A Study of Parking Characteristics in a Central Part of Basrah City

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Abstract

Most parking problems occur in central business district (CBD) areas where enough parking is not provided. When drivers enter these areas, they may suffer a problem of finding a parking space. The first stage of this research project focused on major parking characteristics in a selected part of Basrah CBD. The second stage is the development of a computer program to determine the shortage of spaces and number of decks in suggested multi-deck parking.

The program is written in FORTRAN 90 language to facilitate the running of program on digital computer. The operation of the program was explained with the aid of flow charts. The Parking No.1 in this study was a case study. The output shows that the total number of shortage spaces equal to 335, one deck will give 60 spaces, and will need 6 decks to cover the shortage in city center. It is recommended to use the program as a tool for designing multi decks parking.

الخلاصـــــة

معظم مشاكل المواقف تحدث في منطقة مركز المدينة، عندما لا يوجد عدد كافي من المواقف. عند دخول سائقي المركبات إلى تلك المنطقة سوف يواجهون مشكلة العثور على أماكن مناسبة لإيقاف مركباتهم. إن المرحلة الأولى في هذا البحث هي دراسة الخصائص الأساسية للمواقف في جزء مختار من مركز مدينة البصرة.

إما المرحلة الثانية فهي كتابة برنامج بلغة فورتران يقوم بحساب العدد الكلي للفضاءات الناقصة وعدد الطوابق في المواقف المتعدد الطوابق المقترح لسد النقص . عملية بناء البرنامج تم شرحها مع مخطط سير البرنامج . قمنا باختيار موقف رقم واحد في الدراسة كموقف مقترح للتحويل إلى موقف متعدد الطوابق. المخرجات بينت إن عدد الفضاءات الناقصة هي ٣٣٥ فضاء وان عدد الفضاءات في كل طابق هي ٦٠ فضاء وإننا سوف نحتاج إلى ٦ طوابق لسد النقص الحاصل في عدد الفضاءات .نوصي باستخدام البرنامج كأداة في تصميم المواقف متعددة الطوابق.

1. Introduction

The rapid growth of cities presents a direct challenge to the transportation planner. He must plan, design, construct, and maintain transportation systems for metropolitan areas.

These systems must provide safe and efficient movement of people and goods, and also must be responsive to the needs and travel desires of people.

Parking has an important role to play in providing service to people by allowing them to stop and store their vehicles before participating in activities. Parking areas occupies a substantial part from the urban land use. Driver usually looks for a parking space in areas which are used for business, commercial or residential purposes. The present direction to solve this problem in most cities throughout the world is to operate the existing parking facilities with a full efficiency. This may be achieved by using the appropriate geometric design of parking facilities and a proper traffic management [1].

1-1 Objectives of this Study

1. It intends to determine major parking characteristics in a chosen part of Central Part of Basrah city.
2. Development of a computer program to determine the shortage of spaces and number of decks in suggested multi- deck parking.

2. Background

Generally, parking facilities can be classified into two types: on-street parking and off-street parking. Mcshane and Roess [2] categorized the parking facilities in a number of ways: either by physical characteristics or by type of operation, and/or by type of fee structure. **Table (1)** shows the most common types of parking facilities in use.

Table (1) Types of parking facilities

Type	Operation	Ownership	Fee payment
Curb parking	Parallel Angle	Public	Free Metered
Surface lot	Attendant Self-park	Public Private	Free Metered Other
Parking garage	Attendant Self-park	Public Private	Free Metered Other

The most convenient place to park for a car owner is at curbsides, but this has several disadvantages. First, the flow of traffic along the street is hampered leading to congestion and delay to all travelers. Secondly, even a few parked vehicles along a road effectively reduce the width of the road, and thus reduce its ability to carry the traffic flow [3]. **Table (2)** shows the relation between the number of vehicles parked and the effective loss of carriageway width and the loss of capacity at 24 km/hr [4].

Table (2) The effect of number of parked vehicles on carriageway width and capacity

Parked vehicle per Km (both sides, parallel Parking)	Effective loss of carriageway width (m)	Loss of capacity at 24 km/hr(pcu/hr)
3	0.3	200
6	1.2	275
30	2.1	475
60	2.5	575
120	3.0	675
300	3.7	800

On street or curb parking occurs at the curbside at the edge of the carriageway, parallel to the curb or at angle. The choice that should be made between parallel and angle parking is based on many considerations.

The most common form of curbside parking on roadway is parallel parking. It has least impact on through vehicles and requires less lane width than other parking angle. Angle parking can accommodate up to as many vehicles a long curb than parallel parking. The difference is a function of the angle used; low angles (less than 30 degrees) give little advantage. The maximum advantage is given when 90-degree parking is used [5]. Right angle parking will accommodate nearly two and half times the number of vehicle as parallel.

Off-street parking is the accepted method of satisfying facility parking needs. In many cases, these areas are developed as one large mass parking area. When sitting off-street parking areas, the designer should consider:

- Creating multiple smaller parking areas rather than one large mass.
- Integrating planted islands to increase aesthetics.
- Minimize extensive grading operations by designing to the topography.
- Ensuring a distance of at least 15 meters is provided from proposed parking area for entrances and exits.
- Minimizing the number of entrances and exits.

3. Parking Study

In determining needs for a specific facility, the designer must perform a comprehensive and detailed analysis. Often part of a larger transportation plan, a parking study can be a valuable analytical tool. A parking study can inventory existing parking areas, spaces, and their use to determine the adequacy and efficiency of current configurations. These studies can be used to determine deficiencies in the total number of spaces and how long the spaces are being occupied. The parking study may be used as the basis for recommending additional spaces as well as altering configuration or circulation patterns. The parking study may include the following items [6]:

- Inventory of total parking spaces within a specific area.
- Analysis of specific problems such as poor location or deficiency of visitor or reserved parking areas and employee parking.
- Determination of parking duration and turnover rates.
- Identifying access difficulties and poor pavement or plant material condition.

