
Principles of Design of a Parking Lot for The School Of Engineering Technology Auchi Polytechnic, Auchi, Nigeria

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ABSTRACT

The project focus on design of parking lot in school of Engineering, the parking lot design objective is to maximize the total number of parking spaces available with the considerations that the design should allow for appropriate landscaping of the parking areas without conflicting with lighting. The rapid development of available land in Auchi polytechnic, Auchi has produced large increase in land usage, to the extent that the use of large areas of land for parking cars in the school is uneconomical. It is obvious therefore, that optimum use of the available space in the school for effective space management for car storage during office hours can only be achieved through the use of good parking lot design. The peculiarity of school of Engineering in terms of shortage of space for expansion purposes cannot be overlooked, hence the disorderliness in terms of traffic parking.

Keywords: Parking lot, Traffic, Engineering, parking management, Angle and dimension

Aims Research Journal Reference Format:

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1. INTRODUCTION

A parking lot (American English) or car park (British English), also known as a car lot, is a cleared area that is intended for parking of vehicles. Usually, the term refers to a dedicated area that has been provided with a durable or semi-durable surface. In most countries where cars are the dominant mode of transportation, parking lots are a feature of every city and suburban area. Shopping malls, sports stadiums, mega churches, schools, and similar venues often feature parking lots of immense area. Modern parking lots use a variety of technologies to help motorists find unoccupied parking spaces, retrieve their vehicles, and improve their experience (Brown, 2002). Parking is creating problems mainly because people have to cruise around to find a vacant parking spot in the urban network. A clear need for applications that can reduce those external effects of parking has arisen, especially the last few years. With parking pricing policies reaching their limits in many European cities, possible improvements could be found in Intelligent Transport Systems (ITS).

In higher institution in Nigeria, Parking of cars is a major challenge, mainly due to absence of clearly designated areas of parking in many of our school. The peculiarity of school of Engineering in Auchu polytechnic in terms of shortage of land for expansion purposes cannot be overlooked, hence the congestion in terms of parking facilities and other land uses competing for limited land space. The structure of a parking lot must be able to sustain the live and dead load imposed on it not neglecting the aesthetic value it adds to the environment. The work was restricted to space planning and management in the design of a parking lot in the school of Engineering for storage of cars. The design shall cover a detailed planning proposal for construction by the school.

The aim of this research is to effectively design and manage a central parking lot for the school of engineering technology, Auchu polytechnic, Auchu.

The objectives are as follows:

- i. To design a parking lot for school of Engineering which would cut down the non orderly parking of cars.
- ii. To create free space around the school of Engineering structure that could be landscape.
- iii. To provide a parking lot that will restore sanity and aesthetic beauty to school of Engineering.

1.1 Significance of the Study

The importance of this research is the ability of school of Engineering to adapt to new challenges that increase in technology poses on it. Increase in technology and the advent of the automobile, ushering in the mass use of the automobile to the extent that it begins to litter the environment of the school of Engineering, can be solved by adapting building of a parking lot to house this mess. This research would create a framework for the design of parking

2. LITERATURE REVIEW

2.1 Introduction

A parking lot is an **area that is assigned for parking**. Normally, the parking spaces are marked on the ground with white or yellow lines that form squares that each fit one car. Parking lots are common near shops, bars, restaurants, schools, and other facilities that require parking (Goodburn, 2002). There are parking lots that are open throughout the year, but there are also improvised parking lots that are specially assigned for an event. For example, when there is a music festival that only happens once a year people can decide to open a nearby meadow to provide parking spaces for the visitors of that particular music festival.

Weant and Levinson (2000), state that parking contributes to the appearance of city and suburbs; affects traffic congestion and traffic operations; and equally influences the choice of mode and route of travel which also affects the viability and competitive posture of commercial areas. Since city is characterized by different land use activities and patterns of circulation is partly a function of the land use activities and their spatial distribution, therefore, efficiency of this circulation depends upon existing transportation system which parking facilities are major component.

Osoba (2012), is of the view that the road transport operation is a circulatory system that must be a continuous process and any infringement at any point along the line will definitely affect the whole system and hinder its effectiveness. Therefore, parking facilities are essential in order to allow flow of traffic. Since, parking challenges are no longer confined to the city centres, the challenges now extend throughout the urban region. According to Obot and Umoh (2007), in Nigeria, like elsewhere, where cars are one of the dominant modes of transportation, urban circulation is one of the most obvious problems and parking seems to be an overlooked element in transportation development. Several studies have shown that improvement in the living standards of people as a result of wage increase contributes almost as much as the growth of cities to contemporary urban traffic condition in Nigeria (Tanimowo and Atolagba, 2006).

Akhuewu (2010), opines that however, for a city to function as a system, transportation must be efficient and reliable to facilitate, not only inter-city movement of people and their activities, but encourage intra-city movements within the city. These movements are from point of origin to the point of destination. On-street parking refers to the parking space made available along the curb or shoulder of a street or road that are designed to accommodate vehicle. Olorunfemi (2013), observes that if a city provides on-street parking, particularly in commercial area, it makes conscious choices to provide better access to adjacent land use at the expense of more efficiently moving traffic. The use of on-street parking affects the traffic movement in three ways; it reduces a street's capacity, it reduces safety, and increases service conflict (Richard and David, 2007).

