Traffic Calming in Indian Perspective

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***Abstract*—** Kofi Annan, the UN Secretary General called road accidents a "Global crises". World Health Organisation, which usually speaks about epidemics and quick-fix vaccines, says about 1.75 million deaths take place in road accidents globally; a staggering 10 percent of them happening in India. The ominous forecast that road accidents in this country would grow by 3 percent each year and cost 3 percent of our GDP underscores the magnitude of the crises we face. Estimates suggest the pedestrians are involved in 50 percent of road accidents in the cities. About 676 persons on foot have died in accidents in the capital till October 31 in 2005 as per the report in Deccan Herald,Sunday, November 27, 2005. Volume of traffic and speeding are the two major reasons for accidents of pedestrians in built up area. If by any means we can reduce the speed or volume of vehicles, alter driver behaviour and improve the conditions of non-motorized street user, the number of accidents occurring can be reduced upto a great extent. The mean stated above can be referred to as traffic calming. Traffic calming has become one of the most popular subjects in the Transportation Engineering field over the last ten years. In India it is in nascent stage and held a lot of potential for future. The aim of the study is to see the various traffic calming measures in other countries, its relevancy and application in Indian condition.

***Keywords*—** Horizontal deflection measures, speed control, traffic calming, volume control

I. Introduction

ROAD safety is now of prime concern in India. Despite India having less than one per cent of the world's vehicles, the country accounts for six per cent of total road accidents across the globe and ten per cent of total road fatalities [1], Indian cities are expanding rapidly causing the projected increase in the number of vehicles. Hence the risk of fatalities will increase significantly in the coming years. The most vulnerable among road users are pedestrians, cyclists and motorcyclists.

The main causes of the road accidents include inappropriate speed, inattention to hazards on heavily trafficked roads, absence of safe crossing facilities for pedestrians and other vulnerable road users, violation of traffic rules including erratic parking and driving under the influence of alcohol, and above all a general lack of road safety awareness. Appropriate measures are imperative to tackle the causes of road accidents and reduce the risk of injuries and deaths. Traffic calming is currently one of the most suitable measures for reducing road accidents and improving the safety for non-motorized street users [2]. However, it should be coupled with a comprehensive road safety education campaign to achieve the greatest benefits.

The definition of Traffic Calming varies but the aim of it is to reduce the speed and in some cases the volume of traffic, providing a safer environment for non-motorized road users. The definitions obtained are as follows:

a) ITE's (Institute of Transportation Engineers): "Traffic calming involves changes in street alignment, installation of barriers, and other physical measures to reduce traffic speeds and/or cut-through volumes, in the interest of street safety, livability, and other public purposes."

b) NYSDOT Design Definition (New York State Department of Transportation): "The combination of mainly physical measures that reduce the negative effects of motor vehicle use, alter driver behavior, and improve conditions for non motorized street users"

c) Municipal Government of City of Vancouver, Canada: The practice of using physical techniques to influence traffic movements in neighborhoods. Objectives of traffic calming vary from improving safety through speed reduction measures such as traffic circles to discouraging traffic from entering an area through diversion measures such as "right-in, right-out" intersections.

To summarize we can say that traffic calming is a mean of designing roads using physical measures to encourage people to drive slowly and carefully and enhance the safety of walking and bicycling. The main advantage of traffic calming is that it is self enforcing and does not normally require any complication traffic control devices and is usually highly cost-effective; achieving benefits with a value far greater than the costs.

II. Measures Of Traffic Calming

A. Vertical Deflection Measure

The vertical deflection measure generally deals with the vertical shift of the carriageway. This technique is effective and reliable. The main concerns related to these measures are that they may cause noise and air pollution. Noise is a particularly important issue in residential areas. Other concerns relate to the effect on the emergency services, particularly ambulances carrying critically ill patients and buses carrying elderly and infirm passengers. Another concern relates to drainage, particularly where humps or table-tops that take up the full width of the road are being proposed. Hence a detailed drainage assessment is necessary in design. The different vertical deflection measures are discussed below.

