



CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

1.1.1 Kerala is considered the “Gateway of South India”. This is one of the states of India attracting large number of tourists’ and having the highest literacy rate among all the states of India. The map of the Kerala State is put up at Fig. No. 1.1. State is Located between north latitudes 8 degree 18’ and 12 degree 48’ and east longitudes 74 degree 52’ and 72 degree 22’. This land of eternal beauty encompasses 1.18 per cent of the country.

Kerala is a union state located in the southwestern part of India. With an Arabian sea coastline on the west, it is bordered on the north by Karnataka and by Tamil Nadu on the south and east. Kerala extends over an area of 38,863 sq. km. It has a total coastline of 580 km. Its width varies from 120 kilometers at its maximum and just 30 kilometers at its minimum. The Land is Divided into

- Highlands
- Midlands
- Lowlands

The Highlands accounts for 48 percent of the total land area of Kerala.

The Midlands lie between the mountains and the lowlands.

Lowlands are known as the Coastal Area. This area is very fertile and most of the paddy cultivation is along this area. *Kuttanad* region of Kerala is one of the very few places in India where cultivation is done below sea level. Major cities are Thiruvananthapuram (the capital), Kochi, and Kozhikode. The principal spoken language is Malayalam but many other languages are also spoken.

Kerala has 44 rivers of which 41 are flowing to west and three flow to east. Kerala has large no of lakes and back waters. Vembanadu lake with area of 260 sq.km is the largest in the state. Shastankotta lake is the largest natural fresh water lake.

- 1.1.2 Kerala is mentioned in the ancient epic Mahabharata (800 BC) at several instances as a tribe, as a region and as a kingdom. The first written mention of Kerala is seen in a 3rd-century-BC rock inscription by emperor Asoka the Great, where it is mentioned as *Keralaputra*. This region formed part of ancient Tamilakam and was ruled by the Cheras. They had extensive trade relations with the Greeks, Romans and Arabs. In the 1st century AD Jewish immigrants arrived, and it is believed that St. Thomas the Apostle visited Kerala in the same century. The Chera Kingdom and later the feudal Nair and Namboothiri Brahmin city-states became major powers in the region. Early contact with Europeans later gave way to struggles between colonial and native interests. The States Reorganisation Act of 1 November 1956 elevated Kerala to statehood.
- 1.1.3 The culture of Kerala has persisted through the ages precisely for the reasons of antiquity, unity, continuity and universality of its nature. In its widest sense it embraces the highest achievements of the human spirit in every sphere of life. Thus, in its totality, it represents the quintessence of the collective achievements of people in the fields of religion and philosophy, language and literature, art and architecture, education and learning and economic and social organisation. In fact, all through its history the genius of Kerala has blossomed forth in all its vigour and vitality and has helped its people to reach the peak of excellence in all their endeavours.
- 1.1.4 Kerala is located on the western coast of south-western India. The biodiversity of Kerala is protected by the Agasthyamalai Biosphere Reserve of the eastern hills. One fourth of India's 10,000 plant species along with 900 species of different medicinal plants could be found in National Parks & Wildlife Sanctuaries in Kerala. The 9,400 sq km space that is covered by the forest here in Kerala comprises of the tropical wet evergreen and semi-evergreen forests, tropical moist and dry deciduous forests, and montane subtropical and temperate forests. The other types of flora that can be noticed at National Parks & Wildlife Sanctuaries in Kerala includes the bamboo, wild black pepper (*Piper nigrum*), wild cardamom, the calamus

rattan palm (Calamus rotang - a type of climbing palm), and aromatic vetiver grass (Vetiveria zizanioides)

- 1.1.5 Kerala has been attracting huge investments in the past few years in various sectors. Kerala has achieved a superior position through its “Kerala model of development” with its high human development index, influential and widely used indices to measure human development across countries. This represents the state's achievement of significant improvements in material conditions of living, reflected in indicators of social development that are comparable to that of many developed countries. But the growth of infrastructure in the transport sector doesn't seem to be in pace with the investment, leads to imbalance in the system which seek more focus in that sector.

Kerala Government has taken initiative to carry out a pre-feasibility study for 550-km high-speed rail corridor linking Thiruvananthapuram and Kasaragod. The Delhi Metro Rail Corporation (DMRC) has been engaged by the State Government to examine the viability of having a high speed rail in the state by estimating the possible ridership while establishing the other technical components.

