

Parking

Traffic Engineering

Introduction

- **Parking statistics**

- **Parking accumulation**

- Number of vehicles parked at a given instant of time
 - Expressed thorough accumulation curve by plotting the number of bays occupied with time

- **Parking volume**

- Total number of vehicles parked at a given duration of time
 - Does not account for repetition of vehicles

Parking statistics

– Parking load

- Area under accumulation curve
- Obtained by simply multiplying the number of vehicles occupying the parking area at each time interval with the time interval
- Expressed as vehicle hours.

– Average parking duration

- Ratio of total vehicle hours to the number of vehicles parked

$$parkingduration = \frac{parkingload}{parkingvolume}$$

Parking statistics

- **Parking turnover**

- Ratio of number of vehicles parked in a duration to number of parking bays available

$$parkingturnover = \frac{parkingvolume}{No.ofbaysavailable}$$

- Expressed as vehicles/bay/time duration

Parking statistics

- **Parking index**

- Also called occupancy or efficiency
- Ratio of number of bays occupied in a time duration to the total space available
- An aggregate measure of how effectively the parking space is utilized

$$\text{parking index} = \frac{\text{parking load}}{\text{parking capacity}} \times 100$$

Parking statistics

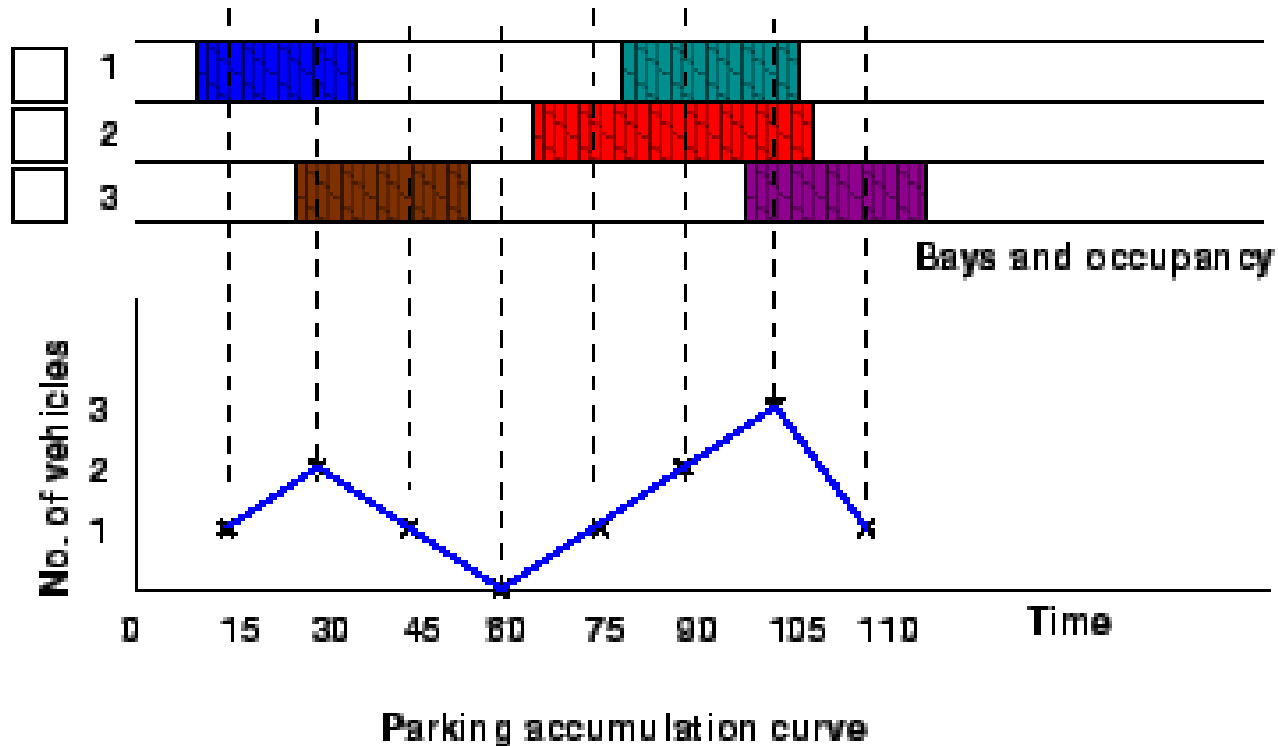


Illustration of parking bays and accumulation curve

- **Parking volume= 5 vehicles.**
- **Parking load = $(1+2+1+0+1+2+3+1) 15/60$
= $11 \times 15/60 = 2.75$ veh hour**
- **Average parking duration = 2.75 veh hours / 5 veh.
= 33 minutes**
- **Parking turnover = 5 veh/ 2 hours per 3 bays = 0.83 veh/hr/bay.**
- **Parking index = $\frac{2.75 \text{ veh hour}}{3 \times 2 \text{ veh hours}} \times 100 = 45.83\%$**

