Black Spot Identification & Crash Data Analysis
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Geetam Tiwari
TRIP CENTRE
Indian Institute of Technology Delhi

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Introduction

➢ This guideline provides guidance towards identification of blackspots and improvement for road crash prone locations through engineering interventions.

➢ It also provide practical guidance in carrying out blackspot improvement programme.

➢ Location specific and infrastructural measures can be implemented to decrease number of crashes. This can be defined as “treating the blackspot sites”.

➢ Blackspot improvement is a crash data led investigation process to understand the causes of road crashes and then to design and implement matching countermeasures.
Road Safety Improvements Approaches

Safe Systems Approach:

- SSA built on the premise that deaths and serious injuries are not acceptable in road systems and no road user should be exposed to the level of kinetic energy that may result in death or serious injuries in road system.
- SSA promoted by The Netherlands as the Sustainable Safety and in Sweden as the “vision zero” policy.
- Sustainable Safety can be achieved by a proactive approach in which human characteristics are used as starting point.
- These characteristics refer on the one hand to human physical vulnerability and on the other hand to human (cognitive) capacities and limitations.
Key Principles of Safe System Approach (SSA)

• Principle 1: Recognition of human fraility
• Principle 2: Acceptance of human error
• Principle 3: Creation of a Forgiving environment and appropriate crash energy management.

Thus design of roads play an important role in road safety and improved geometric design of road infrastructure could in turn improve road safety.
Approaches to the task of treating roads with bad accidents records –

• Single site scheme or blackspot programme: treatment of individual sites (e.g. junctions, bends or short (500m) of road in which road crashes are clustered by safety engineering interventions.

• Route action scheme: safety treatments applied to the whole length of road which has overall bad crash record.

• Mass action scheme: standard treatments are applied to locations having incidences of common type of road crashes.

• Area action scheme: safety treatments will be applied throughout an area having bad overall road crash record.
Black Spot Treatment Process

➢ In blackspot improvement programme, road traffic crashes are analyzed spatially for fixed period of years (3 to 5 years) and where localized higher density of road crashes are identified (clusters) these can indicate that there are deficiencies with the road environment.

➢ Thereafter, suitable remedial measures should be devised and undertaken to rectify the defects to reduce incidences of road crashes and fatalities on identified road stretch.
IDENTIFICATION & PRIORITIZATION OF BLACKSPOTS
- Create initial blackspot list
- Setting reaction levels
- Shortlist blackspots

BLACKSPOT ANALYSIS
- Crash Data Collection & Analysis
- Identify common accident patterns
- Stick & Collision Diagram analysis
- Shortlist treatments for common patterns

SITE INVESTIGATION
- Site Investigation Form
- Physical & Operational Checklist

FINAL DIAGNOSIS
- Additional studies
- Identify treatable patterns & designs
- Decide whether to proceed

DEVELOP COUNTERMEASURES
- Match solutions to patterns & problems
- Estimate likely accident reduction
- Estimate cost of countermeasures
- Do scientific cost benefit analysis

DETAILED DESIGN
- Detailed design drawings
- Technical specifications
- Bill of Quantities / Estimates

IMPLEMENTATION
- Tender documents & procurement
- Construction & Supervision
- Publicity & enforcement campaign

MONITORING & EVALUATION
- Scientific “Before & After” Study
- Statistical tests
- Re-do cost benefit analysis

STAGE 1
Stage 1 can be carried out by Road Agencies, Road Safety Professionals, Research Bodies, Road Safety Consultants & Academic Institutions.
The output of Stage 1 will be a ‘Blackspot Investigation & Treatment Plan’ report
The report shall include, but not limited to, the following:
- Detailed crash data analysis
- Report on site investigation
- Selection process of countermeasures
- Recommended treatments
- Likely crash reductions
- Tentative cost of treatment plan
- Scheme drawings, where applicable

STAGE 2
- Stage 2 to be carried out by Engineering Consultants
- Stage 1 agency shall be retained for guiding detail design, if required

STAGE 3
- Stage 2 agency shall be retained at this stage for guiding implementation, if required

STAGE 4
- Usually carried out by a Monitoring & Evaluation Specialist/ Agency
Blackspot Identification and Prioritization

- Identification of blackspots based on available road crash record is one of the mandatory pre-requisites to undertake blackspot improvement programme.

