Blackspot Auditing on Hill Roads

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What is a Blackspot?

- Geurts et al. (2003)
  - A black spot as a location on the road where the concentration of crashes has exceeded the specified value of the crashes in a certain duration of time. For example more than 4 fatalities in a year

- Elvik (2007)
  a) Numerical definitions based on accident number, accident rate, and accident rate and number;
  b) Statistical definitions based on the critical value of accident number, and the critical value of accident rate,
  c) Model-based definitions based on the Empirical Bayes method and Dispersion value

- MoRTH (2015)
  - a road stretch on NH of about 500m in length, in which either five road accidents took place during the last three years or the ten fatalities took place during the last three years. The
Why identify blackspots?

- Blackspots are also known as
  - Hazardous road locations
  - High-risk locations
  - Accident-prone locations
  - Hotspots
- Road section where accidents are concentrated affects and even determines the safety level of the entire road to some extent.
- Focusing on eliminating safety hazards in concentrated road sections is the most effective and economical way to improve the overall safety of roads.

What is Road Safety Audit (RSA)?

- A thorough and detailed examination of a road design from a road safety perspective.
- As per Austroad: “... a formal examination of a future road or traffic project or an existing road, in which an independent, qualified team* reports on the project’s crash potential and safety performance...”
- As per IRC:SP 88-2019: “A formal, systematic and detailed examination of a road by an independent and qualified team of auditors* that leads to a report of the potential concerns in the project.”
History of RSA

In the late 1980s - Road Safety Engineering (RSE) team in a English County observed number of new roads in the County’s black spot list.

Policy requiring all new road designs to be checked and approved for Safety by the RSE team before construction.

This checking process became Road Safety Audit (RSA) and RSE team became the first road safety audit team.

RSA team applied black spot investigation skills to eliminate safety concerns at the design stage.

First “road safety audit manual” was published by the Institution of Highways and Transportation (IHT) in late 1990 to guide and encourage this new process.

“Road safety audit” came in to use for a thorough and detailed examination of a road design.

Purpose of RSA

To ensure that road users would be exposed to minimal risks of accidents in both new roads and existing roads.

Can help in establishing the application of safety principles in the provision, improvement and maintenance of roads as a means of accident prevention.
Principles of RSA

- Recognition of human frailty
- Acceptance of human error, and
- Creation of a forgiving environment and appropriate crash energy management.
- Purpose is not to penalize accused

RSA is not

- As per SP 088.2019 Manual
  - a check of compliance with standards.
  - a substitute for regular design checks.
  - a crash investigation.
  - an opportunity to re-design a project which needs to be carried out separately.
  - a name for a more detailed site inspection.
  - a way of assessing or rating a project as good or bad.
A good RSA is accomplished when?

• Focus is on road safety issues only.
• Keep relevant standards and guidelines in mind while remembering that audit is more than compliance check with standards.
• Consider the needs of all road users (including pedestrians, two/three wheelers, animal drawn vehicles, depending upon their presence and proportion in the traffic) in all weather and lighting conditions.
• It is thorough and comprehensive.
• It is realistic and practical in findings. But do not rule out options because of cost - it is the road authority that will decide whether the investment can be justified.
• Produce audit report promptly - usually within four weeks of the audit inspection.

What is an RSA?

<table>
<thead>
<tr>
<th>Independent Team of Auditors</th>
<th>Formal Examination</th>
<th>Report of potential safety concerns in project</th>
</tr>
</thead>
<tbody>
<tr>
<td>Qualified Auditors</td>
<td>Systematic</td>
<td>Assesses safety of ALL road users (car drivers / passengers / pedestrians / bicyclists / motorcyclists / trucks / bus passengers / 3-wheelers / users of animal drawn vehicles)</td>
</tr>
</tbody>
</table>
RSA Objectives