Parking surveys

- **To collect the parking statistics**
- **in-out survey**
- **fixed period sampling**
- **license plate method of survey**

Parking surveys

- in-out survey

- Occupancy count in the selected parking lot is taken at the beginning
- Number of vehicles that enter the parking lot for a particular time interval is counted
- Number of vehicles that leave the parking lot is also taken
- Final occupancy in the parking lot is also taken
- Data regarding the time duration for which a particular vehicle used that parking lot cannot be obtained
- Parking duration and turn over is not obtained
- Parking fare cannot be estimated

Parking Surveys

- **Fixed period sampling**
 - Similar to in-out survey
 - All vehicles are counted at the beginning of the survey
 - Count is again taken at fixed time intervals of 15 min. to 1 hr.
 - Chances of missing the number of vehicles that were parked for a short duration.

Parking Surveys

- **License plate method of survey**
 - Results in most accurate and realistic data
 - Every parking stall is monitored at a continuous interval of 15 minutes or so and the license plate number is noted down
 - Data regarding the duration for which a particular vehicle was using the parking bay is obtained
 - If the time interval is shorter, then there are less chances of missing short-term parkers
 - This method is very labor intensive.

III effects of parking

- Congestion

- Parking takes considerable street space leading to the lowering of the road capacity
- Speed will be reduced
- Journey time and delay will also subsequently increase
- Operational cost of the vehicle increases leading to great economical loss to the community

- Accidents

- Careless maneuvering of parking and unparking

III effects of parking

- Environmental pollution
 - Stopping and starting of vehicles while parking and unparking results in noise and fumes
 - Affect the aesthetic beauty of the buildings
 - Cars parked at every available space creates a feeling that building rises from a plinth of cars.
 - Obstruction to fire fighting operations

Parking requirements

- **Residential plot area**

- Less than 300 sq.m require only community parking space.
- For residential plot area from 500 to 1000 sq.m, minimum $1/4^{\text{th}}$ of the open area should be reserved for parking
- Offices may require at least one space for every 70 sq.m as parking area
- One parking space is enough for 10 seats in a restaurant
- Theatres and cinema halls need to keep only 1 parking space for 20 seats.

On street parking

- **Vehicles are parked on the sides of the street**
- **As per IRC standard dimensions of a car is taken as 5 x 2.5 m and for truck 3.75 x 7.5 m**
- **Common types**
 - **Parallel parking**
 - **30° parking**
 - **45° parking**
 - **60° parking**
 - **Right angle parking**

On street parking

- **Parallel parking**

- Vehicles are parked along the length of the road
- No backward movement involved while parking or unparking the vehicle
- Most safest parking from the accident perspective
- Consumes the maximum curb length and therefore only a minimum number of vehicles can be parked for a given kerb length
- Least obstruction to the on-going traffic on the road since least road width is used

