

**HILL ROAD SAFETY AUDIT: JUIT WAKNAGHAT TO KANDAGHAT ON  
NATIONAL HIGHWAY- 22**

Submitted in partial fulfillment of the Degree of  
Bachelor of Technology

by

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## CERTIFICATE

This is to certify that the work entitled “**Hill Road Safety Audit: JUIT Wagnaghat to Kandaghat on National Highway- 22**” submitted by “**NITESH JISTU (101646)**” in fulfillment for the award of Bachelor degree in civil engineering of Jaypee University of Information Technology, Wagnaghat has been carried out under my supervision. This work has not been submitted partially or wholly to any other University or Institute for the award of this or any other degree or diploma.

Name of Supervisor DR ASHOK KUMAR GUPTA

Signature of Supervisor

MR. NERAJ PARIHAR

Date

## **DECLARATION**

I hereby declare that the work presented in this thesis has been carried out by me under the supervision of Mr. Niraj Singh Parihar, Department of Civil Engineering, Jaypee University of Information Technology, Waknaghat, solan-173215, Himachal Pradesh,, and has not been submitted for this or any degree or diploma to any other university or institute. All assistance and help received during the course of the investigation has been duly acknowledged.

**NITESH JISTU (101646)**

## **ACKNOWLEDGEMENT**

I express my heartfelt gratitude to all those who have contributed directly or indirectly towards obtaining my bachelor degree and at the same time I cherish the years spent in the department of civil engineering. I am highly indebted to my esteemed supervisor **DR ASHOK KUMAR GUPTA** and **Mr NIRAJ PARIHAR**, who has guided me through thick and thin. This project would not have been possible without his guidance and active support.

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**NITESH JISTU (101646)**

## **SUMMARY**

This report is addressed to local roads authorities who are often confronted with road safety problems and the dilemma of not knowing exactly what the effect of applying certain measure.

In this report the author travelled through the stretch and concluded necessary sign boards are missing which could enhance safety. The author suggested many sign boards which should be put up that could probably reduce accidents.

Survey was done using camera. The survey team stopped at each and every curve analyze the accident possibility and suggested various sign boards which are shown in upcoming slides.

Sign boards are suggested to reduce road accidents. The corresponding safety measures are given. The estimated price of this whole project has been mentioned.

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# CHAPTER 1

## INTRODUCTION

Giving a step forward towards human safety is one of the major social movements of the new millennium. In our society we have learned to accept causalities. Causality keeps on increasing in small increments every year. These incidents lead to enormous emotional and economic consequences, imposing high economic and social costs to the society. These costs take shape in the form of damage to physical assets, earning capacity, expenditure and most important the loss of our beings.

Increasing incidences of road accidents leading to human injuries have given a sharp rise due to increase in vehicular traffic. Driving on hilly roads is more accident prone due to inadequate sight distances, sharp curves, steep gradients and poor weather conditions which lead to lack of visibility. Further, difficult terrain conditions pose constraints in ensuring adherence to design and construction norms, as also safer operations. Environmental factors like torrential rain, landslides and lack of concentration affects safety of hill road significantly. To avoid these we need to add vigilant application of safety principles during the planning, construction, operation and maintenance stages.

### ROAD SAFETY AUDIT

A Road Safety Audit (RSA) is a formal procedure for assessing safety performance examination of an existing or future road or intersection by an independent audit team.

Road safety audits can be used in any phase of project development from planning and preliminary engineering, design and construction. RSAs can also be used on any sized project from minor rural roads to inter-state National Highways. RSAs can be viewed as a proactive low-cost approach to improve safety. Safety Audits and counter measures should be considered as a necessary cost within the project and not as an additional expense



## **1.1 Objective**

To do the hill road safety audit for a given road stretch and to suggest safety measures, in the form of signs and markings, to enhance road user safety. Objective of the RSA is to assess projects for potential accident elimination / reduction on the basis of road user knowledge, attributes and skills, day/night, wet/dry road conditions.

Since our roads are designed and constructed by striking a socio-economic balance between safety, accessibility, environment, economy and locally available material and skill, RSA may determine the shortfall in safety, but may not be able to correct the deficiencies in pavement design, drainage, and appropriate space standard etc.

Any possible changes in the geometric design features of the road (say, vertical curves) to enhance safety and comfort of road user is not covered in this study.

## **1.2 Organization of the report**

This report is organized into four chapters. The first chapter introduces about the problems in the usability of a road due to different terrain and visibility conditions, especially on hill roads.

Chapter 2 gives a brief study of literature review of accidents. It gives us a broad picture of the causes of accidents, and different type of measures that can be taken to avoid it. This chapter includes information about the various sign boards, their planning and related construction problems and their possible remedies.

Chapter 3 shows the problems and their remedies conducted by the author of the given stretch and accidental data provided by the authorities. It includes the analysis of stretch with required safety measures to reduce accidents.

Towards the end, Chapter 4 gives the cost estimation of the suggested safety measures, in the form of signs, reflectors, and markings, that need to be provided for the given stretch of the road to enhance road user safety.

### **1.3 Why Driving On Hills Is Difficult**

Driving in hills is a very complex, difficult and tiring task. Accidents occur where rhythm of motion changes unexpectedly for driver. Environmental factors like torrential rain and consequent slides affect safety of hill road significantly. Low visibility and icing areas also make driving difficult on hills.

. Driving on hilly roads is more accident prone due to inadequate sight distances, sharp curves, steep gradients and poor weather conditions which lead to lack of visibility. Further, difficult terrain conditions pose constraints in ensuring adherence to design and construction norms, as also safer operations. Environmental factors like torrential rain, landslides and lack of concentration affects safety of hill road significantly. To avoid these we need to add vigilant application of safety principles during the planning, construction, operation and maintenance stages.

### **1.4 Causes of accidents**

Travelling over sharp curves of sub-normal radius in conditions of inadequate sight distance needs frequent deceleration and acceleration. Curves have to be negotiated in varying speeds due to varying degrees of curvature and applying brake when entering a curve and accelerating at the exit. Alternating entry from major valley into a side-valley, crossing of streams by narrow bridges, causeways etc. Steep grades and alternating up and down grades and negotiation of high altitudes. The analysis of an accident situation is governed by PIEV theory. In PIEV theory, 'P' stands for perception, i.e., the ability to see, hear, or become aware of something through the senses. 'I' stand for intellection, i.e., the action or process of understanding, as opposed to imagination, 'E' stands for emotion i.e., a natural instinctive state of mind deriving from one's circumstances, mood, or relationships with others, 'V' stands for volition i.e., the faculty or power of using one's will.

## **1.5 Measures for the safety of hill road**

Following are some safety measures which are a necessity to be kept in mind.

### **1.5.1 Engineering measures**

Incorporating appropriate safety design standards and features in the rural roads can enhance road safety to a great extent. In view of the lower levels of education in the rural areas, the engineering of roads to constrain users to follow safe driving and behavioral standards may be necessary to Supplement Cautionary Signboard. Some of the engineering measures that should be in-built into the design of rural roads are enumerated below. These issues should also be considered at the time of the transect walk so that the local community alerts the engineers at design stage itself to local traffic and pedestrian movement patterns that may have road safety implications.

Geometric design measures which ensures adequate width, curve radii, easy grades and sight distance. Provision of good drainage system, protection like parapets, railings, snow fences, snow shelters. Traffic control devices like signs, signals, pavement markings, delineators, advance public warning system. Maintenance response and safety monitoring.

Following precautions must be taken

- Rural roads have to necessarily have a tortuous path, keeping in view the narrow band width available. All the same, the horizontal curves should be designed scientifically, conforming to the selected design speed and terrain. The horizontal curves must be provided with smooth transition curves and super-elevation. The pavements should be widened at curves.[1]
- The vertical profile of the road should be designed such that the required minimum stopping sight distance is available. Suitable summit and valley curves should be provided.
- In hill roads, blind curves are a safety hazard. Suitable vision beams may be cut at such locations.
- Passing places must be provided at convenient locations particularly on hill roads.
- The provision of rural connectivity leads to the introduction of bus services. Properly designed bus-bays must be provided at bus stop to ensure that the buses do not hamper the normal traffic.
- Where the roads pass through habitations and school, it is necessary that the motorized vehicles

travel at low speeds. This can be ensured by providing adequately designed road humps or rumble strips.

- The junction of rural roads with a main road is always a point of conflict and an accident-prone zone. Such junctions must be designed scientifically by providing minimum turning radii, flaring of the side road with taper, acceleration/deceleration lanes and adequate sight distances.
- Ramps must be provided where field paths and cattle crossings intersect the road.
- Traffic signage's, incorporating warning and regulatory signs, can enhance road safety, especially near habitations and school zones, sharp curves, narrow bridges, junctions, submersible bridges and causeways. The design must incorporate these.
- Hazard markers like reflectorised delineators must be provided at dangerous locations.
- Submersible bridges and causeways should be provided with water depth gauges and guide-posts that shall remain at all times above the highest water level.
- 300mm dia ducts should be provided in the embankment to enable cultivators to thread agricultural wise pipes for irrigating their fields lying on both sides of the road.

### **1.5.2 Enforcement measures**

#### (a) Condition of the Vehicle

The vehicle must be in a mechanically fit condition to operate on hill road.

#### (b) Condition of driver

The driver should be physically and mentally capable and alert to operate in the hills. Drunken driving should be checked (P.I.E.V. Theory).

#### (c) Overloading

Overloading of vehicles (load carriers and passengers) has to be strictly prohibited. Firstly overloaded vehicles don't have balance and tend to easily slip and loose control. Secondly there are so many passengers on board that driver panics during an emergency situation and takes wrong decision.

### **1.5.3 Education measures**

Consciousness among the users about the road condition and appropriate awareness system like pamphlets, mass media publicity. Slogan boards should be erected by traffic control and enforcing authorities.

## **1.6 IS code recommendation**

There are three types of sign board which are used in road safety. These sign boards are a necessity for an individual to know who drives vehicle on road, in order to reduce accidental ratios.

### **1.6.1 Mandatory Signs**

Mandatory signs are road signs which are used to set the obligations of all traffic which use a specific area of road. Most mandatory road signs are circular, may use white symbols on a blue background with white border or black symbols on a white background with a red border, although the latter is also associated with prohibitory signs.