On street parking causes safety and congestion problems by blocking one or two traffic lane, reducing visibility, insecurity and forcing pedestrians to walk in the road if no proper footpaths are provided and it also obstructs access for emergency services thereby resulting into accidents and affecting traffic movement (Rye, 2010). There are two types of on-street parking, official and non-official parking. The official on-street parking includes bank car parks, administrative car parks, office car parks, and recreational car parks and media car park while non-official on-street parking is referred as kerbs as its nearness to destination.

Asiyanbola and Akinpelu (2012); Olorunfemi (2013) pointed out that On-street parking constitutes one major problem that makes traffic situation chaotic in Nigerian cities. Most roads in Nigerian cities are narrow and lack pedestrian lanes. There are cases of double parking along these narrow roads thereby causing traffic congestion. This is due to the non availability of off-street parking facilities along the transportation routes coupled with inadequate traffic management. Subsequently, some cities cannot cope with the explosive growth in the number of people due to urban activities especially at the urban centers. The situation is getting worse with the growing number of visitors and patrons due to urban revitalization, suburban development, and the increasing trend of mobility which make parking situation more challenging. Therefore, Parking is increasingly giving attention as an important aspect of transportation planning (Jeffrey, 2007).

2.2 Car Parking System

Indian Institute of Technology, (2007) define car parking system as a mechanical device that multiplies parking capacity inside a parking lot. Parking systems are generally powered by electric motors or hydraulic pumps that move vehicles into a storage position.

There are two types of car parking systems: traditional and automated. In the long term, automated car parking systems are likely to be more cost effective when compared to traditional parking garages. Automatic multi-storey automated car park systems are less expensive per parking slot, since they tend to require less building volume and less ground area than a conventional facility with the same capacity. Both automated car parking systems and automated parking garage systems reduce pollution - - cars are not running or circling around while drivers look for parking spaces. Automated car parking systems use a similar type of technology to that used for mechanical parcel handling and document retrieval. The driver leaves the car inside an entrance-area and technology parks the vehicle at a designated area. Indian Institute of Technology, (2007).

Hydraulic or mechanical car lifters raise the vehicle to another level for proper storing. The vehicle can be transported vertically (up or down) and horizontally (left and right) to a vacant parking space until the car is needed again. When the vehicle is needed, the process is reversed and the car lifts transport the vehicle back to the same area where the driver left it. In some cases, a turntable may be used to position the car so that the driver can conveniently drive away without the need to back up (Indian Institution of Technology, 2007).

2.3 Parking Management

Parking is the act of stopping and disengaging a vehicle and leaving it unoccupied. Parking on one or both sides of a road is often permitted, though sometime with restrictions. Parking plays an important role in the transport system since all vehicles require a storage location when they are not being used. On-street parking means parking your vehicle on the street, anywhere on or along the curb of streets, in contrast to parking it in a parking garage. In some streets you can always park your vehicle on the street, but sometimes there are restrictions. Mostly these restrictions are presented on traffic signs. Sometimes you're only allowed to park on one side of the street, and sometimes you're not allowed to park your vehicle

2.4 The Effects of Parking Cost On Mode Choice

The most influential factor in deciding whether to park at a destination is the cost (Fontaine, 2003). Swanson (2004) also studied Calgary (and five other Canadian cities) to show the relationship between employment and parking supply on parking rates. Swanson argued that vitality is a major factor in determining the prevailing parking rate. A thriving downtown is likely to have a high employment density, which would increase the demand for parking. Swanson concluded that increasing employment will increase the demand for parking and without an increase in available parking; the cost of parking will rise.

2.5 Challenges of Parking Lot Design in Nigeria

The population of the world is continuously on the increase and towns and cities have grown up around their public transport system. The increasing population and expanding urban centers has been accomplished by increasing car ownership and increasing demand for movement for various purposes. Regardless of income or social status, the condition under which people travel have become more and more difficult and for some absolutely intolerable. Demand for transport and travel intensity tends to increase sharply with the growing size of a city and town especially when the city center or major centers of activity continues to grow in terms of both size and employment (Osuba, 2012).

Parking in public areas can be very tasking with little or no form of security because it is fraught with all sorts of hazards created by either humans or lack of parking structures. In order to reduce the stress of parking and any form of danger or insecurity to cars and owners, adequate parking facilities must be provided to meet up for the demand of parking. Findings in the research work done by Department of Transport Management Technology, Federal university of Technology, Minna, Nigeria (Osuba, 2012) revealed that parking problems and traffic management issues in Nigeria which leads to time delays and traffic congestion are as a result of inadequate parking space, traffic signs/signals, indiscipline, encroachment of illegal activities at car parks etc. Recommendations were made for parking management, parking design standard, parking control, traffic management for both vehicular and pedestrian, land use and land development, enforcement of edict and bye-laws by statutory agencies.

