TRAINING HANDOUTS

INTRODUCTION TO THE BASIC PRINCIPLES OF ROAD SAFETY ENGINEERING

1. Introduction

This lecture would provide an overview of the road safety engineering (RSE) field. This is a special field of traffic engineering. Extensive knowledge of traffic engineering features is an essential key requisite. However, to carry out simple safety works profound knowledge of the existing traffic condition and an open mind to identify the persisting safety problem is enough. Few specialized elements of traffic engineering will be discussed in the lecture entitled 'Road Safety Engineering Tools'.

2. 3E in Road Safety Engineering

Road Safety issue is a problem of multi disciplinary nature. Broadly speaking there are three disciplines involved in the problem. The disciplines are Engineering, Education, Enforcement termed as 3Es. An example may clarify the claim. We, the engineers, provide road signs and marking son the roads. Signing and marking play a very important role in safe operation of road network. Now, if the drivers are unaware of the meanings of the road signs and markings they are unlikely to obey them. So, unless proper education it is not worthwhile to provide any signs and markings. Moreover, without proper enforcement of the orders conveyed by these signs and markings it is most unlikely that the drivers would obey them.

3. Road safety engineering vs. traditional traffic engineering

There are conflicts between the traditional traffic engineering and road safety engineering. Here are few interesting issues where traditional traffic engineering is in conflict with road safety engineering.

- Traditional traffic engineering is concerned with the higher capacity and speed of the road network. The safety aspects are ignored. However, road safety engineer compromises the capacity or speed for road safety.
- Traditional highway engineers are only concerned with the structural aspects of a road network. But other road features (e.g. signing & marking) are most often ignored.
- The conventional practice of bridge designers is to reduce the crest width of highway on the bridges and culverts. Instead of running the hard shoulder over the bridge they provide a slightly raised walkway for the pedestrians. The bridge engineers think that a raised walkway would provide a safe shelter for the pedestrians while on the bridge. This is a nice safe thinking. But the engineers do not think for the provision of a safe passageway for the NMVs. The NMVs are at jeopardy during their crossing maneuver on the bridge, as they have to share the main carriageway with faster moving vehicles. And NMVs have little or no flexibility to leave the main carriageway and provide path for the faster moving motorize vehicles as they are confined on the bridges by the slightly raised walkway for the pedestrians on both edges of a bridge.

4. Whai is a blackspot location?

A high accident location is usually defined as a location that experiences abnormal,

- frequencies,
- rates
- or the severity of accidents

However, such high accident history may not necessarily mean that the location is truly hazardous. A hazardous location would be one that presents a risk to the driver in terms of high probability of accident occurrence or high accident severity.

5. How a high-risk location (blackspot) ranked?

First step of the identification of blackspot location is to define a 'reaction level'.

A 'reaction level' is the number of accidents per highway unit occurring within a defined time scale and above which investigation should take place.

An example of reaction level could be a blackspot definition of 12 or more personal injury accidents at a site in two-year period. This means any location with 12 or more personal injury accidents in two-year period should be taken care of. It is important to be able to identify accident problem sites as efficiently and precisely as possible. However, it must be borne in that the objective of any ranking program must be to produce sites with 'treatable' accident problems.

6. Activities

The Road Safety Engineering activities can be classified into two major groups,

- Improvement of hazardous location on the existing road network
- Road Safety Audit, Prevent accident in the new or rehabilitated road project

Hazardous Location

Location wise this can be categorized into four

- Single Site (Black Spot)
- Route Study
- Mass action Plan
- Area wide

7. Accident cost

In a study it is estimated that the global cost of road accident is US$ 230 Billion per annum. There are several well established methods of finding out the total cost of an accident. Apart from the property damage aspects of road safety, the injuries and fatalities that occur as a result of accidents have serious implications for a country in both social and economic terms. The other cost include the cost in terms of human life, pain, grief, sufferings, hospital cost, institutional cost, insurance cost, loss of input in the society etc.

8. Road Safety Engineering in Bangladesh

Very limited study on road and traffic so far has been carried out in Bangladesh. In many instances we are using the study results carried out in various developing countries. Before adapting various study these results, changes need to be made so that these results suit with our traffic and road environment condition. This is due to the fact that the traffic behavior as well as traffic pattern of our country is in many ways different than those of developing countries. Here are few examples:

- Non Motorized Vehicles (NMVs) are very common mode of transport in our country. Side by side motorized vehicles NMVs share use our highways. However, many developing countries do not allow slow moving NMVs on the highways. So during the designing highways safe facilities for NMVs should be provided.
- The traffic volume composition on our roads is different from many developing countries. Cars are very common vehicles on the highways of various developing countries. Whereas, buses and trucks are common on our roads.
- During road building activity very limited attention is given on the traffic engineering aspects. So, accidents taking place on our road are mostly due to the lack of traffic engineering measures. And of course side by side inadequate road users knowledge is responsible factor of the accident occurrence.

MONITORING OF IMPLEMENTED SCHEMES

Introduction

Monitoring provides information of the performance of the implemented measures. How effective is that measure in reducing target accidents? Are there adverse effects? Is the measure likely to reduce one group of accidents but increase the risk of exposure to another? To be effective we must learn from implemented schemes. If a scheme is successful and we can establish all of the reasons we can use that information in future work. If a scheme fails and we can find out why we can avoid making the same mistake again.

Basic rules for monitoring.

Period of monitoring

In most cases three years data is needed for accident analysis. The system tracks accidents

from one month after completion of the scheme for a period of 36 months.

Construction period

Rate of road accident normally increased during the construction period. The accidents that occur during the construction period should not be considered during the evaluation.

Seasonal variation

Accident rates fluctuate throughout the year. Bad weather and longer daily hours of darkness in winter months are usually associated with higher accident rates. To avoid seasonal variation, the system selects the first month following completion of the measures and compares accidents occurring in that month with the number of accidents occurring in the corresponding month of the previous year.

Before after study

We need to quantify the accident change occurring as a result of implemented measures of important schemes. If a scheme is particularly successful in reducing target accident we must not stop there perhaps a further detailed analysis of ‘after’ accidents will identify secondary treatable problems. If we can quantify the reasons and the extent of the reductions we can apply the same measures at other sites with similar problems. A full study requires three years ‘before’ and three years ‘after’ data.
The steps involved are as follows:

1. Background
2. The original accident analysis
3. The implemented measures
4. ‘Before’ period accidents
5. ‘After’ period accidents
6. Data presentation (change of accident type)
7. Statistical tests
8. Data comparisons
9. Conclusions
10. Recommendations

Using control data and statistics

Control data

In most of the above monitoring measures (and particularly accident changes) it is necessary to take into account other factors not affected by the treatment which might also influence that measure. Examples are : a change in speed limit on roads which include the site; National Road Safety campaigns; traffic management schemes which might affect volume of traffic.

These changes may be compensated for by comparing the same ’before and after’ periods with accidents (or other measurements) at "control" sites which are untreated. Control data can be either by matched pairs or area controls.
When choosing control sites :-

- they should be as similar as possible to treated sites
- they should not be affected by the treatment
- there should be more than 10 times the number of accidents at the control sites

Evaluation

The effect on accidents

This step of the procedure focuses on evaluation of whether the treatment has been successful in achieving its objective of reducing the number of accidents. This therefore requires comparison of the number of accidents in the target group ‘before’ the treatment with the number ‘after’ treatment (with the assumption of a similar ‘before’ pattern if nothing were done), and to study whether any other accident type has increased.

Changes in the environment
A change in the environment of driving habits can affect the accidents occurring at the study site. For example, a change in the national speed limit for the class of road at the site, or closure of a nearby junction to the site producing a marked change in traffic patterns.

