dard Residuals*
1	109.7666	-13.7666	-0.94766
2	120.382	-32.382	-2.2291
3	121.1674	-3.16742	-0.21804
4	118.9553	2.044706	0.140753
5	116.9576	-5.95755	-0.4101
6	132.0838	-9.08384	-0.62531
7	135.9249	-12.9249	-0.88972
8	113.5559	2.444105	0.168246
9	127.8265	-5.82655	-0.40109
10	126.7565	9.243466	0.636297
11	124.5444	15.45559	1.063925
12	126.0435	14.95652	1.02957
13	127.848	23.15202	1.593728
14	124.9011	12.09892	0.83286
15	126.6283	15.37172	1.058151
16	133.2453	-5.24526	-0.36107
17	123.8311	19.16893	1.319542
18	133.3873	2.612691	0.179851
19	129.3327	8.667281	0.596634
20	129.2697	8.730323	0.600974
21	133.1167	-8.11667	-0.55873
22	128.3783	-6.37825	-0.43906
23	126.3928	8.607243	0.592501
24	112.5456	38.45444	2.64711
25	133.0298	7.970244	0.548652
26	130.1043	-20.1043	-1.38393
27	129.8717	-1.87172	-0.12884
28	126.0144	-5.01435	-0.34518
29	118.2131	-1.21311	-0.08351
30	126.1608	-3.16082	-0.21758
31	124.8062	19.19378	1.321252
32	116.7985	0.20151	0.013871
33	102.3777	-25.3777	-1.74694
34	132.3312	-35.3312	-2.43212
35	102.5674	2.432622	0.167456
36	99.16223	3.837765	0.264182
37	108.9708	-6.97077	-0.47985
38	113.9607	-5.96074	-0.41032
39	119.8117	-12.8117	-0.88192
40	116.682	17.31801	1.192129
41	98.35826	0.641742	0.044176
42	119.9129	-15.9129	-1.09541
43	120.0253	3.974691	0.273608

C.1.6 1/curve length and Grade

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.54679703
R Square	0.29898699
Adjusted R Square	0.26393634
Standard Error	14.9526445
Observations	43

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	2	3814.364821	1907.182	8.530141	0.000821337
Residual	40	8943.263086	223.5816		
Total	42	12757.62791			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	136.550927	4.715008861	28.96091	1.87E-28	127.0215384	146.0803	127.0215384	146.080315
X Variable 1	-7.2041247	2.100276917	-3.43008	0.001413	-11.44894264	-2.95931	-11.4489426	-2.95930675
X Variable 2	-628.123463	671.8770783	-0.93488	0.355461	-1986.037678	729.7908	-1986.03768	729.790751

RESIDUAL OUTPUT

Observation	*Predicted Y*	*Residuals*	*dard Residuals*
1	110.563245	-14.56324497	-0.99801
2	123.9339	-35.93390023	-2.46253
3	119.798933	-1.79893306	-0.12328
4	118.624981	2.375019358	0.162759
5	114.208729	-3.208729023	-0.21989
6	131.318525	-8.318525178	-0.57006
7	132.858751	-9.858751295	-0.67561
8	116.44687	-0.4468701	-0.03062
9	130.357741	-8.35774079	-0.57275
10	124.751443	11.24855747	0.770856
11	124.690664	15.3093358	1.049139
12	125.943091	15.05690874	1.03184
13	126.483401	24.51659939	1.680107
14	124.1144	12.88559952	0.883042
15	123.596288	18.40371232	1.261195
16	132.296288	-4.296288267	-0.29442
17	124.697867	18.30213276	1.254233
18	132.980534	3.019466323	0.206922
19	130.923699	7.076300895	0.484934
20	129.054088	8.945911681	0.613058
21	129.023093	-4.023092725	-0.2757
22	129.237388	-7.23738779	-0.49597
23	133.283493	1.716506786	0.117631
24	120.275818	30.72418205	2.105508
25	132.821026	8.178973838	0.5605
26	131.470927	-21.47092681	-1.47139
27	129.684384	-1.684383744	-0.11543
28	119.722349	1.277650556	0.087557
29	115.919082	1.080918459	0.074075
30	129.14165	-6.141650336	-0.42088
31	122.060412	21.93958754	1.503506
32	122.592846	-5.59284582	-0.38327
33	100.655048	-23.65504833	-1.62107
34	132.255149	-35.25514917	-2.41601
35	103.437173	1.562826946	0.1071
36	98.749233	4.25076695	0.291302
37	106.429276	-4.429275723	-0.30354
38	119.630183	-11.63018347	-0.79701
39	117.882333	-10.88233295	-0.74576
40	109.59759	24.40241045	1.672281
41	101.971827	-2.971827351	-0.20366
42	117.71319	-13.71318952	-0.93976
43	120.803091	3.196908817	0.219082