- This section provides simple way to identify blackspots in different states in the country and presents a prioritization exercise based on total number of road crash types and injury severities at all identified blackspots.

- They are shortlisted to enable the road agencies to plan a blackspot improvement programme which is to be implemented in a phased manner this would take care of the urgency by which blackspots are to be treated.
Defining of Blackspots for identification:

• Blackspot is a road section of 300-500m length that has an abnormally high number of road crashes showing a pattern of road crash types due to some underlying local risk factors.

• Volume of traffic in most of the NHs/SHs are substantially high and hence the crash frequency and fatalities are high; the above classes of highways (including expressways) continue to account for the 55-60% of the overall crashes and deaths in the last decade.

• An uniform guiding value cannot be applied across the country for identifying blackspots, it has to be state specific as well as according to road class.
Identification of blackspots

1- AVERAGE ANNUAL TOTAL CRASH VALUES : stepwise procedure to find AACTV
✓ Three year fatality data is collected from official sources.
✓ Road lengths is collected from official website of MoRTH.
✓ Annual Average Total Crashes collected over 3 year period are divided by respective road lengths to get AATC/Km
✓ AATC is further divided to get AATC for 500m of road length.
✓ AATC/500m is multiplied by suitable factors (3 to 15 times that is setting reaction level) to arrive at a number for the particular state considered in the analysis.
2- SETTING REACTION LEVEL: the reaction level for identifying for the blackspots could be 3 times or 5 times or 10 times or 15 times.

- Those road sections (with crash clusters) securing more than 15 times AATC can be termed as 1\textsuperscript{st} order blackspots whereas between 10-15 times AATC and 5-10 times AATC and 3-5 times AATC are termed respectively as 2\textsuperscript{nd}, 3\textsuperscript{rd} and 4\textsuperscript{th} order blackspots.

3- BLACKSPOTS IDENTIFICATION USING A CRASH DATA MANAGEMENT SYSTEM:

Blackspots can be identified using various methods including spatial analysis, cluster analysis, corridor analysis etc.
PRIORITIZATION OF BLACKSPOT FOR TREATMENT

• Identified list of blackspots has to be prioritized for treatments in given financial year to match with the available budget. It is done by severity indices.

• Severity indices: severity score shall be assigned with values given below

  1) Fatal road crashes – 10 points
  2) Serious injury crashes – 5 points
  3) Minor injury crashes – 2 points
  4) Damage only crashes – 1 point
IDENTIFICATION BLACKSPOSTS USING A CRASH DATA MANAGEMENT SYSTEM

1) Cluster Analysis
2) Heat Map Analysis
3) Corridor Analysis

Figure 4-3 Corridor Analysis in a Crash Data System
BLACKSPOT ANALYSIS

1) Detailed Road Crash Data Collection: The investigating team/expert should necessarily visit the police station and gather data from the FIR of each case of road crash for the shortlisted blackspots.

2) Prepare Summary Analysis:
   • Type of crash
   • Severity of crash
   • Type of Victims
   • Type of vehicle involved
   • Type of injuries
Crash Data Analysis
5. Rear End w.r.t Facility Location

No. of Rear-end Crashes: 272

Legend
Black line: Expressway Stretch
Green Dots: Rear End Crash Locations
Red Dots: Toll Plaza and Interchanges Locations
Density (KDE) of Rear End Crashes

Red section has the highest concentration of RE Crashes
Inferences from Crash Data Analysis

- Crashes based on types of collision

<table>
<thead>
<tr>
<th>Type of Crash Collision</th>
<th>Fatal Crashes (%)</th>
<th>Non-Fatal Crashes (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rear End</td>
<td>41%</td>
<td>33%</td>
</tr>
<tr>
<td>Hit Median</td>
<td>12%</td>
<td>18%</td>
</tr>
<tr>
<td>Hit Guardrail + Overturned + Topple Down</td>
<td>11%</td>
<td>26%</td>
</tr>
<tr>
<td>Total (%)</td>
<td>64%</td>
<td>77%</td>
</tr>
</tbody>
</table>

