Roadside Crash Barrier for Safety

Abstract:

Road form vital links and means of transportation network system. Particularly in a country like ours it is indeed the lifeline of the people of Bhutan. The rapid socioeconomic growth in recent years has led to an increase in both traffic and road length. Therefore, it is imperative that due diligence and care is exercised in the road design and construction process. During the planning and design phase of roads, the engineer has to give due consideration to the safety, cost, and use of local materials. However, the road design procedure is influenced by factors like terrain, traffic volumes, vehicle types and travel speeds. The significant costs both in terms of life and finance are associated with road accident. Hence the effective and safe design of roadside crash barriers will minimize the injury to travellers and fewer hazards to vehicles.

Keywords: berm, safety, barrier, hazards, injuries, run-out length

Introduction:

"Ran-off-the-road" road accidents accounts for around sixty-five percent of the vehicular accident worldwide, therefore more effective safety barriers system has become more essential, from guardrails to earth berms to median barriers to energy fascinating barriers and mires. However, main road designers have recognized that safety barriers are hazards in themselves, misfits within the main road setting, which are things to be eliminated where attainable.

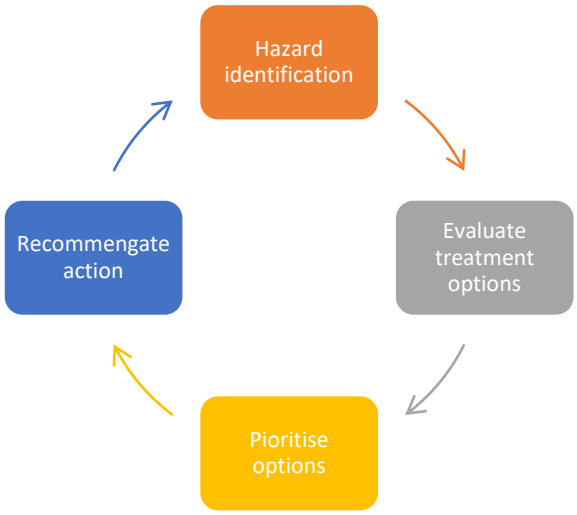
The main purpose of any safety barrier is to scale down the number of main road fatalities and to attenuate personal injuries. Conjointly to be remembered is that the order of stress for service requirements: first to safety, second to economic science, and third to aesthetic. It is expected that drivers travelling at limited speed to the conditions and driving with due care will remain on the road and reach their destinations safely. Inevitably there are occasions when vehicles leave the roadway due to factors that may include:

1. Excess speed or over speeding
2. Fatigue driving
3. Driving under the influence of drugs and alcohol
4. Weather and road condition
5. Mechanical failure etc.

The roadside should be free from potential hazards which can cause serious injury or loss of life for vehicle occupants, careful design and selection of appropriate road safety barriers will minimize the hazards to road users.

Need for Road Side Barriers.

If the vehicle leaves the travelled way and drives across hazards it can cause serious injury and loss of life for travellers. The qualitative risk analysis along with proper engineering judgement will result in installation of roadside safety barriers in a manner that will reduce the hazards and maximizes its benefits to travellers. Generally, four steps are involved in the treatment of roadside hazards as outlined below in fig. 1



(Source: DMR QLD,2000)

Fig. 1 The four steps procedure

Vehicle Accident Statistics:

In Bhutan the total number of motor vehicle crashes increased from 1139 in 2018 to 1450 in 2019, of which 109 were fatal and 692 injuries as per the Road Safety and Transport Authority's annual year publication 2018-2019. Reduction of road crash fatalities, injuries and damage to properties continue to be a major challenge with ever-increasing road users and vehicles. The current motor vehicle crash fatality rate is 10.4 deaths per 10,000 vehicles.

Table 1 Road crashes, fatalities and injuries in Bhutan.

Sl/No	Year	Crash	Death	Injured
1	2005	696	39	247
2	2006	940	71	389
3	2007	523	40	335
4	2008	995	92	488
5	2009	1436	77	579
6	2010	1260	79	611
7	2011	1374	104	623
8	2012	1350	96	611
9	2013	1023	59	601
10	2014	791	76	426
11	2015	715	99	373
12	2016	726	105	355
13	2017	371	50	164
14	2018	1139	110	557
15	2019	1450	109	692

