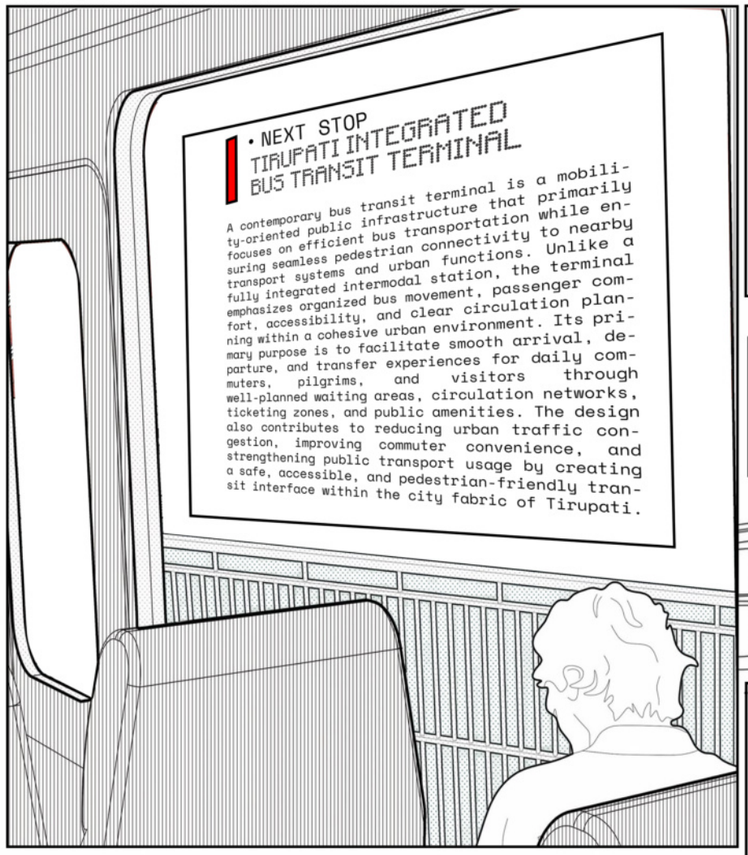
INTRODUCTION

Project brief



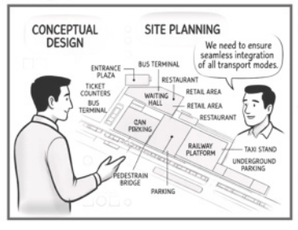
Aim

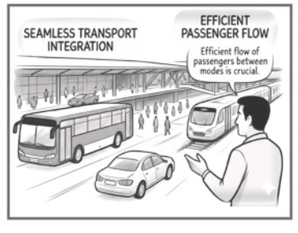
To design a contemporary and efficient bus transit terminal for Tirupati that enhances passenger experience, urban mobility, and future multimodal connectivity through organized circulation and pedestrian-oriented planning.

Components

1. Bus stand
2. Railway walk-way
3. Dorms
4. Passenger Amenities
5. Public Transport Terminals
6. Last-Mile Connectivity
7. Cycle & Pedestrian Paths
8. Hotels
9. Commercial/ Retail Areas
10. Office Areas
11. RTO office

Scope





Conceptual Design and Site Planning
This thesis develops an innovative architectural proposal for the IMS on the existing APSRTC bus terminal site.

It emphasizes seamless integration of multiple transport modes (bus, rail, and future connectivity), efficient passenger flow, optimized land use, and incorporation of commercial and public amenities to enhance convenience and reduce congestion.

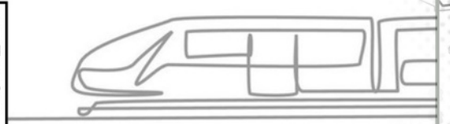
Sustainability and Contextual Integration
The study explores sustainable design strategies, including environmentally friendly materials, energy-efficient systems, and pollution mitigation measures.

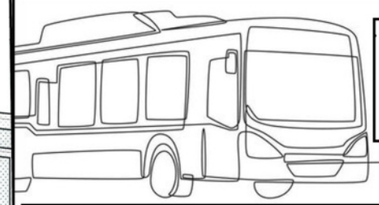
Objectives

- Investigate the layout and planning strategies of diverse transportation hubs, with specific reference to the proposed Inter-Modal Station (IMS) at Tirupati.
- Identify and address challenges in integrating different transit modes (rail, bus, and future connectivity) within a single hub at the Tirupati IMS site.
- Examine trends in information and infotainment technologies relevant to passenger experience in transit projects.
- Analyze spatial programming and planning requirements for a multimode transit hub that incorporates public rest areas, tailored to the unique pilgrimage-driven demands of the Tirupati IMS.

Transport System Connectivity

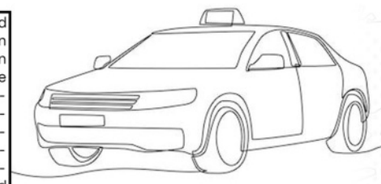
The intermodal station brings together city, regional, and intercity bus services within a single organized terminal. This reduces operational conflicts and allows passengers to transfer easily between different bus routes.





Last-mile connectivity: Dedicated zones for autos, taxis, and feeder services ensure convenient access to surrounding neighborhoods and destinations. This completes the journey by bridging the gap between major transit modes and final destinations.

The proposed transit terminal is planned with the potential for future integration with metro and railway networks to strengthen multimodal connectivity within the city. The design envisions a future pedestrian footbridge connection to the nearby railway station, enabling safer and more efficient passenger movement between transit systems. Provision for future metro connectivity and organized feeder services such as autos and taxis further supports the development of a comprehensive urban mobility network and improved last-mile accessibility in Tirupati.

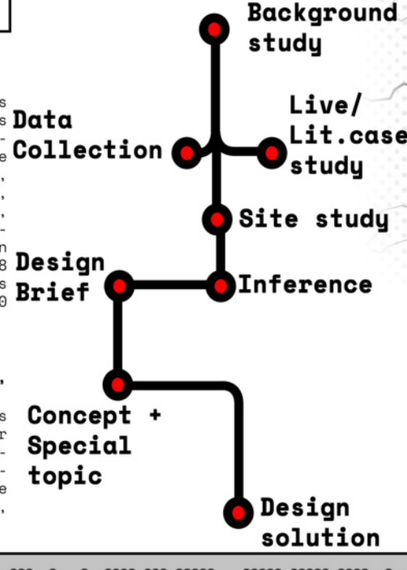


Target Group

Pilgrims and Devotees
The primary target group consists of millions of Hindu pilgrims from across India and abroad visiting the Tirumala Temple. These include individuals, families, and groups traveling for darshan, festivals (e.g., Brahmotsavam, Vaikunta Ekadasi), or vow fulfillment. They often arrive in large numbers by bus (1.7–1.8 lakh daily at the current bus terminal) or train (over 40,000 daily at the railway station),

Local Residents, Commuters, and ancillary users
This group includes Tirupati's residents using the hub for daily/ regional travel, inter-city commuters, tourists exploring the region, and service providers (taxi/auto drivers, vendors).

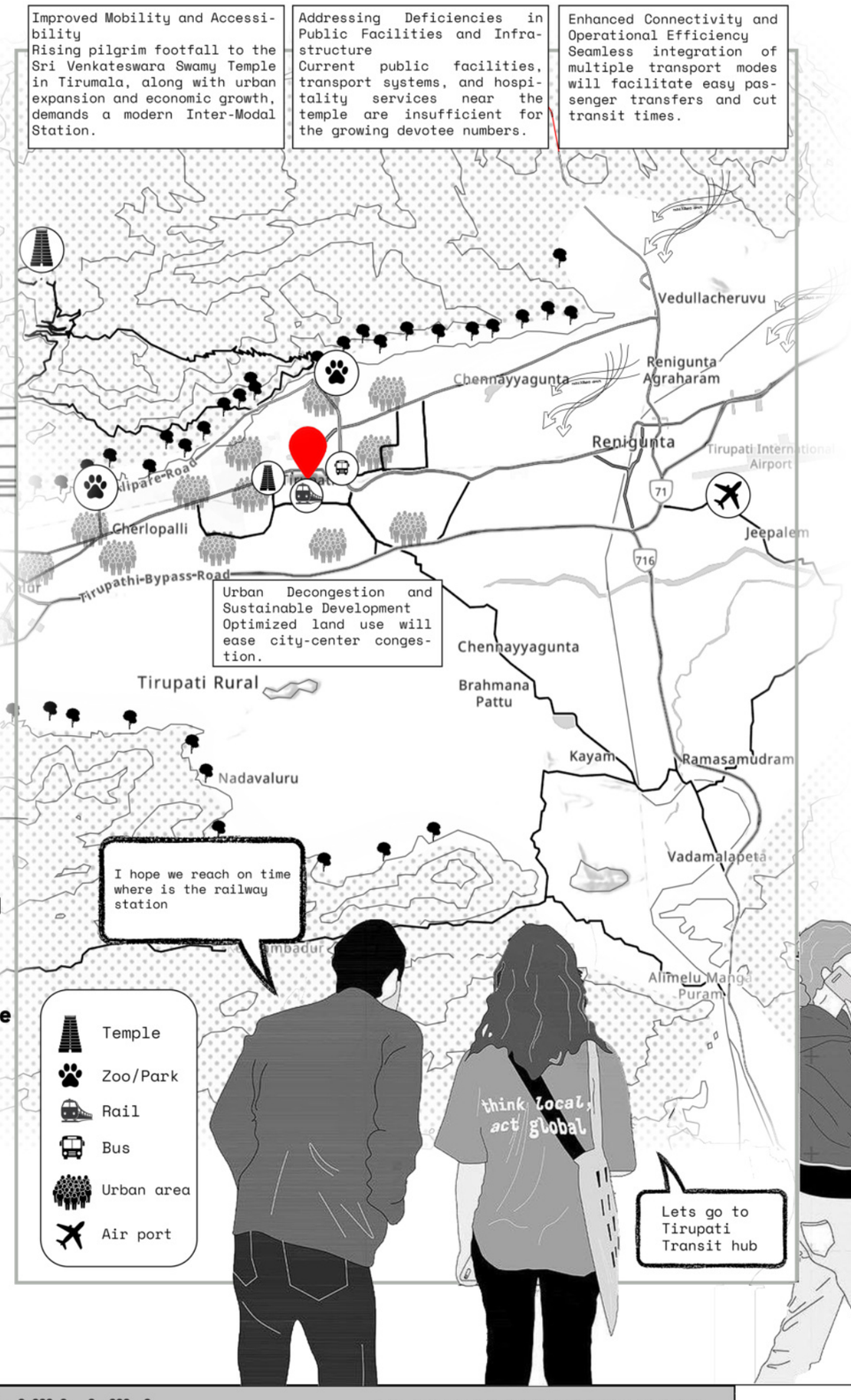
Methodology



Improved Mobility and Accessibility
Rising pilgrim footfall to the Sri Venkateswara Swamy Temple in Tirumala, along with urban expansion and economic growth, demands a modern Inter-Modal Station.

Addressing Deficiencies in Public Facilities and Infrastructure
Current public facilities, transport systems, and hospitality services near the temple are insufficient for the growing devotee numbers.

Enhanced Connectivity and Operational Efficiency
Seamless integration of multiple transport modes will facilitate easy passenger transfers and cut transit times.



TIRUPATI INTEGRATED BUS TRANSIT TERMINAL

ARJUN KODOOR KRISHNADAS

Tirupati ⟶ BUS TERMINUS

L N Q R 4 5 01:00 – PG NO

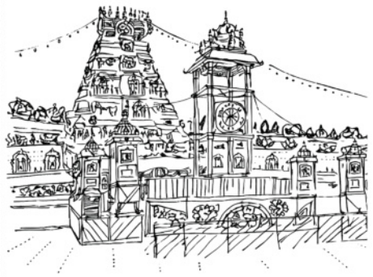
INTRODUCTION

NOTE: ALL DIMENSIONS ARE IN CM

BACKGROUND STUDY

Significance of Tirumala Pligrimage

Tirumala is a sacred place of hindu pilgrimage in India and its fame and popularity transcends national boundaries. Tirumala derives its importance and popularity due to the location of the sacred shrine of Lord Shri Venkateswara.. Being a very important religious center, it attracts pilgrims from all over the country andabroad. It is one of the most popular places of religious pilgrimage with an average of more than 50,000 pilgrims visiting 'Tirumala daily and during special occasions like Brahmotsavams the number even touch about 4 lakhs per day! These pilgrims come daily to Tirumala mainly for religious purpose- to have a darshan of Lord Venkateswara at Tirumala.. The temple itself is believed to have existed from very ancient times and it is said that Lord Sri Venkateswara the presiding deity of this temple is referred to in earliest of the Vedas.



Need For pligrimage Tourism Development

1. Tirumala can currently cater to about 60,000 pilgrims per day, with a saturation capacity of approximately 85,000 pilgrims for darshan.

2. In addition to pilgrims, there is a service population of about one-third, roughly 28,000 persons, present daily.

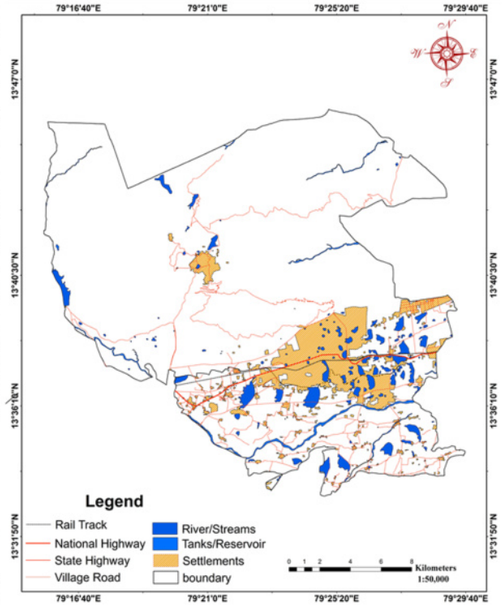
3. This results in a combined population density of about 11,300 persons per sq km or 113 persons per hectare, indicating extremely high congestion levels.

4. Such high density places significant strain on the quality and quantity of amenities, services, and facilities within the Tirumala area.

5. The daily pilgrim inflow is increasing, and under the existing system it will be difficult to accommodate numbers beyond the saturation level.

6. The key future challenge for TTD is to manage the ever-growing pilgrim population, especially ordinary pilgrims, within severe space and time constraints, making planning interventions and systemic improvements essential.

