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Using video-graphic technique for the Pedestrian Safety Analysis (PSA) at mid-block crossings in urban areas of developing countries under mixed traffic conditions

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Abstract
In Urban areas of developing countries like in India, there has been a rapid increase in the pedestrian volumes and traffic-pedestrian conflicts in last few decades. To enhance the pedestrian safety facilities at Mid-block crossings in the CBD areas of Srinagar city. The present study aims to used video graphic method and the field data was collected at different locations in the CBD area of the Srinagar metropolitan area where high pedestrian flow was observed. At these selected locations, the final results obtained from the collected data of pedestrian volume count and pedestrian average speeds (m/sec) were observed during peak hours. Pedestrians were categorized based on different age groups and genders were analysed from the video technique. To enhance pedestrian safety facilities at mid-block locations under mixed traffic conditions, In future there is a need to improve the pedestrian safety facilities at mid-block crossings in urban areas of developing countries under mixed traffic conditions.

Keywords: pedestrians, pedestrian safety measures, mid-block locations, inventory pedestrian safety issues, pedestrian volume

1. Introduction
In India, in Srinagar Metropolitan Area (SMA) there is a lack of cross-marking facilities for pedestrian on urban roads under mixed traffic conditions, and we studied as per IRC 103-2012 guidelines for safety of mid-block crossing in urban areas. Principle of pedestrian crossings at mid-block: Midblock crossings must be provided for people to cross the street safely between building entries or bus stop locations or active land uses on opposite sides of the street at grade pedestrian crossing near midblock, raised pedestrian crossing (Figure 9) should be made mandatory in case of multilane roads with heavy volume of vehicular traffic and as shown in Table 1.

Table1: Standards for Mid-Block Pedestrian Crossing

▪ Residential area	▪ Spacing range: every 80 – 250m ▪ Coordinated with entry points of complexes; location of Bus/train stops, public facilities etc
▪ Commercial / mixed land uses	▪ Spacing range: every 80 – 150m
▪ High intensity commercial areas	▪ Pedestrianzations if possible

(***Source*:** Guidelines for Pedestrian Facilities, IRC 103-2012)

2. Objectives of study
The overall objective is to study the behavior of the pedestrians when they cross the road at mid-block crossings. The main objectives of this study are:
1) Identification of the pedestrian safety issues and safety measurement at midblock crossings in urban areas.
2) To identify the general crossing behaviour of pedestrians at mid-block crossings.
3) To suggest improvement measures at mid-block crossings.

3. Literature review
The current review of literature were studies about the crossing at mid-blocks in urban areas under mixed traffic and homogeneous traffic conditions and as shown in Table 2.

Table 2: The details of crossing treatment at Mid-block crossings

S No	Treatment	Author	Subject or Method
1.	Zebra Crossing	Ekman and Elvik, 1997 (cited in Sanca, 2002) [2].	They do not believe that marked road crossings have a positive safety effect for pedestrians. They argue that collision risks can be higher at marked crossings with no other facilities (e.g. zebra crossing) as they give pedestrian a false sense of security because the road markings are not as visible to vehicles as they are to pedestrians.
2.	Stop Lines	Van Houten *et al*., 2001 [1]. Allen, Bygrave and Harper, 2005	The Local Transport Note 1/04 suggests that, 'increasing the distance between the stop line and the crossing studs from 2m to 3m has been proven to improve safety and comfort for pedestrians by positioning waiting motor vehicles further from the crossing point'. Canadian research has shown that putting give way markings 10 metres in advance of the crossing reduced conflicts between pedestrians and vehicles from 16.8% to 4.3%. A study for TfL examined the behaviour of road users at Advanced Stop Lines (ASLs)

