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Ranking Road Safety Hazardous Locations in Nepal : A Case Study of Kalanki (Ch.10+600) – Koteshwor (Ch.20+994) Road Section

by

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The undersigned certify that they have read, and recommended to the Institute of Engineering for acceptance, a thesis entitled **"Ranking Road Safety Hazardous Locations in Nepal: A Case Study of Kalanki (Ch.10+600) - Koteshwor (Ch.20+994) Road Section"** submitted by **Salin Shakya** in partial fulfillment of the requirements for the degree of Master of Science in Transportation Engineering.

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ABSTRACT

In Nepal, there are many emerging towns and cities due to rapid urbanizations which have arose issues of increased traffic density resulting in frequent road crashes like in Kalanki Koteshwor Ring Road Section.

This study presents six stage methodological framework for ranking road safety hazardous locations based on Analytical Hierarchy Process (AHP) and field survey (condition rating) to identify the hazardous locations of Kalanki Koteshwor Road Section by weighing the safety parameters of the road section and calculating the Safety Hazardous Index (SHI). The results show that road section 'Ch.12+600 km to Ch.14+600 km' is ranked as the most hazardous location with SHI 12.38 and 'Ch.10+600 km to Ch.12+600 km' is ranked as the least hazardous location with SHI 9.30 among the five road sections considered. This ranking can be a prompt technique for prioritizing the treatment of the hazardous locations keeping available road safety budget in mind.

Keywords: Road Safety, Safety Hazardous Index, Weightage of safety factors, Condition Rating, Analytical Hierarchy Process, Ranking of road safety hazardous location.

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CHAPTER ONE: INTRODUCTION

1.1 Background

Road safety has become one of the major challenges of Nepal. Every year large number of innocent people loses their lives on Nepalese roads and many more seriously injured and disabled. According to official statistics provided by the Government of Nepal, 2,762 road deaths were recorded in Nepal in fiscal year 2075/76; in addition there were 14,744 injury victims. It is important to note that many road fatalities and injuries are not reported. This level of under-reporting is believed to be significant.

In Nepal, road system remains the major transportation means that links different parts of the country (DOR, 2013). Geographically, only about 20% of the country is in plain area and remaining 80% is covered by mountains, high mountains and Himalayas. The strategic road network in Nepal is around 13,447.62 km (DOR, 2017/18) and local road network constitutes more than 57,632.04 km of roads (DOLI, 2016). Most of the local roads are built without proper engineering design and supervision.

Government of Nepal has been planning & allocating annual budget approximately 4 million US$ (Source: Ministry of Physical Infrastructure and Transport) for road safety programs to be executed through the concerned agencies like Department of Transport Management and Department of Roads. However, the budgetary requirement for coping the recent scenario of road safety is more demanding. Due to such condition as well, the prioritization of crash prone locations & crash countermeasure becomes a must.

In the past, priorities of the road agencies were connectivity rather than safety. This coupled with the mountainous topography became one of the contributing factors for increased road crashes in the country. With the development of infrastructure and urbanization, the traffic density increased dramatically which resulted in reduction of efficiency of the road network and increased road crashes in alarming rate. This compelled the concerned agencies to the upgradation of existing roads to multilane roads so as to increase the efficiency of road network. However, there are several

crashes reported in such newly constructed multilane road sections as well and one of such examples is Kalanki- Koteshwor Road Section.

1.2 Problem Statement:

Various studies showed that most of the methodologies for identifying hazardous locations require crash data. However, comprehensive road crash data is not easily available. Therefore, it becomes difficult to perform analysis for identification of the safety hazardous location, vulnerable road users, road users involved in crashes, causes of crash etc. which are very important for recommending the safety measures.

As said earlier, crash data availability is very essential for identifying safety hazardous roads. However, there are many roads with crash data poorly recorded or even no crash data recorded. For such scenario, a method is required to identify and rank road segments. In this study, a safety audit based methodology is used to identify the road safety hazardous locations.

Kalanki- Koteshwor is considered as one of the important urban road in Kathmandu Valley. The southern section of Kathmandu Ring Road Expansion Project, is upgraded to 8 lane urban arterial road by Peoples Republic of China on the request of Government of Nepal in 2011. KRR was built for accommodating higher traffic flow avoiding central city congestion. Therefore, it is anticipated to ease the traffic flow with the relatively higher speed for higher volume.

However, this wide urban arterial road after the completion has faced serious allegations of being unsafe. In last fiscal year 075/76, it was recorded that the newly constructed southern section of KRR "Kalanki- Koteshwor road section (10.394 km length)" has suffered 1060 number of road crashes including 17 deaths, 35 serious injury & 717 general injury. Similarly, this current fiscal year for last six months, about 509 number of road crashes have been already reported in which 9 people died, 14 seriously injured and 427 minor injured (Source: Metropolitan Traffic Police Office, Kathmandu). The road section has been deemed a 'death trap' due to lack of zebra crossings, traffic lights, information boards, designated parking stations, median, designated U-turn, and enough pedestrians' overpasses. The problem is alarming and hence proper & immediate actions ought to be taken to resolve it.

1.3 Objectives of study

The main objective of this study is to identify and investigate the safety factors of road elements and rank the road safety hazardous locations. For this, "Safety Hazardous Index" is use to define the risk of a safety factor or a feature causing road crashes.

The specific objectives of the study are:

- To identify geometric elements of roads and safety factors for each geometric element so as to prioritize safety factors using AHP.
- To conduct field survey for condition rating of safety factors.
- To determine the Safety Hazardous Index in order to rank the road safety hazardous locations.

1.4 Organization of the report

The report contains five chapters. The first chapter deals with the general introduction, statement of problem and objectives associated with this research. Chapter two briefly provides the literature review regarding theories and research works. Chapter three deals with the overview of six stage framework ranking methodology and chapter four describes data collection, analysis and interpretation, whereas chapter five deals with the conclusions and recommendations. After that, references and annexes are provided.

1.5 Limitations

- Not more than 10 number of safety factors for each element as it would be complex to deal with large numbers of factors during pairwise comparision.
- Only limited number of road safety experts may be familiar with the road considered for study which can affect the result obtained from questionnaire survey.
- Expert's judgment has to be discarded in case of inconsistency > 0.10 resulting in reduction in sample size.

CHAPTER TWO: LITERATURE REVIEW

2.1. General

Mainly, four factors play a key role in road crash namely: road, human, vehicle and environment. Of these all, only road factor can be easily improved by traffic and transportation engineers to decrease the rate of road crashes and severity. Considering the fact, it is necessitate investigating and ranking the chief parameters of "Road" factor and their various features (Sadeghpour, et al., 2018). Various methodologies have been used in defining the risk of factors or features causing road crash. The base of some studies is the road crash data and establishing statistical modelling of crashes (Cafiso, et al., 2010; Oh, et al., 2004). The base of other studies is explanatory approaches due to the lack of easy accessibility to road crash data or doubt on their accuracy (Habibian, et al., 2011).

2.2. Road Safety Evaluation Approaches

There are three common methods to evaluate the road safety (Habibian, et al., 2011) namely: Traffic Conflict Technique, Subjective Rating System, and Multi Criteria Decision Making Approach.

2.2.1. Traffic Conflict Technique

The concept of traffic conflicts was first proposed by Perkins and Harris as an alternative to crash data; particularly, when there is no accurate and reliable crash data. Their objectives were to define traffic incidents that occur frequently, can be clearly observed, and are related to road crashes. A common definition of a traffic conflict is an observable situation in which two or more road users approach each other in space and time for such an extent that there is a risk of collision if their movements remain unchanged (Leur, et al., 2002).

A variety of observation methods have been developed to measure traffic conflicts. These methods can be classified as subjective or objective. Subjective methods include considerable judgment by the conflict observer and are criticized by several researchers because the grading of severity of the evasive action can vary greatly from one observer to another. Objective methods include a cardinal or ordinal time-proximity dimension in the severity scale. The most widely used measure is the time to collision defined as the time for two vehicles to collide if they continue at their

present speed and on the same path. However, it is noted that the traffic conflict technique requires the interaction of two vehicles and thus may not be useful for rural roads where many incidents are single-vehicle, off-road incidents (Leur, et al., 2002).

2.2.2. Subjective Rating System

"Subjective Rating System" was initially used by Transport Road Research Laboratory in 1990 (European Commission, 2008) to identify and investigate main road parameters leading to crashes. This approach of subjective road safety evaluation involves a drive-through technique (Leur, et al., 2002).

A study completed by the Transport and Road Research Laboratory (*2*) investigated the impact of road design characteristics on driver perception and behavior and the propensity for driver risk acceptance. A 26-km route was selected for investigation and 60 drivers were used to make an assessment of the road safety risk at specific locations along the route (Leur, et al., 2002).

The subjective safety rating was determined by having each test participant drive the route at a "comfortable," self-selected speed and then asked to give a rating of the road safety risk at 45 locations along the route. The rating was based on a subjective 11-point scale, with a score of 0 representing "no chance of a near miss" and a score of 10 representing a "good chance of a near miss" (Leur, et al., 2002).

The objective safety rating was determined by calculating the accident rate based on historical collision statistics. In addition, a driver's selection of vehicle speed was also recorded as it could be used to reflect the perceived safety risk between locations. Higher speeds would reflect lower perceived risk, whereas lower speeds indicate higher risk (Leur, et al., 2002).

The subjective and objective scores were then used to rank the road-user risk at each location and then to compare results. One test was to determine the agreement between observers in ranking the 45 locations, and the second test was to compare the rank of the subjective risk scores with the objective risk scores. The agreement between drivers (Test 1) was found to be significant. For Test 2, the Spearman rank correlation coefficient was used to determine the level of agreement between the subjective and objective risk scores. The coefficient was 0.37, indicating that the

agreement was significantly less than perfect (1.0 represents perfect correlation). The reduction in vehicle speed selection and a driver's adaptation to potential hazard may be the principle reason for the lack of correlation between subjective and objective risk ratings (Leur, et al., 2002).

2.2.3. Multi Criteria Decision Making Approach

"Multi Criteria Decision Making Approach" mainly apply to rank the parameters of road crashes (Agarwal, et al., 2013; Mesbah, 2006; Najib, et al., 2012). Nassiri and Mojarad used Simple Additive Weighting (SAW) to calculate the road Risk Index in Iran's intersection and rural roads (Sadeghpour, et al., 2018).

Furthermore, Lazim A. and Nurnadiah Z. employed Fuzzy TOPSIS to rank the parameters of road crashes in Malaysia (Sadeghpour, et al., 2018). (Najib, et al., 2012) weighted and ranked the main causes of road crashes using Analytic Hierarchy Process (AHP). (Mesbah, 2006) investigated the level of road safety in urban areas, extended a management approach based on AHP. (Habibian, et al., 2011) used AHP to rank the hazardous locations in two lane rural roads when there was no crash data.

2.3. Overview of Decision Making & Criteria Analysis Approach

The decision-making process is a complex task, with large amounts of information, it is extremely difficult or even impossible to take a rational decision, due to the number of intervening variables, their interrelationships, potential solutions that might exist, diverse objectives envisioned for a project, etc.; therefore, some help is called for, and some strategy is required to organize, classify, and evaluate this information (Bhushan, et al., 2007).

Multi-criteria analysis (MCA) establishes preferences between options by reference to an explicit set of objectives that the decision-making body has identified, and for which it has established measurable criteria to assess the extent to which the objectives have been achieved. MCA offers a number of ways of aggregating the data on individual criteria to provide indicators of the overall performance of options. A key feature of MCA is its emphasis on the judgment of the decision making team, in establishing objectives and criteria, estimating relative importance weights and, to some extent, in judging the contribution of each option to each performance criterion (Dodgson, et al., 2009).

A prioritization matrix is a simple tool that provides a way to sort a diverse set of items into an order of importance. It also identifies their relative importance by deriving a numerical value for the priority of each item. The matrix provides a means for ranking projects (or project requests) based on criteria that are determined to be important. This enables a department to see clearly which projects are the most important to focus on first, and which, if any, could be put on hold or discontinued.

Deciding how to prioritize and separate the high priority projects from lower priority projects can be daunting. Since emotions often run high when making these kinds of decisions, a structured and objective approach can be helpful in achieving consensus and balancing the needs of the department and its customers and stakeholders. Using a prioritization matrix is a proven technique for making tough decisions in an objective way.

Social Cost Benefit analysis (SCBA) is used extensively in the US, New Zealand, England, Australia, Singapore, Chile, Ireland, and many other countries to assess and prioritize alternative infrastructure projects, particularly those that demand significant investments. But in the past five years, the UK, Australia, and many US states have also published notes and guidance on the application of multi-criteria decision analysis (MCDA). Some countries, such as Ireland, have imposed thresholds to guide when government should apply SCBA, multi-criteria analysis, or more simple assessments, depending on the size of the proposed investment (Marcelo, et al., 2016).

Multi-criteria decision analysis has gained traction as a way of systematically structuring investment decisions when multiple aspects associated with proposed investments must be reconciled. Multi-criteria decision approaches formalize the inclusion of non-monetary and qualitative factors into decision analysis and can be useful when information or analytical resources are limited. Indeed, MCDAs are currently included in government and multilateral project appraisal and selection practice in regions including the Pacific Island Countries and Argentina, as well as in countries with longstanding and established programs of economic project assessment, including Chile, Ireland, and the UK.MCDAs have the added benefit of flexibility, since they can be recalibrated to accommodate improved data as it becomes available (Marcelo, et al., 2016).

A prioritization matrix supports structured decision-making in the following ways:

• Helps prioritize complex or unclear issues when there are multiple criteria for determining importance.

• Provides a quick and easy, yet consistent, method for evaluating options.

• Takes some of the emotion out of the process

• Quantifies the decision with numeric rankings

Multi-criteria Analysis, A manual published by Department for Communities and Local Government of United Kingdom in 2009 (Dodgson, et al., 2009) insights basic concept on MCA which are as follows.

In practice the most generic form of analysis in government is cost effectiveness analysis (CEA), where the costs of alternative ways of providing similar kinds of output are compared. Less common, although widely used in transport and health and safety, is cost benefit analysis (CBA), in which some important non-marketed outputs are explicitly valued in money terms.

Monetary-based techniques for decision making

• Financial analysis: An assessment of the impact of an option on the decision making organizations own financial costs and revenues. If the impacts are spread over future years, the net impacts in each year need to be discounted to a present value, and this applies equally to cost effectiveness and cost-benefit analysis.

• Cost-effectiveness analysis: An assessment of the costs of alternative options which all achieve the same objective. The costs need not be restricted to purely financial ones.

• Cost-benefit analysis: An assessment of all the costs and benefits of alternative options. CBA is criticized on political or philosophical grounds, to the effect that it is the role of government to apply judgments that are not necessarily a reflection of current preferences. In addition, there may be impacts which cannot readily be quantified in a way which could be set against a scale of monetary values.

2.4. Different Types of Multi Criteria Analysis Techniques

All MCA approaches make the options and their contribution to the different criteria explicit, and all require the exercise of judgment. They differ however in how they combine the data. The main role of the techniques is to deal with the difficulties that human decision-makers have been shown to have in handling large amounts of complex information in a consistent way.

The reason for different types of MCA technique to be present are there are many different types of decision which fit the broad circumstances of MCA, the time available to undertake the analysis may vary, the amount or nature of data available to support the analysis may vary, the analytical skills of those supporting the decision may vary, and the administrative culture and requirements of organizations vary.

Any MCA technique selected should have internal consistency and logical soundness, transparency, ease of use, data requirements not inconsistent with the importance of the issue being considered, realistic time and manpower resource requirements for the analysis process, ability to provide an audit trail, and software availability, where needed.

There are many advantages of MCA over informal judgement which can be listed as below (Dodgson, et al., 2009).

- it is open and explicit
- the choice of objectives and criteria that any decision-making group may make are open to analysis and to change if they are felt to be inappropriate
- Scores and weights, when used, are also explicit and are developed according to established techniques. They can also be cross-referenced to other sources of information on relative values, and amended if necessary
- Performance measurement can be sub-contracted to experts, so need not necessarily be left in the hands of the decision-making body itself
- It can provide an important means of communication, within the decision making body and sometimes, later, between that body and the wider community, and
- Scores and weights are used, it provides an audit trail.

2.4.1. Multi-attribute utility theory

There is no normative model of how individuals should make multi-criteria choices that is without critics. The one that comes closest to universal acceptance is based on multi-attribute utility theory. While this work provided powerful theoretical insights, it does not directly help decision makers in undertaking complex multi-criteria decision tasks. The breakthrough in this respect is the work of Keeney and Raiffa, published in 1976. They developed a set of procedures, consistent with the earlier normative foundations, which would allow decision makers to evaluate multi-criteria options in practice. There are three building blocks for their procedures. First is the performance matrix and the second is procedures to determine whether criteria are independent of each other or not. The third consists of ways of estimating the parameters in a mathematical function which allow the estimation of a single number index, *U*, to express the decision maker's overall valuation of an option in terms of the value of its performance on each of the separate criteria (Dodgson, et al., 2009).

2.4.2. Linear additive models

If it can either be proved, or reasonably assumed, that the criteria are preferentially independent of each other and if uncertainty is not formally built into the MCA model, then the simple linear additive evaluation model is applicable. The linear model shows how an option's values on the many criteria can be combined into one overall value. This is done by multiplying the value score on each criterion by the weight of that criterion, and then adding all those weighted scores together. However, this simple arithmetic is only appropriate if the criteria are mutually preference independent. Most MCA approaches use this additive model. Models of this type have a well-established record of providing robust and effective support to decision-makers working on a range of problems and in various circumstances (Dodgson, et al., 2009).

2.4.3. Outranking methods

One option is said to outrank another if it outperforms the other on enough criteria of sufficient importance (as reflected by the sum of the criteria weights) and is not outperformed by the other option in the sense of recording a significantly inferior performance on any one criterion. The outranking concept does, however, indirectly capture some of the political realities of decision making. In particular it downgrades options that perform badly on any one criterion (which might in turn activate strong

lobbying from concerned parties and difficulty in implementing the option in question). It can also be an effective tool for exploring how preferences between options come to be formed. However, on balance, its potential for widespread public use seems limited (Dodgson, et al., 2009).

2.4.4. Procedure that use qualitative data inputs

Reliable and transparent support for decision making is usually best achieved using numerical weights and scores on a cardinal scale. Decision makers working in government are frequently faced with circumstances where the information in the performance matrix, or about preference weights, consists of qualitative judgements (Dodgson, et al., 2009).

2.4.5. MCA methods based on fuzzy sets

Fuzzy sets attempt to capture the idea that our natural language in discussing issues is not precise. Options are ‘fairly attractive’ from a particular point of view or ‘rather expensive’, not simply ‘attractive’ or ‘expensive’. Fuzzy arithmetic then tries to capture these qualified assessments using the idea of a membership function, through which an option would belong to the set of, say, ‘attractive’ options with a given degree of membership, lying between 0 and 1 (Dodgson, et al., 2009).

These methods tend to be difficult for non-specialists to understand, do not have clear theoretical foundations from the perspective of modelling decision makers preferences and have not yet established that they have any critical advantages that are not available in other, more conventional models. They are unlikely to be of much practical use in government for the near future (Dodgson, et al., 2009).

2.4.6. Analytical Hierarchy Process

The Analytic Hierarchy Process (AHP), introduced by Thomas Saaty (1980), is an effective tool for dealing with complex decision making, and may aid the decision maker to set priorities and make the best decision (Saaty, 2008). By reducing complex decisions to a series of pairwise comparisons, and then synthesizing the results, the AHP helps to capture both subjective and objective aspects of a decision. In addition, the AHP incorporates a useful technique for checking the consistency of the decision maker’s evaluations, thus reducing the bias in the decision making process.

In this study, Klaus D. Goepel version 11.10.2017 AHP Spreadsheet Template is used to check the consistency of pairwise comparisons for the validation of weight calculation for different criteria selected which have salient features as described below (Goepel, 2013).

1. The requirements considered for producing the template are easy-to-use, working without macros and not relying on external links to other workbooks. The template should be flexible in the number of criteria, the number of participants and level of accepted inconsistency in the matrix. In addition, each questionnaire should fit on one page for printing and manual completion.
2. Following are some features of spreadsheet template which were incorporated in the template.

- The workbook consists of 10 (or more) input worksheets for pair-wise comparisons, a sheet for the consolidation of all judgments, a summary sheet to display the result, a sheet with reference tables (random index, limits for geometric consistency index GCI, judgment scales)and a sheet for solving the eigen value problem when using the eigenvector method (EVM).
- Within the input worksheets (questionnaires), priorities are calculated using the row geometric mean method (RGMM).
- Two consistency indices (the consistency ratio CR and the geometric consistency index GCI) are calculated. The level of consistency needed is implemented as a variable input field and can be set between zero and one.
- If CR exceeds, the top 3 inconsistent pair-wise comparisons are highlighted, to allow the participants an adjustment of their judgments.
- Final priorities are shown in a summary sheet; their calculation is based on the eigen vector method (EVM).
- For the solution of the eigen value problem the power method algorithm (e.g. Larsen, 2013) is applied with a fixed number of 12 iterations.
- Different judgment scales are implemented.
- Either individual participants, or an aggregation of individual judgments (AIJ) based on the geometric mean of all participants' judgments (Aull-Hyde et al. , 2006), can be selected.

Some limitations of spreadsheet template are as under.

- The template does not include the hierarchy of the decision problem and the final aggregation of weights, i.e. it is only suitable for finding the weights in each category or sub-category.
- Another limitation is the lack of sensitivity analysis of the final result (Goepel, 2013).

2.4.6.1. How the AHP works

The AHP considers a set of evaluation criteria, and a set of alternative options among which the best decision is to be made. It is important to note that, since some of the criteria could be contrasting, it is not true in general that the best option is the one which optimizes each single criterion, rather the one which achieves the most suitable trade-off among the different criteria.

The AHP generates a weight for each evaluation criterion according to the decision maker's pairwise comparisons of the criteria. The higher the weight, the more important the corresponding criterion. Next, for a fixed criterion, the AHP assigns a score to each option according to the decision maker's pairwise comparisons of the options based on that criterion. The higher the score, the better the performance of the option with respect to the considered criterion. Finally, the AHP combines the criteria weights and the options scores, thus determining a global score for each option, and a consequent ranking. The global score for a given option is a weighted sum of the scores it obtained with respect to all the criteria.

2.4.6.2. Features of AHP

The AHP is a very flexible and powerful tool because the scores, and therefore the final ranking, are obtained on the basis of the pairwise relative evaluations of both the criteria and the options provided by the user. The computations made by the AHP are always guided by the decision maker's experience, and the AHP can thus be considered as a tool that is able to translate the evaluations (both qualitative and quantitative) made by the decision maker into a multi criteria ranking. In addition, the AHP is simple because there is no need of building a complex expert system with the decision maker's knowledge embedded in it.

On the other hand, the AHP may require a large number of evaluations by the user, especially for problems with many criteria and options. Although every single evaluation is very simple, since it only requires the decision maker to express how two options or criteria compare to each other, the load of the evaluation task may become unreasonable. In fact the number of pairwise comparisons grows quadratically with the number of criteria and options. For instance, when comparing 10 alternatives on 4 criteria, $4 \cdot 3/2=6$ comparisons are requested to build the weight vector, and $4 \cdot (10 \cdot 9/2)=180$ pairwise comparisons are needed to build the score matrix.

However, in order to reduce the decision maker's workload the AHP can be completely or partially automated by specifying suitable thresholds for automatically deciding some pairwise comparisons.

Like all modelling methods, the AHP has strengths & weaknesses. The main advantage of the AHP is its ability to rank choices in the order of their effectiveness in meeting conflicting objectives. If the judgements made about the relative importance of the objectives have been in good faith, then the AHP calculations lead inexorably to the logical consequence of those judgements. It is quite hard to fiddle the judgements to get some predetermined results. The further strength of the AHP is its ability to detect inconsistent judgements.

The limitations of the AHP are that it only works because the matrices are all of the same mathematical form. To create such a matrix requires that, if we use the number 9 to represent 'A is absolutely more important than B', then we have to use 1/9 to define the relative importance of B w.r.t. A'. Some people regard that as reasonable, others are less happy about it. The other seeming drawback is that, if the scale is changed from 1-9 to, say 1-29, the numbers in the end result will also change. In many ways that does not matter as the end results simply says that something is relatively better than another at meeting some objective.

In short, the AHP is a useful technique for discriminating between competing options in the light of a range of objectives to be met. The calculations are not complex and while the AHP relies on what might be seen as a mathematical trick.

2.4.6.3. Implementation of AHP

The AHP can be implemented in three steps:

1) Determining the vector of criteria weights.

2) Determining the matrix of option scores.

3) Ranking the options.

These steps will be explained in detail in the methodology chapter..

2.5. Analytical Hierarchy Process Applications

T L. Saaty has suggested the process to derive relative priorities in decision making as Analytical Hierarchy Process through pair wise comparison.

AHP method has been extensively used in a large number of road safety researches and so many researchers have done in order to identify accident prone locations. For instance, (Agarwal, et al., 2013; Habibian, et al., 2011) suggested methodologies for ranking black spots in terms of Safety Hazardous Index & Safety Index respectively using AHP.

(Sadeghpour, et al., 2018) evaluated traffic risk indexes in Iran's rural roads with regards to the two main criteria: Effect on Accidents number & Effects on Accident Severity using a Multi criteria Decision Making Approach of AHP to find the score of Risk Index of each chosen parameters and rank them with regard to the two main criteria.

(Najib, et al., 2012) implied six steps of AHP to identify that 'driving faster than limited speed' has the highest weights among all the causes leading to the accidents in Malaysia.

Also, (Keymanesh, et al., 2017) attempted to identify & prioritize black spots in Baluchistan, Iran with no use of accident data but rather using AHP with the use of Expert Choice Software.

