

Car Park Design: Special Case in Turkey

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Abstract— The uncontrollable increase in the number of vehicles, together with the unregulated urban growth, has led to an increase in the parking needs. Parking needs are very high in areas like shopping centers, hospitals, university campuses and airports in which the traffic could be very intense. Building parking lots that will occupy large areas is quite important both in terms of traffic flow and passenger circulation. In this regard, it is very important to design and efficiently use parking spaces within large buildings. In this study, the above mentioned large-scale parking places have been analyzed according to the vehicle sizes that showed variations over the years and the parking scenarios. For this purpose, Süleyman Demirel University (SDU) main parking area has been chosen. The main reasons for this choice are the intensive daily traffic in the area and the variety in the vehicles that park there. Future applications of this study in a bigger scale could make it possible to develop new design standards and specifications to be used all over the country.

Keywords—Car Park, Parking Strategies, Parking Problems, Turkey

I. Introduction and Literature Review

Coombe et al. [1] stated in their study that the intensive migrations from rural areas to the city centers has brought about a sudden increase in the number of vehicles in cities, which in turn could cause problems, especially in metropolitan cities. Same study showed that this growing number of vehicles will also increase the "parking demand". This increase will not only reflect negatively on the parking areas, but also on the crowded populations. Crowd management, control and escape are fairly new methods in Turkey [2]. Thus, neither the movements of the crowds nor the problems that these could create are included in the studies.

Therefore, it is fair to say that parking is not an issue that concerns only the vehicles or cities. The design and the re-planning of the parking areas aim actually to improve the people's living conditions.

For the study and analysis of parking areas, the sizes and the capacities of the existing parking lots should be investigated [4].

- Determination of the number of people residing in the area
- Determination of the number of vehicles in the same area
- Inventory of existing parking facilities, if any

- Obtaining financial, structural and administrative information
- Parking parameters.

When determining the parking parameters, the additional parameters that should be known can be explained as follows [5]:

- Parking Capacity: Generally, the number of vehicles parked in the area of study in 1 day
- Parking Density: The cumulative number of vehicles parked in the area to be analyzed
- Parking Load: The parking space -time number used within a certain period of time
- Parking Hours: The duration of parking
- Parking Place Utilization: Parking capacity / the number of parking lots

Valleley [6] has estimated by different methods that a car needs 4 different parking places during the day. However, as the study was carried out within the same parking area, the likelihood of a car parking to the same position every time has been overlooked. In this study, the distance required for parking is determined according to the size of the vehicles. This approach is applicable to situations where the parking area is very large. Steierwarld et al [7] has stated that the number of cars wandering around to look for parking space during the day could be as high as 95% especially in areas where the traffic is dense. He claims that this would affect both the driver and the passenger satisfaction. Designers have made certain conclusions about the parking space designs. The space for maneuver for a minimum of one car should at least be the minimum of the size of the vehicle to maneuver and it should be designed in a way to facilitate opening the passenger door easily at the parked position [8]. Mc Cluskey has stated the minimum car parking spaces in his study in [9] (see Figure 1).

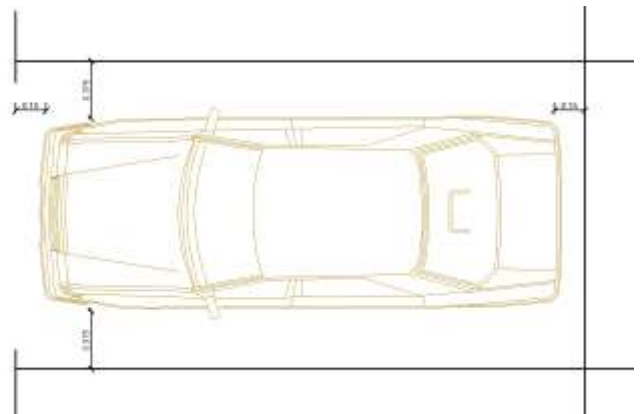


Figure 1. Parking limits for drivers [10]

Parking distances indicated in Figure 1 are calculated according to certain standards. These distances are determined to be 0.15 cm from the rear and the front, and 0.375 cm from the sides. However, many countries have also developed different design methodology and standards.

Stubbs[11]examples of 'best practice' are presented that examine, amongst other things, car-reduced/car-free development and international work on both the accommodation and reduction of parking in residential environments. Ison and Rye [12] show the papers the student or researcher of parking policies and their effects will, therefore, gain increased knowledge of the parking policy research agenda; of parking economics; and of behavioural responses to parking charges and management.