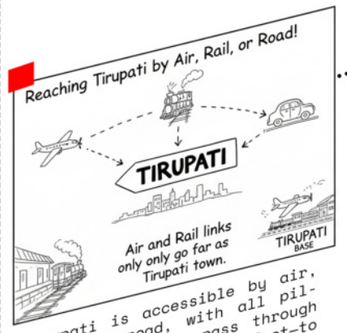
Significance of Tirumala Pligrimage



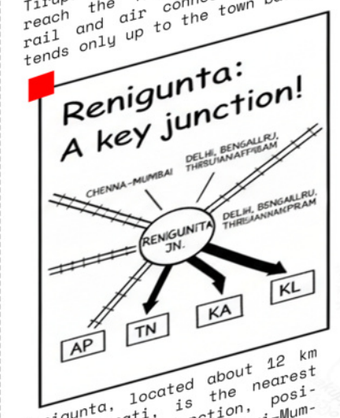
LU/LC category	Area in (km^2)	% to total geographical area
Core urban	11.94	3.07
Peri-urban	12.11	3.12
Village/hamlets/dispersed house hold	7.38	1.90
Industrial mine/quarry	1.28	0.33
Agricultural plantation	9.48	2.44
Cropland	60.88	15.67
Forest	227.46	58.55
Reservoir/tanks	11.12	2.86
River/stream/drain	2.91	0.75
Barren rocky	0.70	0.18
Salt affected	1.18	0.30
Open scrub	11.98	3.08
Reservoir t	11.12	2.86
River/stream/drain	2.91	0.75
Barren rocky	0.70	0.18
Salt affected	1.18	0.30
Open scrub	11.98	3.08
Dense scrub	30.06	7.74
Total	388.48	100.00

Pilgrimage from different states

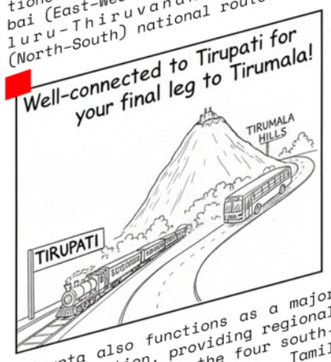
Sl. No	State	Visiting Pilgrims in %
1	Andhra Pradesh	31.12
2	Tamilnadu	22.08
2A	Pondicherry	3.32
3	Karnataka	12.20
4	Maharashtra	8.65
5	Kerala	5.95
6	Uttar Pradesh	4.32
7	Orissa	3.24
8	Madhya Pradesh	3.01
9	Gujarat	2.93
10	Delhi	2.08
11	West Bengal	1.08
Total		100.00



Tirupati is accessible by air, rail, and road, with all pilgrims required to pass through Tirupati—by road or on foot—to reach the Tirumala Hills, as rail and air connectivity extends only up to the town base.

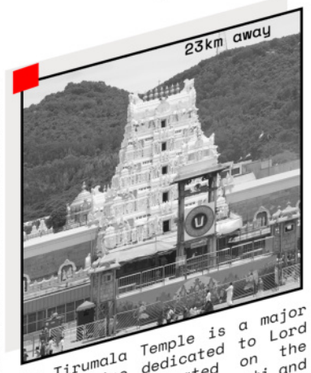


Renigunta, located about 12 km from Tirupati, is the nearest major railway junction, positioned on both the Chennai–Mumbai (East–West) and Delhi–Bengaluru–Thiruvananthapuram (North–South) national routes.



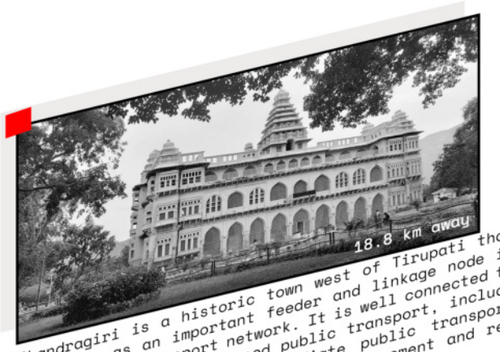
Renigunta also functions as a major highway junction, providing regional connectivity between the four southern states—Andhra Pradesh, Tamil Nadu, Karnataka, and Kerala.

Renigunta Junction is well connected to Tirupati railway station by both rail and road, making the Renigunta-Tirupati-Tirumala corridor the lifeline of the regional economy with significant impacts on Tirupati and its surrounding region.



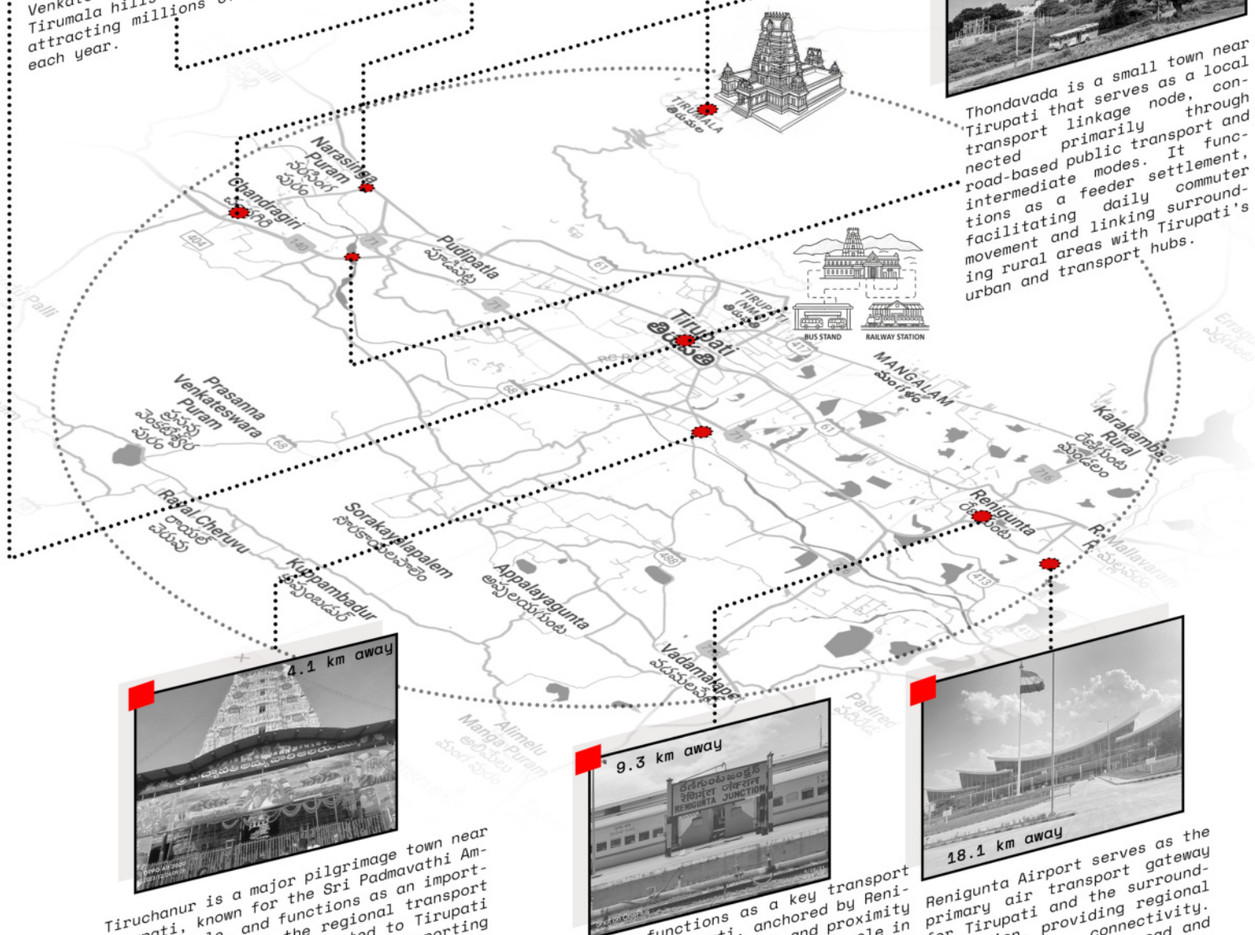
The Tirumala Temple is a major Hindu shrine dedicated to Lord Venkateswara, located on the Tirumala hills near Tirupati and attracting millions of pilgrims each year.

Srinivasa Mangapuram is a temple town near Tirupati, known for the Sri Kalyana Venkateswara Swamy Temple, believed to be where Lord Venkateswara stayed after His marriage.



Chandragiri is a historic town west of Tirupati that functions as an important feeder and linkage node in the regional transport network. It is well connected to Tirupati through road-based public transport, including frequent bus and intermediate public transport services, supporting daily commuter movement and regional connectivity to surrounding rural areas.

Thondavada is a small town near Tirupati that serves as a local transport linkage node, connected primarily through road-based public transport and intermediate modes. It functions as a feeder settlement, facilitating daily commuter movement and linking surrounding rural areas with Tirupati's urban and transport hubs.



Tiruchanur is a major pilgrimage town near Tirupati, known for the Sri Padmavathi Amavari Temple, and functions as an important feeder node in the regional transport network. It is well connected to Tirupati by road and public transport, supporting high daily pilgrim movement and influencing traffic flow within the Tirupati urban region.

Renigunta town functions as a key transport interchange near Tirupati, anchored by Renigunta Junction railway station and proximity to the airport. It plays an important role in regional mobility by linking rail, road, and air networks and acting as a feeder node for Tirupati's passenger and pilgrim movement.

Renigunta Airport serves as the primary air transport gateway for Tirupati and the surrounding region, providing regional and national connectivity. Linked to Tirupati by road and public transport, it supports pilgrim, tourist, and business travel while complementing the city's rail and bus networks.

TIRUPATI INTEGRATED BUS TRANSIT TERMINAL

ARJUN KODOOR KRISHNADAS

Tirupati ⟶ BUS TERMINUS

L N Q R 4 5 02:00 – PG NO

BACKGROUND STUDY

NOTE: ALL DIMENSIONS ARE IN CM

BACKGROUND STUDY

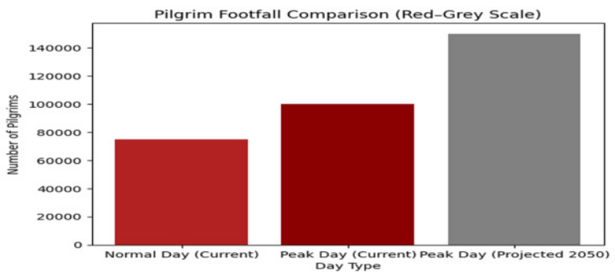
Existing Bus Operation & Terminal Data – CBS Tirupati

Category	Details
Average Daily Bus Operations	3,673 buses
Peak Hour (Inter-State Buses)	11:00 – 12:00
Peak Hour (Rural Buses)	06:00 – 07:00
Peak Hour (Tirupati Buses)	06:00 – 07:00
Average Headway (Inter-State)	33 minutes
Average Headway (Rural)	41 minutes
Average Headway (Tirupati)	7 minutes
Total Bus Bays	66 (including 3 for idle parking)
Daily Passenger Volume	1,68,000 passengers
Total Staff & Crew (State Corps.)	256
Total Service Staff	110
Maximum Bus Trips (Brahmotsavam)	172 downward trips (Tirumala to CBS) during 16:00–17:00 on Day 5
Alipiri Tollgate Vehicle Count	23,18,912 vehicles (January–October 2022)

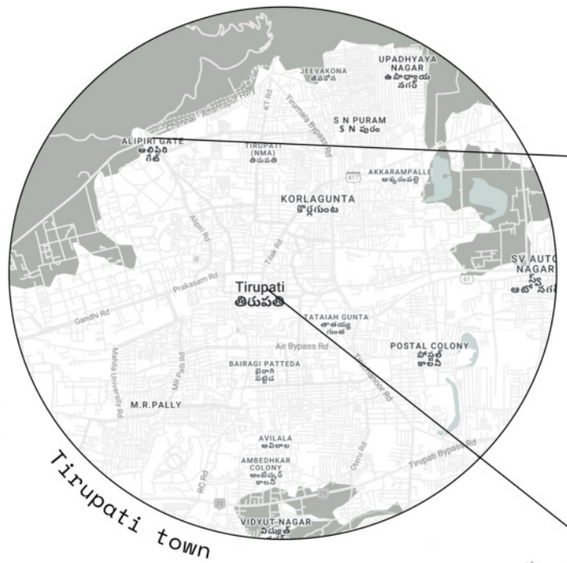
Road Characteristics

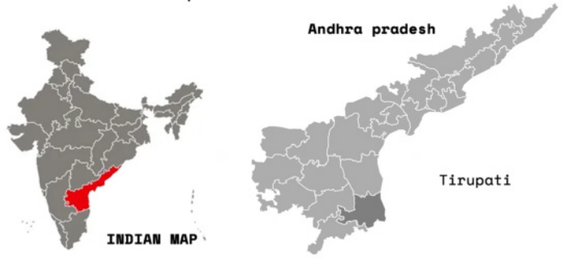
Parameter	Category	Percentage
Right of Way (RoW)	≤ 11 m	26%
Right of Way (RoW)	11 – 20 m	46%
Right of Way (RoW)	21 – 30 m	23%
Carriageway Type	Divided CW	58%
Carriageway Type	Undivided CW	22%
Footpath Availability	No footpath on either side	74%
Abutting Land Use	Residential & Commercial	86%
On-Street Parking	Roads with on-street parking	67%
On-Street Parking Presence	Roads with on-street parking	67%

Footfall Stastics



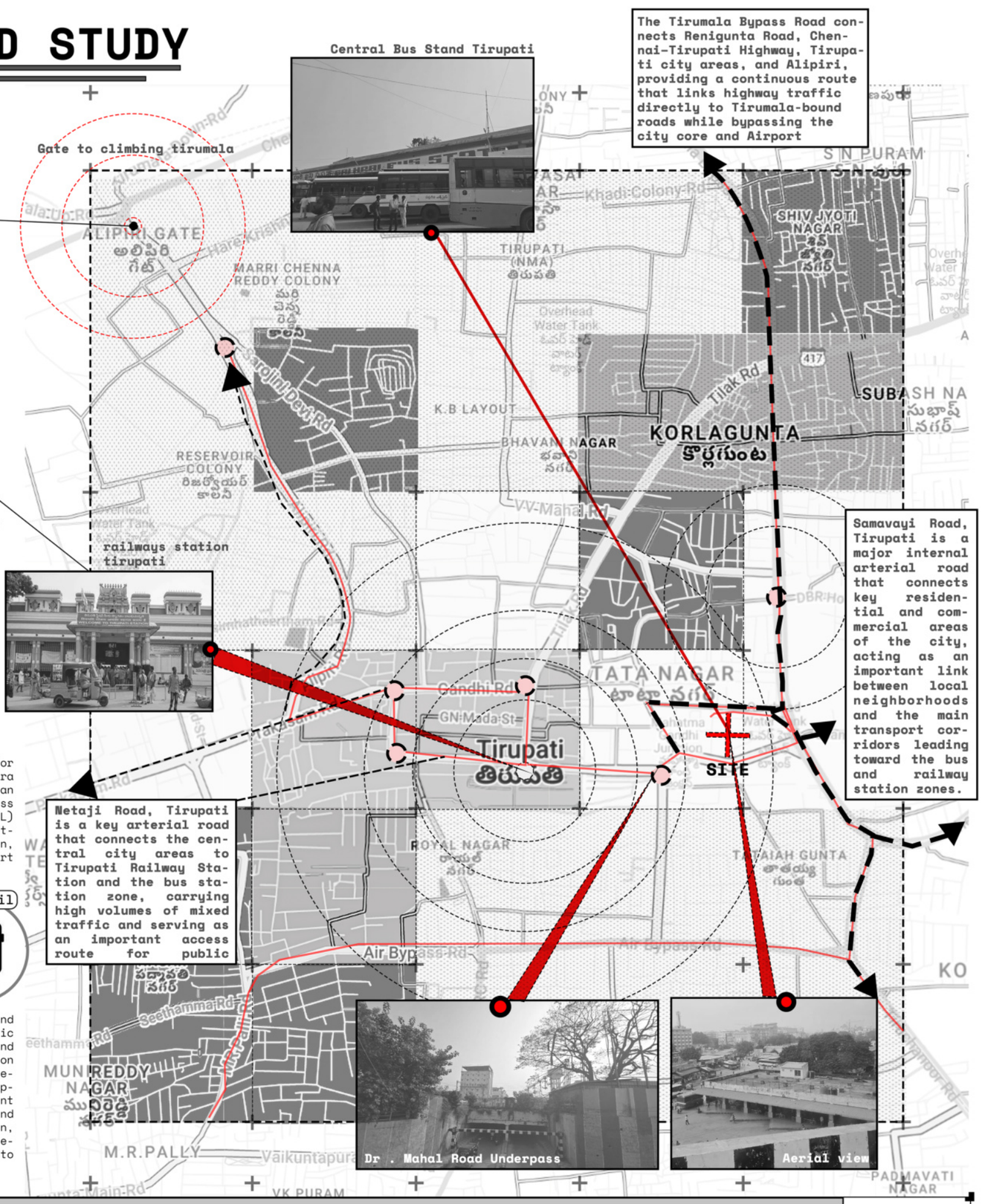
Day Type	Number of Pilgrims
Normal Day (Current)	70,000 – 80,000
Peak Day (Current)	1,00,000
Peak Day (Projected for 2050)	1,50,000





