SPEED BUMPS IN INDIA AND FOREIGN COUNTRIES: A REVIEW PAPER

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Abstract: A vehicle with high speed on the roads can cause accidents and difficulties to non motorized vehicles where interaction between motorized and non motorized traffic is frequent even if the speed limit signs are provided. Controlling the vehicular speed thus becomes an important issue. One of the many ways is to use speed bumps and humps which produces discomfort to driver going at high speed and forces them to slow down. Though rudimentary it ultimately contributes to the safety & prevents accidents. This paper brings to light the research done on speed bumps and humps in India & foreign countries for increasing road safety.

Key word- **Road Accidents; Traffic Calming Measures; Speed Breakers; Road Safety.**

1. INTRODUCTION

The roads of different categories are designed for certain speeds, which the vehicles are required to keep for the proper traffic operations. It is practical to provide certain control measures to ensure that the required safe speeds are maintained. These measures can provide greater safety and convenience for improved traffic movement. Over the past decade, the traffic scenario has changed dramatically. An increase in vehicle numbers has resulted in manifold increase in accident numbers. Traffic safety scenario in India is worsening day by day, and requires proper attention. Accident data shows that more than 1.5lakh people die each year in India in road accidents, which is significantly high compared to other developed countries. The following figure shows the countries with most traffic deaths (Fig 1), countries with fewest roads death (Fig 2), road traffic deaths per 100,000 per capita in various countries as per the WHO research (Fig 3).

