Development of Bus Port

at

Ramnagar, Uttarakhand

Final Detailed Project Report

October, 2020

A Joint Venture of The Government of National Capital Territory of Delhi & The IDFC Foundation.
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CHAPTER 1

Introduction

1. Introduction

1.1. Background

1.1.1. Brief Profile of Ramnagar

Ramnagar is a small town and a municipal board in the Nainital district of Uttarakhand, India. It is located at 29.40°N 79.12°E which is approximately 65 kilometres from Nainital, the headquarters of the district.

Ramnagar is the gateway to the Corbett National Park, the oldest national park and a famous tourist destination of India. Other tourist destinations namely Garjiya Devi Temple and Sitabani temple, Sitabani Wildlife Reserve located nearby also attracts many visitors.

Ramnagar is located at the foothills of the Himalayas on the bank of river Kosi and its proximity to Nainital, which is a famous hill station of Northern India. Ramnagar is the gateway to western Kumaon and Garhwal. It is also the commencement point of Kumaon Hills with the nearby town of Haldwani. Ramnagar is famous for International "Litchi farming".

Figure 1-1: Ramnagar City in Uttarakhand

a) Demographic Profile

In the city, the population growth was 23.94% and 18.57% in the period 1991-2001 and 2001-2011 respectively whereas Nainital district population growth

was 32.73% and 25.13% in the period 1991-2001 and 2001-2011 respectively. The population of Ramnagar city as per the 2011 census stood at 54,787.

Table 1-1: Population

Year	Population
2001	46,205
2011	54,787

b) Connectivity

Ramnagar is one of the major tourist attractions of Uttarakhand adding to the economic growth of Uttarakhand. Ramnagar is conveniently connected by road and railways. The brief of the linkages are as follows:

Road Links	Existing Ramnagar bus station (proposed site of the bus port) is located near to the Railway station. There are regular buses connecting Ramnagar to Nainital, Ranikhet, Haldwani, Haridwar, Dehradun, Kashipur, Moradabad , Meerut, Jaipur and Delhi. National Highway 309 which starts from Kashipur and ends at Bubakhal, Uttarakhand passes through Ramnagar.
Rail Linkages	Ramnagar railway station is under the administrative control of the Izzatnagar division of the North Eastern Railway zone of the Indian Railways. The station is located about 65 km from Nainital having 2 platforms. It has direct rail links to Kashipur, Moradabad, Haldwani, Delhi, Bareilly, Lucknow, Haridwar, Chandigarh, Gurgaon, Mumbai, Agra, Jaisalmer and Varanasi. A total of 11 trains originate/terminate at Ramnagar.
Air Linkages	The nearest operational airport from Ramnagar is located at a distance of 65 km at Pantnagar.

c) Economy

The economy of Ramnagar is primarily based on agriculture along with tourism and allied activities. The Corbett National Park established in 1936 is the oldest and most sought after national park in India. It is the only national park to come under Project tiger.

The tourism potential of the Corbett National Park has begun to be realized in recent decades with the opening of many luxury resorts and the leisure seeking tourists from Delhi and across the country visiting the national park in large numbers. This has resulted in a spurt of economic activity and employment of the local populace in various tourism related activities.

d) Industries

There is negligible industrial activity in Ramnagar due to its location in forest area and applicability of stringent environmental laws. Most of the industries find presence in the nearby cities of Rudrapur, Haldwani, Rampur and Pantnagar.

1.1.2. Objective

The Uttarakhand Transport Corporation ("Project Proponent" or "Authority") proposes to develop a modern Bus Port at Ramnagar to provide better passenger amenities to the general public and to exploit the commercial potential of the site and has sought assistance from Ministry of Road Transport & Highways (MoRTH) under the scheme for "Development of Bus Ports in India under BoT/HAM basis". MoRTH has appointed National Highways Infrastructure Development Corporation (NHIDCL) as a central execution agency for the scheme.

The scope of work of the study broadly included the following:

a) Defining Project Scope
b) Facility Area Planning
c) Estimation of Project Cost
d) Project Revenue and Operations & Maintenance (O&M) Cost Estimation
e) Project Implementation Structure

1.2. Site Appreciation

1.2.1. Location

The bus port site is situated at $29^0$23'47.3"N $79^0$07'32.5"E in Ramnagar, Uttarakhand. It is located within the Kosi Forest Range, Ramnagar Reserve Block.

The existing bus stand is proposed to be redeveloped into a modern bus port. The site is adjacent to NH 309 and the development around the site is a mix of residential and commercial development.

Figure 1-2: Ramnagar Bus Port Site Location

In addition to the aforementioned area, an area of 0.06 acres is additionally provided to be used for exit of buses and other vehicles.

1.2.2. Topographic Survey Map

The topographic survey map of the site is attached as Annexure 1 and a snapshot is shown below.

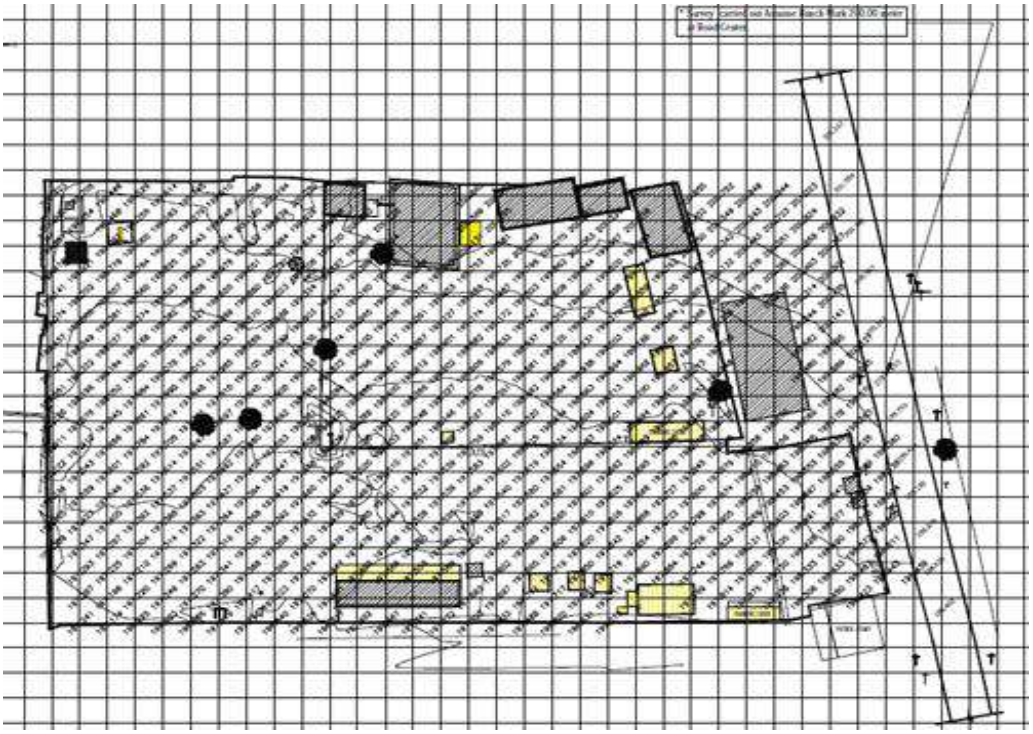


Figure 1-3: Topographic Map

The site photographs are attached as Annexure 2.

1.2.3. Land Use

Two land parcels were leased to Uttarakhand Transport Corporation (UTC) for development of Bus Port.

- Area of 0.5050 hectares leased on August, 2000 for 30 years; and
- Area of 0.6230 hectares leased on June, 2006 for 30 years.

The land use of the site is “Forest”.

1.2.4. Geotechnical Surveys

The geotechnical survey was undertaken and the report is attached as Annexure 3.

1.2.5. Development Challenges

Following challenges are envisaged for the development of the Bus Port at the proposed site:

- The site is on forest land.
- The land can only be used for the purpose of development of bus station.
- The land cannot be transferred to any third party or department or person.
- Applicability of development norms and clearances is not clear.

1.3. Proposed Bus Port Infrastructure

The Ramnagar Bus Port is designed to be a modern public transport hub catering to enhance the comfort and experiences of the users. The objective of designing such a modern Bus Port is to improve the image of the bus based public transport system. The following considerations regarding infrastructure facilities may be incorporated in the Bus Port design.

A. Information Dissemination
   a) Digital Display Board
   b) Public Address System
   c) Clock
   d) Bus Port Smartphone app
   e) Help Me Kiosk
   f) Real time Information Display
   g) Train and Flight Info Display
B. Customer Interface
   a) Tourist Information Centre
   b) Grievance Handling

c) Public Relation Office

C. Facilities
   a) Parcel & Cloak Room
   b) Concourse Area
   c) Toilets
   d) Drinking water fountains
   e) Mother & Baby Care room
   f) Trolleys/ porter
   g) Travel desk – Auto/ Taxi prepaid counter, Railway/ Flight ticket booking counter
   h) Mobile Helper – Assistance on the move
   i) Special Assistance Booth for elderly and differently abled
   j) Parking - Car & Two-wheeler, Auto rickshaw and NMT Parking Area
   k) High-quality Stainless-Steel Seating
   l) Furnished waiting halls (General, Ladies, Premium and Deluxe (Paid))
   m) Dormitories
   n) Lost and Found room

D. Value Added Services
   a) Television, Wi-Fi access, Mobile charging points at suitable places
   b) Food Court
   c) Kids Activity Area
   d) ATMs
   e) Hotel Reservation Counter
   f) Lounge bar and Smoking Room
   g) Freshen up & go - Time capsules
   h) Dust Suppression System
   i) GPS tagging on luggage & children for tracking
   j) Pharmacy and First Aid Centre

1.4. Revisions in the Final DPR

Based on the discussions with NHIDCL officials, the following revisions are made in this report.

a) The concept design is revised and financial viability assessment is undertaken for the revised design.
b) CPWD Plinth Area Rates, 2020 are used in place of CPWD Plinth Area Rates, 2019 for estimating cost.
c) The road pavement is changed from RCC to WMM and bituminous top.
d) The annual concession payment paid by the developer to the Government Authority is not considered.

CHAPTER 2

Planning Norms

2. Planning Norms

The Uttarakhand Building Bye Laws and Regulations (UBBLR), 2011 (Amendment 2016) govern the development of residential, commercial and institutional infrastructure in Uttarakhand. This chapter presents the applicable development regulations as specified in the UBBLR relevant to the planning of the facilities proposed to be developed on the Bus Port site.

The UBBLR does not define norms and planning parameters for a Transport Terminal, so, norms and regulations for commercial building has been considered for development of Bus port.

The brief of development control norms as per UBBLR for the proposed Bus Port are presented in this section. As per UTC, these would be applicable for the project.

2.1. Area Classification

As per UBBLR, following are the correlation of area per geographical region

a) Area Hills: Hill area villages as per revenue records:

i. Entire area falling Under Pithoragarh, Almora, Bagheswar, Chamoli, Uttarkashi, Tehri and Rudera pragyag districts
ii. Old Chakrata, tehsil and Mussorrie, sub division of Dehradun district
iii. Nainital tehsil, Koshiya Katauli tehsil and Dhari tehsil of Nainital district
iv. Entire area of Champawat district except Tanakpur municipal area and entire area of Pauri district except Kotdwar municipal area and entire area of Ramnagar tehsil from Ramnagar northern municipal limits towards north.

b) Area Plains: Remaining part of the state in addition to the above-mentioned hill stations

2.2. Site Development Parameters for Commercial Buildings

The site development parameters for commercial buildings are tabulated below.

Table 2-1: Site Development Parameters for Commercial Building

SN	Type of Building/Projects	Minimum Right of Way in meters		Remarks
		Plain area	Hills area	
1	Commercial /Offices Spaces-Individual site less than 100 sqm	As approved by competent authority keeping in view the site conditions		
2	>100-200 sqm	9.00	4.30	
3	>200-500 sqm	12.00	6.00	In case of hardship the competent authority may reduce it by 1.0m meter with

SN	Type of Building/Projects	Minimum Right of Way in meters		Remarks
		Plain area	Hills area	
				100% parking within the plot
4	>500-1000 sqm	15.00	7.50	Parking provision shall be made within the plot
5	>1000 sqm	18.00	9.00	Parking provision shall be made within the plot

Note:
Under commercial building of more than 2000 sqm, maximum two multipurpose auditorium shall be permissible while exhibition, conference hall, mini theatre/ cinema (with maximum capacity of 100 seats per hall) and other entertainment activities shall be allowed.

2.3. Planning Parameters

2.3.1. Setbacks

Provision of open spaces shall be made a minimum of 5.0 metre around buildings of 12.0m to 15.0 metre heights and thereafter for every 3.0m height or part of it, an additional set back of 1.0 or the setback prescribed before, whichever is more, is required. Setback for Commercial buildings up to 12.0metre heights shall be as under:

Table 2-2: Planning Parameters - Setbacks

SN	Commercial/ Offices Area of plots (sqm)	Minimum Required set back							
		Plain area				Hills area			
		Front	Back	Side-1	Side-2	Front	Back	Side-1	Side-2
1	Upto 200	4.50	--	-	-	3.0	-	-	-
2	Upto 400	6.00	2.00	3.00	-	4.00	-	-	-
3	Upto 600	7.50	3.00	3.00	-	5.00	2.00	2.00	-
4	Upto 1000	8.00	3.00	4.00	1.50	6.00	3.00	3.00	1.50
5	Upto 1500	9.00	4.00	4.50	3.00	7.00	4.00	3.50	3.00
6	Upto 3000	10.00	5.00	4.50	4.50	8.00	5.00	4.50	4.50
7	Above 3000	12.00	6.00	6.00	6.00	9.00	6.00	6.00	6.00

Note:
1. For commercial constructions, no shops shall be opened on road in the back side of building. In case any opening/shop are opened towards sides or towards back, the setback equal to front setback is to be required to be provided.

2. In case of the plot located on more than one road (less in which side/ back setback is not required), front setback shall be towards the wider road and minimum 3.0m setback is to be provided towards other road.

2.3.2. Open Spaces

In non-residential area, the area of open space for park and green belt for ecology shall be 10% of total area of layout and it shall be developed in the form of park, green way/ green belt.

2.3.3. Ground Coverage and Floor Area Ratio (FAR)

Norms of ground coverage and FAR for commercial /offices shall be as under:

Table 2-3: Planning Parameters – Ground Coverage and FAR

SN	Use Group (Plot area in sq. meter)	Plain area		Hills area	
		Max. Ground Coverage%	Permissible FAR	Max. Ground Coverage%	Permissible FAR
1	Upto 100	-	-	-	-
2	Upto 200	65	1.50	70	1.30
3	Upto 500	60	1.70	65	1.50
4	Upto 1000	55	1.80	60	1.70
5	Upto 2500	45	2.00	50	1.90
6	Above 2500	40	2.2	40	2.10

2.4. Parking Requirements

For the use of the occupants and of persons visiting the premises for the purposes of profession, trade, business, recreation or any other activity parking spaces and parking facilities shall be provided within the site conforming to the standards specified below.

Table 2-4: Parking Requirements

SN	Occupancy of Building	Parking Space (per 100 sqm)
1	Commercial area	
	On plots of upto 50 sqm	-
	On plots of upto 250 sqm	3.00 ECS
	On plots of upto 500 sqm	1.50 ECS
	On plots of above 500 sqm	2.50 ECS
2	Multiplex, Mall-Multiplex- Commercial, mixed use/cinema hall	3.50 ECS
3	Hotel	2.50 ECS

The circulation area and ramp norms for equivalent car spaces (ECS) on the basis of nature of parking shall be as follows:

Table 2-5: Parking Norms

SN	Space	Area per ECS
1	Open space/ terrace parking	23.0 sqm
2	Covered Parking/ Stilt Parking	28.0 sqm
3	Basement Parking	32.0 sqm
4	Stack Parking	16.0 sqm

The minimum width of a ramp used for movement of four wheelers shall be 4.0m for one way ramp and 6.0 m for two way ramp and maximum slope of ramp shall be 1:8.

2.5. Development Norms considered for the Project

Based on the above discussion, the development norms to be considered for the project are as follows:

Table 2-6: Applicable Development Norms

SN	Parameter	Value
1	FAR	2.20
2	Ground Coverage	40%
3	Green Area	10% of the site area
4	Parking for Bus Port	2.50 ECS per 100 sqm

The extract of the UBBLR relevant to the development of facilities is produced above. The aforementioned development norms are applicable on the development of the proposed Bus Port along with the associated commercial facilities and parking. The extracted development norms shall aid in understanding the area requirement for the facilities proposed to be developed. The architectural concept plan for the Bus Port Project presented in the chapter 6 is based on the above development norms.

CHAPTER 3

Market Assessment

3. Market Assessment

This chapter illustrates the findings of the primary market and demand survey undertaken to assess the project requirements and demands. The study was aimed at understanding the real estate trends and potential at macro level (city level) as well as micro level (proposed site neighbouring areas).

A primary survey was conducted and data was collected to:

a) Identify commercial development in the micro and macro market.
b) Identify possible gaps and opportunities by analysis of the supply and absorption characteristics of commercial real estate inventory in Ramnagar.
c) Assess the demand for the organised retail spaces by assessment of the rentals of such properties.
d) Assess the demand for the budget hotels by assessment of the occupancy and Average Rack rates (ARR) of such properties.
e) Assess the demand for Multiplexes by assessment of the occupancy and ticket pricing of similar establishments.

The proposed site for Bus port at Ramnagar is situated approximately 1.6 km away from Ramnagar Railway Station. There site is in the midst of the town with ample commercial entities even up to the radius of 2-3 km.

Ramnagar is a single major town in the Corbett area which attracts tourists throughout the year. The existing bus stand is sole point of road connectivity from nearby major towns and cities. There are a few budget hotels near the project site and significant number of star category resorts at a distance from the site and Ramnagar town. All of the hotels surveyed were having low ARRs and healthy occupancy (the survey was conducted in the tourist season, seasonal variation of 30-40% in the hotel occupancy were also observed) indicating that there is still room for a budget category hotel at the subject site.

Plethora of unorganized retail markets in the micro market and overall dearth of decent organized retail spaced are indicative of a scope for development of medium scale organized retail space which would cater to the footfall generated from the proposed Bus Port.

Development of other commercial spaces like multiplexes, restaurants and food courts etc. may also be viable at the project site.

3.1. Real Estate Trends

The economy of Ramnagar is primarily tourism driven. The Corbett National Park has traditionally been a world renowned destination for wild life enthusiasts with ecologists, Tiger conservationists, ornithologists and wild life photographers thronging to the national park in large numbers.

There is now a gradual shift in tourist trend with leisure tourists majorly from Delhi and NCR seeking a quick getaway from the city forming a major portion of the total tourists to the Corbett National Park. Ramnagar's convenient connectivity with Delhi and NCR has been favourable for the city's economy.

The site for the proposed Bus Port is situated at an important location in the center of the Ramnagar city. The site is surrounded by mixed development on two sides with wooded area on the northern side and NH 309 forming the eastern boundary of the site.

The consultant has conducted a primary and secondary survey to assess the real estate and market trends in the city. The market rates for rent or lease of the commercial properties in comparable economic centres in the city have been studied.

The rentals for the commercial shops in the local micro market fetched rentals in the range of Rs.18-25/- per square feet.

Table 3-1: Market Trends- Budget Category Hotels

SN	Hotel	Number of Rooms	Average Occupancy	ARR (INR)	Distance from Site (in Km)
1	Hotel Rudraksh	14	80%	844+tax	1
2	Hotel Corbett Radiance	10	75%	999+tax	1
3	Hotel Himalaya	14	75%	1680+tax)	1
4	Hotel Corbett Kingdom	28	65%	1733+tax	1
5	Tiger House Resort	24	70%	1310+tax	3
6	Hotel Jungle Paradise	28	50%	1260+tax	7.5
7	Madhuban Resort (3 star)	31	60%	1858+tax	8
8	Falcon Nest resort (3 star)	7	80%	2465+tax	9
9	The Le Roi (3 star)	36	65%	2336+tax	9

Source: Primary Survey

Table 3-2: Market Trends- Multiplexes

SN	Multiplex	Ticket Price			Number of Screens	Number of shows per day	Average occupancy (in %)
		Tier 1	Tier 2	Tier 3			
1	K Sera Sera	150	150	150	2	8	40%

Source: Primary Survey

3.1.1. Inference from Primary Survey

a) Commercial Shops

The city does not have a prominent mall, the shops are majorly located in unorganized markets. The presence of shopping arcades and complexes are limited to the sides of the NH 309 hosting both branded and unbranded outlets.

A primary survey was conducted at along the main road (NH 309). Most of the unorganized and organized shops are situated inside the radius of 3 km of the proposed Bus Port site due to socio-economic constraints.

The rentals for the commercial shops in the local micro market fetched rentals in the range of Rs.35-75/- per square feet.

b) Hotels

A survey was conducted at 9 hotels in and around Ramnagar to gauge the viability of the development of a budget hotel at the site.

The survey sample was devised to include similar properties (budget hotel) to assess the viability of development of such a hotel at the proposed site. Hotel Rudraksh, Hotel Corbett Radiance, Hotel Himalaya, Hotel Corbett Kingdom, Tiger House Resort, Hotel Jungle Paradise, Madhuban Resort (3 star), Falcon Nest resort (3 star), The Le Roi (3 star). The details of the survey included the inventory of each property, average occupancy, average rack rate, and distances from the proposed bus port site.

The hotels surveyed which were in the immediate vicinity of the Bus Port site displayed low ARR in the range of Rs.844-1,733/- but a high occupancy of around 75-80%. This may be due to their proximity to both the existing bus stand and the railway station resulting in year round stable business.

The other properties which were situated on the periphery or outside the city fetched higher ARRs but a lower occupancy. These are mostly resorts catering to leisure tourists only, resulting in seasonal nature of their business.

The survey outcome also points towards a demand for a budget hotel with an ARR of Rs.1,000-1,400/-.

c) Multiplexes

A Multiplex is a multi-screen entertainment complex showing multiple films under one roof with other type of supporting business in the vicinity like eateries, shopping arcade and other entertainment avenues. It enables the exhibitor to show a variety of movies appealing to several segments of movie

goers while serving patrons from common support facilities such as box office, concession areas and rest rooms.

Multiplex embodies the luxurious amenities of the modern day cinema -the multiple screen choices, state-of-the-art technology, ergonomic seating, eye-catching architecture, and top of the line concessions, restaurants, and food courts integrating shopping with cinema to generate better opportunities and making it lucrative.

A primary survey was conducted at the only multi-screen movie theatre in the city to assess the feasibility of development of a Multiplex in Ramnagar. The purpose of the survey was to engage with the theatre owner/manager and gauge the state of business in the city. The findings of the primary survey are presented in table 3-2.

The multiplexes surveyed in the city displayed decent occupancy of 40% which are indicative of the presence of a healthy demand for upmarket movie going destinations. The ticket pricing in the surveyed multiplex were lower than the similar multiplexes in the metro cities. The ticket pricing were Rs.150/- whereas the typical ticket price for similar properties would start from Rs.150/- and would go up to Rs.250/- for the big multiplex chains like PVR, INOX and Big Cinemas.

Overall, the absence of established multiplex chains in the city in conjunction with the decent occupancy levels and ticket prices point towards the positive feasibility for the development of a Multiplex at the site. Ticket pricing may be kept at Rs.150/-.

3.1.2. Compatibility Matrix

The various factors that would determine the product mix of activities that would be feasible at the site are as follows:

- Income levels of population residing in the catchment of the site
- Size and composition of population in the catchment area
- Economic base of the area
- Nature of land use in the immediate vicinity of the site
- Availability of nearest shopping complexes, malls, multiplexes vis-à-vis the site
- Connectivity of the site to other parts of the city
- Location of the site with respect to the urban growth corridors of the city
- Property trends in the area with respect to demand for residential and commercial spaces
- Local building bye laws and zoning regulations

We have analysed the various activities that could be suggested for the commercial development at the site. Analysing the immediate context and the real

estate demands of the city, the compatibility matrix of activities would be as follows:

Table 3-3: Compatibility Matrix

Activity	Compatibility
Hypermarket	No
Anchor Stores	**Yes**
Showrooms	**Yes**
Banks	No
ATMs	**Yes**
Small Format shops	**Yes**
Large Format shops	**Yes**
Small Format offices	No
Large Format offices	No
Multiplex	**Yes**
Food Court	**Yes**
Fine Dining Restaurant	**Yes**
Star Category Hotels	No
Budget Hotels	**Yes**
Indoor gaming zone	No
Banquet Halls	No
Convention Centre	No
Auditorium	No
Public Park	No
Car Parking	**Yes**
Apartments	No

3.1.3. Product Mix

Considering the primary and secondary market survey the following components could be developed in the commercial area:

- Budget Hotel
- Multiplex
- Retail
- Food Court

The above shown proposed product mix is derived based on the primary surveys conducted and the analysis of the primary data generated corresponding to the real estate trends and demand assessment in the Ramnagar city. Since the proposed development is on PPP basis, the output of the chapter shall aid in development of concept plan as presented in chapter 6 and gauging the financial feasibility of the Bus Port project with above mentioned revenue generating commercial areas as presented in chapter 8.

CHAPTER 4

Project Plan and Demand Assessment

4. Project Plan and Demand Assessment

The estimation of the size of the Bus Port Facilities and its components is primarily based on the assessment of the Travel Demand. The Travel Demand Assessment Factors in a city are presented below.

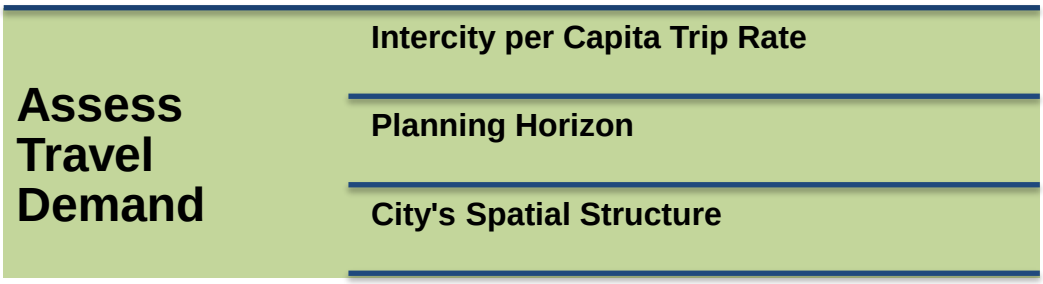


Figure 4-1: Travel Demand Assessment Factors

Further, an accurate assessment of infrastructure requirement driven by the Assessed Travel Demand is critical for the successful development of a Bus Port. Correct assessment leads to building with relevant features and facilities to optimize cost and revenue for long term sustainability of any Bus Port.

Bus Port infrastructure can be grouped in the following manner:

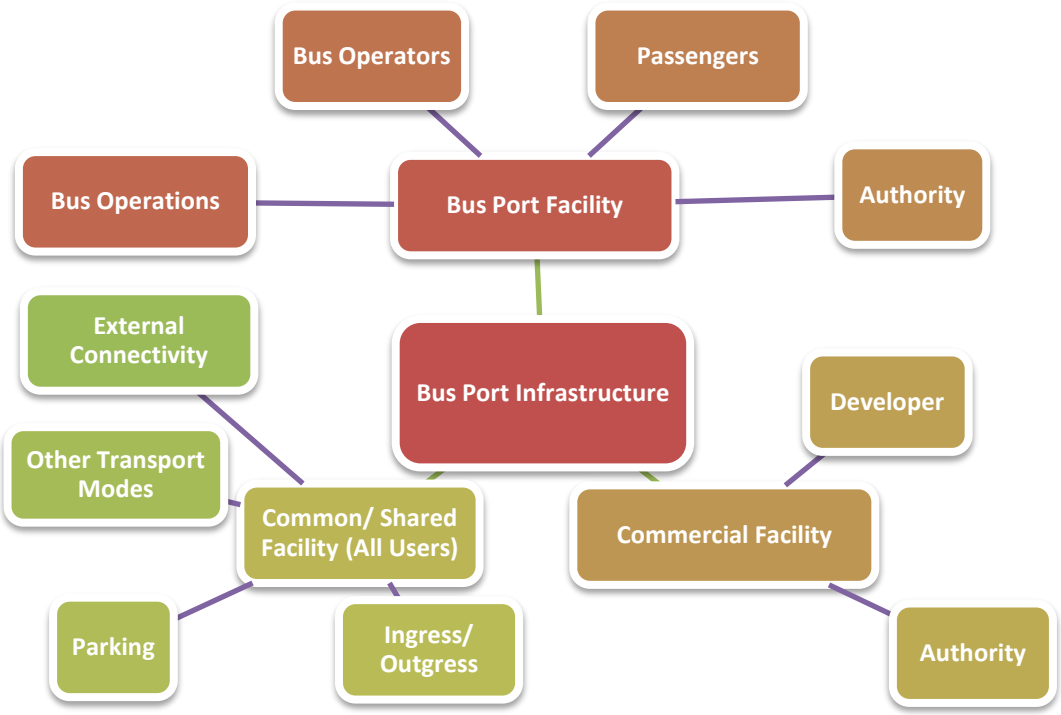


Figure 4-2: Bus Port Infrastructure

Capacity requirement for design needs to be assessed for each of the aforesaid, since designs, estimates, implementation system, financial provisions are made based on the projected demand for ultimate success of project.

Demand assessment is a comprehensive review of all the new developments that will generate trips on the existing transport network. The process of demand assessment for bus port involves following tasks:

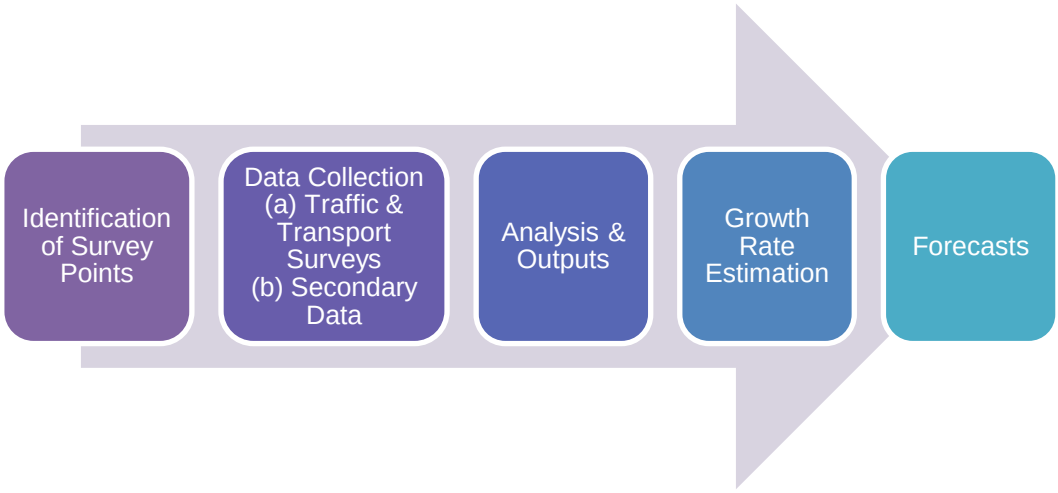


Figure 4-3: Process of Demand Assessment

This Chapter presents the findings of the surveys undertaken for the demand assessment of the proposed Ramnagar Bus Port.

