Parking Study

Scope and Objectives

Parking is an important urban transportation element. Parking affects mode choice as more use of private automobile if parking is available and convenient and the parking cost is reasonable. Inexpensive (free) and plentiful parking is an incentive for using private automobiles where as scarce, inconvenience and/or expensive parking is a substantial disincentive for using private automobiles. Parking control is now in many towns, the key to proper traffic control and transport policy implementation. Parking policy affects how people will travel and good parking management and control can lead to some or all of the following: higher car occupancies, decreasing person trips, faster travel times and less travel delays, greater public transport usage, decreasing congestion and reduced air and noise pollution.

Parking Policies

The formulation of parking policies is one of the most difficult tasks with which a planner has to contend. The difficulty lies in co-coordinating parking policies with several other planning objectives. Following considerations may be taken into account.

- Compromise between amount of curb space devoted to parking spaces and that devoted to moving vehicles
- To make provision for parking of delivery vehicles and for short and long turn parkers.
- To design parking lots and their approaches so that street traffic is not adversely affected by the ingress and egress of vehicles.
- To ensure the interest of business establishments along the street is enhanced by good parking arrangements.
- To ensure that parking policies and public transit policies are complementary
- To preserve the character of the neighborhood by restricting parking and enforcing land use controls.
- To control parking and demand through the pricing mechanism.

Parking has some ill-effects like congestion, accidents, pollution, obstruction to fire-fighting operations etc.

1. Congestion: Parking takes considerable street space leading to the lowering of the road capacity. Hence, speed will be reduced; journey time and delay will also subsequently increase. The operational cost of the vehicle increases leading to great economical loss to the community.
2. Accidents: Careless maneuvering of parking and unparking leads to accidents which are referred to as parking accidents. Common type

of parking accidents occur while driving out a car from the parking area, careless opening of the doors of parked cars, and while bringing in the vehicle to the parking lot for parking.

3. Environmental pollution: They also cause pollution to the environment because stopping and starting of vehicles while parking and unparking results in noise and fumes. They also affect the aesthetic beauty of the buildings because cars parked at every available space create a feeling that building rises from a plinth of cars.
4. Obstruction to fire fighting operations: Parked vehicles may obstruct the movement of firefighting vehicles. Sometimes they block access to hydrants and access to buildings.

Some Definitions

Parking accumulation: the total no. of vehicles parked in an area at a specified moment.

Parking volume: the number of vehicles parking in a particular area over a given period of time, usually measured in veh/day.

Parking load: the area under the parking accumulation curve during a specified period.

Parking duration: the length of time spent in a parking space.

Parking index: percentage of parking bays actually occupied by parked vehicles as compared to the theoretical number available.

$$\text{Parking index} = \frac{\text{No. of bays occupied}}{\text{Theoretical number of bays available}} * 100$$

Parking turnover: rate of usage of the available parking space. If there were 10 parking spaces used by 100 vehicles in a period of 6 hrs. Then the parking turnover would be

$\frac{100}{10}$ vehicles per space in a period of 6 hrs.

Parking surveys are carried out in order to obtain the information necessary to provide an assessment of the parking problem in the area being studied. The objective of any such study is to determine facts which will provide the logical point of departure in relation to indicating parking needs—parking supply and parking usage surveys.

Parking supply survey: concerned with obtaining detailed information regarding whose on and off street features which influence the provision

of parking space, the existing situation with regard to parking space and how it is controlled.

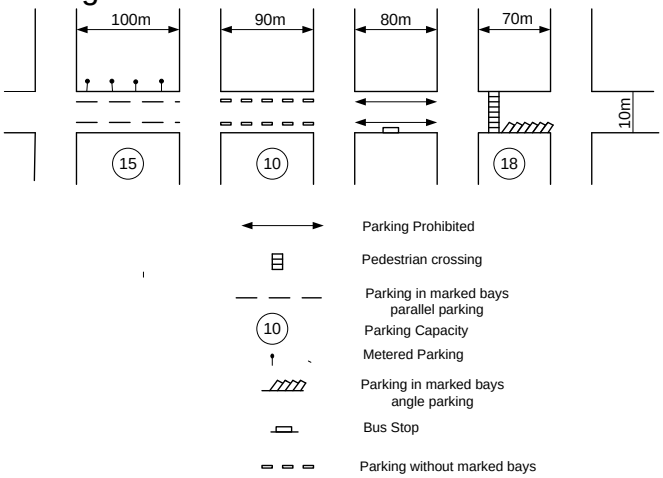
- An inventory of the on street accommodation and of all off street car parks and parking garages serving the traffic area being studied.
- An on street space inventory, a street regulation inventory and an off-street space inventory.