1.2 KERALA DEMOGRAPHY

1.2.1 Kerala population and Census

Census 2001 put Kerala's population at 318.4 lakhs persons which included 154.7 lakh males and 163.7 lakh females. Although Kerala accounts for only 1 per cent of the total area of India, it contains about 3 per cent of the country's population. The population density of the state is about 819 people per square kilometres, three times the national average. Kerala is one of the densest States in the country and it recorded a decadal population growth of + 9.42% (2,740,101 persons). Kerala, with a sex-ratio (females per 1000 males) of 1058, is the only state in India with a positive figure. In the human development and related indices it occupies prime position among the Indian States. The provisional population of Kerala in 2011 is 33387677, with a sex-ratio (females per 1000 males) of 1084, population density of the state is about 819 people per square kilometres.

1.2.2 Decadal Growth of Population

An analysis of the decadal growth of all India population shows that it increased from 1921 to 1971 and since then it started declining gradually. In Kerala the decadal growth rate had been higher rate from 1941 to 1971 and since then growth rate has been declining. The details of decadal growth rate of population at all India and Kerala from 1901 to 2001 are given below Table 1.1 shows decadal growth rates of urban and rural population.

Table 1.1

Basis Year	All India				Kerala			
	Rural	Urban	Total	Decadal growth Rate(%)	Rural	Urban	Total	Decadal growth Rate(%)
1	2	3	4	5	6	7	8	9
1901	125.40	258.50	383.90	-	9.40	4.50	3.90	-
1911	261.40	259.40	520.90	5.75	6.20	5.30	5.50	11.75
1921	232.30	280.90	513.20	-0.31	1.20	5.80	8.0	9.16
1931	455.20	334.60	729.80	11.0	5.90	9.20	5.10	21.85
1941	745.10	441.50	1186.60	14.22	8.30	12.0	10.30	16.04
1951	986.50	624.40	1610.90	13.31	7.20	8.30	7.50	22.82
1961	1302.90	789.40	2092.30	21.64	13.50	5.50	9.0	24.76
1971	1890.50	1091.10	2981.60	24.80	18.80	4.70	13.50	26.69
1981	2238.70	1594.60	3833.30	24.66	16.80	7.70	14.50	19.24
1991	2286.90	176.10	4463.0	23.86	4.10	6.80	10.90	14.32
2001	4116.60	853.60	4970.20	21.34	5.70	2.70	8.40	9.42

1.2.3 Annual Population Growth Rate

The average annual growth in population of Kerala during 1992 to 2001 was 0.91% as against the average annual growth rate of 1.93% in India. In addition to achievements, such as low infant mortality rate and high life expectancy the population growth rate in the State remains lowest in the country.

1.2.4 District wise Population of Kerala State

The District wise population of Kerala state as per census 2001 is given in table 1.2

Table 1.2

District	Population	Males	Females
Thiruvananthapuram	3234356	1569917	1664439
Kollam	2585208	1249621	1335587
Alappuzha	2109160	1014529	1094631
Pathanamthitta	1234016	589398	644618
Kottayam	1953646	964926	988720
Idukki	1129221	566682	562539
Ernakulam	3105798	1538397	1567401
Thrissur	2974232	1422052	1552180
Palakkad	2617482	1266985	1350497
Kozhikode	2879131	1399358	1479773
Wayanad	780619	391273	389346
Malappuram	3625471	1754576	1870895
Kannur	2408956	1152817	1256139
Kasargod	1204078	588083	615995
Total	31,841,374	15,468,614	16,372,760

Malappuram is the most populated district and has a population of 3625471 persons. Second comes Thiruvananthapuram with a population of 3234356 persons followed by Ernakulam with 3105798 persons. Wayanad is the least populated district followed by Idukki and Kasargod.

Whereas, Alappuzha with a population density of 1496 persons per sq.km is the most densely populated district in Kerala followed by Thiruvananthapuram with 1476 persons per sq.km and Kozhikode with 1228 persons per sq.km. Idukki with a density of just 252 persons per sq.km is the least densely populated district followed by Wayanad with a density of 369 persons. The average density of population of the state is 819 persons per sq.km.