4.1. Bus Traffic Demand and Characteristics

As part of the proposed Bus Port study for Ramnagar, traffic data collection was undertaken to develop baseline data. The data collection included the primary surveys in the field and the secondary data collection from various sources. This section presents the details of the various traffic surveys conducted with the locations, schedule and the findings of the primary surveys carried out.

The survey planning has been done after carefully analysing the study requirements and also undertaking a detailed review of the entire available database. A comprehensive site visit has been conducted by the senior members of study team to understand the existing bus operations in the city. Based on the findings of reconnaissance survey, the location for conducting the traffic surveys were identified.

The following surveys were carried out as part of the study to assess the demand for the proposed Bus Port.

- Bus Count including pass through buses survey
- Commuter Perspective survey

The summary of different surveys conducted with the primary purpose and the different outputs from each are as presented in the table below.

Table 4-1: Summary of Primary Surveys

SN	Name of Survey	Purpose	Output
1	Bus Count including pass through buses	To estimate bus demand, characteristics	• Daily/Average bus entering/exiting • Peak hour characteristics
2	Commuter Perspective Survey	To assess the commuter perspective	• Travel purpose • Time spent at Bus Port • Mode Choice (bus, 4 wheeler, 2 wheeler, auto, para-transit) • Facilities preference like waiting room, seating arrangements, public conveniences etc.

4.1.1. Bus Count including Pass through Buses Survey

Bus Count including pass through buses survey was carried out by the Consultant at the existing bus terminal. The bus count including pass through buses survey was conducted by manual counting method.

Bus Count including pass through buses survey data was analysed to find out the number of buses daily entering and exiting from the terminal, buses in peak hour and its characteristics. From Bus count data, the number of buses of Uttarakhand Transport Corporation (UTC), Other State Buses i.e. Uttar Pradesh State Road Transport Corporation (UPSRTC) & Rajasthan State Road Transport Corporation (RSRTC) and Private Buses originating/terminating from/at Ramnagar and passing through Ramnagar were computed and their summary is shown below.

Table 4-2: Bus Count Survey

Bus	Origination/Destination per day	Pass Through per day
UTC	44	23
Other States	-	20
Private	-	19

The peak hour details of UTC and Other States buses is as presented in the table below.

Table 4-3: Peak Hour – Number of Origin-Destination Buses

Peak Hour	Number of Buses in peak period	% Share
09:00 am to 10:00 am	8	18.18%

Table 4-4: Peak Hour – Number of Pass Through Buses

Peak Hour	Number of Buses in peak period	% Share
06:00 pm to 07:00 pm	7	16.28%

The average daily Origin-Destination pattern and Pass Through pattern of the UTC and Other States buses are as presented in the figures below.

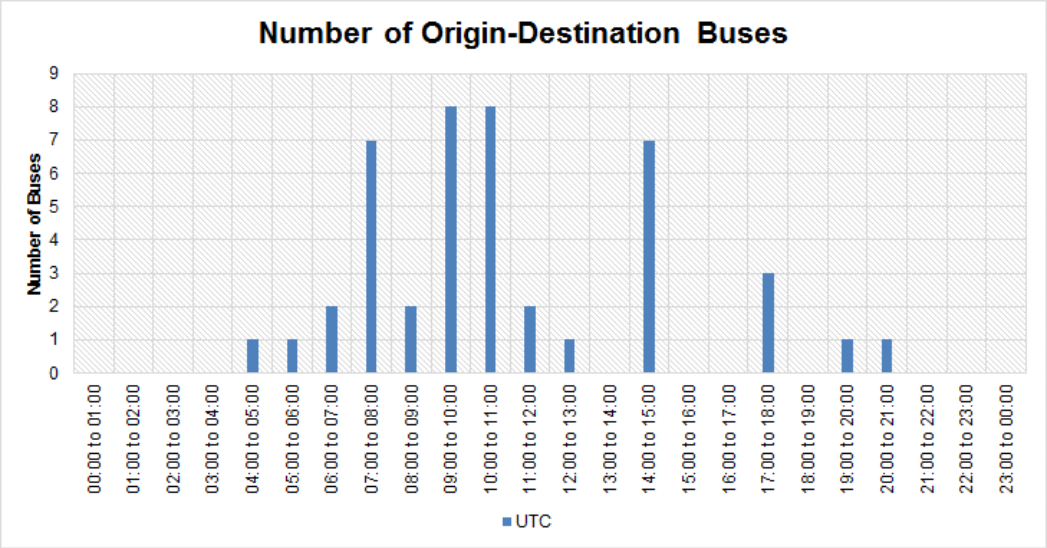


Figure 4-4: Hourly Origin-Destination pattern of UTC Buses

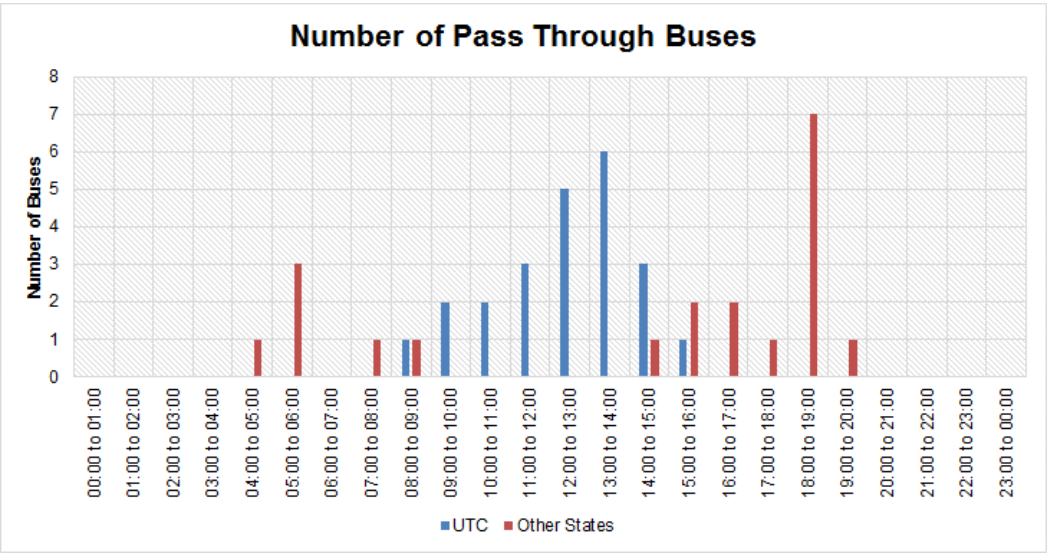


Figure 4-5: Hourly Pass Through pattern of UTC and Other States Buses

4.1.2. Commuter Perspective Survey

In order to appreciate the travel pattern of the passenger in the influence area of the proposed Bus Port, Commuter Perspective survey was conducted at the Existing Bus Stand.

Survey was conducted using an interview method on random sample basis. It was carried out continuously for 24 hours on a normal working day and data regarding origin-destination, trip purpose, time spent at bus stand, access/egress modes and preference on various facilities inside the proposed Bus Port was recorded.

It is observed that the travel purpose of most of the commuters is tourism followed by return to home. The travel purpose distribution of commuters is as shown in the figure below.

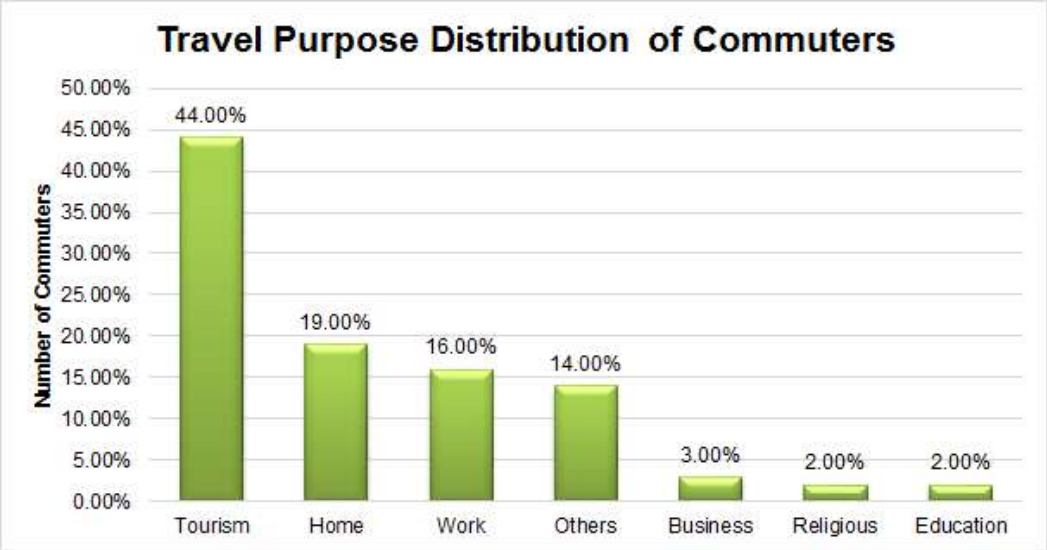


Figure 4-6: Travel Purpose Distribution of Commuters

It is also observed that the main access-dispersal mode is Auto rickshaws (25.00%) followed by Govt. Inter City Bus (21.00%) and Two Wheelers (20.00%). 10.00% and 2.00% commuters preferred Walk and Bicycle respectively as access-dispersal mode. The figure below presents access-dispersal modal share of commuters.

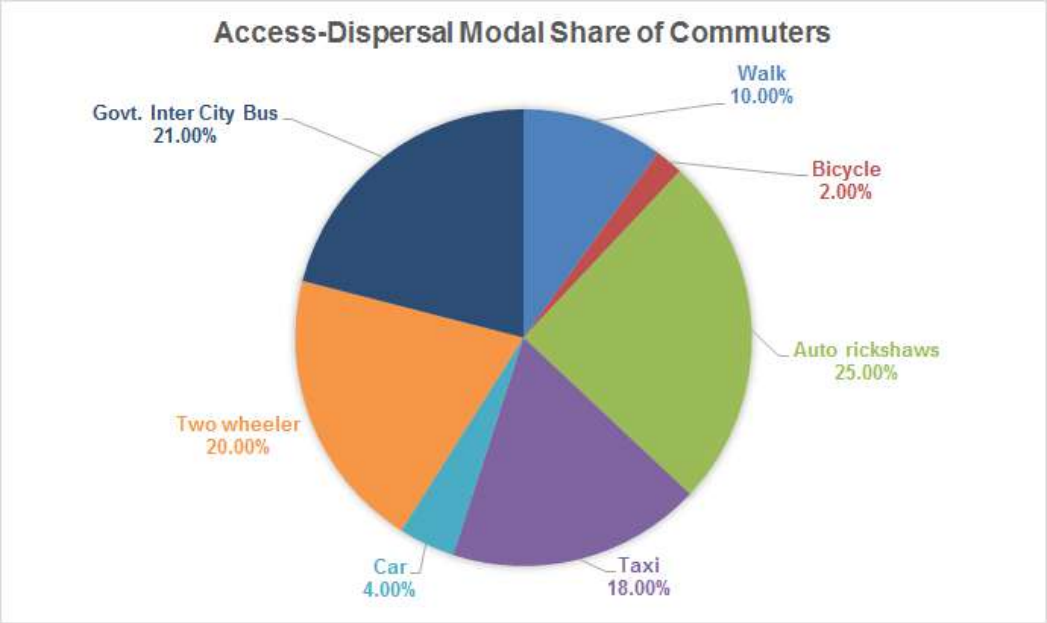


Figure 4-7: Access-Dispersal Modal Share of Commuters

The time spent by the commuters inside the terminal area is one of the important factors in designing the facilities of the Bus Port. The time spent by commuters inside the terminal area as observed is presented in the figure below.

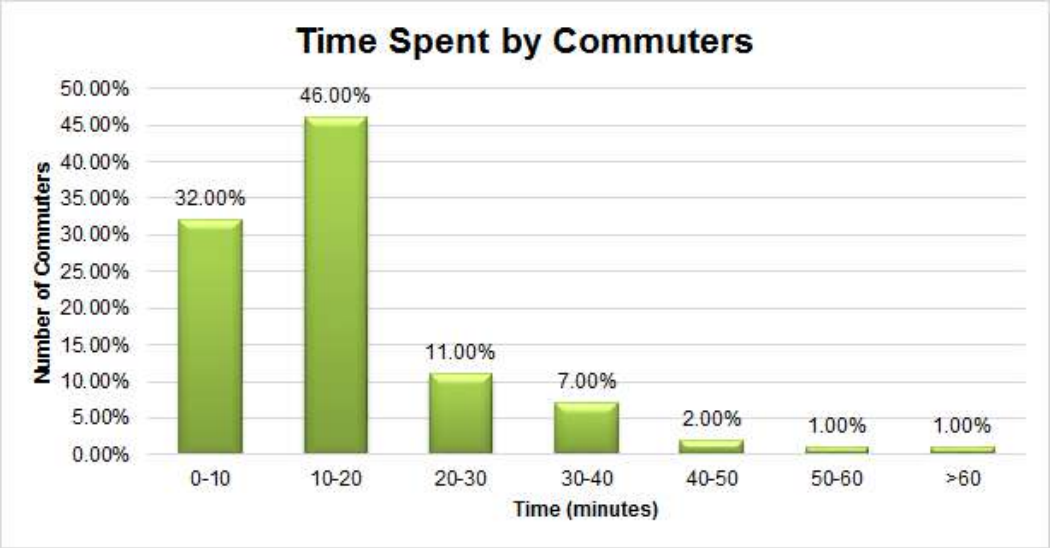


Figure 4-8: Time Spent by Commuters inside the Terminal Area

During the commuter perspective survey, along with the trip characteristic details, users were also inquired about the facilities which should be provided at the proposed Bus Port. The results of the survey are as presented in the figure below.

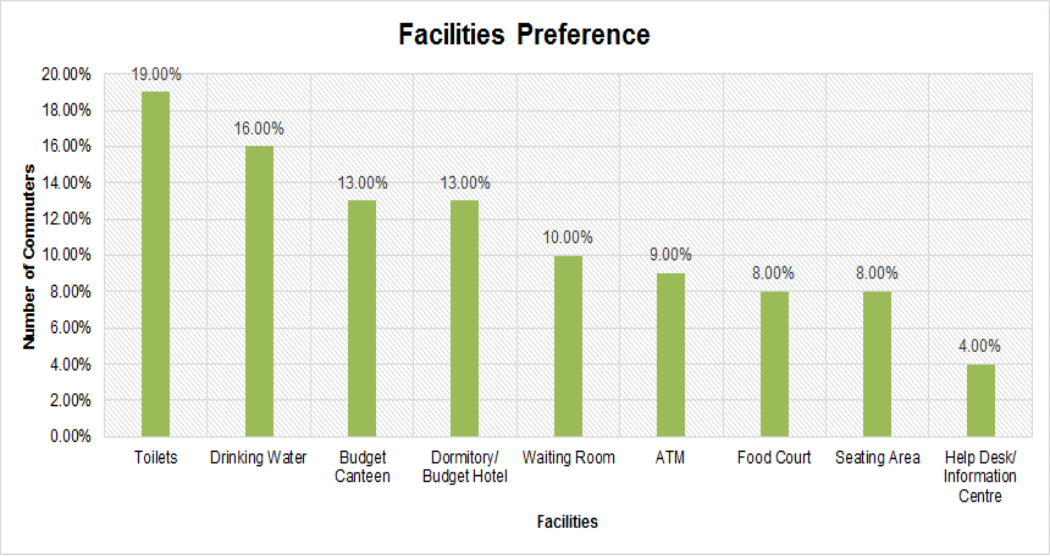


Figure 4-9: Facilities Preference by Commuters

It is observed that Toilets are mostly desired by 19.00% of the commuters and 16.00% preferred Drinking Water at the proposed Bus Port.

4.2. Assessment of Bus Bays Requirement

In order to assess the future bus bay requirement following parameters have been used.

Number of Origin/Destination service Buses	44
Number of Pass Through service Buses	62
Number of Origin/Destination service Buses in Peak Hour	8
Number of Pass Through service Buses in Peak Hour	11
Escalation in Number of Buses per annum	2%
Design period	20 years
Waiting time at Bus Port for Origin/Destination service	15 minutes
Waiting time at Bus Port for Pass Through service	5 minutes
Number of Alighting Bays	1.5 per 10 Boarding Bays
Share of Buses in Idle Parking	10%
Idle Bay Turnover Rate	8 hours
Operational Hours of Bus Port	16 hours

Following table presents the calculated bus bay requirement for Origin/Destination service and Pass Through service.

Table 4-5: Bus Bay Requirement

SN	Description	Formula	Origin/ Destination Service	Pass Through Service
1.	Number of Buses in Peak Hour	A	8	11
2.	Total Time Required (Minutes)	B = A*15 or A*5	120	55
3.	Present Boarding Bays Requirement per Hour	C = B/60	2	1
4.	**Projected Boarding Bays**	**D = C*(1+2%)^20**	**3**	**2**
			5	
5.	**Number of Alighting Bays**	**E = D*(1.5/10)**	**1**	

Table 4-6: Idle Bus Bay Requirement

SN	Description	Formula	Value
1.	Daily Number of Buses in Idle Parking	A = 10%*44	5
2.	Present Idle Parking Bays	B = A*(8/16)	2
3.	**Projected Idle Parking Bays**	**C = B*(1+2%)^20**	**4**

4.3. Assessment of Parking Requirement

Reserving some space to meet the current parking needs and future, as and when the demand justifies such an investment, is adopted as a general strategy to meet the parking space requirements. The Equivalent Car Space (ECS) standards adopted for parking facilities are mentioned in table below.

Table 4-7: ECS Standards adopted for Parking Facilities

Vehicle Type	ECS
Cars/Taxi	1.00
Two Wheelers	0.25
Auto rickshaws	0.50
Bicycles	0.10

Source: Urban and Regional Development Plans Formulation and Implementation (URDPFI) Guidelines

Vehicle Type	ECS per bus bay
NMT	1.00
IPT	1.40
Pick & Drop	0.40
Park & Ride	1.50

Source: Draft Guidelines for Development of Bus Ports in India

Following table provides detailed assessment of parking demand at the bus port for the design period.

Table 4-8: Parking Requirement

SN	Description	ECS Requirement per Boarding/Alighting Bay	Parking Demand (ECS)
1.	NMT	1.00	5
2.	IPT	1.40	7
3.	Pick & Drop	0.40	2
4.	Park & Ride	1.50	8
	Total	**4.30**	**22**

However, parking space is provided as per the applicable building bye-laws. Surface parking area of about 2,700 sqm is provided in the design.

4.4. Bus Port Transport Facilities Requirement

Based on the above, the requirement for the various transport facilities is as follows:

SN	Parameter	Value
A	Number of Bays	
1.	Boarding Bays	5
2.	Alighting Bays	1
3.	Idle Bays	4
	Total	**10**
B	No. of ECS Parking	**60**

The requirement of the Bus Port Facilities including number of bus bays (boarding, alighting and idle bays) was estimated resultant to the primary surveys undertaken and the parking requirement for the bus port in terms of ECS was based on applicable building bye-laws.

The output of the chapter i.e. the number of bus bays and the parking requirement shall aid in planning and subsequent designing of the of the Bus Port facility. The estimation of CAPEX towards construction of Bus Port facility and its concept design shall be based on the output provided above.

CHAPTER 5

Design Philosophy

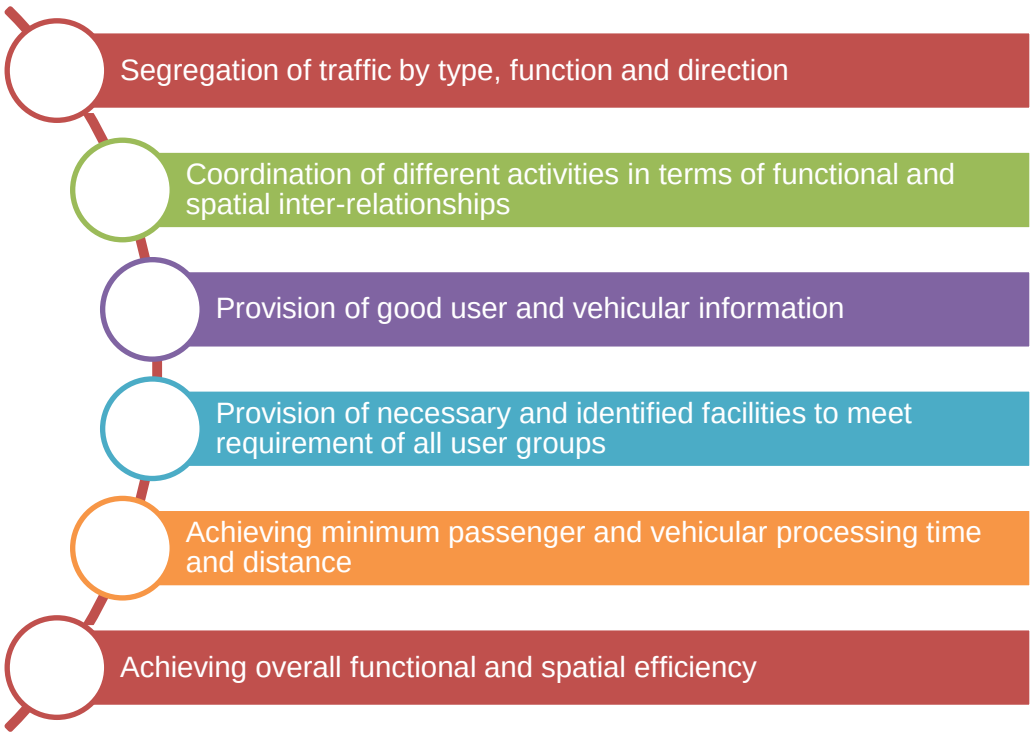
5. Design Philosophy

Design is essentially a decision-making process i.e. existence of a problem demands the designing of a solution. In other words, to design is to formulate a plan to satisfy a particular need and to create solution to address the need.

A design philosophy is a theoretical basis or the driving force behind the said decision making or design process. In the context of Bus Port Development, the design philosophy shall be derived from the perspective of the convenience to the stakeholders as the eventual design should address the specific needs of the users of the facility.

The size of a Bus Port is primarily governed by the following factors:

Broad guidelines to be followed in the preparation of the layout are



5.1. Understanding of Key Elements

Passenger Perspective	Management and Viability Perspective
•Facility for buses with origin / destination •Facility for buses passing through the bus port (drop off & pick-up of passengers)	•Commercial Facilities: Convenience shops/ kiosks exclusively for passengers near waiting area •Commercial Development: Large scale retail/ commercial development for catering town population

5.2. Types of Bus Ports

The growth and development of bus transportation has closely followed advances in automotive technology and the improvement and expansion of road network in the region. Over the past decade bus services have evolved into several general operational categories and characteristic Bus Port types.

a) Intercity Bus Port

The intercity Bus Port is usually found in the downtown core and is accessible directly by local transit, taxi, and auto. It differs from other Bus Port types in that it includes long haul service in excess of several hundred miles and provides for a much greater number of bus movements.

More elaborate "package express" facilities are provided in the intercity Bus Port and a greater amount of concession and rental space is provided to defray higher Bus Port construction and operating costs.

b) Airport-City Bus Port

The airport-city Bus Port provides primarily for the transportation of airline passengers from an urban centre to the major airports it serves.

Oriented to departing and arriving flights, the Bus Port normally has provisions for arrival and departing flight information as well as pre-ticketing and check-in facilities.

c) Urban-Suburban Commuter Bus Port

This type of facility may be located within the downtown core, as a central passenger collection and distribution node, or on the periphery of the core, as a rapid transit feeder station.

It is characterized by a diversified bus route structure and high-turnover commuter-type bus operations. Bus accessibility is an important consideration. Grade separated access by underpass or overpass connections and exclusive bus lanes on connecting highways are desirable to maintain schedule efficiency.

d) Suburban Interstate Bus Port

The suburban interstate Bus Port is a peripheral type designed to avoid the traffic congestion and heavy investment associated with central city.

The Bus Port is usually located adjacent to interstate highway connections with major cities or regional airports and in many instances serves the increasing outlying "urban sprawl" areas.

In an increasing number of cases Bus Ports of this type serve a commuter-type function where the daily journey to work in the central city may take as long as 2 hours.

Sometimes referred to as "park and ride" Bus Ports, because access is primarily by auto, these facilities are provided with open, paved parking spaces.

5.3. Elements for Access to Bus Port

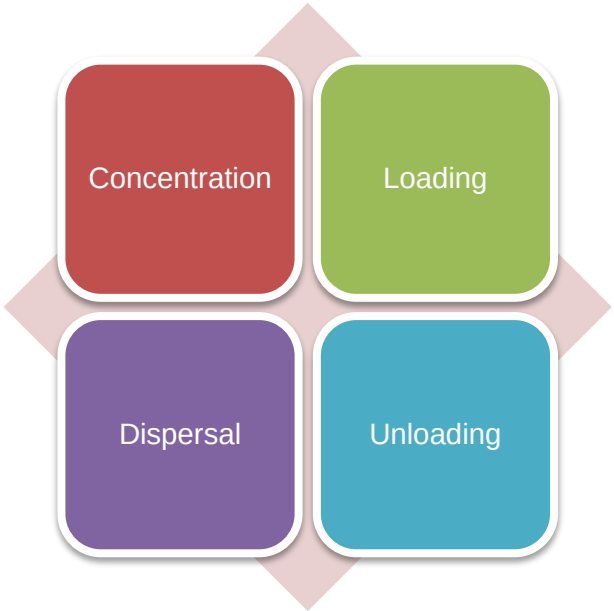
Passengers access bus port through the following modes. In the layout plan, efforts are made to provide for such access as mentioned below.

Walk	An entry point is provided for pedestrians and safe passage to and from buses.
Non-motorized Transport (NMT)	Passengers arrive by cycle rickshaws, e-rickshaws and bicycles. Parking requirements are estimated based on provisions in other similar bus ports and best practices.
Public Transport Bus Service	In the layout plan, bus bays for buses are provided to ensure easy access for passengers arriving/ departing by buses. These are areas where buses will arrive, pickup/drop off passengers and leave.
Intermediate Para Transit (IPT)	Passengers arrive by autos. Parking requirements are estimated based on provisions in other similar bus ports and best practices.
Pick & Drop	Passengers arrive by taxis or with friends/ relatives. Parking requirements are estimated based on provisions in other similar bus ports and best practices.
Park & Ride	Passengers arrive by two wheelers and cars. Parking requirements are estimated based on provisions in other similar bus ports and best practices.

5.4. Bus Port Project Components

Bus Port is meant to act not only as a modal hub future but also intended to be an alluring landmark in the region. The proposed approach and methodology for development of Bus Port is detailed out below.

The functions related to both passengers and vehicles include:



Following exhibits typical facilities considered in the Passenger Facility area, Operations related area and value added facilities in the Passenger Facility area.

Passenger Facility	Value Added Passenger Facility	Operations Related Facility
• Enquiry, Ticketing Office (AC); • Concourse Area designed for peak time boarding passenger • Tourist Information Centre (AC) • Store Room • Parcel Room • Cloak Room • Public Relation Office • Digital Display Boards • Clocks • Public Address System • Surveillance & Security System (CCTV) • Suitable Parking • Toilets and Drinking Water Chambers	• Television, WiFi at suitable places; • Stainless Steel Seating; • Furnished waiting halls (General, Ladies, Premium and Deluxe (Paid)) • Trolleys and Wheel Chairs • Dormitories • Retails Kiosks	• Administrative Offices (AC) • Fire Detection System • Tow Away Vehicles • Mechanized Cleaning Equipment • Rest Room • Routine Workshop • Parking Areas

5.5. Bus Port Area

The contextual design of the bus port has been influenced by the movement pattern of the various transport modes in the site. During the design process, the following criteria for the traffic flow within the site area have been considered:

Circulation	Circulation of all modes of transport – buses, car, two-wheelers, pedestrian etc.
Separation	Separation of modes depending on their usage and movement
Zoning	Zoning of site based on the circulation and separation of different modes to avoid conflict and efficient functional connectivity.

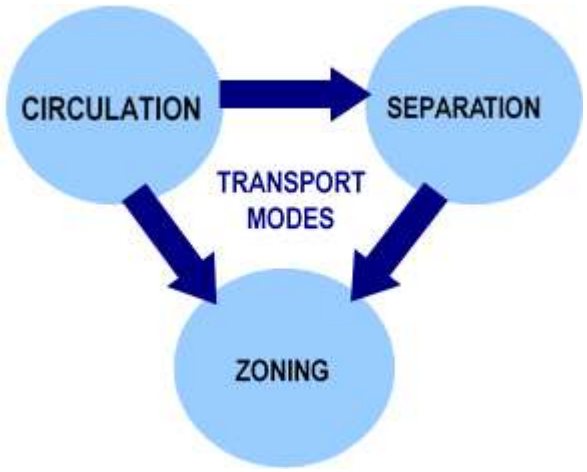


Figure 5-1: Diagram showing the Contextual Site Design Considerations for Movement of Various Transport Modes

5.5.1. Bus Port Building

Bus port design has been based on three main stages related to handling of bus movement - alighting (of passengers), parking (idle) and boarding (of passengers), and their intermediary functions and the smooth & safe movement of passenger to & from modes of city transport. The essential passenger facilities - information, ticketing, waiting & public conveniences are the various components of this building.

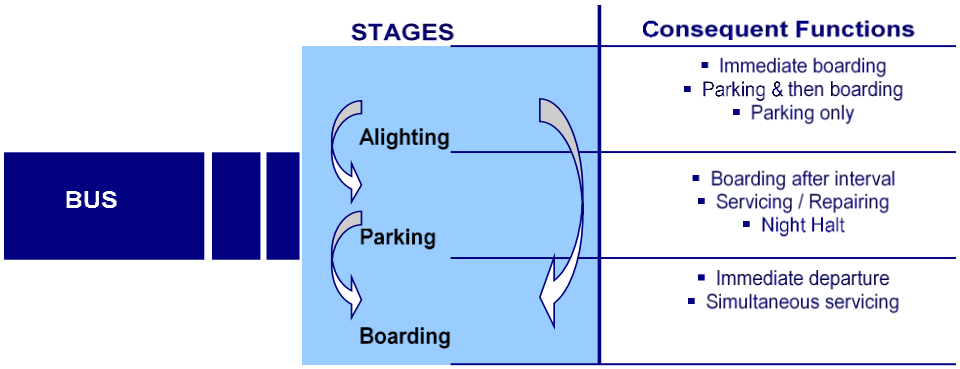


Figure 5-2: Diagram showing Bus Related Stages and their Intermediary Functions

5.5.2. Workshop Area and Idle Parking

The workshop area has been provided so that the buses can easily avail the maintenance and servicing facilities. The placement of the workshop is usually such that it is hidden from the general public's view.

Adequate number of idle parking bays are provided so that the buses can be easily parked.

5.5.3. Passenger Amenities

The activities for the passenger amenities in addition to basic facilities are given below.