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B. Speed Humps

Speed humps are generally paved and placed across the road having a height of three to four inches (75 mm typical maximum height in the UK) [5, 6]. The top of the speed humps are generally rounded and the humps are generally made of flexible surfacing materials. Speed humps are most commonly observed where a big reduction in speed is sought in higher risk areas e.g. around schools. If designed properly the speed humps reduce the speed of vehicle and give an acceptable ride quality at around 10-15 mph, but will be felt more suddenly by the driver at higher speeds. The major disadvantage of this measure is it causes discomfort to passengers in buses and ambulances. The speed humps must have proper markings to make them visible at night.

C. Speed Table

Speed tables (Fig. 1) are generally similar to speed humps but cover a larger area and have a flat top. The material of the speed table is usually different than pavement. Speed tables generally have a relatively smooth gradient on the approach ramps. The flat top should be designed to accommodate the full wheel base of typical large vehicles passing over it. Speed tables often require bollards along the adjacent footway, in order to deter dangerous parking on the footway. Care has to be taken in the selection of the material used for the speed table. Flexible materials can often perform better than block paving, as the latter can unzip where there are heavy traffic flows and heavy vehicles passing over the table. Speed tables are now being adopted in the UK for residential streets where there are generally low or no bus services.

Fig. 1 Speed table

D. Speed Cushion

Speed Cushions (Fig. 2) are similar to road humps but are not provided across the full width of traffic lane but instead are spanned by the width of the axle of a bus or other large vehicles. This can be provided in residential areas and very effective in reducing the speed of vehicles but minimizes passenger discomfort. If designed carefully, speed cushions can enable emergency vehicles to drive at the required speeds, but typical private cars will not be able to pass over them at more than 30 mph without experiencing the impact. Speed cushions can also have different colored pavements or be demarcated using white lines to be identified clearly. Speed cushions are now generally being adopted in the UK in new traffic calming schemes where there are relatively high flows of large vehicles, buses and emergency vehicles. Speed cushions can be quieter than humps and therefore may be more acceptable in residential areas.

Fig. 2 Speed cushion

E. Rumble Strips

Rumble strips are grooves or rows of raised pavement markers placed perpendicular to the direction of travel to alert inattentive drivers. As a vehicle passes over the rumble strips, noise and vibration are produced; alerting the driver that they are approaching a hazard. The spacing of the strips is particularly important as closer spacing means higher speed reduction. It can be preferable to provide a strip adjacent to the kerbline which is free from rumble strips in order not to cause discomfort to cyclists. Rumble strips are typically only 15-25 mm in height and are typically used as an entry treatment to a section of road with reduced speed limit. They tend to be less effective than humps, table tops and cushions because drivers can pass over them at high speeds without severe discomfort.

F. Raised Pedestrian Crossing

A raised pedestrian crossing is a modified speed table where the width of the flat portion is same to that of the pedestrian crossing. It encourages the pedestrian to cross the road at a particular location increasing the safety and also makes them more visible. This measure also encourages the driver to yield. In many cases different materials are used in it for better identification. Guard rails are also often provided in the footpaths to encourage people to cross at a single point.

G. Raised Intersection

Raised intersections (Fig. 3) are speed tables where the flat top includes the whole intersection area. This top also includes the pedestrian crossing. The material used in this raised intersection may be different than that of pavement. Proper demarcation is necessary as pedestrians will often use the raised intersection as an informal pedestrian crossing point.

Generally ramps with smooth gradients are provided on the approaches. This measure reduces the speed of vehicles approaching from all arms. A raised intersection may be used in locations having higher pedestrian activity but may not be

preferable in intersections where bus traffic is higher, as they can cause passenger discomfort and falls on board.

Fig. 3 Raised intersection

H. Textured pavement

The idea of textured pavement is basically to create an uneven surface in pavement by using different pavement material blocks or other means to caution the driver. This technique generates low level noise, creating a psychological effect which encourages drivers to slow down. Any pedestrian crossings should be demarcated clearly in this technique, potentially by using blocks of a contrasting colour.

I. Horizontal Deflection and Narrowing Measure

The horizontal deflection measure provides a horizontal shift and/or narrowing of carriageway thus resulting in a decrease in the speed of the approaching vehicle. This technique in some cases is less effective than vertical deflection measures, but can often work well at junctions. The combination of both vertical and horizontal deflection measures can have a great impact in traffic calming [7,8]. The various techniques for these measures are as given below.