Random fluctuation
The rare and random nature of road accidents can lead to quite large fluctuations in frequencies occurring at a site from year to year, even though there has been no change in the underlying accident rate. This extra variability makes the effect of the treatment more difficult to detect; but a test of statistical significance can be used to determine whether the observed change in accident frequency is likely to have occurred by chance or not.

Regression to the mean
This effect complicates evaluations at high accident or blackspot sites in that accidents at these sites tend to reduce even when no treatment is applied. Even if a 32 year total is considered at the worst accident sites in an area, it is likely that the accident frequencies were at the high end of the naturally occurring random fluctuations, and subsequent years will yield lower numbers. This is known as *regression to the mean*.

No. of injury accidents per site in 1991	No. of sites	Total accidents in 1991	Total accs. at same sites in 1992	Change in accidents (uncontrolled)
9-10	1	10	6	-40%
7-8	2	15	10	-33%
5-6	6	32	20	-38%
3-4	17	61	68	+12%
0-2	96	76	119	+57%
Totals	122	194	223	

Table 7.1
Injury accidents at 122 nodes in Seremban

Possibly the most straightforward way of allowing for both the regression-to-mean effect and changes in the environment would be to use control sites chosen in exactly the same way as the treated sites, and identified as having similar problems, but LEFT untreated. In practice, it is both difficult to find matched control sites and, if investigated, to justify *not* treating them.

Accident migration

There is still some controversy over whether or not this effect exists but several researchers have reported it. It is simply that an increase in accidents tends to be observed at sites adjoining a successfully treated site giving an apparent transfer or 'migration' of accidents.

It can be detected by comparing the accident frequencies in the surrounding area before and after implementation of treatments at sites in the area with a suitable control. It is unclear precisely why this effect occurs but is suspected that drivers are 'compensating' for the improved safety at treated sites by being less cautious elsewhere.

Risk compensation

This is an even more controversial effect, though related to the previous section. The philosophy of "risk compensation" or "risk homeostasis theory" suggests that road users will change their risk-taking behaviour to compensate for any improvements in road safety. That is, road users tend to maintain a fixed level of accepted risk, so will take more risks when given greater accident protection, for example, if provided with seat belts or anti-lock brakes.

Standard tests on accident changes

In evaluating a treatment the answers to the following questions will usually be required :

- Has the treatment been effective?
- If so, how effective has it been?

The k test

It is possible that although accident levels reduced at a treated site in an 'after' period, the general level of accidents is also reducing; the "real" reduction at the site due to the treatment thus being *less* than the actual numbers observed (i.e. *overestimating* effectiveness). Conversely, if the general level of accidents is increasing an *underestimate* of the treatment would be obtained. The "*k* test" can be used to show how the accident numbers at a site change relative to control data.

For a given site or group of similarly treated sites, let:

a = before accidents at site
b = after accidents at site
c = before accidents at control
d = after accidents at control

then $$k = \frac{b/a}{d/c}$$

or, if any of the frequencies are zero then ½ should be added to each, i.e. :

$$k = \frac{(b+\frac{1}{2}).(c+\frac{1}{2})}{(a+\frac{1}{2}).(d+\frac{1}{2})}$$

If $k < 1$ then there has been a *decrease* in accidents relative to the control;

if $k = 1$ then there has been *no change* relative to the control; and

if $k > 1$ then there has been an *increase* relative to the control.

The percentage change at the site is given by :

(k-1) x 100%

The Chi-Squared test

It is important to answer whether the above change in accidents was indeed produced by the treatment or whether this occurred by chance. This test thus determines whether the changes are statistically significant.

Example

On a stretch of road there is a specific site with the following accident record:
Dark accidents = 6, daylight accidents = 3
On the rest of the road over the same period the accident record was:
Dark accidents = 38, daylight accidents = 100 (this is known as "control" information)

It is necessary to establish whether the distribution of dark and daylight accidents at the site is significantly different from expected values.

A table can be set up as follows:

	site	**control**	**total**
dark	6(a)	38(c)	44(g)
light	3(b)	100(d)	103(h)
total	9(e)	138(f)	147(n)

Using formula

$$c^2 = \frac{\left(|ad - bc| - \frac{n}{2}\right)^2 .n}{efgh}$$

$$c^2 = \frac{\left(|100x6 - 3x381| - \frac{174}{2}\right)^2 147}{9x138x44x103} = 4.44$$

Referring to the Chi Squared Distribution Table (Appendix 4B) and looking along the line v = 1 within the main table, the main table, the closest value to the 4.44 calculated above appearing on this line is 3.841. The figure above this is .05 and is the “significance level”- more usually quoted as a percentage – in this case 5%.

This means that the probability of getting 6 dark accidents at a site with a total of 9 accidents by chance when other similar sites have 38 dark out of 138 is only 5%.

The significance level of 5% arrived at above can be looked at ion another way. It can be said that there is a 95% (100 minus 5) chance that the number of dark accidents did not occur by chance. In statistical terms this is known as the “confidence level”.

12 months 'before' and 'after' accident analysis of Khilkhet Bus Stand

Introduction :

Khilkhet Bus Stand is one of the busiest junctions on airport Road. An access road, coming from the residential area west of Airport Road, joins in this junction. There is also another access road, coming from the east of Airport Road, joins to this junction. The residential areas, both side of the road, generate quite a large volume of pedestrian and other commuter traffic. To assist the pedestrians to cross the busy Airport Road a pedestrian overbridge was built by RHD in 1997. This analysis is targeted to study the effect of this structure in reducing the pedestrian accident in this junction. Note however that it is thought that a large proportion of casualty accidents are not reported and this could affect the validity of these findings. This finding is based on an analysis of police records of fatal and serious injury road accidents and minor accidents are not considered due to the underreporting.

Basic principles :

This analysis includes the accidents occurred in the vicinity of the junction. 12 months before and after accident data were analyzed. The accidents occurred in the stretch of Airport Road from Staff Road Level Crossing to Airport Access, excluding the accidents occurred in the vicinity of Khilkhet Bus Stand, was considered as the control (other similar location which is not affected by the treatment). Seasonal variation was avoided by comparing accidents occurring in the same months during before and after period. The period during which work was carried out was excluded from the analysis.

Background of the construction :

The pedestrian overbridge was built by RHD without interpreting the local accident data (?). But from the analysis of the before period accident a cluster of pedestrian accidents was noticed. It is to be noted that, in before period analysis, in six out of 11 injury accidents at least a pedestrian was involved.

Measure :

The local RHD had started to build the overbridge in April 1997 and finished after six month i.e. October 1997. The pedestrian overbridge was built slightly north of the access road coming from the residential area west of the intersection.

'Before' period accidents :

A total of 11 accidents occurred in twelve months period ending March 1997. In six accidents (55%) at least a pedestrian was involved. Three accidents were rear end shunt type. Of the eleven accidents five of them were fatal, 4 grievous injury and 2 simple injury accidents. Six accidents occurred during the hours of darkness.

Pedestrian accident :

Of the six pedestrian accidents (0.5 accidents per month) four of them were fatal. Three accidents occurred during the hours of darkness.

'After' period accidents :

A total of 19 accidents occurred in twelve months period ending October 1998. In ten accidents (52%) at least a pedestrian was involved. Six accidents were rear end shunt type. Of the 19 accidents 9 were fatal and 10 grievous injury accidents. 12 accidents occurred during the hours of darkness.

Pedestrian accident :

Of the ten pedestrian accidents (0.83 per month) six of them were fatal. Eight accidents occurred during the hours of darkness.

