Road Safety Audit for Saugor-Vidisha-Sanchi Section of NH-146
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Abstract—Globally road traffic injuries are appraised to be the eighth leading cause of death, especially for the younger people between age 15 to 29, leading to hospitalizations and also physical disabilities resulting in severe socioeconomic costs across India which is a matter of concern. Road Safety Audit (RSA) is a formal procedure for assessing accident potential and safety performance of new and existing roads. RSA is an efficient, cost effective and proactive approach to improve road safety. It is proved that RSA has the potential to save lives. The objective of this study is to apply the RSA methodology on the selected route, identify deficient road safety features and suggest remedial measures to rectify them which can improve road safety and can also help in decreasing travel time, reducing congestion, and providing improved operating conditions to road users.

Key words: Powered Roller, Road Safety Audit

I. INTRODUCTION
Road accident is directly correlative to the mountainous losses to the economy in the form of charges involved in medication, treatment, reparation to vehicles, loss of property etc. Therefore, there is a critical need to reduce the number and cruelty of road accident by implementing remedial measure at hazardous locations in the road network. Thus, finding of hazardous locations in a road network is an important assignment for improving road safety.

Road Safety Audit can be defined as a systematic approach for evaluation of existing or new roads by an independent audit team at the stages of planning, design, construction, operation & maintenance to achieve accident free roads and to enhance overall safety performance.

Rapid increase in vehicle ownership in India during the last three years has placed a prominent effect on the networks of roads, traffic, control devices, and facilities of road users. This has caused an increase in the accident rate not only in India but also in Madhya Pradesh State. RSA can prove to be an effective tool in reducing this major problem.

II. NEED OF THE STUDY IN VIDISHA CITY
Vidisha is a rapidly developing city in the district Vidisha near the capital city Bhopal and just 12 kilometres from the famous sanchi stupa. Due to the rapid development in economic, industrial and commercial activities, there is an enormous increase in traffic, causing traffic congestion, pollution and other related problems. There is a National Highway and a State Highway which passes through the Vidisha city in addition to major and minor district roads. Vidisha city roads are subjected to mixed and heavy traffic flow with unwarranted or no traffic control measures. All these factors lead to an increase in the road accidents in the city.

III. OBJECTIVE AND SCOPE OF STUDY
The objective of this study is to conduct a RSA according to methodology which has been suggested in IRC:SP:88:2010, identifying accident prone locations through FIR records of police station and their deficiencies therefore suggesting appropriate remedial measures for safety. The scope of this study mainly focuses on-
- Reviewing the literatures based on some significant and incendiary issues responsible for road accidents
- Find out the accident prone location
- Examine safety features adopted in the selected section
- Suggest remedial measures for deficiencies locations of Vidisha road network (NH 146)

IV. LITERATURE REVIEW
Road Safety Audit (RSA) originated in Great Britain (1980) is now spread in several countries around the world including USA, New Zealand, Australia, China, Japan etc and now it is used as a model in many countries for the formulation of guidelines and planning of their trunk roads. World Bank has made it mandatory that all World Bank aided highway projects would be audited from the road safety point of view.

Road Safety Audit can be defined as a systematic approach for evaluation of existing or new roads by an independent audit team at the stages of planning, design, construction, operation & maintenance to achieve accident free roads and to enhance overall safety performance. Projects eligible for audit cover a wide range of types and sizes, on different classes of roads, in urban and rural areas. The varieties of projects covered are major highway projects, development and maintenance projects, minor improvements projects (rehabilitation, retrofitting, upgrading), major four lane and multi-lane projects, Intersection projects both signalized and non-signalized, pedestrian and bicycle route, access road near the project, grade separator and interchanges, rural road providing access to village/habitations.

A. Indian Road Safety Audit Guidelines
Manual on Road Safety Audit, IRC: SP: 88–2010, published RSA guidelines to be used in India. The guideline is to assist public agencies develop their own RSA policies and processes. The main objective of guidelines focused on post-construction phase was to “identify road safety issues for different road users that might result in a crash given the operational characteristics of the road in question”. The main aim of RSA according to the manual is to ensure that all new road schemes operate as safely as practicable. Specific aims of RSA are:
- To recognize the importance of safety in highway design to meet the needs and perceptions of all types of road users; to achieve a balance between needs of
different road user types where they may be in conflict with one another.

- To minimize the risk and severity of accidents likely to occur/occurring on project facility or on adjacent roads and to minimize their severity.
- To reduce long term costs of project facility, bearing in mind that unsafe designs may be expensive or may be impossible to correct at a later stage.
- To increase awareness about safe design practices among all those involved in the planning, design, construction and maintenance of roads.