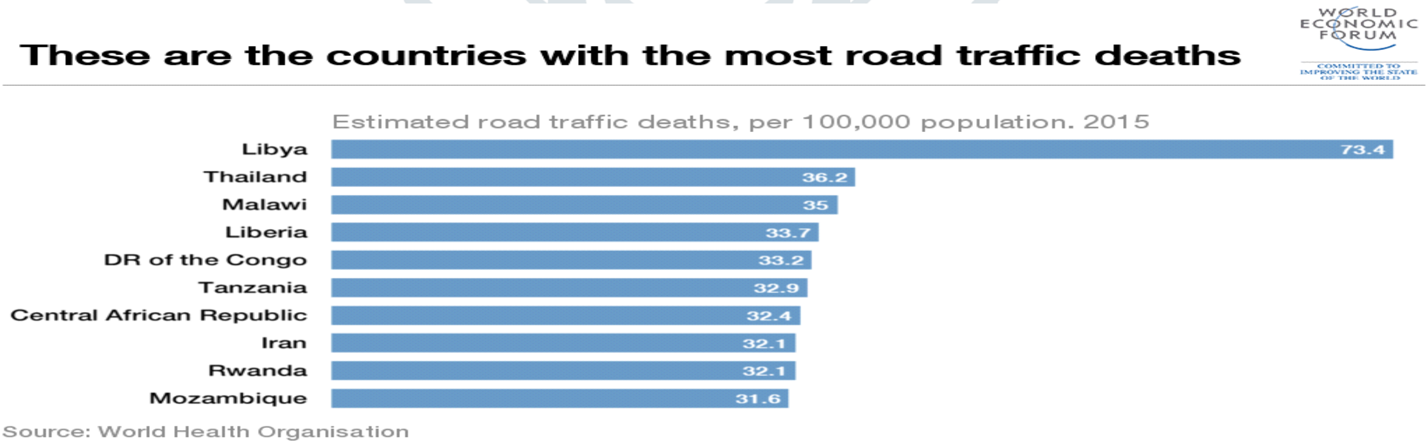

Fig .1 Countries with most traffic deaths

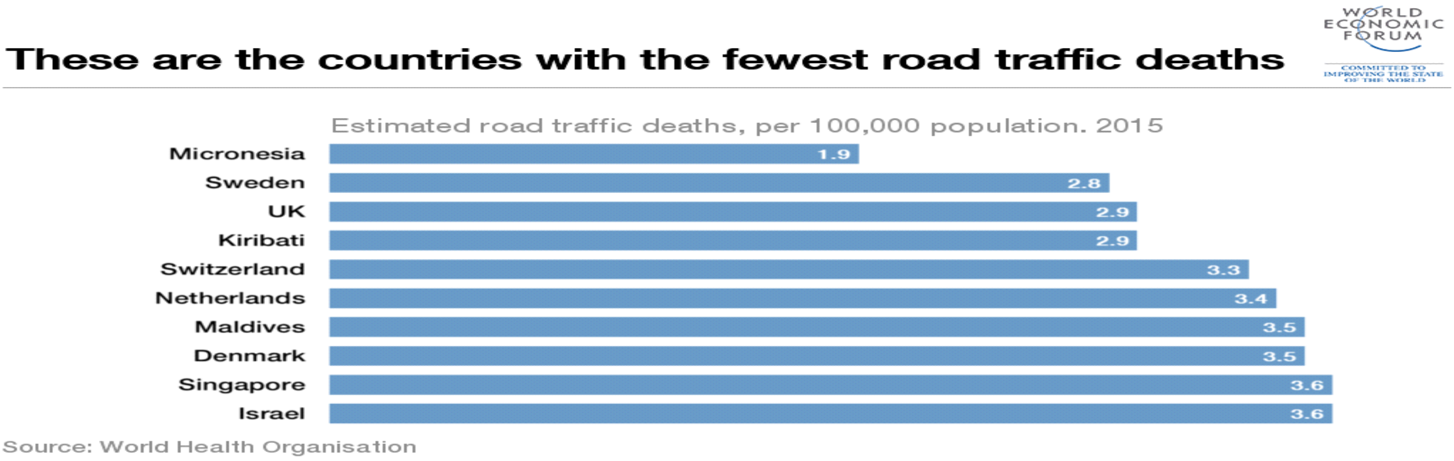

Fig . 2 Countries with fewest road traffic deaths

Analysis of different accidents shows that the main causes of the accident are improper speed, lack of awareness of road safety, driving under the influence of alcohol and narcotics, and habitual traffic violations. Different traffic calming measures are used to decrease the frequency as well as the severity of accidents. The Table 1 gives the comparison between traffic in India and developed countries.

Table: 1 Comparison between traffic in India and developed countries

	Features	India	Other countries
1	Modal mix of traffic in urban areas.	Two wheeler, three wheeler, and on motorized traffic comprise a much larger share in urban traffic.	Cars are the dominant mode.
2	Modal mix of intercity roads.	• Trucks, buses and cars constitute a large share on most highways. • Presence of tractors and non motorized vehicles. • Large variations in speeds.	Cars are the dominant mode and no tractors and non-motorized traffic. Therefore little variation in speeds.
3	Highway passing through townships.	Almost all intercity roads pass through township and villages. Therefore all intercity traffic must intersect with local traffic when passing through these areas.	Extensive network of limited access highways ensures that most long distance traffic uses the same. Traffic on intercity roads passing through townships is generally not long distance traffic and hence has slightly different characteristics and needs.

Source: IRC 99:2018

Out of the various traffic calming measures speed breakers are one of the most widely used devices and are f.und to be very effective. In India, based on locality, place and other factors, speed breakers are provided on the roads. IRC:99 -1988 which was revised in 2018 and IRC : 99-2018 was formed, recommends use of various traffic calming measures like speed bumps, speed humps, markings, speed tables, etc.

As per IRC 99:1988 Use of speed breakers is justified primarily under the following three circumstances:

1. T - intersections of minor road with rural trunk highways, characterized by relatively low traffic volumes on the minor road but very high average operating speed and poor sight distance. Such locations have a very high rate of fatal accidents as such a speed breaker on the minor road is recommended.

2. Intersections of minor road with major road, and mid block sections in urban areas where it is desirable to bring down the speeds.

3. Selected local street areas, schools, colleges, or universities, hospital etc. and other areas where traffic is observed to travel faster than the regulated or safe speed in the area.