Data comparison :

Accident Type	Before	After	% Change
Total	11	19	+8 (73%)
Total pedestrian	6	10	+ 4 (66%)
Nose-to-tail shunt type	3	6	+3 (100%)
Dark accident	6	12	+6 (100%)
Dark pedestrian accident	3	8	+5 (166%)
Fatal injury	5	9	+4 (80%)
Fatal pedestrian accident	4	6	+2 (50%)

Total accident at this location increased from eleven to 19, an increase of eight accident (73%). The targeted accidents were pedestrians accidents. Accident involved pedestrians increased from six in the 'before period' to 10 in the 'after' period, an increase of four accidents (66%). The other major accident type 'rear end shunt' also shows an increase. Dark accident shows an increase of 100%. There is a huge increase in the dark pedestrian accident (166%).

Statistical Test :

The increase in the 'total' and 'pedestrian' before and after accidents were tested using 'K' test. The results show an increase in the total accident but a decrease in the pedestrian accident.

K test

The following symbols will be used during the statistical test.

a = before accidents at sites
b = after accidents at sites
c = before accidents at control
b = after accidents at controls

then, $$k = \frac{b/a}{d/c}$$

	Site		Control	
	Before (a)	After (b)	Before (c)	After (d)
All accidents	11	19	49	71
Total Pedestrian	6	10	18	37

Table : *Injury accidents in one year period at treated site and controls*

All accident

$$k = \frac{19/11}{71/49}$$
$$k = 1.2$$

Comments, as k>1 then there has been an increase relative to the control.

Pedestrian accident

$$k = \frac{10/6}{37/18}$$
$$k = 0.81$$

Comments, as k<1 then there has been a decrease relative to the control.

Conclusion :

Though apparently pedestrian accidents show increase in the site but relative to the control the statistical test shows that the implemented measure may have been successful in reducing pedestrian accident.

FACTORS IN ACCIDENT OCCURRENCE

1. What is a road accident?

A road accident is a rare, multifactorial, randomly occurring event always preceded by a situation in which one or more road users have failed to cope with the situation.

Rare: A “high risk” junction, with 14,000 vehicles passing through the junction each day, recorded a total of 12 injury accidents in three-year period. So the 12 injury accidents relate to a total of more than 15, 330,000 vehicle movements.

Multifactorial: A person or “thing” cannot be a solo cause in an accident. For each accident there is a chain of factors such that each factor is related with each other. Each set of factors in an accident is unique. The factors in each set generally fall into three categories.

- Road and environment : This is the factor we, the engineers, are concern about. Road and environment deficiencies can contributed to accident occurrence. A substandard road element might misguide the driver. Poor and misleading signs or markings might misguide a driver and the consequence is o an accident.

- Vehicle defect : vehicle defects which contribute significantly to accident are mainly those which can develop in a relatively short space of time and are due to lack of regular maintenance.

- Human Factors: The most important group of human factors relate to deficiencies in driver actions, for example travelling too fast for the conditions, failing to give way, improperly overtaking or following too close. The second most important group of human factors is perceptual, for example distraction, inattention, failing to see and misjudgement.

Random: Accident can occur at any point and at any time in the road network. It is impossible to predict accurately where and when the next road accident will occur.

2. Road Accident – A chain of events

Road Accident, a “Chain of events”: The road environment, vehicle defects and human factors are considered to form a chain of events which lead up to an accident.

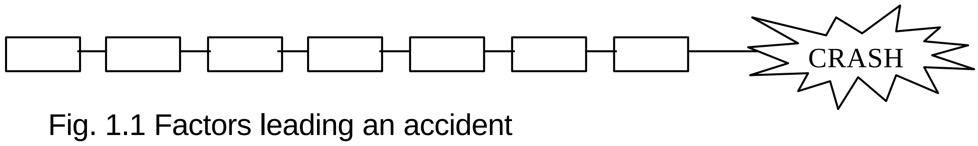


Fig. 1.1 Factors leading an accident

The variety of factors come together to create a situation in which one or more persons fail to cope with the environment. A driver who failed to negotiate a location (say a bend) may well have safely negotiated a location on a numerous occasions when the personal circumstances were different.

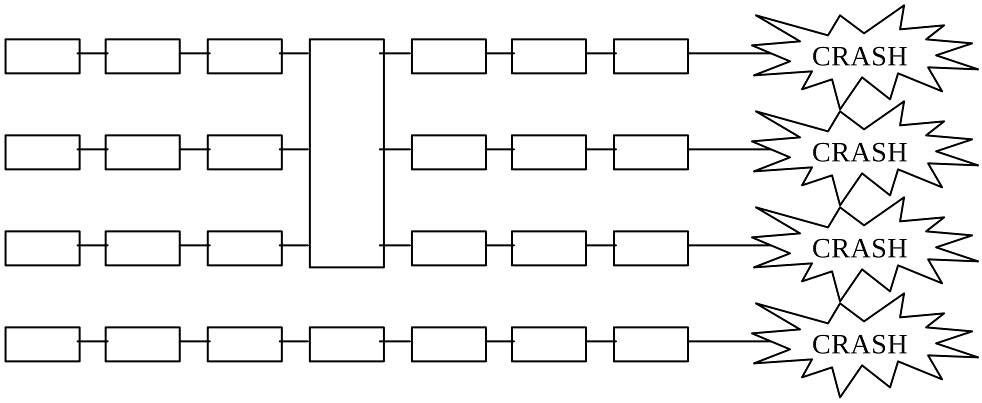


Fig. 1.2 Common factors in accidents

When a number of accidents occur at a particular location it is likely that one or more accidental factors may common in the accidents chain. If we can eliminate the common factor or factors, relater with some accidents, then we can easily break the chain and thus can get rid of the particular accidents.

ROAD SAFETY ENGINEERING IN RRMP-III

1. INTRODUCTION

Under the RRMP-III project there is a specific component of Road Safety Improvement and Road Safety Equipment for the national roads and regional roads.

2. SCOPE OF WORK

Civil works
The improvement of road safety shall be done to improve the overall road safety including the improvements to accident **black spots** on the heavily trafficked national and regional road network in the northwest and southwest part of Bangladesh. These shall generally include:

- Channelisation of inter sections
- Easing of shark curves
- Construction of road side bus bays
- Construction of crash barriers
- Road widening at market areas
- Marking and Signing
- Control road side activities
- Measures to calm down traffic

Road Safety Equipment
This component has been included to improve the conditions of road signs and road markings on the project roads.

3. SELECTION OF BLACKSPOT LOCATIONS

Of the four tasks involved in the road safety improvement, according to the technical proposal, the first task, Task 701, select locations on national and regional roads for road safety improvements, completed in April, 2000.

Selection Criteria
According to the project proposal blackspot locations, located on roads developed during RRMP I & II projects, are to be developed under this component. It has been decided that locations with three fatal accidents or five total accidents occurred during 1997 and 1999 (three years) would be included in the blackspot improvement roster. It is also decided that blackspot locations situated only on National Highways would be selected for improvement. These decisions were taken following several meetings with Road Safety Division, RHD Officials.

Methodology
Police Road Accident Database has been used to identify the blackspot locations. Accident data of all National Roads, developed under RAMP-I & II projects, has been retrieved using 'Microcomputer Accident Analysis Package, version five' ($MAAP_{five}$) software. Police report form for each accident was then collected from respective Divisional Inspector General (DIG) office.
Road Accident Database was established throughout Bangladesh in 1998. So accident data of 1997 is not available from police database. Moreover, it has been felt that police database doesn't contain all the accidents reported to police. So, to collect accident data of the year 1997 and to collect missing data, consultants along with Road Safety Division Officials visited police stations and collected the additional data.

4. LIST OF BLACKSPOT LOCATIONS

Following the above criteria preliminary a total of 35 blackspot locations have been selected based on accident data supplied by police, for improvement on four national roads namely N5, N6, N7 and N8 (see table 01 through 04 for name of the location). Collection of additional accident data resulted in another nine blackspot locations (see table 05).