Size: 60 cm diameter circle As per IRC - 67 - 2001 (CODE OF PRACTICE FOR ROAD SIGNS.)

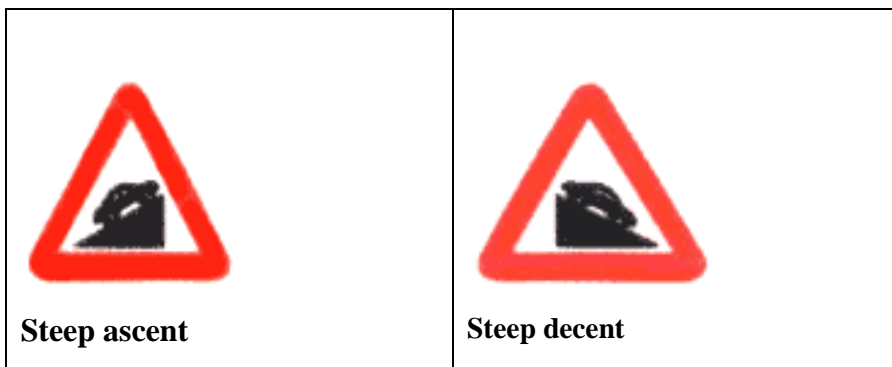


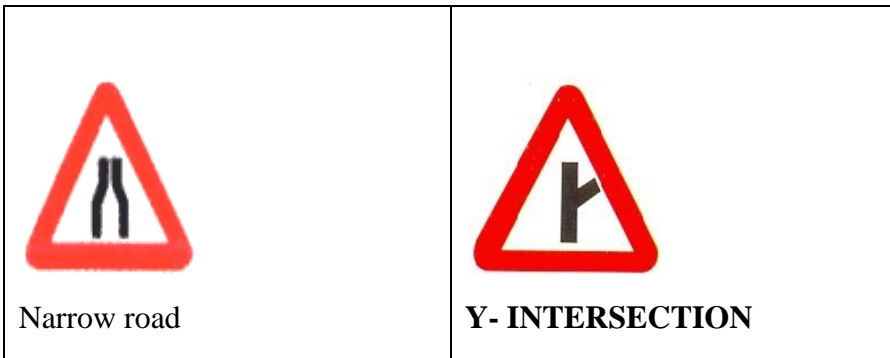
**Fig. 1.1 Mandatory sign boards**

### 1.6.2 Cautionary Signs

Cautionary Signs are meant for cautioning the driver about the hazards lying ahead on the road. The driver should obey these for safety.

Size: 90 x 90 x 90 cm equilateral Triangle As per IRC - 67 - 2001 (CODE OF PRACTICE FOR ROAD SIGNS.)





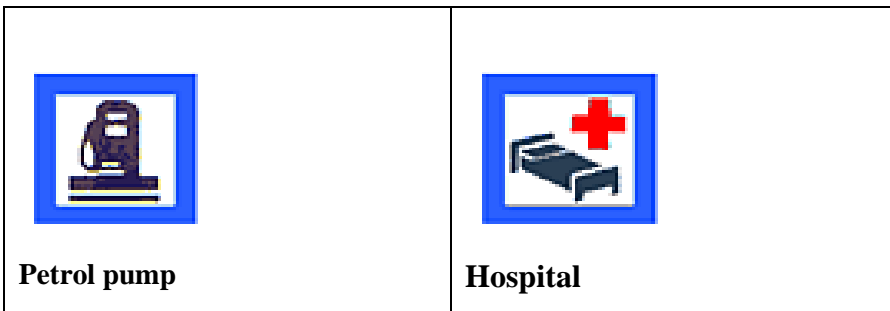
**Fig.1.2 Cautionary sign boards**

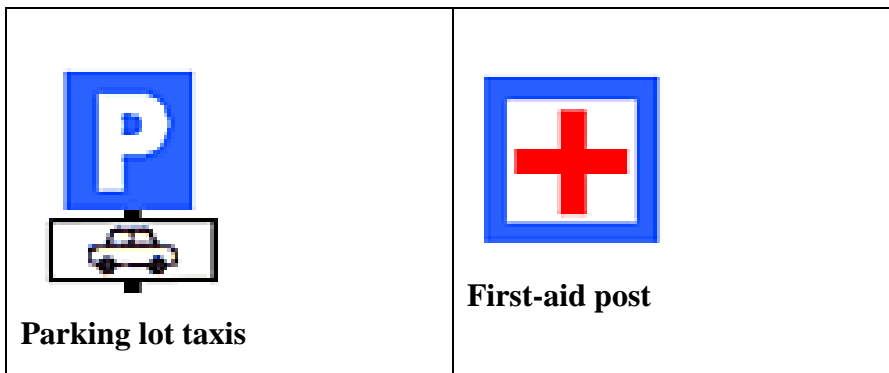
### 1.6.3 Informatory Signs

Informatory Signs are erected on the road to provide information on direction, destination, roadside facilities, etc. to the road user.

Size: 80 x 60 cm As per IRC - 67 – 1977 (Other informatory signs).

Size: (60 x 60) + 60 x 20 cm As per IRC - 67 – 1997 (For all parking vehicles).





**Fig.1.3 Informatory sign boards**

## **1.7 Planning and construction related problems**

Geologically unstable and fissured areas prone to landslides and erosion should be avoided while planning for new road projects on hills. Proper safety features and adequate planning leads to safety of road accidents. Parapet/guide walls, safety barriers, drainage arrangements, appropriate signage, road markings, advance geological studies in order to avoid incidences due to landslides on road and adequate protection works such as breast walls, retaining walls and toe walls have to be erected prior to starting the construction work. Wire crated check walls along the valley side should be provided with the formation cutting for retaining the excavated material so as to check the damage to the habitations in the valley. Sufficient warning signs and arrangements should be provided in order to avoid accidents and loss of precious lives due to blasting operations (adequate with controlled techniques).

The recurring phenomenon of landslides leads to problems like damage to hill roads and loss of precious lives. The major cause for these landslides is deforestation for urbanization and plantation. Due to this rainwater directly penetrates into the soil and causes landslides. Timely proper measures should be undertaken to either prevent or reduce occurrence of landslides.



## 1.8 Driving related problems and possible remedies

Drainage system should take care of cross drainage, road surface drainage, sub-surface drainage and also erosion control in order to avoid landslides and damages to road. In hilly roads drain should be wide enough to allow the flow of big discharges but not deep enough which can lead to vehicles straying in them. The cracks and cavities developing along the hill slope particularly before and during rainy season need careful inspection and sealing well in time.

Parapets, guide walls should be properly washed and white washed on both ends on hill side at regular intervals which avoid accidents due to steep grades, sharp or blind curves and steep dangerous valleys. The standard signs and appropriate distance should be maintained in order to provide sufficient time to driver to understand and respond timely. Use of luminous paints/strips may be used to resist fog problem.

Following are some specific problems and their remedies while travelling on the hill road which should be kept in mind.

**Table 1: Potential accident prone areas and suggested remedial measures.**

Potential accident prone area	Remedies
<ul style="list-style-type: none"><li>• Blind curve<ul style="list-style-type: none"><li>➤ Short</li><li>➤ Long</li></ul></li></ul>	<ul style="list-style-type: none"><li>• Convex reflector</li><li>• Reflector paint</li><li>• Sign board<ul style="list-style-type: none"><li>➤ Drive slow</li><li>➤ Blow horn</li></ul></li></ul>
<ul style="list-style-type: none"><li>• Vertical curve<ul style="list-style-type: none"><li>➤ Not so steep</li><li>➤ Steep</li></ul></li></ul>	<ul style="list-style-type: none"><li>• Sign board<ul style="list-style-type: none"><li>➤ Go slow</li><li>➤ Speed limit (for descent)</li><li>➤ Change the gear (for ascent)</li></ul></li></ul>

<ul style="list-style-type: none"> <li>• U curve</li> </ul>	<ul style="list-style-type: none"> <li>• Convex reflector</li> <li>• Sign board <ul style="list-style-type: none"> <li>➤ Blow horn</li> <li>➤ Speed limit (descent curve)</li> <li>➤ Change the gear(ascent curve)</li> </ul> </li> </ul>
<ul style="list-style-type: none"> <li>• 2-Way road</li> </ul>	<ul style="list-style-type: none"> <li>• Sign board <ul style="list-style-type: none"> <li>➤ Go slow (in both directions)</li> </ul> </li> <li>• Red reflector paint</li> </ul>
<ul style="list-style-type: none"> <li>• Amenities on road side</li> </ul>	<ul style="list-style-type: none"> <li>• Sign board <ul style="list-style-type: none"> <li>➤ Go slow</li> <li>➤ Sign board stating (“vehicle ahead of you can move left/right ”)</li> </ul> </li> </ul>
<ul style="list-style-type: none"> <li>• Straight wide road with steep Grade</li> </ul>	<ul style="list-style-type: none"> <li>• Sign board <ul style="list-style-type: none"> <li>➤ Danger zone</li> </ul> </li> <li>• Speed breaker</li> </ul>

## **CHAPTER 2**

### **Literature review**

#### **2.1 Road Safety Audit Stage I**

##### **Factory Hill, Tiptree**

##### **Wilkins & Sons Roundabout**

#### **2.1.1 Summary**

Location - South-eastbound approach to the roundabout

on the north-east side of Factory Hill, the existing boundary hedge and trees will restrict opportunities for suitable placement of direction or warning signing on this approach. At the detailed design careful consideration of signing provision and location will be required

## **2.2 INTRODUCING ROAD SAFETY AUDIT IN THE PHILIPPINES**

### **Luz V. LAGUNZAD, MEngSci**

#### **2.2.1 summary**

The main beneficiary of safety audit will be those who travel on the highways, by whatever mode. The traveling public should be presented with a consistently safer roads so that the incidence of adverse highway factors contributing to accidents is extremely low.

There are benefits from road safety audits, most of which can be achieved at low cost. The earlier the audit is carried out in the design process, the easier and cheaper it is to achieve the benefits.