Introduction
Tirupati, the spiritual capital of Andhra Pradesh and a major pilgrimage center attracting millions to the Sri Venkateswara Temple at Tirumala (22 km away), grapples with growing urban mobility challenges due to high passenger volumes. To address this, National Highways Logistics Management Limited (NHLML) has proposed its second Intermodal Station (IMS) at the existing APSRTC Central Bus Terminal near Tirupati Railway Station, replacing the current bus stand with an integrated transport hub incorporating commercial and public amenities.

The proposed transit terminal reimagines the existing bus stand in Tirupati as a contemporary and efficiently organized public mobility hub primarily focused on APSRTC bus transportation and pedestrian connectivity. The design emphasizes the segregation of interstate, intercity, rural, and Tirumala shuttle bus movement through a hierarchical circulation network, improving operational efficiency, passenger safety, and traffic management within the city. By utilizing its strategic urban location and multiple access points, the project aims to reduce congestion, optimize circulation, and enhance commuter comfort while creating a passenger-centric transit environment that responds to Tirupati's large daily commuter and pilgrim population.



TIRUPATI INTEGRATED BUS TRANSIT TERMINAL

ARJUN KODOOR KRISHNADAS

Tirupati ⟶ BUS TERMINUS

L N Q R 4 5 03:00 – PG NO

BACKGROUND STUDY

NOTE: ALL DIMENSIONS ARE IN CM

EXISTING SITE CONDITION

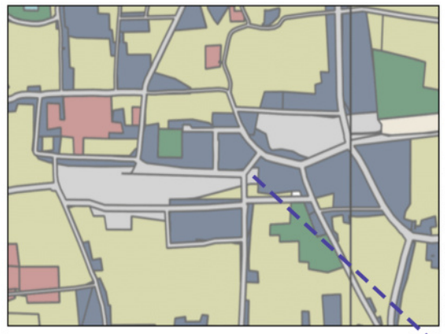
Location & Context

Site Location
Intermodal Station (IMS), Tirupati
Proposed on the existing APSRTC Central Bus Station (CBS) siteTirupati City, Tirupati District, Andhra Pradesh, India
Located near Tirupati Railway Station within the central urban zone

Site Area
Approximate site area: 13.2 acres (≈ 5.35 hectares)
Currently occupied by APSRTC Central Bus Station infrastructure

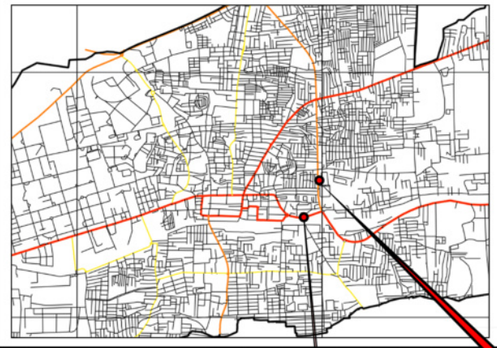
Potentials

- Strategic location enables seamless integration of bus, rail, and para-transit systems.
- High pilgrim and commuter footfall ensures constant activity and viability.
- Central city location offers excellent accessibility and urban visibility.
- Strong potential for transit-oriented mixed-use development.
- Reduce Urban Congestion
- Passenger density supports commercial Activity
- Climate Responsive Design



Residential
Commercial
Conservation
Transport
Public/ Semi Public
Vacant land

The area surrounding the site has major land use which comprises of commercial buildings and the outter ring of these commercial buildings contains residential areas and conservation areas. Few Public areas are there.



Soil condition and Topography

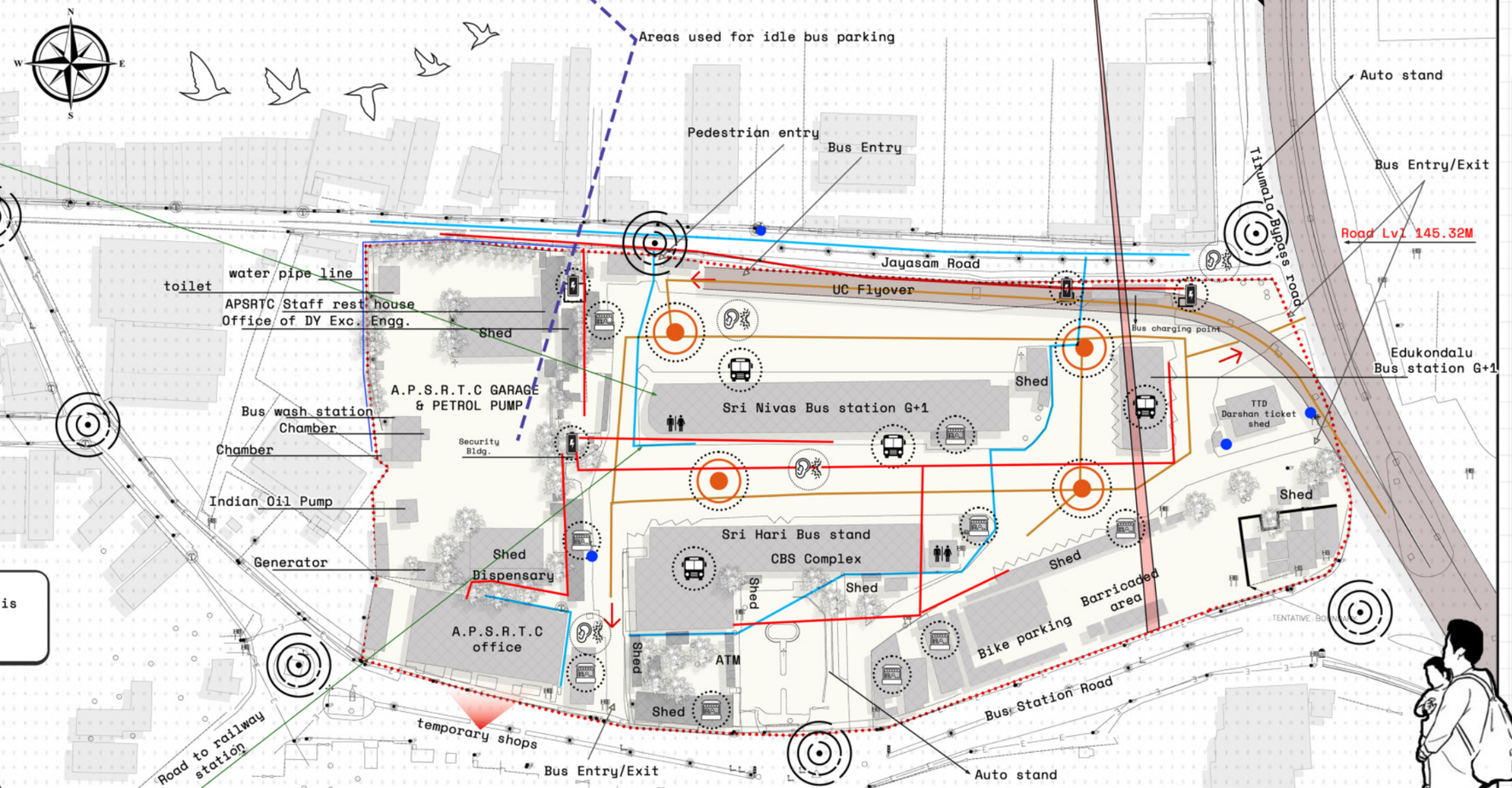
The proposed IMS at Tirupati's Central Bus Terminal is located on red sandy loam soil, typical of the Rayalaseema region. This well-drained soil offers moderate bearing capacity but low organic content, necessitating careful foundation design, such as isolated pads or raft with possible piles

The site of the proposed Inter-Modal Station (IMS) at Tirupati's APSRTC Central Bus Terminal, **being flat/contour-less and adjacent to Tirupati Railway Station, has an elevation of approximately 163 meters** (535 feet) above mean sea level (AMSL).

Cargo area, Sri Hari Bus Station Building

Srinivasa Bus Station Building and Shops

Station Building



The bus stand is not properly planned.

Sri Hari Bus Station Building

Waiting Area

Cargo area and shops, Sri Hari Bus Station Building

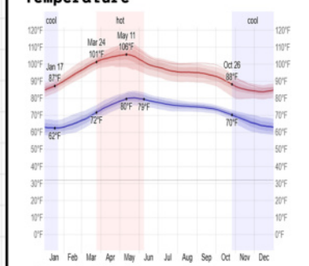
Driver's Lodge

Exisitng waiting area is very crowded and insufficient seats are available
There is large number of idle buses and collision between pedestrian and buses,
There is no proper infrastructure and controlled road management

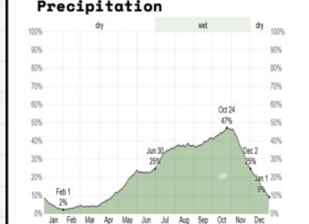
Collision points
ELE. Line
Water Line
Drainage
Shop/ eatery
Bus Stand
Toilet
Street Light
ELE post
Hose Bib
Cctv
Node
Site
Generator

Climate Analysis

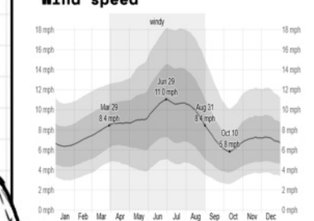
Temperature



Precipitation



Wind speed



Inference
Radiant barrier (reflective foil) to reduce roof heat gain in hot climates
Landscaping, especially on the west side, to minimize heat gain. **Elevated construction** to improve natural ventilation and reduce dampness,**Reduced west-facing glazing** to limit summer heat gain
Long, narrow building form to promote cross-ventilation
Natural ventilation to reduce dependence on air conditioning
Window overhangs and sunshades for passive cooling

TIRUPATI INTEGRATED BUS TRANSIT CENTER

ARJUN KODOOR KRISHNADAS

Tirupati ⟶ BUS TERMINUS

L N Q R 4 5

12:00 – PG NO

SITE ANALYSIS

NOTE: ALL DIMENSIONS ARE IN CM

SWOT ANALYSIS

Strategic location: The site is immediately adjacent to Tirupati Railway Station (≈800 m), enabling strong rail-bus integration potential

High regional connectivity: Direct access from Jayasam Road, Netaji Road, Bus Station Road, Srinivasa Flyover, and proximity to NH-71 and NH-716 strengthens regional and inter-state movement

Large contiguous land parcel: ~13.45 acres allows comprehensive planning for bus bays, commercial zones, parking, and future expansion.

Existing transport hub identity: Already functions as APSRTC Central Bus Station with ~1.68 lakh daily passengers, reinforcing its role as a primary mobility node

Pilgrimage-driven demand: Constant and predictable high footfall due to Tirumala pilgrims ensures viability of intermodal and commercial development.

Severely congested access roads: Narrow ROW (≤20 m for ~72% of surrounding roads) and on-street parking reduce efficiency of bus and pedestrian movement

Poor pedestrian infrastructure: About 74% of surrounding roads lack footpaths, resulting in unsafe pedestrian access between bus station and railway station

Aging and fragmented infrastructure: Existing bus station structures are partially demolished/structurally weakened, with inadequate seating, confusing bus parking, and poor wayfinding.

Operational conflicts: Overlapping zones for buses, autos, taxis, and pedestrians cause delays, missed buses, and operational inefficiencies during peak hours.

Environmental stress: Diesel buses, waterlogging during monsoon, waste mismanagement, and heat buildup affect passenger comfort and site performance

True intermodal integration: Potential to seamlessly connect rail, bus, IPT, taxi, auto, pedestrian, and future metro/ropeway systems within a single organized precinct

Urban decongestion catalyst: Reorganizing circulation and parking can significantly reduce traffic chaos around Mahatma Gandhi Junction and station approaches.

Transit-oriented commercial development: High footfall supports retail, food courts, offices, hotels, and dormitories for staff and bus crew, improving financial sustainability.

Universal accessibility upgrade: Scope to introduce barrier-free design—step-free grand entries, lift lobbies, buggies, wide passages, and gentle turning radii for parking.

Sustainable infrastructure: Integration of EV buses, solar roofs, rainwater harvesting, MLCP, and green buffers aligns with long-term urban resilience goals

Extreme peak-day pressure: Festival events like Brahmotsavam generate sudden surges (up to 1.5 lakh pilgrims/day projected), risking system overload if not designed robustly

Land-use constraints around site: Dense residential and commercial surroundings (≈88%) limit road widening and expansion possibilities

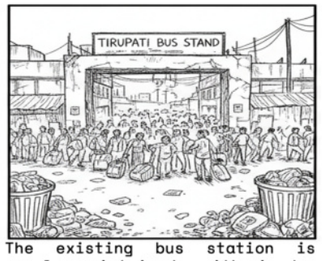
Traffic spillback risk: Poorly phased construction or inadequate traffic management could worsen congestion on Jayasam Road and Srinivasa Flyover.

Climate vulnerability: Monsoon flooding and rising temperatures can disrupt operations if drainage and shading are not carefully resolved.

Coordination complexity: Multiple stakeholders (APSRTC, Railways, Municipal Corporation, NHAI) may slow implementation if integration strategies are not clearly structured.