(Jakimavičius, 2018) applied multi criteria method of AHP along with GIS technology to evaluate Lithuanian road accidents. GIS concepts and technology enable statistical evaluations of spatial patterns of the road accident data. The use of the criterion, representing the spatial dependencies of accidents, in the multi criteria analysis, allows assessing the accident sections based on the concentration of accident

points. The spatial criterion (z-score) used allows for more precise ranking of accident sections.

(Hajeeh, 2012) utilized AHP to analyze the traffic accidents in Kuwait with the main objective to identify the most strategic policies to be used by the authorities in Kuwait in order to minimize the severe effect of traffic accidents both on human and property.

2.6. Saaty's Scale

Saaty, 1990 suggested the weight of the items is found using Relative Weight Matrix (RWM) in AHP. This process is based on pair-wise comparisons. An expert is asked to compare each two items and associate a relative importance to the pair. The relative importance is assessed using the scale in Table 2.1 if item 'x' is more important than item 'y' then this importance is mapped into a scale of 1 to 9 is the absolute importance. In Saaty's scale, the relative importance of item 'y' to item 'x' is the reciprocal of the importance of item 'x' to item 'y' (Habibian, et al., 2011).

Table 2.1 Saaty's Rating Scale

Relative importance	Qualitative Scale	Comments
1	Equal	Two activities contribute equally
3	Moderate importance	Slightly favor one activity over another
5	Strong importance	Strongly favor one activity over another
7	Demonstrated importance	Very Strongly favor one activity over another, its dominance demonstrated in practice
9	Absolute importance	Very strongly to Extremely strongly preferred
2,4,6,8	Values between the levels above	Used only when a compromise in comparison is necessary
Reciprocal	If importance of item x to item y is a_{ij} then the importance of item x is $a_{ji}=1/a_{ij}$	

2.7. Random Index Study

Saaty (at Wharton) and Uppuluri (at Oak Ridge) simulated the experiment with 500 and 100 runs, respectively. Lane and Verdini (1989), Golden and Wang (1990), and Noble (1990) carried out 2500, 1000, and 5000 simulation runs (Alonso, et al., 2006). Various authors have computed and obtained different RIs depending on the simulation method and the number of generated matrices involved in the process (Alonso, et al., 2006).

Table 2.2 RI (n) from various authors

SN	Oak Ridge, 1980	Wharton, 1980	Golde Wang, 1990	Lane, Verdini, 1989	Forman, 1990	Noble, 1990	Tumal Wan, 1994	Aguar et al	Alons Lamata, 2006
	100	500	1000	2500		500		10000	10000
3	0.382	0.58	0.5799	0.52	0.52	0.49	0.5	0.525	0.5245
4	0.946	0.9	0.8921	0.87	0.88	0.82	0.834	0.882	0.8815
5	1.22	1.12	1.1159	1.1	1.10	1.03	1.046	1.115	1.1086
6	1.032	1.24	1.2358	1.25	1.25	1.16	1.178	1.252	1.2479
7	1.468	1.32	1.3322	1.34	1.34	1.25	1.267	1.341	1.3417
8	1.402	1.41	1.3952	1.4		1.31	1.326	1.404	1.4056
9	1.35	1.45	1.4537	1.45		1.36	1.369	1.452	1.4499
10	1.464	1.49	1.4882	1.49		1.39	1.406	1.484	1.4854
11	1.576	1.51	1.5117			1.42	1.433	1.513	1.5141
12	1.476		1.5356	1.54		1.44	1.456	1.535	1.5365
13	1.564		1.5571			1.46	1.474	1.555	1.5551
14	1.568		1.5714	1.57		1.48	1.491	1.57	1.5713
15	1.586		1.5831			1.49	1.501	1.583	1.5838

These results show that the values can change between different experiments. The values obtained by Golden and Wang, Lane and Verdini, and Forman are closer, whereas the values obtained by Saaty and Uppuluri seem to be higher. On the other hand, Noble, Tumala and Wan produced lower RI values. In recent years, authors such as Aguaron et al, Ozdemir, Alonso and Lamata have obtained different RI values but they are all very close (as we can see in Table 2.2) (Alonso, et al., 2006).

CHAPTER THREE: METHODOLOGY

3.1. General

The objectives of the present work have been discussed in the first chapter. In order to fulfill those objectives, a methodology needs to be formulated to achieve the required results. This chapter describes the details of the site considered in the study, the overall method adopted for ranking the safety hazardous locations in Kalanki Koteshwor road section.

3.2. Study Area

Kathmandu Ring Road (KRR) is an eight lane ring road circling around the cities of Kathmandu and Lalitpur. KRR has been classified as National Highway Category (Code H16). It serves as the main arterial road in Kathmandu valley. It has been upgraded for the purpose of reducing the traffic congestion along radial road from Central Business District (CBD). Therefore, it serves as one of the major transport link in Kathmandu Valley. However, in the present scenario, this road link is facing heavy traffic movement creating huge congestion at major intersections.

The Southern section of KRR from Kalanki (CH.10+600) to Koteshwor (CH.20+994) shown in Figure 3.1 was selected as study area.

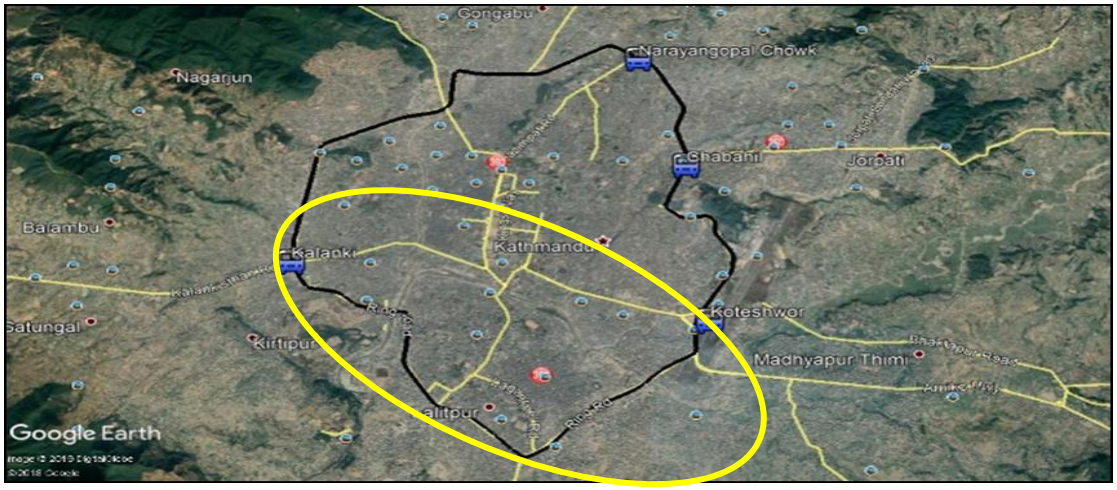

Figure 3.1 Location of study area

The previous two lane KRR has been upgraded to the four lane with service road in both sides from Kalanki to Koteshwor as shown in the Figure 3.2 (DOR, 2019).

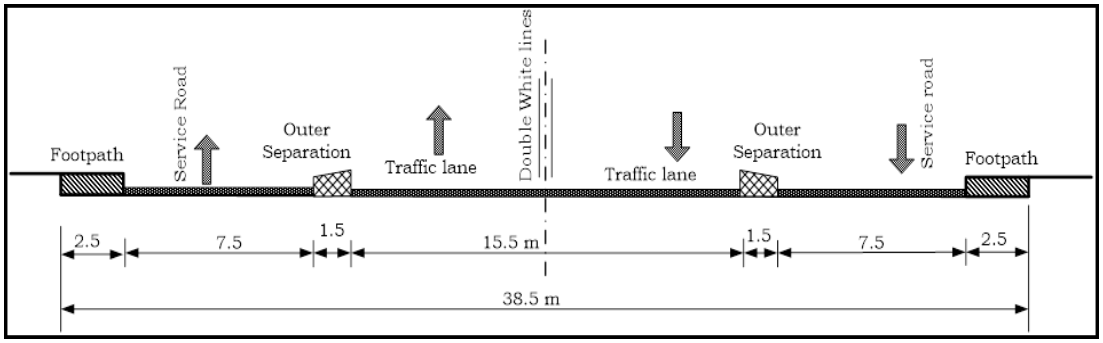

Figure 3.2 General cross-section of K-K section of KRR

Kalanki Koteshwor road section has been built as the urban arterial road with technical parameters as shown in Table 3.1 (Corporation, 2012).

Table 3.1: Technical parameters of K-K section of KRR

Parameters	**Main Road**	**Service Road**
Road Class	Urban Arterial	-
Design Speed	50 km/h	20 km/h
Number of lanes	4 lanes of dual carriageway	2 lanes of single
Right of way	50 m	
Setback	6 m both sides	
Road Width	15.5 m	7.5 m
Road clearance (m)	5.0	
Minimum circular curve radius for normal crown section (m)	400	70
Recommended circular curve radius for actual elevation (m)	200	40
Minimum circular curve radius for actual elevation (m)	100	20
Minimum length of easement curve (m)	45	20
Maximum longitudinal grade recommended (%)	5.5	8
Maximum longitudinal grade limitation (%)	7	9
Minimum length of longitudinal slope section (m)	130	60

Parameters	Main Road	Service Road
Convexity vertical curve limit minimum radius (m)	900	100
Convexity vertical curve general minimum radius (m)	1350	150
Concave vertical curve limit minimum radius (m)	700	100
Concave vertical curve general minimum radius (m)	1050	150
Length of minimum vertical curve (m)	40	20
Pavement structure	Asphalt Concrete pavement	Asphalt Concrete
Design load of bridge and culvert	Maintain the original bridge	China Road Class – I
Seismic peak ground acceleration	0.3 g	0.3g
Chainage from/to	10+600 (Kalanki)	20+994 (Koteshwor)

3.3. Overview of Methodology

The proposed framework for achieving the objectives of the research "Ranking of Safety Hazardous Locations" is divided into six stages as shown in Figure 3.3.

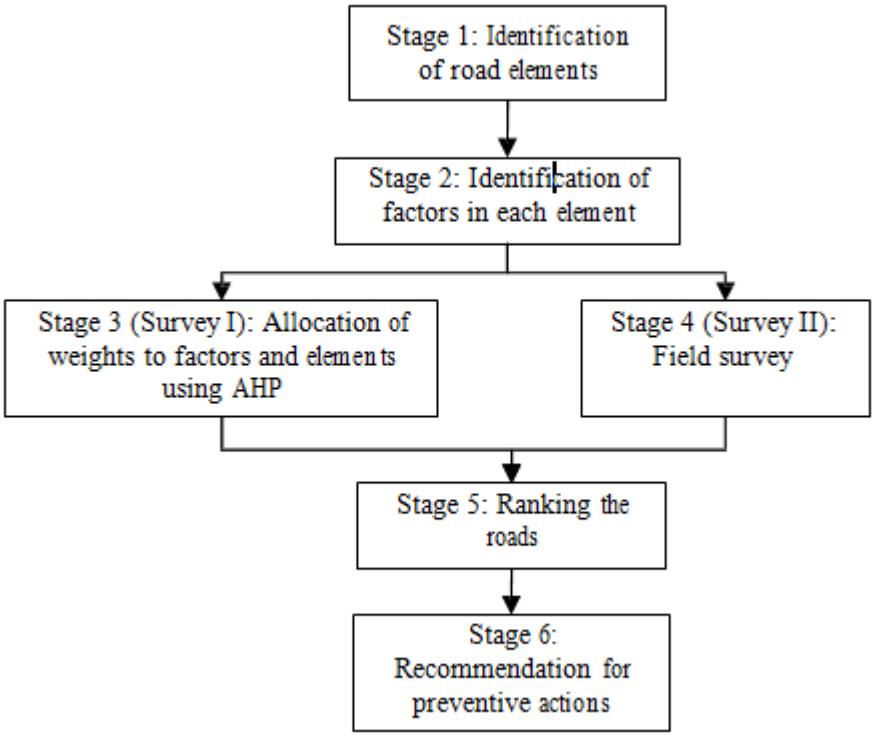

Figure 3.3 Methodology Flow Chart

3.3.1. Stage 1 and 2: Identification of road elements and safety factors for each element

On the basis of literature review related to AHP and road safety, study of "Design of Construction Drawing of The Improvement Project of Kathmandu Ring Road Project in Nepal" (Corporation, 2012), field visit and experiences, four road elements (straight, curve, bridge & merge and intersection) were identified in the selected road section for which factors responsible for the safety of road are also assigned as tabulated below Table 3.2.

Table 3.2 Factors in each element

1. Straight Segments:	A. Speed limit signs and no overtaking signs B. Lighting poles and reflective signs C. Road marking D. Shoulder width E. Pavement maintenance condition F. Drainage

	G. Pedestrian Crossing facilities
2. Horizontal and Vertical Curves:	A. Speed advisory signs, sharp bend, steep up/down grade warning signs B. Lighting poles and reflective signs C. Road marking before and in the curve D. Shoulder width E. Combination of horizontal and vertical curves F. Pavement maintenance condition G. Drainage H. Sight distance provision I. Superelevation in horizontal curves J. Road Safety Intervention
3. Bridges:	A. Speed limit, no overtaking, and load limit signs B. Lighting poles and reflective signs C. Road marking D. Reduction in the pavement and shoulder width E. Pavement maintenance condition F. Drainage G. Guardrails and bridge approach protection
4. Merge & Intersections:	A. Speed limit and warning signs B. Lighting poles and reflective signs C. Road marking D. Shoulder width E. Pavement maintenance condition F. Drainage G. Visibilty (Sight distance)/ turning radius H. Distance to the previous I. Traffic Calming measures/ Appropriate geometry to reducing speed J. Pedestrain Crossing Facilities

3.3.2. Stage 3: Allocation of weights to factors using AHP

Once the criteria have been identified, and the concepts of establishing priorities and consistency were clearly understood, the relative weights were allocated to the selected criteria at each hierarchy level. For this, a scale needs to be established. Many studies have been conducted for finding the most appropriate scale of measurement. The 1-to-9 scale has been preferred over other scales since it most closely resembles our natural ability to distinguish strengths of dominance or preferences between objects. Table 2.1 shows Saaty's Intensity of 1-to-9 Importance Scale.

After selecting the scale of measurement, the pair-wise comparisons were performed with the help of experts. This concept allows evaluating different criteria by comparing two criteria at a time as simply described by Figure 3.4. This approach simplifies the evaluation process by focusing the evaluator's attention to the two alternatives at hand.

Therefore, the pair-wise comparisons need to be performed for all combinations of criteria. Equation 1 provides the number of pair-wise comparisons for n number of criteria or alternatives. For example, for 10 numbers of criteria, 45 pair-wise comparisons would be performed by the evaluator or expert. During the evaluation, the evaluator need to decide the intensity of his or her preference between two criteria, one pair at a time, ignoring other criteria during the process. The process was repeated for all combinations of the criteria. In this way, the evaluator's judgments are kept in consistent check and a ranking of all the criteria based on pair-wise comparison is generated.

No. of pairwise comparisons = $n \times (n - 1)/2$ ……. Equation 1

Where,

n = Number of criteria. Also, represents size of square matrix.

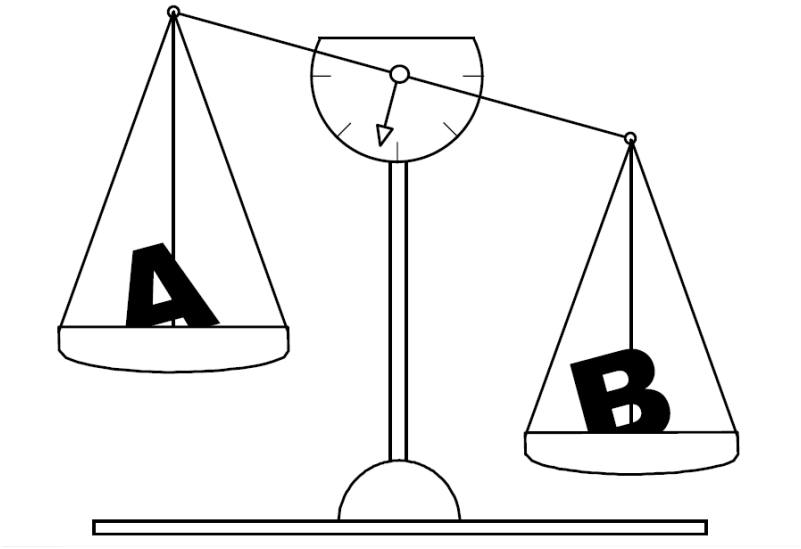

Figure 3.4 Illustration of Pair-wise Comparison

After completing pairwise comparison, the relative weight matrixes (RWM) are constructed and the matrixes would be:

	C_1	C_2	…..	Cn		A_{ij}
C_1	1	w_1/w_2	…..	w_1/w_n		w_1
C_2	w_2/w_1	1	…..	w_2/w_n		w_2
:	:	:	:	:	=	
:	:	:	:	:		
Cn	w_n/w_1	w_n/w_2	…..	1		W_n

Then the process is followed by calculation of matrix eigenvector, A_{ij} and consistency index test (CI) of the criterion. For matrix eigenvector, A_{ij} multiply the n elements in each row, take the nth root, and prepare a new column for the resulting values. Then divide each number by the sum of resulting values of the new column.

Eigen vector, $A_{ij} = \frac{\sum_{i=1}^{n}(\frac{w1}{w2}*\frac{w1}{w2}*\ldots*\frac{w1}{wn})\text{^}(\frac{1}{n})}{\sum[\sum_{i=1}^{n}(\frac{w1}{w2}*\frac{w1}{w2}*\ldots*\frac{w1}{wn})\text{^}(\frac{1}{n})]}$

Eigen value, $\lambda i = \frac{\sum_{j}^{n}(\sum_{i=1}^{n} Aij)wj}{Aij}$

Consistency test, $CI = \frac{\lambda max - n}{n-1}$

The consistency index was then compared with random index (RI) which is shown in Table 3.3. The ratio of consistency index to the random index is called Consistency

ratio (CR). If the CR is greater than 10%, the judgment is considered inconsistent and should be excluded or repeated again.

Consistency ratio, $CR = \frac{CI}{RI}$

Table 3.3: Random Index for different dimensions of RWM (Saaty and Wong 1983)

Dimension	1	2	3	4	5	6	7	8	9
RI	NA	NA	0.58	0.90	1.12	1.24	1.32	1.41	1.45

3.3.3. Stage 4: Field Survey

Entire route of survey was divided into parts of 500m such that the priority index could be prepared and improvements could be made accordingly. The section of road to be analyzed (Kalanki – Koteshwor) contained different segments such as horizontal curves, vertical curves and other facilities such that bridge and pedestrian facilities. These sections were analyzed separately as severity of problem differs from one to another.

This was carried out in following steps:

- Reconnaissance Survey
- Facilities Check
- Comparison with guidelines
- Severity Analysis/ Rating

Reconnaissance Survey

Entire section of road was traversed by motorbike. This was carried out to classify the section into straight section, curves, bridges, merge & intersections and make necessary changes in predefined section of analysis. Section of road where service way to be analyzed were noted.

Facilities Check

After classification and completion of first phase of survey, this survey was carried out to note every road facility throughout the section. Photographs were taken and precise locations were noted with the help of mobile application and GPS. Every bridge site, intersections and curves were thoroughly observed. In every 500m facilities of road section were aggregated. Survey of service lane and main lane was carried out separately. Qualitative description of pavement, drainage and other

facilities were noted. Quantitative descriptions of facility such as speed limit signs were noted.

Comparison with guidelines

Safety guidelines from government and other standards were studied and relevant information was noted. This was compared to data extracted from field. Quantitative and qualitative comparison was done.

Condition Rating

This was carried out with guidance of Road Safety Experts. Safety conditions were rated according to necessity of facility in the section and severity of improvement from safety point of view. Condition rating is assigned between zeros to one as tabulated in Table 3.4, zero is assigned for no deviation with the standard condition and its value increases up to one for very poor condition of safety factors.

Overall condition was rated by qualitative and quantitative analysis. Some of the facilities such as pedestrian crossing were adequate in number but they were not safer enough due to unsuitable and inappropriate placing of the facility.

Table 3.4: Condition rating of a road safety factors

SN	State of condition	Value
1	Excellent condition	0
2	Good condition	0.10-0.24
3	Average condition	0.25-0.49
4	Poor condition	0.50-0.74
5	Very poor condition	0.75-1.00

(Agarwal, et al., 2013)

3.3.4. Stage 5: Ranking the roads

Combining the weight of safety factors & condition rating of each factor obtained from stage 3 & 4, Safety hazardous Index was developed using formulas as below.

Safety hazardous Index at straight sections:

$$SHI_s = \sum (W_{sfs} \times R_{sfs})$$

Safety hazardous Index at curve sections:

$$SHI_c = \sum (W_{sfc} \times R_{sfc})$$

Safety hazardous Index at bridge sections:

$$SHI_b = \sum (W_{sfb} \times R_{sfb})$$

Safety hazardous Index at intersections:

$$SHI_i = \sum (W_{sfi} \times R_{sfi})$$

Where,

SHI_s, SHI_c, SHI_b, SHI_i = Safety Hazardous Index for straight, curve, bridge and intersections respectively.

W_{sfs}, W_{sfc}, W_{sfb}, W_{sfi} = Weight of safety factors at straight, straight, curve, bridge and intersections respectively.

R_{sfs}, R_{sfc}, R_{sfb}, R_{sfi} = Condition rating of safety factors at straight, straight, curve, bridge and intersections respectively.

Further, Safety hazardous index for entire road section (SHI_{rs}) of 2km was obtained by summation of SHI of all elements.

$$SHI_{rs} = SHI_s + SHI_c + SHI_b + SHI_i$$

This was performed for every 2 km road segments of Kalanki- Koteshwor Road Section. It is noted that higher the SHI at a particular location, higher safety hazardous condition at that particular location. In this way, ranking the hazardous locations of 2 km stretch each in Kalanki- Koteshwor Road allows the road safety authorities to implement road safety infrastructure for atleast 2 km stretch in eight lane ring road keeping limited available road safety budget in mind.

3.3.5. Stage 6: Recommendations for preventive actions

In this stage, the required countermeasures or preventive measures are to be suggested after identification of the hazardous locations along the study area based on the available budget and prioritization of countermeasures *(which is not in the scope of this work).*

CHAPTER FOUR: DATA COLLECTION AND ANALYSIS

4.1. Primary Data Collection:

4.1.1. Expert Questionnaire Survey

Expert Questionnaire Survey Form was prepared, and then distributed to 20 experts from various transportation related sectors. The list of experts filling the questionnaire format is provided in **Appendix 1**. The relative weight given by the experts during filling the format is tabulated in **Appendix 2**.

4.1.2. Condition Rating of Safety Factors

For condition rating of factors for each road segment, field survey of site conditions and traffic facilities of Kalanki- Koteshwor section was performed.

4.1.2.1 Condition rating at straight sections

Traffic signage, road marking, lighting poles, pavement condition, drainage, and pedestrian facilities along the straight section are the key indicators used in this study. A separate study was done for the main lane and service lane. There has been the construction of the road section on the right service lane at the chainage of 11+600 to the chainage of 12+600 (Khasibazar to near Balkhu). The main lane has the same feature throughout the section but road marking has been disappeared in some sections. Signage has been insufficient in the section of Kalanki- Balkhu and Balkumari- Koteshwor. In this study, the direction of the straight segment is Kalanki to Koteshwor and the left service road refers to the service road from which vehicular traffic flow from Kalanki to Koteshwor. And the right service road refers to that of Koteshwor to Kalanki as shown in Figure 4.1. The field condition rating data is tabulated in **Appendix 4**.

Figure 4.1 Road section at 11+100-11+600 (right service road)

Figure 4.2 Road section at 16+100-16+600

Figure 4.3 Road section at 17+600-18+100

Figure 4.4 Road section at 20+100-20+980

4.1.2.2 Condition rating at curve sections

There are few significant horizontal curves and vertical curves along the route. Traffic signage, road marking, lighting poles, superelevation, pavement condition, drainage, and pedestrian facilities along the curve section are the key indicators used in this study. Horizontal curves in section chainage of 13+380 to 13+670 (Sanepa) and

chainage of 17+300 to 17+550 (Chapagaun dobato) have a sharp bend in direction as shown in figure 4.5 and 4.6. The rating of such curves is tabulated in **Appendix 5**.

Figure 4.5 Horizontal Curve at Sanepa

Figure 4.6 Horizontal curve at Chapagaun Dobato

4.1.2.3 Condition rating at bridge sections

There are four bridges along the road section. Bridges along the middle carriageway have a weight restriction limit of more than 20 ton and that of side carriageway has 55 ton as seen in Figure 4.7. There is concrete railing on bridges. The broad rating of bridges is tabulated in **Appendix 6**.

Figure 4.7 Khasibazar and Balkhu Bridge

4.1.2.4 Condition rating at merge & intersections

Parameters such as traffic calming measures, safety barriers, pavement condition, traffic calming measures, pedestrian crossing facilities, and visibility are the key indicators used in this study to rate intersections. Road markings that direct the flow of traffic to all legs were already faded and needed to improve, which can be seen in Figure 4.8. Intersections in Ekantakuna, Satdobato, and Balkumari have over-head bridges for pedestrian crossing facilities. These facilities were not considered as these were still under construction. The rating of merging and intersections is tabulated in **Appendix 7**.

Figure 4.8 Kalanki and Koteshwor Intersection

4.2. Secondary Data Collection

Design of Construction Drawing of The Improvement Project of Kathmandu Ring Road in Nepal was used as secondary data source. It was used as a reference to study about the details of existing Kalanki Koteshwor road section. Also, Traffic police statistics (tabulated in **Appendix 7**) along the ring road has been collected to have idea about crash location, types, frequency and fatalities extent. The perception of traffic police were also collected for better knowledge of that road section.