Other places where these may be used (As per IRC 99:1998) include:

1. Any situation where there is consistent record of accidents.

2. Approaches to temporary diversion.

3. Approaches to weak or narrow bridges and culverts requiring speed restriction for safety.

4. Sharp curves with poor sight distance.

Traffic calming devices are necessary and quite common in urban setup. These are physical entities on road surface, that forces drivers to slow down their vehicle. They help other road users such as pedestrian, cyclists and other slow users on road. Speed Bumps generally holds the speed of vehicle below 25 km/h when crossing it. Road bumps are designed for orderly traffic movement and improve safety at certain locations such as sharp curves, residential areas, intersections, accident prone areas, etc. for smooth flow of traffic.

SPEED BUMP:-

Speed bumps are the device that uses the vertical deflection on the road to slow down the moving traffic.The speed bumps reduce speed considerably, avoid over speeding accidents and reduces severity of crash. However, the provision of bumps may cause significant discomfort to drivers as well as passengers, increased damage to the vehicle, increases response time of emergency services, requires additional road markings and traffic signs and causes increase in traffic noise and pollution. (As per IRC:99 2018)

SPEED HUMP:-

The speed humps are rounded & raised areas placed across the roads. The profile of a speed hump can be circular, parabolic or sinusoidal. They are tapered as they reach the kerb on each end to allow proper drainage. Speed humps are suitable where low speeds are desired. The speed humps are inexpensive and relatively easy for bicycles to cross if designed properly. Speed humps cause a rough ride for drivers as well as passengers and can cause severe pain for people with certain skeletal disabilities. They force large vehicles, such as emergency vehicles and those with rigid suspensions, to travel at slower speeds, they may increase noise and air pollution and have questionable aesthetics. Few common shapes used for Speed Bumps are shown in fig.3.

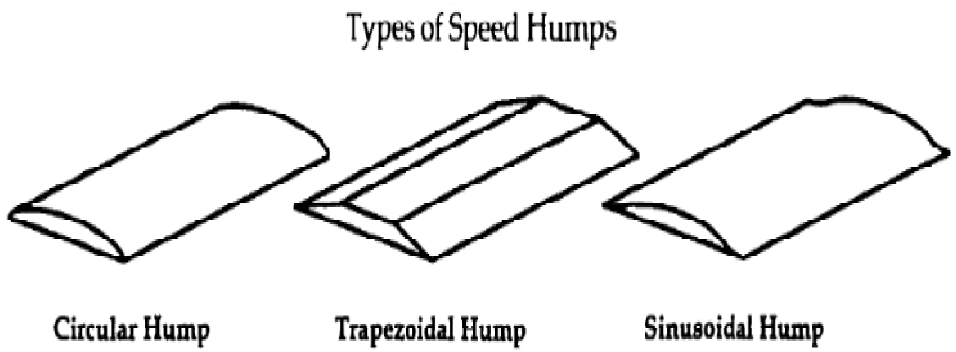

Fig. 3 Types of Speed Humps (Source: IRC 99: 2018)

A comparision between speed bumps and humps according to IRC 99:2018 is given in Table 2 and Fig.5.

Table 2 Comparison of Speed bumps and humps (Source IRC 99: 2018)

	Bumps	Humps
Height	2 to 6 inch	Less than 4 inch
Length	1 to 3 feet	10 to 12 feet
Reduces speed up to	8 to 10 km/h	24 to 32 km/h
Areas where used	Parking lots, intersections	Streets having less traffic