4. Parking Survey

Parking surveys are important to provide the essential data necessary to clarify the problem and develop an adequate program to meet the need; it is not a matter of collecting an interesting data. The most important step in the survey is the determination of parking habits as well as origins, destinations and purpose of driver trips [7].

A comprehensive parking survey has been carried out in a central part of Basrah City (Ashar). The survey includes collecting data about the number and location of existing parking facilities, regulation and fee schedules. Data on existing parking practices, including usage of available spaces, parking duration, illegal parking was also obtained.

5. The Study Area

Plate (1) shows the area for conducting parking in a central part of Basrah City (Ashar). This area compasses about 1.0 square kilometers surrounded by Shatt Al-Arab from the north, Abu-Alas wad from the west, Tamoz street from the south, and Alazezei from the east.

Plate (1) Location of study area

6. Parking Supply Surveys

It is an accounting tabulation and listing of information about location, extent, capacity, layout, type, operation characteristics and type of regulations about the existing established parking facilities both at curb and off-street. The survey was conducted during December 2006.

6-1 Off-Street Parking Inventory

Each parking facility within the study area has been covered completely by using an inventory from. This form was prepared to contain all information needed about the location, capacity, type, method of operation, use and other pertinent characteristics. **Plate (2)** shows the location of parking lots in study area.

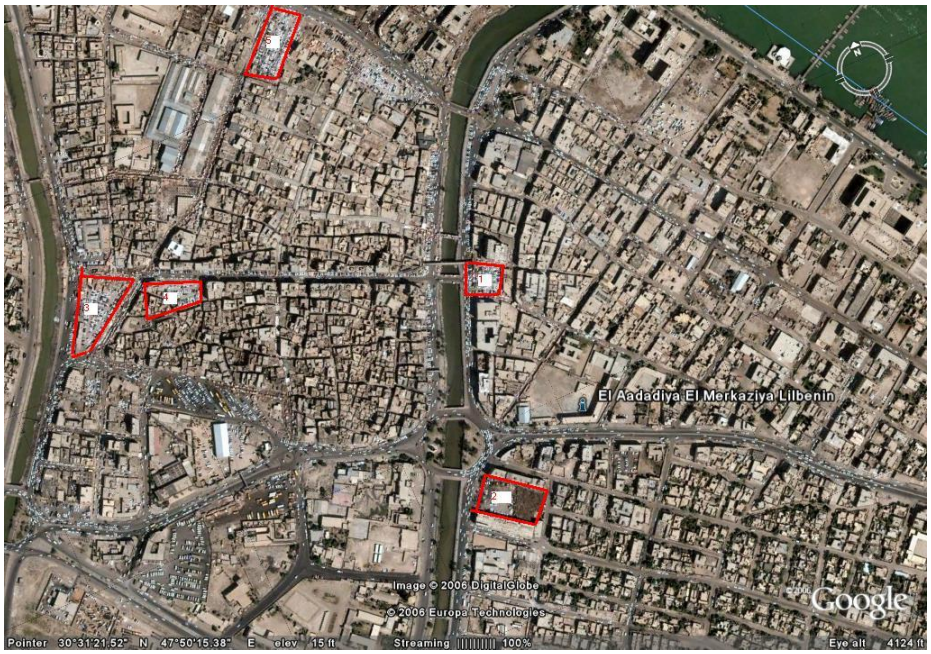

Plate (2) Location of parking lots in study area

6-2 On-Street Parking Inventory

An inventory of all curb spaces available in the study area has been carried out during which all streets have been filled to reveal the existing condition of parking. Information about the location, number of legal parking spaces, direction of flow and the type of parking were collected. **Plate (3)** shows the location of on street parking in study area. Site observations revealed that all streets are unmarked and that no rules govern the parking situation. So, it is necessary to put an assumption about the places where vehicles can park legally to give the most efficient movement for through traffic and the least hazardous position to pedestrians.

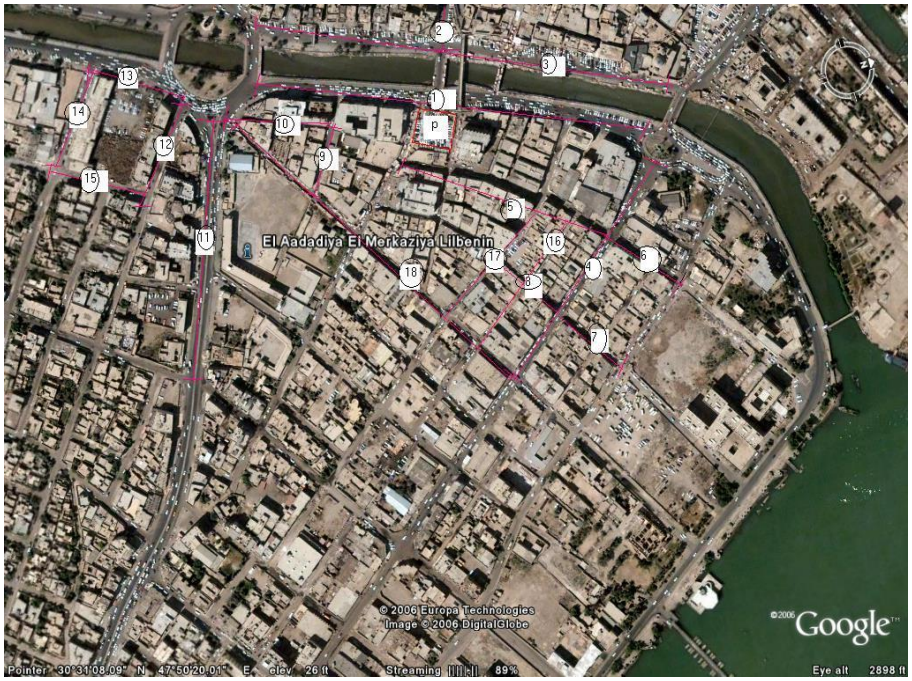

Plate (3) Location of on street parking in study area

The curb parking should be prohibited except when necessary to avoid conflict with other traffic, or to protect the safety of any person or vehicle, or in compliance with law, or the directions of a police officer or official traffic control device No person shall stop, stand or park a vehicle [8]:

A. On the roadway side of any vehicle stopped or parked at the edge or curb of a street.

B. On a sidewalk or between a sidewalk and the curb.

C. Within an intersection.

D. On a crosswalk.

E. Upon any bridge or other elevated structure upon a highway or within a highway tunnel.

F. On any railroad tracks.

G. In the area between roadways of a divided highway, including crossovers.

I. At any place where official signs prohibit stopping.

H. Within a twenty-five feet (7.6m) from the intersection of curb lines or, if none, within fifteen feet (4.6m) of the intersection of property lines at an intersection, except at alleys.

The survey revealed that the study area contains 830 parking spaces. Number of parking spaces and other available characteristics for each local street and alley are presented in **Table (3)**.

Table (3) Existing on-street parking inventory in the study area

Street number	Width (m)	Direction of flow	Number of spaces the Number of places specified for vehicles to park	Type of parking
1	12	One-way	130	Both sides (parallel)
2	10	One-way	170	Both sides (parallel)
3	12	One-way	150	One side (parallel, angle)
4	8	one-way	65	One side (parallel)
5	8	One-way	17	Both sides (parallel)
6	7	Two-way	10	Both sides (parallel)
7	6	Two-way	21	Both sides (parallel)
8	5	One-way	10	One side (parallel)
9	6	One-way	18	Both sides (parallel)
10	5	One-way	15	One side (parallel)
11	9	Two-way	140	Both sides (parallel)
12	8	Two-way	10	Both sides (parallel)
13	12	One-way	12	One side (parallel)
14	8	Two-way	17	Both sides (parallel)
15	6	Two-way	10	One side (parallel)
16	7	One-way	35	Both sides (parallel)
17	6	One-way	10	Both sides (parallel)
18	7	One-way	50	Both sides (parallel)

7. Discussion of Results and Data Analysis

The inventory which was conducted in the study area has revealed a total of 1295 spaces (the Number of places specified for vehicles to park) out of which 465 spaces (36 percent) are located at off-street parking facilities. The remaining 830 spaces (64 percent) are distributed along streets.

7-1 Off–Street Parking

Table (4) give the number of parking spaces, calculated capacity, operational capacity (the number of spaces which specified for vehicles to park in parking lots), and other available characteristics for of each parking by its identification number. The least number of parking spaces in parking number (1) and (4) which contains only 60 spaces. While, the parking number (2) has the largest number of parking spaces which contains 175 spaces.

Table (4) Existing surface parking inventory in the study area

Parking number	Parking type	Parking Area m^2	Parking angle	Operational capacity vehicle	calculated capacity in peak hour vehicle
1	Surface parking	1600	90	60	80
2	Surface parking	7500	90	175	200
3	Surface parking	4000	90	90	110
4	Surface parking	1400	90	60	70
5	Surface parking	3000	90	80	100

7-1-1 Parking Accumulation

Parking accumulation means the total number of vehicles parked in a given area at a given time. All vehicles parked in the study area were counted during each hour of an average week day from 7.00 a.m to 7.00 p.m. The accumulation data for all surface parking illustrated in **Fig.(1)**. At 7.00 a.m, 10 percent of the available spaces were occupied by 50 vehicles. Just after that, the total number of vehicles parked began to increase rapidly until 2.0 p.m. A slight increase occurred after 2.0 p.m to reach the peak parking accumulation at 3.0 p.m when a total of 559 vehicles parked in study area. After 4.0 p.m the number of parked vehicles dropped sharply, reaching only 25.0 percent at 7.0 p.m.

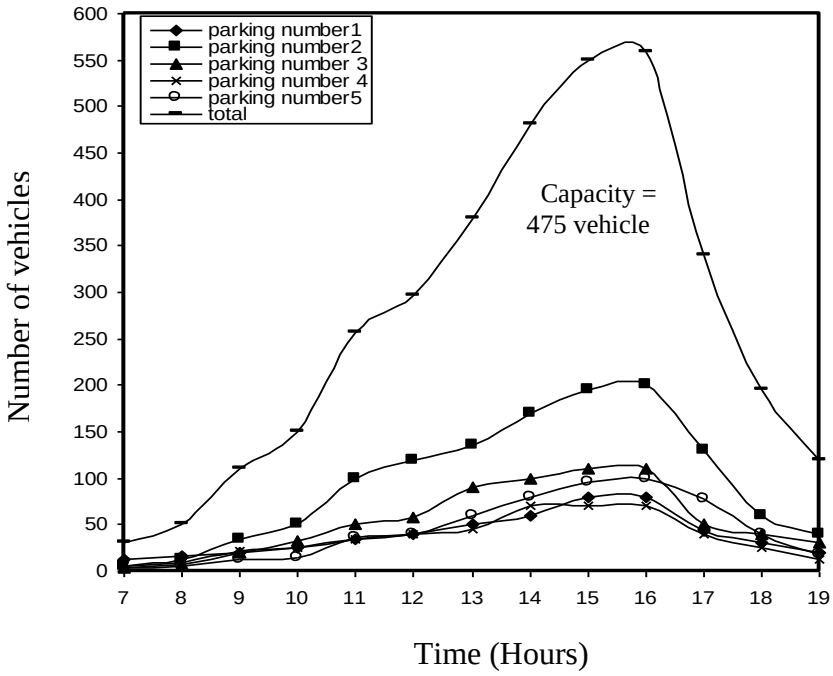

Figure (1) Off–street parking accumulations in study

7-1-2 Parking Occupancy (Parking Index)