			designed to allow priority to cyclists. The study found that all vehicles that encroached at control sites went into the pedestrian crossing, compared with 12% at ASL sites. This indicated that an ASL can provide a buffer zone that discourages vehicles from blocking the pedestrian crossing.
3.	Raised Crossings	Sanca (2002) [2], Jones and Farmer (1993) and Zegeer *et al*. (2001) [3]. Sanca (2002) [2].	the effect of introducing raised zebra or signal-controlled crossings is a reduction in vehicle speed and an increase in vehicles giving way to pedestrians, both of which give a safety benefit to pedestrians and a significantly lower pedestrian collision rate. He does, however, warn that this measure should not be introduced if sight distance is limited, if the street is steep or if the road is a bus route or emergency route. Special care should be paid to drainage.
4.	Pedestrian Refuge Islands/Medians	Zegeer *et al.*, 2001 [3]. Zegeer, 1991 (Lalani, 1976)	Research has shown that painted medians (that were not raised) do not offer significant safety benefits to pedestrians compared with no median at all. Relatively few studies have been conducted on the safety effects of pedestrian refuges however one study undertaken in London (Lalani, 1976) examined the effects of many roadway improvements, including pedestrian refuges. This study concluded that the provision of refuges decreased vehicle collisions, but surprisingly increased pedestrian collisions. Significant collision reductions were only obtained at sites where the purpose of the refuge was very clearly established, i.e. installed for safety reasons, reinforcement of the hatch markings etc.
5.	Pedestrian Crossings with Narrowing	Sanca (2002) [2].	Road narrowing at a crossing can be achieved by widening the footway and therefore reducing the width to cross. It is a measure suitable for low volume streets. According to Sanca (2002) [2]. narrowing at a pedestrian crossing is an effective way to reduce traffic speeds and increase drivers' awareness of other road users.
6.	Vehicle Activated Signs	Sanca (2002) [2].	These signs improve drivers' speed and give way behaviour, and are well accepted by drivers. Pedestrians who use the crossings think it is easier and more convenient to cross.

4. Study Methodology

4.1 Selection of Study Locations

Here, different sites have been selected. The selected sites and their corresponding data are mentioned in figure 1 to figure 7.

Location One: Midblock crossing M A Road, Kothi Bagh

(***Source*:** Google Satellite Map Srinagar City accessed on 04/03/2018)

Fig 1: Midblock Crossing at M.A. Road Kothi Bagh.

Location Two: Foot Over Bridge near Women's College

Fig 2: Foot Over Bridge near Women's College.

4.2 Inventory pedestrian safety issues at mid-block crossing

After visiting each and every site we have collected the major pedestrian safety issues and the lack of facilities which are responsible for the pedestrian fatalities and as shown in figure 3.

Site One: M.A. Road Kothi Bagh:

(***Source*:** Captured by camera on 22/04/2018)

Fig 3: Midblock Crossing at M.A. Road Kothi Bagh.

4.3 The safety issues of this site are as follows

- Poor visibility of the road markings for the pedestrian at the midblock crossings.
- Absence of traffic signs.
- Absence of traffic signals.
- Absence of STOP line and road humps.
- No special provision for the physically disabled people.
- Speed of the traffic is high so that pedestrian face lot of difficulties while crossing the road especially during the peak hours.
- Surface condition of the road is not good. It becomes slippery in wet condition.

5. Case study of Lal chowk

- Insufficient space for on-street parking.
- Average crossing speed is 1.2 to 1.55m/sec
- Width of the road: 21.10 m

- Dimension of the midblock: 2.46 m x 0.4 m
- Spacing of the midblock strips:0.4 m

5.1 The safety issues of this site are as follows:

- Traffic sign is present but its visibility is very low.
- The surface condition of the foot over bridge is very poor.
- Lighting facilities is absent at the foot over bridge so pedestrian have to face difficulties while travelling in the dark conditions.
- No special provision for the physically disabled people.

Foot over bridge near govt. college for women

(***Source*:** Captured by Camera on 22/04/2018)

Fig 4: Foot Over Bridge Near Govt. College for Women.

- The stairs of the foot over bridge is poor.
- No special provision for the elderly and physically challenged people for crossing the foot over bridge.
- Insufficient space for on-street parking.
- Length of the foot over bridge: 26.18 m
- Width of the foot over bridge: 2.39 m
- Width of the stairs: 1.89 m
- Height of the stairs: 0.22 m

6. Results of video graphic surveys

Results after conducting video graphic survey has been shown in different figures. The various collected statistics are pedestrian volume, traffic volume, age of pedestrian etc. By collecting all these variables, peak pedestrian volume can be figured out. The midblock crossings can be rated according to the obtained peak pedestrian volume. The graphs between the pedestrian volume against time duration for the various sites have been plotted, the example of questionnaire and pedestrian volume graphs as shown in figure 5 to figure 7.

Example Question: Do you think this midblock is in need of improvement for pedestrian safety?

