Australasian Road Safety Research, Policing and Education Conference 2012
4 - 6 October 2012, Wellington, New Zealand

iRAP AND ROAD INFRASTRUCTURE SAFETY ASSESSMENT IN BANGLADESH

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Abstract

Road safety is an issue in Bangladesh that poses considerable challenges to road engineering professionals. This is borne by the fact that as many as 55 people are reportedly killed in road crashes each day and vulnerable road users (including pedestrians, motorcyclists and unsafe and informal public transport users) account for a large proportion, more than 80 percent, of road traffic fatalities. The International Road Assessment Programme (iRAP) Bangladesh Pilot Project provided the first ever comprehensive road infrastructure risk assessment of two of Bangladesh's busiest national highways: the Dhaka-Sylhet Highway (N2) and the Joydebpur-Mymensingh Highway (N3). The highways are mostly rated 2-stars or less (out of possible 5-stars) for vehicle occupants, pedestrians, motorcyclists and bicyclists indicating a relatively high level of risk of deaths and injuries.

As an extension of the pilot project, an undergraduate research study on iRAP infrastructure assessment of a high risk corridor of a section of Dhaka-Aricha highway (section of N5 highway) was carried out. The highway fits a classic linear settlement model as it passes through several built-up areas where there is significant roadside development, high side friction and a large number of pedestrian movements. Road infrastructure attributes were collected through extensive field inspection and iRAP risk assessment tools were applied to determine star ratings for various road user categories. The majority of the highway section (27 km) under study was 2-stars or less for pedestrians, motorcyclists and bicyclists. This paper introduces the road safety problem and the iRAP programme in Bangladesh. It discusses some promising findings and experiences of the road infrastructure assessment and highlights a range of affordable cost-effective countermeasures for safety improvements. In particular, the study serves to demonstrate the iRAP methodology as an important tool to be used by the new generation of road engineers who can play significant role in achieving the goals of the Decade of Action for Road Safety.

INTRODUCTION

It is abundantly clear that, many low and middle income countries like Bangladesh are now experiencing a serious road safety crisis. The situation is predicted to worsen in the coming years unless the critical problem, of epidemic nature, is seriously addressed with significant improvements in the relevant sectors in a sustainable manner. According to World health Organization (WHO), nearly 20,000 deaths from road traffic crashes are estimated to occur annually in Bangladesh, although around 4000 deaths are officially reported. Nearly 80 percent of road traffic fatalities are attributed to Vulnerable Road Users (VRUs) - pedestrians, bicyclists, motorcyclists, and users of informal and unsafe motorized and non-motorized transport. It is the poor that are most seriously affected with consequences of plunging poor households into acute poverty. Indeed the tragic premature loss of healthy lives is costly. Permanent disabilities and property damages are exacerbating poverty reduction efforts particularly in rural areas including rural sections of national and regional highways. The road environment factors are particularly prevalent with major roadway defects in design and layout, shoulders, road sides, bridges and approaches, delineation devices and lack of access controls. Unregulated private/business access to inter-urban highways leads to endless linear settlements resulting in high risks for pedestrians and other vulnerable road users.

This paper discusses road safety problems and development of iRAP programme in Bangladesh. It presents some promising findings and experiences of the road infrastructure assessment and highlights a range of affordable cost-effective countermeasures for safety improvements. In particular, the study serves to demonstrate the iRAP methodology as an important tool to be used by new generation of road engineers who can play significant role in achieving the goals of the Decade of Action for Road Safety.

THE CONTEXT OF ROAD INFRASTRUCTURE SAFETY

Road crashes are overwhelmingly caused by human failings, but the greatest untapped potential to prevent death and injury is through the roads themselves. In the United States for example, road conditions are a contributing factor in more than half (53%) of all road deaths and more than a third (38%) of injuries. In terms of crash severity, road condition is the single most lethal contributing factor, ahead of speeding, alcohol or non-use of seat belts (Miller & Zaloshnja, 2009). In Sweden, when considered within a safe system-type framework, road conditions are a contributing factor in at least 59% of fatal crashes (Stigson, Krafft, & Tingvall, 2008). Therefore road infrastructure plays a crucial role in road safety. Well-designed roads can help people use roads safely and minimize the risk that a crash will occur. When a crash occurs, protective road infrastructure can mean the difference between life and death (Bliss, 2009).

