REPUBLIQUE DU Mali
Un peuple- Un but- Une foi
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Ministère de l'Enseignements Supérieur et de la Recherche Scientifique
Direction Générale de l'Enseignement Supérieur et de la Recherche Scientifique
Université Privée Africaine Franco-Arabe

REPUBLIC OF Mali
One people- One Goal- One faith
****
Ministry of Higher Learning and Scientific Research
General Directorate of Higher Education and Scientific Research
Private African Franco-Arab University

TITLE

A dissertation submitted to the faculty of Civil Engineering in partial fulfillment of the requirements for the award of the bachelor's degree of science in Civil Engineering (Construction Technology) at Université Privée Africaine Franco-Arabe (U.P.F.A.)

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Academic year 2024-2025

CERTIFICATION

This is to certify that the thesis entitled: **"DESIGN OF BUS STATION – SOUTHERN PROVINCE"** Submitted by NIZEYIMANA Jean Ben Fontaine to the **Université Privée Africaine Franco-Arabe (U.P.A.F.A.)** for the award of bachelor's degree of Civil Engineering Construction Technology under my direct supervision and guidance. The work embodied in this thesis is original and has not to my knowledge been published or submitted in part or full for any other Degree of this or other University.

Professor Issa NASSOKO

…………………………	**…………………………**
Signature and names of Supervisor	Signature and names of Head of Department

Submitted for the Project Examination held in ………………….…, 2025 at UPAFA

DECLARATION

I, **NIZEYIMANA Jean Ben Fontaine**, declare that the content of this thesis is my own work except where acknowledged. It has never been presented or submitted anywhere else for any other or similar award at any other university or institution of high learning.

Student names and Signature: **NIZEYIMANA Jean Ben Fontaine** ……………………….

DEDICATION

I would gladly dedicate this project work to:

- ✓ Almighty GOD who never leaves me in my daily life.
- ✓ My lovely wife, KAYITESI Marie Solange.
- ✓ Our children.
- ✓ My dear parents for their incomparable supports and advice.
- ✓ My brothers, sisters and all our relatives in general.
- ✓ All our educators; for their inspiration and for shaping us in accomplished people.
- ✓ All friends and classmates who contributed in our studies and strong life.

AKNOWLEDGEMENTS

First and foremost, I am truly thankful to the Almighty God, the most merciful, for the countless blessings in my life, especially in my studies from the beginning up to the completion of this project. I am very grateful to my family for their support and advice.

My special thanks are addressed to Nyanza District for its appreciable technical guidance.

My sincere acknowledgment goes to the entire **Université Privée Africaine Franco-Arabe (U.P.A.F.A.)** administration and staff. My deep appreciation is extended to Supervisor, Professor ISSA NASSOKO for his continuous advice and corrections until the completion of this study project.

I, finally express my gratitude to people who, directly or indirectly contributed to make my studies successful today.

LIST OF FIGURES

LIST OF TABLES

ABREVIATIONS AND SYMBOLS

Chap = Chapiter

e.g = examplii Gratia (example)

etc = Et cetera

AASHTO = American Association of States and Highway Transportation Officials

GPa = Giga Pascal

PCC = Portland Cement Concrete

ESALs = Equivalent Standard Axle Loads

EALF = Equivalent Axle Load Factor

GPS = Global Positioning System

PM = Post Meridian (After noon)

CBR = California Bearing Ratio

MININFRA = Ministry of Infrastructure

RRA = Rwanda Revenue Authority

ONATRACOM = Office National pour le Transport en Commun

RFTC = Rwanda Federation of Transport Cooperative

Ltd = Limited

N = Newton

Kips = Kilopounds

lb = Pounds

m = Linear meter

m^2= square meter

% = percentage

º = degree

TABLE OF CONTENTS

I. CHAPTER ONE

1. INTRODUCTION

Southern province constitute by eight (8) Districts and his headquarter is currently in Nyanza district. Historically, Nyanza was created in 1898 by a King YUHI IV MUSINGA and it was the old Royal Palace of the Rwandan monarchy up to 1959. Due to all these historical facts; later, Nyanza became one of the attractive places for tourists.

Concerning the development of the country in general, Nyanza is one of the rapidly developing towns in Rwanda with the increase of population with many different activities such as commercial inside or with the neighboring places, tourism, different public and private institutions like hospitals, schools, churches, universities, etc. All these enable a considerable movement of traffics of in and out of the region. So, there is a big number of vehicles which need a place to park with comfort-ability. This area is also a very important place for the entry and exit of vehicles from different destinations in surrounding Districts such as Huye, Ruhango and Nyamagabe as well as other provinces and Burundi, the neighboring country.

Actually, public vehicles from different places (as mentioned above) do not have a common temporally pick up and drop off point, that people get lost about information and ticket sell places according to their destinations, therefore; A bus station with adequate conditions of security and safety able to fulfill all needs of users and containing required facilities like public toilets, shops, restaurants and travel shops where tickets are sold in an easy access at one place is needed.

Nyanza District has put such a project of infrastructure in its agenda by intention of solving permanently the transportation problem and its income will also be generated.

2. Background

Today, Nyanza District has an estimated population of 307,000 people in 2002 while it had 323,719 people in 2012 (according to the general population censuses carried out in 2002, 2012 and 2022). Therefore, a population growth rate is considerably high. Tourism and commercial activities are also another fact which imply the mobility of people to be higher simultaneously, public transport to increase rapidly. so, there is a problem of different transportation agencies concerning the lack of parking and easy access to passengers.

Currently, these agencies are at different locations and even their management seem to be difficult, so that some passengers get lost about the travel schedules, where to take vehicles to their destinations and security of luggage's.

3. **Statement of the problem**

Nyanza District has taken an initiative to build a provincial modern bus station or taxi park in Nyanza town, because of many problems occurring and relevant to public transportation infrastructures concerning vehicle parking, drop-off and pick-up places, park, and ride areas, etc.

The purpose of constructing a bus station in this area is to get a space with full requirements and potentiality to accommodate all users' demand so that passengers as well as vehicles will get appropriate service. However, its conditions and facilities should serve in respect to human needs.

4. **Purpose of the Study**

The intent of the study is to design the construction of elements of Nyanza bus station and the pavement structure.

5. **Objectives of the Study**

As far as this study is concerned, the following will be the guiding objectives:

- ✓ To initiate the appropriate structural design of the parking pavement.
- ✓ To study and design a bus station and its facilities to determine whether it will fulfill the current demand and to provide a base line for future trend studies.
- ✓ To generate the parking and its facilities design.
- ✓ To compute the quantities.

6. **Research Question As the questions about this research are:**

- ✓ What is the effective mechanism for handle the complaint from the passenger of Nyanza Bus station?
- ✓ What kind of service standards that can be recommended to the company of transport to improve the service of Nyanza Bus station?

7. **Hypotheses of the Study**

A bus station is a significant element in the operation of bus services. Its design and location affect the efficiency of a transport system, and its impact on other road users. Some stations are regarded more as landmarks than as utilities, and as such are often of prestigious rather than practical design, which may detract seriously from their efficiency.

Local bus services in Nyanza town are centered on bus station. Often there are many buses stops along away in the southern province of Rwanda, with smaller ones at the outer ends of the routes. There may also be intermediate stations, especially at points where many passengers interchange between different bus routes, although most intermediate passengers on urban services board and alight at roadside bus stops.

Bus station may also be used for parking between journeys for buses which are away from their home bases. But they should not normally be regarded as long- term parking facilities, particularly in locations where land is expensive. When they are not required for loading, buses should be parked elsewhere, preferably at depots where there are facilities for vehicle servicing and cleaning. Buses should not normally be permitted to park in streets adjacent to the Nyanza bus station as it is today.

8. **Conceptual framework**

The present study has used some concepts to fulfill its objectives. The concepts used in the study are variables leading to the choice of the bus service, core service quality, value added service quality, critical service quality, passengers' satisfaction, service loyalty and ways to enrich the service quality of public transport.

9. **Significance of the Study**

However, every study must come up with the critical results and findings, for Nyanza District has the bus station which is too old and less benefit to the passengers thus the outcomes of study will be used in the implementation of the modern bus station.

10. **Justification of the study**

Designing urban spaces to improve mobility for all inhabitants is one of the main objectives of the case study, to share the advice and design practices seeking to raise the design standards in public policies for public spaces, mobility, and transportation. Stations are Gateways, the relationship vehicular traffic has with sidewalks and buildings are one point that should receive special attention when designing a bus station. This is because the way a stop interacts with its environment determines whether it's an appropriate access point to the transit system. In addition, if the station has elements to make the passengers' wait more pleasant such as trees, seats, and a shelter to protect them from the rain; it is possible to positively influence the perceptions of public transport for the pedestrians and drivers in the surrounding area. Facilitate Movement, Ease Interactions, the role that public transport stations can play in a neighborhood goes much further than just being where people get on and off a bus.

In fact, if the design and location of the stops are well planned, it is possible to reduce travel times and thus increase confidence in the transit system. Saving a time, station in bus-only lanes make it possible to reduce delays for the other traffic by concentrating stops in traffic flow to a single lane. This also offers an opportunity to create a safer space where passengers can board buses more calmly. They also contribute to condensing activity to a single point on the sidewalk without affecting the flow of pedestrians.

11. **Scope of the study**

As the title stipulates it, this study will consist of field data collection in Nyanza city, production of architectural drawings, structural drawings, design of critical structural members and producing the original of the project report on the design of construction elements of Nyanza bus station.