On street parking

- Length available to park N number of vehicles $L = N / 5.9$

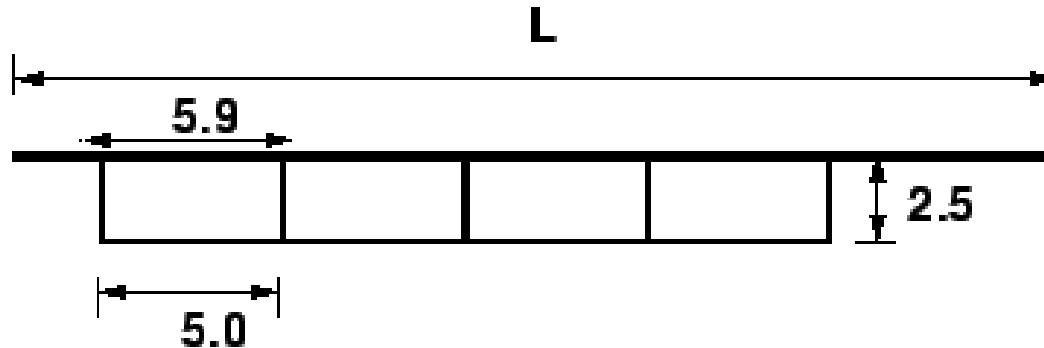


Illustration of parallel parking

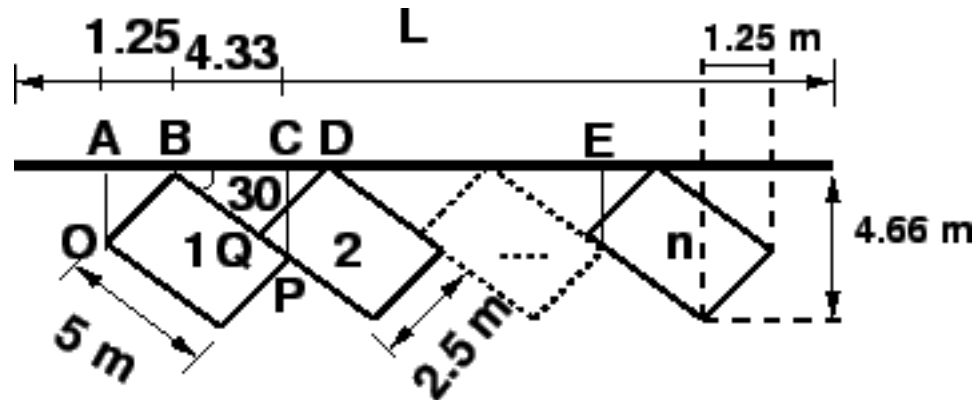
On street parking

- **30° parking**

- Vehicles are parked at 30° with respect to the road alignment
- More vehicles can be parked compared to parallel parking
- Better maneuverability
- Delay caused to the traffic is minimum

On street parking

- Illustration of 30° parking



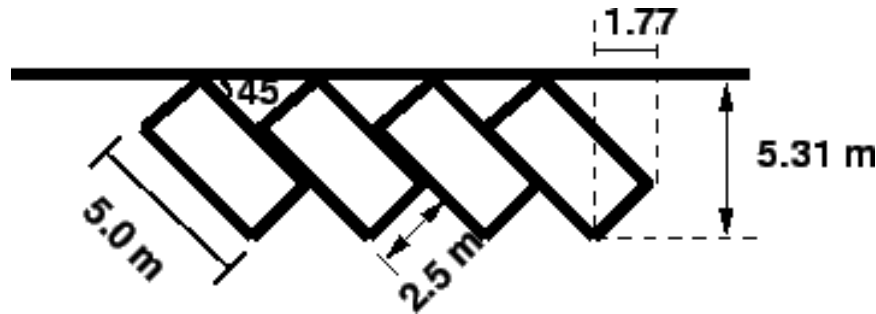
$$\begin{aligned}
 AB &= OB \sin 30^\circ = 1.25, \\
 BC &= OP \cos 30^\circ = 4.33, \\
 BD &= DQ \cos 60^\circ = 5, \\
 CD &= BD - BC = 5 - 4.33 = 0.67, \\
 AB + BC &= 1.25 + 4.33 = 5.58
 \end{aligned}$$

For N vehicles, $L = AC + (N-1)CE = 5.58 + (N-1)5 = 0.58 + 5N$

On street parking

- **45° parking**

- More number of vehicles can be parked
- Compared to parallel parking and 30° parking, more number of vehicles can be accommodated
- Length of parking space $L = 3.54 N + 1.77$

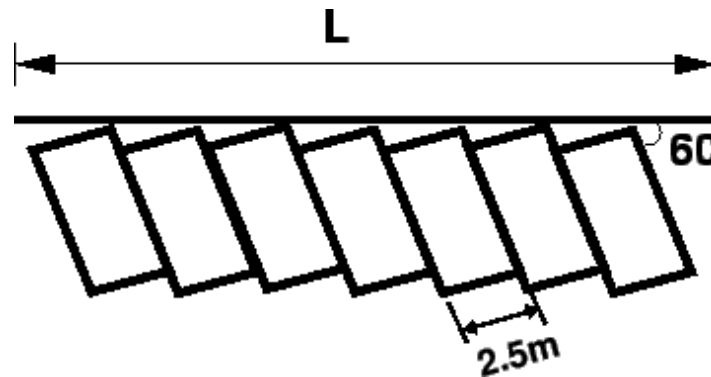


On street parking

- **60° parking**

- Vehicles are parked at 60° to the direction of road
- More number of vehicles can be accommodated
- Length available for parking N vehicles

