International Journal of Engineering and Science Invention (IJESI)
ISSN (Online): 2319-6734, ISSN (Print): 2319-6726
www.ijesi.org ||Volume 13 Issue 9 September 2024 || PP 54-59

Planning of Cross-Pedestrian Facilities in Urban Areas

D. Rajashekar Reddy
Civil Engineering Department,
University College of Engineering, Osmania University, Hyderabad, India
Email: dudipalars@yahoo.com

ABSTRACT
The existing methods for design of infrastructure for transportation are mainly focused towards design for movement of vehicular traffic and thus resulting in inadequate facilities for pedestrians. This is exhibited more mainly in developing countries and due to which pedestrians accidents are increasing and share a major portion in road accidents. Pedestrians being one among the Vulnerable Road Users (VRU's) are usually injured for life when met with an accident and making victim's livelihood difficult for rest of life. Intersections when placed far apart encourage pedestrians to cross at midblock sections and Pedestrians cross road at random locations due to lack of crossing facilities at these midblock sections. Understanding this, a broad literature review was comprehended in field of design of pedestrian facilities.

Keywords: *pedestrian safety, pedestrian preferences, cross walk*

Date of Submission: 02-09-2024 Date of Acceptance: 15-09-2024

I. INTRODUCTION

Walking is one of the oldest and basic modes of transportation that is being used from time immemorial. People walk for many reasons, some for work trips, some for education trips, some for recreation etc. The latest buzz in transportation being is PEDESTRIANIZATION of streets, which mainly focuses on developing better facilities to pedestrians' through well planned and designed facilities. Countries like China, New Zealand, and Copenhagen etc are focussing on pedestrianization. These countries believe that pedestrians' being one of the vulnerable elements of road users should be provided safe facilities. Pedestrians' mainly use facilities like sidewalks, crosswalks for their movement. Sidewalks run along the carriageway while crosswalks are across the carriageway. Sidewalks are designed mainly based on the pedestrian density and walking speed. Pedestrians' cross the road mainly at intersection and Midblock. Many countries have separate warrants to install midblock crosswalks. It is found that crossing road at Midblock section is safer than crossing at intersections as the turning collisions are completely eliminated and pedestrians' has to face only through traffic while crossing. Since Midblock crosswalks are safer, many countries are now trying to develop warrants to install midblock crosswalks. While designing a midblock crosswalk, designer should take into account, pedestrian and vehicle traffic parameters. Improperly placed midblock will cause unnecessary delay for both the road users.

Midblock is the section of a carriageway between two intersections. Drivers enjoy wide roads with few intersections and many lanes. This type of street design will surely help motorists to reach destination quickly and with ease. But if the same motorists are walking along this route, then there perception of road would be different. With few intersections placed far apart, discourages pedestrians' to walk up to intersection to cross road and encourages pedestrians' to cross at midblock sections. Typically the length of midblock varies from 200m to 1000m. Crosswalks located at midblock sections are midblock crosswalks. Major pedestrian attractors and generators are located along midblock sections and if midblock are long, then pedestrians' start crossing at midblock, thereby making route as the shortest. Midblock crossing may be marked or unmarked crosswalks. Unmarked crosswalks are usually provided in low volume roads and where operating speeds are lower. Marked Midblock crosswalks are similar to those found at intersections and used to transfer right of way to pedestrians' from motorists during crossing. Also markings intimate to drivers as where pedestrians' would cross the road. Placement of midblock crossing requires proper engineering study else it might lead to problems regarding safety and delay.

A proper examination of design of transportation facilities shows that main focus is towards design of infrastructure for vehicle traffic. These guidelines have almost neglected pedestrians' in designing infrastructure and hence providing them minimum facilities. In India, the situation is same. Though in India, 50% of trips are

made using walking, there is a lack of proper facilities for pedestrians'. In many cities like Kolkata, Chennai, Delhi, Hyderabad etc. facilities for pedestrians' are insufficient and hence pedestrians' have to compete with vehicle traffic to obtain right of way (ROW). Now-a-days, to provide through and continuous movement for vehicle, intersections are spaced far apart increasing the length of midblock sections. Long Midblock sections encourage pedestrians' to cross at midblock section instead of walking up to intersections to cross. Since there is a lack of facilities for crossing at midblock sections, pedestrians' start crossing randomly and hence increasing delay for vehicle and risk for pedestrians', because motorists do not expect pedestrians' to cross at midblock sections. The situation still gets worsen at sections which have on-street parking where pedestrians' are hidden between parked vehicles and when motorists suddenly notices pedestrian coming in-between parked vehicles. Pedestrians' being vulnerable road users are usually badly injured in accidents.