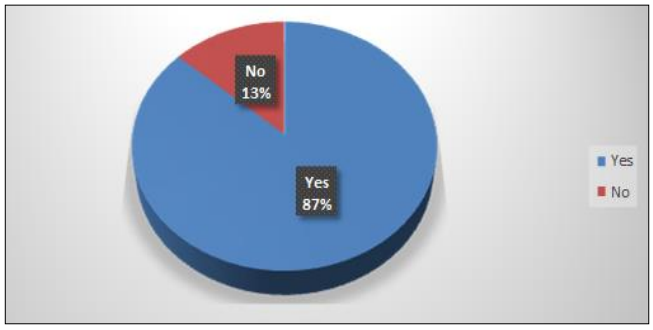


Fig 5: Pie Chart represents response of pedestrian.

87% people responded that present midblock section needs improvement whereas 13% are satisfied with the current midblock section.

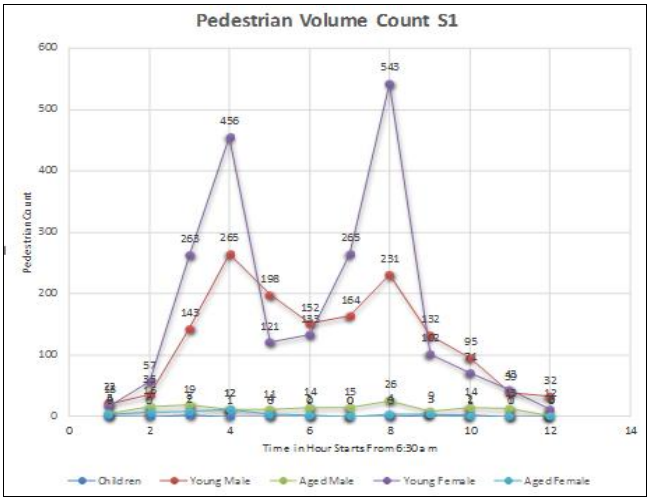


Fig 6: Line chart for Pedestrian volume of various age group vs time duration at site 1.

Data collection

Average crossing speed is 1.2 to 1.55 m/sec
Total pedestrian volume is 2595
Peak pedestrian volume is 804 (both directions)
Age group
Gender- male, female, young male, aged male, young

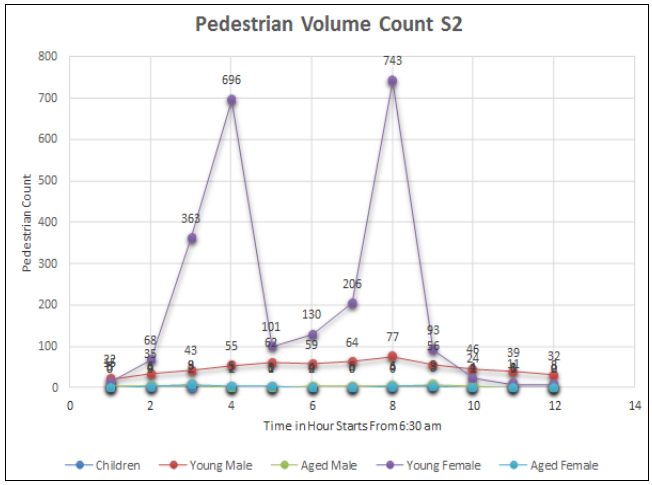


Fig 7: Line chart for Pedestrian volume of various age group Vs time duration at site 2.

7. Conclusions

In Urban areas of developing countries like India, in Srinagar metropolitan area there is lack of pedestrian safety facilities at mid-block crossing in the CBD areas of the city. In future there is scope to provide pedestrian safety facilities like pedestrian signal, pavement markings, traffic signs for safety of pedestrians in urban areas of developing countries. The following general safety measures are as under.

General Safety Measures

Some of the general measures which can be taken at midblock crossings are as follows –

a) Refuge Island

Refuge islands are raised medians placed in the centre of the

roadway at midblock locations. Refuge islands are intended to assist pedestrians in crossing wide streets by providing a safe "refuge" in the centre of the road, allowing pedestrians to cross one direction of traffic at a time. The presence of a refuge island reduces the time a pedestrian must wait for an adequate gap in the traffic stream and reduces the crossing distance that they must face at one time. Pedestrian refuge islands are particularly suitable near pedestrian generators such as hospitals, schools, malls, etc., and may form part of a larger street scraping plan.