- **Primary**
  - Minimize risk of crashes
  - Minimize severity of crashes

- **Secondary objectives**
  - Minimize risk of crashes on adjacent roads (at intersections)
  - Importance of safety in road design
    - needs and perceptions of all road users are met
    - achieve a balance between needs where they may be in conflict
  - Reduce long term costs
  - Awareness of road safety engineering principles in process of planning, designing, constructing, operating, managing and maintaining roads and highways.
  - Awareness of providing safe road schemes for non-motorized as well as motorized road users

More about RSA

**Process**
- Formal examination
- Based on set process
- Become a part of record of the whole road project

**Inputs**
- Time
- Knowledge
- Skill
- Judgment
- Depth and detail

**Expected Outcome**
- Road safety audit report
- Identifies road safety issues
- Provide recommendations
RSA stages

Stages of road project where RSA can be applied as per IRC:SP 88-2019

- **Stage 1:** Feasibility stage or Preliminary Design Stage
- **Stage 2:** Detailed Design stage
- **Stage 3:** Construction Stage
- **Stage 4:** Pre-opening Stage
- **Stage 5:** Safety Audit of Existing Roads

Steps in Road Safety Audit

- **Identification of need**
  - Road authority

- **Preparation of team and team leader**
  - Project manager of road authority

- **Inception**
  - Information provision and audit requirements

- **Assessment of drawings and designs**
  - Audit team

- **Response on audit report**
  - Project manager

- **Completion meeting**
  - Project manager and team leader

- **Audit report preparation**
  - Team leader with audit team

- **Inspect site – day and night**
  - Audit team

- **Follow up and implementation**
  - Project Manager
IRC codes for road safety

- IRC:35 Code of Practice for Road Markings
- IRC:67 Code of Practice for Road Signs
- IRC:SP:88-2019
- IRC:79 Recommended Practice for Road Delineators
- IRC:SP:73 Manual of Specifications and Standards for Two Laning of Highways with Paved Shoulders
- IRC:SP:84 Manual of Specifications and Standards for Four Laning of Highways
- IRC:99 Guidelines for Traffic Calming Measures in Urban and Rural Areas
- IRC:SP:55 Guidelines for Traffic Management in Work Zones
- IRC:119 Guidelines for Traffic Safety
- IRC:SP:48 Hill Road Manual

Road Safety Audit (RSA) Methodology contd - Example from UPPWD

- Flowchart of the blackspot audit methodology
RSA Methodology

Activities to be carried out at an audit location
• Geolocated blackspots
• Recorded observations in checklist
• Captured photographs
• Shot video of the conflicting maneuvers
• Measurements of road design elements
• Speed measurement using laser speed gun

Typologies considered for categorizing BS
Typologies

- **Area Type**
  - Rural
  - Urban

- **Location Typology**
  - Midblock
  - Intersection
  - Settlement or Non-Settlement

- **Junction Typology**
  - Cross Intersection (X)
  - T Junction
  - Y Junction
  - Staggered Junction

- **Road Typology**
  - National Highway (NH)
  - State Highway (SH)

Types of at grade Junctions

- **Alignment type**
  - Curve section
  - Straight section (non-curve)