Looking at pedestrian accidents statistics in India, it can be seen that numbers have been doubled in 4 decades. The actual numbers might be more than as shown in graph due to problem of under-reporting in India. The pedestrian fatality plot also shows continuously increasing trend cautioning urban planners about pedestrian safety. Even though crossing facilities are provided in urban areas, most of them might go under- utilised. It has been seen pedestrians' jaywalking due to badly designed pedestrian signals, most of FOB's and Subways being under-utilized in urban areas. Therefore a thorough study should be made before providing crossing facilities so that it is used to maximum extent and thus ensuring smooth flow of all road users.

II. OBJECTIVE

The present paper was focused towards planning of cross-pedestrian facilities in urban areas. The broad objectives of the paper are:

1) To obtain the rational spacing of cross pedestrian facilities in urban areas for mid-block sections
2) To assess the risk associated with pedestrian while crossing road
3) To study the preferences of pedestrians' for different crossing facilities in urban areas

III. LITERATURE REVIEW

Midblock section in simple term can be defined as an area between intersections where there is only through movement of vehicular traffic. It can also be interpreted as the stretch of road between two adjacent intersections. The vehicular traffic movements in midblock sections are most often through and travel at higher speeds compared to speed near intersection. Medians are usually associated with midblock section to separate opposing vehicular movements. The length of midblock sections may vary from 200 m to 1000m. Longer midblock section help vehicular traffic to move continuously with lesser number of stoppages but such facilities will cause difficulties for pedestrians' to walk up to intersection whenever they want to cross road (Kansas, LTAP fact sheet).

Most of guidelines for design of infrastructure mainly focus on design for vehicular traffic movements and hence results in poor facilities for pedestrian movement. In order to reduce number of stoppages and queue length, urban planners decide to place intersections far apart. Though, a person as a motorist would enjoy this but the same person when walking on same road would have different perception. A crosswalk is defined as "portion of roadway designated for pedestrians' to use for crossing the street". Crosswalks are usually provided at intersections or midblock.

Midblock crosswalk is defined as a crosswalk at a location other than an intersection with traffic controls for both directions of traffic. Midblock crossing should be provided when it is determined that pedestrians' will cross road at midblock rather than using intersection with traffic controls to stop the flow of traffic and allow pedestrians' to cross safely. Most of the studies have shown that crossing at midblock is safer than crossing at intersection as pedestrians' has to face only through vehicular traffic unlike through and turning vehicular traffic at intersection. (ITE 2008 Technical conference and Exhibit) After reviewing 13 studies from 1965 to 2005, it was observed 11 studies showed higher collision risk when marked crosswalks were present at intersection. The requirement of midblock crossing at a particular section mainly depends up on the length of section. Manual of Uniform Traffic Control Device (MUTCD, Section 1A-13) recommends that midblock crossing should be considered when length of midblock exceeds 180m/600ft. Indian Roads Congress (IRC 103-1988) suggests that midblock crossing should be considered only when length exceeds 300m.

Texas Department of Transportation (TDot) has found that pedestrians' will begin to seek out midblock crossing opportunities when intersection spacing exceeds 400ft/120m.

Pedestrian crossing facilities are those facilities that are used by pedestrians' to cross road. Spacing of pedestrian crossing facilities and chances of interaction between pedestrians' and motorists are usually related. Pedestrian crossing facilities when spaced far away would discourage pedestrians' from using it. This would encourage pedestrians' to cross illegally between crossing facilities and thus increasing pedestrian motorist

interaction. Pedestrian facilities should be placed at such distances which pedestrians' would like to walk additionally from their desired crossing point without any facilities. This detour distance is affected by many factors which include road network, land-use, socio cultural and henceforth. Literature shows that this detouring distances various from place to place.

Li.J et.al (2013) stated that spacing of crossing facilities in the arterial road more than 200 meters is rare in foreign, but mostly appear in domestic region.

Pedestrian crossing facilities include at-grade separated and grade-separated crossing facilities. At-grade facilities are usually provided in arterial roads with low traffic and when lengths of mid-block sections are less than 400m. Grade separated facilities are usually provided at expressway and long mid-block sections which are more than 400m. Proper spacing of these facilities is very important to reduce pedestrian-motorists interaction and thus providing smooth flow for different classes of road users.