1.3 KERALA TRANSPORT

Kerala has 145,704 kilometers of roads (4.2% of India's total). There is about 4.62 kilometers of road per thousand population, compared to an all India average of 2.59 kilometers. Most Kerala's villages are connected by road. Traffic in Kerala has been growing at a rate of 10–12% every year, resulting in high traffic and pressure on the roads. Kerala's road density is nearly four times the national average, reflecting the state's high population density.

Three major international airports at Thiruvananthapuram, Kochi, and Kozhikode, link the state with the rest of the nation and the world. A new international airport is coming up at Kannur. The Cochin International Airport at Kochi is the first international airport in India that was built without Central Government funds, and is also the country's first publicly owned airport. The backwaters traversing are also an important mode of inland navigation. The Indian Railways' Southern Railway line runs throughout the state, connecting all major towns and cities except those in the highland districts of Idukki and Wayanad. About ¼th of Kerala population lives in urban areas

1.3.1 National highway in Kerala

National Highways form the prime arterial routes and span about 66,590 km throughout the country and cater to 45 percent of the total road transport demand. The National Highway network in Kerala is of the length of 1523.954 kms. This is only 2.3% of total National Highways in the country. There are eight National Highways in the State

1.3.2 State road network

On the road front, traffic has been growing at a rate of about 11 percent every year, resulting in excessive pressure on the roads in the state. The total road length in Kerala during 2006-07 increased to 162149 km from 160944 km in the previous year, Road density in the state is 417 km/100 sq.km and it is far ahead of national average of 100.39 km/100 sq.km. The length of road per lakh population is 509.23 km and it is much higher than the national average of 321.3 km. Growth of road and Rail is given in the table No. 1.3.

Table 1.3 Growth of Road and Transport sector

	Unit	1980	1985	1991	1996	2001	2004
Road length (PWD)	kms	17408	19107	20237	22863	21508	2299
Road length (PWD) per sq. km	kms	0.45	0.51	0.52	0.57	0.55	0.59
Road length (panchayats)	kms	66158	81515	99022	106920	87094	9897
Motor vehicles	Nos.	174704	319259	647742	1170241	211188	2792
Motor vehicles per 100 sq km	kms	450	821	1667	3011	5434	7184
Railway route length	kms	916	914	998	1198	1198	1198

1.3.3 Railway Lines in Kerala

The history of Railway line started in Kerala with the commissioning of first Railway line between Tirur and Beypore (port) on the Malabar coast on 12-03-1861. Further it was extended from Tirur to Kultiapuram on 01/5/1861 and Kuttipuram to Pattambi – 23/09/1861. The further development of the Railways in the state took place on the dates as mentioned in table 1.4.

Table 1.4

S.	Section	Date of Commissioning	Remarks
1.	Pattambi – Podanur	14/04/1862	Provided direct connection to Madras
2.	Kodalundy to Calicut (Kozhikode)	2/1/1888	
3.	Calicut to Mangalore in Stages	From 1/10/1901 to	

		3/7/1907.	
4.	Shoranur Ernakulam MG line	16/07/1902	Converted to BG in 1934
5.	Tirunalveli – Quilon (Kollam)	1/03/1904	
6.	(Kollam) Quilon – Trivandrum	4/11/1931	
7.	Ernakulam – Kottayam MG	17/10/1956	
8.	Kottayam to Quilon	6/1/1958	
9.	Ernakulam to Trivandrum		Converted to BG on 13.9.1976

There are 200 Railway stations in Kerala . This extensive network connects places both within and outside the state of Kerala . Local train services and long distance express trains ply all over the state making it a convenient and quick method of transport. Long distance trains connect the state to major Indian cities like Kolkata, Coimbatore, Chennai, Hyderabad , Mumbai, and New-Delhi. They also connect Jammu and Kashmir and the North- East. The entire length of the rail route is around 1050 kms and covers 13 Railway routes within its fold. Broad gauge lines measure up to 933 kms while meter gauge lines cover 117kms.



Fig. 1.1

From the Early day's Railway development itself, it can be seen that the Malabar Coast and areas centered around Ernakulam played a very vital role in the development of the area. The Coastal area between Cannanore to Alleppey is well developed and full of habitation all along the under mentioned Railway lines but with no effective Rail based mass transportation system.