Black Spot No.	Location		Police Station	Road Division
	K.M Chainage as per Police Reference	Name of the Spot		
1.	105.00	Natibari	Bera	Pabna
2.	106.0106.4	Nandiara	Bera	Pabna
3.	167.8	Shahebgonj Bazar	Raigonj	Sirajgonj
4.	170.0-170.9	Gurka	Raigonj	Sirajgonj
5.	190.3-190.7	Chonka Bazar	Sherpur	Bogra
6.	249.0-249.5	Fasitola	Gobindagonj	Gaibandha
7.	254.6-254.7	Gobindagonj	Gobindagonj	Gaibandha
8.	258.6-258.9	Katakhali Bridge	Gobindagonj	Gaibandha
9.	259.4-260.1	Baluahat Bazaar	Gobindagonj	Gaibandha
10	270.4-270.6	Boirihorinmari	Palashbari	Gaibandha
11.	271.2-272.1	Palashbari	Palashbari	Gaibandha
12.	364.6-364.8	Kamarpukur	Sayedpur	Nilphamari

**N5 (Dhaka-Khashinathpur-Bogra-Rangpur-Panchaghar)*

Table 01 *List of Blackspot Locations on N5*

Black Spot No.	Location		Police Station	Road Division
	K.M Chainage as per Police Reference	Name of the Spot		
1	127.6-127.9	Bonogram Bazar	Shatia	Pabna
2	148.0-148.3	Jalalpur Bazar	Pabna	Pabna
3	219.7-220.1	Tebaria Hat	Natore	Natore
4	224.5-225.0	Matiapara/ Gorostan Bazar	Natore	Natore
5	230.6-231.2	Jhalmalia Bazar	Potia	Rajshahi
6	233.0-233.5	Putia	Potia	Rajshahi
7	238.6-238.8	Biraldaha Mazar	Potia	Rajshahi
8	251.3-251.8	Katakhali Bazar	Motihar	Rajshahi

**N6 (Kashinathpur-Pabna-Natore-Rajshahi-Chapai)*

Table 02 *List of Blackspot Locations on N6*

Black Spot No.	Location		Police Station	Road Division
	Chainage km as per Police Reference and Spot Identification	Name of the Spot		
1	278.000 - 279.800	Rajarhat bazar	Jessore	Jessore
2	283.525 - 285.000	Rupdia bazar	Jessore	Jessore
3	305.500 - 307.500	Rajghat bazar	Avoynagar	Jessore
4	307.500 - 308.500	Jugnipasha Sesh Shimana	Fultala	Khulna
5	308.500 - 309.500	Jugnipasha	Fultala	Khulna
6	309.500 - 310.500	Bezardanga	Fultala	Khulna
7	310.500 - 312.000	Buriadanga Bus Stand	Fultala	Khulna
8	312.000 - 312.700	Fultala 01	Fultala	Khulna
9	312.700 - 314.000	Fultala 02	Fultala	Khulna
10	314.000 - 315.300	Damodore	Fultala	Khulna
11	315.300 - 316.500	Pather Bazar	Fultala	Khulna

**N7 (Daulatdia - Magura - Jhenaidah - Jessore - Khulna)*

Table 03: *List of Blackspot Locations on N7*

Black Spot No.	Location		Police Station	Road Division
	K.M Chainage as per Police Reference	Name of the Spot		
1	218.0 - 218.3	Torki bus stand	Gournadi	Barisal
2	219.2- 219.5	Katakisthol	Gournadi	Barisal
3	246.5 - 246.7	Barisal Cadet College	Babugonj	Barisal
4	247.1 - 247.3	Barisal Cadet College	Babugonj	Barisal

**N8 (Mawa - Bhanga – Madaripur – Barishal)*

Table 04 *List of Blackspot Locations on N8*

Black Spot No.	Location	Road No.	Police Station	Road Division
1	Dathia	N5	Bera	Pabna
2	Chandaikhona	N5	Raigonj	Sirajgonj
3	Alukdia	N5	Sherpur	Sirajgonj
4	Mohipur	N5	Avoynagar	Bogra
5	Nowapara	N7	Jessore	Jessore
6	Palbarimor	N7	Jessore	Jessore
7	Churaman Khathi Bazar	N7	Jessore	Jessore
8	Chachra More	N7	Jessore	Jessore
9	Batajur	N8	Gournadi	Barishal

Table 05 *List of Additional Blackspot Locations*

5. DESCRIPTION OF CIVIL WORKS ON N7, JESSORE KHULNA ROAD

The design of 14 selected blackspot locations on N7, Jessore Khulna Section finished in this month.
Here is a brief description of the key features of various measures:

Gate: To be constructed on the entrance of few busy locations which will mark the transition of a section where lower speed is required. The width of the carriageway near the gate will be seven meters. Carrigeway will be bounded by kerbs of 150 mm high. The length will be 15 meters. Acoustic rumble strips of 12 mm high and 300 mm wide at 500 mm clear spacing will be installed in between kerbs. Delineation posts of one meter high will be installed on the kerb to make the gate conspicuous.

Speed Reducer: Mainly two types of speed reducers will be installed.

- Circular speed reducers where the surface is part of a cylinder surface.
- Trapezoidal raised area, a plane surface with ramps.

The speed reducers to be installed on the main carriageway will be of 9.5 meters long. The carriageway width will be reduced to six meters near the reducers and the edges will be bounded by kerbs. These types of reducers are capable of maintaining 50-kilometer speed. The speed reducers to be installed on the minor roads will be four meter long and are not bounded by kerbs. This type is capable of marinating 30-kilometer speed. The standard rise for all types is 0.1 meters.

Service Road: The roadside activities near few busy bazaar areas will be separate by constructing barriers alongside the carriageway going through these busy areas. The barrier will be one meter high above the road surface. The lower 600 mm of the barrier will be made of concrete and 75 mm diameter GI pipe supported by vertical members at regular intervals will run through the top of the remaining 400 mm. Each segment will be five meters long and the gaps between the segments will be 100 mm. On both sides of the carriageway service road of 150 mm thick RCC pavement will be constructed. Drain will be provided alongside the service road. The standard width of pavement inside the barrier will be 7.3 meters.

Junction: On few minor road pavements medians will be constructed to separate the conflicting traffic movement. The median will be of three meters wide and 150 mm high above the carriageway level and with ramps on both ends. On the entrances of few minor roads kerb stone of 150 mm effective height will be installed to hinder the random movement of vehicles to and from the carriageway to the adjacent developments. The entry radius of the junction varies from seven to ten meters. Few junctions will be rebuilt on a raised profile, similar to raised area in height and widths but varying length. This would facilitate the pedestrians to cross the roadway, as vehicles will slow their speed while crossing the raised area.

Pedestrian Crossing: The raised area and the junctions rebuilt on raised profile will generally be used as pedestrian crossing. Besides, simple pedestrian crossing, with marking and signing will be installed at few locations. The standard width of the crossings will be three meters.

Bus Bay: Bus Bays will be constructed at potential bus stopping places. The standard length of the bus bays will be 25 meters with ‘S’ curves on both edges. A passenger shelter by the side of the bay with raised platform, benches and sheds will be constructed. The standard length of the bus bay will be doubled or halved in places, depending upon the demand of bus. Shaded Rickshaw standing places will be constructed near the bus bays.

Signing and Marking: The successful operation of the above measures largely depends upon the signing and marking. The consultants have prepared the details of signing and marking.

TRAFFIC SIGNS MANUAL FOR BANGLADESH

1. What is TRAFFIC SIGN ?

Any,
object, device, line or mark
which,
restricts, prohibits, warns, informs, describes.