On Street

- Footpath crossings and accesses to premises
- Loading bays
- Bus stops
- Taxi stands
- Pedestrian crossings
- Visibility splays at junctions
- One way streets
- Private streets
- Service and rear access alleys
- Vacant or unused land suitable for temporary or permanent parking space
- Carriage way widths
- Other local factors (areas of special amenity)

Street regulatory inventory

- Controlled parking
  - By regulation
  - By meters
- Parking prohibited
  - Always
  - During peak hourly only
- Controlled loading and unloading
- Uncontrolled parking



Off Street Parking

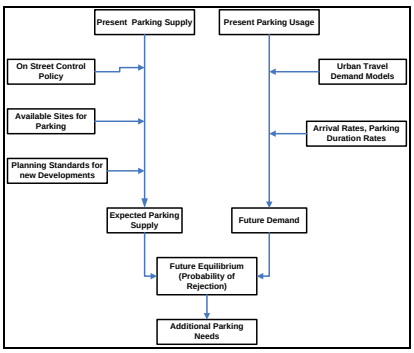
- Type: surface only
  Multistory
  Underground
- Ownership and use
  Publicly owned for public use
  Privately owned for public use
  Private use only
- Commercial vehicles only
- Payment
  Fee charging
  Free
- Time limit
- Number and spaces provided
- Size of parking space
- Number and location of entrances and exits

Parking Demand Analysis

The demand for parking in an area is generated by the land use pattern in the vicinity. Another issue related to the demand for parking is the duration of parking. This is an important variable because the average duration of parking gives an idea as to how frequently the same parking space can be used for parking different vehicles.
IRC (1988) 1 parking space for 80 sq. m of floor area shops and markets
50~99 sq. m. –two flats apartment houses

Parking demand analysis is a difficult task because the various factors affecting demand are interrelated. Some significant factors are

- Growth in population and motor vehicle registration
- Trends in CBD growth such as floor space and retail sales
- Public policies regarding parking supply, public transit and parking pricing structure.



Simplified flow chart for parking analysis

The supply of parking is derived by assessing potential sites for parking facilities, including the possibilities of utilizing any on street parking. The demand for parking can be conveniently derived from trip ends to relevant zones derived from the urban travel demand model.
The average duration that a vehicle is parked in a facility and the numbers of arriving vehicles per unit time are indicators of the traffic load placed on the facility.

If $A = Q * T_d$

Where A—Traffic load
Q—number of vehicles arriving per unit time
T_d—mean parking duration in time

Erlang Formula

$$P_L = \frac{A^M / M!}{1 + A + A^2/2 + \ldots\ldots\ldots\ldots\ldots + A^M/M!}$$

Where P_L—probability of rejection traffic load
M—number of bays
The value of P_L increases with the traffic load and decreases with the number of parking spaces.