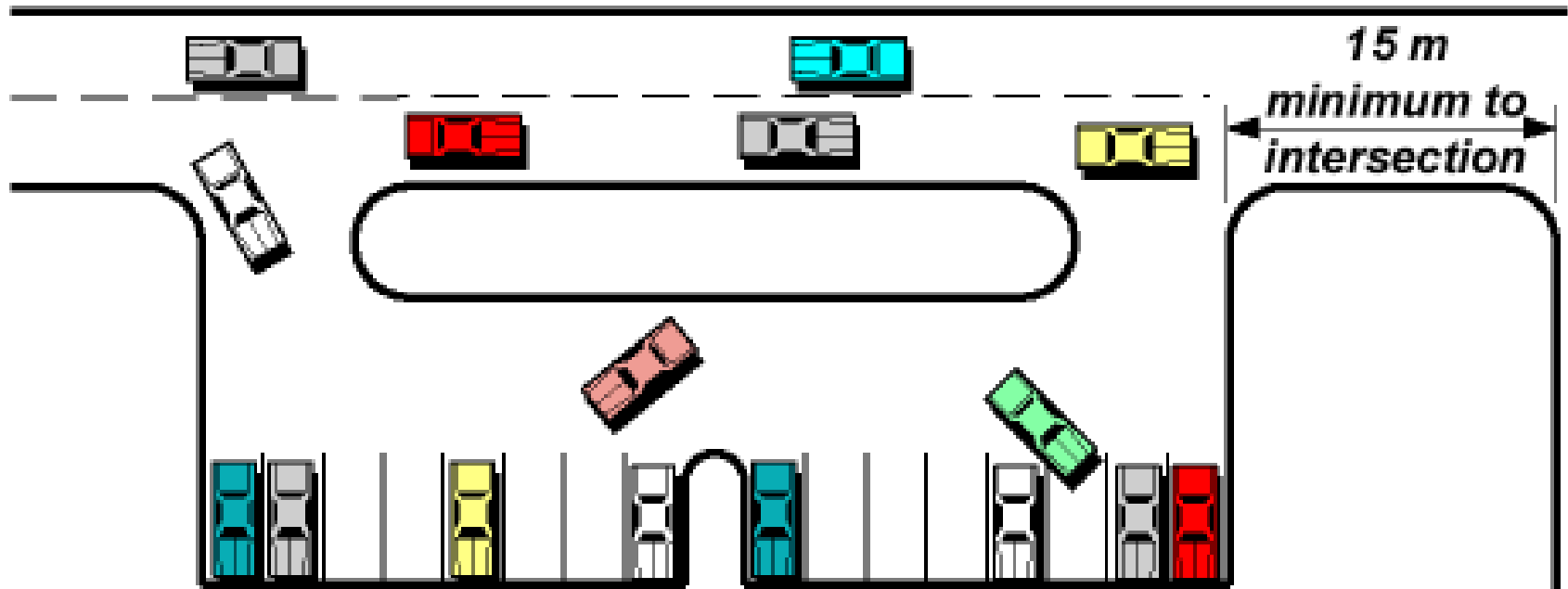
$$L = 2.89N + 2.16.$$



On street parking

- **Right angle parking**

- Vehicles are parked perpendicular to the direction of the road
- Consumes maximum width
- Kerb length required is very little
- Vehicles need complex maneuvering and this may cause severe accidents
- Causes obstruction to the road traffic particularly if the road width is less
- Can accommodate maximum number of vehicles for a given kerb length



cause severe accidents

- Causes obstruction to the road traffic particularly if the road width is less
- Can accommodate maximum number of vehicles for a given kerb length