Sign dose not mean only signs or posters, but also
marking
delineatur
road stud
Traffic Signal
other traffic control device
hand signal of traffic police

2. History of traffic sign manual

- The ninth schedule contains drawings of just 30 signs. The designs are generally
- Outdated
- Missing important signs
- Each road authority and projects are producing their own signs. Hence the inconsistency in signing results.
- BRTA intends to replace the signs.
- Before this the traffic signal has no legal basis because they are not included in the sign manual.

3. Types of sign

Size	• Sign gives order (circular) • Sign warns (triangle) • Sign inform (rectangle)
Colour	• Circular sign with blue circles tells you what you must do. • Circular sign with red circles tells you what you must not do.
Inform	• Blue rectangle is used for information. • Green rectangle is used for route signs on National Highway. • White rectangle with black border is used to show directions on roads other than National Highway
Exceptions	• Hexagonal(Stop Sign) • Invert Triangle (Give Way) • Information (Line)

4. Selection of sign type for present use

5. Design and maintenance

Signs must be used with extreme care.

- Multiplicity of sign might confuse the drivers.
- The appropriate size should be ensured which largely depends upon the speed of traffic
- The placement of sign should be such that it is visible to the road users from a considerable distance.
- Any hindrance (e.g. foliage, sign boards, advertising board) which come between road users and sign plate should be removed.
- The sign should maintain regularity.
- There should not be any deposition of dust on the sign which will reduce the reflectivity of sign.
- The materials used for signs should follow the guidance.
- It should ensure that the sign is protect from being theft.
- Consult the expert before you erect the sign.
- A misguiding sign might lead to a serious accident.

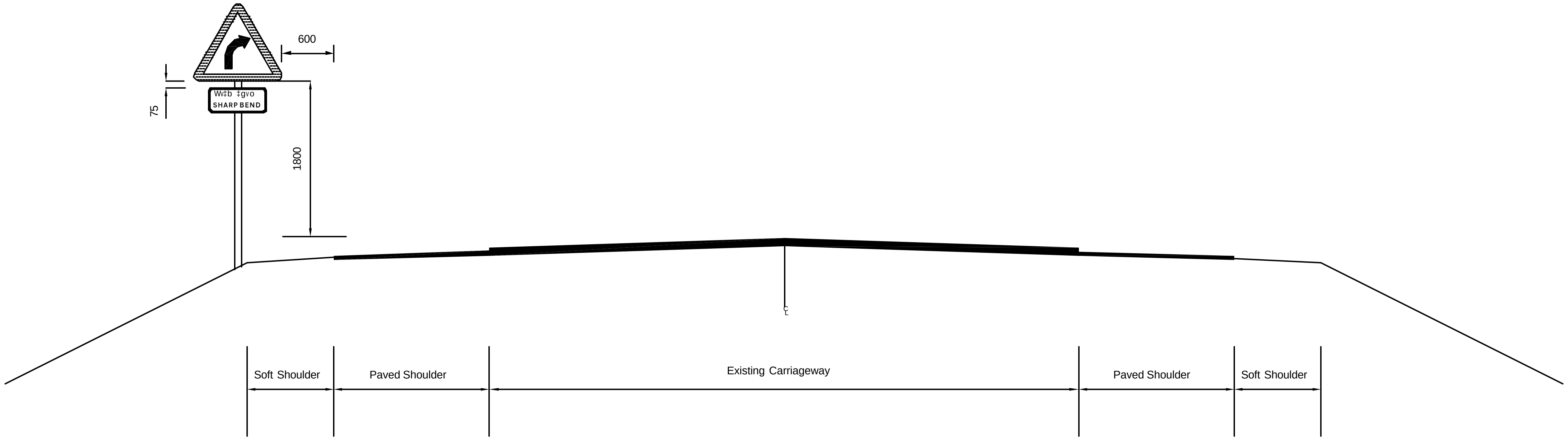


Figure 01

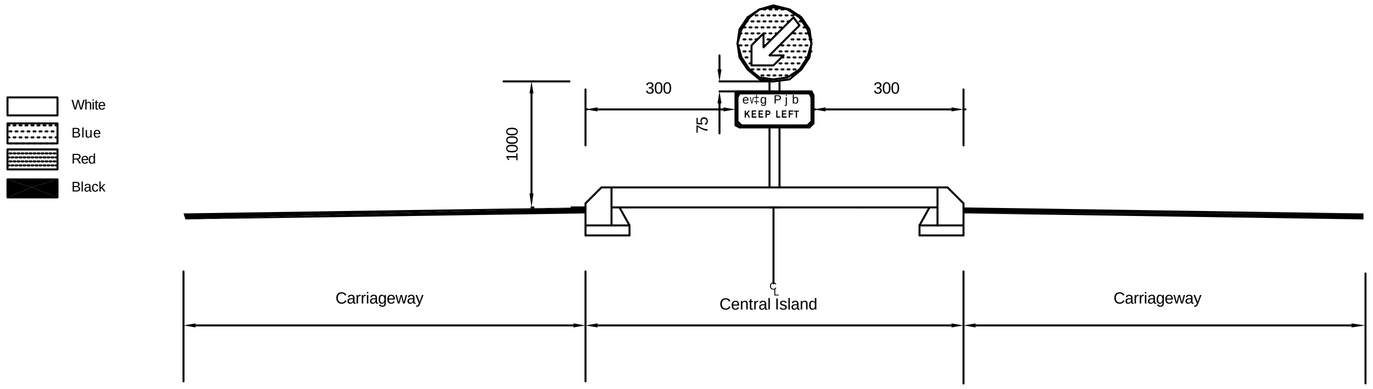


Figure 02

NOTES

Mounting height:
Signs shall be mounted so that the lower edge of the primary sign plate is 1.8 metres above the highest point of the carriageway (fig. 01). The lower edge of the primary signs, to be erected in the central islands, shall be 1 meter above the carriageway level (fig. 02). Where signs to be mounted over or alongside a footway (eg. bus bay sign) the lowest edge shall be 2.1 meters above the carriageway level.

Clearance from the edge of the carriageway:
Signs shall be set back from the road in such a way that the nearest edge of a sign shall be 600 mm clear of the edge of the paved shoulder (fig. 01). The nearest edge of a sign, to be erected in the central islands, shall be 300 mm clear of the edge of the central island (fig. 02).

Supplimentary Plate
Supplimentary plate shall be mounted beneath the primary sign to which they refer to and the gap shall be 75 mm between them.

Angle of sign Plate (Orientation):
If the sign is on the straight section of the roadway the sign plate shall be angled 95° away from the road (fig. 03). On a right hand bend the sign shall be set at an angle 90° to a line tangential to the left-hand edge of the carriageway at the point where the sign is erected (fig. 04). Sign sited on a left hand bend shall be set at an angle 95° measured clockwise from a line jioning the edge of the carriageway with a point on the same edge of carriagway 200 metres in advance of the sign (fig. 05)

Siting:
After erecting the sign it shall be ensured that the vehicle drivers must be able to see the sign from at least 75 meters away. This shall be achieved by cutting foliage and even felling trees or removing temporary structures.

Tiles and letters:
Imaginary tiles and letters of both english and bangla, for text hight 100, are shown in figure 06. When using alternative text hight the other dimensions must be varied proportionally.