4.3. Determination of Weightage of Safety Factors

The Relative Weight Matrices (RWM) or comparison matrices were prepared based on expert questionnaire survey form as shown in Table 4.1. Having a comparison matrix, priority vector, which is the normalized Eigen vector of the matrix, was computed. The priority vector shows relative weights among the factors that experts' compared. Aside from the relative weight, the consistencies of experts' answer were checked. If the value of Consistency Ratio was smaller or equal to 10%, the inconsistency was accepted. Otherwise, the subjective judgments of experts were revised. For revision of judgements, Klaus D. Goepel version 11.10.2017 AHP Spreadsheet Template is used.

The AHP Spreadsheet template shows an indication of three inconsistent inputs. The most inconsistent judgment is marked with "1". The text field after the marking shows the ideal, most consistent judgement. Participants might slightly modify the highlighted judgments in direction of the ideal judgment, in order to improve consistency. After reviewing all answers ideally no line will be highlighted and consistency is within the given threshold to make the result reliable (Goepel, 2013).

The calculation of relative weight of safety factor for straight element and its consistency ratio from one of the expert's questionnaire survey is presented as below.

Table 4.1 Sample of filled Questionnaire Survey Form

Comparison of factors within Straight Segment

Parameters/Factors:

A. Proper posting of speed limit signs and no overtaking signs
B. Lighting poles and reflective signs
C. Road marking and Delineators
D. Shoulder width
E. Pavement maintenance condition
F. Drainage
G. Pedestrian Crossing Facilities

Tick Mark (√) the suitable value from 1 to 9 and 1/9 to 1/2 in respective box.

Intensity of Importance	1	2	3	4	5	6	7	8	9	1/9	1/8	1/7	1/6	1/5	1/4	1/3	1/2
A over B	x																
A over C	x																
A over D			x														
A over E		x															
A over F		x															
A over G														x			
B over C	x																
B over D			x														
B over E		x															
B over F		x															
B over G														x			
C over D			x														
C over E		x															
C over F		x															
C over G														x			
D over E															x		
D over F		x															
D over G														x			
E over F			x														
E over G															x		
F over G															x		

The corresponding RWM was developed as tabulated below.

Table 4.2 Development of RWM

	A	**B**	**C**	**D**	**E**	**F**	**G**
A	1.00	1.00	1.00	3.00	2.00	2.00	0.20
B	1.00	1.00	1.00	3.00	2.00	2.00	0.20
C	1.00	1.00	1.00	3.00	2.00	2.00	0.20
D	0.33	0.33	0.33	1.00	0.25	2.00	0.20
E	0.50	0.50	0.50	4.00	1.00	3.00	0.25
F	0.50	0.50	0.50	0.50	0.33	1.00	0.25
G	5.00	5.00	5.00	5.00	4.00	4.00	1.00

The eigenvector of each factor was computed as the example given in Table 4.3.

Table 4.3 Eigen vector or Priority vector

	A	**B**	**C**	**D**	**E**	**F**	**G**	**$(1xa_{11}x\ldots..xa_{1n})^{1/n}$**	**$A_{ij}(w_i)$**
A	1.00	1.00	1.00	3.00	2.00	2.00	0.20	1.1332	0.1271
B	1.00	1.00	1.00	3.00	2.00	2.00	0.20	1.1332	0.1271
C	1.00	1.00	1.00	3.00	2.00	2.00	0.20	1.1332	0.1271
D	0.33	0.33	0.33	1.00	0.25	2.00	0.20	0.4494	0.0504
E	0.50	0.50	0.50	4.00	1.00	3.00	0.25	0.8693	0.0975
F	0.50	0.50	0.50	0.50	0.33	1.00	0.25	0.4719	0.0529
G	5.00	5.00	5.00	5.00	4.00	4.00	1.00	3.7276	0.4180
								8.92	**1.00**

For example, the calculation of weights is:

Eigen vector, $A_{ij} = \frac{\sum_{i=1}^{n}(\frac{w1}{w1}*\frac{w1}{w2}*\ldots*\frac{w1}{wn})\text{^}(\frac{1}{n})}{\sum[\sum_{i=1}^{n}(\frac{w1}{w1}*\frac{w1}{w2}*\ldots*\frac{w1}{wn})\text{^}(\frac{1}{n})]}$

Eigen vector, A_{ij} = $[(1\ x1x1x3x2x2x0.2)^{1/7}]$ / 8.92= 0.1271

To obtain the consistency ratio (CR), the calculation of Eigen-value was needed as in Table 4.4:

Table 4.4 Eigen Value or Consistency measure

	A	B	C	D	E	F	G	$(1xa_{11}x\ldots\ldots\ldots xa_{1n})^{1/n}$	$A_{ij}(w_j)$	λ_i
A	1.00	1.00	1.00	3.00	2.00	2.00	0.20	1.1332	0.1271	7.2146
B	1.00	1.00	1.00	3.00	2.00	2.00	0.20	1.1332	0.1271	7.2146
C	1.00	1.00	1.00	3.00	2.00	2.00	0.20	1.1332	0.1271	7.2146
D	0.33	0.33	0.33	1.00	0.25	2.00	0.20	0.4494	0.0504	7.7636
E	0.50	0.50	0.50	4.00	1.00	3.00	0.25	0.8693	0.0975	7.7242
F	0.50	0.50	0.50	0.50	0.33	1.00	0.25	0.4719	0.0529	7.6676
G	5.00	5.00	5.00	5.00	4.00	4.00	1.00	3.7276	0.4180	7.6021
								8.92	**1.00**	**52.40**

Eigen value, $\lambda_i = \frac{\sum_j^n (\sum_{i=1}^n Aij) wj}{Aij}$

Eigen value, λ_i

=(1x0.1271+1x0.1271+1*0.1271+3x0.0504+2x0.0975+2x0.0529+0.2x0.418)/ 0.1271 = 7.2146

Next, the consistency index (CI) was calculated using equation below.

Consistency test, CI = $\frac{\lambda max-n}{n-1} = \frac{\frac{52.40}{7}-7}{7-1} = 0.081$

Finally, the consistency ratio was calculated using equation below.

Consistency ratio, CR= $\frac{CI}{RI}$

CR = $\frac{CI}{RI} = \frac{0.081}{1.32} = 0.0614$

Thus, the judgment was acceptable since CR < 0.1. The process was repeated for all the experts. Then, the final weightage for safety factors was calculated by averaging the weight of priority vectors of experts whose judgements were approved by consistency test as shown in **Appendix 3**.

The average weight developed for each element is summarized in tabular form Table 4.5 and graphical form Figure 4.9 to Figure 4.12.

Table 4.5 Average Weight for each element

Road Element	Safety Factors	Avg. Wt.
1. Straight Segments:	A. Speed limit and no overtaking signs	0.1487
	B. Lighting poles and reflective signs	0.0864
	C. Road marking	0.1461
	D. Shoulder width	0.0940
	E. Pavement maintenance condition	0.1539
	F. Drainage	0.0822
	G. Pedestrain Crossing Facilities	0.2886
2. Horizontal and Vertical Curves:	A. Speed advisory signs, sharp bend steep up/ down grade warning signs	0.0999
	B. Lighting poles and reflective signs	0.0681
	C. Road marking & Delineators	0.0672
	D. Shoulder width	0.0547
	E. Combination of horizontal and vertical curves	0.1070
	F. Pavement maintenance condition	0.0749
	G. Drainage	0.0515
	H. Sight distance provision	0.1622
	I. Superelevation in horizontal curves	0.1065
	J. Road Safety Intervention at curve	0.2080
3. Bridges:	A.Speed limit, no overtaking, and load limit signs	0.1464
	B. Lighting poles and reflective signs	0.1097
	C. Road marking	0.1087
	D. Reduction in the pavement and shoulder width	0.1263
	E. Pavement maintenance condition	0.1438
	F. Drainage	0.0751
	G. Guardrails and bridge approach protection	0.2901
4. Merge & Intersections:	A. Speed limit signs and warnings	0.1112
	B. Lighting poles and reflective signs	0.0864
	C. Road marking	0.0800
	D. Shoulder width	0.0335
	E. Pavement maintenance condition	0.0862

	F. Drainage	0.0381
	G. Sight distance provision	0.1763
	H. Distance to the previous intersection and intersection spacing	0.0560
	I. Traffic Calming Measures/ Reducing the speed by appropriate geometry design	0.1845
	J. Pedestrian Crossing Facilities	0.1478

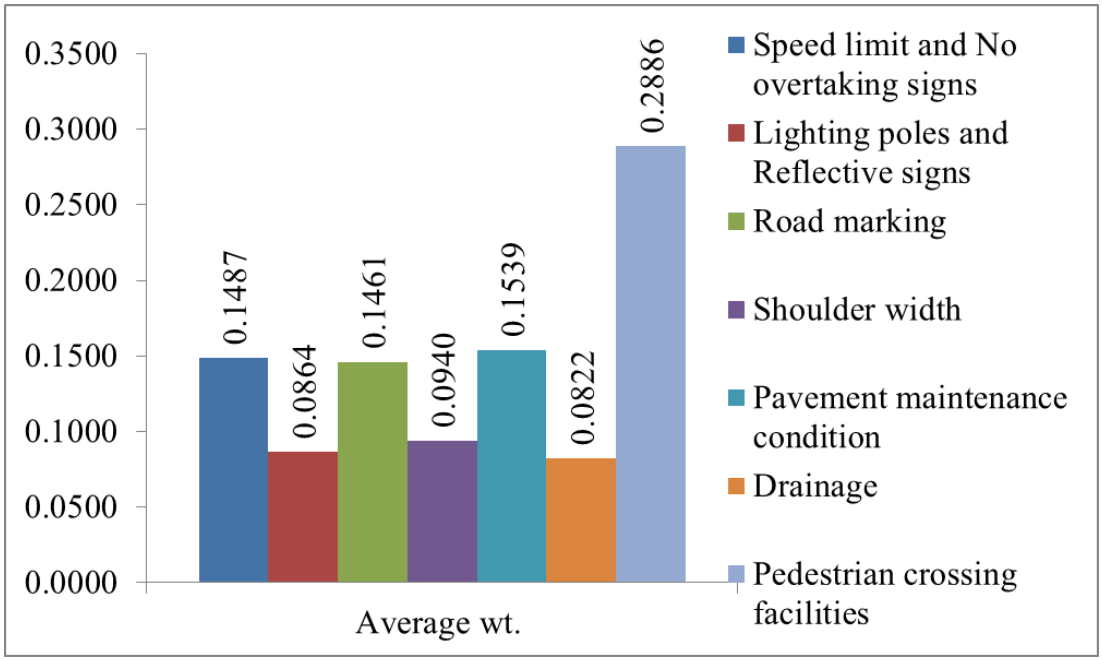

Figure 4.9 Average weight of factors in Straight

Figure 4.9 shows that experts have given more importance to the safety factor 'Pedestrain crossing facilities (28.86%)', 'Pavement maintenance condition (15.39%)', 'Speed limit & No overtaking signs (14.87%)' and 'Road marking (14.61%)' and so on in straight element of KKR.

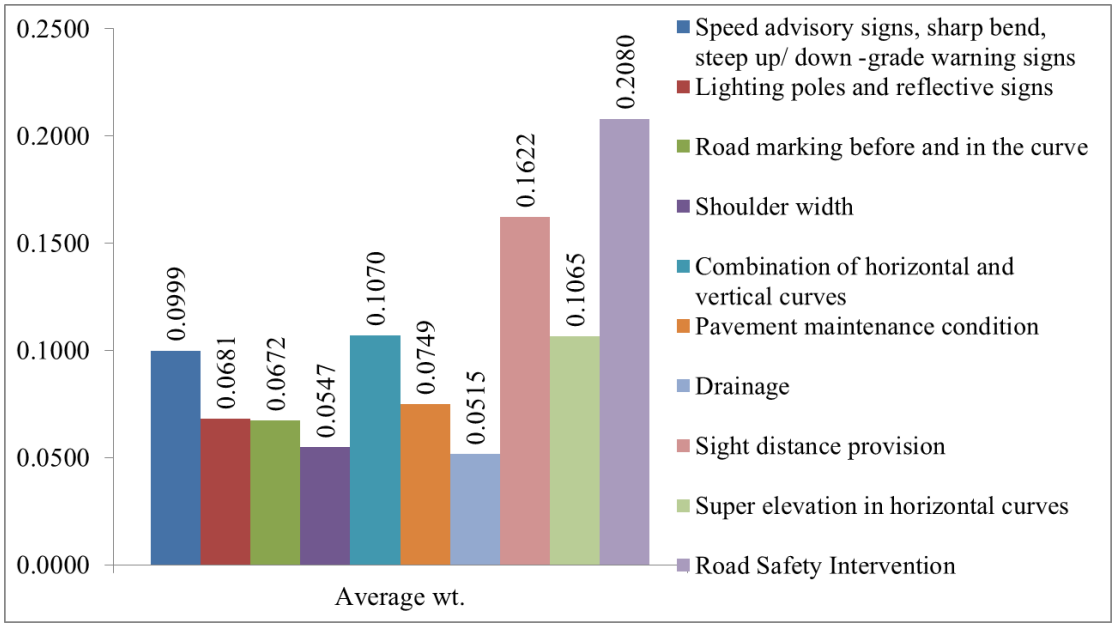

Figure 4.10 Average weight of factors in Curve Element

Similarly, Figure 4.10 shows 'Road safety intervention (20.80%)', 'Sight distance provision (16.22%)', 'Combination of horizontal & vertical curve (10.70%)' and 'Superelevation in horizontal curve (10.65%)' respectively has more priority in curve element.

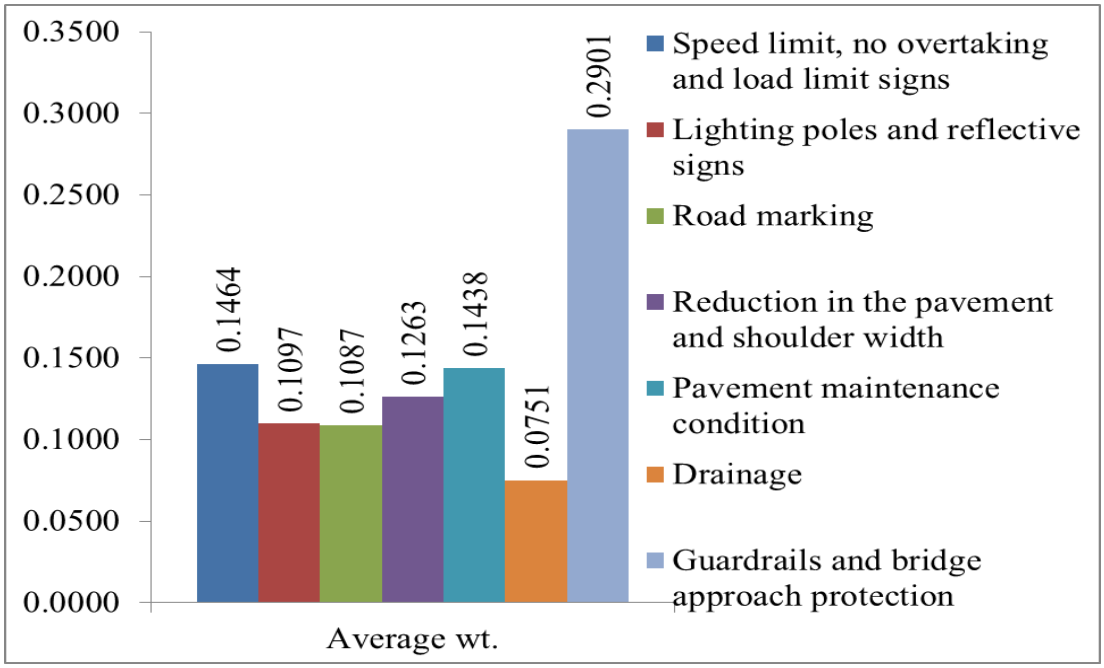

Figure 4.11 Average weight of factors in Bridge Element

Furthermore, ‘Guardrails & bridge approach protection (29.01%)’, ‘Speed limit & No overtaking signs (14.64%)’, ‘Pavement maintenance condition (14.38%)’, and ‘Reduction in pavement width & shoulder width (12.63%)’ respectively has more importance in bridge element as shown in Figure 4.11.

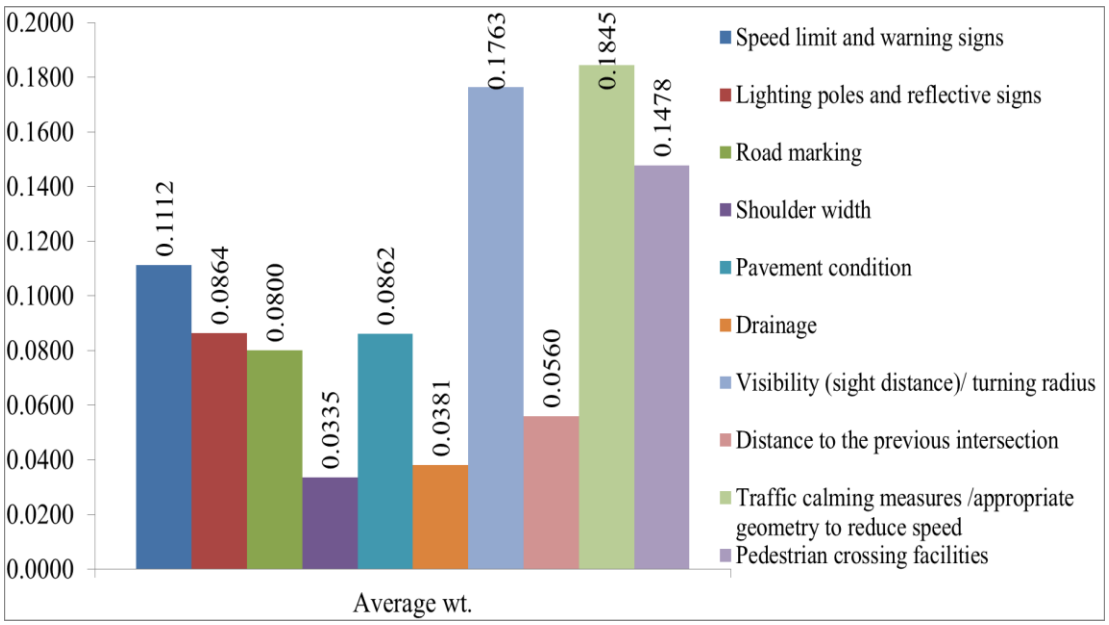

Figure 4.12 Average weight of factors in Intersection

Also, ‘traffic calming measures/ appropriate geometry to reduce speed (18.45%)’, ‘Sight distance provision (17.63%)’, ‘Pedestrian crossing facilities (14.78%)’ and ‘Speed limit and warning signs (11.12%)’ respectively has more weightage in intersection element of KKR as shown in Figure 4.12..

4.4. Development of Safety Hazardous Index

Combining the calculated average weight of safety factors & condition rating for each factor, Safety hazardous Index was developed using formulas as below.

Safety hazardous Index at straight sections (S):

$$SHI_s = \sum (W_{sfs} \times R_{sfs})$$

Safety hazardous Index at curve sections (C):

$$SHI_c = \sum (W_{sfc} \times R_{sfc})$$

Safety hazardous Index at bridge sections (B):

$$SHI_b = \sum (W_{sfb} \times R_{sfb})$$

Safety hazardous Index at intersections (I):

$$SHI_i = \sum (W_{sfi} \times R_{sfi})$$

Where,

SHI_s, SHI_c, SHI_b, SHI_i = Safety Hazardous Index for straight, curve, bridge and intersections respectively.

W_{sfs}, W_{sfc}, W_{sfb}, W_{sfi} = Weight of safety factors at straight, straight, curve, bridge and intersections respectively.

R_{sfs}, R_{sfc}, R_{sfb}, R_{sfi} = Condition rating of safety factors at straight, straight, curve, bridge and intersections respectively.

The sample calculation for a left carriage way (straight section) at Ch. 10+600 to Ch. 10+810 km is shown below:

Table 4.6 Sample Calculation for Straight Element

Description/ safety furniture/ Safety Factors	Avg. wt. (W_{sfs})	Condition Rating (R_{sfs})	Safety Hazardous Index (SHI_s)
Straight road segment (Left)			
Speed limit and No overtaking signs	0.1487	0.60	0.09
Lighting poles and Reflective signs	0.0864	0.60	0.05
Road marking	0.1461	0.50	0.07
Shoulder width	0.0940	0.10	0.01
Pavement condition	0.1539	0.40	0.06
Drainage	0.0822	0.30	0.02
Pedestrian crossing facilities	0.2886	0.65	0.19
		Total SHI=	**0.50**

The detailed calculation data of Safety Hazardous Index for each and every road elements (straight, curve, bridge & intersection) of Kalanki Koteshwor Ch.10+600 to Ch. 20+994 km is provided in **Appendix 8-11**.

4.5. Results

Further, Safety hazardous index for entire road section (SHI_{rs}) of 2km was obtained by summation of SHI of all elements.

$$SHI_{rs} = SHI_s + SHI_c + SHI_b + SHI_i$$

This was performed for every 2 km road segments of entire southern section of Kalanki Koteshwor Ch.10+600 to Ch. 20+994 km and ranking was done based on SHI value with the highest SHI as Rank (1) and so on shown in table below.

Table 4.7 Safety Hazardous Index (SHI) for each 2km road

SN	Chainage, km		SHI for each road element				Total SHI	Rank
	From	To	S	C	B	I		
1	10+600	12+600	5.45	1.96	0.40	1.49	9.30	5
2	12+600	14+600	5.36	1.88	0.76	4.38	12.38	1
3	14+600	16+600	6.37	1.44	0.00	2.29	10.10	4
4	16+600	18+600	5.26	2.38	0.00	2.77	10.41	3
5	18+600	20+994	6.01	2.58	0.46	1.47	10.52	2

Here, Ch.12+600 to Ch.14+600 km was found to have highest SHI value of 12.38 as shown in Figure 4.13, which means this road section is the most vulnerable in consideration of 'Road' factor and it requires to be treated first with the safety counter-measures as per priority of such intervention & budget available.

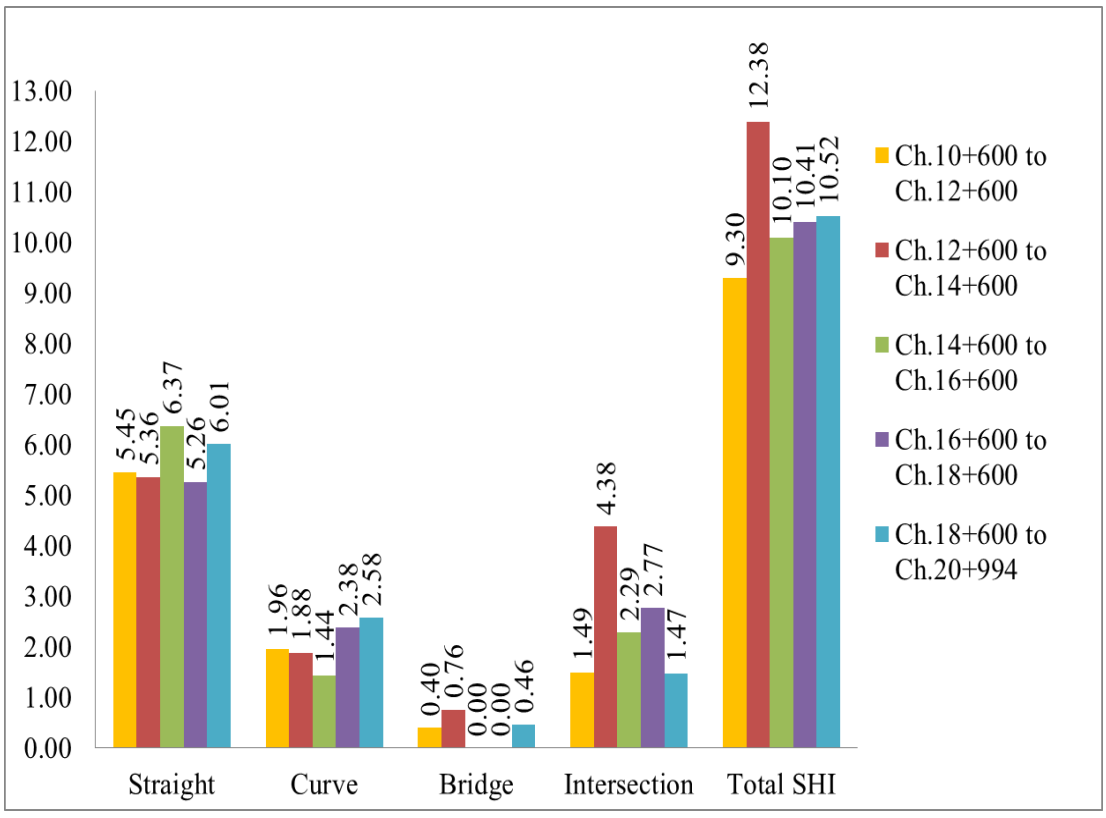

Figure 4.13 SHI for each 2 km road section

4.6. Validation of Procedure

A sample of 460 number of road crash datas recorded in Kalanki Koteshwor Road Section for the months of Bhadra to Magh, 2076 (Source: Metropolitan Traffic Police Office, Kathmandu) was considered for the validation of the methodology used in the study. From crash data collected for six months period on the road sample, the total number of crashes was grouped for each 2 km road sections on the basis of the location of the road crash. Then, the five road sections of Kalanki Koteshwor Road were ranked based on the number of crashes in each road section.