When considering all the studies, it was noticed that the driver's parking behaviors were not adequately taken into account. Car parking scenarios of drivers are important data in terms of parking place design. It is very important to know how the people using the parking place are actually parking their vehicles, as the distance left between the parked car and the next parking space directly affects the other car's flow and their parking situations. The inventory of the existing parking spaces should include the size of the parking space, parking duration, the number of cars entering and exiting the area, restriction of large vehicles (if any), public transportation allocation and the impact on the traffic flow. When we look at the literature, parking spaces generally are composed of the following constituents: sufficient space for the car to move, idle vehicle movement area, maneuver area, and additional areas (green areas, signs, etc.).

Although certain standards (Parking Regulations) are specified in Turkey, it is not known how these standards were determined. Considering the use of resources that help in designing, such as Neufert, it was realized that these designs were actually made blindly by a compilation of data obtained from different sources, as opposed to taking the vehicle sizes and parking standards into account. Therefore, it is absolutely necessary to determine new parking strategies in Turkey.

II. New Approach for Car Parking Design

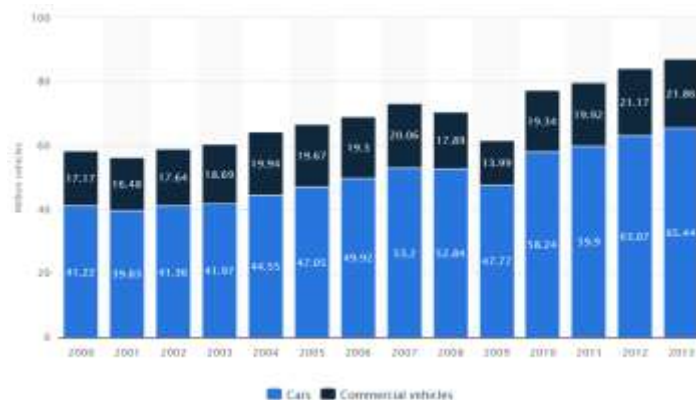
The "parking behavior" of the car drivers in the parking lot is very important. This issue, which did not attract too much attention in the literature, regards the distance that the drivers leave between their vehicle and the other objects when they are parking. When planning to redesign the parking spaces, parking scenarios of the drivers (parking habits / behaviors) should be determined and taken into account. For this reason, "drivers parking behavior" can also be added to the literature in addition to the existing design criteria.

- Determination of conditions the maximum/minimum number of spaces

- A architectural plan of the proposed site to a known scale and levels
- Proposals of future development of sites
- To take into consideration shape and function of the building on the site
- The requirements for water- protection, clients' preference, general public spaces
- Security
- Parking behavior for drivers

A. Vehicle Number and Size

In 2012, 833 million passenger cars were in use worldwide, and over 63 million units were produced in the same year. Worldwide, passenger car sales are expected to continue to increase, with a projection of around 72 million units from 2014 to about 92.5 million units in 2025. Figure 2 displays worldwide automobile production from 2000 to 2013 [13]



Source: Statista 2015

Figure 2. Worldwide automobile production from 2000 to 2013 (in million vehicles)

In addition to the increase in the number of vehicles, the change in the size is also striking (Figure 3).

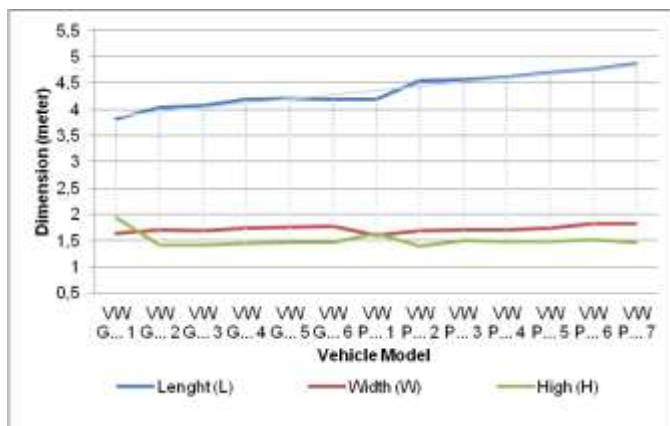


Figure 3. The change in the vehicle size compared to the first generations

The increasing number of vehicles all over the world and the obvious change in the size of the vehicles points strongly towards the importance of the parking space design since the constantly increasing number and dedication of only some specified areas as parking spaces is very important for the parking area design..

B. Parking Behavior

Careful designing of parking spaces is expected to result in a significant improvement for drivers to maneuver. Therefore, first of all, the necessary data should be collected for the parking design. As mentioned above, driver’s parking behavior should also be included in these data (Figure 4).



Figure 4. Car Parking Distance

As shown in Figure 4, different drivers show different parking behaviors within the same parking area.

III. Case Study in Turkey

Drivers’ parking behaviors that were mentioned in this study were monitored in Süleyman Demirel University main parking lot (Figure 5).