J. Mini Roundabouts

Mini Roundabouts (Fig. 4) are generally placed in center of a minor intersection. The same yield rules apply on a mini-roundabout as to a normally sized roundabout. They are very effective in reducing the speed of approaching vehicles from all arms of the intersection and force the traffic to manoeuver thus reducing the speed. Mini roundabouts though effective can be difficult for large vehicles to negotiate and so can require over-run areas to cater for vehicles with trailers. Thus it should be used where the volume of large vehicles is relatively low. Mini-roundabouts also do not suit U-turn movements. They can contribute to a safer environment for pedestrians to cross, by the creation of splitter islands within the flared arms.

K. Chicanes

A chicane is a sharp double bend. Chicanes are created by build outs within minor roads placed alternately to create a sharp S curve. This measure can be very effective in reducing the speed of vehicles and is easy to negotiate for large vehicles. Chicanes can also be used in places where noise pollution is a problem. This can also be achieved in roads where parking volume is high by placing parking lots alternately. Chicanes tend to be less effective at off-peak times, when there is little oncoming traffic to yield to.

Fig. 4 Mini roundabout

L. Neck downs

Neck downs (Fig. 5) are generally kerb extensions near to intersections in approach roads. They are also known as bulb outs. This measure is of significant importance as it decreases the width of the road for pedestrians crossing and draws the attention of the driver to the road enhancing traffic safety. This measure can also reduce the turning radius at intersections resulting in decreased speed of turning vehicles. This measure can also eliminate parking near to intersections, which would otherwise obstruct visibility. For larger vehicles it may however pose problems for turning.

Fig. 5 Neck downs

M. Islands/ Refuges

This is basically an island in the center of carriageway catering for a pedestrian crossing. This is also known as pedestrian refuge island as it provides a refuge to the pedestrians whilst crossing the road. The island can be finished in high quality paving and street furniture where necessary to make it aesthetically pleasant. This measure generally placed near to residential areas and places where the width of the road is broader than standard. In this technique the pedestrian only needs to concentrate on one direction of traffic at a time and so it increases pedestrian safety.

N. Chokers

Chokers (Fig. 6) are generally build outs into a street

reducing the effective carriageway width. This can be achieved by extending the kerb or providing a small island. The width of choker should be decided on the basis of the typical types of vehicle using the road. A choker reduces the speed and volume of the vehicle in the middle of the carriageway. It is also easy for large vehicles to negotiate. They may include a yield or give way line on one of the approaches to give greater priority to the other direction of flow.

Fig. 6 Chokers

O.Volume Control Measures

The measure as the term indicates generally reduces the volume of the traffic. In general terms this is same as the road closure techniques in India. This measure should be regarded as the last resort if speed control measures are not effective [9]. The different means to achieve this measure are given in the following section.

P. Full Closure and Partial Closure

Full closure (Fig. 7) of a road is generally achieved by blocking the mouth of the road by means of bollards or guard rails. This prevents the access of through traffic but allows bicycles and pedestrians to cross easily. This measure is important in residential areas having a parallel route to a main carriageway. Partial closure is achieved blocking the access of one direction traffic. This can be very effective as it decreases the volume of traffic. This is also of particular importance for crossing of pedestrians as they need to concentrate only in one direction. Partial Closure also provides the access to emergency services. The disadvantage of partial closure is illegal turns against the prescribed direction of flow which can cause accidents or traffic jams.

Fig. 7 Full closure

There are other ancillary means of traffic calming like gateway features to alert the motorist to the change in speed limit, wider space allocated to non motorized traffic such as cycle routes, realigned intersection to decrease the speed while approaching a junction etc. These methods can be combined with other measures to greatest effect. This paper does not focus on the role of traffic speed cameras, but these can also be combined with traffic calming to achieve a consistently lower speed along a particular section of road.