Midblock crossing involves interaction of pedestrians' who cross the road and motorist who ride on the same road. The design or requirement of a midblock crossing is guided by various numbers of factors related to pedestrian, motorists, and static characteristics of carriageway and geometrics of road. Marked midblock crossings being basically designed for pedestrian crossing movements, characteristics of pedestrians' form one of the main factors affecting its design. Number of guidelines recommends the requirement of midblock crossing based on pedestrian crossing volume. Most of the design guidelines recommend a marked midblock crossing should be provided when demand for crossing is a minimum of 25 pedestrians' during peak hour and minimum of 75 pedestrians' for any 4 peak hours.

Traffic volume and speed of vehicles affect the gap that is available for pedestrians' to cross road. High volume of vehicle reduces gap that is available for pedestrians' to cross and pedestrians' try to search for rolling gaps between vehicles. High speed of vehicles increases the fatality of crash. IRC 103-1988 recommends that controlled crossing should be provided when approach speeds exceed 65Kph. Warrants available recommends that a crosswalk at midblock location can be installed when operating speed are less than 56Kph. Traffic volumes also decide type of control to be provided at MBC's. Width of road and number of lanes affect the crossing time of pedestrians' and exposure to accidents. Crossings should be provided at locations where carriageway is narrow. Median/ refuge islands are usually associated with wide roads to help pedestrians' to cross road safely. Pedestrians' and cyclists have their intended path of travel which is called as desired lines and identification of these lines for the placement of midblock crossing becomes very important.

Visibility of pedestrians' who are crossing at midblock is one of parameter that affects the placement of MBC's. Motorists should be able to see pedestrians' prior to conflict which mean that motorist should have sufficient sight distance while approaching midblock crossing (MBC's). Like stopping sight distance (SSD), crossing sight distance
(CSD) is defined as *distance up to which a pedestrian can see an approaching vehicle.* This distance is one of the important elements to ensure pedestrian cross road safely. It is calculated as follows-
CSD= (Crossing distance/ Walking speed)* 85^{th} percentile speed of vehicle.

Safety at Midblock crossing

Safety at midblock section is one of the important issues which are given more importance because motorists usually do not expect pedestrians' to cross at midblock locations. Many researchers have shown that marking the crosswalks will lead to false sense of security for pedestrians' and hence more risk of collision (Bruce.F.Herms, 1972).

Cui.Z et al (2005) Evaluated spatial and temporal characteristics of mid-block crossing to evaluate pedestrian behaviour in better way and where and when Mid-block pedestrian crashes (MBPC's) occur. The analysis showed that Midblock pedestrian crashes (MBPC's) were large in number at 150ft away from intersections and more crashes were observed on Friday and Saturday during which was attributed to more recreational and high pedestrian volumes. At controlled crossing, pedestrians' who violate signals and do jaywalking are under more risk. King.M.J et al. (2009) showed that pedestrian crossing illegally have 8 times more chances of collision than pedestrian crossing legally using concept of relative risk. Providing proper safety at MBC's during night time is very important.

Locations where MBC's are provided should have proper overhead lighting so that pedestrians' are visible to motorists at night time. There is always a debate whether marking should be provided at crosswalk or not. At night, a pedestrian waiting to cross at midblock crossing without overhead lighting is under 6 times more risky situation compared to crossing at day light. A study made at university of California showed that marking of crosswalk actually reduces chances of collisions as it intimidates motorists about where pedestrians' would cross. Many countries have guidelines regarding requirement of marked crosswalks. The pedestrians' crash rate

increased at marked crosswalks as the number of lanes and volume of vehicles increases. More number of traffic lanes will hide crossing pedestrians' from adjacent lane and hence speeding vehicle may not notice pedestrian. Crosswalks should be provided with push-button signals to enhance safety of pedestrians'.

Delay aspects

Delay is the difference between actual travel times to travel time in free flow condition. Pedestrian and motorist both incur delay while travelling. Pedestrians' delay is due to vehicular movement and vehicular delay is due to pedestrian movement. There is always a trade-off between these delays.