The rankings obtained by Safety Hazardous Index score and crash history were then compared. Spearman's rank correlation was used to find the level of agreement between the rankings obtained using the two techniques. The result from the correlation analysis provided the validation for the methodology used in the study indicating that the ranking from the Safety Hazardous Index and crash history agree with correlation coefficient of 0.80 with probable error 0.1086 as shown in table below.

Table 4.8 Correlation between SHI score and Crash history

SN	Chainage, km	Rank, R1 and R2		d= R1-R2	d^2	Correlation coefficient, r	Probable Error, P.E.(r)	Result, 6*P.E(r)
		SHI (R1)	Crash (R2)					
1	10+600 to 12+600	9.30 (5)	54 (4)	1	1	0.80	0.1086	0.6516
2	12+600 to 14+600	12.38 (1)	116 (2)	-1	1			
3	14+600 to 16+600	10.10 (4)	44 (5)	-1	1			< r= 0.80
4	16+600 to 18+600	10.18 (3)	91 (3)	0	0			hence, test is significant
5	18+600 to 20+994	10.33 (2)	155 (1)	1	1			
	N=	5	5		4			

Where, $$r = 1 - \frac{6 * \sum d * d}{N * (N * N - 1)}$$

$$P.E.(r) = 0.6745 * \frac{(1 - r * r)}{N\text{^}0.5}$$

CHAPTER FIVE: CONCLUSION/ RECOMMENDATIONS

1. In this study, only safety factors related to each road elements namely: straight, curve, bridge and intersections were taken into consideration for identifying safety hazardous locations. For this, firstly the geometric element of study road and safety factors of each geometric element was identified. Secondly, Expert Questionnaire Survey form was developed and was distributed to road safety experts for pairwise comparisons to collect the data of this study. Then using AHP, the weight of safety factors was found. A road safety inspection was conducted for condition rating and a rating was done to each safety factors. The weighted sum of the ratings termed as 'Safety Hazardous Index' (SHI) was developed as a parameter for ranking of road safety hazardous locations along the study area.

2. The study was completed with the ranking of the road safety hazardous locations along the southern section of Kalanki Koteshwor. During ranking of five road section of KKR with the help of the presented methodology, Road Section 'Ch.12+600 km to Ch.14+600 km' and Road Section 'Ch.18+600 km to Ch.20+994 km' score SHI=12.38 and SHI=10.52 respectively and lies in Rank '1' and '2' as well which suggests these sections are the most hazardous locations to be treated first as per their ranking. Furthermore, the rankings of road sections identified by the proposed method were found to be in good agreement with road crash datas collected from metropolitan traffic police. Therefore, this method can be recommended for roads with no crash datas or crash reports with poor accuracy.

3. The staggering number of crash records in Kalanki Koteshwor Road section shows the urgency for employing preventive measures. Since, all the road safety measures may not be possible to be implemented throughout the Kalanki Koteshwor Road section due to the insufficient availability of budget so the methodology described in this study using Analytical Hierarchy Process (AHP) without using crash data can be firstly useful for the implementing agencies to identify the hazardous locations promptly; secondly, investigate the problems of these locations in detail, and finally implement the available budget properly to improve road safety condition to minimize the road crashes.

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APPENDIX -1

(List of Experts filling the Questionnaire format)

S.N	Name of Expert	Designation, Organization	Remarks
1	Pramila Devi Shakya Bajracharya	Joint Secretary, Ministry of Physical Infrastructure & Transport	Highway Engineer
2	Krishna Nath Ojha	Senior Divisional Engineer/ Unit Chief, Road & Traffic Safety Unit, Department of Roads	Highway Engineer
3	Anil Marsani	Coordinator, MSc in Transportation Engineering, Pulchowk Campus	ToT on Road Safety, Delft Road Safety Course
4	Subhash Dhungel	Independent Road Safety Expert	Road Safety Expert
5	Prof. Dr. Padma Bahadur Shahi	Chairman, Society of Transportation Engineer Nepal (SoTEN)	Road Safety Expert
6	Hemant Tiwari	Chairman, Safe & Sustainable Travel Nepal	ToT on Road Safety; Delft Road Safety Course
7	Mohan Dhoj Kc	Assistant Professor, Pokhara University	ToT on Road Safety
8	Prem Lamsal	Senior Highway Engineer, WorleyParsons	MSc Thesis on Road Safety of Kathmandu - Bhaktapur Road
9	Bishnu K. Basnet	Civil/Transport Engineer, Blue Barn Consulting Engineers	
10	Vibek Gupta	Director, Picasso Consultant Pvt. Ltd	ToT on Road Safety

S.N	Name of Expert	Designation, Organization	Remarks
11	Sambriddhi Shrestha	Civil Engineer, Civil Aviation Authority of Nepal	ToT on Road Safety
12	Anish Khadka	Research Associate, Nepal Injury Research Center (NIRC)	Delft Road Safety Course
13	Gajen Jha	Member Secretary, Road Safety Committee, Nepal Engineers' Association	
14	Subhekhsya Bhatta	Transportation Engineer, World Bank	
15	Dr. Hareram Shrestha	Executive Director, SIDeF & Past President, Nepal Engineers' Association	
16	Suraj Bhattarai	Managing Director, Seismo-Tech Engineering Consultancy Pvt. Ltd.	MSc Thesis on Road Safety related topic
17	Prabesh Gurung	Civil Engineer, Civil Aviation Authority of Nepal	Research on Road Safety Rating
18	Surakshya Kafle	Member, Safe and Sustainable Travel Nepal (SSTN)	Research on Road Safety Rating
19	Sudeep Thapa	Secretary, Safe and Sustainable Travel Nepal (SSTN)	Road Design Engineer
20	Dilman Singh Basnyat	Treasurer, Safe and Sustainable Travel Nepal (SSTN)	ToT on Road Safety

APPENDIX -2

(Relative Weight given by Experts for Straight Element)

Factors	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10
A over B	0.33	2.00	6.00	0.25	0.14	2.00	0.33	1.00	1.00	1.00
A over C	0.50	0.17	8.00	0.20	0.13	2.00	5.00	1.00	0.20	4.00
A over D	0.20	1.00	3.00	6.00	0.20	4.00	0.20	4.00	3.00	4.00
A over E	0.11	1.00	1.00	0.17	0.14	4.00	6.00	2.00	4.00	0.13
A over F	0.25	2.00	2.00	6.00	0.13	3.00	0.25	6.00	4.00	3.00
A over G	0.13	0.33	0.11	0.17	0.11	2.00	0.33	0.20	0.17	0.13
B over C	2.00	0.13	1.00	3.00	7.00	0.20	6.00	1.00	0.14	1.00
B over D	0.33	2.00	2.00	2.00	5.00	1.00	0.20	3.00	0.20	1.00
B over E	0.20	2.00	1.00	1.00	1.00	1.00	8.00	2.00	4.00	0.13
B over F	0.50	2.00	3.00	5.00	0.14	2.00	0.33	8.00	3.00	2.00
B over G	0.25	0.20	1.00	1.00	0.11	1.00	8.00	0.20	0.17	0.14
C over D	0.25	0.17	0.25	3.00	6.00	4.00	6.00	3.00	6.00	0.25
C over E	0.17	2.00	4.00	7.00	5.00	3.00	5.00	2.00	7.00	0.50
C over F	0.33	5.00	5.00	3.00	0.13	4.00	4.00	5.00	8.00	0.25
C over G	0.17	0.14	0.11	0.20	1.00	1.00	9.00	0.14	1.00	0.13
D over E	0.33	2.00	0.17	0.14	0.11	0.25	6.00	1.00	4.00	0.20
D over F	2.00	1.00	0.17	0.20	1.00	1.00	4.00	2.00	4.00	0.11
D over G	0.50	0.14	0.11	0.14	0.11	0.17	0.25	0.20	0.11	2.00
E over F	4.00	5.00	0.17	6.00	1.00	3.00	7.00	3.00	1.00	2.00
E over G	2.00	2.00	0.11	3.00	0.11	0.25	0.33	0.20	0.11	0.14
F over G	0.33	0.13	0.11	0.17	0.11	0.50	0.20	0.25	0.11	0.25

Factors	E11	E12	E13	E14	E15	E16	E17	E18	E19	E20
A over B	1.00	1.00	3.00	0.50	1.00	1.00	1.00	7.00	3.00	0.25
A over C	1.00	1.00	9.00	0.20	1.00	1.00	4.00	2.00	5.00	0.25
A over D	0.17	5.00	8.00	0.25	3.00	4.00	0.25	8.00	5.00	0.14
A over E	0.17	5.00	5.00	0.20	2.00	4.00	0.20	5.00	0.20	0.11
A over F	9.00	4.00	5.00	0.20	2.00	3.00	4.00	3.00	4.00	0.14
A over G	1.00	3.00	7.00	0.13	0.20	0.33	0.17	9.00	1.00	0.20
B over C	2.00	0.20	6.00	0.33	1.00	1.00	4.00	0.20	1.00	1.00
B over D	2.00	1.00	6.00	0.25	3.00	4.00	0.25	7.00	3.00	0.13
B over E	0.50	2.00	8.00	0.20	2.00	3.00	0.20	1.00	0.20	0.13
B over F	1.00	3.00	9.00	0.20	2.00	4.00	4.00	0.25	2.00	0.13
B over G	2.00	0.50	0.20	0.13	0.20	0.17	0.17	4.00	0.25	0.14
C over D	2.00	5.00	9.00	1.00	3.00	4.00	0.14	7.00	1.00	0.13
C over E	0.20	3.00	2.00	0.50	2.00	4.00	0.20	2.00	0.25	0.13
C over F	2.00	4.00	0.14	0.25	2.00	3.00	3.00	3.00	2.00	0.13

Factors	E11	E12	E13	E14	E15	E16	E17	E18	E19	E20
C over G	0.17	2.00	0.14	0.20	0.20	0.17	0.17	6.00	0.25	0.14
D over E	0.25	0.50	0.14	0.33	0.25	1.00	0.33	0.20	0.33	1.00
D over F	4.00	2.00	0.14	0.25	2.00	1.00	6.00	0.14	1.00	3.00
D over G	2.00	0.14	0.11	0.17	0.20	0.17	0.33	0.17	0.33	3.00
E over F	1.00	4.00	0.25	0.33	3.00	0.25	7.00	0.20	3.00	1.00
E over G	0.25	0.20	6.00	0.20	0.25	0.25	2.00	0.50	2.00	1.00
F over G	2.00	0.25	7.00	0.20	0.25	0.20	0.17	3.00	0.25	0.33

(Relative Weight given by Experts for Bridge)

Factors	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10
A over B	0.33	9.00	6.00	0.20	0.13	2.00	0.25	2.00	3.00	2.00
A over C	0.50	9.00	6.00	0.20	4.00	1.00	0.20	1.00	5.00	4.00
A over D	2.00	0.13	8.00	4.00	1.00	0.50	0.14	3.00	1.00	0.33
A over E	0.25	0.13	7.00	5.00	0.13	2.00	0.17	3.00	5.00	0.25
A over F	3.00	0.11	1.00	3.00	0.13	3.00	0.20	4.00	6.00	5.00
A over G	0.20	0.11	1.00	0.14	1.00	2.00	0.17	1.00	0.20	0.25
B over C	2.00	4.00	1.00	2.00	6.00	0.50	5.00	2.00	6.00	2.00
B over D	4.00	0.20	6.00	6.00	1.00	0.50	4.00	2.00	0.33	0.14
B over E	0.25	2.00	5.00	0.33	5.00	2.00	4.00	3.00	3.00	0.11
B over F	5.00	4.00	0.17	3.00	0.17	3.00	5.00	4.00	3.00	4.00
B over G	0.33	0.14	0.11	2.00	7.00	0.25	6.00	1.00	0.20	0.33
C over D	3.00	2.00	0.25	4.00	1.00	1.00	0.20	3.00	0.20	2.00
C over E	0.25	0.25	0.25	4.00	0.13	3.00	0.17	3.00	0.14	0.13
C over F	4.00	3.00	0.25	1.00	0.17	3.00	0.20	4.00	0.33	2.00
C over G	0.20	6.00	0.11	0.33	0.14	0.33	0.20	2.00	0.11	0.50
D over E	0.13	2.00	2.00	1.00	1.00	3.00	4.00	0.33	4.00	0.33
D over F	2.00	0.20	0.50	2.00	1.00	2.00	0.20	6.00	4.00	2.00
D over G	0.17	6.00	0.50	0.17	1.00	3.00	0.25	0.17	0.17	0.33
E over F	9.00	2.00	1.00	5.00	9.00	1.00	3.00	4.00	1.00	1.00
E over G	2.00	0.14	1.00	2.00	9.00	0.25	5.00	2.00	0.13	0.33
F over G	0.13	0.14	1.00	0.13	9.00	0.25	0.33	0.17	0.13	0.50

Factors	E11	E12	E13	E14	E15	E16	E17	E18	E19	E20
A over B	1.00	2.00	0.13	0.50	1.00	1.00	0.25	3.00	3.00	8.00
A over C	1.00	1.00	0.14	0.50	1.00	4.00	1.00	2.00	2.00	5.00
A over D	0.13	0.50	0.14	0.33	3.00	6.00	0.13	7.00	3.00	0.17
A over E	0.13	2.00	0.14	0.25	3.00	6.00	0.20	1.00	0.20	0.11
A over F	2.00	3.00	0.17	0.33	4.00	6.00	1.00	3.00	1.00	0.11
A over G	2.00	0.50	0.17	0.20	1.00	1.00	0.11	2.00	0.20	0.11
B over C	1.00	1.00	1.00	0.50	1.00	1.00	2.00	0.50	1.00	0.33

Factors	E11	E12	E13	E14	E15	E16	E17	E18	E19	E20
B over D	1.00	0.17	9.00	0.50	1.00	4.00	0.25	4.00	2.00	0.11
B over E	0.11	4.00	8.00	0.33	3.00	4.00	0.50	0.25	0.25	0.11
B over F	0.11	5.00	7.00	0.33	4.00	6.00	7.00	1.00	0.20	0.25
B over G	1.00	0.25	8.00	0.20	1.00	1.00	0.11	2.00	0.20	0.11
C over D	2.00	0.50	8.00	0.50	2.00	1.00	0.20	3.00	2.00	0.33
C over E	1.00	5.00	8.00	0.33	3.00	1.00	0.25	2.00	0.25	0.25
C over F	1.00	5.00	8.00	0.33	4.00	1.00	2.00	2.00	2.00	0.50
C over G	2.00	0.33	9.00	0.20	1.00	0.17	0.14	2.00	0.20	0.25
D over E	0.17	3.00	9.00	0.33	0.33	1.00	3.00	0.25	0.33	1.00
D over F	5.00	4.00	8.00	0.33	2.00	1.00	8.00	0.20	1.00	1.00
D over G	2.00	2.00	8.00	0.17	0.25	0.25	0.20	0.33	0.20	1.00
E over F	1.00	1.00	9.00	2.00	3.00	1.00	5.00	0.33	3.00	1.00
E over G	0.13	0.14	8.00	0.25	0.33	0.25	0.17	2.00	1.00	1.00
F over G	0.13	0.25	9.00	0.20	0.25	0.17	0.20	3.00	0.20	1.00

(Relative Weight given by Experts for Curve Element)

Factors	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10
A over B	4.00	0.13	1.00	0.17	1.00	2.00	7.00	3.00	1.00	4.00
A over C	0.33	9.00	5.00	0.14	0.14	0.33	6.00	1.00	0.33	0.33
A over D	0.17	0.17	3.00	6.00	4.00	4.00	7.00	4.00	4.00	0.17
A over E	0.14	1.00	3.00	1.00	0.17	6.00	4.00	4.00	0.33	0.14
A over F	0.11	0.14	2.00	4.00	0.13	3.00	7.00	2.00	5.00	0.11
A over G	0.50	0.13	4.00	4.00	7.00	5.00	5.00	7.00	5.00	0.50
A over H	0.13	0.11	1.00	7.00	0.13	0.50	8.00	1.00	0.25	0.13
A over I	0.13	0.11	5.00	1.00	0.13	0.50	7.00	5.00	0.33	0.13
A over J	0.20	9.00	1.00	0.11	0.11	0.25	0.25	2.00	0.11	0.20
B over C	1.00	4.00	1.00	5.00	0.25	0.25	8.00	1.00	0.20	1.00
B over D	0.11	4.00	5.00	8.00	0.14	0.33	0.17	4.00	1.00	0.11
B over E	0.13	6.00	2.00	1.00	0.17	0.25	7.00	3.00	0.25	0.13
B over F	0.14	7.00	1.00	2.00	0.13	0.33	8.00	2.00	3.00	0.14
B over G	0.17	7.00	5.00	3.00	0.11	3.00	0.20	4.00	3.00	0.17
B over H	0.13	0.13	1.00	0.14	0.11	0.25	7.00	1.00	0.20	0.13
B over I	0.17	0.13	1.00	1.00	0.13	0.25	9.00	5.00	1.00	0.17
B over J	0.33	0.13	5.00	0.20	0.11	0.20	9.00	1.00	0.17	0.33
C over D	0.13	1.00	6.00	5.00	1.00	4.00	6.00	3.00	8.00	0.13
C over E	0.11	1.00	0.17	1.00	0.13	1.00	5.00	1.00	1.00	0.11
C over F	0.11	5.00	0.14	0.25	0.11	0.33	4.00	8.00	4.00	0.11
C over G	0.13	7.00	6.00	0.20	0.17	0.33	0.17	2.00	4.00	0.13
C over H	0.11	1.00	0.13	0.14	1.00	0.33	0.20	1.00	1.00	0.11
C over I	0.13	0.11	0.11	1.00	0.13	0.25	6.00	3.00	3.00	0.13

Factors	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10
C over J	0.14	0.11	0.13	1.00	0.14	0.20	8.00	1.00	0.25	0.14
D over E	2.00	0.11	0.25	0.33	0.13	0.25	0.20	0.25	0.14	2.00
D over F	3.00	7.00	0.20	0.20	0.14	0.33	0.17	0.17	1.00	3.00
D over G	3.00	7.00	0.25	0.50	1.00	0.33	4.00	0.50	1.00	3.00
D over H	1.00	9.00	0.11	0.14	1.00	0.17	3.00	0.33	0.17	1.00
D over I	2.00	9.00	0.11	0.14	0.11	0.20	4.00	0.33	0.25	2.00
D over J	1.00	0.11	0.14	0.14	0.11	0.14	3.00	0.14	0.11	1.00
E over F	0.33	0.11	6.00	5.00	1.00	4.00	0.17	3.00	5.00	0.33
E over G	1.00	7.00	5.00	7.00	0.17	4.00	6.00	4.00	5.00	1.00
E over H	1.00	6.00	0.14	1.00	1.00	1.00	5.00	1.00	0.17	1.00
E over I	2.00	6.00	0.11	2.00	1.00	1.00	6.00	2.00	1.00	2.00
E over J	2.00	6.00	9.00	0.25	0.11	0.25	7.00	0.33	0.20	2.00
F over G	1.00	7.00	0.11	3.00	1.00	1.00	0.25	5.00	1.00	1.00
F over H	2.00	6.00	1.00	0.20	0.20	0.25	0.20	0.25	0.20	2.00
F over I	2.00	6.00	0.11	0.13	0.11	0.33	0.17	0.33	0.17	2.00
F over J	1.00	1.00	0.25	0.13	0.11	0.20	0.33	0.17	0.14	1.00
G over H	1.00	0.14	0.25	0.11	0.11	0.20	4.00	0.17	0.25	1.00
G over I	2.00	0.14	0.11	0.14	0.17	0.20	0.17	0.33	0.20	2.00
G over J	2.00	0.13	0.20	0.14	0.11	0.14	6.00	0.20	0.14	2.00
H over I	1.00	0.13	0.11	1.00	1.00	2.00	4.00	3.00	1.00	1.00
H over J	2.00	7.00	0.11	1.00	0.11	0.50	5.00	1.00	0.20	2.00
I over J	1.00	7.00	1.00	0.25	0.11	0.33	7.00	0.25	0.20	1.00

Factors	E11	E12	E13	E14	E15	E16	E17	E18	E19	E20
A over B	5.00	1.00	8.00	0.33	3.00	1.00	2.00	1.00	3.00	5.00
A over C	2.00	0.33	7.00	0.25	1.00	3.00	3.00	3.00	3.00	0.33
A over D	9.00	3.00	6.00	0.17	3.00	3.00	0.14	5.00	3.00	0.17
A over E	1.00	0.20	7.00	0.17	3.00	4.00	0.11	0.25	4.00	0.17
A over F	0.13	2.00	7.00	0.25	2.00	4.00	0.20	4.00	3.00	0.11
A over G	0.13	4.00	8.00	0.25	4.00	7.00	5.00	2.00	2.00	0.50
A over H	1.00	0.50	7.00	0.20	1.00	3.00	0.14	1.00	1.00	0.11
A over I	0.25	0.50	8.00	0.20	5.00	4.00	0.33	2.00	1.00	0.11
A over J	1.00	0.14	7.00	0.11	1.00	2.00	0.11	6.00	1.00	0.14
B over C	2.00	0.50	3.00	0.33	0.33	1.00	2.00	2.00	2.00	1.00
B over D	1.00	2.00	4.00	0.20	4.00	4.00	0.13	4.00	3.00	0.11
B over E	2.00	0.14	3.00	0.17	2.00	1.00	0.11	1.00	2.00	0.14
B over F	0.14	0.17	3.00	0.25	2.00	1.00	0.17	2.00	0.33	0.13
B over G	5.00	3.00	4.00	0.33	3.00	6.00	2.00	3.00	2.00	0.17
B over H	2.00	0.25	5.00	0.25	1.00	5.00	0.13	1.00	0.25	0.11
B over I	0.13	0.25	4.00	0.25	4.00	4.00	0.20	3.00	0.33	0.14

Factors	E11	E12	E13	E14	E15	E16	E17	E18	E19	E20
B over J	0.13	0.20	3.00	0.11	1.00	3.00	0.11	5.00	0.25	0.11
C over D	0.33	4.00	8.00	0.33	3.00	5.00	0.14	3.00	1.00	0.11
C over E	1.00	1.00	7.00	0.50	1.00	4.00	0.13	0.17	2.00	0.11
C over F	5.00	0.33	7.00	0.25	2.00	1.00	0.13	0.17	0.20	0.13
C over G	5.00	0.33	8.00	0.33	2.00	5.00	2.00	0.20	0.33	0.13
C over H	0.13	0.17	9.00	0.20	1.00	4.00	0.11	0.17	0.25	0.11
C over I	0.13	0.14	7.00	0.25	3.00	1.00	0.14	0.14	0.33	0.13
C over J	0.20	0.13	7.00	0.17	1.00	4.00	0.13	1.00	0.25	0.13
D over E	2.00	0.25	0.11	0.50	0.25	1.00	0.50	0.14	2.00	0.25
D over F	1.00	0.33	0.13	0.25	0.25	1.00	3.00	0.17	0.20	0.25
D over G	1.00	0.20	0.13	0.33	0.33	1.00	7.00	0.20	0.25	0.33
D over H	0.14	0.13	0.11	0.25	0.33	3.00	0.50	0.14	0.25	0.33
D over I	0.14	0.14	0.11	0.33	0.20	3.00	0.50	0.13	0.20	0.20
D over J	0.17	0.14	9.00	0.17	0.17	2.00	0.50	1.00	0.20	0.17
E over F	5.00	4.00	3.00	0.33	3.00	1.00	3.00	2.00	0.20	3.00
E over G	5.00	4.00	4.00	0.33	2.00	5.00	9.00	3.00	0.50	2.00
E over H	1.00	1.00	5.00	0.20	1.00	1.00	0.17	1.00	0.25	1.00
E over I	0.13	2.00	3.00	0.25	2.00	1.00	1.00	1.00	0.25	2.00
E over J	0.11	0.25	3.00	0.17	0.33	3.00	0.33	3.00	0.20	0.33
F over G	3.00	1.00	3.00	0.50	2.00	5.00	6.00	2.00	1.00	2.00
F over H	2.00	0.17	3.00	0.25	0.25	1.00	0.11	0.50	0.50	0.25
F over I	2.00	0.33	4.00	0.33	0.33	1.00	0.50	0.33	0.25	0.33
F over J	0.14	0.14	4.00	0.20	0.25	4.00	0.13	4.00	0.25	0.25
G over H	0.14	0.14	3.00	0.25	0.25	3.00	0.11	0.25	0.20	0.25
G over I	0.20	0.20	2.00	0.33	0.33	1.00	0.17	0.33	0.33	0.33
G over J	2.00	0.14	3.00	0.17	0.20	1.00	0.13	4.00	0.33	0.20
H over I	1.00	2.00	3.00	2.00	3.00	1.00	3.00	1.00	3.00	3.00
H over J	1.00	0.50	3.00	0.25	1.00	1.00	2.00	3.00	0.25	1.00
I over J	1.00	0.33	4.00	0.20	0.25	1.00	0.33	5.00	0.20	0.33

(Relative Weight given by Experts for Merge & Intersection)

Factors	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10
A over B	2.00	5.00	6.00	0.14	8.00	2.00	0.14	1.00	3.00	3.00
A over C	3.00	1.00	4.00	1.00	1.00	1.00	0.13	2.00	1.00	4.00
A over D	4.00	1.00	6.00	3.00	1.00	3.00	0.13	5.00	0.25	4.00
A over E	1.00	0.14	1.00	1.00	0.17	3.00	0.14	3.00	2.00	5.00
A over F	5.00	4.00	1.00	0.17	1.00	3.00	0.20	8.00	6.00	4.00
A over G	1.00	1.00	0.14	0.14	0.14	0.33	0.17	1.00	0.11	0.25
A over H	8.00	1.00	3.00	5.00	0.13	2.00	0.20	9.00	1.00	0.33
A over I	6.00	0.11	1.00	0.13	0.11	0.50	0.17	0.25	0.13	0.11