Road safety audit will not necessarily make every new design totally "safe" but it will put road safety consciousness high on the decision-making agenda. It will also cause deliberate decisions to be made on the basis of carefully considered safety advices. Road safety auditing should be part of the total quality management approach to road design and network management. It provides the means to

direct importance on the safety principles and practices of road network delivery and to remedy or correct safety deficiencies before road users are exposed to them.

Safety audit process has the benefit of not only improving the safety of the schemes themselves but also of evolving design standards to produce safer roads.

## **2.3 The importance of a road accident data system and its utilisation.**

**by**

**Chris Baguley**

### **2.3.1 Summary**

This paper has attempted to give an overview of the main current road accident statistics of developing countries, and highlighted the fact that these countries generate a highly disproportionate amount (85%) of the world's fatalities. The situation also tends to be worsening as these countries' vehicle fleets are growing rapidly, and efforts to improve safety are not keeping pace. However, methods applied in many of the developed countries have demonstrated that it is possible to slow or arrest this growth in accidents. To achieve this requires dedicated safety workers to carry out regular, in-depth analyses of patterns of accidents and to then target many of these with various (low-cost) remedial actions that are likely to yield the most effective results.

For this, the establishment of a reliable road accident database and analysis system is of paramount importance, and this must be made accessible to all those bodies able to contribute to accident reduction (like the Police, highway engineers, vehicle engineers, education services, etc). Indeed, it is likely that an unreliable or inaccessible database will only lead to inefficient management of road safety. The paper has discussed the more important elements of such a system and illustrated these with selected examples from systems in use.

### **3.4 UNIFIED TRAFFIC AND TRANSPORTATION INFRASTRUCTURE (PLG & ENGG) CENTRE (U T T I P E C)**

#### **3.4.1 Summary**

In India numbers of agencies are involved in bad traffic management. However, due to lack of standardised, proper road markings, there are frequent problems in safe and smooth movement of traffic. It is, therefore, essential to adopt uniform standardised road markings on all the roads. It is also important to devise a system whereby the road markings are regularly maintained or repainted, according to time cycle. Subject to approval, the guidelines given herein shall be mandatory for all the road owning, development and maintenance agencies in India.

## CHAPTER 3

### Survey and Analysis of stretch

#### 3.1 Accidental Data

From the records given by local authority, the estimated figures of road accidents on the road stretch from Wagnaghat to Kandaghat in the year 2007-2013, were as follows:

**Table 2: Accidental data provided by the Kandaghat police station as recorded from year 2007-13**

<b>YEAR</b>	<b>NO. OF ACCIDENT</b>
<b>2007</b>	<b>25</b>
<b>2008</b>	<b>29</b>
<b>2009</b>	<b>20</b>
<b>2010</b>	<b>30</b>
<b>2011</b>	<b>33</b>
<b>2012</b>	<b>38</b>
<b>2013</b>	<b>42</b>

This data was used to identify the danger zones on the chosen road stretch.


### 3.2 Survey of Stretch




The survey team travelled through the stretch and concluded necessary sign boards are missing which could enhance safety. The author suggested many sign boards which should be put up that could probably reduce accidents. Survey was done using camera. The author stopped at each and every curve, analyze the accident possibility and suggested various sign boards which are shown in the report.

#### 3.2.1 Stretches from J.U.I.T. TO KANDAGHAT





In the given stretch, the survey team estimated the accidental prone area and hence its remedies are given.




**Table 3: Potential accident prone features on the chosen road stretch (JUIT Wagnaghat to Kandaghat) and proposed remedial measures.**

Problem feature	Remedies	
<ul style="list-style-type: none"> <li>• Kaichi turn (long vertical blind curve)</li> </ul>	<ul style="list-style-type: none"> <li>• Convex Reflector</li> <li>• Sign Board               <ul style="list-style-type: none"> <li>➤ Blow Horn(on both sides ascent as well as descent)</li> <li>➤ Change the gear(ascent curve)</li> <li>➤ Speed Limit(descent curve)</li> </ul> </li> </ul>	

<ul style="list-style-type: none"> <li>• Waknaghat Curve( long blind curve)</li> </ul>	<ul style="list-style-type: none"> <li>• Reflector Paint</li> <li>• Sign Board <ul style="list-style-type: none"> <li>➤ Blow Horn</li> <li>➤ U turn</li> <li>➤ No parking bus stop</li> </ul> </li> </ul>	
<ul style="list-style-type: none"> <li>• JK tyre( blind steep curve)</li> </ul>	<ul style="list-style-type: none"> <li>• Convex reflector</li> <li>• Sign Board <ul style="list-style-type: none"> <li>✓ Go Slow and Speed Limit(Descent)</li> <li>✓ Change The Gear(Ascent)</li> <li>✓</li> </ul> </li> <li>• Delinators</li> <li>• Marking</li> <li>• Steel barrier</li> </ul>	
<ul style="list-style-type: none"> <li>• Kyari bangla(right hand curve)</li> </ul>	<ul style="list-style-type: none"> <li>• Sign Board <ul style="list-style-type: none"> <li>✓ Right hand curve</li> <li>✓ Y intersection</li> <li>✓ Overtaking prohibited</li> </ul> </li> <li>• Marking</li> </ul>	



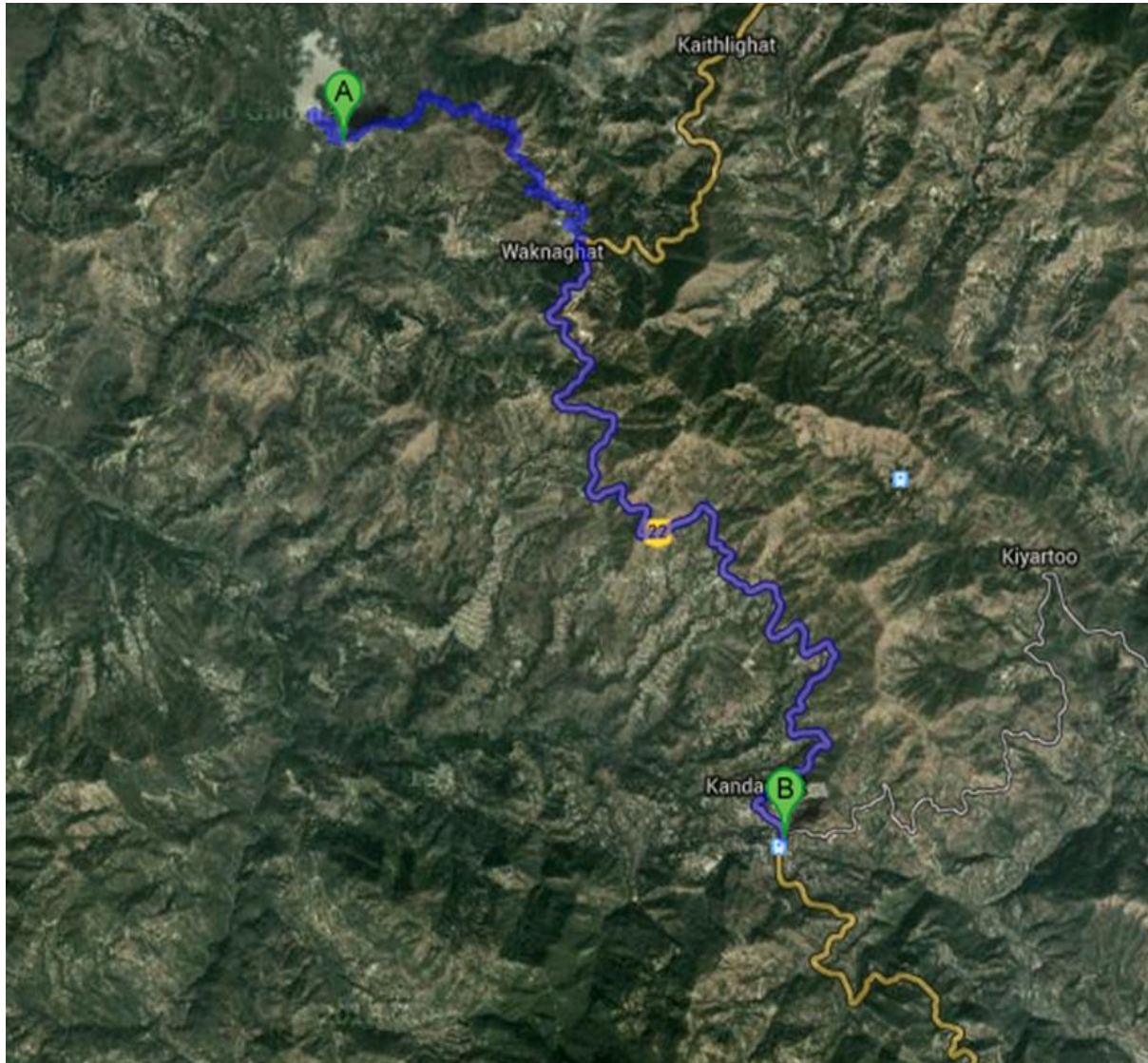
<ul style="list-style-type: none"> <li>• Pin bend curve</li> </ul>	<ul style="list-style-type: none"> <li>• Sign Board <ul style="list-style-type: none"> <li>➤ Right/left pin bend</li> <li>➤ No Overtaking</li> </ul> </li> <li>• Delineators</li> </ul>	
<ul style="list-style-type: none"> <li>• Destination curve</li> </ul>	<ul style="list-style-type: none"> <li>• Sign board <ul style="list-style-type: none"> <li>➤ Y intersection</li> <li>➤ Zigzag curve</li> </ul> </li> <li>• Markings</li> <li>• Delineators</li> </ul>	
<ul style="list-style-type: none"> <li>• Falcon crest(left reverse bend)</li> </ul>	<ul style="list-style-type: none"> <li>• Sign board <ul style="list-style-type: none"> <li>✓ Left reverse bend</li> <li>✓ Steep gradient</li> </ul> </li> <li>• Delineators</li> <li>• Markings</li> </ul>	
<ul style="list-style-type: none"> <li>• Merging road at curve</li> </ul>	<ul style="list-style-type: none"> <li>• Sign board <ul style="list-style-type: none"> <li>✓ Left pin bend</li> <li>✓ Y intersection</li> <li>✓ Overtaking prohibited</li> </ul> </li> <li>• Delineator</li> </ul>	