- Crashes are distributed all over.
- **Average Rate: 3.39 Accident per km**
- Identification of **crashes locations** based on hotspot analysis
  - 0 to 3 km, 9km, 27km, 31 km, 49 km, 53 km, 61 to 62 km, 75 km, 81 km, 87 km, 90 km, 114 km, 123 km, 165 km
- Exit and Entry Ramps are unsafe.
1) **Site Visit**: Investigating team to make thorough inspection of the blackspot site where road crashes have occurred. The two main reasons for doing the site inspection are-

   i) to accurately assess the road conditions and other site factors which may be relevant; and

   ii) to actually experience the problems that road users are facing.

Ideally, the engineering investigating team should walk as well as drive through the site in both day and night-time conditions.
2) **Recording of Findings**:

- Video cameras, or digital cameras and voice recorders, enable images of the site to be recorded along with a spoken commentary of issues.
- Following safety protocol shall be followed for all site visits: Ensure personal safety / team safety, Ensure public safety.

3) **Site Investigation Form**:

- Investigation team shall use site investigation form these may include the typical aspects like obstructions to the visibility, lack of visual clues, uncontrolled junction maneuvering, visibility funnel (in the case of intersections and curves) and lack of pedestrian facilities, etc.
CHECKLISTS

3 Types of Checklists

1. Checklist for Entry, Exit Ramps and Interchanges

2. Checklist for linear sections

3. Checklist for toll plazas
Checklist for Entry/Exit, and Interchanges

Divided into 5 Sections

- **Section 1**: General Items
- **Section 2**: Check for Signs
- **Section 3**: Traffic Calming Measures
- **Section 4**: Check for Guardrail
- **Section 5**: Lighting Condition
4) **Site Investigation Checklists**:
   - both physical checklist and operational checklist will have to be used. The checklist will pose questions to be answered during the site visit.

5) **Additional Surveys and Studies**:
   - Detailed examination of witness statements in the Police case file.
   - Traffic counts and surveys of classified turning volume counts at junctions
   - Pedestrian counts
   - Surveys of pedestrian crossing behaviour
   - Measurement of visibility distances
   - Spot speed surveys.
   - Conflict studies
1 **Final Diagnosis**: Investigation team is expected to come out with diagnosed problems for each of the blackspot site. The findings have to be drawn and clearly expressed with sound reasoning, because these are the basis for selecting the countermeasures.

2) **Identify Treatable Problems**: The analysis should always yield results with two types of locations such as –

- Locations where distinct problems are identified
- Locations where the analysis are inconclusive
3) **Countermeasures**: certain engineering treatments, if implemented properly, are very successful in reducing certain common crash types. These engineering treatments are generally known as countermeasures. Likely contributory factors along with potential countermeasures are given below:

<table>
<thead>
<tr>
<th>Likely Contributory Factors</th>
<th>Possible Countermeasures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excessive speed not matching the road environment.</td>
<td>Speed limiting measures</td>
</tr>
<tr>
<td></td>
<td>Install vertical speed calming measures – speed breakers etc.</td>
</tr>
<tr>
<td>Driver fatigue</td>
<td>Provide speed limiting signs and initiate speed enforcement.</td>
</tr>
<tr>
<td>Road alignment unclear</td>
<td>Install warning signs along with advisory speed limit.</td>
</tr>
<tr>
<td>Excessive speeds- loss of control</td>
<td>Improve control</td>
</tr>
<tr>
<td></td>
<td>Mark no overtaking zones</td>
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</table>
IMPLEMENTATION OF BLACKSPOT MITIGATION MEASURES

The formulation of mitigation scheme has benefits such as:

i. Enable safety engineer to check mitigation measures suitability at the site and there will not be any conflicts or other problems.

ii. Client will have better understanding of the mitigation proposals and subsequently make provision for budgeting, approvals, etc.

iii. Enable bidders to better understand and thus give a realistic quote.

iv. Provide a basis for controlling the construction work on site.