Factors	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10
A over J	7.00	0.14	0.13	5.00	0.11	1.00	0.13	1.00	0.17	0.11
B over C	2.00	7.00	2.00	5.00	0.14	1.00	4.00	1.00	0.25	1.00
B over D	3.00	8.00	6.00	4.00	1.00	3.00	0.14	5.00	1.00	0.13
B over E	4.00	0.13	0.33	6.00	0.17	3.00	0.11	5.00	4.00	0.14
B over F	5.00	0.20	0.33	6.00	0.13	3.00	0.14	8.00	4.00	0.14
B over G	4.00	0.14	8.00	5.00	0.14	0.25	0.17	1.00	0.20	0.50
B over H	8.00	0.13	2.00	4.00	0.14	3.00	4.00	7.00	1.00	0.25
B over I	6.00	0.11	0.14	0.20	0.11	0.20	0.17	0.25	0.11	0.25
B over J	7.00	0.11	1.00	2.00	0.11	1.00	1.00	1.00	0.13	2.00
C over D	2.00	4.00	2.00	6.00	1.00	4.00	0.13	4.00	3.00	0.20
C over E	0.50	3.00	0.33	0.20	0.17	4.00	0.14	4.00	9.00	0.20
C over F	4.00	0.11	0.50	6.00	0.13	3.00	3.00	8.00	9.00	4.00
C over G	1.00	0.13	0.25	0.14	1.00	0.25	4.00	2.00	1.00	0.25
C over H	7.00	0.13	3.00	1.00	0.17	4.00	5.00	7.00	6.00	4.00
C over I	3.00	0.17	0.14	0.14	0.11	0.25	0.14	0.33	0.25	0.11
C over J	6.00	0.17	0.13	2.00	0.11	1.00	0.25	0.25	0.25	4.00
D over E	0.20	7.00	0.25	0.50	0.17	0.33	0.25	0.25	3.00	4.00
D over F	2.00	5.00	0.33	0.25	0.14	0.33	0.33	2.00	3.00	0.14
D over G	0.25	5.00	0.33	0.17	1.00	0.20	2.00	0.20	0.33	2.00
D over H	3.00	0.11	4.00	0.33	0.13	2.00	3.00	3.00	4.00	4.00
D over I	0.50	0.13	0.50	0.13	0.11	0.17	2.00	0.14	0.11	0.20
D over J	5.00	0.11	0.50	0.33	0.11	0.25	2.00	0.14	0.11	0.20
E over F	3.00	9.00	1.00	0.20	1.00	2.00	3.00	3.00	1.00	0.11
E over G	0.50	0.17	1.00	0.14	6.00	0.25	2.00	0.33	0.13	2.00
E over H	8.00	4.00	6.00	0.25	5.00	3.00	4.00	3.00	0.25	4.00
E over I	2.00	0.13	8.00	0.13	0.11	0.17	0.13	0.17	0.11	2.00
E over J	4.00	0.11	1.00	0.33	0.11	0.25	0.17	0.17	0.11	0.33
F over G	0.17	0.13	1.00	0.17	6.00	0.20	0.13	0.14	0.11	0.33
F over H	3.00	0.14	7.00	2.00	0.14	3.00	0.11	2.00	0.33	4.00
F over I	0.25	0.11	1.00	0.17	0.11	0.20	0.14	0.14	0.11	0.17
F over J	3.00	0.13	1.00	3.00	0.11	0.33	5.00	0.13	0.11	0.25
G over H	6.00	1.00	6.00	5.00	5.00	6.00	3.00	4.00	8.00	0.33
G over I	1.00	0.11	1.00	0.25	0.11	0.25	4.00	1.00	1.00	0.11
G over J	5.00	8.00	1.00	6.00	0.11	2.00	5.00	3.00	1.00	0.11
H over I	0.14	5.00	3.00	0.20	0.11	0.20	3.00	0.17	0.11	0.20
H over J	0.50	2.00	2.00	3.00	0.11	0.20	4.00	0.17	0.11	0.25
I over J	9.00	1.00	1.00	0.17	1.00	4.00	5.00	4.00	1.00	1.00

Factors	E11	E12	E13	E14	E15	E16	E17	E18	E19	E20
A over B	1.00	2.00	3.00	0.25	1.00	4.00	0.50	2.00	2.00	4.00
A over C	1.00	1.00	4.00	0.25	1.00	6.00	3.00	2.00	1.00	2.00
A over D	4.00	3.00	3.00	0.50	3.00	6.00	5.00	5.00	3.00	2.00
A over E	0.11	3.00	4.00	0.33	3.00	6.00	0.50	2.00	0.20	0.14
A over F	4.00	5.00	5.00	0.25	4.00	4.00	2.00	4.00	2.00	7.00
A over G	1.00	0.33	5.00	0.17	1.00	2.00	0.14	1.00	0.25	0.11
A over H	1.00	4.00	5.00	0.20	7.00	4.00	3.00	1.00	0.20	0.14
A over I	2.00	0.50	4.00	0.14	0.25	6.00	0.13	4.00	0.17	0.13
A over J	1.00	1.00	4.00	0.11	1.00	3.00	0.33	7.00	0.14	0.13
B over C	0.17	1.00	4.00	0.33	1.00	4.00	4.00	0.33	1.00	0.20
B over D	9.00	5.00	5.00	0.50	4.00	4.00	4.00	3.00	3.00	0.14
B over E	3.00	5.00	6.00	0.33	4.00	4.00	0.50	0.33	0.20	0.13
B over F	3.00	3.00	7.00	0.33	4.00	4.00	3.00	0.25	2.00	0.17
B over G	2.00	0.25	7.00	0.20	1.00	1.00	0.14	1.00	0.25	0.13
B over H	5.00	5.00	6.00	0.17	7.00	4.00	3.00	1.00	0.20	0.14
B over I	2.00	0.33	6.00	0.14	0.25	6.00	0.14	0.33	0.17	0.13
B over J	2.00	1.00	6.00	0.20	1.00	1.00	0.20	3.00	0.14	0.13
C over D	0.17	4.00	5.00	0.50	4.00	1.00	2.00	6.00	2.00	0.20
C over E	3.00	3.00	6.00	0.33	4.00	1.00	0.25	0.50	0.20	0.14
C over F	3.00	6.00	7.00	0.33	6.00	1.00	1.00	2.00	2.00	0.25
C over G	2.00	0.25	6.00	0.25	2.00	0.20	0.13	1.00	0.25	0.13
C over H	2.00	4.00	7.00	0.20	7.00	1.00	0.33	1.00	0.33	0.11
C over I	0.33	0.33	6.00	0.20	0.33	1.00	0.14	3.00	0.25	0.14
C over J	0.14	1.00	4.00	0.17	0.33	1.00	0.25	4.00	0.20	0.13
D over E	1.00	0.20	3.00	0.33	0.25	1.00	0.25	0.25	0.20	0.11
D over F	1.00	0.50	4.00	0.33	2.00	1.00	3.00	0.20	1.00	0.50
D over G	0.13	0.14	5.00	0.25	0.20	0.17	0.13	0.33	0.33	0.13
D over H	0.13	2.00	7.00	0.20	3.00	1.00	2.00	0.50	1.00	0.14
D over I	2.00	0.17	8.00	0.17	0.17	1.00	0.14	0.50	0.20	0.13
D over J	2.00	0.25	8.00	0.17	0.17	0.17	0.20	0.50	0.25	0.14
E over F	1.00	2.00	0.13	0.50	3.00	1.00	6.00	2.00	4.00	9.00
E over G	2.00	0.25	0.14	0.25	0.33	0.17	0.17	2.00	3.00	1.00
E over H	2.00	5.00	0.14	0.20	3.00	2.00	3.00	1.00	2.00	1.00
E over I	0.25	0.25	0.14	0.17	0.20	1.00	0.13	3.00	2.00	1.00
E over J	0.25	0.20	0.17	0.17	0.20	0.25	0.25	2.00	1.00	1.00
F over G	2.00	0.33	0.17	0.25	0.17	0.17	0.11	2.00	0.33	0.14
F over H	2.00	3.00	0.17	0.20	2.00	1.00	0.33	1.00	0.25	0.13
F over I	0.20	0.20	0.17	0.17	0.14	1.00	0.13	2.00	0.20	0.14
F over J	0.14	0.33	0.14	0.17	0.17	0.25	0.25	2.00	0.20	0.13
G over H	4.00	7.00	0.14	2.00	4.00	6.00	7.00	1.00	4.00	1.00
G over I	1.00	1.00	0.17	0.33	1.00	4.00	2.00	2.00	3.00	1.00

Factors	E11	E12	E13	E14	E15	E16	E17	E18	E19	E20
G over J	1.00	3.00	0.17	0.20	1.00	1.00	5.00	2.00	3.00	1.00
H over I	2.00	0.25	0.20	0.25	0.17	1.00	0.14	2.00	0.33	1.00
H over J	0.17	0.25	0.25	0.25	0.17	0.25	0.25	0.33	0.25	1.00
I over J	5.00	0.25	0.20	0.50	4.00	0.17	2.00	0.50	1.00	1.00

APPENDIX -3

(Average Weight Calculation for consistent judgements)

For Straight Element:

Experts	A	B	C	D	E	F	G	CR
1	0.0278	0.0661	0.0426	0.1555	0.3552	0.1014	0.2514	2.00
2	0.2776	0.0943	0.2351	0.0507	0.0973	0.0583	0.1868	8.00
3	0.1448	0.1448	0.1291	0.0551	0.0724	0.0304	0.4233	9.00
4	0.0942	0.0585	0.3361	0.0797	0.0269	0.0275	0.3770	8.00
5	0.2538	0.1044	0.2802	0.0537	0.0739	0.0394	0.1945	9.00
6	0.0262	0.0344	0.0823	0.0764	0.1316	0.2072	0.4418	9.00
7	0.1271	0.1271	0.1271	0.0504	0.0975	0.0529	0.4180	6.00
8	0.1574	0.1426	0.1426	0.0453	0.0410	0.0615	0.4097	9.00
9	0.0726	0.0726	0.0355	0.1793	0.3291	0.0253	0.2856	9.00
10	0.3799	0.0763	0.2413	0.0191	0.0626	0.1664	0.0543	10.00
11	0.2014	0.0808	0.0663	0.0557	0.3275	0.0530	0.2154	10.00
12	0.0210	0.0355	0.0355	0.3066	0.2322	0.1637	0.2055	8.00
Average wt.	0.1487	0.0864	0.1461	0.0940	0.1539	0.0822	0.2886	

For Bridge Element:

Experts	A	B	C	D	E	F	G	CR
1	0.0636	0.136	0.091	0.039	0.359	0.027	0.285	4.00
2	0.1795	0.099	0.163	0.232	0.062	0.058	0.207	10.00
3	0.2159	0.1846	0.1956	0.0663	0.0829	0.0318	0.2229	9.00
4	0.1738	0.0938	0.0211	0.1548	0.0499	0.0431	0.4635	9.00
5	0.1330	0.1003	0.1394	0.2818	0.0434	0.0413	0.2609	8.00
6	0.0414	0.0558	0.0680	0.0855	0.1875	0.1430	0.4189	7.00
7	0.2063	0.1763	0.1947	0.0741	0.0903	0.0433	0.2149	4.00
8	0.2866	0.2094	0.0693	0.0568	0.0568	0.0506	0.2705	4.00
9	0.0305	0.0831	0.0425	0.2226	0.1215	0.0255	0.4743	10.00
10	0.2685	0.1042	0.1919	0.0361	0.1548	0.1625	0.0820	10.00
11	0.1045	0.0535	0.0788	0.0522	0.2804	0.0848	0.3458	6.00
12	0.0528	0.0210	0.0500	0.2137	0.2360	0.1904	0.2360	9.00
Average wt.	0.1464	0.1097	0.1087	0.1263	0.1438	0.0751	0.2901	

For Curve Element:

Experts	A	B	C	D	E	F	G	H	I	J	CR
1	0.022	0.018	0.019	0.194	0.132	0.16	0.12	0.139	0.101	0.095	2.00
2	0.1227	0.031	0.047	0.026	0.095	0.054	0.037	0.167	0.137	0.284	8.00
3	0.1938	0.1334	0.1320	0.0245	0.0886	0.0466	0.0272	0.1374	0.0527	0.1639	9.00
4	0.0540	0.0445	0.1402	0.0230	0.1036	0.0224	0.0234	0.1503	0.0931	0.3455	8.00
5	0.0528	0.0348	0.0433	0.0187	0.1418	0.0525	0.0361	0.1852	0.1306	0.3042	9.00
6	0.0163	0.0229	0.0351	0.0505	0.0555	0.0817	0.0845	0.1786	0.1334	0.3416	9.00
7	0.1690	0.1175	0.1343	0.0254	0.0927	0.0511	0.0384	0.1382	0.0594	0.1740	6.00
8	0.2295	0.1731	0.1567	0.0741	0.0831	0.0982	0.0396	0.0446	0.0568	0.0443	9.00
9	0.0291	0.0202	0.0162	0.1161	0.1326	0.0628	0.0139	0.2757	0.1092	0.2243	9.00
10	0.1410	0.1511	0.0299	0.0204	0.1744	0.0873	0.0676	0.1563	0.1432	0.0288	10.00
11	0.1496	0.0586	0.0363	0.0315	0.0284	0.0897	0.0640	0.1667	0.1287	0.2465	10.00
12	0.0191	0.0132	0.0164	0.0524	0.1557	0.0922	0.0664	0.2072	0.1331	0.2443	8.00
Average wt.	0.0999	0.0681	0.0672	0.0547	0.1070	0.0749	0.0515	0.1622	0.1065	0.2080	

For Intersection Element:

Experts	A	B	C	D	E	F	G	H	I	J	CR
1	0.2085	0.223	0.112	0.051	0.125	0.035	0.13	0.016	0.079	0.02	10.00
2	0.1004	0.081	0.096	0.028	0.044	0.041	0.196	0.025	0.283	0.106	7.00
3	0.1331	0.127	0.109	0.027	0.042	0.019	0.135	0.018	0.253	0.136	10.00
4	0.0417	0.0350	0.1106	0.0522	0.0163	0.0149	0.1892	0.0300	0.2603	0.2499	7.00
5	0.1158	0.1012	0.1057	0.0260	0.0501	0.0374	0.2391	0.0220	0.1657	0.1369	10.00
6	0.0172	0.0255	0.0336	0.0340	0.0498	0.0588	0.1327	0.1255	0.2355	0.2875	9.00
7	0.1122	0.1189	0.1223	0.0312	0.0468	0.0242	0.1246	0.0188	0.2561	0.1449	7.00
8	0.2733	0.1533	0.0456	0.0374	0.0418	0.0406	0.1897	0.0379	0.0374	0.1430	4.00
9	0.0516	0.0598	0.0239	0.0259	0.0754	0.0201	0.3215	0.0311	0.2563	0.1343	8.00
10	0.2024	0.0635	0.1394	0.0300	0.1538	0.1099	0.0974	0.0898	0.0553	0.0584	9.00
11	0.0419	0.0364	0.0425	0.0318	0.2108	0.0301	0.1820	0.0843	0.1591	0.1810	10.00
12	0.0363	0.0115	0.0184	0.0281	0.1777	0.0274	0.1780	0.1733	0.1735	0.1759	5.00
Average wt.	0.1112	0.0864	0.0800	0.0335	0.0862	0.0381	0.1763	0.0560	0.1845	0.1478	

Here,

1, 2, 3…….12 numbers denotes experts with consistent judgements;

A, B, C…….J denotes safety factors for each road elements; and

CR denotes Consistency Ratio.

APPENDIX -4

(Condition Rating of Straight Element)

Description/ safety furniture	10+600 -10+810	11+250-11+575	11+860-12+100	12+100-12+600
Straight road segment (Left)				
Speed limit and No overtaking signs	0.60	0.65	0.90	0.85
Lighting poles and Reflective signs	0.60	0.70	0.70	0.90
Road marking	0.50	0.52	0.65	0.40
Shoulder width	0.10	0.25	0.10	0.20
Pavement condition	0.40	0.20	0.20	0.30
Drainage	0.30	0.30	0.40	0.30
Pedestrian crossing facilities	0.65	0.65	0.85	0.60

Description/ safety furniture	12+600-13+100	13+100-13+380	13+670-13+700	14+150-14+600
Straight road segment (Left)				
Speed limit and No overtaking signs	0.75	0.55	0.40	0.40
Lighting poles and Reflective signs	0.50	0.74	0.60	0.70
Road marking	0.50	0.60	0.20	0.50
Shoulder width	0.20	0.10	0.10	0.10
Pavement condition	0.32	0.30	0.40	0.35
Drainage	0.20	0.65	0.25	0.35
Pedestrian crossing facilities	0.50	0.20	0.65	0.50

Description/ safety furniture	14+600-15+100	15+100-15+420	15+800-16+100	16+100-16+600
Straight road segment (Left)				
Speed limit and No overtaking signs	0.70	0.80	0.60	0.90

Description/ safety furniture	14+600-15+100	15+100-15+420	15+800-16+100	16+100-16+600
Lighting poles and Reflective signs	0.40	0.60	0.70	0.90
Road marking	0.40	0.25	0.49	0.60
Shoulder width	0.10	0.18	0.20	0.25
Pavement condition	0.30	0.30	0.40	0.40
Drainage	0.25	0.25	0.50	0.30
Pedestrian crossing facilities	0.45	0.40	0.60	0.50

Description/ safety furniture	16+600-17+100	17+100-17+300	17+600-17+700	17+900-18+150
Straight road segment (Left)				
Speed limit and No overtaking signs	0.70	0.50	0.49	0.50
Lighting poles and Reflective signs	0.70	0.70	0.80	0.65
Road marking	0.45	0.40	0.40	0.40
Shoulder width	0.20	0.10	0.10	0.10
Pavement condition	0.40	0.30	0.35	0.30
Drainage	0.40	0.30	0.49	0.35
Pedestrian crossing facilities	0.40	0.60	0.40	0.62

Description/ safety furniture	18+500-18+700	18+950-19+600	19+600-20+100	20+460-20+994
Straight road segment (Left)				
Speed limit and No overtaking signs	1.00	0.80	0.80	0.80
Lighting poles and Reflective signs	0.70	0.90	0.90	0.85
Road marking	0.60	0.50	0.50	0.50
Shoulder width	0.10	0.15	0.10	0.10
Pavement condition	0.30	0.30	0.30	0.30

Description/ safety furniture	18+500-18+700	18+950-19+600	19+600-20+100	20+460-20+994
Drainage	0.20	0.20	0.40	0.20
Pedestrian crossing facilities	0.65	0.65	0.85	0.40

Description/ safety furniture	10+600 - 10+810	11+250-11+575	11+860-12+100	12+100-12+600
Straight road segment (Right)				
Speed limit sign and No overtaking signs	0.90	0.90	-	-
Lighting poles and Reflective signs	0.90	0.90	-	-
Road marking	0.80	0.50	-	-
Shoulder width	0.10	0.10	-	-
Pavement condition	0.40	0.30	-	-
Drainage	0.40	0.30	-	-
Pedestrian crossing facilities	0.20	1.00	-	-

Description/ safety furniture	12+600-13+100	13+100-13+380	13+670-13+700	14+150-14+600
Straight road segment (Right)				
Speed limit sign and No overtaking signs	0.90	0.70	0.90	0.85
Lighting poles and Reflective signs	0.90	0.90	0.95	0.70
Road marking	0.90	0.40	0.40	0.74
Shoulder width	0.25	0.10	0.20	0.2
Pavement condition	0.84	0.20	0.30	0.50
Drainage	0.60	0.20	0.30	0.50
Pedestrian crossing facilities	0.60	0.45	0.50	0.24

Description/ safety furniture	**14+600-14+750**	**15+100-15+420**	**15+800-16+100**	**16+100-16+600**
Straight road segment (Right)				
Speed limit sign and No overtaking signs	0.65	1.00	1.00	1.00
Lighting poles and Reflective signs	0.80	0.80	0.75	0.75
Road marking	0.50	0.46	0.50	0.40
Shoulder width	0.10	0.10	0.10	0.20
Pavement condition	0.50	0.40	0.30	0.30
Drainage	0.40	0.30	0.30	0.30
Pedestrian crossing facilities	0.85	0.85	0.90	0.60

Description/ safety furniture	**16+600-17+100**	**17+100-17+300**	**17+600-17+700**	**17+900-18+150**
Straight road segment (Right)				
Speed limit sign and No overtaking signs	1.00	1.00	1.00	0.50
Lighting poles and Reflective signs	0.90	0.85	0.90	0.95
Road marking	0.30	0.30	0.40	0.50
Shoulder width	0.10	0.10	0.15	0.15
Pavement condition	0.30	0.40	0.30	0.30
Drainage	0.30	0.40	0.30	0.30
Pedestrian crossing facilities	0.45	0.80	0.45	0.50

Description/ safety furniture	**18+600-18+700**	**18+950-19+600**	**19+600-20+100**	**20+460-20+994**
Straight road segment (Right)				
Speed limit sign and No overtaking	1.00	1.00	1.00	0.50

Description/ safety furniture	18+600-18+700	18+950-19+600	19+600-20+100	20+460-20+994
signs				
Lighting poles and Reflective signs	0.75	0.85	0.85	0.85
Road marking	0.50	0.50	0.50	0.65
Shoulder width	0.20	0.10	0.10	0.15
Pavement condition	0.30	0.30	0.40	0.40
Drainage	0.20	0.20	0.40	0.25
Pedestrian crossing facilities	0.70	0.65	0.10	0.50

Description/ safety furniture	10+600 - 10+810	11+250-11+575	11+860-12+100	12+100-12+600
Straight road segment (Middle)				
Speed limit sign and No overtaking signs	0.50	1.00	0.78	1.00
Lighting poles and Reflective signs	0.70	0.80	0.80	0.85
Road marking	0.70	0.42	0.62	0.42
Shoulder width	0.10	0.10	0.10	0.10
Pavement condition	0.40	0.20	0.20	0.30
Drainage	0.30	0.30	0.40	0.30
Pedestrian crossing facilities	0.65	0.65	0.85	0.60

Description/ safety furniture	12+600-13+100	13+100-13+380	13+670-14+100	14+100-14+600
Straight road segment (Middle)				
Speed limit sign and No overtaking signs	0.30	0.50	0.00	0.00
Lighting poles and Reflective signs	0.75	0.74	0.75	0.65

Description/ safety furniture	12+600-13+100	13+100-13+380	13+670-14+100	14+100-14+600
Road marking	0.45	0.42	0.40	0.40
Shoulder width	0.15	0.10	0.20	0.10
Pavement condition	0.32	0.30	0.40	0.35
Drainage	0.20	0.35	0.25	0.35
Pedestrian crossing facilities	0.50	0.20	0.65	0.50

Description/ safety furniture	14+600-15+100	15+100-15+420	15+800-16+100	16+100-16+600
Straight road segment (Middle)				
Speed limit sign and No overtaking signs	0.20	0.90	0.50	0.00
Lighting poles and Reflective signs	0.70	0.74	0.74	0.70
Road marking	0.30	0.40	0.45	0.40
Shoulder width	0.10	0.10	0.10	0.10
Pavement condition	0.50	0.40	0.30	0.30
Drainage	0.40	0.30	0.30	0.30
Pedestrian crossing facilities	1.00	1.00	1.00	0.60

Description/ safety furniture	16+600-17+100	17+100-17+300	17+600-17+700	17+900-18+600
Straight road segment (Middle)				
Speed limit sign and No overtaking signs	0.00	0.00	0.00	0.00
Lighting poles and Reflective signs	0.74	0.70	0.74	0.74
Road marking	0.42	0.30	0.35	0.30
Shoulder width	0.10	0.15	0.10	0.10

Description/ safety furniture	16+600-17+100	17+100-17+300	17+600-17+700	17+900-18+600
Pavement condition	0.30	0.40	0.30	0.30
Drainage	0.30	0.40	0.30	0.30
Pedestrian crossing facilities	0.45	0.80	0.48	0.50

Description/ safety furniture	18+600-18+700	18+950-19+600	19+600-20+100	20+460-20+994
Straight road segment (Middle)				
Speed limit sign and No overtaking signs	0.50	0.00	0.90	0.70
Lighting poles and Reflective signs	0.78	0.80	0.80	0.80
Road marking	0.35	0.40	0.35	0.48
Shoulder width	0.10	0.10	0.2	0.15
Pavement condition	0.30	0.30	0.40	0.40
Drainage	0.20	0.20	0.40	0.25
Pedestrian crossing facilities	0.70	1.00	0.10	0.50

APPENDIX -5

(Condition Rating of Curve Element)

Description/ safety furniture	**10+810-11+250**	**11+575-11+860**	**13+380-13+670**	**15+420-15+800**
Sharp horizontal (Middle Carriageway)	**Kalanki Chowk**	**Khasi bazar**	**Sanepa**	**Ekantakuna**
Speed advisory signs, sharp bend, steep up/ down -grade warning signs	0.32	0.50	0.10	0.10
Lighting poles and reflective signs	0.70	0.80	0.65	0.70
Road marking before and in the curve	0.25	0.65	0.40	0.40
Shoulder width	0.10	0.10	0.15	0.20
Combination of horizontal and vertical curves	0.30	0.20	0.55	0.65
Pavement maintenance condition	0.30	0.20	0.20	0.20
Drainage	0.35	0.20	0.20	0.30
Sight distance provision	0.40	0.10	0.10	0.10
Super elevation in horizontal curves	0.90	0.00	0.00	0.00
Road Safety Intervention	0.20	1.00	1.00	1.00