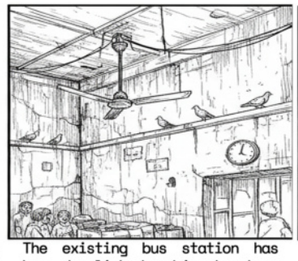
ROUTE OF BUSES AND ENTRY

Bus Category	Existing Entry	Existing Exit	Existing Issues
Interstate Buses	Bus Stand Road and connectivity from Srinivasa Flyover	Bus Stand Road	Shares circulation with local and regional buses, causing congestion and operational conflict
Intercity / Regional Buses	Bus Stand Road	Bus Stand Road	Mixed circulation with interstate and rural buses leads to traffic overlap
Rural Buses	Bus Stand Road	Bus Stand Road	Frequent stopping and passenger loading create congestion near terminal frontage
Tirumala Shuttle Buses	Tirumala Bypass Road	Tirumala Bypass Road	Shuttle movement overlaps with other bus circulation during peak pilgrim hours
Overall Terminal Condition	Common access system	Common access system	Lack of segregated ingress and egress, pedestrian-vehicular conflict, and absence of dedicated exit toward Jayasam Road create heavy congestion within the site

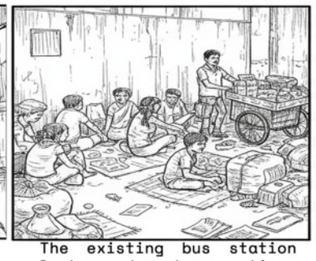


The existing bus station is poorly maintained, with inadequate cleanliness and waste management leading to unhygienic conditions for passengers.

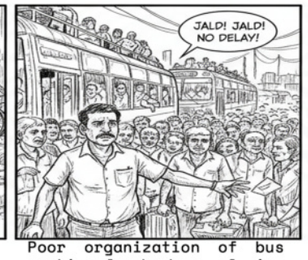
The existing bus station lacks sufficient space and infrastructure to efficiently accommodate and manage a large volume of buses.



The existing bus station has been demolished and is structurally weakened, making it unsuitable for continued operation or expansion.

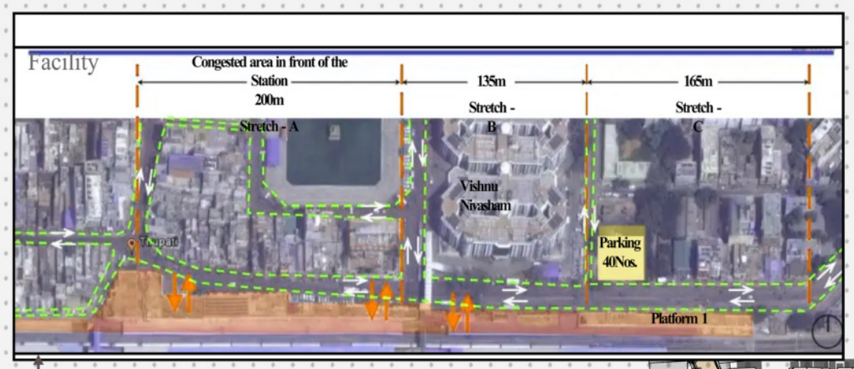


The existing bus station lacks adequate seating, making it unable to comfortably accommodate large numbers of passengers.



Poor organization of bus parking leads to confusion among passengers and frequent difficulty in locating the correct buses.

The existing bus station has poor pedestrian connectivity to the railway station, making transfers inconvenient and unsafe for passengers.



TIRUPATI INTEGRATED BUS TRANSIT TERMINAL

ARJUN KODOOR KRISHNADAS

Tirupati ⟶ BUS TERMINUS

L N Q R 4 5

13:00 – PG NO

SITE ANALYSIS

NOTE: ALL DIMENSIONS ARE IN CM

EXISTING SITE CONDITION

The front building of the Tirupati bus stand, housing the Depot Manager's office, is severely damaged, with visible structural distress and neglected façades.
Its deteriorated condition not only undermines the image of the bus stand but also hampers efficient administrative functioning.

The existing idle bus parking and workshop areas at the Tirupati bus stand are poorly organized and inadequately equipped, with insufficient maintenance facilities and inefficient circulation. This lack of infrastructure leads to operational delays, poor upkeep of buses, and underutilization of valuable transit space.

The existing toilets within the buildings are in a deteriorating condition, with poor sanitation, damaged fixtures, and inadequate ventilation.
This lack of proper infrastructure creates unhygienic conditions and significantly affects user comfort and public health.

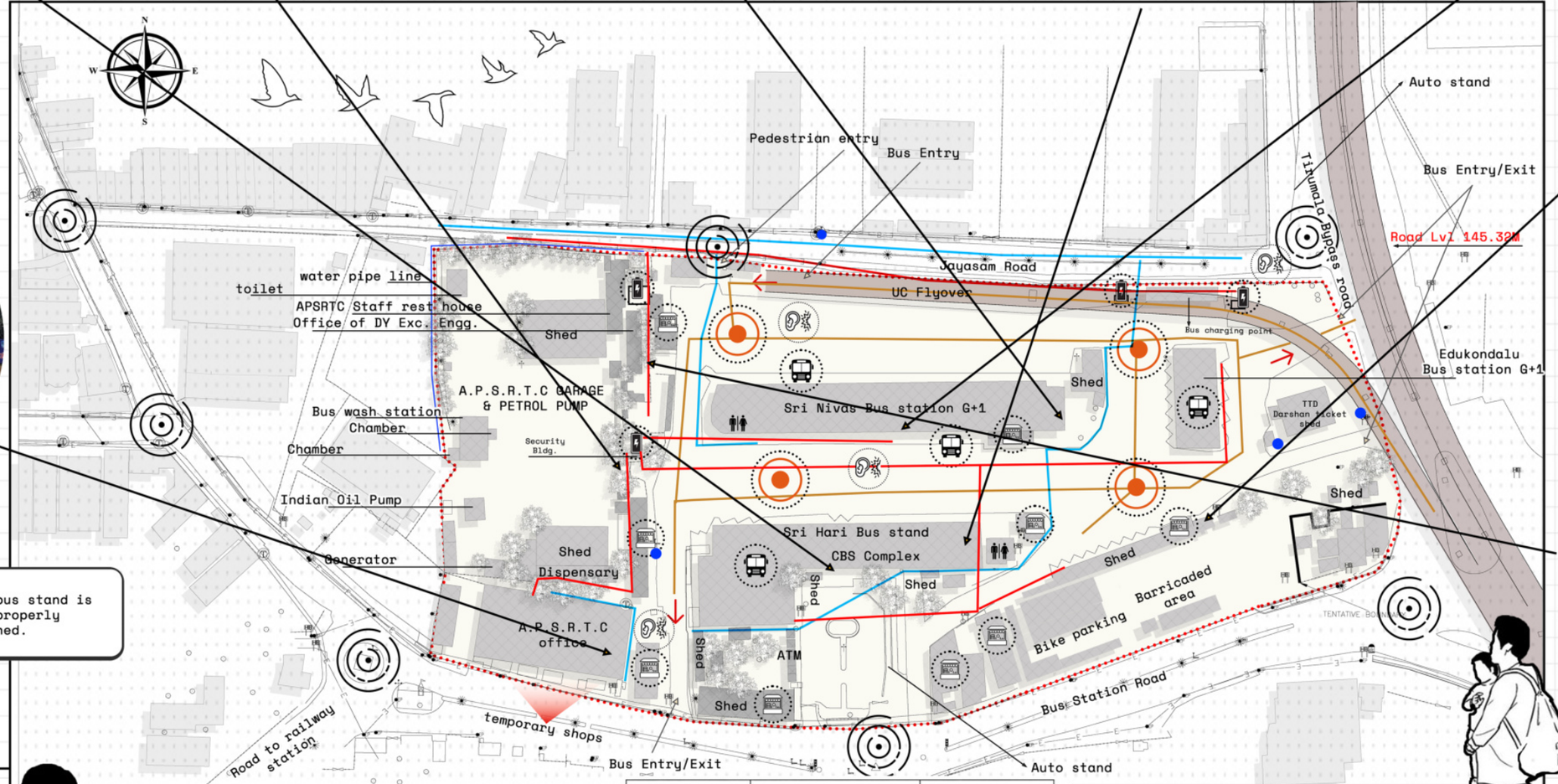
The demolished front buildings have left behind an underutilized and poorly defined area within the bus stand premises.
This vacant space currently lacks functional planning, resulting in inefficient land use and a weakened urban edge.

The waiting areas feature an outdated façade design, reflecting old architectural styles that no longer meet current functional or aesthetic needs. Slight but visible structural damage is observed, indicating the need for timely repair and upgradation.

The RTO office at the Tirupati bus stand is in a visibly deteriorated condition, with cramped interiors, poor maintenance, and inadequate basic facilities.

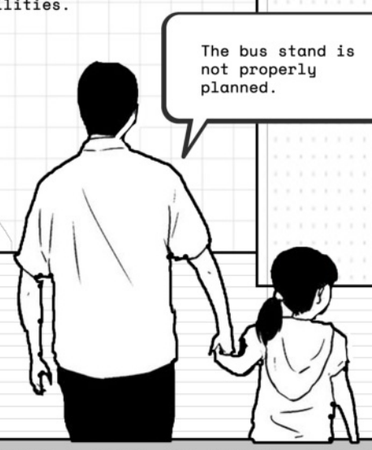
Waiting sheds are improperly placed in a scattered manner across the site, lacking a coherent layout or hierarchy.
This results in visual clutter, inefficient circulation, and discomfort for passengers.

The maintenance areas and staff offices lack basic amenities and are not supported by properly defined rooms or functional layouts.
This inadequate infrastructure affects staff comfort, operational efficiency, and overall management of the facility.



Entry Road	Description	Purpose
Railway Station Road (Station Road)	Primary direct access to the station.	Main station entrance.
Renigunta Road	Connects to Renigunta and NH corridors.	Regional and highway access.
Netaji Road	Secondary access from city side.	Urban and local access.

Collision points
ELE. Line
Water Line
Drainage
Shop/ eatery
Bus Stand
Toilet
Street Light
E ELE post
Hose Bib
Cctv
Node
Site
Generator



TIRUPATI INTEGRATED BUS TRANSIT TERMINAL

ARJUN KODOOR KRISHNADAS

Tirupati → BUS TERMINUS

L N Q R 4 5

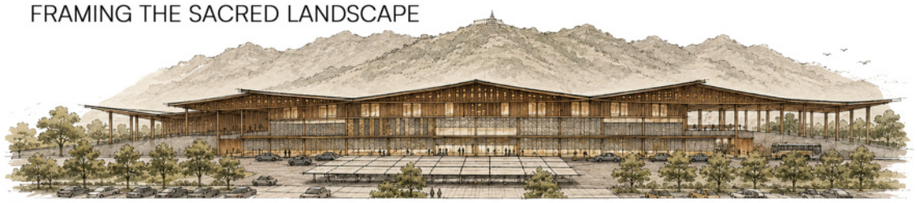
14:00 – PG NO

SITE ANALYSIS

NOTE: ALL DIMENSIONS ARE IN CM

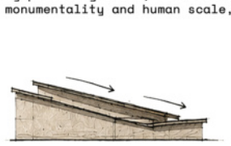
CONCEPT

FRAMING THE SACRED LANDSCAPE



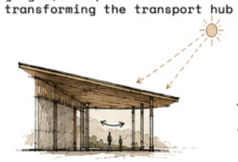
The architectural form is conceived as an extension of the landscape of Tirupati, drawing direct inspiration from the undulating profile of the Tirumala Hills. Rather than imposing a singular monumental mass, the building is articulated as a series of gently sloping roof planes that rise and fall in response to the natural skyline of the surrounding terrain. This fragmented roofscape reduces the perceived scale of the terminal while establishing a strong visual relationship with the sacred hills beyond.

The shifting roof forms reinterpret the rhythm and silhouette of the Eastern Ghats, allowing the architecture to visually merge with its context. The large overhanging roofs not only echo the landscape aesthetically but also respond climatically by providing shade, diffused daylight, and protection from heavy monsoon rains. The resulting form creates a balance between monumentality and human scale, transforming the transport hub into a grounded, regionally rooted public space.



1. SLOPING ROOF LANGUAGE

The roof form echoes the rise and fall of the Tirumala hills. Interconnected sloping planes create visual rhythm, reduce the building's perceived scale, and efficiently guide rainwater flow.



2. DEEP OVERHANGS

Large roof overhangs provide protection from sun and rain, create shaded waiting spaces, and improve passenger comfort throughout the terminal.

3. OPEN, POROUS & CONNECTED

Open facades, shaded voids, and perforated elements enhance natural ventilation and create a breathable terminal with smooth passenger movement.

4. TRADITIONAL MATERIALS & IDENTITY

The design incorporates traditional materials associated with Tirupati, such as stone, wood, and earthy textures, creating a timeless architectural character rooted in regional identity.

FORM EVOLUTION

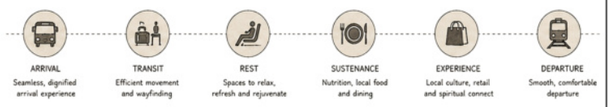
A horizontal mass sits on the site

The form is pulled and shaped to respond to the hills.

Roof planes rise and fall, echoing the natural topography.

Open, porous facades allow movement, views and ventilation.

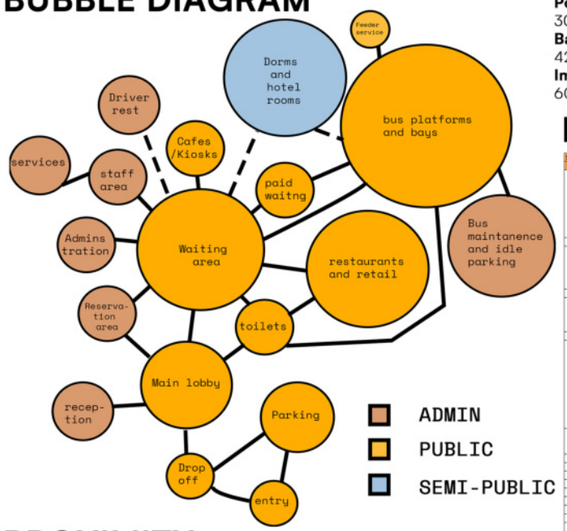
FUNCTIONAL CONCEPT



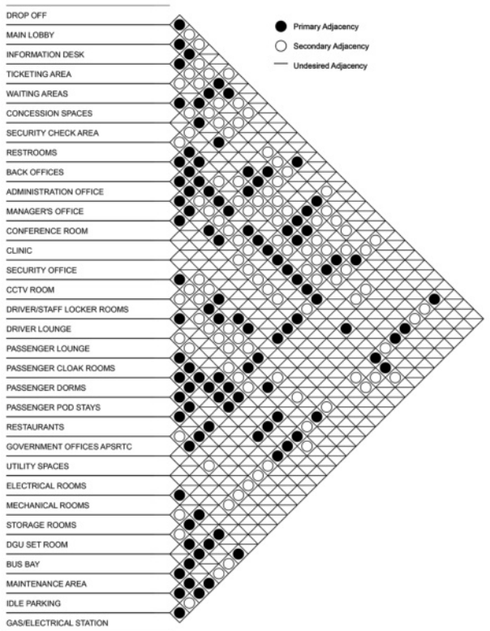
Conventional intermodal stations are typically conceived as transit exchange points that function as spaces whose sole purpose is to facilitate the transfer of passengers between modes of transport. While operationally efficient, such facilities fail to address the holistic reality of travel, particularly in a pilgrimage city like Tirupati, where millions of devotees arrive from across the country, often after long journeys, and require far more than a platform and a ticket counter.