(*Source*: http://www.tcat.ca/wp-content/uploads/2016/07/pedrefugeilsand.jpg)

Fig 8: Refuge Island.

b) Kerb Extensions

Kerb extensions "extend" the sidewalk or kerb line at specific points to reduce the width of the travelled portion of the roadway or extend out into the spaced allocated for kerb side parking. Kerb extensions reduce the distance pedestrians have to walk, hence pedestrians require smaller gaps in traffic in order to cross and pedestrian delays are likely to be shorter. Kerb extensions can provide a refuge for pedestrians, improve the sight distance and sight lines for both pedestrians and motorists, and may also be considered as a traffic calming measure.

(***Source*:** http://www.roadsafety/wp-content/uploads/2016/07/pedrefugeilsand.jpg)

Fig 9: Kerb extension

c) Raised Crosswalk

A raised crosswalk is a marked pedestrian crossing point at an intersection or mid-block location constructed at a higher elevation than the adjacent roadway. The raised surface improves drivers' awareness of the potential for pedestrians and has a traffic calming effect as one of its effects is to reduce speed. Raised crosswalk applications should be considered within the context of the road authority's traffic calming policies and practices.

(***Source*:** http://wp-content/uploads/2016/07/pedrefugeilsand.jpg)

Fig 10: Raised crosswalk

d) Pedestrian Warning Signs

Warning signs are used to alert drivers to danger or potential danger ahead. They indicate a need for extra caution by road users and may require a reduction in speed or other man oeuvre. This section contains advice on when to use each sign. Adequate warning signs can greatly assist road safety. To be most effective however, they should be used sparingly.

(***Source*:** http://warningsign/uploads/2016/07/pedrefugeilsand.jpg)

Fig 11: Pedestrian warning signs.

e) Use of Speed Breakers

These are the small undulations which are made on the surface on the road, due to which drivers of the vehicles are forced to reduce the speed of their vehicles.

Fig 12: Speed breaker.

f) Use of 3D Paint on road

This type of paint can be used to give an illusion of some

obstruction to the driver when he is speeding up.

(***Source*:** https://www.firstpost.com/photos/optical-illusion-delhi-gets-its-first-3d-zebra-crossing-at-rajaji-road-2893888.html)

Fig 13: 3D Paint for pedestrian mid-block crossings.

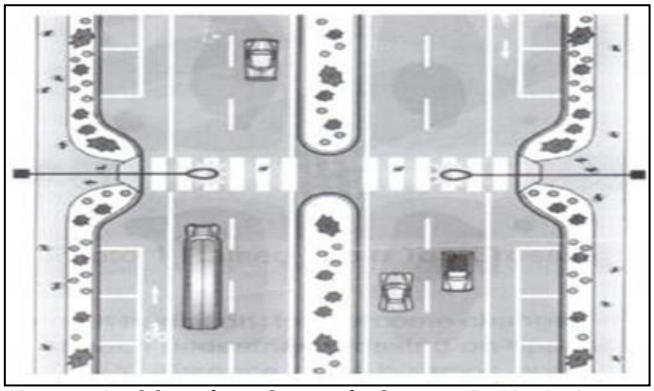
g) Proposed Mid-block Crossings

(Safety facilities for pedestrians on urban roads)

The ideal midblock crossing consists of all the facilities such as:

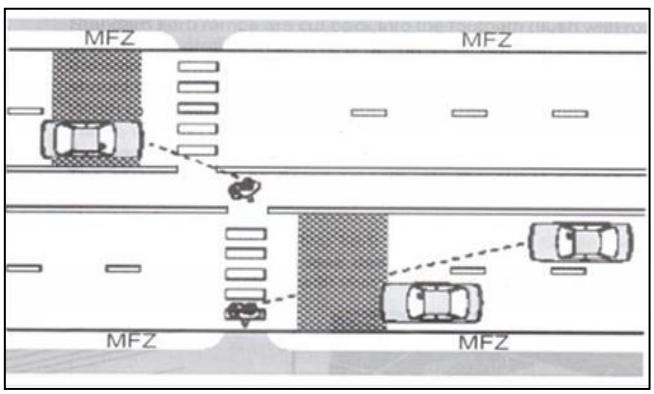
- There must be proper lightening facilities.
- It should consist of stop line before the crossings.
- Proper midblock marking.
- Consists of speed breaker or road humps.
- Proper installation of traffic signs and signals.
- Proper facilities of on-street parking.

As per IRC guidelines 103- 2012 for pedestrian safety facilities



(***Source*:** Guidelines for pedestrian facilities, IRC 103-2012)

Fig 14: Midblock crossing kerb extensions.



(***Source*:** Guidelines for pedestrian Facilities, IRC 103-2012)

Fig 15: A Midblock Crossing with a Median Refuge.

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