II. CHAPTER

0. LITERATURE REVIEW

1. INTRODUCTION

In this chapter, we shall discuss about some visits we made of the same topic and engineering points of view reported by some experts in engineering domain.

2. PUBLIC TRANSPORTATION COMPONENTS AND DESIGN ELEMENTS

Bus station elements

Station

A station is defined as a high-quality public transport facility which acts as a central departure and or destination point to accommodate high passenger volumes. Stations generally serve key catchment areas such as commercial and business areas and contain some supporting infrastructures such as public amenities and facilities.

3. Station types:

According to Trans-link, bus stations are classified into three types regarding their function within the network: (transl-ink, 2022).

- Standard stations

- Intro-model stations
- Multi –model stations

a. Standard stations

Standard stations primarily provide access to beginning and end-of-trip movement from multiple services and are generally located along public transport corridors. Standard stations are typically not intended for interchanging purposes.

b. Intro-modal stations

Similar to standard stations, infra-modal stations act as a destination or departure point for high priority services operating in significant catchment areas. In addition, intra - model stations act as key point of transfer between the same modes (i.e bus to bus) along two or more public transport corridors.

c. Multi-modal stations

Multi-modal stations build on infra-modal stations by providing transfers between different modes (e.g bus to train). These stations function significant catchment areas and where two or more public transport corridors come together with different modes.

4. Functional station design principles

The selection of the appropriate station layout for use in a site or for a particular operational purpose is only the preliminary step towards planning a fully functional station.
For a station to function completely, key functional station design principles must be considered. The inclusion of functional station design principles is aimed at ensuring that the passenger requirements are fully incorporated within station planning and design.

Functional station design principles will serve other purposes including meeting current station operation demands and future growth (ensuring stations are able to cope with future predicted passenger demands).

Ensuring that the arrangements of key station components are correctly incorporated will contribute towards quality outcomes for station design. The inclusion of these design principles is to be done in conjunction with the selection of station layouts and consideration of locality, operational and capacity factors.

5. Safety

Safety is essential for the safe operation and public acceptance of the transit system. hence, Bus stations are to provide a safe environment for users. The design of bus station and the layout of its facilities and amenities should provide a clear sight line into and throughout the station.

Parking area should be provided with direct access via passenger shelters or waiting halls. The latter should be provided with lighting where they will be used regularly during evenings.

allocation hours and travel schedules should not be overlooked, a notice board or screen needs also to be provided on the sight of every passenger for informational facility.

6. Drainage

Water drainage should be according to British Design Standard, Rainwater from roofs should be collected in catchments or tanks. Where it will serve in cleaning and in toilets, then used water should be directed to the sewers. Down pipes from roof gutters of buildings must be connected to the tanks and when full, water may be drained to the sewers as well as used water.

Storm water sewerage system are designed to flow by gravity, however there are limitations regarding to velocity of flow and diameter. The following steps are referred while designing storm water sewerage system:

- Determining of catchment area.
- Choose runoff coefficient.
- Compute intensity of rainfall and time of concentration.
- Calculate design flow.
- Design the sewer with self-cleansing velocity of 1m/s.

Whereby, sewage drainage system also known as sanitary sewerage system, as for the design of storm water drainage system. The design of sewage drainage system can be divided into two steps:

- Estimation of the amount of sewage.
- System design.

Parking areas must be properly sloped and drained to take care of runoff. Apply the following minimums:

- Ideal slope for all parking area pavements is 2%.
- Longitudinal pavement slope should be between 1%-5%.
- Pavement cross slope should be between 1%-10%.
- Storm water should be collected on the perimeter of parking areas with a minimum of 2% slope along concrete curb and gutter.

7. Vehicle parking space

In a station, the parking area space dimensions depend upon the size and type of a vehicle, larger vehicles such as buses or coaches occupy more. whereby, small vehicles like cars or motorcycle space is smaller. The vehicle allocated parking space in parking area is shown by painted lines (usually black and white or black and yellow) or Krebs referred to as borders between two adjacent vehicles. These Krebs are usually made of the following standard dimensions:

- Length: 50 – 60cm.
- Thickness: 20cm.
- Height: 10cm.

The painted lines in station increase safety, aesthetics, and control circulation. on other hand, they reduce jamming due to parking and movements inside the station.

8. Geometry of parking

Parking areas take on many configurations, Parking spaces may be parallel, perpendicular, or angled (30, 45, or 60 degree) to the driving lane, or aisle.

i) **30° angle parking**

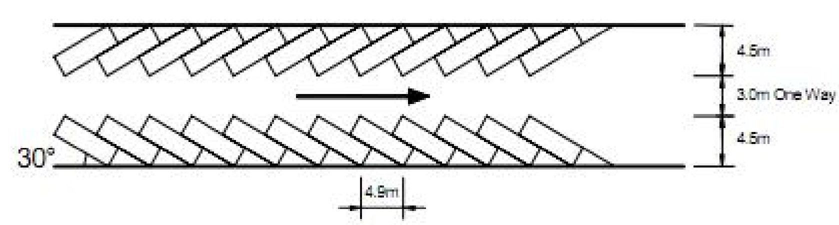


Figure 1: Layout of a 30° angle parking (Stockton-on-Tees, 2006)

Advantages:

● Easy parking.

● Reduced width requirements for layout.

Disadvantages

● It requires the most pavements per vehicle.

● It does not work well with two-way aisles.

ii) **45˚ angle parking**

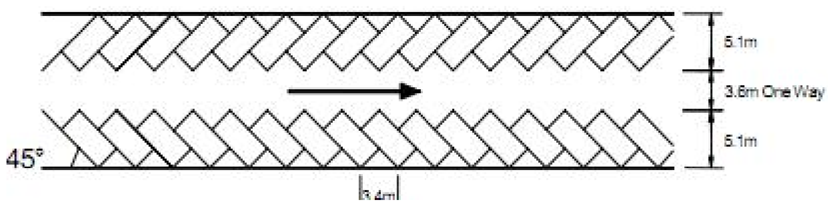


Figure 2: Layout of a 45˚ angle parking (Stockton-on-Tees, 2006)

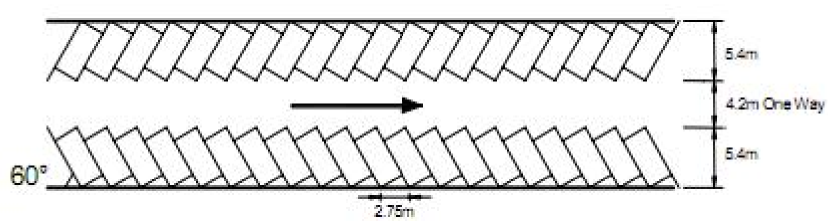
Advantages

- Reduced width requirements for layout
- Easy maneuvering in and out of parking spaces
- Good visibility to the rear

Disadvantages

- It does not work well with two-way aisles
- It requires more pavements per vehicle than perpendicular parking configuration

iii) 60˚ angle



parking

Figure 3: Layout of a 60˚ angle parking (Stockton-on-Tees, 2006)

Advantages

- Easy maneuvering in and out of parking spaces.
- Good visibility.
- Lends itself to either one-or two-way aisles.
- Most common short term parking configuration.

Disadvantages

- Requires more pavement per vehicle than perpendicular configuration.
- Handles less vehicles per linear meter.

iv) Right angle parking

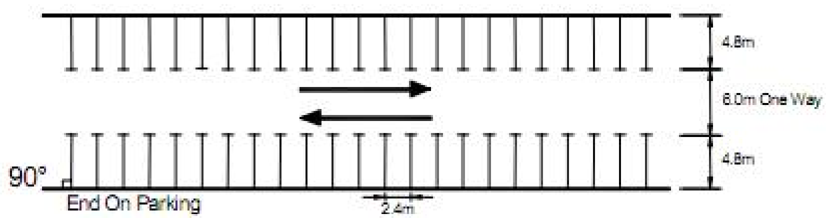


Figure 4: Layout of a right-angle parking (Stockton-on-Tees, 2006)

Advantages:

- Works well with either one- or two-way aisles.
- Handles the most vehicles per square meter of pavement.
- Handles most vehicles per linear meter.

Disadvantages

- Requires widest area.
- Difficult maneuvering for some drivers.
- Two-way traffic can create some visibility problems.

9. Design and location considerations of a bus station

Stations can function most effectively when supported by the appropriate land uses conductive to high levels of passenger activity. While other factors outside of the station operations (i.e operational capacity and network characteristics) also influence the functionality of a station. Ultimately, the location characteristics provide the key driver for passengers using the station.

The site-specific characteristics of a station location must be considered to create an attractive, seamless integration with the surrounding environment. And the location of a bus station may depend upon the following factors:

- ✓ Easy and convenient approach of passengers to the bus station.
- ✓ Nearness to the garages and workshops to minimize the dead kilometer.
- ✓ Cost of land in the area, where the bus station is to be built.
- ✓ Attractive and seamless integration with the surrounding environment.

Bus stations are typically located near arterial roads.

10. Facilities and amenities to passengers

Irrespective of the efficiency of bus services, passengers must wait for a more or less time at the bus station. On the other hand, the greater the operational disorder, the more will be the need for bus stations and various facilities and amenities therein. So, bus station facilities cannot be overlooked. Because, if passengers must wait at bus station, they need different facilities and amenities. (D KULSHRESTHA, 2010).

The amenities required depend upon the density of traffic generating at and passing through the bus station, toilets, lavatory blocks, shops and passenger shelters are essential.