Blackspots Typology

<table>
<thead>
<tr>
<th>BS Type</th>
<th>BS Type based on location typology</th>
<th>Major Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type 1</td>
<td>Midblock</td>
<td></td>
</tr>
<tr>
<td>Type 2</td>
<td>Midblock (through settlement)</td>
<td></td>
</tr>
<tr>
<td>Type 3</td>
<td>Midblock (near settlement)</td>
<td></td>
</tr>
<tr>
<td>Type 4</td>
<td>Staggered junction</td>
<td></td>
</tr>
<tr>
<td>Type 5</td>
<td>Staggered junction (through settlement)</td>
<td></td>
</tr>
<tr>
<td>Type 6</td>
<td>Staggered junction (near settlement)</td>
<td></td>
</tr>
<tr>
<td>Type 7</td>
<td>T-junction</td>
<td></td>
</tr>
<tr>
<td>Type 8</td>
<td>T-junction (through settlement)</td>
<td></td>
</tr>
<tr>
<td>Type 9</td>
<td>T-junction (near settlement)</td>
<td></td>
</tr>
<tr>
<td>Type 10</td>
<td>Y-junction</td>
<td></td>
</tr>
<tr>
<td>Type 11</td>
<td>Y-junction (through settlement)</td>
<td></td>
</tr>
<tr>
<td>Type 12</td>
<td>Y-junction (near settlement)</td>
<td></td>
</tr>
<tr>
<td>Type 13</td>
<td>Intersection</td>
<td></td>
</tr>
<tr>
<td>Type 14</td>
<td>Intersection (through settlement)</td>
<td></td>
</tr>
<tr>
<td>Type 15</td>
<td>Intersection (near settlement)</td>
<td></td>
</tr>
<tr>
<td>Type 16</td>
<td>Multi-leg junction</td>
<td></td>
</tr>
<tr>
<td>Type 17</td>
<td>Multi-leg junction (through settlement)</td>
<td></td>
</tr>
<tr>
<td>Type 18</td>
<td>multi-leg junction (near settlement)</td>
<td></td>
</tr>
</tbody>
</table>
**Distribution of BS Types**

BS type 14 and Type 8 are having the highest BS type.

BS type 14 is four leg intersection passing through the settlement.

BS type 8 is T junction passing through the settlement.

**Summary of representative BSs contd**

<table>
<thead>
<tr>
<th>Blackspot no.</th>
<th>BS Type</th>
<th>Junction Type</th>
<th>Major road</th>
<th>Minor Road</th>
</tr>
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<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Road category</td>
<td>Divided/ Undivided</td>
</tr>
<tr>
<td>1</td>
<td>Type 14</td>
<td>X</td>
<td>NH</td>
<td>Divided</td>
</tr>
<tr>
<td>4</td>
<td>Type 8</td>
<td>T</td>
<td>NH</td>
<td>Divided</td>
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<tr>
<td>5</td>
<td>Type 13</td>
<td>X</td>
<td>MDR</td>
<td>Undivided</td>
</tr>
<tr>
<td>6</td>
<td>Type 10</td>
<td>Y</td>
<td>NH</td>
<td>Undivided</td>
</tr>
<tr>
<td>10</td>
<td>Type 1</td>
<td>Mid block</td>
<td>ODR</td>
<td>Undivided</td>
</tr>
<tr>
<td>11</td>
<td>Type 13</td>
<td>X</td>
<td>ODR</td>
<td>Undivided</td>
</tr>
<tr>
<td>12</td>
<td>Type 11</td>
<td>Y (Settlement)</td>
<td>ODR</td>
<td>Undivided</td>
</tr>
<tr>
<td>13</td>
<td>Type 6</td>
<td>Staggered</td>
<td>SH</td>
<td>Undivided</td>
</tr>
<tr>
<td>14</td>
<td>Type 7</td>
<td>T</td>
<td>SH</td>
<td>Undivided</td>
</tr>
<tr>
<td>18</td>
<td>Type 3</td>
<td>Mid block</td>
<td>ODR</td>
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</tr>
<tr>
<td>28</td>
<td>Type 14</td>
<td>X (Settlement)</td>
<td>SH</td>
<td>Undivided</td>
</tr>
<tr>
<td>35</td>
<td>Type 14</td>
<td>Staggered (Settlement)</td>
<td>MDR</td>
<td>Undivided</td>
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<tr>
<td>38</td>
<td>Type 4</td>
<td>Staggered</td>
<td>MDR</td>
<td>Undivided</td>
</tr>
<tr>
<td>47</td>
<td>Type 8</td>
<td>Staggered (settlement)</td>
<td>NH</td>
<td>Divided</td>
</tr>
<tr>
<td>50</td>
<td>Type 2</td>
<td>Midblock (Settlement)</td>
<td>SH</td>
<td>Undivided</td>
</tr>
<tr>
<td>53</td>
<td>Type 14</td>
<td>X (Settlement)</td>
<td>SH</td>
<td>Undivided</td>
</tr>
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</table>

### 7. Case Study of Blackspots Inspection
Mohiddinpur Sugar Mill Blackspot (BS1)  

**Type 14**

**BS 1: Major observations**

**Major Road observations**

- Raised **median** was obstructing the pedestrian crossing.