Rather than designing an intermodal station, the proposal envisions a fully integrated, self-sufficient ecosystem that accommodates every phase of the traveller's experience, from arrival and transit to rest, sustenance, and departure.

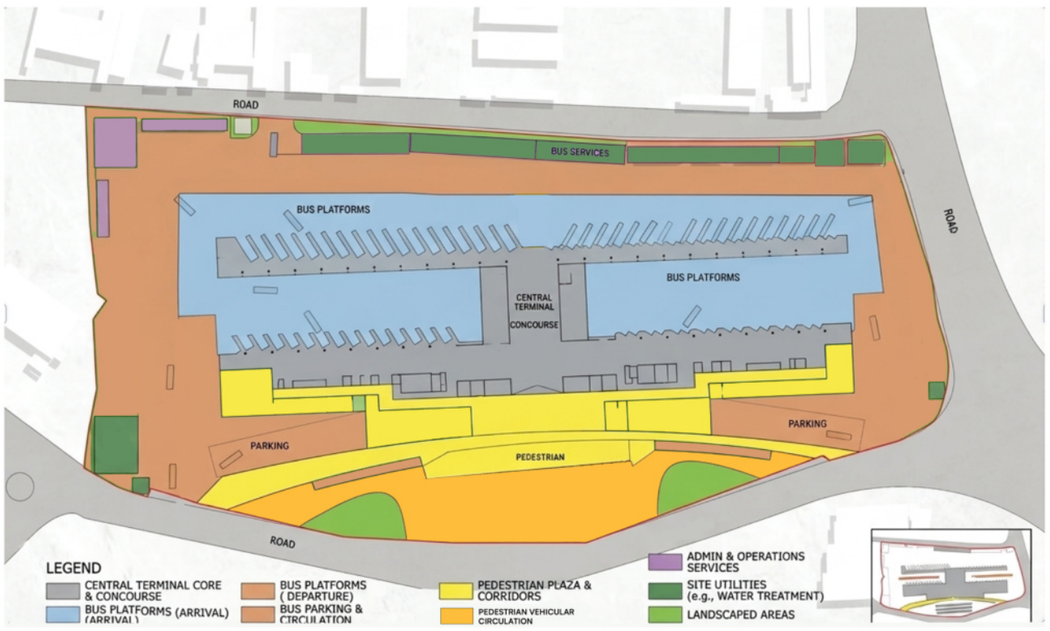
BUBBLE DIAGRAM



PROXIMITY



ZONING



DESIGN ASSUMPTIONS

Effective working hours = 12 hours/day
Peak demand multiplier:
Present scenario = 1.4
Festival / future scenario = 1.5
Proposed terminal capacity = 110 bus bays

Terminal designed considering:
pilgrimage surge,
intercity and local transit integration,
operational flexibility,
future expansion,
and festival crowd management.

PRESENT SCENARIO CALCULATION

Daily Bus Movement
Total buses/day = 3672 buses
Average Hourly Flow
3672÷12=306 buses/hour

Peak Hour Demand
306×1.4=428 buses/hour
Bay Efficiency Based on 110 Bays
428÷110=3.89 buses/hour/bay
Implied Dwell Time
60÷3.89≈15 minutes/bus

FESTIVAL / FUTURE SCENARIO CALCULATION

Daily Bus Movement
Total buses/day = 4300 buses
Average Hourly Flow
4300÷12=358 buses/hour

Peak Hour Demand
358×1.5=537 buses/hour

Bay Efficiency Based on 110 Bays
537÷110=4.88 buses/hour/bay

Implied Dwell Time
60÷4.88≈12 minutes/bus

Category	Number of Bays	Function
Active Boarding / Alighting Bays	78 Bays	Passenger boarding and departure operations
Idle / Layover Parking Bays	20 Bays	Waiting, crew change, temporary holding
Festival Surge / Reserve Bays	12 Bays	Peak season overflow and future expansion
Total	110 Bays	—

DESIGN INFERENCE

Proposed capacity = 110 bus bays

Operational demand during normal conditions:
approximately 3.9 buses/hour/bay

Operational demand during festival conditions:
approximately 4.9 buses/hour/bay

Average dwell time:
12—15 minutes per bus

The proposed terminal capacity ensures:
smooth circulation,
efficient passenger handling,
operational flexibility,
and long-term scalability for future growth.

DESIGN BRIEF

SL NO	SPACE TYPOLOGY	ATTRIBUTE	OCCUPANT	CASE STUDY 1	CASE STUDY 2 –	CASE STUDY	DPR	SPACE NOS	ACHIEVED AREA	REMARKS
		Footfall		~20,000 – 40,000+ passengers per day using Vyttila Mobility Hub buses (local + intercity combined Morning peak (2 hrs): ~4,000 – 6,000 people (~2,000 – 3,000 per hour) Evening peak (3 hrs): ~6,000 – 8,000 people (~2,000 – 2,700 per hour)	Typical weekday footfall: ~50,000 passengers/day Weekend/holiday footfall: ~70,000–80,000 passengers/day Peak festival surges: Can exceed 2 lakh passengers in short periods Morning peak (2 hours): ~5,000–7,500 people/hour total (~10,000–15,000) Evening peak (3 hours): ~10,000–12,500 people/hour total (~20,000–25,000	200000 lakh passengers a day Morning peak: ~25,000–37,500 total (~12,500–18,750/hour) Evening peak: ~50,000–62,500 total (~16,500–20,800/hour)				Normal peak hour: ~ 17,000 passengers/hour High-demand / seasonal peak: ~ 22,000–25,000 passengers/hour
	Site Area			11.1 acres	86 acres	37 acres			13.45	—
	Ground Coverage				FSI – 0.074		Minimum coverage should be 50% of the podium block subject to a minimum of 3M in any side			—
	Grand Lobby	Integrated Terminal	All	475	2014 (can occupy 1300 people)	10850				—
	Bus bays	Integrated Terminal	All	60 no / 3150	245 nos / 12862	500 / 2500	12000 -15000			from DPR
1		Interstate Buses	All					110	12000 -15000	from DPR
		Rural Buses	All							from DPR
		Buses for Tirumala	All							from DPR
		Pedestrian walkway	All							
	Unpaid area	-	All		office designed for Ground and First Floor for the built up area of 833 Sqm consisting Reception lobby, 2 numbers of Transport Office, CCTV room, Refreshment Room and Electrical room. Gents and Ladies Toilets planned at Ground Floor with 17 Water Closets. IO Urinals and 19 Wash basins and at First Floor 4 water Closets. 4 Wash Basins and 2 Urinals.				From case study
		ticketing	All	30sqm + 54.5 m2 front Queeing space - 3 counters + 1 disabled	20 Nos / 419	1 nos		20	500	From case study
		Atm	All	8	1 nos / 19	4 nos		2	20	From case study
		security room	Staff	20	1 nos / 115	5 nos		2	150	From case study
		Staff change room	Staff	22	-	-		5	500	From case study
		Cctv room	Staff	-	1 nos / 19	-		1	25	From case study
		crew mess room	Staff	20.6	4 Drivers dormitory for 340 drivers which covers a total area of 1258Sqm	-		5	1300	From case study
		cleaners room	Staff	17.2	4 toilet blocks for drivers	-			50	From case study
		staff toilets	Staff	-		2nos / 500 sqft each			50	From case study
	Paid and commercial area									
	Hotels/restaurant		All	-	-	3 restaurant and 3 smaller eateries inside the terminus, 3 locker rooms, 10 travel agency offices, shops, supermarkets, ATtwt, dorm rooms (A/C and non-A/C) for rent, toilets, round-the-clock security, pure drinking water free of cost facilitated b a Reverse osmosis treatment lant,	20000 - 30000	15	100	from DPR
	Commercial/ Retail Areas		All	-	-		15000 – 20000		10000	from DPR
		Shops	All	15	49 shops / 1412	34 nos	10000	25	2000	From case study
		Restaurant	All	-	2 nos / 405	10 nos / 23000	-	5	1000	From case study
		Fastfood	All	-	2 nos / 370	-	-	3	500	From case study
		Medical Centre	All	-	1 nos / 26.98	1 nos / 150 sqmt	-	1	50	From case study
		Mothers Room	All	I nos / 20	I nos / 24.5	-	-	2	50	From case study
		Dorms	All	-	1 Gent's dormitory for 100 people which covers an area of 3775qm. 1 Ladies dormitory for 40 people which covers an area of 2305qm.		-	1 Gent's dormitory for 100 people which covers an area of 3775qm. 1 Ladies dormitory for 40 people which covers an area of 2305qm.	1 Gent's dormitory for 100 people which covers an area of 3775qm. 1 Ladies dormitory for 40 people which covers an area of 2305qm.	From case study
		Store rooms	All	-	2 nos / 77	1 nos	-	3	100	From case study
	Toilets		All	350 sq meter	4 Toilet blocks for Ladies and Gents planned in the ground floor at different locations having 74 wash basins, 35 urinals and 91 Water Closets totally.even 35 urinals and 91 Water Closets totally. 2 Toilet Blocks for Ladies and Gents Dormitory. 4 Toilet Blocks for Drivers Dormitory and2 Toilet Blocks for Commercial area Ladies and Gentsbaving 91 wash basins. 72 urinals. 95 WCs and 57 baths totally.	18 - 22 blocks and 6-8 staff blocks	-	WCs → 95 × 1.5 = 142.5 sq m Urinals → 72 × 1.0 = 72.0 sq m Wash basins → 91 × 0.8 = 72.8 sq m Baths → 57 × 2.5 = 142.5 sq m	300 sq m	From case study
	Services	Workshop	Staff		2 acres of area is designated for bus depot. Inside the Bus Depot Work Shop for an area of 1920 Sqm with the clear height of 6.5 meters is planned. and 555 Sqm Office area is planned in Ground and First floor inside the works shop.	1400 sq mt	-	1000		From case study
		Fuel Filling	Staff		0.8 Acres of land is designated for Fuel Filling station adjacent to the works shop.	1 nos / 855 sqmt	-			From case study
		Sub – station	Staff		Substation is designed with Ground and First Floor for the built up area of 793 Sqm to accommodate 2 numbers 2000 KVA oil type Transformer. HT panel room, DG synchronizing panel and LT panel room. Open space is designed for 2 numbers of 1500 KVA DG sets at adjacent to substation,	350 sqm	-			From case study
		Water treatment plant	staff	-	Didn't achieve area	RO plant 2lakh litres per day and 2 iron removal plant 50000 litres			3000	
		Tele maintanence room	Staff	17 nos	-	-	-			From case study
		Emergency Equipment room	Staff	-	-	-	-			From case study
		Cash Handling Room	Staff	-	-	-	-			From case study
		UPS	Staff	60 nos	-	-	-			From case study
		AHU	Staff	-	-	-	-			From case study
		Electrical Room	Staff	-	-	-	-			From case study
		Escalator Control panel	Staff	-	-	-	-			From case study
		DG room	Staff	70	-	-	-			From case study
		Sewage treatment plant	Staff	70	-	-	-			From case study
		Pump room	Staff	70	35.2 sq meter	2 nos / 140 sq meter	-			From case study
		Loading Unloading area	Staff	55.17	-	-	-			From case study
	Parking for Cars/ Taxis/ 2-wheelers		All	-	Car parking capacity: 324 cars can be accommodated on-site within the dedicated parking area at the terminus. Two-wheeler parking capacity: 1,769 two-wheelers are provided in the public parking area. Car parking area: Approximately 6,000–8,000 sq m (based on typical design norm of ~18–25 sq m per car including circulation). Two-wheeler parking area: Approximately 5,500–7,000 sq m (using ~2–2.5 sq m per bike inclusive of aisle circulation).	Public Parking Area: 2850 Sqm Double Basement Parking Structure Capacity Of 3000 Two Wheelers Inmate Parking Area: 2000 Sqm Staff Parking Area: 200 Sq. m	30000 - 50000		15000 excluding idle parking for buses	from DPR
	Office Areas		All	-	833 Sqm	-	2000 – 3000		2000 – 3000	from DPR
	Inter-Modal Connectivity		All	-	-	-	-			from DPR
	IPT Stand (100 Bays)		All	-	-	-	-		2500	from DPR
	Pick-up/ Drop-Off Bays (50 Bays)		All	-	-	-	-	30 bays	1000	from DPR
									17395 built structure + approx 3000 for outer service buildings	

