Black Spots Management

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ABSTRACT

The economic growth and increase in population in developing countries is causing steep increase of traffic and demand for better highway facilities. The phenomenal growth of motor vehicles on their road networks, high speeds and traffic mix are causing huge increase of accidents, loss of human lives and an inestimable misery to the families of victims. Although the accident investigation and maintaining statistics of accidents is a police function, there is ample scope for Highway Engineers to analyse all available information and suggest short/long term mitigation measures.

The experience in various countries shows that formal systematic black spot management is a demonstrably effective and cost beneficial tool to improve the road safety. The accident analysis done and safety audit of various aspects of highway conducted to reduce the unexpected situations and convey unambiguous message. The paper outlines the black spot management system to reduce accident locations and road fatalities.

1.0 Introduction

Road safety is a major public health and transportation problem in many countries. Each year large numbers of people die/injured as a result of road traffic collision. These road traffic injuries take away the human and financial resources that a country need for development. Reducing road casualties and fatalities will reduce suffering and make resources available for more productive use to speed up growth.

UN General Assembly passed resolution 64/2551 on March 2010 and declared 2011–2020 the Decade of Action for road safety, with a global goal of stabilizing road fatality and then reducing the forecasted level of global road fatalities by increasing safety related activities conducted at national, regional and global levels.

In the decade of action plan, Government of India, Ministry of Road Transport & Highways (MoRTH) has taken up the improvement of 786 nos. black spots at country level.

2.0 Road Accident and its Causes

The collision of one road user with the other road user or with the fixed object within the roadway or running off from the roadway is termed as road accident. These accidents may cause damage to property, vehicles and injury to users or even death of road users.

The road accidents caused due to various factors are as follows:
2.1 Road

The geometry of the road influences the road user behaviour. The defective geometric design like inadequate width of carriageway & shoulders, improper super elevation, steep embankment slopes, inadequate site distance, poor horizontal/vertical geometry, blind intersection, narrow & weak bridges, absence of signs, improper lighting, etc. might cause accidents. In addition, the physical condition of road such as riding surface, skidding, potholes, ruts or any other damaged state of road will result in accidents.

2.2 Vehicle

The type of vehicle, its operation characteristics such as acceleration/deceleration rate, braking efficiency, lighting, etc. influence the road user behaviour and might cause accidents. The vehicle defects that might result in accidents may be failure of brakes, steering system, tyre burst, axle breaking etc.

2.3 Road User

The road users responsible for accidents may be driver of one or more vehicles involved, pedestrians, passengers and animals.

2.3.1 Drivers

The accidents may be caused due to excessive speed, rash & negligent driving, violating traffic rules & regulations, right of way violation, failure to see or understand traffic situation, sign or signal, temporary effects due to fatigue & sleep, intoxicating effects of alcohol, overage and bad eye sights, etc.

2.3.2 Pedestrians

Pedestrians' actions are less predictable than the motorists. The accidents may be caused due to pedestrian carelessness while moving on the road, violating regulations, etc.

2.3.3 Passengers

Passengers are alighting or getting into moving vehicle, alighting at intersection or signals, travelling on rooftops of vehicles, stretching head and hand outside of moving vehicles, etc. cause accidents.

2.3.4 Animals

Animals become the cause of accidents due to their haphazard movements on the road.

2.4 Environmental Factors

Unfavourable, weather conditions like mist, fog, rainfall, snow, dust or smoke that restricts normal visibility and render driving unsafe.

2.5 Natural Calamities

This will include accidents due to landsides, avalanches, earthquake, shooting boulders, tsunami, etc. which is beyond the control of human.
2.6 Miscellaneous

Ribbon developments, incorrect signal light, gate of level crossing not closed when required, badly located service stations, etc.

3.0 Approach and Methodology

A detailed methodology has been drawn and presented in flow diagram:

4.0 Accident Data Collection

Accident data is the base measure of safety. The existence of reliable accident data is thus crucial element in the management of road safety. The best source of validated accident data will be the police authorities i.e. either the
policeman attending the scene of the accident or the officer at a police station who receives the report by the parties involved/witnesses. It is known that there are substantial numbers of under reporting of road accidents to the police. The level of under reporting will vary from place to place; though it is likely that the level will tend to be lower with increasing severity of injury.