Figure 5. Analysis Space in SDU

The sizes of the parked cars and parking behaviors of the drivers were regularly noted for 3 months. During this 90-day continuous period, around 13500 vehicles (an average of 150 vehicles per day) were counted. The data in Table 1 were recorded. The dimensions of the vehicles of interest in the parking lot (Figure 6), and the parking distances were determined (Table 1).

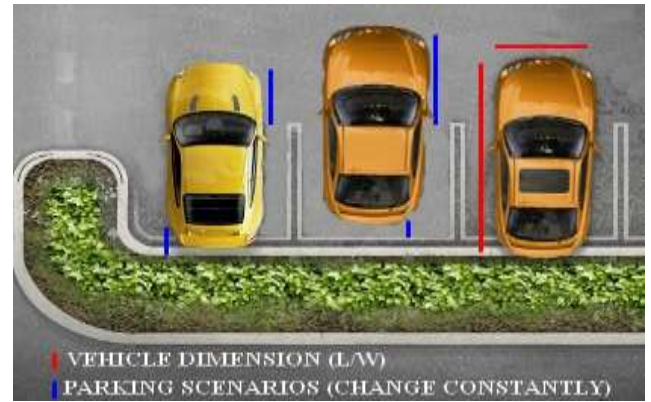


Figure 6. Araçların The conditions of the vehicles in the area

The analysis was fulfilled for each type and model individually of vehicle. The results are represent in Table 1.

TABLE I. CAR DIMENSIN OF CASE STUDY AREA

	Dimensions		
	Length (L)	Width (W)	High (H)
Average	4.213	1.821	1.512
Median	4.570	1.901	1.523
Minimum Dimension	2.500	1.512	1.230
Maximum Dimension	5.430	2.432	2.451

Parking space dimensions:

$$P_L = V_L + F_D + B_D \tag{1}$$

$$P_W = V_W + F_D + R_W + L_W \tag{2}$$

Annotations about formulas shows in Figure 7.

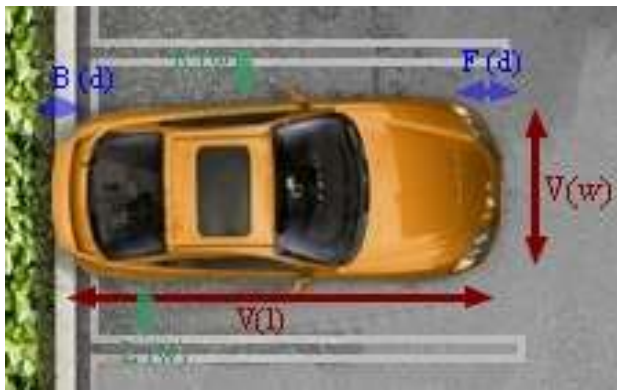


Figure 7. Size and parking distances of the vehicles

According to this analysis and mathematical calculations a conclusion can be shown that parking space dimensions for perpendicular parking in Turkey, should be “5.07” m in length and “2.78” meters in width. These dimensions have to be adopted as minimum parking lot dimensions in every environment in Turkey parking design standards.

However, when considering the parking distances that the drivers keep, the $F(d)$ value was found to be very high as 40 cm (Figure 8).



Figure 8. The conditions of the vehicles in the area

In this case, the imprecise parking of the vehicle in a way that its tail sticks out, blocks the maneuver and the circulation space behind it. As a result of this, it was noticed that the drivers could “hesitate” when parking towards the front end. These cases indicated the presence of higher pavements in these areas compared to standard heights which, have affected the driver’s parking situations.

IV. Conclusion, Discussion and Future Works

The designs and use of areas within the same region and their operations could be very problematic in Turkey as these designs are not based on logic and analysis. Many projects to be applied on the same area for parking spaces could become completely inoperable after a while. These problems arise both because of the drivers’ vague and clumsy parking and the projects that were designed without initial analysis and data.

This study could be seen as a good start to eliminate these design scenarios made without analysis. It is also important in terms of identifying new strategies for parking space design. Future projections that will be used in designing parking areas, the physical conditions of the location as well as the driver’s behavior and consideration of the size of the vehicles that will benefit from the parking space have been found to be quite important. This may prevent the blindly made designs in Turkey. The accuracy of parking space designing handbooks by Neufert or unknown sources can be tested. At the same time, “random” parking lot design scenarios in the country can be avoided by specifications to be established.

This work should be tried in 45 degree and 60 degree parking spaces. In addition to this, roadside parking spaces at critical points in the city such as the city axis can be analyzed. This work should not be limited to only a specific location; it should be aimed to be applied in the whole region, or even the whole country. This country-wide study could yield new standards for parking. By this, both the drivers will be able to park more efficiently and the parking space designs will improve.

Acknowledgment

The research team hereby expresses a great appreciation to university management especially executive board in rectorate for give data for this study in Suleyman Demirel University. Also special thanks our students who are joining our research group lecture of architectural modeling.

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