Today, automobile is the dominant mode of transportation in most nations of the earth including Nigeria, where an average family has at least a car, which has led to many transport and traffic problems within cities and inter-cities and the challenges of parking in large gatherings such as churches, shopping malls is beginning to be a great issue. Over the years engineers and architects have found a way to create more parking spaces within minimum size of land by the design and construction of multi-storey car parks. This is line with the trend in modern cities all over the world of developing high-rise buildings as to overcome the challenges of urban over population, for optimal use of scarce land resources, as status symbol, etc. (Ede,2014). Multi-storey car park also known as a parking garage or a parking structure is a building designed for car parking with a number of floors or levels on which parking takes place.

It is essentially a stacked parking lot that has multiple access and exit system to avoid traffic congestion in and out. Car parking systems have been around almost since the time cars were invented. There are car parking systems in most areas where there is significant amount of traffic. Car parking systems and the accompanying technologies have increased and diversified over the years. Car parking systems were developed in the early 20th century in response to the need for storage space for vehicles. Multi-storey car park is used virtually in every advanced nation. It is called parking structure is used in the United States especially when it is necessary to distinguish the structure from the garage in a house.

2.6 Traffic Flow

According to Wattle Worth (1976), reported that, there have been many significant developments in traffic flow. Some of these developments have led to very useful relationship while some applications have not been all that useful. He further said that probably, the most useful result of traffic flow theory is the development of the relationship among the macroscopic variables of traffic stream flow (flow rate, speed and density). Traffic Engineering uses the flow theory for the development of the level of services concept. However, there, has been some criticism of the traffic flow theory work regarding the lag between the theoretical development and the application of some portion of the flow theory work. The traffic flow theories have largely looked into the basic relationship (why things happen). The traffic Engineers owe them a lot, for these theorists are physicists and mathematicians.

The fundamental characteristics of traffic stream flow are:

- (i) Flow
- (ii) Speed
- (iii) Density

Litman (2011) conceptualized parking problem in terms of a paradigm shift which describes a fundamental change in how a problem is perceived and solutions evaluated. The paradigm also assumes that parking lots should almost never be filled and that parking facility costs should be incorporated into the costs of buildings or subsidized by governments and that every destination should satisfy its own parking needs. The old parking paradigm asserts that parking requirements should be applied rigidly without exception or variation and that parking management should be seen as a last resort to be applied only if increasing supply is infeasible.

3. METHODOLOGY

3.1 Design Principles and Planning Consideration

The goal of this work is to reduce the spaces that are daily converted to parking spaces for cars in the school of Engineering Auchi Polytechnic, Auchi. It is imperative at this point to properly examine the issue of space management through proper spatial planning techniques.

3.2 Design Requirements

Parking of cars in higher institution of learning is a crucial issue of our times during office hour. As the number of cars increases geometrically, the need to house them in close proximity creates a challenging design problem.

3.2.1 Functional Requirements

The car park or lot must foremost deal with the Functional/Operational need - as in providing for safe and efficient passage of the automobile. This is a very complex challenge as automotive, engineering and traffic issues relative to site locations must be integrated to create the appropriate solution.

Therefore designing the parking garage requires an integrated design approach of many professionals. Parking has often been reduced to the construction of the most minimal stand-alone structure or parking lot without human, aesthetic or integrative considerations. This has given parking a poor public perception and has frequently disrupted existing urban fabric. However, many architects, engineers, and planners have envisioned and constructed far more complex, aesthetic, and integrative structures. This should be the goal of good parking design.

3.2.2 Structural Integration

The efficient integration of structure is crucial to maximum functioning of the parking lot:

- i. The parking lot is typically an exposed structure and must be designed to withstand all aspects of environmental conditions.
- ii. There are ideal structural bays that allow for maximum number of parking spaces and flow of automobiles dependent upon site and structure.
- iii. Cast in place concrete, pre-cast concrete and structural steel can be used for the structural design.
- iv. Typical construction issues such as natural hazards in the location of construction apply and compound the solutions in designing a structure that is completely exposed to the weather and constant movement from automobiles.
- v. Size and length of some structures compound the expansion and contraction issues already of key importance in parking lot design.
- vi. Drainage and floor slope is very important, as ponding water can create long term maintenance problems.

3.3 Signs and direction

- i. Color-coding, numbering, visual cues, music, and even machines for marking your ticket with your exact location to locate your car for easy retrieval
- ii. Locate signs in areas where driver can read in a timely fashion.
- iii. Clear, simple, and direct messages.
- iv. Floor coding can be useful
- v. Signage should locate all major internal pedestrian access points as well as external major roads and buildings.

4. RESULTS AND DISCUSSIONS

4.1 Introduction

In order to achieve the objective of this research program, various angles such as 30°, 45°, 60°, 90° were used to design the parking lot. Below is a detailed of the angles and dimensions for designing parking lots as shown in table 4.1.