Pedestrian delay is calculated usually as the time difference between arrival times at kerb of crosswalk to departure time from kerb once sufficient gap is obtained. Literature shows that pedestrian can wait maximum up to 1 minute to cross after which they get frustrated and try to run within small gaps**.** Jin.S et al. (2012) studied the effect of pedestrian crossing movement on delay to vehicles and also variation of capacity with different pedestrian flows on crosswalks using simulation. Simulation study was made to understand the effect of pedestrian crossing on vehicle capacity and delay. The delay study showed that as pedestrian flow on crosswalks increased, the vehicular delay increased whereas pedestrian delay decreased

Cross pedestrian facilities

Cross pedestrian facilities are those facilities which aid pedestrians' to cross road safely and efficiently. These facilities are provided across carriageway. Crossing facilities are usually integrated with refuge islands/ medians as width of road increases. Design and placement of these facilities should include proper engineering judgement as any wrong decision made would put pedestrians' in dangerous situation. Basically these facilities are classified as:

1. At grade crossing facilities
2. Grade separated facilities

At grade facilities includes those facilities which have no spatial separation. These Facilities share common space with vehicles and most of the facilities are separated temporally. Some of the most common facilities under this category include:

1. Zebra Crossing: This type of crossing is one of the most commonly used facilities and belongs to category of controlled crossing. These crossing have white-black stripes on carriageway preceded by stop line. This type of crossing is commonly found at intersections where pedestrians' have a separate phase for crossing. These crossing ensure that right of way is transferred to pedestrians' once they step on the marking, although pedestrians' are advised to look for conflicting traffic before crossing. The width of this crossing varies between 2m to 4m (Indian Roads Congress- IRC 103-1988). Markings should always be accompanied by proper sign boards.

2. Pedestrian signals: Similar to vehicular signals, pedestrian signals are provided at locations where pedestrian crossing volume is high and warrants require conflicting traffic to separate temporally. Pedestrians' are provided right of way after each phase of vehicle signals. These signals include three indications namely "steady walk", "Flashing Don't walk", "Steady Don't walk".

Pedestrian signals should be installed only after warrants are satisfied and when there is a strong requirement as they cause delay for vehicle traffic and require maintenance costs.

Similarly there are other types of at grade crossing facilities namely pelican crossing, puffin crossing, toucan crossing which are commonly found in western countries. Unlike at grade facilities, grade separated facilities provide both spatial and temporal separation. This includes:

1. Foot-over bridges/ Overpasses (FOB) 2. Underpass/Subway

FOB facilities allow pedestrians' to cross road above the motorway and underpass allow to cross below the carriageway. These facilities are only provided at sites with high vehicle and high pedestrian volume. Using FOB/Underpass, pedestrians' can enjoy uninterrupted flow, hence minimising delay for both. Since these facilities are more costly compared to pedestrian signal/Zebra crossing, economic analysis should be carried out before installation

Pedestrian safety

Pedestrian safety is one of the major concerns for decision makers and practitioners. Every year 2, 70,000 pedestrians' in world lose their lives because of road accidents (WHO, 2013). Globally pedestrians' constitute 22% of total road accidents and even 2/3rd in some countries. Pedestrian accidents are more fatal and disabling pedestrians' for rest of life. The most common factors that contribute for pedestrian risk are lack of safe infrastructure, high speed and high volume of vehicles etc. Pedestrian accidents have huge amount of economic impact affecting gross national product (GNP) of country. Studies have shown that road accident are

estimated to costs between 1 to 2% of GNP. The existing roadway design often cater the needs of vehicular traffic providing inadequate facilities for pedestrians' and hence being put at risk of accident.
Pedestrian safety can be measured using various risk indicators which are usually based on exposure for vehicles. Now-a-days researchers are using surrogate measures to indicate risk associated with pedestrians' while crossing road. Surrogate measures of safety indicate indirectly the risk associated with conflict/crossing. Some of surrogate measure of safety includes Gap time (GT), Encroachment time (ET), Post encroachment time (PET), Time to collision (TTC) etc.

Post encroachment time (PET) being one of surrogate measures of safety that is widely used to indicate chances of conflict. This measure is used to obtain severity of collision between two roads users when they enter common spatial area based on a temporal difference that is below a stated threshold value, which is usually in the range of 1 to 2 sec. PET is an actual measure of available gap when the vehicles are in the conflict configuration. PET is the time difference between two road users passing common spatial zone. A low PET indicates an encounter with high severity.

PET plays an important role in establishing its correlation with crashes with best results. Research has shown that PET<=1sec will result in severe fatal crashes (Kraay et.al, 1986). Even though PET is a proxy indicator of accident situation, the severity of collision is proportional to amount of kinetic being exchanged between colliding bodies and speed of colliding objects. (Carlsson, 1996 and Englund et.al, 1998).