Provision of different types of amenities and facilities at bus station is in fact, a social obligation, to make passengers' journey comfortable.

Some of these facilities and amenities are the following:

1. Shelter

A shelter is a structure provided at every bus station or bus stop serving as a weather protection to the passengers. its roofs should be such that rainwater is directed away for the vehicle side. A shelter generally services as a seat for waiting passengers.

Figure 5: Transit shelters

2. Public toilets and showers

Public toilets in such a public infrastructure is a very important facility for passengers or users of a station as well as showers should also be provided. toilets are used by many people a day, so they need to be always clean with availability of water.

3. Travel Shop

A travel shop provides timetable information and sells tickets for Express services.

4. Shops

The following range currently exists:

- Garage.
- Restaurants.
- Super Market, internet café, etc

There are some other facilities and amenities in bus station which should not be overlooked, because they also play a great role in serving passengers such as restaurants, offices, shops, Travel Information, etc.

5. Pavement structure and materials

6. Definition of pavement:

Pavement is the main structure and surface construction of road laid in courses of concrete stone or asphalt above a sub-grade. For the case of bus station to be designed, the pavement will be made of asphalt.

7. Types of pavements

AASHTO categorizes pavements into two groups according to their components and they are the following:

- ❖ Rigid pavement
- ❖ Flexible pavement

a) Rigid pavement:

This is the one in which Portland cement is as binding materials. The principle of Rigid Pavement is that it distributes the wheel loads by the beam action of the Portland Cement Concrete (PCC) slab, which is made of a material that has a high modulus of elasticity, on the order of 27.6 to 34.5 GPA. It distributes the wheel loads over a large area of the pavement, thus reducing the high stresses experienced at the surface of the pavement to a level that is acceptable to the sub-grade soil.

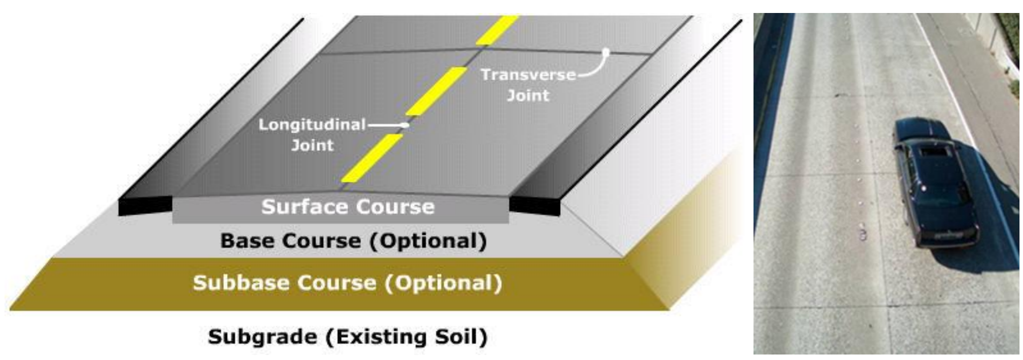


Figure 6: Rigid pavement layout

b) Flexible pavement:

This is the one in which bituminous is used as binding materials and is made generally by 4 layers. This type of pavement is cheaper than rigid one.

Flexible pavements are so named because the total pavement structure deflects, or flexes, under loading. A flexible pavement structure is typically composed of several layers of materials. Each layer receives loads from the above layer, spreads them out, and passes on these loads to the next layer below. Thus, the stresses will be reduced, which are maximum at the top layer and minimum on the top of sub grade.

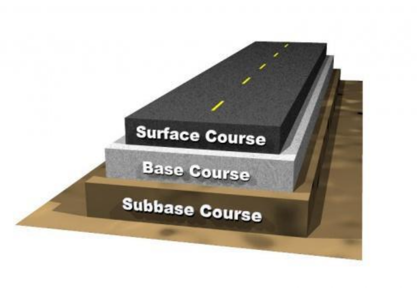


Figure 7: Basic flexible pavement structure.

8. Design procedures

For flexible pavements, structural design is mainly concerned with determining appropriate layer thickness and composition. The main design factors are stresses due to traffic load and temperature variations. There are two commonly methods used while designing a flexible pavement which are: Empirical design and mechanistic empirical design.

Empirical design: An empirical approach is one which is based on the results of experimentation or experience.

Mechanistic-Empirical Design

Empirical-Mechanistic method of design is based on the mechanics of materials that relates input, such as wheel load, to an output or pavement response (i.e. pavement reaction to loading).

The 1993 AASHTO *Guide* equation requires several inputs related to loads, pavement structure and sub-grade support. These inputs are:

The predicted loading. The predicted loading is simply the predicted number of 80KN The 1993 AASHTO Guide equation requires a number of inputs related to loads, pavement (18,000 lb.) ESALs that the pavement will experience over its design lifetime.

- **Reliability**. The reliability of the pavement design-performance process is the probability that a pavement section designed using the process will perform satisfactorily over the traffic and environmental conditions for the design period (AASHTO, 1993). The $\mathbf{Z_R}$
- **(**standard normal deviation) and $\mathbf{S_o}$**(**combined standard error of the traffic prediction and performance prediction) variables account for reliability.

- **Pavement structure**. The pavement structure is characterized by the Structural Number (SN). The Structural Number is an abstract number expressing the structural strength of a pavement required for given combinations of soil support (M_R), total traffic expressed in ESALs, terminal serviceability and environment.

The Structural Number is converted to actual layer thicknesses as it is used to calculate the layers thickness, so $\mathbf{SN=A_1D_1+A_2D_2M_2+A_3D_3M_3}$,using a layer coefficient (**A**) that represents the relative strength of the construction materials in that layer. Additionally, all layers below the HMA layer are assigned a drainage coefficient (**M**) that represents the relative loss of strength in a layer due to its drainage characteristics and the total time it is exposed to near-saturation moisture conditions and (**D)** which represent the thickness of each layer.

Generally, for quick-draining layers they can have coefficients as high as 1.4 while slow-draining layers can have drainage coefficients as low as 0.40. Keep in mind that a drainage coefficient is basically a way of making a specific layer thicker. If a fundamental drainage problem is suspected, thicker layers may only be of marginal benefit. A better solution is to address the actual drainage problem by using very dense layers (to minimize water infiltration) or providing a drainage system. Because of the peril associated with its use, often the drainage coefficient is neglected (i.e., set as m = 1.0).

- **Serviceable life**. The difference in present serviceability index (PSI) between construction and end-of-life is the serviceability life. The equation compares this to default values of 4.2 for the immediately-after-construction value and 1.5 for end-of-life (terminal serviceability Index). Typical values used now are:

Post-construction: 4.0 – 5.0 depends upon construction quality, smoothness, etc.
End-of-life (called “terminal serviceability”): 1.5 – 3.0 depending upon pavement use.

- **Sub-grade support**. Sub-grade support is characterized by the sub-grade's resilient modulus(M_R). Intuitively, the amount of structural support offered by the sub-grade should be a large factor in determining the required pavement structure.

The Structural Number determines the total number of ESALs that a particular pavement can support and determines what the 80KN (18,000 lb.) ESAL is for a given load. For that reason, it is the unknown in the design process using mechanical method.

This design process usually proceeds as follows:

1. Assume a structural number (SN) for ESAL calculations. Although often not overtly stated, a structural number must be assumed to calculate ESALs.
2. Determine the load equivalency factor (LEF). Typically, a standard set of load types is used (e.g., single unit trucks, tractor-trailer trucks and buses).
3. Estimate the traffic count for each load type for the entire design life of the pavement and multiply it by the calculated LEF to obtain the total number of ESALs expected over the design life of the pavement.
4. Determine and gather flexible pavement design inputs (Z_R, S_o, ΔPSI and M_R) as described above.
5. Check to see that the computed SN value is reasonably close to that assumed for ESAL using the design chart for flexible pavement.

After getting **SN,** it is required to replace its value in the layer thickness formula mentioned above so as to know their thicknesses’ last calculation we will do is to check the deformation which is based on comparing the N-life and the calculated standard axle load, if N-life is greater than the ESALS of our pavement, the bus station will satisfy its serviceability during its design period without deformation.

9. Pavement materials

a. Aggregate

"Aggregate" is a collective term for the mineral materials such as sand, gravel and crushed stone that are used with a binding medium (such as water, bitumen, Portland cement, lime, etc.) to form compound materials (such as asphalt concrete and Portland cement concrete).

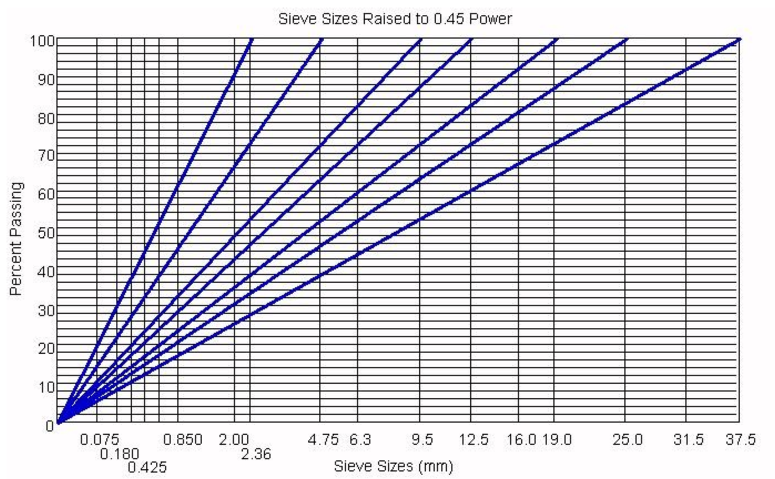


Figure 8: Graph showing sieve analysis

b. Asphalt

"Asphalt" is a dark brown to black, highly viscous, hydrocarbon produced from petroleum distillation residue. This distillation can occur naturally, resulting in asphalt lakes, or occur in a petroleum refinery using crude oil.

c. Portland Cement

Portland cement is the chief ingredient in cement paste – the binding agent in Portland cement concrete (PCC). It is a hydraulic cement that, when combined with water, hardens into a solid mass.