PROBABILITY OUTPUT

Percentile	*Y*
1.162790698	77
3.488372093	88
5.813953488	96
8.139534884	97
10.46511628	99
12.79069767	102
15.11627907	103
17.44186047	104
19.76744186	105
22.09302326	107
24.41860465	108
26.74418605	110
29.06976744	111
31.39534884	116
33.72093023	117
36.04651163	117
38.37209302	118
40.69767442	121
43.02325581	121
45.34883721	122
47.6744186	122
50	123
52.3255814	123
54.65116279	123
56.97674419	124
59.30232558	125
61.62790698	128
63.95348837	128
66.27906977	134
68.60465116	135
70.93023256	136
73.25581395	136
75.58139535	137
77.90697674	138
80.23255814	138
82.55813953	140
84.88372093	141
87.20930233	141
89.53488372	142
91.86046512	143
94.18604651	144
96.51162791	151
98.8372093	151

C.1.3 Grade and Curve Length

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.544629
R Square	0.296621
Adjusted R Square	0.261452
Standard Error	14.97786
Observations	43

ANOVA

	df	*SS*	*MS*	*F*	*ignificance F*
Regression	2	3784.182	1892.091	8.434178	0.000879
Residual	40	8973.446	224.3361		
Total	42	12757.63			

	Coefficients	*andard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*Ipper 95.0%*
Intercept	130.5099	5.430842	24.03125	2.19E-25	119.5338	141.4861	119.5338	141.4861
X Variable 1	-7.43327	2.041009	-3.64196	0.000768	-11.5583	-3.30824	-11.5583	-3.30824
X Variable 2	0.010199	0.011884	0.858205	0.395893	-0.01382	0.034217	-0.01382	0.034217

RESIDUAL OUTPUT

Observation	*Predicted Y*	*Residuals*	*dard Residuals*
1	108.8403	-12.8403	-0.87846
2	125.4681	-37.4681	-2.56334
3	118.3767	-0.37671	-0.02577
4	117.162	3.83802	0.262574
5	113.4056	-2.40561	-0.16458
6	131.0596	-8.05962	-0.55139
7	131.8755	-8.87553	-0.60721
8	114.9864	1.013563	0.069342
9	133.0431	-11.0431	-0.7555
10	123.8813	12.11867	0.829087
11	123.4621	16.53789	1.131423
12	124.8537	16.14634	1.104636
13	125.4112	25.58884	1.750635
14	123.6264	13.37365	0.914945
15	122.6315	19.3685	1.325077
16	131.2625	-3.26254	-0.2232
17	125.4794	17.52063	1.198657
18	132.2722	3.727771	0.255032
19	132.4606	5.539426	0.378974
20	127.9947	10.00534	0.684506
21	128.4251	-3.42513	-0.23433
22	128.1917	-6.19175	-0.4236
23	136.4958	-1.49576	-0.10233
24	121.3435	29.65648	2.028919
25	131.8449	9.155063	0.626335
26	131.1278	-21.1278	-1.44544
27	129.9163	-1.91629	-0.1311
28	122.8818	-1.88184	-0.12874
29	115.9177	1.082283	0.074043
30	129.7939	-6.7939	-0.4648
31	121.6864	22.31355	1.52656
32	121.87	-4.87003	-0.33318
33	100.1322	-23.1322	-1.58257
34	131.4676	-34.4676	-2.35807
35	103.6857	1.314328	0.089918
36	100.8087	2.191341	0.149918
37	105.799	-3.79896	-0.2599
38	118.1931	-10.1931	-0.69735
39	121.8813	-14.8813	-1.01809
40	113.333	20.66697	1.41391
41	101.8885	-2.88855	-0.19762
42	118.2213	-14.2213	-0.97294
43	119.5415	4.4585	0.305024