The accident data shall be collected for road network from the police station. The photocopy of FIRs of accidents details is procured or recorded from the FIRs. The data collected from the police stations is in their own format and regional language. This needs to be translated into English language and transformed on the format as per IRC 53. The details of accident shall be recorded for year wise as per IRC 53: 2012 as follows:

i. Police station name

ii. Date/month/year and time of accident

iii. Accident Chainage or nearest km post

iv. Details of accident victims: Nos of fatality/seriously injured/non injured

v. Details of numbers of vehicles involved in accident, Accident with Pedestrian/ Tree/ Parapet/ Railing/ Crash Barrier, etc.

vi. Type of Manoeuvre: Diverging/merging/crossing/stationery/parked/ U-turning, etc

vii. Accident Spot Location: Urban, Rural, Industrial, School/College, Religious, Others (Specify)

viii. Classification of Accident: Hit Pedestrian, Head on collision, Hit from Back, Hit from Side, Hit Fix/Stationary Object, Overturn, Run off road, Others (Specify)

ix. Classification of Accident: Fatal, Grievous injury, Minor injury, Non injury

x. Cause of Accident: Drunken, Over speeding, Red light Jumping, Driving wrong side, Mechanical Failure, Unknown, Not Applicable


xii. Load Condition: Normally Loaded, Over loaded/Hanging, Empty, Unknown

The accident victims detail shall also be collected from the nearby trauma care centre of accident prone locations. A collation shall be done about the accident fatality/grievous details of police and trauma care centre. Accordingly, the increase nos. of fatality occurred on black spot shall be updated.

5.0 Accident Data Analysis

The accidents are classified according to the most serious injuries during the crash. The crash severity rating used by police is as follows:
A fatal crash is one where at least one fatality happened.

Grievous injury accident is one where an injury requiring hospitalisation and report to police station.

Minor injury and non-injury are where injury requiring no hospitalisation/reporting to police station.

Accident collision diagram shall be prepared for each location showing reason of accident and numbers of various kind of accidents such as Hit Pedestrian, Head on collision, Hit from Back, Hit from Side, Hit Fix/Stationary Object, Overtake, Run off road, etc.

Presently, there is no defined accident analysis technique/methodology followed in India. “Accident Black Spots” or “Black Spots” are locations where the road accidents repeatedly take place or tend to cluster together. Black Spots may be Nodes (junctures/intersections) or Links (mid-block between adjacent Nodes) or Cells (areas).

In order to quantify the criticality of an accident site, a system of assigning scores can be adopted based on the severity of accident. The score termed as Accident Severity Index (ASI). Accident Severity Index is a dimensionless value indicating the hazardousness of a spot on the road.

The following equation has been used:

$$ASI = (N_f x W_f) + (N_g x W_g)$$

Whereas,

- $N_f$ = No. of fatal accidents or fatality at the spot;
- $W_f$ = Weightage assigned to fatal accident or fatality = 7;
- $N_g$ = No. of grievous accident or grievous injured persons;
- $W_g$ = Weightage assigned to grievous accident or grievous person = 3

Note:

i. The value of $W_f = 7$ and $W_g = 3$ was recently adopted for black spots determination while doing safety audit of NHAI PPP projects and given very satisfactory results

ii. In some countries, minor injury & non-injury are considered and weightage of 1 adopted but in India generally these accidents are not recorded therefore these accidents may not be considered for determination of black spots.

Accident Severity Index will be determined for each location based on numbers of fatal/grievous accidents {ASI(n)} and numbers of fatality/grievous persons {ASI(p)}. The final ASI of each location will be determined.

$$ASI = \frac{1}{2} (ASI(n) + ASI(p))$$

The Hazardous Spots on the road network are prioritized based on Accident Severity Index (ASI).

6.0 Site Study and Public Consultation

A detailed site inspection of the black spot locations shall be conducted and details collected as follows:
i. Road Carriageways: Single lane, Two lanes, Three lanes with/without central divider (median), Four lanes with/without central divider.

ii. Road Type: with/without service road

iii. Road Geometry: Straight road, Slight Curve, Sharp Curve, Flat Road, Gentle incline/decline, Steep incline/decline, Hump, Dip

iv. Intersection Type: T-Junction, Y-Junction, Four arm Junction, Staggered Junction, Junction with more than 4 arms, Roundabout Junction, Intersection below grade separator, Manned Rail crossing, Unmanned Rail Crossing

v. Pavement Type: Bituminous, Concrete, Gravelled

vi. Pavement Condition: Poor, Fair, Good, Very Good

vii. Pavement Markings: Provided, Faded, Not existent,

viii. Signs: Type of Signs and their spacing

ix. Lighting: Adequate, Not provided

x. Traffic Calming Measures: Rumble strips, Speed hump, etc.

A video film can be prepared on each black spot to capture the road features details and traffic plying at that location.

The details can also be collected from road owning authorities i.e. PWD such as any project reports, design details, data, drawings, etc.

The officials shall also be requested to highlight, any deficiencies that need to be addressed. The community input nearby the black spot shall be taken in addition to details provided by police for the probable cause of accidents on the black spot locations.