A. Information Dissemination a) Digital Display Board b) Real time Information Display c) Public Address System d) Clock e) Bus Port Smartphone app f) Help Me Kiosk g) Train and Flight Info Display	B. Facilities a) Concourse Area b) Waiting Area with quality Seating space c) Toilets d) Drinking water fountains e) Mother & Baby Care room f) Parcel & Cloak Room g) Trolleys/ porter
C. Customer Interface a) Grievance Handling	

b) Public Relation Office c) Tourist Information Centre	h) Travel desk – Auto/ Taxi prepaid counter, Railway/ Flight ticket booking counter i) Mobile Helper – Assistance on the move j) Special Assistance Booth for elderly and differently abled k) Parking - Car & Two-wheeler, Auto rickshaw and NMT Parking Area l) Furnished waiting halls (General, Ladies, Premium and Deluxe (Paid)) m) Dormitories n) Lost and Found room
D. Value Added Services a) Television, Wi-Fi access, Mobile charging points at suitable places b) Food Court c) Kids Activity Area d) ATMs e) Hotel Reservation Counter f) Lounge bar and Smoking Room g) Freshen up & go - Time capsules h) Dust Suppression System i) GPS tagging on luggage & children for tracking j) Pharmacy and First Aid Centre	

5.5.4. Overall Aesthetics

Design guidelines to regulate the total development character and aesthetic have been formulated based on the following aspects:

a) Urban Design Guidelines (massing and volume, external furniture, signage)
b) Architectural Façade (Elements, Material, Colour)
c) Functional Essentials (Value Added Services during Implementation Phase)
d) Site Development Specifications (surface finishes & colours, plantation heights) and External Area Maintenance
   - Footpaths, Railings, Curbs and
   - Handicap access
e) Maintenance Procedures
   Laying down guidelines for the selected bidder to follow such as
   - Maintenance and repairs of the facility and all its components, including roads, pavements, building, toll plaza and allied works.
   - Setting performance standards to ensure management of complete operations & maintenance activity of minimum acceptable level.
   - Laying down timetable for Periodic inspections
   - Ensure minimal disruption of the operations of the Bus Port during maintenance phase.
f) Guidelines for Cleanliness will cover the following
   - Trash Collection / Maintenance of Receptacles (bins)
   - Drinking Fountains – cleaning a purification
   - Cleaning of Building & Furniture Surfaces
   - Cleaning Carpeted & Non carpeted floors
   - Cleaning of Toilets and Public Conveniences

5.5.5. Infrastructural Support

The offerings which will support all the Bus Port functions and bring the necessary ambience effect are listed below:

a) Core Target Segment for customization
b) High quality of developed infrastructure amenities
   - Assured water supply
   - Assured quality and adequacy of power
   - Provision of Sewerage Treatment Plant
   - Drainage and Sewerage
   - Excellent Telecommunication facilities
c) External/ Internal Connectivity
   - People Transport
   - Internal Connectivity
   - Telecom Connectivity
   - Wifi
d) Superior maintenance and Estate Management
e) Planning the systems in such a way so as to use minimum energy.
f) Recycle and reuse the waste products to the maximum possible extent
g) Cost efficiency should be at the conceptual level itself
h) Provision for development and aesthetic value of surrounding environment i.e. plantations etc. in the proposed Bus Port
i) Use of National and International Standard Practices.

5.6. Functional/Planning Elements

General functional organization of the bus port is determined by site configuration, volume and type of bus operations, and passenger & bus traffic circulation. Although all Bus Port types to some extent share common planning problems, there are some significant differences in design rationale.

Since the site is plain, there will be movement of both vehicles and passengers at the same level and provisions must be made, for obvious safety reasons to separate the two as much as possible.

5.6.1. Pedestrian Requirements for Bus Port

The design of pedestrian facilities for passengers is dependent on the category of Bus Port and its pedestrian traffic patterns. Commuter passenger Bus Ports, with extreme but short peak traffic patterns and repetitive users, can be designed for lower standards of service than long-distance Bus Ports, where the users are generally unfamiliar with the facility and peak traffic levels may be sustained over several hours. Detailed studies of the use of pedestrian facilities indicate that maximum capacity coincides with the most crowded pedestrian concentrations, representing a poor design environment. Many of the elements of aesthetic design are lost in this type of crowded environment, as the pedestrian becomes

preoccupied with the difficulties caused by the close interaction and conflicts with other persons. The challenge to the Bus Port designer is to balance the space requirements for a comfortable and aesthetically pleasing human environment against the space restraints caused by building configuration and cost.

Table 5-1: Areas for Pedestrian Level of Service

Type	Area per passenger (in sqm)
LOS A	≥ 1.2
LOS B	0.9 - 1.2
LOS C	0.7 - 0.9
LOS D	0.3 - 0.7
LOS E	0.2 - 0.3
LOS F	< 0.2

Source: Fruin

The most recent approach to the design of pedestrian spaces has been the use of the level-of-service concept. On the basis of this concept, a qualitative evaluation is made of human convenience at various traffic concentrations and this is translated into appropriate design parameters.

5.7. Architectural Design

Bus Ports harness this much needed inter-modal connectivity. The various modes of public transport, including intermediate public transport, work with mutual coordination at such nodes. They are designed with the logic to complement each other rather than being involved in cutthroat competition amongst themselves. These nodes experience large number of footfall comprising of various classes of society and thereby provide us with a perfect opportunity to communicate with the city and create an impact.

Additionally, a Bus Port becomes a hub and major public space and especially in festive season. Hence, a public gathering space features should be complementing to the proposed centre.

Qualities of a public space

- Public spaces should be inclusive to everyone. They should function as urban hubs that physically and mentally connect different parts of the city and its inhabitants.
- Public space accepts diversity as a norm.
- These are the places where anyone can come, and further, where most events are spontaneous rather than pre-planned, where celebrations are held, where people mix with others, friends run into each other or simply move about or sit and watch others.
- Public spaces have no entrance fee, no dress code, and no script. They offer surprises and unexpected pleasures: the sight of children playing, youth strolling, the elderly chatting, the fatigued resting, and the lonely and

melancholy and bored escaping their troubles. There are no clear distinctions between observers and observed; all are on stage; all are part of the audience.

- The more diluted and scattered the exchange opportunities, the more the city begin to lose the very thing which makes it a city: a concentration of exchange opportunities. What makes a city efficient, and an exciting place to be, is this diversity and density of potential exchanges.

5.8. Urban Design Context

The proposal developed to design the existing Bus Port precincts has taken due care on the built form configuration from an urban design perspective in the years to come. The design proposal envisages built forms to largely utilize and reflect the plot geometries available on location. The built form has to be conceived to create a new identity for the urban pocket. Material choice for the exteriors is proposed to match with the external ambience.

As per new urbanism trends in the architectural treatments of building, sensitive use of glass, natural stone and composite panel finishes to be added.

The human scale spaces and street treatment, preservation of existing movement patterns around the urban development, creating a unique identity of the built environment in terms of an existing urban landmark can be evident in the way the proposal has been structured and conceived.

A balance between the public and private realm is central to the practice's design approach. Buildings and their surrounding spaces should interrelate and define one another, with external spaces functioning as rooms without roofs. It is the building's scale and relationship with the street or square that helps to encourage public activity and create a people-friendly environment.

5.9. Green Features in Bus Port

Light colored External Finishes	External Finishes are light colored so as to absorb minimum heat and reflect most of it keeping inner spaces cooler.
Rain water Harvesting	Rain water harvesting system has been provided to recharge rain water from roof and site.
Dual water piping system	Dual piping system has been provided in site. Water from STP has been used for flushing purpose.
Solar power	Photovoltaic (PV) panels has been provided on walkways to generate power.
Light Fixtures	LED light fixture has been provided for bus port and external lighting.
Landscaping	Green area has been provided at various places in site.
Natural lighting	100% day lit spaces has been provided in design to minimize use of electrical lighting in day time.

5.10. Case Studies from India

5.10.1. Anand Vihar ISBT Redevelopment Plan

Anand Vihar ISBT is presently functioning on plot area of 10.2 hectares and has a triangular shape facing road no. NH56. DIMTS has been entrusted by Transport Department GNCTD, the work of designing and redevelopment of Anand Vihar ISBT as a state of the art, modern integrated Bus Terminal.

Figure 5-3: ISBT Anand Vihar Redevelopment Plan

Anand Vihar ISBT is designed as a state of the art, modern integrated Bus Terminal. The design is an emulation of a modern building which has to sensitively respond to its complex functional requirements and to the category of the end users. While being modern, in its design and appearance, the design carefully incorporates functional requirements which would be subjected to heavy dirty use by its components.

The site posed a district challenge of integrating an existing (under construction) elevated metro station and via duct which bisects the site into two areas along with an adjoining major Railway Station.

The design recognizes the independent characteristics and ownerships of all these components. The design of the ISBT creates a strong urban form which is in harmony with the other modes of transportation.

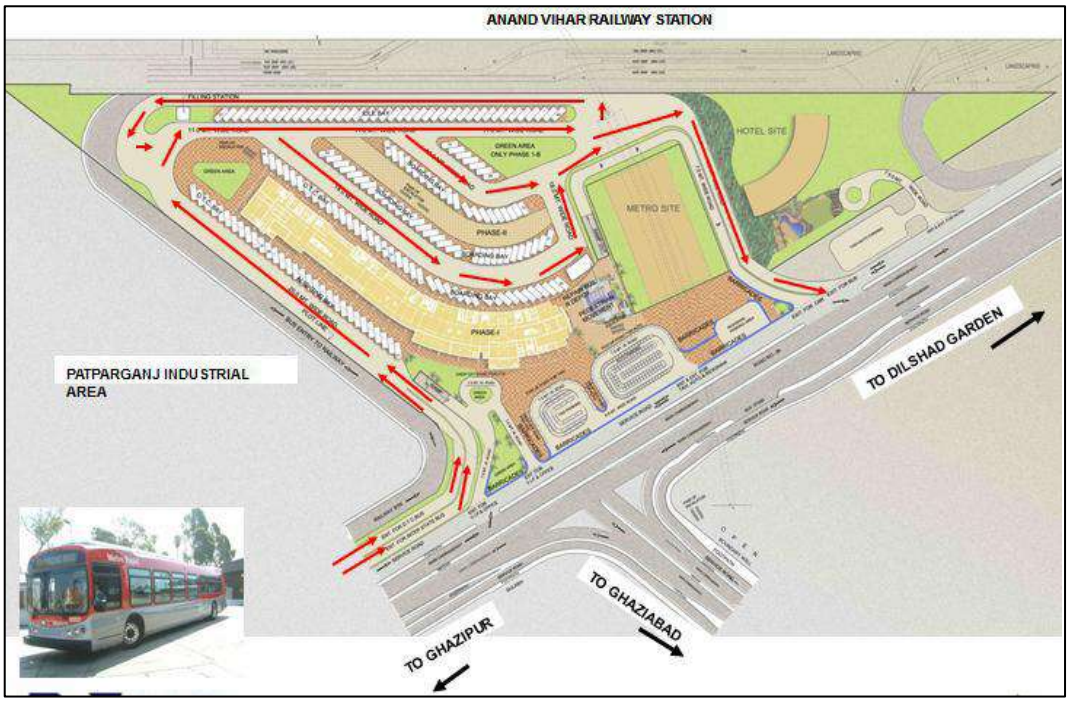


Figure 5-4: Segregated Paths for Bus

Figure 5-5: Planned ISBT - Segregated Paths for Bus, Taxi, and Auto-rickshaw

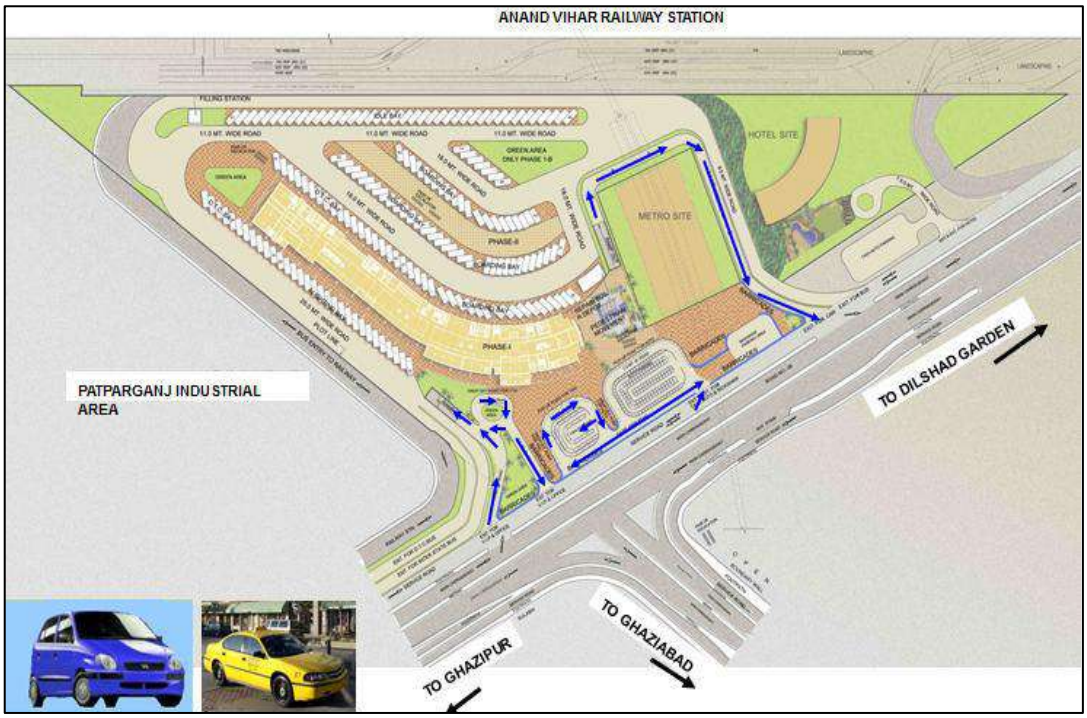


Figure 5-6: Segregated Paths for Car/Taxi

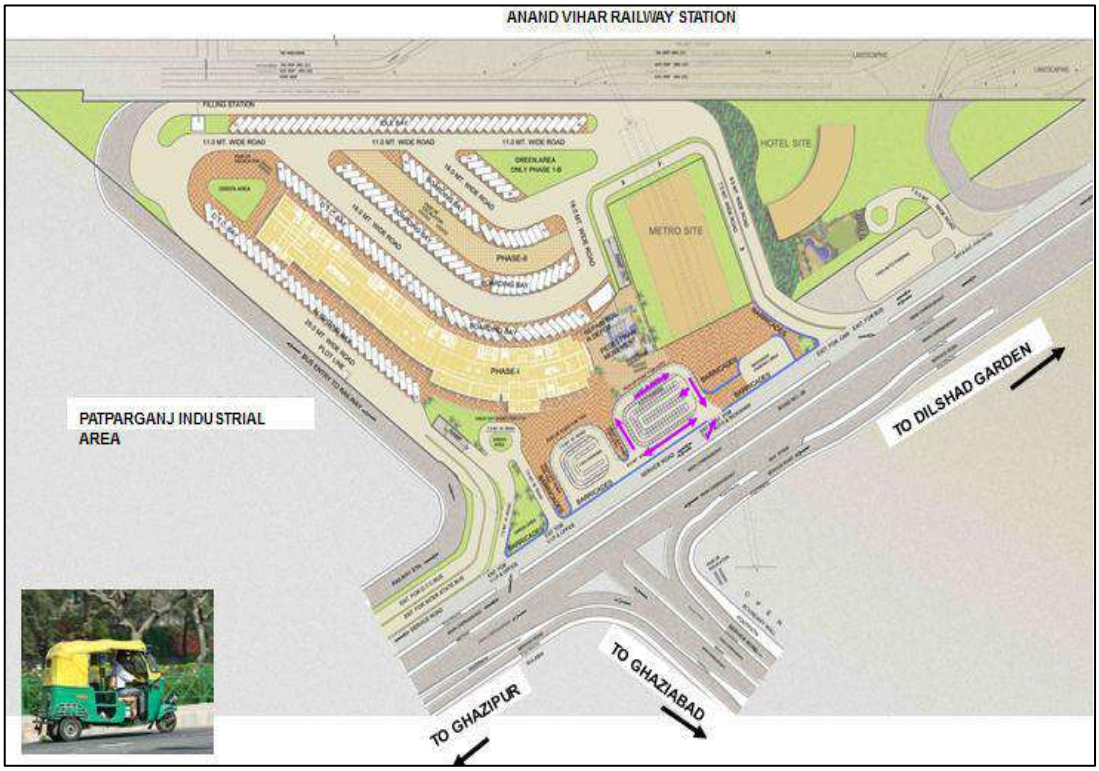


Figure 5-7: Segregated Path for Auto-rickshaw

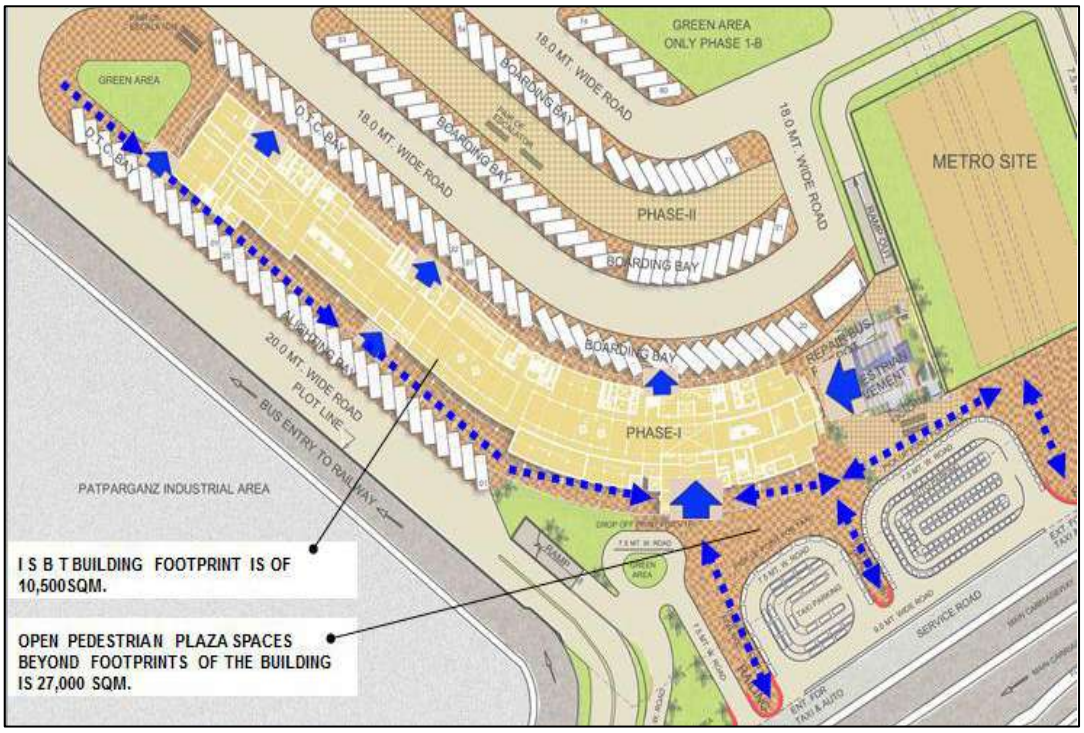


Figure 5-8: Pedestrian Movement at grade levels

Well Planned Network of foot-over bridges

A well planned network of foot over bridges is proposed for integration of pedestrian movement coming between ISBT Terminal, Metro Station and Anand Vihar Railway Station.

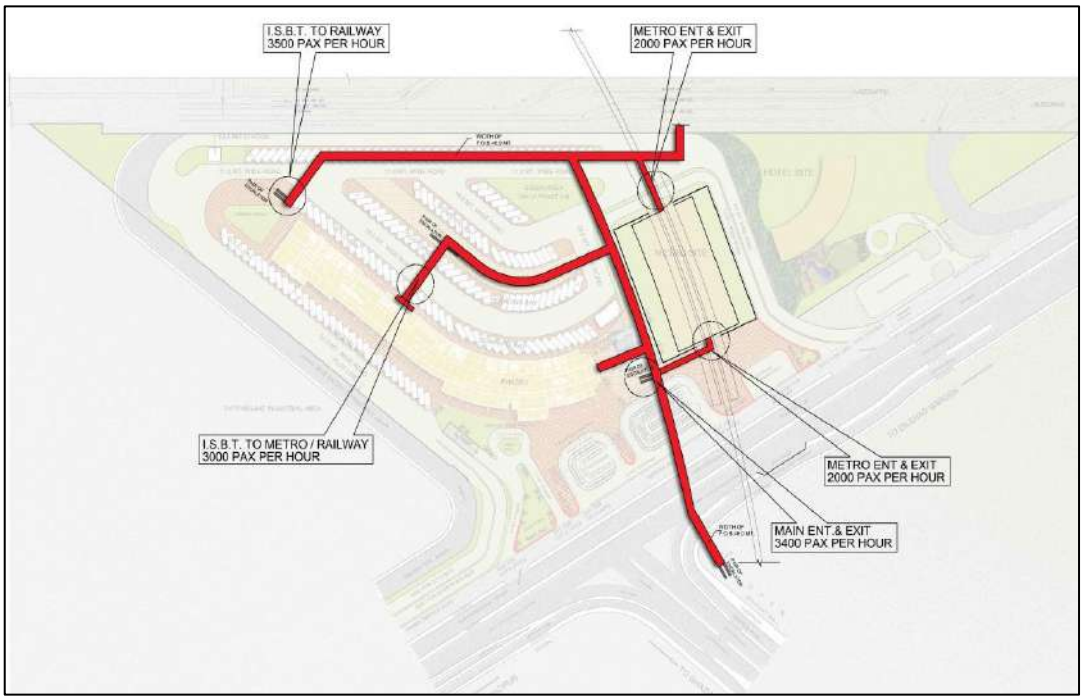


Figure 5-9: Proposed ISBT - Planned Foot Over Bridges

Phase wise development of site.

The site to be developed in two phases. Phase I construction includes main ISBT Building with boarding and alighting platforms along either side of buildings. This is to facilitate the commuter to board/alight the buses under shelter.

In Phase-I, the site to be barricaded and a separate safe pedestrian passage is planned so that the commuter can reach the present ISBT platforms. Before the start of Phase-I construction present ISBT shelters shall be trimmed to create periphery road for bus movement. The existing underground services like electrical cables, storm water drains/sewerage shall be re-routed/rehabilitated before the start of Phase-I construction. The Ground floor and first floor areas shall be dedicated for ISBT use.

All the facilities like ticketing counter, security checking or waiting lounges, rest rooms, drivers' rest room, ISBT office, Police Check Post, Fire Control Room, Essential Shopping, etc. are planned on the ground floor. Separate dedicated entries for Public and Office has also been planned.

Food courts, Restaurant facilities and Shopping Arcade has been planned at concourse level and the facilities like dormitories for LIG, MIG, and HIG are being provided on upper level.

The concourse level has a double height atrium which is created for a visual communication with commercial area on the upper level. The two floors are linked with stairs, escalators and lifts.

In order to create a strong design element and an environment friendly jali has been proposed at concourse level. This creates natural ventilation in design a building. To improve the comfort condition, fume draft ventilation is proposed in the concourse which will further give cooling effect and comfort to passengers inside the terminal in peak of summer.

Features

- There is dedicated, independent approach to the office floors through dedicated lift and stairs circulation cores.
- All parking facilities and utilities are planned in the basement.
- All office areas are centrally air conditioned.
- Basement Floor shall be built in two phases. It will accommodate car parking as per requirement besides the following utilities:
- STP/ETP
- DG Sets and Sub-Station
- Fire and Domestic Water Storage Tank
- Garbage Collection Chamber
- Essential Stores
- Lift and Staircases Lobby

The Entire Basement shall be mechanically ventilated as per fire regulations.

Figure 5-10: Landscape plan

Landscape Strategy

- Landscape to reinforce Symbolic connection
- Green Envelope to be provided in pedestrian plaza
- Outdoor rooms defined by tree corridors
- Diversity of outdoor spaces for multiple uses
- Lighting to create safe and engaging night time use
- Public art to add meaning and interpretation of the site

5.10.2. ISBT Kashmere Gate

The Inter State Bus Terminal of Kashmere Gate is located in North Delhi, in Planning Zone (Division) 'C' of the Union territory of Delhi, as per the Delhi Development Authority. It is the oldest and biggest inter-state bus terminal of the city, catering to a vast city wide population traveling across towards the states of Punjab, Himachal Pradesh, Uttarakhand and Uttar Pradesh.

The Maharana Pratap ISBT at Kashmere gate was proposed in the 1962 Master Plan of Delhi. The site for the terminal chosen on different criteria, firstly, it is located at the intersection of the two National Highways, NH-1 and NH-24. It is a site on the ring road, which runs all around Delhi and is connected to all national highways and thus easily accessible. Also the site is in close proximity to the Old Delhi railway station. ISBT Kashmere gate was initially designed to handle 500 buses per day.

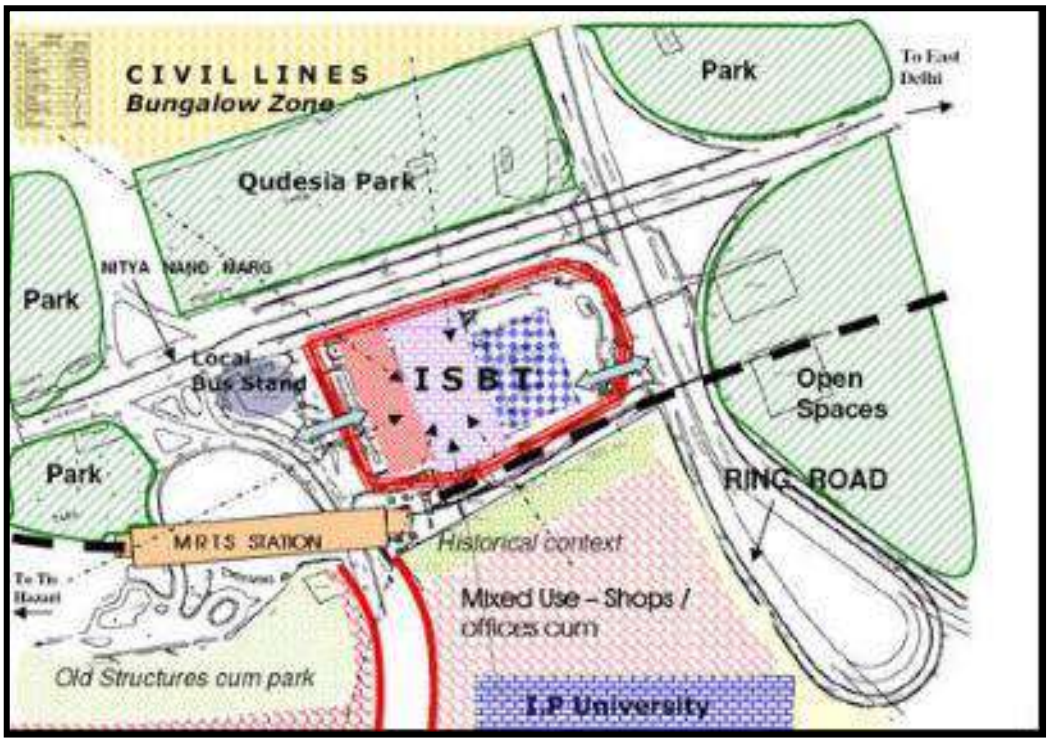


Figure 5-11: Location of ISBT Kashmere Gate

The project site is the major entry point of this zone. The connectivity of the zone has been enhanced by the fully developed Delhi Metro Link (Phase I), which connects the north-western portions of Delhi to Central Delhi, and onwards to East Delhi. The Kashmere Gate MRTS terminal is the key point of interchange for passengers in two different metro lines. Project site is a regional level landmark for North India, since most inter-state bus traffic either originates or terminates at this location.

Consequently, the project site is the focal point of a considerable volume of floating population.

Locationally, the project site is positioned at the intersection of two 60 m wide arterial roads, known as the Ring Road and the Nitya Nand Marg. It is adjacent to the Kashmere Gate terminal of the Delhi MRTS, and has proximity to the Guru Govind Singh Indraprastha University campus. The project site is developed in the form of an inter-state bus terminal, comprising bus parking areas, circulation zone, waiting areas and office developments.

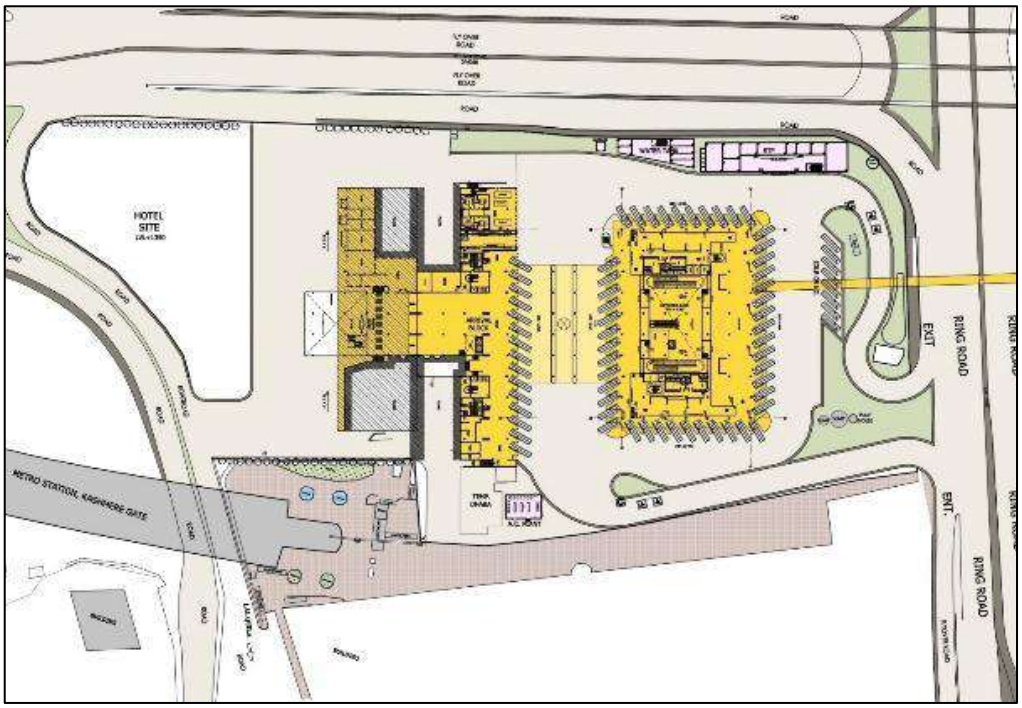


Figure 5-12: Site plan of ISBT Kashmere Gate

Salient Features

The ISBT is designed as a state of the art, modern integrated Bus Terminal. While being modern, in its design and appearance, the design carefully incorporates functional requirements which would be subjected to heavy dirty use by its components. The Upgradation and Renovation shall broadly comprise the following:

- Face lifting of the building while maintaining the original context of the exposed concrete character of the facade
- Provision of escalators and elevators
- Provision of heat, ventilation and air conditioning, CCTV, Security Equipment and BMS of the Terminal
- Providing continuous FOB for conflict-free connectivity to the terminal from the ring road
- Provision of bus, car/taxi and two wheeler parking
- Development of commercial areas in the Terminal
- Supplement the public transport in Delhi through a city-wide integrated multi-modal network of mass transit systems
- To facilitate an effective multi-modal changeover by integrating the existing ISBT with the Metro station and Old Delhi Railway Station
- To provide a state-of-the-art Multi Modal Transit Center that is user friendly, catering to varied passengers' comfort, pedestrian-friendly, handicapped-friendly, and aided with facilities as per best international practices
- To improve passenger amenities

Key Components in the ISBT

The project site is developed in the form of a large inter-state bus terminal and has the following key divisions:

a) The Arrival Block

Catering to the arrival of passengers inside the terminal premises, the block is close to the existing auto, taxi and two wheeler parking. It comprises of vendor shops, ranging from foods & beverages to book stalls, waiting spaces, public conveniences, an electric sub-station and a pump house. Encroachments by vendors, blocking of the pedestrian pathways by food stalls, unkempt waiting spaces for passengers can be observed at the site.