<ul style="list-style-type: none"> <li>• Left deep curve</li> </ul>	<ul style="list-style-type: none"> <li>• Convex reflector</li> <li>• Delineator</li> <li>• Markings</li> </ul>	
<ul style="list-style-type: none"> <li>• Kandaghat curve</li> </ul>	<ul style="list-style-type: none"> <li>• Sign board <ul style="list-style-type: none"> <li>✓ Speed limit</li> <li>✓ Y intersection</li> <li>✓ Informatory sign board</li> </ul> </li> <li>• Marking</li> </ul>	
<ul style="list-style-type: none"> <li>• Kandaghat market</li> </ul>	<ul style="list-style-type: none"> <li>• Sign board <ul style="list-style-type: none"> <li>✓ Parking prohibited</li> </ul> </li> <li>• Speed breaker</li> <li>• Rumble strip</li> </ul>	

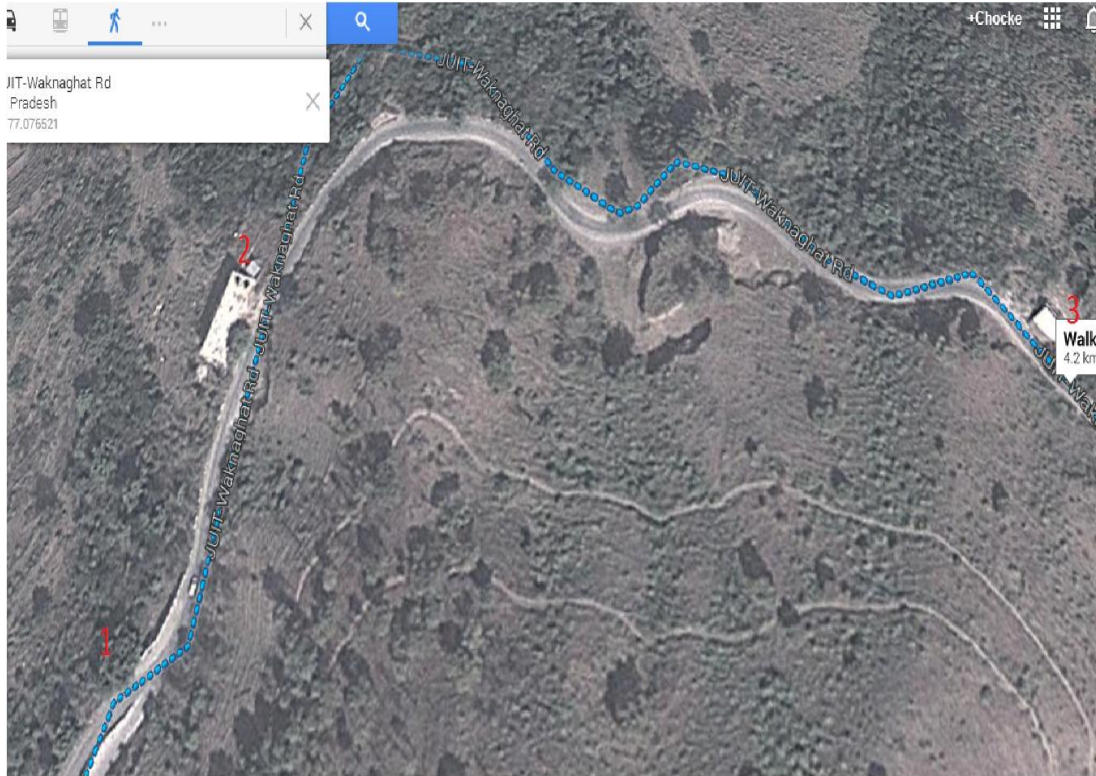
### 3.3 ANALYSIS OF STRECH

In this chapter we are showing the safety measures to be used, so that to reduce the accidental activity. The satellite image shows the critical curves and the following pics give the cautionary, mandatory and informatory sign boards where are necessary.

**Figure A** shows the satellite image of the stretch from Jaypee University to kandaghat.



**Figure B** shows the satellite image of three critical points which are accidental prone area



**Fig1** two road merging



**Fig 2** right blind curve with series of bend

Fig B shows three critical points which are accidental prone area. In this picture there are three spots that have been marked. These spots are critical curves

### **Figure 1: Two way road**

In the above shown figure, the two roads are merging together. This location is highly prone to accidents because the traffic coming from downhill slope will be at a very high speed. So, in order to avoid such situation these two safety measures should be set up. The first one instructs the prohibition of overtaking any vehicle and the other one shows that the two roads are merging together. The road merging with the downhill slope has a very less reaction time so for the safety of the passengers the road safety measure should be installed

### **Figure 2: Right blind curve**

Mountain roads are often too narrow for 2 vehicles to pass easily and have many sharp curves that prevent seeing approaching traffic. Forthcoming vehicles, livestock or wild animals on the road, or slow-moving SUVs possibly may come across without caution.

This is a right long blind curve for the up going cars. Thus we require convex reflectors so that upgoing cars can see the cars from opposite direction. In this figure2, since the visibility of vehicles is almost negligible at the turn. Since it's a very long right turn the location is such that it does not provide any sight to the driver. In order to avoid accidents, convex reflectors is used. Convex reflector provides adequate sight distances via big enough vertical curve radii to allow for stopping once a driver has detected an object in travel lane. Convex reflector deals with the problems have to do with sight distance deficiency.



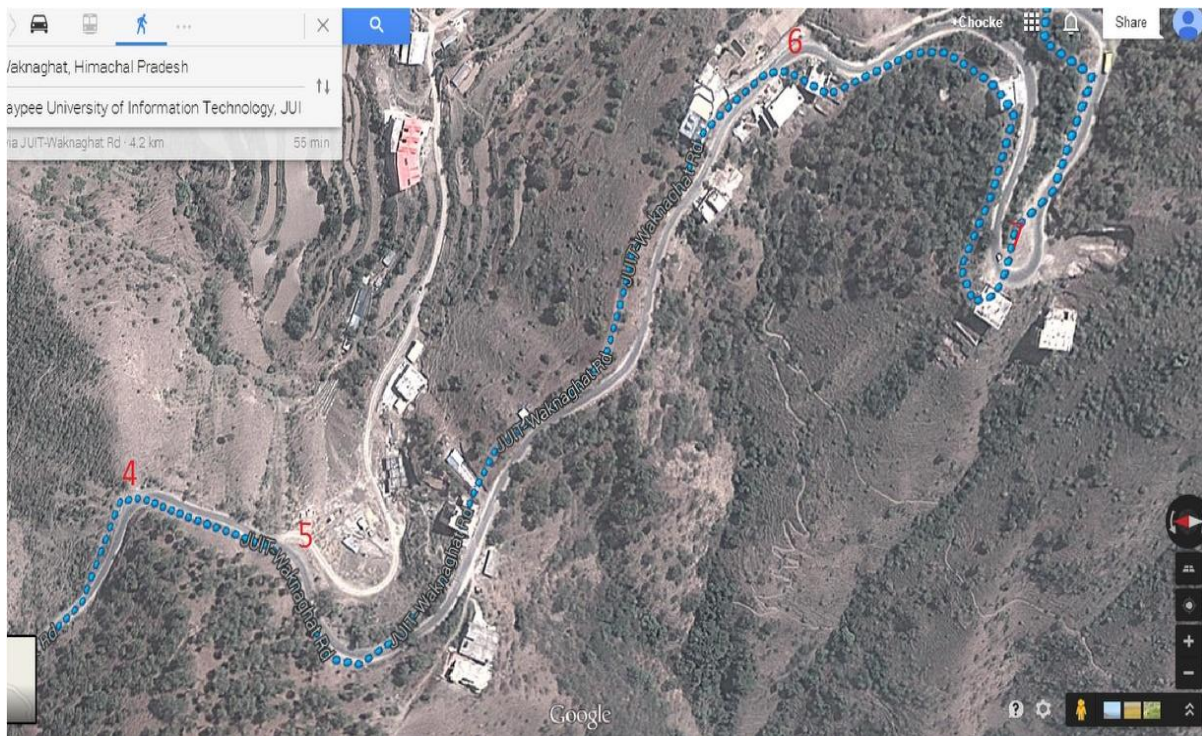
**Fig 3 shows blind curve with series of bend**

**Figure 3:Left blind curvewith series of bend**

Curves in the same sense in which the first one is light one and the second is very pronounced which results to accidental situation is double blind curve as shown in fig b. In **Fig. B(location3)**, there are two bends and the road is downhill slope so the speed of the vehicles is high and they are unaware of series of bends. As the reaction time for visibility of approaching vehicles is zero which leads to the nervousness of driver resulting in many accidents. Therefore for all the vehicles travelling on such a place need to be very careful as there are series of bends which does not provide any visibility and overtaking is prohibited. So in order to avoid such accidents cautionary road sign boards should be used.

As the width of the curve and road is also less so the steel barriers are provided so as to stop the vehicle from going out o the road in case of high speed. Delinators are also provided which help the driver to know the end side of the curve at night time.

**Figure C** shows blind curves and merging roads



Location 4,5,6 identifies some critical curves.

Location 4 is a highly accidental prone as it is a short blind curve



**Fig 4** shows short blind curve



**Fig 5** shows two merging road

**Figure 4:** Short blind curve

In this figure 4, there is a deep valley on one side and a sharp, isolated curve on the left hand side too so the driver has very high chances of committing an error leading to accident. This place is more accidental prone due to inadequate sight distance. So such a road sign should be used so as to make the driver feel conscious of the danger present and an advisory board is used to slow their speed as the curve accidental prone area.

### **Figure 5: Two way path**

In this figure 5, there is a two-way path in which one of them is under-construction and the other one is mettle. Since it is a downhill slope, the traffic coming from up is high and the visibility is also very low making the location to be a very highly accidental prone area. In order to avoid road mishaps these road signs must be necessarily used.

Point where two road merge should be provided with informatory sign of blow horn as shown in fig 5 so that car coming from another road can judge the car at other road and can stop before joining the main road.