It is the percentage of parking spaces occupied by parked vehicles at a specific limit of the time of the day [9]. Parking occupancy is an important factor considering for commercial investment and it is relation to trip purpose. Trip purpose categories include working, shopping, business, social-recreational, sale service, and miscellaneous. Home and work trips represent lower limits of parking occupancy than other trip purpose [6]. Parking Index can be represented by the following [1]:

$$PI = \frac{ACCVEH}{TOTSPC} \quad \text{..... (1)}$$

where:

PI= Parking Index,

ACCVEH= Accumulation vehicles,

TOTSPC=Total space in parking place.

Table (5) shows the parking occupancy for parking number (1) is more than the parking occupancy for any other parking.

Table (5) parking characteristics for surface parking in study area

Parking number	Parking Index %	Average parking duration (hour)	Turn over rate (vehicle /space/day)	Parking volume Vehicle
1	133.3	2.88	2.67	160
2	114.3	3.1	2.27	397
3	122.2	2.29	2.33	210
4	116.7	3.1	2.25	135
5	125	3.2	2.20	176

7-1-3 Parking Duration

Parking duration is the period of time that vehicles are parked. Parking duration is affected by trip purpose, city size and parking type. The average duration period range between (2.88 to 3.20) hour for different parking in study area which could be clear in **Table (5)**.

7-1-4 Parking Turnover

The OECD Road Research Group [9] defined the parking turnover as the number of vehicles per hour utilizing a parking space (U_T, vehicle/space/hour). Turnover is sometimes calculated for the day period, for instance, the period 7:00 am to 7.00 p.m., and it is measured in (vehicle/space/day). The turnover is related to percentage of parked vehicle directly and inversely with parking durations of parked vehicles. The turnover rate is calculated [1]:

$$U_T = \left[\sum_{L=1}^{N} NPRK / SPC\right] / T \quad \text{..... (2)}$$

where:

U_T = Turnover rate (vehicle/space/hour)

N= Total number of spaces at parking area

NPRK= Total number

SPC= Parking spaces

T=Unit time (hour)

Table (5) shows the parking turnover for different parking in study area.

7-2 On–Street Parking

The 830 spaces (64 percent) are distributed along streets in study area.

7-2-1 On–Street Parking Accumulation

Figure (2) shows the parking accumulation during each hour for both legal and illegal parkers for study area. Legal parking is the parked vehicle in first row, while illegal parking is the parked vehicle near intersections, second row, on side walk, on pedestrian crossing, and near the prohibited sign. At 7.00 a.m, there were 50 vehicles utilizing about 6.0 percent of the available 830 curb spaces. The accumulation of parked vehicles increased reaching its maximum at 2.0 p.m to 4.0 when a total of 817 vehicles parked including 237 vehicles illegally parked. After that it decreases reaching its minimum at 7.0 p.m were 100 vehicles utilizing about 11 percent of the available spaces.

Table (6) shows the number of legally and illegally parked vehicles in all streets for study area at 2.0 p.m to 4.0 p.m when the illegally parked vehicles were utilizing most streets.

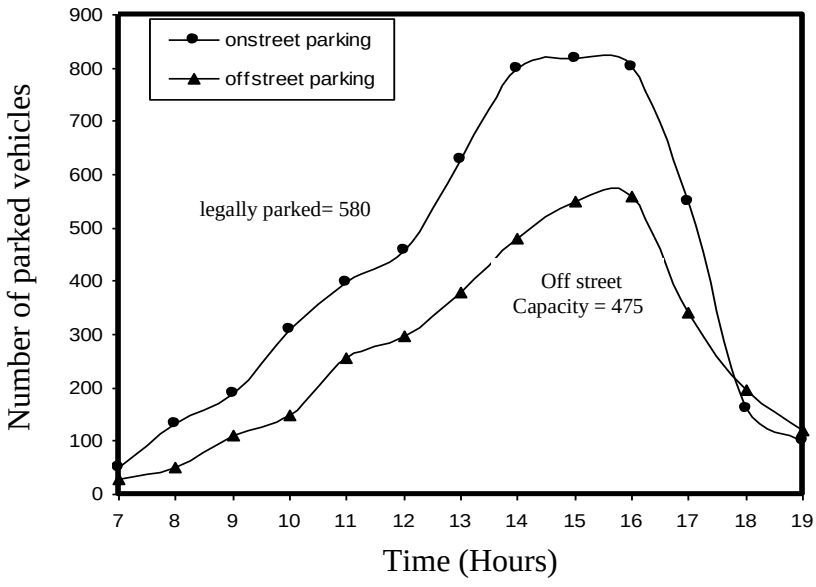

Figure (2) Parking accumulations in study area

Table (6) Legally and illegally parked vehicle

Street number	Number of spaces	Legally parked vehicles	Illegally parked vehicles	Parking index %
1	130	91	77	129.2
2	170	130	27	92.35
3	150	131	59	126.67
4	65	59	28	133.84
5	17	10	2	70.58
6	10	6	-	60.00
7	21	19	2	100.00
8	10	5	-	50.00
9	18	11	4	83.33
10	15	9	-	60.00
11	140	18	2	13.5
12	10	6	3	90
13	12	8	2	83.33
14	17	15	7	129.4
15	10	6	-	60
16	35	30	5	114
17	10	6	2	80
18	50	20	1	42

7-2-2 Parking Occupancy (Parking Index)

Table (6) shows the parking index at a selected on street parking in peak hour at 2 p.m. to 4 p.m. Street (4) has the largest parking index which is equal to 133.84 while street (11) has the smallest parking index which equals to 13.5.