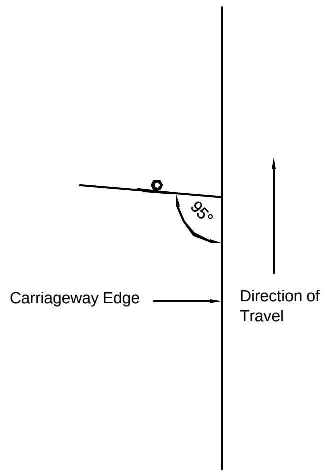


Figure 03

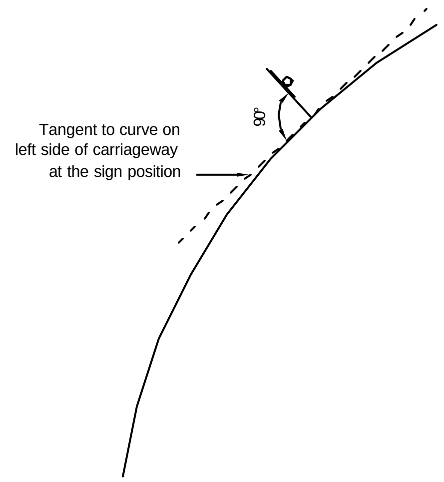


Figure 04

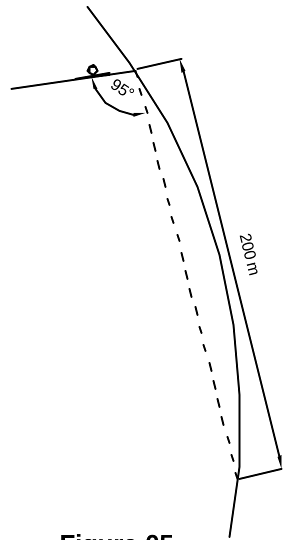
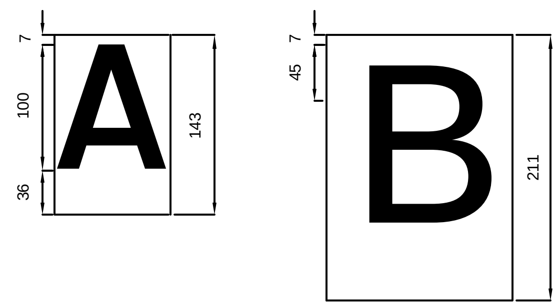


Figure 05

Tiles and letters



Scale 1:6

Figure 06

STEPS INVOLVED IN DEVISING REMEDIAL MEASURE

1. Administration

Each new investigation must be recorded in a central register as soon as it is received. A master file will be opened for each investigation. The master file (bearing the investigation number) will contain a copy of all the administration papers and as the investigation proceeds, a record of all relevant developments (meetings notes, working papers etc.) that arise as a result of the investigation. A working file should be opened at the same time. The working file will contain all of the working details relevant to the investigation, drawings, site photographs, calculations stick diagrams.

2. Building up Accident Analysis

If possible three years data should be used in urban areas and five years data in rural areas. In many cases, accidents that have occurred on approaches to the location have been directly or indirectly attributed to events occurring at the location. When investigating hazardous locations it is important to extend the analysis to include accidents occurring within 100m of that location.

Retrieve Accident Data

Refer to the latest MAAP*five* user manual and retrieve the latest accident data for the location and the immediate vicinity.

Print Date: Mon 09-15-1997

STICK DIAGRAM ANALYSIS

ACCIDENT RECORD FILE POLY
CONDITIONS SET THANA = 9,10

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
NoV	03	02	01	01	02	02	02	02	02	01	02	02	02	02	02	02	02	02	01
SEV	G	G	F	G	M	F	G	S	S	M	S	G	F	M	S	S	G	G	G
DAY	3	2	5	2	1	4	3	5	2	7	3	6	2	1	6	5	5	1	6
HH	17	17	20	06	06	08	00	17	10	20	21	17	14	10	10	13	00	01	10
<-\	<-\					<-\													
/->		/->	/->		/->	/->	/->	/->	/->				/->		/->	/->			
PED			PED	PED															
><	><				><	><							><		><				
>>											>>	>>		>>			>>	>>	
Prk																			
Trk		Trk					Trk	Trk					Trk				Trk	Trk	
Tmp				Tmp															
M-B		M-B			M-B	M-B						M-B		M-B	M-B	M-B			
Bus	Bus								Bus		Bus					Bus			

NoV= No.of.Vehs SEV= Severity DAY= Day of Week HH = Hour of Day
<-\= Left Turn /->= Right Turn PED= Pedestrian >< = Head On
>> = Rear End Prk= Parked Veh Trk= Truck etc. Tmp= Tempo/Micro
M-B= Mini Bus Bus= Bus

Stick Number = Accident Code Number:-
1=0004 2=0010 3=0009 4=0137 5=0020 6=0001 7=0032 8=0070
9=0031 10=0013 11=0009 12=0030 13=0041 14=0149 15=0062 16=0026
17=0132 18=0091 19=0099

Figure 1. MAAP*five* accident printout

Accident summary
When the data is ready it will be possible to prepare the preliminary accident summary. A typical accident summary will state the total number of accidents that have occurred in the period, the major accident types (with percentages of the total) and any important features found in the analysis.

Accident Stick Diagram
Each stick diagram page presents the details of ten accidents. By entering each of the basic items of information by day, date, time, light conditions, road surface, severity of injury and adding the accident conflict (a diagram of the collision) we can recreate each accident in a more visual, fairly easy to understand form.

ACCIDENT STICK DIAGRAM SHEET

LOCATION : .... ACCIDENTS FOR .... MONTHS TO .... 19 ....

	1	2	3	4	5	6	7	8	9	10
POLICE REFERENCE										
DAY										
DATE										
TIME										
LIGHT CONDITIONS										
ROAD SURFACE										
SEVERITY										
CONFLICT										

ACCIDENT SUMMARY

SITE DIAGRAM

N

Figure 2. Stick diagram

As the work progresses you are likely to see and note certain similarities. Perhaps, similar accident types, direction of travel, time of the day, day of the week. You should note these points. When the stick diagram is complete you should have a reasonable ‘feel’ for the accidents occurring at the site.

Preparation of accident plot
Using a small scale plan or drawing, carefully plot the location of each accident and link the location to a balloon showing the accident conflict. As the accident plot builds up you will notice further similarities, in the accidents, again you should note any observations made.
As the work progresses certain pieces of information may not be clear or more detail may be required. The police accident reporting form includes fuller details, of the incident. Sketches and comments on the form often yield important clues and detail local Thana police office to inspect the details.
By examining both the stick diagram and the accident plot, the dominant accident types should now be quite clear.