TIRUPATI INTEGRATED BUS TRANSIT TERMINAL

ARJUN KODOOR KRISHNADAS

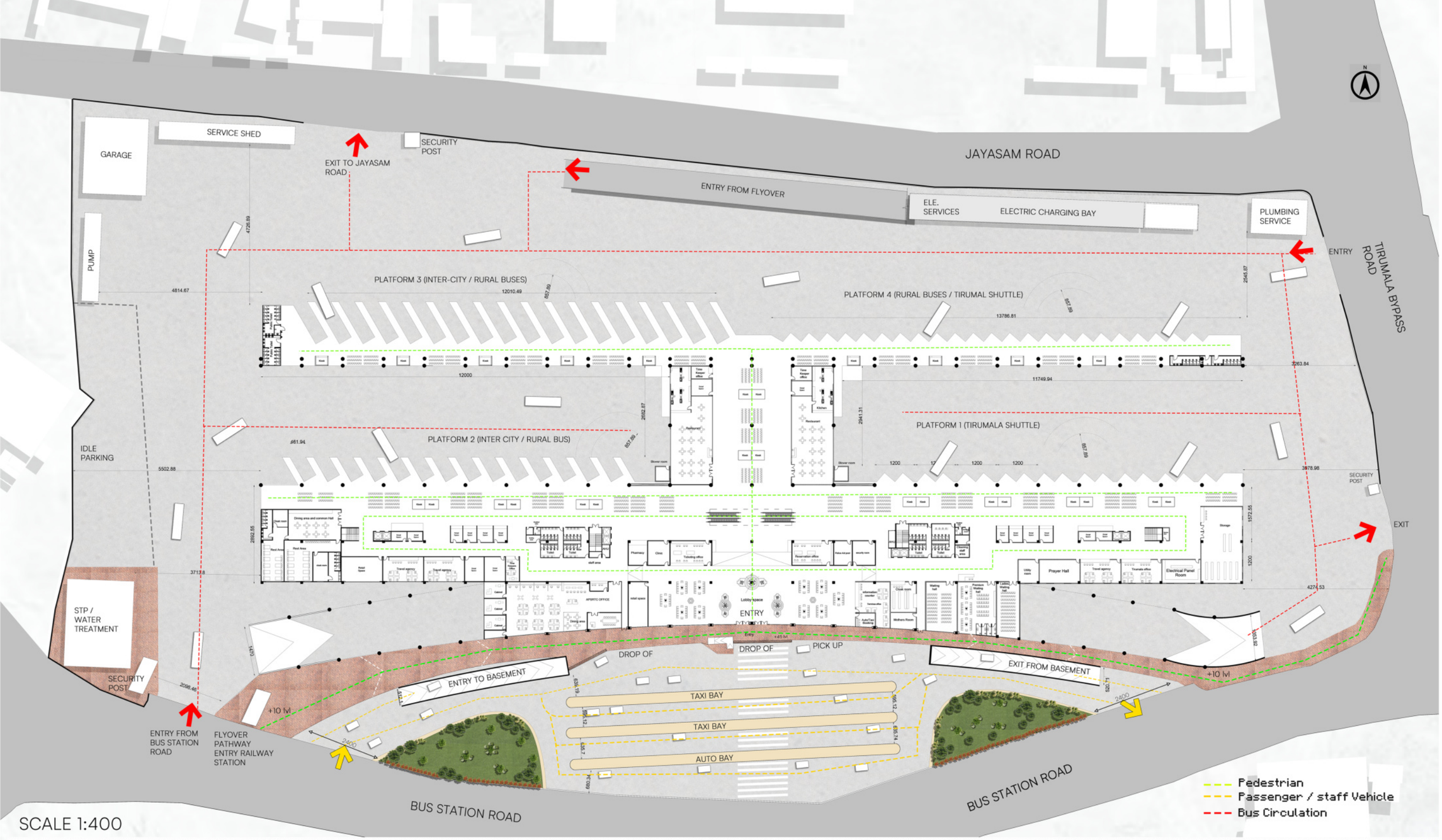
Tirupati ⟶ BUS TERMINUS

L N Q R 4 5

16:00 – PG NO

DESIGN DEVELOPMENT

NOTE: ALL DIMENSIONS ARE IN CM



SCALE 1:400

Circulation and Access Planning

The proposed transit terminal is designed through a hierarchical circulation system to reduce vehicular conflict and improve operational efficiency.
The 13-acre site utilizes four major access points:
Bus Stand Road
Jayasam Road
Tirumala Bypass Road
Srinivasa Flyover

Traffic movement is segregated based on trip distance, operational frequency, and passenger intensity.

Bus Category Segregation

Interstate Buses

Entry provided from Srinivasa Flyover access.
Exit directed towards Jayasam Road.
Segregated from local transit to reduce congestion within the city core.
Planned near longer-duration parking and passenger waiting facilities.

Intercity / Regional Buses

Main entry provided from Bus Stand Road.
Exit directed towards Jayasam Road.
Positioned close to the central concourse for easy passenger accessibility.

Rural Buses

Located near public access zones and local commuter areas.
Connected through Bus Stand Road access.
Designed for short-duration stopping and frequent passenger movement.

Tirumala Shuttle Buses

Dedicated entry and exit provided through Tirumala Bypass Road.
Planned as a high-frequency shuttle corridor with rapid turnaround movement.
Located closer to pilgrim circulation and waiting areas.

LANDSCAPE

Neem (Azadirachta indica)

Height: 12—18 m
usage: Extremely drought-resistant, excellent for shade + air purification
Use zone: Along road edges (heat + pollution buffer)

Pongamia (Pongamia pinnata)

Height: 10—15 m
usage: Fast-growing, nitrogen-fixing, ideal for avenue planting
Use zone: Linear planting along pathways

Areca Palm (Dypsis lutescens)

Height: 6—9 m
usage: Vertical element, minimal spread → good for tight spaces
Use zone: Near waiting areas / plazas

Bougainvillea

Height: 2—4 m (can be trained)
usage: Extremely hardy, low water, dust barrier + color
Use zone: Edges facing roads/bus movement

Ixora

Height: 2—4 m (can be trained)
usage: Extremely hardy, low water, dust barrier + color
Use zone: Edges facing roads/bus movement

Doob Grass (Cynodon dactylon)

Height: 50—100 mm (lawn level)
Usage: Highly durable, survives heat → low-cost ground cover
Use zone: Open patches + in-between planting

Agave (Agave americana / Agave attenuata)

Height: 0.6 — 1.5 m
Why use: Highly drought-resistant, strong sculptural form → low maintenance and ideal for hot climates
Use zone: Foreground planting, edges near pathways

Permeable Interlocking Pavers
Rubberised Asphalt
High-Viscosity/High-Modulus Modified Asphalt
Interlocking Concrete Pavers

TIRUPATI INTEGRATED BUS TRANSIT TERMINAL

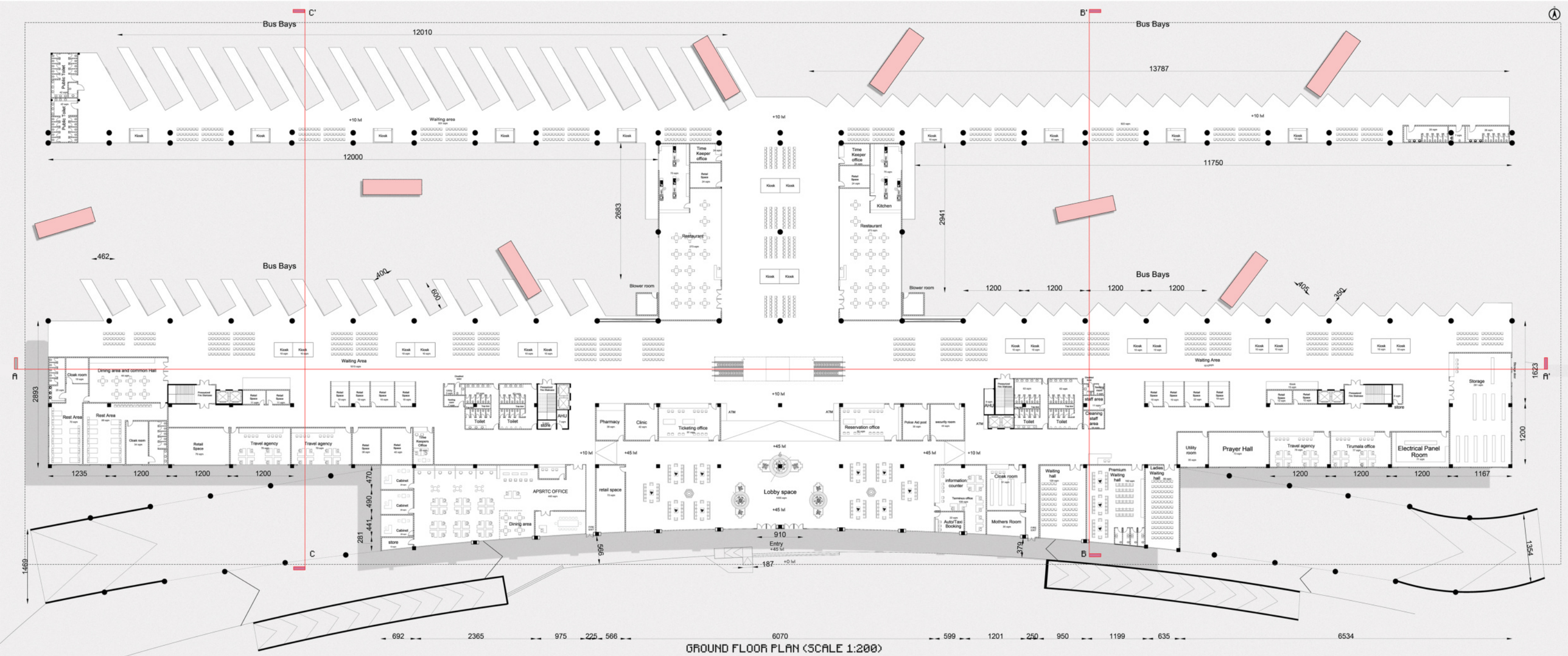
ARJUN KODOOR KRISHNADAS

Tirupati → BUS TERMINUS

L N Q R 4 5 17:00 – PG NO

MASTER PLAN

NOTE: ALL DIMENSIONS ARE IN CM



GROUND FLOOR PLAN (SCALE 1:200)

VIEW BUS BAYS

INTERIOR VIEWS

VIEW FROM FLYOVER

TIRUPATI INTEGRATED BUS TRANSIT TERMINAL

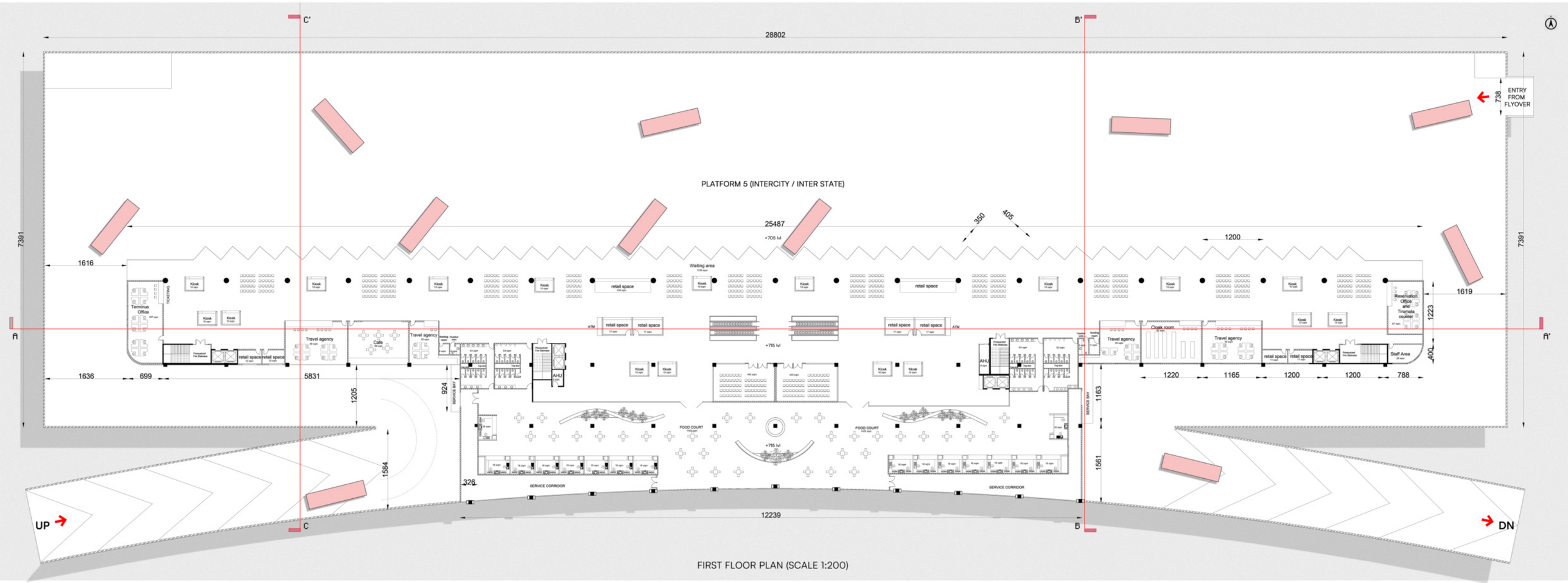
ARJUN KODOOR KRISHNADAS

Tirupati ⟶ BUS TERMINUS

L N Q R 4 5 18:00 – FG NO

GROUND FLOOR PLAN

NOTE: ALL DIMENSIONS ARE IN CM



FIRST FLOOR PLAN (SCALE 1:200)

WAITING AREAS

OFFICE AREAS / TICKETING

PLATFORM 5

WAITING AREAS

TIRUPATI INTEGRATED BUS TRANSIT TERMINAL

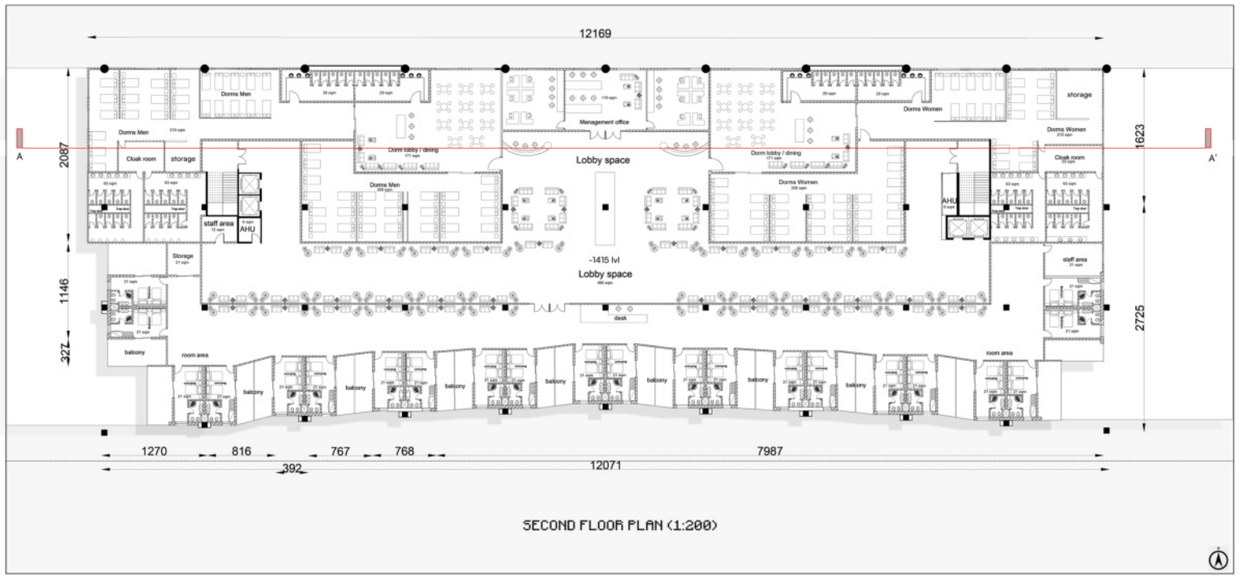
ARJUN KODOOR KRISHNADAS

Tirupati ⟶ BUS TERMINUS

L N Q R 4 5 19:00 – PG NO

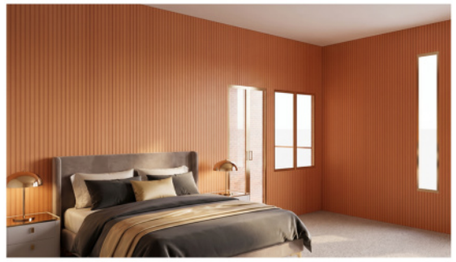
FIRST FLOOR PLAN

NOTE: ALL DIMENSIONS ARE IN CM



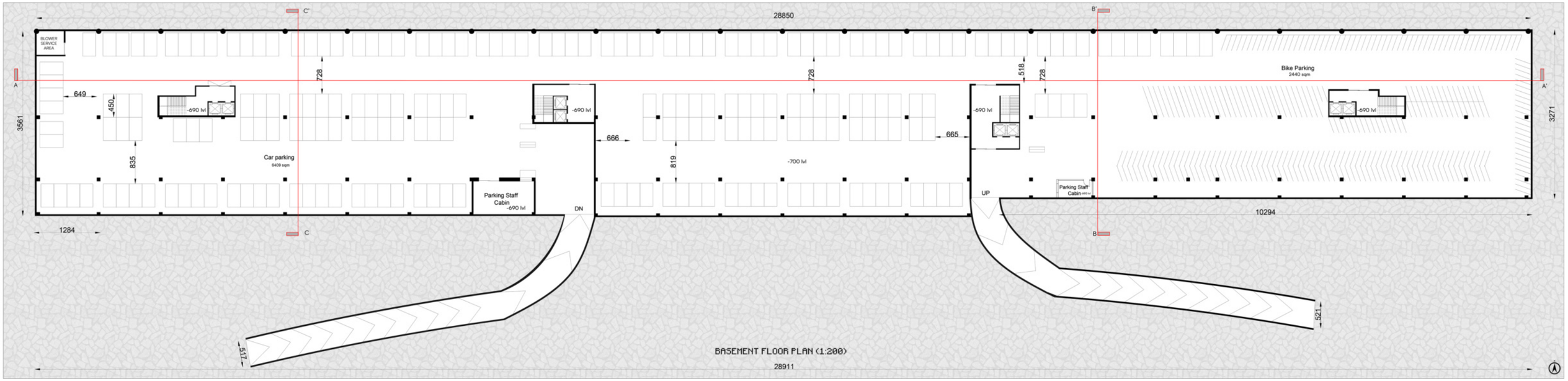
SECOND FLOOR PLAN (1:200)