Ernakulam – Shornur is Double line Electrified

Ernakulam – Alleppey (Alappuzha) is Single line Electrified

Ernakulam – Kottayam is Single line Electrified and Double line Electrified line work expected to be completed in 3 years.

Shoranur – Kannur is Double line non Electrified.

Hence the Kerala Government felt the need of providing the suburban rail services on the existing Railway tracks..

Considering the above, Government of Kerala vide their G.O. No. 163/2007//Tran dated 10.5.2007, entrusted the Feasibility Study for introduction of Suburban Services for Ernakulam and Kozhikode cities, to Delhi Metro rail Corporation (DMRC). The copy of the order is put up as annexure 1.1 to this chapter. This study was mainly for the rail network to be used as suburban. However, the Kerala Government felt that there is need to provide the fast Rail connection for the public of Kerala and tourist coming from other part of India and abroad.

A rail based mass rapid transport system is preferred over the road based for the following regions.

1. Rail system being more energy efficient
2. More economical in land use
3. Damage to environment is much lesser than the road traffic
4. High carrying capacity
5. Quick conveyance
6. More comfortable and safe
7. Journey much cheaper than road

Therefore, it is always desirable to take advantage of existing rail system and make use of the existing line capacity to provide the comfortable journey to the public but it may be only for normal trains. The High speed trains need the dedicated tracks with upgraded track parameters and different technology.