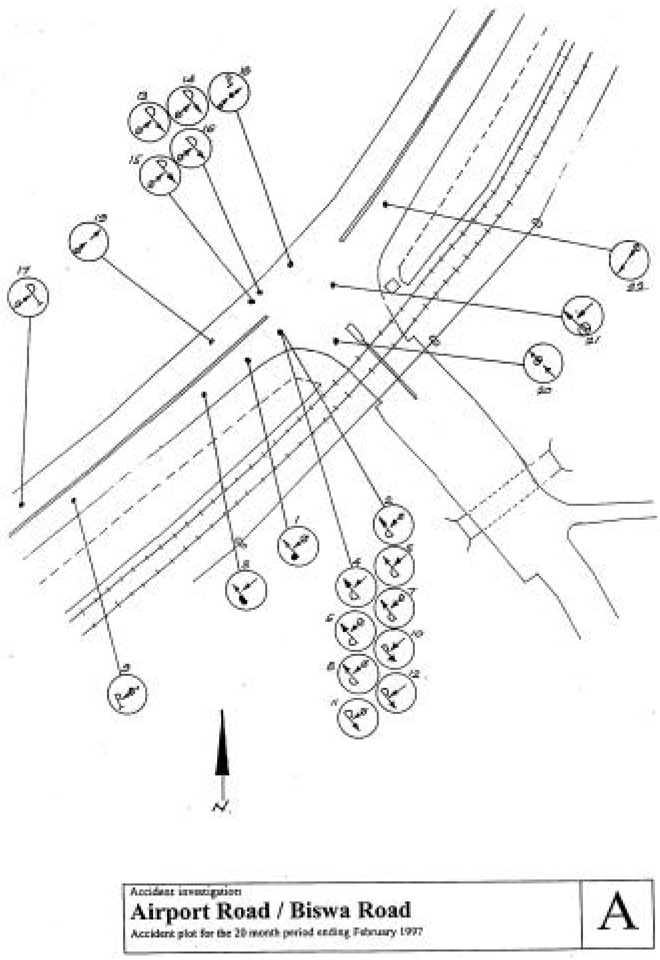


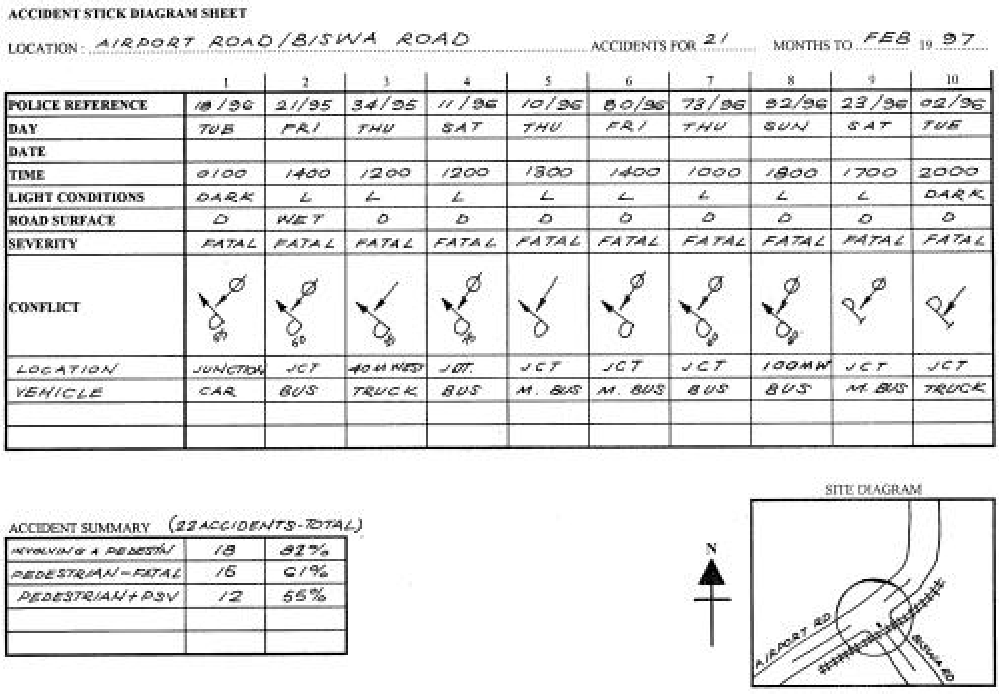
Figure 3. Accident plot. The accident plot shows the major problem, 14 pedestrian accidents occurring in the junction. Ten of these accidents resulted in a fatality

Quantifying accident problems

An analysis finds that nine accidents in a total of 20, involve pedestrian injury. How do we gauge the extent of this problem? A simple but effective technique is to compare the accident rate at the subject site with the accident rates found at similar (control)

Preparing the sorted stick diagram

By now you should have a good understanding of the accidents occurring at the location and it is possible to sort the accidents into groups of the similar, or dominant accident types. Re-number the accidents to show the major problems first, followed by secondary less common accident types and finally the rare or individual accidents. Re-draw the stick diagram in the sorted order.



ACCIDENT STICK DIAGRAM SHEET

LOCATION : AIRPORT ROAD/BISWA ROAD ACCIDENTS FOR 21 MONTHS TO FEB 19 97

	1	2	3	4	5	6	7	8	9	10
POLICE REFERENCE	18/96	21/95	34/95	11/96	10/96	80/96	73/96	92/96	23/96	02/96
DAY	TUE	FRI	THU	SAT	THU	FRI	THU	SUN	SAT	TUE
DATE										
TIME	0100	1400	1200	1200	1300	1400	1000	1800	1700	2000
LIGHT CONDITIONS	DARK	L	L	L	L	L	L	L	L	DARK
ROAD SURFACE	D	WET	D	D	D	D	D	D	D	D
SEVERITY	FATAL	FATAL	FATAL	FATAL	FATAL	FATAL	FATAL	FATAL	FATAL	FATAL
CONFLICT										
LOCATION	JUNCTION	JCT	40M WEST	JCT.	JCT	JCT	JCT	100M W	JCT	JCT
VEHICLE	CAR	BUS	TRUCK	BUS	M. BUS	M. BUS	BUS	BUS	M. BUS	TRUCK

ACCIDENT SUMMARY (22 ACCIDENTS-TOTAL)

INVOLVING A PEDESTN	18	82%
PEDESTRIAN – FATAL	16	61%
PEDESTRIAN + PSV	12	55%

SITE DIAGRAM

Figure 4. The sorted stick diagram

Clear problems have been identified

If clear, definable problems have been identified, write up a summary and an overview of the problems identified on the accident investigation sheet. The fuller, more complete analysis should be filed in the working file for future reference.

3. The site visit

The inventory

The first stage of the site visit will be to take details of the relevant features at the site. The numbers of lanes, details and location of the signs, the width of median strips, the traffic signal arrangements, the location of items that may have featured in accidents. Careful planning of site photographs will save a considerable amount of time and will be a useful reference point later.

The site investigation

The timing of the site visit can be very important. If the analysis has identified a problem occurring during peak hours, at night time or at weekends, the site visit must be planned to take place at those times. If the accidents are occurring on a particular day of the week, perhaps there is a special event, for example a market is held on that day and this activity is a factor in those accidents. The only way to find out exactly what is going on is to visit the site on that day, as close to the time of the accidents as possible.

During the site visit always:

- Looking for clues or likely factors in the accidents
- Keep the accident record in mind

4. Assessing all of the factors and producing the scheme recommendations

To carry out the assessment you need to review all of the information and data relating to the site. If during the course of the investigation you have met and discussed the site with other officials, it is likely that they will have provided you with very useful background information and local knowledge. Local police officers (who may have attended the scene of the accidents) often provide a valuable insight into the cause of those accidents. This additional information provides further useful information which can be added to the assessment process.

Effective road safety engineering treats the cause, not the symptoms. If the problem involves vehicles leaving the carriageway at a bend, we could install a crash barrier. A crash barrier would certainly reduce the severity of future accidents at the site, but the problem would still exist. To remove the problem we need to look further.

Two heads are better than one. To widen the scope of the assessment it is recommended that you discuss each stage with your colleagues. Only when you are entirely satisfied with the conclusion, and the Head of the Road Safety Unit agrees with you, can we start to develop the countermeasures.

In many cases identifying countermeasures is fairly straight forward. If the problem is clearly defined the course of action may be quite clear.

5. Finding appropriate countermeasures to the problem

There is often a wide range of measures available for the engineer. . Selecting the correct measure(s) for each problem is a question of balancing the most appropriate measure and ensuring that the measure is suitable for that site's circumstances. In many cases the final specifications will include a combination of several items. There is always a risk that a keen engineer will hurry to a conclusion.

ROAD SAFETY ENGINEERING STRATEGIES

1. Introduction

The potential of accident reduction through low-cost engineering measure at hazardous sites is particularly high. Simple remedial measure can significantly reduce the problem. By identifying and eliminating the features which make the site hazardous, engineers can improve road safety. This often means reducing the complexity of an intersection or enabling manoeuvres to be made in stages. Reducing the number of decisions drivers must take at any one time simplifies the driving task and helps drivers to progress in safety and comfort with a minimum a minimum conflict with other traffic and pedestrians.