Table 4.1: Various Angles and Dimensions for Designing of Parking Lot

A	B	C	D	E	F	G
0°	8.0	8.0	12.0	23.0	28.0	-
	8.5	8.5	12.0	23.0	29.0	-
	9.0	9.0	12.0	23.0	30.0	-
	9.5	9.5	12.0	23.0	32.0	-
	10.0	10.0	12.0	23.0	32.0	-
30°	8.0	16.5	11.0	16.0	44.0	37.1
	8.5	16.9	11.0	17.0	44.8	37.4
	9.0	17.3	11.0	18.0	45.6	37.8
	9.0	17.8	11.0	19.0	46.6	38.4
	10.0	18.2	11.0	20.0	47.5	38.7
45°	8.0	19.1	14.0	11.3	52.2	46.5
	8.5	19.4	13.5	12.0	52.3	46.5
	9.0	19.8	13.0	12.7	52.5	46.5
	9.5	20.1	13.0	13.4	53.3	46.5
	10.0	20.5	13.0	14.1	54.0	46.9
60°	8.0	20.4	19.0	9.2	59.8	55.8
	8.5	20.7	18.5	9.8	59.9	55.6
	9.0	21.0	18.0	10.4	60.0	55.5
	9.5	21.1	18.0	11.0	60.4	55.6
	10.0	21.5	18.0	11.5	61.0	56.0
90°	8.0	20.1	25.0	8.1	65.2	63.8
	8.5	20.2	24.0	8.6	64.4	62.9
	9.0	20.3	24.0	9.6	64.3	62.7
	9.5	20.4	24.0	9.6	64.4	62.7
	10.0	20.5	24.0	10.2	65.0	63.3

Source: Baerwald IE (Ed.) Traffic Engineering Handbook.

Where A = parking angle, B = stall width, C= stall to curb, D= Aisle width, E = curb length per car,
F = curb to curb, G = stall centre

4.2 Various Types of Parking Angles

30° Oblique spaces

This method of parking and circulation allows for easy entry and exit for use only with one way traffic. This method is the most favourable and also has its own share of waste space created just above the parking space.