Ogden (1996) argued that the percentage of accident reductions resulting from safer roads will be greater than the percentage of crashes attributable to road factor and accident reductions could reasonably be expected to accrue from the provision of a safer road environment. According to Anderson (1976), road environment improvements have shown more substantial results on highway safety than the results of both vehicle and driver programs combined. Anderson asserted that through highway safety improvements, the accident toll of Bangladesh could be reduced by at least 50 percent. The Japanese success in the 1970s in halving its traffic accidents was brought about mainly by traffic engineering measures to improve the road and roadside environment (Koshi 1986). In the UK program established in 1987 to reduce road accident casualties by one-third by the year 2000, road safety engineering measures were expected to deliver at least one-third of this target reduction (Burrough 1991; Sabey 1995). Indeed, in its review the European Transport Safety Council (ETSC 1996) recommends that the systematic application of low-cost road and traffic engineering measures continues to be one of the most cost-effective tools for reducing road accidents and consequent death, injury and damage throughout the European Union in the coming years.

The above observations are especially cogent to realize that the road component remains a major consideration in the overall road safety management strategies. Indeed, as Fisher and Camou (1977) remarked, the road component is a most important determinant of traffic accident frequency. Many of the observed characteristics of accidents and fatalities are indicative of problems and deficiencies associated with road infrastructure and roadside environment in Bangladesh. It is therefore time for countries like Bangladesh to quickly tighten this area of road safety engineering practice through sustained understanding, innovation and commitment. Essentially this should be pursued with due regard to the learning of the complex phenomena of accidents involving road, human, vehicle, psychological and technological factors and with particular consideration of the prevailing conditions, social acceptability and requirements of the vulnerable road users. This responsibility and obligation needs to be understood and delivered by road engineers putting safety into its proper perspectives, which would require significant specialized training and awareness programs in Bangladesh.

ROAD SAFETY IN BANGLADESH

Characteristics of the Problem

With phenomenal increase of motorized vehicles in recent years, road traffic injuries have emerged as one of the main reasons for mortality and disability in Bangladesh. Road traffic accidents cause one-fifth of injury related hospital admissions in Bangladesh. Compared with many other countries in the world, road users including children are highly vulnerable in the traffic situation in Bangladesh. Statistics showed that in terms of vehicle ownership, Bangladesh has one of the highest fatality rates internationally in road accidents, over 100 deaths per 10000 motor vehicles. About 70% road accident fatalities are occurred in rural areas including rural sections of national highways. Pedestrians, bicyclists and motorcyclists are the most vulnerable road users and they are the victims of 80% of the fatalities. Trucks and buses are the major contributors (80%) to road accident fatalities, especially pedestrian fatalities. It has been observed from the studies that up to 62% of urban road accident deaths are pedestrians alone and in Dhaka city, they represented nearly 70%.

Summary of Crash Characteristics

Based on data from the computerized road crash database (MAAP5) maintained by Bangladesh Police and Bangladesh Road Transport Authority (BRTA) for 1998-2010, key accident parameters have been identified. These characteristics of accident provide useful guidance in developing effective road safety countermeasures in Bangladesh. The principal findings obtained through analysis of accident data are (see Hoque et al., 2011 and 2012):

- Most of the accidents ended up with severe and devastating consequences involving fatalities or serious injuries.

- The severity of accident outcomes on highways is often devastating with a result of involving many fatalities and injuries, up to 60 deaths and 150 injuries on the spot in a single accident at one location.