ROOMS



LOBBY SPACE

EXTERIOR VIEW



BASEMENT FLOOR PLAN (1:200)

28911

TIRUPATI INTEGRATED BUS TRANSIT TERMINAL

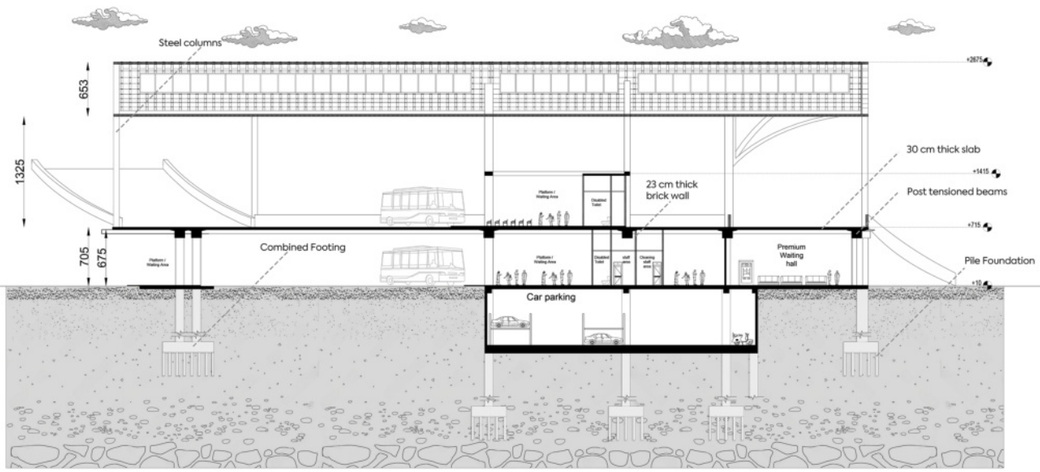
ARJUN KODOOR KRISHNADAS

Tirupati ⟶ BUS TERMINUS

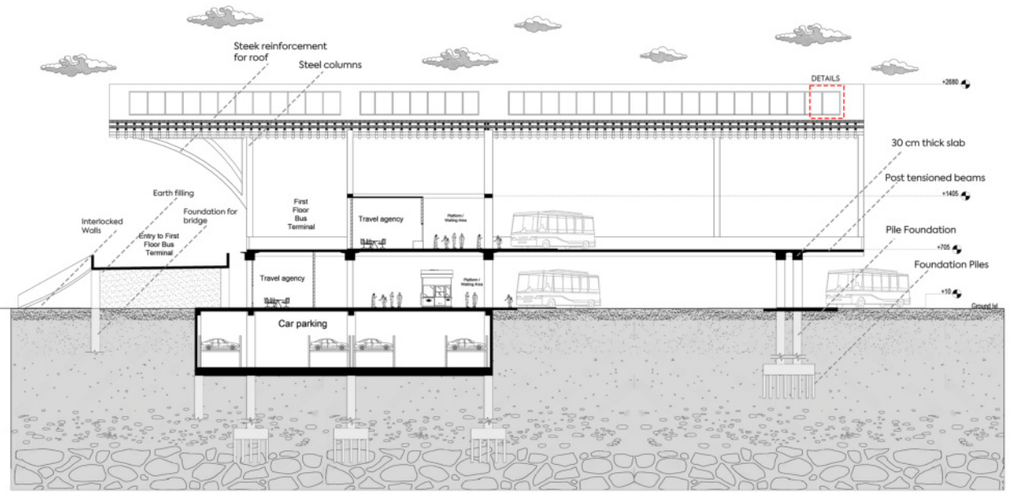
SECOND FLOOR PLAN , BASEMENT PLAN

L N Q R 4 5 20:00 – PG NO

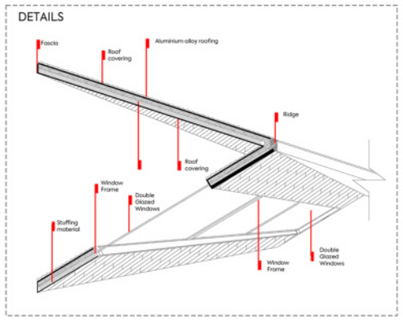
NOTE: ALL DIMENSIONS ARE IN CM

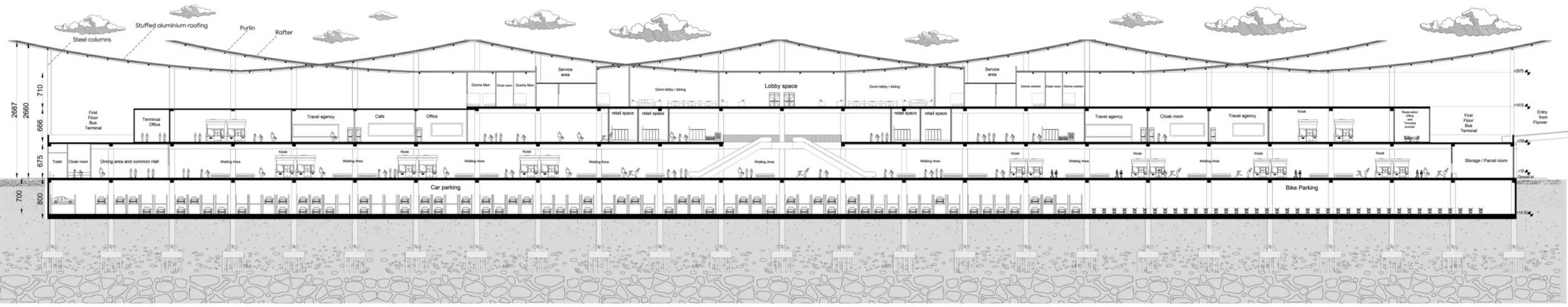


SECTION B-B'



SECTION C-C'





SECTION A-A'

TIRUPATI INTEGRATED BUS TRANSIT TERMINAL

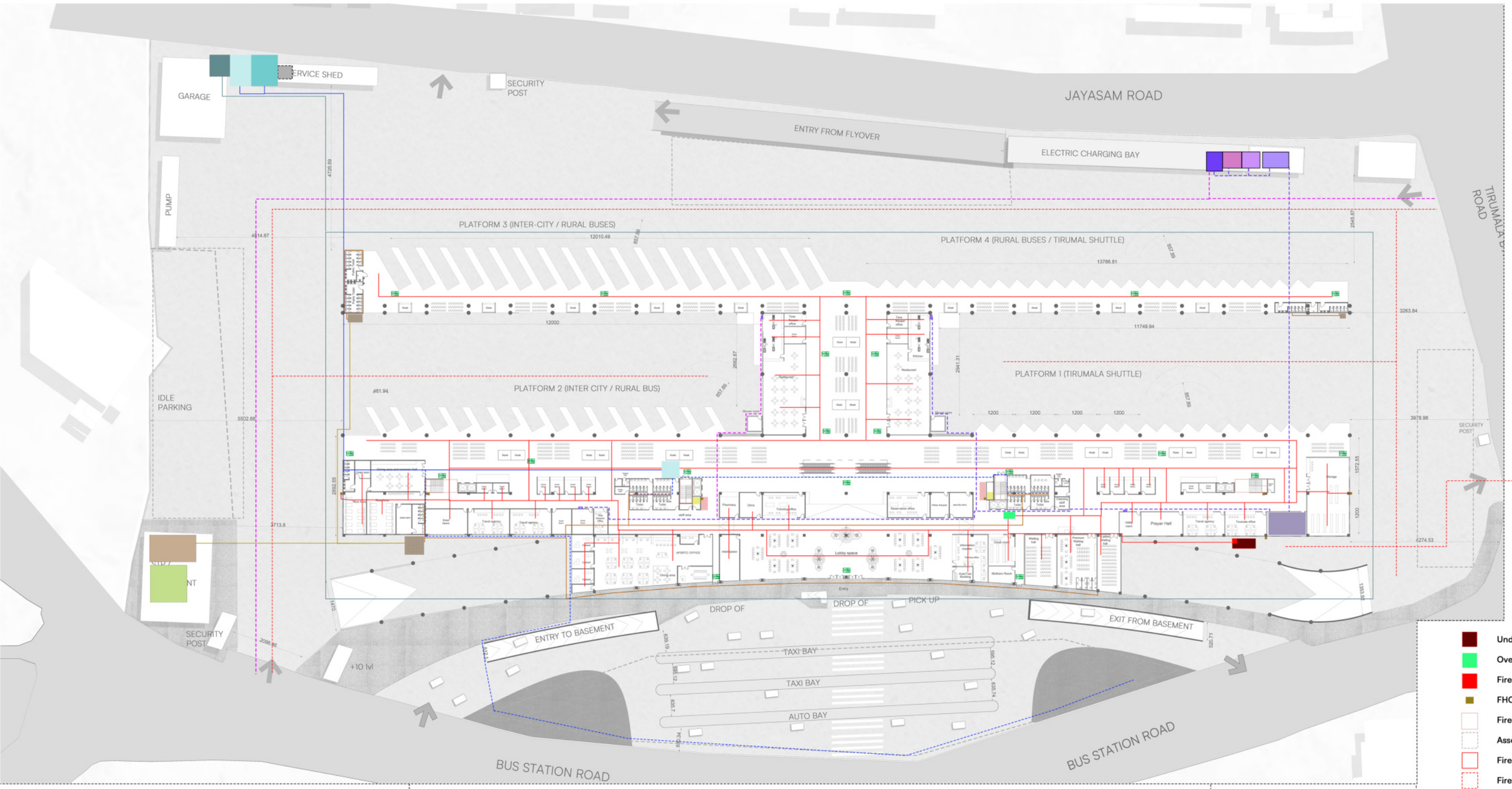
ARJUN KODOOR KRISHNADAS

Tirupati ⟶ BUS TERMINUS

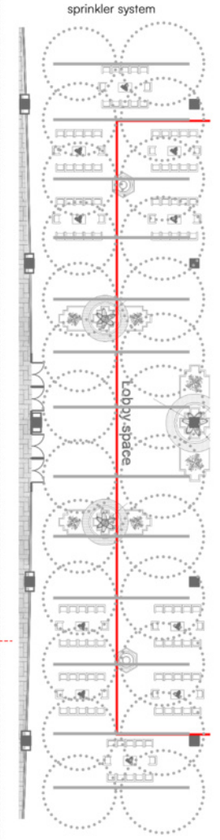
SECTIONS

L N Q R 4 5 21:00 – PG NO

NOTE: ALL DIMENSIONS ARE IN CM



FIRE



- Underground Fire Water Tank
- Overhead Fire Water Tank
- Fire Pump Room
- FHC Shaft
- Fire Stairs
- Assembly Area
- Fire Water Line (Sprinkler line)
- Fire Truck Route
- Fire Exit Signage

Capacity of UG fire tank: 120,000 L (120 kL)

Capacity of OH fire tank: 25,000 L (25 kL)

ELECTRICAL

- Transformer
- DG Room
- LT Panel Room
- HT Panel Room
- Distribution Board
- Electric Panel & ELV Room
- Electric Supply Line
- Diesel Vehicle Route

ELECTRICAL LOAD CALCULATIONS

Total Unit Electrical Load:
200 W/sq.m (bus terminal — moderate to high usage with HVAC)
Connected Load Calculation:
Unit Electrical Load × Built-up Area
= 15,247 × 0.20 = 3049 kW (≈ 3050 kW)

Maximum Demand
Diversity Factor = 0.75
3050 × 0.75 = 2287 kW
Maximum Demand = 2287 kW (≈ 2300 kW)

Transformer Capacity

kVA = kW / 0.8
2287 / 0.8 = 2859 kVA (≈ 2900 kVA)

DG Backup

50% of maximum demand

DG Load = 2300 × 0.5 = 1150 kW

kVA = 1150 / 0.8 = 1437 kVA

DG Set: 1500 kVA

Proposed Electrical Infrastructure
3 × 1000 kVA Transformers (2 working + 1 standby)
1 × 1500 kVA DG Backup
60 sq.m LT Panel Room
40 sq.m HT Panel Room

PLUMBING

Septic Tank Capacity

Space	Sewage Generation (cu.m/day) *(80% of water)*	Sludge Storage (cu.m) *(0.1 cu.m/p for 2 yr cycle)*	Total Capacity (cu.m)
Waiting Halls	4.0	30	34
Food Court	59.0	160	219
Dormitory 1	10.8	20	30.8
Dormitory 2	10.8	20	30.8
Bedrooms (22 Nos)	4.7	9	13.7

Total Septic Tank Capacity - 330 cu.m
Treated Water Tank Calculation
Sewage = 0.8 × 182 = 146 kL ,Treated reuse = ~73 kL

Total Water Demand - 1,11,645 L (≈ 112 kL) + Passenger peak demand = 70 kL , Total = 273 kL
Overhead tank = 91 kL

Underground Tank Capacity
UG Tank = 1.5 × Daily Demand
1.5 × 112 kL = 168 kL (≈ 170 kL)
Tank Size: 10 m × 7 m × 2.5 m

Water Demand Capacity

Assumptions (NBC)
Waiting areas → 1 person / 1.5 sq.m → 15 L/person/day
Food court → 1 person / 1.2 sq.m → 45 L/person/day
Dormitories / Bedrooms → 135 L/person/day