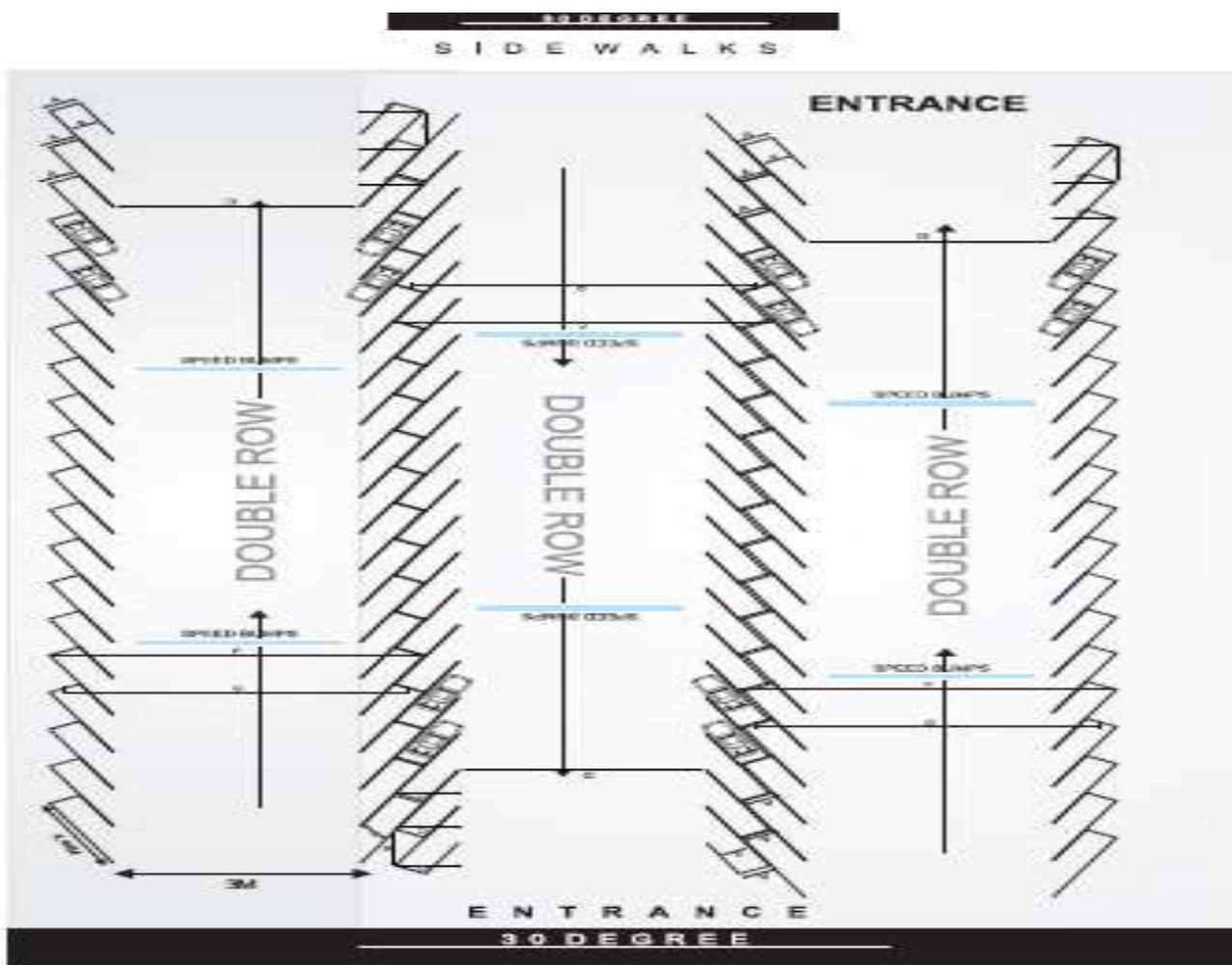


Fig. 3.1a. 30° parking angle



Fig. 3.1b. Model of 30° parking angle

45° Oblique or echelon parking

This method is a little more difficult to exit than the previous but has less waste space. This method is for one way traffic only. This type of parking usually consumes 22.1 square meters per car or 19.2 square meters where interlocking in adjacent rows.

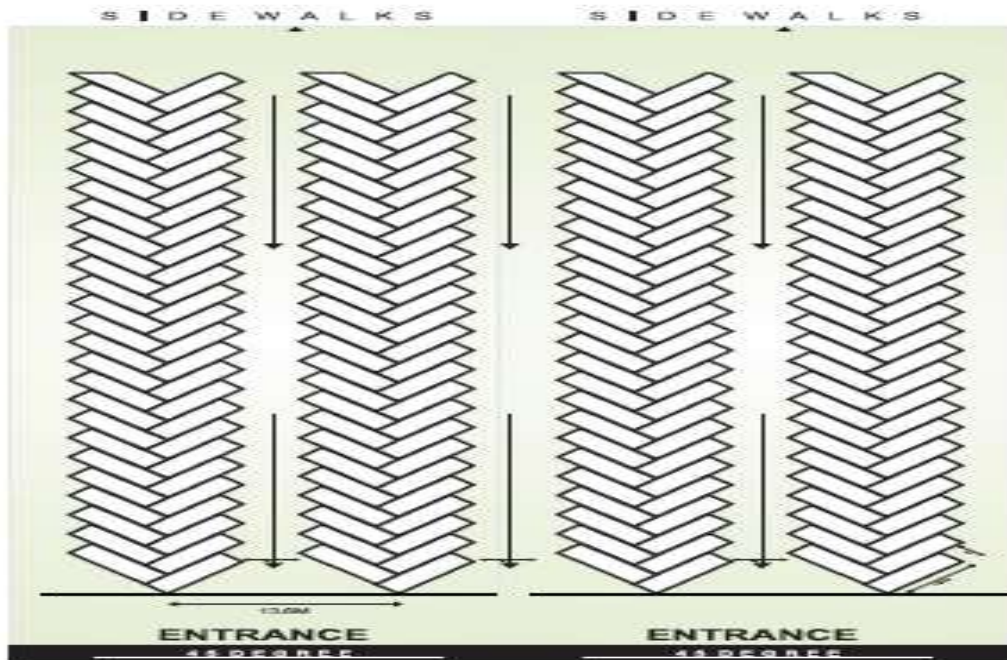


Fig. 3.2a. 45° parking angle

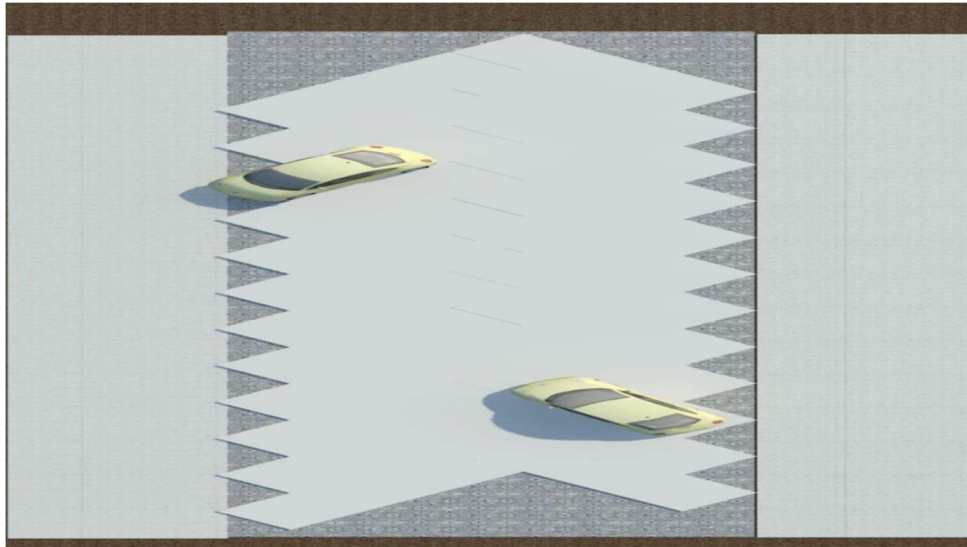


Fig. 3.2b. Model of 45° parking angle

60° Oblique parking

The system of parking involves angle parking and it is similar to perpendicular parking, except the cars are aligned in an angle. Thus allows for easy entry and exit for use only with one way traffic. This method is the most favourable and also has its own share of waste space created just above the parking space.