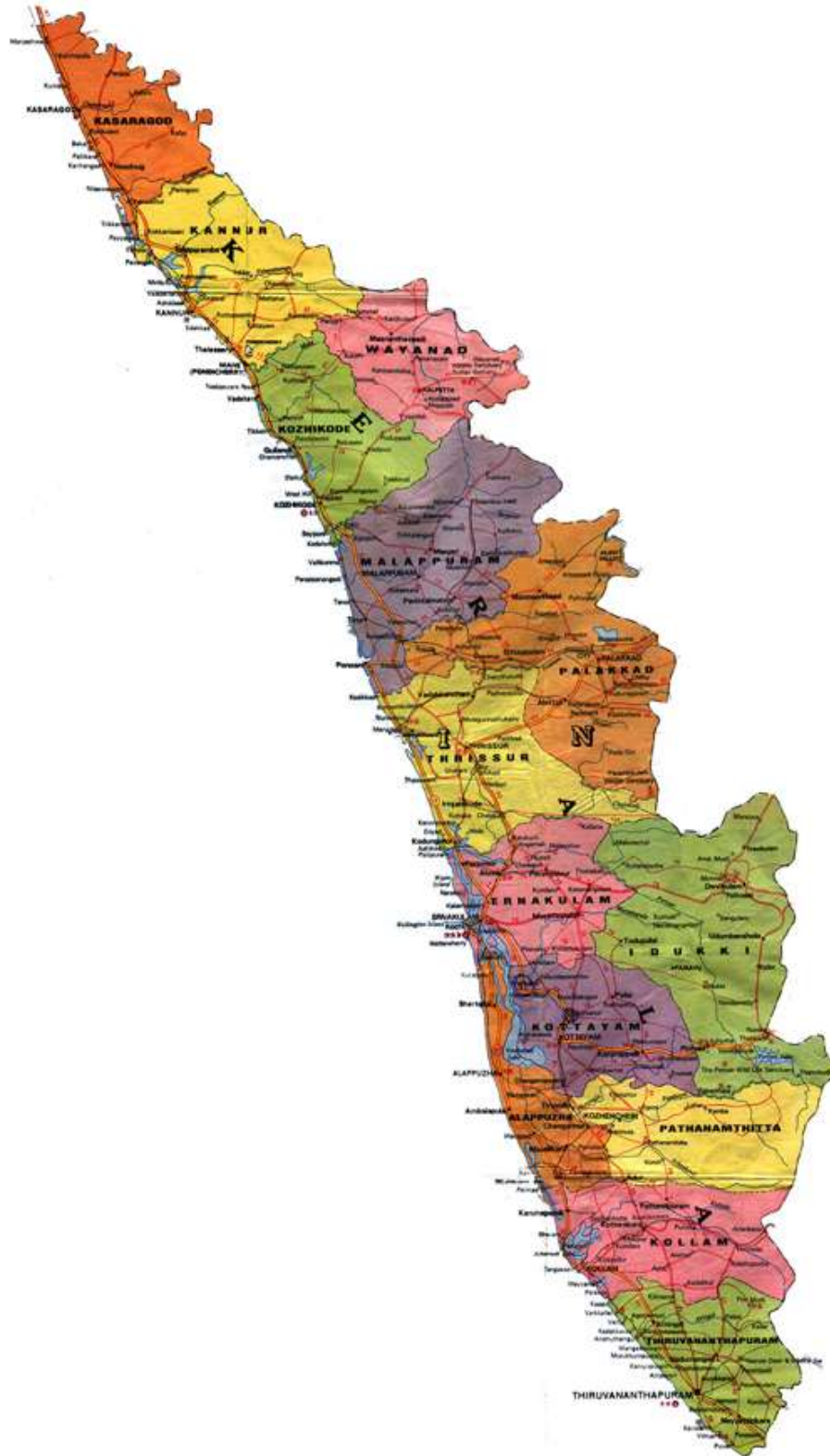


Fig. 1.2 The map of Kerala State with District details

The state has three major international airports at Thiruvananthapuram, Cochin, and Kozhikode, that link the state with the rest of the nation and the world. A fourth international airport is proposed at Kannur. The share of air trips for the intercity travel is negligible. Even though the rail is connected from North to south with stations at all major towns, the frequency of the long distance fast commuting train service is very less. This made the priority of mode more towards the private mode i.e. four wheeler and bus.

Traffic in Kerala has been growing at a rate of 10–11% every year, resulting in high traffic and pressure on the roads resulting in increased travel time for the users. Kerala's annual total of road accidents is among the Nation's highest. Widening of the National Highways is still not accomplished due to Resettlement and Rehabilitation issues.

An efficient transport network is vital to a strong economy - locally, regionally and nationally - by providing high quality access to labour, suppliers and customers. It is very important that substantial investment is needed to improve the existing network, focusing on road transport, on heavy rail and public transport and airports. Here the present effort is to establish the viability of a high speed rail link proposed between Southern end of the Kerala state i.e. Thiruvananthapuram to the Northern end of the Kerala state i.e. Kasargod. The analytical challenges are the higher dependence on the present travel pattern and the attractiveness of the proposed mode against many factors like travel time, cost, connectivity, land use of the access points, comfort etc.

This situation doesn't warrant for a comfortable ride by road due to its capacity constraint, congestion and ultimately the riding quality and safety. In this background, Kerala Government has taken initiative to carry out a pre-feasibility study for 550-km high-speed rail corridor linking Thiruvananthapuram and Kasaragod.

High Speed Rail (HSR) is a new rail technology which allows trains to run at a speed of 200-350 kilometers per hour much higher than the conventional rail. This railway technology is particularly popular in the European Union. Specific definitions by the European Union include 200 km/h for upgraded track and 250 km/h or faster for new track.

Investing in HSR is on the front line of action to revitalize the railways. The ultimate objective is to provide infrastructure for the public to change modal split in favor of passenger transport with the aim of reducing congestion, accidents and environmental impacts.

Prima facie, the need for HSR depends on the existing volume of inter city traffic where the new lines are proposed, the likely time savings, generated traffic, willingness to pay of potential users, and release of capacity in congested roads, airports or conventional rail lines.

1.4 Economic Benefits of High-speed rail

High speed trains require dedicated track at a cost substantially higher than the conventional rail line. Infrastructure maintenance cost is comparable with conventional rail but the building costs and the acquisition, operation and maintenance costs of specific rolling stock make this transport alternative an expensive option.

HSR infrastructure is associated with lower total travel time, higher comfort and reliability, reduction in the probability of accident, and in some cases the release of extra capacity which helps to alleviate congestion in other modes of transport. HSR investment reduces the net environmental impact of transport and boosts regional development. The following table briefs the possible benefits that can be accrued by having high speed rail.

Goal	Benefits of HSR
Economic efficiency	lower energy consumption per passenger kilometer reduced land usage for a given capacity compared to motorways reduction in travel time It would be a high quality system with seated accommodation of good comfort
Environment	Displaced usage from more environmentally damaging modes of transport
Regional development	Integrated development of region and allow the commuters to move across the region efficiently
Safety	high-speed rail has the added advantage of being much simpler to control due to its predictable course, even at very high passenger loads high speed rail systems reduce the possibility of collisions with automobiles or people, while lower speed rail systems used by high speed trains may have level crossings.