10. Circulation systems

In Stations/terminals, we may find the following different circulation systems: non – motorized vehicles (pedestrians, bicyclists) and motorized vehicles or simply automobiles. Each system requires different facilities and may serve a variety of roles depending upon the station location and program. A hierarchy shall be established for the various circulation systems that gives priority of access (including directness of route and proximity to the platforms) in the following order: (Design Criteria (Revision 0), July 2008)

- ❖ Pedestrians.
- ❖ Bicyclists.
- ❖ Feeder Buses (Fixed Route) and shuttles.
- ❖ Taxi and Automobile drop-off and pick-up facilities, including spaces for individuals with disabilities. Parking for disabled individuals shall be located closest to the platform access points; and
- ❖ Automobile park-and-ride facilities.

Recommended Circulation Systems Dimensions
(Design Criteria (Revision 0), July 2008)

Note: Dimensions are from curb to curb (in meters)

Bus Parking Area

- Single lane (one-way) 5.08m
- Entrance drive (two-way) 6.615m width
- Entrance drive (5 or more buses) 9.144m width
- Entrance radii @ intersection 7.62m min radius
- Turn-around 25.4m diameter
- Pullout 16.51m or bus length +3.048m deep

1:5 min. pull in taper; 1:2 min. pull out taper

Park-and-Ride Area

- Single lane (one-way) 4.064m
- Entrance drive (two-way) 7.112m width (single-lane, two-way)
  10.16m width (single-lane, with right turn-lane)
- Distribution aisles (two-way) 6.096m width

- Parking aisle (two-way) 6.096m width
- Parking space (90 degree) 2.28m wide x 4.572m to curb or as per jurisdictional guidelines

Drop-Off and Pick-Up Area

- Entrance drive 7.112m width (single-lane, two-way)
  10.16m width (single-lane, with right turn lane)
- Distribution aisle 6.096m width
- Parking aisle 6.096m width
- (Diagonal 60 degree) parking space 2.286m x 5.08m
- Curbside parking space 2.54m x5.588m

11. Vehicular entrances and exits

The location of entrances and exits at each station site shall be based upon the following factors:

- ✓ Projected traffic volumes, physical site conditions, land availability, the functional classification of adjacent roadways, and the location of traffic signals;
- ✓ Direct access to and from local residential streets shall be avoided, if possible;
- ✓ Entrance roadways shall be designed to contain sufficient traffic storage capacity to meet expected transit patronage at peak times and to prevent queues from extending onto public streets.
- ✓ Access to and from the station site onto more than one street is preferred.

III. CHAPTER THREE

0. **METHODOLOGY**

1. **Introduction**

This project is intended to design a bus station facility for motorized vehicles in Nyanza district, taking Busasamana Sector as the case study.

Two sessions such as data collection and data analysis will involve in carrying out this research. Firstly, data was collected through various survey methods and consultation of qualified key people from the Nyanza District in charge of infrastructure.

This chapter thoroughly explains the methodology used in order to achieve the research objectives.

2. **Description of the area of study**

Before detailing the methods used, it is useful to start by describing the area of study.The area of this study is located in Southern Province, Nyanza District, precisely in the heart of Busasamana Sector and is commonly known as Nyanza Town.

The area of this study covers the terrain between Rwanda Revenue Authority office and High court of the Republic and is situated along the asphalt road leading to Nyanza Prehistorically Museum at Rukali.

This area was chosen for terminal of motorized vehicles as it is situated in the heart of Nyanza town where the traffic movement is higher.

3. **Data collection**

Data collection with aid of some materials/equipment's

Using a GPS (Global Positioning System) device, we walked around the surface to be built and the area of study was found to be 9,902 square meters. The following table shows a list of data taken from site, and the figure shows the current site shape.

Table 1: GPS coordinates taken from the site

GPS COORDINATES **Date&time: Dec 06th, 2024 at 09 am.** **DISTRICT: NYANZA** **SECTOR: BUSASAMANA** **CELL: NYANZA** **VILLAGE: KAVUMU**			
NO	**X**	**Y**	**Z**
1	472173	4739447	1812
2	472211	4739414	1811
3	472254	4739396	1808
4	472260	4739417	1805
5	472265	4739437	1802
6	472248	4739459	1803
7	472240	4739471	1802
8	472234	4739495	1804
9	472232	4739521	1804
10	472241	4739548	1806
11	472234	4739553	1806

12	472218	4739543	1806
13	472184	4739566	1809
14	472162	4739467	1810

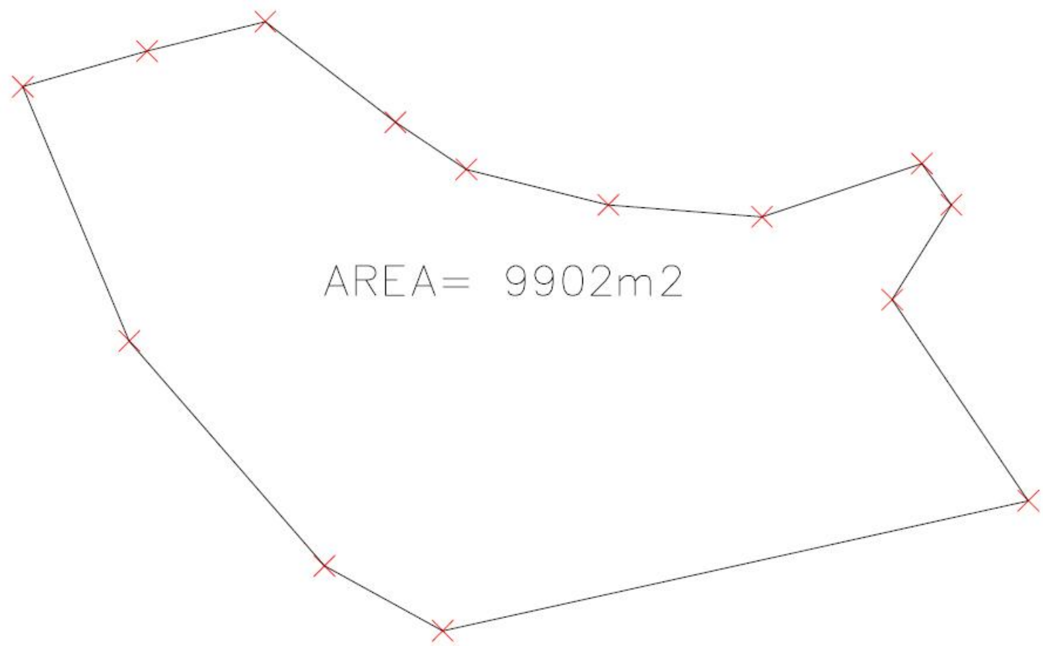


Figure 9: Shape of the ground to be built

A digital camera was also an equipment that we used during the visit and the following is one of the pictures taken showing the situation of the site:

Figure 10: Photo showing the site

- **Data collection by consultation**
- **Consultation from relevant Institutions**

This process was carried out in dealing with relevant institution, Nyanza District, whereby the district engineer and other staff in charge of infrastructures gave us the required information for this project which is normally in agenda of the district.

- **Consultation from motorization statistics**

As statistics stipulate it, vehicle ownership has dramatically increased in Rwanda. The table below shows the statistics of vehicles in Rwanda till August 2024.

Cars, minibuses, and buses play the key mode of public transport in Rwanda where the total number is 27,384 vehicles.

Table 2: Total Number of Different Types Vehicles till 2022 in Rwanda

(RRA 2012)

Vehicle Type	Number of Vehicles	Percentage
Car	21,422	**18.1%**
Pick up	13,834	**11.7%**
Jeep	15,254	**12.9%**
Minibus	5,451	**4.6%**
Bus	511	**0.4%**
Trucks	3,849	**3.2%**
Motorcycle	57,650	**48.6%**
Others	685	**0.6%**
Total	118,656	**100.0%**

- **Passenger inventory in public transportation mode**

General statistics show the number and distribution of different types of public transport vehicles and their relative passenger carrying capacities as demonstrated in **Table.3.** It is evident that minibus represents the most dominant mode of public transport vehicle with a total of 2,163 numbers of vehicles having 38,934 passenger carrying capacity, which represents a share of 54% of all public transport passengers. The Medium Buses are the next prominent mode having 588 numbers of vehicles and with a passenger capacity of **16,271**, i.e. **22.5%** of the total supply capacity.

The number of buses in Rwanda is still low, although they are better than Medium and mini-buses because of higher carrying capacity.