Probability of Rejection for Selected Traffic Loads and Parking Spaces

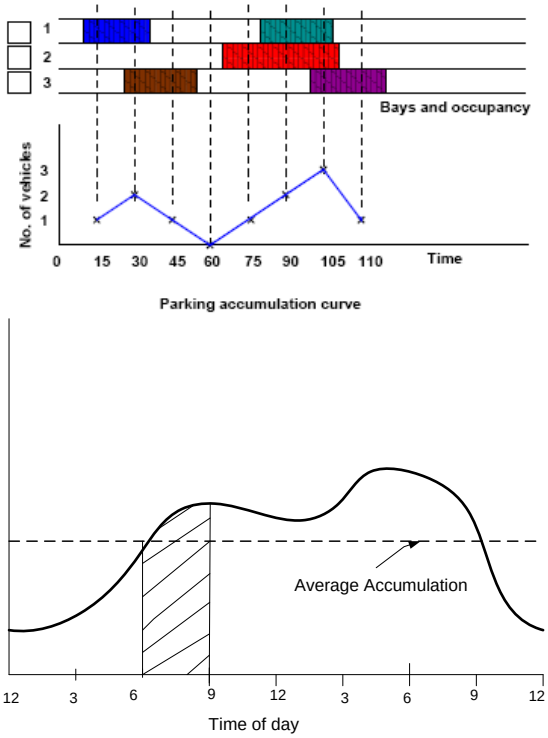
Traffic Load A	Number of Parking Spaces				
	M=1	M=5	M=10	M=50	M=100
1	0.5	0	0	0	0
2	0.67	0.04	0	0	0
3	0.75	0.11	0	0	0
4	0.8	0.2	0	0	0
5	0.83	0.28	0.02	0	0
10	0.91	0.56	0.21	0	0
50	0.98	0.9	0.8	0.1	0
100	0.99	0.95	0.9	0.51	0.08

Different Methods of Parking Demand Analysis

Parking demand may be evaluated by different methods. One of the methods is by cordon counts of the selected area and recording accumulation of vehicles during peak hour by subtracting the outgoing vehicles form the traffic volume entering the cordoned area.

Another method is counting the number of vehicles parked in the area under study during periods of the day; and this method is useful when

parking demand is less than the space available for parking. By noting the registration number of each parked vehicle at any desired time interval, it is possible to estimate the duration of parking of each vehicle at the parking area.



Another useful method of field study is by interviewing the drivers of the parked vehicles, shop owners and other vehicle owners in the locality. This method is useful when the parking demand is higher than the available parking space.

Parking Characteristics and Parking Space Inventory

Study is directed to note the present parking practices prevalent in the area under consideration and the general problems in parking. In case of curb parking, it is also necessary to study the parking pattern, interference to smooth flow of traffic and the accidents involved during parking and unparking operations.

The area under study is fully surveyed and a map is prepared showing all places where curb parking and off street parking facilities can be provided to meet the parking demand. The traffic engineer has to strike a balance between capacity and parking demands and to design proper facilities for parking.

Types of Parking Facilities

Parking facilities may be divided into two types:

- On street or curb parking
- Off street parking

On Street Parking

Vehicles are parked on the kerb which may be designed for parking. It is quite convenient for these who could find a suitable space to park their vehicles near the place they wish to stop; but for others who could not find a parking space it is a problem and often they may have to park their vehicles at a far off place and walk down to the destination. Unless parking facilities has been adequately designed in advance while planning a new town, it might lead to a lot of inconvenience and congestion due to decreased road capacity as well as increase in accidents. Kerb parking facility may be either restricted or unrestricted type. The restricted kerb parking may either be controlled by police or by meters and a certain fee is collected from those who park their vehicles for a certain duration of parking. For the design of kerb parking, the following points are worth noting:

