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Rolling Barriers: Emerging Concept to Reduce Road Accidents*: An Indian Perspective*

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Abstract. The latest emerging technologies for road safety focuses on finding ways to avoid or minimize road accidents to road users with special concern by reducing the causes of road accidents. As depicted by data of certain advanced countries like Korea, Malaysia, Australia, United States of America, the major number of accidents causing death was very high during a previous couple of years due to the increased number of vehicles on road, which is getting unmanageable. However, Urethane Rollers invented in Korea has served to re-direct the uncontrolled moving vehicles and to balance it again causing reduction of accidents. In this paper, a study is carried out to explain its need in India perspective for using "Rolling Barriers" (RB) which has minimized the accidents rate in the above-mentioned countries. Rolling barriers provides cushioning effect during a crash, reduces the high-speed effect, constitutes material resilience with stiffness and have other performance characteristics that reduce injury to occupants and damage to the vehicle. The roller barriers are extremely effective and its implementation has given signified results in reducing the road accidents at flat roads, curved roads sections, ramps, medians, entrances/exit ramps in the parking garage etc. steep curved roads as in the mountainous terrain.

Keywords: Accidents, Urethane, Rolling Barriers, Stiffness, Resilience, Crash cushioning.

1. Introduction

The Rolling Barriers are the barrier that absorbs impact energy and converts that impact energy into rotational energy and directs the vehicles forward rather than potentially breaking through an immovable barrier.[1] In India, the year 2016 has recorded the highest number of road accidents around 4,80,652 which comprised 1,50,785 deaths. The Indian Express, dated 11 Sept. 2017 has claimed in the report by Transport Research Wing under Ministry of Road Transport and Highways, Government of India that there are 17 deaths on road every hour in India. As per the records, 34.5 % accident deaths occurred on National Highways, while 27.9 % accident deaths took place on state highways. The report says that over speeding is the biggest cause of casualties i.e. 66.5 % of all road

accident with 61% of death due to over speeding. Other factors constitute the unchecked surge in motorization and human errors. Cities with large population saw majority of accidents. Chennai leads with 7486 accidents followed by Delhi 7,375 accidents. [2].

Even though efforts are being made by the Govt. to reduce the severity of road accidents but the results have not been significantly fruitful. Primarily it is based on 4 E's (i.e.) Education, Engineering, Enforcement and Emergency care. Nearly 700 Accidents prone spot have been found out by Ministry of Road Transport and Highways (MRTH) [3]. Safety road roller are also being used as a barrier for safety of the road users in certain countries like Malaysia Road Accessory (RB) prevents driver and passenger from fatal and destructive accident by not only absorbing shock energy but also converting shock energy into rotational energy.[4] Safety roller can be recycled and eco-friendly. Safety roller barriers are easily adjustable by adding or removing a roller.

Figure 1: Rolling Barriers at the Roadside and vehicle collision.[5]

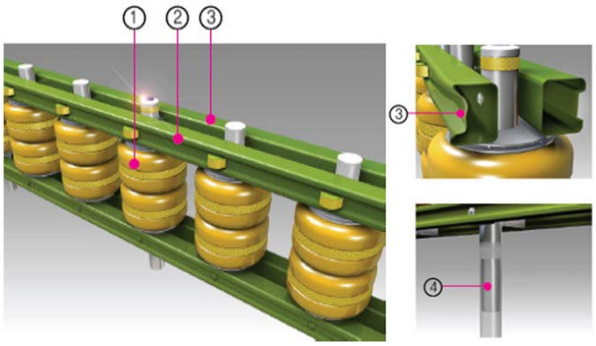

Figure 2. Components

1. Roller absorbs collision shock (shock energy to rotational energy)
2. Front rail absorbs 2nd shock
3. Back rail absorbs 3rd shock
4. Metal pipe inserted in to strengthen post.[4]

Kim et al (2004) in a study concluded that the use of longitudinal barriers results in reduction of the accidents by more than 50 percent in a year. In a strength performance test of the 8-ton truck, and in a passenger protection test with 1.3-ton passenger car, the RB satisfies the MOCT's Guidelines for Installation and Management of Road Safety Facilities.[6]. Wadekar et al (2017) published that the accidents that occurs on major roadways like expressway has observed 14,500 accidents resulting to 1,400 deaths since its inception. India, being on the threshold of fetching a the place among the developed country needs to make its efforts that withstand on Shock Absorbing Rolling Barrier. RB can help to reduce accidents and fatalities. [7]