Figure 5-13: ISBT Kashmere Gate Arrival Block

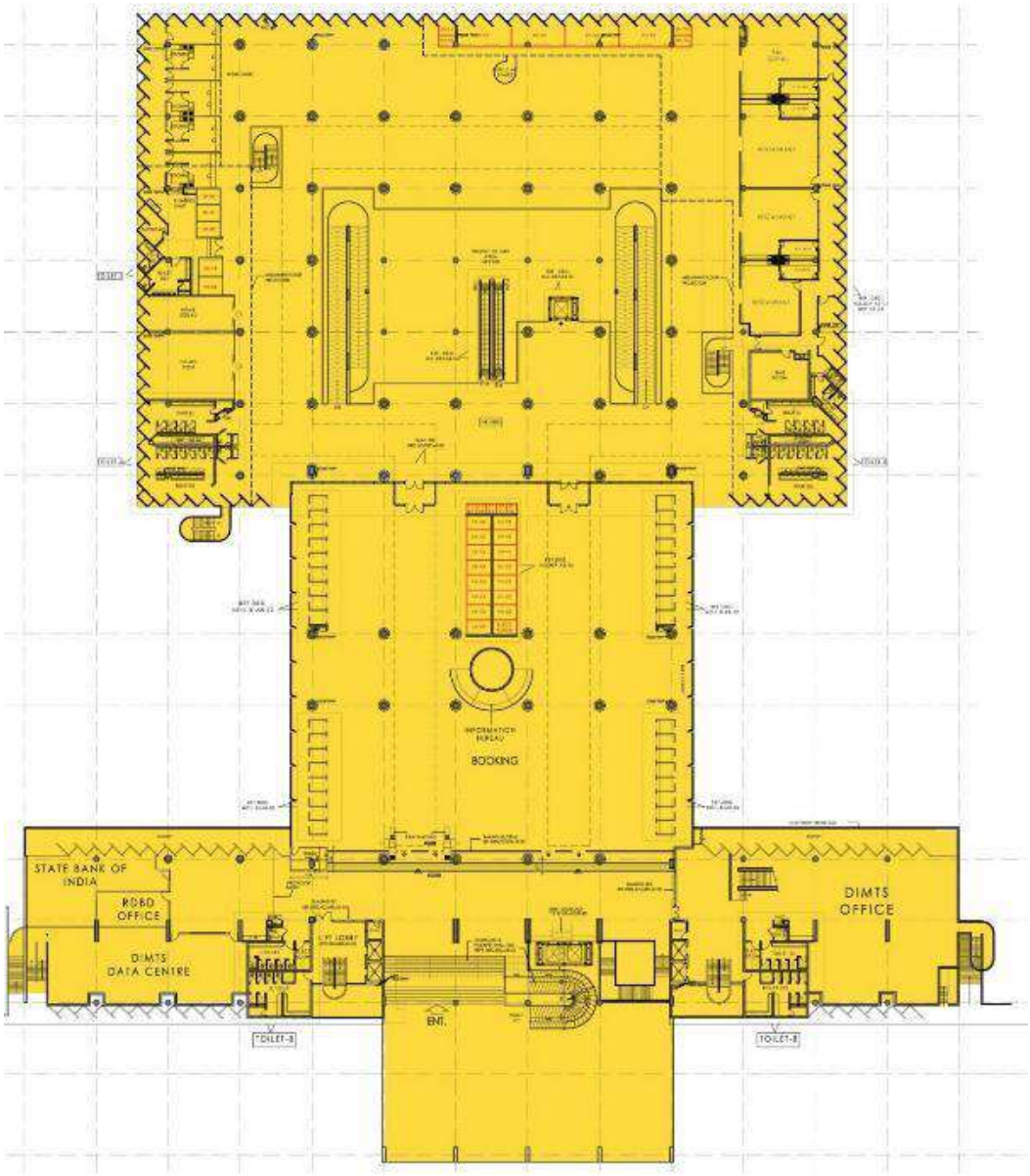


Figure 5-14: Terminal Building – Arrival floor plan

b) The Link Block

Close to the staff parking, the block provides an exclusive entry to the employees of the government and quasi-government offices located in the terminal premises. A six storey, rectangular shaped building structure has been developed at the onset of the Link Block, as an office space development. Comprising state and regional transport offices, like Rajasthan Tourism, Punjab Tourism, Himachal and J&K Tourism, Pollution Control Board, Mahanagar Telephone Nigam Limited and the Rural Development Board, among others. The Link Block also comprises large waiting spaces for passengers, seating areas, inquiry counters, a few vendor stalls (selling books, medicines, etc) and more than 40 vacant ticketing counters. Besides public conveniences, the block has a dilapidated state of infrastructure and observes low passenger footfalls

(owing to its location on the first floor). Passengers arriving from the Kashmere Gate terminal of the MRTS, enter the premises via the Link Block.

Figure 5-15: Previous Link Block at ISBT Kashmere gate

Figure 5-16: Link Block

c) The Departure Block

Comprising existing bus bays, the block has the maximum passenger footfalls (as it is located on the ground floor). The block has majority of the vendor stalls/shops (selling foods & beverages, magazines, books, medicines, STD booths, clothing & accessories, durables, bags etc.), waiting spaces for passengers, public conveniences, cloak room, a few ticket counters and inquiry

offices. The departure block has a poor state of infrastructure and is directly connected with the vehicular entry/exit of the terminal (from the Ring Road).

Figure 5-17: Departure Block ISBT Kashmere Gate

From an accessibility standpoint, the project site enjoys excellent advantages. It is easily accessible by road, with most of the inter-state bus traffic either originating or terminating at this landmark for the northern region. The site has excellent visibility from Ring Road, the major traffic artery at the city level. Moreover, the project site is a corner plot with entry possible from two adjacent sides of the property, with potential for excellent transport planning within the project site.

However, the surroundings of the project site provide a relatively poor visual image, an aspect that is likely to change over time. Project site enjoys the unique advantage of a considerable level of footfalls at the project site, an aspect that is likely to accord considerable advantage to the project site from the perspective of retail, and possibly hospitality, development. Overall, the project site possesses considerable real estate potential which may be unlocked through careful structuring of development typologies on the project site.

Figure 5-18: Departure Block

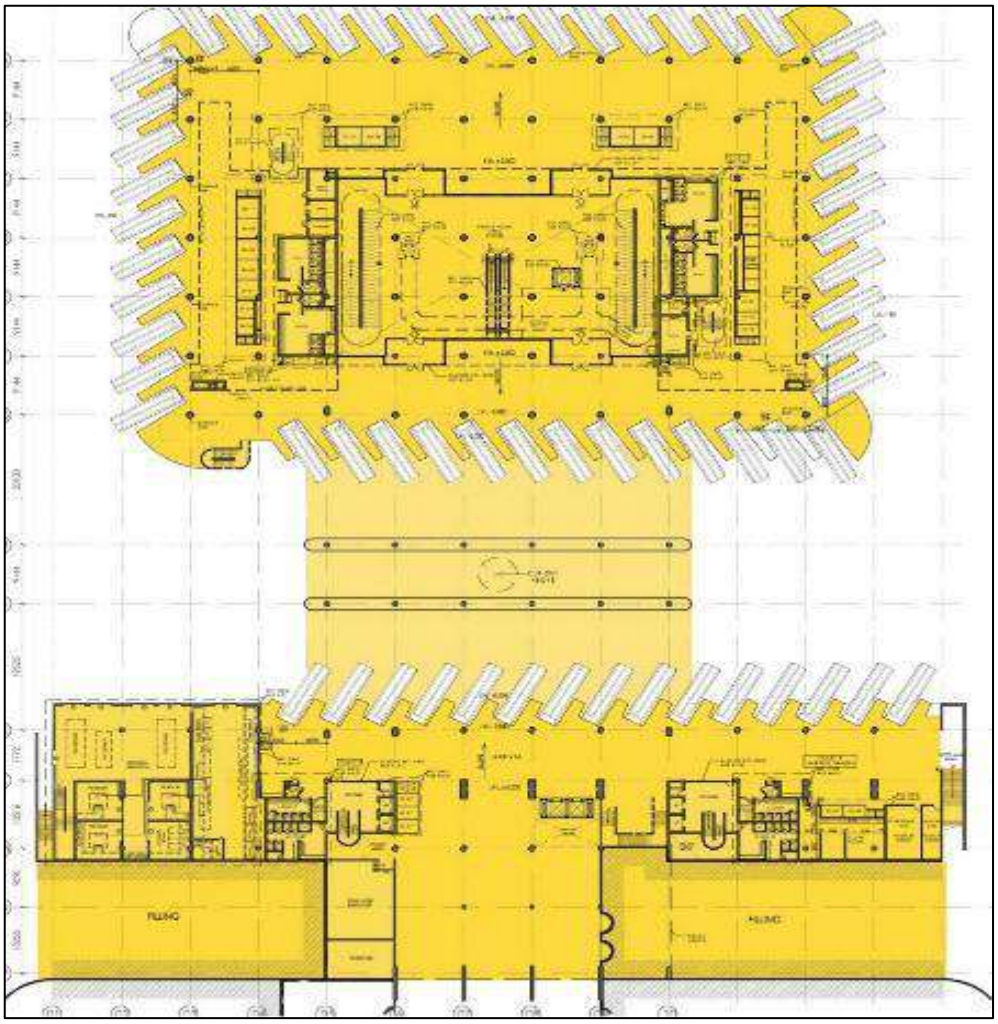


Figure 5-19: Ground level plan showing boarding and alighting bays

5.10.3. ISBT Chandigarh

Sector 43 ISBT was recently developed on a 21-acre site in south-east Chandigarh, between junctions 58 and 59 on Vikas Marg. As presented in Figure the site is adjacent to District Court Complex and near Judicial Academy, opposite Kajheri Village.

Figure 5-20: ISBT Chandigarh Location

The terminal provides interstate bus connections for Punjab, Haryana, Uttarakhand, Himachal Pradesh, and Jammu and Kashmir; and intra-city as well as sub-urban connections. Bus services include A/C and non A/C services for inter-city and sub-urban routes. The terminal serves over 80,000 passenger trips per day approximately with an average occupancy of 45 per bus.

Figure 5-21: Facility Placement at ISBT Chandigarh

The existing terminal premises comprises of five sections. Passenger volume during peak operation hours stood at 8,000 at the time of the survey, based on average passenger stay duration at 20 mins.

The buses ply over 91 routes (37 long, 47 local, 7 sub-urban) approximately. On average, 2 buses enter the terminal premises per minute, i.e. 120 per hour. The average bus frequency is 3-5 mins, average idle bus parking 20 mins, average offloading time 1 min, and average loading time 6 mins.

Vehicular circulation in the terminal. For ISBT buses, entry and exit to the terminal is from Vikas Marg.

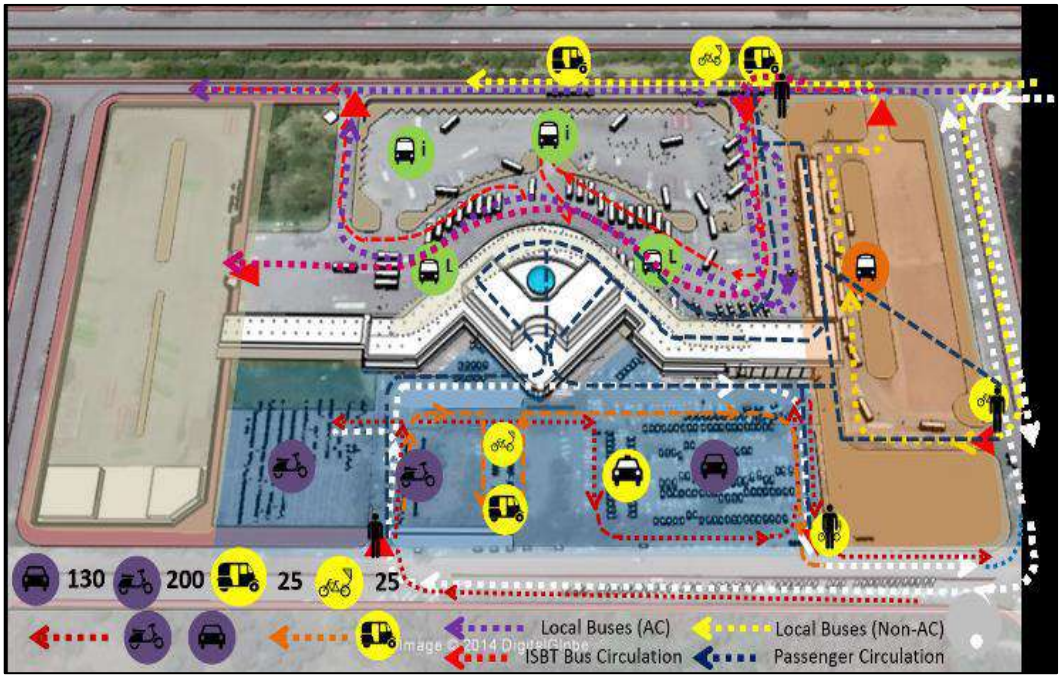


Figure 5-22: Vehicular Circulation

Evaluation of then operations showed that due to lack of designated unloading bays, drivers park and unload randomly within the bus parking area and main carriageway. Additionally, city buses also access the interstate bus zone to offload passengers, and to access the local bus depot. This creates bus-pedestrian circulation conflicts, rendering the terminal inefficient and risky. This also results in ambiguous bus movement resulting in chaotic circulation.

Vehicular parking can be accessed from the arterial road along the terminal site's periphery. It comprises 25 auto-rickshaw parking, 130 car parking (including taxi), 200 two-wheeler parking, and can accommodate up to 355 vehicles (ECS) at a time.

The terminal building comprises four floors with built-up area of over 8,500 sq. m. (excluding the currently vacant basement parking for two-wheelers).

The ground floor houses 11 reservation counters, 28 loading bays, shops, tourism offices, cloak room, and basic amenities like toilets and drinking water. It also includes facilities like a restaurant, Chandigarh Transport Undertaking (CTU) office, information, police assistance counter etc.

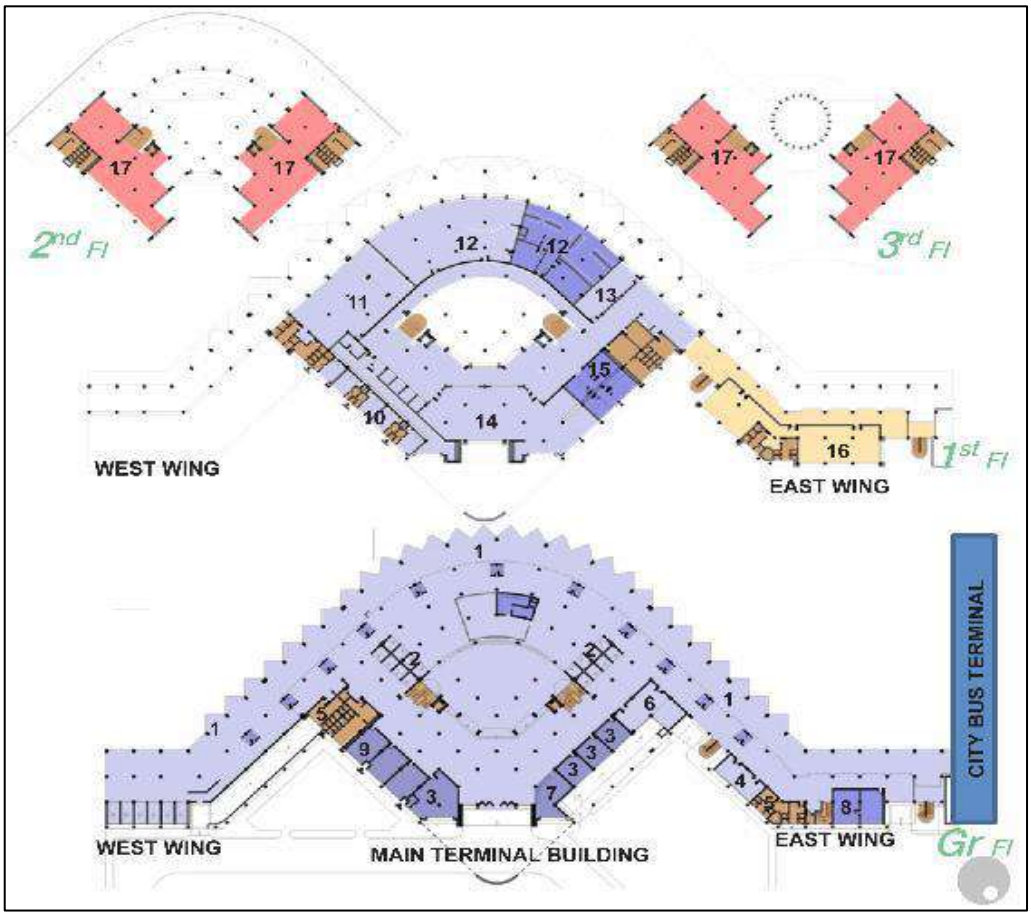


Figure 5-23: Floorwise Layout

The first floor houses a commuter lodge, consisting of five rest rooms with attached toilets, and a dormitory with dining hall and kitchen. It also accommodates a post office, railway reservation office, and five tourist offices. In the first floor's east wing, drivers and conductors have been provided rest rooms, drinking water, and toilets. The second and third floors are designated for commercial activity, including pantry and toilets.

5.11. Proposed Design philosophy

The designed bus port is a user-friendly transport hub with amenities for commuters such as help line for buses, taxi and auto rickshaw passengers.

a) Design features

i. Segregation between modes is very essential, particularly between pedestrians & other modes; and between public & private modes for better and safe mobility of commuters in the Bus Port area.

ii. Transfer is an essential part of multimodal trip and traveler has to change modes at transfer nodes. Hence seamless travel is an important characteristic of the system.
iii. Zoning for placement of Interstate bus movement related activities and movement activity of taxis/ autos/ private vehicles.
iv. Segregation of pedestrian and vehicular traffic.
v. Segregation of alighting and boarding platforms.
vi. Strategy for ensuring pedestrian connectivity between various types of buses and modes of transportation.
vii. Light-weight materials chosen enhance the curved forms implying the Bus Port to be a modern and high-tech building. Moreover the building shapes are corresponding to the efficient flow of traffic that has been one of the prime design criteria.
viii. Angular Boarding Bays are provided for boarding platforms.
ix. Placement of workshop area/ active bus parking area/ building area.
x. Maximum commercial exploitation, within the framework of local Bye Laws, for increasing the viability of the project for development.
xi. Adequate provisioning for infra utilities (power supply, water supply, water treatment, sewerage, sewage treatment, storm water drainage, solid waste management etc.)
xii. Dramatic cantilever roofs, projecting far out over the buses on either side.
xiii. Good and ample signage at all the critical junctures is necessary to guide and segregate the transit modes. These lead to legible spaces and helps in guiding the users through the complex mesh of transit modes and their related facilities.
xiv. The massive transparent facade and clerestories aid in natural lighting.

b) Design qualities

i. Inclusive to everyone - urban hubs that physically and mentally connect different parts of the city and its inhabitants.
ii. Accepts diversity as a norm.
iii. Maximize exchange opportunities while minimizing travel by concentrating exchange opportunities in one convenient place.
iv. Easy to get to and get through; it is visible both from a distance and up close.
v. Perceptions about safety, cleanliness, and the availability of places to sit.

c) Zoning Concept

Zoning of the proposed Bus Port site in the concept has been explained below:-

i. All the buses moving in one direction within the site.
ii. Separate entry and exit for buses and other vehicles.
iii. Parking is easily accessible without creating any hurdle to bus movement.
iv. Workshop, fuel station and washing space is at rear side as to give having maximum utilization of site by commercial & Bus Port building.

v. Modular toilets and bathing spaces.

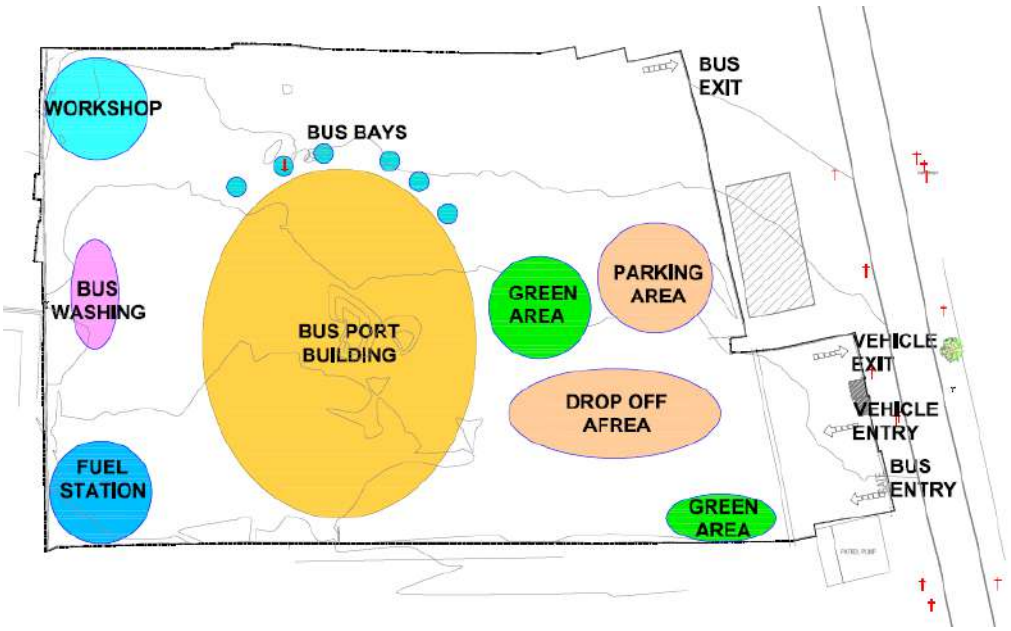


Figure 5-24: Zoning Plan

d) Commercial Development

Based on the market assessment study, a suitable product mix has been suggested.

CHAPTER 6

Concept Design

6. Concept Design

6.1. Design Standards

The design criteria of Bus Port determines its size and factors to be taken into consideration in planning the facilities. The activities to be undertaken in a Bus Port is primarily governed by the following factors:

- Traffic Demand
- Traffic Characteristics
- Function of Bus Port

The following design standards are adopted in the overall design of the concept for the Bus Port.

6.1.1. Bus Bay Requirement and Parking

The bus bay requirement for the Ramnagar Bus Port are calculated based on the outputs derived from the Traffic Survey and are presented below.

Bays	Number
Boarding Bays	5
Alighting Bays	1
Idle Parking Bays	4
Total Bays	**10**

Moreover, in the proposed bus port design, parking of 60 ECS is provided for bus port area.

6.1.2. Traffic Circulation

The space provisions for the purpose of Traffic Circulation in the Bus Port are tabulated in the table below:

Table 6-1: Traffic Circulation

Description	Value
ROW of entry roads for bus movement	7.00 m (2 lanes of 3.50 m each)
ROW of exit roads for bus movement	7.00 m (2 lanes of 3.50 m each)
ROW of entry road for other vehicles movement	3.50 m
ROW of exit road for other vehicles movement	3.50 m
ROW of road for Pedestrian movement	6.00 m

6.1.3. Passenger Circulation

Level of Service (LoS) A has been adopted for the calculation of the area requirement for passenger circulation. An area per person ≥ 3.3 sqm (LOS A as

per Fruin standards) is the desired space for people to move comfortably in the Bus Port.

6.2. Facilities Proposed in the Bus Port

SN	Facilities in the Bus Port Building and Passenger Access Area
1	Digital Display Boards, PA system, Surveillance & Security System (CCTV)
2	Toilets, Drinking water fountains
3	Car and two wheeler Parking for office staff and visitors
4	Designated Parking area for Auto rickshaws, Taxis and NMTs
5	Bus Port with one-way traffic and no conflicts; segregated pedestrian (via elevated walkways) and vehicular movement

SN	Bus Port Office Area Facilities
1	Air-conditioned administrative offices
2	Fire Detection System and BMS for control of HVAC

SN	Bus Port Operations Facility
1	Designed with boarding and alighting bays
2	Idle Parking bays for the buses
3	Rest Rooms

SN	Facilities for Information Dissemination at the Bus Port
1	Bus Port Information broadcast on Mobile (bus info/terminal info/ navigation/ you are here etc.)
2	Trains and flight info system for intermodality
3	Real time bus arrival in PIS
4	Info of bus information and bus port location at Railways stations and Airports in the city

SN	Bus Port User Interface
1	Complaint Redressal - Housekeeping
2	Feedback collection – online and paper based
3	Lost and found

SN	Bus Port Building Aesthetics
1	Distinct branding, logo and colour scheme
2	Displays for Cultural/ social/ Historical heritage of the city, photographs and places to go
3	Murals/ panting / statue/ fountains
4	Ambient Music and lighting

SN	Facilities for User Convenience at the Bus Port
1	Mobile Help desk – Assistance on the move
2	High Quality Stainless Steel seating
3	Hotel reservation counters
4	Travel desk - Taxi/ prepaid counter, railway ticket
5	TV in waiting area
6	Smoking room
7	Clock – Digital
8	Free Wifi
9	Commercial Area
10	Dormitories/ Yatri Niwas

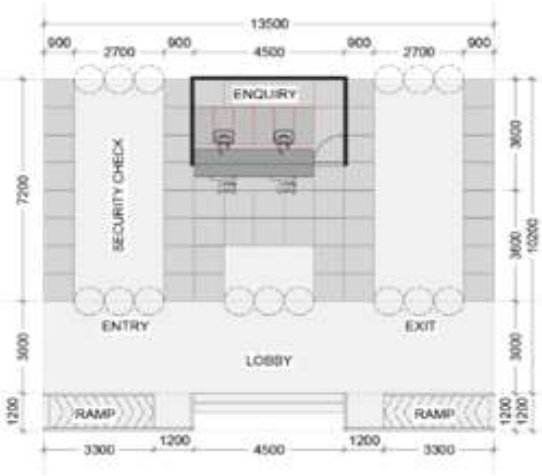
SN	Facilities for User Convenience at the Bus Port
11	Prepaid taxi booth
12	Mobile charging points
13	GPS tagging on luggage & children for tracking
14	Freshen up & go - Time capsules
15	Cloak/ Parcel Room
16	Food Court
17	Kids activity area
18	Trolleys/ Wheelchair, porter
19	ATMs
20	Child care

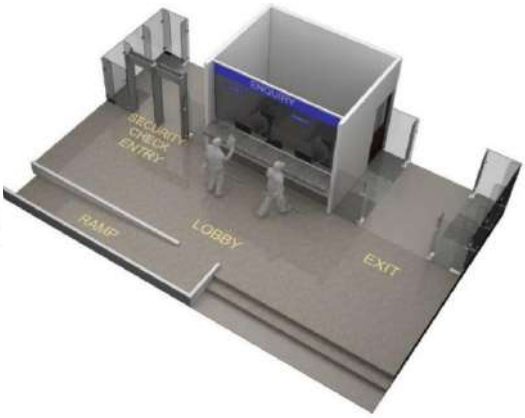
SN	Green Building
1	The buildings have been designed to be eco-friendly with GRIHA 3 star rating or more
2	Completely day lit spaces for with minimal artificial lighting
3	Complete retention and reuse of waste water
4	Rainwater harvesting and its use for landscape purposes
5	Complex ready for easy Solar PV installation

6.3. Architectural Space Standards for Bus Port Building Facilities

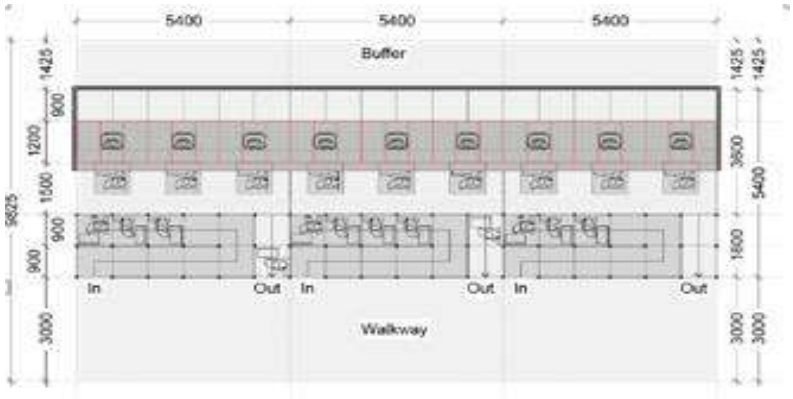
This section provides the space standards and functional layouts for Bus Port Passenger Facilities to be provided in the Bus Port building. The layouts for the Bus Port components are scalable and can be replicated based on the specific requirements as per the requirements of the bus port.