V. RSA AND IT’S METHODOLOGY

Road safety audit is a formal procedure for assessing accidents and safety performance in the new road provision schemes, the improvement and rehabilitation of existing road & in their maintenance. The auditor’s role is to provide independent advice in the form of written recommendations. It is carried out in six stages as per the standard guidelines and methodology suggested by the Indian Roads Congress (IRC SP 88). The major stages involved are feasibility study, preliminary design phase, detailed design phase, construction phase, pre-opening phase and monitoring existing phase. The major steps involved in the audit stages are initiating the audit, gathering project reports and plans, studying the plan, undertaking the audit and completion. All the stages of RSA as mentioned in IRC:SP:88-2010 along with their checklists have their respective tasks that are to be completed in that particular stage accordingly. To achieve objectives of RSA following methodological steps are followed in this study

- Review of relevant literature,
- To study methodology given in IRC:SP:88:2010 for road safety audit,
- To carry out road safety audit on selected route based on the proposed methodology.
- Identification of the deficient road safety features.
- Determination of hazardous location and the black spots.
- To suggest remedial measures to improve road safety.

VI. ROAD SAFETY AUDIT OF STUDY AREA

Traffic conditions in Vidisha city are heterogeneous. The city has trading, commercial, administrative, institutional and residential activities. The road network which I have taken is one of the busiest routes of Vidisha city which deals with the colleges, schools, public places and markets. So locations have high frequency of accidents but fatality is less. Many locations suffer parking problems, bus stops, culverts, pavement maintenance, drainage system, roadside obstacles, extra widening, lighting arrangement, marking, super elevations, encroachments etc. So it is important for a road organization to also examine the deficiency of location with a high accident numbers or severity.

For conducting road safety audit

A. Various information was gathered such as

- Accident data required.
- Maps of the region and road network.
- Street lighting, Traffic Signs and Road Markings.
- Alignment of Road, Horizontal and Vertical curves.

B. Data was collected from

- Various Reference books and Civil Engineering Handbooks.
- Various Research papers published in International, National and IRC journals.
- Internet data.
- Traffic Police and FIR data, Vidisha City.
- Various concerned Authorities.

C. Identification of safety issues and there remedial measures at various locations- After reviewing the audit work plan the site was visited and then identification of the safety deficiencies was made. Suggestion for minimizing the safety hazards by using appropriate checklist data was then given at different locations along NH 146

- Project: Road Safety Audit of NH 146 from sagar puliya to sanchi petrol pump.
- Project Environment: Urban
- RSA stage(s): Existing Stage.
- Name of Road: NH 146 Saugor-Vidisha-Bhopal road
- Number of Lanes: Single lane, 2 Way Road
- Type of Road: National Highway 146
- Length of Study Area:12.00 km
- Project Background: The road connects Vidisha city to Bhopal via Raisen. This NH146 passes through the centre of the city. Various colleges, schools, public places, banks, commercial and industrial buildings etc. are located on this road. It is a densely populated area having high volume of mixed traffic.
- Checklists Adopted: Checklist6 (Existing Roads), Checklist8 (alignment), Checklist10 (junctons), Checklist11 (road sign), Checklist12 (road marking), and Checklist13 (lighting) of IRC: SP: 88- 2010.

As per the data obtained from dehaat thana and city kotwaali road accidents have earned vidisha a doubtful distinction. The accident figures have reached alarming proportions. Nearly 125 people met with accidents in vidisha city during last one year. As per 5 year data obtained from the traffic police, dehaat thana of vidisha city following conclusive points were obtained:

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Year</th>
<th>Total no. of accidents</th>
<th>Person Killed</th>
<th>Person Injured</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>2011</td>
<td>100</td>
<td>16</td>
<td>84</td>
</tr>
<tr>
<td>2.</td>
<td>2012</td>
<td>105</td>
<td>18</td>
<td>87</td>
</tr>
<tr>
<td>3.</td>
<td>2013</td>
<td>98</td>
<td>19</td>
<td>79</td>
</tr>
<tr>
<td>4.</td>
<td>2014</td>
<td>111</td>
<td>21</td>
<td>90</td>
</tr>
<tr>
<td>5.</td>
<td>2015</td>
<td>125</td>
<td>26</td>
<td>99</td>
</tr>
</tbody>
</table>

Table 1: Trend in Road Accidents occurrence year wise

<table>
<thead>
<tr>
<th>Month</th>
<th>Number of Accidents</th>
<th>Month</th>
<th>Number of Accidents</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>02</td>
<td>July</td>
<td>00</td>
</tr>
<tr>
<td>February</td>
<td>02</td>
<td>August</td>
<td>02</td>
</tr>
<tr>
<td>March</td>
<td>05</td>
<td>September</td>
<td>02</td>
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<tr>
<td>April</td>
<td>05</td>
<td>October</td>
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</tr>
<tr>
<td>May</td>
<td>01</td>
<td>November</td>
<td>02</td>
</tr>
<tr>
<td>June</td>
<td>00</td>
<td>December</td>
<td>03</td>
</tr>
</tbody>
</table>

Table 2: Trend in Road Accidents fatalities in different months of the year 2015

Source: khatouni-karyalay thana prabhari, Dehaat thana, Vidisha
Based on the audit and data collected from the police station 10 black spots due to multiplicity of accident causative factors were identified along the section.