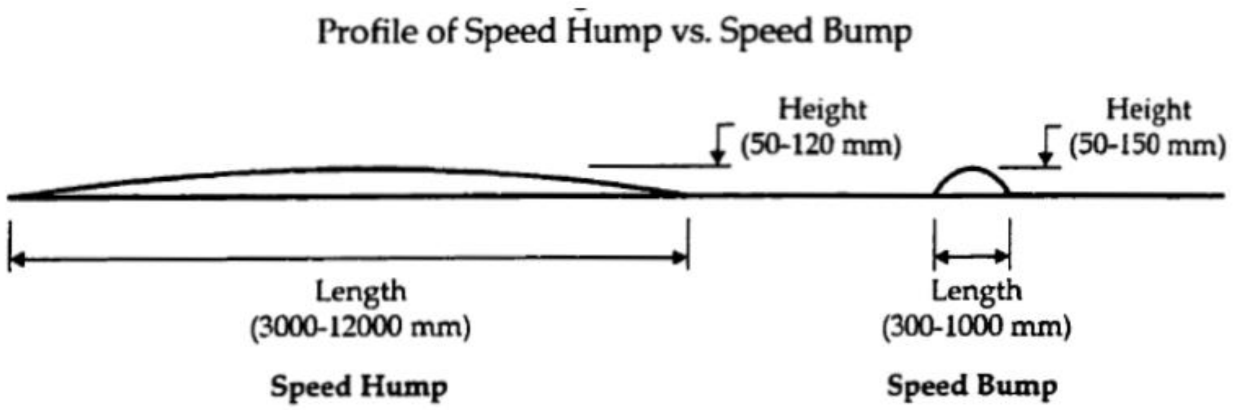

Fig.4 Comparison of Speed bumps and humps (Source IRC 99: 2018)

As per the IRC guidelines the various parameters of road bump/hump can be defined as under:

LENGTH:-Length is the most significant geometric design parameter for speed bump. Effective bumps should be as long as an automotive wheelbase to isolate the impacts on these vehicles entering and leaving the bumps. If heavier vehicles are to be expected, longer velocity bumps should be used. Experiments have shown that maximum accelerations tend to happen at greater speeds as lengths are increased, and more linear dynamic impacts are produced. Overall, longer bumps exhibit better speed reduction features. Longer bumps may be even better suited for heavy vehicles, although there is no firm establishment of upper boundaries.

HEIGHT:-Speed bump heights can affect vertical acceleration magnitudes and percieved discomfort peak concentrations. High bumps can cause harm to car undercarriages when existing the steps. Heights of bumps are generally between 50 and 120 mm, the most common being 75 or 100 mm.

WIDTH:-Speed bumps can either span a road's full length or taper off the curb or edge of the road. In an urban environment, the benefit of the latter strategy is that drainage at the curb and gutter is not impacted, and therefore facilities are less costly. Unless preventive steps are taken, drivers can try to exploit decreased widths and manouvere around bumps.

SPACING:- Since the goal of traffic calming is to decrease car speeds across whole roads, a main factor to consider is the layout design or spacing of speed bumps. Previous study from several nations indicates that speed bumps should be positioned between 40 and 60 meters apart in order to attain general speeds of 25 to 30 km/h as per IRC: 99 2018. For speeds of 50 km/h, greater spacing, up to 100 meters can be used. With extra traffic calming measures, bump spacing may be improved.

MATERIALS, MARKING AND SIGNAGE:-Speed bumps with all speed reduction measures should be extremely noticeable at sufficient distance to alert drivers to lower speeds and to prevent harm or loss of control to vehicles. This fundamentally eliminates the opportunity on the part of the government highway authority for any legal liability. For their speed bump facilities, most nations have created unique signs and markings and generally use pre-warnings (Fig.6), design speed signs(Fig.5), contrasting materials and protective bollards(Fig.7).

In railway **On roads**

fig.5 Design speed signs

fig.6 Pre warning signs

fig.7 (Protective bollards)

2. LITERATURE REVIEW

The studies on road bumps/ humps encompasses a wide array of enquiries on development of speed bump system that can respond instantaneously to traffic conditions. Speed bumps at the intersections have various effects on vehicles and on psychology of driver. Various researchers have conducted researches on speed bumps covering the criteria or the guidelines for geometrical bump and hump designs, optimization for designs, effectiveness of bumps and humps, variation of speed over bump, factors which influence bump design, problems due to speed bumps and humps, accidents occurred, etc.