7-2-3 Parking Duration

The duration of on-street parking is considerably less than that for off-street parking. An average duration for curb parking is 1.3 hour which is less than that for off street parking (2.91hour) by about 1.61 hour. The stander deviation equal to 0.276 hour **Table (7)** shows the average duration period at a selected on street parking.

7-2-4 Parking Turnover Rate

Table (7) gives the parking turnover at a selected on street parking, the number of parking given in the table is for those parking legally (since they are utilizing legal spaces). The turnover is ranging between 1.67 at street (9) to 6.1 at street (15). An average curb parking turnover 4.2 which is highest than off street parking turnover.

Table (7) Parking space turnover at selected on street parking during and average week day between 7.00 a.m. and 7.00 p.m.

Street number	Number of spaces	Legally parked vehicles	Turnover (vehicle/space/day)	Duration period hour
1	130	700	5.38	1.1
2	170	823	4.84	1.5
3	150	753	5.02	0.8
4	65	332	5.11	0.75
5	17	93	5.47	1.3
6	10	61	6.1	1.6
7	21	65	3.1	1.2
8	10	35	3.5	1.4
9	18	30	1.67	0.9
10	15	31	2.07	1.3
11	140	300	2.14	1.25
12	10	53	5.3	1.6
13	12	45	3.75	1.8
14	17	74	4.35	1.1
15	10	61	6.1	0.9
16	35	153	4.37	1.9
17	10	48	4.8	2.0
18	50	84	1.68	0.8

8. Programming

The next step after analysis the survey data is writing the computer program which calculates the total shortage space in study area and determines the number of stories for suggested multi-decks parking to convert this shortage. The program is written in FORTRAN 90 language. This language enables the program builder to work with statements that are essentially algebraic in nature [10].

The operation of the program is summarized by the flow chart shown in **Fig.(3)**. The program begins by reading input data. The input data is divided into three types. These types are:

1. Information about suggested parking such as; parking area, parking dimension, ramp dimension, number of lifter, lifter dimension, and parking angle.
2. Information about the on street parking in each street such as; number of spaces, number of legally parked vehicles, number of illegally parked vehicles, distances to suggested parking, and distances to current lots parking.
3. Information about the growth rate and design year.