Description/ safety furniture	**17+300-17+600**	**17+700-17+900**	**18+700-18+950**	**20+100-20+400**
Sharp horizontal (Middle Carriageway)	**Chapgaun Dobato**	**Satobato**	**Gwarko**	**Balkumari**
Speed advisory signs, sharp bend, steep up/ down -grade warning signs	0.10	0.20	0.70	0.90

Description/ safety furniture	17+300-17+600	17+700-17+900	18+700-18+950	20+100-20+400
Sharp horizontal (Middle Carriageway)	**Chapgaun Dobato**	**Satobato**	**Gwarko**	**Balkumari**
Lighting poles and reflective signs	0.80	0.30	0.80	0.90
Road marking before and in the curve	0.40	0.10	0.60	0.70
Shoulder width	0.20	0.10	0.20	0.10
Combination of horizontal and vertical curves	0.20	0.10	0.40	0.50
Pavement maintenance condition	0.20	0.30	0.20	0.30
Drainage	0.40	0.20	0.20	0.20
Sight distance provision	0.10	0.10	0.10	0.30
Super elevation in horizontal curves	0.00	0.00	0.00	0.00
Road Safety Intervention	0.40	0.20	0.70	1.00

Sharp horizontal (Side Carriageway)	**Khasibazar**	**Sanepa**		**Ekantakuna**	
	L	**R**	**L**	**R**	**L**
Speed advisory signs, sharp bend, steep up/ down -grade warning signs	0.50	0.10	0.10	0.10	0.10
Lighting poles and reflective signs	0.85	0.65	0.65	0.70	0.70
Road marking before and in the curve	0.50	0.40	0.40	0.10	0.10
Shoulder width	0.10	0.15	0.20	0.20	0.10

Sharp horizontal (Side Carriageway)	Khasibazar	Sanepa		Ekantakuna	
	L	R	L	R	L
Combination of horizontal and vertical curves	0.50	0.60	0.40	0.50	0.60
Pavement maintenance condition	0.20	0.20	0.20	0.20	0.20
Drainage	0.40	0.40	0.40	0.40	0.40
Sight distance provision	0.10	0.10	0.10	0.10	0.10
Super elevation in horizontal curves	0.00	0.00	0.00	0.00	0.00
Road Safety Intervention	1.00	0.80	0.75	0.80	0.70

Sharp horizontal (Side Carriageway)	Chapgaun Dobato		Satobato		Gwarko	
	R	L	R	L	R	L
Speed advisory signs, sharp bend, steep up/ down -grade warning signs	0.10	0.10	0.10	0.20	0.50	0.70
Lighting poles and reflective signs	0.80	0.80	0.30	0.20	0.70	0.80
Road marking before and in the curve	0.40	0.40	0.10	0.10	0.50	0.70
Shoulder width	0.15	0.20	0.10	0.10	0.20	0.40
Combination of horizontal and vertical curves	0.40	0.70	0.10	0.10	0.10	0.20
Pavement maintenance condition	0.40	0.40	0.10	0.10	0.20	0.30

Sharp horizontal (Side Carriageway)	**Chapgaun Dobato**		**Satobato**		**Gwarko**	
	R	**L**	**R**	**L**	**R**	**L**
Drainage	0.40	0.40	0.10	0.20	0.20	0.20
Sight distance provision	0.10	0.10	0.10	0.10	0.10	0.10
Super elevation in horizontal curves	0.00	0.00	0.00	0.00	0.00	0.00
Road Safety Intervention	0.65	0.90	0.30	0.30	0.70	0.90

Description/ safety furniture	**10+810-11+250**		**13+700-14-150**		**14+750-15+100**
Sharp Vertical	**Kalanki Chowk**		**Sanepa Height**		**Bagdol**
	L	**R**	**R**	**L**	**L**
Speed advisory signs, sharp bend, steep up/ down -grade warning signs	0.20	0.20	0.55	0.20	0.60
Lighting poles and reflective signs	0.70	0.70	0.85	0.85	0.90
Road marking before and in the curve	0.20	0.20	0.60	0.60	0.75
Shoulder width	0.10	0.10	0.15	0.20	0.20
Combination of horizontal and vertical curves	0.30	0.30	0.70	0.80	0.70
Pavement maintenance condition	0.20	0.20	0.20	0.30	0.20
Drainage	0.30	0.30	0.30	0.30	0.30
Sight distance provision	0.40	0.40	0.20	0.10	0.15
Super elevation in horizontal curves	0.90	0.90	0.90	0.10	0.10
Road Safety Intervention	0.20	0.20	0.20	0.35	0.20

Description/ safety furniture	18+150-18+600		20+100-20+460	
Sharp Vertical	**B&B**		**Balkumari**	
	R	**L**	**R**	**L**
Speed advisory signs, sharp bend, steep up/ down - grade warning signs	0.90	0.90	0.90	0.90
Lighting poles and reflective signs	0.85	0.85	0.85	0.85
Road marking before and in the curve	0.20	0.40	0.20	0.40
Shoulder width	0.15	0.20	0.20	0.10
Combination of horizontal and vertical curves	0.90	0.80	0.40	0.35
Pavement maintenance condition	0.15	0.15	0.15	0.15
Drainage	0.10	0.10	0.10	0.10
Sight distance provision	0.40	0.60	0.50	0.60
Super elevation in horizontal curves	0.25	0.20	0.35	0.40
Road Safety Intervention	0.25	0.35	0.25	0.35

APPENDIX -6

(Condition Rating of Bridge Element)

Description/ safety furniture	**11+500**	**13+040**	**13+170**	**19+920**
Bridges	**Khasi Bazar**	**Balkhu 1**	**Balkhu 2 Bishnumati**	**Balkumari**
Speed limit, no overtaking and load limit signs	1.00	1.00	0.00	0.90
Lighting poles and reflective signs	0.80	0.80	1.00	0.85
Road marking	0.50	0.50	0.80	0.60
Reduction in the pavement and shoulder width	0.10	0.10	0.10	0.10
Pavement maintenance condition	0.10	0.00	0.15	0.15
Drainage	0.20	0.25	0.20	0.30
Guardrails and bridge approach protection	0.25	0.30	0.40	0.40

APPENDIX -7

(Condition Rating of Intersection Element)

Description/ safety furniture	**11+100**	**11+570**	**11+914**	**12+840**
Merging and intersections	**Kalanki**	**Balkhu Bhatbhateni Supermarket**	**Sita Petrol Pump**	**Balkhu/ TU**
Speed limit and warning signs	0.37	0.74	0.74	0.24
Lighting poles and reflective signs	0.13	0.37	1.00	0.50
Road marking	0.49	0.74	0.49	0.50
Shoulder width	0.74	0.74	0.10	0.10
Pavement condition	0.10	0.10	0.00	0.00
Drainage	0.00	0.00	0.50	0.49
Visibility (sight distance)/ turning radius	0.00	0.30	0.10	0.74
Distance to the previous intersection	0.10	0.15	0.10	0.40
Traffic calming measures /appropriate geometry to reduce speed	0.49	1.00	1.00	1.00
Pedestrian crossing facilities	0.62	1.00	1.00	0.74

Description/ safety furniture	**13+030**	**13+325**	**13+460**	**13+710**
Merging and intersections	**Balkhu/ kirtipur**	**Balkhu Bridge East/ Bagmati Gusingal Road**	**Sanepa**	**Star Hospital new location**
Speed limit and warning signs	0.37	1.00	1.00	0.55
Lighting poles and reflective	0.50	1.00	1.00	1.00

Description/ safety furniture	13+030	13+325	13+460	13+710
Merging and intersections	**Balkhu/ kirtipur**	**Balkhu Bridge East/ Bagmati Gusingal Road**	**Sanepa**	**Star Hospital new location**
signs				
Road marking	0.49	0.74	0.49	0.49
Shoulder width	0.10	0.24	0.24	0.24
Pavement condition	0.00	0.15	0.10	0.10
Drainage	0.00	0.10	0.15	0.20
Visibility (sight distance)/ turning radius	0.24	0.74	0.74	0.74
Distance to the previous intersection	0.40	0.20	0.15	0.15
Traffic calming measures /appropriate geometry to reduce speed	1.00	1.00	1.00	1.00
Pedestrian crossing facilities	0.74	1.00	1.00	0.49

Description/ safety furniture	14+150	14+560	15+530	15+630
Merging and intersections	**Sanepa Naya bato**	**Dhobighat**	**Nakkhu**	**Ekantakuna**
Speed limit and warning signs	1.00	0.37	0.55	0.45
Lighting poles and reflective signs	1.00	0.50	0.55	0.55
Road marking	1.00	0.49	0.55	0.40
Shoulder width	0.10	0.10	0.10	0.25
Pavement condition	0.10	0.15	0.40	0.25

Description/ safety furniture	**14+150**	**14+560**	**15+530**	**15+630**
Merging and intersections	**Sanepa Naya bato**	**Dhobighat**	**Nakkhu**	**Ekantakuna**
Drainage	0.20	0.20	0.50	0.50
Visibility (sight distance)/ turning radius	0.50	0.24	0.55	0.88
Distance to the previous intersection	0.15	0.25	0.18	0.20
Traffic calming measures /appropriate geometry to reduce speed	1.00	1.00	0.70	0.59
Pedestrian crossing facilities	1.00	0.74	0.88	0.50

Description/ safety furniture	**15+870**	**16+110**	**16+825**
Merging and intersections	**Yatayat**	**Kusunti**	**Mahalaxmisthan**
Speed limit and warning signs	0.80	0.50	0.45
Lighting poles and reflective signs	0.85	0.70	0.70
Road marking	0.40	0.55	0.50
Shoulder width	0.35	0.20	0.13
Pavement condition	0.20	0.25	0.30
Drainage	0.65	0.68	0.55
Visibility (sight distance)/ turning radius	0.90	0.85	0.75
Distance to the previous intersection	0.25	0.15	0.83
Traffic calming measures /appropriate geometry to reduce speed	0.85	0.80	0.65
Pedestrian crossing facilities	0.10	0.80	0.65

Description/ safety furniture	**17+180**	**17+370**	**17+640**
Merging and intersections	**Talchhikhel**	**Chapagaun Dobato**	**Satdobato**
Speed limit and warning signs	0.20	0.40	0.30
Lighting poles and reflective signs	0.85	0.85	0.80
Road marking	0.35	0.60	0.50
Shoulder width	0.13	0.10	0.18
Pavement condition	0.25	0.25	0.23
Drainage	0.45	0.75	0.70
Visibility (sight distance)/ turning radius	0.40	0.45	0.33
Distance to the previous intersection	0.45	0.15	0.10
Traffic calming measures /appropriate geometry to reduce speed	0.65	0.85	0.80
Pedestrian crossing facilities	0.30	0.70	0.30

Description/ safety furniture	**18+150**	**18+700**	**19+800**	**20+994**
Merging and intersections	**Satdobato ANFA**	**Gwarko**	**Balkumari**	**Koteshwor**
Speed limit and warning signs	0.90	0.30	0.60	0.45
Lighting poles and reflective signs	0.90	0.80	0.85	0.65
Road marking	0.85	0.60	0.75	0.90
Shoulder width	0.10	0.13	0.13	0.10
Pavement condition	0.25	0.25	0.23	0.15
Drainage	0.60	0.65	0.55	0.70
Visibility (sight distance)/ turning radius	0.90	0.22	0.30	0.20
Distance to the previous intersection	0.10	0.13	0.13	0.10

Description/ safety furniture	**18+150**	**18+700**	**19+800**	**20+994**
Merging and intersections	**Satdobato ANFA**	**Gwarko**	**Balkumari**	**Koteshwor**
Traffic calming measures /appropriate geometry to reduce speed	0.80	0.75	0.75	0.60
Pedestrian crossing facilities	0.90	0.45	0.68	0.70

APPENDIX -8

(Safety Hazardous Index Calculation for Straight Element)

Description/ safety furniture	10+600 -11+810	11+250- 11+575	11+860- 12+100	12+100- 12+600
Straight road segment (Left) = 2.13				
Speed limit and No overtaking signs	0.09	0.10	0.13	0.13
Lighting poles and Reflective signs	0.05	0.06	0.06	0.08
Road marking	0.07	0.08	0.09	0.06
Shoulder width	0.01	0.02	0.01	0.02
Pavement condition	0.06	0.03	0.03	0.05
Drainage	0.02	0.02	0.03	0.02
Pedestrian crossing facilities	0.19	0.19	0.25	0.17

Description/ safety furniture	12+600- 13+100	13+100- 13+380	13+670- 13+700	14+150- 14+600
Straight road segment (Left) = 1.71				
Speed limit and No overtaking signs	0.11	0.08	0.06	0.06
Lighting poles and Reflective signs	0.04	0.06	0.05	0.06
Road marking	0.07	0.09	0.03	0.07
Shoulder width	0.02	0.01	0.01	0.01
Pavement condition	0.05	0.05	0.06	0.05
Drainage	0.02	0.05	0.02	0.03
Pedestrian crossing facilities	0.14	0.06	0.19	0.14

Description/ safety furniture	14+600- 15+100	15+100- 15+420	15+800- 16+100	16+100- 16+600
Straight road segment (Left) = 1.88				
Speed limit and No overtaking signs	0.10	0.12	0.09	0.13

Description/ safety furniture	14+600-15+100	15+100-15+420	15+800-16+100	16+100-16+600
Lighting poles and Reflective signs	0.03	0.05	0.06	0.08
Road marking	0.06	0.04	0.07	0.09
Shoulder width	0.01	0.02	0.02	0.02
Pavement condition	0.05	0.05	0.06	0.06
Drainage	0.02	0.02	0.04	0.02
Pedestrian crossing facilities	0.13	0.12	0.17	0.14

Description/ safety furniture	16+600-17+100	17+100-17+300	17+600-17+700	17+900-18+150
Straight road segment (Left) = 1.78				
Speed limit and No overtaking signs	0.10	0.07	0.07	0.07
Lighting poles and Reflective signs	0.06	0.06	0.07	0.06
Road marking	0.07	0.06	0.06	0.06
Shoulder width	0.02	0.01	0.01	0.01
Pavement condition	0.06	0.05	0.05	0.05
Drainage	0.03	0.02	0.04	0.03
Pedestrian crossing facilities	0.12	0.17	0.12	0.18

Description/ safety furniture	18+600-18+700	18+950-19+600	19+600-20+100	20+460-20+994
Straight road segment (Left) = 2.14				
Speed limit and No overtaking signs	0.15	0.12	0.12	0.12
Lighting poles and Reflective signs	0.06	0.08	0.08	0.07
Road marking	0.09	0.07	0.07	0.07
Shoulder width	0.01	0.01	0.01	0.01
Pavement condition	0.05	0.05	0.05	0.05

Description/ safety furniture	18+600-18+700	18+950-19+600	19+600-20+100	20+460-20+994
Drainage	0.02	0.02	0.03	0.02
Pedestrian crossing facilities	0.19	0.19	0.25	0.12

Description/ safety furniture	10+600 - 10+810	11+250-11+575	11+860-12+100	12+100-12+600
Straight road segment (Right) = 1.14				
Speed limit sign and No overtaking signs	0.13	0.13	0.00	0.00
Lighting poles and Reflective signs	0.08	0.08	0.00	0.00
Road marking	0.12	0.07	0.00	0.00
Shoulder width	0.01	0.01	0.00	0.00
Pavement condition	0.06	0.05	0.00	0.00
Drainage	0.03	0.02	0.00	0.00
Pedestrian crossing facilities	0.06	0.29	0.00	0.00

Description/ safety furniture	12+600-13+100	13+100-13+380	13+670-13+700	14+150-14+600
Straight road segment (Right) = 2.15				
Speed limit sign and No overtaking signs	0.13	0.10	0.13	0.13
Lighting poles and Reflective signs	0.08	0.08	0.08	0.06
Road marking	0.13	0.06	0.06	0.11
Shoulder width	0.02	0.01	0.02	0.02
Pavement condition	0.13	0.03	0.05	0.08
Drainage	0.05	0.02	0.02	0.04
Pedestrian crossing facilities	0.17	0.13	0.14	0.07

Description/ safety furniture	14+600-14+750	15+100-15+420	15+800-16+100	16+100-16+600
Straight road segment (Right) = 2.38				
Speed limit sign and No overtaking signs	0.10	0.15	0.15	0.15
Lighting poles and Reflective signs	0.07	0.07	0.06	0.06
Road marking	0.07	0.07	0.07	0.06
Shoulder width	0.01	0.01	0.01	0.02
Pavement condition	0.08	0.06	0.05	0.05
Drainage	0.03	0.02	0.02	0.02
Pedestrian crossing facilities	0.25	0.25	0.26	0.17

Description/ safety furniture	16+600-17+100	17+100-17+300	17+600-17+700	17+900-18+150
Straight road segment (Right) = 2.04				
Speed limit sign and No overtaking signs	0.15	0.15	0.15	0.07
Lighting poles and Reflective signs	0.08	0.07	0.08	0.08
Road marking	0.04	0.04	0.06	0.07
Shoulder width	0.01	0.01	0.01	0.01
Pavement condition	0.05	0.06	0.05	0.05
Drainage	0.02	0.03	0.02	0.02
Pedestrian crossing facilities	0.13	0.23	0.13	0.14

Description/ safety furniture	18+600-18+700	18+950-19+600	19+600-20+100	20+460-20+994
Straight road segment (Right) = 2.03				
Speed limit sign and No overtaking	0.15	0.15	0.15	0.07

Description/ safety furniture	18+600-18+700	18+950-19+600	19+600-20+100	20+460-20+994
signs				
Lighting poles and Reflective signs	0.06	0.07	0.07	0.07
Road marking	0.07	0.07	0.07	0.09
Shoulder width	0.02	0.01	0.01	0.01
Pavement condition	0.05	0.05	0.06	0.06
Drainage	0.02	0.02	0.03	0.02
Pedestrian crossing facilities	0.20	0.19	0.03	0.14

Description/ safety furniture	10+600 - 10+810	11+250-11+575	11+860-12+100	12+100-12+600
Straight road segment (Middle)=2.18				
Speed limit sign and No overtaking signs	0.07	0.15	0.12	0.15
Lighting poles and Reflective signs	0.06	0.07	0.07	0.07
Road marking	0.10	0.06	0.09	0.06
Shoulder width	0.01	0.01	0.01	0.01
Pavement condition	0.06	0.03	0.03	0.05
Drainage	0.02	0.02	0.03	0.02
Pedestrian crossing facilities	0.19	0.19	0.25	0.17

Description/ safety furniture	12+600-13+100	13+100-13+380	13+670-14+100	14+100-14+600
Straight road segment (Middle) =1.50				
Speed limit sign and No overtaking signs	0.04	0.07	0.00	0.00
Lighting poles and Reflective signs	0.06	0.06	0.06	0.06

Description/ safety furniture	12+600-13+100	13+100-13+380	13+670-14+100	14+100-14+600
Road marking	0.07	0.06	0.06	0.06
Shoulder width	0.01	0.01	0.02	0.01
Pavement condition	0.05	0.05	0.06	0.05
Drainage	0.02	0.03	0.02	0.03
Pedestrian crossing facilities	0.14	0.06	0.19	0.14

Description/ safety furniture	14+600-15+100	15+100-15+420	15+800-16+100	16+100-16+600
Straight road segment (Middle) =2.12				
Speed limit sign and No overtaking signs	0.03	0.13	0.07	0.00
Lighting poles and Reflective signs	0.06	0.06	0.06	0.06
Road marking	0.04	0.06	0.07	0.06
Shoulder width	0.01	0.01	0.01	0.01
Pavement condition	0.08	0.06	0.05	0.05
Drainage	0.03	0.02	0.02	0.02
Pedestrian crossing facilities	0.29	0.29	0.29	0.17

Description/ safety furniture	16+600-17+100	17+100-17+300	17+600-17+700	17+900-18+600
Straight road segment (Middle) =1.44				
Speed limit sign and No overtaking signs	0.00	0.00	0.00	0.00
Lighting poles and Reflective signs	0.06	0.06	0.06	0.06
Road marking	0.06	0.04	0.05	0.04
Shoulder width	0.01	0.01	0.01	0.01

Description/ safety furniture	16+600-17+100	17+100-17+300	17+600-17+700	17+900-18+600
Pavement condition	0.05	0.06	0.05	0.05
Drainage	0.02	0.03	0.02	0.02
Pedestrian crossing facilities	0.13	0.23	0.14	0.14

Description/ safety furniture	18+600-18+700	18+950-19+600	19+600-20+100	20+460-20+994
Straight road segment (Middle) =1.84				
Speed limit sign and No overtaking signs	0.07	0.00	0.13	0.10
Lighting poles and Reflective signs	0.07	0.07	0.07	0.07
Road marking	0.05	0.06	0.05	0.07
Shoulder width	0.01	0.01	0.02	0.01
Pavement condition	0.05	0.05	0.06	0.06
Drainage	0.02	0.02	0.03	0.02
Pedestrian crossing facilities	0.20	0.29	0.03	0.14

Summary:

SN	Chainage, km		SHI of straight element			
	From	To	Left	right	middle	Total SHI
1	10+600	12+600	2.13	1.14	2.18	5.45
2	12+600	14+600	1.71	2.15	1.50	5.36
3	14+600	16+600	1.88	2.37	2.12	6.37
4	16+600	18+600	1.78	2.04	1.44	5.26
5	18+600	20+994	2.14	2.03	1.84	6.01

APPENDIX -9

(Safety Hazardous Index Calculation for Curve Element)

Description/ safety furniture	**10+810-11+250**	**11+575-11+860**	**13+380-13+670**	**15+420-15+800**
Sharp horizontal (Middle Carriageway)	**Kalanki Chowk**	**Khasi bazar**	**Sanepa**	**Ekantakuna**
Speed advisory signs, sharp bend, steep up/ down -grade warning signs	0.03	0.05	0.01	0.01
Lighting poles and reflective signs	0.05	0.05	0.04	0.05
Road marking before and in the curve	0.02	0.04	0.03	0.03
Shoulder width	0.01	0.01	0.01	0.01
Combination of horizontal and vertical curves	0.03	0.02	0.06	0.07
Pavement maintenance condition	0.02	0.01	0.01	0.01
Drainage	0.02	0.01	0.01	0.02
Sight distance provision	0.06	0.02	0.02	0.02
Super elevation in horizontal curves	0.10	0.00	0.00	0.00
Road Safety Intervention	0.04	0.21	0.21	0.21
SHI	**0.38**	**0.42**	**0.39**	**0.41**

Description/ safety furniture	**17+300-17+600**	**17+700-17+900**	**18+700-18+950**	**20+100-20+400**
Sharp horizontal (Middle Carriageway)	**Chapgaun Dobato**	**Satobato**	**Gwarko**	**Balkumari**
Speed advisory signs, sharp bend, steep up/ down -grade warning signs	0.01	0.02	0.07	0.09

Description/ safety furniture	17+300-17+600	17+700-17+900	18+700-18+950	20+100-20+400
Sharp horizontal (Middle Carriageway)	**Chapgaun Dobato**	**Satobato**	**Gwarko**	**Balkumari**
Lighting poles and reflective signs	0.05	0.02	0.05	0.06
Road marking before and in the curve	0.03	0.01	0.04	0.05
Shoulder width	0.01	0.01	0.01	0.01
Combination of horizontal and vertical curves	0.02	0.01	0.04	0.05
Pavement maintenance condition	0.01	0.02	0.01	0.02
Drainage	0.02	0.01	0.01	0.01
Sight distance provision	0.02	0.02	0.02	0.05
Super elevation in horizontal curves	0.00	0.00	0.00	0.00
Road Safety Intervention	0.08	0.04	0.15	0.21
SHI	**0.26**	**0.15**	**0.40**	**0.55**

Sharp horizontal (Side Carriageway)	**Khasibazar**	**Sanepa**		**Ekantakuna**	
	L	**R**	**L**	**R**	**L**
Speed advisory signs, sharp bend, steep up/ down -grade warning signs	0.05	0.01	0.01	0.01	0.01
Lighting poles and reflective signs	0.06	0.04	0.04	0.05	0.05
Road marking before and in the curve	0.03	0.03	0.03	0.01	0.01
Shoulder width	0.01	0.01	0.01	0.01	0.01

Sharp horizontal (Side Carriageway)	Khasibazar	Sanepa		Ekantakuna	
	L	R	L	R	L
Combination of horizontal and vertical curves	0.05	0.06	0.04	0.05	0.06
Pavement maintenance condition	0.01	0.01	0.01	0.01	0.01
Drainage	0.02	0.02	0.02	0.02	0.02
Sight distance provision	0.02	0.02	0.02	0.02	0.02
Super elevation in horizontal curves	0.00	0.00	0.00	0.00	0.00
Road Safety Intervention	0.21	0.17	0.16	0.17	0.15
SHI	**0.46**	**0.71**		**0.67**	

Sharp horizontal (Side Carriageway)	Chapgaun Dobato		Satobato		Gwarko	
	R	L	R	L	R	L
Speed advisory signs, sharp bend, steep up/ down -grade warning signs	0.01	0.01	0.01	0.02	0.05	0.07
Lighting poles and reflective signs	0.05	0.05	0.02	0.01	0.05	0.05
Road marking before and in the curve	0.03	0.03	0.01	0.01	0.03	0.05
Shoulder width	0.01	0.01	0.01	0.01	0.01	0.02
Combination of horizontal and vertical curves	0.04	0.07	0.01	0.01	0.01	0.02
Pavement maintenance condition	0.03	0.03	0.01	0.01	0.01	0.02