Appendix C

C.1. Regression Analysis for Horizontal Curves

C.1.1 Grade and Superelevation

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.608503416
R Square	0.570276407
Adjusted R Square	0.338790227
Standard Error	14.17196113
Observations	43

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	2	4723.848621	2361.924	11.75997	9.61611E-05
Residual	40	8033.779286	200.8445		
Total	42	12757.62791			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	147.8836823	6.948683449	21.28226	2E-23	133.8398694	161.927495	133.8398694	161.927495
X Variable 1	-7.162264347	1.887636409	-3.794303	0.000491	-10.9773198	-3.34720889	-10.9773198	-3.34720889
X Variable 2	-2.990458232	1.274991998	-2.345472	0.024049	-5.567313155	-0.41360331	-5.56731316	-0.41360331

RESIDUAL OUTPUT

Observation	*Predicted Y*	*Residuals*	*ıdard Residuals*
1	114.887334	-18.88733395	-1.365637
2	118.0630167	-30.06301672	-2.173688
3	133.1853464	-15.18534636	-1.097967
4	119.9544231	1.04557689	0.0756
5	114.5980948	-3.598094779	-0.260158
6	136.5217955	-13.52179548	-0.977685
7	135.4183164	-12.41831639	-0.897899
8	107.3402527	8.659747349	0.626138
9	128.773819	-6.773818955	-0.489777
10	127.6908554	8.309144563	0.600788
11	127.4175877	12.58241229	0.909764
12	127.0280864	13.97191363	1.010231
13	127.5652562	23.43474381	1.694435
14	129.3595311	7.64046887	0.552439
15	131.0965931	10.9034069	0.788364
16	133.0906039	-5.090603853	-0.368073
17	123.952365	19.04763499	1.377228
18	128.1952237	7.804776272	0.56432
19	129.4721026	8.52789736	0.616604
20	132.2427505	5.757249496	0.416274
21	131.4435798	-6.443579762	-0.465899
22	125.0454827	-3.045482687	-0.220202
23	128.6303237	6.369676287	0.460556
24	126.8623816	24.13761837	1.745256
25	126.4828272	14.51717281	1.049655
26	128.3813505	-18.38135053	-1.329052
27	126.2962828	1.703717249	0.123186
28	135.9804057	-14.98040566	-1.083149
29	111.3030274	5.696972554	0.411916
30	126.4458057	-3.445805662	-0.249147
31	119.6651839	24.33481606	1.759514
32	118.5228289	-1.522828893	-0.110107
33	96.6783169	-19.6783169	-1.422829
34	129.3746003	-32.3746003	-2.340826
35	107.5382244	-2.538224406	-0.183525
36	99.67851165	3.32148835	0.240158
37	105.1720536	-3.172053551	-0.229353
38	113.4124365	-5.412436531	-0.391343
39	116.1076747	-9.107674674	-0.658525
40	112.4524527	21.54754731	1.557982
41	95.01191327	3.988086732	0.288356
42	117.6469488	-13.64694876	-0.986734
43	118.0140334	5.985966644	0.432812

C.1.4 Grade , superelevation and Curve Length

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.61297279
R Square	0.37573565
Adjusted R Square	0.32771531
Standard Error	14.2901547
Observations	43

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	4793.495551	1597.832	7.824511118	0.000330728
Residual	39	7964.132356	204.2085		
Total	42	12757.62791			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	145.186239	8.39208853	17.30037	6.81008E-20	128.2116376	162.1608	128.211638	162.1608398
X Variable 1	-6.8817943	1.963032844	-3.505695	0.00116163	-10.8524029	-2.911186	-10.852403	-2.9111856
X Variable 2	-2.8858138	1.29805236	-2.223188	0.032067824	-5.51137252	-0.260255	-5.5113725	-0.26025513
X Variable 3	0.0066856	0.011447916	0.584002	0.562582101	-0.01646999	0.029841	-0.01647	0.029841197