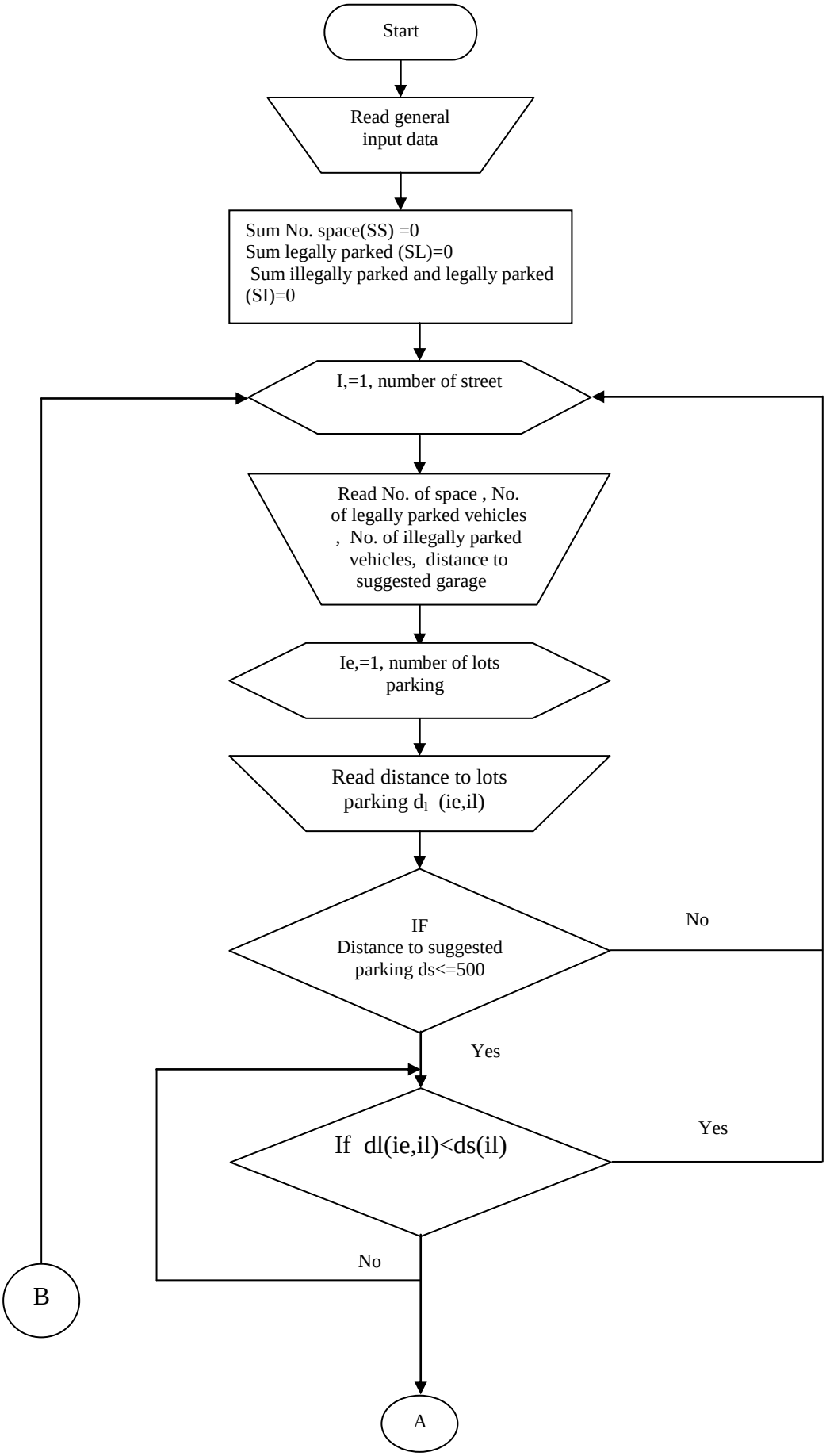

Figure (3) Flow chart of programming

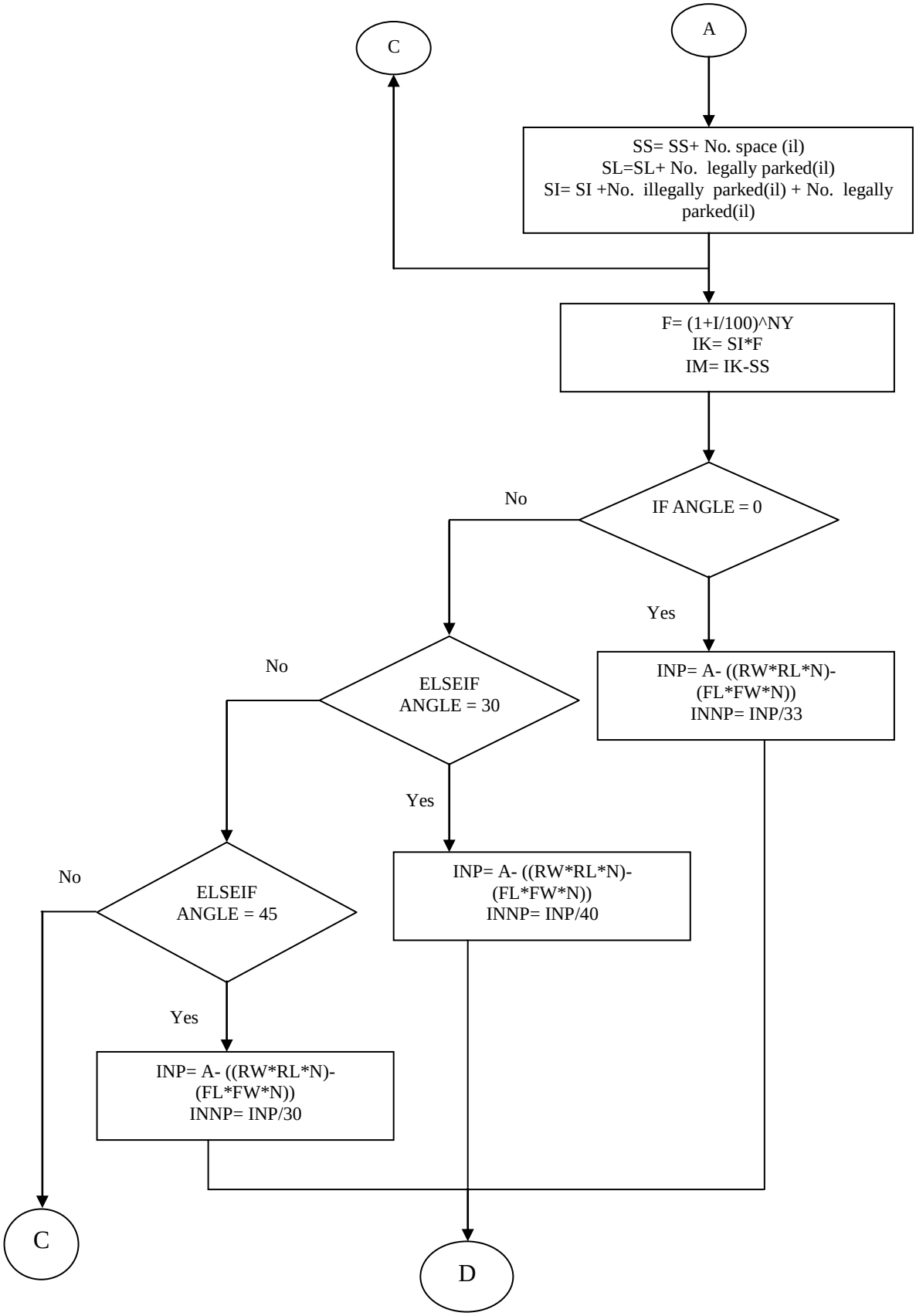

Figure (3) Continued

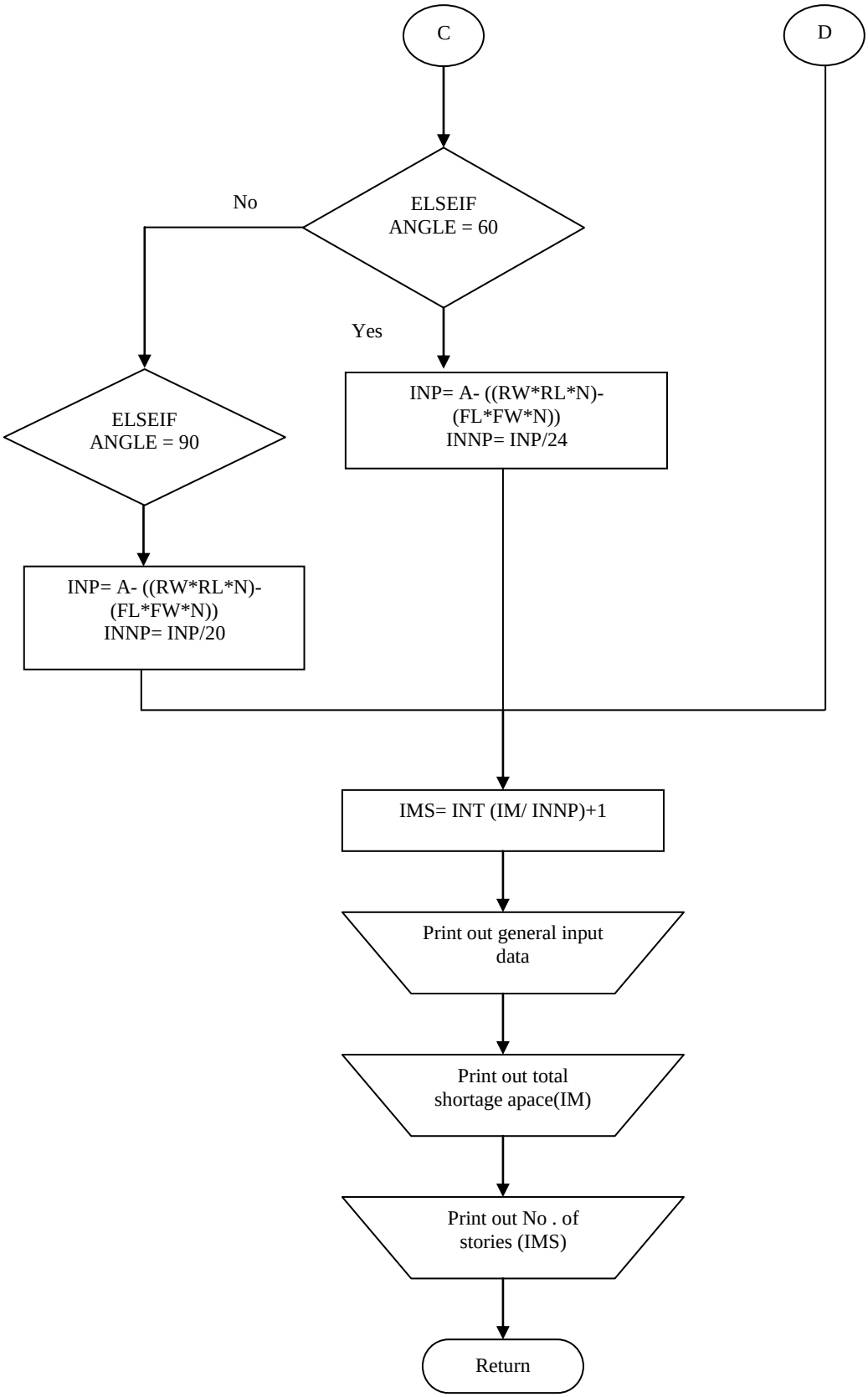

Figure (3) Continued

Table (8) gives in detail the meaning of each variable used in program.

Table (8) Input data

Row number	Variable name	Description	Type	Value
RN1	AFACIL	Parking facility name	C	-
RN2	L	Parking length	R	Numeric
	W	Parking width	R	Numeric
	RW	Ramp width	R	Numeric
	P	Number of current parking	I	Numeric
RN3	IN	Number of roads	I	Numeric
	INGL	Parking angle	I	Numeric
	I	Growth rate	I	Numeric
	NY	Design year	I	Numeric
	RN	Ramp direction	I	Numeric
RN4	NOSPC(IY) IY=1,IN	Number of space	I	Numeric
	INOSPC(IY) IY=1,IN	Legally parked vehicle	I	Numeric
	IZ(IY) IY=1,IN	Illegally parked vehicle	I	Numeric
	D(IY) IY=1,IN	Distance between roads and future parking	R	Numeric
RN5	DP(IA,IL) IA=1,P IL=1,IN	Distance between roads and current parking	R	Numeric

The second step determines the shortage spaces in study area during the design year. The third step calculates number of spaces in one deck and number of decks in future parking

The last step write the number of shortage spaces in the study area and number of spaces in one deck and number of decks in future parking.

9. Case Study

In order to collect the required data for program, the appropriate site must be selected. The Parking (1) in this study was chosen as case study. This parking is located on street against ashar river between the Frahedie building and Alhrerei building over a area of 1600m². The program run by using all the input parameters to obtain the model's output. The

output shows the total number of shortage spaces equal to 335, one deck will give 60 spaces, and will need 6 decks to cover the shortage in city center. **Figures (4)** and **(5)** show the plane of ground floor and ramp section. Details of the inputs and outputs are given in the Appendix.