**Fig 6 shows the Keechi turn**

### **Figure 6: Kaichi turn**

Shows the u turn with zero visibility and less width of curve

In this figure there is a vertical steep slope and it is blind curve too. The visibility for the driver is zero. Since it is a downhill slope the vehicles approaching is not visible to the driver. If the driver doesn't slow down it will go down out of lane. So for safety measures of the driver, convex reflector is used which will allow visibility with time to react for the oncoming vehicles. Convex



reflector shows the approaching car on the other side of curve. Since width of curve is less the driver can stop before and let other vehicle pass.

And other sign board used is to make driver aware of the u turn and the driver can take proper action to safely handle the curve.

Car coming from upside will be at high speed. Sometime driver loses their control in such type of curves due to the change in gradient and car can go out of the road. So as to avoid these accidents steel barrier are used of high strength so as to stop vehicles from going out of road.

**FigureD** shows satellite image of wagnaghat





**Fig 7 shows school crossing**



**Fig 8 the wagnaghat chowk**

**Figure 7:the wagnaghat chowk:**

Fig 7 shows for the the crossing point for school children and vetereny hospitals. As the road have steep gradient for downhill traffic therefore these sign should be provided to reduce road mishaps. And driver can slow down his speed.

Rumble strip is used which aware driver to slow down by getting the vibration from the strip. Another sign board help driver to know about the crossing of school which will help driver to know about the coming hazard and slow down his speed.

Fig 8 shows the wakhagha tchowk where we are placing an informatory sign for vehicles who are moving down to chandigarh or shimla . With the help of this sign we can show direction so that vehicles heading towards Chandigarh do not move down to shimla and vehicles who are not familiar with shimla also get to know about the location

And the proper bus stop is provided with yellow rectangle so as to avoid traffic. Proper place for bus stop avoid traffic and conjunction of road.

**FigureE** shows the satellite image of wagnaghat and bhara gate



**Fig 9**shows wagnaghat u turn

**Fig 10**shows two merging point

**Figure 9:** U-turn (wagnaghat curve)

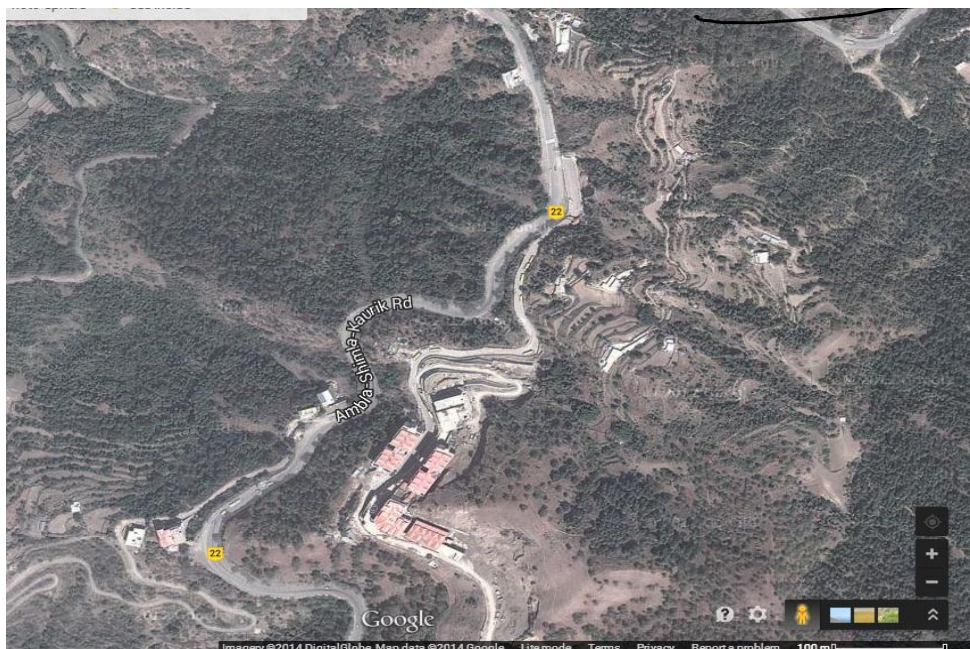
In this picture we have the wakna chowk( long blind curve) . It is a accident prone area with successive vertical curves, chowk with a safety measure of overtaking sign board to avoid accident between vehicles heading towards the curve or crossing the lane curve especially when the bus is stopped. In such curves which are more prone to accident acc to the data safety measures have to be taken place. The sign board shown is important to tell to inform the driver about how to drive and steer , to brake. Proper informatory board is provided so that the curve does not get congested after stopping of bus..

**Figure 10: diverging road**

Fig 10 shows diverging of road to university road and crossing point which is prone to pedestrian accident. Therefore these sign board should be provided so the driver can slow down his speed and can control the vehicle travelling towards the blind curve.

Providing rumble strip will reduce the speed of the vehicle and can eliminate the use of other sign board.

**Figure F shows accident prone areas near jktyre**





**Fig11 shows left blind curve**

**Fig12 shows jktyre blind curve**

**Fig 11 left blind curve:**

Curves in the same sense in which the first one is blind curve and the second is very pronounced as shown in fig which results accidental situation is double blind curve. In fig 11, there are two bends and the road is downhill slope so the speed of the vehicles is high and they are unaware of series of bends. As the reaction time for visibility of approaching vehicles is zero which leads to the nervousness of driver resulting in many accidents. Therefore for all the vehicles travelling on such a place need to be very careful as there are series of bend. With superhighways and advancement in automobile technology speed of vehicles has increased manifold. With this overtaking has come as a maneuver to save time on road. But some place where the roads have series of bend are narrow overtaking becomes dangerous. At these place this sign is installed which prohibit overtaking ensuring safety.

**Fig12 jktyre blind curve :**

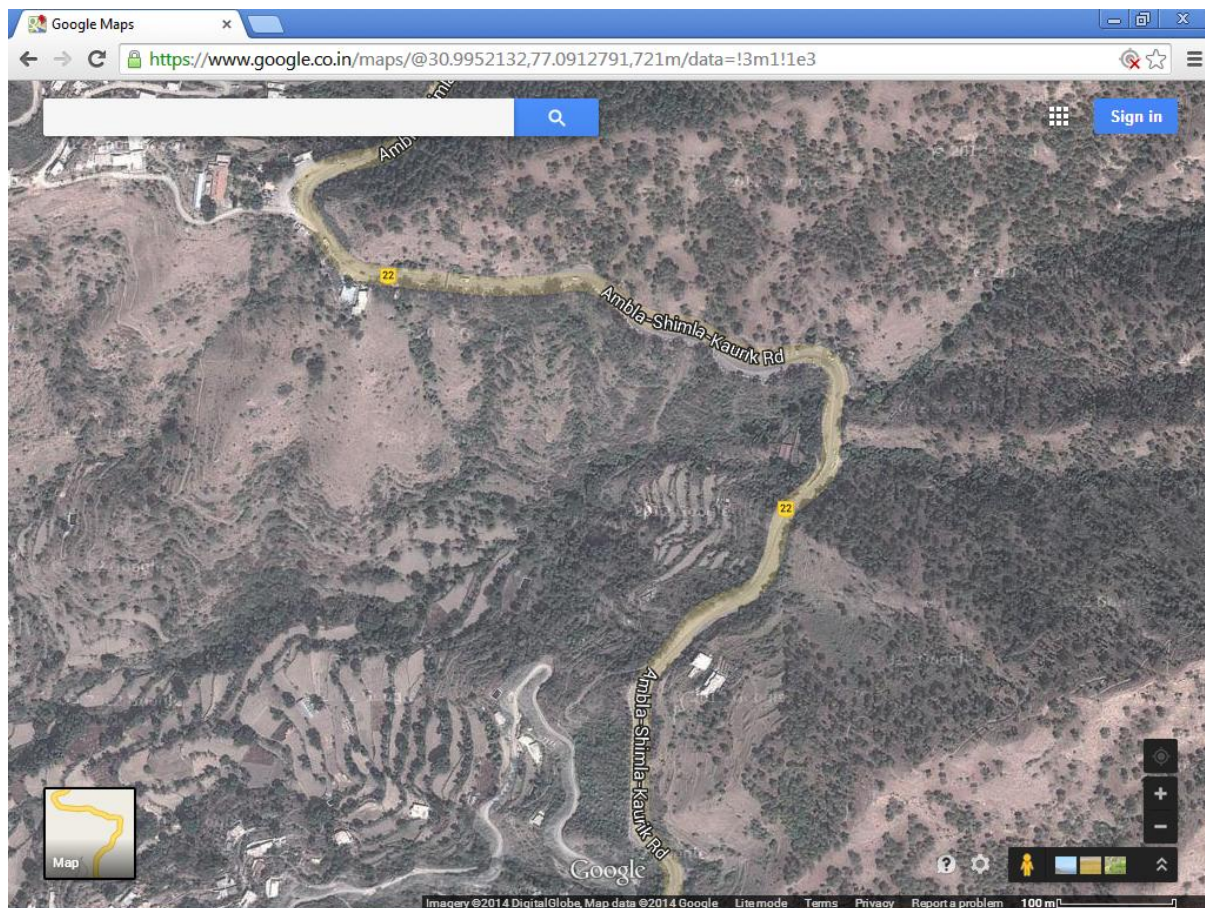
left blind curve that is dangerous for the drivers if the necessary precautions are not taken. **Fig. 12** depicts that the sign board is necessary for vehicles heading towards the curve because the vehicles heading towards the curve cannot see the vehicles coming from the front. It is a left blind curve with zero visibility. It is used to inform the driver to keep the vehicle more towards the left side to avoid any sort of accident with the vehicle merging from the other side. Moreover, the terrain is additionally mountainous, therefore the side distance can be too short to make the

decision and hence under these circumstances the safety measures should be provided as shown in fig12.

As there is zero visibility and the curve has less width so convex reflector can be provided so that the approaching vehicle can be seen

Delineators are also used as they are suitable for all kinds of roads. Their reflectors give best reflective performance to show the road geometry during day and night making it convenient for drivers and keep them away from road hazards. These results in avoidance of accidents. The Delineators are available in different fittings for different purposes.