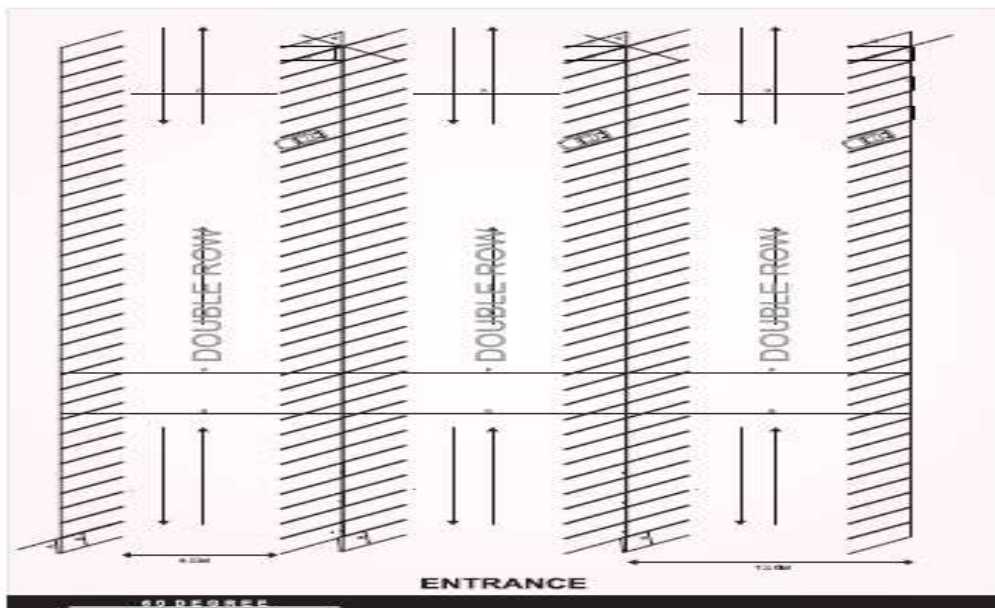


Fig. 3.3a. 60° parking angle

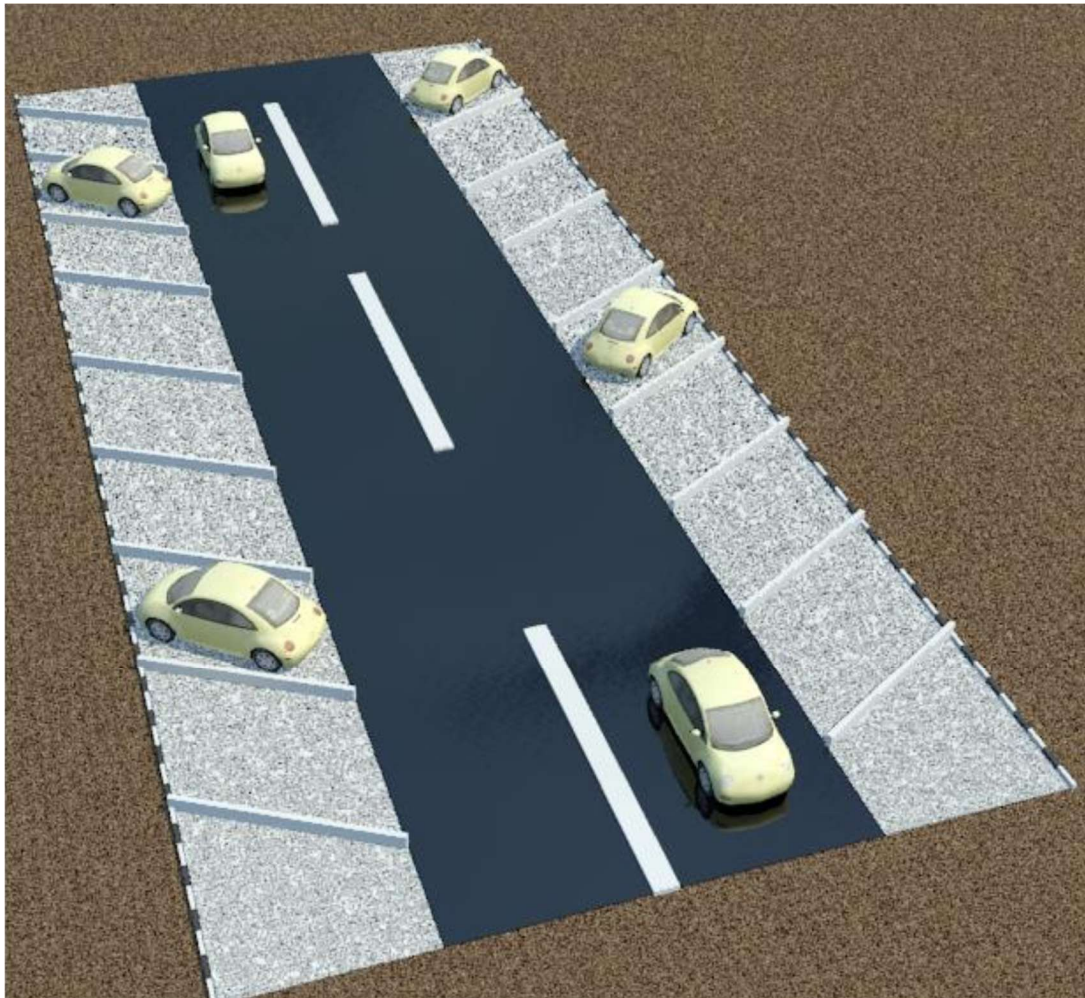


Fig. 3.3b. Model of 60° parking angle

90° Head-on to parking

This is one of the most space-efficient methods existing as it consumes only 18.8 square meter of space per car, though, it is very tedious to manoeuvre in and out of the parking space. Also, the process of one car exiting a parking space temporarily disturbs the movement of another along the passage way.

This type of parking is suitable for two-way traffic. There are two types in this category:

- i. The first category provides a parking space width of 2300mm. This reduced space allowance consequently affects the width of the two-way traffic road to allow for adequate manoeuvring. Here, the allowance for the passage way is 6500mm.
- ii. The second category provides a parking space of 2500mm width. This increased space allowance allows for a reduced passageway width of 5500mm while still supporting adequate circulation and manoeuvring