Table 3: Distribution of Passengers using private or public transport in Rwanda (MININFRA 2022)

Type of Vehicle/Operator	Company	Individual	Total	Percentage
Bus and Medium Bus for ONATRACOM	2,580	0	2,580	
Bus, Medium Bus and Mini-bus for Private Operators	18,197	39,590	57,787	
Total for Bus, Medium Bus and Mini-bus for all Operators	20,777	39,590	60,367	83.5%
Taxi Cab	844	1,444	2,288	3.2%
Motorbike	0	9,609	9,609	13.3%
Total for all vehicles	21,621	50,643	72,264	100.0%
Percentage	29.9%	70.1%	100.0%	

Table 4: Public Transport Vehicles and Their Passenger Carrying Capacity (MININFRA 2022)

Type of Vehicle /Operator	Number of Vehicle	Percentage of Vehicle	Passenger Capacity/ Vehicle	Total Passenger carrying Capacity	Percentage Of passenger Carrying capacity

Bus	110	0.8%	51 to 80	5,162	7.1%
Medium Bus	588	4.5%	25 to 33	16,271	22.5%
Mini-bus	2,163	16.6%	18	38,934	53.9%
Taxi Cab	579	4.4%	4	2,316	3.2%
Motorbike	9,609	73.6%	1	9,609	13.3%
Total for all Vehicles	13,049	100.0%		72,292	100.0%

- **Design of parking and its pavement**
- **Design of parking**

When designing the parking, below are some of the specifications we consider:

- ➢ Size of vehicles:
  - ✓ Size of taxi cab (small car): 1.90m x 4.2m;
  - ✓ Size of minibus: 2.00m x 4.60m;
  - ✓ Size of medium bus (coaster): 2.00m x 6.20m;
  - ✓ Size of bus (coach): 9.5m x 2.5m;
- ➢ Angle of parking lot: 45°;
- ➢ Width of access roads for circulation inside (1way including manoeuvring): 5.6m;
- ➢ Number of access roads: 9 roads.

- **Design of parking space lot:**

For our case, the bus station contains 3 kinds of parking space lots, and are the following:

4. **Parking space lot for buses**

One row is provided for large buses (coaches) at length of 54.77m and 11 lots corresponding to 11 buses.

Lot for 1 bus: length: 9.5m + 0.25 x 2 = 10.00m

Width: 2.5 + 0.25 x 2 = 3.00m

Area occupied by 1 bus = 10m x 3m = 30m^2

Total area occupied by 11buses = 30 x 11m = 330m^2

1. **Parking lot for medium and mini-buses**

Note: medium and mini-buses will use the same lots.

9 rows are provided to hold medium and mini-buses with 8 lots per row

Lot for 1medium/mini-bus: length: 6.20m + 2.50 x 2= 6.70m

Width: 2.00m x 2.5x2 = 2.5m

Area occupied by 1medium/mini-bus: 6.7 x 2.5m = 16.75m^2

number of buses per row : 8 buses

total number of buses per 9 rows = 9 x 8 = 72 buses

total area to be occupied by 72 buses = 72 x 16.75m2 = 2,414.16m^2

2. **Parking lot for taxi cab**

We provided 2rows of taxi cabs with 8 cars per row

Lot for 1car: length: 4.2 +0.25 x2 = 4.7m

Width: 1.9m +0.25x2 = 2.4m

Area occupied by 1car = 4.7m x 2.4m = 11.28m^2

Total number of cars in 2rows = 8 x 2 = 16cars

Total area occupied by cars in 2rows = 16x 11.28m^2= 180.48m^2

- **Design of pavement**

Determination of equivalent standard axle load

The pavement of the parking will be of type of flexible pavement; therefore, its design is the same as the design of flexible pavement.

According to the principles of pavement designs, the traffic count should be done a week,during 24 hours. Refering to the number of vehicless that can be in the parking when saturated and the schedule of travel in Nyanza, we use the following points to calculate repetition (reference to the current situation):

- 3 Travel agencies(volcano,horizon and RFTC)
- Each vehicleleaves in 30 min with passengers
- The count was done in 6 hours during peak day(work day,).

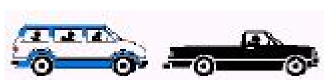
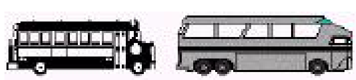
Federal Highway Administration (FHWA) provided the equivalent load factors to use while designing.it divides vehicles into thirteen (13) different classes as shown in Figure below. When ESALs are calculated, the effects of vehicle classes 1-3 (motorcycles, passenger cars and pickup trucks) are minimal since their axle loads are so light compared to the other vehicle classes. For example, one tractor semi-trailer combination is equivalent to about 2.0 ESALs and one passenger car.

Table 5: Table showing Equivalent Axle Load Factor

Vehicle type FHWA	Class	Flexible EALF	Rigid EALF
Cars and Motorcycles	1,2	0.001	0.001
Pickups, Panel Vans	3	0.004	0.005
Buses	4	0.300	0.300
2-axles, 6-tire Singles	5	0.170	0.170

3-axles or more Singles	6, 7	0.700	1.000
4-axles Combos	8	0.700	0.780
5-axles or more Combos	9-11	1.100	1.780

<u>Table 6</u>: The tabulated calculations:

Vehicle type	**Class**	**Repetitions**	**Flexible EALF**	**ESALS(W_{18})**
Light traffic vehicles 	2	764	0.001	0.764
Panel vans 	3	6912	0.004	27.648
Buses 	4	528	0.300	158.4
				SUM: 186.812ESAL$_S$

Therefore, the total Equivalent standard Axle Load on that segment of the Road is equal to 186.812 ESAL (W_{18}) as an average daily.

For the design life, as our segment can be considered as urban Streets Roads then the design life shall be25 years**: 186.812*365*25=1,704,659.5≈2millions ESAL$_S$ (W_{18})**

- **DETERMINATION OF OTHER DESIGN PARAMETERS**
  - **Modulus of resilience**

Definition: It is the ratio of the force per unit area required to penetrate a soil with 3 standard circular pistons at the rate of 1.25 mm/min to that required for corresponding penetration of standard material.

The effect of changes in moisture content on the strength/stiffness of the sub-grade shall be taken into account by evaluating the design sub-grade strength parameters (i.e. CBR of modulus) at the equilibrium moisture content likely to occur during the design life, i.e. The Design Moisture Content. The provision of subsurface drainage may, under certain circumstances, allow a lower Design Moisture Content, and hence generally higher Design CBR.
For our case we did not have the opportunities of getting soil sample for calculating the CBR. But the district gave us the bearing capacity of the soil from where we are doing the study which is equal to **2500KN/m²**,therefore from the knowledge we have in soil mechanics the more the soil is hard the greater the CBR and as the bearing capacity is high we assume CBR to be 10.The selection was done based on the table below:

Table 7: Table showing Modulus of Resilience

Classification	CBR	M_R (psi)	Typical Description
Good	≥ 10	20,000	Gravels, crushed stone and sandy soils. GW, GP, GM, SW, SP, SM soils are often in this category.
Fair	5 – 9	10,000	Clayey gravel and clayey sand, fine silt soils. GM, GC, SM, SC soils are often in this category.
Poor	3 – 5	5,000	Fine silty sands, clays, silts, organic soils. CL, CH, ML, MH, CM, OL, OH soils are often in this category.

Another method used to find the value of M_R is to use the formula where MR=1,500*CBR,from there **MR=1500*10 =15,000 psi.**

- The standard deviation is assumed to be 0.4.

For simple determination of SN from design chart we need to name the category of pavement for easy assumption of reliability(R)

- Reliability R (%) for urban divided primary Route is equal to 90%;
- Present serviceability index (PSI) equal to 4.2 and terminal serviceability index (TSI) equal to 1.9 for urban divided primary Route. Therefore, loss of serviceability (ΔPSI) = PSI – TSI.

Therefore(ΔPSI) = 4.2-1.9=2.3

By plotting all these value on the chart, we get the value of the overall thickness index or the structure number (SN) equals to 3 **(Appendix 1)**

- **Pavement thickness determination**

So having the structure number equal to 3 we find the thickness of the pavement and material made it by replacing in the equation, $\mathbf{SN = a_1 D_1 + a_2 D_2 M_2 + a_3 D_3 M_3}$.

Where:

❖ a_1, a_2, and a_3 are structural-layer coefficients of the wearing surface, base and sub-base. The coefficients will depend on the type of the material that will be used during construction work. In our project we have decided to use:

- ✓ Wearing layer: hot mix asphalt concrete, a_1=0.44.
- ✓ Base layer: dense graded crushed stone because its drainage and bearing capacity, which is high, a_2=0.18.
- ✓ Sub-base layer: crushed stone, which is commonly used, and which is good, a_3=0.11

❖ Layers, D_1, D_2, and D_3 = thickness of the wearing surface, base, and sub-base layers in inches, respectively.

❖ M_2 and M_3= drainage coefficients for the base and sub-base, respectively. Therefore, M_2 and M_3will take the value of 1.0 for a material with a good drainage characteristic for example a sandy material.

Thickness of layer will depend to the designed ESAL$_S$.

Table 8: Pavement Layer

Design Traffic (ESAL'S)	Sub-base (mm)	Base (mm)
<1 x 10^5	125	125
>1 x 10^5<2 x 10^5	125	125
>2 x 10^5	150	150

Let replace all values in the equation of SN to find the thickness of the wearing layer:

$3=0.44*D_1+0.18*125*1.0+0.11*125*1.0$
125mm=4.92inch

Therefore $D_1= \frac{3-[(0.18*4.92)+(0.11*4.92)]}{0.44} = 3.57$ inch
=3.57*2.54=8.89cm
$D_1 \approx 9$cm
$D_2=12.5$cm
$D_3=12.5$cm

IV. CHAPTER FOUR

0. RESULTS AND INTERPRETATION OF DATA

1. **Introduction**

After gathering data needed, they were thoroughly analyzed using various means in order to get a meaningful and understandable information for the study.