Source: RSTA annual report 2018-2019

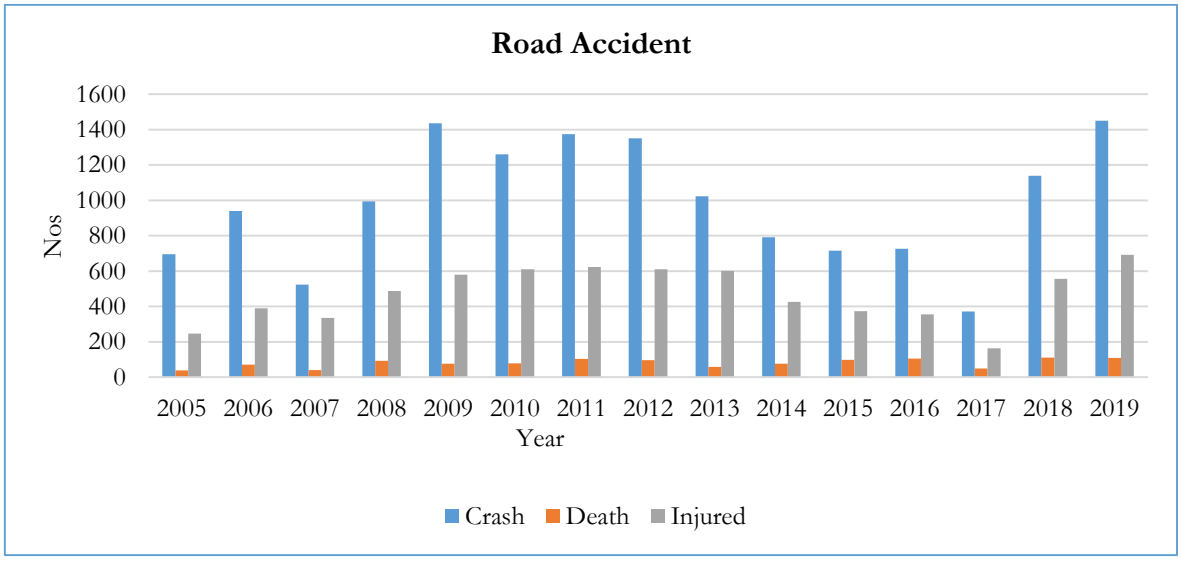


Fig: 2 Yearly Road Crashes, fatalities and injuries in Bhutan

Types of Road Safety Barriers and Selection:

Safety barriers are generally grouped into three different types as rigid, semi-rigid and flexible barriers. The more flexible barriers will minimise the severity of vehicle impact with the barriers. Proper selection of types of barriers will provide the required degree of protection with lowest cost. In country like ours where road is of high value to tourism industry environmental impact consideration is one of most important factor in choosing barriers. Following selection criteria for roadside barriers issued by AASHTO can be referred during design and selection of barriers on our roads.

Fig: 3 a) Rigid concrete barriers, b) Semi-rigid W-Beam barrier on approach to bridge

Table 2 Section criteria for road side barriers.

Criteria	Comments
Performance	The Barrier must possess sufficient structural integrity to contain and redirect design vehicle.
Deflection	Expected deflection of barrier should not exceed available room to deflect.
Site Conditions	Slope approaching the barrier and distance from the carriageway may prevent the use of some barrier types.
Compatibility	Barrier must be compatible with site condition and geographical terrene.
Cost	Lower cost with high-performance barriers can be one of the criteria for selection of barrier types.
Maintenance	
I. Routine maintenance	Some types of the barrier system require more routine maintenance then the other system.
B. Simplicity	Easy designs, besides costing less, are more likely to be constructed and repaired properly by field personnel.
Aesthetics	Barriers aesthetic is also one of the most important criteria to be considered in country like ours.
Field Experience	The performance and maintenance requirements of existing systems should be monitored to identify problems, especially those which could be lessened or eliminated by using a different barrier type.

Earthen Safety Barriers:

Earthen road barriers are one of the easiest and cheapest road safety barriers. Earthen berms are raised mounds of earth, typically forming an extended ridge. Some berms are a natural feature of the landscape, whereas others are artificially constructed. On the average a berm or mound ought to be four to five times longer than its height, more and more streaming out into the remaining landscape. The berm shape and style may have more than one peak to offer it an extra interest in addition as the form to perform its purpose. Berms are frequently made using the waste materials like sand, plant debris, waste rubble and asphalt from roads and soil, merely use as the fill material for the majority of the berm, forming its shape around it with soil and firmly tamping. Berms are often quadrangle or triangular. Standard quadrangle safety berm shall be a minimum height of fifty percent of the diameter of the biggest transport tyre mistreatment the road and for normal triangular safety berm, the minimum height shall be sixty-six percent of the largest vehicle tyre.

Fig:3 Heap earth barriers and Sandbags fill barriers.