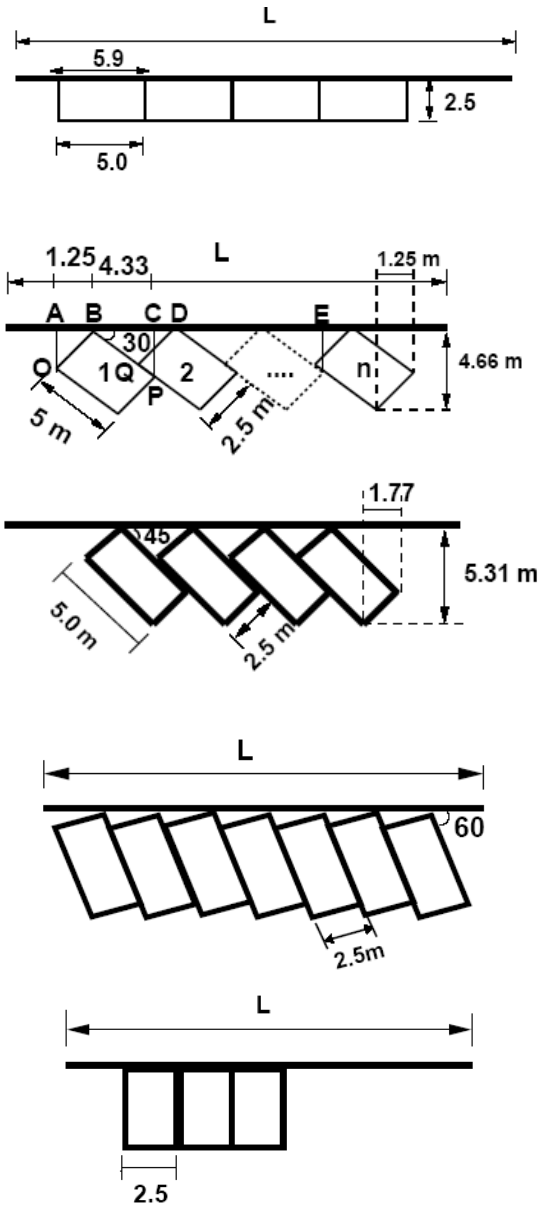
- Whether requirement for on street parking exists in a particular location
- Whether the capacity of the roadway will be enough (after providing on street parking) to cater to the traffic on the road.
- Whether on street parking will increase safety hazards.

Depending on parking duration, space occupancy and the distribution of vehicle size, it is possible to determine curb parking geometry.

- Parallel parking
- Angle parking 30°, 45°, 60°, 90°

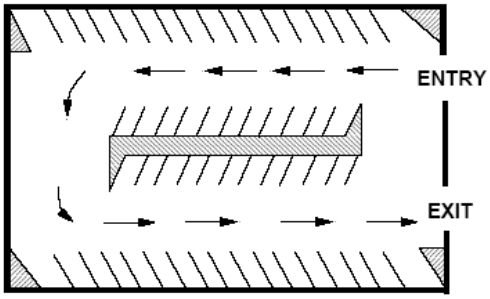
Parallel parking is generally preferred when the width of kerb parking space and the width of the street are limited. But the parking and unparking operations are more difficult as few forward and reverse movements are necessary before parking properly or before taking out. Parallel parking may be with equal spacing, facing the same direction or may be two cars placed closely with open intervals between two car units. It is considered to be the safest type of parking.

Angle parking accommodates more vehicles per unit length of curb. The width of road for parking and unparking maneuver is also more with parking. Angle parking is more convenient for the motorists than the parallel parking but produces much more obstructions to the through traffic resulting in more accidents than the parallel parking geometry used in parking, 45 degree angle is considered the best from all considerations.



Off Street Parking

When parking facility is provided at a separate place away from the kerb, it is known as off street parking. The facilities are built solely for the purpose of parking vehicles. The main advantage of this method is that there is no undue congestion and delay on the road as in the kerb parking. But the main drawback is some of the owners will have to walk a greater distance after parking the vehicle. It is also not possible to provide the off street parking facility at very close intervals especially in business centers of a city. Some of the basic types of off street parking facilities are: Open paved space (surface parking garage), multi stored parking garage, park and ride facility, mechanical garage, attendant parking.



Parking lots are convenient where sufficient space is available at comparatively low cost. The parking of vehicles may be done by owners or drivers of the cars and then this is called self parking system. If the vehicle is left by the driver at the entrance space and again collected from there, the parking and delivering operations being carried out by attendants, it is called attendant system. Most important advantage of attendant parking is less space required to store and maneuver the same number of cars.

Multi storeyed parking garages are restored to when the floor space available for the parking garage is less and very costly. It is possible to construct multi storeyed garages to park a large number of cars at a time. It is necessary to provide the inter floor travel facility for the vehicles which may be either by elevators or by ramps. In mechanized garages the elevators may be designed to move both in vertical and in horizontal directions to carry and place the vehicle in the appropriate parking stall and to deliver it back. If ramps are provided for driving the vehicles to and from the parking stall, the space requirement will be increased considerably. On the other hand, if there is a mechanical break down or a power failure, the functioning of the elevator system would come to a standstill.