On street parking

- **Right angle parking**

- Length available for parking N number of vehicles is $L = 2.5N$

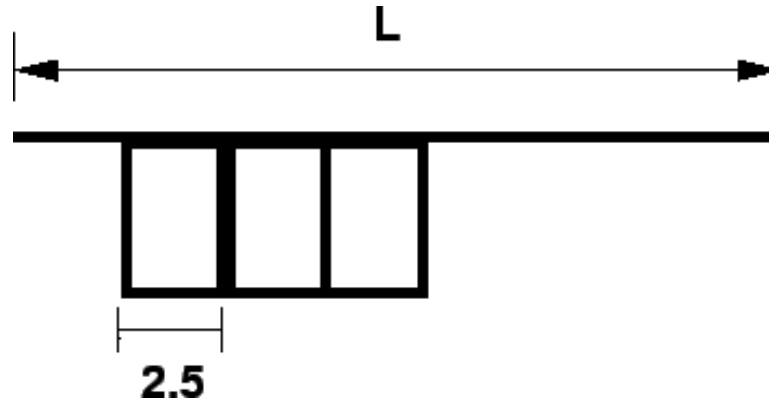


Illustration of 30° parking

Off street parking

- Areas exclusively allotted away from the main stream of traffic

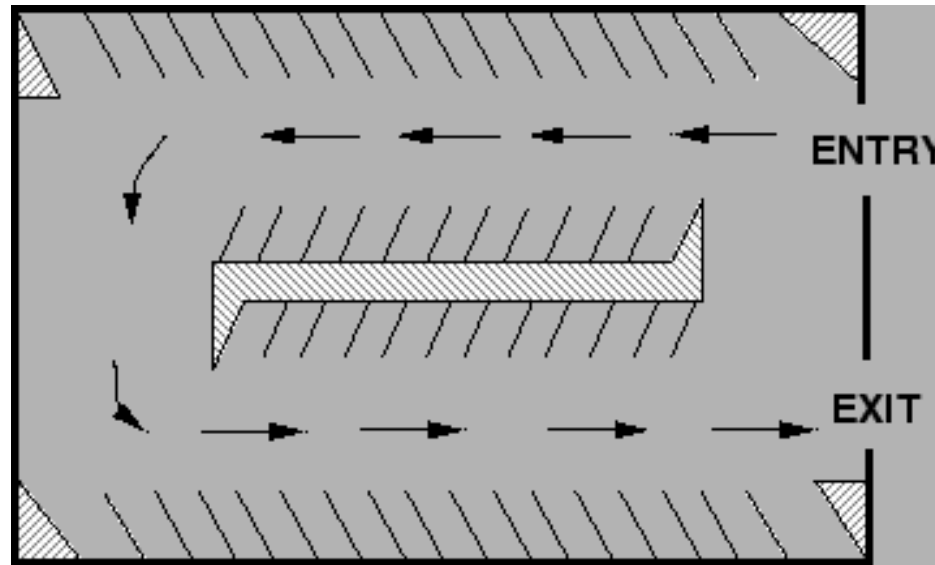


Illustration of off-street parking

Off street parking

- Areas exclusively allotted away from the main stream of traffic

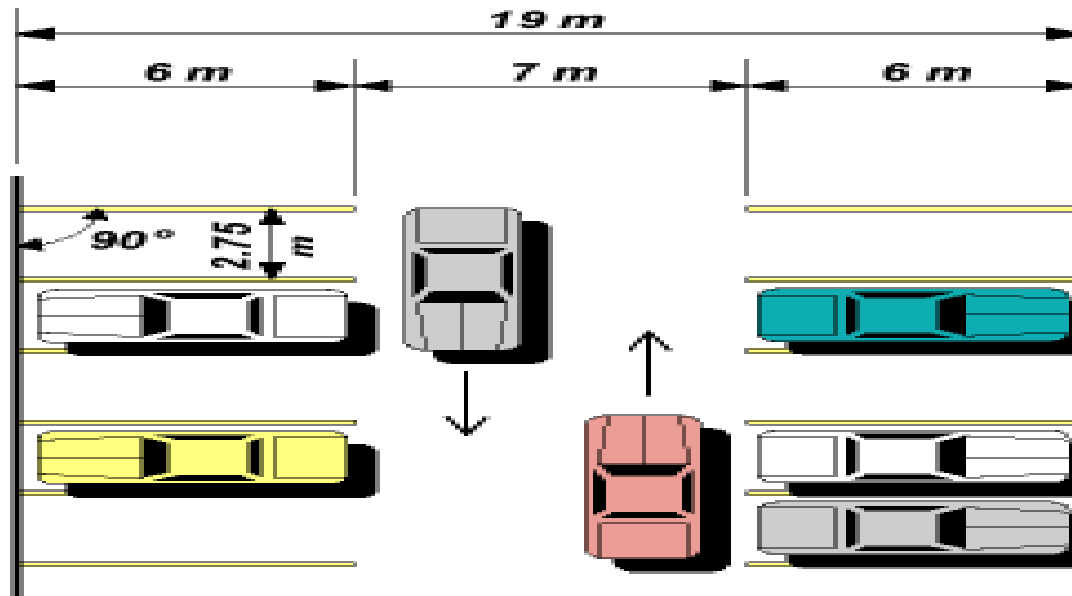
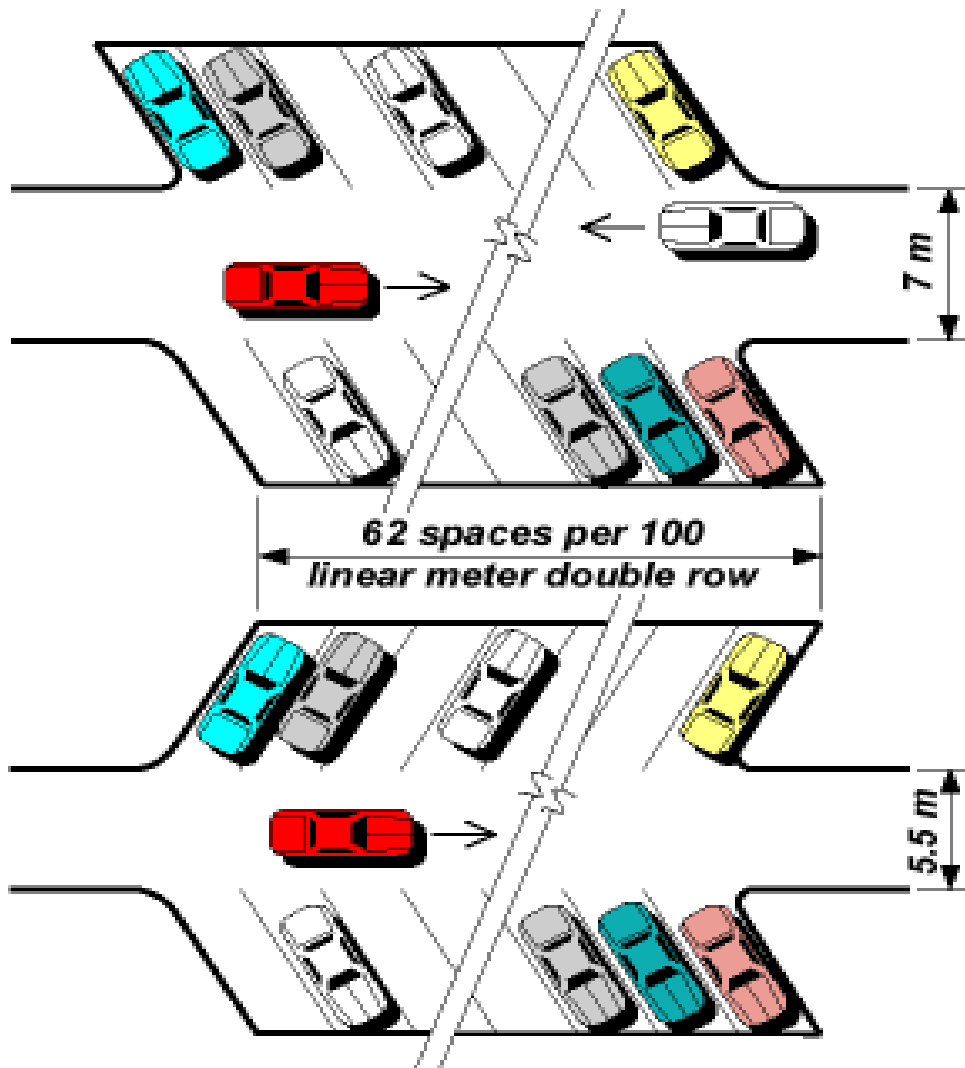
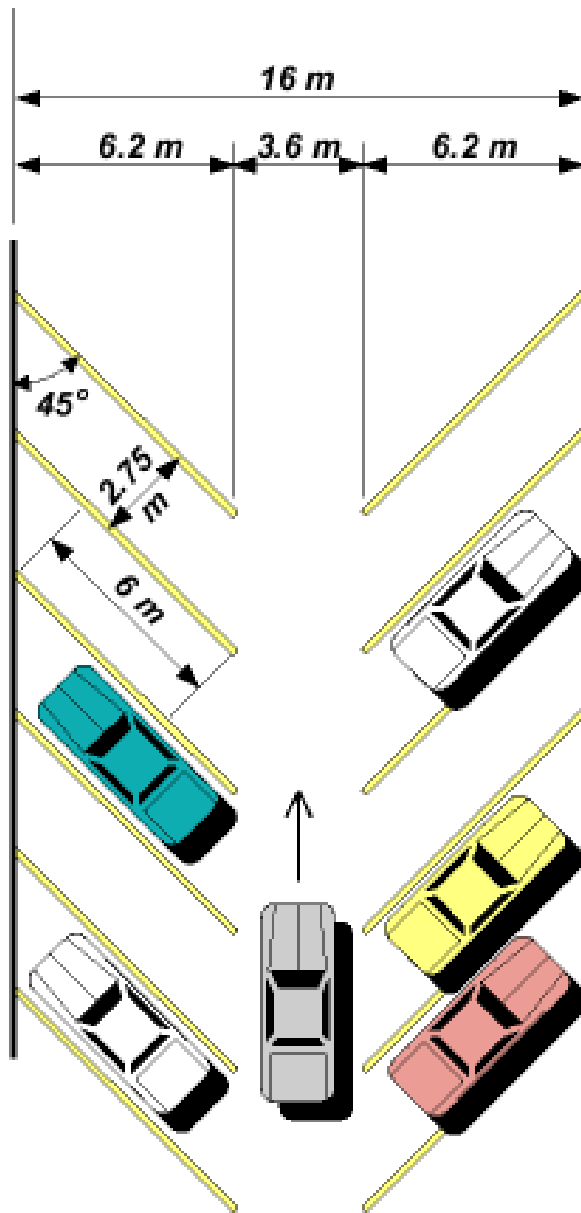