There are four basic strategies for accident reduction through the use of countermeasures. These are:

1. **Single site**: The treatment of specific type of accident at a single location;
2. **Route action plan**: the application of known remedies along a route with high accident rate;
3. **Mass action Plan**: the application of known remedy to locations with common accident problem;
4. **Area wide schemes**: the application of various treatments over a wide area of town / city (e.g. traffic management and traffic calming (speed reducing device)).

2. Single Site

Single site investigations are the basis of Road Safety Engineering. The investigation of accidents occurring at a single location leads to an understanding of the cause of the accidents, and it is then possible to devise countermeasures that help future road users to cope.

All stages of the investigation are important, but it should be kept in mind that a thorough and complete analysis that identifies the full extent of the problem(s) will probably lead to the implementation of measures that will achieve the best reduction in the numbers of accidents. A weak or compromised analysis will not.

3. Route action Plan

Encouraged by the results of single site techniques engineers began to look for wider applications for these techniques. One practice to emerge from this search is the analysis of accidents along sections of the highway or route studies. Route studies begin with an analysis of accidents occurring on a (typically four to 15 km long) section of road. The analysis is then used to identify the route’s accident problems so that accident countermeasures can be designed and implemented.

The design and implementation of remedial works based on the findings of single site accident analysis have consistently resulted in reductions in the number of road traffic accidents. However route study work allows the engineer to take a much wider perspective of the accident problems and to address them from three standpoints.

1. overall or route wide problems for which it has been found that wider-reaching, more effective measures can be identified and employed
2. localised specific problems which are more likely to be understood and thus more effectively treated within a route study
3. consistency and clarity of information to road users which can only be assessed and provided on a route basis and which improves the road users’ chances of coping safely

4. Mass action plan

The Royal Society for the Prevention of Accidents (RoSPA, UK) defines Mass Action schemes as *'The application of a remedy to locations with a common accident problem'*.
Mass Action Plans reverse from this approach. Road Safety Engineering, Mass Action Plans start by first having a measure that is known to reduce certain types of road traffic accidents. The database is then used to search for locations with a history of those accidents. The practice works towards implementing the measure at the most suitable sites or locations. The remedy is known and it is applied at locations with specific problems.
As the experience of a Road Safety Unit develops and grows, monitoring exercises will identify several low cost but effective measures and practices. Road Safety Engineers can take advantage of this by using Mass Action Plan techniques. The effective measures are then applied to a large number of problem locations quickly and efficiently.

A Mass Action Plan normally involves small-scale improvements, but there is no reason why larger scale work cannot be carried out in this way. The program might include work at individual locations or along sections of the highway. Most highway agencies use a variety of Mass Action plans to improve the road network.
A Mass Action Plan could be used to improve :

- traffic capacity - by implementing traffic engineering measures at junctions along a route
- the general roadside environment - by carrying out a landscaping program of planting trees and shrubs along a route or in areas
- maintenance of the network - by improving street lighting, and implementing road surface programs.

5. Area wide schemes

A more recent concept of investigating accidents across a wider area, particularly urban residential areas. Area wide road safety engineering turns attention to residential areas where both the problem of accidents and the approach to accident reduction is quite different. In urban area it will not be uncommon to find over 80 personal injury accidents per square kilometer per year. If treatment is carried out over say 4 sq. km., the potential for accident reduction can be high. Accidents in residential areas are more likely to be scattered throughout the area. They often involve different accident types and consequently routine blackspot and route-wide practices are less likely to be effective.

This technique is beyond the scope of RHD staff as RHD is only responsible for the road network rather than residential area. However, authority responsible for residential area may need to involve RHD officials during devising strategies for reducing accident in residential areas as many residential areas in Bangladesh has direct access to RHD roads.

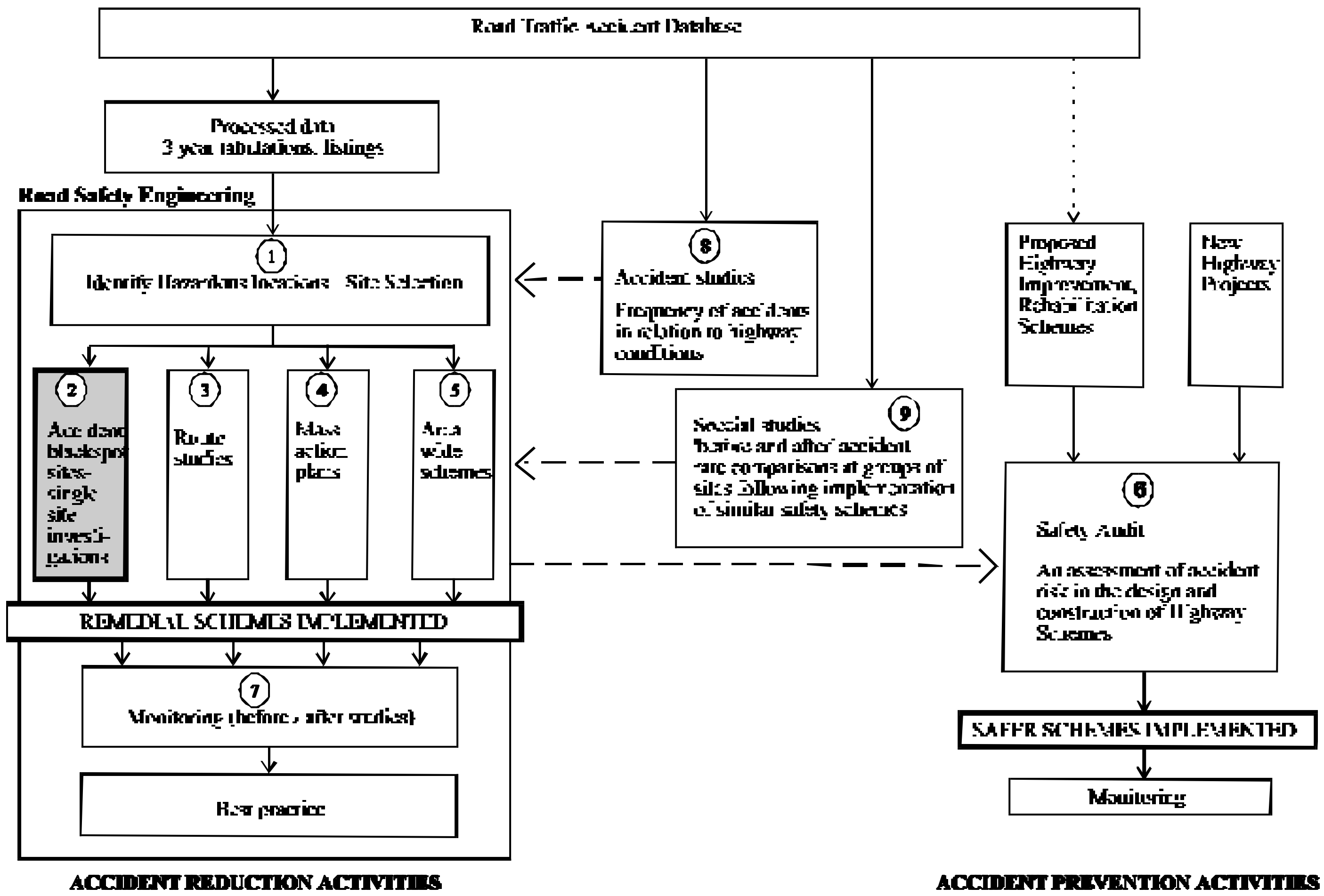


Figure 1. Treating Accident Blackspots in Bangladesh in Road Safety Engineering