The site visit we made, enabled us to get the useful information about the region in general and specifically the site, namely the geography conditions as well as the usage of existing parking modes by different agencies and their locations in Nyanza town.

Therefore, this chapter discusses the findings of the present study.

2. **Dimensions and angle of parking lot**

Among many different types of parking geometry (30º, 45º, 60º and 90º), for our case we chose 45º as the angle of parking for its advantages to hold many vehicles and easy maneuvering. There are also different stall dimensions according to the type of vehicle as shown below:

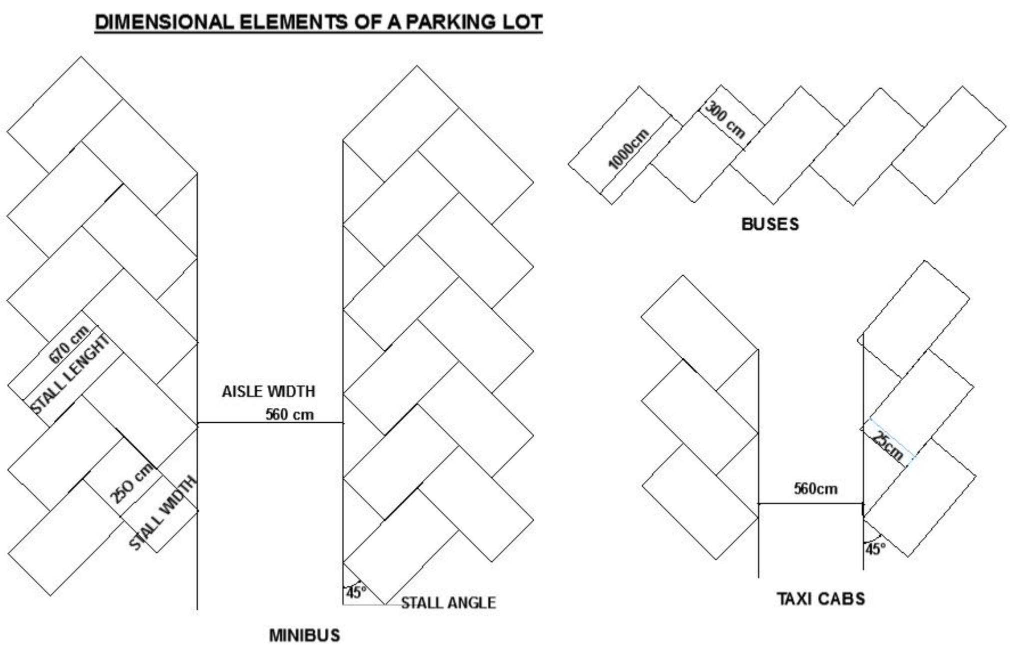


Figure 11: dimensional elements of a parking lot

3. **Parking space inventory**

The demand or the number of motorized vehicles which are supposed to be held in the bus stations **99 vehicles** and the total area to be used by vehicles for parking, loading and unloading as well as maneuvering will be **2,924.64 square meters**. The following table and chart show the details:

Table 9: Parking demand

s/n	**Type of vehicle**	**Number of vehicles**	**Area occupied by vehicles (m^2)**
1	Buses	11	330
2	Medium/mini-buses	72	2,414.16
3	Taxi cabs	16	180.48
TOTAL		**99**	**2,924.64**

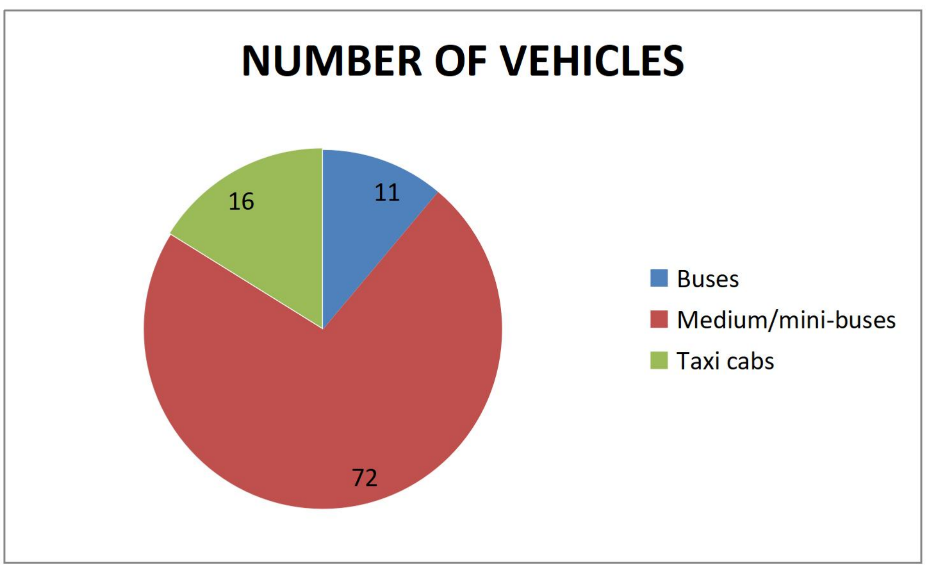


Figure 12: bus station capacity demand

4. **Thickness of pavement area**

After designing the pavement of the parking area of the study, layer thicknesses are
The figure below shows the layer thicknesses of the designed pavement of parking area:

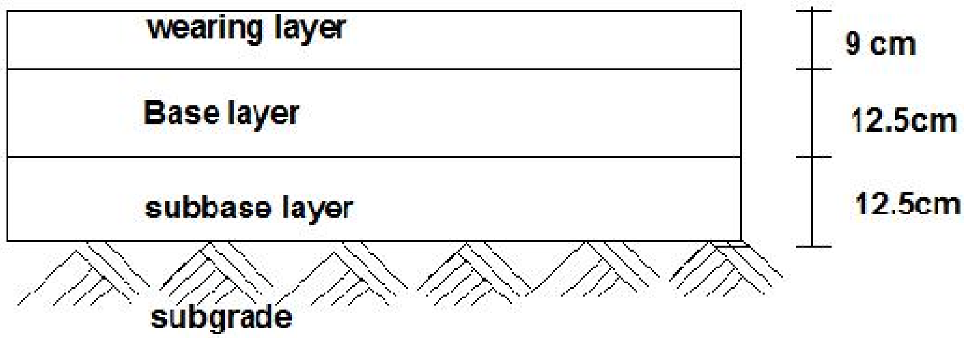


Figure 13: typical flexible pavement thickness

- **Wearing course:**

This is the uppermost layer of the parking pavement structure which directly receives and assaults the traffic load. Material for this course consists of asphalt concrete, a mixture of bitumen binder with a series of fine graded aggregates.

- **Base course**

The base course is the layer directly located above the sub-base course, its role is to resist the vertical forces received from the wearing course and dismiss the resulting pressures on the pavement support. The base layer is made of better calibrated materials.

- **Subbase course**

The sub-base is a load spreading layer directly laid on the sub grade to improve drainage reduces stress in sub grade and prevents mud entering the road structure. These functions are well fulfilled if conditions are too wet. If the sub-base becomes saturated it can no longer spread the wheel load in a correct manner down to the underlying sub grade.
Sub-base materials may consist of naturally occurring coarse-graded soils (late-rites) or blended and processed soils.

5. **The inventory of vehicles for usage in public transportation in Rwanda**

There are different types of vehicles specifically for use in public transportation, namely passenger vehicles. According to the carrying capacity, in Rwanda we have large buses (51 – 80 people), medium buses (25-33 people), Minibus (18people), taxi cabs (4people) and motor bikes carrying 1person, the following table and chart show the total number of people using public transportation mode in Rwanda.

Table 10: vehicle types and their passenger carrying capacity

Type of Vehicle	**Number of Vehicle**	**Total Passenger carrying Capacity**	**Percentage Of passenger Carrying capacity**
Bus	110	5,162	7.1%
Medium Bus	588	16,271	22.5%
Mini-bus	2,163	38,934	53.9%
Taxi Cab	579	2,316	3.2%
Motorbike	9,609	9,609	13.3%
Total for all Vehicles	**13,049**	**72,292**	**100.0%**

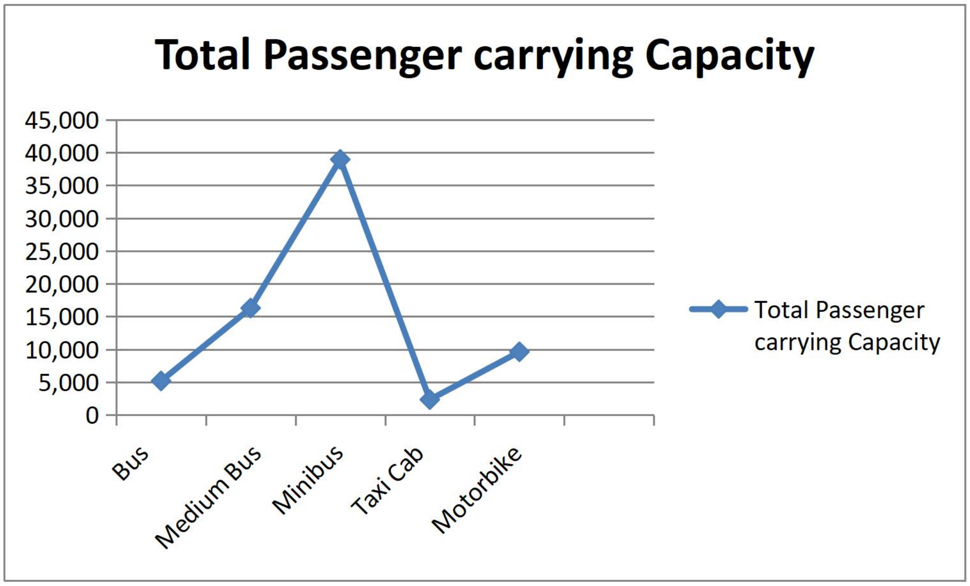


Figure 14: chart showing passenger carrying capacity relative to type of vehicle

V. CHAPTER FIVE

1. CONCLUSION

The study of the bus station was done in the area where there is lack of parking area, the followings are problems to which this project will be as remedy:

- People get lost while searching where their destination travel agency.
- The public transportation is not controlled.
- It causes the disorder in Nyanza town because the travel agencies situate at different location and vehicles parks anywhere so we can have some accidents and pollution of the area.
- People waste a time in waiting the vehicles when in crossing and parking in un located places, this also generates traffic jam.