Illustration of off-street parking

Off street parking

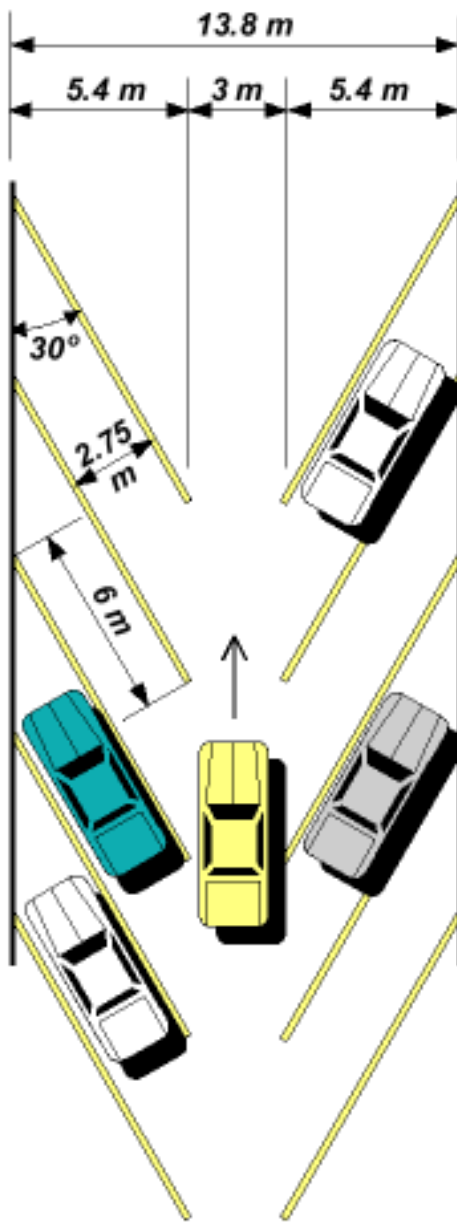


street parking

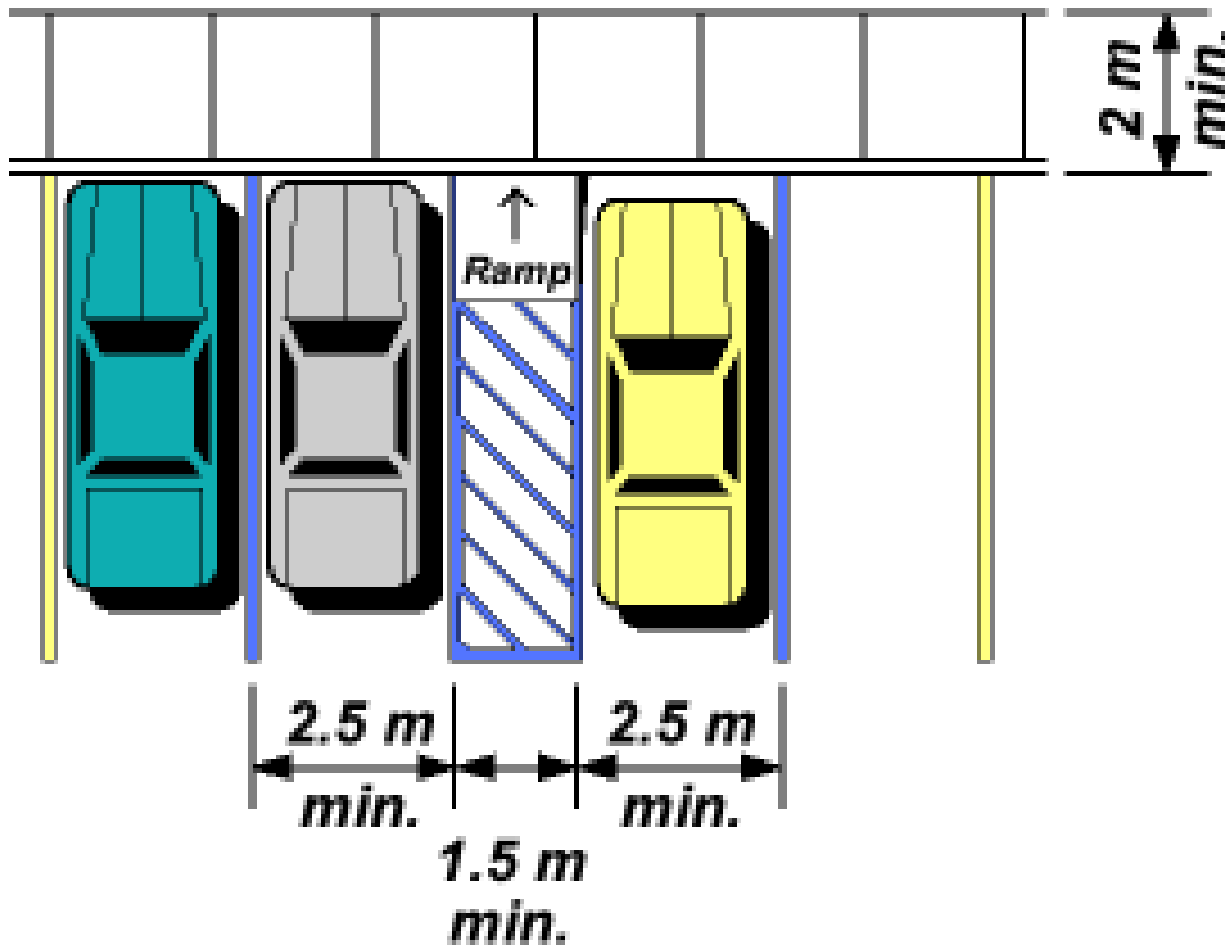


45 Degree Parking Dimensions and Geometry

Off street parking



Off street parking



Accessible Parking Space

Example 1

From an in-out survey conducted for a parking area consisting of 40 bays, the initial count was found to be 25.

Table gives the result of the survey.

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 [1](#).

Find the accumulation, total parking load, average occupancy and efficiency of the parking lot.

Table 1: In-out survey data

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

Solution

Table 2: In-out parking survey solution

Time	In	Out	Accumulation	Occupancy	Parking load
(1)	(2)	(3)	(4)	(5)	(6)
5	3	2	26	65	130
10	2	4	24	60	120
15	4	2	26	65	130
20	5	4	27	67.5	135
25	7	3	31	77.5	155
30	8	2	37	92.5	185
35	2	7	32	80	160
40	4	2	34	85	170
45	6	4	36	90	180
50	4	1	39	97.5	195
55	3	3	39	97.5	195
60	2	5	36	90	180
			Total		1735

$$(25+3-2=26)$$

$$26/40 \times 100 = 65\%$$

$$26 \times 5 = 130 \text{ veh.mts}$$

Solution

- Accumulation can be found out as initial count plus number of vehicles that entered the parking lot till that time minus the number of vehicles that just exited for that particular time interval.
- For the first time interval of 5 minutes, accumulation can be found out as $25+3-2 = 26$.