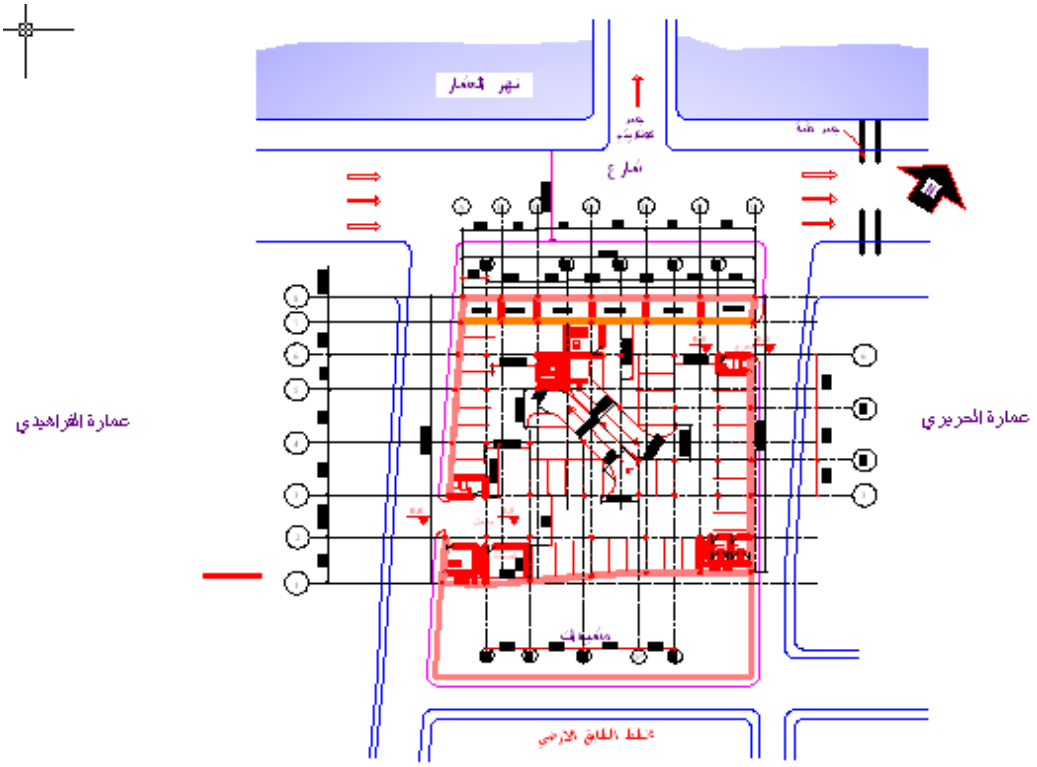

Figure (4) Ground floor plan

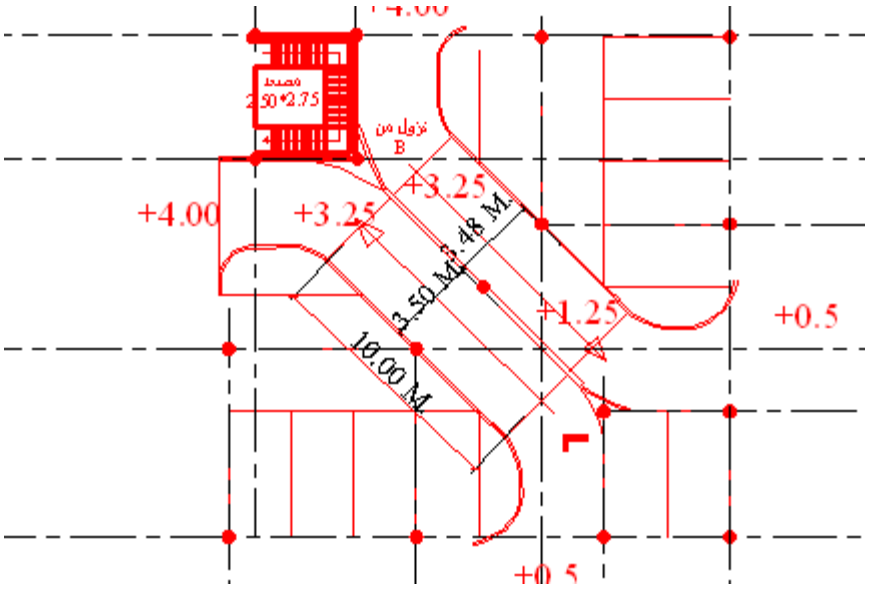

Figure (5) Ramp section

10. Conclusions and Recommendation

The conclusions of this study may be summarized into the following aspects:

1. Curb spaces (on street parking) represent about 64 percent of the available capacity in Basrah city center.
2. The study shows that peak parking accumulation occurred in the evening, usually between 3.00 and 5.00 p.m.
3. In peak hour, the parking index for all off street parking is greater than 100 percent.
4. The average parking duration period range between (2.88 to3.20) hr. for different off street parking in study area.
5. The turn over rate range between (2.22 to2.67) (vehicle/space/day) for different off street parking in study area .
6. In curb spases, parking index range between(13.5-133.84) percent.
7. An average curb parking turnover of 4.2 is highest than off street parking turnover.
8. For the parking (1) as multi decks parking, the total number of shortage spaces equal to 335 center during design period (which is equal to 20 years).
9. One deck in parking (1) will give 60 spaces.
10. 6 decks will cover the shortage spaces in city center during design year.

Also it is recommended to use the program as a tool for designing multi decks parking.

11. References

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Appendix (1)

ashar park

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39.0   40.4   3.0    5      5      2
19     90     3.0    20     1

0      0      40     0
130    91     77     250
130    90     10     300
40     40     17     500
150    131    59     350
65     59     28     450

17     10     2      450
21     19     2      500
10     6      0      500
10     5      0      500
18     11     4      500
15     9      1      200
140    18     1      250
10     6      3      500
12     8      2      620
17     15     7      450
35     30     0      600
10     6      0      300
50     20     0      200

550    700    750    800    350

550    700    750    800    350
400    350    500    680    555

200    300    600    700    600

550    450    700    800    850

200    500    800    700    750

200    500    800    700    750
200    500    800    700    750

200    500    800    700    750

200    500    800    700    750

200    500    800    700    750


500    500    600    700    600

500    400    600    700    600

500    400    600    700    600

500    400    600    700    600


500    400    600    700    600
500    500    600    700    600
500    500    600    700    600
500    500    600    700    600
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