- Accidents and fatalities on national highways are characterized as clustering on selected sections, identified as Hazardous Road Locations (HRLs), nearly 40% of accidents concentrated

on around 2% of the highway network, demonstrating that accidents are amenable to site specific treatments.

- Nearly two-thirds of casualty-accidents were on rural roads and highways which are mostly undivided with significant roadside developments.
- National and regional highways were featured in nearly 64% of the total accidents.
- Accidents are highly clustered, 5% of the national highway network accounted for nearly 50% of its fatal accidents.
- Pedestrians are the most vulnerable road user group and 'hit-pedestrian' crashes accounted for more than 40% of fatal crashes.
- Following 'hit-pedestrian', other predominant crash types are 'head-on' and 'rear-end' with 'head-on' showing increasing trend.
- Busses and trucks are involved in around 70% of the total casualty accidents whereas they constitute only 9% of the total registered vehicles; their share is nearly 80 percent of single vehicle fatal accidents.
- There is significant involvement of motorcycle in both single and multiple vehicle fatal accidents.
- Among nine major national highway routes, the majority of the casualty accidents took place in N1, N2 and N5 which are vital corridors for road based transport in Bangladesh.
- About 2.5% of reported accidents occurred on bridges and culverts.

ROAD INFRASTRUCTURE IMPROVEMENT

Background

The road safety challenge of catering for a vast mix of road users is clearly evident from the above problem characteristics and the results of recent iRAP pilot assessment (iRAP, 2010). Coinciding with the global event, the UN Decade of Action for Road Safety in Bangladesh was formally launched with the commitment to devise and implement actions under the five pillars of the decade through combined and co-ordinated efforts towards achieving reduction of fatalities by 50% during the decade 2011-2020 in Bangladesh. Following the national launch of the Decade, a national workshop was held and included participation by UN-ESCAP and iRAP road safety experts and the leading road safety specialist professionals from the key road safety stakeholders in the government and non-government sectors and a set of draft preliminary goals, targets and indicators and a plan of actions were developed in the following areas of interventions.

- Institutional and Road Safety Management (Policy and Legislation)
- Road User Behaviour (Enforcement, Education and Awareness)
- Road Infrastructure (Design/Maintenance and Traffic Management)
- Vehicle Standards and NMV/MTW (Vehicle Design, Fitness and VRUs)
- Post-Accident and Emergency Care (First Aid and Pre/Post Hospital Care)

The workshop recognised that the adoption of the Safe System approach in the planning and design of all future road infrastructures in critically important. Particular emphasis was placed on applying the iRAP methodology as a tool for road infrastructure safety improvement as the iRAP Pilot Study identified a range of economically viable countermeasures that have the potential to prevent thousands of deaths and serious injuries.

Elimination of “High Risk Roads” on the network and promotion of the Safe System approach were identified as one of the important targets within the road infrastructure safety area with following activities:

- Implementation of actions to upgrade the worst 10% of the road network.
- Identification and treatment of Hazardous Road Locations (HRLs) and Black Spots and priority crash types.
- Application of iRAP inspection methodology for assessing star ratings of national highways.
- Strengthening iRAP collaboration for infrastructure safety initiatives.
- Undertaking safe corridor demonstration projects through collaborative partnership approach.

To achieve the above targets, a Memorandum of Understanding (MoU) was signed between Roads and Highways Division, Bangladesh (RHD) and iRAP with a view to work in partnership. Some of the striking areas of co-operation are:

- Establishment of an iRAP implementation team within RHD to ensure the iRAP recommendations are included in existing and future Bangladesh Government and development bank funded corridor upgrades, and to oversee future iRAP assessments in Bangladesh.
- Extension of iRAP assessments to national highways in Bangladesh, particularly the primary national highways which are approximately 4,000 km in length and are planned for upgrade to 4 lane divided carriageways.
- Integration of iRAP performance measures into national policy and strategies, consistent with the iRAP guide titled *A World Free of High Risk Roads*.
- Creating a Safer Highways Demonstration Corridor.
- Training for RHD engineers, design staff and consultants likely to be undertaking road construction and maintenance operations in Bangladesh.
- Securing financial support for joint RHD-iRAP activities from development banks, including the World Bank and Asian Development Bank.
- Participation in the annual iRAP Asia Pacific Workshop.
- Promotional activities coinciding with the official launch of the United Nations Decade of Action for Road Safety, 11 May 2011.