Sharp horizontal (Side Carriageway)	**Chapgaun Dobato**		**Satobato**		**Gwarko**	
	R	**L**	**R**	**L**	**R**	**L**
Drainage	0.02	0.02	0.01	0.01	0.01	0.01
Sight distance provision	0.02	0.02	0.02	0.02	0.02	0.02
Super elevation in horizontal curves	0.00	0.00	0.00	0.00	0.00	0.00
Road Safety Intervention	0.14	0.19	0.06	0.06	0.15	0.19
SHI	**0.78**		**0.29**		**0.79**	

Description/ safety furniture	**10+810-11+250**		**13+700-14-150**		**14+750-15+100**
Sharp Vertical	**Kalanki Chowk**		**Sanepa Height**		**Bagdol**
	L	**R**	**R**	**L**	**L**
Speed advisory signs, sharp bend, steep up/ down -grade warning signs	0.02	0.02	0.05	0.02	0.06
Lighting poles and reflective signs	0.05	0.05	0.06	0.06	0.06
Road marking before and in the curve	0.01	0.01	0.04	0.04	0.05
Shoulder width	0.01	0.01	0.01	0.01	0.01
Combination of horizontal and vertical curves	0.03	0.03	0.07	0.09	0.07
Pavement maintenance condition	0.01	0.01	0.01	0.02	0.01
Drainage	0.02	0.02	0.02	0.02	0.02
Sight distance provision	0.06	0.06	0.03	0.02	0.02
Super elevation in horizontal curves	0.10	0.10	0.10	0.01	0.01
Road Safety Intervention	0.04	0.04	0.04	0.07	0.04
SHI	**0.70**		**0.78**		**0.36**

Description/ safety furniture	18+150-18+600		20+100-20+460	
Sharp Vertical	**B&B**		**Balkumari**	
	R	**L**	**R**	**L**
Speed advisory signs, sharp bend, steep up/ down - grade warning signs	0.09	0.09	0.09	0.09
Lighting poles and reflective signs	0.06	0.06	0.06	0.06
Road marking before and in the curve	0.01	0.03	0.01	0.03
Shoulder width	0.01	0.01	0.01	0.01
Combination of horizontal and vertical curves	0.10	0.09	0.04	0.04
Pavement maintenance condition	0.01	0.01	0.01	0.01
Drainage	0.01	0.01	0.01	0.01
Sight distance provision	0.06	0.10	0.08	0.10
Super elevation in horizontal curves	0.03	0.02	0.04	0.04
Road Safety Intervention	0.05	0.07	0.05	0.07
SHI	**0.90**		**0.84**	

Summary:

SN	Chainage, km		SHI of curve element					Total SHI
	From	To						
1	10+600	12+600	0.38	0.42	0.46	0.70	-	1.96
2	12+600	14+600	0.39	0.71	0.78	-	-	1.88
3	14+600	16+600	0.41	0.67	0.36	-	-	1.44
4	16+600	18+600	0.26	0.15	0.78	0.29	0.90	2.38
5	18+600	20+994	0.40	0.55	0.79	0.84	-	2.58

APPENDIX -10

(Safety Hazardous Index Calculation for Bridge Element)

Description/ safety furniture	**11+500**	**13+040**	**13+170**	**19+920**
Bridges	**Khasi Bazar**	**Balkhu 1**	**Balkhu 2 Bishnumati**	**Balkumari**
Speed limit, no overtaking and load limit signs	0.15	0.15	0.00	0.13
Lighting poles and reflective signs	0.09	0.09	0.11	0.09
Road marking	0.05	0.05	0.09	0.07
Reduction in the pavement and shoulder width	0.01	0.01	0.01	0.01
Pavement maintenance condition	0.01	0.00	0.02	0.02
Drainage	0.02	0.02	0.02	0.02
Guardrails and bridge approach protection	0.07	0.09	0.12	0.12
SHI	**0.40**	**0.41**	**0.36**	**0.46**

Summary:

SN	**Chainage, km**		**SHI of bridge element**		**Total SHI**
	From	**To**			
1	10+600	12+600	0.40	-	0.40
2	12+600	14+600	0.40	0.36	0.76
3	14+600	16+600	-	-	0.00
4	16+600	18+600	-	-	0.00
5	18+600	20+994	0.46	-	0.46

APPENDIX -11

(Safety Hazardous Index Calculation for Intersection Element)

Description/ safety furniture	**11+100**	**11+570**	**11+914**	**12+840**
Merging and intersections	**Kalanki**	**Balkhu Bhatbhateni Supermarket**	**Sita Petrol Pump**	**Balkhu/ TU**
Speed limit and warning signs	0.04	0.08	0.08	0.03
Lighting poles and reflective signs	0.01	0.03	0.09	0.04
Road marking	0.04	0.06	0.04	0.04
Shoulder width	0.02	0.02	0.00	0.00
Pavement condition	0.01	0.01	0.00	0.00
Drainage	0.00	0.00	0.02	0.02
Visibility (sight distance)/ turning radius	0.00	0.05	0.02	0.13
Distance to the previous intersection	0.01	0.01	0.01	0.02
Traffic calming measures /appropriate geometry to reduce speed	0.09	0.18	0.18	0.18
Pedestrian crossing facilities	0.09	0.15	0.15	0.11
SHI	**0.31**	**0.60**	**0.58**	**0.58**

Description/ safety furniture	**13+030**	**13+325**	**13+460**	**13+710**
Merging and intersections	**Balkhu/ kirtipur**	**Balkhu Bridge East/ Bagmati Gusingal Road**	**Sanepa**	**Star Hospital new location**
Speed limit and warning signs	0.04	0.11	0.11	0.06
Lighting poles and reflective	0.04	0.09	0.09	0.09

Description/ safety furniture	13+030	13+325	13+460	13+710
Merging and intersections	Balkhu/ kirtipur	Balkhu Bridge East/ Bagmati Gusingal Road	Sanepa	Star Hospital new location
signs				
Road marking	0.04	0.06	0.04	0.04
Shoulder width	0.00	0.01	0.01	0.01
Pavement condition	0.00	0.01	0.01	0.01
Drainage	0.00	0.00	0.01	0.01
Visibility (sight distance)/ turning radius	0.04	0.13	0.13	0.13
Distance to the previous intersection	0.02	0.01	0.01	0.01
Traffic calming measures /appropriate geometry to reduce speed	0.18	0.18	0.18	0.18
Pedestrian crossing facilities	0.11	0.15	0.15	0.07
SHI	**0.48**	**0.76**	**0.73**	**0.61**

Description/ safety furniture	14+150	14+560	15+530	15+630
Merging and intersections	Sanepa Naya bato	Dhobighat	Nakkhu	Ekantakuna
Speed limit and warning signs	0.11	0.04	0.06	0.05
Lighting poles and reflective signs	0.09	0.04	0.05	0.05
Road marking	0.08	0.04	0.04	0.03
Shoulder width	0.00	0.00	0.00	0.01

Description/ safety furniture	**14+150**	**14+560**	**15+530**	**15+630**
Merging and intersections	**Sanepa Naya bato**	**Dhobighat**	**Nakkhu**	**Ekantakuna**
Pavement condition	0.01	0.01	0.03	0.02
Drainage	0.01	0.01	0.02	0.02
Visibility (sight distance)/ turning radius	0.09	0.04	0.10	0.15
Distance to the previous intersection	0.01	0.01	0.01	0.01
Traffic calming measures /appropriate geometry to reduce speed	0.18	0.18	0.13	0.11
Pedestrian crossing facilities	0.15	0.11	0.13	0.07
SHI	**0.73**	**0.50**	**0.55**	**0.52**

Description/ safety furniture	**15+870**	**16+110**	**16+825**
Merging and intersections	**Yatayat**	**Kusunti**	**Mahalaxmisthan**
Speed limit and warning signs	0.09	0.06	0.05
Lighting poles and reflective signs	0.07	0.06	0.06
Road marking	0.03	0.04	0.04
Shoulder width	0.01	0.01	0.00
Pavement condition	0.02	0.02	0.03
Drainage	0.02	0.03	0.02
Visibility (sight distance)/ turning radius	0.16	0.15	0.13
Distance to the previous intersection	0.01	0.01	0.05

Description/ safety furniture	15+870	16+110	16+825
Merging and intersections	**Yatayat**	**Kusunti**	**Mahalaxmisthan**
Traffic calming measures /appropriate geometry to reduce speed	0.16	0.15	0.12
Pedestrian crossing facilities	0.01	0.12	0.10
SHI	**0.59**	**0.63**	**0.60**

Description/ safety furniture	17+180	17+370	17+640
Merging and intersections	**Talchhikhel**	**Chapagaun Dobato**	**Satdobato**
Speed limit and warning signs	0.02	0.04	0.03
Lighting poles and reflective signs	0.07	0.07	0.07
Road marking	0.03	0.05	0.04
Shoulder width	0.00	0.00	0.01
Pavement condition	0.02	0.02	0.02
Drainage	0.02	0.03	0.03
Visibility (sight distance)/ turning radius	0.07	0.08	0.06
Distance to the previous intersection	0.03	0.01	0.01
Traffic calming measures /appropriate geometry to reduce speed	0.12	0.16	0.15
Pedestrian crossing facilities	0.04	0.10	0.04
SHI	**0.42**	**0.57**	**0.45**

Description/ safety furniture	18+150	18+700	19+800	20+994
Merging and intersections	**Satdobato ANFA**	**Gwarko**	**Balkumari**	**Koteshwor**
Speed limit and warning signs	0.10	0.03	0.07	0.05

Description/ safety furniture	18+150	18+700	19+800	20+994
Merging and intersections	**Satdobato ANFA**	**Gwarko**	**Balkumari**	**Koteshwor**
Lighting poles and reflective signs	0.08	0.07	0.07	0.06
Road marking	0.07	0.05	0.06	0.07
Shoulder width	0.00	0.00	0.00	0.00
Pavement condition	0.02	0.02	0.02	0.01
Drainage	0.02	0.02	0.02	0.03
Visibility (sight distance)/ turning radius	0.16	0.04	0.05	0.04
Distance to the previous intersection	0.01	0.01	0.01	0.01
Traffic calming measures /appropriate geometry to reduce speed	0.15	0.14	0.14	0.11
Pedestrian crossing facilities	0.13	0.07	0.10	0.10
SHI	**0.74**	**0.45**	**0.54**	**0.48**

Summary:

SN	Chainage, km		SHI of merge & intersection element							Total SHI
	From	To								
1	10+600	12+600	0.31	0.60	0.58	-	-	-	-	1.49
2	12+600	14+600	0.58	0.48	0.76	0.73	0.61	0.73	0.50	4.38
3	14+600	16+600	0.55	0.52	0.59	0.63	-	-	-	2.29
4	16+600	18+600	0.60	0.42	0.57	0.45	0.74	-	-	2.77
5	18+600	20+994	0.45	0.54	0.48	-	-	-	-	1.47

APPENDIX -12

(Road Crash Data)

(Source: Metropolitan Traffic Police Office, Kathmandu)

Road Crash Fatalities in last FY 2075/76

S.N.	Month	Road Crash	Death	Serious Injured	General Injured
1	Shrawan	66	2	2	56
2	Bhadra	87	2	3	57
3	Asoj	94	0	4	83
4	Kartik	61	1	1	40
5	Mangsir	88	1	2	47
6	Poush	82	3	2	33
7	Magh	104	1	7	70
8	Falgun	78	0	2	72
9	Chaitra	103	2	6	41
10	Baisakh	101	2	2	70
11	Jestha	207	5	4	152
12	Asar	89	1	2	60
	Total	**1060**	**17**	**35**	**717**

Road Crash Fatalities in current FY 2076/77

S.N.	Month	Road Crash	Death	Serious Injured	General Injured
1	Shrawan	72	1	4	69
2	Bhadra	90	0	2	73
3	Asoj	77	1	3	74
4	Kartik	86	3	1	73
5	Mangsir	83	4	1	76
6	Poush	101	0	3	62
13	**Total**	**509**	**9**	**14**	**427**

Road Crash Datas from Bhadra to Magh

For Chainage 10+600 km to 12+600 km

Date	Location	Vehicle involved	Injured	Death	Chainage
5/30/76	Kalanki Chowk	Bus+Car	0	0	11+100
5/30/76	Sita Petrol Pump	Truck+ Motorcycle+Bus	0	0	11+920
6/1/76	Khasibazar	Car+Motorcycle	1	0	11+570
6/6/76	Kalanki Chowk	Truck+island	0	0	11+100
6/8/76	Kalanki Chowk	Bus+Island	0	0	11+100
6/8/76	Sita Petrol Pump	pickup+Car	0	0	11+920
6/16/76	Kalanki Chowk	Truck+Island	0	0	11+100
6/16/76	Khasibazar	Scooter+Motorcycle	0	0	11+570
6/16/76	Sita Petrol Pump	Jeep+Car	0	0	11+970
6/17/76	Kalanki Chowk	Bus+Car	0	0	11+100
6/17/76	Khasibazar	Motorcycle+Motorcycle	2	0	11+620
6/18/76	Khasibazar	Truck+Car	0	0	11+670
6/24/76	Kalanki Chowk	Bus+Bus	0	0	11+150
6/28/76	Sita Petrol Pump	Motorcycle+Pedestrian	1	0	11+820
7/2/76	Sita Petrol Pump	Mini Truck+Motorcycle	1	0	11+870

Date	Location	Vehicle involved	Injured	Death	Chainage
7/3/76	Kalanki Chowk	Tipper+Motorcycle	0	0	11+150
7/3/76	Sita Petrol Pump	Car+Tanker	0	0	11+920
7/5/76	Kalanki Chowk	Tipper+Car	0	0	11+100
7/16/76	Kalanki Chowk	Truck+Car	0	0	11+950
7/18/76	Kalanki Chowk	Truck+island	0	0	11+950
7/18/76	Kalanki Chowk	Bus	0	0	11+150
7/26/76	Kalanki Chowk	Van+Van	0	0	11+100
8/7/76	Balkhu	Motorcycle+Passenger	1	0	12+540
8/7/76	Khasibazar	Van+Pedestrian	1	0	11+670
8/11/76	Sita Petrol Pump	Truck+Car	0	0	11+970
8/12/76	Kalanki Chowk	Container+Bus	0	0	11+100
8/15/76	Kalanki Chowk	Container+Car	0	0	11+100
8/16/76	Kalanki Underpass	Van+Pedestrian	1	0	11+100
8/17/76	Kalanki Chowk	Container+Cycle	0	0	11+150
8/19/76	Sita Petrol Pump	Truck+Pedestrian	1	0	12+070
8/21/76	Kalanki Chowk	Truck+island	0	0	11+100

Date	Location	Vehicle involved	Injured	Death	Chainage
8/21/76	Kalanki Chowk	Truck+Car	0	0	11+100
8/21/76	Khasibazar	Mini Truck+3 Pedestrian	3	0	11+620
8/21/76	Khasibazar	Motorcycle+Scooter	1	0	11+570
8/26/76	Sita Petrol Pump	Tipper+Taxi	0	0	11+920
8/28/76	Kalanki Chowk	Bus+Bus	0	0	11+150
8/29/76	Kalanki Chowk	Car+Truck	0	0	11+50
8/30/76	Kalanki Chowk	Truck+Car	0	0	11+150
9/1/76	Kalanki Chowk	Truck+ Car	0	0	11+100
9/4/76	Kalanki Chowk	Bus+Pedestrian	1	0	11+100
9/5/76	Kusunti Height	Motorcycle	1	0	10+060
9/6/76	Balkhu	Pickup+Motorcycle	2	0	12+540
9/8/76	Sita Petrol Pump	Scooter+4 Pedestrian	5	0	11+970
9/14/76	Kalanki-Khasi bazar	Bus+Motorcycle	1	0	11+570
9/15/76	Kalanki Chowk	Bus+Car	0	0	11+150
9/15/76	Kalanki Chowk	Bus+Traffic Island	0	0	11+150
9/15/76	Khasibazar	Car+Taxi	0	0	11+620

Date	Location	Vehicle involved	Injured	Death	Chainage
9/15/76	Khasibazar	Tipper+Mini Truck	0	0	11+620
9/18/76	Kalanki-Khasi bazar	Bus+Van	0	0	11+620
9/24/76	Kalanki-Khasi bazar	Motorcycle+2 Pedestrian	2	0	11+570
9/26/76	Kalanki Underpass	Car+Mini Truck	3	0	11+200
9/28/76	Kalanki-Khasi bazar	Taxi+Tanker	0	0	11+620
10/4/76	Sita Petrol Pump	Bus+Car	0	0	11+970
10/10/76	Sita Petrol Pump	Motorcycle+Motorcycle	1	0	11+920

From Chainage 12+600 km to 14+600 km

Date	Location	Vehicle involved	Injured	Death	Chainage
5/28/76	Pa.Ni. Ka	Car+Bus	0	0	12+840
5/30/76	Sanepa Chowk	Motorcycle+ Truck	0	0	13+460
5/31/76	Balkhu Chowk	Mini Truck+Truck+ Scooter	1	0	13+040
5/31/76	Nayabato	Motorcycle+ Pedestrian	3	0	14+150
6/2/76	Dhobighat	Motorcycle+ Pedestrian	1	0	14+560
6/5/76	Sanepa Chowk	Tipper+Tipper	0	0	13+510
6/7/76	Balkhu	Car+Tipper	0	0	13+040

Date	Location	Vehicle involved	Injured	Death	Chainage
	Chowk				
6/8/76	Star Hospital	Tempo	3	0	13+710
6/10/76	Sanepa Chowk	Motorcycle+ Motorcycle	3	0	13+410
6/12/76	Pa.Ni. Ka	Van+Scooter	1	0	12+840
6/13/76	Dhobighat	Car+Pickup	0	0	14+560
6/13/76	Sanepa Chowk	Pickup+ Pedestrian	1	0	13+560
6/13/76	Star Hospital	Scooter+ Motorcycle	1	0	13+710
6/15/76	Nayabato	Bus+Passenger	1	0	13+950
6/16/76	Nayabato	Motorcycle +Pedestrian	1	0	14+350
6/24/76	Dhobighat	Motorcycle	1	0	14+560
6/24/76	Nayabato	Taxi+Scooter	2	0	14+150
6/26/76	Balkhu Chowk	Taxi+Motorcycle	1	0	13+040
6/28/76	Balkhu Chowk	Container+Car	0	0	13+090
6/28/76	Sanepa Chowk	Scooter+Car	0	0	13+460
6/30/76	Sanepa Chowk	Motorcycle+Pedestrian	3	0	13+410
7/2/76	Balkhu Chowk	Bus+Bus	0	0	13+090
7/2/76	Sanepa Chowk	Motorcycle+Motorcycle	2	0	13+460
7/5/76	Balkhu Chowk	Car+Truck	0	0	13+040
7/7/76	Balkhu	Scooter+Truck	2	0	13+040

Date	Location	Vehicle involved	Injured	Death	Chainage
7/8/76	Sanepa Chowk	Motorcycle+ Truck	1	0	13+460
7/8/76	Sanepa Chowk	Pickup	0	0	13+460
7/9/76	Sanepa Chowk	Car+Traffic Police+Bus	1	0	13+460
7/11/76	Balkhu Chowk	Scooter+Car	1	0	13+090
7/13/76	Balkhu Chowk	Motorcycle+Car	2	0	13+040
7/13/76	Pa.Ni. Ka	Motorcycle+Mini Truck	1	0	12+840
7/14/76	Balkhu Chowk	Car+Tipper	1	0	13+090
7/14/76	Sanepa Chowk	Motorcycle+Car	2	0	13+460
7/16/76	Balkhu	Motorcycle+ Pedestrian	1	0	13+090
7/16/76	Balkhu Chowk	Taxi+Taxi	0	0	13+040
7/20/76	Balkhu	Bus+Truck	1	0	13+150
7/20/76	Balkhu Chowk	Taxi+Car+Car+ Crane	0	0	13+040
7/20/76	Dhobighat	Motorcycle+ Cycle	1	0	14+510
7/22/76	Balkhu Chowk	Bus+Taxi	0	0	13+040
7/23/76	Nayabato	Scooter	1	0	14+400
7/24/76	Balkhu Chowk	Car+Pickup	0	0	13+090
7/27/76	Balkhu	Motorcycle+Bus	1	0	12+740
7/27/76	Sanepa Chowk	Pickup+Pickup	0	0	13+460

Date	Location	Vehicle involved	Injured	Death	Chainage
7/28/76	Balkhu Chowk	Truck+Car	0	0	13+090
7/29/76	Balkhu Chowk	Truck+Car	0	0	13+090
7/29/76	Sanepa Chowk	Scooter+Scooter	0	0	13+560
7/29/76	Sanepa Chowk	Motorcycle+Jeep	1	0	13+660
7/30/76	Sanepa Chowk	Taxi+Pedestrian	1	0	13+510
7/30/76	Sanepa Chowk	Taxi+Van	0	0	13+460
8/1/76	Balkhu Chowk	Motorcycle+Tanker	1	0	13+040
8/1/76	Balkhu Chowk	Pickup+Scooter	1	0	13+140
8/1/76	Dhobighat	Motorcycle+ Motorcycle+ Scooter	3	0	14+560
8/4/76	Balkhu Chowk	Bus+Passenger	1	0	13+090
8/4/76	Dhobighat	Cycle+Scooter+ Taxi	1	0	14+560
8/6/76	Balkhu Chowk	Micro+Car	0	0	12+990
8/6/76	Sanepa Chowk	Scooter+Scooter	1	0	13+360
8/8/76	Balkhu Chowk	Motorcycle+Motorcycle	2	0	13+040
8/8/76	Nayabato	Bus+Motorcycle	1	0	13+900
8/8/76	Star Hospital	Motorcycle+ Motorcycle	3	0	13+710

Date	Location	Vehicle involved	Injured	Death	Chainage
8/10/76	Balkhu Chowk	Bus+Motorcycle	1	0	13+040
8/11/76	Balkhu Chowk	Car+Truck	0	0	13+040
8/11/76	Sanepa Height	Motorcycle	1	0	14+100
8/13/76	Balkhu Chowk	Motorcycle+Mini Tipper	0	0	13+040
8/14/76	Sanepa Chowk	Car+Mini Truck	0	0	13+410
8/16/76	Dhobighat	Motorcycle+ Pedestrian	1	0	14+560
8/16/76	Nayabato	Motorcycle+ Tanker	0	0	13+900
8/16/76	Star Hospital	Scooter+Pickup	1	0	13+760
8/17/76	Balkhu Chowk	Bus+Car	0	0	13+040
8/17/76	Star Hospital	Car+Truck	0	0	13+710
8/18/76	Sanepa Chowk	2 Motorcycle+ Scooter	2	0	13+460
8/19/76	Balkhu Chowk	Bus+Van	0	0	13+090
8/20/76	Balkhu Chowk	Truck+ Motorcycle	0	0	13+090
8/20/76	Dhobighat	Motorcycle+ Pedestrian	2	0	14+510
8/21/76	Balkhu Chowk	Taxi+Pickup	0	0	13+090
8/22/76	Balkhu Chowk	Truck+Car	0	0	13+040

Date	Location	Vehicle involved	Injured	Death	Chainage
8/23/76	Balkhu Chowk	Truck+Car	0	0	13+040
8/23/76	Nayabato	Tractor	3	0	14+400
8/23/76	Sanepa Chowk	Motorcycle+ Motorcycle	1	0	13+460
8/23/76	Sanepa Chowk	Motorcycle+Car	1	0	13+460
8/24/76	Balkhu Chowk	Scooter+ Pedestrian	1	0	12+990
8/25/76	Balkhu bridge	Bus+Bus	1	0	13+090
8/25/76	Balkhu Chowk	Car+Truck	0	0	13+040
8/25/76	Dhobighat	Motorcycle+ Pedestrian	1	0	14+460
8/26/76	Balkhu	Truck+Car	0	0	13+200
8/26/76	Balkhu Chowk	Motorcycle	1	0	13+040
8/27/76	Balkhu Chowk	Bus+Scooter	1	0	13+040
8/27/76	Sanepa Chowk	Mini Truck +Bus	0	0	13+460
8/30/76	Balkhu Chowk	Bus+Bus	0	0	13+140
8/30/76	Nayabato	Bus+Motorcycle	0	0	14+150
9/1/76	Balkhu Chowk	Motorcycle+Taxi	1	0	13+090
9/2/76	Dhobighat	Scooter	0	0	14+510
9/2/76	Sanepa Chowk	Motorcycle+ Pedestrian	1	0	13+510
9/4/76	Balkhu	Motorcycle	0	0	13+090

Date	Location	Vehicle involved	Injured	Death	Chainage
	Chowk				
9/6/76	Balkhu Chowk	Taxi +Car	0	0	13+090
9/6/76	Pa.Ni. Ka	Tipper+Bus	0	0	12+840
9/8/76	Balkhu Chowk	Taxi+Bus	0	0	13+040
9/8/76	Sanepa Chowk	Motorcycle+ Motorcycle	0	0	13+560
9/9/76	Pa.Ni. Ka	Car+Pedestrian	1	0	12+840
9/10/76	Balkhu	Motorcycle+Van	1	0	12+740
9/10/76	Balkhu Chowk	Motorcycle+ Truck	1	0	13+040
9/10/76	Pa.Ni. Ka	Van+Van	0	0	12+840
9/10/76	Sanepa Chowk	Motorcycle+ Scooter	2	0	13+510
9/10/76	Sanepa Height	Scooter+ Tatamobile	0	0	14+100
9/13/76	Sanepa Chowk	Motorcycle	1	0	13+510
9/14/76	Balkhu	Truck+Car	0	0	12+940
9/15/76	Balkhu Chowk	Truck+Car	0	0	13+090
9/15/76	Star Hospital	Scooter+ Motorcycle	0	0	13+760
9/16/76	Sanepa Bridge	Scooter+4 wheeler	1	0	13+325
9/16/76	Sanepa Chowk	Motorcycle	2	0	13+410
9/17/76	Balkhu Chowk	Car+Taxi	0	0	13+040
9/20/76	Sanepa	Car+Ambulance	0	0	13+325