III. Effectiveness Of Traffic Calming

Traffic calming measures are adopted and effectively implemented in European Countries and America. These are proved to be very effective in reducing the speed and volume of vehicles. Though it can be very effective there are certain disadvantages which must be borne in mind. In summary the disadvantages are:

a) Traffic calming measures are very effective in reducing the speed of vehicles but may not be accepted readily by the people using that section of road and can cause a public outcry if public consultation is not allowed for.

b) Traffic calming measures (essentially vertical deflection measures) can also cause inconvenience to emergency vehicles. Thus the response time for the emergency services increases and may in the worst case increase the risk of loss of life.

c) Vertical Deflections (speed humps, speed cushions etc.) also causes discomfort to passengers of large vehicles, such as buses.

d) Vertical deflection may also increase noise pollution, particularly in residential areas and can be minimized by proper design.

e) Vertical deflection may also slightly increase the fuel consumption of vehicles and so may affect air quality.

f) A full closure also tends to block the access of the local vehicles.

g) Textured surfacing may cause discomfort to cyclists.

It should be noted that there is plenty of evidence from around the world that traffic calming measures are effective in improving safety despite their disadvantages.

The advantages of having traffic calming measures are discussed below:

a) The prime advantage of traffic calming is it reduces the speed and in some cases the volume of the vehicles.

b) The severity of accidents and not just the frequency can diminish as a subsequent effect of reduction of speed and volume.

c) Traffic calming can make the road a more pleasant place to walk and cycle and also gives a sense of safety and security among the non-motorized users.

d) Crossing widths can be reduced, which is particularly important for child pedestrian safety.

e) Traffic calming may reduce noise levels if designed properly.

f) Traffic calming measures can deter rat-running, in other words inappropriate use of residential roads for commuting purposes.

g) Traffic calming measures can deter inappropriately high volumes of HGV traffic and encourage them to use main roads instead.

h) Measures with different surface colour treatments easily alert the driver of the approaching hazard and thus reduce the risk of accidents.

i) Traffic calming measures typically achieve high benefit-cost ratios and reduce the burden of cost of road traffic accidents on the emergency services, the state and society in general.

IV. Conclusions

Traffic calming intends to encourage people to drive slowly in a road and enhances non-motorized activity. This has proved to be effective in reducing accident rates. A specific traffic calming measure may not be successful in isolation. The most appropriate combination of measures should be sought for a particular area. Generally traffic calming should be provided in the residential areas and shopping streets, where there is a high accident rate. The principle of 'worst first' should be adopted, rather than an ad-hoc approach as the latter will reduce public acceptance. Proper design and planning is required for traffic calming to select the location as well as the type of measure to be used. Public consultation is also required during the planning and design stage as this may affect the design at large. The volume control measures should be taken as a last resort if the other proves ineffective. Though vertical deflection like speed humps causes discomfort to passengers of large vehicles, speed tables with much smoother ramp can be used effectively in that situation. The reduction in speed of the vehicles is also dependent upon the spacing of the vertical deflection measure. Closely spaced deflections mean lower speed. Well designed vertical deflections can be comfortable to vehicles at lower speeds.

Implementation of traffic calming has costs but these are usually much less than the cost of the accidents and fatal injuries. Cost estimates should include the construction cost as well as the maintenance cost and also any costs potentially arising from increasing journey times as appropriate.

In India we have a heterogeneous mix of traffic. The foremost requirement in urban areas should be to provide adequate space for non-motorized users. This could comprise an increase in footpath width and separate lanes for bicycles where the volumes of such road users are high. Proper enforcement is also necessary where the footpath is encroached upon for commercial activities. The next important aspect is identifying the crossing points for pedestrians in zones of high pedestrian activity and providing proper crossing (such as speed tables with pedestrian crossings) as part of the traffic calming measures. This will encourage pedestrians to cross at a designated safer point and thus increases their safety. The junctions with the highest level of pedestrian activity should also be identified and should be provided with proper traffic calming measures. The non signalized junctions should be provided with traffic calming measures to reduce the speed of approaching vehicles.

Traffic calming measures are relatively new in India. It is essential to learn from the mistakes made in other countries, in order that we can achieve a better standard of safety. The appropriateness of various traffic calming measures should be evaluated in Indian condition before implementation. Traffic calming is an efficient means of increasing safety and should definitely be promoted and implemented more extensively in the future.

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