Research Project Using the iRAP Methodology

Background

Following the completion of an iRAP assessment of two of Bangladesh’s busiest national highways, the Dhaka-Sylhet Highway (N2) and the Joydebpur-Mymensingh Highway (N3), students of Bangladesh University of Engineering and Technology (BUET) undertook a research project on a 27 km stretch of the Dhaka-Aricha Highway (N5).

The purpose of the research project was primarily to provide students of Bangladesh University of Engineering and Technology (BUET) an opportunity to learn about infrastructure risk assessment and

undertake a preliminary iRAP assessment. The results presented here may be subject to review as part of ongoing training and development.

An early first step in the research project was participation in a United Nations Decade of Action for Road Safety workshop, an initiative of the UN Economic and Social Commission for Asia and the Pacific (UNESCAP) and Government of Bangladesh. The Workshop included discussions on a national road safety strategy and key road safety actions. In particular, the workshop focused on:

- Institutional and Road Safety Management (Policy and Legislation)
- Road User Behaviour (Enforcement, Education and Awareness)
- Road Infrastructure (Design/Maintenance and Traffic Management)
- Vehicle Standards and NMV/MTW (Vehicle Design, Fitness and VRUs)
- Post-Accident and Emergency Care (First Aid and Pre/Post Hospital Care)

The workshop recognised that the adoption of the Safe System approach in the planning and design of all future road infrastructures in critically important. Particular emphasis was placed on applying the iRAP methodology as a tool for road infrastructure safety improvement.

In addition to the workshop, the students also participated in information sessions on the iRAP methodology as part of the project preparation.

Field Data Collection

Field data collection for the risk assessment was performed in consultation with RHD officials in various times (see Figure 1). Road design features that are included in iRAP analsyes along the of 27 kilometre section of road were noted down.

Figure 1: Field studies for the assessment of section of N5 by the project team

Records were made for each 100 metre length of road. The following is a summary of the features along the 27 km section:

- The highway passes through several built up (especially commercial) areas with extensive linear developments.

- 21 km of the road is divided with a median barrier while 6 km was single-lane undivided. Intersections are at-grade and there is very little formal provision for pedestrians and bicyclists.

- A significant number of non-motorized vehicles (particularly rickshaws and bicycles) and informal/locally manufactured unsafe vehicles (like nosimon, korimon etc.) were observed.
- Although no formal speed measurements were made, a large speed-differential between vehicles was observed. For example, relatively fast-moving trucks and buses shared the road with much slower-moving non-motorised vehicles.
- There are several commercial and educational institutions by the highway. So a huge number of pedestrians move along and across the roadway, but there were almost no pedestrian facilities.
- A significant percentage of the overall observed length had very poor roadway surface condition. Signs and markings (even before approaching curves) were largely not present.
- There was a large number of severely overloaded and unstable vehicles and there was extremely poor compliance with the road rules by the road users.
- Markets were set up very close to the highway in some places, leaving very unsafe conditions not only for the vehicle occupants but for the pedestrians passing along and across the highway as well.
- Frequent vehicle breakdown and road blockage were observed, especially before intersections.

Star Ratings

After the field observations were completed, the data was used to create Star Ratings for each road user type. This was done using the iRAP Demonstrator, available online at www.iraptools.net.[1]

From the results, it is clear that among the road users, motorcyclists, bicyclists and pedestrians are the more vulnerable since most of the road sections for the mentioned users are of 2–star ratings. However, the provision for vehicle occupants is generally better, as shown in Table 1.