	Reduces the accidents
Weather	If the rail system is well-designed and well-operated, severe weather conditions such as heavy snow, heavy fog, and storms do not affect the journeys; whereas flights are generally canceled or delayed under these conditions. Nevertheless, snow and wind can cause some disturbances
Comfort	Train passengers can have the choice between standing or waiting for a bookable connection. Easy for passengers to move around during the journey
Number of stations	Stopping pattern can allow a multitude of possible journeys, increasing the potential market

1.5 OBJECTIVE OF THE STUDY

The objective of the Detailed Feasibility Study is to assess the transport demand forecast of various rail corridors in the study area and formulation of improvement measures on the railway routes for enabling to run the High Speed train.

The proposed corridor starts at Trivandrum in Kerala state and ends at Mangalore in Karnataka with nine major stations initially and three more stations adding in the future. Trains will run at an average speed of about 300 KMPH with nine stations proposed in the first phase including Thiruvananthapuram, Kollam, Kottayam, Ernakulam, Thrissur, Calicut, Kannur Kasaragod and Mangalore. Three more stations are planned in the next phase at Chengannur, Tirur and Thalassery. The proposal for the consent of Karnataka Government for connecting the High Speed route to Mangalore covering about 50 Kms. distance in Karnataka State has been sent to GoK and being pursued.

The scope of the assignment is to examine technical and financial feasibility of the proposed High Speed Rail Corridors connecting between Thiruvananthapuram to Kasaragod will include the following.

i. Transport Demand Forecast

The traffic study will comprise the following tasks:

- Origin – Destination Survey and Opinion Survey of rail passengers will be conducted at major Railway Stations
- Classified road traffic volume count will be carried out at selected locations to capture traffic flows.
- Origin - Destination studies will be carried out by Road Side Interview (RSI) Survey Method at the selected locations. . The O-D survey for buses will also be done separately.
- The average speed to commute both by rail as well as by road to various O-D pairs (public transport as well as by personalised mode) shall be accessed through preliminary data and secondary data.
- The Opinion Survey will be conducted along with O-D Survey to assess the preference of mode.
- The traffic growth rates will be estimated.
- The divertible traffic will be estimated to assess the rail share.
- The traffic load on proposed corridor will be assessed for different horizon years.

ii. Engineering Study

- Reconnaissance survey will be conducted and the preliminary alignment will be marked on Topographical Maps published by Survey of India, after ascertaining all possible options.
- An on-site alignment review will be carried out at important locations e.g. locations where the proposed alignment is likely to cross the existing major roads, rivers and streams, forest areas and other major land marks.
- The configuration of the route alignment indicating the extent of Underground/Elevated/At Grade portions will be suggested. Suitable locations for the mother car depot and secondary depot will be identified.
- The study shall identify station locations and the inter change points with the existing rail network.

- Consultant shall study the implications of adopting 250 kmph and 300 kmph for the proposed corridors and recommend the optimum speed to be adopted, by consulting foreign consultants as high speed rail is planning for the first time in the country.
- The number of receiving substations, their locations and capacity will be indicated along with the power requirements for the system.
- The land requirement and the affected properties requiring R & R will be indentified.

The proposed route alignment shall be presented to the Client/Govt of Kerala, before finalizing the draft pre-feasibility report.

iii. Rail System Selection

- Recommendations regarding selection of system parameters / technology will be made:
- Planning parameters such as ruling gradient, maximum degree of curvature, type and length of transition curves, maximum cant, maximum cant deficiency etc.
- Track Structure and types of turnouts
- Type of Traction System
- Type of S & T System
- Type of Rolling Stock
- Philosophy of Train operations

iv. Costing and Financial Analysis

- Abstract project cost will be worked out
 - The approximate Operations and the Maintenance costs will be assessed.
 - The financial analysis will be carried out to assess financial viability of the project.
- v. Implementation plan/strategy along with institutional arrangement and legal cover will be recommended.
- vi. Possible funding options will be indicated with the recommendations of consultant on how the project is to be funded

The proposed stations on High Speed Rail Connection are shown in Fig. 1.3



Fig. 1.3