- **Non-standard rumble strip** on both approach lanes to the junctions.

- **Non-standard bar markings** on both approach lanes of the junction.

- **Edge drop** between pavement and soft shoulder.

- Flashing beacon was **non-functional**.
BS 1: Minor Road Observation

Minor Road observations

• Non-standard rumble strips on minor road

• Speed limit sign on minor road

• Give way sign was present

• Paved shoulder with roadside activity

Hazardous Situations:

1. Pedestrians are facing conflict from oncoming vehicles while crossing the road.

2. Passengers of a bus and para transit are facing a risk of getting hit by other vehicles while boarding and deboarding at the informal stop.

3. The risk to cyclists and pedestrians from fast & wrong side moving vehicles.

4. Obstruction of sight distance due to overloaded sugarcane vehicles specially for cyclists and motorcyclists.
Recommendations BS 1

- Change of texture with the help of cut stones.
- Sequential application of interventions such as:
  - Set of bar markings as per the design speed
  - Rumble strips as per the standard.
- Provide continuous zebra-crossing.
- Design of bus stop as per the Draft IRC 80 section 4, Figure 1.
- Road marking as per IRC:35-2015.
- Repair the non-functional flashing beacon present on the major road.
- Provide lightings.
- Minor Road: Install the rumble strips and speed breaker on the minor road with adequate road signages and markings (as per IRC:99-2018).

Option 1:
- Change of texture with the help of cut stones for at least 250 m of the intersection.

Option 2:
- Provide the median (as shown in the figure) to streamline the traffic.
- U-turn on both sides is proposed at 250m away from intersection
- Provide 50m gap for u-turn for tractors to access the sugar mill.

Rithani Peer Blackspot (BS 4)

Type 8
BS 4: Major Road observations

- **Pedestrian crossing** is wrongly placed before the rumble strips.
- **Conflicting movements** at the junction.
- **Raised median** is obstructing the crossing.
- **Concrete block** is acting as hazard.
- **Edge drop** between pavement and soft shoulder.

BS 4 Minor road observations

- **Non-standard speed breaker** is present
- **Stop sign** is present.
- **Road-side activities** are present.
BS 4 Minor road observations

• Non-standard speed breaker is present

Hazardous Situations:

1. Pedestrians are facing conflict from oncoming vehicles while crossing the road.

2. Passengers of a bus and paratransit transport are facing a risk of getting hit by other vehicles while boarding and deboarding at the informal stop.

3. The risk to cyclists and pedestrians due to fast moving vehicles.

Recommendations BS 4

• Change of texture with the help of cut stones.

• Sequential application of interventions such as:
  • Set of bar markings as per design speed
  • Rumble strips as per standard.

• Pedestrian crossing for the zones passing through the settlement.

• Design of bus stop as per the Draft IRC 80 section 4, Figure 1 for rural four lane highway intersection.

• Increase the lumen intensity for the nighttime visibility at the intersection.

• May install flashing beacon on the major road

• Minor Road: May install the combination of Rumble strips and speed breaker on the minor road with road signages.
Jai Puliya Blackspot (BS 5)

Type 13/ Rural Intersection

BS 5: Major Road observations

- **No speed** reduction measures.

- **Bar markings** (1 set on each side) present on both side of the intersection.

- **No warning/informatory sign** to users on main road regarding intersection ahead.

- **Earthen shoulder** is not well maintained.

- **No lighting** facility for nighttime.
**BS 5 Minor roads observations**

- Rumble strip was not present.
- No other measures were present.
- New overlay layer was done.
- Masking of signages

**Hazardous Situations:**

1. **Pedestrians** are facing conflict from oncoming vehicles while crossing the road.
2. The **risk to cyclists and pedestrians** due to fast moving vehicles.
3. **Risk of the crash** due to conflicting traffic maneuver at the intersection.
Recommendations BS 5

- **Change of texture** with the help of cut stones.