Gundaliya (2017), did a survey on problems due to speed bumps and humps with following outcomes-

a) Speed breakers are very effective in reducing the speed of vehicles but people may not accept it readily and can cause public outcry if public is not consulted in prior.

b) They are uncomfortable and painful to people suffering from medical conditions such as back problems.

c) Road users, especially, the two wheelers try to avoid speed breakers to remove all possible discomfort caused by speed breakers.

d) Speed humps are a major problem for an emergency vehicle such as ambulance, police and fire engines.

e) Different vehicles respond differently to bumps. Heavy vehicles like buses, trucks and other public transport vehicles are prone to discomfort unless humps are traversed at very low speeds.

f) Seed humps have been known to cause accidents and injuries.

g) Vehicles may get damaged frequently even at normal speed levels. This problem is more severe with older, heavier vehicles and the vehicles with low ground clearance.

h) Speed breakers cause atmospheric pollution from the acceleration and deceleration of traffic at speed breakers.

i) Speed breakers create additional traffic noise. Heavy vehicles generate substantially more noise while traversing a hump generates a considerable amount.

j) It is observed that the road surface near the humps shows development of potholes and signs of subsidence which requires a greater road maintenance cost.

k) Practically provision of speed breakers is not a complete solution to improve road safety or to reduce the accidents. This is because in many of the cases it is found that accidents are caused due to careless driving of the car driver or of other factors that are not solved by the speed breakers.

He concluded that, speed breakers increases operating cost as well as causes significant discomfort to passengers. It is suggested that the effect on the comfort should be measured after implementation. In India, there is a strong need for a proper study before and after implementation of speed breakers to check their effectiveness.

As per the Road Accident Report: 2014, in India a total of 4726 lives were lost due to crashes at speed breakers on National Highways. More lives were lost on State Highways and on other roads due to speed breakers. So, this is a point of concern to study and review the selection of traffic calming measures selection. The fig.9 shows the various effects of improper speed bumps on roads.

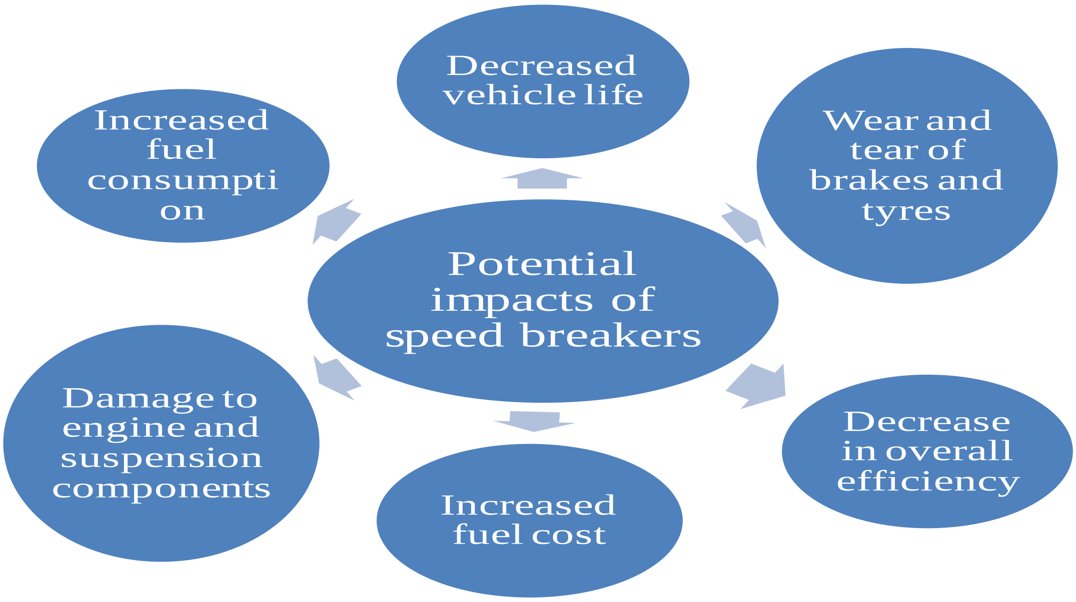

Fig.8 (Effects of improper speed bumps)