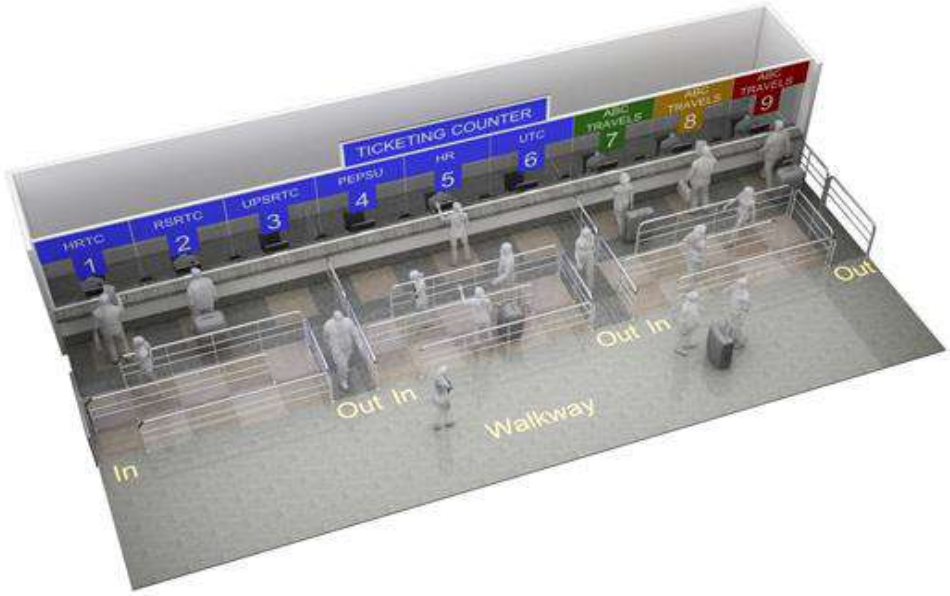
6.3.1. Entrance Lobby



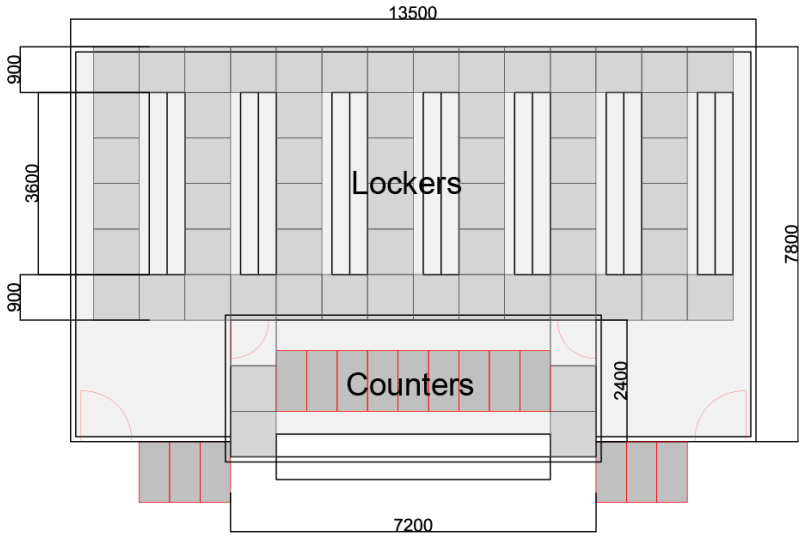


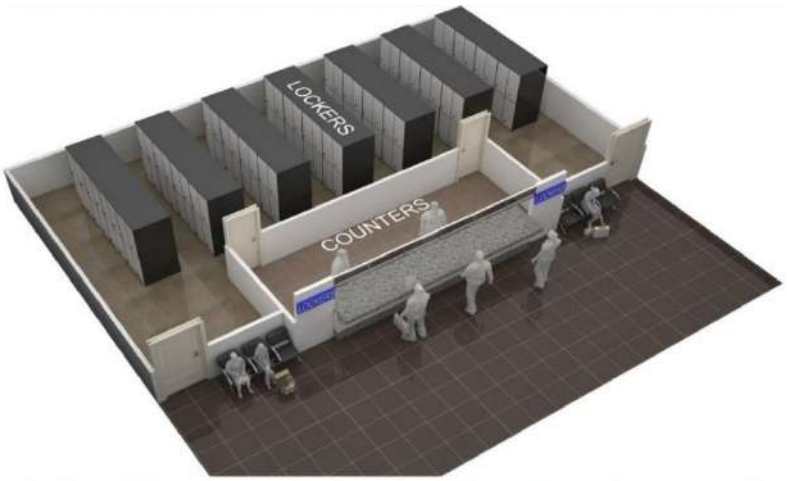
6.3.2. Ticketing and Queuing



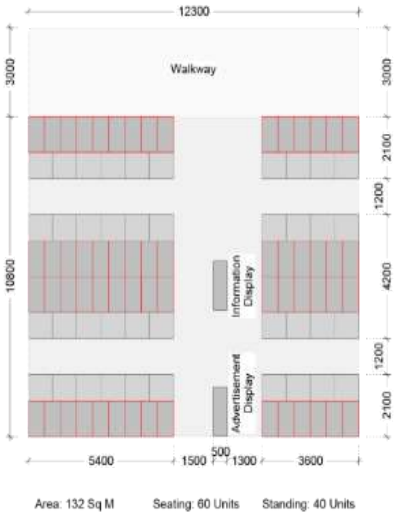


6.3.3. Cloak Room

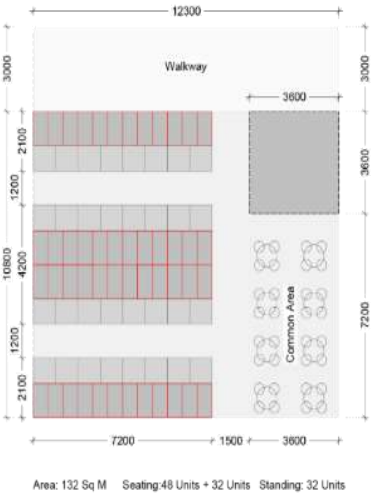




6.3.4. Waiting Areas

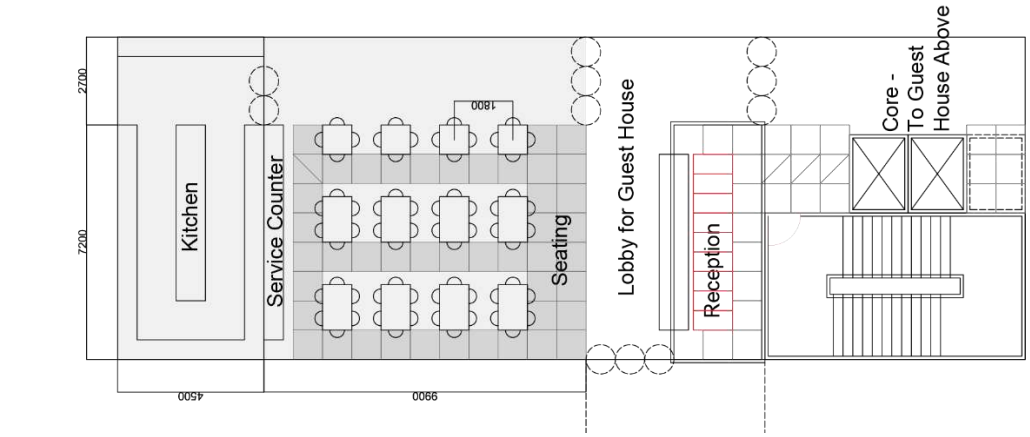


Waiting Area – Type 1

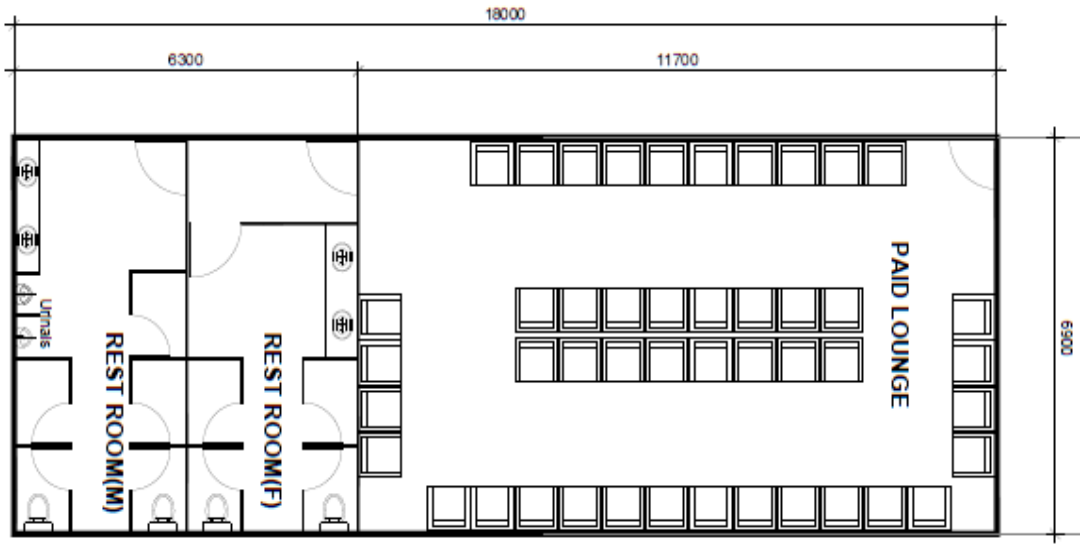


Waiting Area – Type 2

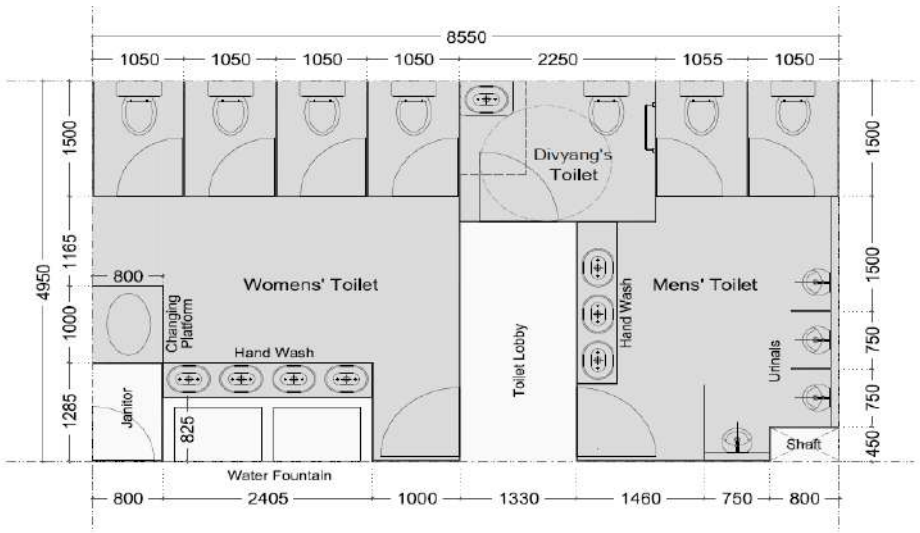
6.3.5. Cafeteria



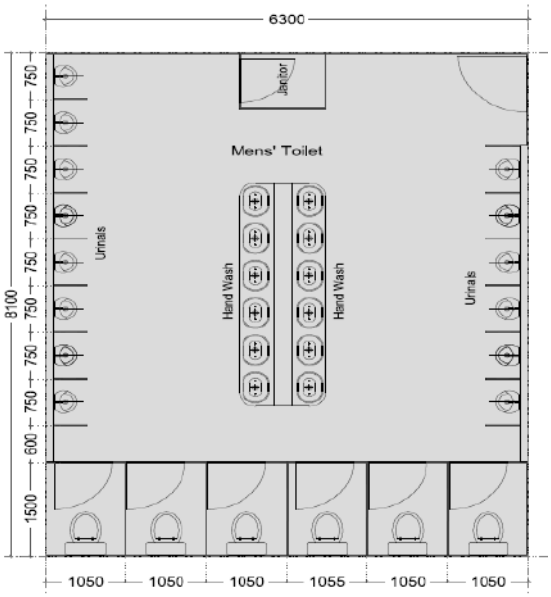
6.3.6. Passenger Lounge



6.3.7. Restrooms

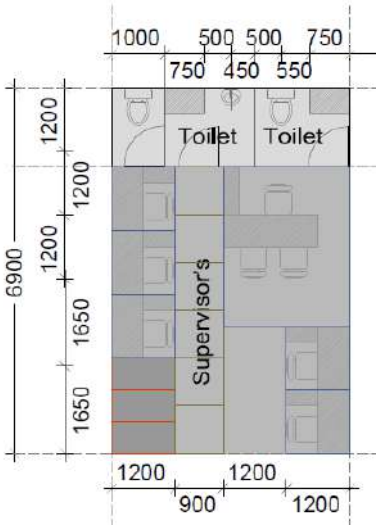


Restroom – Type 1

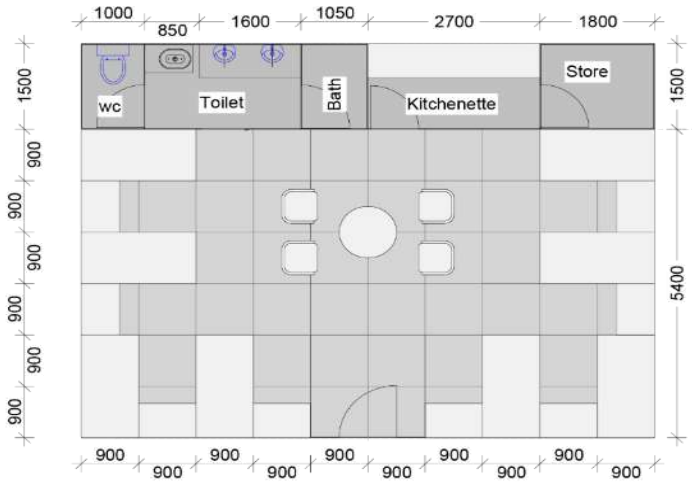


Restroom – Type 2

6.3.8. Back Office



6.3.9. Staff Dormitory & Driver's Lounge



6.4. Design of Bus Bay Arrangement

The boarding bays have to be easily accessible by the bus with minimum manoeuvring.

Four alternatives of arranging the bus bays are shown in figure below.

Option 1: Saw tooth Bay

In a Saw tooth Bay setup, the buses are parked in saw-tooth shape and is generally used where quick turnaround of buses is required.

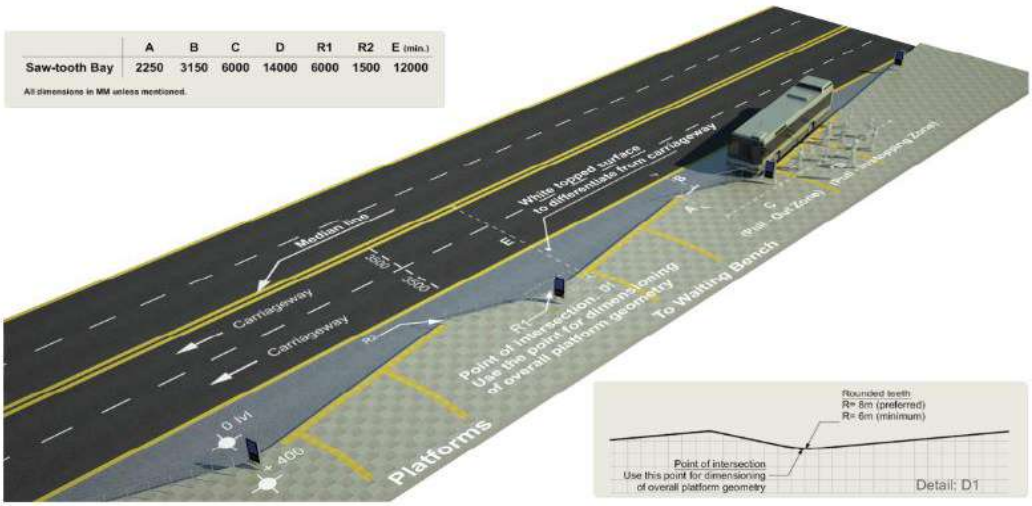


Figure 6-1: Passenger Boarding/Alighting Bay Options- Saw tooth Bay

Option 2: Parking Bays at 45° angle

In this setup, the buses are parked at 45° angle which requires the bus to back out from the parking bay with dwell time of 3-5 minutes.

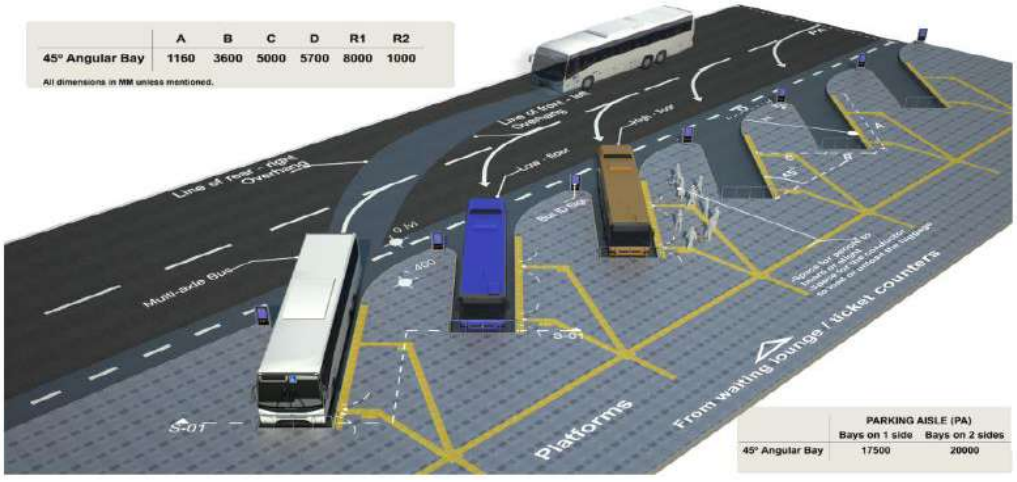


Figure 6-2: Passenger Boarding/Alighting Bay Options- Angular 45° Bay

Option 3: Parking Bays at 60° angle

In Option 3, the bus bays are at 60° to the platform. This parking configuration requires the bus to back out from the parking bay and is generally used for intercity bus operations with dwell time in excess of 5 minutes.

Figure 6-3: Passenger Boarding/Alighting Bay Options- Angular 60° Bay

Option 4: Parking Bays at 90° angle

In Option 4, the bus bays are at 90° to the platform. This is a compact parking configuration and requires minimal parking space per bus. However, in this configuration, buses have to back out leading to increased dwell time.

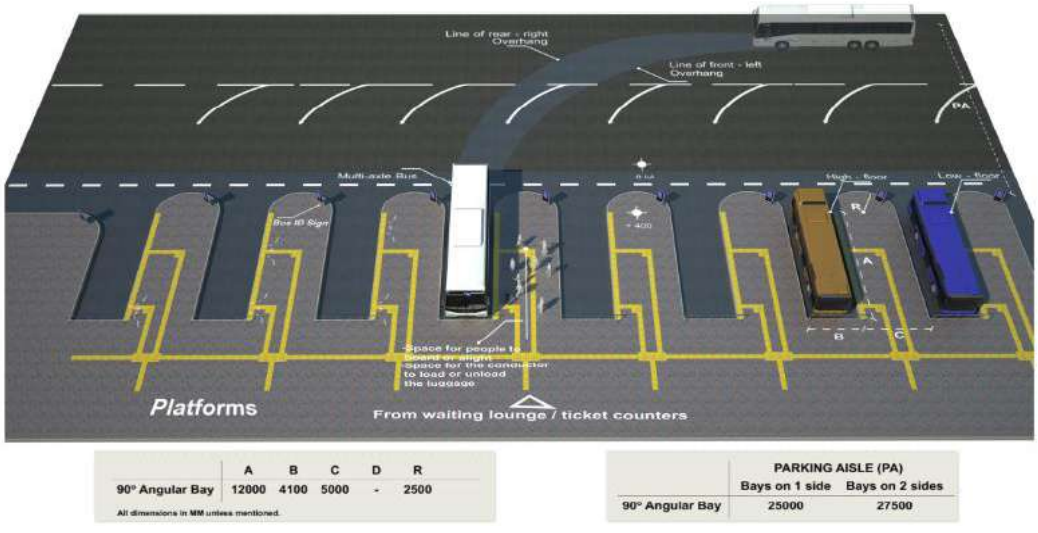


Figure 6-4: Passenger Boarding/Alighting Bay Options- Angular 90° Bay

It is preferable that buses turn head first into the bay because boards are more visible and drivers find it more convenient. By considering vehicular and pedestrian manoeuvrability, peak demand and area required per bay, Option 3 will

provide the best solution for Boarding Bays and the same has been considered in the concept development for the Bus Port.

6.5. Functional and Geometric Design Dimension Parameters

The following table indicates the minimum dimensions related to functional and geometric design aspects of the bus port components.

Table 6-2: Minimum Functional and Geometric Dimensions

SN	Parameter	Minimum Requirement
1	Bus Bay dimension	3.5m x 12.0m clear space along with a stub arm of 2.5m wide
2	Turning radius for bus movement	not less than 14.0m
3	Driveway width for bus	not less than 16.0m
4	Width of the passenger platform, in case of bus bays on only one side of the passenger platform	not less than 9.0 m
5	Clear height of passenger concourse in the boarding area including boarding platforms	not less than 6.0m
6	Driveway width at the bus entry/exit gates	not less than 7.00 m

6.5.1. Circulation

a) Patterns of circulation play a determining role in the architectural organization of this bus port. There is a strict segregation of vehicular (bus movement) and pedestrians in the entire Bus Port.
b) One way bus movement.
c) Providing clear circulation will assist the flow of passengers create regular movement patterns inside the Bus Port. Effective signage will be used to differentiate between the different objectives in the Bus Port (travel, retail etc.) and to prioritize circulation flow. e.g. the information provided about travel should be more conspicuous than that provided for retail and other ancillary activities.
d) The key aim of successful circulation will be to reduce areas having high concentrations of people. This will be done specifically to avoid bottlenecks in the Bus Port, allowing sufficient space before and after the ticket counters, elevators, stairs and other critical points, where congestion could occur.
e) Vertical circulation is provided from various points throughout the Bus Port in the form of stairs and lifts. The combination of non-mechanical and mechanical means of vertical circulation ensures that there is not a reliance being placed on the local electrical infrastructure which is generally considered unreliable. This being said, in the event of a power failure, an emergency backup Diesel Generator will be implemented, which will cause the lifts to restart automatically.
f) Pedestrians have conflict free movement which eases the movement patterns and prevents unwanted accidents.

6.5.2. Entrances and Exits

a) At entrances and exits of the Bus Port, Mild steel gates have been provided for security and safety purpose and also for avoiding trespassing during non-operational hours.
b) Apart from the Gates which will remain open during the operational hours, boom barriers have been provided for monitoring and managing the bus entry/ exit system.
c) Large sign boards on Gantry structures have been provided at the entrance of the Bus port.
d) Security cabin have been provided near the entrance and exit which houses space for 1 personnel who would manage the bus entry/ exit and assign necessary instructions for parking etc.
e) Segregation of private vehicles and buses is provisioned to provide conflict free movement between the two modes.

6.5.3. Parking

a) Adequate space has been provided for parking of Private vehicles.
b) Islands with soft landscape have been planned at the edges of the parking lot.
c) Parking area is defined with cement concrete kerbs and individual parking space is demarcated by paint.
d) Parking calculation is done as per the Uttarakhand Building Bye-Laws and Regulations, 2011 (Amendment 2016).

6.5.4. Bus bays

a) The buses are parked at an angle of 60^{o} for the boarding bays and in saw-tooth formation for the alighting bays.
b) Tyre stopper provision has been made about 1m before the kerb so that the front overhang of the bus is within the bay and not projected onto the platform.
c) The edge of the bay is defined by a 300mm high cement concrete kerb.
d) Steel space frame canopy with tensile fabric has been planned for above the bus bays partially to provide shade to the alighting passengers.

6.5.5. Platforms

Platforms are the spaces for passengers to move and maneuver before and after boarding and alighting their buses respectively. These are not enclosed spaces, but roofed areas so that there is protection from sun and rains.

a) For visual transparency within the platforms, minimum mandatory enclosures are planned in this area like ticket counters, police control room etc.
b) Flamed granite is used in flooring for ease of maintenance, durability and for its non-slip characteristic to aid the old age and physically challenged passengers.

c) Tactile flooring for the visually impaired people has been integrated with the granite flooring throughout the platform areas.
d) Directional signage directing towards various spaces like toilets, drinking water etc. is planned at various locations for the ease of the commuters.
e) All wall surfaces and column surfaces are cladded with polished granite up to ceiling for ease of maintenance and durability.

6.5.6. Administrative areas

a) Ticket counters and Enquiry counters have workstations along with granite window counter for ticketing.
b) The windows in ticket counters are UPVC sliding windows with fixed glass at lower portion of window with opening for cash and ticket transaction.
c) Aluminium grill for security has been provided at the window.
d) RCC slab at 3.3 m level is provided with Gypsum false ceiling below.
e) Quartzite stone flooring is within the rooms.
f) All of the rooms are finished with Vitrified tiles on floor, Plastic paint on walls and Oil Bound Distemper finish on walls.

6.5.7. Toilets

a) Sanitary provisions have been made as per National Building Code (2016).
b) The extract of the reference from NBC is stated below.

Table 6-3: Fixtures at Stations: Male and Female

SN	Fixtures	Junction stations, Intermediate stations and Bus stations	
		Males	Females
1	Water Closet	3 for up to 1000. Add 1 per additional 1000 or part thereof	4 for up to 1000. Add 1 per additional 1000 or part thereof
2	Urinals	4 for up to 1000. Add 1 per additional 1000 or part thereof	-
3	Wash Basins	1 per wc/ urinal	1 per wc
4	Toilet for Disabled	1 per 4000	1 per 4000

c) The toilet is finished in ceramic tile flooring.
d) In walls, cladding is in ceramic tile up to 7 feet height and Oil Bound distemper finish above 7 feet.
e) Wash basins counters are made of Polished Granite.
f) Looking Mirror is fixed in wooden frames at length along the entire wall above the wash basin up to 7 feet height.

6.5.8. Vertical Circulation elements

a) Combination of manual and automatic vertical circulation elements is provided.

b) Staircases have been provided as per the provisions in the National Building Code 2016.
c) Flamed finish granite is for the floors.
d) Walls are cladded with polished granite up to ceiling for ease of maintenance.
e) The Geometry of stone cuts is coordinated with the floor joints.

6.5.9. Shops/ Commercial areas

a) Apart from mandatory facilities in the Bus Port, certain other facilities like kiosks, food court etc. are provided.
b) Some shops are provisioned for in the Ground floor that would primarily cater to the basic requirements of the passengers.
c) Bare shell of these rooms is provisioned for and the finishing in terms of floor finish, wall cladding etc. shall be done as per the end user or the retailer to whom the shop would be allotted or leased out.
d) Each of the shop is provisioned with rolling shutter for security.
e) Windows for natural ventilation are UPVC finished frames with fixed glass and aluminium grills.

6.5.10. Common areas

a) All common areas are user friendly.
b) All seating in waiting areas is in brushed finish stainless steel finish fixed to the floor and not kept lose.
c) Seats are with arm rests to discourage sleeping.
d) Bollards are used at entrance areas to control vehicular access in the pedestrian zone.

6.5.11. Signage

Signage are user-friendly and provide information essential to users, engendering a sense of reassurance, security and orientation when entering, exiting or transferring. It shall guide users to various areas, provide information of the Bus Port and its services and provide information on bus services. User information shall cover the following as the minimum.

a) Static signage such as Bus port name, destination of services, platform number, way finding signs, direction, entry and exit etc.
b) Variable signage such as real time travel information to customers etc.
c) Maps and long term changeable information on scheduled services and ticket costs.
d) Information on the use or operation of a place or system.
e) Intermodal connections
f) Emergency exits
g) Rules of conduct to users
h) All signage shall have alternate pictorial signage. User information displays are so located that users seeking information have ready access without

obstructing free flow of users. Signs shall be placed at decision points and perpendicular to the line of sight.

6.6. Area Statement

The table below presents the area statement of the project.

Table 6-4: Area Statement

Facility	Built-up Area (in sqm)
Bus Port Building	
Ground floor	2,680
First Floor	2,026
Sub Total	**4,706**
Workshop	
Ground Floor	200
Sub Total	**200**
Guard Room	
Ground Floor	20
Sub Total	**20**
Total	**4,926**

In addition to the aforementioned areas, open rooftop restaurant having an area of 400 sqm is also provided.

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6.7. Concept Plans

Concept plans have been prepared and same are provided below.