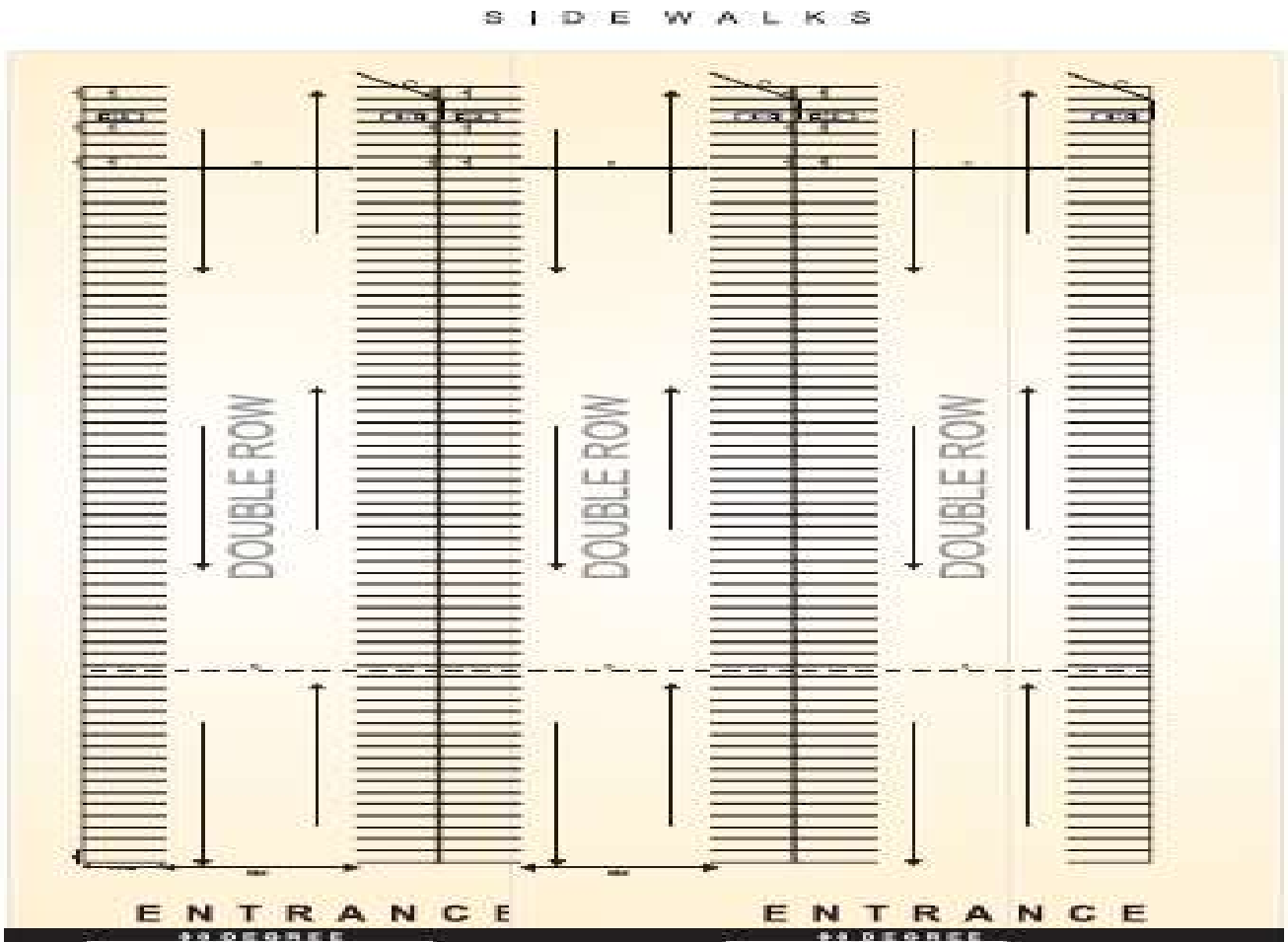


Fig. 3.4a. 90° parking angle

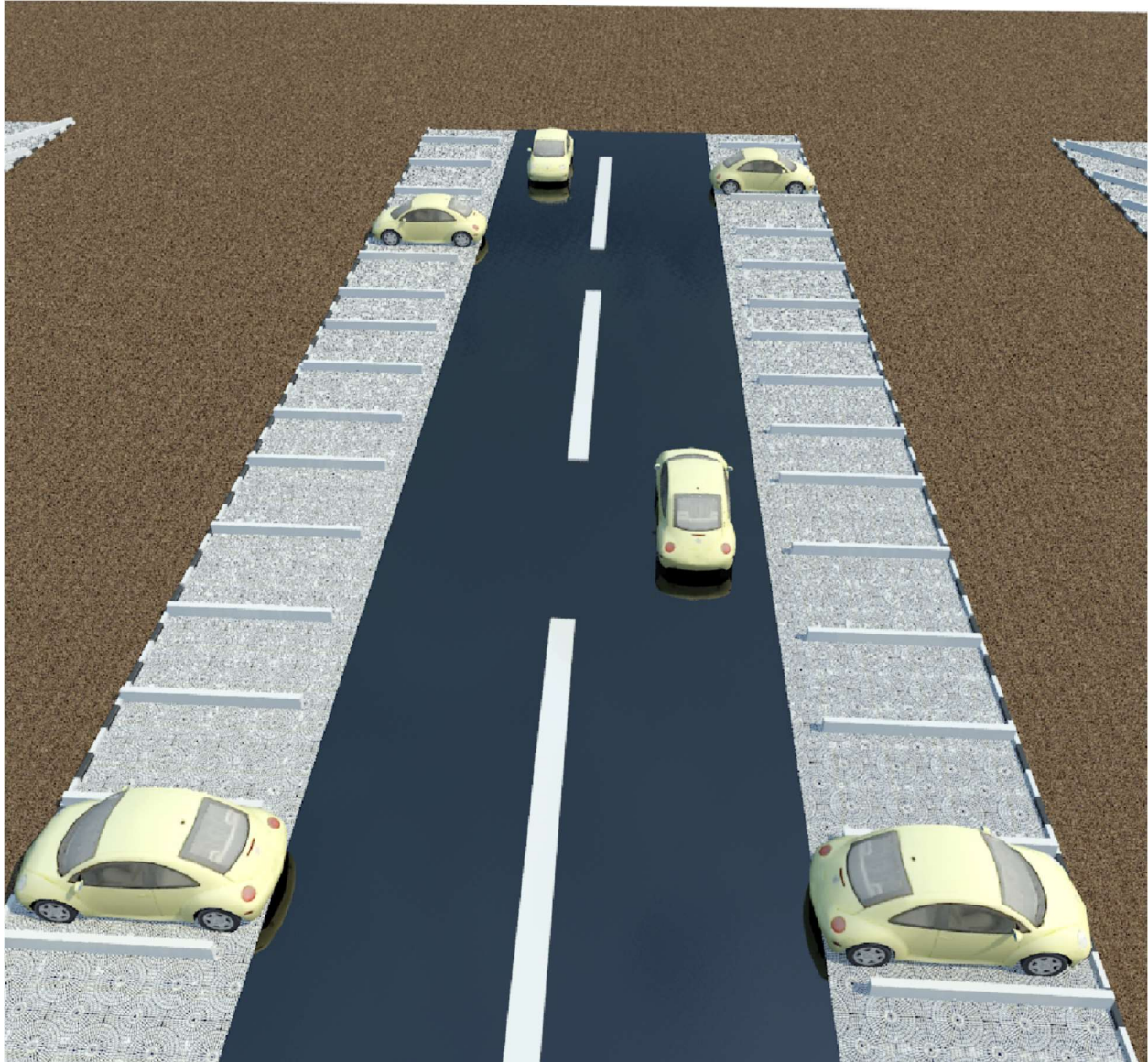


Fig. 3.4b. Model of 90° parking angle

5. CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

The design of a central parking lot for school of Engineering technology in Auchi Polytechnic, Auchi is a project which has been embarked upon as an academic exercise but not withstanding its potential for full execution. As a result, in-depth analysis and study of the project is very essential in order to get a good grasp of the design and what it entails as well as what is involved for general consideration. With the design a large numbers of cars parked on open ground surfaces scatter around school of Engineering Technology will be a thing of the past.

5.1 Recommendations

It is recommended that in managing the spaces left in school of Engineering Technology, a solution to the parking menace has to be proffered. A way out of this is through the use of a well design parking lot. This will add to the aesthetics of the faculty of school of Engineering environment. Again, recognising the peculiarity of school of Engineering Technology in terms of shortage of land for expansion purposes and congestion in terms of offices and lecture hall, it is imperative to accept these design principles. It is hoped that this work will serve as measure to various problems of parking in the school.

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