**Figure G** shows critical curves near kyari bangla





**Fig 13 shows kyari curve**

**Fig 14 shows right hand curve**

**Fig 13 kyaribangla curve:**

It is observed that in hilly areas, the changing of curves without any visibility separated by straight stretches and elevations **Fig.13**, the number of accidents increases due to the violation of the “No Passing Rule” at the end of the straight stretch and the consequent invasion of the opposite lane is not allowed.

Fig 13 shows an accident prone area with successive vertical curves with a safety measure of overtaking sign board to avoid accident between vehicles heading towards the curve. The sign board shown is important to tell to inform the driver about how to drive and steer, to brake and to control the vehicle travelling towards the blind curve. These sign boards will reduce accident frequency especially night accident frequency. Other sign is used to tell the road user of side road where the speed has to be slow down and proper indicator should be used.

**Fig 14 left hand long curve**

after a straight and wide patch. Cautionary sign board is used to tell the road user of the coming hazard. Mainly these type of curve with a straight and wide patch the speed of the vehicle is high and the driver gets difficult to control the vechile at such high speed. Therefore the sign board is used to make driver aware of such situation.



**Fig 15 shows right left pin bend**

**Fig 15 right pin bend :**

The image shown in **Fig. 15** shows the Pin Bends curve with a sharp turns . This sign cautions you about a sharp Right turn on the road ahead. It gives time to reduce the speed to manage the turn and also sets eyes of the driver on turn. Absence of this sign could lead to major accidents as sharp bends in hilly road don't get sighted easily.

vertical curve for the coming vehicles. Two sign boards have been shown - one to inform the driver to lower down its speed since it is an accident prone area and the driver should be 10 times alert and drive carefully, and the other to make sure that the driver in any case should not overtake the vehicle in front. If you see it is a downhill road, speed is a bit high and in case of overtake the vehicle may come in contact with the oncoming vehicle leading to accident. Therefore the vehicles should driven carefully and never overtake.

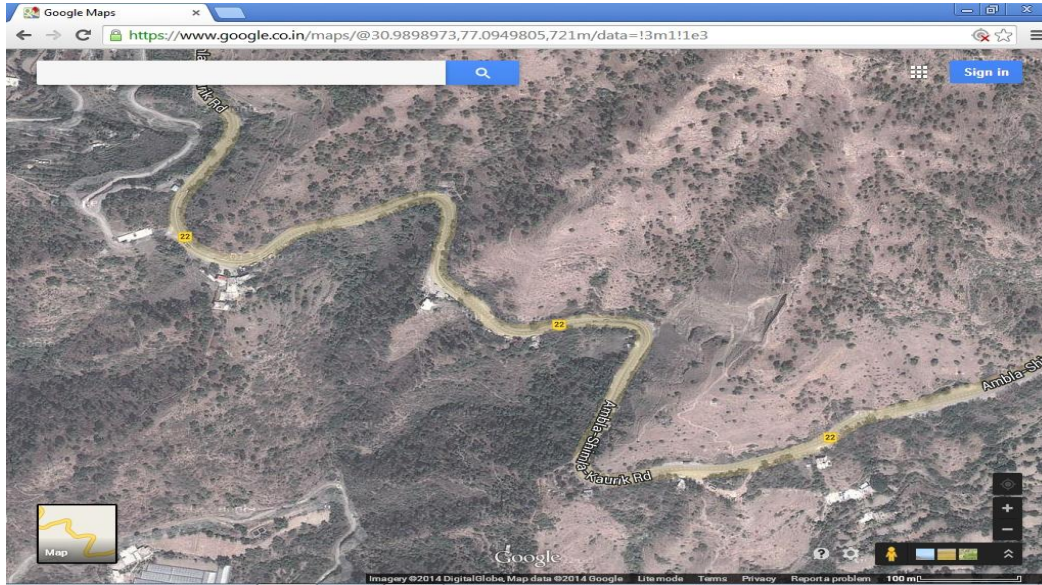
**Fig 15 left pin bend :**

On the other hand the image shown in **Fig 15** shows the left pin bend. This sign cautions you about a sharp left turn on the road ahead. These are essentially erected on Hilly roads. It gives time to reduce the speed to manage the turn and also sets eyes of the driver on turn. Absence of this sign could lead to major accidents, as sharp bends in hilly road don't get sighted going vehicles. The sign shown indicates the driver to slow down as it indicates a vertical steep curve for down coming



vehicles with the left curve. The long straight alignment followed by an isolated close curve increases the accidental factors.

**Figure H** shows satellite image of deep curves and two way path



**Fig 16 shows deep valley curve**



**Fig 17 shows two way path**

**Fig 16 deep valley curve:**

Longer the sight distance, the safer is the road and consequently lesser accidents will happen. Any driver should always be able to see the length of the roadway ahead that he/she drives on. As the curve is very much pronounced **Refer Fig 16** and vehicles moving at a high rate have the sight distance too short to make the decision while approaching the oncoming vehicles. To avoid such

accidental situation convex reflector is used with the left hand curve sign board. Convex reflector help to see the approaching vehicles which are at other side of curve. And sign board is used to make driver aware of the curve and can slow down their speed. This sign board also help at the night time.

**Fig 17 shows two way path**

Fig shows the two way path at the curve which is accidental prone .as fig shows the long curve with the merging of unmettled . vehicles moving at NH 22 will be at high speed and sudden merging of road at curve with low vision of other road make accidental situation so as to avoid such accident the sign board as shown in fig17 is used.



**Fig 18 shows left pin bend**

**Fig 19 shows left revrse bend**

**Fig 18 shows left pin bend**

Fig 18 shows a short deep curve after a long straight patch where cautionary sign board is placed so the driver can slow down his speed. These both fig18 are more accidental prone for loaded vehicles. As overloaded vechilescant control their speed. So as to avoid accident at these curves sign board as shown in fig is used. This sign board will help driver to slow down so to turn the curve.

**Fig 19 shows left revrse bend**

Fig. 19 provides the sign board that the driver needs to take into account to avoid an accident. To make the driver cautious about the turn and slow down his vehicle, the sign board is already been provided by the authority for safety measures.



**Fig 20 shows right hand blind curve  
mergin groad**

**Fig 21 shows blind curve with**

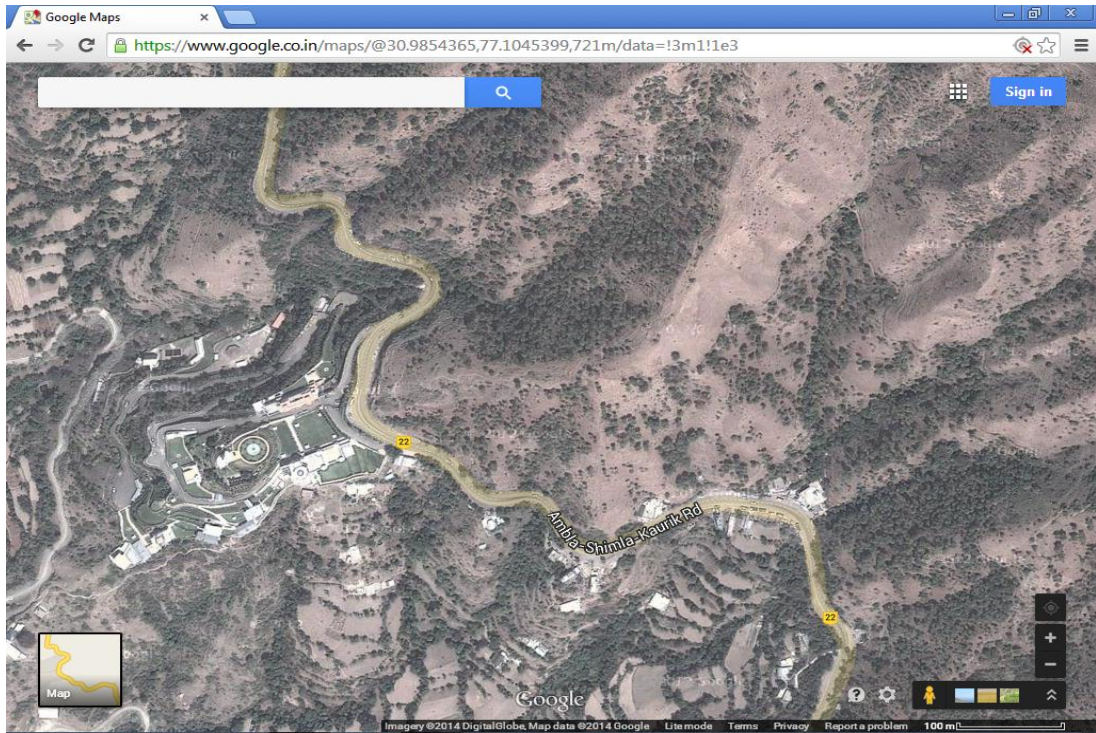
**The Fig. 20~21**

shows two different blind curve with merging road. To make the drivers cautious about the blind curve a proper marking and convex reflector is used which help both in day and night. In fig 21 we can use the white marking of the curve which make driver aware of the road liniment and convex reflector is used so that approaching vehicles can be seen by the driver before approaching the curve to avoid unnecessary accident on the road. Fig 21 shows the curve which is accidental prone area as the two road are merging at this curve. The car coming from upside will be at high speed due to the straight patch before the curve which make driver to apply sudden brakes or they loses their control at the curve. And since the road is merging at curve it make difficult for road user of nh 22 to judge the car from another road. So as to avoid these condition sign board as shown in fig is used.

Reflector are also used so the driver can see the approaching curve ay night time and can slow down their speed.

Flexible Polycarbonate Convex Mirrors are virtually unbreakable and are 200 times stronger than glass. It is not affected by any type of light ray and will not produce toxic fumes if burnt. Ideal for surveillance, these heavy duty, virtually unbreakable polycarbonate mirrors are ideal for areas prone to vandalism.