Site Layout Plan

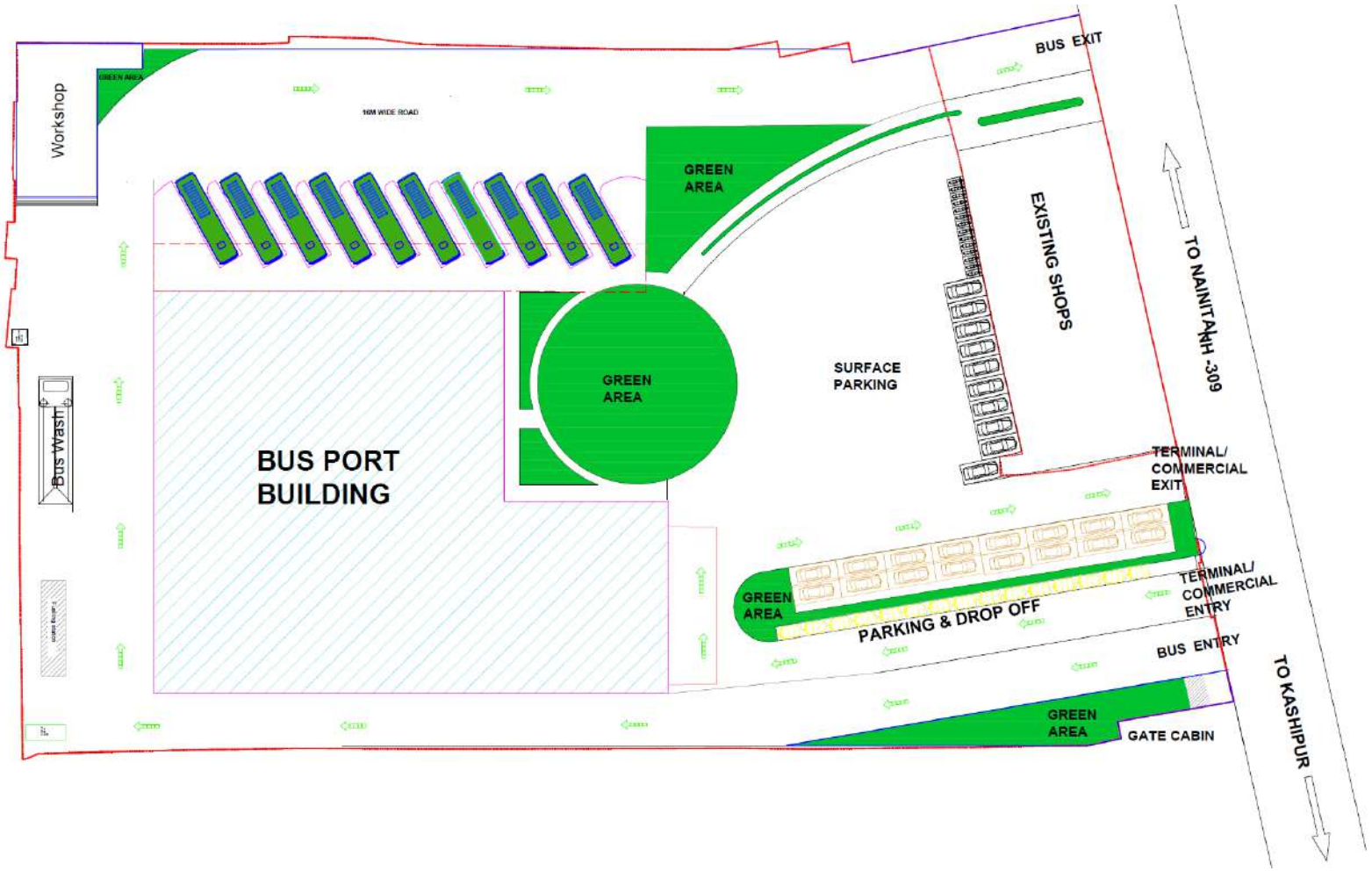


Figure 6-5: Site Layout Plan

Ground Floor Plan

Figure 6-6: Ground Floor Plan

First Floor Plan

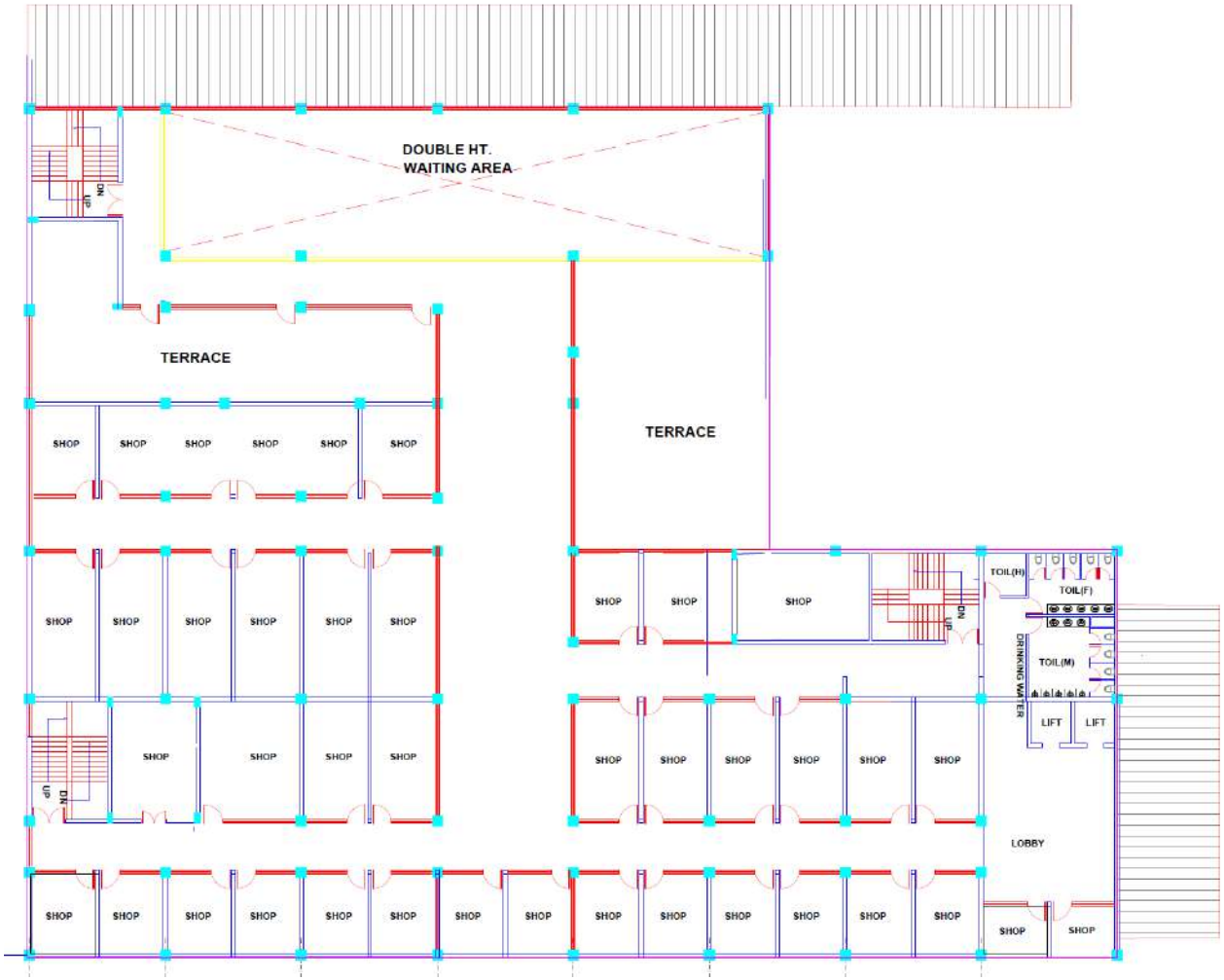


Figure 6-7: First Floor Plan

Bus Circulation

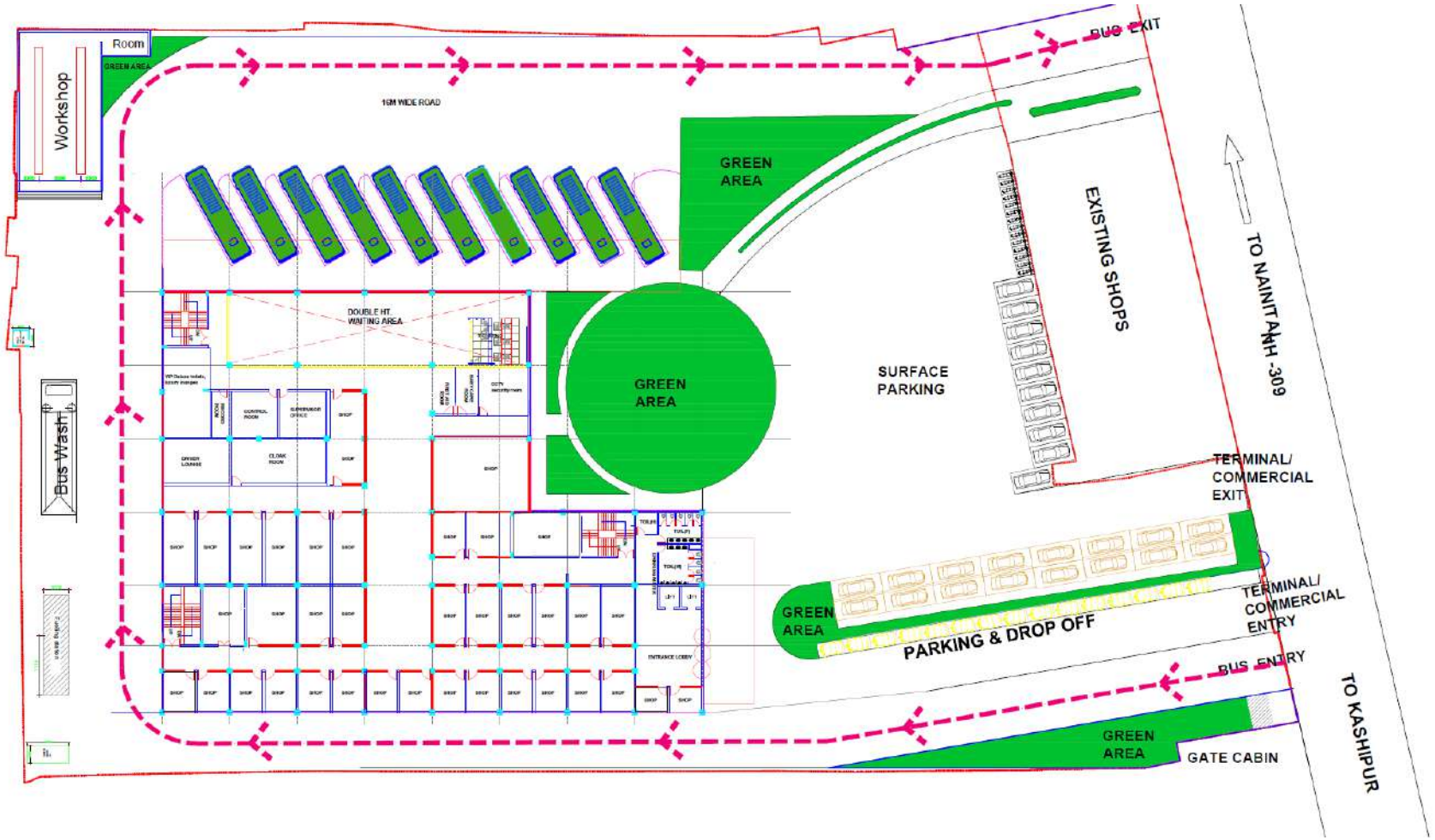


Figure 6-8: Bus Circulation

Vehicular Circulation

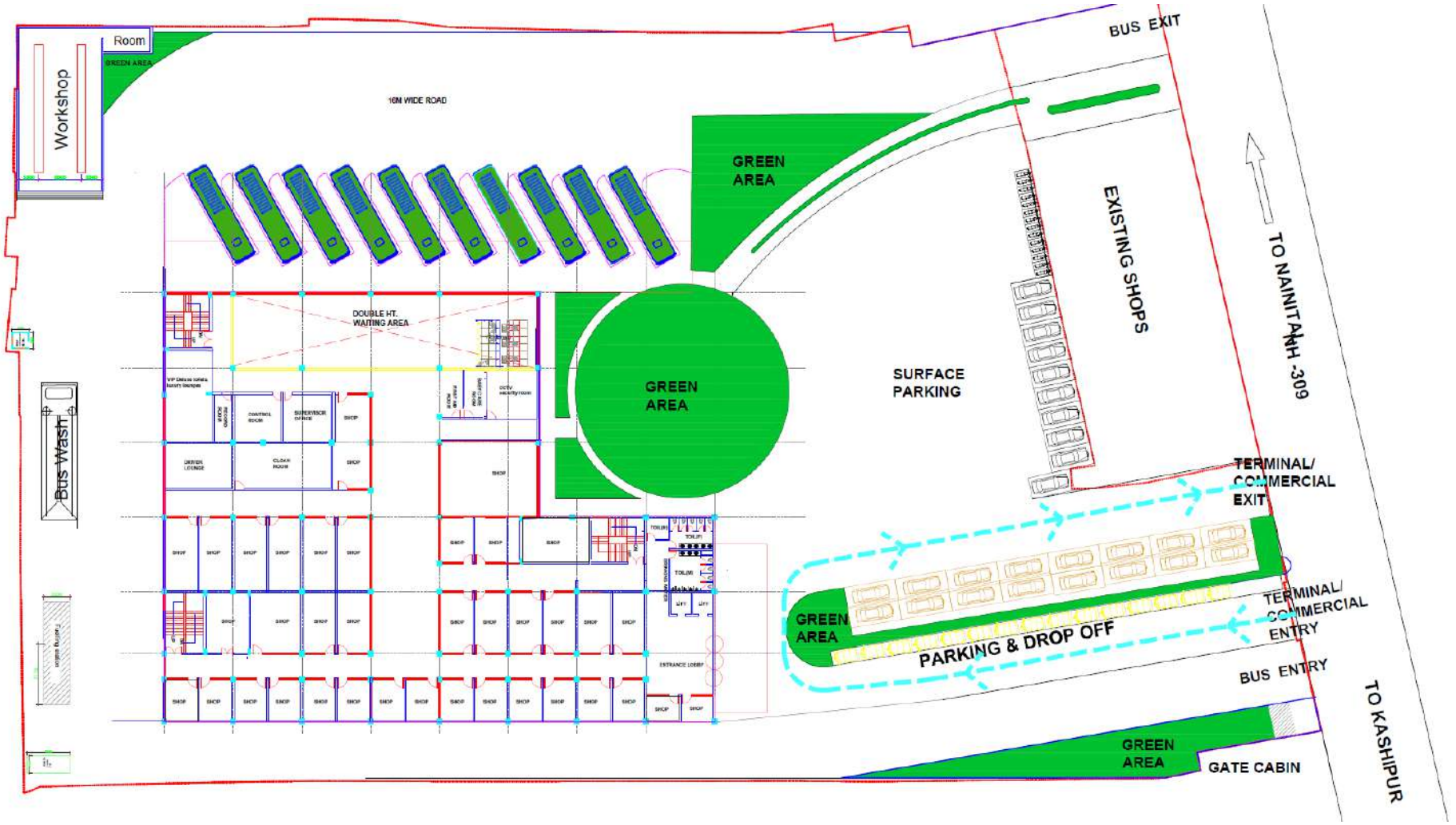


Figure 6-9: Vehicular Circulation

Pedestrian Circulation

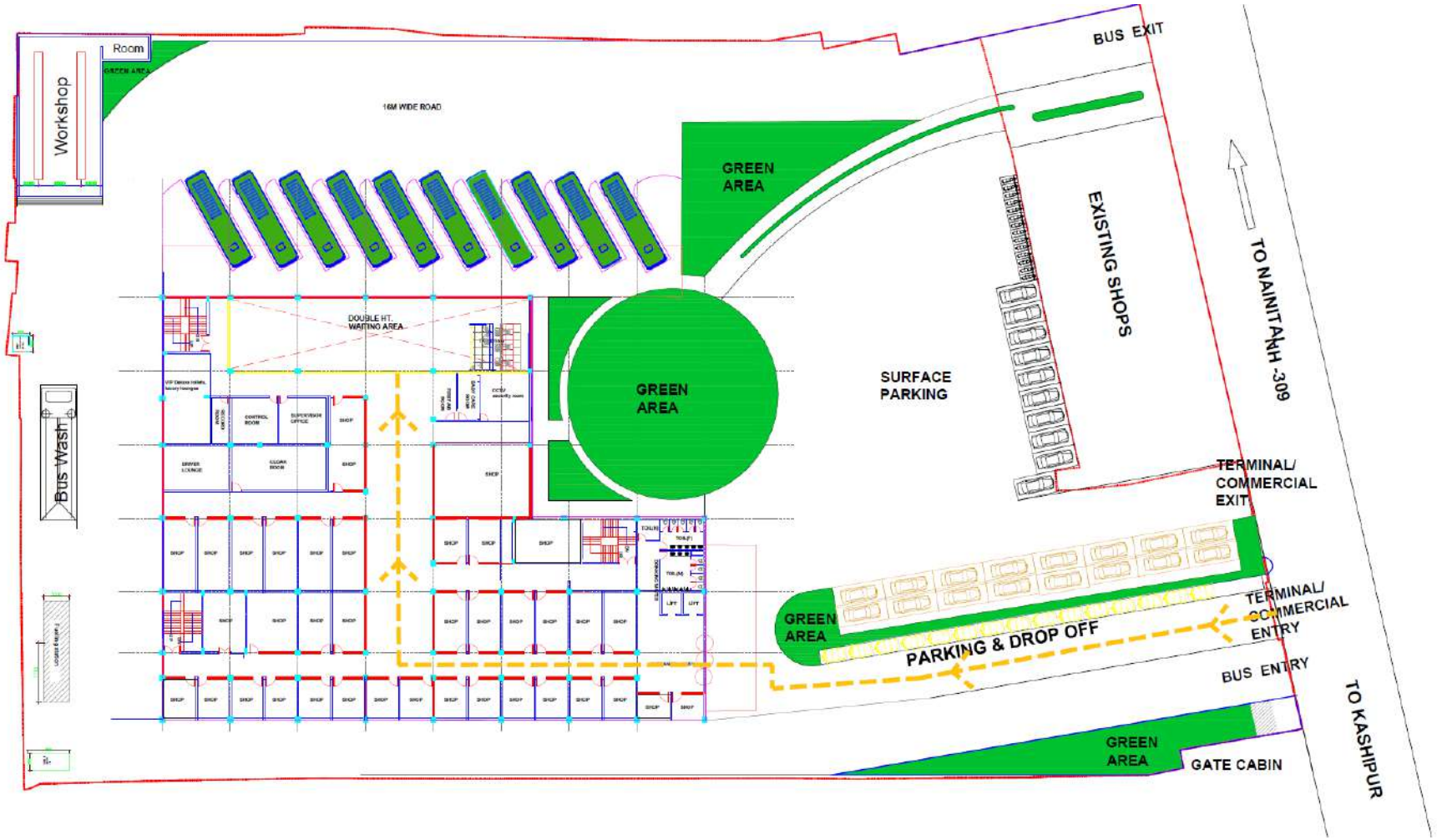


Figure 6-10: Pedestrian Circulation

CHAPTER 7

Project Cost Estimation

7. Project Cost Estimation

7.1. Project Cost Estimation Basis

The project cost has been assessed separately for Bus Port and commercial facilities to be developed on PPP basis. Since the project is envisaged to be developed by private developer after selection under competitive bidding, the optimization of project cost is key for winning and development of the project from the perspective of any potential bidder.

The project cost has been estimated using CPWD Plinth Area Rates, 2020 since the project facilities shall be developed by the private developer according to the market needs and trends.

7.1.1. Detailed Project Cost Estimation

The table below presents the project cost estimated for different project facilities.

Table 7-1: Summary of Project Cost

Description	Cost (in Rs. Crores)
Bus Port	18.41
Workshop, Fuel Station & Washing	0.90
Solar Plant	0.65
Quality & Contingency @ 3%	0.60
IDC	1.97
Total Project Cost incl. IDC	**22.53**

CHAPTER 8

Project Structure & Financial Feasibility

8. Project Structure & Financial Feasibility

8.1. Project Structure

The project is envisaged to be developed on PPP basis with the following assumptions:

- The successful developer shall design, finance, build the Bus Port Facility and Commercial Facilities (together referred as Project Facilities).
- The successful developer shall operate the Bus Port Facility for a specified period after which it shall be handed back to authority.
- The developer shall develop and operate the Commercial Facilities for a specified period.

It may be noted that the specified period (or Concession Period) for which Bus Port Facility and Commercial Facilities would be given to a developer may be same or different depending upon the project structure.

8.2. Tentative Roles of Authority and Private Developer

8.2.1. Role of Government/ Authority

The Authority shall have the following role.

- Act as a Concessioning Authority
- Provide necessary administrative and legislative support to the Developer
- Assessment of technology provided by the vendor/ Developer
- Assistance in providing clearances for the project

8.2.2. Role of Developer

The Developer shall have the following role.

- Design, build and operate the project for the Concession Period
- Arrange finances for the project
- Collect revenues from the operations of the project including Entry Fee
- Collect revenues from commercial area
- Maintenance and Operations of the Project Facilities for the Concession Period
- Capital expenditure for expansion and replacement
- Transfer the project to the Authority after the completion of Concession period

8.2.3. Role of NHIDCL

NHIDCL shall have the following role.

- Finalization of the Drawings and Documents

- Coordination with MoRTH for finalization of Documents
- Coordination with State Nodal Agency for implementation of project
- Inspection and Monitoring of Construction Works
- Inspection and Monitoring of O&M
- Assisting Parties in resolution of disputes

8.3. Financial Viability Assessment

The financial viability analysis for the Bus Port Facility has been conducted to assess the probable returns for the project for development under PPP project structure. The section below provides financial assessment of the project.

8.4. Methodology – Discounted Cash Flow

Discounted cash flow method is the most preferred method for assessment of project potential and valuation for such projects and widely followed in the infrastructure sector. The methodology takes into account the projected revenue, capital cost and operations cost for the operational period of the project. Based on the cash flow projections, the parameters such as Project IRR, Equity IRR and Net Present Value (NPV) are estimated. For assessment of project potential and conducting discounted cash flow assessment, the following steps have been followed.

- Detailed market assessment for
  - projecting the product mix,
  - probable rentals,
  - possible increase in rentals
  - Capital cost of commercial component
  - Operational cost estimation and increase in O&M cost
- Assessment of financial issues such as debt to equity ratio, interest rates, taxes etc.
- Development of suitable project structure and risk allocation
- Estimation of Capital cost
- Estimation of O&M cost for the operations period
- Projecting the cash flow for the concession period
- Assessment of NPV & IRR

8.5. Financial Analysis

To check the financial feasibility of the project and to suggest a suitable project structure for the transaction to take place, a financial model has been developed for the project. The key highlights of the financial model are as follows:

- The financial model estimates the project revenues and cash flows for the full term of the concession period

- The financial model has been designed to run sensitivity analysis under different scenarios. Sensitivities have been run under different scenarios for inputs such as capital cost, rentals etc.
- The values for the input parameters for calculation of revenues and cost have been taken based on current market trends and industry practices.

8.5.1. Inputs for Revenue Estimation

The table below provides the inputs to the revenue estimates from commercial development.

Table 8-1: Input Assumptions for Revenue Estimation

SN	Assumptions	Unit	Value
Bus Port			
1	Rental for commercial space at ground floor	Rs./sqft/month	60
2	Rental for commercial space for upper floors	Rs./sqft/month	50 (First Floor) & 40 (second and above floors)
3	Increase in rentals	% per annum	5%
4	Absorption Rate	Year 1	75%
		Year 2	85%
		Year 3	95%
5	Rental value from commercial (kiosks, small shops) in high footfall area	Rs/sqft/month	90
6	Revenues from advertisement, parking and kiosks	% of commercial revenues	5%
7	Adda Fee for UTC Buses	Rs/Entry/Day	50
8	Adda Fee for Other Buses	Rs/Entry/Day	100
9	Escalation in Adda Fee	% per annum	5%
10	Increase in Bus Trips	% per annum	2%
11	Night Bus Parking Charges	Rs. Per Bus Per Night	100
Solar Plant[1]			
12	Capacity	in KW	100
13	Number of Units produced	Unit per KW per day	4
14	Operational days	Number of Days	300
Parking			
15	Average occupancy	%	75%
16	Parking Charges	Rs. Per ECS per usage	30 for first 2 hours 5 for additional 1 hour
17	Escalation in revenue	% per annum	3%
18	Turnaround time of vehicles	Hours	2

1 It is to be noted that power output of solar plant will be used for internal consumption.

8.5.2. Inputs for Operations and Maintenance Expenses

The table below provides the inputs to the estimation of Operations and Maintenance (O&M) expenses of the project.

Table 8-2: Input Assumptions for O&M Expenses Estimation

SN	Description	Unit	Value
1	O&M expenses of Bus Port	% of capital cost	2%
2	O&M expenses of Solar Plant	% of capital cost	0.5%
3	Increase in O&M expenses	% per annum	5%
4	Other expenses for Commercial Space (marketing, asset management etc.)	% of rentals	3%

8.5.3. Inputs for Capital Cost Phasing

The construction period is assumed to be 2 years for the project. The table below provides the inputs to the capital cost phasing for the project.

Table 8-3: Input Assumptions for Capital Cost Phasing

SN	Description	% Breakup	2022	2023
1	Civil Works	70%	50%	50%
2	Mechanical works & Electrical	30%	20%	80%

8.5.4. Financial Assumption Inputs

The table below provides the financial assumption inputs for estimation of project viability.

Table 8-4: Financial Assumption Inputs

S. No.	Description	Unit	Value
1	Start of Construction	Year	2022
2	Years for Construction	No. of years	2
3	Operating Year	Year	2024
4	Max Depreciation Rate for Accounts - SLM	%	95%
5	Max Depreciation Rate for Taxation - WDV	%	100%
6	Accelerated Depreciation Rate for Solar Plant	%	40%
7	Debt	%	67%
8	Equity	%	33%
9	Upfront equity as a % of total equity	%	25%
10	Long Term Loan Interest Rate	%	13.5%
11	Syndication & other charges	%	1%
12	Repayment Period	Years	10
13	Moratorium after start of operations	Years	0
14	Concession Period	Years	25
15	Corporate Tax	%	25.63%
16	MAT	%	19.24%

8.5.5. Financial Viability Analysis

The table below present Revenue & Expense streams from various facilities, Net Present Value (NPV) and Equity Internal Rate of Return (EIRR) to the developer.

Table 8-5: Financial Viability Analysis

Amount (in Rs. Lakhs)

Year	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
	1	2	3	4	5	6	7	8	9	10
Revenue										
Rentals from Commercial space inside the Bus Port	245	291	341	359	376	395	415	436	458	480
Entry Fee	26	28	30	32	34	37	39	42	45	48
Revenue from Vehicle Parking	51	52	54	55	57	59	60	62	64	66
Revenue from Open Rooftop Restaurant	83	87	91	96	101	106	111	117	123	129
Revenue from Advertisement	12	15	17	18	19	20	21	22	23	24
Total Revenue	**416**	**473**	**534**	**560**	**587**	**616**	**647**	**679**	**712**	**748**
Expense										
Manpower, IT and Utilities Expenses	114	120	126	132	139	146	153	161	169	177
Operating Expenses	16	16	17	18	19	20	21	22	23	24
Expenses incurred on Marketing, Asset Management etc.	7	9	10	11	11	12	12	13	14	14
Expenses incurred on Open Rooftop Restaurant	55	57	60	63	67	70	73	77	81	85
Total Expenses	**192**	**203**	**214**	**225**	**236**	**248**	**260**	**273**	**287**	**301**
EBITDA	**224**	**270**	**320**	**335**	**352**	**369**	**387**	**406**	**426**	**447**
Depreciation	43	43	43	43	43	43	43	43	43	43
Interest on long term loans	194	173	153	132	112	92	71	51	31	10
Profit Before Tax	**-12**	**54**	**124**	**160**	**197**	**234**	**273**	**312**	**353**	**394**
Tax	0	10	24	31	38	45	53	60	68	76
Profit After Tax	**-12**	**44**	**100**	**129**	**159**	**189**	**220**	**252**	**285**	**318**
Net Cash to Developer	**-120**	**-65**	**-8**	**21**	**51**	**81**	**112**	**144**	**176**	**210**

NPV (25 years)	**255.95**
EIRR (25 years)	**14.40%**

8.6. Sensitivity Analysis

The Consultant has identified the following parameters based on which a sensitivity analysis has been carried out.

Table 8-6: Sensitivity Parameters

SN	Parameter	Variation
1	Construction Cost	±10%, ±5%
2	Commercial - Retail Lease Rentals	±10%, ±5%
3	Entry Fee - UTC	Rs.25/-, Rs.50/-, Rs.100/- and Rs.150/-

The following is the Equity NPVs and IRRs for 25 years based on the parameters and ranges mentioned above.

Table 8-7: Sensitivity Analysis

Parameter	Variation	NPV (in Rs. Crores)	EIRR (%)
Construction Cost	+10%	0.80	12.69%
	+5%	1.68	13.51%
	0%	2.56	14.40%
	-5%	3.43	15.39%
	-10%	4.30	16.46%
Commercial - Retail Lease Rentals	+10%	4.63	16.33%
	+5%	3.60	15.38%
	0%	2.56	14.40%
	-5%	1.51	13.43%
	-10%	0.46	12.44%
Entry Fee - UTC	150	4.48	16.15%
	100	3.53	15.29%
	50	2.56	14.40%
	25	2.07	13.96%

The following scenarios have been worked out for the sensitivity analysis.

Table 8-8: Sensitivity Scenarios

SN	Variation in			NPV (in Rs. Crores)	EIRR (%)
	Construction Cost	Commercial - Retail Lease Rentals	Entry Fee - UTC		
1	-10%	+10%	150	8.25	20.41%
2	-5%	+5%	100	5.42	17.29%
3	0%	0%	50	2.56	14.40%
4	+5%	-5%	25	0.14	12.13%
5	+10%	-10%	25	-1.80	10.43%

Further, Equity NPVs and IRRs for different concession periods have been worked out as shown below.

Table 8-9: Sensitivity Analysis – Concession Period

SN	Concession Period	NPV (in Rs. Crores)	EIRR (%)
1	15	-2.56	7.43%
2	20	0.42	12.51%
3	25	2.56	14.40%
4	30	4.10	15.28%
5	33	4.81	15.57%
6	49	6.99	16.16%
7	60	7.62	16.24%
8	99	8.23	16.28%

Further, keeping VGF for different concession periods for Bus Port and Commercial area equal to **20% i.e. 4.51 Crores,** the NPV and Equity IRR is calculated as shown below.

Table 8-10: Sensitivity Analysis – VGF

SN	Concession Period	NPV (in Rs. Crores)	EIRR (%)
1	15	0.56	13.04%
2	20	3.55	16.61%
3	25	5.68	17.93%
4	30	7.22	18.50%
5	33	7.94	18.69%
6	49	10.11	19.01%
7	60	10.74	19.05%
8	99	11.36	19.06%

8.7. Project Risk Assessment

Recently, the design-build-operate-transfer structures of PPP have gained popularity as a means of effectively delivering large-scale transportation infrastructure projects such as urban rail transport and bus transport. Past experiences suggest that introducing competition and market forces into the procurement of public infrastructure can make decision making more accountable, contribute to greater technological innovation, and reduce the potential for construction-cost escalations that consistently have plagued transportation projects.

BOT is a development of existing practice wherein bids are generally evaluated on the basis of the lowest public sector subsidy/grant required or highest premium.

8.7.1. Evaluation of Project Structuring Options

a) Key issues and Structures

Options available under PPP framework can be grouped in terms of:

- Role of Private Sector during construction phase (Project Implementation Phase). This phase involves detailed engineering activities, planning, construction and raising finances.
- Role of Private Sector during operations phase (Project Operations Phase). This phase involves operation, maintenance, management, revenue collection, loan repayments, additional investments on capacity augmentation and replacement.

Key inputs to a large urban transport infrastructure project are in terms of identifying adequate financial, technical and manpower resources. Besides, the aforesaid, local and site specific issues pertaining to rehabilitation of affected people (if any), present condition of utilities which may require relocation and environment related aspects also play a major role. Further, often the capacity to pay/willingness to pay over in a potentially high demand scenario can also effect the decision of selecting a project structure.

Further a public policy which supports public transport over private transport can also provide key thrust to select a suitable project structure which ensures long term high usage of public transport over private transport.

The solution to the aforesaid can be found through allocating risks to the agency which can best manage such risk. e.g. utility relocation, where the cost and volume of work involved is difficult to be ascertained by a private operator due to (1) incomplete information on location and extent of diversion required and (2) incomplete information on quality of assets since the utility asset may have deteriorated beyond a condition where it may require a new system/materials. Therefore if such a risk is put on a private operator, the private operator may put a very large premium to take on such risk.

Build Operate and Transfer (BOT)

BOT is the most common form of PPP. It is possible to identify one single private developer who would be responsible for both project implementation phase as well as project operations phase. Therefore, such selected operator shall undertake - detailed engineering activities, plan and construct, raise finances, operate, maintain, manage, collect revenue, repay loan, make additional investments for capacity augmentation and replacement. The single point responsibility is a good PPP structure and also led to innovation in construction, design and operations.

While a financially strong project would involve payment to the government, a financially weaker project can be supported by government through a capital and/or operations grant.

The private financing component gives the private sector the flexibility to plan its capital investment to maximise returns. This ensures optimal use of capital

resources in government projects. While the government retains ownership of the facility, the BOT approach attracts private financing to the extent possible for the project that can be repaid with revenues generated during the facility's operation.

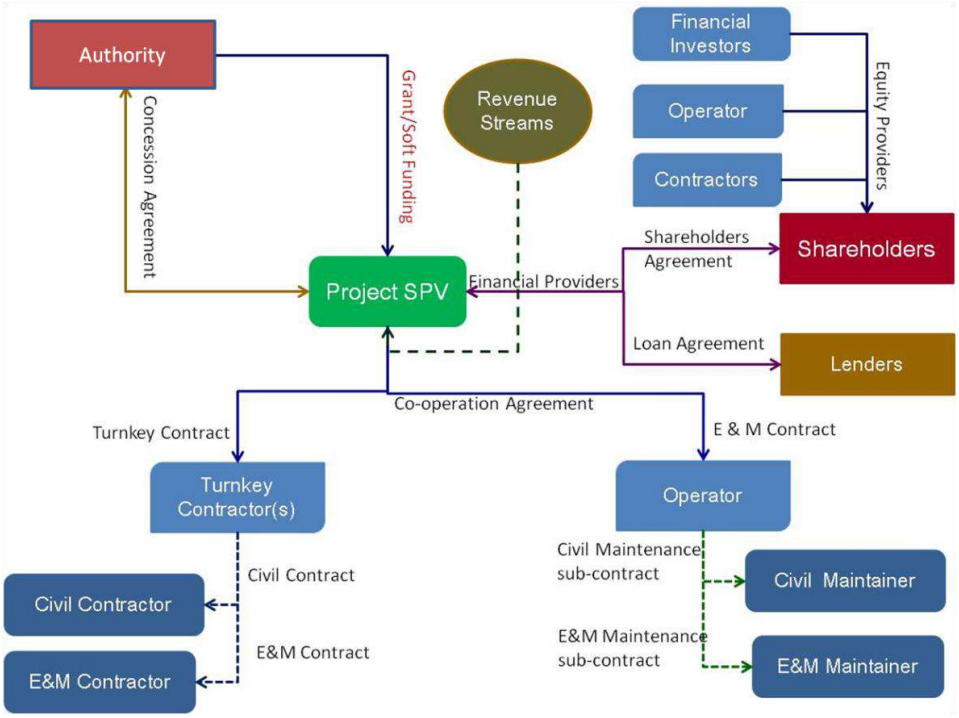


Figure 8-1: Typical Deal Flow Diagram - BOT

b) Typical Risk Allocation Matrix

The table below shows the typical risk allocation matrix in different project structuring scenarios.