RESIDUAL OUTPUT

Observation	*Predicted Y*	*Residuals*	*ıdard Residuals*
1	115.072799	-19.07279922	-1.385064
2	121.07064	-33.0706401	-2.401585
3	132.853665	-14.85366471	-1.078671
4	119.902262	1.097738463	0.079718
5	114.109425	-3.109424784	-0.225806
6	135.195078	-12.19507829	-0.885605
7	134.665061	-11.66506112	-0.847115
8	108.141823	7.858177123	0.57066
9	132.082518	-10.0825176	-0.732191
10	126.87014	9.129860052	0.663009
11	126.944445	13.05555498	0.948093
12	127.235641	13.76435856	0.999566
13	127.751776	23.24822399	1.688283
14	128.313284	8.686715977	0.630828
15	130.195352	11.8046481	0.857252
16	132.629786	-4.629785664	-0.336214
17	126.148469	16.85153067	1.223756
18	128.567583	7.432417011	0.539741
19	131.884254	6.115746063	0.444125
20	132.120689	5.879311161	0.426955
21	130.406038	-5.406038404	-0.392586
22	124.569093	-2.569092786	-0.186567
23	132.24633	2.753670122	0.199971
24	129.309588	21.69041185	1.575155
25	126.022193	14.9778074	1.087686
26	129.222649	-19.22264948	-1.395946
27	125.190717	2.809282767	0.20401
28	134.214427	-13.21442692	-0.95963
29	110.737959	6.262041264	0.454749
30	125.254781	-2.254780705	-0.163742
31	118.912145	25.0878553	1.821877
32	117.930105	-0.930104644	-0.067544
33	96.6951085	-19.69510847	-1.430256
34	128.565407	-31.56540731	-2.292275
35	107.053107	-2.053106831	-0.149096
36	99.2983608	3.701639158	0.268813
37	104.929414	-2.929414219	-0.212734
38	113.652323	-5.652322848	-0.410471
39	114.994029	-7.994028874	-0.580525
40	111.501032	22.49896775	1.633872
41	95.0127002	3.987299767	0.289557
42	116.776648	-12.77664823	-0.927838
43	117.751156	6.248843668	0.45379

C.1.2 Superelevation and Curve Length

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.4231
R Square	0.179014
Adjusted R Square	0.137965
Standard Error	16.18165
Observations	43

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	2	2283.794	1141.897	4.360951	0.019351522
Residual	40	10473.83	261.8459		
Total	42	12757.63			

	Coefficients	*Standard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	135.1078	8.927893	15.13322	3.78E-18	117.063808	153.1517	117.0638	153.1517
X Variable 1	-3.46084	1.458085	-2.37355	0.022509	-6.407739748	-0.51394	-6.40774	-0.51394
X Variable 2	0.016504	0.012569	1.313052	0.196649	-0.008899336	0.041908	-0.0089	0.041908

RESIDUAL OUTPUT

Observation	*Predicted Y*	*Residuals*	*Standard Residuals*
1	127.887	-31.887	-2.01923
2	125.4537	-37.4537	-2.37174
3	139.0982	-21.0982	-1.33604
4	124.3602	-3.36017	-0.21278
5	119.7017	-8.70175	-0.55103
6	125.3879	-2.38791	-0.15121
7	125.4312	-2.43119	-0.15395
8	113.8604	2.139577	0.135488
9	132.3294	-10.3294	-0.65411
10	123.8694	12.13064	0.768167
11	125.4144	14.58558	0.923625
12	126.1996	14.80038	0.937227
13	126.1996	24.80038	1.570472
14	125.3879	11.61209	0.73533
15	129.3439	12.65613	0.801443
16	124.2851	3.71493	0.235246
17	129.7479	13.25209	0.839182
18	120.2536	15.74642	0.997134
19	130.1631	7.836881	0.496267
20	128.1745	9.825541	0.622198
21	122.8668	2.133204	0.135084
22	117.1164	4.883595	0.309251
23	129.6235	5.376494	0.340464
24	139.1214	11.87861	0.752207
25	115.0407	25.95932	1.643861
26	123.6965	-13.6965	-0.86732
27	114.2435	13.7565	0.871124
28	131.8454	-10.8454	-0.68678
29	112.3345	4.665546	0.295443
30	114.2185	8.781509	0.556085
31	116.1089	27.89113	1.766192
32	115.0839	1.916094	0.121336
33	113.0397	-36.0397	-2.28219
34	117.7767	-20.7767	-1.31567
35	121.1993	-16.1993	-1.02581
36	114.5588	-11.5588	-0.73195
37	116.8013	-14.8013	-0.93729
38	115.9181	-7.9181	-0.50141
39	109.7674	-2.76739	-0.17524
40	115.0694	18.93061	1.198771
41	108.8739	-9.87389	-0.62526
42	116.8008	-12.8008	-0.81061
43	118.3461	5.653918	0.358032