The capacity and spacing of access point to parking facilities must be sufficient to accommodate incoming vehicles without a backup on the surface streets. The discharge of outgoing vehicles should pose no problems—important where the approaches are close to street intersections. Both in parking lots and garages, the basic traffic operations consists of five steps namely entrance, acceptance, storage, delivery and exit. Hence some definite space is required in front of the parking lot or garage for vehicles during entrance, acceptance and exit operations. This space provided is called reservoir area, the size of which depends on the average rate of arrival of vehicles to be parked during peak hour, the average time required to dispose off one car and the number of attendants employed for storage operations.

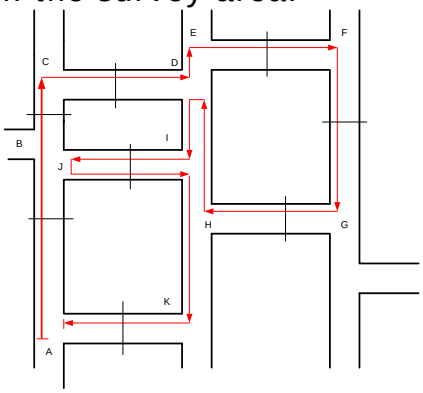
Parking Usage Survey

Usage reflects the desire to park close to the destination but within the limitations imposed by the available supply as well as the desire to park

at a reasonable cost. Demand is a constant reflecting the desire to park at the trip destination where as usage is a variable that depends upon the conditions at the terminal area and upon the characteristics of the trip as well as of the trip maker.

Concentration survey is to determine not only where vehicles do park but also the actual number parked at any given instant at all locations (on and off street) within the survey area.

Duration survey is conducted to determine the lengths of time that vehicles are stored within the survey area.



Parking Survey
On street

Patrol : 2
Street : King Street
Section : AB
Side : Right
Date : Friday, 02/02/2011

AM PM

8:00		8:30		9:00		9:30		10:00		10:30		11:00		11:30		12:00		12:30		1:00		1:30
L	R	L	R	L	R	L	R	L	R	L	R	L	R	L	R	L	R	L	R	L	R	L
	421		421		421		336		814		836		129		129		129		129		451	
	545		356		353		402		336		402		402		402		402		402		402	
	817		27		350		421		402		921		921		921		921		921		921	
			98		114		333		921		421		56		56		56		56		56	
			113		27		350		421		455		455		455		455		455		455	
			545		714		114		333		333		312		312		312		312		312	
			120		98		27		356		356		356		356		356		356		444	
			817		113		97		114		114		99		99		99		99		99	
					656		714		27		97		97		97		97		97		97	
					545		98		97		221		221		221		221		221		221	
					212		113		221		65		76		76		76		76		76	
					149		450		714		714		714		714		714		714		714	
					120		656		98		95		98		98		98		98		98	
					88		545		113		113		113		113		113		113		113	
					817		212		450		450		450		450		450		79		77	

					44		149		428		426		426		426		426		426		426	
							150		656		656		345		345		345		21		21	
							120		118		118		118		118		118		118		118	
							817		212		212		212		212		212		212		244	
							44		149		150		150		150		150		150		150	
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Question 1:

From an In-out survey conducted for a parking area consisting of 40 bays, the initial count was found to be 25. The number of vehicles coming in and out of the parking lot for a time interval of 5 minutes is as shown in the table. Find the accumulation, total parking load, average occupancy and efficiency of the parking lot.

Time	In	Out
5	3	2
10	2	4
15	4	2
20	5	4
25	7	3
30	8	2
35	2	7
40	4	2
45	6	4
50	4	1
55	3	3
60	2	5

Question 2:

The parking survey data collected from a parking lot by license plate method is s shown in the table below. Find the average occupancy, average turnover, parking load, parking capacity and efficiency of the parking lot.

Bay	Time			
	0-15	15-30	30-45	45-60
1	1456	9813	-	5678
2	1945	1945	1945	1945
3	3473	5463	5463	5463

4	3741	3741	9758	4825
5	1884	1884	-	7594
6	-	7357	-	7893
7	-	4895	4895	4895
8	8932	8932	8932	-
9	7653	7653	8998	4821
10	7321	-	2789	2789
11	1213	1213	3212	4778
12	5678	6678	7778	8888