Design of Longitudinal Road Safety Barriers:

Barriers are usually designed to shield motorists from roadside hazards, the design process involves selection of safety barriers types, location and size. Usually following steps are followed in design process:

1. Data collection:

   Both site inspection and desktop studies regarding traffic volume, vehicle types, speed, road width, topography and site geology etc. has to be collected in detail.

2. Designed Vehicle:

   It is necessary to determine the design vehicle to be adopted for barriers, barriers are normally not designed for heavy vehicles because of the relatively low volume and high cost.

3. Site selection:

   Sites with sharp horizontal and vertical curves, mountainous routes, high volume, high speed vehicle moves, where barrier penetration could lead to serious disaster (e.g. a school, hospital etc.) a designer should do risk assessment before designing barrier.

4. Determine Run-Out length:

   Straight road section

   The run-out length (LR) is the distance needed for a vehicle that has left the road to come to the stop and it depends on vehicle speed. As per AASHTO following run-out length has to be adopted.

Table 3. Run –out length (LR) required for different speed of vehicles

Sl/No	Design speed (km/h)	Minimum Run –out length LR (m)
1	50	40
2	60	50
3	70	60
4	80	75
5	90	85
6	100	100
7	110	110

Curved road section

In curves it is assumed that a vehicle leaving road will follow a tangential runout path hence a line from the outside edge of hazards to a tangent point can be used to determine the length of the barrier. It usually depends upon the radius of the curve.

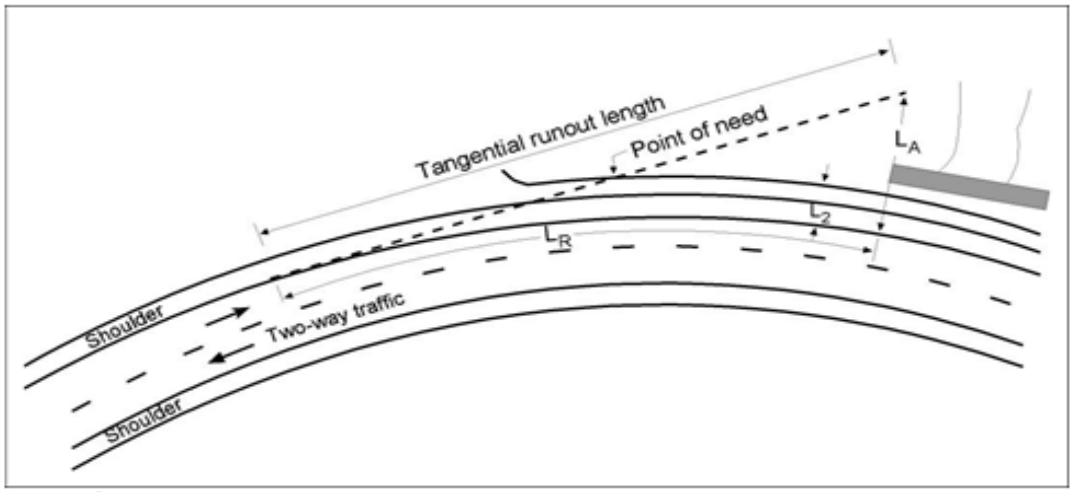


Fig:4 Length of run-out length in curved roads. (Source: AASHTO, 2002)

5. Height of barriers:

The required barrier system height has to be established after crash testing using appropriate vehicle test. If the barrier is too low the vehicle may pass over the top of the barrier and if too high, it will block the sight distances. For trapezoidal earthen barrier, its height should be minimum 50% of the diameter of the largest vehicular tyre using the road and for triangular type berm, the height should not be less than 66% of the largest vehicle tyre using the road.

Conclusion:

Roads in Bhutan typically run through steep terrain and run-off accident is possible and dangerous, thus crash cushion barrier will be one of the measures to reduce the impact on an errant vehicle through the use of vehicle attenuating system. The barrier will be able to contain or redirect the errant vehicle without imposing much hazard Several barriers are developed. However, correct design and installed barriers system have been to be most effective in reducing the harm and alteration of the severity of personal injuries. Barrier recommendation are based on the premise that a traffic barrier should generally be installed if it reduces the severity of potential crashes, it is important to note that the probability of frequency of run off the road crashes in not directly related to the severity. Crash cushion earthen material barriers will be one of the economic measures to reduce impact on an errant vehicle through the use of vehicle attenuating system and also no major structure and cost are involved in construction and maintenance. It's aesthetic look and most environmental friendly construction made it most feasible barrier type

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Dorji is an Executive Engineer at Bridge Division, under Department of Roads, Ministry of Works and Human Settlement, Thimphu, Bhutan. He has more than 20 years of field experience in road and bridge construction works. He has a Masters Degree in Structural Engineering from Vellore Institute of Technology, India.