C.2.2. 1/ Tangent Length and Grade

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.518313
R Square	0.268648
Adjusted R Square	0.23685
Standard Error	12.69732
Observations	49

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	2	2724.202	1362.101	8.448612	0.000749732
Residual	46	7416.206	161.2219		
Total	48	10140.41			

	Coefficients	*tandard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*Jpper 95.0%*
Intercept	130.6092	3.584684	36.43534	1.41E-35	123.3935856	137.8248	123.3936	137.8248
X Variable 1	-3.73588	1.263271	-2.95731	0.004886	-6.278716155	-1.19305	-6.27872	-1.19305
X Variable 2	-2786.42	1929.228	-1.44432	0.155427	-6669.752088	1096.919	-6669.75	1096.919

RESIDUAL OUTPUT

Observation	*Predicted Y*	*Residuals*	*dard Residuals*
1	124.0869	-18.0869	-1.4551
2	118.1798	-1.17978	-0.09491
3	108.2068	-12.2068	-0.98205
4	110.1238	2.876195	0.231392
5	116.1094	-3.10944	-0.25016
6	129.3141	-5.31414	-0.42753
7	129.1679	3.832077	0.308293
8	121.7686	-2.76856	-0.22273
9	116.9827	5.017322	0.403647
10	124.3983	11.60174	0.933368
11	122.6963	0.303746	0.024437
12	123.8573	4.142739	0.333286
13	123.3597	1.640313	0.131964
14	123.844	2.155973	0.173449
15	121.8746	7.12545	0.573247
16	123.3106	4.689369	0.377263
17	123.8002	2.199763	0.176972
18	127.6267	7.373328	0.593189
19	125.6926	10.30739	0.829236
20	126.9243	10.07572	0.810599
21	126.1029	-6.10288	-0.49098
22	111.6679	24.33209	1.957533
23	126.9027	-7.90268	-0.63578
24	119.2664	3.733612	0.300372
25	123.2971	-1.29705	-0.10435
26	124.4713	-1.4713	-0.11837
27	124.3475	13.65255	1.098357
28	127.9865	-10.9865	-0.88387
29	128.899	7.100952	0.571276
30	124.0316	-14.0316	-1.12885
31	119.1393	-1.13928	-0.09166
32	123.2102	6.789795	0.546244
33	117.3491	19.65094	1.580932
34	121.4179	10.5821	0.851337
35	118.0178	-52.0178	-4.18487
36	98.28142	-19.2814	-1.5512
37	103.0709	-2.07091	-0.16661
38	122.4689	-18.4689	-1.48584
39	117.0146	4.985415	0.40108
40	117.0888	-11.0888	-0.8921
41	116.2285	-6.22847	-0.50108
42	118.8535	-14.8535	-1.19497
43	106.8984	17.10159	1.375834
44	116.7768	6.223237	0.500664
45	119.8179	7.182054	0.577801
46	115.1565	-10.1565	-0.8171
47	111.2583	8.741717	0.703277
48	102.1041	5.895902	0.474329
49	103.5499	10.45015	0.840721

C.2. Regression Analysis for Tangents

C.2.1. Tangent Length and Grade

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.512849
R Square	0.263014
Adjusted R Square	0.230971
Standard Error	12.74613
Observations	49

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	2	2667.069	1333.535	8.208191	0.00089446
Residual	46	7473.339	162.4639		
Total	48	10140.41			