**Figure I shows accidental prone curves near destination**



**Fig 22 show side way road**

**Fig 23 shows starting or series**

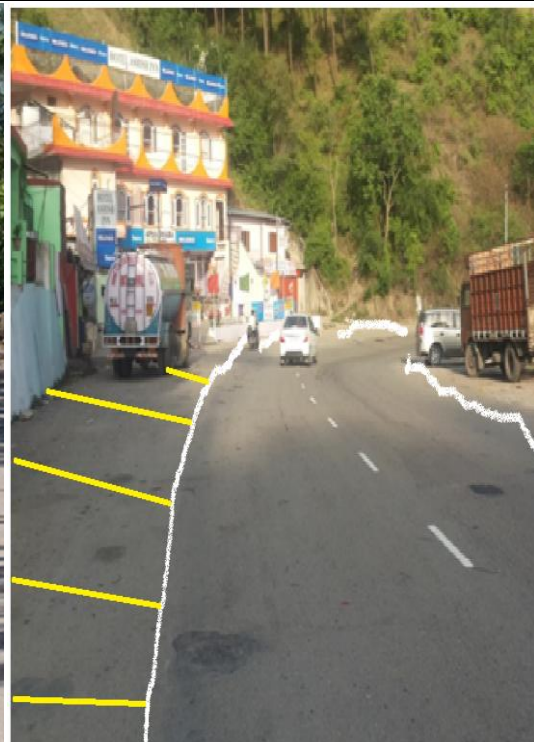
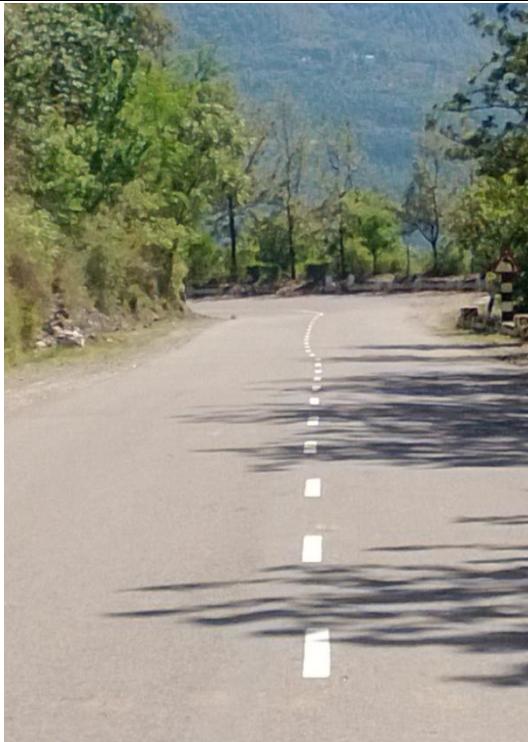
**of bend**

**Figure 22:shows side way road**

the road was provided without marking there is no division made for both upcoming and downgoing vehicles which makes it practically a road with one lane. Driving off the road and head on accidents occurs when the vehicle entering the curve with a too high speed without lane markings can lead to loss of control over the vehicle. Due to which the upcoming and down going vehicles run out from there lanes and leads to collision between vehicles. To avoid this, pavement marking should be done. And the road sign depicts the actual formation of road ahead. The road is divided into two forming a shape of Y. This helps driver in managing the intersection carefully.

**Figure 23: shows zigzag curve**

This road sign indicates the actual design i.e., a sort of Z formation of the road ahead. It cautions the driver about the zigzag turn towards Left. The driver should reduce the speed at the sight of this sign and maneuver the vehicle cautiously.



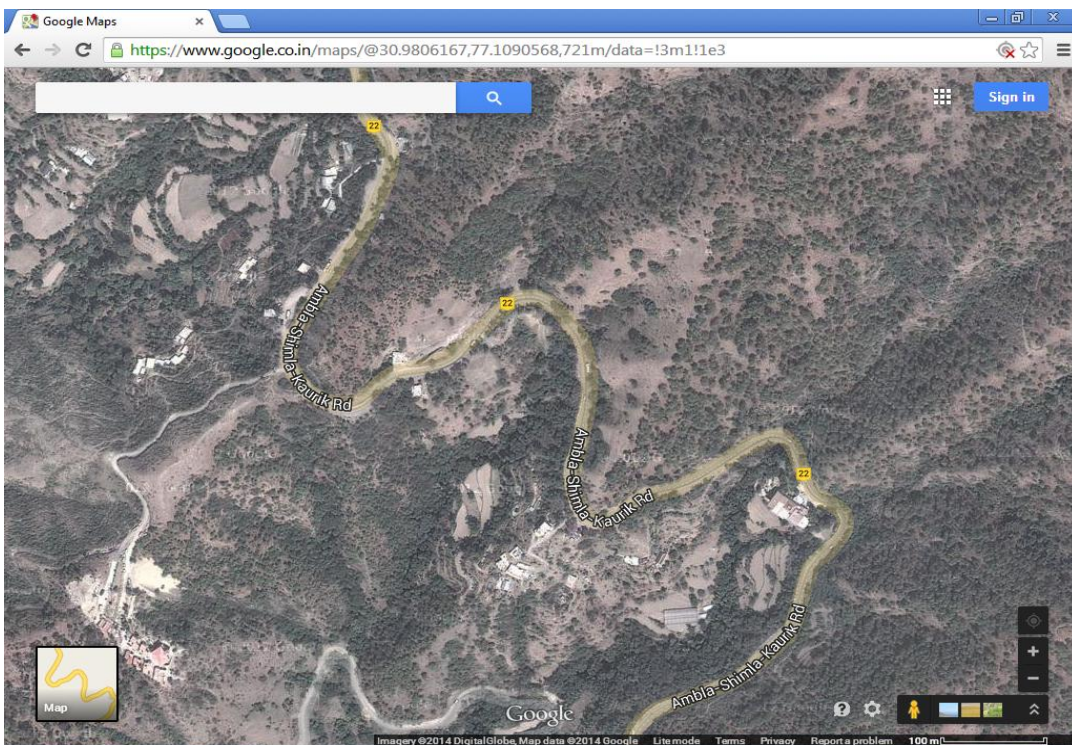
**Fig 24 shows the curve provided with Sign board by authority**

**Fig 25 shows curve provided marking**

**Figure 24** shows left blind curve where authorities have provided sign board to make driver aware of coming hazard.

Figure 25 shows wide curve where proper road marking is provided. Both for road and parking.

Figure J shows critical curves near falcon crest





**Fig 26 shows blind curve**

**Fig 27 shows falcon crest curve**

**Figure 26 shows blind curve**

Fig 26 shows curve with merging road. The roads are merging together with a pronounced curve where the visibility is negligible while overtaking. This location is highly prone to accidents because the traffic coming from the downhill slope will be at a very high speed. So, in order to avoid accidents precautionary signs of two way road and overtaking prohibited is necessarily be used. A pavement marking is used in such a way so that vehicles should not cross each other.

**Figure 27 shows falcon crest curve**

Fig 27 shows falcon crest curve which highly accident prone due to the change in the gradient of the road which start with right reverse bend. As the vehicle coming from uphill will be at speed and due to the change in slope and series of bend it becomes difficult for driver to control the vehicle and can cause accident. So to avoid these accident two sign board with delinator are used. Two sign board used help driver of coming hazard and can change the gear to slow down. Choose a gear that will keep you moving at an appropriate speed while you ride down the hill. Avoid

gearing down to first gear — it may be too low and could cause you to skid. Choose a gear that will keep you within the power band as you go up the hill. Move into the right-hand lane position if your visibility is limited. This will create space between you and any oncoming traffic that may wander over the centre line.



**Fig 28 shows curve with change in gradient**

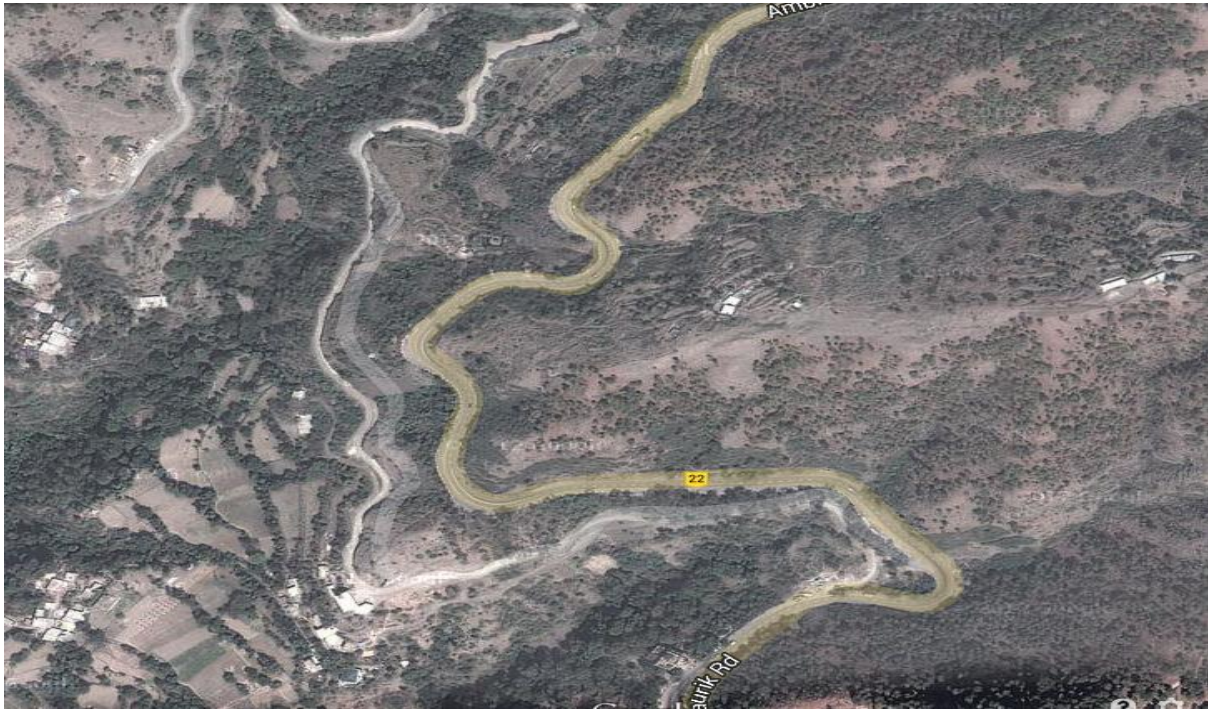
**Figure 28 steep blind curve**

In this picture we have used two sign boards for the vehicle going upstream. This curve is adjoining the national highway (NH-24) which basically gives a picture of vehicles coming at a great speed, to make them cautious about the steep curve a sign board is used and the other sign board is used to inform them to slower the vehicle before approaching the curve to avoid unnecessary accident on the road. As the curve is steep the driver has to change the gear so as to remain in their lane. Reflector are used to tell about the end point of the road at night time as the road are narrow in the hilly areas.