- Culvert near usha agro industries
- Petal mill intersection
- 4-legged junction at SATI gate
- 4 legged junction at durga nagar square
- Railway over bridge
- Gandhi chowk intersection
- Staggered intersection near sabzi mandi and bus stand
- Edegaah square
- Culvert near rangai
- Curve near rangai temple and location near rangai bridge

Thus it can be concluded that:
- Accident Rate has highly increased in 2015
- Fatality Rate is rapidly increasing.
- People aged 15-20 and 21-30 are major victims of accidents
- Major causes of the accidents are the bad roads and improper traffic control devices.
- Most of the accidents have occurred in March-April.

VII. CONCLUSIONS

Globally millions of people are surviving with the grief of death or disability of a family member from road traffic injury. RSA is an efficient, cost-effective and proactive approach for improving the road safety. The main objective of this study was to conduct RSA on one of the busiest route and lifeline of the Vidisha city NH 146 which connects the city to Sagar and Bhopal thereby finding the main deficiencies on this route which leads to the road accidents and suggesting appropriate measures to control them. The following conclusions were drawn based on this study:

- Most of the locations along the selected section have inappropriate shoulders and have severe pavement edge drop which often leads the driver loose balance over the vehicle. Shoulders are either not leveled properly or have insufficient width. As per IRC specifications, shoulder width should be minimum 1.2 m.
- As per IRC specifications, guard rails should be provide where height of embankment is greater than 3 m. Culverts near rangai temple and in front of usha industries there is a gap at the approach of culvert which increases the chances of off-tracking and overturning of vehicles from the road. Thus properly delineated guard rails with appropriate length should be provided.
- Construction barricades are not installed at bridge construction site. Providing proper barricades will improve the safety.
- Most of the sections near bus stand, sabzi mandi overbridge passes through the congested residential area, where the colony, shopping complex, colleges, bus stands and mandi area are near the road. Thus fast moving traffic comes in contact with the slow moving traffic which increases the chance of collision. Thus, appropriate approaches should be provided at these locations.
- Parking area should be provided at jeevandhara hospital, sabzi mandi, Gandhi square, bus stand along the road side for the breakdown of vehicles so that they do not occupy the carriageway width
- At some locations bus stops are on the carriageway width (ahmedpur square, main bus stand, edegaah intersection, petal mill) which disturbs the smooth and continuous traffic flow. These bus stops should be away from the carriageway width.
- Near SATI college and circuit house plantation is along the road side and in fact on the footpath due to which pedestrian movement is hindered and footpaths could not be utilized.
- Proper traffic sign boards were not present across the stretch of the road. So the traffic could neither be regulated nor warned of the oncoming hazard. Also, no traffic signals were present at the junctions where most of the fatal accidents are possible.
- At most of the junctions and approach roads a lot of hoardings are hanged which distract the road users attention and often lead to fatal accidents. Hence, these should be immediately removed.
- Several road side vendors are on the road side. The drivers slow down suddenly at these places leading to a conjunction in the traffic network. Hawkers point are to be created away from the intersection.
- Most of the length of the highway is not provided with adequate street lighting especially area near rangai temple, amrai restaurant etc. which hinders the visibility at night. Thus proper street lights along the entire length of highway and high mast lights at intersections should be provided.
- The pavement markings are not present at maximum section of the road, otherwise if present were found faint and non-reflecting at night hence were of no use in conveying information to the traffic. Hence, road paint or thermoplastic road markings having reflective characteristics at night and during bad weather conditions can be used on the road surface to convey warnings, to provide information and to indicate the required manoeuvres. Some of the recommendations by IRC for road markings is given as follows.
- Provide Broken single white lines of width 10cm and length 3m to divide carriage way.
- Provide continuous solid double line of 10 cm width for declaring no-overtaking zone
- For pedestrians, provide zebra crossings with white colour stripes 50 cm wide, 50 cm apart & 2-4m long
- Provide edge markings with white colour solid line of width 15-20 cm.
- Rumble strips can be provided on shoulders at sharp curves to alert drivers who have strayed from carriageway
- Besides this EEE i.e engineering enforcement and education measures can also help a lot in reducing traffic accidents. Measures for emergency medical response should also be sound and improved further.
- Along with this, various traffic calming measures at busy locations like speed humps, chicanes, curb extensions, road humps 75 mm high, speed breakers should be provided.
VIII. RECOMMENDATIONS FOR FURTHER WORK

Following are the recommendations suggested for further works:

1) A new and more effective approach to carry on a road safety audit can be found apart from the one suggested in IRC:SP 88:2010.

2) The accuracy and effectiveness of RSA can be improved by utilizing GPS and remote sensing technologies to mark black spot locations and integrating it with GIS.

3) More accidents causing parameters could be included in the Checklist for Road Safety Audit.

4) New advanced and non-cumbersome methods should be implied for conducting Road safety Audits.

5) New computer programs and software’s could be developed for undertaking Road safety Audit and thereby analyzing Road safety Audit result.

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