Space	Occupant Load	Consumption / Person / Day	Total Water Demand	Overhead Tank Capacity (50%)	Tank Size
Waiting Halls (500 sq.m)	333	15 L	4,995 L	2,500 L	2 x 2 x 0.8 m
Food Court (1965 sq.m)	1638	45 L	73,710 L	36,800 L	6 x 4 x 1.6 m
Dormitory 1	100	135 L	13,500 L	6,750 L	3 x 2.5 x 1 m
Dormitory 2	100	135 L	13,500 L	6,750 L	3 x 2.5 x 1 m
Bedrooms (22 Nos)	44	135 L	5,940 L	3,000 L	2.5 x 2 x 0.8 m

Rainwater Harvesting Tank Calculation
RWH Tank Capacity = Site Coverage × 50 L = 350 kL

- UG Domestic Water Tank
- OH Domestic Water Tank
- Pump Room
- RWH Tank
- Fresh Water Line(UG to OH)
- Fresh Water Line(OH to Toilets/wash/etc.)
- Rainwater Line
- STP
- Treated Water Tank
- Septic Tank
- Toilet to Septic Tank
- septic Tank to STP

MECHANICAL

- AHU
- Rooftop Chiller Unit

HVAC COOLING LOAD CALCULATIONS

Space Type — Cooling Load Criteria (Thumb Rule)

Waiting Areas → 1 TR / 12 sq.m
Food Court → 1 TR / 10 sq.m
Dormitories → 1 TR / 14 sq.m

COOLING LOAD CALCULATION

Space	Area (sq.m)	Cooling Factor	Load (TR)
Waiting Hall (5 Nos)	500	12	42
Food Court	1965	10	197
Dormitory 1	717	14	51
Dormitory 2	717	14	51

TOTAL COOLING LOAD

Total Cooling Load
Total calculated load: 341 TR
Safety factor (15%): 51 TR
Total design load: 392 TR (≈ 390 TR)

PROPOSED HVAC SYSTEM

Waiting Halls	50 TR Air-Cooled Chiller + AHUs
Food Court	2 × 100 TR Air-Cooled Chillers + Dedicated AHUs
Dormitories	2 × 50 TR Air-Cooled Chillers + AHUs

TIRUPATI INTEGRATED BUS TRANSIT TERMINAL

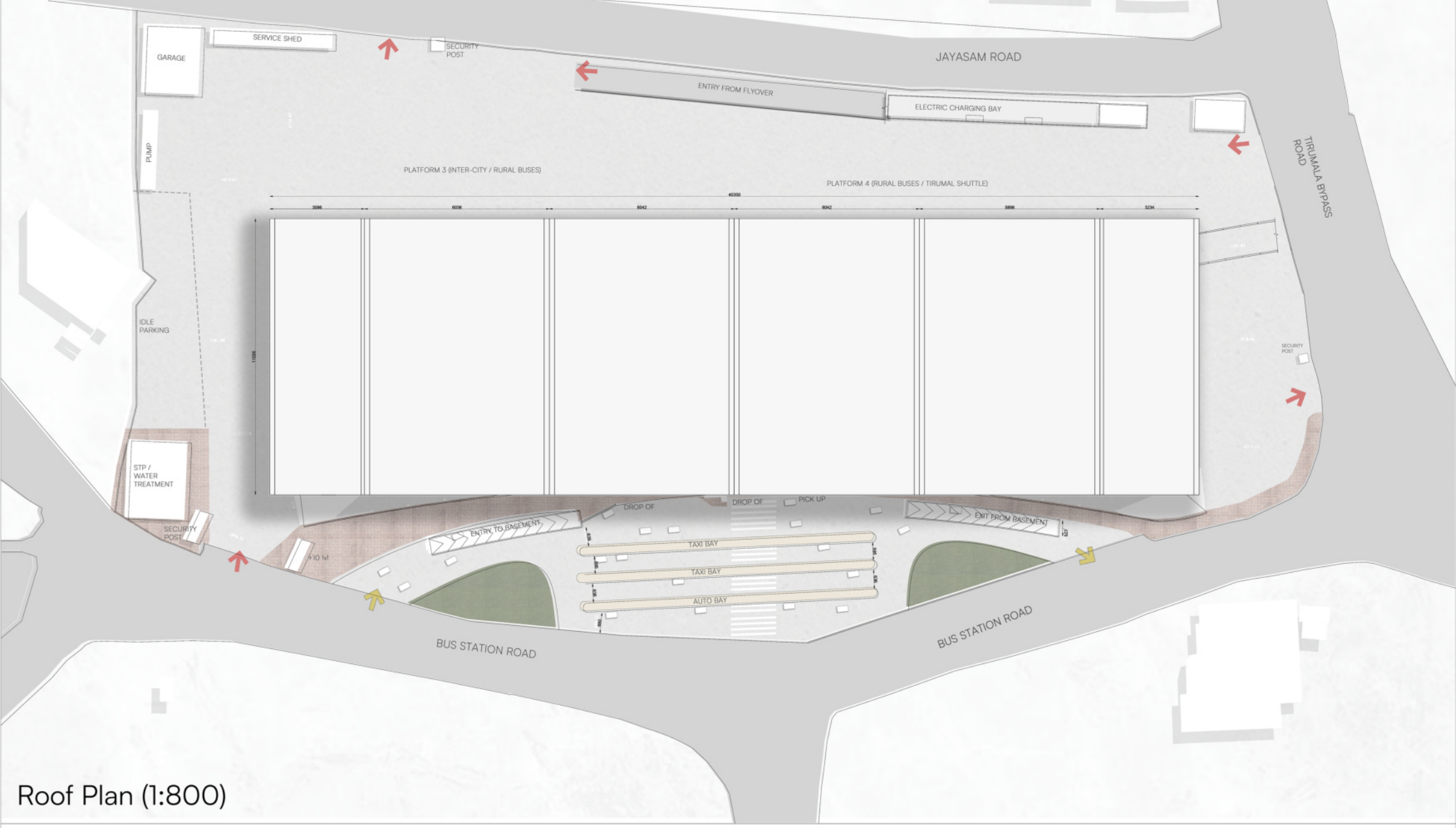
ARJUN KODOOR KRISHNADAS

Tirupati ⟶ BUS TERMINUS

L N Q R 4 5 22:00 – PG NO

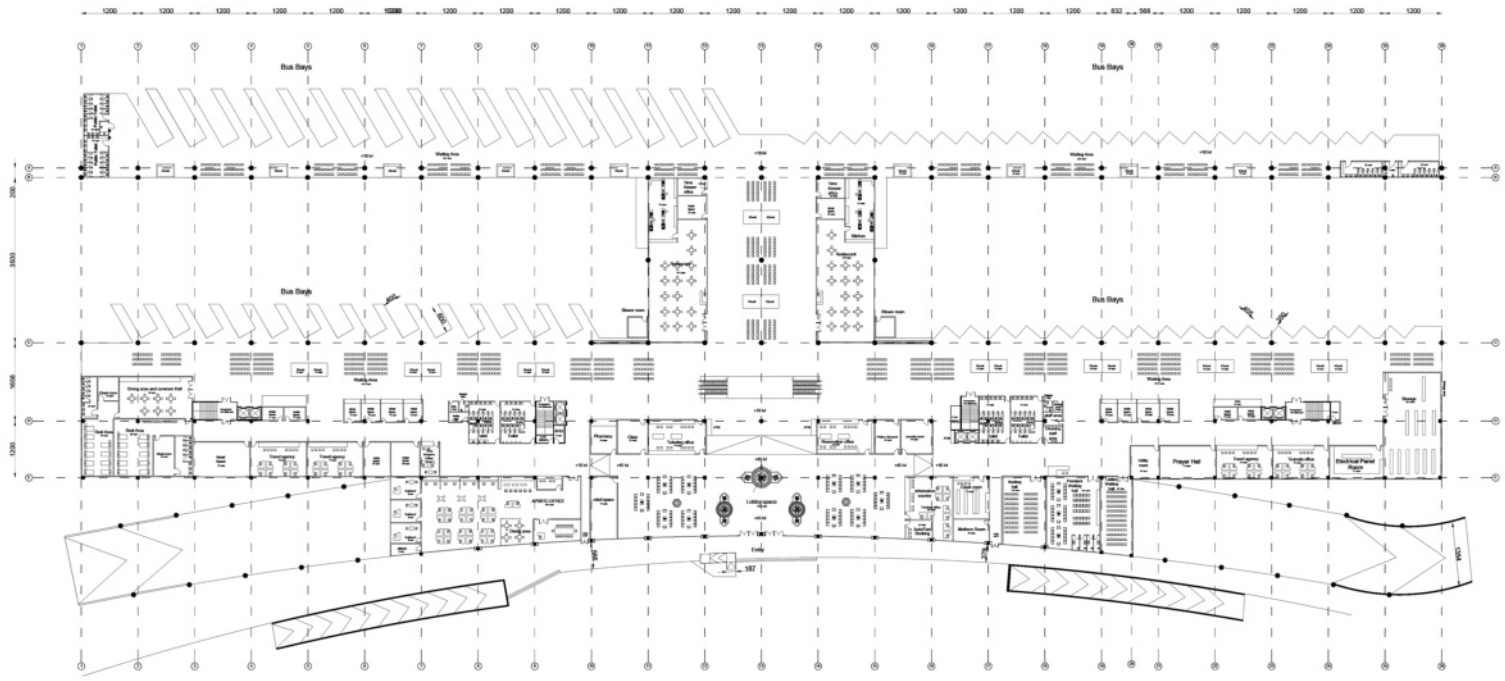
SERVICE PLAN

NOTE: ALL DIMENSIONS ARE IN CM

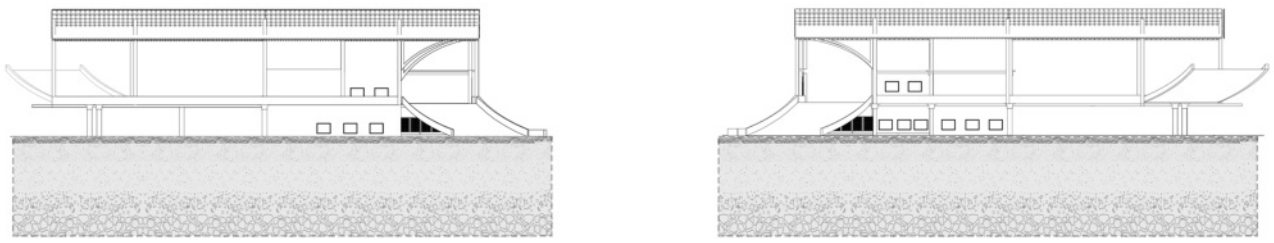


Roof Plan (1:800)

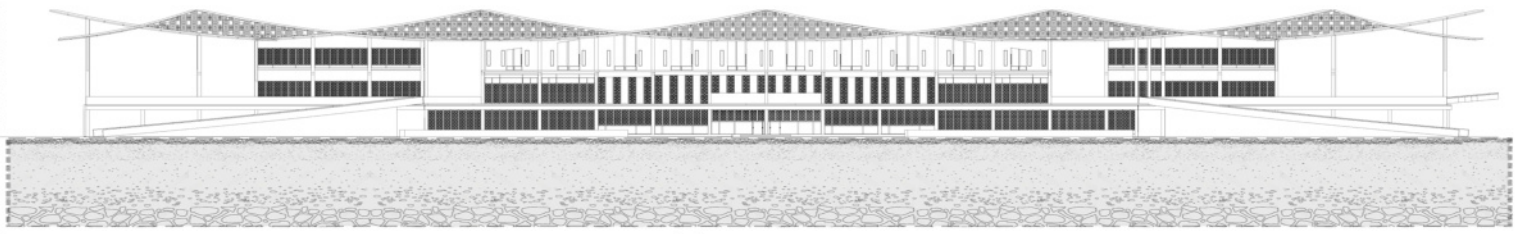
Column Layout (1:800)



Elevations (1:800)



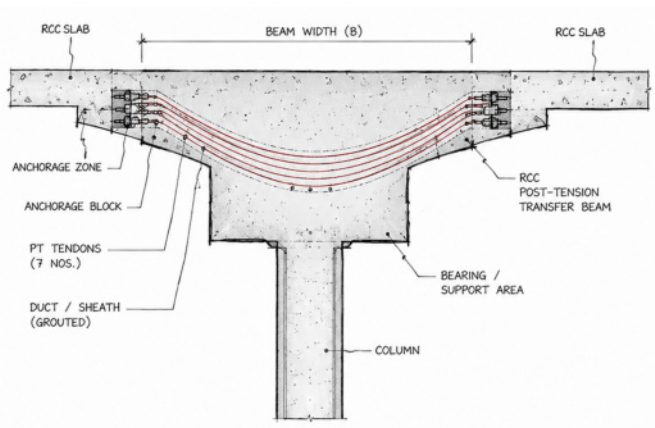
Side



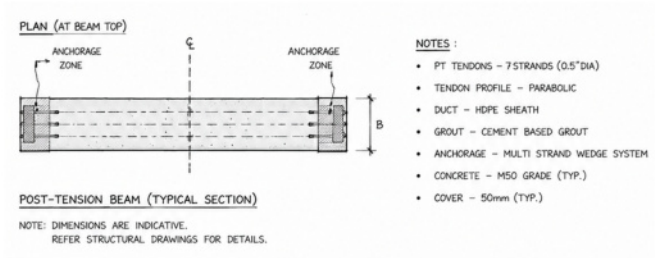
Front

The Tirupati Integrated Bus Terminal is envisioned as a contemporary transit hub that blends functionality with regional identity. Inspired by the rhythmic forms of traditional South Indian architecture, the design features a flowing roofscape, warm material palette, and open, naturally lit spaces that enhance passenger comfort and movement. Positioned as a multi-modal transport node, the terminal integrates efficient circulation, elevated connectivity, and public-friendly infrastructure while creating a strong architectural landmark for the city of Tirupati.

Post tension Beams



A post-tensioned transfer beam system has been adopted for the Tirupati Multi-Tier Bus Terminal to efficiently achieve the required 35-meter span while accommodating bus movement on both the ground floor and first-floor deck. The system minimizes the need for intermediate columns, creating large unobstructed spaces that improve vehicular circulation, passenger movement, and operational flexibility within the terminal. Compared to conventional RCC beams, post-tensioning enables a structurally efficient and slender beam profile capable of carrying heavy dynamic bus loads with reduced deflection and cracking. The parabolic tendon arrangement enhances load distribution across the long span, making the structure suitable for high-capacity transport infrastructure while supporting the project's vision of a modern, efficient, and future-ready intermodal transit hub for Tirupati.



TIRUPATI INTEGRATED BUS TRANSIT TERMINAL

ARJUN KODOOR KRISHNADAS

Tirupati ⟶ BUS TERMINUS

ROOF PLAN , ELEVATIONS , DETAILS

L N Q R 4 5 23:00 – PG NO

NOTE: ALL DIMENSIONS ARE IN CM