During this study we suggest using the bus station which benefits from its layout where all parking spaces are closely located to make easy found for passengers.

2. RECOMMENDATIONS

- The bus station is the costly public infrastructures, according to its usage, the institutions which oversee management should collaborate with the users to take care of it, by directing every type of vehicles in their expected places.
- It is not designed for private business but public transportation.
- Based on the work we have done; we proposed the design for parking lot and its pavement; therefore, the design must be followed in order to guarantee its stability (i.e. thickness of layers of pavement and dimension of parking)
- The facilities that make it comfortable for everyone using the bus station must be available; these are like shops, restaurant, public toilets, and others as located on the proposed drawing. Finally parking areas must have the required slope and drainage to facilitate the runoff.
- The recommendation to district is to perform a regular assessment and cleaning for the bus station last long for designed period.References

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APPENDICES

- **APPENDIX 1: BILL OF QUANTITY OF A BUILDING AND THE FLEXIBLE PAVEMENT FOR PARKING AREA**

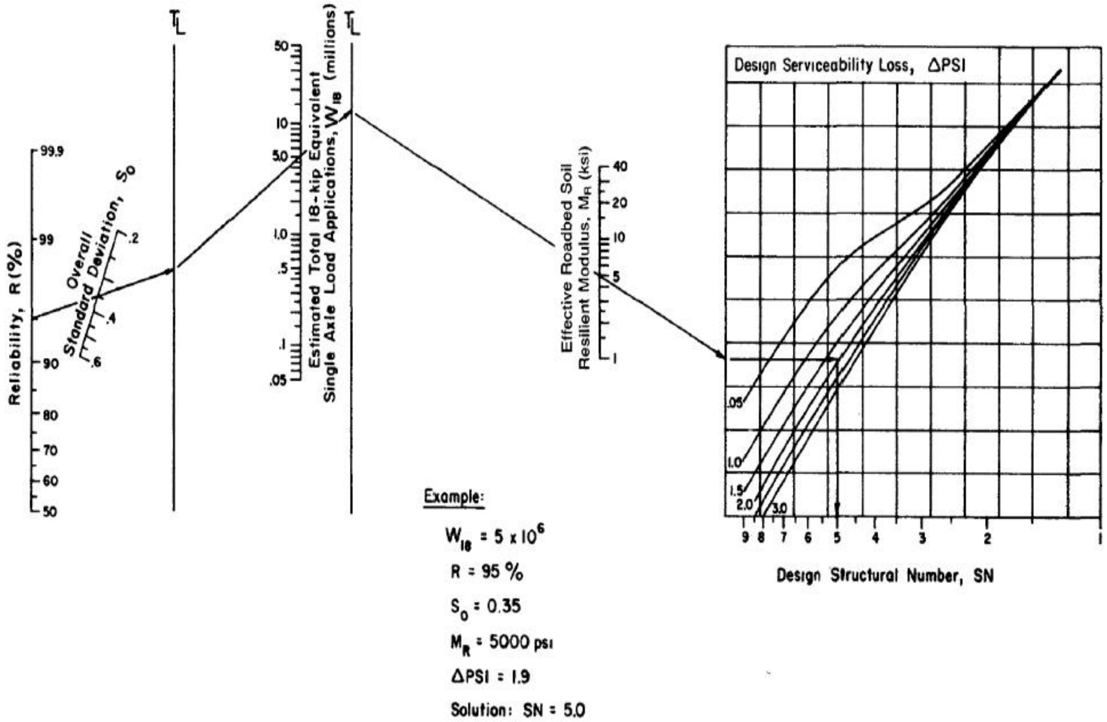
No of item	DESCRIPTION	UNIT	QUANTITY	EXPLANATION	
			A. BUILDING		
I	**EARTHWORK CALCULATIONS:**				
I.1	20cm wall	m^3	288.4		
I.2	10cm wall	m^3	14.4		
	Sub - total		**302.8**		
II	**FOUNDATION**				
II.1	20cm wall	m^3	288.4		
II.2	10cm wall	m^3	14.4		
	Sub - total		**302.8**		
III	**DPC**				
III.1	20cm wall	m	600.83		
III.2	10cm wall	m	95.84		
	Sub - total		**696.7**		
IV	**SUPERSTRUCTURE (BRICKWORK)**				
IV.1	20cm wall	m^3	343.63	**mix ratio: 1:6**	
IV.2	10cm wall	m^3	21.084	**20cm WALL: (block size: 40x20x30cm)**	**10cm WALL: (brick size: 21x10x7cm)**
IV.3	Parapet wall (20cm thick)	m^3	36.192	number of blocks=**19926 Cement Blocks**	number of bricks=**11980 Bricks**
IV.4	front upper wall (20cm thick)	m^3	126.67	Cement = 1*28.294*1440/6 *50 = 136 **bags of cement**	Cement = 1*3.473*1440/6*50 = **17 bags of cement**
	Total brickwork in superstructure		**527.6**	**Sand =** 6*28.294/6 =	**Sand =** 6*3.473/6 = 3.473m^3 **of sand**

				28.294**m^3 of sand**	
V	**REINFORCED CONCRETE STRUCTURE**				
V.1	Column: C1 (77 columns)	m^3	8.624	C1: Rectangular shaped inside the building	**<u>Mix ratio: 1:2:4</u>**
V.2	C2 (33 columns)	m^3	2.9014	C2: Circular shaped column for barza	Cement = 1*1.92*63.907*1440 / 7*50 = **400 bags of cement**
V.3	Lintel	m^3	24.545		
	Tie beam	m^3	24.545		
V.4	SUB-COLUMN: SB/C1	m^3	2.464	SB/C1: Sub/column of rectangular shape	Sand = 2*1.52*63.907/7 = **27.75m^3**
V.5	SUB-COLUMN: SB/C2	m^3	0.828	SB/C2: Sub/column of circular shape	Gravel = 4*1.52*63.907/7 = **55.58m^3**
	Sub - total		**63.91**		
VI	**ROOF STRUCTURE**				
VI.1	Purlins (40X40X3mm)	pcs	130		
VI.2	Rafters (60x40x3mm)	pcs	50		
VI.3	Tie beam (1) (60x40x3mm)	pcs	34		
VI.4	Tie beam (2) (60x40x3mm)	pcs	8		
VI.5	King post (60x40x3mm)	pcs	50		
VI.6	Queen post (1) (60x40x3mm)	pcs	50		
VI.7	Queen post (2) (60x40x3mm)	pcs	50		
VI.8	Diagonals (1)	pcs	50		
VI.9	Diagonals (2)	pcs	50		
VII	**ROOF COVERING**				
VII.1	Iron sheets (630x90cm)	pcs	180		
VII.2	Iron sheets (200x90cm)	pcs	188		
VII.3	Ridge cover	m	30		
VIII	**OPENINGS**				
VIII.1	Doors: D1 (180x240cm)	pcs	23		
VIII.2	D2 (170x240cm)	pcs	7		
VIII.3	D3 (90x210cm)	pcs	8		

