5.2 PEDESTRIAN STUDIES

People walk for many reasons: to go to a neighbor's house, to run errands, for school, or to get to a business meeting. People also walk for recreation and health benefits or for the enjoyment of being outside. Some pedestrians must walk to transit or other destinations if they wish to travel independently. It is a public responsibility to provide a safe, secure, and comfortable system for all people who walk. In this lecture we will discuss about the pedestrian problems, pedestrian survey (data collection), characteristics, different level of services, and design principles of pedestrian facilities. There are many problems related to safety security of pedestrians.

Pedestrian Problems

Accidents Circumstances - Pedestrian accidents occurs in a variety of ways; the most common type involves pedestrian crossing or entering the street at or between intersections.

1. Darting: It is used to indicate the sudden appearance of a pedestrian from behind a vehicle or other sight obstruction.
2. Dashing: It refers to the running pedestrians.

Special Problems

1. Age: Children under 15 years of age from the largest group of pedestrian victims and have the highest injury rate per population in their age group, the elderly have the highest fatality rate because of the lower probability of their recovery from injuries.
2. Intoxication and Drug effects: Alcohol and drugs impair the behavior of pedestrians to the extent that they may be a primary cause of accident.

3. Dusk and Darkness: Special pedestrian safety problems arise during the hours of dusk and darkness, when it is most difficult for motorists to see pedestrians.

Definition of a Pedestrian

Any person afoot is the definition of Uniform Vehicle Code of pedestrian. However expand this definition to explicitly include people with disabilities, such as who use wheelchairs or other mobility devices. At the beginning and end of every motorist's trip, he or she is pedestrian. The driver and/or passenger walks to the vehicle, which is parked, drives to a destination, parks the vehicle again, and walks to the final destination. In urban centers, pedestrian flows can be significant, and they must be accommodated in planning and design of traffic facilities and controls. Pedestrian safety is also a major issue, as the pedestrian is at a visible disadvantage where potential pedestrian-vehicle conflict exist, such as at the intersections.

It is important to recognize the forces influencing the demand for provision of more and better pedestrian facilities. Undoubtedly one important factor has been the increased awareness of the environmental problems created by the rapid national and worldwide growth in vehicle travel, but of equal important has been the recognition by many people of need for physical fitness and the role that play in achieving this.

Factors affecting pedestrian demand

The demand for pedestrian facilities is influenced by a number of factors of which some of the most important are

1. **The nature of the local community**- Walking is more likely to occur in a community that has a high proportion of young people.
2. **Car ownership** -The availability of the private car reduces the amount of walking, even for short journey.
3. **Local land use activities**- Walking is primarily used for short distance trips. Consequently the distance between local origins and destinations (e.g. homes and school, homes and shops) is an important factor influencing the level of demand, particularly for the young and elderly.
4. **Quality of provision**- If good quality pedestrian facilities are provided, then demand will tend to increase.
5. **Safety and security**- It is important that pedestrians perceive the facilities to be safe and secure. For pedestrians this means freedom from conflict with motor vehicle, as well as a minimal threat from personal attack and the risk of tripping on uneven surfaces.

Terminology

1. Pedestrian speed is the average pedestrian walking speed, generally expressed in units of meters per second.
2. Pedestrian flow rate is the number of pedestrians passing a point per unit of time, expressed as pedestrians per 15 min or pedestrians per minute. Point refers to a line of sight across the width of a walkway perpendicular to the pedestrian path.
3. Pedestrian flow per unit of width is the average flow of pedestrians per unit of effective walkway width, expressed as pedestrians per minute per meter (p/min/m). Pedestrian density is the average number of pedestrians per unit of area within a walkway or queuing area, expressed as pedestrians per square meter (p/m2).

4. Pedestrian space is the average area provided for each pedestrian in a walkway or queuing area, expressed in terms of square meters per pedestrian. This is the inverse of density, and is often a more practical unit for analyzing pedestrian facilities.
5. Platoon refers to a number of pedestrians walking together in a group, usually involuntarily, as a result of signal control and other factors.

Data collection

Before deciding on the appropriate extent and standard of pedestrian facilities, it is important to assess the potential demand. The possible methods of obtaining such estimates are manual count, video survey, and attitude survey described as follows.

Manual counts

Count the flow of pedestrian through a junction, across a road, or along a road section/footway manually using *manual clicker and tally marking sheet*. Manual counts need to satisfy the following conditions.