Observations from literature review

1. Absence of proper guidelines in India regarding midblock crossing.
2. Most of guidelines in developing countries ensure designing only for motorised section neglecting non-motorised transport (NMT's).
3. Pedestrians' are in great danger while crossing roads due to improper facilities and hence constitute about 2/3rd of total road accidents.
4. No proper guidelines regarding spacing of crossing facilities.
5. Though pedestrian safety is one of important issue, no proper guidelines in India show how pedestrian safety/ risk can be quantified while crossing road.
6. Though there are plenty of guidelines in western countries regarding midblock crosswalks, those cannot be used to design midblock crosswalks for Indian conditions due to various factors
7. Pedestrian crossing facilities are usually placed without any preference study.

IV. DISCUSION

Highway Capacity Manual (HCM) suggests a speed of 1.2m/s for design of pedestrian facilities which do not comply with Indian conditions. The 85th percentile acceptable walking distance was found to be 90m which indicates that spacing of crossing facilities should be 180m. IRC 103-1988 suggests that midblock crossing should be provided only when length of midblock crossing exceeds 300m. This indicates that pedestrians' prefer to walk a maximum distance of 150m either upstream or downstream to cross road. Li.J et.al (2013) showed that average spacing of crossings at Tokyo, Paris, NewYork, Beijing, and Shanghai was 133m, 84m, 156m, 278m, and 293m respectively. Akin.D, Sisiopiku.V.P (2000) showed that 83% of pedestrians' claimed that the existence of a midblock crossing influenced their decision to cross at a certain location and 71.2% pedestrians' used midblock crossing properly. This shows the importance of midblock crosswalks and also indicates increased compliance towards midblock crossings. By providing crossing facilities at this spacing would direct pedestrian to use midblock pedestrian crossing to cross road and thus reducing density of pedestrians' at intersections. This will ultimately lead to better flow of vehicles at intersections and increase the intersection capacity. The female pedestrians' had higher additional walking distance compared to male which can be interpreted that female pedestrians' are more safety conscious compared to male pedestrians' and preferred to walk more additionally to reach safe crossing facilities. Also young pedestrian (age<20) and old pedestrian (age>55) had short additional walking distance, which indicated that they would prefer to walk less additional distance to use safe crossing facilities.

V. CONCLUSION

Pedestrians' in urban areas are constrained to walk less due to lack of time. By providing proper planned and designed midblock pedestrian crossings would help them to minimize walking distance before crossing and thus increasing intersection capacity and providing better flow of vehicles. Intersections are not safe place to cross road due to improperly planned pedestrian phases and turning vehicles. Midblock pedestrian crossing provides sufficient time gap for pedestrians' to cross before vehicles arrive from intersection. Grade-separated facilities though more safe compared to at-grade facilities are not usually preferred for crossing road for various reasons.

REFERENCES

[1]. Akin, D., Sisiopiku, V.P. (2000) "Study of pedestrian crossing preference and perceptions". Institute of Transportation Engineers.
[2]. Cui, Z., and Nambisan, S.S. (2005) "Methodology for evaluating safety at pedestrian midblock crossing". Transportation Research Record. Pp- 75-82, Transportation Research Board, Washington, D.C.
[3]. IRC: 103-1988- "Guidelines for Pedestrian Facilities". The Indian RoadsCongress 1989.
[4]. Jin, S., Qu, X., Xu, C., and Wang, D.H. (2012) "Dynamic characteristics of traffic flow with consideration of pedestrians road-crossing behaviour". PhysicaA. Elsevier journal. Pp-3381-3990.
[5]. King, M.J., Soole, D., and Ghafourian.A. (2009) "Illegal pedestrian crossing at signalised intersections: Incidence and relative risk". Accident analysis andPrevention-Elsevier, pp.485-490.
[6]. Li, J., Gao, Y., and Yin, H. (2013) "Pedestrian Facilities Planning on Tianjin New Area Program". Social and Behavioural sciences (2013) Elsevier.Pp.683-692.
[7]. Manual on Uniform Traffic control devices (MUTCD)- Section 1A-13.
[8]. "Pedestrians safety"- A road safety manual for decision makers and practitioners- World Health Organisation (2013).
[9]. Rastogi, R., Thaniarasu, L., and Chandra, S. (2011) "Design implication of walking speed for pedestrian facilities". Journal of Transportation Engineering. Vol. 137, No. 10. American Society of Civil Engineering.
[10]. "Road accidents in India (2010)" - Ministry of Road Transport and Highways (MORTH). Government of India.