Rao. et al in 2017 his analysis of road accident data 2015 exposes that about 1,374 accidents and 400 deaths takes place every day on Indian roads which further interprets that 57 accidents and loss of 17 lives on an average every hour in the country. He concluded, the RB safes life and also prevents maximum damage level of the vehicles and established that the rolling barrier systems are the future technology in transportation engineering.[5] Reddy et al (2017) perceived that every year approximately 1.25 million people die over the world due to road traffic crash. The federal highway administration suggested that the guardrail installed in the road way can minimize the large number of accidents. A Korea based company ETI (evaluation in traffic innovation) is involved in design rolling barriers system. [8]

2. Barriers

Rolling Barriers are also known as guardrails, longitudinal barriers. RB retain vehicles on their path and check vehicles from hitting with hazardous obstacles and roadway such as rocks, traffic sign posts, bridge supports, trees and construction walls. Rolling Barriers are characterized in two types, by the

functions they serve and conferring to the degree that how much they can deflect a vehicle when it hits into the RB. [9]

2.1 Types of barriers according to its functions
2.1.1 Roadside barriers: Its primary function is to protect traffic from outside obstacle and hazards. The hazard could be such as steep slope, heavy rigid body (eg. stone) and accumulated water body.
*2.1.2 Median barriers***:** Its function is to prevent vehicles to cross over a median to avoid head-on collision.
2.1.3 Bridge barriers: it is generally having greater dimension in comparison to road side barriers. This barriers prevent vehicles from crashing off the side of the bridge and jumping onto the river, railways and roadways below.
2.1.4 Work zone barriers: they are temporary barriers and can be reallocated depending upon the work zone. It prevents the traffic from work zone hazards.[9]

2.2 Types of Barriers according to stiffness
2.2.1 Flexible barriers: it consists of weak post corrugated guide rail and cable line barriers.
2.2.2 Semi rigid barriers: They Includes heavy post blocked out corrugated guiderail with a line box beam guiderail and thrie-beam rail. They deflect 3-6feet (0.91 to 1.83m).
2.2.3 Rigid barriers: they are simple rigid body and made with cement concrete. The deflection of rigid barrier is almost zero. [9]

Table 1. Percentage of collision of vehicles on various objects/obstacles

S. no	Objects of impact of vehicles	Total percentage
1.	Concrete Barriers	23%
2.	Guard rail	19%
3.	Flowerpots and curb stones	15%
4.	Bridge wall	13%
5.	Overhead bridge pillar/tunnel wall	13%
6.	Trees	5%

3. Working mechanism of Rolling Barriers

They consist of both flexible property and semi rigid property of barrier stiffness. RB are different in mechanisms than the other types of normal barriers. It also reduces the hazard and road accidents. Urethane has become the material of choice in so many of today's performance driven applications because it illustrate extraordinary physical and mechanical properties that other material simply can't match. [10]

Roller Barriers absorbing the collision shock in three points, the barrel, the buffering bracket, and the liquidity of the rail shocking mechanism. The shock energy absorb from a curved crash is absorbs then the shock is converting in a rotational energy. Shock energy absorbs the gain by its upper and lower safety guard rail. Shock energy will be again by the back side of safety rails.

Finally the safety roller barriers will leave the cover back to the lane. Thus, this decreases the car damage and ensures the safety of drivers and passenger in the vehicles. Besides strong resilience and shock energy absorbing capacity of RB the cost and maintenance of repair significantly less, this is another economic advantage of this technology. [11]

Table 2: Percentage of type of accidents

S. No	Types of accidents	Constituting percentage
1.	Run off road to left	32%
2.	Run off road to right	23%
3.	Collision with another vehicle moving ahead or waiting	21%
4.	Collision with another vehicle which starts, stops or Stationary	10%
5.	Collision with another vehicle moving laterally in same direction	5%
6.	Collision with another oncoming vehicle	2%