1. The time period(s) in the day over which the counts are undertaken must coincide with the peak times of the activity of study.
2. The day(s) of the week and month(s) of the year when observations are made must be representative of the demand. School holidays, early closing, and special events should be avoided since they can result in non-typical conditions.
3. The survey locations need to be carefully selected in order to ensure that the total existing demand is observed.

Advantages of this manual counting are that these are simple to set up and carry out, and flexible to response observed changes in demand on site and disadvantages are that these are labour intensive also simple information can be achieved and not detailed information.

Video survey

Cameras are setup at the selected sites and video recording taken of the pedestrians during the selected observation periods. A suitable vantage point for the camera is important. Such survey produces a permanent record of pedestrian movement and their interaction with vehicles. In it the record of behavior pattern is also obtained which helps in analyzing the crossing difficulties.

Attitude survey

Detailed questionnaire requires enabling complete information about pedestrian's origins and destination points, also can gather information on what new facilities, or improvements to existing facilities, need to be provided to divert trips to walking, or increase the current pedestrian activities.

Pedestrian Flow characteristic

In many ways pedestrian flow are similar to those used for vehicular flow because it can be described in terms of familiar variables such as speed, volume, rate of flow and density. Other measures related specifically to

pedestrian flow include the ability to cross a pedestrian traffic stream, to walk in the reverse direction of a major pedestrian flow, to manoeuvre generally without conflicts and changes in walking speed, and the delay experienced by pedestrians at signalized and unsignalized intersections. It is dissimilar to the vehicular flow in that pedestrian flow may be unidirectional, bidirectional, or multi-directional. Pedestrian do not always travel in clear ”lanes” although they may do sometimes under heavy flow.

Pedestrian Speed-Density Relationships

The fundamental relationship between speed, density, and volume for pedestrian flow is analogous to vehicular flow. As volume and density increase, pedestrian speed declines. As density increases and pedestrian space decreases, the degree of mobility afforded to the individual pedestrian declines, as does the average speed of the pedestrian stream, it is shown in Fig. 1.

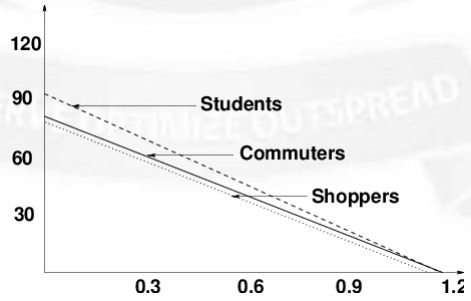

Figure 1: Relationship between pedestrian speed and density

Flow-Density Relationships

The relationship among density, speed, and flow for pedestrians is similar to that for vehicular traffic streams, and is expressed in equation.

$$Q_{ped} = S_{ped} * D_{ped} \quad (1)$$

where, Q_{ped}= unit flow rate (p/min/m), S_{ped}= pedestrian speed (m/min), and D_{ped}= pedestrian density (p/m^2). Pedestrian density is an awkward variable in that it has fractional values in pedestrian per square meter. This relationship often expressed in terms of Space module(M) which is the inverse of pedestrian density. The inverse of density is more practical unit for analyzing pedestrian facilities ,so expression becomes

$$Q_{ed} = \frac{S_{ped}}{M} \quad (2)$$

where M in(m^2/*ped*). The basic relationship between flow and space, recorded by several researchers, is illustrated in the Fig. 2.

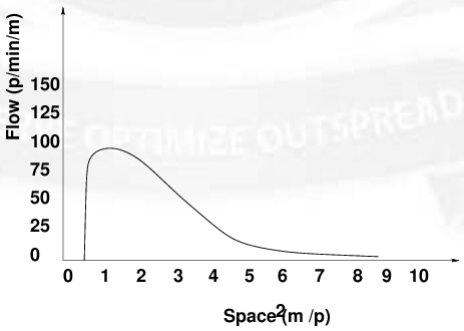

Figure 2: Relationship between pedestrian space & flow

The conditions at maximum flow represent the capacity of the walkway facility. From Fig. 2, it is apparent that all observations of maximum unit flow fall within a narrow range of density, with the average space per pedestrian varying between 0.4 and 0.9 m^2/p. Even the outer range of these observations indicates that maximum flow occurs at this density, although the actual flow in this study is considerably higher than in the others. As

space is reduced to less than 0.4 m^2/p, the flow rate declines precipitously. All movement effectively stops at the minimum space allocation of 0.2 to 0.3 m^2/p.