Sahoo (2009), did a study to prepare a definite procedure for the bump design and suggested guidelines for the same. In this study, a computer model was developed to simulate geometric characteristics of speed bumps and the speed of the automobiles. On the basis of the research the following steps were suggested; 1) select particular design 85th percentile bump-crossing speed, 2) find out the required A/W ratio from a suitable equation. Then by choose the bump shape: circular, parabolic and bump width compute a bump height satisfying the A/W ratio & Bump height's permissibility checked. Based on the observation from the survey, Bump-crossing speed was predicted based on area to width ratio using different geometric designs of the speed bump was R-Square(statistic that tells variance from actually measured values) equals to 0.56 for two wheelers and 0.6 for Passenger Cars.

Weber (1998), studied geometric roadway design features the goal of slowing down traffic in residential neighborhoods. The purpose of this research was to work towards developing Canada's speed bump design norms with posted speeds of 30-50 km/h while keeping in mind the acceptable amount of discomfort, no vehicle harm, road safety, minimizing noise and displacement caused, and minimizing installation and maintenance costs. On current bumps and on wood produced speed bumps duplicated from current on-road speed bumps, several off-road & on-road experiments were performed.
In this, accelerations were registered and compared to criteria of discomfort determined by recording speeds above current bumps. To estimate the accelerations measured using the acceleration of the Root Sum of Squares (RSS), a multiple regression model was formulated and optimal factorial designs were formed which produced levels of acceleration equal to the criteria of discomfort. From the model & optimal designs, speed bump's lengths and heights were recommended. On streets expended to carry automobile traffic only, 5.2m by 100mm, 7.9m by 100mm and 9.1m by 75mm speed bumps were recommended for desired speeds of 30, 40 and 50km/h respectively. On bus routes, 6.1m by 100mm and 8.8m by 100mm speed.

Ponnaluri and Groce (2005), performed a survey to verify the efficiency by getting the velocity variation before and after the installation of the speed bumps. While installing the speed bumps, the main issue is the efficacy of regulating the speed of the vehicles that pass over it. This case study includes a description for the compilation and assessment of the pre and post installation traffic volume and speed measurement comparison. The segment of the study was Dorman Road in Polk County, central Florida, about 2,600 feet long, consisting of five bumps with a 25 mph speed limit. Speed information was gathered over a successive 2 weekdays in increments of 15 minutes.A month before & after installation of speed bumps, the pre & post installation information were gathered. Traffic volume percentage distribution charts were prepared and the third degree regression model was discovered to be the best fit by comparing it with the R^2 values from several iterations. For pre-and post-installation, R^2 values showing the effectiveness of bumps in obtaining enhanced travel behavior consistency were achieved to be 0.89 & 0.86.

A lot of concern has been voiced about speed bumps, particularly their effectiveness and their potential to create unwanted noise and vibration.
Zaidel et al.(1992), carried out the studies in Netherlands and Australia where it has shown that well designed bumps generate very small rates of undesirable noise and low vibrations except for vehicles passing by. The impact was negligible for neighboring structures or people.

Zachary et al.(2000), conducted a matched case–control study among Oakland residents younger than 15 years over the 5-year period March 1, 1995, to March 1, 2000. Case patients were children who were seen in the emergency department at

Children's Hospital Oakland after having been struck and injured by an automobile on a residential street. Findings suggested that speed humps make children's living environments safer.

3. CONCLUSION

This area needs more research regarding the safety of people and problems occurring due to provision of speed bumps and humps. It is also necessary to carry out the study of the bumps which are being provided without considering its design criteria which ultimately leads to poor safety of road users, pedestrian and cause damage to vehicles. Also while making this review paper it was seen that the research on this topic is very less in India compared to other countries. so, this need to be focused on for safety and betterment of citizens. The selection of location and type of speed breakers (bumps/humps) in India is arbitrary in most cases. Proper analysis & survey need to be done before & after execution of any hump/bump to make these devices effective in achieving comfort and safety.

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