- It is being tabulated in column 4.
- Occupancy or parking index is given by equation For the first time interval of five minutes, $Parking\ index = \frac{26}{40} \times 100 = 65\%$.

Solution

- The occupancy for the remaining time slot is similarly calculated and is tabulated in column 5.
- Average occupancy is the average of the occupancy values for each time interval.
- Thus it is the average of all values given in column 5 and the value is 80.63%.
- Parking load is tabulated in column 6.
- It is obtained by multiplying accumulation with the time interval. For the first time interval, parking load = $26 \times 5 = 130$ vehicle minutes.
- Total parking load is the summation of all the values in column 5 which is equal to 1935 vehicle minutes or 32.25 vehicle hours

Example 2

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

Example 2: Solution

Bay	Time				Time				
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	15	30	45	60	15	30	45	60	Turn over
1	1456	9813	-	5678	1	1	0	1	3
2	1945	1945	1945	1945	1	1	1	1	1
3	3473	5463	5463	5463	1	1	1	1	2
4	3741	3741	9758	4825	1	1	1	1	3
5	1884	1884	-	7594	1	1	0	1	2
6	-	7357	-	7893	0	1	0	1	2
7	-	4895	4895	4895	0	1	1	1	1
8	8932	8932	8932	-	1	1	1	0	1
9	7653	7653	8998	4821	1	1	1	1	3
10	7321	-	2789	2789	1	0	1	1	2
11	1213	1213	3212	4778	1	1	1	1	3
12	5678	6678	7778	8888	1	1	1	1	4
	Accumulation				10	11	9	11	
	Occupancy				0.83	0.92	0.75	0.92	2.25

Thank You