Speed-Flow Relationships

The following Fig. 3 illustrates the relationship between pedestrian speed and flow. These curves, similar to vehicle flow curves, show that when there are few pedestrians on a walkway (i.e., low flow levels), there is space available to choose higher walking speeds. As flow increases, speeds decline because of closer interactions among pedestrians. When a critical level of crowding occurs, movement becomes more difficult, and both flow and speed decline.

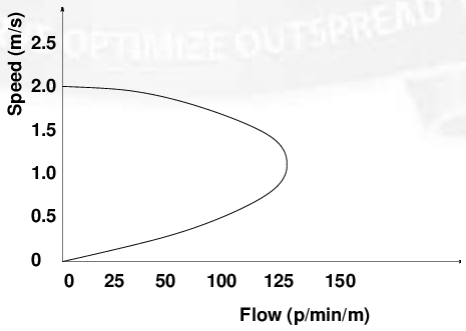

Figure 3: Relationships between Pedestrian Speed and Flow

The Fig. 4 confirms the relationships of walking speed and available space, and suggests some points of demarcation for developing LOS criteria. The outer range of observations indicates that at an average space of less than 1.5 m_2/p, even the slowest pedestrians cannot achieve their desired walking speeds. Faster pedestrians, who walk at speeds of up to 1.8 m/s, are not able to achieve that speed unless average space is 4.0 m_2/p or more.

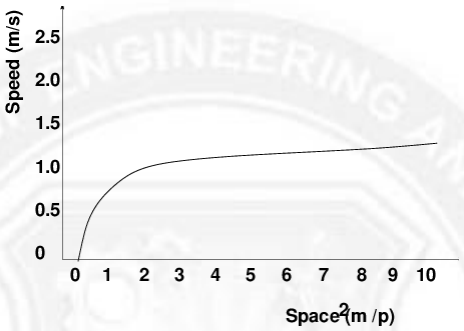

Figure 4: Relationships between Pedestrian Speed and Space

Pedestrian Space Requirements

Pedestrian facility designers use body depth and shoulder breadth for minimum space standards, at least implicitly. A simplified body ellipse of 0.50 m * 0.60 m, with total area of 0.30 m_2 is used as the basic space for a single pedestrian, as shown in Fig. 5 this represents the practical minimum for standing pedestrians. In evaluating a pedestrian facility, an area of 0.75 m_2 is used as the buffer zone for each pedestrian. A walking pedestrian requires a certain amount of forward space. This forward space is a critical dimension, since it determines the speed of the trip and the number of pedestrians that are able to pass a point in a given time period. The forward space in the Fig 6 is categorized into a pacing zone and a sensory zone.

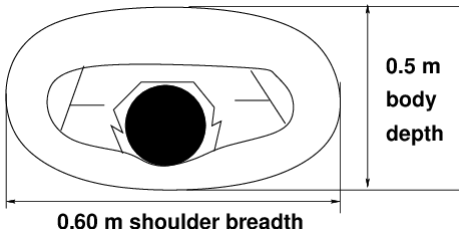

Figure 5: Pedestrian body ellipse

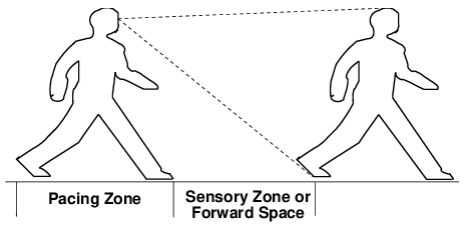

Figure 6: Pedestrian walking space requirement

Pedestrian Walking Speed

Pedestrian walking speed is highly dependent on the proportion of elderly pedestrians (65 years old or more) in the walking population. If 0 to 20 per cent of pedestrians are elderly, the average walking speed is 1.2 m/s on walkways. If elderly people constitute more than 20 per cent of the total pedestrians, the average walking speed decreases to 1.0 m/s. In addition, a walkway upgrade of 10 per cent or more reduces walking speed by 0.1 m/s. On sidewalks, the free-flow speed of pedestrians is approximately 1.5 m/s. There are several other conditions that could reduce average pedestrian speed, such as a high percentage of slow-walking children in the pedestrian flow.

Pedestrian Start-Up Time and Capacity

A pedestrian start-up time of 3 s is a reasonable midrange value for evaluating crosswalks at traffic signals. A capacity of 75p/min/m or 4,500p/h/m is a reasonable value for a pedestrian facility if local data are not available. At capacity, a walking speed of 0.8 m/s is considered a reasonable value.