7.0 Safety Audit of Black Spot

Safety audit of each location shall be conducted as per IRC SP 88: 2010 to see how the road location interacts with the surroundings and to visualize the potential obstacles and conflicts, which the road user is likely to encounter.

A night time inspection shall also be done. The information available to road users can also be markedly different at night time and it can be surprising what additional issues can be identified on a night time inspection.

The inspection shall also include adjacent sections of road on the intersection as it is at these locations that the greater hazards could occur.

The inspection would be carried out from the point of view of all road user groups and not just motorists. The inspection for different user groups would include different types of movements such as crossing the road, entering the traffic flow as well as for travelling along the highway. The black spot will be investigating to determine
Are accidents being caused by the physical condition of road or adjacent property, and can the problem be eliminated or corrected?

Are deficiencies in road geometry, median opening, structure width, etc?

Is the pedestrian/cyclist crossing facilities such as footpath, railing, zebra crossing, etc existing?

Is a “blind” corner or restricted sight line at a junction responsible for accidents?

Are the existing signs, signals and markings performing the job for which they were intended? Have conditions at the site changed since the devices were installed? Are replacements needed? Could the devices be causing accidents rather than preventing them?

Is traffic properly channelized to minimize the accidents?

Would accidents be prevented by the prohibition of any single movement such as turn at a minor road?

Could some type of traffic be diverted to other roads/bypassed where problems are unlikely to be transferred?

Is night time accidents out of proportions to day time ones thus needing special night time protection, e.g. retro reflective signs, street lighting or traffic signals?

Are there any particular times of day, year or weather conditions when accidents are common?

Do adequate drainage facilities exist?

Is accidents are caused by location of public facilities along road such as bus stop, truck parking, petrol pump, restaurant/dhaba, etc?

Do conditions indicate the need for additional levels of law enforcements?

8.0 Audit Report

The audit report shall contain the features of the project, deficiencies which involve hazards and make recommendations about corrective actions. The recommendations must reflect sound judgment of the audit team and shall be backed with convincing reasons for appreciated by the decision makers.

The report is to be a concise, brief document setting out a summary of the measures to be taken, the reasoning behind recommendation of such measures and the items identified that require remedial measures/treatment from the safety point of view. The recommendations would be numbered or identified in a way, which make them easy to refer to in the follow-up visits.

Safety issue shall be given priority of high, medium, low considering the safety problem. Accordingly, mitigation measures short and long term on black spot location is suggested. The rough cost for implementation of mitigation measures is also be determined based on PWDs schedule of rates or market rates as applicable. A cost benefit analysis of each black spot is also done to prioritize investment.
9.0 Implementation of Mitigation Measures

Safety is a very important attribute. As far as road is concern, it should be provided with such measures which are adoptable to the limitation of an ordinary vehicle and ordinary driver. The road should provide for simplifying the task of road user so that they do not make mistakes/errors and even if they do, they should have some protection from major injury. Mitigation measures are implemented so that:-

- Road geometry commensurate with the expected traffic volume and operating speed
- No surprise element/obstruction over sudden variation in geometric is present
- Elements in monotony/fatigue are eliminated
- Logical and uniform cautionary signage system is installed
- Lane and intersection marking to channelise and guide traffic are provided
- Advance notifications of any special features are provided
- Protection wayward vehicles leaving there normal path is taken care of
- Provision of incident management such as accidents and removal of road blockage is taken care of
- Urban areas with high pedestrians are provided with lightening for improved safety of pedestrians

10.0 Safety Awareness

Safety awareness is an important aspect to reduce accident on black spot locations. A safety awareness campaign shall be specifically formulated preferably in regional local language and a campaign shall be run at least for one day for population nearby the black spot in association with panchayat and local administration.

11.0 Monitoring and Evaluation

It is important to establish the effectiveness of the safety mitigation works undertaken by implementing agency. The treated black spot location shall be visited to monitor the progress of remedial measures and assess the impact of the remedial measures in terms of reduction in accidents, injuries and fatalities.

The first step of the procedure focuses on evaluating whether the treatment has been successful in achieving its objective of reducing the number of accidents. This therefore requires comparison of the numbers of accidents of the target group “before” the treatment with the number “after” treatment and to study whether any other accident type has increased. Therefore, accident analysis shall be carried out every quarter after implementation of mitigation measures.

The statistical analysis will be carried out to determine the change in the frequency of accident is by chance or due to mitigation measures implemented at various sites. The cumulative frequency of numbers of accidents will be determined and finally “k” test or “Chi Square test” will be conducted.

A video film shall be prepared on each location to assess the change scenario i.e. traffic plying behaviour on black spot location after implementation of mitigation measures.
About Authors:

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