	Coefficients	*Standard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	123.5222	3.997447	30.90026	2.06E-32	115.475717	131.5686	115.4757	131.5686
X Variable 1	0.002797	0.002134	1.310892	0.196401	-0.00149776	0.007091	-0.0015	0.007091
X Variable 2	-3.95506	1.226009	-3.22596	0.002314	-6.42288444	-1.48723	-6.42288	-1.48723

RESIDUAL OUTPUT

Observation	*Predicted Y*	*Residuals*	*Standard Residuals*
1	122.364	-16.364	-1.31145
2	116.7662	0.233813	0.018738
3	109.6193	-13.6193	-1.09148
4	114.3337	-1.33373	-0.10689
5	115.1448	-2.14482	-0.17189
6	132.4392	-8.4392	-0.67634
7	131.0268	1.973214	0.158138
8	119.985	-0.98501	-0.07894
9	115.4525	6.547523	0.524735
10	123.1188	12.88121	1.032333
11	121.7396	1.2604	0.101012
12	122.299	5.701029	0.456895
13	122.0193	2.980715	0.238882
14	122.464	3.536003	0.283384
15	120.0788	8.921222	0.71497
16	121.543	6.456993	0.51748
17	122.9215	3.078468	0.246716
18	128.5368	6.463228	0.51798
19	126.1677	9.832316	0.787987
20	125.4512	11.54882	0.925552
21	124.7149	-4.71494	-0.37787
22	110.2709	25.72908	2.061994
23	127.0485	-8.04852	-0.64503
24	122.1859	0.814064	0.065241
25	122.8292	-0.82921	-0.06646
26	123.1002	-0.10019	-0.00803
27	123.9962	14.00385	1.122304
28	127.1482	-10.1482	-0.8133
29	132.5741	3.425891	0.27456
30	124.3031	-14.3031	-1.14629
31	122.8382	-4.83816	-0.38774
32	123.7388	6.261159	0.501785
33	116.2287	20.77132	1.664667
34	120.2131	11.78685	0.944629
35	116.2586	-50.2586	-4.02785
36	100.1225	-21.1225	-1.69281
37	105.1313	-4.13125	-0.33109
38	121.6613	-17.6613	-1.41542
39	116.1252	5.874804	0.470822
40	116.5898	-10.5898	-0.84869
41	115.323	-5.323	-0.4266
42	118.375	-14.375	-1.15205
43	110.4122	13.58776	1.088958
44	118.0993	4.900735	0.392757
45	119.0348	7.965239	0.638355
46	117.9259	-12.9259	-1.03591
47	115.1499	4.850083	0.388698
48	99.66022	8.339778	0.668371
49	101.4699	12.53006	1.004191

Operating Speed Characaterstics on Curves											
Cars				Buses				Trucks			
Avg.	Std.	Var.	$V85^{th}$	Avg.	Std.	Var.	$V85^{th}$	Avg.	Std.	Var.	$V85^{th}$
89	18	324	107	64	19	361	83	72	18	324	90
77	20	400	97	71	13	169	84	62	18	324	80
107	19	361	126	98	17	289	115	91	20	400	111
103	32	1024	135	94	18	324	112	90	22	484	112
96	23	529	119	92	14	196	106	86	18	324	104
113	23	529	136	99	19	361	118	93	17	289	110
113	21	441	134	104	17	289	121	95	15	225	110
101	27	729	128	93	17	289	110	82	24	576	106
91	20	400	129	102	18	324	120	88	23	529	111
120	22	484	142	108	15	225	123	101	31	961	132
125	23	529	148	108	15	225	123	113	27	729	140
130	21	441	151	107	16	256	123	119	24	576	143
131	20	400	151	111	16	256	127	115	24	576	139
123	23	529	146	106	14	196	120	113	23	529	136
127	21	441	148	103	21	441	124	105	22	484	127
108	23	529	131	106	20	400	126	108	20	400	128
131	19	361	150	122	18	324	140	108	23	529	131
123	21	441	143	116	15	225	131	105	21	441	126
130	18	324	148	110	12	144	122	111	23	529	134
123	20	400	144	118	18	324	136	102	25	625	127
133	20	400	153	108	18	324	126	114	13	169	127
122	12	144	134	110	35	1225	145	115	19	361	133
125	23	529	148	107	18	324	125	105	21	441	126
116	22	484	138	105	15	225	120	107	25	625	132
127	21	441	148	118	17	289	135	120	13	169	133
96	18	324	114	91	15	225	106	89	18	324	107
111	24	576	135	107	15	225	122	99	22	484	121
108	15	225	123	99	16	256	115	104	18	324	122
110	19	361	129	89	13	169	102	78	23	529	101
111	15	225	126	108	19	361	127	85	14	196	99
130	21	441	151	121	17	289	138	110	21	441	131
108	20	400	128	93	13	169	106	87	15	225	102
58	18	324	76	64	17	289	81	58	15	225	73
83	14	196	97	89	21	441	110	85	41	1681	126
94	17	289	111	94	10	100	104	83	11	121	94
90	12	144	102	96	11	121	107	87	12	144	99
88	16	256	104	92	14	196	107	82	11	121	93
96	16	256	112	90	17	289	106	88	16	256	104
89	23	529	112	79	18	324	97	84	22	484	106
103	13	169	143	96	12	144	118	90	12	144	120
88	14	196	102	79	17	289	96	81	16	256	97
92	29	841	121	77	18	324	95	69	20	400	89
106	19	361	125	95	22	484	117	98	32	1024	130