Table 8-11: Summary of Risk Allocation Matrix

Risk Type	Sensitivity	Risk Period	Primary Risk Bearer	Remarks
a) Pre-Operative Risk				
Financing Risk	High	Typically within 90 days from signing of concession agreement	Developer	The developer will be required to ensure financial closure of the project unless a time extension may be provided by the Authority in terms of the Concession Agreement. Inability to ensure financial closure within the stipulated time and any further extension thereof would result in

Risk Type	Sensitivity	Risk Period	Primary Risk Bearer	Remarks
				a default on the part of the developer and accordingly performance security would be forfeited / encashed.
Approvals/ Permits	Medium	Typically within 90 days from signing of concession agreement	Developer	The Authority will facilitate in obtaining necessary clearances and approvals. However the responsibility of obtaining the same will be with the developer.
b) Risk During Construction Period				
Design Risk	High	Typically within 24 months from date of signing of the Concession Agreement	Developer	The developer will be required to submit a detailed construction design for review. The developer should also to provide design warranties for the project.
Construction Risk	Medium	Typically within 24 months from compliance date	Developer	For the duration of the concession period, the developer is required to furnish a performance security. During the construction period, the developer is required to facilitate periodic inspection and required to submit monthly progress reports.
Delays in construction	Medium	Timelines as per the Concession Agreement	Authority and Developer	In the event of delay in construction beyond the extension as may be provided by the Authority to the developer, performance security shall be forfeited. In case of delay due to Authority, developer is entitled to receive suitable compensation from the Authority.
c) Operation Phase Risk				
Revenue Risk	Low	Entire Concession Period	Developer	A notification could be issued to the effect that all buses would be required to halt, drop and pick up

Risk Type	Sensitivity	Risk Period	Primary Risk Bearer	Remarks
				passengers from the bus terminal. However, the developer may not been able to ensure that all buses use the bus terminal facilities as per the schedules, therefore it may impact entry fee revenues. However, the share of entry fee is insignificant when compared to overall revenue stream for the project.
Policy Risk	Low	Entire Concession Period	Authority	In case of any changes/ modification in laws, interpretations of the same or impositions of new statutory or regulatory approvals or taxes or duties imposed subsequent to the proposal acceptance date, the authority would take necessary action to ensure that there is no change (beyond the agreed terms) to the developer's legal, commercial and financial position as a result of such change.
Change of Scope of Risk	Medium	Entire Concession Period	Authority and Developer	If any variations are initiated by the developer, a proposal for the same would be sought from the developer and if found reasonable, necessary changes would be made to the concession period. In case variations are initiated by the Authority, the developer would be entitled to make a claim for additional cost.

Risk Type	Sensitivity	Risk Period	Primary Risk Bearer	Remarks
Performance Risk	High	Entire Concession Period	Developer	The developer is required to maintain standards during the construction as well as O&M period as per the detailed specifications in the concession agreement. In case of non-compliance, the Authority has the power to invoke the performance security.
Operation and Maintenance Risk	Medium	Entire Concession Period	Developer	The developer is required to create an O&M manual, detailing the regular and preventive maintenance which would be undertaken. Strict adherence to the performance standards as per the concession agreement and O&M manual is required failing which the Authority has the right to invoke the performance security and impose a penalty for non-compliance.
d) Other Risks				
Handover/ Hand back Risk	Medium	In case of Termination or expiry of concession	Developer	The Authority has the right to assess the condition of the project facilities to ensure that they met the standards specified in the concession agreement after taking into account reasonable wear and tear. Any shortfalls needed to be remedied by the developer prior to handover of assets.
Force Majeure	Low	Entire Concession Period	Authority and Developer	This risk is partially covered through insurance. In case of force majeure prior to commencement of the project, an extension to the concession period for the time period of the force majeure would be provided with

Risk Type	Sensitivity	Risk Period	Primary Risk Bearer	Remarks
				each party bearing its own respective costs. In case of a force majeure subsequent to the commencement date and before construction completion, an extension of the concession period for the duration of force majeure would be provided. In case of a force majeure subsequent to issue of the completion certificate, the developer would be required to make reasonable efforts to collect the user charges. In the event that developer is unable to collect the user charges, the concession period would be extended by the time period for which the developer was unable to collect the user charges. In case of force majeure as a political event disrupting the project, the Authority would reimburse the entire loss incurred by the developer.

8.8. Taxes Applicable for the Project

8.8.1. Corporate Tax Rate

The corporate tax rate for domestic companies is 22% plus surcharge of 12% (when total income exceeds Rs.10 Crores) plus health and education cess. The total tax rate comes out to be 25.63%. The corporate tax gets calculated by adjusting for any carry forward losses of the previous years from the profits of current year.

8.8.2. Minimum Alternate Tax (MAT)

The MAT is payable on book profits at a rate of 18.5% plus health and education cess. The total tax rate comes out to be 19.24%. Further, MAT credit can be carried forward and can be set off against payable corporate tax during subsequent years as per section 115JAA of the Income Tax Act.

8.8.3. Tax Holidays - Deductions under 80IA

Section 80IA (1) provides for tax holiday of 10 consecutive years out of first 15 years of business for development and O&M of infrastructure projects. However for Bus Port development project, 80IA tax holiday benefit shall not be applicable for profits earned from commercial component. Hence 80IA benefit has not been considered in our analysis.

CHAPTER 9

Recommendations and Way Forward

9. Recommendations and Way Forward

9.1. Recommendations

9.1.1. PPP Model: BOT

Based on the financial analysis, it is recommended that the project implementation through private participation on Build, Operate and Transfer (BOT) may be explored. This is recommended as the Equity IRR of the project with 20% VGF is in the range expected by the developer. Based upon the market dynamic at the time of bidding, the project may attract private players. In addition it will give the following benefits of the PPP framework:

a) The mobilisation of finances, design of the project, would be the responsibility of the developer.

   The entire finance required for the project would have to be raised by the developer within a pre-specified timeframe. Therefore, the project proponent would not be responsible for raising the funds for meeting the initial capital expenditure.

b) The project will be implemented through an open, transparent and competitive bidding process and therefore, it would get constructed at the lowest possible cost by the government.

c) The risk of time bound completion of the project would be passed on to the developer. Since the revenue streams from the project would commence only after completion of the project, it would be in the interest of the developer to complete the project as early as possible. Project proponent may also stipulate a penalty to be paid by the developer in case of delay in implementation of the project.

d) The risk of overruns in construction cost and operational expenses would be passed on to the developer. Since, the developer would be responsible for the implementation of the project, any increase in cost of the project would also be borne by him.

e) The developer would be responsible for operations, maintenance and management of the project for the entire concession period.

9.1.2. Concession Period and Development Option

The bus port project to be completed in a single phase and concession period of 99 years may be given to attract more developers and healthy competition. The nodal agency may be asked to increase the lease period of the land (more than the agreed concession period) for development of project.

9.1.3. Payment Structure

Evaluation of possible payment options are set out below:

a) Upfront One-time Payment: Bidders are required to quote one-time payment amount in the price proposal and typically, it would be paid over say 2 years from the date of signing to commissioning of the Project. For the price evaluation purpose, this is the simplest method, however, payment to authority is limited to one-time only.

   In case, the bidders bid negative premium (i.e. grant), it would be paid on completion of the construction of Bus Port facility.

b) Annual Lease Rentals: Successful developer is required to pay annual Lease Rentals (for the entire Concession Period) based on prevailing circle rate or any other fixed parameter, may be paid by the tenant/ lessees directly to the authority.

c) Upfront plus Annual Lease Rentals: A combination of Upfront premium payment payable by the successful developer plus annual Lease Rentals (for the entire Concession Period) based on prevailing circle rate or any other fixed parameter, may be paid by the developer to the authority.

   For the aforementioned option, there are two streams of payment to authority, however, only one variable to be quoted by the bidders, therefore the price evaluation will be simple and straight forward.

   In case, the bidders bid negative upfront premium (i.e. grant), it would be paid on completion of the construction of Bus Port facility.

Out of the three options, Option (a) may be used as the bidding parameter for the project.

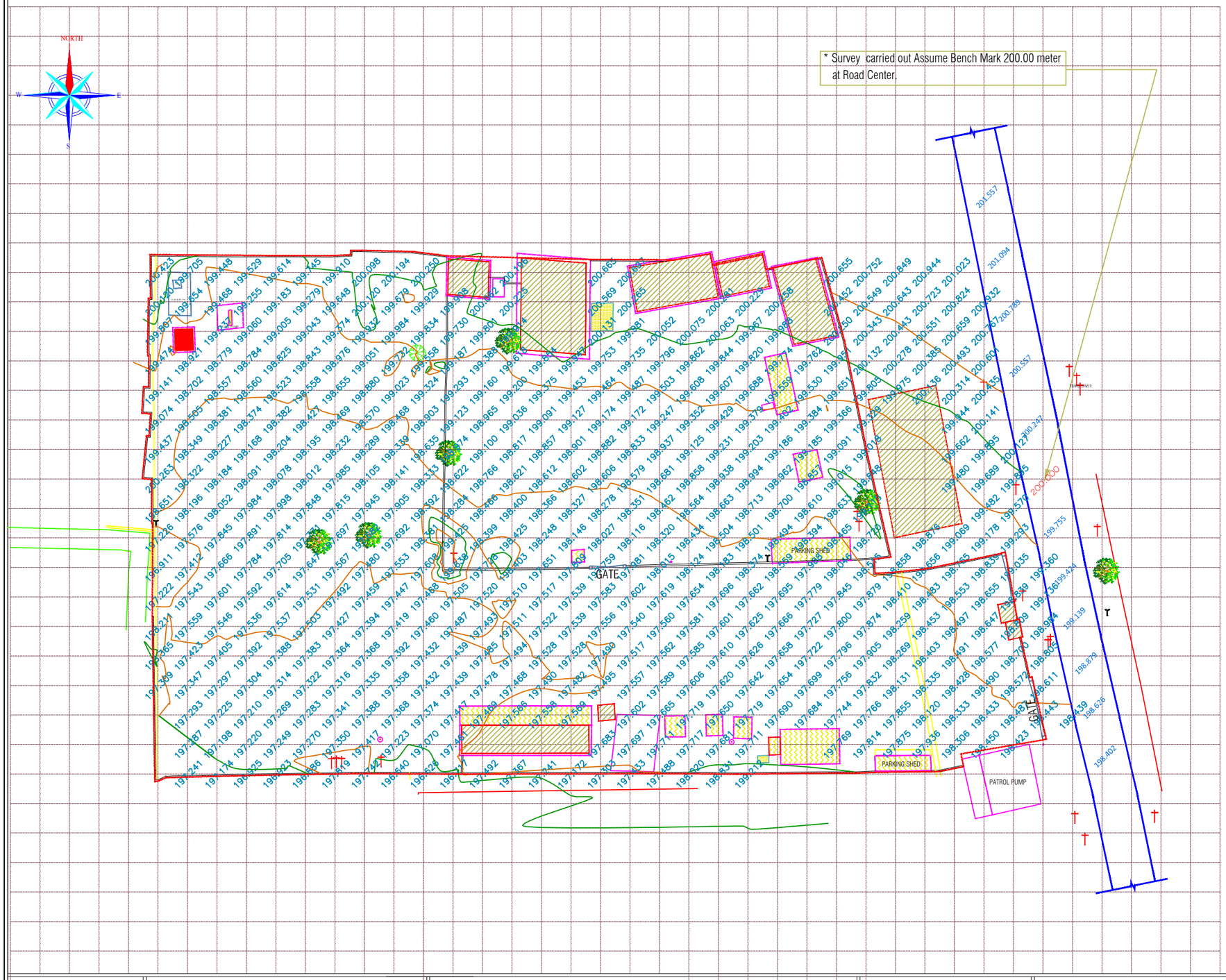
9.2. Way Forward

The steps in development of the project have been listed below:

a) Approval of the DPR
b) Preparation and approval on the project structure
c) Preparation of Bid Documents
d) Approval from competent authority on the Bid Documents
e) Undertake Bid Process Management
f) Execution of Agreement with Selected Developer

Annexure 1

Topographic Survey Map



LEGEND

BOUNDARY WALL	
PROPERTY LINE	
ROAD	
DRAIN	
LIGHT POLE	
TREE BIG	
TREE MEDIUM	
SHED	
BUILDING	
ELECTRICAL POLE	

Note :-

* All levels and Dimensions are in meter.
* Grid Level 05 X 05 Meter & Contour 1 Meter interval.
* Survey carried out Assume Bench Mark 200.00 meter at Road Center.

Plot Area

PLOT AREA = 11465.444 Sq.Mt. = 13712.56 Sq.Yd. (2.833 Acre)

N W E S

CLIENT

NHIDCL
BUILDING INFRASTRUCTURE - BUILDING THE NATION

PROJECT MANAGEMENT CONSULTANT:

Joint Venture of Govt. of NCT of Delhi and IDFC Foundation
1st Floor, I.S.B.T. Kashmere Gate, Delhi 110006.

DIMTS
We help people move

DRAWING TITLE -
SURVEY PLAN

DRAWING NO -
SP-01

NAME OF CLIENT- NHIDCL

PROJECT TITLE - PROPOSED BUS PORT, RAMNAGAR

Annexure 2

Site and Survey Photographs

Annexure 2: Site and Survey Photographs

Fuelling Station

Waiting Area

Booking Counter

Boarding Bays for Buses

Development in the Vicinity

Public Conveniences

Entry Gate

Exit Gate

Annexure 3

Geotechnical Survey Report

GEOTECHNICAL INVESTIGATION REPORT

FOR

DEVELOPMENT OF BUS PORT

AT

RAMNAGAR, UTTRAKHAND.

SUBMITTED TO

M/S DELHI INTEGRATED MULTI-MODEL TRANSIT SYSTEM LIMITED (DIMTS).

1st Floor, Maharana Pratap ISBT Building,
Kashmere Gate, New Delhi – 110006, India.

PROJECT NO - 1797

JUNE. - 2019

BY

SAI GEOTECHNICAL ENGINEERS PVT. LTD.

(AN ISO 9001-2015 CERTIFED COMPANY)
(MoRTH EMPANELLED COMPANY)
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REPORT ON GEOTECHNICAL INVESTIGATION FOR DEVELOPMENT OF BUS PORT AT RAMNAGAR, UTTRAKHAND.

CONTENTS

REPORT ON
GEOTECHNICAL INVESTIGATION
FOR
DEVELOPMENT OF BUS PORT AT
RAMNAGAR, UTTRAKHAND.

1.0 INTRODUCTION:

1.1 This report presented herein deals with the field and laboratory investigations carried out by us to access the nature of sub-strata and to evaluate the soil parameters required for design of foundations for Development of Bus Port at Ramnagar, Uttrakhand for **M/s Delhi Integrated Multi-Model Transit System Limited.**

1.2 Client's help is gratefully acknowledged in providing borehole locations, close supervision and checking during boring, sampling, various testing operations and cooperation and guidance during preparation of report.

1.3 The work of Geotechnical Investigation was awarded to **M/s Sai Geotechnical Engineers Pvt. Ltd.**, 22, Indraprastha Apartment, 826, Shalimar Garden Ext-1, Sahibabad, Ghaziabad (U.P.) by **M/s Delhi Integrated Multi-Model Transit System Limited.**

1.4 This report is based upon the results of field and laboratory tests conducted on selected soil samples collected from two bore holes (BH-1 & BH-2) as specified in scope of work.

2.0 DETAILS OF SITE :

2.1 The details of the site & various test locations for the proposed project are shown in the figure. The proposed Project site is located at **Ramnagar, Uttrakhand.**

3.0 SCOPE OF WORK:

The scope of work provided to us for this project was limited to the following:-

3.1 Mobilizing necessary plant, equipments and personnel to the project site, setting up the equipment, shifting of the equipment from one test location to another location, carrying out the field investigations on land and demobilization on completion of work.

3.2 Making 150 mm nominal diameter bore holes at various locations in all types of soil using suitable approved method of boring at the specified locations to be given at site by the Engineer-in-Charge up to 15.00 m depth or refusal whichever occurs earlier.

Refusal shall mean when SPT field 'N' value reaches 100 for 30 cm or less penetration of SPT sampler.

3.2.1 Conducting standard penetration tests in the bore holes at 1.50 m interval in depth & at every change of strata, whichever is earlier as per specifications / instructions of Engineer-in-Charge.

3..2 Collecting undisturbed soil samples from bore holes at 3.00 m interval in depth or at every change of strata, whichever is earlier as per specifications.

3.2.3 Collecting disturbed soil samples from bore holes at regular interval and at every identifiable change of strata to supplement the boring records.

3.2.4 Recording the depth of ground water table in all the bore holes if observed up to the depth of exploration during boring work as per specifications & withdrawing the casing pipe.

3.3 Conducting the following laboratory tests on selected disturbed / undisturbed soil samples collected from various bore holes / test locations :-

(a) Liquid and plastic limits.

(b) Sieve analysis.

(c) Hydrometer analysis.

(d) Tri-axial shear test (UUT).

(e) Direct shear test.

(f) Consolidation test.

(g) Bulk & dry density.

(h) Natural moisture content.

(i) Specific gravity.

3.4 Preparation and submission of report in three copies.

4.0 FIELD INVESTIGATIONS:

4.1 Necessary plant, equipment and personnel for conducting the requisite field work were mobilized to the site. These were shifted from one test location to another location during execution of the field work and demobilized on satisfactory completion of the entire field work.

4.2 Three bore holes (BH-1 to BH-3) carried out were first marked on the ground surface as per the layout given to us by the Engineer-in-Charge.

4.3 All bore holes were bored at this site using shell and auger method as per IS: 1892-1979. Casing as required was used to retain the bore holes.

Sl. No.	Test Type / Number	Test conducted at / up to a depth (m) from existing ground level
(1)	BH – 1 & BH – 2	15.0 m
(2)	Standard penetrations-n tests in bore holes	1.50 m interval & at every change of strata whichever is earlier
(3)	Undisturbed soil sampling in bore holes	3.00 m interval & at every change of strata whichever is earlier

4.3.1 Standard penetration tests were conducted in the above bore holes at every 1.50 m interval & at change of strata as per specifications / instructions of Engineer-in-Charge. The bores were cleaned up to the desired depths. Standard split spoon sampler attached to lower end of 'A' drill rods was driven in the bore holes by means of standard hammer of 63.5 Kg. falling freely from a height of 75 cm. The sampler was driven 45 cm as per specifications & the numbers of blows required for each 15 cm penetration were recorded. The numbers of blows for the first 15 cm penetration were not taken into account. This was considered as seating drive. The numbers of blows for next 30 cm penetration were designated as SPT 'N' value. Wherever the total penetration was less than 45 cm, the number of blows & the depth penetrated is incorporated in respective bore logs. Disturbed soil samples obtained from standard split spoon sampler for all the above standard penetration tests were collected in polythene bags of suitable size. These samples were properly sealed, labelled, recorded and carefully transported to the laboratory for testing.

4.3.2 Undisturbed soil samples were collected from the bore holes at every 3.00 m interval in depth & at change of strata as per sampling specifications, in thin walled sampling tubes of 100 mm dia and 450 mm length fitted to an adopter with ball and socket arrangement. These sampling tubes after retrieval from the bore holes were properly waxed and sealed at both ends. These were carefully labeled and transported to the laboratory for testing. Undisturbed soil samples wherever slipped during lifting, were duly marked in the field bore logs as well as in the soil profile.

4.3.3 Disturbed soil samples were also collected from the bore holes at suitable depths/intervals to supplement the boring records. These samples were collected in polythene bags of suitable size. These samples were properly sealed, labeled, recorded & carefully transported to the laboratory for testing.

4.3.4 The depth of ground water table was checked / measured in all bore holes during the boring activity.

4.3.5 **Summary of bore holes:**

Borehole No	Location	Depth of Soil (m)	Water table (m)
BH – 1	Bus Stand, Ramnagar.	4.50	Nil
BH – 2	Bus Stand, Ramnagar.	4.00	Nil

5.0 LABORATORY INVESTIGATIONS:

5.1 The following laboratory tests were conducted on selected soil samples recovered from various bore hole / test locations: -

(a) Liquid Limit & Plastic Limits.

(b) Sieve analysis.

(c) Hydrometer analysis.

(d) Tri-axial shear test (UUT).

(e) Direct shear test.

(f) Consolidation test.

(g) Bulk & dry density.

(h) Natural moisture content.

(i) Specific gravity.

All the above laboratory tests were carried out as per relevant Indian Standards. All the soil samples were identified and classified as per IS: 1498-1970.

6.0 FINDING OF GEOTECHNICAL INVESTIGATION:

The study of bore logs/results of laboratory and other field tests as above from ground level reveal that:-

6.1 At the locations of bore holes BH-1

The sub-soil strata: -

From existing ground surface to 1.50m depth consists of Filled Up.

From 1.50m to 2.50m depths consists of Brownish Silty Sand with Gravels (SM), SPT field 'N' value 15 showing medium dense compactness of the strata.

From 2.50m to 3.00m depths consists of Brownish Silty Sand (SM).

From 3.00m to 4.50m depths consists of Brownish Silty Sand with Boulders (SM), SPT field 'N' values ranging from 107 to 129 showing hard dense compactness of the strata.

The depth wise observed & corrected SPT values of subsoil strata are given in Soil Profile of respective bore holes.

6.2 At the locations of bore holes BH-2

The sub-soil strata: -

From existing ground surface to 1.50m depth consists of Filled Up.

From 1.50m to 2.50m depths consists of Brownish Silty Sand with Gravels (SM), SPT field 'N' value is 13 showing medium dense compactness of the strata.

From 2.50m to 3.00m depths consists of Brownish Silty Sand (SM).

From 3.00m to 4.05m depths consists of Brownish Silty Sand with Boulders (SM), SPT field 'N' values ranging from 106 to 113 showing hard dense compactness of the strata.

The depth wise observed & corrected SPT values of subsoil strata are given in Soil Profile of respective bore holes.

7.0 TYPE AND DEPTH OF FOUNDATIONS:

Based upon the results of field investigations, laboratory test results & considering the structure going to construct, the following type of foundations have been analyzed herein below : -

❖ **OPEN SHALLOW FOUNDATIONS**:

The allowable bearing capacity of sub-soil strata for Open foundation has been computed from shear and settlement failure considerations.

Allowable Bearing Capacity

The net intensity of loading which the foundation will carry without undergoing settlement in excess of the permissible value for the structure under consideration but not exceeding net safe bearing capacity.

Net Safe Bearing Capacity from Shear consideration

For Clayey Soil ($\phi = 0$)

The values are computed from unconfined compressive strength UCS, using the following equation;

$q_d = C\ N_c\ S_c\ d_c$ - Refer IS:6403, Clause 5.3

Where

q_d = Net Ultimate bearing capacity

A factor of safety of 2.5 is used.

Considering $\phi = 0$, $N_c = 5.14$

Thus the equation is simplified as

$q_{(Net\ safe)} = 1 / 2.5 \times C \times 5.14\ S_c\ d_c$

$= 2.056\ C\ S_c\ d_c$

For C - ϕ Soils

Refer IS: 6403 – 1981, Clause 5.1

General Shear Failure

$q_d = C\ N_c\ S_c\ d_c + \gamma\ D\ (N_q - 1)\ S_q\ d_q + 0.5\ \gamma\ B\ N\gamma\ S\gamma\ d\gamma\ W'$

Local Shear Failure

$q_{d'}$ = $2/3C\ N'_c\ Sc\ dc + \gamma\ D\ (N'_q - 1)\ S_q\ d_q + 0.5\ \gamma\ B\ N\gamma'\ S\gamma\ d\gamma\ W'$

Where

qd and qd' are net ultimate bearing capacity for general and local shear failure
Net safe bearing capacity = 1 / 2.5 x Net ultimate bearing capacity

Bearing capacity factor shall be determined for ϕ for general shear failure and $\phi' = \tan^{-1}(0.67 \tan\phi)$ for local shear failure.

Shape and depth factors shall be determined as per IS: 6403-1981.

For cohesion less soil with e_o value less than 0.55, values are computed for General shear failure, for e_o values between 0. 55 to 0.75 the values are computed by linear interpolation between local and general shear failure, and for eo value greater than 0.75 the values are computed for local shear failure.

For footing resting on multilayer deposit, Bowls recommends that the ultimate bearing capacity of footing be determined using average values of cohesion, C_{av} and angle of shearing resistance, ϕ_{av}. The average values are computed over a depth H below the base of footing,

Where

H = $0.5\ B \tan(45 + \phi/2)$

Safe Bearing pressure from settlement Consideration.

For normal consolidated clay

Sf = Sc + Si
Sc = λ Soed
Si = $pB(1-\mu^2)\ I\ /E$; will be negligible
μ = poission's ratio,
Soed = $\Sigma(h_I\ C_c\ /(1 + e_0))\ \log_{10}((\Delta p' + p_0')\ /\ p_0'))$
(Reference: clause 9.2.2.2 IS 8009 (Part I))

Where;

h_I = thickness of soil layer (m)
C_c = Compression index
e_0 = Initial void ratio
p_0' = effective overburden pressure (t/sq.m)
$\Delta p'$ = net increase in pressure at centre of cohesive soil layer

For pre-compressed clays

S_1 = Sc (for fully saturated clays)
Sc = λ Soed; λ is taken from table – 1, IS: 8009 (Part – 1), 0.7
Soed = $\Sigma m_v\ h_I\ \Delta p$

(Reference: clause 9.2.2.3 IS 8009 (Part I))

Where;

h_I = thickness of soil layer (m)
m_v = Coefficient of volume compression
Δp = net increase in pressure at center of cohesive soil layer

If clays are lightly over consolidated, then the above method may be adopted but if the clay is heavily over consolidated, it may not be necessary to compute the settlement.

If the soil deposits consist of several regular soil layers in the influence zone, the settlement of each layer below the foundation shall be computed and summed to obtain the total settlement.

The settlement contribution by non cohesive / partially cohesive soil layer shall be estimated by the methods in clause 9.1, IS: 8009 (Part I); De Beer Marten method shall be used.

De Beer and Martens' Procedure

S_2 = $(2.303 / C_i) \log_{10} ((\Delta p + p_0') / p_0'))h_i$
h_I = thickness of soil layer (m)
C_i = a constant of compressibility = $3/2 (C_{kd} / p_0')$
C_{kd} = average static cone resistance
p_0' = effective overburden pressure (t/sq.m)
Δp =net increase in pressure at centre of non cohesive/ partially cohesive soil layer
Total settlement = $S_1 + S_2$

For purely non-cohesive soils

Settlement shall be determined for unit pressure for a specified width of footing based on Corrected SPT values between the level of base of footing and the depth equal to 1.5 to 2.0 times the width of footing. Corrections shall be applied as applicable. Refer; IS: 8009 (Part-1).

Open Foundation:

Type of foundation (s)	Depth of Foundation,(m)	Size of Footing(m)
Strip Footing	2.00m	1.0-2.0 width
Isolated Square Footing	2.00m	1.50m x 1.50m 2.00m x 2.00m 3.00m x 3.00m 4.00m x 4.00m

8.0 RECOMMENDATIONS

Depending on the field and laboratory observations of subsoil strata, test results and the type of structures proposed at site, the types of foundations, depths and net safe bearing capacities recommended for design purposes are given in the following table. The net SBC/API in the following table are the lower of the values obtained from shear failure criterion as per IS: 6403 and settlement failure criterion as per IS: 8009, Part-I.

Type of Foundation: Strip footing

For Permissible settlement = 50.0 mm

Depth of Foundation (m)	Size of Foundation (m)	Safe Bearing Capacity (t/m^2)		
		Shear	Settlement	Recommended
2.00	1.0	11.00	36.40	11.00
	2.0	13.20	40.10	11.00

Type of Foundation: Isolated Square footing

For Permissible settlement = 50.0 mm

Depth of Foundation (m)	Size of Foundation (m)	Safe Bearing Capacity (t/m^2)		
		Shear	Settlement	Recommended
2.00	1.50 x 1.50	12.10	61.80	12.00
	2.00 x 2.00	13.20	70.50	12.00
	3.00 x 3.00	15.50	80.30	12.00
	4.00 x 4.00	17.70	105.90	12.00

- The ground water was not encountered in the bore holes at the time of boring activities at site. For design purpose water table effect has considered as the ground water table may rise in heavy rainy season or due to unforeseen reasons.
- Filled up strata is available up to 1.50m depth at both bore holes under consideration, therefore minimum depth of foundation shall be constructed at least 0.50m below filled up strata.
- The site falls in earthquake zone –IV as per IS: 1893 (Part1), 2016 and the structure shall be designed accordingly.

9.0 CLOSURE

We appreciate the opportunity given to us to submit this report. This presented report is based on observations and tests on samples collected from the boreholes as decided by the client. In case any difference is noticed in the field subsoil strata and reported subsoil strata during excavation please contact us before proceeding with further construction.

For SAI GEOTECHNICAL ENGINEERS PVT. LTD.

NAVIN BIHARI JOHARI
MANAGING DIRECTOR

BOREHOLE NO. : 1 **SHEET NO :** 11

Project : Soil Investigations work for Development of Bus Port at Ramnagar, Uttrakhand.