Indicators at the centre line and marking of road with white line also help the driver at night time and these marking can reduce the use of sign board at many places.

**Figure K shows Problem faced by the driver near Kandaghat**



**Fig 29 shows pin bend with merging road**

**Figure29 pin bend curve**

Fig 29 shows intersections located in areas of substandard geometric conditions often have reduced sight distances and, as a result, may appear hidden to the approaching traffic. Hidden intersections may pose a hazard to the through and turning traffic, creating a potential for serious collisions especially at curves. When drivers need to be warned about a hidden and unexpected intersection, Road sign is placed on the highway in advance of the intersection. Figure 29 has shown in fig 29 as seen in same fig due to wide curve the overtaking should be avoided so as to minimize the accidents. So, in order to avoid situation these two safety measures should be set up. One to prohibit overtaking and other to show that two roads are merging. We can also use pavement marking on road instead of using two way road sign.

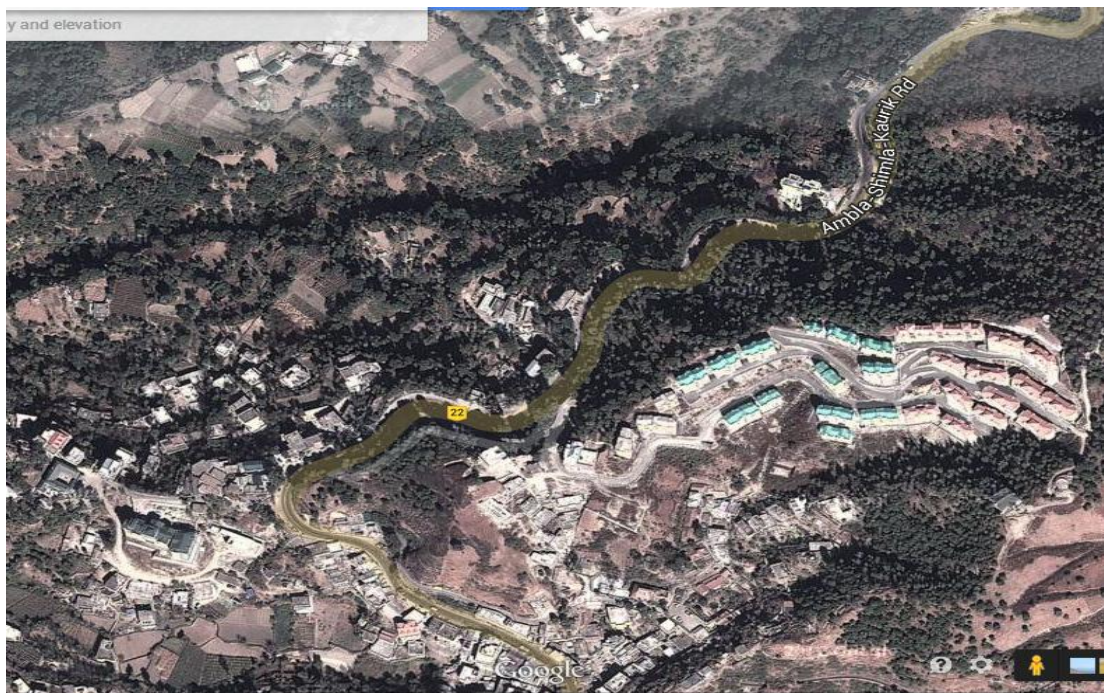


**Fig 30 shows left reverse bend**

**Figure 30 left reverse bend**

It is a left reverse bend and vehicles moving at a high rate have the sight distance too short to make the decision while approaching the oncoming vehicles. Since there are series of bends ahead the driver gets confused at these types of situations. To avoid such accidental situations, sign boards as shown in fig 29 are used. Left hand reverse bend. This sign is used where the nature of the reverse bend is not obvious to approaching traffic and constitutes a hazard. If the first curve is to the left, a left reverse bend sign is used.

**Figure L** shows curves near kandaghat and view of market



A high traffic volume inside towns causes environmental problems and additionally increases the risk of accidents.



**Fig 31 left deep blind curve**

**Fig 32 shows steep blind curve**

**Figure 31:deep blind curve**

shows the steep blind curve with entrance of kandaghat. Cars coming from upside will be at high speed due to steep gradient. And it is difficult to control car at steep gradient so in order to avoid accident in such places convex reflector is used so that approaching vehicle can be seen by the driver and can control the vehicle.

**Figure32: steep curve**

shows a downstream curve, the sign boards used here are basically to inform the driver about the speed limit and the the merging road and the steep curve which may increase chances of accident taking place if the vehicle is at great speed or more on the right hand side of the road while moving down.Fig 32 shows a downstream steep curve, the sign boards used here are basically to inform the driver about the speed limit and the series of bends ahead and the steep curve which may increase chances of accident taking place if the vehicle is at great speed or more on the right hand side of the road while moving down. The passenger of a vehicle involved in an accident whose impact speed is 80km/hr are 20 times more likely to be killed then if the impact speed was 32km/hr, therefore the speed limit for a light motor vehicle is 30km/hr and for heavy motor vehicle is 20km/hr.



**Fig 33 shows merging point of three road**

**Figure 33 merging point**

At junction **Fig. 33** with heavy traffic, waiting times for traffic required to give way may be long. This may tempt road users to enter the junction with small safety margins. Frequent crossing and turning maneuvers can create dangerous situation and makes the traffic situation complex. This location is highly accident-prone since the upcoming and down-coming vehicles are unaware of the road. This is also a high traffic zone because of the main kandaghat office; there is also a nearby school, taxi stand and stoppage for the local and inter-state buses. Therefore in order to avoid such accidents informatory signboards should be used. For indicating that there are three road merging. So informatory sign board should be placed which tell the direction of the merging road.



## **Fig 34 shows the kandahgat market**

### **Figure 34:Kandaghat market**




Fig 34 shows the entry of kandaghat market. Proper marking on the road should be done. Centre white line shown in fig divide the lane which help the driver to stay in its lane and also reduce the traffic as it is more traffic prone area.



Another informatory sign board used as shown in fig tell the about the restriction of parking. Due to the parking of vehicles by road side as shown in fig34 make road congested which lead to collision of vehicles due to the less width of road.

Modular speed used as shown in fig 34 provide high resistance to severe impacts. The interlocking grip design allows it to behave like one single Bump. The precoloured materials (black and yellow) and UV stabilizers result in permanent colours which does not fade easily. Acrylic reflectors fixed on front and back help in identifying the location of the speed breaker from a large distance.



## CHAPTER 7

### COST ESTIMATION

Model no.	Specification	Unit Price(per piece)*	Picture
Convex mirror 60 CMS	Akiton convex mirror is complete with mounting hardware. Having polycarbonate reflective mirrors made up of polycarbonate & outdoor use with Hood,Made of ABS,Fibre,Plastic,dimension 80 cm.	4855/-	
Warning/cautionary sign	Akiton roads signs conforming to IRC:67-2001 standard sign boards made up of 2 mm ACP / aluminium sheet with HIP retro reflective tape grade 1-2 with 3 years reflectivity warrentary on back side angle framing without post.  Equilateral triangle shaped dimension: 900 mm .Dimension: 600 mm.	3700/-	
Informatory Signs	Akiton roads signs conforming to IRC:67-2001 standard sign boards made up of 2 mm ACP / aluminium sheet with HIP retro reflective tape grade 1-2 with 3 years reflectivity warrentary on back side angle framing without	4500	

	<p>post. Rectangular shape Dimension: 800*600mm. Dimension: 600*450mm.</p>		
Rumble strip	<p>Flexible rubber Rumble Strips come in rolls that are 1/4" thick by 4"W and 50'L</p> <p>Rumble stripes are available in either bright orange or neon yellow/green</p> <p>Choose from removable or permanent adhesive to attach your rumble strip to the road; one gallon of removable adhesive covers 12 rolls, one gallon of permanent adhesive covers 9 rolls</p>	1500/-	
Pole stand	<p>Portable Sign Stands are ideal for use in high wind areas or areas where sign posts cannot be placed in the ground</p> <p>Steel sign stands are 22" in diameter and have a 37 lb. base</p> <p>Stands are adjustable and work with a telescopic post that adjusts from 4-1/2'H up to 8'H</p>	1900/-	



Delineator	<p>Bright orange delineator posts have two 3"W reflective bands, a 3"Dia. reflective top and measure 42"H x 4"Dia.</p> <p>Each delineator post weighs only 2 lbs. and must be used with a base (sold separately)</p> <p>Bases come in 13.2 lb. or 17.3 lb sizes</p>	1700/-	
Sbeed breaker	<p>Striped Rubber Speed Bumps have cat eye reflectors and reflective yellow stripes for added visibility and safety</p> <p>Speed bumps have two 1-1/4"W channels on the bottom to allow for cables, pipes or wires to pass through</p> <p>Speed bumps are easily removed for storage or surface</p>	18765/-	

	<p>maintenance and come with an installation hardware kit</p> <p>Speed Bumps are available in 4'L x 12"W x 2-1/2"H or 6'L x 12"W x 2-1/2"H sizes for concrete or asphalt installations</p>		
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LABOUR COST FOR INSTALLATION = Rs200/- PER DAY (20% of material used)

TRANSPORTION CHARGES = Rs5000/-

COST OF POLES = 1900\*44=83600

CAUTIONARY SIGN BOARD =3700\*34=125800

INFORMATORY SIFN BOARD =4500\*7=31500

CONVEX REFLECTOR =4855\*3=14565

SPEED BREAKER =18765

RUMBLE STRIP =1500\*15=22500

DELINATORS =1700\*40=68000

Rs 3,64,730

Total coast = 3,64,730+5000+72946= Rs 4,42,676/-

**Total cost for the measure to reduce accident from juit to kandaghat is 4,42,676**

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- [7] Sign boards used from [www.ajsscale.com](http://www.ajsscale.com)
- [8] [www.indiamart.in](http://www.indiamart.in)