Operating Speed Characaterstics on Tangents											
Cars				Buses				Trucks			
Avg.	Std.	Var.	V85th	Avg.	Std.	Var.	V85th	Avg.	Std.	Var.	V85th
91	24	576	115	80	12	144	92	85	23	529	108
97	26	676	123	98	20	400	118	93	18	324	111
89	16	256	105	68	21	441	89	65	22	484	87
97	20	400	117	84	17	289	101	97	23	529	120
97	20	400	117	84	17	289	101	97	22	484	119
111	20	400	131	95	17	289	112	98	28	784	126
114	19	361	133	104	11	121	115	95	23	529	118
112	22	484	134	99	12	144	111	96	19	361	115
126	16	256	142	109	12	144	121	113	21	441	134
104	19	361	125	106	18	324	124	112	20	400	132
107	18	324	125	110	13	169	123	107	20	400	127
108	17	289	127	108	15	225	123	110	17	289	127
110	17	289	127	110	17	289	127	109	23	529	132
108	19	361	132	112	14	196	126	107	20	400	127
111	21	441	129	104	14	196	118	108	20	400	128
122	24	576	146	114	17	289	131	119	19	361	138
125	23	529	148	122	20	400	142	107	22	484	129
132	25	625	157	110	21	441	131	104	18	324	122
101	13	169	114	105	14	196	119	105	19	361	124
133	27	729	160	102	16	256	118	97	19	361	116
112	18	324	130	104	17	289	121	109	13	169	122
110	24	576	134	105	15	225	120	110	15	225	125
113	18	324	131	108	16	256	124	115	14	196	129
109	20	400	129	111	14	196	125	93	18	324	111
120	20	400	140	122	17	289	139	112	23	529	135
99	23	529	122	86	18	324	104	95	23	529	118
122	20	400	142	118	17	289	135	112	17	289	129
102	19	361	121	89	12	144	101	77	16	256	93
102	19	361	121	85	19	361	104	97	26	676	123
120	20	400	140	110	9	81	119	97	14	196	111
121	25	625	146	117	20	400	137	101	15	225	116
117	24	576	141	110	16	256	126	92	15	225	107
57	14	196	71	56	58	3364	114	49	52	2704	101
94	10	100	104	62	10	100	72	63	10	100	73
118	13	169	131	90	15	225	105	77	14	196	91
91	18	324	109	91	17	289	108	87	11	121	98
110	16	256	126	97	12	144	109	85	12	144	97
90	17	289	107	87	16	256	103	85	14	196	99
112	21	441	133	93	17	289	110	88	40	1600	128
122	17	289	139	101	16	256	117	97	13	169	110
94	25	625	119	84	19	361	103	77	10	100	87
94	21	441	115	104	22	484	126	80	32	1024	112
99	26	676	125	90	16	256	106	70	20	400	90