Table 1: Overall Star Ratings of 27 km assessment of N5 Highway

Star Rating	Vehicle occupants		Motorcyclists		Bicyclists		Pedestrians	
	Percentage	Length (km)	Percentage	Length (km)	Percentage	Length (km)	Percentage	Length (km)
5 Star	0%	0	0%	0	0%	0	0%	0
4 Star	73%	19.8	0%	0	0.4%	0.1	0%	0
3 Star	26%	7.1	16%	4.3	0.4%	0.1	9.58%	2.6
2 Star	0.4%	0.1	58%	15.5	99%	26.7	90.42%	24.4
1 Star	0%	0	27%	7.2	0.4%	0.1	0%	0

[1] To access the iRAP Demonstrator, contact greg.smith@irap.org.

Figure 2: Typical sections of N5 Highway rated 2-stars.

The results for vehicle occupants, which show that almost three-quarters of roads is in the 4-star bracket, are largely a function of the fact that (a) much of the road is divided with a median thus reducing the risk of death and injury in a head-on crash and (b) the speed used in the analysis was 60 km/h.

Possible countermeasures for N5

Although a formal analysis of countermeasure options was not undertaken as part of the research project, the field observations and star ratings provide some guidance. For example, the following countermeasures are likely to help improve the situation:

- reducing the likelihood and severity of run-off road and head-on crashes by widening shoulders, installing roadside safety barriers and median barriers
- reducing the likelihood and severity of pedestrian crashes by installing crossing facilities and footpaths
- reducing risk at intersections through grade separation, roundabouts and traffic signals
- reducing the risk of all crash types by managing speed to within tolerable limits.

THE WAY FORWARD

In many ways, Bangladesh embodies the spirit of the United Nations Decade of Action for Road Safety. It is a nation where a substantial road safety challenges exist, but where there is strong support for safety. The Bangladesh Government has been a keen supporter of calls for the declaration of a Decade of Action on Road Safety and is putting in place strategies to save lives. Bangladesh is looking forward to achieving the goals on reducing 50% of fatalities and serious injuries over the period 2011-2020 and eliminating “High Risk Roads” by promoting safe system approach with the application of iRAP methodology for assessing star ratings on national highways.

With the finance of ADB, a new project of assessment of around 1000 km of highway is underway. This will provide a strong basis for iRAP activities in Bangladesh for the future, and very importantly, provide guidance for investment in safer roads. However, iRAP also provides a strong basis to support the development, implementation and monitoring of road safety strategy in Bangladesh throughout the Decade of Action. The preliminary findings of iRAP studies provide useful guidance for improvements to the highways that will potentially prevent thousands of deaths and serious injuries.

CONCLUSIONS

Road infrastructure and environmental deficiencies are particularly prevalent in accidents and casualties and engineering safety on the road has clearly emerged as a priority issue in Bangladesh. Aspects of road infrastructure safety improvement in the context of safe system approach are therefore outlined in this paper. In particular, the paper discusses road inspection and assessment of national highways in Bangladesh by demonstrating the application of iRAP methodology.

As the Decade of Action for Road Safety (2011-2020) draws near, it becomes increasingly important for countries such as Bangladesh to set in place comprehensive plans for road safety. Bangladesh is a nation where substantial road safety challenges exist, but where the will to act in the interest of those using the roads is strong. It is evident from the materials presented in the paper that iRAP methodology can be an important tool for new generation of engineers and would provide a strong basis to support the development, implementation and monitoring of road safety strategy in Bangladesh throughout the Decade of Action.

ACKNOWLEDGEMENT

The work presented in this paper is a part of the research work carried out at the Department of Civil Engineering, Bangladesh University of Engineering and Technology (BUET). The opinion and views expressed in this paper are those of the authors. The valuable assistance of iRAP is gratefully acknowledged. The reviewers' comments and suggestions are also gratefully acknowledged.

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