- **Sequential application** of interventions such as:
  - Set of bar markings as per design speed
  - Rumble strips as per standard.

- **Install red road studs** (per IRC:35-2015).

- **Design of kerb side bus stop** as per the Draft IRC 80 section 5, clause 5.6 and figure 5 for rural two-lane highway.

- **Install flashing beacon** on the major road to warn the driver.

- **Provide lighting** at the intersection for the nighttime traffic.

- **Minor Road**: Install the combination of rumble strips and speed breaker with road signages.
BS 6: Major Road observations

- **Crash cushion** not present at conflicting section.

- **Merging as well as diverging section** having conflicting movements.

- **No measures to reduce speed** on the approach side of the junction for traffic coming from Meerut.

- No formal bus stop **facility** was available.

BS 6: Major Road observations

- **Roadside hazards** such as poles, trees are present.

- **30 kmph speed limit** sign was present.

- Give way sign **wrongly placement** on major road.

- **No lightings** for nighttime.

- **No measures on minor road.**
BS 6: Major Road observations

- Roadside hazards such as poles, trees

Hazardous Situations

1. Passengers of a bus and para transit transport are facing the risk of getting hit by other vehicles while boarding and deboarding at an informal stop.
2. Pedestrians are facing conflict from oncoming vehicles while crossing the road.
3. The risk to cyclists and pedestrians due to fast moving vehicles.
4. Risk of the crash due to conflicting traffic maneuver at the junction.
5. Wrong side movements near the junction is causing conflict.

- No measures on minor road.

- No lightings for nighttime.

Recommendations BS 6

- Improve traffic management to reduce possible conflicts by redesigning the junction.
- Close the road Mawana road approaching the Y junction from Mawana town direction.
- Change of texture with the help of cut stones.
- Sequential application of interventions such as:
  - Set of bar markings as per design speed
  - Rumble strips as per standard.
- Provide lighting at the intersection for the nighttime traffic.
- Design of bus stop as per the Draft IRC 80 section 4.
- Minor Road: install the combination of rumble strips and speed breaker with road signages.
Gayatri College to Kalindi College Blackspot (BS 10)

Type 01

Case Study of Blackspots Inspection in Hill Roads
Chandwan

Available measures:
- 4-Lane divided
- Signages
- Road Markings
- Lighting

Not Available Measures:
- Grade separator
- Bypass
- Rumble strips
- Crash barriers

Gurha Morh

Available measures:
- 4-Lane divided
- Signages
- Road Markings
- Lighting

Not Available Measures:
- Grade separator
- Bypass
- Rumble strips
- Crash barriers
Kootah Morh
Ch. 54+350 Ch. 54+850

Available Measures:
• Grade separator
• Bypass
• Rumble strips
• Crash barriers

Rajbagh

Available Measures:
• Ch. 37+300, to 37+800

Available measures:
• 4-Lane divided
• Signages

Not Available Measures:
• Grade separator
• Bypass
• Rumble strips
• Crash barriers
Swanka Morh

Ch. 80+600 to Ch. 80+900

Available measures:
- 4-Lane divided
- Signages
- Road Markings
- Lighting

Not Available Measures:
- Grade separator
- Bypass
- Rumble strips
- Crash barriers

Assar Morh

Available measures:
- Road markings
- Road signs
- Road studs

Not Available Measures:
- Crash Barriers
- Retaining wall
- Breast wall

No delineation and pavement markings present on junction (Curve)
Khellani Pump

Available measures:
- Breast wall
- Crash barriers
- Road studs
- Road signs

Not Available Measures:
- Road markings

Lalpadi

Available measures:
- Road markings
- Road signs
- Road studs

Not Available Measures:
- Crash Barriers
- Retaining wall
- Breast wall
Thanks and Discussion