REDUCED LEVEL OF B/HOLE : 100.000 m

DATE STARTED : 29/05/2019

DATE COMPLETED : 29/05/2019

FIELD TEST RESULTS														LABORATORY TEST RESULTS																
						SPT TEST RESULTS								GRAIN SIZE ANALYSIS											SHEAR STRENGTH CHARACTERISTICS				
ELEVATION IN METERS	DEPTH IN METERS BELOW REFERENCE	NATURE OF SAMPLING	DEPTH OF SAMPLE BELOW REFERENCE LEVEL	SAMPLE REFERENCE NO.	LEVEL OF WATER TABLE / L.W.L IN MTS.	DEPTH IN METERS	NO. OF BLOWS	PENETRATION (CM)	N. VALUE (Recorded)	N. VALUE (Corrected)	DIA. OF CASING USED (MM)	SYMBOLIC REPRESENTATION	DESCRIPTION OF SOIL WITH I.S. CLASSIFICATION	GRAVEL (%)	SAND (%)	SILT (%)	CLAY (%)	LIQUID LIMIT (%)	PLASTIC LIMIT (%)	PLASTICITY INDEX (%)	BULK DENSITY (t / cum.)	DRY DENSITY (t/cum)	MOISTURE CONTENT (%)	SPECIFIC GRAVITY	TEST PERFORMED			Voide ratio (e_0)	Compression (C_c)
100.00	0.00	DS	0.00	0		0.00 - 1.50							Filled Up																
98.50	1.50	SPT	1.50	1		1.50 - 1.95	15	30	15	21			Brownish Silty Sand With Gravels (SM)	10.0	50.0	40.0	0.0	N	P											
97.50	2.50	UDS	2.50	1	Not Met	2.50 - 2.90					150		Brownish Silty Sand (SM)								1.76	1.63	7.8	2.64	DST	0.00	30		
97.00	3.00	SPT	3.00	2		3.00 - 3.45	129	30	129	156			Brownish Silty Sand With Boulders (SM)	38.0	51.0	11.0	0.0	N	P											
95.50	4.50	SPT	4.50	3		4.50 - 4.55	107	5	107	107			Boulder Strata																

NOTE : 1. CLASSIFICATION OF SOIL AS PER IS : 1498

2. ABBREVATION USED : DS = DISTURBED SAMPLE UDS = UNDISTURBED SAMPLE UU = UNCONSOLIDATED UNDRAINED DST = DIRECT SHEAR TEST

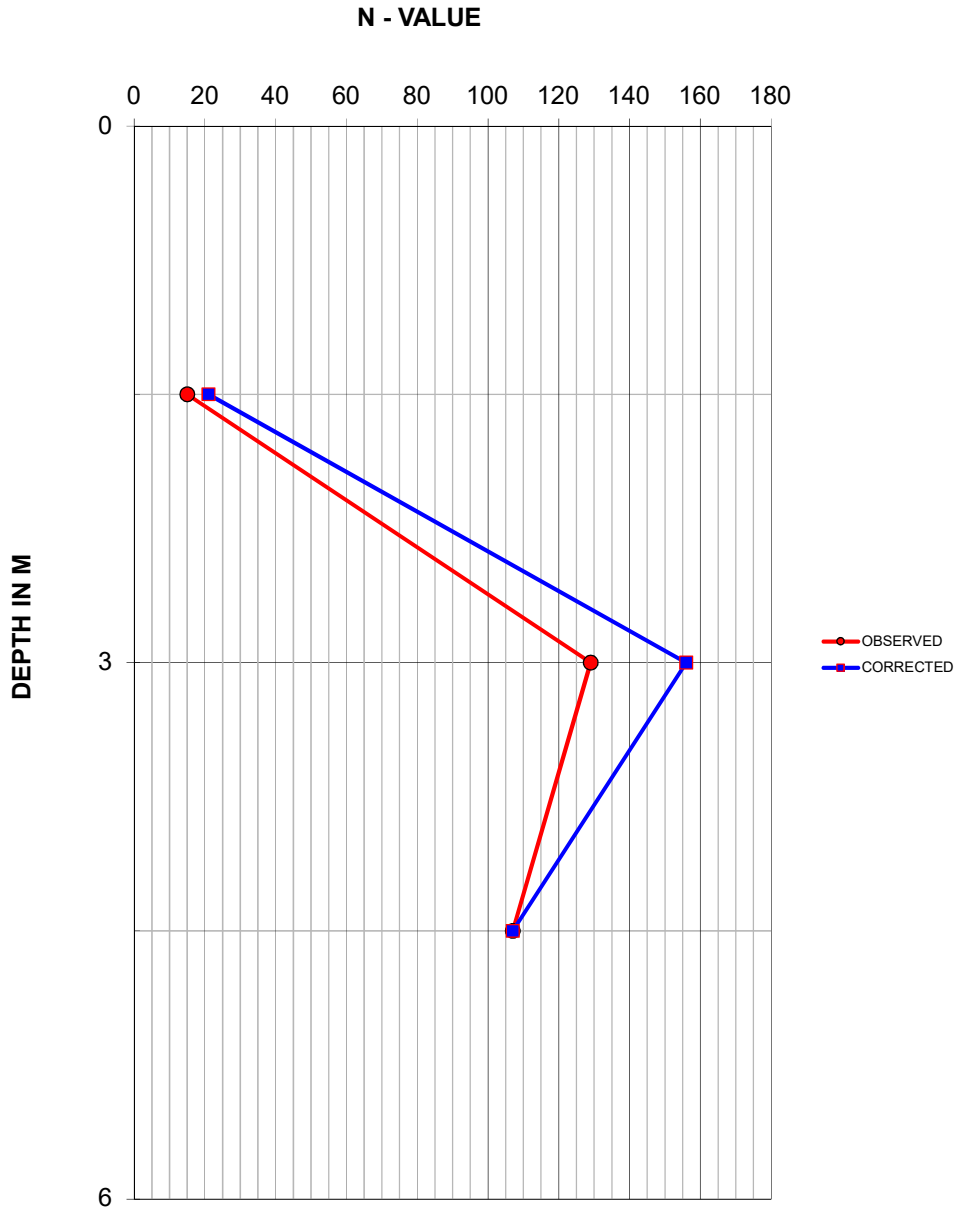
BORE LOG CHART AND DATA SHEET

SAI GEOTECHNICAL ENGINEERS PVT. LTD

Project : Soil Investigations work for Development of Bus Port at Ramnagar, Uttrakhand.

STANDARD PENETRATION TEST CURVES

BOREHOLE NO. : 1



BOREHOLE NO. : 2 **SHEET NO :** 13

Project : Soil Investigations work for Development of Bus Port at Ramnagar, Uttrakhand.

REDUCED LEVEL OF B/HOLE : 100.000 m

DATE STARTED : 30/05/2019

DATE COMPLETED : 30/05/2019

FIELD TEST RESULTS														LABORATORY TEST RESULTS																
						SPT TEST RESULTS								GRAIN SIZE ANALYSIS											SHEAR STRENGTH CHARACTERISTICS				
ELEVATION IN METERS	DEPTH IN METERS BELOW REFERENCE	NATURE OF SAMPLING	DEPTH OF SAMPLE BELOW REFERENCE LEVEL	SAMPLE REFERENCE NO.	LEVEL OF WATER TABLE / L.W.L IN MTS.	DEPTH IN METERS	NO. OF BLOWS	PENETRATION (CM)	N. VALUE (Recorded)	N. VALUE (Corrected)	DIA. OF CASING USED (MM)	SYMBOLIC REPRESENTATION	DESCRIPTION OF SOIL WITH I.S. CLASSIFICATION	GRAVEL (%)	SAND (%)	SILT (%)	CLAY (%)	LIQUID LIMIT (%)	PLASTIC LIMIT (%)	PLASTICITY INDEX (%)	BULK DENSITY (t / cum.)	DRY DENSITY (t/cum)	MOISTURE CONTENT (%)	SPECIFIC GRAVITY	TEST PERFORMED			Voide ratio (e_0)	Compression (C_c)
100.00	0.00	DS	0.00	0		0.00 - 1.50							Filled Up																
98.50	1.50	SPT	1.50	1		1.50 - 1.95	13	30	13	18			Brownish Silty Sand With Gravels (SM)	8.0	53.0	39.0	0.0	N	P	-										
97.50	2.50	UDS	2.50	1	Not Met	2.50 - 2.90					150		Brownish Silty Sand (SM)								1.72	1.58	8.6	2.63	DST	0.00	30		
97.00	3.00	SPT	3.00	2		3.00 - 3.45	106	30	106	129			Brownish Silty Sand With Boulders (SM)	35.0	52.0	13.0	0.0	N	P	-										
95.50	4.00	SPT	4.00	3		4.00 - 4.05	113	5	113	113			Boulder Strata																

NOTE : 1. CLASSIFICATION OF SOIL AS PER IS : 1498

2. ABBREVATION USED : DS = DISTURBED SAMPLE UDS = UNDISTURBED SAMPLE UU = UNCONSOLIDATED UNDRAINED DST = DIRECT SHEAR TEST

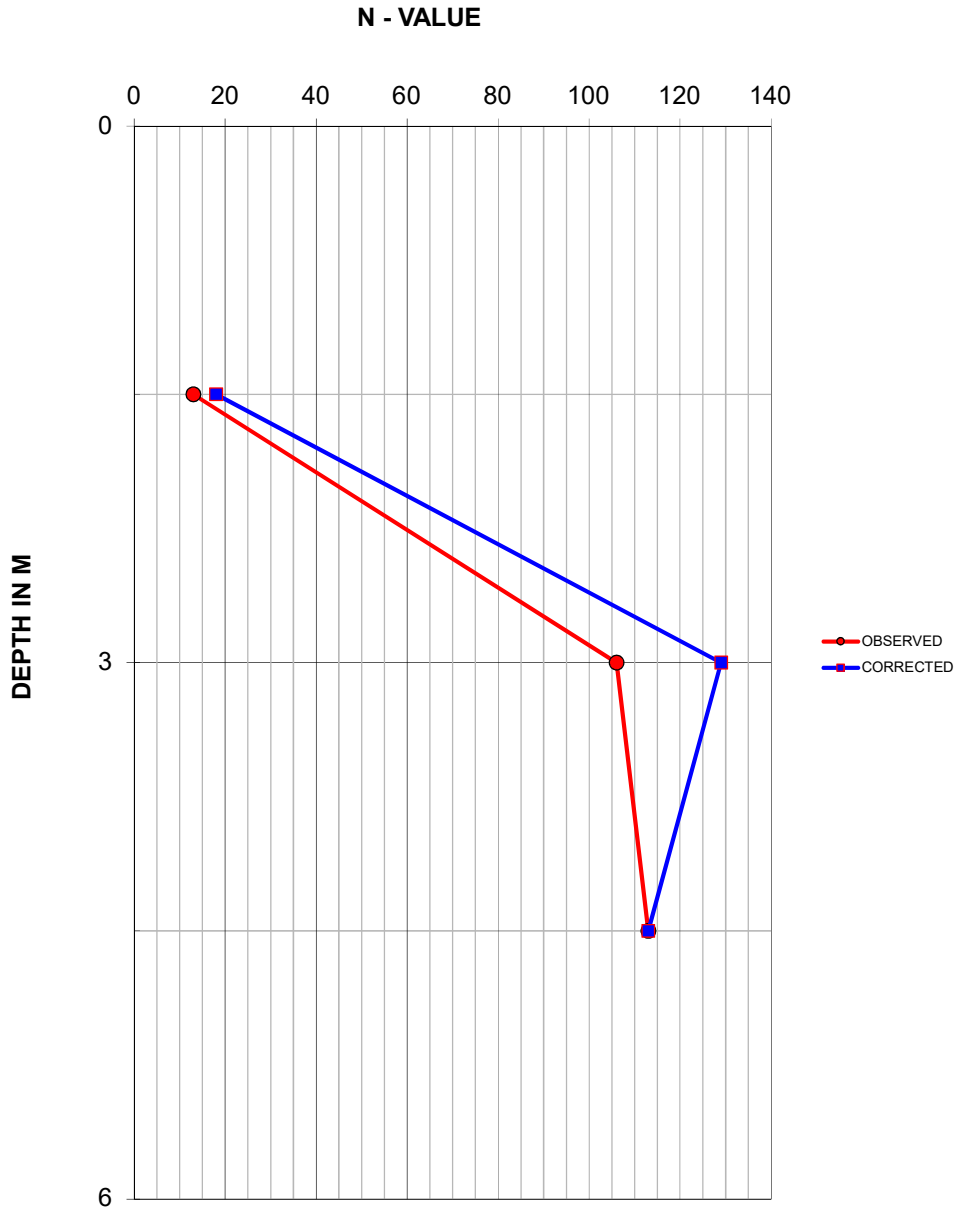
BORE LOG CHART AND DATA SHEET

SAI GEOTECHNICAL ENGINEERS PVT. LTD

Project : Soil Investigations work for Development of Bus Port at Ramnagar, Uttrakhand.

STANDARD PENETRATION TEST CURVES

BOREHOLE NO. : 2



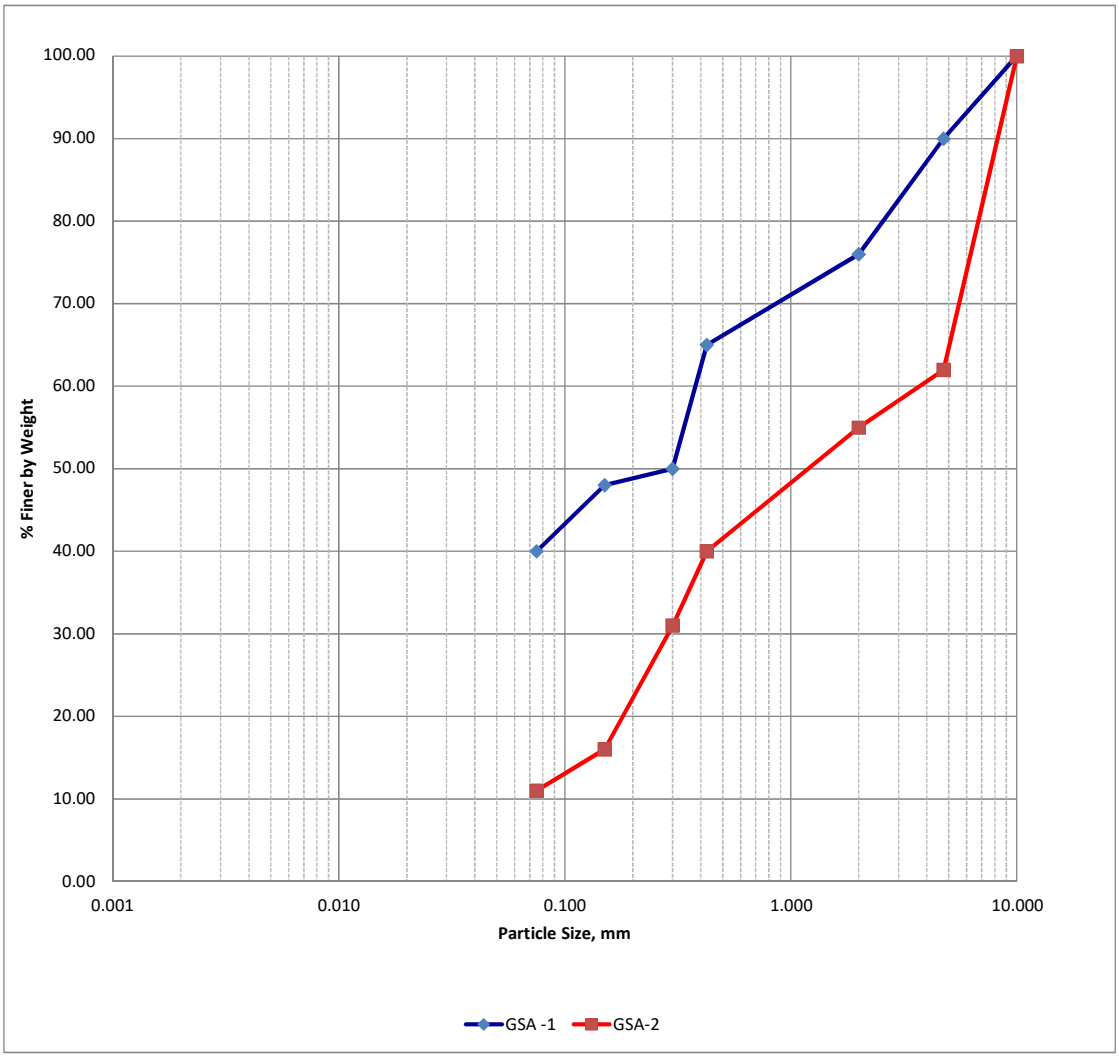
SAI GEOTECHNICAL ENGINEERS PVT. LTD.

GRAIN SIZE ANALYSIS : IS:2720(PART-4)-1985

Project : Soil Investigations work for Development of Bus Port at Ramnagar, Uttrakhand.

SAMPLE DETAILS			TESTS RESULTS							
Borehole Number	Sample Depth, m	Sample Description	% Gravel	% Sand	% Silt	% Clay	D_{60}	D_{10}	C_u	C_c
1	1.50	(SM)	10.0	50.0	40.0	0.0				
1	3.00	(SM)	38.0	51.0	11.0	0.0				

GRAIN SIZE GRAPH



SAI GEOTECHNICAL ENGINEERS PVT. LTD.

GRAIN SIZE ANALYSIS : IS:2720(PART-4)-1985

Project : Soil Investigations work for Development of Bus Port at Ramnagar, Uttrakhand.

SAMPLE DETAILS			TESTS RESULTS							
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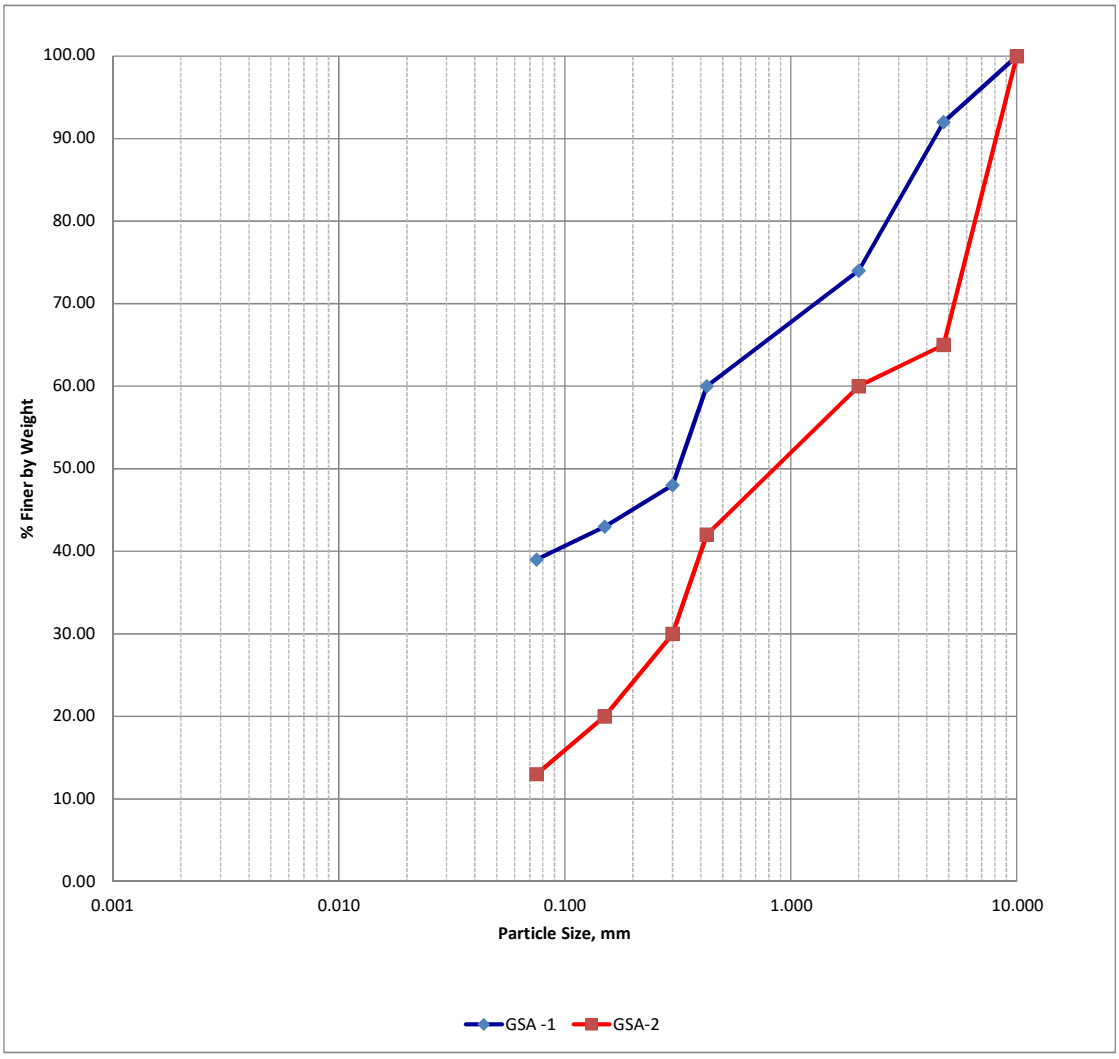
1	1.50	(SM)	8.0	53.0	39.0	0.0				
1	3.00	(SM)	35.0	52.0	13.0	0.0				

GRAIN SIZE GRAPH



BEARING CAPACITY CALCULATION

1	Project Name	=	Development of Bus Port at Ramnagar, Uttrakhand
2	Structure	=	Bus Station Building
3	Borehole reffered	=	BH-1
4	Type of footing	=	Isolated
5	Depth of footing (D), cm	=	200.0
6	Width of footing (B), cm	=	150.0
7	Length of footing (L), cm	=	150.0
8	Borehole Level (GL), m	=	100.000
9	Foundation Level (FL), m	=	98.000
10	Classification / Type of soil Strata	=	Silty Sand With Gravels
11	Cohesion (T/m^2)	=	0.0
12	Angle of internal Friction (Degree)	=	30
13	Field Dry density	=	1.58
14	Field moisture content (%)	=	8.60
14	Water Table Level (WT in m)	=	Not Met
15	Specific Gravity of soil	=	2.64
16	Inclination of load to vertical	=	0.00
17	Design SPT N value	=	15

SBC CALCULATIONS : (Ref : IS: 6403 - 1989)

Depth of foundation below GL

Df = GL - FL
= 2.000 M
= 200 CM

RATIO B/L =
= 1

Hence the shape of base is considered as strip footing
Therefore the factors vide 5.1 - 2.1

Sc = 1

Sq = 1

Sr = 1

The back filling is to be with proper compaction the correction for depth is applied vide clause 5.1.2.2 and the depth factors are :

d_c = Depth Factor = $1.0 + 0.2\ D / B\ (N\phi)^{1/2}$
d_q = Depth Factor = 1 for $\phi < 10.0$ or $1 + 0.1\ (D / B)\ (N\phi)^{1/2}$ for $\phi > 10$
d_γ = Depth Factor = 1 for $\phi < 10.0$ or $1 + 0.1\ (D / B)\ (N\phi)^{1/2}$ for $\phi > 10$

$(N\phi)^{1/2} = \tan (45 + \phi/2)$

= 1.732

dc = 1.00 (Considered on conservative side)

and dq & dr = 1.00 (Considered on conservative side)

The inclination factors vide clause 5.1.2.3

i_c = Inclination Factor = $[(1.0 - \alpha / 90)]^2$ = 1
i_q = Inclination Factor = $[(1.0 - \alpha / 90)]^2$ = 1
i_γ = Inclination Factor = $[(1.0 - \phi / \alpha)]^2$ = 1

The effective surcharge at the base level of foundation for dry and saturated condition

q = γ x Df
Where γ = Submerged unit Weight , t/m3

γ**bulk** = 1.72

γsub = 1.00 t/m3

q = 2.00 t/m2

Effect of water table vide clause 5.1.2.4
Depth of water table below GL:

Dw = GL - WT

WT = Not Met m

Dw > (Df + B)

Consider for design porpose W' = 0.50

Void Ratio = $(G.\gamma)/\gamma d - 1$

< 0.67

if e < 0.55 , it is general shear failure case

e > 0.75, it is local shear failure case

if 0.55 < e < 0.75 , it is mixed shear failure case.
(interpolate between 1 & 2)

ϕ	=	30.00	degree	ϕ' =	$\tan^{-1}(0.67 \tan(\phi))$	
	=	0.5236	radians	=	21.15843	degree
				=	0.3693	radians
Nc	=	$(N_q - 1) \times \cot\phi$		=		30.14
Nq	=	$e^{(\pi \tan(\phi'))} \times \tan^2(\pi/4 + \phi/2)$		=		18.40
Nr	=	$2(N_q + 1)\tan\phi$		=		22.40
Nc'	=	$(N_q - 1) \times \cot\phi$		=		15.98
Nq'	=	$e^{(\pi \tan(\phi'))} \times \tan^2(\pi/4 + \phi/2)$		=		7.18
Nr'	=	$2(N_q + 1)\tan\phi$		=		6.34

Table (clause 5.1.1) are interpolated as :

Nc	=	22.00
Nq	=	11.95
Nr	=	13.16

The ultimate net bearing capacity vide clause 5.1.2 :

q_d = $c N_c s_c d_c i_c + q(N_q - 1) s_q d_q i_q + 0.5 \gamma B N_\gamma s_\gamma d_\gamma i_\gamma W'$

= 30.37 t/m²

q net = qd/2.50

= 12.15

Safe net bearing capacity = 12.10 t/m²

Settlement Failure Consideration

Allowable Settlement Consideration	=	50.0	mm
Load Intensity assumed at Foundation depth	=	10.0	t/m^2
Depth of Footing	=	2.0	m
Width of Footing	=	1.5	m
Length of Footing	=	1.5	m
Depth of Influence zone below Foundation depth	=	2.3	m

Layer No	Depth		Layer Thickness	Effective Layer	Type of strata	Corr. Av. SPT N Value
	From	to				
1	2.00	3.00	1.0	1.0	Coarse Grained	15
2	3.00	15.00	12.0	1.3	Coarse Grained	50

Layer -1

The Settlement of coarse grained strata layers comprising of Silty Sand layers within Influence zone were computed by using the Chart of Settlement Vs SPT N value as per IS: 8009 Part -I.

Settlement for Coarse grained soil

Thickness of Layer = 1.0
Average SPT 'N' value = 15

Settlement under 10 t/m^2 : 16.71 mm From Figure 9 of IS:8009 Part -I

Hence total settlement = 16.71 mm

Water Correction Factor = 0.50

Rigidity Correction Factor = 0.80

Corrected settlement = 11.89 mm

Layer -2

The Settlement of fine grained strata layers comprising of clayey silt/Sandy Silt layers within Influence zone were computed by using thethe following equation as per IS:8009, Part - I :

$S = m_v \times \Delta p \times H$

Where,

m_v = Coeffcient of volume compressibilty (cm^2/kg) = 0.0147 cm^2/kg

Δp = Effective Pressure (kg/cm^2) = 5.63 kg/cm^2

H = Thickness of Layer (cm) = 100 cm

Settlement = 6.61 mm

Total settlement = 11.89 mm

Corrected settlement = 8.08 mm
Permissible settlement = 50.0 mm

Net allowable Bearing pressure for permissible settlement
= 61.87 t/m^2

BEARING CAPACITY CALCULATION

1	Project Name	=	Development of Bus Port at Ramnagar, Uttrakhand
2	Structure	=	Bus Station Building
3	Borehole reffered	=	BH-1
4	Type of footing	=	Open Foundation - Strip
5	Depth of footing (D), cm	=	200.0
6	Width of footing (B), cm	=	200.0
7	Length of footing (L), cm	=	1000.0
8	Borehole Level (GL), m	=	100.000
9	Foundation Level (FL), m	=	98.000
10	Classification / Type of soil Strata	=	Silty Sand With Gravels
11	Cohesion (T/m^2)	=	0.0
12	Angle of internal Friction (Degree)	=	30
13	Field Dry density	=	1.58
14	Field moisture content (%)	=	8.60
14	Water Table Level (WT in m)	=	Not Met
15	Specific Gravity of soil	=	2.64
16	Inclination of load to vertical	=	0.00
17	Design SPT N value	=	15

SBC CALCULATIONS : (Ref : IS: 6403 - 1989)

Depth of foundation below GL

Df = GL - FL
= 2.000 M
= 200 CM

RATIO B/L =
= 0.2

Hence the shape of base is considered as strip footing
Therefore the factors vide 5.1 - 2.1

Sc = 1

Sq = 1

Sr = 1

The back filling is to be with proper compaction the correction for depth is applied vide clause 5.1.2.2 and the depth factors are :

d_c = Depth Factor = $1.0 + 0.2\ D / B\ (N\phi)^{1/2}$
d_q = Depth Factor = 1 for $\phi < 10.0$ or $1 + 0.1\ (D / B)\ (N\phi)^{1/2}$ for $\phi > 10$
d_γ = Depth Factor = 1 for $\phi < 10.0$ or $1 + 0.1\ (D / B)\ (N\phi)^{1/2}$ for $\phi > 10$

$(N\phi)^{1/2} = \tan (45 + \phi/2)$

= 1.732

dc = 1.00 (Considered on conservative side)

and dq & dr = 1.00 (Considered on conservative side)

The inclination factors vide clause 5.1.2.3

i_c = Inclination Factor = $[(1.0 - \alpha / 90)]^2$ = 1
i_q = Inclination Factor = $[(1.0 - \alpha / 90)]^2$ = 1
i_γ = Inclination Factor = $[(1.0 - \phi / \alpha)]^2$ = 1

The effective surcharge at the base level of foundation for dry and saturated condition

q = γ x Df
Where γ = Submerged unit Weight , t/m3

γ**bulk** = 1.72

γsub = 1.00 t/m3

q = 2.00 t/m2

Effect of water table vide clause 5.1.2.4
Depth of water table below GL:

Dw = GL - WT

WT = Not Met m

Dw > (Df + B)

Consider for design porpose W' = 0.50

Void Ratio = $(G.\gamma)/\gamma d - 1$

< 0.67

if e < 0.55 , it is general shear failure case

e > 0.75, it is local shear failure case

if 0.55 < e < 0.75 , it is mixed shear failure case.
(interpolate between 1 & 2)

ϕ	=	30.00	degree	ϕ' =	$\tan^{-1}(0.67 \tan(\phi))$	
	=	0.5236	radians	=	21.15843	degree
				=	0.3693	radians
Nc	=	$(N_q - 1) \times \cot\phi$		=		30.14
Nq	=	$e^{(\pi \tan(\phi))} \times \tan^2(\pi/4 + \phi/2)$		=		18.40
Nr	=	$2(N_q + 1)\tan\phi$		=		22.40
Nc'	=	$(N_q - 1) \times \cot\phi$		=		15.98
Nq'	=	$e^{(\pi \tan(\phi))} \times \tan^2(\pi/4 + \phi/2)$		=		7.18
Nr'	=	$2(N_q + 1)\tan\phi$		=		6.34

Table (clause 5.1.1) are interpolated as :

Nc	=	22.00
Nq	=	11.95
Nr	=	13.16

The ultimate net bearing capacity vide clause 5.1.2 :

q_d = $c N_c s_c d_c i_c + q(N_q - 1) s_q d_q i_q + 0.5 \gamma B N_\gamma s_\gamma d_\gamma i_\gamma W'$

= 33.20 t/m²

q net = qd/2.50

= 13.28

Safe net bearing capacity = 13.20 t/m²

Settlement Failure Consideration

Allowable Settlement Consideration	=	50.0 mm
Load Intensity assumed at Foundation depth	=	10.0 t/m^2
Depth of Footing	=	2.0 m
Width of Footing	=	2.0 m
Length of Footing	=	10.0 m
Depth of Influence zone below Foundation depth	=	3.0 m

Layer No	Depth		Layer Thickness	Effective Layer	Type of strata	Corr. Av. SPT N Value
	From	to				
1	2.00	3.00	1.0	1.0	Coarse Grained	15
2	3.00	15.00	12.0	2.0	Coarse Grained	50

Layer -1

The Settlement of coarse grained strata layers comprising of Silty Sand layers within Influence zone were computed by using the Chart of Settlement Vs SPT N value as per IS: 8009 Part -I.

Settlement for Coarse grained soil

Thickness of Layer =	1.0	m	
Average SPT 'N' value =	15		
Settlement under 10 t/m^2 :	18.20	mm	From Figure 9 of IS:8009 Part -I
Hence total settlement =	18.20	mm	
Water Correction Factor =	0.50		
Rigidity Correction Factor =	0.80		
Corrected settlement =	9.71	mm	

Layer -2

The Settlement of coarse grained strata layers comprising of Silty Sand layers within Influence zone were computed by using the Chart of Settlement Vs SPT N value as per IS: 8009 Part -I.

Settlement for Coarse grained soil

Thickness of Layer =	2.0	m	
Average SPT 'N' value =	50		
Settlement under 10 t/m^2 :	4.65	mm	From Figure 9 of IS:8009 Part -I
Hence total settlement =	4.65	mm	
Water Correction Factor =	0.50		
Rigidity Correction Factor =	0.80		
Corrected settlement =	4.96	mm	
Total settlement =	14.66	mm	
Corrected settlement =	12.46	mm	
Permissible settlement =	50.0	mm	

Net allowable Bearing pressure for permissible settlement

= 40.12 t/m^2