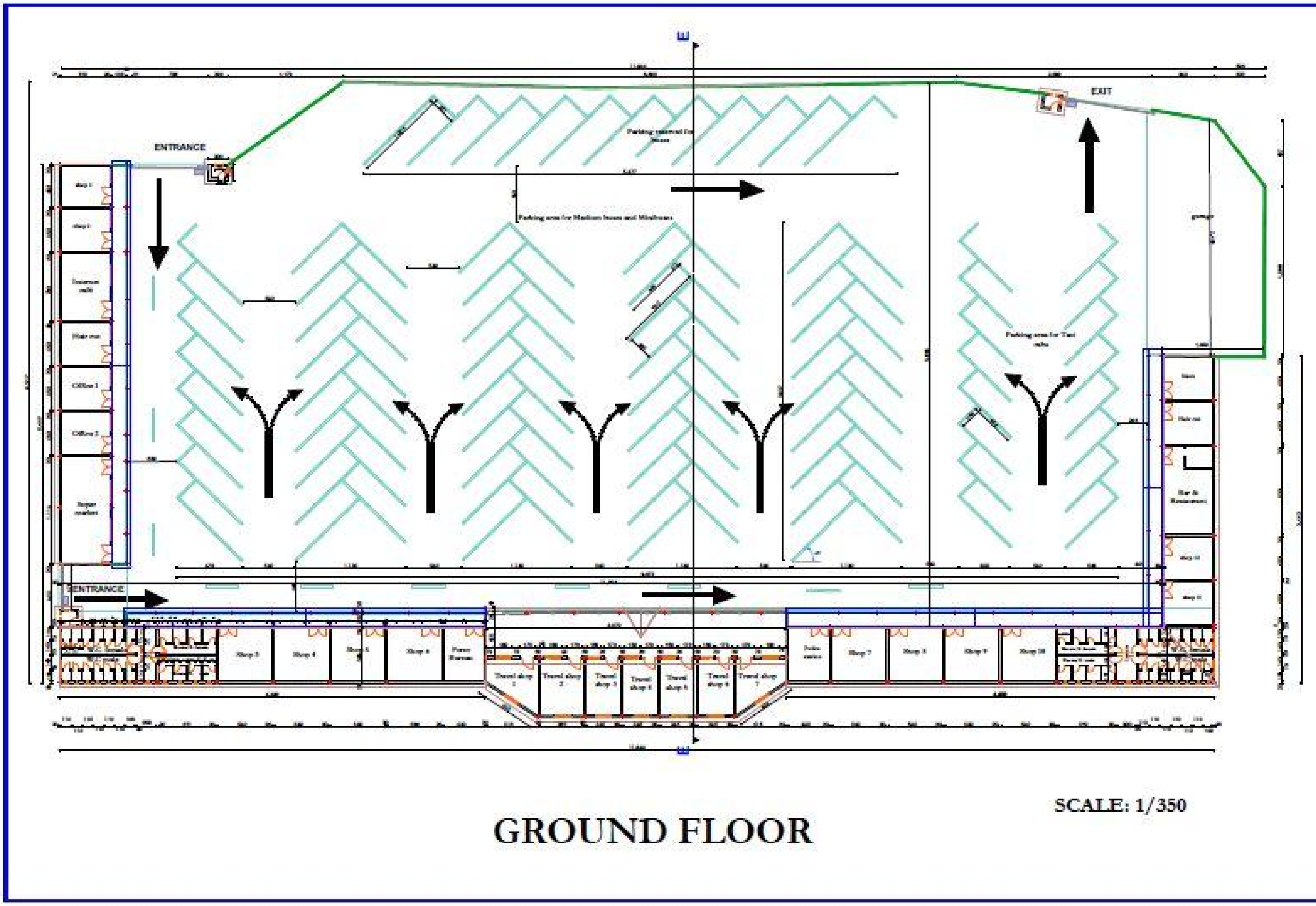
VIII.4	windows: W1 (200x180cm)	pcs	20	
VIII.5	W2(200x250cm)	pcs	11	
VIII.6	W3 (170x180cm)	pcs	7	
VIII.7	W4 (140x70cm)	pcs	2	
VIII.8	W5 (70x50cm	pcs	37	
VIII.9	W6 (40x200cm)	pcs	4	
IX	**PLASTERING**	m^2	4539.8	**<u>Mix ratio: 1:5</u>** **Volume of plaster = 136.135m³** cement = 1*136.135*1440/5*50 = **785 bags** Sand = 5*136.135/5 = **136.135m³**
X	**PAINTING**	m^2	4481.1	
XI	**FLOORING**			
XI.1	Tiling	m^2	1024.8	
XII	**CEILING**	m^2	1024.8	
XIII	**ELECTRICITY**			
XIII.1	Pipes 3/4	pcs	175	
XIII.2	wires VOB 2.5mm²	Rlx	40	
XIII.3	Wires VOB 1.5mm²	Rlx	40	
XIII.4	Florescent Lamps	pcs	96	
XIII.5	circuit breakers	pcs	10	
XIII.6	Sockets	pcs	80	
XIII.7	Switches	pcs	48	
XIII.8	Switches box	pcs	48	
XIII.9	Junction box	pcs	145	
XIV	**SANITATION**			
XIV.1	Water closets	pcs	28	
XIV.2	shower tray	pcs	16	
XIV.3	urinal	pcs	8	
XIV.4	wash basins	pcs	22	
XIV.5	septic tank	pcs	2	plastic tankS
XIV.6	pit (50m)	pcs	2	
XV	**FENCING**			
XV.1	Earthwork calculations:	m^3	70.828	
XV.2	Foundation	m^3	70.828	
XV.3	Wall elevation	m^3	12.956	
XV.4	Metal bars: 1st bars	pcs	615	1st bar= long bars (120cm height)

XV.5	2nd bars	pcs	615	2nd bar= short bars (60cm height)
XV.6	Access barrier	pcs	3	gate barrier (700cm long)
XVI	**SECURITY HOUSE**			
XVII. 1	Earthwork calculations:	m^3	4.8	
XVII. 2	Foundation	m^3	4.8	
XVII. 3	DPC	m^2	9.6	
XVII. 4	Wall elevation	m^3	10.32	
XVII. 5	Metal sheets (260*90cm)	pcs	3	
XVII. 6	Purlins (40X40X3mm)	pcs	3	
XVII. 7	Rafters (60x40x3mm)	pcs	3	
XVII	**CURBS**			
XVII. 1	Concrete curbs (120*20*20cm)	pcs	703	
	B. FLEXIBLE PAVEMENT FOR PARKING AREA			
XVIII	Wearing course (9cm thick)	m^3	550.5	HMA = 6% of total volume of dry aggregate **HMA = 33.06m^3**
XIX	Base layer (12.5cm thick)	m^3	764.58	
XX	Subbase layer (12.5cm thick)	m^3	764.58	

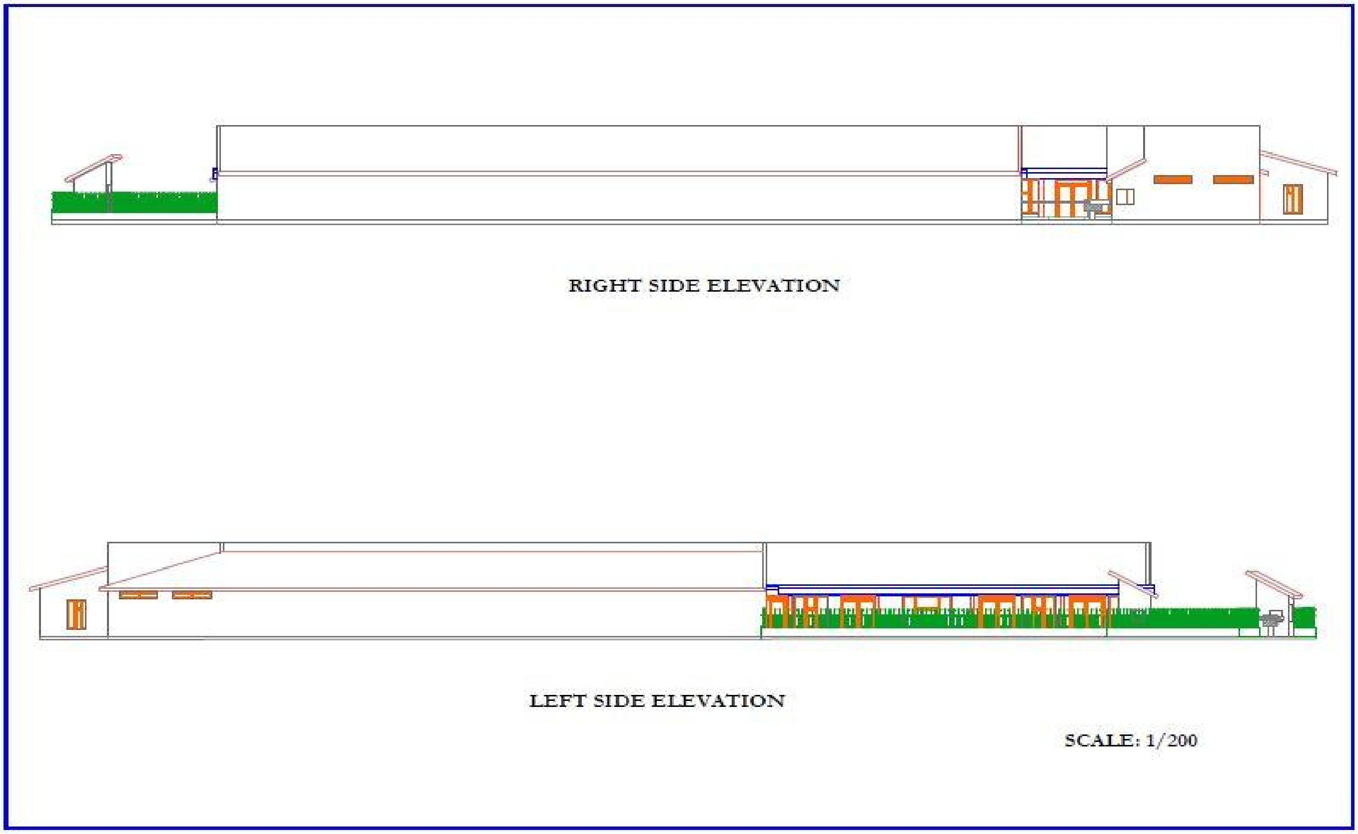
- **APPENDIX 2: CHART SHOWING THE DETERMINATION OF SN**



- **APPENDIX 3: FLOOR PLAN OF THE DESIGNED BUS STATION**



- **APPENDIX 4: SIDE ELEVATION OF THE DESIGNED BUS STATION**



- **APPENDIX 5: SECTIONS BB AND EE**