Date	Location	Vehicle involved	Injured	Death	Chainage
	Bridge				
9/26/76	Balkhu	Motorcycle+ Scooter	1	0	13+040
9/27/76	Sanepa Bridge	Car+Pickup	0	0	13+275
9/29/76	Balkhu bridge	Motorcycle+Car	0	0	13+090
9/29/76	Sanepa Chowk	Motorcycle+Car	1	0	13+360
10/1/76	Balkhu Chowk	Motorcycle+Car	0	0	13+090

From Chainage 14+600 km to 16+600 km

Date	Location	Vehicle involved	Injured	Death	Chainage
6/2/76	Kusunti Height	Motorcycle+ Motorcycle	2	0	16+110
6/5/76	Satdobato	Motorcycle+Motorcycle	2	0	14+900
6/6/76	Ekantakuna	Car+Truck	1	0	15+630
6/8/76	Ekantakuna	Truck+Car	0	0	15+680
6/8/76	Nakkhu Dobato	Car+Bus	0	0	15+530
6/9/76	Ekantakuna	Motorcycle+ Pedestrian	1	0	15+630
6/12/76	Dhobighat	Motorcycle+ Pedestrian	1	0	14+610
6/17/76	Yatayat	Sumo+Pedestrian	1	0	15+920
6/20/76	Dhobighat	Motorcycle+Cow	1	0	14+610
7/16/76	Nakkhu Dobato	Truck+Pedestrian	0	1	15+580
7/18/76	Ekantakuna	Tanker+Car	0	0	15+630
7/18/76	Ekantakuna	Taxi+Cycle	1	0	15+680

Date	Location	Vehicle involved	Injured	Death	Chainage
7/22/76	Bagdol	Motorcycle+ Motorcycle+Mini Truck	0	0	14+900
7/23/76	Ekantakuna	Motorcycle+ Pedestrian	2	0	15+680
7/24/76	Bagdol	Scooter	2	0	14+960
7/24/76	Ekantakuna	Car+Truck	0	0	15+630
7/24/76	Nakkhu Dobato	Car+Motorcycle	1	0	15+580
7/25/76	Yatayat	Motorcycle+ Pedestrian	3	0	15+970
7/27/76	Ekantakuna	Motorcycle+ Pedestrian	2	0	15+580
7/28/76	Nakkhu Dobato	Car+Taxi	0	0	15+530
7/29/76	Nakkhu Dobato	Taxi+Car	0	0	15+480
8/1/76	Ekantakuna	Truck+Car	1	0	15+530
8/1/76	Ekantakuna	Motorcycle+ Pedestrian	1	0	15+730
8/3/76	Ekantakuna	Scooter+ Pedestrian	1	0	15+630
8/5/76	Bagdol	Car+Scooter	0	0	14+900
8/9/76	Bagdol	Tipper+Cow	1 (Cow)	0	14+960
8/16/76	Ekantakuna	Jeep+Motorcycle	1	0	15+680
8/17/76	Ekantakuna	Motorcycle	0	0	15+630
8/22/76	Yatayat	Car+ Bus	0	0	15+870
8/26/76	Kusunti Height	Scooter+ Pedestrian	1	0	16+160
8/27/76	Ekantakuna	Motorcycle+Car	1	0	15+630
9/5/76	Sanepa Height	Truck+ Car	0	0	14+950

Date	Location	Vehicle involved	Injured	Death	Chainage
9/7/76	Sanepa Height	Motorcycle+Pickup	2	0	14+950
9/9/76	Ekantakuna	Taxi+Motorcycle	1	0	15+680
9/11/76	Nakkhu Dobato	Car+Van	0	0	15+430
9/13/76	Ekantakuna	Motorcycle+ Scooter	0	0	15+580
9/13/76	Nakkhu Dobato	Motorcycle	1	0	15+580
9/15/76	Ekantakuna	Motorcycle	1	0	15+530
9/15/76	Ekantakuna	Truck+Scooter	1	0	15+530
9/15/76	Nakkhu Dobato	Car+Bus	0	0	15+530
9/20/76	Nakkhu Dobato	Truck+ Car	0	0	15+580
9/26/76	Sanepa-Dhobighat	Motorcycle+ Pedestrian	1	0	14+950
9/28/76	Sanepa-Dhobighat	Scooter+ Motorcycle	1	0	14+950
10/2/76	Ekantakuna	Truck + Car	0	0	15+580

From Chainage 16+600 km to 18+600 km

Date	Location	Vehicle involved	Injured	Death	Chainage
5/26/76	Talchhikhel	Motorcycle+ Pedestrian	1	0	17+180
6/1/76	Gwarko	Minitruck+Jeep	0	0	18+600
6/1/76	Satdobato Chowk	Pickup+Truck	0	0	17+640
6/2/76	B&B	Motorcycle+ Pedestrian	1	0	18+230
6/5/76	Satdobato	Tempo+Jeep	0	0	17+640

Date	Location	Vehicle involved	Injured	Death	Chainage
	Chowk				
6/5/76	Thasikhel	Motorcycle+ Motorcycle	2	0	16+900
6/7/76	Swimming pool Satdobato	Taxi+Motorcycle	1	0	18+140
6/8/76	B&B	Car+Truck	0	0	18+230
6/9/76	Chapagaun Dobato	Minitruck+Van	0	0	17+420
6/9/76	Swimming pool Satdobato	Motorcycle+Car	0	0	18+190
6/9/76	Talchhikhel	Motorcycle+ Pedestrian	1	0	17+180
6/10/76	Swimming pool Satdobato	Motorcycle+ Pedestrian	1	0	18+140
6/13/76	Swimming pool Satdobato	Car+Truck	0	0	18+190
6/14/76	Swimming pool Satdobato	Motorcycle+Bus+Car	1	0	18+140
6/15/76	Thasikhel	Motorcycle+ Scooter	2	0	16+950
6/16/76	Satdobato Chowk	Taxi+Pickup	0	0	17+690
6/17/76	Swimming pool Satdobato	Van	1	0	18+090
6/18/76	Swimming	Car+Pedestrian	1	0	18+140

Date	Location	Vehicle involved	Injured	Death	Chainage
	pool Satdobato				
6/20/76	Swimming pool Satdobato	Sumo+Pedestrian	0	1	18+140
6/22/76	Satdobato	Bus+Car	0	0	17+490
6/24/76	B&B	Minitruck+ Pedestrian	1	0	18+270
6/28/76	B&B	Car+Scooter	1	0	18+250
7/2/76	B&B	Bus+Tempo+Bus	1	0	18+230
7/3/76	Chapagaun Dobato	Jeep+Truck	0	0	17+320
7/3/76	Satdobato Chowk	Car+Container	0	0	17+590
7/3/76	Thasikhel	Taxi+Divider	0	0	16+950
7/4/76	Thasikhel	Car+Unknown	0	0	16+900
7/5/76	Mahalaxmis than	Car+Truck	0	0	18+875
7/6/76	Chapagaun Dobato	Micro+Bus	0	0	17+270
7/8/76	B&B	Truck+ Motorcycle	0	1	18+230
7/8/76	Chapagaun Dobato	Scooter+ Pedestrian	1	0	17+370
7/8/76	Swimming pool Satdobato	Taxi+Motorcycle	1	0	18+090
7/9/76	Thasikhel	Motorcycle+Motorc ycle	1	0	16+900
7/10/76	Satdobato Chowk	Scooter	2	0	17+690

Date	Location	Vehicle involved	Injured	Death	Chainage
7/11/76	B&B	Scooter+Scooter	2	0	18+270
7/14/76	Satdobato Chowk	Car+Pickup	1	0	17+740
7/16/76	Chapagaun Dobato	Motorcycle+ Scooter	1	0	17+370
7/16/76	Satdobato Chowk	Tipper+ Motorcycle	0	0	17+790
7/18/76	B&B	Motorcycle+ Motorcycle	3	0	18+200
7/18/76	Thasikhel	Car+Car	0	0	16+850
7/28/76	Gwarko	Car+Pickup	0	0	18+600
7/30/76	Gwarko	Motorcycle+Car	1	0	18+550
8/1/76	B&B	Motorcycle+ Pedestrian	1	0	18+300
8/1/76	Talchhikhel	Motorcycle+Bus+ Pedestrian	2	0	17+120
8/2/76	Anfa gate	Motorcycle+ Pedestrian	1	0	18+150
8/2/76	Satdobato Chowk	Taxi+Motorcycle	1	0	17+790
8/3/76	Gwarko	Bus+Car	0	0	18+600
8/3/76	Satdobato Chowk	Truck+Car	0	0	17+640
8/4/76	Satdobato Chowk	Bus+Bus+ Scooter	0	0	17+640
8/5/76	B & B	Bus+Passenger	1	0	18+230
8/6/76	B&B	Scooter+ Pedestrian	1	0	18+250
8/6/76	B&B	Truck+Car	0	0	18+250
8/8/76	Swimming pool Satdobato	Motorcycle+Jeep	2	0	18+040

Date	Location	Vehicle involved	Injured	Death	Chainage
8/9/76	B&B	Bus+Pickup	0	0	18+230
8/9/76	Talchhikhel	Tempo+Car	0	0	18+120
8/13/76	Chapagaun	Car+Truck	0	0	17+400
8/13/76	Chapagaun Dobato	Car+Truck	0	0	17+420
8/13/76	Satdobato Chowk	Bus+Car+ Motorcycle	0	0	17+640
8/14/76	Satdobato Chowk	Motorcycle+ Pedestrian	1	0	17+640
8/17/76	Chapagaun Dobato	Car+Tipper	0	0	17+370
8/17/76	Satdobato	Car+Bus	0	0	17+540
8/17/76	Talchhikhel	Pedestrian+Car	0	1	17+180
8/18/76	Satdobato Chowk	Truck+Car	0	0	17+640
8/19/76	B and B Oralo	Motorcycle+ Scooter	0	0	18+250
8/19/76	Thasikhel	Pickup + Motorcycle	0	0	16+700
8/20/76	Gwarko	Car+Pickcup	0	0	18+650
8/20/76	Satdobato Chowk	Tanker+Car	0	0	17+640
8/22/76	Chapagaun Dobato	Car+Mini Truck	0	0	17+370
8/23/76	Swimming pool Satdobato	Motorcycle+ Scooter	0	0	18+190
8/28/76	B and B	Motorcycle+Car	0	0	18+200
8/28/76	Chapagaun Dobato	Car+Bus	0	0	17+400
8/28/76	Chapagaun Dobato	Motorcycle+ Pedestrian	0	1	17+370

Date	Location	Vehicle involved	Injured	Death	Chainage
8/29/76	Talchhikhel	Scooter+Pickup	1	0	17+180
9/2/76	Anfa gate	Bus+Truck	0	0	18+100
9/4/76	Thasikhel	Van+Taxi+Truck	0	0	16+850
9/5/76	Anfa gate	Motorcycle+ Motorcycle	0	0	18+150
9/9/76	Satdobato Chowk	Truck+Micro	0	0	17+690
9/9/76	Satdobato-Thasikhel	Motorcycle+ Scooter	3	0	17+140
9/10/76	Anfa gate	Car+Pedestrian	1	0	18+200
9/11/76	Thasikhel	Motorcycle	0	0	16+700
9/13/76	Satdobato Chowk	Truck+Car	0	0	17+590
9/15/76	Chapagaun	Tanker+Car			17+420
9/24/76	Anfa gate	Pickup+Tanker	0	0	18+150
9/24/76	Satdobato-Mahalaxmisthan	Taxi+Car+ Container	0	0	17+640
9/26/76	Satdobato Chowk	Truck+ Car	0	0	17+640
9/27/76	Chapagaun	Pickup+Mini tipper	0	0	17+370
10/1/76	Satdobato Chowk	Car+Car	0	0	17+640
10/2/76	Satdobato Chowk	Scooter+ Pedestrian	4	0	17+540
10/2/76	Satdobato Chowk	Motorcycle+Car	0	0	17+640
10/3/76	Swimming pool Satdobato	Motorcycle	2	0	18+190

Date	Location	Vehicle involved	Injured	Death	Chainage
10/4/76	Satdobato	Scooter+ Pedestrian	1	0	17+490

From Ch.18+600 km to Ch.20+994 km

Date	Location	Vehicle involved	Injured	Death	Chainage
5/26/76	Balkumari	Motorcycle+ Scooter	2	0	19+800
5/26/76	Gwarko Chowk	Container+Car	0	0	18+950
5/26/76	Koteshwor Chowk	Micro+Haice	1	0	20+980
5/28/76	Gwarko	Scooter	2	0	18+700
5/30/76	Balkumari	Minitruck+ Pedestrian	1	0	19+800
6/1/76	Gwarko (Gun cinema)	Motorcycle+ Pedestrian	1	0	19+100
6/3/76	Koteshwor Overhead Bridge	Car+Truck	0	0	20+980
6/4/76	Gwarko	Scooter+Car	0	0	18+650
6/4/76	Mahalaxmist han	Motorcycle+ Scooter	1	0	18+825
6/6/76	Balkumari	2 Pickup+Car	2	0	19+750
6/6/76	Balkumari	Car+Motorcycle	0	0	19+700
6/8/76	Balkumari	Tempo+Car	0	0	19+800
6/8/76	Balkumari	Scooter+Pickup	1	0	19+750
6/8/76	Thasikhel	Motorcycle+ Motorcycle	1	0	19+900
6/9/76	Balkumari	Motorcycle+ Cycle	1	0	19+800

Date	Location	Vehicle involved	Injured	Death	Chainage
6/10/76	Balkumari	Mini Truck+Wall	0	0	19+700
6/13/76	Koteshwor Bhatbhateni	Car+Scooter	1	0	20+380
6/13/76	Koteshwor Chowk	Car+Jeep	0	0	20+980
6/14/76	Gwarko Chowk	Motorcycel+Pickup	1	0	19+150
6/15/76	Koteshwor Chowk	Micro+Car	0	0	20+980
6/16/76	Gwarko	Truck+Scooter	0	0	18+750
6/17/76	Gwarko (Gud cinema)	Motorcycle+ Pedestrian	1	0	19+200
6/17/76	Koteshwor Chowk	Bus+Car+ Motorcycle	0	0	20+980
6/17/76	Koteshwor Overhead Bridge	Bus+Taxi+Truck	0	0	20+780
6/18/76	Balkumari	Motorcycle+ Scooter	1	0	19+650
6/20/76	Koteshwor Chowk	Car+Scooter	1	0	20+980
6/22/76	Koteshwor Chowk	Bus+Car	0	0	20+980
6/22/76	Koteshwor Chowk	Motorcycle +Pedestrian	1	0	20+980
6/26/76	Koteshwor Overhead Bridge	Truck+Taxi	0	0	20+780
7/1/76	Balkumari	Bus+Bus	0	0	19+600
7/2/76	Balkumari	Motorcycle+	1	0	19+900

Date	Location	Vehicle involved	Injured	Death	Chainage
	Bridge	Truck			
7/2/76	Koteshwor Overhead Bridge	Motorcycle+ Pedestrian	1	0	20+780
7/2/76	Koteshwor Overhead Bridge	Scooter+ Pedestrian	1	0	20+730
7/3/76	Gwarko	Motorcycle+ Tipper	1	0	18+750
7/4/76	Koteshwor Chowk	Bus+Truck+Car	0	0	20+980
7/5/76	Balkumari	Truck+Scooter+Pedestrian	2	1	19+700
7/5/76	Koteshwor Chowk	Motorcycle+ Pedestrian	1	0	20+930
7/7/76	Koteshwor Chowk	Motorcycle+ Scooter	0	0	20+930
7/7/76	Koteshwor Overhead Bridge	Car+Tipper	0	0	20+830
7/9/76	Balkumari	Van+Van	0	0	19+800
7/9/76	Balkumari Bridge	Motorcycle+ Pedestrian	1	0	19+850
7/9/76	Koteshwor Chowk	Truck+Pickup	0	0	20+980
7/9/2076	Koteshwor Chowk	Car+Motorcycle	0	0	20+930
7/10/76	Balkumari	Scooter+ Motorcycle	2	0	19+800
7/10/76	Balkumari	Bus+Motorcycle	2	0	19+750

Date	Location	Vehicle involved	Injured	Death	Chainage
7/10/76	Koteshwor Chowk	Taxi+Bus	0	0	20+980
7/11/76	Balkumari	Taxi+Motorcycle	0	0	19+830
7/13/76	Balkumari	Motorcycle+ Cycle	2	0	19+700
7/14/76	Koteshwor Chowk	Car+Truck	0	0	20+930
7/16/76	Balkumari	Taxi+Scooter	1	0	19+800
7/18/76	Balkumari	Motorcycle+Car	0	0	19+800
7/18/76	Koteshwor Chowk	Micro+ Motorcycle	1	0	20+980
7/20/76	Koteshwor Chowk	Tipper+Tipper+ Tipper+Car	0	0	20+930
7/20/76	Koteshwor Overhead Bridge	Car+Car	0	0	20+780
7/20/76	Koteshwor Overhead Bridge	Motorcycle+Bus	2	0	20+780
7/24/76	Balkumari	Motorcycle+2 Pedestrian	2	0	19+800
7/24/76	Gwarko	Jeep+Motorcycle	1	0	18+700
7/24/76	Koteshwor Chowk	Car+Micro	0	0	20+930
7/25/76	Balkumari Bridge	Motorcycle+ Pedestrian	1	0	19+900
7/25/76	Balkumari Bridge	Bus+Pedestrian	1	0	19+900
7/25/76	Koteshwor Chowk	Truck+Car	0	0	20+980
7/25/76	Koteshwor	Taxi+Car	0	0	20+930

Date	Location	Vehicle involved	Injured	Death	Chainage
	Chowk				
7/26/76	Gwarko Chowk	Van+Tipper	0	0	18+700
7/26/76	Koteshwor Chowk	Car+Bus	0	0	20+930
7/28/76	Balkumari	Truck+Car	0	0	19+750
7/28/76	Gwarko	Car+Van	0	0	18+800
7/28/76	Koteshwor Chowk	Car+Bus	0	0	20+980
7/29/76	Balkumari	Bus+Passenger	1	0	19+700
7/29/76	Koteshwor Chowk	Gas Tanker+Tipper	0	0	20+930
8/2/76	Balkumari	Bus+Motorcycle	0	0	19+750
8/3/76	Koteshwor Overhead Bridge	Motorcycle+ Pedestrian+Mini Truck	1	0	20+780
8/4/76	Koteshwor Chowk	Tempo+Car	0	0	20+930
8/5/76	Koteshwor Chowk	Bus+Car	0	0	20+980
8/5/76	Koteshwor Chowk	Motorcycle+Car	1	0	20+930
8/6/76	Gwarko	Bus+Taxi+school bus+Pedestrian	4	0	18+700
8/6/76	Gwarko	Motorcycle+Van	0	0	18+750
8/6/76	Koteshwor Chowk	Taxi+Tanker	0	0	20+980
8/7/76	Gwarko (Gud cinema)	Car+Pedestrian	0	1	19+200
8/7/76	Koteshwor Chowk	Truck+Taxi	0	0	20+980

Date	Location	Vehicle involved	Injured	Death	Chainage
8/7/76	Koteshwor Chowk	Motorcycle+ Traffic police	1	0	20+980
8/7/76	Koteshwor Chowk	Truck+Car	0	0	20+980
8/8/76	Koteshwor Chowk	Car+Car	0	0	20+880
8/8/76	Koteshwor Chowk	Car+Car	0	0	20+980
8/9/76	Koteshwor Chowk	Car+Car	0	0	20+930
8/11/76	Balkumari	Motorcycle+Pickup+Pedestrian	2	0	19+750
8/11/76	Mahalaxmisthan	Truck+Car	0	0	18+825
8/13/76	Koteshwor Chowk	Bus+Car	0	0	20+930
8/14/76	Koteshwor Chowk	Sumo+ Motorcycle	2	0	20+930
8/15/76	Koteshwor Chowk	Car+Tipper	0	0	20+930
8/16/76	Balkumari	Motorcycle+ Pedestrian+Micro	1	0	19+750
8/17/76	Balkumari	Pickup +Motorcycle	0	0	19+800
8/17/76	Mahalaxmisthan	Car+Truck	0	0	18+825
8/18/76	Balkumari	Bus+Car	0	0	19+800
8/19/76	Balkumari	Motorcycle+ Cycle	0	0	19+750
8/19/76	Gwarko	Pedestrian+ Motorcycle	0	0	18+700

Date	Location	Vehicle involved	Injured	Death	Chainage
8/19/76	Gwarko	Van+Truck	0	0	18+700
8/20/76	Balkumari	Motorcycle+ Scooter	1	0	19+750
8/21/76	Balkumari	Car+Bus	0	0	19+800
8/21/76	Koteshwor Chowk	Bus+Passenger	0	0	20+930
8/21/76	Koteshwor Chowk	Car+Tipper	0	0	20+930
8/22/76	Koteshwor Chowk	Bus+Car	0	0	20+980*
8/23/76	Koteshwor Chowk	Truck+Car	0	0	20+930
8/23/76	Mahalaxmist han	Scooty+ Pedestrian	1	0	18+875
8/25/76	Balkumari	Bus+Car	0	0	19+750
8/25/76	Balkumari	Motorcycle+Pedes trian	1	0	19+800
8/26/76	Balkumari	Taxi+Motorcycle	0	0	19+700
8/26/76	Gwarko	Jeep+Motorcycle	0	0	18+700
8/26/76	Gwarko	Motorcycle	1	0	18+700
8/26/76	Koteshwor Bhatbhateni	Car+Pedestrian	1	0	20+330
8/26/76	Koteshwor Chowk	Bus+Car	0	0	20+930
8/27/76	Balkumari	Mini Truck+Pedestrian	1	0	19+650
8/27/76	Koteshwor Chowk	Car+Jeep	0	0	20+980
8/28/76	Balkumari	Bus+Motorcycle	2	0	19+800
8/30/76	Gwarko	Truck+Jeep	0	0	18+650
8/30/76	Koteshwor	Motorcycle+Bus	0	0	20+930

Date	Location	Vehicle involved	Injured	Death	Chainage
	Chowk				
9/1/76	Balkumari	Motorcycle+ Motorcycle	1	0	19+750
9/1/76	Balkumari	Motorcycle+ Pedestrian	2	0	19+800
9/1/76	Koteshwor Chowk	Bus+Car	0	0	20+930
9/3/76	Balkumari	Car+Motorcycle	1	0	19+800
9/3/76	Balkumari	Taxi+Pedestrian	1	0	19+800
9/4/76	Koteshwor	Motorcycle+ Scooter	2	0	20+880
9/4/76	Koteshwor Chowk	Jeep+Car	0	0	20+930
9/4/76	Koteshwor Chowk	Bus+Car	0	0	20+930
9/4/76	Koteshwor Chowk	Car+Taxi	0	0	20+930
9/5/76	Balkumari	Motorcycle+ Scooter	1	0	19+750
9/5/76	Gwarko Chowk	Motorcycle+ Scooter	2	0	18+700
9/6/76	Balkumari	Scooter+ Pedestrian	2	0	19+700
9/6/76	Koteshwor	Car+Bus	0	0	20+830
9/7/76	Koteshwor Chowk	Tippper+Scooter	0	0	20+930
9/7/76	Koteshwor Overhead Bridge	Tipper+Tipper	0	0	20+780
9/8/76	Koteshwor Chowk	Car+Container	0	0	20+980

Date	Location	Vehicle involved	Injured	Death	Chainage
9/8/76	Koteshwor Overhead Bridge	Truck+ Motorcycle	2	0	20+780
9/9/76	Gwarko	Truck+	1	0	18+750
9/9/76	Koteshwor Chowk	Bus+Car	0	0	20+980
9/10/76	Koteshwor Bhatbhateni	Scooter+Scooter	0	0	20+380
9/11/76	Gwarko (Gud cinema)	Jeep+Bus	0	0	19+200
9/11/76	Gwarko (Gud cinema)	Motorcycle+ Cycle	1	0	19+200
9/11/76	Koteshwor Chowk	Bus+Car	0	0	20+980
9/12/76	Balkumari	Bus+Car	0	0	19+700
9/12/76	Koteshwor Overhead Bridge	Motorcycle+ Micro	0	0	20+780
9/13/76	Balkumari	Motorcycle+ Pedestrian	2	0	19+600
9/15/76	Koteshwor Bhatbhateni	Motorcycle+ Pedestrian	1	0	20+430
9/16/76	Balkumari	Bus+Car	0	0	19+800
9/16/76	Koteshwor Overhead Bridge	Motorcycle+ Motorcycle+ Pedestrian	1	0	20+730
9/16/76	Koteshwor-Balkumari	Motorcycle+ Motorcycle	1	0	20+550
9/20/76	Koteshwor	Scooter+Pedestrian	1	0	20+880
9/22/76	Balkumari	Motorcycle+	1	0	19+800

Date	Location	Vehicle involved	Injured	Death	Chainage
		Scooter			
9/23/76	Gwarko-Balkumari	Car	0	0	18+750
9/24/76	Balkumari	Motorcycle+Pedestrian	0	0	19+800
9/26/76	Koteshwor	Motorcycle+ Pedestrian	1	0	20+830
9/27/76	Koteshwor Overhead Bridge	Bus	1	0	20+730
10/2/76	Balkumari	Motorcycle+ Scooter	2	0	19+700
10/2/76	Balkumari Bridge	Bus+Taxi	0	0	19+900
10/2/76	Koteshwor Bhatbhateni	Motorcycle+ Motorcycle	1	0	20+430
10/4/76	Balkumari	Car+Motorcycle	1	0	19+800