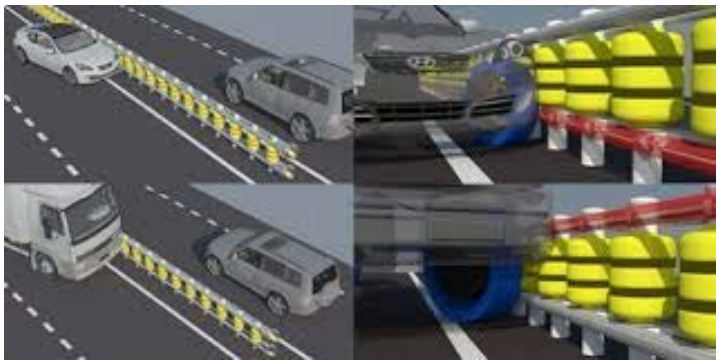

Figure 3. Rolling Barriers at the midroad and vehicle collision with diversion.[4]

Figure 4. Rolling Barriers at the U-turn.[8]

Rolling Barriers can be for two way traffic by installing them at the midroad and used as dividers (figure 3). Roller Barriers can be used at turning of roads to avoid accidents at turnings. The figure 4 shows is the RB installed at the U turn, to reduce fatal damage during the turning. U turns are much prone to accidents.

4. Test performance comparison during crushing between conventional barriers and RB

Performance test has been carried out to compare normal and RB to measure the degree of damage imparted to the barrier during a vehicle impact. The figure 5 shows the representations of the crash test (test 1). It was observed that the conventional barriers experienced more damage in comparison to RB. In a similar crash test (test 2) a comparison is done between passenger car and heavy vehicle impact to a RB, as shown in figure 6. It was seen that impact of passenger car delivered no damage to the RB, while slight damage is recorded in case of heavy vehicle. [4]

Findings of crash test

4.1 Passenger Safety Performance:

Theoretical Head Impact Velocity (THIV): 32.4kmh (Below 33kmh)

Post Impact Head Deceleration (PHD): 9.9 gs (Below 20g's).

4.2 Scatter Prevention Performance:

No scatters of the safety barrier.

4.3 Test Vehicle Behavior Performance:

Not overthrown or a sudden stop after collision.

76.9% (Exit speed: 78.4kmh)

43.7% (Exit angle: 8.74degree)
Result: Satisfied with Criteria. [4]

Test 1: SB4 Crash test

Figure 5. Crash test comparison between conventional barriers and RB (KSI Korea).[8]

Test 2: SB5 Crash test

Figure 6. Crash test for car and truck collision at RB (KSI Korea).[8]

5. Future works

In the domain of material advancements in the last few decades we have developed exciting materials in engineering science. For materials election or fabrication of RB and cost factors will play a significant role.

Materials: While selecting material for RB we need to see the properties required in the installed component.one of the most important properties in this regard is resilience and shock absorbing capacity, as this is the primary feature of the RB in absorbing the impact Energy imparted by the decelerating vehicle .Crash cushioning property plays an important role in fulfilling the main purpose of the RB. Another property which can add to the Functionality of the RB is thermal resistance, as large amount of heat is generated during the impact event. Using materials that are thermal insulators will ensure the proper working of the RB.

Cost optimisation: Cost is another factor to decide the material of RB, as large number of rollers is to be installed at the side and the middle of the road.

6. Implementation of RB

The efficient implementation of the RB will cater multiple objectives as discussed above, however RB can be applied resourcefully at following sites

- National Highways and major roadways require its competent use.
- Other accident prone sites like in curved road sections, U turns etc.
- Gradients and slopes in the urban or state or national road arteries.
- Inclines in parking lots and garages.

7. Conclusion

India is among those developing economies in the world which will soon take up the band of developed nations. The high growing economy not only requires monetary growth but also the life safety and high status of living of the nationals. Due to the high number of road fatalities it is imperative for India to take measures towards the safeguard of human life by eradicating or by minimizing road accidents. Rolling barriers in this context will serve a potential role for the achievement of higher degree of safety on road. RB not only absorbs the vehicle impact but also

safeguards the vehicle damage and secondarily diverts the wrong moving vehicle. By implementing RB in the cities India will come in that group of countries who have already using this technology. The Indian highways records large number of accidents and this technology will definitely elucidate this problem in a highly efficient manner. RB will safeguard the vehicle & human life and also increase the overall efficiency of the traffic flow. As the undue traffic jams due to accidents will be decreased.

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